Katolight Corporation

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Katolight University - Gen II Training - Rev:06-01-06

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Installation Manual

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Install_Manual_KL_03-06

CALIFORNIA PROPOSITION 65

WARNING

ENGINE EXHAUST FROM THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS, AND OTHER REPRODUCTIVE HARM.

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Product Identification Information

Locate and record numbers in the spaces below immediately after unpacking your generator set. This ensures that the numbers are readily available for future reference.

Model Designation: _____

Serial Number: _____

How to Read Katolight Model Numbers

Katolight's model numbering format is composed of six sections:

1. Prefix
2. First number group
3. First letter
4. Second letter
5. Third letter
6. Last number

Forward

This Installation Guide provides general instructions for installing your Katolight generator set properly. It is essential that every person who works on or with the generator set be completely familiar with the contents of this manual, and that he/she carefully follows the instructions contained herein.

Each installation may require some modification of the suggested guidelines in this manual. Installations must be consistent with locally applicable standards and take into consideration safety guidelines and measures.

Following this guide will result in an efficient and reliable installation. Carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions section at the beginning of this manual.

IMPORTANT

Information in this publication represents data available at the time of print. Katolight reserves the right to change this publication and the products represented without notice and without any obligation or liability whatsoever.

All instructions and diagrams have been checked for accuracy and simplicity of application. However, the skills of the installer are most important. Katolight does not guarantee the result of any installation contained in this manual. Nor can Katolight assume responsibility for any injury or damage to property. Persons engaging in installation do so entirely at their own risk.

Figures and Tables

The following is a list of all figures and tables contained in this manual.

Figure 1-1……Typical generator set installation
Figure 2-1……Lifting provisions
Figure 4-1……Typical pad type vibration
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Figure 4-3……Recommended anchor bolt
Figure 5-1……Typical center top pivoted louver
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Safety Precautions

IMPORTANT SAFETY INSTRUCTIONS

Electromechanical equipment, including generator sets, transfer switches, switchgear, and accessories, can cause bodily harm and pose life-threatening danger when improperly installed, operated, or maintained.

Dangers, Warnings and Cautions are used in this manual to alert the operator to special instructions concerning a particular procedure that may be hazardous if performed incorrectly. These safety alerts alone can not eliminate the hazards that they signal. Strict compliance to these special instructions and common sense operation are major accident prevention measures. Observe all warnings found on the equipment. Ensure that warning labels are legible and not obstructed by dirt, grease or other equipment. Katolight Corporation can not anticipate every possible circumstance that might involve a hazard. The warnings in this manual and on tags and decals affixed to equipment are, therefore, not all inclusive.

DANGER

Danger indicates the presence of a hazard that will cause severe personal injury, death, or substantial property damage.

WARNING

Warning indicates the presence of a hazard that can cause severe personal injury, death, or substantial property damage.

CAUTION

Caution indicates the presence of a hazard that will or can cause minor personal injury or property damage.

This symbol signifies high voltage.

The following safety rules should be strictly complied with:

ACCIDENTAL STARTING

Be aware that the generator set could start at any time in the "AUTO" mode. Keep clear of all moving parts and be sure to turn switch to the "OFF" position before servicing and disconnect the negative battery cable after disconnecting the battery charger circuit.

BATTERY

For proper unit operation, battery minus (-) terminal must always be connected to ground. Reverse connection of the battery will severely damage or destroy the battery charging alternator, regulator and other polarity sensitive devices.

Wear protective safety eyeglasses and gloves when handling starting batteries and electrolyte. Battery acid can cause serious burns if it contacts eyes or skin.

Servicing of batteries is to be performed or supervised by personnel knowledgeable of batteries and the required precautions. Keep unauthorized personnel away from batteries.

Do not smoke or use an open flame when servicing batteries. Batteries generate an explosive gas during charging.

The replacement starting battery or batteries must be of equal size and cold cranking amps.

The generator controls must be in the off position when replacing the batteries.

Do not dispose of battery or batteries in a fire. The battery is capable of exploding.

Do not open or mutilate the battery. Released electrolyte has been known to be harmful to the skin and eyes and to be toxic.

A battery presents a risk of electrical shock and high short circuit current. The following precautions are to be observed when working on batteries:

1. Remove watches, rings, or other metal objects
2. Use tools with insulated handles

VENTED BATTERIES

The installation of the engine generator shall provide enough ventilation to ensure that gases generated by vented batteries during charging or caused by equipment malfunction are removed.

The electrolyte is a dilute sulfuric acid that is harmful to the skin and eyes. It is electrically conductive and corrosive. The following procedures are to be observed:

1. Wear full eye protection and protective clothing
2. Where electrolyte contacts the skin, wash it off immediately with water

3. Where electrolyte contacts the eyes, flush thoroughly and immediately with water
4. Spilled electrolyte is to be washed down with an acid-neutralizing agent. A common practice is to use a solution of one pound (500 grams) bicarbonate of soda solution to be added until the evidence of reaction (foaming) has ceased. The resulting liquid is to be flushed with water and the area dried.

Lead acid batteries present a risk of fire because they generate hydrogen gas. The following procedures are to be followed:

1. DO NOT SMOKE when near batteries
2. DO NOT cause flame or spark in battery area
3. Discharge static electricity from body before touching batteries by first touching a grounded metal surface

FIRE HAZARD

Keep fire extinguishers in accessible locations. Use appropriate fire extinguishers as recommended by NFPA.

Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage, which present a potential fire hazard.

When an open bottom base is used, the stationary engine generator assembly is to be installed over noncombustible materials. It should be located such that it prevents combustible materials or loose debris from accumulating under or inside the generator set.

Do not service the engine when any ignition source such as an open flame is present. “DANGER” signs must be placed to warn of the fire hazard. No work may be performed on the engine involving an ignition source such as open flames, cutting, welding, or grinding.

A fire extinguisher (dry chemical or carbon dioxide, CO2) must be immediately available to the mechanics while working. When liquefied or natural gas leaks or escapes, it can result in dangerous accumulations of gas, which might cause a serious flash or explosion. Careful ventilation of the area is mandatory in the event of a fuel leak.

EXHAUST SYSTEM

Engine exhaust gases contain DEADLY carbon monoxide gas, which is colorless and odorless. If breathed in sufficient concentrations, this gas can cause severe nausea, fainting, or death. Provide adequate ventilation to prevent buildup of exhaust gases. When the generator is installed inside a room or enclosure, exhaust gases must be piped outdoors. Install the exhaust system so exhaust gas does not leak at joints or piping connections. Make certain that the extended exhaust piping is plumbed properly and that the exhaust is not near an intake ventilator.

Increase the exhaust pipe diameter as necessary to reduce back pressure. Use a minimum number of fittings and elbows to prevent back pressure in the engine exhaust system. Be sure the enclosure has proper ventilation to accommodate the engine cooling system.

FUEL SYSTEM

Gaseous, Natural Gas and Liquid Propane Gas are extremely flammable and vapors are EXPLOSIVE. Comply with all laws regulating the storage and handling of these fuels. Check for leaks frequently and correct such leakage immediately.

Do not fill fuel tanks while the engine is running.

Do not smoke or use open flame at any time when fuel is being handled. Fuel vapors are both toxic and flammable.

Liquid petroleum gas (LPG) systems operate at tank pressures around 100 psi or above. The tank pressures are regulated down. Vaporized LPG systems operate at pressures near 6 oz., as do most natural gas systems.

Safety precautions when handling liquefied petroleum gas cannot be over-emphasized. There are state, county and city codes, and fire regulations covering the handling and storage of liquefied petroleum gas or natural gas. In addition to the safety suggestions in this manual, all local codes and fire regulations on this subject must be followed explicitly. Where local codes are more stringent than the suggestions in this manual, the local codes must be given priority.

Before proceeding with any service, be certain that all switches are in the OFF position, disconnect battery ground cable, remove fuses in DC systems and turn off the battery charger. These safety suggestions apply to service of any engine using liquefied petroleum gas or natural gas fuel regardless of the work to be performed. When servicing the engine, ensure that there is adequate ventilation. This is to avoid the accumulation of gas/air mixtures in and about the engine caused by undetected leaks.

Any service performed on the fuel system requires that:

- All threaded connections are sealed with proper pipe thread compound. Replace defective fittings and reseal all connections.
- Fuel system is checked for leaks. Leaks are not permissible. Odorants, which are strong smelling components (an odor similar to spoiled cabbage), are added to liquefied petroleum gas as a warning agent to indicate the leakage of even small quantities of gas.

- A soap solution applied with a soft brush will bubble to indicate leaks. Never use an open flame to check for leaks. All leaks must be sealed.
- All flexible fuel connections are checked, metallic and neoprene, with the soap solution.

It is important to remember that all gas fuel systems are pressurized. Be certain that the fuel valves are tightly closed and all fuel has been vented before starting any repair work on the fuel system.

HAZARDOUS NOISE

Prolonged unprotected exposure to hazardous noise levels may cause loss of hearing. Never operate the generator set without a muffler or with a faulty exhaust system. Ear protection may be required.

HAZARDOUS VOLTAGE/ELECTRICAL SHOCK

Dangerous voltages are present at power terminals of this equipment. Contact with such terminals will result in extremely dangerous and possibly lethal electric shock. Never allow any unqualified person to install, operate or service the equipment. The standby electric system must be installed, tested, and inspected per the manufacturer's recommendations. All codes, standards, regulations, and laws pertaining to the installation must be strictly complied with.

Accidental contact with electrical equipment can cause severe injury and death if the equipment is not properly grounded. The frame and external electrically conductive parts of this equipment must be properly connected to an approved earth ground, in accordance with applicable electrical codes. A grounding lug is provided on the generator and in other equipment for this purpose.

CAUTION: RISK OF ELECTRIC SHOCK!

The grounded conductor must be bonded to ground in accordance with the National Electrical Code, NFPA 70. The unit shall not be used in floating output applications.

Remove all electrical power before removing protective shields for service or maintenance. Exercise extreme caution when working on or around electrical components. Open or poorly insulated conductors are extremely dangerous during operation. Severe, possibly fatal, shock may result. Make certain that all conductors are properly insulated or guarded, all grounds are made and that the area is dry. Do not tamper with interlocks.

In the event of an accident from electrical shock, shut down the generator set immediately. If the set cannot be shut down, free the victim from contact with a dry nonconductor, avoiding direct contact with victim until free of the

conductor. If the victim is unconscious, apply artificial respiration if qualified and get medical help immediately.

Verify that all power leads and control connections are properly insulated before starting the generator set. Neglecting this may result in extensive damage to equipment and personal injury. This problem arises if the unit is started before electrical installation is completed.

Make certain the area is well ventilated to dissipate any flammable vapors, which may collect from fuels. When servicing any part of the electrical system or making any connections, be sure the main switch is OFF and disconnect battery ground cable or remove fuse in DC system. Turn off the battery charger. Clean or service the generator set only when the engine is shut down. If the unit stops because of an engine safety device, do not attempt to restart until the cause for shutdown has been corrected.

HOT PARTS

The exhaust manifold, turbocharger(s), and extended exhaust piping are HOT when the engine is running. These can remain hot for long periods of time after the engine shuts off. Avoid contact with these parts. Consider insulating the exhaust system if installation is such that unintentional contact with the exhaust system components is likely.

Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.

MOVING PARTS

Moving parts can cause severe personal injury or death. Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.

HANDLING

Do not use lifting devices with marginal capacities when lifting or moving the unit. Observe the center of gravity of the equipment to be lifted and do not allow the generator set to swing if suspended. Make certain the supporting structure is adequate to support the unit. Failure to observe this warning may result in equipment damage and serious or fatal injury.

NOTE

Enclosure doors are factory adjusted for fit and smooth operation. Misalignment can occur during shipment or handling. If this has happened to your enclosure, the doors may be re-adjusted by the following method:

Single Door Unit

- **Slightly loosen the nuts on the inside of the door hinge. If the housing is insulated, the nuts will be behind the foam insulation.**
- **Close door and center in opening. Open the door, being careful not to bump it, and tighten nuts. Re-check door for fit and free movement. If necessary, repeat above steps until proper fit is achieved.**

Double Door Unit

- **Slightly loosen nuts on the inside of both doors. If housing is insulated, the nuts will be behind the foam insulation.**
- **Close the doors and center from top to bottom. Adjust doors side to side leaving approximately 1/8" gap between them. Open the doors, being careful not to bump them, and tighten nuts. Re-check doors for fit and free movement. If necessary, repeat above steps until proper fit is achieved.**

If more adjustment is necessary, the nut/studs that mount the hinges to the enclosure may also be adjusted.

1 General

When installed properly and according to applicable codes, your Katolight generator set will perform safely and reliably. Incorrect installation can cause continuing problems. Figure 1-1 illustrates a typical installation. Your authorized generator set distributor/dealer can provide advice about or assistance with your installation.

This manual references organizations and their codes that govern generator set selection and installation for US installations. Installers must comply with national and local codes when applicable.

NFPA 37……..Stationary Engines and Gas Turbines
NFPA 54……..National Fuel Gas Code
NFPA 70……..National Electric Code®
NFPA 99……..Standard for Health Care Facilities
NFPA 101……Life Safety Code
NFPA 110……Emergency Standby Power Systems
UL-2200……...Stationary Engine Generator Assemblies

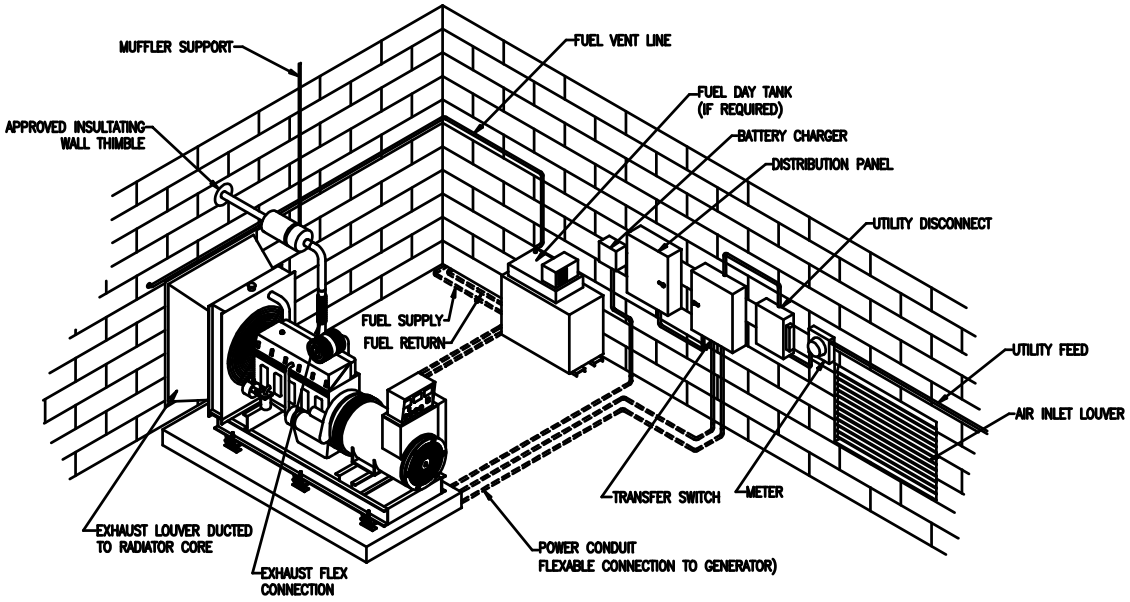


Figure 1-1: Typical generator set installation

2 Lifting Provisions

To ensure personal safety and prevent damage to the product, we strongly recommend the guidelines in Figure 2-1 be observed when lifting Katolight generator sets. Due to the different designs, dimensions and weights of the generator sets, specific instructions for each model are not provided. It is the responsibility of the dealer/distributor to see that generator set lifting is performed within the framework of these guidelines.

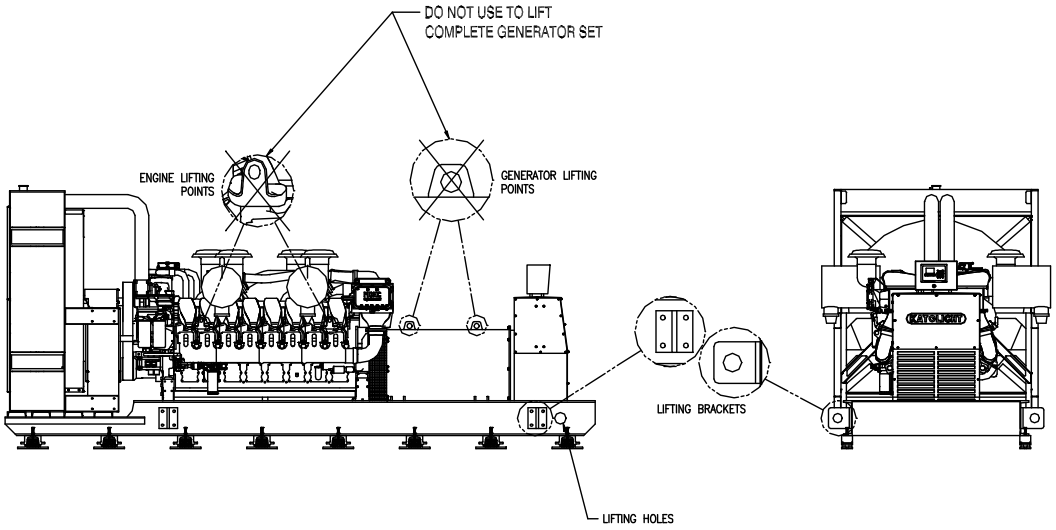


Figure 2-1: Lifting provisions

3 Location

The location of the generator set is influenced by factors such as ventilation, exhaust piping, electrical service, fuel supply and accessibility for maintenance and service.

Before selecting the location for your generator set, consider the following:

- Supporting structure must be adequate for the generator set and accessories. For information on mounting on an inertia pad, see Section 4. For any other set-up, consult a structural engineer for an appropriate design.
- Area should be clean, dry and not subject to flooding
- Ventilation should be available in the area with a minimum amount of duct work
- Exhaust gas must be piped away from the structure and any ventilation intakes. Piping must incorporate large radius, low restriction elbows.
- An adequate supply of fuel should be available at all times to sustain operation
- The main diesel fuel supply should be as close as possible to the unit. If the main fuel tank is installed underground, an auxiliary pump and day tank are necessary to transfer fuel from the main tank to the day tank.
- Vibration should be effectively isolated and dampened to reduce transmission of vibration and prevent fatigue fractures of connected systems.
- Area should provide easy access for maintenance and repair. A minimum clearance of three feet between an installed generator set and adjacent walls or other electrical equipment should be maintained on three sides of the generator set. Clearance of five feet should be maintained at the rear of the generator set to facilitate removal, should it become necessary.
- Applicable fire rating codes and standards must be met
- When an open bottom base is used, the stationary engine generator assembly is to be installed over noncombustible materials. It should be located such that it prevents combustible materials or loose debris from accumulating under or inside the generator set.

Local weather conditions will have a direct influence on location of the unit and the type of accessory equipment required to assure reliable operation. Extreme ambient temperature variations should be avoided. For ambient temperatures below 60 degrees, starting aids such as jacket water heaters and lubricating oil heaters will ensure dependable starting. Anti-condensation or

strip heaters are available for control panels and generators to maintain a temperature above the dew point to prevent condensation of moisture.

Standard Katolight transfer switches located indoors in heated facilities are enclosed in NEMA 1 enclosures. Various other NEMA enclosures may be needed. If the generator set is located outside, heaters are needed below 32 degrees Fahrenheit.

Consider preventive maintenance issues when selecting a generator set location. See Section 9 for a list of service points that should be accessible.

4 Mounting

Your Katolight generator set should be installed in a location that is able to support the weight of the unit and accessories, resist dynamic loading, and does not transmit generator noise and vibration. See Section 3 for detailed information on selecting a location for your generator set.

WEIGHT

The weight of the generator set and accessories will determine the type and design of the support structure. Generator set weight can be found in the specification sheet for your particular model. Be sure that the weight of accessory items and fuel (if a sub-base tank is used) are added to the total requirements.

INERTIA PAD/BASE

Your generator set must be mounted on a substantial inertia pad or base. The composition of the inertia pad should follow standard practice for the required loading. Common specifications call for 2500 psi concrete reinforced with eight-gage wire mesh or number 6 reinforcing bars on 12-inch (30-cm) centers.

To determine the depth of the inertia pad, the following formula can be used:

BASE DEPTH =	Wu / d * w * l

Where Wu = engine-generator set weight in pounds
d = concrete density (usually 145 lbs per cubic foot)
w = foundation width in feet
l = foundation length in feet

The inertia pad should be a minimum of twelve inches wider and twelve inches longer than the unit base. The inertia pad may be constructed higher than the floor level by three to eight inches for ease of maintenance.

To reduce the amount of unit vibration transmitted, you must isolate your inertia pad from the foundation. One method for isolating the inertia pad from the foundation is to use eight to ten inches of wet gravel or sand as a bed in the inertia pad pit. For other methods, consult a qualified structural engineer.

To allow settlement of the inertia pad from the foundation, expansion joints should be incorporated between the inertia pad and the foundation.

VIBRATION ISOLATION

Vibration is a normal by-product of the operation of any generator set. Vibration transmitted to surrounding areas will increase the noise level and if severe, can cause structural damage. To minimize this risk, all generator sets should have vibration isolation between the generator base and inertia pad.

All fuel, coolant, exhaust and electrical connections must have flexible sections to isolate vibration. Leaks or fractures can develop rapidly without vibration isolation and there is a danger of eventual total failure.

For generator sets enclosed within a building, where maximum vibration isolation is required, spring mounts provide vibration isolation between the generator base and the structure. Check state and local codes for such requirements.

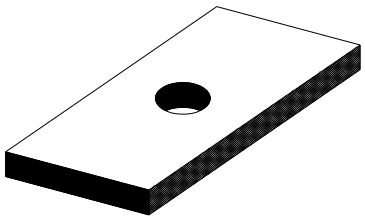


Figure 4-1: Typical pad type vibration

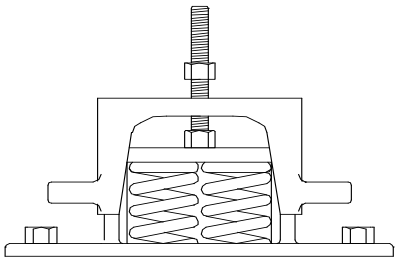


Figure 4-2: Spring mount vibration isolator

Anchor bolts should be loosened and double nutted after installation to avoid base distortion caused by unlevel inertia pads.

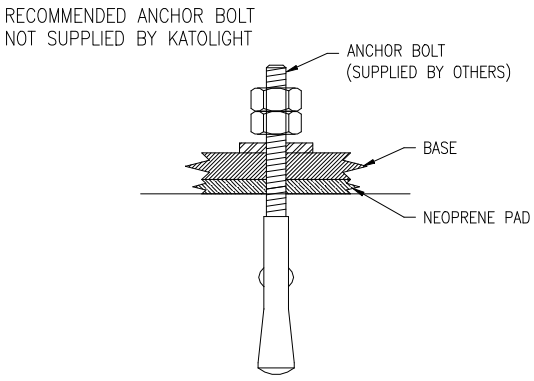


Figure 4-3: Recommended anchor bolt

5 Air Requirements

GENERAL

When installing engine generator sets, great care must be taken to insure adequate ventilation. Proper installations require enough ventilation to cool the engine generator set as well as supply adequate air for combustion.

When installing the ventilation system, the following factors should be considered:

- Location of intake and exhaust louvers
- Method of actuation of intake and exhaust louvers
- Ambient temperature
- Routing of exhaust air duct

The air intake and exhaust should be in line to provide engine room ventilation air flow which will parallel the generator set air flow over the engine, through the radiator and/or exhaust louver. The inlet and outlet openings must be large enough to provide the volume of air required by the engine generator.

NOTE

Exhaust louver effective opening should be at least 25% to 50% larger than engine radiator core. Intake louver should be 50% to 100% larger in effective opening than engine radiator core.

In most applications, intake and exhaust louvers should be used. Figure 5-1 indicates a typical louver.

Care should be taken to provide adequate open space outside the exhaust louver so as not to obstruct airflow.

Units with mounted radiators should be installed with ducting between the radiator and the exhaust louver to prevent recirculation of air.

CAUTION

Ensure that the exhaust ducting is installed so that no recirculation of radiator exhaust air occurs. Failure to prevent recirculation could cause the unit to overheat and shut down.

The exhaust louver should not be exposed to high prevailing winds, since wind pressure may reduce fan discharge and reduce cooling. The duct should be constructed with as few bends as possible. All units can be

supplied with radiator duct flanges of the required size to meet the customer's application.

If bends are required, they should be in the form of gradual sweeps to allow airflow with minimum restriction. Increase duct size one-fourth to one-half to compensate for bends.

Motorized and gravity louvers may be used to prevent entry of cold air which may cause difficulty in engine starting. (Refer to Chapter 8 for recommendations for wiring motorized louvers). Louvers also reduce the entry of rain, snow and insects into the building.

A gravity-operated louver can be used for the exhaust air. When the set operates, outlet airflow will open the louver and it will close automatically by gravity when the unit is shut down.

Generating sets with automatic start require the use of motor operated intake or fixed louvers or dampers. Motor operated louvers are held closed by spring tension and are driven to the open position by a motor operating through a mechanical linkage.

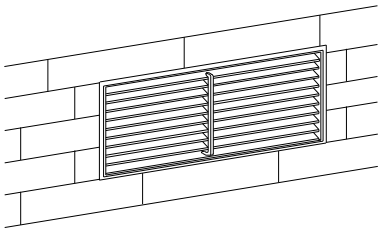


Figure 5-1: Typical center top pivoted louver

CAUTION

Care should be taken in wiring the system to ensure that the intake louver motor is supplied with power during all possible modes of unit operation, i.e. true power failure, simulated power failure due to incorporation of a system test switch, or automatic plant exercising. Incorrectly wired louver motors could result in the louvers closing prematurely during engine cool-down, resulting in overheating, engine shutdown, and possible damage to the unit.

In some extreme cold weather applications, the opening of intake louvers immediately upon starting may cause carburetor icing and vaporizing problems with engines utilizing gaseous fuels. Diesel engines may also be affected if lightly loaded. Thermostatically controlled louvers may be used to reduce the difficulties encountered with cold weather applications.

Figure 5-2 illustrates a typical generator set installation for units with unit-mounted radiators, indicating ducting and preferred locations of the louvers.

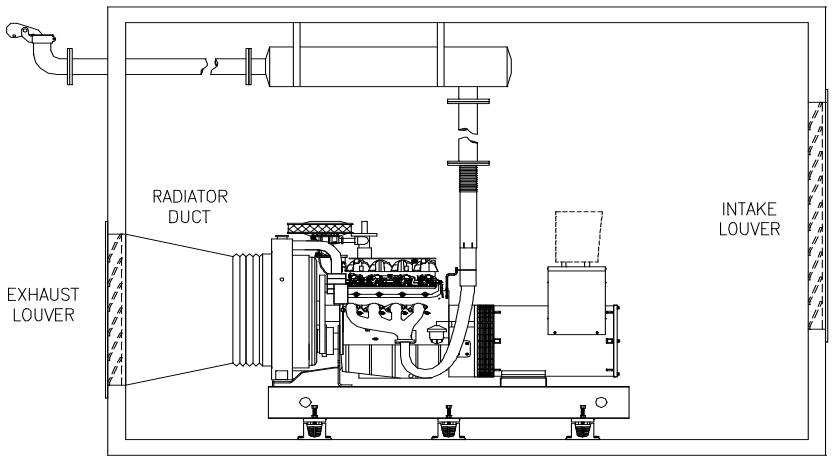


Figure 5-2: Typical installation with louvers

Engine-generator sets with remote cooling will not have an engine driven fan to move air through the generator room. As a result, a fan or some other means of moving air through the room must be considered. The fan must move the required amount of air against the allowable static friction.

The following formula may be used to estimate the amount of airflow required to remove engine and generator radiated heat and supply sufficient combustion air. The formula is based on air temperature of 100°F. Allowable room air temperature rise is 20° to 30° F.

$$V = \frac{Q}{0.018 * \Delta T}$$

Where V = Air flow through the engine-generator room (CFM)
Q = Engine-generator set radiated heat (BTU/min)
ΔT= Allowable room air temperature

Higher elevation installations will require increased airflow. Add 10% for each increase of 2500 feet. Also increase airflow for non-insulated exhaust silencer and other equipment that may add to the radiated heat in the room. Also keep in mind the required combustion airflow for the engine.

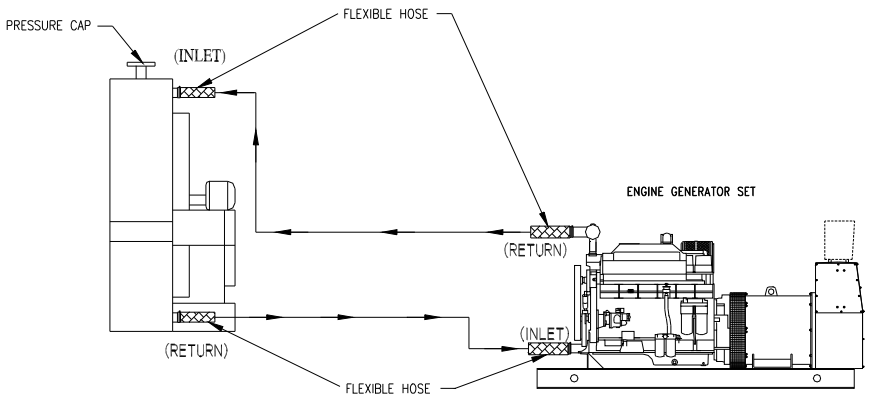


Figure 5-3: Typical remote radiator installation

6 Exhaust System

Proper exhaust system installation is essential for maximum generator set engine efficiency. Because exhaust fumes are deadly, great care must be taken when installing the exhaust system. Consideration must be given to back pressure, piping, and placement. Figures 6-1 and 6-2 show the general arrangement of recommended exhaust systems.

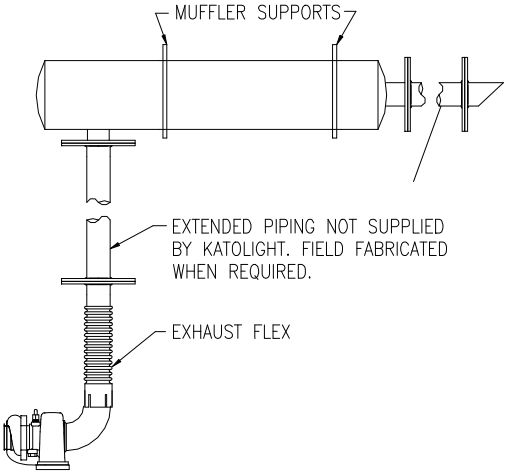


Figure 6-1: Typical side inlet exhaust

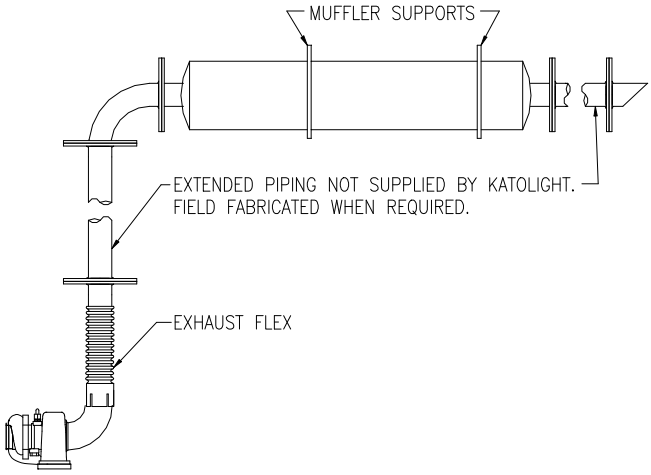


Figure 6-2: Typical end inlet exhaust

PLACEMENT

The exhaust pipe should terminate outdoors, away from doors, windows, or other building openings in an area where exhaust can dissipate. Placement of piping and exhaust silencer should take into account the location of combustible materials. If location cannot avoid these concerns, remove combustible materials on a regular basis. Keep dry grass, foliage, and combustible landscaping material a safe distance from the exhaust system.

WARNING

Inhalation of exhaust gases can cause death. Exhaust pipes must not terminate near fresh inlet vents of any type or near combustible materials. Avoid exhaust gas recirculation which could cause the engine-generator set to overheat. Generator sets installed outdoors inside enclosures should have their exhaust directed so that it will disperse away from buildings and building air intakes.

BACK PRESSURE

The installed exhaust system must not exceed the engine manufacturer's maximum exhaust back pressure limit. Damage may result from excessive back pressure. Causes may include:

- Insufficient exhaust pipe diameter
- Exhaust run too long
- Exhaust silencer too small or designed improperly
- Too many bends and/or constrictions in piping
- Obstruction in exhaust piping

Your Katolight generator set has been sized so that exhaust system back pressure is kept within the acceptable limits. However, in situations when extended piping or a flex connector other than the one supplied by Katolight must be used, contact Katolight to ensure that back pressure will not exceed the engine manufacturer's specification.

PIPING

Exhaust piping must conform to all applicable codes. Routing of exhaust piping should be as short and direct as possible. Exhaust piping should be of Schedule 40 black iron, steel or other suitable material having adequate strength and durability. The recommended material for exhaust piping is Schedule 40 black iron pipe. Where possible, sweep elbows with a radius of at least three times the pipe diameter should be used.

Exhaust pipes must be independently supported with no weight applied to the engine, turbocharger, exhaust manifold or flex connector. Where exhaust pipes attach to the engine, they must be connected with flexible connectors to minimize vibrations that can cause damage to the exhaust system.

CAUTION

Weight applied and vibration extended to the exhaust manifold or turbocharger could result in damage to these components. No exhaust piping weight may be carried by the engine, exhaust manifold or turbocharger.

FLEXIBLE SECTION

The Katolight supplied exhaust flex should be installed directly off the engine turbo elbow/manifold. This limits the stress on the engine exhaust manifold or turbocharger resulting from engine motion on its vibration mounts and temperature-induced changes in pipe dimensions. The flexible section should not be bent or used to make up for misalignment between the engine exhaust and the exhaust piping. Since typical exhaust temperatures range from 800~F (427~C) to over 1200~F (649~C) for some engines, seamless stainless steel should be used for the flexible section.

CAUTION

When installing a silencer, make certain flow direction is correct. Check inlet and outlet marking on the silencer nameplate.

EXTENDED PIPING

Engine exhaust piping can accumulate a considerable amount of condensed moisture after unit shutdown, particularly if the exhaust system is run through lengthy piping. To prevent condensed moisture from running back into the engine, exhaust piping should be sloped away from the engine and a condensate trap and drain should be incorporated at a low point ahead of engine manifolds. The trap should be drained periodically.

Horizontal extended exhaust pipe should terminate with a 45° tail pipe to prohibit rain from entering the system. A screen should be placed across the end of the tail pipe to keep birds and rodents from entering the system. Where vertical exhaust stack is necessary, a rain cap should be fitted to exclude rain and snow from the exhaust pipe.

Where there is a danger of extending piping coming in contact with combustible material or personnel, the piping should be insulated or shielded.

PIPING INSULATION

The heat rejected by exhaust piping and the amount of ventilating air required can be substantially reduced by insulating exhaust piping with suitable high-temperature insulation. Exhaust temperatures are given on each generator model's specification sheet. DO NOT insulate piping for the turbocharger or manifold.

WALL THIMBLE

Exhaust piping passing through combustible walls or partitions must be guarded at the point of passage by a metal ventilated thimble to prevent exhaust pipe heat from being transmitted to the combustible material (Figure 6-3). Thimbles must be suitable for the application. Consider the type of exhaust system, construction materials used and local fire codes.

Wall thimbles can be fabricated at a local sheet metal shop to the specifications furnished by the installation engineer. The thimbles should be constructed so that they extend at least three inches both ways from the surface of the wall or roof. Holes are provided at both ends to allow cooling air to circulate through the thimble. If screening is used on the outer end to keep birds, rodents, etc., from entering the thimble, make sure that the mesh is large enough so that it doesn't impair air circulation through the thimble. If the exhaust pipe must exit through a roof, a rain shield must be included above the thimble. The rain cap as shown on the end of the exhaust pipe is recommended only in areas not subject to freezing temperatures. In an area where freezing is common, extend the exhaust piping well beyond the roof

and use a gradual "U" bend at the end to direct the exhaust outlet downward which will keep rain, snow, etc., out of the pipe. The outlet of the pipe should be far enough from the roof to prevent ignition of the roof material from hot exhaust.

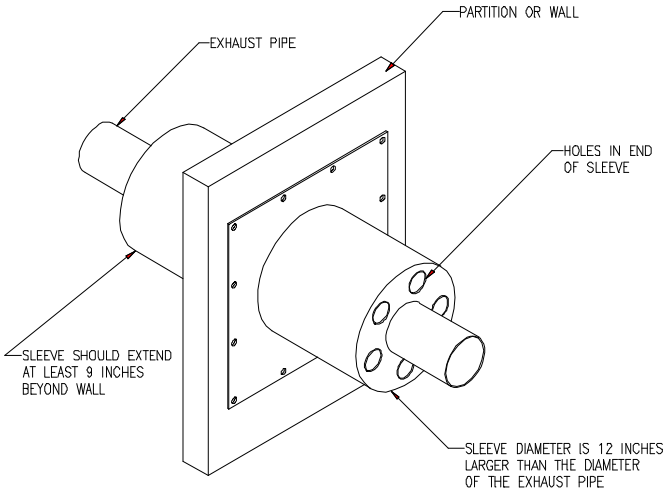


Figure 6-3: Wall thimble installation

TYPE OF FITTINGS (In Inches)	1-1/2	2	2-1/2	3	3-1/2	4	5	6	8	10	12
Standard Elbow (In Feet)	4.4	5.3	6.4	8.1	9.6	11	14	16	21	26	32
Long Rad. Elbow (In Feet)	2.8	3.5	4.2	5.2	6	7	9	11	14	17	20
Med. Rad. Elbow (In Feet)	3.6	4.6	5.4	6.8	8	9	12	14	18	22	26
Standard Tee (In Feet)	9.3	13	14	17	19	22	27	18	44	56	67

Table 6-1: Equivalent lengths of pipe fittings

7

Fuel System

GENERAL

The fuel system must be installed properly to assure availability of fuel for starting and continuous running throughout the emergency. Before connecting the fuel lines to the engine, ensure that fuel connections are free from dirt, grease, water and other contaminants that could damage the engine.

The components comprising a fuel system will differ according to the generator set location, type of fuel and anticipated time of operation desired.

DIESEL APPLICATIONS

The following basic components comprise a representative diesel fuel system:

1. Main Fuel Tank Incorporating:
   a. Fill Line
   b. Vent Line
   c. Supply Line with Foot Valve
   d. Return Line

2. Day Tank (if required)
   a. Pump Control Switch

3. Electric Fuel Transfer Pump (if necessary)

MAIN FUEL TANK

The best location for the main fuel tank is as close to the engine as possible. If building codes and insurance regulations permit, the tank could be located in the same room as the generator set, or in an adjoining room. If this is not possible, the tank should be located in a convenient location compliant with local, regional and national codes.

The fuel level in the main tank should be level with the engine's fuel transfer pump inlet. If located in the room, the tank should be on the same general level as the engine's fuel injection pump but lower than the injectors. When the tank must be placed higher or lower than this, it often requires the usage of priming or float tanks. When the main tank can be located close to the set and where the vertical lift is five feet or less, the fuel injection pump may be capable of supplying sufficient fuel. If the horizontal run is too great, or the vertical height exceeds five feet, a transfer pump is required. As a general rule, when static head and dynamic suction (horizontal head) exceed six inches hg (column mercury) an auxiliary pump and tank are required. A float tank or transfer tank is required with the auxiliary pump. The auxiliary pump

should be of the positive displacement type, operated electrically from the load side of the transfer switch.

All tanks must be vented to a safe area in the event of an overflow and to allow air and other gases to escape to atmosphere. The vent must, however, prevent dust, dirt and moisture from entering the tank. Return lines are required. Keep the return space at least 12 inches away from the pick-up or fuel supply in the day tank. If this is not done, air bubbles could be entrapped in the fuel and cause erratic operation. At least five percent of capacity should be allowed in a diesel main tank for expansion of the fuel. If the main tank is to be located overhead, an auxiliary fuel shut-off solenoid should be used.

The capacity of the fuel tank will be determined by the fuel consumption of the unit and the continuous operating time necessary. Minimum fuel supply must be sufficient to allow the set to operate for the prescribed number of hours. Before installing a fuel tank, review all local code requirements governing fuel tanks.

The number of lines connected to an underground fuel tank, whose depth of burial exceeds the below grade depth of the electric generating unit, will vary as a function of day tank positioning with regard to the engine and the number of ancillary devices utilized. However, all underground tanks must have the following:

- A vent line terminating above ground level in a screened or hooded type vent cap with unrestricted opening to atmosphere and a safe area, in the event of an overflow, that meets all necessary codes.
- A fuel fill line terminating above grade level, and fitted with an appropriate cap, and terminating in a fuel filler box with an appropriate cap plainly marked for the fuel utilized.
- A fuel supply line connected from the tank to an electric fuel transfer pump is needed when the fuel tank is located below the fuel lifting capacity of the set. The end of the fuel supply line within the tank must be fitted with a foot valve (permits flow in one direction only) to prevent loss of transfer pump prime when the transfer pump is not in operation.
- The day tank should be positioned so that the bottom of the day tank is above the level of the engine fuel filters in order to provide a positive head of pressure for the fuel injection pump, (except for Cummins engines). The mounting of the day tank in this manner will prevent loss of prime to the unit fuel injection pump and is recommended particularly in applications where the unit is utilized as a standby power source. In all applications, the return lines should returned to the main tank.

Local and national regulations governing fuel tank location must be checked before planning the installation. Fuel tanks must be adequately vented to prevent pressurization due to fuel expansion when heated.

CAUTION

The fuel system needs to be sized to handle the fuel flow required by the engine. Engine fuel flow is greater than engine fuel consumption and varies for different engine models. Engine fuel flow and consumption can be found on the model specification sheets located in the Operation and Maintenance manual.

The fill, supply and return lines as well as all diesel fuel system piping must be constructed of black iron pipe. Do not use galvanized pipe for diesel fuel applications.

CAUTION

Galvanized tanks and piping must not be used since the diesel fuel and the galvanized coating react chemically to produce flaking which quickly clogs filters or causes failure of the fuel pump or injectors. Do not use Teflon tape on fuel fittings as it can clog the fuel injectors.

Cast iron and aluminum fittings and pipe should be avoided since they are porous and can leak fuel. Flexible fuel lines must be used to connect the unit to the fuel supply and return lines. Flexible lines must be of the type approved for diesel fuels.

WARNING!

Leaky fuel lines and fuel connections can introduce the possibility of explosion and fire, which can result in injury or death. Ensure fuel lines are properly connected and flexible lines are used between the engine and supply and return lines.

Fuel filters and drains must be located in easily accessible areas to promote regular and frequent service. Cleanliness of the fuel is critical for diesel engines that have easily damaged or clogged precision fuel injectors and pumps.

DAY TANK

The day tank provides a ready supply of fuel at the injector pump. Day tanks are used when the engine pump does not have the necessary lift to draw fuel from the main tank. If the main tank is above the level of the injectors, the day tank is used to remove the fuel head pressure that would otherwise be placed on the engine fuel system components.

When installing the day tank for Cummins engines, make certain the tank is at, or slightly below, the level of the fuel filters to assure maintenance of fuel system prime. However, the top of the day tank must be below the injector drain connection of the engine.

A slight head of fuel can cause leakage through the injectors and result in hydraulic lock problems, (filling of the engine cylinder with liquid fuel). The injector return line must always be at or below the level of the fitting on the engine. The line must drain toward the day tank.

FUEL OIL TRANSFER PUMP

The fuel oil transfer pump (auxiliary pump) is used to supply fuel from the main tank to the day tank.

Single phase 120 VAC or 240 VAC, the AC power supply for the transfer pump should be taken from the load side of the transfer switch. The pump will operate when its circuit is closed by the action of the level switch.

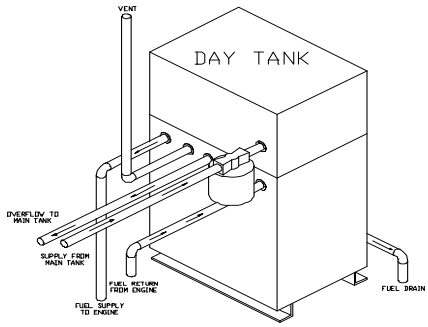


Figure 7-1: Fuel day tank

Fuel is then drawn from the main tank through a foot valve and is pumped into the day tank. Operation continues until the fuel level in the day tank rises causing the float to rise, opening the float switch and disconnecting the pump motor.

DIESEL FUEL RECOMMENDATIONS

Katolight Corporation recommends the use of #2-D diesel fuel.

#2-D Diesel Fuel:
A good quality 40 cetane (min) #2-D diesel fuel is best for most Katolight diesel generator set installations. This must be a distillate fuel which meets the requirements for #2-D in the ASTM diesel fuel classification D-975-60T. Most major brands of fuel oils conform to ASTM specifications.

#1-D Diesel Fuel:

A #1-D grade 40 cetane (min) diesel fuel may be best if operating at altitudes above 5000 feet or in cold weather (below 40° F) conditions. Kerosene is included in the #1-D class of fuel. This fuel has a lower flash point (more volatile) and is of lower viscosity (flows more freely) than #2-D.

#2 Domestic Type (Furnace) Oil:
#2 domestic or furnace oil may be used. The #2 domestic fuel should have properties as close as possible to that of #2 diesel fuel. Check ASTM D-396-60T. Particular attention must be given to the sulfur content – this must be less than one percent by weight. High sulfur content can lead to increased engine wear and shorter injector life, especially if intermittent operation or low operating temperatures exist.

#4-D Grade Fuel: (NOT RECOMMENDED)
The high sulfur content plus low cetane rating of this class of fuel makes it unsuitable for diesel generator set use.

GASEOUS FUEL SYSTEMS

System Variations: The gaseous fuel systems used can be grouped in four general classifications. The systems are covered in the following sequence:

1. Natural Gas (including manufactured gas)
2. LP Vapor
3. Liquefied Withdrawal
4. Dual Fuel Systems (natural gas and LP gas)
5. Zero Pressure Regulation

1. & 2. NATURAL GAS AND VAPOR PROPANE (FIGURE 7-2A):

Natural, manufactured, sewage and most LP Vapor gas systems are vapor fuels as supplied by the utilities. These fuel system components are used in a similar manner. When the heating content of the fuel falls below 1000 BTU per cubic foot, as it does with manufactured sewage and some natural gas fuels, the set will have to be derated. Check with the factory for application details. The gas distribution companies will provide piping from the main transmission line to the building. The primary regulator should be furnished by the utility company. It is the responsibility of the utility company to insure that sufficient pressure is present at all times to operate the primary regulator. Installation, repair and alteration to gas piping should be undertaken only by the utility company or personnel authorized by them. Piping should be rigidly mounted but protected against damage from vibration. Only UL or AGA approved flexible connection should be used.

3. LIQUID WITHDRAWAL

Most LPG systems are operated from vapor. The main tank is sized to vaporize the fuel volume needed for ambient temperature of the installation. Sizing the LPG tank must be the responsibility of the fuel supplier. Give the fuel supplier the fuel volume required.

Vaporizers: Vaporizers are devices used exclusively with LPG systems. LPG in liquid form is introduced under tank pressure into the vaporizer which uses engine coolant heat to convert the liquid into a vapor state. Vaporizers may be referred to as converters; both names describe its function. There are several types of vaporizers. One type is strictly a vaporizer and must be used in conjunction with other pressure regulators. This type of vaporizer may be required if tank size is limited; low ambient temperatures or high fuel volume are conditions affecting the installation. The type classified as vaporizer-regulators provide vaporization plus primary and secondary regulation of gas pressure.

Fire regulations in most localities prohibit liquid LP high-pressure fuel lines inside a building or enclosure. This automatically precludes high-pressure equipment on or near an engine installed inside a building. Under such regulations, the coolant lines can be extended and the vaporizer mounted outside the structure.

Gas at permissible pressure (usually about 20 psi maximum) is allowed inside the building. The vaporizer must be mounted below the level of the engine water pump and within 25 feet of the engine. If freezing temperatures are common, don't overlook the fact that water inside the vaporizer could freeze unless antifreeze is added to the system.

4. DUAL FUEL SYSTEMS (NATURAL OR LP VAPOR)

In many applications, natural gas is the main fuel and LPG is used as the emergency fuel when natural gas is not available. The dual fuel system (in common use) offers automatic changeover from one fuel to the other.

During operation on natural gas, pressure existing in the common line to the carburetor closes off the LP Vapor regulator. Cutting off the natural gas operates a pressure switch in the line which automatically opens the LP Vapor solenoid and closes the natural gas solenoid.

5. ZERO PRESSURE REGULATION

The Zero Pressure Regulator System works on Zero Pressure air and Zero Pressure gas, the engine vacuum is what mixes the fuel and air through the mixer on the carb.

The system still requires 7 to 11" of water column (4 to 6 ounces) on either Natural Gas or LP Vapor.

The flow control valve is left with the tower in the upright position on either fuel and with the spring left in. The Zero Pressure System only requires the installer to give the correct pressure and volume to the system. NOTE: A dog tag on the system shows the fuel consumption and pressures required for each system.

Gas Piping: Piping must never be used to ground electrical apparatus. Piping must be rigidly mounted but protected against vibration. Where flexible connections are required, use only approved connections. A flexible section should be used between the point where the gas leaves the rigid fuel line and enters the engine.

All gas lines and piping should be of black iron. Joints and connections must be sealed. The pipe should be of sufficient size to maintain the proper pressure level when operating at full load. In addition to the actual fuel consumption, the following factors must be considered:

- Pressure loss due to number of fittings
- Specific gravity of gas
- Pressure loss due to length of piping

At the end of the chapter is a list of steps to follow when calculating pipe capacities for gas flow rates.

This procedure is based on a pressure drop of 0.5" H2O which allows for a normal amount of restriction from fittings.

Table 7-1, Gaseous Fuel Pipe Capacity, lists the capacity of various sizes and lengths of pipe. The capacity (in cubic feet per hour) is calculated using the specific gravity of 0.6 as base. A pressure drop of 0.5" (water column) is used to account for a nominal number of fittings and metering equipment in this table.

Main Components: Solenoid valves used in a gaseous fuel system are designed to close and stop fuel the instant the engine stops. They should not be relied upon to completely seal the fuel system. A ruptured diaphragm or a piece of grit could prevent the valves from sealing. Resulting in gas continuing to flow through the carburetor into the engine and out into the surrounding air. Some gaseous fuels are heavier than air and tend to settle in low areas. This could present a serious hazard, especially in enclosed applications. Safeguards against this should be incorporated in each system.

The common components of a gas system are as follows:

Primary regulator: This regulator is used to provide pressure regulation of the gas from the high-pressure supply line or with LPG with the supply tank.

The primary regulator reduces line pressures to allowable inlet pressures for the secondary regulator. This regulator is supplied by the utility or fuel company.

Secondary regulator: The low-pressure type regulator admits fuel to the engine in response to engine demand similar to the float valve in a gasoline carburetor. The secondary regulator is not supplied by Katolight and must be supplied by the purchaser. Natural gas and LPG vapor withdrawal inlet pressures must be from four to six ounces per square inch.

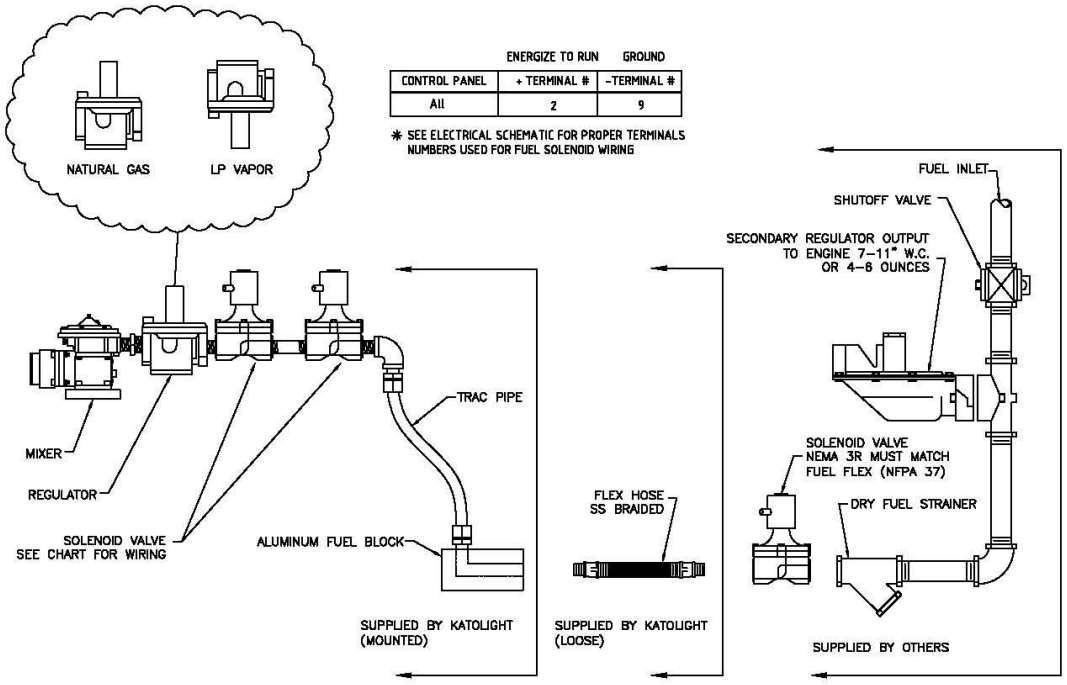
PRESSURE REDUCING VALVE

The pressure-reducing valve regulates the volume of fuel to the carburetor. The volume is proportional to the load on the engine.

This device is factory mounted for LP gas vapor withdrawal fuel systems, the valve is inverted and the internal spring removed. Consult factory for drawings showing modifications for propane fuel systems.

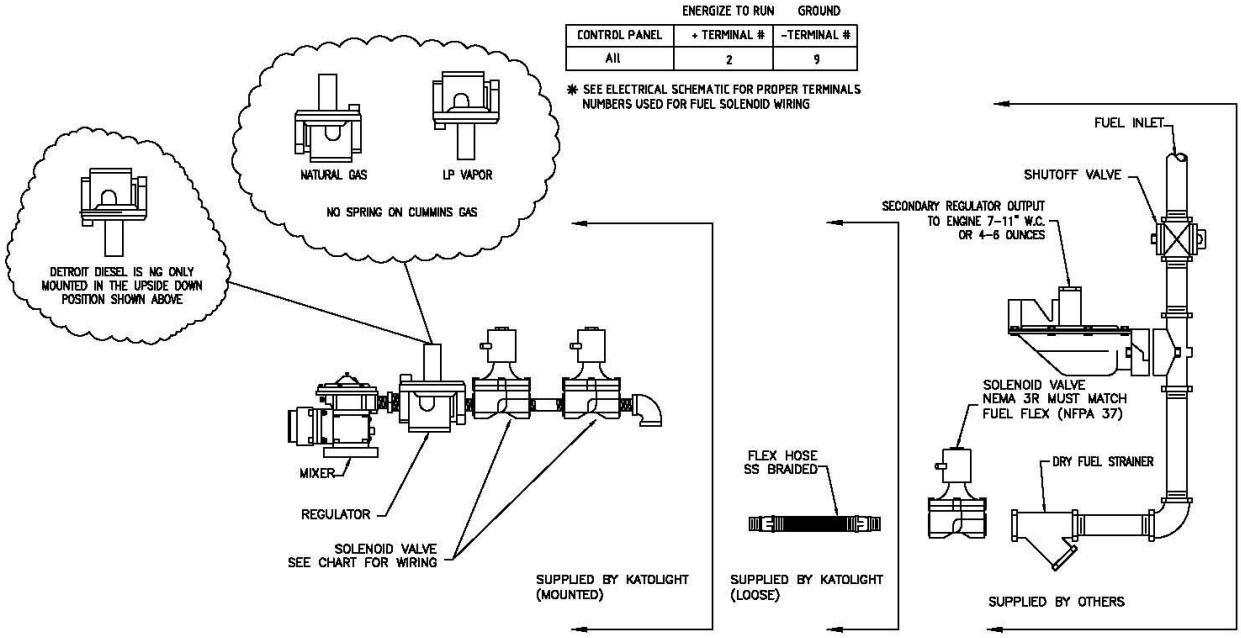
Fuel shut-off solenoid: This device automatically shuts off the fuel supply when the engine stops. All Katolight automatic fuel shut-off valves are electrically activated solenoids that seal off the fuel the instant the ignition switch is turned off.

Carburetor: Gas carburetors operate on gaseous fuels only.



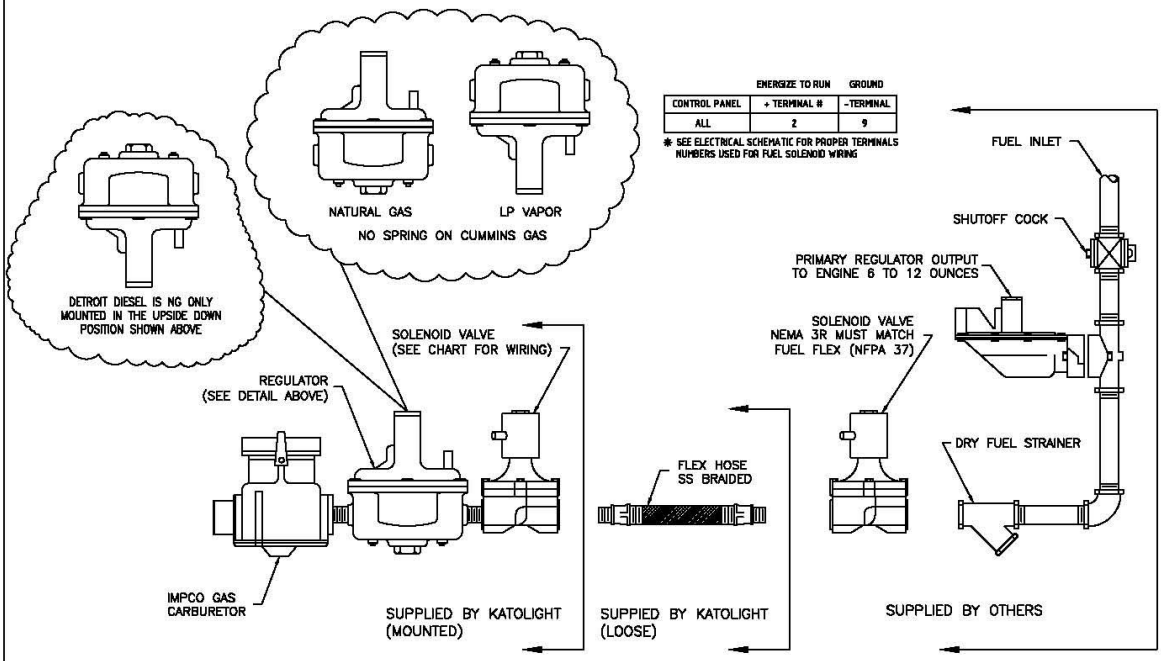
STANDARD PRODUCT LINE (SP UL)

(COVERS GM 8.1L)



CUSTOM PRODUCT LINE (CP UL)

(COVERS GM 8.1L, CUMMINS AND DETROIT DIESEL)



	ENERGIZE TO RUN	GROUND
CONTROL PANEL	+ TERMINAL #	-TERMINAL
ALL	2	9

* SEE ELECTRICAL SCHEMATIC FOR PROPER TERMINALS NUMBERS USED FOR FUEL SOLENOID WIRING

CUSTOM PRODUCT LINE (CP NON UL)
(COVERS CUMMINS AND DETROIT DIESEL)

	ENERGIZE TO RUN	GROUND
CONTROL PANEL	+ TERMINAL #	-TERMINAL #
All	2	9

* SEE ELECTRICAL SCHEMATIC FOR PROPER TERMINALS NUMBERS USED FOR FUEL SOLENOID WIRING

LC50 INITIAL ADJUSTMENTS:

THE MAIN ADJUSTMENT SCREW (MAS) SETTINGS ARE MEASURED FROM THE MAS VALVE BODY (NOT THE JAM NUT) TO THE EXTERIOR END OF THE MAS SCREW. THE ZERO-PRESSURE REGULATOR SETTINGS ARE MEASURED FROM THE TOP OF THE SPRING ADJUSTMENT SCREW TO THE TOP OF THE SPRING TOWER.

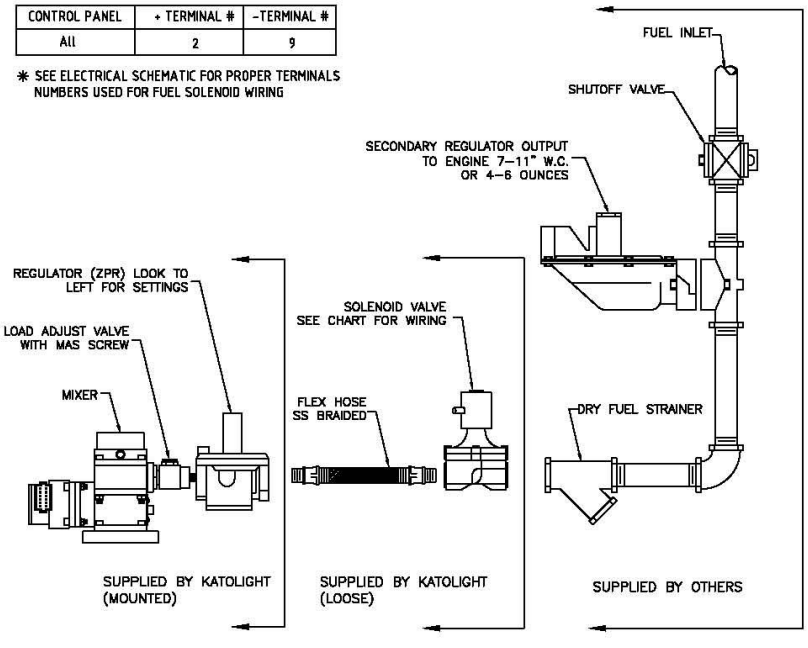
THESE INITIAL SETTINGS SHOULD GET THE GENSETS UP AND RUNNING FOR THE FINAL ADJUSTMENTS WITH AN OXYGENSENSOR OR EXHAUST ANALYZER. THE MAS SHOULD BE ADJUSTED FIRST WITH SIGNIFICANT (75-85%) LOAD ON THEENGINE. THE ZPR SHOULD THEN BE ADJUSTED AT NO-LOAD. ONE OR TWO MORE ITERATIONS AT FULL LOAD FOR THE MAS AND NO LOAD FOR THE ZPR SHOULD PROVIDE THE CORRECT AIR/FUEL RATIO OVER THE ENTIRE OPERATING RANGE.

50MM LC50 (5.0 AND 5.7 GM)
NG: MAS (3/4") 19MM, ZPR (MAXITROL R500Z) (5/8) 16MM
LP (VAP): MAS (5/8") 16MM, ZPR (MAXITROL R500Z) (9/16) 14MM
TIMING: NG=34° LP=32°

43MM LC50 (4.3 GM)
NG: MAS (11/16") 17MM, ZPR (MAXITROL R500Z) (5/8) 16MM
LP (VAP): MAS (19/32") 15MM, ZPR (MAXITROL R500Z) (9/16) 14MM
TIMING: NG=35° LP=28°

38MM LC50 (3.0 GM)
NG: MAS (7/16") 11MM, ZPR (MAXITROL R500Z) (5/8) 16MM
LP (VAP): MAS (3/8") 9.5MM, ZPR (MAXITROL R500Z) (9/16) 14MM
TIMING: NG=33° LP=26°

38MM LC50 (2.5L NISSAN)
NG: MAS (3/8") 10MM, ZPR (MAXITROL R500Z) (9/16) 14MM
LP (VAP): MAS (5/16") 8MM, ZPR (MAXITROL R500Z) (9/16) 14MM
TIMING: NG=17° LP=12°



CUSTOM PRODUCT LINE (CP NON UL)
(COVERS GM 3.0L, 4.3L, 5.0L, 5.7L AND NISSAN 2.5L)

LC50 INITIAL ADJUSTMENTS:

THE MAIN ADJUSTMENT SCREW (MAS) SETTINGS ARE MEASURED FROM THE MAS VALVE BODY (NOT THE JAM NUT) TO THE EXTERIOR END OF THE MAS SCREW. THE ZERO-PRESSURE REGULATOR SETTINGS ARE MEASURED FROM THE TOP OF THE SPRING ADJUSTMENT SCREW TO THE TOP OF THE SPRING TOWER.

THESE INITIAL SETTINGS SHOULD GET THE GENSETS UP AND RUNNING FOR THE FINAL ADJUSTMENTS WITH AN OXYGENSENSOR OR EXHAUST ANALYZER. THE MAS SHOULD BE ADJUSTED FIRST WITH SIGNIFICANT (75-95%) LOAD ON THEENGINE. THE ZPR SHOULD THEN BE ADJUSTED AT NO-LOAD. ONE OR TWO MORE ITERATIONS AT FULL LOAD FOR THE MAS AND NO LOAD FOR THE ZPR SHOULD PROVIDE THE CORRECT AIR/FUEL RATIO OVER THE ENTIRE OPERATING RANGE.

50MM LC50 (5.0 AND 5.7 GM)
NG: MAS (3/4") 19MM, ZPR (MAXITROL R800Z) (5/8) 16MM
LP (VAP): MAS (5/8") 16MM, ZPR (MAXITROL R500Z) (9/16) 14MM
TIMING: NG=34° LP=32°

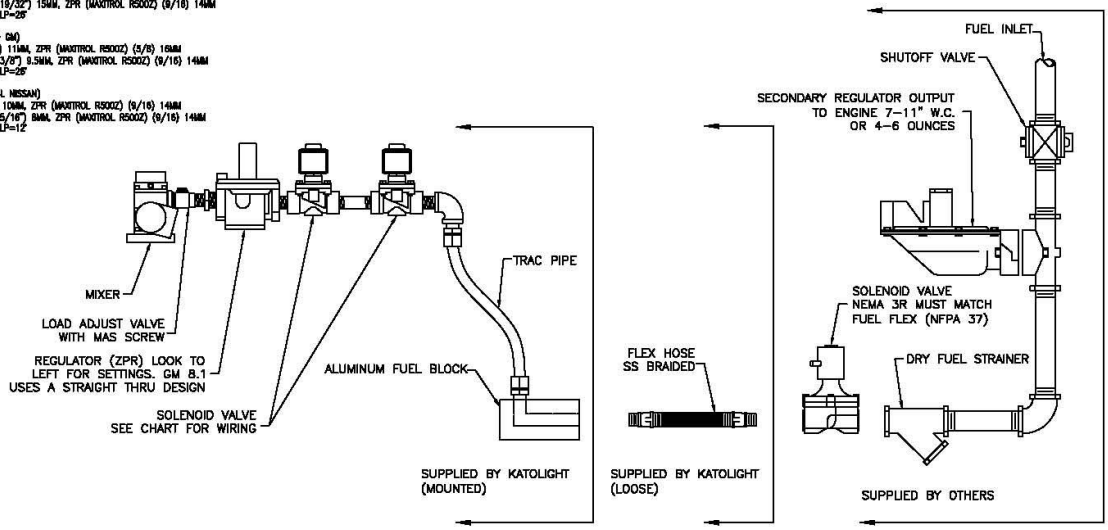
43MM LC50 (4.3 GM)
NG: MAS (11/16") 17MM, ZPR (MAXITROL R800Z) (5/8) 16MM
LP (VAP): MAS (19/32") 15MM, ZPR (MAXITROL R500Z) (9/16) 14MM
TIMING: NG=35° LP=28°

36MM LC50 (3.0 GM)
NG: MAS (7/16") 11MM, ZPR (MAXITROL R500Z) (5/8) 16MM
LP (VAP): MAS (3/8") 9.5MM, ZPR (MAXITROL R500Z) (9/16) 14MM
TIMING: NG=33° LP=28°

36MM LC50 (2.5L NISSAN)
NG: MAS (3/8") 10MM, ZPR (MAXITROL R500Z) (9/16) 14MM
LP (VAP): MAS (5/16") 8MM, ZPR (MAXITROL R500Z) (9/16) 14MM
TIMING: NG=17° LP=12°

	ENERGIZE TO RUN	GROUND
CONTROL PANEL	+ TERMINAL #	-TERMINAL #
All	2	9

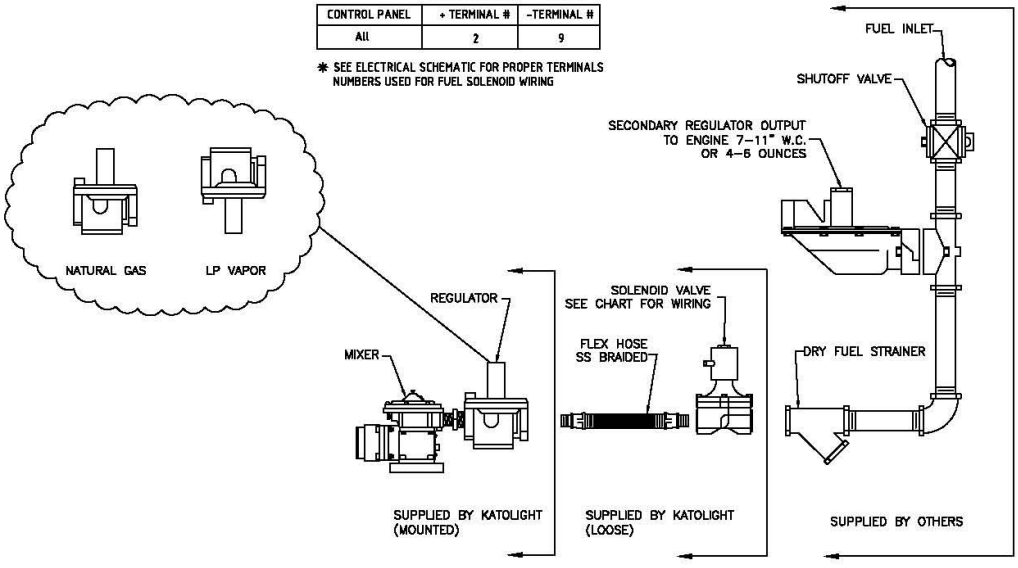
* SEE ELECTRICAL SCHEMATIC FOR PROPER TERMINALS NUMBERS USED FOR FUEL SOLENOID WIRING



STANDARD PRODUCT LINE (CP UL / SP UL)
(COVERS GM 3.0L, 4.3L, 5.0L, 5.7L NISSAN 2.5L)

	ENERGIZE TO RUN	GROUND
CONTROL PANEL	+ TERMINAL #	-TERMINAL #
All	2	9

* SEE ELECTRICAL SCHEMATIC FOR PROPER TERMINALS NUMBERS USED FOR FUEL SOLENOID WIRING



CUSTOM PRODUCT LINE (CP NON UL)
(COVERS GM 8.1L)

*NFPA 37 requires the electric solenoid to be placed ahead of any flexible connector. This solenoid is not supplied by Katolight.

DETERMINING PIPE SIZE FOR GASEOUS FUEL SYSTEMS

1. Obtain the fuel consumption in cubic feet per hour at 100% load from the engine generator model specification sheet for the type of fuel used.
2. Refer to the correction chart below and select the correction factor for the type of fuel used.

Fuel Specific Gravity	Fuel	Correction Factor
.65	Natural Gas	.962
1.00	Air	.775
1.50	Propane	.633
2.10	Butane	.535

3. Divide the fuel consumption from step 1 by the correction factor to obtain adjusted flow rate
4. Determine length of pipe between the fuel source and generator set
5. From table 6.1, choose the column of the nearest pipe length
6. Move down the column until the figure equal to or greater than the adjusted flow rate obtained in step 3 is encountered
7. Move horizontally to the left column to determine the correct pipe size

Iron Pipe Size (in.) Nominal	Length of Pipe (ft.)													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/4	43	29	24	20	18	16	15	14	13	12	11	10	9	8
3/8	95	65	52	45	40	36	33	31	29	27	24	22	20	19
1/2	175	120	97	82	73	66	61	57	53	50	44	40	37	35
3/4	360	250	200	170	151	138	125	118	110	103	93	84	77	72
1	680	465	375	320	285	260	240	220	205	195	175	160	145	135
1-1/4	1400	950	770	660	580	490	460	460	430	400	360	325	300	280
1-1/2	2100	1460	1180	990	900	810	750	690	650	620	550	500	460	430
2	3950	2750	2200	1900	1680	1520	1400	1300	1220	1150	1020	950	850	800
2-1/2	6300	4350	3520	3000	2650	2400	2250	2050	1950	1850	1650	1500	1370	1280
3	11000	7700	6250	5300	4750	4300	3900	3700	3450	3250	2950	2650	2450	2280
4	23000	15800	12800	10900	9700	8800	8100	7500	7200	6700	6000	5500	5000	4600

Table 7.1: Gaseous Fuel Pipe Capacity

EXAMPLE

- Engine – generator set operating with a fuel consumption of 700 cubic feet per hour and at a distance of 50 feet from the fuel supply
- Fuel used is propane and has a specific gravity of 1.5
- Dividing the flow rate of 700 CFH by the correction factor of 0.633 for propane gives the adjusted capacity of 1105 CFH

- Reading down the 50-foot pipe length column in table 6.1 until a figure equal to or greater than 1106 is encountered, we get a figure of 1680
- Reading directly across to the left column gives the required pipe size of 2 inches

8 Electrical Requirements

GENERAL

The electrical system consists of the AC power supplied to the generator and the DC starting and control circuitry. These circuits must be enclosed in separate conduits.

BATTERIES

The batteries need to be provided with enough capacity to provide the cranking motor current specified on the unit specification sheet. The recommended batteries are lead-acid or nickel cadmium. They can be shipped wet or dry. If shipped dry, they can be stored indefinitely and when ready to use filled with electrolyte (acid) with a specific gravity of 1.250 to 1.265. It is recommended that batteries be placed on trickle charge for 12 hours after electrolyte is added.

Batteries should be located as close as possible to the generator set to eliminate line losses.

Nickel cadmium batteries are shipped wet. It is advisable that batteries be placed on trickle charge for 12 hours when received.

Coat battery terminal connections with grease to prevent corrosion. Check the electrolyte level periodically. Make certain all vent caps are in place and unobstructed.

BATTERY RACKS AND CABLES

Where the battery installation requires remote battery location, the correct cross sectional area of battery cables is of importance in minimizing line drop. Battery racks or boxes are supplied by Katolight Corporation for lead-acid batteries.

AC POWER OUTPUT WIRING

All wiring must be in accordance with applicable electrical codes. Wires must be of adequate size, properly insulated and supported in an approved manner. Wires should not be placed where they may interfere with plant operation. Figure 8-1 illustrates the various generator connections for Katolight generators.

WARNING

Accidental contact with electrical equipment can cause severe injury and death if the equipment is not properly grounded. Ensure that all equipment is properly grounded.

AUTOMATIC TRANSFER SWITCH

Installing an automatic transfer switch is primarily an electrical operation and therefore should be handled by a licensed electrician. Instructions and detailed wiring diagrams will accompany the switch.

The transfer switch is designed to be mounted on a wall or other vertical surface free from vibration. The switch should be at the electrical service entrance and yet within 100 feet with No. 12AWG wire from the generator set control cabinet.

REMOTE/AUDIBLE ALARM

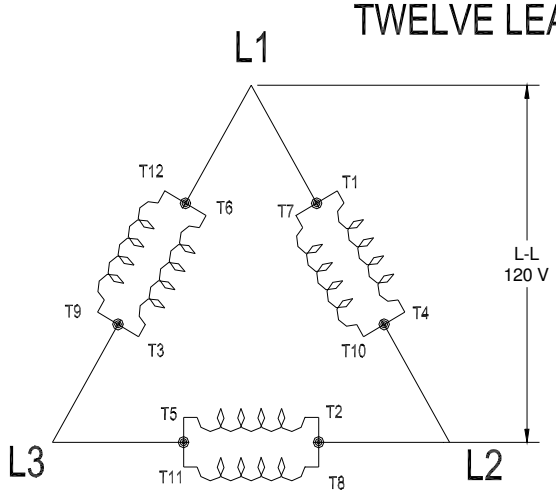
An external fault indicator or audible alarm can be wired to the generator set. Make certain external fault indicator or audible alarm is rated for 2 amperes maximum and 12 or 24 VDC depending on the DC voltage of the system. The indicator will become illuminated or the alarm will sound when an overcrank, low lube pressure, high coolant temperature or overspeed condition occurs.

ACCESSORY WIRING

When motor operated louvers are required for a generator set installation, the louver motors must be wired to operate whenever the engine generator set runs, during emergency conditions, normal periodic exercising, or for maintenance.

Katolight suggests the louver motors be wired to a distribution panel on the load side of the automatic transfer switch. The louver motor control circuit is wired to “energized to run” contacts in the generator set control panel.

TWELVE LEAD PARALLEL DELTA

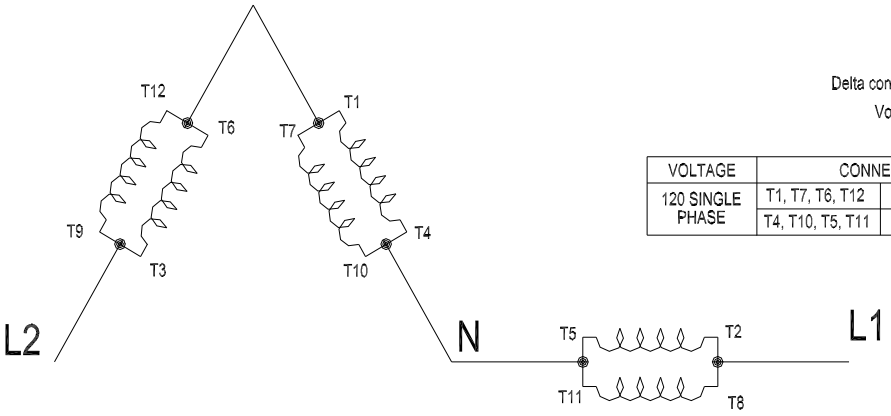


Delta connection with 12 lead generators only.

Voltages: 60 Hz 120v TO 139v
50 Hz 100v TO 120v

VOLTAGE	CONNECT		L1	L2	L3
120 DELTA	T1, T7, T6, T12	T2, T8, T4, T10	T1	T2	T3
	T3, T5, T9, T11				

TWELVE LEAD ZIG-ZAG OR OPEN DELTA

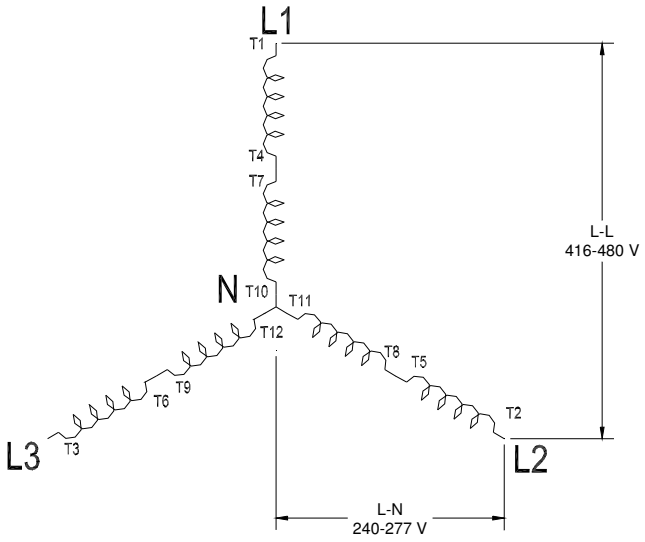


Delta connection with 12 lead generators only.

Voltages: 60 Hz 120/240v single phase
50 Hz 110/220v single phase

VOLTAGE	CONNECT		L1	L2
120 SINGLE PHASE	T1, T7, T6, T12	T3, T9	T2, T8	T3, T9
	T4, T10, T5, T11	T2, T8		

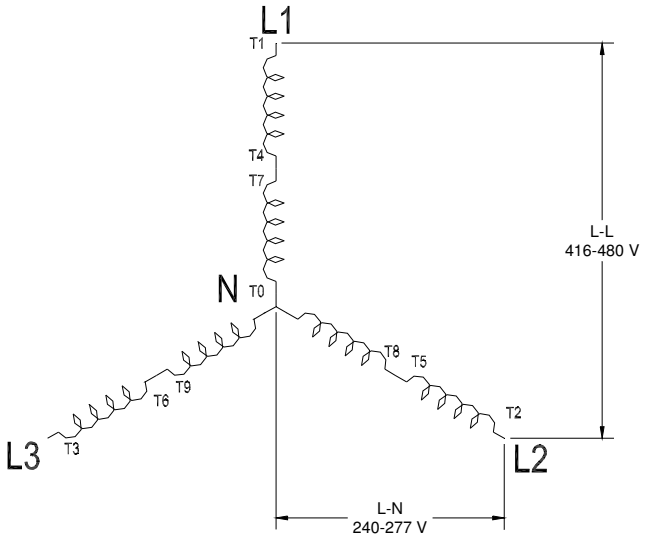
TWELVE LEAD SERIES WYE



Voltages: 60 Hz 240/416v TO 277/480v
50 Hz 220/380v TO 240/416v

VOLTAGE	CONNECT			L1	L2	L3	NEUTRAL
480-416 WYE	T10, T11, T12			T1	T2	T3	T10, T11, T12
	T4, T7	T5, T8	T6, T9				

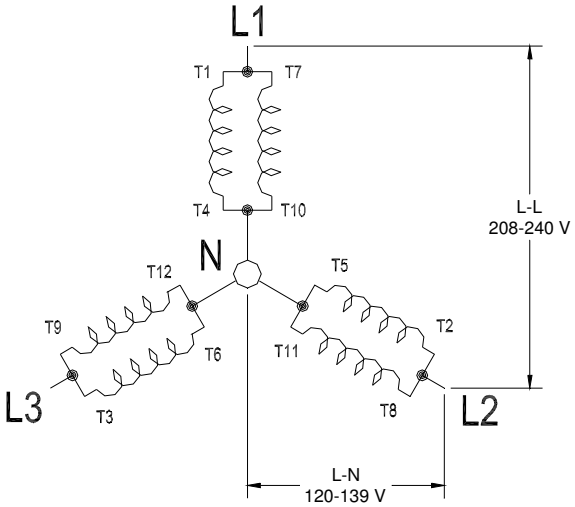
TEN LEAD SERIES WYE



Voltages: 60 Hz 240/416v TO 277/480v
50 Hz 220/380v TO 240/416v

VOLTAGE	CONNECT			L1	L2	L3	NEUTRAL
480-416 WYE				T1	T2	T3	T0
	T4, T7	T5, T8	T6, T9				

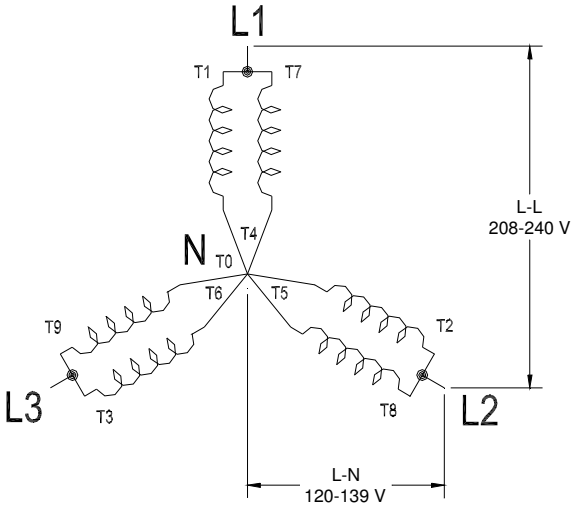
TWELVE LEAD PARALLEL WYE



Voltages: 60 Hz 120/208v TO 139/240v
50 Hz 110/190v TO 120/208v

VOLTAGE	CONNECT			L1	L2	L3	NEUTRAL
240-208 WYE	T10, T11, T12		T4, T5, T6	T1	T2	T3	T10, T11, T12
	T1, T7	T2, T8	T3, T9				T4, T5, T6

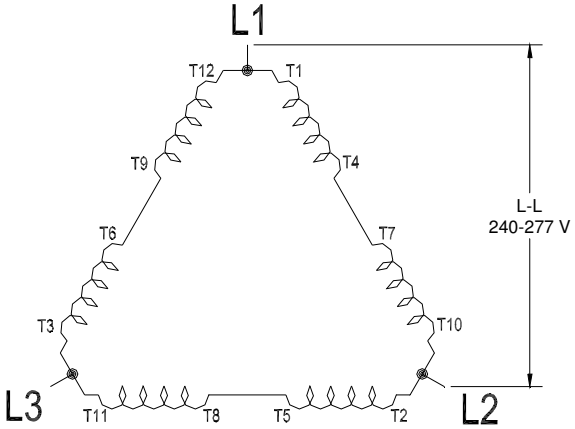
TEN LEAD PARALLEL WYE



Voltages: 60 Hz 120/208v TO 139/240v
50 Hz 110/190v TO 120/208v

VOLTAGE	CONNECT			L1	L2	L3	NEUTRAL
240-208 WYE	T4, T5, T6, T0			T1	T2	T3	T4, T5, T6
	T1, T7	T2, T8	T3, T9				

TWELVE LEAD SERIES DELTA



Voltages: 60 Hz 120/240v TO 138/277v
50 Hz 110/220v TO 120/240v

VOLTAGE	CONNECT			L1	L2	L3
240-277 DELTA	T4, T7	T5, T8	T6, T9	T1	T2	T3
	T1, T12	T2, T10	T3, T11			

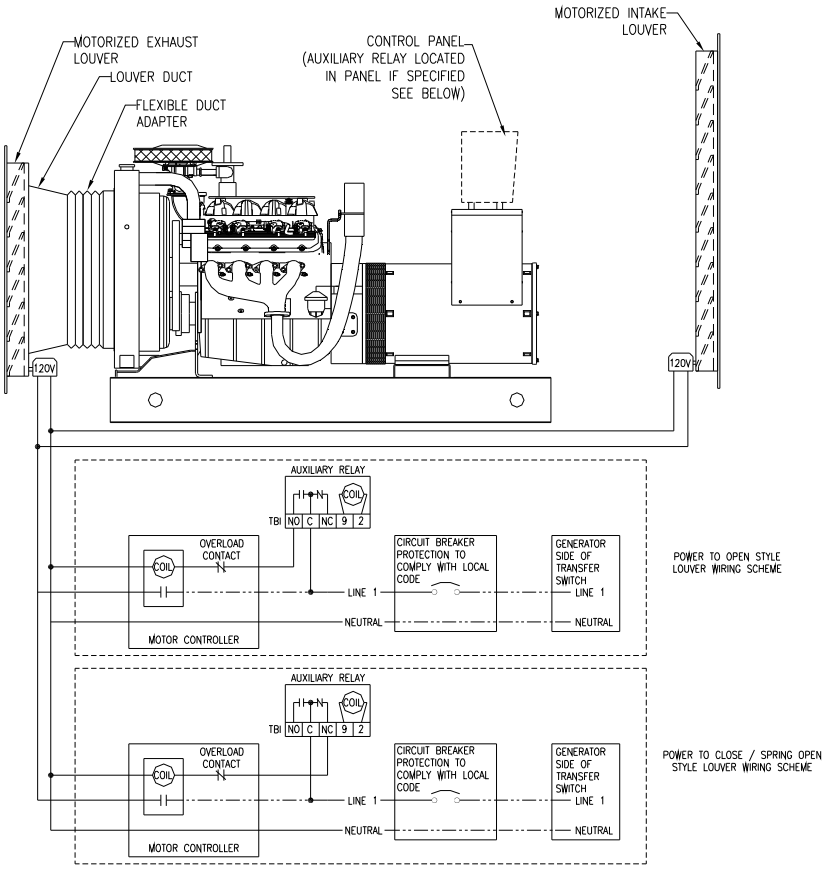


Figure 8-1: Suggested motorized louver wiring

As an alternate-wiring scheme, the louver motor may be wired directly to the generator output leads, prior to the mainline circuit breaker. The installation contractor must add any necessary wiring devices and circuit protection to comply with the local electrical code requirements.

There are many other wiring schemes, which may be used to safely wire the louver motors, and control circuits to insure the louvers will open when the engine generator set runs. If there are any questions, consult your generator set supplier.

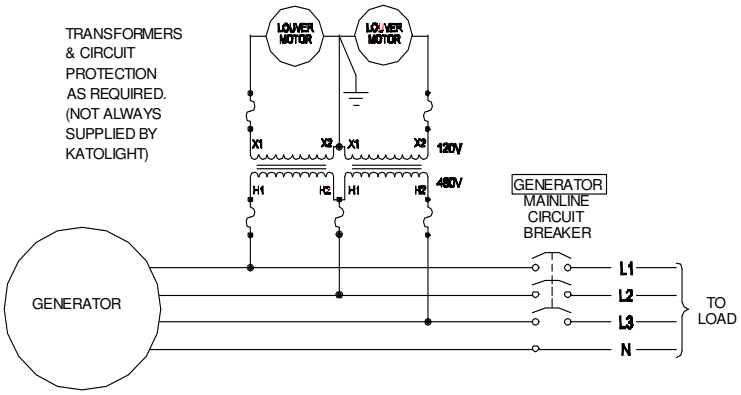


Figure 8-2: Optional motorized louver wiring

9 Service

Install the generator set in an area that can be quickly reached for repair in case of malfunction. Service entrances should be large enough to permit service of components such as engine, radiator or generator in the event major overhaul or replacement is needed.

The location for items requiring service varies from model to model. All service items should be known and considered when planning the installation. An item requiring routine attention must, of course, be made more accessible.

In general, the following service points should be accessible:

- Air Cleaner
- Primary Fuel Filter
- Secondary Fuel Filter
- Lube Oil Dip Stick
- Oil Filter
- Starting Battery
- Starter
- Battery Charger & Voltage Regulator
- Generator & Control Systems

If your generator set requires service or repairs, simply contact an authorized Katolight dealer for assistance. Service technicians are factory-trained and are capable of handling all of your service needs.

When contacting a Katolight Authorized Dealer, always supply the complete model number and serial number of your unit, which are located on your generator set nameplate.

To locate the Katolight Authorized Dealer nearest you, call 800-325-5450 or visit www.katolight.com.

NOTE

For standby units, it is important that servicing is performed on a calendar basis. Failure to do this may result in the generator set not starting or operating properly when the unit is most needed. Consult your Operation and Instruction Manual provided with the generator set for servicing information.

10 Installation Checklist

Prior to initial start-up, refer to the following installation checklist to ensure that the generator set is installed properly.

CHECK	OK	CHECK	OK
1. Adequate clearance on all sides.		18. Condensate trap or drain installed.	
2. Adequate incoming air flow.		19. Muffler exhaust flow in right direction.	
3. Adequate outgoing air flow.		20. Exhaust line free of excessive elbows and restrictions.	
4. Radiator duct flange connected.		21. Exhaust line shielded/protected.	
5. Antifreeze required/installed.		22. Battery in cool location.	
6. Water heater properly connected and of proper voltage.		23. Battery properly charged.	
7. Proper size fuel line and connectors.		24. Battery of proper size and voltage.	
8. Fuel lines protected.		25. Battery cables correct size.	
9. Fuel pump lift adequate.		26. Battery charger operating.	
10. Flexible fuel connectors.		27. Generator properly connected.	
11. Fuel return line.		28. All controller contacts clean.	
12. Gas pressure okay.		29. Transfer switch operating correctly.	
13. Solenoid shut-off valve installed (gas).		30. Binding posts tight (all connections).	
14. Proper size exhaust line.		31. Operator has instruction manual.	
15. Flexible exhaust connection installed.		32. Maintenance schedule posted.	
16. Exhaust nipple installed on manifold below flexible exhaust connection (condensate trap).		33. No loose parts, belts, bolts, nuts, etc.	
17. Exhaust piping sloped away from engine.			

11

Start-Up Request Form

To provide an authorized factory start-up at the lowest possible prices, we must request that the following checklist and tasks be completed prior to a Katolight representative's arrival at the installation site to perform the start-up.

Unit Serial Number: _____ Contact Name: _____

Company Name: _____ Title: _____

Please attach a map or directions to the site. Phone Number: _____

☐ Unit set in place on vibration pads with floor anchor/studs to prevent movement.

☐ Radiator ducted to properly sized air discharge louvers.

☐ Unit full of oil and water/anti-freeze mix.

☐ Battery filled with acid and fully charged.

☐ Battery charger mounted with AC and DC wired, if not supplied mounted by the factory.

☐ All AC and DC electrical connections made.

☐ Engine heater wired to normal AC power supply.

☐ Fuel inlet and return lines run between the unit and fuel storage system, system filled and primed to the engine with proper fuel.

☐ Exhaust system in place and supported so that the exhaust manifold does not carry weight of exhaust system.

☐ Air inlet louver motor wired to an emergency generator source point to open upon the start of an engine generator set.

☐ Generator room cleaned of construction debris including excess nails, bolts, nuts, panel knockouts, etc. It is very important that the radiator fan area is checked for debris, as damage to the equipment and personal injury can occur if loose items come in contact with the fan when the unit is initially started.

Consult your Katolight Installation Guide on any questions.

If, upon arrival at the installation site, our representative cannot perform the start-up as a result of defective Katolight equipment, the problems will be resolved and we will reschedule another start-up date at the earliest possible date at no additional charge.

If the start-up cannot be performed due to an incomplete installation or for reasons beyond Katolight's control, you may incur an additional start-up charge at a later date.

Signature: _____ Date: _____

PO BOX 3329
100 Power Drive
Mankato, MN 56001
Phone: 507-625-7973
Fax: 507-625-2968
www.katolight.com

Zenith MX 100

Transfer Switch jumpers

Shaded areas are blind stabs and have no electrical connections. Example: if there is no jumper on W5 the board will recognize 60 hertz.
All of the stabs are paired except W14 FTS (L)

W4	60 HZ	
W5	50 HZ	
W6	3 PHASE	
W7	1 PHASE	
W8	ST MODEL	STANDARD MODEL
W9	DLY MODL	DELAY MODEL
W10	DIS CCTD	DISABLE COIL CONTROL TIME DELAY
W11	EN CCTD	ENABLE COIL CONTROL TIME DELAY
W12	TS (L)	TEST SWITCH WITH LOAD
W13	TS (NL)	TEST SWITCH WITH NO LOAD
W14	FTS (L)	FAST TEST SWITCH WITH LOAD (T) 30 SEC
W15	AUTO TST	FOR FACTORY USE
W16	RUN	
W17	ATR BYP	*NOT A BYPASS SWITCH* *exception see note below*
W18	ATR EN	*BYPASS SWITCH** exception see note below*

*For 600 amp units and above or for F17 transfer switches, change the jumper from ATR BYP to ATR EN

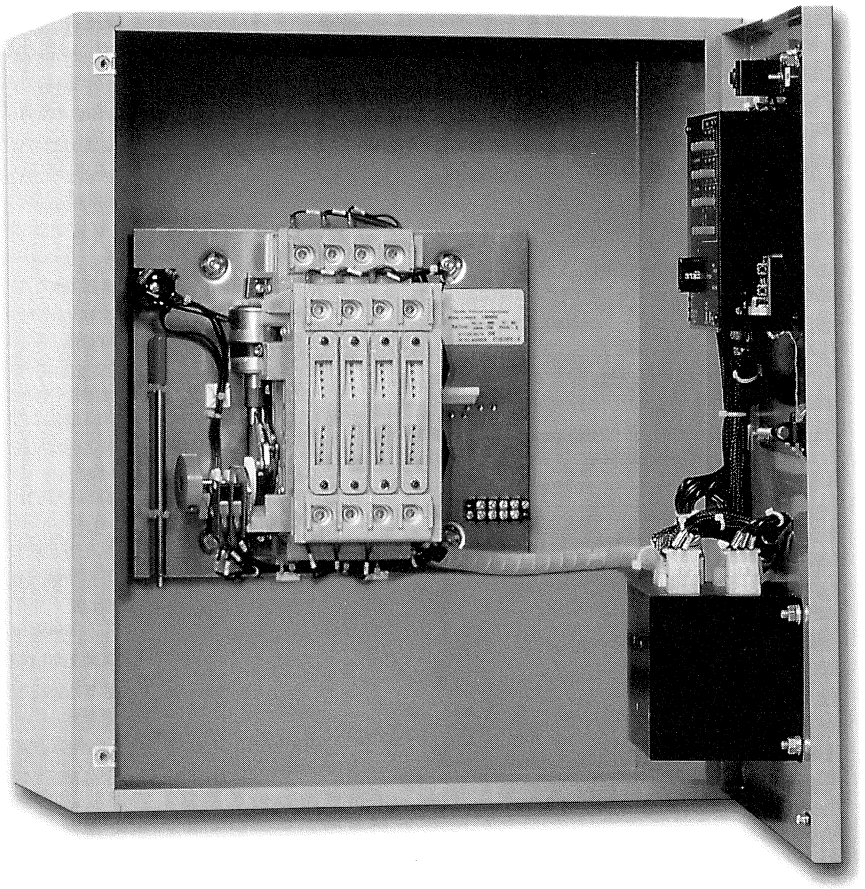
Zenith Coil Test Information

Part #	Line Voltage	Coil Resistance (Ω) ± 6%
K-2207	120	6.0
K-2208	208	18.1
K-2209	480	89.6
K-2211	277	44.7
K-2212	380/415	62.8
K-2213	575/600	162.4
K-2228	240	28.8
K-2229	120	1.8
K-2230	208	5.3
K-2231	240	5.3
K-2232	277	14.4
K-2233	380/415	20.1
K-2234	480	28.5
K-2235	575/600	47.2

Notes:

1. Full wave rectified DC for a pulse time of .5 sec
2. Duty cycle 10 %

GE Zenith Controls



52R-1000G
4/01

Katolight University - Ge

Operation and Maintenance Manual

Authorized Service

For GE parts and service, call: 773 299-6600

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Introduction

GE Zenith Transfer Switches are used to provide a continuous source of power for lighting and other critical loads by automatically transferring from the normal source of power to an emergency source of power in the event that the normal source voltage falls below preset limits.

Voltage sensing and system control is performed via a state-of-the-art microcontroller located on the cabinet door. It is designed to give highly accurate control of the transfer switch system.

All GE Zenith transfer switches are designed for use on emergency or standby systems, and are rated for total system or motor loads. Transfer switches are UL Listed under Standard 1008 and CSA Certified under Standard C22.2 No. 178 and IEC Listed under Standard 947.

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Safety

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

The safe operation of your switch is GE Zenith's focus. The proper storage, installation, operation and maintenance will help increase the life of the switch.

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

Equipment Inspection and Storage

Once you have received the transfer switch, inspect it for any damage. This includes damage to the enclosure, power panel, control panel and wiring harness. If any damage is found or suspected, file a claim as soon as possible with the carrier and notify the nearest GE Zenith representative.

Before installation, it is necessary to store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature	Operating Temperature (Ambient):	Humidity
-30°C to +75°C (-22°F to +167°F)	**40-400 AMP** *(molded shell)* -20°C to +65°C (-4°F to +149°F) **40-4000 AMP** *(all other frame and panel types)* -20°C to +60°C (-4°F to +140°F)	5% to 95% (non-condensing)

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred, with a vacuum, due to shipment or installation.

⚠ WARNING ⚠

Do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections.
4. Verify the correct connection of all control wires.
5. Check settings of all timers and adjust as necessary.
6. Adjust any optional accessories as required.
7. Check the lug torque values of the power connections.

NOTE: Lug torque values are specified in the power panel manual.

8. Make sure that all covers and barriers are installed and properly fastened.

NOTE: Power panels ship from GE Zenith in the Normal Position.

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Installation

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Each GE Zenith transfer switch is factory wired and tested. A complete information package is furnished with each switch which includes:

a. Sequence of operation.
b. Description and operation of all accessories supplied.
c. Power panel connection diagram and schematic.
d. Description and identification of all customer field connections.

Installation of GE Zenith transfer switches includes:

a. Mounting the transfer switch cabinet.
b. Connection of all Normal, Emergency, and Load cables or bus bars.
c. Connection of external control circuits as required.

Mounting

Adequate lifting means must be used to mount the transfer switch into place. The recommended method for moving the transfer switch using the lifting eyes, where supplied, and a spreader bar is illustrated in *Figure 1*. Enough room should be allowed to open the cabinet doors fully for inspection and servicing of the switch per NEC and local codes.

⚠ CAUTION ⚠

Before drilling conduit entry holes or any accessory mounting holes, cover and protect the switch and control panel to prevent dirt and metal fragments from entering the mechanical and electrical components.

Failure to do so may result in damage and malfunction of the switch.

Power Connections

GE Zenith transfer switches are supplied with UL listed solderless screw type terminals as standard for the Normal, Emergency and Load power connections. *Table 1* lists the number and sizes of cable lugs supplied as standard for each switch amp rating.

Connect the Normal, Emergency, and Load conductors to the clearly marked terminals on the transfer switch. Remove surface oxides from cables by cleaning with a wire brush. Verify that all connections are correct before tightening the lugs. All cable lug connections must be tightened to the proper torque values as shown in *Table 2*.

NOTE: Do not run cables or wiring behind front-connected transfer switches.

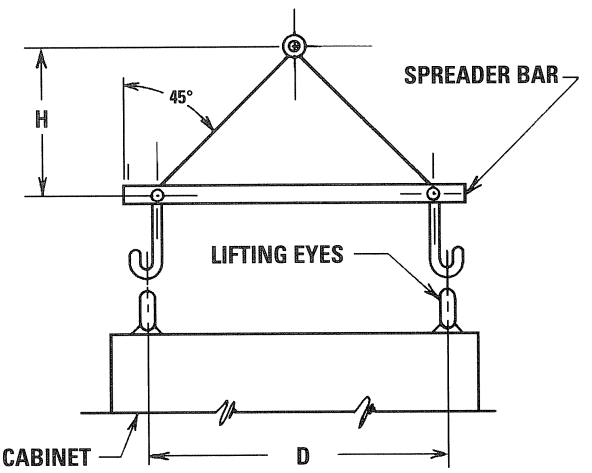

Figure 1

NOTE: When lifting the switch using a spreader bar, height H must be equal to half of distance D.

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Screw Type Terminals for External Power Connections				
Switch Size (Amps)	Normal, Emergency & Load Terminals		Neutral Bar (When Required)	
	Cable Per Pole	Range of Wire Sizes	No. of Cables	Range of Wire Sizes
40	1	#8 to 1/0 AWG	3	#8 to 1/0 AWG
80	1	#8 to 1/0 AWG	3	#8 to 1/0 AWG
100	1	#8 to 1/0 AWG	3	#8 to 1/0 AWG
150	1	#8 to 3/0 AWG	3	#8 AWG to 300 MCM
200, 225, 250*(1)	1	#6 AWG to 250 MCM	3	#6 AWG to 300 MCM
260, 300*, 400	1	#4 AWG to 600 MCM	3	#4 AWG to 300 MCM
600	2	#2 AWG to 600 MCM	8	#2 AWG to 600 MCM
800, 1000, 1200	4	#2 AWG to 600 MCM	12	#2 AWG to 600 MCM
1600, 2000 2600, 3000	8	#2 AWG to 600 MCM	12	#2 AWG to 600 MCM

Table 1 (1) 200 amp unit utilizes #6 ō 250 MCM wire effective approximately 11/1/00.

Engine Start Control Connections

Engine-start control wires connect to control terminals below of the MX100. Engine start terminals are indicated by a schematic symbol (the symbol indicates the contact state for a de-energized Normal source). *Figure 2* shows the engine-start contacts.

Make all other necessary control connections to the control panel terminal blocks per the schematics supplied with the ATS.

NOTE: All control wires (18-12 AWG) must be torqued to 19 in/lbs.

Tightening Torque for Lugs		
Socket Size Across Flats	Torque	
	Lb. - In.	Lb. - Ft.
1/8	45	4
5/32	100	8
3/16	120	10
7/32	150	12
1/4	200	17
5/16	275	23
3/8	375	31
1/2	500	42
9/16	600	50

Table 2

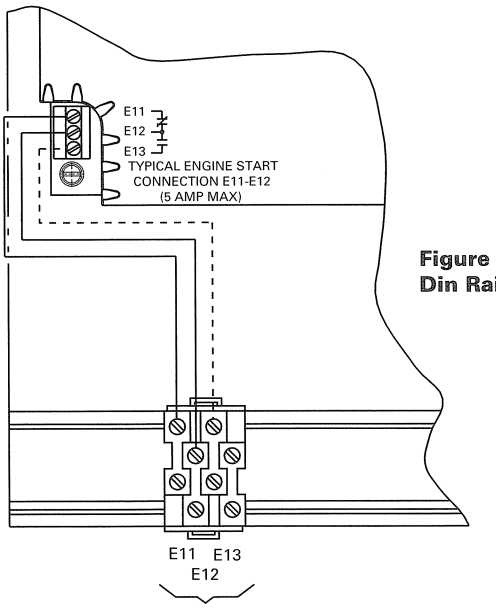

Figure 2 – Din Rail

The engine-start terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Terminals for field connections to the A3 Emergency auxiliary contacts and the A4 Normal auxiliary contacts are also provided. These terminals are clearly marked and appear on the side of the power panel (right hand side for 30-400 A switch). On 400 amp metal frame units these terminals appear on the bracket above the operator handle.

* IEC Ratings Only

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⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Functional Test

Functional testing of the ATS consists of electrical tests described in this section. Before proceeding, refer to the information package supplied with the ATS and read and understand the information on all accessories provided.

⚠ CAUTION ⚠

Certain accessories, per specific schematics, can inhibit automatic transfer.

1. Unlock the enclosure.
2. Open the enclosure.
3. Verify the correct system voltage.

NOTE: The equipment rating nameplate on the transfer switch lists the voltage. See *Figure 3*.

4. Close the Normal source circuit. breaker.

NOTE: The controller will illuminate the Normal Available LED if proper voltage is sensed.

WARNING – HIGH VOLTAGE SET

5. Verify the phase to phase voltages at the Normal line terminals.
6. Close the Emergency source circuit breaker.
7. Start the generator's engine.

NOTE: The controller will illuminate the Emergency Available LED when preset voltage and frequency levels are reached.

8. Verify the phase to phase voltages at the Emergency line terminals.
9. Verify that the phase rotation of the Emergency source is the same as the phase rotation of the Normal source.
10. Shut down the generator's engine.
11. Place the starting control in the Automatic position.
12. Complete the visual inspection of the transfer switch.
13. Close the enclosure.
14. Lock the enclosure.

GE Zenith Controls

SERIAL NUMBER:
RATING: VOLTS - HZ -
AMPS - PHASE -
SYSTEM VOLTS:
MODEL NUMBER:

Figure 3

⚠ CAUTION ⚠

Engine Gen-Set could start when engine control wires are attached.

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Initial Energization

After all options and accessories are checked and verified, follow these steps to set up the ATS. Refer to MX100 display *Figure 4*. The annunciation LEDs illuminate to indicate (1) source availability, (2) ATS position, and (3) MX100 control function (timing).

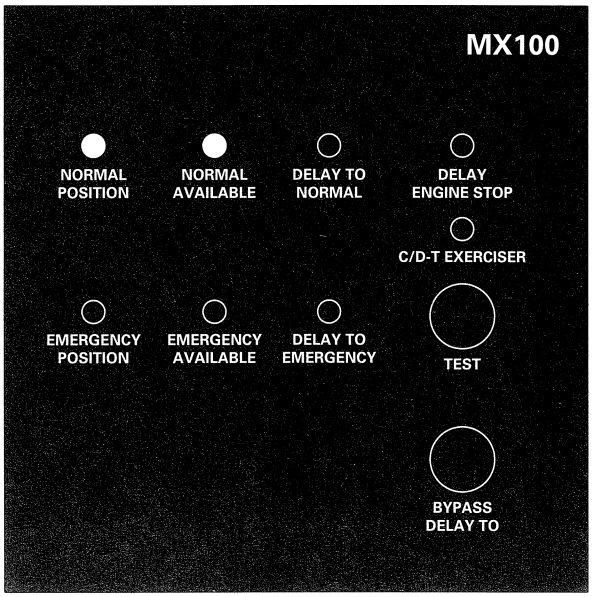

Figure 4 – Standard Transition Annunciation LEDs and Test Switch

NOTE: If LEDs are flashing, refer to Troubleshooting and Diagnostics.

1. Unlock the enclosure.
2. Open the enclosure.
3. Place the Disconnect Switch in the Inhibit.

NOTE: This step is only performed if the "DS" Option was purchased.

4. Close the external (up-stream) Normal circuit breaker.

NOTE: The normal Available and Normal Position LED's will illuminate.

NOTE: If the Normal Available LED does not illuminate, verify that the Normal Source Voltage is above the preset pick-up value.

NOTE: On the initial start-up, the Delay to Engine Stop Timing LED will illuminate for the duration of its setting.

NOTE: The Gen-Set will start and run while Delay to Engine Stop is timing.

5. Close the External (up-stream) Emergency line circuit breaker.
6. Start the engine generator in MANUAL mode.

NOTE: When the voltage and frequency reach preset values, the Emergency Available LED will illuminate.

7. Verify the phase to phase voltages at the Emergency line terminals.
8. Verify that the phase rotation of the Emergency source is the same as the phase rotation of the Normal source. (either A-B-C or A-C-B.)
9. Shut down the generator's engine. (Place in Automatic Mode.)

NOTE: The Emergency Available LED will turn off.

NOTE: The engine generator will continue to run if the Delay to Engine Stop LED is illuminated.

10. Place the disconnect switch to ENABLE.
11. Complete the visual inspection of the transfer switch.
12. Close the enclosure.
13. Lock the enclosure.

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Standard Transition ATS Testing (w/o A6 or T3/W3)

For this test description, please refer to MX100 standard transition display *Figure 4.*

Initiate testing with the ATS in Normal position and Normal power available (Normal Position and Normal Available LEDs illuminated).

Step 1: Press and hold the test switch until transfer.

NOTE: Releasing the test switch prematurely will abort the test.

The delay to engine start timer (P) begins its timing cycle. After the P timer has completed its timing cycle, the engine start contacts close to start the generator.

When Emergency voltage and frequency reach preset pickup points the Emergency Available LED illuminates. Simultaneously, the delay to emergency timer (W) begins its timing cycle and the Delay to Emergency LED illuminates. When the W time delay is completed the switch will transfer to emergency. The Delay to Emergency and Normal Position LEDs go off, and the Emergency Position LED illuminates.

Step 2: Release the test switch to start retransfer to Normal.

The delay to normal timer (T) begins its timing cycle illuminating the Delay to Normal LED. When the T timer has completed its timing cycle the switch will transfer into Normal. The Delay to Normal and Emergency Position LEDs go off, and the Normal Position LED illuminates. The delay engine stop timer (U) begins its timing cycle and the Delay Engine Stop LED illuminates. The generator runs unloaded for the duration of the U timing cycle. When the timer completes its timing cycle, the generator will stop. The Delay Engine Stop and the Emergency Available LEDs go off.

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

Delayed Transition ATS Testing

Refer to Delayed Transition display *Figure 5.* Initiate testing with the ATS in Normal position and Normal power available (Normal Position and Normal Available LEDs illuminated).

Step 1: Press and hold the test switch until transfer (releasing the test switch prematurely will abort the test).

The delay to engine start timer (P) begins its timing cycle. After the P time delay the engine start contacts close to start the generator.

When Emergency voltage and frequency reach the preset pickup points the Emergency Available LED illuminates. Simultaneously, the delay to open normal timer (W) begins its timing cycle and the Delay to Open Normal LED illuminates. After the W time delay the ATS transfers out of Normal position into the Open position. The Delay to Open Normal and Normal Position LEDs go off, and the Open Position and Delay to Emergency LEDs illuminate.

Step 2: Release the test switch.

Time delay to emergency (DW) then begins. When the DW time delay is completed the switch will transfer to Emergency. The Delay to Emergency and Open Position LEDs go off, and the Emergency Position LED illuminates.

The MX100 microcontroller will automatically begin the retransfer sequence to Normal. The delay to open emergency (T) timer begins its timing cycle and the Delay to Open Emergency LED illuminates. When the T timer has completed its timing cycle, the ATS transfers to the open position. The Delay to Open Emergency and the Emergency Position LEDs turn off, and the Open Position and the Delay to Normal LEDs illuminate. The delay to normal timer (DT) then begins its timing cycle illuminating the Delay to Normal LED. When the DT timer has completed its timing cycle the ATS will transfer out of the open position into the Normal position. Delay to Normal and the Open Position LEDs turn off, and the Normal Position LED illuminates.

The delay engine stop timer (U) begins its timing cycle and the Delay Engine Stop LED illuminates. The generator runs unloaded for the duration of the U timing cycle. Upon completion of the U time delay, the generator will stop. The Delay Engine Stop and the Emergency Available LEDs go off.

Operation and Testing *(cont'd)*

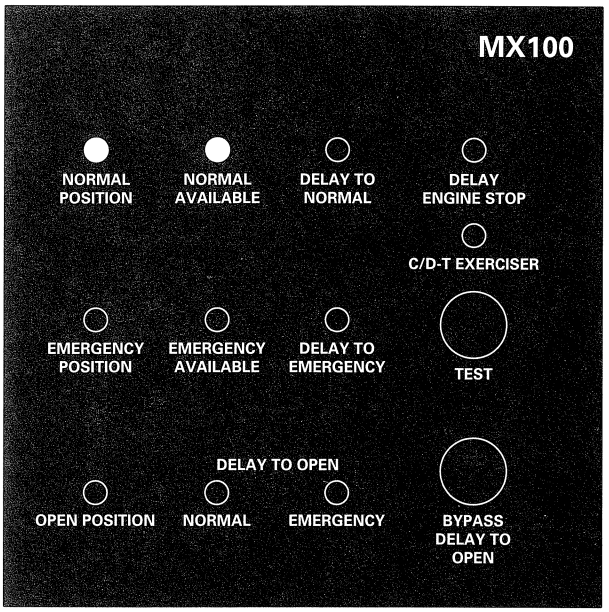

Figure 5 – Delayed Transition Annunciation LEDs and Test Switch

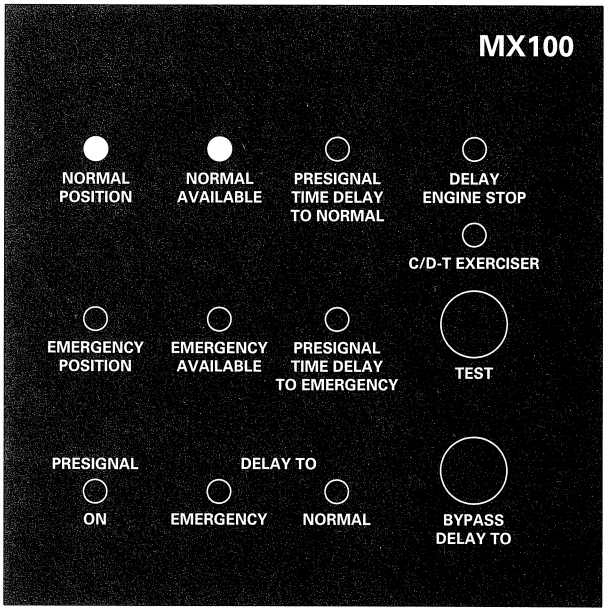

Figure 6 – Standard Transition w/A6 Annunciation LEDs and Test Switch

Standard Transition Transfer Sequence (w/o A6 or T3/W3)	LED Annunciation Status						
	Normal Position	Normal Available	Emergency Position	Emergency Available	Delay to Normal	Delay to Emergency	Delay Engine Stop
Normal Position	●	●					
W Time Delay	●	○		●		●	
Emergency Position		○	●	●			
T Time Delay		●	●	●	●		
Normal Position/ Engine Overrun Timer	●	●		●			●

○ Illuminated only when running TEST, not on Normal power failure

Delay Transition Transfer Sequence	LED Annunciation Status									
	Normal Position	Normal Available	Emergency Position	Emergency Available	Delay to Normal	Delay to Emergency	Delay Engine Stop	Open Position	Delay to Open Normal	Delay to Open Emergency
Normal Position	●	●								
W Time Delay	●	○		●					●	
Open Position/DW Time Delay		○		●		●		●		
Emergency Position		○	●	●						
T Time Delay		●	●	●						●
Open Position/DT Time Delay		●		●	●			●		
Normal Position/ Engine Overrun Timer	●	●		●			●			

○ Illuminated only when running TEST, not on Normal power failure

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Standard Transition ATS Testing (w/A6 or T3/W3)

Refer to Standard Transition w/A6 or T3/W3 display *Figure 6.* Initiate testing with the ATS in Normal position and Normal power available (Normal Position and Normal Available LEDs illuminated).

Press and hold the test switch until transfer (releasing the test switch prematurely will abort the test).

The delay to engine start timer (P) begins its timing cycle. After the P time delay the engine start contacts close to start the generator.

When Emergency voltage and frequency reach the preset pickup points the Emergency Available LED illuminates. Simultaneously, the delay to emergency timer (W) begins its timing cycle and the Delay to Emergency LED illuminates. After the W time delay the ATS presignal is initiated. The Delay to Emergency and Normal Position LEDs go off, and the Presignal On and Presignal Time Delay to Emergency LEDs illuminate.

Release the test switch.

Presignal Time Delay to emergency (TA6) then begins. When the TA6 time delay is completed, the switch will transfer to Emergency. The Presignal Time Delay to Emergency and Presignal On LEDs go off, and the Emergency Position LED illuminates.

The MX100 microcontroller will automatically begin the retransfer sequence to Normal. The delay to normal (T) timer begins its timing cycle and the Delay to Normal LED illuminates. When the T timer has completed its timing cycle, the ATS presignal is initiated. The Delay to Normal and the Emergency Position LEDs turn off, and the Presignal On and the Presignal Time Delay to Normal LEDs illuminate. The Presignal Time Delay to normal (TA5) then begins. When the TA5 timer has completed its timing cycle, the ATS will transfer to the Normal position. Presignal Time Delay to Normal and Presignal On LEDs turn off, and the Normal Position LED illuminates.

The delay engine stop timer (U) begins its timing cycle and the Delay Engine Stop LED illuminates. The generator runs unloaded for the duration of the U timing cycle. Upon completion of the U time delay, the generator will stop. The Delay Engine Stop and the Emergency Available LEDs go off.

The MX100 continuously monitors source voltage. In the event that Normal voltage falls below a preset drop-out value, the unit will perform in exactly the same way as noted in the test procedure (either standard transition or delayed transition).

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

Standard Transition Transfer w/A6 or T3/W3 Sequence	LED Annunciation Status									
	Normal Position	Normal Available	Emergency Position	Emergency Available	Presignal Time Delay to Normal	Presignal Time Delay to Emergency	Delay Engine Stop	Presignal On	Delay to Emergency	Delay to Normal
Normal Position	●	●								
W Time Delay	●	○		●					●	
Open Position/TA6 Time Delay		○		●		●		●		
Emergency Position		○	●	●						
T Time Delay		●	●	●						●
Open Position/TA5 Time Delay		●		●	●			●		
Normal Position/ Engine Overrun Timer	●	●		●			●			

○ Illuminated only when running TEST, not on Normal power failure

Sequence of Operation - Standard Transition

Operation Sequence

Normal Power Failure. When Normal voltage has fallen below the preset dropout value, the engine start (P) timer begins its timing cycle (factory set 3 seconds). The P timer allows for momentary under-voltage conditions in the Normal source without triggering the generator to start. If the Normal voltage remains below the dropout point throughout the P timing cycle, a generator start signal will be sent. The MX100 then monitors generator voltage and frequency to determine if they are within preset parameters. When the generator voltage and frequency reach acceptable limits the W timer begins its timing cycle. The W timer governs either the time delay for transfer to Emergency or to the open position (standard or delayed transition, respectively). The W timer (typically 1 second) assures that the generator voltage and frequency are stable before transfer. The transfer to Emergency sequence is then completed as follows:

Standard Transition—after the W time delay, the ATS transfers to Emergency position and load power is supplied by the generator.

Delayed Transition—following the W time delay, the switch opens out of Normal to the Open position. The DW timer is activated. The DW time delay is typically set to 5 seconds. After the DW time delay, the switch completes transfer to Emergency.

Standard Transition w/A6 or T3/W3—following the W time delay, the presignal is initiated. The TA6 timer is started. The TA6 time delay is typically set to 5 seconds. After the TA6, the ATS transfers to Emergency.

When the W time is completed, the CCE relay energizes the CE solenoid to close the transfer switch into the emergency source. The SE limit switch activates to de-energize the CCE relay.

Restoration of Normal Power. When Normal power reaches the preset pickup value, the T timer begins its timing cycle (factory set 30 minutes). The T timer is used to ensure that the Normal source has fully restored before retransfer. If Normal voltage remains above the pickup values for the duration of the T timer, transfer to Normal position is performed. Retransfer is accomplished as follows:

Standard Transition—ATS transfers to the Normal position and the load power is supplied by utility.

Delayed Transition—the switch opens out of Emergency to the Open position. The DT timer activates, typically set to 5 seconds. After the DT time delay, the switch completes transfer to Normal.

Standard Transition w/A6 or T3/W3—following the T time delay, the presignal is initiated. The TA5 timer is started. The TA5 time delay is typically set to 5 seconds. After the TA5, the ATS transfers to Normal.

When the T time delay is completed, the CCN relay energizes the CN solenoid to retransfer the switch into the normal source. The SN limit switch activates to de-energize the CCN relay. Simultaneously, the engine over-run timer U begins its timing cycle. This timer provides a period of time for the engine generator to run without load and cool down before shutdown.

Control Features

A6. Motor load disconnect capability (standard transition only). Ensures that closing into the oncoming source does not create a large disturbance due to phase angle difference between the load and the oncoming source. Motor loads can be disconnected for an adjustable period of 0-60 seconds prior to transfer of the main contacts. This feature includes LEDs to indicate when the motor load is disconnected.

CDT Exerciser. A built in 7 day exerciser timer is incorporated into the MX100, (standard feature, all models). Pressing the initiate switch will start a timer that will continue for 167 hours and 40 minutes. Along with initiating the timer, an LED will illuminate to indicate that the timer has been started. After 167 hours and 40 minutes, a load test (ATS transfers to Emergency) or a no load test (ATS signals the genset to start but does not transfer) occurs. The exercise mode is determined by the MX100 PCboard jumper location (TSL = load, TSNL = no load). The test lasts for 20 minutes. The CDT Exerciser LED will flash when the exercising is in progress. This 20 minute exercise does not include the time delay to retransfer to normal (T timer) when the ATS is transferred (load test) or the time delay engine stop (U timer) for either load or no load tests. Disabling the exercise event is done by pressing the disable/enable switch. When this is done the exercise event will not occur, although the timer will not be affected. The CDT Exerciser LED will turn off when the disable/enable switch is pressed for the first time after initiating the timer. Pressing the disable/enable switch again will re-enable the exercise event while turning the CDT Exerciser LED back on. The time of the exercise event can be changed by re-initiating the event. The time that the button is pressed will be the end of the exercise event one week later.

CDT Exerciser Notes

1. To avoid unintentional intiating/disabling the button should be held down for 3 seconds when pressed.
2. A 9V battery is supplied to prevent CDT exercise timer from losing it's "set exercise time" in the event of an extended power outage. The battery can back up the processor for up to 8 hours. The battery should be replaced if it has supplied power to the microprocessor for an extended outage.
3. The 9V battery cannot be plugged into a PCboard that is deenergized. The PCboard includes large capacitors that the battery will not be able to charge. If the capacitors are charged, the battery will still discharge eventually due to the load of the PCboard. Therefore, do not install a battery until the PCboard is energized. The battery will then be able to maintain the CDT "set exercise time" in the event of an extended outage.

R50. In-phase monitor (standard transition w/o A6 only). R50 ensures that the phase angle difference between the load voltage and the oncoming source voltage is minimal (live source-to source transfers). The feature requires a fast acting transfer switch, therefore is only available with a standard transition ATS. The in-phase monitor is suitable for isochronous through 3% droop governors. The microprocessor anticipates the synchronized condition by monitoring the phase angle and frequency differential between the sources. Then it signals a transfer at the precise moment to ensure minimal phase difference between the sources at the completion of transfer. R50 also includes a PCboard-mounted switch to override the in-phase monitor function if necessary. The override toggle switch is located below the MX100 cover, but the toggle position to enable or disable the function is clearly indicated on the cover.

YEN. Pushbutton time delay transfer/retransfer bypass.

Control Options

Six control input options can be used with the MX100:

- 6A
- C
- C/D
- D
- Q2
- ZNET100

Note: Consult the factory when field adding Q2 option.

6A. Maintained test switch. An auxiliary two position maintained test switch is located on the cabinet door. This is in addition to the standard test switch found on all MX100 models. When the auxiliary test switch is activated in the TEST position, it will simulate a Normal line failure. The transfer switch will automatically transfer the load to the Emergency position. When the test switch is returned to the AUTOMATIC position the transfer switch will restore the load to the Normal position. Should Emergency fail while ATS is in Emergency position the ATS will transfer back to Normal immediately, if Normal is available.

C. *Plant Exerciser.* Automatically starts generator for selected time intervals. Runs generator unloaded.

C/D. *Plant Exerciser.* Automatically starts generator to run unloaded, or simulate a power failure and starts generator to run under load.

D. *Plant Exerciser.* Automatically starts generator for select time intervals. Simulates a power failure and runs generator under load.

Q2. *Connections for remote peak shave or area protection.* Includes bypass for immediate return to Normal if Emergency line fails and Normal is available.

ZNET100. *Communication Capability.* The MX100 can be equipped with an optional network card that allows digital communication of ATS position, source availability, control timers and test mode. A test signal can also be initiated from a remote PC or annunciator panel. Communication is via one twisted pair of wires.

Sequence of Operation - Delayed Transition

Transfer of the load to the Emergency source begins automatically when any phase of the Normal source falls below the preset dropout point and this under-voltage failure condition is detected by the MX100 microcontroller. The engine start timer P begins its timing cycle. The P time delay is provided to override momentary outages and to prevent nuisance starting of the engine generator. If the Normal source voltage returns above the pickup setting, the P timing cycle is reset, and the transfer sequence is stopped.

If the normal source voltage does not return before the P time delay is completed, the P timer drops out and sends a starting signal to the engine generator. The microcontroller senses the voltage and frequency of the Emergency source. When both the voltage and the frequency of the Emergency source reach the preset values timer W begins its timing cycle. The W timer provides an adjustable transfer delay to the Emergency source as required.

When the W time is completed, the CCNO relay energizes the CNO solenoid to open the transfer switch out of the Normal source. The switch is now in a neutral (both sources open) position. The switch remains in a neutral position for the duration of the DW time delay. DW is an adjustable time delay between the opening of the Normal source and closing into the Emergency source.

After the DW time delay has elapsed, the CCE relay energizes. The switch then completes transfer to the Emergency source by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

The sequence for retransfer to the Normal source begins automatically when the microcontroller detects that the voltage on all phases of the Normal source has been restored.

When the Normal source restores, switching to the Normal source is initiated by energizing timer T, beginning its timer cycle. The T timer provides an adjustable delay to insure that the Normal source has stabilized before reconnection to the load. If the Normal source fails before the T time delay completes, the retransfer sequence is stopped.

When the T time delay is completed, the CCEO relay energizes the CEO solenoid to open the switch out of Emergency and into a neutral position. The switch remains in neutral for the DT time delay. When the DT time delay has elapsed, the CCN relay energizes the CN solenoid to complete retransfer of the switch into the normal source. The SN limit switch activates to de-energize the CCN relay. Simultaneously, the engine overrun timer U begins its timing cycle. This timer provides a period of time for the engine generator to run without load and cool down before shutdown.

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User Settings

All user settings are adjustable on the back of the MX100 display. *Figure 6* shows the MX100 user adjustments.

Voltage and Frequency Pickup/Dropout Adjustments

Normal Pickup Voltage %: Pickup voltage is adjustable from 85 to 100% of nominal line voltage. Standard factory setting is 90%.

Normal Dropout Voltage %: The dropout voltage is adjustable from 75 to 98% of nominal line voltage. Standard factory setting is 80%. Dropout must be a minimum of 2% below Normal pickup voltage under all conditions. Note: The microprocessor will automatically set the Normal dropout voltage 2% below the Normal pickup voltage if it is not properly set by the user.

Normal Pickup Frequency %: The pickup frequency is adjustable from 90 to 100% of nominal line frequency. Standard factory setting is 90%.

Emergency Pickup Voltage %: The pickup voltage is adjustable 85 to 100% of nominal line voltage. The standard factory setting is 90%.

Emergency Dropout Voltage %: The dropout voltage is adjustable from 75 to 98% of nominal line voltage. Standard factory setting is 80%. Emergency dropout voltage must be a minimum of 2% below emergency pickup voltage under all conditions. *Note:* The microprocessor will automatically set the Emergency dropout voltage 2% below the Emergency pickup voltage if it is not properly set by the user.

Emergency Pickup Frequency %: The pickup frequency is adjustable from 90 to 100% of nominal line frequency. Dropout is fixed at 2 Hz below pickup. Dropout has a 5 second delay. Standard factory setting is 95%.

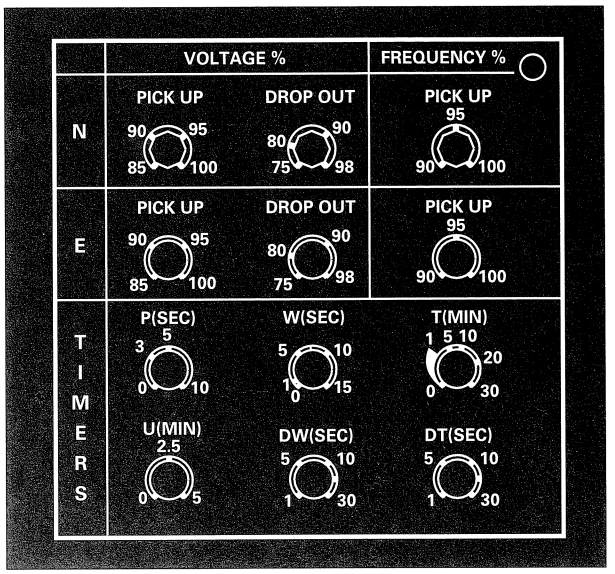

Figure 7 – Delayed Transition User Adjustments

Factory Settings of Voltage, Frequency and Timer Adjustments	
Normal Pickup Voltage	90% Nominal V
Normal Dropout Voltage	80% Nominal V
Normal Pickup Frequency	90% Nominal F
Emergency Pickup Voltage	90% Nominal V
Emergency Dropout Voltage	80% Nominal V
Emergency Pickup Frequency	95% Nominal F
P Timer	3 seconds
W Timer	1 second
T Timer	30 minutes
U Timer	5 minutes
DW Timer *	5 seconds
DT Timer *	5 seconds
TA5 **	5 seconds
TA6 **	5 seconds

* Delayed
** Standard w/A6 or T3/W3
V = Line Voltage
F = Line Frequency

NOTE: All adjustments are factory preset to values in the table above, unless otherwise specified by the user.

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Timer Adjustments

P Timer (delay to engine start). Time delay before engine start after Normal voltage failure: adjustable 0 to 10 seconds. P timer is designed to avoid engine starts on momentary Normal source failures. Standard factory setting is 3 seconds.

W Timer (delay to Emergency or delay to open Normal timer). Time delay before initiating transfer to Emergency: adjustable 0 to 15 seconds. Standard factory setting is 1 second. After the successful acquisition of correct Emergency voltage and frequency, the W timer function provides a time delay before initiating transfer to Emergency. This permits the Emergency source to stabilize. On completion of the time out, transfer to Emergency is initiated.

Transfer to Emergency is non-commit. This means that should the Normal voltage be restored before the timeout of the W timer, the ATS will remain in the Normal position and initiate the delay to engine stop timer.

T Timer (delay to Normal or delay to open Emergency). Time delay before initiating retransfer to Normal: adjustable 0 to 30 minutes. Standard factory setting is 30 minutes. On return of acceptable Normal voltage the time delay is initiated. T time delay ensures Normal source has stabilized before transferring to Normal position. On completion of the time out, transfer to Normal is initiated. Should Emergency power fail when the ATS is in the Emergency position, the T timer function will be bypassed when normal power is restored.

U Timer (delay engine stop). Time delay to engine stop, after retransfer to Normal, for purpose of cooling the engine after the load is removed: adjustable 0 to 5 minutes. Standard factory setting is 5 minutes.

DW Timer (time delay from Open position to Emergency position). Delayed Transition Transfer only: adjustable 0 to 30 seconds. Standard factory setting is 5 seconds. DW timer activates when the switch enters open position on a transfer from Normal to Emergency. After time out, the transfer to Emergency is complete.

DT Timer (time delay from Open position to Normal position). Delayed Transition Transfer only: adjustable 0 to 30 seconds. Standard factory setting is 5 seconds. DT timer activates when the switch enters the open position on transfer from Emergency to Normal. After time out, the transfer to Normal is complete.

MX100, Standard Transition w/A6 or T3/W3 (A6 = motor load disconnect circuit) (T3/W3 = elevator presignal circuit)

TA5 (presignal time delay to normal). Time delay is available only on standard transition ATSs specifically configured with the presignal circuit. Adjustable 0 to 30 seconds. Standard factory setting is 5 seconds.

TA6 (presignal time delay to emergency). Time delay is available only on standard transition ATSs specifically configured with the presignal circuit. Adjustable 0 to 30 seconds. Standard factory setting is 5 seconds.

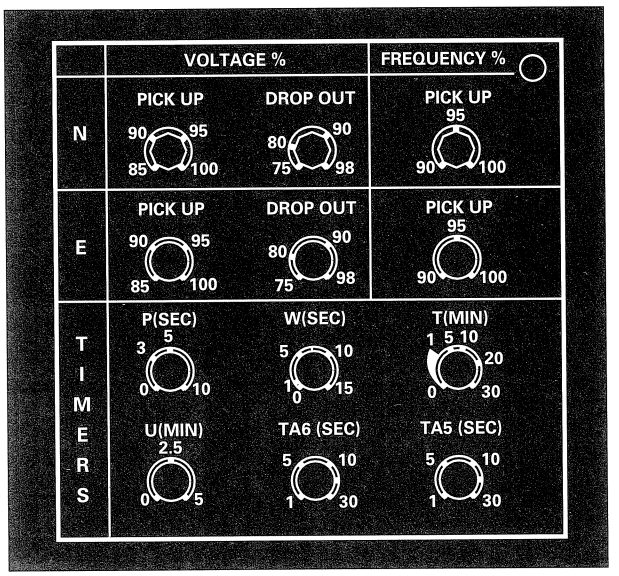

Figure 8 - Standard Transition w/A6 or T3/W3 User Adjustments

Maintenance and Testing

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

⚠ WARNING ⚠

Both power sources must be disconnected before manual operation of the switch.

A preventive maintenance program will insure high reliability and long life for the transfer switch. The preventive maintenance program for the transfer switch should include the following items:

Inspection and Cleaning

The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (do not use emery cloth or a file). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken or badly worn parts.

Servicing

All worn or inoperative parts must be replaced using GE Zenith recommended replacement parts. Please refer to the Replacement Parts manual for specific part information and ordering procedures. Please contact the GE Zenith Technical Services Department for the Replacement Parts manual.

The operating mechanism of the transfer switch is lubricated with Lubriplate 105. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional Lubriplate.

GE Zenith can provide complete preventative maintenance services. Please contact the GE Zenith Technical Services Department for additional information.

Testing

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. **Both power sources must be disconnected before manual operation of the switch.** Insert the handle and operate the transfer switch between the Normal and Emergency positions. The transfer switch should operate smoothly without binding. Return the switch to the Normal position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the TS test switch. P timer will time out and the micro-controller will send an engine start signal. When the W time has elapsed, the switch will complete its transfer by closing into the Emergency source.

Deactivating the test switch will start retransfer to the Normal source. The switch will complete its retransfer to Normal after the time delay of the T timer. The U engine overrun timer allows the engine generator to run unloaded for a preset cool down period.

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

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Troubleshooting and Diagnostics

⚠ DANGER ⚠

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.
These charts may indicate problems that require authorized GE Zenith service personnel.
Hazardous voltages may exist on termination plugs other than those that go into the MX100.

General Troubleshooting

The following troubleshooting guide is used to recognize, and determine basic faults. When using this guide, it will ask several questions about the condition of the switch. This guide will then list an order of the possible faults. You will then look at the first suspected fault to determine if it is the problem. If it is not a fault, you go to the second suspected fault. If you go through all of the suspected faults, or the chart instructs you to, call a GE Zenith Representative for further assistance.

NOTE: When you use the troubleshooting charts, the Annunciation column refers to the LED's on the control panel.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
No engine start	EMERGENCY AVAILABLE LED off	Engine start wires not properly connected	Check engine start connections (Figure 2).
		Generator is in OFF position	Place Engine Control Switch in AUTO.
No engine stop	DELAY TO ENGINE STOP LED on	U timing cycle not complete	Check U timer setting.
	NORMAL AVAILABLE, NORMAL POSITION, and EMERGENCY AVAILABLE LEDs on	Engine start wires not properly connected	Check engine start connections (Figure 2).
		Generator in MANUAL	Place Engine Control Switch in AUTO.
ATS will not transfer to EMERGENCY	EMERGENCY AVAILABLE LED off	Emergency voltage or frequency not within settings	Check: engine start connections, generator breaker closed, generator output (compare to MX100 settings) and place engine control switch in AUTO.
	All LEDs off	Power supply harness unplugged (18 pin connector on MX100)	Plug in harness.
	NORMAL POSITION and EMERGENCY POSITION flashing	Limit switch harness unplugged	Plug in harness.
	DELAY TO OPEN NORMAL LED on	**W** timing cycle not complete	Check **W** Timer setting.
ATS will not transfer to NORMAL	NORMAL AVAILABLE LED off	Normal voltage or frequency not within acceptable parameters	Check: normal voltage within MX100 settings; verify Normal breaker source breaker is closed.
	All LEDs off	Power supply harness unplugged (18 pin connector on MX100)	Plug in harness.
	NORMAL POSITION and EMERGENCY POSITION LEDs flashing	Limit switch harness unplugged	Plug in harness.
	DELAY TO OPEN EMERGENCY LED on	**T** timing cycle not complete	Check **T** Timer setting.
Improper LED annunciation	Neither source available LEDs illuminate, position LED only	MX100 PC board may be configured for wrong frequency (60 Hz vs. 50 Hz)	1. Verify source voltage and frequency. 2. Consult GE Zenith Controls for information to reconfigure hardware.
	NORMAL and/or EMERGENCY AVAILABLE LEDs on when frequency is below the present pick up value	MX100 PC board may be configured for wrong frequency (60 Hz vs. 50 Hz)	1. Verify source voltage and frequency. 2. Consult GE Zenith Controls for information to reconfigure hardware.

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Diagnostic Annunciation

The MX100 controller incorporates diagnostics that allows ease of troubleshooting. Diagnostic annunciations are flashing position LEDs. The symptoms that the diagnostic annunciation indicate include inhibiting transfer or incorrect transfer sequence. A more general troubleshooting chart that addresses system problems precedes these charts.

⚠ DANGER ⚠

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.

These charts may indicate problems that require authorized GE Zenith service personnel.

Hazardous voltages may exist on termination plugs other than those that go into the MX100.

Standard Transition ATS

(Two Position ATS—Normal and Emergency)
(Not for Standard Transition w/A6)

⚠ WARNING ⚠

If limit switch plug is disconnected or reconnected and power is available, the switch may transfer.

Use caution when servicing.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
ATS will not transfer out of Normal	Flashing NORMAL POSITION LED	Solenoid circuit	Contact authorized GE Zenith service representative.
ATS will not transfer out of Emergency	Flashing EMERGENCY POSITION LED	Solenoid circuit	Contact authorized GE Zenith service representative.
ATS will not transfer; ATS is not in a defined position as indicated by the limit switch contact (no SN or SE limit switch input)	Flashing NORMAL POSITION and EMERGENCY POSITION LEDs	1. Limit switch plugs not connected 2. Limit switches not within adjustment	1. Connect all plugs to the MX100. 2. Contact authorized GE Zenith service representative.

Troubleshooting and Diagnostics *(cont'd)*

Delayed Transition ATS

(Three Position ATS—Normal, Open and Emergency)

⚠ WARNING ⚠

If limit switch plug is disconnected or reconnected and power is available, the switch may transfer.

Use caution when servicing.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
ATS will not transfer out of Normal	Flashing NORMAL POSITION LED	Solenoid circuit	Put ZTG in AUTO. Disconnect and reconnect MX100 18 pin plug. Contact authorized GE Zenith service representative.
ATS will not transfer out of Emergency	Flashing EMERGENCY POSITION LED	Solenoid circuit	Put ZTG in AUTO. Disconnect and reconnect MX100 18 pin plug. Contact authorized GE Zenith service representative.
ATS will not transfer out of Open position	Flashing OPEN POSITION LED	Solenoid circuit	Put ZTG in AUTO (ref. ZTC Power Panel Manual 51R-1000). Disconnect and reconnect MX100 18 pin plug. Contact authorized GE Zenith service representative.
ATS is not in a defined position as indicated by the limit switch contacts (no SN or SNO limit switch inputs)	Flashing NORMAL POSITION and OPEN POSITION LEDs	Limit switches not registered as opened or closed	Contact authorized GE Zenith service representative.
ATS is not in a defined position as indicated by the limit switch contacts (no SN or SEO limit switch inputs)	Flashing EMERGENCY POSITION and OPEN POSITION LEDs	Limit switches not registered as opened or closed	Contact authorized GE Zenith service representative.
ATS is not in a defined position as indicated by the limit switch contacts (no SN, SE, SNO, or SEO limit switch inputs)	Flashing NORMAL POSITION, OPEN POSITION and EMERGENCY POSITION LEDs	1. Limit switch plugs not connected 2. Limit switches not registered as opened or closed	Connect all plugs to the MX100.

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Standard Transition ATS (with A6)

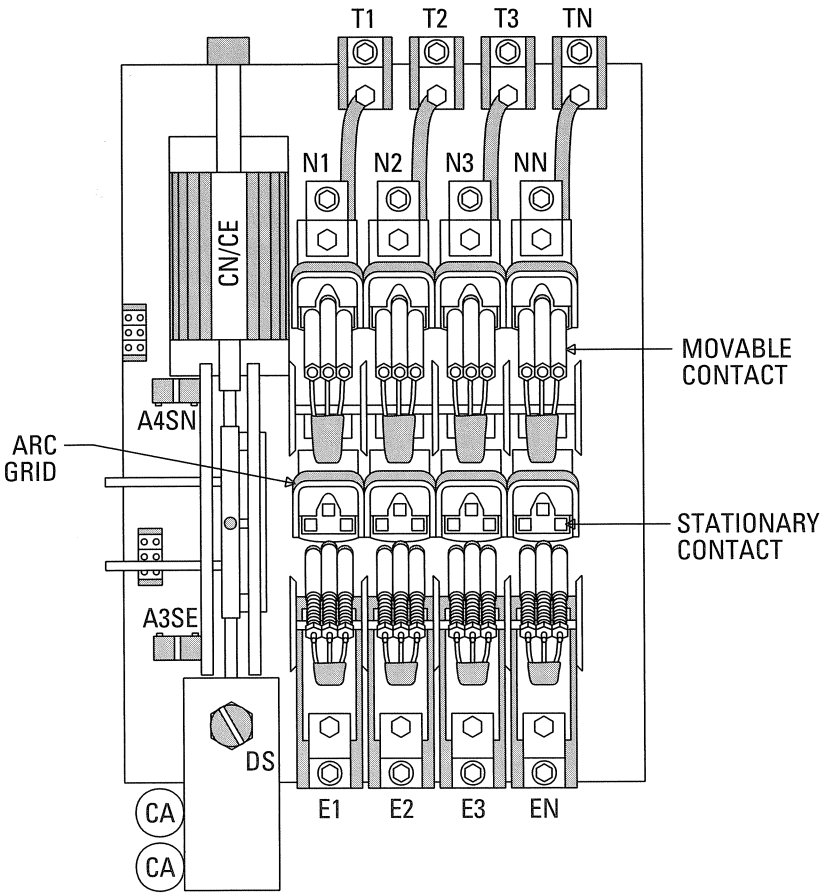
⚠ WARNING ⚠

If limit switch plug is disconnected or reconnected and power is available, the switch may transfer.

Use caution when servicing.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
ATS will not transfer out of Normal; motor load still connected	Flashing NORMAL POSITION LED	Motor load disconnect relay is not latching	Check connections to RA6 relay.
ATS will not transfer out of Emergency; motor load still connected	Flashing EMERGENCY POSITION LED	Motor load disconnect relay is latched	Check connections to RA6 relay.
ATS will not transfer after motor load disconnect operated	Flashing MOTOR CONTROL OFF LED	Solenoid circuit	Contact authorized GE Zenith service representative.
ATS is not in a defined position as indicated by the limit switch contacts (no SN or RA6 limit switch inputs)	Flashing NORMAL POSITION and MOTOR CONTROL OFF LEDs	Limit switches not registered as closed or RA6 contact is not registered	Contact authorized GE Zenith service representative.
ATS is not in a defined position as indicated by the limit switch contacts (no SE or RA6 limit switch inputs)	Flashing EMERGENCY POSITION and MOTOR CONTROL OFF LEDs	Limit switches not registered as closed or RA6 contact is not registered	Contact authorized GE Zenith service representative.
ATS is not in a defined position as indicated by the limit switch contacts (no SN, SE, SNO, or SEO limit switch inputs)	Flashing NORMAL POSITION, OPEN POSITION and EMERGENCY POSITION LEDs	1. Limit switch plugs not connected 2. Limit switches not registered as opened or closed	Connect all plugs to the MX100.

Power Panel — 40 to 260 Amps Linear Actuator Type



Tag	Description	Recommended as Spares	Stock Numbers by Amperage					
			40	80	100	150	225	260
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug		PS-4419	PS-4423	PS-4423	27P-1128	27P-1126	27P-1127
	Wire Size		#14-2	#14-1/0	#14-1/0	#8-3/0	#6 to 250 MCM	#6 to 350 MCM
	Stationary Contact Assembly Kit		27P-1141	27P-1141	27P-1141	27P-1111	27P-1111	27P-1111
	Stationary Load Contact Assembly Kit		27P-1140	27P-1140	27P-1140	27P-1109	27P-1109	27P-1109
	Arc Grid Assembly Kit		27P-1142	27P-1142	27P-1142	27P-1142	27P-1142	27P-1142
	Movable Contact Assembly Kit		27P-1036	27P-1036	27P-1036	27P-1037	27P-1037	27P-1037
CN/CE, CA	Linear Actuator and Capacitors	*				CA (See Note)		
	Note: 2S denotes two capacitors wired in series		Coil Volts	Poles	CN/CE	Quantity	Part	mf
			120	2	K-2104PN	1	PS-4007	340-408
			240	2	K-2105PN	1	PS-4016	108-130
				3				
			208	3	K-2141PN	1	PS-4084	145-174
				4	K-2142PN	1	PS-4084	145-174
			575/600	3	K-2198PN	2S	PS-4083	36-43
				4	K-2197PN	2S	PS-4083	36-43
			480	3	K-2119PN	2S	PS-4008	72-86
				4	K-2111PN	2S	PS-4008	72-86
			416	3	K-2190PN	2S	PS-4008	72-86
SN	CN1 Cut-out Switch		L-5022					
SE	CE1 Cut-out Switch		L-5022					
A3	Emergency Position Auxiliary Contact		SPDT, L-5022; DPDT, L-5021					
A4	Normal Position Auxiliary Contact		SPDT, L-5022; DPDT, L-5021					
DS	Disconnect Switch (older versions)	*	Operator L-4018; Contact Block L-1028					

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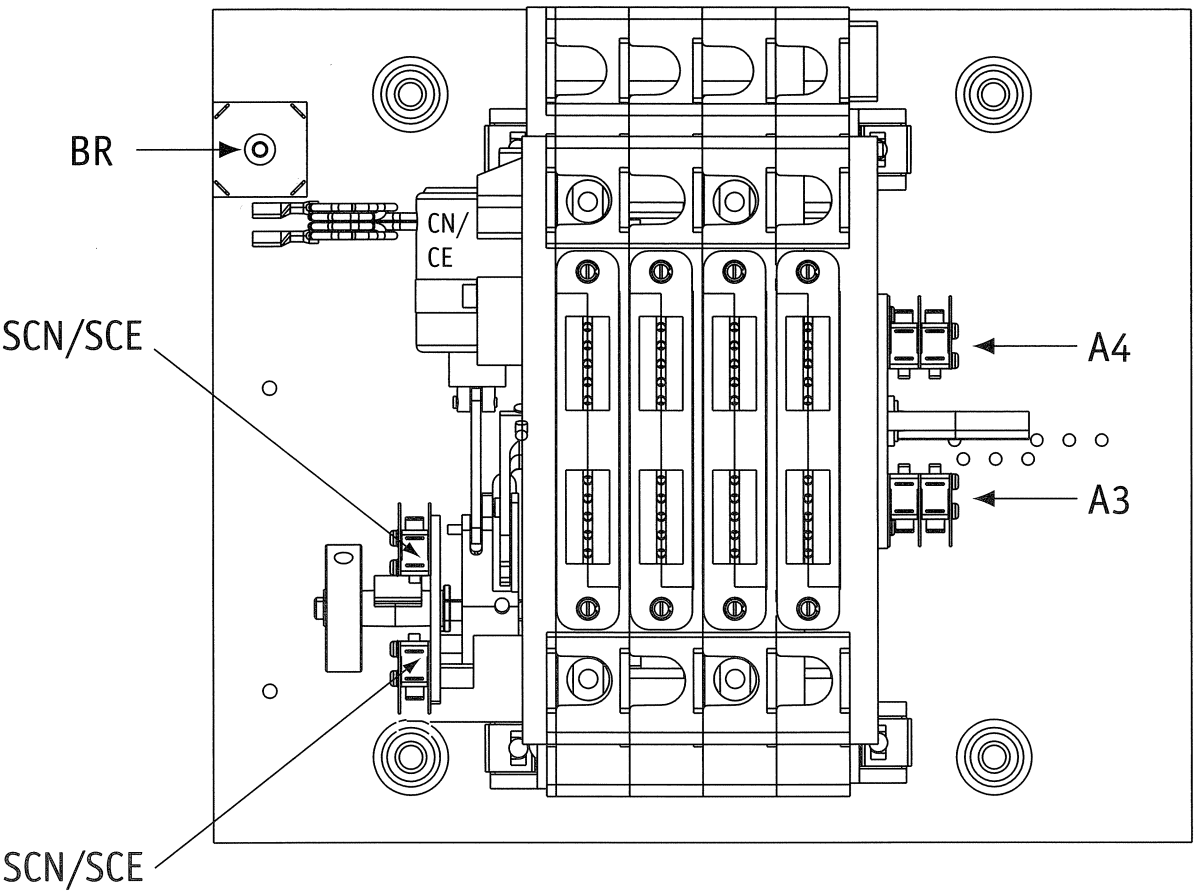
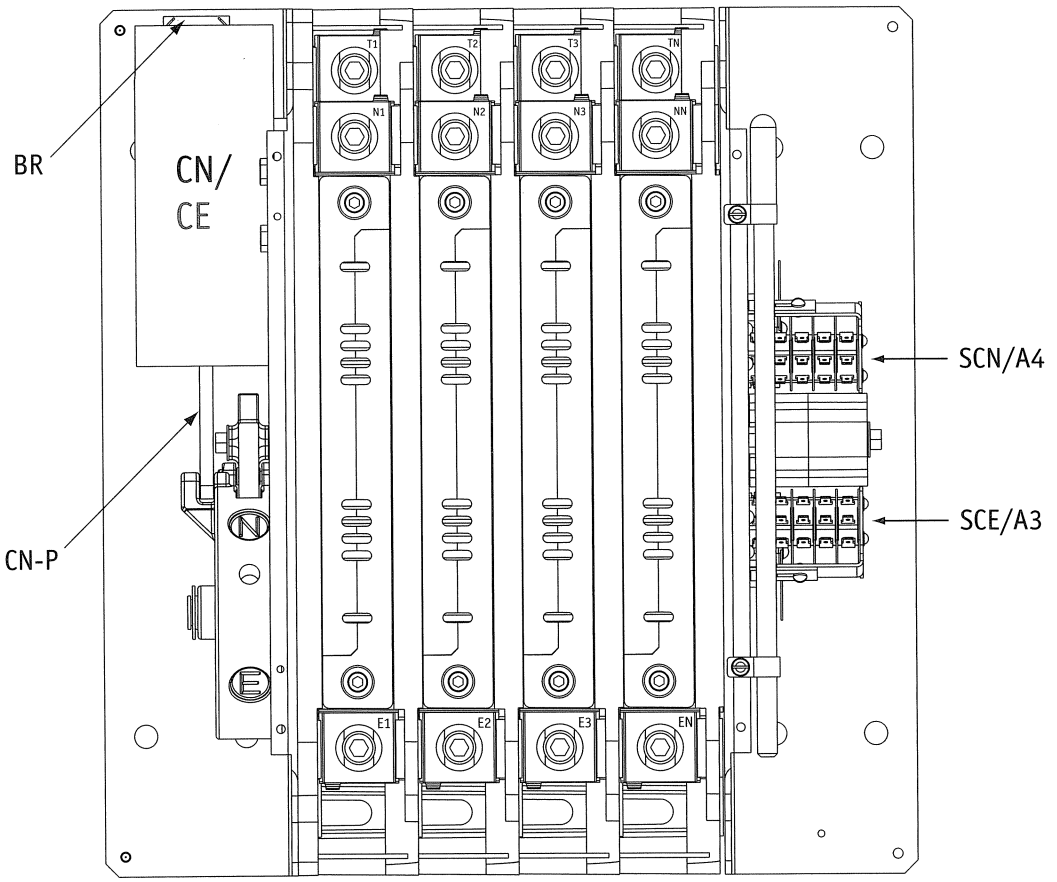
Power Panel — 40 to 225 Amps Solenoid Type



Tag	Description	Recommended as Spares	40 to 225 Amps	
CN/CE	Solenoid	*	120	K-2207
			208	K-2208
			220	K-2208
			240	K-2228
			277	K-2211
			380/416	K-2212
			440/480	K-2209
			575/600	K-2213
	Solenoid Plunger and Link	*	ALL	57P-1030
SCN/SCE	Coil Cutout Switch		120-480V	L-3078
SCN/SCE	Coil Cutout Switch		600V	L-4027
BR	Rectifier	*	ALL	PS-5152
A3/A4	Auxiliary Contacts			L-3078

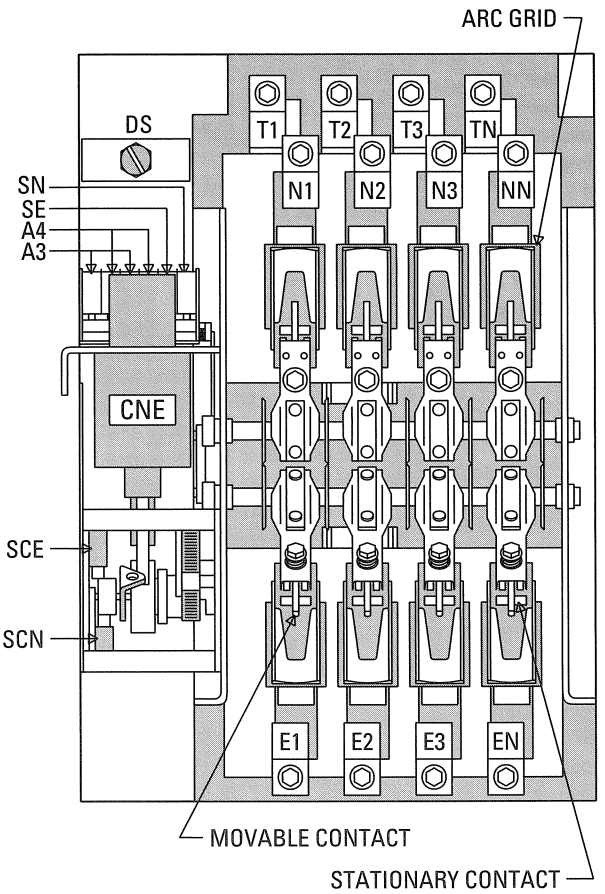
Power Panel — 225 to 400 Amps Molded Type



Tag	Description	Recommended as Spares	Stock		
			225, 250*	260, 300*	400
N 1,2,3 N E 1,2,3 N T 1,2,3 N	Cable Connection Lug		S-2701	S-2701	S-2701
	Wire Size			#4-600 MCM	#4-600 MCM
			Coil Volts		
CN/CE	Solenoid	*	120	K-2229	
			208/220	K-2230	
			240	K-2231	
			277	K-2232	
			380/416	K-2233	
			440/480	K-2234	
			575/600	K-2235	
CN-P	Solenoid Plunger and Link	*	58P-1029		
SCN/SCE	Coil Cutout Switches		L-3079		
A3/A4	Auxiliary Contacts		L-3078		
BR	Rectifier	*	PS-5152		

* IEC ratings only

Power Panel — 400 Amps Metal Frame Type



Tag	Description			Recommended as Spares	Part Number
					400
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Normal Emergency	Cable Connection Lugs #4-600 MCM			PS-1815F
	Load				PS-1815
	Normal Side Line Contact Kit				46P-1100E
	Normal Side Neutral Contact Kit				46P-1101E
	Emergency Side Line Contact Kit				46P-1102E
	Emergency Side Neutral Contact Kit				46P-1103E
	Arc Chute and Runner				46P-1140
CNE	Main ATS Operating Coils	Coil Volts	Poles	*	
		120	2		K-2178
		240	2,3,4		K-2189
		208	2,3,4		K-2177
		575/600	2,3,4		K-2196
		480	2,3,4		K-2176
		416	2,3,4		K-2188
		380	2,3,4		K-2188
SN	CN1 Limit Switch				L-5021
SE	CE1 Limit Switch				
A3	ATS Emergency Position Switch				
A4	ATS Normal Position Switch				
SCN/SCE	CNE Limit Switches				L-3079
DS	ATS Solenoid Disconnect Switch				
	Operator 2 – Position Maintain				L-4018
	Contact Block N.C. (1)			*	L-1029
BR	Rectifier			*	PS-5152

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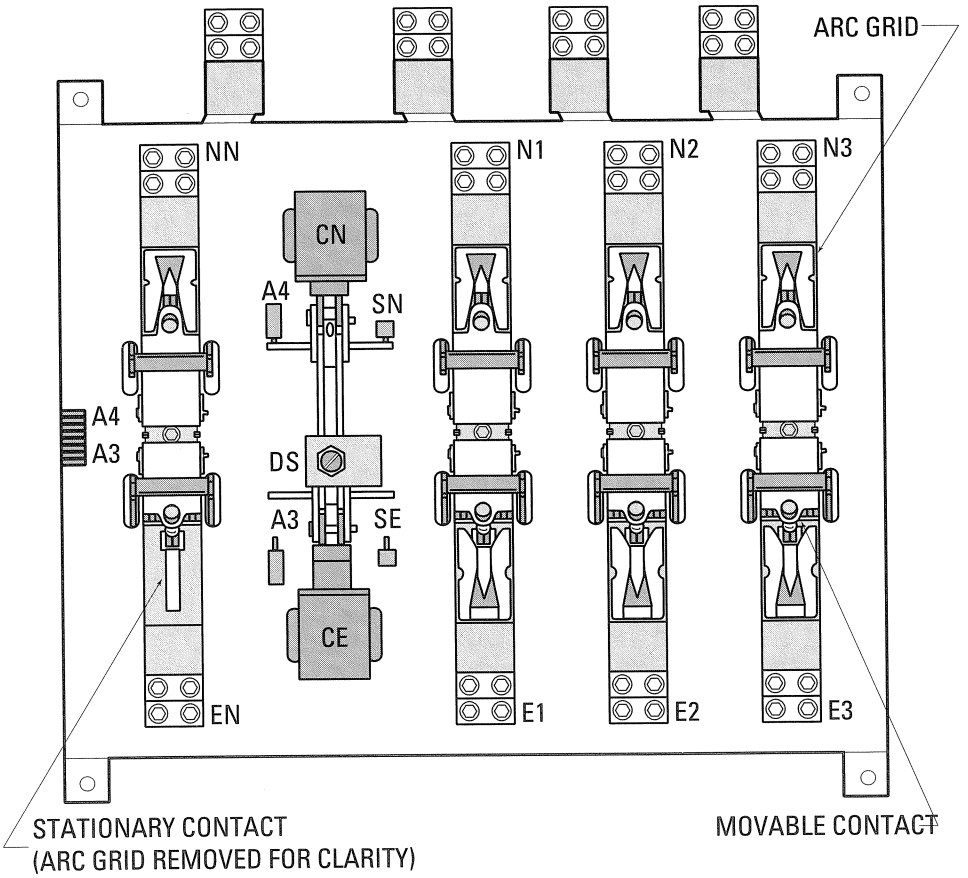
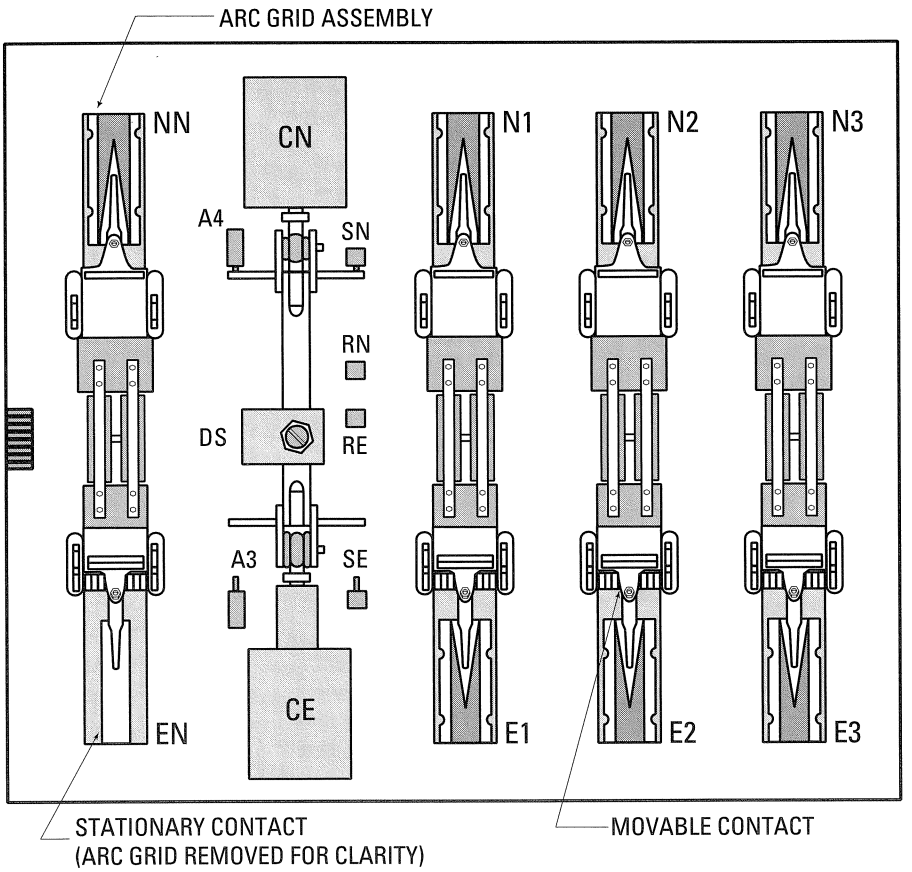
Power Panel — 600 to 1200 Amps



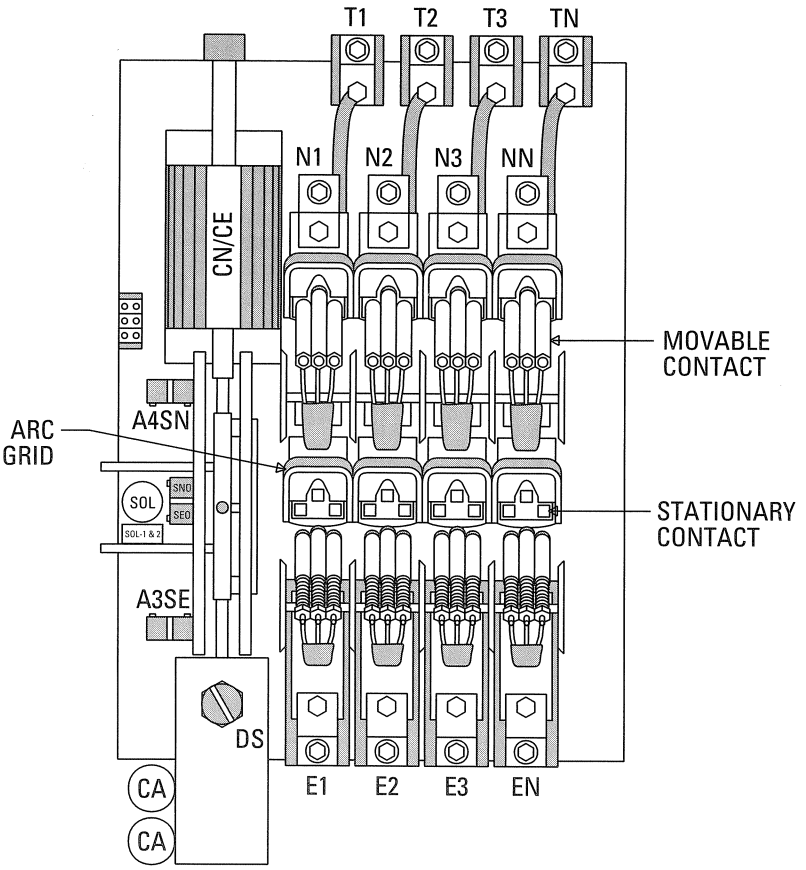
Tag	Description	Coil Volts	Poles	Recommended as Spares	Stock Numbers by Amperage 600	800	1000	1200
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug				S1393F (2)	S1392F (4)	S1392F (4)	S1392F (4)
	Wire Size				#2-600 MCM	#2-600 MCM	#2-600 MCM	#2-600 MCM
	Stationary Contact Assembly Kit				Consult Factory			
	Arc Grid Assembly Kit				23P-1366			
	Movable Contact Assembly Kit				Consult Factory			
CN/CE	Main Operating Coils	Coil Volts	Poles	*				
		120	2		K-2090F	K-2073F	K-2073F	K-2073F
		240	2		K-2092F	K-2070F	K-2070F	K-2070F
			3		K-2078F	K-2070F	K-2070F	K-2070F
			4		K-2091F	K-2074F	K-2074F	K-2074F
		208	3,4		K-2091F	K-2074F	K-2074F	K-2074F
		575/600	3		K-2095F	K-2095F	K-2155F	K-2155F
			4		K-2094	K-2094	K-2155F	K-2155F
		480	3		K-2080F	K-2071F	K-2071F	K-2071F
			4		K-2079F	K-2071F	K-2071F	K-2071F
		416	3		K-2080F	K-2071F	K-2071F	K-2071F
SN	CCN Cutout Switch		23P-1333		23P-1333			
SE	CCE Cutout Switch		23P-1327		23P-1327	23P-1452		
A3	Emergency Position Auxiliary Contact		(Qty 1) 23P-1327 (Qty 2) 23P-1328 (Qty 3) 23P-1334 (Qty 4) 23P-1336					
A4	Normal Position Auxiliary Contact		(Qty 1) 23P-1333 (Qty 2) 23P-1334 (Qty 3) 23P-1328 (Qty 4) 23P-1330					
DS	Disconnect Switch (older versions)		Operator L-4009; Contact Block L-1020	*	Operator L-4009; Contact Block L-1020			

Power Panel — 1600 to 3000 Amps



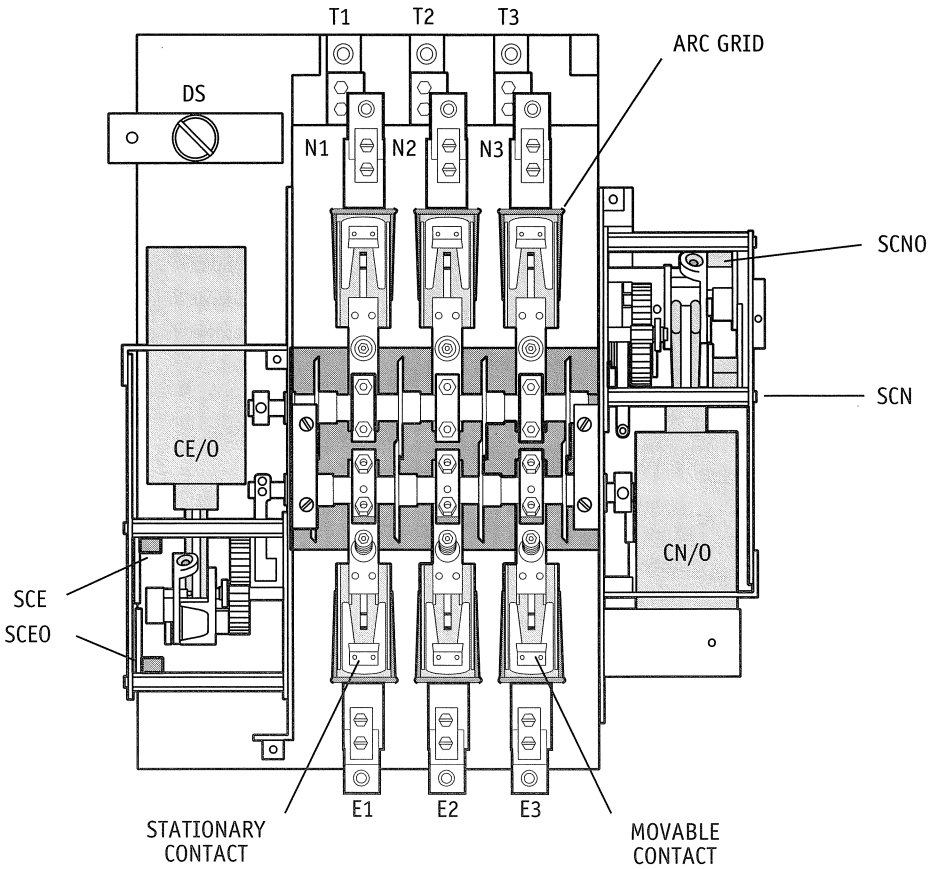
Tag	Description			Recommended as Spares	Stock Numbers by Amperage		
					1600	2000	3000
N 1,2,3 E 1,2,3 T 1,2,3	Cable Connection Lug				S1126F (2) Optional	S1126F (2) Optional	S1126F (2) Optional
	Wire Size				(8) #2-600 MCM	(8) #2-600 MCM	(8) #2-600 MCM
	Stationary Contact Assembly Kit				23P-1587	23P-1587	23P-1618
	Arc Grid Assembly Kit				23P-1171	23P-1171	23P-1171
	Movable Contact Assembly Kit				23P-1400	23P-1400	23P-1400
CN/CE	Main Operating Coils	**Coil Volts**	**Poles**	*			
		120	2		SPO	SPO	SPO
		240	2,3		K-2123	K-2123	K-2123
			4		K-2127	K-2127	K-2127
		208	3		K-2125	K-2125	K-2125
			4		K-2128	K-2128	K-2128
		575/600	3		K-2153	K-2153	K-2153
			4		K-2154	K-2154	K-2154
		480	3		K-2120	K-2120	K-2120
			4		K-2130	K-2130	K-2130
		416	3		K-2126	K-2126	K-2126
SN	CCN Cutout Switch		23P-1352		23P-1352		
SE	CCE Cutout Switch		23P-1356		23P-1356		
A3	Emergency Position Auxiliary Contact		(Qty 1) 23P-1356 (Qty 2) 23P-1357 (Qty 3) 23P-1353 (Qty 4) 23P-1355				
A4	Normal Position Emergency Contact		(Qty 1) 23P-1352 (Qty 2) 23P-1353 (Qty 3) 23P-1357 (Qty 4) 23P-1359				
DS	Disconnect Switch (older version)		Operator L-4009; Contact Block L-1020	*	Operator L-4009; Contact Block L-1020		
RN, RE	Rectifier		PS-5151 (Up to 240V); PS-5151 (Up to 600V)	*	PS-5151 (Up to 240V); PS-5151 (Up to 600V)		

Delayed Transition — 40 to 260 Amps



Tag	Description	Recommended as Spares	Stock Numbers by Amperage					
			40	80	100	150	225	260
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug		PS-4419	PS-4423	PS-4423	27P-1128	27P-1126	27P-1127
	Wire Size		#14-2	#14-1/0	#14-1/0	#8-3/0	#6 to 250 MCM	#6 to 350 MCM
	Stationary Contact Assembly Kit		27P-1141	27P-1141	27P-1141	27P-1111	27P-1111	27P-1111
	Stationary Load Contact Assembly Kit		27P-1140	27P-1140	27P-1140	27P-1109	27P-1109	27P-1109
	Arc Grid Assembly Kit		27P-1142	27P-1142	27P-1142	27P-1142	27P-1142	27P-1142
	Movable Contact Assembly Kit		27P-1036	27P-1036	27P-1036	27P-1037	27P-1037	27P-1037
CN/CE, CA	Linear Actuator and Capacitors	*				CA (See Note)		
	Note: 2S denotes two capacitors wired in series		Coil Volts	Poles	CN/CE	Quantity	Part	mf
			120	2	K-2104PN	1	PS-4007	340-408
			240	2	K-2105PN	1	PS-4016	108-130
				3				
			208	3	K-2141PN	1	PS-4084	145-174
				4	K-2142PN	1	PS-4084	145-174
			575/600	3	K-2198PN	2S	PS-4083	36-43
				4	K-2197PN	2S	PS-4083	36-43
			480	3	K-2119PN	2S	PS-4008	72-86
				4	K-2111PN	2S	PS-4008	72-86
			416	3	K-2190PN	2S	PS-4008	72-86
SN	CN1 Cut-out Switch		L-5022					
SE	CE1 Cut-out Switch		L-5022					
A3	Emergency Position Auxiliary Contact		SPDT, L-5022; DPDT, L-5021					
A4	Normal Position Auxiliary Contact		SPDT, L-5022; DPDT, L-5021					
DS	Disconnect Switch (older version)		Operator L-4018; Contact Block L-1028					
SOL	Center Position Solenoid		K-2204					

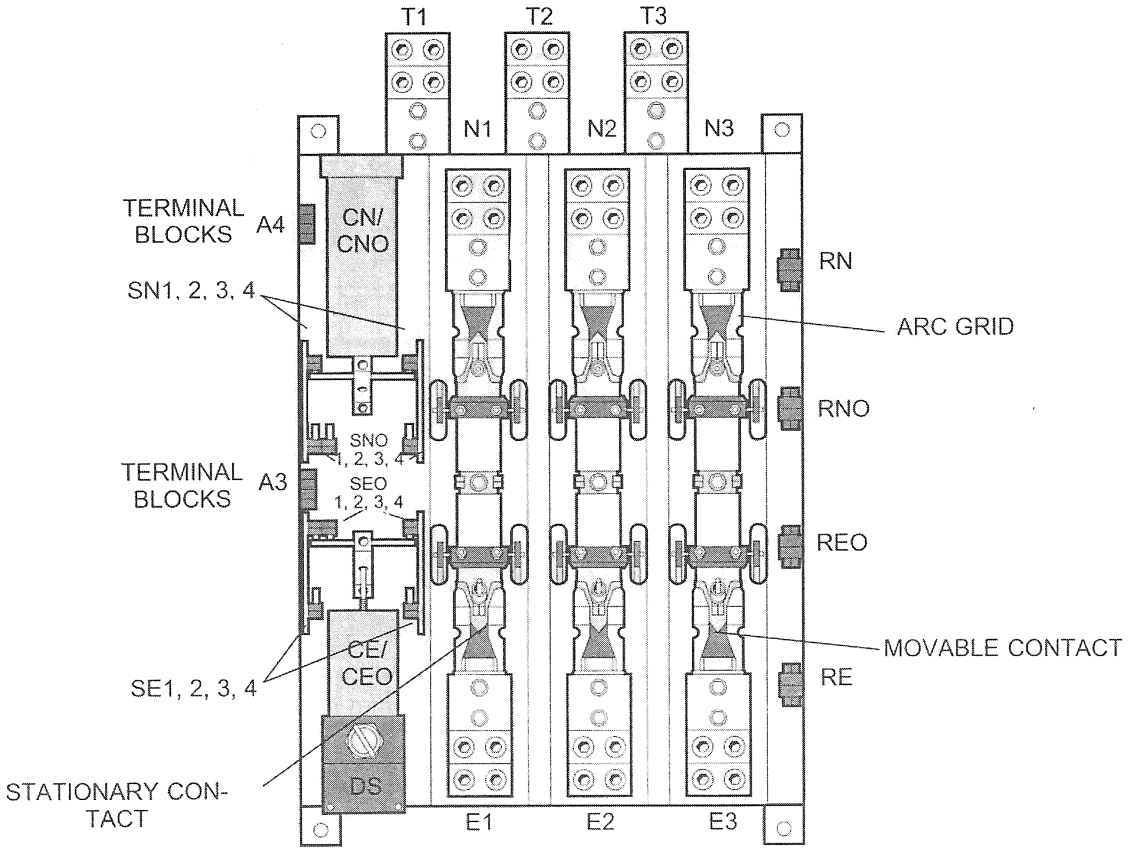
Delayed Transition — 400 Amps



Tag	Description	Recommended as Spares	Stock Numbers by Amperage
			400
NL 1,2,3 EL 1,2,3 T 1,2,3 NLN,ELN,TN	Cable Connection Lug, CU Wire		S-1422
NL 1,2,3	Movable and Stationary Contact Assembly (For 3P Units)		46P-1100E
NLN			46P-1101E
EL 1,2,3			46P-1102E
ELN			46P-1103E
	Arc Grid Assembly Kit		46P-1099
RTN/RTE	Coil Rectifier	*	PS-5152
SCN/SCNO	Sol Limit Switch		L-3079
SCE/SCE	Sol Limit Switch		L-3079
SN/SNO	Emergency Position Contact		46P-1133
SE/SEO	Normal Position Contact		46P-1133
DS	Disconnect Switch	*	Operator: L-4018; Contact Block: L-1029
CN/CNO CE/CEO	Main Operator Solenoids	*	**See Chart Below**

Voltage System					Solenoid Part No. VDC
Volts	Ph	Wire	Coil VDC	Pole	
240	3	3	240	3	K-2189
120/208	3	4	208	3,4	K-2177
480	3	3	480	3	K-2176
277/480	3	4	480	3,4	K-2176
240/416	3	4	416	3	Consult Factory

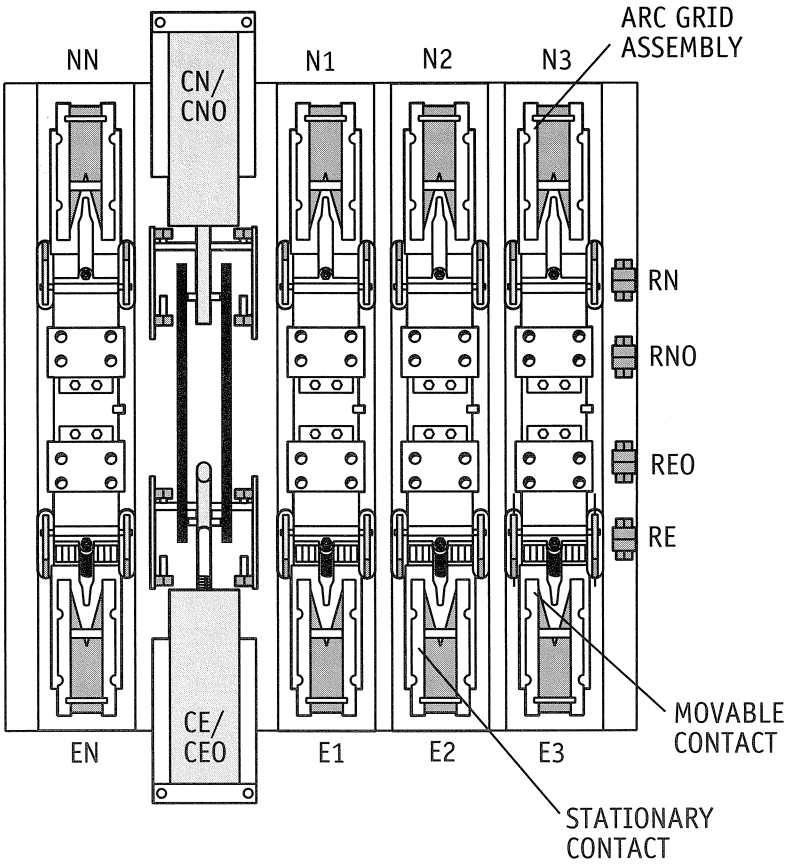
Delayed Transition — 600 to 1200 Amps



Tag	Description	Recommended as Spares	Stock Numbers by Amperage	
			600	800-1200
NL 1,2,3 EL 1,2,3 T 1,2,3 NN, EN, TN	Cable Connection Lug, CU Wire		S-1393F (2) 600MCM-2	S-1392F (4) 600MCM-2
	Stationary Contact Assembly Kit		23P-1471	26P-1336
	Arc Grid Assembly Kit		23P-1366	23P-1366
	Movable Contact Assembly Kit		23P-1469	26P-1334
	Movable Contact		23P-1470	26P-1335
RN/RNO RE/REO	Coil Rectifier	*	PS-5151 (Up to 240 VAC) PS-5151 (Up to 600 VAC)	
SN/SNO	Limit Switch		23P-1535(L); 23P-1533(R)	
SE/SEO	Limit Switch		23P-1536(L); 23P-1534(R)	
A3	Emergency Position Auxiliary Contact		23P-1536	
A4	Normal Position Auxiliary Contact		23P-1535	
DS	Disconnect Switch	*	Operator: L-4009; Contact Block: L-1020	
CN/CNO CE/CEO	Main Operator Solenoids	*	See Chart Below	

Voltage System					Solenoid Part No.	
Volts	Ph	Wire	Coil VDC	Pole	600	800-1200
240	3	3	240	3	K-2146	K-2147
120/208	3	4	208	3,4	K-2146	K-2147
480	3	3	480	3	K-2158	K-2157
277/480	3	4	480	3,4	K-2158	K-2157
240/416	3	4	416	3	Consult Factory	

Delayed Transition — 1600 to 3000 Amps



Tag	Description	Recommended as Spares	Stock Numbers by Amperage		
			1600	2000	3000
N 1,2,3 E 1,2,3 T 1,2,3 NLN,ELN	Cable Connection Lug, CU Wire		S-1126F(2) Optional (8) 600MCM-2		
	Stationary Contact Assembly Kit		23P-1587	23P-1587	23P-1618
	Arc Grid Assembly Kit		23P-1171	23P-1171	23P-1171
	Movable Contact Assembly Kit		23P-1400	23P-1400	23P-1344
CN/CNO CE/CEO	Main Operator Solenoids	*	See Chart Below		

Voltage System					Solenoid Part No.		
Volts	Ph	Wire	Coil VDC	Pole			
120	1	2	120	2	S.P.O.	S.P.O.	S.P.O.
120/240	1	3	240	2,3	K-2151	K-2151	K-2151
240	3	3	240	3	K-2151	K-2151	K-2151
120/208	3	4	208	3,4	K-2151	K-2151	K-2151
480	3	3	480	3	K-2160	K-2160	K-2160
575	3	3	575/600	3	S.P.O.	S.P.O.	S.P.O.
277/480	3	4	480	3,4	K-2160	K-2160	K-2160
120/240	2	4	240	4	K-2151	K-2151	K-2151
240/416	3	4	416	3	Consult Factory		

Operating Coil Hardware Kit				
SN/SNO-1,2	Switch Bracket Assembly	23P-1540	23P-1540	23P-1540
SE/SEO-1,2	Switch Bracket Assembly	23P-1541	23P-1541	23P-1541
SN/SNO-3,4	Switch Bracket Assembly	23P-1542	23P-1542	23P-1542
SE/SEO-3,4	Switch Bracket Assembly	23P-1543	23P-1543	23P-1543

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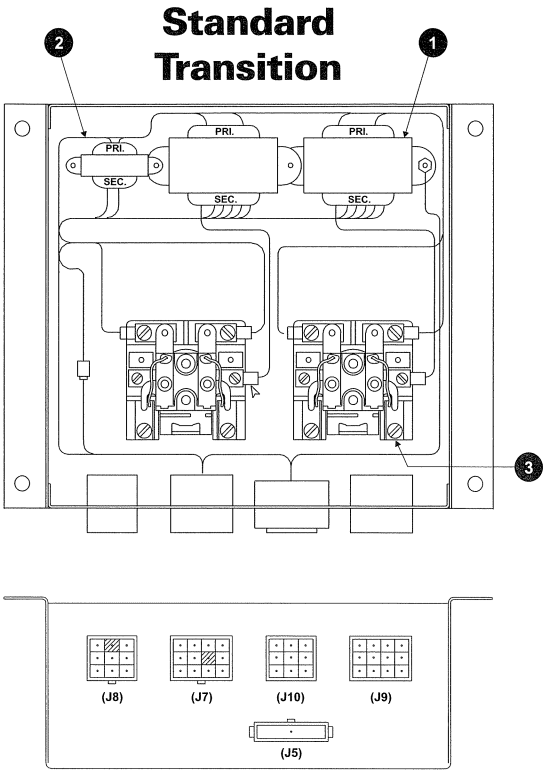
Relay/Transformer Box (R/T Box)

Each MX100 microprocessor based ATS controller requires a relay/transformer box to apply line voltage to the ATS operator via coil control relays. Also required is a means to power the MX100 printed circuit board and a means to apply sensing voltage proportional to line voltage. This is accomplished by the relay transformer box. This method of switching operator voltage and applying power and sensing voltage to the printed circuit board isolates the MX100 from the line voltage, further protecting the controller from harmful line transients. Two versions of the R/T box exist depending on the type of ATS (standard transition or delayed transition).

The following layout drawings of the R/T box components (standard and delayed transition) include a bill of materials for replacement parts. Schematics are included to indicate proper wiring.



40-400 Amp Molded Power Section

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1VA XFMR Part No.	25VA XFMR Part No.
50P-1015	120V	K-3216	K-3224
50P-1016	208-220V	K-3217	K-3225
50P-1017	230-240V	K-3218	K-3226
50P-1018	277V	K-3219	K-3227
50P-1019	380-400V	K-3220	K-3228
50P-1020	416-440V	K-3221	K-3229
57P-1121	460-480V	K-3222	K-3230
57P-1122	575-600V	K-3223	K-3231

40-4000 Amp - All Other Standard Types

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1VA XFMR Part No.	25VA XFMR Part No.
50P-1005	120V	K-3216	K-3224
50P-1006	208-220V	K-3217	K-3225
50P-1007	230-240V	K-3218	K-3226
50P-1008	277V	K-3219	K-3227
50P-1009	380-400V	K-3220	K-3228
50P-1010	416-440V	K-3221	K-3229
50P-1011	460-480V	K-3222	K-3230
50P-1012	575-600V	K-3223	K-3231

Bill of Material

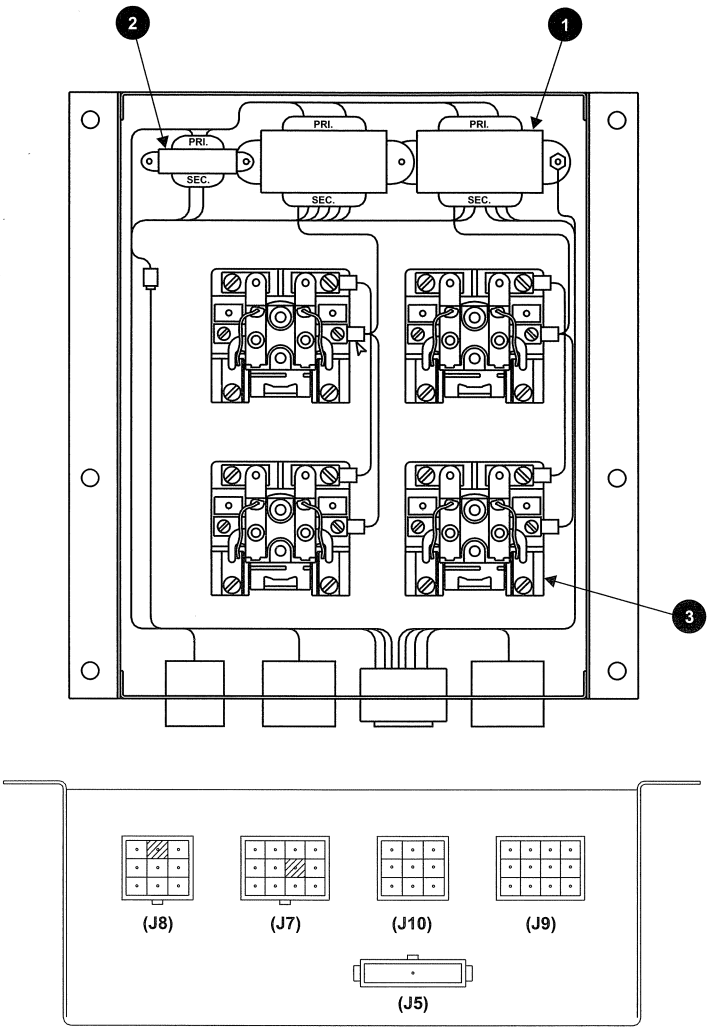
Item	Part No.	Description	Qty
1	See Chart	Transformer (1 VA)	2
2	See Chart	Transformer (25 VA)	2
3	K-1274	Relay Flange Mounted	2

Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer, 25VA	2
2	See Chart	Transformer, 1VA	1
3	K-1260	Coil Control Relay, 24V	2

Relay/Transformer Box (R/T Box) *(cont'd)*

Delayed Transition



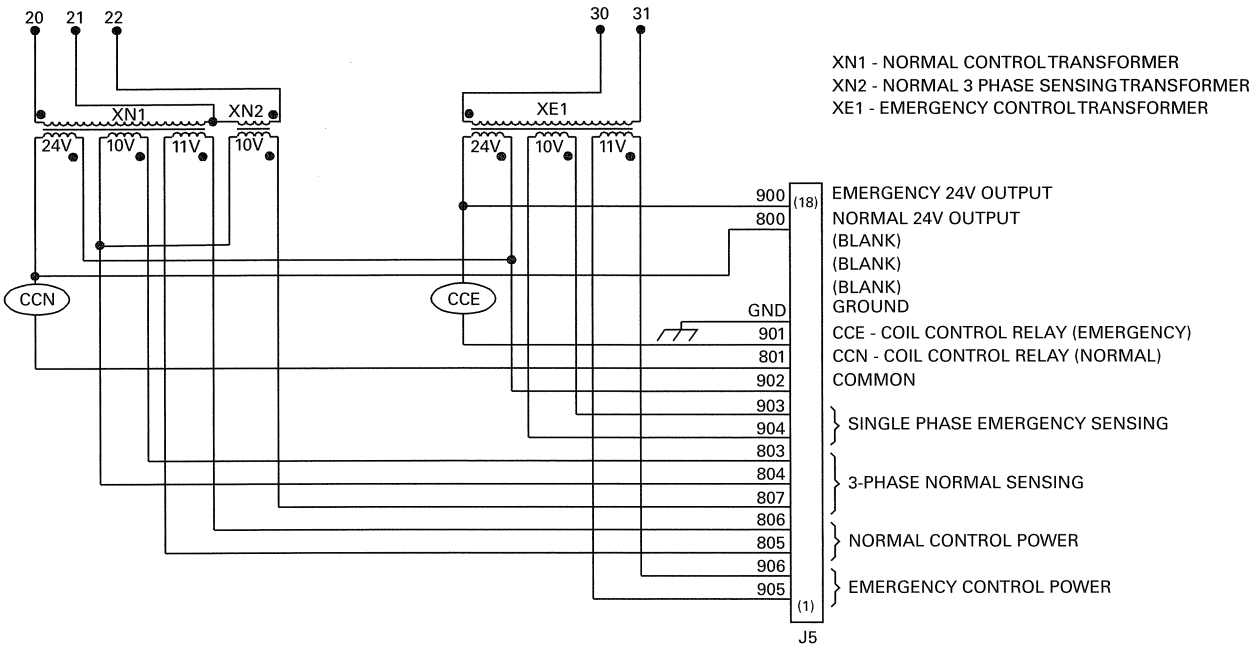
Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer, 25VA	2
2	See Chart	Transformer, 1VA	1
3	K-1260	Coil Control Relay, 24V	4

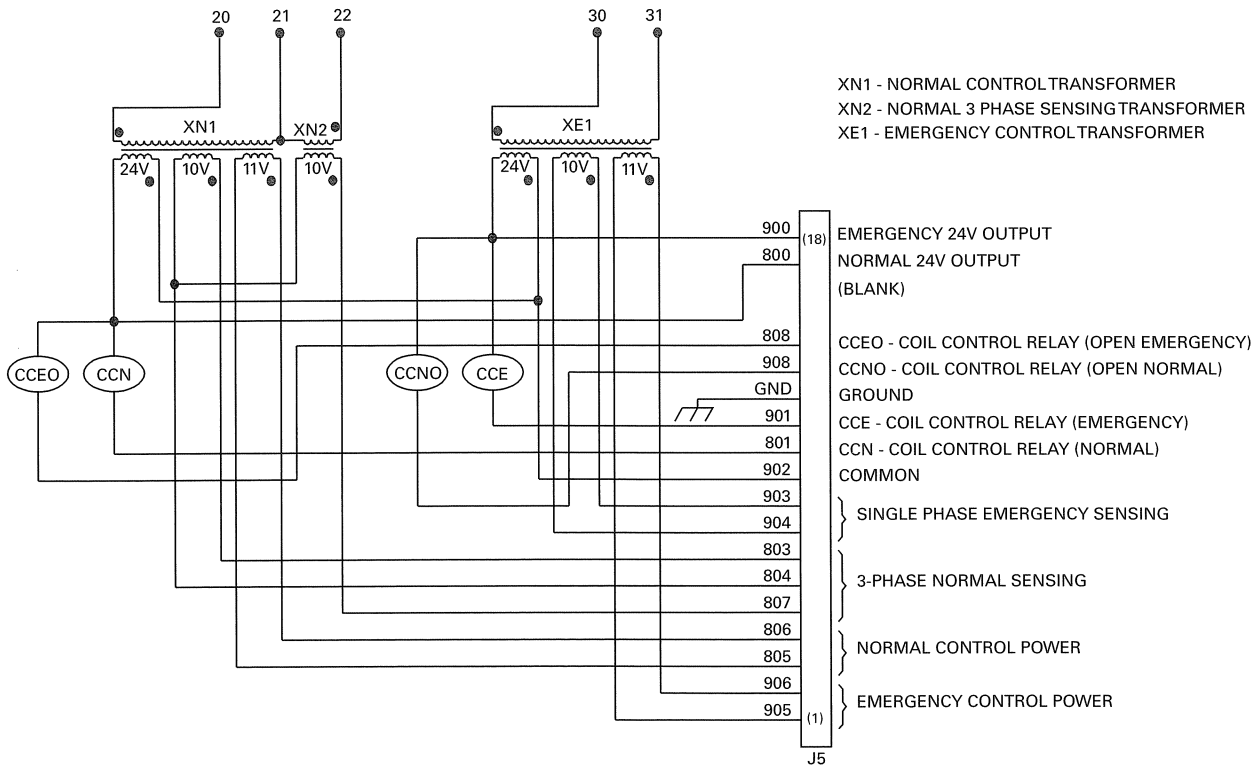
Transformer Usage

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1VA XFMR Part No.	25VA XFMR Part No.
50P-1013	120V	K-3216	K-3224
50P-1014	208-220V	K-3217	K-3225
50P-1015	230-240V	K-3218	K-3226
50P-1016	277V	K-3219	K-3227
50P-1017	380-400V	K-3220	K-3228
50P-1018	416-440V	K-3221	K-3229
50P-1019	460-480V	K-3222	K-3230
50P-1020	575-600V	K-3223	K-3231

Standard Transition R/T Box Schematic



Delayed Transition R/T Box Schematic



Standard Drawings Technical Reference

Standard Drawings

GE Zenith Transfer Switch — ZTG(D)K series				
Transfer Switch Amperage	**Legend Operation Accessories**	**Power Circuit and Layout**	**Power Circuit and Layout (2 Pole)**	**MX100 Door View**
30-200	52A-0900	52A-7000	52A-7001	50A-1000
225-260		52A-1000	52A-1001	
400		52A-2000	52A-2001	
600-1200		52A-3000	52A-3001	
1600-3000		52A-8000	52A-8001	
D 40-260	52A-0900D	52A-4000	52A-4001	50A-1000D
D 400		52A-5000	52A-5001	50A-1000
D 600-3000		52A-6000	52A-6001	

GE Zenith Transfer Switch — ZTG(2)K series				
Transfer Switch Amperage	**Legend Operation Accessories**	**Power Circuit and Layout**	**Power Circuit and Layout (2 Pole)**	**MX100 Door View**
225-400	52A-0900	54A-1000	54A-1001	50A-1000

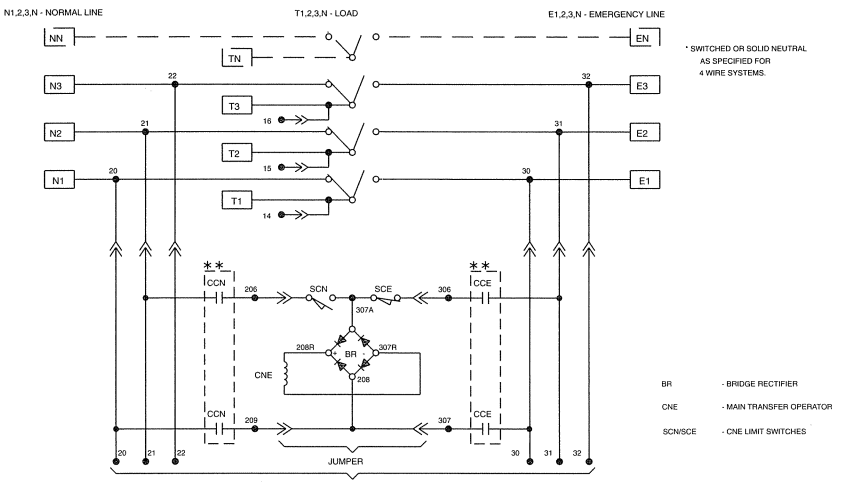
Accessory Drawings

Microprocessor — MX100		
Option Code	**Drawing #**	**ZTG(D)K**
C	50R-1006	X
C/DT	(INTERNAL TO MX100)	X
C/D	50R-1002	X
C/D 365 DAYS	50R-1003	X
D	50R-1006	X
HT	50R-1008	X
	50R-1009	
Q2	50R-1001	X
Q3	50R-1024	X
6A	50R-1010	X
YEN	(INTERNAL TO MX100)	X
ZNET (F32)	50R-1022	X
A6 or T3/W3	50R-1012	X
CTAP	50R-1020	X
MANUAL	50R-1026	X
Q2K	50R-1001	X
Q2M	50R-1001	X
R50	(INTERNAL TO MX100)	X

Drawing #52A-7000, Page 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
F	S-7543 UPDATED DWG	10/02/00	SG SB

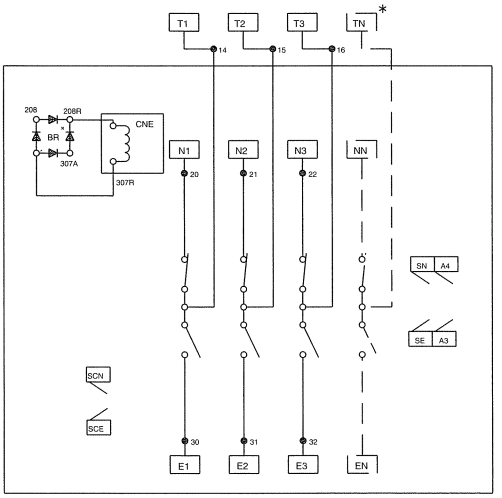
ATS POWER CIRCUIT SCHEMATIC



* SWITCHED OR SOLID NEUTRAL AS SPECIFIED FOR 4 WIRE SYSTEMS.

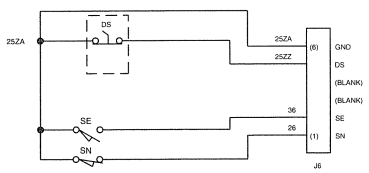
BR - BRIDGE RECTIFIER
CNE - MAIN TRANSFER OPERATOR
SCN/SCE - CNE LIMIT SWITCHES

ATS POWER PANEL LAYOUT



AUXILIARY CONTACTS

LIMIT SWITCH SCHEMATIC



TO MX SERIES CONTROL PANEL

SE - EMERGENCY POSITION LIMIT SWITCH

SN - NORMAL POSITION LIMIT SWITCH

DS - DISCONNECT SWITCH ON MX100

LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUGS - SEE SHT 2 MX100 CONTROLLER - 50A-1000	ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE.

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TOLERANCES ON:
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

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SIGNATURES		DATE
MODEL	SB	06/09/97
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE:
MODEL / ASSEMBLY FILE: ZTG(2/3)K3-22 (30-225A)
CTQs
CRITICAL TO QUALITY CHARACTERISTIC

TITLE
ATS POWER CIRCUIT & LIMIT SWITCHES
FIRST MADE FOR -

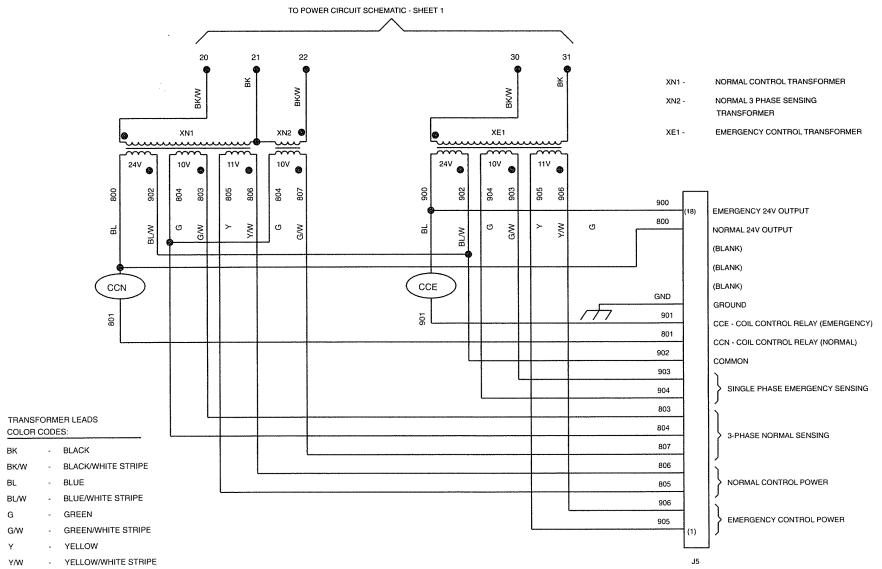
SIZE	CAGE CODE	DWG NO
B		52A-7000

SCALE: - SHEET 1 OF 2

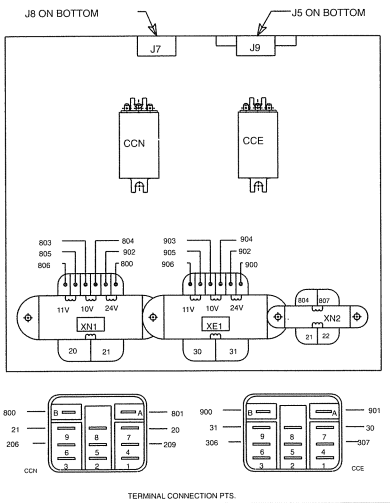
Drawing #52A-7000, Page 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
F	S-7543 UPDATED DWG	10/02/00	SG SB

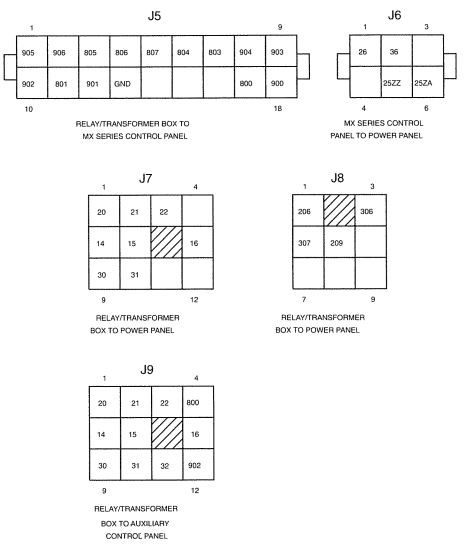
RELAY/TRANSFORMER BOX SCHEMATIC



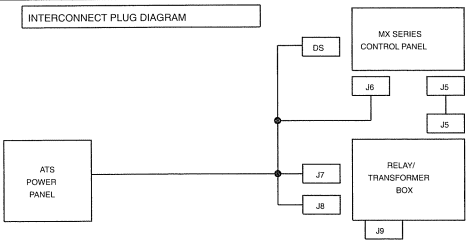
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



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TOLERANCES ON
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

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SIGNATURES		DATE
MODEL	SB	06/09/97
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE:
MODEL / ASSEMBLY FILE: ZTG(2/3)K3-22 (30-225A)
P CTDs
CRITICAL TO QUALITY CHARACTERISTIC

TITLE
RELAY/XFR BOX & INTERCONNECT PLUGS
FIRST MADE FOR -

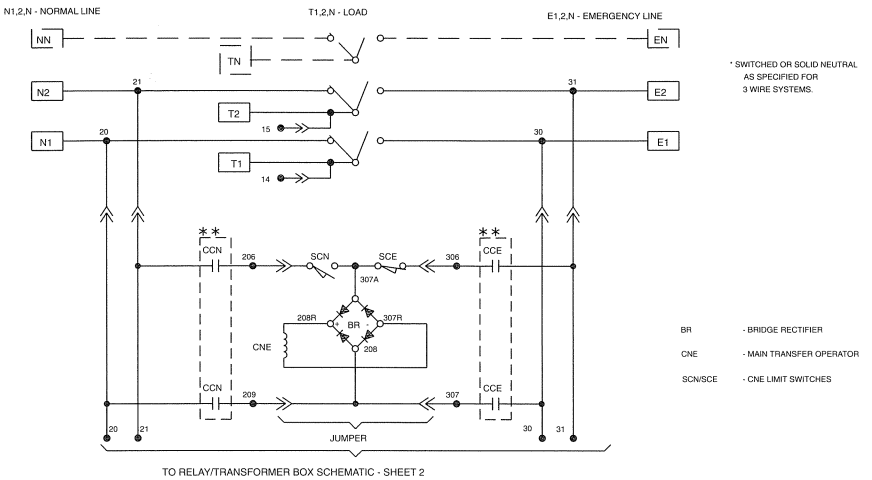
SIZE	CAGE CODE	DWG NO
B		52A-7000

SCALE: - SHEET 2 OF 2

Drawing #52A-7001, Page 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
G	S-7543 UPDATED DWG	10/03/00	SG SB

ATS POWER CIRCUIT SCHEMATIC



* SWITCHED OR SOLID NEUTRAL AS SPECIFIED FOR 3 WIRE SYSTEMS.

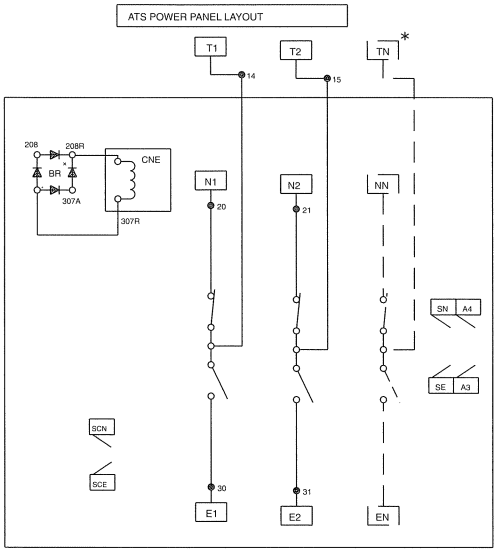
BR - BRIDGE RECTIFIER

CNE - MAIN TRANSFER OPERATOR

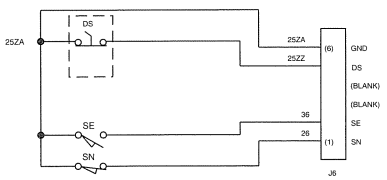
SCN/SCE - CNE LIMIT SWITCHES

AUXILIARY CONTACTS

ATS POWER PANEL LAYOUT



LIMIT SWITCH SCHEMATIC



SE - EMERGENCY POSITION LIMIT SWITCH

SN - NORMAL POSITION LIMIT SWITCH

DS - DISCONNECT SWITCH ON MX100

LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUGS - SEE SHT 2 MX100 CONTROLLER - 50A-1000	ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE.

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TOLERANCES ON

2 PL. DECIMALS – .020

3 PL. DECIMALS – .005

ANGLES – 1

FRACTIONS – 1/64

FINISH

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MODEL	SB	06/09/97
DETAIL		
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MFG		
QUALITY		
ISSUED		

DRAWING FILE:

MODEL / ASSEMBLY FILE: ZTG(2/3)K3-22 (30-225A), 2

CTQs

CRITICAL TO QUALITY CHARACTERISTIC

TITLE

ATS POWER CIRCUIT & LIMIT SWITCHES

FIRST MADE FOR: -

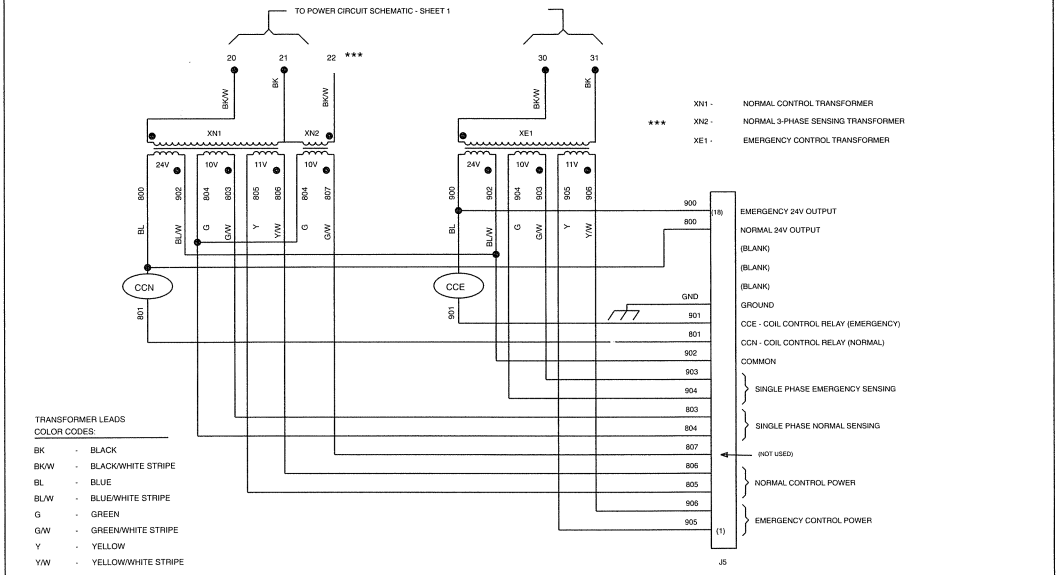
SIZE	CAGE CODE	DWG NO
B		52A-7001

SCALE: - SHEET 1 OF 2

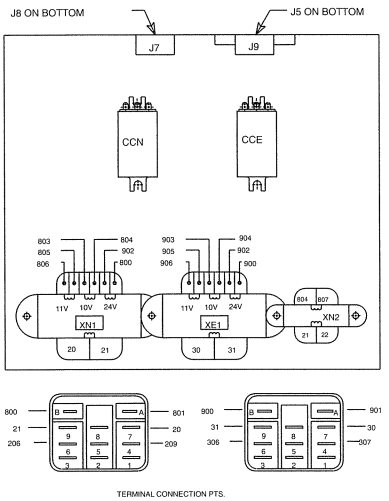
Drawing #52A-7001, Page 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
G	S-7543 UPDATED DWG	10/03/00	SG SB

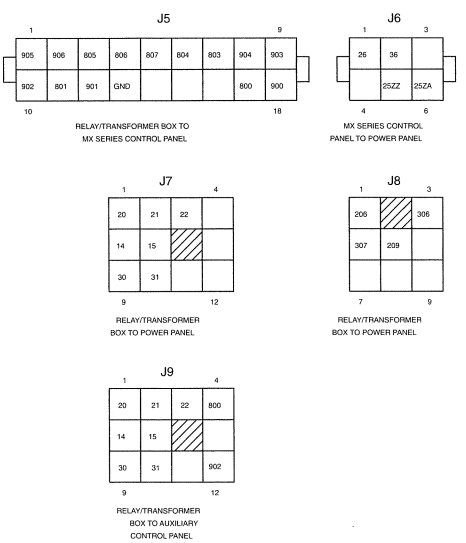
RELAY/TRANSFORMER BOX SCHEMATIC



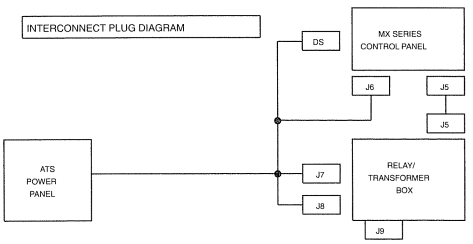
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



LEGEND

- WIRE CONNECTION
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRE #22 IS NOT CONNECTED TO ATS POWER PANEL.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	SB	06/09/97
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE
MODEL / ASSEMBLY FILE: ZTG(2/3)K3-22 (30-225A) 2F
CTQs
CRITICAL TO QUALITY CHARACTERISTIC

TITLE
RELAY/XFR BOX
& INTERCONNECT PLUGS
FIRST MADE FOR:

SIZE	CAGE CODE	DWG NO
B		52A-7001
SCALE: -		SHEET 2 OF 2

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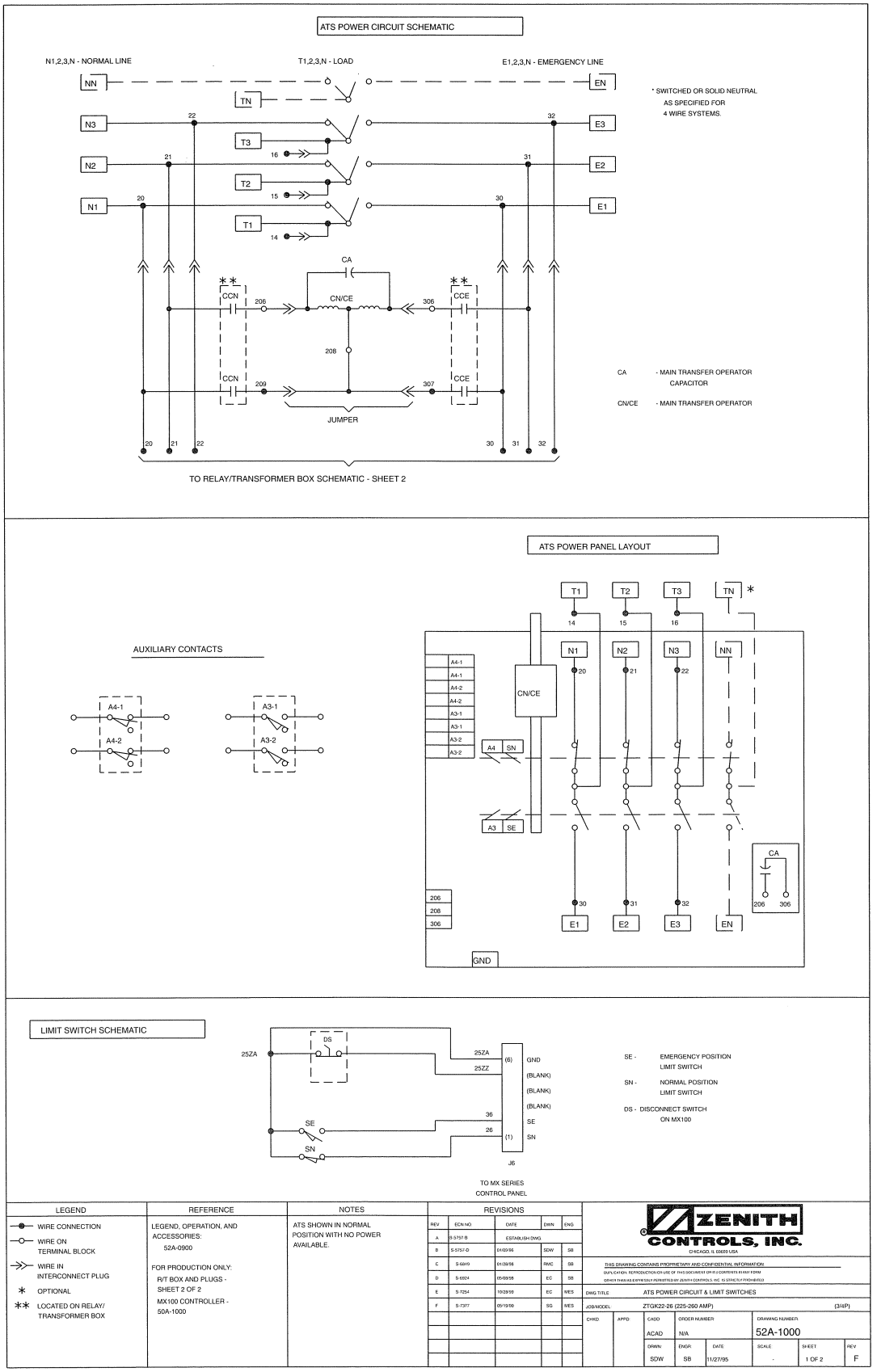
Drawing #52A-1000, Page 1



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUGS - SHEET 2 OF 2 MX100 CONTROLLER - 50A-1000	ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE.

REVISIONS				
REV.	ECN NO.	DATE	DWN	ENG.
A	S-5757-B	ESTABLISH DWG.		
B	S-5757-D	01/03/96	SDW	SB
C	S-6849	01/29/96	RWC	SB
D	S-6924	05/03/96	EC	SB
E	S-7254	10/28/96	EC	MES
F	S-7377	05/19/98	SG	MES

ZENITH CONTROLS, INC.
CHICAGO, IL 60609 USA

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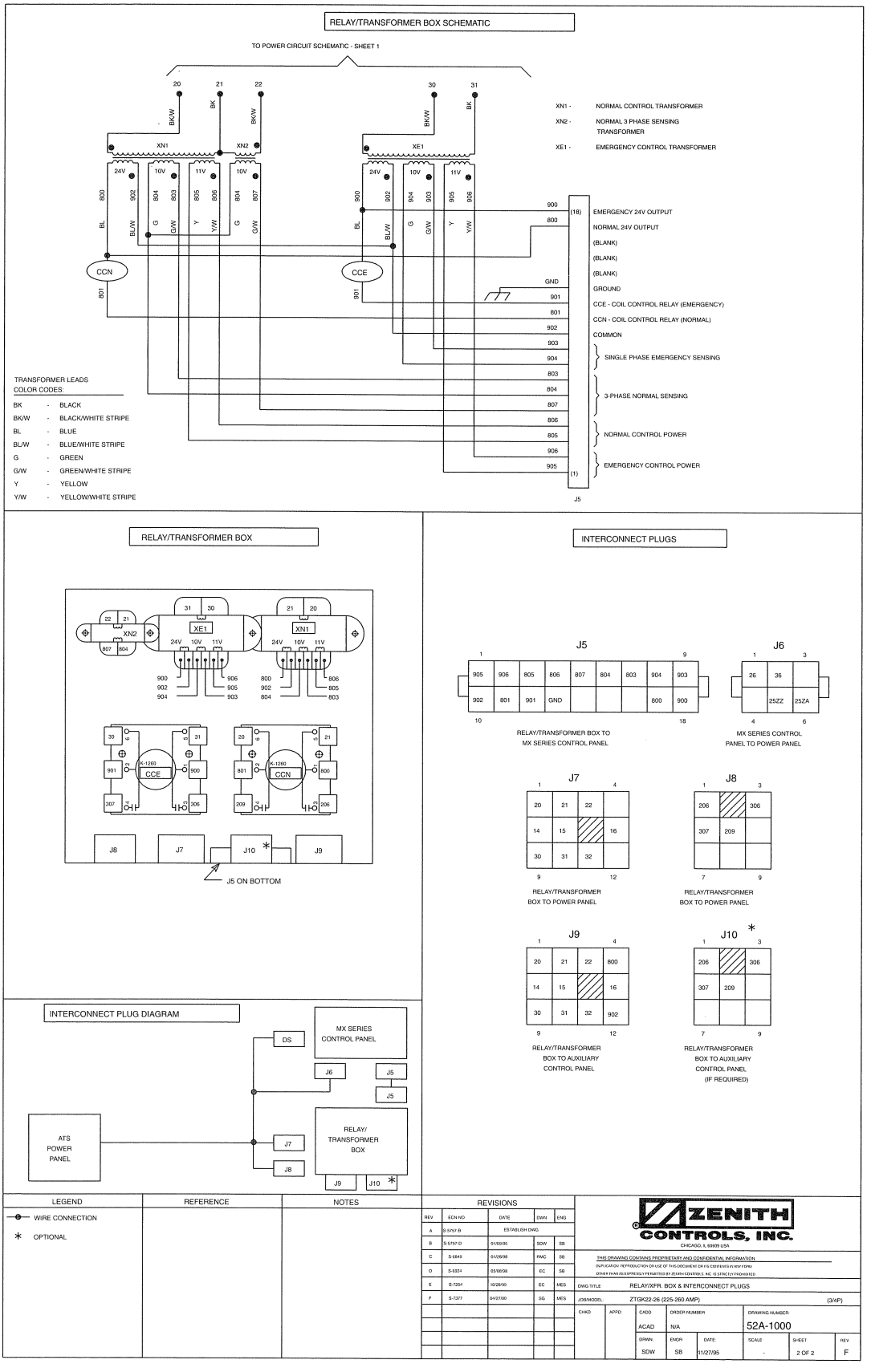
DWG TITLE	ATS POWER CIRCUIT & LIMIT SWITCHES					
JOB/MODEL	ZTGK22-26 (225-260 AMP)					(3/4P)
CHKD	APPD	CADD	ORDER NUMBER	DRAWING NUMBER		
		ACAD	N/A	52A-1000		
		DRWN	ENGR	DATE	SCALE	SHEET	REV
		SDW	SB	11/27/95	-	1 OF 2	F

Drawing #52A-1000, Page 2



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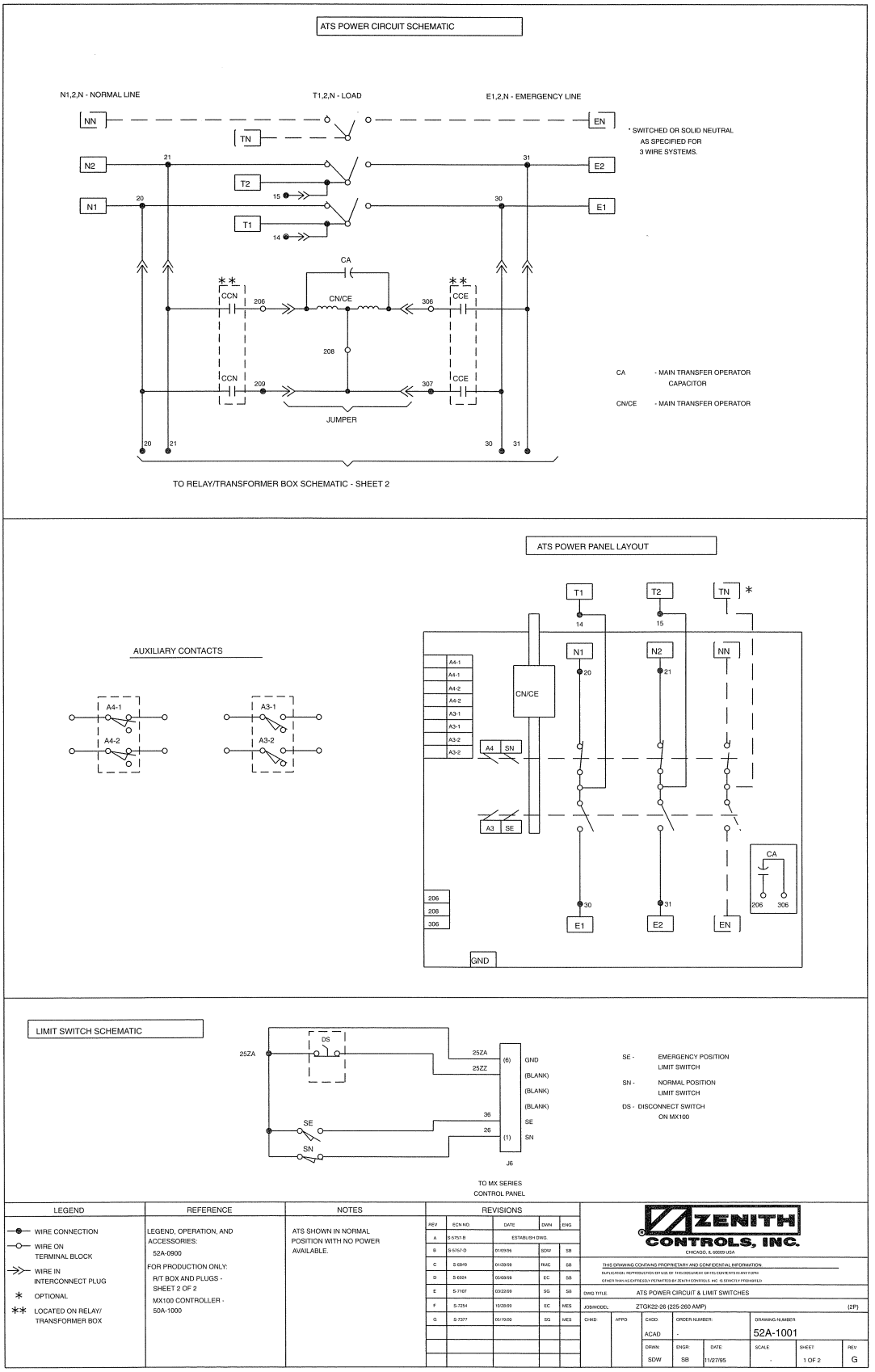
Drawing #52A-1001, Page 1



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUGS - SHEET 2 OF 2 MX100 CONTROLLER - 50A-1000	ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE.

REVISIONS				
REV	ECN NO.	DATE	DWN	ENG
A	S-5757-B	ESTABLISH DWG.		
B	S-5757-D	01/05/96	SDW	SB
C	S-6849	01/29/98	RWC	SB
D	S-6924	05/08/98	EC	SB
E	S-7107	03/22/99	SG	SB
F	S-7254	10/20/99	EC	MES
G	S-7377	05/10/00	SG	MES

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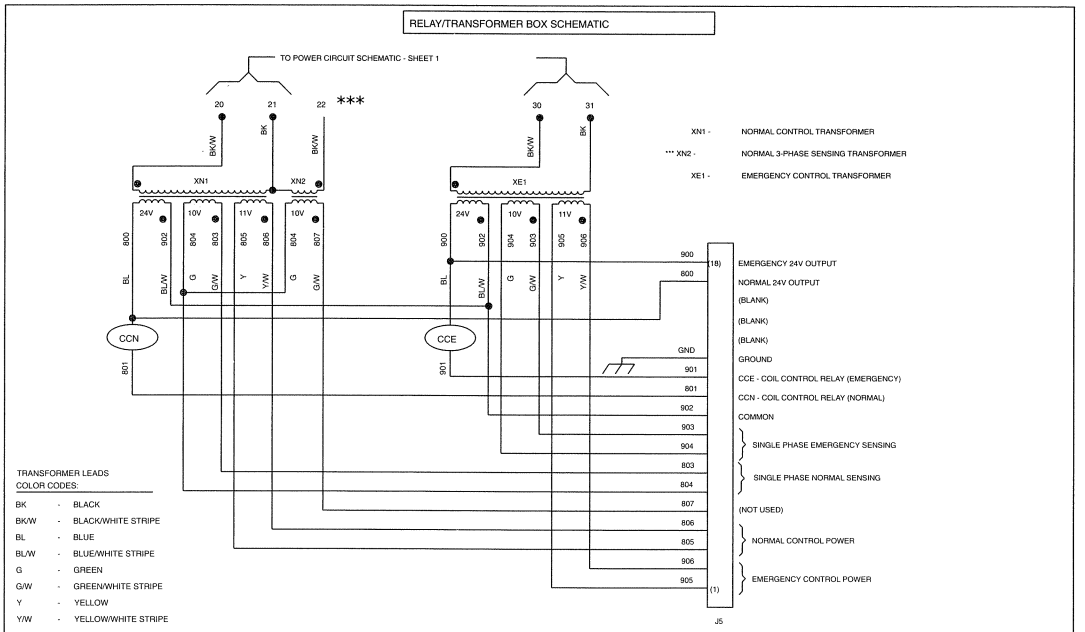
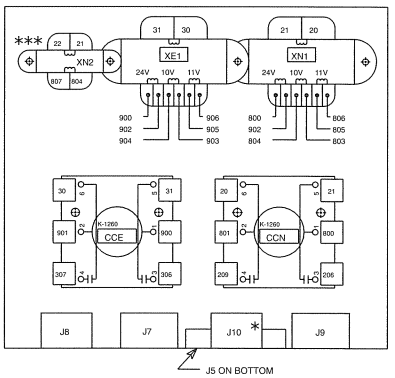
DWG TITLE:	ATS POWER CIRCUIT & LIMIT SWITCHES					
JOB/MODEL:	ZTGK22-26 (225-260 AMP)					(2P)
CHKD	APPD	CADD: ACAD	ORDER NUMBER: -		DRAWING NUMBER: 52A-1001	
		DRAWN: SDW	ENGR: SB	DATE: 11/27/95	SCALE: -	SHEET: 1 OF 2	REV: G

Drawing #52A-1001, Page 2

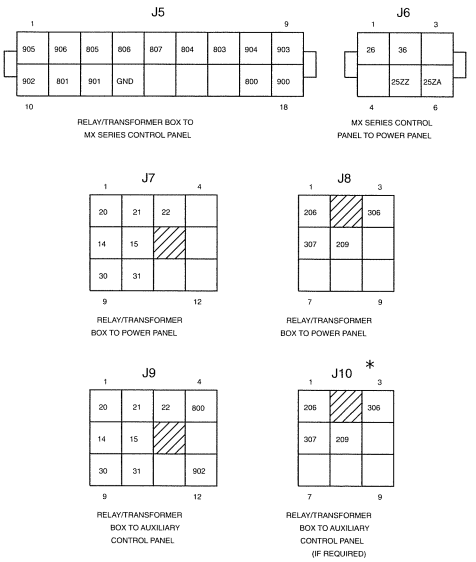
RELAY/TRANSFORMER BOX SCHEMATIC



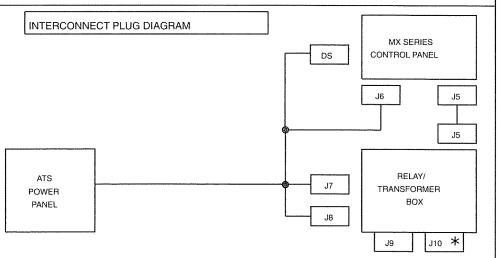
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



LEGEND

- WIRE CONNECTION
- * OPTIONAL
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRE #22, IS NOT CONNECTED TO ATS POWER PANEL.

NOTES

REVISIONS

REV	ECN NO.	DATE	DWN	ENG
A	S-5757-B	ESTABLISH DWG.		
B	S-5757-D	01/05/96	SDW	SB
C	S-6649	01/25/96	RMC	SB
D	S-6824	05/08/98	EC	SB
E	S-7107	03/23/99	SG	SB
F	S-7254	10/28/99	EC	MES
G	S-7377	04/27/00	SG	MES

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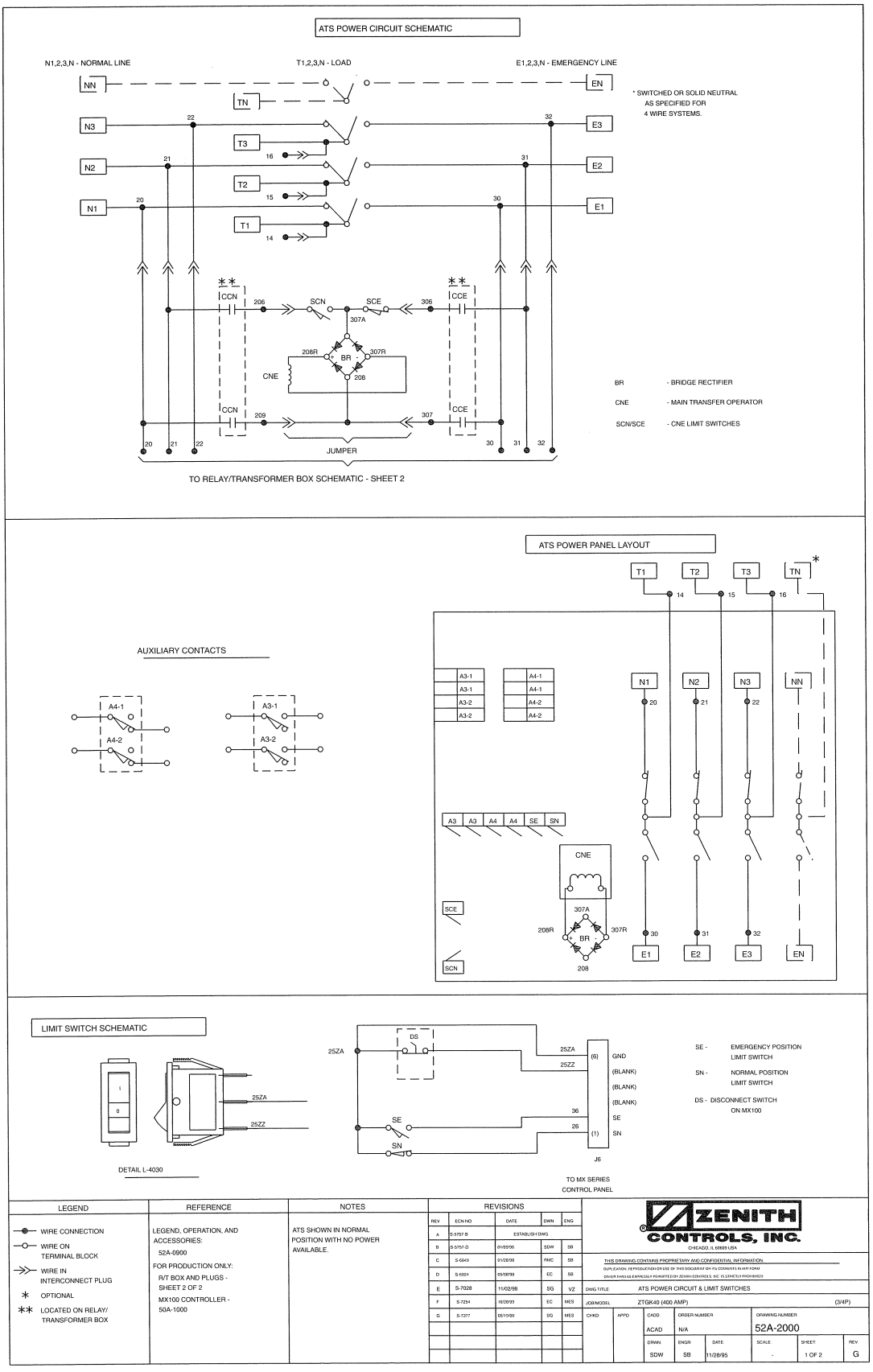
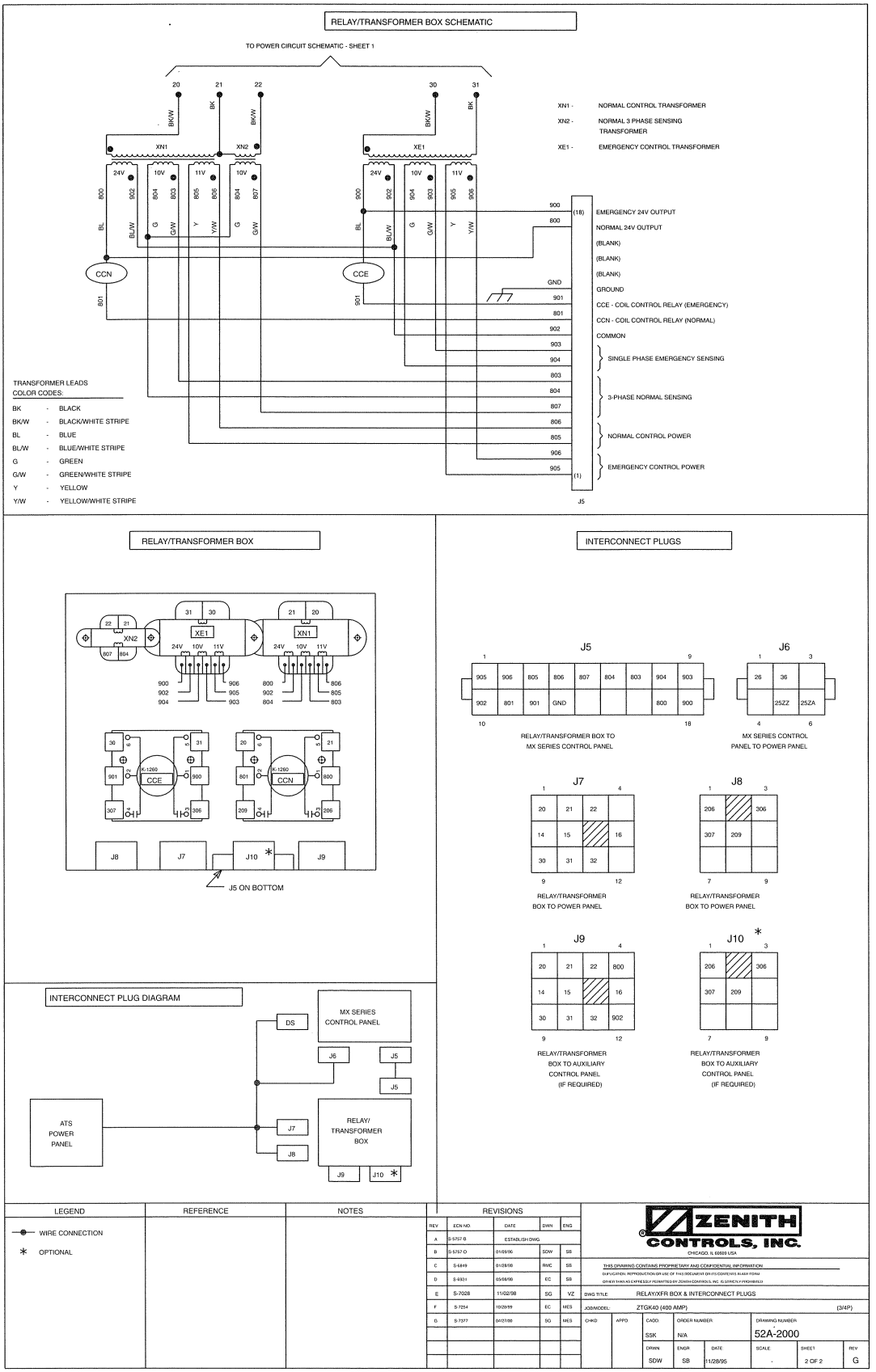
DWG TITLE:	RELAY/XFR BOX & INTERCONNECT PLUGS
JOB/MODEL:	ZTGK22-26 (225-260 AMP) (2P)
CHKD:	APPD:
CADD: ACAD	ORDER NUMBER: -
DRAWING NUMBER:	52A-1001
DRWN: SDW	ENGR: SB
DATE:	11/28/95
SCALE:	-
SHEET:	2 OF 2
REV:	G

Drawing #52A-2000, Page 1



Drawing #52A-2000, Page 2



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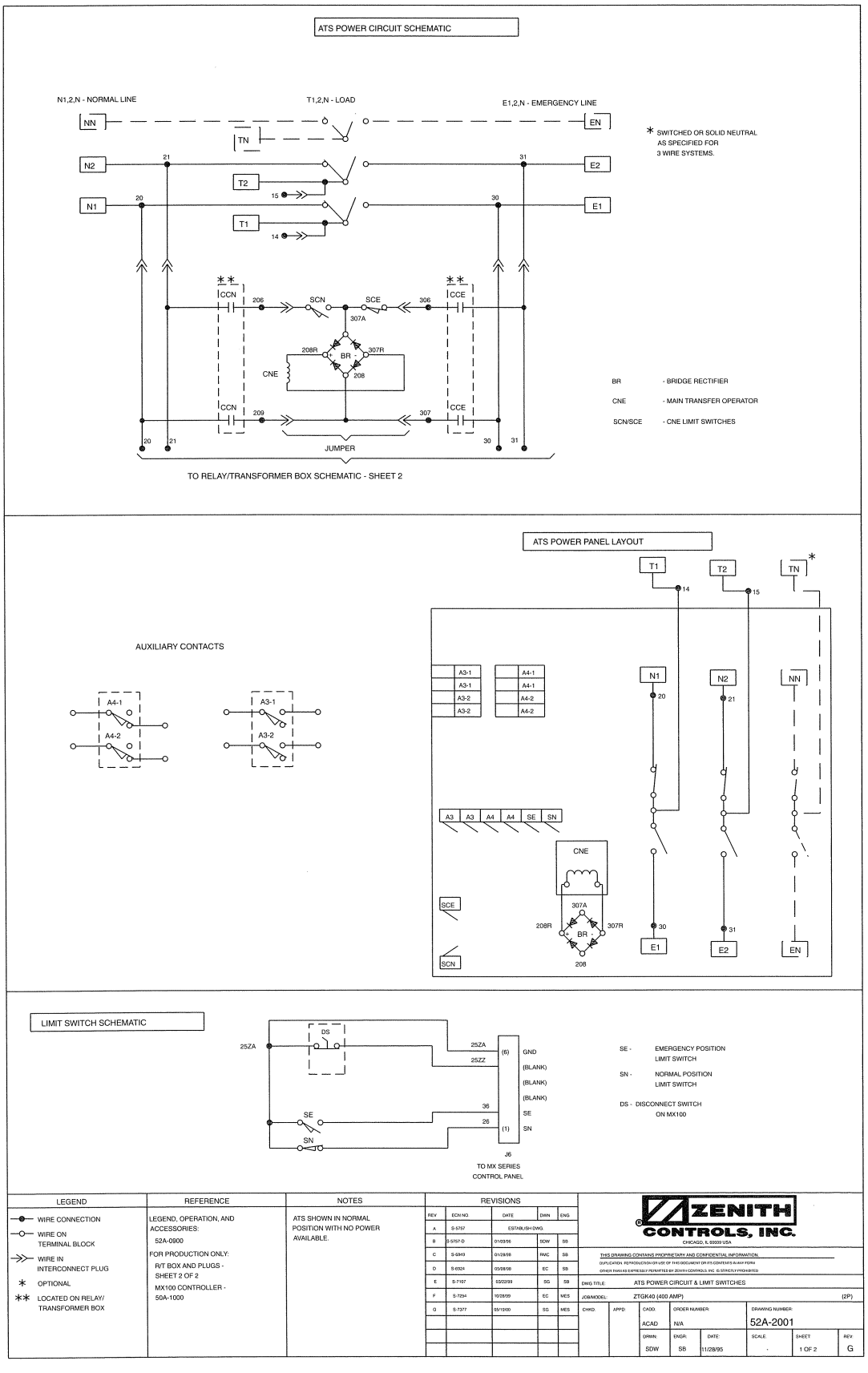
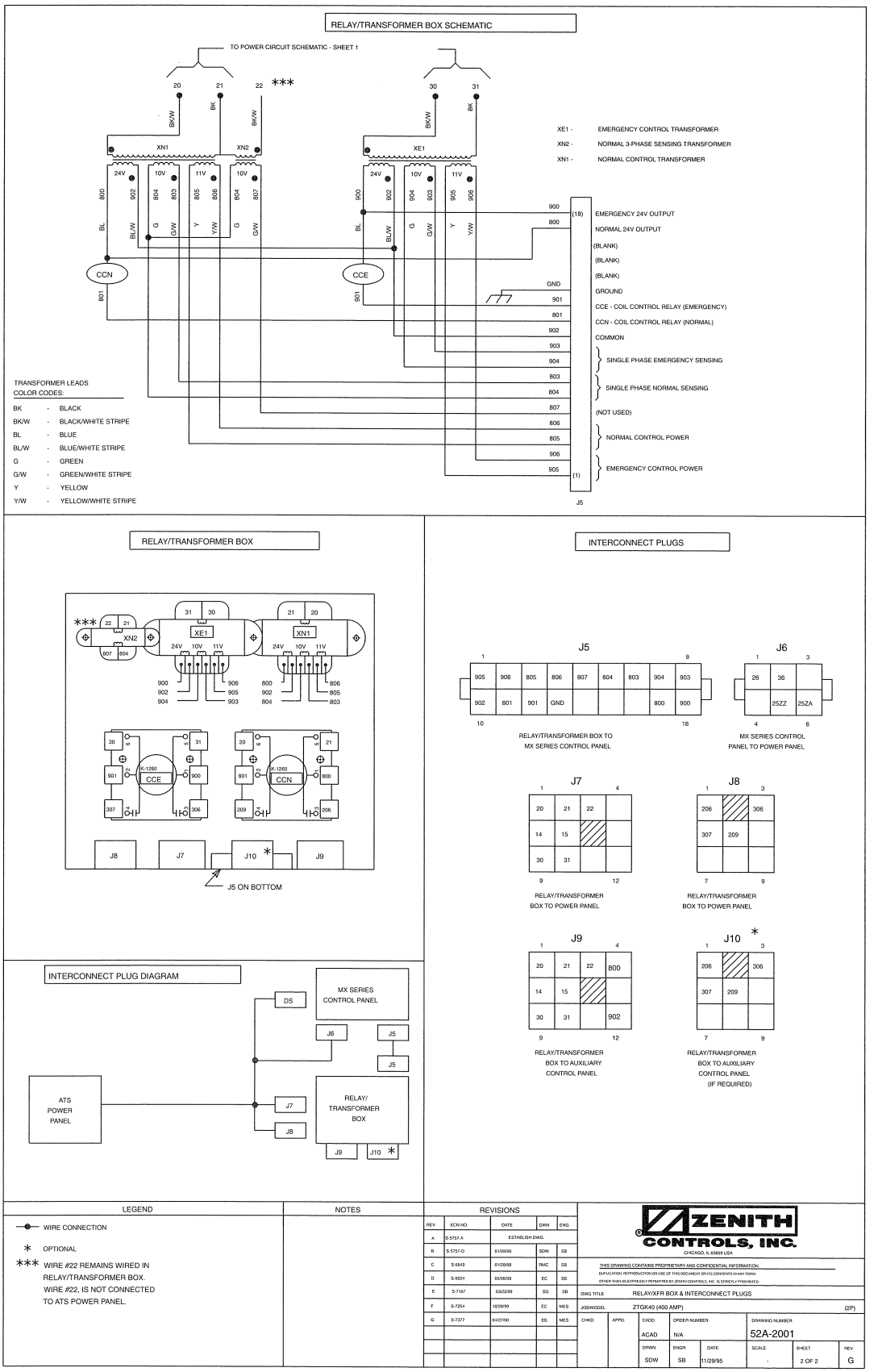
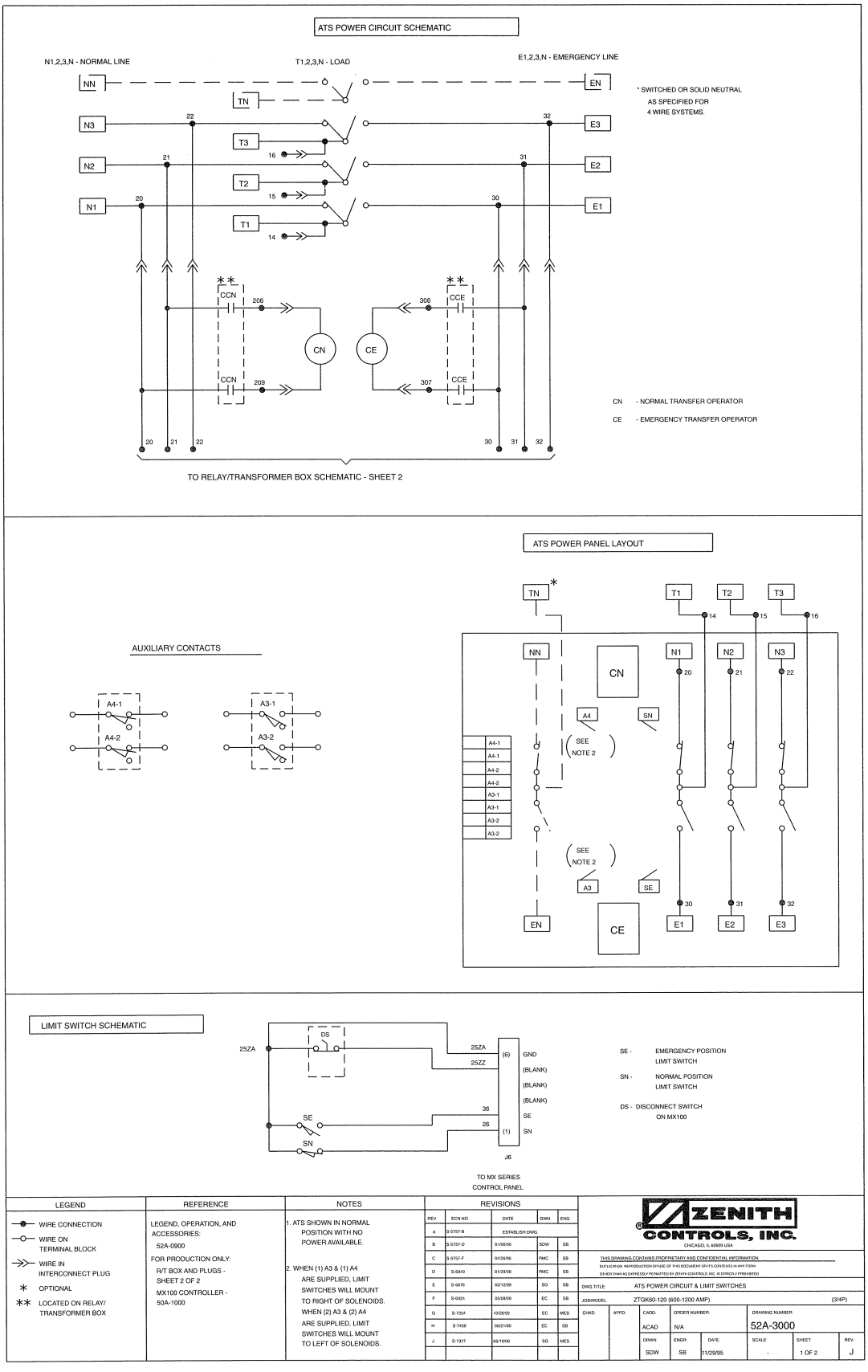
Drawing #52A-2001, Page 1



Drawing #52A-2001, Page 2



Drawing #52A-3000, Page 1



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUGS - SHEET 2 OF 2 MX100 CONTROLLER - 50A-1000	1. ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE. 2. WHEN (1) A3 & (1) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO RIGHT OF SOLENOIDS. WHEN (2) A3 & (2) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO LEFT OF SOLENOIDS.

REVISIONS				
REV	ECN NO	DATE	DWN	ENG
A	S-5757-B	ESTABLISH DWG.		
B	S-5757-D	01/05/95	SDW	SB
C	S-5757-F	04/26/96	RMC	SB
D	S-6940	01/28/98	RMC	SB
E	S-6976	02/13/98	SG	SB
F	S-6924	05/08/98	EC	SB
G	S-7254	10/28/99	EC	MES
H	S-7456	06/21/00	EC	SB
J	S-7377	09/19/00	SG	MES

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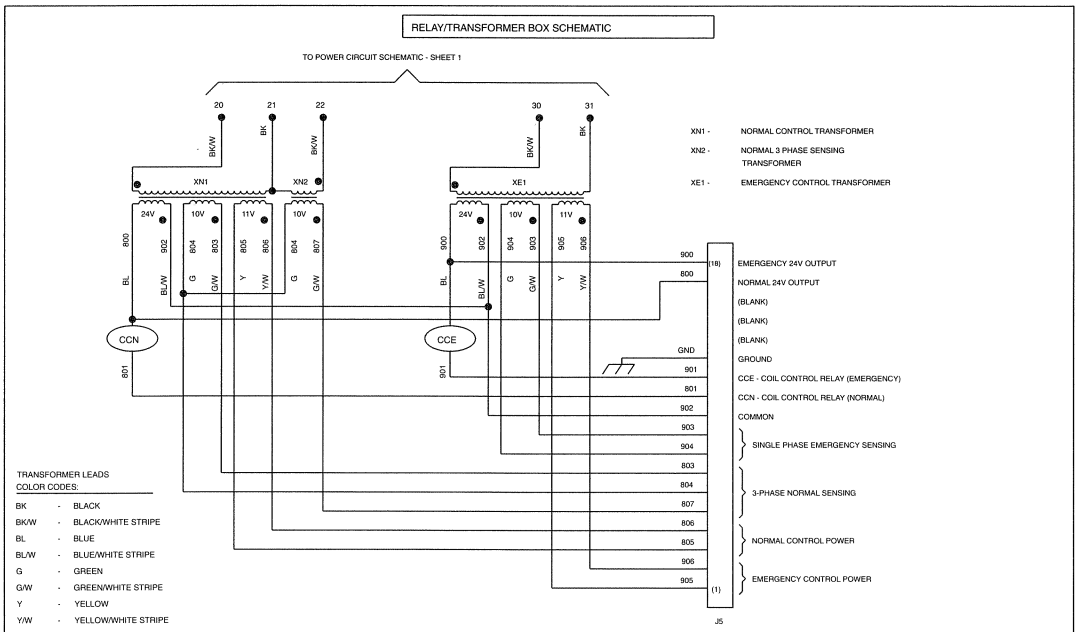
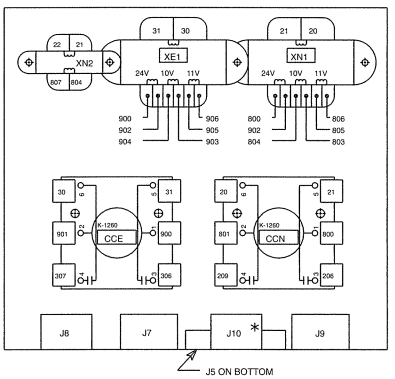
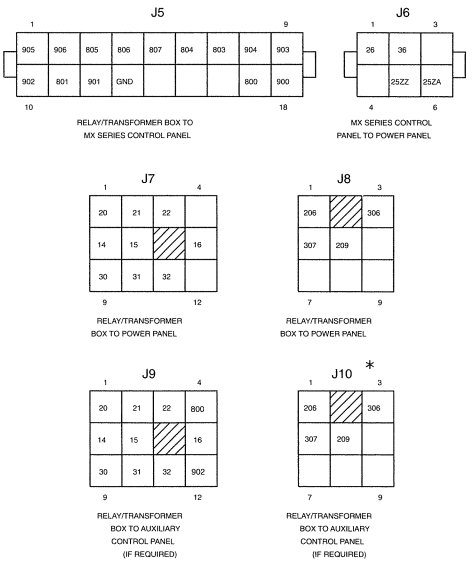
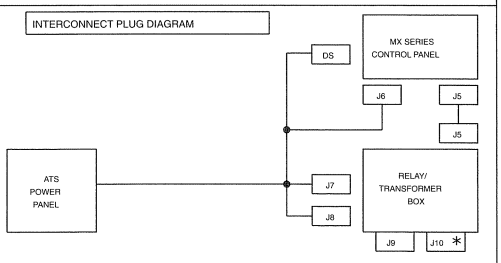
DWG TITLE:	ATS POWER CIRCUIT & LIMIT SWITCHES					
JOB/MODEL:	ZTGK60-120 (600-1200 AMP)					(3/4P)
CHKD:	APPD:	CADD: ACAD	ORDER NUMBER: N/A	DRAWING NUMBER: 52A-3000		
		DRWN: SDW	ENGR: SB	DATE: 11/29/95	SCALE: -	SHEET: 1 OF 2	REV: J

Drawing #52A-3000, Page 2









LEGEND	REFERENCE	NOTES
WIRE CONNECTION		
* OPTIONAL		

REVISIONS				
REV	ECN NO.	DATE	DWN	ENG
A	S-5757-9	ESTABLISH DWG.		
B	S-5757-D	01/02/96	SDW	SB
C	S-5757-F	04/05/96	RMC	SB
D	S-5949	01/08/98	RMC	SB
E	S-6976	02/12/99	SG	SB
F	S-6924	05/06/99	EC	SB
G	S-7254	10/26/99	EC	MES
H	S-7450	05/21/00	EC	SB
J	S-7377	04/27/00	SG	MES

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DWG TITLE:	RELAY/XFR. BOX & INTERCONNECT PLUGS					
JOB/MODEL:	ZTGK60-120 (600-1200 AMP)					(3/4P)
CHKD.	APPD.	CADD ACAD	ORDER NUMBER N/A	DRAWING NUMBER 52A-3000		
		DRWN. SDW	ENGR. SB	DATE: 11/29/95	SCALE: -	SHEET 2 OF 2	REV J

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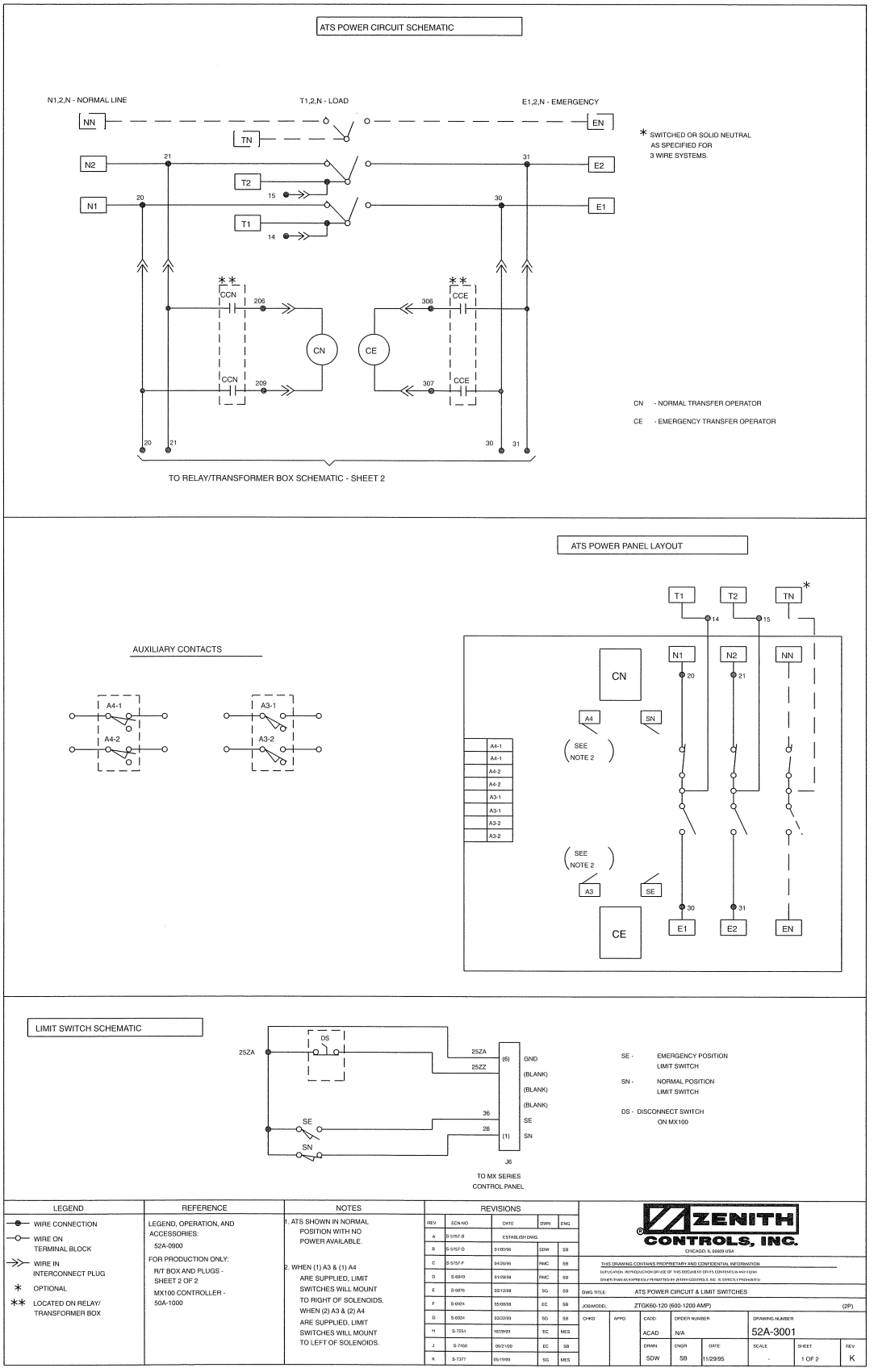
Drawing #52A-3001, Page 1



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUGS - SHEET 2 OF 2 MX100 CONTROLLER - 50A-1000	1. ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE. 2. WHEN (1) A3 & (1) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO RIGHT OF SOLENOIDS. WHEN (2) A3 & (2) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO LEFT OF SOLENOIDS.

REVISIONS				
REV	ECN NO.	DATE	DWN	ENG
A	S-5757-B	ESTABLISH DWG.		
B	S-5757-D	01/02/96	SDW	SB
C	S-5757-F	04/26/96	RMC	SB
D	S-6849	01/29/98	RMC	SB
E	S-6976	02/12/98	SG	SB
F	S-6924	05/08/98	EC	SB
G	S-6924	03/22/99	SG	SB
H	S-7254	10/28/99	EC	MES
J	S-7456	05/21/00	EC	SB
K	S-7377	05/10/99	SG	MES

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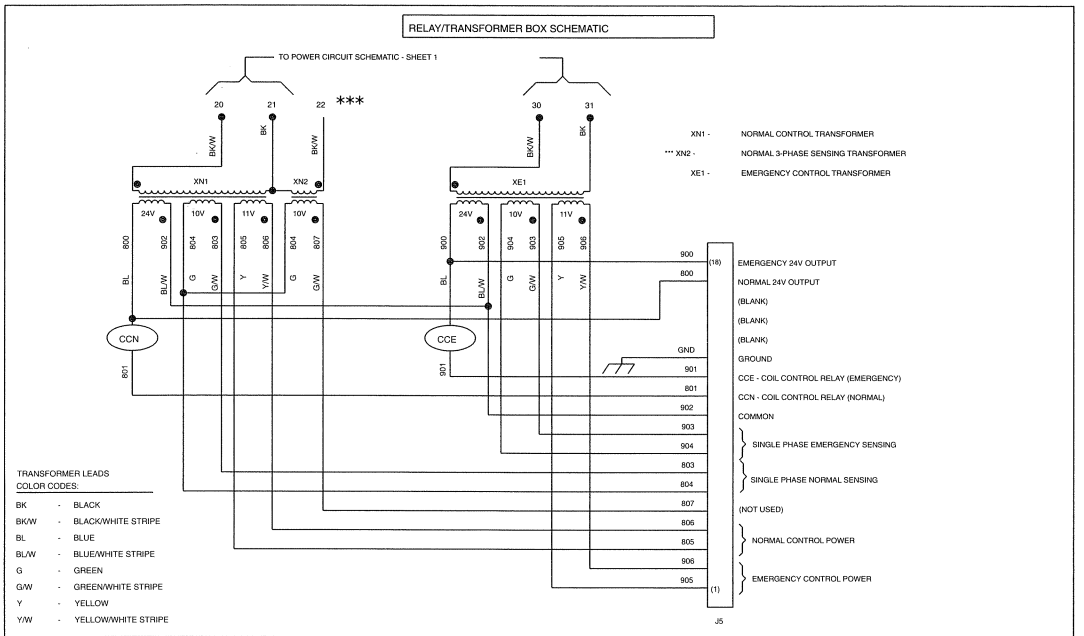
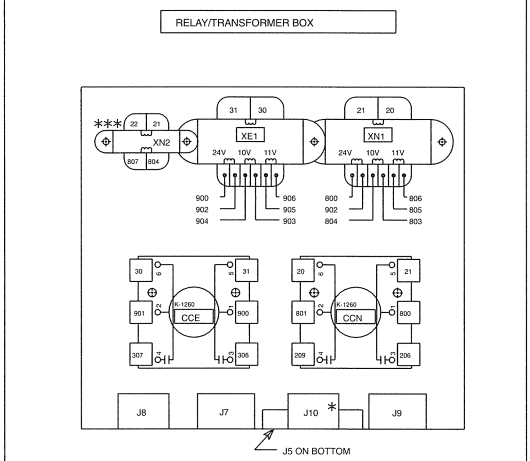
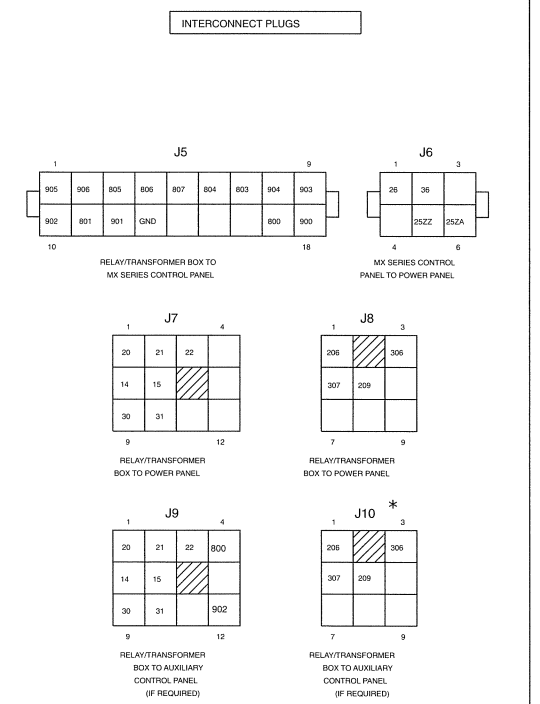
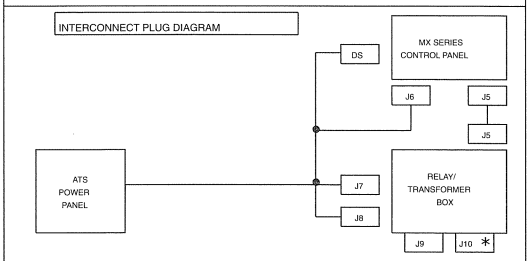
DWG TITLE:	ATS POWER CIRCUIT & LIMIT SWITCHES					
JOB/MODEL:	ZTGK60-120 (600-1200 AMP)					(2P)
CHKD	APPD	CADD: ACAD	ORDER NUMBER: N/A	DRAWING NUMBER: 52A-3001		
		DRWN: SDW	ENGR: SB	DATE: 11/29/95	SCALE: -	SHEET: 1 OF 2	REV: K

Drawing #52A-3001, Page 2









LEGEND

- WIRE CONNECTION
- * OPTIONAL
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRE #22 IS NOT CONNECTED TO ATS POWER PANEL.

NOTES

REVISIONS

REV.	ECN NO.	DATE	DWN.	ENG.
A	S-5757-B	ESTABLISH DWG.		
B	S-5757-D	01/03/96	SDW	SB
C	S-5757-F	04/26/96	RMC	SB
D	S-6849	01/28/98	RMC	SB
E	S-6876	02/12/98	SG	SB
F	S-6924	05/08/98	EC	SB
G	S-7107	03/23/99	SG	SB
H	S-7254	10/26/99	EC	MES
J	S-7456	06/21/00	EC	SB
K	S-7377	04/27/00	SG	MES

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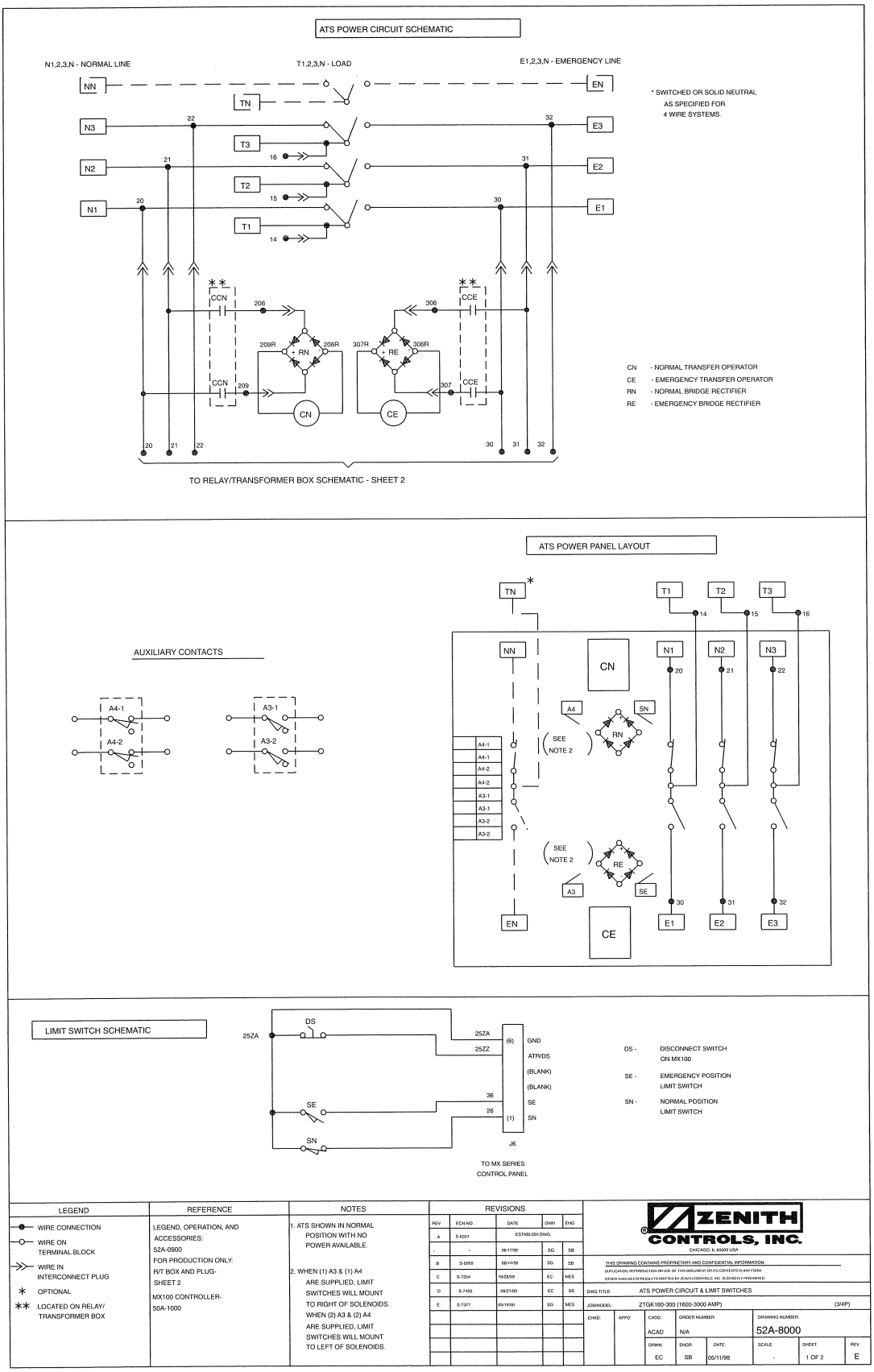
DWG TITLE:	RELAY/XFR BOX & INTERCONNECT PLUGS
JOB/MODEL:	ZTGK60-120 (600-1200 AMP) (2P)
CHKD:	APPD:
CADD:	ACAD N/A
ORDER NUMBER:	
DRAWING NUMBER:	52A-3001
DRWN:	SDW
ENGR:	SB
DATE:	11/29/95
SCALE:	-
SHEET:	2 OF 2
REV	K

Drawing #52A-8000, Page 1



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUG- SHEET 2 MX100 CONTROLLER- 50A-1000	1. ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE. 2. WHEN (1) A3 & (1) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO RIGHT OF SOLENOIDS. WHEN (2) A3 & (2) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO LEFT OF SOLENOIDS.

REVISIONS				
REV.	ECN NO.	DATE	DWN	ENG.
A	S-6924	ESTABLISH DWG.		
-	-	06/17/98	SG	SB
B	S-6969	06/18/98	SG	SB
C	S-7254	10/28/98	EC	MES
D	S-7459	05/21/00	EC	SB
E	S-7377	05/19/00	SG	MES

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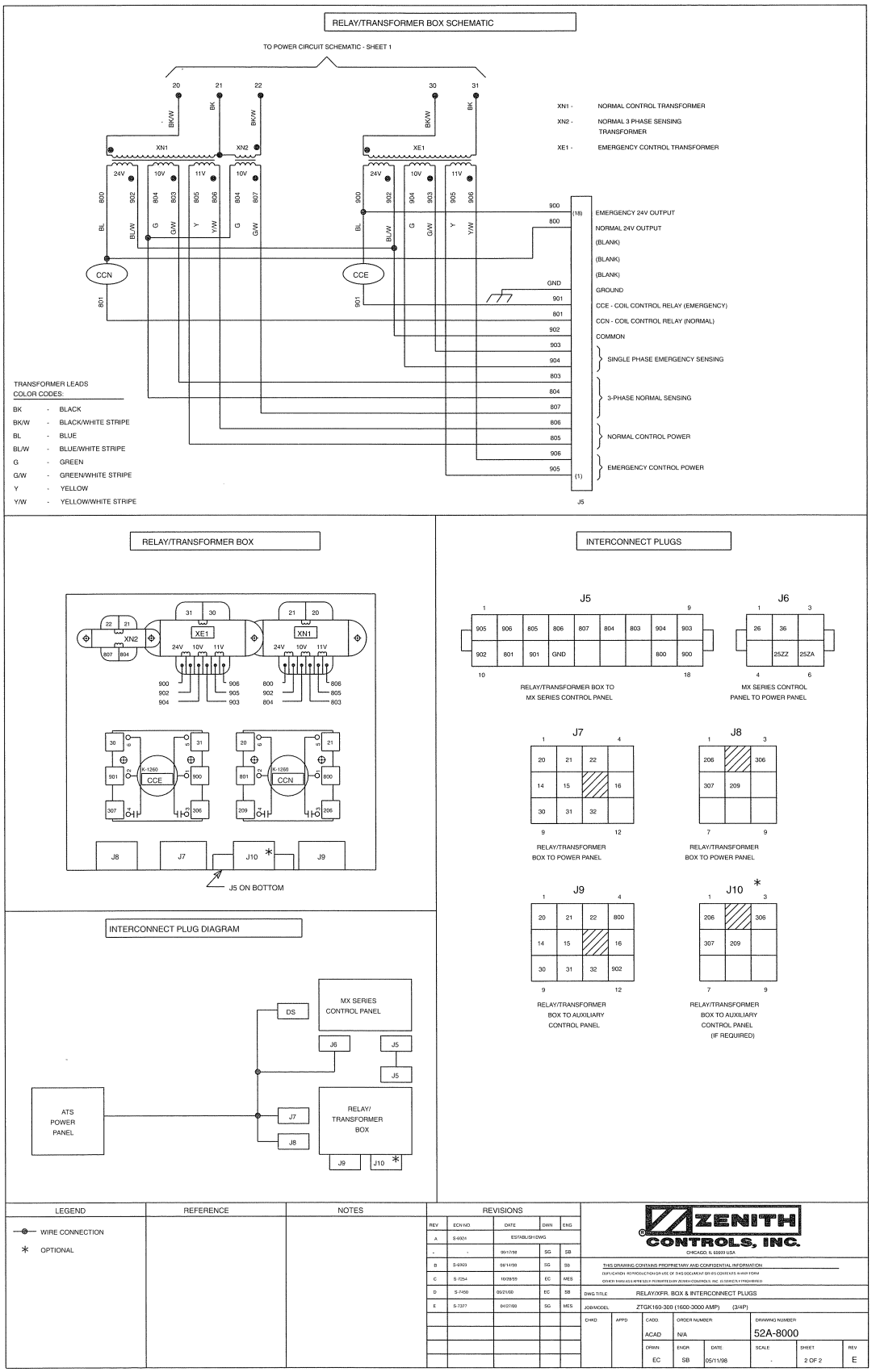
DWG TITLE: ATS POWER CIRCUIT & LIMIT SWITCHES
JOB/MODEL: ZTGK 160-300 (1600-3000 AMP) (3/4P)

CHKD:	APPD:	CADD:	ORDER NUMBER:	DRAWING NUMBER:
		ACAD	N/A	52A-8000

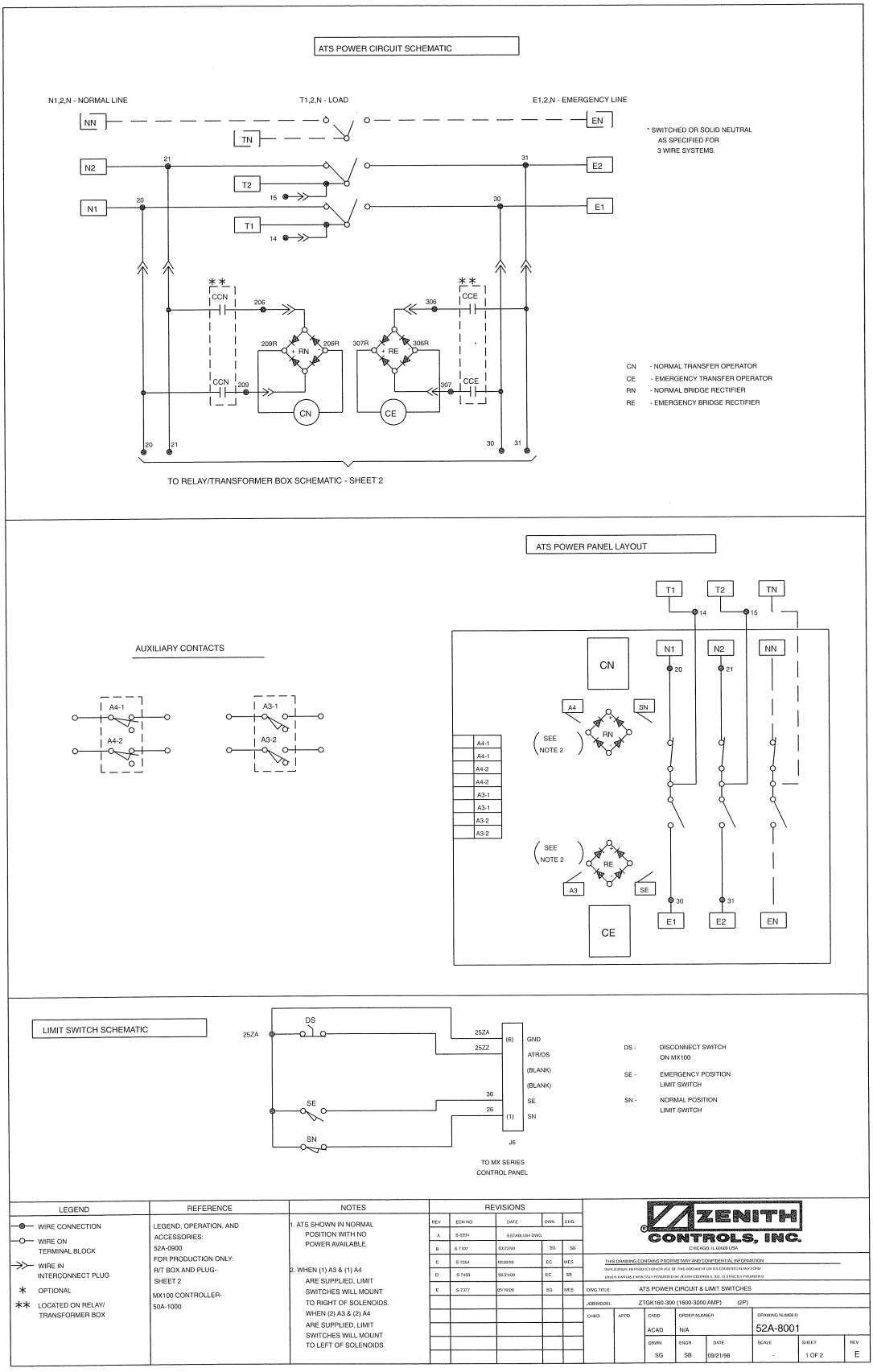
DRWN:	ENGR:	DATE:	SCALE:	SHEET:	REV:
EC	SB	05/11/98	-	1 OF 2	E

Drawing #52A-8000, Page 2



Katolight University - Gen II Training - Rev:06-01-06 - Page 115

Drawing #52A-8001, Page 1



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUG- SHEET 2 MX100 CONTROLLER- 50A-1000	1. ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE. 2. WHEN (1) A3 & (1) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO RIGHT OF SOLENOIDS. WHEN (2) A3 & (2) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO LEFT OF SOLENOIDS.

REVISIONS				
REV	ECN NO	DATE	DWN	ENG
A	S-0334	ESTABLISH DWG.		
B	S-7107	03/20/99	SG	SB
C	S-7254	10/29/99	EC	MES
D	S-7458	06/21/00	EC	SB
E	S-7377	05/19/00	SG	MES

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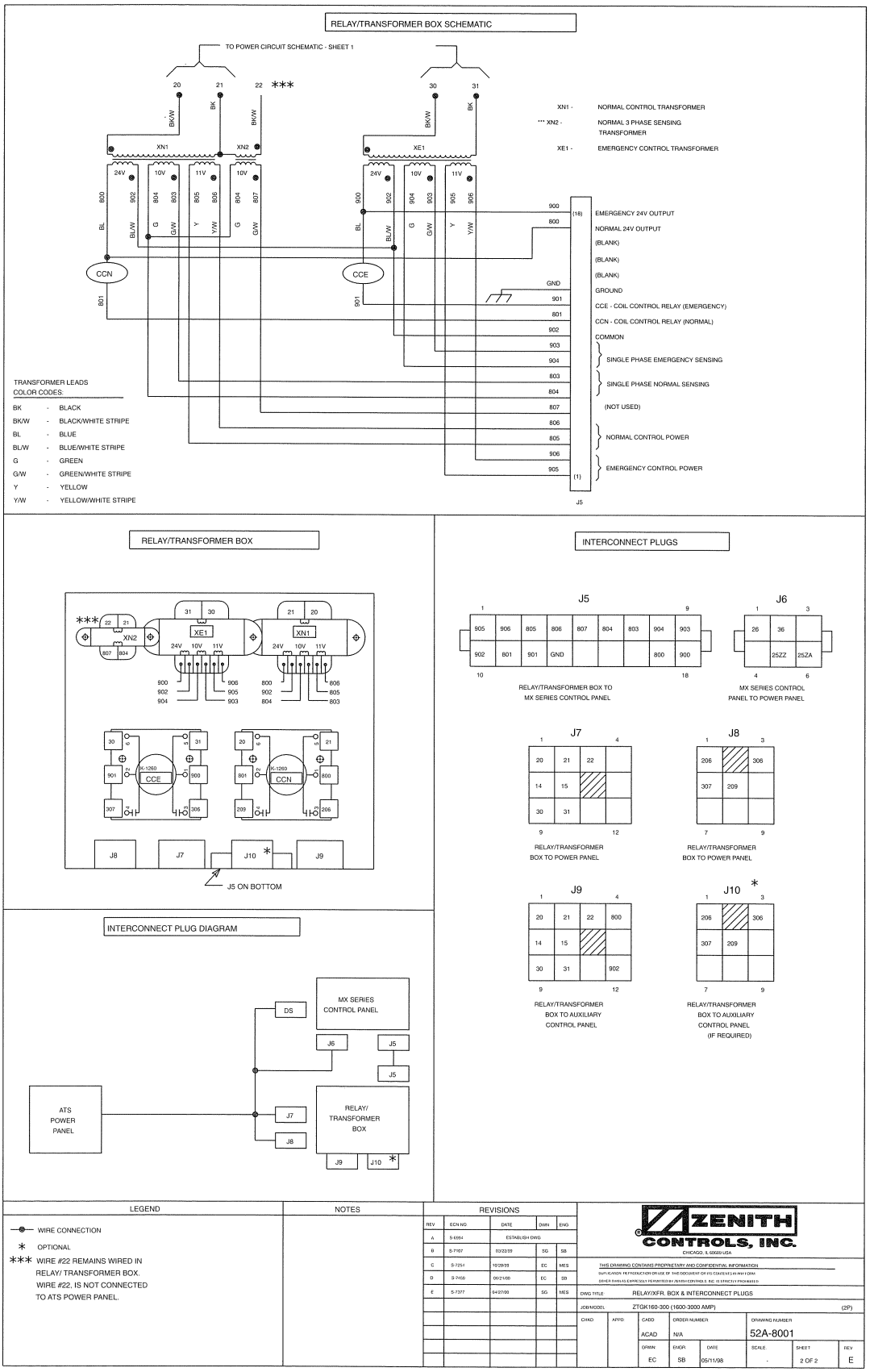
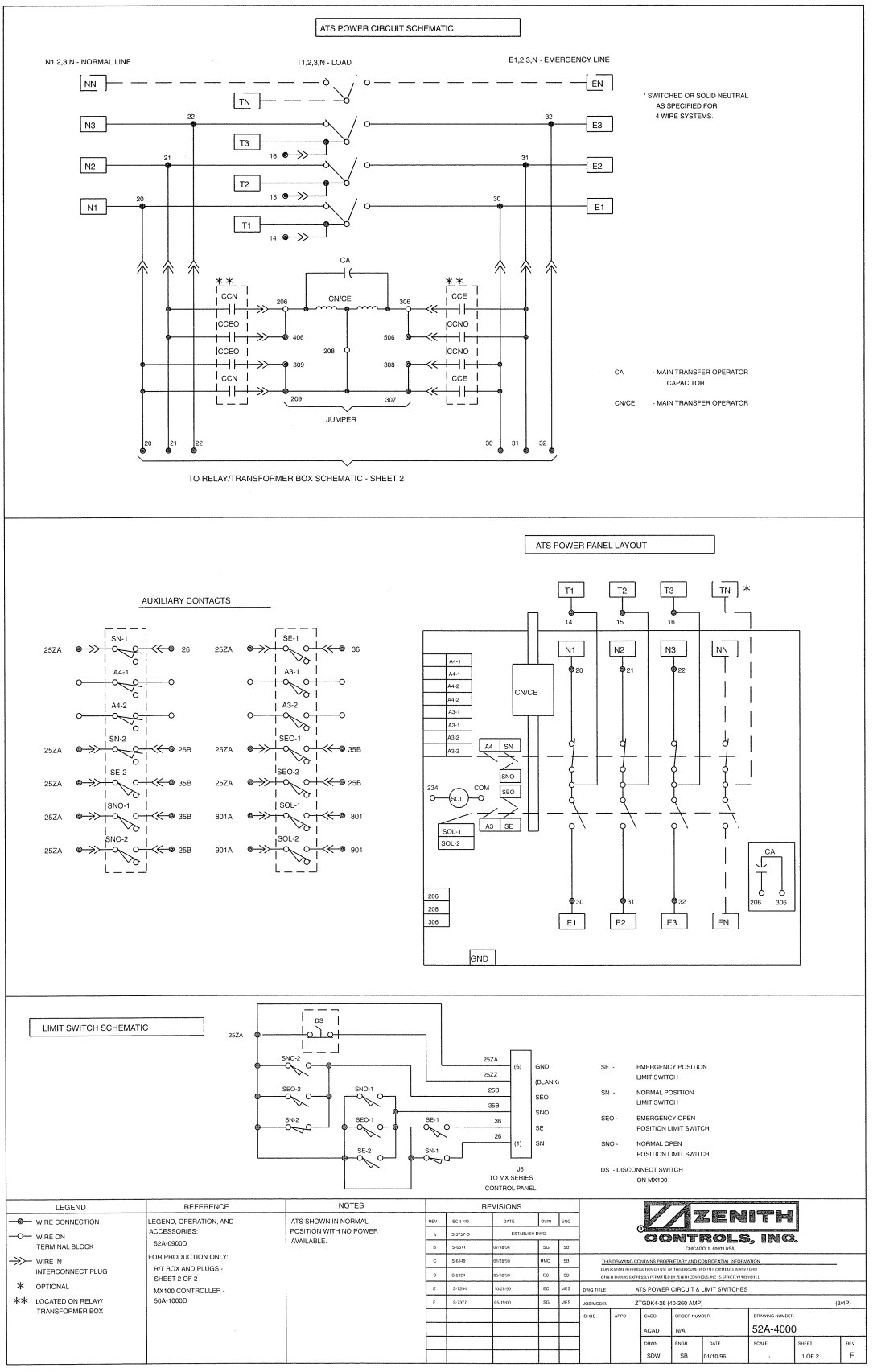
DWG TITLE	ATS POWER CIRCUIT & LIMIT SWITCHES					
JOB MODEL	ZTGK160-300 (1600-3000 AMP) (2P)					
CHKD	APPD	CADD	ORDER NUMBER		DRAWING NUMBER	
		ACAD	N/A		52A-8001	
		DRWN	ENGR	DATE	SCALE	SHEET / REV
		SG	SB	09/21/98	-	1 OF 2 / E

Drawing #52A-8001, Page 2



Drawing #52A-4000, Page 1



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900D FOR PRODUCTION ONLY: R/T BOX AND PLUGS - SHEET 2 OF 2 MX100 CONTROLLER - 50A-1000D	ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE.

REVISIONS				
REV	ECN NO.	DATE	DWN	ENG
A	S-5757 O	ESTABLISH DWG		
B	S-6511	07/18/95	SG	SB
C	S-6849	01/23/98	RWC	SB
D	S-6934	03/16/98	EC	SB
E	S-7264	10/28/99	EC	MES
F	S-7377	05/19/00	SG	MES

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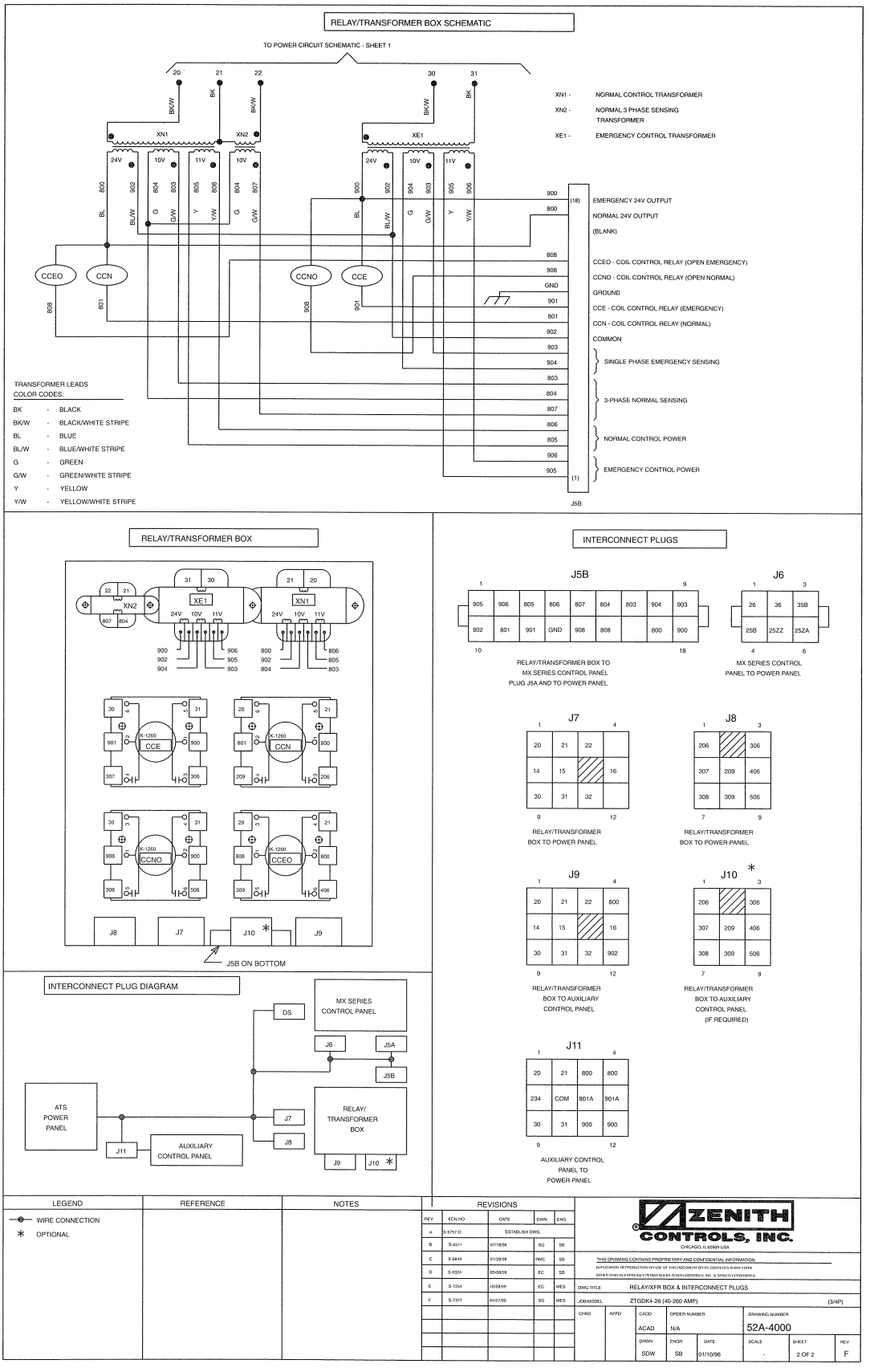
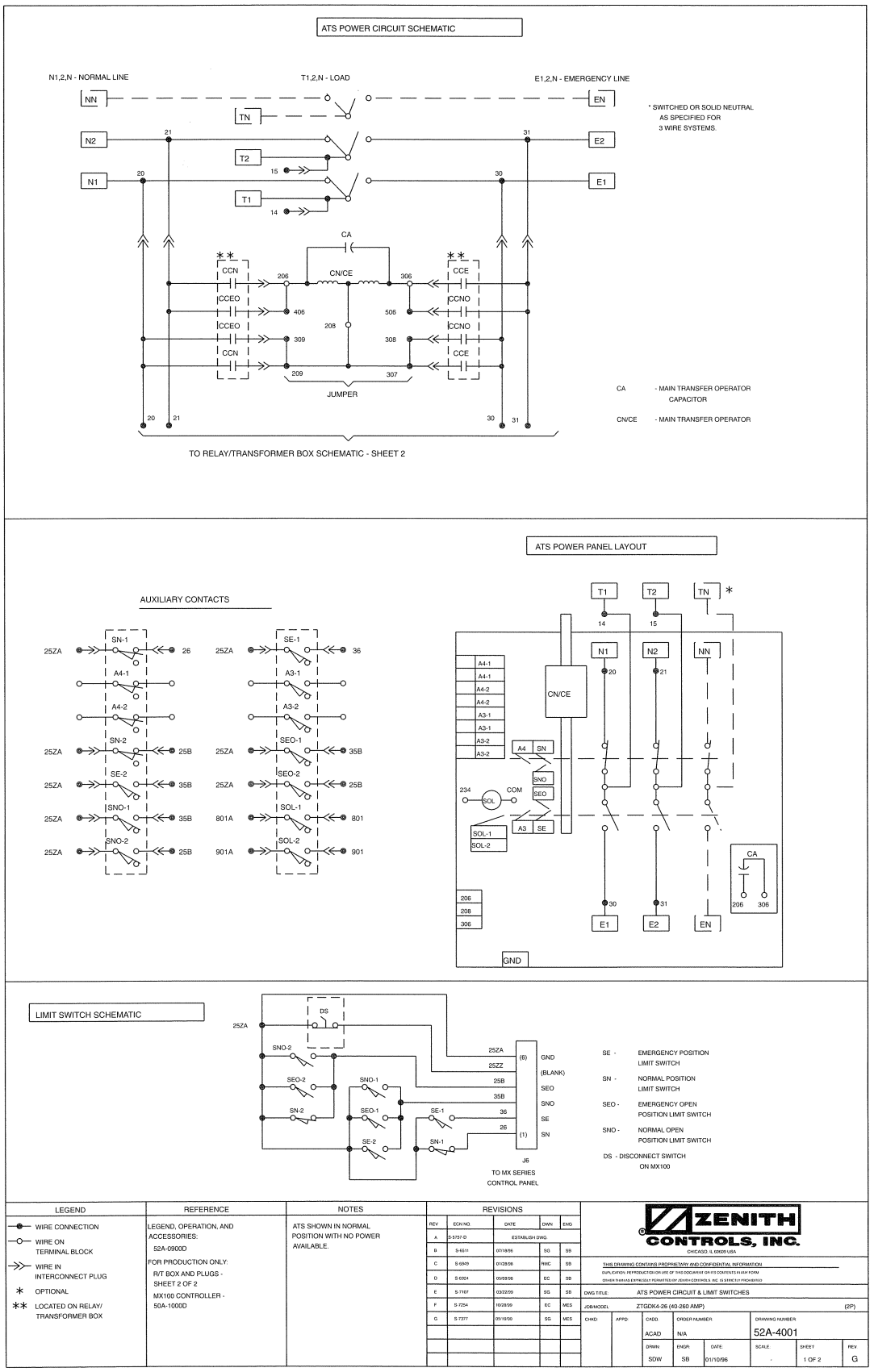
DWG TITLE	ATS POWER CIRCUIT & LIMIT SWITCHES
JOB/MODEL	ZTGDK4-26 (40-260 AMP) (3/4P)

CHKD	APPD	CADD	ORDER NUMBER	DRAWING NUMBER			
		ACAD	N/A	52A-4000			
		DRWN	ENGR	DATE	SCALE	SHEET	REV
		SDW	SB	01/10/96	-	1 OF 2	F

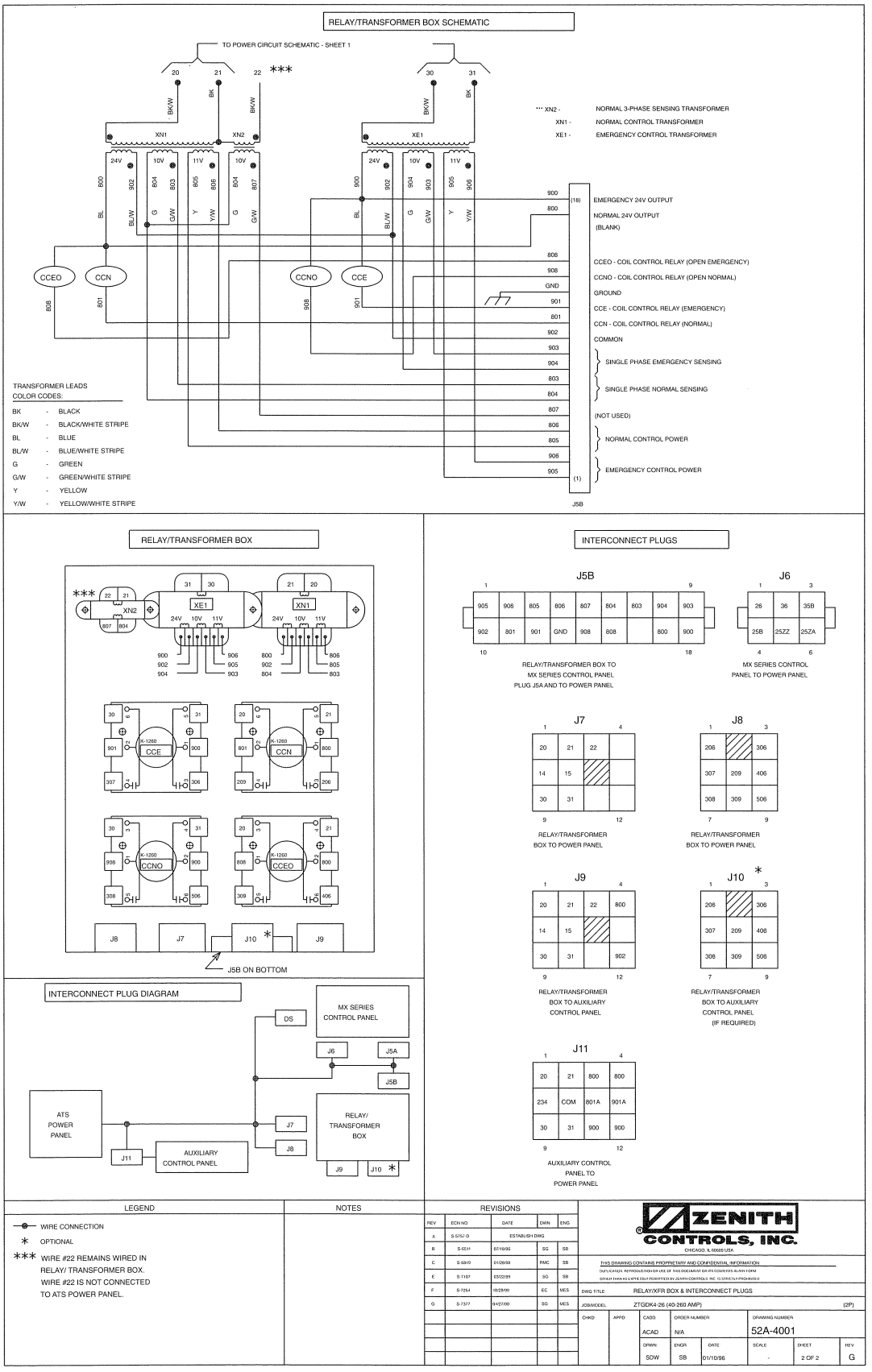
Drawing #52A-4000, Page 2



Drawing #52A-4001, Page 1



Drawing #52A-4001, Page 2



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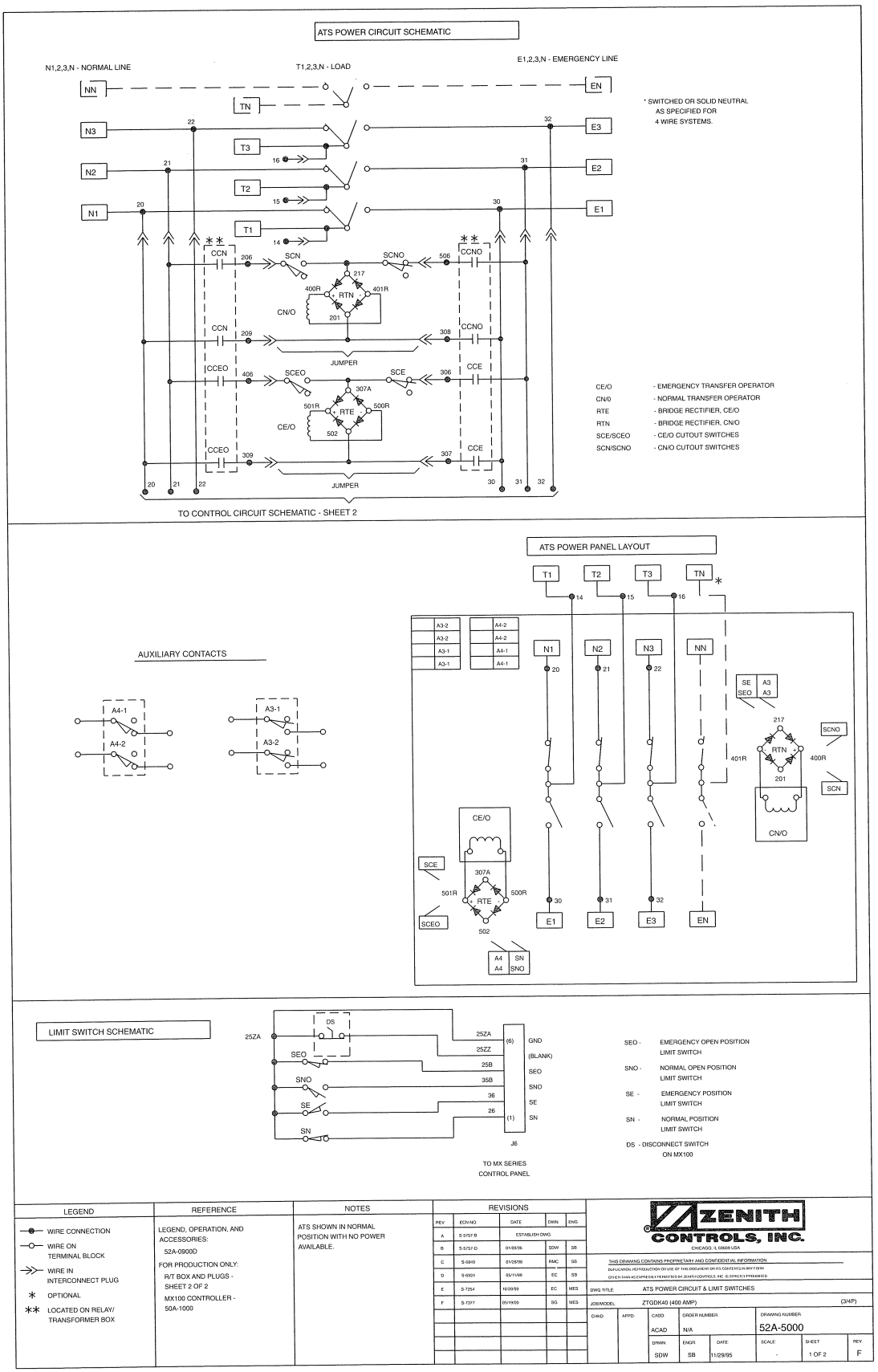
Drawing #52A-5000, Page 1



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 52A-0900D FOR PRODUCTION ONLY: R/T BOX AND PLUGS - SHEET 2 OF 2 MX100 CONTROLLER - 50A-1000	ATS SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE.

REVISIONS				
REV	ECN/NO	DATE	DWN	ENG
A	S-5757-B	ESTABLISH DWG		
B	S-5757-D	01/09/96	SDW	SB
C	S-5849	01/28/99	RMC	SB
D	S-6924	05/11/98	EC	SB
E	S-7254	10/28/99	EC	MES
F	S-7377	05/19/00	SG	MES

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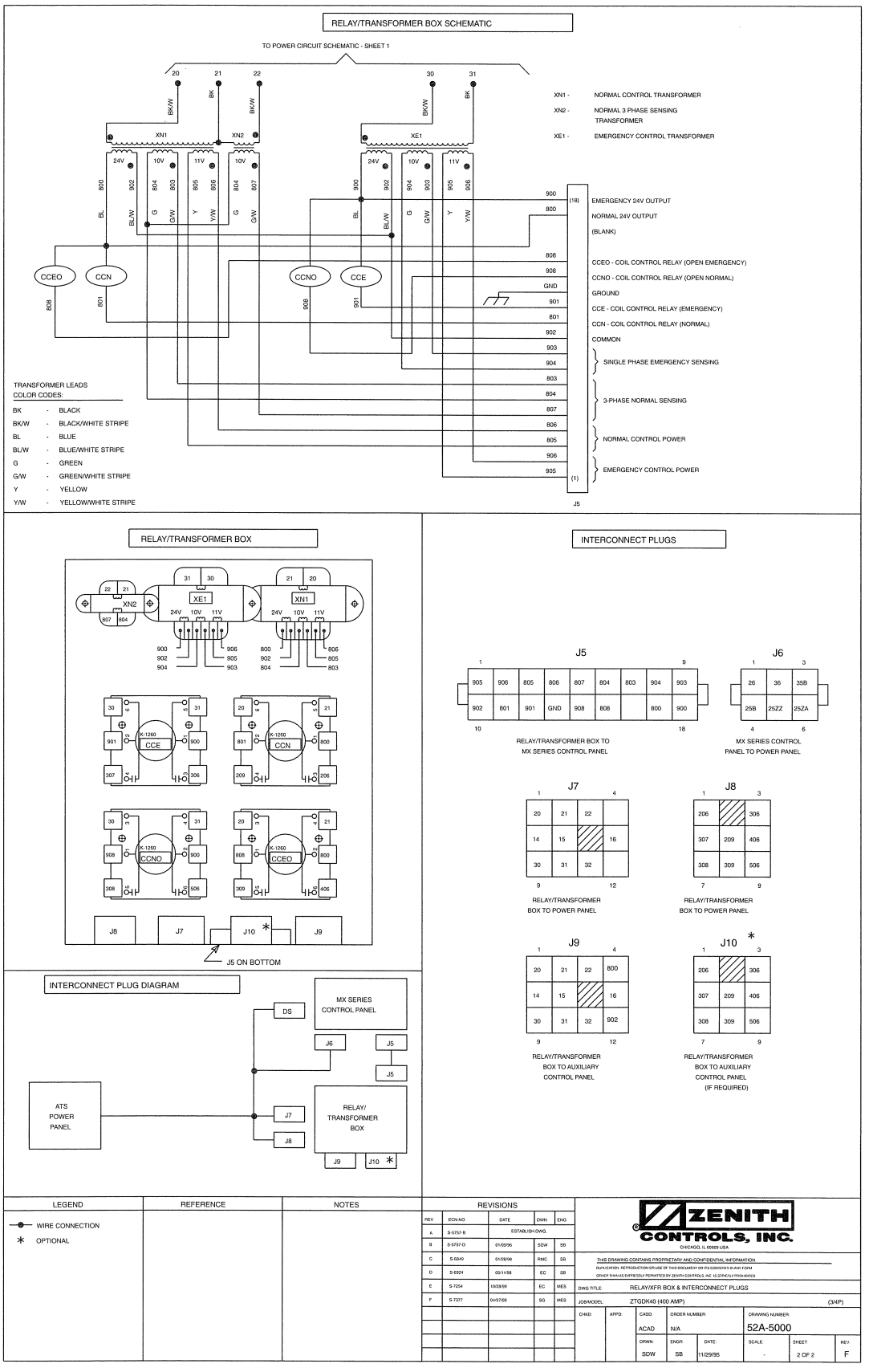
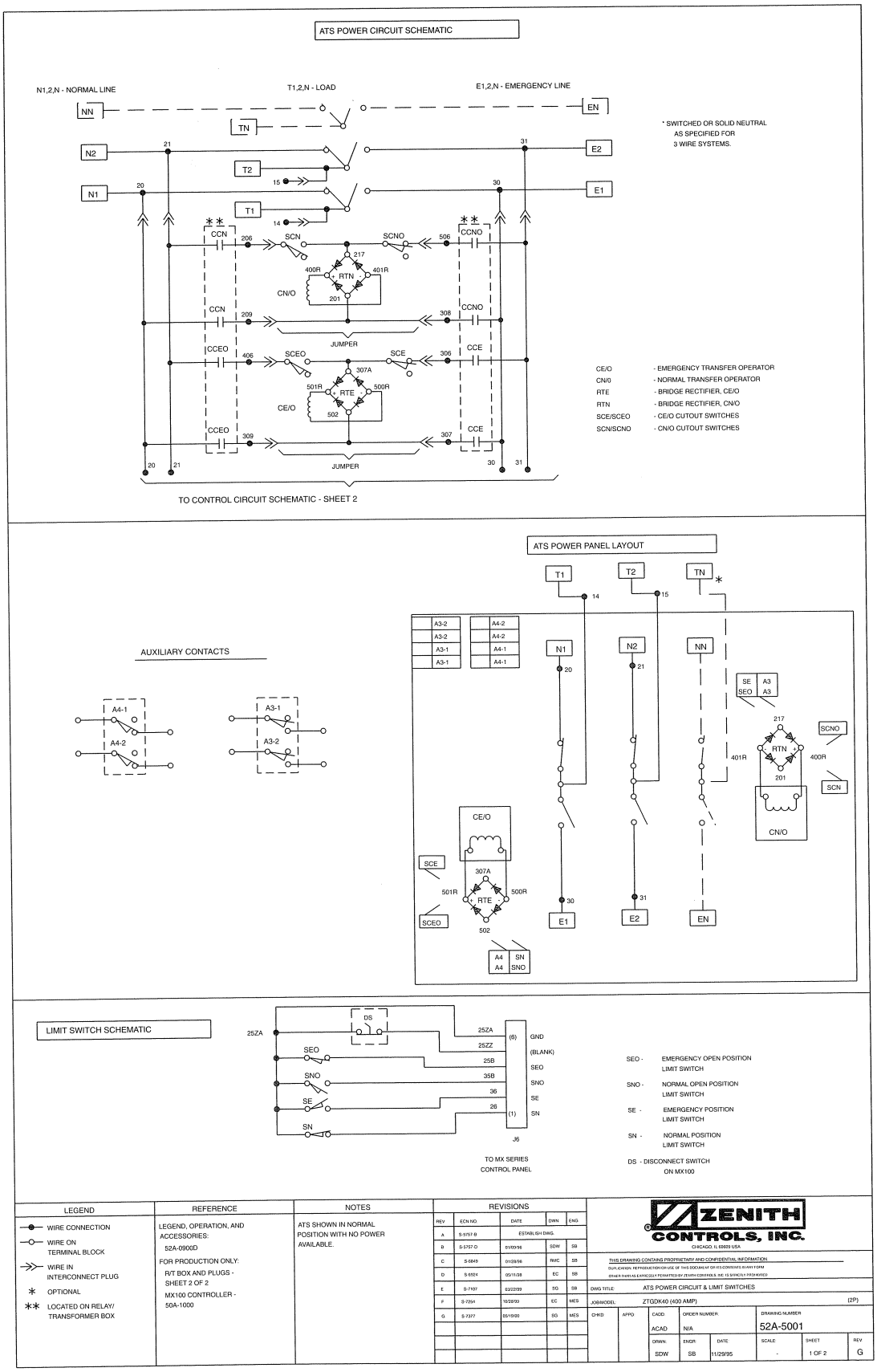
DWG TITLE:	ATS POWER CIRCUIT & LIMIT SWITCHES
JOB/MODEL:	ZTGDK40 (400 AMP) (3/4P)
DRAWN:	SDW
APPD:	SB
CADD:	ACAD
ORDER NUMBER:	N/A
DRAWING NUMBER:	52A-5000
ENGR:	11/29/95
SCALE:	-
SHEET:	1 OF 2
REV:	F

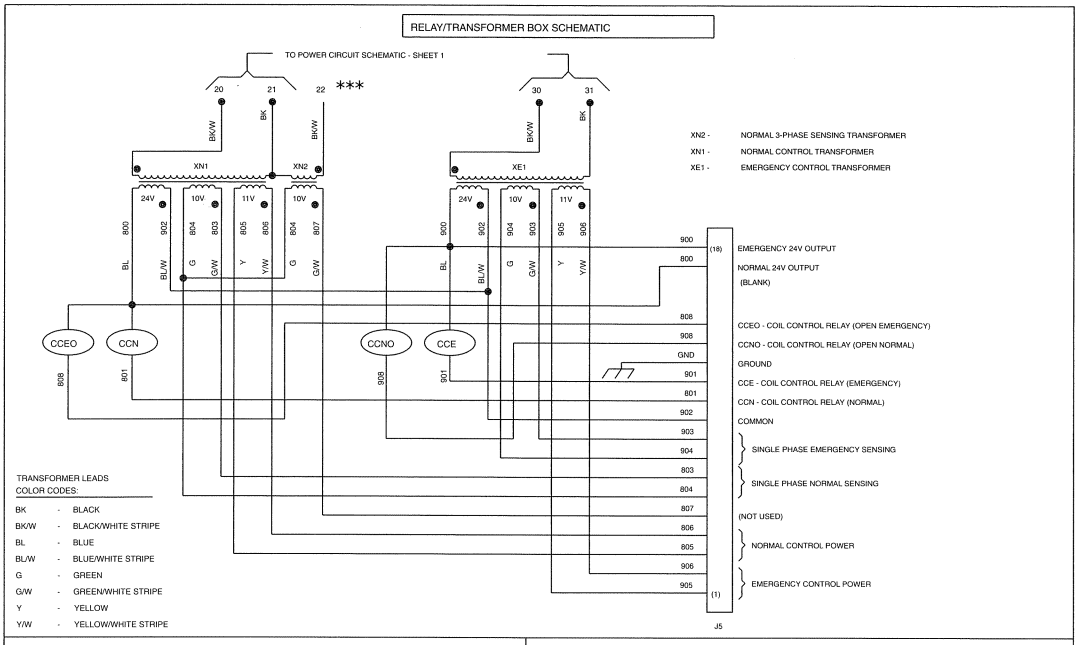
Drawing #52A-5000, Page 2

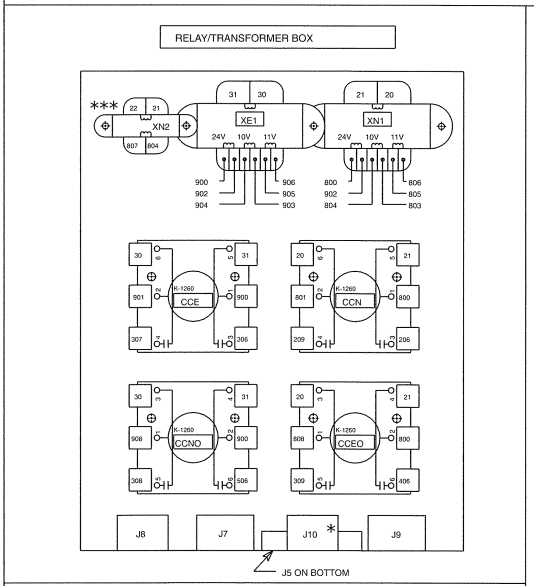


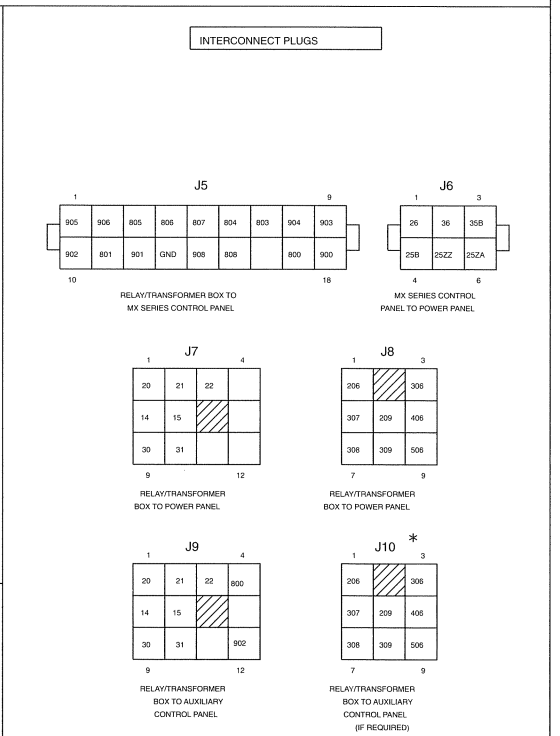
Drawing #52A-5001, Page 1

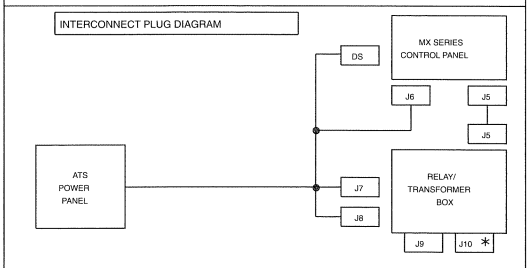


Drawing #52A-5001, Page 2









LEGEND

- WIRE CONNECTION
- * OPTIONAL
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRE #22, IS NOT CONNECTED TO ATS POWER PANEL.

NOTES

REVISIONS

REV	ECN NO.	DATE	DWN	CNG
A	S-5757-B	ESTABLISH DWG.		
B	S-5757-D	01/03/96	SDW	SB
C	S-6849	01/28/98	RMC	SB
D	S-6924	05/11/98	EC	SB
E	S-7107	02/22/99	SG	SB
F	S-7254	10/20/99	EC	MES
G	S-7377	04/27/00	SG	MES

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DWG TITLE	RELAY/XFR BOX & INTERCONNECT PLUGS
JOB/MODEL	ZTGDK40 (400 AMP) (2P)
CHKD	
APPD	
CADD	ACAD
ORDER NUMBER	N/A
DRAWING NUMBER	52A-5001
DRWN	SDW
ENGR	SB
DATE	11/29/95
SCALE	-
SHEET	2 OF 2
REV	G

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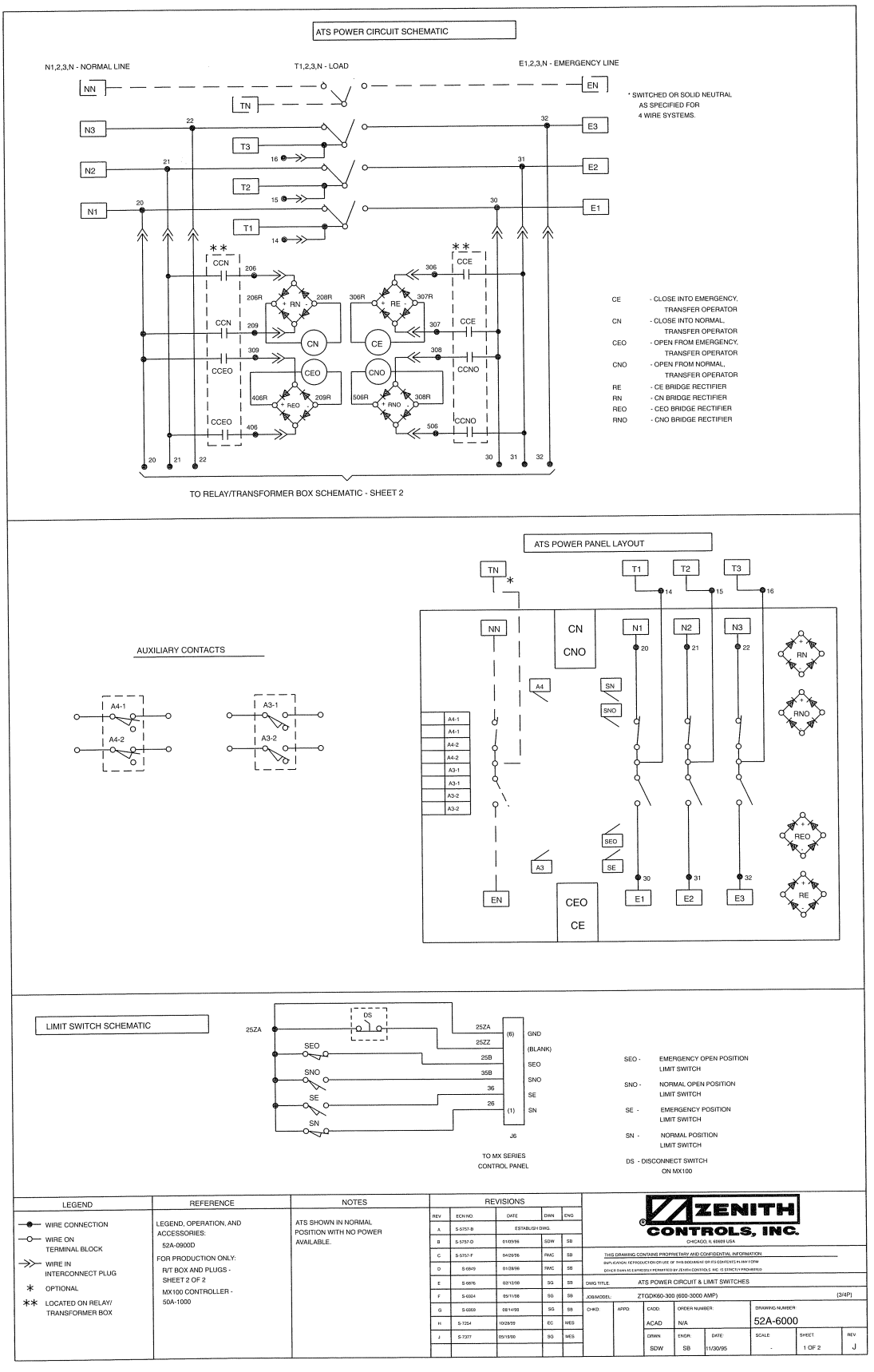
Drawing #52A-6000, Page 1



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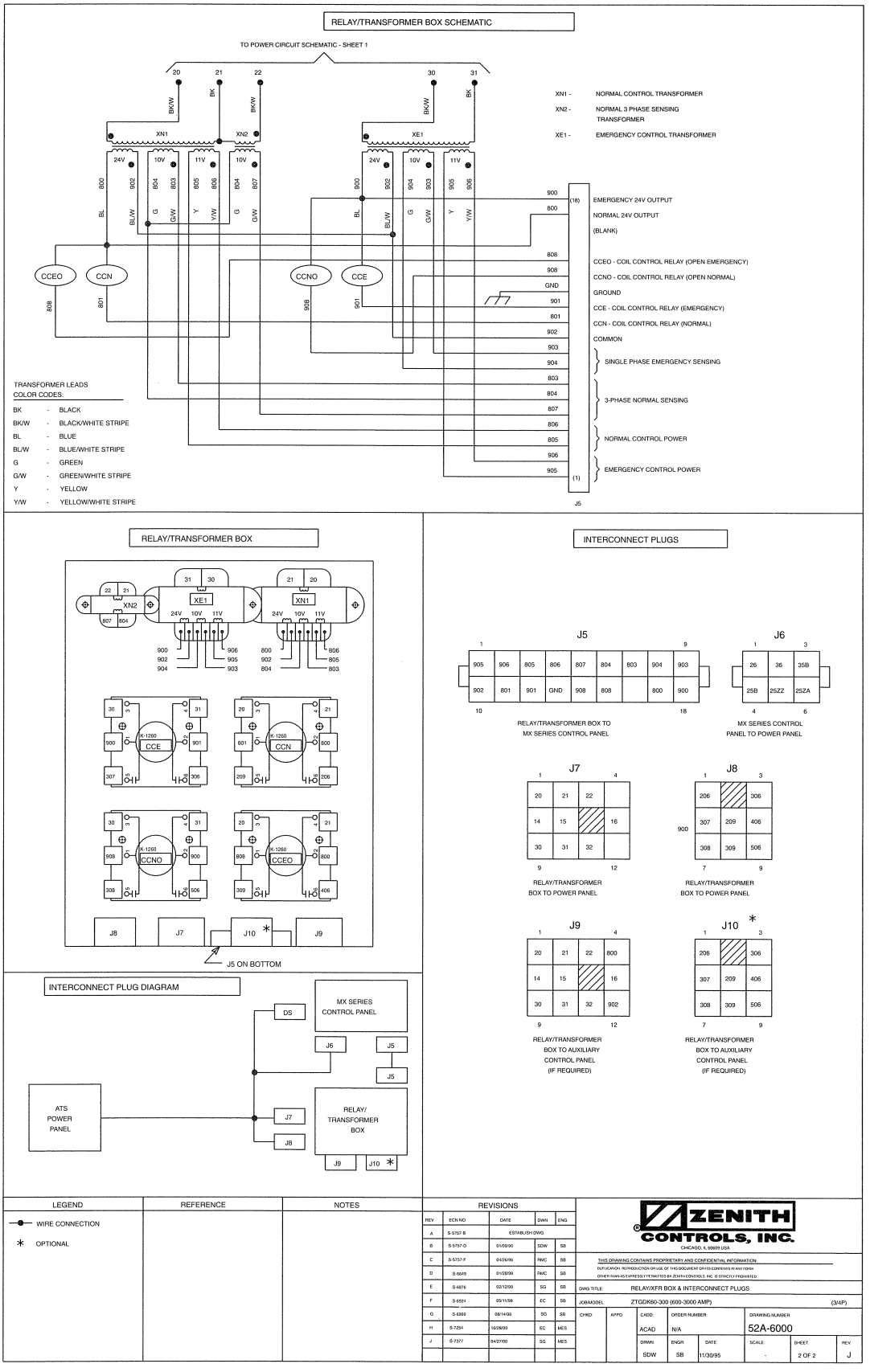
Drawing #52A-6000, Page 2



LEGEND	REFERENCE	NOTES
WIRE CONNECTION		
* OPTIONAL		

REVISIONS

REV	ECN NO	DATE	DWN	ENG
A	S-5757-B	ESTABLISH DWG		
B	S-5757-D	01/05/95	SDW	SB
C	S-5757-F	04/26/95	RMC	SB
D	S-6045	01/25/96	RMC	SB
E	S-6676	02/12/96	SG	SB
F	S-6924	05/11/96	EC	SB
G	S-6969	08/14/96	SG	SB
H	S-7254	10/28/96	EC	MES
J	S-7377	04/27/00	SG	MES

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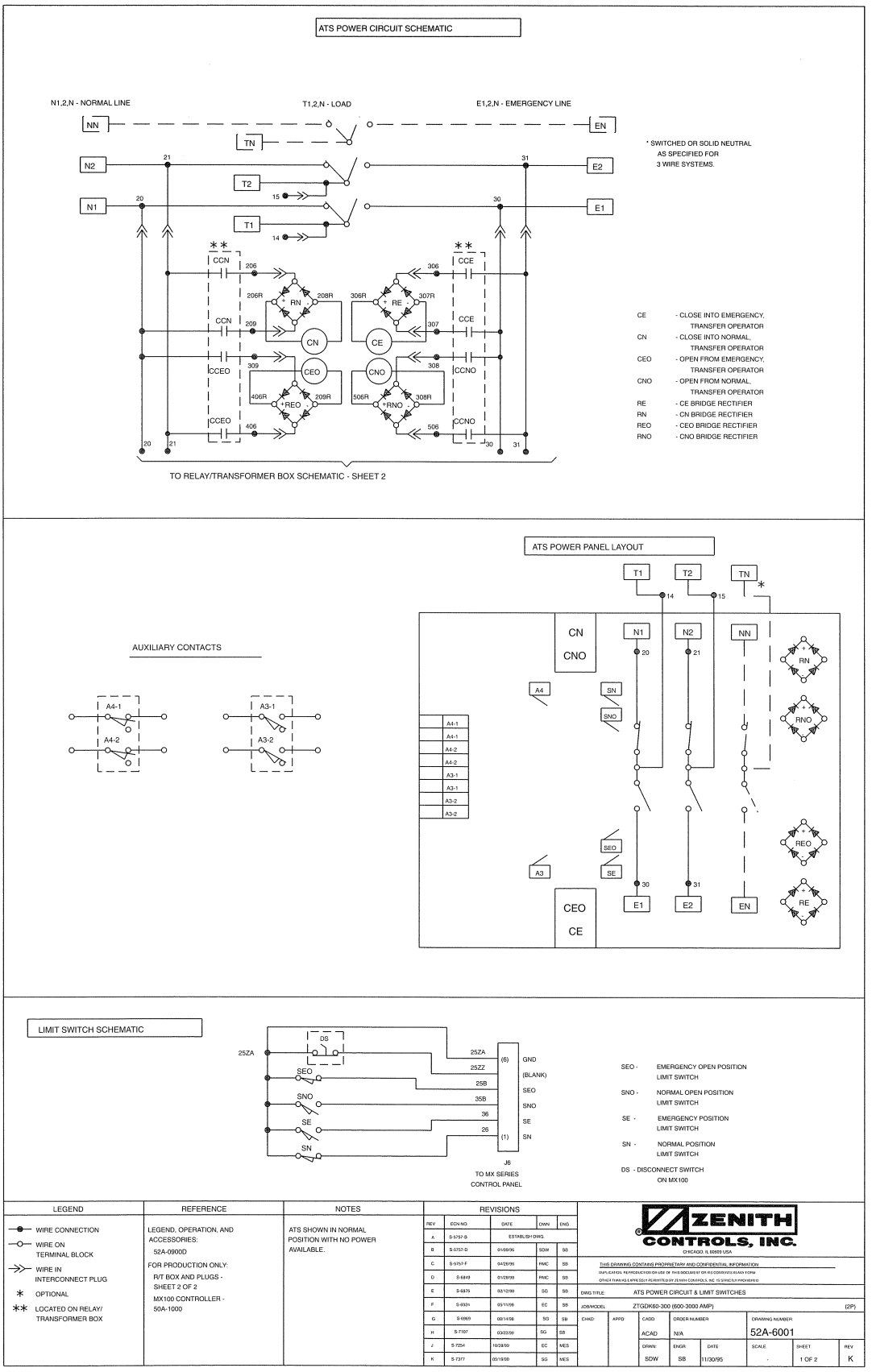
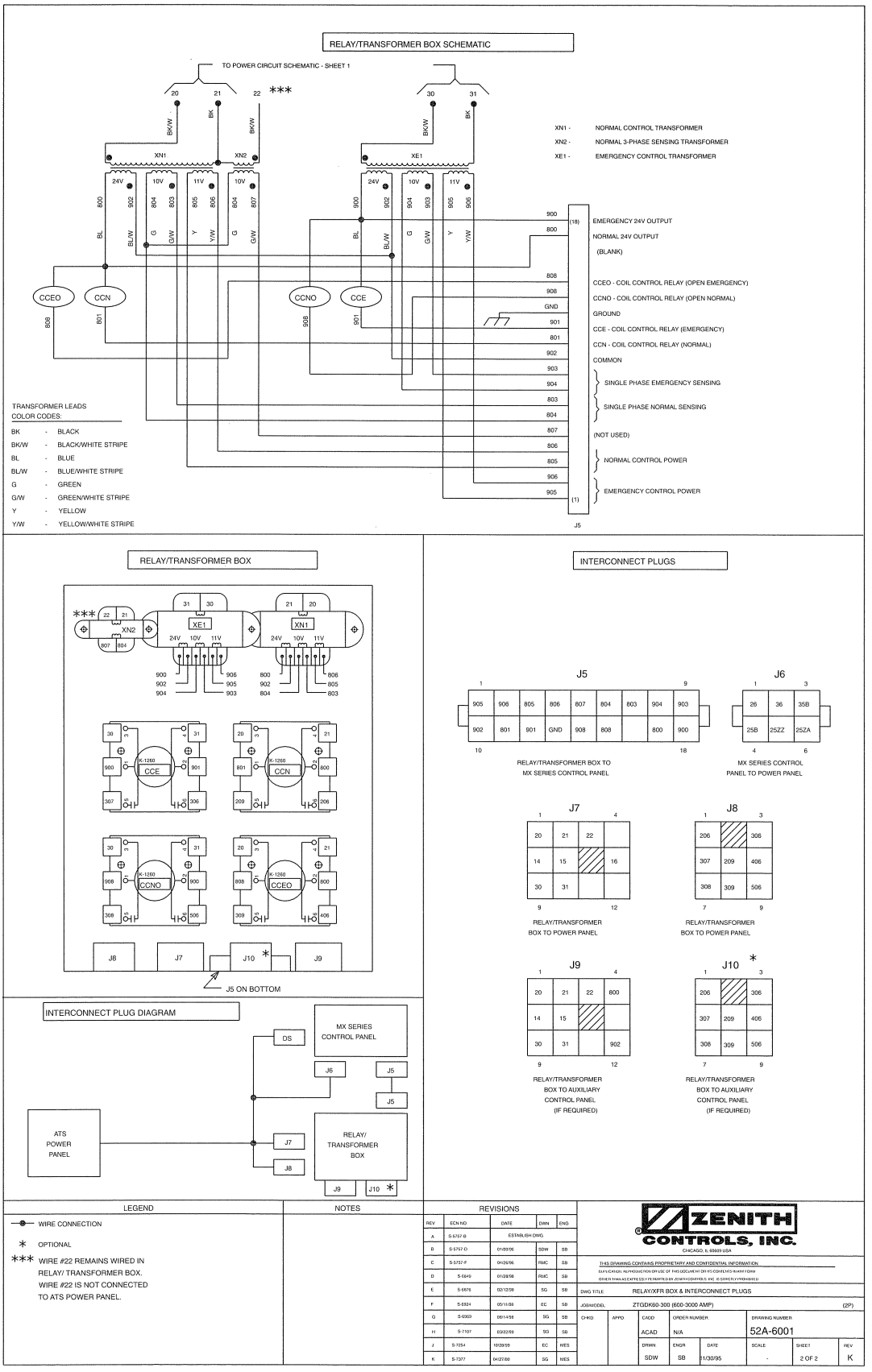
DWG TITLE:	RELAY/XFR BOX & INTERCONNECT PLUGS				
JOB MODEL:	ZTGDX60-300 (600-3000 AMP)				(3/4P)
CHKD	APPD	CADD: ACAD	ORDER NUMBER: N/A	DRAWING NUMBER: 52A-6000	
		DRWN: SDW	ENGR: SB	DATE: 11/30/95	SCALE: -
					SHEET: 2 OF 2
					REV: J

Drawing #52A-6001, Page 1



Drawing #52A-6001, Page 2



LEGEND

- WIRE CONNECTION
- * OPTIONAL
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRE #22 IS NOT CONNECTED TO ATS POWER PANEL.

NOTES

REVISIONS

REV	ECN NO.	DATE	DRN	ENG
A	S-5757-B	ESTABLISH DWG.		
B	S-5757-D	01/09/96	SDW	SB
C	S-5757-F	04/26/96	RMC	SB
D	S-6649	01/28/98	RMC	SB
E	S-6976	02/12/98	SG	SB
F	S-6924	05/11/99	EC	SB
G	S-6969	08/14/98	SG	SB
H	S-7107	03/03/99	SG	SB
J	S-7254	10/28/99	EC	MES
K	S-7377	04/27/00	SG	MES

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DWG TITLE:	RELAY/XFR BOX & INTERCONNECT PLUGS					
JOB/MODEL	ZTGDK60-300 (600-3000 AMP)					(2P)
CHKD	APPD	CADD	ORDER NUMBER	DRAWING NUMBER		
		ACAD	N/A	52A-6001		
		DRWN	ENGR	DATE	SCALE	SHEET / REV
		SDW	SB	11/30/95	-	2 OF 2 / K

Drawing #50R-1012, Page 1

LEGEND:

RA6N ..... Normal Presignal Relay...24VAC. Relay...K-1232; Base K-1228
RA6E..... Emergency Presignal Relay...24VAC...K-1232; Base K-1228
TB..... Terminal Block ... Y610090
J8..... Plug-R/T Box
PS-5083...Pin male (Qty. 3)
PS-5084...Socket female (Qty. 3)
J11..... Plug...PS-5077...Pin housing 9 pt.
PS-5078...Socket receptacle 9 pt.
PS-5083...Pin male (Qty. 8)
PS-5084...Socket female (Qty. 8)
PS-5085...Polarization Key
MX100..... Delay Model with Presignal overlay/static shield assembly
R/T BOX... Standard ATS model

Relay/Transformer Box
CCE..... Control Relay, Close Emergency
CCN..... Control Relay, Close Normal
XE1..... Control Transformer, Emergency
XN1,XN2..... Control Transformer, Normal

Power Panel Limit Switches
A3R..... Auxiliary Contact-Emergency Position
A4R..... Auxiliary Contact-Normal Position
SE-1,2..... Emergency Position
SN-1,2..... Normal Position

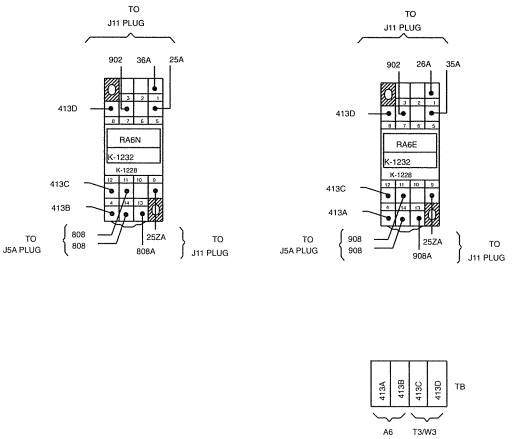
Interconnect Plugs
J5A, J5B, J6, J7, J8, J11

OPERATION:

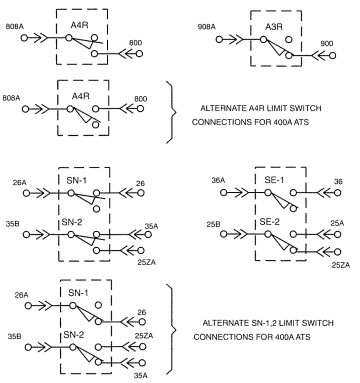
When Normal restores, A6 circuit opens (or T3/W3 circuit closes) (adjustable) until MX100 timer times out.
The Normal transfer relay(s) picks up and closes its contacts to transfer the switch to Normal. A6 recloses (or T3/W3 circuit reopens).

When Normal fails, A6 circuit is open (or T3/W3 circuit closes) (adjustable) until MX100 timer times out.
The Emergency transfer relay(s) picks up and closes its contacts to transfer the switch to Emergency. A6 recloses (or T3/W3 circuit reopens).

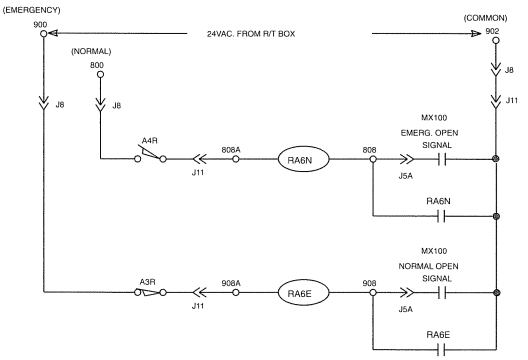
MX100 DIN RAIL



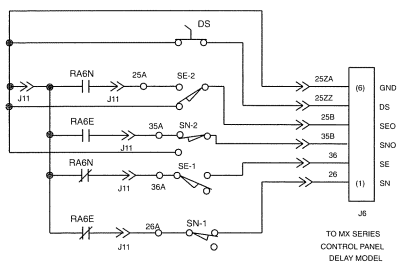
TYPICAL LIMIT SWITCHES ON POWER PANEL



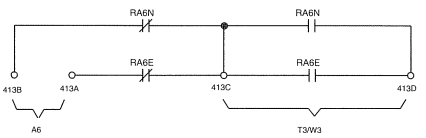
CONTROL RELAY SCHEMATIC



TYPICAL LIMIT SWITCH SCHEMATIC



CUSTOMER CONNECTIONS



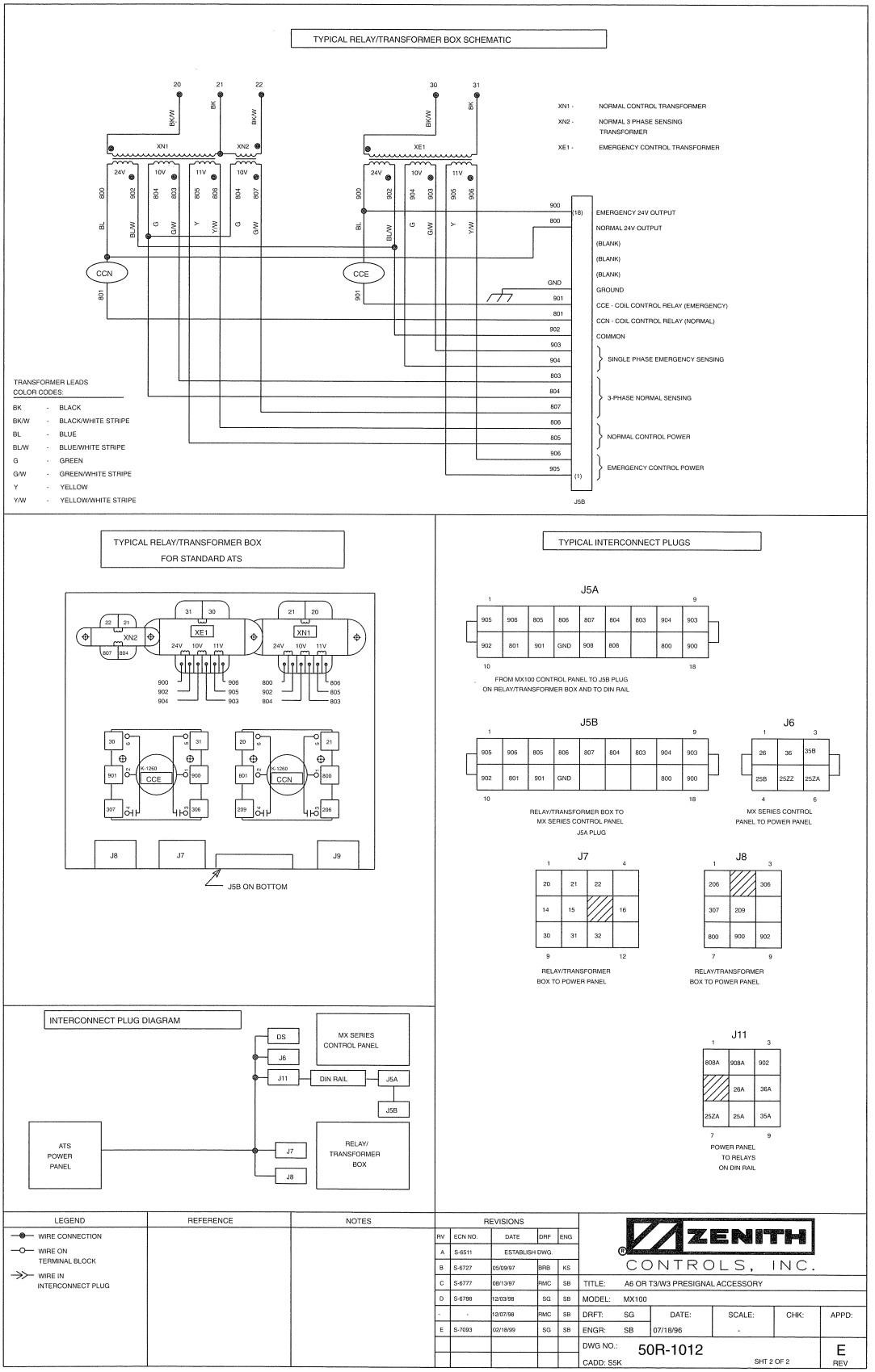
LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG	SEE ACCOMPANYING STANDARD ATS DIAGRAM FOR ATS POWER PANEL LAYOUT AND POWER CIRCUIT SCHEMATIC.	AT3 SHOWN IN NORMAL POSITION WITH NO POWER AVAILABLE.

REVISIONS				
RV	ECN NO.	DATE	DRF	ENG
A	S-6511	ESTABLISH DWG.		
-	S-6511	08/30/96	BRB	SB
B	S-6727	05/09/97	BRB	KS
C	S-6777	08/13/97	RMC	SB
D	S-6788	12/03/98	SG	SB
-	-	12/07/98	RMC	SB
E	S-7093	02/18/99	SG	SB

ZENITH CONTROLS, INC.

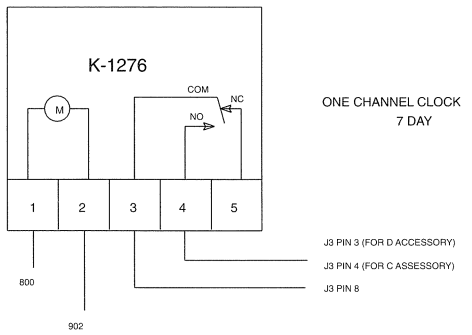
TITLE: A6 OR T3/W3 PRESIGNAL ACCESSORY					
MODEL: MX100					
DRFT: SG	DATE:	SCALE:	CHK:	APPD:	
ENGR: SB	07/18/96	-			
DWG NO.: 50R-1012					E REV
CADD: S5K		SHT 1 OF 2			

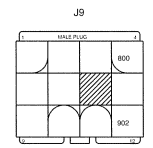
Drawing #50R-1012, Page 2



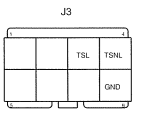
Drawing #50R-1006, Page 1

CONNECTION DIAGRAM





RELAY/TRANSFORMER FOX
TO CLOCK



MX 100 CONTROL PANEL
TO CLOCK ON DIN RAIL

LEGEND

Exercise clock, Weekly program with 20 settings.
See sheet 2 for programming instructions.
K-1276..... Clock 24V, 60 HZ

J3 Plug-MX100..... PS-5134...Socket Receptacle 8 pt. Mini
PS-5127...Socket Female Mini (Qty. 2)

J9 Plug-R/T Box..... PS-5080... Socket Receptacle 12 Pt.
PS-5084... Socket Female .093" (Qty. 2)

OPERATION

The "C" plant exercisor starts the engine (No Load Test) by closing the TSNL circuit.

The "D" plant exercisor simulates normal line failure, starts generator, and transfers load to emergency at selected time intervals.

NOTES

1. Total GENERATOR running time = clock ON time + "U" timer ON time (if U is used).
2. Mount Clock and Transformer to Din Rail on MX100 Control Panel.

CAUTION

⚠ Before changing the time setting, turn Disconnect Switch (DS) to "OFF" position; after desired selection has been made, return DS to "ON" position

LEGEND	REFERENCE	NOTES

REVISIONS

REV	ECN NO	DATE	DWN	ENG
H	S-7036-1	12/21/98	SG	SB

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DWG TITLE	C OR D CLOCK ACCESSORIES
JOB/MODEL	MX100

CHKD	APPD	CADD	ORDER NUMBER	DRAWING NUMBER
		S5K	-	50R-1006

DRWN	ENGR	DATE	SCALE	SHEET	REV
SDW	SB	11/20/95	-	SHT 1 OF 2	H

Drawing #50R-1006, Page 2

Digi 20 PROGRAMMING INSTRUCTIONS

The circular keypads are positioned to provide a sequential path for programming. Starting with Prog. to select a program, clockwise to to select ON or OFF. Then h for hour, m for minute, and finally Day to select day or days of the week. If an input is missing or incomplete, the missing segments will flash when the or program key is depressed. (For example, if no ON or OFF is selected, the ON symbol will flash). The missing entry must be completed before programming can resume. While programming, pressing the h, m or Day key longer then 2 seconds will cause a rapid roll of the parameter. A program consists of: 1. ON or OFF command, 2. Hour and minute, and 3. Day or multiple days on which it is to occur.
Note: A flashing display indicates either incomplete data entry or the battery is low. Check to see if days and ON or OFF times are entered, and check the power supply to the time control.

IMPORTANT: Depress reset key (Res.) before beginning to set time and program

SETTING TIME AND DAY OF CLOCK

1. Select military (24:00 hr.) or AMPM (12:00 hr.) time mode by depressing and holding h key while pressing –1h key to toggle between military and AM/PM. (AM appears in display when in AM/PM mode).
2. Press and hold down key.
3. If setting the time when daylight savings time is in effect, press –1h key ance (–1h will appear in display).
4. Set hour with h key. If AM or PM does not appear in display, the unit is in see note above to change display.
5. Set minutes with m key.
6. Press Day key repeatedly to the day of the week (1 is Monday, 7 is Sunday).
7. Release key, colon will begin flashing. If the days are flashing, the day of the week was not entered. (See step 6).

PROGRAMMING

1. Press Prog. key will appear in display. (Pressing Prog. key again, display will show the number of free programs: Fr 20). Press again to advance to 1st program.
2. Press key, ON symbol will appear. Pressing the key again will toggle to OFF . Select ON or OFF for the program with the key.
3. Press h to select hour for switching time.
4. Press m to select minute for switching time.
5. If the program is to occur every day of the week, (24 hour time control) ignore Day key and press Prog. key to advance to next program.
6. If 7 day time control is desired, press Day key. 1 2 3 4 5 6 (Mon. thru Sat.) block of days appears in display. Pressing Day key again, 1 2 3 4 5 (Mon. thru Fri.) appears in display. Press Day key again, 6 7 (Sat. & Sun.) appears in display. Pressing Day key again, 1 (Mon.) appears in display. Repeated presses will cycle through all days of the week, and back to 1 thru 7 (Mon. thru Sun.). Select day or block of days desired with the Day key.
7. Press Prog. key and repeat steps 2 thru 6 to enter additional programs of ON and OFF times. Note that more than one OFF time program may be entered, enabling automatic control of manual overrides.
8. Press key to enter run mode.

IMPORTANT: THE OUTPUT RELAYS WILL SWITCH ON (OR OFF) ONLY AT THE PROGRAMMED TIMES, AFTER PROGRAMMING IS COMPLETED. IF A CHANNEL SHOULD BE ON, IT MUST BE MANUALLY TURNED ON WITH THE KEY. FOR EXAMPLE: PROGRAMMING IS COMPLETED AT 2PM AND CH1 WAS PROGRAMMED TO BE ON AT 8AM AND OFF AT 5PM. AFTER PRESSING THE KEY, CH1 WILL BE OFF; PRESS TO TURN IT ON. IT WILL ASSUME AUTOMATIC OPERATION AT THE 5PM OFF TIME.

REVIEW AND CHANGE OF PROGRAMS

1. To review a program at any time press Prog. key. Programs will be displayed in the sequence they were entered with repeated presses of Prog. key.
2. To change a program, select the program to be changed with Prog. key, and enter the new time of day and/or days of week just as in the programming steps shown above. The old program is overwritten with the new selections. Press Prog. to store the new program.
3. To delete an individual program, select the program as in step 1 and press the m key and then the h key until "--:--" appears in dispaly. Press either Prog. or key until "--:--: flashes. The program is deleted after a few seconds.

MANUAL OVERRIDE

While in Run mode, (symbol is in display), pressing the key will reverse the load status (switch load OFF it is ON, or switch ON if it is OFF). A hand symbol appears in display to indicate the override is active. At the next scheduled switching time, automatic time control will resume, eliminating the override.
Pressing the key a second time appears in the display indicating the load is switched permanently ON.
Pressing the key a third time appears in the display indicating the load is switched permanently OFF.
Pressing the key a fourth time returns to automatic, appears in the display.

LEGEND	REFERENCE	NOTES

REVISIONS

REV	ECN NO.	DATE	DFT	ENG
H	S-7036-1	12/21/98	SG	SB

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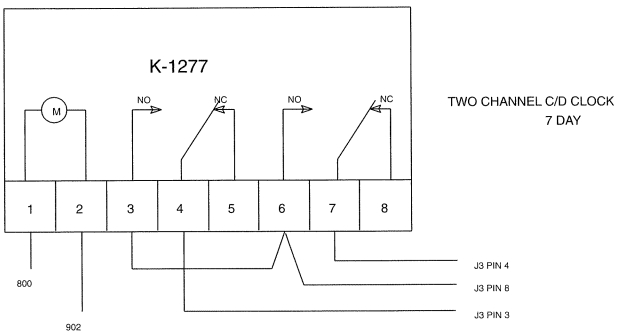
DWG TITLE: C OR D CLOCK ACCESSORIES
JOB/MODEL: MX100

CHK'D:	APP'D:	CADD:	ORDER NUMBER:	DRAWING NUMBER:
		ACAD	-	50R-1006

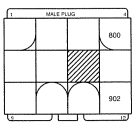
DRWN:	ENGR:	DATE:	SCALE:	SHEET:	REV:
SDW	SB	11/20/95	N/A	2 OF 2	H

Drawing #50R-1002, Page 1

CONNECTION DIAGRAM

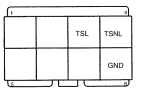


J9



RELAY/TRANSFORMER BOX
TO CLOCK

J3



MX100 CONTROL PANEL
TO CLOCK ON DIN RAIL

LEGEND

C/D..... Exercise clock, Weekly program with 42 set-point programs
See sheets 2 & 3 for programming instructions.
K-1277..... Clock 24V, 60 Hz
K-1279... Din Rail Mounting Base.

J3 Plug-MX100..... PS-5134...Socket Receptacle 8 pt. Mini
PS-5127...Socket Female Mini (Qty. 3)

J9 Plug-R/T Box..... PS-5080... Socket Receptacle 12 Pt.
PS-5084... Socket Female .093" (Qty. 2)

OPERATION

C-MODE: The "C" plant exercisor starts the engine (No Load Test) by closing the TSNL circuit "C2".

D-MODE: The "D" plant execisor simulates normal line failure, starts generator, and transfers load to emergency at the selected time intervals.

NOTES

1. Total GENERATOR running time = "C" ON time + "U" timer ON time (if U is used).
2. Mount Clock to Din Rail on MX100 Control Panel.

CAUTION

⚠ Before changing the time setting, turn Disconnect Switch (DS) to "INHIBIT" position; after desired selection has been made, return DS to "AUTO" position

LEGEND	REFERENCE	NOTES

REVISIONS

REV	ECN NO	DATE	DWN	ENG
H	S-7035-1	12/21/98	SG	SB

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DWG TITLE: C/D WITH 7 DAY CLOCK
JOB/MODEL: MX100

CHKD:	APP'D:	CADD:	ORDER NUMBER:		DRAWING NUMBER:		
		SSK	-		50R-1002		
		DRWN:	ENGR:	DATE:	SCALE:	SHEET:	REV:
		SDW	SB	11/20/95	-	SHT 1 OF 2	H

Drawing #50R-1002, Page 2

Digi 42/2 PROGRAMMING INSTRUCTIONS

The circular keypads are positioned to provide a sequential path for programming. Starting with Prog. to select a program, clockwise to to select ON or OFF. Then h for hour, m for minute, and finally Day to select day or days of the week. If an input is missing or incomplete, the missing segments will flash when the or program key is depressed. (For example, if no ON or OFF is selected, the ON symbol will flash). The missing entry must be completed before programming can resume. While programming, pressing the h, m or Day key longer then 2 seconds will cause a rapid roll of the parameter. A program consists of: 1. ON or OFF command, 2. Hour and minute, and 3. Day or multiple days on which it is to occur.
Note: A flashing display indicates either incomplete data entry or the battery is low. Check to see if days and ON or OFF times are entered, and check the power supply to the time control.

IMPORTANT: Depress reset key (Res.) before beginning to set time and program

MANUAL OR AUTOMATIC DAYLIGHT TIME CHANGEOVER

For areas where Daylight is not observed, please ignore this section.
The Digi 42/2 offers the option of manual or completely automatic daylight time chageover in the spring and fall. For manual changeover, depressing the –1h key sets clock time up or down 1 hour to change the time twice a year. For automatic changeover, perform the following programming, which only needs to be done during initial installation, or if the reset key is depressed at any time. When programmed for auto changeover, the time switch will automatically change the time at 2 AM on the first Sunday of April and the last Sunday of October until the year 2079.

1. Select military (24:00 hr.) or AM/PM (12:00 hr.) time mode by simultaneously depressing the –1h key and h keys. (AM appears in display when in AM/PM mode).
2. Enter the Daylight Time Program by pressing the –1h and Day once simultaneously. A "1" will appear uner "Mo" in display. Then set the current (today's) date with the m key and the month with the h key. (If military time, set date with h key and month with m key). For example: Feb 15 would appear as 02:15 if in AM/PM or as 15:02 if in miliatary time.
3. Press –1h key once. A "12" will appear under "Tu" in display. Then enter the current year with the m key. If you overshoot the current year, hold down the m key and the years will scroll to 2079 and back to 1995, 1996, 1997, etc.
4. Press –1h key once. A "3" will appear under "We" in display, and "AU" (for preset European dates). If European dates are desired, press key to enter the data and exit Daylight Time programming mode.
5. Press m key once. "cHA" will appear in display (for entering North American dates). NOTE: If the m key is inadvertantly pressed two times, and "HA" appears in display, press the m key two more times, or until display shows "cHA". ("HA" for specific dates is not used at present).
6. Press –1h key once. A "4" will appear under "Th" in display. Enter the date for changeover to Summer Daylight Time for the current year (see chart below for dates) by entering the date with the m key and the month with the h key. (If in militar time, set date with h key and month with m key). For example: April 7 would appear as 04:07 if in AM/PM time, 07:04 if in military time.
7. Press –1h key once. A "5" will appear under "Fr" in display. Enter the date changeover to Winter Time for the current year (see chart below for dates) by entering date with the m key and the month with the h key. (If in military time, set date with h key and month with m key).
8. Press key to enter the data and exit the Daylight Time programming mode.

Daylight Time Changeover Dates

1996.....April 07.....October 27	1999.....April 04.....October 31
1997.....April 06.....October 26	2000.....April 02.....October 29
1998.....April 05.....October 25	2001.....April 01.....October 28

SETTING TIME AND DAY OF CLOCK

1. Select military (24:00 hr.) or AMPM (12:00 hr.) time mode by depressing and holding h key while pressing –1h key to toggle between military and AM/PM. (AM appears in display when in AM/PM mode).
2. Press and hold down key.
3. If Automatic Daylight Time Changeover is not programmed, press –1h key once if setting the timer when daylight time is in effect (–1h appears in display).
4. Set hour with h key. If AM or PM does not appear in display, the unit is in see note above to change display.
5. Set minutes with m key.
6. Press Day key repeatedly to the day of the week (1 is Monday, 7 is Sunday).
7. Release key, colon will begin flashing. If the days are flashing, the day of the week was not entered. (See step 6).

PROGRAMMING

1. Press Prog. key will appear in display. (Pressing Prog. key again, display will show the number of free programs: Fr 42). Press again to advance to 1st program.
2. Press 1 key or 2 key, ON symbol will appear below CH1 or CH2. Pressing the key again will toggle to OFF . Pressing a third time clears the ON/OFF for the channel from the program. Pressing again returns to ON. Select ON or OFF for the program with the key.
   Note: ON or OFF can be selected for BOTH CHANNELS. (Both channels can switch ON at the same time, or one can switch ON and the other OFF from the same program).
3. Press h to select hour for switching time.
4. Press m to select minute for switching time.
5. If the program is to occur every day of the week, (24 hour time control) ignore Day key and press Prog. key to advance to next program.
6. If 7 day time control is desired, press Day key, a flashing underline appears below day 1. Pressing the Day key a second time advances the underline to day 2, etc. Use the Day key to advance to a day of the week to be omitted from the program and press the Sel. (select) key, the day will flash. Continue pressing Day and Sel. keys to omit days until only the desired days remain and are not flashing.
7. Press Prog. key and repeat steps 2 thru 6 to enter additional programs of ON and OFF times. Note that more than one OFF time program may be entered, enabling automatic control of manual overrides.
8. Press key to enter run mode.

8th DAY (HOLIDAY OR VACATION) PROGRAM

Multiple programs (more than one ON and OFF time) may be entered to be implemented on holidays or vacation periods. (A typical program is: OFF, 12:01Am to have the load(s) OFF during the holiday).

is: OFF, 12:01Am to have the load(s) OFF during the holiday).

1. Press Prog. key, select ON or OFF, h and m as with normal programming, but do not select or omit any days.
2. Press key. will appear in the display, indicating 8th day holiday/vacation program.
3. Press key to enter run mode. Time switch is now permanently preset for the ON/OFF schedule to be implemented on holiday or extended vacation period in the future as described below.

HOLIDAY PROGRAM: Pre-select Day or Series of Days for 8th Day Program to Occur.

The holiday program may be implemented at any time up to 6 days in advance of the holiday(s) or vacation period. It may also be activated on the holiday or first day of the vacation period.
1. While in Run mode, press key. "--Ho" appears in display.
2. Press Day key to select the day of week Holiday program is to begin.
3. Press Sel. key to select the number of days Holiday program is to run. Up to 99 days. If Sel. key is held down, numbers roll up rapidly to 99 then to 01).
4. Press key to store, holiday symbol appears in display.
5. To review or change the Holiday Program, press key. To cancel Holiday Program, press key.

On the day that the Holiday Program is selected to begin, the 8th day program will be implemented at 12:00AM Midnight and have priority over the regular daily programs. The display will show the holiday symbol and the number of days the program is to run, which will count down each day and revert to the normal display, when all days of the holiday/vacation period have expired. To cancel holiday program, press key.

IMPORTANT: THE OUTPUT RELAYS WILL SWITCH ON (OR OFF) ONLY AT THE PROGRAMMED TIMES, AFTER PROGRAMMING IS COMPLETE. IF A CHANNEL SHOULD BE ON, IT MUST BE MANUALLY TURNED ON WITH THE KEY. FOR EXAMPLE: PROGRAMMING IS COMPLETE AT 2PM AND CH1 WAS PROGRAMMED TO BE ON AT 8AM AND OFF AT 5PM. AFTER PRESSING THE KEY, CH1 WILL BE OFF; PRESS TO TURN IT ON. IT WILL ASSUME AUTOMATIC OPERATION AT THE 5PM OFF TIME.

REVIEW AND CHANGE OF PROGRAMS

1. To review a program at any time press Prog. key. Programs will be displayed in the sequence they were entered with repeated presses of Prog. key.
2. To change a program, select the program to be changed with Prog. key, and enter the new time of day and/or days of week just as in the programming steps shown above. The old program is overwritten with the new selections. Press Prog. to store the new program.
3. To delete an individual program, select the program as in step 1 and press the m key and then the h key until "--:--" appears in dispaly. Press either Prog. or key until "--:--: flashes. The program is deleted after a few seconds.

MANUAL OVERRIDE

While in Run mode, (symbol is in display), pressing the key will reverse the load status (switch load OFF it is ON, or switch ON if it is OFF). A hand symbol appears in display to indicate the override is active. At the next scheduled switching time, automatic time control will resume, eliminating the override.
Pressing the key a second time appears in the display indicating the load is switched permanently ON.
Pressing the key a third time appears in the display indicating the load is switched permanently OFF.
Pressing the key a fourth time returns to automatic, appears in the display.

LEGEND	REFERENCE	NOTES

REVISIONS

REV	ECN NO.	DATE	DFT	ENG
H	S-7036-1	12/21/98	SG	SB

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DWG TITLE: C/D ACCESSORIES - MX100
JOB/MODEL: MX100

CHKD:	APPD:	CADD:	ORDER NUMBER:	DRAWING NUMBER:
		ACAD	-	50R-1002

DRWN:	ENGR:	DATE:	SCALE:	SHEET:	REV:
SDW	SB	11/13/95	N/A	2 OF 2	H

Drawing #50R-1003, Page 1

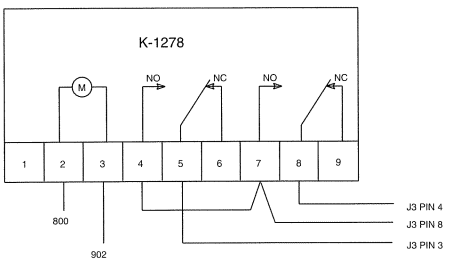
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
J	S-7625 ADD GRASSLIN TIMER	02/13/01	KK

CONNECTION DIAGRAM

TWO CHANNEL C/D CLOCK
365 DAY

DIGI 322-45/2Y

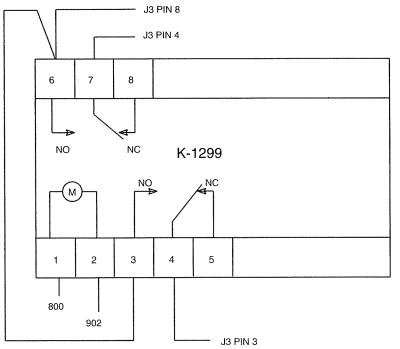
OPERATING INSTRUCTIONS - SEE SHEETS 2 & 3.



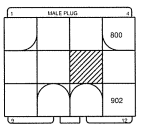
MFR: GRASSLIN

TALENTO 892

OPERATING INSTRUCTIONS - SEE SHEETS 4 THRU 14.

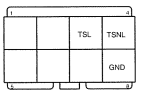


J9



RELAY/TRANSFORMER BOX
TO CLOCK

J3



MX100 CONTROL PANEL
TO CLOCK ON DIN RAIL

LEGEND

C/D..... Exercise clock, 365 day program.
See sheets 2 & 3 for programming instructions.
K-1278..... Clock 24V, 60 Hz (No longer available).
K-1299..... Clock 24V, 60 Hz

J3 Plug-MX100..... PS-5134...Socket Receptacle 8 pt. Mini
PS-5127...Socket Female Mini (Qty. 3)

J9 Plug-R/T Box..... PS-5080... Socket Receptacle 12 Pt.
PS-5084... Socket Female .093" (Qty. 2)

OPERATION

C-MODE: The "C" plant exercisor starts the engine (No Load Test) by closing the TSNL circuit "C2".

D-MODE: The "D" plant execisor simulates normal line failure, starts generator, and transfers load to emergency at the selected time intervals.

NOTES

1. Total GENERATOR running time = "C" ON time + "U" timer ON time (if U is used).
2. Mount Clock and Transformer to Din Rail on MX100 Control Panel.

CAUTION

⚠ Before changing the time setting, turn Disconnect Switch (DS) to "INHIBIT" position; after desired selection has been made, return DS to "AUTO" position

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	SG	02/13/01
DETAIL		
CHECKED		
ENGRG	KK	
MFG		
QUALITY		
ISSUED		

DRAWING FILE 50r-1003-j-1.dwg
MODEL / ASSEMBLY FILE MX100
CTQs: CRITICAL TO QUALITY CHARACTERISTIC

TITLE
C/D WITH 365 DAY CLOCK
FIRST MADE FOR

SIZE	CAGE CODE	DWG NO
B		50R-1003

SCALE: - SHEET 1 OF 14

Drawing #50R-1003, Page 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
J	S-7625 ADD GRASSLIN TIMER	02/13/01	KK

DIGI 322-45/2 Y-24

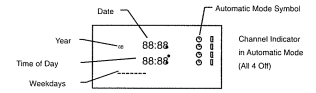
KEYPAD DESCRIPTION

Mo-Su - Day selector
✱Reset - Clears all programs and actual time
✱S/W - Switch for daylight savings time functions
Prior. - Sets priorities
Year - Sets year when setting actual time
CL - To cancel an individual program step
R - Used to review the program
1X - Used to enter a one time schedule
N - Used to enter an intermediate step in a program block
- Recalls actual time (Time of Day)
S - Used to store the final step in a program block
- Sets the momentary contact (IMP)
- Used to set the end of a multiday holiday period
Day - Used to set the day of the month
Month - Used to set the month
h+ - Hour advance
h- - Hour reverse
m+ - Minute advance
m- - Minute reverse
I/O - Sets ON(1), OFF(0) command for each channel
- Manual override for each channel
✱ Recessed buttons - use a long pen point

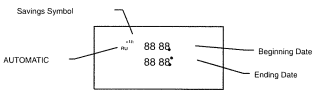
LCD DISPLAY ELEMENTS

The LCD incorporates a number of different elements to display various data and information.

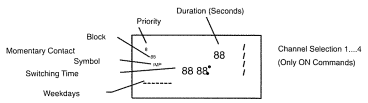
1. Example: Actual date and time of day



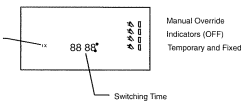
2. Example: Daylight savings time



3. Example: Momentary Contact



4. Example: Other displays



BLOCK FORMATION

The purpose of the blocks is to simplify the programming, i.e. switching times that are repeated for different holidays or periods need not be repeated. Likewise, when programming ON and OFF times the date need only be entered once.

The time switch assigns a block number to each program or date block entered from 00 to 99. All programs withour a date (7-day programs) automatically receive the block number 00.

Programs with dates - individual days or period of days - are assigned an ascending block number (01, 02.....99). All programs within a block are stored by pressing "N". The last program or portion of a program within a block is entered by pressing "S", thus closing the block.

EXECUTION OF PROGRAMS

At beginning of each day the microprocessor determines which of the stored programs for that day have the highest priority. Only the highest priority program(s) will be executed.
Once the digi 322 is programmed,it will automatically "look back" and assume the correct ON or OFF switch position.

PRIORIY

The microprosessor automatically assigns the lowest priority - "0" -to standard 7-day programs.
Holiday programs with a duration of more than one day automatically receive priority "1".
Holiday programs for one day only automatically receive priority "2".
A higher priority can be manually assigned to any holiday program by using the "Prior." key.

PROGRAM STORAGE CAPACITY

The digi 322 can store up to 322 programs. These 322 programs can be freely assigned to different dates or periods, switching times or channels.
A storage position is used each time the button "N" or "S" is pressed. If all storage positions are used up, four 8's will be shown in the display.

If a program step is not complete and storage is attempted with the "N" or "S" button, the missing components will blink in the LCD.

SETTING THE TIME

[Example: 8:15 AM, July 10., 1991]
Press "Reset" to clear the time and all programs.
While holding :

Press "Year"	to 91
Press "Month"	to 7 (July)
Press "Day"	to 10
Press "h+"	to 8 (AM)
Press "m+"	to 15

Release the . The correct date and time will be displayed, as will the day of the week; the time colon will blink. Channel setting and override status will be indicated on the right and the +1h indicates that Daylight Saving Time is in effect, if appropriate.

DAYLIGHT SAVINGS TIME (DST) FUNCTIONS

The digi 322 is pre-programmed for DST to begin on the last Sunday in March and to end on the last Sunday in September every year. You can program a different DST as follows:

To cancel pre-programmed DST:

Press "S/W"	(dates will appear)
Press "CL"	to cancel - (zeros will appear)
Press "S"	to store
Press	to display the time of day

To program different dates for DST:

[Example: For 1991, April until October 27]

Press "S/W"	the dates 03:31 to 09:29 are displayed
Press "CL"	the display shows zeros
Press "Month"	to 4 (April)
Press "Day"	to 7
Press	to set the ending date
Press "Mounth"	to 10 (Ocober)
Press "Day"	to 27
Press "S"	to store
Press	to display the time of day

PROGRAMMING 7-DAY SCHEDULES

NOTE: The actual time of day must be set prior to programming. Check DST. We recommend that all programs be first written out on the enclosed program worksheets.

[Example: Channel 1 on at 7 AM and off at 6 PM, Monday thru Friday]

Press "h+"	to 7 AM (press 9 times)
Press "m+"	to 00 (once)_____
Press "Sa"	to omit Saturday
Press "Su"	to omit Sunday
Press "I/O"	(for channel 1) to 1 (ON)
Press "N"	to store
Press "h+"	to 6 PM
Press "m+"	to 00 (once)_____
Press "Sa"	to omit Saturday
Press "Su"	to omit Sunday
Press "I/O"	(for channel 1) twice to 0 (OFF)___
Press "S"	to store

Weekly program steps are automatically assigned to block "00" and priority "0".

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	SG	02/13/01
DETAIL		
CHECKED		
ENG/PD	KK	
MFG		
QUALITY		
ISSUED		
DRAWING FILE	50r-1003-j-2.dwg	
MODEL / ASSEMBLY FILE	MX100	
# CTQs	CRITICAL TO QUALITY CHARACTERISTIC	

TITLE
C/D WITH 365 DAY CLOCK
DIGI 322-45/2 Y-24
FIRST MADE FOR

SIZE	CAGE CODE	DWG NO
B		50R-1003
SCALE: -		SHEET 2 OF 14

Drawing #50R-1003, Page 3

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
J	S-7625 ADD GRASSLING TIMER	02/13/01	KK

PROGRAMMING INDIVIDUAL HOLIDAYS

[Example: July 4th - fixed date holiday; Labor Day (September 2, 1991) - 1-time schedule; Channel 1 off at 12:01 AM]

NOTE: Fixed day holidays will stay in the program until the year 2079 when the internal clock stops. As one time holiday commands are executed the month and day go to zero (visible if you review the program). The month and day for the next year can be substituted for the zeros. For example: If you have a holiday program for Thanksgiving 1991 it is executed on November 28. If you review the program on November 29th you will see 00.00 not 11.28; you can enter 11.26, and press the "N" key to program Thanksgiving for 1992.

Press "Month"	to 07 (July)
Press "Day"	to 04
Press "N"	to store
Press "Month"	to 09 (September)
Press "Day"	to 02
Press "1X"	1-time schedule only
Press "N"	to store
Press "h+"	to 12 AM
Press "m+"	to 01
Press "I/O"	(for channel 1) twice to 0 (OFF)
Press "S"	to store this and close the block

Individual Holiday programs are automatically assigned priority 2.

NOTE: Ignore the days of the week indicator.

PROGRAMMING MULTIDAY HOLIDAY PERIODS

[Example: Channel 1 off (we will use an OFF command at 12:01 AM) each day from June 22, 1991 until September 3, 1991 inclusive]. The daily program will resume September 4. As this "School Summer Vacation" will be different in 1992 this becomes a 1X (one time) schedule.

Press "Month"	to 06 (June)
Press "Day"	to 22
Press →	to set the end date
Press "Month"	to 09 (September)
Press "Day"	to 03
Press "1X"	to set one time
Press "N"	to store
Press "h+"	to 12 AM
Press "m+"	to 01
Press I/O"	(for channel 1) twice to 0 (OFF)
Press "S"	to store this and close the block

Multiday holiday program are automatically assigned priority 1. These periods can be programmed with a 7-day schedule that is different than the standard 7-day schedule. Simply follow the above procedure and add the respective Monday thru Sunday keys for the desired days of the week before selecting the hours.

If no ON or OFF times are programmed for some or all days of the week during a multiday holiday period, the standard 7-day schedule will be executed.

REPEAT CHANNEL SELECTION

The control of loads is not restricted to a single channel. All loads can be turned on or off at the same time. For example, load 1 can be turned OFF simultaneous to load 2 being turned ON.

SPECIAL PROGRAM FUNCTIONS

MOMENTARY CONTACT PROGRAM

Short duration programs in 1-second intervals up to 59 seconds can be programmed for loads such as bells.

[Example: A noon whistle (channel 2) for six seconds Monday thru Friday]

Press "h+"	to 12 PM - noon
Press "m+"	once to 00
Press "I/O"	(channel 2) once to 1
Press "Pulse"	to 6 (seconds)
Press "Sa, Su"	to eliminate Saturday & Sunday
Press "S"	to store

NOTE: This can only be used for ON commands.

PRIORITIES

Pressing the "Prior." key after entering the date for a holiday program permits the assignment of a higher priority (the highest is 9). This allows that standard holiday programs with priority 1 or 2 are overridden with special programs.

MANUAL OVERRIDE

The digi 322 provides temporary and fixed overrides. Each channel has an elongated button below the . Pressing this button will change the status of a channel, i.e. ON to OFF or OFF to ON. The small in the display will change to indicating an override condition. This is a temporary override which will in turn be overridden by the next program change. For example, if lights are programmed to turn off at 4 PM and they are turned on manually at 2 PM, they will turn off at 4 PM. Pushing the button again will give a FIX 1 (ON) and pushing it another time will give a FIX 0 (OFF). These are permanent ON or OFF commands which will not be overridden by the program. Pushing the elongated button one more time will return to automatic operation.

PROGRAM REVIEW

The program can be reviewed by pushing the "R" key successively. Block 00 is reviewed first and each weekly ON/OFF command will be displayed on successive screens. A blank screen indicates the end of block 00. Block 01 is reviewed next. The first screens show the holidays followed by a blank screen. The ON/OFF commands for those days are next followed by another blank screen which indicates the end of block 01. Block 02 and any additional blocks are reviewed in the same manner. Press the to return to the TOD display anytime.

CANCELLING PROGRAMS

Use the "R" key to find the program step to be cancelled. Pressing the "CL" key will cancel that step and it is deleted from memory. To delete holidays from the program you must clear both the date and the time/on/off positions. The reset key will cancel all program steps and also the current time of day, date etc.

EDITING PROGRAMS

Use the "R" key to find the program step to be corrected. Make the changes as in normal programming and then use the "N" key to store the change.

BATTERY-POWERED RESERVE

In case of power failure, the built-in nickel-cadmium battery maintains the time of day, program storage and the LCD display of 150 hours (6+ days). During this time, all programmed switching events will be carried out but the relays will not operate. The battery reserve operates to its full capacity only if the digi 322 has been connected to electrical power for at least 140 hours.

NOTES:

1. When power is restored after a power failure, the digi 322 "looks back" and assumes the correct ON or OFF switch position.
2. After entering a time of day and pressing N or S, the display may still show the hour that was entered. For example: if 2:00 PM had been enterned, the display may show "PM 02:--" after pressing N or S. To enter the next time of day program, it is necessary to change the hour with the h+ or h- key even if the next time of day program is to be the same hour as previously entered. If the hour is not changed, the Digi322 will not accept the next program. For example: After entering a 2:00 PM program, if the next time of day program is to be 2:30 PM, press the h+ key to 3 PM, and then the h-key back to 2 PM, and then press the m+ key to :30.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED FRACTIONS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	SG	02/13/01
DETAIL		
CHECKED		
ENGRG	KK	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 50r-1003-j-3.dwg
MODEL / ASSEMBLY FILE: MX100
CTQs
CRITICAL TO QUALITY CHARACTERISTIC

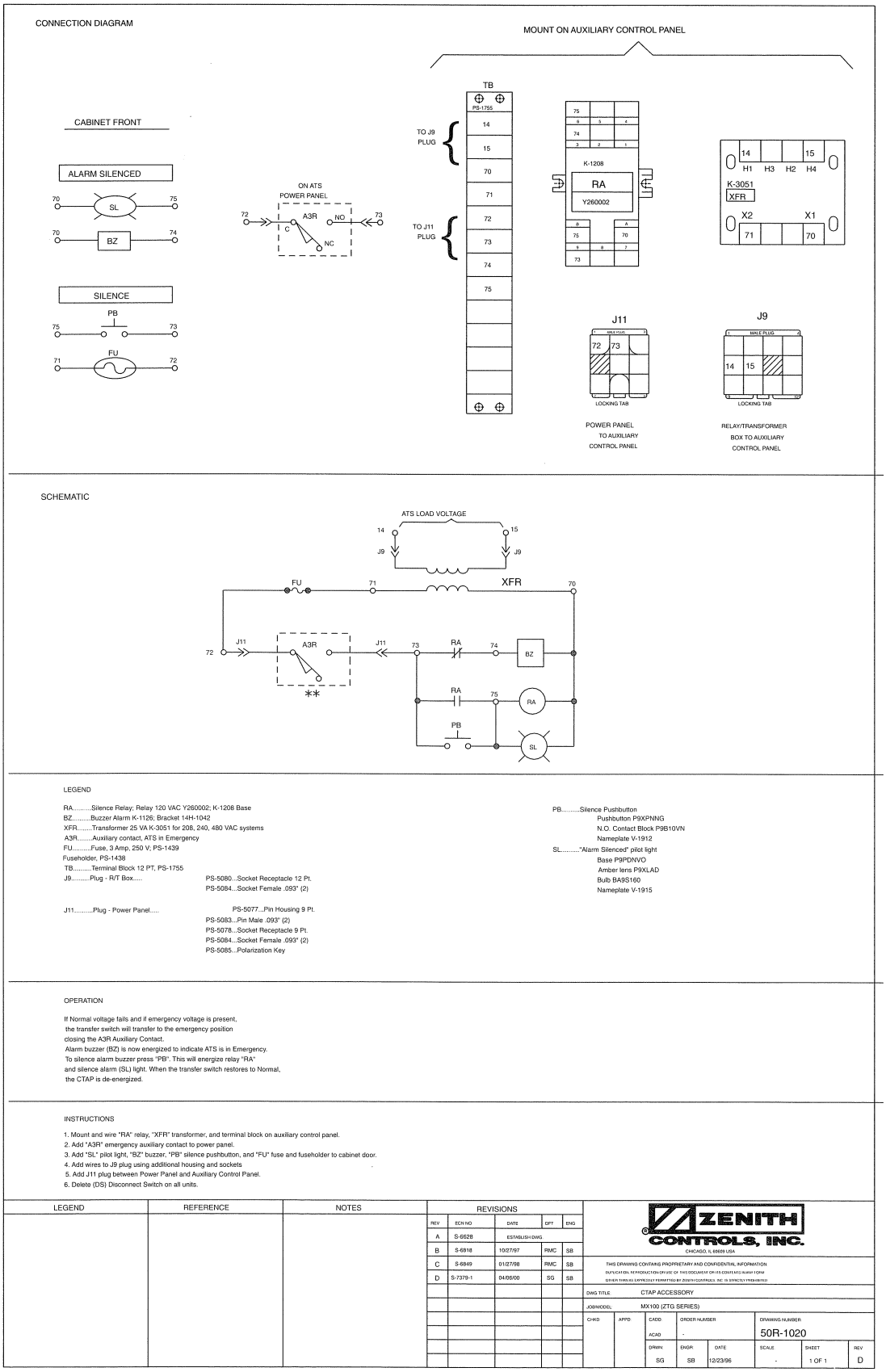
TITLE
C/D WITH 365 DAY CLOCK
DIGI 322-45/2 Y-24

FIRST MADE FOR

SIZE	CAGE CODE	DWG NO
B		50R-1003

SCALE: - SHEET 3 OF 14

Drawing #50R-1020



LEGEND

RA.....Silence Relay; Relay 120 VAC Y260002; K-1208 Base
BZ.....Buzzer Alarm K-1126; Bracket 14H-1042
XFR.....Transformer 25 VA K-3051 for 208, 240, 480 VAC systems
A3R.....Auxiliary contact, ATS in Emergency
FU.....Fuse, 3 Amp, 250 V; PS-1439
Fuseholder, PS-1438
TB.....Terminal Block 12 PT, PS-1755
J9.....Plug - R/T Box.....
PS-5080...Socket Receptacle 12 Pt.
PS-5084...Socket Female .093" (2)

J11.....Plug - Power Panel.....
PS-5077...Pin Housing 9 Pt.
PS-5083...Pin Male .093" (2)
PS-5078...Socket Receptacle 9 Pt.
PS-5084...Socket Female .093" (2)
PS-5085...Polarization Key

PB.....Silence Pushbutton
Pushbutton P9XPNNG
N.O. Contact Block P9B10VN
Nameplate V-1912
SL....."Alarm Silenced" pilot light
Base P9PDNVO
Amber lens P9XLAD
Bulb BA9S160
Nameplate V-1915

OPERATION

If Normal voltage fails and if emergency voltage is present, the transfer switch will transfer to the emergency position closing the A3R Auxiliary Contact. Alarm buzzer (BZ) is now energized to indicate ATS is in Emergency. To silence alarm buzzer press "PB". This will energize relay "RA" and silence alarm (SL) light. When the transfer switch restores to Normal, the CTAP is de-energized.

INSTRUCTIONS

1. Mount and wire "RA" relay, "XFR" transformer, and terminal block on auxiliary control panel.
2. Add "A3R" emergency auxiliary contact to power panel.
3. Add "SL" pilot light, "BZ" buzzer, "PB" silence pushbutton, and "FU" fuse and fuseholder to cabinet door.
4. Add wires to J9 plug using additional housing and sockets
5. Add J11 plug between Power Panel and Auxiliary Control Panel.
6. Delete (DS) Disconnect Switch on all units.

LEGEND	REFERENCE	NOTES

REVISIONS				
REV	ECN NO	DATE	DFT	ENG
A	S-6628	ESTABLISH DWG.		
B	S-6818	10/27/97	RMC	SB
C	S-6849	01/27/98	RMC	SB
D	S-7379-1	04/06/00	SG	SB

ZENITH CONTROLS, INC.
CHICAGO, IL 60639 USA

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DWG TITLE:	CTAP ACCESSORY
JOB/MODEL:	MX100 (ZTG SERIES)

CHKD	APPD	CADD	ORDER NUMBER	DRAWING NUMBER
		ACAD	-	50R-1020

DRWN	ENGR	DATE	SCALE	SHEET	REV
SG	SB	12/23/96	-	1 OF 1	D

Drawing #50R-1008

SCHEMATIC

FIG. A (120 VAC SYSTEMS)

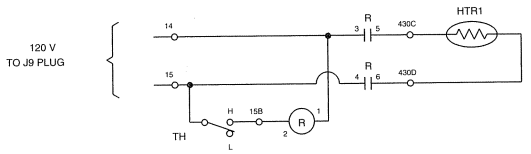
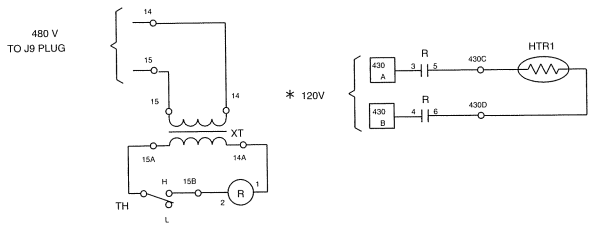
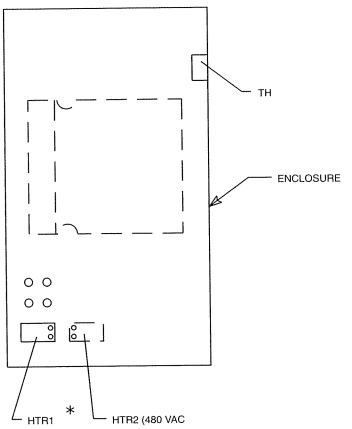


FIG. B (480 VAC SYSTEMS/120 VAC CONTROL VOLTAGE)

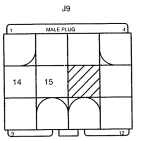


* Customer provides 120VAC control voltage

CABINET MOUNTING



* THE HEATER WILL BE MOUNTED 1" BELOW THE NEUTRAL BAR MOUNTING HOLES.



RELAY/TRANSFORMER BOX
TO AUXILIARY CONTROL PANEL

FIG.C (208 OR 240 VAC SYSTEMS)

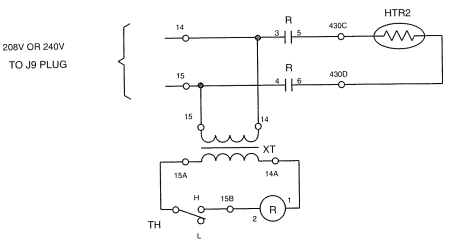
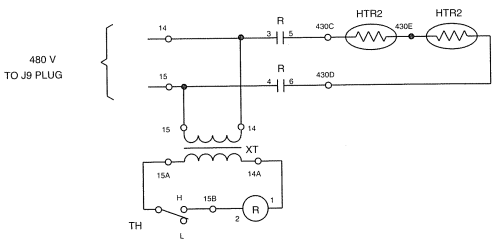


FIG.D(480 VAC SYSTEMS)



THERMOSTAT

LEGEND:

T1, T2.....	Load voltage from ATS
430A, 430B	Control voltage 120 V (for fig. B option only)
TH.....	Thermostat, PS-4822
HTR1	Strip heater, 125W., 120V, PS-7306
HTR2	Strip heater, 150W., 240 V, PS-7307
XT.....	Transformer 480/120 V, K-3026, 10 VA 240/120 V, K-3025, 10 VA 208/120 V, K-3106, 10 VA 277/120 V, K-3018, 10 VA 575/120 V, K-3022, 10 VA
R.....	Relay, DPDT: K-1086
J9 Plug-R/T Box.....	PS-5080... Socket Receptacle 12 Pt. PS-5084... Socket Female .093" (Qty. 2)

OPERATION:

When temperature in cabinet drops below thermostat set point, heater is turned "ON". Above set point, heater turns "OFF".

NOTES:

1. Thermostat factory set at 50 F unless otherwise specified.
2. Use wire (Y740033) for heater wiring.
3. (*)Use for Fig. A or Fig. B option only.
4. Mount Transformer and Relay on auxiliary control panel.

LEGEND	REFERENCE	NOTES

REVISIONS				
RV	ECN NO.	DATE	DRF	ENG
A	S-5757-A	ESTABLISH DWG.		
B	S-6449	05/15/96	ALA	SB
C	S-6849	01/27/98	RMC	SB

ZENITH CONTROLS, INC.

TITLE: HEATER AND THERMOSTAT				
MODEL: ZTG & ZTS SERIES				
DRFT: SDW	DATE:	SCALE:	CHK:	APPD:
ENGR: SB	12/04/95	N/A		
DWG NO.: 50R-1008				C REV
CADD: S5K		SHT. OF 1 1		

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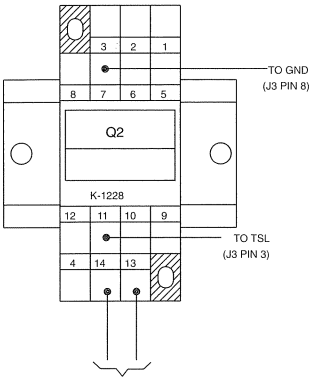
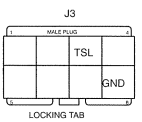
Drawing #50R-1001, Page 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
L	S-7636 REVISED DWG	02/15/01	SB

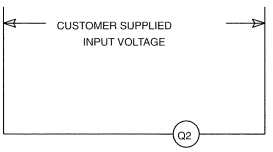
CONNECTION DIAGRAM

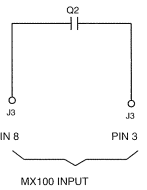




MX100 CONTROL PANEL
TO Q2 RELAY ON DIN RAIL

SCHEMATIC





LEGEND

Q2 Relay.....	K-1232, 24VAC; K-1242, 24VDC; K-1204, 120VAC
	K-1228, Base
	PS-6161 Din Rail
J3 Plug - MX100.....	PS-5134 Socket Receptacle 8 pt. Mini
	PS-5127 Socket Female Mini (Qty. 2)

OPERATION

Q2 - Remote Peak Shave or Area Protection Circuit
Energize Q2 Relay to simulate a normal line failure causing the Generator to start and transfer the load to Emergency. Should Emergency fail during this operation, the transfer switch will retransfer back to Normal.

INSTRUCTIONS

Mount Q2 Relay on Din Rail on MX1OO Control Panel.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	SG	02/15/01
DETAIL		
CHECKED		
ENGRG	SB	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 50r-1001-l-1.dwg
MODEL / ASSEMBLY FILE: MX100
CTQs
CRITICAL TO QUALITY CHARACTERISTIC

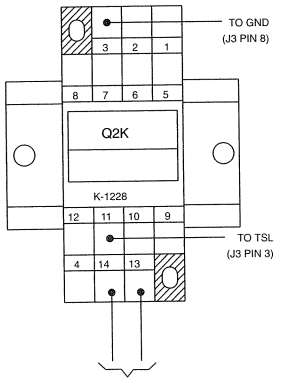
TITLE: Q2 ACCESSORY
FIRST MADE FOR

SIZE	CAGE CODE	DWG NO
B		50R-1001
SCALE: -		SHEET 1 OF 3

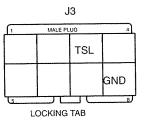
Drawing #50R-1001, Page 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
L	S-7636 REVISED DWG	02/15/01	SB

CONNECTION DIAGRAM

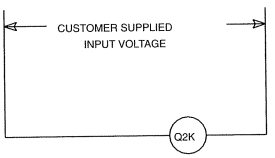


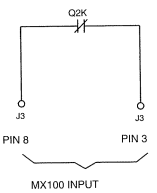
CUSTOMER SUPPLIED
INPUT VOLTAGE



MX100 CONTROL PANEL
TO Q2K RELAY ON DIN RAIL

SCHEMATIC





MX100 INPUT

LEGEND

Q2K Relay..... K-1232, 24VAC; K-1242, 24VDC; K-1204, 120VAC
K-1228, Base
PS-6161 Din Rail

J3 Plug - MX100..... PS-5134 Socket Receptacle 8 pt. Mini
PS-5127 Socket Female Mini (Qty. 2)

OPERATION

Q2K - Remote Peak Shave or Area Protection Circuit
De-energize Q2K Relay to simulate a normal line failure causing the Generator to start and transfer the load to Emergency. Should Emergency fail during this operation, the transfer switch will retransfer back to Normal.

INSTRUCTIONS

Mount Q2K Relay on Din Rail on MX1OO Control Panel.

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THIRD ANGLE PROJECTION

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	SG	02/15/01
DETAIL		
CHECKED		
ENGRG	SB	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 50r-1001-l-2.dwg
MODEL / ASSEMBLY FILE: MX100
CTQs
CRITICAL TO QUALITY CHARACTERISTIC

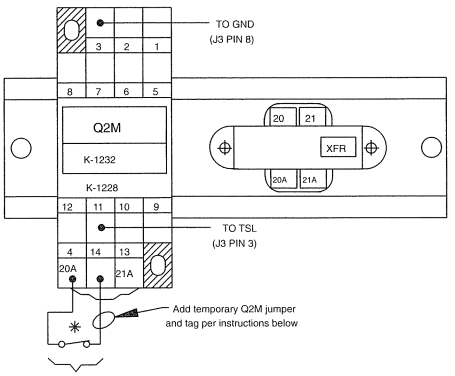
TITLE: Q2K ACCESSORY
FIRST MADE FOR

SIZE	CAGE CODE	DWG NO
B		50R-1001
SCALE: -		SHEET 2 OF 3

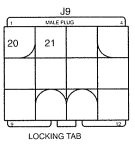
Drawing #50R-1001, Page 3

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
L	S-7636 REVISED DWG	02/15/01	SB

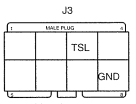
CONNECTION DIAGRAM



EXTERNAL CONTACT N.C.
(CUSTOMER SUPPLIED)

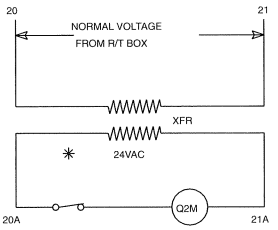


RELAY/TRANSFORMER BOX
TO XFR ON DIN RAIL

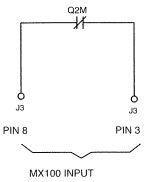


MX100 CONTROL PANEL
TO Q2M RELAY ON DIN RAIL

SCHEMATIC



EXTERNAL
CONTACT N.C.
(CUSTOMER
SUPPLIED)



✳ NOTE -MAX DISTANCE EXTERNAL CONTACT CAN BE LOCATED FROM CONTROLLER

AWG	MAX FT
18	400
16	650
14	1000

LEGEND

Q2M RELAY.....	K-1232, 24 VAC
	K-1228, Base
	PS-6161 Din Rail
J3 Plug - MX100.....	PS-5134 Socket Receptacle 8 pt. Mini
	PS-5127 Socket Female Mini (Qty. 2)
J9 Plug-R/T Box.....	PS-5080..... Socket Receptacle 12 Pt.
	PS-5084..... Socket Female .093" (Qty. 2)
XFR.....	Transformer 10VA
	K-3102 208/24 VAC
	K-3103 240/24 VAC
	K-3104 277/24 VAC
	K-3105 480/24 VAC
	K-3107 575/24 VAC

OPERATION

Q2M - Remote Peak Shave or Area Protection Circuit
Open external N.C. contact to simulate a normal line failure causing the Generator to start and transfer the load to Emergency. Should Emergency fail during this operation, the transfer switch will retransfer back to Normal.

INSTRUCTIONS

1. Add temporary Q2M jumper. Identify with tag marked "TEMPORARY Q2M JUMPER".
2. Mount Q2M Relay and XFR Transformer on Din Rail on MX100 Control Panel.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	SG	02/15/01
DETAIL		
CHECKED		
ENGRG	SB	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 50r-1001-I-3.dwg
MODEL / ASSEMBLY FILE: MX100
CTQs
CRITICAL TO QUALITY CHARACTERISTIC

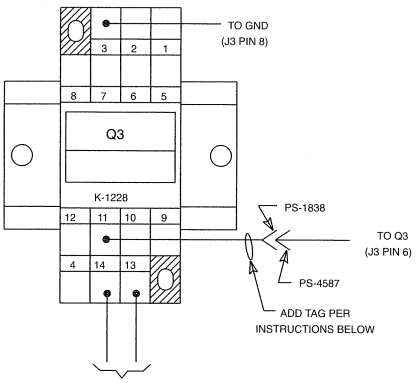
TITLE: Q2M ACCESSORY
FIRST MADE FOR:
SIZE: B | CAGE CODE | DWG NO: 50R-1001
SCALE: - | SHEET 3 OF 3

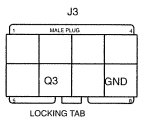
Katolight University - Gen II Training - Rev:06-01-06 - Page 143

Drawing #50R-1024

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-7636 REVISED DWG	02/15/01	SB

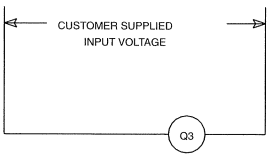
CONNECTION DIAGRAM

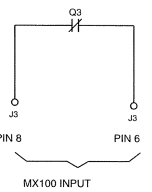




MX100 CONTROL PANEL
TO Q3 RELAY ON DIN RAIL

SCHEMATIC





LEGEND

Q3 Relay.....	K-1232, 24VAC; K-1242, 24VDC; K-1204, 120VAC
	K-1228, Base
	PS-6161 Din Rail
J3 Plug - MX100.....	PS-5134 Socket Receptacle 8 pt. Mini
	PS-5127 Socket Female Mini (Qty. 2)

OPERATION

Q3 - Remote Inhibit Transfer to Emergency Circuit.
Voltage applied to Q3 input will allow transfer to Emergency, conversely, no input on Q3 will result in no transfer to Emergency. To enable Q3 option engage Q3 jumper.

INSTRUCTIONS

1. Add tag marked "TO ENABLE Q3 OPTION ENGAGE Q3 JUMPER".
2. Q3 Relay on Din Rail on MX1OO Control Panel.

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THIRD ANGLE PROJECTION

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PL. DECIMALS – .020
3 PL. DECIMALS – .005
ANGLES – 1
FRACTIONS – 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	SG	02/15/01
DETWL		
CHECKED		
ENGRG	SB	
MFG		
QUALITY		
ISSUED		

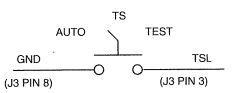
DRAWING FILE: 50r-1024-d-1.dwg
MODEL / ASSEMBLY FILE: MX100
CTQs:
CRITICAL TO QUALITY CHARACTERISTIC

TITLE: Q3 ACCESSORY
FIRST MADE FOR

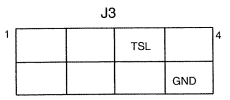
SIZE	CAGE CODE	DWG NO
B		50R-1024
SCALE: -		SHEET 1 OF 1

Drawing #50R-1010

CONNECTION TO MX100 CONTROL PANEL:



TS MOUNTED ON DOOR OF ENCLOSURE



MX100 CONTROL PANEL
TO TEST SWITCH CONTACT

LEGEND:

6A..... Maintained Test Switch
P9XSMD0N, 2 Pos. Operator
P9B10VN, N.O. Contact Block
V-1505, Nameplate

J3..... Plug - MX100
PS-5134...Socket Receptacle 8 pt. Mini
PS-5127...Socket Female Mini (Qty. 2)

OPERATION:

When activated in the TEST position, TS will simulate a normal line failure.
The TS will automatically transfer the load to the emergency position.
When the test switch is returned to the AUTOMATIC position, the transfer switch will restore the load to the normal line position.
is in the Emergency position, the ATS will transfer back to Normal.

Should Emergency fail while the ATS

LEGEND	REFERENCE	NOTES

REVISIONS

REV	ECN NO	DATE	DFT	ENG
A	S-6149	ESTABLISH DWG.		
B	S-7379-1	04/06/00	SG	SB

ZENITH CONTROLS, INC.
CHICAGO, IL 60609 USA

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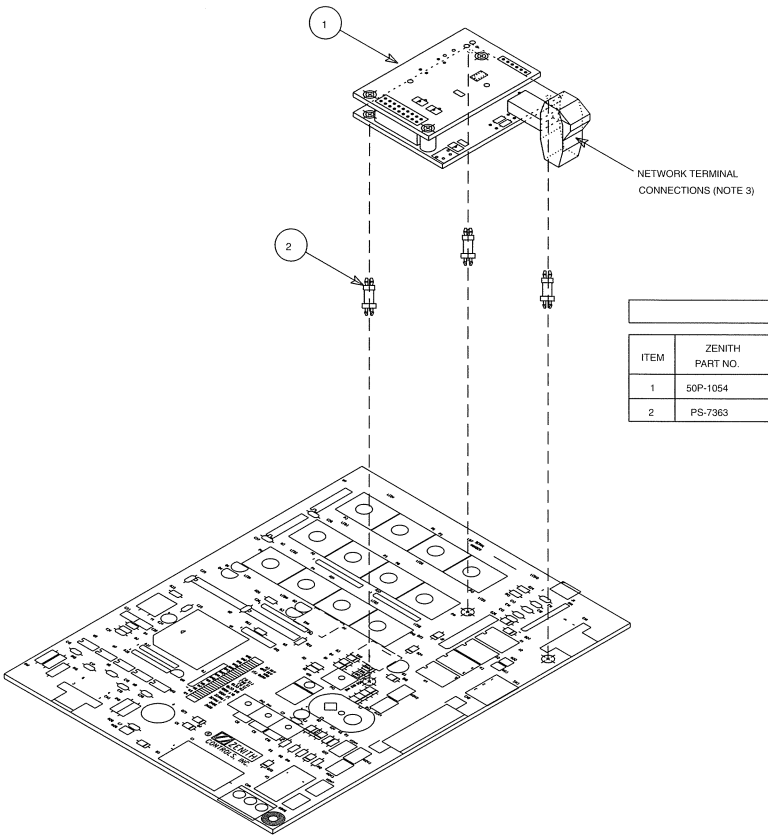
DWG TITLE: 6A TEST SWITCHES
JOB/MODEL: MX100

CHKD:	APPD:	CADD:	ORDER NUMBER:	DRAWING NUMBER:
		ACAD:	-	50R-1010

DRWN:	ENGR:	DATE:	SCALE:	SHEET:	REV:
ALA	SB	25/15/96	-	1 OF 1	B

Drawing #50R-1022

COMPONENT LAYOUT



LEGEND

ITEM	ZENITH PART NO.	DESCRIPTION	QTY.
1	50P-1054	MX100 NETWORK CARD	1
2	PS-7363	STANDOFF	3

INSTRUCTIONS

NOTES:

1. DISCONNECT ALL POWER TO MX100 PC BOARD AND DISCHARGE CAP BEFORE PLUGGING IN NETWORK CARD.
2. GROUND YOURSELF AND FOLLOW ESD PRECAUTIONS WHEN HANDLING NETWORK CARD AS WELL AS MX100 PC BOARD.
3. NETWORK CABLE TO BE BELDEN 8471, 16WG (UNSHIELDED TWO CONDUCTOR TWISTED PAIR) NOT INCLUDED.

OPERATION

NETWORK CARD ALLOWS COMMUNICATION OF ATS POSITION, AVAILABLE SOURCE AND TIMERS RUNNING TO A REMOTE ANNUNCIATOR PANEL, PC OR PLC VIA ONE PAIR OF TWISTED WIRES.

ALA	NLS	DWN	DWG	TOLERANCES: DECIMAL: XX ±.015 XXX ±.005 ANGULAR ±1 FRACTIONAL ±1/64 UNLESS OTHERWISE SPECIFIED	ZENITH CONTROLS, INC. CHICAGO, IL 60603 USA
01/27/98	ESTABLISH DRAWING	DATE	DESCRIPTION	REF ASSY: SEE DATABASE	THIS DRAWING CONTAINS PROPRIETARY AND CONFIDENTIAL INFORMATION. DUPLICATION, REPRODUCTION OR USE OF THIS DOCUMENT OR ITS CONTENTS IN ANY FORM OTHER THAN AS EXPRESSLY PERMITTED BY ZENITH CONTROLS, INC. IS STRICTLY PROHIBITED
S-6702-1		ECN NO.		FINISH: PER PART SPECIFICATION	DWG TITLE: MX100 NETWORK COMMUNICATIONS
					JOB/MODEL: MX100
A		REV		MATERIAL:	CHKD: / APPD: / CADD: ACAD / ORDER NUMBER: - / DRAWING NUMBER: 50R-1022
					DRWN: ALA / ENGR: NLS / DATE: 01/27/98 / SCALE: N/A / SHEET: 1 OF 1 / REV: A

Katolight University - Gen II Training - Rev:06-01-06 - Page 146

GE Zenith Controls

GE Industrial Systems – Power Equipment Business
General Electric Company
830 West 40th Street, Chicago, IL 60609 USA
773 299-6600, Fax: 773 247-7805
www.zenithcontrols.com

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED DWG	2/03/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR-BASED CONTROL PANEL 40-260A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS - RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box

- CCE..... Control Relay, Close Source 2
- CCN..... Control Relay, Close Source 1
- XE1..... Control Transformer, Source 2
- XN1,XN2..... Control Transformer, Source 1

Power Panel

- N1,2,3(N)..... Source 1 Line _____
- E1,2,3(N)..... Source 2 Line _____
- T1,2,3(N)..... Load Connections
- CNE.....Transfer Operator
- GND..... Ground
- NB..... Neutral Bar (if required)
- RE..... Bridge Rectifier, CE
- RN..... Bridge Rectifier, CN
- SE..... Source 2 Position Limit Switch
- SN..... Source 1 Position Limit Switch

Interconnect Plugs

J1, J2, J4, J5, J6, J7, J8 and J9 For Panel Mounted

Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values, or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location and handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset "Restore" values, the MX control panel energizes the CCE control relay to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When Source 1 line voltage reaches the preset "Restore" values, the MX control panel energizes the CCN control relay to operate the main transfer operator. The load is now re-transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch

The Test Switch simulates source 1 line failure when activated.
To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.
Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐ C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.

CALIBRATE
Source 1 & Source 2 Calibrate capabilities for voltage a frequency.

- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
  System Data: Total Life Transfers (N2P)
  Days Powered Up
  Total Transfers to S2
  Total S1 Failures
  Total S1 available in Hrs
  Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2 Indicating LED lights.
  L1 Indicates Switch in Source 2 position.
  L L2 Indicates Switch in Source 1 position.
  L3 Indicates Source 1 available.
  L4 Indicates Source 2 available.
- P Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In-Phase Monitor. Prevents transfer until two sources are in-phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.
- C/B 3 POLE, Industrial Circuit Breaker (Cabled from the Source 1 side of the ATS to the Load lugs of Circuit Breaker) see sheet (2)

☐ D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Additional Auxiliary Contact closed when switch is in Source 2 position.
- A4 Additional Auxiliary Contact closed when switch is in Source 1 position.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load.
  Can be configured by end user for 1, 7, 14, 28, 356 day cycle.
- VI Voltage Imbalance (Three Phase) User Configured On or Off.
  Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable.
  Resolution: 1% Increments
  Minimum Differential: 2% minimum between "Fail" and "Restore" settings.
  Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

- ☐STS Shunt Trip Selector.
- ☐GFP Ground Fault Potection
- ☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.
- ☐6A Test Switch, Maintained/Momentary. Door mount
- ☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- ☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)
- ☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)
- ☐A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)
- ☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)
- ☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0-60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)
- ☐ BC Battery charger.
- ☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.
- ☐ F Fan contact, operates when generator is running.
- ☐ HT Heater and Thermostat.
- ☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.
- ☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- ☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.
- ☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- ☐T3/W3 Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer. (Maximum: 2 circuits)
- ☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0-60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re-closes after transfer. Can be config. by end user for Pre-transfer, Post-transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)
- ☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

- 59C-1032 (3 POLE), 59C-1033 (4 POLE) } NEMA 1
- 59C-1035 (3 POLE), 59C-1036 (4 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING - TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT-HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

SIGNATURES		DATE
MODEL	GG	11/08/03
DETAIL		
CHECKED		
ENGRG	MF	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-1000-d-1.dwg
MODEL / ASSEMBLY FILE: ZTGSE40-260AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC
AutoCad Generated

GE Zenith Controls

TITLE
LEGEND, OPERATION, AND ACCESSORIES

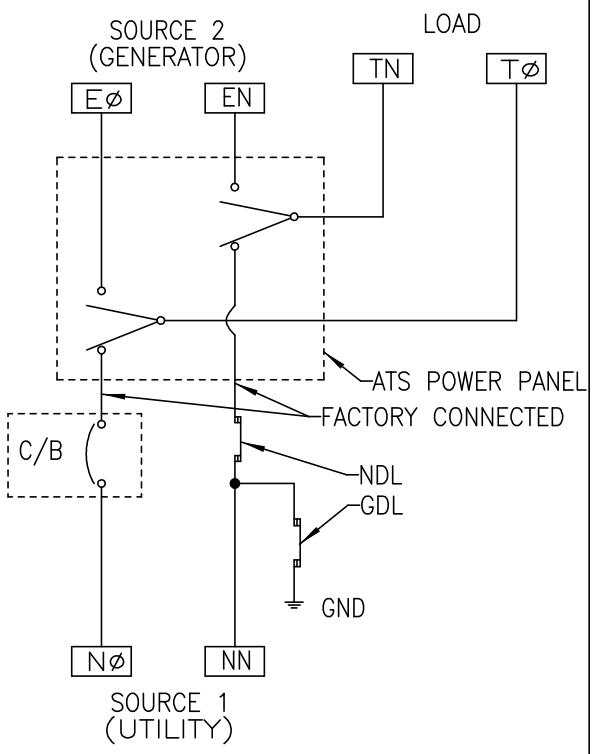
FIRST MADE FOR: ZTGSE40-260AMP (3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-1000

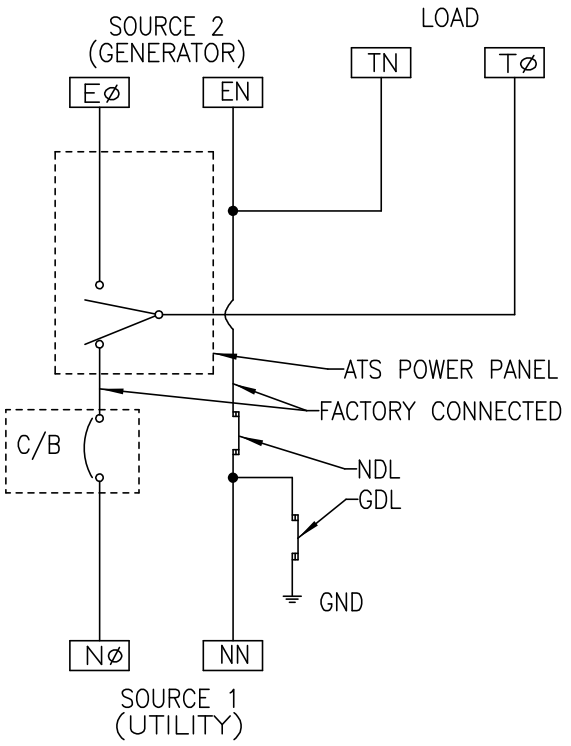
SCALE: NA SHEET 1 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S–8079 REVISED SHT 1,2 & 5	2/04/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

40–260A 3,4P C/B PART NO.

PART NO.	DESCRIPTION	40AMP QTY	80AMP QTY	100AMP QTY	150AMP QTY	200AMP QTY	225AMP QTY	260AMP QTY
SELA36AT0060	MCCB, SPECTRA RMS SE150 FRAME 3P	1	–	–	–	–	–	–
SRPE60A40	RATING PLUG 40A	1	–	–	–	–	–	–
SELA36AT0100	MCCB, SPECTRA RMS SE150 FRAME 3P	–	1	–	–	–	–	–
SRPE100A80	RATING PLUG 80A	–	1	–	–	–	–	–
SFLA36AT0250	MCCB, SPECTRA RMS SF250 FRAME 3P	–	–	1	1	1	–	–
SRPF250A100	RATING PLUG 100A	–	–	1	–	–	–	–
SRPF250A150	RATING PLUG 150A	–	–	–	1	–	–	–
SRPF250A200	RATING PLUG 200A	–	–	–	–	1	–	–
SGLA36AT0400	MCCB, SPECTRA RMS SG600 FRAME 3P	–	–	–	–	–	1	1
SRPG400A225	RATING PLUG 225A	–	–	–	–	–	1	–
SRPG400A250	RATING PLUG 250A	–	–	–	–	–	–	1
TCAL18	LUG, 12 AWG–3/0	6	6	–	–	–	–	–
TCAL29	LUG, 8 AWG–350MCM	–	–	6	6	6	–	–
TCLK265	C/B LUG KIT, 2 POLE SG FRAME	–	–	–	–	–	–	–
TCLK365	C/B LUG KIT, 3 POLE SG FRAME	–	–	–	–	–	2	2

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3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	11/10/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a–1000–d–2.dwg
MODEL / ASSEMBLY FILE: ZTGSE40–260AMP (3/4 POLE)
CTQs | ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

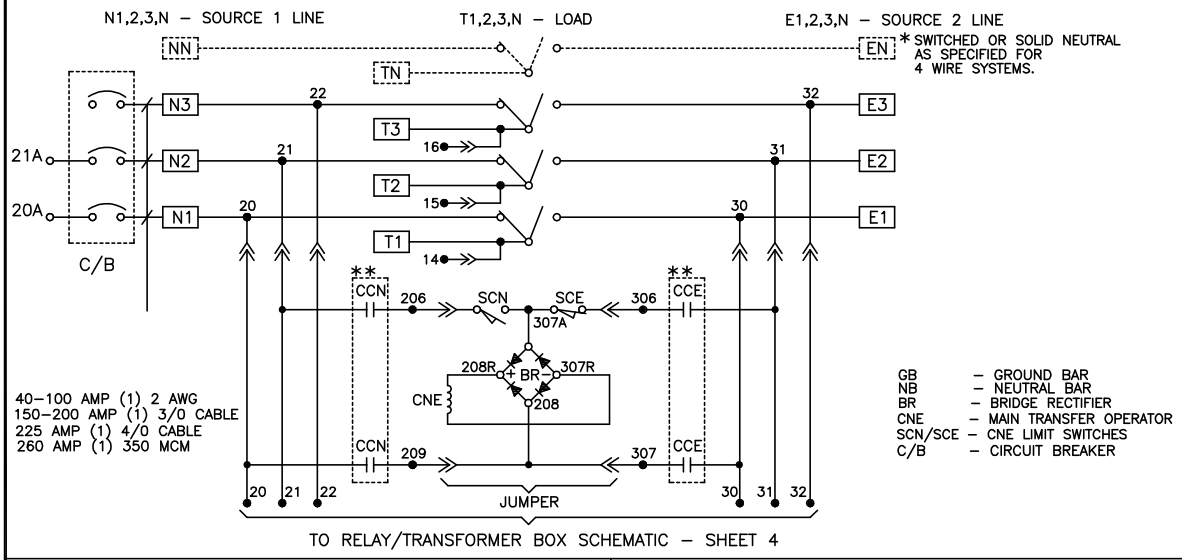
FIRST MADE FOR: ZTGSE40–260AMP (3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A–1000

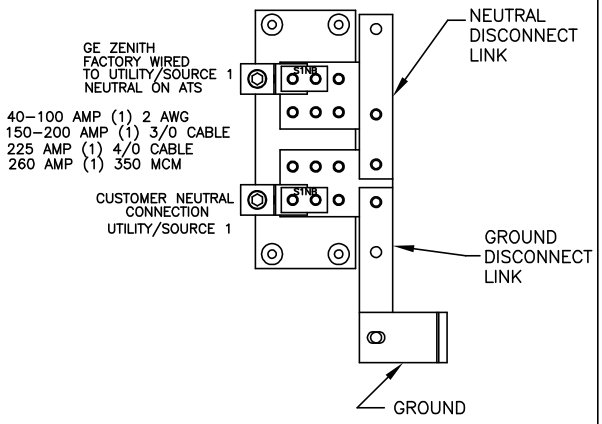
SCALE: NA SHEET 2 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1,2 & 5	2/03/04	GG FS

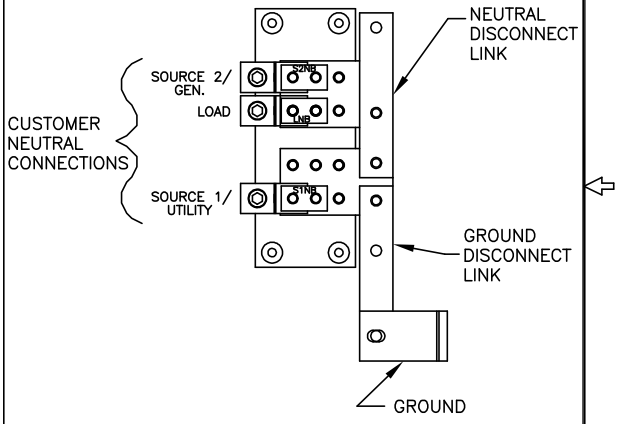
ATS POWER CIRCUIT SCHEMATIC



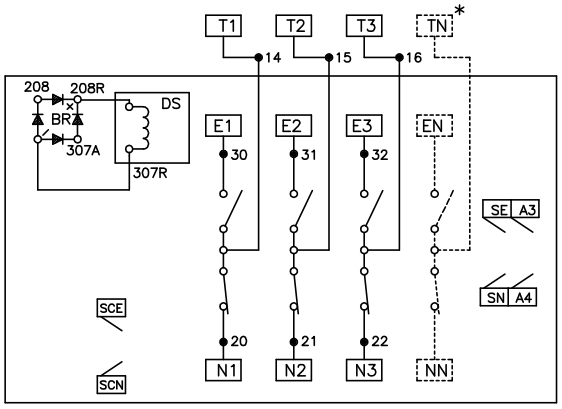
SWITCHED NEUTRAL



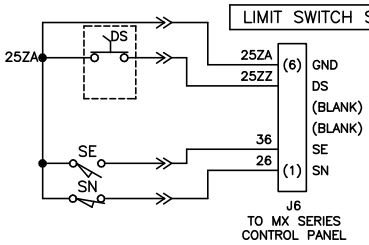
SOLID NEUTRAL



ATS POWER PANEL LAYOUT



LIMIT SWITCH SCHEMATIC



LEGEND	REFERENCE	NOTES
— WIRE CONNECTION —o— WIRE ON TERMINAL BLOCK —>> WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX.	FOR PRODUCTION ONLY: R/T BOX AND PLUGS – SEE SHT 3.	ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE.

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THIRD ANGLE PROJECTION

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APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/08/03
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-1000-d-3.dwg
MODEL / ASSEMBLY FILE: ZTGSE40-260AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

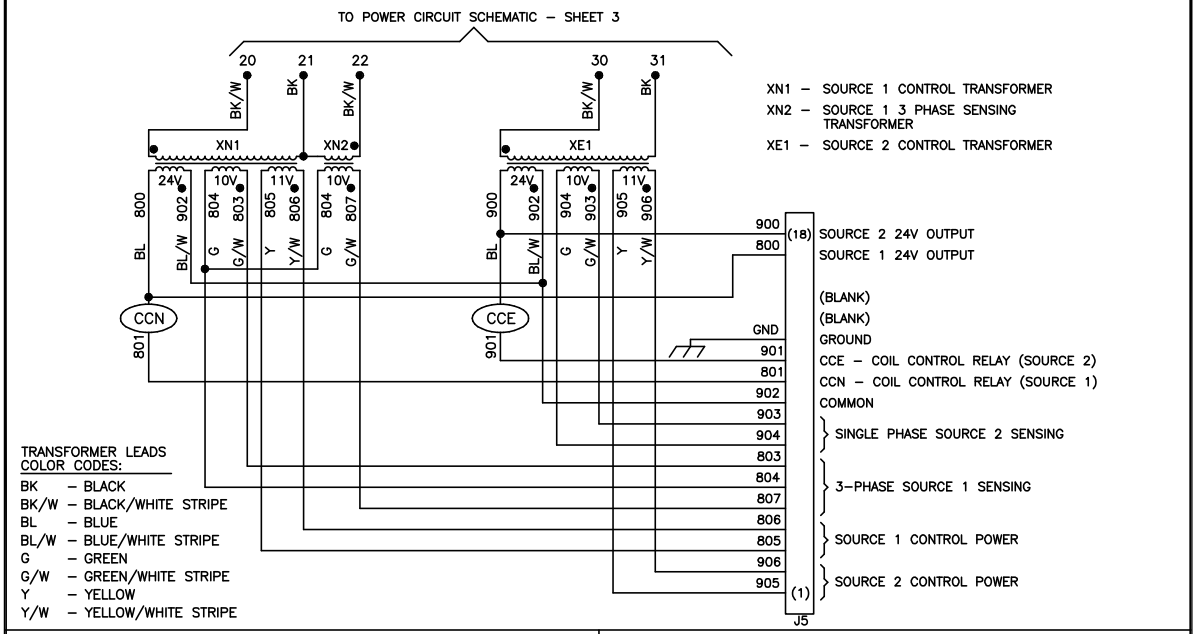
TITLE
ATS POWER CIRCUIT& LAYOUT (INVERTED DESIGN)
FIRST MADE FOR: ZTGSE40-260AMP (3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-1000

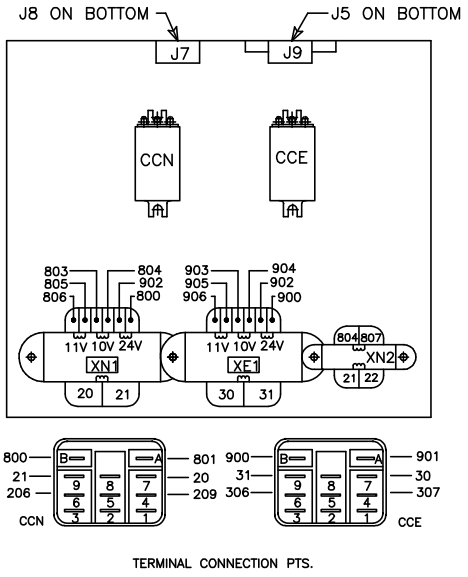
SCALE: NA SHEET 3 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1,2, & 5	2/03/04	GG FS

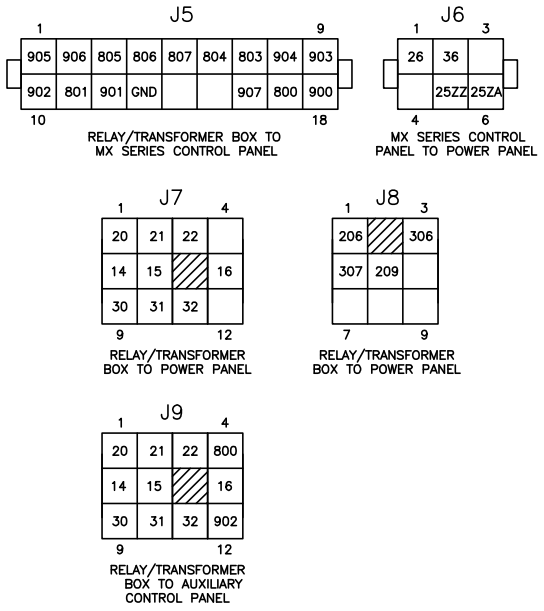
RELAY/TRANSFORMER BOX SCHEMATIC



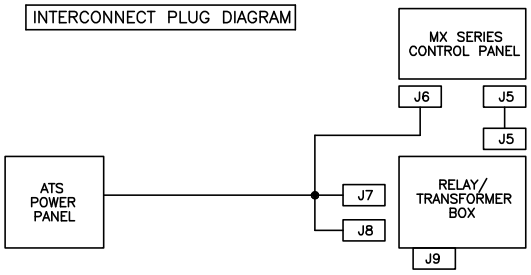
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



LEGEND

—●— WIRE CONNECTION

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3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
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SIGNATURES		DATE
MODEL	GG	11/08/03
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-1000-d-4.dwg
MODEL / ASSEMBLY FILE: ZTGSE40-260AMP (3/4 POLE)
CTQs
⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
RELAY/XFR BOX&INTERCONNECT PLUGS (INVERTED DESIGN)

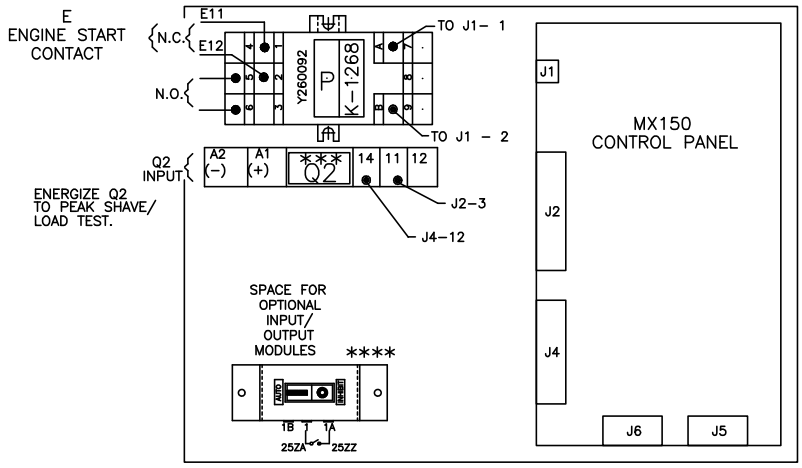
FIRST MADE FOR: ZTGSE40-260AMP (3/4 POLE)

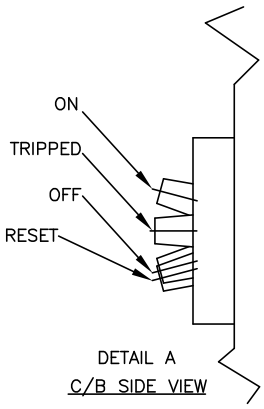
SIZE	CAGE CODE	DWG NO
B		80A-1000

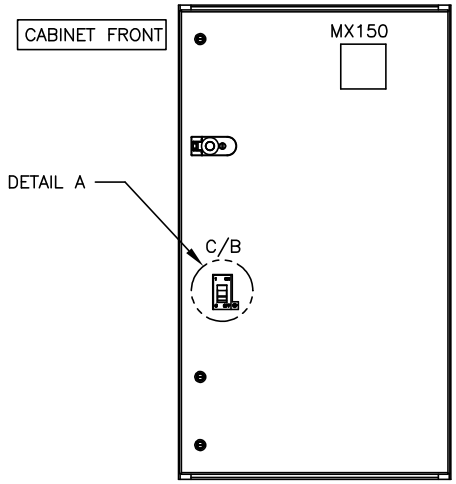
SCALE: NA SHEET 4 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED DWG	01/15/04	AMG FS

INSIDE VIEW OF CABINET DOOR

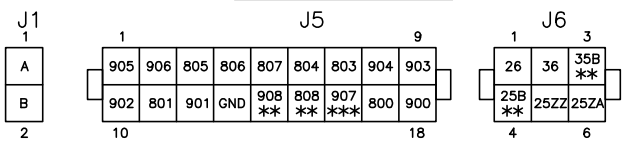






NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS

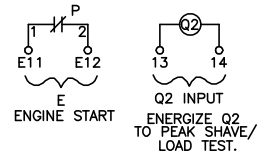


FROM MX150 CONTROL PANEL TO P RELAY

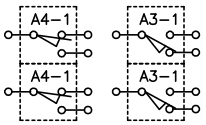
FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS



AUXILIARY CONTACTS
LOCATED ON ATS POWER PANEL



LEGEND

- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  K-1306, 24VAC;
  K-1307, 24VDC;
  K-1308, 120VAC;
  PS-3147 CLIP
  TB..TERMINAL BLOCK, PS-1754
- **** DISCONNECT SWITCH (DS)
  DS:....L-4030
  BRACKET:..... 57H-1031
  LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	20 AMP @ 125, 250 VAC
UMD	UMD1,2	10 AMP @ 277 VAC OR 30 VDC

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THIRD ANGLE PROJECTION

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ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	MF/GG	11/08/03
DETAIL		
CHECKED		
ENGRG	MF	11/08/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-1000-d-5.dwg
MODEL / ASSEMBLY FILE: ZTGSE40-260AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIDE DOOR CABINET FRONT, PLUGS,CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGSE40-260AMP (3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-1000

SCALE: NA SHEET 5 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S–8079 REVISED SHT 1,2 & 5	2/04/04	FS GG

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR–BASED CONTROL PANEL 40–260A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS – RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box

- CCE..... Control Relay, Close Source 2
- CCN..... Control Relay, Close Source 1
- XE1..... Control Transformer, Source 2
- XN1,XN2..... Control Transformer, Source 1

Power Panel

- N1,2,(N)..... Source 1 Line
- E1,2,(N)..... Source 2 Line
- T1,2,(N)..... Load Connections
- CNE.....Transfer Operator
- GND.....Ground
- NB..... Neutral Bar (if required)
- RE..... Bridge Rectifier, CE
- RN..... Bridge Rectifier, CN
- SE..... Source 2 Position Limit Switch
- SN..... Source 1 Position Limit Switch

Interconnect Plugs

J1, J2, J4, J5, J6, J7, J8 and J9 For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values, or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location and handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset "Restore" values, the MX control panel energizes the CCE control relay to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When Source 1 line voltage reaches the preset "Restore" values, the MX control panel energizes the CCN control relay to operate the main transfer operator. The load is now re–transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch

The Test Switch simulates source 1 line failure when activated.
To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.
Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐ C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.

CALIBRATE
Source 1 & Source 2 Calibrate capabilities for voltage a frequency.

CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.

DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto

E Engine Start Contacts.

EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken

System Data: Total Life Transfers (N2P)
Days Powered Up
Total Transfers to S2
Total S1 Failures
Total S1 available in Hrs
Total S2 available in Hrs. (NIP)

KP Frequency, Indication S1 & S2 Indicating LED lights.

L L1 Indicates Switch in Source 2 position.
L2 Indicates Switch in Source 1 position.
L3 Indicates Source 1 available.
L4 Indicates Source 2 available.

P Time Delay Source 2 Start. Adjustable 0–10 seconds. Standard setting in 3 seconds. Adjust via SET menu.

Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.

R50 In–Phase Monitor. Prevents transfer until two sources are in–phase.

S13 Transfer Commit or no Commit to transfer upon Engine start.

T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.

U Source 2 Stop Delay Timer.

W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.

YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.

C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 side of the ATS to the Load lugs of Circuit Breaker) see sheet (2).

☐ D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

A3 Additional Auxiliary Contact closed when switch is in Source 2 position.

A4 Additional Auxiliary Contact closed when switch is in Source 1 position.

CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load.
Can be configured by end user for 1, 7, 14, 28, 356 day cycle.

VI Voltage Imbalance (Three Phase) User Configured On or Off.
Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% minimum between "Fail" and "Restore" settings.
Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

☐STS Shunt Trip Selector.

☐GFP Ground Fault Potection

☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.

☐6A Test Switch, Maintained/Momentary. Door mount

☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.

☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)

☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)

☐A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)

☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)

☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0–60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)

☐ BC Battery charger.

☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.

☐ F Fan contact, operates when generator is running.

☐ HT Heater and Thermostat.

☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.

☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.

☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.

☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.

☐T3/W3 Elevator Pre–Signal Auxiliary Contacts: Open 0–60 seconds prior to transfer to either direction, re–closes after transfer. (Maximum: 2 circuits)

☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0–60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re–closes after transfer. Can be config. by end user for Pre–transfer, Post–transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)

☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

59C–1031 (2 POLE)
59C–1032 (3 POLE) } NEMA 1

59C–1034 (2 POLE)
59C–1035 (3 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING – TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT–HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH ✓
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SIGNATURES		DATE
MODEL	GG	11/08/03
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a–1001–d–1.dwg
MODEL / ASSEMBLY FILE: ZTGSE 40–260 AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LEGEND, OPERATION, AND ACCESSORIES

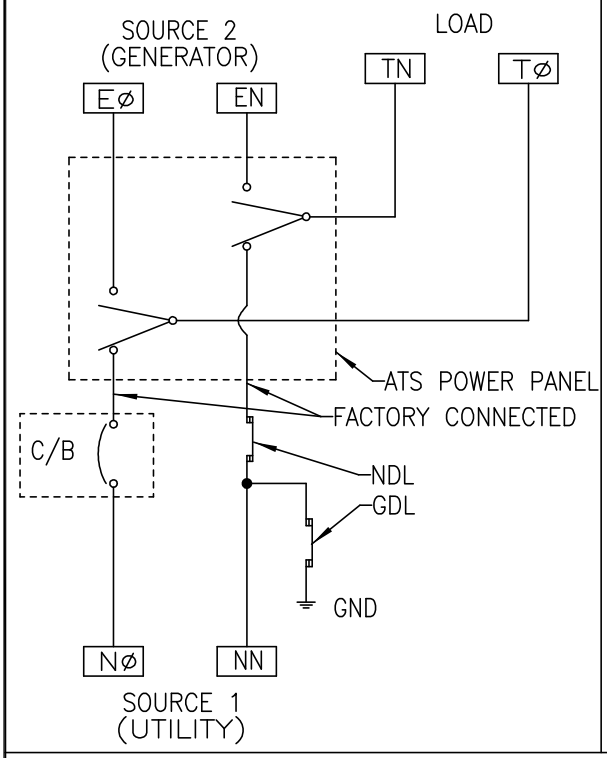
FIRST MADE FOR: ZTGSE 40–260 AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A–1001

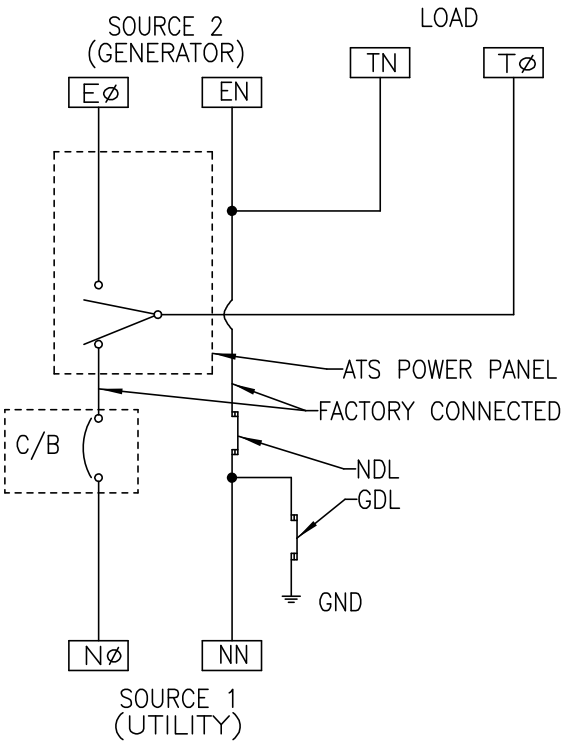
SCALE: NA SHEET 1 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S–8079 REVISED SHT 1,2 & 5	2/04/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

40–260A 2P C/B PART NO.

PART NO.	DESCRIPTION	40AMP QTY	80AMP QTY	100AMP QTY	150AMP QTY	200AMP QTY	225AMP QTY	260AMP QTY
SELA24AT0060	MCCB, SPECTRA RMS SE150 FRAME 2P	1	–	–	–	–	–	–
SRPE60A40	RATING PLUG 40A	1	–	–	–	–	–	–
SELA24AT0100	MCCB, SPECTRA RMS SE150 FRAME 2P	–	1	–	–	–	–	–
SRPE100A80	RATING PLUG 80A	–	1	–	–	–	–	–
SFLA24AT0250	MCCB, SPECTRA RMS SF250 FRAME 2P	–	–	1	1	1	–	–
SRPF250A100	RATING PLUG 100A	–	–	1	–	–	–	–
SRPF250A150	RATING PLUG 150A	–	–	–	1	–	–	–
SRPF250A200	RATING PLUG 200A	–	–	–	–	1	–	–
SGLA26AT0400	MCCB, SPECTRA RMS SG600 FRAME 2P	–	–	–	–	–	1	1
SRPG400A225	RATING PLUG 225A	–	–	–	–	–	1	–
SRPG400A250	RATING PLUG 250A	–	–	–	–	–	–	1
TCAL18	LUG, 12 AWG–3/0	6	6	–	–	–	–	–
TCAL29	LUG, 8 AWG–350MCM	–	–	6	6	6	–	–
TCLK265	C/B LUG KIT, 2 POLE SG FRAME	–	–	–	–	–	–	–
TCLK365	C/B LUG KIT, 3 POLE SG FRAME	–	–	–	–	–	2	2

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SIGNATURES		DATE
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MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a–1001–d–2.dwg
MODEL / ASSEMBLY FILE: ZTGSE40–260AMP (2 POLE)
CTQs | ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

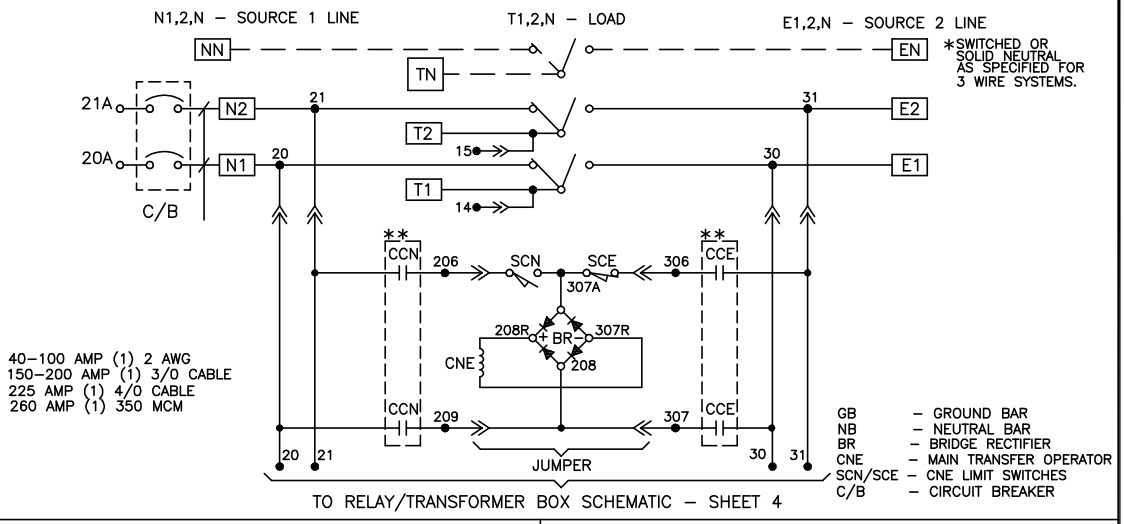
FIRST MADE FOR: ZTGSE40–260AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A–1001

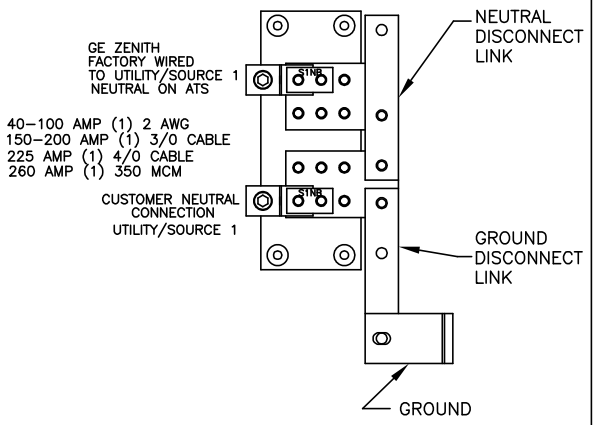
SCALE: NA SHEET 2 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1,2 & 5	02/04/04	GG FS

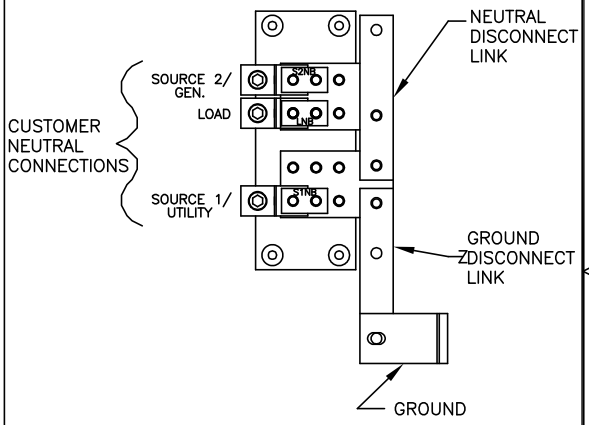
ATS POWER CIRCUIT SCHEMATIC



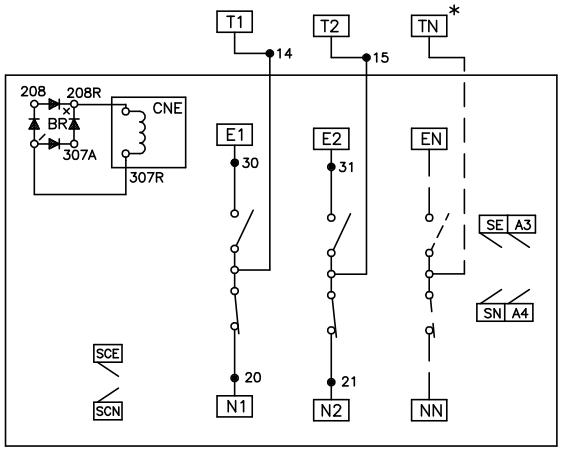
SWITCHED NEUTRAL



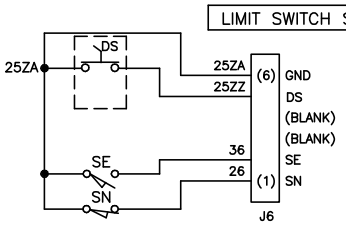
SOLID NEUTRAL



ATS POWER PANEL LAYOUT



LIMIT SWITCH SCHEMATIC



SE – SOURCE 2 POSITION LIMIT SWITCH
SN – SOURCE 1 POSITION LIMIT SWITCH
DS – DISCONNECT SWTICH

LEGEND	REFERENCE	NOTES
● WIRE CONNECTION ○ WIRE ON TERMINAL BLOCK ≫ WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	FOR PRODUCTION ONLY: R/T BOX AND PLUGS – SEE SHT 2	ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	MF/GG	11/08/03
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-1001-d-3
MODEL / ASSEMBLY FILE: ZTGSE40-260AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

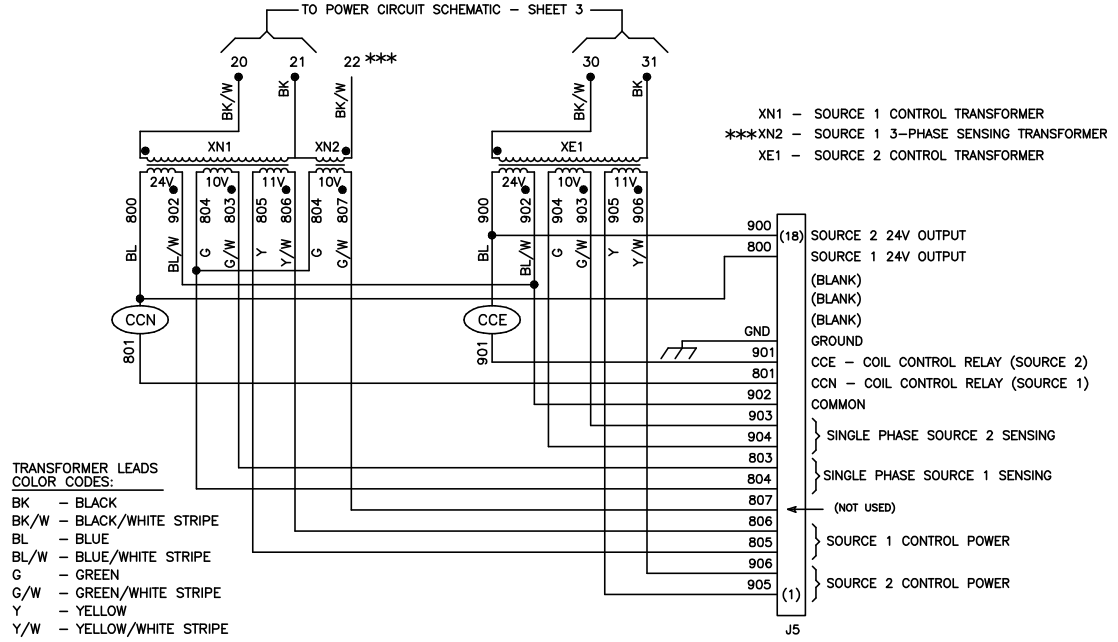
TITLE
ATS POWER CIRCUIT & LAYOUT (INVERTED DESIGN)
FIRST MADE FOR: ZTGSE40-260AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-1001

SCALE: NA SHEET 3 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	02/04/04	GG FS

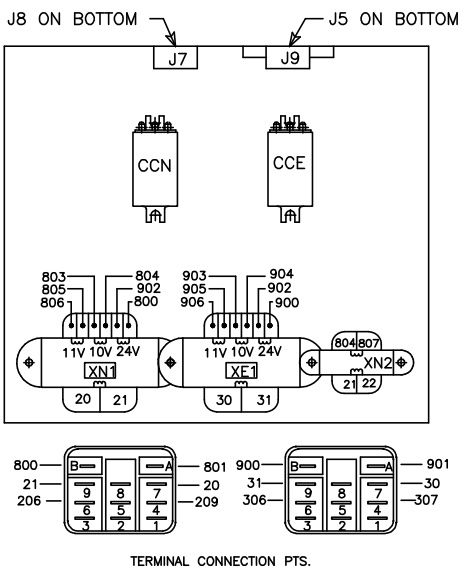
RELAY/TRANSFORMER BOX SCHEMATIC



TRANSFORMER LEADS COLOR CODES:

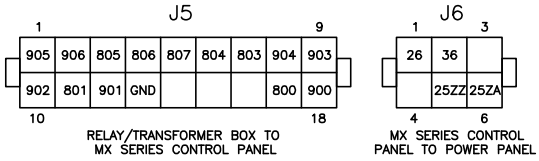
- BK – BLACK
- BK/W – BLACK/WHITE STRIPE
- BL – BLUE
- BL/W – BLUE/WHITE STRIPE
- G – GREEN
- G/W – GREEN/WHITE STRIPE
- Y – YELLOW
- Y/W – YELLOW/WHITE STRIPE

RELAY/TRANSFORMER BOX



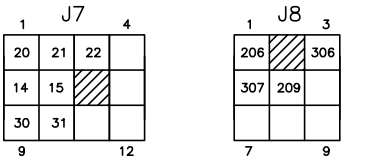
TERMINAL CONNECTION PTS.

INTERCONNECT PLUGS



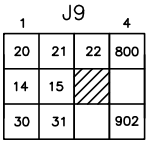
RELAY/TRANSFORMER BOX TO MX SERIES CONTROL PANEL

MX SERIES CONTROL PANEL TO POWER PANEL



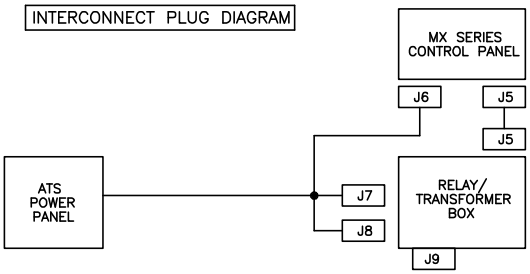
RELAY/TRANSFORMER BOX TO POWER PANEL

RELAY/TRANSFORMER BOX TO POWER PANEL



RELAY/TRANSFORMER BOX TO AUXILIARY CONTROL PANEL

INTERCONNECT PLUG DIAGRAM



LEGEND
● WIRE CONNECTION
*** WIRE #22 REMAINS WIRED IN RELAY/TRANSFORMER BOX. WIRE #22 IS NOT CONNECTED TO ATS POWER PANEL.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	MF/GG	11/08/03
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-1001-d-4
MODEL / ASSEMBLY FILE: ZTGSE40-260AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
RELAY/XFR BOX&INTERCONNECT PLUGS(INVERTED DESIGN)

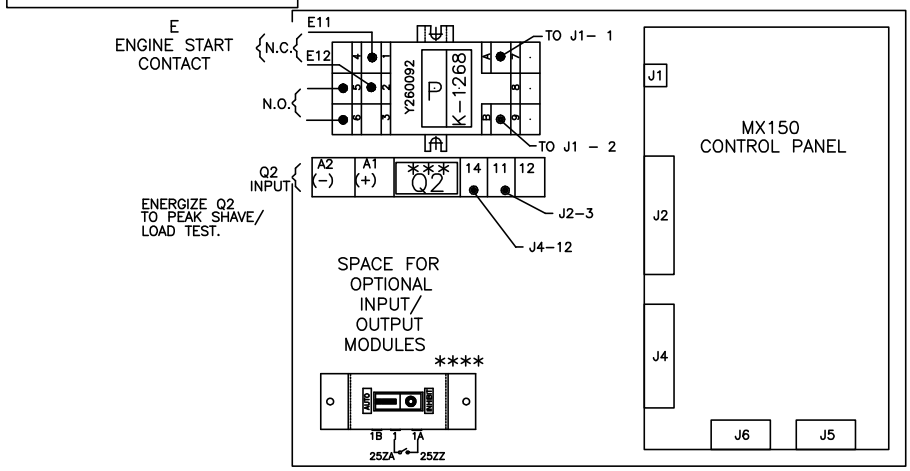
FIRST MADE FOR: ZTGSE40-260AMP (2 POLE)

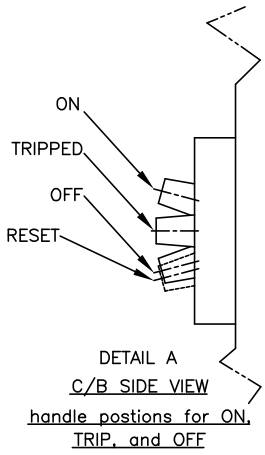
SIZE	CAGE CODE	DWG NO
B		80A-1001

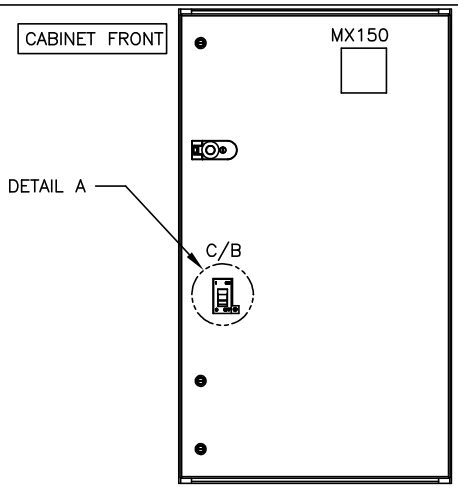
SCALE: NA SHEET 4 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED DWG	01/20/04	AMG FS

INSIDE VIEW OF CABINET DOOR

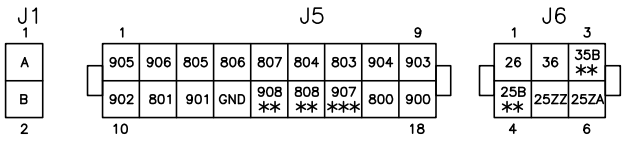






NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS

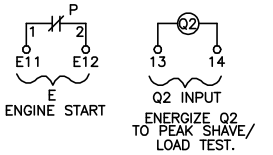


FROM MX150 CONTROL PANEL TO P RELAY

FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

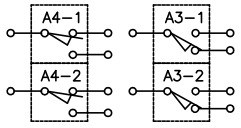
FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS



AUXILIARY CONTACTS

LOCATED ON ATS POWER PANEL



LEGEND

- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  - K-1306, 24VAC;
  - K-1307, 24VDC;
  - K-1308, 120VAC;
  - PS-3107 CLIP
- TB..TERMINAL BLOCK, PS-1754

**** DISCONNECT SWITCH (DS)
DS:....L-4030
BRACKET:..... 57H-1031
LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	20 AMP @ 125, 250 VAC
UMD	UMD1,2	10 AMP @ 277 VAC OR 30 VDC

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	MF/GG	11/08/03
DETAIL		
CHECKED		
ENGRG	MF/GG	11/08/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-1001-d-5.dwg
MODEL / ASSEMBLY FILE: ZTGSE40-260AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIDE DOOR, CABINET FRONT, PLUGS,CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGSE40-260AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-1001

SCALE: NA SHEET 5 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1,2 & 5	2/04/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR-BASED CONTROL PANEL 400-600A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS – RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box
- CCE.....Control Relay, Close Source 2
- CCN.....Control Relay, Close Source 1
- XE1.....Control Transformer, Source 2
- XN1,XN2.....Control Transformer, Source 1

Power Panel
- N1,2,3(N).....Source 1 Line _____
- E1,2,3(N).....Source 2 Line _____
- T1,2,3(N).....Load Connections
- CE.....Source 2 Transfer Operator
- CN.....Source 1 Transfer Operator
- GND.....Ground
- NB.....Neutral Bar (if required)
- RE.....Bridge Rectifier, CE
- RN.....Bridge Rectifier, CN
- SE.....Source 2 Position Limit Switch
- SN.....Source 1 Position Limit Switch

Interconnect Plugs
- J1, J2, J4, J5, J6, J7, J8 and J9 For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values, or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location and handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset "Restore" values, the MX control panel energizes the CCE control relay to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When Source 1 line voltage reaches the preset "Restore" values, the MX control panel energizes the CCN control relay to operate the main transfer operator. The load is now re-transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch
The Test Switch simulates source 1 line failure when activated.
To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.
Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.
- CALIBRATE Source 1 & Source 2 Calibrate capabilities for voltage a frequency.
- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
  - System Data: Total Life Transfers (N2P)
  - Days Powered Up
  - Total Transfers to S2
  - Total S1 Failures
  - Total S1 available in Hrs
  - Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2
- L Indicating LED lights.
  - L1 Indicates Switch in Source 2 position.
  - L2 Indicates Switch in Source 1 position.
  - L3 Indicates Source 1 available.
  - L4 Indicates Source 2 available.
- P Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In-Phase Monitor. Prevents transfer until two sources are in-phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.
- C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 side of the ATS to the Load lugs of Circuit Breaker) see sheet 2.

☐D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Additional Auxiliary Contact closed when switch is in Source 2 position.
- A4 Additional Auxiliary Contact closed when switch is in Source 1 position.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 356 day cycle.
- VI Voltage Imbalance (Three Phase) User Configured On or Off. Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable. Resolution: 1% Increments Minimum Differential: 2% minimum between "Fail" and "Restore" settings. Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

- ☐STS Shunt Trip Selector.
- ☐GFP Ground Fault Potection
- ☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.
- ☐6A Test Switch, Maintained/Momentary. Door mount
- ☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- ☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)
- ☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)
- ☐A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)
- ☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)
- ☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0-60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)
- ☐ BC Battery charger.
- ☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.
- ☐ F Fan contact, operates when generator is running.
- ☐ HT Heater and Thermostat.
- ☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.
- ☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- ☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.
- ☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- ☐T3/W3 Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer. (Maximum: 2 circuits)
- ☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0-60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re-closes after transfer. Can be config. by end user for Pre-transfer, Post-transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)
- ☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

400 AMP:
- 59C-1020 (3 POLE), 59C-1021 (4 POLE) } NEMA 1
- 59C-1023 (3 POLE), 59C-1024 (4 POLE) } NEMA 3R

600 AMP:
- 59C-1042 (3 POLE), 59C-1043 (4 POLE) } NEMA 1
- 59C-1045 (3 POLE), 59C-1046 (4 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING – TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT-HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	11/10/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-2000-d-1.dwg
MODEL / ASSEMBLY FILE: ZTGSE400-600AMP (3 /4 POLE)
AutoCad Generated
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LEGEND, OPERATION, AND ACCESSORIES

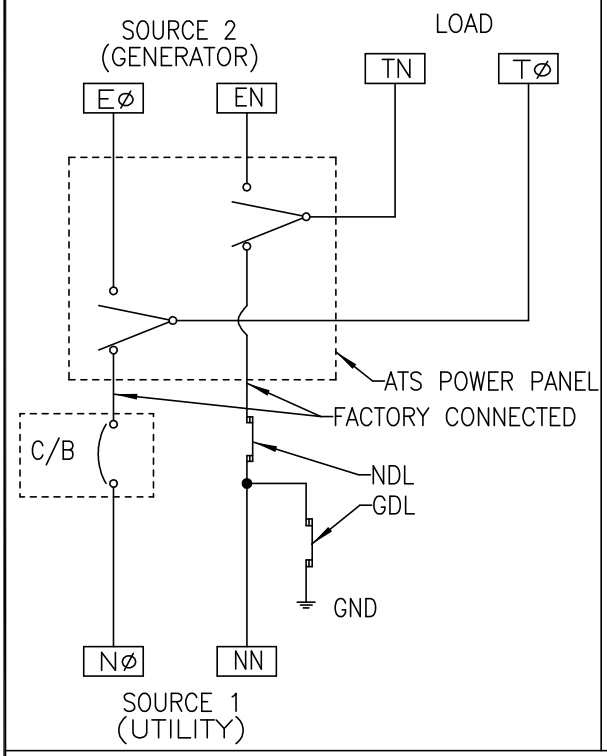
FIRST MADE FOR: ZTGSE400-600AMP (3 /4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-2000

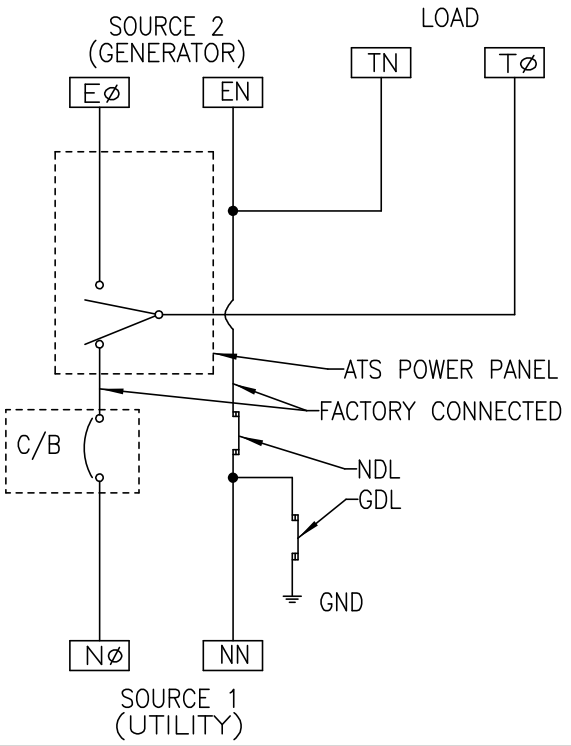
SCALE: NA SHEET 1 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S–8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

400A 3,4P C/B PART NO.		
PART NO.	DESCRIPTION	4/3P
SGLA36AT0600	MCCB SPECTRA RMS SG600A FRAME 3P	1
SRPG600A400	RATING PLUG 400A	1
TCLK365	C/B LUG KIT, 2 POLE SG FRAME	2

600A 3,4P C/B PART NO.		
PART NO.	DESCRIPTION	4/3P
SKLA36AT0800	MCCB SPECTRA RMS SK800A FRAME 3P	1
SRPK800A600	RATING PLUG 600A	1
TCAL81	LUG, (3) 3/0–500MCM	6

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	11/10/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a–2000–d–2.dwg
MODEL / ASSEMBLY FILE: ZTGSE400–600AMP (3/4 POLE)
CTQs | ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

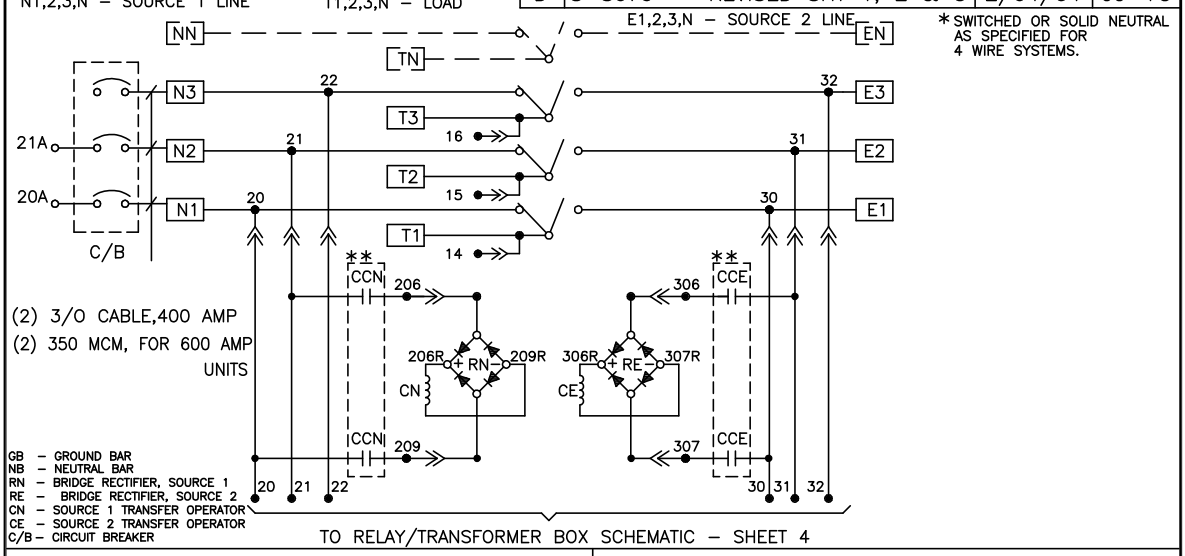
FIRST MADE FOR: ZTGSE400–600AMP (3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A–2000

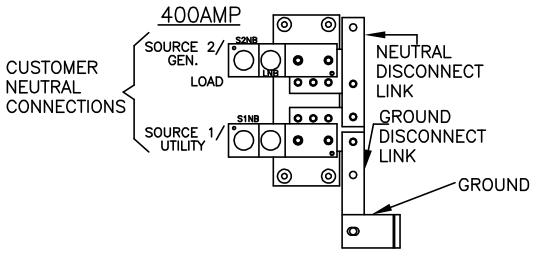
SCALE: NA SHEET 2 OF 5

ATS POWER CIRCUIT SCHEMATIC

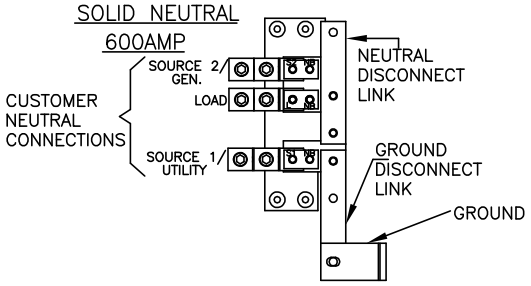
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS



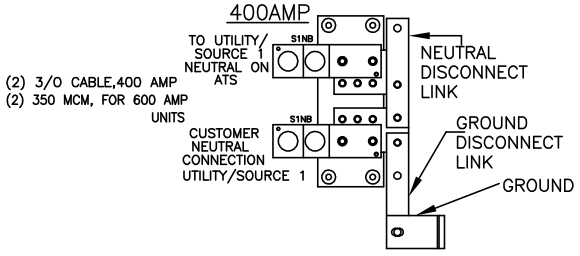
SOLID NEUTRAL 400AMP



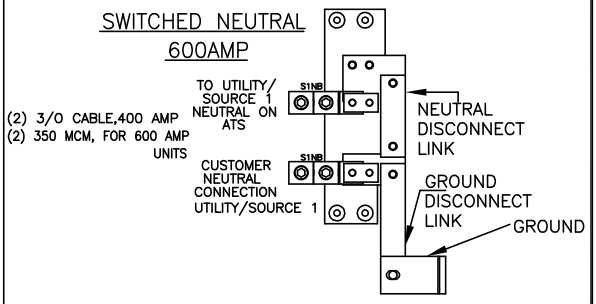
SOLID NEUTRAL 600AMP



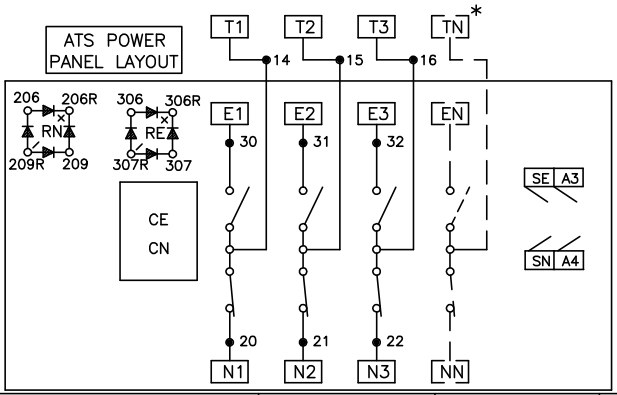
SWITCHED NEUTRAL 400AMP



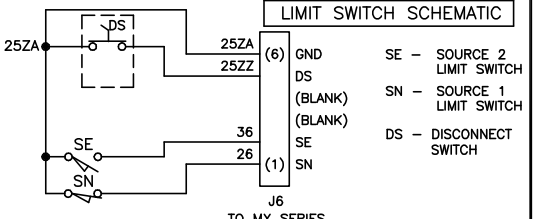
SWITCHED NEUTRAL 600AMP



ATS POWER PANEL LAYOUT



LIMIT SWITCH SCHEMATIC



LEGEND	REFERENCE
WIRE CONNECTION	FOR PRODUCTION ONLY: R/T BOX AND PLUGS – SEE SHT 4
WIRE ON TERMINAL BLOCK	
WIRE IN INTERCONNECT PLUG	NOTES
* OPTIONAL	ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE.
** LOCATED ON RELAY/ TRANSFORMER BOX	

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

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SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	11/10/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-2000-d-3.dwg
MODEL / ASSEMBLY FILE: ZTGSE400-600AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
ATS POWER CIRCUIT & LAYOUT (INVERTED DESIGN)

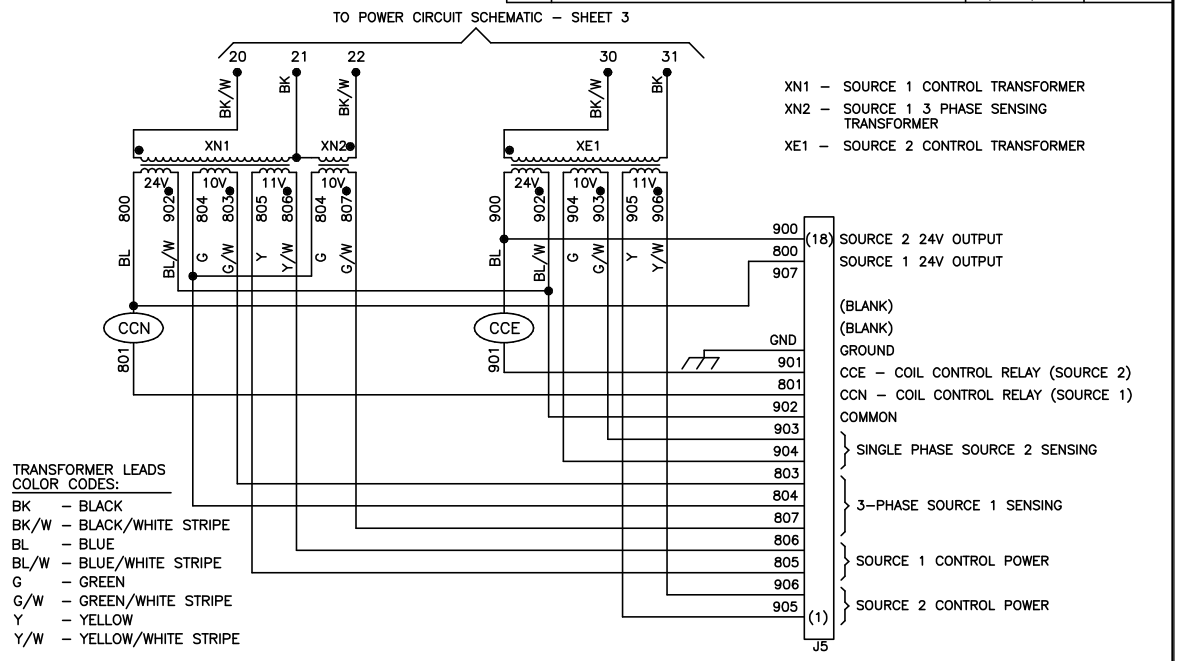
FIRST MADE FOR: ZTGSE400-600AMP (3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-2000

SCALE: NA SHEET 3 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

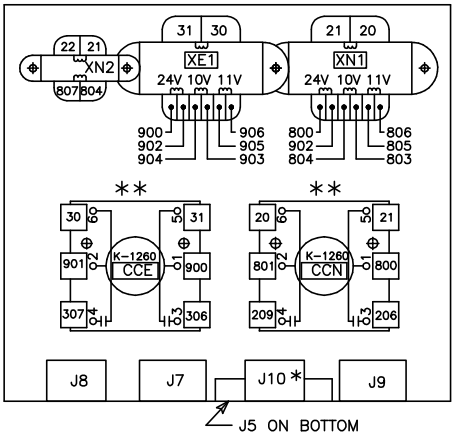
RELAY/TRANSFORMER BOX SCHEMATIC



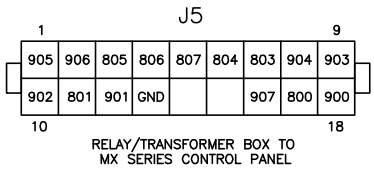
TRANSFORMER LEADS COLOR CODES:

- BK – BLACK
- BK/W – BLACK/WHITE STRIPE
- BL – BLUE
- BL/W – BLUE/WHITE STRIPE
- G – GREEN
- G/W – GREEN/WHITE STRIPE
- Y – YELLOW
- Y/W – YELLOW/WHITE STRIPE

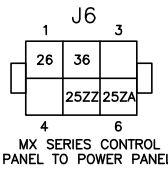
RELAY/TRANSFORMER BOX



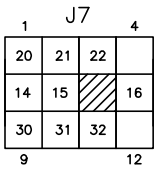
INTERCONNECT PLUGS



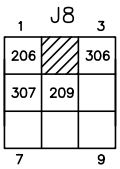
RELAY/TRANSFORMER BOX TO MX SERIES CONTROL PANEL



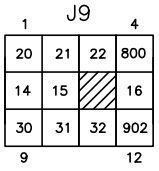
MX SERIES CONTROL PANEL TO POWER PANEL



RELAY/TRANSFORMER BOX TO POWER PANEL

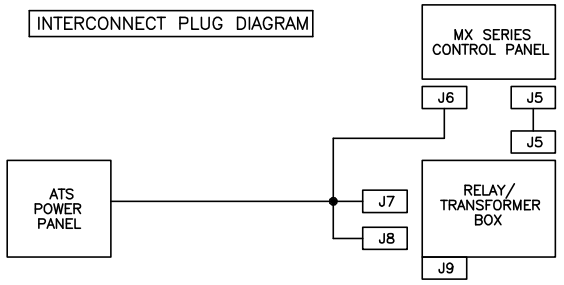


RELAY/TRANSFORMER BOX TO POWER PANEL



RELAY/TRANSFORMER BOX TO AUXILIARY CONTROL PANEL

INTERCONNECT PLUG DIAGRAM



LEGEND

- —●— WIRE CONNECTION
- ** DRAWN TO SHOW WIRE NUMBER TO RELAY TERMINAL NUMBER.

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THIRD ANGLE PROJECTION

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3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	11/10/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-2000-d-4.dwg
MODEL / ASSEMBLY FILE: ZTGSE400-600AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
RELAY/XFR BOX &INTERCONNECT PLUGS(INVERTED DESIGN)

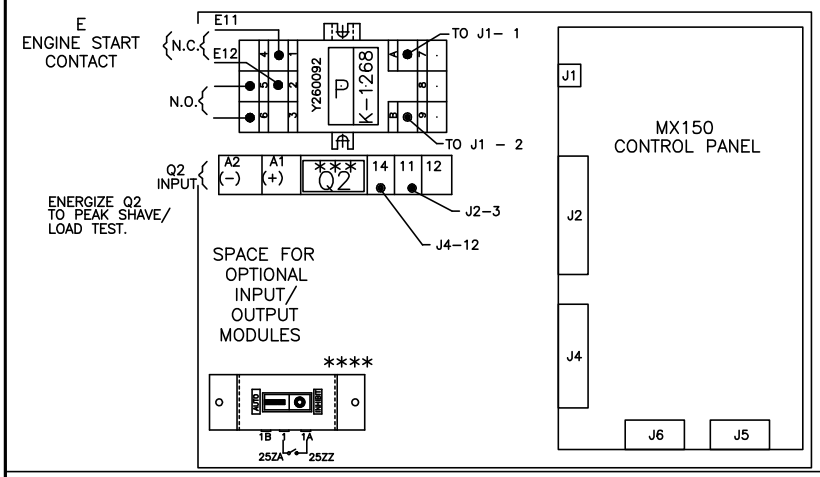
FIRST MADE FOR: ZTGSE400-600AMP (3/4 POLE)

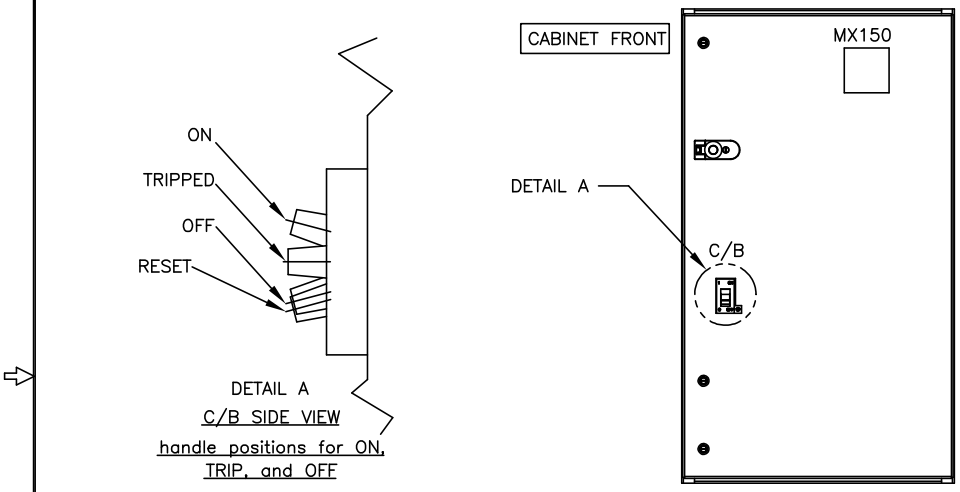
SIZE	CAGE CODE	DWG NO
B		80A-2000

SCALE: NA SHEET 4 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 SEE SHEET 1 AND 2	01/20/04	AMG FS

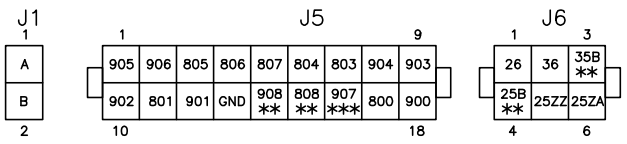
INSIDE VIEW OF CABINET DOOR





NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS

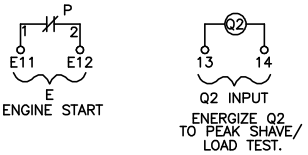


FROM MX150 CONTROL PANEL TO P RELAY

FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS



LEGEND

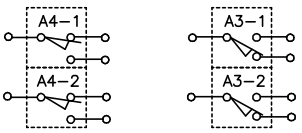
- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  - K-1306, 24VAC;
  - K-1307, 24VDC;
  - K-1308, 120VAC;
  - PS-3147 CLIP
- TB..TERMINAL BLOCK, PS-1754
- **** DISCONNECT SWITCH (DS)
  - DS:....L-4030
  - BRACKET:..... 57H-1031
  - LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

AUXILIARY CONTACTS

LOCATED ON ATS POWER PANEL



RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	20 AMP @ 125, 250 VAC
UMD	UMD1,2	10 AMP @ 277 VAC OR 30 VDC

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THIRD ANGLE PROJECTION

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ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

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SIGNATURES		DATE
MODEL	GG	11/17/03
DETAIL		
CHECKED		
ENGRG	MF	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-2000-d-5.dwg
MODEL / ASSEMBLY FILE: ZTGSE400-600AMP(3/4 POLE)
CTQs
⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIDE DOOR, CABINET FRONT, PLUGS CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGSE400-600AMP(3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-2000

SCALE: NA SHEET 5 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR-BASED CONTROL PANEL 400-600A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS - RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box

- CCE..... Control Relay, Close Source 2
- CCN..... Control Relay, Close Source 1
- XE1..... Control Transformer, Source 2
- XN1,XN2..... Control Transformer, Source 1

Power Panel

- N1,2,(N)..... Source 1 Line _____
- E1,2,(N)..... Source 2 Line _____
- T1,2,(N)..... Load Connections
- CE..... Source 2 Transfer Operator
- CN..... Source 1 Transfer Operator
- GND..... Ground
- NB..... Neutral Bar (if required)
- RE..... Bridge Rectifier, CE
- RN..... Bridge Rectifier, CN
- SE..... Source 2 Position Limit Switch
- SN..... Source 1 Position Limit Switch

Interconnect Plugs

J1, J2, J4, J5, J6, J7, J8 and J9 For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values, or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location and handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset "Restore" values, the MX control panel energizes the CCE control relay to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When Source 1 line voltage reaches the preset "Restore" values, the MX control panel energizes the CCN control relay to operate the main transfer operator. The load is now re-transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch

The Test Switch simulates source 1 line failure when activated. To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position. Testing at least once a month is recommended. For hospital emergency systems, test once a week.

C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.
- CALIBRATE Source 1 & Source 2 Calibrate capabilities for voltage a frequency.
- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
- System Data: Total Life Transfers (N2P), Days Powered Up, Total Transfers to S2, Total S1 Failures, Total S1 available in Hrs, Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2
- L Indicating LED lights.
  - L1 Indicates Switch in Source 2 position.
  - L2 Indicates Switch in Source 1 position.
  - L3 Indicates Source 1 available.
  - L4 Indicates Source 2 available.
- P Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In-Phase Monitor. Prevents transfer until two sources are in-phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.
- C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 side of the ATS to the Load lugs of Circuit Breaker)

☐ D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Additional Auxiliary Contact closed when switch is in Source 2 position.
- A4 Additional Auxiliary Contact closed when switch is in Source 1 position.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 356 day cycle.
- VI Voltage Imbalance (Three Phase) User Configured On or Off. Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable. Resolution: 1% Increments Minimum Differential: 2% minimum between "Fail" and "Restore" settings. Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

- ☐STS Shunt Trip Selector.
- ☐GFP Ground Fault Potection
- ☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.
- ☐6A Test Switch, Maintained/Momentary. Door mount
- ☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- ☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)
- ☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)
- ☐A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)
- ☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)
- ☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0-60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)
- ☐ BC Battery charger.
- ☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.
- ☐ F Fan contact, operates when generator is running.
- ☐ HT Heater and Thermostat.
- ☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.
- ☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- ☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.
- ☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- ☐T3/W3 Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer. (Maximum: 2 circuits)
- ☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0-60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re-closes after transfer. Can be config. by end user for Pre-transfer, Post-transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)
- ☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

400 AMP:

- 59C-1019 (2 POLE), 59C-1020 (3 POLE) } NEMA 1
- 59C-1022 (2 POLE), 59C-1023 (3 POLE) } NEMA 3R

600 AMP:

- 59C-1041 (2 POLE), 59C-1042 (3 POLE) } NEMA 1
- 59C-1044 (2 POLE), 59C-1045 (3 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING - TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT-HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

SIGNATURES		DATE
MODEL	GG	11/08/03
DETAIL		
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ENGRG	MF	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-2001-d-1.dwg
MODEL / ASSEMBLY FILE: ZTGSE400-600AMP (2 POLE)
AutoCad Generated
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE: LEGEND, OPERATION, AND ACCESSORIES

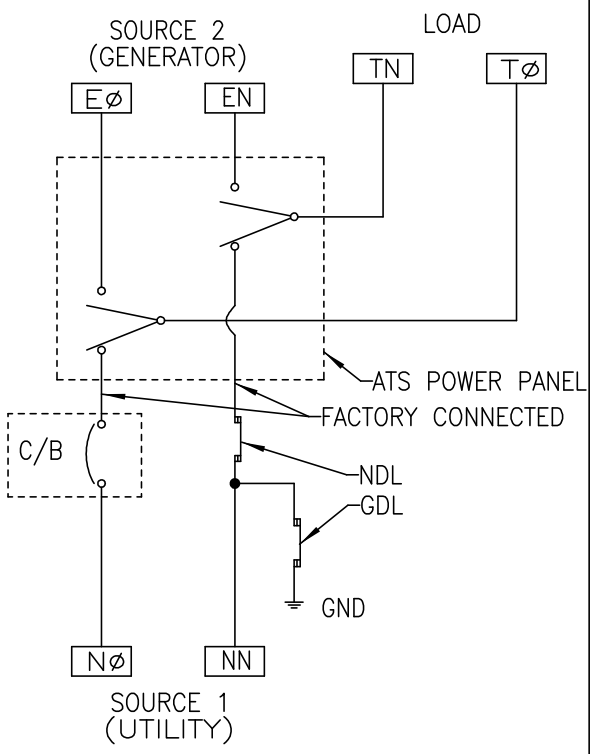
FIRST MADE FOR: ZTGSE400-600AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-2001

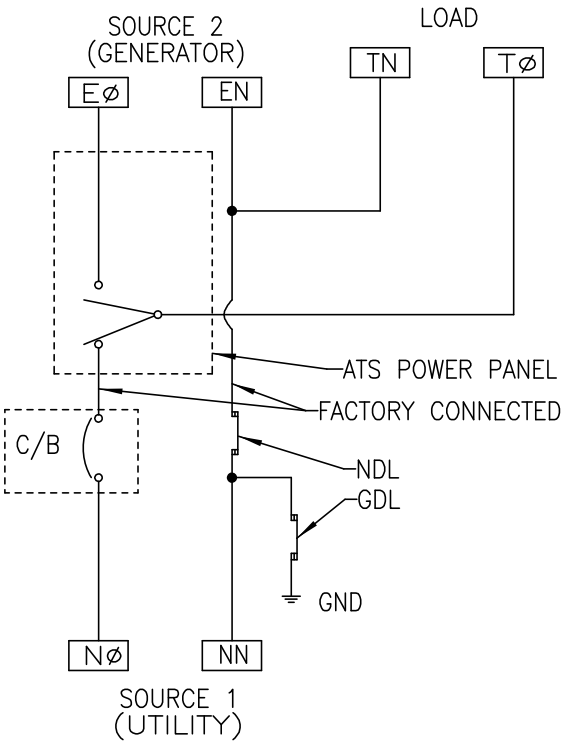
SCALE: NA SHEET 1 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S–8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

400A 2P C/B PART NO.

PART NO.	DESCRIPTION	2P
SGLA26AT0600	MCCB SPECTRA RMS SG600A FRAME 2P	1
SRPG600A400	RATING PLUG 400A	1
TCLK265	C/B LUG KIT, 2 POLE SG FRAME	2

600A 2P C/B PART NO.

PART NO.	DESCRIPTION	2P
SKLA26AT0800	MCCB SPECTRA RMS SK800A FRAME 2P	1
SRPK800A600	RATING PLUG 600A	1
TCAL81	LUG, (3) 3/0–500MCM	4

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	11/10/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a–2001–d–2.dwg
MODEL / ASSEMBLY FILE: ZTGSE400–600AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

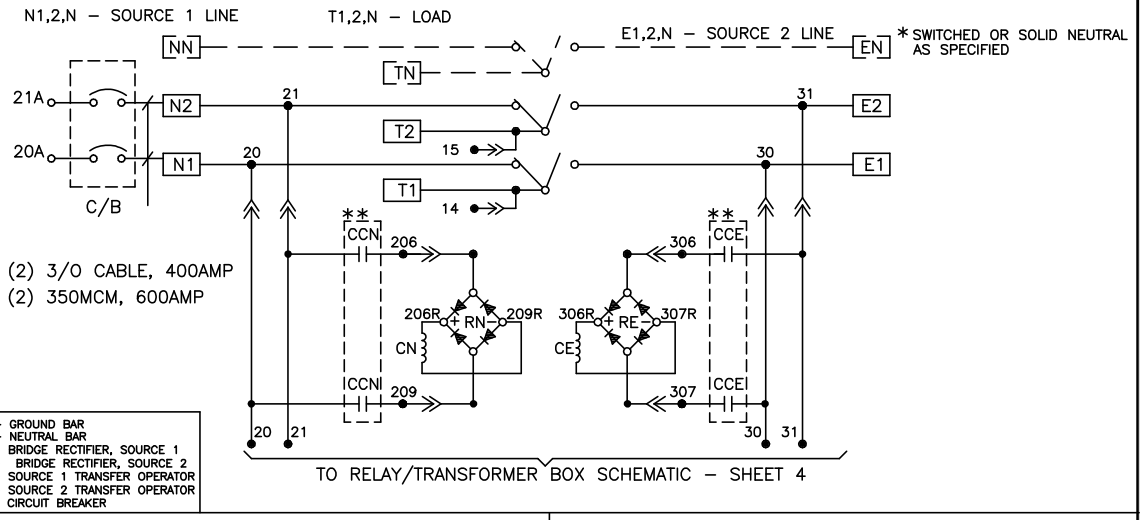
FIRST MADE FOR: ZTGSE400–600AMP (2 POLE)

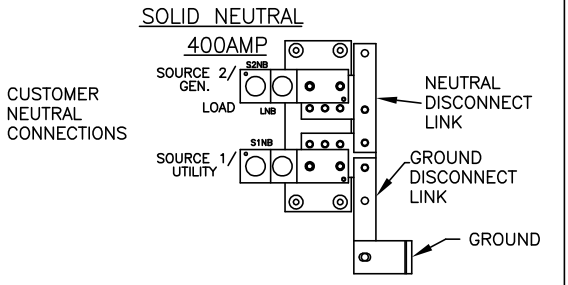
SIZE	CAGE CODE	DWG NO
B		80A–2001

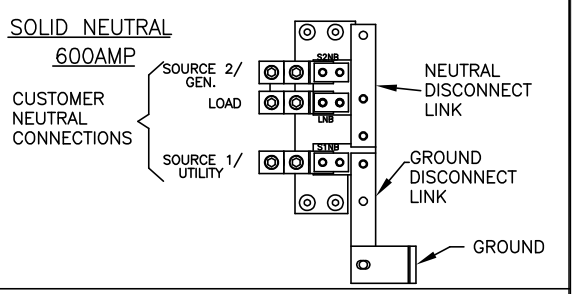
SCALE: NA SHEET 2 OF 5

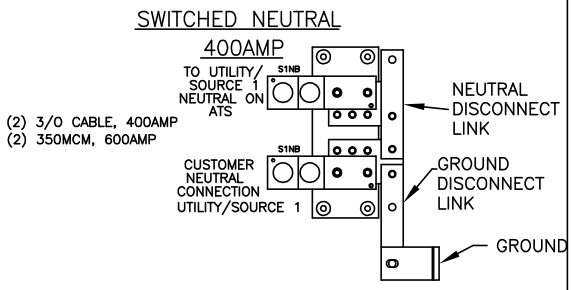
ATS POWER CIRCUIT SCHEMATIC

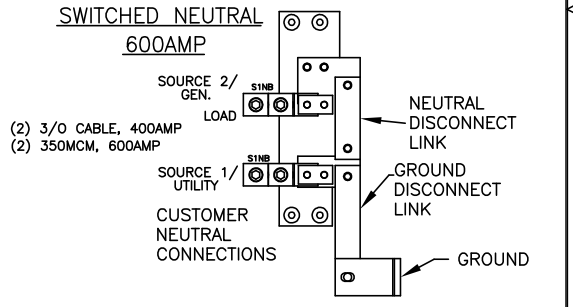
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

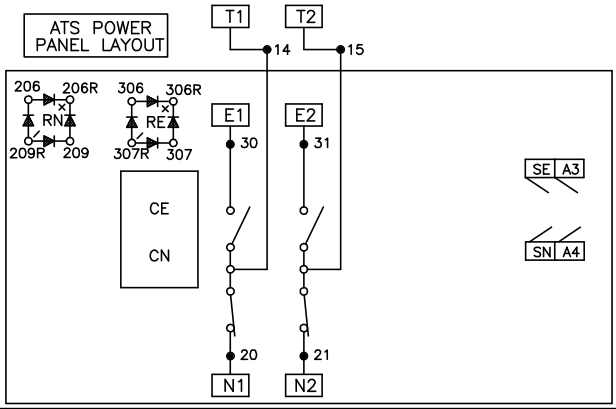




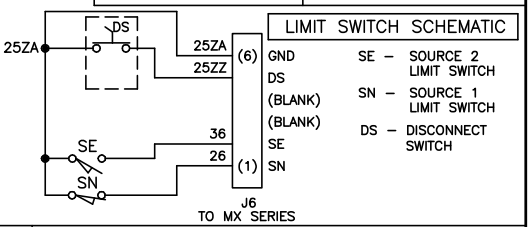








LEGEND	REFERENCE
● WIRE CONNECTION ○ WIRE ON TERMINAL BLOCK ≫ WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	FOR PRODUCTION ONLY: R/T BOX AND PLUGS – SEE SHT 3
	NOTES
	ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE.



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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	MF/GG	11/08/03
DETAIL		
CHECKED		
ENGRG	MF	11/08/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-2001-d-3.dwg
MODEL / ASSEMBLY FILE: ZTGSE400-600AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
ATS POWER CIRCUIT & LAYOUT (INVERTED DESIGN)

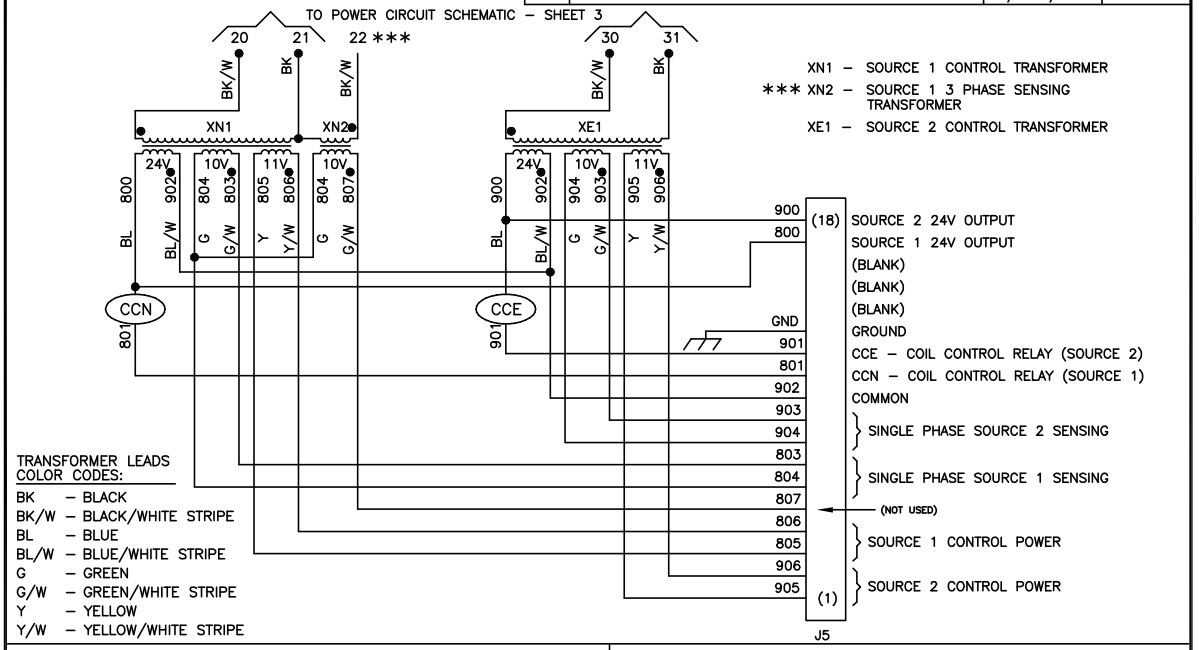
FIRST MADE FOR: ZTGSE400-600AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-2001

SCALE: NA SHEET 3 OF 5

REVISIONS				
REV.	DESCRIPTION		DATE	APPROVED
D	S-8079	REVISED SHT 1 2 & 5	2/04/04	GG FS

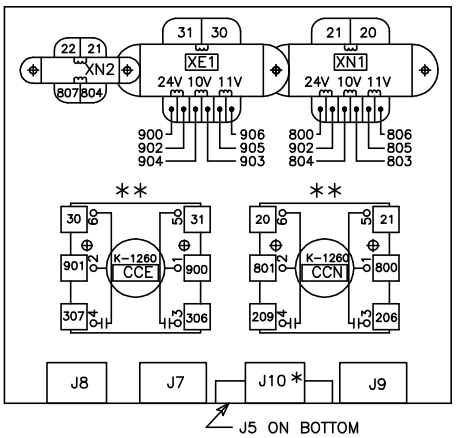
RELAY/TRANSFORMER BOX SCHEMATIC



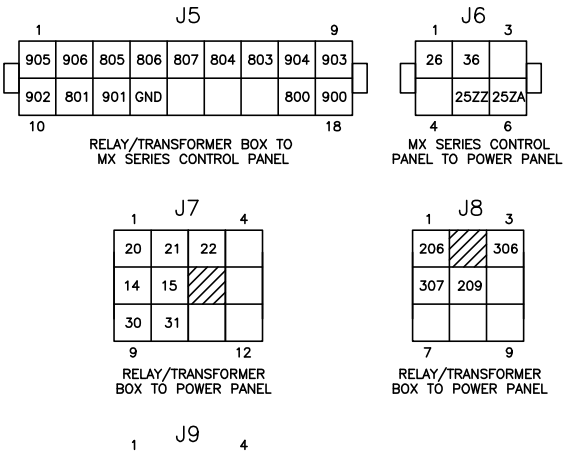
TRANSFORMER LEADS COLOR CODES:

- BK – BLACK
- BK/W – BLACK/WHITE STRIPE
- BL – BLUE
- BL/W – BLUE/WHITE STRIPE
- G – GREEN
- G/W – GREEN/WHITE STRIPE
- Y – YELLOW
- Y/W – YELLOW/WHITE STRIPE

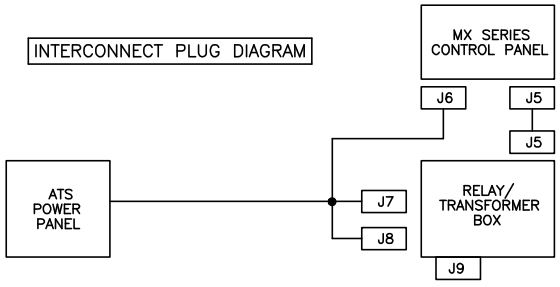
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



LEGEND

- —●— WIRE CONNECTION
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRE #22 IS NOT CONNECTED TO ATS POWER PANEL.
- ** DRAWN TO SHOW WIRE NUMBER TO RELAY TERMINAL NUMBER.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/08/03
DETAIL		
CHECKED		
ENGRG	MF/	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-2001-d-4.dwg
MODEL / ASSEMBLY FILE: ZTGSE400-600AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
RELAY/XFR BOX&INTERCONNECT PLUGS

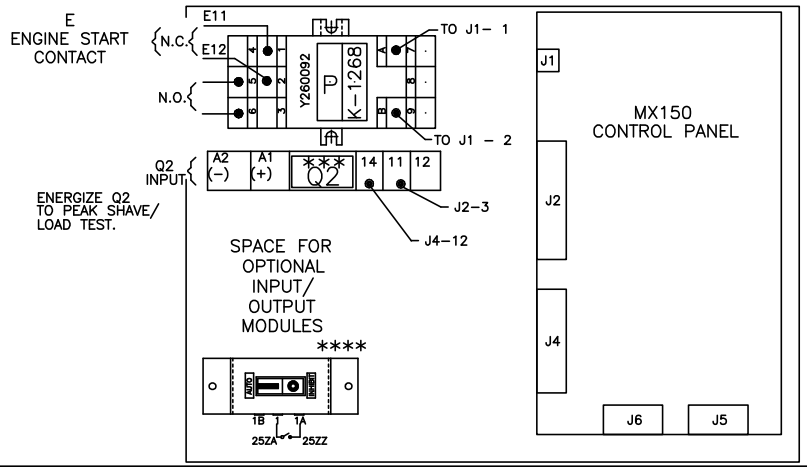
FIRST MADE FOR: ZTGSE400-600AMP (2 POLE)

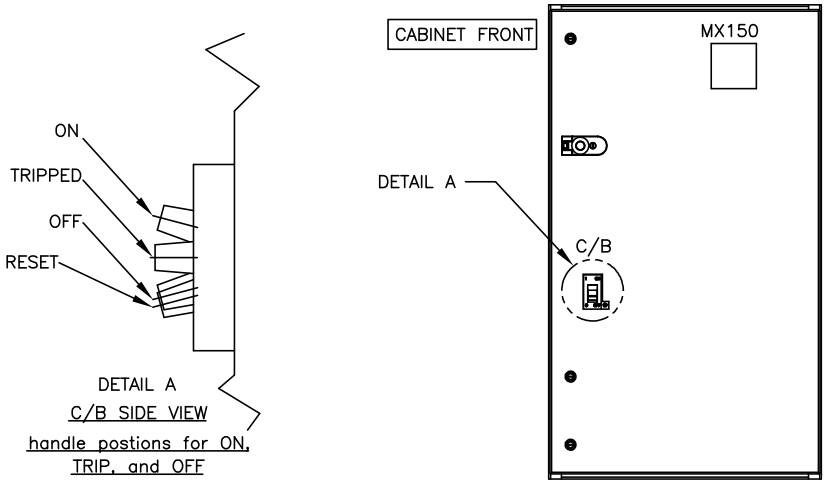
SIZE	CAGE CODE	DWG NO
B		80A-2001

SCALE: NA SHEET 4 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED	01/20/04	AMG FS

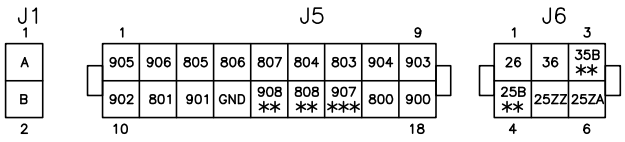
INSIDE VIEW OF CABINET DOOR





NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS

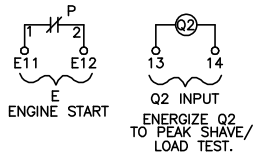


FROM MX150 CONTROL PANEL TO P RELAY

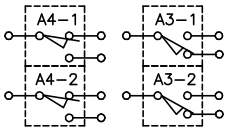
FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS



AUXILIARY CONTACTS
LOCATED ON ATS POWER PANEL



LEGEND

- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  - K-1306, 24VAC;
  - K-1307, 24VDC;
  - K-1308, 120VAC;
  - PS-3147 CLIP

TB..TERMINAL BLOCK, PS-1754

- **** DISCONNECT SWITCH (DS)
  - DS:....L-4030
  - BRACKET:..... 57H-1031
  - LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	20 AMP @ 125, 250 VAC
UMD	UMD1,2	10 AMP @ 277 VAC OR 30 VDC

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THIRD ANGLE PROJECTION

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	MF/GG	11/08/03
DETAIL		
CHECKED		
ENGRG	MF	11/08/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-2001-d-5.dwg
MODEL / ASSEMBLY FILE: ZTGSE40-600AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIED DOOR, CABINET FRONT, PLUGS,CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGSE 40-600AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-2001

SCALE: NA SHEET 5 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR-BASED CONTROL PANEL 800A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS – RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box

CCE..... Control Relay, Close Source 2
CCN..... Control Relay, Close Source 1
XE1,XE2..... Control Transformer, Source 2
XN1,XN2..... Control Transformer, Source 1

Power Panel

N1,2,3,(N)..... Source 1 Line_____
E1,2,3,(N)..... Source 2 Line_____
T1,2,3,(N)..... Load Connections
CE..... Source 2 Transfer Operator
CN..... Source 1 Transfer Operator
GND..... Ground
NB..... Neutral Bar (if required)
SE..... Source 2 Position Limit Switch
SN..... Source 1 Position Limit Switch

Interconnect Plugs

J1, J2, J4, J5, J6, J7 and J8
J9 and J10..... For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location and handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset "Restore" values, the MX control panel energizes the CCE control relay to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When Source 1 line voltage reaches the preset "Restore" values, the MX control panel energizes the CCN control relay to operate the main transfer operator. The load is now re-transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch

The Test Switch simulates source 1 line failure when activated.
To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.
Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐ C. MSTDG OPTION PACKAGE.

6 Test Switch, Momentary.
A3 Auxiliary Contact Closed when the switch is in Source 2 position.
A4 Auxiliary Contact Closed when the switch is in Source 1 position.

CALIBRATE
Source 1 & Source 2 Calibrate capabilities for voltage a frequency.

CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.

DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto

E Engine Start Contacts.

EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
System Data: Total Life Transfers (N2P)
Days Powered Up
Total Transfers to S2
Total S1 Failures
Total S1 available in Hrs
Total S2 available in Hrs. (NIP)

KP Frequency, Indication S1 & S2

L Indicating LED lights.
L1 Indicates Switch in Source 2 position.
L2 Indicates Switch in Source 1 position.
L3 Indicates Source 1 available.
L4 Indicates Source 2 available.

P Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting in 3 seconds. Adjust via SET menu.

Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.

R50 In-Phase Monitor. Prevents transfer until two sources are in-phase.

S13 Transfer Commit or no Commit to transfer upon Engine start.

T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.

U Source 2 Stop Delay Timer.

W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.

YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.

C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 Normal side of the ATS to the Load lugs of Circuit Breaker) see sheet 2.

☐ D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

A3 Additional Auxiliary Contact closed when switch is in Source 2 position.

A4 Additional Auxiliary Contact closed when switch is in Source 1 position.

CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load.
Can be configured by end user for 1, 7, 14, 28, 356 day cycle.

VI Voltage Imbalance (Three Phase) User Configured On or Off.
Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% minimum between "Fail" and "Restore" settings.
Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

☐STS Shunt Trip Selector.

☐GFP Ground Fault Potection

☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.

☐6A Test Switch, Maintained/Momentary. Door mount

☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.

☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)

☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)

☐A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)

☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)

☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0-60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)

☐ BC Battery charger.

☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.

☐ F Fan contact, operates when generator is running.

☐ HT Heater and Thermostat.

☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.

☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.

☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.

☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.

☐T3/W3 Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer. (Maximum: 2 circuits)

☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0-60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re-closes after transfer. Can be config. by end user for Pre-transfer, Post-transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)

☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

59C-1014 (3 POLE)
59C-1015 (4 POLE) } NEMA 1

59C-1017 (3 POLE)
59C-1018 (4 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING – TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT-HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	11/10/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-3000-d-1.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (3 /4 POLE)
AutoCad Generated
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LEGEND, OPERATION, AND ACCESSORIES

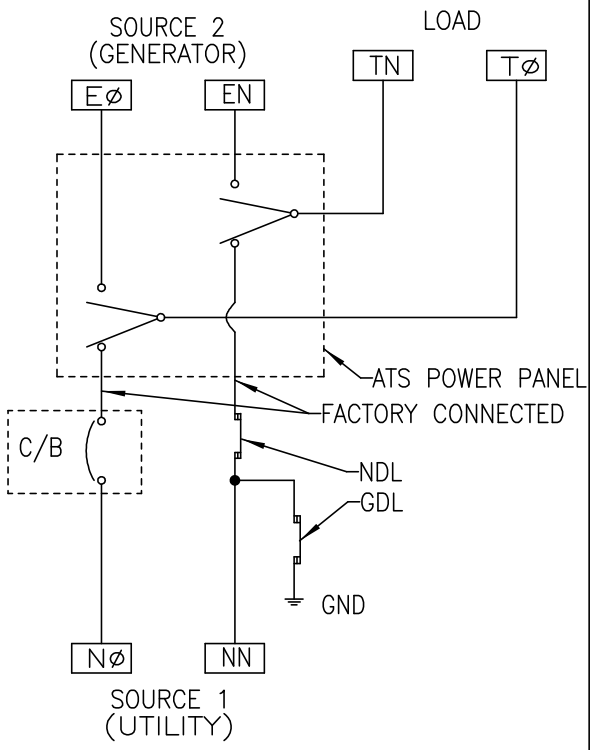
FIRST MADE FOR: ZTGSE800AMP (3 /4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-3000

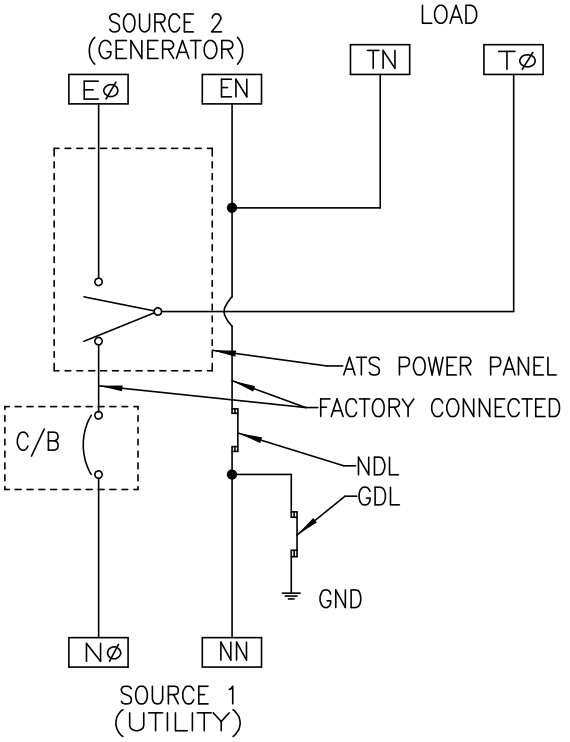
SCALE: NA SHEET 1 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

800A 3,4P C/B PART NO.

PART NO.	DESCRIPTION	4/3P
SKLA36AT1200	MCCB SPECTRA RMS SK1200A FRAME 3P	1
SRPK1200A800	RATING PLUG 800A	1
TCAL125	LUG, (4) 250-500MCM	6

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-3000-d-2.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (3/4 POLE)
CTQs | CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

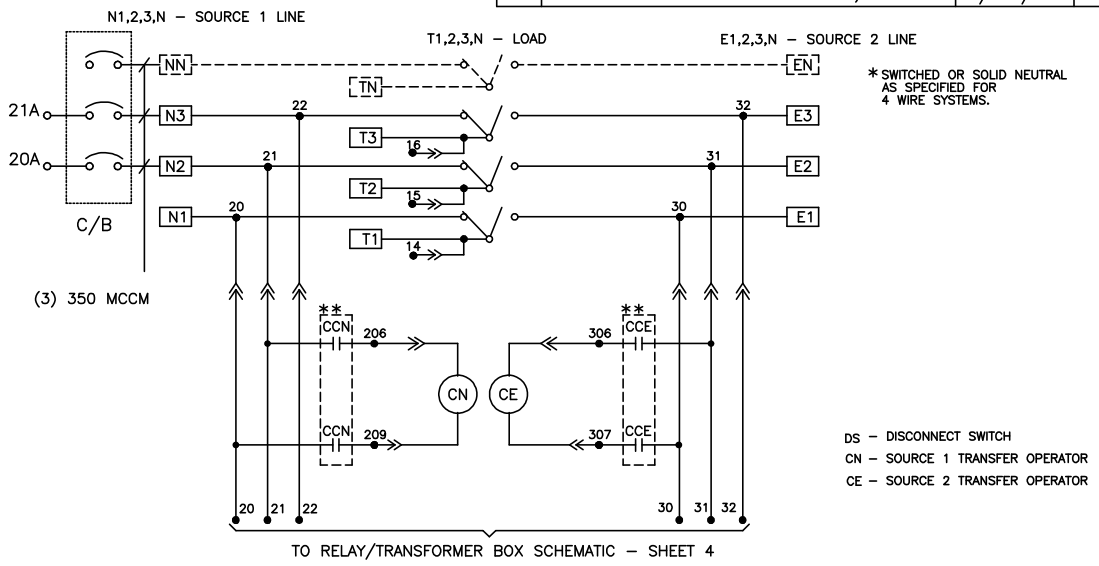
FIRST MADE FOR: ZTGSE800AMP (3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-3000

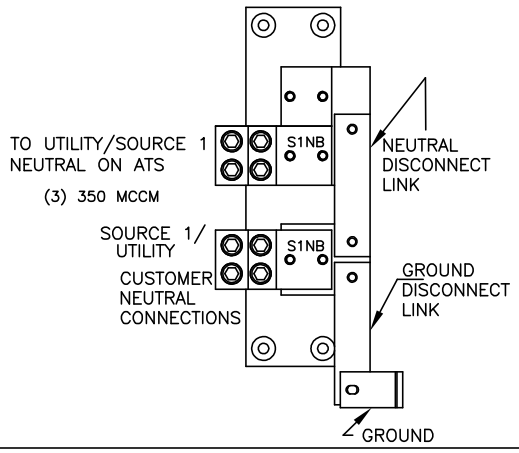
SCALE: NA SHEET 2 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

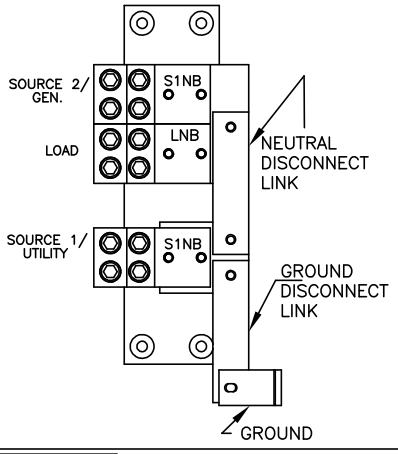
ATS POWER CIRCUIT SCHEMATIC



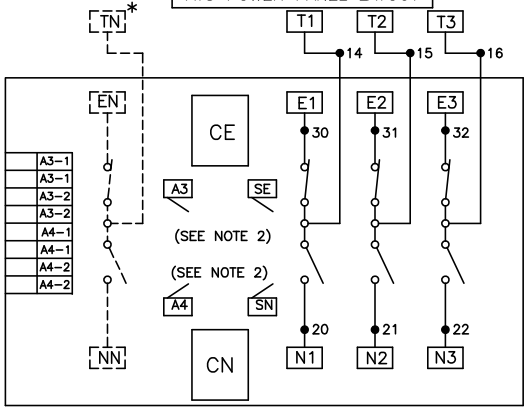
SWITCHED NEUTRAL 800AMP



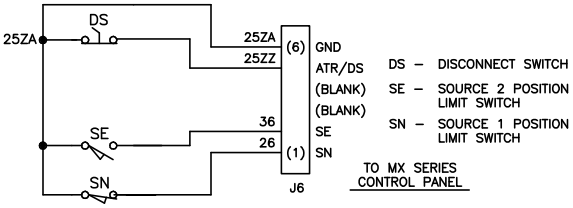
SOLID NEUTRAL 800AMP



ATS POWER PANEL LAYOUT



LIMIT SWITCH SCHEMATIC



LEGEND	REFERENCE	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 70A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUG- SHEET 2 MX150 CONTROLLER- 70A-0500	1. ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE. 2. WHEN (1) A3 & (1) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO RIGHT OF SOLENOIDS. WHEN (2) A3 & (2) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO LEFT OF SOLENOIDS.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

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SIGNATURES		DATE
MODEL	GG	11/20/03
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-3000-d-3.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
ATS POWER CIRCUIT & LAYOUT (INVERTED DESIGN)

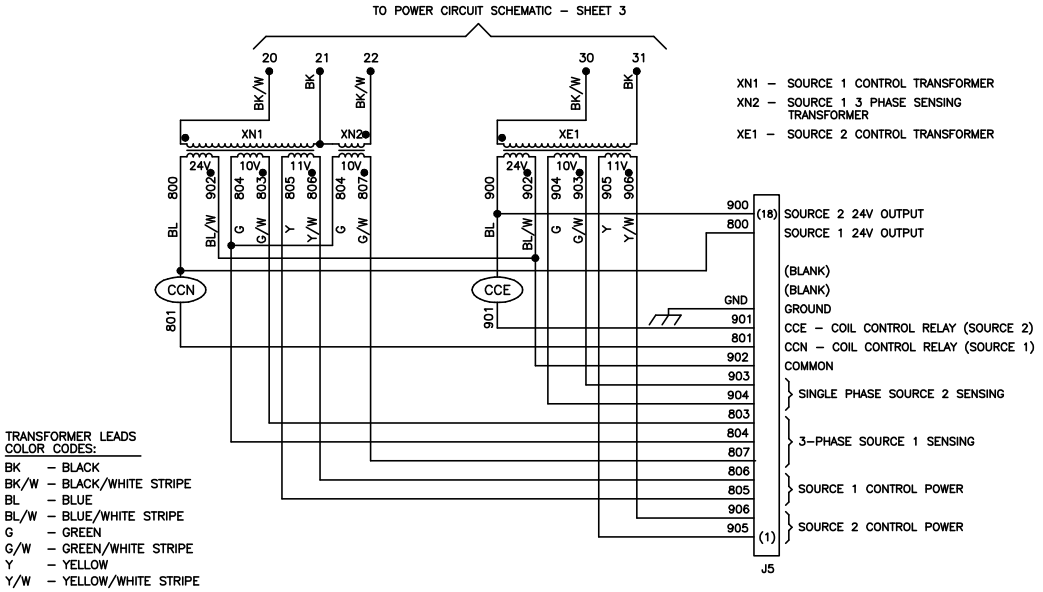
FIRST MADE FOR: ZTGSE800AMP (3/4 POLE)E

SIZE	CAGE CODE	DWG NO
B		80A-3000

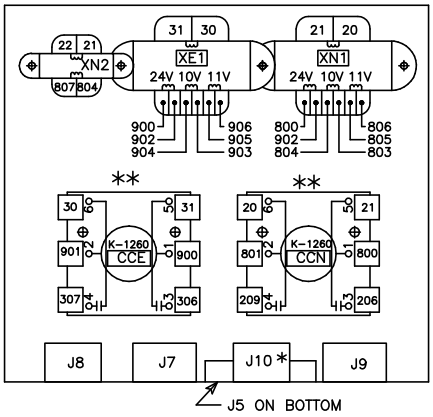
SCALE: NA SHEET 3 of 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

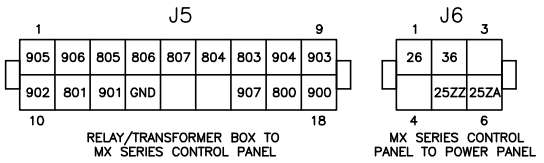
RELAY/TRANSFORMER BOX SCHEMATIC

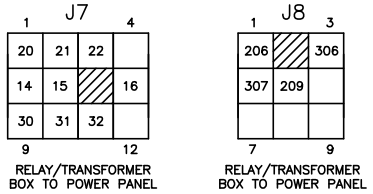


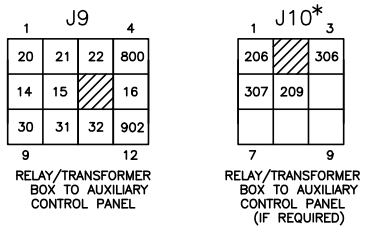
RELAY/TRANSFORMER BOX



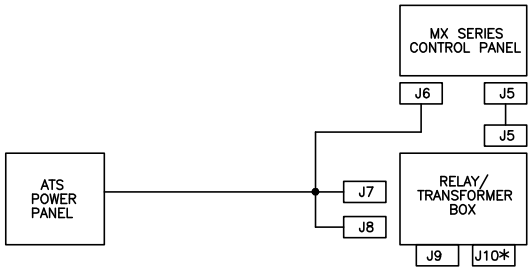
INTERCONNECT PLUGS







INTERCONNECT PLUG DIAGRAM



LEGEND

- WIRE CONNECTION
- * OPTIONAL
- ** DRAWN TO SHOW WIRE NUMBER TO RELAY TERMINAL NUMBER

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/20/03
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-3000-d-4.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
RELAY/XFR BOX & INTERCONN. PLUGS (INVERTED DESIGN)

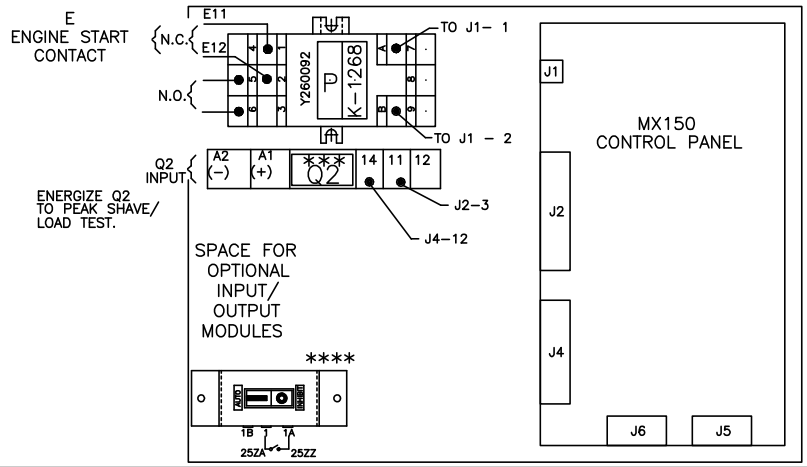
FIRST MADE FOR: ZTGSE800AMP (3/4 POLE)

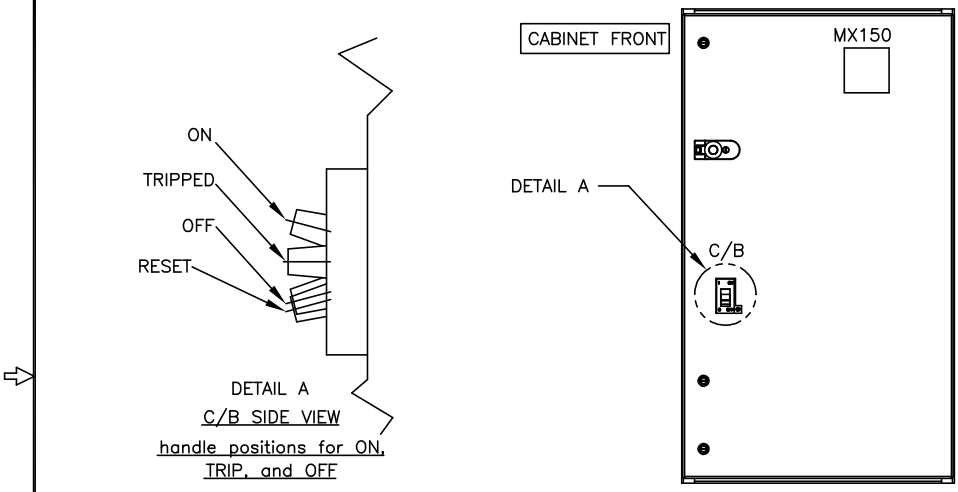
SIZE	CAGE CODE	DWG NO
B		80A-3000

SCALE: NA SHEET 4 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED DWG	01/20/04	AMG FS

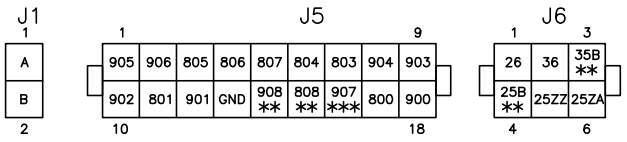
INSIDE VIEW OF CABINET DOOR





NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS



FROM MX150 CONTROL PANEL TO P RELAY

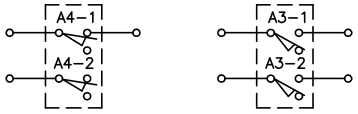
FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

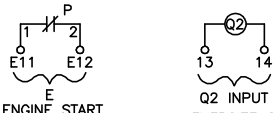
FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS

AUXILIARY CONTACTS

LOCATED ON ATS POWER PANEL





LEGEND

- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  - K-1306, 24VAC;
  - K-1307, 24VDC;
  - K-1308, 120VAC;
  - PS-3147 CLIP
- **** DISCONNECT SWITCH (DS)
  - DS:....L-4030
  - BRACKET:..... 57H-1031
  - LABELS:.....V-2003, V-1896, V-1897

TB..TERMINAL BLOCK, PS-1754

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	20 AMP @ 125, 250 VAC
UMD	UMD1,2	10 AMP @ 277 VAC OR 30 VDC

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

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TOLERANCES ON:

2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/20/03
DETAIL		
CHECKED		
ENGRG	MF	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-3000-d-5.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP(3/4 POLE)
CTQs
⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIDE DOOR, CABINET FRONT, PLUGS,CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGSE800AMP(3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-3000

SCALE: NA SHEET 5 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S–8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR–BASED CONTROL PANEL 800A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS – RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box

- CCE..... Control Relay, Close Source 2
- CCN..... Control Relay, Close Source 1
- XE1,XE2..... Control Transformer, Source 2
- XN1,XN2..... Control Transformer, Source 1

Power Panel

- N1,2,3,(N)..... Source 1 Line _____
- E1,2,3,(N)..... Source 2 Line _____
- T1,2,3,(N)..... Load Connections
- CE..... Source 2 Transfer Operator
- CN..... Source 1 Transfer Operator
- GND..... Ground
- NB..... Neutral Bar (if required)
- SE..... Source 2 Position Limit Switch
- SN..... Source 1 Position Limit Switch

Interconnect Plugs

- J1, J2, J4, J5, J6, J7 and J8
- J9 and J10..... For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location and handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset "Restore" values, the MX control panel energizes the CCE control relay to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When Source 1 line voltage reaches the preset "Restore" values, the MX control panel energizes the CCN control relay to operate the main transfer operator. The load is now re–transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch

The Test Switch simulates source 1 line failure when activated.
To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.
Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐ C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.
- CALIBRATE Source 1 & Source 2 Calibrate capabilities for voltage a frequency.
- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
- System Data: Total Life Transfers (N2P)
  Days Powered Up
  Total Transfers to S2
  Total S1 Failures
  Total S1 available in Hrs
  Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2
- L Indicating LED lights.
  - L1 Indicates Switch in Source 2 position.
  - L2 Indicates Switch in Source 1 position.
  - L3 Indicates Source 1 available.
  - L4 Indicates Source 2 available.
- P Time Delay Source 2 Start. Adjustable 0–10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In–Phase Monitor. Prevents transfer until two sources are in–phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.
- C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 side of the ATS to the Load lugs of Circuit Breaker) see sheet 2.

☐ D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Additional Auxiliary Contact closed when switch is in Source 2 position.
- A4 Additional Auxiliary Contact closed when switch is in Source 1 position.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 356 day cycle.
- VI Voltage Imbalance (Three Phase) User Configured On or Off. Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable. Resolution: 1% Increments Minimum Differential: 2% minimum between "Fail" and "Restore" settings. Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

- ☐STS Shunt Trip Selector.
- ☐GFP Ground Fault Potection
- ☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.
- ☐6A Test Switch, Maintained/Momentary. Door mount
- ☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- ☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)
- ☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)
- ☐ A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)
- ☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)
- ☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0–60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)
- ☐ B9 Battery charger.
- ☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.
- ☐ F Fan contact, operates when generator is running.
- ☐ HT Heater and Thermostat.
- ☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.
- ☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- ☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.
- ☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- ☐T3/W3 Elevator Pre–Signal Auxiliary Contacts: Open 0–60 seconds prior to transfer to either direction, re–closes after transfer. (Maximum: 2 circuits)
- ☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0–60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re–closes after transfer. Can be config. by end user for Pre–transfer, Post–transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)
- ☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

- 59C–1013 (2 POLE), 59C–1014 (3 POLE) } NEMA 1
- 59C–1016 (2 POLE), 59C–1017 (3 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING – TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT–HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH ✓
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SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a–3001–d–1.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LEGEND, OPERATION, AND ACCESSORIES

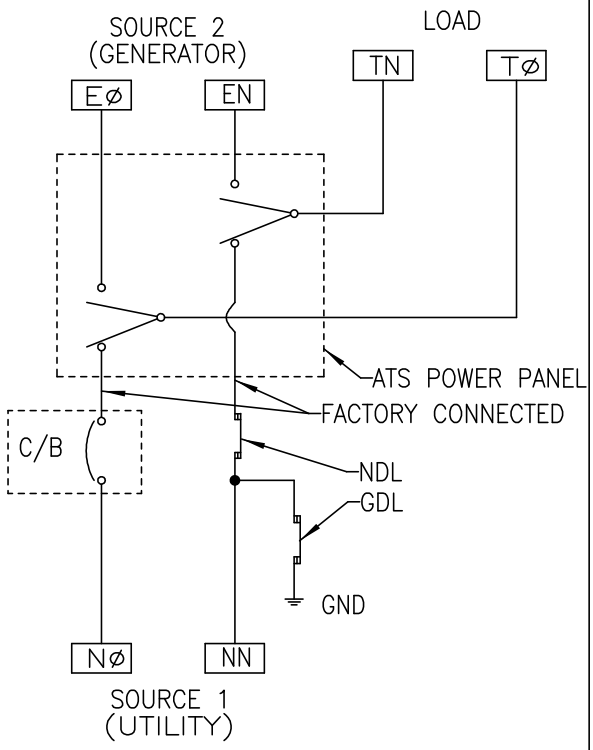
FIRST MADE FOR: ZTGSE800AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A–3001

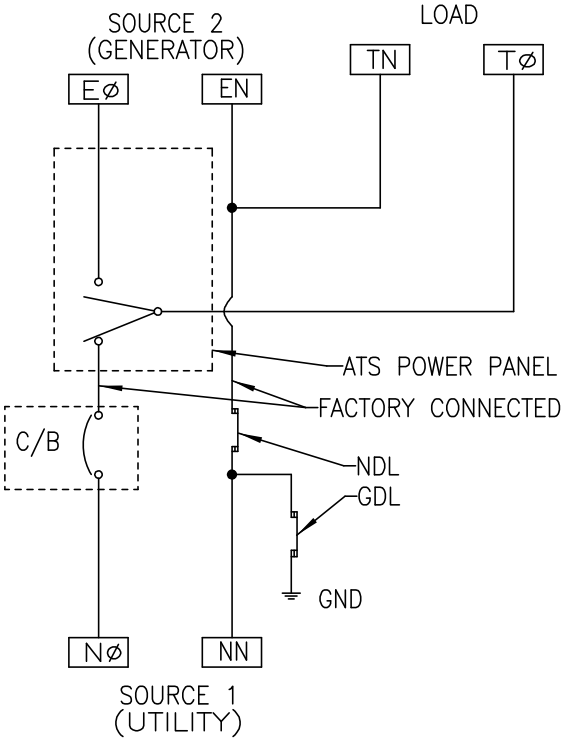
SCALE: NA SHEET 1 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S–8079 REVISED SHT 1, 2 & 5	2/04/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

800A 2P C/B PART NO.

PART NO.	DESCRIPTION	2P
SKLA26AT1200	MCCB SPECTRA RMS SK1200A FRAME 2P	1
SRPK1200A800	RATING PLUG 800A	1
TCAL125	LUG, (4) 250–500MCM	4

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/10/03
DETAIL		
CHECKED		
ENGRG	MF	11/10/03
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a–3001–d–2.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (2 POLE)
CTQs | ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

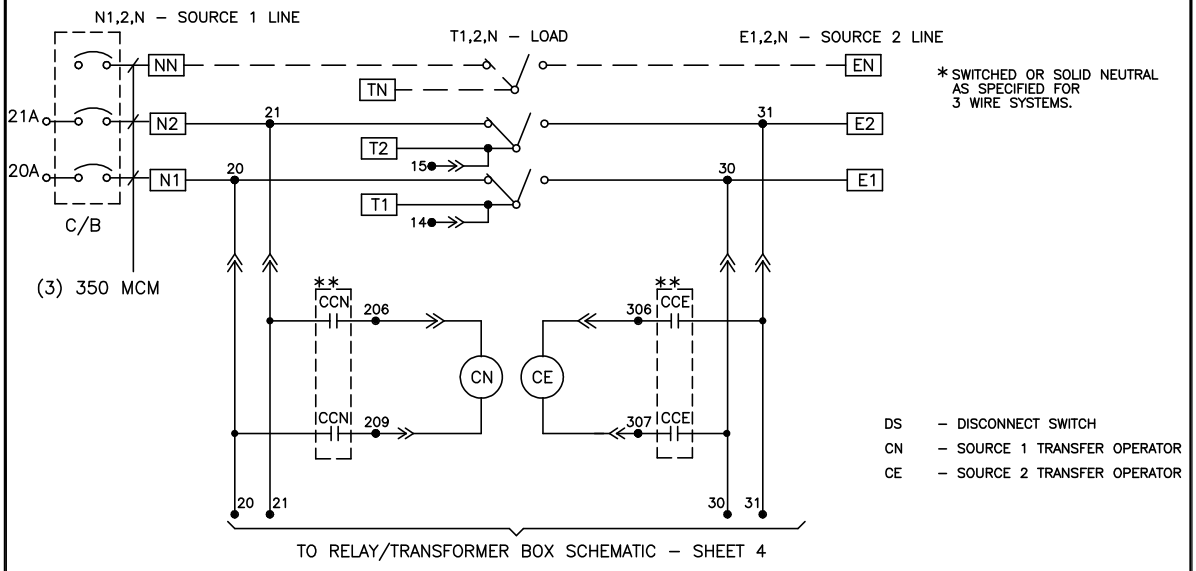
FIRST MADE FOR: ZTGSE800AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A–3001

SCALE: NA SHEET 2 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED SHT 1,2 & 5	2/04/04	GG FS

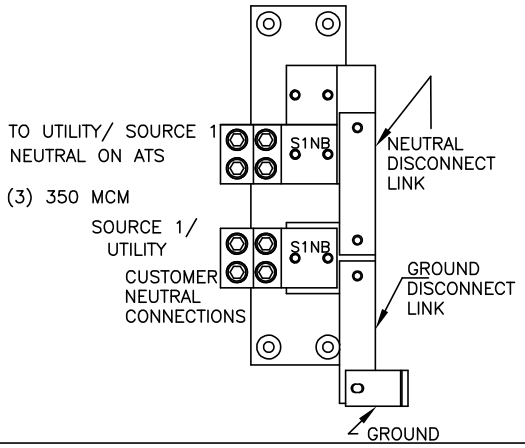
ATS POWER CIRCUIT SCHEMATIC



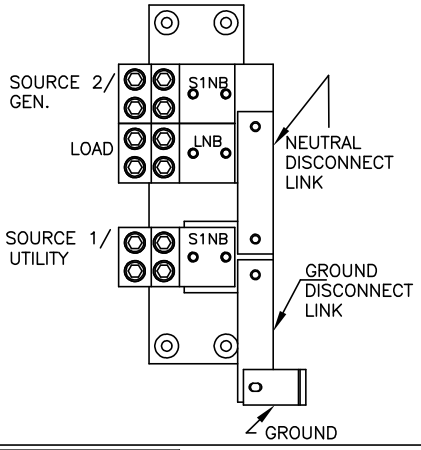
* SWITCHED OR SOLID NEUTRAL AS SPECIFIED FOR 3 WIRE SYSTEMS.

DS – DISCONNECT SWITCH
CN – SOURCE 1 TRANSFER OPERATOR
CE – SOURCE 2 TRANSFER OPERATOR

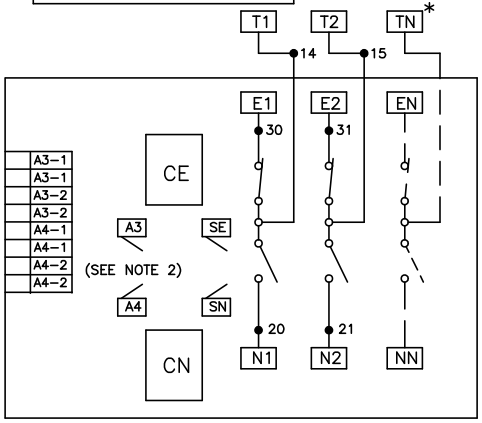
SWITCHED 800AMP



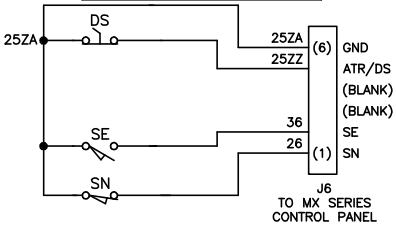
SOLID 800AMP



ATS POWER PANEL LAYOUT



LIMIT SWITCH SCHEMATIC



DS – DISCONNECT SWITCH
SE – SOURCE 2 POSITION LIMIT SWITCH
SN – SOURCE 1 POSITION LIMIT SWITCH

LEGEND	REFERENCE	NOTES
● WIRE CONNECTION ○ WIRE ON TERMINAL BLOCK ≫ WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/	LEGEND, OPERATION, AND ACCESSORIES: 70A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUG- SHEET 2 MX150 CONTROLLER- 70A-0500	1. ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE. 2. WHEN (1) A3 & (1) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO RIGHT OF SOLENOIDS. WHEN (2) A3 & (2) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO LEFT OF SOLENOIDS.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/20/03
DETAIL		
CHECKED		
ENGRG	MF	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-3001-d-3.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
ATS POWER CIRCUIT & LAYOUT (INVERTED DESIGN)

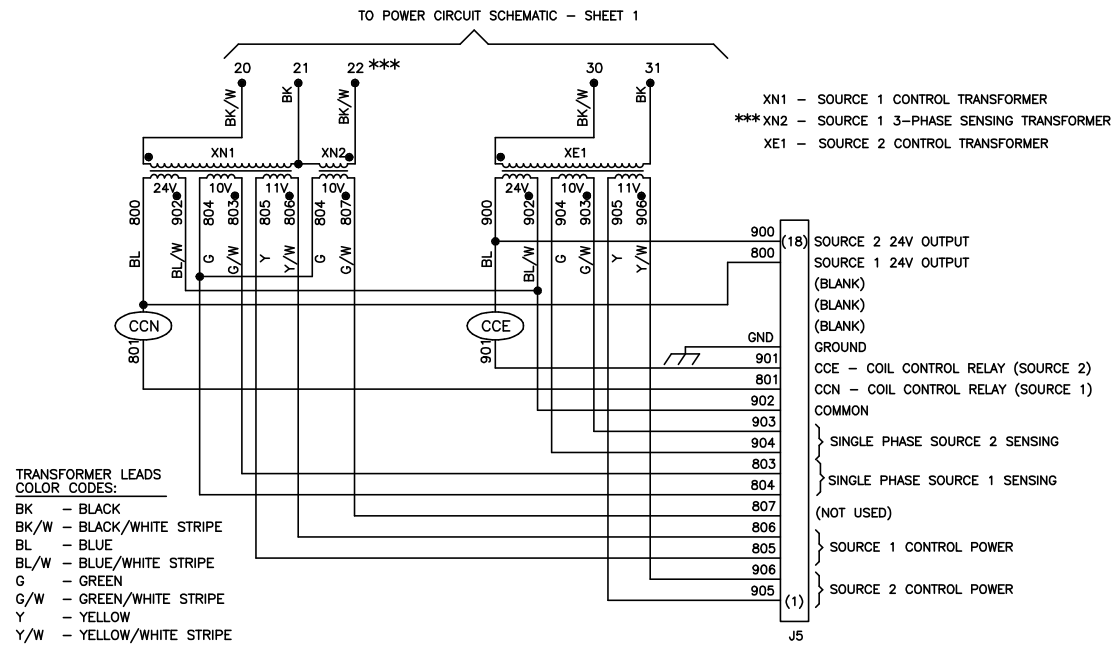
FIRST MADE FOR: ZTGSE800AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-3001

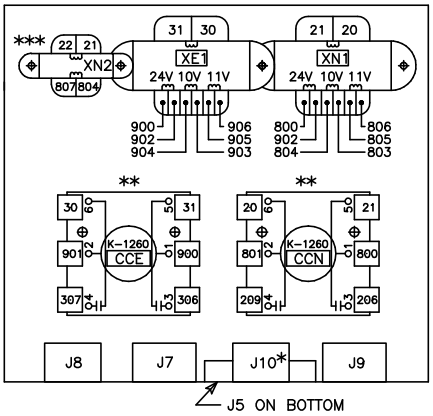
SCALE: NA SHEET 3 OF 5

REVISIONS				
REV.	DESCRIPTION		DATE	APPROVED
D	S-8079	REVISED SHT 1, 2 & 5	2/04/04	GG FS

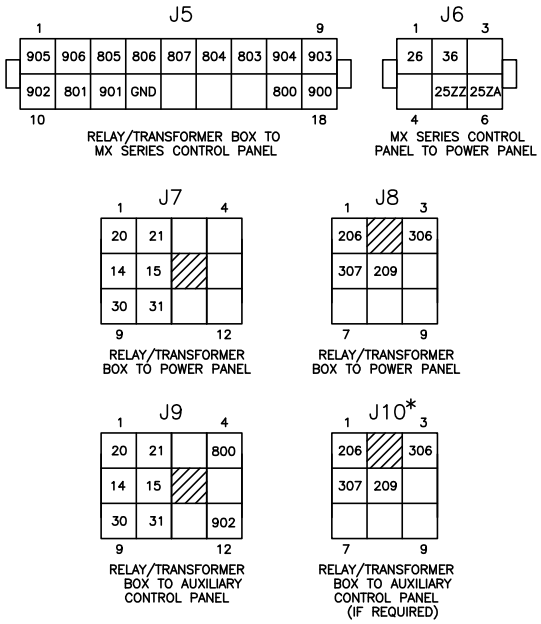
RELAY/TRANSFORMER BOX SCHEMATIC



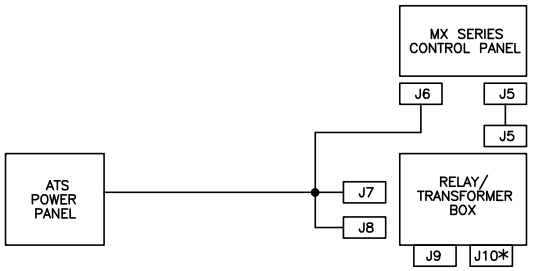
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



LEGEND

- WIRE CONNECTION
- * OPTIONAL
- ** DRAWN TO SHOW WIRE NUMBER TO RELAY TERMINAL NUMBER.
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRES #22, #32 ARE NOT CONNECTED ON ATS POWER PANEL.

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THIRD ANGLE PROJECTION

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ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/20/03
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-3001-d-4.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

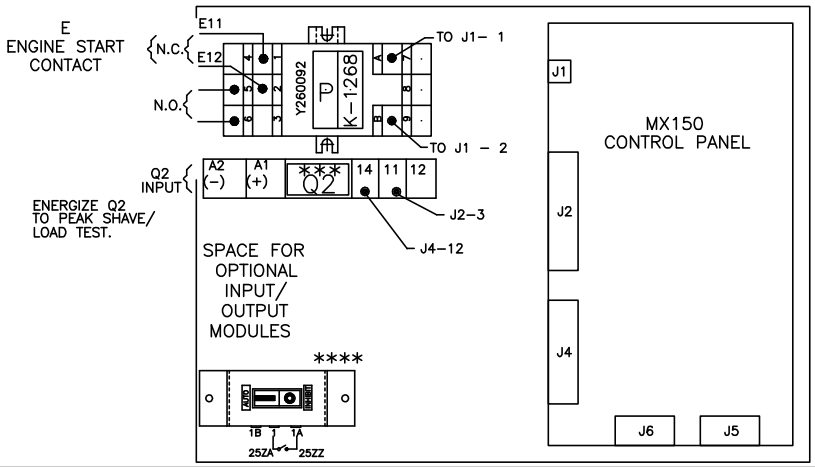
TITLE
RELAY/XFR BOX & INTERCONNECT PLUGS (INVERTED DESIGN)
FIRST MADE FOR: ZTGSE800AMP (2 POLE)

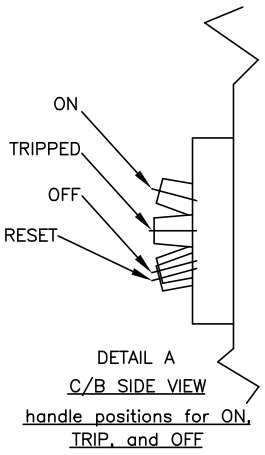
SIZE	CAGE CODE	DWG NO
B		80A-3001

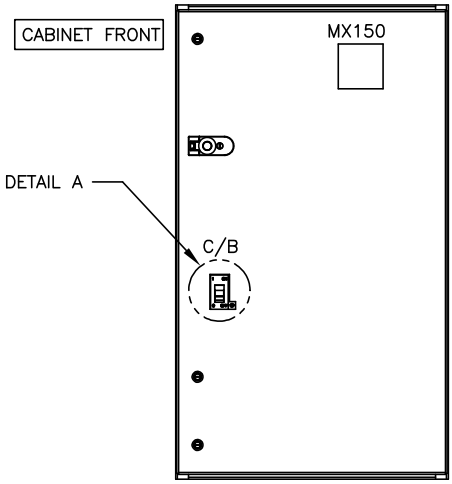
SCALE: – SHEET 4 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8079 REVISED DWG	01/20/04	AMG FS

INSIDE VIEW OF CABINET DOOR

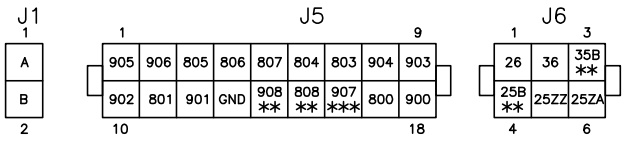






NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS

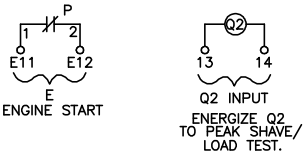


FROM MX150 CONTROL PANEL TO P RELAY

FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

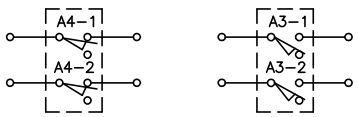
FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS



AUXILIARY CONTACTS

LOCATED ON ATS POWER PANEL



LEGEND

- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  - K-1306, 24VAC;
  - K-1307, 24VDC;
  - K-1308, 120VAC;
  - PS-3147 CLIP
- TB..TERMINAL BLOCK, PS-1754
- **** DISCONNECT SWITCH (DS)
  - DS:....L-4030
  - BRACKET:..... 57H-1031
  - LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	20 AMP @ 125, 250 VAC
UMD	UMD1,2	10 AMP @ 277 VAC OR 30 VDC

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THIRD ANGLE PROJECTION

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TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/20/03
DETAIL		
CHECKED		
ENGRG	MF	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 80a-3001-d-5.dwg
MODEL / ASSEMBLY FILE: ZTGSE800AMP (2 POLE)
CTQs
⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIDE DOOR, CABINET, FRONT PLUGS,CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGSE800AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		80A-3001

SCALE: NA SHEET 5 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED	2/04/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR-BASED CONTROL PANEL 40-600A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS - RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box
- CCE .....CE/O Control Relay, Source 2
- CCEO.....CE/O Control Relay, Open Source 2
- CCN.....CN/O Control Relay, Source 1
- CCNO.....CN/O Control Relay, Open Source 1
- XE1, (XE2*)... Control Transformer, Source 2
- XN1,XN2 .....Control Transformer, Source 1

Power Panel
- N1,2,3,(N) .... Source 1 Line
- E1,2,3,(N) .... Source 2 Line
- T1,2,3,(N) .... Load Connections
- CE ..... Source 2 Transfer Operator
- CEO ..... Transfer Operator, Open Source 2
- CN ..... Source 1 Transfer Operator
- CNO ..... Transfer Operator, Open Source 1
- CN/CEO ..... Transfer Operator, Open Source 2
- CE/CNO ..... Transfer Operator, Open Source 1
- GND ..... Ground
- NB ..... Neutral Bar (if required)
- RE ..... Bridge Rectifier, CE (600-4000 Amp)
- RN ..... Bridge Rectifier, CN (600-4000 Amp)
- SE ..... Source 2 Position
- SEO ..... Source 2 Open Position
- SN ..... Source 1 Position
- SNO..... Source 1 Open Position

Interconnect Plugs
- J1, J2, J4, J5, J6, J7, and J8
- J9 and J10.....For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values, or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location & handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset "Restore" values, the MX control panel energizes the CCNO control relay to operate the transfer operator. The load is now transferred to open position. After the set time delay, the MX control panel energizes CCE control relay to operate the transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When the Source 1 line voltage reaches the preset "Restore" values the MX control panel energizes the CCEO control relay to operate the transfer operator. The load is now transferred to open position. After the set time delay, the MX control panel energizes CCN control relay to operate the transfer operator. The load is now re-transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation Source 2

Test Switch

The Test Switch simulates source 1 line failure when activated.

To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.

Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.
- CALIBRATE Source 1 & Source 2 Calibrate capabilities for voltage a frequency.
- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
  - System Data: Total Life Transfers (N2P)
  - Days Powered Up
  - Total Transfers to S2
  - Total S1 Failures
  - Total S1 available in Hrs
  - Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2
- L Indicating LED lights.
  - L1 Indicates Switch in Source 2 position.
  - L2 Indicates Switch in Source 1 position.
  - L3 Indicates Source 1 available.
  - L4 Indicates Source 2 available.
- P Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In-Phase Monitor. Prevents transfer until two sources are in-phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.
- C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 side of the ATS to the Load lugs of Circuit Breaker) see sheet 2.

☐D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Additional Auxiliary Contact closed when switch is in Source 2 position.
- A4 Additional Auxiliary Contact closed when switch is in Source 1 position.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 356 day cycle.
- VI Voltage Imbalance (Three Phase) User Configured On or Off. Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable. Resolution: 1% Increments Minimum Differential: 2% minimum between "Fail" and "Restore" settings. Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

- ☐STS Shunt Trip Selector.
- ☐GFP Ground Fault Potection
- ☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.
- ☐6A Test Switch, Maintained/Momentary. Door mount
- ☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- ☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)
- ☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)
- ☐A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)
- ☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)
- ☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0-60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)
- ☐ BC Battery charger.
- ☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.
- ☐ F Fan contact, operates when generator is running.
- ☐ HT Heater and Thermostat.
- ☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.
- ☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- ☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.
- ☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- ☐T3/W3 Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer. (Maximum: 2 circuits)
- ☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0-60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re-closes after transfer. Can be config. by end user for Pre-transfer, Post-transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)
- ☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

40-400 AMP:
- 59C-1020 (3 POLE), 59C-1021 (4 POLE) } NEMA 1
- 59C-1023 (3 POLE), 59C-1024 (4 POLE) } NEMA 3R

600 AMP:
- 59C-1042 (3 POLE), 59C-1043 (4 POLE) } NEMA 1
- 59C-1045 (3 POLE), 59C-1046 (4 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING - TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT-HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
- 2 PL. DECIMALS ± .020
- 3 PL. DECIMALS ± .005
- ANGLES ± 1°
- FRACTIONS ± 1/64

FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/04/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1000-a-1.dwg
MODEL / ASSEMBLY FILE: ZTGDSE40-600AMP (3 /4 POLE)
CTQs
CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LEGEND, OPERATION, AND ACCESSORIES

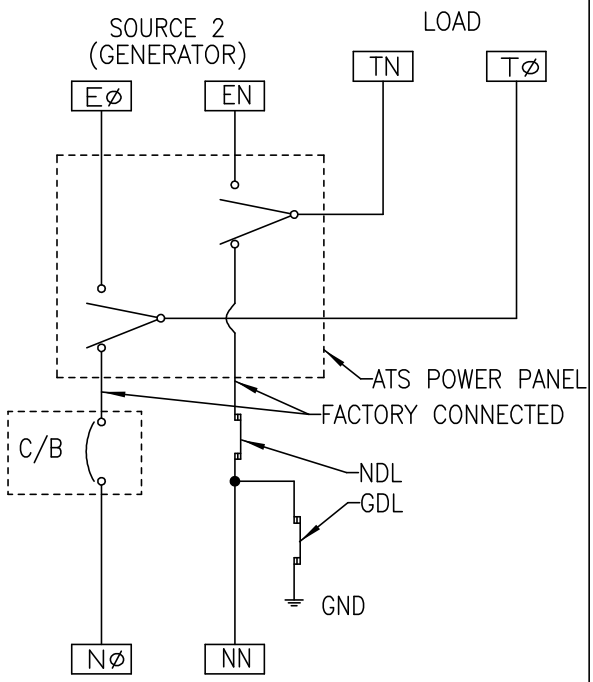
FIRST MADE FOR: ZTGDSE40-600AMP (3 /4 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-1000

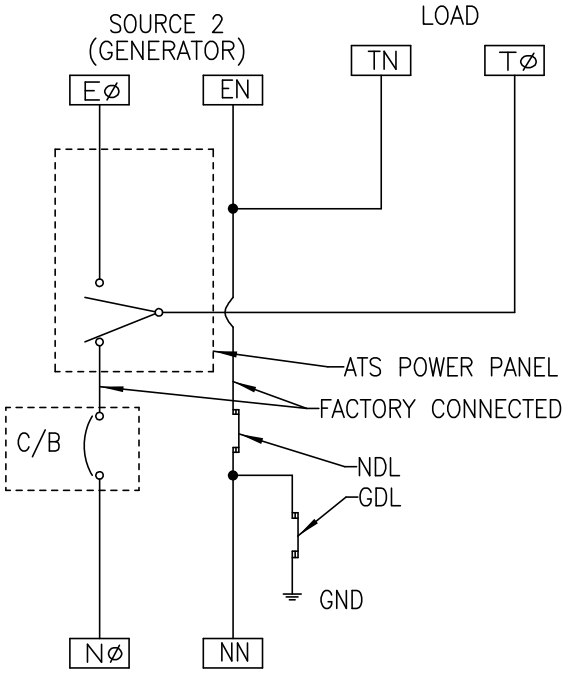
SCALE: NA SHEET 1 OF 6

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S–8083 ESTABLISHED	2/04/04	GG FS

SINGLE LINE DIAGRAM SWITCHED NEUTRAL



SINGLE LINE DIAGRAM SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

40–260A 3,4P C/B PART NO.

PART NO.	DESCRIPTION	40AMP QTY	80AMP QTY	100AMP QTY	150AMP QTY	200AMP QTY	225AMP QTY	260AMP QTY
SELA36AT0060	MCCB, SPECTRA RMS SE150 FRAME 3P	1	–	–	–	–	–	–
SRPE60A40	RATING PLUG 40A	1	–	–	–	–	–	–
SELA36AT0100	MCCB, SPECTRA RMS SE150 FRAME 3P	–	1	–	–	–	–	–
SRPE100A80	RATING PLUG 80A	–	1	–	–	–	–	–
SFLA36AT0250	MCCB, SPECTRA RMS SF250 FRAME 3P	–	–	1	1	1	–	–
SRPF250A100	RATING PLUG 100A	–	–	1	–	–	–	–
SRPF250A150	RATING PLUG 150A	–	–	–	1	–	–	–
SRPF250A200	RATING PLUG 200A	–	–	–	–	1	–	–
SGLA36AT0400	MCCB, SPECTRA RMS SG600 FRAME 3P	–	–	–	–	–	1	1
SRPG400A225	RATING PLUG 225A	–	–	–	–	–	1	–
SRPG400A250	RATING PLUG 250A	–	–	–	–	–	–	1
TCAL18	LUG, 12 AWG–3/0	6	6	–	–	–	–	–
TCAL29	LUG, 8 AWG–350MCM	–	–	6	6	6	–	–
TCLK265	C/B LUG KIT, 2 POLE SG FRAME	–	–	–	–	–	–	–
TCLK365	C/B LUG KIT, 3 POLE SG FRAME	–	–	–	–	–	2	2

400A 3,4P C/B PART NO.

PART NO.	DESCRIPTION	4/3P
SGLA36AT0600	MCCB SPECTRA RMS SG600A FRAME 3P	1
SRPG600A400	RATING PLUG 400A	1
TCLK365	C/B LUG KIT, 2 POLE SG FRAME	2

600A 3,4P C/B PART NO.

PART NO.	DESCRIPTION	4/3P
SKLA36AT0800	MCCB SPECTRA RMS SK800A FRAME 3P	1
SRPK800A600	RATING PLUG 600A	1
TCAL81	LUG, (3) 3/0–500MCM	6

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/04/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a–1000–a–2.dwg
MODEL / ASSEMBLY FILE: ZTGDSE40–600AMP (3 /4 POLE)
CTQs | ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

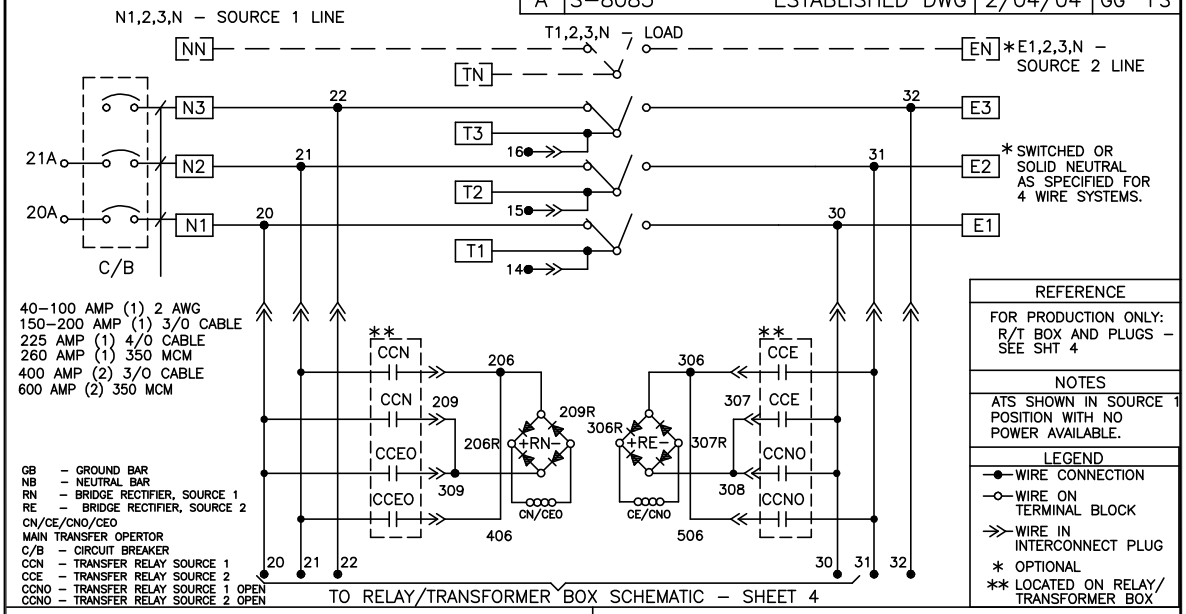
FIRST MADE FOR: ZTGDSE40–600AMP (3 /4 POLE)

SIZE	CAGE CODE	DWG NO
B		82A–1000

SCALE: NA SHEET 2 OF 6

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

ATS POWER CIRCUIT SCHEMATIC



REFERENCE

FOR PRODUCTION ONLY: R/T BOX AND PLUGS – SEE SHT 4

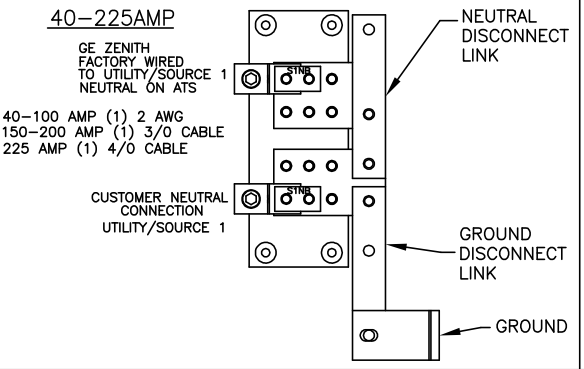
NOTES

ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE.

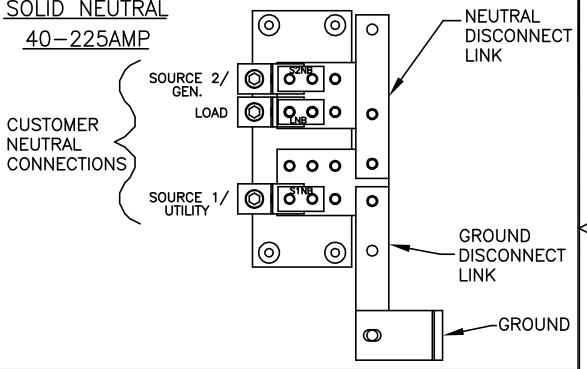
LEGEND

- WIRE CONNECTION
- WIRE ON TERMINAL BLOCK
- WIRE IN INTERCONNECT PLUG
- * OPTIONAL
- ** LOCATED ON RELAY/ TRANSFORMER BOX

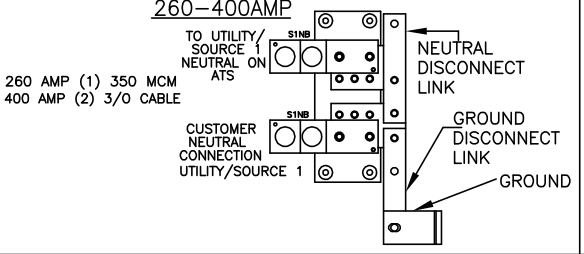
SWITCHED NEUTRAL 40–225AMP



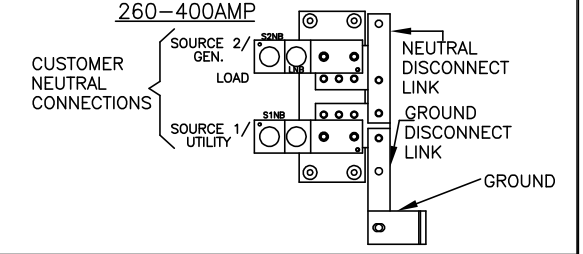
SOLID NEUTRAL 40–225AMP



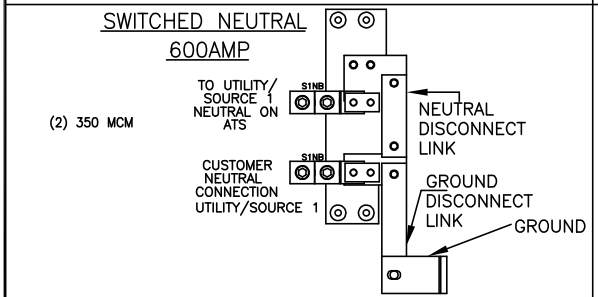
SWITCHED NEUTRAL 260–400AMP



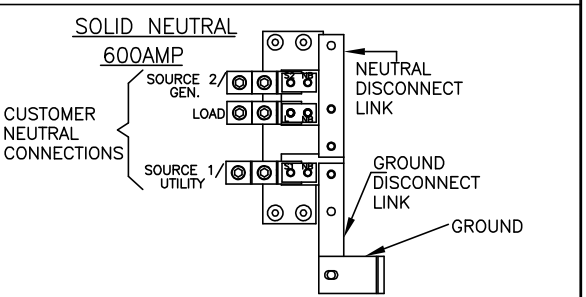
SOLID NEUTRAL 260–400AMP



SWITCHED NEUTRAL 600AMP



SOLID NEUTRAL 600AMP



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THIRD ANGLE PROJECTION

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APPLIED PRACTICES
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TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/04/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1000-a-3.dwg
MODEL / ASSEMBLY FILE: ZTGDSE40-600AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
ATS POWER CIRCUIT, NEUTRAL & GROUND DISCCONNECT LINKS

FIRST MADE FOR: ZTGDSE40-600AMP (3/4 POLE)

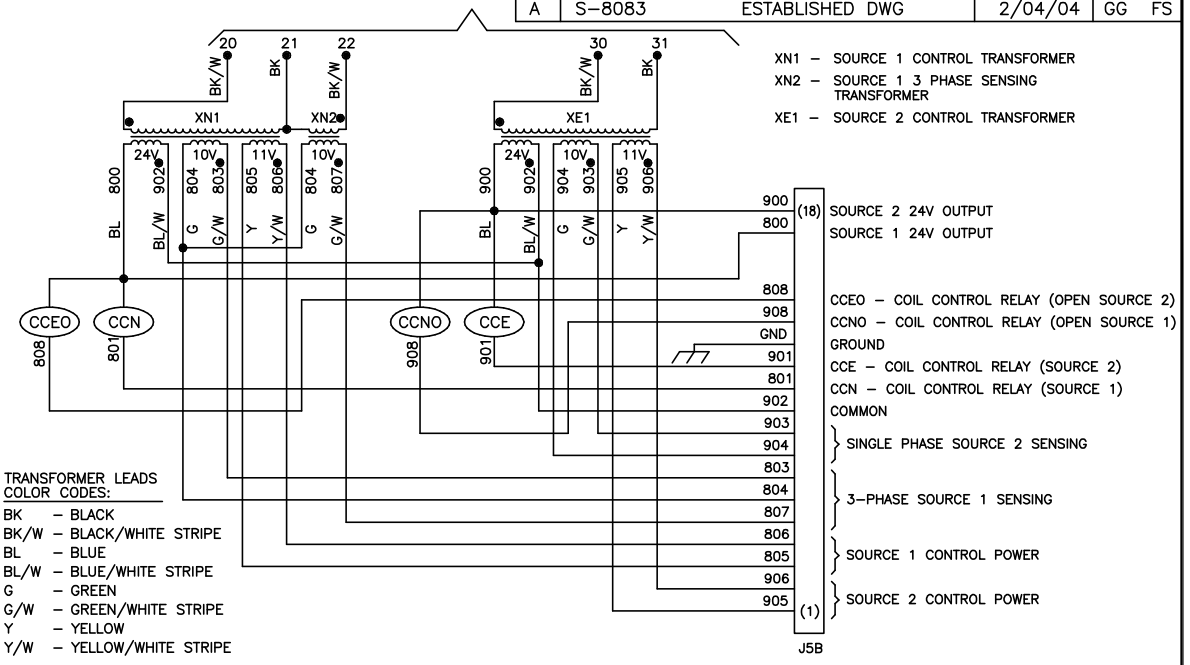
SIZE	CAGE CODE	DWG NO
B		82A-1000

SCALE: NA SHEET 3 OF 6

RELAY/TRANSFORMER BOX SCHEMATIC

TO POWER CIRCUIT SCHEMATIC – SHEET 3

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S–8083 ESTABLISHED DWG	2/04/04	GG FS

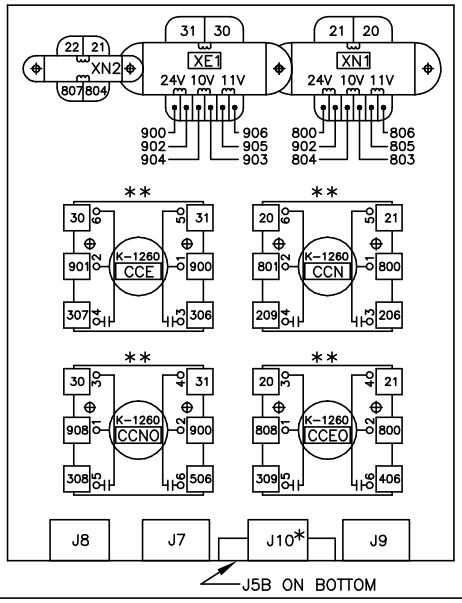


XN1 – SOURCE 1 CONTROL TRANSFORMER
XN2 – SOURCE 1 3 PHASE SENSING TRANSFORMER
XE1 – SOURCE 2 CONTROL TRANSFORMER

TRANSFORMER LEADS COLOR CODES:

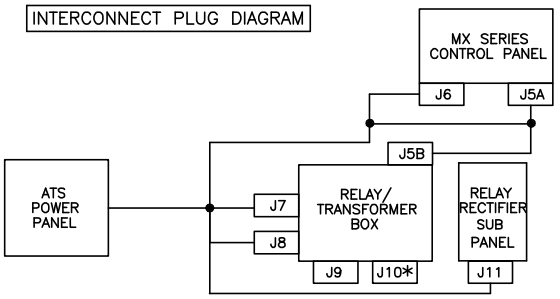
BK – BLACK
BK/W – BLACK/WHITE STRIPE
BL – BLUE
BL/W – BLUE/WHITE STRIPE
G – GREEN
G/W – GREEN/WHITE STRIPE
Y – YELLOW
Y/W – YELLOW/WHITE STRIPE

RELAY/TRANSFORMER BOX



J5B ON BOTTOM

INTERCONNECT PLUG DIAGRAM



INTERCONNECT PLUGS

J5B

1								9
905	906	805	806	807	804	803	904	903
902	801	901	GND	908	808	907	800	900
10								18

RELAY/TRANSFORMER BOX TO MX SERIES CONTROL PANEL PLUG J5A AND POWER PANEL

J6

1		3
26	36	35B
25B	25ZZ	25ZA
4		6

MX SERIES CONTROL PANEL TO POWER PANEL

J7

1			4
20	21	22	
14	15		16
30	31	32	
9			12

RELAY/TRANSFORMER BOX TO POWER PANEL

J8

1		3
206		306
307	209	406
308	309	506
7		9

RELAY/TRANSFORMER BOX TO POWER PANEL

J9

1			4
20	21	22	800
14	15		16
30	31	32	902
9			12

RELAY/TRANSFORMER BOX TO AUXILIARY CONTROL PANEL

J10*

1		3
206		306
307	209	406
308	309	506
7		9

RELAY/TRANSFORMER BOX TO AUXILIARY CONTROL PANEL (IF REQUIRED)

J11

1				5
20	21		800	800
234	COM	901A	801A	801A
30	31	901A	900	900
11				15

POWER PANEL TO RELAY–RECTIFIER SUB PANEL

LEGEND

– WIRE CONNECTION
* OPTIONAL
** DRAWN TO SHOW WIRE NUMBER TO RELAY TERMINAL NUMBER

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THIRD ANGLE PROJECTION

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/04/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a–1000–a–4.dwg
MODEL / ASSEMBLY FILE:
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

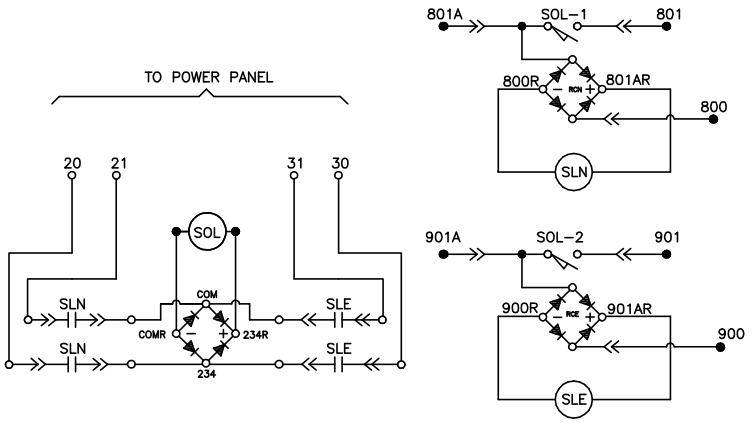
TITLE: RELAY/XFER BOX & INTERCONN. PLUGS (INVERTED DESIGN)

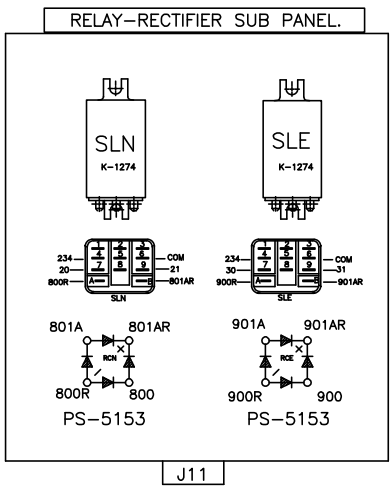
FIRST MADE FOR: ZTGDSE40–600AMP (3/4 POLE)

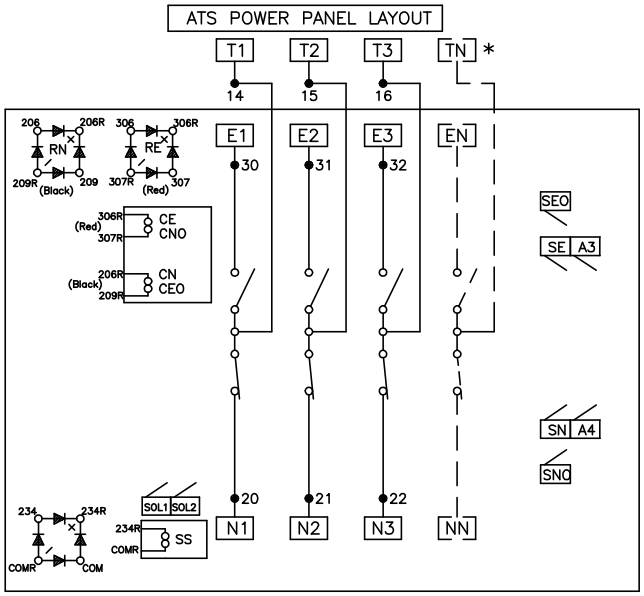
SIZE	CAGE CODE	DWG NO	
B		82A–1000	
SCALE:		SHEET 4 OF 6	

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

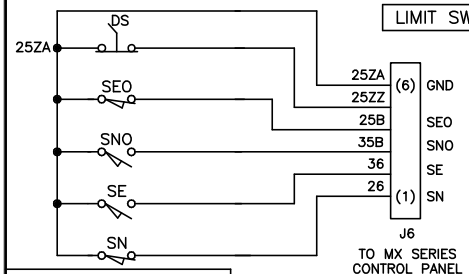
CONTROL CIRCUIT SCHEMATIC







LIMIT SWITCH SCHEMATIC



DS – DISCONNECT SWITCH
SE – SOURCE 2 POSITION LIMIT SWITCH
SN – SOURCE 1 POSITION LIMIT SWITCH
SEO – SOURCE 2 OPEN POSITION LIMIT SWITCH
SNO – SOURCE 1 OPEN POSITION LIMIT SWITCH

LIMIT SWITCH CHART

X = ACTUATED	ATS LOCATION		
	SOURCE 1	MID POSITION OPEN	SOURCE 2
SN	X		
SNO		X	X
SEO	X	X	
SE			X
SOL1		X (MOMENTARY)	
SOL2		X (MOMENTARY)	

LEGEND
- WIRE CONNECTION
- WIRE IN INTERCONNECT PLUG
- * OPTIONAL

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3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

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SIGNATURES		DATE
MODEL	GG	2/04/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1000-a-5.dwg
MODEL / ASSEMBLY FILE:
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

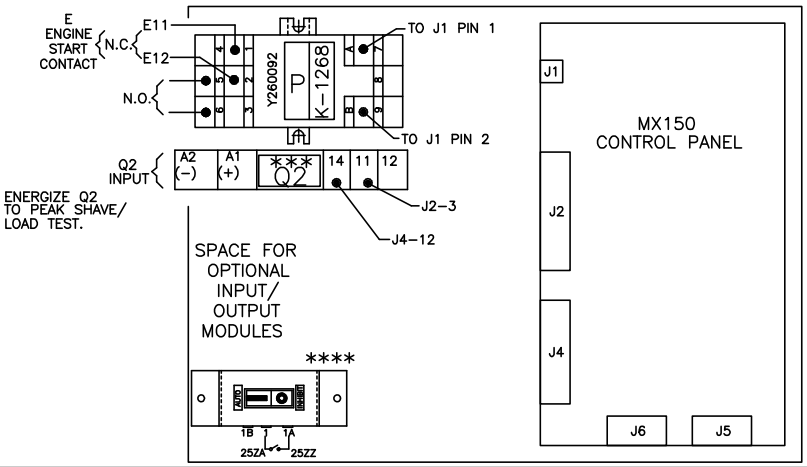
GE Zenith Controls

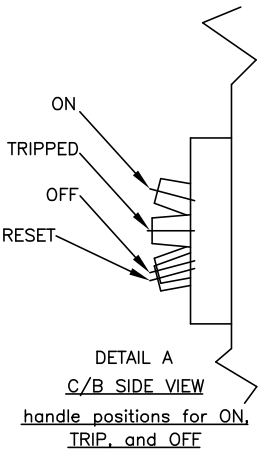
TITLE
MX BOARD, SUB PANEL
POWER PANEL & LIMIT SWITCH
FIRST MADE FOR: ZTGDSE40-600AMP (3/4 POLE)

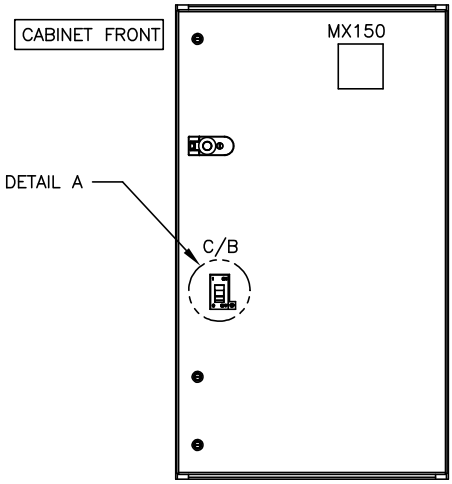
SIZE	CAGE CODE	DWG NO	
B		82A-1000	
SCALE:		SHEET	5 OF 6

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

INSIDE VIEW OF CABINET DOOR

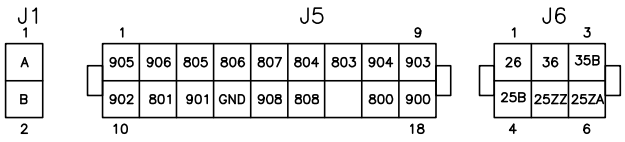






NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS

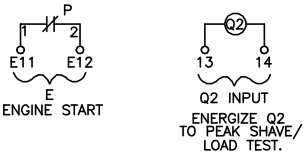


FROM MX150 CONTROL PANEL TO P RELAY

FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS



LEGEND

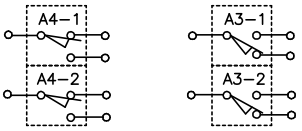
- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  K-1306, 24VAC;
  K-1307, 24VDC;
  K-1308, 120VAC;
  PS-3147 CLIP
- **** DISCONNECT SWITCH (DS)
  DS:....L-4030
  BRACKET:..... 57H-1031
  LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

AUXILIARY CONTACTS

LOCATED ON ATS POWER PANEL



RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	10 AMP @ 125, 250 VAC

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THIRD ANGLE PROJECTION

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TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

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SIGNATURES		DATE
MODEL	GG	2/04/04
DETAIL		
CHECKED		
ENGRG	VS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1000-a-6.dwg
MODEL / ASSEMBLY FILE: ZTGDSE40-600AMP(3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIDE DOOR, CABINET FRONT, PLUGS CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGDSE40-600AMP(3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-1000

SCALE: NA SHEET 6 OF 6

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR-BASED CONTROL PANEL 40-600A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS - RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box
- CCE ..... CE/O Control Relay, Source 2
- CCEO ..... CE/O Control Relay, Open Source 2
- CCN ..... CN/O Control Relay, Source 1
- CCNO ..... CN/O Control Relay, Open Source 1
- XE1,..... Control Transformer, Source 2
- XN1,XN2 ..... Control Transformer, Source 1

Power Panel
- N1,2,(N)..... Source 1 Line _____
- E1,2,(N)..... Source 2 Line _____
- T1,2,(N)..... Load Connections
- CE ..... Source 2 Transfer Operator
- CEO ..... Transfer Operator, Open Source 2
- CN ..... Source 1 Transfer Operator
- CNO ..... Transfer Operator, Open Source 1
- CN/CEO ..... Transfer Operator, Open Source 2
- CE/CNO ..... Transfer Operator, Open Source 1
- GND ..... Ground
- NB ..... Neutral Bar (if required)
- RE ..... Bridge Rectifier, CE (600-4000 Amp)
- RN ..... Bridge Rectifier, CN (600-4000 Amp)
- SE ..... Source 2 Position
- SEO ..... Source 2 Open Position
- SN ..... Source 1 Position
- SNO ..... Source 1 Open Position

Interconnect Plugs
- J1, J2, J4, J5, J6, J7, and J8
- J9 and J10 ..... For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values, or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location and handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage & frequency reach the preset "Restore" values, the MX control panel energizes the CCNO control relay to operate the transfer operator. The load is now transferred to open position. After the set time delay, the MX control panel energizes CCE control relay to operate the transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When the Source 1 line voltage reaches the preset "Restore" values the MX control panel energizes the CCEO control relay toperate the transfer operator. The load is now transferred to open position. After the set time delay, the MX control panel energizes CCN control relay to operate the transfer operator.

The load is now re-trasferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch

The Test Switch simulates source 1 line failure when activated.

To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.

Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.
- CALIBRATE Source 1 & Source 2 Calibrate capabilities for voltage a frequency.
- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
  - System Data: Total Life Transfers (N2P)
    Days Powered Up
    Total Transfers to S2
    Total S1 Failures
    Total S1 available in Hrs
    Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2
- L Indicating LED lights.
  - L1 Indicates Switch in Source 2 position.
  - L2 Indicates Switch in Source 1 position.
  - L3 Indicates Source 1 available.
  - L4 Indicates Source 2 available.
- P Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In-Phase Monitor. Prevents transfer until two sources are in-phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.
- C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 side of the ATS to the Load lugs of Circuit Breaker) see sheet 2.

☐D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Additional Auxiliary Contact closed when switch is in Source 2 position.
- A4 Additional Auxiliary Contact closed when switch is in Source 1 position.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 356 day cycle.
- VI Voltage Imbalance (Three Phase) User Configured On or Off. Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable. Resolution: 1% Increments Minimum Differential: 2% minimum between "Fail" and "Restore" settings. Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

- ☐STS Shunt Trip Selector.
- ☐GFP Ground Fault Potection
- ☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.
- ☐6A Test Switch, Maintained/Momentary. Door mount
- ☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- ☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)
- ☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)
- ☐A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)
- ☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)
- ☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0-60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)
- ☐ BC Battery charger.
- ☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.
- ☐ F Fan contact, operates when generator is running.
- ☐ HT Heater and Thermostat.
- ☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.
- ☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- ☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.
- ☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- ☐T3/W3 Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer. (Maximum: 2 circuits)
- ☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0-60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re-closes after transfer. Can be config. by end user for Pre-transfer, Post-transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)
- ☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

40-400 AMP:
- 59C-1019 (2 POLE), 59C-1020 (3 POLE) } NEMA 1
- 59C-1022 (2 POLE), 59C-1023 (3 POLE) } NEMA 3R

600 AMP:
- 59C-1041 (2 POLE), 59C-1042 (3 POLE) } NEMA 1
- 59C-1044 (2 POLE), 59C-1045 (3 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING - TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT-HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	11/08/03
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1001-a-1.dwg
MODEL / ASSEMBLY FILE: ZTGDSE40-600AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE: LEGEND, OPERATION, AND ACCESSORIES

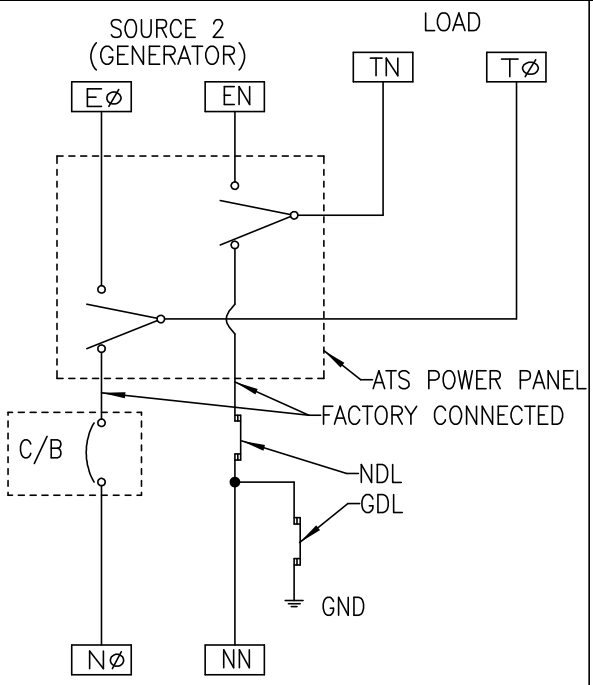
FIRST MADE FOR: ZTGDSE40-600AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-1001

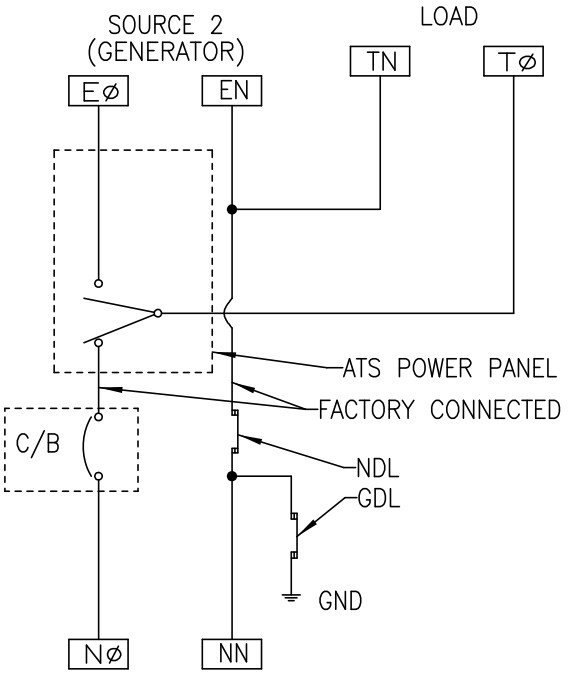
SCALE: NA SHEET 1 OF 6

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

40-260A 2P C/B PART NO.

PART NO.	DESCRIPTION	40AMP QTY	80AMP QTY	100AMP QTY	150AMP QTY	200AMP QTY	225AMP QTY	260AMP QTY
SELA24AT0060	MCCB, SPECTRA RMS SE150 FRAME 2P	1	–	–	–	–	–	–
SRPE60A40	RATING PLUG 40A	1	–	–	–	–	–	–
SELA24AT0100	MCCB, SPECTRA RMS SE150 FRAME 2P	–	1	–	–	–	–	–
SRPE100A80	RATING PLUG 80A	–	1	–	–	–	–	–
SFLA24AT0250	MCCB, SPECTRA RMS SF250 FRAME 2P	–	–	1	1	1	–	–
SRPF250A100	RATING PLUG 100A	–	–	1	–	–	–	–
SRPF250A150	RATING PLUG 150A	–	–	–	1	–	–	–
SRPF250A200	RATING PLUG 200A	–	–	–	–	1	–	–
SGLA26AT0400	MCCB, SPECTRA RMS SG600 FRAME 2P	–	–	–	–	–	1	1
SRPG400A225	RATING PLUG 225A	–	–	–	–	–	1	–
SRPG400A250	RATING PLUG 250A	–	–	–	–	–	–	1
TCAL18	LUG, 12 AWG-3/0	6	6	–	–	–	–	–
TCAL29	LUG, 8 AWG-350MCM	–	–	6	6	6	–	–
TCLK265	C/B LUG KIT, 2 POLE SG FRAME	–	–	–	–	–	2	2
TCLK365	C/B LUG KIT, 3 POLE SG FRAME	–	–	–	–	–	2	2

400A 2P C/B PART NO.

PART NO.	DESCRIPTION	2P
SGLA26AT0600	MCCB SPECTRA RMS SG600A FRAME 2P	1
SRPG600A400	RATING PLUG 400A	1
TCLK265	C/B LUG KIT, 2 POLE SG FRAME	2

600A 2P C/B PART NO.

PART NO.	DESCRIPTION	2P
SKLA26AT0800	MCCB SPECTRA RMS SK800A FRAME 2P	1
SRPK800A600	RATING PLUG 600A	1
TCAL81	LUG, (3) 3/0-500MCM	4

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64

FINISH

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SIGNATURES		DATE
MODEL	GG	2/04/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1001-a-2.dwg
MODEL / ASSEMBLY FILE: ZTGDSE40-600AMP (2 POLE)
CTQs | CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

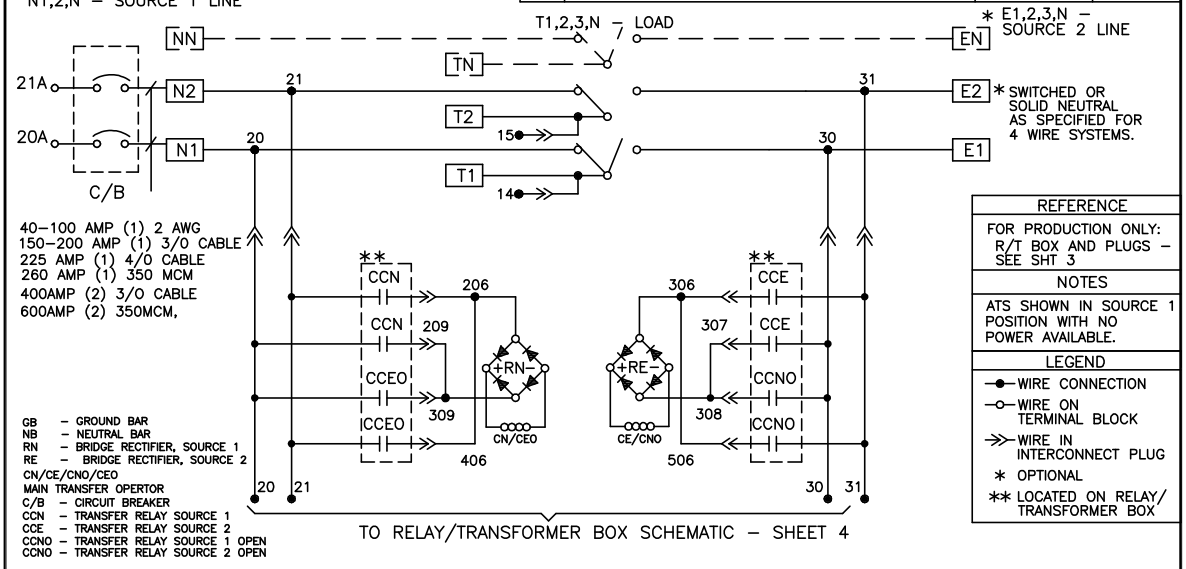
FIRST MADE FOR: ZTGDSE40-600AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-1001

SCALE: NA SHEET 2 OF 6

ATS POWER CIRCUIT SCHEMATIC

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

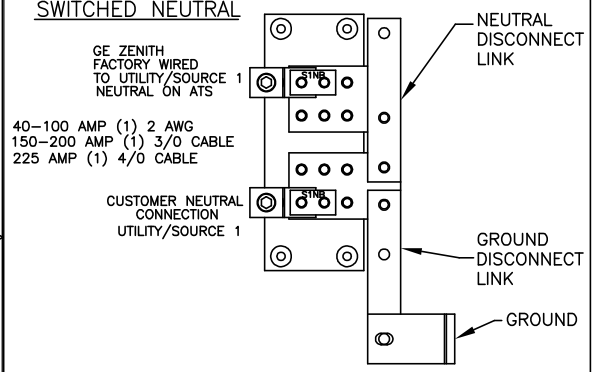


REFERENCE
FOR PRODUCTION ONLY: R/T BOX AND PLUGS – SEE SHT 3

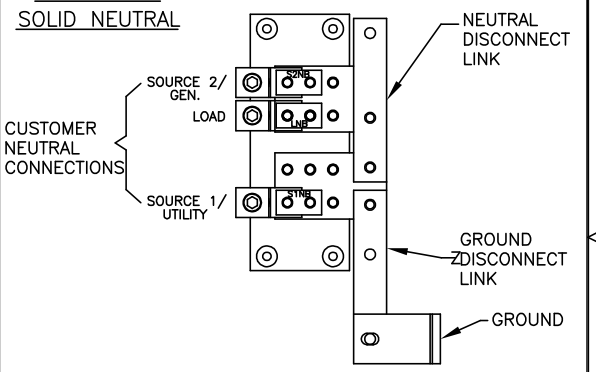
NOTES
ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE.

LEGEND
- WIRE CONNECTION
- WIRE ON TERMINAL BLOCK
- WIRE IN INTERCONNECT PLUG
- * OPTIONAL
- ** LOCATED ON RELAY/ TRANSFORMER BOX

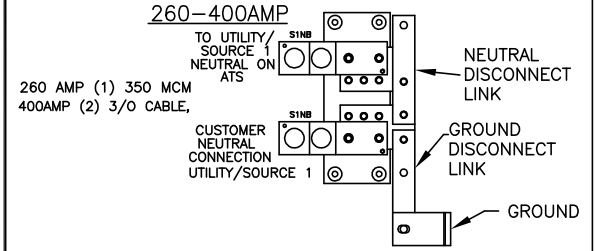
40–225AMP SWITCHED NEUTRAL



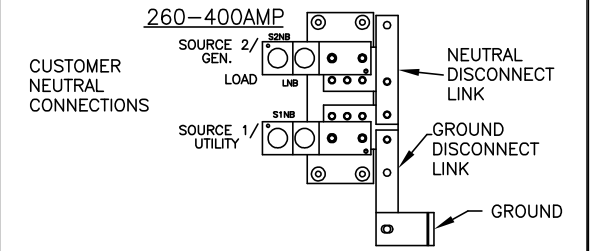
40–225AMP SOLID NEUTRAL



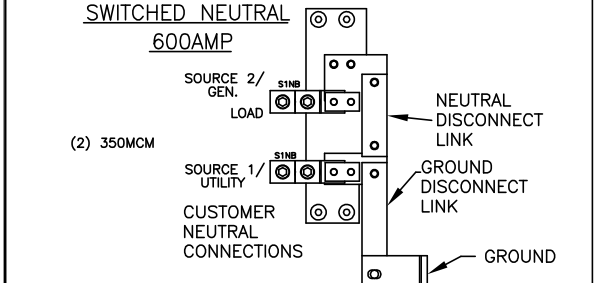
SWITCHED NEUTRAL 260–400AMP



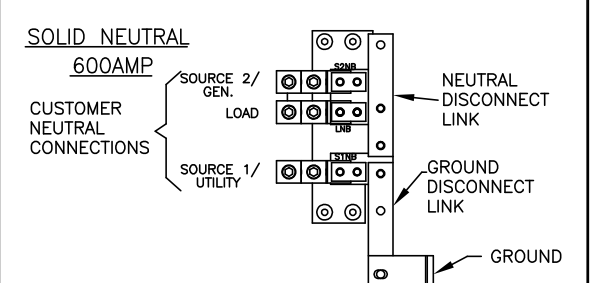
SOLID NEUTRAL 260–400AMP



SWITCHED NEUTRAL 600AMP



SOLID NEUTRAL 600AMP



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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
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SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1001-a-3.dwg
MODEL / ASSEMBLY FILE: ZTGSE40-600AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
ATS POWER CIRCUIT, NEUTRAL & GROUND DISCCONNECT LINKS
FIRST MADE FOR: ZTGSE40-600AMP (2 POLE)

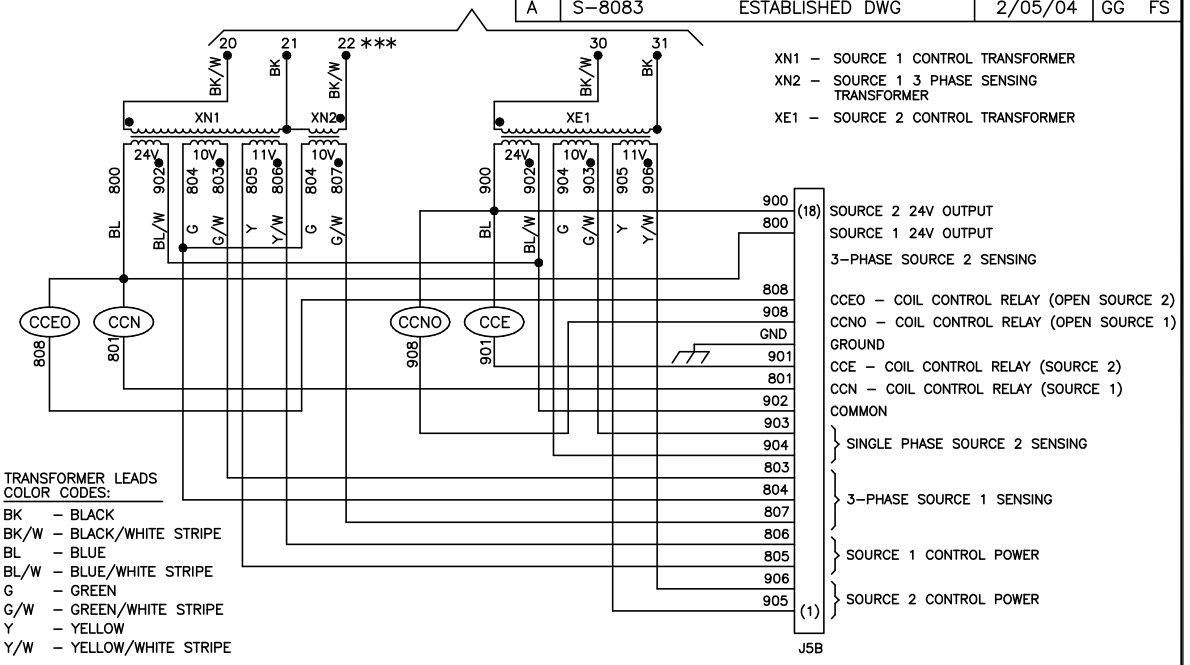
SIZE	CAGE CODE	DWG NO
B		82A-1001

SCALE: NA SHEET 3 OF 5

RELAY/TRANSFORMER BOX SCHEMATIC

TO POWER CIRCUIT SCHEMATIC – SHEET 3

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S–8083 ESTABLISHED DWG	2/05/04	GG FS

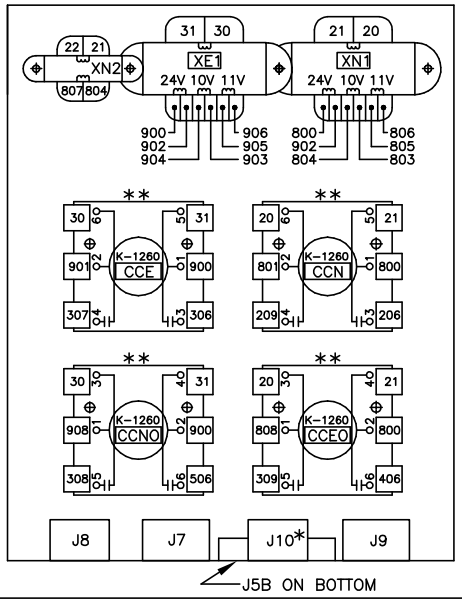


XN1 – SOURCE 1 CONTROL TRANSFORMER
XN2 – SOURCE 1 3 PHASE SENSING TRANSFORMER
XE1 – SOURCE 2 CONTROL TRANSFORMER

TRANSFORMER LEADS COLOR CODES:

BK – BLACK
BK/W – BLACK/WHITE STRIPE
BL – BLUE
BL/W – BLUE/WHITE STRIPE
G – GREEN
G/W – GREEN/WHITE STRIPE
Y – YELLOW
Y/W – YELLOW/WHITE STRIPE

RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS

J5B

1									9
905	906	805	806	807	804	803	904	903	
902	801	901	GND	908	808		800	900	
10									18

RELAY/TRANSFORMER BOX TO MX SERIES CONTROL PANEL PLUG J5A AND POWER PANEL

J6

1		3
26	36	35B
25B	25ZZ	25ZA
4		6

MX SERIES CONTROL PANEL TO POWER PANEL

J7

1			4
20	21	22	
14	15		16
30	31	32	
9			12

RELAY/TRANSFORMER BOX TO POWER PANEL

J8

1		3
206		306
307	209	406
308	309	506
7		9

RELAY/TRANSFORMER BOX TO POWER PANEL

J9

1			4
20	21	22	800
14	15		16
30	31	32	902
9			12

RELAY/TRANSFORMER BOX TO AUXILIARY CONTROL PANEL

J10*

1		3
206		306
307	209	406
308	309	506
7		9

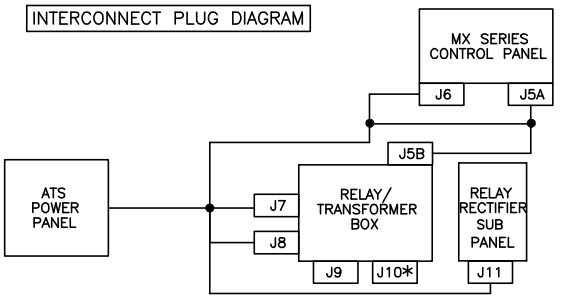
RELAY/TRANSFORMER BOX TO AUXILIARY CONTROL PANEL (IF REQUIRED)

J11

1				5
20	21		800	800
234	COM	901A	801A	801A
30	31	901A	900	900
11				15

POWER PANEL TO RELAY–RECTIFIER SUB PANEL

INTERCONNECT PLUG DIAGRAM



LEGEND

- WIRE CONNECTION
- * OPTIONAL
- ** DRAWN TO SHOW WIRE NUMBER TO RELAY TERMINAL NUMBER.
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRE #22 IS NOT CONNECTED TO ATS POWER PANEL.

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THIRD ANGLE PROJECTION

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TOLERANCES ON:

2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64

FINISH

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SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a–1001–a–4.dwg

MODEL / ASSEMBLY FILE:

CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
RELAY/XFR BOX & INTERCONN. PLUGS

FIRST MADE FOR: ZTGDSE40–600AMP (2 POLE)

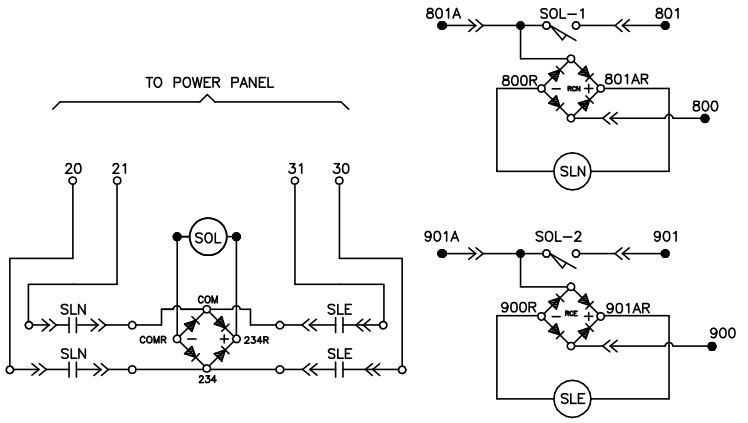
SIZE	CAGE CODE	DWG NO
B		82A–1001

SCALE:

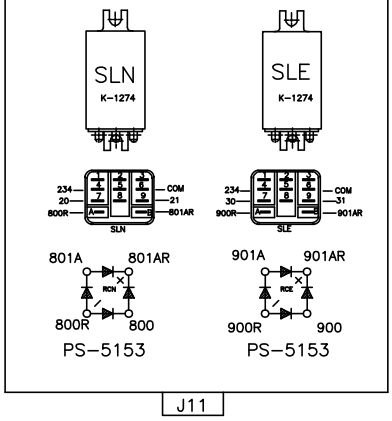
SHEET 4 OF 6

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/05/04	GG FS

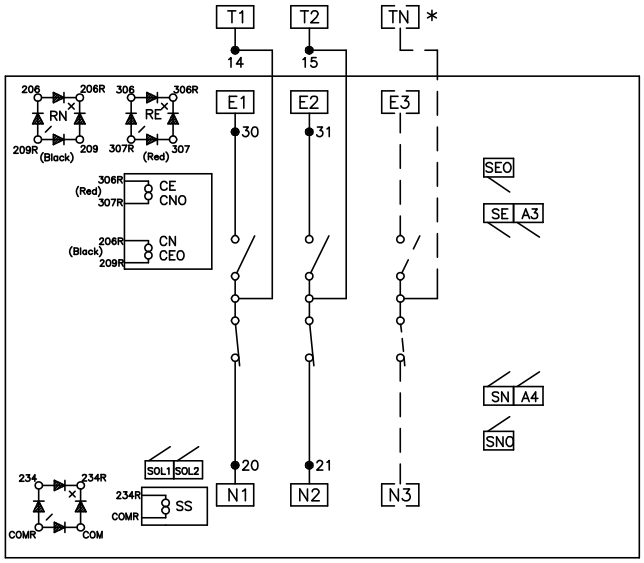
CONTROL CIRCUIT SCHEMATIC



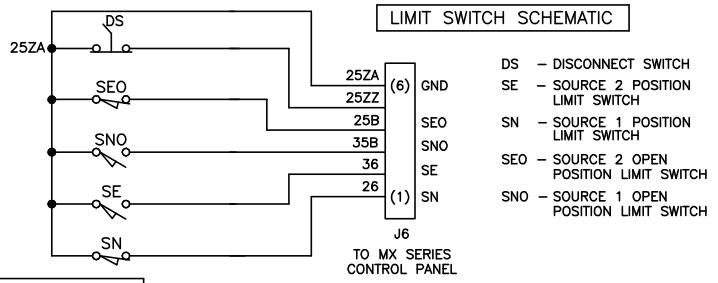
RELAY-RECTIFIER SUB PANEL.



ATS POWER PANEL LAYOUT



LIMIT SWITCH SCHEMATIC



DS – DISCONNECT SWITCH
SE – SOURCE 2 POSITION LIMIT SWITCH
SN – SOURCE 1 POSITION LIMIT SWITCH
SEO – SOURCE 2 OPEN POSITION LIMIT SWITCH
SNO – SOURCE 1 OPEN POSITION LIMIT SWITCH

LIMIT SWITCH CHART

X = ACTUATED	ATS LOCATION		
	SOURCE 1	MID POSITION OPEN	SOURCE 2
SN	X		
SNO		X	X
SEO	X	X	
SE			X
SOL1		X (MOMENTARY)	
SOL2		X (MOMENTARY)	

LEGEND
- WIRE CONNECTION
- WIRE IN INTERCONNECT PLUG
- * OPTIONAL

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1001-a-5.dwg
MODEL / ASSEMBLY FILE:
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

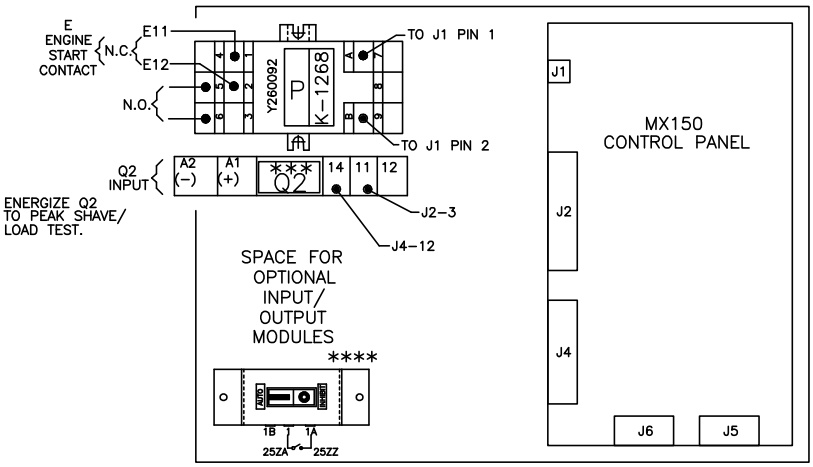
TITLE
MX BOARD & SUB PANEL
POWER PANEL & LIMIT SWITCH

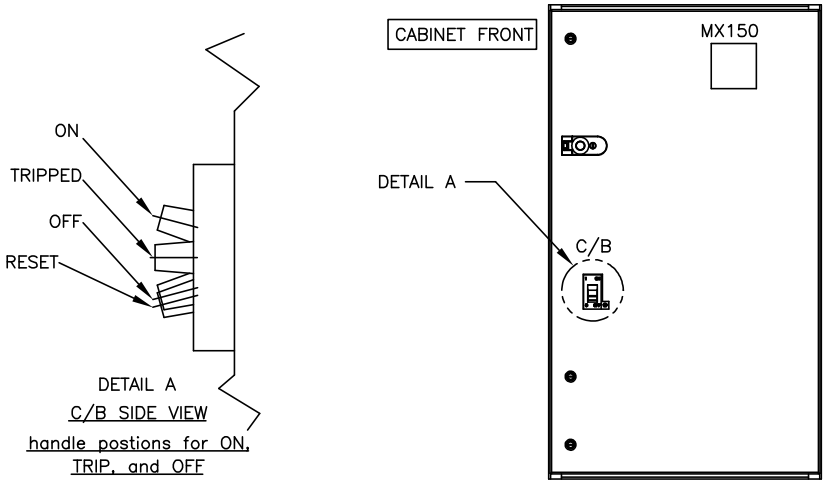
FIRST MADE FOR: ZTGDSE40-600AMP (2 POLE)

SIZE	CAGE CODE	DWG NO	
B		82A-1001	
SCALE:		SHEET	5 OF 6

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/05/04	GG FS

INSIDE VIEW OF CABINET DOOR





NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS

J1

	1	2
A		
B		

FROM MX150 CONTROL PANEL TO P RELAY

J5

1									9
905	906	805	806	807	804	803	904	903	
902	801	901	GND				800	900	

10 18

FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

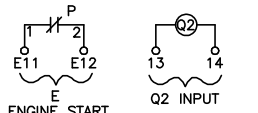
J6

1		3
26	36	35B
25B	25ZZ	25ZA

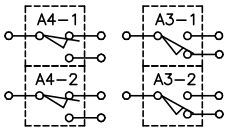
4 6

FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS



AUXILIARY CONTACTS
LOCATED ON ATS POWER PANEL



LEGEND

- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  K-1306, 24VAC;
  K-1307, 24VDC;
  K-1308, 120VAC;
  PS-3147 CLIP
- **** DISCONNECT SWITCH (DS)
  DS:....L-4030
  BRACKET:..... 57H-1031
  LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	10 AMP @ 125, 250 VAC

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THIRD ANGLE PROJECTION

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2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

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SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-1001-a-6.dwg
MODEL / ASSEMBLY FILE: ZTGSE 40-600AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIDE DOOR, CABINET FRONT, PLUGS,CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGSE40-600AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-1001

SCALE: NA SHEET 6 OF 6

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S–8083 ESTABLISHED DWG	2/04/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR–BASED CONTROL PANEL 800A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS – RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box
- CCE .....CE/O Control Relay, Source 2
- CCEO.....CE/O Control Relay, Open Source 2
- CCN .....CN/O Control Relay, Source 1
- CCNO.....CN/O Control Relay, Open Source 1
- XE1, (XE2*)... Control Transformer, Source 2
- XN1,XN2 .....Control Transformer, Source 1

Power Panel
- N1,2,3,(N) .... Source 1 Line _____
- E1,2,3,(N) .... Source 2 Line _____
- T1,2,3,(N) .... Load Connections
- CE ..... Source 2 Transfer Operator
- CEO ..... Transfer Operator, Open Source 2
- CN ..... Source 1 Transfer Operator
- CNO ..... Transfer Operator, Open Source 1
- CN/CEO ..... Transfer Operator, Open Source 2
- CE/CNO ..... Transfer Operator, Open Source 1
- GND ..... Ground
- NB ..... Neutral Bar (if required)
- RE ..... Bridge Rectifier, CE
- RN ..... Bridge Rectifier, CN
- SE ..... Source 2 Position
- SEO ..... Source 2 Open Position
- SN ..... Source 1 Position
- SNO..... Source 1 Open Position

Interconnect Plugs
- J1, J2, J4, J5, J6, J7, and J8
- J9 and J10.....For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values, or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location & handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset "Restore" values, the MX control panel energizes the CCNO control relay to operate the transfer operator. The load is now transferred to open position. After the set time delay, the MX control panel energizes CCE control relay to operate the transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When the Source 1 line voltage reaches the preset "Restore" value the MX control panel energizes the CCEO control relay to operate transfer operator. The load is now transferred to open position. After the set time delay, the MX control panel energizes CCN control relay to operate the transfer operator.

The load is now re–transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch

The Test Switch simulates source 1 line failure when activated.

To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.

Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐ C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.
- CALIBRATE Source 1 & Source 2 Calibrate capabilities for voltage a frequency.
- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
  - System Data: Total Life Transfers (N2P)
  - Days Powered Up
  - Total Transfers to S2
  - Total S1 Failures
  - Total S1 available in Hrs
  - Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2
- L Indicating LED lights.
  - L1 Indicates Switch in Source 2 position.
  - L2 Indicates Switch in Source 1 position.
  - L3 Indicates Source 1 available.
  - L4 Indicates Source 2 available.
- P Time Delay Source 2 Start. Adjustable 0–10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In–Phase Monitor. Prevents transfer until two sources are in–phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.
- C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 Normal side of the ATS to the Load lugs of Circuit Breaker) see sheet 2.

☐ D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Additional Auxiliary Contact closed when switch is in Source 2 position.
- A4 Additional Auxiliary Contact closed when switch is in Source 1 position.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 356 day cycle.
- VI Voltage Imbalance (Three Phase) User Configured On or Off. Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable. Resolution: 1% Increments Minimum Differential: 2% minimum between "Fail" and "Restore" settings. Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

- ☐STS Shunt Trip Selector.
- ☐GFP Ground Fault Potection
- ☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.
- ☐6A Test Switch, Maintained/Momentary. Door mount
- ☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- ☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)
- ☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)
- ☐A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)
- ☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)
- ☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0–60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)
- ☐ BC Battery charger.
- ☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.
- ☐ F Fan contact, operates when generator is running.
- ☐ HT Heater and Thermostat.
- ☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.
- ☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- ☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.
- ☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- ☐T3/W3 Elevator Pre–Signal Auxiliary Contacts: Open 0–60 seconds prior to transfer to either direction, re–closes after transfer. (Maximum: 2 circuits)
- ☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0–60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re–closes after transfer. Can be config. by end user for Pre–transfer, Post–transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)
- ☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:

- 59C–1014 (3 POLE), 59C–1015 (4 POLE) } NEMA 1
- 59C–1017 (3 POLE), 59C–1018 (4 POLE) } NEMA 3R

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING – TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT–HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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THIRD ANGLE PROJECTION

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TOLERANCES ON:
- 2 PL. DECIMALS ± .020
- 3 PL. DECIMALS ± .005
- ANGLES ± 1°
- FRACTIONS ± 1/64

FINISH ✓

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SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a–2000–a–1.dwg
MODEL / ASSEMBLY FILE: ZTGDSE800AMP (3 /4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE: LEGEND, OPERATION, AND ACCESSORIES

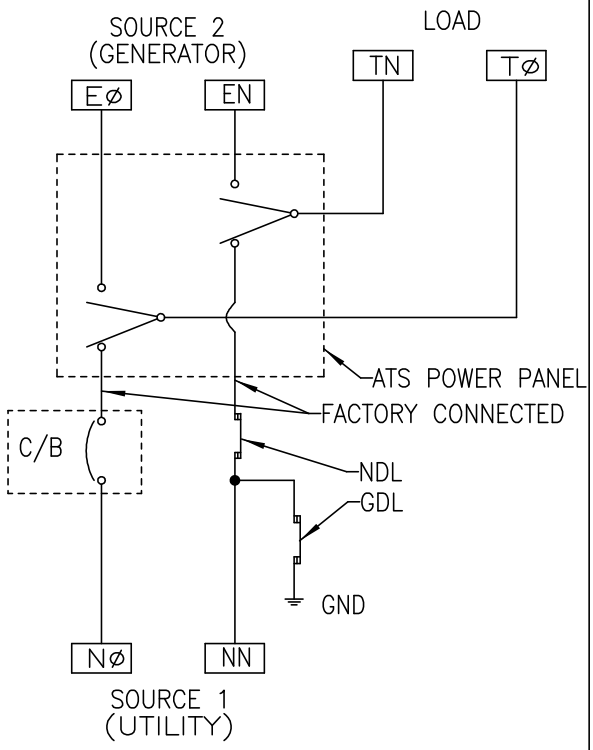
FIRST MADE FOR: ZTGDSE800AMP (3 /4 POLE)

SIZE	CAGE CODE	DWG NO
B		82A–2000

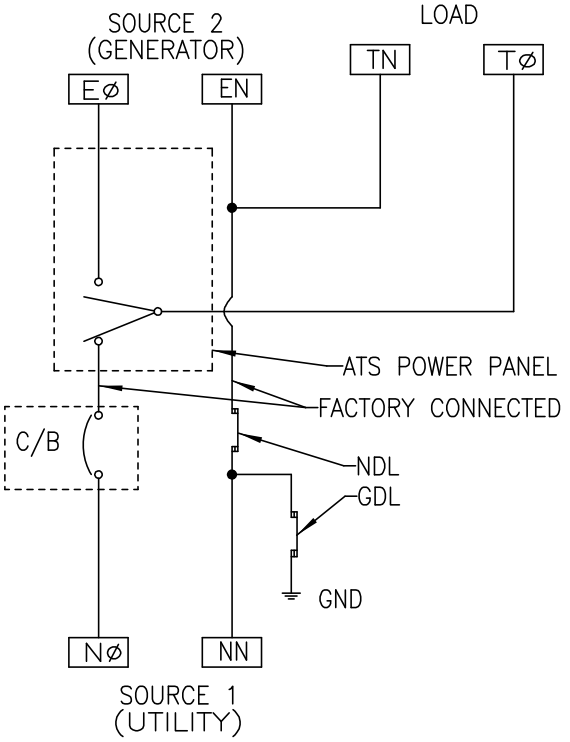
SCALE: NA SHEET 1 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

800A 3,4P C/B PART NO.

PART NO.	DESCRIPTION	4/3P
SKLA36AT1200	MCCB SPECTRA RMS SK1200A FRAME 3P	1
SRPK1200A800	RATING PLUG 800A	1
TCAL125	LUG, (4) 250-500MCM	6

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SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-2000-a-1.dwg
MODEL / ASSEMBLY FILE: ZTGDSE800AMP (3/4 POLE)
CTQs
CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

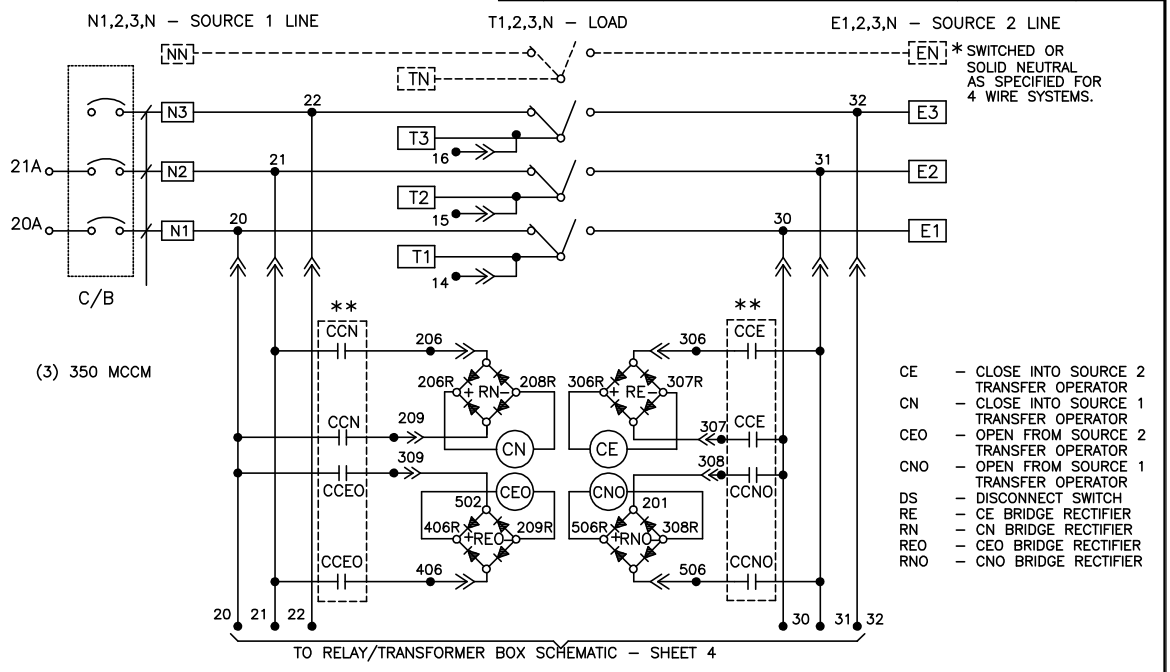
FIRST MADE FOR: ZTGDSE800AMP (3/4 POLE)

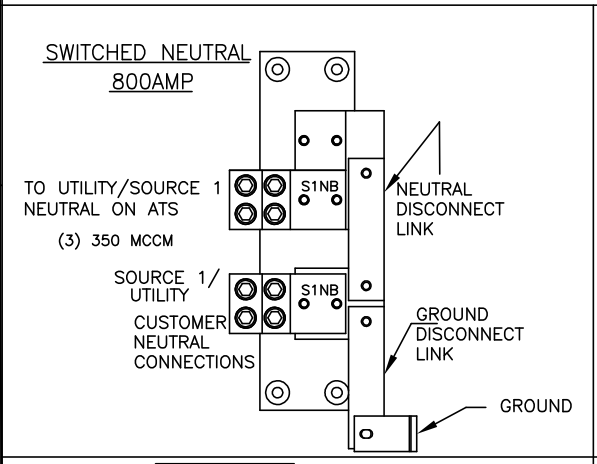
SIZE	CAGE CODE	DWG NO
B		82A-2000

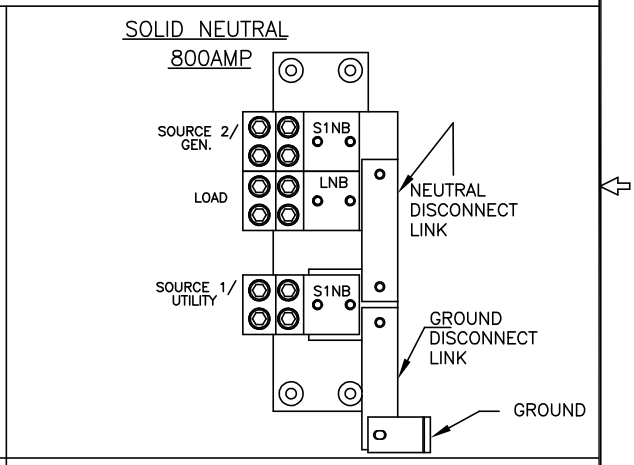
SCALE: NA SHEET 2 OF 5

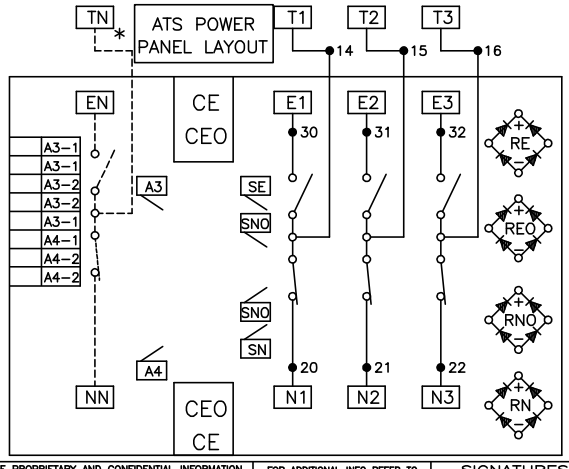
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/05/04	GG FS

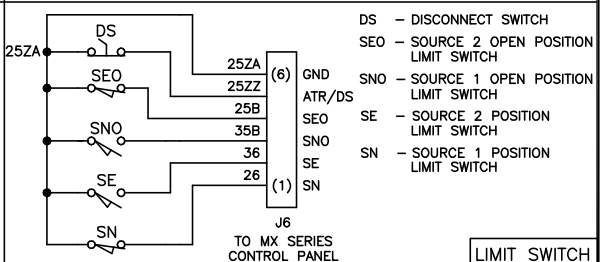
ATS POWER CIRCUIT SCHEMATIC











LIMIT SWITCH SCHEMATIC

LEGEND	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX	1. ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE. 2. WHEN (1) A3 & (1) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO RIGHT OF SOLENOIDS. WHEN (2) A3 & (2) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO LEFT OF SOLENOIDS.

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SIGNATURES		DATE
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DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-2000-a-3.dwg
MODEL / ASSEMBLY FILE: ZTGDSE800AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
ATS POWER CIRCUIT & LAYOUT (INVERTED DESIGN)

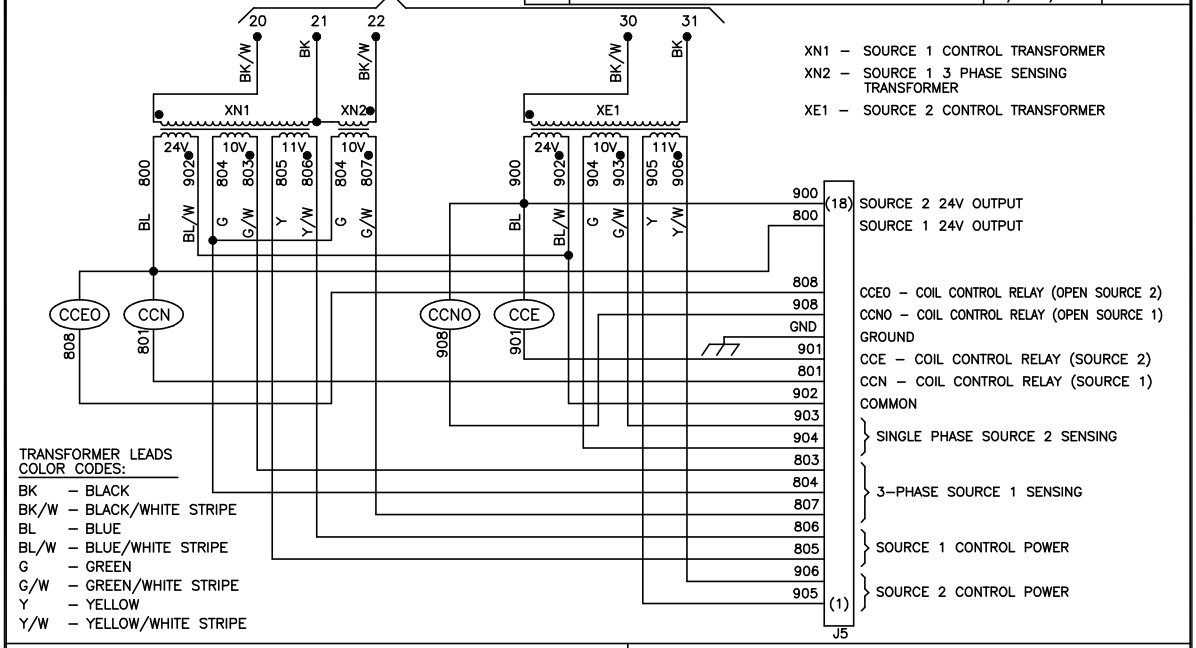
FIRST MADE FOR: ZTGDSE800AMP (3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-2000

SCALE: NA SHEET 3 of 5

RELAY/TRANSFORMER BOX SCHEMATIC

TO POWER CIRCUIT SCHEMATIC – SHEET 3

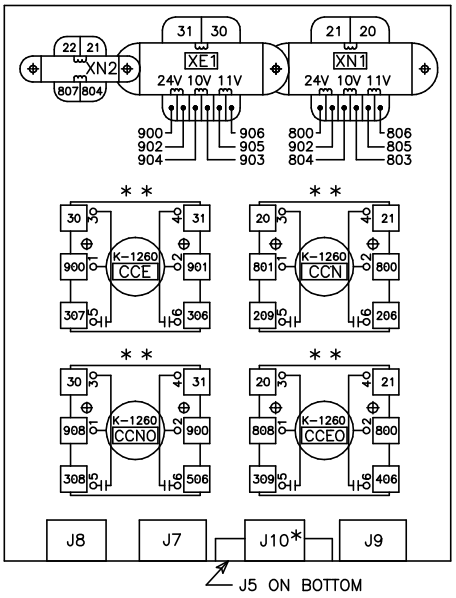


XN1 – SOURCE 1 CONTROL TRANSFORMER
XN2 – SOURCE 1 3 PHASE SENSING TRANSFORMER
XE1 – SOURCE 2 CONTROL TRANSFORMER

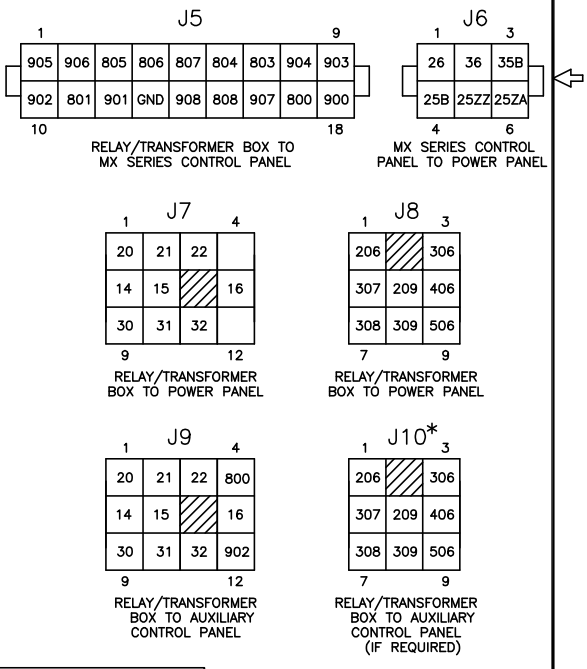
TRANSFORMER LEADS COLOR CODES:

BK – BLACK
BK/W – BLACK/WHITE STRIPE
BL – BLUE
BL/W – BLUE/WHITE STRIPE
G – GREEN
G/W – GREEN/WHITE STRIPE
Y – YELLOW
Y/W – YELLOW/WHITE STRIPE

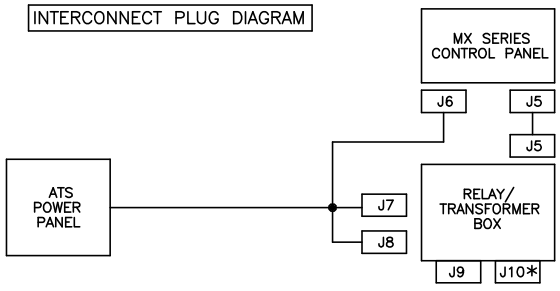
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



LEGEND

—●— WIRE CONNECTION
* OPTIONAL
** DRAWN TO SHOW WIRE NUMBER TO RELAY TERMINAL NUMBER.

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S–8083 ESTABLISHED DWG	2/05/04	GG FS

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a–2000–a–4.dwg
MODEL / ASSEMBLY FILE: ZTGDSE800AMP (3/4 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
RELAY/XFR
BOX & INTERCONNECT PLUGS

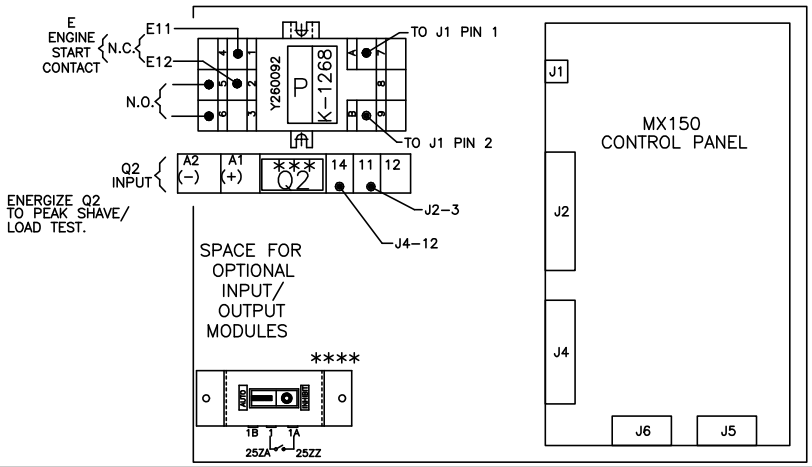
FIRST MADE FOR: ZTGDSE800AMP (3/4 POLE)

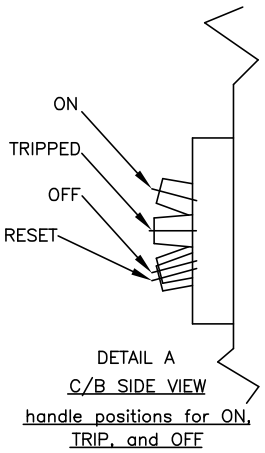
SIZE	CAGE CODE	DWG NO
B		82A–2000

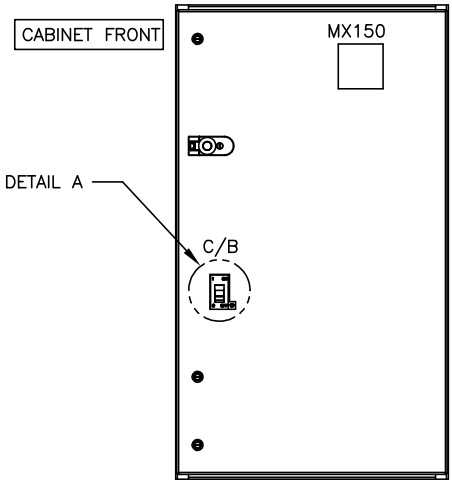
SCALE: NA SHEET 4 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/05/04	GG FS

INSIDE VIEW OF CABINET DOOR

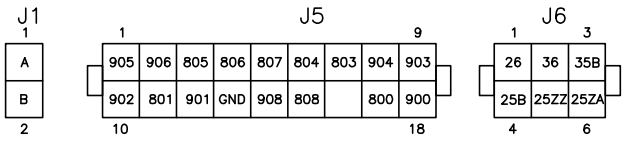






NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS



FROM MX150 CONTROL PANEL TO P RELAY

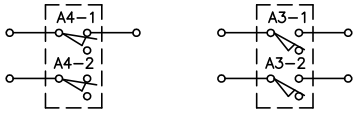
FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

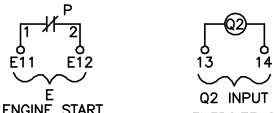
FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS

AUXILIARY CONTACTS

LOCATED ON ATS POWER PANEL





LEGEND

- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  - K-1306, 24VAC;
  - K-1307, 24VDC;
  - K-1308, 120VAC;
  - PS-3147 CLIP
- **** DISCONNECT SWITCH (DS)
  - DS:....L-4030
  - BRACKET:..... 57H-1031
  - LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	10 AMP @ 125, 250 VAC

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:

2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-2000-a-5.dwg

MODEL / ASSEMBLY FILE: ZTGDSE800AMP(3/4 POLE)

CTQs — ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE

INSIDE DOOR, CABINET FRONT, PLUGS,CUSTOMER CONNECTIONS

FIRST MADE FOR: ZTGDSE800AMP(3/4 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-2000

SCALE: NA SHEET 5 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S–8083 ESTABLISHED DWG	2/04/04	GG FS

SERVICE ENTRANCE ATS WITH MX150 MICROPROCESSOR–BASED CONTROL PANEL 800A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS – RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box
- CCE ..... CE/O Control Relay, Source 2
- CCEO ..... CE/O Control Relay, Open Source 2
- CCN ..... CN/O Control Relay, Source 1
- CCNO ..... CN/O Control Relay, Open Source 1
- XE1,..... Control Transformer, Source 2
- XN1,XN2 ..... Control Transformer, Source 1

Power Panel
- N1,2,(N)..... Source 1 Line _____
- E1,2,(N)..... Source 2 Line _____
- T1,2,(N)..... Load Connections
- CE ..... Source 2 Transfer Operator
- CEO ..... Transfer Operator, Open Source 2
- CN ..... Source 1 Transfer Operator
- CNO ..... Transfer Operator, Open Source 1
- CN/CEO ..... Transfer Operator, Open Source 2
- CE/CNO ..... Transfer Operator, Open Source 1
- GND ..... Ground
- NB ..... Neutral Bar (if required)
- RE ..... Bridge Rectifier, CE (600–4000 Amp)
- RN ..... Bridge Rectifier, CN (600–4000 Amp)
- SE ..... Source 2 Position
- SEO ..... Source 2 Open Position
- SN ..... Source 1 Position
- SNO ..... Source 1 Open Position

Interconnect Plugs
- J1, J2, J4, J5, J6, J7, and J8
- J9 and J10.....For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset "Fail" values or when the C/B Breaker is tripped (Breaker can be tripped via button located on Breaker next to handle; refer to Breaker Manual for button location and handle position indications), Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage & frequency reach the preset "Restore" values, the MX control panel energizes the CCNO control relay to operate the transfer operator. The load is now transferred to open position. After the set time delay, the MX control panel energizes CCE control relay to operate the transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When the Source 1 line voltage reaches the preset "Restore" value the MX control panel energizes the CCEO control relay toperate the transfer operator. The load is now transferred to open position. After the set time delay, the MX control panel energizes CCN control relay to operate the transfer operator.

The load is now re–trasferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch
The Test Switch simulates source 1 line failure when activated.
To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.
Testing at least once a month is recommended. For hospital emergency systems, test once a week.

☐ C. MSTDG OPTION PACKAGE.

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.

CALIBRATE
Source 1 & Source 2 Calibrate capabilities for voltage a frequency.

- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending (*E*) appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect switch, Auto/Inhibit. Inhibits transfer in either direction when in Inhibit. Allows Automatic operation when in Auto.
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
  - System Data: Total Life Transfers (N2P)
  - Days Powered Up
  - Total Transfers to S2
  - Total S1 Failures
  - Total S1 available in Hrs
  - Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2
- L Indicating LED lights.
  - L1 Indicates Switch in Source 2 position.
  - L2 Indicates Switch in Source 1 position.
  - L3 Indicates Source 1 available.
  - L4 Indicates Source 2 available.
- P Time Delay Source 2 Start. Adjustable 0–10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In–Phase Monitor. Prevents transfer until two sources are in–phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.
- C/B 2 POLE, Industrial Circuit Breaker (Cabled from the Source 1 side of the ATS to the Load lugs of Circuit Breaker) see sheet 2.

☐ D. MEXEG OPTION PACKAGE.

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Additional Auxiliary Contact closed when switch is in Source 2 position.
- A4 Additional Auxiliary Contact closed when switch is in Source 1 position.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 356 day cycle.
- VI Voltage Imbalance (Three Phase) User Configured On or Off. Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable. Resolution: 1% Increments Minimum Differential: 2% minimum between "Fail" and "Restore" settings. Factory default: 10% "Fail", 8% "Restore", 30 seconds.

E. OPTIONAL ACCESSORIES:

- ☐STS Shunt Trip Selector.
- ☐GFP Ground Fault Potection
- ☐TVSS Transient Voltage Surge Suppressor; Source 1 & Load protection Available.
- ☐6A Test Switch, Maintained/Momentary. Door mount
- ☐ 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- ☐A1 Auxiliary Contact, Operates on Source 1line failure. (Maximum: 2 circuits)
- ☐A1E Auxiliary Contact, Operates on Source 2 line failure.(Maximum: 2 circuits)
- ☐ A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position. (Maximum: 2 circuits)
- ☐ A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position. (Maximum: 2 circuits)
- ☐ A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0–60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer. (Maximum: 2 circuits)
- ☐ BC Battery charger.
- ☐ CTAP Alarm Panel on transfer to Source 2 with Silence button.
- ☐ F Fan contact, operates when generator is running.
- ☐ HT Heater and Thermostat.
- ☐ M80 Digital Power Meter with Display, Amps, Volts and Frequency.
- ☐M82A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- ☐M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus.
- ☐ Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- ☐T3/W3 Elevator Pre–Signal Auxiliary Contacts: Open 0–60 seconds prior to transfer to either direction, re–closes after transfer. (Maximum: 2 circuits)
- ☐UMD Universal Motor Load Disconnect Circuit: Aux. Con opens 0–60 sec. adjustable, 1 sec. increments) prior to transfer in either direction, re–closes after transfer. Can be config. by end user for Pre–transfer, Post–transfer or both. Factory default 5 sec. Timers are not bypassed when transferring from dead source. (Maximum: 2 circuits)
- ☐ ZNET Network Communication Interface Card.

ASSEMBLE PER:
- 59C–1013 (2 POLE), 59C–1014 (3 POLE) } NEMA 1
- 59C–1016 (2 POLE), 59C–1017 (3 POLE) } NEMA 3R

NOTES:
1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 volts, sometimes listed as 120/208 volts) with one leg having a grounded center tap, one line will be 160 to 208 volts to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 VOLT LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING – TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT–HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a–2001–a–1.dwg
MODEL / ASSEMBLY FILE: ZTGDSE800AMP (2 POLE)
AutoCad Generated
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LEGEND, OPERATION, AND ACCESSORIES

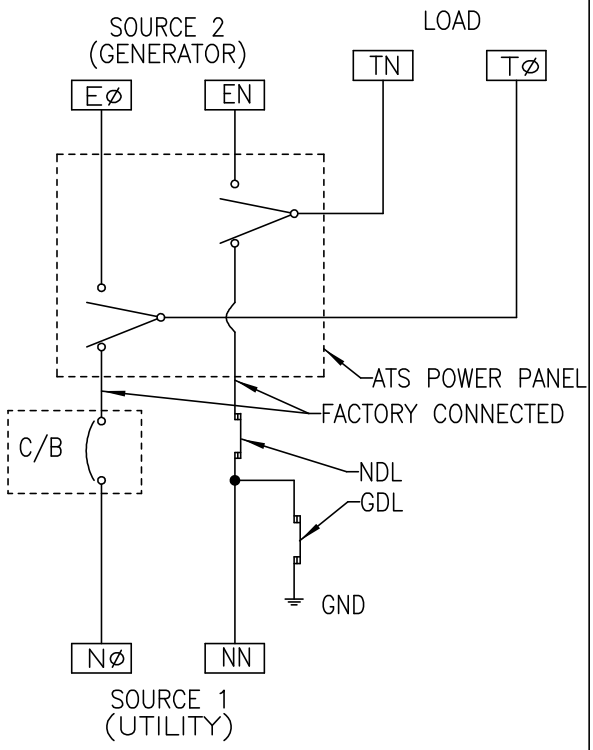
FIRST MADE FOR: ZTGDSE800AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		82A–2001

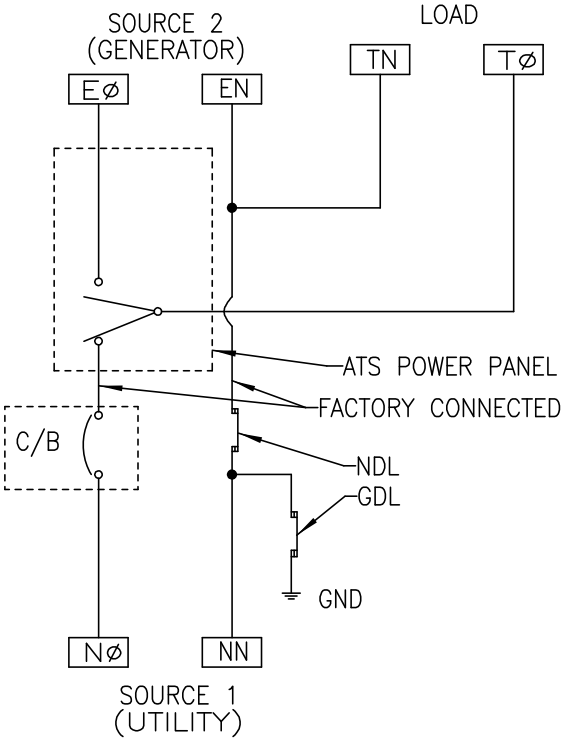
SCALE: NA SHEET 1 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/05/04	GG FS

SINGLE LINE DIAGRAM
SWITCHED NEUTRAL



SINGLE LINE DIAGRAM
SOLID NEUTRAL



LEGEND:
- ATS – AUTOMATIC TRANSFER SWITCH
- C/B – MOLDED CASE CIRCUIT BREAKER
- NDL – NEUTRAL DISCONNECT LINK
- GDL – GROUND DISCONNECT LINK

800A 2P C/B PART NO.

PART NO.	DESCRIPTION	2P
SKLA26AT1200	MCCB SPECTRA RMS SK1200A FRAME 2P	1
SRPK1200A800	RATING PLUG 800A	1
TCAL125	LUG, (4) 250-500MCM	4

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TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-2001-a-2.dwg
MODEL / ASSEMBLY FILE: ZTGDSE800AMP (2 POLE)
CTQs | CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
LINE DIAGRAM

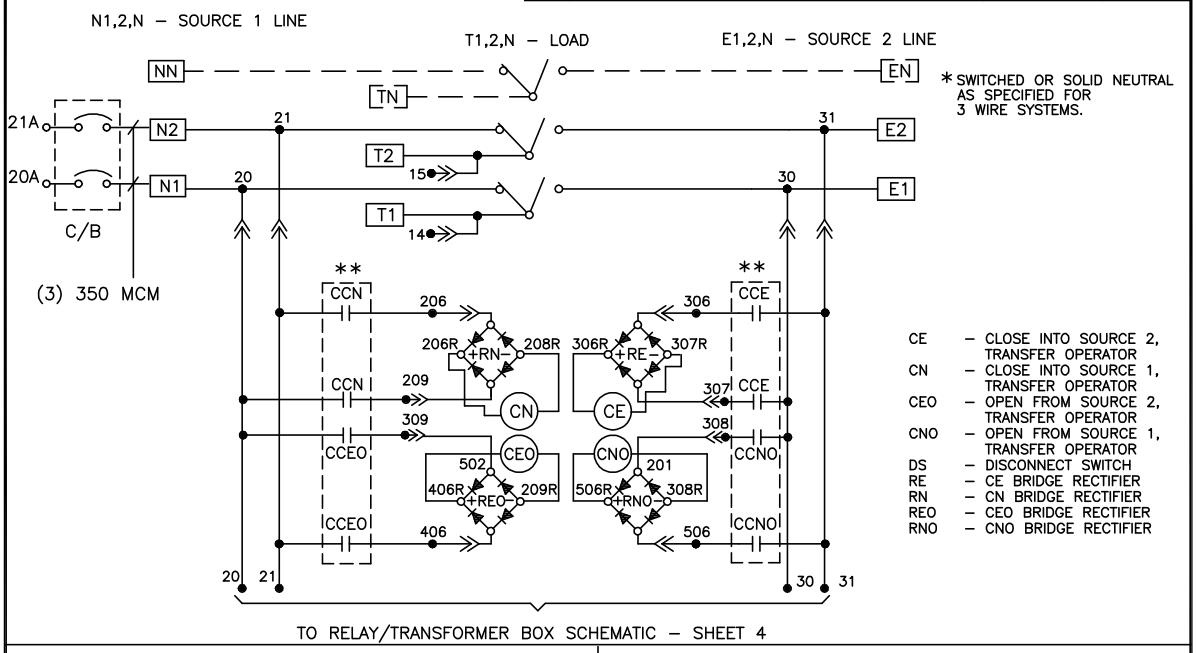
FIRST MADE FOR: ZTGDSE800AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-2001

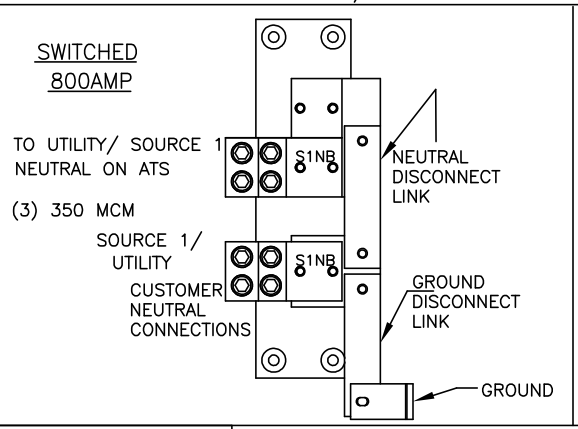
SCALE: NA SHEET 2 OF 5

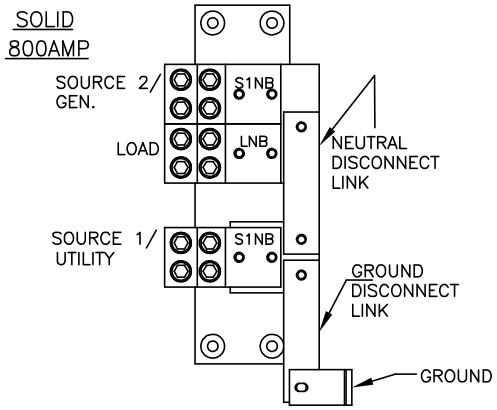
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

ATS POWER CIRCUIT SCHEMATIC

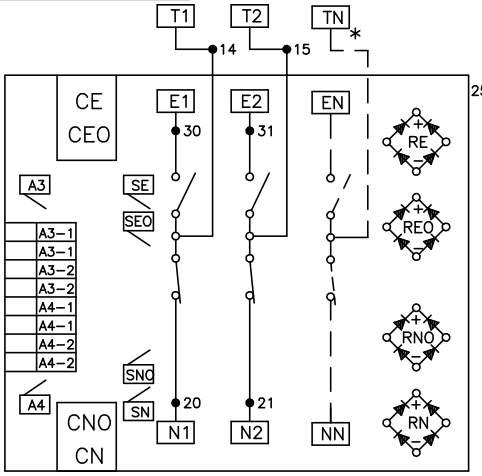


CE – CLOSE INTO SOURCE 2, TRANSFER OPERATOR
CN – CLOSE INTO SOURCE 1, TRANSFER OPERATOR
CEO – OPEN FROM SOURCE 2, TRANSFER OPERATOR
CNO – OPEN FROM SOURCE 1, TRANSFER OPERATOR
DS – DISCONNECT SWITCH
RE – CE BRIDGE RECTIFIER
RN – CN BRIDGE RECTIFIER
REO – CEO BRIDGE RECTIFIER
RNO – CNO BRIDGE RECTIFIER

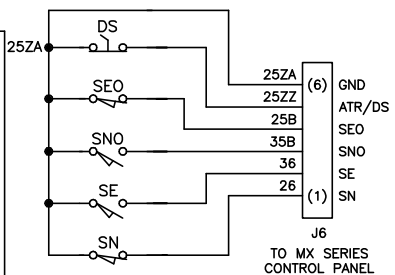




LIMIT SWITCH SCHEMATIC



LIMIT SWITCH SCHEMATIC



DS – DISCONNECT SWITCH
SEO – SOURCE 2 OPEN POSITION LIMIT SWITCH
SNO – SOURCE 1 OPEN POSITION LIMIT SWITCH
SE – SOURCE 2 POSITION LIMIT SWITCH
SN – SOURCE 1 POSITION LIMIT SWITCH

LEGEND	NOTES
WIRE CONNECTION WIRE ON TERMINAL BLOCK WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER-BOX	1. ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE. 2. WHEN (1) A3 & (1) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO RIGHT OF SOLENOIDS. WHEN (2) A3 & (2) A4 ARE SUPPLIED, LIMIT SWITCHES WILL MOUNT TO LEFT OF SOLENOIDS.

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THIRD ANGLE PROJECTION

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH
AutoCad Generated

SIGNATURES	DATE
MODEL GG	2/05/04
DETAIL	
CHECKED	
ENGRG FS	
MFG	
QUALITY	
ISSUED	

DRAWING FILE: 82a-2001-a-3.dwg
MODEL / ASSEMBLY FILE: ZTGDSE800AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
ATS POWER CIRCUIT & LAYOUT (INVERTED DESIGN)
FIRST MADE FOR: ZTGDSE800AMP (2 POLE)

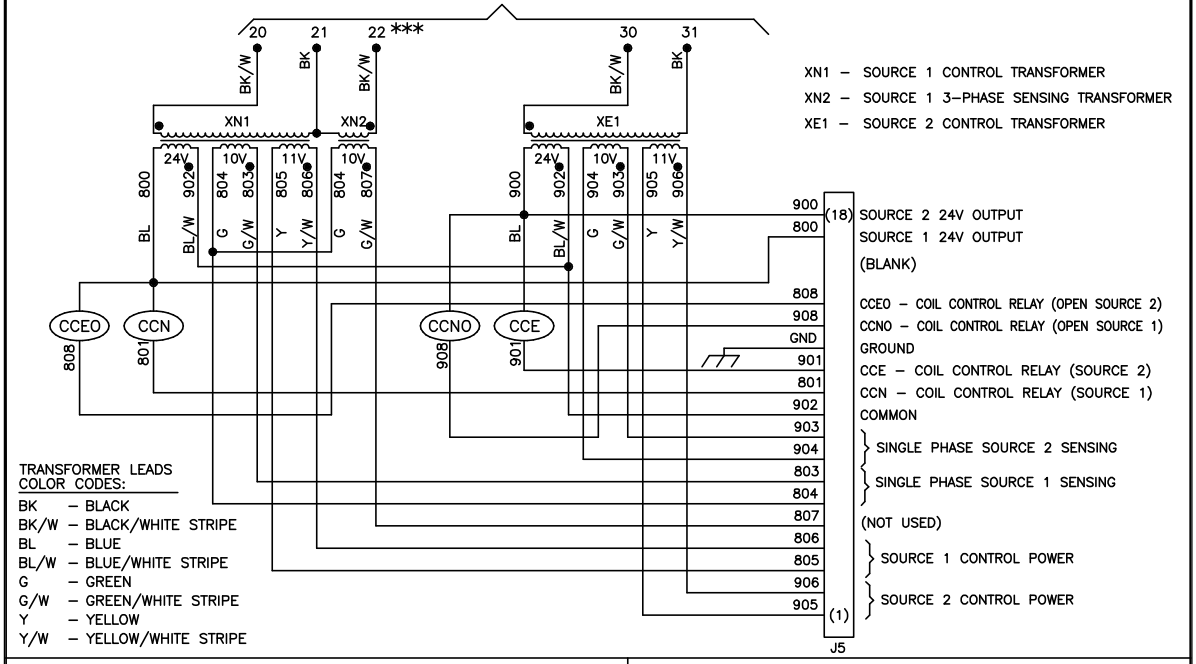
SIZE	CAGE CODE	DWG NO
B		82A-2001

SCALE: NA SHEET 3 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/05/04	GG FS

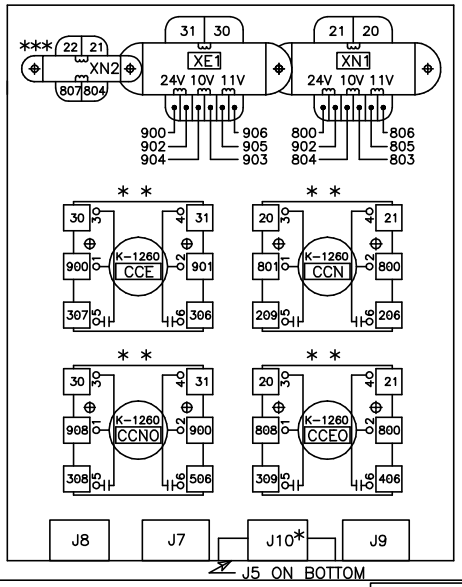
RELAY/TRANSFORMER BOX SCHEMATIC

TO POWER CIRCUIT SCHEMATIC – SHEET 3

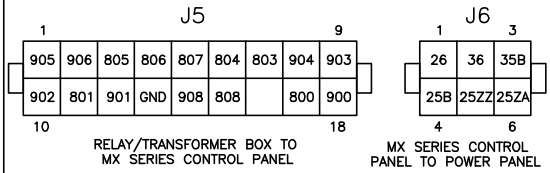


XN1 – SOURCE 1 CONTROL TRANSFORMER
XN2 – SOURCE 1 3-PHASE SENSING TRANSFORMER
XE1 – SOURCE 2 CONTROL TRANSFORMER

RELAY/TRANSFORMER BOX

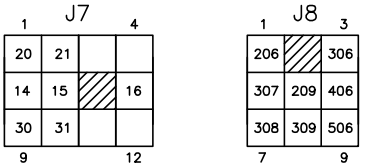


INTERCONNECT PLUGS



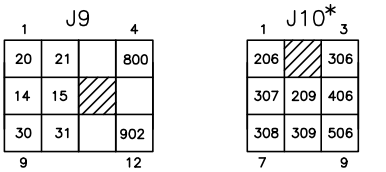
RELAY/TRANSFORMER BOX TO MX SERIES CONTROL PANEL

MX SERIES CONTROL PANEL TO POWER PANEL



RELAY/TRANSFORMER BOX TO POWER PANEL

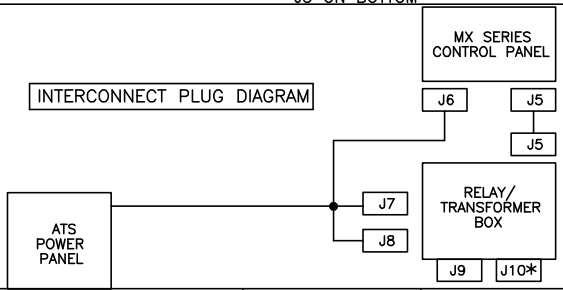
RELAY/TRANSFORMER BOX TO POWER PANEL



RELAY/TRANSFORMER BOX TO AUXILIARY CONTROL PANEL

RELAY/TRANSFORMER BOX TO AUXILIARY CONTROL PANEL (IF REQUIRED)

INTERCONNECT PLUG DIAGRAM



LEGEND

- WIRE CONNECTION
- * OPTIONAL
- ** DRAWN TO SHOW WIRE NUMBER TO RELAY TERMINAL NUMBER
- *** WIRE #22 REMAINS WIRED IN RELAY/ TRANSFORMER BOX. WIRES #22, #32 ARE NOT CONNECTED ON ATS POWER PANEL.

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THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH

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SIGNATURES		DATE
MODEL	GG	2/05/04
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 82a-2001-a-4.dwg
MODEL / ASSEMBLY FILE: ZTGDSE800AMP (2 POLE)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

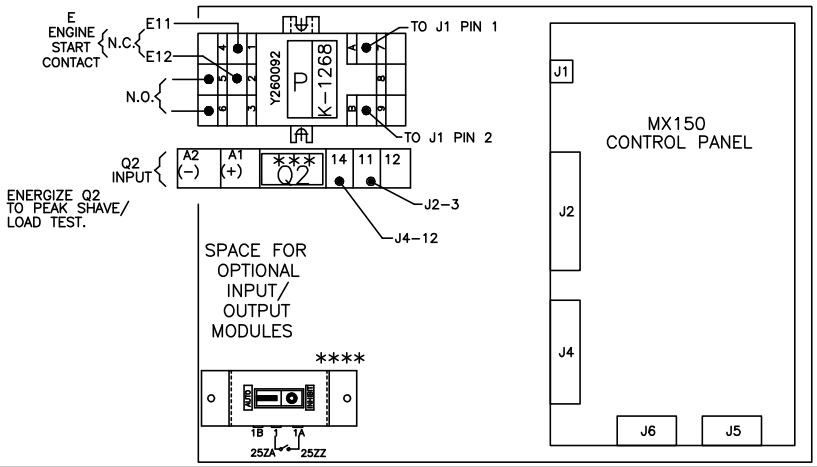
TITLE
RELAY/XFR
BOX & INTERCONNECT PLUGS
FIRST MADE FOR: ZTGDSE800AMP (2 POLE)

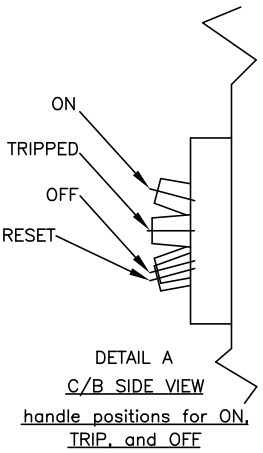
SIZE	CAGE CODE	DWG NO
B		82A-2001

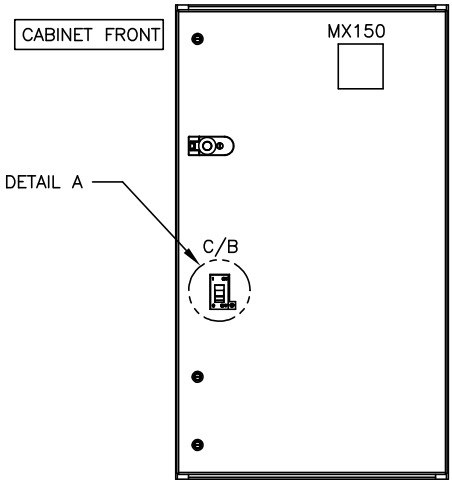
SCALE: NA SHEET 4 OF 5

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	S-8083 ESTABLISHED DWG	2/04/04	GG FS

INSIDE VIEW OF CABINET DOOR

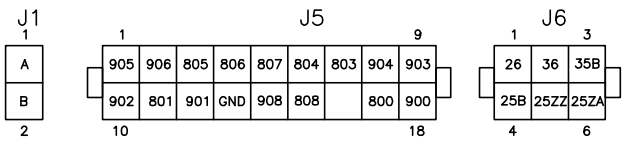






NOTE: J2,J4 TERMINALS FOR ADDED OPTIONAL ACCESSORIES ONLY.

INTERCONNECT PLUGS

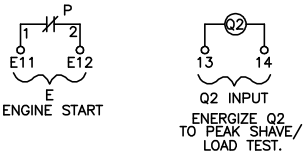


FROM MX150 CONTROL PANEL TO P RELAY

FROM MX150 CONTROL PANEL TO J5 PLUG ON RELAY/TRANSFORMER BOX

FROM MX150 CONTROL PANEL TO ATS POWER PANEL

CUSTOMER CONNECTIONS



LEGEND

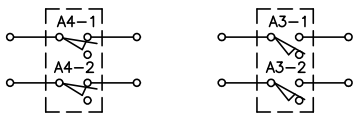
- —●— WIRE CONNECTION
- —○— WIRE ON TERMINAL BLOCK
- * OPTIONAL
- ** DELAY UNIT ONLY
- *** RELAY:
  - K-1306, 24VAC;
  - K-1307, 24VDC;
  - K-1308, 120VAC;
  - PS-3147 CLIP
- **** DISCONNECT SWITCH (DS)
  - DS:....L-4030
  - BRACKET:..... 57H-1031
  - LABELS:.....V-2003, V-1896, V-1897

NOTES

1. DO NOT RUN WIRES THROUGH DISCONNECT PLUG.

AUXILIARY CONTACTS

LOCATED ON ATS POWER PANEL



RELAY	CONTACT	RATING
P	E	10 AMP @ 240 VAC 10 AMP @ 28 VDC
	A3, A4	10 AMP @ 125, 250 VAC

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MODEL / ASSEMBLY FILE: ZTGDSE800AMP (2 POLE)
CTQs
⊖ CRITICAL TO QUALITY CHARACTERISTIC

GE Zenith Controls

TITLE
INSIDE DOOR, CABINET, FRONT PLUGS,CUSTOMER CONNECTIONS

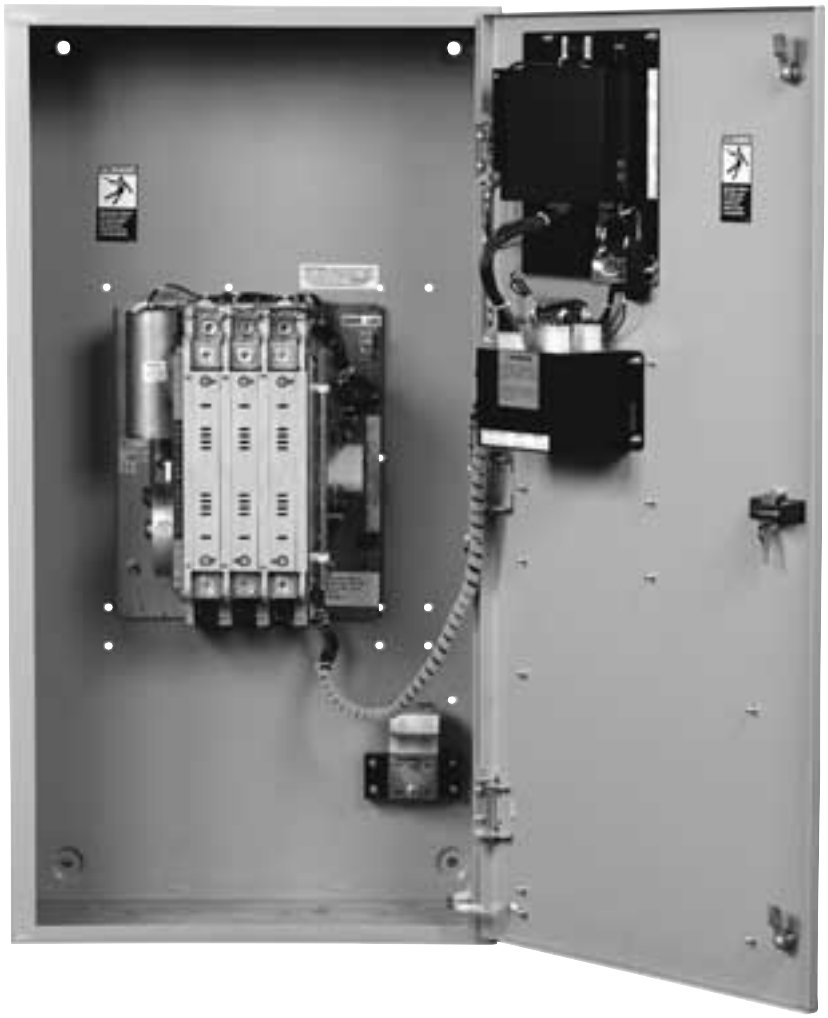
FIRST MADE FOR: ZTGDSE800AMP (2 POLE)

SIZE	CAGE CODE	DWG NO
B		82A-2001

SCALE: NA SHEET 5 OF 5

GE Zenith Controls

ZTG/ZTGD Series Transfer Switches
40-3000 Amps



70R-1000C
12/03

Operation and Maintenance Manual

Authorized Service

For GE Zenith parts and service, call: (773) 299-6600

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Introduction

GE Zenith Transfer Switches are used to provide a continuous source of power for lighting and other critical loads by automatically transferring from source 1 power to source 2 power in the event that source 1 voltage falls below preset limits.

Voltage sensing and system control is performed via a state-of-the-art microcontroller located on the cabinet door. It is designed to give highly accurate control of the transfer switch system.

All GE Zenith transfer switches are designed for use on emergency or standby systems, and are rated for total system or motor loads. Transfer switches are UL Listed under Standard 1008 and CSA Certified under Standard C22.2 No. 178 and IEC Listed under Standard 947.

NOTES: A protective device such as a molded case circuit breaker or fused disconnect switch MUST be installed on both sources of incoming power for circuit protection and as a disconnection device.

All references made within this manual about the term "S1" or "Source 1" relate to a Normal Power Source. All references made about the term "S2" or "Source 2" relate to an Emergency or Alternative Power Source.

Safety / Installation

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

The safe operation of your switch is GE Zenith's focus. The proper storage, installation, operation and maintenance will help increase the life of the switch.

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

Equipment Inspection and Storage

Once you have received the transfer switch, inspect it for any damage. This includes damage to the enclosure, power panel, control panel and wiring harness. If any damage is found or suspected, file a claim as soon as possible with the carrier and notify the nearest GE Zenith representative.

Before installation, if it is necessary, store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature	Operating Temperature (Ambient):	Humidity
-30°C to +75°C (-22°F to +167°F)	**40-400 AMP** *(molded shell)* -20°C to +65°C (-4°F to +149°F) **40-4000 AMP** *(all other frame and panel types)* -20°C to +60°C (-4°F to +140°F)	5% to 95% (non-condensing)

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred, with a vacuum, due to shipment or installation.

⚠ WARNING ⚠

Do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections.
4. Verify the correct connection of all control wires.
5. Check settings of all timers and adjust as necessary.
6. Adjust any optional accessories as required.
7. Check the lug torque values of the power connections.

   NOTE: Lug torque values are specified in table 2 on pg.4.

8. Make sure that all covers and barriers are installed and properly fastened.

   NOTE: Power panels ship from GE Zenith in Source 1 Position.

Each GE Zenith transfer switch is factory wired and tested. A complete information package is furnished with each switch which includes:

a. Sequence of operation.
b. Description and operation of all accessories supplied.
c. Power panel connection diagram and schematic.
d. Description and identification of all customer field connections.

Installation of GE Zenith transfer switches includes:

a. Mounting the transfer switch cabinet.
b. Connection of Source 1, Source 2, and Load cables or bus bars.
c. Connection of external control circuits as required.

Mounting

Adequate lifting means must be used to mount the transfer switch into place. The recommended method for moving the transfer switch using the lifting eyes, where supplied, and a spreader bar is illustrated in *Figure 1.* Enough room should be allowed to open the cabinet doors fully for inspection and servicing of the switch per NEC and local codes.

⚠ CAUTION ⚠

Before drilling conduit entry holes or any accessory mounting holes, cover and protect the switch and control panel to prevent dirt and metal fragments from entering the mechanical and electrical components.

Failure to do so may result in damage and malfunction of the switch.

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Power Connections

GE Zenith transfer switches are supplied with UL listed solderless screw type terminals as standard for the Source 1, Source 2 and Load power connections. *Table 1* lists the number and sizes of cable lugs supplied as standard for each switch amp rating.

Connect the Source 1, Source 2, and Load conductors to the clearly marked terminals on the transfer switch. Remove surface oxides from cables by cleaning with a wire brush. Verify that all connections are correct before tightening the lugs. All cable lug connections must be tightened to the proper torque values as shown in *Table 2*.

NOTE: Do not run cables or wiring behind front-connected transfer switches.

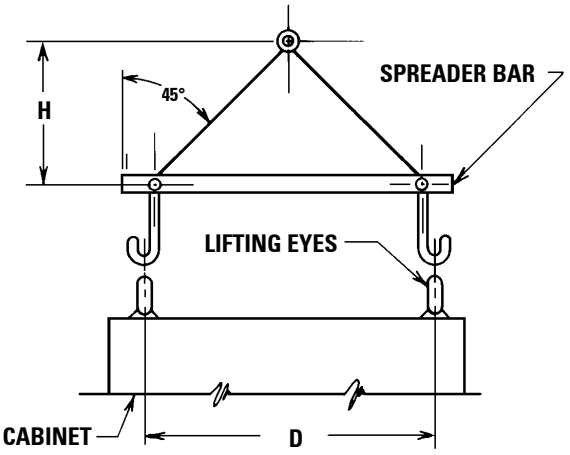

Figure 1

NOTE: When lifting the switch using a spreader bar, height H must be equal to half of distance D.

Power Connections: Screw Type Terminals for External Power Connections

Switch Size (Amps)	Source 1, Source 2 & Load Terminals		Neutral Bar (When Required)	
	Cable Per Pole	Range of Wire Sizes	No. of Cables	Range of Wire Sizes
40	1	#8 to 3/0 AWG	3	#14 to 1/0 AWG
80	1	#8 to 3/0 AWG	3	#14 to 1/0 AWG
100	1	#8 to 3/0 AWG	3	#14 to 1/0 AWG
150	1	#8 to 3/0 AWG	3	#6 AWG to 350 MCM
200, 225	1	#6 AWG to 250 MCM	3	#6 AWG to 350 MCM
260	1	#6 AWG to 350 MCM	3	#6 AWG to 350 MCM
400	1	#4 AWG to 600 MCM	4	#4 AWG to 600 MCM
600	2	#2 AWG to 600 MCM	8	#4 AWG to 600 MCM
800, 1000, 1200	4	#2 AWG to 600 MCM	12	#4 AWG to 600 MCM
1600, 2000 2600, 3000	8	#2 AWG to 600 MCM	24	#4 AWG to 600 MCM

Table 1

Engine Start Control Connections

Engine-start control wires connect to control terminals beside the MX150. Engine start terminals are indicated by a schematic symbol (the symbol indicates the contact state for a de-energized normal source). *Figure 3* shows the engine-start contacts.

Make all other necessary control connections to the control panel terminal blocks per the schematics supplied with the ATS.

NOTE: All control wires (18-12 AWG) must be torqued to 19 in/lbs.

Tightening Torque for Lugs

Socket Size Across Flats	Torque	
	Lb. - In.	Lb. - Ft.
1/8	45	4
5/32	100	8
3/16	120	10
7/32	150	12
1/4	200	17
5/16	275	23
3/8	375	31
1/2	500	42
9/16	600	50

Table 2

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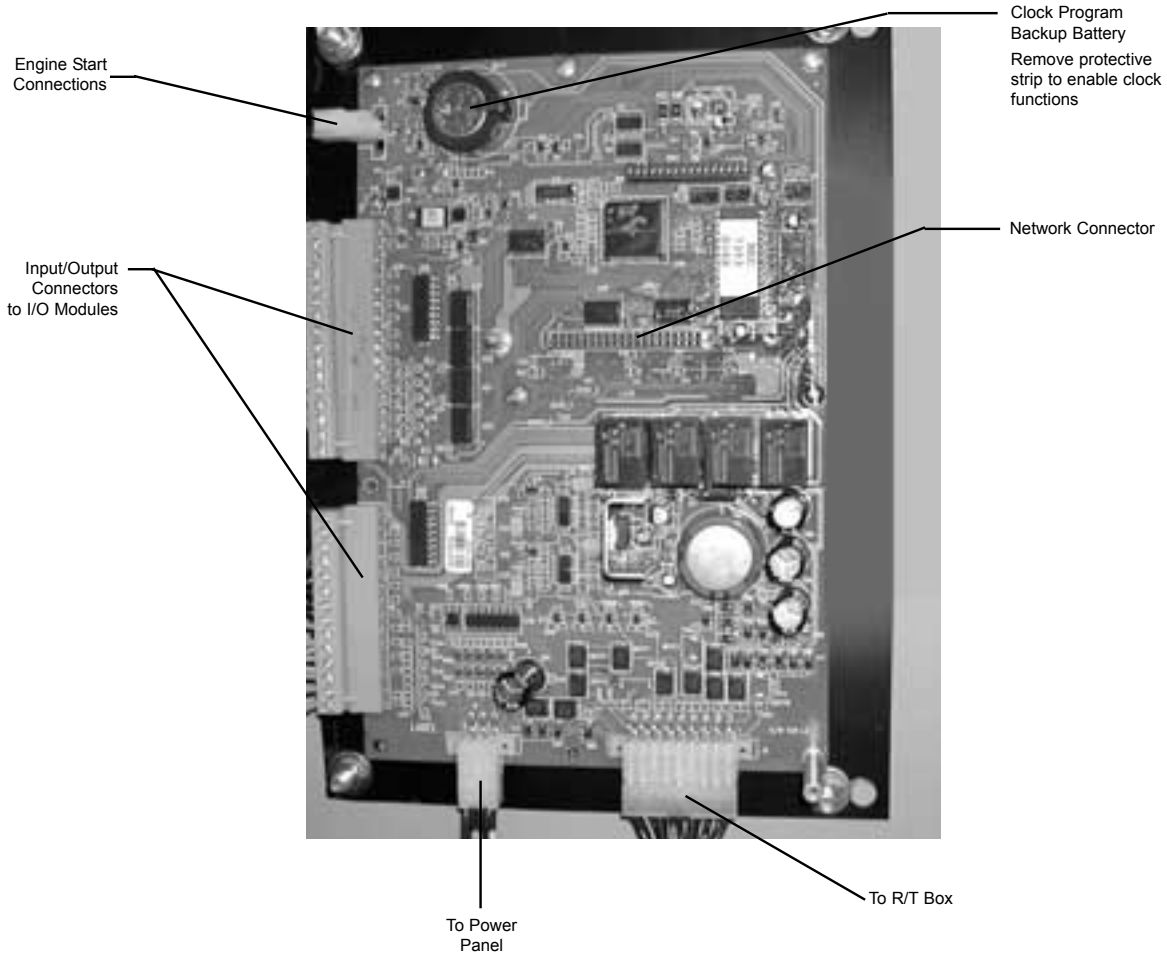
⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Control Connections

Figure 2



A complete information package is furnished with each transfer switch including a complete connection diagram and schematic which details all necessary control circuit field connections.

The engine start control wires connect to the engine start relay terminals located to the left of the microprocessor. Figure 2 shows the location of these terminals.

The terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Katolight University - Gen II Training - Rev:06-01-06 - Page 213

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

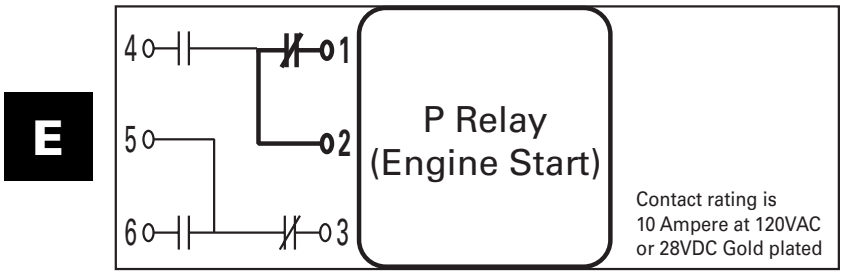


Figure 3

Engine Start Control Connections

The engine-start terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Terminals for field connections to the A3 Source 2 auxiliary contacts and the A4 Source 1 auxiliary contacts are also provided. These terminals are clearly marked and appear on the side of the power panel. On 400 amp metal frame units these terminals appear on the bracket above the operator handle.

Initial Energization

Before proceeding, refer to the information package supplied with the ATS and read and understand the information on all accessories provided.

1. Unlock the enclosure.
2. Open the enclosure.
3. Verify the correct system voltage.

   NOTE: The equipment rating nameplate on the transfer switch lists the voltage. See *Figure 4*.

4. Close Source 1 circuit. breaker.

   NOTE: The controller will illuminate Source 1 Available LED if proper voltage is sensed.

5. Verify the phase to phase voltages at the Normal line terminals.
6. Close the Source 2 circuit breaker.
7. Start the generator engine.

   NOTE: The controller will illuminate Source 2 Available LED when preset voltage and frequency levels are reached.

8. Verify the phase to phase voltages at Source 1 line terminals.
9. Verify that the phase rotation of Source 1 is the same as the phase rotation of Source 2.

10. Shut down the generator engine.
11. Place the starting control in the Automatic position.
12. Complete the visual inspection of the transfer switch.
13. Close the enclosure.
14. Lock the enclosure.

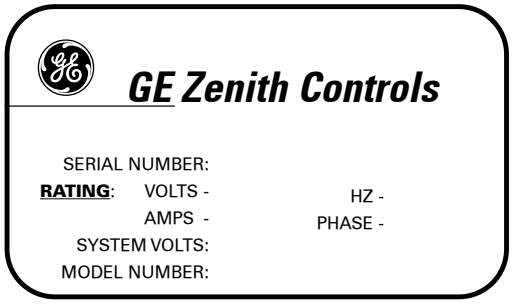


Figure 4

⚠ CAUTIONS ⚠

Certain accessories, per specific schematics, can inhibit automatic transfer.
Engine Gen-Set could start when engine control wires are attached.

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Initial Energization *(cont'd)*

After all options and accessories are checked and verified, follow these steps to set up the ATS. Refer to MX150 display *Figure 5*. The annunciation LEDs illuminate to indicate (1) source availability, (2) ATS position, and (3) MX150 control function (timing).

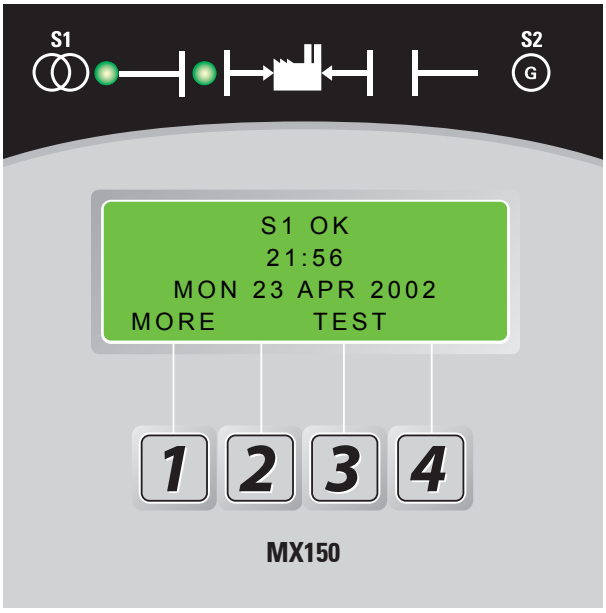


Figure 5 – LCD and keypad

1. Unlock the enclosure.
2. Open the enclosure.
3. Place the Disconnect Switch in the Inhibit.

   NOTE: This step is only performed if the "DS" Option was purchased.

4. Close the external (up-stream) Source 1 circuit breaker.

   NOTES: Source 1 Available and Source 1 Position LED's will illuminate.

   If Source 1 Available LED does not illuminate, verify that Source 1 Voltage is above the preset restore value.

   The Gen-Set will start and run while Source 2 stop Delay Timer is timing.

5. Close the External (up-stream) Source 2 line circuit breaker.
6. Start the engine generator in MANUAL mode.

   NOTE: When the voltage and frequency reach preset values, the Source 2 Available LED will illuminate.

7. Verify the phase to phase voltages at Source 2 line terminals.
8. Verify that the phase rotation of Source 2 is the same as the phase rotation of Source 1.

9. Shut down the generator's engine. (Place in Automatic Mode.)

   NOTE: Source 2 Available LED will turn off.

   NOTE: The engine generator will continue to run for the duration of Source 2 Stop Delay Timer.

10. Place the disconnect switch to ENABLE.
11. Complete the visual inspection of the transfer switch.
12. Close the enclosure.
13. Lock the enclosure.

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

MX150 Controller

Consists of two major assemblies:

I. The **Microprocessor** contains the following:

A. MX150 Board - Customer Input and Output (I/O) for system interface. Located on the left hand side of the back of the unit (see figure 6)

1. I/O accessories that can be found here are:
   a. Engine start relay P output
   b. Pre-Signal to transfer T3, W3 and UMD output (optional)
   c. Transfer Inhibit Q3 and Q7 input (optional)
   d. Remote test Q2 input (optional)
   e. Network interface ZNET input/output (optional)

B. LCD and Keypad located on the exterior of the door (see figure 7)

1. User accessibility to the following:
   a. LED indication of source availability
   b. LED indication of transfer switch position
   c. LCD screen indicates:
      (1) timer count down (numeric)
      (2) event reporting (text)
   d. Keypad provides user interface to: *[in conjunction with LCD screen]*
      (1) Setting sensors and timers
      (2) Configuring logic accessories

II. The **R/T box** (relay transformer box) contains the following: (see figure 6)

A. Relays which are required for controller output to energize the transferring mechanism of the transfer switch at line voltage.

B. Transformers which drop line voltage to control level for controller input.

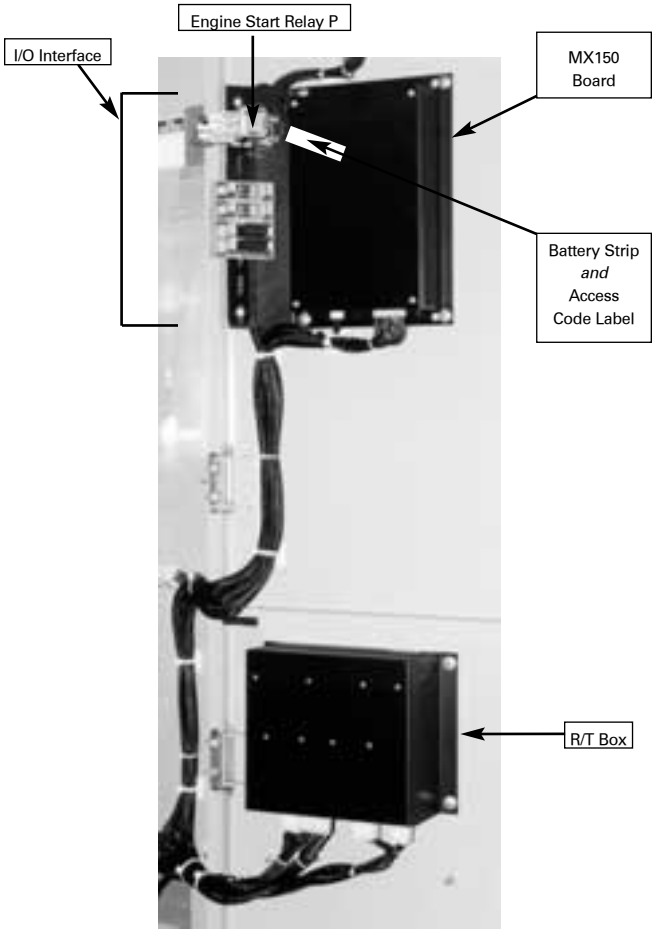


Figure 6

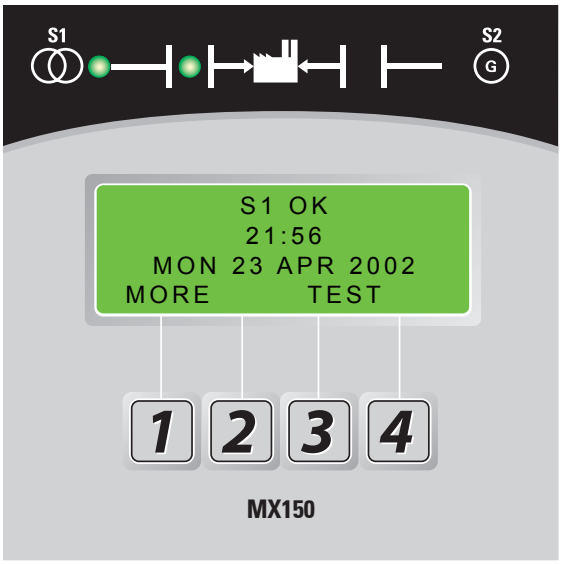


Figure 7

LCD & Keypad

These options are accessible through the LCD and keypad (see figure below). To become familiar with the options loaded into a particular unit, scrolling through the SET and CFG menu will show the descriptions of the options (see pages 17). These menus are the very same menus that are used to access the setting and/or configuration of these options. The SET (setting) menu is primarily used to show or change, time and voltage settings. The CFG menu is primarily used to turn an option on or off. When scrolling through these menus, no changes can be made without entry of the access code. The factory set six-digit access code is located on a white label on the back of the unit (see figure 9 pgs. 17-19).

The MX150 has many logic options. Each controller is downloaded with options at the time of manufacture. The collection of options that any one controller has is specified at the time of order placement. The following pages include all the options that can reside in the controller. Not all units include all options.

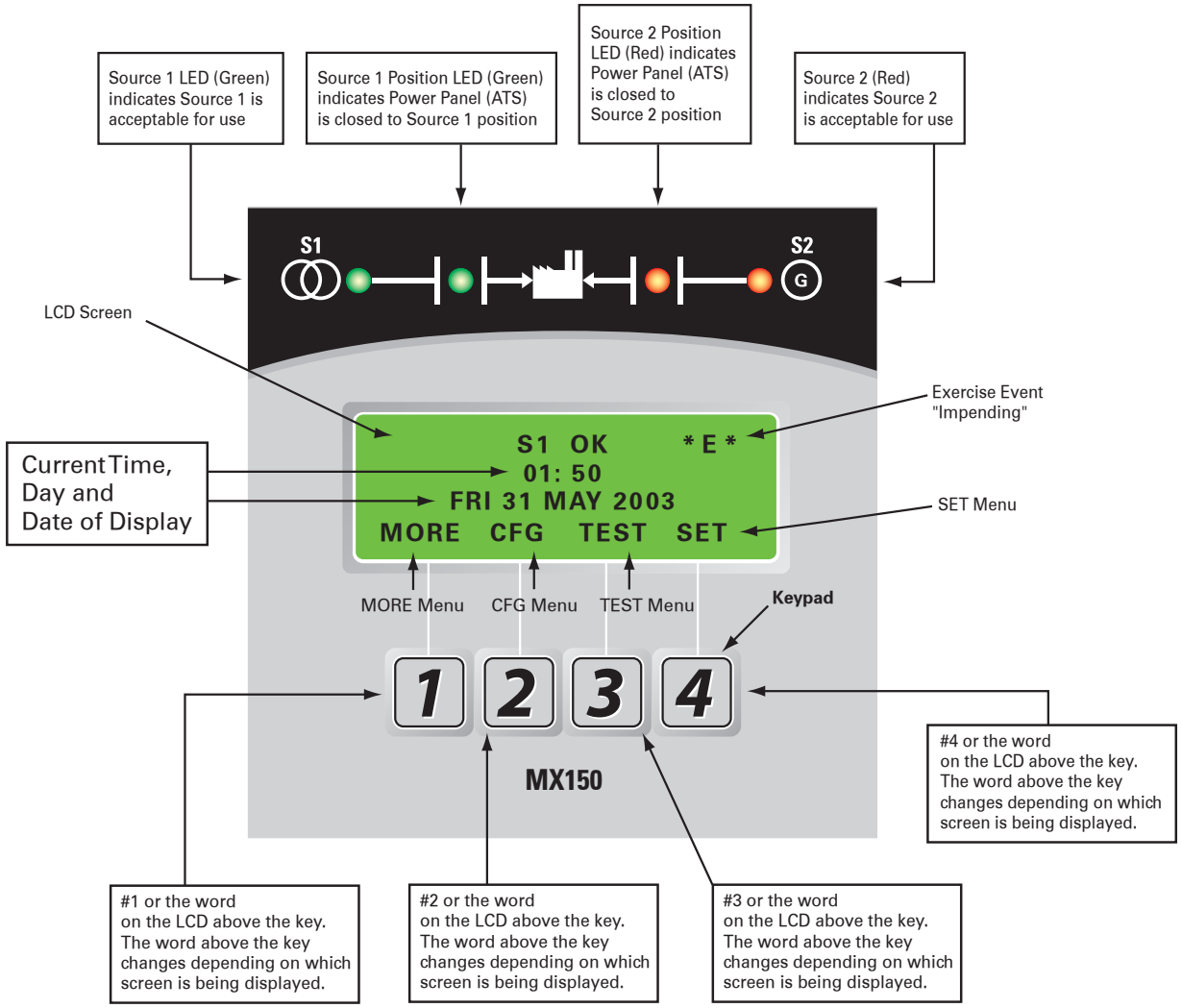


Figure 8

User Setting for Voltage & Frequency

Source 1

Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 1.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 18).
Once satisfied, the T timer will begin timing to transfer to Source 1.

Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold.
Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, P timer begins timing to signal Source 2 Generator to start.

Source 2

Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 2.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 18).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold.
Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, T timer will be bypassed to expedite the transfer to Source 1.

Frequency "Restore"
Factory Default: 95%
This adjustment determines the minimum acceptable frequency required to transfer to Source 2.
Adjust via the SET menu. Range is 90% to 100% in 1% increments (see page 18).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Frequency "Fail"
Factory Default: 90%
This adjustment determines the low frequency threshold.
Adjust via the SET menu. Range is 88% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting.
Once satisfied, the W timer will begin timing to transfer to Source 2.

Standard Features, MSTDG Option Pkg.

6
Test Switch, Momentary

A3
Auxiliary Contact: Closed when the switch is in Source 2 position.

A4
Auxiliary Contact: Closed when the switch is in Source 1 position.

Calibrate
While monitoring the actual Phase to Phase voltage levels and Frequency with a calibrated test equipment, the Phase to Phase voltage sensing and Frequency can be adjusted accordingly. Calibration capabilities are available for Frequency and AB, BC, CA Phase to Phase voltage for both Sources. Adjust via SET menu (see page 18)

CDT
Load or NO-Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1, 7, 14, or 28 days. Factory Default is 20minutes. When exerciser is impending, (*E*) appears in the upper right hand corner of LCD screen. See page 14-15 for instructions. Configured via CFG (see page 17). Set via SET menu (see page 18).

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(800-4000 Amp units)

DT *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 1 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds Adjust via SET menu (see page 18)

DW *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 2 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds.Adjust via SET menu (see page 18)

E
Engine Start Contact

Std. Features, MSTDG Option Pkg. *(cont'd)*

EL/P

Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken

System Data: Total Life Transfers (N2P)
Days Powered Up
Total Transfers to S2
Total S1 Failures
Time S1 available in Hrs
Time S2 available in Hrs. (N1P)

K/P

Frequency Indication for S1 and S2

L

LNP Center-off position LCD-Indicator
Indicating LED lights:

- **L1** Indicates Switch in Source 2 position.
- **L2** Indicates Switch in Source 1 position.
- **L3** Indicates Source 1 available.
- **L4** Indicates Source 2 available.

P1

Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting is 3 seconds.
Adjust via SET menu (see page 18)

Q2

Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present.

R2E

Under voltage sensing of Source 2 for single-phase. (R17 replaces R2E for Utility to Utility switches)

R50

In Phase Monitor this feature restricts **Live to Live Source Transfers** to occur unless both Sources are within 7 electrical degrees or less of each other. (live Source to live Source transfers usually occur during transfer back to Source 1 or during Testing). R50 does not change the operation of the Automatic Transfer Switch in a power failure mode. After all timer functions have elapsed, **the CHECKING FOR SOURCE SYNCHRONISM** will be displayed as well as the direction of transfer (S1-S2 for example denotes transfer from Source 1 to Source2). When synchronism is accomplished, transfer will take place.

Notes:
- **If S2 Frequency is less than S1 Frequency, display will show a series of (- - - - -…..) symbols.**
- **If S2 Frequency is greater than S1 Frequency, display will show a series of (+++++…..) symbols.**
- **Each (-) or (+) symbol represents 10 electrical degrees out of phase. A maximum of 18 symbols (180 electrical degrees) can be monitored.**
- **The number of (-) or (+) symbols decrease as the two sources approach synchronism and increase as the two sources drift out of synchronism.**
- **If S1 and S2 Frequencies are identical, the display will show a series of alternating symbols (ŧŧŧŧ…) which also indicate the approximate out of phase degrees**

In the event that the Sources do not come within 7 electrical degrees of each other within 60 seconds, the unit will display the message: **SYNCH CHECKING** and will allow the user to **BYPASS**. If the **BYPASS** button is pressed, the unit will display the message: **WARNING MAY CAUSE DAMAGE TO THE LOAD**. Pressing **XFR** will actually bypass the R50. Since R50 is a passive device, the length of time it takes to reach Synchronism is dependent on the frequency difference between the two Sources. Source 1 is usually a Utility and the frequency is not within the control of the consumer. Source 2 needs to be adjusted to create an adequate difference in order for the transfer to happen a timely fashion.

Note: For optimum performance, Source 2 Generator should be adjusted a Maximum of 2 Hertz above or below the Utility frequency, minimum of 0.1 Hertz. (58 to 59.9) or (60.1 to 62) Hertz. Adjustment of Generator to 60Hertz could cause lengthy transfer delay.

R50 Feature can be turned ON or OFF via CFG Menu (see page 17). Factory Default if OFF.

S13

Transfer Commit. Configured via CFG menu. (see page 17) When this Feature is set to OFF: The transfer Switch is not committed to transfer unless the outage duration is longer than the timers that precede the transfer to Source 2 position. This assumes that the outage will be an isolated event. When this Feature is set to ON: The transfer Switch is committed to transfer to Source 2 position once the W timer has begun timing, even if Source 1 power returns before the transfer to Source 2. This is to ensure that the transfer takes place, because one outage may be followed by another.

T

Time Delay (S1) Source 1 Stable Timer. To delay transfer to Source 1 (immediate retransfer on Source 2 failure). Adjustable 0-60 minutes in 1 second increments. Standard setting is 30 minutes. Adjust via SET menu (see page 18)

U

(S2) Source 2 Stop Delay Timer. Allows Engine to run unloaded after switch retransfer to Source 1. Adjustable 0-60 minutes in 1 second increments. Standard setting is 5 minutes. Adjust via SET menu (see page 18)

W

Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2. Adjustable 0-5 minutes in 1 second increments. Standard setting is 1 second. Adjust via SET menu (see page 18)

YEN

Bypass Timers Key utilizing Keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.

Standard Features, MEXEG Option Pkg.

In addition to the features listed under the MSTDG Option Package, this enhanced package includes the following features:

A3
Additional Auxiliary contact: closed when switch is in Source 2 position.

A4
Additional Auxiliary contact: Closed when the transfer switch is in Source 1 position.

CDP (replaces CDT)
Clock Exerciser Load/ No Load: Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load.
Can be configured by end user for 1, 7, 14, 28, 365 day cycle.

VI
Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between "Fail" and "Restore" settings.
Factory default: 10% "Fail", 8% "Restore, 30 Seconds.
See CFG Menu page 17 to configure ON or OFF.
See SET Menu page 18 to set Percentage and time windows

Optional Accessories

6A
Test Switch, Maintained / Momentary

6AP
Test Switch, Maintained / Momentary, utilizing Keypad

A1
Auxiliary Contact, operates on Source 1 line failure.

A1E
Auxiliary Contact, operates on Source 2 line failure.

A3
Auxiliary Contacts: Closed when the transfer switch is in Source 2 position.

A4
Auxiliary Contacts: Closed when the transfer switch is in Source 1 position.

A62
Sequential Universal Motor Load Disconnect Circuit. Normally closed Auxiliary contacts for Motor Loads. Open 0-60 seconds prior to transfer, after transfer, or both in either direction then re-close in timed sequence after transfer. Factory default: 20 seconds

CTAP
Alarm Panel on transfer to Source 2 with Silence button.

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(40-600 Amp units)

HT
Heater and Thermostat.

Manual
Manual Transfer Switch transfers in either direction by depressing designated pushbuttons.

M80
Digital Power Meter with Display: Amps, Volts, and Frequency.

M82
Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.

M83A
Digital Meter w/Diplay of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/Modbus.

T3/W3
Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer. Factory default: 20 seconds

UMD
Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-5 minutes prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both. Factory default: 15 seconds

VI
Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between “Fail” and “Restore” settings.
Factory default: 10% “Fail”, 8% “Restore, 30 Seconds.
See CFG Menu page 17 to configure ON or OFF.
See SET Menu page 18 to set Percentage and time windows

ZNET
Network Communications Interface Card

How to Set the System Clock

How to Set the System Clock

Set System Clock, time and date

- If the clock is not set, the display will show SET SYSTEM CLOCK on the second line of the S1 OK screen.
- The S1 OK screen will show time (hours and minutes) on the second line if the system clock has been set. (Date on third line)

Setting the System Clock

(Start from **S1 OK** screen)

1. Remove battery protective white plastic strip near **P** relay. *
2. Press **MORE** then press **SET**.
3. Press **MORE** and scroll to **SET SYSTEM CLOCK** using the **MORE** key.
4. Press **SEL**.
5. **ENTER ACCESS CODE** located on the white label on the back of the controller.
6. Press **SEL**.
7. Use the up and down keys to change the hour value.
8. Press **SAVE** (this will enter this value and move cursor to minutes).
9. Use the up and down keys to change the minutes.
10. Press **SAVE** (this will enter this value and move cursor to month).
11. Use the up and down key up to change the month.
12. Press **SAVE** (This will enter this value and complete the clock setting).
13. Use the up and down keys to change the date.
14. Press **SAVE** (this will enter this value and move cursor to year).
15. Use the up and down keys to change year.
16. Press **SAVE** (this will enter this value and compete the clock setting).
17. To edit settings, press **SEL** and repeat steps 6-16.
18. If the setting is satisfactory, press **MORE** (unit then returns to the **SET** menu then press **BACK**, then **ESC**.)

* Replacement battery part #K-4100
Battery will last 5 years and provides power to retain clock function only (Controller functions without battery).

CDT One Event Timer Exerciser

Load or No-Load

One event Exerciser with adjustable Timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1,7,14, or 28 days. Factory default is 20 minutes.

How to CONFIGURE (CFG) and Set (SET) the Timer Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG TIMER EXERCISER** screen.
3. The third line of the **CONFG TIMER EXERCISER** will show either **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **OFF**.
4. If the third line of the **CONFG TIMER EXERCISER** shows **DAILY**, **WEEKLY**, **14 DAY**, or **28 DAY** as desired, then proceed to step 10.
5. If the third line of the **CONFG TIMER EXERCISER** shows **OFF** or if another timer selection is desired, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY**, **WEEKLY**, **14 DAY**, or 28 **DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** to scroll to **CONFG TIMER EXERCISER (XFR)** or **(NO XFR)**.
11. Press Up or Down to select **XFR** (Load Transfer) or **NO XFR** (No Load Transfer).
12. Press **SAVE**.
13. Press **MORE** repeatedly to **BACK** then **S1 OK** screen.

Set (SET) the Exerciser:

14. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
15. Press **MORE** repeatedly until **EXER S2 RUN TIME** screen.
16. Press **SEL**
17. Enter **ACCESS** code located on white label on the back of the controller.
18. Press **SEL**
19. Cursor is indicated as a line under character to be changed. Change values with up and down keys.
20. Press **SAVE** when complete.
21. Press **MORE** repeatedly until **SET USER SETUP** then press **BACK** then **ESC** to the **S1 OK** screen.

CDT One Event Timer Exerciser *(cont'd)*

How to Initiate CDT Exerciser and to start an exercise cycle every 1, 7, 14, or 28 days

From S1 screen

1) Press **TEST**
2) Press **MORE**
3) Press **START TEST TIMER** (to initiate Test).

- If the CDT Exerciser is Factory configured for a Load Exerciser, the Controller will immediately start a load exercise. The controller will start the generator, transfer the load to Source 2 and remain in Source 2 for the duration set for **EXER S2 RUN TIME** in the **SET** menu. The controller will retransfer the load back to Source 1 after the S1 stable timer has timed out and run the generator unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).
- If the CDT Exerciser is Factory configured for a No-Load Exerciser, the Controller will immediately start a No-load exercise. The controller will start the generator and run it unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).

Exercise will be repeated at the same time as initiated on every 1, 7, 14, or 28 days according to the selection made in the Configure **CFG** menu.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle

If the CDT Exerciser is Factory configured for a No-Load Exerciser Or allow the controller to complete retransfer to Source 1 If the CDT Exerciser is Factory configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press Test
2) Press **MORE**
3) Press **BYPASS EXER**

To re-institute the next exercise event back, press **CANCL BPASS**

How to initiate a new exercise start time

1) Press **TEST**
2) Press **MORE**
3) Press **EXER CANCL**
4) Press **START TIMER TEST**

How to check the next exercise event

1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS**, **HOURS**, and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:

- ***E*** appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= CDT (Exerciser) timing period +T (S1 stable Timer) timing period.

CDP Clock Exerciser

Load / No-Load Clock Exerciser

Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by the end user for 1, 7, 14, 28, or 365 day cycles.

- A total of 7 independent No Load exercise periods (up to 10 hours each) can be programmed for each of the daily, weekly, 14-day, and 28-day exercisers.
- A total of 12 independent No Load exercise periods (up to 10 hours) can be programmed for the 365-day Exerciser.

How to Configure (CFG) the Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG CLOCK EXERCISER** screen.
3. The third line of the **CONFG CLOCK EXERCISER** will show either **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, **365 DAY** or **OFF**.
4. If the third line of the **CONFG CLOCK EXERCISER** shows **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **365 DAY** as desired, press **MORE** repeatedly to **BACK**. Press **ESC** then proceed to the **SET** menu to set the **EXERCISER**.
5. If the third line of the **CONFG CLOCK EXERCISER** shows **OFF**, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **365 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** repeatedly to **BACK** then **ESC** to **S1 OK** screen.

How to set (SET) the DAILY Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
2. Press **MORE** repeatedly until **SET EXERCISER** screen.
3. Press **SEL**.
4. Enter **ACCESS** code located on white label on the back of the controller.
5. Press **SEL**
6. Cursor is indicated as a line under character to be changed. Change values with up and down keys. Press **SAVE** after each entry to save value and to move to the next value to be changed.
7. Press **BACK** when complete.
8. Press **MORE** repeatedly until **SET USER SETUP**. Press **BACK** then **ESC** to the **S1 OK** screen.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle.

If the CD Exerciser is configured or Set for a No-Load Exercise. Or allow the controller to complete retransfer to Source 1. If the CD Exerciser is configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press **TEST**
2) Press **MORE**
3) Press **BYPASS EXER**

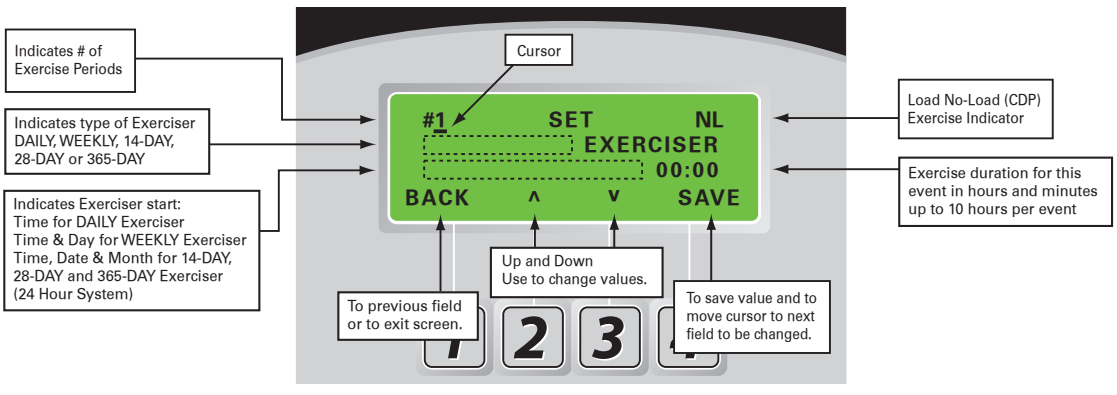
To re-institute the next exercise event back, press **CANCL BPASS**

How to check the next exercise event

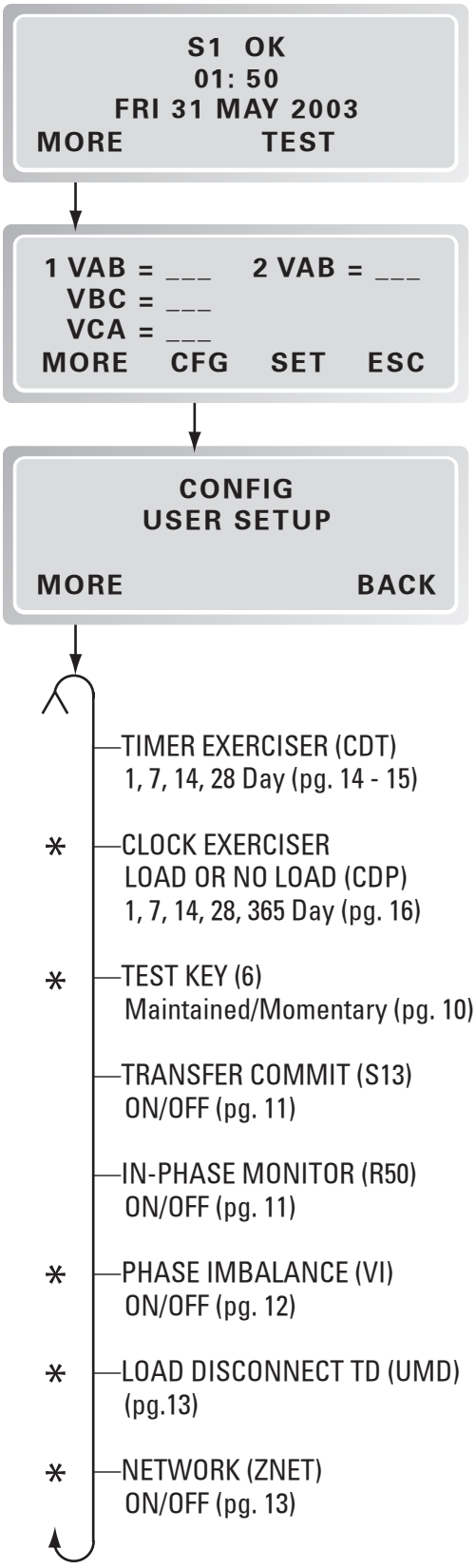
1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS**, **HOURS**, and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:

- In the **S1 OK** screen, an (***E***) appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= **CDT** (Exerciser) timing period +T (S1 Stable Timer) timing period.
- A value greater than zero must be entered in the Exerciser duration field to be accepted as a valid exercise period.
- The Exercise cycle will be repeated on a regular basis as programmed and initiated in the **SET** menu depending on what Exerciser was configured (selected) in the **CFG** menu.



MX150 User Setup - CFG Menu



⁎ Optional Accessories

Turn options ON or OFF via keypad through the CFG menu

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

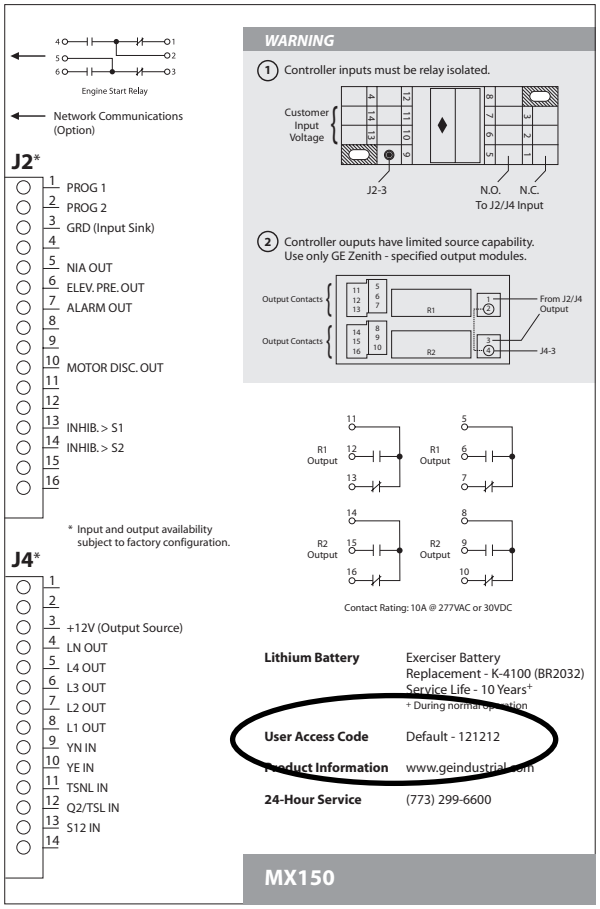
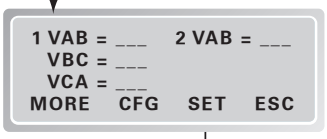


Figure 9

MX150 User Setup - SET Menu



- SET SYSTEM CLOCK (pg.14)
- DAYLIGHT SAVINGS ON/OFF
- * CLOCK EXERCISER (CDP) (pg.16)
- EXER S2 RUNTIME (CDT) (pg.14 - 15)
- S1 UNDER VOLTAGE (pg.10)
  - Fail
  - Restore
- S2 UNDER VOLTAGE (pg.10)
  - Fail
  - Restore
- S2 UNDER FREQUENCY (pg.10)
  - Fail
  - Restore
- * SET % PHASE IMBALANCE (VI) FAIL 5%, RESTORE 3% (pg.12)
- * SET PHASE IMBALANCE (VI) TIME DELAY 30 seconds (pg.12)
- TIME DELAY S2 START (P1) (pg.11)
- TIME DELAY S2 STABLE (W) (pg.11)
- * LOAD PRESIGNAL TD (T3/W3) (pg.13)
- * LOAD DISCONNECT TD (UMD) (pg.13)
- ATS OPEN TIME TO S2 (DW) DELAY units only (pg.10)
- TIME DELAY S1 STABLE (T) (pg.11)
- ATS OPEN TIME TO S1 (DT) DELAY units only (pg.10)
- S2 STOP DELAY (U) (pg.11)
- CALIBRATE S1 (pg.10)
- CALIBRATE S2 (pg.10)

* Optional Accessories

Change adjustable values through the SET menu.

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

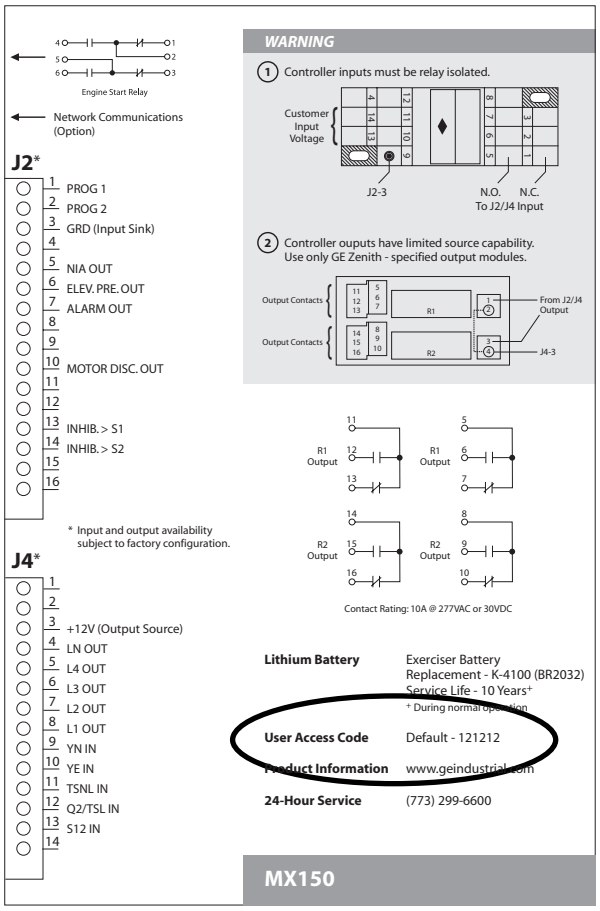
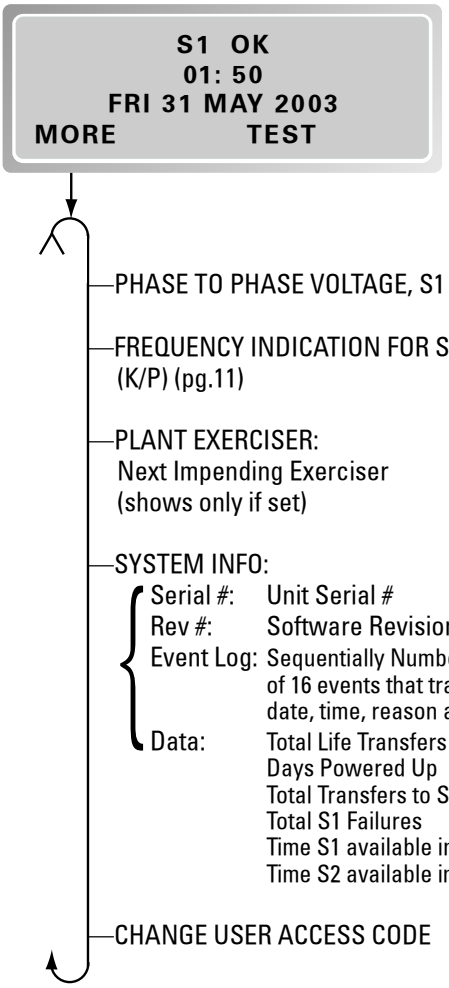


Figure 9

MX150 User Setup - System Info



View System Data

Enter six digit access code
(The factory assigned six-digit access code
is located on the back of the controller)

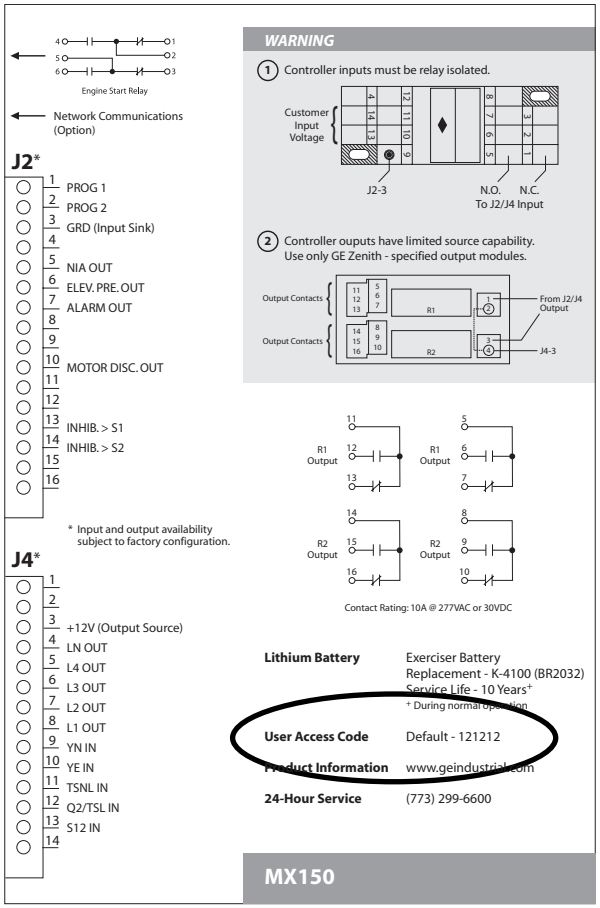


Figure 9

Testing

⚠ NOTICE ⚠

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701)

ATS Testing

Start generator and verify proper voltage, frequency and phase sequence (match to Source 1). Shut down gen set and place in Auto. Complete the visual inspection of the transfer switch, and close the cabinet door.

Initiate the test by pressing the TEST button on the LCD keypad. The controller will then prompt for your access code. After entering the code, three test options will appear—XFR LOAD, FAST TEST and NO XFR (See Figure 10).

- **XFR LOAD** test starts the generator and using the current timer settings, transfers the load to Source 2.
- **FAST TEST** test presets timer values to a maximum 30 seconds during the test. After completion of the test, all timers are reset to their original values. (T3, W3, DT and DW remain)
- **NO XFR** test starts the generator but does not transfer the load to the Source 2.

Press and hold the desired test option button until the switch transfers to Source 2 (load test) or until the generator has been run for the desired amount of time (no load test). Releasing the test button before W timer timeout will abort the test (Exception: when the transfer commit option, is configured “ON”).

To test lamps, press TEST then scroll through MORE, then press LAMP TEST. To cancel LAMP TEST press MORE.

Standard Transition

When the test is initiated, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCE relay energizes the CE solenoid to close the transfer switch in to Source 2. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1 sequence.The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCN relay energizes the CN solenoid to retransfer the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

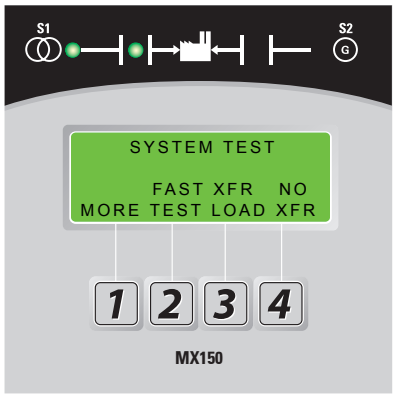


Figure 10

Delayed Transition

Source 1 Power Failure:

When the test is initiated, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCNO relay energizes the CNO solenoid to open the transfer switch out of Source 1 position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the CCE relay energizes. The switch then completes transfer to Source 2 by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1sequence.The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCEO relay energizes the CEO solenoid to open the switch out of Source 2 position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the CCN relay energizes the CN solenoid to complete re-transfer of the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

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Sequence of Operation

Standard Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCE relay energizes the CE solenoid to close the transfer switch in to Source 2. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1sequence.The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCN relay energizes the CN solenoid to retransfer the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCNO relay energizes the CNO solenoid to open the transfer switch out of Source 1 position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the CCE relay energizes. The switch then completes transfer to Source 2 by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1 sequence.The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCEO relay energizes the CEO solenoid to open the switch out of Source 2 position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the CCN relay energizes the CN solenoid to complete re-transfer of the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Table 3

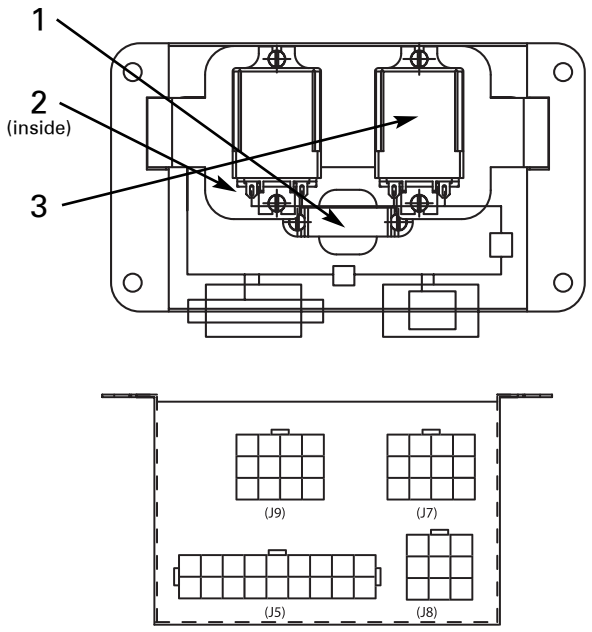
Timer Designations as they appear in the SET menu						
ATS Type	**P**	**W**	**DW**	**T**	**DT**	**U**
Standard	Time Delay S2 Start	Time Delay S2 Stable	→	Time Delay S1 Stable	→	S2 Stop Delay
Delay	Time Delay S2 Start	Time Delay S2 Stable	ATS Open Time to S2	Time Delay S1 Stable	ATS Open Time to S1	S2 Stop Delay
Source 1 Fails	Transfer to Source 2 →			Source 1 Returns ↓	Transfer to Source 1 →	Engine Cooldown

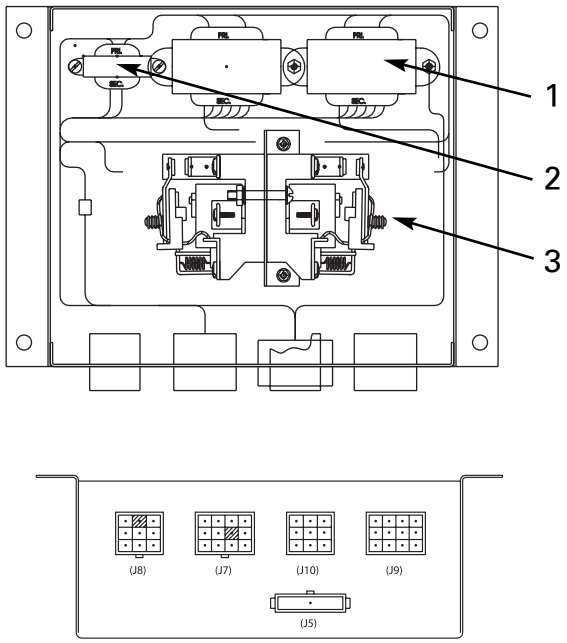
Relay/Transformer (R/T Box)

Standard Transition

Each MX150 microprocessor based ATS controller requires a relay/transformer box to apply line voltage to the ATS operator via coil control relays. Also required is power for the MX150 printed circuit board and an application of sensing voltage proportional to line voltage. This is accomplished by the relay transformer box. This method of switching operator voltage and applying power and sensing voltage to the printed circuit board isolates the MX150 from the line voltage, further protecting the controller from harmful line transients. Two versions of the R/T box exist depending on the type of ATS (standard transition or delayed transition).

The following layout drawings of the R/T Box components (standard and delayed transition) include a bill of materials for replacement parts. Schematics are included to indicate proper wiring.





40-225 Amp Molded Power Section Transformer Usage *(see Figure 10)*

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
57P-1115	120V	K-3216	K-3224
57P-1116	208-220V	K-3217	K-3225
57P-1117	230-240V	K-3218	K-3226
57P-1118	277V	K-3219	K-3227
57P-1119	380-400V	K-3220	K-3228
57P-1120	416-440V	K-3221	K-3229
57P-1121	460-480V	K-3222	K-3230
57P-1122	575-600V	K-3223	K-3231

40-3000 Amp - All Other Standard Types Transformer Usage *(see Figure 11)*

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
50P-1005	120V	K-3216	K-3224
50P-1006	208-220V	K-3217	K-3225
50P-1007	230-240V	K-3218	K-3226
50P-1008	277V	K-3219	K-3227
50P-1009	380-400V	K-3220	K-3228
50P-1010	416-440V	K-3221	K-3229
50P-1011	460-480V	K-3222	K-3230
50P-1012	575-600V	K-3223	K-3231

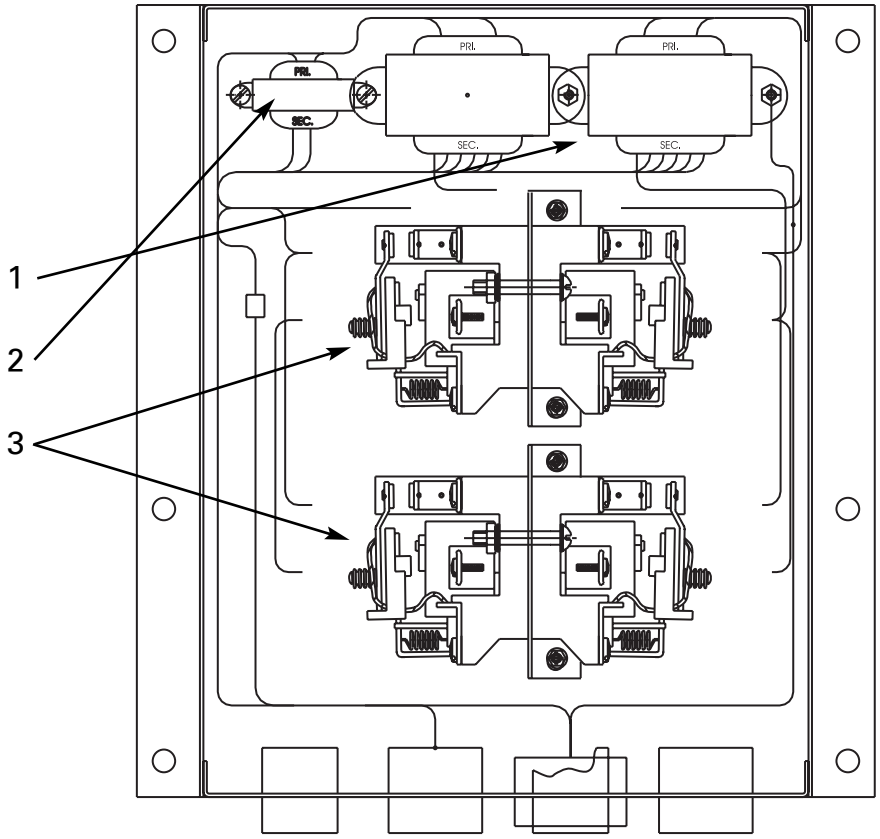
Bill of Material

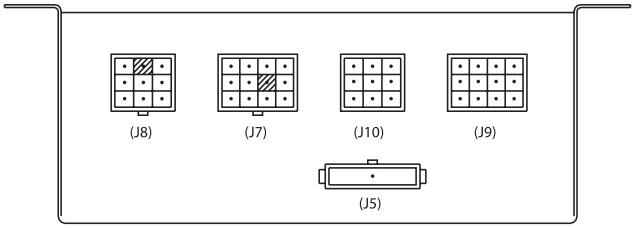
Item	Part No.	Description	Qty
1	See Chart	Transformer (1 VA)	1
2	See Chart	Transformer (25 VA)	2
3	K-1274	Relay Flange Mounted	2

Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (25 VA)	2
2	See Chart	Transformer (1 VA)	1
3	K-1260	Coil Control Relay (24V)	2

Delayed Transition





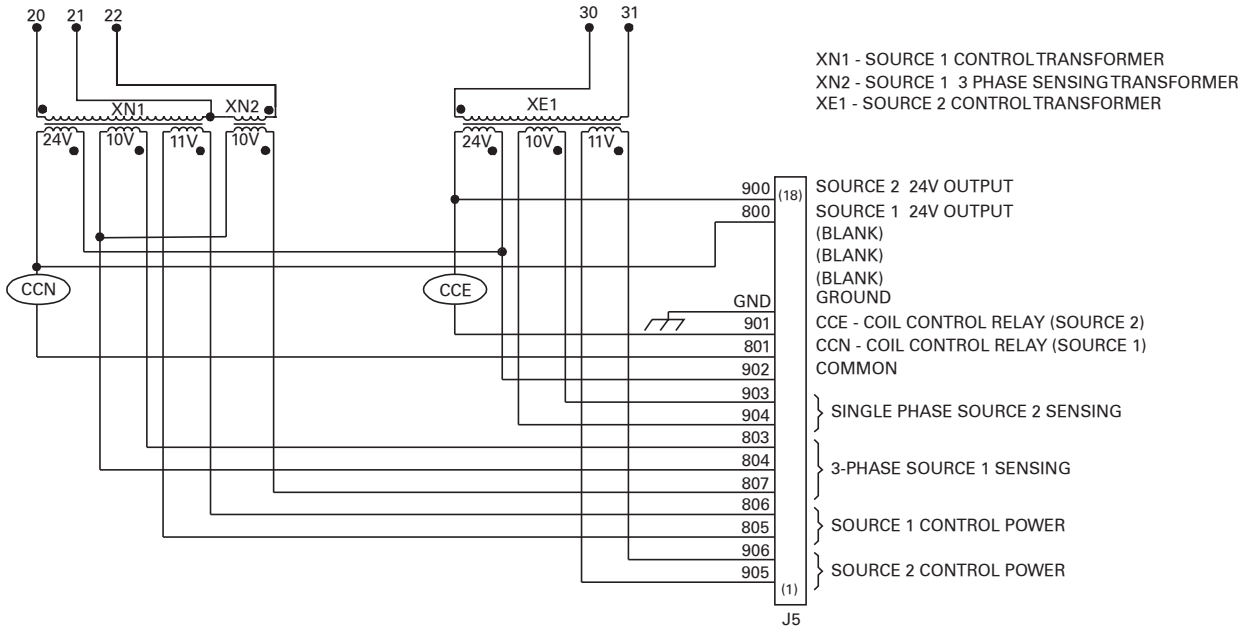
Transformer Usage

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
50P-1013	120V	K-3216	K-3224
50P-1014	208-220V	K-3217	K-3225
50P-1015	230-240V	K-3218	K-3226
50P-1016	277V	K-3219	K-3227
50P-1017	380-400V	K-3220	K-3228
50P-1018	416-440V	K-3221	K-3229
50P-1019	460-480V	K-3222	K-3230
50P-1020	575-600V	K-3223	K-3231

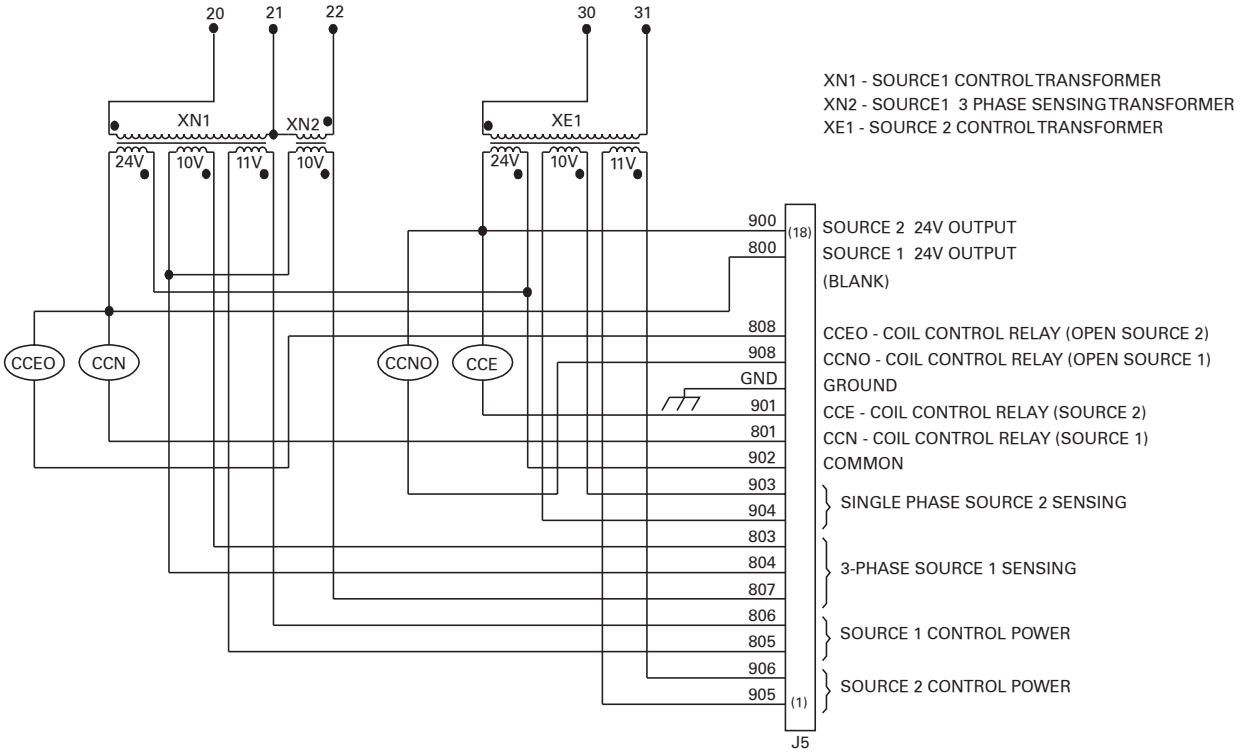
Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (25 VA)	2
2	See Chart	Transformer (1 VA)	1
3	K-1260	Coil Control Relay (24V)	4

Standard Transition R/T Box Schematic



Delayed Transition R/T Box Schematic



Troubleshooting and Diagnostics

⚠ DANGER ⚠

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.
These charts may indicate problems that require authorized GE Zenith service personnel.
Hazardous voltages may exist on termination plugs other than those that go into the MX150.

General Troubleshooting

The following troubleshooting guide is used to recognize, and determine basic faults. When using this guide, it will ask several questions about the condition of the switch. This guide will then list an order of the possible faults. You will then look at the first suspected fault to determine if it is the problem. If it is not a fault, you go to the second suspected fault. If you go through all of the suspected faults, or the chart instructs you to, call a GE Zenith Representative for further assistance.

NOTE: When you use the troubleshooting charts, the Annunciation column refers to the LED's on the control panel.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
Engine does not START	SOURCE 2 AVAILABLE LED off	Engine start wires not terminated properly	Check engine start connections
		Generator is in OFF position	Investigate why Engine Control Switch was turned off
Engine does not stop	LCD Display - "TD Engine Cool Down"	U timing cycle not complete	Check U timer setting
	SOURCE 1 POSITION, and SOURCE 1 and SOURCE 2 AVAILABLE LEDs on, but U timer has timed out	Engine start wires not terminated correctly	Check Engine Start Connections
		Generator in MANUAL	Place generator in AUTO
ATS will not transfer to SOURCE 2 ZTG Series	SOURCE 2 AVAILABLE LED off	SOURCE 2 voltage or frequency not within acceptable parameters	Check: Engine Start Connections, Generator Breaker, Generator Output, and Engine Control Switch
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "S1 _ _ _ _ TD XFR S1>S2 Time Remaining _ _ _ _"	**W** timing cycle not complete	Check **W** Timer setting
ATS will not transfer to SOURCE 1 ZTGD Series	LCD Display - "ATS Open Time Remaining _ _ _ _"	**DW** timing cycle not complete	Check **DW** Timer setting
	SOURCE 1 AVAILABLE LED off	SOURCE 1 voltage or frequency not within acceptable parameters	Check utility and utility breakers
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "Diagnostic Code 001"	Limit switch or RT box connector unplugged	Call Technical Services
	LCD Display - "S1 OK Time Remaining _ _ _ _ Bypass"	**T** timing cycle not complete	Check **T** Timer setting
	LCD Display - "ATS Open Time Remaining _ _ _ _"	**TD** timing cycle not complete	Check **DT** Timer setting

Maintenance and Testing

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

⚠ WARNING ⚠

Both power sources must be disconnected before manual operation of the switch.

A preventive maintenance program will insure high reliability and long life for the transfer switch. The preventive maintenance program for the transfer switch should include the following items:

Inspection and Cleaning

The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (do not use emery cloth or a file). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken or badly worn parts.

Servicing

All worn or inoperative parts must be replaced using GE Zenith recommended replacement parts. Please refer to the Replacement Parts manual for specific part information and ordering procedures. Please contact the GE Zenith Technical Services Department for the Replacement Parts manual.

The operating mechanism of the transfer switch is lubricated with Lubriplate 105. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional Lubriplate.

GE Zenith can provide complete preventative maintenance services. Please contact the GE Zenith Technical Services Department for additional information.

CDT battery replacement - lithium batteries may last up to 10 years, however it is recommended that battery replacement be included in a 3-5 year service cycle. The battery maintains the exerceser memory only and does not otherwise affect the operation.

Testing

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. **Both power sources must be disconnected before manual operation of the switch.** Insert the handle and operate the transfer switch between the Source 1 and Source 2 positions. The transfer switch should operate smoothly without binding. Return the switch to Source 1 position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the TS test switch. P timer will time out and the microcontroller will send an engine start signal. When the W time has elapsed, the switch will complete its transfer by closing into Source 2.

Deactivating the test switch will start retransfer to Source 1. The switch will complete its retransfer to Source 1 after the time delay of the T timer. The U engine overrun timer allows the engine generator to run unloaded for a preset cool down period.

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

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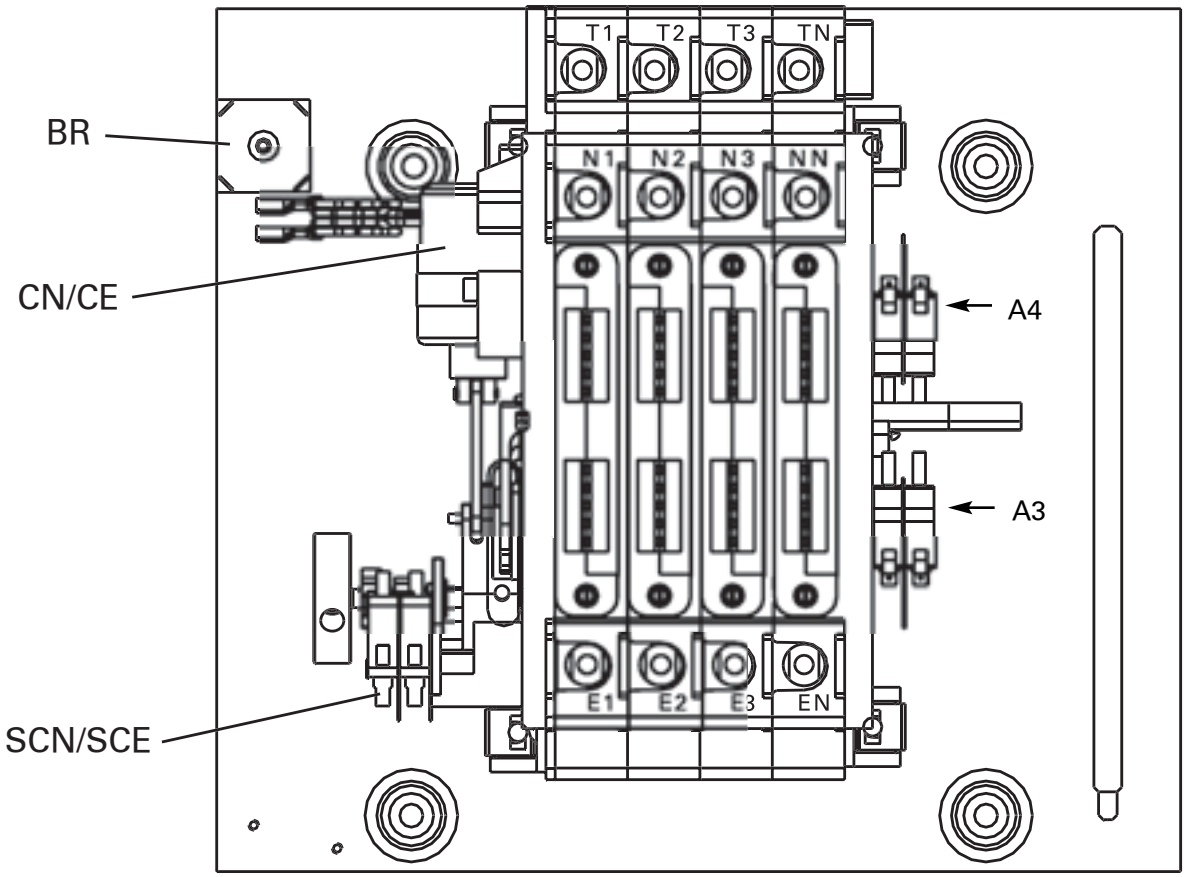
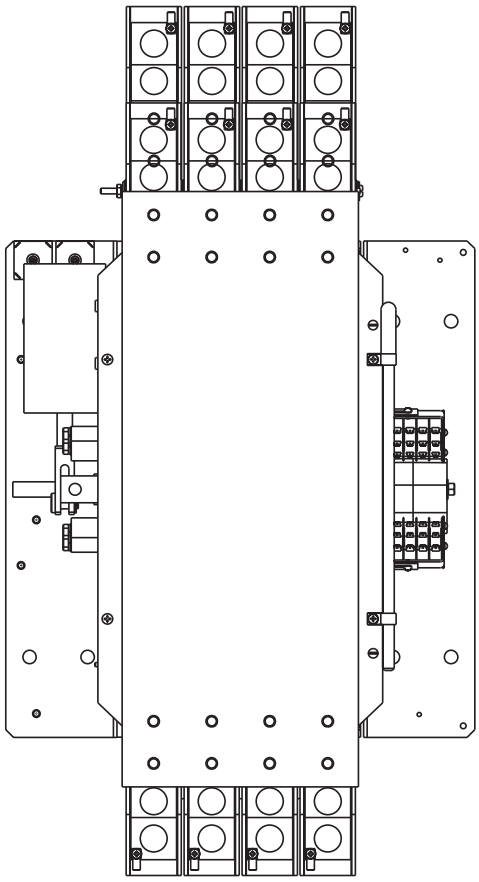
Power Panel and Replacement Parts

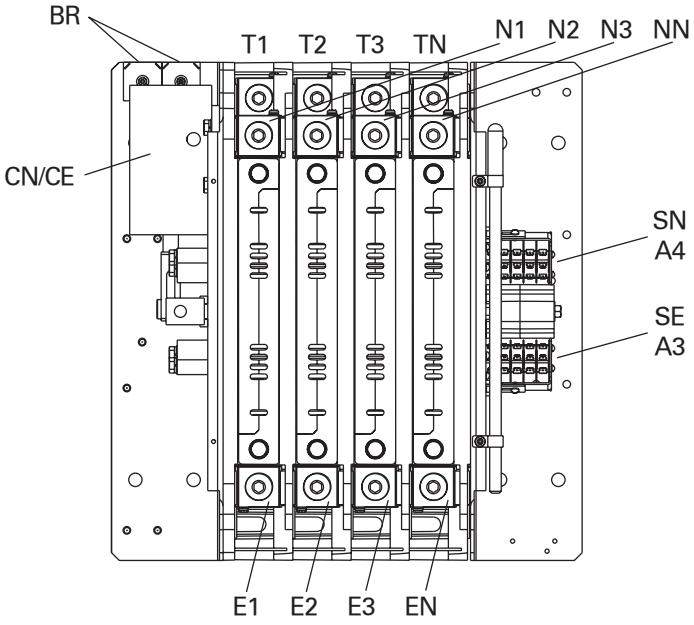
Standard Transition - 40 to 260 Amps Solenoid Type



Tag	Description	Recommended as Spares	Voltage 40 to 260 Amps	Part #
CN/CE	Solenoid	*	120V	K-2207
			208V	K-2208
			220V	K-2208
			240V	K-2228
			277V	K-2211
			380/416V	K-2212
			440/480V	K-2209
			575/600V	K-2213
	Solenoid Plunger and Link	*	ALL V	57P-1030
SCN/SCE	Coil Cutout Switch		120-480V	L-3078
SCN/SCE	Coil Cutout Switch		600V	L-4027
BR	Rectifier	*	100-240V	PS-5152
BR	Rectifier	*	241-600V	PS-5076
A3/A4	Auxiliary Contacts		ALL V	L-3078

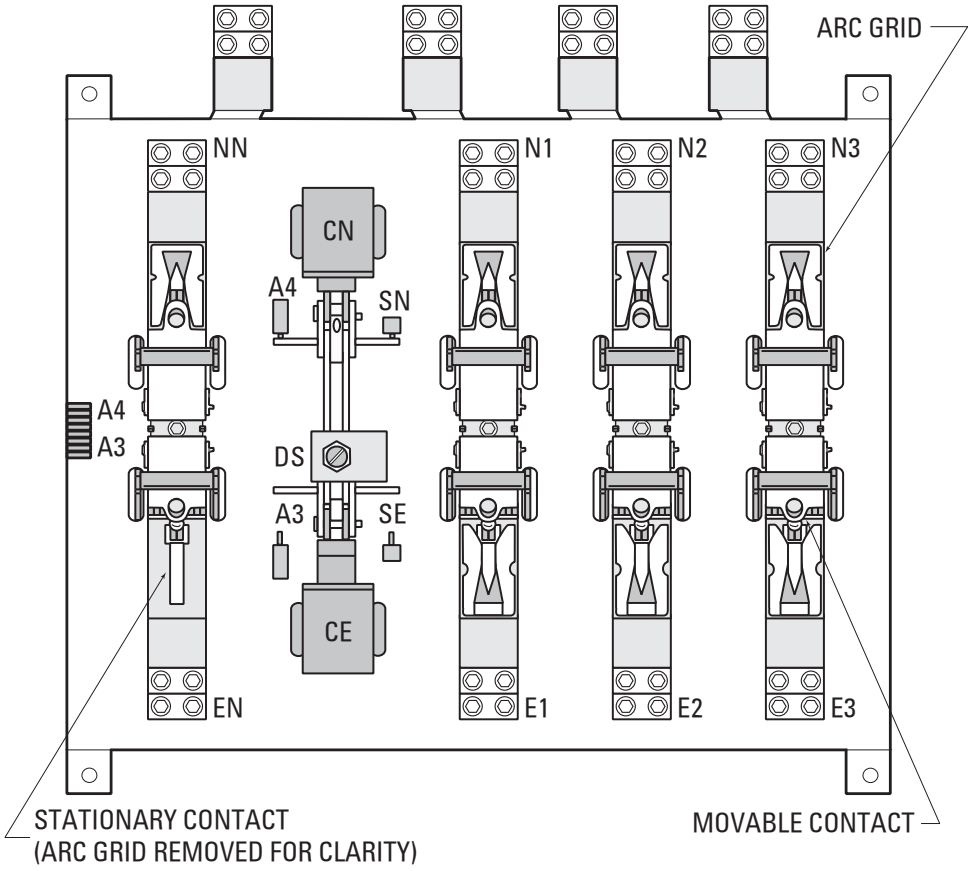
Standard Transition - 400 to 600 Amps Molded Type





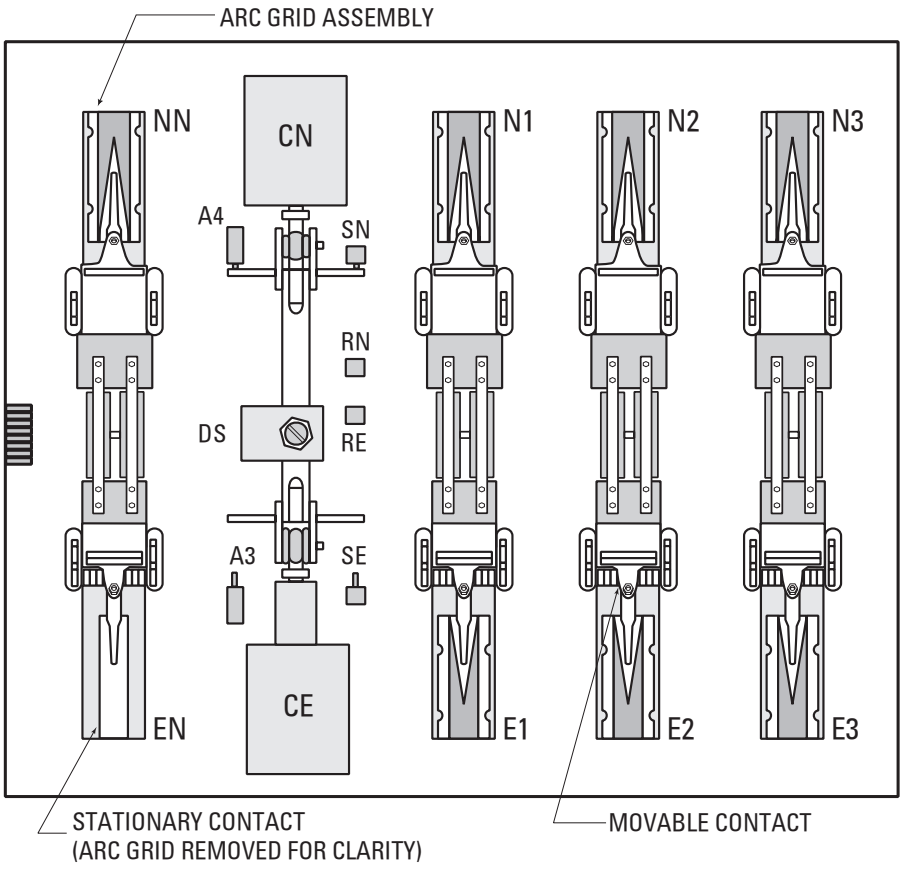
Tag	Description	Recommended as Spares	Stock Numbers by Amperage	
			400	600
N 1,2,3 N E 1,2,3 N T 1,2,3 N	Cable Connection Lug		S-2701	S-1393F
	Wire Size		#4-600 MCM	#2-600 MCM
			Coil Volts	
CN/CE	Solenoid	*	120	K-2245B
			208/220	K-2246B
			380/416	K-2247B
			440/480	K-2248B
			575/600	K-2249B
SN/SE	Coil Cutout Switches		L-3078	
A3/A4	Auxiliary Contacts			
BR	Rectifier	*	PS-5076	

Standard Transition - 800 to 1200 Amps



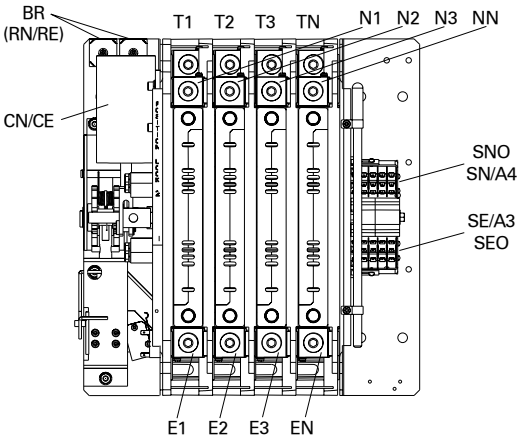
Tag	Description	Coil Volts	Poles	Recommended as Spares	Stock Numbers by Amperage 800	1000	1200
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug				S1392F (4)	S1392F (4)	S1392F (4)
	Wire Size				#2-600 MCM	#2-600 MCM	#2-600 MCM
	Stationary Contact Assembly Kit				Consult Factory		
	Arc Grid Assembly Kit				23P-1366		
	Movable Contact Assembly Kit				Consult Factory		
CN/CE	Main Operating Coils	Coil Volts	Poles	*			
		120	2		K-2073F	K-2073F	K-2073F
		240	2		K-2070F	K-2070F	K-2070F
			3		K-2070F	K-2070F	K-2070F
			4		K-2074F	K-2074F	K-2074F
		208	3,4		K-2074F	K-2074F	K-2074F
		575/600	3,4		K-2155	K-2155	K-2155
		480	3		K-2071F	K-2071F	K-2071F
			4		K-2071F	K-2071F	K-2071F
		416	3		K-2071F	K-2071F	K-2071F
SN	CCN Cutout Switch		23P-1333		23P-1333		
SE	CCE Cutout Switch		23P-1327		23P-1452		
A3	Emergency Position Auxiliary Contact		(Qty 1) 23P-1327 (Qty 2) 23P-1328 (Qty 3) 23P-1334 (Qty 4) 23P-1336				
A4	Normal Position Auxiliary Contact		(Qty 1) 23P-1333 (Qty 2) 23P-1334 (Qty 3) 23P-1328 (Qty 4) 23P-1330				
DS	Disconnect Switch (older versions)		Operator L-4009; Contact Block L-1020	*	Operator L-4009; Contact Block L-1020		

Standard Transition - 1600 to 3000 Amps

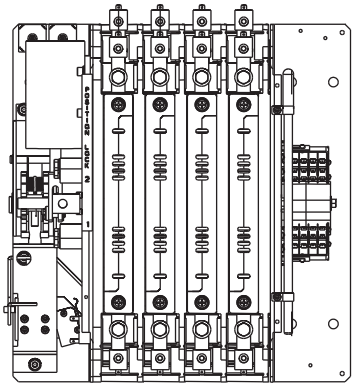


Tag	Description	Coil Volts	Poles	Recommended as Spares	Stock Numbers by Amperage 1600	2000	3000
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug				S1126F (2) Optional	S1126F (2) Optional	S1126F (2) Optional
	Wire Size				(8) #2-600 MCM	(8) #2-600 MCM	(8) #2-600 MCM
	Stationary Contact Assembly Kit				23P-1594	23P-1594	23P-1594
	Arc Grid Assembly Kit				23P-1171	23P-1171	23P-1171
	Movable Contact Assembly Kit				23P-1400	23P-1400	23P-1400
CN/CE	Main Operating Coils	Coil Volts	Poles	*			
		120	2		SPO	SPO	SPO
		240	2,3		K-2123F	K-2123F	K-2123F
			4		K-2127F	K-2127F	K-2127F
		208	3		K-2125F	K-2125F	K-2125F
			4		K-2128F	K-2128F	K-2128F
		575/600	3		K-2153F	K-2153F	K-2153F
			4		K-2154F	K-2154F	K-2154F
		480	3		K-2120F	K-2120F	K-2120F
			4		K-2130F	K-2130F	K-2130F
		416	3		K-2126F	K-2126F	K-2126F
SN	CCN Cutout Switch		23P-1352		23P-1352		
SE	CCE Cutout Switch		23P-1356		23P-1356		
A3	Emergency Position Auxiliary Contact		(Qty 1) 23P-1356 (Qty 2) 23P-1357 (Qty 3) 23P-1353 (Qty 4) 23P-1355				
A4	Normal Position Auxiliary Contact		(Qty 1) 23P-1352 (Qty 2) 23P-1353 (Qty 3) 23P-1357 (Qty 4) 23P-1359				
DS	Disconnect Switch (older versions)		Operator L-4009; Contact Block L-1020	*	Operator L-4009; Contact Block L-1020		
RN, RE	Rectifier		23P-1473 (Up to 240V); 23P-1582 (Up to 600V)	*	23P-1473 (Up to 240V); 23P-1582 (Up to 600V)		

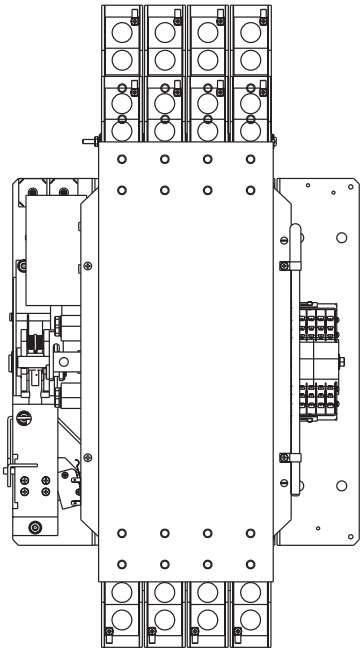
Delayed Transition - 40 to 600 Amps



100-400 Amps



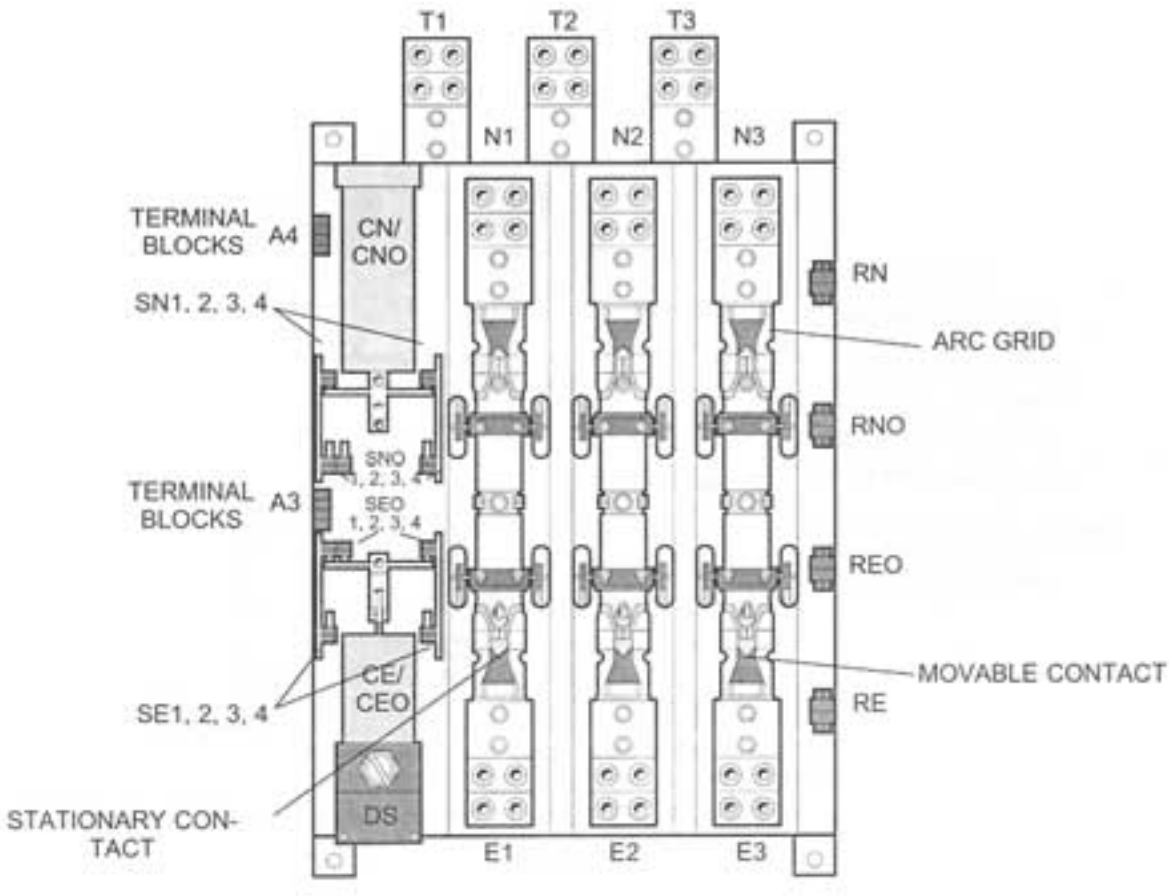
40-80 Amps



600 Amps

Tag	Description	Recommended as Spares		Stock Numbers by Amperage		
				40-80	100-400	600
N 1,2,3 N E 1,2,3 N T 1,2,3 N	Cable Connection Lug			S-2515	S-2701	S-1393F
	Wire Size			#8-3/0 AWG	#4-600 MCM	#2-600 MCM
			Coil Volts	MAIN	SECONDARY	
CN/CE	Solenoid	*	120	K-2245B	58P-1106	
			208/240	K-2246B	58P-1107	
			380/415	K-2247B	58P-1108	
			440/480	K-2248B	58P-1109	
			575/600	K-2249B	58P-1110	
			575/600	K-2249B	58P-1110	
	Handle-Manual		E-3054			
	Handle-Grip		L-3078			
A3/A4	Auxiliary Contacts		L-3078			
SNO/SEO	Coil Cutout Switch		E-3521			
BR	Rectifier (>380V)	*	PS-5076			
BR	Rectifier	*	PS-5152			

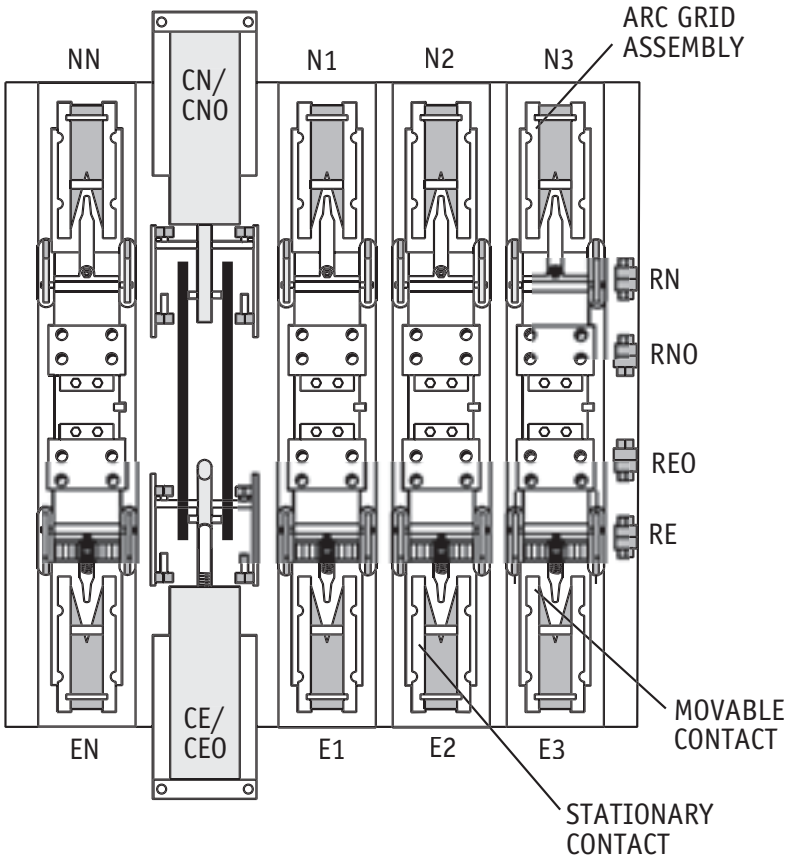
Delayed Transition - 800 to 1200 Amps



Tag	Description	Recommended as Spares	Stock Numbers by Amperage
			1000-1200
NL 1,2,3 EL 1,2,3 T 1,2,3 NN, EN, TN	Cable Connection Lug, CU Wire		2-1392F (4) 600MCM-2
	Stationary Contact Assembly Kit		26P-1336
	Arc Grid Assembly Kit		23P-1366
	Movable Contact Assembly Kit		26P-1334
	Movable Contact		26P-1335
RN/RNO RE/REO	Coil Rectifier	*	23P-1473 (Up to 240 VAC) 23P-1582 (Up to 600 VAC)
SN/SNO	Limit Switch		23P-1535(L); 23P-1533(R)
SE/SEO	Limit Switch		23P-1536(L); 23P-1534(R)
A3	Emergency Position Auxiliary Contact		23P-1536
A4	Normal Position Auxiliary Contact		23P-1535
DS	Disconnect Switch	*	Operator: L-4009; Contact Block: L-1020
CN/CNO CE/CEO	Main Operator Solenoids	*	**See Chart Below**

Voltage System					Solenoid Part No.
Volts	**Ph**	**Wire**	**Coil VDC**	**Pole**	**800-1200**
240	3	3	240	3	K-2147
120/208	3	4	208	3,4	K-2147
480	3	3	480	3	K-2157
277/480	3	4	480	3,4	K-2157
240/416	3	4	416	3	Consult Factory

Delayed Transition - 1600 to 3000 Amps



Tag	Description	Recommended as Spares	Stock Numbers by Amperage		
			1600	2000	3000
N1,2,3 E1,2,3 T1,2,3 NLN,ELN	Cable Connection Lug, CU Wire		S-1126F(2) Optional (8) 600MCM-2		
	Stationary Contact Assembly Kit		23P-4134X	23P-4134Y	23P-4134Z
	Arc Grid Assembly Kit		23P-1171	23P-1171	23P-1171
	Movable Contact Assembly Kit		23P-1400	23P-1400	23P-1344
CN/CNO CE/CEO	Main Operator Solenoids	*	**See Chart Below**		
Voltage System					**Solenoid Part No.**
Volts	**Ph**	**Wire**	**Coil VDC**	**Pole**	
120	1	2	120	2	S.P.O.	S.P.O.	S.P.O.
120/240	1	3	240	2,3	K-2151	K-2151	K-2151
240	3	3	240	3	K-2151	K-2151	K-2151
120/208	3	4	208	3,4	K-2151	K-2151	K-2151
480	3	3	480	3	K-2160	K-2160	K-2160
575	3	3	575/600	3	S.P.O.	S.P.O.	S.P.O.
277/480	3	4	480	3,4	K-2160	K-2160	K-2160
120/240	2	4	240	4	K-2151	K-2151	K-2151
240/416	3	4	416	3	Consult Factory		
Operating Coil Hardware Kit							
SN/SNO-1,2		Switch Bracket Assembly			23P-1540	23P-1540	23P-1540
SE/SEO-1,2		Switch Bracket Assembly			23P-1541	23P-1541	23P-1541
SN/SNO-3,4		Switch Bracket Assembly			23P-1542	23P-1542	23P-1542
SE/SEO-3,4		Switch Bracket Assembly			23P-1543	23P-1543	23P-1543

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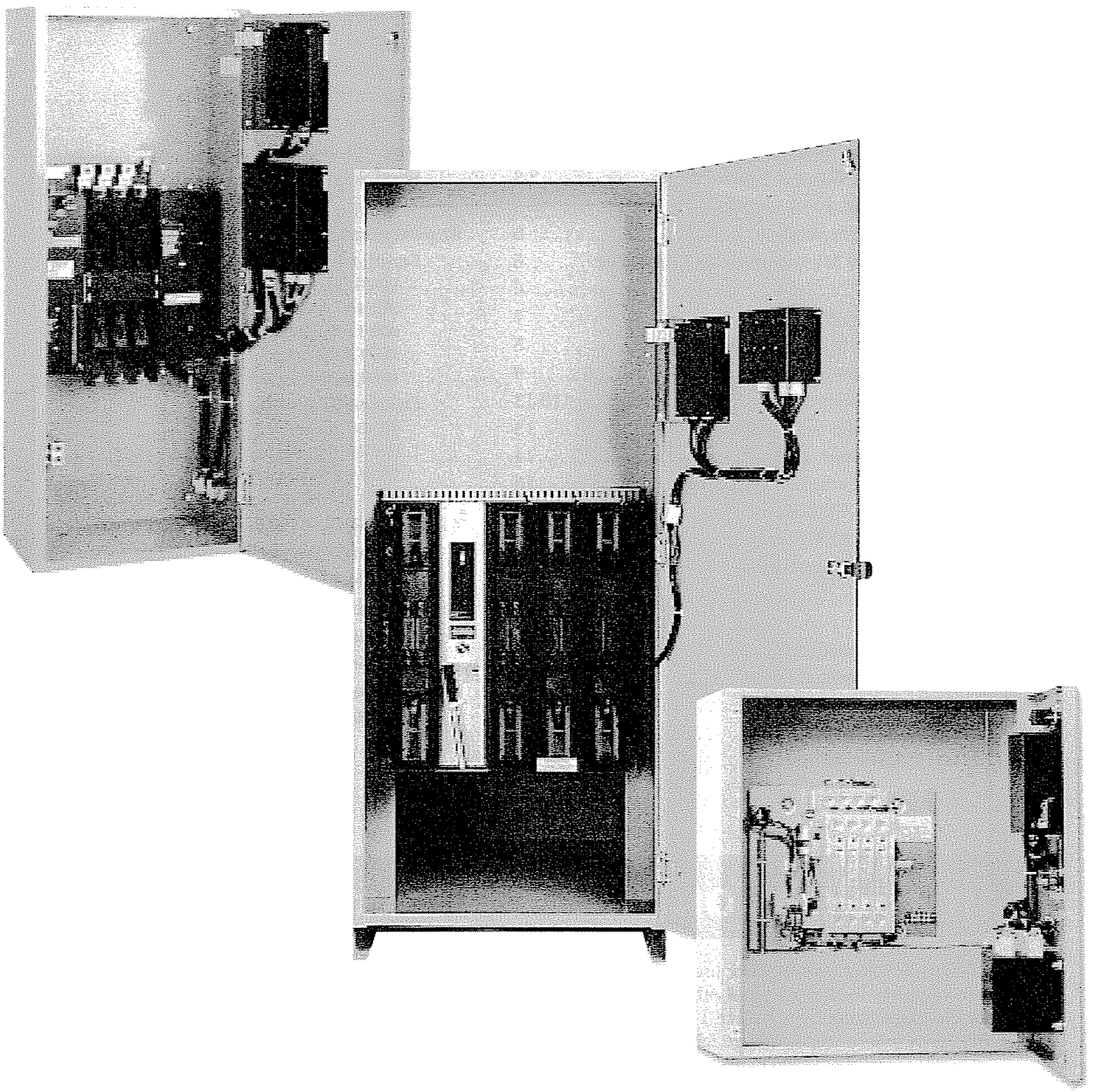
GE Zenith Controls

A Product of GE Industrial Systems
General Electric Company
830 West 40th Street, Chicago, IL 60609 USA
773 299-6600, Fax: 773 247-7805
www.geindustrial.com

GE Zenith Controls

ZTS/ZTSD Series Transfer Switches
40-4000 Amps



71R-3000
5/03

Operation and Maintenance Manual

Authorized Service

For GE parts and service, call: 773 299-6600

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Introduction

GE Zenith Transfer Switches are used to provide a continuous source of power for lighting and other critical loads by automatically transferring from source 1 power to source 2 power in the event that source 1 voltage falls below preset limits.

Voltage sensing and system control is performed via a state-of-the-art microcontroller located on the cabinet door. It is designed to give highly accurate control of the transfer switch system.

All GE Zenith transfer switches are designed for use on emergency or standby systems, and are rated for total system or motor loads. Transfer switches are UL Listed under Standard 1008 and CSA Certified under Standard C22.2 No. 178 and IEC Listed under Standard 947.

NOTES:

A protective device such as a molded case circuit breaker or fused disconnect switch MUST be installed on both sources of incoming power for circuit protection and as a disconnection device.

All references made within this manual about the term "S1" or "Source 1" relate to a Normal Power Source. All references made about the term "S2" or "Source 2" relate to an Emergency or Alternative Power Source.

Safety

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

The safe operation of your switch is GE Zenith's focus. The proper storage, installation, operation and maintenance will help increase the life of the switch.

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

Equipment Inspection and Storage

Once you have received the transfer switch, inspect it for any damage. This includes damage to the enclosure, power panel, control panel and wiring harness. If any damage is found or suspected, file a claim as soon as possible with the carrier and notify the nearest GE Zenith representative.

Before installation, if it is necessary, store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature	Operating Temperature (Ambient):	Humidity
-30°C to +75°C (-22°F to +167°F)	**40-400 AMP** *(molded shell)* -20°C to +65°C (-4°F to +149°F) **40-4000 AMP** *(all other frame and panel types)* -20°C to +60°C (-4°F to +140°F)	5% to 95% (non-condensing)

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred, with a vacuum, due to shipment or installation.

⚠ WARNING ⚠

Do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections.
4. Verify the correct connection of all control wires.
5. Check settings of all timers and adjust as necessary.
6. Adjust any optional accessories as required.
7. Check the lug torque values of the power connections.

   NOTE: Lug torque values are specified in table 2 on pg.2.

8. Make sure that all covers and barriers are installed and properly fastened.

   NOTE: Power panels ship from GE Zenith in Source 1 Position.

Each GE Zenith transfer switch is factory wired and tested. A complete information package is furnished with each switch which includes:

a. Sequence of operation.
b. Description and operation of all accessories supplied.
c. Power panel connection diagram and schematic.
d. Description and identification of all customer field connections.

Installation of GE Zenith transfer switches includes:

a. Mounting the transfer switch cabinet.
b. Connection of Source 1, Source 2, and Load cables or bus bars.
c. Connection of external control circuits as required.

Mounting

Adequate lifting means must be used to mount the transfer switch into place. The recommended method for moving the transfer switch using the lifting eyes, where supplied, and a spreader bar is illustrated in *Figure 1.* Enough room should be allowed to open the cabinet doors fully for inspection and servicing of the switch per NEC and local codes.

⚠ CAUTION ⚠

Before drilling conduit entry holes or any accessory mounting holes, cover and protect the switch and control panel to prevent dirt and metal fragments from entering the mechanical and electrical components.

Failure to do so may result in damage and malfunction of the switch.

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Power Connections

GE Zenith transfer switches are supplied with UL listed solderless screw type terminals as standard for the Source 1, Source 2 and Load power connections. *Table 1* lists the number and sizes of cable lugs supplied as standard for each switch amp rating.

Connect the Source 1, Source 2, and Load conductors to the clearly marked terminals on the transfer switch. Remove surface oxides from cables by cleaning with a wire brush. Verify that all connections are correct before tightening the lugs. All cable lug connections must be tightened to the proper torque values as shown in *Table 2*.

NOTE: Do not run cables or wiring behind front-connected transfer switches.

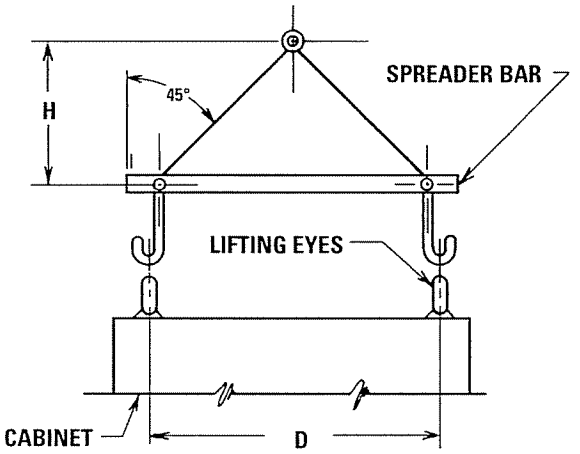

Figure 1

NOTE: When lifting the switch using a spreader bar, height H must be equal to half of distance D.

Power Connections: Screw Type Terminals for External Power Connections				
Switch Size (Amps)	Source 1, Source 2 & Load Terminals		Neutral Bar (When Required)	
	Cable Per Pole	Range of Wire Sizes	No. of Cables	Range of Wire Sizes
40	1	#8 AWG to 1/0	3	#8 AWG to 1/0
80	1	#8 AWG to 1/0	3	#8 AWG to 1/0
100	1	#8 AWG to 1/0	3	#8 AWG to 1/0
150	1	#8 AWG to 3/0	3	#8 AWG to 300 MCM
200, 225, 2500	1	#6 AWG to 250 MCM	3	#6 AWG to 300 MCM
260, 300*, 400	1	#4 AWG to 600 MCM	3	#4 AWG to 300 MCM
600	2	#2 AWG to 600 MCM	8	#2 AWG to 600 MCM
800, 1000, 1200	4	#2 AWG to 600 MCM	12	#2 AWG to 600 MCM
1600, 2000 2600, 3000, 4000	Line, Load and Neutral terminals are located in the rear of switch and arranged for bus bar locations			

Table 1

Engine Start Control Connections

Engine-start control wires connect to control terminals beside the Entelli-Switch 250. Engine start terminals are indicated by a schematic symbol (the symbol indicates the contact state for a de-energized normal source). *Figure 2* shows the engine-start contacts.

Make all other necessary control connections to the control panel terminal blocks per the schematics supplied with the ATS.

NOTE: All control wires (18-12 AWG) must be torqued to 19 in/lbs.

Tightening Torque for Lugs		
Socket Size Across Flats	Torque	
	Lb. - In.	Lb. - Ft.
1/8	45	4
5/32	100	8
3/16	120	10
7/32	150	12
1/4	200	17
5/16	275	23
3/8	375	31
1/2	500	42
9/16	600	50

Table 2

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

E

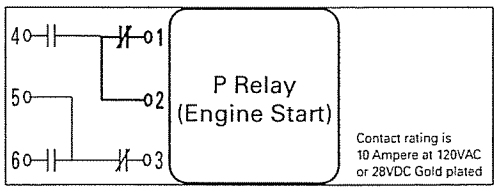

Figure 2

Engine Start Control Connections

The engine-start terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Transfer Switch. Figure 5 (pg.5) shows location of engine start connections for Automatic Transfer Switch.

Terminals for field connections to the A3 Source 2 auxiliary contacts and the A4 Normal auxiliary contacts are also provided. These terminals are clearly marked and appear on the side of the power panel. On 400 amp metal frame units these terminals appear on the bracket above the operator handle.

Initial Energization

Before proceeding, refer to the information package supplied with the ATS and read and understand the information on all accessories provided.

1. Unlock the enclosure.
2. Open the enclosure.
3. Verify the correct system voltage.

   NOTE: The equipment rating nameplate on the transfer switch lists the voltage. See *Figure 3.*

4. Close Source 1 circuit. breaker.

   NOTE: The controller will illuminate Source 1 Available LED if proper voltage is sensed.

5. Verify the phase to phase voltages at Source 1 line terminals.
6. Close Source 2 source circuit breaker.
7. Start the generator's engine.

   NOTE: The controller will illuminate Source 2 Available LED when preset voltage and frequency levels are reached.

8. Verify the phase to phase voltages at Source 1 line terminals.
9. Verify that the phase rotation of Source 1 is the same as the phase rotation of Source 2.

10. Shut down the generator's engine.
11. Place the starting control in the Automatic position.
12. Complete the visual inspection of the transfer switch.
13. Close the enclosure.
14. Lock the enclosure.

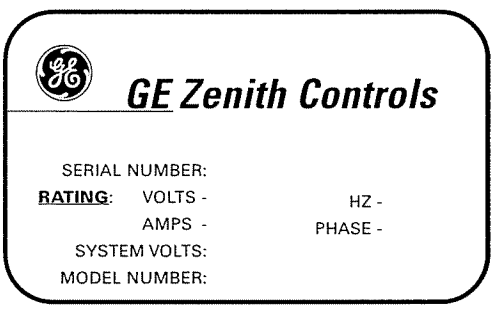

Figure 3

⚠ CAUTIONS ⚠

Certain accessories, per specific schematics, can inhibit automatic transfer.

Engine Gen-Set could start when engine control wires are attached.

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Initial Energization (cont'd)

After all options and accessories are checked and verified, follow these steps to set up the ATS. Refer to Entelli-Switch 250 display *Figure 4*. The annunciation LEDs illuminate to indicate (1) source availability, (2) ATS position, and (3) Entelli-Switch 250 control function (timing).

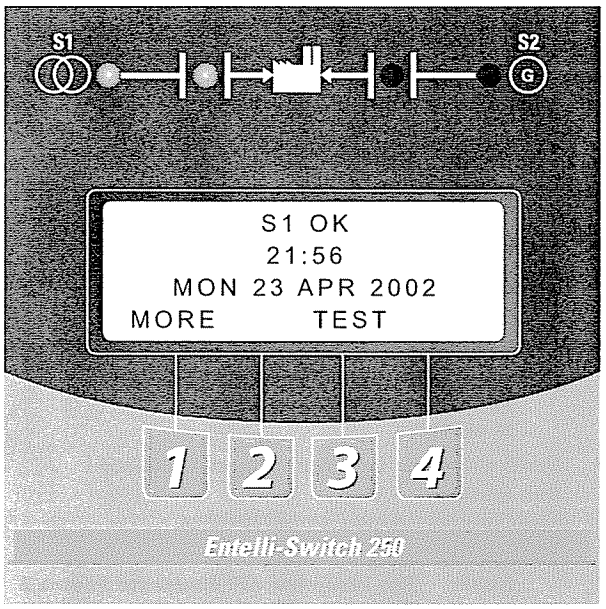

Figure 4 – LCD and keypad

1. Unlock the enclosure.
2. Open the enclosure.
3. Place the Disconnect Switch in the Inhibit.

   NOTE: This step is only performed if the "DS" Option was purchased.

4. Close the external (up-stream) Source 1 circuit breaker.

   NOTES: Source 1 Available and Source 1 Position LED's will illuminate.

   If Source 1 Available LED does not illuminate, verify that Source 1 Voltage is above the preset restore value.

   The Gen-Set will start and run while Source 2 stop Delay Timer is timing.

5. Close the External (up-stream) Source 2 line circuit breaker.
6. Start the engine generator in MANUAL mode.

   NOTE: When the voltage and frequency reach preset values, the Source 2 Available LED will illuminate.

7. Verify the phase to phase voltages at Source 2 line terminals.
8. Verify that the phase rotation of Source 2 is the same as the phase rotation of Source 1.

9. Shut down the generator's engine. (Place in Automatic Mode.)

   NOTE: Source 2 Available LED will turn off.

   NOTE: The engine generator will continue to run for the duration of Source 2 Stop Delay Timer.

10. Place the disconnect switch to ENABLE.
11. Complete the visual inspection of the transfer switch.
12. Close the enclosure.
13. Lock the enclosure.

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

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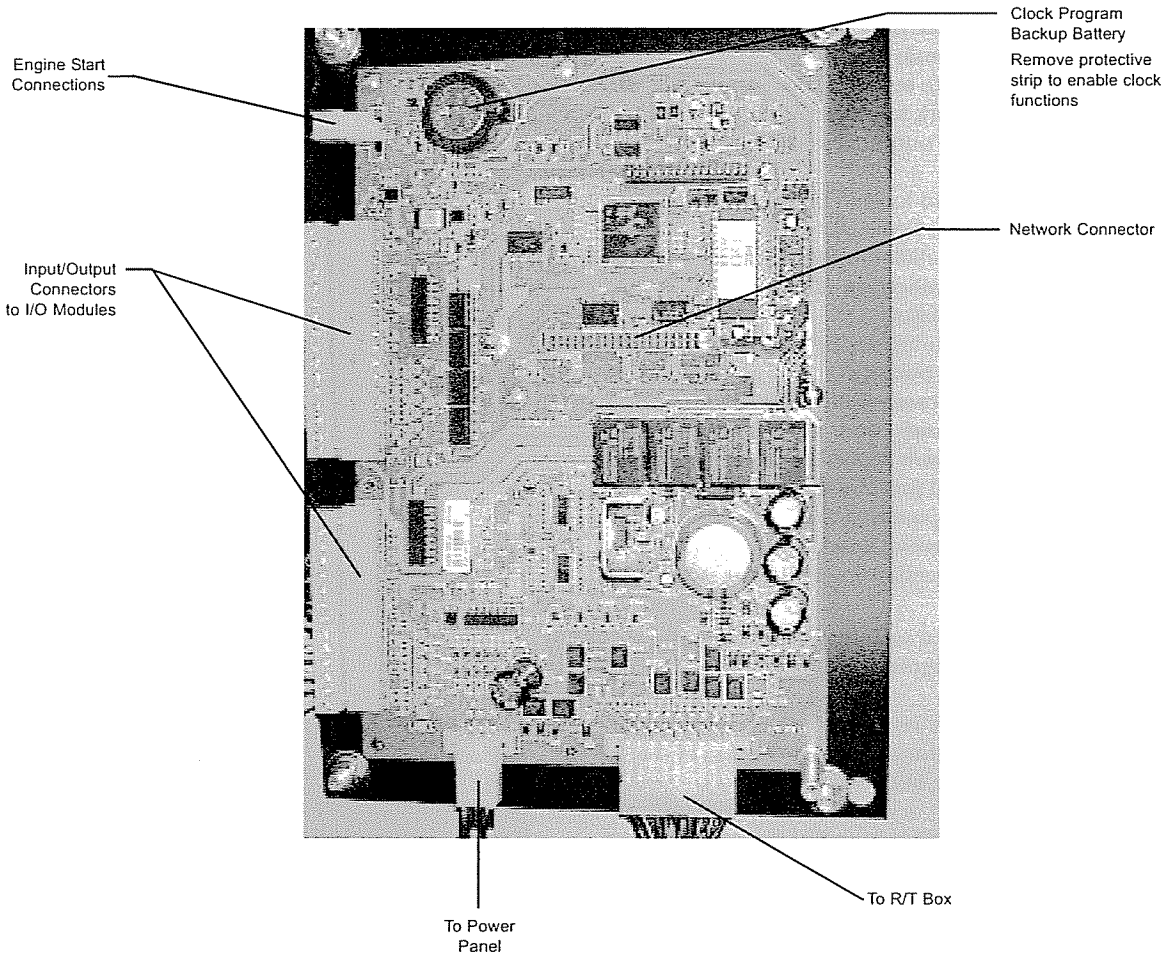
⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Control Connections

Figure 5



A complete information package is furnished with each transfer switch including a complete connection diagram and schematic which details all necessary control circuit field connections.

The engine start control wires connect to the engine start relay terminals located to the left of the microprocessor. Figure 5 shows the location of these terminals.

The terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

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Entelli-Switch 250 Controller

Consists of two major assemblies:

I. The **Microprocessor** contains the following:

A. Entelli-Switch 250 Board - Customer Input and Output (I/O) for system interface. Located on the left hand side of the back of the unit (see figure 6)

1. I/O accessories that can be found here are:
   a. Engine start relay P output
   b. Pre-Signal to transfer T3, W3 and UMD output (optional)
   c. Transfer Inhibit Q3 and Q7 input (optional)
   d. Remote test Q2 input (optional)
   e. Network interface ZNET input/output (optional)

B. LCD and Keypad located on the exterior of the door (see figure 7)

1. User accessibility to the following:
   a. LED indication of source availability
   b. LED indication of transfer switch position
   c. LCD screen indicates:
      (1) timer count down (numeric)
      (2) event reporting (text)
   d. Keypad provides user interface to: *[in conjunction with LCD screen]*
      (1) Setting sensors and timers
      (2) Configuring logic accessories

II. The **R/T box** (relay transformer box) contains the following: (see figure 6)

A. Relays which are required for controller output to energize the transferring mechanism of the transfer switch at line voltage.

B. Transformers which drop line voltage to control level for controller input.

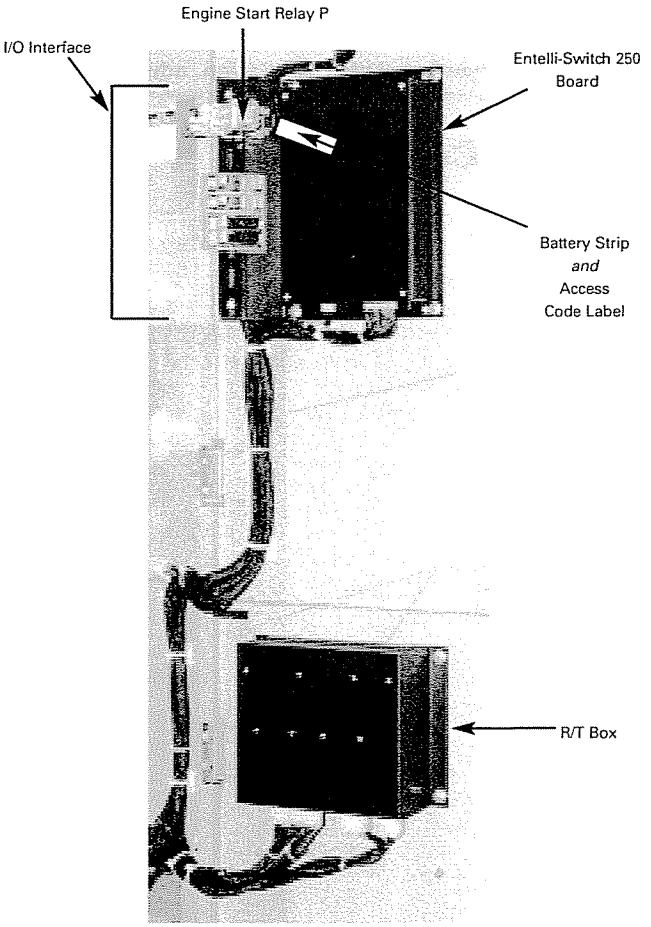

Figure 6

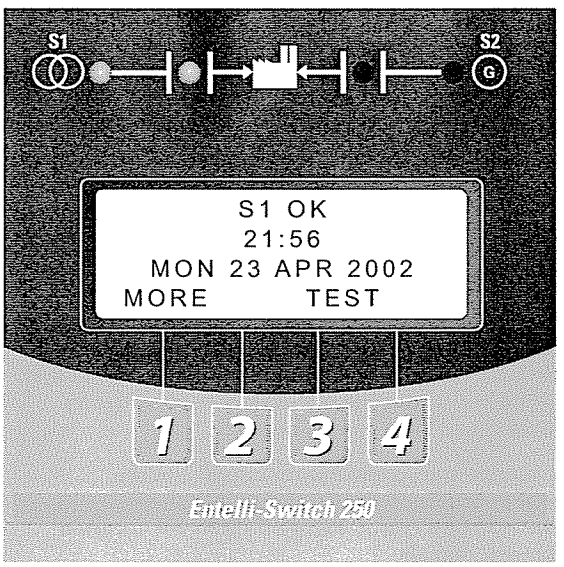

Figure 7

LCD & Keypad

These options are accessible through the LCD and keypad (see figure below). To become familiar with the options loaded into a particular unit, scrolling through the SET and CFG menu will show the descriptions of the options (see pages 16-17). These menus are the very same menus that are used to access the setting and/or configuration of these options. The SET (setting) menu is primarily used to show or change, time and voltage settings. The CFG menu is primarily used to turn an option on or off. When scrolling through these menus, no changes can be made without entry of the access code. The factory set six-digit access code is located on a white label on the back of the unit (see figure 10 pgs. 16-18).

The Entelli-Switch 250 has many logic options. Each controller is downloaded with options at the time of manufacture. The collection of options that any one controller has is specified at the time of order placement. The following pages include all the options that can reside in the controller. Not all units include all options.

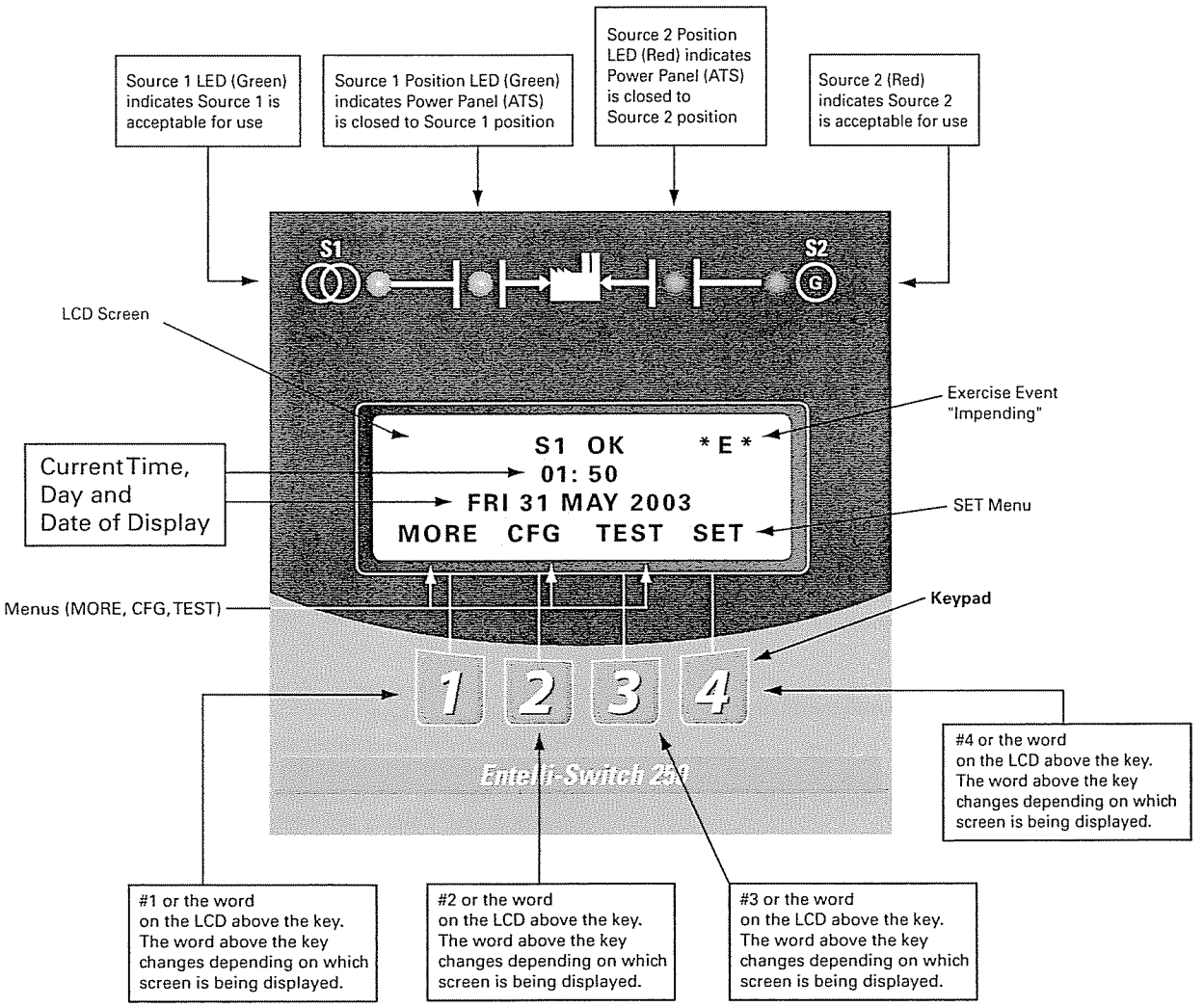

Figure 8

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User Setting for Voltage & Frequency

Standard 3-Phase Sensing on 3 and 4 Pole Units

Source 1

Under Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 1.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 17).
Once satisfied, the T timer will begin timing to transfer to Source 1.

Under Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold.
Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, P timer begins timing to signal Source 2 Generator to start.

Under Frequency "Restore"
Factory Default: 95%
This adjustment determines the minimum acceptable frequency required to transfer to Source 1.
Adjust via the SET menu. Range is 90% to 100% in 1% increments (see page 17).
Once satisfied, the T timer will begin timing to transfer to Source 1.

Under Frequency "Fail"
Factory Default: 90%
This adjustment determines the low frequency threshold.
Adjust via the SET menu. Range is 88% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once satisfied, the T timer will begin timing to transfer to Source 1.

Over Frequency "Restore"
Factory Default: 102%
This adjustment determines the minimum acceptable Over Frequency threshold at which the transfer switch is allowed to re-transfer to Source 1.
Adjust via the SET menu. Range is 102% to 104% in 1% increments (see page 17). "Restore" must be a minimum of 1% below "Fail" setting.

Over Frequency "Fail"
Factory Default: 105%
This adjustment determines the maximum acceptable Over Frequency.
Adjust via the SET menu. Range is 103% to 105% in 1% increments (see page 17).Once exceeded, the P timer begins timing to signal the generator to start.

Source 2

Under Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 2.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 17).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Under Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold.
Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, T timer will be bypassed to expedite the transfer to Source 1.

Over Voltage "Fail"
Factory Default: 110%
This adjustment determines the maximum acceptable Over Voltage. Adjust via the SET menu. Range is 105% to 110% in 1% increments (see page 17). Once exceeded, the T timer will be bypassed to expedite the transfer to Source 1.

Over Voltage "Restore"
Factory Default: 105%
This adjustment determines the minimum acceptable Over Voltage threshold at which the transfer switch is allowed to transfer to Source 2. Adjust via the SET menu. Range is 103% to 105% in 1% increments (see page 17). "Restore" must be a minimum of 2% below "Fail" setting.

Under Frequency "Restore"
Factory Default: 95%
This adjustment determines the minimum acceptable frequency required to transfer to Source 2.
Adjust via the SET menu. Range is 90% to 100% in 1% increments (see page 17).
Once satisfied, the W timer will begin timing to transfer to Source 2.

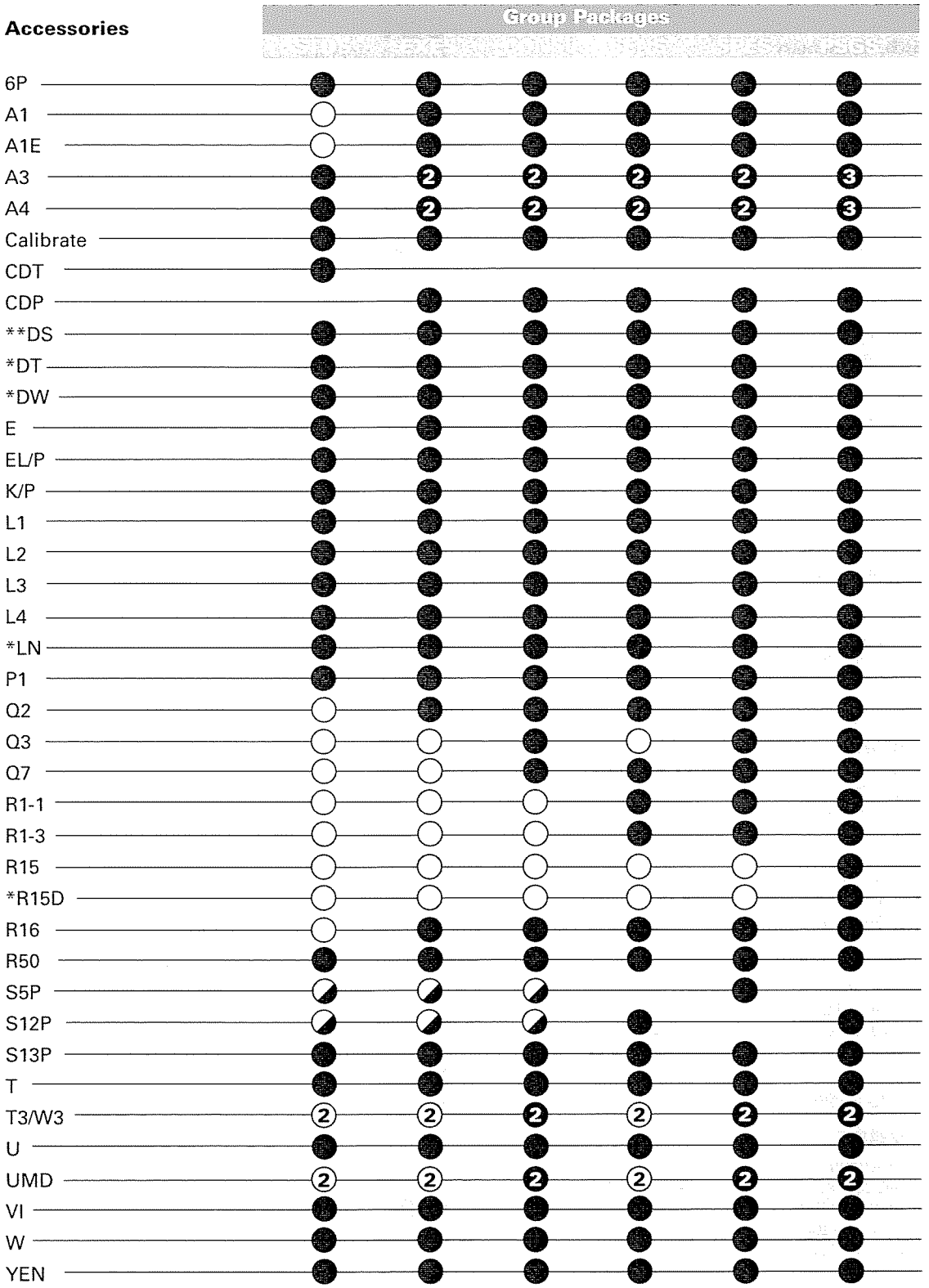
Under Frequency "Fail"
Factory Default: 90%
This adjustment determines the low frequency threshold.
Adjust via the SET menu. Range is 88% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once satisfied, the W timer will begin timing to transfer to Source 2.

Over Frequency "Fail"
Factory Default: 105%
This adjustment determines the maximum acceptable Over Frequency. Adjust via the SET menu. Range is 103% to 105% in 1% increments (see page 17). Once exceeded, the T timer will be bypassed to expedite the transfer to Source 1.

Over Frequency "Restore"
Factory Default: 102%
This adjustment determines the minimum acceptable Over Frequency threshold at which the transfer switch is allowed to re-transfer to Source 2. Adjust via the SET menu. Range is 102% to 104% in 1% increments (see page 17). "Restore" must be a minimum of 1% below "Fail" setting.

Accessory Group Packages

Table 3



● Standard Accessory included in the group package.
○ Optional Accessory not included but can be added to group package.
◪ Optional Accessory. Can not be used with accessory having the same symbol.
— N/A
②❷ Denotes an Accessory with 2 circuits as a standard.
❸ Denotes an Accessory with 3 circuits as a standard.

* Delayed Transition Units Only.
** Optional for 40-400 Amp

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Accessory Definitions

6P
Test Switch, Momentary

6A
Test Switch, Maintained Auto/Momentary Test

6AP
Test Switch, Maintained/Momentary utilizing keypad

6B
Test Switch, Maintained - Auto / Momentary - Test, Key Operated

6C
Test Switch, Maintained - Auto / Maintained - Test, Key Operated

A1
Auxiliary Contact, operates on Source 1 line failure.

A1E
Auxiliary Contact, operates on Source 2 line failure.

A3
Auxiliary Contact: Closed in emergency (Source 2) Additional Available (10 max.) and need to be specified.

A4
Auxiliary Contact: Closed in normal (Source 1) Additional Available (10 max.) and need to be specified.

A62
Sequential Universal Motor Load Disconnect Circuit. Normally closed auxiliary contacts for motor loads. Open 0-60 seconds prior to transfer, after transfer, or both in either direction then re-close in timed sequence after transfer.

AB3
Auxiliary Contact: Closed in bypass emergency (Source 2) (S.P.D.T.) (Standard up to 400 Amp) Additional Available (10 max.) and need to be specified.

AB4
Auxiliary Contact: Closed in bypass normal (Source 1) (S.P.D.T.) (Standard up to 400 Amp) Additional Available (10 max.) and need to be specified.

B9
Battery charger connections.

Calibrate
While monitoring the actual Phase to Phase voltage levels and Frequency with a calibrated test equipment, the Phase to Phase voltage sensing and Frequency can be adjusted accordingly. Calibration capabilities are available for Frequency and AB, BC, CA Phase to Phase voltage for both Sources. Adjust via SET menu (see page 18)

CDP
Clock Exerciser Load/ No Load: Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 365 day cycle. (See page 16)

CDT
Load or NO-Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1, 7, 14, or 28 days. Factory Default is 20minutes. When exerciser is impending, (*E*) appears in the upper right hand corner of LCD screen. See page 15 for instructions. Configured via CFG (see page 17). Set via SET menu (see page 18).

CTAP
Alarm Panel on transfer to Source 2 with Silence button.

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(40-400 Amps optional, 600-4000 Amps standard)

DT *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 1 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds Adjust via SET menu (see page 18)

DW *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 2 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds.Adjust via SET menu (see page 18)

E
Engine Start Contact

EL/P
Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
System Data: Total Life Transfers (N2P)
Days Powered Up
Total Transfers to S2
Total S1 Failures
Time S1 available in Hrs
Time S2 available in Hrs. (N1P)

F
Fan contact, operates when generator is running.

HT
Heater and Thermostat

K
Frequency Meter, Door mount.

K/P
Frequency Indication for S1 and S2

L
LNP Center-off position LCD-Indicator
Indicating LED lights:
- **L1** Indicates Switch in Source 2 position.
- **L2** Indicates Switch in Source 1 position.
- **L3** Indicates Source 1 available.
- **L4** Indicates Source 2 available.

Accessory Definitions (cont'd)

M1
Single Phase Amp Meter

M2
Three Phase Amp Meter

M80
3000 Digital Power Monitor

M82
5200 Digital Power Meter

M83A
EPM 5300 Digital Power Meter with Modbus Port

M83B
EPM 5350 Digital Power Meter with Ethernet Port

M84
7430 Digital Power Meter , Wye or Delta

M85A
EPM 9450 Digital Power Meter, Ethernet

M85B
EPM 9450 Digital Power Meter with Internal 56K Mod.

M86A
EPM 9650 Digital Power Meter, Wye or Delta, RS232 or RS485

M86B
EPM 9650 Digital Power Meter, Wye or Delta, RS232 or RS485

N1
Running Time Meter, Door mount

N2
Operation Counter, Door Mount

P1
Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting is 3 seconds.
Adjust via SET menu (see page 18)

P2
Time Delay S2 Start. Adjustable 1/6 to 300 seconds.

Q2
Remote Peak Shave or Area Protection Circuit. Energize Q2 to simulate Source 1 Line failure causing the Generator to start and transfer the load to Source 2. Should Emergency fail during this operation, Transfer Switch will retransfer back to Source 1.

Q3
Remote inhibit transfer to Source 2 circuit. Energize Q3 input to allow transfer to Source 2. To enable Q3 option, engage Q3 jumper.

Q7
Inhibit transfer to Source 1 circuit. Energize Q7 input to prevent transfer to Source 1.

R1-1/R1-3
Source 1 Over Voltage sensing for single and three phase systems.
Source 1 Over Voltage "Fail"
Factory Default: 110%
This adjustment determines the maximum acceptable over voltage. Adjust via the SET menu. Range is 105% to 110% in 1% increments (see page 18).
Once exceeded, the P timer begins timing to signal the Generator to start.

Source 1 Over Voltage "Restore"
Factory Default: 105%
This adjustment determines the minimum acceptable over Voltage threshold at which the Transfer Switch is allowed to automatically transfer to Source 1. Adjust via SET menu. Range is 103% to 108% in 1% increments. "Restore" must be a minimum of 2% below "Fail" setting (see page 18).

R15/R15D
Load Shed
Should Source 2 become overloaded, a signal can be given to switch to the dead or Mid position.

R16
Phase Rotation Sensing
Can be turned on or off via CFG menu (see page 17).
Factory Default is on.
This feature prevents Line Source to Line Source transfers from occurring between dissimilar phase sequences. This condition is primarily caused by an installation error. Connections from Source 1 and Source 2 need be verified, compared, and corrected to remedy the inconsistent phase rotation between the sources.
WARNING: Turning off this feature can cause severe damage to loads.

R26
Interruptable Power Rate Provisions.
Allow transfer out of Source 1 position to Source 2 or dead Source 2. Alarm and Pre-Signal circuit included.

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R50

In Phase Monitor this feature restricts **Live to Live Source Transfers** to occur unless both Sources are within 7 electrical degrees or less of each other. (live Source to live Source transfers usually occur during transfer back to Source 1 or during Testing). R50 does not change the operation of the Automatic Transfer Switch in a power failure mode. After all timer functions have elapsed, **the CHECKING FOR SOURCE SYNCHRONISM** will be displayed as well as the direction of transfer (S1-S2 for example denotes transfer from Source 1 to Source2). When synchronism is accomplished, transfer will take place.

Notes:
- **If S2 Frequency is less than S1 Frequency, display will show a series of (-----.....) symbols.**
- **If S2 Frequency is greater than S1 Frequency, display will show a series of (+++++.....) symbols.**
- **Each (-) or (+) symbol represents 10 electrical degrees out of phase. A maximum of 18 symbols (180 electrical degrees) can be monitored.**
- **The number of (-) or (+) symbols decrease as the two sources approach synchronism and increase as the two sources drift out of synchronism.**
- **If S1 and S2 Frequencies are identical, the display will show a series of alternating symbols (+-+-+...) which also indicate the approximate out of phase degrees**

In the event that the Sources do not come within 7 electrical degrees of each other within 60 seconds, the unit will display the message: **SYNCH CHECKING** and will allow the user to **BYPASS**. If the **BYPASS** button is pressed, the unit will display the message: **WARNING MAY CAUSE DAMAGE TO THE LOAD**. Pressing **XFR** will actually bypass the R50. Since R50 is a passive device, the length of time it takes to reach Synchronism is dependent on the frequency difference between the two Sources. Source 1 is usually a Utility and the frequency is not within the control of the consumer. Source 2 needs to be adjusted to create an adequate difference in order for the transfer to happen a timely fashion.

Note: For optimum performance, Source 2 Generator should be adjusted a Maximum of 2 Hertz above or below the Utility frequency, minimum of 0.1 Hertz. (58 to 59.9) or (60.1 to 62) Hertz. Adjustment of Generator to 60Hertz could cause lengthy transfer delay.

R50 Feature can be turned ON or OFF via CFG Menu (see page 17). Factory Default if OFF.

S5P

Auto / Semi Manual selector
In "Auto" position, retransfer to Source 1 is automatic after the T timer has timed out. The T time delay is bypassed if Source 2 fails.
In "Manual", retransfer to Source 1 is upon depression of BYPASS DELAY button YEN or if Source 2 fails.

S12P

Auto / Manual Selector
In "Auto" position, the Automatic Transfer Switch functions automatically as specified with the Switch drawings.
In "Manual" the Automatic Transfer Switch will transfer to either direction upon depression of Source 1 or Source 2 transfer buttons.
Should Source 1 fail, the Generator (Source 2), will automatically start. Once transferred in Manual, the Switch maintains position selected even if selected power fails.

S13P

Transfer Commit. Configured via CFG menu.
(see page 17) When this Feature is set to OFF:
The transfer Switch is not committed to transfer unless the outage duration is longer than the timers that precede the transfer to Source 2 position. This assumes that the outage will be an isolated event. When this Feature is set to ON: The transfer Switch is committed to transfer to Source 2 position once the W timer has begun timing, even if Source 1 power returns before the transfer to Source 2. This is to ensure that the transfer takes place, because one outage may be followed by another.

S14

Test / Auto / Source 1 Selector, Door mount

SW1

Auto/Off/Start Engine control selector, Door mount
(Keyed or non-keyed operation available)

SW2

Auto / Off Engine control selector, Door mount
(Keyed or non-keyed operation available)

SW3

Source Priority Selector Switch, Door mount
Allows selection of Source 1 or Source 2 to be the Prime Source. Transfer Switch will transfer to selected Prime Source if that Source is available. (Keyed or non-keyed operation available)

T

Time Delay (S1) Source 1 Stable Timer. To delay transfer to Source 1 (immediate retransfer on Source 2 failure). Adjustable 0-60 minutes in 1 second increments. Standard setting is 30 minutes. Adjust via SET menu (see page 18)

T3/W3

Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer.

U

(S2) Source 2 Stop Delay Timer. Allows Engine to run unloaded after switch retransfer to Source 1. Adjustable 0-60 minutes in 1 second increments. Standard setting is 5 minutes. Adjust via SET menu (see page 18)

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Accessory Definitions (cont'd)

UMD
Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-60 seconds prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both.

VI
Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between "Fail" and "Restore" settings.
Factory default: 10% "Fail", 8% "Restore", 30 Seconds.
See CFG Menu page 17 to configure ON or OFF.
See SET Menu page 18 to set Percentage and time windows

W
Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2. Adjustable 0-5 minutes in 1 second increments. Standard setting is 1 second. Adjust via SET menu (see page 18)

YEN
Bypass Timers Key utilizing Keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.

ZNET
Network Communications Interface Card

How to Set the System Clock

How to Set the System Clock

Set System Clock, time and date

- If the clock is not set, the display will show SET SYSTEM CLOCK on the second line of the S1 OK screen.
- The S1 OK screen will show time (hours and minutes) on the second line if the system clock has been set. (Date on third line)

Setting the System Clock

(Start from **S1 OK** screen)

1. Remove battery protective white plastic strip near **P** relay. *
2. Press **MORE** then press **SET**.
3. Press **MORE** and scroll to **SET SYSTEM CLOCK** using the **MORE** key.
4. Press **SEL**.
5. **ENTER ACCESS CODE** located on the white label on the back of the controller.
6. Press **SEL**.
7. Use the up and down keys to change the hour value.
8. Press **SAVE** (this will enter this value and move cursor to minutes).
9. Use the up and down keys to change the minutes.
10. Press **SAVE** (this will enter this value and move cursor to month).
11. Use the up and down key up to change the month.
12. Press **SAVE** (This will enter this value and complete the clock setting).
13. Use the up and down keys to change the date.
14. Press **SAVE** (this will enter this value and move cursor to year).
15. Use the up and down keys to change year.
16. Press **SAVE** (this will enter this value and compete the clock setting).
17. To edit settings, press **SEL** and repeat steps 6-16.
18. If the setting is satisfactory, press **MORE** (unit then returns to the **SET** menu then press **BACK**, then **ESC**.)

* Replacement battery part #K-4100
Battery will last 5 years and provides power to retain clock function only (Controller functions without battery).

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CDT One Event Timer Exerciser

Load or No-Load

One event Exerciser with adjustable Timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1,7,14, or 28 days. Factory default is 20 minutes.

How to CONFIGURE (CFG) and Set (SET) the Timer Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG TIMER EXERCISER** screen.
3. The third line of the **CONFG TIMER EXERCISER** will show either **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **OFF**.
4. If the third line of the **CONFG TIMER EXERCISER** shows **DAILY**, **WEEKLY**, **14 DAY**, or **28 DAY** as desired, then proceed to step 10.
5. If the third line of the **CONFG TIMER EXERCISER** shows **OFF** or if another timer selection is desired, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY**, **WEEKLY**, **14 DAY**, or **28 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** to scroll to **CONFG TIMER EXERCISER (XFR)** or **(NO XFR)**.
11. Press Up or Down to select **XFR** (Load Transfer) or **NO XFR** (No Load Transfer).
12. Press **SAVE**.
13. Press **MORE** repeatedly to **BACK** then **S1 OK** screen.

Set (SET) the Exerciser:

14. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
15. Press **MORE** repeatedly until **EXER S2 RUN TIME** screen.
16. Press **SEL**
17. Enter **ACCESS** code located on white label on the back of the controller.
18. Press **SEL**
19. Cursor is indicated as a line under character to be changed. Change values with up and down keys.
20. Press **SAVE** when complete.
21. Press **MORE** repeatedly until **SET USER SETUP** then press **BACK** then **ESC** to the **S1 OK** screen.

How to Initiate CDT Exerciser and to start an exercise cycle every 1, 7, 14, or 28 days

From S1 screen

1) Press **TEST**
2) Press **MORE**
3) Press **START TEST TIMER** (to initiate Test).

- If the CDT Exerciser is Factory configured for a Load Exerciser, the Controller will immediately start a load exercise. The controller will start the generator, transfer the load to Source 2 and remain in Source 2 for the duration set for **EXER S2 RUN TIME** in the **SET** menu. The controller will retransfer the load back to Source 1 after the S1 stable timer has timed out and run the generator unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).
- If the CDT Exerciser is Factory configured for a No-Load Exerciser, the Controller will immediately start a No-load exercise. The controller will start the generator and run it unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).

Exercise will be repeated at the same time as initiated on every 1, 7, 14, or 28 days according to the selection made in the Configure **CFG** menu.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle

If the CDT Exerciser is Factory configured for a No-Load Exerciser Or allow the controller to complete retransfer to Source 1 If the CDT Exerciser is Factory configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press Test
2) Press **MORE**
3) Press **BYPASS EXER**

To re-institute the next exercise event back, press **CANCL BPASS**

How to initiate a new exercise start time

1) Press **TEST**
2) Press **MORE**
3) Press **EXER CANCL**
4) Press **START TIMER TEST**

How to check the next exercise event

1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS**, **HOURS**, and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:

- ***E*** appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= CDT (Exerciser) timing period +T (S1 stable Timer) timing period.

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Load / No-Load Clock Exerciser

Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by the end user for 1, 7, 14, 28, or 365 day cycles.

- A total of 7 independent No Load exercise periods (up to 10 hours each) can be programmed for each of the daily, weekly, 14-day, and 28-day exercisers.
- A total of 12 independent No Load exercise periods (up to 10 hours) can be programmed for the 365-day Exerciser.

How to Configure (CFG) the Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG CLOCK EXERCISER** screen.
3. The third line of the **CONFG CLOCK EXERCISER** will show either **DAILY, WEEKLY, 14 DAY, 28 DAY, 365 DAY** or **OFF**.
4. If the third line of the **CONFG CLOCK EXERCISER** shows **DAILY, WEEKLY, 14 DAY, 28 DAY,** or **365 DAY** as desired, press **MORE** repeatedly to **BACK**. Press **ESC** then proceed to the **SET** menu to set the **EXERCISER**.
5. If the third line of the **CONFG CLOCK EXERCISER** shows **OFF**, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY, WEEKLY, 14 DAY, 28 DAY,** or **365 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** repeatedly to **BACK** then **ESC** to **S1 OK** screen.

How to set (SET) the DAILY Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
2. Press **MORE** repeatedly until **SET EXERCISER** screen.
3. Press **SEL**.
4. Enter **ACCESS** code located on white label on the back of the controller.
5. Press **SEL**
6. Cursor is indicated as a line under character to be changed. Change values with up and down keys. Press **SAVE** after each entry to save value and to move to the next value to be changed.
7. Press **BACK** when complete.
8. Press **MORE** repeatedly until **SET USER SETUP**. Press **BACK** then **ESC** to the **S1 OK** screen.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle.

If the CD Exerciser is configured or Set for a No-Load Exercise. Or allow the controller to complete retransfer to Source 1. If the CD Exerciser is configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press **TEST**
2) Press **MORE**
3) Press **BYPASS EXER**

To re-institute the next exercise event back, press **CANCL BPASS**

How to check the next exercise event

1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS, HOURS,** and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:

- In the **S1 OK** screen, an (*E*) appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= **CDT** (Exerciser) timing period +T (S1 Stable Timer) timing period.
- A value greater than zero must be entered in the Exerciser duration field to be accepted as a valid exercise period.
- The Exercise cycle will be repeated on a regular basis as programmed and initiated in the **SET** menu depending on what Exerciser was configured (selected) in the **CFG** menu.

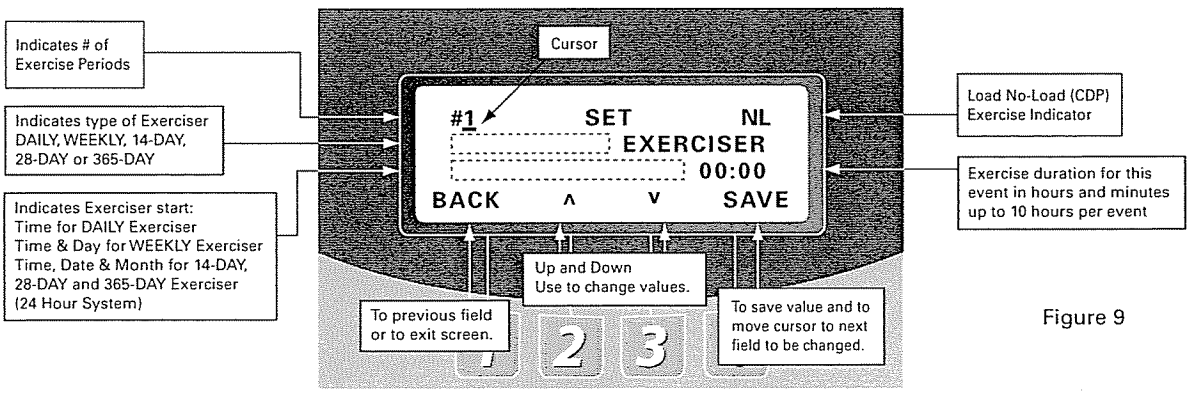

Figure 9

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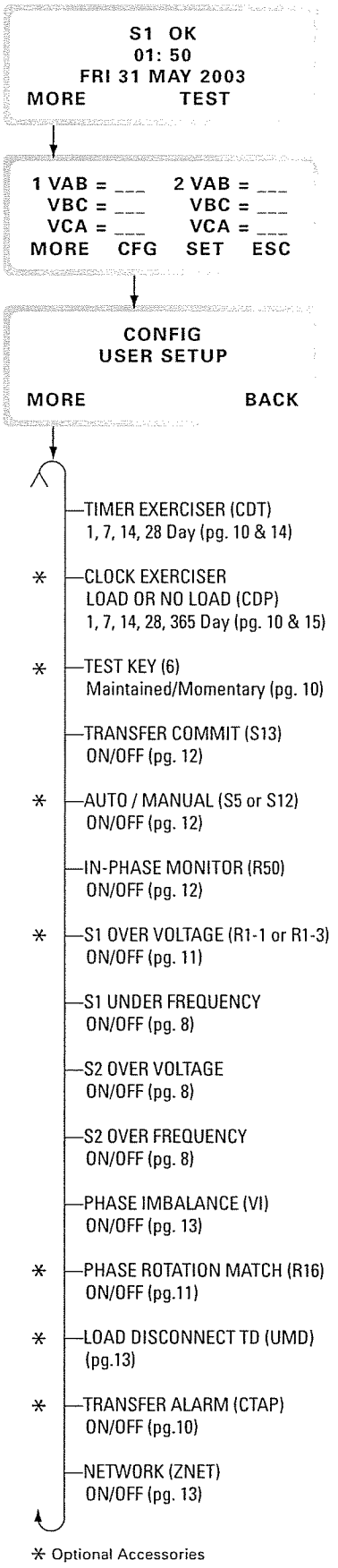

Turn options ON or OFF via keypad through the CFG menu

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

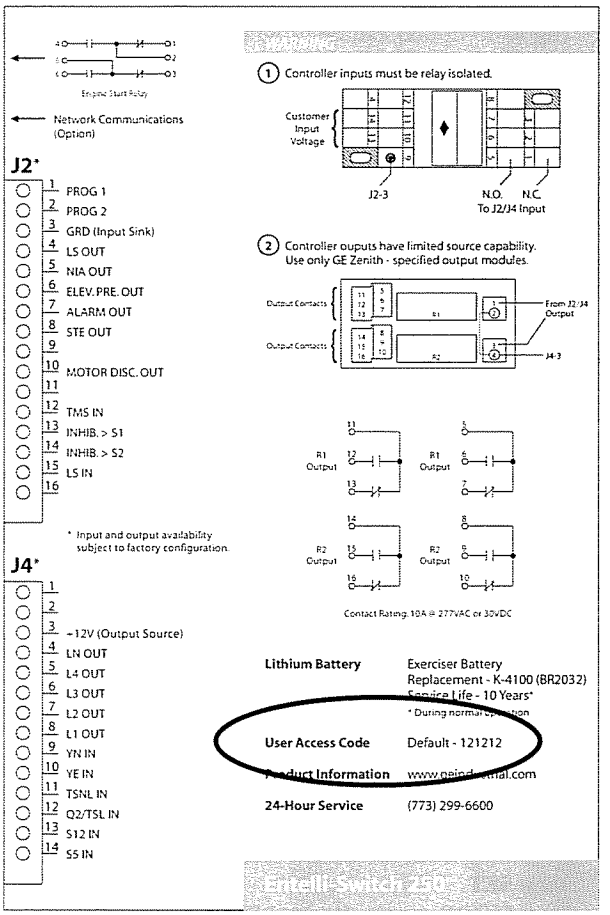

Figure 10

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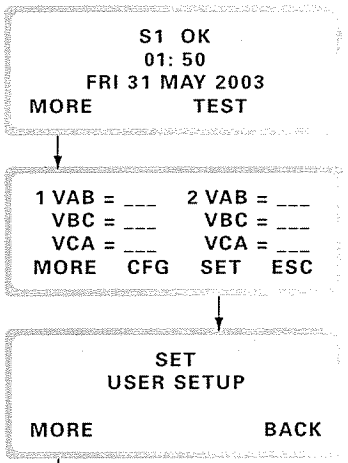


- SET SYSTEM CLOCK (pg.13)
- DAYLIGHT SAVINGS ON/OFF
- * CLOCK EXERCISER (CDP) (pg.10 & 15)
- EXER S2 RUNTIME (CDT) (pg.10 & 14)
- S1 UNDER VOLTAGE (pg.8) Fail Restore
- S1 UNDER FREQUENCY (pg.8) Fail Restore
- * S1 OVER VOLTAGE (pg.11) Fail Restore
- S1 OVER FREQUENCY (pg.8) Fail Restore
- S2 UNDER VOLTAGE (pg.8) Fail Restore
- S2 UNDER FREQUENCY (pg.8) Fail Restore
- S2 OVER VOLTAGE (pg.8) Fail Restore
- S2 OVER FREQUENCY (pg.8) Fail Restore
- SET % PHASE IMBALANCE (VI) FAIL 5%, RESTORE 3% (pg.13)
- SET PHASE IMBALANCE (VI) TIME DELAY 30 seconds (pg.13)
- TIME DELAY S2 START (P1) (pg.11)
- TIME DELAY S2 STABLE (W) (pg.13)
- * LOAD PRESIGNAL TD (T3/W3) (pg.12)
- * LOAD DISCONNECT TD (UMD) (pg.13)
- * ATS OPEN TIME TO S2 (DW) DELAY units only (pg.10)
- TIME DELAY S1 STABLE (T) (pg.12)
- * ATS OPEN TIME TO S1 (DT) DELAY units only (pg.10)
- S2 STOP DELAY (U) (pg.12)
- CALIBRATE S1 (pg.10)
- CALIBRATE S2 (pg.10)

* Optional Accessories

Change adjustable values through the SET menu.

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

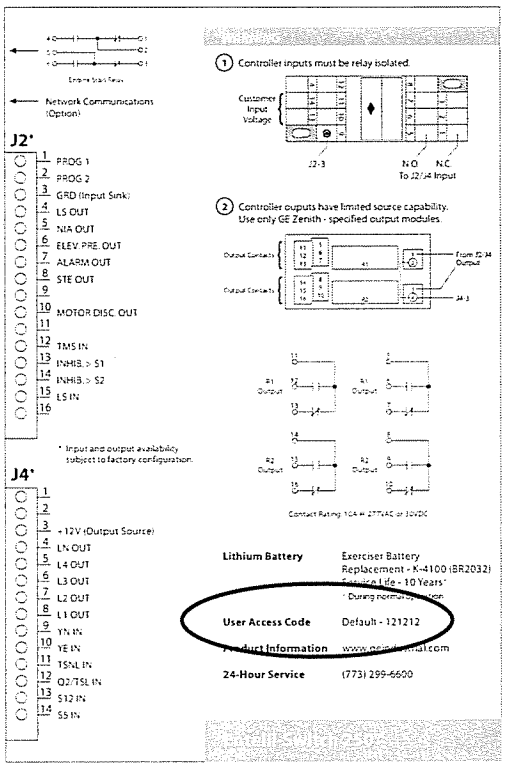
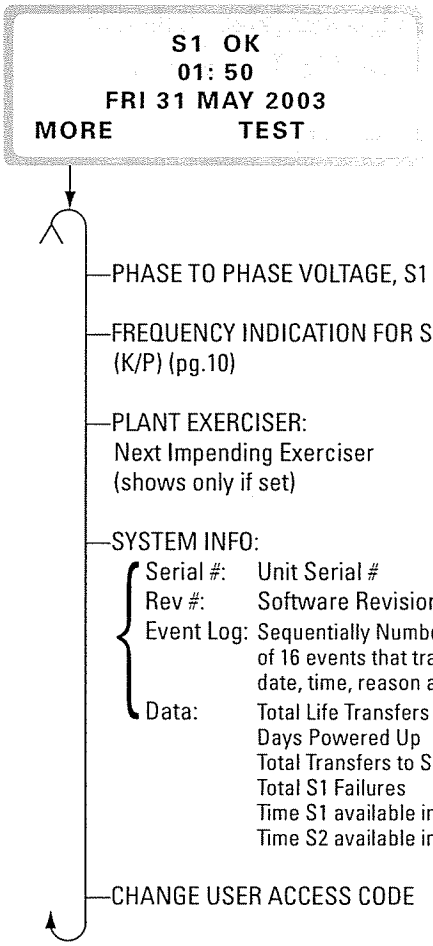


Figure 10



View System Data

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

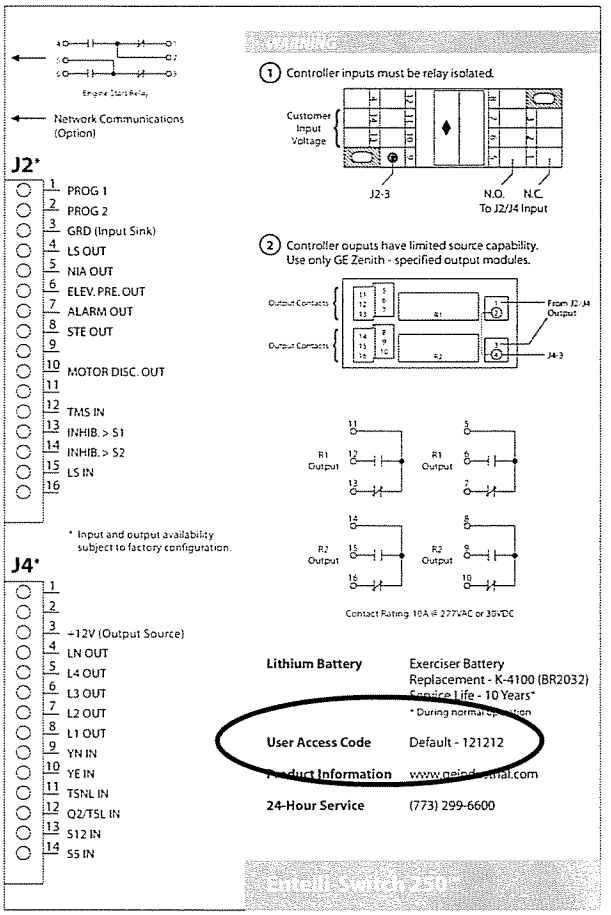


Figure 10

⚠ NOTICE ⚠

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701)

ATS Testing

Start generator and verify proper voltage, frequency and phase sequence (match to Source 1). Shut down gen set and place in Auto. Complete the visual inspection of the transfer switch, and close the cabinet door.

Initiate the test by pressing the TEST button on the LCD keypad. The controller will then prompt for your access code. After entering the code, three test options will appear—XFR LOAD, FAST TEST and NO XFR (See Figure 11).

- **XFR LOAD** test starts the generator and using the current timer settings, transfers the load to Source 2.
- **FAST TEST** test presets timer values to a maximum 30 seconds during the test. After completion of the test, all timers are reset to their original values. (T3, W3, DT and DW remain)
- **NO XFR** test starts the generator but does not transfer the load to the Source 2.

Press and hold the desired test option button until the switch transfers to Source 2 (load test) or until the generator has been run for the desired amount of time (no load test). Releasing the test button before W timer timeout will abort the test (Exception: when the transfer commit option, is configured "ON").

To test lamps, press TEST then scroll through MORE, then press LAMP TEST. To cancel LAMP TEST press MORE.

Standard Transition

When the test is initiated, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCE relay energizes the CE solenoid to close the transfer switch in to Source 2. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1 sequence.The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCN relay energizes the CN solenoid to retransfer the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

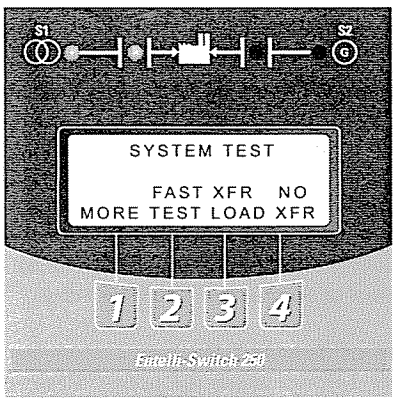


Figure 11

Delayed Transition

Source 1 Power Failure:

When the test is initiated, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCNO relay energizes the CNO solenoid to open the transfer switch out of Source 1 position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the CCE relay energizes. The switch then completes transfer to Source 2 by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1sequence.The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCEO relay energizes the CEO solenoid to open the switch out of Source 2 position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the CCN relay energizes the CN solenoid to complete re-transfer of the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

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Sequence of Operation

Standard Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCE relay energizes the CE solenoid to close the transfer switch in to Source 2. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1sequence.The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCN relay energizes the CN solenoid to retransfer the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCNO relay energizes the CNO solenoid to open the transfer switch out of Source 1 position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the CCE relay energizes. The switch then completes transfer to Source 2 by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1 sequence.The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCEO relay energizes the CEO solenoid to open the switch out of Source 2 position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the CCN relay energizes the CN solenoid to complete re-transfer of the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Table 4

Timer Designations as they appear in the SET menu						
ATS Type	**P**	**W**	**DW**	**T**	**DT**	**U**
Standard Transition	Time Delay S2 Start	Time Delay S2 Stable	→	Time Delay S1 Stable	→	S2 Stop Delay
Delayed Transition	Time Delay S2 Start	Time Delay S2 Stable	ATS Open Time to S2	Time Delay S1 Stable	ATS Open Time to S1	S2 Stop Delay
Source 1 Fails	Transfer to Source 2 →			Source 1 Returns ↓	Transfer to Source 1 →	Engine Cooldown

Standard Transition

Each Entelli-Switch 250 microprocessor based ATS controller requires a relay/transformer box to apply line voltage to the ATS operator via coil control relays. Also required is power for the Entelli-Switch 250 printed circuit board and an application of sensing voltage proportional to line voltage. This is accomplished by the relay transformer box. This method of switching operator voltage and applying power and sensing voltage to the printed circuit board isolates the MX250 from the line voltage, further protecting the controller from harmful line transients. Two versions of the R/T box exist depending on the type of ATS (standard transition or delayed transition).

The following layout drawings of the R/T Box components (standard and delayed transition) include a bill of materials for replacement parts. Schematics are included to indicate proper wiring.

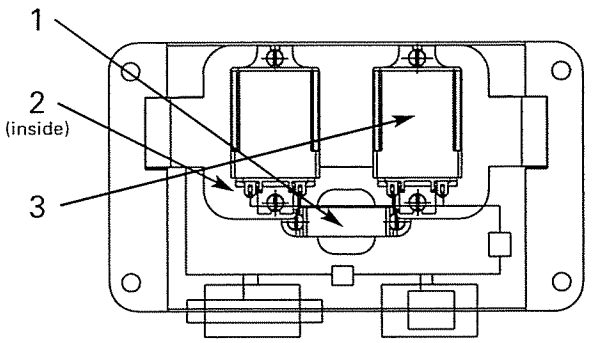


Figure 12

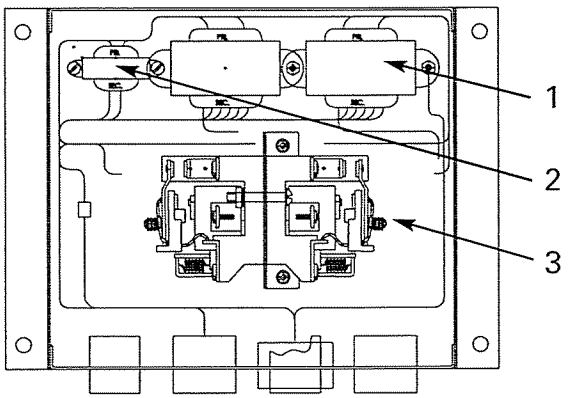
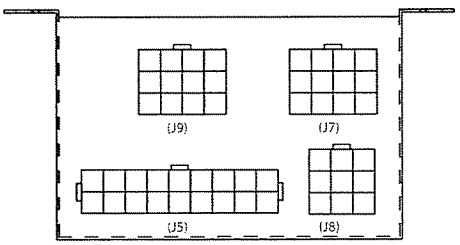
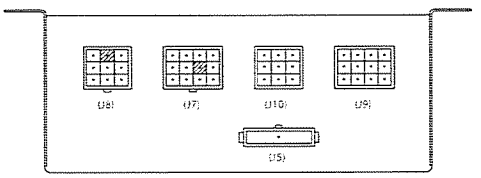


Figure 13





40-225 Amp Molded Power Section Transformer Usage *(see Figure 12)*

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
57P-1015	120V	K-3216	K-3224
57P-1016	208-220V	K-3217	K-3225
57P-1017	230-240V	K-3218	K-3226
57P-1018	277V	K-3219	K-3227
57P-1019	380-400V	K-3220	K-3228
57P-1020	416-440V	K-3221	K-3229
57P-1021	460-480V	K-3222	K-3230
57P-1022	575-600V	K-3223	K-3231

40-3000 Amp - All Other Standard Types Transformer Usage *(see Figure 13)*

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
50P-1026	120V	K-3216	K-3224
50P-1027	208-220V	K-3217	K-3225
50P-1028	230-240V	K-3218	K-3226
50P-1029	277V	K-3219	K-3227
50P-1030	380-400V	K-3220	K-3228
50P-1031	416-440V	K-3221	K-3229
50P-1032	460-480V	K-3222	K-3230
50P-1033	575-600V	K-3223	K-3231

Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (1 VA)	2
2	See Chart	Transformer (25 VA)	2
3	K-1274	Relay Flange Mounted	2

Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (25 VA)	2
2	See Chart	Transformer (1 VA)	2
3	K-1260	Coil Control Relay (24V)	2

Delayed Transition

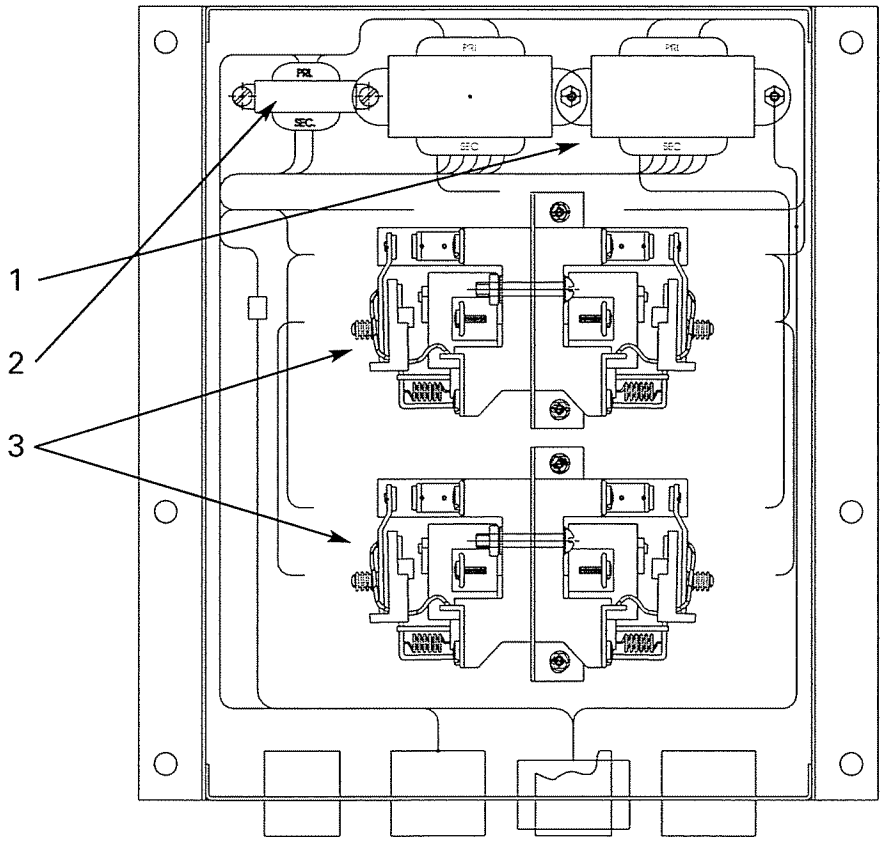
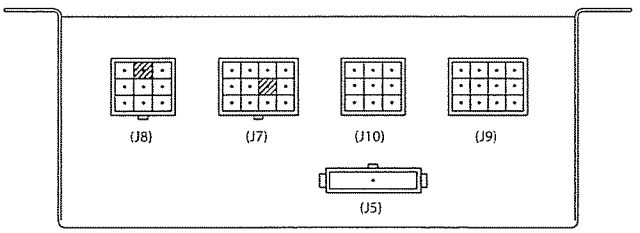


Figure 14



Transformer Usage

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
50P-1034	120V	K-3216	K-3224
50P-1035	208-220V	K-3217	K-3225
50P-1036	230-240V	K-3218	K-3226
50P-1037	277V	K-3219	K-3227
50P-1038	380-400V	K-3220	K-3228
50P-1039	416-440V	K-3221	K-3229
50P-1040	460-480V	K-3222	K-3230
50P-1041	575-600V	K-3223	K-3231

Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (25 VA)	2
2	See Chart	Transformer (1 VA)	2
3	K-1260	Coil Control Relay (24V)	4

Standard Transition R/T Box Schematic

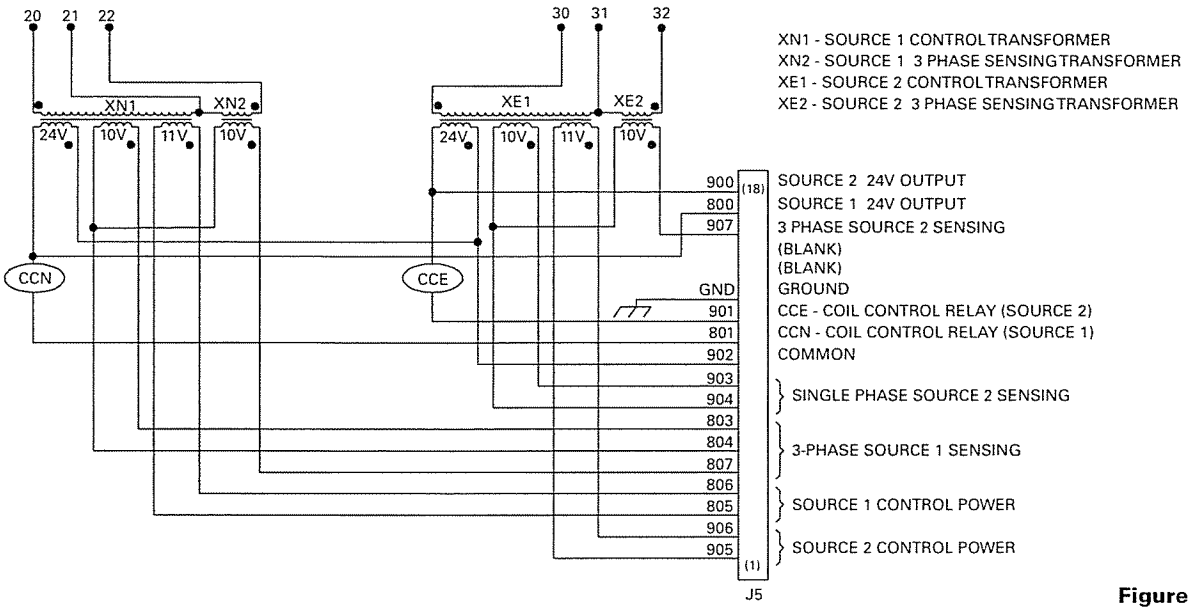


Figure 15

Delayed Transition R/T Box Schematic

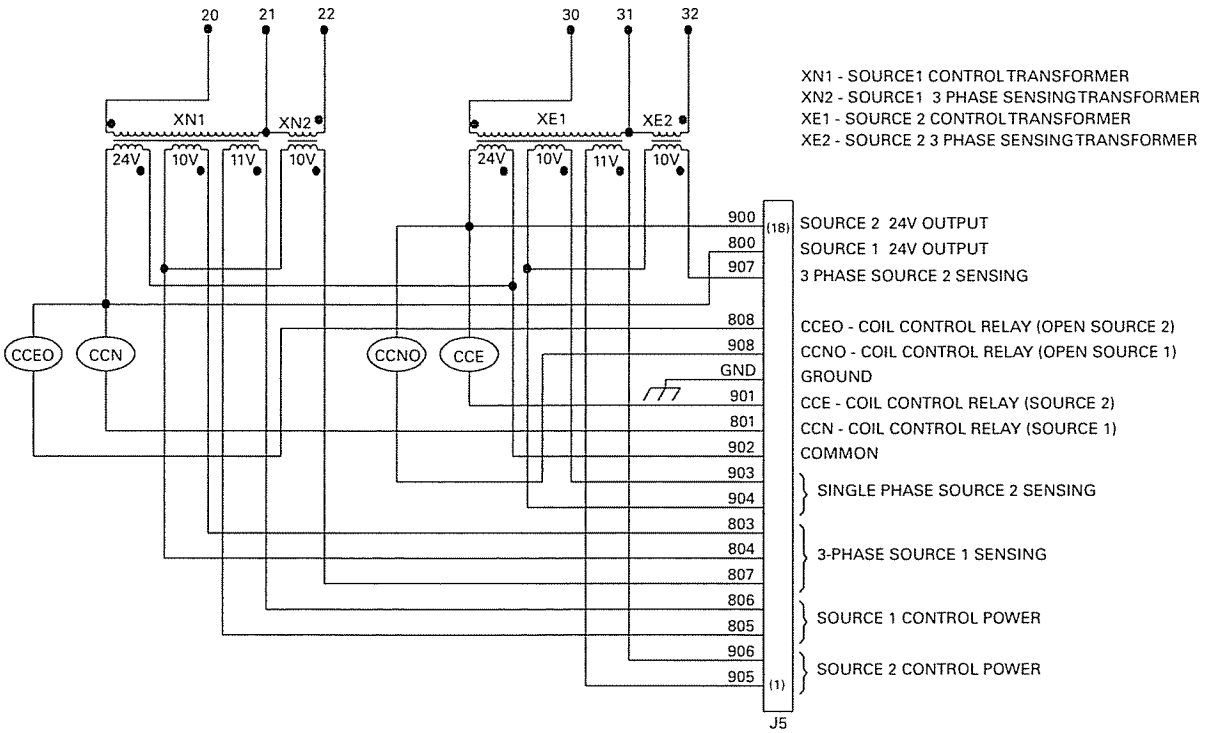


Figure 16

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Troubleshooting and Diagnostics

⚠ DANGER ⚠

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.
These charts may indicate problems that require authorized GE Zenith service personnel.
Hazardous voltages may exist on termination plugs other than those that go into the Entelli-Switch 250.

General Troubleshooting

The following troubleshooting guide is used to recognize, and determine basic faults. When using this guide, it will ask several questions about the condition of the switch. This guide will then list an order of the possible faults. You will then look at the first suspected fault to determine if it is the problem. If it is not a fault, you go to the second suspected fault. If you go through all of the suspected faults, or the chart instructs you to, call a GE Zenith Representative for further assistance.

NOTE: When you use the troubleshooting charts, the Annunciation column refers to the LED's on the control panel.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
Engine does not START	SOURCE 2 AVAILABLE LED off	Engine start wires not terminated properly	Check engine start connections
		Generator is in OFF position	Investigate why Engine Control Switch was turned off
Engine does not stop	LCD Display - "TD Engine Cool Down"	U timing cycle not complete	Check U timer setting
	SOURCE 1 POSITION, and SOURCE 1 and SOURCE 2 AVAILABLE LEDs on, but U timer has timed out	Engine start wires not terminated correctly	Check Engine Start Connections
		Generator in MANUAL	Place generator in AUTO
ATS will not transfer to SOURCE 2 ZTG Series	SOURCE 2 AVAILABLE LED off	SOURCE 2 voltage or frequency not within acceptable parameters	Check: Engine Start Connections, Generator Breaker, Generator Output, and Engine Control Switch
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "S1 _ _ _ _ TD XFR S1>S2 Time Remaining _ _ _ _"	**W** timing cycle not complete	Check **W** Timer setting
ATS will not transfer to SOURCE 1 ZTGD Series	LCD Display - "ATS Open Time Remaining _ _ _ _"	**DW** timing cycle not complete	Check **DW** Timer setting
	SOURCE 1 AVAILABLE LED off	SOURCE 1 voltage or frequency not within acceptable parameters	Check utility and utility breakers
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "Diagnostic Code 001"	Limit switch or RT box connector unplugged	Call Technical Services
	LCD Display - "S1 OK Time Remaining _ _ _ _ Bypass"	**T** timing cycle not complete	Check **T** Timer setting
	LCD Display - "ATS Open Time Remaining _ _ _ _"	**TD** timing cycle not complete	Check **DT** Timer setting

Table 5

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⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

⚠ WARNING ⚠

Both power sources must be disconnected before manual operation of the switch.

A preventive maintenance program will insure high reliability and long life for the transfer switch. The preventive maintenance program for the transfer switch should include the following items:

Inspection and Cleaning

The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (do not use emery cloth or a file). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken or badly worn parts.

Servicing

All worn or inoperative parts must be replaced using GE Zenith recommended replacement parts. Please refer to the Replacement Parts manual for specific part information and ordering procedures. Please contact the GE Zenith Technical Services Department for the Replacement Parts manual.

The operating mechanism of the transfer switch is lubricated with Lubriplate 105. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional Lubriplate.

GE Zenith can provide complete preventative maintenance services. Please contact the GE Zenith Technical Services Department for additional information.

CDT battery replacement - lithium batteries may last up to 10 years, however it is recommended that battery replacement be included in a 3-5 year service cycle. The battery maintains the exerceser memory only and does not otherwise affect the operation.

Testing

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. **Both power sources must be disconnected before manual operation of the switch.** Insert the handle and operate the transfer switch between the Source 1 and Source 2 positions. The transfer switch should operate smoothly without binding. Return the switch to Source 1 position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the TS test switch. P timer will time out and the microcontroller will send an engine start signal. When the W time has elapsed, the switch will complete its transfer by closing into Source 2.

Deactivating the test switch will start retransfer to Source 1. The switch will complete its retransfer to Source 1 after the time delay of the T timer. The U engine overrun timer allows the engine generator to run unloaded for a preset cool down period.

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

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Standard Transition — 40 to 200 Amps

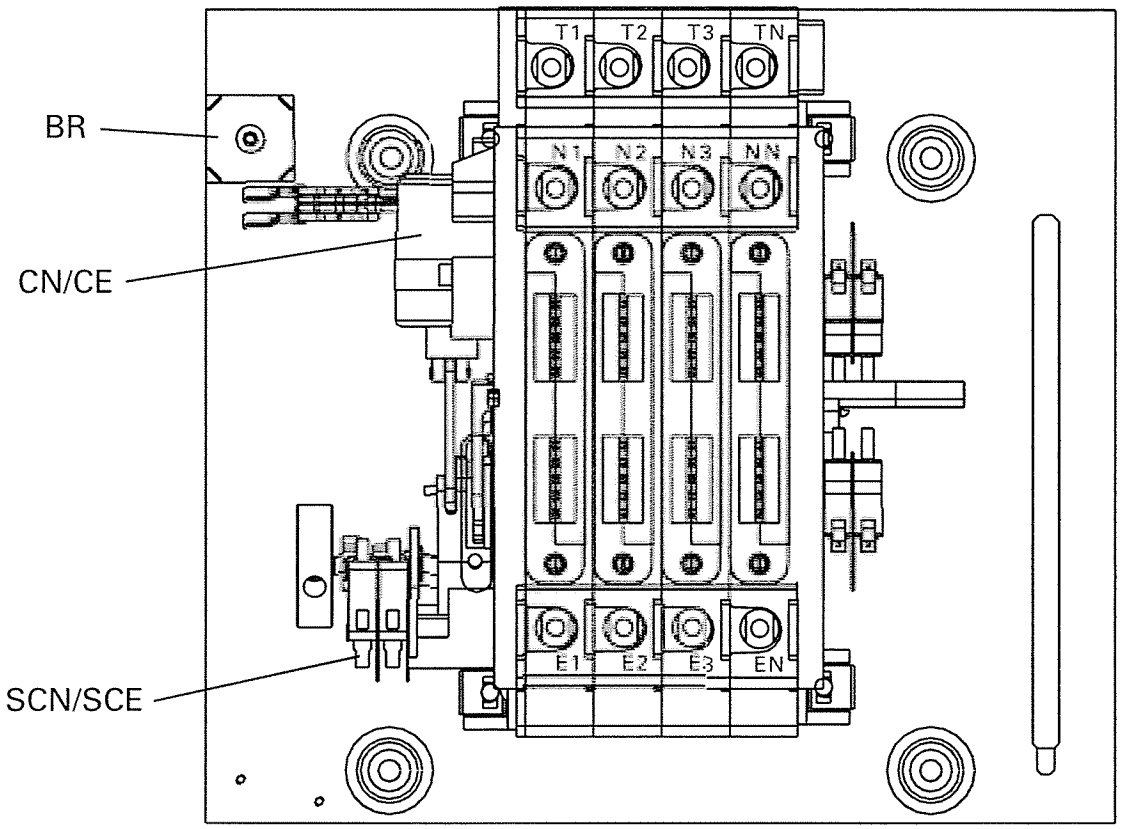

Figure 17

TAG	DESCRIPTION	VOLTAGE	40 TO 200 AMPS
CN/CE	Solenoid	120 208 220 240 277 380/416 440/480 575/600	K-2207 K-2208 K-2208 K-2228 K-2211 K-2212 K-2209 K-2213
	Solenoid Plunger and Link	ALL	57P-1030
SCN/SCE	Coil Cutout Switch	120-480V	L-3078
SCN/SCE	Coil Cutout Switch	600V	L-4027
BR	Rectifier	ALL	PS-5076
A3/A4	Auxiliary Contacts		L-3078

Standard Transition - 225 to 400 Amps

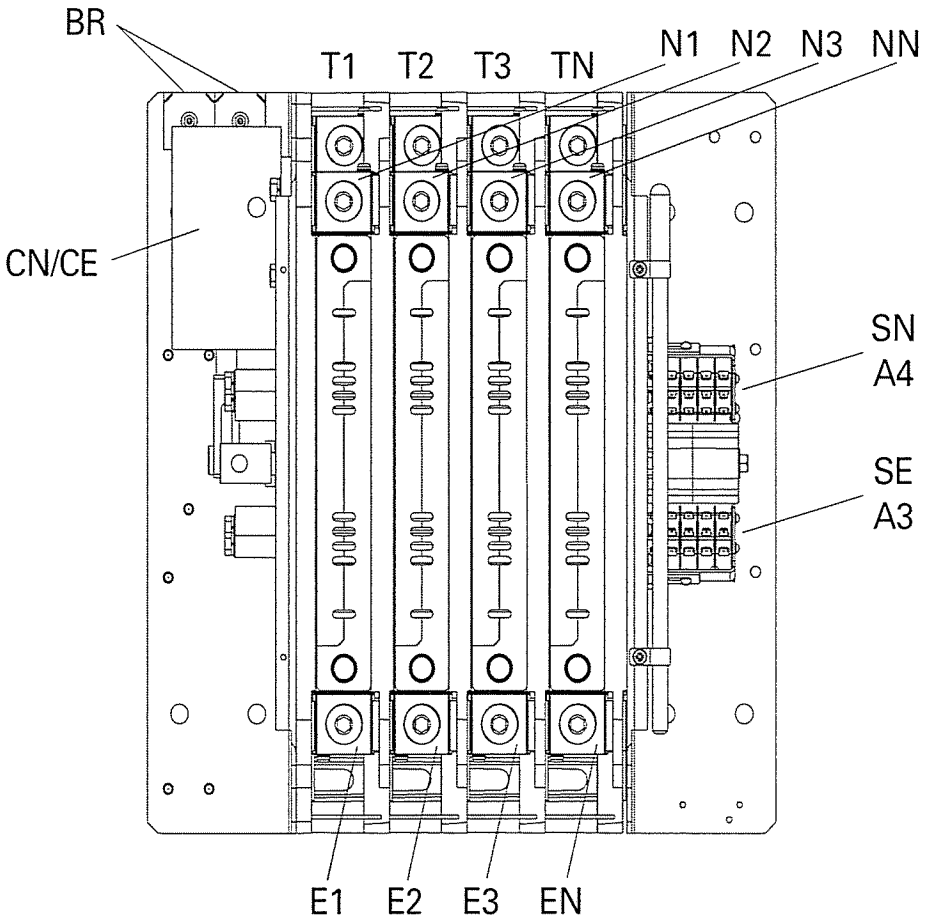

Figure 18

Tag	Description	Recommended as Spares	Stock Numbers by Amperage		
			225, 250*	260, 300*	400
N 1,2,3 N E 1,2,3 N T 1,2,3 N	Cable Connection Lug		S-2701	S-2701	S-2701
	Wire Size			#4-600 MCM	#4-600 MCM
			Coil Volts		
CN/CE	Solenoid	*	120	K-2245B	
			208/220	K-2246B	
			380/416	K-2247B	
			440/480	K-2248B	
			575/600	K-2249B	
SN/SE	Coil Cutout Switches		L-3078		
A3/A4	Auxiliary Contacts				
BR	Rectifier	*	PS-5076		

Standard Transition — 600 to 1200 Amps

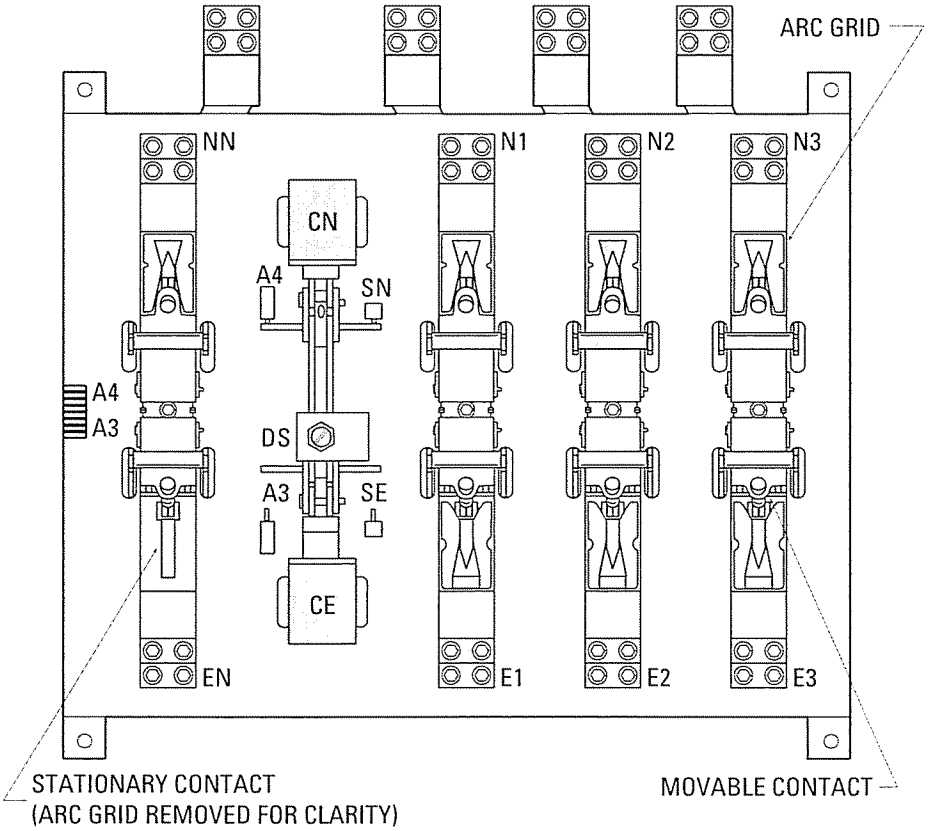

Figure 19

TAG	DESCRIPTION			STOCK NUMBERS BY AMPERAGE			
				600	800	1000	1200
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug			S1393F (2)	S1392F (4)	S1392F (4)	S1392F (4)
	Wire Size			#2-600 MCM	#2-600 MCM	#2-600 MCM	#2-600 MCM
	Stationary Contact Assembly Kit			Consult Factory			
	Arc Grid Assembly Kit			23P-1366			
	Movable Contact Assembly Kit			Consult Factory			
CN/CE	Main Operating Coils	Coil Volts	Poles				
		120	2	K-2090F	K-2073F	K-2073F	K-2073F
		240	2	K-2092F	K-2070F	K-2070F	K-2070F
			3	K-2078F	K-2070F	K-2070F	K-2070F
			4	K-2091F	K-2074F	K-2074F	K-2074F
		208	3,4	K-2091F	K-2074F	K-2074F	K-2074F
		575/600	3,4	K-2095	K-2155	K-2155	K-2155
		480	3	K-2080F	K-2071F	K-2071F	K-2071F
			4	K-2079F	K-2071F	K-2071F	K-2071F
		416	3	K-2080F	K-2071F	K-2071F	K-2071F
SN	CCN Cut-out Switch		23P-1333				
SE	CCE Cut-out Switch		23P-1327	23P-1452			
A3	Emergency Position Aux Contact		(Qty 1) 23p-1327 (Qty 2) 23p-1328 (Qty 3) 23p-1334 (Qty 4) 23p-1336				
A4	Normal Position Aux Contact		(Qty 1) 23p-1333 (Qty 2) 23p-1334 (Qty 3) 23p-1328 (Qty 4) 23p-1330				
DS	Disconnect Switch		Operator L-4009; ; Contact Block L-1020				

Standard Transition — 1600 to 3000 Amps

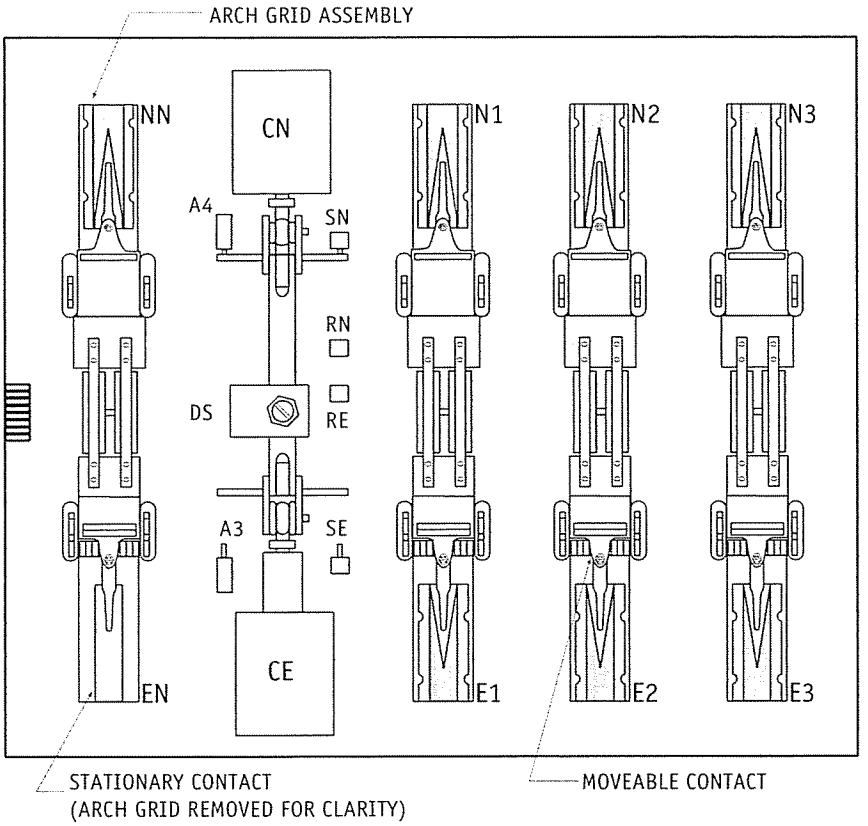

Figure 20

TAG	DESCRIPTION			STOCK NUMBERS BY AMPERAGE		
				1600	2000	3000
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug			S1126F (2) Optional	S1126F (2) Optional	S1126F (2) Optional
	Wire Size			(8) #2-600 MCM	(8) #2-600 MCM	(8) #2-600 MCM
	Stationary Contact Assembly Kit			23P-1594	23P-1594	23P-1594
	Arc Grid Assembly Kit			23P-1171	23P-1171	23P-1171
	Movable Contact Assembly Kit			23P-1400	23P-1400	23P-1400
CN/CE	Main Operating Coils	Coil Volts	Poles			
		120	2	SPO	SPO	SPO
		240	2,3	K-2123F	K-2123F	K-2123F
			4	K-2127F	K-2127F	K-2127F
		208	3	K-2125F	K-2125F	K-2125F
			4	K-2128F	K-2128F	K-2128F
		575/600	3	K-2153F	K-2153F	K-2153F
			4	K-2154F	K-2154F	K-2154F
		480	3	K-2120F	K-2120F	K-2120F
			4	K-2130F	K-2130F	K-2130F
		416	3	K-2126F	K-2126F	K-2126F
SN	CCN Cut-out Switch		23P-1352			
SE	CCE Cut-out Switch		23P-1356			
A3	Emergency Position Aux Contact		(Qty 1) 23p-1356 (Qty 2) 23p-1357 (Qty 3) 23p-1353 (Qty 4) 23p-1355			
A4	Normal Position Aux Contact		(Qty 1) 23p-1352 (Qty 2) 23p-1353 (Qty 3) 23p-1357 (Qty 4) 23p-1359			
DS	Disconnect Switch		Operator L-4009; ; Contact Block L-1020			
RN, RE	Rectifier		23P-1473 (Up to 240V); 23P-1582 (Up to 600V)			

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Standard Transition — 4000 Amps

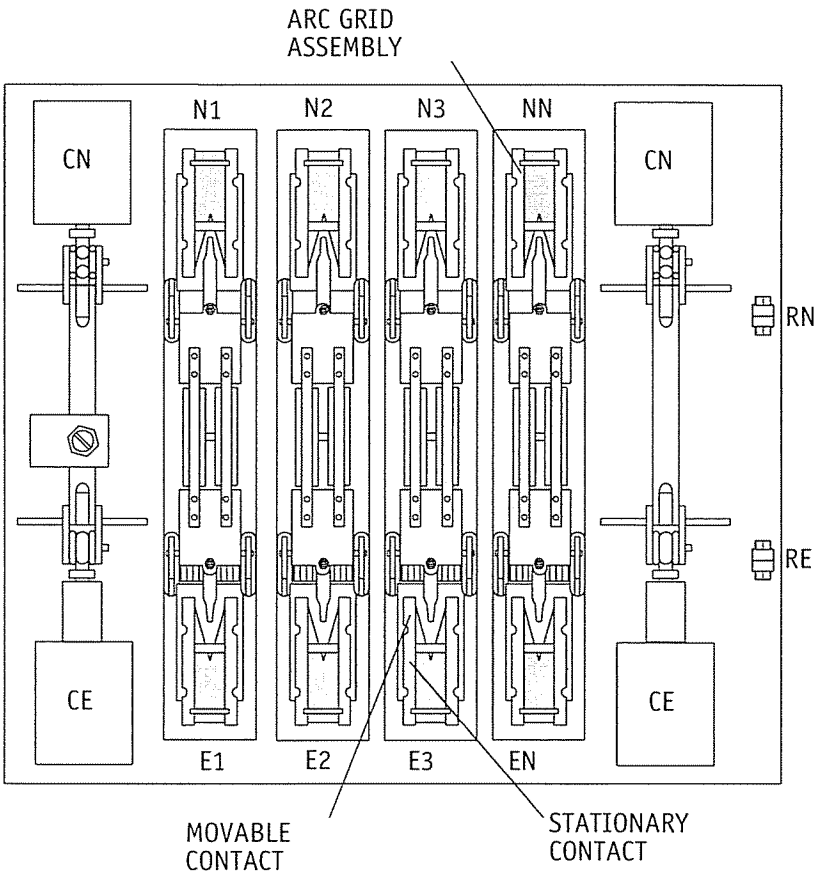
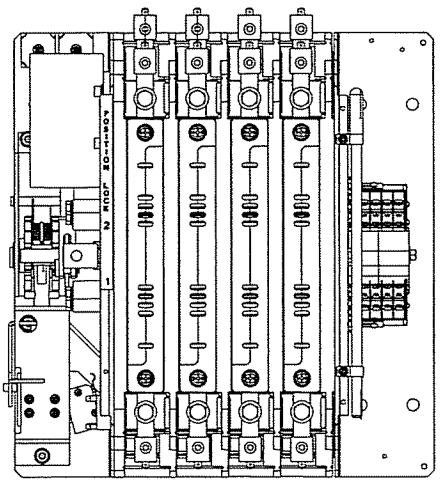


Figure 21

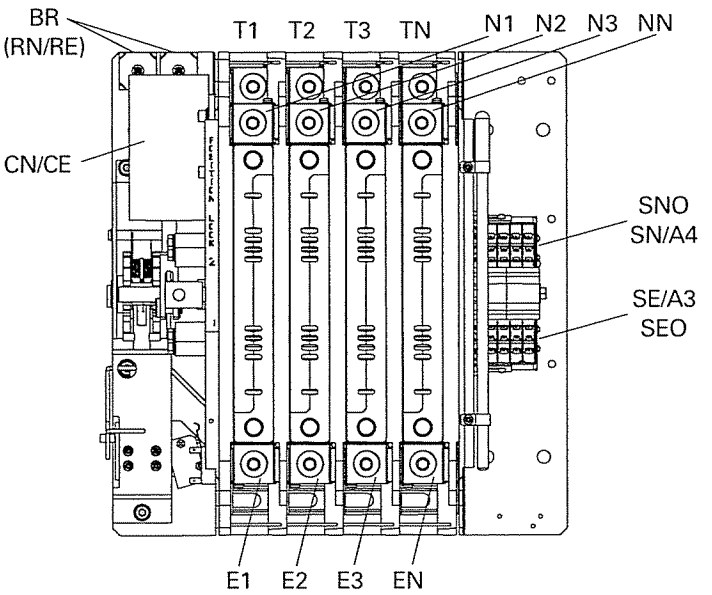
TAG	DESCRIPTION			STOCK NUMBERS
N 1,2,3, N E 1,2,3, N	Cable Connection Lug			S1511F (3) Optional
T 1,2,3, N	Wire Size			(12) #2-600 MCM
	Stationary Contact Assembly Kit			23P-1655
	Arc Grid Assembly Kit			23P-1171
	Movable Contact Assembly Kit			23P-1640
CN/CE	Main Operating Coils	Coil Volts	Poles	
		240	3	K-2219
			4	K-2219
		208	3	K-2226
			4	K-2226
		575/600	3	K-2221
			4	K-2221
		480	3	K-2218
			4	K-2218
		416	3	K-2220
SN	CCN Cut-out Switch		23P-1352	
SE	CCE Cut-out Switch		23P-1356	
A3	Emergency Position Aux Contact		(Qty 1) 23p-1356 (Qty 2) 23p-1357 (Qty 3) 23p-1353 (Qty 4) 23p-1355	
A4	Normal Position Aux Contact		(Qty 1) 23p-1352 (Qty 2) 23p-1353 (Qty 3) 23p-1357 (Qty 4) 23p-1359	
DS	Disconnect Switch		Operator L-4009; ; Contact Block L-1020	
RN, RE	Rectifier		23P-1473 (Up to 240V); 23P-1582 (Up to 600V)	

Delayed Transition - 40 to 400 Amps



40-80 Amps

Figure 22



100-400 Amps

Figure 23

Tag	Description	as Spares		Stock Numbers by Amperage	
				40-80	100-400
N 1,2,3 N E 1,2,3 N T 1,2,3 N	Cable Connection Lug			S-2515	S-2701
	Wire Size			#8 MCM-3/0	#4-600 MCM
			Coil Volts	MAIN	SECONDARY
CN/CE	Solenoid	*	120	K-2245B	58P-1106
			208/240	K-2246B	58P-1107
			380/415	K-2247B	58P-1108
			440/480	K-2248B	58P-1109
			575/600	K-2249B	58P-1110
			575/600	K-2249B	58P-1110
	Handle-Manual	*	E3054		
	Handle-Grip		L-3078		
A3/A4	Auxiliary Contacts		L-3078		
SNO/SEO	Coil Cutout Switch	*	E3521		
BR	Rectifier (>380V)	*	PS-5076		
BR	Rectifier		PS-5152		

Delayed Transition - 600 to 1200 Amps

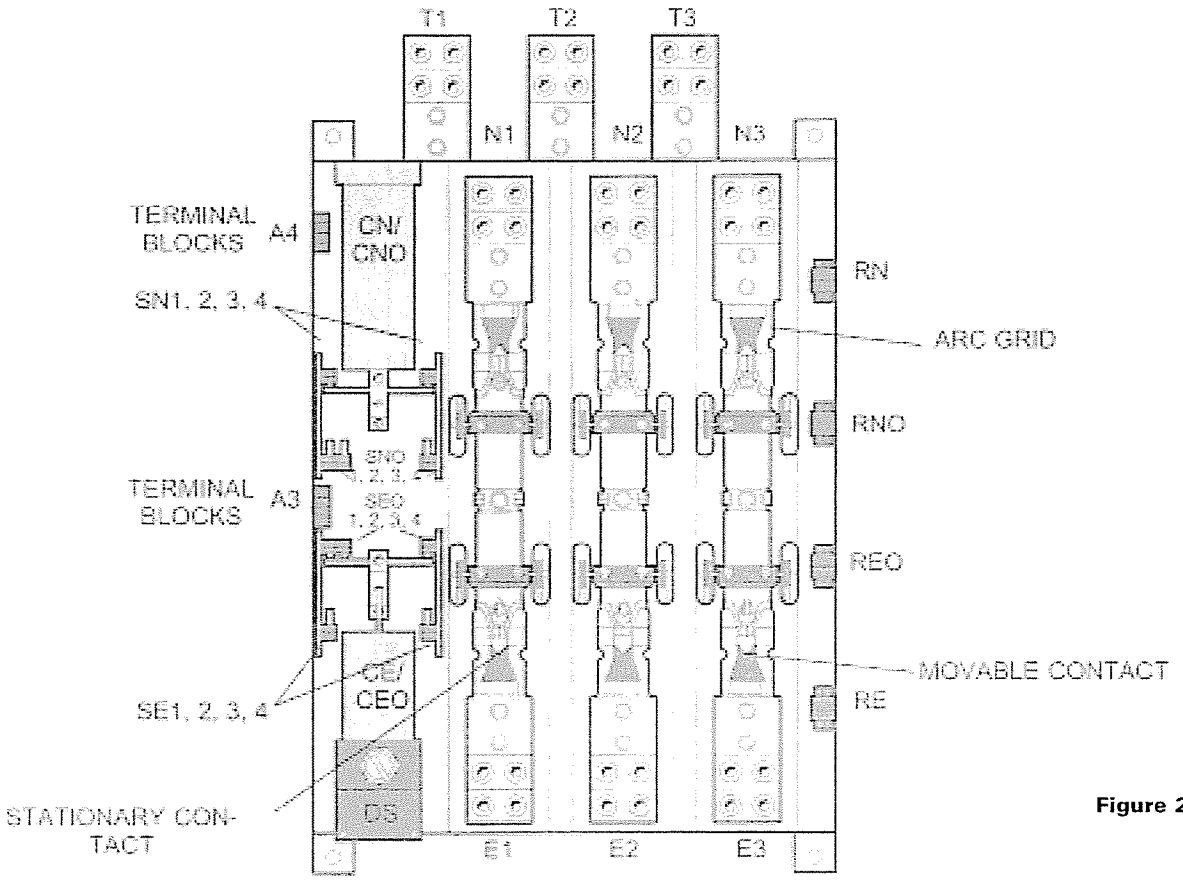


Figure 24

Tag	Description	Recommended as Spares	Stock Numbers by Amperage
			1000-1200
NL 1,2,3 EL 1,2,3 T 1,2,3 NN, EN, TN	Cable Connection Lug, CU Wire		2-1392F (4) 600MCM-2
	Stationary Contact Assembly Kit		26P-1336
	Arc Grid Assembly Kit		23P-1366
	Movable Contact Assembly Kit		26P-1334
	Movable Contact		26P-1335
RN/RNO RE/REO	Coil Rectifier	*	23P-1473 (Up to 240 VAC) 23P-1582 (Up to 600 VAC)
SN/SNO	Limit Switch		23P-1535(L); 23P-1533(R)
SE/SEO	Limit Switch		23P-1536(L); 23P-1534(R)
A3	Emergency Position Auxiliary Contact		23P-1536
A4	Normal Position Auxiliary Contact		23P-1535
DS	Disconnect Switch	*	Operator: L-4009; Contact Block: L-1020
CN/CNO CE/CEO	Main Operator Solenoids	*	See Chart Below

Voltage System					Solenoid Part No.
Volts	Ph	Wire	Coil VDC	Pole	800-1200
240	3	3	240	3	K-2147
120/208	3	4	208	3,4	K-2147
480	3	3	480	3	K-2157
277/480	3	4	480	3,4	K-2157
240/416	3	4	416	3	Consult Factory

Delayed Transition - 1600 to 3000 Amps

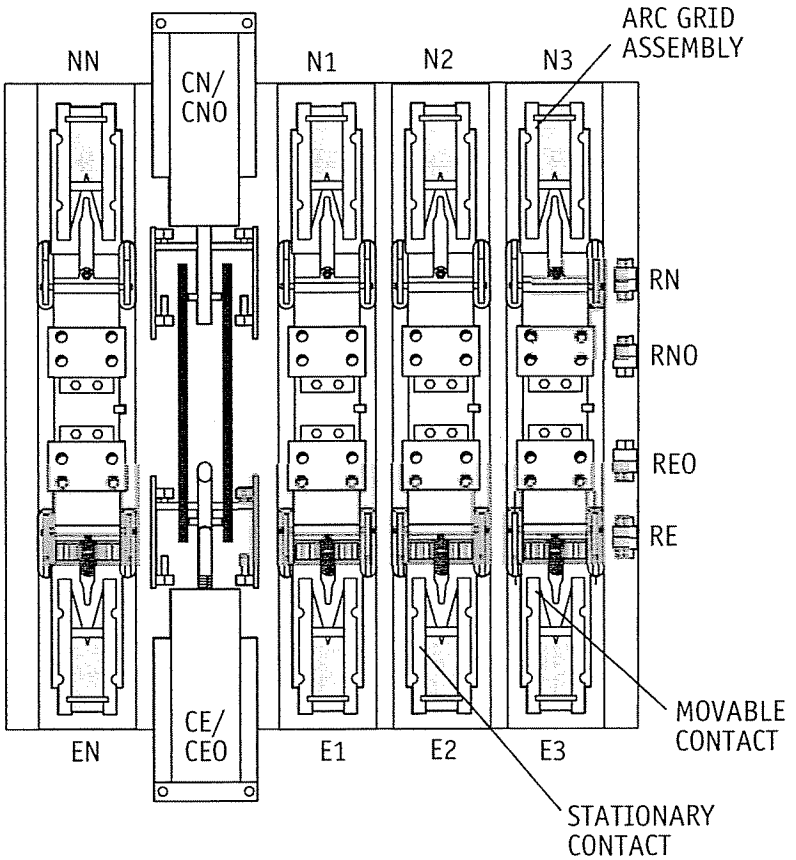


Figure 25

Tag	Description	Recommended as Spares	Stock Numbers by Amperage		
			1600	2000	3000
N1,2,3 E1,2,3 T1,2,3 NLN,ELN	Cable Connection Lug, CU Wire		S-1126F(2) Optional (8) 600MCM-2		
	Stationary Contact Assembly Kit		23P-4134X	23P-4134Y	23P-4134Z
	Arc Grid Assembly Kit		23P-1171	23P-1171	23P-1171
	Movable Contact Assembly Kit		23P-1400	23P-1400	23P-1344
CN/CNO CE/CEO	Main Operator Solenoids	*	See Chart Below		

Voltage System					Solenoid Part No.		
Volts	Ph	Wire	Coil VDC	Pole			
120	1	2	120	2	S.P.O.	S.P.O.	S.P.O.
120/240	1	3	240	2,3	K-2151	K-2151	K-2151
240	3	3	240	3	K-2151	K-2151	K-2151
120/208	3	4	208	3,4	K-2151	K-2151	K-2151
480	3	3	480	3	K-2160	K-2160	K-2160
575	3	3	575/600	3	S.P.O.	S.P.O.	S.P.O.
277/480	3	4	480	3,4	K-2160	K-2160	K-2160
120/240	2	4	240	4	K-2151	K-2151	K-2151
240/416	3	4	416	3	Consult Factory		

Operating Coil Hardware Kit				
SN/SNO-1,2	Switch Bracket Assembly	23P-1540	23P-1540	23P-1540
SE/SEO-1,2	Switch Bracket Assembly	23P-1541	23P-1541	23P-1541
SN/SNO-3,4	Switch Bracket Assembly	23P-1542	23P-1542	23P-1542
SE/SEO-3,4	Switch Bracket Assembly	23P-1543	23P-1543	23P-1543

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Delayed Transition — 4000 Amps

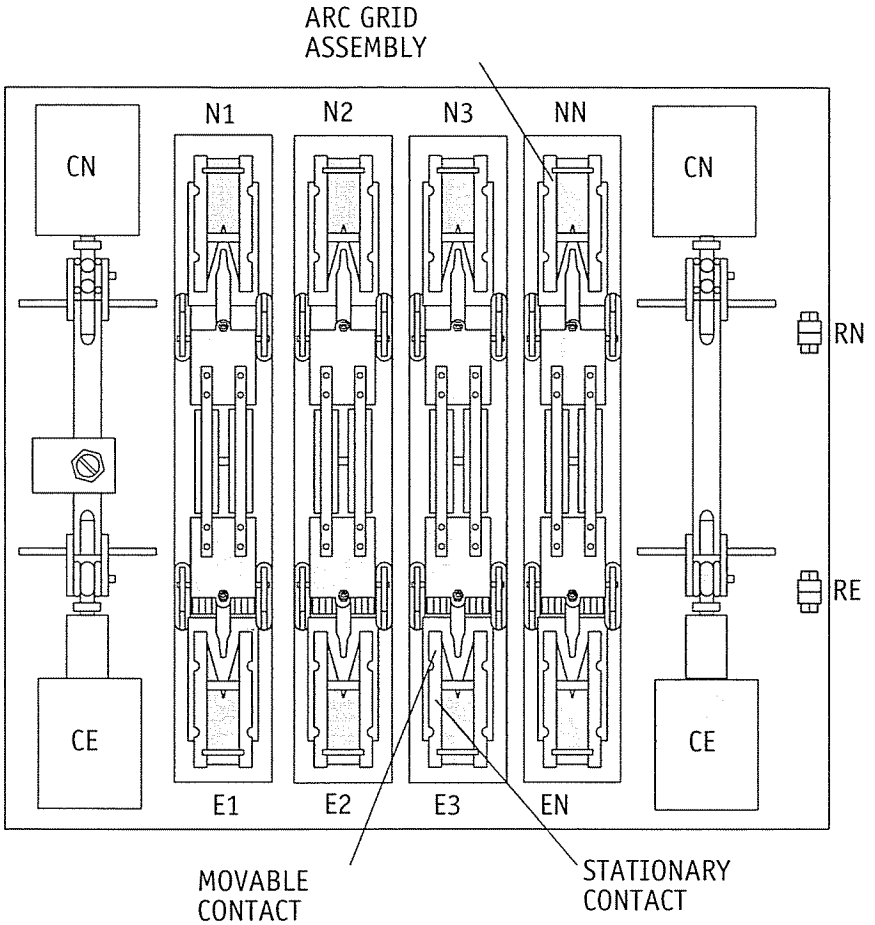


Figure 26

TAG	DESCRIPTION			STOCK NUMBERS
N 1,2,3, N E 1,2,3, N	Cable Connection Lug			S1511F (3) Optional
T 1,2,3, N	Wire Size			(12) #2-600 MCM
	Stationary Contact Assembly Kit			23P-1655
	Arc Grid Assembly Kit			23P-1171
	Movable Contact Assembly Kit			23P-1640
CN/CE	Main Operating Coils	Coil Volts	Poles	
		240	3	K-2215
			4	K-2215
		208	3	K-2227
			4	K-2227
		575/600	3	K-2217
			4	K-2217
		480	3	K-2214
			4	K-2214
		416	3	SPO
SN/SNO	CCN Cut-out Switch		23P-1568	
SE/SEO	CCE Cut-out Switch		23P-1569	
A3	Emergency Position Aux Contact		(Qty 1) 23p-1356 (Qty 2) 23p-1357 (Qty 3) 23p-1353 (Qty 4) 23p-1355	
A4	Normal Position Aux Contact		(Qty 1) 23p-1352 (Qty 2) 23p-1353 (Qty 3) 23p-1357 (Qty 4) 23p-1359	
DS	Disconnect Switch		Operator L-4009; ; Contact Block L-1020	
RN, RNO, RE, REO	Rectifier		23P-1473 (Up to 240V); 23P-1582 (Up to 600V)	

Standard Control Panel Layout (SSRCP)

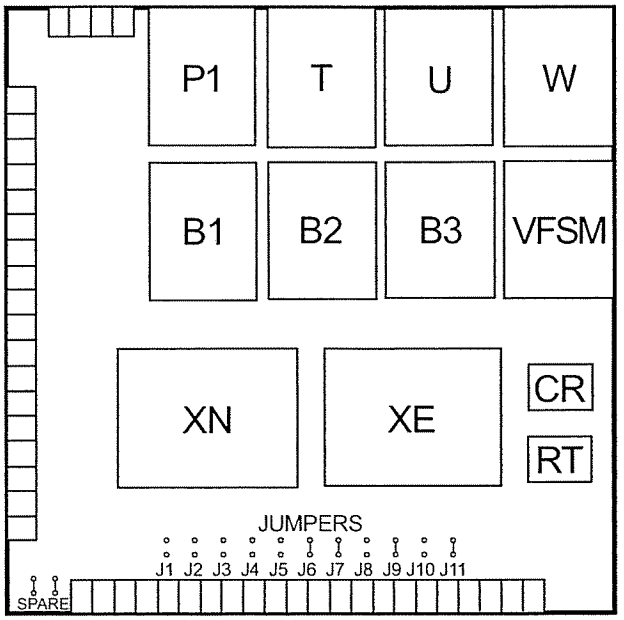


Figure 27

JUMPER	CONNECTS POINTS	REMOVE WHEN ACCESSORIES USED
J1	23, 23A	B1
J2	23A, 23B	B2
J3	23B, 23C	B3
J4	23C, 23Z	JIN, TS, C/D
J5	23Z, 27	T, YN
J6	25, 25Z	T3, R4
J7	28, 28Z	S1, C, C/D
J8	28Z, 29	P1 & U
J9	33A, 33Y	ER1, 2, 3, J1E
J10	33Z, 37	W
J11	35, 35Z	R4, W3

Panel Mount Control Relays

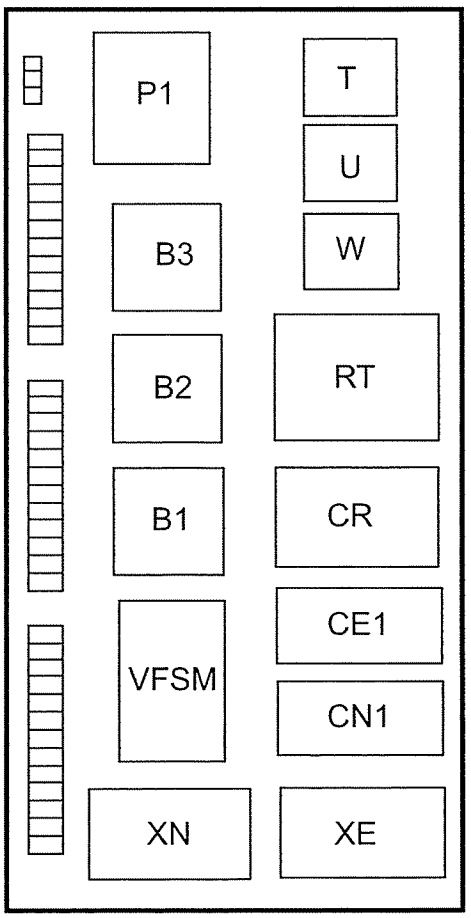
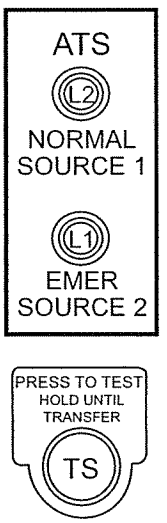


Figure 28



TAG	DESCRIPTION
L1 L2	ATS Source 2 (EMER) Position Indicator ATS Source 1 (NORMAL) Position Indicator Lens Source 1 (NORMAL) Lens Source 2 (EMER) Bulb Socket Source 2 (EMER) Bulb Source 1 (NORMAL) Bulb
TS	Test Switch Operator, Momentary Contact Block N.C. Contact Mounting Base

Sequence of Operation

The information package supplied with the transfer switch includes a schematic diagram and description of operation of all accessories provided.

The sequence for load transfer to Source 2 begins automatically when any phase of Source 1 falls below the preset "fail" or dropout point and this undervoltage failure condition is detected by the solid state phase relays B1, B2, B3.

The phase relays drop out, de-energizing Source 1 control relay CR, and engine start timer P1 begins its timing cycle. The P1 time delay is provided to override momentary outages and to prevent nuisance starting of the engine generator. If Source 1 voltage returns above the "restore" or pickup setting of the phase relays, the P1 timing cycle is reset to zero by the re-energization of the CR relay.

If Source 1 voltage does not return before the P1 time delay is completed, the P1 timer drops out and sends a starting signal to the engine generator. Source 2 voltage and frequency sensing relay VFSM monitors the voltage and frequency of Source 2. When both the voltage and the frequency of Source 2 reach the preset "restore" or pickup points, the VFSM relay initiates the transfer to Source 2 and timer W begins its timing cycle. The W timer provides an adjustable transfer delay to Source 2 as required.

When the W time delay is completed, Source 2 control relay RT energizes and picks up the power relay, CE1 or CCE. The power relay connects voltage from Source 2 to the Source 2 switch operating circuit causing the switch to transfer its main contacts to Source 2. The switch is mechanically locked in Source 2 position. The power relay and Source 2 operator are de-energized when the SE limit switch is activated by the operator. The SN limit switch is deactivated at the same time, readying Source 1 control circuit for retransfer when Source 1 is restored.

The sequence for retransfer to Source 1 begins automatically when the voltage on all phases of Source 1 reach the preset "restore" or pickup point and this condition is detected by the solid state phase relays.

When Source 1 restores, the solid state phase relays B1, B2, B3 pick up and initiate retransfer of the switch to Source 1 by energizing timer T and beginning its timing cycle. The T timer provides an adjustable delay to ensure that Source 1 has stabilized before reconnection to the load. If Source 1 fails before the T time delay is completed, the phase relays drop out and the T timing cycle is reset to zero.

When the T time delay is completed, Source 1 control relay CR energizes and picks up the power relay, CN1 or CNN. The power relay connects voltage from Source 1 to Source 1 switch operating circuit causing the retransfer of the main switch contacts to Source 1. The switch is mechanically locked in Source 1. The power relay and Source 1 operator are de-energized when the SN limit switch is activated by the operator. The SN limit switch also energizes the engine over-run timer U and begins its timing cycle. The timer provides a period of time for the engine generator to run without load and cool down before shutdown. After the U time delay is completed, the P1 timer is energized and the engine generator is shutdown.

Solid State Timers

Solid state timers are adjustable from 0.1 second to 100 hours. The red timing indicator in the upper left corner flashes as the timer progresses through the timing cycle. When the timing cycle is completed, the indicator remains illuminated. A flathead screwdriver is required to change the setting, as shown in *Figure 30.*

The time unit is selected by turning the rotary switch at the lower right of the timer. Four selections are available: "Seconds", "Minutes", "Hours", "10 Hours". The time unit selected is displayed in the window below the time setting dial.

The time range is selected by turning the rotary switch at the lower left of the timer. Four ranges are available: "0-0.5", "0-1.0", "0-5.0", "0-10.0". The dial digits appear in the windows around the time setting knob.

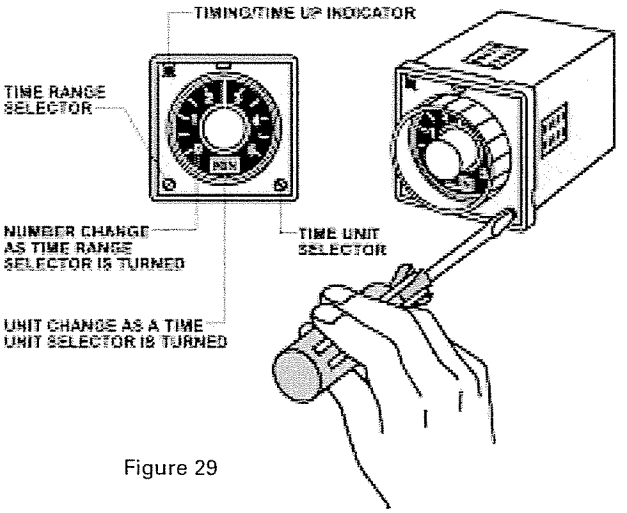


Figure 29

⚠ CAUTION ⚠

Do NOT change the setting while the timer is energized. Timer malfunction or damage may occur.

The factory setting of the solid state timers used in the Zenith standard package are shown in *Table 4.*

Timer	Factory Setting
T	30 minutes
U	5 minutes
W	1 second

Table 4

Voltage/Frequency Sensor (VFSM)

The "restore" or pickup point may be adjusted by rotating the adjustment screw as shown in *Figure 31.* Counter-clockwise rotation increases the pickup voltage.

"Restore"/Pickup Voltage (at 100% Frequency)
Adjustable: 80% to 95%
Factory Set: 90%
"Restore"/Pickup Frequency
Adjustable: 80% to 100%
Factory Set: 95%

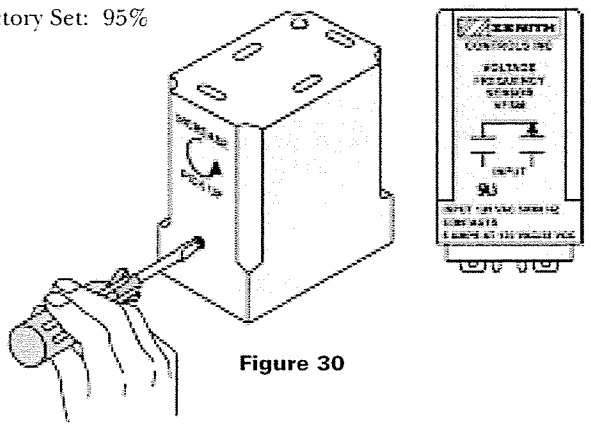


Figure 30

Solid State Phase Relay (ARSM)

The "restore" or pickup and "fail" or dropout points may be adjusted by using the following procedure. Use of a variable voltage supply (Variac) is required. The relay is illustrated in *Figure 32.*

1. Turn the "restore" or pickup adjustment fully clockwise.
2. Turn the "fail" or dropout adjustment fully counter-clockwise.
3. Set Variac to the desired "restore" or pickup voltage.
4. Rotate the "restore" or pickup adjustment counter-clockwise very slowly until the relay picks up. The LED will illuminate.
5. Set Variac to the desired "fail" or dropout voltage.
6. Rotate the "fail" or dropout adjustment clockwise very slowly until the relay drops out. The LED will go out.
7. Verify the setting by raising the voltage until the relay restores or picks up and lowering the voltage until the relay fails or drops out.

"Restore"/Pickup Voltage:
75% to 115% of Nominal
Factory Set:
90% of Nominal

"Fail"/Dropout Voltage:
55% to 105% of Nominal
Factory Set:
80% of Nominal

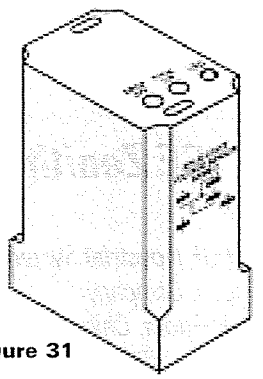


Figure 31

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GE Zenith Controls

A Product of GE Industrial Systems
General Electric Company
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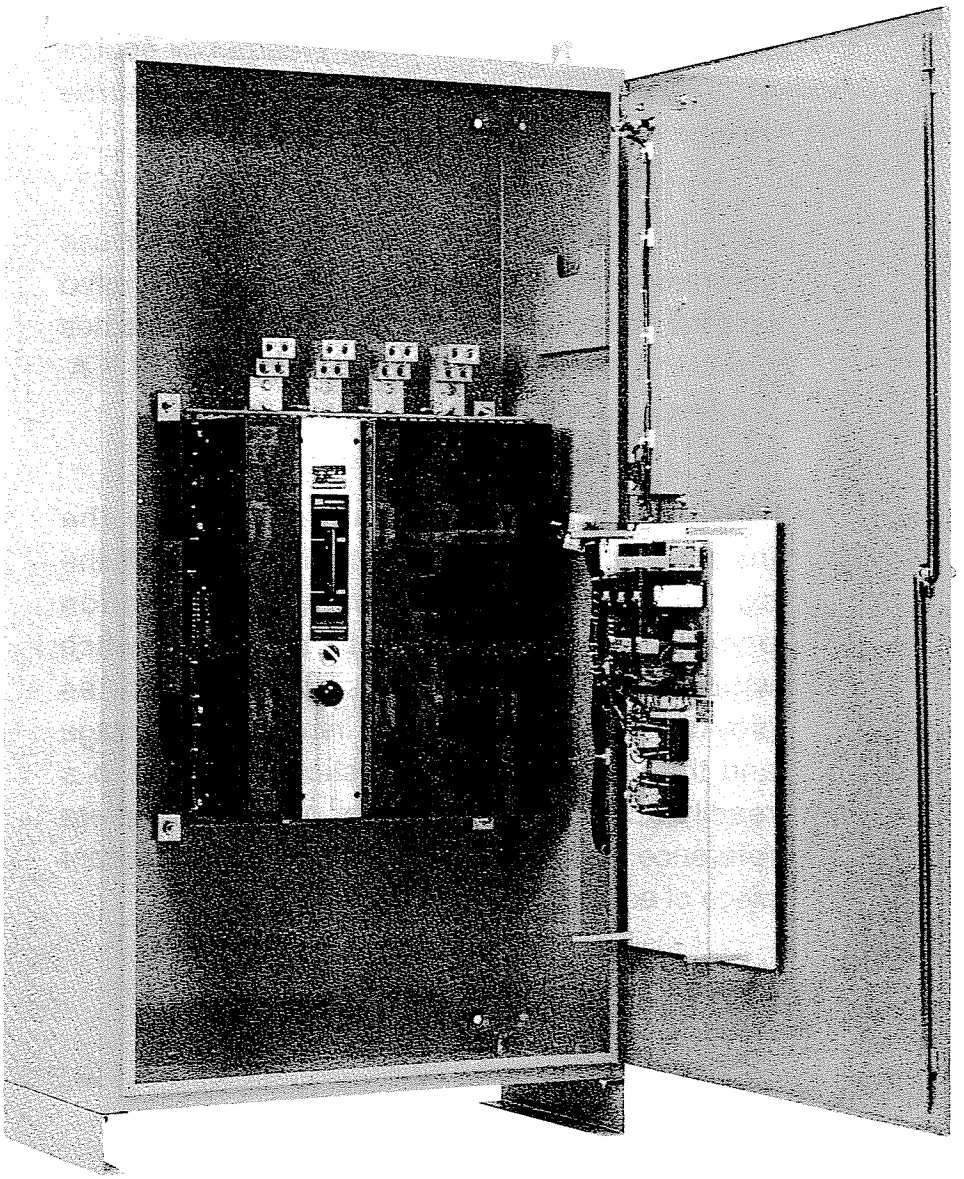
ZENITH®
CONTROLS, INC.

INSTRUCTION MANUAL
AUTOMATIC TRANSFER SWITCH
40 THRU 4000 AMPS
ZTSH SERIES



ZENITH CONTROLS, INC.
43R-1000E
Rev. 1/99

ISO 9001

INTRODUCTION

Zenith transfer switches are used to provide a continuous source of power for lighting and other critical loads by automatically transferring from the normal source of power to an emergency source of power in the event that the normal source voltage falls below preset limits.

All Zenith transfer switches are designed for use on emergency or standby systems, and are rated for total system or motor loads. Transfer switches are U.L. Listed under Standard 1008 and C.S.A. Certified under Standard C22.2 No. 178.

This manual provides information on the installation, operation, and maintenance of the switch. In addition, a complete information package is supplied with each transfer switch which details the features and accessories provided on that switch. The information package and the instruction manual should be kept in a readily accessible location to provide complete reference information on this critically important piece of equipment.

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SECTION I – INSTALLATION

DANGER: HAZARDOUS VOLTAGE. CAN CAUSE SEVERE INJURY OR DEATH.
Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Each transfer switch is factory wired and tested. A complete information package is furnished with each switch which includes:

a. Sequence or Operation.
b. Description and Operation of all accessories supplied.
c. Power panel connection diagram and schematic.
e. Description and identification of all customer field connections.

Installation of Zenith transfer switches includes:

a. Mounting the transfer switch cabinet.
b. Connection of all Normal, Emergency, and Load cables or bus bars.
c. Connection of external control circuits as required.

1. EQUIPMENT INSPECTION & STORAGE

Immediately inspect the transfer switch when received to detect any damage which may have occurred during transit. If damage is found or suspected, file claims as soon as possible with the carrier and notify the nearest Zenith representative.

Before installation, it is necessary to store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature:
-30°C to +65°C (-22°F to +149°F)

Humidity:
5% to 95% (non-condensing)

2. MOUNTING

Adequate lifting means must be used to mount the transfer switch into place. The recommended method for moving the transfer switch using the lifting eyes and a spreader bar is illustrated in *Figure 1* below. Enough room should be allowed to open the cabinet doors fully for inspection and servicing of the switch per NEC and local codes.

Before drilling conduit entry holes or any accessory mounting holes, cover and protect the switch and control panel to prevent dirt and metal fragments from entering the mechanical and electrical components. Failure to do so may result in damage and malfunction of the switch.

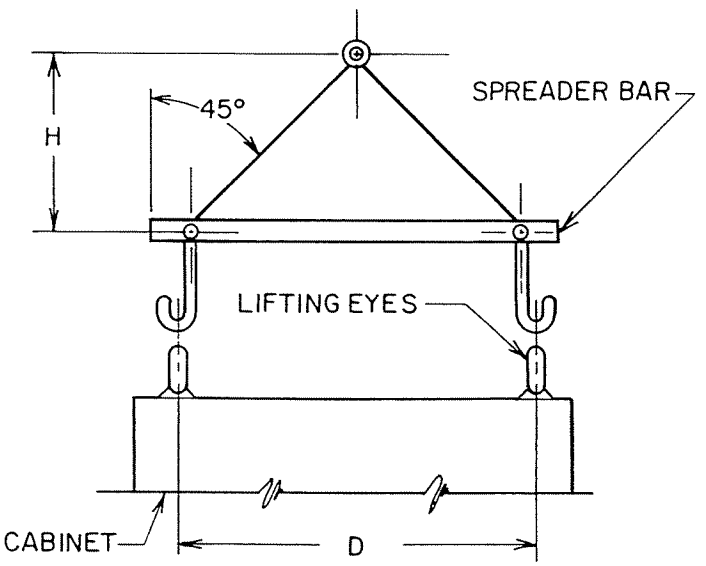


Figure 1

NOTE: When lifting the switch using a spreader bar, Height H must equal half of distance D.

3. POWER CONNECTIONS

Zenith transfer switches are supplied with U.L. Listed solderless screw type terminals as standard for the Normal, Emergency, and Load power connections. *Table 1* lists the number and sizes of the cable lugs supplied as standard for each switch amp rating.

Connect the Normal, Emergency, and Load conductors to the clearly marked terminals on the transfer switch. Remove surface oxides from cables by cleaning with a wire brush. Verify that all connections are correct before tightening the lugs. All cable lug connections must be tightened to the proper torque values as shown in *Table 2.*

Do not run cables or wiring behind front-connected transfer switches.
In cases where the Normal, Emergency, and Load connections are made to a rear connected bus bar, a compression washer, flat washer, and a minimum grade 5 bolt must be used and torqued to the values in *Table 3.*

Tightening Torque for Lugs

Socket Size Across Flat	Torque	
	Lb.-In.	Lb.-Ft.
1/8	45	4
5/32	100	8
3/16	120	10
7/32	150	12
1/4	200	17
5/16	275	23
3/8	375	31
1/2	500	42
9/16	600	50

Table 2

Tightening Torque for Bus Bars

Bolt Size	Torque Bolt (Grade 5)	
	Lb.-In.	Lb.-Ft.
1/4 – 20	72	6
5/16 – 18	132	11
3/8 – 16	300	25
1/2 – 13	720	60

Table 3

Screw Type Terminals for External Power Connections

Switch Size (Amps)	Normal, Emergency & Load Terminals		Fully Rated Neutral Bar (When Required)	
	Cable Per Pole	Range of Wire Sizes	Number of Cables	Range of Wire Sizes
40	1	#14 to 2 AWG	3	#14 to 1/0 AWG
80	1	#14 to 1/0 AWG	3	#14 to 1/0 AWG
100	1	#14 to 1/0 AWG	3	#14 to 1/0 AWG
150	1	#8 to 3/0 AWG	3	#6 AWG to 300 MCM
225	1	#6 AWG to 250 MCM	3	#6 AWG to 300 MCM
260	1	#6 AWG to 350 MCM	3	#6 AWG to 300 MCM
400	1	#4 AWG to 600 MCM	4	#2 AWG to 600 MCM
600	2	#2 AWG to 600 MCM	8	#2 AWG to 600 MCM
800	4	#2 AWG to 600 MCM	12	#2 AWG to 600 MCM
1000	4	#2 AWG to 600 MCM	12	#2 AWG to 600 MCM
1200	4	#2 AWG to 600 MCM	12	#2 AWG to 600 MCM
1600	Line and load terminals are located in rear and arranged for bus bar connection.		12	3/0 AWG to 750 MCM
2000			12	3/0 AWG to 750 MCM
3000			12	3/0 AWG to 750 MCM
4000			12	3/0 AWG to 750 MCM

Table 1

4. CONTROL CONNECTIONS

A complete information package is furnished with each transfer switch including a complete connection diagram and schematic which details all necessary control circuit field connections.

The engine start control wires connect to the terminals specified in the upper left corner of the control panel. *Figure 2* below shows the location of these terminals on the standard SSRCP printed circuit board mounted on the steel backplate. These terminals are clearly identified by a pre-printed label attached to the steel control panel. In the case of manual transfer switches, or in other applications not requiring the standard control panel, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

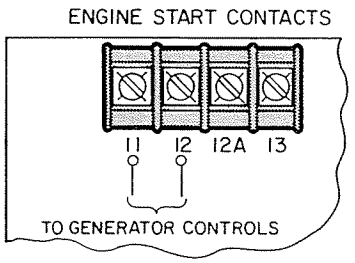
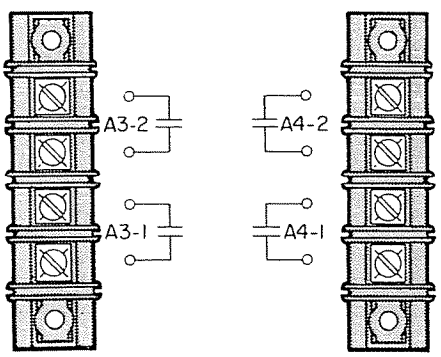


Figure 2

Terminals for field connection to the A3 Emergency auxiliary contacts and the A4 Normal Auxiliary contacts are also provided. These terminals are clearly marked and appear on the left side of the power panel. On 400 amp units, these terminals appear on the disconnect switch bracket above the operator handle, and are marked as illustrated in *Figure 3*.



400 AMP UNIT

Figure 3

Make all other necessary external control connections to the appropriate terminal blocks located on the control panel. Insure that all connections are tightened to the torque specified in *Figure 4* below.

Control Wire Connections

Wire Size (AWG)	Torque Lb.-In.
18 – 16	19
14 – 8	19
6 – 4	36

Figure 4

5. FINAL EQUIPMENT INSPECTION

Prior to energizing the transfer switch:

a. Remove any debris incurred due to shipment or installation. DO NOT use a blower since debris may become lodged in the electrical and mechanical components and cause damage. Use of a vacuum is recommended.
b. Verify that all cabled connections are correct and that phase rotation of both sources match.
c. Check engine start connections and verify the correct connection of all control wires.
d. Check settings of all timers and adjust as necessary. Also adjust any optional accessories as required.
e. Check the integrity of power connections by verifying actual lug torque values as specified in this manual.
f. Make sure that all covers and barriers are installed and properly fastened.

6. FUNCTIONAL TEST

The functional testing of the transfer switch consists of manual and electrical tests described in this section. Before proceeding, refer to the information package supplied with the transfer switch. Read and understand all instructions and review the operation of all accessories provided.

6. FUNCTIONAL TEST (Continued)

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. Both power sources MUST be disconnected before manual operation of the switch. Insert the handle and operate the transfer switch between the Normal and Emergency positions. The transfer switch should operate smoothly without binding. Return the switch to the Normal position, remove the handle, and return it to the holder provided.

Before starting the electrical operation test, check the equipment rating nameplate on the transfer switch to verify the correct system voltage. An example of the equipment rating nameplate is shown in *Figure 5*.

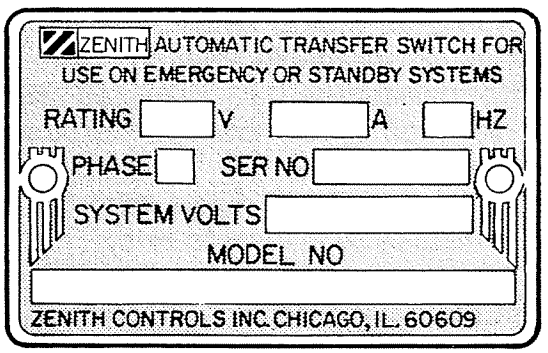


Figure 5

First, close the Normal source circuit breaker. The phase relays B1, B2, and B3 will pick up and the LED indicators will be illuminated. Verify the phase to phase voltages at the Normal line terminals.

Next, close the Emergency source breaker and start the engine generator. The VFSM relay will pick up and the LED indicator will be illuminated. Check the phase to phase voltages at the Emergency line terminals. Also, verify that the phase rotation of the Emergency source is the same as the phase rotation of the Normal source.

After the sources have been verified, shut down the engine generator, and put the starting control in the automatic position. Complete the visual inspection of the transfer switch, and close and lock the cabinet door.

Initiate the electrical transfer test by activating the TS switch. The CR control relay will drop out and the P1 engine start timer will start its timing cycle.

After, the P1 timer has completed its timing cycle, the engine start contact will close and signal the engine generator to start. The VFSM relay will energize. The switch will transfer to the Emergency source after the time delay of the W timer.

Deactivating the test switch will start retransfer to the Normal source. The switch will retransfer to the Normal source after the time delay of the T timer. The U engine over-run timer allows the engine generator to run unloaded for a preset cool-down time period.

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. See National Electric Code articles 700 and 701.

SECTION II – OPERATION AND FEATURES

1. SEQUENCE OF OPERATION

Figure 6 on the facing page is a typical schematic diagram of a Zenith transfer switch with a Module 9 accessory package. The information package supplied with the transfer switch includes a schematic diagram and description of operation of all accessories provided.

The sequence for load transfer to the Emergency source begins automatically when any phase of the Normal source falls below the preset dropout point and this undervoltage failure condition is detected by solid state phase relays B1, B2, B3.

The phase relays drop out, de-energizing the normal control relay CR, and engine start timer P1 begins its timing cycle. The P1 time delay is provided to override momentary outages and to prevent nuisance starting of the engine generator. If the Normal source voltage returns above the pickup setting of the phase relays, the P1 timing cycle is reset to zero by the re-energization of the CR relay.

If the Normal source voltage does not return before the P1 time delay is completed, the P1 timer drops out and sends a starting signal to the engine generator. An Emergency voltage and frequency sensing relay VFSM monitors the voltage and frequency of the Emergency source. When both the voltage and the frequency of the Emergency source reach the preset pickup points, the VFSM relay initiates the transfer to the Emergency source and timer W begins its timing cycle. The W timer provides an adjustable transfer delay to the Emergency source as required.

When the W time delay is completed, the Emergency control relay RT energizes and picks up the power relay, CE1 or CCE. The power relay connects voltage from the Emergency source to the Emergency switch operating circuit causing the switch to transfer its main contacts to the Emergency source. The switch is mechanically locked in the Emergency position. The power relay and Emergency operator are de-energized when the SE limit switch is activated by the operator. The SN limit switch is deactivated at the same time, readying the Normal control circuit for retransfer when the Normal source is restored.

The sequence for retransfer to the Normal source begins automatically when the voltage on all phases of the Normal source reach the preset pickup point and this condition is detected by the solid state phase relays.

When the Normal source restores, the solid state phase relays B1, B2, B3 pick up and initiate retransfer of the switch to the Normal source by energizing timer T and beginning its timing cycle. The T timer provides an adjustable delay to insure that the Normal source has stabilized before reconnection to the load. If the Normal source fails before the T time delay is completed, the phase relays drop out and the T timing cycle is reset to zero.

When the T time delay is completed, the Normal control relay CR energizes and picks up the power relay, CN1 or CCN. The power relay connects voltage from the Normal source to the Normal switch operating circuit causing the retransfer of the main switch contacts to the Normal source. The switch is mechanically locked in the Normal position. The power relay and the Normal operator are de-energized when the SN limit switch is activated by the operator. The SN limit switch also energizes the engine over-run timer U and begins its timing cycle. The timer provides a period of time for the engine generator to run without load and cool down before shutdown. After the U time delay is completed, the P1 timer is energized and the engine generator is shutdown.

Typical Schematic Diagram

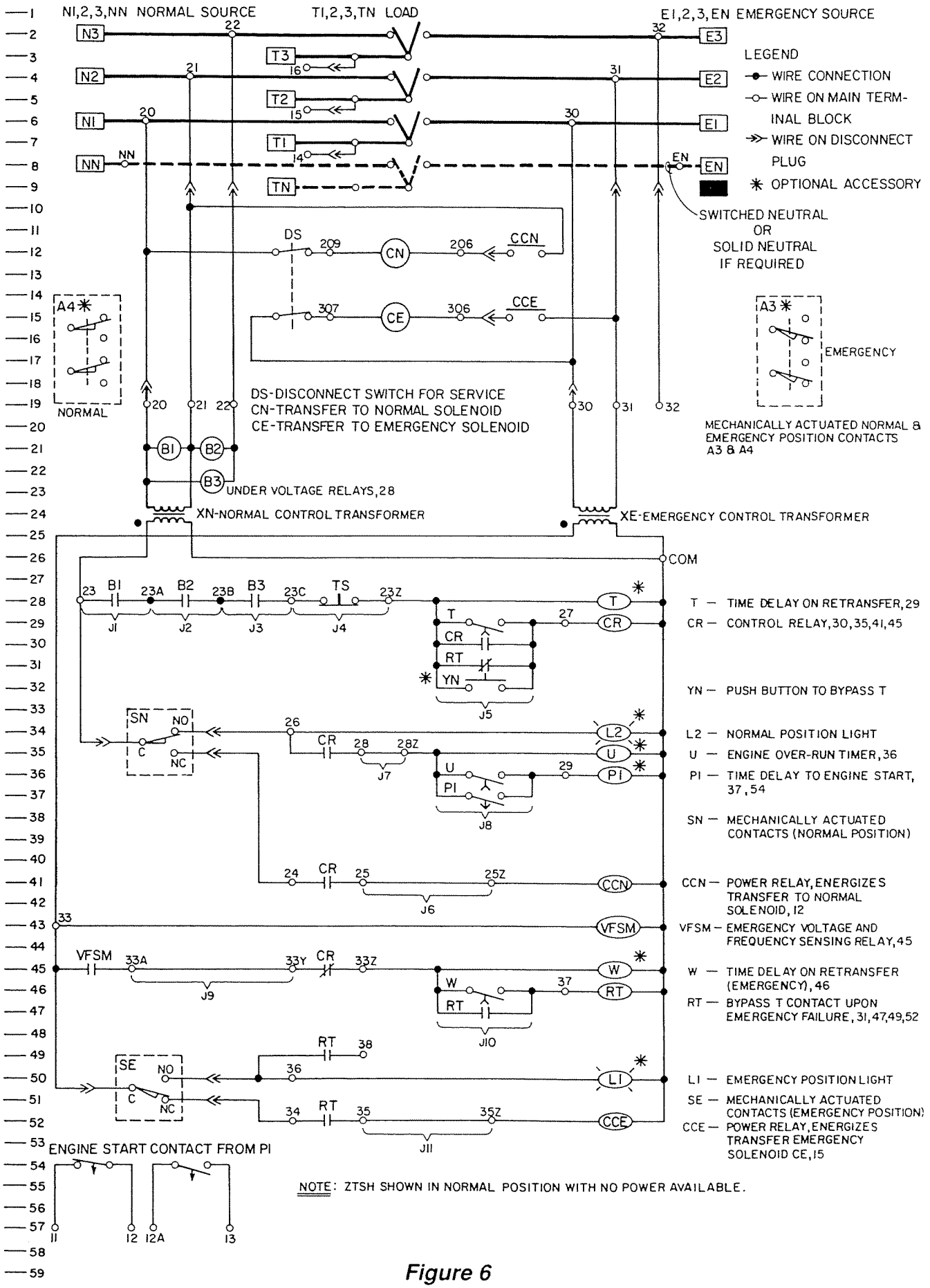


Figure 6

2. ZENITH MODULE 9 ACCESSORY PACKAGE

The Zenith Module 9 Accessory package includes nine of the commonly specified accessories. These accessories are:

A3 Auxiliary contact closes when the switch is in the Emergency position.

A4 Auxiliary contact closes when the switch is in the Normal position.

E Engine start contact closes to start the engine generator when the Normal source fails. 1 N.O., 1 N.C. contacts.

L1 Pilot light which indicates that the switch is in the Emergency position.

L2 Pilot light which indicates that the switch is in the Normal position.

P1 Solid state adjustable timer with range from 0.5 to 6.0 seconds. The contact closes to start the engine generator.

T Adjustable time delay to retransfer to Normal source after restoration.

U Adjustable time delay for engine cool down after the engine generator is signaled to shut down.

W Adjustable time delay to transfer to Emergency source after Normal source failure.

3. ZENITH OPTIONAL ACCESSORIES

Many control accessories are available to meet specific and special requirements. Some of the more commonly specified accessories are:

A6 Motor disconnect to de-energize external motor control circuit prior to transfer in either direction.

C Plant Exerciser which automatically starts the engine generator to run unloaded at selected intervals.

C/D Plant exerciser to allow engine generator to start and run unloaded or to simulate a power failure, start the engine generator, and run under load. This occurs at pre-selected intervals.

L3 Pilot light which indicates that the Normal source is available.

L4 Pilot light which indicates that the Emergency source is available.

P2 Pneumatic adjustable timer with range from 0.5 to 300 seconds. The contact closes to start the engine generator.

Q2 Peak shave or area protection control. Transfer is initiated when the remote area relay indicates failure or when peak shave mode is desired.

R4 In-Phase monitor prevents transfer until both sources are in phase. For use with Isochronous governors.

R43 In-Phase monitor prevents transfer until both sources are in phase. For use with mechanical governors.

S1 Four-position engine control selector switch: "Stop", "Hand Crank", "Test", and "Automatic".

S2 Disconnect switch in series with option E to disconnect engine-starting circuit.

S3 Source selector switch to select either source as the primary source.

T3/ W3 Presignal time delay prior to transfer in either direction.

YE Pushbutton transfer to Emergency. Provides manual control of transfer to Emergency source.

YN Pushbutton retransfer to Normal. Provides manual control to retransfer to Normal Source.

SECTION III – MAINTENANCE AND TESTING

DANGER: HAZARDOUS VOLTAGE. CAN CAUSE SEVERE INJURY OR DEATH.
Turn OFF all power before maintenance, adjustment, or removal of transfer switch or any of its components.

A preventive maintenance program will insure high reliability and long life for the transfer switch. The preventative maintenance program for the transfer switch should include the following items.

1. INSPECTION AND CLEANING

Before doing any work on the transfer switch, de-energize all sources of power. The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. DO NOT use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (DO NOT USE EMERY CLOTH OR A FILE). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken, or badly worn parts.

2. SERVICING

All worn or inoperative parts must be replaced using Zenith recommended replacement parts. Appendix B at the back of this manual includes replacement part information for typical power and control panel configurations. When ordering parts provide the model number or serial number from the transfer switch rating nameplate.

The operating mechanism of the transfer switch is lubricated with Lubriplate 105. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional Lubriplate.

3. TESTING

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. Both power sources MUST be disconnected before manual operation of the switch. Insert the handle and operate the transfer switch between the Normal and Emergency positions. The transfer switch should operate smoothly without binding. Return the switch to the Normal position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning, and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the TS test switch. The CR control relay will drop out and the P1 engine start timer will start its timing cycle.

After, the P1 timer has completed its timing cycle, the engine start contact will close and signal the engine generator to start. The VFSM relay will energize. The switch will transfer to the Emergency source after the time delay of the W timer.

Deactivating the test switch will start retransfer to the Normal source. The switch will retransfer to the Normal source after the time delay of the T timer. The U engine over-run timer allows the engine generator to run unloaded for a preset cool-down time period.

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. See National Electric Code articles 700 and 701.

SECTION III – MAINTENANCE AND TESTING

4. TROUBLESHOOTING

Before beginning any troubleshooting activity, refer to the information package supplied with the transfer switch and review the description and operation of all accessories supplied. Also refer to Section II of this manual, Operation and Features.

CONDITION	*ITEMS TO BE CHECKED*
1. ENGINE GENERATOR DOES NOT START When Normal source fails or Test switch TS activated.	A. Verify the setting of time delay P1. B. Make sure timer P1 drops out and the engine-start contact closes after time delay is completed. C. Make sure the starting battery is charged and connected to the engine generator. D. Generator controls in "Automatic" mode. E. Verify wiring of the engine-start contact. F. If the generator does not start, contact the generator dealer.
2. DOES NOT TRANSFER TO EMERGENCY After generator starts.	A. Emergency source breaker should be closed. B. Emergency source voltage and frequency should meet the preset pick up values of the VFSM relay. C. Make sure Emergency control relay RT picks up after time delay W. D. Verify the circuit connections from the power relay, CE1 or CCE, to the Emergency switch operating circuit.
3. DOES NOT RETRANSFER TO NORMAL When Normal source restores or Test switch TS deactivated.	A. Normal source voltage should meet the preset pickup value of the phase relays. B. Make sure Normal control relay CR picks up after time delay T. C. Verify the circuit connections from the power relay, CN1 or CCN, to the Normal switch operating circuit.
3. ENGINE GENERATOR DOES NOT SHUTDOWN After retransfer to Normal	A. Verify the setting of engine over-run time delay U. B. Make sure timer P1 picks up and the engine-start contact has opened. C. Generator controls in "Automatic" mode. D. Verify wiring of the engine-start contact.

Table 4

FIELD NOTES

Model Number _____

Serial Number _____

Date Shipped _____

Start-Up Date _____

Drawings Supplied _____

TEST AND MAINTENANCE NOTES

DATE	TESTED	OBSERVATIONS	NOTES

SECTION IV – ADJUSTMENTS AND SETTINGS

1. SOLID STATE TIMERS

Solid state timers are adjustable from 0.1 second to 100 hours. The red timing indicator in the upper left corner flashes as the timer progresses through the timing cycle. When the timing cycle is complete, the indicator remains illuminated. A flat-head screwdriver is required to change the setting as shown in *Figure 7* below.

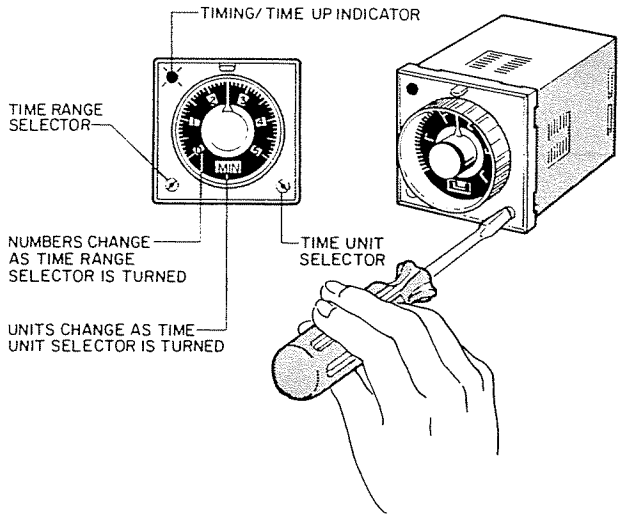


Figure 7

The time unit is selected by turning the rotary switch at the lower right of the timer. Four selections are available: "Seconds", "Minutes", "Hours", "10 Hours". The time unit selected is displayed in the window below the time setting knob.

The time range is selected by turning the rotary switch at the lower left of the timer. Four ranges are available: "0-0.5", "0-1.0", "0-5.0", "0-10.0". The dial digits appear in the windows around the time setting knob.

CAUTION: Do NOT change the setting while the timer is energized. Timer malfunction or damage may occur.

The factory setting of the solid state timers used in the Zenith Module 9 accessory package are shown in *Table 5* below.

TIMER	FACTORY SETTING
T	30 minutes
U	5 minutes
W	1 second

Table 5

2. VOLTAGE/FREQUENCY SENSOR (VFSM)

The pickup point may be adjusted by rotating the adjustment screw as shown in *Figure 8* below. Counter-clockwise rotation increases the pickup voltage.

Pickup Voltage (at 100% Frequency):
Adjustable: 80% to 95%
Factory set: 90%

Pickup Frequency:
Adjustable: 80% to 100%
Factory set: 95%

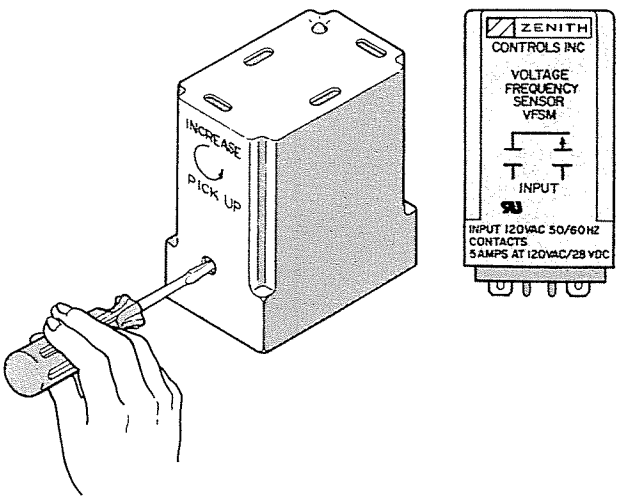


Figure 8

3. SOLID STATE PHASE RELAY (ARSM)

The pickup and dropout points may be adjusted by using the following procedure. Use of a variable voltage supply (Variac) is required. The relay is illustrated in *Figure 9* below.

1. Turn the pickup adjustment fully clockwise.
2. Turn the dropout adjustment fully counter-clockwise.
3. Set Variac to the desired pickup voltage.
4. Rotate the pickup adjustment counter-clockwise very slowly until the relay picks up. The LED will illuminate.
5. Set Variac to the desired dropout voltage.
6. Rotate the dropout adjustment clockwise very slowly until the relay drops out. The LED will go out.
7. Verify setting by raising the voltage until the relay picks up and lowering the voltage until the relay drops out.

Pickup Voltage: 75% to 115% of Nominal
Factory Set: 90% of Nominal

Dropout Voltage: 55% to 105% of Nominal
Factory Set: 80% of Nominal

4. ELECTRONIC TIME SWITCH Z1000-1A

This time switch is used for either the C or C/D option (See page 7). Instructions for programming the time switch are located inside the cover of the switch. An indicating light will appear in the left side of the display to indicate the time switch is in operation. If the time switch has a flashing display, it indicates that a power outage has occurred. To restore the display, press the clock key and check the time of day. The battery should be checked and replaced if necessary.

Due to the 10-year memory retention feature, cutting the power to the time switch will not erase the user's program. The user's settings can be changed or cleared at any time. This feature eliminates the need for having to reprogram the time switch after long power outages.

The time switch will keep the clock running if power is lost by the installation of a 9 volt battery. It will not perform any of the programmed operations during a power outage.

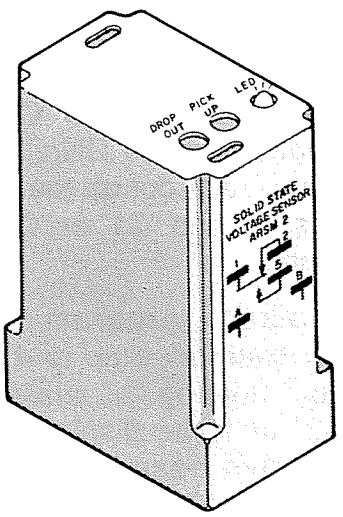


Figure 9

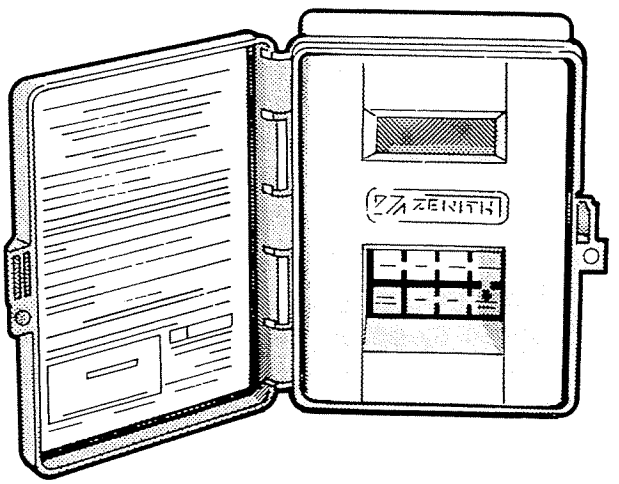


Figure 10

5. ELECTRONIC TIME SWITCH Z2000-2A

This time switch is used for the C/D option (see page 7). Time switch Z2000-1A is used for the C option.

A. Setting Time and Day:

Press and hold "⏲" button during the following adjustments:

1. Press "d" to set day pointer to correct day: 1 = Monday . . .7 = Sunday.
2. Press "h" to set the hour. The time of day is expressed in 24-hour military time: 04:00 = 4 a.m. . . . 20:00 = 8 p.m.
3. Press "m" to set minutes.
4. Release "⏲" button. Clock is running.

B. Programming:

Twenty-four total ON or OFF settings are available on one, several, or all days of the week.

1. Press "Prog" button. The blank program entry field will appear with two flashing points: "_:_"
2. Press either "C1" or "C2" depending on which channel you wish to program.
3. Next, select either "ON" or "OFF" by pressing "C1" or "C2" which toggles the ON/OFF mode.
4. You will now see the pointer flashing above "1" for Monday. To lock in Monday, press "Prog". If you want to enter further days, press "d" then "Prog" to lock them in. Solid pointers must be displayed over each day that the switching command is required.
5. Once the days are selected, press "h" button to enter the desired hour and press "m" to enter the desired minutes. To enter the program into the time switch, press "Prog". When the programming is complete, press "⏲" to return to the clock run mode. If the "⏲" button is not pressed, it will switch to the clock run mode after 60 seconds.

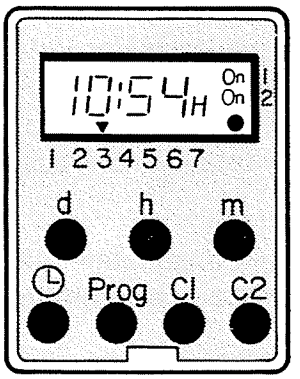


Figure 11

C. Program Review and Change:

Press "Prog" button to recall and review the "C1" and "C2" ON/OFF times. An "E" is displayed if all 24 positions are used or if the next available position is not filled. To change or clear a program, press "Prog" button to find the program to be changed or cleared. Change by pressing "d", "h", or "m" buttons as required. Clear the entire program by simultaneously pressing "h" and "m". Press "⏲" to return to the clock run mode.

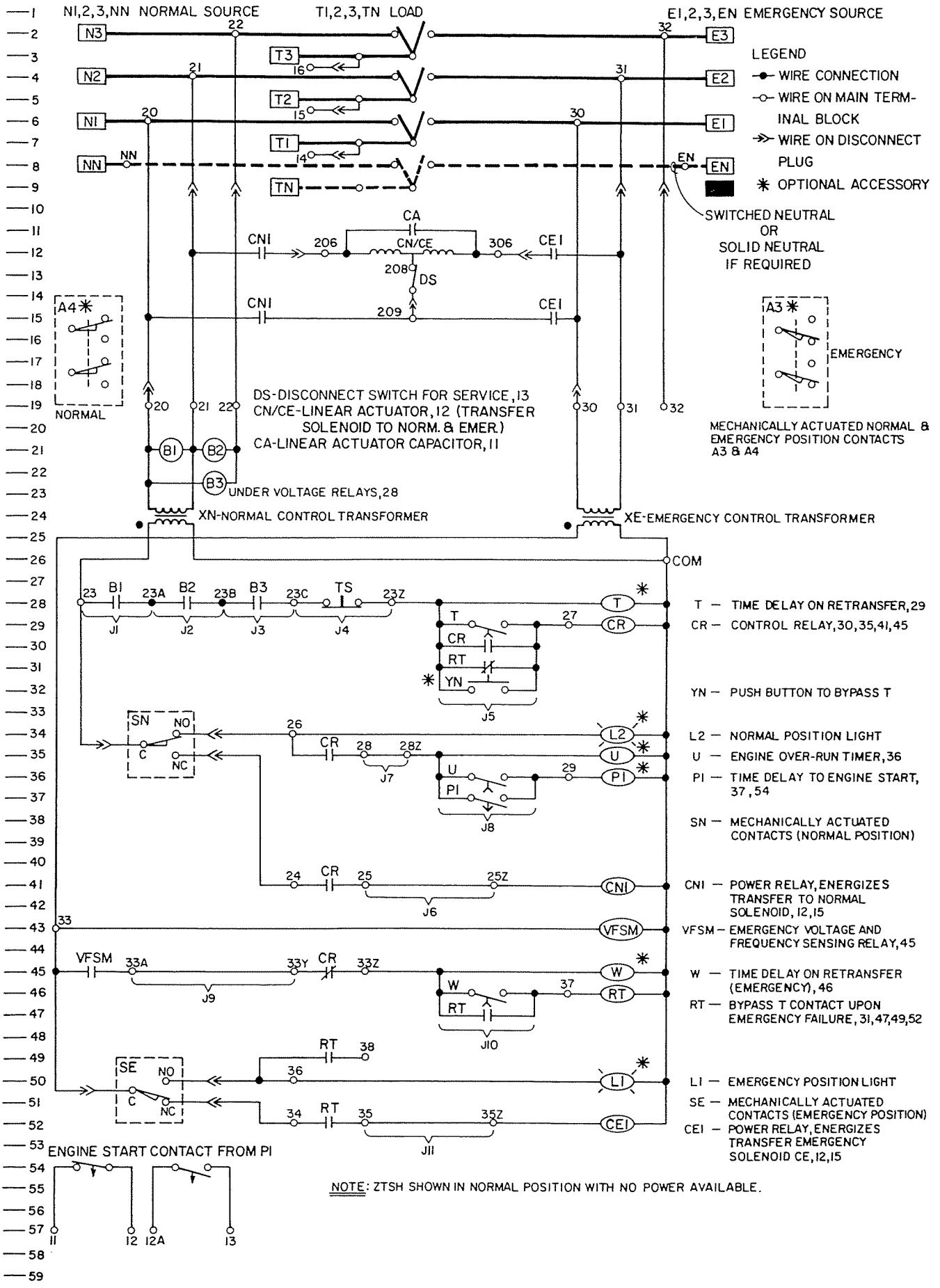
D. Program Override

Each ON/OFF state can be manually changed by pressing "C1" or "C2". The next counteracting program cancels the manual override and resumes previous programming.

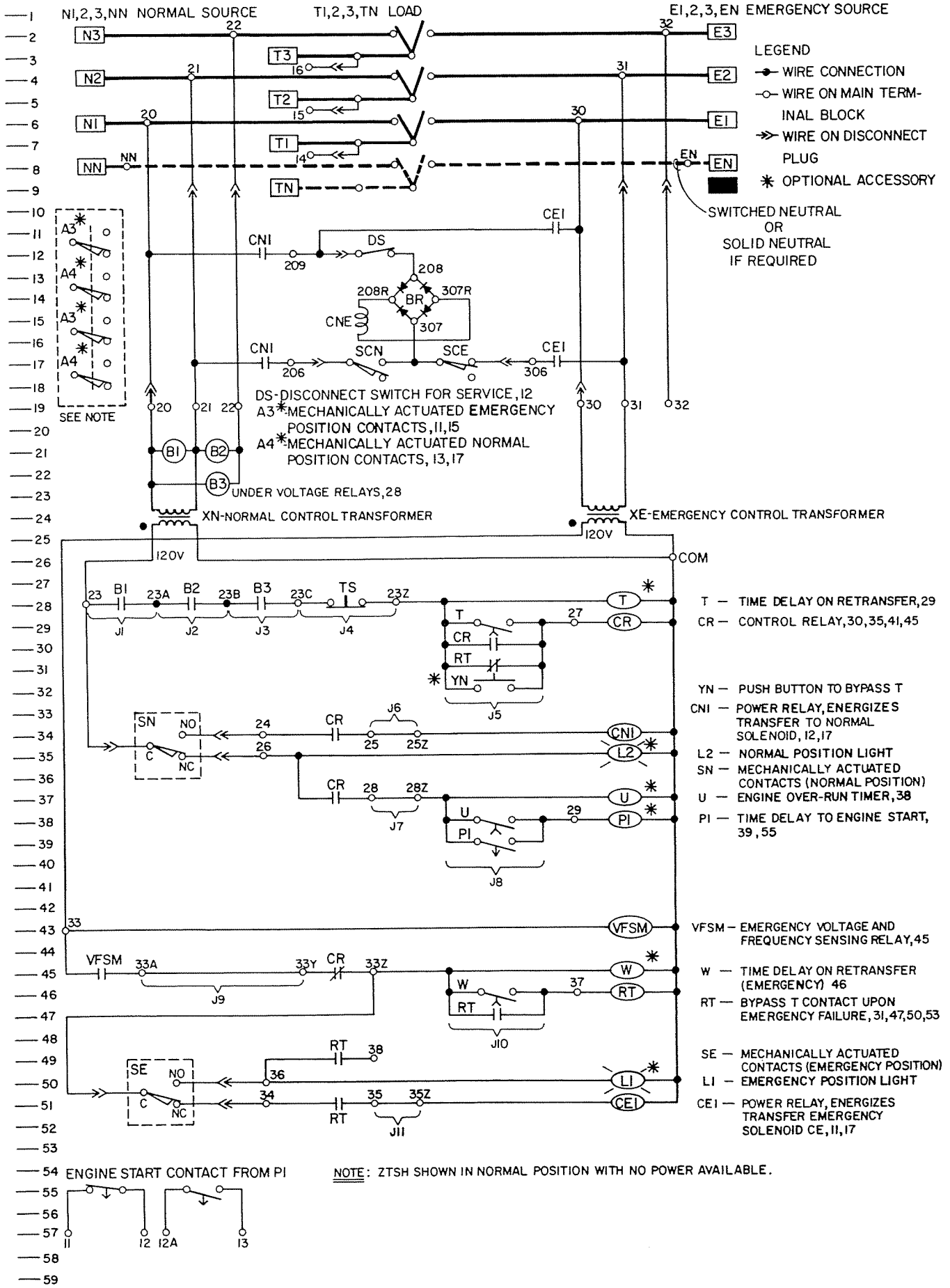
To continuously override automatic programming, press "m" and "C1" or "C2". The continuous override ON/OFF state is preceded by a black dot on the display. To cancel, press "m" and "C1" or "C2" until the dot disappears.

The automatic program can be continuously overridden up to 47 days by pressing and holding "h" while pressing "C1" or "C2" until the display shows the number of days desired. Starting the following day at "0:00", the display will show a "0:00", both "C1" and "C2" off, and an "H" in the lower right hand corner.

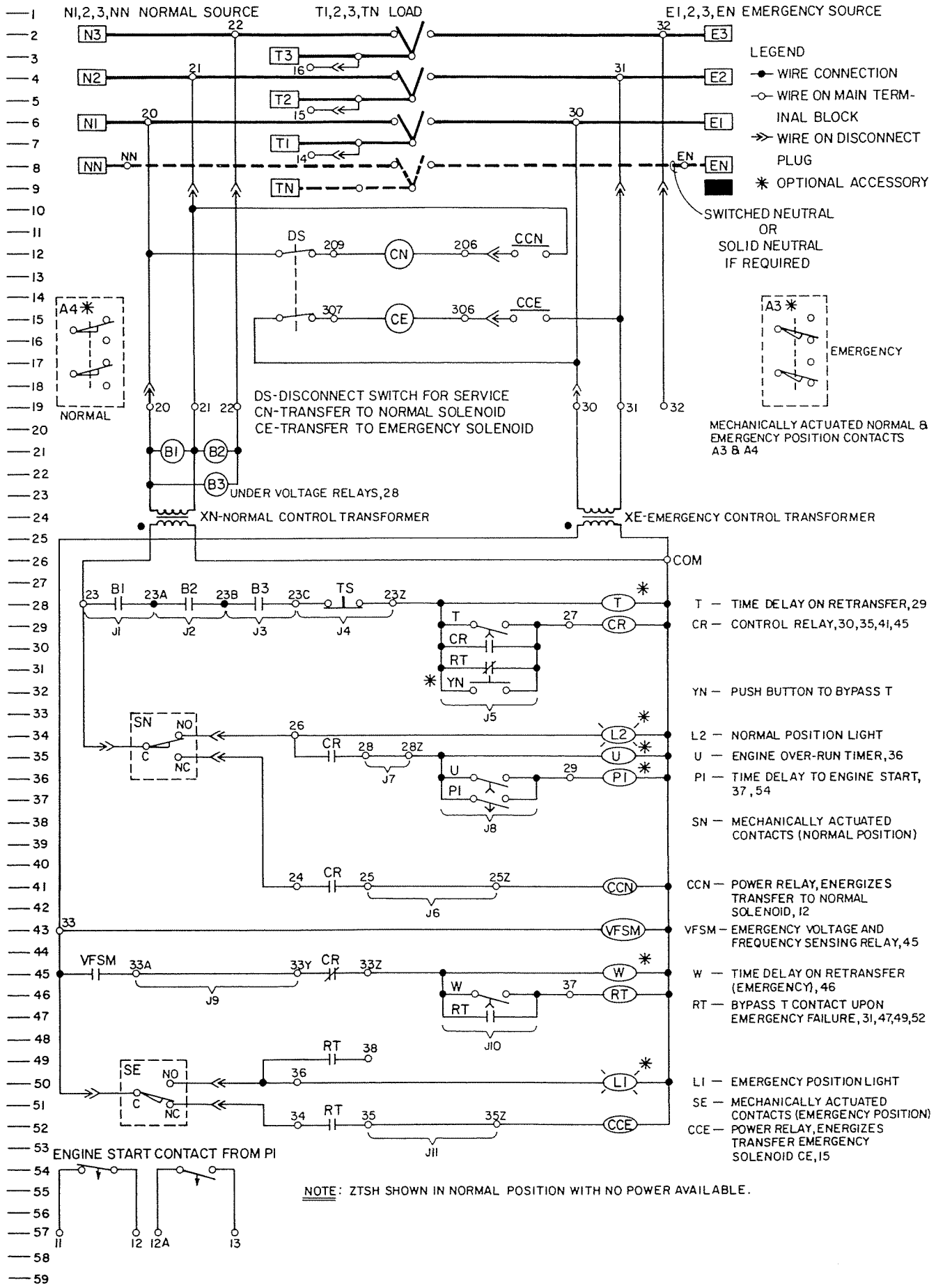
APPENDIX A - TYPICAL SCHEMATIC DIAGRAM 40 - 260 AMPS



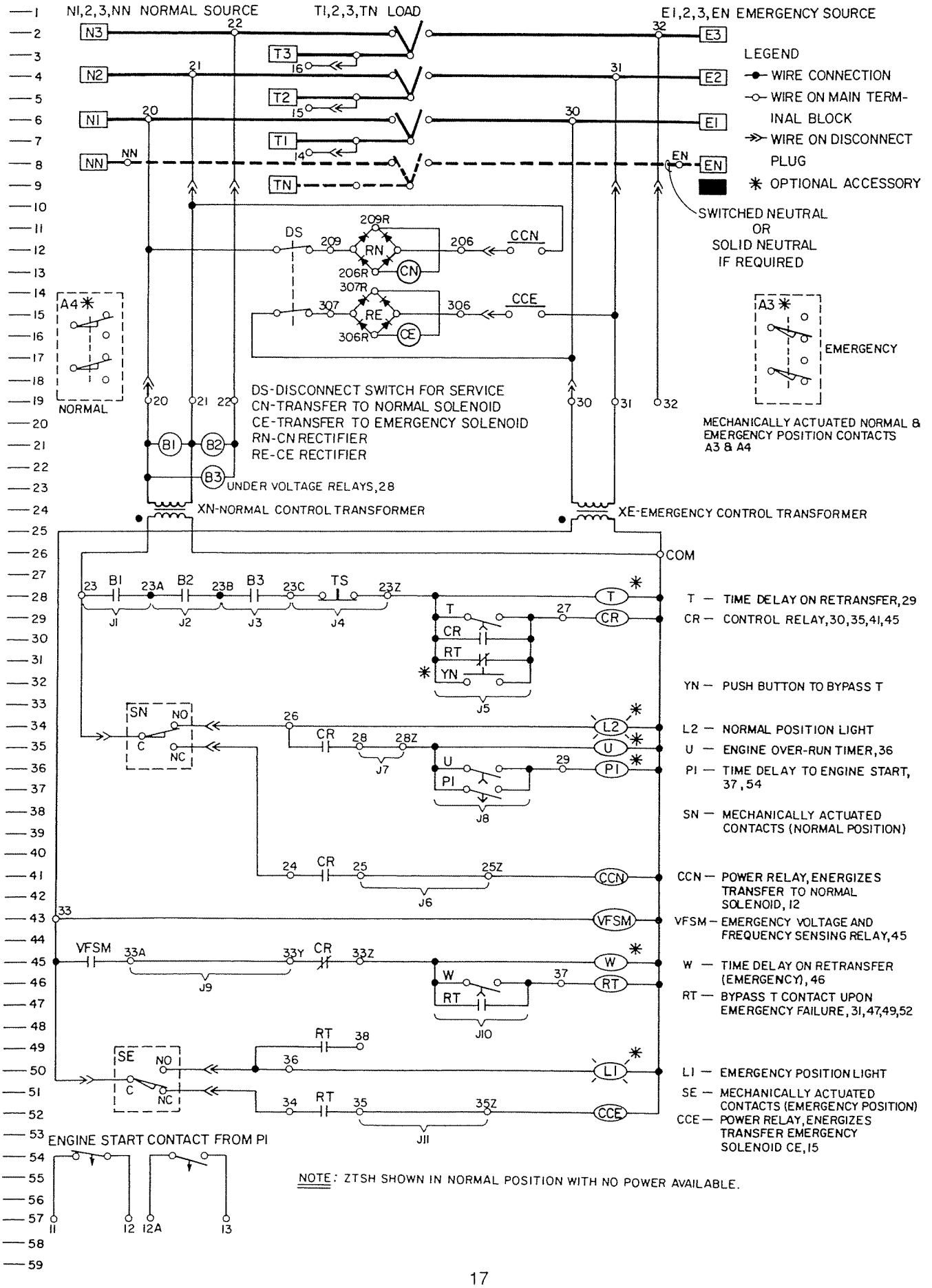
APPENDIX A - TYPICAL SCHEMATIC DIAGRAM 400 AMPS



APPENDIX A - TYPICAL SCHEMATIC DIAGRAM 600 - 1200 AMPS

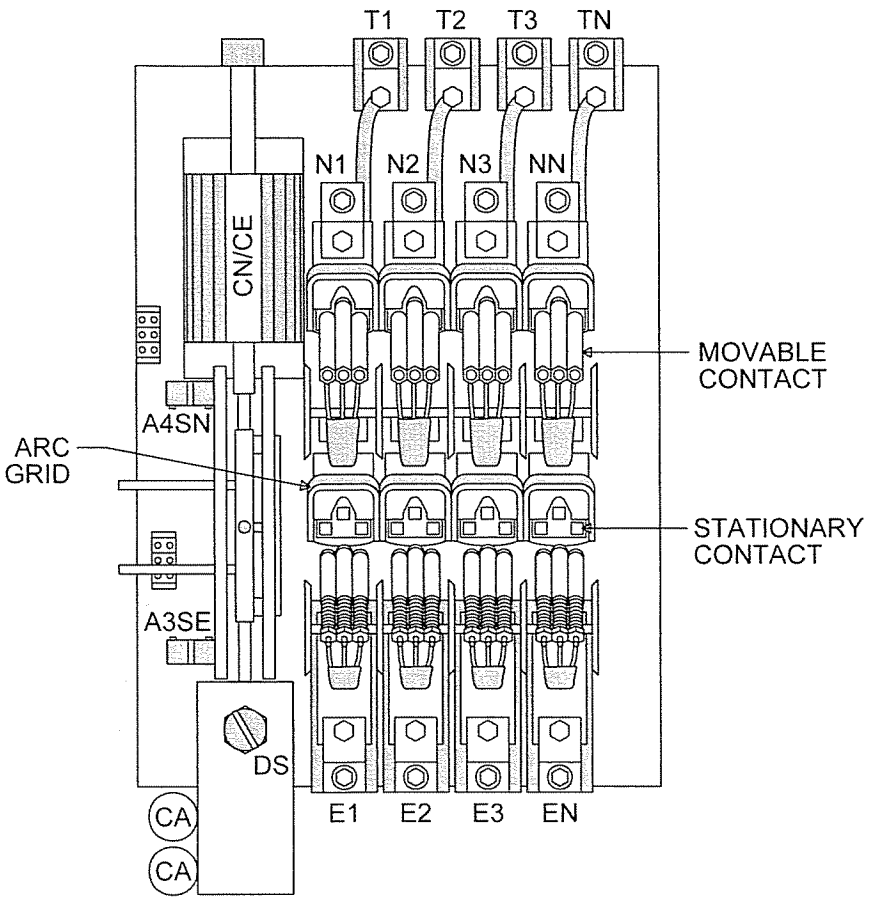


APPENDIX A - TYPICAL SCHEMATIC DIAGRAM 1600 - 3000 AMPS



APPENDIX B - REPLACEMENT PARTS

1. POWER PANEL - 40 TO 260 AMPS



TAG	DESCRIPTION	STOCK NUMBERS BY AMPERAGE					
		40	80	100	150	225	260
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug	PS-4419	PS-4423	PS-4423	27P-1128	27P-1126	27P-1127
	Wire Size	#14-2	#14-1/0	#14-1/0	#8-3/0	#6 to 250 MCM	#6 to 350 MCM
	Stationary Contact Assembly Kit	27P-1141	27P-1141	27P-1141	27P-1111	27P-1111	27P-1111
	Stationary Load Contact Assembly Kit	27P-1140	27P-1140	27P-1140	27P-1109	27P-1109	27P-1109
	Arc Grid Assembly Kit	27P-1014	27P-1014	27P-1014	27P-1014	27P-1014	27P-1014
	Movable Contact Assembly Kit	27P-1036	27P-1036	27P-1036	27P-1037	27P-1037	27P-1037
CN/CE, CA	Linear Actuator and Capacitors			CN/CE	CA (See Note)		
		Coil Volts	Poles		Quantity	Part	mf
	Note: 2S denotes two capacitors wired in series	120	2	K-2104PN	1	PS-4007	340-408
		240	2	K-2105PN	1	PS-4016	108-130
			3				
		208	3	K-2141PN	1	PS-4084	145-174
			4	K-2142PN	1	PS-4084	145-174
		575/600	3	K-2198PN	2S	PS-4083	36-43
			4	K-2197PN	2S	PS-4083	36-43
		480	3	K-2119PN	2S	PS-4008	72-86
			4	K-2111PN	2S	PS-4008	72-86
		416	3	K-2190PN	2S	PS-4008	72-86
SN	CN1 Cut-out Switch	L-5022					
SE	CE1 Cut-out Switch	L-5022					
A3	Emergency Position Auxiliary Contact	SPDT, L-5022; DPDT, L-5021					
A4	Normal Position Auxiliary Contact	SPDT, L-5022; DPDT, L-5021					
DS	Disconnect Switch	Operator I-4018; Contact Block L-1028					

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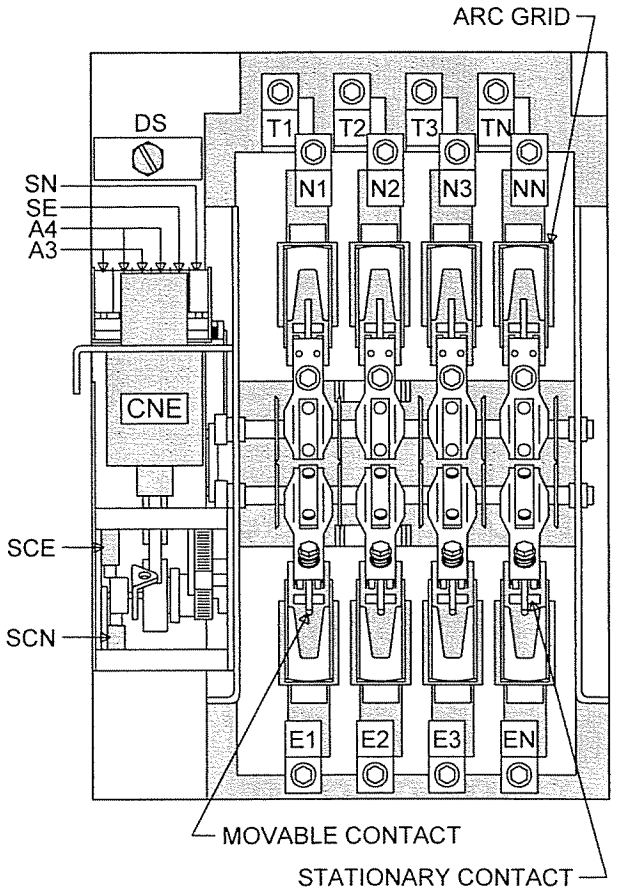
2. POWER PANEL - 400 AMPS



TAG	DESCRIPTION			PART NUMBER
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Normal Emergency Load	Cable Connection Lugs #4-600 MCM		PS1815F PS1815
	Stationary Contact Assembly Kit			
	Stationary Load Contact Assembly Kit			46P-1100E
	Arc Grid Assembly Kit			46P-1101E
	Movable Contact Assembly Kit			46P-1102E
	Linear Actuator and Capacitors			46P-1103E
	Linear Actuator and Capacitors			46P-1140
CNE	Main ATS Operating Coils	Coil Volts	Poles	
		120	2	K-2178
		240	3,4	K-2189
		208	3,4	K-2177
		575/600	3,4	K-2196
		480	3,4	K-2176
		416	3,4	K-2188
		380	3,4	K-2188
SN	CN1 Limit Switch			L-5021
SE	CE1 Limit Switch			
A3	ATS Emergency Position Switch			
A4	ATS Normal Position Switch			
SCN/SCE	CNE Limit Switches			L-3079
DS	ATS Solenoid Disconnect Switch			L-4018 L-1029
	Operator 2 - Position Maintain			
	Contact Block N.C. (1)			
BR	Rectifier			PS-5076

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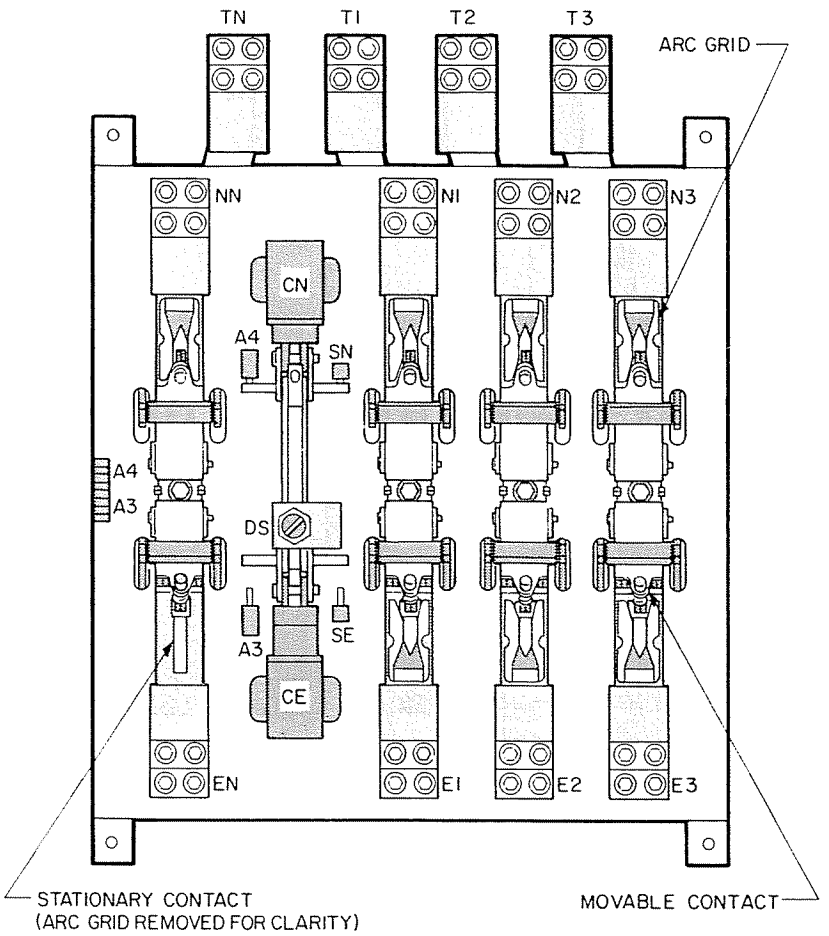
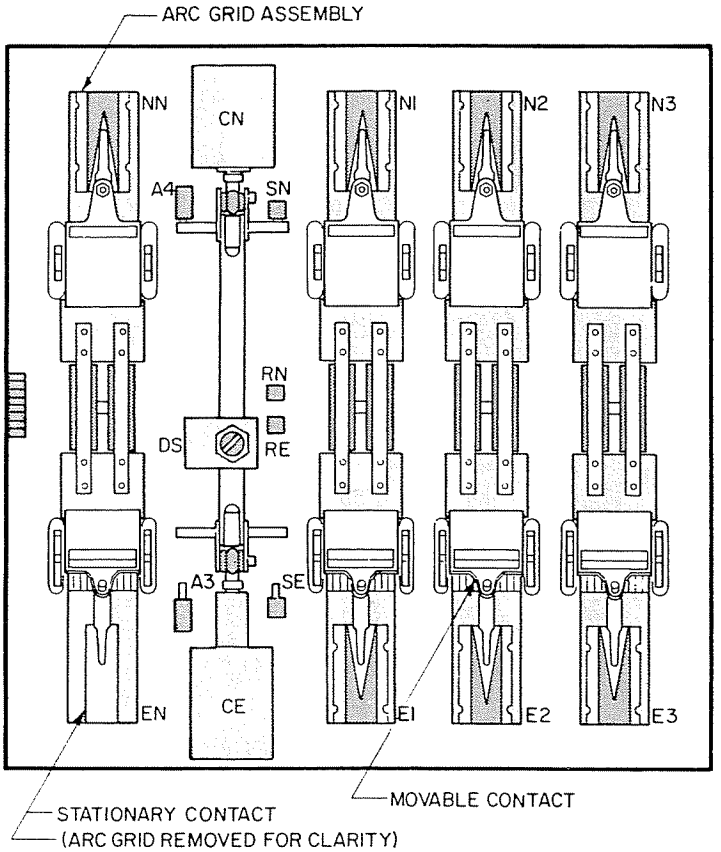
APPENDIX B - REPLACEMENT PARTS (Continued)

3. POWER PANEL - 600-1200 AMPS



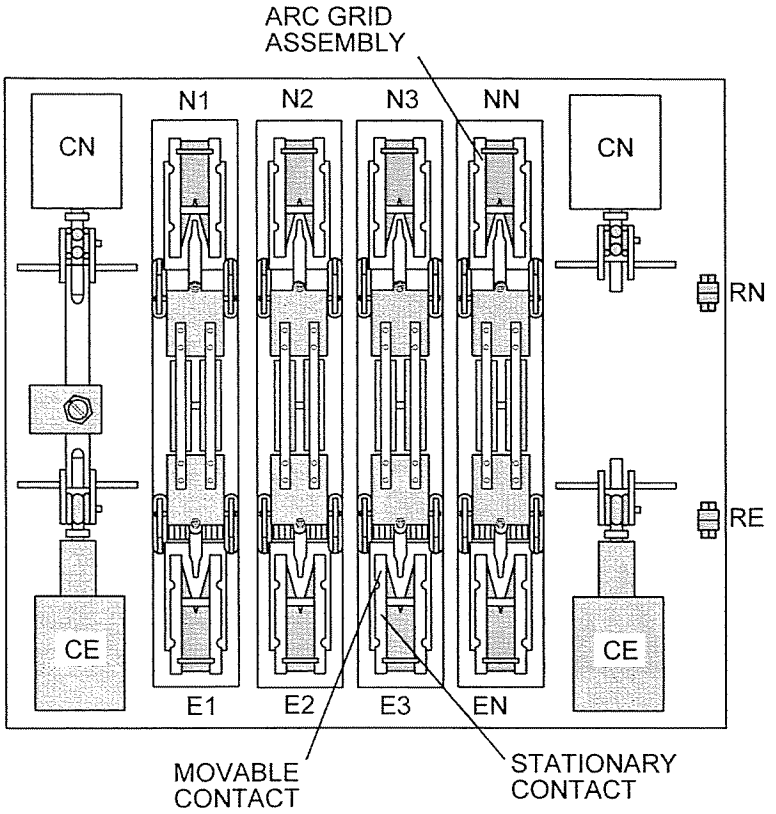
TAG	DESCRIPTION			STOCK NUMBER BY AMPERAGE			
				600	800	1000	1200
N 1,2,3,N E 1,2,3,N T 1,2,3,N	Cable Connection Lugs			S1393F (2)	**S1392F** **(4)**	S1392F (4)	S1392F (4)
	Wire Size			#2-600 MCM	#2-600 MCM	#2-600 MCM	#2-600 MCM
	Stationary Contact Assembly Kit			Consult Factory			
	Arc Grid Assembly Kit			23P-1366			
	Moveable Contact Assembly Kit			Consult Factory			
CN,CE	Main Operating Coils	Coil Volts	Poles				
		120	2	K2090F	K2073F	K2073F	K2073F
		240	2	K2092F	K2070F	K2070F	K2070F
			3	K2078F	K2070F	K2070F	K2070F
			4	K2091F	K2074F	K2074F	K2074F
		208	3,4	K2091F	K2074F	K2074F	K2074F
		575/600	3,4	K2095	K2155	K2155	K2155
		480	3	K2080F	K2071F	K2071F	K2071F
			4	K2079F	K2071F	K2071F	K2071F
		416	3	K2080F	K2071F	K2071F	K2071F
SN	CCN Cut-out Switch		23P-1333				
SE	CCE Cut-out Switch		23P-1327		23P-1452		
A3	Emergency Position Aux. Contact		(Qty. 1) 23P-1327 (Qty. 2) 23P-1328 (Qty. 3) 23P-1334 (Qty. 4) 23P-1336				
A4	Normal Position Aux. Contact		(Qty. 1) 23P-1333 (Qty. 2) 23P-1334 (Qty. 3) 23P-1328 (Qty. 4) 23P-1330				
DS	Disconnect Switch		Operator L-4009; Contact Block L-1020				

4. POWER PANEL - 1600-3000 AMPS



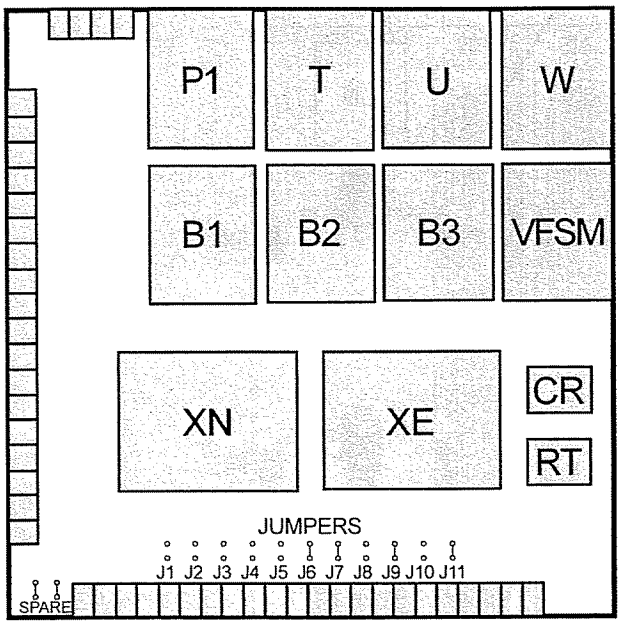
TAG	DESCRIPTION			STOCK NUMBER BY AMPERAGE		
				1600	2000	3000
N 1,2,3,N E 1,2,3,N	Cable Connection at Rear			S-1126F (2) Optional	S-1126F (2) Optional	S-1126F (2) Optional
T 1,2,3,N	Wire Size			(8) #2-600 MCM	(8) #2-600 MCM	(8) #2-600 MCM
	Stationary Contact Assembly Kit			23P-1594	23P-1594	23P-1619
	Arc Grid Assembly Kit			23P-1171	23P-1171	23P-1171
	Moveable Contact Assembly Kit			23P-1400	23P-1400	23P-1344
CN, CE	Main Operating Coils	Coil Volts	Poles			
		120	2	SPO	SPO	SPO
		240	2, 3	K-2123	K-2123	K-2123
			4	K-2127	K-2127	K-2127
		208	3	K-2125	K-2125	K-2125
			4	K-2128	K-2128	K-2128
		575/600	3	K-2153	K-2153	K-2153
			4	K-2154	K-2154	K-2154
		480	3	K-2120	K-2120	K-2120
			4	K-2130	K-2130	K-2130
		416	3	K-2126	K-2126	K-2126
SN	CN Cut-out Switch	23P-1352				
SE	CE Cut-out Switch	23P-1356				
A3	Emergency Position Aux Contact	(Qty. 1) 23P-1356 (Qty. 2) 23P-1357 (Qty. 3) 23P-1353 (Qty. 4) 23P-1355				
A4	Normal Position Aux Contact	(Qty. 1) 23P-1352 (Qty. 2) 23P-1353 (Qty. 3) 23P-1357 (Qty.4) 23P-1359				
DS	Disconnect Switch	Operator L-4009; Contact Block L-1020				
RN, RE	Rectifier	23P-1473 (Up to 240V); 23P-1582 (Up to 600V).				

5. POWER PANEL - 4000 AMPS



TAG	DESCRIPTION			STOCK NUMBERS
N 1,2,3, N E 1,2,3, N	Cable Connection Lug			S1511F (3) Optional
T 1,2,3, N	Wire Size			(12) #2-600 MCM
	Stationary Contact Assembly Kit			23P-1655
	Arc Grid Assembly Kit			23P-1171
	Movable Contact Assembly Kit			23P-1640
CN/CE	Main Operating Coils	Coil Volts	Poles	
		240	3	K-2219
			4	K-2219
		208	3	K-2226
			4	K-2226
		575/600	3	K-2221
			4	K-2221
		480	3	K-2218
			4	K-2218
		416	3	K-2220
SN	CCN Cut-out Switch		23P-1352	
SE	CCE Cut-out Switch		23P-1356	
A3	Emergency Position Aux Contact		(Qty 1) 23p-1356 (Qty 2) 23p-1357 (Qty 3) 23p-1353 (Qty 4) 23p-1355	
A4	Normal Position Aux Contact		(Qty 1) 23p-1352 (Qty 2) 23p-1353 (Qty 3) 23p-1357 (Qty 4) 23p-1359	
DS	Disconnect Switch		Operator L-4009; ; Contact Block L-1020	
RN, RE	Rectifier		23P-1473 (Up to 240V); 23P-1582 (Up to 600V)	

6. STANDARD CONTROL PANEL (SSRCP)

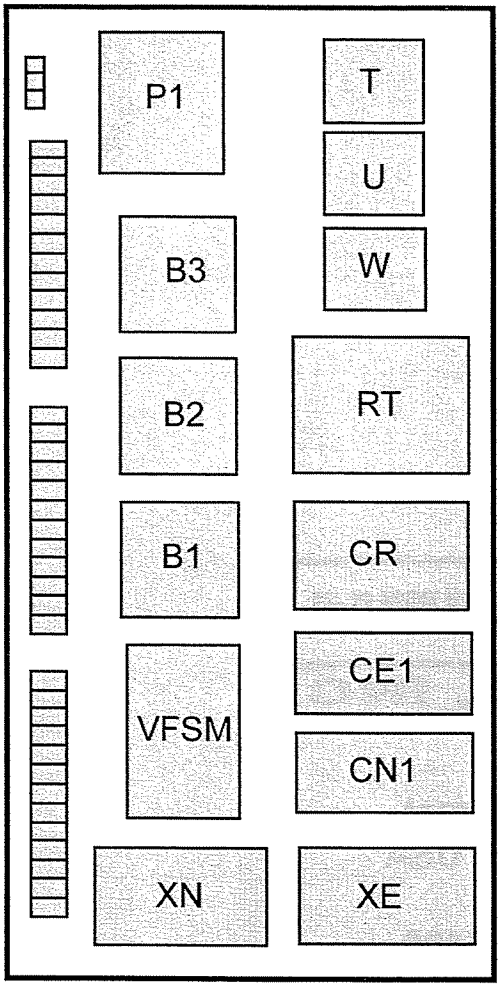


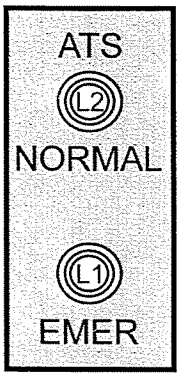
JUMPER	CONNECTS POINTS	REMOVE WHEN ACCESSORIES USED
J1	23, 23A	B1
J2	23A, 23B	B2
J3	23B, 23C	B3
J4	23C, 23Z	JIN, TS, C/D
J5	23Z, 27	T, YN
J6	25, 25Z	T3, R4
J7	28, 28Z	S1, C, C/D
J8	28Z, 29	P1 & U
J9	33A, 33Y	ER1, 2, 3, J1E
J10	33Z, 37	W
J11	35, 35Z	R4, W3

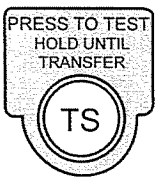
TAG	DESCRIPTION	VOLTAGE 50/60 HZ		PART NUMBER
XN, XE	Control Transformers (See Note 1)	120 V		K-3068
		208 V		K-3070
		240 or 480 V		K-3071
		416 V		K-3089
B 1, 2, 3	Phase Relays Solid State (See Note 1)	120 V		K-1185
		208 or 240 V		K-1186
		480 V		K-1188
VFSM	Voltage Frequency Sensor	120 V		K-1192
CR	Control Relay	120 V		K-1204
RT	Bypass T Relay	120 V		K-1204
CN1, CE1 or CCN, CCE	Transfer Relays (Mounted below SSRCP)	ZTSH 4-40, ZTSH 160-300	120 V	K-1120
		ZTSH 60-120	120 V	K-1095
T	Time Delay-to-Normal, Timer Solid State	0.1 sec. to 100 hours; adjustable	120 V	K-1230
U	Engine Cool Down, Timer Solid State	0.1 sec. to 100 hours; adjustable	120 V	K-1230
W	Time Delay Emergency, Timer Solid State	0.1 sec. to 100 hours; adjustable	120 V	K-1230
P1	Time Delay Engine Start Timer	0.5 sec. to 6 sec.; adjustable	120 V	K-1201
P2	Optional (Mounted below SSRCP)	0.5 sec. to 300 sec.; adjustable	120 V	K-1061
J1 - J11	Jumpers			PS-5067

NOTES: 1. If -6 voltage system (575/600V) is supplied, then XN, XE is K-3087 and B1, 2, 3 is K-1185 (120V) supplied with XB (575-600V/120V) 3 phase transformer assembly.

7. OPTIONAL CONTROL PANEL AND CABINET DOOR PILOT DEVICES







TAG	DESCRIPTION	PART NUMBER
L1	ATS Emergency Position Indicator	
L2	ATS Normal Position Indicator	
	Lens (Normal)	PS-5048 (Green)
	Lens (Emergency)	PS-5047 (Red)
	Bulb Socket	PS-5046 (Incandescent)
	Emergency Bulb	PS-5105 (Incandescent)
	Normal Bulb	PS-5105 (Incandescent)
TS	Test Switch	
	Operator, Momentary	L-1025
	Contact Block N.C.	L-1029
	Contact Mounting Base	PS-3473

TAG	DESCRIPTION	VOLTAGE 50/60 HZ		PART NUMBER
XN, XE	Control Transformers (See Note 1)	120 V		K-3068
		208 V		K-3053
		240 or 480 V		K-3041
		416 V		K-3055
B 1, 2, 3	Phase Relays Electro-Mechanical-Standard Solid State (See Note 1)	120 V		K-1055 (K-1185)
		208 or 240 V		K-1056 (K-1186)
		480 V		K-1058 (K-1188)
VFSM	Voltage Frequency Sensor	120 V		K-1192
CR	Control Relay	120 V		Y-260002
RT	Bypass T Relay	120 V		Y-260002
CN1, CE1 or CCN, CCE	Transfer Relays	ZTSH 4-40, ZTSH 160-300	120 V	K-1120
		ZTSH 60-120	120 V	K-1095
T	Time Delay-to-Normal, Timer Solid State	0.1 sec. to 100 hours; adjustable	120 V	K-1230
U	Engine Cool Down, Timer Solid State	0.1 sec. to 100 hours; adjustable	120 V	K-1230
W	Time Delay Emergency, Timer Solid State	0.1 sec. to 100 hours; adjustable	120 V	K-1230
P1	Time Delay Engine Start Timer	0.5 sec. to 6 sec.; adjustable	120 V	K-1201
P2	Optional	0.5 sec. to 300 sec.; adjustable	120 V	K-1061

NOTES: 1. If -6 voltage system (575/600V) is supplied, then XN, XE is K-3059 and B1, 2, 3 is K-1055 (120V) supplied with XB (575-600V/120V) 3 phase transformer assembly.

Rev. 7/97

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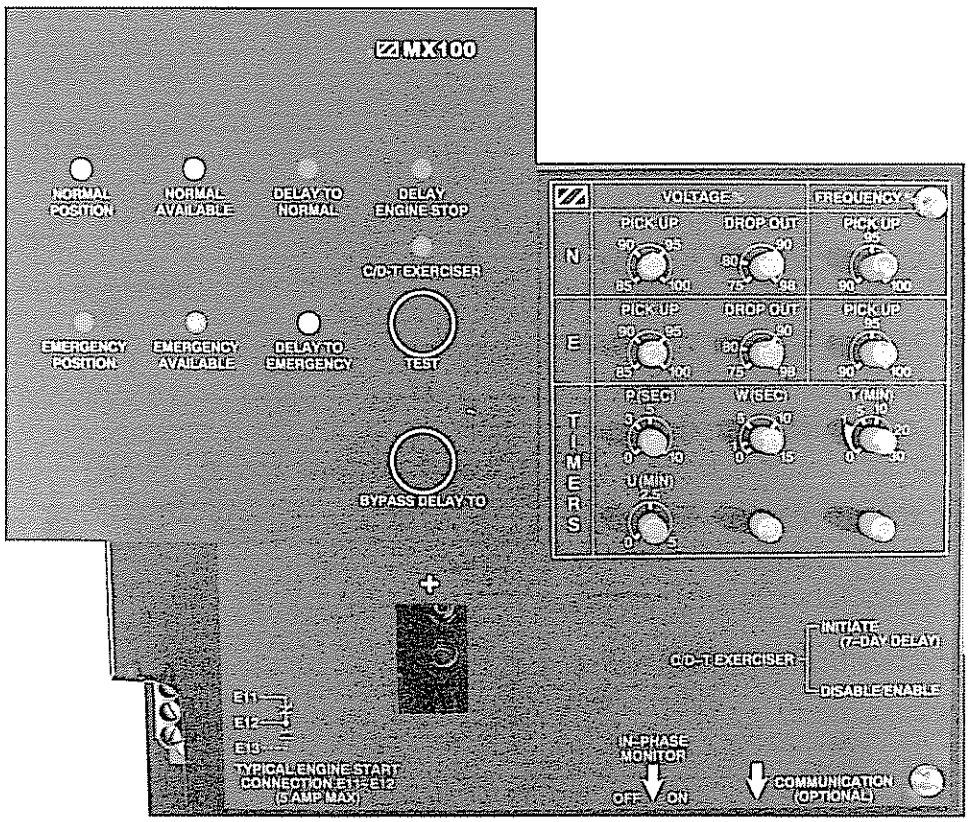
OPERATION AND MAINTENANCE MANUAL
TRANSFER SWITCH CONTROL PANEL
MX100 MICROPROCESSOR CONTROLLER



ZENITH CONTROLS, INC.

ISO 9001

50R-1000C
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Safety

⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Installation for each ATS is detailed in the information package which includes:

- Operation and Maintenance Manual for Control Panel (this manual)
- Power Panel Manual
- Specific Schematics Supplied With Each Transfer Switch

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred due to shipment or installation. **DO NOT** use a blower since debris may become lodged in the electrical and mechanical components and cause damage. Use of a vacuum is recommended.
2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections and verify the correct connection of all control wires.
4. Check settings of all timers and adjust as necessary. Also adjust any optional accessories as required.
5. Check the integrity of power connections by verifying actual lug torque values as specified in the power panel manual.
6. Make sure that all covers and barriers are installed and properly fastened.

NOTE: Power Panels ship from Zenith in the Normal Position.

Equipment Inspection and Storage

Immediately inspect the transfer switch when received to detect any damage which may have occurred during transit. If damage is found or suspected, file claims as soon as possible with the carrier and notify the nearest Zenith representative.

Before installation, it is necessary to store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature:	-30 C to + 85 C (-22 F to +149 F)
Operating Temperature (Ambient):	-20 C to +75 C (-4 F to +167 F) [40-260 Amps] -20 C to +60 C (-4 F to +104 F) [400-4000 Amps]
Humidity:	5% to 95% (non-condensing)

Installation

⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Engine Start Control Connections

Engine-start control wires connect to control terminals below of the MX100. Engine start terminals are indicated by a schematic symbol (the symbol indicates the contact state for a de-energized Normal source). Figure 1 shows the engine-start contacts.

Make all other necessary control connections to the control panel terminal blocks per the schematics supplied with the ATS. **All control wires (18-12 AWG) must be torqued to 19 in-lbs.**

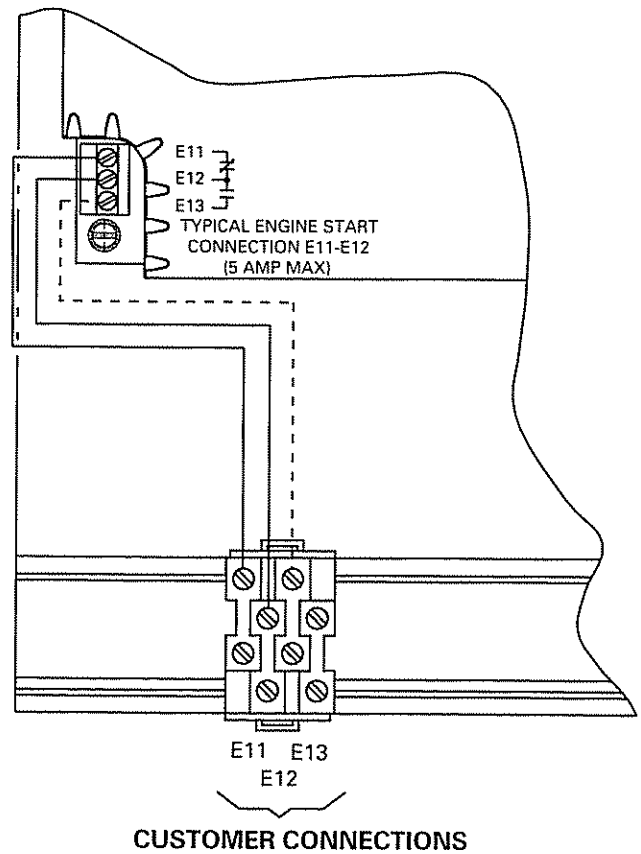

Figure 1 - Din Rail

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⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Initial Energization

Functional testing of the ATS consists of electrical tests described in this section. Before proceeding, refer to the information package supplied with the ATS and read and understand the information on all accessories provided. (Caution: Certain accessories, per specific schematics, can inhibit automatic transfer. See Section 3.)

After all options and accessories are checked and verified, follow these steps to set up the ATS. Refer to MX100 display Figure 2. The annunciation LEDs illuminate to indicate (1) source availability, (2) ATS position, and (3) MX100 control function (timing).

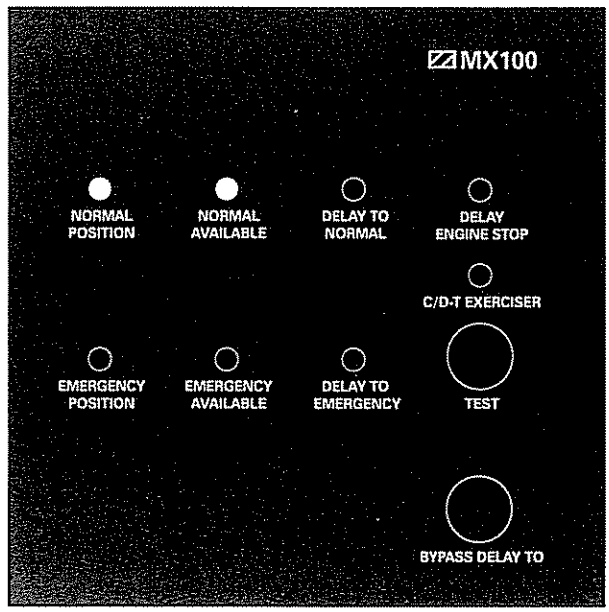

Figure 2 - Standard Transition Annunciation LEDs and Test Switch

⚠ CAUTION

Engine Gen-Set could start when engine control wires are attached.

NOTICE: **If LEDs are flashing, refer to Troubleshooting and Diagnostics.**

Step 1: If equipped with the disconnect switch (DS) option, turn to INHIBIT. Close the external (up-stream) Normal circuit breaker. The Normal Available and Normal Position LEDs illuminate. (If the Normal Available LED does not illuminate verify that Normal source voltage is above the preset pick-up value.) On initial start-up, the Delay to Engine Stop Timing LED will illuminate for the duration of its setting.

NOTICE: **Gen-Set will start and run while Delay to Engine Stop is timing.**

Step 2: Close the external (up-stream) Emergency line circuit breaker and start the engine generator in MANUAL mode. When the voltage and the frequency reach preset values, the Emergency Available LED will illuminate.

Step 3: Verify the line-to-line voltages at the Emergency line terminals, and verify that the Emergency and Normal source phase rotations are the same (either A-B-C or A-C-B).

Step 4: After the sources have been verified, shut down the engine generator (place in AUTOMATIC mode). The Emergency Available LED will turn off.

NOTICE: **Engine generator will continue to run if Delay to Engine Stop Timing LED is illuminated.**

Step 5: Turn the DS (disconnect switch) to ENABLE if so equipped. Make a final inspection of the ATS and close and lock the cabinet door.

Operation and Testing

Standard Transition ATS Testing (w/o A6 or T3/W3)

For this test description, please refer to MX100 standard transition display *Figure 2*.

Initiate testing with the ATS in Normal position and Normal power available (Normal Position and Normal Available LEDs illuminated). **Press and hold the test switch until transfer (releasing the test switch prematurely will abort the test).** The delay to engine start timer (P) begins its timing cycle. After the P timer has completed its timing cycle, the engine start contacts close to start the generator.

When Emergency voltage and frequency reach preset pickup points the Emergency Available LED illuminates. Simultaneously, the delay to emergency timer (W) begins its timing cycle and the Delay to Emergency LED illuminates. When the W time delay is completed the switch will transfer to emergency. The Delay to Emergency and Normal Position LEDs go off, and the Emergency Position LED illuminates.

Release the test switch to start retransfer to Normal. The delay to normal timer (T) begins its timing cycle illuminating the Delay to Normal LED. When the T timer has completed its timing cycle the switch will transfer into Normal. The Delay to Normal and Emergency Position LEDs go off, and the Normal Position LED illuminates. The delay engine stop timer (U) begins its timing cycle and the Delay Engine Stop LED illuminates. The generator runs unloaded for the duration of the U timing cycle. When the timer completes its timing cycle, the generator will stop. The Delay Engine Stop and the Emergency Available LEDs go off.

⚠ NOTICE

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

Standard Transition Transfer Sequence (w/o A6 or T3/W3)	LED Annunciation Status						
	Normal Position	Normal Available	Emergency Position	Emergency Available	Delay to Normal	Delay to Emergency	Delay Engine Stop
Normal Position	●	●					
W Time Delay	●	○		●		●	
Emergency Position		○	●	●			
T Time Delay		●	●	●	●		
Normal Position/ Engine Overrun Timer	●	●		●			●

○ **Illuminated only when running TEST, not on Normal power failure**

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Delayed Transition ATS Testing

Refer to Delayed Transition display Figure 3. Initiate testing with the ATS in Normal position and Normal power available (Normal Position and Normal Available LEDs illuminated). Press and hold the test switch until transfer (releasing the test switch prematurely will abort the test).

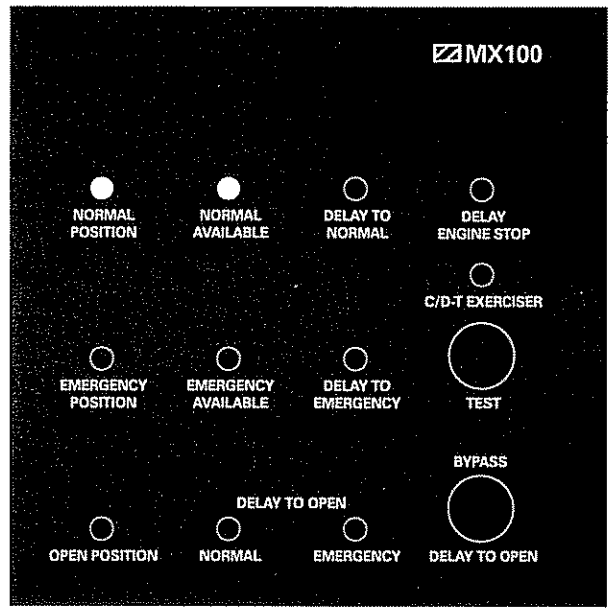

Figure 3 - Delayed Transition Annunciation LEDs and Test Switch

The delay to engine start timer (P) begins its timing cycle. After the P time delay the engine start contacts close to start the generator.

When Emergency voltage and frequency reach the preset pickup points the Emergency Available LED illuminates. Simultaneously, the delay to open normal timer (W) begins its timing cycle and the Delay to Open Normal LED illuminates. After the W time delay the ATS transfers out of Normal position into the Open position. The Delay to Open Normal and Normal Position LEDs go off, and the Open Position and Delay to Emergency LEDs illuminate. (Releasing the test switch now will allow the test to continue.)

Time delay to emergency (DW) then begins. When the DW time delay is completed the switch will transfer to Emergency. The Delay to Emergency and Open Position LEDs go off, and the Emergency Position LED illuminates.

The MX100 microcontroller will automatically begin the retransfer sequence to Normal. The delay to open emergency (T) timer begins its timing cycle and the Delay to Open Emergency LED illuminates. When the T timer has completed its timing cycle, the ATS transfers to the open position. The Delay to Open Emergency and the Emergency Position LEDs turn off, and the Open Position and the Delay to Normal LEDs illuminate. The delay to normal timer (DT) then begins its timing cycle illuminating the Delay to Normal LED. When the DT timer has completed its timing cycle the ATS will transfer out of the open position into the Normal position. Delay to Normal and the Open Position LEDs turn off, and the Normal Position LED illuminates.

The delay engine stop timer (U) begins its timing cycle and the Delay Engine Stop LED illuminates. The generator runs unloaded for the duration of the U timing cycle. Upon completion of the U time delay, the generator will stop. The Delay Engine Stop and the Emergency Available LEDs go off.

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⚠ NOTICE

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

Delay Transition Transfer Sequence	LED Annunciation Status									
	Normal Position	Normal Available	Emergency Position	Emergency Available	Delay to Normal	Delay to Emergency	Delay Engine Stop	Open Position	Delay to Open Normal	Delay to Open Emergency
Normal Position	●	●								
W Time Delay	●	○		●					●	
Open Position/ DW Time Delay		○		●		●		●		
Emergency Position		○	●	●						
T Time Delay		●	●	●						●
Open Position/ DT Time Delay		●		●	●			●		
Normal Position/ Engine Overrun Timer	●	●		●			●			

○ **Illuminated only when running TEST, not on Normal power failure**

Standard Transition ATS Testing (w/A6 or T3/W3)

Refer to Standard Transition w/A6 or T3/W3 display Figure 4. Initiate testing with the ATS in Normal position and Normal power available (Normal Position and Normal Available LEDs illuminated). Press and hold the test switch until transfer (releasing the test switch prematurely will abort the test).

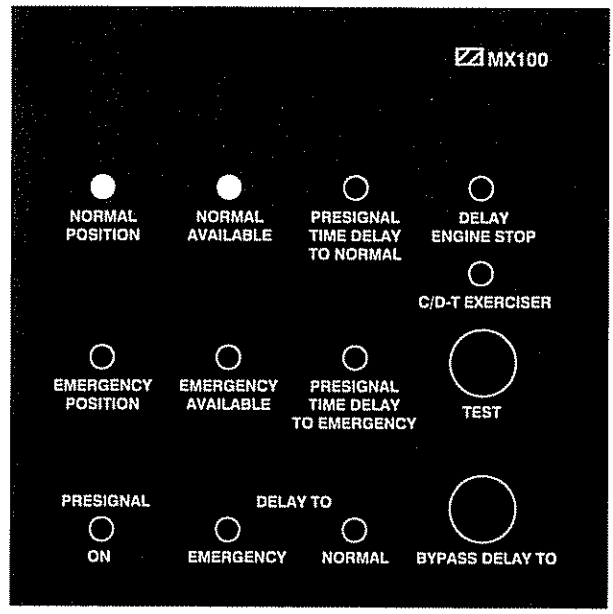

Figure 4 - Standard Transition w/A6 Annunciation LEDs and Test Switch

The delay to engine start timer (P) begins its timing cycle. After the P time delay the engine start contacts close to start the generator.

When Emergency voltage and frequency reach the preset pickup points the Emergency Available LED illuminates. Simultaneously, the delay to emergency timer (W) begins its timing cycle and the Delay to Emergency LED illuminates. After the W time delay the ATS presignal is initiated. The Delay to Emergency and Normal Position LEDs go off, and the Presignal On and Presignal Time Delay to Emergency LEDs illuminate. (Releasing the test switch now will allow the test to continue).

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Presignal Time Delay to emergency (TA6) then begins. When the TA6 time delay is completed, the switch will transfer to Emergency. The Presignal Time Delay to Emergency and Presignal On LEDs go off, and the Emergency Position LED illuminates.

The MX100 microcontroller will automatically begin the retransfer sequence to Normal. The delay to normal (T) timer begins its timing cycle and the Delay to Normal LED illuminates. When the T timer has completed its timing cycle, the ATS presignal is initiated. The Delay to Normal and the Emergency Position LEDs turn off, and the Presignal On and the Presignal Time Delay to Normal LEDs illuminate. The Presignal Time Delay to normal (TA5) then begins. When the TA5 timer has completed its timing cycle, the ATS will transfer to the Normal position. Presignal Time Delay to Normal and Presignal On LEDs turn off, and the Normal Position LED illuminates.

The delay engine stop timer (U) begins its timing cycle and the Delay Engine Stop LED illuminates. The generator runs unloaded for the duration of the U timing cycle. Upon completion of the U time delay, the generator will stop. The Delay Engine Stop and the Emergency Available LEDs go off.

⚠ NOTICE

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

Standard Transition Transfer w/A6 or T3/W3 Sequence	LED Annunciation Status									
	Normal Position	Normal Available	Emergency Position	Emergency Available	Presignal Time Delay to Normal	Presignal Time Delay to Emergency	Delay Engine Stop	Presignal On	Delay to Emergency	Delay to Normal
Normal Position	●	●								
W Time Delay	●	○		●					●	
Open Position/ TA6 Time Delay		○		●		●		●		
Emergency Position		○	●	●						
T Time Delay		●	●	●						●
Open Position/ TA5 Time Delay		●		●	●			●		
Normal Position/ Engine Overrun Timer	●	●		●			●			

○ Illuminated only when running TEST, not on Normal power failure

The MX100 continuously monitors source voltage. In the event that Normal voltage falls below a preset drop-out value, the unit will perform in exactly the same way as noted in the test procedure (either standard transition or delayed transition).

Operation Sequence

Normal Power Failure. When Normal voltage has fallen below the preset dropout value, the engine start (P) timer begins its timing cycle (factory set 3 seconds). The P timer allows for momentary undervoltage conditions in the Normal source without triggering the generator to start. If the Normal voltage remains below the dropout point throughout the P timing cycle, a generator start signal will be sent. The MX100 then monitors generator voltage and frequency to determine if they are within preset parameters. When the generator voltage and frequency reach acceptable limits the W timer begins its timing cycle. The W timer governs either the time delay for transfer to Emergency or to the open position (standard or delayed transition, respectively). The W timer (typically 1 second) assures that the generator voltage and frequency are stable before transfer.

The transfer to Emergency sequence is then completed as follows:

Standard Transition—after the W time delay, the ATS transfers to Emergency position and load power is supplied by the generator.

Delayed Transition—following the W time delay, the switch opens out of Normal to the Open position. The DW timer is activated. The DW time delay is typically set to 5 seconds. After the DW time delay, the switch completes transfer to Emergency.

Standard Transition w/A6 or T3/W3—following the W time delay, the presignal is initiated. The TA6 timer is started. The TA6 time delay is typically set to 5 seconds. After the TA6, the ATS transfers to Emergency.

Restoration of Normal Power. When Normal power reaches the preset pickup value, the T timer begins its timing cycle (factory set 30 minutes). The T timer is used to ensure that the Normal source has fully restored before retransfer. If Normal voltage remains above the pickup values for the duration of the T timer, transfer to Normal position is performed. Retransfer is accomplished as follows:

Standard Transition—ATS transfers to the Normal position and the load power is supplied by utility.

Delayed Transition—the switch opens out of Emergency to the Open position. The DT timer activates, typically set to 5 seconds. After the DT time delay, the switch completes transfer to Normal.

Standard Transition w/A6 or T3/W3—following the T time delay, the presignal is initiated. The TA5 timer is started. The TA5 time delay is typically set to 5 seconds. After the TA5, the ATS transfers to Normal.

The U timer then times out (factory set 5 minutes) to allow the generator to run unloaded for a cooldown period.

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Control Features and Options

Control Features

A6. Motor load disconnect capability (standard transition only). Ensures that closing into the oncoming source does not create a large disturbance due to phase angle difference between the load and the oncoming source. Motor loads can be disconnected for an adjustable period of 0-60 seconds prior to transfer of the main contacts. This feature includes LEDs to indicate when the motor load is disconnected.

CDT Exerciser. A built in 7 day exerciser timer is incorporated into the MX100, (standard feature, all models). Pressing the initiate switch will start a timer that will continue for 167 hours and 40 minutes. Along with initiating the timer, an LED will illuminate to indicate that the timer has been started. After 167 hours and 40 minutes, a load test (ATS transfers to Emergency) or a no load test (ATS signals the genset to start but does not transfer) occurs. The exercise mode is determined by the MX100 PCboard jumper location (TSL = load, TSNL = no load). The test lasts for 20 minutes. The CDT Exerciser LED will flash when the exercising is in progress. This 20 minute exercise does not include the time delay to retransfer to normal (T timer) when the ATS is transferred (load test) or the time delay engine stop (U timer) for either load or no load tests. Disabling the exercise event is done by pressing the disable/enable switch. When this is done the exercise event will not occur, although the timer will not be affected. The CDT Exerciser LED will turn off when the disable/enable switch is pressed for the first time after initiating the timer. Pressing the disable/enable switch again will re-enable the exercise event while turning the CDT Exerciser LED back on. The time of the exercise event can be changed by re-initiating the event. The time that the button is pressed will be the end of the exercise event one week later.

CDT Exerciser Notes

1. To avoid unintentional intiating/disabling the button should be held down for 3 seconds when pressed.
2. A 9V battery is supplied to prevent CDT exercise timer from losing it's "set exercise time" in the event of an extended power outage. The battery can back up the processor for up to 8 hours. The battery should be replaced if it has supplied power to the microprocessor for an extended outage.
3. The 9V battery cannot be plugged into a PCboard that is deenergized. The PCboard includes large capacitors that the battery will not be able to charge. If the capacitors are charged, the battery will still discharge eventually due to the load of the PCboard. Therefore, do not install a battery until the PCboard is energized. The battery will then be able to maintain the CDT "set exercise time" in the event of an extended outage.

R50. In-phase monitor (standard transition w/o A6 only). R50 ensures that the phase angle difference between the load voltage and the oncoming source voltage is minimal (live source-to source transfers). The feature requires a fast acting transfer switch, therefore is only available with a standard transition ATS. The in-phase monitor is suitable for isochronous through 3% droop governors. The microprocessor anticipates the synchronized condition

by monitoring the phase angle and frequency differential between the sources. Then it signals a transfer at the precise moment to ensure minimal phase difference between the sources at the completion of transfer. R50 also includes a PCboard-mounted switch to override the in-phase monitor function if necessary. The override toggle switch is located below the MX100 cover, but the toggle position to enable or disable the function is clearly indicated on the cover.

YEN. Pushbutton time delay transfer/retransfer bypass.

Control Options

Five control input options can be used with the MX100:

- 6A
- C
- C/D
- Q2
- ZNET100

Note: Consult the factory when field adding Q2 option.

6A. *Maintained test switch.* An auxiliary two position maintained test switch is located on the cabinet door. This is in addition to the standard test switch found on all MX100 models. When the auxiliary test switch is activated in the TEST position, it will simulate a Normal line failure. The transfer switch will automatically transfer the load to the Emergency position. When the test switch is returned to the AUTOMATIC position the transfer switch will restore the load to the Normal position. Should Emergency fail while ATS is in Emergency position the ATS will transfer back to Normal immediately, if Normal is available.

C. *Plant Exerciser.* Automatically starts generator for selected time intervals. Runs generator unloaded.

C/D. *Plant Exerciser.* Automatically starts generator to run unloaded, or simulate a power failure and starts generator to run under load.

Q2. *Connections for remote peak shave or area protection.* Includes bypass for immediate return to Normal if Emergency line fails and Normal is available.

Z-NET100. *Communication Capability.* The MX100 can be equipped with an optional network card that allows digital communication of ATS position, source availability, control timers and test mode. A test signal can also be initiated from a remote PC or annunciator panel. Communication is via one twisted pair of wires.

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User Settings

All user settings are adjustable on the back of the MX100 display. Figure 5 shows the MX100 user adjustments.

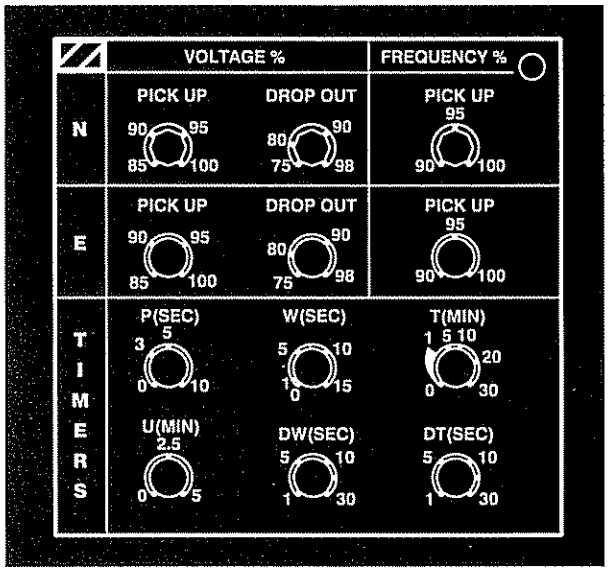

Figure 5 - Delayed Transition User Adjustments

⚠ NOTICE

All adjustments are factory preset to values in the table below, unless otherwise specified by the user.

Factory Settings of Voltage, Frequency and Timer Adjustments	
Normal Pickup Voltage	90% Nominal Line Voltage
Normal Dropout Voltage	80% Nominal Line Voltage
Normal Pickup Frequency	90% Nominal Line Frequency
Emergency Pickup Voltage	90% Nominal Line Voltage
Emergency Dropout Voltage	80% Nominal Line Voltage
Emergency Pickup Frequency	95% Nominal Line Frequency
P Timer	3 seconds
W Timer	1 second
T Timer	30 minutes
U Timer	5 minutes
DW Timer *	5 seconds
DT Timer *	5 seconds
TA5 **	5 seconds
TA6 **	5 seconds

* Delayed
** Standard w/A6 or T3/W3

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Voltage and Frequency Pickup/Dropout Adjustments

Normal Pickup Voltage %: Pickup voltage is adjustable from 85 to 100% of nominal line voltage. Standard factory setting is 90%.

Normal Dropout Voltage %: The dropout voltage is adjustable from 75 to 98% of nominal line voltage. Standard factory setting is 80%. Dropout must be a minimum of 2% below Normal pickup voltage under all conditions. Note: The microprocessor will automatically set the Normal dropout voltage 2% below the Normal pickup voltage if it is not properly set by the user.

Normal Pickup Frequency %: The pickup frequency is adjustable from 90 to 100% of nominal line frequency. Standard factory setting is 90%.

Emergency Pickup Voltage %: The pickup voltage is adjustable 85 to 100% of nominal line voltage. The standard factory setting is 90%.

Emergency Dropout Voltage %: The dropout voltage is adjustable from 75 to 98% of nominal line voltage. Standard factory setting is 80%. Emergency dropout voltage must be a minimum of 2% below emergency pickup voltage under all conditions. Note: The microprocessor will automatically set the Emergency dropout voltage 2% below the Emergency pickup voltage if it is not properly set by the user.

Emergency Pickup Frequency %: The pickup frequency is adjustable from 90 to 100% of nominal line frequency. Dropout is fixed at 2 Hz below pickup. Dropout has a 5 second delay. Standard factory setting is 95%.

Timer Adjustments

P Timer (delay to engine start). Time delay before engine start after Normal voltage failure: adjustable 0 to 10 seconds. P timer is designed to avoid engine starts on momentary Normal source failures. Standard factory setting is 3 seconds.

W Timer (delay to Emergency or delay to open Normal timer). Time delay before initiating transfer to Emergency: adjustable 0 to 15 seconds. Standard factory setting is 1 second. After the successful acquisition of correct Emergency voltage and frequency, the W timer function provides a time delay before initiating transfer to Emergency. This permits the Emergency source to stabilize. On completion of the time out, transfer to Emergency is initiated.

Transfer to Emergency is non-commit. This means that should the Normal voltage be restored before the timeout of the W timer, the ATS will remain in the Normal position and initiate the delay to engine stop timer.

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T Timer (delay to Normal or delay to open Emergency). Time delay before initiating retransfer to Normal: adjustable 0 to 30 minutes. Standard factory setting is 30 minutes. On return of acceptable Normal voltage the time delay is initiated. T time delay ensures Normal source has stabilized before transferring to Normal position. On completion of the time out, transfer to Normal is initiated. Should Emergency power fail when the ATS is in the Emergency position, the T timer function will be bypassed when normal power is restored.

U Timer (delay engine stop). Time delay to engine stop, after retransfer to Normal, for purpose of cooling the engine after the load is removed: adjustable 0 to 5 minutes. Standard factory setting is 5 minutes.

DW Timer (time delay from Open position to Emergency position). Delayed Transition Transfer only: adjustable 0 to 60 seconds. Standard factory setting is 5 seconds. DW timer activates when the switch enters open position on a transfer from Normal to Emergency. After time out, the transfer to Emergency is complete.

DT Timer (time delay from Open position to Normal position). Delayed Transition Transfer only: adjustable 0 to 60 seconds. Standard factory setting is 5 seconds. DT timer activates when the switch enters the open position on transfer from Emergency to Normal. After time out, the transfer to Normal is complete.

MX100, Standard Transition w/A6 or T3/W3
(A6 = motor load disconnect circuit)
(T3/W3 = elevator presignal circuit)

TA5 (presignal time delay to normal). Time delay is available only on standard transition ATSs specifically configured with the presignal circuit. Adjustable 0 to 60 seconds. Standard factory setting is 5 seconds.

TA6 (presignal time delay to emergency). Time delay is available only on standard transition ATSs specifically configured with the presignal circuit. Adjustable 0 to 60 seconds. Standard factory setting is 5 seconds.

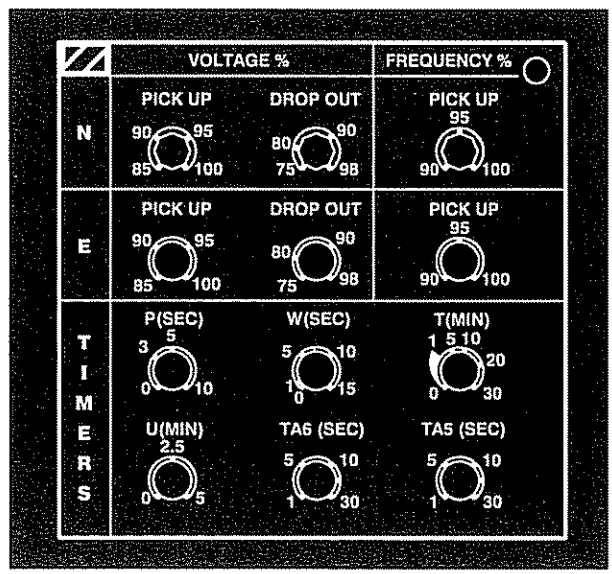

Figure 6 - Standard Transition w/A6 or T3/W3 User Adjustments

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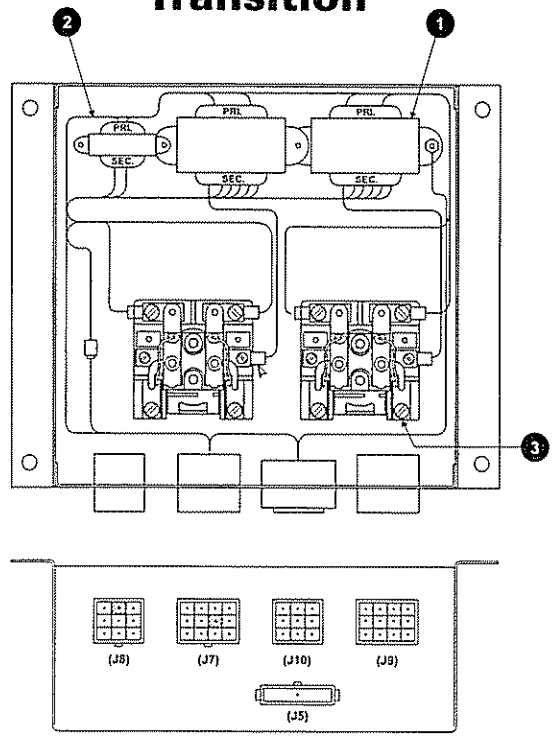
Relay/Transformer Box (R/T Box)

Each MX100 microprocessor based ATS controller requires a relay/transformer box to apply line voltage to the ATS operator via coil control relays. Also required is a means to power the MX100 printed circuit board and a means to apply sensing voltage proportional to line voltage. This is accomplished by the relay transformer box. This method of switching operator voltage and applying power and sensing voltage to the printed circuit board isolates the MX100 from the line voltage, further protecting the controller from harmful line transients. Two versions of the R/T box exist depending on the type of ATS (standard transition or delayed transition).

The following layout drawings of the R/T box components (standard and delayed transition) include a bill of materials for replacement parts. Schematics are included to indicate proper wiring.

Standard Transition



Bill of Material

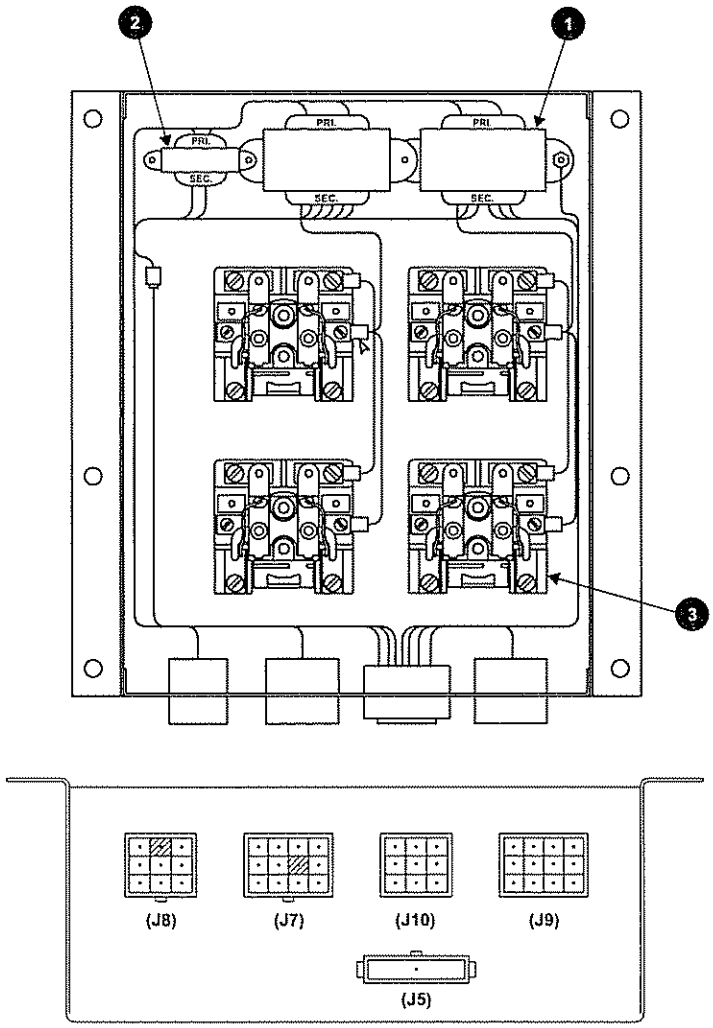
Item	Part No.	Description	Qty
1	See Chart	Transformer, 25VA	2
2	See Chart	Transformer, 1VA	1
3	K-1260	Coil Control Relay, 24V	2

Transformer Usage

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1VA XFMR Part No.	25VA XFMR Part No.
50P-1005	120V	K-3216	K-3224
50P-1006	208-220V	K-3217	K-3225
50P-1007	230-240V	K-3218	K-3226
50P-1008	277V	K-3219	K-3227
50P-1009	380-400V	K-3220	K-3228
50P-1010	416-440V	K-3221	K-3229
50P-1011	460-480V	K-3222	K-3230
50P-1012	575-600V	K-3223	K-3231

Relay/Transformer Box (R/T Box) *(cont'd)*

Delayed Transition



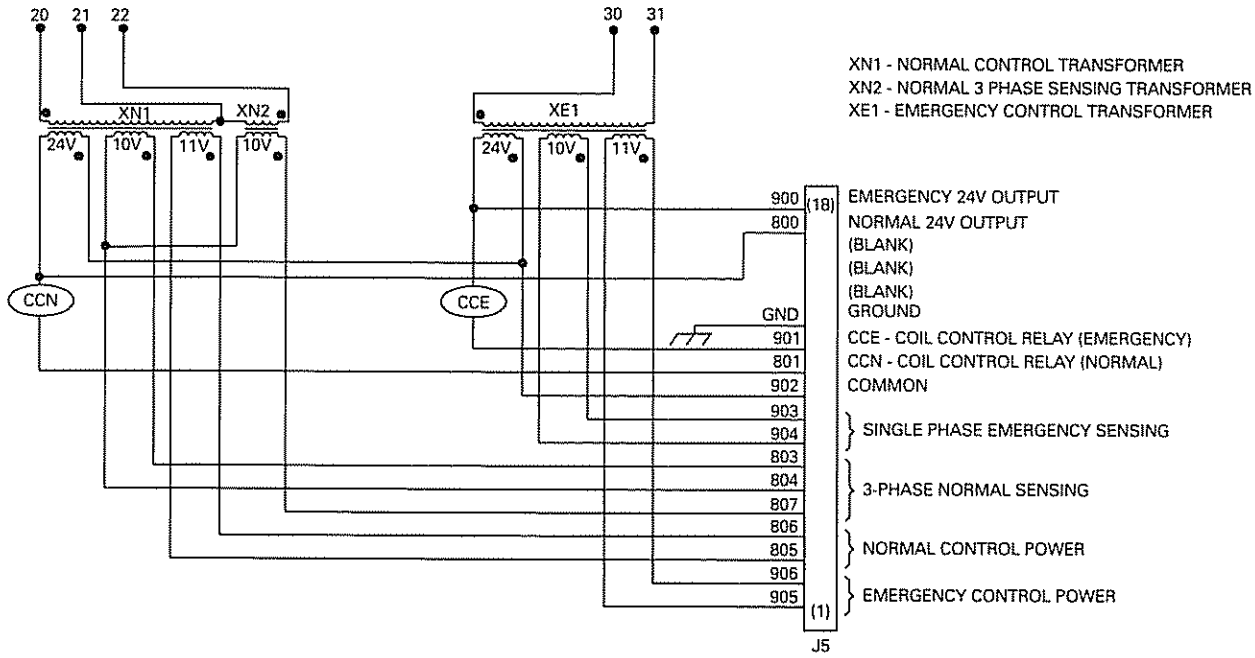
Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer, 25VA	2
2	See Chart	Transformer, 1VA	1
3	K-1260	Coil Control Relay, 24V	4

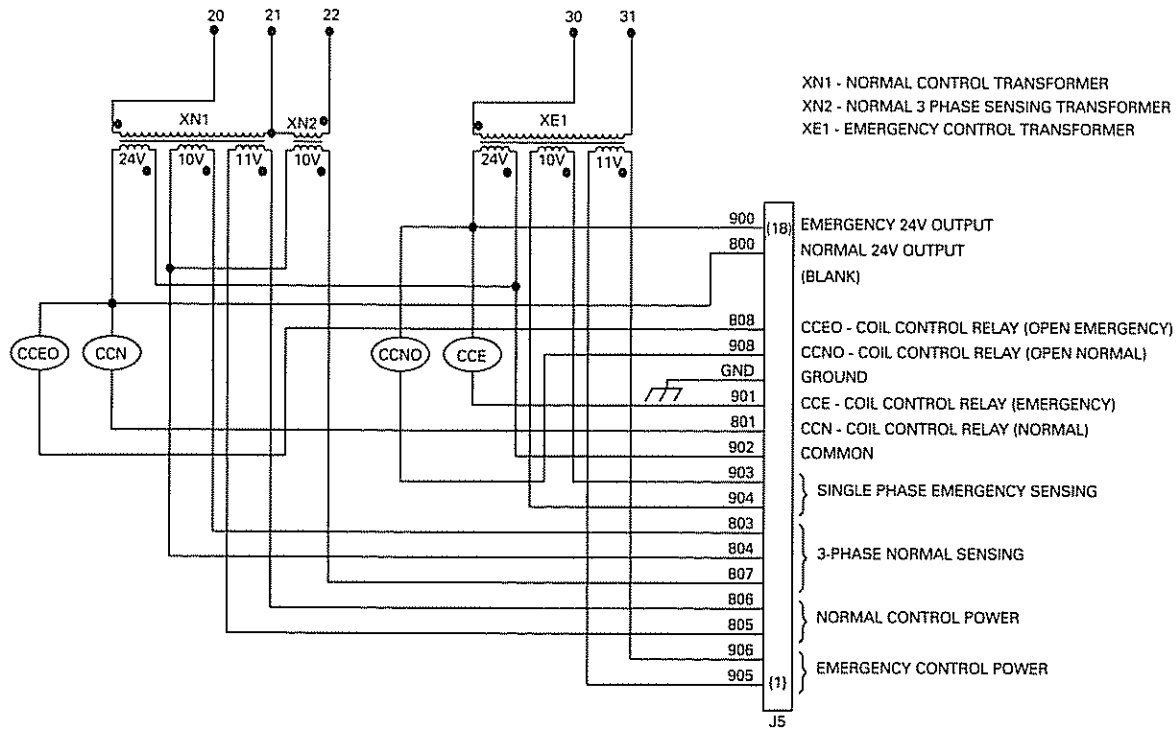
Transformer Usage

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1VA XFMR Part No.	25VA XFMR Part No.
50P-1013	120V	K-3216	K-3224
50P-1014	208-220V	K-3217	K-3225
50P-1015	230-240V	K-3218	K-3226
50P-1016	277V	K-3219	K-3227
50P-1017	380-400V	K-3220	K-3228
50P-1018	416-440V	K-3221	K-3229
50P-1019	460-480V	K-3222	K-3230
50P-1020	575-600V	K-3223	K-3231

Standard Transition R/T Box Schematic



Delayed Transition R/T Box Schematic



Troubleshooting and Diagnostics

⚠ DANGER

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.
These charts may indicate problems that require authorized Zenith service personnel.
Hazardous voltages may exist on termination plugs other than those that go into the MX100.

General Troubleshooting

The following chart can be used to troubleshoot the ATS system. Diagnostics are indicated by one or more flashing position LED(s). Diagnostic troubleshooting charts follow this chart.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
No engine start	EMERGENCY AVAILABLE LED off	Engine start wires not properly connected	Check engine start connections (Figure 1)
		Generator in OFF position	Place engine control switch in AUTO
No engine stop	DELAY TO ENGINE STOP LED on	U timing cycle not complete	Check U timer setting
	NORMAL AVAILABLE, NORMAL POSITION, and EMERGENCY AVAILABLE LEDs on	Engine start wires not properly connected	Check engine start connections (Figure 1)
		Generator in MANUAL	Place engine control switch in AUTO
ATS will not transfer to EMERGENCY	EMERGENCY AVAILABLE LED off	Emergency voltage or frequency not within settings	Check: engine start connections, generator breaker closed, generator output (compare to MX100 settings) and place engine control switch in AUTO
	All LEDs off	Power supply harness unplugged (18 pin connector on MX100)	Plug in harness
	EMERGENCY AVAILABLE LED on	ZTC models only - verify zero volts DC from pin 5 to pin 6 of 6 pin plug on MX100	If 5V measured, ZTC is tripped; refer to Power Panel Manual (51R-1000) for ZTC instructions
ATS will not transfer to NORMAL	NORMAL AVAILABLE LED off	Normal voltage or frequency not within acceptable parameters	Check: normal voltage within MX100 settings; verify Normal breaker source breaker is closed
	All LEDs off	Power supply harness unplugged (18 pin connector on MX100)	Plug in harness
	NORMAL AVAILABLE LED on	ZTC models only - verify zero volts DC from pin 5 to pin 6 of 6 pin plug on MX100	If 5V measured, ZTC is tripped; refer to Power Panel Manual (51R-1000) for ZTC instructions
Improper LED annunciation	Neither source available LEDs illuminate, position LED only	MX100 PC board may be configured for wrong frequency (60 Hz vs. 50 Hz)	1. Verify source voltage and frequency 2. Consult Zenith Controls for information to reconfigure hardware
	NORMAL and/or EMERGENCY AVAILABLE LEDs on when frequency is below the present pick up value	MX100 PC board may be configured for wrong frequency (60 Hz vs. 50 Hz)	1. Verify source voltage and frequency 2. Consult Zenith Controls for information to reconfigure hardware

Diagnostic Annunciation

The MX100 controller incorporates diagnostics that allows ease of troubleshooting. Diagnostic annunciations are flashing position LEDs. The symptoms that the diagnostic annunciation indicate include inhibiting transfer or incorrect transfer sequence. A more general troubleshooting chart that addresses system problems precedes these charts.

⚠ DANGER

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.

These charts may indicate problems that require authorized Zenith service personnel.

Hazardous voltages may exist on termination plugs other than those that go into the MX100.

Standard Transition ATS

(Two Position ATS—Normal and Emergency)
(Not for Standard Transition w/A6)

⚠ WARNING

If limit switch plug is disconnected or reconnected and power is available, the switch may transfer.

Use caution when servicing.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
ATS will not transfer out	Flashing NORMAL POSITION LED	Solenoid circuit	Contact authorized Zenith service representative
ATS will not transfer out	Flashing EMERGENCY POSITION LED	Solenoid circuit	Contact authorized Zenith service representative
ATS will not transfer; ATS is not in a defined position as indicated by the limit switch contact (no SN or SE limit switch input)	Flashing NORMAL POSITION and EMERGENCY POSITION LEDs	1. Limit switch plugs not connected 2. Limit switches not within adjustment	1. Connect all plugs to the MX100 2. Contact authorized Zenith service representative

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Delayed Transition ATS (Three Position ATS—Normal, Open and Emergency)

⚠ WARNING

If limit switch plug is disconnected or reconnected and power is available, the switch may transfer.

Use caution when servicing.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
ATS will not transfer out of Normal	Flashing NORMAL POSITION LED	1. ZTC in manual mode (ZTC models only) 2. Solenoid circuit	1. Put ZTC in AUTO (ref. ZTC Power Panel Manual 51R-1000) disconnect and reconnect MX100 18 pin plug 2. Contact authorized Zenith
ATS will not transfer out of Emergency	Flashing EMERGENCY POSITION LED	1. ZTC in manual mode (ZTC models only) 2. Solenoid circuit	1. Put ZTC in AUTO (ref. ZTC Power Panel Manual 51R-1000) disconnect and reconnect MX100 18 pin plug 2. Contact authorized Zenith
ATS will not transfer out of Open position	Flashing OPEN POSITION LED	1. ZTC in manual mode (ZTC models only) 2. Solenoid circuit	1. Put ZTC in AUTO (ref. ZTC Power Panel Manual 51R-1000) disconnect and reconnect MX100 18 pin plug 2. Contact authorized Zenith
ATS is not in a defined position as indicated by the limit switch contacts (no SN or SNO limit	Flashing NORMAL POSITION and OPEN POSITION LEDs	Limit switches not registered as opened or closed	Contact authorized Zenith service representative
ATS is not in a defined position as indicated by the limit switch contacts (no SN or SEO limit switch	Flashing EMERGENCY POSITION and OPEN POSITION LEDs	Limit switches not registered as opened or closed	Contact authorized Zenith service representative
ATS is not in a defined position as indicated by the limit switch contacts (no SN, SE, SNO, or SEO	Flashing NORMAL POSITION, OPEN POSITION and EMERGENCY POSITION LEDs	1. Limit switch plugs not connected 2. Limit switches not registered as opened or closed	Connect all plugs to the MX100

Standard Transition ATS (with A6)

⚠ WARNING

If limit switch plug is disconnected or reconnected and power is available, the switch may transfer.

Use caution when servicing.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
ATS will not transfer out of Normal; motor load still connected	Flashing NORMAL POSITION LED	Motor load disconnect relay is not latching	Check connections to RA6 relay
ATS will not transfer out of Emergency; motor load still connected	Flashing EMERGENCY POSITION LED	Motor load disconnect relay is latched	Check connections to RA6 relay
ATS will not transfer after motor load disconnect operated	Flashing MOTOR CONTROL OFF LED	Solenoid circuit	Contact authorized Zenith service representative
ATS is not in a defined position as indicated by the limit switch contacts (no SN or RA6 limit	Flashing NORMAL POSITION and MOTOR CONTROL OFF LEDs	Limit switches not registered as closed or RA6 contact is not registered	Contact authorized Zenith service representative
ATS is not in a defined position as indicated by the limit switch contacts (no SE or RA6 limit switch	Flashing EMERGENCY POSITION and MOTOR CONTROL OFF LEDs	Limit switches not registered as closed or RA6 contact is not registered	Contact authorized Zenith service representative
ATS is not in a defined position as indicated by the limit switch contacts (no SN, SE, SNO, or SEO	Flashing NORMAL POSITION, OPEN POSITION and EMERGENCY POSITION LEDs	1. Limit switch plugs not connected 2. Limit switches not registered as opened or closed	Connect all plugs to the MX100

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GE Zenith Controls

MX150 Microprocessor Controller
Transfer Switch Control Panel

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Authorized Service

For GE parts and service, call: (773) 299-6600

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Introduction

GE Zenith Transfer Switches are used to provide a continuous source of power for lighting and other critical loads by automatically transferring from source 1 power to source 2 power in the event that source 1 voltage falls below preset limits.

Voltage sensing and system control is performed via a state-of-the-art microcontroller located on the cabinet door. It is designed to give highly accurate control of the transfer switch system.

All GE Zenith transfer switches are designed for use on emergency or standby systems, and are rated for total system or motor loads. Transfer switches are UL Listed under Standard 1008 and CSA Certified under Standard C22.2 No. 178 and IEC Listed under Standard 947.

NOTES: A protective device such as a molded case circuit breaker or fused disconnect switch MUST be installed on both sources of incoming power for circuit protection and as a disconnection device.

All references made within this manual about the term "S1" or "Source 1" relate to a Normal Power Source. All references made about the term "S2" or "Source 2" relate to an Emergency or Alternative Power Source.

Safety / Installation

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

The safe operation of your switch is GE Zenith's focus. The proper storage, installation, operation and maintenance will help increase the life of the switch.

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

Equipment Inspection and Storage

Once you have received the transfer switch, inspect it for any damage. This includes damage to the enclosure, power panel, control panel and wiring harness. If any damage is found or suspected, file a claim as soon as possible with the carrier and notify the nearest GE Zenith representative.

Before installation, if it is necessary, store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature	Operating Temperature (Ambient):	Humidity
-30°C to +75°C (-22°F to +167°F)	**40-400 AMP** *(molded shell)* -20°C to +65°C (-4°F to +149°F) **40-4000 AMP** *(all other frame and panel types)* -20°C to +60°C (-4°F to +140°F)	5% to 95% (non-condensing)

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred, with a vacuum, due to shipment or installation.
2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections.
4. Verify the correct connection of all control wires.
5. Check settings of all timers and adjust as necessary.
6. Adjust any optional accessories as required.
7. Check the lug torque values of the power connections.

   NOTE: Lug torque values are specified in the power panel manual.

8. Make sure that all covers and barriers are installed and properly fastened.

   NOTE: Power panels ship from GE Zenith in Source 1 Position.

⚠ WARNING ⚠

Do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Each GE Zenith transfer switch is factory wired and tested. A complete information package is furnished with each switch which includes:

a. Sequence of operation.
b. Description and operation of all accessories supplied.
c. Power panel connection diagram and schematic.
d. Description and identification of all customer field connections.

Installation of GE Zenith transfer switches includes:

a. Mounting the transfer switch cabinet.
b. Connection of Source 1, Source 2, and Load cables or bus bars.
c. Connection of external control circuits as required.

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⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

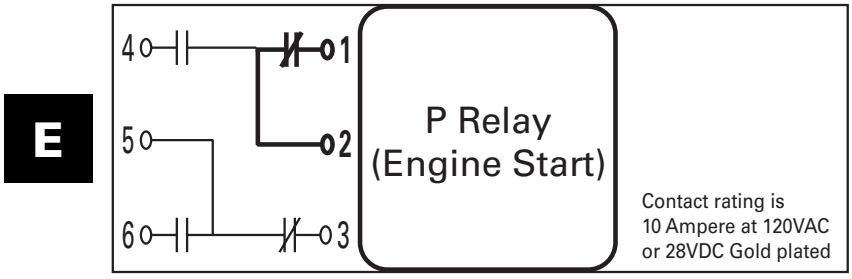

Figure 3

Engine Start Control Connections

The engine-start terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Terminals for field connections to the A3 Emergency auxiliary contacts and the A4 Normal auxiliary contacts are also provided. These terminals are clearly marked and appear on the side of the power panel. On 400 amp metal frame units these terminals appear on the bracket above the operator handle.

Initial Energization

Before proceeding, refer to the information package supplied with the ATS and read and understand the information on all accessories provided.

1. Unlock the enclosure.
2. Open the enclosure.
3. Verify the correct system voltage.

   NOTE: The equipment rating nameplate on the transfer switch lists the voltage. See *Figure 3*.

4. Close Source 1 circuit. breaker.

   NOTE: The controller will illuminate Source 1 Available LED if proper voltage is sensed.

5. Verify the phase to phase voltages at the Normal line terminals.
6. Close the Emergency source circuit breaker.
7. Start the generator's engine.

   NOTE: The controller will illuminate Source 2 Available LED when preset voltage and frequency levels are reached.

8. Verify the phase to phase voltages at Source 1 line terminals.
9. Verify that the phase rotation of Source 1 is the same as the phase rotation of Source 2.

10. Shut down the generator's engine.
11. Place the starting control in the Automatic position.
12. Complete the visual inspection of the transfer switch.
13. Close the enclosure.
14. Lock the enclosure.

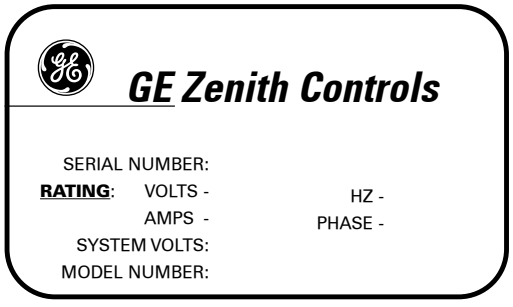

Figure 4

⚠ CAUTIONS ⚠

Certain accessories, per specific schematics, can inhibit automatic transfer.
Engine Gen-Set could start when engine control wires are attached.

Initial Energization *(cont'd)*

After all options and accessories are checked and verified, follow these steps to set up the ATS. Refer to MX150 display *Figure 5*. The annunciation LEDs illuminate to indicate (1) source availability, (2) ATS position, and (3) MX150 control function (timing).

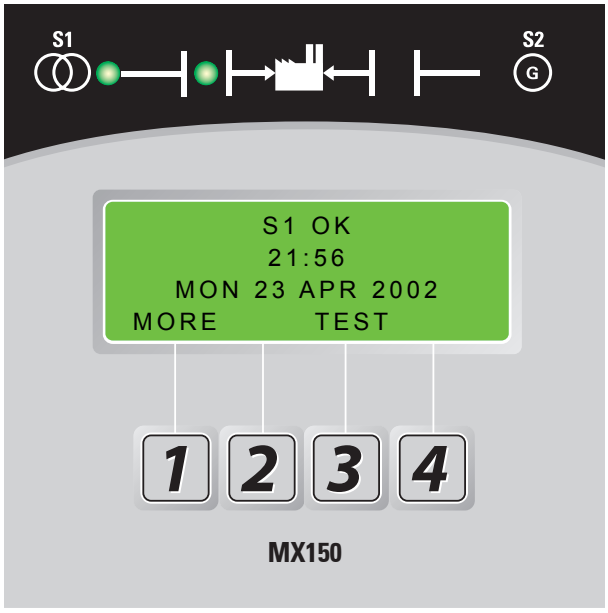

Figure 5 – LCD and keypad

1. Unlock the enclosure.
2. Open the enclosure.
3. Place the Disconnect Switch in the Inhibit.

   NOTE: This step is only performed if the "DS" Option was purchased.

4. Close the external (up-stream) Source 1 circuit breaker.

   NOTES: Source 1 Available and Source 1 Position LED's will illuminate.

   If Source 1 Available LED does not illuminate, verify that Source 1 Voltage is above the preset restore value.

   The Gen-Set will start and run while Source 2 stop Delay Timer is timing.

5. Close the External (up-stream) Source 2 line circuit breaker.
6. Start the engine generator in MANUAL mode.

   NOTE: When the voltage and frequency reach preset values, the Source 2 Available LED will illuminate.

7. Verify the phase to phase voltages at Source 2 line terminals.
8. Verify that the phase rotation of Source 2 is the same as the phase rotation of Source 1.
9. Shut down the generator's engine. (Place in Automatic Mode.)

   NOTE: Source 2 Available LED will turn off.

   NOTE: The engine generator will continue to run for the duration of Source 2 Stop Delay Timer.

10. Place the disconnect switch to ENABLE.
11. Complete the visual inspection of the transfer switch.
12. Close the enclosure.
13. Lock the enclosure.

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

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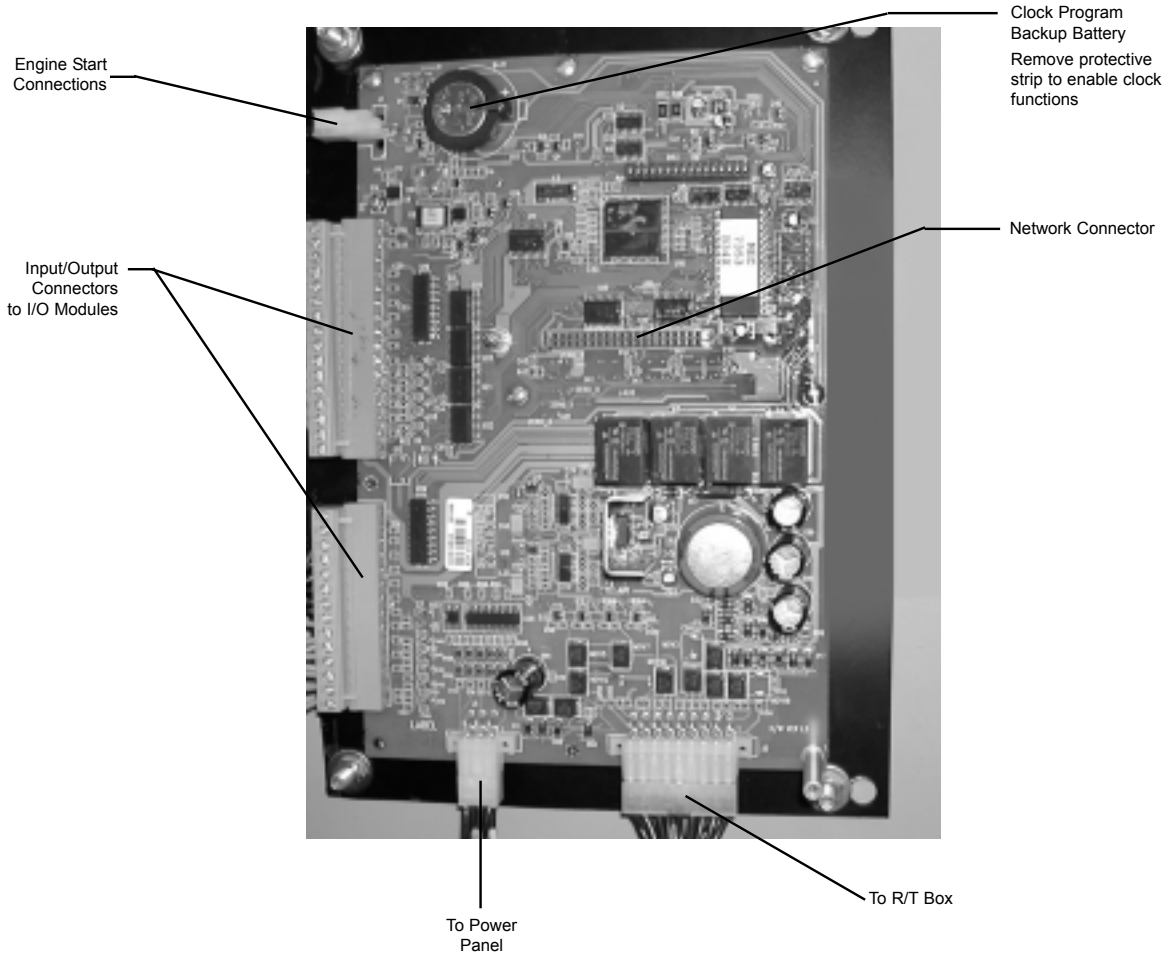
⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Control Connections

Figure 2



A complete information package is furnished with each transfer switch including a complete connection diagram and schematic which details all necessary control circuit field connections.

The engine start control wires connect to the engine start relay terminals located to the left of the microprocessor. Figure 2 shows the location of these terminals.

The terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

MX150 Controller

Consists of two major assemblies:

I. The **Microprocessor** contains the following:

A. MX150 Board - Customer Input and Output (I/O) for system interface. Located on the left hand side of the back of the unit (see figure 6)
1. I/O accessories that can be found here are:
a. Engine start relay P output
b. Pre-Signal to transfer T3, W3 and UMD output (optional)
c. Transfer Inhibit Q3 and Q7 input (optional)
d. Remote test Q2 input (optional)
e. Network interface ZNET input/output (optional)

B. LCD and Keypad located on the exterior of the door (see figure 7)
1. User accessibility to the following:
a. LED indication of source availability
b. LED indication of transfer switch position
c. LCD screen indicates:
(1) timer count down (numeric)
(2) event reporting (text)
d. Keypad provides user interface to: *[in conjunction with LCD screen]*
(1) Setting sensors and timers
(2) Configuring logic accessories

II. The **R/T box** (relay transformer box) contains the following: (see figure 6)

A. Relays which are required for controller output to energize the transferring mechanism of the transfer switch at line voltage.

B. Transformers which drop line voltage to control level for controller input.

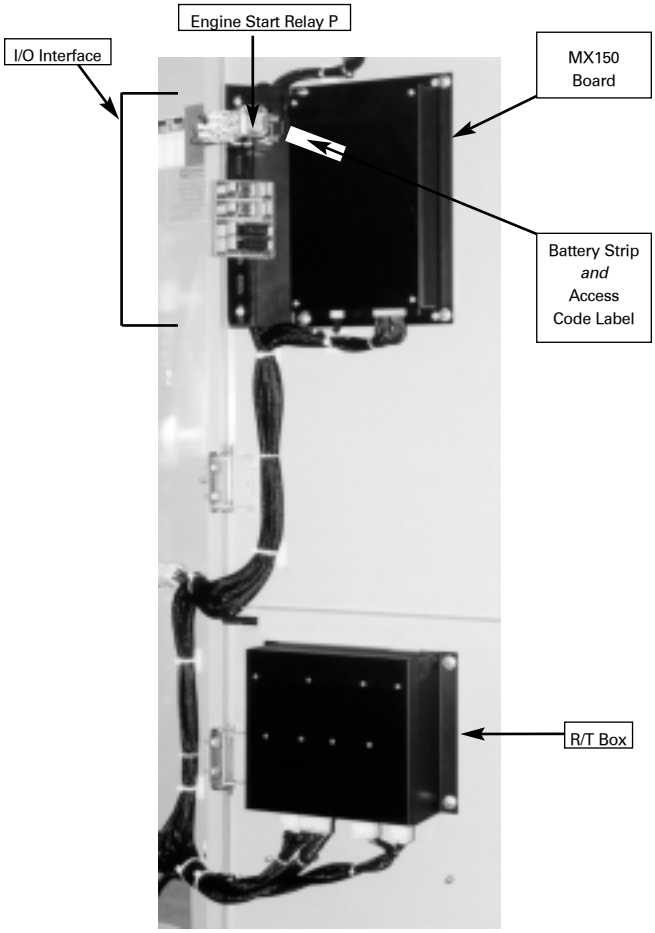


Figure 6

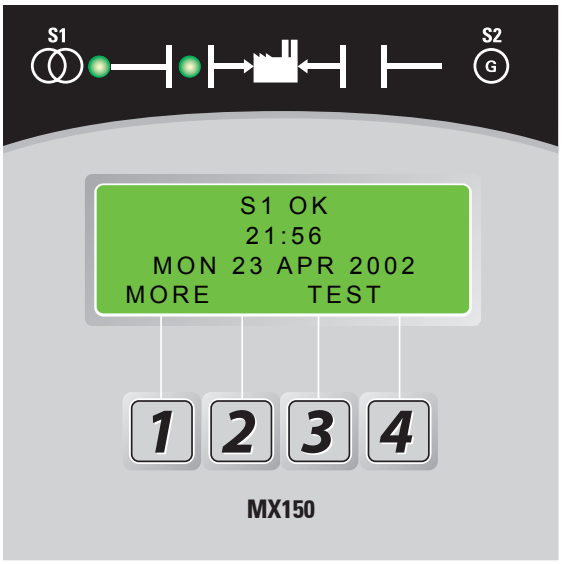


Figure 7

LCD & Keypad

These options are accessible through the LCD and keypad (see figure below). To become familiar with the options loaded into a particular unit, scrolling through the SET and CFG menu will show the descriptions of the options (see pages 16). These menus are the very same menus that are used to access the setting and/or configuration of these options. The SET (setting) menu is primarily used to show or change, time and voltage settings. The CFG menu is primarily used to turn an option on or off. When scrolling through these menus, no changes can be made without entry of the access code. The factory set six-digit access code is located on a white label on the back of the unit (see figure 9 pgs. 16-18).

The MX150 has many logic options. Each controller is downloaded with options at the time of manufacture. The collection of options that any one controller has is specified at the time of order placement. The following pages include all the options that can reside in the controller. Not all units include all options.

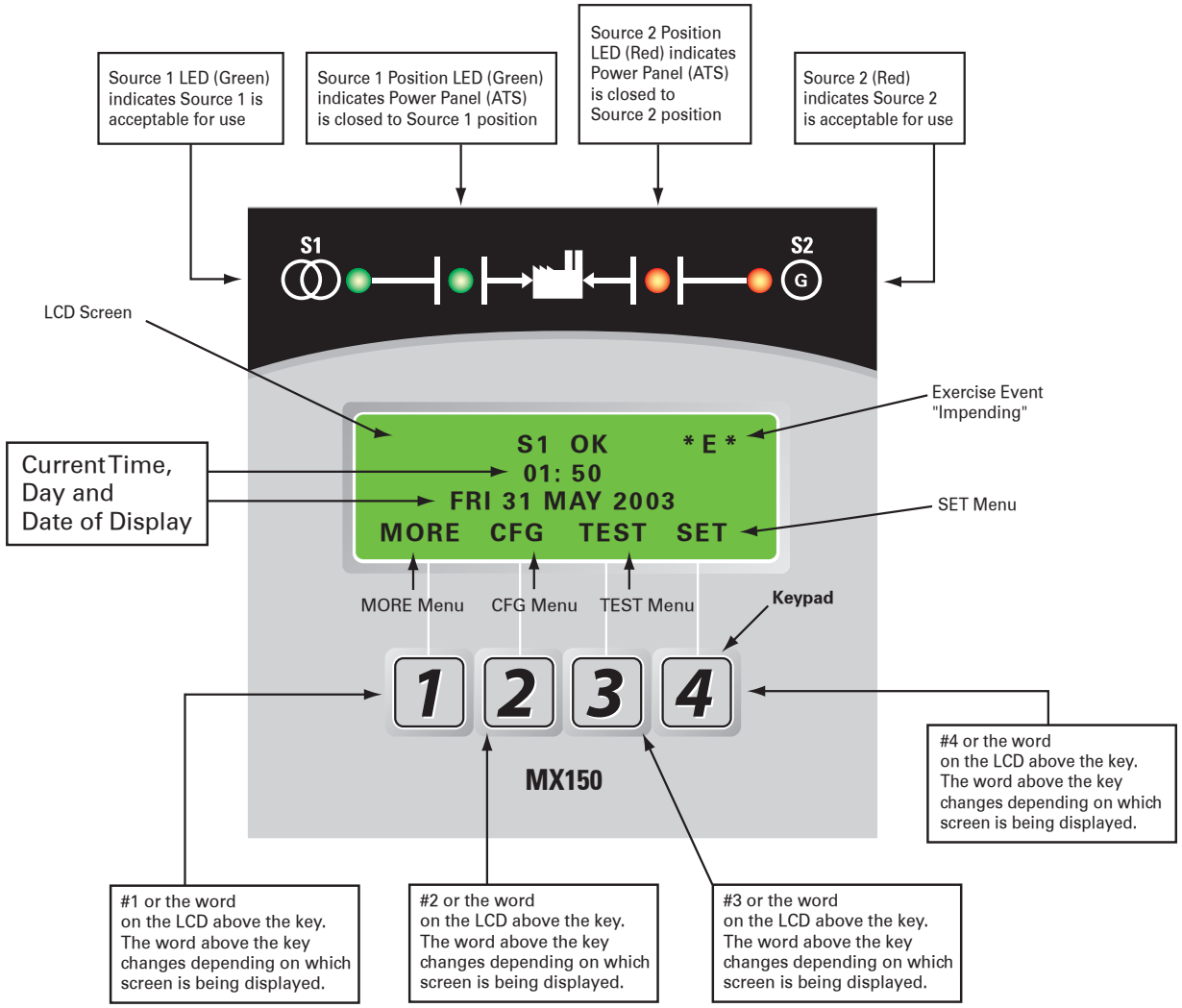


Figure 8

User Setting for Voltage & Frequency

Source 1

Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 1.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 17).
Once satisfied, the T timer will begin timing to transfer to Source 1.

Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold.
Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, P timer begins timing to signal Source 2 Generator to start.

Source 2

Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 2.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 17).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold.
Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, T timer will be bypassed to expedite the transfer to Source 1.

Frequency "Restore"
Factory Default: 95%
This adjustment determines the minimum acceptable frequency required to transfer to Source 2.
Adjust via the SET menu. Range is 90% to 100% in 1% increments (see page 17).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Frequency "Fail"
Factory Default: 90%
This adjustment determines the low frequency threshold.
Adjust via the SET menu. Range is 88% to 98% in 1% increments (see page 17).
"Fail" must be a minimum of 2 % below "Restore" setting.
Once satisfied, the W timer will begin timing to transfer to Source 2.

Standard Features, MSTDG Option Pkg.

6
Test Switch, Momentary

A3
Auxiliary Contact: Closed when the switch is in Source 2 position.

A4
Auxiliary Contact: Closed when the switch is in Source 1 position.

Calibrate
While monitoring the actual Phase to Phase voltage levels and Frequency with a calibrated test equipment, the Phase to Phase voltage sensing and Frequency can be adjusted accordingly. Calibration capabilities are available for Frequency and AB, BC, CA Phase to Phase voltage for both Sources. Adjust via SET menu (see page 18)

CDT
Load or NO-Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1, 7, 14, or 28 days. Factory Default is 20minutes. When exerciser is impending, (*E*) appears in the upper right hand corner of LCD screen. See page 13-14 for instructions. Configured via CFG (see page 16). Set via SET menu (see page 17).

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(800-4000 Amp units)

DT *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 1 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds Adjust via SET menu (see page 17)

DW *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 2 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds.Adjust via SET menu (see page 17)

E
Engine Start Contact

Std. Features, MSTDG Option Pkg. *(cont'd)*

EL/P

Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken

System Data: Total Life Transfers (N2P)
Days Powered Up
Total Transfers to S2
Total S1 Failures
Time S1 available in Hrs
Time S2 available in Hrs. (N1P)

K/P

Frequency Indication for S1 and S2

L

LNP Center-off position LCD-Indicator
Indicating LED lights:

- **L1** Indicates Switch in Source 2 position.
- **L2** Indicates Switch in Source 1 position.
- **L3** Indicates Source 1 available.
- **L4** Indicates Source 2 available.

P1

Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting is 3 seconds.
Adjust via SET menu (see page 17)

Q2

Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present.

R2E

Under voltage sensing of Source 2 for single-phase. (R17 replaces R2E for Utility to Utility switches)

R50

In Phase Monitor this feature restricts **Live to Live Source Transfers** to occur unless both Sources are within 7 electrical degrees or less of each other. (live Source to live Source transfers usually occur during transfer back to Source 1 or during Testing). R50 does not change the operation of the Automatic Transfer Switch in a power failure mode. After all timer functions have elapsed, **the CHECKING FOR SOURCE SYNCHRONISM** will be displayed as well as the direction of transfer (S1-S2 for example denotes transfer from Source 1 to Source2). When synchronism is accomplished, transfer will take place.

Notes:
- **If S2 Frequency is less than S1 Frequency, display will show a series of (- - - - -…..) symbols.**
- **If S2 Frequency is greater than S1 Frequency, display will show a series of (+++++…..) symbols.**
- **Each (-) or (+) symbol represents 10 electrical degrees out of phase. A maximum of 18 symbols (180 electrical degrees) can be monitored.**
- **The number of (-) or (+) symbols decrease as the two sources approach synchronism and increase as the two sources drift out of synchronism.**
- **If S1 and S2 Frequencies are identical, the display will show a series of alternating symbols (ŧŧŧŧ…) which also indicate the approximate out of phase degrees**

In the event that the Sources do not come within 7 electrical degrees of each other within 60 seconds, the unit will display the message: **SYNCH CHECKING** and will allow the user to **BYPASS**. If the **BYPASS** button is pressed, the unit will display the message: **WARNING MAY CAUSE DAMAGE TO THE LOAD**. Pressing **XFR** will actually bypass the R50. Since R50 is a passive device, the length of time it takes to reach Synchronism is dependent on the frequency difference between the two Sources. Source 1 is usually a Utility and the frequency is not within the control of the consumer. Source 2 needs to be adjusted to create an adequate difference in order for the transfer to happen a timely fashion.

Note: For optimum performance, Source 2 Generator should be adjusted a Maximum of 2 Hertz above or below the Utility frequency, minimum of 0.1 Hertz. (58 to 59.9) or (60.1 to 62) Hertz. Adjustment of Generator to 60Hertz could cause lengthy transfer delay.

R50 Feature can be turned ON or OFF via CFG Menu (see page 16). Factory Default if OFF.

S13

Transfer Commit. Configured via CFG menu. (see page 16) When this Feature is set to OFF: The transfer Switch is not committed to transfer unless the outage duration is longer than the timers that precede the transfer to Source 2 position. This assumes that the outage will be an isolated event. When this Feature is set to ON: The transfer Switch is committed to transfer to Source 2 position once the W timer has begun timing, even if Source 1 power returns before the transfer to Source 2. This is to ensure that the transfer takes place, because one outage may be followed by another.

T

Time Delay (S1) Source 1 Stable Timer. To delay transfer to Source 1 (immediate retransfer on Source 2 failure). Adjustable 0-60 minutes in 1 second increments. Standard setting is 30 minutes. Adjust via SET menu (see page 17)

U

(S2) Source 2 Stop Delay Timer. Allows Engine to run unloaded after switch retransfer to Source 1. Adjustable 0-60 minutes in 1 second increments. Standard setting is 5 minutes. Adjust via SET menu (see page 17)

W

Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2. Adjustable 0-5 minutes in 1 second increments. Standard setting is 1 second. Adjust via SET menu (see page 17)

YEN

Bypass Timers Key utilizing Keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.

Standard Features, MEXEG Option Pkg.

In addition to the features listed under the MSTDG Option Package, this enhanced package includes the following features:

A3
Additional Auxiliary contact: closed when switch is in Source 2 position.

A4
Additional Auxiliary contact: Closed when the transfer switch is in Source 1 position.

CDP (replaces CDT)
Clock Exerciser Load/ No Load: Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load.
Can be configured by end user for 1, 7, 14, 28, 365 day cycle.

VI
Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between “Fail” and “Restore” settings.
Factory default: 10% “Fail”, 8% “Restore, 30 Seconds.
See CFG Menu page 16 to configure ON or OFF.
See SET Menu page 17 to set Percentage and time windows

Optional Accessories

6A
Test Switch, Maintained / Momentary

6AP
Test Switch, Maintained / Momentary, utilizing Keypad

A1
Auxiliary Contact, operates on Source 1 line failure.

A1E
Auxiliary Contact, operates on Source 2 line failure.

A3
Auxiliary Contacts: Closed when the transfer switch is in Source 2 position.

A4
Auxiliary Contacts: Closed when the transfer switch is in Source 1 position.

A62
Sequential Universal Motor Load Disconnect Circuit. Normally closed Auxiliary contacts for Motor Loads. Open 0-60 seconds prior to transfer, after transfer, or both in either direction then re-close in timed sequence after transfer.

CTAP
Alarm Panel on transfer to Source 2 with Silence button.

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(40-600 Amp units)

HT
Heater and Thermostat.

Manual
Manual Transfer Switch transfers in either direction by depressing designated pushbuttons.

M80
Digital Power Meter with Display: Amps, Volts, and Frequency.

M82
Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.

M83A
Digital Meter w/Diplay of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/Modbus.

T3/W3
Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer.

UMD
Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-60 seconds prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both.

VI
Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between “Fail” and “Restore” settings.
Factory default: 10% “Fail”, 8% “Restore, 30 Seconds.
See CFG Menu page 16 to configure ON or OFF.
See SET Menu page 17 to set Percentage and time windows

ZNET
Network Communications Interface Card

How to Set the System Clock

How to Set the System Clock

Set System Clock, time and date

- If the clock is not set, the display will show SET SYSTEM CLOCK on the second line of the S1 OK screen.
- The S1 OK screen will show time (hours and minutes) on the second line if the system clock has been set. (Date on third line)

Setting the System Clock

(Start from **S1 OK** screen)

1. Remove battery protective white plastic strip near **P** relay. *
2. Press **MORE** then press **SET**.
3. Press **MORE** and scroll to **SET SYSTEM CLOCK** using the **MORE** key.
4. Press **SEL**.
5. **ENTER ACCESS CODE** located on the white label on the back of the controller.
6. Press **SEL**.
7. Use the up and down keys to change the hour value.
8. Press **SAVE** (this will enter this value and move cursor to minutes).
9. Use the up and down keys to change the minutes.
10. Press **SAVE** (this will enter this value and move cursor to month).
11. Use the up and down key up to change the month.
12. Press **SAVE** (This will enter this value and complete the clock setting).
13. Use the up and down keys to change the date.
14. Press **SAVE** (this will enter this value and move cursor to year).
15. Use the up and down keys to change year.
16. Press **SAVE** (this will enter this value and compete the clock setting).
17. To edit settings, press **SEL** and repeat steps 6-16.
18. If the setting is satisfactory, press **MORE** (unit then returns to the **SET** menu then press **BACK**, then **ESC**.)

* Replacement battery part #K-4100
Battery will last 5 years and provides power to retain clock function only (Controller functions without battery).

CDT One Event Timer Exerciser

Load or No-Load

One event Exerciser with adjustable Timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1,7,14, or 28 days. Factory default is 20 minutes.

How to CONFIGURE (CFG) and Set (SET) the Timer Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG TIMER EXERCISER** screen.
3. The third line of the **CONFG TIMER EXERCISER** will show either **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **OFF**.
4. If the third line of the **CONFG TIMER EXERCISER** shows **DAILY**, **WEEKLY**, **14 DAY**, or **28 DAY** as desired, then proceed to step 10.
5. If the third line of the **CONFG TIMER EXERCISER** shows **OFF** or if another timer selection is desired, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY**, **WEEKLY**, **14 DAY**, or 2**8 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** to scroll to **CONFG TIMER EXERCISER (XFR)** or **(NO XFR)**.
11. Press Up or Down to select **XFR** (Load Transfer) or **NO XFR** (No Load Transfer).
12. Press **SAVE**.
13. Press **MORE** repeatedly to **BACK** then **S1 OK** screen.

Set (SET) the Exerciser:

14. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
15. Press **MORE** repeatedly until **EXER S2 RUN TIME** screen.
16. Press **SEL**
17. Enter **ACCESS** code located on white label on the back of the controller.
18. Press **SEL**
19. Cursor is indicated as a line under character to be changed. Change values with up and down keys.
20. Press **SAVE** when complete.
21. Press **MORE** repeatedly until **SET USER SETUP** then press **BACK** then **ESC** to the **S1 OK** screen.

CDT One Event Timer Exerciser *(cont'd)*

How to Initiate CDT Exerciser and to start an exercise cycle every 1, 7, 14, or 28 days

From S1 screen

1) Press **TEST**
2) Press **MORE**
3) Press **START TEST TIMER** (to initiate Test).

- If the CDT Exerciser is Factory configured for a Load Exerciser, the Controller will immediately start a load exercise. The controller will start the generator, transfer the load to Source 2 and remain in Source 2 for the duration set for **EXER S2 RUN TIME** in the **SET** menu. The controller will retransfer the load back to Source 1 after the S1 stable timer has timed out and run the generator unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).
- If the CDT Exerciser is Factory configured for a No-Load Exerciser, the Controller will immediately start a No-load exercise. The controller will start the generator and run it unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).

Exercise will be repeated at the same time as initiated on every 1, 7, 14, or 28 days according to the selection made in the Configure **CFG** menu.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle

If the CDT Exerciser is Factory configured for a No-Load Exerciser Or allow the controller to complete retransfer to Source 1 If the CDT Exerciser is Factory configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press Test
2) Press **MORE**
3) Press **BYPASS EXER**

To re-institute the next exercise event back, press **CANCL BPASS**

How to initiate a new exercise start time

1) Press **TEST**
2) Press **MORE**
3) Press **EXER CANCL**
4) Press **START TIMER TEST**

How to check the next exercise event

1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS**, **HOURS**, and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:

- ***E*** appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= CDT (Exerciser) timing period +T (S1 stable Timer) timing period.

CDP Clock Exerciser

Load / No-Load Clock Exerciser
Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by the end user for 1, 7, 14, 28, or 365 day cycles.

- A total of 7 independent No Load exercise periods (up to 10 hours each) can be programmed for each of the daily, weekly, 14-day, and 28-day exercisers.
- A total of 12 independent No Load exercise periods (up to 10 hours) can be programmed for the 365-day Exerciser.

How to Configure (CFG) the Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG CLOCK EXERCISER** screen.
3. The third line of the **CONFG CLOCK EXERCISER** will show either **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, **365 DAY** or **OFF**.
4. If the third line of the **CONFG CLOCK EXERCISER** shows **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **365 DAY** as desired, press **MORE** repeatedly to **BACK**. Press **ESC** then proceed to the **SET** menu to set the **EXERCISER**.
5. If the third line of the **CONFG CLOCK EXERCISER** shows **OFF**, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **365 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** repeatedly to **BACK** then **ESC** to **S1 OK** screen.

How to set (SET) the DAILY Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
2. Press **MORE** repeatedly until **SET EXERCISER** screen.
3. Press **SEL**.
4. Enter **ACCESS** code located on white label on the back of the controller.
5. Press **SEL**
6. Cursor is indicated as a line under character to be changed. Change values with up and down keys. Press **SAVE** after each entry to save value and to move to the next value to be changed.
7. Press **BACK** when complete.
8. Press **MORE** repeatedly until **SET USER SETUP**. Press **BACK** then **ESC** to the **S1 OK** screen.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle.

If the CD Exerciser is configured or Set for a No-Load Exercise. Or allow the controller to complete retransfer to Source 1. If the CD Exerciser is configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press **TEST**
2) Press **MORE**
3) Press **BYPASS EXER**

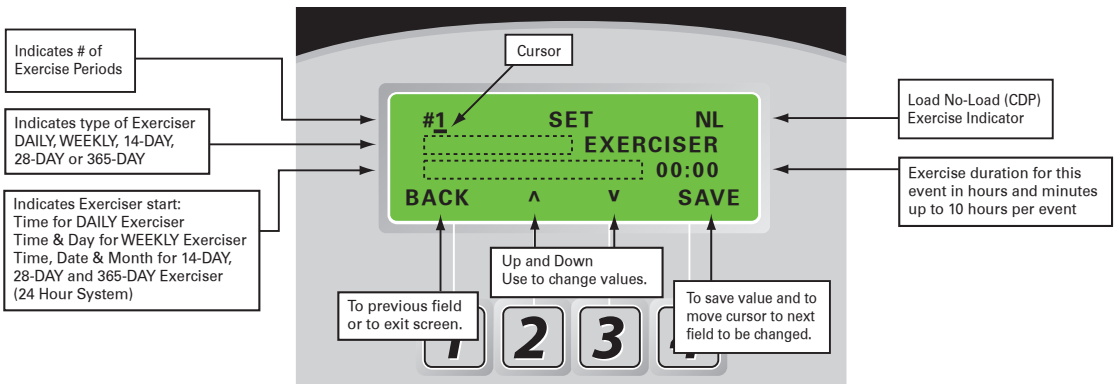
To re-institute the next exercise event back, press **CANCL BPASS**

How to check the next exercise event

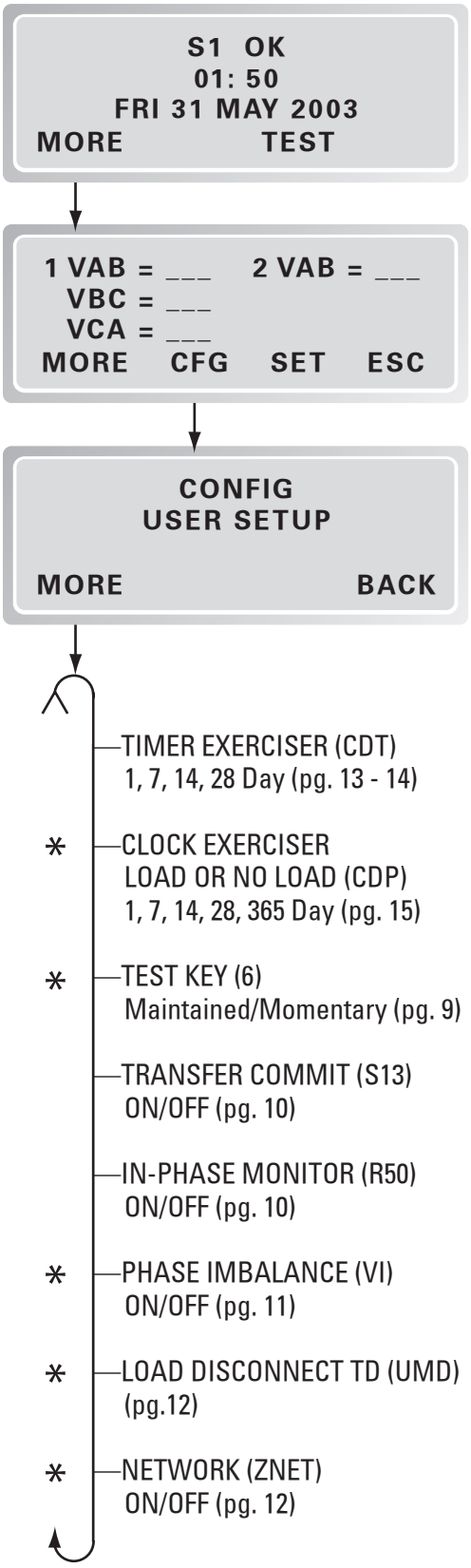
1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS**, **HOURS**, and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:

- In the **S1 OK** screen, an (***E***) appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= **CDT** (Exerciser) timing period +T (S1 Stable Timer) timing period.
- A value greater than zero must be entered in the Exerciser duration field to be accepted as a valid exercise period.
- The Exercise cycle will be repeated on a regular basis as programmed and initiated in the **SET** menu depending on what Exerciser was configured (selected) in the **CFG** menu.



MX150 User Setup - CFG Menu



⁎ Optional Accessories

Turn options ON or OFF via keypad through the CFG menu

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

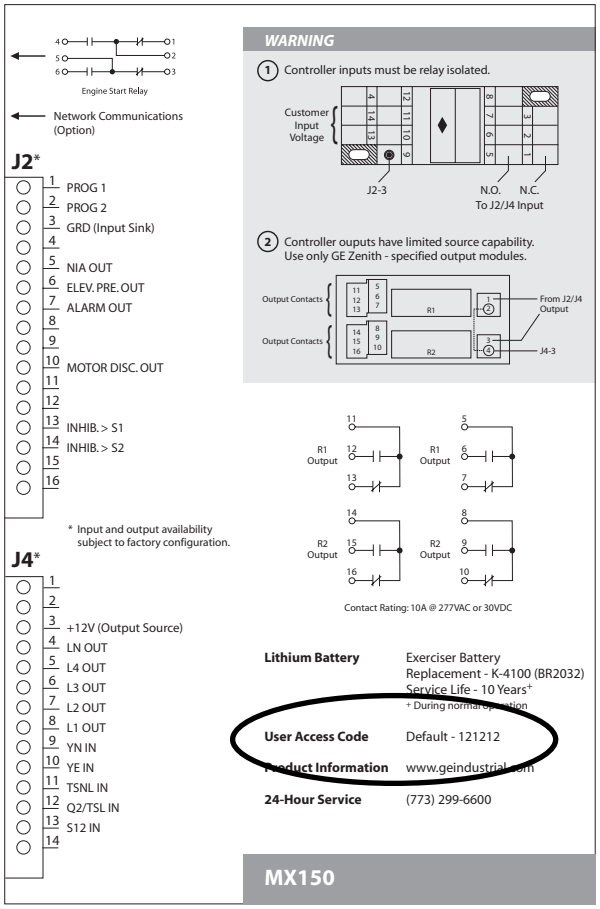
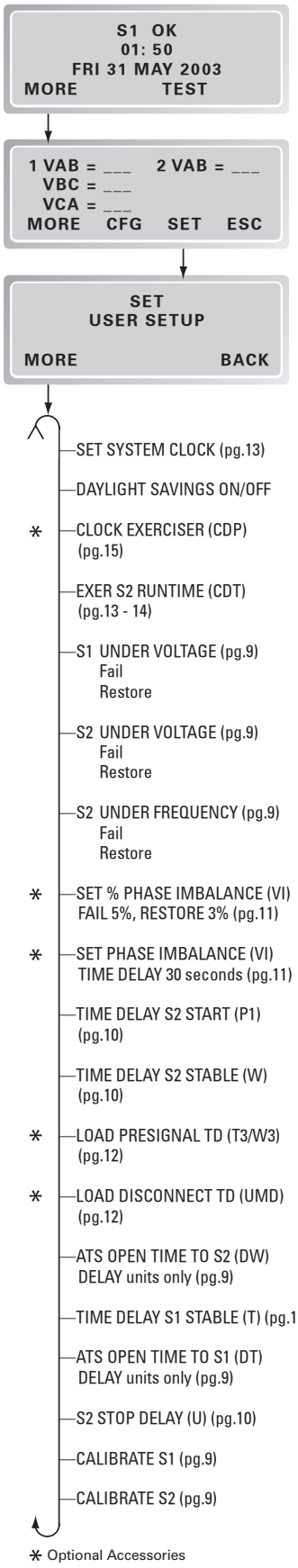


Figure 9

MX150 User Setup - SET Menu



Change adjustable values through the SET menu.

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

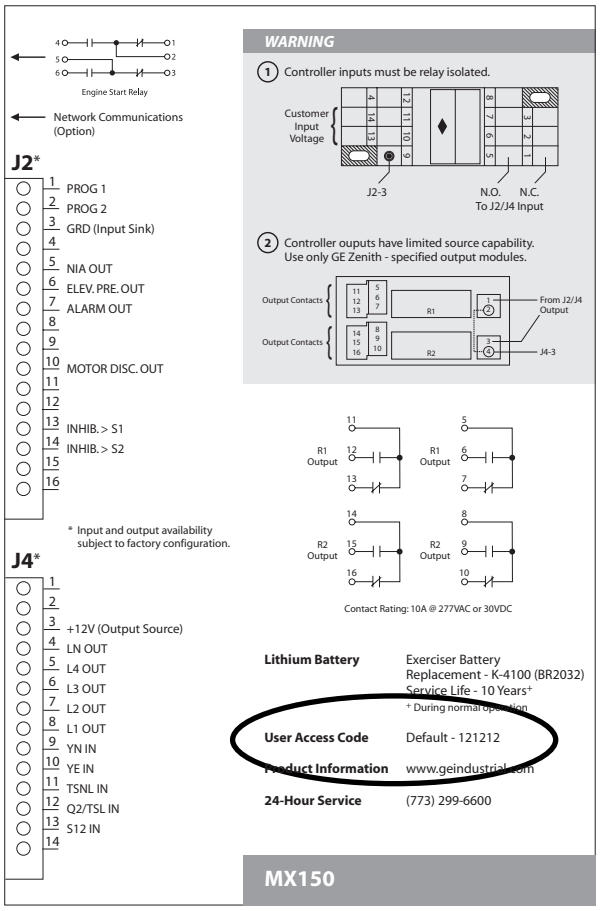
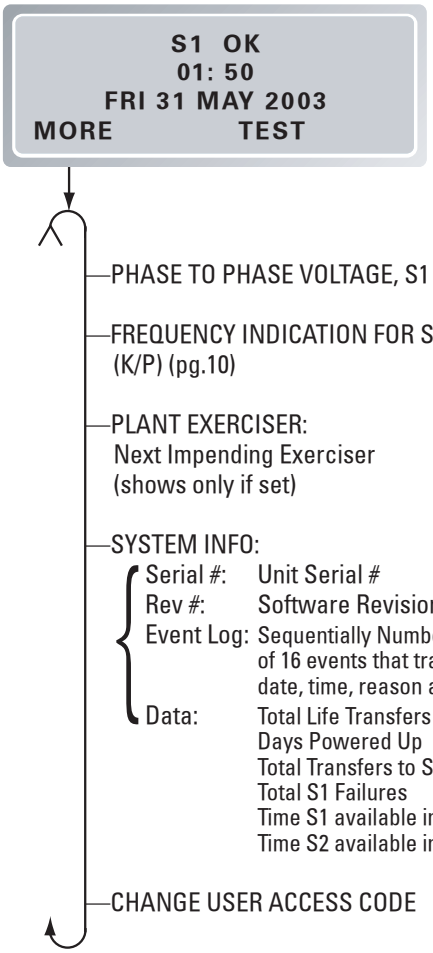


Figure 9

MX150 User Setup - System Info



View System Data

Enter six digit access code
(The factory assigned six-digit access code
is located on the back of the controller)

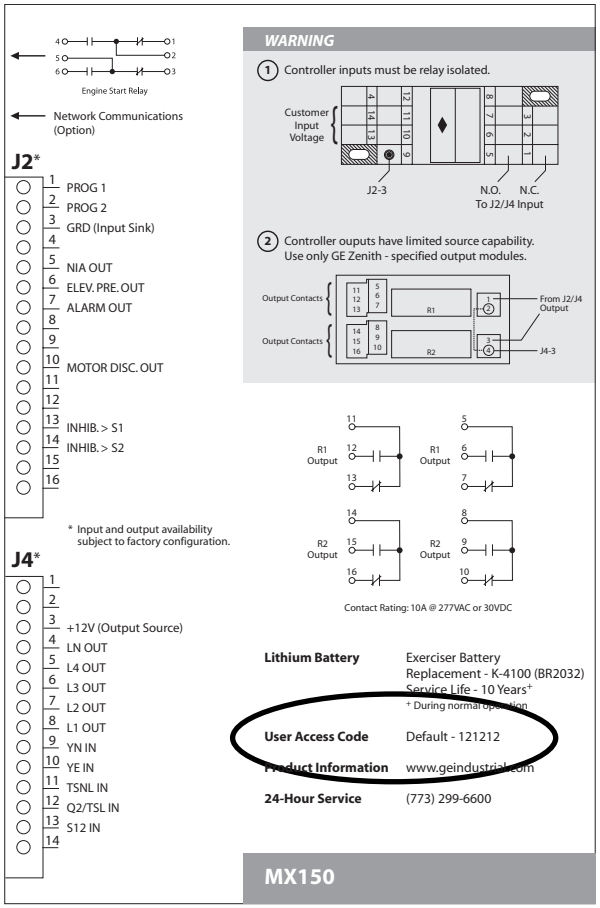


Figure 9

Testing

⚠ NOTICE ⚠

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701)

ATS Testing

Start generator and verify proper voltage, frequency and phase sequence (match to Source 1). Shut down gen set and place in Auto. Complete the visual inspection of the transfer switch, and close the cabinet door.

Initiate the test by pressing the TEST button on the LCD keypad. The controller will then prompt for your access code. After entering the code, three test options will appear—XFR LOAD, FAST TEST and NO XFR (See Figure 10).

- **XFR LOAD** test starts the generator and using the current timer settings, transfers the load to Source 2.
- **FAST TEST** test presets timer values to a maximum 30 seconds during the test. After completion of the test, all timers are reset to their original values. (T3, W3, DT and DW remain)
- **NO XFR** test starts the generator but does not transfer the load to the Source 2.

Press and hold the desired test option button until the switch transfers to Source 2 (load test) or until the generator has been run for the desired amount of time (no load test). Releasing the test button before W timer timeout will abort the test (Exception: when the transfer commit option, is configured “ON”).

To test lamps, press TEST then scroll through MORE, then press LAMP TEST. To cancel LAMP TEST press MORE.

Standard Transition

When the test is initiated, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCE relay energizes the CE solenoid to close the transfer switch in to Source 2. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1 sequence.The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCN relay energizes the CN solenoid to retransfer the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

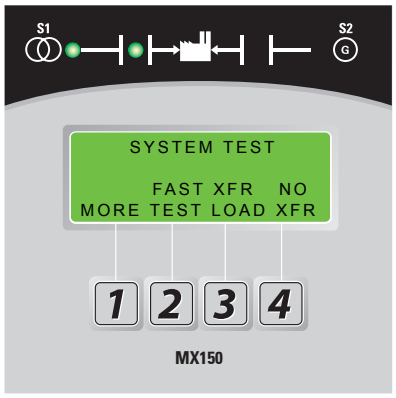


Figure 10

Delayed Transition

Source 1 Power Failure:

When the test is initiated, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCNO relay energizes the CNO solenoid to open the transfer switch out of Source 1 position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the CCE relay energizes. The switch then completes transfer to Source 2 by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1sequence.The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCEO relay energizes the CEO solenoid to open the switch out of Source 2 position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the CCN relay energizes the CN solenoid to complete re-transfer of the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

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Sequence of Operation

Standard Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCE relay energizes the CE solenoid to close the transfer switch in to Source 2. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1sequence.The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCN relay energizes the CN solenoid to retransfer the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCNO relay energizes the CNO solenoid to open the transfer switch out of Source 1 position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the CCE relay energizes. The switch then completes transfer to Source 2 by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1 sequence.The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCEO relay energizes the CEO solenoid to open the switch out of Source 2 position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the CCN relay energizes the CN solenoid to complete re-transfer of the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Table 3

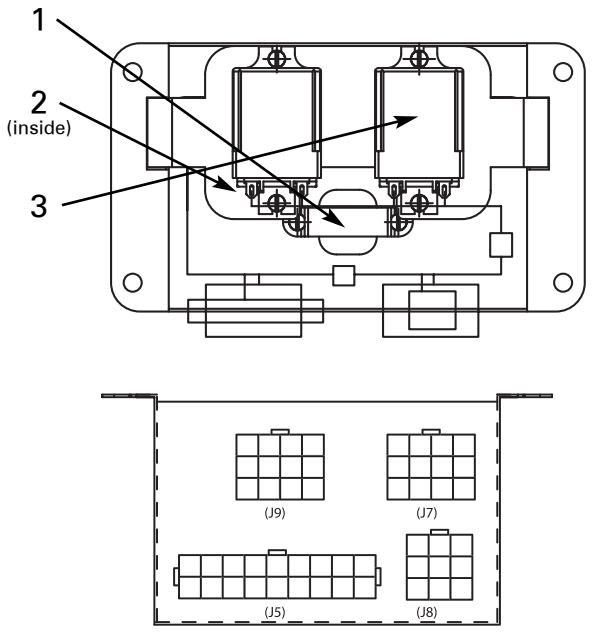
Timer Designations as they appear in the SET menu						
ATS Type	**P**	**W**	**DW**	**T**	**DT**	**U**
Standard	Time Delay S2 Start	Time Delay S2 Stable	→	Time Delay S1 Stable	→	S2 Stop Delay
Delay	Time Delay S2 Start	Time Delay S2 Stable	ATS Open Time to S2	Time Delay S1 Stable	ATS Open Time to S1	S2 Stop Delay
Source 1 Fails	Transfer to Source 2 →			Source 1 Returns ↓	Transfer to Source 1 →	Engine Cooldown

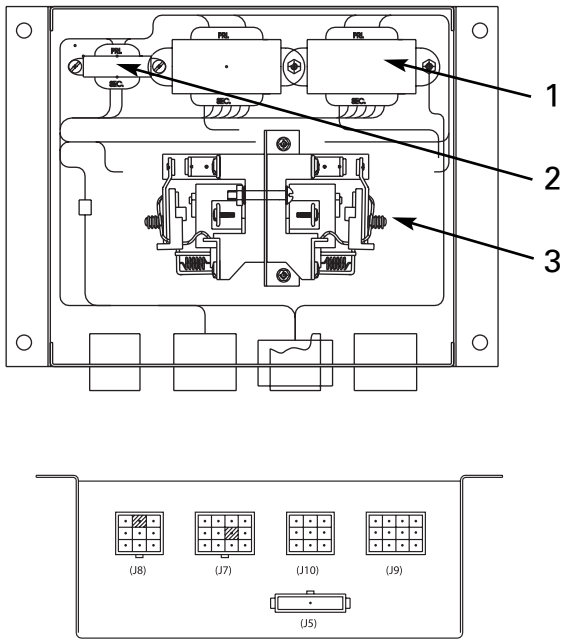
Relay/Transformer (R/T Box)

Standard Transition

Each MX150 microprocessor based ATS controller requires a relay/transformer box to apply line voltage to the ATS operator via coil control relays. Also required is power for the MX150 printed circuit board and an application of sensing voltage proportional to line voltage. This is accomplished by the relay transformer box. This method of switching operator voltage and applying power and sensing voltage to the printed circuit board isolates the MX150 from the line voltage, further protecting the controller from harmful line transients. Two versions of the R/T box exist depending on the type of ATS (standard transition or delayed transition).

The following layout drawings of the R/T Box components (standard and delayed transition) include a bill of materials for replacement parts. Schematics are included to indicate proper wiring.





40-225 Amp Molded Power Section Transformer Usage *(see Figure 10)*

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
57P-1115	120V	K-3216	K-3224
57P-1116	208-220V	K-3217	K-3225
57P-1117	230-240V	K-3218	K-3226
57P-1118	277V	K-3219	K-3227
57P-1119	380-400V	K-3220	K-3228
57P-1120	416-440V	K-3221	K-3229
57P-1121	460-480V	K-3222	K-3230
57P-1122	575-600V	K-3223	K-3231

40-3000 Amp - All Other Standard Types Transformer Usage *(see Figure 11)*

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
50P-1005	120V	K-3216	K-3224
50P-1006	208-220V	K-3217	K-3225
50P-1007	230-240V	K-3218	K-3226
50P-1008	277V	K-3219	K-3227
50P-1009	380-400V	K-3220	K-3228
50P-1010	416-440V	K-3221	K-3229
50P-1011	460-480V	K-3222	K-3230
50P-1012	575-600V	K-3223	K-3231

Bill of Material

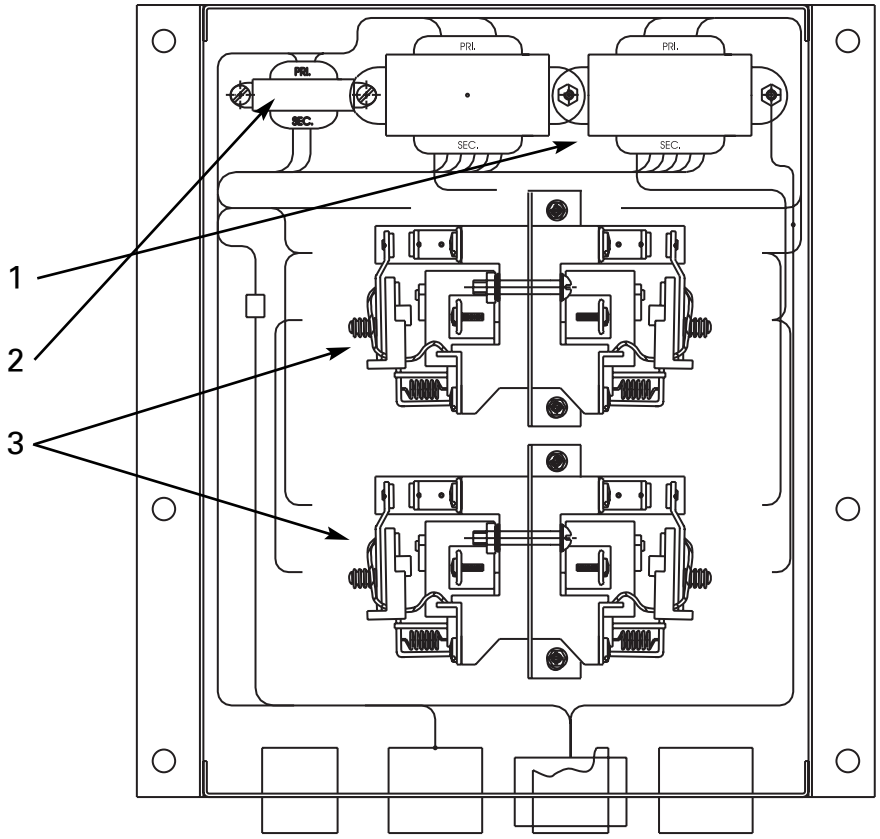
Item	Part No.	Description	Qty
1	See Chart	Transformer (1 VA)	1
2	See Chart	Transformer (25 VA)	2
3	K-1274	Relay Flange Mounted	2

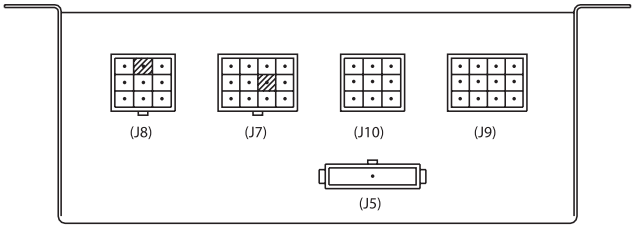
Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (25 VA)	2
2	See Chart	Transformer (1 VA)	1
3	K-1260	Coil Control Relay (24V)	2

Relay/Transformer (R/T Box) *(cont'd)*

Delayed Transition





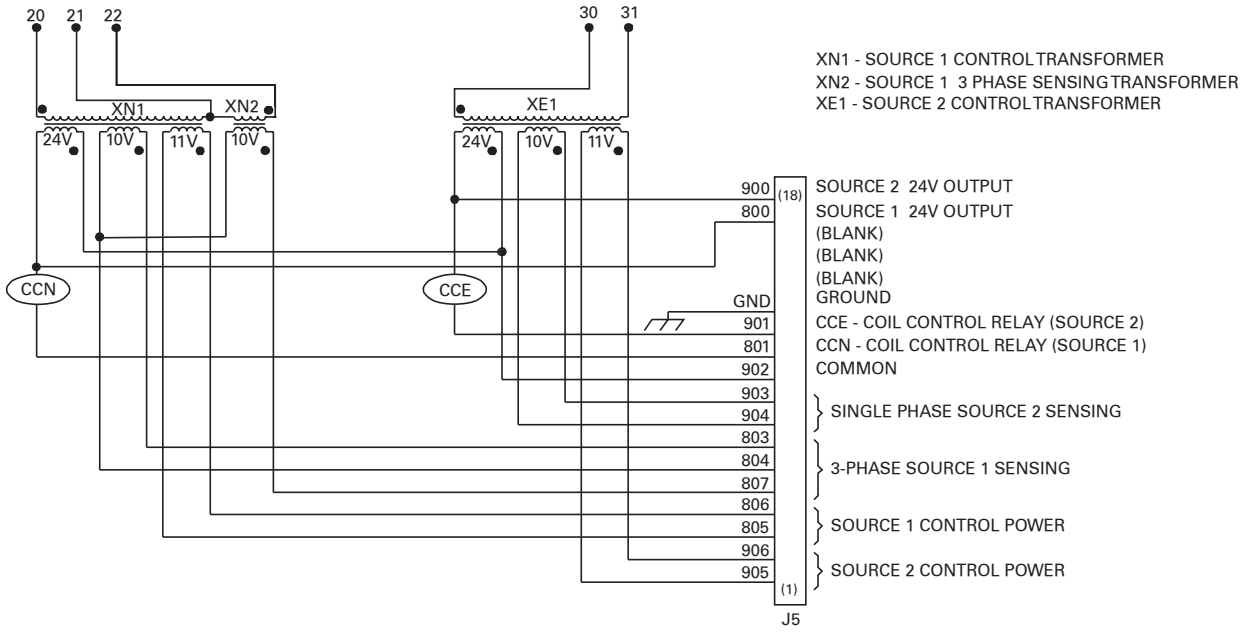
Transformer Usage

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
50P-1013	120V	K-3216	K-3224
50P-1014	208-220V	K-3217	K-3225
50P-1015	230-240V	K-3218	K-3226
50P-1016	277V	K-3219	K-3227
50P-1017	380-400V	K-3220	K-3228
50P-1018	416-440V	K-3221	K-3229
50P-1019	460-480V	K-3222	K-3230
50P-1020	575-600V	K-3223	K-3231

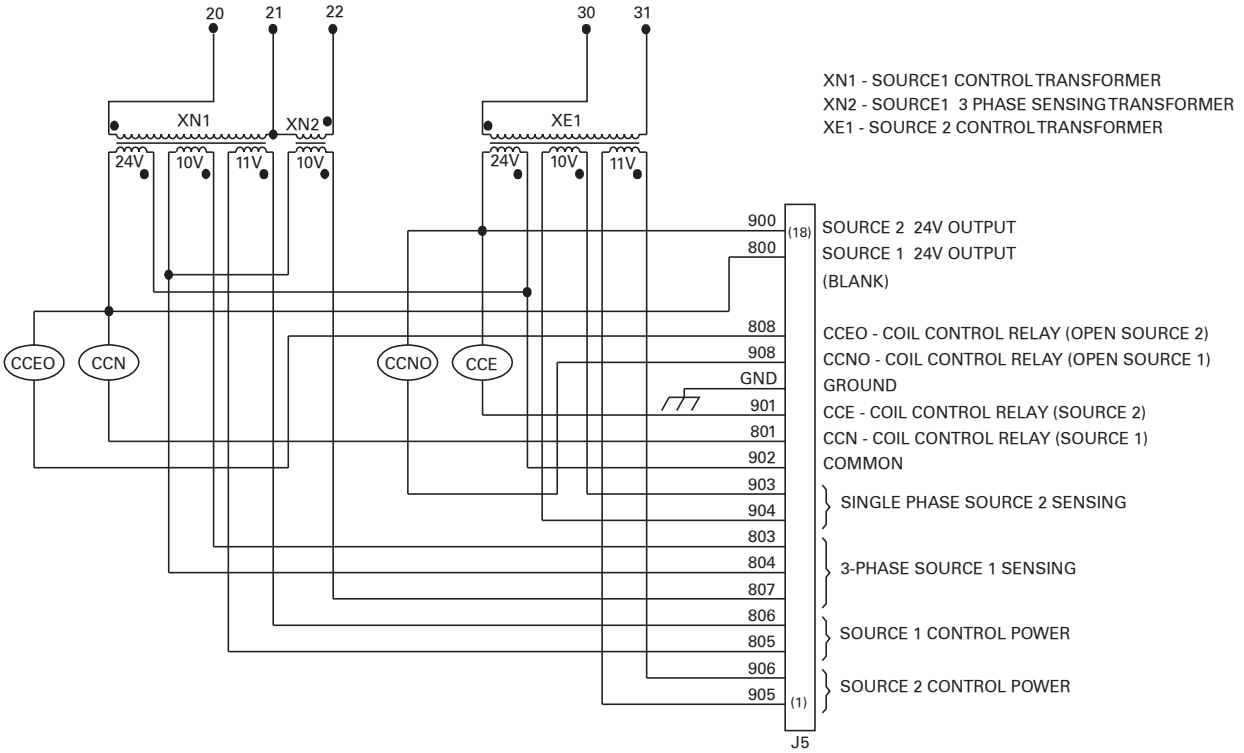
Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (25 VA)	2
2	See Chart	Transformer (1 VA)	1
3	K-1260	Coil Control Relay (24V)	4

Standard Transition R/T Box Schematic



Delayed Transition R/T Box Schematic



Troubleshooting and Diagnostics

⚠ DANGER ⚠

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.
These charts may indicate problems that require authorized GE Zenith service personnel.
Hazardous voltages may exist on termination plugs other than those that go into the MX150.

General Troubleshooting

The following troubleshooting guide is used to recognize, and determine basic faults. When using this guide, it will ask several questions about the condition of the switch. This guide will then list an order of the possible faults. You will then look at the first suspected fault to determine if it is the problem. If it is not a fault, you go to the second suspected fault. If you go through all of the suspected faults, or the chart instructs you to, call a GE Zenith Representative for further assistance.

NOTE: When you use the troubleshooting charts, the Annunciation column refers to the LED's on the control panel.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
Engine does not START	SOURCE 2 AVAILABLE LED off	Engine start wires not terminated properly	Check engine start connections
		Generator is in OFF position	Investigate why Engine Control Switch was turned off
Engine does not stop	LCD Display - "TD Engine Cool Down"	U timing cycle not complete	Check U timer setting
	SOURCE 1 POSITION, and SOURCE 1 and SOURCE 2 AVAILABLE LEDs on, but U timer has timed out	Engine start wires not terminated correctly	Check Engine Start Connections
		Generator in MANUAL	Place generator in AUTO
ATS will not transfer to SOURCE 2 ZTG Series	SOURCE 2 AVAILABLE LED off	SOURCE 2 voltage or frequency not within acceptable parameters	Check: Engine Start Connections, Generator Breaker, Generator Output, and Engine Control Switch
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "S1 _ _ _ _ TD XFR S1>S2 Time Remaining _ _ _ _"	**W** timing cycle not complete	Check **W** Timer setting
ATS will not transfer to SOURCE 1 ZTGD Series	LCD Display - "ATS Open Time Remaining _ _ _ _"	**DW** timing cycle not complete	Check **DW** Timer setting
	SOURCE 1 AVAILABLE LED off	SOURCE 1 voltage or frequency not within acceptable parameters	Check utility and utility breakers
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "Diagnostic Code 001"	Limit switch or RT box connector unplugged	Call Technical Services
	LCD Display - "S1 OK Time Remaining _ _ _ _ Bypass"	**T** timing cycle not complete	Check **T** Timer setting
	LCD Display - "ATS Open Time Remaining _ _ _ _"	**TD** timing cycle not complete	Check **DT** Timer setting

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Maintenance and Testing

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

⚠ WARNING ⚠

Both power sources must be disconnected before manual operation of the switch.

A preventive maintenance program will insure high reliability and long life for the transfer switch. The preventive maintenance program for the transfer switch should include the following items:

Inspection and Cleaning

The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (do not use emery cloth or a file). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken or badly worn parts.

Servicing

All worn or inoperative parts must be replaced using GE Zenith recommended replacement parts. Please refer to the Replacement Parts manual for specific part information and ordering procedures. Please contact the GE Zenith Technical Services Department for the Replacement Parts manual.

The operating mechanism of the transfer switch is lubricated with Lubriplate 105. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional Lubriplate.

GE Zenith can provide complete preventative maintenance services. Please contact the GE Zenith Technical Services Department for additional information.

CDT battery replacement - lithium batteries may last up to 10 years, however it is recommended that battery replacement be included in a 3-5 year service cycle. The battery maintains the exerceser memory only and does not otherwise affect the operation.

Testing

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. **Both power sources must be disconnected before manual operation of the switch.** Insert the handle and operate the transfer switch between the Source 1 and Source 2 positions. The transfer switch should operate smoothly without binding. Return the switch to Source 1 position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the TS test switch. P timer will time out and the microcontroller will send an engine start signal. When the W time has elapsed, the switch will complete its transfer by closing into Source 2.

Deactivating the test switch will start retransfer to Source 1. The switch will complete its retransfer to Source 1 after the time delay of the T timer. The U engine overrun timer allows the engine generator to run unloaded for a preset cool down period.

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

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GE Zenith Controls

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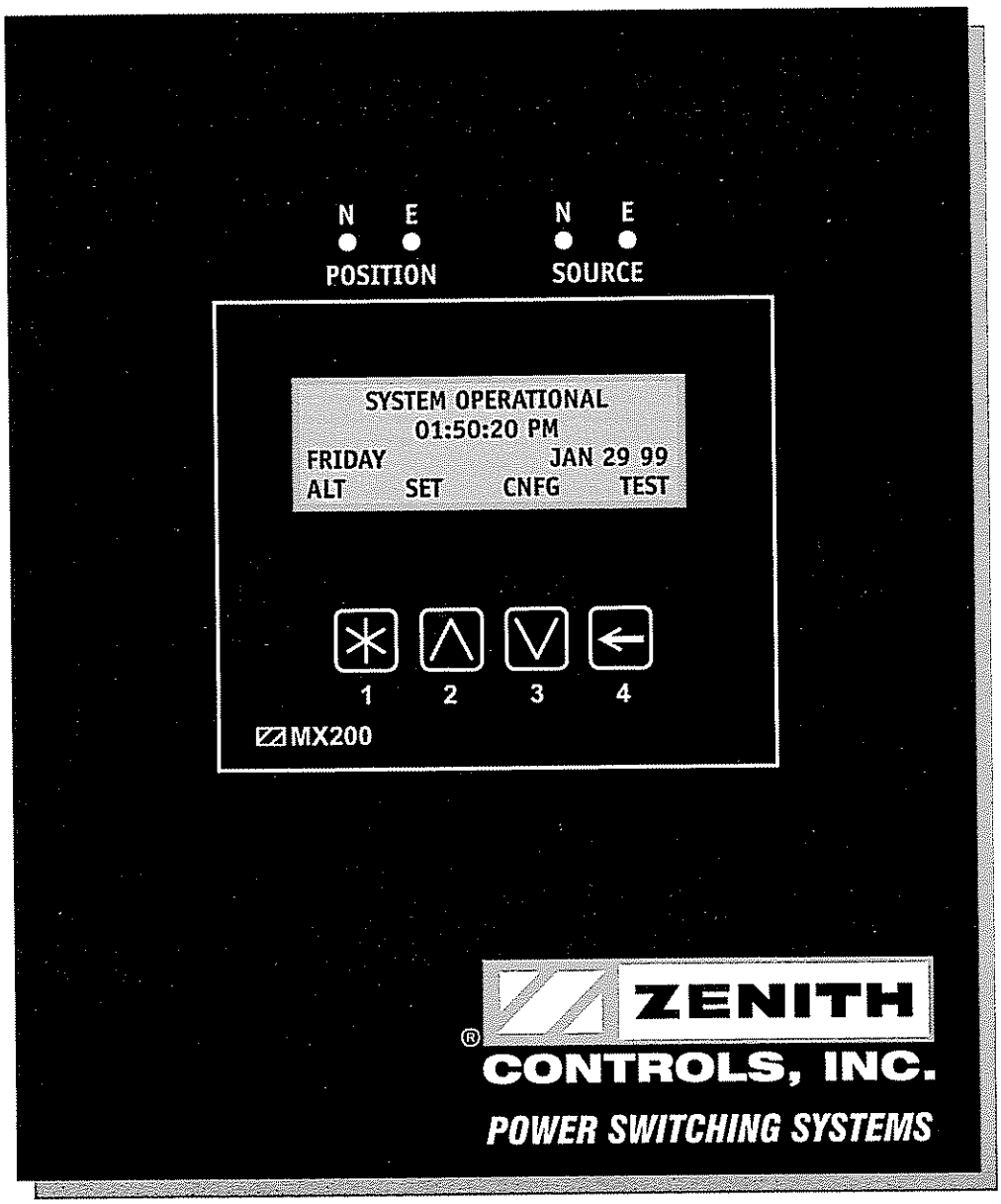
OPERATION AND MAINTENANCE MANUAL
TRANSFER SWITCH CONTROL PANEL
MX200 MICROPROCESSOR CONTROLLER



ZENITH
CONTROLS, INC.

ISO 9001 50R-2000C 12/98

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☞ = Quick Start

Safety

⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Installation for each ATS is detailed in the information package which includes:

- Operation and Maintenance Manual for Control Panel (this manual)
- Power Panel Manual
- Specific Schematics Supplied With Each Transfer Switch

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred due to shipment or installation. **DO NOT** use a blower since debris may become lodged in the electrical and mechanical components and cause damage. Use of a vacuum is recommended.
2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections and verify the correct connection of all control wires.
4. Check settings of all timers and adjust as necessary. Also adjust any optional accessories as required.
5. Check the integrity of power connections by verifying actual lug torque values as specified in the power panel manual.
6. Make sure that all covers and barriers are installed and properly fastened.

NOTE: Power Panels ship from Zenith in the Normal Position.

Equipment Inspection and Storage

Immediately inspect the transfer switch when received to detect any damage which may have occurred during transit. If damage is found or suspected, file claims as soon as possible with the carrier and notify the nearest Zenith representative.

Before installation, it is necessary to store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature:	-30 C to + 85 C (-22 F to +149 F)
Operating Temperature (Ambient):	-20 C to +75 C (-4 F to +167 F) [40-260 Amps] -20 C to +60 C (-4 F to +104 F) [400-4000 Amps]
Humidity:	5% to 95% (non-condensing)

The MX200 Controller Overview

The MX200 CONTROLLER consists of two major assemblies:

I. The ***Microprocessor*** contains the following:

A. Customer Input and Output (I/O) for system interface. Located on the left hand side of the back of the unit (see figure 1)
   1. I/O accessories that can be found here are:
      a. Engine start relay P output
      b. Source Availability A1 and A1E output (optional)
      c. Pre-Signal to transfer T3, W3 and A6 output (optional)
      d. Transfer Inhibit Q3 and Q7 input (optional)
      e. Remote test Q2 input (optional)
      f. Load shed R15 input (optional)
      g. Network interface ZNET200 input/output (optional)

B. LCD and Keypad located on the exterior of the door (see figure 2)
   1. User accessibility to the following:
      a. LED indication of source availability
      b. LED indication of transfer switch position
      c. LCD screen indicates:
         (1) timer count down (numeric)
         (2) event reporting (text)
      d. Keypad provides user interface to: *[in conjunction with LCD screen]*
         (1) Setting sensors and timers
         (2) Configuring logic accessories

II. The ***R/T box*** (relay transformer box) contains the following: (see figure 1)

A. Relays which are required for controller output to energize the transferring mechanism of the transfer switch at line voltage.

B. Transformers which drop line voltage to control level for controller input.

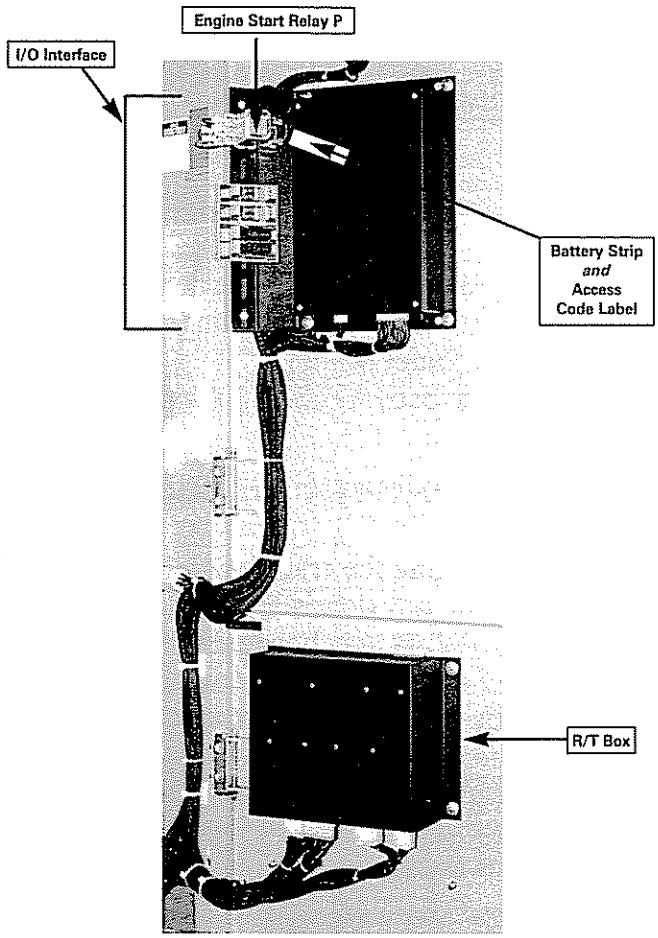


Figure 1

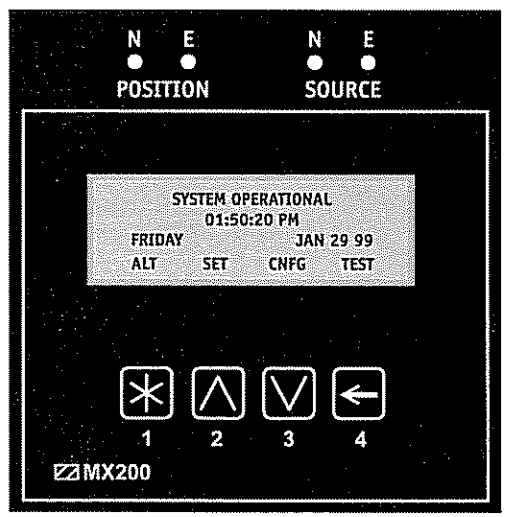


Figure 2

⚠ DANGER

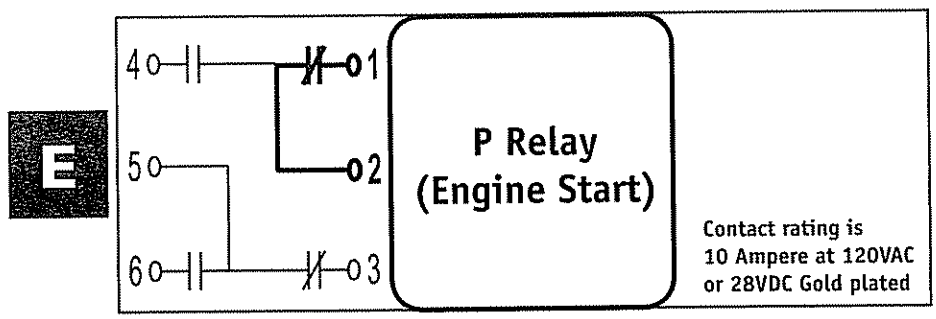
HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Connecting Engine Start may cause Generator to start. Before connecting, turn Generator OFF.

Engine Control Connections (E contacts)

Connections for Engine Control are located on the upper left side of the unit (see figure 1). The P relay provides this output. This contact is controlled by the P timer. To change response time to Normal power outage (see page 18 and 20).



The above diagram represents a de-energized P relay (utility shown de-energized). The majority of generator manufacturers require a contact closure to start Engine. Use terminals #1 and #2.

Note 1: Bypass Isolation Transfer Switches have an auxiliary Engine Start feature. This provides an Engine Start even if the ATS and controls are isolated (*THIS IS A STANDARD FEATURE EXCLUSIVELY ON ZENITH BYPASS PRODUCTS*). The Customer connections on these products are located on the Power Panel, upper right-hand corner. Please refer to the Power Panel instruction manual for complete details.

Note 2: Products equipped with Engine control options such as S1, S2 or P2 provide customer connections on an auxiliary terminal block located on the MX200 DIN rail or auxiliary control panel. Please refer to corresponding option drawing.

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Installation - Optional Accessories

⚠ DANGER

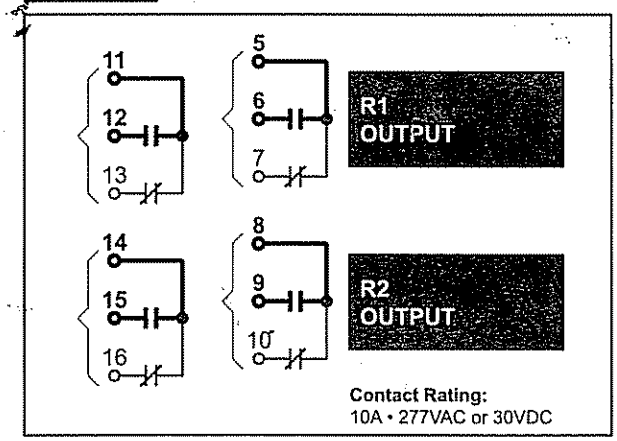
HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Generally the input and output options are located below the P relay on the same DIN rail (see figure 1). In some cases it may be necessary to mount additional accessories on an auxiliary panel.

Output Option Connections

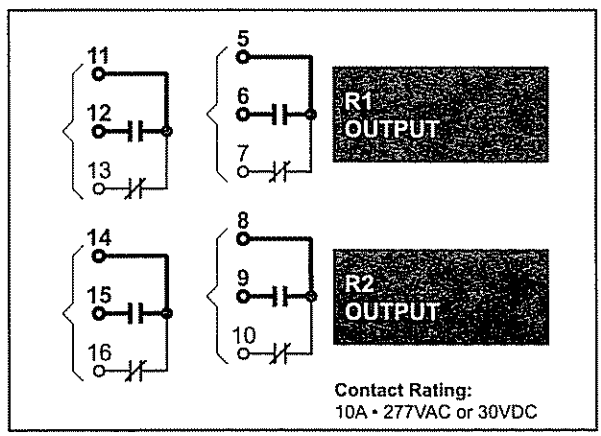
A1



Auxiliary contact(s) that operate(s) based on Normal source availability. Contacts located on R1 and/or R2. Refer to labeling.

Example: Terminal numbers 11 and 12 are closed when Normal source is acceptable (11 and 13 are open). When the Normal source is unacceptable, the opposite is true. Diagrams are shown with Normal unavailable.

A1E



Auxiliary contact(s) that operate(s) based on Emergency source availability. Contacts located on R1 and/or R2. Refer to labeling.

Example: Terminal numbers 11 and 12 are closed when Emergency source is acceptable (11 and 13 are open). When the Emergency source is unacceptable, the opposite is true. Diagrams are shown with Emergency unavailable.

⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

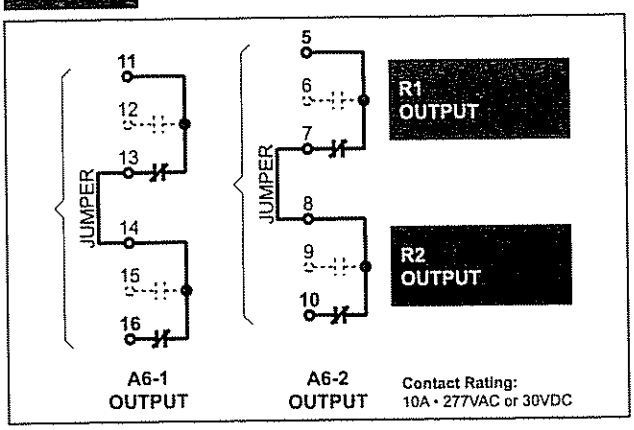
Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Output Option Connections *(cont'd)*

A3/A4

These connections are located on the Power Panel. Exact location depends upon which model is used. Refer to the Power Panel instruction manual for details. In all cases the A4 contact closes when the Transfer Switch is in the Normal position and the A3 contact closes when the Transfer Switch is in the Emergency position.

A6



Auxiliary contact(s) that open prior to transfer in either direction.

Example: Terminals 11 to 16 will open five* seconds prior to transfer in either direction and close instantaneously after transfer.

* Pre-signal time is adjustable via T3/W3 timers (see page 11, 19 and 20)

For complete sequence of operation, see page 19

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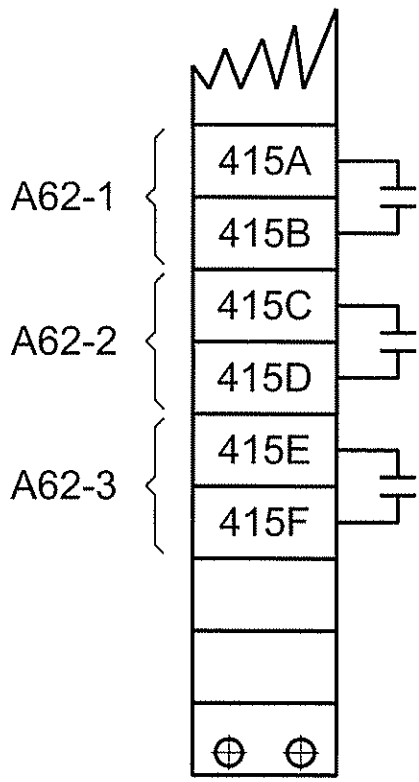
⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Output Option Connections *(cont'd)*

A62



Contact Ratings:
5A 250 VAC

Auxiliary contact(s) that open prior* to transfer in either direction and close in sequence** after transfer.

All A62 contacts will open five* seconds prior to transfer in either direction. Contacts close after transfer when their corresponding timers have timed out.

- A62-1 contact sequence timer is T62-1
- A62-2 contact sequence timer is T62-2
- A62-3 contact sequence timer is T62-3

Example: When all three sequence timers are set for 5 seconds:

- A62-1 closes 5 seconds after transfer and starts T62-2 timer
- A62-2 will close 10 seconds after transfer and then start the T62-3 timer
- A62-3 will then close 15 seconds after transfer and so on.

* pre-signal time is adjustable via T3/W3 timers (see page 11, 19 and 20)

** sequence timers are adjustable and located on the auxiliary panel

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Installation - Optional Accessories *(cont'd)*

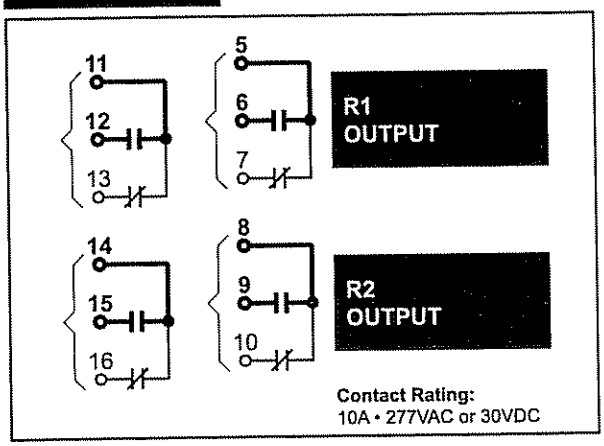
⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Output Option Connections *(cont'd)*

T3/W3



Auxiliary contacts that close five* seconds prior to transfer, and open instantaneously after transfer. Contacts located on R1 and/or R2. Refer to labeling.

- T3 is prior to transfer to Normal.
- W3 is prior to transfer to Emergency.
- T3/W3 is canceled when transfer is due to source outage.

*pre-signal time is adjustable (see page 11, 19 and 20)

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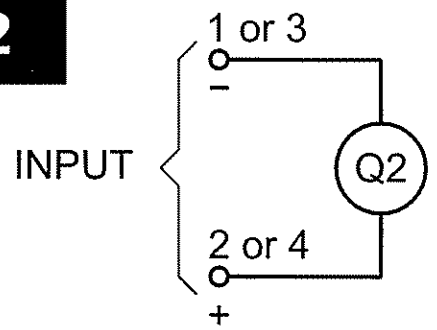
⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Input Options Connections

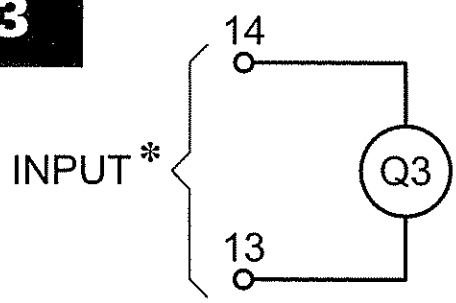
Q2



Remote Peak Shave or Area Protection Circuit
Energize Q2 input to simulate a Normal line failure causing the Generator to start and transfer the load to Emergency. Should Emergency fail during this operation, the Transfer Switch will retransfer back to Normal.

Q2 Input Modules:
K-1267, 120VAC INPUT (*Standard*)
K-1266, 24V (AC or DC) or 12VDC INPUT (*Optional*)

Q3

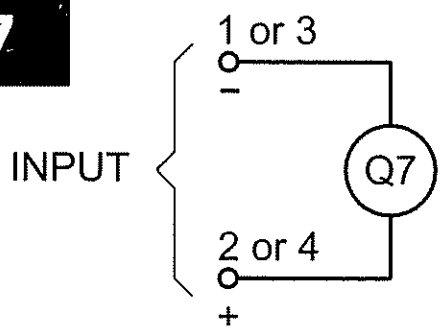


Remote Inhibit Transfer to Emergency Circuit
Voltage applied to Q3 input will allow transfer to Emergency. Conversely, no input on Q3 will inhibit transfer to Emergency.

* To enable Q3 option, engage Q3 jumper.

Q3 Relay:
K-1204, 120VAC *(Standard)*
K-1232, 24VAC; K-1242, 24VDC *(Optional)*

Q7



Remote Inhibit Transfer to Normal Circuit
Energize Q7 input to prevent transfer to Normal.

Q7 Input Modules:
K-1267, 120VAC INPUT (*Standard*)
K-1266, 24V (AC or DC) or 12VDC INPUT (*Optional*)

Installation - Optional Accessories *(cont'd)*

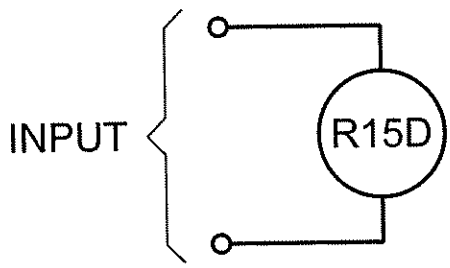
⚠ DANGER

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Input Options Connections *(cont'd)*

R15/R15D



Load Shed
Input, that when energized, causes the unit to transfer out of the Emergency position. The customer can use this to prevent generator overload.

On a ***Standard*** transfer switch, the R15 will transfer the unit to a dead Normal.

On a ***Delay*** transfer switch, the R15D will transfer the unit to a neutral (open) position. (Unit will transfer to Normal if acceptable)

Q3 is used to keep the unit from transferring back to Emergency.

R15/R15D Relay:
K-1204, 120VAC *(Standard)*
K-1232, 24VAC; K-1242, 24VDC *(Optional)*

Communication Connections

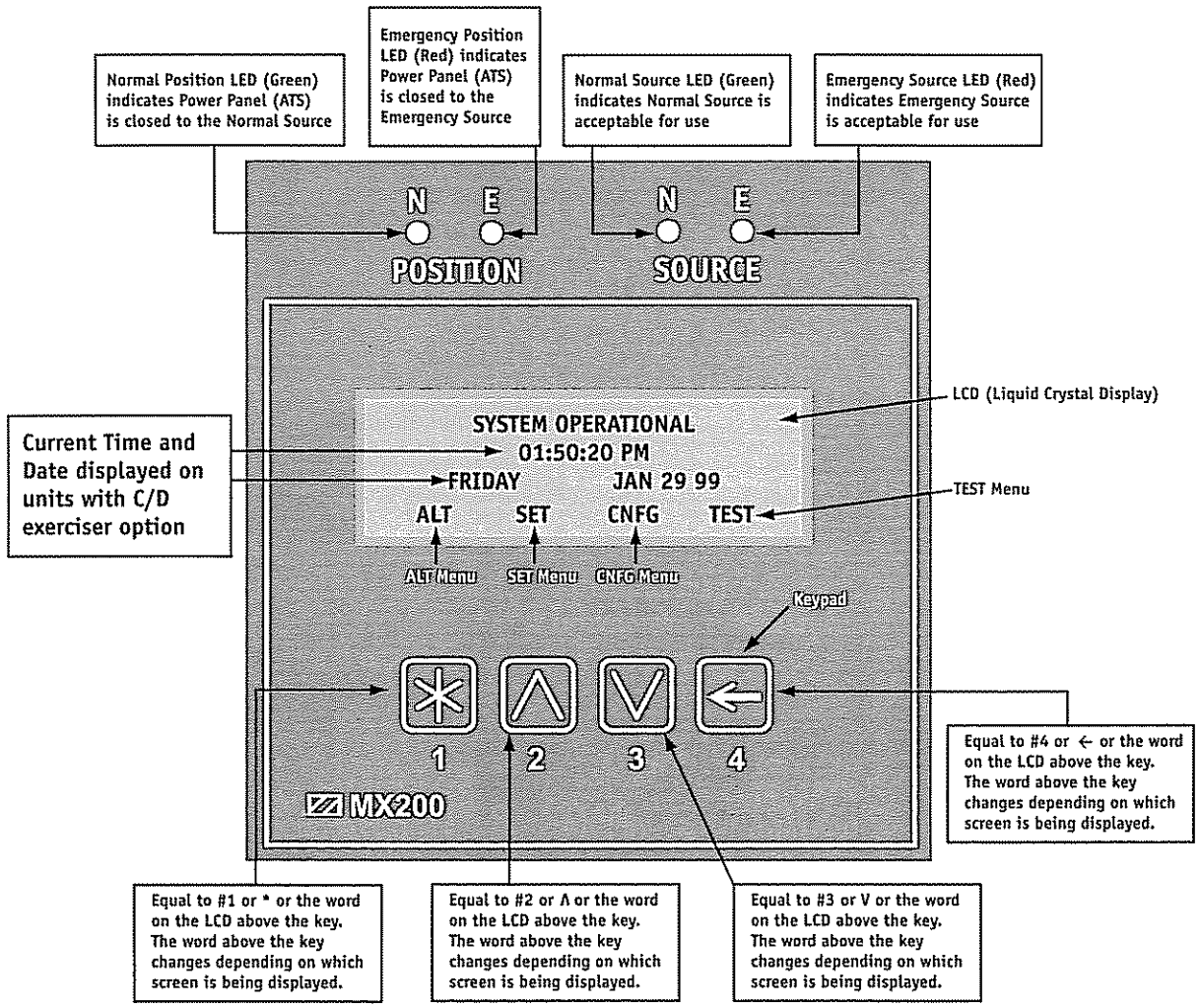
ZNET200

Network card allows communication of ATS position, available source, timers running, etc. to a remote annunciator panel, PC or PLC via one pair of twisted wires. Connections located below P relay. Refer to labeling. Network cable to be Belden 8471, 16AWG (unshielded two conductor twisted pair, not included).

Programmable Options

These options are accessible through the LCD and keypad (see figure below). To become familiar with the options loaded into a particular unit, scrolling through the SET and CNFG menu will show the descriptions of the options (see page 11 and 12). These menus are the very same menus that are used to access the setting and/or configuration of these options. The SET (setting) menu is primarily used to show or change, time and voltage settings. The CNFG menu is primarily used to turn an option on or off. When scrolling through these menus, no changes can be made without entry of the access code. The factory set six-digit access code is located on a white label on the back of the unit (see figure 1).

The MX200 has many logic options. Each controller is downloaded with options at the time of manufacture. The collection of options that any one controller has is specified at the time of order placement. The following pages include all the options that can reside in the controller. Not all units include all options.



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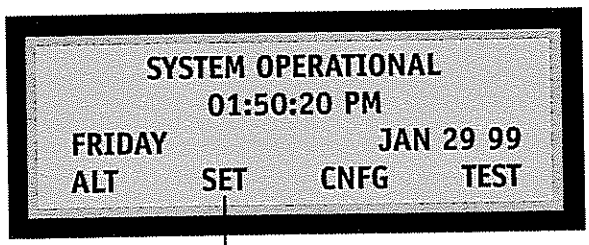
User Settings - SET Menu



- SYSTEM CLOCK (pg. 14)
- * EXERCISER EVENTS (pg. 15)
- N PICKUP VOLTAGE (pg. 22)
- N DROPOUT VOLTAGE (pg. 22)
- N PICKUP FREQ (pg. 22)
- E PICKUP VOLTAGE (pg. 23)
- E DROPOUT VOLTAGE (pg. 23)
- E PICKUP FREQ (pg. 23)
- ENG START DELAY (pg. 18)
- * DELAY TO EMERG PRE SIGNAL (pgs. 19-20)
- * EMERG PRE SIGNAL (pgs. 19-20)
- * DELAY TO OPEN NORMAL (pgs. 18 and 20)
- DELAY TO EMERG (pgs. 18 and 20)
- DELAY TO NORMAL (pgs. 18 and 20)
- * DELAY TO NORMAL PRE SIGNAL
- * NORMAL PRE SIGNAL (pgs. 19-20)
- * DELAY TO EMERG OPEN (pgs. 18-20)
- ENG STOP DELAY (pgs. 18 and 20)
- CALIBRATE NORMAL
- CALIBRATE EMERGENCY

* optional

Change adjustable values through keypad via SET menu.

Key stroke (SET ^ 2) (SELECT ^ v 2 3) scroll to accessory description to be changed, then (SET <- 4).

Enter six-digit access code (******)♦

(SET <- 4) (SELECT ^ v 2 3) scroll to choose New Value

(STORE <- 4) this will be repeated for each digit to be set then (BACK * 1) to get out of SET screens and save your changes.

♦ The factory assigned six-digit access code is located on the white label on the back of the controller (see figure 1).

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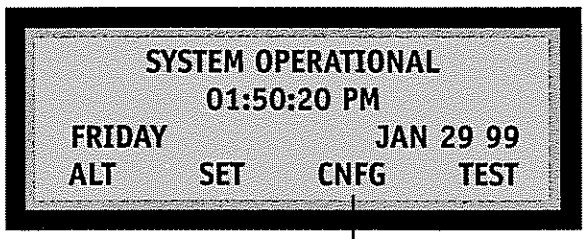
User Settings - CNFG Menu



- ✳ N OVER VOLTAGE (pg. 22)
- ✳ N UNDER FREQ (pg. 22)
- ✳ N OVER FREQ (pg. 22)
- ✳ E OVER VOLTAGE (pg. 23)
- ✳ E OVER FREQ (pg. 23)
- ✳ IN PHASE MONITOR (pg. 21)
- TRANSFER COMMIT (pg. 26)
- ✳ EXERCISER (pgs. 15-17)
- TEST MENU KEY
- DATE STYLE
- ✳ CONFIG NO TRANSFER (pg. 21) (Phase Rotation)

Turn options ON or OFF via keypad through the CNFG menu.

Key stroke (CNFG ∨ 3) (SELECT ∧ 2 ∨ 3) scroll to accessory description then (CNFG ← 4)

enter six-digit access code (******)♦

(CNFG ← 4) (∨ 3) scroll to ON or OFF

(STORE ← 4) (BACK * 1) to get out of CNFG screen and save changes.

♦ The factory assigned six-digit access code is located on the white label on the back of the controller (see figure 1).

✻ optional

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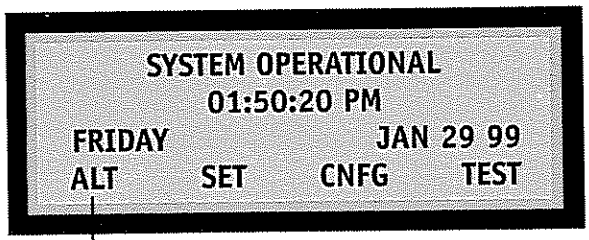
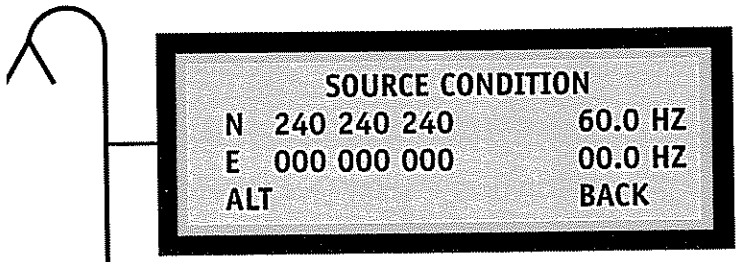
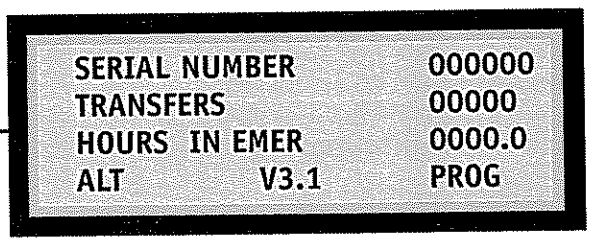
User Settings - ALT Menu





This screen displays line to line voltage values of both sources (A to B, B to C and A to C). Frequency of both sources is also displayed. Display will remain once selected, until transfer occurs. This is an alternate main screen.

This screen provides a lamp test. Pressing (TEST ← 4) key will test LEDs above screen. This display will revert back to SYSTEM OPERATIONAL after 5 seconds.



This screen provides:

SERIAL NUMBER of the transfer switch unique to each switch.
TRANSFERS is a count of how many times the unit has transferred to Emergency (Total).
HOURS IN EMER is a running total of hours the unit has provided Emergency to the load.
V# is the software version number.

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How to Set the System Clock

Set **SYSTEM CLOCK**, time and date:

- Only controllers with the Plant exerciser (C/D) option will show a system clock.
- When the controller does not have this option, the second and third line of the display will be blank during **SYSTEM OPERATIONAL** screen.
- When the clock is present but not set, the display will show **SET SYSTEM CLOCK** on the second line of the **SYSTEM OPERATIONAL** screen.
- The **SYSTEM OPERATIONAL** screen will show time (hours, minutes and seconds) on the second line if the system clock has been set. (Date on third line)

Set the system clock via the SET menu: (Start from **SYSTEM OPERATIONAL** screen)

* 1. Remove battery protective white plastic strip near P relay (see figure 1)
2. Press **SET**
3. Scroll to **SET SYSTEM CLOCK** using the up and down keys (SELECT)
4. Press **SET**
5. **ENTER ACCESS CODE** located on the white label on the back of the controller (see figure 1)
6. Press **SET**
7. Use the up and down keys to change the hour value (AM or PM is also selected)
8. Press **STORE** (this will enter this value and move cursor to minutes)
9. Use the up and down keys to change the minutes
10. Press **STORE** (this will enter this value and move cursor to month)
11. Use the up and down keys to change the month
12. Press **STORE** (this will enter this value and move cursor to date)
13. Use the up and down keys to change the date
14. Press **STORE** (this will enter this value and move cursor to year)
15. Use the up and down keys to change year
16. Press **STORE** (this will enter this value and complete the clock setting)
17. To edit settings, press **SET** and repeat steps 6 - 16
18. If the setting is satisfactory, press BACK (unit then returns to the **SYSTEM OPERATIONAL** screen)

* *Replacement battery Part # K-4100*
Battery will last 5 years and provides power to retain clock function only
(Controller functions without battery)

How to Set the Plant Exerciser C/D

- Units equipped with this option will display the time of day on second line of **SYSTEM OPERATIONAL** screen (if time is correct, go to step one; if not, see page 14 "How to Set the System Clock").
- When the second line displays **SET SYSTEM CLOCK** the unit is equipped with the exerciser option, but the **SYSTEM CLOCK** has not been set. **SYSTEM CLOCK** must be set before proceeding (see page 14 "How to Set the System Clock").
- When a unit is not equipped with this option, the second and third line of the **SYSTEM OPERATIONAL** screen will be blank (Plant Exerciser option is not installed).

Verify the Exerciser is on with the following:

1. Beginning from the **SYSTEM OPERATIONAL** screen, press **CNFG**
2. Using up and down keys, scroll to **CONFIG EXERCISER** screen
3. The lower right-hand corner (above **CNFG**) will show on or off
4. If **on**: press **BACK** and skip to step 12
5. If **off**: continue
6. Press **CNFG**
7. Enter **ACCESS CODE** located on white label on the back of the controller (see figure 1)
8. Press **CNFG**
9. Select "**on**" using up and down keys
10. Press **STORE**
11. Press **BACK** to return the **SYSTEM OPERATIONAL** screen.

Set the **PLANT EXERCISER** via the **SET** menu after verifying the unit is equipped with this option and it is turned on as per above:

12. Beginning from the **SYSTEM OPERATIONAL** screen, press **SET**
13. Using up and down keys, scroll to **SET PLANT EXERCISER** screen (if this screen cannot be found begin at the top of the page)
14. Press **SET**
15. Enter **ACCESS CODE** located on white label on the back of the controller (see figure 1)
16. Press **SET**
17. The **SET 1WEEK EXER** screen is now displayed (refer to page 16 and 17 to verify type of exerciser installed; 1WEEK, 2WEEK, DAILY OR CLNDR)
18. Press **SET** again
19. Cursor is indicated as a line under character to be changed, move cursor via **STORE** key
20. Change values with up and down keys, press **STORE** after each entry (test duration is hours and minutes)
21. Press **STORE** when complete, until **SAVING RECORD** is displayed
22. Press **BACK** twice when done to return to the **SYSTEM OPERATIONAL** screen.

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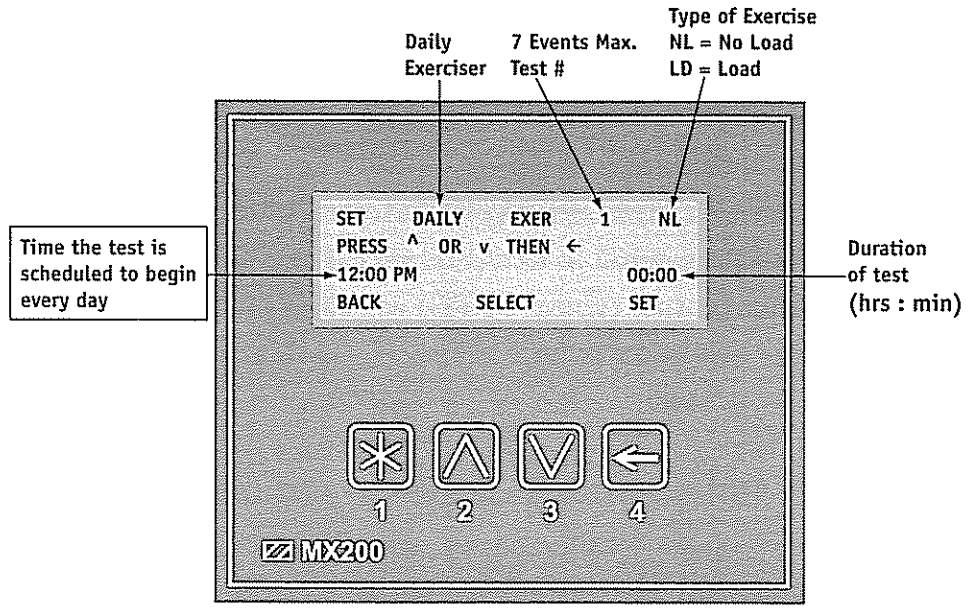
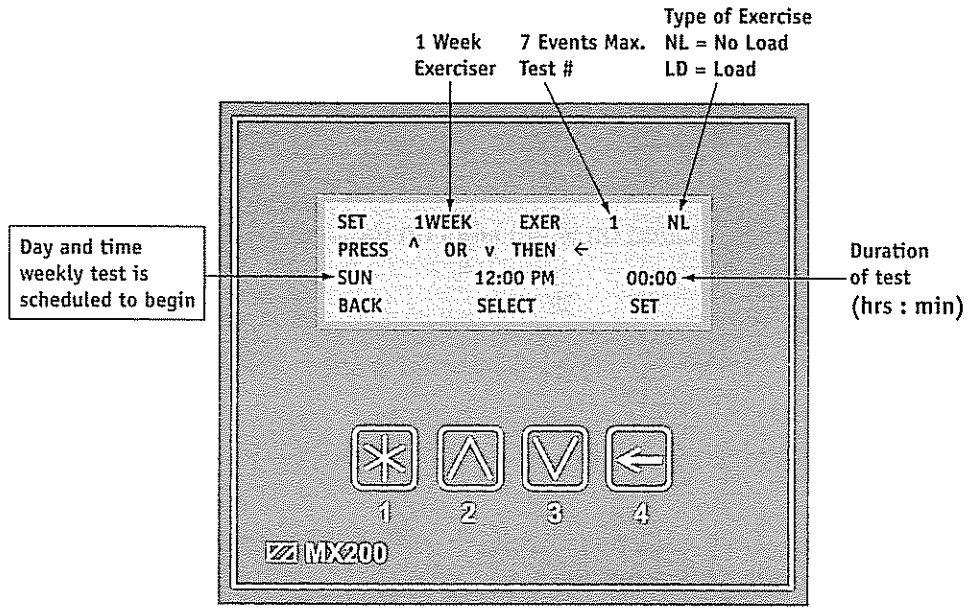
Exerciser Types

Units equipped with the Exerciser Option require that the System Clock be set first. (see page 14)

Daily Exerciser



1 Week Exerciser



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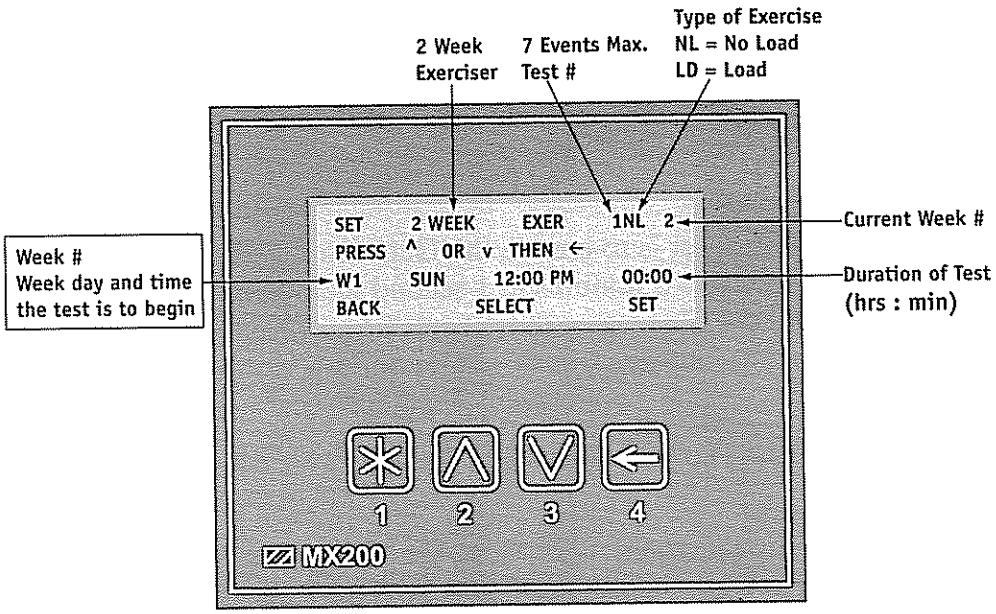
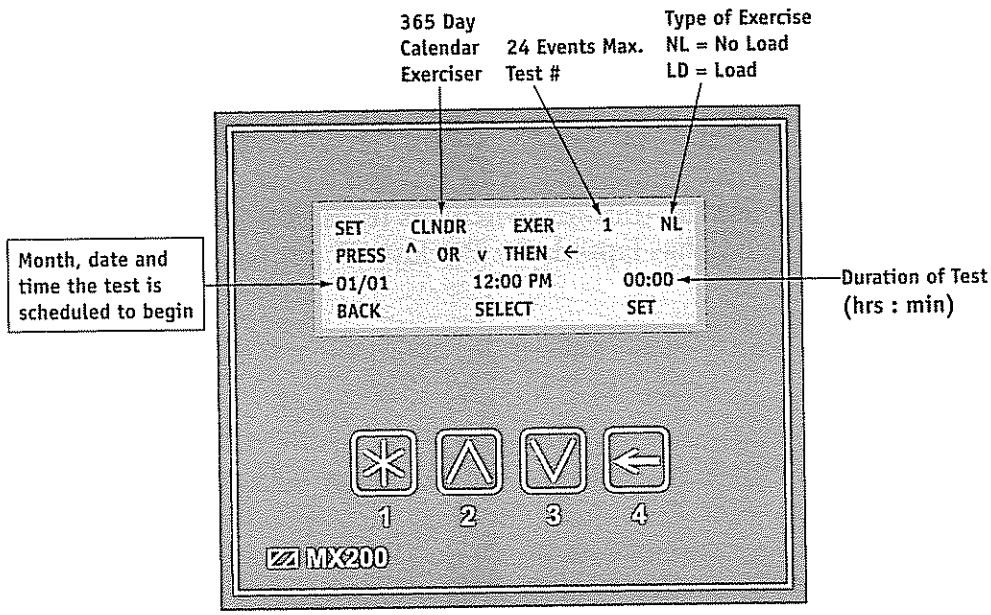
2 Week Exerciser



365 Day Calendar Exerciser



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Timers

P (Engine Start Timer)

adjust via SET menu *(see page 11)*

Factory default 3 seconds

- The purpose of this timer is to ensure that the transfer switch does not start the engine when the Normal power outage is very short.
- The P time range is 0 to 10 seconds in 1/10 of a second increments.
- Timer begins when the Normal fails to meet adjusted parameters.
- When the time setting has lapsed, P relay contacts will operate to start engine (DPDT).

W (Transfer to Emergency Timer)

adjust via SET menu *(see page 11)*

Factory default 1 second

- The purpose of this timer is to ensure the Generator is stable before transfer.
- The W time range is 0 to 5 minutes in 1 second increments.
- Timer begins once the Generator output satisfies adjusted parameters.
- When time setting has lapsed, transfer to Generator will be initiated.

T (Transfer to Normal Timer)

adjust via SET menu *(see page 11)*

Factory default 30 minutes

- The purpose of this timer is to verify that the Normal source has consistently met the sensor parameters for a minimum duration.
- The T time range is 0 to 60 minutes in 1 second increments.
- The T timer begins when Normal satisfies sensor parameters.
- When the timer setting has lapsed, retransfer back to Normal will be initiated. (Timer bypassed upon Emergency failure)

U (Engine Cool Down Timer)

adjust via SET menu *(see page 11)*

Factory default 5 minutes

- The purpose of this timer is to run the Generator unloaded prior to stop.
- The time range is 0 to 60 minutes in 1 second increments.
- The timer begins once the transfer switch has transferred to Normal.
- When the timer setting has lapsed, the P relay will operate to stop engine.

DT/DW (Open Delay Timers)

adjust via SET menu *(see page 11)*

Factory default 5 seconds

- Both DT and DW are center position timers for Delay style ATS Power Panels.
- The purpose of these timers is to control the center off position of delay power panels to allow the back EMF of the load to decay before re-energizing the load.
- These timers have a range of 0 to 10 minutes in increments of one second.
- DT controls how long the ATS stays open when transferring from Emergency to Normal.
- DW controls how long the ATS stays open when transferring from Normal to Emergency.

T3/W3, A6 and A62 (Pre-signal Timers)

adjust via SET menu *(see page 11)*
output connection *(see page 5-7)*

Factory default 20 seconds

* ■ Both T3 and W3 are pre-signal timers.
  - ■ The purpose of these timers is to provide an output prior to transfer.
  - ■ These outputs are provided to coordinate building systems preparedness for the impending interruption that will occur when transferring from one live source to another.
  - ■ These timers have a range of 0 to 60 seconds in increments of one second.
  - ■ Output is relay contacts (DPDT).
  - ■ T3 takes place prior to transfer to Normal and W3 takes place prior to transfer to Emergency.
  - ■ These timers are bypassed when transferring from a dead source (power outage).
  - ■ Outputs from these timers are commonly used in conjunction with elevators and UPS systems.

Example: A five second T3 timer setting will give a relay output of a 5 second duration, during the last 5 seconds prior to transferring to the Normal source. Once the ATS is in the Normal position, the T3 signal is terminated.

Note: The operation of T3 time is added to the T time (T+T3 = transfer delay to Normal). Both T and T3 are canceled if the generator fails during transfer delay. The operation of W3 time is added to the W time (W+W3 = transfer delay to Emergency). W3 is canceled during Normal power loss transfer to Emergency. W3 is only active during testing. W timer is always used when transferring to Emergency.

* ■ **A6** provides contact pre-signal in both directions and is normally closed.
  - ■ **A6** utilizes T3/W3 timers to provide pre-signal time setting. This option is configured without the dead source bypassing feature utilized on the standard T3/W3 operating scheme.

* ■ **A62** option utilizes independent external timers to sequence contact outputs after transfer. These contacts are normally closed contacts that open prior to transfer in both directions (pre-signal duration determined by T3/W3 setting) and re-close in sequence after the transfer is complete (determined by the external timers designated T61, T62, T63...).
  - ■ **A62** option is commonly used to shed multiple motor loads prior to transfer and sequentially add these loads after transfer is complete. This option is configured without the bypassing feature utilized on the standard T3/W3 operating scheme.

* optional

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Timer Designations

Timer Designations as they appear in the SET menu

ATS Type	P	W	W3 (A6)	DW	T	T3 (A6)	DT	U
Standard ATS	ENG. START DELAY	TO EMERGENCY	→	→	TO NORMAL	→	→	ENG. STOP DELAY
Standard ATS with pre-signal option; T3/W3, A6 or A62	ENG. START DELAY	TO PRESIGNAL	EMERGENCY PRESIGNAL	→	TO N-PRE	NORMAL PRESIGNAL	→	ENG. STOP DELAY
Delay ATS	ENG. START DELAY	TO OPEN N	→	TO EMERGENCY	TO OPEN E	→	TO NORMAL	ENG. STOP DELAY
Delay ATS with pre-signal option; T3/W3, A6 or A62	ENG. START DELAY	TO E-PRE	TO OPEN N	TO EMERGENCY	TO N-PRE	TO OPEN E	TO NORMAL	ENG. STOP DELAY
NORMAL FAILS →	TRANSFER TO EMERGENCY →			NORMAL RETURNS →	TRANSFER TO NORMAL →			ENGINE COOLDOWN →

* R50 (In Phase Monitor)

can be turned on or off via CNFG menu *(see page 12)*

Factory default off

- This feature restricts ***live source to live source transfers*** to occur only when sources are within 7 electrical degrees or less of each other (***Live source to live source transfers*** usually occur during transfer back to Normal or testing).
- R50 does not change the operation of the ATS in a power failure mode.
- R50 operation occurs after all timer functions have lapsed.
- Once the transfer timers have lapsed, the CHECKING FOR SOURCE SYNCHRONISM will be displayed.
- Transfer will then take place once the sources come into sync.
- In the event that the sources do not come within 7 electrical degrees of each other, within 60 seconds the unit will display the message: SYNCH CHECKING PRESS ← TO BYPASS.
- If ← is pressed at this point, the following will be displayed: WARNING PRESSING ← MAY CAUSE DAMAGE TO LOAD DUE TO OUT OF PHASE TRANSFER. Pressing ← again will then actually bypass the R50.
- Since this is a passive device the amount of time that it takes to sync is dependent on the frequency difference between the two sources.
- The Normal source is usually a utility and the frequency is not within the control of the consumer. The Emergency source needs to be adjusted to create an adequate difference in order for the transfer to happen in a timely fashion.

Note: **For optimum performance the generator should be adjusted maximum 2 Hertz above or below the utility frequency, minimum .1 Hertz different (58 to 59.9) or (60.1 to 62) Hertz** *(adjustment of generator to 60.0 hz will cause lengthy transfer delay).*

* R16 (Phase Sequencing/Rotation)

can be turned on or off via CNFG menu *(see page 12)*

Factory default on

This feature prevents ***live source to live source transfers*** from occurring between dissimilar phase sequences. This condition is primarily caused by an installation error. Connections from the Normal and Emergency need to be verified, compared and corrected to remedy the inconsistent phase rotation between the two sources.

WARNING: Turning off this option can cause severe damage to loads.

* optional

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Pick Up Voltage

Factory Default: 90%

This adjustment determines the minimum acceptable voltage required to transfer to Normal. Adjust via the SET menu. Range is 85 to 100% in 1% increments *(see page 11)*. Once satisfied, the T timer will begin timing to transfer to Normal.

Pick Up Frequency

Factory Default: 95%

This adjustment determines the minimum acceptable frequency required to transfer to Normal. Adjust via the SET menu. Range is 90 to 100% in 1% increments *(see page 11)*. Once satisfied, the T timer will begin timing to transfer to Normal.

Drop Out Voltage

Factory Default: 80%

This adjustment determines the low voltage threshold. Adjust via the SET menu. Range is 75 to 98% in 1% increments *(see page 11)*. Drop out must be a minimum of 2% below pickup setting. Once voltage falls below threshold, P timer begins timing to signal generator to start.

* *Over Voltage (R1)*

This feature, when on, provides a maximum voltage threshold at 110% of nominal system voltage. Turn on or off via CNFG menu *(see page 12)*. Once threshold is exceeded, P timer begins timing to signal generator to start.

* *Under Frequency (J1N)*

This feature, when on, provides a minimum frequency threshold at 2Hz below pick up frequency. Turn on or off via the CNFG menu *(see page 12)*. Once the frequency drops below this threshold for more than 5 seconds, the P timer will begin timing to signal the generator to start.

* *Over Frequency (J2N)*

This feature, when on, provides a maximum frequency threshold of 2 Hz above nominal frequency. Turn on or off via CNFG menu *(see page 12)*. Once frequency exceeds threshold, P timer begins timing to signal generator to start.

* optional

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Pick Up Voltage

Factory Default: 90%

This adjustment determines the minimum acceptable voltage. Adjust via the SET menu. Range is 85 to 100% in 1% increments *(see page 11)*. Once satisfied, the W timer will begin timing to transfer to Emergency.

Pick Up Frequency

Factory Default: 95%

This adjustment determines the minimum acceptable frequency. Adjust via the SET menu. Range is 90 to 100% in 1% increments *(see page 11)*. Once satisfied, the W timer will begin timing to transfer to Emergency.

Drop Out Voltage

Factory Default: 80%

This adjustment determines the low voltage threshold. Adjust via the SET menu. Range is 75 to 98% in 1% increments *(see page 11)*. Drop out must be a minimum of 2% below pickup setting. Once the voltage falls below this threshold, the T timer will be bypassed to expedite the transfer to Normal.

* *Over Voltage (R8)*

This feature, when on, provides a maximum voltage threshold at 110% of nominal voltage. Turn on or off via the CNFG menu *(see page 12)*. Once this threshold is exceeded, the T timer will be bypassed to expedite the transfer to Normal.

* *Over Frequency (J2E)*

This feature, when on, provides a maximum frequency threshold of 2Hz above of nominal frequency. Turn on or off via the CNFG menu *(see page 12)*. Once the frequency exceeds this threshold, the T timer will be bypassed to expedite the transfer to Normal.

Under Frequency

This feature provides a minimum frequency threshold at 2Hz below pick up frequency. Once the frequency drops below this threshold, if sustained for more than 5 seconds, the T timer will be bypassed to expedite the transfer to Normal.

* optional

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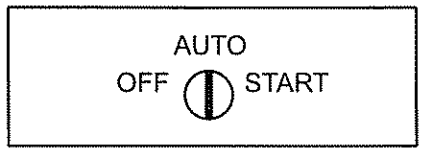
Optional Pilot Devices

Door Mounted Options

The S options are usually options related to a manually operated switch mounted on the door of the enclosure, which provides access to a feature or function.

S1



Selector Switch

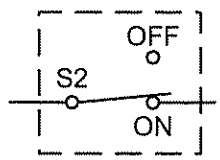
Provides start-stop control of the engine from the transfer switch panel.

AUTO Position provides Normal operation of the transfer switch and the engine.

OFF Position disconnects the transfer switch start contact from the engine. Then engine can only be started manually in this position.

START Position closes the circuit to the engine, causing it to start and run until the switch is moved from the start position.

S2



Engine Disconnect Switch

Interrupts the engine start circuit when in the "OFF" position.

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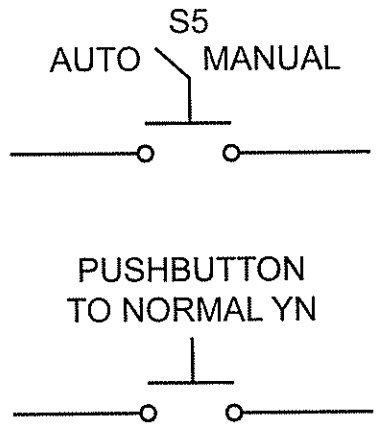
S5

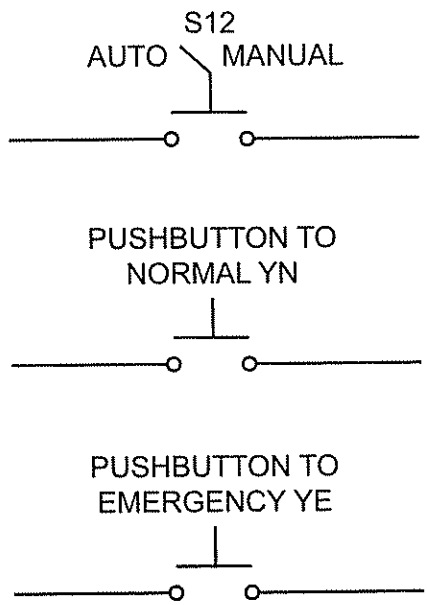


Auto/Manual Retransfer Selector Switch

In **AUTO**, retransfer to Normal is Automatic after T timer times out. T time delay is bypassed if Emergency fails.

In **MANUAL**, retransfer to Normal occurs upon manual depression of YN or if Emergency fails.

S12



Auto/Manual Selector Switch

When the S12 is in the AUTO position, the Automatic Transfer Switch functions automatically as specified with the switch drawing.

When the S12 Switch is in the MANUAL position, the Automatic Transfer Switch will transfer either direction only by depression of Normal (YN) or Emergency (YE) Pushbutton.

NOTE:	When in MANUAL, the switch maintains position, even if the selected power fails.

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S13 Transfer Commit

(this feature is standard)

can be turned on or off via CNFG menu *(see page 12)*

When the Transfer commit is set to the Y (Yes) position

- The ATS is committed to transfer to the Emergency position once the W timer has begun timing, even if Normal returns before the transfer to Emergency occurs.
- This is to ensure that the transfer takes place, because one outage is often followed by another.

When the transfer commit is set to N (No) position (factory default)

- The ATS is not committed to transfer unless the outage duration is longer than the timers that precede the transfer to the Emergency position.
- This assumes that the outage will be an isolated event.

S14 Test Switch, Three Position, Key Operated (Spring Return to Center)

Holding the Selector Switch in **TEST** will transfer the ATS to Emergency. Releasing the switch (to **AUTO** position) will return the ATS to Normal through the **T** timer function.

Holding the Selector Switch in **YN** Normal position will bypass the **T** timer and immediately transfer the ATS back to Normal. Releasing the Selector Switch allows the Selector Switch to return to **AUTO** position.

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⚠ NOTICE

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

Start generator and verify proper voltage, frequency and phase sequence (match to Normal). Shut down gen set and place in Auto. Complete the visual inspection of the transfer switch, and close the cabinet door.

Initiate the test by pressing the TEST button on the LCD keypad. The controller will then prompt for your access code (as shown on Figure 1). After entering the code, three test options will appear—STD LOAD, FAST LOAD and NO LOAD (See Figure 3).

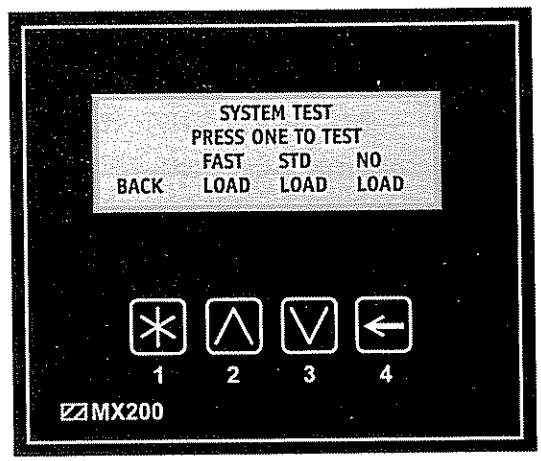

Figure 3

- **STD LOAD** test starts the generator and using the current timer settings, transfers the load to the Emergency source.
- **FAST LOAD** test presets timer values to a maximum 30 seconds during the test. After completion of the test, all timers are reset to their original values. (T3, W3, DT and DW remain)
- **NO LOAD** test starts the generator but does not transfer the load to the Emergency source. Press and hold the desired test option button until the switch transfers to the Emergency source (load test) or until the generator has been run for the desired amount of time (no load test). Releasing the test button before W timer timeout will abort the test (Exception: see transfer commit option, page 26).

When the test is initiated, the controller first starts the P timer. Upon completion of the P time delay, an engine start signal is sent. After Emergency has reached preset levels, the W timer begins its timing cycle. This timer is used to ensure the voltage and frequency of Emergency has stabilized before transfer. If either the voltage or frequency of Emergency fall below preset limits the test will be terminated, and the U timer will time out. If the voltage and frequency remain within preset limits for the duration of the W time delay, the transfer switch will close into the Emergency source.

Deactivating the test switch initiates retransfer to the Normal source. The switch will retransfer after the time delay of the T timer. This timer is used to ensure that the Normal source is stable before retransfer. Immediately after retransfer, the U timer begins its timing cycle. The U timer is the engine cool down timer which allows the engine generator to run unloaded.

NOTE: Only the P timer is used during the no load test.

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Troubleshooting

Before beginning any troubleshooting activity, refer to the information package supplied with the transfer switch and review the description and operation of all accessories supplied. Also refer to the Installation section of this manual.

Engine Does Not START

Annunciation	Possible Cause	Corrective Action
EMERGENCY AVAILABLE LED off	Engine start wires not terminated properly	Check Engine Start Connections
	Generator in "OFF" position	Investigate why Engine Control Switch was turned off

Engine Does Not STOP

Annunciation	Possible Cause	Corrective Action
LCD Display - "Delay to Engine Stop"	**U** timing cycle not complete	Check **U** Timer setting
NORMAL POSITION, and NORMAL and EMERGENCY AVAILABLE LEDs on, but U timer has timed out	Engine start wires not terminated correctly	Check Engine Start Connections
	Generator in "Manual"	Put generator in "Auto"

ATS Will Not Transfer To EMERGENCY

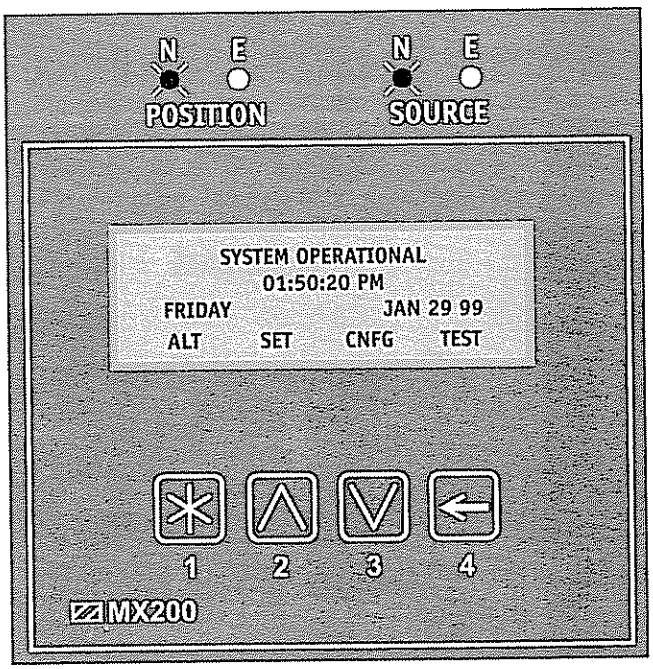
Annunciation	Possible Cause	Corrective Action
EMERGENCY AVAILABLE LED off	Emergency voltage or frequency not within acceptable parameters	Check Engine Start Connections, Generator Breaker, Generator output, and Engine Control Switch
None	Power supply connector unplugged	Plug in connector
LCD Display - "Mechanical Failure"	Limit switch or RT box connector unplugged	Plug in connector
LCD Display - "Delay to Emergency"	**W** timing cycle not complete	Check **W** Timer setting

ATS Will Not Transfer To NORMAL

Annunciation	Possible Cause	Corrective Action
NORMAL AVAILABLE LED off	Normal voltage or frequency not within acceptable parameters	Check utility and utility breakers
None	Power supply connector unplugged	Plug in connector
LCD Display - "Mechanical Failure"	Limit switch or RT box connector unplugged	Plug in connector
LCD Display - "Delay to Normal"	**T** timing cycle not complete	Check **T** Timer setting

Power Failure Sequence of Operation

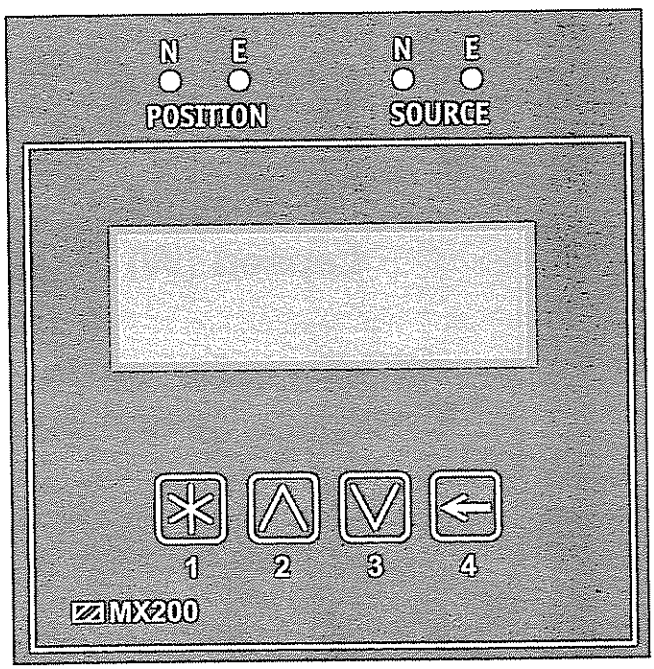
LEDs Green - Green



Normal Source Available

ATS Normal Position

LEDs OFF

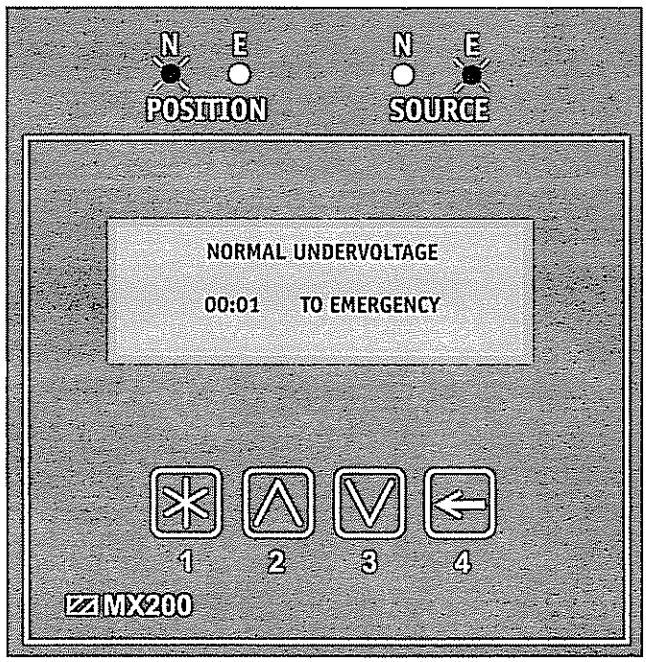


Normal Source Failed

Engine Starts After ENG START DELAY (P) (No Power Available)

Power Failure Sequence of Operation *(cont'd)*

LEDs Green - Red

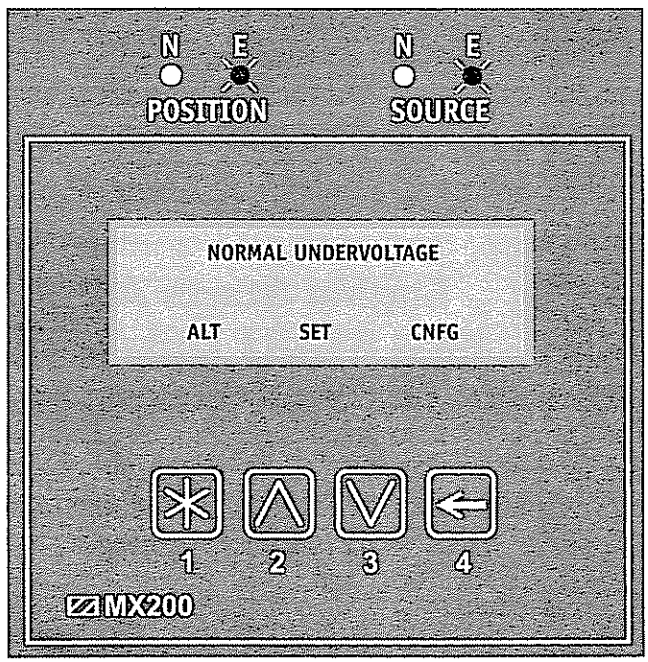


ENG START DELAY Lapsed

Emergency Source Available

Transfer TO EMERGENCY Timing (W)

LEDs Red - Red

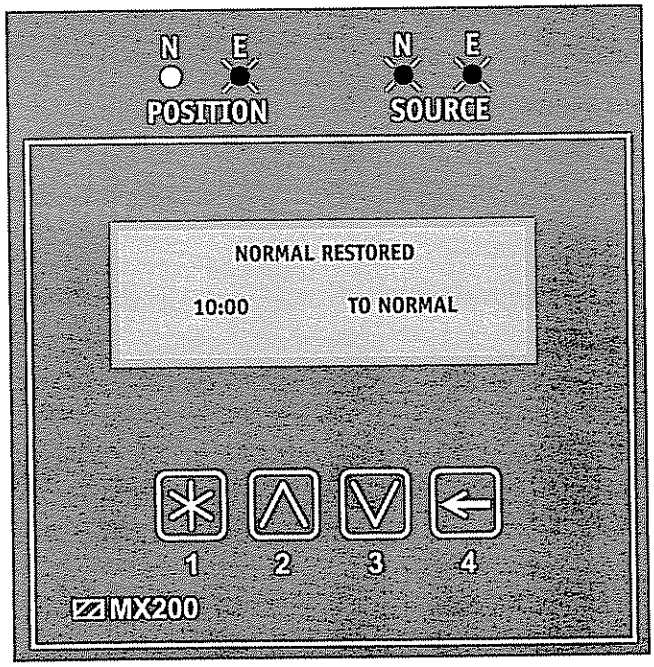


TO EMERGENCY Lapsed (W)

ATS Transferred to Emergency Position

Power Failure Sequence of Operation *(cont'd)*

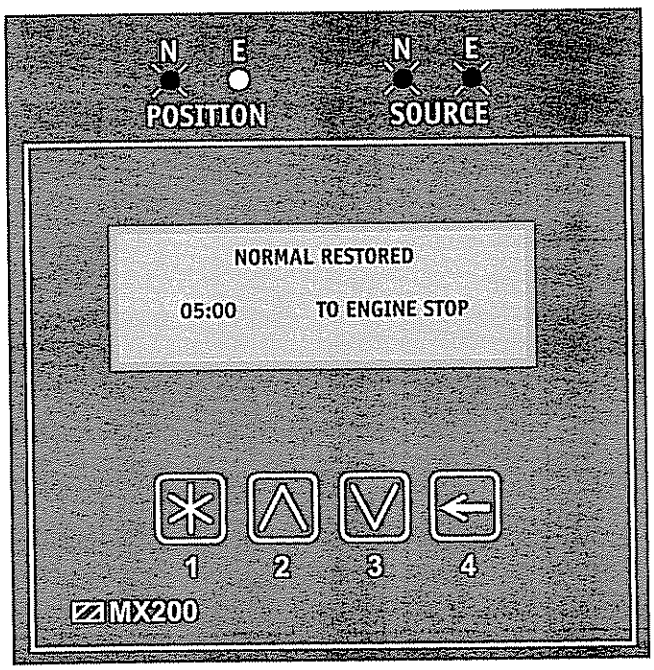
LEDs Red - Green - Red



Normal Source Returned

TO NORMAL Timing (T)

LEDs Green - Green - Red



Transfer TO NORMAL Lapsed (T)

ATS Transferred to Normal Position

Once ENGINE STOP is complete, return to Screen #1

Index of Terms

Term	Definition	Page
A1	Normal Availability output relay contact	4
A1E	Emergency Availability output relay contact	4
A3	Emergency position output contact	5
A4	Normal position output contact	5
A6	Pre-signal contact either direction	5
A62	A6 with sequential pick up after transfer	6
Access Code	Six numeric digit required for program changes	2 (figure 1)
ALT	Alternate Main Screen	13
ATS	Automatic Transfer Switch	
Aux. Panel	Auxiliary Control Panel	
Battery	Clock Battery K-4100	14
CNFG	Menu for configure parameters	12
D Type Switch	Transfer switch with an off position (3 position)	
DS	Disconnect Switch (located on Power Panel)	
DT	Delay Timer from open to Normal (D Type Switch)	18, 20
DW	Delay Timer from open to Emergency (D Type Switch)	18, 20
E	Emergency	
E-Contact	Engine Start output relay contact	3
Emergency	Alternate Power Plant / Engine Generator Set	
Exerciser Clock	Time clock for automatic generator test	15-17
Input	Voltage applied from a remote source	
J1N	Normal Under Frequency Sensor	22
J2E	Emergency Over Frequency Sensor	23
J2N	Normal Over Frequency Sensor	22
Keypad	User interface keys	10
LCD	Liquid Crystal Display	10
LED	Light Emitting Diode	10
MX200	Micro processor based controller	
N	Normal	
Normal	Utility power (preferred source)	
Output	Indication via dry contacts	3-7
P	Delay timer to Engine Start	18, 20
P2	Extended time range P	

Index of Terms

Term	Definition	Page
Pre-Signal	Signal prior to transfer	19, 20
Power Panel	Structure that transfers load between two sources of power	
Q2	Input for Remote Peak Shave/Test	8
Q3	Input to inhibit transfer to Emergency	8
Q7	Input to inhibit transfer to Normal	8
R1	Normal Over Voltage Sensor	22
R8	Emergency Over Voltage Sensor	23
R15 (load shed)	Input to transfer off Emergency to dead Normal	9
R15D (load shed)	Input to transfer off Emergency to open position (D Type Switch)	9
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S13	Transfer Commit	26
S14	Selector; Test-Auto-YN	26
S2	Selector; Engine (OFF-ON)	24
S5	Selector; Auto or Manual retransfer	25
SET	Menu for Setting parameters	11
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T3	Pre-signal to Normal transfer timer	19, 20
Test	Simulated utility power outage	
Test Switch	Simulates utility power outage	
U	Engine cool down timer	18, 20
UPS	Uninterruptable Power Source	
W	Delay timer to transfer to Emergency	18, 20
W3	Pre-signal to Emergency transfer timer	19, 20
YE	Push button to Emergency	25
YN	Push button to Normal	25
ZNET200	Network communication card	9
ZTS	Zenith Transfer Switch	

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GE Zenith Controls

Entelli-Switch 250
Microprocessor Controller
Transfer Switch Control Panel

71R-2000A
11/04

Operation and Maintenance Manual

Authorized Service

For GE parts and service, call: (773) 299-6600

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Introduction

GE Zenith Transfer Switches are used to provide a continuous source of power for lighting and other critical loads by automatically transferring from source 1 power to source 2 power in the event that source 1 voltage falls below preset limits.

Voltage sensing and system control is performed via a state-of-the-art microcontroller located on the cabinet door. It is designed to give highly accurate control of the transfer switch system.

All GE Zenith transfer switches are designed for use on emergency or standby systems, and are rated for total system or motor loads. Transfer switches are UL Listed under Standard 1008 and CSA Certified under Standard C22.2 No. 178 and IEC Listed under Standard 947.

NOTES: A protective device such as a molded case circuit breaker or fused disconnect switch MUST be installed on both sources of incoming power for circuit protection and as a disconnection device.

All references made within this manual about the term "S1" or "Source 1" relate to a Normal Power Source. All references made about the term "S2" or "Source 2" relate to an Emergency or Alternative Power Source.

Safety / Installation

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

The safe operation of your switch is GE Zenith's focus. The proper storage, installation, operation and maintenance will help increase the life of the switch.

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

Equipment Inspection and Storage

Once you have received the transfer switch, inspect it for any damage. This includes damage to the enclosure, power panel, control panel and wiring harness. If any damage is found or suspected, file a claim as soon as possible with the carrier and notify the nearest GE Zenith representative.

Before installation, if it is necessary, store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature	Operating Temperature (Ambient):	Humidity
-30°C to +75°C (-22°F to +167°F)	**40-400 AMP** *(molded shell)* -20°C to +65°C (-4°F to +149°F) **40-4000 AMP** *(all other frame and panel types)* -20°C to +60°C (-4°F to +140°F)	5% to 95% (non-condensing)

Table 1

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred, with a vacuum, due to shipment or installation.
2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections.
4. Verify the correct connection of all control wires.
5. Check settings of all timers and adjust as necessary.
6. Adjust any optional accessories as required.
7. Check the lug torque values of the power connections.

   NOTE: Lug torque values are specified in the power panel manual.

8. Make sure that all covers and barriers are installed and properly fastened.

   NOTE: Power panels ship from GE Zenith in Source 1 Position.

⚠ WARNING ⚠

Do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Each GE Zenith transfer switch is factory wired and tested. A complete information package is furnished with each switch which includes:

a. Sequence of operation.
b. Description and operation of all accessories supplied.
c. Power panel connection diagram and schematic.
d. Description and identification of all customer field connections.

Installation of GE Zenith transfer switches includes:

a. Mounting the transfer switch cabinet.
b. Connection of Source 1, Source 2, and Load cables or bus bars.
c. Connection of external control circuits as required.

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⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

E

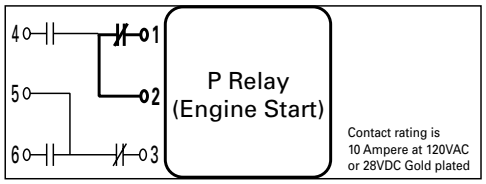


Figure 1

Engine Start Control Connections

The engine-start terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Figure 2 shows location of engine start connections for Bypass Isolation Transfer Switch. Figure 5 (pg.6) shows location of engine start connections for Automatic Transfer Switch.

Terminals for field connections to the A3 Source 2 auxiliary contacts and the A4 Source 1 auxiliary contacts are also provided. These terminals are clearly marked and appear on the side of the power panel. On 400 amp metal frame units these terminals appear on the bracket above the operator handle.

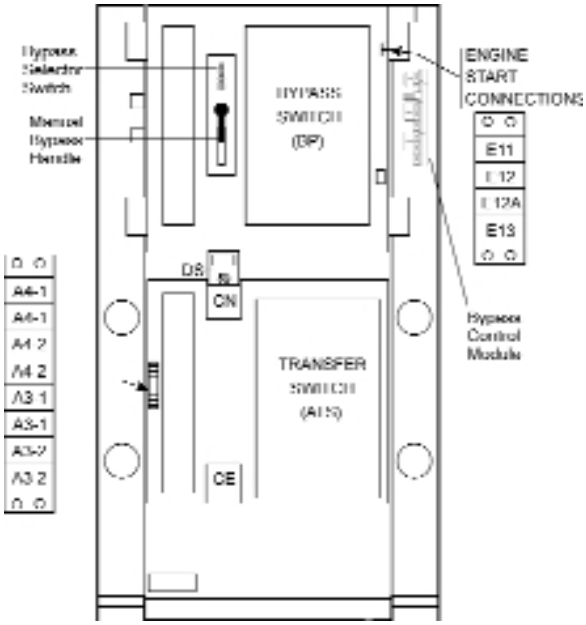


Figure 2 (Typical)

Initial Energization

Before proceeding, refer to the information package supplied with the ATS and read and understand the information on all accessories provided.

1. Unlock the enclosure.
2. Open the enclosure.
3. Verify the correct system voltage.

   NOTE: The equipment rating nameplate on the transfer switch lists the voltage. See *Figure 3*.

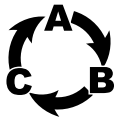
4. Close Source 1 circuit. breaker.

   NOTE:The controller will illuminate Source 1 Available LED if proper voltage is sensed.

5. Verify the phase to phase voltages at Source 1 line terminals.
6. Close Source 2 circuit breaker.
7. Start the generator's engine.

   NOTE: The controller will illuminate Source 2 Available LED when preset voltage and frequency levels are reached.

8. Verify the phase to phase voltages at Source 1 line terminals.
9. Verify that the phase rotation of Source 1 is the same as the phase rotation of Source 2.



10. Shut down the generator's engine.
11. Place the starting control in the Automatic position.
12. Complete the visual inspection of the transfer switch.
13. Close the enclosure.
14. Lock the enclosure.

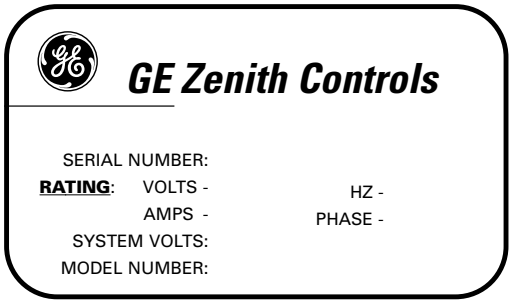


Figure 3

⚠ CAUTIONS ⚠

Certain accessories, per specific schematics, can inhibit automatic transfer.
Engine Gen-Set could start when engine control wires are attached.

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Initial Energization *(cont'd)*

After all options and accessories are checked and verified, follow these steps to set up the ATS. Refer to Entelli-Switch 250 display *Figure 4*. The annunciation LEDs illuminate to indicate (1) source availability, (2) ATS position, and (3) Entelli-Switch 250 control function (timing).

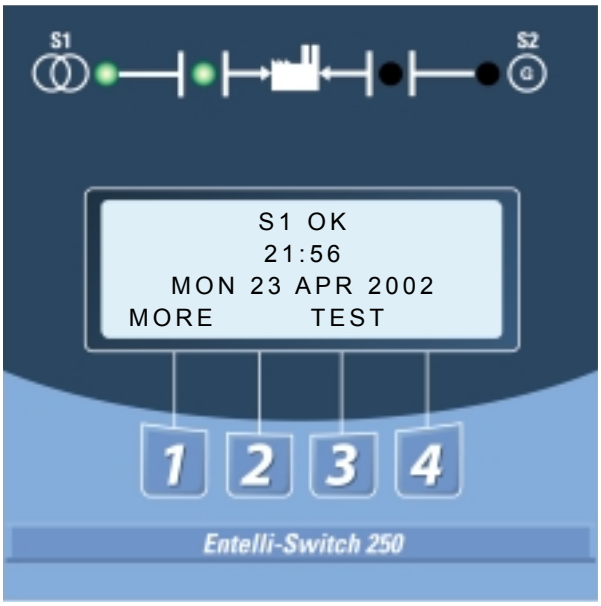


Figure 4 – LCD and keypad

1. Unlock the enclosure.
2. Open the enclosure.
3. Place the Disconnect Switch in the Inhibit.

   NOTE: This step is only performed if the "DS" Option was purchased.

4. Close the external (up-stream) Source 1 circuit breaker.

   NOTES: Source 1 Available and Source 1 Position LED's will illuminate.

   If Source 1 Available LED does not illuminate, verify that Source 1 Voltage is above the preset restore value.

   The Gen-Set will start and run while Source 2 stop Delay Timer is timing.

5. Close the External (up-stream) Source 2 line circuit breaker.
6. Start the engine generator in MANUAL mode.

   NOTE: When the voltage and frequency reach preset values, the Source 2 Available LED will illuminate.

7. Verify the phase to phase voltages at Source 2 line terminals.
8. Verify that the phase rotation of Source 2 is the same as the phase rotation of Source 1.

9. Shut down the generator's engine. (Place in Automatic Mode.)

   NOTE: Source 2 Available LED will turn off.

   NOTE: The engine generator will continue to run for the duration of Source 2 Stop Delay Timer.

10. Place the disconnect switch to ENABLE.
11. Complete the visual inspection of the transfer switch.
12. Close the enclosure.
13. Lock the enclosure.

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

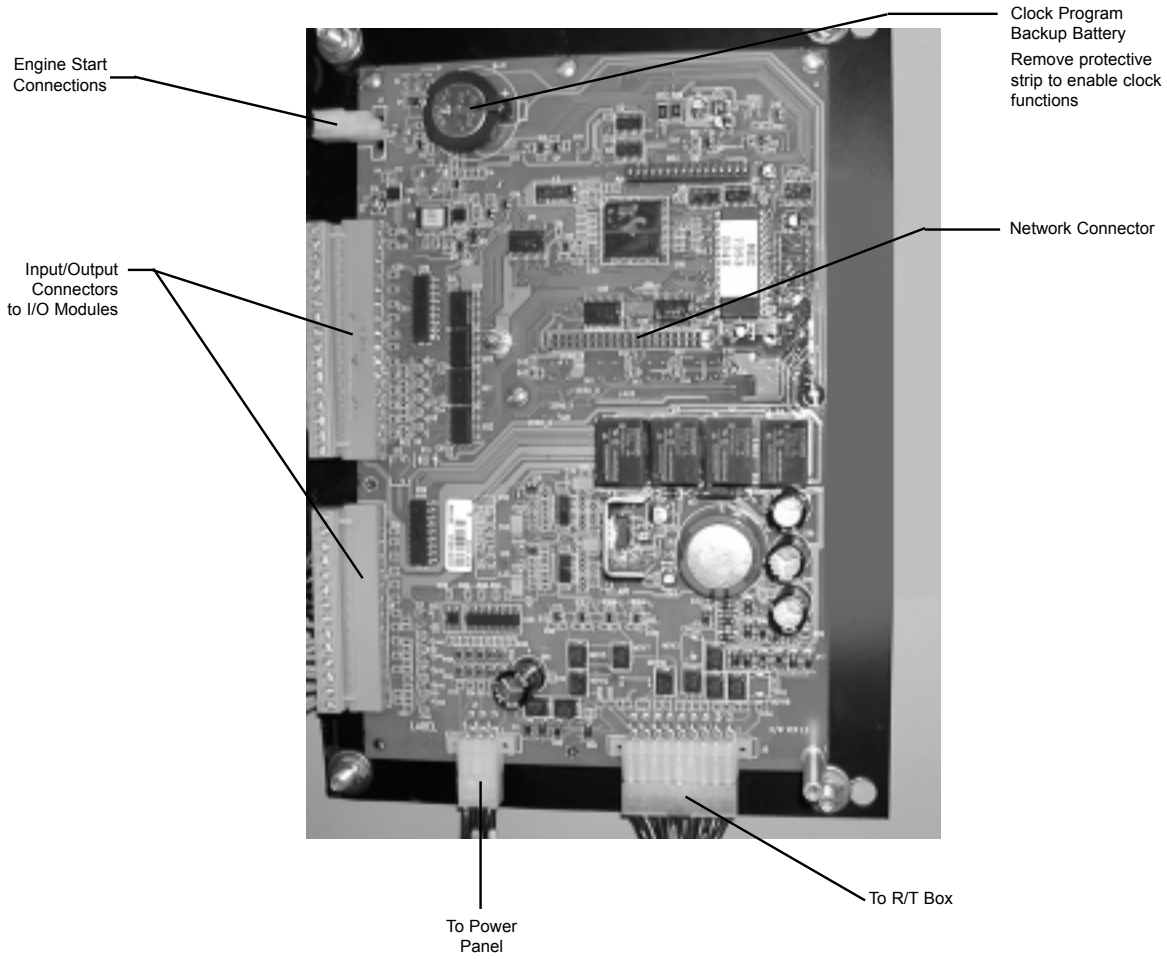
⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Control Connections

Figure 5



A complete information package is furnished with each transfer switch including a complete connection diagram and schematic which details all necessary control circuit field connections.

The engine start control wires connect to the engine start relay terminals located to the left of the microprocessor. Figure 5 shows the location of these terminals.

The terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

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Entelli-Switch 250 Controller

Consists of two major assemblies:

I. The **Microprocessor** contains the following:

A. Entelli-Switch 250 Board - Customer Input and Output (I/O) for system interface. Located on the left hand side of the back of the unit (see figure 6)

1. I/O accessories that can be found here are:
   a. Engine start relay P output
   b. Pre-Signal to transfer T3, W3 and UMD output (optional)
   c. Transfer Inhibit Q3 and Q7 input (optional)
   d. Remote test Q2 input (optional)
   e. Network interface ZNET input/output (optional)

B. LCD and Keypad located on the exterior of the door (see figure 7)

1. User accessibility to the following:
   a. LED indication of source availability
   b. LED indication of transfer switch position
   c. LCD screen indicates:
      (1) timer count down (numeric)
      (2) event reporting (text)
   d. Keypad provides user interface to: *[in conjunction with LCD screen]*
      (1) Setting sensors and timers
      (2) Configuring logic accessories

II. The **Controls Power Supply (CPS)**

Contains transformers which drop line voltage to control level for controller input and SCR inputs (see figure 6).

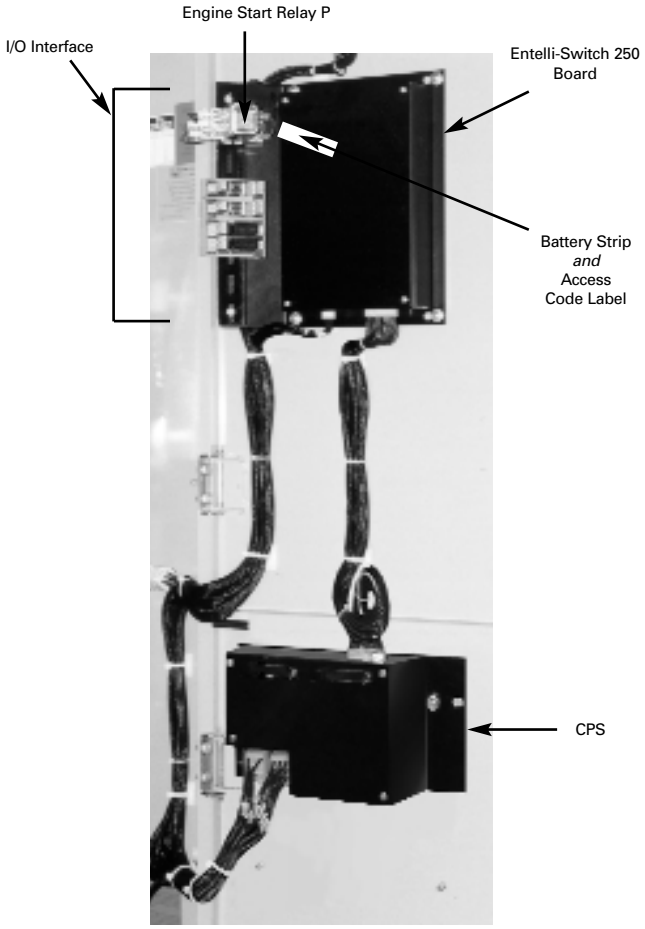

Figure 6

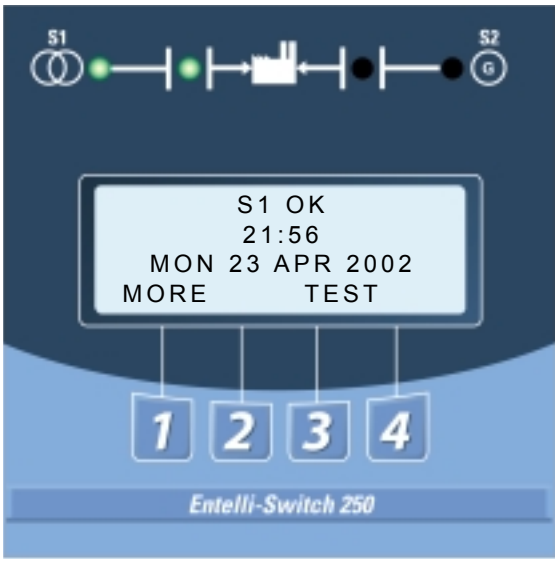

Figure 7

LCD & Keypad

These options are accessible through the LCD and keypad (see figure below). To become familiar with the options loaded into a particular unit, scrolling through the SET and CFG menu will show the descriptions of the options (see pages 17-18). These menus are the very same menus that are used to access the setting and/or configuration of these options. The SET (setting) menu is primarily used to show or change, time and voltage settings. The CFG menu is primarily used to turn an option on or off. When scrolling through these menus, no changes can be made without entry of the access code.

The factory set six-digit access code is located on a white label on the back of the unit (see figure 10 pgs. 17-19).

The Entelli-Switch 250 has many logic options. Each controller is downloaded with options at the time of manufacture. The collection of options that any one controller has is specified at the time of order placement. The following pages include all the options that can reside in the controller. Not all units include all options.

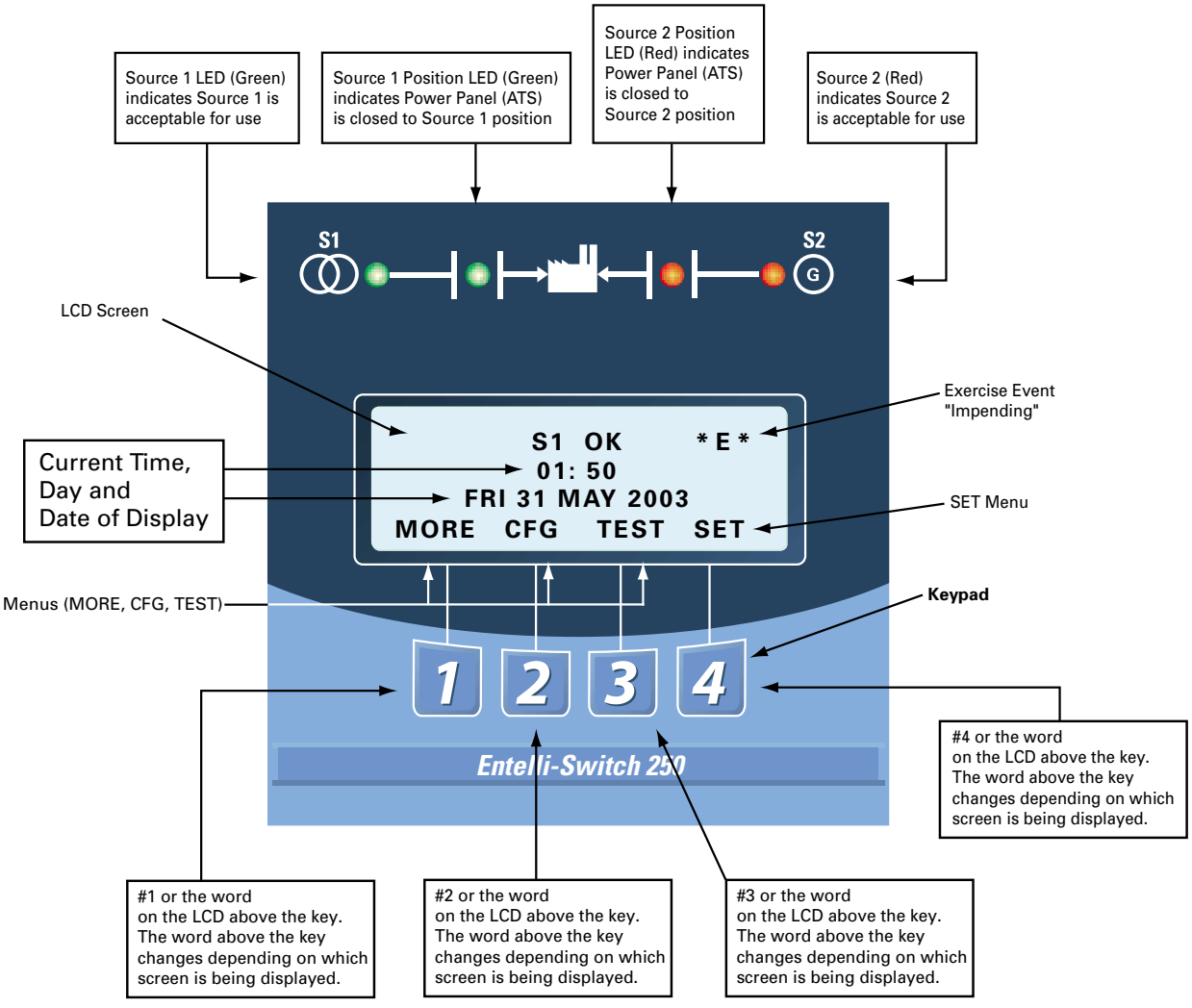

Figure 8

User Setting for Voltage & Frequency

Standard 3-Phase Sensing on 3 and 4 Pole Units

Source 1

Under Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 1.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 18).
Once satisfied, the T timer will begin timing to transfer to Source 1.

Under Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold. Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, P timer begins timing to signal Source 2 Generator to start.

Under Frequency "Restore"
Factory Default: 95%
This adjustment determines the minimum acceptable frequency required to transfer to Source 1.
Adjust via the SET menu. Range is 90% to 100% in 1% increments (see page 18).
Once satisfied, the T timer will begin timing to transfer to Source 1.

Under Frequency "Fail"
Factory Default: 90%, (5 seconds minimum).
This adjustment determines the low frequency threshold. Adjust via the SET menu. Range is 88% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once satisfied, the T timer will begin timing to transfer to Source 1.

Over Frequency "Restore"
Factory Default: 102%
This adjustment determines the minimum acceptable Over Frequency threshold at which the transfer switch is allowed to re-transfer to Source 1.
Adjust via the SET menu. Range is 102% to 104% in 1% increments (see page 18). “Restore” must be a minimum of 1% below “Fail” setting.

Over Frequency "Fail"
Factory Default: 105%
This adjustment determines the maximum acceptable Over Frequency.
Adjust via the SET menu. Range is 103% to 105% in 1% increments (see page 18).Once exceeded, the P timer begins timing to signal the generator to start.

Source 2

Under Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 2.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 18).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Under Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold. Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, T timer will be bypassed to expedite the transfer to Source 1.

Over Voltage "Fail"
Factory Default: 110%
This adjustment determines the maximum acceptable Over Voltage. Adjust via the SET menu. Range is 105% to 110% in 1% increments (see page 18). Once exceeded, the T timer will be bypassed to expedite the transfer to Source 1.

Over Voltage "Restore"
Factory Default: 105%
This adjustment determines the minimum acceptable Over Voltage threshold at which the transfer switch is allowed to transfer to Source 2. Adjust via the SET menu. Range is 103% to 105% in 1% increments (see page 18). “Restore” must be a minimum of 2% below “Fail” setting.

Under Frequency "Restore"
Factory Default: 95%
This adjustment determines the minimum acceptable frequency required to transfer to Source 2.
Adjust via the SET menu. Range is 90% to 100% in 1% increments (see page 18).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Under Frequency "Fail"
Factory Default: 90%, (5 seconds minimum).
This adjustment determines the low frequency threshold. Adjust via the SET menu. Range is 88% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once satisfied, the W timer will begin timing to transfer to Source 2.

Over Frequency "Fail"
Factory Default: 105%
This adjustment determines the maximum acceptable Over Frequency. Adjust via the SET menu. Range is 103% to 105% in 1% increments (see page 18). Once exceeded, the T timer will be bypassed to expedite the transfer to Source 1.

Over Frequency "Restore"
Factory Default: 102%
This adjustment determines the minimum acceptable Over Frequency threshold at which the transfer switch is allowed to re-transfer to Source 2. Adjust via the SET menu. Range is 102% to 104% in 1% increments (see page 18). “Restore” must be a minimum of 1% below “Fail” setting.

Accessory Group Packages

Table 2

Accessories	Group Packages					
	STDS	EXES	CONS	SENS	SPES	PSGS
6P	●	●	●	●	●	●
A1	○	●	●	●	●	●
A1E	○	●	●	●	●	●
A3	●	②❷	②❷	②❷	②❷	❸
A4	●	②❷	②❷	②❷	②❷	❸
Calibrate	●	●	●	●	●	●
CDT	●					
CDP		●	●	●	●	●
**DS	●	●	●	●	●	●
*DT	●	●	●	●	●	●
*DW	●	●	●	●	●	●
E	●	●	●	●	●	●
EL/P	●	●	●	●	●	●
K/P	●	●	●	●	●	●
L1	●	●	●	●	●	●
L2	●	●	●	●	●	●
L3	●	●	●	●	●	●
L4	●	●	●	●	●	●
*LN	●	●	●	●	●	●
P1	●	●	●	●	●	●
Q2	○	●	●	●	●	●
Q3	○	○	●	○	●	●
Q7	○	○	●	●	●	●
R1-1	○	○	○	●	●	●
R1-3	○	○	○	●	●	●
R15	○	○	○	○	○	●
*R15D	○	○	○	○	○	●
R16	○	●	●	●	●	●
R50	●	●	●	●	●	●
S5P	◪	◪	◪		●	
S12P	◪	◪	◪	●		●
S13P	●	●	●	●	●	●
T	●	●	●	●	●	●
T3/W3	②	②	②❷	②	②❷	②❷
U	●	●	●	●	●	●
UMD	②	②	②❷	②	②❷	②❷
VI	●	●	●	●	●	●
W	●	●	●	●	●	●
YEN	●	●	●	●	●	●

● Standard Accessory included in the group package.
○ Optional Accessory not included but can be added to group package.
◪ Optional Accessory. Can not be used with accessory having the same symbol.
— N/A
②❷ Denotes an Accessory with 2 circuits as a standard.
❸ Denotes an Accessory with 3 circuits as a standard.

* Delayed Transition Units Only.
** Optional for 40-400 Amp

Accessory Definitions

6P
Test Switch, Momentary

6A
Test Switch, Maintained Auto/Momentary Test

6AP
Test Switch, Maintained/Momentary utilizing keypad

6B
Test Switch, Maintained - Auto / Momentary - Test, Key Operated

6C
Test Switch, Maintained - Auto / Maintained - Test, Key Operated

A1
Auxiliary Contact, operates on Source 1 line failure.

A1E
Auxiliary Contact, operates on Source 2 line failure.

A3
Auxiliary Contact: Closed in emergency (Source 2) Additional Available (10 max.) and need to be specified.

A4
Auxiliary Contact: Closed in normal (Source 1) Additional Available (10 max.) and need to be specified.

A62
Sequential Universal Motor Load Disconnect Circuit. Normally closed auxiliary contacts for motor loads. Open 0-60 seconds prior to transfer, after transfer, or both in either direction then re-close in timed sequence after transfer.

AB3
Auxiliary Contact: Closed in bypass emergency (Source 2) (S.P.D.T.) (Standard up to 400 Amp) Additional Available (10 max.) and need to be specified.

AB4
Auxiliary Contact: Closed in bypass normal (Source 1) (S.P.D.T.) (Standard up to 400 Amp) Additional Available (10 max.) and need to be specified.

B9
Battery charger connections.

Calibrate
While monitoring the actual Phase to Phase voltage levels and Frequency with a calibrated test equipment, the Phase to Phase voltage sensing and Frequency can be adjusted accordingly. Calibration capabilities are available for Frequency and AB, BC, CA Phase to Phase voltage for both Sources. Adjust via SET menu (see page 18)

CDP
Clock Exerciser Load/ No Load: Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by end user for 1, 7, 14, 28, 365 day cycle. (See page 16)

CDT
Load or NO-Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1, 7, 14, or 28 days. Factory Default is 20minutes. When exerciser is impending, (*E*) appears in the upper right hand corner of LCD screen. See page 15 for instructions. Configured via CFG (see page 17). Set via SET menu (see page 18).

CTAP
Alarm Panel on transfer to Source 2 with Silence button.

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(40-400 Amps optional, 600-4000 Amps standard)

DT *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 1 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds Adjust via SET menu (see page 18)

DW *(Delayed Transition Only)*
Time Delay from Neutral Switch position to Source 2 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds.Adjust via SET menu (see page 18)

E
Engine Start Contact

EL/P
Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken

System Data: Total Life Transfers (N2P)
Days Powered Up
Total Transfers to S2
Total S1 Failures
Time S1 available in Hrs
Time S2 available in Hrs. (N1P)

F
Fan contact, operates when generator is running.

HT
Heater and Thermostat

K
Frequency Meter, Door mount.

K/P
Frequency Indication for S1 and S2

L
LNP Center-off position LCD-Indicator
Indicating LED lights:

- **L1** Indicates Switch in Source 2 position.
- **L2** Indicates Switch in Source 1 position.
- **L3** Indicates Source 1 available.
- **L4** Indicates Source 2 available.

Accessory Definitions *(cont'd)*

M1
Single Phase Amp Meter

M2
Three Phase Amp Meter

M80
3000 Digital Power Monitor

M82
5200 Digital Power Meter

M83A
EPM 5300 Digital Power Meter with Modbus Port

M83B
EPM 5350 Digital Power Meter with Ethernet Port

M84
7430 Digital Power Meter , Wye or Delta

M85A
EPM 9450 Digital Power Meter, Ethernet

M85B
EPM 9450 Digital Power Meter with Internal 56K Mod.

M86A
EPM 9650 Digital Power Meter, Wye or Delta, RS232 or RS485

M86B
EPM 9650 Digital Power Meter, Wye or Delta, RS232 or RS485

N1
Running Time Meter, Door mount

N2
Operation Counter, Door Mount

P1
Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting is 3 seconds.
Adjust via SET menu (see page 18)

P2
Time Delay S2 Start. Adjustable 1/6 to 300 seconds.

Q2
Remote Peak Shave or Area Protection Circuit. Energize Q2 to simulate Source 1 Line failure causing the Generator to start and transfer the load to Source 2. Should Emergency fail during this operation, Transfer Switch will retransfer back to Source 1.

Q3
Remote inhibit transfer to Source 2 circuit. Energize Q3 input to allow transfer to Source 2. To enable Q3 option, engage Q3 jumper.

Q7
Inhibit transfer to Source 1 circuit. Energize Q7 input to prevent transfer to Source 1.

R1-1/R1-3
Source 1 Over Voltage sensing for single and three phase systems.
Source 1 Over Voltage "Fail"
Factory Default: 110%
This adjustment determines the maximum acceptable over voltage. Adjust via the SET menu. Range is 105% to 110% in 1% increments (see page 18).
Once exceeded, the P timer begins timing to signal the Generator to start.

Source 1 Over Voltage "Restore"
Factory Default: 105%
This adjustment determines the minimum acceptable over Voltage threshold at which the Transfer Switch is allowed to automatically transfer to Source 1. Adjust via SET menu. Range is 103% to 108% in 1% increments. "Restore" must be a minimum of 2% below "Fail" setting (see page 18).

R15/R15D
Load Shed
Should Source 2 become overloaded, a signal can be given to switch to the dead or Mid position.

R16
Phase Rotation Sensing
Can be turned on or off via CFG menu (see page 17). Factory Default is on.
This feature prevents Line Source to Line Source transfers from occurring between dissimilar phase sequences. This condition is primarily caused by an installation error. Connections from Source 1 and Source 2 need be verified, compared, and corrected to remedy the inconsistent phase rotation between the sources.
WARNING: Turning off this feature can cause severe damage to loads.

R26
Interruptable Power Rate Provisions.
Allow transfer out of Source 1 position to Source 2 or dead Source 2. Alarm and Pre-Signal circuit included.

R50
In Phase Monitor this feature restricts **Live to Live Source Transfers** to occur unless both Sources are within 7 electrical degrees or less of each other. (live Source to live Source transfers usually occur during transfer back to Source 1 or during Testing). R50 does not change the operation of the Automatic Transfer Switch in a power failure mode. After all timer functions have elapsed, **the CHECKING FOR SOURCE SYNCHRONISM** will be displayed as well as the direction of transfer (S1-S2 for example denotes transfer from Source 1 to Source2). When synchronism is accomplished, transfer will take place.

Accessory Definitions *(cont'd)*

Notes: - If S2 Frequency is less than S1 Frequency, display will show a series of (- - - - -…..) symbols.
- If S2 Frequency is greater than S1 Frequency, display will show a series of (+++++…..) symbols.
- Each (-) or (+) symbol represents 10 electrical degrees out of phase. A maximum of 18 symbols (180 electrical degrees) can be monitored.
- The number of (-) or (+) symbols decrease as the two sources approach synchronism and increase as the two sources drift out of synchronism.
- If S1 and S2 Frequencies are identical, the display will show a series of alternating symbols (+-+-+…) which also indicate the approximate out of phase degrees

In the event that the Sources do not come within 7 electrical degrees of each other within 60 seconds, the unit will display the message: **SYNCH CHECKING** and will allow the user to **BYPASS**. If the **BYPASS** button is pressed, the unit will display the message: **WARNING MAY CAUSE DAMAGE TO THE LOAD**. Pressing **XFR** will actually bypass the R50. Since R50 is a passive device, the length of time it takes to reach Synchronism is dependent on the frequency difference between the two Sources. Source 1 is usually a Utility and the frequency is not within the control of the consumer. Source 2 needs to be adjusted to create an adequate difference in order for the transfer to happen a timely fashion.

Note: For optimum performance, Source 2 Generator should be adjusted a Maximum of 2 Hertz above or below the Utility frequency, minimum of 0.1 Hertz. (58 to 59.9) or (60.1 to 62) Hertz. Adjustment of Generator to 60Hertz could cause lengthy transfer delay.

R50 Feature can be turned ON or OFF via CFG Menu (see page 17). Factory Default if OFF.

S5P

Auto / Semi Manual selector
In "Auto" position, retransfer to Source 1 is automatic after the T timer has timed out. The T time delay is bypassed if Source 2 fails.
In "Manual", retransfer to Source 1 is upon depression of BYPASS DELAY button YEN or if Source 2 fails.

S12P

Auto / Manual Selector
In "Auto" position, the Automatic Transfer Switch functions automatically as specified with the Switch drawings.
In "Manual" the Automatic Transfer Switch will transfer to either direction upon depression of Source 1 or Source 2 transfer buttons.
Should Source 1 fail, the Generator (Source 2), will automatically start. Once transferred in Manual, the Switch maintains position selected even if selected power fails.

S13P

Transfer Commit. Configured via CFG menu. (see page 17) When this Feature is set to OFF: The transfer Switch is not committed to transfer unless the outage duration is longer than the timers that precede the transfer to Source 2 position. This assumes that the outage will be an isolated event. When this Feature is set to ON: The transfer Switch is committed to transfer to Source 2 position once the W timer has begun timing, even if Source 1 power returns before the transfer to Source 2. This is to ensure that the transfer takes place, because one outage may be followed by another.

S14

Test / Auto / Source 1 Selector, Door mount

SW1

Auto/Off/Start Engine control selector, Door mount (Keyed or non-keyed operation available)

SW2

Auto / Off Engine control selector, Door mount (Keyed or non-keyed operation available)

SW3

Source Priority Selector Switch, Door mount
Allows selection of Source 1 or Source 2 to be the Prime Source. Transfer Switch will transfer to selected Prime Source if that Source is available. (Keyed or non-keyed operation available)

T

Time Delay (S1) Source 1 Stable Timer. To delay transfer to Source 1 (immediate retransfer on Source 2 failure). Adjustable 0-60 minutes in 1 second increments. Standard setting is 30 minutes. Adjust via SET menu (see page 18)

T3/W3

Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer.

U

(S2) Source 2 Stop Delay Timer. Allows Engine to run unloaded after switch retransfer to Source 1. Adjustable 0-60 minutes in 1 second increments. Standard setting is 5 minutes. Adjust via SET menu (see page 18)

UMD

Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-60 seconds prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both.

Accessory Definitions *(cont'd)*

VI

Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between "Fail" and "Restore" settings.
Factory default: 10% "Fail", 8% "Restore", 30 Seconds.
See CFG Menu page 17 to configure ON or OFF.
See SET Menu page 18 to set Percentage and time windows

W

Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2. Adjustable 0-5 minutes in 1 second increments. Standard setting is 1 second. Adjust via SET menu (see page 18)

YEN

Bypass Timers Key utilizing Keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.

ZNET

Network Communications Interface Card

How to Set the System Clock

How to Set the System Clock

Set System Clock, time and date

- If the clock is not set, the display will show SET SYSTEM CLOCK on the second line of the S1 OK screen.
- The S1 OK screen will show time (hours and minutes) on the second line if the system clock has been set. (Date on third line)

Setting the System Clock

(Start from **S1 OK** screen)

1. Remove battery protective white plastic strip near **P** relay. *
2. Press **MORE** then press **SET**.
3. Press **MORE** and scroll to **SET SYSTEM CLOCK** using the **MORE** key.
4. Press **SEL**.
5. **ENTER ACCESS CODE** located on the white label on the back of the controller.
6. Press **SEL**.
7. Use the up and down keys to change the hour value.
8. Press **SAVE** (this will enter this value and move cursor to minutes).
9. Use the up and down keys to change the minutes.
10. Press **SAVE** (this will enter this value and move cursor to month).
11. Use the up and down key up to change the month.
12. Press **SAVE** (This will enter this value and complete the clock setting).
13. Use the up and down keys to change the date.
14. Press **SAVE** (this will enter this value and move cursor to year).
15. Use the up and down keys to change year.
16. Press **SAVE** (this will enter this value and compete the clock setting).
17. To edit settings, press **SEL** and repeat steps 6-16.
18. If the setting is satisfactory, press **MORE** (unit then returns to the **SET** menu then press **BACK**, then **ESC**.)

* Replacement battery part #K-4100
Battery will last 5 years and provides power to retain clock function only (Controller functions without battery).

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CDT One Event Timer Exerciser

Load / No-Load
One event Exerciser with adjustable Timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1,7,14, or 28 days. Factory default is 20 minutes.

How to CONFIGURE (CFG) and Set (SET) the Timer Exerciser

1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG TIMER EXERCISER** screen.
3. The third line of the **CONFG TIMER EXERCISER** will show either **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **OFF**.
4. If the third line of the **CONFG TIMER EXERCISER** shows **DAILY**, **WEEKLY**, **14 DAY**, or **28 DAY** as desired, then proceed to step 10.
5. If the third line of the **CONFG TIMER EXERCISER** shows **OFF** or if another timer selection is desired, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY**, **WEEKLY**, **14 DAY**, or 2**8 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** to scroll to **CONFG TIMER EXERCISER (XFR)** or **(NO XFR)**.
11. Press Up or Down to select **XFR** (Load Transfer) or **NO XFR** (No Load Transfer).
12. Press **SAVE**.
13. Press **MORE** repeatedly to **BACK** then **S1 OK** screen.

Set (SET) the Exerciser:

14. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
15. Press **MORE** repeatedly until **EXER S2 RUN TIME** screen.
16. Press **SEL**
17. Enter **ACCESS** code located on white label on the back of the controller.
18. Press **SEL**
19. Cursor is indicated as a line under character to be changed. Change values with up and down keys.
20. Press **SAVE** when complete.
21. Press **MORE** repeatedly until **SET USER SETUP** then press **BACK** then **ESC** to the **S1 OK** screen.

How to Initiate CDT Exerciser and to start an exercise cycle every 1, 7, 14, or 28 days
From S1 screen
1) Press **TEST**
2) Press **MORE**
3) Press **START TEST TIMER** (to initiate Test).

- If the CDT Exerciser is Factory configured for a Load Exerciser, the Controller will immediately start a load exercise. The controller will start the generator, transfer the load to Source 2 and remain in Source 2 for the duration set for **EXER S2 RUN TIME** in the **SET** menu. The controller will retransfer the load back to Source 1 after the S1 stable timer has timed out and run the generator unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).
- If the CDT Exerciser is Factory configured for a No-Load Exerciser, the Controller will immediately start a No-load exercise. The controller will start the generator and run it unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).

Exercise will be repeated at the same time as initiated on every 1, 7, 14, or 28 days according to the selection made in the Configure **CFG** menu.

How to Bypass (Cancel) an exercise during an exercise cycle
1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle
If the CDT Exerciser is Factory configured for a No-Load Exerciser Or allow the controller to complete retransfer to Source 1 If the CDT Exerciser is Factory configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged
1) Press Test
2) Press **MORE**
3) Press **BYPASS EXER**
To re-institute the next exercise event back, press **CANCL BPASS**

How to initiate a new exercise start time
1) Press **TEST**
2) Press **MORE**
3) Press **EXER CANCL**
4) Press **START TIMER TEST**

How to check the next exercise event
1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS**, **HOURS**, and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:
- ***E*** appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= CDT (Exerciser) timing period +T (S1 stable Timer) timing period.

CDP Clock Exerciser

Load / No-Load Clock Exerciser
Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by the end user for 1, 7, 14, 28, or 365 day cycles.

- A total of 7 independent No Load exercise periods (up to 10 hours each) can be programmed for each of the daily, weekly, 14-day, and 28-day exercisers.
- A total of 12 independent No Load exercise periods (up to 10 hours) can be programmed for the 365-day Exerciser.

How to Configure (CFG) the Exerciser
1. Beginning from the **S1 OK** screen, press **MORE** then **CFG**.
2. Press **MORE** to scroll to **CONFIG CLOCK EXERCISER** screen.
3. The third line of the **CONFG CLOCK EXERCISER** will show either **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, **365 DAY** or **OFF**.
4. If the third line of the **CONFG CLOCK EXERCISER** shows **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **365 DAY** as desired, press **MORE** repeatedly to **BACK**. Press **ESC** then proceed to the **SET** menu to set the **EXERCISER**.
5. If the third line of the **CONFG CLOCK EXERCISER** shows **OFF**, continue.
6. Press **SEL**.
7. Enter **ACCESS** code located on white label on the back of the controller.
8. Press **UP** or **DOWN** to select **DAILY**, **WEEKLY**, **14 DAY**, **28 DAY**, or **365 DAY** as desired.
9. Press **SAVE**.
10. Press **MORE** repeatedly to **BACK** then **ESC** to **S1 OK** screen.

How to set (SET) the DAILY Exerciser
1. Beginning from the **S1 OK** screen, press **MORE** then **SET**.
2. Press **MORE** repeatedly until **SET EXERCISER** screen.
3. Press **SEL**.
4. Enter **ACCESS** code located on white label on the back of the controller.
5. Press **SEL**
6. Cursor is indicated as a line under character to be changed. Change values with up and down keys. Press **SAVE** after each entry to save value and to move to the next value to be changed.
7. Press **BACK** when complete.
8. Press **MORE** repeatedly until **SET USER SETUP**. Press **BACK** then **ESC** to the **S1 OK** screen.

How to Bypass (Cancel) an exercise during an exercise cycle
1) Press **BPASS**
2) Allow the controller to complete the Engine cool down cycle.

If the CD Exerciser is configured or Set for a No-Load Exercise. Or allow the controller to complete retransfer to Source 1. If the CD Exerciser is configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged
1) Press **TEST**
2) Press **MORE**
3) Press **BYPASS EXER**

To re-institute the next exercise event back, press **CANCL BPASS**

How to check the next exercise event
1) From **S1 OK** screen, press **MORE** three times.
2) The unit will display the **PLANT EXERCISER NEXT** event in **DAYS**, **HOURS**, and **MINUTES**
3) Press **ESC** to **S1 OK** Screen.

Notes:
- In the **S1 OK** screen, an (***E***) appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position)= **CDT** (Exerciser) timing period +T (S1 Stable Timer) timing period.
- A value greater than zero must be entered in the Exerciser duration field to be accepted as a valid exercise period.
- The Exercise cycle will be repeated on a regular basis as programmed and initiated in the **SET** menu depending on what Exerciser was configured (selected) in the **CFG** menu.

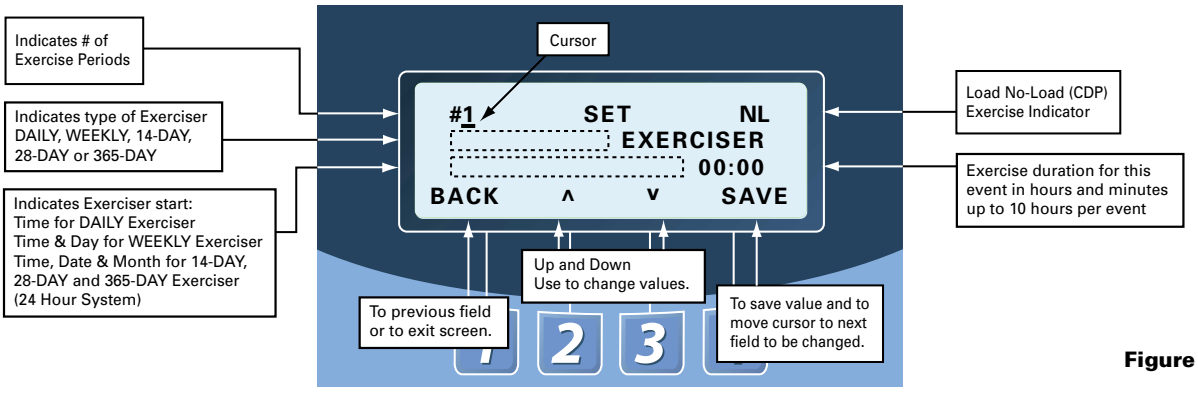
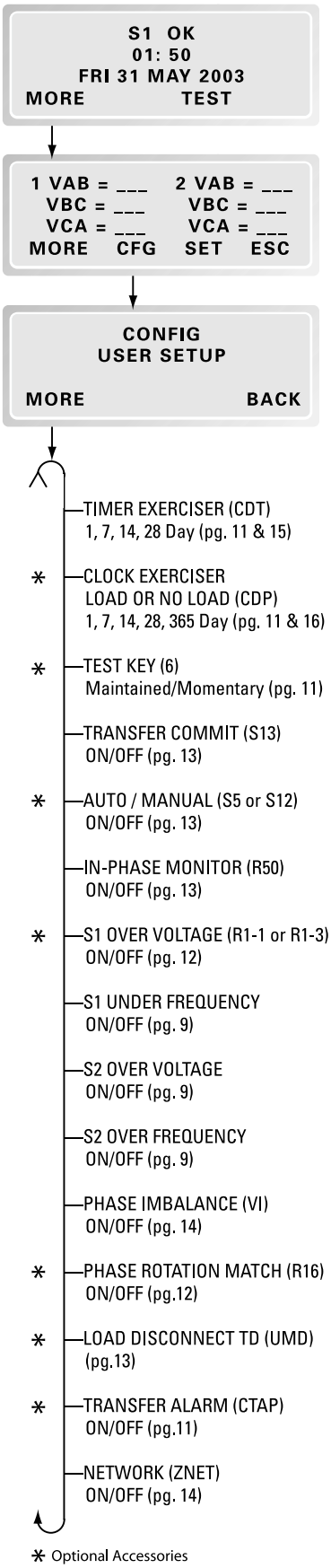


Figure 9

Entelli-Switch 250 User Setup - CFG Menu



Turn options ON or OFF via keypad through the CFG menu

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

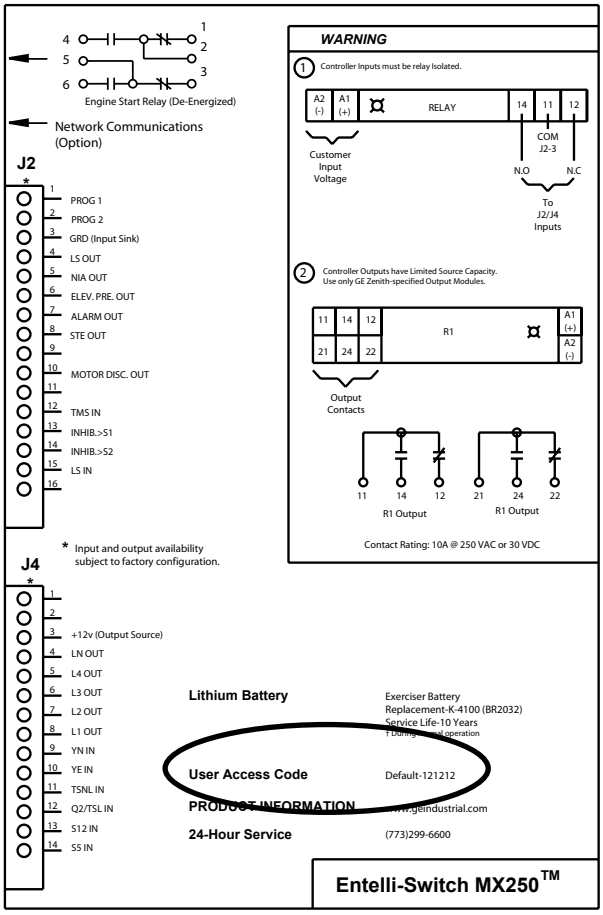


Figure 10

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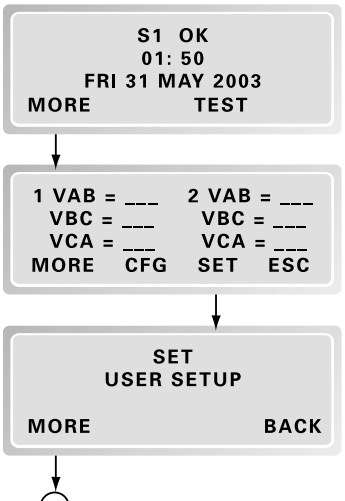
Entelli-Switch 250 User Setup - SET Menu



- SET SYSTEM CLOCK (pg.14)
- DAYLIGHT SAVINGS ON/OFF
- * CLOCK EXERCISER (CDP) (pg.11 & 16)
- EXER S2 RUNTIME (CDT) (pg.11 & 15)
- S1 UNDER VOLTAGE (pg.9) Fail Restore
- S1 UNDER FREQUENCY (pg.9) Fail Restore
- * S1 OVER VOLTAGE (pg.12) Fail Restore
- S1 OVER FREQUENCY (pg.9) Fail Restore
- S2 UNDER VOLTAGE (pg.9) Fail Restore
- S2 UNDER FREQUENCY (pg.9) Fail Restore
- S2 OVER VOLTAGE (pg.9) Fail Restore
- S2 OVER FREQUENCY (pg.9) Fail Restore
- SET % PHASE IMBALANCE (VI) FAIL 5%, RESTORE 3% (pg.14)
- SET PHASE IMBALANCE (VI) TIME DELAY 30 seconds (pg.14)
- TIME DELAY S2 START (P1) (pg.12)
- TIME DELAY S2 STABLE (W) (pg.14)
- * LOAD PRESIGNAL TD (T3/W3) (pg.13)
- * LOAD DISCONNECT TD (UMD) (pg.13)
- * ATS OPEN TIME TO S2 (DW) DELAY units only (pg.11)
- TIME DELAY S1 STABLE (T) (pg.13)
- * ATS OPEN TIME TO S1 (DT) DELAY units only (pg.11)
- S2 STOP DELAY (U) (pg.13)
- CALIBRATE S1 (pg.11)
- CALIBRATE S2 (pg.11)

* Optional Accessories

Change adjustable values through the SET menu.

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

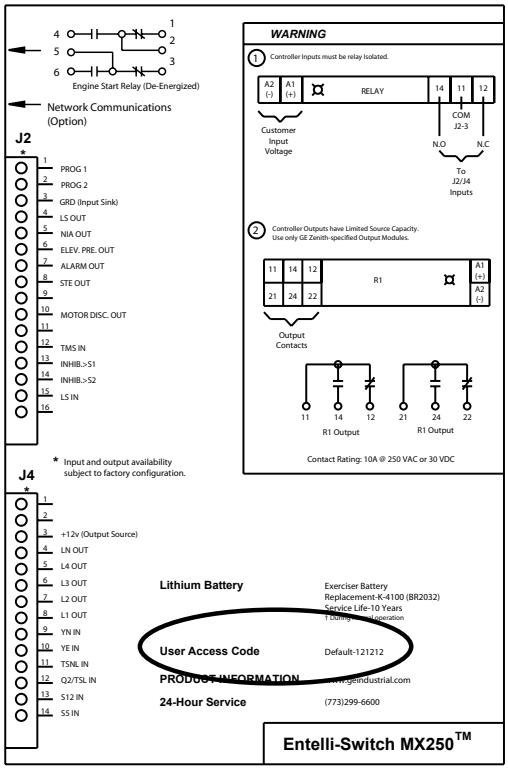


Figure 10

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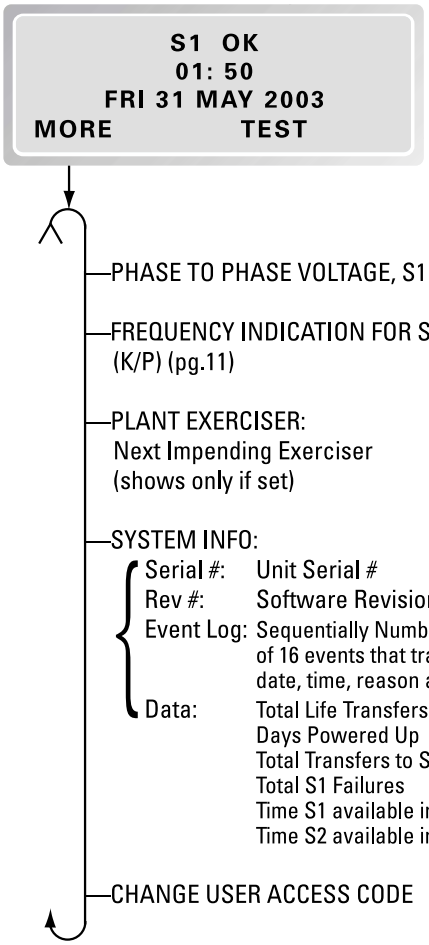

View System Data

Enter six digit access code
(The factory assigned six-digit access code
is located on the back of the controller)

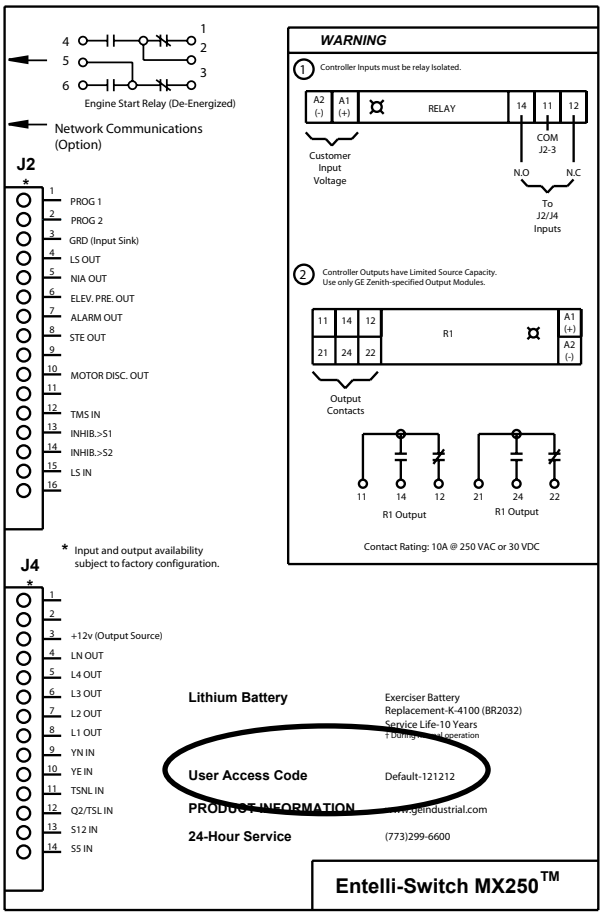

Figure 10

Testing

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

⚠ WARNING ⚠

Both power sources must be disconnected before manual operation of the switch.

Introduction

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. **Both power sources must be disconnected before manual operation of the switch.** Insert the handle and operate the transfer switch between the Source 1 and Source 2 positions. The transfer switch should operate smoothly without binding. Return the switch to the Source 1 position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the test switch. P timer will time out and the microcontroller will send an engine start signal. When the W time has elapsed, the switch will complete its transfer by closing into the Source 2.

Deactivating the test switch will start retransfer to Source 1. The switch will complete its retransfer to Source 1 after the time delay of the T timer. The U engine overrun timer allows the engine generator to run unloaded for a preset cool down period.

Test Options

The ATS can be tested in either of two positions:

1) **"Auto Position"**
   Full Transfer Test - This test checks the complete operation of the ATS by transferring the load's power source from Source 1 to Source 2.
2) **"Test Position"**
   This procedure is recommended for Preventive Maintenance (PM) of ATS without interrupting the Load thru the BYPASS/ISOLATION SWITCH.

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

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⚠ NOTICE ⚠

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701)

ATS Testing

Start generator and verify proper voltage, frequency and phase sequence (match to Source 1). Shut down gen set and place in Auto. Complete the visual inspection of the transfer switch, and close the cabinet door.

Initiate the test by pressing the TEST button on the LCD keypad. The controller will then prompt for your access code. After entering the code, three test options will appear—XFR LOAD, FAST TEST and NO XFR (See Figure 11).

- **XFR LOAD** test starts the generator and using the current timer settings, transfers the load to Source 2.
- **FAST TEST** test presets timer values to a maximum 30 seconds during the test. After completion of the test, all timers are reset to their original values. (T3, W3, DT and DW remain)
- **NO XFR** test starts the generator but does not transfer the load to the Source 2.

Press and hold the desired test option button until the switch transfers to Source 2 (load test) or until the generator has been run for the desired amount of time (no load test). Releasing the test button before W timer timeout will abort the test (Exception: when the transfer commit option, is configured "ON").

To test lamps, press TEST then scroll through MORE, then press LAMP TEST. To cancel LAMP TEST press MORE.

Standard Transition

When the test is initiated, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the MX controller initiates a transfer signal through the SCR-E to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1 sequence. The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the MX controller initiates a transfer signal through the SCR-N to operate the main transfer operator. The load is now transferred to Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

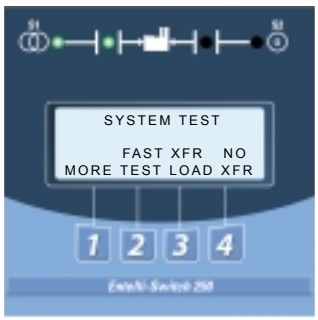

Figure 11

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:

When the test is initiated, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the MX controller initiates a transfer signal through the SCR-NO to operate the main transfer operator. The load is now transferred to the Open position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the MX controller initiates a transfer signal through the SCR-E to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1 sequence.The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the MX controller initiates a transfer signal through the SCR-EO to operate the main transfer operator. The load is now transferred to the Open position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the MX contoller initiates a transfer signal through the SCR-N to operate the main transfer operator. The load is now transferred to Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

⚠ NOTICE ⚠

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701)

Closed Transition

GE Zenith Closed Transition Transfer Switches are designed to Transfer the Load between two available sources with out interrupting power to the Load (Make-Before-Break). Paralleling of the two sources occurs within a predefined window of synchronization and lasts less than 100 milliseconds. The initial Source is then disconnected.

Initiating a Closed Transition
When a Test is initiated, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle. After the (W) time delay, the ATS closes into Source 2 only after the controller ensures the proper phase relationship between the two Sources. After the ATS closes into Source 2, the SE limit switch becomes activated. The controller initiates a transfer signal through the SCR-NO which opens the ATS out of Source 1. The SNO limit switch activates. The ATS has now closed back into Source 2 position without interrupting the load.

Re-Transfer with Closed Transition
Deactivating the Test Switch initiates the re-transfer. When Source 1 voltage and frequency reach the preset "Restore" values, the time delay to open Source 2 timer (T) begins its timing cycle. After the (T) time delay, the ATS closes into Source 1 only after the controller ensures the proper phase relationship between the two Sources. After the ATS closes into Source1, the SN limit switch becomes activated. The controller initiates a transfer signal through the SCR-EO which opens the ATS out of Source 2. The SEO limit switch activates. The ATS has now closed back into Source 1 position without interrupting the load.

The ATS defaults to an open transition transfer when Source 1 fails. Closed transition transfer is not possible with only one source available. If the optional Transition Mode Selector (TMS) is available, one can select an Open Transition Transfer or a Closed Transition Transfer when both Sources are available..

If while in Closed Transition Mode, the ATS fails to open the source it is attempting to "transfer out of" within 100 milliseconds, an Alarm will sound and the source that the ATS just closed into will be opened leaving the ATS in its initial source while disabling all other transfer operations until the problem is corrected and the "Fail to Open Lockout Reset" has been pressed.

A signal will be provided (STE) to Shunt Trip the Generator Circuit Breaker if the Transfer Switch remains closed into both Sources for more than 325 milliseconds. The load will then be fed by the Source 1. The maximum time that the two Sources would be parallel, under these conditions, is less than 500 milliseconds. Before operating the Closed Transition Transfer Switch, the condition must be corrected and the Shunt Trip reset. Refer to procedure for servicing the Switch after Shunt Tripping occures.

The unit is Factory set to accomplish transfer within 5 electrical degrees.
Requires an Isochronous Governor with an operating frequency of 60+/- 0.2 Hz.
Requires a Shunt Trip Breaker on the Generator set with a response time not exceeding 50 milliseconds.

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⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Emergency Service Procedure for Extended Parallel Time

ZTSCT Transfer Switch

If Source 2 breaker shunt trip was triggered after an extended parallel time (malfunction) occurred. Follow these steps to open the transfer switch.

1) Disconnect all power sources from the transfer switch by opening all line breakers (Source 1 and Source 2).
2) Open the cabinet door and turn the disconnect switch to the INHIBIT position.
3) Remove the service access cover on the left hand side of the transfer switch.
4) The manual operator and the manual handle will now be exposed. Insert the handle into the Source 2 side operator. Open the Source 2 side contacts.
5) Close the cabinet door.
6) Energize Source 1 to supply the load until further repairs can be done.

ZBTSCT Transfer/Bypass Switch

a. Auto Location:

Removal of closed transition transfer switch after Source 2 breaker shunt trip.

1) Disconnect all power sources from bypass-isolation transfer switch.
2) Open the bottom cabinet door and turn the Disconnect Switch (DS) to the INHIBIT position.
3) Remove the service access cover on the left hand side of the transfer switch.
4) The manual operator and the manual handle will now be exposed. Insert the handle into the Source 2 side manual operator. Open the Source 2 side contacts.
5) Close bottom cabinet door.
6) Energize Source 1 power.
7) Close the bypass contacts (BN).*
8) Isolate the transfer switch.*
9) Remove the transfer switch from the bypass-isolation transfer switch as indicated on the bypass instruction label to inspect and repair.
10) Re-install the transfer switch after maintenance with contacts closed to the same source as the bypass switch. Reinstall the manual handle in its holder and the service access cover on the left side of the transfer switch.
11) Re-connect the transfer switch to AUTO.*

b. Auto Location:

Removal of the closed transition transfer switch if Source 1 and Source 2 contacts remain open.

1) Close the bypass switch into the available source.*
2) Turn the DS to INHIBIT. Remove the transfer switch service access cover. Close the transfer switch into the same source as the bypass switch. (Incorrect sequencing is prevented by the interlocks while the transfer switch is in AUTO only.)
3) Remove the transfer switch from the bypass-isolation transfer switch to inspect and repair.*

c. Test Location:

Removal of the closed transition transfer switch if both Source 1 and Source 2 contacts remain open.

1) Close the bypass switch contacts (BN) as indicated on the bypass instruction label on the cabinet door.
2) Disconnect all power sources from bypass-isolation closed transition transfer switch.
3) Open bottom cabinet door. Turn the Disconnect Switch (DS) to the INHIBIT position.
4) Remove the service access cover on the left side of the transfer switch.
5) The manual operator and the manual handle will not be exposed. Insert the handle into the Source 1 side and close the Source 1 contacts.
6) Close the bottom cabinet door.
7) Energize Source 1 power.
8) Remove the automatic transfer switch from the bypass-isolation transfer switch.*
9) Re-install the transfer switch after maintenance with contacts closed to the same source as the bypass switch. Reinstall the manual handle in its holder and the service access cover on the left side of the transfer switch.
10) Re-connect the transfer switch to AUTO.*

* As described in the Sequence of Operation section located in the ZTSCT/ZBTSCT Series Manual (71R-5000)

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Sequence of Operation

Standard Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the MX controller initiates a transfer signal through the SCR-E to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1 sequence.The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the MX controller initiates a transfer signal through the SCR-N to operate the main transfer operator. The load is now transferred to Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:
When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the MX controller initiates a transfer signal through the SCR-NO to operate the main transfer operator. The load is now transferred to the Open position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the MX controller initiates a transfer signal through the SCR-E to operate the main transfer operator. The load is now transferred to Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

Restoration of Source 1 Power:
When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1 sequence. The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the MX controller initiates a transfer signal through the SCR-EO to operate the main transfer operator. The load is now transferred to the Open position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the MX controller initiates a transfer signal through the SCR-N to operate the main transfer operator. The load is now transferred to Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Table 3

Timer Designations as they appear in the SET menu

ATS Type	P	W	DW	T	DT	U
Standard Transition	Time Delay S2 Start	Time Delay S2 Stable	→	Time Delay S1 Stable	→	S2 Stop Delay
Delay/ Open Transition	Time Delay S2 Start	Time Delay S2 Stable	ATS Open Time to S2	Time Delay S1 Stable	ATS Open Time to S1	S2 Stop Delay
Source 1 Fails	Transfer to Source 2 →			Source 1 Returns ↓	Transfer to Source 1 →	Engine Cooldown

Closed Transition

GE Zenith Closed Transition Transfer Switches are designed to Transfer the Load between two available sources with out interrupting power to the Load (Make-Before-Break). Paralleling of the two sources occurs within a predefined window of synchronization and lasts less than 100 milliseconds. The initial Source is then disconnected.

Initiating a Closed Transition
When a Test is initiated, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle. After the (W) time delay, the ATS closes into Source 2 only after the controller ensures the proper phase relationship between the two Sources. After the ATS closes into Source 2, the SE limit switch becomes activated. The controller initiates a transfer signal through the SCR-NO which opens the ATS out of Source 1. The SNO limit switch activates. The ATS has now closed into Source 2 position without interrupting the load.

Re-Transfer with Closed Transition
Deactivating the Test Switch initiates the re-transfer. When Source 1 voltage and frequency reach the preset "Restore" values, the time delay to open Source 2 timer (T) begins its timing cycle. After the (T) time delay, the ATS closes into Source 1 only after the controller ensures the proper phase relationship between the two Sources. After the ATS closes into Source1, the SN limit switch becomes activated. The controller initiates a transfer signal through the SCR-EO which opens the ATS out of Source 2. The SEO limit switch activates. The ATS has now closed back into Source 1 position without interrupting the load.

The ATS defaults to an open transition transfer when Source 1 fails. Closed transition transfer is not possible with only one source available. If the optional Transition Mode Selector (TMS) is available, one can select an Open Transition Transfer or a Closed Transition Transfer when both Sources are available..

If while in Closed Transition Mode, the ATS fails to open the source it is attempting to "transfer out of" within 100 milliseconds, an Alarm will sound and the source that the ATS just closed into will be opened leaving the ATS in its initial source while disabling all other transfer operations until the problem is corrected and the "Fail to Open Lockout Reset" has been pressed.

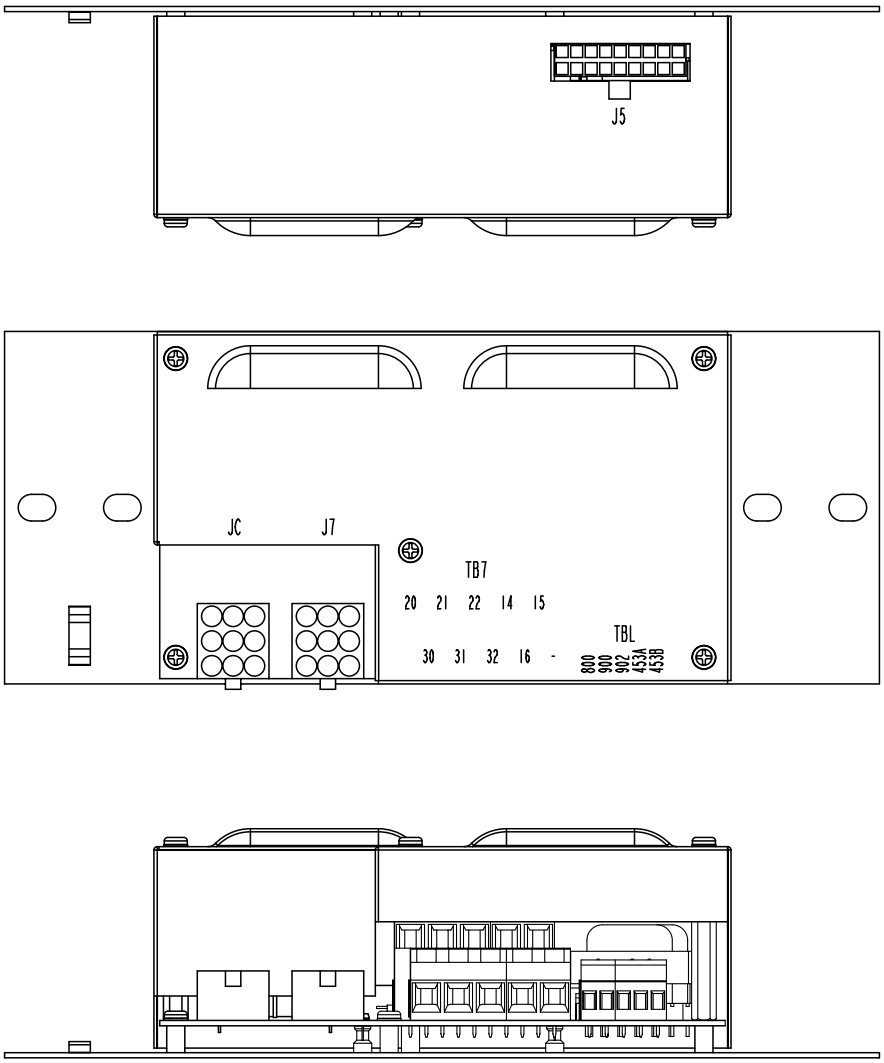
A signal will be provided (STE) to Shunt Trip the Generator Circuit Breaker if the Transfer Switch remains closed into both Sources for more than 325 milliseconds. The load will then be fed by the Source 1. The maximum time that the two Sources would be parallel, under these conditions, is less than 500 milliseconds. Before operating the Closed Transition Transfer Switch, the condition must be corrected and the Shunt Trip reset. Refer to procedure for servicing the Switch after Shunt Tripping occures.

The unit is Factory set to accomplish transfer within 5 electrical degrees.
Requires an Isochronous Governor with an operating frequency of 60+/- 0.2 Hz.
Requires a Shunt Trip Breaker on the Generator set with a response time not exceeding 50 milliseconds.

Controls Power Supply (CPS)

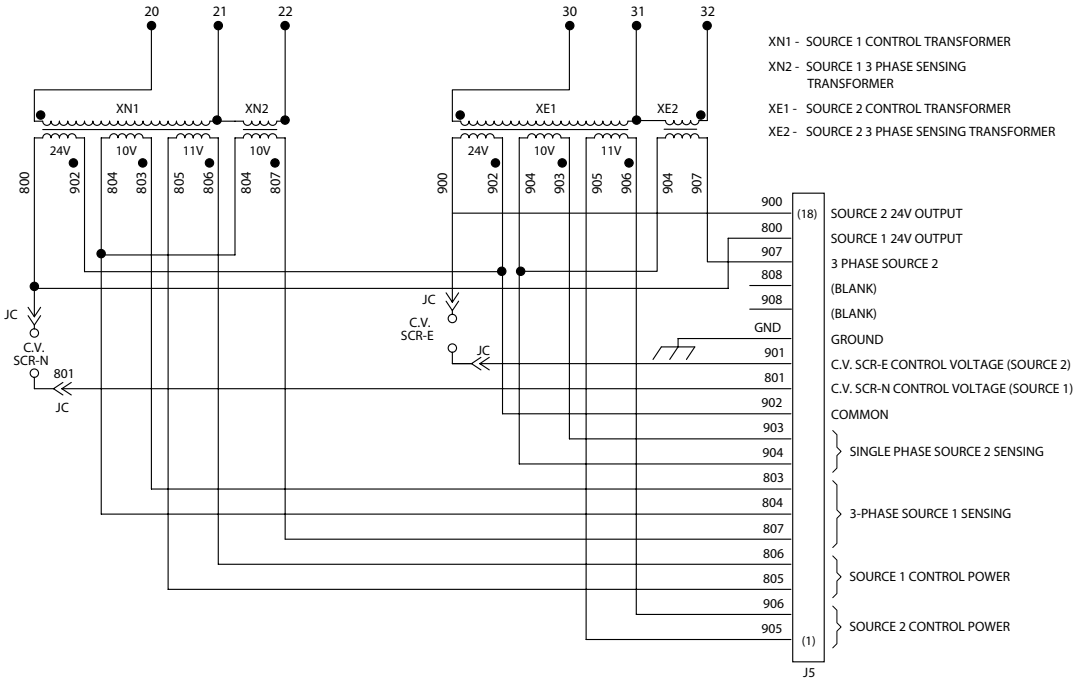
Standard and Delay Transition

Each MX250 microprocessor based ATS controller requires a Controls Power Supply (CPS) to apply line voltage to the ATS operator via SCRs. Also required is power for the MX250 printed circuit board and an application of sensing voltage proportional to line voltage. This is accomplished by the Controls Power Supply (CPS). This method of switching operator voltage and applying power and sensing voltage to the printed circuit board isolates the MX250 from the line voltage, further protecting the controller from harmful line transients.

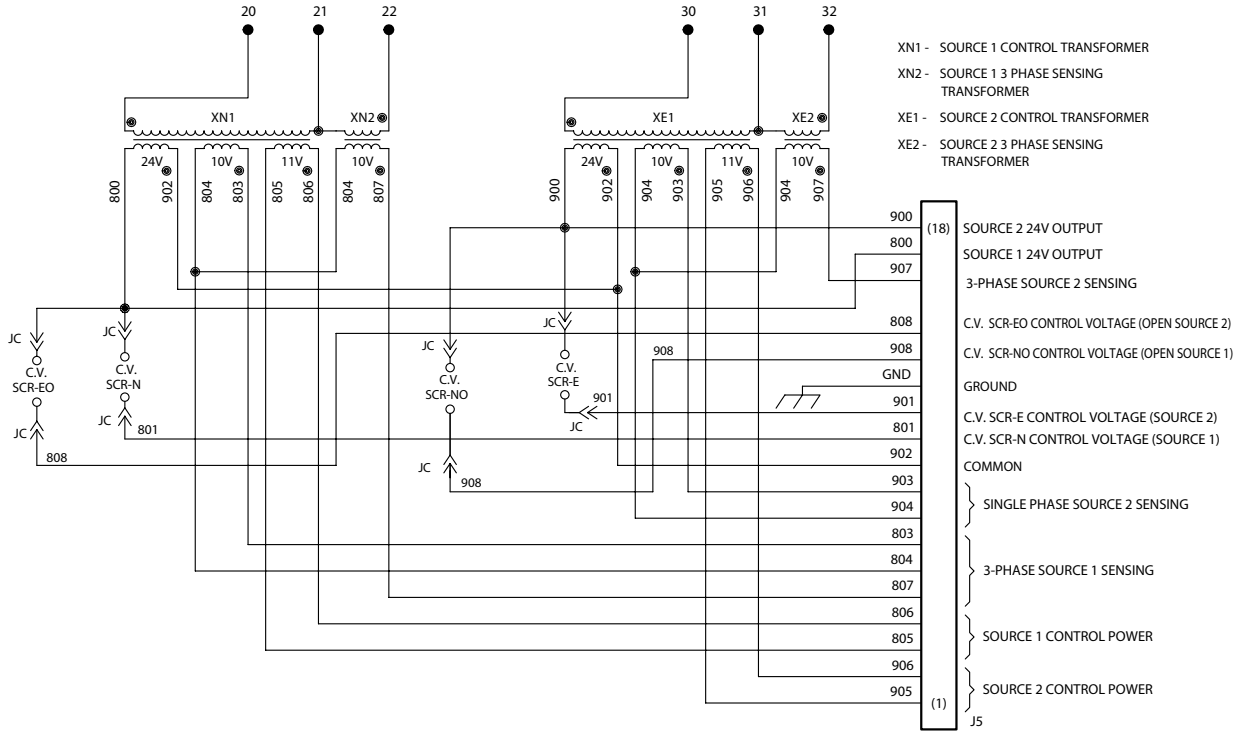


Primary Voltage at 50/60 Hz	CPS Assembly Part No.	CPS Board No.
120V	50P-1224	50P-1200
208-220V	50P-1225	50P-1201
230-240V	50P-1226	50P-1202
277V	50P-1227	50P-1203
380-400V	50P-1228	50P-1204
416-440V	50P-1229	50P-1205
460-480V	50P-1230	50P-1206
575-600V	50P-1231	50P-1207

Standard Transition CPS Schematic



Delayed Transition CPS Schematic



Troubleshooting and Diagnostics

⚠ DANGER ⚠

HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH.
These charts may indicate problems that require authorized GE Zenith service personnel.
Hazardous voltages may exist on termination plugs other than those that go into the Entelli-Switch 250.

General Troubleshooting

The following troubleshooting guide is used to recognize, and determine basic faults. When using this guide, it will ask several questions about the condition of the switch. This guide will then list an order of the possible faults. You will then look at the first suspected fault to determine if it is the problem. If it is not a fault, you go to the second suspected fault. If you go through all of the suspected faults, or the chart instructs you to, call a GE Zenith Representative for further assistance.

NOTE: When you use the troubleshooting charts, the Annunciation column refers to the LED's on the control panel.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
Engine does not START	SOURCE 2 AVAILABLE LED off	Engine start wires not terminated properly	Check engine start connections
		Generator is in OFF position	Investigate why Engine Control Switch was turned off
Engine does not stop	LCD Display - "TD Engine Cool Down"	U timing cycle not complete	Check U timer setting
	SOURCE 1 POSITION, and SOURCE 1 and SOURCE 2 AVAILABLE LEDs on, but U timer has timed out	Engine start wires not terminated correctly	Check Engine Start Connections
		Generator in MANUAL	Place generator in AUTO
ATS will not transfer to SOURCE 2 ZTS Series	SOURCE 2 AVAILABLE LED off	SOURCE 2 voltage or frequency not within acceptable parameters	Check: Engine Start Connections, Generator Breaker, Generator Output, and Engine Control Switch
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "S1 _ _ _ _ TD XFR S1>S2 Time Remaining _ _ _ _"	**W** timing cycle not complete	Check **W** Timer setting
ATS will not transfer to SOURCE 1 ZTSD Series	LCD Display - "ATS Open Time Remaining _ _ _ _"	**DW** timing cycle not complete	Check **DW** Timer setting
	SOURCE 1 AVAILABLE LED off	SOURCE 1 voltage or frequency not within acceptable parameters	Check utility and utility breakers
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "Diagnostic Code 001"	Limit switch or RT box connector unplugged	Call Technical Services
	LCD Display - "S1 OK Time Remaining _ _ _ _ Bypass"	**T** timing cycle not complete	Check **T** Timer setting
	LCD Display - "ATS Open Time Remaining _ _ _ _"	**TD** timing cycle not complete	Check **DT** Timer setting

Table 4

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Maintenance and Testing

⚠ CAUTION ⚠

Due to hazardous voltage and current, GE Zenith recommends that a GE Zenith Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

⚠ WARNING ⚠

Both power sources must be disconnected before manual operation of the switch.

A preventive maintenance program will insure high reliability and long life for the transfer switch. The preventive maintenance program for the transfer switch should include the following items:

Inspection and Cleaning

The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (do not use emery cloth or a file). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken or badly worn parts.

Servicing

All worn or inoperative parts must be replaced using GE Zenith recommended replacement parts. Please refer to the Replacement Parts manual for specific part information and ordering procedures. Please contact the GE Zenith Technical Services Department for the Replacement Parts manual.

The operating mechanism of the transfer switch is lubricated with Lubriplate 105. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional Lubriplate.

GE Zenith can provide complete preventative maintenance services. Please contact the GE Zenith Technical Services Department for additional information.

CDT battery replacement - lithium batteries may last up to 10 years, however it is recommended that battery replacement be included in a 3-5 year service cycle. The battery maintains the exerceser memory only and does not otherwise affect the operation.

Testing

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. **Both power sources must be disconnected before manual operation of the switch.** Insert the handle and operate the transfer switch between the Source 1 and Source 2 positions. The transfer switch should operate smoothly without binding. Return the switch to Source 1 position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the TS test switch. P timer will time out and the micro-controller will send an engine start signal. When the W time has elapsed, the switch will complete its transfer by closing into Source 2.

Deactivating the test switch will start retransfer to Source 1. The switch will complete its retransfer to Source 1 after the time delay of the T timer. The U engine overrun timer allows the engine generator to run unloaded for a preset cool down period.

NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

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GE Zenith Controls

A Product of GE Industrial Systems
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Asco Facts®

Published by Automatic Switch Co. Florham Park, New Jersey 07932

File Index: Automatic Transfer Switches Volume 6, Number 1

How to Maintain Reliability in Emergency Power Transfer Systems

Part I of three parts.

INTRODUCTION

Blackouts such as the one that plunged the northeast United States and parts of Canada into darkness on November 9, 1965, and the one in New York on July 13, 1977, have emphasized a very important aspect of emergency power systems: Emergency systems must be tested, inspected, and maintained. Facilities that followed regular programs of preventive maintenance had little, if any, difficulty when those blackouts hit, while many of those who did not, had major problems and some complete failures.[1,2]

The National Electrical Manufacturers Association (NEMA) recognizes the need for preventive maintenance in their Publication 1CS23: "a maintenance program and schedule should be established for each particular installation to assure minimum down time. The program should include periodic testing. tightening of connections inspection for evidence of over-heating and excessive contact erosion, removal of dust and dirt, and replacement of contacts when required."

Furthermore, the National Fire Protection Association (NFPA) 7084 defines electrical preventive maintenance as "the practice of conducting routine inspections. tests, and the servicing of electrical equipment so that impending troubles can be detected and reduced, or eliminated." They also state,[5] "the purpose of this recommended practice is to reduce hazard to life and property that can result from failure or malfunction of industrial-type electrical systems and equipment." NFPA-76A6 requires that an emergency power transfer system be tested for at least thirty minutes at least every thirty days.

Because of the proven need for preventive maintenance of emergency systems, this AscoFacts will discuss what should be done to properly maintain automatic transfer switches which are the "hearts" of the systems. When there is a power failure it is up to the automatic transfer switch to sense the failure, initiate the starting of the emergency generator, and put it on line at the proper time to supply power to the loads. If the transfer switch does not function properly, the loads could be left without power no matter how elaborate the rest of the system may be. Thus, preventive maintenance is a program to insure the reliability of the transfer switch and related elements.

A preventive maintenance program should be comprehensive enough to minimize the probability of experiencing a major malfunction in the emergency power system. However, the procedure should be such that it can be performed in the shortest period of time. The suggestions in this series of AscoFacts will help to achieve these goals.

INSTALLATION PRECAUTIONS

Actually. preventive maintenance begins with the installer when the automatic transfer switch arrives at the job site. Be sure the shipping carton or crate is not damaged. If it is, of course, notify the shipper. Look for handling instructions on the outside of the carton or crate so that it can be moved and unpacked without damage to the contents. For example. there may be a warning that the carton is top heavy.

The equipment should be placed in a safe, dry area and partially unpacked for inspection and removal of the manufacturer's handling and installation instructions. If the equipment is to be stored for an extended period of time, it should be protected from physical damage, dirt, and water. Ambient temperature in the storage area should be above -30'C but not over 65 C.7 Heat should be used to prevent condensation inside the equipment.

If a fork lift is to be used after the equipment is unpacked, the equipment should be in an upright position and care should be taken not to damaged any handles, knobs or other protrusions.

If the equipment is to be lifted, lifting plates should be secured to the frame with hardware as described in the mounting instructions. Lifting cables or chains should be long enough so that the distance between the top of the equipment and the hoist is greater than one half the longest horizontal dimension of the equipment.[8]

The installer should closely follow the manufacturer's instructions. If there is any question on any part of the unpacking or installation procedure, the manufacturer's representative or the manufacturer should be contacted.

After the equipment is installed, it should be thoroughly cleaned and vacuumed taking special care to remove any loose metal particles which may have collected during installation. Before energizing the circuits, the switch should be manually operated in accordance with the manufacturer's instructions. Next, the phase rotation between the normal source and the emergency source should be checked. Then the switch can be energized and given a functional test in accordance with the manufacturer's instructions

DRAWING AND MANUALS

Before attempting to test, inspect, or maintain an emergency power transfer system, atleast one set of the manufacturer's drawings and manuals should be on hand. These should be kept in a clean and readily accessible location.[9] For convenience, additional copies should be readily accessible. These can usually be obtained easily from the manufacturer. Drawings and manuals are an indispensable aid in understanding the sequence of operation of the equipment; establishing test and inspection procedures; determining the type and frequency of tests; troubleshooting; stocking spare parts; conforming to code requirements for periodic preventive maintenance.

TESTING

Regular testing of an emergency power system will uncover potential problems which could cause a malfunction during an actual power failure. Furthermore, regular testing gives maintenance personnel an opportunity to become familiar with the equipment and observe the sequence of operation. By being

familiar with the equipment personnel on duty during an actual power failure can respond more quickly if a malfunction occurs.

An automatic emergency power system should be tested under conditions simulating a normal utility source failure–field surveys have proven this. Experience shows that the rate of discovery of potential problems when a system is tested automatically with the emergency generating equipment under load for at least one-half' hour, is almost twice the rate when a systems is tested by manually starting the generating equipment and letting it run unloaded.

A test switch is recommended on the transfer switch to simulate a normal power failure. Some manufacturers supply this as standard equipment. The advantage of a test switch is that it does not cause a loss of power to connected loads as is caused if the main disconnect is opened to simulate a failure. A test switch opens one of the sensing circuits and the controls react as if there were a normal power failure. In the meantime, the loads stay connected to the normal source. Power is interrupted to the loads only when the load is being transferred from the normal to the emergency source and vice versa. This interruption is only for a few cycles. On the other hand, if the main disconnect is opened to simulate loss of normal power then the power to the load could be interrupted for up to ten seconds. The interruption could be much longer if a malfunction occurs during start-up of the emergency generator. When a test switch is used, fewer maintenance personnel are needed because the potential of experiencing an extended power outage during the test is significantly reduced.

While it is not always recommended, the control circuits of an emergency power system can be designed so that a clock will automatically initiate a test of the system at a designated hour on a specific day for a predetermined test period, This type of test can be restricted to running the engine generator set unloaded or it can include an actual transfer of loads to the generator output. Using a clock to initiate testing under load or no-load conditions is not recommended for the following reasons.

1. With no load interruption, the engine generator set is tested unloaded. Thus, engine performance can be adversely affected. Also, the transfer switch is not tested, and the interconnecting control wires are not verified as being intact. The transfer switch is a mechanical device that has been lubricated for life. However, ever, to keep the lubrication adequate, the switch should be periodically operated.

2. There may be installations where automatic tests are not easily integrated into the operation of a building and it may be difficult to stop the clock.

3. A clock malfunction of improper setting could result in a test at a most inopportune time.

4. Clocks are usually set to initiate a test on weekends or during early morning hours. If a malfunction occurs, skeleton crews are usually not equipped to handle it.

When a test switch is used to test an emergency power transfer system in the automatic mode, all relays, timing, and sensing circuits operate in accordance with the engineered sequence of operation. If the test procedure is written in accordance with this predictable sequence of operation then precious steps and man-hours can be saved. It is possible for one man to initiate a test and then move to another location to initiate another action or monitor and record certain test results. The automatic sequence of operation should not vary greatly in time so that maintenance personnel movements can be correlated to that sequence. Furthermore, test procedures can include emergency procedures to cover any malfunction. This is added insurance. Key people should be trained to react almost instinctively when certain mal-functions occur. For example. in a multiple engine-generator system with automatic load-dump capabilities an overspeed condition on one set may cause certain loads to be shed by retransferring them from the emergency source of power to the normal. The test procedure should simulate such a condition and include steps to confirm that the loads were retransferred steps to reset the failed generator and put it back on the line: steps to confirm that the load is again transferred to the emergency source of power.

It should be noted that some systems of this type frequently utilize load dump relay (LDR) circuits on preselected transfer switches to dump some of the load back on the normal source when one or more generator fails on a multiple generator system. This arrangement permits the dumped loads to be fed by the available normal source and thereby avoid major shutdowns of dumped loads during test periods. A minimum check list for an emergency power system should include at least the following items.

1. Loose control wires and cables.
2. The time from when the test switch is activated until the engine starts to crank.
3. The time required for the engine to achieve nominal voltage and frequency after the test switch is activated.
4. The time that the transfer switch remains on the emergency generator after the test switch is released.
5. The time that the engine generator set runs unloaded after the load circuits have been retransferred back to the normal source of power.
6. Proper shutdown of the engine generator set and engine auxiliary devices.

Subsequent issues of AscoFacts in this series on maintaining reliability will cover record keeping, inspection, preventive maintenance and repair, and bypass-isolation switches.

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Asco Facts®

Published by Automatic Switch Co. Florham Park, New Jersey 07932

File Index: Automatic Transfer Switches Volume 6, Number 2

How to Maintain Reliability in Emergency Power Transfer Systems

Part II of three parts.

Part I of this series of AscoFacts discussed the importance of testing automatic transfer switches. It is also important to have a record of those test.

RECORD KEEPING

Accurate and comprehensive test records should be kept for several reasons. They may be required by national, state and local codes. Also the records will serve as the basis for determining whether corrective maintenance or replacement of certain elements in the system is necessary or desirable. They can help chart the wear of the system over its service life and can be used as reference data for recom-mendations to modify existing equipment.

INSPECTION

In addition to putting the system through test procedures, visual inspection is also necessary to guard against system malfunction.

Before starting a scheduled operational test, the equipment should be checked for loose control wires and any discoloration of power connections caused by excessive heat due to loose connections. Also inspect for excessive dust and dirt particles and "craters" left in the dust by excessive moisture. With proper care, this type of inspection can usually be done without de-energizing the equipment.

If the transfer switch is subjected to a fault current resulting from a short in the distribution system, the switch should be checked immediately to determine if it was damaged. Such damage can be a potential source of fire, jeopardize the safety of personnel, or adversely affect the operation of the switch. To check the switch for such damage, first de-energize the switch by opening both the normal and the emergency breakers, and then look for any of the following:

1. Damage to insulating parts.
2. Evidence of arcing between live parts and to ground.
3. Welded or significantly eroded main and /or arcing contacts.

While the switch is de-energized, a dielectric test should also be conducted to determine if the switch will withstand twice the rated voltage plus 1000 volt rms10. The length of down-time for this inspection is kept to a minimum if the design of the transfer switch allows inspection of the live parts without major disassembly or removal of switch sub-assemblies such as a portion of the drive mechanism, etc.

After the inspection and any necessary repairs are completed, re-energize the transfer switch and test it.

DETAILED INSPECTION SUGGESTION

An in-depth inspection should be performed at least annually. This must be done with the equipment de-energized. However, this is frequently difficult to schedule when critical loads are involved. Thus, such inspections are usually performed after regular working hours or on weekends. At those times, labor rates are at a premium. For that reason, the downtime must be kept to a minimum. (Bypass-isolation switches are helpful for making in-depth inspection with-out downtime. These will be discussed later.)

To save time, careful preparation with regard to the inspection procedure and the availability of tools and replacement parts are helpful. However, the design of the equipment and the skill of the maintenance personnel are the prime factors in saving time when an inspection of this type is performed. For complex systems, it is often advantageous to factory-train maintenance personnel. Some manufacturers can provide a factory technician to conduct in-house inspection and maintenance training classes for personnel at start-up time. However, the instructions included in equipment manuals will usually be adequate.

Equipment should be designed so that the inspection can be performed without removing equipment from the enclosure. All connections should be accessible from the front and tightened with common tools. Also, no special tools should be needed to install or remove covers and parts.

Main Operating Mechanism

The main operating mechanism of an automatic transfer switch should be rugged and simple and lubricated for life. However, the parts that are lubricated should be checked at this time. If, due to environmental conditions, the mechanism requires lubrication, the manufacturer's recommendations should be followed.

Contacts

UL Standard 1008 requires that an automatic transfer switch be capable of from 2000 to 6000 cycles of operation under load, depending on amperage size, without parts replacement. However, the main current carrying contacts should be checked during this inspection as required under NEMA ICS2-447.85.3 To do this easily, the pole covers and arc chutes should be able to be removed without any disassembly of the operating mechanism. Expensive time is consumed if the operating mechanism must first be partially disassembled or if the operating mechanism must be lubricated and adjusted after it is reassemble. The best rule to follow is to choose equipment that does not require major disassembly for inspection and preventive maintenance. Contacts on transfer switches that employ integral overcurrent protection cannot be conveniently inspected.

Most large transfer switches are furnished with main current-carrying contacts and arc-interruption contacts. Main contacts should not show arc damage.

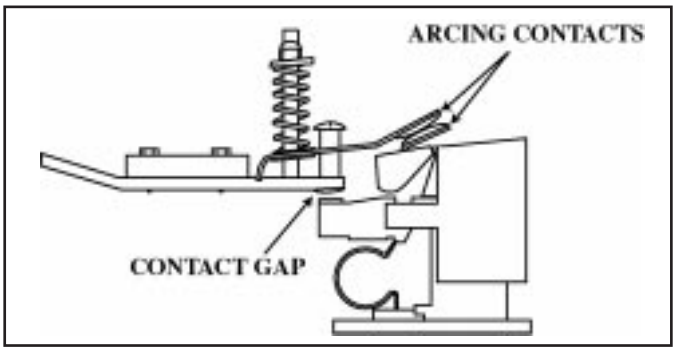

Figure 1. Side view of contacts.

Arc damage or wear on the arcing contacts is a result of the magnitude of the current, voltage, power factor, and most important, on the number of interruptions. If the arcing contacts are used up, they should be replaced.

To properly check the arcing contacts, a manual operating means is necessary. This will allow the switch to be operated slowly, to determine if the arcing contacts should be replaced or re-adjusted. If this means is a handle, it should be removable and stored on the switch.

Arcing contacts on the main power poles should make and break simultaneously. If one arcing contact breaks before the other, then that contact would probably show greater wear and should be re-adjusted so that future wear is reduced. Since the arcing contacts make before the main contacts, and break after them, there is always a main contact gap when the arc contacts just begin to touch. See Figure 1.

A decrease in this gap may be attributable to excessive arc contact wear. By using the manual operating handle, the switch can be stopped when the arc contacts "kiss." This is the point at which the main contact gap is measured. Check the manufacturer's specifications to determine the need for adjustments.

Main operator control contacts mounted on the transfer switch should also be inspected for proper adjustments. The operation can be checked by using the manual handle and operating the switch slowly.

MANUAL OPERATING MEANS

Because the manual means of operating the transfer switch plays an important role in checking it, some points should be discussed briefly about the manual means.

Much has been written about operating handles which permit slow operation, and operating handles of the Quick-Make-Quick-Break (QMQB) variety. To the maintenance man, an operating handle which permits slow operating is advantageous for the reasons outlined previously. This type of handle can also be used for manual transfer if the power sources are first disconnected. This is achieved by first opening the feeder breakers, operating the handle to transfer the contacts, and then reclosing the feeder breakers.

Some think that QMQB operators can solve all emergency power system malfunction problems instantaneously. Actually, this type of operator has limited usage in a properly designed transfer switch. By its nature, it cannot be used for inspection and adjustment of contacts because it does not permit slow operation. A need for such a device reflects little confidence in the reliability of the equipment and may actually detract from safe and normal operation. The following should be seriously considered.11

1. A QMQB operator is not a fast cure all for system malfunctions because the status of the alternate power system and the cause of the failure must be determined before a manual transfer is attempted. Also to be considered is the availability of qualified personnel who are familiar with the manual operation of the transfer switch and who are capable of determining the adequacy of the alternate source of power before manually transferring the load.

   Failure of the transfer switch to automatically transfer the load may have been caused by circumstances extraneous to the transfer switch. For example, the generator may not have achieved normal voltage. Thus, impromptu operation of the QMQB will transfer the load to a low voltage source and may create a worse condition than if the load remained without power. Also if the automatic controls are inhibiting transfer because of inadequate emer-gency source voltage or frequency, manual transfer may overload the emergency system.

   Other conditions, such as a dead cranking battery or loss of fuel will prevent starting of the emergency generator and therefore prevent automatic transfer. Corrective measures must be applied before a manual transfer is attempted.

2. When QMQB operators are used, a means must first be provided to dis-connect the automatic controls to prevent energizing the electrical operator during manual transfer. This is necessary because the direction of transfer can be contrary to the direction selected by the automatic controls.

3. To be safe, QMQB operators intended for switching load should be operated from outside of the enclosure to prevent the possibility of electrical shock or other hazards to the operator.

DESIRABLE FEATURES

To make inspection easy and safe, it is desirable to have the following additional features in the transfer switch:

1. Transfer switches rated 100 amperes or larger are usually mechanically held in both the normal and emergency positions. In such switches, the main contact pressure depends on the mech-anical locking mechanism of the main operator. Automatic operation of these switches in either direction requires electrical control power. Thus, the main poles of the transfer switch should be the type that are held closed mechanically and energized even when the control circuit is de-energized. In this type of design, the load remains energized while the sensing and control circuitry is de-energized for inspection.

2. Sensing and control circuitry on a panel separate from the main transfer switch panel.

3. Compact and light-weight sensing and control panels to allow for mounting on an enclosed door that swings out and away from the energized main poles of the transfer switch.

4. A harness containing a disconnect means to allow the sensing and control panels to be completely de-energized. With the sensing and control panels de-energized, the control relay contacts, time delays, and pick-up and drop-out values of the sensing circuits can be checked.

   With the harness disconnected, the transfer switch is incapable of auto-matically responding to a power outage. Therefore, emergency procedures must be written and personnel must be ready to respond if an emergency should occur. Being prepared, personnel can save precious time in manually trans-ferring the loads to the acceptable emergency source.

   The next and final issue in this series of AscoFacts will discuss preventive main-tenance and repair, and bypass-isolation switches

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REFERENCES, CONTINUED

10. Tests and Test Procedures, NEMA Standard ICS 1-109, National Electrical Manufacturers Associa-tion, Washington, D.C.
11. Manual Operation of Automatic Transfer Switches, Publication 1A929, Automatic Switch Company, Florham Park, N.J

Asco Facts®

Published by Automatic Switch Co. Florham Park, New Jersey 07932

File Index: Automatic Transfer Switches | Volume 6, Number 3

How to Maintain Reliability in Emergency Power Transfer Systems

Part III of three parts.

The last two issues of AscoFacts in this three-part series discussed testing and inspection of automatic transfer switches. Another important aspect in assuring reliability is preventive maintenance and repair

PREVENTIVE MAINTENANCE AND REPAIR

Dirt, dust and moisture cause most malfunctions in automatic transfer switches. Eliminating these is the best preventive maintenance that can be performed. Dust should be removed by a vacuum means during the annual inspection. Do not use compressed air because the flying dust and other particles can settle on uncovered control relay contacts and armature surfaces, and adhere to lubricated surfaces.[2] If condensation moisture is found to be a problem, a small space heater can be used.

Replacement Parts

There are no consumable spare parts in an emergency power transfer system. However, replacement parts should be kept on hand in case a malfunction occurs. The quantity of replacement parts will be determined by the following factors:

1. Manufacturer's recommendations.
2. Replacement parts common to all installed equipment. If a majority of the manufacturer's recommended replacement parts are common to all transfer switches on the premises regardless of type, system voltage or amperage size, then a minimum quantity of replacement parts are required. For example, if all control relays are identical and are powered from the secondary of a control power transformer, the same coil can be used on all control relays.
3. Availability of replacement parts from a local source such as a stocking distributor. However, if loads are critical, parts should be purchased and kept on hand.

Each replacement kit should be opened and the contents checked for the correct parts when they are received. The installation instructions should be studied so that maintenance personnel know how to change the parts. No special tools should be required to install the parts. An inventory list of the spare parts kits should be kept.

BYPASS-ISOLATION SWITCHES FOR LOADS THAT CANNOT TOLERATE DOWNTIME

In many installations, it is very difficult to perform regular testing or detailed inspections on the emergency systems because some or all of the loads connected to the system are vital to human life or are critical in the operation of continuous processes. De-energizing these loads for any length of time is difficult. This results in lack of maintenance. In such installations, a means can be provided to bypass the critical loads directly to a reliable source of power without downtime of the loads. The transfer switch can then be isolated for safe inspection and maintenance.

Appendix C of NFPA-76A5 states that hospitals should consider properly designed and installed bypass arrangements to permit testing and maintenance of system components that could not be otherwise maintained without disruption of important hospital functions. Two-way bypass-isolation switches are available to meet this need. These switches perform three functions:

1. Shunt the service around the transfer switch without interrupting power to the load. See Figure 2.
2. Allow the transfer switch to be tested without interruption of power to the load. See Figure 3.
3. Electrically isolate the transfer switch from both sources of power and load conductors to permit inspection and maintenance of all transfer switch components. See Figure 4.

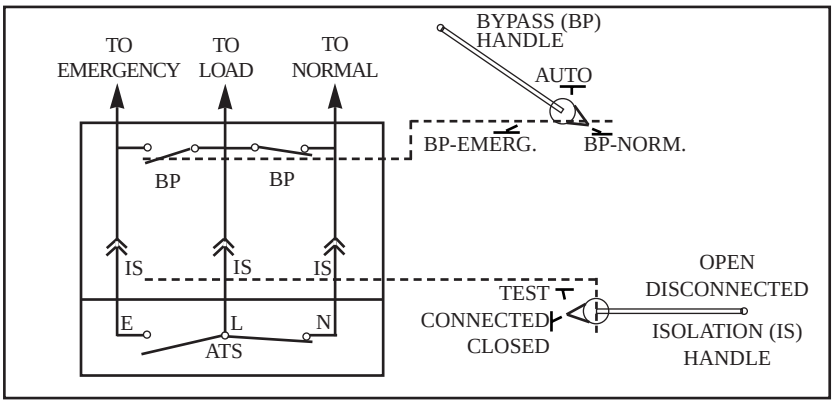

Figure 2. With bypass (upper) handle in the bypass-to normal (PB-NORM) position, the load gets power directly from the normal source through the right-hand BP contact, The isolation (lower) handle is shown in the closed position.

The functions outlined above are accomplished by operating two handles in an easy-to-follow sequence. This equipment can be furnished as a complete automatic transfer and bypass-isolation switch for new installations or as a replacement for existing equipment. They can be supplied with a drawout mechanism so the transfer switch can be easily removed for maintenance.

In addition to the two-way switches, one-way switches are also available which bypass to only one preselected source. Field experience shows that the somewhat higher price for a two-way switch is fully justified when considering its over-whelming advantages over one-way switches. For example, a two-way bypass-isolation switch allows either power source to be selected to feed the lead during bypass. The operator can choose the source that is the more dependable at that time.

Furthermore, when the transfer switch is in the test or open position as shown in Figures 3 and 4, a two-way bypass-isolation switch can be used to transfer the load to the alternate source if the source to which it has been bypassed fails. One-way devices cannot provide these features.

Experience has shown that critical loads that warrant bypass switches to permit periodic maintenance of transfer switches should be provided with the capability to transfer critical loads in two directions. Such an arrangement assures the backup capability to transfer critical loads to an available normal or emergency power source.

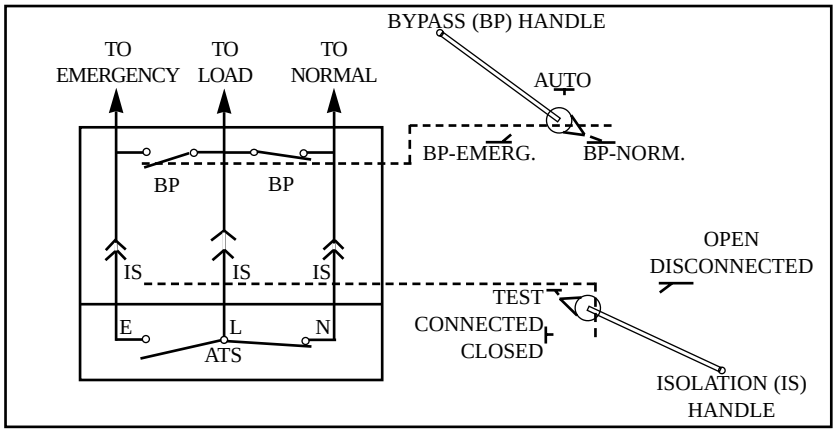

Figure 3. With the isolation (lower) handle moved to the test position, the transfer switch can be electrically tested without disrupting the load.

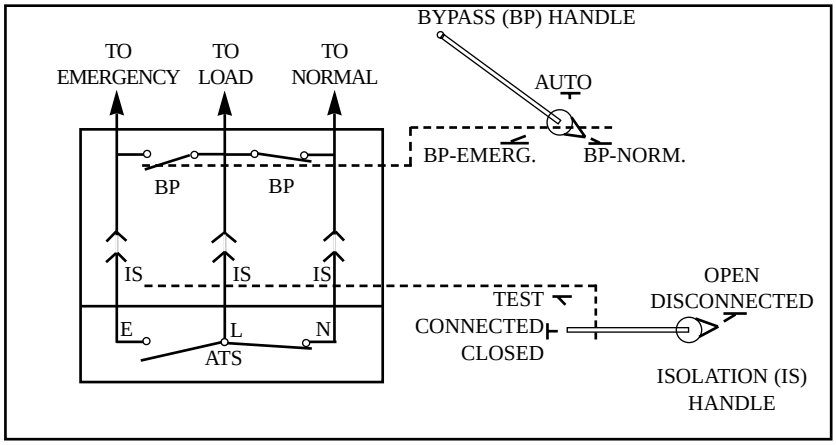

Figure 4. With the isolation handle moved to the open position, and the load being fed directly from the normal, the automatic transfer switch (ATS) is completely isolated and can be removed without interrupting the load.

REFERENCES

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2. Arthur Freund, *Maintaining the Emergency Power Automatic Transfer System*, Electrical Construction and Maintenance, March 1979.
3. *AC Automatic Transfer Switches, NEMA Standard ICS2-447*, National Electrical Manufacturers Association, Washington D.C.
4. *Electrical Equipment Mantenance 1977,* NFPA No. 70B, National Fire Protection Association, Boston, Mass, Page 9 paragraph 1-3 Definitions.
5. Ibid, Page 9 paragraph 1-1, Purpose.
6. *Essential Electrical Systems for Health Care Facilities 1977*, NFPA No. 76A National Fire Protection Association, Boston, Mass.
7. *New Rating Requirements for Automatic Transfer Switches,* P564 Project Report on Rating Structure, IEEE Conference Record 78CH1302-91A, June 1978.
8. *Service and Installation Procedures NEMA Standard ICSI-108,* National Electrical Manufacturers Association, Washington, D.C.
9. *Essential Electrical Systems for Hospitals CSA Standard Z32.4-M1978* Canadian Standards Association, Rexdale, Ontario, Canada M9W-1R3.
10. *Test and Test Procedures, NEMA Standard ICS 1-109*. National Electrical Manufacturers Association, Washington D.C.
11. *Manual Operation of Automatic Transfer Switches,* Publication 1A929, Automatic Switch Company, Florham Park, N.J.
12. *When Should You Consider Using a Bypass-Isolation Means in An Emergency Power System?* ASCOFacts, Volume 2, Numbers 1 and 2, Automatic Switch Company, Florham Park, N.J.

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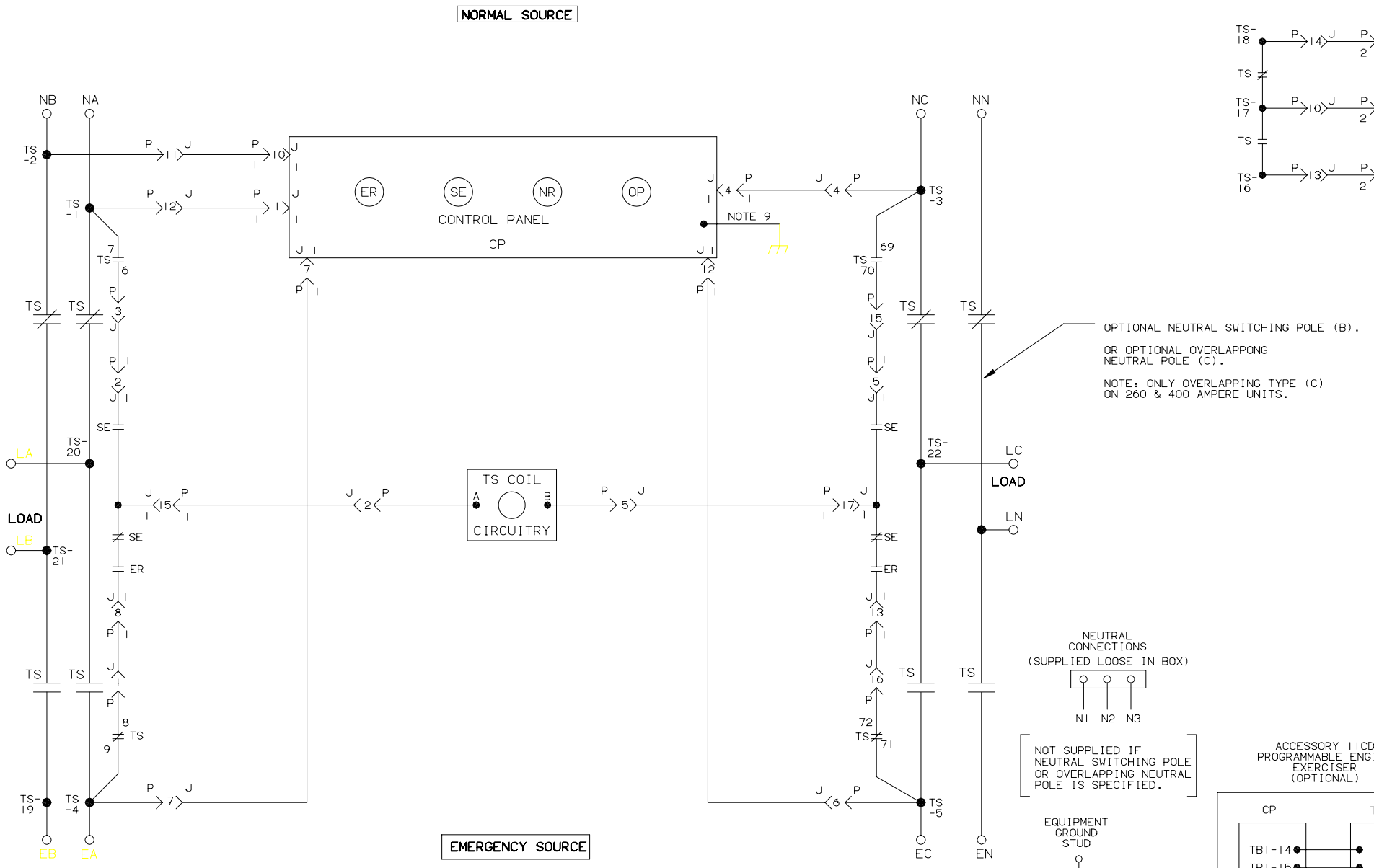
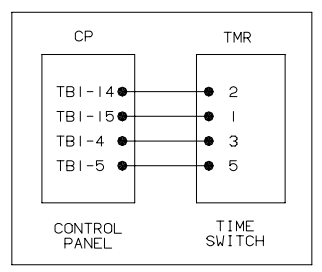
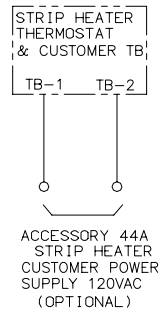
ELEMENTARY DIAGRAM

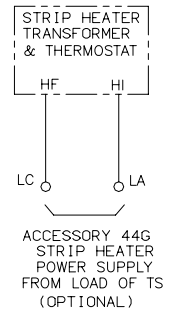


ACCESSORY 11CD
PROGRAMMABLE ENGINE EXERCISER
(OPTIONAL)



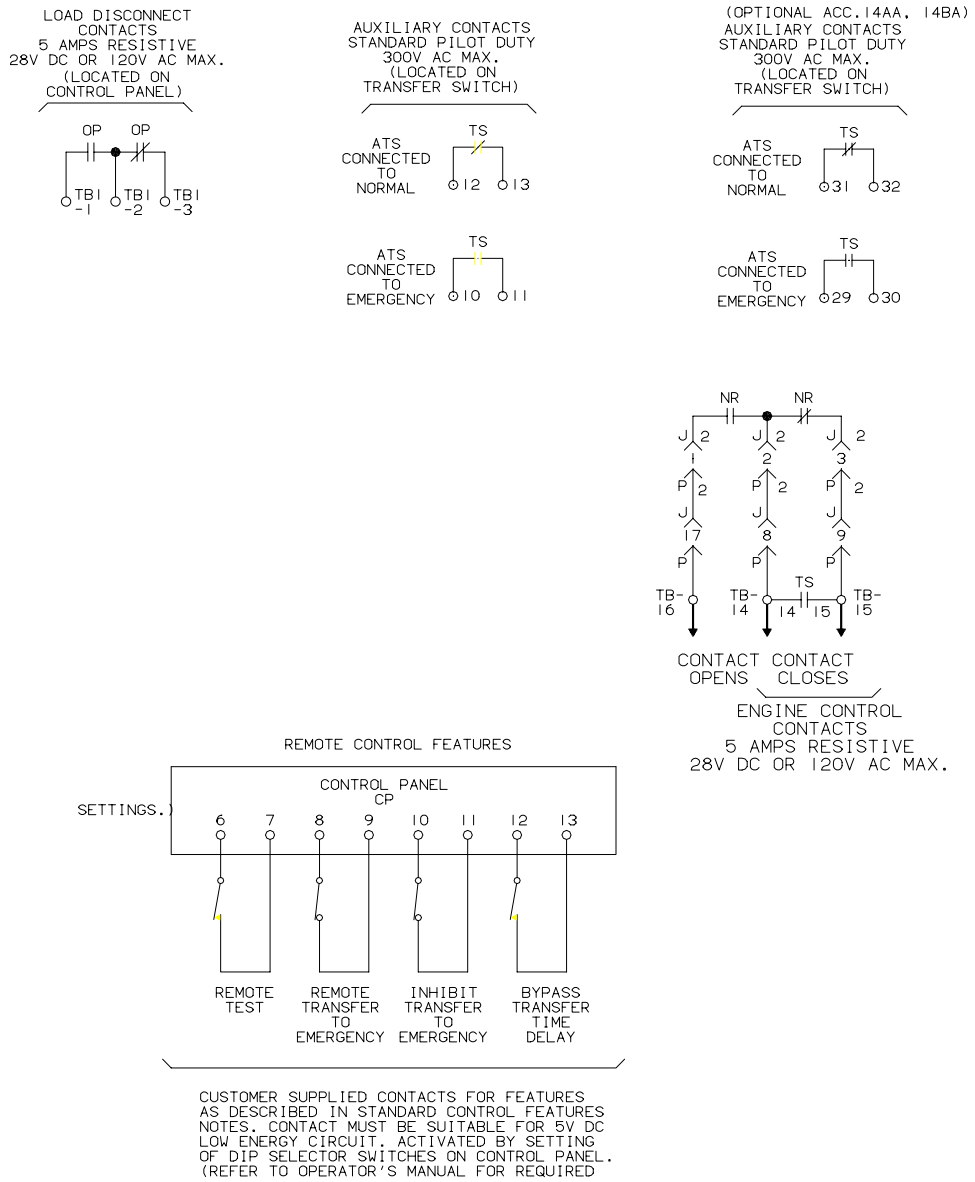


ACCESSORY 44A
STRIP HEATER
CUSTOMER POWER
SUPPLY 120VAC
(OPTIONAL)



ACCESSORY 44G
STRIP HEATER
POWER SUPPLY
FROM LOAD OF TS
(OPTIONAL)

CUSTOMER CONNECTIONS



POWER CONNECTIONS

SIZES OF UL LISTED SOLDERLESS SCREW TYPE TERMINALS FOR EXTERNAL POWER CONNECTIONS

SWITCH RATING (AMPS)	RANGE OF AL-CU WIRE SIZES (UNLESS SPECIFIED COPPER ONLY)
30-104	ONE #14 TO 2/0 AWG
150	ONE #8 TO 3/0 AWG
200	ONE #8 TO 3/0 AWG COPPER (CU) ONLY
225, 260, 400	TWO #1/0 AWG TO 250 MCM OR ONE #4 AWG TO 600 MCM
600,800	THREE #2 AWG TO 600 MCM
2600-4000A	SUITABLE FOR BUS BAR

GENERAL NOTES

1. SWITCH SHOWN DE-ENERGIZED CONNECTED TO NORMAL SOURCE. DEVICE SYMBOLS AND DESIGNATIONS ARE IN ACCORDANCE WITH NEMA PUB. ICS 1-1983, PART 1-101A.
2. TS WIRES:#20 AWG ON 30-200 AMPS AND #16 AWG ON 225-800 AMPS, CONTROL PANEL WIRING IS #16 AWG. ALL WIRES ARE STRANDED COPPER.
3. O INDICATES CUSTOMER CONNECTION POINTS.
4. ● INDICATES FACTORY CONNECTION POINTS.
5. CONNECTION POINTS THAT HAVE BOTH CUSTOMER CONNECTIONS AND FACTORY CONNECTIONS ARE SHOWN OPEN AS CUSTOMER CONNECTION POINTS.
6. THE TRANSFER UNIT IS MOUNTED ON THE BACK INSIDE SURFACE OF THE ENCLOSURE. THE CONTROL PANEL AND ANY OPTIONAL ACCESSORIES ARE MOUNTED ON THE INSIDE SURFACE OF THE DOOR.
7. **AN OPERATOR'S MANUAL IS FURNISHED WITH EACH AUTOMATIC TRANSFER SWITCH, REFER TO THIS PUBLICATION PRIOR TO INSTALLATION AND OPERATION OF THE SWITCH.**
8. SWITCH AND ALL CONTROL FEATURES ARE LISTED UNDER UL-1008.
9. GROUND STRAP ON CONTROL PANEL IS AFFIXED TO CHASSIS (ENCLOSURE) AT LOWER LEFT CONTROL PANEL MOUNTING STUD.
10. USE X SUFFIX WHEN SPECIFYING ENCLOSURES OTHER THAN TYPE 1 OR ACCESSORIES.

COMPUTER GENERATED DRAWING

BASIC CATALOG NUMBERS ASCO	POLES	AMPS	VOLT CODE	CONTROL CODE	OPTIONAL ACCESSORY	ENCLOSURE CODE
300	B C	3	200	1 ALL UNITS	X SEE NOTE 10	C
			4			
			6			
			30			
			70			
			104			
			150			
			225			
			260			
			400			
			600			
			800			
			2600			
			3000			
			4000			

SUFFIXES

SUFFIX CODE DESCRIPTIONS

VOLTAGE CODES (3 PHASE, 3 OR 4 WIRE, 50-60HZ)		CONTROL CODES ALL UNITS	POLE CODES		ENCLOSURE CODES	
4	199-208V	1 STANDARD	B	SWITCHED NEUTRAL	C	TYPE 1
6	220-240V					TYPE 3R
9	460-480V		C	OVERLAPPING NEUTRAL	X C	TYPE 4
G	575-600V					TYPE 12
X	399-415V					
X	364-380V					SEE NOTE 10

COMPOSITE 3 PHASE WIRING FOR
ASCO® SERIES 300 AUTOMATIC TRANSFER SWITCHES
RATED UP TO 600V AC MAX.
WITH MICROPROCESSOR CONTROLS

CATALOG NUMBER _____ CERTIFIED TO ASCA® S.O. _____

DATE _____ BY _____

DRAWN	DATE	CHECKED	DATE	APP. DFTG.	DATE	APP. ENG.	DATE
CC	2/95					SH	2/95

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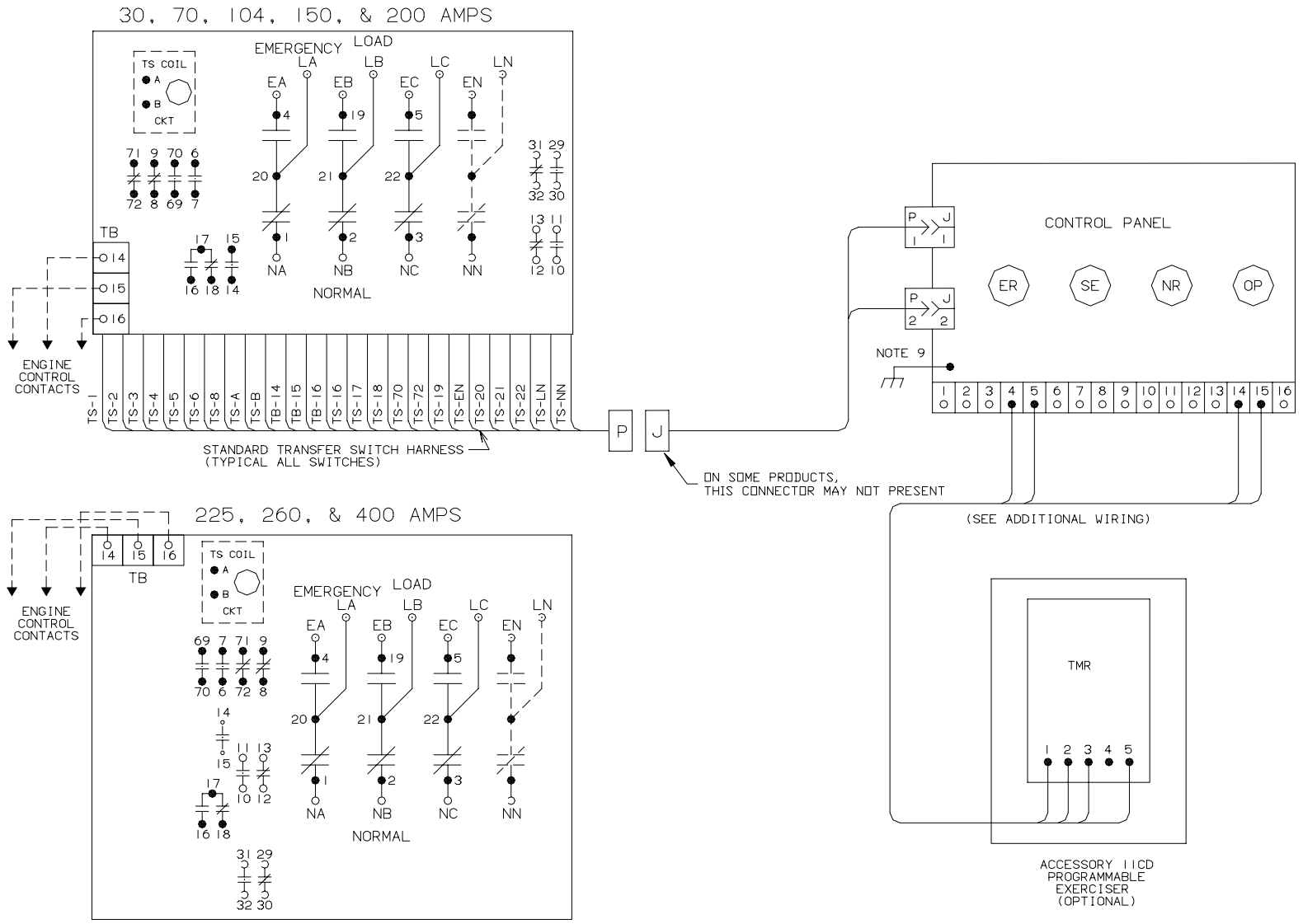
E.R. NO.	ITEM CHGD.	CHG.	DATE	APVD.
147713	SEE ECN	J	4-7-98	JJC
146709	SEE ECN	H	12/97	WT
145472	SEE ECN	G	8/97	YZ

DS 493577

AL ☐ AP ☐ ☐ ☐ ☐ CHG LTR J — SHEET 1 OF 2

PHYSICAL DIAGRAM



(ACCESSORY 11CD ONLY)

WIRE NO	ADDITIONAL WIRING	AWG / CLR
	WIRES TO BE ADDED	
1	CP-TB1-4, TMR-3	16
2	CP-TB1-5, TMR-5	16
3	CP-TB1-14, TMR-2	16
4	CP-TB1-15, TMR-1	16

CONTROL FEATURES

VOLTAGE AND FREQUENCY SENSING

A. DIFFERENTIAL TYPE VOLTAGE SENSING ON ALL PHASES OF NORMAL SOURCE. DROPOUT SETTING SELECTABLE AT 90, 85, 80 OR 70% OF NOMINAL. FACTORY SET AT 85%. PICKUP VOLTAGE ADJUSTABLE AT 90 OR 95% OF NOMINAL. (DEFAULT IS 95% IF DROPOUT IS SET TO 90%). FACTORY SET AT 90%. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

B. SINGLE PHASE VOLTAGE SENSING OF EMERGENCY SOURCE. NON-ADJUSTABLE DROPOUT SETTING AT 75% OF NOMINAL. NON-ADJUSTABLE PICKUP SETTING AT 90% OF NOMINAL.

C. FREQUENCY SENSING OF EMERGENCY SOURCE. NON-ADJUSTABLE DROPOUT SETTING AT 85% OF NOMINAL. NON-ADJUSTABLE PICKUP SETTING AT 95% OF NOMINAL.

TIME DELAYS

A. MOMENTARY NORMAL SOURCE OUTAGE DELAY - ACTIVATED WHEN THE NORMAL SOURCE FAILS. DEACTIVATED WHEN THE NORMAL SOURCE IS ACCEPTABLE. PROVIDES A SELECTABLE (1 OR 3 SECOND) DELAY ON TRANSFER AND ENGINE STARTING SIGNALS. FACTORY SET AT 3 SECONDS. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

B. TRANSFER TO EMERGENCY DELAY - ACTIVATED AFTER THE MOMENTARY NORMAL SOURCE OUTAGE DELAY EXPIRES AND THE EMERGENCY SOURCE IS SENSED TO BE ACCEPTABLE. TRANSFER TO EMERGENCY IS COMMITTED TO ON INITIATION OF DELAY. DEACTIVATED WHEN THE EMERGENCY SOURCE IS UNACCEPTABLE. PROVIDES AN ADJUSTABLE DELAY FROM 0 TO 5 MINUTES. FACTORY SET AT 0 MINUTES. (REFER TO OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

C. RETRANSFER TO NORMAL DELAY - ACTIVATED WHEN THE NORMAL SOURCE IS ACCEPTABLE, DEACTIVATED WHEN THE NORMAL SOURCE FAILS WITH NO TRANSFER TO NORMAL. ALSO DEACTIVATED WHEN THE EMERGENCY SOURCE FAILS WHILE THE NORMAL SOURCE IS ACCEPTABLE WITH TRANSFER TO NORMAL. ADJUSTABLE DELAY FROM 1 SECOND TO 30 MINUTES. FACTORY SET TO 30 MINUTES. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

D. UNLOADED RUNNING (ENGINE COOLDOWN) DELAY - ACTIVATED ON EXPIRATION OF RETRANSFER TO NORMAL DELAY OR FOLLOWING EXPIRATION OF THE NORMAL SOURCE OUTAGE DELAY WITHOUT A COMMIT TO TRANSFER TO EMERGENCY. NON-ADJUSTABLE DELAY OF 5 MINUTES.

E. MOMENTARY EMERGENCY SOURCE OUTAGE DELAY-ACTIVATED WHEN THE SWITCH IS IN THE EMERGENCY POSITION AND THE EMERGENCY SOURCE FAILS. FACTORY SET AT 4 SECONDS. RESET IF EMERGENCY RESTORES WITHIN 4 SECONDS.

ENGINE CONTROL CONTACTS

ONE SET OF FORM C CONTACTS (1 N/O & 1 N/C) THAT CHANGE POSITION ON EXPIRATION OF THE NORMAL SOURCE OUTAGE DELAY AND RESET ON EXPIRATION OF THE UNLOADED RUNNING (ENGINE COOLDOWN) DELAY. OUTPUT CONTACTS (NR) ARE RATED 5 AMPS RESISTIVE AT 28V DC OR 120V AC MAXIMUM.

OPERATOR INTERFACE INDICATORS & CONTROLS MEMBRANE TYPE

A. TRANSFER SWITCH TEST - MOMENTARY PUSHBUTTON TO SIMULATE NORMAL SOURCE FAILURE SEQUENCE OF OPERATION. PRESS AND HOLD FOR AT LEAST 15 SECONDS TO ALLOW TIME FOR ENGINE-GENERATOR SET TO START.

B. BYPASS TIME DELAY - MOMENTARY PUSHBUTTON TO BYPASS EITHER THE TRANSFER TO EMERGENCY DELAY, ENGINE EXERCISER PERIOD OR THE RETRANSFER TO NORMAL DELAY DEPENDING ON WHICH DELAY IS ACTIVE AT THE TIME THE PUSHBUTTON IS ACTIVATED.

C. SET ENGINE EXERCISER - MOMENTARY PUSHBUTTON TO ACTIVATE A SEVEN (7) DAY TIMER FOR AUTOMATIC WEEKLY TESTING OF THE ENGINE GENERATOR SET EITHER WITH OR WITHOUT LOAD TRANSFER. THE TIMER IS POWERED BY A NON-RECHARGEABLE 9V BATTERY WHEN NORMAL AND EMERGENCY SOURCES ARE UNAVAILABLE. DEPRESSING THE MOMENTARY PUSHBUTTON FOR 5 SECONDS SETS THE TIME OF WEEK AT WHICH TESTING IS TO OCCUR. THE FEATURE IS ACTIVATED BY SETTING A DIP SELECTOR SWITCH ON THE CONTROL PANEL. ENGINE START WITH OR WITHOUT LOAD TRANSFER IS SELECTED WITH A SECOND DIP SELECTOR SWITCH ON THE CONTROL PANEL. FACTORY SET TO DISABLED, NO LOAD. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

D. LOAD CONNECTED TO INDICATORS
GREEN LED INDICATOR TO INDICATE WHEN THE TRANSFER SWITCH LOAD IS CONNECTED TO THE NORMAL SOURCE.
RED LED INDICATOR TO INDICATE WHEN THE TRANSFER SWITCH IS CONNECTED TO THE EMERGENCY SOURCE.

E. SOURCE AVAILABLE INDICATORS
GREEN LED INDICATOR TO INDICATE WHEN THE NORMAL SOURCE IS AVAILABLE.
RED LED INDICATOR TO INDICATE WHEN THE EMERGENCY SOURCE IS AVAILABLE.

REMOTE CONTROL FEATURES

THE FOLLOWING CONTROL PANEL INPUTS PROVIDE REMOTE CONTROL FUNCTIONS FOR THE AUTOMATIC TRANSFER SWITCH. EACH CONTROL FUNCTION CAN BE IMPLEMENTED BY THE CUSTOMER PROVIDING THE FORM OF CONTROL CONTACT DESCRIBED. EACH CONTROL CONTACT MUST BE SUITABLE FOR A 5V DC LOW ENERGY CIRCUIT. EACH CONTROL FEATURE IS ACTIVATED BY SETTING A DIP TYPE SELECTOR SWITCH ON THE CONTROL PANEL. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

A. REMOTE TEST FEATURE - REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT SIMULATES A FAILURE OF THE NORMAL SOURCE SIMILAR TO THE SEQUENCE OUTLINED FOR THE TRANSFER SWITCH TEST PUSHBUTTON. THE TRANSFER SWITCH WILL REMAIN CONNECTED TO THE EMERGENCY SOURCE UNDER ALL CONDITIONS WHILE THE CONTACT IS OPEN.

B. REMOTE TRANSFER TO EMERGENCY FEATURE - REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT CAUSES ENGINE START AND TRANSFER TO THE EMERGENCY SOURCE. RECLOSURE OF THE CONTACT ACTIVATES THE RETRANSFER TO NORMAL DELAY PRIOR TO RETRANSFER, IN THE EVENT THAT THE EMERGENCY SOURCE FAILS WHILE THE TRANSFER SWITCH IS CONNECTED TO EMERGENCY AND THE REMOTE CONTACT IS OPEN, THE TRANSFER SWITCH WILL AUTOMATICALLY RETRANSFER TO THE NORMAL SOURCE.

C. INHIBIT TRANSFER TO EMERGENCY FEATURE - REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT WILL PROHIBIT THE TRANSFER SWITCH FROM TRANSFERRING TO THE EMERGENCY SOURCE WHILE CONNECTED TO THE NORMAL SOURCE.

D. BYPASS TRANSFER TIME DELAY FEATURE - REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT BYPASSES THE RETRANSFER TO NORMAL DELAY IF ACTIVE.

LOAD DISCONNECT FEATURE

ONE SET OF FORM C CONTACTS (1 N/O & 1 N/C) THAT CHANGE POSITION ON ACTIVATION OF A SELECTABLE TIME DELAY BEFORE TRANSFER (LD TDBT) AND RESET EITHER IMMEDIATELY FOLLOWING TRANSFER OR FOR THE SAME DELAY AS SET FOR PRE-SIGNAL BEFORE TRANSFER. SELECTABLE AS 0, 3, 10 OR 20 SECONDS. FACTORY SET AT 0. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS). OUTPUT CONTACTS (OP) ARE RATED 5 AMPS RESISTIVE AT 28V DC OR 120V AC MAXIMUM.

MOTOR LOAD TRANSFER FEATURE

INPHASE TRANSFER CONTROL LOGIC TO INITIATE AN INPHASE TRANSFER OF MOTOR LOADS BETWEEN LIVE SOURCES. USED TO HELP PREVENT NUISANCE TRIPPING OF DISTRIBUTION CIRCUIT BREAKERS AND POSSIBLE DAMAGE TO MECHANICAL LOADS ASSOCIATED WITH OUT OF PHASE TRANSFER. ACTIVATED BY SETTING A DIP SWITCH ON THE CONTROL PANEL. FACTORY SET AS DISABLED. (REFER TO OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

OTHER STANDARD FEATURES

A. SOLID NEUTRAL CONNECTION WITH FULL RATED TERMINAL LUGS FOR NORMAL, EMERGENCY AND LOAD.

B. EQUIPMENT GROUND STUD FOR INSTALLATION OF CUSTOMER PROVIDED GROUND TERMINATIONS.

OPTIONAL ACCESSORIES

PROGRAMMABLE ENGINE EXERCISER (ACCESSORY 11CD)

A PROGRAMMABLE SEVEN (7) DAY ELECTRONIC TIME SWITCH FOR AUTOMATIC WEEKLY TESTING OF THE ENGINE GENERATOR SET EITHER WITH OR WITHOUT LOAD. EACH DAY OF THE WEEK IS INDIVIDUALLY PROGRAMMABLE. THE TIME OF DAY IS PRESERVED FOR UP TO 150 HOURS BY A BATTERY BUILT INTO THE ELECTRONIC TIME SWITCH. THE FEATURE IS ACTIVATED BY SETTING A DIP SELECTOR SWITCH ON THE CONTROL PANEL. ENGINE START WITH OR WITHOUT LOAD TRANSFER IS SELECTED WITH A SECOND DIP SELECTOR SWITCH ON THE CONTROL PANEL. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL AND TIME SETTINGS).

SERIAL COMMUNICATIONS INTERFACE (ACCESSORY 72A)

RS-485 SERIAL INTERFACE TO CONTROL PANEL, FOR REMOTE MONITORING AND CONTROL FROM ASCO COMMUNICATIONS BASED PRODUCTS.

ACC. 14AA	(2) AUXILIARY CONTACT CLOSED ON NORMAL.
ACC 14BA	(2) AUXILIARY CONTACT CLOSED ON EMERGENCY.
ACC. 44A	STRIP HEATER, THERMOSTAT & TB. CUSTOMER POWER SUPPLY 120VAC.
ACC. 44G	STRIP HEATER, THERMOSTAT & TRANSFOMER. POWER SUPPLY FROM LOAD TERMINALS OF TRANSFER SWITCH.
ACC.37B	EXTENSION HARNESS FOR UNITS SHIPPED OPEN TO ACCOMODATE CUSTOMER MOUNTING OF CONTROLS AND SWITCH. EXTENSION IS 1828mm (72IN) LONG.

WIRING DIAGRAM, ASCO 300 AUTOMATIC TRANSFER SWITCHES

145236	SEE ECN			F	7/8/97	YZ	
144041	SEE ECN			E	4/3/97	YZ	
143730	SEE ECN			D	2/97	YZ	
E.R. NO.	ITEM CHGD.			CHG.	DATE	APVD.	

DRAWN	DATE	CHECKED	DATE	APP. DFTG.	DATE	APP. ENG.	DATE
CC	2/95					SH	2/95

DS 493577

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AL | AP | CHG LTR: J | SHEET 2OF2

SINGLE PHASE WIRING FOR ASCO SERIES 300 AUTOMATIC TRANSFER SWITCHES RATED 600, 800, 1000 & 1200 AMPERES WITH GROUP 1 CONTROLS

CONTROL FEATURES

VOLTAGE AND FREQUENCY SENSING

A. DIFFERENTIAL TYPE VOLTAGE SENSING ON ALL PHASES OF NORMAL SOURCE. DROPOUT SETTING SELECTABLE AT 90, 85, 80 OR 70% OF NOMINAL. FACTORY SET AT 85%. PICKUP VOLTAGE ADJUSTABLE AT 90 OR 95% OF NOMINAL. (DEFAULT IS 95% IF DROPOUT IS SET TO 90%). FACTORY SET AT 90%. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

B. SINGLE PHASE VOLTAGE SENSING OF EMERGENCY SOURCE. NON-ADJUSTABLE DROPOUT SETTING AT 75% OF NOMINAL. NON-ADJUSTABLE PICKUP SETTING AT 90% OF NOMINAL.

C. FREQUENCY SENSING OF EMERGENCY SOURCE. NON-ADJUSTABLE DROPOUT SETTING AT 85% OF NOMINAL. NON-ADJUSTABLE PICKUP SETTING AT 95% OF NOMINAL.

TIME DELAYS

A. MOMENTARY NORMAL SOURCE OUTAGE DELAY – ACTIVATED WHEN THE NORMAL SOURCE FAILS. DEACTIVATED WHEN THE NORMAL SOURCE IS ACCEPTABLE. PROVIDES A SELECTABLE (1 OR 3 SECOND) DELAY ON TRANSFER AND ENGINE STARTING SIGNALS. FACTORY SET AT 3 SECONDS. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

B. TRANSFER TO EMERGENCY DELAY– ACTIVATED AFTER THE MOMENTARY NORMAL SOURCE OUTAGE DELAY EXPIRES AND THE EMERGENCY SOURCE IS SENSED TO BE ACCEPTABLE. TRANSFER TO EMERGENCY IS COMMITTED TO ON INITIATION OF DELAY. DEACTIVATED WHEN THE EMERGENCY SOURCE IS UNACCEPTABLE. PROVIDES AN ADJUSTABLE DELAY FROM 0 TO 5 MINUTES. FACTORY SET AT 0 MINUTES. (REFER TO OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

C. RETRANSFER TO NORMAL DELAY – ACTIVATED WHEN THE NORMAL SOURCE IS ACCEPTABLE. DEACTIVATED WHEN THE NORMAL SOURCE FAILS WITH NO TRANSFER TO NORMAL. ALSO DEACTIVATED WHEN THE EMERGENCY SOURCE FAILS WHILE THE NORMAL SOURCE IS ACCEPTABLE WITH TRANSFER TO NORMAL. ADJUSTABLE DELAY FROM 1 SECOND TO 30 MINUTES. FACTORY SET TO 30 MINUTES. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

D. UNLOADED RUNNING (ENGINE COOL DOWN) DELAY – ACTIVATED ON EXPIRATION OF RETRANSFER TO NORMAL DELAY OR FOLLOWING EXPIRATION OF THE NORMAL SOURCE OUTAGE DELAY WITHOUT A COMMIT TO TRANSFER TO EMERGENCY. NON-ADJUSTABLE DELAY OF 5 MINUTES.

E. MOMENTARY EMERGENCY SOURCE OUTAGE DELAY–ACTIVATED WHEN THE SWITCH IS IN THE EMERGENCY POSITION AND THE EMERGENCY SOURCE FAILS. FACTORY SET AT 4 SECONDS. RESET IF EMERGENCY RESTORES WITHIN 4 SECONDS.

ENGINE CONTROL CONTACTS

ONE SET OF FORM C CONTACTS (1 N/O & 1 N/C) THAT CHANGE POSITION ON EXPIRATION OF THE NORMAL SOURCE OUTAGE DELAY AND RESET ON EXPIRATION OF THE UNLOADED RUNNING (ENGINE COOL DOWN) DELAY. OUTPUT CONTACTS (NR) ARE RATED 5 AMPS RESISTIVE AT 28V DC OR 120V AC MAXIMUM.

OPERATOR INTERFACE INDICATORS & CONTROLS MEMBRANE TYPE

A. TRANSFER SWITCH TEST – MOMENTARY PUSH-BUTTON TO SIMULATE NORMAL SOURCE FAILURE SEQUENCE OF OPERATION. PRESS AND HOLD FOR AT LEAST 15 SECONDS TO ALLOW TIME FOR ENGINE-GENERATOR SET TO START.

B. BYPASS TIME DELAY – MOMENTARY PUSH-BUTTON TO BYPASS EITHER THE TRANSFER TO EMERGENCY DELAY, ENGINE EXERCISER PERIOD OR THE RETRANSFER TO NORMAL DELAY DEPENDING ON WHICH DELAY IS ACTIVE AT THE TIME THE PUSH-BUTTON IS ACTIVATED.

C. SET ENGINE EXERCISER – MOMENTARY PUSH-BUTTON TO ACTIVATE A SEVEN (7) DAY TIMER FOR AUTOMATIC WEEKLY TESTING OF THE ENGINE GENERATOR SET EITHER WITH OR WITHOUT LOAD TRANSFER. THE TIMER IS POWERED BY A NON-RECHARGEABLE 9V BATTERY WHEN NORMAL AND EMERGENCY SOURCES ARE UNAVAILABLE. DEPRESSING THE MOMENTARY PUSH-BUTTON FOR 5 SECONDS SETS THE TIME OF WEEK AT WHICH TESTING IS TO OCCUR. THE FEATURE IS ACTIVATED BY SETTING A DIP SELECTOR SWITCH ON CONTROL PANEL. ENGINE START WITH OR WITHOUT LOAD TRANSFER IS SELECTED WITH A SECOND DIP SELECTOR SWITCH ON THE CONTROL PANEL. FACTORY SET TO DISABLED, NO LOAD. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

D. LOAD CONNECTED TO INDICATORS GREEN LED INDICATOR TO INDICATE WHEN THE TRANSFER SWITCH LOAD IS CONNECTED TO THE NORMAL SOURCE. RED LED INDICATOR TO INDICATE WHEN THE TRANSFER SWITCH IS CONNECTED TO THE EMERGENCY SOURCE.

E. SOURCE AVAILABLE INDICATORS GREEN LED INDICATOR TO INDICATE WHEN THE NORMAL SOURCE IS AVAILABLE. RED LED INDICATOR TO INDICATE WHEN THE EMERGENCY SOURCE IS AVAILABLE.

LOAD DISCONNECT FEATURE

ONE SET OF FORM C CONTACTS (1 N/O & 1 N/C) THAT CHANGE POSITION ON ACTIVATION OF A SELECTABLE TIME DELAY BEFORE TRANSFER (LD TDBT) AND RESET EITHER IMMEDIATELY FOLLOWING TRANSFER OR FOR THE SAME DELAY AS SET FOR PRE-SIGNAL BEFORE TRANSFER. SELECTABLE AS 0, 3, 10 OR 20 SECONDS. FACTORY SET AT 0. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS). OUTPUT CONTACTS (OP) ARE RATED 5 AMPS RESISTIVE AT 28 VDC OR 120 VAC MAXIMUM.

MOTOR LOAD TRANSFER FEATURE

INPHASE TRANSFER CONTROL LOGIC TO INITIATE AN INPHASE TRANSFER OF MOTOR LOADS BETWEEN LIVE SOURCES. USED TO HELP PREVENT NUISANCE TRIPPING OF DISTRIBUTION CIRCUIT BREAKERS AND POSSIBLE DAMAGE TO MECHANICAL LOADS ASSOCIATED WITH OUT OF PHASE TRANSFER. ACTIVATED BY SETTING A DIP SWITCH ON THE CONTROL PANEL. FACTORY SET AS DISABLED. (REFER TO OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

REMOTE CONTROL FEATURES

THE FOLLOWING CONTROL PANEL INPUTS PROVIDE REMOTE CONTROL FUNCTIONS FOR THE AUTOMATIC TRANSFER SWITCH. EACH CONTROL FUNCTION CAN BE IMPLEMENTED BY THE CUSTOMER PROVIDING THE FORM OF CONTROL CONTACT DESCRIBED. EACH CONTROL CONTACT MUST BE SUITABLE FOR A 5 VDC LOW ENERGY CIRCUIT. EACH CONTROL FEATURE IS ACTIVATED BY SETTING A DIP TYPE SELECTOR SWITCH ON THE CONTROL PANEL. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

A. REMOTE TEST FEATURE – REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT SIMULATES A FAILURE OF THE NORMAL SOURCE SIMILAR TO THE SEQUENCE OUTLINED FOR THE TRANSFER SWITCH TEST PUSH-BUTTON. THE TRANSFER SWITCH WILL REMAIN CONNECTED TO THE EMERGENCY SOURCE UNDER ALL CONDITIONS WHILE THE CONTACT IS OPEN.

B. REMOTE TRANSFER TO EMERGENCY FEATURE – REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT CAUSES ENGINE START AND TRANSFER TO THE EMERGENCY SOURCE. RECLOSURE OF THE CONTACT ACTIVATES THE RETRANSFER TO NORMAL DELAY PRIOR TO RETRANSFER. IN THE EVENT THAT THE EMERGENCY SOURCE FAILS WHILE THE TRANSFER SWITCH IS CONNECTED TO EMERGENCY AND THE REMOTE CONTACT IS OPEN, THE TRANSFER SWITCH WILL AUTOMATICALLY RETRANSFER TO THE NORMAL SOURCE.

C. INHIBIT TRANSFER TO EMERGENCY FEATURE – REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT WILL PROHIBIT THE TRANSFER SWITCH FROM TRANSFERRING TO THE EMERGENCY SOURCE WHILE CONNECTED TO THE NORMAL SOURCE.

D. BYPASS TRANSFER TIME DELAY FEATURE – REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT BYPASSES THE RETRANSFER TO NORMAL DELAY IF ACTIVE.

GENERAL NOTES

1. SWITCH SHOWN DE-ENERGIZED CONNECTED TO NORMAL SOURCE. DEVICE SYMBOLS AND DESIGNATIONS ARE IN ACCORDANCE WITH NEMA PUB. ICS 1-1983, PART 1-101A.
2. TS WIRES: #16 AWG ON 600-1200 AMPS, CONTROL PANEL WIRING IS #16 AWG. ALL WIRES ARE STRANDED COPPER.
3. ○ INDICATES CUSTOMER CONNECTION POINTS.
4. ● INDICATES FACTORY CONNECTION POINTS.
5. CONNECTION POINTS THAT HAVE BOTH CUSTOMER CONNECTIONS AND FACTORY CONNECTIONS ARE SHOWN OPEN AS CUSTOMER CONNECTION POINTS.
6. THE TRANSFER UNIT IS MOUNTED ON THE BACK INSIDE SURFACE OF THE ENCLOSURE. THE CONTROL PANEL AND ANY OPTIONAL ACCESSORIES ARE MOUNTED ON THE INSIDE SURFACE OF THE DOOR.
7. **AN OPERATOR'S MANUAL IS FURNISHED WITH EACH AUTOMATIC TRANSFER SWITCH. REFER TO THIS PUBLICATION PRIOR TO INSTALLATION AND OPERATION OF THE SWITCH.**
8. GROUND STRAP ON CONTROL PANEL IS AFFIXED TO CHASSIS (ENCLOSURE) AT LOWER LEFT CONTROL PANEL MOUNTING STUD.

OPTIONAL ACCESSORIES

ACCESSORY 11BG – PROGRAMMABLE ENGINE EXERCISER & SOURCE AVAILABILITY SIGNAL MODULES

PROGRAMMABLE ENGINE EXERCISER: A PROGRAMMABLE SEVEN (7) DAY OR FOURTEEN (14) DAY ELECTRONIC TIME SWITCH FOR AUTOMATIC WEEKLY TESTING OF THE ENGINE GENERATOR SET EITHER WITH OR WITHOUT LOAD. EACH DAY OF THE WEEK IS INDIVIDUALLY PROGRAMMABLE. THE TIME OF DAY IS PRESERVED BY A BATTERY BUILT INTO THE GROUP 1 TRANSFER SWITCH CONTROL PANEL.

THE FEATURE IS ACTIVATED BY SETTING A DIP SELECTOR SWITCH ON THE CONTROL PANEL. ENGINE START WITH OR WITHOUT LOAD TRANSFER IS SELECTED WITH A SECOND DIP SELECTOR SWITCH ON THE CONTROL PANEL. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL AND TIMER SETTINGS).

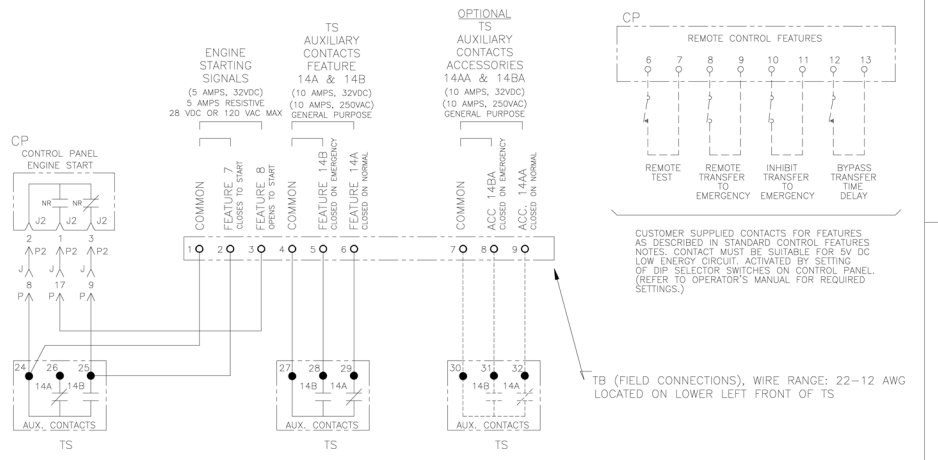
SOURCE AVAILABILITY SIGNALLING : ONE FORM C CONTACT EACH FOR THE NORMAL & EMERGENCY SOURCES SIGNAL THE ACCEPTABILITY OF THE SOURCE AS SENSED BY THE GROUP 1 CONTROL PANEL. THE SIGNAL CONTACTS OPERATE IN CONJUNCTION WITH THE SOURCE AVAILABILITY LED STATUS INDICATION PROVIDED ON THE OPERATOR INTERFACE. FIELD WIRING TERMINALS ARE PROVIDED AS SHOWN, LOCATED ON THE INSIDE DOOR BEHIND THE OPERATOR INTERFACE. CONTACTS RATED 2 AMPS @ 30VDC, 0.5 AMPS @ 125 VAC (RESISTIVE).

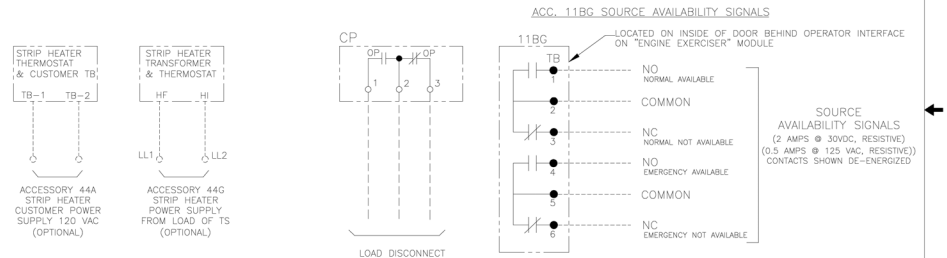
SERIAL COMMUNICATIONS INTERFACE (ACCESSORY 72A)

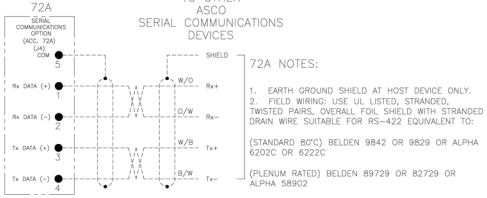
RS-485 SERIAL INTERFACE TO CONTROL PANEL FOR REMOTE MONITORING AND CONTROL FROM ASCO COMMUNICATIONS BASED PRODUCTS.

ACC. 14AA (2) AUXILIARY CONTACT CLOSED ON NORMAL.
ACC. 14BA (2) AUXILIARY CONTACT CLOSED ON EMERGENCY.
ACC. 44A STRIP HEATER, THERMOSTAT & TB. CUSTOMER POWER SUPPLY 120VAC.
ACC. 44G STRIP HEATER, THERMOSTAT & TRANSFOMER. POWER SUPPLY FROM LOAD TERMINALS OF TRANSFER SWITCH.

FIELD CONNECTIONS







72A NOTES:

1. EARTH GROUND SHIELD AT HOST DEVICE ONLY.
2. FIELD WIRING: USE UL LISTED, STRANDED, TWISTED PAIRS, OVERALL FOIL SHIELD WITH STRANDED DRAIN WIRE SUITABLE FOR RS-422 EQUIVALENT TO:

(STANDARD 80°C) BELDEN 9842 OR 9829 OR ALPHA 6202C OR 6222C

(PLENUM RATED) BELDEN 89729 OR 82729 OR ALPHA 58902

BASE CATALOG NUMBER / CATALOG NUMBER SUFFIXES

TS FRAME	CATALOG TYPE	NEUTRAL TYPE	PHASE POLES	AMPS	VOLT CODE	CONTROLLER	OPTIONAL ACCESSORY	ENCLOSURE CODE
H	300	B C	2	600 800 1000 1200	C E F H J K L M N P Q R	1	X	C F G L
							BLANK FOR NONE	BLANK FOR OPEN TYPE

EXPLANATION OF CATALOG NUMBER CODES

NEUTRAL TYPE CODE	NEUTRAL TYPE DESCRIPTION
BLANK	SOLID
B	SWITCHING
C	OVERLAPPING

VOLTAGE CODES 1 PHASE (2 OR 3 WIRE) 50 OR 60 Hz CODE	NOMINAL VOLTAGE
C	208
D	220
E	230
F	240
H	380
J	400
K	415
L	440
M	460
N	480
P	550
Q	575
R	600

ENCLOSURE CODES CODE	TYPE	DESCRIPTION
BLANK		OPEN TYPE (NO ENCLOSURE)
C	1	GENERAL PURPOSE, INDOOR
F	3R	OUTDOOR, RAINPROOF, SLEET & ICE RESISTANT
G	4	INDOOR/OUTDOOR, WATERTIGHT & DUSTTIGHT
L	12	INDOOR, INDUSTRIAL ENVIRONMENTS, OILTIGHT & DUSTTIGHT

CATALOG NUMBER _____
CERTIFIED TO ASCO® S.O. _____
BY _____
DATE _____
FORM REV F
PROJECT NAME:

WIRING DIAGRAM
SERIES H300 ATS
GROUP 1 CONTROLS

THIRD ANGLE PROJECTION

	BY	DATE
DRAWN BY	BWM	4/01
CHECKED	BK	4/10/01
DRAFTING APPROVAL		
FINAL APPROVAL	WK	4/10/01

MANUFACTURING TOLERANCES TO BE IN ACCORDANCE WITH ASCO PROCEDURE MP-1-003. FOR PLASTIC PARTS SEE MP-1-055.

ASSEM. REF. NO.

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CHANGE LETTER	ECN NO.	BY	APP.	DATE
F	167603 SEE ECN	BK	BK	07/22/04
E	167217 SEE ECN	SDH	SDH	06/04/04
D	166704 SEE ECN	BWM	WK	03/31/04
C	164762 ADD 11BG	BWM	WK	9/03
B	161046 SEE ECN	BWM	SDH	6/02
A	157813 SEE ECN	BWM	WK	5/24/01
—	157352 ISSUE	BWM	WK	4/01

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AE AN AM AJ AL
CH AV AA PS AR
AG AP AC AS

COMPUTER GENERATED DRAWING

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SIZE DWG. NO. DS717500

CHANGE LETTER F ECN NO. 167603 SHEET 1 OF 4

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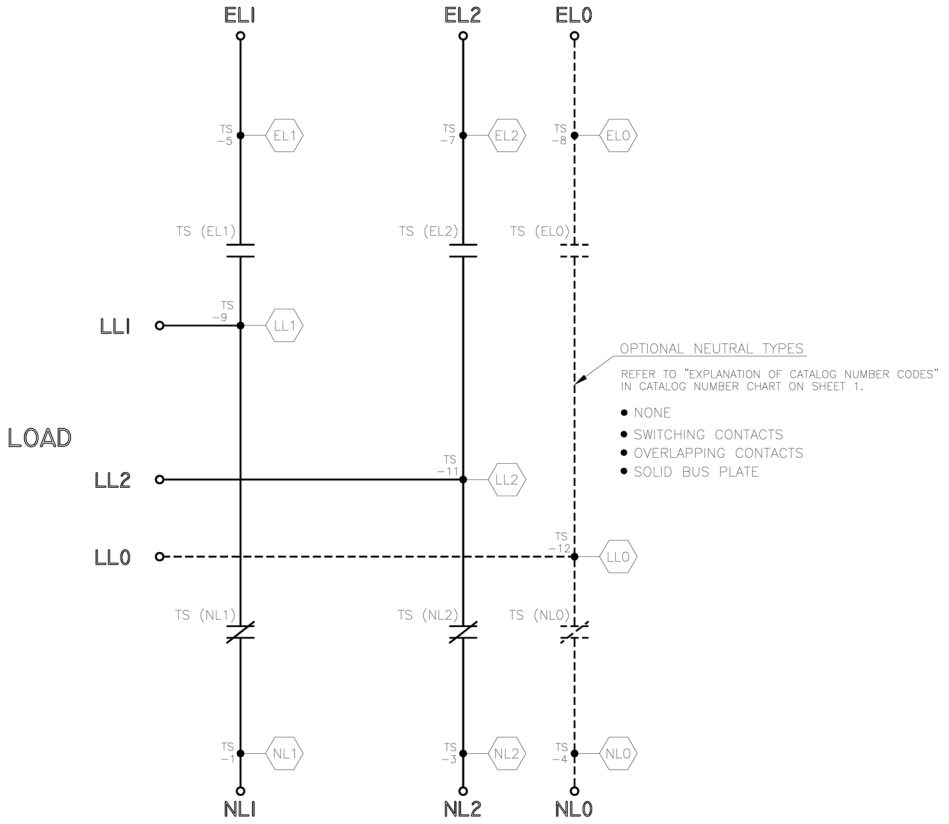
MAIN POWER POLES

EMERGENCY



OPTIONAL NEUTRAL TYPES

REFER TO "EXPLANATION OF CATALOG NUMBER CODES" IN CATALOG NUMBER CHART ON SHEET 1.

- NONE
- SWITCHING CONTACTS
- OVERLAPPING CONTACTS
- SOLID BUS PLATE

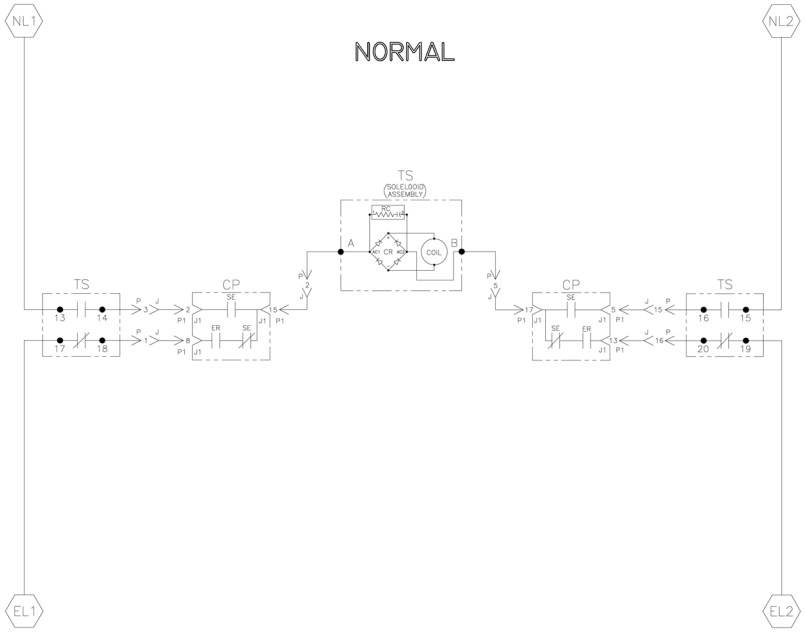
NORMAL

NOTE:
ATS SHOWN CLOSED ON NORMAL SOURCE.

TS CONTROL CONTACTS					
TS	SOLENOID POSITION				
	CLOSED BEFORE NORMAL	TDC	>	<	BEFORE TDC	CLOSED EMERG
13–14						
15–16						
17–18						
19–20						

TDC (TOP DEAD CENTER)
TRANSFER SWITCH TEST & ADJUSTMENT PROCEDURE SPECIFIES CONTROL CUT-OFF (CONTACT OPENING) SETTING.

TS OPERATOR CIRCUIT



CHANGE LETTER	ECN NO.	BY	APP.	DATE
F	167603	BK	BK	07/22/04
	SEE ECN			
E	167217	SDH	SDH	06/04/04
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	SEE ECN			
C	164762	BWM	WK	9/03
	ADD 11BG			
B	161046	BWM	SDH	6/02
	SEE ECN			
A	157813	BWM	WK	5/24/01
	SEE ECN			
—	157352	BWM	WK	4/01
	ISSUE			

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CH	☐	AV	☐	AA	☐	PS	☐	AR	☐	☐
AG	☐	AP	☐	AC	☐	AS	☐			☐

PROJECT NAME:

WIRING DIAGRAM
SERIES H300 ATS
GROUP 1 CONTROLS

THIRD ANGLE PROJECTION

ASSEM. REF. NO.

COMPUTER GENERATED DRAWING

	BY	DATE
DRAWN BY	BWM	4/01
CHECKED	BK	4/10/01
DRAFTING APPROVAL		
FINAL APPROVAL	WK	4/10/01

MANUFACTURING TOLERANCES TO BE IN ACCORDANCE WITH ASCO PROCEDURE MP-I-003. FOR PLASTIC PARTS SEE MP-I-005.

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SCALE 1:1 | ACAD | FILE

SIZE DWG. NO. DS717500

CHANGE LETTER F | TCN NO. 167603 | SHEET 2 OF 4

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WIRE RUN LISTING

HARNESS LOCATOR 1 — BOX CHECKED IF HARNESS IS MODIFIED ☐

WIRE No.	713082 (P) MAIN TS	AWG CLR
1	P-1,TS-18	16
2	P-2,TS-A	
3	P-3,TS-14	
4	P-4,TS-3	
5	TS-3,TS-15	
6	P-5,TS-B	
7	P-6,TS-7	
8	TS-7,TS-19	
9	P-7,TS-5	
10	TS-5,TS-17	
11	P-8,TS-24	
12	TS-24,TB-1	
13	P-9,TS-25	
14	TS-25,TB-2	
15	P-10,TS-21	
16	P-11,TS-2	
17	P-12,TS-1	
18	TS-1,TS-13	
19	P-13,TS-22	
20	P-14,TS-23	
21	P-15,TS-16	
22	P-16,TS-20	
23	P-17,TB-3	
24	P-18,TS-6	
25	P-19,TS-9	
26	P-20,TS-10	
27	P-21,TS-11	
	P-22,TS-4	
	P-23,TS-8	
	P-24,TS-12	
	TS-27,TB-4	
	TS-28,TB-5	
	TS-29,TB-6	
	DEAD END WIRES	
11	P-11,TS-2	
18	P-18,TS-6	
20	P-20,TS-10	

HARNESS LOCATOR 2 — BOX CHECKED IF HARNESS IS MODIFIED ☐

WIRE No.	HARNESS 483763 (J, P1, P2) TS-CP HARNESS	AWG CLR
1	J-1,P1-8	16
2	J-2,P1-15	
3	J-3,P1-2	
4	J-4,P1-4	
5	J-5,P1-17	
6	J-6,P1-12	
7	J-7,P1-7	
8	J-8,P2-2	
9	J-9,P2-3	
10	J-10,P2-8	
11	J-11,P1-10	
12	J-12,P1-1	
13	J-13,P2-9	
14	J-14,P2-10	
15	J-15,P1-5	
16	J-16,P1-13	
17	J-17,P2-1	
18	J-18,P1-14	

OPTIONAL ACCESSORIES

HARNESS LOCATOR 3

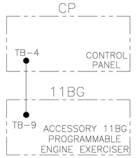
WIRE No.	OPTIONAL ACC. 11BG CKTS.	AWG CLR
28	CP-TB-4,11BG-TB-9	16

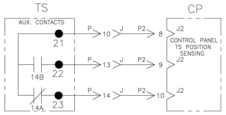
HARNESS LOCATOR 4

WIRE No.	OPTIONAL ACC. 14AA & 14BA	AWG CLR
32	TS-30,TB-7	16
33	TS-31,TB-8	
34	TS-32,TB-9	

CONTROL SIGNALS & INDICATION

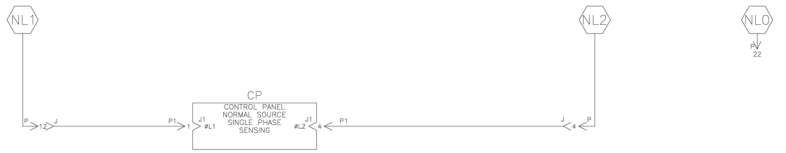
ACCESSORY 11BG PROGRAMMABLE ENGINE EXERCISER & SOURCE AVAILABILITY SIGNAL (OPTIONAL)





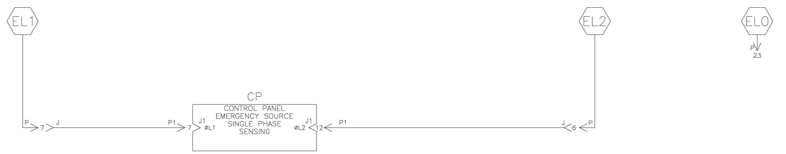
NORMAL SOURCE CIRCUITS

NORMAL



EMERGENCY SOURCE CIRCUITS

EMERGENCY



LOAD TERMINAL CIRCUITS

LOAD

CHANGE LETTER	ECN NO.	BY	APP.	DATE
F	167603	BK	BK	07/22/04
	SEE ECN			
E	167217	SDH	SDH	06/04/04
	SEE ECN			
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	SEE ECN			
C	164762	BWM	WK	9/03
	ADD 11BG			
B	161046	BWM	SDH	6/02
	SEE ECN			
A	157813	BWM	WK	5/24/01
	SEE ECN			
—	157352	BWM	WK	4/01
	ISSUE			

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PROJECT NAME:
WIRING DIAGRAM
SERIES H300 ATS
GROUP 1 CONTROLS

THIRD ANGLE PROJECTION

	BY	DATE
DRAWN BY	BWM	4/01
CHECKED	BK	4/10/01
DRAFTING APPROVAL		
FINAL APPROVAL	WK	4/10/01

MANUFACTURING TOLERANCES TO BE IN ACCORDANCE WITH ASCO PROCEDURE MP-I-003. FOR PLASTIC PARTS SEE MP-I-005.

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SIZE | DWG. NO. DS717500

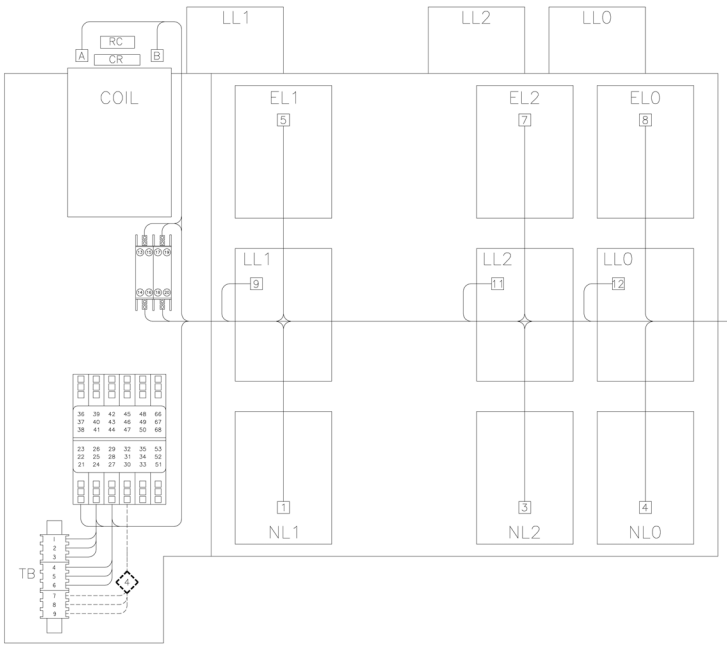
CHANGE LETTER F | SCN NO. 167603 | SHEET 3 OF 4

Katolight University - Gen II Training - Rev:06-01-06 - Page 446

PHYSICAL DIAGRAM

ENCLOSURE

TS (TRANSFER SWITCH) VIEW FROM INSIDE FRONT



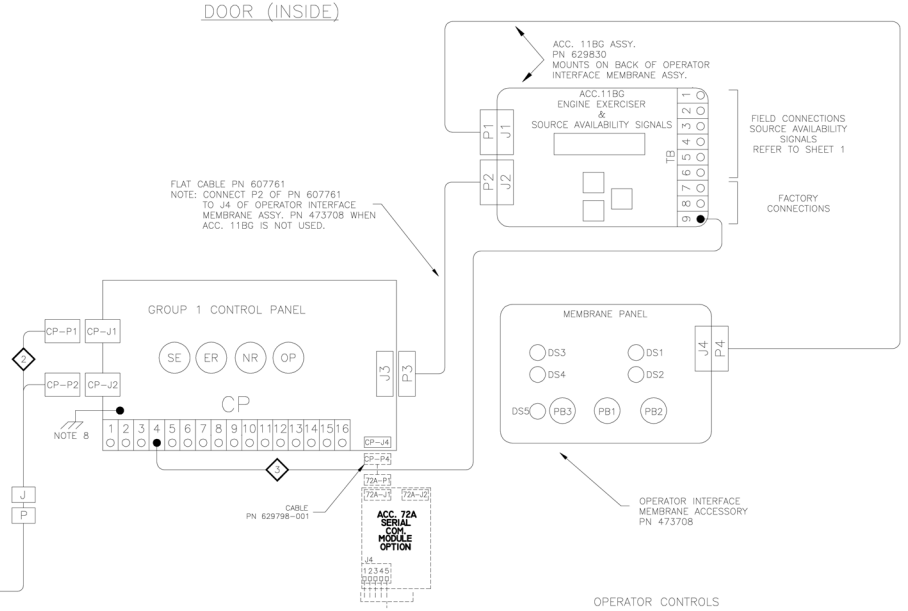
TO LOAD OF ATS
(OPTIONAL ACC. 44G)
OR
TO CUSTOMER POWER
SUPPLY 120VAC
(OPTIONAL ACC. 44A)

HEATER
ACCESSORY

DOOR HINGE

BONDING STRAP
PN 098323-019

DOOR (INSIDE)



ASCO OPTIONAL
SERIAL COMMUNICATION
DEVICE

OPERATOR CONTROLS

ID	DESCRIPTION
DS1	TS CONNECTED TO NORMAL
DS2	TS CONNECTED TO EMERGENCY
DS3	NORMAL SOURCE AVAILABLE
DS4	EMERGENCY SOURCE AVAILABLE
DS5	ENGINE EXERCISER
PB1	BYPASS TIME DELAY
PB2	TRANSFER SWITCH TEST
PB3	SET ENGINE EXERCISER

CHANGE LETTER	ECN NO.	BY	APP.	DATE
F	167603	BK	BK	07/22/04
	SEE ECN			
E	167217	SDH	SDH	06/04/04
	SEE ECN			
D	166704	BWM	WK	03/31/04
	SEE ECN			
C	164762	BWM	WK	9/03
	ADD 11BG			
B	161046	BWM	SDH	6/02
	SEE ECN			
A	157813	BWM	WK	5/24/01
	SEE ECN			
—	157352	BWM	WK	4/01
	ISSUE			

PROJECT NAME:

WIRING DIAGRAM
SERIES H300 ATS
GROUP 1 CONTROLS

THIRD ANGLE PROJECTION

	BY	DATE
DRAWN BY	BWM	4/01
CHECKED	BK	4/10/01
DRAFTING APPROVAL		
FINAL APPROVAL	WK	4/10/01

MANUFACTURING TOLERANCES TO BE IN ACCORDANCE WITH ASCO PROCEDURE MP-I-003. FOR PLASTIC PARTS SEE MP-I-005.

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CH	☐	AV	☐	AA	☐	PS	☐	AR	☐		
AG	☐	AP	☐	AC	☐	AS	☐				

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SIZE | DWG. NO. | DS717500

CHANGE LETTER F | TCN # NO. 167603 | SHEET 4 OF 4

THREE PHASE WIRING FOR ASCO SERIES 300 AUTOMATIC TRANSFER SWITCHES RATED 600, 800, 1000 & 1200 AMPERES WITH GROUP I CONTROLS

CONTROL FEATURES

VOLTAGE AND FREQUENCY SENSING

A. DIFFERENTIAL TYPE VOLTAGE SENSING ON ALL PHASES OF NORMAL SOURCE. DROPOUT SETTING SELECTABLE AT 90, 85, 80 OR 70% OF NOMINAL. FACTORY SET AT 85%. PICKUP VOLTAGE ADJUSTABLE AT 90 OR 95% OF NOMINAL. (DEFAULT IS 95% IF DROPOUT IS SET TO 90%). FACTORY SET AT 90%. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

B. SINGLE PHASE VOLTAGE SENSING OF EMERGENCY SOURCE. NON-ADJUSTABLE DROPOUT SETTING AT 75% OF NOMINAL. NON-ADJUSTABLE PICKUP SETTING AT 90% OF NOMINAL.

C. FREQUENCY SENSING OF EMERGENCY SOURCE. NON-ADJUSTABLE DROPOUT SETTING AT 85% OF NOMINAL. NON-ADJUSTABLE PICKUP SETTING AT 95% OF NOMINAL.

TIME DELAYS

A. MOMENTARY NORMAL SOURCE OUTAGE DELAY – ACTIVATED WHEN THE NORMAL SOURCE FAILS. DEACTIVATED WHEN THE NORMAL SOURCE IS ACCEPTABLE. PROVIDES A SELECTABLE (1 OR 3 SECOND) DELAY ON TRANSFER AND ENGINE STARTING SIGNALS. FACTORY SET AT 3 SECONDS. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

B. TRANSFER TO EMERGENCY DELAY– ACTIVATED AFTER THE MOMENTARY NORMAL SOURCE OUTAGE DELAY EXPIRES AND THE EMERGENCY SOURCE IS SENSED TO BE ACCEPTABLE. TRANSFER TO EMERGENCY IS COMMITTED TO ON INITIATION OF DELAY. DEACTIVATED WHEN THE EMERGENCY SOURCE IS UNACCEPTABLE. PROVIDES AN ADJUSTABLE DELAY FROM 0 TO 5 MINUTES. FACTORY SET AT 0 MINUTES. (REFER TO OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

C. RETRANSFER TO NORMAL DELAY – ACTIVATED WHEN THE NORMAL SOURCE IS ACCEPTABLE. DEACTIVATED WHEN THE NORMAL SOURCE FAILS WITH NO TRANSFER TO NORMAL. ALSO DEACTIVATED WHEN THE EMERGENCY SOURCE FAILS WHILE THE NORMAL SOURCE IS ACCEPTABLE WITH TRANSFER TO NORMAL. ADJUSTABLE DELAY FROM 1 SECOND TO 30 MINUTES. FACTORY SET TO 30 MINUTES. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

D. UNLOADED RUNNING (ENGINE COOL DOWN) DELAY – ACTIVATED ON EXPIRATION OF RETRANSFER TO NORMAL DELAY OR FOLLOWING EXPIRATION OF THE NORMAL SOURCE OUTAGE DELAY WITHOUT A COMMIT TO TRANSFER TO EMERGENCY. NON-ADJUSTABLE DELAY OF 5 MINUTES.

E. MOMENTARY EMERGENCY SOURCE OUTAGE DELAY–ACTIVATED WHEN THE SWITCH IS IN THE EMERGENCY POSITION AND THE EMERGENCY SOURCE FAILS. FACTORY SET AT 4 SECONDS. RESET IF EMERGENCY RESTORES WITHIN 4 SECONDS.

ENGINE CONTROL CONTACTS

ONE SET OF FORM C CONTACTS (1 N/O & 1 N/C) THAT CHANGE POSITION ON EXPIRATION OF THE NORMAL SOURCE OUTAGE DELAY AND RESET ON EXPIRATION OF THE UNLOADED RUNNING (ENGINE COOL DOWN) DELAY. OUTPUT CONTACTS (NR) ARE RATED 5 AMPS RESISTIVE AT 28V DC OR 120V AC MAXIMUM.

OPERATOR INTERFACE INDICATORS & CONTROLS MEMBRANE TYPE

A. TRANSFER SWITCH TEST – MOMENTARY PUSH-BUTTON TO SIMULATE NORMAL SOURCE FAILURE SEQUENCE OF OPERATION. PRESS AND HOLD FOR AT LEAST 15 SECONDS TO ALLOW TIME FOR ENGINE-GENERATOR SET TO START.

B. BYPASS TIME DELAY – MOMENTARY PUSH-BUTTON TO BYPASS EITHER THE TRANSFER TO EMERGENCY DELAY, ENGINE EXERCISER PERIOD OR THE RETRANSFER TO NORMAL DELAY DEPENDING ON WHICH DELAY IS ACTIVE AT THE TIME THE PUSH-BUTTON IS ACTIVATED.

C. SET ENGINE EXERCISER – MOMENTARY PUSH-BUTTON TO ACTIVATE A SEVEN (7) DAY TIMER FOR AUTOMATIC WEEKLY TESTING OF THE ENGINE GENERATOR SET EITHER WITH OR WITHOUT LOAD TRANSFER. THE TIMER IS POWERED BY A NON-RECHARGEABLE 9V BATTERY WHEN NORMAL AND EMERGENCY SOURCES ARE UNAVAILABLE. DEPRESSING THE MOMENTARY PUSH-BUTTON FOR 5 SECONDS SETS THE TIME OF WEEK AT WHICH TESTING IS TO OCCUR. THE FEATURE IS ACTIVATED BY SETTING A DIP SELECTOR SWITCH ON THE CONTROL PANEL. ENGINE START WITH OR WITHOUT LOAD TRANSFER IS SELECTED WITH A SECOND DIP SELECTOR SWITCH ON THE CONTROL PANEL. FACTORY SET TO DISABLED, NO LOAD. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

D. LOAD CONNECTED TO INDICATORS
GREEN LED INDICATOR TO INDICATE WHEN THE TRANSFER SWITCH LOAD IS CONNECTED TO THE NORMAL SOURCE.
RED LED INDICATOR TO INDICATE WHEN THE TRANSFER SWITCH IS CONNECTED TO THE EMERGENCY SOURCE.

E. SOURCE AVAILABLE INDICATORS
GREEN LED INDICATOR TO INDICATE WHEN THE NORMAL SOURCE IS AVAILABLE.
RED LED INDICATOR TO INDICATE WHEN THE EMERGENCY SOURCE IS AVAILABLE.

LOAD DISCONNECT FEATURE

ONE SET OF FORM C CONTACTS (1 N/O & 1 N/C) THAT CHANGE POSITION ON ACTIVATION OF A SELECTABLE TIME DELAY BEFORE TRANSFER (LD TDBT) AND RESET EITHER IMMEDIATELY FOLLOWING TRANSFER OR FOR THE SAME DELAY AS SET FOR PRE-SIGNAL BEFORE TRANSFER. SELECTABLE AS 0, 3, 10 OR 20 SECONDS. FACTORY SET AT 0. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS). OUTPUT CONTACTS (OP) ARE RATED 5 AMPS RESISTIVE AT 28 VDC OR 120 VAC MAXIMUM.

MOTOR LOAD TRANSFER FEATURE

INPHASE TRANSFER CONTROL LOGIC TO INITIATE AN INPHASE TRANSFER OF MOTOR LOADS BETWEEN LIVE SOURCES. USED TO HELP PREVENT NUISANCE TRIPPING OF DISTRIBUTION CIRCUIT BREAKERS AND POSSIBLE DAMAGE TO MECHANICAL LOADS ASSOCIATED WITH OUT OF PHASE TRANSFER. ACTIVATED BY SETTING A DIP SWITCH ON THE CONTROL PANEL. FACTORY SET AS DISABLED. (REFER TO OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

REMOTE CONTROL FEATURES

THE FOLLOWING CONTROL PANEL INPUTS PROVIDE REMOTE CONTROL FUNCTIONS FOR THE AUTOMATIC TRANSFER SWITCH. EACH CONTROL FUNCTION CAN BE IMPLEMENTED BY THE CUSTOMER PROVIDING THE FORM OF CONTROL CONTACT DESCRIBED. EACH CONTROL CONTACT MUST BE SUITABLE FOR A 5 VDC LOW ENERGY CIRCUIT. EACH CONTROL FEATURE IS ACTIVATED BY SETTING A DIP TYPE SELECTOR SWITCH ON THE CONTROL PANEL. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL SETTINGS).

A. REMOTE TEST FEATURE – REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT SIMULATES A FAILURE OF THE NORMAL SOURCE SIMILAR TO THE SEQUENCE OUTLINED FOR THE TRANSFER SWITCH TEST PUSH-BUTTON. THE TRANSFER SWITCH WILL REMAIN CONNECTED TO THE EMERGENCY SOURCE UNDER ALL CONDITIONS WHILE THE CONTACT IS OPEN.

B. REMOTE TRANSFER TO EMERGENCY FEATURE – REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT CAUSES ENGINE START AND TRANSFER TO THE EMERGENCY SOURCE. RECLOSURE OF THE CONTACT ACTIVATES THE RETRANSFER TO NORMAL DELAY PRIOR TO RETRANSFER. IN THE EVENT THAT THE EMERGENCY SOURCE FAILS WHILE THE TRANSFER SWITCH IS CONNECTED TO EMERGENCY AND THE REMOTE CONTACT IS OPEN, THE TRANSFER SWITCH WILL AUTOMATICALLY RETRANSFER TO THE NORMAL SOURCE.

C. INHIBIT TRANSFER TO EMERGENCY FEATURE – REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT WILL PROHIBIT THE TRANSFER SWITCH FROM TRANSFERRING TO THE EMERGENCY SOURCE WHILE CONNECTED TO THE NORMAL SOURCE.

D. BYPASS TRANSFER TIME DELAY FEATURE – REQUIRES A CUSTOMER SUPPLIED, REMOTE, NORMALLY CLOSED CONTACT. OPENING OF THE CONTACT BYPASSES THE RETRANSFER TO NORMAL DELAY IF ACTIVE.

GENERAL NOTES

1. SWITCH SHOWN DE-ENERGIZED CONNECTED TO NORMAL SOURCE. DEVICE SYMBOLS AND DESIGNATIONS ARE IN ACCORDANCE WITH NEMA PUB. ICS 1-1983, PART 1-101A.
2. TS WIRES: #16 AWG ON 600-1200 AMPS, CONTROL PANEL WIRING IS #16 AWG. ALL WIRES ARE STRANDED COPPER.
3. ○ INDICATES CUSTOMER CONNECTION POINTS.
4. ● INDICATES FACTORY CONNECTION POINTS.
5. CONNECTION POINTS THAT HAVE BOTH CUSTOMER CONNECTIONS AND FACTORY CONNECTIONS ARE SHOWN OPEN AS CUSTOMER CONNECTION POINTS.
6. THE TRANSFER UNIT IS MOUNTED ON THE BACK INSIDE SURFACE OF THE ENCLOSURE. THE CONTROL PANEL AND ANY OPTIONAL ACCESSORIES ARE MOUNTED ON THE INSIDE SURFACE OF THE DOOR.
7. **AN OPERATOR'S MANUAL IS FURNISHED WITH EACH AUTOMATIC TRANSFER SWITCH. REFER TO THIS PUBLICATION PRIOR TO INSTALLATION AND OPERATION OF THE SWITCH.**
8. GROUND STRAP ON CONTROL PANEL IS AFFIXED TO CHASSIS (ENCLOSURE) AT LOWER LEFT CONTROL PANEL MOUNTING STUD.

OPTIONAL ACCESSORIES

ACCESSORY 11BG – PROGRAMMABLE ENGINE EXERCISER & SOURCE AVAILABILITY SIGNAL MODULES

PROGRAMMABLE ENGINE EXERCISER: A PROGRAMMABLE SEVEN (7) DAY OR FOURTEEN (14) DAY ELECTRONIC TIME SWITCH FOR AUTOMATIC WEEKLY TESTING OF THE ENGINE GENERATOR SET EITHER WITH OR WITHOUT LOAD. EACH DAY OF THE WEEK IS INDIVIDUALLY PROGRAMMABLE. THE TIME OF DAY IS PRESERVED BY A BATTERY BUILT INTO THE GROUP 1 TRANSFER SWITCH CONTROL PANEL.

THE FEATURE IS ACTIVATED BY SETTING A DIP SELECTOR SWITCH ON THE CONTROL PANEL. ENGINE START WITH OR WITHOUT LOAD TRANSFER IS SELECTED WITH A SECOND DIP SELECTOR SWITCH ON THE CONTROL PANEL. (REFER TO THE OPERATOR'S MANUAL FURNISHED WITH EACH TRANSFER SWITCH REGARDING CONTROL PANEL AND TIMER SETTINGS).

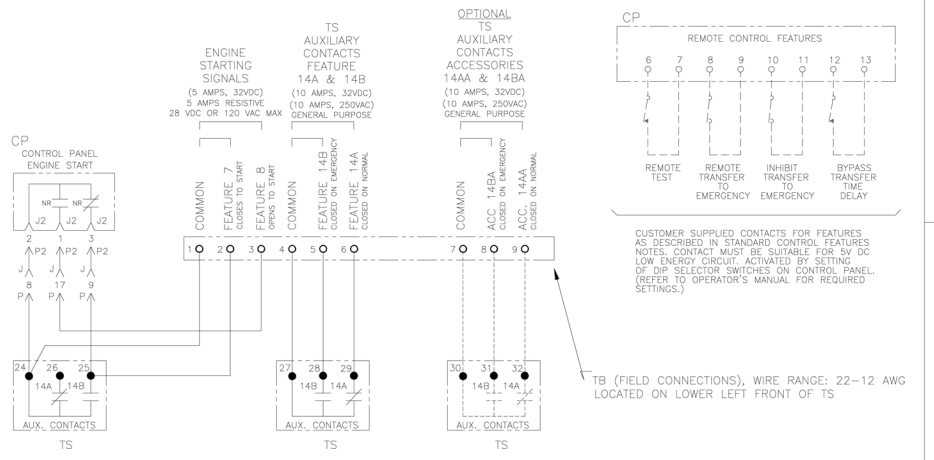
SOURCE AVAILABILITY SIGNALLING : ONE FORM C CONTACT EACH FOR THE NORMAL & EMERGENCY SOURCES SIGNAL THE ACCEPTABILITY OF THE SOURCE AS SENSED BY THE GROUP 1 CONTROL PANEL. THE SIGNAL CONTACTS OPERATE IN CONJUNCTION WITH THE SOURCE AVAILABILITY LED STATUS INDICATION PROVIDED ON THE OPERATOR INTERFACE. FIELD WIRING TERMINALS ARE PROVIDED AS SHOWN, LOCATED ON THE INSIDE DOOR BEHIND THE OPERATOR INTERFACE. CONTACTS RATED 2 AMPS @ 30VDC, 0.5 AMPS @ 125 VAC (RESISTIVE).

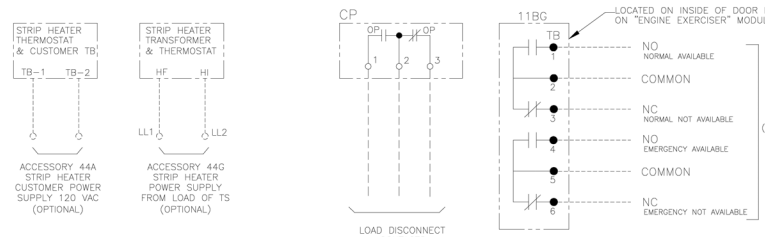
SERIAL COMMUNICATIONS INTERFACE (ACCESSORY 72A)

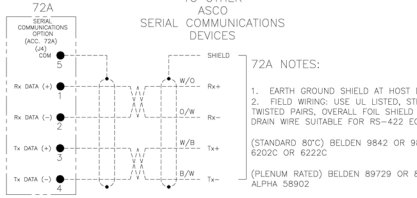
RS-485 SERIAL INTERFACE TO CONTROL PANEL FOR REMOTE MONITORING AND CONTROL FROM ASCO COMMUNICATIONS BASED PRODUCTS.

ACC. 14AA (2) AUXILIARY CONTACT CLOSED ON NORMAL.
ACC. 14BA (2) AUXILIARY CONTACT CLOSED ON EMERGENCY.
ACC. 44A STRIP HEATER, THERMOSTAT & TB. CUSTOMER POWER SUPPLY 120VAC.
ACC. 44G STRIP HEATER, THERMOSTAT & TRANSFOMER. POWER SUPPLY FROM LOAD TERMINALS OF TRANSFER SWITCH.

FIELD CONNECTIONS







BASE CATALOG NUMBER						CATALOG NUMBER SUFFIXES			
TS FRAME	CATALOG TYPE	NEUTRAL TYPE	PHASE POLES	AMPS	VOLT CODE	CONTROLLER	OPTIONAL ACCESSORY	ENCLOSURE CODE
H	300	B C	3	600 800 1000 1200	C E F H J K L M N P Q R	1	X BLANK FOR NONE	C F G L BLANK FOR OPEN TYPE

EXPLANATION OF CATALOG NUMBER CODES						
NEUTRAL TYPE		VOLTAGE CODES 3 PHASE (3 OR 4 WIRE) 50 OR 60 Hz		ENCLOSURE CODES		
CODE	DESCRIPTION	CODE	NOMINAL VOLTAGE	CODE	TYPE	DESCRIPTION
BLANK	SOLID			BLANK		OPEN TYPE (NO ENCLOSURE)
B	SWITCHING			C	1	GENERAL PURPOSE, INDOOR
C	OVERLAPPING					
		C	208			
		D	220	F	3R	OUTDOOR, RAINPROOF, SLEET & ICE RESISTANT
		E	230	G	4	INDOOR/OUTDOOR, WATERTIGHT & DUSTTIGHT
		F	240			
		H	380			
		J	400			
		K	415	L	12	INDOOR, INDUSTRIAL ENVIRONMENTS, OILTIGHT & DUSTTIGHT
		L	440			
		M	460			
		N	480			
		P	550			
		Q	575			
		R	600			

CATALOG NUMBER _____
CERTIFIED TO ASCO® S.O. _____
BY _____
DATE _____
FORM REV F
PROJECT NAME:
WIRING DIAGRAM
SERIES H300 ATS
GROUP 1 CONTROLS
THIRD ANGLE PROJECTION
ASSEM. REF. NO.

	BY	DATE
DRAWN BY	BWM	4/01
CHECKED	BK	4/10/01
DRAFTING APPROVAL		
FINAL APPROVAL	WK	4/10/01

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CHANGE LETTER	ECN NO.	BY	APP.	DATE
F	167603 SEE ECN	BK	BK	07/22/04
E	167217 SEE ECN	SDH	SDH	06/04/04
D	166704 SEE ECN	BWM	WK	03/31/04
C	164762 ADD 11BG	BWM	WK	9/03
B	161046 SEE ECN	BWM	SDH	6/02
A	157813 SEE ECN	BWM	WK	5/24/01
—	157352 ISSUE	BWM	WK	4/01

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AE AN AM AJ AL
CH AV AA PS AR
AG AP AC AS

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CHANGE LETTER F | SCN NO. 167603 | SHEET 1 OF 4

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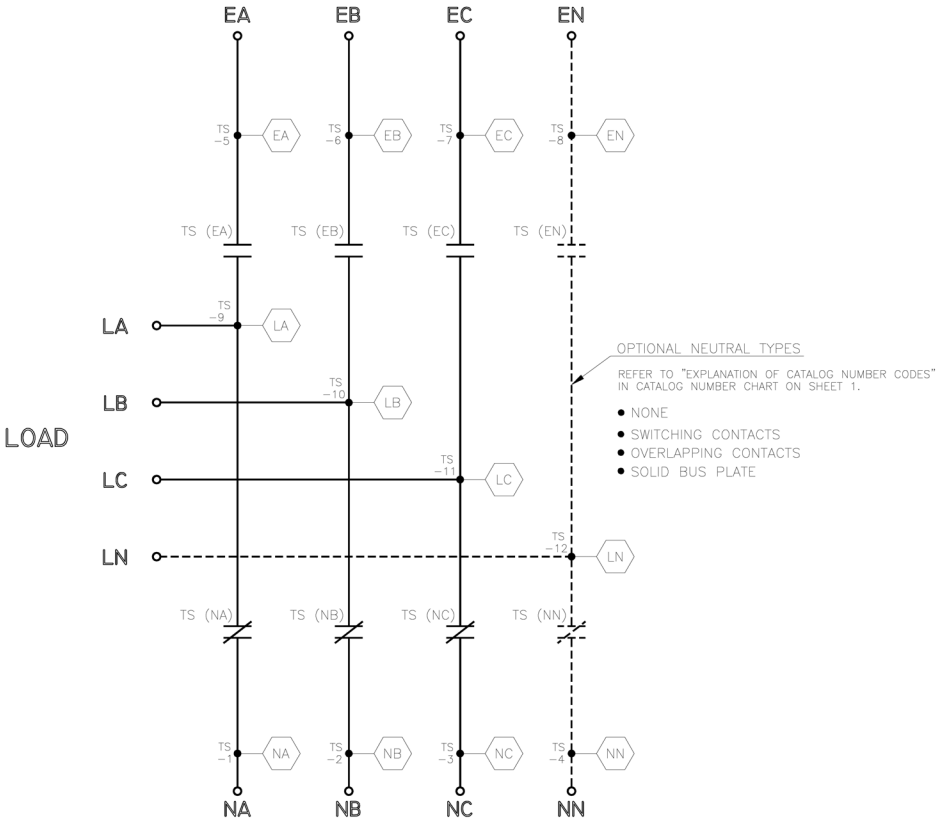
MAIN POWER POLES

EMERGENCY



OPTIONAL NEUTRAL TYPES

REFER TO "EXPLANATION OF CATALOG NUMBER CODES" IN CATALOG NUMBER CHART ON SHEET 1.

- NONE
- SWITCHING CONTACTS
- OVERLAPPING CONTACTS
- SOLID BUS PLATE

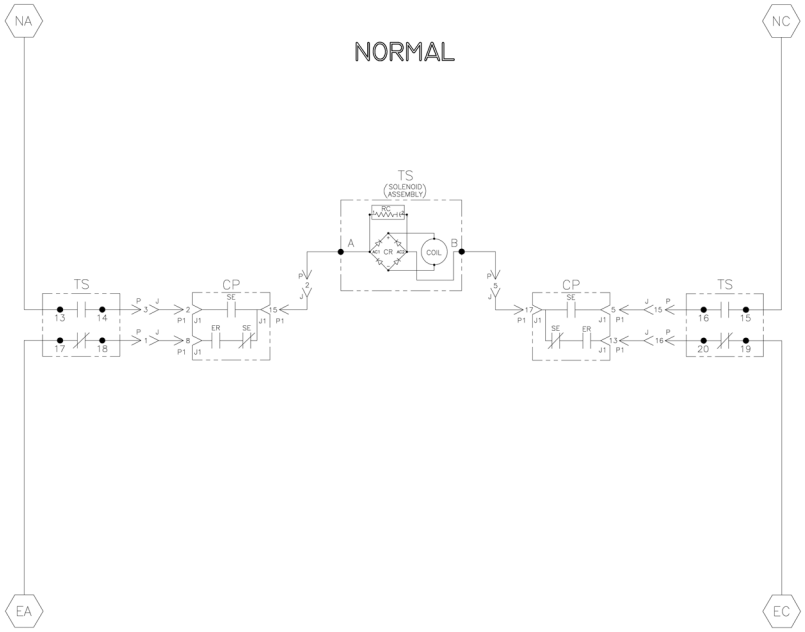
NORMAL

NOTE:
ATS SHOWN CLOSED ON NORMAL SOURCE.

TS CONTROL CONTACTS					
TS	SOLENOID POSITION				
	CLOSED NORMAL	BEFORE TDC	>	<	BEFORE TDC	CLOSED EMERG
13-14						
15-16						
17-18						
19-20						

TDC (TOP DEAD CENTER)
TRANSFER SWITCH TEST & ADJUSTMENT PROCEDURE SPECIFIES CONTROL CUT-OFF (CONTACT OPENING) SETTING.

TS OPERATOR CIRCUIT



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	ADD 11BG			
B	161046	BWM	SDH	6/02
	SEE ECN			
A	157813	BWM	WK	5/24/01
	SEE ECN			
—	157352	BWM	WK	4/01
	ISSUE			

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CH	☐	AV	☐	AA	☐	PS	☐	AR	☐	☐
AG	☐	AP	☐	AC	☐	AS	☐			☐

PROJECT NAME:

WIRING DIAGRAM
SERIES H300 ATS
GROUP 1 CONTROLS

THIRD ANGLE PROJECTION

ASSEM. REF. NO.

COMPUTER GENERATED DRAWING

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DRAWN BY	BWM	4/01
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CHANGE LETTER F | TCN NO. 167603 | SHEET 2 OF 4

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WIRE RUN LISTING

1 HARNESS LOCATOR — 713082 (P) MAIN TS

BOX CHECKED IF HARNESS IS MODIFIED

WIRE No.	713082 (P) MAIN TS	AWG CLR
1	P-1,TS-18	16
2	P-2,TS-A	
3	P-3,TS-14	
4	P-4,TS-3	
5	P-5,TS-B	
6	P-6,TS-7	
7	TS-7,TS-19	
7	P-7,TS-5	
7	TS-5,TS-17	
8	P-8,TS-24	
8	TS-24,TB-1	
9	P-9,TS-25	
9	TS-25,TB-2	
10	P-10,TS-21	
11	P-11,TS-2	
12	P-12,TS-1	
12	TS-1,TS-13	
13	P-13,TS-22	
14	P-14,TS-23	
15	P-15,TS-16	
16	P-16,TS-20	
17	P-17,TB-3	
18	P-18,TS-6	
19	P-19,TS-9	
20	P-20,TS-10	
21	P-21,TS-11	
22	P-22,TS-4	
23	P-23,TS-8	
24	P-24,TS-12	
25	TS-27,TB-4	
26	TS-28,TB-5	
27	TS-29,TB-6	

2 HARNESS LOCATOR — HARNESS 483763 (J, P1, P2) TS-CP HARNESS

BOX CHECKED IF HARNESS IS MODIFIED

WIRE No.	HARNESS 483763 (J, P1, P2) TS-CP HARNESS	AWG CLR
1	J-1,P1-8	16
2	J-2,P1-15	
3	J-3,P1-2	
4	J-4,P1-4	
5	J-5,P1-17	
6	J-6,P1-12	
7	J-7,P1-7	
8	J-8,P2-2	
9	J-9,P2-3	
10	J-10,P2-8	
11	J-11,P1-10	
12	J-12,P1-1	
13	J-13,P2-9	
14	J-14,P2-10	
15	J-15,P1-5	
16	J-16,P1-13	
17	J-17,P2-1	
18	J-18,P1-14	

OPTIONAL ACCESSORIES

3 HARNESS LOCATOR — OPTIONAL ACC. 11BG CKTS.

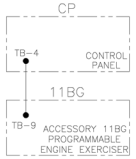
WIRE No.	OPTIONAL ACC. 11BG CKTS.	AWG CLR
28	CP-TB-4,11BG-TB-9	16

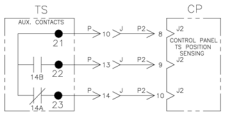
4 HARNESS LOCATOR — OPTIONAL ACC. 14AA & 14BA

WIRE No.	OPTIONAL ACC. 14AA & 14BA	AWG CLR
32	TS-30,TB-7	16
33	TS-31,TB-8	
34	TS-32,TB-9	

CONTROL SIGNALS & INDICATION

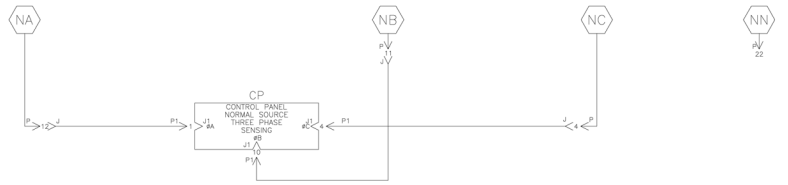
ACCESSORY 11BG PROGRAMMABLE ENGINE EXERCISER & SOURCE AVAILABILITY SIGNAL (OPTIONAL)





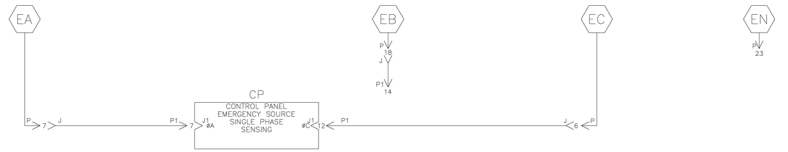
NORMAL SOURCE CIRCUITS

NORMAL



EMERGENCY SOURCE CIRCUITS

EMERGENCY



LOAD TERMINAL CIRCUITS

LOAD

CHANGE LETTER	ECN NO.	BY	APP.	DATE
F	167603	BK	BK	07/22/04
	SEE ECN			
E	167217	SDH	SDH	06/04/04
	SEE ECN			
D	166704	BWM	WK	03/31/04
	SEE ECN			
C	164762	BWM	WK	9/03
	ADD 11BG			
B	161046	BWM	SDH	6/02
	SEE ECN			
A	157813	BWM	WK	5/24/01
	SEE ECN			
—	157352	BWM	WK	4/01
	ISSUE			

PROJECT NAME:

WIRING DIAGRAM
SERIES H300 ATS
GROUP 1 CONTROLS

THIRD ANGLE PROJECTION

	BY	DATE
DRAWN BY	BWM	4/01
CHECKED	BK	4/10/01
DRAFTING APPROVAL		
FINAL APPROVAL	WK	4/10/01

MANUFACTURING TOLERANCES TO BE IN ACCORDANCE WITH ASCO PROCEDURE MP-I-003. FOR PLASTIC PARTS SEE MP-I-005.

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SIZE DWG. NO. DS717501

CHANGE LETTER F | ECN NO. 167603 | SHEET 3 OF 4

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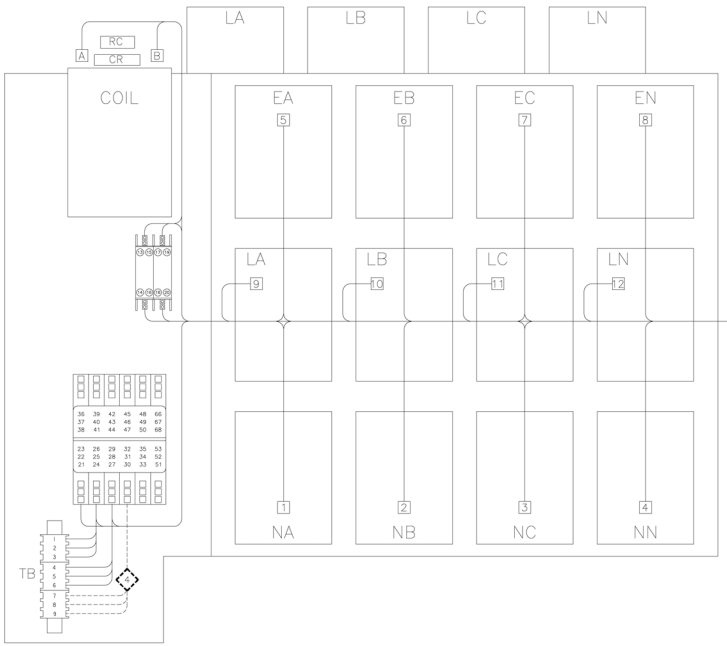
PHYSICAL DIAGRAM

ENCLOSURE

TS (TRANSFER SWITCH) VIEW FROM INSIDE FRONT



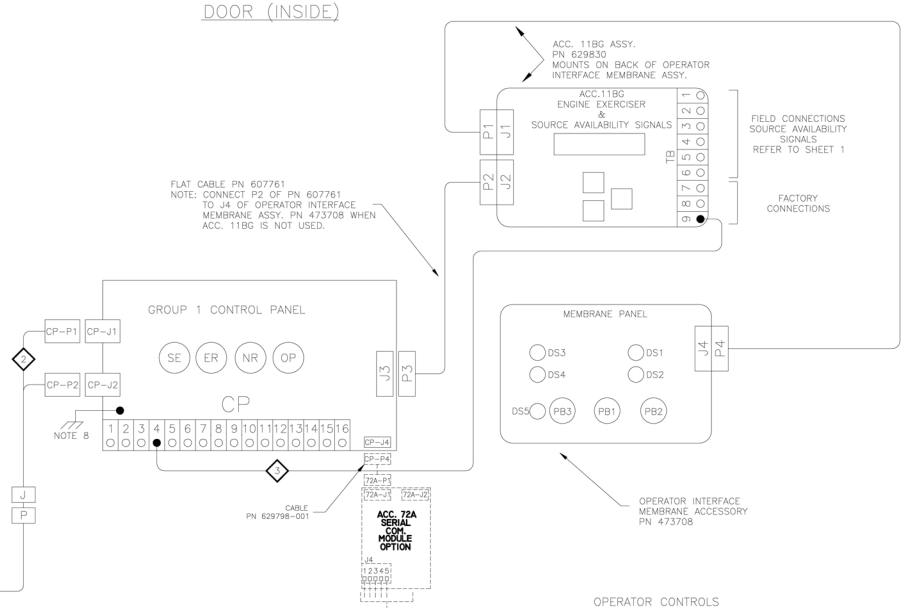
TO LOAD OF ATS
(OPTIONAL ACC. 44G)
OR
TO CUSTOMER POWER
SUPPLY 120VAC
(OPTIONAL ACC. 44A)

HEATER
ACCESSORY

DOOR HINGE

BONDING STRAP
PN 098323-019

DOOR (INSIDE)



ASCO OPTIONAL
SERIAL COMMUNICATION
DEVICE

OPERATOR CONTROLS

ID	DESCRIPTION
DS1	TS CONNECTED TO NORMAL
DS2	TS CONNECTED TO EMERGENCY
DS3	NORMAL SOURCE AVAILABLE
DS4	EMERGENCY SOURCE AVAILABLE
DS5	ENGINE EXERCISER
PB1	BYPASS TIME DELAY
PB2	TRANSFER SWITCH TEST
PB3	SET ENGINE EXERCISER

CHANGE LETTER	ECN NO.	BY	APP.	DATE
F	167603	BK	BK	07/22/04
	SEE ECN			
E	167217	SDH	SDH	06/04/04
	SEE ECN			
D	166704	BWM	WK	03/31/04
	SEE ECN			
C	164762	BWM	WK	9/03
	ADD 11BG			
B	161046	BWM	SDH	6/02
	SEE ECN			
A	157813	BWM	WK	5/24/01
	SEE ECN			
—	157352	BWM	WK	4/01
	ISSUE			

PROJECT NAME:

WIRING DIAGRAM
SERIES H300 ATS
GROUP 1 CONTROLS

THIRD ANGLE PROJECTION

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DRAWN BY	BWM	4/01
CHECKED	BK	4/10/01
DRAFTING APPROVAL		
FINAL APPROVAL	WK	4/10/01

MANUFACTURING TOLERANCES TO BE IN ACCORDANCE WITH ASCO PROCEDURE MP-I-003. FOR PLASTIC PARTS SEE MP-I-005.

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SIZE DWG. NO. DS717501

CHANGE LETTER F | ECN NO. 167603 | SHEET 4 OF 4

Operator's Manual

ASCO® Series 300 Automatic Transfer Switches D design, 30 through 230 amps

⚠ DANGER

DANGER is used in this manual to warn of high voltages capable of causing shock, burns, or death.

⚠ WARNING

WARNING is used in this manual to warn of possible personal injury.

⚠ CAUTION

CAUTION is used in this manual to warn of possible equipment damage.

An experienced licensed electrician must install the ATS.

30–200 amp. sizes

Refer to the outline and wiring drawings provided with your ASCO Series 300 ATS for all installation details.

ASCO Series 300 Automatic Transfer Switches (ATSs) are Listed under Underwriters Laboratories UL 1008 Standard for Safety for Automatic Transfer Switches. ASCO Series 300s are also Listed under CSA C22.2 No. 178 Standard for Automatic Transfer Switches. All control features are UL Component Recognized, which assures that ASCO automatic transfer switches meet OSHA Safety Requirements and will be acceptable to electrical inspectors.

ASCO Series 300 Automatic Transfer Switches are suitable for emergency and standby system applications. They meet emergency system rating requirements as defined in National Electrical Code (NEC) Article 700 and UL 1008. Also, they are suitable for the requirements of NEC Article 517 – Health Care Facilities, NEC Article 701 – Legally Required Standby Systems, NEC Article 702 – Optional Standby Systems, NFPA 99 Health Care Facilities, and NFPA 110 Emergency and Standby Power Systems.

Rating Label

Each automatic transfer switch contains a rating label to define the loads and fault circuit withstand / closing ratings. Refer to the label on the transfer switch for specific values.

⚠ WARNING

Do not exceed the values on the rating label. Exceeding the rating can cause personal injury or serious equipment damage.

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	section
INSTALLATION	1
SEQUENCE OF OPERATION	2
TESTING & SERVICE	3
ADJUSTMENTS	4
CONTROL FEATURES	5
INDEX	back cover

ASCO POWER TECHNOLOGIES L.P. 50 Hanover Road, Florham Park, New Jersey 07932–1591 USA
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Nameplate

The Transfer Switch nameplate includes data for each specific ASCO Series 300 ATS. Use the ATS only within the limits shown on this nameplate.

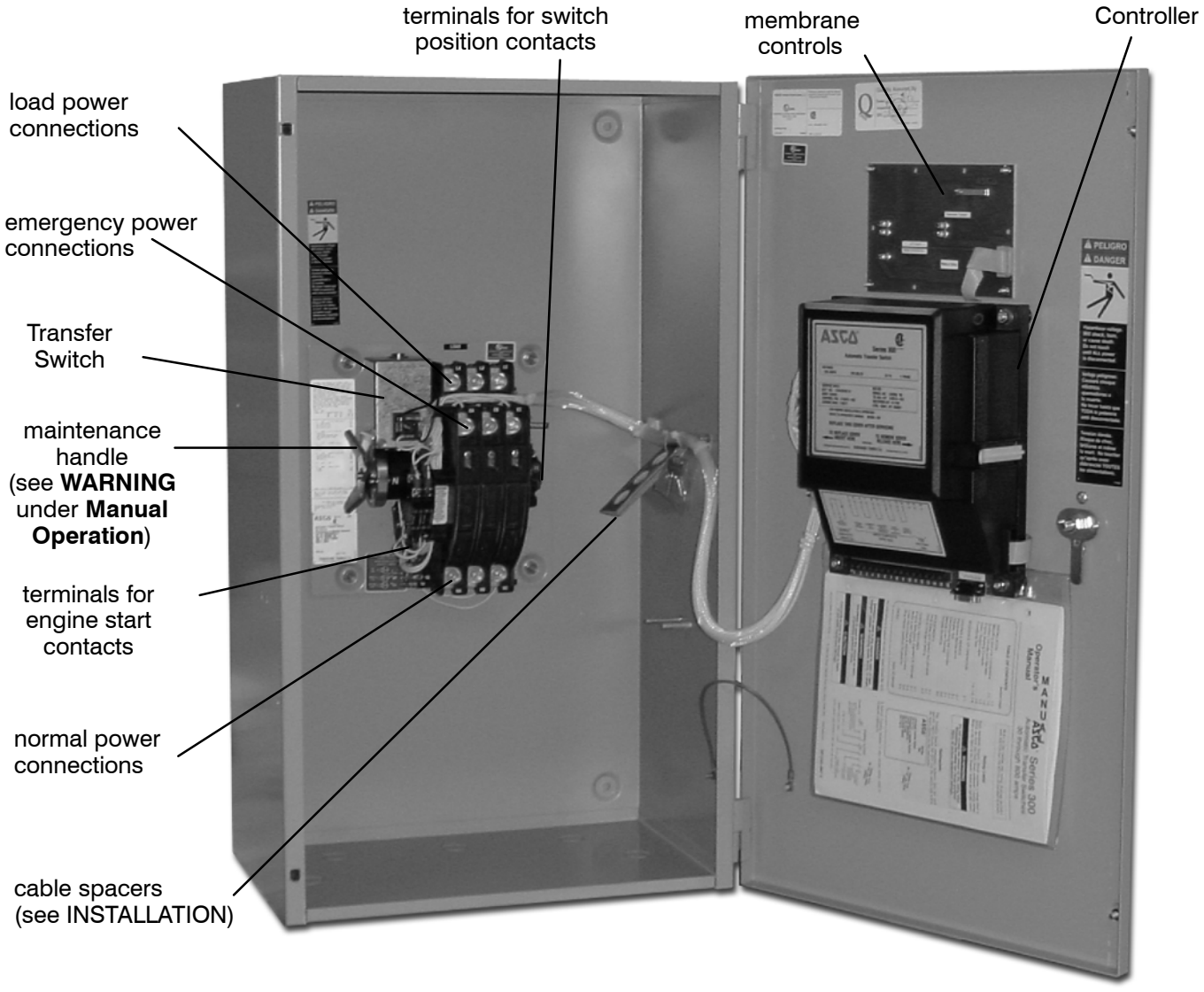
Catalog Number Identification

A typical Catalog Number is shown below with its elements explained. The example is for a Series 300 ATS with switched neutral, 3 pole, 200 amp, 480 V, in a Type 1 enclosure:

D 300 B 3 200 N 1 C

Neutral	Phase Poles	Amperes	Voltage		Controller	Enclosure
B – switched	2 – single Ø	30	A 115	K 415	1 – standard	C – type 1
C – overlapping	3 – three Ø	70	B 120	L 440	1X – if accessories ordered	F – type 3R
blank – solid		104	C 208	M 460		G – type 4
		150	D 220	N 480		L – type 12
		200 *	E 230	P 550		blank – open type
			F 240	Q 575		
			H 380	R 600		
			J 400			

* 200 amp. limited to 480 volts



200 amp. size in typical enclosure with location of customer connections

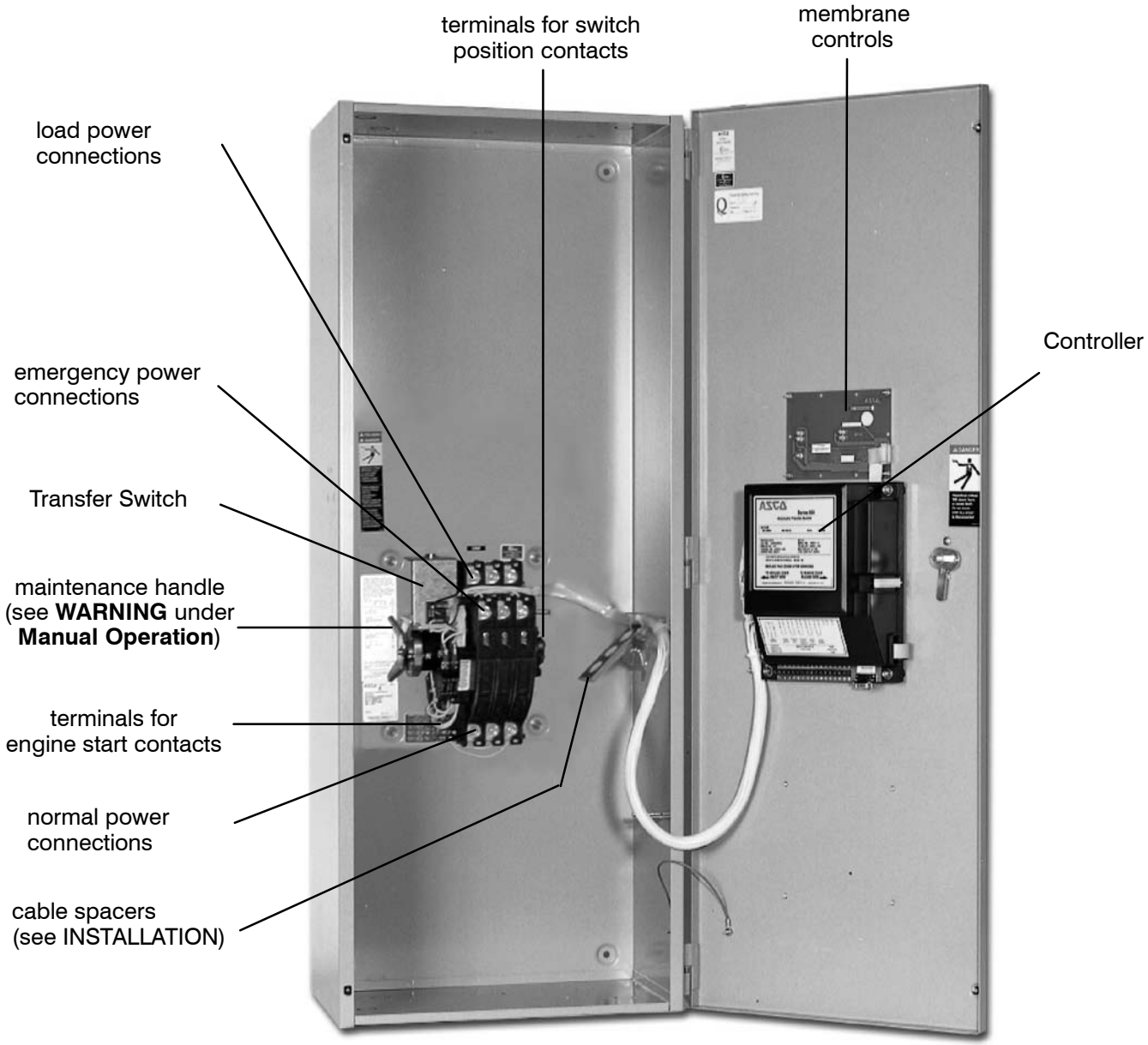
Catalog Number Identification

A typical Catalog Number is shown below with its elements explained. The example is for a Series 300 ATS with switched neutral, 3 pole, 230 amp, 480 V, in a Type 1 enclosure:

D 300 | B | 3 | 230 | N | 1 | C

Neutral	Phase Poles	Amperes	Voltage	Controller	Enclosure
B – switched C – overlapping blank – solid	2 – single Ø 3 – three Ø	230 **	A 115 B 120 C 208 D 220 E 230 F 240 H 380 J 400 K 415 L 440 M 460 N 480	1 – standard 1X – if accessories ordered	C – type 1 F – type 3R G – type 4 L – type 12 blank – open type

** 230 amp. limited to 480 volts



230 amp. size in typical enclosure with location of customer connections

SECTION 1 INSTALLATION

Series 300 Automatic Transfer Switches are factory wired and tested. Installation requires skid removal then securing the enclosure to the supporting foundation.

Mounting

Refer to the applicable enclosure outline drawing furnished with this switch and mount the Series 300 according to details and instructions shown on diagram.

Line Connections

Refer to the Wiring Diagram provided with your Series 300 ATS. All wiring must be made in accordance with the National Electrical Code and local codes.

It is unnecessary to remove pole covers from the transfer switch. If you do remove them, reinstall them carefully.

⚠ DANGER

De–energize the conductors before making any line or auxiliary circuitry connections. Be sure that Normal and Emergency line connections are in proper phase rotation. Place engine generator starting control in the OFF position. Make sure engine generator is not in operation.

⚠ CAUTION

Protect the automatic transfer switch from construction grit and metal chips to prevent malfunction or shortened life of the ATS.

Connecting Power Conductors

After the power cables have been tested, connect them to the appropriate terminal lugs on the transfer switch as shown on the wiring diagram provided with this Series 300. Make sure the lugs provided are suitable for use with the cables being installed. Standard terminal lugs are solderless screw type and will accept the wire sizes listed on the drawings provided with the Series 300. Be careful when stripping insulation from the cables; avoid nicking or ringing the conductor. Remove surface oxides from cables by cleaning with a wire brush. When aluminum cable is used, apply joint compound to conductors. Tighten cable lugs to the torque specified on rating label.

Three cable spacers are included with 150, 200, and 230 ampere transfer switches. When installing power cables, run the cables through the cable spacers as shown in Figure 1–1. Position cable spacers within 1½ inches from lugs.

⚠ CAUTION

The cable spacers must be located as shown for 150, 200, and 230 ampere transfer switches.

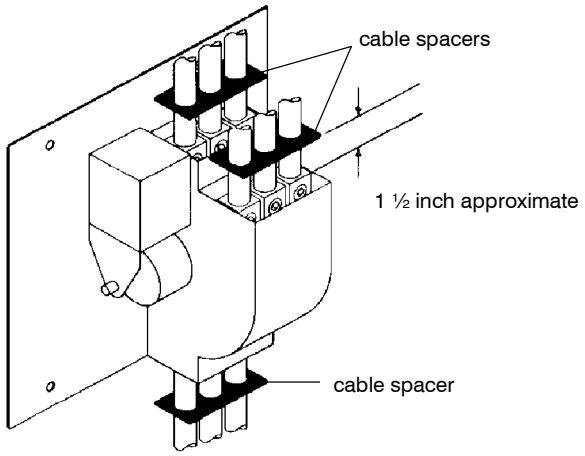


Figure 1–1. Cable spacers for 150, 200, & 230 amp. transfer switches.

Controller Ground

A grounding wire must be connected to the controller's lower left mounting stud. Because the controller is mounted on the enclosure door, a conductive strap must be used between the enclosure and the door. This connection provides proper grounding which does not rely upon the door hinges.

Harnesses

The transfer switch is connected to the left side of the controller by a plug–in harness (two plugs).

Auxiliary Circuits

Connect auxiliary circuit wires to appropriate terminals on transfer switch as shown on the wiring diagram provided with this Series 300 Automatic Transfer Switch. Make the necessary auxiliary connections by referring to **Section 5, Control Features**.

Engine Starting Contacts

Customer connections for engine control contact and TS auxiliary contacts connections are located on terminal block TB which is mounted on the front lower left of the transfer switch. Refer to wiring diagram provided with the Series 300 ATS and connect the engine start wires to the appropriate terminals. See Figure 1–2 and Table A.

Table A. Engine start connections.

When normal source fails	Terminals on transfer switch
contact closes	TB14 and TB15
contact opens	TB14 and TB16

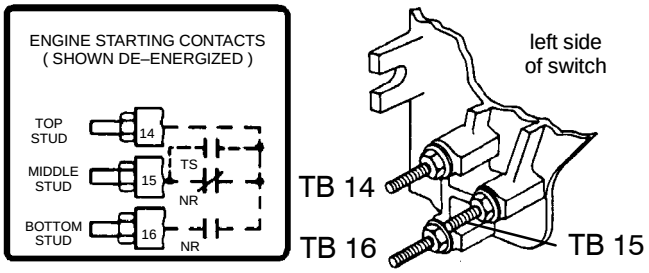


Figure 1–2. Engine starting contact label and terminals located on the transfer switch.

Connections to Controller for other Control Features

(located on bottom of Controller)

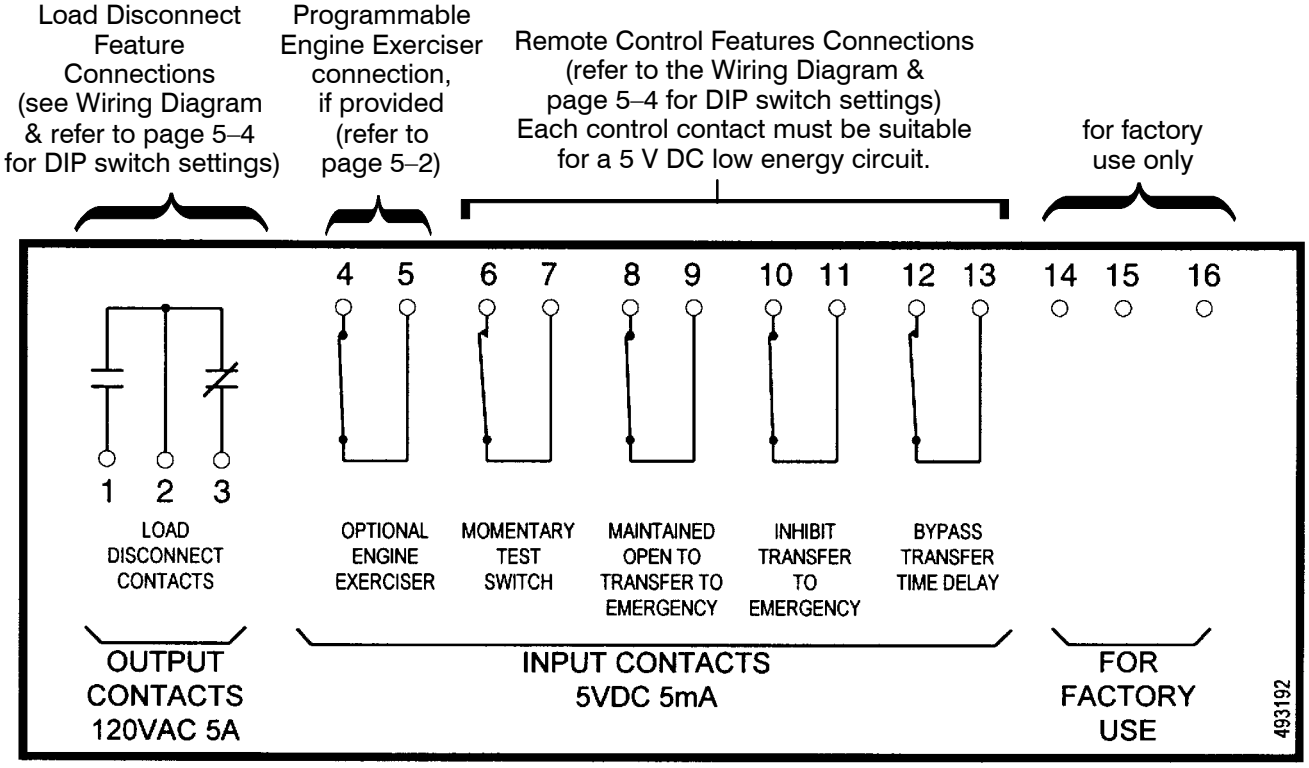


Figure 1–3. Input / output label on the Controller showing possible connections to the lower terminal block.

Functional Test

The Functional Test consists of three checks: manual operation, voltage checks, and electrical operation.

⚠ CAUTION

Do these checks in the order presented to avoid damaging the automatic transfer switch.

Read all instructions on the Wiring Diagram and labels affixed to the automatic transfer switch. Note the control features that are provided and review their operation before proceeding.

1 – Manual Operation Test

A maintenance handle is provided on the Transfer Switch for maintenance purposes only. Manual operation of the transfer switch should be checked before it is energized (operated electrically).

⚠ WARNING

Do not manually operate the transfer switch until both power sources are disconnected: open both circuit breakers.

1. After deenergizing both power sources, open the enclosure door. Locate and the maintenance handle on the left side of the transfer switch frame. See Figure 1–4.
2. Grasp the attached maintenance handle and turn it with thumb and fingers as shown to manually operate it. The maintenance handle turns the opposite direction of the weight. Move it up or down as shown to manually operate the transfer switch. It should operate smoothly without any binding. If it does not, check for shipping damage or construction debris.

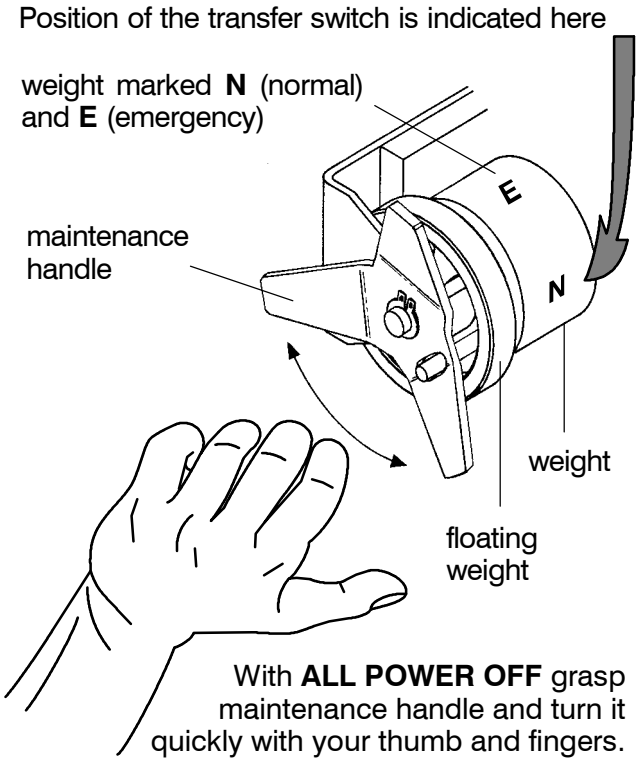


Figure 1–4. Maintenance handle and positions.

3. Return the transfer switch to the Normal position.

Note: If Normal and Emergency connections are reversed this operation is also reversed.

⚠ WARNING

Verify that the maintenance handle has been removed before proceeding!

Now continue to **2 – Voltage Checks** on next page.

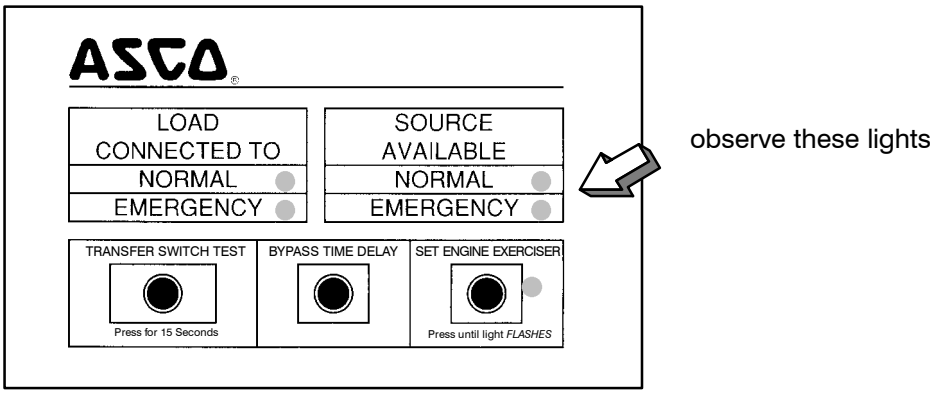


Figure 1–5. Standard controls and indicators.

2 – Voltage Checks

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ CAUTION

Verify that the feeders have been connected to the proper lugs.

⚠ DANGER

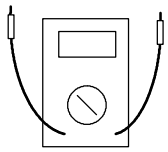
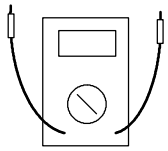
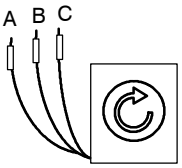
Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1 through 6 at the right. Observe the status lights. See Figure 1–5.

- ● Black circle means light is on.
- ❍ White circle means light is off.

* If necessary, adjust voltage regulator on the generator according to the manufacturer's recommendations. The Automatic Transfer Switch will respond only to the rated voltage specified on the Transfer Switch nameplate.

Also see page 4–1 for the HI–LOW voltage adjust setting in the controller. The LOW setting shifts all voltage settings down 4.2%; for example, 240 V to 230 V.

1	Close the normal source circuit breaker. The *Load Connected To Normal* and the *Normal Source Available* lights should come on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ❍
2	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch normal source terminals.	
3	Close the emergency source circuit breaker. (Start generator, if necessary.) The *Load Connected To Normal* and the *Emergency Source Available* lights should come on.	SOURCE AVAILABLE NORMAL ❍ EMERGENCY ●
4	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch emergency source terminals.*	
5	Use a phase rotation meter to check phase rotation of emergency source; it must be the <u>same</u> as the normal source.	
6	Shut down the engine–generator, if applicable. The *Emergency Source Accepted* light should go off. Then put the starting control selector switch (on the generator set) in the *automatic* position. Close enclosure door.	SOURCE AVAILABLE NORMAL ❍ EMERGENCY ❍

Now continue to **3 – Electrical Operation** on next page.

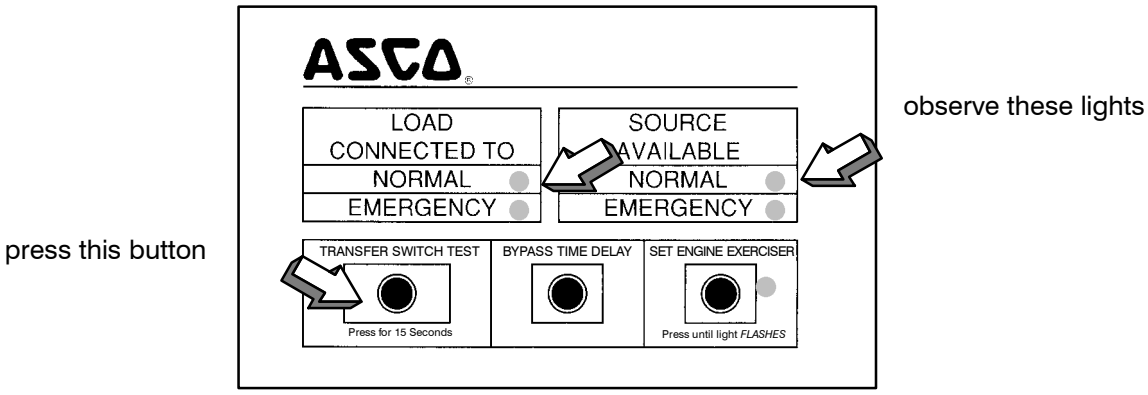


Figure 1–6. Standard controls and indicators.

3 – Electrical Operation

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ CAUTION

Verify that the feeders have been connected to the proper lugs.

⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1 through 8 at the right. Observe the status lights. See Figure 1–6.

- ● Black circle means light is on.
- ❍ White circle means light is off.

NOTE: If Motor Load Transfer feature is activated, then transfer may not occur immediately after the respective time delays. Transfer will only occur when the phase relationship between sources is correct.

This completes the Functional Test of the ASCO Series 300 Automatic Transfer Switch. Leave the engine–generator starting control in the *automatic* position.

1	The normal source must be available and the generator must be ready to start. Check that the *Normal Source Available* light is on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○
2	Press and hold the *Transfer Switch Test* button until the engine starts and runs. This should happen within 15 sec.	TRANSFER SWITCH TEST
3	The *Emergency Source Available* light should come on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ●
4	If the *transfer to emergency delay* is used the transfer should occurs after a time delay (up to 5 minutes). For immediate transfer press the *Bypass Time Delay* button.	BYPASS TIME DELAY
5	The transfer switch should transfer to the Emergency position. The *Load Connected to Emergency* light should come on and the *Load Connected to Normal* light should go off.	LOAD CONNECTED TO NORMAL ○ EMERGENCY ●
6	If the *retransfer to normal delay* is used the retransfer should occur after a time delay (up to 30 minutes). For immediate retransfer press the *Bypass Time Delay* button.	BYPASS TIME DELAY
7	The transfer switch should transfer back to the Normal position. The *Load Connected to Normal* light should come on and the *Load Connected to Emergency* light should go off.	LOAD CONNECTED TO NORMAL ● EMERGENCY ○
8	The *unloaded running delay* keeps the generator running for 5 minutes (cool–down period). Then the generator should stop and the *Emergency Source Available* light should go off.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○

SECTION 2 SEQUENCE OF OPERATION

Transfer To Emergency

The sequence for load transfer to emergency source begins automatically when normal source voltage falls below the preset dropout point or when *Transfer Switch Test* button is pressed. An under voltage condition on any phase of the normal source is detected by the sensor.

When the normal source voltage fails or the *Transfer Switch Test* button is pressed, the SE relay de-energizes and relay NR begins its timing cycle (1 or 3 seconds, *momentary normal source outage delay*). The NR relay is provided with a time delay on dropout to override momentary outages and prevent nuisance starting of the engine-driven generator. If the normal source voltage returns above the sensor dropout setting before the time delay expires, the NR relay timing cycle is reset to zero and relay SE energizes.

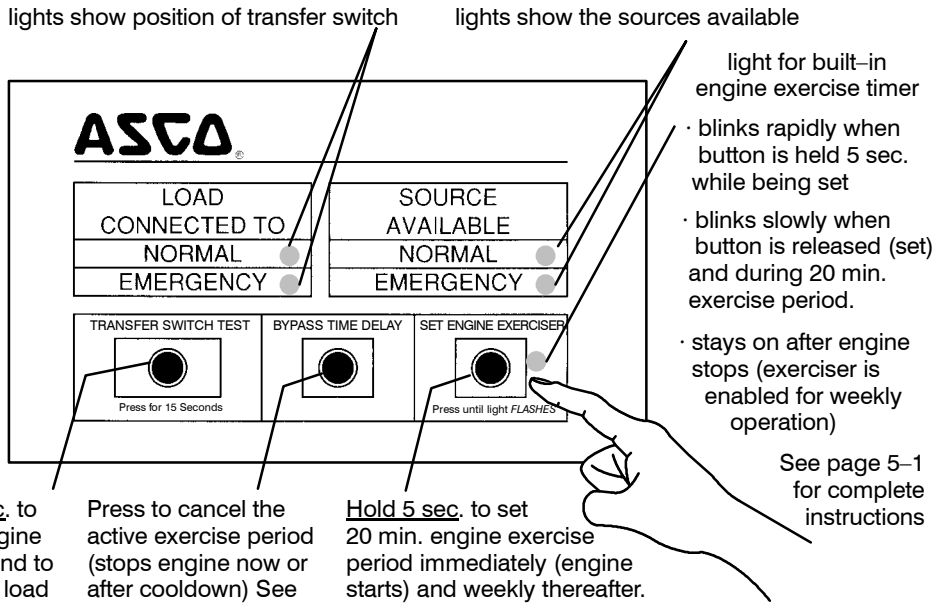


Figure 2–1. Membrane controls and indicator lights.

If the normal source voltage does not return above the sensor dropout setting before the time delay expires, the NR relay de-energizes and signals the engine-driven generator to start. At the same time, a voltage and frequency sensor begins monitoring the emergency source. The sensor will accept the emergency source only when both voltage and frequency reach preset pickup points. Usually about ten seconds elapse from dropout of the NR relay to acceptance by the sensor. This time span occurs because the engine-driven generator must crank, start, and run up to nominal pickup points. For this reason, if the *Transfer Switch Test* button is pressed it must be held for 15 seconds. If the emergency source is available immediately, the sensor may accept it as soon as NR relay drops out.

When the emergency source is accepted by the sensor, relay ER begins its timing cycle (*transfer to emergency delay*). ER relay is provided with an adjustable (0 to 5 minutes) time delay on pickup to delay transfer of the load to the emergency source. For immediate transfer press *Bypass Time Delay* button.

ER relay energizes, the TS coil is energized, the transfer switch operates, and all switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the emergency source.

The transfer switch will remain in the Emergency position until the normal source is restored. If the *Transfer Switch Test* button is used, the transfer switch will remain on emergency until the *retransfer to normal delay* times out.

Retransfer to Normal

The sequence for load retransfer to the normal source automatically begins when the voltage sensor detects restoration of the normal source. The voltage level must rise above the preset pickup point on all phases before the sensor will accept the normal source.

When the normal source is accepted by the sensor, relay SE begins its timing cycle (adjustable 1 sec. to 30 min., *retransfer to normal delay*). For immediate retransfer press *Bypass Time Delay* button. SE relay is provided with a time delay on pickup to prevent immediate load retransfer to the normal source. The delay insures that the normal source has stabilized before reconnection of vital loads. If the normal source voltage falls below the present dropout point before the time delay expires, the timing cycle is reset to zero. If the emergency source fails for more than 4 seconds during the timing cycle, ER relay drops out and the load is immediately retransferred to the normal source, if that source is acceptable.

SE relay energizes and ER relay is dropped out. The TS coil is energized, the transfer switch operates, and all switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the normal source again.

Upon retransfer to the normal source, NR relay begins its timing cycle (*unloaded running delay [engine cooldown]*). NR relay is provided with a 5 minute time delay on pickup to keep the engine running for a cool-down period.

NR relay energizes after the time delay and signals the engine-driven generator to shut down. All circuits are reset for any future normal source failure.

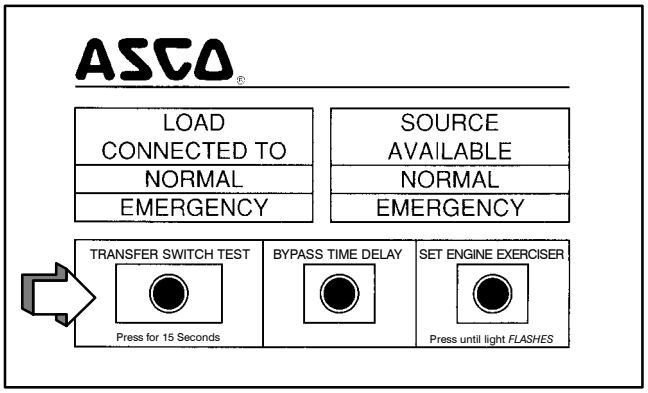
Activation of standard control features shown in Section 5 will alter the sequence of operation and introduce additional time delays during transfer operations.

SECTION 3 TESTING & SERVICE

PREVENTIVE MAINTENANCE

Reasonable care in preventive maintenance will insure high reliability and long life for the automatic transfer switch.

Operate the switch at least once a month. Perform this four step Electrical Operation Test. This is a test with load transfer.



Transfer Switch Test

1.	Press and hold the door-mounted *TRANSFER SWITCH TEST* button until the engine starts and runs. This should happen within 15 seconds.
2.	The transfer switch will operate to the Emergency position. If the *Transfer To Emergency Delay* is used, the transfer will occur after a time delay (up to 5 minutes). For immediate transfer press *BYPASS TIME DELAY* button.
3.	The Transfer Switch will operate back to the Normal position after the *Retransfer To Normal Delay* (up to 30 minutes). For immediate retransfer press *BYPASS TIME DELAY* button.
4.	*Unloaded Running (Engine Cooldown) Delay* allows engine to run unloaded for 5 minutes.

Clean and inspect the switch once a year. De-energize all sources, then brush and vacuum away any excessive dust accumulation. Remove the transfer switch barriers and check contact condition. Replace contacts when pitted or worn excessively. Reinstall the barriers carefully.

Maintain transfer switch lubrication. The transfer switch has been properly lubricated, and under normal operating conditions no further lubricating is required. Renew factory lubrication if the switch is subjected to severe dust or abnormal operating conditions. Relubricate the operator if TS coil is replaced. Order **lubrication 625550–001** (Castrol *Endurex*® 4000 lubricant).

Replacement parts. Replacement parts are available in kit form. When ordering parts provide the Serial No. and Catalog No. from the transfer switch nameplate. Contact your local ASCO Power Technologies sales office or ASI. In the United States call 1–800–800–ASCO (2726), or in Canada call 1–888–234–ASCO (2726).

DISCONNECTING THE CONTROLLER

The harness disconnect plugs are furnished for repair purposes only and should not have to be unplugged. If the controller must be isolated, follow these steps carefully.

Disconnecting the Plugs

⚠ WARNING

Do not unplug the controller until step 1a. or 1b. below is completed.

1. Observe the position of the transfer switch.
   a. If the transfer switch is in the *Normal* position, place standby engine starting control in the *off* position. Then open the emergency source circuit breaker.
   b. If the transfer switch is in the *Emergency* position, open the normal source circuit breaker. Place the engine starting control in the *test* or *run* position.
2. Separate the quick disconnect plugs by squeezing the latches. Do not pull on the harness wires.
3. Label, remove, and tape the signal wires connected to the engine start terminals on the transfer switch: TB1 and TB3, or TB1 and TB2.

Reconnecting the Plugs

⚠ WARNING

Do not reconnect the controller until step 1a. or 1b. and 2 below are completed.

1. Observe the position of the transfer switch.
   a. If the transfer switch is in the *Normal* position, be sure that the standby engine starting control is still in the *off* position. The emergency source circuit breaker still should be open.
   b. If the transfer switch is in the *Emergency* position, normal source circuit breaker still should be open.
2. Reconnect the signal wires connected to the appropriate engine start terminals on the transfer switch. See **Section 1**, *Engine Starting Contacts*.
3. The harness plugs and sockets are keyed. Carefully align the plugs with the sockets and press straight in until both latches click.
4. Restore the opposite source as follows:
   a. If the transfer switch is in the *Normal* position, place the standby engine starting control in the *automatic* position. Then close the emergency source circuit breaker.
   b. If the transfer switch is in the *Emergency* position, close the normal source circuit breaker. The load will be automatically retransferred to the normal source after the *Retransfer to Normal Delay*. For immediate retransfer, press *BYPASS TIME DELAY* button. Place the engine starting control in the *automatic* position.

MANUAL LOAD TRANSFER

This procedure will manually transfer the load if the controller is disconnected.

⚠ WARNING

Do not manually operate the transfer switch until both power sources are disconnected: open both circuit breakers.

1. Open normal and emergency source circuit breakers.
2. Use the maintenance handle to manually operate transfer switch to the opposite source. See page 1–3, *Manual Operation Test*.
3. If the transfer switch is in the Emergency position manually start the engine generator and then close the emergency source circuit breaker.

TROUBLE-SHOOTING

Note the control features that are activated or furnished on the switch and review their operation. Refer to **Section 5**, **Control Features**.

⚠ WARNING

Proceed with care!
The automatic transfer switch is energized.

Table 3-1. Trouble-Shooting Checks.

PROBLEM	CHECK IN NUMERICAL SEQUENCE		
	1 OPERATION	2 GEN-SET	3 VOLTAGE
Gen-Set does not start when the *TRANSFER SWITCH TEST* button is pressed and held for 15 seconds or when the normal source fails.	Hold the *TRANSFER SWITCH TEST* button 15 sec. or the outage must be long enough to allow for the 1 or 3 sec. *Momentary Normal Source Outage Delay* plus engine cranking and starting time.	Starting control must be in automatic position. Batteries must be charged and connected. Check wiring to engine starting contacts.	—
Transfer switch does not transfer the load to emergency source after the gen-set starts.	Wait for *Transfer to Emergency Delay* (0 to 5 min.) to time out. For immediate transfer, press the *BYPASS TIME DELAY* button. If Motor Load Transfer is active, wait for in-phase condition (see below).	Generator output circuit breaker must be closed. Generator frequency must be at least 57 Hz.	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals EA and EC (or EL1 and EL2 for 2 pole switches). * * These are factory settings.
Transfer switch does not transfer the load to normal source when normal returns or when *TRANSFER SWITCH TEST* button is released.	Wait for *Retransfer to Normal Delay* (1 sec. to 30 min.) to time out. For immediate re–transfer, press *BYPASS TIME DELAY* button. If Motor Load Transfer is active, wait for in-phase condition (see below).	—	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals NB and NC, NC and NA, and NA and NB (or NL1 and NL2 for 2 pole switches).
Gen-Set does not stop after load retransfer to the normal source.	Wait for the 5 minute *Unloaded Running Delay* to time out.	Starting control must be in automatic position.	—

Trouble-Shooting the Motor Load Transfer Feature (refer to page 5–3)

⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

1. Connect a voltmeter (set for twice system phase–to–phase voltage) between Transfer Switch terminals NA and EA.
2. Manually start generator. Voltmeter needle should sweep back and forth at a regular rate between 0 and about twice system voltage.
3. Press and hold TRANSFER SWITCH TEST button. The load should transfer to emergency source when meter needle is near 0 volts. If transfer does not occur, Motor Load Transfer feature is not operating.
4. Release the **Transfer Switch Test** button. The load should retransfer back to the normal source after the *Retransfer to Normal Delay*, if used. The retransfer should occur when the needle is near 0 volts. If retransfer does not occur after the time delay, the Motor Load Transfer feature is not operating.
5. For immediate retransfer, press the BYPASS TIME DELAY button. Then disconnect the voltmeter.

If the problem is isolated to circuits on the controller or the transfer switch, call your local ASCO Power Technologies sales office or ASI. In the United States, call 1–800–800–2726. In Canada, call 1–888–234–2726. Furnish the Serial No., Bill of Material (BOM) No., & Catalog No. from transfer switch nameplate.

SECTION 4 ADJUSTMENTS

Time Delay Adjustment

Standard time delays are set to customer specifications (if none specified, standard factory settings are used).

To change a setting, follow procedure on page 4-2. Use Table 4-1 as a guide to time delay values and their corresponding adjustment DIP switch or potentiometer.

Table 4-1. Time Delay Settings

DESCRIPTION	LABELS	FACTORY SETTING	ADJUSTMENT RANGE	S3 DIP SWITCH		ADJUSTMENT POTENTIOMETER
Override Momentary Normal Source Outages	TD ES	3 seconds	1 second	Actuator 1 on		—
			3 seconds	Actuator 1 off		
Transfer to Emergency	TIMER N/E	0 minutes (full ccw)	0 to 5 minutes	—	—	P2
Override Momentary Emergency S. Outages	—	4 seconds	non-adjustable	—	—	—
Retransfer to Normal	TIMER E/N	30 minutes (full cw)	1 second to 30 minutes	—	—	P1
Unloaded Running (Engine Cooldown)	—	5 minutes	non-adjustable	—	—	—

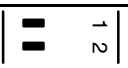
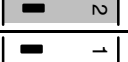
Sensor Adjustments

Voltage and frequency sensor pickup and dropout points are set to customer specifications (if none specified, standard factory settings are used). To change a setting, follow procedure on page 4–2. Use Tables 4-2 and 4–3 for settings and corresponding DIP switch actuators.

⚠ WARNING

Any change in these settings may affect the normal operation of the automatic transfer switch. This change could allow the load circuits to remain connected to a low voltage source.

Table 4-2. Voltage and Frequency Settings. (□ Shaded DIP switches are standard factory settings).

DESCRIPTION	LABELS	SETTING	% of nominal		S1 DIP SWITCH	
			FACT. SET	ADJ RANGE		
Normal Source Voltage	PU / N	Pickup	90 %	95 % *	Actuator 3 off	
				90 %	Actuator 3 on	
	DO / N	Dropout	85 %	90 % *	Actuator 1 off Actuator 2 off	
				85 %	Actuator 1 on Actuator 2 off	
				80 %	Actuator 1 off Actuator 2 on	
				70 %	Actuator 1 on Actuator 2 on	
Emergency Source Voltage	– –	Pickup	90 %	non-adjustable	– –	
	– –	Dropout	75 %	non-adjustable		
Emergency Source Frequency	– –	Pickup	95 %	non-adjustable	– –	
	– –	Dropout	85 %	non-adjustable		
	60 / 50 Hz	60 / 50 Hz	60 Hz	60 Hz	Actuator 4 off	
				50 Hz	Actuator 4 on	
Voltage Phases	3 Ø , 1 Ø	3 Ø / 1 Ø	3 Ø	3 phase	Actuator 6 off	
				1 phase	Actuator 6 on	

* If dropout voltage is set to 90%, the pickup voltage must be set to 95%.

Table 4-3. Transformer Voltage Adjust.
(Low setting shifts all voltage settings down 4.2%; for example, 240 V to 230 V, or 480 V to 460 V)

DESCRIPTION	LABELS	FACTORY SETTING	ADJUSTMENT	S3 DIP SWITCH	
Voltage Adjust (4.2%)	LOW / HI	HI	LOW	Actuator 2 off	
			HI	Actuator 2 on	

⚠ WARNING

Do not make any setting changes while the controller is energized.

How to Change a Setting

1. Prevent the transfer switch from operating by disconnecting one source first, then the other, as follows:
   a. If the transfer switch is in the Normal position, open the emergency source circuit breaker. Turn the engine starting control to *off*. Then open the normal source circuit breaker.
   b. If the transfer switch is in the Emergency position, open the normal source circuit breaker. Turn engine starting control to *test* or *run*. Then open the emergency source circuit breaker.
2. Disconnect both harness plugs from controller by squeezing the latches. Do not pull on the wires.
3. Remove cover from the controller by releasing latch on right side with your thumb. See Figure 4-1.
4. Locate the appropriate adjustment potentiometer or DIP switch for the setting that you want to change. Refer to Table 4-1 and Table 4–2 on page 4-1 and Figure 4-2, Figure 4–3, Figure 4–4 on page 4–2.
5. Use a small screwdriver to turn the potentiometer clockwise to increase the time delay or counterclockwise to decrease it. See Figure 4-3.
6. Use a ball-point pen (or similar pointed tool) to slide the switch actuators left or right so they match the illustration next to the setting (left = off, right = on). Recheck the setting. See Figure 4-4.
7. Install the cover on the controller by hooking it on the left side and latching the right side.
8. Reconnect both harness plugs to the controller by aligning and pressing straight in until latches click.

⚠ WARNING

Close the enclosure door.

9. Close the enclosure door, then restore both sources:
   a. If the transfer switch is in the Normal position first close the normal source circuit breaker, then close the emergency source circuit breaker.
   b. If the transfer switch is in the Emergency position, close the normal source circuit breaker. The load will be automatically retransferred to the normal source. Then close the emergency source circuit breaker.
10. Turn the engine starting control to *automatic*.

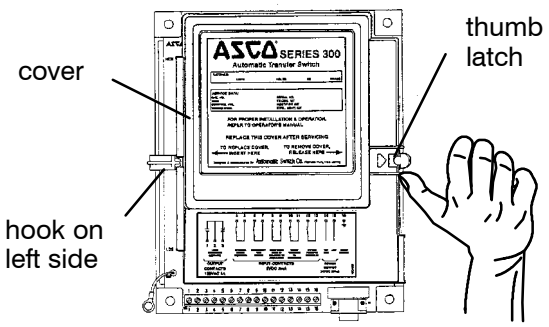


Figure 4-1. Controller cover latch.

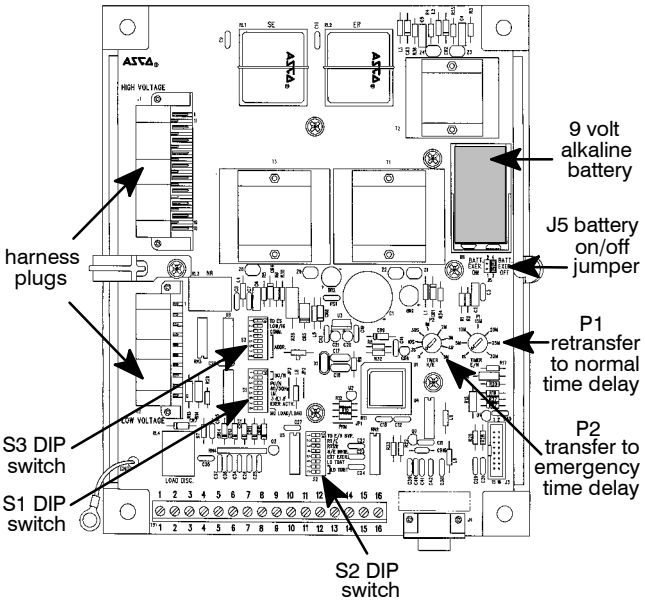


Figure 4-2. Location of potentiometers, DIP switches, battery, and battery jumper.

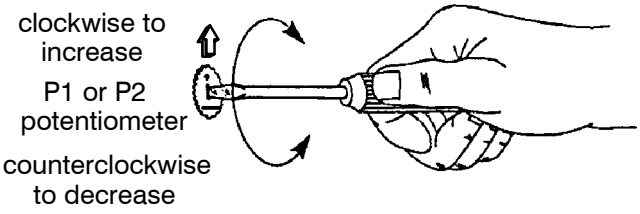


Figure 4-3. Changing time delay potentiometers.

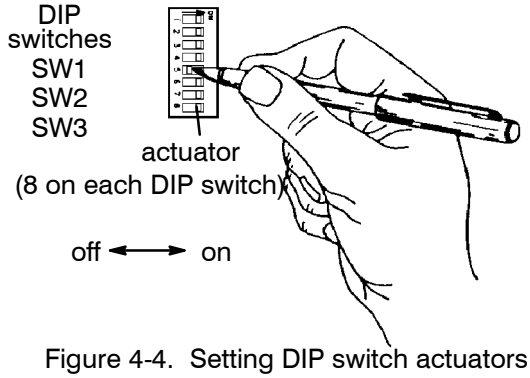


Figure 4-4. Setting DIP switch actuators.

SECTION 5 CONTROL FEATURES – ENGINE EXERCISERS

These timers periodically exercise the emergency engine-generator plant. They can be set to exercise with or without load transfer, or they can be completely disabled. The engine-generator should be exercised under load once a week for a minimum time period of 20 minutes, or follow the recommendations of the engine-generator set manufacturer. Refer to page 4–2 for location of DIP switches, battery (provided), and jumper block in the controller.

BUILT–IN ENGINE EXERCISER

The engine exerciser included in ASCO Series 300 Automatic Transfer Switches provides a once a week 20–minute exercise period. It occurs immediately when the SET ENGINE EXERCISER push button is pressed (and held for at least 5 seconds), and then at the same time weekly thereafter. A 9 volt alkaline battery (*Duracell*® MN1604, *Everready*® 522, or *Panasonic*® 6AM6) is furnished and installed in the controller to maintain the setting. The battery jumper block must be shifted to the ON position. See Figure 4–2 on page 4–2.

Fill in day and time set. Week Day _____ Time _____.

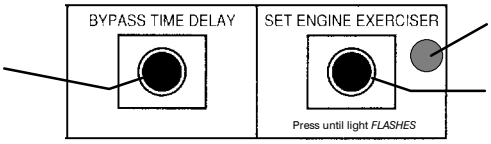
DIP Switch Settings

FUNCTION	S1 DIP SWITCH		S2 DIP SWITCH	
Std. Timer Enabled	Actuator 7 on	7	Actuator 5 on	5
Std. Timer Disabled	Actuator 7 off	7	Actuator 5 on	5
Exercise without Load	Actuator 8 off	8		
Exercise with Load	Actuator 8 on	8		

Shaded DIP switches are standard factory settings.

Press to cancel an active exercise period (stops generator).

If *Exercise with Load* is set, retransfers load to Normal, then stops generator after 5 min. cooldown.



status light

Press and hold for 5 sec. or until status light blinks rapidly to set exercise period immediately and every week hereafter (generator starts).

If *Exerciser with Load* is set, transfers load to Emergency.

Figure 5-1. Operator panel pushbuttons and light.

Select below either *Exercise without Load* or *Exercise with Load* according to the setting of DIP switch S1, actuator 8. The load transfers from the Normal source to Emergency source (generator) and back again if *Exercise with Load* is selected.

Exercise without Load, DIP Switch S1, Actuator 8 off (8) How to Set Built–In Timer

Step	Push Button	Status Light	Function	Explanation
1	*SET ENGINE EXERCISER* hold 5 sec.	blinks rapidly ●○●○●○	set exercise period	Exercise the generator now and every week at this time hereafter.
2	release	blinks slowly ●○○●○○	exercise period now active	Generator starts and runs.
3	press *BYPASS TIME DELAY*	● stays on	cancel active exercise period	Generator stops.
4	—	● stays on	generator off	Exerciser enabled; repeats every 7 days.

Exercise with Load, DIP Switch S1, Actuator 8 on (8) How to Set Built–In Timer

Step	Push Button	Status Light	Function	Explanation
1	*SET ENGINE EXERCISER* hold 5 sec.	blinks rapidly ●○●○●○	set exercise period	Exercise the generator now and every week at this time hereafter.
2	release	blinks slowly ●○○●○○	exercise period now active	Generator starts and runs; the load transfers to Emergency.
3	press *BYPASS TIME DELAY*	blinks slowly ●○○●○○	cancel active exercise period	The load retransfers to Normal; then generator runs for 5 minute cooldown (light blinks slowly during cooldown).
4	—	● stays on	generator off	Exerciser enabled; repeats every 7 days.

NOTE: Every time *SET ENGINE EXERCISER* push button is pressed (held 5 seconds) the exercise period is changed.

Optional Accessory 11BG – SOURCE AVAILABILITY SIGNAL & PROGRAMMABLE ENGINE EXERCISER MODULE

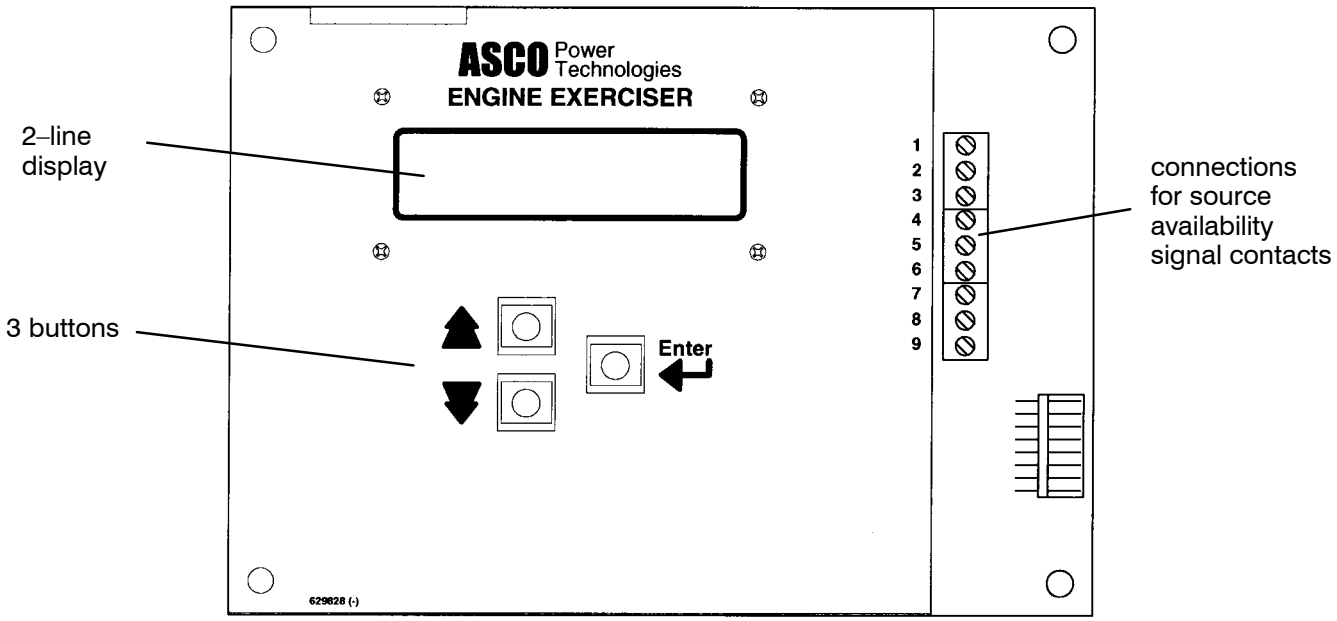


Figure 5–2. Accessory 11BG module (mounted behind operator interface and connected to the controller) includes source availability signal contacts and a programmable engine exerciser.

Source Availability Signal Contacts

The module provides one Form C contact each for the normal and emergency sources signal the acceptability of the source as sensed by the controller. The signal contacts operate in conjunction with the *Source Available* lights on the operator interface. Field wiring terminals are provided as shown in Figure 5–3 and the wiring diagram.

Contact ratings:

2 amps @ 30 Vdc, 0.5 amp. @ 125 Vac resistive

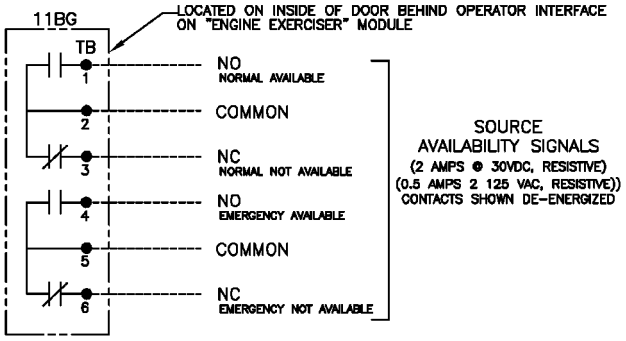


Figure 5–3. Source availability signal contacts.

Programmable Engine Exerciser

The module includes a programmable engine exerciser that provides for weekly or biweekly operation. This optional exercise timer may have to be turned on (enabled) by setting the S1 DIP switch actuator 7 to off, and S2 DIP switch actuator 5 to off. A backup battery in the controller (see page 4–2 and page 5–3) must be turned on to maintain the settings and to allow programming with the normal and emergency power turned off (page 5–1).

The programmable engine exerciser incorporates a 7 day or 14 day time base. Proper controller settings must be made to determine whether or not the test will be done with or without load transfer (S1 DIP switch actuator 8).

See next page for instructions on setting the timer.

DIP Switch Settings in the Controller

(see page 4–2)

FUNCTION	S1 DIP SWITCH		S2 DIP SWITCH	
Opt. Timer Enabled	Actuator 7 off	7	Actuator 5 off	5
Opt. Timer Disabled	Actuator 7 off	7	Actuator 5 on	5
Exercise without Load	Actuator 8 off	8		
Exercise with Load	Actuator 8 on	8		

Shaded DIP switches are standard factory settings.

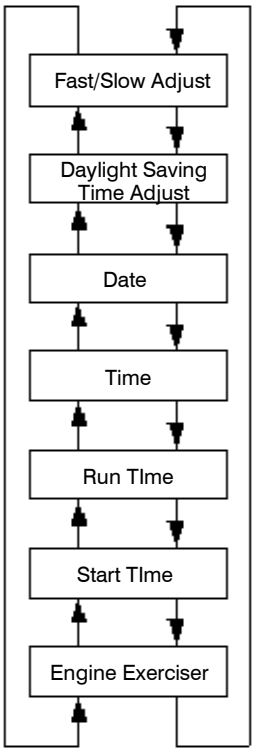
How to Set Optional Programmable Engine Exerciser (part of Acc. 11BG module)

⚠ DANGER

Hazardous voltage capable of causing shock, burns, or death is used in this transfer switch. Deenergize both Normal & Emergency power sources before programming the exerciser.

Navigating the Menu

Use the UP and DOWN arrow keys to move through the displays.



Changing the Parameters

Use the UP and DOWN arrow keys to move though the displays to the parameter to be changed. Push the ENTER key to start the editing process. The first parameter will flash. Use the UP and DOWN arrow keys to adjust the parameter to the desired value and press the ENTER key to save the value. The next parameter will now flash. Repeat the process until each parameter is properly configured.

Engine Exerciser Display

The Engine Exerciser Display shows the status of the engine exerciser. When the unit is shipped from the factory the programmable engine exerciser is "Disabled" and must be set to "Enabled" by the customer. When the engine exerciser is running, this display will count down the remaining time until the end of the exercise period.

Start Time Display

The Start Time Display shows the engine exerciser start time. There are four parameters that determine the start time:

weekly ("Every") or bi–weekly ("Alt") operation
day of week ("Sun" through "Sat")
start hour (0 through 23)
start minutes (0 through 59)

For example, if the user wants the exerciser to run every other Saturday at 3 PM, the proper configuration would be:

"Alt Sat @ 15:00"

NOTE: When choosing bi–weekly operation, the exerciser will always run on the week designated "(1)" on the date display.

Run Time Display

The Run Time Display shows the run time for the engine exerciser. The default setting from the factory is 30 minutes.

Time Display

The Time Display shows the present system time. The format is "hours:minutes:seconds".

NOTE: During total power outages, power to the accessory is maintained by a battery in the Controller (see page 4–2). Be sure that the 9–volt alkaline battery is fresh and enabled (jumper in ON position) so that the time and date settings are not lost.

Date Display

The Date Display shows the present system date. The format is "day of week (week) month/day of month/year".

NOTE: Week is either week 1 or week 2. This is used in conjunction with the bi–weekly timer.

Daylight Savings Time Adjust Display

This display shows whether the automatic daylight saving time adjustment is active. The factory default is "NO". If enabled, the unit will automatically adjust for daylight saving time at 2 AM on the first Sunday of April and the last Sunday of October.

Fast / Slow Adjust Display

This display shows the automatic fast/slow adjustment value. The factory default is 0. This feature can be used to trim a clock that runs fast or slow. For example, if your clock runs 10 seconds slow per week, change the fast/slow adjust value to "+10" and the unit will automatically add 10 seconds to the clock every week.

NOTE: Adjustments are made Sunday morning at 2 AM. If you want your exerciser period to start at 2 AM on Sunday, you cannot use this feature and the adjustment must be set to 0.

Programmable Engine Exerciser Settings

Fill in your settings for future reference

Weekly or Bi–weekly	Day of Week	Start Time	Run Time
Every = weekly *Alt* = bi–weekly	*Sun* through *Sat*	*0 – 23* hour *0 – 59* minute	*0 – 23* hour *0 – 59* minute *30* minutes is the default setting

Date exerciser was set _____

CONTROL FEATURES *(continued)*

INPHASE MONITOR FOR MOTOR LOAD TRANSFER

Inphase monitoring logic controls transfer and retransfer of motor loads, so that inrush currents do not exceed normal starting currents. It avoids nuisance tripping of circuit breakers and mechanical damage to motor couplings.

The Motor Load Transfer feature is built into the controller. DIP switch S1 (actuator 5) activates this feature: right = ON, left = OFF.

FUNCTION	S1 DIP SWITCH	
enable	Actuator 5 on	
disable	Actuator 5 off	

☐ Shaded DIP switches are standard factory settings.

Note

If the Motor Load Transfer feature is enabled, it will be activated following the Load Disconnect Feature Delay Before Transfer delay.

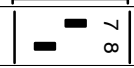
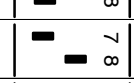
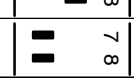
LOAD DISCONNECT FEATURE

Connect external circuits to the terminals indicated on the Wiring Diagram provided with the ATS.

The double throw (Form C) contact is rated for 28 VDC or 120 VAC (5 amps resistive). The contact operates prior to a selectable 0, 3, 10, or 20 second delay before transfer of the Automatic Transfer Switch. The contact resets either immediately following transfer or after the same delay as set for pre–signal before transfer.

Time delay between the load disconnect control signal and initiation of transfer is set on the controller with DIP switch S2 (actuators 6, 7, 8) as shown below:

Delay Before Transfer

LD TDBT	S2 DIP SWITCH	
0 (disable)	Actuator 7 on Actuator 8 on	
3 seconds	Actuator 7 on Actuator 8 off	
10 seconds	Actuator 7 off Actuator 8 on	
20 seconds	Actuator 7 off Actuator 8 off	

☐ Shaded DIP switches are standard factory settings.

Delay After Transfer*

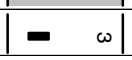
LD TDAT	S2 DIP SWITCH	
enable	Actuator 6 on	
disable	Actuator 6 off	

*Enabling the Delay After Transfer will cause the control signal to reset after the same delay as set for the Delay Before Transfer.

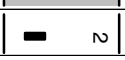
REMOTE CONTROL FEATURES

These remote control features require a customer–supplied normally closed contact suitable for a 5 V dc low energy circuit. Refer to the Wiring Diagram provided with the ATS. Activate appropriate DIP switch S2 actuators below.

Remote Test (terminals CP6–7)

RTSW	S2 DIP SWITCH	
disable	Actuator 3 on	
enable	Actuator 3 off	

Remote Transfer to Emergency (CP8–9)

RT /E	S2 DIP SWITCH	
disable	Actuator 2 on	
enable	Actuator 2 off	

Bypass Transfer Time Delay (CP12–13)

TD E/N BYP.	S2 DIP SWITCH	
disable	Actuator 1 on	
enable	Actuator 1 off	

Inhibit Transfer to Emergency (CP10–11)

N/E INHIB.	S2 DIP SWITCH	
disable	Actuator 4 on	
enable	Actuator 4 off	

OPTIONAL STRIP HEATER (Accessory 44)

Accessory 44 Strip Heater is designed to keep ambient temperatures within the Automatic Transfer Switch enclosure at acceptable levels. This accessory consists of a mounting bracket with strip heater, thermostat, and terminal block. A transformer with fuses is included when the power for the assembly is derived from voltages above 120 V ac. The 120 V ac customer powered assembly does not include a transformer. This optional accessory is available factory installed or in kit form.

Turn the thermostat's dial to required setting as shown.

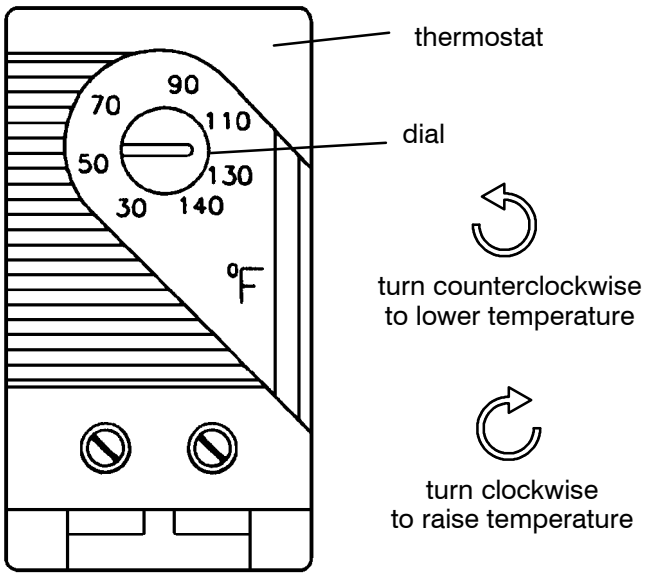


Figure 5–4. Thermostat.

AVAILABLE KITS FROM ASCO

Controls

Description	Accessory	Kit
Programmable Engine Exerciser & Source Availability Contacts	11BG	K629830
Serial Communication Module	72A	K601110

Strip Heater – Accessory 44

Description	Accessory	Kit
120 volt customer supplied voltage (without transformer)	44A	K613127–001
208 – 480 volt ATS derived voltage (with transformer)	44G	K613127–002
380 volt ATS derived voltage (with transformer)	44G	K613127
550 – 600 volt ATS derived voltage (with transformer)	44G	K613127–003

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Operator's Manual

ASCO® Series 300 Automatic Transfer Switches E design, 260 and 400 amp. sizes

⚠ DANGER

DANGER is used in this manual to warn of high voltages capable of causing shock, burns, or death.

⚠ WARNING

WARNING is used in this manual to warn of possible personal injury.

⚠ CAUTION

CAUTION is used in this manual to warn of possible equipment damage.

An experienced licensed electrician must install the ATS.

260 & 400 amp sizes

Refer to the outline and wiring drawings provided with your ASCO Series 300 ATS for all installation details.

ASCO Series 300 Automatic Transfer Switches (ATSs) are Listed under Underwriters Laboratories UL 1008 Standard for Safety for Automatic Transfer Switches. ASCO Series 300s are also Listed under CSA C22.2 No. 178 Standard for Automatic Transfer Switches. All control features are UL Component Recognized, which assures that ASCO automatic transfer switches meet OSHA Safety Requirements and will be acceptable to electrical inspectors.

ASCO Series 300 Automatic Transfer Switches are suitable for emergency and standby system applications. They meet emergency system rating requirements as defined in National Electrical Code (NEC) Article 700 and UL 1008. Also, they are suitable for the requirements of NEC Article 517 – Health Care Facilities, NEC Article 701 – Legally Required Standby Systems, NEC Article 702 – Optional Standby Systems, NFPA 99 Health Care Facilities, and NFPA 110 Emergency and Standby Power Systems.

Rating Label

Each automatic transfer switch contains a rating label to define the loads and fault circuit withstand / closing ratings. Refer to the label on the transfer switch for specific values.

⚠ WARNING

Do not exceed the values on the rating label. Exceeding the rating can cause personal injury or serious equipment damage.

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TESTING & SERVICE	3
ADJUSTMENTS	4
CONTROL FEATURES	5
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ASCO POWER TECHNOLOGIES L.P. 50 Hanover Road, Florham Park, New Jersey 07932–1591 USA
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Nameplate and Catalog Number Identification

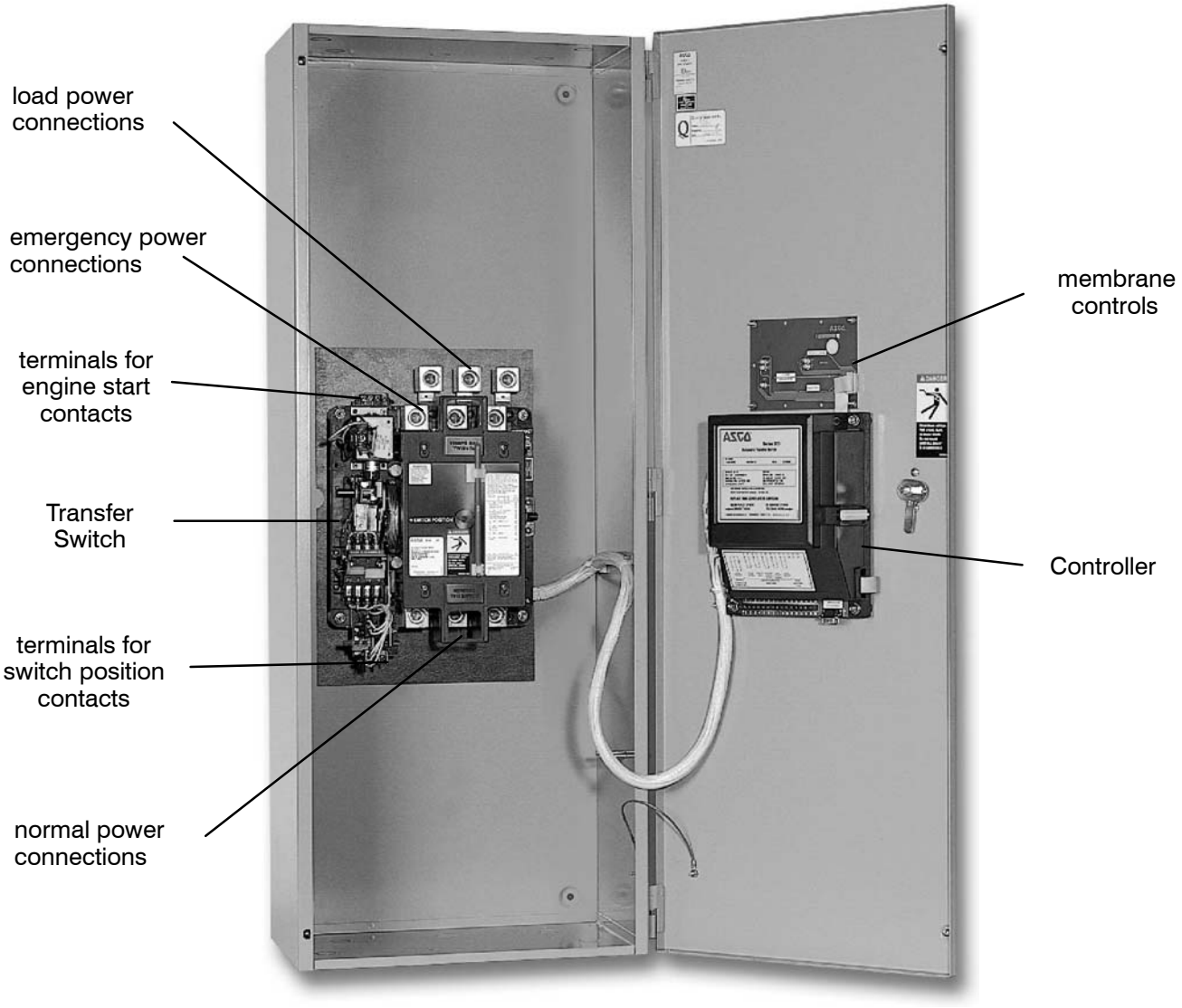
The Transfer Switch nameplate includes data for each specific ASCO Series 300 ATS. Use the ATS only within the limits shown on this nameplate. A typical Catalog Number is shown below with its elements explained.

The example is for a Series 300 ATS with switched neutral, 3 pole, 400 amp., 480 V, in a Type 1 enclosure:

E 300	C	3	400	N	1	C

transfer switch prefix letter

Neutral	Phase Poles	Amperes	Voltage		Controller	Enclosure
C – overlapping	2 – single Ø	260	A 115	K 415	1 – standard	C – type 1
blank – solid	3 – three Ø	400	B 120	L 440	1X – if accessories ordered	F – type 3R
			C 208	M 460		G – type 4
			D 220	N 480		L – type 12
			E 230	P 550		blank – open type
			F 240	Q 575		
			H 380	R 600		
			J 400			



400 amp. size in typical enclosure with location of customer connections

SECTION 1 INSTALLATION

Series 300 Automatic Transfer Switches are factory wired and tested. Installation requires skid removal then securing the enclosure to the supporting foundation.

Supporting Foundation

The supporting foundation for the enclosure must be level and straight. Refer to the applicable enclosure outline drawing included with the Series 300 for all mounting details including door opening space.

If bottom cable entry is used, the foundation must be prepared so that the conduit stubs are located correctly. Refer to the enclosure outline drawing for specified area and location. Provide cable bending space and clearance to live metal parts. When a concrete floor is poured, use interlocking conduit spacer caps or a wood or metal template to maintain proper conduit alignment.

Mounting

Refer to the applicable enclosure outline drawing furnished with this switch and mount the Series 300 according to details and instructions shown on diagram.

⚠ CAUTION

Protect the switch from construction grit and metal chips to prevent malfunction or shortened life of the automatic switch switch.

Mount the ASCO ATS vertically to a rigid supporting structure. Level all mounting points by using flat washers behind the holes to avoid distortion of the switch.

Transfer switches rated 260 and 400 amp. are mounted on an insulator backing piece (installed behind the transfer switch). If the transfer switch is removed from the cabinet and then reinstalled, this insulator piece must be placed behind the transfer switch. See Figure 1–1.

Line Connections

Refer to the Wiring Diagram provided with your Series 300 ATS. All wiring must be made in accordance with the National Electrical Code and local codes.

⚠ DANGER

De–energize the conductors before making any line or auxiliary circuitry connections. Be sure that Normal and Emergency line connections are in proper phase rotation. Place engine generator starting control in the OFF position. Make sure engine generator is not in operation.

It is not necessary to remove the barriers from the transfer switches to install cables.

⚠ WARNING

Be sure that the insulator piece is behind 260 and 400 ampere transfer switches.

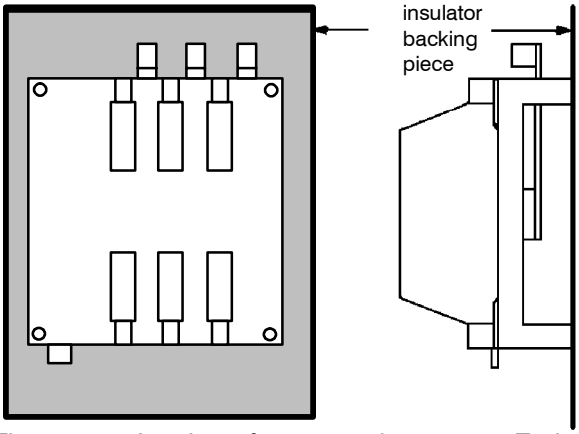


Figure 1-1. Insulator for 260 and 400 amp. E–design transfer switches.

The controller is mounted on the cabinet door. An add-on DIN rail is provided for some optional accessories and is mounted below the controller on the door.

Testing Power Conductors

Do not connect the power conductors to the ASCO Series 300 transfer switch until they are tested. Installing power cables in conduit, cable troughs and ceiling-suspended hangers often requires considerable force. The pulling of cables can damage insulation and stretch or break the conductor's strands. For this reason, after the cables are pulled into position, and before they are connected, they should be tested to verify that they are not defective or have been damaged during installation.

Connecting Power Conductors

After the power cables have been tested, connect them to the appropriate terminal lugs on the transfer switch as shown on the wiring diagram provided with this Series 300. Make sure the lugs provided are suitable for use with the cables being installed. Standard terminal lugs are solderless screw type and will accept the wire sizes listed on the drawings provided with the Series 300. Be careful when stripping insulation from the cables; avoid nicking or ringing the conductor. Remove surface oxides from cables by cleaning with a wire brush. When aluminum cable is used, apply joint compound to conductors. Tighten cable lugs to the torque specified on rating label.

Do not run cables behind the switch. Cables can be bundled on the right side of the switch. Maintain proper electrical clearance between the live metal parts and grounded metal: ½ inch minimum.

Engine Starting Contacts

The engine control contact connections are located on the transfer switch. Connect signal wires to appropriate terminals as specified in Table A, shown in Figure 1–2.

Table A. Engine start connections.

When normal source fails	Terminals on transfer switch
contact closes	TB14 and TB15
contact opens	TB14 and TB16

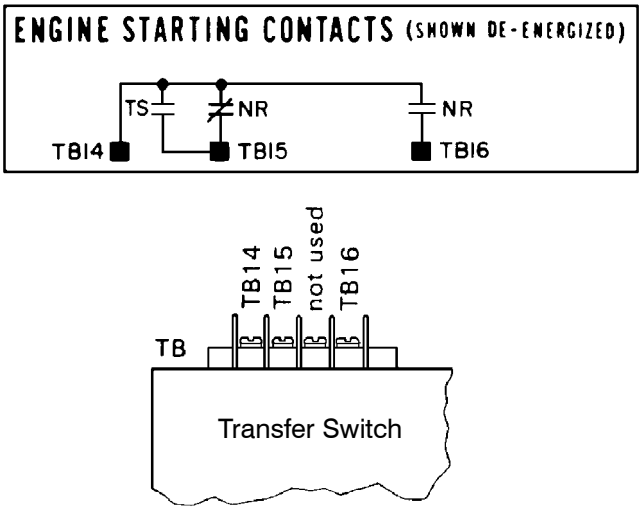


Figure 1-2. Engine starting contact label and location for 260 and 400 amp. E–design transfer switches.

Controller Ground

A grounding wire must be connected to the controller's lower left mounting stud. Because the controller is mounted on the enclosure door, a conductive strap must be used between the enclosure and the door. This connection provides proper grounding which does not rely upon the door hinges.

Harnesses

The transfer switch is connected to the left side of the controller by a plug–in harness (two plugs).

Auxiliary Circuits

Connect auxiliary circuit wires to appropriate terminals on transfer switch. Note the control features that are furnished on this switch. Make the necessary auxiliary connections by referring to **Section 5, Control Features**.

Connections to Controller for other Control Features (located on bottom of Controller):

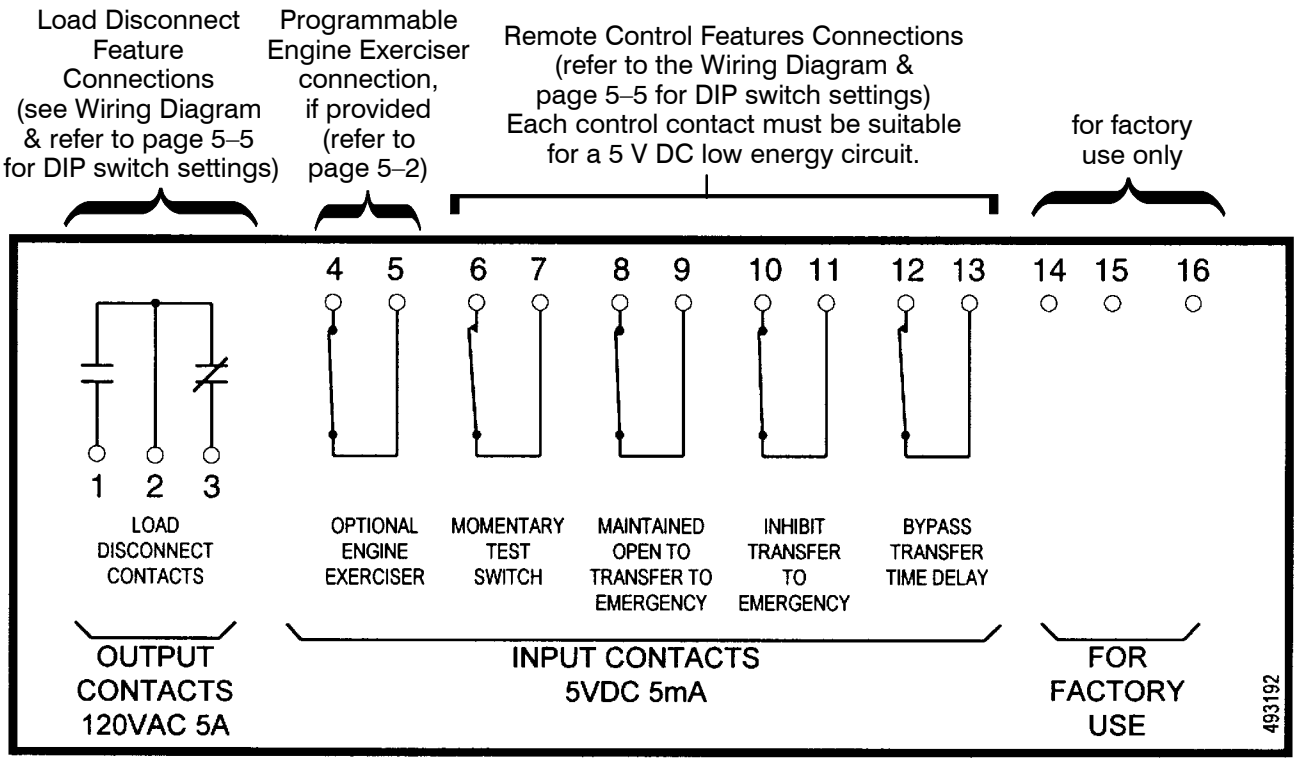


Figure 1-3. Input / output label on the Controller showing possible connections to the lower terminal block.

Functional Test

The Functional Test consists of three checks: manual operation, voltage checks, and electrical operation.

⚠ CAUTION

Do these checks in the order presented to avoid damaging the automatic transfer switch.

Read all instructions on the Wiring Diagram and labels affixed to the automatic transfer switch. Note the control features that are provided and review their operation before proceeding.

1 – Manual Operation Test

A detachable manual operator handle is provided on the Transfer Switch for maintenance purposes only. Manual operation of the transfer switch should be checked before it is energized (operated electrically).

⚠ WARNING

Do not manually operate the transfer switch until both power sources are disconnected: open both circuit breakers.

1. Insert the maintenance handle into the hole in the shaft, left side of the operator.
2. Move the maintenance handle as shown to manually operate the transfer switch. The switch should operate smoothly without any binding. If it does not, check for shipping damage or construction debris.
3. Return the transfer switch to the *N* (normal) position.
4. Remove the maintenance handle and store it on the transfer switch in the place provided.

⚠ WARNING

Verify that the maintenance handle has been removed before proceeding!

Now continue to **2 – Voltage Checks** on next page.

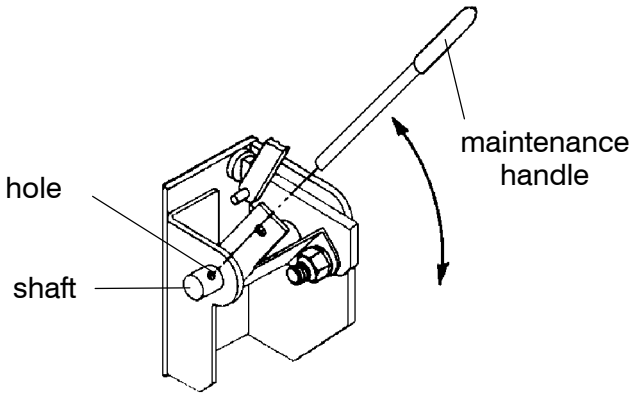


Figure 1-4. Removable maintenance handle on 260 and 400 amp. E–design transfer switches.

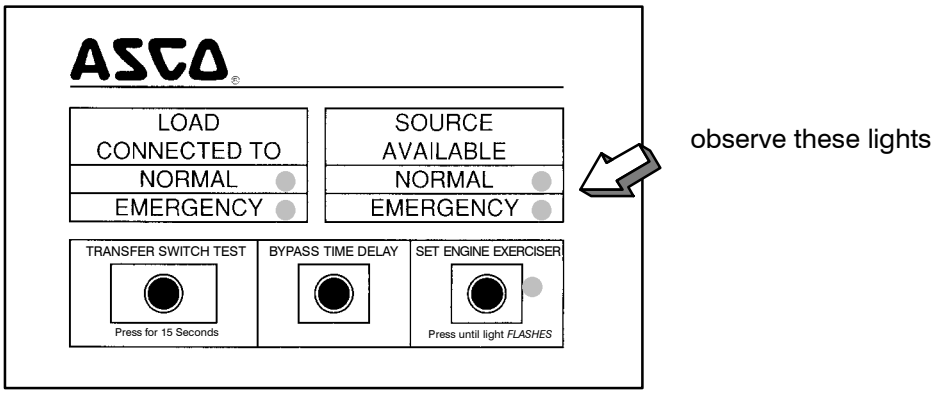


Figure 1–5. Standard controls and indicators.

2 – Voltage Checks

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ CAUTION

Verify that the feeders have been connected to the proper lugs.

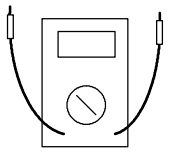
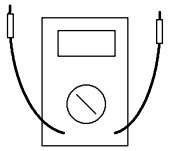
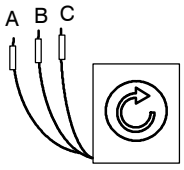
⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1 through 6 at the right. Observe the status lights. See Figure 1–5.

- ● Black circle means light is on.
- ❍ White circle means light is off.

* If necessary, adjust voltage regulator on the generator according to the manufacturer's recommendations. The Automatic Transfer Switch will respond only to the rated voltage specified on the Transfer Switch nameplate.

1	Close the normal source circuit breaker. The *Transfer Switch Connected To Normal* and the *Normal Source Available* lights should come on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○
2	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch normal source terminals.	
3	Close the emergency source circuit breaker. (Start generator, if necessary.) The *Transfer Switch Connected To Normal* and the *Emergency Source Available* lights should come on.	SOURCE AVAILABLE NORMAL ○ EMERGENCY ●
4	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch emergency source terminals.*	
5	Use a phase rotation meter to check phase rotation of emergency source; it must be the same as the normal source.	
6	Shut down the engine–generator, if applicable. The *Emergency Source Accepted* light should go off. Then put the starting control selector switch (on the generator set) in the *automatic* position. Close enclosure door.	SOURCE AVAILABLE NORMAL ○ EMERGENCY ○

Now continue to **3 – Electrical Operation** on next page.

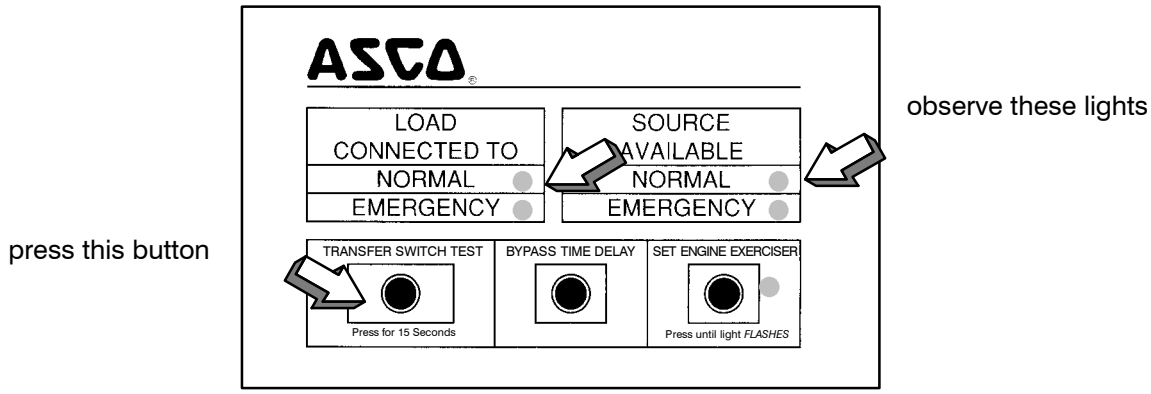


Figure 1–6. Standard controls and indicators.

3 – Electrical Operation

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ CAUTION

Verify that the feeders have been connected to the proper lugs.

⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1 through 8 at the right. Observe the status lights. See Figure 1–6.

- ● Black circle means light is on.
- ❍ White circle means light is off.

NOTE: If Motor Load Transfer feature is activated, then transfer may not occur immediately after the respective time delays. Transfer will only occur when the phase relationship between sources is correct.

This completes the Functional Test of the ASCO Series 300 Automatic Transfer Switch. Leave the engine–generator starting control in the *automatic* position.

1	The normal source must be available and the generator must be ready to start. Check that the *Normal Source Available* light is on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○
2	Press and hold the *Transfer Switch Test* button until the engine starts and runs. This should happen within 15 sec.	TRANSFER SWITCH TEST
3	The *Emergency Source Available* light should come on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ●
4	The transfer switch should transfer to the Emergency position. The *Load Connected to Emergency* light should come on and the *Load Connected to Normal* light should go off.	LOAD CONNECTED TO NORMAL ○ EMERGENCY ●
5	If the *transfer to emergency delay* is used the transfer should occurs after a time delay (up to 5 minutes). For immediate transfer press the *Bypass Time Delay* button.	BYPASS TIME DELAY
6	The transfer switch should transfer back to the Normal position. The *Load Connected to Normal* light should come on and the *Load Connected to Emergency* light should go off.	LOAD CONNECTED TO NORMAL ● EMERGENCY ○
7	If the *retransfer to normal delay* is used the retransfer should occur after a time delay (up to 30 minutes). For immediate retransfer press the *Bypass Time Delay* button.	BYPASS TIME DELAY
8	The *unloaded running delay* keeps the generator running for 5 minutes (cool–down period). Then the generator should stop and the *Emergency Source Available* light should go off.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○

SECTION 2 SEQUENCE OF OPERATION

Transfer To Emergency

The sequence for load transfer to emergency source begins automatically when normal source voltage falls below the preset dropout point or when *Transfer Switch Test* button is pressed. An under voltage condition on any phase of the normal source is detected by the sensor.

When the normal source voltage fails or the *Transfer Switch Test* button is pressed, the SE relay de-energizes and relay NR begins its timing cycle (1 or 3 seconds, *momentary normal source outage delay*). The NR relay is provided with a time delay on dropout to override momentary outages and prevent nuisance starting of the engine-driven generator. If the normal source voltage returns above the sensor dropout setting before the time delay expires, the NR relay timing cycle is reset to zero and relay SE energizes.

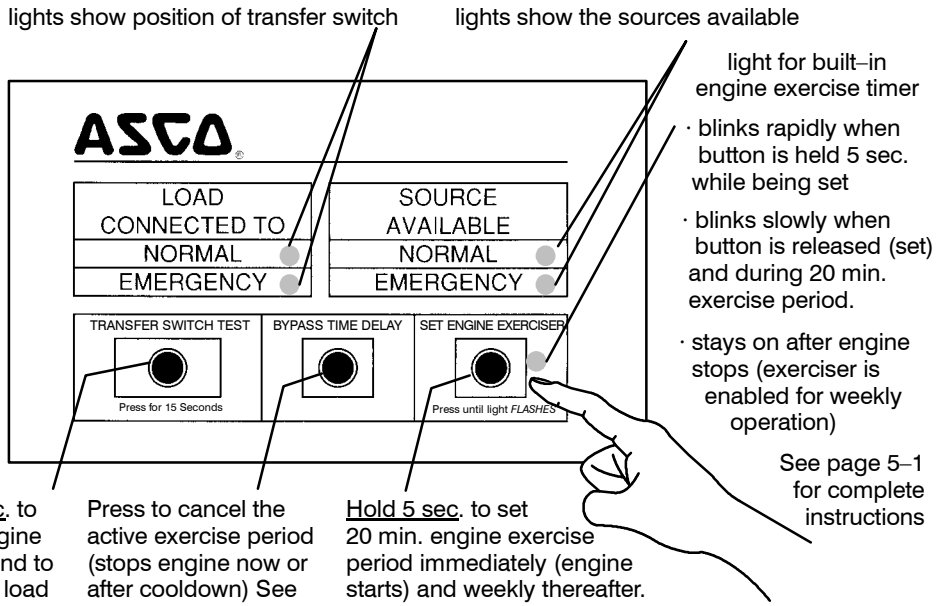


Figure 2–1. Membrane controls and indicator lights.

If the normal source voltage does not return above the sensor dropout setting before the time delay expires, the NR relay de-energizes and signals the engine-driven generator to start. At the same time, a voltage and frequency sensor begins monitoring the emergency source. The sensor will accept the emergency source only when both voltage and frequency reach preset pickup points. Usually about ten seconds elapse from dropout of the NR relay to acceptance by the sensor. This time span occurs because the engine-driven generator must crank, start, and run up to nominal pickup points. For this reason, if the *Transfer Switch Test* button is pressed it must be held for 15 seconds. If the emergency source is available immediately, the sensor may accept it as soon as NR relay drops out.

When the emergency source is accepted by the sensor, relay ER begins its timing cycle (*transfer to emergency delay*). ER relay is provided with an adjustable (0 to 5 minutes) time delay on pickup to delay transfer of the load to the emergency source. For immediate transfer press *Bypass Time Delay* button.

ER relay energizes, the TS coil is energized, the transfer switch operates, and all switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the emergency source.

The transfer switch will remain in the Emergency position until the normal source is restored. If the *Transfer Switch Test* button is used, the transfer switch will remain on emergency until the *retransfer to normal delay* times out.

Retransfer to Normal

The sequence for load retransfer to the normal source automatically begins when the voltage sensor detects restoration of the normal source. The voltage level must rise above the preset pickup point on all phases before the sensor will accept the normal source.

When the normal source is accepted by the sensor, relay SE begins its timing cycle (adjustable 1 sec. to 30 min., *retransfer to normal delay*). For immediate retransfer press *Bypass Time Delay* button. SE relay is provided with a time delay on pickup to prevent immediate load retransfer to the normal source. The delay insures that the normal source has stabilized before reconnection of vital loads. If the normal source voltage falls below the present dropout point before the time delay expires, the timing cycle is reset to zero. If the emergency source fails for more than 4 seconds during the timing cycle, ER relay drops out and the load is immediately retransferred to the normal source, if that source is acceptable.

SE relay energizes and ER relay is dropped out. The TS coil is energized, the transfer switch operates, and all switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the normal source again.

Upon retransfer to the normal source, NR relay begins its timing cycle (*unloaded running delay [engine cooldown]*). NR relay is provided with a 5 minute time delay on pickup to keep the engine running for a cool-down period.

NR relay energizes after the time delay and signals the engine-driven generator to shut down. All circuits are reset for any future normal source failure.

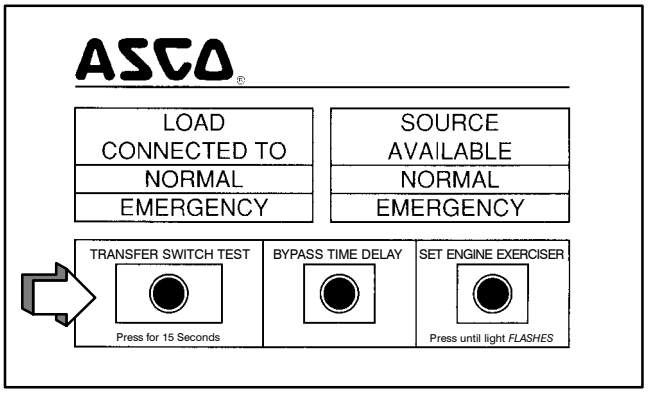
Activation of standard control features shown in Section 5 will alter the sequence of operation and introduce additional time delays during transfer operations.

SECTION 3 TESTING & SERVICE

PREVENTIVE MAINTENANCE

Reasonable care in preventive maintenance will ensure high reliability and long life for the automatic transfer switch.

Operate the switch at least once a month. Perform this 4–step Electrical Operation Test (test with load transfer).



Transfer Switch Test

1.	Press and hold the door-mounted *TRANSFER SWITCH TEST* button until the engine starts and runs. This should happen within 15 seconds.
2.	The transfer switch will operate to the Emergency position. If the *Transfer To Emergency Delay* is used, the transfer will occur after a time delay (up to 5 minutes). For immediate transfer press *BYPASS TIME DELAY* button.
3.	The Transfer Switch will operate back to the Normal position after the *Retransfer To Normal Delay* (up to 30 minutes). For immediate retransfer press *BYPASS TIME DELAY* button.
4.	*Unloaded Running (Engine Cooldown) Delay* allows engine to run unloaded for 5 minutes.

Checklist for Yearly Inspection

☐ **Clean the enclosure.** De–energize all sources, then brush and vacuum away any excessive dust accumulation. Remove any moisture with a clean cloth.

☐ **Check the transfer switch contacts**. Remove the transfer switch barriers and check contact condition. Replace the contacts if they become pitted or worn excessively. Reinstall the barriers carefully.

☐ **Maintain transfer switch lubrication**. The transfer switch has been properly lubricated, and under normal operating conditions no further lubricating is required. Renew factory lubrication if the switch is subjected to severe dust or abnormal operating conditions. Relubricate the operator if TS coil is replaced. Order **lubrication 625550–001** (Castrol *Endurex*® 4000 lubricant).

☐ **Check all cable connections & retighten them**. Torque to values shown on transfer switch label.

DISCONNECTING THE CONTROLLER

The harness disconnect plugs are furnished for repair purposes only and should not have to be unplugged. If the controller must be isolated, follow these steps carefully.

Disconnecting the Plugs

⚠ WARNING

Do not unplug the controller until step 1a. or 1b. below is completed.

1. Observe the position of the transfer switch.
   a. If the transfer switch is in the *Normal* position, place standby engine starting control in the *off* position. Then open the emergency source circuit breaker.
   b. If the transfer switch is in the *Emergency* position, open the normal source circuit breaker. Place the engine starting control in the *test* or *run* position.
2. Separate the quick disconnect plugs by squeezing the latches. Do not pull on the harness wires.
3. Label, remove, and tape the signal wires connected to the engine start terminals on the transfer switch: TB14 and TB15, or TB14 and TB16.

Reconnecting the Plugs

⚠ WARNING

Do not reconnect the controller until step 1a. or 1b. and 2 below are completed.

1. Observe the position of the transfer switch.
   a. If the transfer switch is in the *Normal* position, be sure that the standby engine starting control is still in the *off* position. The emergency source circuit breaker still should be open.
   b. If the transfer switch is in the *Emergency* position, normal source circuit breaker still should be open.
2. Reconnect the signal wires connected to the appropriate engine start terminals on the transfer switch. See **Section 1**, *Engine Starting Contacts*.
3. The harness plugs and sockets are keyed. Carefully align the plugs with the sockets and press straight in until both latches click.
4. Restore the opposite source as follows:
   a. If the transfer switch is in the *Normal* position, place the standby engine starting control in the *automatic* position. Then close the emergency source circuit breaker.
   b. If the transfer switch is in the *Emergency* position, close the normal source circuit breaker. The load will be automatically retransferred to the normal source after the *Retransfer to Normal Delay*. For immediate retransfer, press *BYPASS TIME DELAY* button. Place the engine starting control in the *automatic* position.

MANUAL LOAD TRANSFER

This procedure will manually transfer the load if the controller is disconnected.

⚠ WARNING

Do not manually operate the transfer switch until both power sources are disconnected: open both circuit breakers.

1. Open normal and emergency source circuit breakers.
2. Use the maintenance handle to manually operate transfer switch to the opposite source. See page 1–3, *Manual Operation Test*.
3. If the transfer switch is in the Emergency position manually start the engine generator and then close the emergency source circuit breaker.

TROUBLE-SHOOTING

Note the control features that are activated or furnished on the switch and review their operation. Refer to **Section 5**, **Control Features**.

⚠ WARNING

Proceed with care!
The automatic transfer switch is energized.

Table 3-1. Trouble-Shooting Checks.

PROBLEM	CHECK IN NUMERICAL SEQUENCE		
	1 OPERATION	2 GEN-SET	3 VOLTAGE
Gen-Set does not start when the *TRANSFER SWITCH TEST* button is pressed and held for 15 seconds or when the normal source fails.	Hold the *TRANSFER SWITCH TEST* button 15 sec. or the outage must be long enough to allow for the 1 or 3 sec. *Momentary Normal Source Outage Delay* plus engine cranking and starting time.	Starting control must be in automatic position. Batteries must be charged and connected. Check wiring to engine starting contacts.	—
Transfer switch does not transfer the load to emergency source after the gen-set starts.	Wait for *Transfer to Emergency Delay* (0 to 5 min.) to time out. For immediate transfer, press the *BYPASS TIME DELAY* button. If Motor Load Transfer is active, wait for in-phase condition (see below).	Generator output circuit breaker must be closed. Generator frequency must be at least 57 Hz.	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals EA and EC (or EL1 and EL2 for 2 pole switches). * * These are factory settings.
Transfer switch does not transfer the load to normal source when normal returns or when *TRANSFER SWITCH TEST* button is released.	Wait for *Retransfer to Normal Delay* (1 sec. to 30 min.) to time out. For immediate re–transfer, press *BYPASS TIME DELAY* button. If Motor Load Transfer is active, wait for in-phase condition (see below).	—	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals NB and NC, NC and NA, and NA and NB (or NL1 and NL2 for 2 pole switches).
Gen-Set does not stop after load retransfer to the normal source.	Wait for the 5 minute *Unloaded Running Delay* to time out.	Starting control must be in automatic position.	—

Trouble-Shooting the Motor Load Transfer Feature (refer to page 5–5)

⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

1. Connect a voltmeter (set for twice system phase–to–phase voltage) between Transfer Switch terminals NA and EA.
2. Manually start generator. Voltmeter needle should sweep back and forth at a regular rate between 0 and about twice system voltage.
3. Press and hold TRANSFER SWITCH TEST button. The load should transfer to emergency source when meter needle is near 0 volts. If transfer does not occur, Motor Load Transfer feature is not operating.
4. Release the **Transfer Switch Test** button. The load should retransfer back to the normal source after the *Retransfer to Normal Delay*, if used. The retransfer should occur when the needle is near 0 volts. If retransfer does not occur after the time delay, the Motor Load Transfer feature is not operating.
5. For immediate retransfer, press the BYPASS TIME DELAY button. Then disconnect the voltmeter.

HELP If the problem is isolated to circuits on the controller or the transfer switch, call your local ASCO Power Technologies sales office or ASI. In the United States, call 1–800–800–2726. In Canada, call 1–888–234–2726. Please furnish the Serial No., Bill of Material (BOM) No., and Catalog No. from transfer switch nameplate.

SECTION 4 ADJUSTMENTS

Time Delay Adjustment

Standard time delays are set to customer specifications (if none specified, standard factory settings are used).

To change a setting, follow procedure on page 4-2. Use Table 4-1 as a guide to time delay values and their corresponding adjustment DIP switch or potentiometer.

Table 4-1. Time Delay Settings

DESCRIPTION	LABELS	FACTORY SETTING	ADJUSTMENT RANGE	S3 DIP SWITCH		ADJUSTMENT POTENTIOMETER
Override Momentary Normal Source Outages	TD ES	3 seconds	1 second	Actuator 1 on		—
			3 seconds	Actuator 1 off		
Transfer to Emergency	TIMER N/E	0 minutes (full ccw)	0 to 5 minutes	—	—	P2
Override Momentary Emergency S. Outages	—	4 seconds	non-adjustable	—	—	—
Retransfer to Normal	TIMER E/N	30 minutes (full cw)	1 second to 30 minutes	—	—	P1
Unloaded Running (Engine Cooldown)	—	5 minutes	non-adjustable	—	—	—

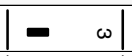
Sensor Adjustments

Voltage and frequency sensor pickup and dropout points are set to customer specifications (if none specified, standard factory settings are used). To change a setting, follow procedure on page 4–2. Use Tables 4-2 and 4–3 for settings and corresponding DIP switch actuators.

⚠ WARNING

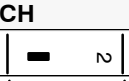
Any change in these settings may affect the normal operation of the automatic transfer switch. This change could allow the load circuits to remain connected to a low voltage source.

Table 4-2. Voltage and Frequency Settings. (☐ Shaded DIP switches are standard factory settings).

DESCRIPTION	LABELS	SETTING	% of nominal		S1 DIP SWITCH	
			FACT. SET	ADJ RANGE		
Normal Source Voltage	PU / N	Pickup	90 %	95 % *	Actuator 3 off	
				90 %	Actuator 3 on	
	DO / N	Dropout	85 %	90 % *	Actuator 1 off Actuator 2 off	
				85 %	Actuator 1 on Actuator 2 off	
				80 %	Actuator 1 off Actuator 2 on	
				70 %	Actuator 1 on Actuator 2 on	
Emergency Source Voltage	– –	Pickup	90 %	non-adjustable	– –	
	– –	Dropout	75 %	non-adjustable		
Emergency Source Frequency	– –	Pickup	95 %	non-adjustable	– –	
	– –	Dropout	85 %	non-adjustable		
	60 / 50 Hz	60 / 50 Hz	60 Hz	60 Hz	Actuator 4 off	
				50 Hz	Actuator 4 on	
Voltage Phases	3 ∅ , 1 ∅	3 ∅ / 1 ∅	3 ∅	3 phase	Actuator 6 off	
				1 phase	Actuator 6 on	

* If dropout voltage is set to 90%, the pickup voltage must be set to 95%.

Table 4-3. Transformer Voltage Adjust.
(Low setting shifts all voltage settings down 4.2%; for example, 240 V to 230 V, or 480 V to 460 V)

DESCRIPTION	LABELS	FACTORY SETTING	ADJUSTMENT	S3 DIP SWITCH	
Voltage Adjust (4.2%)	LOW / HI	HI	LOW	Actuator 2 off	
			HI	Actuator 2 on	

⚠ WARNING

Do not make any setting changes while the controller is energized.

How to Change a Setting

1. Prevent the transfer switch from operating by disconnecting one source first, then the other, as follows:
   a. If the transfer switch is in the Normal position, open the emergency source circuit breaker. Turn the engine starting control to *off*. Then open the normal source circuit breaker.
   b. If the transfer switch is in the Emergency position, open the normal source circuit breaker. Turn engine starting control to *test* or *run*. Then open the emergency source circuit breaker.
2. Disconnect both harness plugs from controller by squeezing the latches. Do not pull on the wires.
3. Remove cover from the controller by releasing latch on right side with your thumb. See Figure 4-1.
4. Locate the appropriate adjustment potentiometer or DIP switch for the setting that you want to change. Refer to Table 4-1 and Table 4–2 on page 4-1 and Figure 4-2, Figure 4–3, Figure 4–4 on page 4–2.
5. Use a small screwdriver to turn the potentiometer clockwise to increase the time delay or counterclockwise to decrease it. See Figure 4-3.
6. Use a ball-point pen (or similar pointed tool) to slide the switch actuators left or right so they match the illustration next to the setting (left = off, right = on). Recheck the setting. See Figure 4-4.
7. Install the cover on the controller by hooking it on the left side and latching the right side.
8. Reconnect both harness plugs to the controller by aligning and pressing straight in until latches click.

⚠ WARNING

Close the enclosure door.

9. Close the enclosure door, then restore both sources:
   a. If the transfer switch is in the Normal position first close the normal source circuit breaker, then close the emergency source circuit breaker.
   b. If the transfer switch is in the Emergency position, close the normal source circuit breaker. The load will be automatically retransferred to the normal source. Then close the emergency source circuit breaker.
10. Turn the engine starting control to *automatic*.

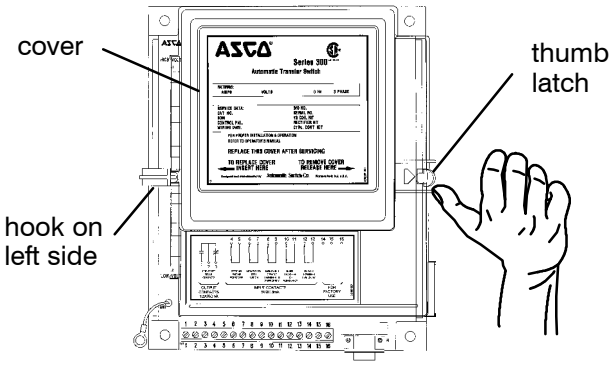


Figure 4-1. Controller cover latch.

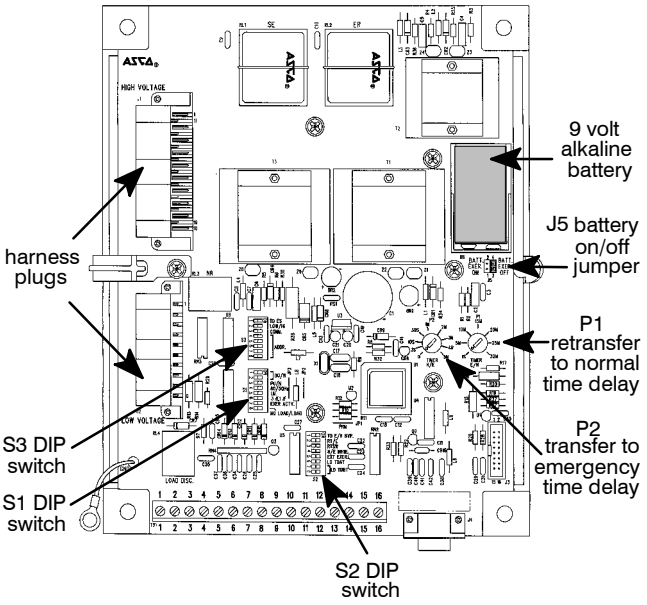


Figure 4-2. Location of potentiometers.

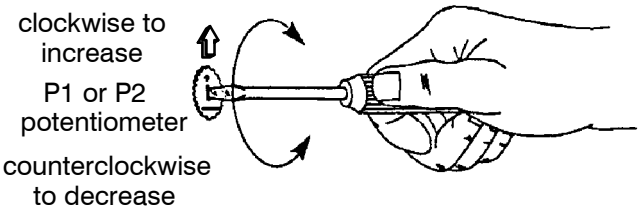


Figure 4-3. Changing time delay potentiometers.

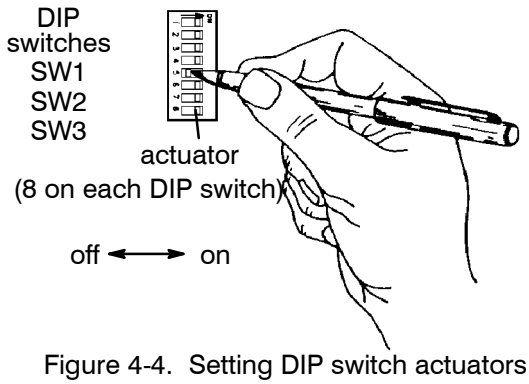


Figure 4-4. Setting DIP switch actuators.

SECTION 5 CONTROL FEATURES – ENGINE EXERCISERS

These timers periodically exercise the emergency engine-generator plant. They can be set to exercise with or without load transfer, or they can be completely disabled. The engine-generator should be exercised under load once a week for a minimum time period of 20 minutes, or follow the recommendations of the engine-generator set manufacturer. Refer to page 4–2 for location of DIP switches, battery (provided), and jumper block in the controller.

BUILT–IN ENGINE EXERCISER

The engine exerciser included in ASCO Series 300 Automatic Transfer Switches provides a once a week 20–minute exercise period. It occurs immediately when the SET ENGINE EXERCISER push button is pressed (and held for at least 5 seconds), and then at the same time weekly thereafter. A 9 volt alkaline battery (*Duracell*® MN1604, *Everready*® 522, or *Panasonic*® 6AM6) is furnished and installed in the controller to maintain the setting. The battery jumper block must be shifted to the ON position. See Figure 4–2 on page 4–2.

Fill in day and time set. Week Day _____ Time _____.

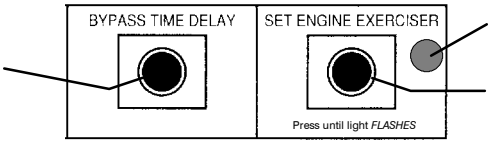
DIP Switch Settings

FUNCTION	S1 DIP SWITCH		S2 DIP SWITCH	
Std. Timer Enabled	Actuator 7 on	7	Actuator 5 on	5
Std. Timer Disabled	Actuator 7 off	7	Actuator 5 on	5
Exercise without Load	Actuator 8 off	8		
Exercise with Load	Actuator 8 on	8		

Shaded DIP switches are standard factory settings.

Press to cancel an active exercise period (stops generator).

If *Exercise with Load* is set, retransfers load to Normal, then stops generator after 5 min. cooldown.



status light

Press and hold for 5 sec. or until status light blinks rapidly to set exercise period immediately and every week hereafter (generator starts).

If *Exerciser with Load* is set, transfers load to Emergency.

Figure 5-1. Operator panel pushbuttons and light.

Select below either *Exercise without Load* or *Exercise with Load* according to the setting of DIP switch S1, actuator 8. The load transfers from the Normal source to Emergency source (generator) and back again if *Exercise with Load* is selected.

Exercise without Load, DIP Switch S1, Actuator 8 off (8) — How to Set Built–In Timer

Step	Push Button	Status Light	Function	Explanation
1	*SET ENGINE EXERCISER* hold 5 sec.	blinks rapidly ●○●○●○	set exercise period	Exercise the generator now and every week at this time hereafter.
2	release	blinks slowly ●○○●○○	exercise period now active	Generator starts and runs.
3	press *BYPASS TIME DELAY*	● stays on	cancel active exercise period	Generator stops.
4	—	● stays on	generator off	Exerciser enabled; repeats every 7 days.

Exercise with Load, DIP Switch S1, Actuator 8 on (8) — How to Set Built–In Timer

Step	Push Button	Status Light	Function	Explanation
1	*SET ENGINE EXERCISER* hold 5 sec.	blinks rapidly ●○●○●○	set exercise period	Exercise the generator now and every week at this time hereafter.
2	release	blinks slowly ●○○●○○	exercise period now active	Generator starts and runs; the load transfers to Emergency.
3	press *BYPASS TIME DELAY*	blinks slowly ●○○●○○	cancel active exercise period	The load retransfers to Normal; then generator runs for 5 minute cooldown (light blinks slowly during cooldown).
4	—	● stays on	generator off	Exerciser enabled; repeats every 7 days.

NOTE: Every time *SET ENGINE EXERCISER* push button is pressed (held 5 seconds) the exercise period is changed.

Optional Accessory 11BG – SOURCE AVAILABILITY SIGNAL & PROGRAMMABLE ENGINE EXERCISER MODULE

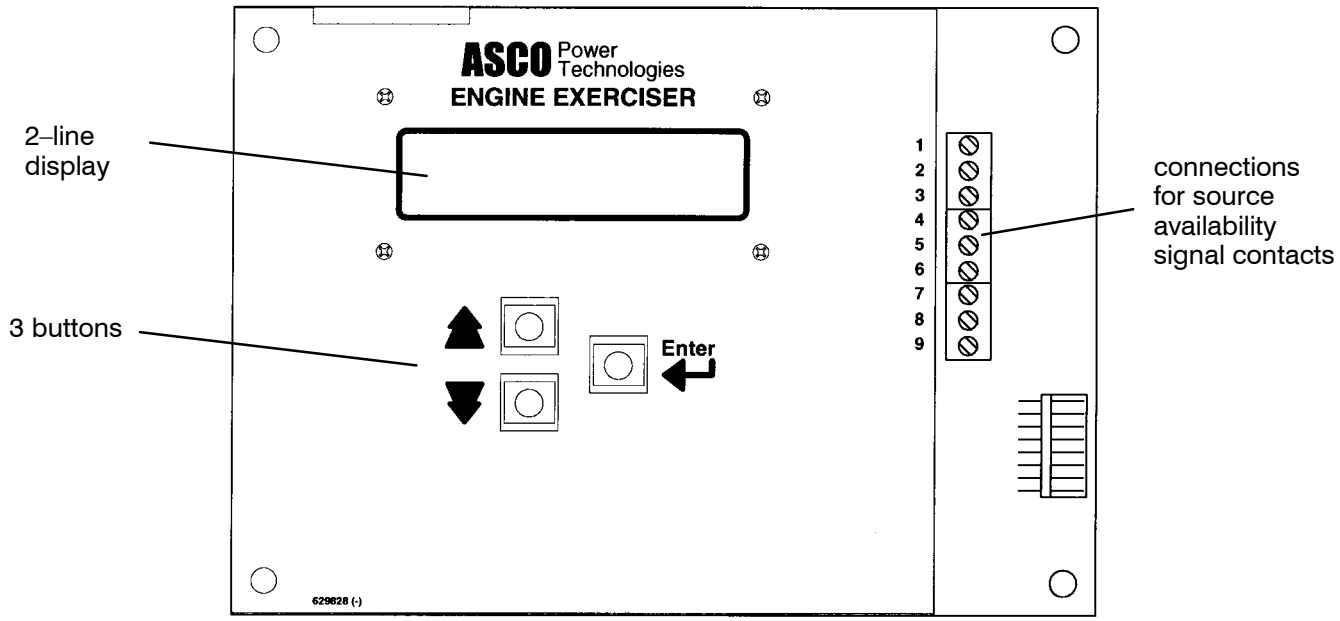


Figure 5–2. Accessory 11BG module (mounted behind operator interface and connected to the controller) includes source availability signal contacts and a programmable engine exerciser.

Source Availability Signal Contacts

The module provides one Form C contact each for the normal and emergency sources signal the acceptability of the source as sensed by the controller. The signal contacts operate in conjunction with the *Source Available* lights on the operator interface. Field wiring terminals are provided as shown in Figure 5–3 and the wiring diagram.

Contact ratings:

2 amps @ 30 Vdc, 0.5 amp. @ 125 Vac resistive

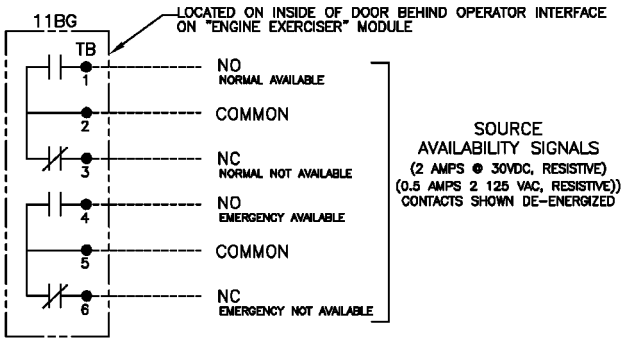


Figure 5–3. Source availability signal contacts.

Programmable Engine Exerciser

The module includes a programmable engine exerciser that provides for weekly or biweekly operation. This optional exercise timer may have to be turned on (enabled) by setting the S1 DIP switch actuator 7 to off, and S2 DIP switch actuator 5 to off. A backup battery in the controller (see page 4–2 and page 5–3) must be turned on to maintain the settings and to allow programming with the normal and emergency power turned off (page 5–1).

The programmable engine exerciser incorporates a 7 day or 14 day time base. Proper controller settings must be made to determine whether or not the test will be done with or without load transfer (S1 DIP switch actuator 8).

See next page for instructions on setting the timer.

DIP Switch Settings in the Controller

(see page 4–2)

FUNCTION	S1 DIP SWITCH		S2 DIP SWITCH	
Opt. Timer Enabled	Actuator 7 off		Actuator 5 off	
Opt. Timer Disabled	Actuator 7 off		Actuator 5 on	
Exercise without Load	Actuator 8 off			
Exercise with Load	Actuator 8 on			

Shaded DIP switches are standard factory settings.

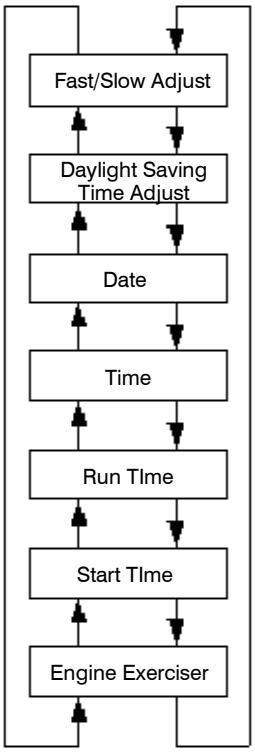
How to Set Optional Programmable Engine Exerciser (part of Acc. 11BG module)

⚠ DANGER

Hazardous voltage capable of causing shock, burns, or death is used in this transfer switch. Deenergize both Normal & Emergency power sources before programming the exerciser.

Navigating the Menu

Use the UP and DOWN arrow keys to move through the displays.



Changing the Parameters

Use the UP and DOWN arrow keys to move though the displays to the parameter to be changed. Push the ENTER key to start the editing process. The first parameter will flash. Use the UP and DOWN arrow keys to adjust the parameter to the desired value and press the ENTER key to save the value. The next parameter will now flash. Repeat the process until each parameter is properly configured.

Engine Exerciser Display

The Engine Exerciser Display shows the status of the engine exerciser. When the unit is shipped from the factory the programmable engine exerciser is "Disabled" and must be set to "Enabled" by the customer. When the engine exerciser is running, this display will count down the remaining time until the end of the exercise period.

Start Time Display

The Start Time Display shows the engine exerciser start time. There are four parameters that determine the start time:

weekly ("Every") or bi–weekly ("Alt") operation
day of week ("Sun" through "Sat")
start hour (0 through 23)
start minutes (0 through 59)

For example, if the user wants the exerciser to run every other Saturday at 3 PM, the proper configuration would be:

"Alt Sat @ 15:00"

NOTE: When choosing bi–weekly operation, the exerciser will always run on the week designated "(1)" on the date display.

Run Time Display

The Run Time Display shows the run time for the engine exerciser. The default setting from the factory is 30 minutes.

Time Display

The Time Display shows the present system time. The format is "hours:minutes:seconds".

NOTE: During total power outages, power to the accessory is maintained by a battery in the Controller (see page 4–2). Be sure that the 9–volt alkaline battery is fresh and enabled (jumper in ON position) so that the time and date settings are not lost.

Date Display

The Date Display shows the present system date. The format is "day of week (week) month/day of month/year".

NOTE: Week is either week 1 or week 2. This is used in conjunction with the bi–weekly timer.

Daylight Savings Time Adjust Display

This display shows whether the automatic daylight saving time adjustment is active. The factory default is "NO". If enabled, the unit will automatically adjust for daylight saving time at 2 AM on the first Sunday of April and the last Sunday of October.

Fast / Slow Adjust Display

This display shows the automatic fast/slow adjustment value. The factory default is 0. This feature can be used to trim a clock that runs fast or slow. For example, if your clock runs 10 seconds slow per week, change the fast/slow adjust value to "+10" and the unit will automatically add 10 seconds to the clock every week.

NOTE: Adjustments are made Sunday morning at 2 AM. If you want your exerciser period to start at 2 AM on Sunday, you cannot use this feature and the adjustment must be set to 0.

Programmable Engine Exerciser Settings

Fill in your settings for future reference

Weekly or Bi–weekly	Day of Week	Start Time	Run Time
Every = weekly *Alt* = bi–weekly	*Sun* through *Sat*	*0* – *23* hour *0* – *59* minute	*0* – *23* hour *0* – *59* minute *30* minutes is the default setting

Date exerciser was set _____

CONTROL FEATURES *(continued)*

INPHASE MONITOR FOR MOTOR LOAD TRANSFER

Inphase monitoring logic controls transfer and retransfer of motor loads, so that inrush currents do not exceed normal starting currents. It avoids nuisance tripping of circuit breakers and mechanical damage to motor couplings.

The Motor Load Transfer feature is built into the controller. DIP switch S1 (actuator 5) activates this feature: right = ON, left = OFF.

FUNCTION	S1 DIP SWITCH	
enable	Actuator 5 on	
disable	Actuator 5 off	

☐ Shaded DIP switches are standard factory settings.

Note

If the Motor Load Transfer feature is enabled, it will be activated following the Load Disconnect Feature Delay Before Transfer delay.

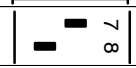
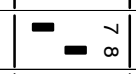
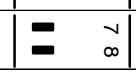
LOAD DISCONNECT FEATURE

Connect external circuits to the terminals indicated on the Wiring Diagram provided with the ATS.

The double throw (Form C) contact is rated for 28 VDC or 120 VAC (5 amps resistive). The contact operates prior to a selectable 0, 3, 10, or 20 second delay before transfer of the Automatic Transfer Switch. The contact resets either immediately following transfer or after the same delay as set for pre–signal before transfer.

Time delay between the load disconnect control signal and initiation of transfer is set on the controller with DIP switch S2 (actuators 6, 7, 8) as shown below:

Delay Before Transfer

LD TDBT	S2 DIP SWITCH	
0 (disable)	Actuator 7 on Actuator 8 on	
3 seconds	Actuator 7 on Actuator 8 off	
10 seconds	Actuator 7 off Actuator 8 on	
20 seconds	Actuator 7 off Actuator 8 off	

☐ Shaded DIP switches are standard factory settings.

Delay After Transfer*

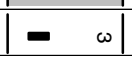
LD TDAT	S2 DIP SWITCH	
enable	Actuator 6 on	
disable	Actuator 6 off	

*Enabling the Delay After Transfer will cause the control signal to reset after the same delay as set for the Delay Before Transfer.

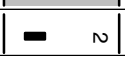
REMOTE CONTROL FEATURES

These remote control features require a customer–supplied normally closed contact suitable for a 5 V dc low energy circuit. Refer to the Wiring Diagram provided with the ATS. Activate appropriate DIP switch S2 actuators below.

Remote Test (terminals CP6–7)

RTSW	S2 DIP SWITCH	
disable	Actuator 3 on	
enable	Actuator 3 off	

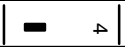
Remote Transfer to Emergency (CP8–9)

RT /E	S2 DIP SWITCH	
disable	Actuator 2 on	
enable	Actuator 2 off	

Bypass Transfer Time Delay (CP12–13)

TD E/N BYP.	S2 DIP SWITCH	
disable	Actuator 1 on	
enable	Actuator 1 off	

Inhibit Transfer to Emergency (CP10–11)

N/E INHIB.	S2 DIP SWITCH	
disable	Actuator 4 on	
enable	Actuator 4 off	

OPTIONAL STRIP HEATER (Accessory 44)

Accessory 44 Strip Heater is designed to keep ambient temperatures within the Automatic Transfer Switch enclosure at acceptable levels. This accessory consists of a mounting bracket with strip heater, thermostat, and terminal block. A transformer with fuses is included when the power for the assembly is derived from voltages above 120 V ac. The 120 V ac customer powered assembly does not include a transformer. This optional accessory is available factory installed or in kit form.

Turn the thermostat's dial to required setting as shown.

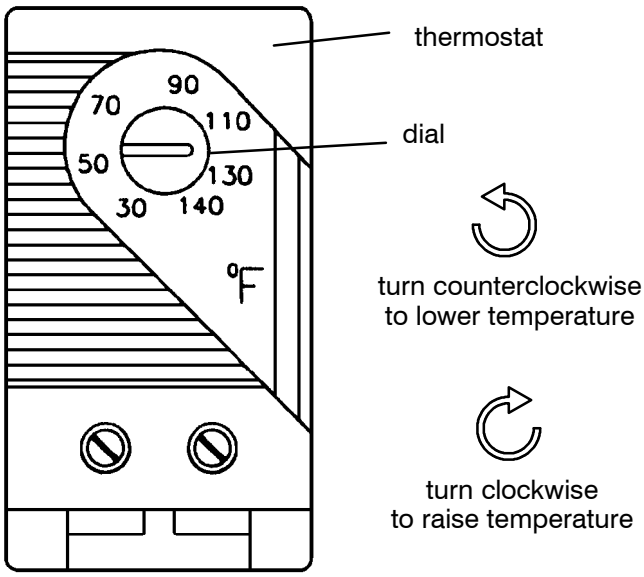


Figure 5–4. Thermostat.

AVAILABLE KITS FROM ASCO

Controls

Description	Accessory	Kit
Programmable Engine Exerciser & Source Availability Contacts	11BG	K629830
Serial Communication Module	72A	K601110

Strip Heater – Accessory 44

Description	Accessory	Kit
120 volt customer supplied voltage (without transformer)	44A	K613127–001
208 – 480 volt ATS derived voltage (with transformer)	44G	K613127–002
380 volt ATS derived voltage (with transformer)	44G	K613127
550 – 600 volt ATS derived voltage (with transformer)	44G	K613127–003

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Operator's Manual

ASCO® Series 300 Automatic Transfer Switches G design 1000 through 3000 amps

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TESTING & SERVICE	3
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⚠ DANGER

DANGER is used in this manual to warn of high voltages capable of causing shock, burns, or death.

⚠ WARNING

WARNING is used in this manual to warn of possible personal injury.

⚠ CAUTION

CAUTION is used in this manual to warn of possible equipment damage.

Refer to the outline and wiring drawings provided with ASCO Series 300 ATS for all installation details.

An experienced licensed electrician must install the ATS.

1000, 1200, 1600 amp. sizes

2000 amp. size

ASCO POWER TECHNOLOGIES L.P. 50 Hanover Road, Florham Park, New Jersey 07932–1591 USA
telephone 1 800 937–2726 (ASCO), for service call 1 800 800–2726 (ASCO) www.asco.com

381333–122 C

ASCO POWER TECHNOLOGIES CANADA PO Box 1238, 17 Airport Road, Brantford, Ontario, Canada N3T 5T3
telephone 519 758–8450, fax 519 758–0876, for service call 1 888 234–2726 (ASCO) www.asco.ca

Nameplate

The Transfer Switch nameplate includes data for each specific ASCO Series 300 ATS. Use the ATS only within the limits shown on this nameplate.

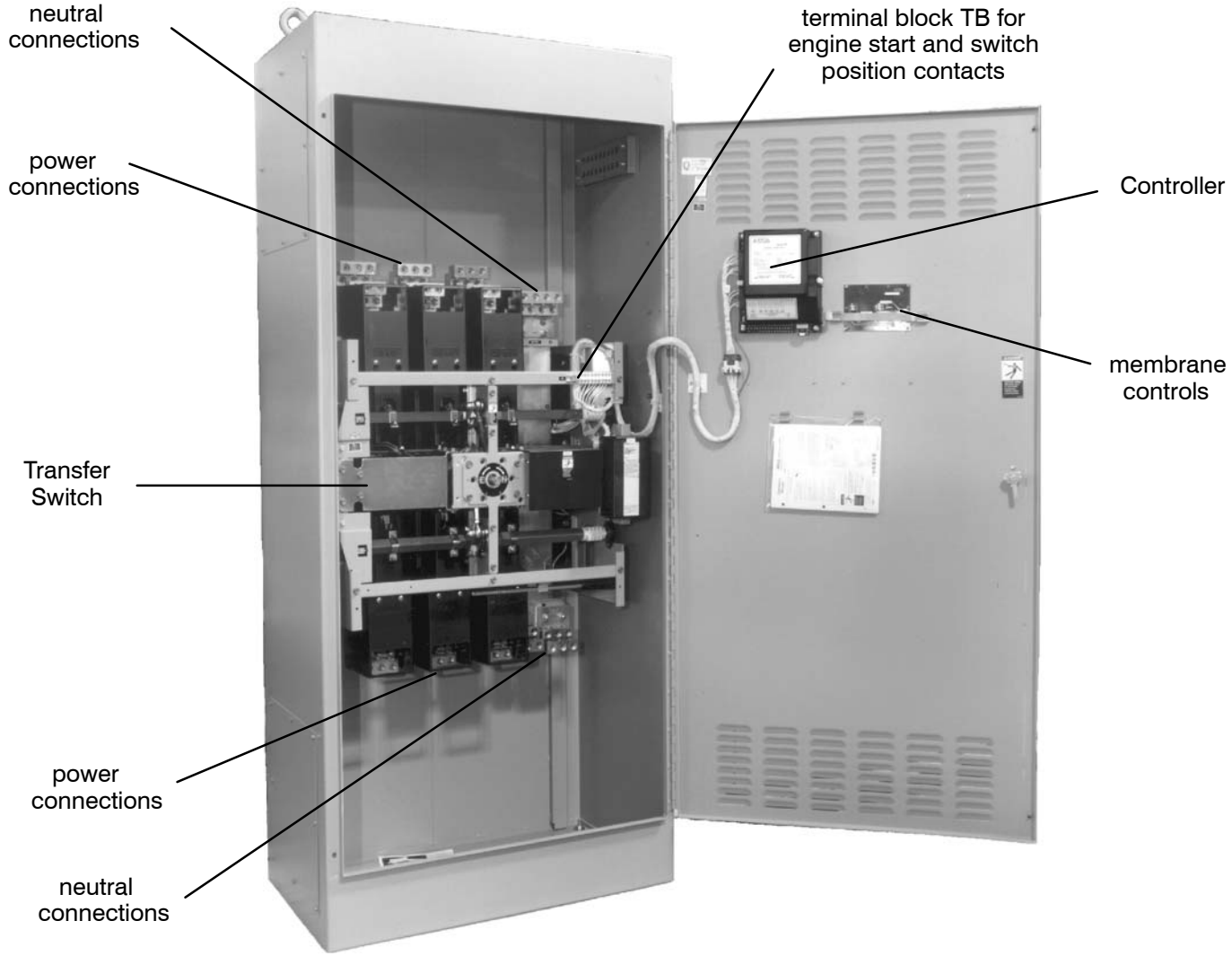
Catalog Number Identification

A typical Catalog Number is shown below with its elements explained. The example is for a G–design Series 300 ATS with switched neutral, 3 pole, 2000 amp, 480 V, in a Type 1 enclosure:

G300 ___ 3 2000 N 1 C

Neutral	Phase Poles	Amperes	Voltage		Controller	Enclosure
B – switched	2 – single Ø	1000	C 208	L 440	1 – standard	C – type 1
C – overlapping	3 – three Ø	1200	D 220	M 460	1X – if accessories ordered	F – type 3R
blank – solid		1600	E 230	N 480		G – type 4 *
		2000	F 240	P 550		L – type 12 *
		2600	H 380	Q 575		blank – open type
		3000	J 400	R 600		
			K 415			

* type 4 & 12 enclosures are available only for 1000, 1200, & 1600 amp. sizes



2000 amp. size in typical enclosure with location of customer connections

SECTION 1 INSTALLATION

ASCO Series 300 Automatic Transfer Switches (ATSs) are Listed under Underwriters Laboratories UL 1008 Standard for Safety for Automatic Transfer Switches. ASCO Series 300s are also Listed under CSA C22.2 No. 178 Standard for Automatic Transfer Switches. All control features are UL Component Recognized, which assures that ASCO automatic transfer switches meet OSHA Safety Requirements and will be acceptable to electrical inspectors.

ASCO Series 300 Automatic Transfer Switches are suitable for emergency and standby system applications. They meet emergency system rating requirements as defined in National Electrical Code (NEC) Article 700 and UL 1008. Also, they are suitable for the requirements of NEC Article 517 – Health Care Facilities, NEC Article 701 – Legally Required Standby Systems, NEC Article 702 – Optional Standby Systems, NFPA 99 Health Care Facilities, and NFPA 110 Emergency and Standby Power Systems.

Rating Label

Each automatic transfer switch contains a rating label to define the loads and fault circuit withstand / closing ratings. Refer to the label on the transfer switch for specific values.

⚠ WARNING

Do not exceed the values on the rating label. Exceeding the rating can cause personal injury or serious equipment damage.

Series 300 Automatic Transfer Switches are factory wired and tested. Installation requires skid removal then securing the enclosure to the supporting foundation.

Remove the Shipping Skid

Open the front door and remove the four lag screws (two in front, two in rear) securing the enclosure to the wood skid.

Supporting Foundation

The supporting foundation for the enclosure must be level and straight. Refer to the applicable enclosure outline drawing included with the Series 300 for all mounting details including door opening space.

If bottom cable entry is used, the foundation must be prepared so that the conduit stubs are located correctly. Refer to the enclosure outline drawing for specified area and location. Provide cable bending space and clearance to live metal parts. When a concrete floor is poured, use interlocking conduit spacer caps or a wood or metal template to maintain proper conduit alignment.

Mounting

Refer to the applicable enclosure outline drawing furnished with this switch and mount the Series 300 according to details and instructions shown on diagram.

Auxiliary Cable Box for 1000–2000 amp

An auxiliary cable box is required if the power cables do not enter the enclosure directly adjacent to the terminal lugs (for example, if all power cables enter the top or bottom). Order ASCO part no. 609027 if needed.

⚠ CAUTION

Do not route the power cables along the sides of the Transfer Switch.

Line Connections

Refer to the Wiring Diagram provided with your Series 300 ATS. All wiring must be made in accordance with the National Electrical Code and local codes.

It is unnecessary to remove pole covers from the transfer switch. If you do remove them, reinstall them carefully.

⚠ DANGER

De–energize the conductors before making any line or auxiliary circuitry connections. Be sure that Normal and Emergency line connections are in proper phase rotation. Place engine generator starting control in the OFF position. Make sure engine generator is not in operation.

Testing Power Conductors

Do not connect the power conductors to the ASCO Series 300 transfer switch until they are tested. Installing power cables in conduit, cable troughs and ceiling-suspended hangers often requires considerable force. The pulling of cables can damage insulation and stretch or break the conductor's strands. For this reason, after the cables are pulled into position, and before they are connected, they should be tested to verify that they are not defective or have been damaged during installation.

⚠ CAUTION

Protect the automatic transfer switch from construction grit and metal chips to prevent malfunction or shortened life of the ATS.

Connecting Power Conductors

After the power cables have been tested, connect them to the appropriate terminal lugs on the transfer switch as shown on the wiring diagram provided with this Series 300. Make sure the lugs provided are suitable for use with the cables being installed. Standard terminal lugs are solderless screw type and will accept the wire sizes listed on the drawings provided with the Series 300. Be careful when stripping insulation from the cables; avoid nicking or ringing the conductor. Remove surface oxides from cables by cleaning with a wire brush. When aluminum cable is used, apply joint compound to conductors. Tighten cable lugs to the torque specified on rating label.

Controller Ground

A grounding wire must be connected to the controller's lower left mounting stud. Because the controller is mounted on the enclosure door, a conductive strap must be used between the enclosure and the door. This connection provides proper grounding which does not rely upon the door hinges.

Engine Starting Contacts

Customer connections for engine control contact and TS auxiliary contacts connections are located on terminal block TB which is mounted on the front of the transfer switch. Refer to wiring diagram provided with the Series 300 ATS and connect the engine start wires to the appropriate terminals. See Figure 1–1 and Table A.

Table A. Engine start connections.

When normal source fails	Terminals on transfer switch
contact closes	TB1 and TB2
contact opens	TB1 and TB3

Auxiliary Circuits

Connect auxiliary circuit wires to appropriate terminals on transfer switch terminal block TB as shown on the wiring diagram provided with this Series 300 Automatic Transfer Switch. Make the necessary auxiliary connections by referring to **Section 5, Control Features**.

Harnesses

The transfer switch is connected to the left side of the controller by a plug–in harness (two plugs).

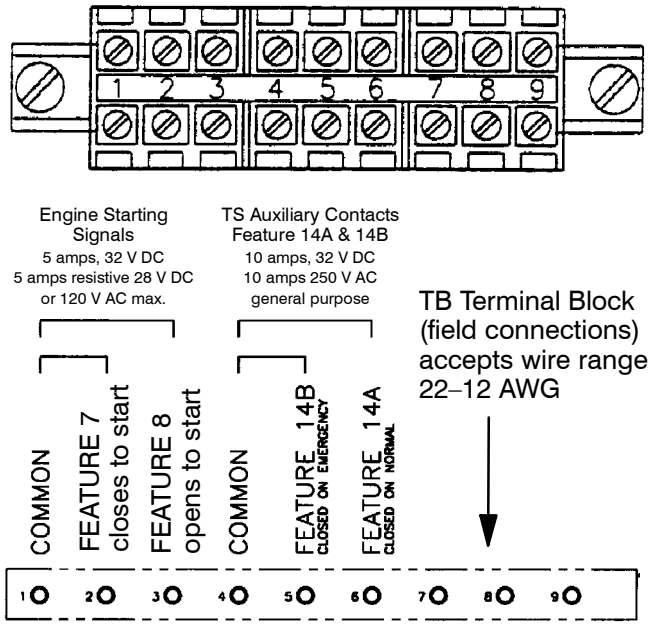


Figure 1-1. Connections to engine starting contact terminal block located on the Transfer Switch.

Connections to Controller for other Control Features

(located on bottom of Controller)

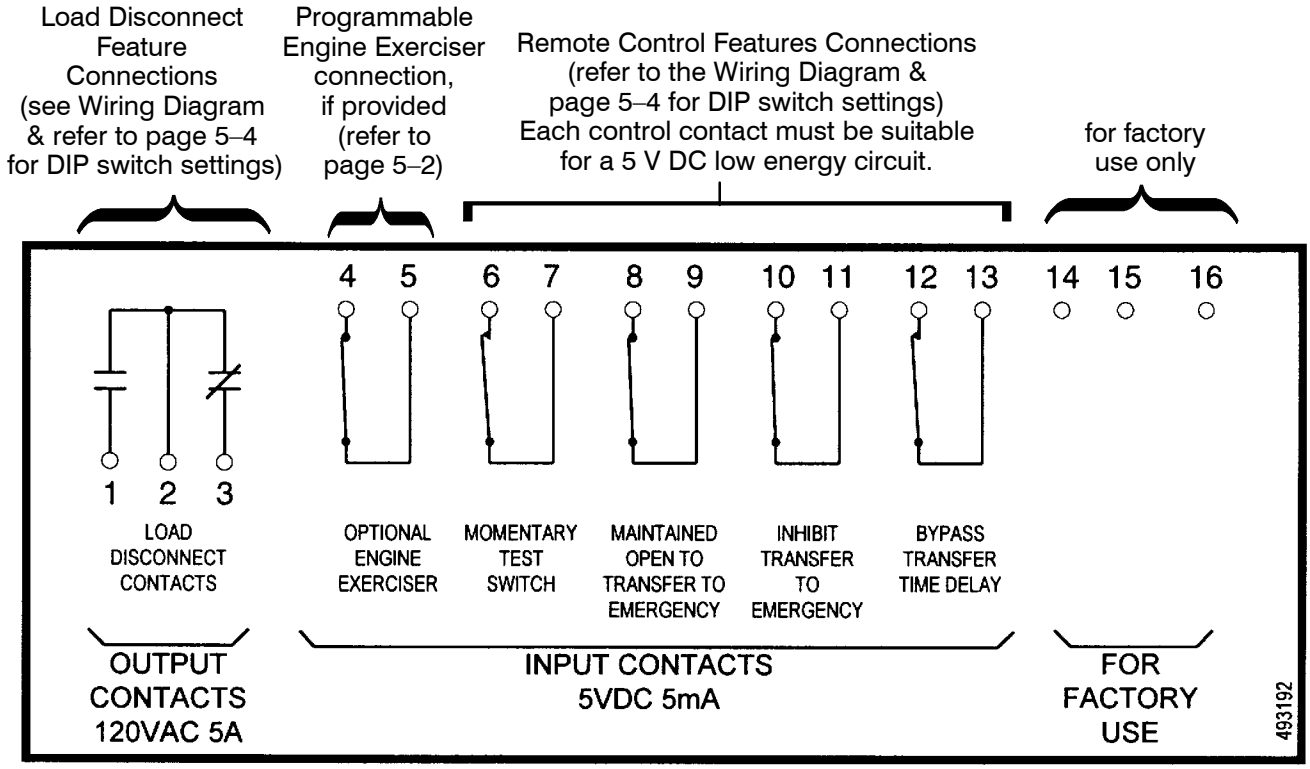


Figure 1-2. Input / output label on the Controller showing possible connections to the lower terminal block.

INSTALLATION *(continued)*
Functional Test

The Functional Test consists of three checks: manual operation, voltage checks, and electrical operation.

⚠ CAUTION

Do these checks in the order presented to avoid damaging the automatic transfer switch.

Read all instructions on the Wiring Diagram and labels affixed to the automatic transfer switch. Note the control features that are provided and review their operation before proceeding.

1 – Manual Operation Test

A detachable maintenance handle is provided on the frame of the Transfer Switch for maintenance purposes only. Manual operation of the transfer switch should be checked before it is energized (operated electrically).

⚠ WARNING

Do not manually operate the transfer switch until both power sources are disconnected: open both circuit breakers.

Table B. Maintenance handle positions.

ATS Position		Indicators
Normal	E / N	OPEN upper contacts open CLOSED lower contacts closed
Emergency	E / N	CLOSED upper contacts closed OPEN lower contacts open

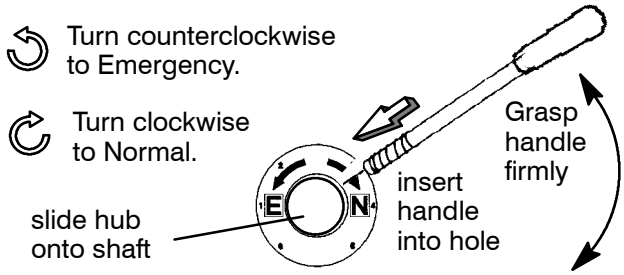


Figure 1-3. Maintenance handle.

1. After deenergizing both power sources, open the enclosure door. Locate and remove the maintenance handle and hub stored on the transfer switch frame. Then install the hub onto the center operator shaft and insert the handle firmly into the hole in the side of the hub (spring fully compressed). See Figure 1–3 and 1–4 and Table B.
2. If the transfer switch is closed on Normal (window shows *CLOSED*), grasp handle firmly and turn it counterclockwise. The transfer switch should operate smoothly without binding. If it does not, check for shipping damage or construction debris.
3. Turn the handle clockwise to return the transfer switch to the Normal position. Observe that the window indicators (left side) show the top shaft *OPEN* and the bottom shaft *CLOSED*.

   Note: If Normal and Emergency connections are reversed this operation is also reversed.
4. Remove the maintenance handle and hub and store it on the frame in the place provided.

⚠ WARNING

Verify that the maintenance handle and hub have been removed before proceeding!

Now continue to **2 – Voltage Checks** on next page.

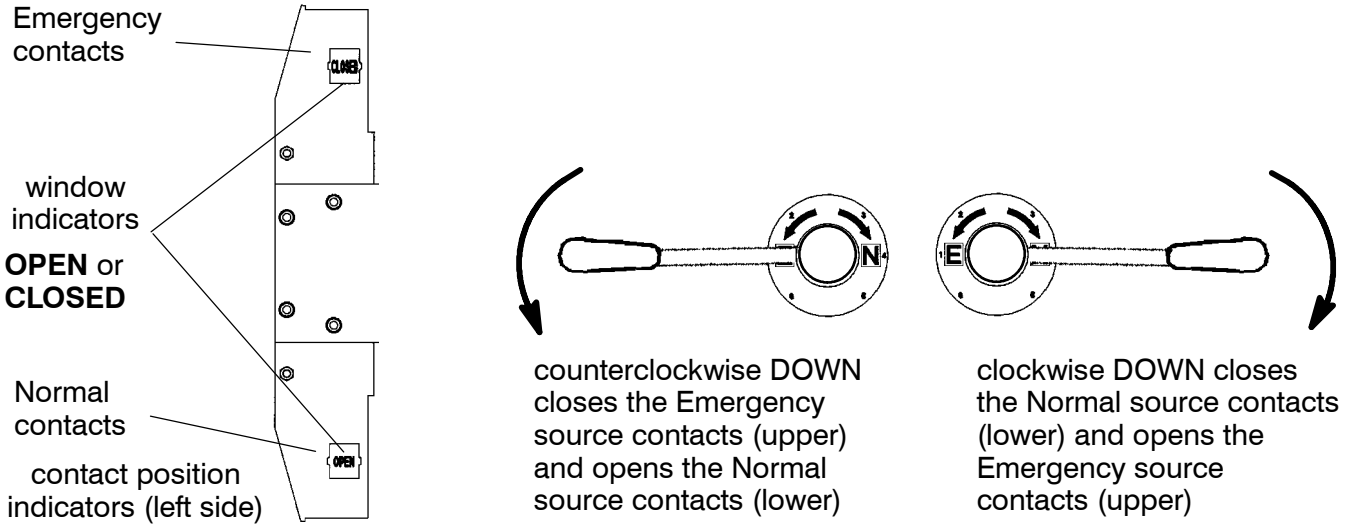


Figure 1-4. Contact position indicators and maintenance handle operation.

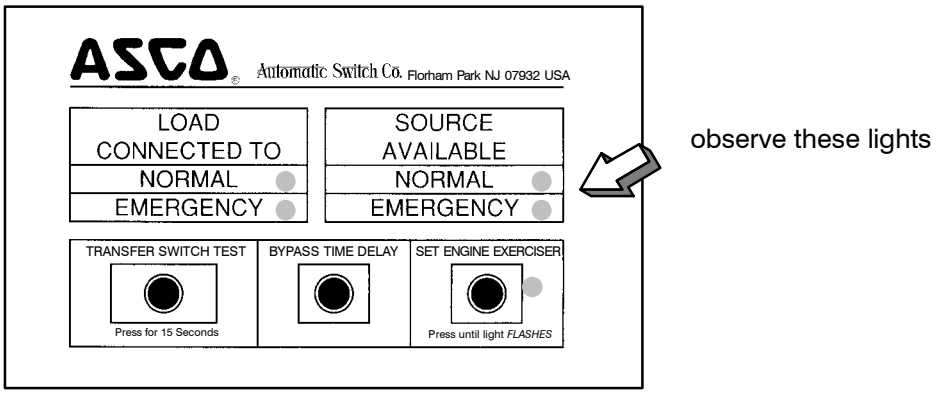


Figure 1–5. Standard controls and indicators.

2 – Voltage Checks

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ CAUTION

Verify that the feeders have been connected to the proper lugs.

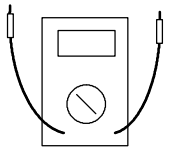
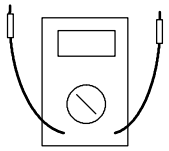
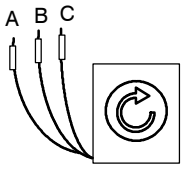
⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1 through 6 at the right. Observe the status lights. See Figure 1–5.

- ● Black circle means light is on.
- ❍ White circle means light is off.

* If necessary, adjust voltage regulator on the generator according to the manufacturer's recommendations. The Automatic Transfer Switch will respond only to the rated voltage specified on the Transfer Switch nameplate.

1	Close the normal source circuit breaker. The *Transfer Switch Connected To Normal* and the *Normal Source Available* lights should come on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○
2	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch normal source terminals.	
3	Close the emergency source circuit breaker. (Start generator, if necessary.) The *Transfer Switch Connected To Normal* and the *Emergency Source Available* lights should come on.	SOURCE AVAILABLE NORMAL ○ EMERGENCY ●
4	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch emergency source terminals.*	
5	Use a phase rotation meter to check phase rotation of emergency source; it must be the same as the normal source.	
6	Shut down the engine–generator, if applicable. The *Emergency Source Accepted* light should go off. Then put the starting control selector switch (on the generator set) in the *automatic* position. Close enclosure door.	SOURCE AVAILABLE NORMAL ○ EMERGENCY ○

Now continue to **3 – Electrical Operation** on next page.

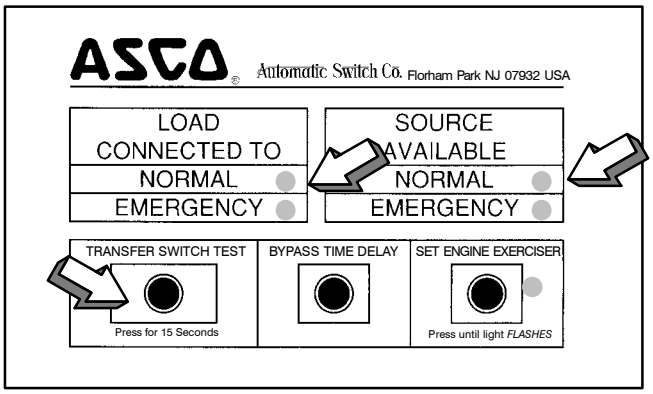


Figure 1–6. Standard controls and indicators.

3 – Electrical Operation

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ CAUTION

Verify that the feeders have been connected to the proper lugs.

⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1 through 8 at the right. Observe the status lights. See Figure 1–6.

- ● Black circle means light is on.
- ❍ White circle means light is off.

NOTE: If Motor Load Transfer feature is activated, then transfer may not occur immediately after the respective time delays. Transfer will only occur when the phase relationship between sources is correct.

This completes the Functional Test of the ASCO Series 300 Automatic Transfer Switch. Leave the engine–generator starting control in the *automatic* position.

1	The normal source must be available and the generator must be ready to start. Check that the *Normal Source Available* light is on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○
2	Press and hold the *Transfer Switch Test* button until the engine starts and runs. This should happen within 15 sec.	TRANSFER SWITCH TEST
3	The *Emergency Source Available* light should come on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ●
4	The transfer switch should transfer to the Emergency position. The *Load Connected to Emergency* light should come on and the *Load Connected to Normal* light should go off.	LOAD CONNECTED TO NORMAL ○ EMERGENCY ●
5	If the *transfer to emergency delay* is used the transfer should occurs after a time delay (up to 5 minutes). For immediate transfer press the *Bypass Time Delay* button.	BYPASS TIME DELAY
6	The transfer switch should transfer back to the Normal position. The *Load Connected to Normal* light should come on and the *Load Connected to Emergency* light should go off.	LOAD CONNECTED TO NORMAL ● EMERGENCY ○
7	If the *retransfer to normal delay* is used the retransfer should occur after a time delay (up to 30 minutes). For immediate retransfer press the *Bypass Time Delay* button.	BYPASS TIME DELAY
8	The *unloaded running delay* keeps the generator running for 5 minutes (cool–down period). Then the generator should stop and the *Emergency Source Available* light should go off.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○

SECTION 2 SEQUENCE OF OPERATION

Transfer To Emergency

The sequence for load transfer to emergency source begins automatically when normal source voltage falls below the preset dropout point or when *Transfer Switch Test* button is pressed. An under voltage condition on any phase of the normal source is detected by the sensor.

When the normal source voltage fails or the *Transfer Switch Test* button is pressed, the SE relay de-energizes and relay NR begins its timing cycle (1 or 3 seconds, *momentary normal source outage delay*). The NR relay is provided with a time delay on dropout to override momentary outages and prevent nuisance starting of the engine-driven generator. If the normal source voltage returns above the sensor dropout setting before the time delay expires, the NR relay timing cycle is reset to zero and relay SE energizes.

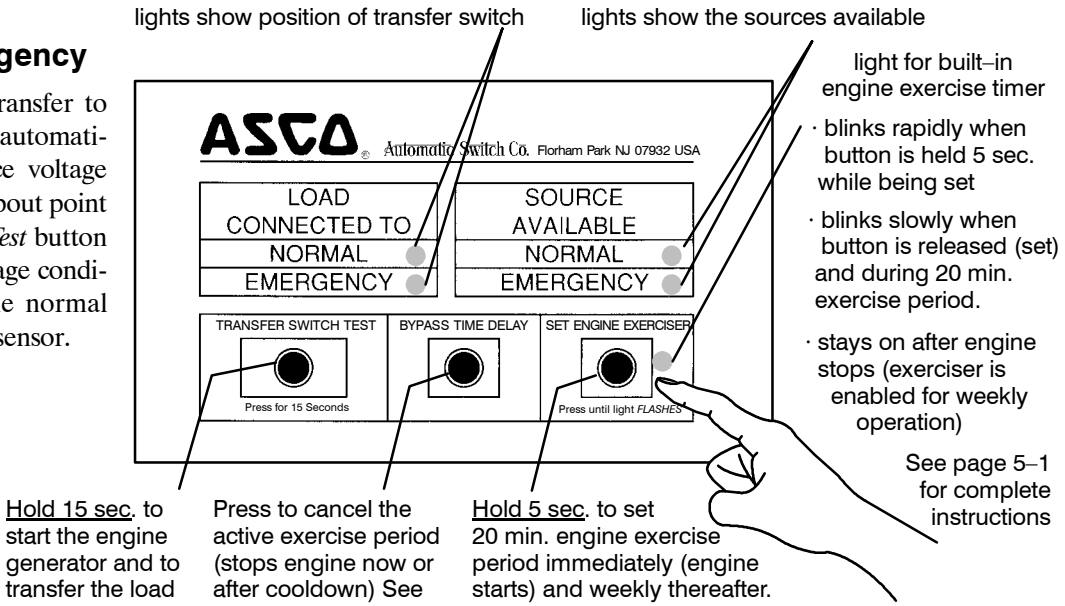


Figure 2–1. Membrane controls and indicator lights.

If the normal source voltage does not return above the sensor dropout setting before the time delay expires, the NR relay de-energizes and signals the engine-driven generator to start. At the same time, a voltage and frequency sensor begins monitoring the emergency source. The sensor will accept the emergency source only when both voltage and frequency reach preset pickup points. Usually about ten seconds elapse from dropout of the NR relay to acceptance by the sensor. This time span occurs because the engine-driven generator must crank, start, and run up to nominal pickup points. For this reason, if the *Transfer Switch Test* button is pressed it must be held for 15 seconds. If the emergency source is available immediately, the sensor may accept it as soon as NR relay drops out.

When the emergency source is accepted by the sensor, relay ER begins its timing cycle (*transfer to emergency delay*). ER relay is provided with an adjustable (0 to 5 minutes) time delay on pickup to delay transfer of the load to the emergency source. For immediate transfer press *Bypass Time Delay* button.

ER relay energizes, the TS coil is energized, the transfer switch operates, and all switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the emergency source.

The transfer switch will remain in the Emergency position until the normal source is restored. If the *Transfer Switch Terst* button is used, the transfer switch will remain on emergency until the *retransfer to normal delay* times out.

Retransfer to Normal

The sequence for load retransfer to the normal source automatically begins when the voltage sensor detects restoration of the normal source. The voltage level must rise above the preset pickup point on all phases before the sensor will accept the normal source.

When the normal source is accepted by the sensor, relay SE begins its timing cycle (adjustable 1 sec. to 30 min., *retransfer to normal delay*). For immediate retransfer press *Bypass Time Delay* button. SE relay is provided with a time delay on pickup to prevent immediate load retransfer to the normal source. The delay insures that the normal source has stabilized before reconnection of vital loads. If the normal source voltage falls below the present dropout point before the time delay expires, the timing cycle is reset to zero. If the emergency source fails for more than 4 seconds during the timing cycle, ER relay drops out and the load is immediately retransferred to the normal source, if that source is acceptable.

SE relay energizes and ER relay is dropped out. The TS coil is energized, the transfer switch operates, and all switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the normal source again.

Upon retransfer to the normal source, NR relay begins its timing cycle (*unloaded running delay [engine cooldown]*). NR relay is provided with a 5 minute time delay on pickup to keep the engine running for a cool-down period.

NR relay energizes after the time delay and signals the engine-driven generator to shut down. All circuits are reset for any future normal source failure.

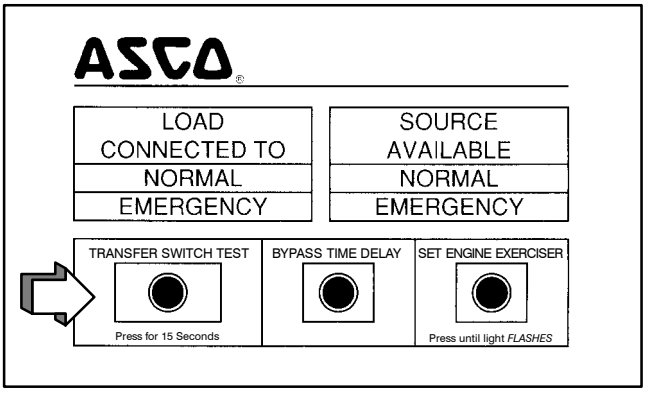
Activation of standard control features shown in Section 5 will alter the sequence of operation and introduce additional time delays during transfer operations.

SECTION 3 TESTING & SERVICE

PREVENTIVE MAINTENANCE

Reasonable care in preventive maintenance will insure high reliability and long life for the automatic transfer switch.

Operate the switch at least once a month. Perform this four step Electrical Operation Test. This is a test with load transfer.



Transfer Switch Test

1.	Press and hold the door-mounted *TRANSFER SWITCH TEST* button until the engine starts and runs. This should happen within 15 seconds.
2.	The transfer switch will operate to the Emergency position. If the *Transfer To Emergency Delay* is used, the transfer will occur after a time delay (up to 5 minutes). For immediate transfer press *BYPASS TIME DELAY* button.
3.	The Transfer Switch will operate back to the Normal position after the *Retransfer To Normal Delay* (up to 30 minutes). For immediate retransfer press *BYPASS TIME DELAY* button.
4.	*Unloaded Running (Engine Cooldown) Delay* allows engine to run unloaded for 5 minutes.

Clean and inspect the switch once a year. De-energize all sources, then brush and vacuum away any excessive dust accumulation. Remove the transfer switch barriers and check contact condition. Replace contacts when pitted or worn excessively. Reinstall the barriers carefully.

Maintain transfer switch lubrication. The transfer switch has been properly lubricated, and under normal operating conditions no further lubricating is required. Renew factory lubrication if the switch is subjected to severe dust or abnormal operating conditions. Relubricate the operator if TS coil is replaced. Order ***lubrication kit 75-100***.

Replacement parts. Replacement parts are available in kit form. When ordering parts provide the Serial No. and Catalog No. from the transfer switch nameplate. Contact your local ASCO Power Technologies sales office.

DISCONNECTING THE CONTROLLER

The harness disconnect plugs are furnished for repair purposes only and should not have to be unplugged. If the controller must be isolated, follow these steps carefully.

Disconnecting the Plugs

⚠ WARNING

Do not unplug the controller until step 1a. or 1b. below is completed.

1. Observe the position of the transfer switch.
   a. If the transfer switch is in the *Normal* position, place standby engine starting control in the *off* position. Then open the emergency source circuit breaker.
   b. If the transfer switch is in the *Emergency* position, open the normal source circuit breaker. Place the engine starting control in the *test* or *run* position.
2. Separate the quick disconnect plugs by squeezing the latches. Do not pull on the harness wires.
3. Label, remove, and tape the signal wires connected to the engine start terminals on the transfer switch: TB1 and TB3, or TB1 and TB2.

Reconnecting the Plugs

⚠ WARNING

Do not reconnect the controller until step 1a. or 1b. and 2 below are completed.

1. Observe the position of the transfer switch.
   a. If the transfer switch is in the *Normal* position, be sure that the standby engine starting control is still in the *off* position. The emergency source circuit breaker still should be open.
   b. If the transfer switch is in the *Emergency* position, normal source circuit breaker still should be open.
2. Reconnect the signal wires connected to the appropriate engine start terminals on the transfer switch. See **Section 1**, *Engine Starting Contacts*.
3. The harness plugs and sockets are keyed. Carefully align the plugs with the sockets and press straight in until both latches click.
4. Restore the opposite source as follows:
   a. If the transfer switch is in the *Normal* position, place the standby engine starting control in the *automatic* position. Then close the emergency source circuit breaker.
   b. If the transfer switch is in the *Emergency* position, close the normal source circuit breaker. The load will be automatically retransferred to the normal source after the *Retransfer to Normal Delay*. For immediate retransfer, press *BYPASS TIME DELAY* button. Place the engine starting control in the *automatic* position.

MANUAL LOAD TRANSFER

This procedure will manually transfer the load if the controller is disconnected.

⚠ WARNING

Do not manually operate the transfer switch until both power sources are disconnected: open both circuit breakers.

1. Open normal and emergency source circuit breakers.
2. Use the maintenance handle to manually operate transfer switch to the opposite source. See page 1–3, *Manual Operation Test*.
3. If the transfer switch is in the Emergency position manually start the engine generator and then close the emergency source circuit breaker.

TROUBLE-SHOOTING

Note the control features that are activated or furnished on the switch and review their operation. Refer to **Section 5**, **Control Features**.

⚠ WARNING

Proceed with care!
The automatic transfer switch is energized.

Table 3-1. Trouble-Shooting Checks.

PROBLEM	CHECK IN NUMERICAL SEQUENCE		
	1 OPERATION	2 GEN-SET	3 VOLTAGE
Gen-Set does not start when the *TRANSFER SWITCH TEST* button is pressed and held for 15 seconds or when the normal source fails.	Hold the *TRANSFER SWITCH TEST* button 15 sec. or the outage must be long enough to allow for the 1 or 3 sec. *Momentary Normal Source Outage Delay* plus engine cranking and starting time.	Starting control must be in automatic position. Batteries must be charged and connected. Check wiring to engine starting contacts.	—
Transfer switch does not transfer the load to emergency source after the gen-set starts.	Wait for *Transfer to Emergency Delay* (0 to 5 min.) to time out. For immediate transfer, press the *BYPASS TIME DELAY* button. If Motor Load Transfer is active, wait for in-phase condition (see below).	Generator output circuit breaker must be closed. Generator frequency must be at least 57 Hz.	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals EA and EC (or EL1 and EL2 for 2 pole switches). * * These are factory settings.
Transfer switch does not transfer the load to normal source when normal returns or when *TRANSFER SWITCH TEST* button is released.	Wait for *Retransfer to Normal Delay* (1 sec. to 30 min.) to time out. For immediate re–transfer, press *BYPASS TIME DELAY* button. If Motor Load Transfer is active, wait for in-phase condition (see below).	—	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals NB and NC, NC and NA, and NA and NB (or NL1 and NL2 for 2 pole switches).
Gen-Set does not stop after load retransfer to the normal source.	Wait for the 5 minute *Unloaded Running Delay* to time out.	Starting control must be in automatic position.	—

Trouble-Shooting the Motor Load Transfer Feature (refer to page 5–3)

⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

1. Connect a voltmeter (set for twice system phase–to–phase voltage) between Transfer Switch terminals NA and EA.
2. Manually start generator. Voltmeter needle should sweep back and forth at a regular rate between 0 and about twice system voltage.
3. Press and hold TRANSFER SWITCH TEST button. The load should transfer to emergency source when meter needle is near 0 volts. If transfer does not occur, Motor Load Transfer feature is not operating.
4. Release the **Transfer Switch Test** button. The load should retransfer back to the normal source after the *Retransfer to Normal Delay*, if used. The retransfer should occur when the needle is near 0 volts. If retransfer does not occur after the time delay, the Motor Load Transfer feature is not operating.
5. For immediate retransfer, press the BYPASS TIME DELAY button. Then disconnect the voltmeter.

If the problem is isolated to circuits on the controller or the transfer switch, call your local ASCO Power Technologies sales office. Furnish Serial No., Bill of Material (BOM) No., & Catalog No. from the transfer switch nameplate.

SECTION 4 ADJUSTMENTS

Time Delay Adjustment

Standard time delays are set to customer specifications (if none specified, standard factory settings are used).

To change a setting, follow procedure on page 4-2. Use Table 4-1 as a guide to time delay values and their corresponding adjustment DIP switch or potentiometer.

Table 4-1. Time Delay Settings

DESCRIPTION	LABELS	FACTORY SETTING	ADJUSTMENT RANGE	S3 DIP SWITCH		ADJUSTMENT POTENTIOMETER
Override Momentary Normal Source Outages	TD ES	3 seconds	1 second	Actuator 1 on		—
			3 seconds	Actuator 1 off		
Transfer to Emergency	TIMER N/E	0 minutes (full ccw)	0 to 5 minutes	—	—	P2
Override Momentary Emergency S. Outages	—	4 seconds	non-adjustable	—	—	—
Retransfer to Normal	TIMER E/N	30 minutes (full cw)	1 second to 30 minutes	—	—	P1
Unloaded Running (Engine Cooldown)	—	5 minutes	non-adjustable	—	—	—

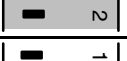
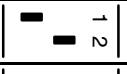
Sensor Adjustments

Voltage and frequency sensor pickup and dropout points are set to customer specifications (if none specified, standard factory settings are used). To change a setting, follow procedure on page 4–2. Use Tables 4-2 and 4–3 for settings and corresponding DIP switch actuators.

⚠ WARNING

Any change in these settings may affect the normal operation of the automatic transfer switch. This change could allow the load circuits to remain connected to a low voltage source.

Table 4-2. Voltage and Frequency Settings. (☐ Shaded DIP switches are standard factory settings).

DESCRIPTION	LABELS	SETTING	% of nominal		S1 DIP SWITCH	
			FACT. SET	ADJ RANGE		
Normal Source Voltage	PU / N	Pickup	90 %	95 % *	Actuator 3 off	
				90 %	Actuator 3 on	
	DO / N	Dropout	85 %	90 % *	Actuator 1 off Actuator 2 off	
				85 %	Actuator 1 on Actuator 2 off	
				80 %	Actuator 1 off Actuator 2 on	
				70 %	Actuator 1 on Actuator 2 on	
Emergency Source Voltage	– –	Pickup	90 %	non-adjustable	– –	
	– –	Dropout	75 %	non-adjustable		
Emergency Source Frequency	– –	Pickup	95 %	non-adjustable	– –	
	– –	Dropout	85 %	non-adjustable		
	60 / 50 Hz	60 / 50 Hz	60 Hz	60 Hz	Actuator 4 off	
				50 Hz	Actuator 4 on	
Voltage Phases	3 Ø , 1 Ø	3 Ø / 1 Ø	3 Ø	3 phase	Actuator 6 off	
				1 phase	Actuator 6 on	

* If dropout voltage is set to 90%, the pickup voltage must be set to 95%.

Table 4-3. Transformer Voltage Adjust.
(Low setting shifts all voltage settings down 4.2%; for example, 240 V to 230 V, or 480 V to 460 V)

DESCRIPTION	LABELS	FACTORY SETTING	ADJUSTMENT	S3 DIP SWITCH	
Voltage Adjust (4.2%)	LOW / HI	HI	LOW	Actuator 2 off	
			HI	Actuator 2 on	

⚠ WARNING

Do not make any setting changes while the controller is energized.

How to Change a Setting

1. Prevent the transfer switch from operating by disconnecting one source first, then the other, as follows:
   a. If the transfer switch is in the Normal position, open the emergency source circuit breaker. Turn the engine starting control to *off*. Then open the normal source circuit breaker.
   b. If the transfer switch is in the Emergency position, open the normal source circuit breaker. Turn engine starting control to *test* or *run*. Then open the emergency source circuit breaker.
2. Disconnect both harness plugs from controller by squeezing the latches. Do not pull on the wires.
3. Remove cover from the controller by releasing latch on right side with your thumb. See Figure 4-1.
4. Locate the appropriate adjustment potentiometer or DIP switch for the setting that you want to change. Refer to Table 4-1 and Table 4–2 on page 4-1 and Figure 4-2, Figure 4–3, Figure 4–4 on page 4–2.
5. Use a small screwdriver to turn the potentiometer clockwise to increase the time delay or counterclockwise to decrease it. See Figure 4-3.
6. Use a ball-point pen (or similar pointed tool) to slide the switch actuators left or right so they match the illustration next to the setting (left = off, right = on). Recheck the setting. See Figure 4-4.
7. Install the cover on the controller by hooking it on the left side and latching the right side.
8. Reconnect both harness plugs to the controller by aligning and pressing straight in until latches click.

⚠ WARNING

Close the enclosure door.

9. Close the enclosure door, then restore both sources:
   a. If the transfer switch is in the Normal position first close the normal source circuit breaker, then close the emergency source circuit breaker.
   b. If the transfer switch is in the Emergency position, close the normal source circuit breaker. The load will be automatically retransferred to the normal source. Then close the emergency source circuit breaker.
10. Turn the engine starting control to *automatic*.

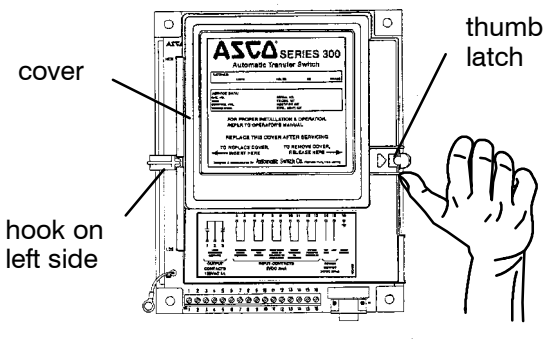


Figure 4-1. Controller cover latch.

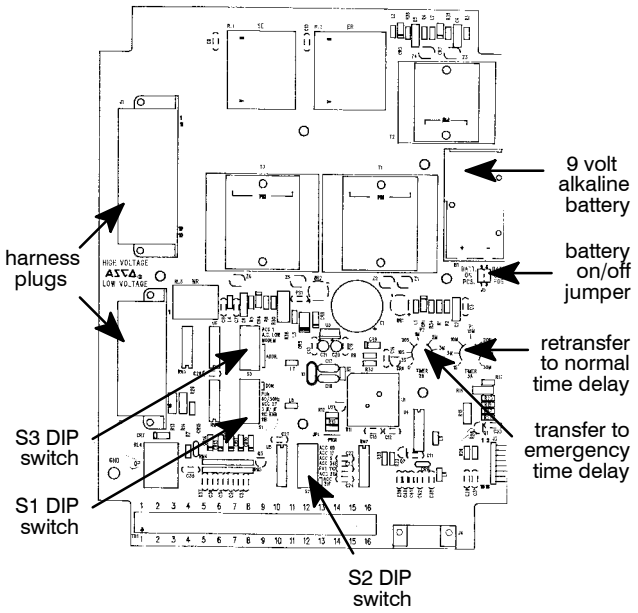


Figure 4-2. Location of potentiometers.

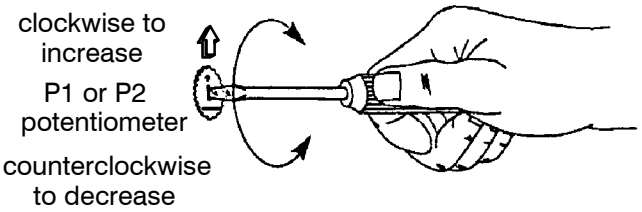


Figure 4-3. Changing time delay potentiometers.

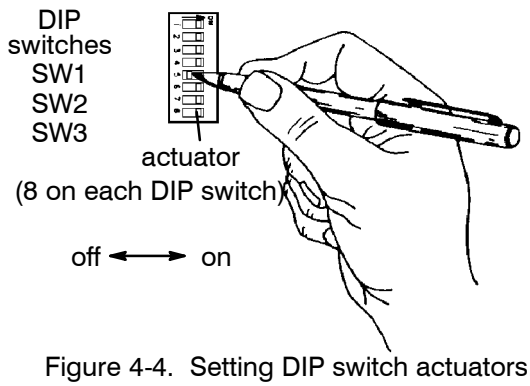


Figure 4-4. Setting DIP switch actuators.

SECTION 5 CONTROL FEATURES – ENGINE EXERCISERS

These timers periodically exercise the emergency engine-generator plant. They can be set to exercise with or without load transfer, or they can be completely disabled. The engine-generator should be exercised under load once a week for a minimum time period of 20 minutes, or follow the recommendations of the engine-generator set manufacturer. Refer to page 4–2 for location of DIP switches, battery (provided), and jumper block in the controller.

BUILT–IN ENGINE EXERCISER

The engine exerciser included in ASCO Series 300 Automatic Transfer Switches provides a once a week 20–minute exercise period. It occurs immediately when the SET ENGINE EXERCISER push button is pressed (and held for at least 5 seconds), and then at the same time weekly thereafter. A 9 volt alkaline battery (*Duracell*® MN1604, *Everready*® 522, or *Panasonic*® 6AM6) is furnished and installed in the controller to maintain the setting. The battery jumper block must be shifted to the ON position. See Figure 4–2 on page 4–2.

Fill in day and time set. Week Day _____ Time _____.

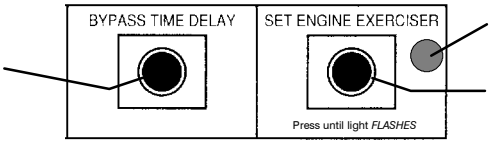
DIP Switch Settings

FUNCTION	S1 DIP SWITCH		S2 DIP SWITCH	
Std. Timer Enabled	Actuator 7 on	7	Actuator 5 on	5
Std. Timer Disabled	Actuator 7 off	7	Actuator 5 on	5
Exercise without Load	Actuator 8 off	8		
Exercise with Load	Actuator 8 on	8		

Shaded DIP switches are standard factory settings.

Press to cancel an active exercise period (stops generator).

If *Exercise with Load* is set, retransfers load to Normal, then stops generator after 5 min. cooldown.



status light

Press and hold for 5 sec. or until status light blinks rapidly to set exercise period immediately and every week hereafter (generator starts).

If *Exerciser with Load* is set, transfers load to Emergency.

Figure 5-1. Operator panel pushbuttons and light.

Select below either *Exercise without Load* or *Exercise with Load* according to the setting of DIP switch S1, actuator 8. The load transfers from the Normal source to Emergency source (generator) and back again if *Exercise with Load* is selected.

Exercise without Load, DIP Switch S1, Actuator 8 off (8) — How to Set Built–In Timer

Step	Push Button	Status Light	Function	Explanation
1	*SET ENGINE EXERCISER* hold 5 sec.	blinks rapidly ●○●○●○	set exercise period	Exercise the generator now and every week at this time hereafter.
2	release	blinks slowly ●○○●○○	exercise period now active	Generator starts and runs.
3	press *BYPASS TIME DELAY*	● stays on	cancel active exercise period	Generator stops.
4	—	● stays on	generator off	Exerciser enabled; repeats every 7 days.

Exercise with Load, DIP Switch S1, Actuator 8 on (8) — How to Set Built–In Timer

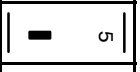
Step	Push Button	Status Light	Function	Explanation
1	*SET ENGINE EXERCISER* hold 5 sec.	blinks rapidly ●○●○●○	set exercise period	Exercise the generator now and every week at this time hereafter.
2	release	blinks slowly ●○○●○○	exercise period now active	Generator starts and runs; the load transfers to Emergency.
3	press *BYPASS TIME DELAY*	blinks slowly ●○○●○○	cancel active exercise period	The load retransfers to Normal; then generator runs for 5 minute cooldown (light blinks slowly during cooldown).
4	—	● stays on	generator off	Exerciser enabled; repeats every 7 days.

NOTE: Every time *SET ENGINE EXERCISER* push button is pressed (held 5 seconds) the exercise period is changed.

OPTIONAL PROGRAMMABLE ENGINE EXERCISER (Accessory 11CD)

The optional programmable engine exerciser provides seven days of different exercise periods. The timer is connected and mounted below the controller. A permanent backup battery maintains the setting; when power is lost to timer, output switch deenergizes.

DIP Switch Settings

FUNCTION	S1 DIP SWITCH		S2 DIP SWITCH	
Opt. Timer Enabled	Actuator 7 off		Actuator 5 off	
Opt. Timer Disabled	Actuator 7 off		Actuator 5 on	
Exercise without Load	Actuator 8 off			
Exercise with Load	Actuator 8 on			

Shaded DIP switches are standard factory settings.

The Accessory 11CD Programmable Engine Exerciser incorporates a 7 day time base, and therefore, each day of the week can be uniquely programmed to test the engine generator set either with or without load. The proper controller settings must be made to determine whether or not the test will be conducted with or without load (refer to page 5–1 for proper selection). For convenience, Block Programming is also provided, whereby up to seven days can be grouped together if the *ON* and *OFF* times are the same.

See next page for instructions on setting the timer. ☞

How to Set Optional Programmable Engine Exerciser (Accessory 11CD)

⚠ WARNING

Proceed with care!
The automatic transfer switch is energized.

Setting the Clock (Time and Day)

Step	Press Button	Display	Meaning
1	**reset**	1234567 (blink) 00 00 ⊙ ○	after self-test, clears memory
2 ↓ Note	hold **h**, then press **±1h**	1 2 3 4 5 6 7 AM 12 00 ⊙ ○	military 24 hr or AM/PM 12 hr time
	Repeat step 2 to toggle between military (blank display) and AM/PM time.		
3	hold ⊙ (clock symbol)	1234567 (blink) 00 00 ⊙ ○	hold ⊙ while setting thru step 7
4	**±1h** once (if Daylight Saving Time)	±1h	do nothing if it is Standard Time.
5	**h** (hold for fast count)	[00] 00	hour
6	**m** (hold for fast count)	00 [00]	minute
7	**Day**	Mo Tu We Th Fr Sa Su	day
8	release ⊙	: blinking	time & date set, clock starts

Programming Engine On-Off Period(s)

Step	Press Button	Display	Meaning
1	**Prog.** (do not hold)	1 2 3 4 5 6 7 — : —	begin
2	**hand**	⊙	on
3	**h**	start hour	start engine
4	**m**	start minute	
5	**Day**	start day	
Note	Successive pressing displays blocks of days: Mon–Sat, Mon–Fri, Sat & Sun (1 is Monday)		
6	**Prog.**	1 2 3 4 5 6 7 — : —	begin
7	Press **hand** (2 times)	○	off
8	**h**	stop hour	stop engine
9	**m**	stop minute	
10	**Day**	stop day	
11	⊙	: blinking	program set

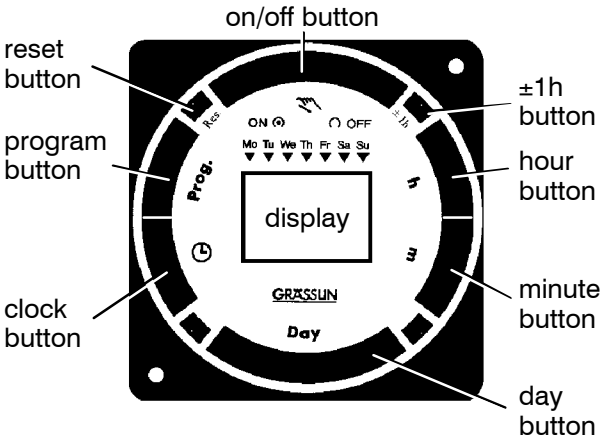


Figure 5-2. Exerciser display and push buttons

Changing or Checking Time Programs

By operating the *Prog.* button, the individual commands as programmed can, at any time, be brought consecutively into the display for revision or checking. Revisions are accomplished by programming over the existing programs using the steps at the left.

Canceling Time Programs

After the selecting the desired program, use the *h* and *m* buttons to set hours and minutes to zero; the —:— will be displayed. This program has been made ineffective and will no longer be carried out. To cancel all programs, press the *Res. (reset)* button. This clears all memory including the time base and program storage.

Manual Override

⚠ WARNING

Do not manually override the exerciser unless you are sure that the controller has been set for exercise without load (see page 5–2). Failure to do so could result in possible injury if the transfer switch operates while the enclosure door is open.

Step	Press Button	Display	Meaning
1	**hand**	⊙ hand	on
2	**hand**	[⊙]	permanent on
3	**hand**	[○]	permanent off
4	**hand**	⊙ ○	back to automatic

Daylight Savings / Standard Time Change

To change to Daylight Savings time, press the ±*1h* button once. Clock advances by one hour and **+1h** appears in display. To change to Standard Time, press the ±*1h* button again; the clock sets back one hour and **+1h** disappears.

CONTROL FEATURES *(continued)*

INPHASE MONITOR FOR MOTOR LOAD TRANSFER

Inphase monitoring logic controls transfer and retransfer of motor loads, so that inrush currents do not exceed normal starting currents. It avoids nuisance tripping of circuit breakers and mechanical damage to motor couplings.

The Motor Load Transfer feature is built into the controller. DIP switch S1 (actuator 5) activates this feature: right = ON, left = OFF.

FUNCTION	S1 DIP SWITCH	
enable	Actuator 5 on	
disable	Actuator 5 off	

☐ Shaded DIP switches are standard factory settings.

Note

If the Motor Load Transfer feature is enabled, it will be activated following the Load Disconnect Feature Delay Before Transfer delay.

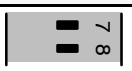
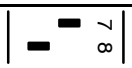
LOAD DISCONNECT FEATURE

Connect external circuits to the terminals indicated on the Wiring Diagram provided with the ATS.

The double throw (Form C) contact is rated for 28 VDC or 120 VAC (5 amps resistive). The contact operates prior to a selectable 0, 3, 10, or 20 second delay before transfer of the Automatic Transfer Switch. The contact resets either immediately following transfer or after the same delay as set for pre–signal before transfer.

Time delay between the load disconnect control signal and initiation of transfer is set on the controller with DIP switch S2 (actuators 6, 7, 8) as shown below:

Delay Before Transfer

LD TDBT	S2 DIP SWITCH	
0 (disable)	Actuator 7 on Actuator 8 on	
3 seconds	Actuator 7 on Actuator 8 off	
10 seconds	Actuator 7 off Actuator 8 on	
20 seconds	Actuator 7 off Actuator 8 off	

☐ Shaded DIP switches are standard factory settings.

Delay After Transfer*

LD TDAT	S2 DIP SWITCH	
enable	Actuator 6 on	
disable	Actuator 6 off	

*Enabling the Delay After Transfer will cause the control signal to reset after the same delay as set for the Delay Before Transfer.

REMOTE CONTROL FEATURES

These remote control features require a customer–supplied normally closed contact suitable for a 5 V dc low energy circuit. Refer to the Wiring Diagram provided with the ATS. Activate appropriate DIP switch S2 actuators below.

Remote Test (terminals CP6–7)

RTSW	S2 DIP SWITCH	
disable	Actuator 3 on	
enable	Actuator 3 off	

Remote Transfer to Emergency (CP8–9)

RT /E	S2 DIP SWITCH	
disable	Actuator 2 on	
enable	Actuator 2 off	

Bypass Transfer Time Delay (CP12–13)

TD E/N BYP.	S2 DIP SWITCH	
disable	Actuator 1 on	
enable	Actuator 1 off	

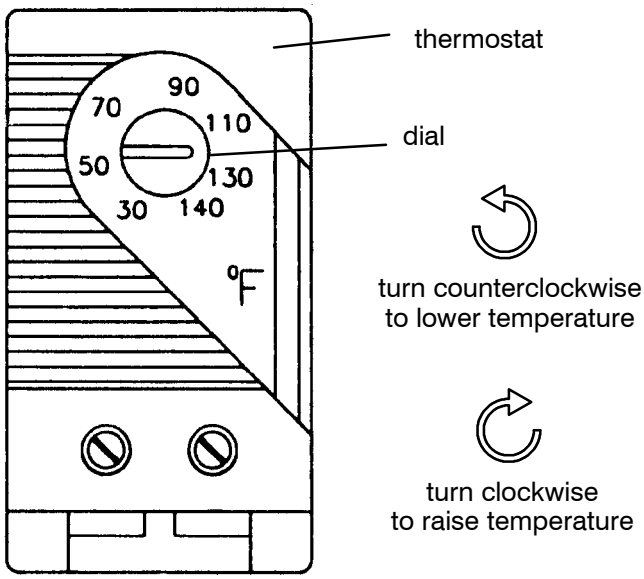
Inhibit Transfer to Emergency (CP10–11)

N/E INHIB.	S2 DIP SWITCH	
disable	Actuator 4 on	
enable	Actuator 4 off	

OPTIONAL STRIP HEATER (Accessory 44)

Accessory 44 Strip Heater is designed to keep ambient temperatures within the Automatic Transfer Switch enclosure at acceptable levels. This accessory consists of a mounting bracket with strip heater, thermostat, and terminal block. A transformer with fuses is included when the power for the assembly is derived from voltages above 120 V ac. The 120 V ac customer powered assembly does not include a transformer. This optional accessory is available factory installed or in kit form.

Turn the thermostat's dial to required setting as shown.



AVAILABLE KITS FROM ASCO

Controls

Description	Accessory	Kit
Programmable Engine Exerciser	11CD	K601111
Serial Communication Module	72A	K601110

Strip Heater – Accessory 44

Description	Accessory	Kit
120 volt customer supplied voltage (without transformer)	44A	K613127–001
208 – 480 volt ATS derived voltage (with transformer)	44G	K613127–002
380 volt ATS derived voltage (with transformer)	44G	K613127
550 – 600 volt ATS derived voltage (with transformer)	44G	K613127–003

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Printed in U.S.A.

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Operator's Manual

ASCO® Series 300 Automatic Transfer Switches H design 600 through 1200 amps

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⚠ DANGER

DANGER is used in this manual to warn of high voltages capable of causing shock, burns, or death.

⚠ WARNING

WARNING is used in this manual to warn of possible personal injury.

⚠ CAUTION

CAUTION is used in this manual to warn of possible equipment damage.

Refer to the outline and wiring drawings provided with ASCO Series 300 ATS for all installation details.

An experienced licensed electrician must install the ATS.

600, 800, 1000 amp. sizes

1200 amp. size

ASCO POWER TECHNOLOGIES L.P. 50 Hanover Road, Florham Park, New Jersey 07932–1591 USA
telephone 1 800 937–2726 (ASCO), for service call 1 800 800–2726 (ASCO) www.asco.com

381333–201 C

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Nameplate

The Transfer Switch nameplate includes data for each specific ASCO Series 300 ATS. Use the ATS only within the limits shown on this nameplate.

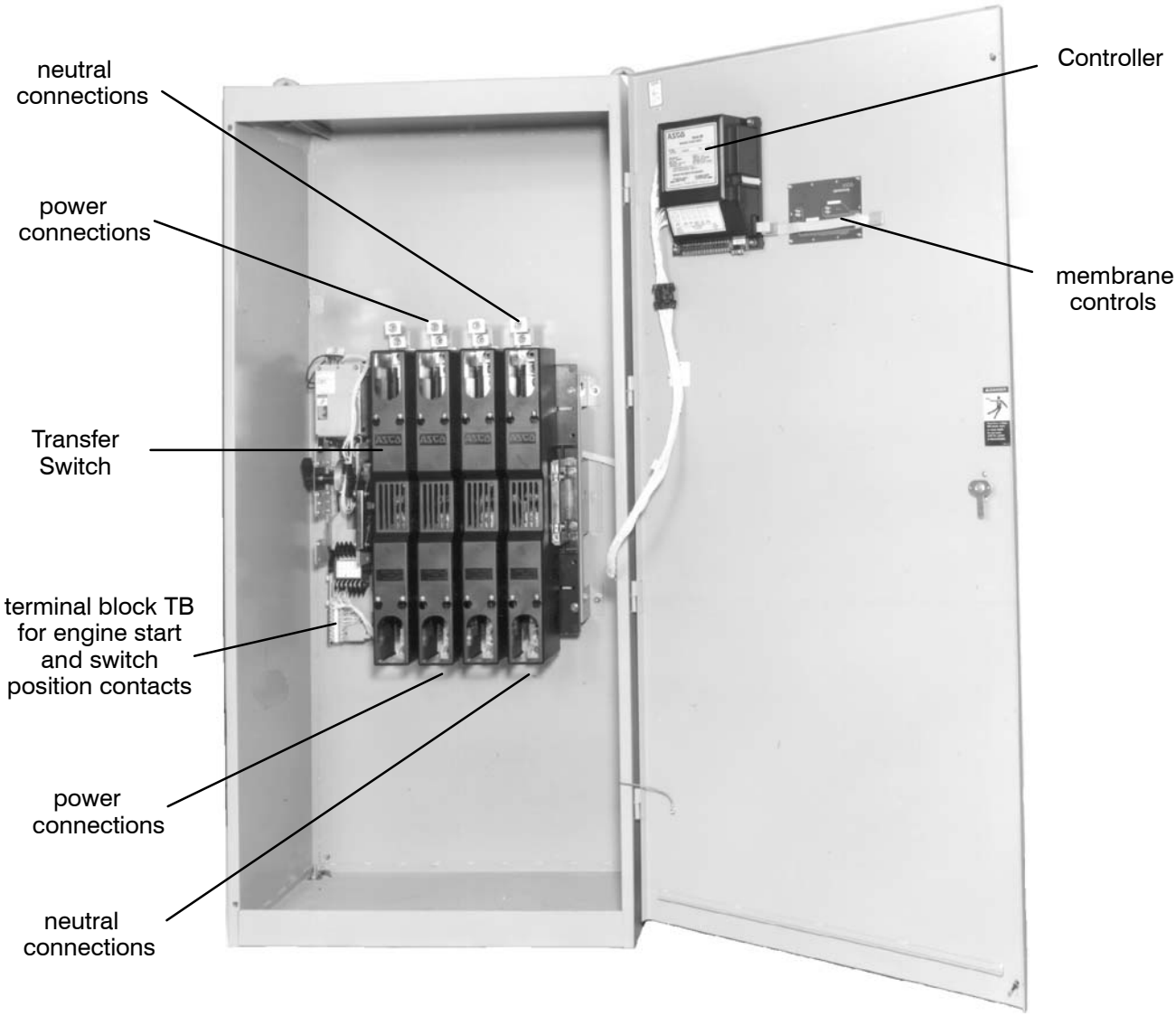
Catalog Number Identification

A typical Catalog Number is shown below with its elements explained. The example is for a Series 300 ATS with switched neutral, 3 pole, 600 amp, 480 V, in a Type 1 enclosure:

H 300 | B | 3 | 600 | N | 1 | C

Neutral	Phase Poles	Amperes	Voltage		Controller	Enclosure
B – switched	2 – single Ø	600	C 208	L 440	1 – standard	C – type 1
C – overlapping	3 – three Ø	800	D 220	M 460	1X – if accessories ordered	F – type 3R
blank – solid		1000	E 230	N 480		G – type 4 *
		1200	F 240	P 550		L – type 12 *
			H 380	Q 575		blank – open type
			J 400	R 600		
			K 415			

* available 600 – 1000 amp. sizes only



600 amp. size in typical enclosure with location of customer connections

ASCO Series 300 Automatic Transfer Switches (ATSs) are Listed under Underwriters Laboratories UL 1008 Standard for Safety for Automatic Transfer Switches. All control features are UL Component Recognized, which assures that ASCO automatic transfer switches meet OSHA Safety Requirements and will be acceptable to electrical inspectors.

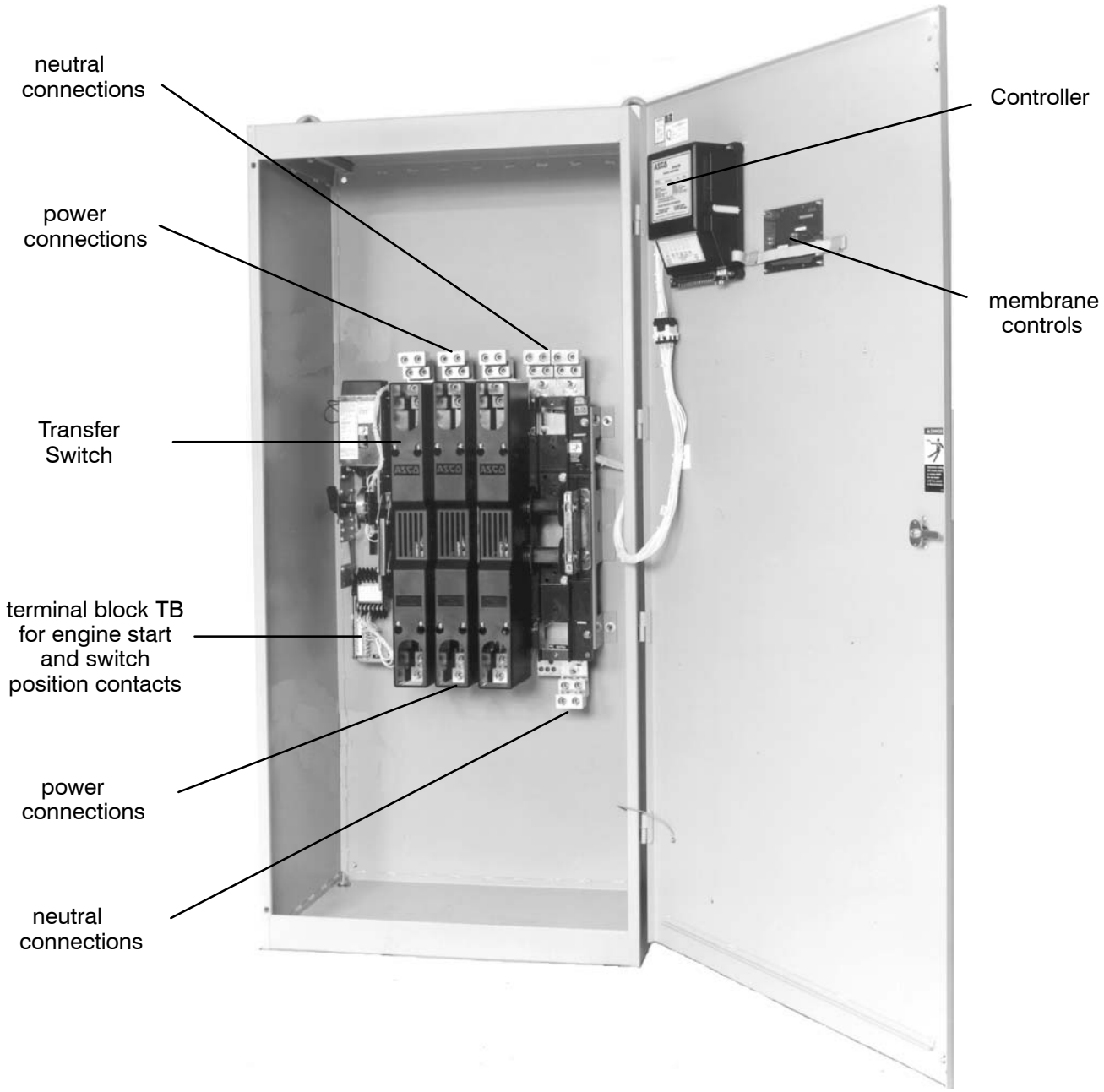
ASCO Series 300 Automatic Transfer Switches are suitable for emergency and standby system applications. They meet emergency system rating requirements as defined in National Electrical Code (NEC) Article 700 and UL 1008. Also, they are suitable for the requirements of NEC Article 517 – Health Care Facilities, NEC Article 701 – Legally Required Standby Systems, NEC Article 702 – Optional Standby Systems, NFPA 99 Health Care Facilities, and NFPA 110 Emergency and Standby Power Systems.

Rating Label

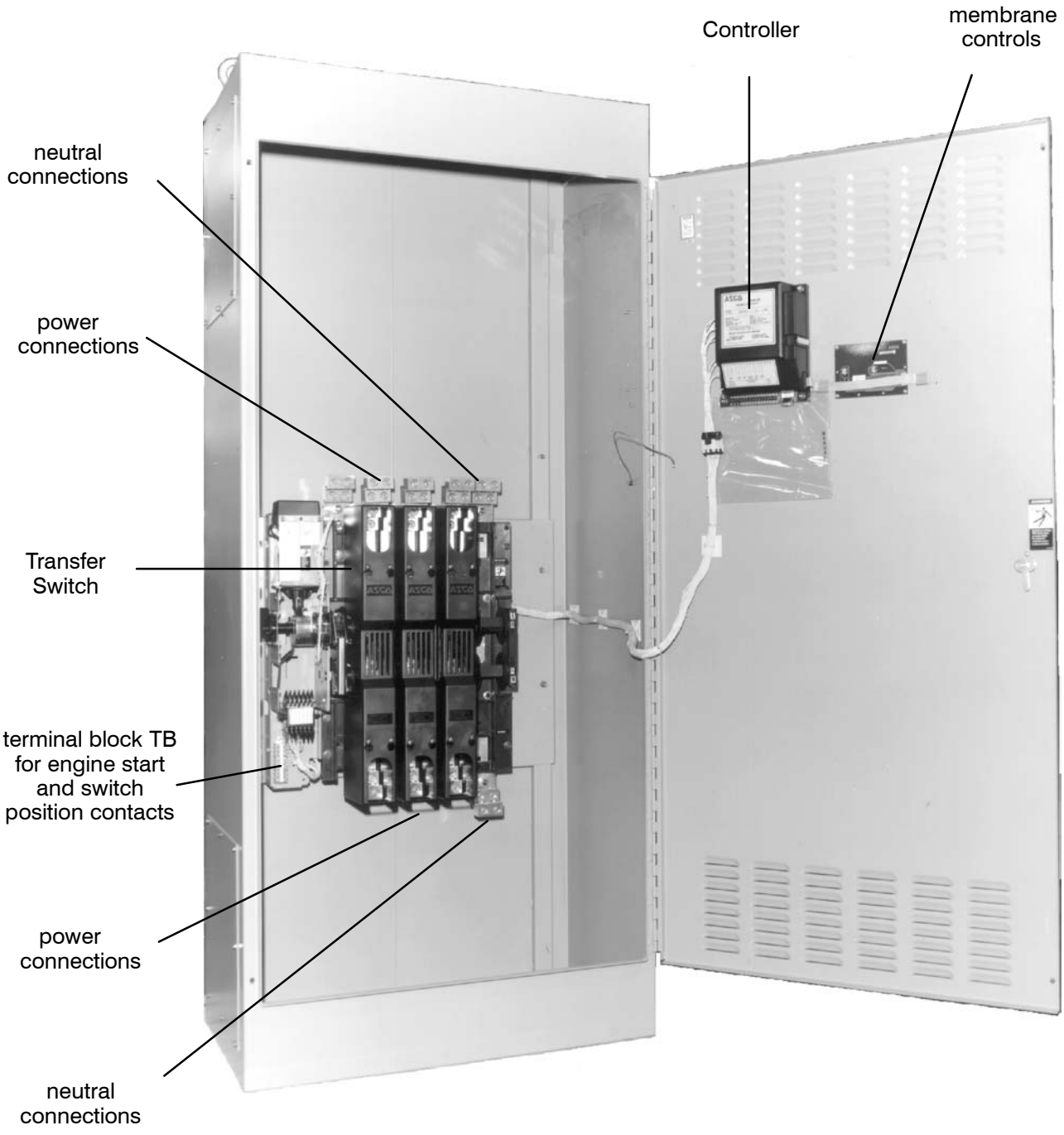
Each automatic transfer switch contains a rating label to define the loads and fault circuit withstand / closing ratings. Refer to the label on the transfer switch for specific values.

⚠ WARNING

Do not exceed the values on the rating label. Exceeding the rating can cause personal injury or serious equipment damage.



800 and 1000 amp. size in typical enclosure with location of customer connections



1200 amp. size in typical enclosure with location of customer connections

SECTION 1 INSTALLATION

Series 300 Automatic Transfer Switches are factory wired and tested. Installation requires skid removal then securing the enclosure to the supporting foundation.

Remove the Shipping Skid

Open the front door and remove the four lag screws (2 in front, 2 in rear) securing enclosure to the wood skid.

Supporting Foundation

The supporting foundation for the enclosure must be level and straight. Refer to the applicable enclosure outline drawing included with the Series 300 for all mounting details including door opening space.

If bottom cable entry is used, the foundation must be prepared so that the conduit stubs are located correctly. Refer to the enclosure outline drawing for specified area and location. Provide cable bending space and clearance to live metal parts. When a concrete floor is poured, use interlocking conduit spacer caps or a wood or metal template to maintain proper conduit alignment.

Mounting

Refer to the applicable enclosure outline drawing furnished with this switch and mount the Series 300 according to details and instructions shown on diagram.

Line Connections

Refer to the Wiring Diagram provided with your Series 300 ATS. All wiring must be made in accordance with the National Electrical Code and local codes.

It is unnecessary to remove pole covers from the transfer switch. If you do remove them, reinstall them carefully.

⚠ DANGER

De–energize the conductors before making any line or auxiliary circuitry connections. Be sure that Normal and Emergency line connections are in proper phase rotation. Place engine generator starting control in the OFF position. Make sure engine generator is not in operation.

Testing Power Conductors

Do not connect the power conductors to the ASCO Series 300 transfer switch until they are tested. Installing power cables in conduit, cable troughs and ceiling-suspended hangers often requires considerable force. The pulling of cables can damage insulation and stretch or break the conductor's strands. For this reason, after the cables are pulled into position, and before they are connected, they should be tested to verify that they are not defective or have been damaged during installation.

⚠ CAUTION

Protect the automatic transfer switch from construction grit and metal chips to prevent malfunction or shortened life of the ATS.

Connecting Power Conductors

After the power cables have been tested, connect them to the appropriate terminal lugs on the transfer switch as shown on the wiring diagram provided with this Series 300. Make sure the lugs provided are suitable for use with the cables being installed. Standard terminal lugs are solderless screw type and will accept the wire sizes listed on the drawings provided with the Series 300. Be careful when stripping insulation from the cables; avoid nicking or ringing the conductor. Remove surface oxides from cables by cleaning with a wire brush. When aluminum cable is used, apply joint compound to conductors. Tighten cable lugs to the torque specified on rating label.

Controller Ground

A grounding wire must be connected to the controller's lower left mounting stud. Because the controller is mounted on the enclosure door, a conductive strap must be used between the enclosure and the door. This connection provides proper grounding which does not rely upon the door hinges.

Harnesses

The transfer switch is connected to the left side of the controller by a plug–in harness (two plugs).

Engine Starting Contacts

Customer connections for engine control contact and TS auxiliary contacts connections are located on terminal block TB which is mounted on the front lower left of the transfer switch. Refer to wiring diagram provided with the Series 300 ATS and connect the engine start wires to the appropriate terminals. See Figure 1–1 and Table A.

Table A. Engine start connections.

When normal source fails	Terminals on transfer switch
contact closes	TB1 and TB2
contact opens	TB1 and TB3

Auxiliary Circuits

Connect auxiliary circuit wires to appropriate terminals on transfer switch terminal block TB as shown on the wiring diagram provided with this Series 300 Automatic Transfer Switch. Make the necessary auxiliary connections by referring to **Section 5, Control Features**.

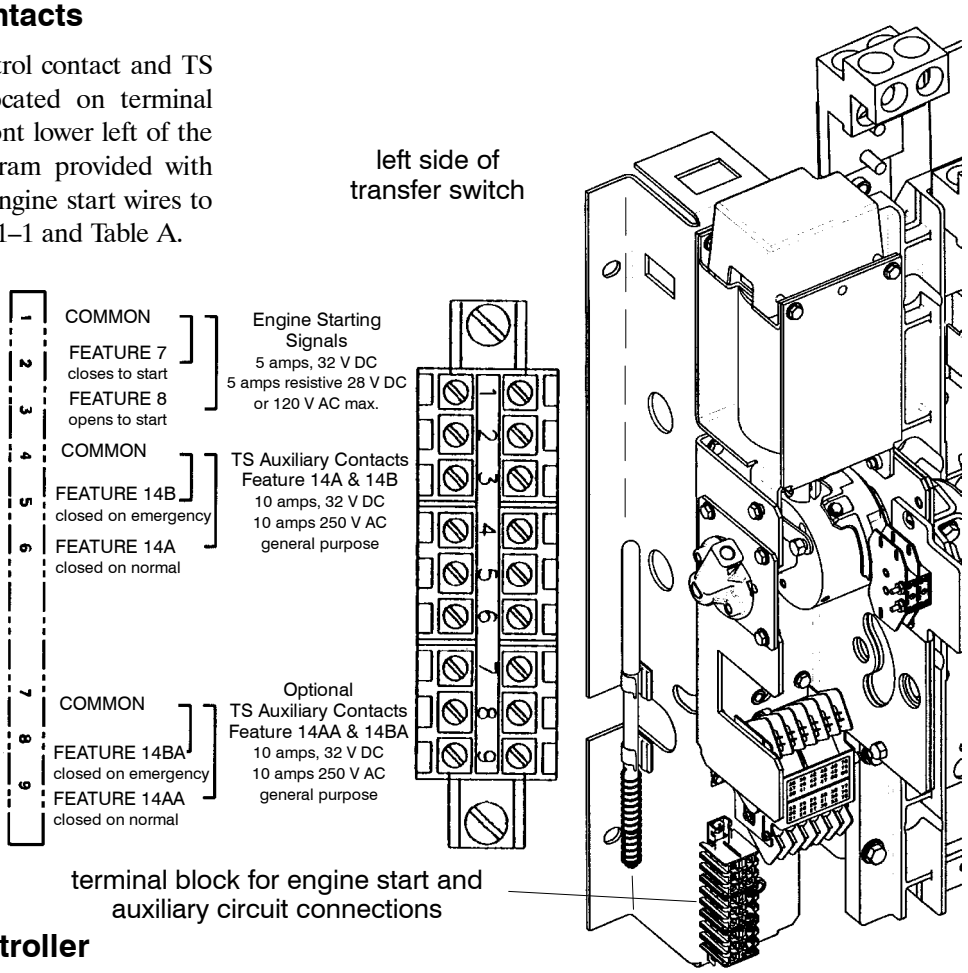


Figure 1-1. Engine start and auxiliary circuit terminal block TB located on the transfer switch.

Connections to Controller for other Control Features

(located on bottom of Controller)

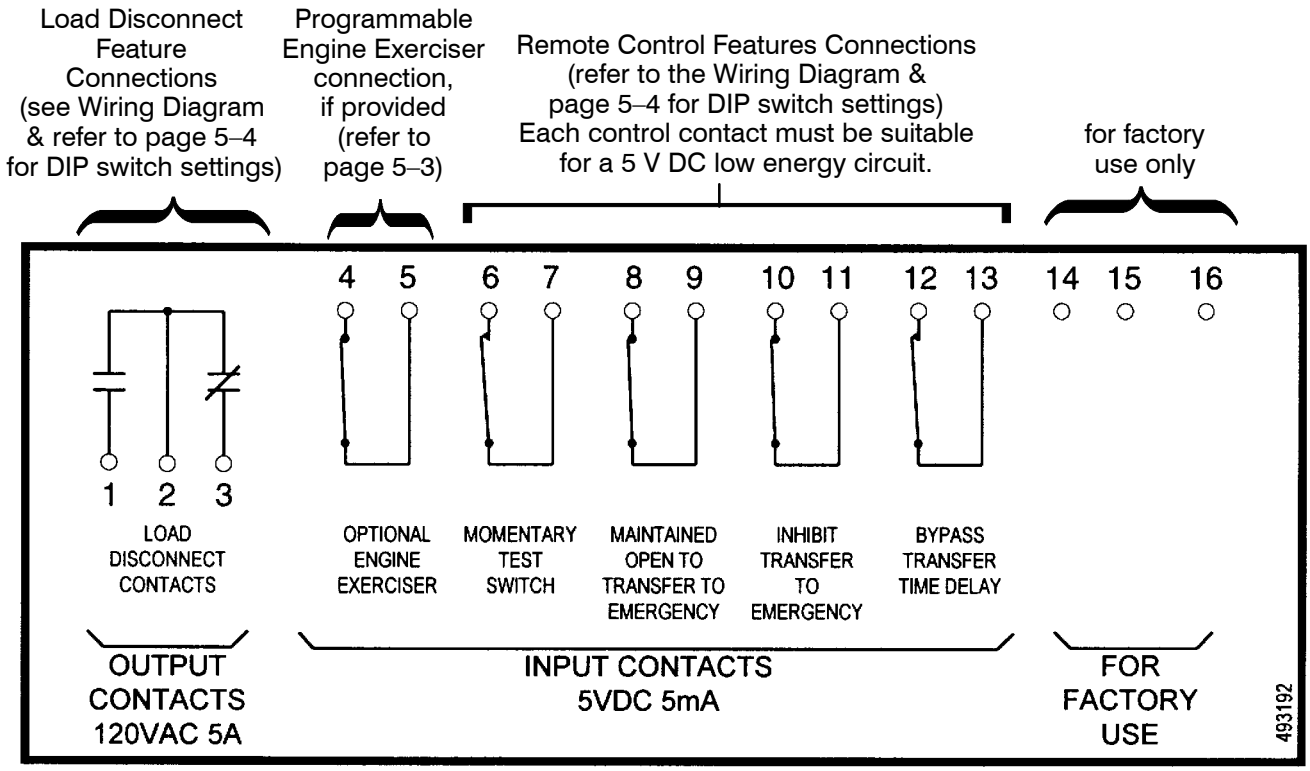


Figure 1-2. Input / output label on the Controller showing possible connections to the lower terminal block.

Functional Test

The Functional Test consists of three checks: manual operation, voltage checks, and electrical operation.

⚠ CAUTION

Do these checks in the order presented to avoid damaging the automatic transfer switch.

Read all instructions on the Wiring Diagram and labels affixed to the automatic transfer switch. Note the control features that are provided and review their operation before proceeding.

1 – Manual Operation Test

A detachable maintenance handle is provided on the frame of the Transfer Switch for maintenance purposes only. Manual operation of the transfer switch should be checked before it is energized (operated electrically).

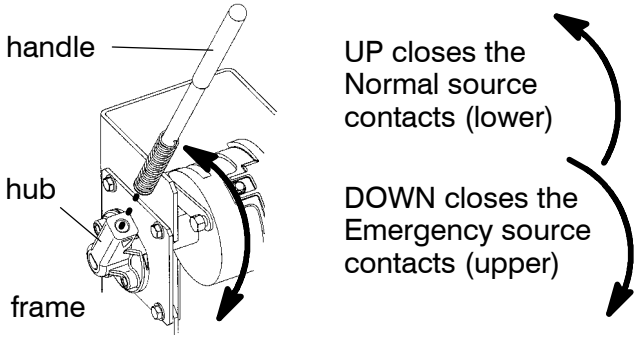
⚠ WARNING

Do not manually operate the transfer switch until both power sources are disconnected: open both circuit breakers.

1. After deenergizing both power sources, open the enclosure door. Locate and remove the maintenance handle from the clips on the left side of the transfer switch frame. Insert the handle into the hole in the molded hub on the left side of the operator. See Figures 1–3 and 1–4 and Table B.
2. Move the maintenance handle up or down as shown to manually operate the transfer switch. It should operate smoothly without any binding. If it does not, check for shipping damage or construction debris.

Table B. Maintenance handle positions.

ATS Position		Handle	Indicators
Normal	E N	up	E = O upper contacts open N = C lower contacts closed
Emergency	E N	down	E = C upper contacts closed N = O lower contacts open



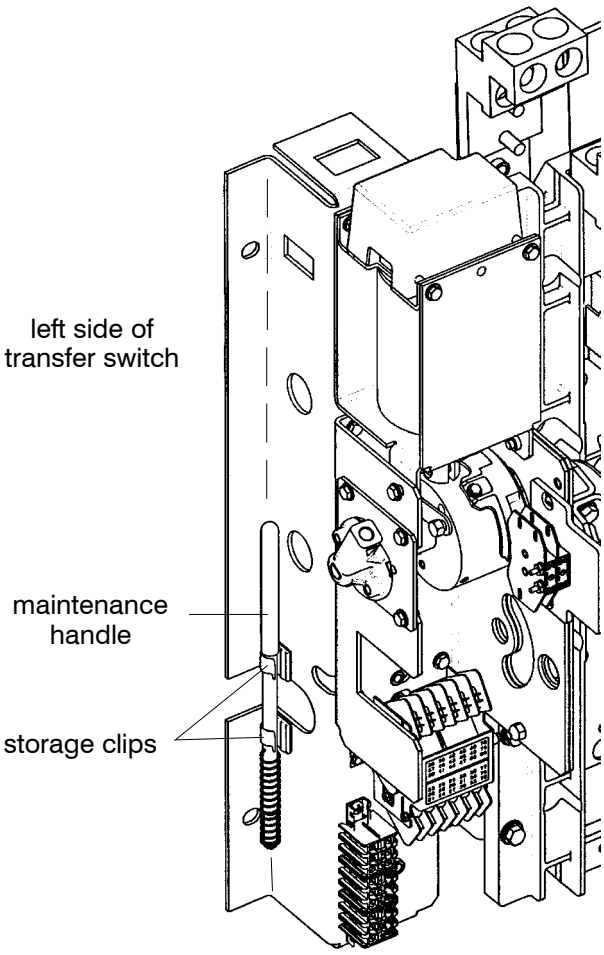


Figure 1-3. Maintenance handle and its storage clips.

3. Return the transfer switch to the Normal position. Observe that the window indicators (right side) show the top shaft O (open) and the bottom shaft C (closed).

   Note: If Normal and Emergency connections are reversed this operation is also reversed.

4. Remove the maintenance handle and store it on the frame (left side) in the clips provided.

⚠ WARNING

Verify that the maintenance handle has been removed before proceeding!

Now continue to **2 – Voltage Checks** on next page.

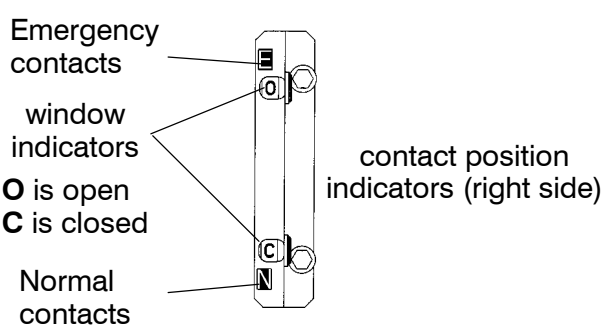


Figure 1-4. Maintenance handle operation and contact position indicators.

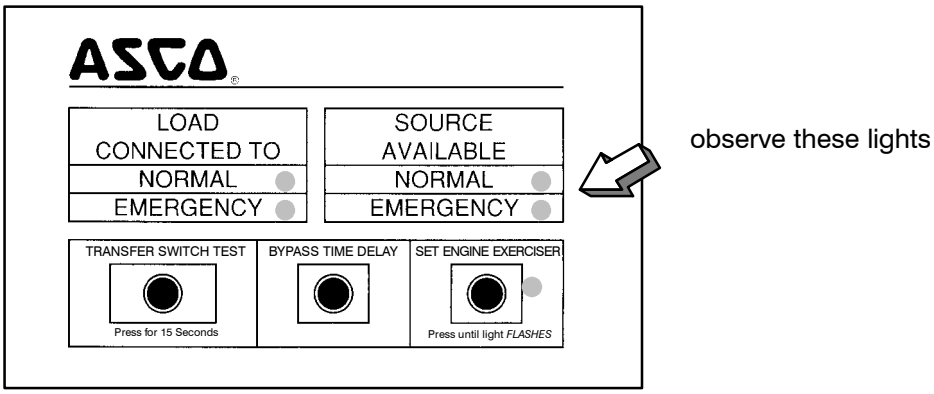


Figure 1–5. Standard controls and indicators.

2 – Voltage Checks

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ CAUTION

Verify that the feeders have been connected to the proper lugs.

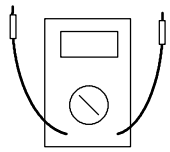
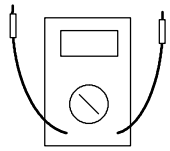
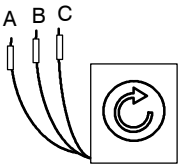
⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1 through 6 at the right. Observe the status lights. See Figure 1–5.

- ● Black circle means light is on.
- ❍ White circle means light is off.

* If necessary, adjust voltage regulator on the generator according to the manufacturer's recommendations. The Automatic Transfer Switch will respond only to the rated voltage specified on the Transfer Switch nameplate.

1	Close the normal source circuit breaker. The *Transfer Switch Connected To Normal* and the *Normal Source Available* lights should come on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ❍
2	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch normal source terminals.	
3	Close the emergency source circuit breaker. (Start generator, if necessary.) The *Transfer Switch Connected To Normal* and the *Emergency Source Available* lights should come on.	SOURCE AVAILABLE NORMAL ❍ EMERGENCY ●
4	Use an accurate voltmeter to check phase to phase and phase to neutral voltages present at the transfer switch emergency source terminals.*	
5	Use a phase rotation meter to check phase rotation of emergency source; it must be the same as the normal source.	
6	Shut down the engine–generator, if applicable. The *Emergency Source Accepted* light should go off. Then put the starting control selector switch (on the generator set) in the *automatic* position. Close enclosure door.	SOURCE AVAILABLE NORMAL ❍ EMERGENCY ❍

Now continue to **3 – Electrical Operation** on next page.

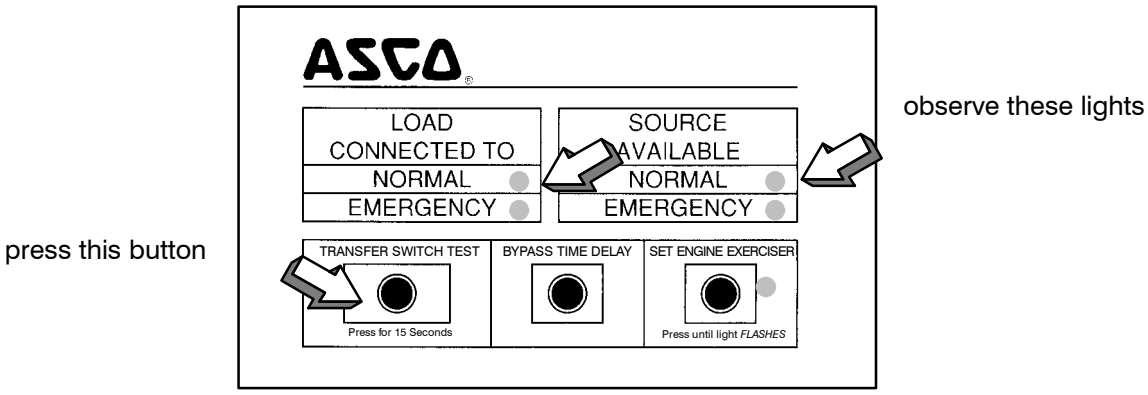


Figure 1–6. Standard controls and indicators.

3 – Electrical Operation

First check nameplate on transfer switch; rated voltage must be the same as normal and emergency line voltages.

⚠ CAUTION

Verify that the feeders have been connected to the proper lugs.

⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

Perform steps 1 through 8 at the right. Observe the status lights. See Figure 1–6.

- ● Black circle means light is on.
- ❍ White circle means light is off.

NOTE: If Motor Load Transfer feature is activated, then transfer may not occur immediately after the respective time delays. Transfer will only occur when the phase relationship between sources is correct.

This completes the Functional Test of the ASCO Series 300 Automatic Transfer Switch. Leave the engine–generator starting control in the *automatic* position.

1	The normal source must be available and the generator must be ready to start. Check that the *Normal Source Available* light is on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○
2	Press and hold the *Transfer Switch Test* button until the engine starts and runs. This should happen within 15 sec.	TRANSFER SWITCH TEST
3	The *Emergency Source Available* light should come on.	SOURCE AVAILABLE NORMAL ● EMERGENCY ●
4	The transfer switch should transfer to the Emergency position. The *Load Connected to Emergency* light should come on and the *Load Connected to Normal* light should go off.	LOAD CONNECTED TO NORMAL ○ EMERGENCY ●
5	If the *transfer to emergency delay* is used the transfer should occurs after a time delay (up to 5 minutes). For immediate transfer press the *Bypass Time Delay* button.	BYPASS TIME DELAY
6	The transfer switch should transfer back to the Normal position. The *Load Connected to Normal* light should come on and the *Load Connected to Emergency* light should go off.	LOAD CONNECTED TO NORMAL ● EMERGENCY ○
7	If the *retransfer to normal delay* is used the retransfer should occur after a time delay (up to 30 minutes). For immediate retransfer press the *Bypass Time Delay* button.	BYPASS TIME DELAY
8	The *unloaded running delay* keeps the generator running for 5 minutes (cool–down period). Then the generator should stop and the *Emergency Source Available* light should go off.	SOURCE AVAILABLE NORMAL ● EMERGENCY ○

SECTION 2 SEQUENCE OF OPERATION

Transfer To Emergency

The sequence for load transfer to emergency source begins automatically when normal source voltage falls below the preset dropout point or when *Transfer Switch Test* button is pressed. An under voltage condition on any phase of the normal source is detected by the sensor.

When the normal source voltage fails or the *Transfer Switch Test* button is pressed, the SE relay de-energizes and relay NR begins its timing cycle (1 or 3 seconds, *momentary normal source outage delay*). The NR relay is provided with a time delay on dropout to override momentary outages and prevent nuisance starting of the engine-driven generator. If the normal source voltage returns above the sensor dropout setting before the time delay expires, the NR relay timing cycle is reset to zero and relay SE energizes.

If the normal source voltage does not return above the sensor dropout setting before the time delay expires, the NR relay de-energizes and signals the engine-driven generator to start. At the same time, a voltage and frequency sensor begins monitoring the emergency source. The sensor will accept the emergency source only when both voltage and frequency reach preset pickup points. Usually about ten seconds elapse from dropout of the NR relay to acceptance by the sensor. This time span occurs because the engine-driven generator must crank, start, and run up to nominal pickup points. For this reason, if the *Transfer Switch Test* button is pressed it must be held for 15 seconds. If the emergency source is available immediately, the sensor may accept it as soon as NR relay drops out.

When the emergency source is accepted by the sensor, relay ER begins its timing cycle (*transfer to emergency delay*). ER relay is provided with an adjustable (0 to 5 minutes) time delay on pickup to delay transfer of the load to the emergency source. For immediate transfer press *Bypass Time Delay* button.

ER relay energizes, the TS coil is energized, the transfer switch operates, and all switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the emergency source.

The transfer switch will remain in the Emergency position until the normal source is restored. If the *Transfer Switch Test* button is used, the transfer switch will remain on emergency until the *retransfer to normal delay* times out.

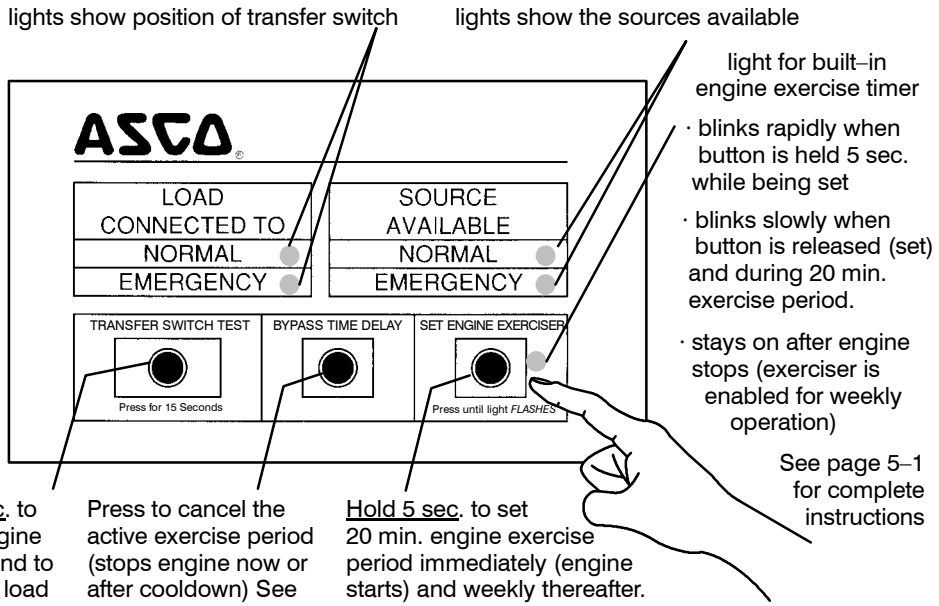


Figure 2–1. Membrane controls and indicator lights.

Retransfer to Normal

The sequence for load retransfer to the normal source automatically begins when the voltage sensor detects restoration of the normal source. The voltage level must rise above the preset pickup point on all phases before the sensor will accept the normal source.

When the normal source is accepted by the sensor, relay SE begins its timing cycle (adjustable 1 sec. to 30 min., *retransfer to normal delay*). For immediate retransfer press *Bypass Time Delay* button. SE relay is provided with a time delay on pickup to prevent immediate load retransfer to the normal source. The delay insures that the normal source has stabilized before reconnection of vital loads. If the normal source voltage falls below the present dropout point before the time delay expires, the timing cycle is reset to zero. If the emergency source fails for more than 4 seconds during the timing cycle, ER relay drops out and the load is immediately retransferred to the normal source, if that source is acceptable.

SE relay energizes and ER relay is dropped out. The TS coil is energized, the transfer switch operates, and all switch contacts (mains, controls, auxiliaries) reverse position. The transfer switch is now supplying the load from the normal source again.

Upon retransfer to the normal source, NR relay begins its timing cycle (*unloaded running delay [engine cooldown]*). NR relay is provided with a 5 minute time delay on pickup to keep the engine running for a cool-down period.

NR relay energizes after the time delay and signals the engine-driven generator to shut down. All circuits are reset for any future normal source failure.

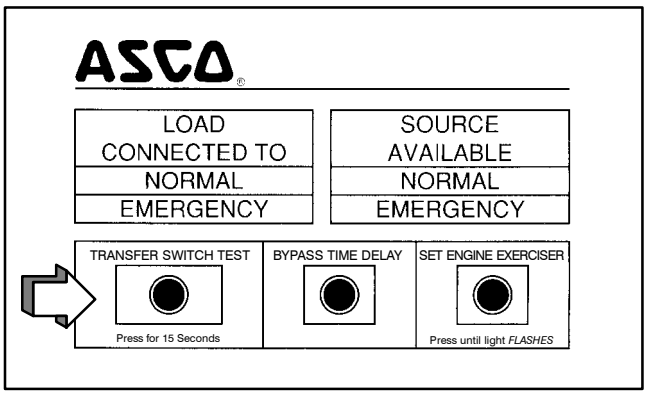
Activation of standard control features shown in Section 5 will alter the sequence of operation and introduce additional time delays during transfer operations.

SECTION 3 TESTING & SERVICE

PREVENTIVE MAINTENANCE

Reasonable care in preventive maintenance will insure high reliability and long life for the automatic transfer switch.

Operate the switch at least once a month. Perform this four step Electrical Operation Test. This is a test with load transfer.



Transfer Switch Test

1.	Press and hold the door-mounted *TRANSFER SWITCH TEST* button until the engine starts and runs. This should happen within 15 seconds.
2.	The transfer switch will operate to the Emergency position. If the *Transfer To Emergency Delay* is used, the transfer will occur after a time delay (up to 5 minutes). For immediate transfer press *BYPASS TIME DELAY* button.
3.	The Transfer Switch will operate back to the Normal position after the *Retransfer To Normal Delay* (up to 30 minutes). For immediate retransfer press *BYPASS TIME DELAY* button.
4.	*Unloaded Running (Engine Cooldown) Delay* allows engine to run unloaded for 5 minutes.

Clean and inspect the switch once a year. De-energize all sources, then brush and vacuum away any excessive dust accumulation. Remove the transfer switch barriers and check contact condition. Replace contacts when pitted or worn excessively. Reinstall the barriers carefully.

Maintain transfer switch lubrication. The transfer switch has been properly lubricated, and under normal operating conditions no further lubricating is required. Renew factory lubrication if the switch is subjected to severe dust or abnormal operating conditions. Relubricate the operator if TS coil is replaced. Order ***lubrication kit 75-100***.

Replacement parts. Replacement parts are available in kit form. When ordering parts provide the Serial No. and Catalog No. from the transfer switch nameplate. Contact your local ASCO Power Technologies sales office or ASI. In the United States call 1–800–800–ASCO (2726), or in Canada call 1–888–234–ASCO (2726).

DISCONNECTING THE CONTROLLER

The harness disconnect plugs are furnished for repair purposes only and should not have to be unplugged. If the controller must be isolated, follow these steps carefully.

Disconnecting the Plugs

⚠ WARNING

Do not unplug the controller until step 1a. or 1b. below is completed.

1. Observe the position of the transfer switch.
   a. If the transfer switch is in the *Normal* position, place standby engine starting control in the *off* position. Then open the emergency source circuit breaker.
   b. If the transfer switch is in the *Emergency* position, open the normal source circuit breaker. Place the engine starting control in the *test* or *run* position.
2. Separate the quick disconnect plugs by squeezing the latches. Do not pull on the harness wires.
3. Label, remove, and tape the signal wires connected to the engine start terminals on the transfer switch: TB1 and TB3, or TB1 and TB2.

Reconnecting the Plugs

⚠ WARNING

Do not reconnect the controller until step 1a. or 1b. and 2 below are completed.

1. Observe the position of the transfer switch.
   a. If the transfer switch is in the *Normal* position, be sure that the standby engine starting control is still in the *off* position. The emergency source circuit breaker still should be open.
   b. If the transfer switch is in the *Emergency* position, normal source circuit breaker still should be open.
2. Reconnect the signal wires connected to the appropriate engine start terminals on the transfer switch. See **Section 1**, *Engine Starting Contacts*.
3. The harness plugs and sockets are keyed. Carefully align the plugs with the sockets and press straight in until both latches click.
4. Restore the opposite source as follows:
   a. If the transfer switch is in the *Normal* position, place the standby engine starting control in the *automatic* position. Then close the emergency source circuit breaker.
   b. If the transfer switch is in the *Emergency* position, close the normal source circuit breaker. The load will be automatically retransferred to the normal source after the *Retransfer to Normal Delay*. For immediate retransfer, press *BYPASS TIME DELAY* button. Place the engine starting control in the *automatic* position.

MANUAL LOAD TRANSFER

This procedure will manually transfer the load if the controller is disconnected.

⚠ WARNING

Do not manually operate the transfer switch until both power sources are disconnected: open both circuit breakers.

1. Open normal and emergency source circuit breakers.
2. Use the maintenance handle to manually operate transfer switch to the opposite source. See page 1–3, *Manual Operation Test*.
3. If the transfer switch is in the Emergency position manually start the engine generator and then close the emergency source circuit breaker.

TROUBLE-SHOOTING

Note the control features that are activated or furnished on the switch and review their operation. Refer to **Section 5**, **Control Features**.

⚠ WARNING

Proceed with care!
The automatic transfer switch is energized.

Table 3-1. Trouble-Shooting Checks.

PROBLEM	CHECK IN NUMERICAL SEQUENCE		
	1 OPERATION	2 GEN-SET	3 VOLTAGE
Gen-Set does not start when the *TRANSFER SWITCH TEST* button is pressed and held for 15 seconds or when the normal source fails.	Hold the *TRANSFER SWITCH TEST* button 15 sec. or the outage must be long enough to allow for the 1 or 3 sec. *Momentary Normal Source Outage Delay* plus engine cranking and starting time.	Starting control must be in automatic position. Batteries must be charged and connected. Check wiring to engine starting contacts.	—
Transfer switch does not transfer the load to emergency source after the gen-set starts.	Wait for *Transfer to Emergency Delay* (0 to 5 min.) to time out. For immediate transfer, press the *BYPASS TIME DELAY* button. If Motor Load Transfer is active, wait for in-phase condition (see below).	Generator output circuit breaker must be closed. Generator frequency must be at least 57 Hz.	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals EA and EC (or EL1 and EL2 for 2 pole switches). * * These are factory settings.
Transfer switch does not transfer the load to normal source when normal returns or when *TRANSFER SWITCH TEST* button is released.	Wait for *Retransfer to Normal Delay* (1 sec. to 30 min.) to time out. For immediate re–transfer, press *BYPASS TIME DELAY* button. If Motor Load Transfer is active, wait for in-phase condition (see below).	—	Voltmeter should read at least 90% of nominal phase to phase voltage between transfer switch terminals NB and NC, NC and NA, and NA and NB (or NL1 and NL2 for 2 pole switches).
Gen-Set does not stop after load retransfer to the normal source.	Wait for the 5 minute *Unloaded Running Delay* to time out.	Starting control must be in automatic position.	—

Trouble-Shooting the Motor Load Transfer Feature (refer to page 5–3)

⚠ DANGER

Use extreme caution when using a meter to measure voltages in the following steps. Do not touch power terminals; shock, burns, or death could result !

1. Connect a voltmeter (set for twice system phase–to–phase voltage) between Transfer Switch terminals NA and EA.
2. Manually start generator. Voltmeter needle should sweep back and forth at a regular rate between 0 and about twice system voltage.
3. Press and hold TRANSFER SWITCH TEST button. The load should transfer to emergency source when meter needle is near 0 volts. If transfer does not occur, Motor Load Transfer feature is not operating.
4. Release the **Transfer Switch Test** button. The load should retransfer back to the normal source after the *Retransfer to Normal Delay*, if used. The retransfer should occur when the needle is near 0 volts. If retransfer does not occur after the time delay, the Motor Load Transfer feature is not operating.
5. For immediate retransfer, press the BYPASS TIME DELAY button. Then disconnect the voltmeter.

If the problem is isolated to circuits on the controller or the transfer switch, call your local ASCO Power Technologies sales office or ASI. In the United States, call 1–800–800–2726. In Canada, call 1–888–234–2726. Furnish the Serial No., Bill of Material (BOM) No., & Catalog No. from transfer switch nameplate.

SECTION 4 ADJUSTMENTS

Time Delay Adjustment

Standard time delays are set to customer specifications (if none specified, standard factory settings are used).

To change a setting, follow procedure on page 4-2. Use Table 4-1 as a guide to time delay values and their corresponding adjustment DIP switch or potentiometer.

Table 4-1. Time Delay Settings

DESCRIPTION	LABELS	FACTORY SETTING	ADJUSTMENT RANGE	S3 DIP SWITCH		ADJUSTMENT POTENTIOMETER
Override Momentary Normal Source Outages	TD ES	3 seconds	1 second	Actuator 1 on		—
			3 seconds	Actuator 1 off		
Transfer to Emergency	TIMER N/E	0 minutes (full ccw)	0 to 5 minutes	—	—	P2
Override Momentary Emergency S. Outages	—	4 seconds	non-adjustable	—	—	—
Retransfer to Normal	TIMER E/N	30 minutes (full cw)	1 second to 30 minutes	—	—	P1
Unloaded Running (Engine Cooldown)	—	5 minutes	non-adjustable	—	—	—

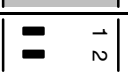
Sensor Adjustments

Voltage and frequency sensor pickup and dropout points are set to customer specifications (if none specified, standard factory settings are used). To change a setting, follow procedure on page 4–2. Use Tables 4-2 and 4–3 for settings and corresponding DIP switch actuators.

⚠ WARNING

Any change in these settings may affect the normal operation of the automatic transfer switch. This change could allow the load circuits to remain connected to a low voltage source.

Table 4-2. Voltage and Frequency Settings. (☐ Shaded DIP switches are standard factory settings).

DESCRIPTION	LABELS	SETTING	% of nominal		S1 DIP SWITCH	
			FACT. SET	ADJ RANGE		
Normal Source Voltage	PU / N	Pickup	90 %	95 % *	Actuator 3 off	
				90 %	Actuator 3 on	
	DO / N	Dropout	85 %	90 % *	Actuator 1 off Actuator 2 off	
				85 %	Actuator 1 on Actuator 2 off	
				80 %	Actuator 1 off Actuator 2 on	
				70 %	Actuator 1 on Actuator 2 on	
Emergency Source Voltage	– –	Pickup	90 %	non-adjustable	– –	
	– –	Dropout	75 %	non-adjustable		
Emergency Source Frequency	– –	Pickup	95 %	non-adjustable	– –	
	– –	Dropout	85 %	non-adjustable		
	60 / 50 Hz	60 / 50 Hz	60 Hz	60 Hz	Actuator 4 off	
				50 Hz	Actuator 4 on	
Voltage Phases	3 Ø , 1 Ø	3 Ø / 1 Ø	3 Ø	3 phase	Actuator 6 off	
				1 phase	Actuator 6 on	

* If dropout voltage is set to 90%, the pickup voltage must be set to 95%.

Table 4-3. Transformer Voltage Adjust.
(Low setting shifts all voltage settings down 4.2%; for example, 240 V to 230 V, or 480 V to 460 V)

DESCRIPTION	LABELS	FACTORY SETTING	ADJUSTMENT	S3 DIP SWITCH	
Voltage Adjust (4.2%)	LOW / HI	HI	LOW	Actuator 2 off	
			HI	Actuator 2 on	

⚠ WARNING

Do not make any setting changes while the controller is energized.

How to Change a Setting

1. Prevent the transfer switch from operating by disconnecting one source first, then the other, as follows:
   a. If the transfer switch is in the Normal position, open the emergency source circuit breaker. Turn the engine starting control to *off*. Then open the normal source circuit breaker.
   b. If the transfer switch is in the Emergency position, open the normal source circuit breaker. Turn engine starting control to *test* or *run*. Then open the emergency source circuit breaker.
2. Disconnect both harness plugs from controller by squeezing the latches. Do not pull on the wires.
3. Remove cover from the controller by releasing latch on right side with your thumb. See Figure 4-1.
4. Locate the appropriate adjustment potentiometer or DIP switch for the setting that you want to change. Refer to Table 4-1 and Table 4–2 on page 4-1 and Figure 4-2, Figure 4–3, Figure 4–4 on page 4–2.
5. Use a small screwdriver to turn the potentiometer clockwise to increase the time delay or counterclockwise to decrease it. See Figure 4-3.
6. Use a ball-point pen (or similar pointed tool) to slide the switch actuators left or right so they match the illustration next to the setting (left = off, right = on). Recheck the setting. See Figure 4-4.
7. Install the cover on the controller by hooking it on the left side and latching the right side.
8. Reconnect both harness plugs to the controller by aligning and pressing straight in until latches click.

⚠ WARNING

Close the enclosure door.

9. Close the enclosure door, then restore both sources:
   a. If the transfer switch is in the Normal position first close the normal source circuit breaker, then close the emergency source circuit breaker.
   b. If the transfer switch is in the Emergency position, close the normal source circuit breaker. The load will be automatically retransferred to the normal source. Then close the emergency source circuit breaker.
10. Turn the engine starting control to *automatic*.

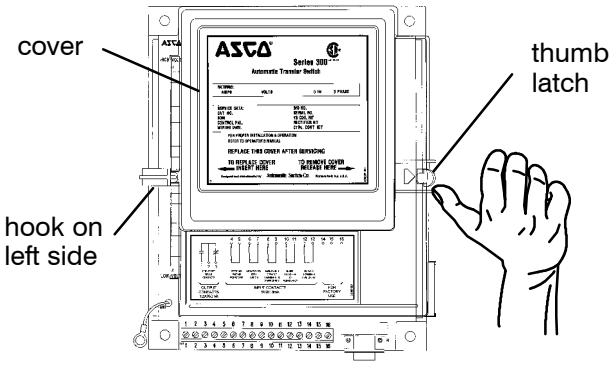


Figure 4-1. Controller cover latch.

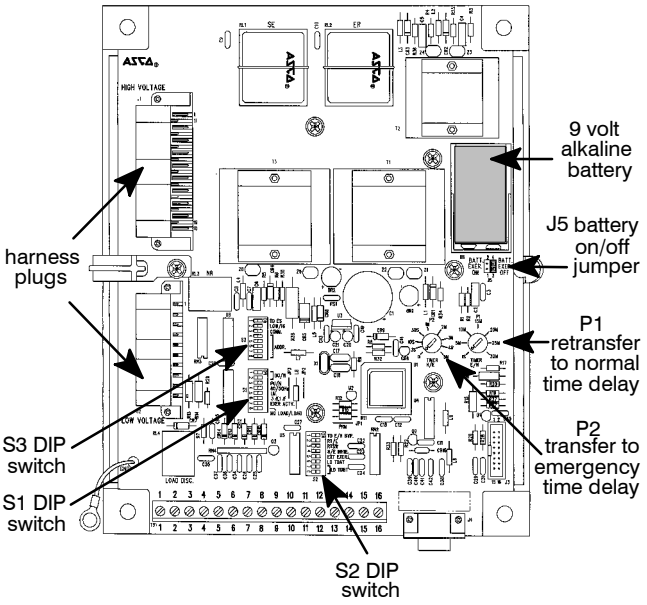


Figure 4-2. Location of potentiometers.

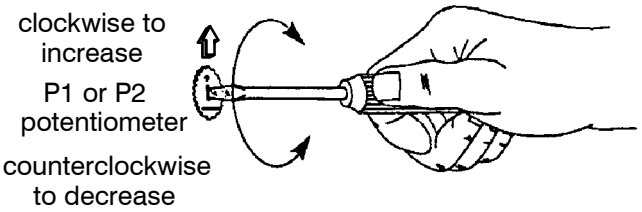


Figure 4-3. Changing time delay potentiometers.

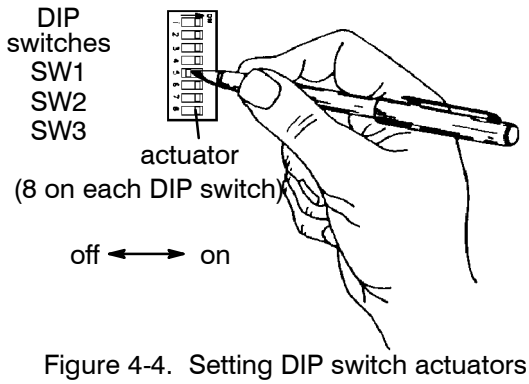


Figure 4-4. Setting DIP switch actuators.

SECTION 5 CONTROL FEATURES – ENGINE EXERCISERS

These timers periodically exercise the emergency engine-generator plant. They can be set to exercise with or without load transfer, or they can be completely disabled. The engine-generator should be exercised under load once a week for a minimum time period of 20 minutes, or follow the recommendations of the engine-generator set manufacturer. Refer to page 4–2 for location of DIP switches, battery (provided), and jumper block in the controller.

BUILT–IN ENGINE EXERCISER

The engine exerciser included in ASCO Series 300 Automatic Transfer Switches provides a once a week 20–minute exercise period. It occurs immediately when the SET ENGINE EXERCISER push button is pressed (and held for at least 5 seconds), and then at the same time weekly thereafter. A 9 volt alkaline battery (*Duracell*® MN1604, *Everready*® 522, or *Panasonic*® 6AM6) is furnished and installed in the controller to maintain the setting. The battery jumper block must be shifted to the ON position. See Figure 4–2 on page 4–2.

Fill in day and time set. Week Day _____ Time _____.

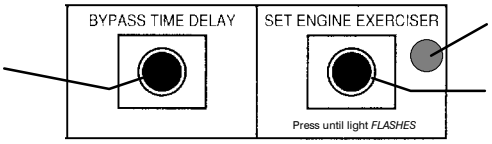
DIP Switch Settings

FUNCTION	S1 DIP SWITCH		S2 DIP SWITCH	
Std. Timer Enabled	Actuator 7 on	7	Actuator 5 on	5
Std. Timer Disabled	Actuator 7 off	7	Actuator 5 on	5
Exercise without Load	Actuator 8 off	8		
Exercise with Load	Actuator 8 on	8		

Shaded DIP switches are standard factory settings.

Press to cancel an active exercise period (stops generator).

If *Exercise with Load* is set, retransfers load to Normal, then stops generator after 5 min. cooldown.



status light

Press and hold for 5 sec. or until status light blinks rapidly to set exercise period immediately and every week hereafter (generator starts).

If *Exerciser with Load* is set, transfers load to Emergency.

Figure 5-1. Operator panel pushbuttons and light.

Select below either *Exercise without Load* or *Exercise with Load* according to the setting of DIP switch S1, actuator 8. The load transfers from the Normal source to Emergency source (generator) and back again if *Exercise with Load* is selected.

Exercise without Load, DIP Switch S1, Actuator 8 off (8) How to Set Built–In Timer

Step	Push Button	Status Light	Function	Explanation
1	*SET ENGINE EXERCISER* hold 5 sec.	blinks rapidly ●○●○●○	set exercise period	Exercise the generator now and every week at this time hereafter.
2	release	blinks slowly ●○○●○○	exercise period now active	Generator starts and runs.
3	press *BYPASS TIME DELAY*	● stays on	cancel active exercise period	Generator stops.
4	—	● stays on	generator off	Exerciser enabled; repeats every 7 days.

Exercise with Load, DIP Switch S1, Actuator 8 on (8) How to Set Built–In Timer

Step	Push Button	Status Light	Function	Explanation
1	*SET ENGINE EXERCISER* hold 5 sec.	blinks rapidly ●○●○●○	set exercise period	Exercise the generator now and every week at this time hereafter.
2	release	blinks slowly ●○○●○○	exercise period now active	Generator starts and runs; the load transfers to Emergency.
3	press *BYPASS TIME DELAY*	blinks slowly ●○○●○○	cancel active exercise period	The load retransfers to Normal; then generator runs for 5 minute cooldown (light blinks slowly during cooldown).
4	—	● stays on	generator off	Exerciser enabled; repeats every 7 days.

NOTE: Every time *SET ENGINE EXERCISER* push button is pressed (held 5 seconds) the exercise period is changed.

Optional Accessory 11BG – SOURCE AVAILABILITY SIGNAL & PROGRAMMABLE ENGINE EXERCISER MODULE

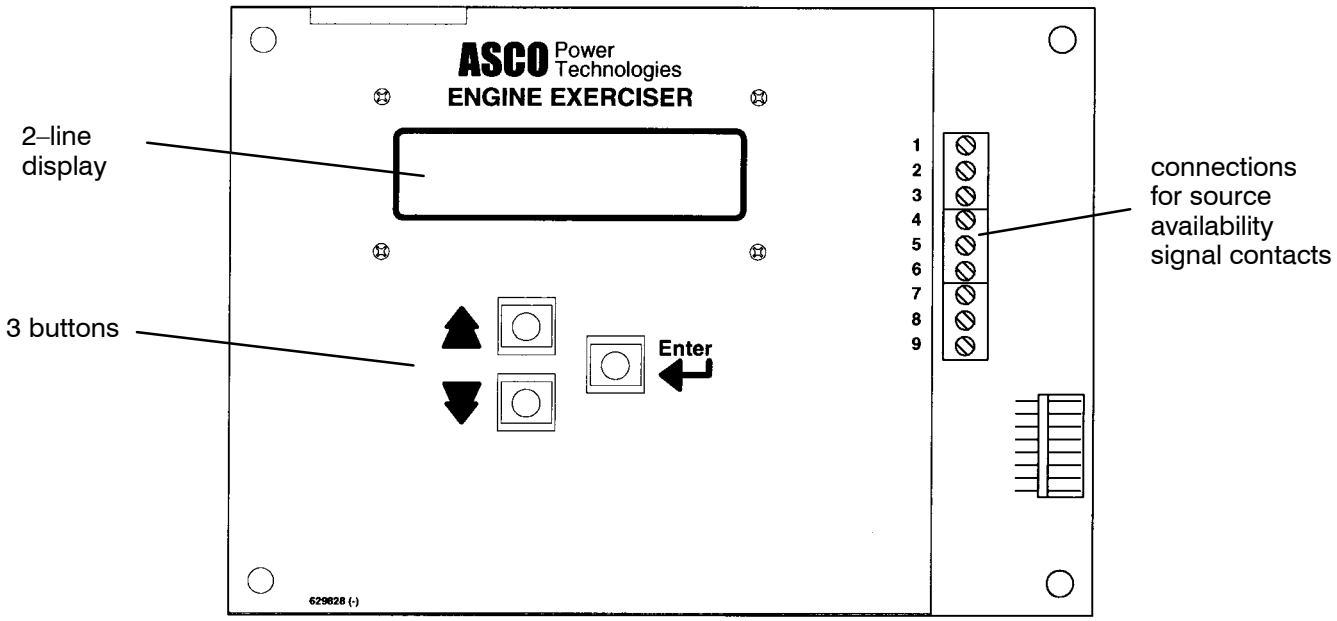


Figure 5–2. Accessory 11BG module (mounted behind operator interface and connected to the controller) includes source availability signal contacts and a programmable engine exerciser.

Source Availability Signal Contacts

The module provides one Form C contact each for the normal and emergency sources signal the acceptability of the source as sensed by the controller. The signal contacts operate in conjunction with the *Source Available* lights on the operator interface. Field wiring terminals are provided as shown in Figure 5–3 and the wiring diagram.

Contact ratings:

2 amps @ 30 Vdc, 0.5 amp. @ 125 Vac resistive

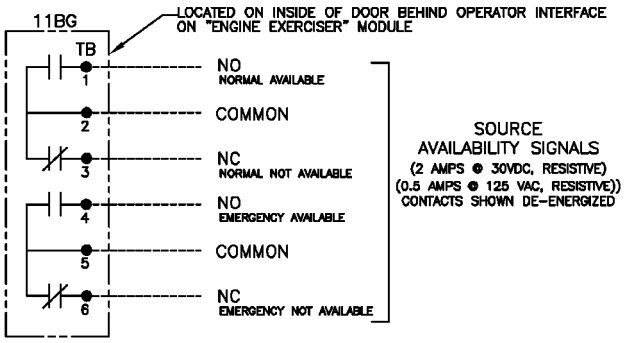


Figure 5–3. Source availability signal contacts.

Programmable Engine Exerciser

The module includes a programmable engine exerciser that provides for weekly or biweekly operation. This optional exercise timer may have to be turned on (enabled) by setting the S1 DIP switch actuator 7 to off, and S2 DIP switch actuator 5 to off. A backup battery in the controller (see page 4–2 and page 5–3) must be turned on to maintain the settings and to allow programming with the normal and emergency power turned off (page 5–1).

The programmable engine exerciser incorporates a 7 day or 14 day time base. Proper controller settings must be made to determine whether or not the test will be done with or without load transfer (S1 DIP switch actuator 8).

See next page for instructions on setting the timer.

DIP Switch Settings in the Controller

(see page 4–2)

FUNCTION	S1 DIP SWITCH		S2 DIP SWITCH	
Opt. Timer Enabled	Actuator 7 off		Actuator 5 off	
Opt. Timer Disabled	Actuator 7 off		Actuator 5 on	
Exercise without Load	Actuator 8 off			
Exercise with Load	Actuator 8 on			

Shaded DIP switches are standard factory settings.

How to Set Optional Programmable Engine Exerciser (part of Acc. 11BG module)

⚠ DANGER

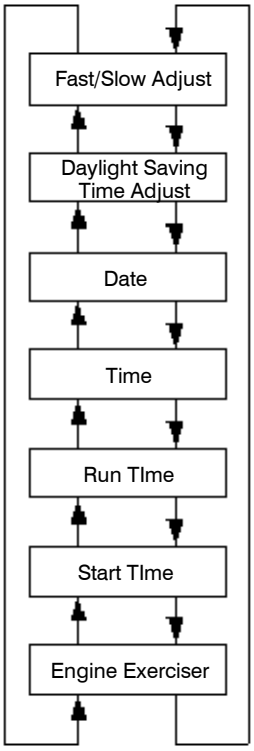
Hazardous voltage capable of causing shock, burns, or death is used in this transfer switch. Deenergize both Normal & Emergency power sources before programming the exerciser.

Navigating the Menu

Use the UP and DOWN arrow keys to move through the displays.

Changing the Parameters

Use the UP and DOWN arrow keys to move though the displays to the parameter to be changed. Push the ENTER key to start the editing process. The first parameter will flash. Use the UP and DOWN arrow keys to adjust the parameter to the desired value and press the ENTER key to save the value. The next parameter will now flash. Repeat the process until each parameter is properly configured.



Engine Exerciser Display

The Engine Exerciser Display shows the status of the engine exerciser. When the unit is shipped from the factory the programmable engine exerciser is "Disabled" and must be set to "Enabled" by the customer. When the engine exerciser is running, this display will count down the remaining time until the end of the exercise period.

Start Time Display

The Start Time Display shows the engine exerciser start time. There are four parameters that determine the start time:

weekly ("Every") or bi–weekly ("Alt") operation
day of week ("Sun" through "Sat")
start hour (0 through 23)
start minutes (0 through 59)

For example, if the user wants the exerciser to run every other Saturday at 3 PM, the proper configuration would be:

"Alt Sat @ 15:00"

NOTE: When choosing bi–weekly operation, the exerciser will always run on the week designated "(1)" on the date display.

Run Time Display

The Run Time Display shows the run time for the engine exerciser. The default setting from the factory is 30 minutes.

Time Display

The Time Display shows the present system time. The format is "hours:minutes:seconds".

NOTE: During total power outages, power to the accessory is maintained by a battery in the Controller (see page 4–2). Be sure that the 9–volt alkaline battery is fresh and enabled (jumper in ON position) so that the time and date settings are not lost.

Date Display

The Date Display shows the present system date. The format is "day of week (week) month/day of month/year".

NOTE: Week is either week 1 or week 2. This is used in conjunction with the bi–weekly timer.

Daylight Savings Time Adjust Display

This display shows whether the automatic daylight saving time adjustment is active. The factory default is "NO". If enabled, the unit will automatically adjust for daylight saving time at 2 AM on the first Sunday of April and the last Sunday of October.

Fast / Slow Adjust Display

This display shows the automatic fast/slow adjustment value. The factory default is 0. This feature can be used to trim a clock that runs fast or slow. For example, if your clock runs 10 seconds slow per week, change the fast/slow adjust value to "+10" and the unit will automatically add 10 seconds to the clock every week.

NOTE: Adjustments are made Sunday morning at 2 AM. If you want your exerciser period to start at 2 AM on Sunday, you cannot use this feature and the adjustment must be set to 0.

Fill in your settings for future reference

Weekly or Bi–weekly	Day of Week	Start Time	Run Time
Every = weekly *Alt* = bi–weekly	*Sun* through *Sat*	*0 – 23* hour *0 – 59* minute	*0 – 23* hour *0 – 59* minute *30* min. is default setting

Date exerciser was set _____

CONTROL FEATURES *(continued)*

INPHASE MONITOR FOR MOTOR LOAD TRANSFER

Inphase monitoring logic controls transfer and retransfer of motor loads, so that inrush currents do not exceed normal starting currents. It avoids nuisance tripping of circuit breakers and mechanical damage to motor couplings.

The Motor Load Transfer feature is built into the controller. DIP switch S1 (actuator 5) activates this feature: right = ON, left = OFF.

FUNCTION	S1 DIP SWITCH	
enable	Actuator 5 on	
disable	Actuator 5 off	

☐ Shaded DIP switches are standard factory settings.

Note

If the Motor Load Transfer feature is enabled, it will be activated following the Load Disconnect Feature Delay Before Transfer delay.

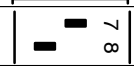
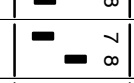
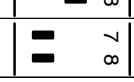
LOAD DISCONNECT FEATURE

Connect external circuits to the terminals indicated on the Wiring Diagram provided with the ATS.

The double throw (Form C) contact is rated for 28 VDC or 120 VAC (5 amps resistive). The contact operates prior to a selectable 0, 3, 10, or 20 second delay before transfer of the Automatic Transfer Switch. The contact resets either immediately following transfer or after the same delay as set for pre–signal before transfer.

Time delay between the load disconnect control signal and initiation of transfer is set on the controller with DIP switch S2 (actuators 6, 7, 8) as shown below:

Delay Before Transfer

LD TDBT	S2 DIP SWITCH	
0 (disable)	Actuator 7 on Actuator 8 on	
3 seconds	Actuator 7 on Actuator 8 off	
10 seconds	Actuator 7 off Actuator 8 on	
20 seconds	Actuator 7 off Actuator 8 off	

☐ Shaded DIP switches are standard factory settings.

Delay After Transfer*

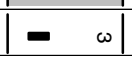
LD TDAT	S2 DIP SWITCH	
enable	Actuator 6 on	
disable	Actuator 6 off	

*Enabling the Delay After Transfer will cause the control signal to reset after the same delay as set for the Delay Before Transfer.

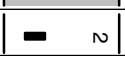
REMOTE CONTROL FEATURES

These remote control features require a customer–supplied normally closed contact suitable for a 5 V dc low energy circuit. Refer to the Wiring Diagram provided with the ATS. Activate appropriate DIP switch S2 actuators below.

Remote Test (terminals CP6–7)

RTSW	S2 DIP SWITCH	
disable	Actuator 3 on	
enable	Actuator 3 off	

Remote Transfer to Emergency (CP8–9)

RT /E	S2 DIP SWITCH	
disable	Actuator 2 on	
enable	Actuator 2 off	

Bypass Transfer Time Delay (CP12–13)

TD E/N BYP.	S2 DIP SWITCH	
disable	Actuator 1 on	
enable	Actuator 1 off	

Inhibit Transfer to Emergency (CP10–11)

N/E INHIB.	S2 DIP SWITCH	
disable	Actuator 4 on	
enable	Actuator 4 off	

OPTIONAL STRIP HEATER (Accessory 44)

Accessory 44 Strip Heater is designed to keep ambient temperatures within the Automatic Transfer Switch enclosure at acceptable levels. This accessory consists of a mounting bracket with strip heater, thermostat, and terminal block. A transformer with fuses is included when the power for the assembly is derived from voltages above 120 V ac. The 120 V ac customer powered assembly does not include a transformer. This optional accessory is available factory installed or in kit form.

Turn the thermostat's dial to required setting as shown.

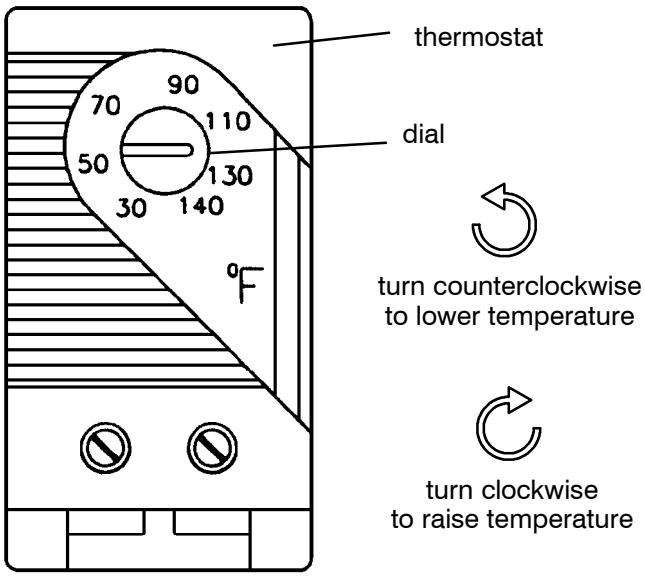


Figure 5–4. Thermostat.

AVAILABLE KITS FROM ASCO

Controls

Description	Accessory	Kit
Programmable Engine Exerciser & Source Availability Contacts	11BG	K629830
Serial Communication Module	72A	K601110

Strip Heater – Accessory 44

Description	Accessory	Kit
120 volt customer supplied voltage (without transformer)	44A	K613127–001
208 – 480 volt ATS derived voltage (with transformer)	44G	K613127–002
380 volt ATS derived voltage (with transformer)	44G	K613127
550 – 600 volt ATS derived voltage (with transformer)	44G	K613127–003

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Printed in U.S.A.

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Series A300 Engine Start Contacts

Each ASCO Series A300 Transfer Switch is equipped with a normally closed contact and normally open contact to start the engine.

The engine start contacts are located on the contactor portion of the Transfer Switch NEVER on the control panel.

30-800 Amp ATS's

- Terminals TB 14 & TB 15 closes a contact to start the engine.
- Terminals TB 14 & TB 16 opens a contact to start the engine.

Further information regarding engine start contacts for 30-800 amp ATS's can be found on page 1-2 of the 30-800 amp operator's manual.

1000-2000 Amp ATS's

- Terminals 1&3 on the TB close a contact to start the engine
.
- Terminals 1&2 on the TB open a contact to start the engine.

Further information regarding engine start contacts for 1000-2000 amp ATS's can be found on page 1-3 of the 1000-2000 amp operator's manual.

2600-3000 Amp ATS's

- Terminals TB 14 & TB 15 closes a contact to start the engine.
- Terminals TB 14 & TB 16 opens a contact to start the engine.

Further information regarding engine start contacts for 2600-3000 amp ATS's can be found on page 1-2 of the 2600-3000 amp operator's manual.

Series A300 Auxiliary Contacts

All Series A300 Transfer Switches come standard with a dry contact closed when the ATS is in its Normal position and a dry contact closed when the ATS is in its Emergency position.

These contacts are for customer use, and are rated for 10 amps either 480 vac or 32 vdc.

The auxiliary contacts are always located on the contactor position of the ATS (never on the ATS control panel).

30-800 Amp ATS's

- Terminals 12 & 13 close a contact when the ATS is in Normal position.
- Terminals 10 & 11 close a contact when the ATS is in Emergency position.

1000-2000 Amp ATS's

- Terminals 4 & 6 on TB close a contact when the ATS is in Normal position.
- Terminals 4 & 5 on TB close a contact when the ATS is in Emergency position.

2600-3000 Amp ATS's

- Terminals 12 & 13 on TB close a contact when the ATS is in Normal position.
- Terminals 10 & 11 on TB close a contact when the ATS is in Emergency position.

Series A300 Time Delays

All Series A300 Transfer Switches have five (5) standard time delays. Some of the delays are adjustable and some are not. The adjustments for the time delays that are settable are all found on the ATS control panel.

The time delays are:

- Override Momentary Normal Side Outages
- Transfer to Emergency
- Override Momentary Emergency Side Outages
- Retransfer to Normal
- Engine Cool Down

Override Momentary Normal Side Outages:

- This time delay can be set for either 1 or 3 seconds. Actuator # 1 on the dipswitch bank S3 controls the setting.

Transfer to Emergency:

- The adjustment range for this time delay is 0-5 minutes. Potentiometer P2 controls the setting.

Override Momentary Emergency Side Outages:

- This time delay is set for 4 seconds and it is not adjustable.

Retransfer to Normal:

- The adjustment range for this time is 1 second – 30 minutes. Potentiometer P1 controls the setting.

Engine Cool Down:

- This time delay is set for 5 minutes and is not adjustable.
- For further information regarding these time delays, see the following pages of the operator's manual.
  30-800 Amp ATS's, pages 4-1 & 4-2 of the 30-800 Amp O&M Manual.
  1000-2000 Amp ATS's, pages 4-1 & 4-2 of the 1000-2000 O&M Manual.
  2600-3000 Amp ATS's, pages 4-1 & 4-2 of the 2600-3000 O&M Manual.

Series A300 Voltage & Frequency Sensing

All Series A300 Transfer Switches sense the Nominal Voltage of Normal power, and the Nominal Voltage and Frequency of the Generator.

Normal Source Voltage:

- Pick Up: The Normal source pick up can be for either 90% or 95%. Actuator 3 on dip switch bank S1 controls the setting.
- Drop Out: The Normal source drop out voltage can be set for 70%, 80%, 85%, or 90%. Actuators 1 & 2 on dip switch bank S1 control the settings.
- Note: The drop out setting must be set lower than the pick up setting.

Emergency Source Voltage:

- Pick Up: This setting is non-adjustable (factory set at 90%)
- Drop Out: This setting is non-adjustable (factory set at 75%)

Emergency Source Frequency:

- Pick Up: This setting is non-adjustable (factory set at 95%)
- Drop Out: This setting is non-adjustable (factory set at 85%)

For further information regarding voltage and frequency sensing see page 4-1 of the operator's manual.

Series A300 Load Disconnect
(Elevator Pre-Signal)

Each Series A300 Transfer Switch comes standard with a Load Disconnect feature. The Load Disconnect Circuit is normally used for Elevator Interface.

Definition: One set of form "C" contacts (1 N/O & 1 N/C) that change position before the ATS transfers (adjustable time delay) and resets either immediately following a transfer or stays held after a transfer for the same amount of time that the pre-signal was set for.

The adjustment for the time delay is found on the ATS control panel. Actuators 7&8 on the dip switch bank S2 control the length of the pre-signal delay (see page 5-3 of the operator's manual)

If a post time delay is needed, then actuator 6 on dip switch bank S2 (when enabled) will cause the contacts to hold their position after the ATS transfers. The contacts will hold their position for the same amount of time that the pre-signal was set for.

30-3000 Amp ATS's

- Terminals 1&2 on TB1 closes a contact before transfer
- Terminals 1&3 on TB1 opens a contact before transfer

*TB1 is located on the bottom of the ATS control panel.

For further information regarding the load disconnect feature, see page 5-3 of the operator's manual.

Series A300 Inphase Monitor

All Series A300 Transfer Switches are equipped with an Inphase Monitor.

Definition: An Inphase Monitor is a device that monitors the phase angle between the ATS's Normal source voltage and its Emergency source voltage. An Inphase Monitor will only allow the ATS to transfer when the two sources approach synchronism. The Inphase Monitor passively controls the actuation of the ATS and does not actively control the governor.

The Inphase Monitor controls the actuation of the ATS only when the ATS is transferring from one energized source to another.

The Series A300 Inphase Monitor ships from the factory de-activated. Actuator 5 on dip switch bank S1 enables the Inphase Monitor.

In order for the Inphase Monitor to work properly, the voltage and frequency of the generator must be within certain tolerance in relationship to the voltage and frequency of the Normal source.

Voltage: The voltage of the generator must be within 2% of the voltage of the Normal source (plus or minus)

Frequency: The frequency of the generator must be within 2 hertz of the frequency of the Normal source (plus or minus)

If either the voltage or frequency of the generator is out of tolerance, the Inphase Monitor will not allow the ATS to transfer.

Series A300 Provisions

All Series A300 Transfer Switched are equipped with provisions for:

- Remote test switch or contact
- Remote transfer to Emergency switch or contact
- Remote bypass to Normal time delay
- Remote inhibit transfer to Emergency switch or contact.

Remote Test Switch:

- Actuator 3 on dip switch bank S2 activates the provision.
- A normally closed, momentary contact should be wired across terminals 6&7 on TB1 (bottom of ATS control panel). The momentary contacts should be opened for 15 seconds (or until the ATS transfers) to test the ATS.

Remote Transfer to Emergency Switch:

- Actuator 2 on dip switch bank S2 activates the provision.
- A normally closed, maintained contact should be wired across terminals 8&9 on TB1 (bottom of ATS control panel). The maintained contact should be opened to transfer the ATS to the generator. The ATS will remain on generator power until the contact is re-closed.
- If the generator should fail and if normal power is acceptable, the ATS will ignore the opened contact and re-transfer to normal power.

Remote Bypass to Normal Time Delay:

- Actuator 1 on dip switch bank S2 activates to provision
- A normally closed, momentary contact should be wired across terminals 12&13 on TB1 (bottom of the ATS control panel). The momentary contacts should be opened to bypass the re-transfer to normal time delay.

Inhibit Transfer to Emergency:

- Actuator 4 on dip switch bank S2 activates the provision.

- A normally closed, maintained contact should be wires across terminals 10&11 on TB1 (bottom of ATS control panel). The maintained contact should be opened to prevent the ATS from transferring to the generator. The ATS will remain on its Normal side whenever the customer supplied contact is open (even if normal power fails).

- This provision strictly inhibits the ATS from transferring to Emergency. It will not force the ATS back to its Normal if the ATS is already supplying power from the generator.

Series A300 Spare Parts

					Two Pole Switches							
					Voltage							
Amperes	115-120		190-208		220-240		380-416		460-480		575-600	
	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor
30-104	343500-041	N/A	343500-042	N/A	343500-063	N/A	343500-064	N/A	343500-065	N/A	343500-086	N/A
150-200	343510-001	N/A	343510-002	N/A	343510-003	N/A	343510-004	N/A	343510-005	N/A	343510-006	N/A
225-400	343501-001	N/A	343501-002	N/A	343501-003	N/A	343501-004	N/A	343501-005	N/A	343501-006	N/A
600-800	473879	In Kit	473880	In Kit	473881	In Kit	473883-064	In Kit	473882	In Kit	473883	In Kit
E1000-E1200	343530-061	017349-022	343530-062	017349-028	343530-063	017349-040	343530-064	017349-011	343530-065	017349-015	343530-066	017349-034
				Control Module		Control Module		Control Module		Control Module		Control Module
G1000-G2000			611478-001	605113-B	611478-002	605113-C	611478-003	605113-D	611478-004	605113-E	611478-005	605113-F
				Three Pole Switches & Two Pole Switches with Overlapping Neutral								
					Voltage							
Amperes	115-120		190-208		220-240		380-416		460-480		575-600	
	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor
30-104			343500-062	N/A	343500-063	N/A	343500-064	N/A	343500-025	N/A	343500-066	N/A
150-200			343510-022	N/A	343510-023	N/A	343510-024	N/A	343510-025	N/A	343510-026	N/A
225-400			343501-022	N/A	343501-023	N/A	343501-024	N/A	343501-025	N/A	343501-026	N/A
600-800			473880	In Kit	473881	In Kit	473883-001	In Kit	473882	In Kit	473883	In Kit
E1000-E1200			343530-062	017349-028	343530-063	017349-040	343530-064	017349-011	343530-065	017349-015	343530-066	017349-034
				Control Module		Control Module		Control Module		Control Module		Control Module
G1000-G2000			611478-001	605113-B	611478-002	605113-C	611478-003	605113-D	611478-004	605113-E	611478-005	605113-F
				Resistor		Resistor		Resistor		Resistor		Resistor
2600-3000			343550-015	017349-022	343550-015	017349-022	343550-016	017349-027	343550-003	017349-041	343550-005	017349-041
4000			343551-005	017349-044	343551-001	017349-029	343551-006	017349-031	343551-003	017349-040		
				Four Pole Switches & Three Pole Switches with Overlapping Neutral								
					Voltage							
Amperes	115-120		190-208		220-240		380-416		460-480		575-600	
	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor	Coil Kit	Resistor
30-104			343500-062	N/A	343500-063	N/A	343500-064	N/A	343500-025	N/A	343500-066	N/A
150-200			343510-022	N/A	343510-023	N/A	343510-024	N/A	343510-025	N/A	343510-026	N/A
225-400			343501-032	N/A	343501-033	N/A	343501-034	N/A	343501-035	N/A	343501-036	N/A
600-800			473880	In Kit	473881	In Kit	473883-001	In Kit	473882	In Kit	473883	In Kit
E1000-E1200			343530-072	017349-026	343530-073	017349-026	343530-074	017349-020	343530-075	017349-015	343530-076	017349-015
				Control Module		Control Module		Control Module		Control Module		Control Module
G1000-G2000			611478-001	605113-B	611478-002	605113-C	611478-003	605113-D	611478-004	605113-E	611478-005	605113-F
				Resistor		Resistor		Resistor		Resistor		Resistor
2600-3000			343550-015	017349-022	343550-015	017349-022	343550-016	017349-027	343550-003	017349-041	343550-005	017349-041
4000			343551-005	017349-044	343551-001	017349-029	343551-006	017349-031	343551-003	017349-040		

Series A300 Spare Parts

Additional Replacement Parts (All Switches)

Door MTD Replacement Parts

Membrane Assy (incl. Ribbon Cable)	473708	473708
Ribbon Cable	473709	473709
Gasket for Membrane Assy	487409	487409

Acc. 72A Serial Communication

To add to Switch

Acc. Module	601110

Replacement Parts

Circuit Board	489607
Cable Assembly	489672

Acc 11CD External Exerciser

Complete Acc Module	601111
Replacement Time Clock	489110-001

Transfer Switch Coil Control Contacts

Amperes	Part Number	Part Number
30-200	353581	353581
225-400	335606	335606
600-800	479954	479954
E1000-E1200	353584	353584
G1000-G2000	611479	611479
2600-4000	259590	259590

Transfer Switch Control Panel

Voltage	Part Number
115-120	473670-001
199-208	473670-002
220	473670-008
230-240	473670-003
380	473670-004
399-416	473670-005
460-480	473670-006
575-600	473670-007

Rectifier/Snubber

411785

Lubrication Kit for Coil Core Tube

75100

Additional Replacement Parts (G1000-G2000 Switches)

Operating Solenoid Assembly

When a coil needs to be changed
if the spring and/or core is damages, the
entire solenoid assembly must be replaced

Voltage	Amperes	Amperes	Part Number
190/208	All	All	493932-001
220/240	All	All	493932-002
380/400/415	All	All	493932-003
440/480	All	All	493932-004
550/600	All	All	493932-005

Control Module Component-Relay SER, ERR

Voltage	Amperes	Part Number
190/208	All	603988-001-D
220/240	All	603988-001-E
380/400/415	All	603988-001-G
440/480	All	603988-001-J
550/600	All	603988-001-K

ASCO A300 DIP SWITCH SETTINGS

SWITCH 1		DESCRIPTION	FACTORY SETTINGS
Act. 1	ON	NSV Dropout	
Act. 1	OFF	NSV Dropout	Left is on
Act. 2	ON	NSV Dropout	
Act. 2	OFF	NSV Dropout	Right is off
Act. 3	ON	NSV Dropout 90%	
Act. 3	OFF	NSV Dropout 95%	ON
Act. 4	ON	ES Freq. 50Hz	
Act. 4	OFF	ES Freq. 60Hz	OFF
Act. 5	ON	Motor Load Transfer ON	
Act.5	OFF	Motor Load Transfer OFF	OFF
Act. 6	ON	Single Phase	
Act. 6	OFF	Three Phase	OFF
Act. 7	ON	Opt. Timer Disabled/STD Timer Enabled*	
Act. 7	OFF	Opt. Timer Enabled/STD Timer Disabled*	OFF
Act. 8	ON	Exercise with Load	
Act. 8	OFF	Exercise without Load	OFF

SWITCH 2		DESCRIPTION	FACTORY SETTINGS
Act. 1	ON	Bypass Transfer Time Delay Disable	
Act. 1	OFF	Bypass Transfer Time Delay Enable	ON
Act. 2	ON	Remote Transfer to E (Peak Shave) Disable	
Act. 2	OFF	Remote Transfer to E (Peak Shave) Enable	ON
Act. 3	ON	Remote Test Disable	
Act. 3	OFF	Remote Test Enable	ON
Act. 4	ON	Inhibit Transfer to Emergency Disable	
Act. 4	OFF	Inhibit Transfer to Emergency Enable	ON
Act. 5	ON	Opt Timer Disabled/STD Timer Enabled*	
Act. 5	OFF	Opt Timer Enabled/STD Timer Disabled*	ON
Act. 6	ON	Delay After Transfer Enable	
Act. 6	OFF	Delay After Transfer Disable	OFF
Act. 7	ON	Delay Before Transfer	
Act. 7	OFF	Delay Before Transfer	ON
Act. 8	ON	Delay Before Transfer	
Act. 8	OFF	Delay Before Transfer	ON

SWITCH 3		DESCRIPTION	FACTORY SETTINGS
Act. 1	ON	Time Delay to Engine Start 1 second	
Act. 1	OFF	Time Delay to Engine Start 3 seconds	OFF
Act. 2	ON	Transformer Voltage Adj. HI	
Act. 2	OFF	Transformer Voltage Adj. LOW	ON
Act. 3		NOT USED	
Act. 4		Used with Acc. 72A Communication Module Only	
Act. 5		Used with Acc. 72A Communication Module Only	
Act. 6		Used with Acc. 72A Communication Module Only	
Act. 7		Used with Acc. 72A Communication Module Only	
Act. 8		Used with Acc. 72A Communication Module Only	

***Both Actuators Must Be Set For Correct Operation**

Katolight Automatic Solid State Engine Control (KASSEC)

HIGHLIGHTS

- Compatible with virtually all engines in today's marketplace
- Reliable Katolight solid-state design
- External alarm circuit for remote failure indication. Source 2 Amp Resistive
- Ease of installation, simple mounting bracket

DESCRIPTION

Katolight Automatic Solid State Engine Control (KASSEC) will automatically start and stop diesel, gasoline, natural gas and LPG engines or engine-generator sets under the control of an automatic transfer switch of load start contact closed to run. KASSEC is manufactured and tested to the highest quality control standards to ensure reliability.

SPECIFICATIONS

- Consistent operation from -30° C (-22° F) to +60° C (+140° F)
- Reliable Katolight solid-state design
- Accommodates requirements for NFPA-110 annunciator for hospital application
- Compatibility with virtually all engines in today's marketplace
- Barrier screw type terminals U.L. and C.S.A. listed, with approved means for solderless connection of conductors
- Adjustable seven (7) to fifty (50) second engine cranking circuit
- Adjustable one (1) or five (5) crank / rest cycles
- Adjustable seven (7) to fifty (50) second oil failure circuit
- External alarm circuit for remote failure indication. Source 2 Amp Resistive
- Available for 12 or 24 volt negative ground battery systems
- Four (4) crank disconnects are available. (Mag pickup, engine alternator, 110 VAC, and auxiliary 12V DC or 24V DC). The mag pickup and engine alternator crank disconnects are adjustable.
- Positive lockout circuits prohibit recranking while engine is running
- First failure shutdown lockout
- 8 amp relay contacts for start and ignition system
- Unit is sealed with a durable conformal coating

Katolight Automatic Solid State Engine Control (KASSEC)

INSTALLATION GUIDE

KASSEC will be in the “standby monitoring” mode whenever terminals #1 and #4 have battery voltage on them. In the “standby monitoring” mode, KASSEC will draw approximately 15 mA of current on the 12 volt model and approximately 17 mA of current on the 24 volt mode.

In the “standby monitoring” mode: when battery voltage is placed on Terminal #8 by the closing of a remote switch, relay or a transfer switch, the logic signal in KASSEC will operate the relays in KASSEC initiating cranking. Terminals #2 and #3 will have battery voltage on during the “cranking” period. During the “cranking rest” period, Terminals #2 and #3 will have zero voltage on them.

If the engine starts, one or more of the crank disconnect terminals #5, 6, 7 or 12 must have a signal placed on them. The KASSEC “start” relay will then open and Terminal #3 will go to zero volts. KASSEC is now in the “run” mode.

KASSEC has cyclic cranking which is adjustable. If the engine does not start in the first period of the cranking cycle, cranking will rest for the second period of the cranking cycle. These periods are equal. KASSEC will repeat cycle-cranking for an adjustable amount of cranks (1-5). If the engine has not started, KASSEC will go into an “overcrank failure” mode and both the Common Alarm Terminal #23 and the Overcrank Failure Terminal #13 will activate and battery voltage will be supplied from these terminals to be used for a failure light. Terminals #2 and #3 will go to zero volts. KASSEC is now locked in an “overcrank failure” mode resettable by turning the power to Terminal #4 off and on again.

When the engine starts, the Oil Failure circuit of KASSEC starts timing. If the Oil Failure Sender Terminal #24 does not activate (open from the ground) before the end of the timing period, KASSEC will go into the “low oil pressure failure” mode and shut the engine down. Terminals #2 and #3 will go to zero volts. The Common Alarm Terminal #23 and the Oil Failure Terminal #14 will activate and battery voltage will be supplied by these terminals to be used for a failure light. KASSEC is now locked in a “low oil pressure failure” mode resettable by turning the power to Terminal #4 off and on again. If Terminal #24 is grounded while KASSEC is in the “run” mode, KASSEC will go into the “low oil pressure failure” mode and shut the engine down. Terminals #2 and #3 will go to zero volts. The Common Alarm Terminal #23 and the Oil Failure Terminal #14 will activate and battery voltage will be supplied by these terminals to be used for a failure light. KASSEC is now locked in a “low oil pressure failure” mode resettable by turning the power to Terminal #4 off and on again.

If any of the Failure Sender Terminals (#18, 19, 21, or 22) go to ground while KASSEC is in a “cranking” or “run” mode, KASSEC will go into a “failure” mode and shut the engine down. Terminals #2 and #3 will go to zero volts. The Failure Lamp Terminal (#16, 20, 17, or 15) respectively coinciding with the Failure Sender will activate and battery voltage will be supplied by this terminal to be used for a failure light. The Common Alarm Terminal (#23) will activate and supply battery voltage. KASSEC is now locked in a “failure” mode resettable by turning the power to Terminal #4 off and on again.

NOTE: “battery voltage” or “supply voltage” will refer to the battery’s positive voltage. “Ground” will refer to the negative side of the battery.

Terminal #1 supplies battery voltage to the high current requirement sections of the circuit. Battery voltage is supplied by KASSEC to the six Failure Lamps (Terminals #13, 14, 15, 16, 17 and 20), the Common Alarm Terminal #23, the Start Terminal #3 and the “energized to run” terminal #2.

Terminal #2 is the “energized to run” terminal. Up to 8 amps is available from this terminal to supply an external engine “run” component such as an ignition coil or fuel solenoid.

Terminal #3 is the Starter Solenoid Terminal. Up to 8 amps is available from this terminal to supply a starter solenoid on the engine.

Terminal #4 supplies battery voltage to all the logic circuitry. Anytime Terminal #4 is brought from the ground to battery voltage, KASSEC will be reset. Note: Terminal #4 is the main reset terminal for KASSEC.

Terminal #5 is the Mag Pickup Crank Disconnect input. This is one of four crank disconnects on KASSEC. When KASSEC is in the “cranking” mode and the input frequency of the mag pickup equals a value set by the adjustable resistor on KASSEC, KASSEC will crank disconnect and go into the “run” mode. If the signal from the mag pickup is lost while KASSEC is in the “run” mode and this is the only crank disconnect being used, KASSEC will go into the “overcrank failure” mode and shut the engine down.

NOTE: Whenever Terminal #5 is not in use, it must be tied to Terminal #9, Ground, to prevent accidental triggering of the crank disconnect circuitry.

Terminal #6 is the Engine Alternator Crank Disconnect Terminal. This is one of four crank disconnects on KASSEC. When an A.C. signal from the stator terminal of the engine alternator is fed to this terminal and KASSEC is in the “cranking” mode, KASSEC will crank disconnect and go into the “run” mode. With KASSEC in the “run” mode, the unit will not shut down or go into overcrank with loss of the alternator Crank Disconnect.

Terminal #7 is the Auxiliary Crank Disconnect Terminal. This is one of four crank disconnects on KASSEC. When a positive voltage is placed on this terminal and KASSEC is in the “cranking” mode, KASSEC will go into a “run” mode and this is the only crank disconnect being used. Loss of the positive voltage on Terminal #7 will place KASSEC into an “overcrank failure” mode and shut the engine down.

Terminal #8 is the Transfer Switch Terminal. This terminal is the main controlling terminal. Anytime this terminal is at battery positive, the unit will be in active modes of trying to start, run, failure. If Terminals #1 and #4 have battery voltage on them and Terminal #8 has no battery voltage present, KASSEC is in a “standby” position. Whenever this terminal is brought to battery voltage, KASSEC will be in an “operate” mode. The only exception to this is when a shutdown failure has occurred. KASSEC can only be reset from a failure mode by bringing Terminal #4 from Ground to battery voltage.

Terminal #9 is the Ground Terminal for KASSEC. All the grounded points should be common to this terminal.

Terminal #10 is not connected.

Terminal #11 is not connected.

NOTE: Terminals #10 and #11 are left open for isolation between Ground and the 120 volts A.C. These terminals may be used as tie points if needed.

Terminal #12 is the 120 volt A.C. Crank Disconnect. This is one of four crank disconnects on KASSEC. When KASSEC is in the “cranking mode” and a 120 volt A.C. 60 Hz. Signal is fed to this terminal, KASSEC will crank disconnect and go into a “run” mode. With KASSEC in the “run” mode, the unit will not shut down or go into “overcrank” mode with loss of the 120 Volt Crank Disconnect.

Terminal #13 is the Overcrank Failure Indicator Terminal. When an overcrank failure occurs, the unit has cranked for a preset number of times and failed to start or the loss of the overcrank signal (mag pickup or auxiliary crank disconnect) has occurred. The maximum “on state” load current that Terminal #13 can supply is two (2) amps resistive.

Terminal #14 is the Oil Failure Indicator Terminal. If Terminal #24 is brought to ground after the oil timer on KASSEC times out, Terminal #14 will supply battery voltage indicating an oil failure. The maximum “on state” load current that Terminal #14 can supply is two (2) amps resistive.

Terminal #15 is a failure indicator output terminal. If Terminal #22 is brought to ground, Terminal #15 will supply battery voltage for a failure lamp. The maximum “on state” load current that Terminal #15 can supply is two (2) amps resistive.

Terminal #16 is a failure indicator output terminal. If Terminal #18 is brought to ground, Terminal #16 will supply battery voltage for a failure lamp. The maximum “on state” load current that Terminal #16 can supply is two (2) amps resistive.

Terminal #17 is a failure indicator output terminal. If Terminal #21 is brought to ground, Terminal #17 will supply battery voltage for a failure lamp. The maximum “on state” load current that Terminal #17 can supply is two (2) amps resistive.

Terminal #18 is a failure sender input terminal. If this terminal is brought to ground, Terminal #16 will indicate a failure and the engine will shut down.

Terminal #19 is a failure sender input terminal. If this terminal is brought to ground, Terminal #20 will indicate a failure and the engine will shut down supplying battery voltage. This terminal will also supply battery voltage if the number of recranks has been satisfied or if a crank disconnect (mag pickup or auxiliary crank disconnect) has been lost. The maximum “on state” load current that Terminal #23 can supply is two (2) amps resistive.

Terminal #20 is a failure indicator output terminal. If Terminal #19 is brought to ground, Terminal #20 will supply battery voltage for a failure lamp. The maximum “on state” load current that Terminal #20 can supply is two (2) amps resistive.

Terminal #21 is the failure sender input terminal. If this terminal is brought to ground, Terminal #17 will indicate a failure and the engine will shut down.

Terminal #22 is a failure sender input terminal. If this terminal is brought to ground, Terminal #15 will indicate a failure and the engine will shut down.

Terminal #23 is the Common Alarm Terminal. When any of the failutres (Terminal #13, 14, 15, 16, 17, or 20) are supplying battery voltage, Terminal #23 will be supplying battery voltage. This terminal will also supply battery voltage if the number of recranks has been satisfied or is a crank disconnect (mag pickup or auxiliary crank disconnect) has been lost. The maximum “on state” load current that Terminal #23 can supply is two (2) amps resistive.

NOTE: When an inductive load is connected on Terminal #23, a clamping diode must be connected across the inductive load.

Terminal #24 is the Oil Failure Sender Terminal. If this terminal is brought to ground after a preset time delay, set by an adjustable resistor, Terminal #14 will supply battery voltage for a failure lamp and the engine will shut down.

Terminal #5 Mag Pickup	Terminal #6 Engine Alternator	Terminal #7 Auxiliary	Terminal #12 120 Volt	Will Shut Down?
		X		YES
X				YES
X		X		YES
			X	NO
		X	X	NO
X			X	NO
X		X	X	NO
	X			NO
	X	X		NO
X	X			NO
X	X	X		NO
	X		X	NO
	X	X	X	NO
X	X		X	NO
X	X	X	X	NO

(1) Note: Both must be disconnected before unit will shut down.

For a full understanding of the crank disconnects on KASSEC, refer to the crank disconnect chart. Any combination of crank disconnects may be used. As can be seen from the chart, if the signal on Terminal #5, the Mag Pickup Crank Disconnect, is lost while KASSEC is in the "run" mode and this is the only crank disconnect being used, KASSEC will go into an "overcrank failure" mode and shut the engine down. The same is true for Terminal #7, the Auxiliary Crank Disconnect. When used by itself, if this signal is lost while KASSEC is in the "run" mode, KASSEC will go into an "overcrank failure" mode and shut the engine down.

When the combination of Terminals #5 and #7 are used together and KASSEC is in the "run" mode, both crank disconnect signals must be lost, then KASSEC will go into an "overcrank failure" mode and shut the engine down. When using any other crank disconnect or combination of other crank disconnects, loss of one or all of the crank disconnects will not shut the engine down.

INSTALLATION RECOMMENDATIONS

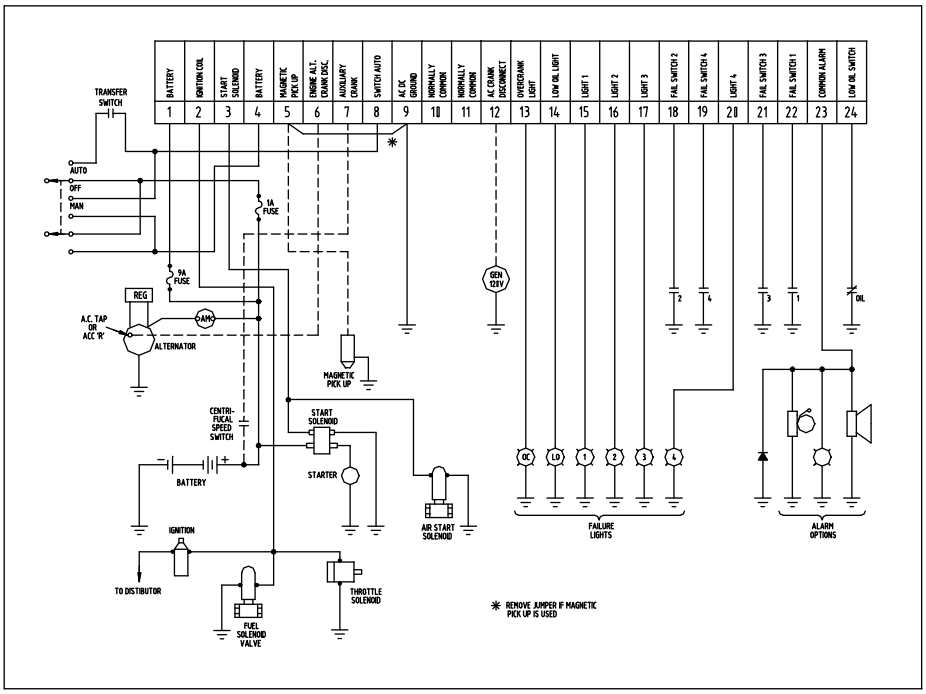
When solid state electronics are used as engine controls, the major problems causing the majority of malfunctions are excessive load currents connected to the outputs, low battery voltages (mainly at cranking) and EMI electrical noise. The following information will help alleviate these problems and insure a proper running system.

1. An auxiliary relay driven by KASSEC should be used whenever the current of an output exceeds the following parameters: total current of starter and ignition outputs, 8 amps; any single failure output 2 amps resistive.
2. If the cranking system for a particular engine demands a very high cranking current, another battery which supplies power only to KASSEC may be required.
3. When fused properly, the maximum load current that KASSEC can supply is 8 amps and the maximum input operating current for KASSEC is 1 amp. The size of wire used to supply power to KASSEC under maximum load should never be less than #16. Proper sizing of wire will eliminate excessive voltage drops when the system requires maximum power.
4. Although KASSEC has been designed to reject induced noise, certain precautions should be taken to reduce the common noise which is present on all engine and generator sets. To prevent false signals from being induced into the magnetic pickup circuitry of KASSEC, the wires to KASSEC from the magnetic pickup should be a twisted of shielded pair.
5. Whenever an inductive load is de-energized, a back EMF which can damage solid state components is generated. To alleviate this effect, a clamping diode should be connected across all inductive loads.
6. Components such as the ignition system, high and low voltage wiring, starter, A.C. generator wiring and battery charger to alternator all generate a certain amount of noise. If possible, wiring connected to KASSEC should be routed away from these components.

7. A voltmeter, test light or other appropriate test instrument should be used to check the input and output terminal of KASSEC. Shorting any of KASSEC's terminals to battery positive or negative when testing could create major problems if the wrong terminals were to be shorted. This type of testing can result in blown fuses and damage to KASSEC's solid state components.

NOTE: Due to the fact that KASSEC utilizes electrical control to start and stop the engine, any hydraulic or pneumatic devices such as starters or fuel solenoids must have an electrical to mechanical interface to activate them.

DIAGRAM



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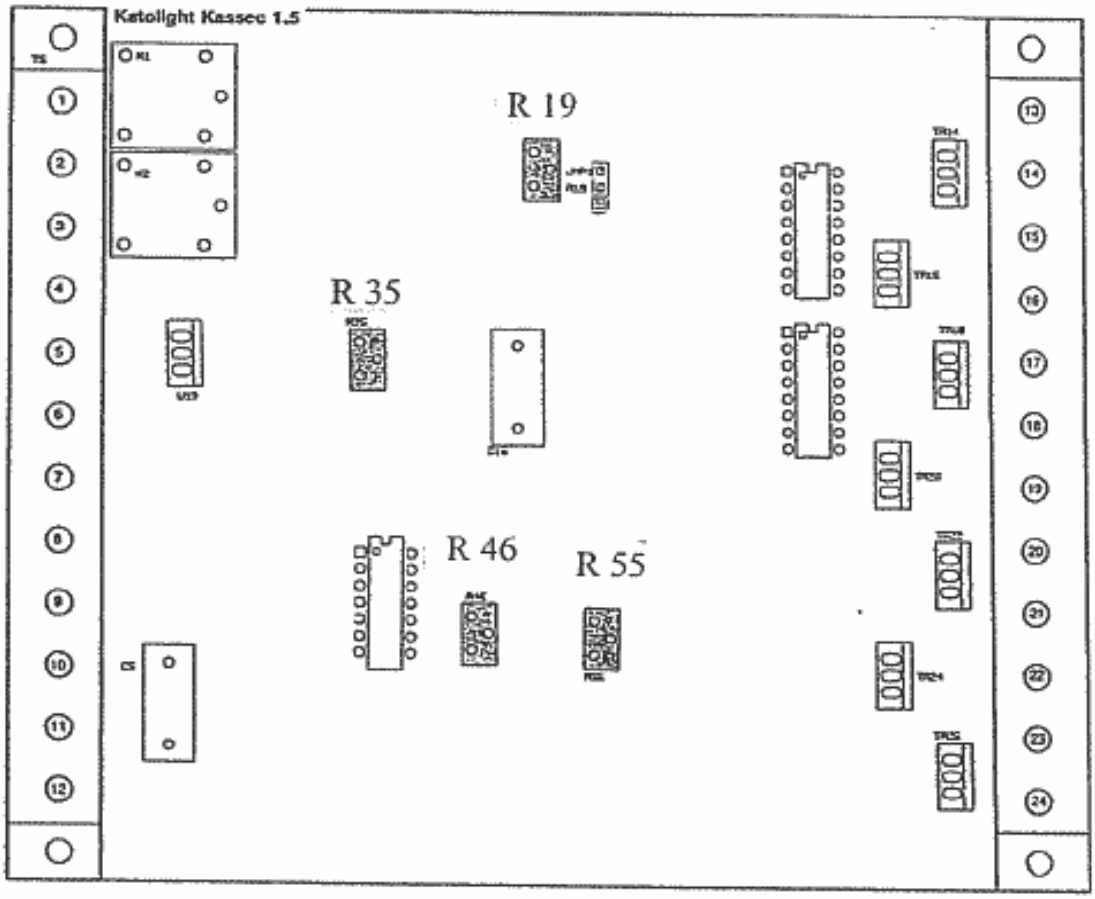
Service Bulletin KASSEC 1.5

KATOLIGHT CORPORATION

HIGHLIGHTS

- By taking advantage of new manufacturing process, Katolight is able to offer improvements in the Katolight Automatic Solid State Engine Control.
- Nicknamed Kassec 1.5, the engine control is physically and electrically interchangeable with its predecessor.
- The Kassec 1.5 offers the ability to utilize different crank disconnect simultaneously.
- Although factory adjusted and tested, the Kassec 1.5 potentiometers are shown in the diagram below.



- R46 Mag Pickup Crank Disconnect: Clockwise increases disconnect frequency.
- R35 Engine Alternator Clockwise increases disconnect frequency.
- R55 Oil Failure Time Set Counter clockwise increases time before failure.
- R19 Crank Time Set Counter clockwise increases length of crank time.
- JMP1 1 TO 2 Yields one shot 2 TO 3 Yields 5 cycle

NOTE! ANY UNIT THAT IS STILL UNDER WARRANTY:
FACTORY AUTHORIZATION MUST BE OBTAINED FOR EACH INDIVIDUAL UNIT BY SERIAL NUMBER BEFORE ANY ADJUSTMENTS ARE MADE.

No. 126 January 1991

For support or information, call us at 800-325-5450 or visit us at www.katolight.com

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Speed Monitor

Model SM124

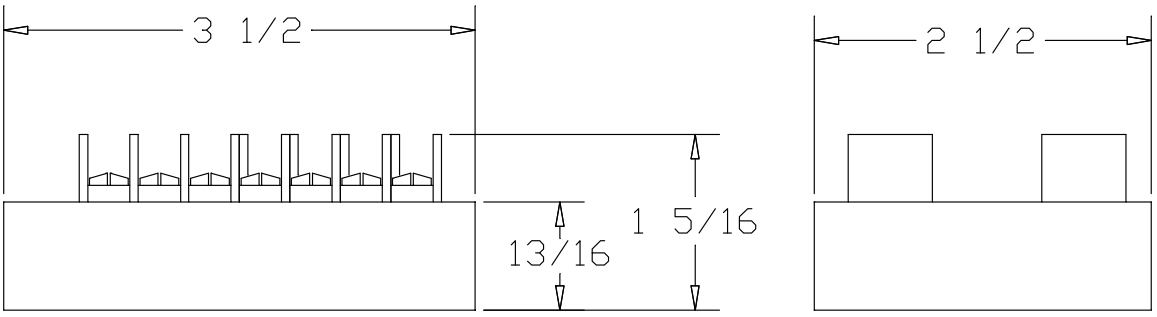
HIGHLIGHTS

- Protects generator sets against overspeed
- Construction - epoxy encapsulated
- Sensing - 120 VAC

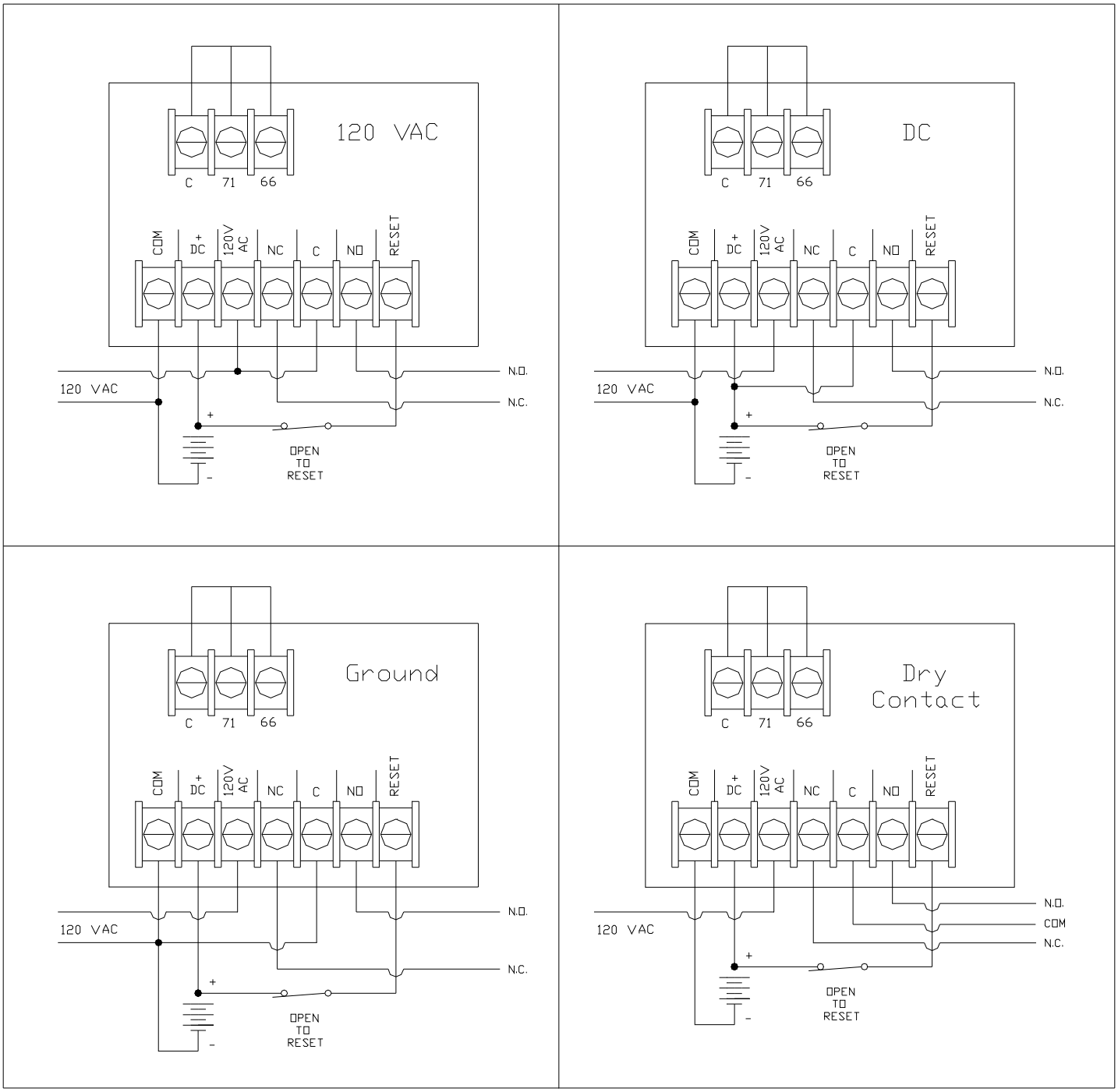
SPECIFICATIONS

- Construction - epoxy encapsulated
- Sensing - 120 VAC
- Operating trip point - 66.5 or 71 Hz (selectable)
- Switch contact rating - .6 amp, 120 VAC resistive (2 amp, 40 VDC)
- Operating temperature - -40 to +70° C (-40 to -158° F)
- Current draw - .07 amp maximum
- Voltage - 12 or 24 VDC #79029
- Accuracy - ± .5 Hz
- Mounting - 2 holes

DIMENSIONS



ALTERNATIVE APPLICATIONS



Note: Install jumper between common © and 66 or 71 select trip frequency.

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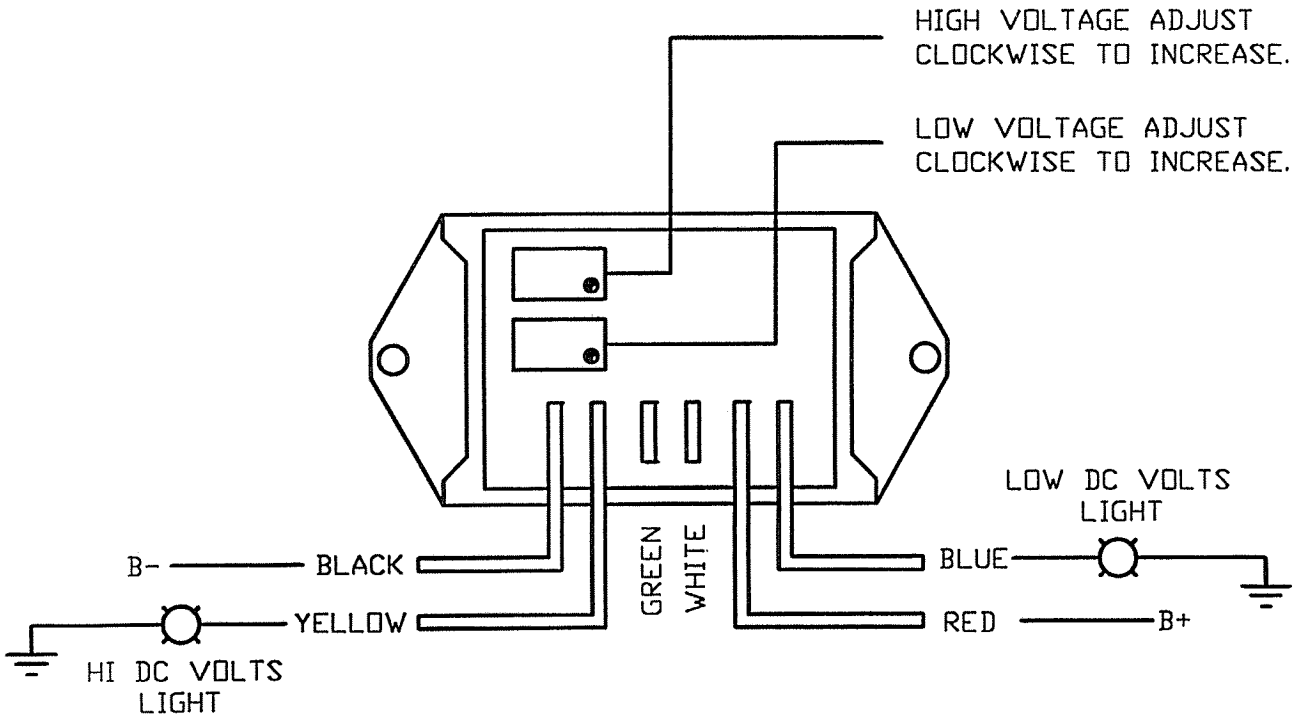
DC VOLTAGE SENSING RELAY



NOTE:

1. HIGH VOLTAGE RELAY SHOULD CLOSE AT
   15 VDC FOR 12VDC SYSTEMS AND
   30 VDC FOR 24VDC SYSTEMS
2. LOW VOLTAGE RELAY SHOULD CLOSE AT
   10.3 VDC FOR 12VDC SYSTEMS AND
   22.3 VDC FOR 24VDC SYSTEMS
3. WHITE JUMPER IS CUT FOR 12VDC OPERATION.
4. GREEN JUMPER IS CUT FOR 24VDC OPERATION.

KATOLIGHT
MANKATO, MINNESOTA

DC VOLTAGE SENSING RELAY

SIZE	DATE	DWG NO
A	3-24-2000	800-153

SCALE	PART NO	DWN BY	SHEET
NONE	35064	SL	1 OF 1

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DGC-1000 Settings File Print Out

File Name Y:\Public\TestBay Information\Final KDGC set-ups\104623-19321-122104.DG1

GenSet ID
GenSet Serial #
Comments

Sensing Transformer Settings

Generator PT Primary Voltage = 480 Volts
Generator PT Secondary Voltage = 240 Volts
Generator CT Primary Current = 200 Amps

Pre-Alarm Settings

Low Fuel Pre-Alarm Status = Enabled
Low Fuel Pre-Alarm Threshold = 30 % Full Tank
Low Coolant Temp Pre-Alarm Status = Enabled
Low Coolant Temp Pre-Alarm Threshold = 55 Deg. F
Battery Overvoltage Pre-Alarm Status = Enabled
Battery Overvoltage Pre-Alarm Threshold = 15.0 Volts
Maintenance Interval Pre-Alarm Status = Disabled
Maintenance Interval Pre-Alarm Threshold = 400 Hours
Engine KW Overload Pre-Alarm Status = Enabled
Engine KW Overload Pre-Alarm Threshold = 95 % of Rated KW
High Coolant Temp Pre-Alarm Status = Enabled
High Coolant Temp Pre-Alarm Threshold = 215 Deg. F
Low Oil Pressure Pre-Alarm Status = Enabled
Low Oil Pressure Pre-Alarm Threshold = 20 PSI
Low Battery Voltage Pre-Alarm Status = Enabled
Low Battery Voltage Pre-Alarm Threshold = 10.0 Volts
Low Battery Voltage Pre-Alarm Time Delay = 10 Seconds
Weak Battery Voltage Pre-Alarm Status = Enabled
Weak Battery Voltage Pre-Alarm Threshold = 7.5 Volts
Weak Battery Voltage Pre-Alarm Time Delay = 10 Sec.
Audible Alarm Buzzer = Enabled
Battery Charger Failure Pre-Alarm = Enabled
Fuel Level Sender Failure Pre-Alarm = Enabled
Active DTC Pre-Alarm = Disabled
Loss of ECU Communication Pre-Alarm = Disabled

Alarm Settings

High Coolant Temp Alarm Status = Enabled
High Coolant Temp Alarm Threshold = 225 Deg. F
High Coolant Temp Alarm Time Delay = 60 Sec.
Low Oil Pressure Alarm Status = Enabled
Low Oil Pressure Alarm Threshold = 15 PSI
Low Oil Pressure Alarm Time Delay = 10 Sec.
Low Fuel Alarm Status = Disabled
Low Fuel Alarm Threshold = 10 % Full Tank
OverSpeed Alarm Status = Enabled
OverSpeed Alarm Threshold = 118 % of Rated
OverSpeed Alarm Time Delay = 100 mSec.
Coolant Temperature Sender Fail Alarm = Enabled

Coolant Temp Sender Failure Alarm Time Delay = 10 Minutes
Oil Pressure Sender Failure Alarm = Enabled
Loss of Generator Voltage Alarm = Enabled
Magnetic Pick-up Failure Alarm = Enabled
Global Sender Failure Alarm Time Delay = 10 Sec.
Loss of ECU Communication Alarm = Disabled

Crank Settings

Generator Cranking Style = Cycle
Number of Crank Cycles = 5
Cycle Crank Time = 9 Sec.
Continuous Crank Time = 10 Sec. (Disabled by Generator Cranking Style)
Crank Disconnect Limit = 35 % of Rated
Pre-Crank Delay = 0 Sec.
Pre-Start Contact after Disconnect = Disabled

System Settings

Genset KW Rating = 105 KW
No Load Cool Down Time = 0 Minutes
Generator Engine RPM Rating = 1800 RPM
System Battery Voltage = 12 Volts
NFPA Level = 0
Number of Flywheel Teeth = 129
Speed Signal Source = Magnetic Pick-up and Generator
Generator Connection = 3 Phase Line - Neutral
Generator Frequency = 60 Hertz
Unit System = English
Generator Rotation = ABC
CAN Bus Support = Disabled
CAN Bus DTC Support = Disabled
J1939 Source Address for this Unit = 234
J1939 Engine Start/Stop Configuration = Not Configured
Accelerator Pedal Position = 0
Volvo Engine RPM Select = Primary

Programmable Input Settings

Programmable Input 1 Function = Auxiliary Input
Programmable Input 1 is Configured as a Pre-Alarm
Auxiliary Input 1 Name = HIGHFUEL

Programmable Input 2 Function = Auxiliary Input
Programmable Input 2 is not configured as an Alarm or a Pre-Alarm
Auxiliary Input 2 Name = AUX IN2

Programmable Input 3 Function = Auxiliary Input
Programmable Input 3 is not configured as an Alarm or a Pre-Alarm
Auxiliary Input 3 Name = AUX IN 3

Programmable Input 4 Function = Auxiliary Input
Programmable Input 4 is not configured as an Alarm or a Pre-Alarm
Auxiliary Input 4 Name = AUX IN 4

DGC-1000 Settings File Print Out

Auxiliary Outputs Configuration

	1	2	3	4	5	6	7	8
High Coolant Temperature Alarm								
Low Oil Pressure Alarm								
Coolant Temperature Sender Failure Alarm								
Oil Pressure Sender Failure Alarm								
Loss of Voltage Sender Failure Alarm								
MPU Speed Sender Failure Alarm								
Low Fuel Alarm			X	X				
Low Coolant Level Alarm			X	X				
Overcrank Alarm								
Emergency Stop Alarm			X	X				
Overspeed Alarm								
Low Fuel Pre-Alarm			X	X	X			
Low Coolant Temperature Pre-Alarm			X	X				
Battery Overvoltage Pre-Alarm			X	X				
KW Overload Pre-Alarm								
High Coolant Temperature Pre-Alarm								
Low Oil Pressure Pre-Alarm								
Low Battery Voltage Pre-Alarm			X	X				
Weak Battery Voltage Pre-Alarm			X	X				
Battery Charger Failure Pre-Alarm								
Scheduled Maintenance Pre-Alarm								
Switch not in Auto	X	X	X	X				
Fuel Leak / Sender Failure Pre-Alarm								
Cooldown Timer Active								
Auxiliary Input 1 Closed						X		
Auxiliary Input 2 Closed								
Auxiliary Input 3 Closed								
Auxiliary Input 4 Closed								
Load Button 1 - Load 1								
Load Button 2 - Load 2								
Load Button 3 - Load 3								
Load Button 4 - Load 4								

Modem Configuration Settings

Modem Dialout Number 1 =
Pager ID for Dialout Number 1 =
Modem Dialout Number 2 =
Pager ID for Dialout Number 2 =
Modem Dialout Number 3 =
Pager ID for Dialout Number 3 =
Modem Dialout Number 4 =
Pager ID for Dialout Number 4 =
Unit Name Sent to Pager = DGC-1000
Number of Rings for Modem to wait before answering = 2
Modem off-line delay = 10 Minutes
Modem Inter-Dialout Time Delay = 15 Sec.
Pager Company Buffer Limit = 80 Characters
Pager Communication Parity = 8 Data Bits, No Parity

Modem Dialout Configuration

DGC-1000 Settings File Print Out

	Dialout
High Coolant Temperature Alarm	
Low Oil Pressure Alarm	
Coolant Temperature Sender Failure Alarm	
Oil Pressure Sender Failure Alarm	
Loss of Voltage Sender Failure Alarm	
MPU Speed Sender Failure Alarm	
Low Fuel Alarm	
Low Coolant Level Alarm	
Overcrank Alarm	
Emergency Stop Alarm	
Overspeed Alarm	
Low Fuel Pre-Alarm	
Low Coolant Temperature Pre-Alarm	
Battery Overvoltage Pre-Alarm	
KW Overload Pre-Alarm	
High Coolant Temperature Pre-Alarm	
Low Oil Pressure Pre-Alarm	
Low Battery Voltage Pre-Alarm	
Weak Battery Voltage Pre-Alarm	
Battery Charger Failure Pre-Alarm	
Scheduled Maintenance Pre-Alarm	
Switch not in Auto	
Fuel Leak / Sender Failure Pre-Alarm	
Cooldown Timer Active	
Auxiliary Input 1 Closed	
Auxiliary Input 2 Closed	
Auxiliary Input 3 Closed	
Auxiliary Input 4 Closed	
Active DTC Pre-Alarm	
Loss of ECU Communication Alarm	
Loss of ECU Communication Pre-Alarm	

Coolant Temperature Sender Curve Information

Ohms	Degrees Fahrenheit
10	320
30	300
60	242
100	205
150	180
200	160
300	138
400	122
600	104
800	89
2750	32

Oil Pressure Sender Curve Information

Ohms	PSI
0	150
25	113
50	83
75	68
100	52
125	37

Ohms	PSI
150	26
175	17
200	10
225	6
250	0

Fuel Level Sender Curve Information

Ohms	Percent Fuel Level
0	100
33	99
58	87
84	75
110	62
136	50
162	38
188	26
214	13
240	1
250	0

ECU Timer Values

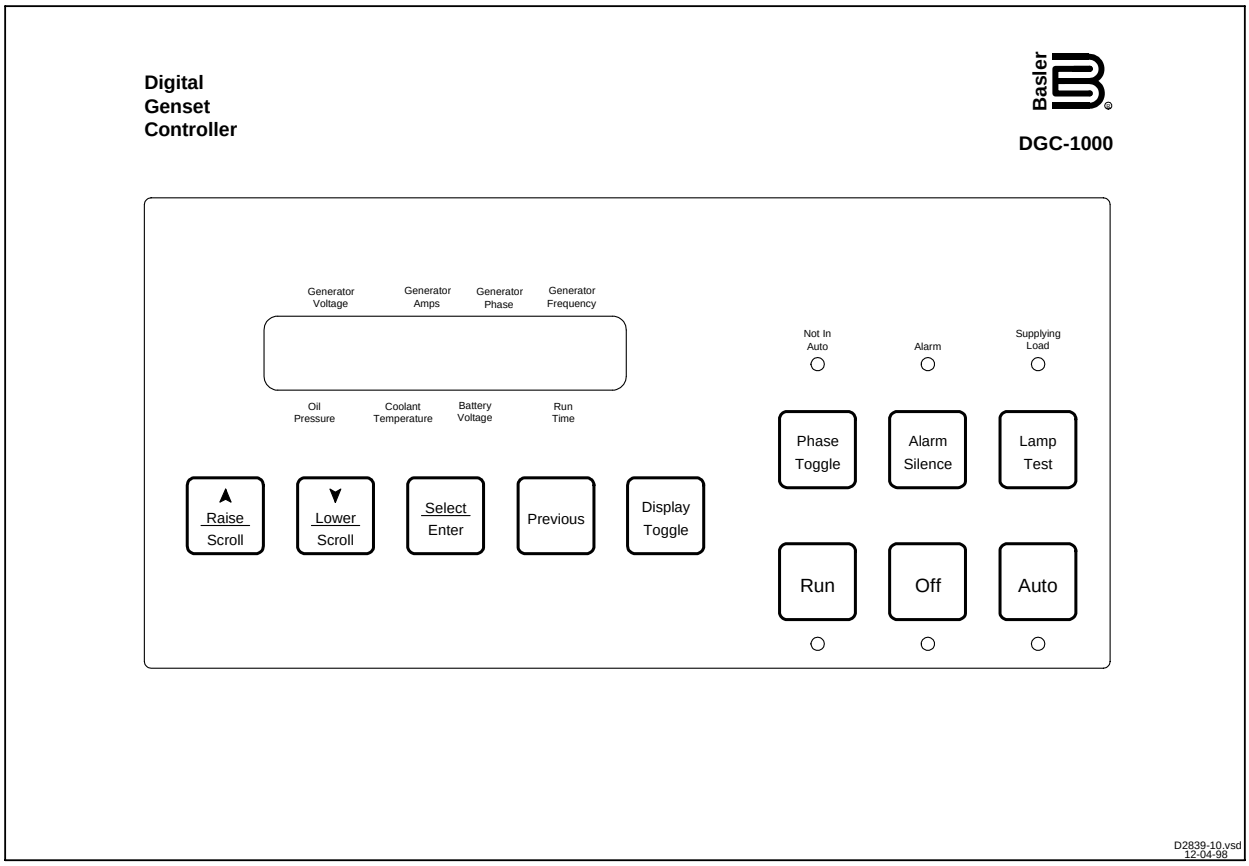
Engine Shut Down Time = 15 Sec.
ECU Settling Time = 6000 MilliSec.
ECU Pulse Cycle Time = 15 Min.
ECU Response Timeout = 5 Sec.

INSTRUCTION MANUAL

DGC-1000

DIGITAL GENSET CONTROLLER

(Katolight equivalent is KDGC-2001)



Basler Electric

Publication: 9358900990
Revision: E 11/05

INTRODUCTION

This instruction manual provides information about the operation and installation of the DGC-1000 Digital Genset Controller. To accomplish this, the following information is provided.

- General Information and Specifications
- Controls and Indicators
- Functional Description
- Communication Software
- Installation
- Test Procedures

WARNING!

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures in this manual.

NOTE

Be sure that the controller is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear panel. When the controller is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

First Printing: January 2002

Printed in USA

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November 2005

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It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Should further information be required, contact Basler Electric.

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PRODUCT REVISION HISTORY

DGC-1000 Digital Genset Controllers with part number 93589XXXXX incorporate an SAE CAN/J1939 interface to support electronically controlled engine applications and replace earlier versions of the DGC-1000 with part number 93275XXXXX.

The following information provides a historical summary of the changes made to the embedded software (firmware), PC software (BESTCOMS), and hardware of the DGC-1000. The corresponding revisions made to this instruction manual (9358900990) are also summarized. Revisions are listed in chronological order.

Firmware Version	Change
3.04.XX, 06/02	• Initial release
3.05.XX, 09/02	• Increased ECU settling time • Embedded the firmware part number for display on HMI LCD and in BESTCOMS • Maximum value for low fuel alarm threshold was increased to 100%
3.06,XX, 03/03	• Not released for production
3.07.XX, 09/03	• Added capability of Stop/Start control for Volvo Penta EDC
3.08.XX	• Not released to production
3.09.XX, 04/04	• Added access level setting for third-party Modbus programs • Added Event Log capability • Added Volvo Speed Select and Accelerator Position settings
3.11.XX, 10/05	• Added support for MTU MDEC ECUs • Added configurable ECU contact and pulsing disable settings
3.12.XX, 11/05	• Added 4-Wire Delta Auxiliary Input function

BESTCOMS Version	Change
2.01.00, 06/02	• Initial release
2.02.XX, 09/02	• Added display of the firmware part number • Corrected power factor polarity display error
2.03.XX	• Not released to production
2.04.XX, 09/03	• Added support for Volvo Penta EDC
2.05.XX	• Not released to production
2.06.XX, 04/04	• Added access level setting for third-party Modbus programs • Added communication port phone book • Added Event Log selection to menu bar • Added Volvo Speed Select and Accelerator Position settings
2.07.XX, 10/05	• Added support for MTU MDEC ECUs • Required OEM-level password access to change CANBus Interface settings • Added configurable ECU contact and pulsing disable settings
2.08.XX, 11/05	• Added 4-Wire Delta Auxiliary Input function

Hardware Version	Change
C, 06/02	• Initial release
D, 09/02	• Converted capacitors C52 and C64 to non-polarized part
E, 09/02	• Replaced Digital circuit board micro controller with new part programmed with firmware version 3.05.XX
F, 01/03	• Began using anti-static packing materials during shipment
G, 09/03	• Added Volvo engine Stop/Start control via J1939 interface
H, 02/04	• Minor firmware enhancements
J, 04/04	• Implemented firmware version 3.09
K, 08/04	• Modified LCD heater circuitry to compensate for supplier changes in LCD heater control chip
L, 08/04	• Minor firmware and BESTCOMS software enhancements
M, 11/04	• Implemented firmware version 3.10

Manual Revision	Change
—, 01/02	• Initial release
A, 06/02	• Added new BESTCOMS screen images • Added ECU and state machines documentation to Section 3 • Created Appendix A, *DGC-1000 Settings Record*
B, 08/03	• Added material pertaining to DGC-1000 communication with Volvo Penta EDCs • Added rear-panel HMI information and diagram showing the location of the CAN connector to Section 2 • Added information regarding DGC Isolator Kits to Section 4 • Added a table listing CAN terminations and a diagram showing the CAN cable assembly to Section 4 • Replaced the System Settings screen, shown in Section 6, with revised screen containing additional settings • Inserted additional settings of BESTCOMS System Settings screen to the settings record of Appendix A
C, 04/04	*Section 3* • Added single-phase formulas for total kVA, kW to Section 3 • Added oil filter differential pressure, fuel filter differential pressure, and crankcase pressure parameters to Table 3-1 *Section 4* • Added torque specification for mounting hardware to Section 4 • Changed all *Volvo Penta EDC* references in text and illustrations to *Volvo Penta EDC III*. *Section 6* • Incorporated changes to Phone Book and Comm Port screens • Added description of Event Log screen, Metering screen's ECU Data tab, Engine Configuration screen, third party access level, and CAN Bus Speed Select and Accelerator Position settings
D, 08/05	• Added material pertaining to DGC-1000 communication with MTU MDEC ECUs • Added recommendation of a user-supplied serial server for DGC-1000 communication over an Ethernet LAN/WAN • Add information about configurable ECU contact and pulsing disable settings
E, 11/05	• Added 4-Wire Delta formulas to Section 3, *Functional Description, Microprocessor, Formulas.* • Added 4-Wire Delta information to Section 6, *BESTCOMS Software, Setting Definitions, Input/Output Settings, Programmable Input Contact Setup Tab* • Added Programmable Input Contact Setup chart to the DGC-1000 Settings Record in Appendix A.

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Figure 1-1. DGC-1000 Style Number Identification Chart 1-2

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SECTION 1 • GENERAL INFORMATION

DESCRIPTION

The DGC-1000 Digital Genset Controller provides integrated engine/genset control, protection, and metering in a single package. Microprocessor-based technology allows for precise measurement, setpoint adjustment, and timing functions. Front panel controls and indicators provides quick and simple operation. BESTCOMS software allows easy customizing of the DGC-1000 for a specific application. Because of the DGC-1000's low sensing burden, dedicated potential transformers (PTs) and current transformers (CTs) are not required. The backlit liquid crystal display (LCD) can be read under any lighting and temperature condition.

A CANBus interface provides electronic communication with engine control units (ECUs) supporting the SAE J1939 protocol or the MTU MDEC proprietary protocol. The CANBus interface provides direct access to oil pressure, coolant temperature, and engine speed sensors. These parameters can be read directly from the ECU over the J1939 communication interface. When available, engine diagnostic data can also be accessed.

FEATURES

DGC-1000 Digital Genset Controllers have the following features.

- Resistant to moisture, salt fog, dust, and chemical contaminants
- Resistant to the entrance of insects and rodents
- Suitable for mounting in any top-mount enclosure
- Suitable for controlling isolated generating systems or paralleled generating systems
- Easy setup through serial communication and BESTCOMS software
- CANBus interface provides high-speed communication with the ECU on electronically-controlled engines utilizing the SAE J1939 protocol or MTU MDEC protocol

FUNCTIONS

DGC-1000 Digital Genset Controllers perform the following functions.

Protection

- Engine oil pressure
- Fuel level sender
- Coolant temperature
- Overload

Control

- Engine cranking
- Engine cool-down

Monitoring

- Battery condition
- Engine maintenance
- Battery charger failure

Detection

- Fuel leak
- Low coolant level

Metering

- Generator voltage
- Generator current
- Generator frequency
- Engine coolant temperature
- Engine oil pressure
- Engine rpm
- Engine run-time
- Watts
- VA
- Power factor
- Watthours
- Battery voltage
- Fuel level

Reporting

- Engine diagnostics

OUTPUTS

Six sets of isolated, form A output contacts are provided: Start, Fuel Solenoid, Pre-start, Alarm, Pre-alarm, and EPS Supplying Load. An addition eight sets of Form C output contacts are available as an option. See *Specifications, Output Contacts* for contact ratings and terminal assignments.

OPTIONAL EQUIPMENT

Optional equipment available to the DGC-1000 is described in the following paragraphs.

Auxiliary Inputs and Outputs (Style AXX)

An auxiliary I/O assembly, with four sets of input contacts and eight sets of output contacts, is available for applications that require more input and output contacts. The additional input contacts can be assigned to a desired function by using BESTCOMS to label the inputs so that the front panel LCD displays the proper message. The additional output contacts can be programmed through BESTCOMS to perform the desired actions.

Dial-Out Modems (Style X1X and X2X)

Two dial-out modems are available. When an alarm or pre-alarm condition occurs, the modem will dial up to four telephone numbers, in sequence, until an answer is received and the condition is annunciated. The standard modem (style X1X) has an operating temperature range of 0°C to 50°C (32°F to 122°F). The extended operating temperature range modem (style X2X) operates over the range of –40°C to 70°C (–40°F to 158°F). Both modems support the MNP10EC protocol for optimizing data transmission in cellular applications.

Enhanced Communication (Style XXC)

Enhanced communication provides remote start/stop genset control, remote fault viewing and reset, and remote engine/generator parameter metering. This option requires a dial-out modem.

Remote Annunciation Display Panel (RDP-110)

Applications requiring remote annunciation can use the Remote Display Panel, RDP-110. This display panel can annunciate all DGC-1000 alarms, pre-alarms, and operating conditions.

MODEL AND STYLE NUMBER

DGC-1000 electrical characteristics and operating features are defined by a combination of letters and numbers that make up the style number. The DGC-1000 style number identification chart is shown in Figure 1-1.

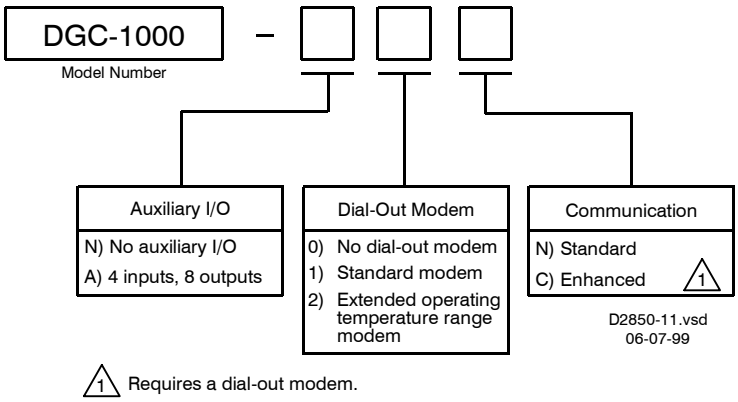

Figure 1-1. DGC-1000 Style Number Identification Chart

The model number and style number appear on a label located on the Analog circuit board. Upon receipt of a unit, be sure to check the style number against the requisition and packing list to ensure that they agree.

Style Number Example

If a style number of A1C were specified, the DGC-1000 would have the following features.

DGC-1000 Digital Genset Controller

- A Auxiliary I/O: 4 contact inputs and 8 contact outputs
- 1 Dial-Out Modem: standard modem
- C Communication: enhanced communication

SPECIFICATIONS

DGC-1000 electrical and physical specifications are listed in the following paragraphs.

Current Sensing

Continuous Rating

1 A Inputs:	0.02 to 1 A
5 A Inputs:	0.1 to 5 A

One Second Rating

1 A Inputs:	2.0 A
5 A Inputs:	10.0 A

Accuracy: ±0.5% of reading or ±1 A, whichever is greater (at 25°C (77°F))

Terminals:

1 A Inputs:	P9, P11 (A-phase), P6, P8 (B-phase), P3, P5 (C-phase)
5 A Inputs:	P10, P11 (A-phase), P7, P8 (B-phase), P4, P5 (C-phase)

Voltage Sensing

Continuous Rating: 12 to 576 V rms, 50/60 Hz

One Second Rating: 720 V rms

Accuracy: ±0.5% or reading or ±1 V, whichever is greater (at 25°C (77°F))

Burden: 1 VA

Terminals: P34 (A-phase), P35 (B-phase), P36 (C-phase), P37 (neutral)

Frequency

Range: 4 to 70 Hz

Accuracy: ±0.25% of reading or ±0.1 Hz, whichever is greater (at 25°C (77°F))

Contact Sensing

Configuration

Emergency Stop:	NC, dry
Battery Charger Failure:	NO, dry
Automatic Transfer Switch:	NO, dry
Low Coolant Level:	NO, dry
Auxiliary 1 – 4:	NO, dry

Terminals

Emergency Stop:	P17, P18
Battery Charger Failure:	P16, P41
Automatic Transfer Switch:	P15, P41
Low Coolant Level:	P14, P41
Auxiliary 1:	P5, P41
Auxiliary 2:	P9, P41
Auxiliary 3:	P13, P41
Auxiliary 4:	P17, P41

Engine System Inputs *

* Stated accuracies are subject to the accuracy of the senders used.

Fuel Level Sensing

Input Range:	240 to 33 Ω nominal
Accuracy:	±1% at 25°C (77°F)
Default Transducer:	Isspro R-8925 or equivalent

Fuel Leak Sensing

Detection Level:	<5 Ω across fuel level input

Coolant Temperature Sensing

Input Range:	637.5 to 62.6 Ω (corresponds to 100 to 300°F (37 to 149°F))
Accuracy at 25°C (77°F):	±0.5% of reading or ±1°, whichever is greater for measurement range of 37 to 115°C (99 to 239°F)
Default Transducer:	Stewart Warner 334-P

Oil Pressure Sensing

Input Range:	240 to 33.5Ω (corresponds to 1 to 100 psi)
Accuracy at 25°C (77°F)	
0 to 100 psi:	±0.5% of reading or ±1 psi, whichever is greater
0 to 690 kPa:	±0.5% of reading or ±7 kPa, whichever is greater
Default Transducer:	Stewart Warner 411-K

Battery Voltage Sensing

Nominal:	12 or 24 Vdc
Range:	8 to 32 Vdc
Battery Dip Ride-Through:	6 Vdc for 0.75 s
Accuracy:	±0.5% of reading or ±0.1 Vdc, whichever is greater at 25°C (77°F)
Burden:	16 W maximum

Magnetic Pickup Sensing

Voltage Range:	3 V peak (during cranking) to 35 V peak continuous into 10 kΩ
Frequency Range:	32 to 10,000 Hz

Engine Speed Sensing

Range:	750 to 3,600 rpm
Accuracy:	±0.5% of reading or ±2 rpm, whichever is greater at 25°C (77°F)

Output Contacts

Configuration

Start:	SPST, NO
Fuel Solenoid:	SPST, NO
Pre-Start:	SPST, NO
Alarm:	SPST, NO
Pre-Alarm:	SPST, NO
EPS Supplying Load:	SPST, NO
Auxiliary 1 – 8:	SPDT

Ratings

Start:	10 A at 24 Vdc, make, carry, and break
Fuel Solenoid:	10 A at 24 Vdc , make, carry, and break
Pre-Start:	2 A at 30 Vdc, make, carry, and break
Alarm:	2 A at 30 Vdc, make, carry, and break
Pre-Alarm:	2 A at 30 Vdc, make, carry, and break
EPS Supplying Load:	2 A at 30 Vdc, make, carry, and break
Auxiliary 1 – 8:	2 A at 30 Vdc, make, carry, and break

Terminals

Start:	P25, P26
Fuel Solenoid:	P19, P20
Pre-Start:	P21, P22
Alarm:	P23, P24
Pre-Alarm:	P27, P28
EPS Supplying Load:	P29, P30
Auxiliary 1:	P4 (NO), P2 (NC), P3 (COM)
Auxiliary 2:	P8 (NO), P6 (NC), P7 (COM)
Auxiliary 3:	P12 (NO), P10 (NC), P11 (COM)
Auxiliary 4:	P16 (NO), P14 (NC), P15 (COM)
Auxiliary 5:	P20 (NO), P18 (NC), P19 (COM)
Auxiliary 6:	P23 (NO), P21 (NC), P22 (COM)
Auxiliary 7:	P26 (NO), P24 (NC), P25 (COM)
Auxiliary 8:	P29 (NO), P27 (NC), P28 (COM)

Horn Output

Compatible Devices:	Basler 29760, Mallory SC628NL
Terminals:	P31 (–), P45 (+)

Calculated Data

Power Factor

Range:	+1.0 to –1.0, both leading and lagging
Accuracy:	±0.01 PF at 25°C (77°F)

Kilovoltamperes

Range:	0 to 9,999 kVA
Accuracy:	±0.5% of reading or ±0.1 kVA, whichever is greater at 25°C (77°F)

Kilowatts

Range:	0 to 9,999 kW
Accuracy:	±0.5% of reading or ±0.1 kW, whichever is greater at 25°C (77°F)

Kilowatthours

Range:	0 to 999,999,999 kWh
Accuracy:	±0.5% of reading or ±1 kWh, whichever is greater at 25°C (77°F)

Engine Run Time

Range:	0 to 99,999 h
Accuracy:	±0.5% of reading or ±1 h, whichever is greater at 25°C (77°F)

Maintenance Interval

Range:	0 to 5,000 h
Accuracy:	±0.5% of reading or ±1 h, whichever is greater at 25°C (77°F)

Communication Interface

Full Duplex RS-232 Port

Connection:	Female DB-9 connector (COM1)
Baud:	1200, 2400, or 9600
Data Bits:	8
Parity:	None, Odd, or Even
Stop Bits:	1

Telephone Modem (FCC, part 68 approved modem)

Operating Temperature Range

Standard (style X1X):	0 to 50°C (32 to 122°F)
Extended (style X2X):	–40 to 70°C (–40 to 158°F)

CANBus Interface

Differential Bus Voltage:	1.5 to 3 Vdc
Maximum Voltage:	–32 to 32 Vdc with respect to negative battery terminal
Communication Rate:	250 kb/s maximum

Environment

Temperature Range

Operating:	–40 to 70°C (–40 to 158°F)
Storage:	–40 to 85°C (–40 to 185°F)

Type Tests

Shock:	Withstands 15 G in each of three mutually perpendicular planes
Vibration:	Withstands 2 G, in each of three mutually perpendicular planes, without structural damage or degradation of performance. Device was swept over the range of 10 to 500 Hz for a total of six 15-minute sweeps.
Salt Fog:	Qualified to ASTM-117B-1989

Radio Interference:	Type tested using a 5 W, handheld transceiver operating at random frequencies centered around 144 and 440 MHz with the antenna located within 150 mm (6”) of the device in both vertical and horizontal planes.
Dielectric Strength:	2,352 Vac at 50/60 Hz for 1 second between voltage sensing inputs and all other circuits. 500 Vac at 50/60 Hz for 1 minute between any of the following groups. Current Sensing Inputs: 8 mA RS-232 Port (COM1): 6 mA

UL Recognition

All DGC-1000 controllers are UL recognized per Standard 508, *Standard for Industrial Control Equipment* (UL file E97035).

CSA Certification

All DGC-1000 controllers are CSA certified per Standard CAN/CSA-C22.2, Number 14-95, CSA file LR 23131.

Physical

Weight:	907 g (2.0 lb)
Dimensions:	See Section 4, *Installation* for device dimensions and panel cutout requirements.

SECTION 2 • HUMAN-MACHINE INTERFACE

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SECTION 2 • HUMAN-MACHINE INTERFACE

INTRODUCTION

The DGC-1000 human-machine interface (HMI) consists of controls and indicators accessed at the front panel and terminals and connectors accessed at the rear panel.

FRONT PANEL

Figure 2-1 shows the HMI components of the front panel. Table 2-1 lists the locators of Figure 2-1 along with a description of each HMI component.

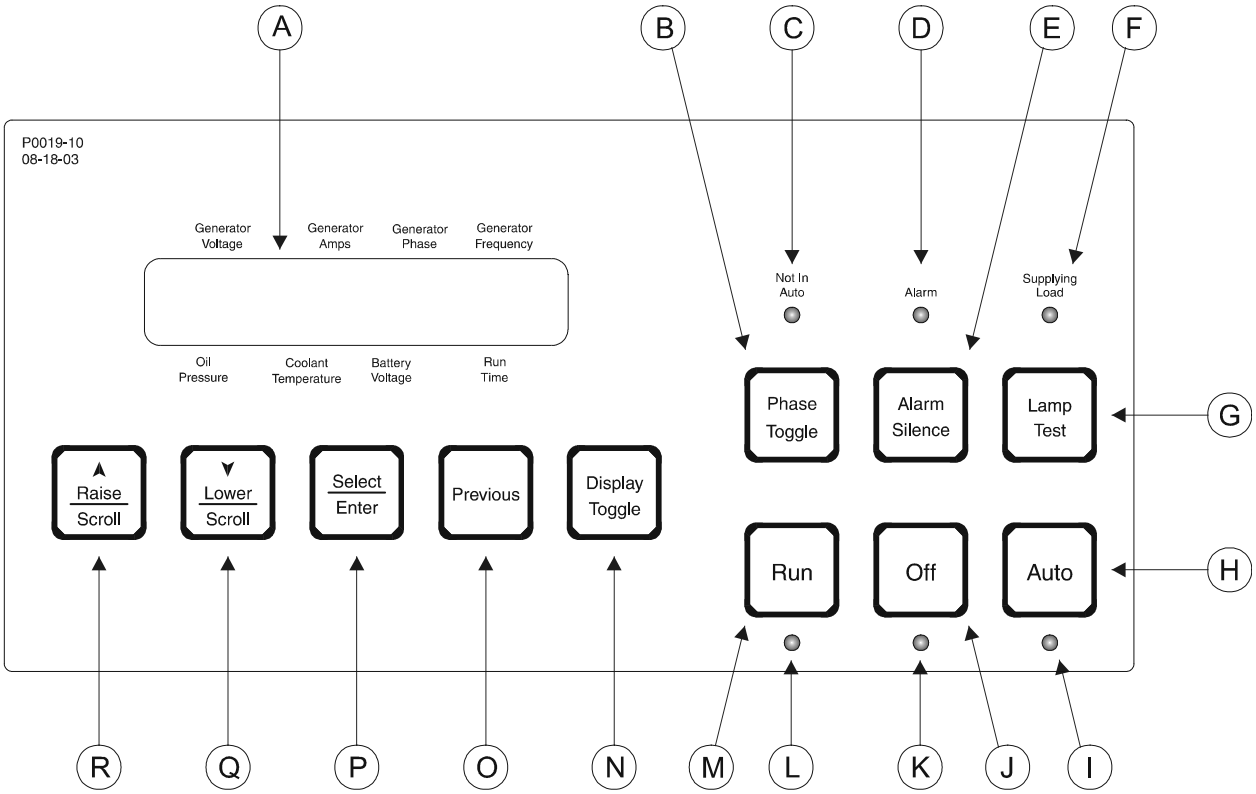

Figure 2-1. Front Panel HMI Components

Table 2-1. Front Panel HMI Descriptions

Locator	Description
A	*Display*. The two line by 20 character liquid crystal display (LCD) is the primary interface for metering, alarms, pre-alarms, and protective functions. The LCD has three display modes: Normal, Alternate, and Menu. In Normal mode, the displayed parameters correspond to one of the eight labels surrounding the display. In Alternate mode, the LCD displays parameters and the corresponding labels. In Menu mode, the LCD scrolls through the DGC-1000 parameters.
B	*Phase Toggle Pushbutton.* Pressing this control scrolls through the parameters available in Normal display mode.
C	*Not in Auto Indicator.* This red LED lights when the DGC-1000 is not operating in Auto mode.
D	*Alarm Indicator.* This red indicator lights continuously during alarm conditions and flashes during pre-alarm conditions.
E	*Alarm Silence Pushbutton.* Pressing this control resets the DGC-1000 audible alarm.
F	*Supplying Load Indicator.* This green indicator lights when the generator is supplying more than two percent of rated current.
G	*Lamp Test Pushbutton.* Pressing this control tests the DGC-1000 indicators by exercising all LCD segments and lighting all LEDs.

Locator	Description
H	*Auto Pushbutton.* Pressing this control places the DGC-1000 in Auto mode.
I	*Auto Mode Indicator.* This green LED lights when the DGC-1000 is operating in Auto mode.
J	*Off Pushbutton.* Pressing this control places the DGC-1000 in Off mode.
K	*Off Mode Indicator.* This red LED lights when the DGC-1000 is in Off mode.
L	*Run Mode Indicator.* This green LED lights when the DGC-1000 is operating in Run mode.
M	*Run Pushbutton.* Pressing this control places the DGC-1000 in Run mode.
N	*Display Toggle Pushbutton.* Pressing this control scrolls through the display modes.
O	*Previous Pushbutton.* Pressing this control scrolls through LCD display modes.
P	*Select/Enter Pushbutton.* This control is pressed to enter menu sublevels and select setpoints.
Q	*Lower/Scroll Pushbutton.* This control is pressed to scroll backward through menus or decrement setpoints.
R	*Raise/Scroll Pushbutton.* This control is pressed to scroll forward through menus or increment setpoints.

REAR PANEL

All DGC-1000 terminals and connectors are accessed at the rear panel. Figure 2-2 shows the HMI components (except the CAN interface connector) of the rear panel HMI. Table 2-2 lists the locators of Figure 2-2 along with a description of each rear panel HMI component.

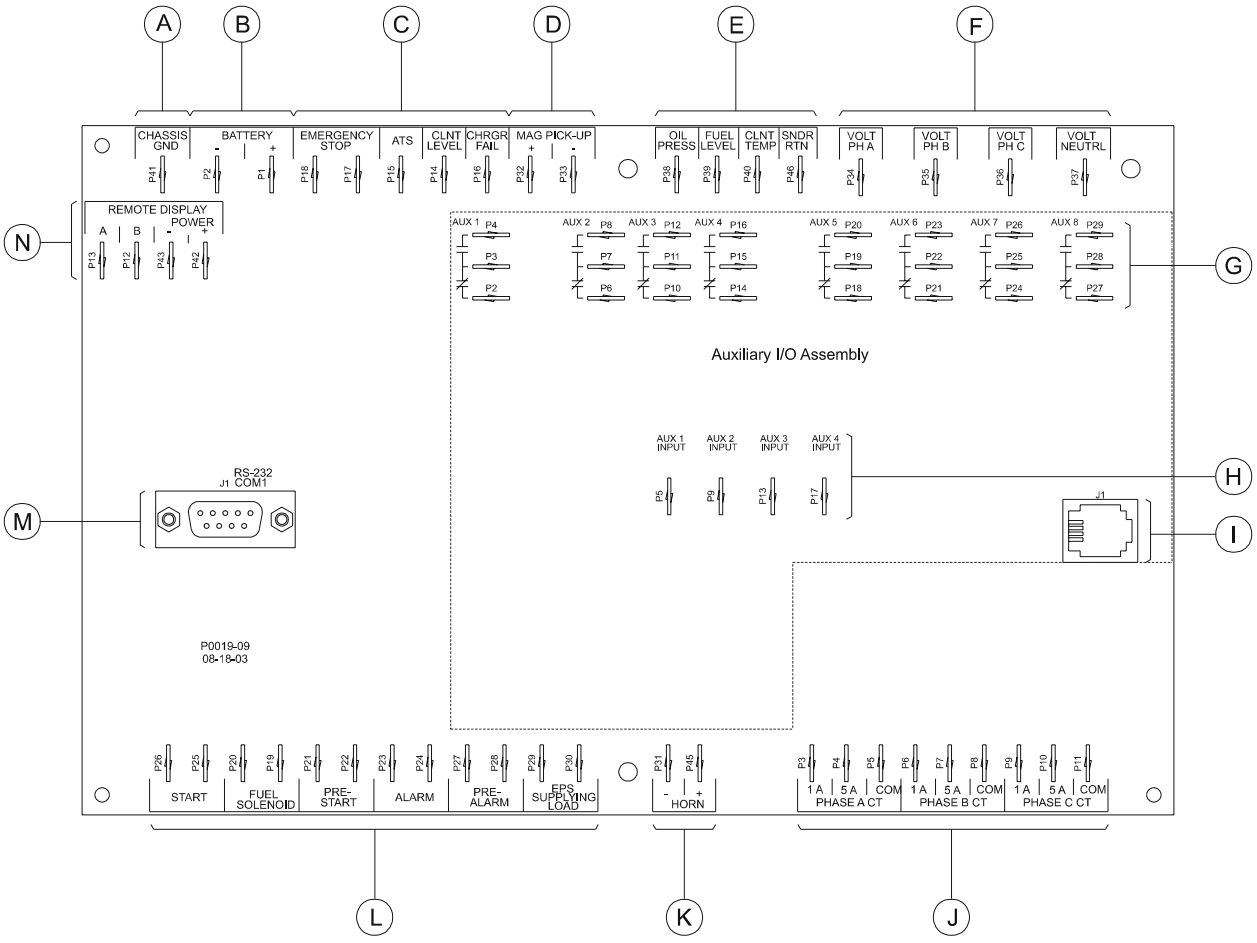

Figure 2-2. Rear Panel HMI Components

Table 2-2. Rear Panel HMI Descriptions

Locator	Terminals	Description
A	P41	*Chassis Ground.* This terminal provides the chassis ground connection. The DGC-1000 must be hard-wired to earth ground with no smaller than 12 AWG copper wire.
B	P1 (+), P2 (–)	*Battery.* DGC-1000 operating power is applied to these terminals. The DGC-1000 accepts a nominal input of 12 Vdc or 24 Vdc.
C		<u>*Contact Sensing Inputs*</u>
	P17, P18	*Emergency Stop.* An open circuit at this input initiates an emergency stop. During an emergency stop, the DGC-1000 removes power from all output relays.
	P15, P2	*Automatic Transfer Switch.* A closed circuit at this input starts the engine when the DGC-1000 is operating in Auto mode.
	P14, P2	*Coolant Level.* When the voltage sensed at this input decreases to zero, the DGC-1000 annunciates a low coolant level condition.
	P16, P2	*Battery Charger Fail.* When the voltage sensed at this input decreases to zero, the DGC-1000 annunciates a battery charger failure.
D	P32 (+), P33 (–)	*Magnetic Pickup.* Voltage received at this input is scaled and conditioned for use as a speed signal. This input is not used when the CAN interface is enabled.
E		<u>*Transducer Inputs*</u>
	P38, P46	*Oil Pressure.* This input connects to a user-supplied oil pressure transducer. The default oil pressure transducer is Stewart Warner 411-K or equivalent.
	P39, P46	*Fuel Level.* This input connects to a user-supplied fuel level transducer. The default fuel level transducer is Isspro R-8925 or equivalent.
	P40, P46	*Coolant Temperature.* This input connects to a user-supplied coolant temperature transducer. The default coolant temperature transducer is Stewart Warner 334-P or equivalent.
F		<u>*Voltage Sensing Inputs*</u>
	P34	*A-phase.* This input connects to phase A of the generator output.
	P35	*B-phase.* This input connects to phase B of the generator output.
	P36	*C-phase.* This input connects to phase C of the generator output.
	P37	*Neutral.* This input connect to the generator neutral in phase-to-neutral sensing applications.
G		<u>*Auxiliary Output Contacts (style AXX)*</u>
	<u>*NO, COM, NC*</u>	These eight sets of programmable, SPDT output contacts can be programmed to close when any one of the selected inputs is active.
	P4, P3, P2	*Auxiliary 1 Output*
	P8, P7, P6	*Auxiliary 2 Output*
	P12, P11, P10	*Auxiliary 3 Output*
	P16, P15, P14	*Auxiliary 4 Output*
	P20, P19, P18	*Auxiliary 5 Output*
	P23, P22, P21	*Auxiliary 6 Output*
	P26, P25, P24	*Auxiliary 7 Output*
	P29, P28, P27	*Auxiliary 8 Output*
H		<u>*Auxiliary Contact Inputs (style AXX)*</u>
		These four sets of contact inputs are designed for use with normally-open contact inputs. Each input can be programmed as an alarm, pre-alarm, or neither.
	P5, P2	*Auxiliary 1 Input*
	P9, P2	*Auxiliary 2 Input*
	P13, P2	*Auxiliary 3 Input*
	P17, P2	*Auxiliary 4 Input*

Locator	Terminals	Description
I	J1	*Modem (style X1X or X2X).* USOC RJ-11C four-terminal telephone jack provides dial-in and dial-out capability.
J	*1 A/5A, COM*	*Current Sensing Inputs*
	P3/P4, P5	*A-phase.* This input connects to a CT monitoring the generator phase A current.
	P6/P7, P8	*B-phase.* This input connects to a CT monitoring the generator phase B current.
	P9/P10, P11	*C-phase.* This input connects to a CT monitoring the generator phase C current.
K	P31 (–), P45 (+)	*Horn.* This output supplies power to an external horn. Recommended devices are Basler 29760 and Mallory SC628NL.
L		*Output Contacts*
	P25, P26	*Start.* This normally-open set of contacts connects to the start solenoid and closes when the DGC-1000 initiates engine cranking.
	P19, P20	*Fuel Solenoid.* This normally-open set of contacts connects to the fuel solenoid. The fuel solenoid output closes when engine cranking is initiated and opens when a stop command is received by the DGC-1000.
	P21, P22	*Pre-Start.* This normally-open set of contacts closes to energize the glow plugs prior to engine cranking. Depending on system setup, the Pre-Start output may open upon engine startup or stay closed during engine operation.
	P23, P24	*Alarm.* This normally-open set of contacts closes when an alarm condition is detected. Section 3, *Functional Description, Software, Alarms* provides information about alarm conditions.
	P27, P28	*Pre-Alarm.* This normally-open set of contacts closes when a pre-alarm condition is detected. Section 3, *Functional Description, Software, Pre-Alarms* provides information about alarm conditions.
	P29, P30	*EPS Supplying Load.* This set of normally-open output contacts closes when the controlled generator is supplying power to the load.
M	COM1	*RS-232 Communication Port.* This female DB9 connector uses serial communication to enhance DGC-1000 setup. A standard serial cable connects the DGC-1000 to a PC.
N	P13 (A), P12 (B), P42 (+), P43 (–)	*Remote Display Connections.* Remote Display Panel, RDP-110, connects to these terminals. The RDP-110 annunciates all DGC-1000 alarms, pre-alarms, and operating conditions in accordance with NFPA specifications.

CAN INTERFACE CONNECTOR

The CANBus interface enables the DGC-1000 to communicate with the genset's ECU and gather engine parameters, battery voltage, and other information. Using the ECU to obtain engine information eliminates the need to use transducers and the associated wiring.

The location of the CAN interface connector is shown in Figure 2-3.

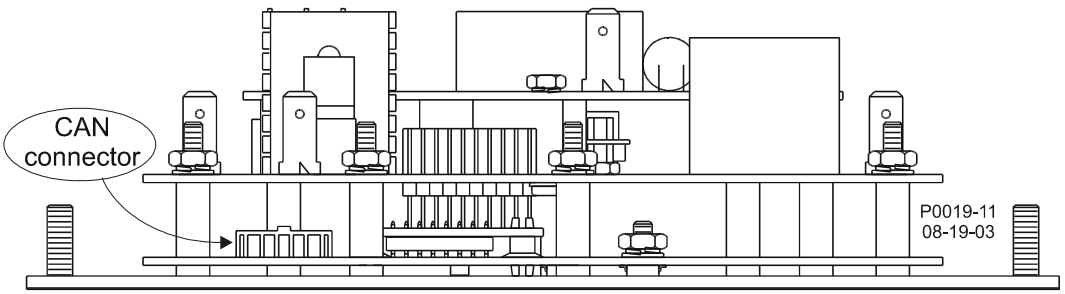

Figure 2-3. CAN Interface Connector Location

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SECTION 3 • FUNCTIONAL DESCRIPTION

GENERAL

DGC-1000 Digital Genset Controllers use microprocessor based technology to provide integrated engine-generator set control, protection, and metering in a single package. Microprocessor based technology allows for exact measurement, setpoint adjustment and timing functions. Refer to the following paragraphs for the DGC-1000 functional description.

Circuit functional description is divided into *Inputs*, *Microprocessor*, *Outputs*, *Phone Modems* and *Software*. Circuit functions illustrated in Figure 3-1 are described in the following paragraphs.

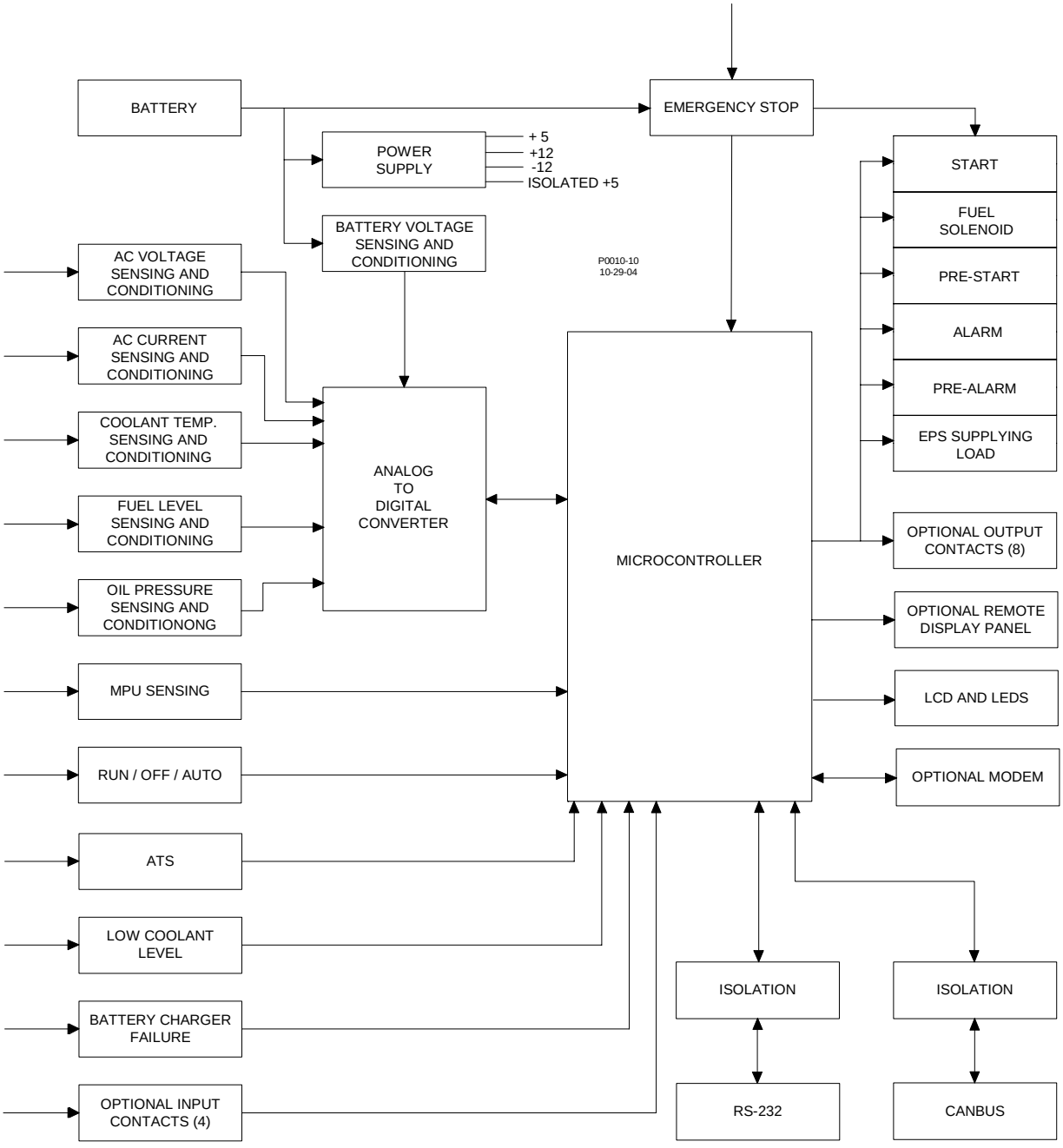

Figure 3-1. DGC-1000 Function Block Diagram

INPUTS

There are nine types of inputs to the DGC-1000 Controller. They are:

- Battery operating voltage
- Contact sensing inputs
- Transducer inputs
- Speed signal inputs
- Voltage inputs
- Current inputs
- RS-232 serial communication
- CAN interface for ECU communication
- Programmable contact sensing inputs

The following paragraphs describe these inputs.

Battery Operating Voltage

Required operating voltage is a nominal 12 or 24 Vdc. Operating voltage may be in the range of 8 to 32 Vdc. An internal switching power supply uses the battery voltage to generate a +12 Vdc, -12 Vdc, +5 Vdc, a stable +5 Vdc reference and an isolated +5 Vdc. The isolated +5 Vdc supply is for the RS-232 serial communications port. The dc reference voltage is for internal use.

Battery operating voltage is conditioned (filtered and reduced to a level suitable for microprocessor input) and sensed by the microprocessor.

Contact Sensing Inputs

Four external contact sensing inputs (Emergency Stop, Automatic Transfer Switch, Low Coolant Level, and Battery Charger Failure) provide external stimulus to the DGC-1000 Controller.

Emergency Stop

This input is continuously monitored. An open circuit indicates an Emergency Stop. Opening this circuit removes power from all output relays.

Automatic Transfer Switch

This input is continuously monitored by the microprocessor and is used to start the engine when in the auto mode. A closed contact initiates the start sequence.

Low Coolant Level

This input is continuously monitored by the microprocessor. When battery (–) potential is connected to this input, a low coolant level is indicated.

Battery Charger Failure

This input is continuously monitored by the microprocessor. When battery (–) potential is connected to this input, a battery charger failure is indicated.

Transducer Inputs

The DGC-1000 transducer inputs are programmable. This gives the user the flexibility to choose the transducer to be used in a particular application. For details on programming, see Section 6, *BESTCOMS Software, Programmable Senders*.

Coolant Temperature

A current of less than 20 milliamperes is provided to the coolant temperature transducer (sending unit). The developed voltage is measured and scaled for use by the internal circuitry. This input is not used when the CAN interface is enabled.

Oil Pressure

A current of 30 milliamperes is provided to the oil pressure transducer. The developed voltage is measured and scaled for use by the internal circuitry. This input is not used when the CAN interface is enabled.

Fuel Level And Fuel Leak

A current of less than 20 milliamperes is provided to the fuel level transducer. The developed voltage is measured and scaled for use by the internal circuitry. The internal fuel level transducer failure circuitry and the fuel leak detector also use this input. An open circuit across these terminals will indicate a failed fuel level transducer. A resistance of less than five ohms is used to indicate either a failed fuel level transducer or a fuel leak detector contact closure.

Sender Return Connection

It is important to connect the sender return terminal to battery minus at the engine chassis of the genset. The purpose of this connection is to isolate the analog senders voltage signals from the voltage drop that exists in the power leads between the DGC-1000 and the engine's battery. This voltage drop will adversely affect the accuracy of the readings from the analog senders. Because this input provides some resistive isolation with respect to battery minus within the DGC-1000, leaving it disconnected will cause considerable error in the readings from the analog senders and the battery voltage. The input should also not be jumpered back to battery minus at the DGC-1000 as this will defeat the purpose of having a separate connection

NOTE

The sender return terminal must be connected to battery minus back at the engine chassis to minimize the error in the analog sender and battery voltage readings.

Speed Signal Inputs

Generator Voltage

The voltage from the monitored generator is scaled and conditioned for use by the internal circuitry as a speed signal source circuitry. Differential amplifiers provide isolation for these inputs.

Magnetic Pickup

The voltage from the magnetic pickup is scaled and conditioned for use by the internal circuitry as a speed signal source. This input is not used when the CAN interface is enabled.

Voltage Inputs

Monitored generator voltages are sensed and scaled to levels suitable for use by the internal circuitry. Differential amplifiers provide isolation for these inputs. Internal circuitry selects line-to-line, line-to-neutral or single-phase values. Menu selections by the user determine these switch settings.

Current Inputs

Monitored generator currents are sensed and scaled to values suitable for use by the internal circuitry. Internal current transformers provide isolation. Two taps on the primary of these transformers accommodate either one or five ampere circuits.

Serial Communication/Ethernet Adaptor Port

This optically-isolated RS-232 port enables communication between the DGC-1000 and a PC running BESTCOMS software or a serial server connected to an Ethernet network.

Since the DGC-1000 does not communicate directly over Ethernet, an external device is required. One such device is the Vlinx Ethernet Serial Server, model ESP901 from B & B Electronics Manufacturing Company (www.bb-elec.com). This “serial server” has a 10/100 Mbps connection to an Ethernet LAN/WAN and a serial port to connect to the DGC-1000. Software included with the serial server is to be installed on the PC running BESTCOMS. The serial server manual assists the user in installing the software, configuring the server, and setting up a virtual communication port with the serial communication parameters necessary to communicate with BESTCOMS. Once installed and configured, the network is transparent to the DGC-1000 and BESTCOMS.

CAN Interface for ECU Communications

A controller area network (CAN) is a standard interface that allows communication between multiple controllers on a common network using the SAE J1939 message protocol or MTU MDEC communication protocol. Applications using an engine-driven generator set controlled by a DGC-1000, may also have an Engine Control Unit (ECU). The CAN interface allows the ECU and a DGC-1000 to communicate. The ECU will report operating information to the DGC-1000 via the interface. Operating parameters and diagnostic information, if supported, are decoded and displayed for monitoring.

The primary use of the CAN interface is to obtain engine operating parameters for monitoring speed, coolant temperature, oil pressure, coolant level and engine hours without the need for direct connection to individual senders. These parameters are transmitted via the CAN interface at preset intervals. See the column labeled Update Rate in Table 3-1 for transmission rates. This information can also be transmitted upon user request.

Table 3-1. Operating Parameters Obtained from CAN Interface Using J1939 Communication

Parameter	Metric Units	English Units	Update Rate	Decimal Place	SPN#
ECU Parameters Menu – Main Menu					
Throttle Position	%	%	50 ms	10th	91
Percent Load at Current RPM	%	%	50 ms	None	92
Actual Engine Percent Torque	%	%	Engine speed dependent	None	513
Engine Speed	rpm	rpm	Engine speed dependent	None	190
Injection Control Pressure	MPa	psi	500 ms	None	164
Injector Metering Rail Pressure	MPa	psi	500 ms	None	157
Total Engine Hours	hours	hours	Requested 1.5 s	100th	247
Trip Fuel	liters	gallons	Requested 1.5 s	None	182
Total Fuel Used	liters	gallons	Requested 1.5 s	None	250
Engine Coolant Temperature	°C	°F	1 s	None	110
Fuel Temperature	°C	°F	1 s	None	174
Engine Oil Temperature	°C	°F	1 s	10th	175
Engine Intercooler Temperature	°C	°F	1 s	None	52
Fuel Delivery Pressure	kPa	psi	500 ms	10th	94
Engine Oil Level	%	%	500 ms	10th	98
Engine Oil Pressure	kPa	psi	500 ms	10th	100
Coolant Pressure	kPa	psi	500 ms	10th	109
Coolant Level	%	%	500 ms	10th	111
Fuel Rate	liter/hr	gal/hr	100 ms	100th	183
Barometric Pressure	kPa	psi	1 s	10th	108
Ambient Air Temperature	°C	°F	1 s	10th	171
Air Inlet Temperature	°C	°F	1 s	None	172
Boost Pressure	kPa	psi	500 ms	None	102
Intake Manifold Temperature	kPa	psi	500 ms	None	105
Air Filter Differential Pressure	kPa	psi	500 ms	100th	107
Exhaust Gas Temperature	°C	°F	500 ms	10th	173
Electrical Potential Voltage	volts	volts	1 s	10th	168
Battery Potential Voltage Switched	volts	volts	1 s	10th	158
Oil Filter Differential Pressure	kPa	psi	1 s	10th	99
Fuel Filter Differential Pressure	kPa	psi	1 s	None	95
Crankcase Pressure	kPa	psi	500 ms	100th	101
Engine Configuration Submenu – Press Select to enter submenu and Previous to exit submenu					
Engine Speed at Idle Point 1	rpm	rpm	5 s	None	188
Percent Torque at Idle Point 1	%	%	5 s	None	539
Engine Speed at Point 2	rpm	rpm	5 s	None	528
Percent Torque at Point 2	%	%	5 s	None	540
Engine Speed at Point 3	rpm	rpm	5 s	None	529
Percent Torque at Point 3	%	%	5 s	None	541
Engine Speed at Point 4	rpm	rpm	5 s	None	530
Percent Torque at Point 4	%	%	5 s	None	542
Engine Speed at Point 5	rpm	rpm	5 s	None	531
Percent Torque at Point 5	%	%	5 s	None	543
Engine Speed at High Idle Point 6	rpm	rpm	5 s	None	532

Parameter	Metric Units	English Units	Update Rate	Decimal Place	SPN#
Gain (Kp) of Endspeed Governor	%/rpm	%/rpm	5 s	100th	545
Reference Engine Torque	N•m	lb/ft	5 s	None	544
Maximum Momentary Engine Override Speed Point 7	rpm	rpm	5 s	None	533
Maximum Momentary Engine Override Time Limit	s	s	5 s	10th	534
Requested Speed Control Range Lower Limit	rpm	rpm	5 s	None	535
Requested Speed Control Range Upper Limit	rpm	rpm	5 s	None	536
Requested Torque Control Range Lower Limit	%	%	5 s	None	538

Table 3-2 lists the operating parameters and annunciations obtained from the CAN interface using the MTU MDEC communication protocol.

Table 3-2. Operating Parameters Obtained from CAN Interface Using MTU MDEC Communication

Parameter	Metric Units	English Units	Update Rate	Decimal Place
Engine Coolant Temperature	°C	°F	100 ms when parameter changes, ≤20 s when not changing	None
Engine Oil Pressure	KPa	psi	100 ms when parameter changes, ≤20 s when not changing	10th
Engine Speed	rpm	rpm	100 ms when parameter changes, ≤20 s when not changing	None
Alarms, Pre-Alarms	N/A	N/A	As they occur	N/A

WARNING!

When the CAN interface is enabled, the unit will ignore the following sender inputs: oil pressure, coolant temperature and magnetic pickup.

The diagnostic function obtains the diagnostic condition of the transmitting electronic components. The DGC-1000 will receive an unsolicited message of the currently active diagnostic trouble codes (DTC). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request. See Table 3-3 for details on diagnostic messaging.

Table 3-3. Diagnostic Information Transmitted Over CAN Interface

Parameter	Transmission Repetition Rate
Active Diagnostic Trouble Code	1 s
Lamp Status	1 s
Previously Active Diagnostic Trouble Code	On request
Request to Clear Previously Active DTCs	On request
Request to Clear Active DTCs	On request

DTCs are reported in coded diagnostic information which include the Suspect Parameter Number (SPN), Failure Mode Identifier (FMI) and Occurrence Count (OC). All parameters have an SPN and are used to display or identify the items for which diagnostics are being reported. The FMI defines the type of failure detected in the subsystem identified by an SPN. The problem may not be an electrical failure but may be a subsystem condition needing to be reported to a technician or operator. The OC contains the number of times a fault has gone from active to previously active.

Programmable Contact Sensing Inputs

If the DGC-1000 has the auxiliary input and output option, there are four programmable contact sensing inputs. Each input is designed to accept a normally open contact. The contact is connected between the input and battery minus. These inputs may be configured through the BESTCOMS PC program as an alarm, pre-alarm or neither. When the contact sensing input is closed, the front panel display shows the name of the closed input if it was programmed as alarm or pre-alarm. If neither is programmed, no indication is given on the front panel display. Programming the input as neither is useful when a call to a pager without an alarm or pre-alarm is necessary or to close additional contacts using the auxiliary outputs.

Each input also has a programmable name, which may be up to eight characters in length. The default names are AUX IN 1, AUX IN 2, AUX IN 3, and AUX IN 4.

MICROPROCESSOR

Software stored in the programmable flash memory controls how the DGC-1000 functions and makes all decisions based on programming and system inputs. Formulas that are used to determine the various calculated quantities and circuits related to microprocessor inputs are described in the follow paragraphs.

Formulas

For line-to-line (VL-L) voltage sensing:

$$V_{AB} = \sqrt{V_A{}^2 + V_A \times V_B + V_B{}^2}$$
$$V_{BC} = \sqrt{V_B{}^2 + V_B \times V_C + V_C{}^2}$$
$$V_{CA} = \sqrt{V_C{}^2 + V_C \times V_A + V_A{}^2}$$

For the four-wire delta case (with the mid-point between phases B and C connected to the voltage neutral terminal on the DGC-1000):

$$V_{AB} = \sqrt{V_A{}^2 + V_B{}^2}$$
$$V_{BC} = V_B + V_C$$
$$V_{CA} = \sqrt{V_C{}^2 + V_A{}^2}$$

For three-phase voltage sensing configurations:

kVA: $kVA_A = (V_{AB} \times I_A) \div (1000\ \sqrt{3})$
$kVA_B = (V_{BC} \times I_B) \div (1000\ \sqrt{3})$
$kVA_C = (V_{CA} \times I_C) \div (1000\ \sqrt{3})$
$kVA_{TOTAL} = KVA_A + KVA_B + KVA_C$

kW: $kW_A = kVA_A \times PF$
$kW_B = kVA_B \times PF$
$kW_C = kVA_C \times PF$
$kW_{TOTAL} = kVA_{TOTAL}\ PF$

PF (power factor) equals the cosine of the measured angle between voltage and current zero-crossings.

For single-phase (V_A to V_B) voltage sensing configurations:

kVA: Total kVA $= kVA_A + kVA_B$
$= (V_{AN} \times I_A \div 1000) + (V_{BN} \times I_B \div 1000)$

kW: Total kW $= kW_A + kW_B$
$= (kVA_A \times PF) + (kVA_B \times PF)$

Related Circuits

Zero Crossing Detection

The zero crossing of the A phase voltage or A to B line voltage and the B phase current is detected and used to calculate the phase angle between the current and voltage. This zero crossing is also used to measure the generator frequency.

Signal Switching

Solid state switches under microprocessor control, select the voltage or current sensing signal that is applied to the rms-to-dc converter. The resulting signal is sent to the twelve-bit analog-to-digital converter where it is digitized for use by the microprocessor.

RMS-to-DC Converter

Scaled and conditioned signals representing the voltage and current sensing inputs are used as the input to the rms to dc converter. This converter output is a dc level proportional to the rms value of the input.

Analog-to-Digital Converter

Signals from the rms to dc converter, coolant temperature sensing input, fuel level sensing input and the oil pressure sensing input are digitized by the twelve-bit, analog-to-digital converter. The digitized information is stored in random access memory (RAM). This information is used by the microprocessor for all metering and protection functions.

OUTPUTS

Each output relay is controlled by the microprocessor and the emergency stop contact input. All outputs are electrically isolated from each other and from the internal circuitry. Two outputs (start and fuel solenoid) are associated with engine cranking functions. The remaining four outputs (Figure 3-1) are associated with the following conditions: pre-start, supplying load, pre-alarm and alarm.

Emergency Stop Contact Input Interaction

When the emergency stop contact input is open, all output contacts open. When the emergency stop contact input is closed and a signal is given by the microprocessor, the output contacts close

Remote Display Panel

When the DGC-1000 is combined with the RDP-110, many of the alarm and pre-alarm conditions are indicated remotely. The following alarms are indicated by LED's and an audible alarm on the RDP-110: low coolant level, high coolant temperature, low oil pressure, overcrank, overspeed, emergency stop, fuel leak/fuel level sender failure and engine sender unit failure. The following pre-alarms are also displayed on the RDP-110: high coolant temperature, low coolant temperature, low oil pressure, low fuel level, battery overvoltage, weak battery and battery charger failure. In addition to these alarms and pre-alarms, the RDP-110 also indicates when the RUN/OFF/AUTO switch is not in auto and when the Emergency Power System (EPS) is supplying load.

Optional Auxiliary Outputs

If the DGC-1000 has the auxiliary input and output option, there are eight programmable output contacts. These outputs may be programmed through the BESTCOMS PC program to close when any of the selected inputs is active. Multiple outputs may be programmed to close when a single input is active. Also, multiple inputs may be programmed to close a single output.

TELEPHONE MODEMS

Two modems with dial-in, dial-out capability are available as optional equipment on the DGC-1000. The standard modem is rated from 0°C to 50°C (32°F to 122°F). The extended operating temperature range modem is rated from -40°C to 70°C (–40°F to 158°F). With the optional phone modem, the DGC-1000 can dial out to inform a pager that an alarm or pre-alarm condition has occurred. Up to four phone numbers can be dialed in sequence until an answer is received. The supplied modem is registered with the FCC under Part 68.

Type of Service

The DGC-1000 is designed to be used on standard device telephone lines and connects to the telephone line by means of a standard jack called the USOC RJ-11C. Connection to telephone company provided coin service (central office implemented systems) is prohibited. Connection to party lines service are subject to state tariffs.

Telephone Company Procedures

The goal of the telephone company is to provide you with the best service it can. In order to do this, it may occasionally be necessary for them to make changes in their equipment, operations or procedures. These changes might affect your service or the operation of your equipment, the telephone company will give you notice, in writing, to allow you to make any changes necessary to maintain uninterrupted service.

In certain circumstances, it may be necessary for the telephone company to request information from you concerning the equipment which you have connected to your telephone line. Upon request of the telephone company, provide the FCC registration number and the ringer equivalence number (REN); both items are listed on the label on the modem on the rear of the DGC-1000. The sum of all of the RENs on your telephone lines should be less than five in order to assure proper service from the telephone company. In some cases, a sum of five may not be usable on a given line.

If Problems Arise

If any of your telephone equipment is not operating properly, you should immediately remove it from your telephone line because it may cause harm to the telephone network. If the telephone company notes a problem, they may temporarily disconnect service. When practical, they will notify you in advance of this disconnection. If advance notice is not feasible, you will be notified as soon as possible. When you are notified, you will be given the opportunity to correct the problem and be informed of your right to file a complaint with the FCC. Contact your telephone company if you have any questions about your telephone line.

Cellular Communications

Data transfer over an analog cellular system may be optimized when the MNP10-EC (Microcom Network Protocol, Class 10, Enhanced Cellular) protocol is used. The modem connected to the PC must be capable of supporting this protocol. It is also necessary to invoke this protocol with the appropriate initialization string. This initialization string may be stored independently with each of the phone book entries. (Refer to the Section 6, *BESTCOMS Software*.) When MNP10-EC protocol is enabled on the landline modem, the DGC-1000 modem will automatically use MNP10-EC. This allows the user to enable and disable the MNP10-EC protocol by simply changing the initialization string. An example of a typical initialization strings is as follows:

AT &F\N5-SEC=1,18-K1M1L2

AT	Informs the modem that commands are being sent to it.
&F	Forces factory default settings.
\N5	Forces connection using MNP10-EC. (\N2 would allow the protocol to be negotiated as LAPM or MNP.)
-SEC=1,18	Enables MNP10-EC protocol, and sets the transmit level at –18dBm
-K1	Enables V.42 LAPM to MNP10 conversion.
M1	Enables speaker during dial-up. (M2 would leave speaker on all of the time, and M0 turns the speaker off.)
L2	Sets the speaker volume. (L0 is off, and L3 is the maximum value.)

The required initialization string will differ between different makes and models of modems. Please consult the modem's manual for the proper initialization strings.

MNP10-EC adjusts the communication parameters during cellular connection and transmission to provide quicker initial connection, to provide maximum throughput and to avoid disconnects. MNP10-EC recognizes typical signal impairments caused by the cellular environment and quickly recovers from the impairments. Typical impairments for which MNP10-EC compensates include frequent hand-offs, dropouts, call inference, fading and echo. Performance is significantly improved when the modems on each end of the connection support MNP10-EC.

SOFTWARE

Software embedded in the DGC-1000 controls all aspects of device functionality. This comprises power-up initialization, front panel set up and configuration, input contact status monitoring, protective function detection and annunciation, system parameter monitoring, output contact status control and RS-232 serial communications.

Power-Up Sequence

When battery power is first applied, the DGC-1000 initiates a power up sequence. The version of embedded software is displayed on the LCD and the memory is checked. Then all configuration data stored in non-volatile EEPROM is brought into main memory. Immediately after this, the LCD display begins in the Normal mode. When the Normal mode is displayed, all enabled functions are activated and input monitoring begins.

NOTE

The run-time counter, kilowatt-hour meter and maintenance timers are updated in volatile memory once per minute. Updated values are saved to nonvolatile memory when the Auto/Off/Run mode of operation is changed. Additionally, while the engine is running, the run time counter is saved every 15 minutes and the kilowatt-hour meter is saved every eight hours. If the battery power source fails during operation, these values are not updated and the changes made after the last save operation are irretrievably lost.

Watchdog Timer

The purpose of the watchdog timer is to re-initialize the microprocessor and restart the software execution process in the event that normal software execution is interrupted. During normal software execution, the watchdog timer is periodically reset to prevent it from expiring and initiating a software reset.

When the watchdog timer expires, the unit re-initializes itself as it normally does on power-up. If the user was logged into BESTCOMS when a watchdog timeout occurs, then BESTCOMS will lose communication with the DGC-1000. The user must close and reopen communications. If the watchdog times out five times between power cycles, then the unit will lock-up in a safe mode. The LCD of a locked up unit will read: "WATCHDOG FAILURE," "CYCLE POWER TO RESET." As long as the unit has not gone into the safe mode, BESTCOMS will notify the user of a watchdog timeout next time he or she logs onto the unit. After a watchdog timeout, the unit will return to the mode ("Run" but only if engine speed is still above crank disconnect speed; "Off" or "Auto") it was last in before the reset occurred, unless it has gone into the safe mode. The user must cycle the power to get out of safe mode. When in safe mode, the user cannot log on with BESTCOMS and the engine is shut off.

Cool Down Timer

In the Auto mode, this feature allows the engine to cool down by running unloaded for a programmed period of time. The cool down period of 0 to 60 minutes is programmed from the BESTCOMS software in one-minute increments. This cool down period will start when the load is removed or when the ATS contact opens. If load is removed from the generator prior to the ATS contact opening, the timer will start and continue to count while the ATS contact opens. At the time of the ATS contact opening, the remaining time of the cool down timer will be used and once the total remaining time is consumed, the engine will shutdown. A setting of 0 is used when no cool down period is desired.

Speed Source Failure

This function monitors the signal from the speed signal source selected from the BESTCOMS software. If only one source is selected and the signal from that source is lost, an alarm and a shutdown occurs and SPEED SIGNAL SOURCE FAILURE is displayed on the LCD. If both magnetic pickup and generator voltage are selected as speed signal sources and the magnetic pickup unit (MPU) fails, the DGC-1000 will switch to using generator voltage as the speed signal source and the LCD display will alternate between displaying the run time and MPU on the display. If the generator voltage signal also fails, an alarm and shutdown occurs. This function checks for the presence of a signal only; it is not a sender continuity check.

Cranking

The DGC-1000 is programmable for either cycle crank or continuous crank. If cycle cranking is chosen, the number of crank cycles allowed before the system shuts down can be selected. A crank cycle is defined as 5 to 15 seconds of crank followed by an equal number of seconds of rest, selectable in 1-second increments. The maximum number of cycles the DGC-1000 will allow is 7. If NFPA 100 Level 1 is chosen, the number of crank cycles is 5.

If a delay to crank feature has been selected, the DGC-1000 will close the pre-start contact upon receipt of a start command. The pre-start contact is programmable to either remain energized or to drop out after the delay has expired.

Figure 3-2 illustrates one normal and four abnormal engine starts (crank curves).

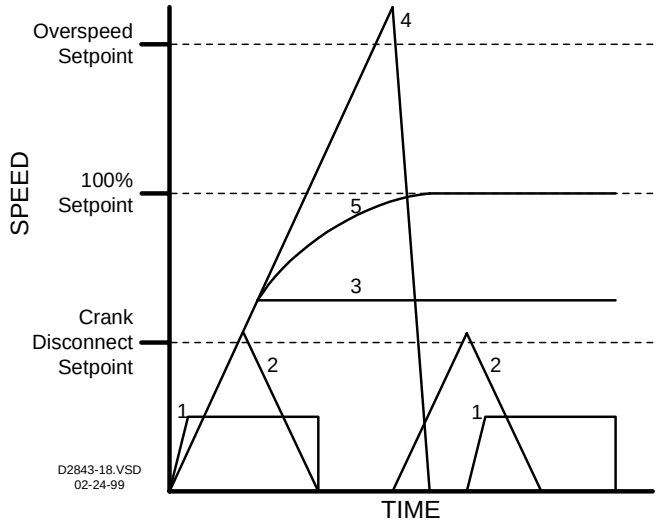

Figure 3-2. Normal and Abnormal Engine Crank Curves

Abnormal Start Curve One

This curve shows the typical cycle crank when a start signal is received. When the signal is received, the fuel solenoid and start contacts close and engine speed begins to increase. The fuel solenoid and start contacts remain closed until the crank cycle time is met. The start contact will open if the prime mover speed increases past the crank disconnect speed setting. The fuel solenoid contact remains closed above the crank disconnect speed. If the prime mover fails to start after the prescribed time, the rest timer is started and the starter solenoid and fuel solenoid contacts are opened. The crank cycle is repeated until the prime mover speed increases past the crank disconnect setpoint or the programmed number of crank cycles has been met and an overcrank condition occurs.

Abnormal Start Curve Two

This curve shows a failure to start condition. The prime mover reaches the crank disconnect setpoint but fails to start. If this condition occurs, the DGC-1000 has cranked the engine through one cycle of crank time and the engine is coasting down to a stop. After the rest period time has expired, the DGC-1000 will continue to cycle crank for the remainder of the crank cycles or the engine starts.

Abnormal Start Curve Three

This curve shows an engine start but the engine fails to reach rated speed. If this condition occurs, the start contact opens and the engine continues to run until it is turned off.

Abnormal Start Curve Four

This curve shows a typical overspeed occurrence. If this condition occurs, the engine, upon reaching the overspeed setpoint, will be shut down by the DGC-1000 opening the fuel solenoid contact and annunciate an alarm by closing the alarm contact.

Normal Start Curve Five

This curve shows a typical normal start and run condition. When this occurs, the start contact opens after the prime mover passes through the crank disconnect speed setpoint. The engine speed increases until the 100% setpoint is reached.

Alarms

Reset of all alarms can only be done locally by setting the Auto/Off/Run switch to the OFF position. All alarm conditions will light a red LED (labeled Alarm) along with displaying the condition on the LCD screen and sounding the optional audible alarm. All alarms have a common Form A contact. When an alarm condition occurs, the display indicates the cause of the alarm, the Form A Alarm contact closes and the fuel solenoid contact opens which shuts down the engine.

Overcrank Alarm

When the crank timer times out, cranking terminates. At that time, the common alarm contacts close and the LCD displays the message OVERCRANK and the current overcrank setting.

Overspeed Alarm

If the engine speed exceeds the overspeed value programmed by BESTCOMS and continues until the programmed delay time expires, an overspeed alarm occurs. At that time, the common alarm contact closes and the LCD displays the message OVERSPEED and the current overspeed setting.

High Coolant Temperature Alarm

If the engine coolant temperature exceeds the level programmed by the BESTCOMS software, an alarm occurs. At that time, the common alarm contact closes and the LCD displays the message, HIGH COOLANT TEMP and the current high coolant temperature setting.

Low Oil Pressure Alarm

If the oil pressure decreases below the low oil pressure alarm setting programmed by the BESTCOMS software, an alarm occurs. At that time, the common alarm contact closes and the LCD displays the message, LOW OIL PRESSURE and the current low oil pressure alarm setting.

Engine Sender Fault Alarm

If a failure of an engine sender (transducer) is enabled by the BESTCOMS software and a failure occurs, an alarm occurs. At that time, the common alarm contact closes and the LCD displays the message SENDER FAILURE and the failed sender. If a short circuit is detected across the fuel level transducer/fuel leak detector input, the message SENDER FAIL/FUEL LEAK is displayed.

Low Fuel Level Alarm

If the fuel level decreases below the low fuel level alarm setting programmed by the BESTCOMS software, an alarm occurs. At that time, the common alarm contact closes and the LCD displays the message, LOW FUEL LEVEL and the current low fuel level alarm setting.

Low Coolant Level Alarm

This alarm stops the engine when a loss of coolant is detected via the low coolant level contact input. At that time, the common alarm contact closes and the LCD displays the message LOW COOLANT LEVEL.

CAN Bus Alarm

A CAN Bus Failure annunciation may be enabled only when the CAN interface is enabled. The CAN interface is configurable from BESTCOM. When configured to pre-alarm, annunciation occurs when CAN communication is lost either by the unit becoming disconnected from the ECU or the ECU malfunctioning. If CAN communication is lost and the annunciation is configured as an alarm, then a normal alarm sequence will occur, including a CANBUS FAILURE ALARM message that appears on the display.

MTU MDEC ECU Alarms

A DGC-1000 connected to a genset equipped with an MTU MDEC engine controller is capable of annunciating a set of alarms unique to the MDEC ECU. Alarms issued by the MDEC ECU can be viewed on the MTU MDEC tab of the BESTCOMS Metering screen or through the front panel display. When an MDEC alarm is in effect, the front panel Alarm LED lights and the alarm message text is displayed on the front panel LCD. The first line displayed in an MDEC alarm message is MDEC ECU ALARM. The second line of an MDEC alarm message displays text specific to the alarm condition. If multiple alarms exist at the same time, then the first alarm encountered is the one displayed. The following paragraphs describe each of the eight MDEC alarm types. For more detailed information, refer to your MDEC ECU documentation.

HIGH CHARGE AIR TEMP. This alarm is annunciated when the MDEC ECU detects excessive turbocharger air temperature.

HIGH OIL TEMPERATURE. This alarm is annunciated when the MDEC ECU detects excessive engine oil temperature.

HIGH COOLANT TEMP. This alarm is annunciated when the MDEC ECU detects excessive engine coolant temperature. The trigger for this alarm is controlled by the ECU and operates independently of the DGC-1000 high coolant temperature alarm setting.

LO AFTERCLR COOL LVL. This alarm is annunciated when the MDEC ECU detects that the engine aftercooler coolant level is low.

LO FUEL DLV PRESSURE. This alarm is annunciated when the MDEC ECU detects low engine fuel pressure. The trigger for this alarm is controlled by the ECU and operates independently of the DGC-1000 low oil pressure alarm setting.

OVERSPEED. This alarm is annunciated when the MDEC ECU detects excessive engine speed (rpm).

COMBINED RED. This alarm is annunciated when the MDEC ECU issues a “red” shutdown (Level 2) message.

Pre-Alarms

A pre-alarm condition is annunciated by the DGC-1000 in the following ways:

- The front panel Alarm LED flashes on and off.
- The horn output cycles on and off. (The horn output can be enabled or disabled for pre-alarms in BESTCOMS.)
- A single set of Form A (SPST) output contacts closes.
- The front panel LCD displays the pre-alarms and associated values.

Low oil pressure, high coolant temperature, and battery voltage pre-alarms are shown on the main display of the front panel LCD. All other pre-alarms are individually displayed in sequence using the Alternate display mode. Values are flashed on and off to indicate their pre-alarm status. All pre-alarm parameters are displayed in this manner before non-pre-alarm parameters.

Pre-alarms are reset by correcting the cause of the pre-alarm. Audible pre-alarms are reset by pressing the Alarm Silence pushbutton on the front panel.

Magnetic Pickup (MPU) Failure Pre-Alarm

If the speed signal source is selected for MPU/GEN (Magnetic Pickup, Generator Frequency) via BESTCOMS, a pre-alarm will be annunciated when the MPU fails.

High Coolant Temperature Pre-Alarm

If engine coolant temperature increases above the high coolant temperature pre-alarm setpoint programmed by the BESTCOMS software for the programmed delay time, a pre-alarm occurs.

Low Coolant Temperature Pre-Alarm

If engine coolant temperature decreases below the low coolant temperature pre-alarm setpoint programmed by the BESTCOMS software for the programmed delay time, a pre-alarm occurs.

Weak Battery Pre-Alarm

If the battery voltage drops below 60% of the nominal voltage for more than 2 seconds during engine cranking, a pre-alarm occurs. The message, WEAK BATTERY is displayed in the alternate display mode and is reset by scrolling through the alternate display.

Low Battery Voltage Pre-Alarm

If the battery voltage decreases below the low battery voltage value programmed by the BESTCOMS software, a pre-alarm occurs.

Battery Overvoltage Pre-Alarm

If the battery voltage exceeds the battery over voltage level programmed by the BESTCOMS software, a pre-alarm occurs.

Low Fuel Level Pre-Alarm

If the fuel level decreases below the low fuel level pre-alarm value programmed by the BESTCOMS software, a pre-alarm occurs.

Engine Overload Pre-Alarm

If the engine load exceeds the engine overload level pre-alarm value programmed by the BESTCOMS software, a pre-alarm occurs.

Battery Charger Failure Pre-Alarm

If a battery charger failure is detected via the battery charger fail contact input, a pre-alarm occurs.

Maintenance Pre-Alarm

When the next scheduled maintenance timer reaches zero hours, a pre-alarm occurs. After the required maintenance is performed, the pre-alarm can be cleared either from BESTCOMS or the front panel. To clear the pre-alarm from the front panel, go to the alternate display mode and scroll to the screen that displays HRS TO NEXT SERVICE. Pressing the Select/Enter button while on this screen will clear the maintenance pre-alarm and reset the maintenance timer back to its programmed starting value.

Active DTC Pre-Alarm

When CAN Bus and DTC Support are both enabled, an "active DTC" pre-alarm may be enabled from BESTCOMS to announce the presence of a current condition that is causing a diagnostic trouble code to be sent to the DGC-1000 from the ECU.

CAN Bus Pre-Alarm

A CAN Bus Failure annunciation may be enabled only when the CAN interface is enabled. The CAN interface is configurable from BESTCOMS. When configure to alarm, annunciation occurs when CAN communication is lost either by the unit becoming disconnected from the ECU or the ECU malfunctioning. If CAN communication is lost and the annunciation is a pre-alarm, a screen will appear in the Alternate Display stating the pre-alarm and will be viewable only when the pre-alarm is in progress.

MTU MDEC ECU Pre-Alarms

A DGC-1000 connected to a genset equipped with an MTU MDEC engine controller is capable of annunciating a set of pre-alarms unique to the MDEC ECU. Pre-alarms issued by the MDEC ECU can be viewed on the MTU MDEC tab of the BESTCOMS Metering screen or through the alternate display mode of the front panel display. If more than one pre-alarm is present, the Raise and Lower pushbuttons can be used to scroll through the list. When an MDEC ECU pre-alarm is active, the front panel Alarm LED flashes on and off. The first line displayed in an MDEC pre-alarm message is MDEC ECU PREALARM. The second line of an MDEC pre-alarm message displays text specific to the pre-alarm condition. The following paragraphs describe each of the eight MDEC pre-alarm types. For more detailed information, refer to your MDEC ECU documentation.

HIGH ECU TEMPERATURE. This pre-alarm is annunciated when excessive temperature is detected within the ECU.

HIGH OIL TEMPERATURE. This pre-alarm is annunciated when the MDEC ECU detects excessive engine oil temperature.

HIGH INTERCOOLER TEMP. This pre-alarm is annunciated when the MDEC ECU detects excessive coolant temperature in the engine aftercooler.

HIGH CHARGE AIR TEMP. This pre-alarm is annunciated when the MDEC ECU detects excessive turbocharger air temperature.

HIGH COOLANT TEMP. This pre-alarm is annunciated when the MDEC ECU detects excessive engine coolant temperature. The trigger for this alarm is controlled by the ECU and operates independently of the DGC-1000 high coolant temperature pre-alarm setting.

SS OVERRIDE ON. This pre-alarm is annunciated when the MDEC ECU broadcasts an override pre-alarm.

HIGH FUEL RAIL PRESS. This pre-alarm is annunciated when the MDEC ECU detects excessive pressure in the engine’s fuel rail.

LOW FUEL RAIL PRESS. This pre-alarm is annunciated when the MDEC ECU detects low pressure in the engine’s fuel rail.

LOW COOLANT LEVEL. This pre-alarm is annunciated when the MDEC ECU detects low engine coolant level.

LOW CHARGE AIR PRESS. This pre-alarm is annunciated when the MDEC ECU detects low air pressure at the output of the engine turbocharger.

LOW FUEL DELIV PRESS. This pre-alarm is annunciated when the MDEC ECU detects low engine fuel pressure.

LOW OIL PRESSURE. This pre-alarm is annunciated when the MDEC ECU detects low engine oil pressure.

COMBINED YELLOW. This alarm is annunciated when the MDEC ECU issues a “yellow” warning (Level 1) message.

MTU MDEC ECU Fault Codes

A DGC-1000 connected to a genset equipped with an MTU MDEC engine controller tracks and displays the active fault codes issued by the MDEC ECU. Active MDEC ECU fault codes can be viewed on the MTU MDEC tab of the BESTCOMS Metering screen or through the alternate display mode of the front panel display. If any MDEC fault codes are active, an alternate mode display screen with the text MDEC ACTIVE FAULTS SEL/ENTER TO VIEW will appear as the last screen in the list of alternate mode screens. Pressing **Select/Enter** views the first fault. The **Raise/Scroll** and **Lower/Scroll** keys can be used to scroll through all active faults. When one has scrolled through all the faults in the list, a screen will appear with the text NO MORE FAULTS PREVIOUS TO EXIT. One can scroll through the faults list as many times as desired. Pressing **Previous** at any time returns to the alternate mode display screens. The menu mode is accessed by pressing **Display Toggle** at any time. If no fault codes are active, the MDEC ACTIVE FAULTS screen will not be displayed in the alternate mode screens.

A fault code is displayed with a first line of MDEC FAULT CODE: XXX, where XXX is the fault code number. The second line of a fault code message displays text describing the fault. MDEC ECU fault codes are listed below with the corresponding fault numbers. Fault numbers not listed display “NO TEXT AVAILABLE” as the descriptive text. For more detailed information, refer to your MDEC ECU documentation.

3, L1 T-FUEL
5, L1 T-CHRG AIR
9, L1 T-INTERCOOLER
15, L1 P-LUBE OIL
16, L2 P-LUBE OIL
19, L1 T-EXHAUST A
21, L1 T-EXHAUST B
23, L1 COOLANT LEVEL
24, L2 COOLANT LEVEL
30, ENGINE OVERSPEED
31, CHRGR1 OVERSPD 1
32, CHRGR1 OVERSPD 2
33, L1 P-FUELFLT DIF
44, L1 LEVEL INTRCLR
45, L2 LEVEL INTRCLR
51, L1 T-LUBE OIL
57, L1 P-COOLANT
58, L2 P-COOLANT
63, L1 P-CRANKCASE
65, L1 P-FUEL
67, L1 T-COOLANT
68, L2 T-COOLANT
69, L1 T-EXTERN 1
70, L2 T-EXTERN 1
71, L1 T-EXTERN 2
72, L2 T-EXTERN 2
73, L1 P-EXTERN 1
74, L2 P-EXTERN 1
75, L1 P-EXTERN 2
76, L2 P-EXTERN 2
77, LIN EXT CLNT LEV
78, LIN INTERCLR LEV
79, L BIN-EXTERN 3
80, L BIN-EXTERN 4
90, IDLE SPEED LOW
91, RUNUP SPEED LOW
92, START SPEED LOW
93, PREHT TMP. LIM 2
94, PREHT TMP. LIM 1
100, EDM NOT VALID
101, IDM NOT VALID
102, INVLD FUEL CNS 1
103, INVLD FUEL CNS 2
104, OP HRS1 INVALID
105, OP HRS2 INVALID
106, ERR REC1 INVALID
107, ERR REC2 INVALID
118, L1 SPPLY VOLT LO
119, L2 SPPLY VOLT LO
120, L1 SPPLY VOLT HI
121, L2 SPPLY VOLT HI
122, L1 T-ELECTRONIC
134, 15V POSECU DEFCT
136, 15V NEGECU DEFCT
137, L1 5V BUFFR TEST
138, SENSOR PWR DEFCT
139, L1 TE BUFFR TEST
140, TE BUF ECU DEFCT
142, BANK1ECU DEFECT
144, BANK2ECU DEFECT
145, 15V GOODECU DFCT
147, AD-TST1ECU DEFCT
149, AD-TST2ECU DEFCT
151, AD-TST3ECU DEFCT
170, MI MODULE FAIL
171, MI NOT ACTIVE
172, TBO EXPIRED
173, MODL WRITE LIMIT
180, CAN1 NODE LOST
181, CAN2 NODE LOST
183, CAN NO PU-DATA
184, CAN PUDATA EE-FL
185, CAN LESS MAILBXS
186, CAN1 BUS OFF
187, CAN1 ERROR PASSV
188, CAN2 BUS OFF
189, CAN2 ERROR PASSV
201, SD T-COOLANT
202, SD T-FUEL
203, SD T-CHARGE AIR
205, SD T-CLNT INTERC
208, SD P-CHARGE AIR
211, SD P-LUBE OIL
214, SD P-CRANKCASE
215, SD P-RAIL FUEL
216, SD T-LUBE OIL
220, SD COOLANT LEVEL
222, SD LVL LKG FUEL
223, SD LVL INTERCLR
230, SD CRANKSHFT SPD
231, SD CAMSHAFT SPD
245, SD POWER SUPPLY
246, SD T-ELECTRONIC
249, SD CAN STOP
250, SD CAN SPD DEMND
251, SD CAN UP/DOWN
252, SD CAN NOTCH POS
253, SD CAN OVERRIDE
254, SD CAN TST OVRSP
260, SD 15V POS SPPLY
261, SD 15V NEG SPPLY
262, SD 5V BUFFR TEST
263, SD TE BUFFR TEST
264, SD BANK 1 TEST
265, SD BANK 2 TEST
266, SD SPD DEMAND AN
267, SD SPDMTEST BNCH
269, SD LOAD PLS ANLG
271, SD T-EXTERN 1
272, SD T-EXTERN 2
273, SD P-EXTERN 1
274, SD P-EXTERN 2
275, MD EXT.CLNT LVL
276, MD INTERCLER LVL
277, MISDATA BIN-EXT3
278, MISDATA BIN-EXT4
279, SD CANRES TRIPFL
280, SD CAN ALRM RST
281, SD ADTEST1 SPPLY
282, SD ADTEST2 SPPLY
283, SD ADTEST3 SPPLY
284, SD CAN LAMP TEST

DISPLAY OPERATION

The DGC-1000 has three display modes: Normal, Alternate, and Menu. Pressing the **Display Toggle** pushbutton when in the Normal display mode allows the user to scroll through the Normal, Alternate, and menu display modes. DTC mode, when enabled, may be selected while in the Alternate mode. Figure 3-3 shows the top level of each display mode.

Normal Mode

This mode displays the engine and generator parameters as described by the labeling on the front panel. Pressing the **Phase Toggle** pushbutton when the engine is running scrolls through the voltage and current measurements that are available.

Alternate Display Mode

After pressing the **Display/Toggle** pushbutton to enter the alternate display mode, pressing the **Raise/Scroll** or **Lower/Scroll** pushbutton allows the user to scroll through the alternate display mode screens.

Quantities are displayed in the following order.

- Oil pressure
- Coolant temperature
- Fuel level
- Battery voltage
- Total kilowatt load
- Hours to next service
- Generator A-B voltage
- Generator B-C voltage (3-phase sensing)
- Generator C-A voltage (3-phase sensing)
- Generator A-N voltage (except 3-phase L-L sensing)
- Generator B-N voltage (except 3-phase L-L sensing)
- Generator C-N voltage (3-phase L-N sensing only)
- Generator phase A, B, and C currents
- Phase A kVA
- Phase B kVA
- Phase C kVA (3-phase sensing)
- Total kVA
- Generator phase A kilowatts
- Generator phase B kilowatts
- Generator phase C kilowatts (3-phase sensing)
- Generator total kilowatt-hours
- Generator power factor
- Generator frequency
- Total run hours
- Engine speed
- Unit identification number
- Coolant level (CAN interface enabled)
- Active DTC list (CAN interface and diagnostics enabled)
- Previous DTC list (CAN interface and diagnostics enabled)
- MDEC ECU pre-alarms
- MDEC ECU active faults

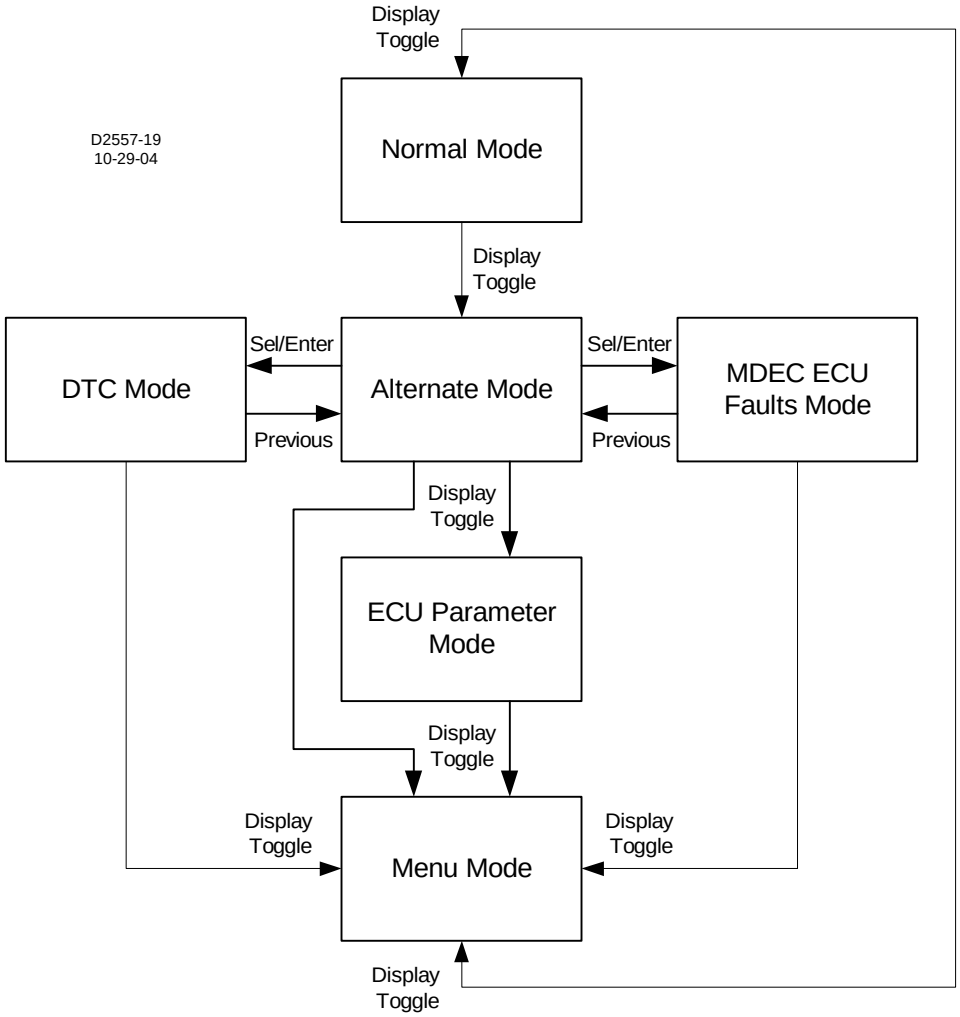

Figure 3-3. Top Level of Display Modes

Diagnostic Trouble Codes (DTC) Display Mode

Access to the Diagnostic Trouble Codes (DTCs) screens can be gained in the Alternate Display mode. The DTCs are the last two screens in the Alternate Display list. DTC screens are only available when the CAN interface and DTCs are enabled.

If there are no DTCs communicating with the unit, the **Select/Enter** button will have no affect, and "ACTIVE DTC LIST" and "NO DTC(S) TO VIEW" will be displayed. If there is at least one DTC communicating with the unit, the **Select/Enter** button will be an active input, and "ACTIVE DTC LIST" and "PRESS SELECT TO VIEW" will be displayed.

Pressing **Select/Enter** when “ACTIVE DTC LIST” and “PRESS SELECT TO VIEW” is displayed will put the DGC-1000 in DTC Mode. The next screen to appear will display the diagnostic lamp status information obtained from the ECU. One of five possible lamp status messages will be displayed. The list of possible messages in decreasing order of priority includes:

1. ENGINE STOP LAMP LIT
2. WARNING LAMP LIT
3. MALFUNCTION LAMP LIT
4. PROTECT LAMP LIT
5. NO LAMP IS LIT

Only one lamp status will be displayed from the front panel, the one with the highest priority that is currently true. The user may use BESTCOMS to view the status of all lamps. An example of the lamp status screen is shown below.

CURRENT LAMP STATUS
ENGINE STOP LAMP LIT

To be notified that a lamp status exists, the pre-alarm for Active DTCs must be enabled (from BESTCOMS). When one or more Active DTCs exists in the ECU, a lamp status should exist indicating the severity of the combined DTCs. After the pre-alarm is annunciated (through LED, Horn, and/or Dial-Out, the user will know to check the Lamp Status, Active DTCs in the system, and what relationship DTCs have with the parameters. (From the front panel, use the “ECU Parameters” menu to check the relationship. From BESTCOMS, hover the mouse over the DTC to see it’s related parameter).

To view the list of currently active DTCs, press **Raise/Scroll**. The next screen to appear will display the first DTC, the number of DTCs, the Suspect Parameter Number (SPN), the Failure Mode Indicator (FMI) and the Occurrence Count (OC).

NOTE: Always refer to the engine’s manual for the meaning of SPN and FMI combinations, *especially* for proprietary DTC descriptions.

In the DTC screen example of Figure 3-4, the first DTC of five is being displayed, the SPN is 111 (Coolant Level), the FMI is 1 (low voltage from the sender, thus we have Low Coolant Level), and the OC is 2 (the unit has had a low coolant level twice before). Refer to the engine manufacturer’s CAN Interface documentation for specific descriptions of codes.

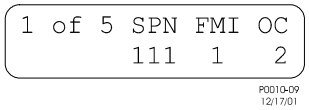

Figure 3-4. DTC Screen Example

After viewing the last DTC, screen 5 of 5, "VIEWED ALL ACTIVE" and "USE SELECT TO CLEAR" will be displayed. (The same applies when viewing previous DTCs.)

Pressing **Select/Enter** to clear the DTCs (active or previous) will result in one of four responses:

1. A positive acknowledgement which causes the following message to be displayed: "ACTIVE DTC(S) HAVE BEEN ERASED."
2. A negative acknowledgement which causes the following message to be displayed: "ERROR - NEGATIVE ACK" and "CANNOT ERASE DTC(S)."
3. A timeout for acknowledgement (when approximately two seconds have passed with CAN working and no positive or negative acknowledgement has been received). The following message will be displayed: "ERROR - ACK TIME OUT" and "CANNOT ERASE DTC(S)."
4. A CAN communications failure (CAN is disconnected or ECU is not working properly). The following message will be displayed: "ERROR - DISCONNECTED" and "CANNOT ERASE DTC(S)."

After viewing the response, the only way to back out of the screen is to press **Previous**. The user is then taken back to the Alternate Display Mode. Pressing **Display Toggle** will take the user to the Menu Mode screens. This also applies when viewing previous DTCs.

If the user is viewing active DTCs, and there is a change to active DTCs, then a message is displayed saying "DTC(S) HAVE CHANGED" and "PRESS PREVIOUS." The only way to back out of the screen is to press **Previous**. The user is then taken back to the Alternate Display Mode. Pressing **Display Toggle** will take the user to the Menu Mode screens. This also applies when viewing previous DTCs.

ECU Parameters Mode

The *ECU Parameters Menu* appears between the Alternate Display and Menu Mode when pressing **Display Toggle** and showcases parameters metered from the ECU. This menu is only viewable when J1939 communication is enabled. Only parameters related to genset applications are metered from the ECU and displayed here. A sub-menu is also accessible within this Menu for viewing the *Engine Configuration* parameters.

If a parameter is never sent after communication is established or the ECU has sent information notifying the DGC-1000 that the parameter is not supported (non-applicable), then the parameter’s screen will be hidden and skipped when scrolling from screen to screen in the “ECU Parameters” menu.

If a DTC is “associated” with one of the parameters, then the screens will work like Pre-Alarm screens from the Alternate Display. When scrolling through the menu, the user is taken straight to the new “DTC-related” screens first. The “DTC-related” screen will then blink while alternating between the parameter’s value and the DTC information.

NOTE: If no ECU support is required, then parameters are only updated within the DGC-1000 unit when “pulsing” the ECU and while the engine is “running.”

The following list includes all the engine system monitoring parameters read from the ECU (if supported) in the order in which they appear when pressing **Raise/Scroll**, having started from the ECU Parameters menu.

- Throttle Position
- Percent Load at Current RPM
- Actual Engine Percent Torque
- Injection Control Pressure
- Injector Metering Rail Pressure
- Injector Metering Rail Pressure
- Engine Speed*
- Total Engine Hours*
- Trip Fuel
- Total Fuel Used
- Engine Coolant Temperature*
- Fuel Temperature
- Engine Oil Temperature
- Engine Intercooler Temperature
- Fuel Delivery Pressure
- Engine Oil Level
- Engine Oil Pressure*
- Coolant Pressure
- Coolant Level
- Fuel Rate
- Barometric Pressure
- Ambient Air Temperature
- Air Inlet Temperature
- Boost Pressure
- Intake Manifold Temperature
- Air Filter Differential Pressure
- Exhaust Gas Temperature
- Electrical Potential (Voltage)*
- Battery Potential (Voltage), Switched
- Oil Filter Differential Pressure
- Fuel Filter Differential Pressure
- Crankcase Pressure
- Engine Configuration (Sub-Menu)

* These parameters may be monitored either directly by the DGC-1000 itself or by the DGC-1000 and the appropriate analog sender when the CAN bus/J1939 interface is disabled.

To start viewing the engine configuration parameters read from the ECU, press **Select/Enter** at the Engine Configuration sub-menu. The following list includes parameters in the order in which they appear when pressing **Raise/Scroll**:

- Engine Speed at Idle, Point 1
- Percent Torque at Idle, Point 1
- Engine Speed at Point 2
- Percent Torque at Point 2
- Engine Speed at Point 3
- Percent Torque at Point 3
- Engine Speed at Point 4
- Percent Torque at Point 4
- Engine Speed at Point 5
- Percent Torque at Point 5
- Engine Speed at High Idle, Point 6
- Gain (KP) of the Endspeed Governor
- Reference Engine Torque
- Maximum Momentary Engine Override Speed, Point 7
- Maximum Momentary Override Time Limit

- Requested Speed Control Range Lower Limit
- Requested Speed Control Range Upper Limit
- Requested Torque Control Range Lower Limit
- Requested Torque Control Range Upper Limit

Menu Mode

After pressing the **Display Toggle** pushbutton twice to begin the Menu display mode (first time selects the Alternate mode), pressing **Select/Enter** begins the next level of menus. Pressing the **Raise/Scroll** or **Lower/Scroll** pushbutton (Figure 3-5) allows the user to scroll through the menu display mode screens. Pressing the **Display Toggle** pushbutton returns the display to the Normal mode.

Menu 1

Menu 1 is the alarm and pre-alarm menu. Pressing **Select/Enter** (Figure 3-6) from this menu begins the 1.x menu level. Pressing **Raise/Scroll** and **Lower/Scroll** from this menu scrolls through the 1.x menu level.

Menu 1.1

Menu 1.1 displays the overspeed alarm. Pressing **Select/Enter** begins the 1.1.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel. Pressing **Previous** goes back to the 1.1.1 level.

Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.1.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.1 level. Pressing **Raise/Scroll** goes to the 1.2 menu level. Pressing **Lower/Scroll** goes to the 1.13 menu level.

Menu 1.2

Menu 1.2 displays the high coolant temperature alarm. Pressing **Select/Enter** begins the 1.2.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.2.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.2.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the engine crank disconnect speed is exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.2 level. Pressing **Raise/Scroll** goes to the 1.3 menu level Pressing **Lower/Scroll** goes to the 1.1 menu level.

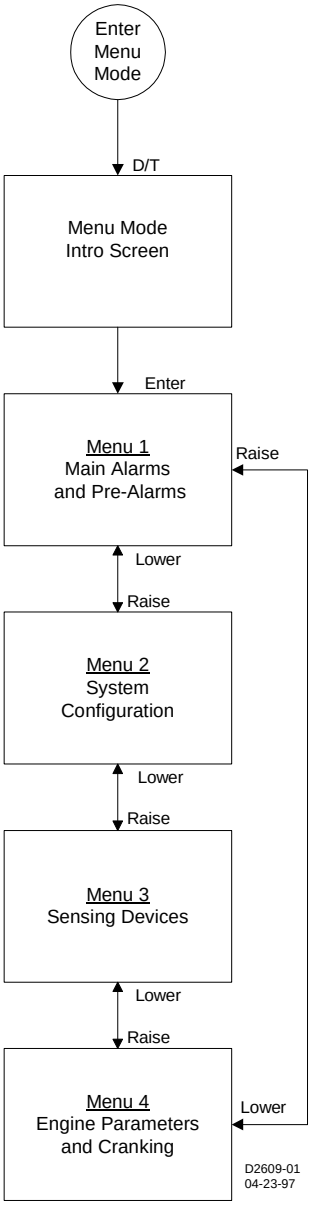

Figure 3-5. Menu Display Modes

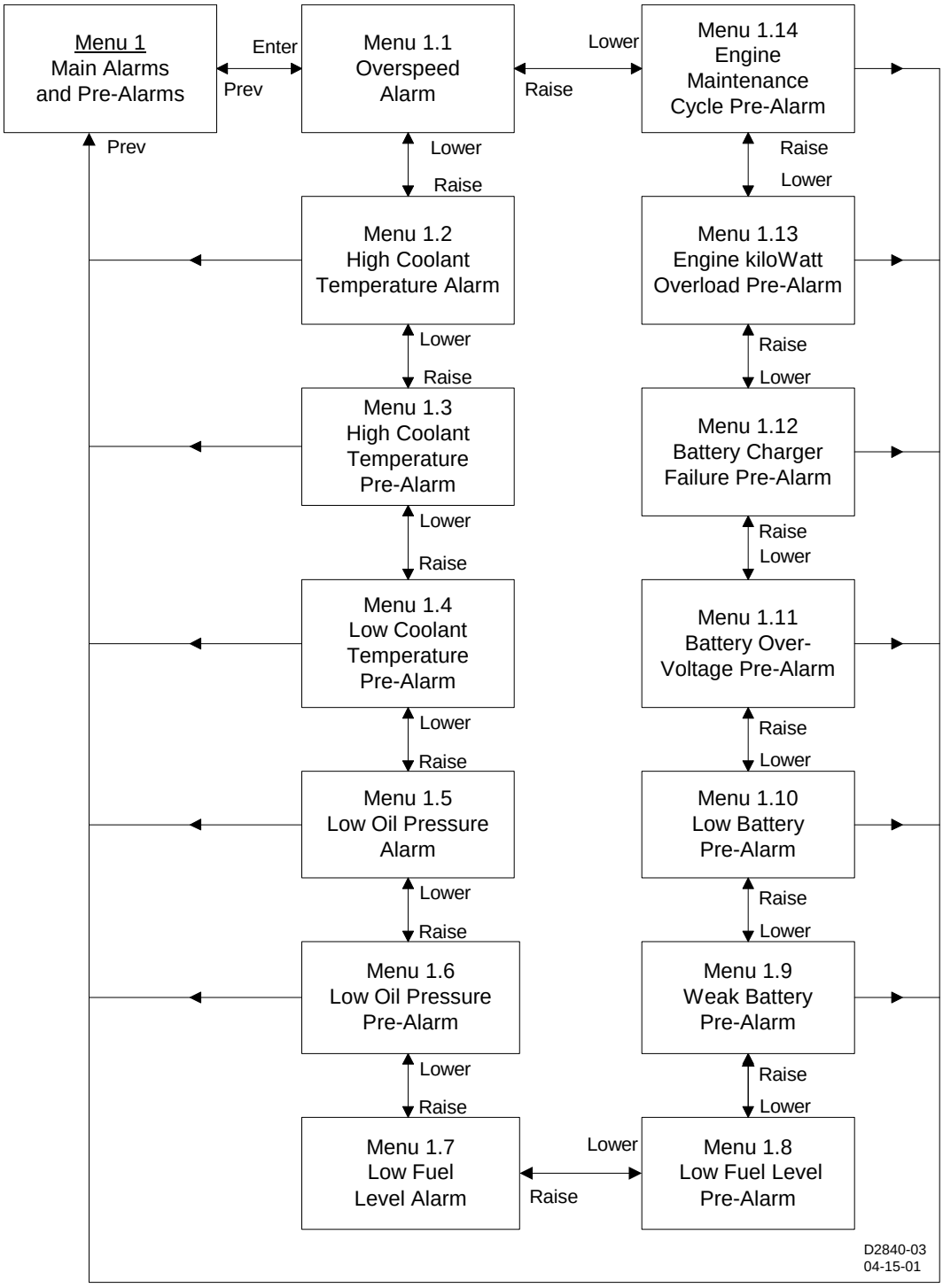

Figure 3-6. Menu 1

Menu 1.3

Menu 1.3 displays high coolant temperature pre-alarm. Pressing **Select/Enter** begins the 1.3.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** returns to the 1.3.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.3.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the engine crank disconnect speed is exceeded. This is not front panel adjustable.

Pressing **Previous** twice goes back to the 1.3 level. Pressing **Raise/Scroll** goes to the 1.4 menu level Pressing **Lower/Scroll** goes to the 1.2 menu level.

Menu 1.4

Menu 1.4 displays low coolant temperature pre-alarm. Pressing **Select/Enter** begins the 1.4.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.4.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.4.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.4 level. Pressing **Raise/Scroll** goes to the 1.5 menu level Pressing **Lower/Scroll** goes to the 1.3 menu level.

Menu 1.5

Menu 1.5 displays low oil pressure alarm. Pressing **Select/Enter** begins the 1.5.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.5.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.5.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the engine crank disconnect speed is exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.5 level. Pressing **Raise/Scroll** goes to the 1.6 menu level Pressing **Lower/Scroll** goes to the 1.4 menu level.

Menu 1.6

Menu 1.6 displays low oil pressure pre-alarm. Pressing **Select/Enter** begins the 1.6.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.6.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.6.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the engine crank disconnect speed is exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.6 level. Pressing **Raise/Scroll** goes to the 1.7 menu level Pressing **Lower/Scroll** goes to the 1.5 menu level.

Menu 1.7

Menu 1.7 displays low fuel level alarm. Pressing **Select/Enter** begins the 1.7.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is adjustable from the front panel.

Pressing **Previous** goes back to the 1.7.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.7.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected, press **Select/Enter** to save the new settings.

Pressing **Previous** twice goes back to the 1.7 level. Pressing **Raise/Scroll** goes to the 1.8 menu level Pressing **Lower/Scroll** goes to the 1.6 menu level.

Menu 1.8

Menu 1.8 displays low fuel level pre-alarm. Pressing **Select/Enter** begins the 1.8.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is adjustable from the front panel.

Pressing **Previous** goes back to the 1.8.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.8.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected, press **Select/Enter** to save the new settings.

Pressing **Previous** twice goes back to the 1.8 level. Pressing **Raise/Scroll** goes to the 1.9 menu level Pressing **Lower/Scroll** goes to the 1.7 menu level.

Menu 1.9

Menu 1.9 displays weak battery pre-alarm. Pressing **Select/Enter** begins the 1.9.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.9.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.9.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.9 level. Pressing **Raise/Scroll** goes to the 1.10 menu level Pressing **Lower/Scroll** goes to the 1.8 menu level.

Menu 1.10

Menu 1.10 displays low battery pre-alarm. Pressing **Select/Enter** begins the 1.10.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.10.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.10.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.10 level. Pressing **Raise/Scroll** goes to the 1.11 menu level Pressing **Lower/Scroll** goes to the 1.9 menu level.

Menu 1.11

Menu 1.11 displays battery over voltage pre-alarm. Pressing **Select/Enter** begins the 1.11.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.11.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.11.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.11 level. Pressing **Raise/Scroll** goes to the 1.12 menu level Pressing **Lower/Scroll** goes to the 1.10 menu level.

Menu 1.12

Menu 1.12 displays battery charger failure pre-alarm. Pressing **Select/Enter** begins the 1.12.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.12.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.12.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.12 level. Pressing **Raise/Scroll** goes to the 1.13 menu level Pressing **Lower/Scroll** goes to the 1.11 menu level.

Menu 1.13

Menu 1.13 displays kilowatt overload pre-alarm. Pressing **Select/Enter** begins the 1.13.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.13.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.13.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.13 level. Pressing **Raise/Scroll** goes to the 1.14 menu level Pressing **Lower/Scroll** goes to the 1.12 menu level.

Menu 1.14

Menu 1.14 display engine maintenance pre-alarm. Pressing **Select/Enter** begins the 1.14.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.14.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.14.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.14 level. Pressing **Raise/Scroll** goes to the 1.1 menu level. Pressing **Lower/Scroll** goes to the 1.13 menu level.

Pressing **Previous** from any 1.x level menu goes to menu 1. Pressing **Raise/Scroll** goes to menu 2. Pressing **Lower/Scroll** goes to menu 3.

Menu 2

Menu 2 system configuration. Pressing **Select/Enter** from this menu (Figure 3-7) begins the 2.x level of menus. Pressing **Raise/Scroll** and **Lower/Scroll** from this menu scrolls through the 2.x levels of menus.

Menu 2.1

Menu 2.1 displays generator voltage sensing connection. Pressing **Select/Enter** begins the 2.1.1 level and displays the sensing configuration. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 2.1 level. Pressing **Raise/Scroll** goes to menu 2.2. Pressing **Lower/Scroll** goes to the 2.4 menu.

Menu 2.2

Menu 2.2 displays options. Pressing **Select/Enter** (Figure 3-8) begins the 2.2.1 level and displays the speed signal source selection. This is not adjustable from the front panel.

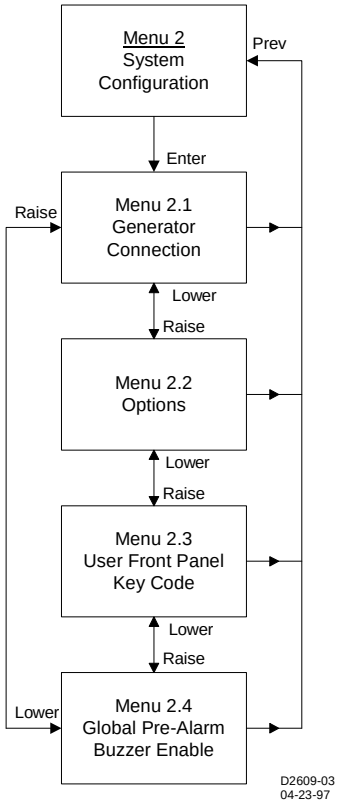

Figure 3-7. Menu 2

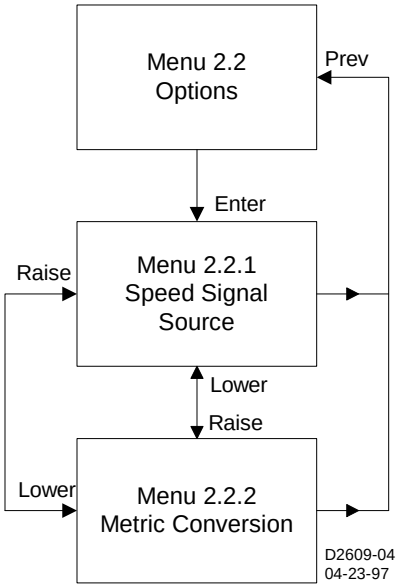

Figure 3-8. Menu 2.2

Pressing **Previous** goes back to the 2.2 level. Pressing **Raise/Scroll** or **Lower/Scroll** goes to menu 2.2.2 and displays metric conversion.

Pressing **Select/Enter** displays the status of this feature. To change to the metric display press **Raise/Scroll** and enter the user key code followed by the **Select/Enter** key. Press **Raise/Scroll** and then **Select/Enter**. The display will indicate that the new setting has been saved. Press previous twice to go to menu 2.2. Press **Raise/Scroll** to go to menu 2.3. Press **Lower/Scroll** to go to menu 2.1.

Menu 2.3

Menu 2.3 changes user key code. Press **Select/Enter** and then the user key code followed by **Select/Enter** twice. Press the key sequence for the new key code followed by **Select/Enter** twice. The user will be asked to re-enter the new key code. After entering the new key code followed by **Select/Enter** twice, the display will indicate the new code has been saved.

Pressing **Raise/Scroll** will go to menu 2.4. Pressing **Lower/Scroll** will go menu 2.2.

Menu 2.4

Menu 2.4 pre-alarm audible alarm enable. Pressing **Select/Enter** will display the status of the pre-alarm audible alarm. This feature is not adjustable from the front panel. Pressing **Previous** will go to menu 2.4.

Pressing **Raise/Scroll** will go to menu 2.1. Pressing **Lower/Scroll** will go to menu 2.3.

Pressing **Previous** from any 2.x menu will go to menu 2. Pressing **Raise/Scroll** goes to menu 3. Pressing **Lower/Scroll** goes to menu 1.

Menu 3

Menu 3 sensing devices. Pressing **Select/Enter** (Figure 3-9) begins the 3.1 level of menus.

Menu 3.1

Menu 3.1 transformer ratios menu. Menu 3.1.1 (Figure 3-10) displays generator potential transformer primary voltage rating. Pressing **Select/Enter** displays the value. This is not adjustable from the front panel. Pressing **Previous** twice goes to menu 3.1. Pressing **Raise/Scroll** goes to menu 3.1.2. Pressing **Lower/Scroll** goes to menu 3.1.5.

Menu 3.1.2

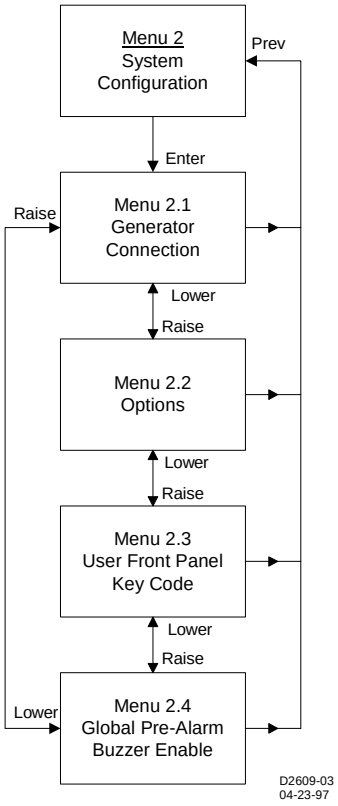

Figure 3-9. Menu 3

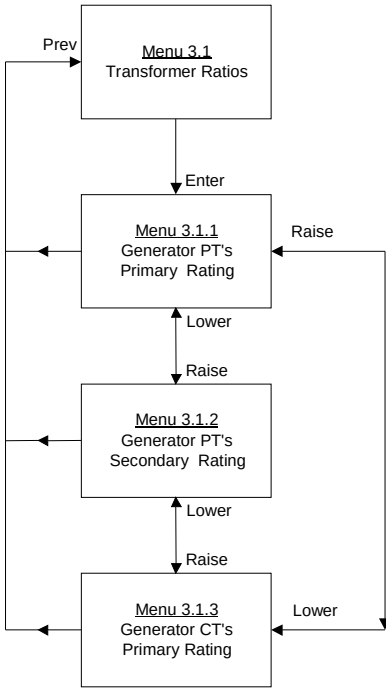

Figure 3-10. Menu 3.1

Menu 3.1.2 displays the generator potential transformer secondary voltage rating. Pressing **Select/Enter** displays the value. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.1. Pressing **Raise/Scroll** goes to menu 3.1.3. Pressing **Lower/Scroll** goes to menu 3.1.1.

Menu 3.1.3

Menu 3.1.3 displays the generator current transformer primary current rating. Pressing **Select/Enter** displays the value. This is not adjustable from the front panel. Pressing previous goes to menu 3.1. Pressing **Raise/Scroll** goes to menu 3.1.1. Pressing **Lower/Scroll** goes to menu 3.1.2.

Pressing **Raise/Scroll** from menu 3.1 goes to menu 3.2.

Menu 3.2

Menu 3.2 sender failure alarm menu. Pressing **Select/Enter** (Figure 3-11) begins menu 3.2.1

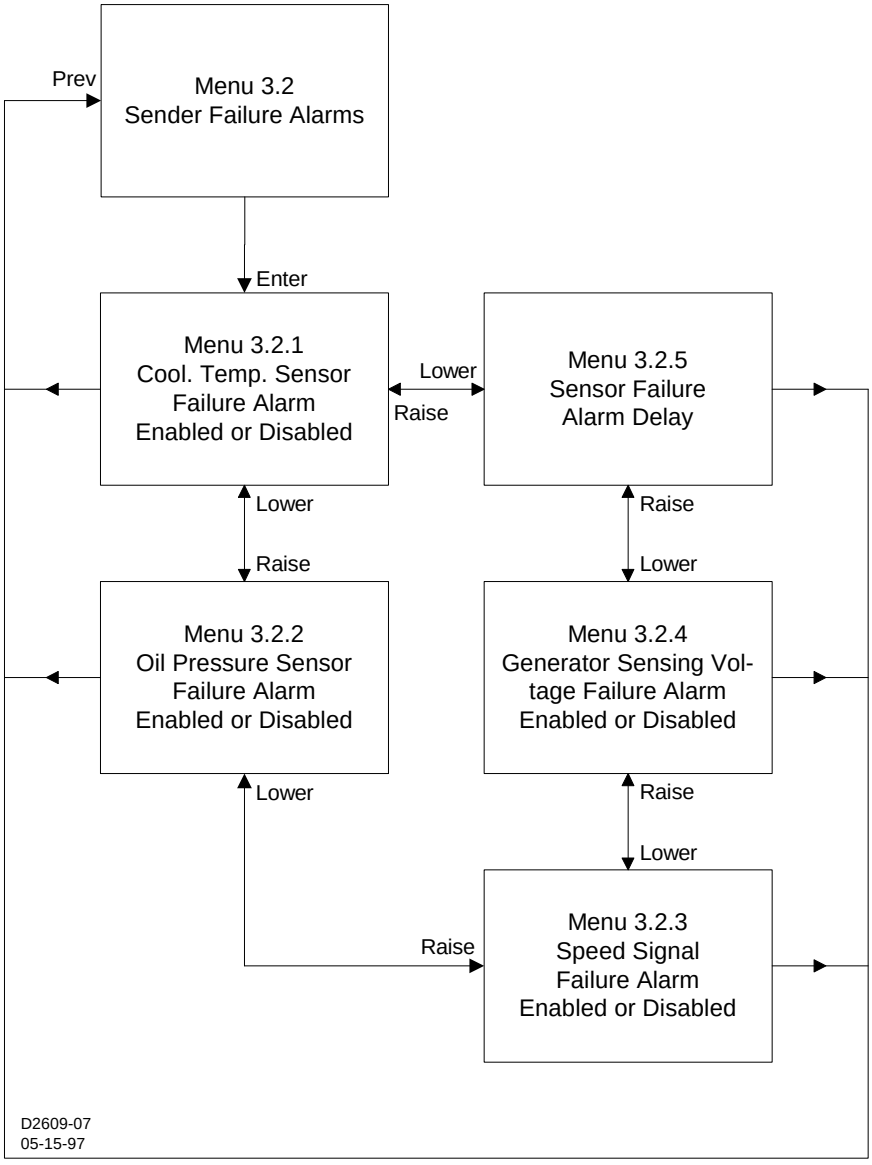

Figure 3-11. Menu 3.2

Menu 3.2.1

Menu 3.2.1 displays coolant temperature sensor failure alarm. Pressing **Select/Enter** displays the status of this alarm. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.2.1.

Pressing **Raise/Scroll** goes to menu 3.2.2. Pressing **Lower/Scroll** goes to menu 3.2.5.

Menu 3.2.2

Menu 3.2.2 displays oil pressure sensor failure alarm. Pressing **Select/Enter** displays the status of this alarm. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.2.2.

Pressing **Raise/Scroll** goes to menu 3.2.3. Pressing **Lower/Scroll** goes to menu 3.2.1.

Menu 3.2.3

Menu 3.2.3 displays speed signal failure alarm. Pressing **Select/Enter** displays the status of this alarm. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.2.3.

Pressing **Raise/Scroll** goes to menu 3.2.4. Pressing **Lower/Scroll** goes to menu 3.2.2.

Menu 3.2.4

Menu 3.2.4 displays voltage sensing failure alarm. Pressing **Select/Enter** displays the status of this alarm. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.2.4.

Pressing **Raise/Scroll** goes to menu 3.2.5. Pressing **Lower/Scroll** goes to menu 3.2.3.*Menu 3.2.5.* Menu 3.2.5 displays sensor failure alarm time delay. Pressing **Select/Enter** displays the delay time. After pressing **Raise/Scroll** or **Lower/Scroll** the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected, press **Select/Enter** to save the new setting. Pressing **Previous** goes to menu 3.2. Pressing **Raise/Scroll** goes to menu 3.2.1. Pressing **Lower/Scroll** goes to menu 3.2.4.

Pressing **Raise/Scroll** from menu 3.2 goes to menu 3.3. Pressing **Lower/Scroll** from menu 3.2 goes to menu 3.1.

Menu 3.3

Menu 3.3 displays the input calibration function. This function is for Basler Electric Company use only. For more information contact Basler Electric Company.

Pressing **Previous** goes to menu 3. Pressing **Raise/Scroll** from menu 3 goes to menu 4. Pressing **Lower/Scroll** goes to menu 2.

Menu 4

Menu 4 (Figure 3-12) displays engine parameters and cranking. Pressing **Select/Enter** from menu 4 begins menu 4.1.

Menu 4.1

Menu 4.1 displays cool down time. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected, press **Select/Enter** to save the new setting. Pressing **Previous** goes to menu 4.1. Pressing **Raise/Scroll** goes to menu 4.2. Pressing **Lower/Scroll** goes to menu 4.7.

Menu 4.2

Menu 4.2 displays cranking mode. Pressing **Select/Enter** displays the cranking mode selected. This is not adjustable from the front panel. Pressing **Previous** goes to menu 4.2. Pressing **Raise/Scroll** goes to menu 4.3. Pressing **Lower/Scroll** goes to menu 4.1. *Menu 4.3.* Menu 4.3 displays the number of crank cycles. Pressing **Select/Enter** displays the number of crank cycles selected. This is not adjustable from the front panel. Pressing **Previous** goes to menu 4.3. Pressing **Raise/Scroll** goes to menu 4.4. Pressing **Lower/Scroll** goes to menu 4.2.

Menu 4.4

Menu 4.4 displays continuous crank time. Pressing **Select/Enter** displays the continuous crank time selected. This is not adjustable from the front panel. Pressing **Previous** goes to menu 4.4. Pressing **Raise/Scroll** goes to menu 4.5. Pressing **Lower/Scroll** goes to menu 4.3.

Menu 4.5

Menu 4.5 displays cycle crank time. Pressing **Select/Enter** displays the cycle crank time selected. This is not adjustable from the front panel. Pressing **Previous** goes to menu 4.5. Pressing **Raise/Scroll** goes to menu 4.6. Pressing **Lower/Scroll** goes to menu 4.4.

Menu 4.6

Menu 4.6 displays pre-crank delay time. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected press **Select/Enter** to save the new setting. Pressing **Previous** goes to menu 4.6. Pressing **Raise/Scroll** goes to menu 4.7. Pressing **Lower/Scroll** goes to menu 4.5.

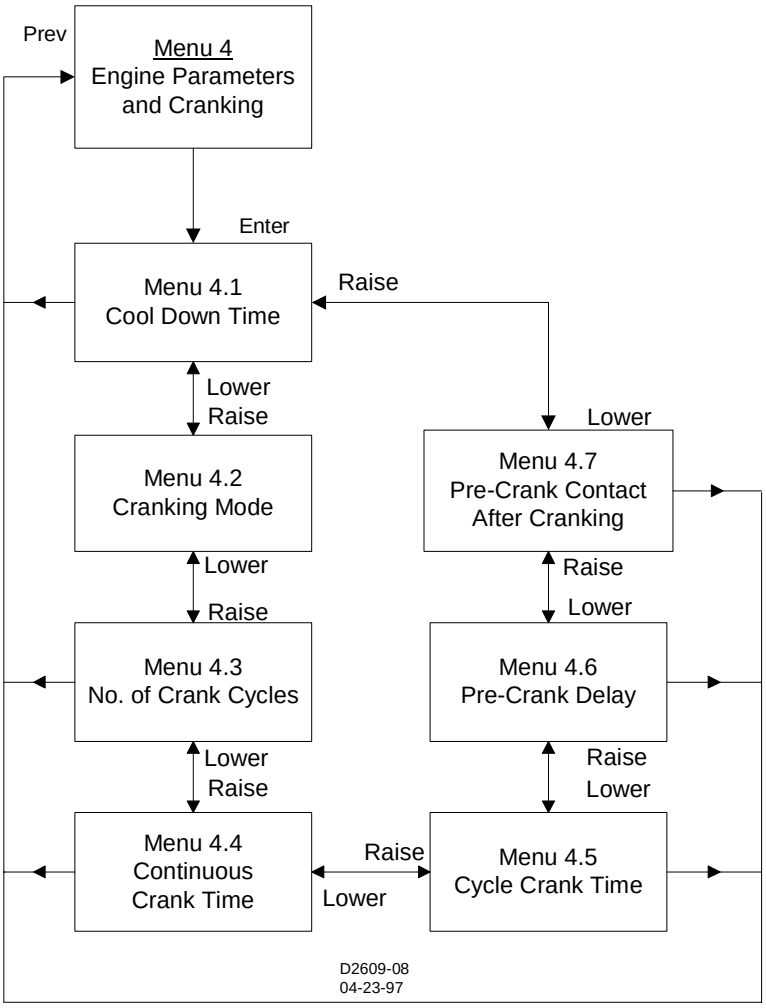

Figure 3-12. Menu 4

Menu 4.7

Menu 4.7 displays the status of the Pre-crank contact after cranking. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected, press **Select/Enter** to save the new setting. Pressing **Previous** goes to menu 4.7. Pressing **Raise/Scroll** goes to menu 4.1. Pressing **Lower/Scroll** goes to menu 4.6.

Pressing **Previous** twice goes to the normal display mode.

Exiting Menu Mode

You may exit Menu mode (from any menu level) by pressing the **Display Toggle** pushbutton (see Figure 3-13). If the **Display Toggle** pushbutton is pressed before a parameter setpoint change has been saved, then the old setpoint value is preserved.

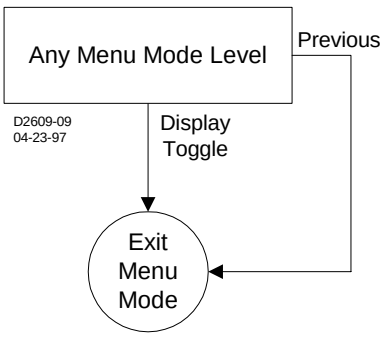

Figure 3-13. Exiting Menu Mode

NOTE

Using DISPLAY TOGGLE to exit Menu mode will save the user's place within the menu system so that the next time Menu mode is entered, the display will return to the same screen.

As an alternative, pressing **Previous** allows the user to back out of the menu mode one level at a time so that the next time menu mode is entered, the display will start at the top of the menu structure.

Modifying Setpoints

To modify an existing setpoint, press the **Select/Enter** pushbutton (Figure 3-14). Press **Raise/Scroll** or **Lower/Scroll** buttons to raise or lower the current parameter setpoint. Press the **Select/Enter** pushbutton to save the modified setpoint value or press the **Previous** pushbutton to exit the parameter setting screen without changing the value.

Once in the menu mode, the first time an attempt is made to change a setting that is front panel adjustable, the user will be prompted to enter the key code. Upon successful entry of the key code, the user may modify any of the adjustable settings without re-entering the key code during the current menu mode session. The only exception to this is changing the key code itself. Changing the key code always requires entry of the existing key code. Also, whether the key code is actually changed or not, any further changes to other settings after that will require the key code to be entered once again. Leaving the Menu mode after an editing session automatically terminates the editing privilege.

Press the **Display Toggle** pushbutton to exit the menu mode.

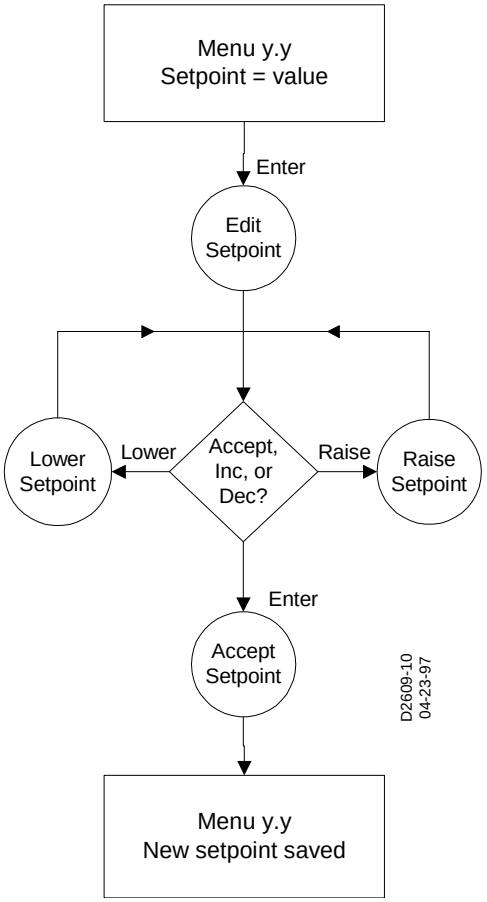

Figure 3-14. Modifying Setpoints

Key Code

The DGC-1000 is delivered with a key code consisting of the following pushbutton sequence.

1. Raise/Scroll
2. Lower/Scroll
3. Select/Enter
4. Previous
5. Display Toggle
6. Select/Enter
7. Select/Enter

The key code can be changed by accessing the CHANGE KEYCODE screen of Menu 2. Observe the following guidelines when changing the key code.

- Allowable key code pushbuttons are Raise/Scroll, Lower/Scroll, Select/Enter, Previous, Display Toggle, Phase Toggle, Alarm Silence, and Lamp Test.
- A key code entry must be followed by two presses of the Select/Enter pushbutton.
- A key code can consist of one to eight presses of the allowable key code pushbuttons.
- A key code cannot contain consecutive presses of the Previous pushbutton.

Front Panel Adjustable Parameters

Most settings are viewable at the front panel. The settings listed in Table 3-4 can be adjusted at the front panel.

Table 3-4. Front Panel Adjustable Settings

Parameter	Setting Range, Increment
Sensor Failure Alarm Time Delay	1 to 10 s, 1s
Metric Conversion	On or Off
Low Fuel Pre-Alarm Level	10 to 100%, 1%
Low Fuel Alarm Level	2 to 50%, 1%
Pre-Crank Contact After Cranking	Open or Closed
Cool-Down Time	0 to 60 m, 1 m
Pre-Crank Time Delay	0 to 30 s, 1 s

FIRMWARE UPGRADES

Future enhancements to DGC-1000 functionality may make a firmware upgrade desirable. Since DGC-1000 stores its firmware in flash memory, upgrading firmware with BESTCOMS is a straightforward procedure and requires no disassembly of hardware. Refer to Section 6, *BESTCOMS Software* for detailed instructions on upgrading DGC-1000 firmware.

WARNING!

The DGC-1000 should be removed from service for the purpose of upgrading firmware as it will not be able to control or monitor the genset once the firmware upgrade procedure has been started.

ENGINE CONTROL UNIT (ECU) SUPPORT

Enabling of ECU Support

To enable ECU support, select “Enable ECU Support” in the CANBus Interface area of the BESTCOMS System Settings screen. After re-sending the settings, the DGC-1000 will begin to ignore analog input for coolant temperature, oil pressure and engine speed, and it will no longer calculate engine run time. Once the DGC-1000 establishes communications with an ECU, the engine run time, coolant level, coolant temperature, oil pressure and engine speed will be updated with the ECUs values.

NOTE

With Enable ECU Support selected, a non-programmable Coolant Level Sender Fail alarm can annunciate either when the engine is off or running. Coolant level is only metered and displayed when Enable ECU Support is selected in BESTCOMS.

ECU Limitations

For some ECUs, an external source cannot stop the engine without removing power from the ECU. Turning off power to the ECU is the only way to remove fuel from the engine, shutting it down. Different ECU manufacturers have their own rpm-setpoints for reapplying fuel to an engine. If the ECU is powered up and the engine is still spinning above 60 rpm, then the ECU will automatically turn the fuel on. Detroit Diesel J1939 ECUs, for example, have a setpoint of 60 rpm.

Not being able to stop the engine without removing ECU power causes two problems. The first problem is that the only way to stop the engine is to turn the ECU off and wait for the engine speed to fall below 60 rpm before powering the ECU back up. Otherwise, the engine will take off running. The second problem is that while the ECU is off, you can no longer meter and update coolant level, coolant temperature, oil pressure or engine speed values, effectively disabling features like low coolant temperature alarm/pre-alarm and crank control.

The DGC-1000 Solution

The DGC-1000 resolves ECU limitations by using timers. There are four user-programmable timers in ECU Timers under the Configure pull-down menu in BESTCOMS. In the ECU Related Time Values box you will see the following timers and their corresponding default values.

- *Pulse Cycle Time.* The time in minutes the unit waits before pulsing.
- *Response Timeout.* The time in seconds to attempt communications with the ECU when the DGC-1000 is in the Pulsing state or Connecting state.
- *Settling Time.* The time in tenths of seconds to gather data after connecting to the ECU during the Pulsing state. This allows all the metered values to be sent and ramp up to their steady-state values. Metered values are sent out by the ECU at different rates as designated by the J1939 protocol. ECU values initially sent are low and the ECU takes time to average out its own data values.
- *Engine Shut Down.* The time in seconds to stay disconnected from the ECU when going from Running to Shut-Down before starting the first pulse. This timer should allow enough time for the engine to slow down so that when the DGC-1000 pulses, the ECU will not start the engine.

Alarm and Pre-Alarm

If ECU communication is not established during the connecting state or is lost during the Pre-Start, Cranking, Resting, Running or Cooling states, then a non-programmable ECU Communications Fail alarm will be annunciated. If the last pulse was unsuccessful (ECU communications was not established) then the ECU Communications Fail pre-alarm will be annunciated. The pre-alarm is only checked after the Pulsing state and is annunciated only during the Ready state.

To clear Coolant Level Alarms when the ECU Power Support is needed, the user must first correct the condition causing the alarm and then pulse the ECU to update the data. The user may remotely pulse the ECU via BESTCOMS or locally pulse the ECU by pressing the keys in the ordered sequence **Auto** to **Off** on the front panel.

Fuel Solenoid Relay

For some ECUs, connecting to an external fuel solenoid may not be an option. In this case, the fuel solenoid relay has been designated to control ECU operating power. For example, Detroit Diesel's J1939 ECU applies fuel to the engine only after engine speed rises above 60 rpm. The following timers control the fuel solenoid relay when the unit is not running.

- Pulse Cycle Time - Fuel Solenoid is open.
- Response Timeout - Fuel Solenoid is closed.
- Settling Time - Fuel Solenoid is closed.
- Engine Shut Down - Fuel Solenoid is open.

In applications that do not require a separate pre-start contact function, the pre-start relay can also be used to control ECU operating power. Refer to the ECU Interface paragraphs in the BESTCOMS section for more information.

In an MTU MDEC ECU application, the ECU has a stop contact input to stop the engine. If this input is not connected to battery voltage, the engine will stop running. The fuel solenoid relay is wired such that when it is desired that the engine run, the stop input is connected to battery voltage. When it is desired that the engine stop, the fuel solenoid relay opens and removes battery voltage from the stop input.

NOTE

When ECU Support is enabled, during the Pre-Start and Resting states, the fuel solenoid is closed.

Eleven States of Operation

The DGC-1000 supports 11 operating states.

- Restart/Power-Up - The initial state.
- Ready - The DGC-1000 is in the Off or Auto-Off mode.
- Pulsing - ECU Only - pulses (momentarily powers up) the ECU for updated information.
- Connecting - ECU Only - The system configuration just changed to Run or Auto-Run.
- Pre-Start - Closes the pre-start relay or pauses the DGC-1000 while it is not safe to crank.
- Cranking - Cranks the engine until it is above the crank disconnect speed.
- Resting - Occurs between crank cycles and does not crank the engine.
- Running - The unit is no longer cranking and is now running.
- Cooling - Cool down running engine if a load was or is applied when going to Auto-Off mode.
- Shutting Down - ECU Only - Wait for engine to stop rotating before "pulsing."
- Alarm - Alarm was triggered. Wait for the alarm to clear.

Display Values (ECU Support Enabled)

The ECU is able to give the DGC-1000 in-depth information about the values it sends. This makes it possible for the DGC-1000 to display accurate information when metering these values from the ECU. After pulsing the unit, if the pulse was successful, the last values gathered when powering off the ECU are displayed until the next pulse. The following is a list of display values.

- Value-the actual value is displayed if the last pulse was successful or the engine is running.
- No Communications (abbreviated as NC)- displayed if the last pulse was unsuccessful.
- Not Applicable (abbreviated as NA)-The ECU does not monitor this data value.
- ECU Data Not Sent (abbreviated as NS)-data was not sent in the time designated by the protocol.
- Sender Failure (abbreviated as SF)-The ECU has determined a sender failure for that metered value.

Constantly Powered ECUs

The DGC-1000 supports ECUs that have the ability to cut-off fuel from the engine without powering the ECU off. The DGC-1000 requests engine run-time every minute to keep the ECU from going into a sleep-mode. After the Pulse Cycle Timer expires, the DGC-1000 checks to see if ECU communications exist. If so, then the DGC-1000 will not pulse the ECU. The same goes for Connecting, except that the DGC-1000 remembers if it skipped the Connecting state. If it did, then the DGC-1000 will also skip the Engine Shutting Down state when it turns off the engine.

For constantly powered ECUs, it is recommended that the Engine Shut Down Timer be set to its minimum value. This ensures that if the DGC-1000 temporarily loses power while running, the unit will go straight into the Run state and go to the Shutting Down state when the unit goes to Off. It is also recommended that the Response Timeout Timer be set to its minimum value in order to set the ECU Communications Fail pre-alarm as soon as possible.

The following screens will be displayed on the front panel if the last attempt to pulse the ECU for an information update was unsuccessful.

In the Normal display mode:

```
"READY"
"NC  NC  24.0  NC"
```

In the Alternate and ECU Parameters display modes:

```
"ENGINE SPEED"
"NO COMMUNICATIONS"
```

Normal Program Control

If an engine is not equipped with an ECU, then ECU support should be disabled for the DGC-1000 to use Analog sender data. An engine with ECU support disabled or ECU support enabled with a constant power supply and accessible fuel solenoid will follow the normal program control flowchart. See Figure 3-15.

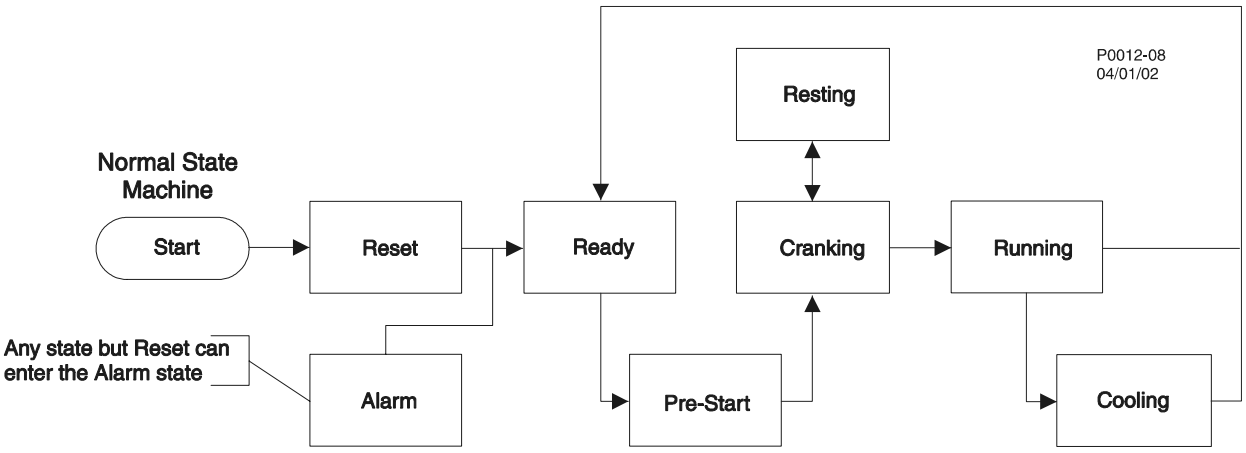

Figure 3-15. Normal Program Control Flowchart

ECU Power Support Program Control

If an engine has an ECU, then ECU Support should be enabled for the DGC-1000 to use sender data communicated over the CANBus protocol interface from the ECU. If the engine can only be shut down by powering off the ECU, then the genset will need ECU Power Support enabled. An engine with ECU Support enabled and a need for ECU Power Support through the fuel solenoid will follow the ECU Power Support diagram. See Figure 3-16.

NOTE

ECU Power Support is not a selectable option. The DGC-1000 will decide between using the fuel solenoid output relay or controlling the fuel to provide ECU Power Support. This smart technology is derived by doing the following:

After the Pulse Cycle Timer expires, the DGC-1000 checks to see if ECU communications are present. If so, then the DGC-1000 will not pulse the ECU. The same goes for Connecting, except the DGC-1000 remembers if it skipped the Connecting state. If it did, then it will also skip the Engine Shutting Down state when the DGC-1000 turns off the engine.

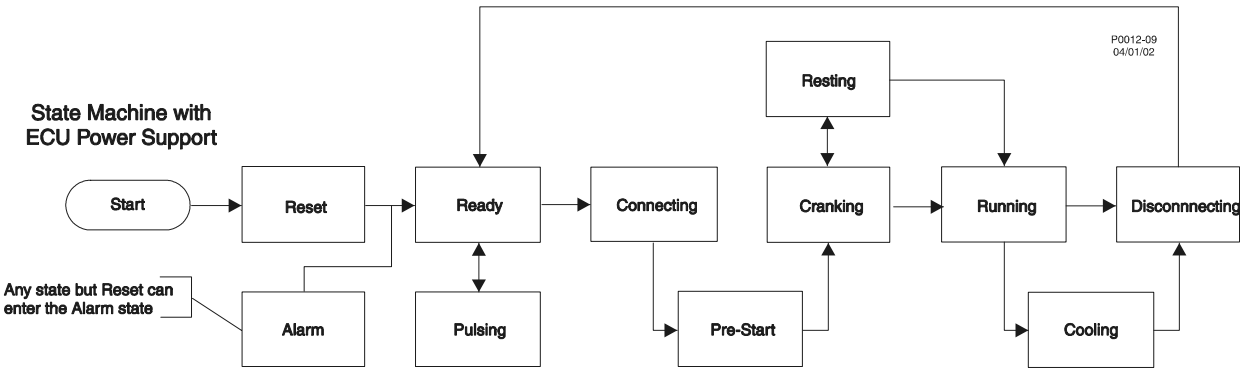

Figure 3-16. ECU Power Support Program Control

Output Relay Status

Tables 3-5 and 3-6 represent the output relay status for each of the 11 states that make up the State Transition Function. The fuel solenoid relay varies between these two types of matrixes and is bolded to emphasize this. The letter O represents an open relay state and the letter C represents a closed relay state.

Table 3-5. Normal Output Relay Matrix

Relay	Current State										
	Reset	**Ready**	**xxx**	**xxxx**	**Pre-Start**	**Crank**	**Rest**	**Run**	**Cool**	**xxx**	**Alarm**
Alarm	O	O			O	O	O	O	O		C
PreStart	O	O			C	C	C	*	*		O
Starter	O	O			O	C	O	O	O		O
Fuel	O	O			O	C	O	C	C		o

Table 3-6. Output Relay Matrix With ECU Support

Relay	Current State										
	Reset	**Ready**	**Pulse**	**Connect**	**Pre-Start**	**Crank**	**Rest**	**Run**	**Cool**	**Shut-down**	**Alarm**
Alarm	O	O	O	O	O	O	O	O	O	O	C
PreStart	O	O	O	O	C	C	C			O	O
Starter	O	O	O	O	O	C	O	O	O	O	O
Fuel	**	O	C	C	C	C	C	C	C	O	O

Notes for Tables 3-4 and 3-5

* If the "Pre-Start Contact After Disconnect" is enabled from BESTCOMS, then the Pre-Start contact will always be closed during Running and Cooling. Otherwise, it will be open.

** If ECU Support is enabled and the previous SysConfig was Run or Auto-Run with the ATS-Switch closed, then close the fuel solenoid, otherwise leave it open.

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SECTION 4 • INSTALLATION

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SECTION 4 • INSTALLATION

INTRODUCTION

DGC-1000 Digital Genset Controllers are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a unit, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric, Highland Illinois.

If the controller will not be installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

HARDWARE

DGC-1000 controllers are packaged for mounting in any top-mount enclosure. The front panel is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants. It also inhibits insect and rodent entrance.

A DGC-1000 controller is secured to a panel by the four permanently-attached 10-32 by ⅝ inch (½ inch usable) studs and four nylon lined nuts (supplied). Hardware mounting torque is 30 in-lb (3.4 N•m).

MOUNTING

Case cutout dimensions are shown in Figure 4-1. Overall dimensions are shown in Figures 4-2.

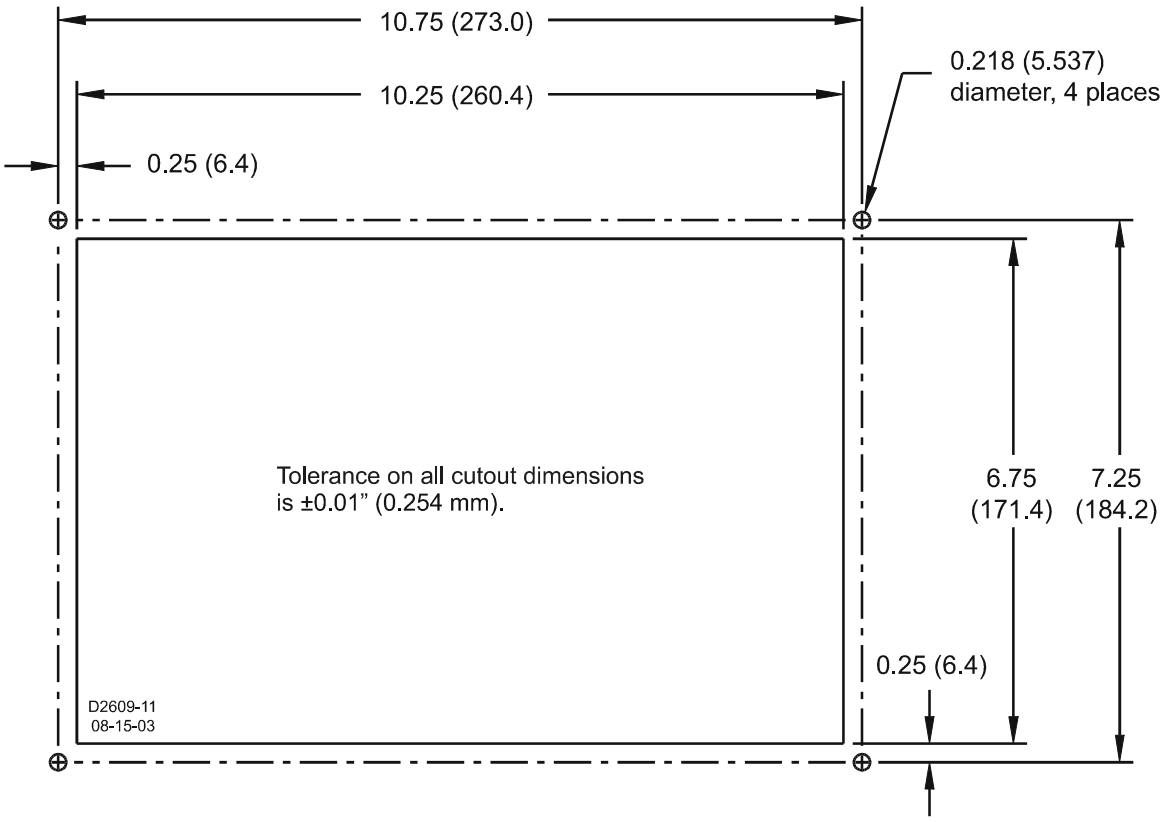


Figure 4-1. Cutout Dimensions in Inches (Millimeters)

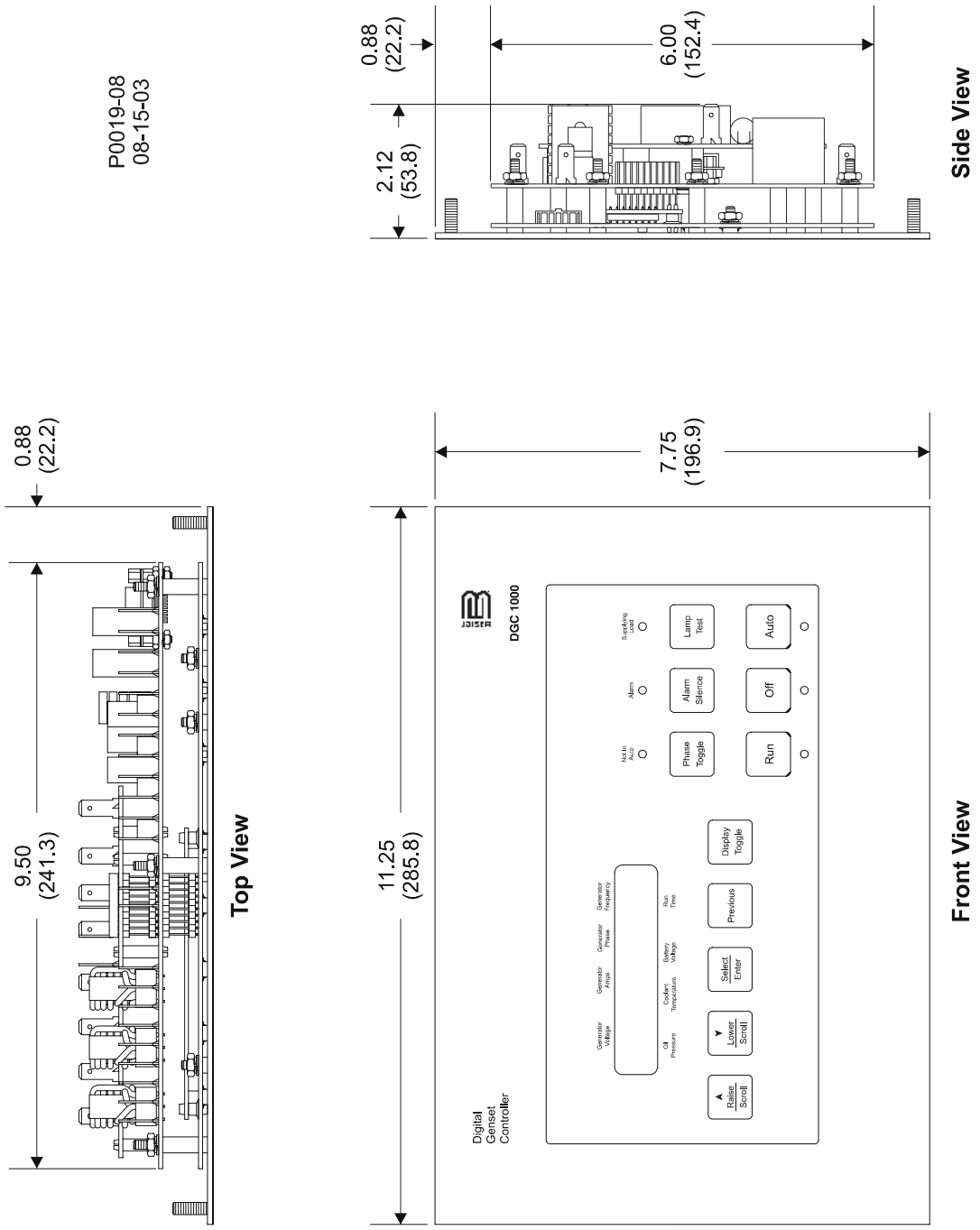


Figure 4-2. DGC-1000 Dimensions

DGC Isolator Kit

The optional DGC Isolator Kit provides an economical way to reduce the level of shock and vibration transmitted from a generator to the DGC-1000. The DGC Isolator Kit eliminates the need to mount an isolator box on top of the generator conduit box and simplifies wiring considerations. Isolator kits are available with either black- or gray-colored gaskets. Kit part number 9 3554 06 100 is supplied with a black gasket and kit part number 9 3554 06 101 is supplied with a gray gasket.

The DGC Isolator Kit provides vibration dampening at frequencies greater than 48 hertz. Above 90 hertz, vibration transmissibility is less than 10 percent of the input magnitude.

CONNECTIONS

NOTE

Ensure that the DGC-1000 control power wiring is correct. Reverse polarity will not damage the controller, but it will prevent the DGC-1000 from operating.

Be sure that the DGC-1000 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear panel of the controller.

Except as noted above, connections should be made with wire no smaller than 14 AWG.

Be sure to supply the controller with the correct level of operating power.

DGC-1000 Terminations

DGC-1000 terminals, excluding the serial communication port and CAN interface, consist of quarter-inch blade, quick-connect terminals. These terminals accept female, quarter-inch connectors. All DGC-1000 terminals are located on the rear panel of the controller. The connectors used on the DGC-1000 make it easy to remove the controller for out-of-circuit testing or maintenance.

DGC-1000 terminals are illustrated and described in Section 2, *Human-Machine Interface.*

Communication Port

The RS-232 port on the rear panel uses a DB9 female connector. Figure 4-3 illustrates the pin assignments of the communication port and Table 4-1 identifies the RS-232 connector pin functions. A standard communication cable terminated with a DB9 male connector is used for PC interface with the DGC-1000 as shown in Figure 4-4.

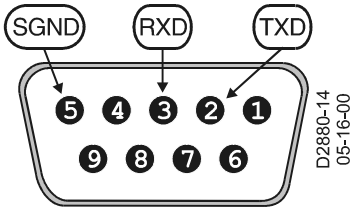


Figure 4-3. DGC-100 Communication Port Pin Assignments

Table 4-1. DGC-1000 Communication Port Pin Assignments

Pin	Function	Name	Direction
1	N/C	—	N/A
2	Transmit Data	TXD	From DGC-1000
3	Receive Data	RXD	To DGC-1000
4	N/C	—	N/A
5	Signal Ground	GND	N/A
6	N/C	—	N/A
7	N/C	—	N/A
8	N/C	—	N/A
9	N/C	—	N/A

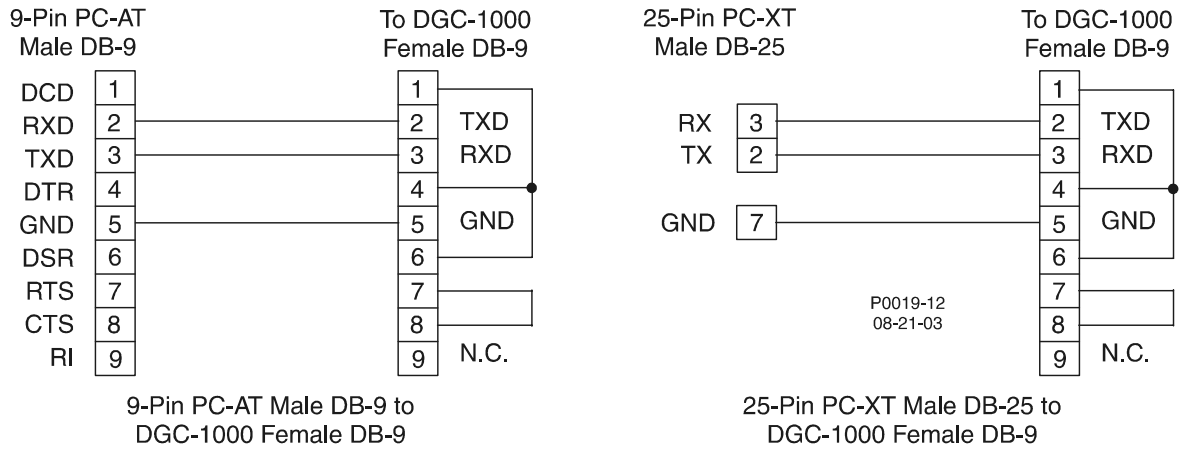


Figure 4-4. Personal Computer to DGC-1000 Connections

CAN Connections

The CAN connector mates with the cable assembly (Basler P/N 9358900002) provided with the DGC-1000. The cable assembly is illustrated in Figure 4-5 and the termination assignments are listed in Table 4-2.

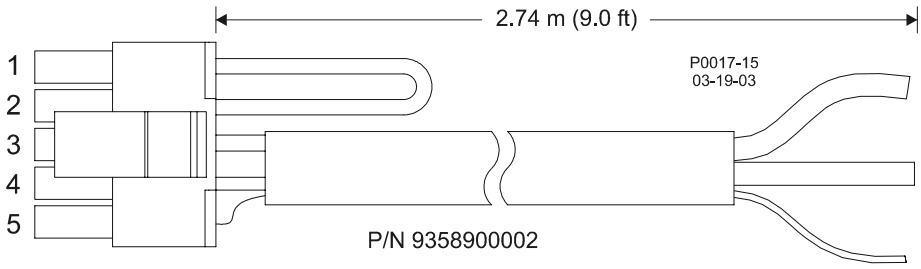


Figure 4-5. CAN Cable Assembly

Table 4-2. CAN Cable Assembly Termination Assignments

Termination	Function	User Termination
Pin 1	Termination Resistor	*
Pin 2		
Pin 3	CAN High	Red Wire
Pin 4	CAN Low	Black Wire
Pin 5	Drain	Uninsulated Wire †

* If the DGC-1000 is not providing one end of the J1939 backbone, cut the jumper connected across pins 1 and 2 to disconnect the internal terminating resistor.

† The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, cut the drain connection to the DGC-1000.

Note: If the DGC-1000 is not part of the J1939 backbone, the stub connecting the DGC-1000 to the backbone should not exceed 914 millimeters (3 feet) in length.

DGC-1000 Connections for Typical Applications

Figures 4-6 through 4-9 illustrate typical applications using the DGC-1000. A typical DGC-1000 ladder diagram is shown in Figure 4-6. Figure 4-7 shows typical ac connections for a direct-connected, single-phase, three-wire sensing system. Figure 4-8 shows typical ac connections for a direct-connected, three-phase, line-to-line sensing system. Figure 4-9 shows typical ac connections for a direct-connected, three-phase, line-to-neutral sensing system.

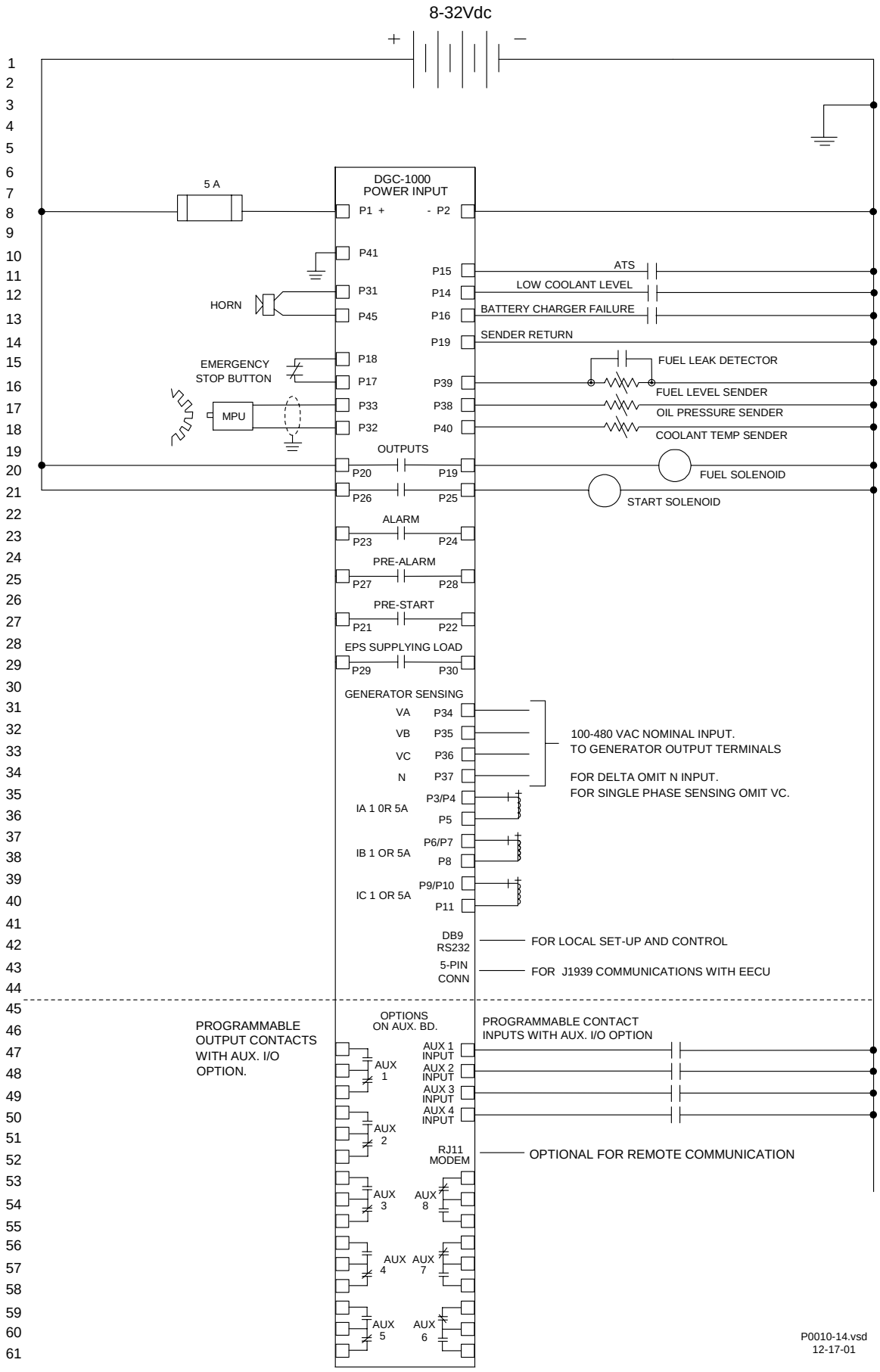


Figure 4-6. DGC-1000 System Ladder Diagram

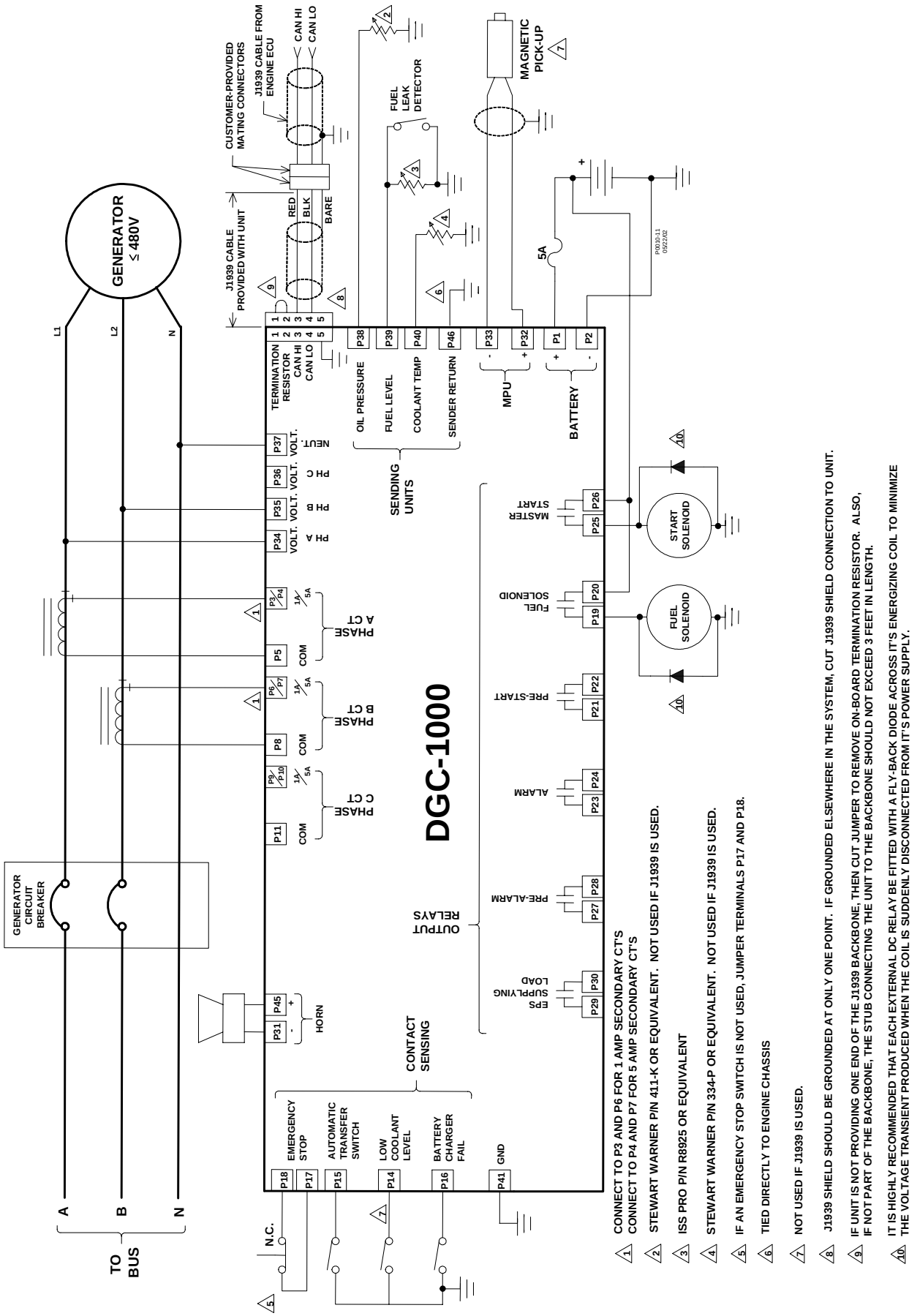
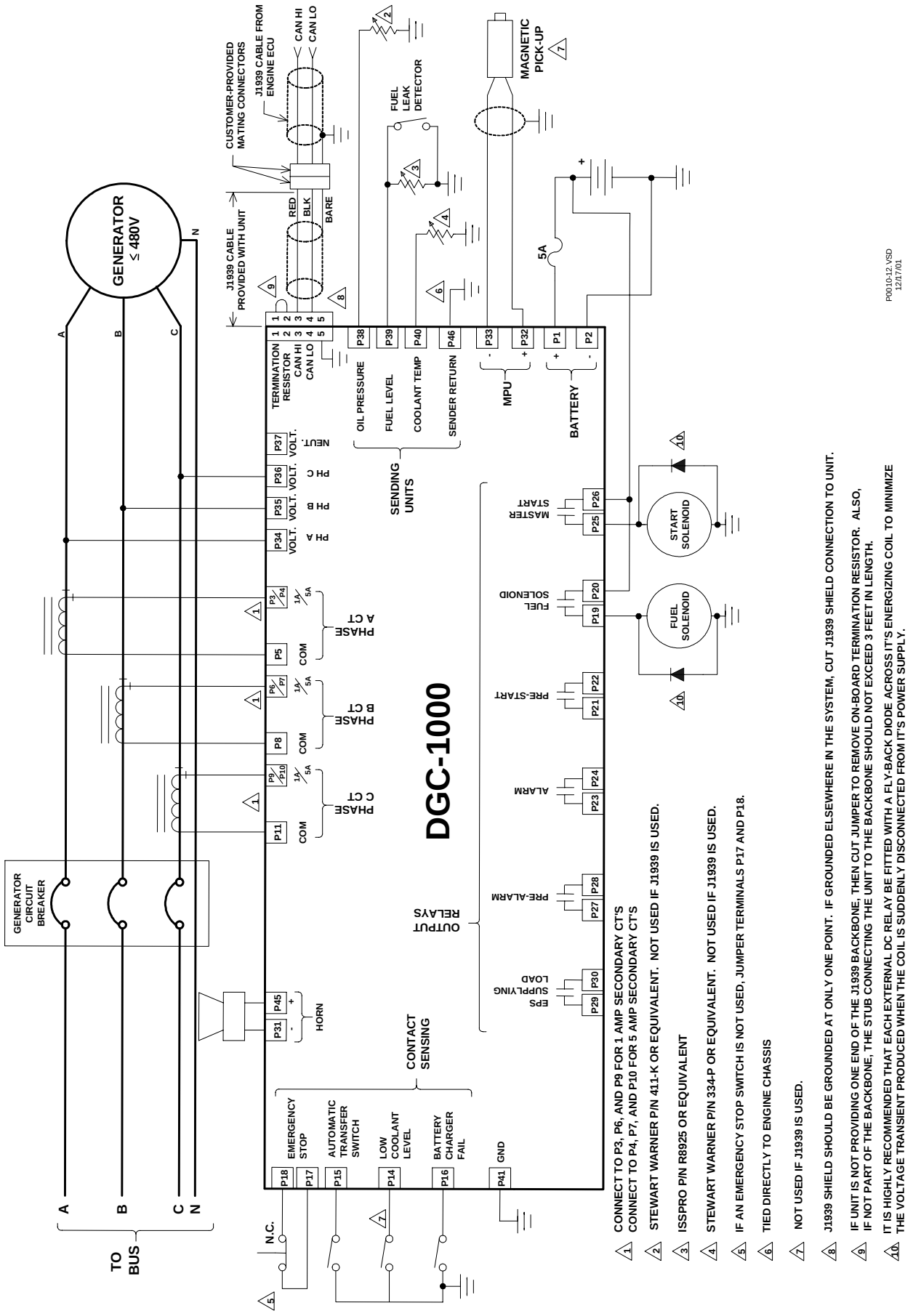


Figure 4-7. Direct-Connected, Single-Phase, Three-Wire Sensing



1. CONNECT TO P3, P6, AND P9 FOR 1 AMP SECONDARY CT'S
   CONNECT TO P4, P7, AND P10 FOR 5 AMP SECONDARY CT'S
2. STEWART WARNER P/N 411-K OR EQUIVALENT. NOT USED IF J1939 IS USED.
3. ISSPRO P/N R8925 OR EQUIVALENT
4. STEWART WARNER P/N 334-P OR EQUIVALENT. NOT USED IF J1939 IS USED.
5. IF AN EMERGENCY STOP SWITCH IS NOT USED, JUMPER TERMINALS P17 AND P18.
6. TIED DIRECTLY TO ENGINE CHASSIS
7. NOT USED IF J1939 IS USED.
8. J1939 SHIELD SHOULD BE GROUNDED AT ONLY ONE POINT. IF GROUNDED ELSEWHERE IN THE SYSTEM, CUT J1939 SHIELD CONNECTION TO UNIT.
9. IF UNIT IS NOT PROVIDING ONE END OF THE J1939 BACKBONE, THEN CUT JUMPER TO REMOVE ON-BOARD TERMINATION RESISTOR. ALSO, IF NOT PART OF THE BACKBONE, THE STUB CONNECTING THE UNIT TO THE BACKBONE SHOULD NOT EXCEED 3 FEET IN LENGTH.
10. IT IS HIGHLY RECOMMENDED THAT EACH EXTERNAL DC RELAY BE FITTED WITH A FLY-BACK DIODE ACROSS IT'S ENERGIZING COIL TO MINIMIZE THE VOLTAGE TRANSIENT PRODUCED WHEN THE COIL IS SUDDENLY DISCONNECTED FROM IT'S POWER SUPPLY.

Figure 4-8. Direct-Connected, Three-Phase, Line-to-Line Sensing

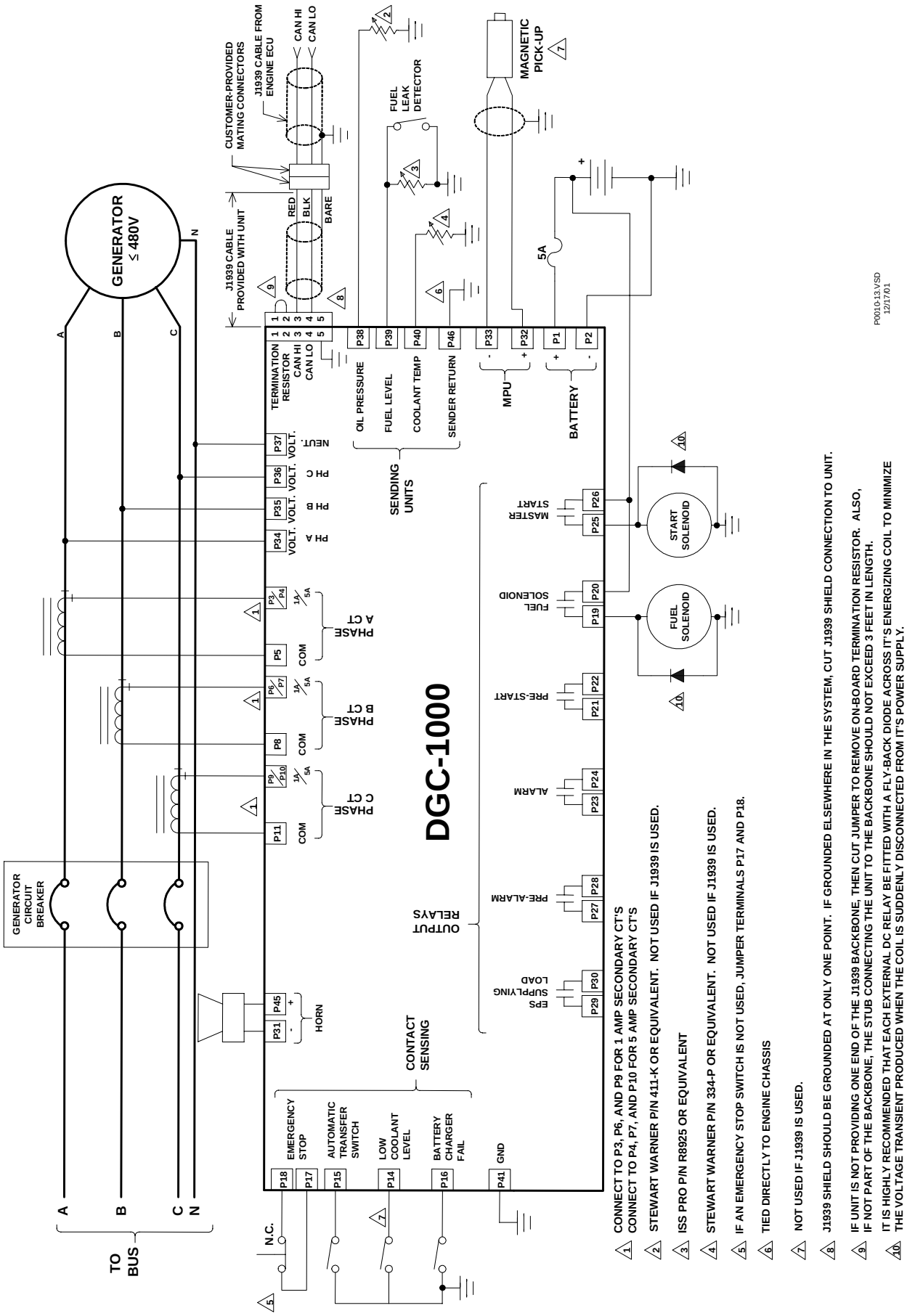


Figure 4-9. Direct-Connected, Three-Phase, Line-to-Neutral Sensing

Volvo Penta EDC III Applications

Volvo engines equipped with Volvo Penta EDC III controllers, like the TAD124xGE series, can receive engine control commands (such as start and stop) from the DGC-1000 through the SAE J1939 communication interface. To invoke this feature, the EDC must receive a J1939 message containing engine control information within one second of waking (exiting sleep mode). If the EDC III does not receive an engine control message within the prescribed time, it will enter the stand-alone mode and ignore any J1939 control messages. If this occurs, the EDC III must be forced back into sleep mode by pressing the auxiliary stop button on the engine or by momentarily disconnecting EDC power.

The interconnection diagrams of Figures 4-10, 4-11, and 4-12 illustrate the DGC-1000 and EDC connections that allow the DGC-1000 to awaken the EDC and start the engine, or simply acquire engine status information. Wakeup of the EDC is initiated by using the DGC-1000 fuel solenoid output contacts to apply battery power to the EDC. To stop the engine, the DGC-1000 issues a sleep command through the J1939 interface to the EDC and opens the fuel solenoid output contacts. This causes the EDC to stop the engine and enter the sleep mode.

In order for the DGC-1000 to communicate with the EDC, two DGC-1000 settings must be changed from their default values.

- The J1939 address of the DGC-1000 must be set at 17.
- The engine start/stop configuration setting must be set for “Volvo Penta EDC III”.

In order for the Volvo engine to operate at rated rpm, verify the following DGC-1000 settings.

- Speed Select setting should be set at “Primary”.
- Accelerator Position setting should be set at 50%.

The above settings are configured on the BESTCOMS System Settings screen. Section 6, *BESTCOMS Software* has information about adjusting DGC-1000 settings through BESTCOMS.

MTU MDEC ECU Applications

MTU MDEC ECUs, supplied on some Detroit Diesel engines, can receive engine control commands from the DGC-1000 and transmit engine operating status information to the DGC-1000 through the SAE J1939 communication interface.

In order for the DGC-1000 to communicate with the MDEC ECU, ECU support must be enabled on the BESTCOMS System Settings screen and “MTU MDEC” must be selected as the engine configuration. The appropriate ECU module type, speed demand source, and engine rpm must also be selected.

The MTU MDEC ECU must be configured properly in order for CAN communication to function correctly. The parameters listed in Table 4-3 must be configured in the ECU with the MDEC service tool. Contact Detroit Diesel if ECU reconfiguration is required and your facility is not equipped to perform this task.

Table 4-3. MTU MDEC ECU Configuration Parameters

MDEC Parameter Number	Parameter Name	Description and Value
200	CAN Interface Config Param	Set to 898 – Indicates one CAN bus with PIMS
201.01	CAN Monitor Nodes 1–16	Binary value indicating which communication devices are on the CAN network. If a binary representation of this parameter’s value does not have the bit set corresponding to a value of 00100000, take the value in this register, add 32 to it, and rewrite it to the register to set the bit. This informs the MTU MDEC ECU that a third part controller resides on the CAN bus.
156.19	CAN Speed Demand Switch Active	Set to 1 – This is necessary only if it is desired to set the engine speed demand source and speed demand from the DGC-1000. This capability may be blocked by setting the parameter to 0.

The interconnection diagrams of Figure 4-13, 4-14, and 4-15 illustrate DGC-1000 and MDEC ECU connections for three types of generator sensing configurations.

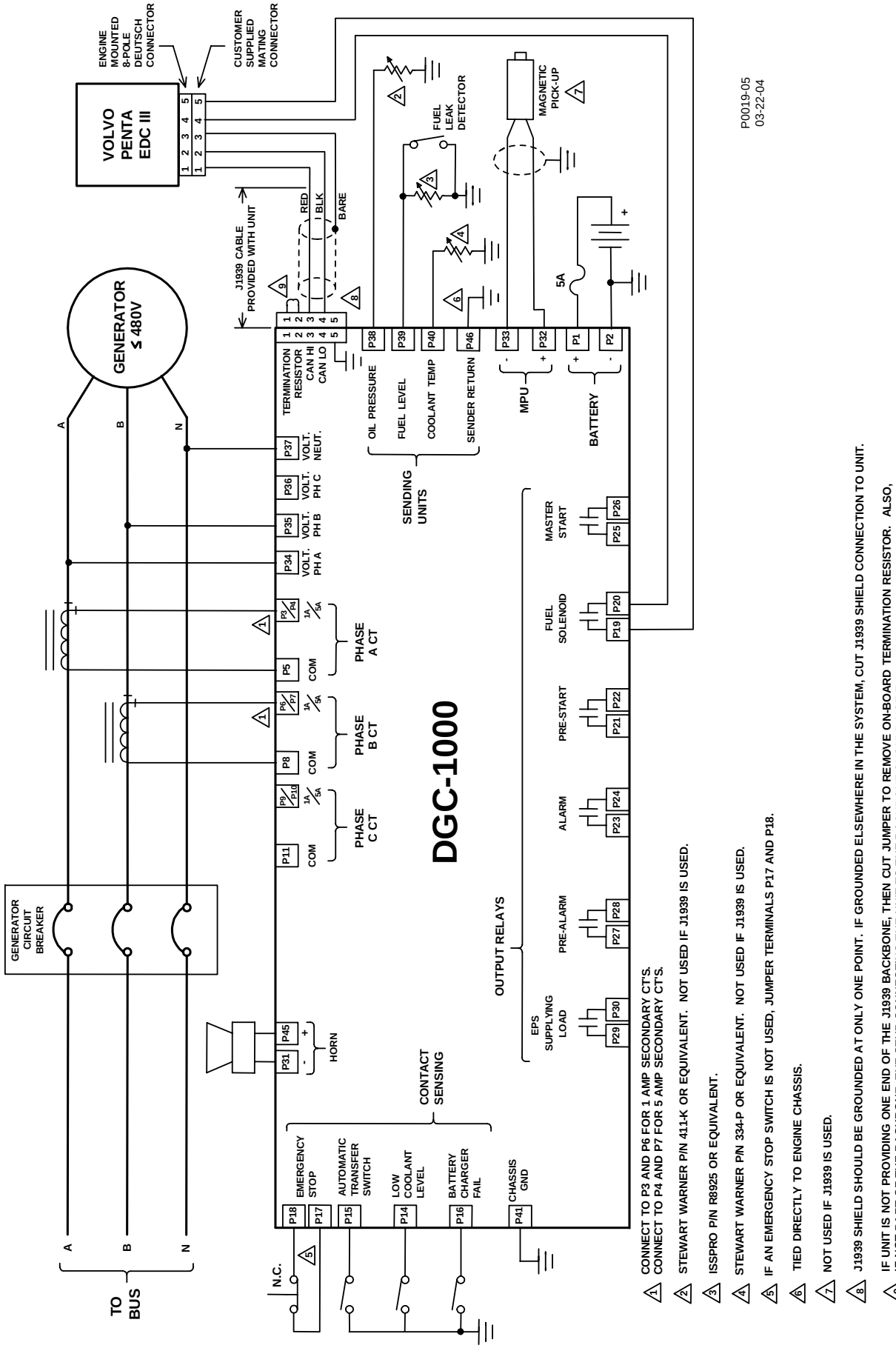


Figure 4-10. Direct-Connected, Single-Phase, Three-Wire Sensing, Volvo Penta EDC III

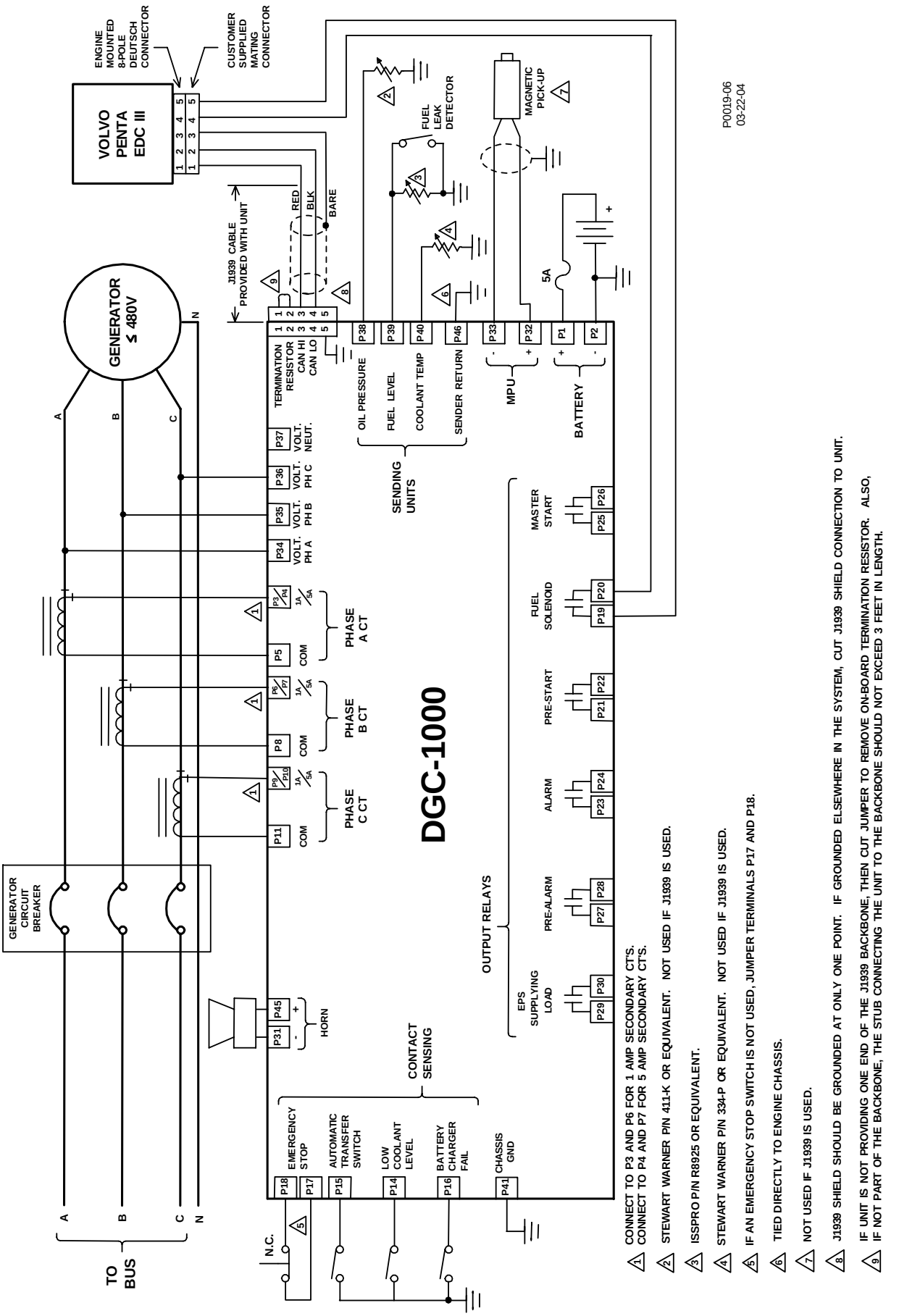


Figure 4-11. Direct-Connected, Three-Phase, Line-to-Line Sensing, Volvo Penta EDC III

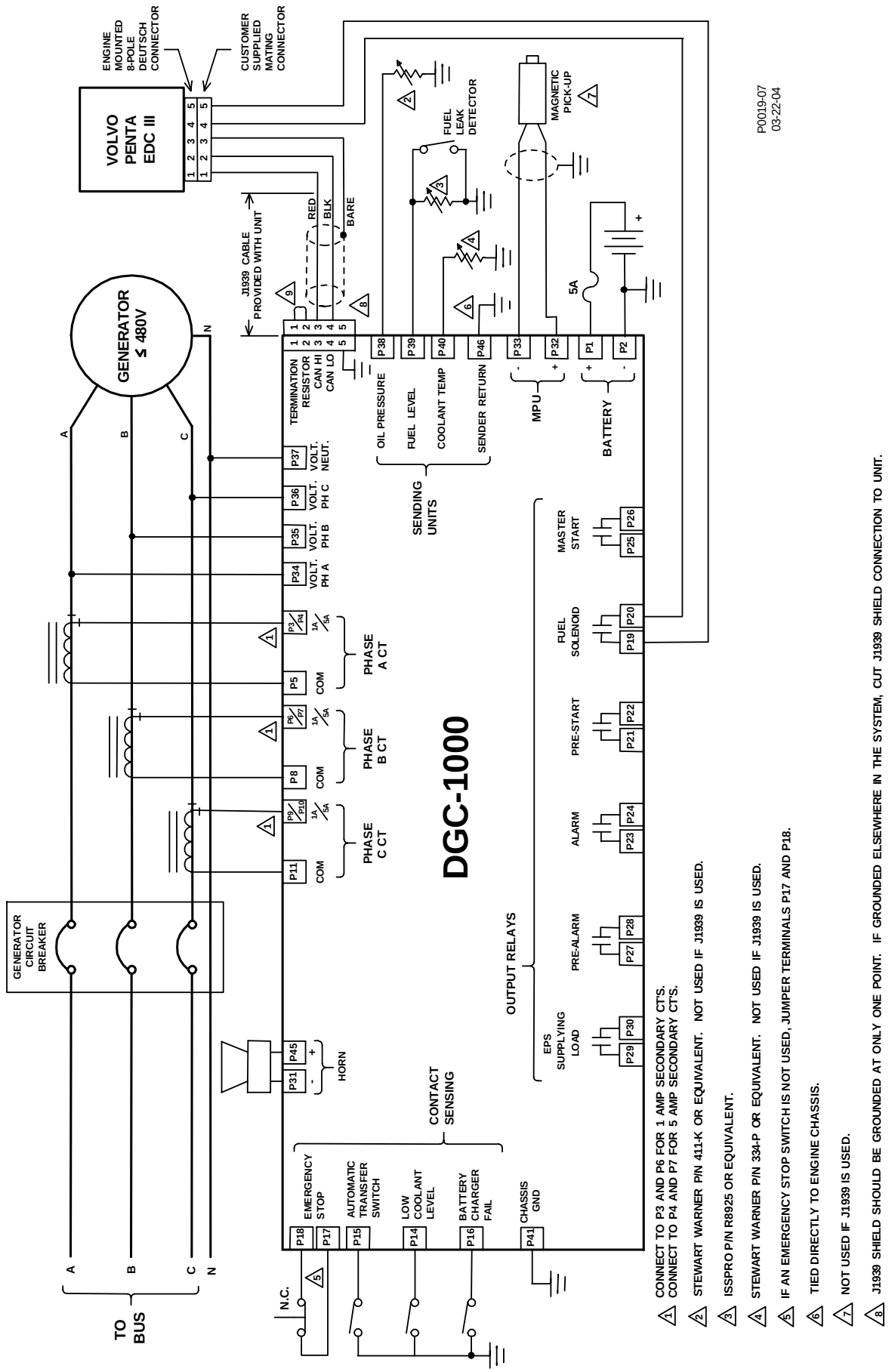


Figure 4-12. Direct-Connected, Three-Phase, Line-to-Neutral Sensing, Volvo Penta EDC III

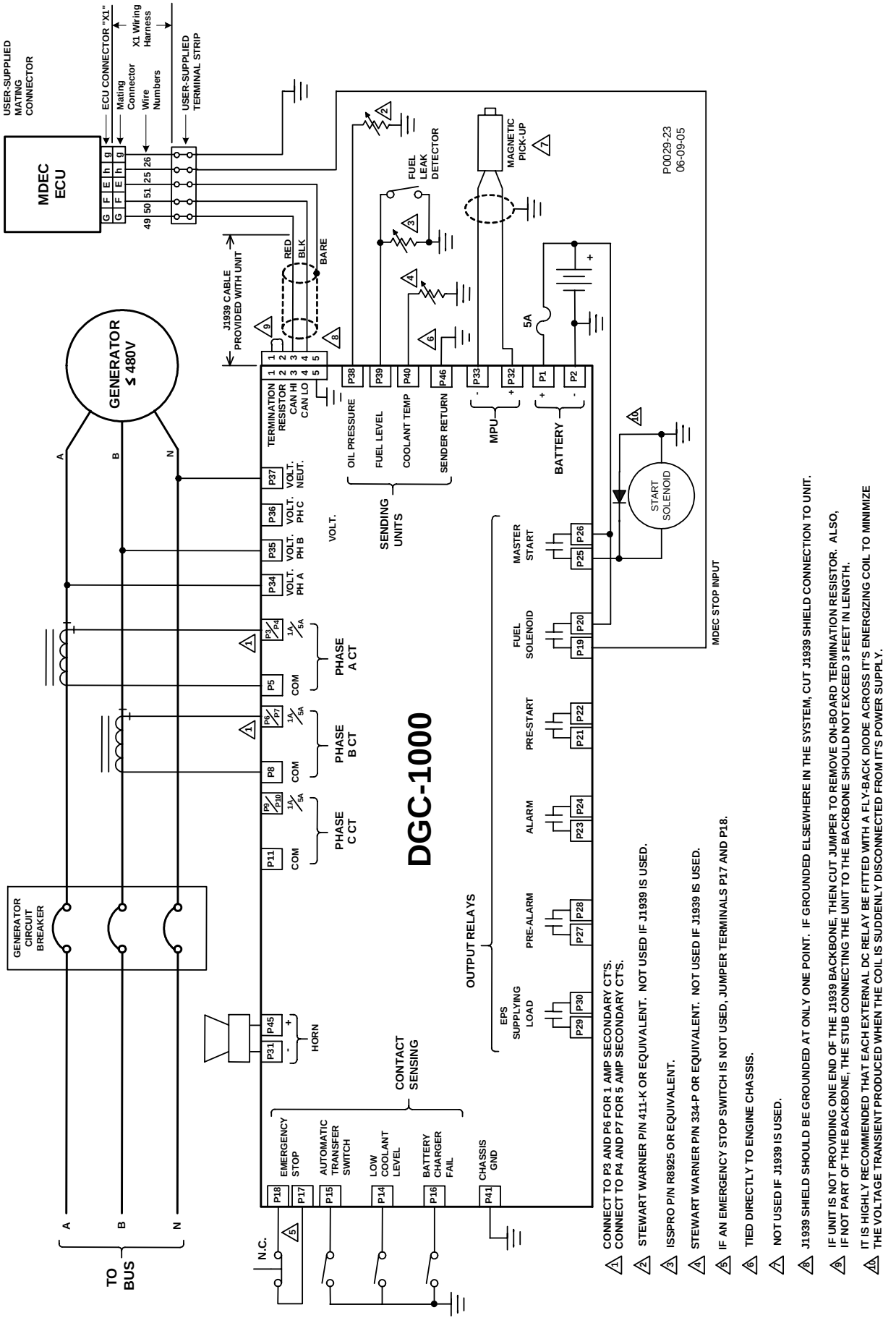
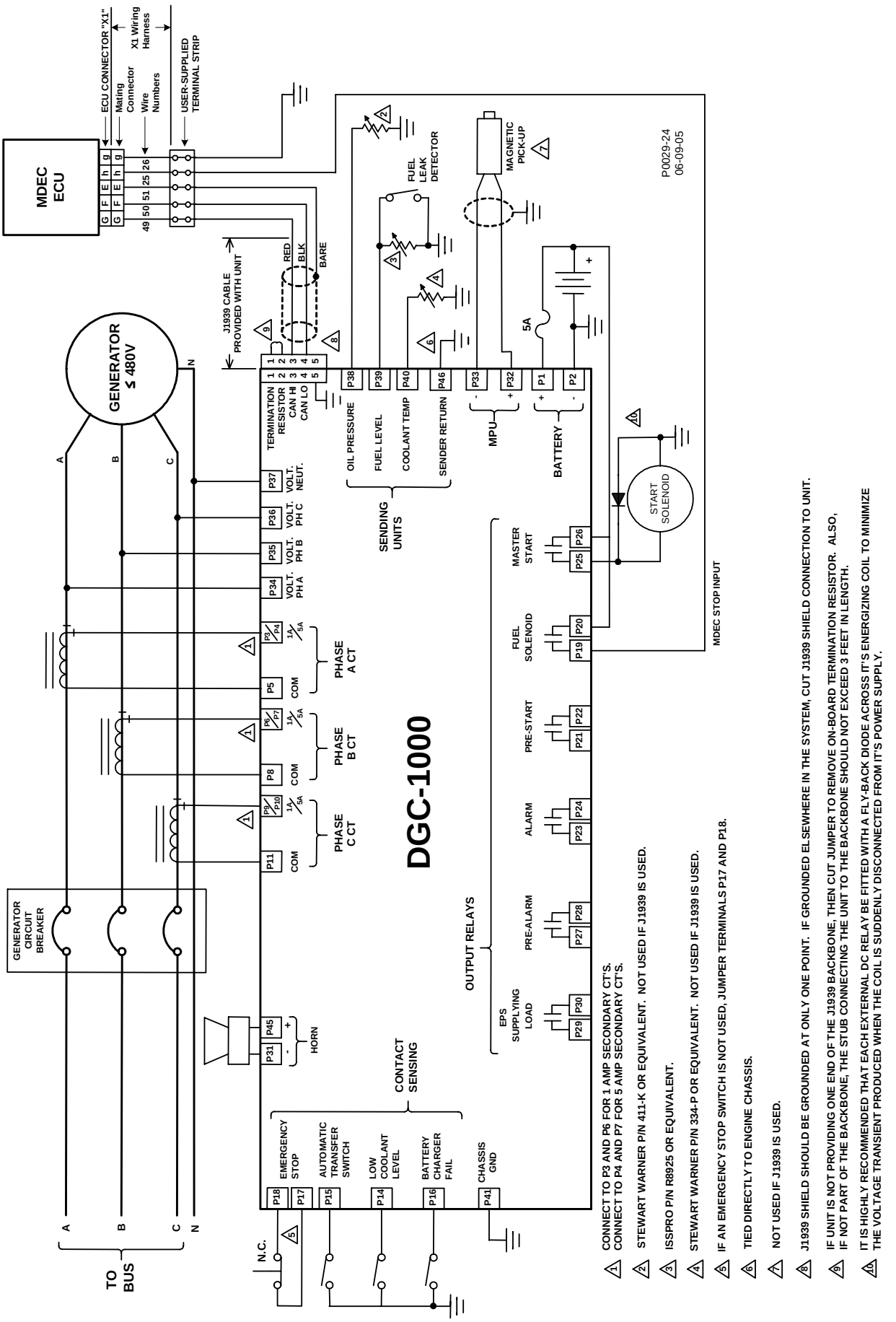


Figure 4-13. Direct-Connected, Single-Phase, Three-Wire Sensing, MTU MDEC ECU



1. CONNECT TO P3 AND P6 FOR 1 AMP SECONDARY CT'S. CONNECT TO P4 AND P7 FOR 5 AMP SECONDARY CT'S.
2. STEWART WARNER P/N 411-K OR EQUIVALENT. NOT USED IF J1939 IS USED.
3. ISSPRO P/N R8925 OR EQUIVALENT.
4. STEWART WARNER P/N 334-P OR EQUIVALENT. NOT USED IF J1939 IS USED.
5. IF AN EMERGENCY STOP SWITCH IS NOT USED, JUMPER TERMINALS P17 AND P18.
6. TIED DIRECTLY TO ENGINE CHASSIS.
7. NOT USED IF J1939 IS USED.
8. J1939 SHIELD SHOULD BE GROUNDED AT ONLY ONE POINT. IF GROUNDED ELSEWHERE IN THE SYSTEM, CUT J1939 SHIELD CONNECTION TO UNIT.
9. IF UNIT IS NOT PROVIDING ONE END OF THE J1939 BACKBONE, THEN CUT JUMPER TO REMOVE ON-BOARD TERMINATION RESISTOR. ALSO, IF NOT PART OF THE BACKBONE, THE STUB CONNECTING THE UNIT TO THE BACKBONE SHOULD NOT EXCEED 3 FEET IN LENGTH.
10. IT IS HIGHLY RECOMMENDED THAT EACH EXTERNAL DC RELAY BE FITTED WITH A FLY-BACK DIODE ACROSS IT'S ENERGIZING COIL TO MINIMIZE THE VOLTAGE TRANSIENT PRODUCED WHEN THE COIL IS SUDDENLY DISCONNECTED FROM IT'S POWER SUPPLY.

Figure 4-14. Direct-Connected, Three-Phase, Line-to-Line Sensing, MTU MDEC ECU

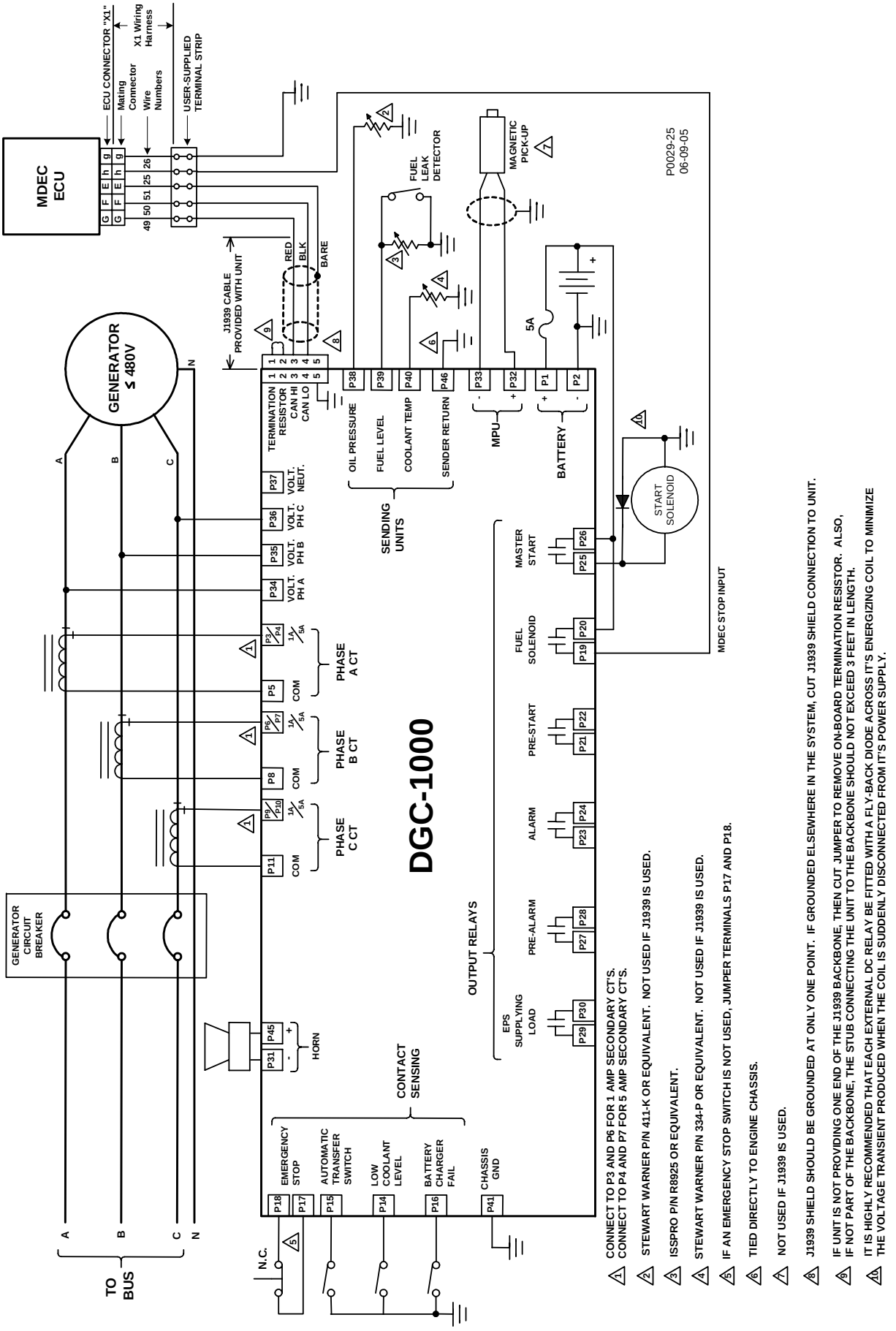


Figure 4-15. Direct-Connected, Three-Phase, Line-to-Neutral Sensing, MTU MDEC ECU

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SECTION 5 • TESTING

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SECTION 5 • TESTING

INTRODUCTION

The procedures of this section test DGC-1000 operation using the preset, factory-default settings.

EQUIPMENT REQUIRED

- Power supply, 12 or 24 Vdc
- Fuse, 2 A
- Voltage source, 60 Hz, 0 to 120 Vac
- Current source, 60 Hz, 0 to 5 Aac
- Signal generator, sine-wave, 0 to 5 kHz, 0 to 5V
- Digital voltmeter, 4½ digits (Fluke 8050A or equivalent)
- Continuity tester
- SPST switch (4)
- Variable resistor, 250 ohms (2)
- Variable resistor, 2,500 ohms

INITIAL TEST PROCEDURE

Unless otherwise specified, the test procedures in this manual use the default parameter settings provided in Table 5-1.

Table 5-1. Default Parameter Settings

Parameter	Setting
Comm Baud Rate	9600 baud
Remote Delay Time	1 millisecond/10
Comm Parity	None
Device Address	125
Settings Source	User
Generator Connection	3-ph L-N
NFPA Level	0
ECU Support	Disabled
Engine Configuration	Standard J1939
Unit System	English
Battery Volts	24 volts
Generator Frequency	60 Hz
Rated Engine RPM	1800 rpm
Number Flywheel Teeth	126
Genset kW Rating	300 kilowatt
No Load Cool Down Time	0 minutes
Generator PT Primary Voltage	480 Vac
Generator PT Secondary Voltage	480 Vac
Generator CT Primary Current	500 Aac
Low Fuel Alarm Enable	ON
Low Fuel Alarm Threshold	2% full tank
Low Fuel Pre-alarm Enable	OFF
Low Fuel Pre-alarm Threshold	25% full tank

Parameter	Setting
Low Coolant Temperature Pre-alarm Enable	OFF
Low Coolant Temperature Pre-alarm Threshold	50 degrees F
Battery Overvoltage Pre-alarm Enable	OFF
Battery Overvoltage Pre-alarm Threshold	30.0 Vdc
Maintenance Interval Pre-alarm Enable	OFF
Maintenance Interval Pre-alarm Threshold	500 hours
Engine kW Overload Pre-alarm Enable	OFF
Engine kW Overload Pre-alarm Threshold	105 % of rated
High Coolant Temperature Pre-alarm Enable	ON
High Coolant Temperature Pre-alarm Threshold	250 degrees F
Low Oil Pressure Pre-alarm Enable	ON
Low Oil Pressure Pre-alarm Threshold	25 psi
Low Battery Voltage Pre-alarm Enable	OFF
Low Battery Voltage Pre-alarm Threshold	20.0 Vdc
Low Battery Voltage Pre-alarm Activation Time Delay	10 seconds
Weak Battery Pre-alarm Enable	OFF
Weak Battery Pre-alarm Threshold	15.0 Vdc
Weak Battery Pre-alarm Activation Time Delay	2 seconds
High Coolant Temperature Alarm Enable	ON
High Coolant Temperature Alarm Threshold	275 degrees F
High Coolant Temperature Alarm Arming Delay After Crank Disconnect	60 seconds
Low Oil Pressure Alarm Enable	ON
Low Oil Pressure Alarm Threshold	15 psi
Low Oil Pressure Alarm Arming Delay After Crank Disconnect	10 seconds
Overspeed Alarm Enable	ON
Overspeed Alarm Threshold	110% of rated
Overspeed Alarm Activation Time Delay	50 millisecond
Coolant Temperature Sender Failure Alarm Enable	OFF
Oil Pressure Sender Failure Alarm Enable	OFF
Speed Failure Alarm Enable	OFF
Loss of Generator Voltage Alarm Enable	OFF
Pre-alarm Buzzer Enable	ON
Battery Charger Failure Pre-alarm Enable	OFF
Global Sender Failure Alarm Time Delay	10 seconds
Coolant Temp. Sender Failure Alarm Activation Time Delay	5 minutes
Cranking Style	Cycle
Number of Crank Cycles	2
Cycle Crank Time	5 seconds
Continuous Crank Time	10 seconds
Crank Disconnect Limit	30 % of rated
Pre-Crank Delay	0 seconds
Pre-crank Contact After Crank Disconnect	Open
Generator Speed Mode	MPU/GEN
Generator Rotation	A-B-C

Step 1. Connect the DGC-1000 test setup as shown in Figure 5-1.

Step 2. Apply operating voltage to battery voltage terminals.

Result: The LCD displays DGC 1000 and the software version for approximately one second before switching to the normal display mode and at the same time, the Alarm sounds. The audible alarm will sound continuously when Not In Auto or in Alarm. The audible alarm may be silenced by pressing the Alarm Silence switch on the front panel.

Step 3 Press the Off switch to place the DGC-1000 in the OFF position.

Step 4. Verify that LEDs Not In Auto and Off are ON, the Alarm LED is flashing, and the LCD backlight is ON with system parameters displayed.

Step 5. Press the Lamp Test switch and verify that all six LEDs are ON (Not In Auto, Alarm, and Off are red; Supplying Load, Run, and Auto are green). All LCD pixels should be visible.

Step 6. Verify Run, Off, and Auto switches, along with their respective LEDs, toggle as each switch is operated. Not In Auto LED should be OFF when Auto is selected.

Step 7. Verify that switches Raise/Scroll, Lower/Scroll, Select/Enter, Previous, and Display/Toggle are functional by scrolling through the unit menus.

METERING TEST PROCEDURES

Metering Battery And Generator Voltages

NOTE

Displayed voltage is equal to the generator potential transformer primary voltage setting times the applied voltage divided by the generator potential transformer secondary voltage setting.

Step 1. Verify that the battery input (terminals P1 and P2) voltage is 24.0 Vdc.

Step 2. Verify that the DGC-1000 displayed value is 24.0 ±0.5 Vdc.

Step 3. Apply 120.0 Vac, 60.0 hertz to phase A (line-to-neutral) generator voltage input (terminals P34 and P37).

Step 4. Verify that the DGC-1000 generator frequency displayed value is 60.0 ±0.2 hertz.

Step 5. Verify that the DGC-1000 phase A to neutral voltage displayed value is 120.0 ±2.0 Vac.

Step 6. Remove the voltage.

Step 7. Apply 120.0 Vac, 60.0 hertz to phases A and B generator voltage input (terminals P34 and P35).

Step 8. Verify that the DGC-1000 generator A to B voltage displayed value is 120.0 ±2.0 Vac.

Step 9. Remove the voltage.

Step 10. Apply 120.0 Vac, 60.0 hertz (line-to-neutral) to phase B generator voltage input (terminals P35 and P37).

Step 11. Verify that the DGC-1000 line-to-neutral voltage displayed value is 120.0 ±2.0 Vac.

Step 12. Remove the voltage.

Step 13. Apply 120.0 Vac, 60.0 hertz to phases B and C generator voltage input (terminals P35 and P36).

Step 14. Verify that the DGC-1000 generator B to C voltage displayed value is 120.0 ±2.0 Vac.

Step 15. Remove the voltage.

Step 16. Apply 120.0 Vac, 60.0 hertz (line-to-neutral) to phase C generator voltage input (terminals P36 and P37).

Step 17. Verify that the DGC-1000 line-to-neutral voltage displayed value is 120.0 ±2.0 Vac.

Step 18. Remove the voltage.

Step 19. Apply 120.0 Vac, 60.0 hertz to phases C and A generator voltage input (terminals P36 and P34).

Step 20. Verify that the DGC-1000 generator C to A voltage displayed value is 120.0 ±2.0 Vac.

Step 21. Remove the voltage.

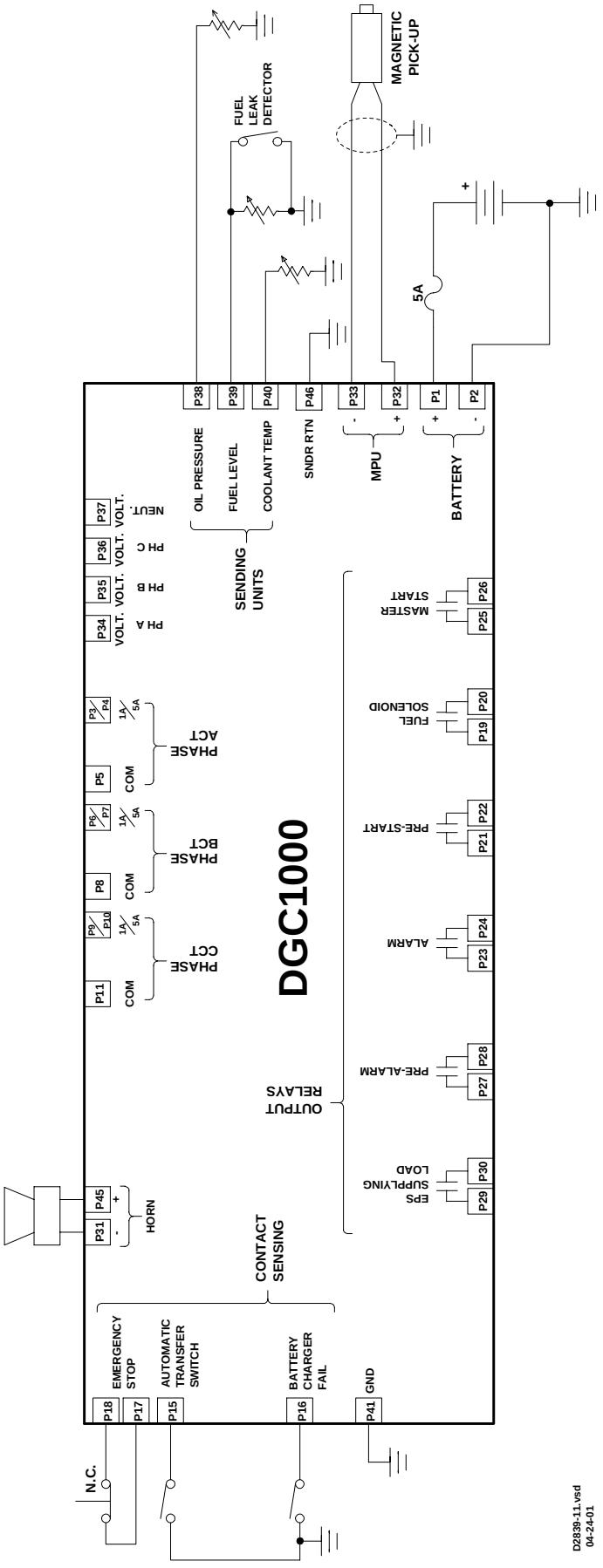

Figure 5-1. Test Set Diagram

Metering Generator Current

> **NOTE**
>
> Displayed current is equal to the generator current transformer primary current setting times the applied current divided by one or five (the nominal current value).

Step 1. Apply 1.000 Aac to the DGC-1000 generator five ampere phase A CT input (terminals P4 and P5).

Step 2. Verify that the DGC-1000 phase A current displayed value is 100.0 ±2.0 amperes.

Step 3. Remove the current.

Step 4. Apply 1.000 Aac to the DGC-1000 generator five ampere phase B CT input (terminals P7 and P8).

Step 5. Verify that the DGC-1000 phase B current displayed value is 100.0 ±2.0 amperes.

Step 6. Remove the current.

Step 7. Apply 1.000 Aac to the DGC-1000 generator five ampere phase C CT input (terminals P10 and P11).

Step 8. Verify that the DGC-1000 phase C current displayed value is 100.0 ±2.0 amperes.

Step 9. Remove the current.

Oil Pressure

Step 1. Apply 60 ohms across the Oil Pressure transducer input (terminals P38 and P2).

Step 2. Verify that the DGC-1000 displayed value is 80 ±2.0 psi.

Coolant Temperature

Step 1. Apply 100 ohms across the Coolant Temperature transducer input (terminals P40 and P2).

Step 2. Verify that the DGC-1000 displayed value is 205 ±4.0°F.

Percent Fuel Level

Step 1. Apply 137 ohms across the Fuel Level transducer input (terminals P39 and P2).

Step 2. Verify that the DGC-1000 displayed value is 50 ±2.0%.

Engine Speed (RPM)

> **NOTE**
>
> RPM as derived from the MPU is equal to [MPU output frequency (hertz) times 60] divided by the number of flywheel teeth.
>
> RPM as derived from the generator is equal to [generator output voltage frequency] divided by the rated generator frequency (hertz) times the rated rpm.

Step 1. Apply a 5 Vac, 3,780 hertz sine wave to the DGC-1000 magnetic pickup unit inputs (terminals P32 and P33).

Step 2. Verify that the DGC-1000 displayed value is 1,800 ±36 rpm.

Step 3. Remove the voltage.

Generator Power Factor

> **NOTE**
>
> The DGC-1000 uses phase A voltage and phase B current for Power Factor calculations. Therefore, if this test is performed with the current lagging the voltage by 120 degrees, the displayed Power Factor will be approximately 1.00.

Step 1. Apply 120 Vac to phase A to neutral generator voltage inputs (terminals P34 and P37).

Step 2. Apply 1.0 Aac to phase B current transformer inputs (terminals P7 and P8) in phase with the phase A to neutral voltage.

Step 3. Verify that the DGC-1000 displayed value is -0.50 ±0.02.

Step 4. Remove voltage and current.

Generator kW And kVA

> **NOTE**
>
> The displayed kW is equal to the kVA times the power factor.

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals P34 and P37), phase B to neutral (terminals P35 and P37), and phase C to neutral (terminals P36 and P37).

Step 2. Apply in series and in phase with the voltage 1 Aac to Phase A current transformer input (terminals P3 and P5), Phase B current transformer input (terminals P6 and P8), and Phase C current transformer input (terminals P9 and P11).

Step 3. Verify that the DGC-1000 displayed value for individual phase kW is –30 ±2 kW.

Step 4. Verify that the DGC-1000 displayed value for total kW is –90 ±2 kW.

Step 5. Verify that the DGC-1000 displayed value for individual phase kVA is 60 ±2 kVA.

Step 6. Verify that the DGC-1000 displayed value for total kVA is within 180 ±5 kVA.

Step 7. Remove voltage and current.

CRANKING TEST PROCEDURES

Crank Cycle

> **NOTE**
>
> The DGC will go into cvercrank if the Off switch is not pressed before two crank cycles expire. Pressing Off will reset this condition if it occurs.

Step 1. Verify that all output contacts are open.

Step 2. Press the Run switch on the front panel.

Step 3. Verify that the DGC-1000 displays CRANKING STATUS.

Step 4. Verify that only the Master Start, Auxiliary Start, Fuel Solenoid and Pre-Start output contacts are closed during CRANKING CYCLE.

Step 5. Verify that only the Pre-Start contact remains closed during RESTING.

Step 6. Press the Off switch on the front panel.

Step 7. Press the Auto switch on the front panel.

Step 8. Apply a contact closure across the Automatic Transfer Switch input (terminals P15 and P2).

Step 9. Verify that the DGC-1000 displays CRANKING STATUS.

Step 10. Verify that only the Master Start, Auxiliary Start, Fuel Solenoid and Pre-Start output contacts are closed during CRANKING CYCLE.

Step 11. Verify that only the Pre-Start contact remains closed during RESTING.

Step 12. Press the Off switch on the front panel.

Step 13. Open the contact across the Automatic Transfer Switch inputs.

Running

Step 1. Press the Run switch on the front panel.

Step 2. Within 5 seconds of beginning cranking, apply in parallel 120 Vac to phase A to neutral (terminals P34 and P37), phase B to neutral (terminals P35 and P37) and phase C to neutral (terminals P36 and P37).

Step 3. Verify that only the fuel solenoid output contact is closed.

Step 4. Verify that the DGC-1000 normal mode display now meters the active generator values listed on the front panel instead of displaying READY.

Step 5. Press the Off switch on the front panel.

Step 6. Remove the voltage.

Step 7. Press the Auto switch on the front panel.

Step 8. Apply a contact closure across the Automatic Transfer Switch input (terminals P15 and P2).

Step 9. Within 5 seconds of beginning cranking, apply in parallel 120 Vac to phase A to neutral (terminals P34 and P37), phase B to neutral (terminals P35 and P37), and phase C to neutral (terminals P36 and P37).

Step 10. Verify that only the Fuel Solenoid output contact is closed.

Step 11. Verify that the DGC-1000 normal mode display now meters the active generator values listed on the front panel instead of displaying READY.

Step 12. Press the Off switch on the front panel.

Step 13. Remove the voltage.

Step 14. Open the contact across the Automatic Transfer Switch inputs.

PROTECTIVE FUNCTION TEST PROCEDURES

Overcrank

Step 1. Press the Run switch on the front panel.

Step 2. Verify that after two crank cycles the DGC-1000 display indicates GEN OVER-CRANK ALARM and that only the Alarm output contacts are closed.

Step 3. Press the Off switch on the front panel and verify that the DGC-1000 resets to the Ready mode and that all output contacts open.

Overspeed

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals P34 and P37), phase B to neutral (terminals P35 and P37), and phase C to neutral (terminals P36 and P37).

Step 2. Apply a 5 Vac, 4,000 hertz sine wave to the DGC-1000 MPU inputs (terminals P32 and P33).

Step 3. Press the Run switch on the front panel.

Step 4. Slowly increase the frequency to the DGC-1000 MPU input until an overspeed shutdown occurs.

Step 5. Verify shutdown occurs within 4,158 ±83 hertz (1,980 ±38 rpm).

Step 6. Verify that the DGC-1000 display indicates GEN OVERSPEED ALARM and that only the Alarm output contacts are closed.

Step 7. Remove the voltages.

Step 8. Press the Off switch on the front panel and verify that the DGC-1000 resets to the Ready mode and that all output contacts open.

Low Oil Pressure

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals P34 and P37), phase B to neutral (terminals P35 and P37), and phase C to neutral (terminals P36 and P37).

Step 2. Press the Run switch on the front panel.

Step 3. Wait ten seconds after crank disconnect. Increase the resistance across the Oil Pressure sender input (terminals P38 and P2) until a Pre-alarm occurs. Note that an alarm or pre-alarm will occur only if the sender input detects resistance in the range of 5 to 280 ohms. An open or shorted sender will not result in an alarm or pre-alarm.

Step 4. Verify that the DGC-1000 display value is 25 ±2 PSI when Pre-alarm occurs.

Step 5. Verify that the DGC-1000 displays an alternately flashing dark field in the oil pressure location and that the Pre-alarm output contact has closed.

Step 6. While monitoring displayed oil pressure, further increase the resistance across the Oil Pressure sender input until a low oil pressure shutdown occurs. Note that an alarm or pre-alarm will occur only if the sender input detects resistance in the range of 5 to 280 ohms. An open or shorted sender will not result in an alarm or pre-alarm.

NOTE

Oil pressure below 15 psi is displayed as 0.

Step 7. Verify that the DGC-1000 displayed value is within 0 to 17 psi when shutdown occurs.

Step 8. Verify that the DGC-1000 display indicates LOW OIL PRESSURE ALARM and that only the Alarm output contacts are closed.

Step 9. Remove the voltage and return the resistance to 60 ohms.

Step 10. Press the Off switch on the front panel and verify that the DGC-1000 resets to the Ready mode and that all output contacts open.

High Coolant Temperature

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals P34 and P37), phase B to neutral (terminals P35 and P37), and phase C to neutral (terminals P36 and P37).

Step 2. Press the Run switch on the front panel.

Step 3. Wait 60 seconds after crank disconnect. Decrease the resistance across the Coolant Temperature sender input (terminals P40 and P2) until a Pre-alarm occurs. Note that an alarm or pre-alarm will occur only if the sender input detects resistance in the range of 5 to 3,100 ohms. An open or shorted sender will not result in an alarm or pre-alarm.

Step 4. Verify that the DGC-1000 display value is 250 ±5 degrees when Pre-alarm occurs.

Step 5. Verify that the DGC-1000 displays an alternately flashing dark field in the coolant temperature location and that the Pre-alarm output contact has closed.

Step 6. While monitoring displayed coolant temperature, further decrease the resistance across the Coolant Temperature sender input until an over temperature shutdown occurs.

Step 7. Verify that the DGC-1000 displayed value is 275 ±6 degrees when shutdown occurs.

Step 8. Verify that the DGC-1000 indicates OVER TEMP ALARM and that only the Alarm and Pre-alarm output contacts are closed.

Step 9. Remove the voltage and return the resistance to 100 ohms.

Step 10. Press the Off switch on the front panel and verify that the DGC-1000 resets to the Ready mode and that all output contacts open.

Emergency Stop

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals P34 and P37), phase B to neutral (terminals P35 and P37), and phase C to neutral (terminals P36 and P37).

Step 2. Press the Run switch on the front panel.

Step 3. Open the contact across the Emergency Stop inputs (terminals P17 and P18).

Step 4. Verify that the DGC-1000 indicates EMERGENCY SHUTDOWN SWITCH PRESSED and that all output contacts are open.

Step 5. Reapply the contact closure across the Emergency Stop inputs.

Step 6. Press the Off switch on the front panel and verify that the DGC-1000 resets to the Ready mode and that all output contacts open.

Step 7. Remove the voltage.

Low Coolant Level

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals P34 and P37), phase B to neutral (terminals P35 and P37), and phase C to neutral (terminals P36 and P37).

Step 2. Press the Run switch on the front panel.

Step 3. Close the Low Coolant Level contact.

Step 4. Verify that the DGC-1000 indicates LOW COOLANT LEVEL and that the Alarm contact is closed.

Step 5. Open the Low Coolant Level contact.

Step 6. Press the Off switch on the front panel and verify that the DGC-1000 resets to the Ready mode and that all output contacts open.

Step 7. Remove the voltage.

Low Fuel Level

Step 1. Apply 30 ohms across the Fuel Level transducer input (terminals P39 and P2).

Step 2. Press the Display/toggle pushbutton to enter the alternate display mode and press the Raise/Scroll pushbutton to access the Fuel Level quantity screen.

Verify that the DGC-1000 displayed value is 100%.

Step 3. Increase the resistance until the LOW FUEL alarm occurs. Note that an alarm or pre-alarm will occur only if the sender input detects resistance in the range of 5 to 280 ohms. An open or shorted sender will not result in an alarm or pre-alarm.

Verify that only the alarm contact closes.

Step 4. Slowly decrease the resistance until the DGC-1000 resets to the Ready mode.

Verify that all output contacts are open and the resistance is 236 ±5 ohms.

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SECTION 6 • BESTCOMS SOFTWARE

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SECTION 6 • BESTCOMS SOFTWARE

INTRODUCTION

BESTCOMS-DGC-100 software provides a user-friendly communication link between the DGC-1000 and the user. All DGC-1000 settings can be changed through BESTCOMS and all DGC-1000 settings can be saved in a computer file for use later to configure other controllers with the same settings.

INSTALLATION

BESTCOMS-DGC-1000 software operates with IBM-compatible personal computers (PCs) using Microsoft® Windows® 95, 98, Me, 2000, XP, and NT®. The minimum recommended operating requirements are listed below.

- IBM-compatible PC, 486DX2 or faster and a minimum of 4 MB of RAM
- CD-ROM drive
- An available serial port

Installing BESTCOMS-DGC-1000

1. Insert the BESTCOMS CD-ROM into the PC CD-ROM drive.
2. When the DGC-1000 Setup and Documentation CD menu appears, click the Install button for the BESTCOMS application. The setup utility automatically installs BESTCOMS-DGC-1000 on your PC.

Connecting the DGC-1000 and PC

Connect a communication cable between the rear RS-232 connector of the DGC-1000 and the appropriate communication port of the PC. Refer to Figure 2-2 for the location of the DGC-1000 RS-232 connector and Figure 4-4 for the required connections between the DGC-1000 and a PC.

STARTING BESTCOMS

BESTCOMS is started by clicking the Windows® Start button, pointing to Programs, the Basler Electric folder, and then clicking the BESTCOMS-DGC-1000 icon. At startup, a screen with the program title and version number (Figure 6-1) is displayed briefly. After this dialog is displayed, the Sensing Transformers screen (Figure 6-2) is displayed.

Figure 6-1. BESTCOMS Title and Version

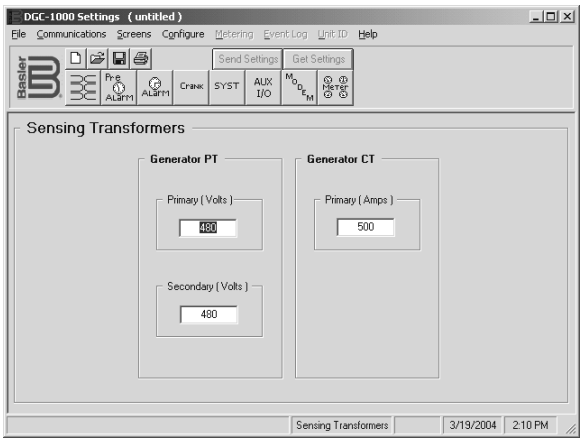

Figure 6-2. Sensing Transformers Screen

ESTABLISHING COMMUNICATION

Communication between BESTCOMS and the DGC-1000 must be established before reading or changing settings. BESTCOMS screen settings are updated only after communication is opened or the communication settings have been changed.

DGC-1000 communication with BESTCOMS can be established through the RS-232 serial interface or optional modem.

Initiating RS-232 Communication

Open the DGC-1000 RS-232 port by clicking **Communications** on the menu bar, clicking **Open**, and then **RS232 Connection**. When RS232 Connection is selected, the Comm Port screen of Figure 6-3 appears. Select the appropriate communication port for you PC and click the **Initialize** button. (Information about altering the baud rate, parity setting, and unit identification is provided in *Changing the Communication Parameters*. Information about using the RS-232 phone book (Phone Book 2) is provided in *RS-232 Phone Book*.) When the Password screen of Figure 6-4 appears, enter the appropriate password and click **OK**. The DGC-1000 is delivered with the following default passwords.

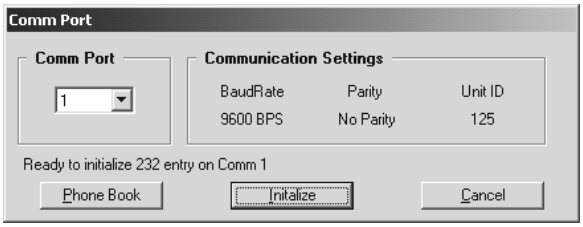

Figure 6-3. RS-232 Comm Port Screen

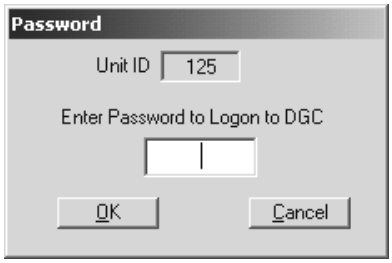

Figure 6-4. Password Screen

DGC. This limited access password allows all DGC-1000 settings to be read, but prevents any settings changes.

DGC1000. This full access password allows all DGC-1000 settings to be read and changed.

OEMLVL. This special access password allows all DGC-1000 settings to be read and changed. It also allows the DGC-1000 embedded firmware to be upgraded.

Passwords are case sensitive; all default passwords use upper-case letters. More information about passwords is provided in the *Password Protection* sub-section.

The unit ID number displayed in the Password screen indicates the identification number of the DGC-1000. Information about changing the unit ID for polled communication is provided in Changing the Communication Parameters.

When the appropriate password is entered in the Password screen and OK is clicked, communication with the DGC-1000 is established.

RS-232 Phone Book

The RS-232 phone book (Phone Book 2, Figure 6-5) is accessed by clicking the **Phone Book** button on the RS-232 Comm Port screen (accessed by clicking **Communications** on the menu bar, then **Open**, RS232 Connection). This screen allows phone book entries to be selected, added, edited, and deleted.

Selecting an Entry. A phone book entry is selected from the list of entries in the Name window of the phone book screen. When an entry in the list is highlighted, the entry's communication port number is indicated in the Comm Port field. Clicking **OK** selects the entry and returns to the Comm Port screen. The communication port number will be displayed in the Comm Port field of the Comm Port screen.

Adding an Entry. A phone book entry is added to the list of entries in the Name window of the phone book screen by clicking **Add Entry**. When the Add Entry button is clicked, an Add New Entry screen appears. This screen has a field for assigning a descriptive name to the entry and a Comm Port field for assigning a communication port number to the entry. Clicking the **OK** button saves the entry and returns to the Phone Book 2 screen.

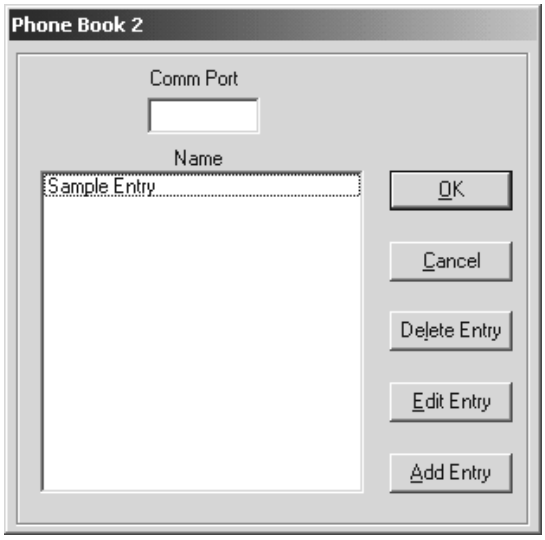

Figure 6-5. RS-232 Phone Book (Phone Book 2)

Editing an Entry. A phone book entry is edited by selecting the desired entry in the Name window and clicking the **Edit Entry** button. When the Edit Entry button is clicked, an Edit Entry screen appears and allows the entry name and port number to be changed as desired. Clicking the **OK** button saves the entry and returns to the Phone Book 2 screen.

Deleting an Entry. A phone book entry is deleted by selecting the desired entry in the Name window and clicking the **Delete Entry** button.

Initiating Modem Communication

Establish a modem connection by clicking **Communications** on the menu bar, clicking **Open**, and then **Modem Connection**. When Modem Connection is selected, the Comm Port screen of Figure 6-6 appears. Select the appropriate communication port and click the **Initialize** button. (Information about altering the baud rate, parity setting, and unit identification is provided in *Changing the Communication Parameters*.) If the selected communication port is available, the Phone Book screen of Figure 6-7 will appear when the **Initialize** button is clicked. Select the desired entry from the list in the Name window and click the **Dial Number** button to connect with the phone book entry. Creating, editing, and accessing phone book entries is discussed in the following paragraphs.

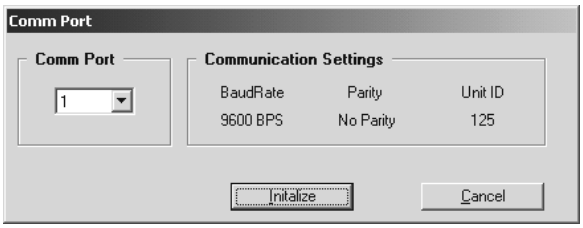

Figure 6-6. Modem Comm Port Screen

Modem Phone Book

The modem phone book (Figure 6-7) is accessed by clicking the **Initialize** button of the Comm Port screen after selecting a modem connection (see previous paragraph). This screen allows phone book entries to be selected, added, edited, and deleted much like the RS-232 phone book. Modem phone book features that differ from the RS-232 phone book are described in the following paragraphs.

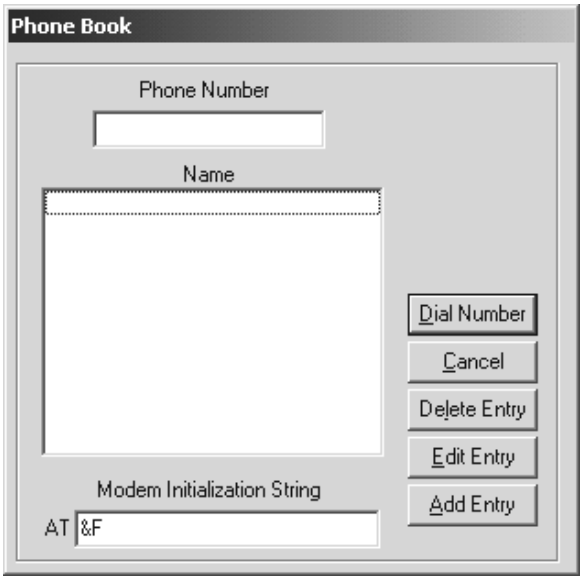

Figure 6-7. Modem Phone Book

Phone Number Field. The phone number field is displayed on the Add New Entry screen, Edit Entry screen, and Phone Book screen. This field displays the telephone number associated with the selected phone book entry and is used by the modem when dialing out.

Modem Initialization String. This field is displayed on the Add New Entry screen, Edit Entry screen, and Phone Book screen. The default string, AT&F, resets the modem to its default, factory profile. Consult your modem documentation for the appropriate AT command.

Dial Number Button. Clicking this button initiates communication by causing the modem to dial the selected phone book entry.

Unit ID

Clicking **Unit ID** on the menu bar and then clicking **Select Another Unit ID** displays the Select Another Unit dialog box. The ID number of another DGC-1000 on the same network can be entered in the Unit ID field. Clicking the **Save** button causes BESTCOMS to disconnect from the current DGC-1000 and log onto the DGC-1000 identified by the number in the Unit ID field. Because this feature allows selection of a new unit ID without breaking communication, it is useful for applications where a modem is used to remotely connect to a network of units.

CHANGING SETTINGS

DGC-1000 settings are arranged into seven groups.

- Sensing Transformers
- Pre-Alarms
- Alarms
- Crank
- System
- Auxiliary I/O
- Modem

Each setting group has a corresponding button (shown in Figure 6-8) that can be selected to access that group of settings. The seven setting groups can also be accessed by clicking **Screens** on the menu bar and then selecting the desired setting group from the list. Once a setting group is accessed, the individual settings of the group can be viewed and changed.

A setting is changed by clicking within the setting field and typing the new setting. If the new setting is outside the prescribed setting range, a dialog box showing the acceptable range appears when another setting field is accessed or when attempting to send the new setting to the DGC-1000. The following paragraphs describe how settings are sent to the DGC-1000.

SENDING AND RECEIVING SETTINGS

When communication is enabled, DGC-1000 settings can be sent and received through BESTCOMS.

Sending Settings

Setting changes are sent to the DGC-1000 by clicking the **Send Settings** button. This causes all BESTCOMS settings to become the DGC-1000 settings. Settings can also be sent to the DGC-1000 by clicking **Communications** on the menu bar and clicking **Send to DGC**.

Receiving Settings

DGC-1000 settings are retrieved by clicking the **Get Settings** button. This causes the current settings of the DGC-1000 to be loaded into BESTCOMS. Settings can also be received from the DGC-1000 by clicking **Communications** on the menu bar and clicking **Get from DGC**. Settings are also automatically retrieved when logging onto the DGC-1000.

SETTING DEFINITIONS

Each of the seven setting groups has a corresponding BESTCOMS screen. The settings of each screen are categorized by one or more tabs. In the following paragraphs, settings are arranged and defined according to the organization of the BESTCOMS screens and tabs.

Sensing Transformers

The button displaying a transformer icon is clicked to access the Sensing Transformers screen. The Sensing Transformers screen can also be accessed by clicking **Screens** on the menu bar and clicking **Sensing Transformers**. Sensing Transformer settings are shown in Figure 6-8 and described in the following paragraphs.

Generator PT – Primary (Volts). This setting selects the rating of the primary side of the transformer used to sense generator voltage. The primary voltage setting is adjustable from 1 to 15,000 Vac.

Generator PT – Secondary (Volts). This setting selects the rating of the secondary side of the transformer used to sense generator voltage. The secondary voltage setting is adjustable from 1 to 480 Vac.

Generator CT – Primary (Amps). This setting selects the rating of the primary side of the transformer used to sense generator current. The primary current setting is adjustable from 1 to 5,000 Aac.

Pre-Alarms

Click the **Pre Alarm** button to access the Pre-Alarm Settings screen or click **Screens** on the menu bar and click **Pre-Alarm Settings**. The Pre-Alarms screen consists of five tabs.

- Low Fuel-Low Cool-Batt. OverVolt.
- Maint. Interv.-Eng. kW Overload-Hi Cool
- Low Oil-Low Batt. Volt-Weak Batt Volt
- Audible – Battery Charger – Fuel Level Sender
- CAN Bus – Diagnostic Trouble Codes.

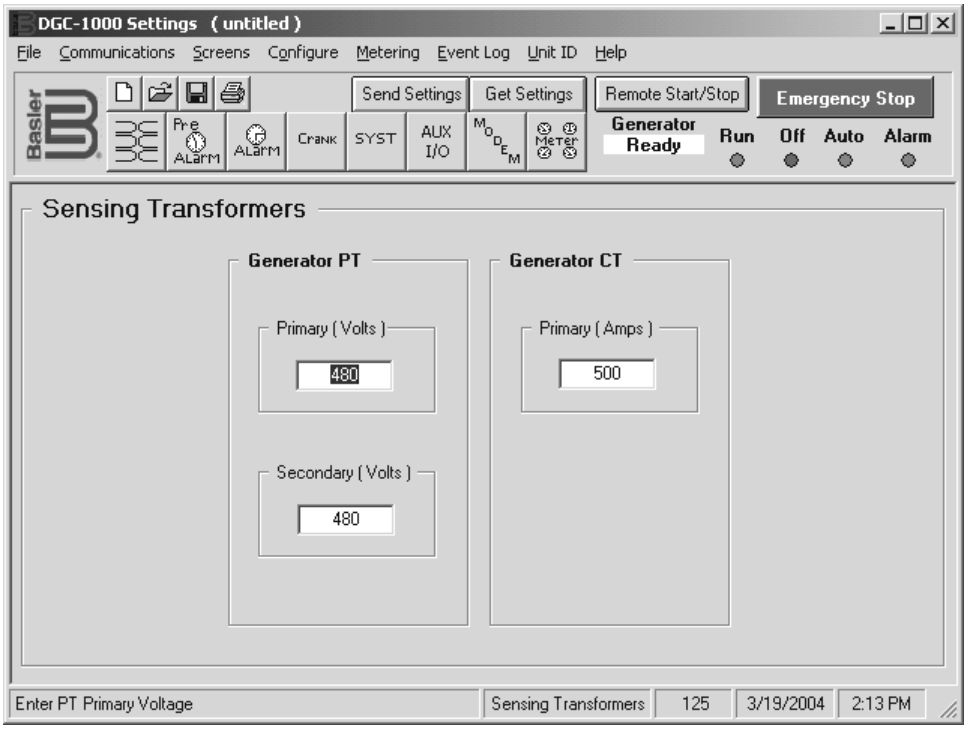

Figure 6-8. Sensing Transformers Screen

Low Fuel-Low Cool-Batt. OverVolt Tab

The Low Fuel-Low Cool-Batt. OverVolt tab settings are shown in Figure 6-9 and described in the following paragraphs.

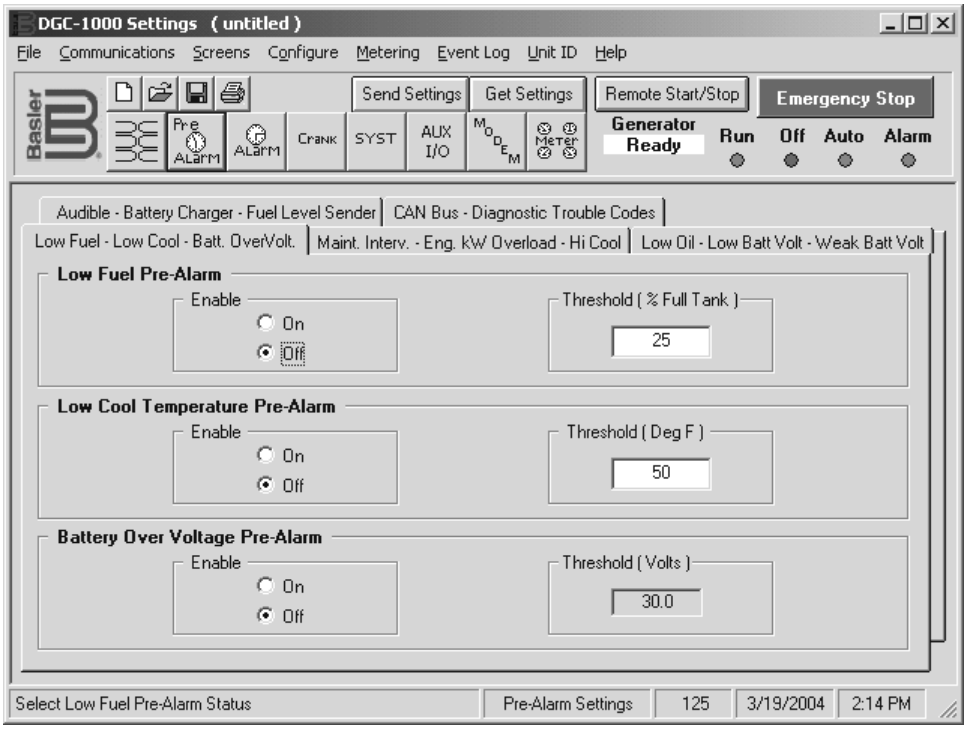

Figure 6-9. Pre-Alarms Screen, Low Fuel-Low Cool-Batt. OverVolt. Tab

Low Fuel Pre-Alarm – Enable. This setting enables and disables annunciation of a low fuel pre-alarm.

Low Fuel Pre-Alarm – Threshold (% Full Tank). This setting selects the fuel level that will trigger a low fuel pre-alarm. A threshold setting of 10 to 100 percent may be entered.

Low Cool Temperature Pre-Alarm – Enable. This setting enables and disables annunciation of a low coolant temperature pre-alarm.

Low Cool Temperature Pre-Alarm – Threshold (Deg). This setting selects the coolant temperature that will trigger a low coolant temperature pre-alarm. A threshold setting of 50 to 100 degrees Fahrenheit or 10 to 38 degrees Celsius may be entered. The unit of measure (Fahrenheit or Celsius) is determined by the Unit System setting of the System screen.

Battery Over Voltage Pre-Alarm – Enable. This setting enables and disables annunciation of a battery overvoltage pre-alarm.

Battery Over Voltage Pre-Alarm – Threshold (Volts). This read-only setting displays the voltage level that will trigger a battery overvoltage pre-alarm. The threshold is fixed at 15 Vdc for systems operating at 12 Vdc and 30 Vdc for systems operating at 24 Vdc.

Maint. Interv. – Eng. kW Overload – Hi Cool Tab

The Maint. Interv. – Eng. kW Overload – Hi Cool Tab settings are shown in Figure 6-10 and described in the following paragraphs.

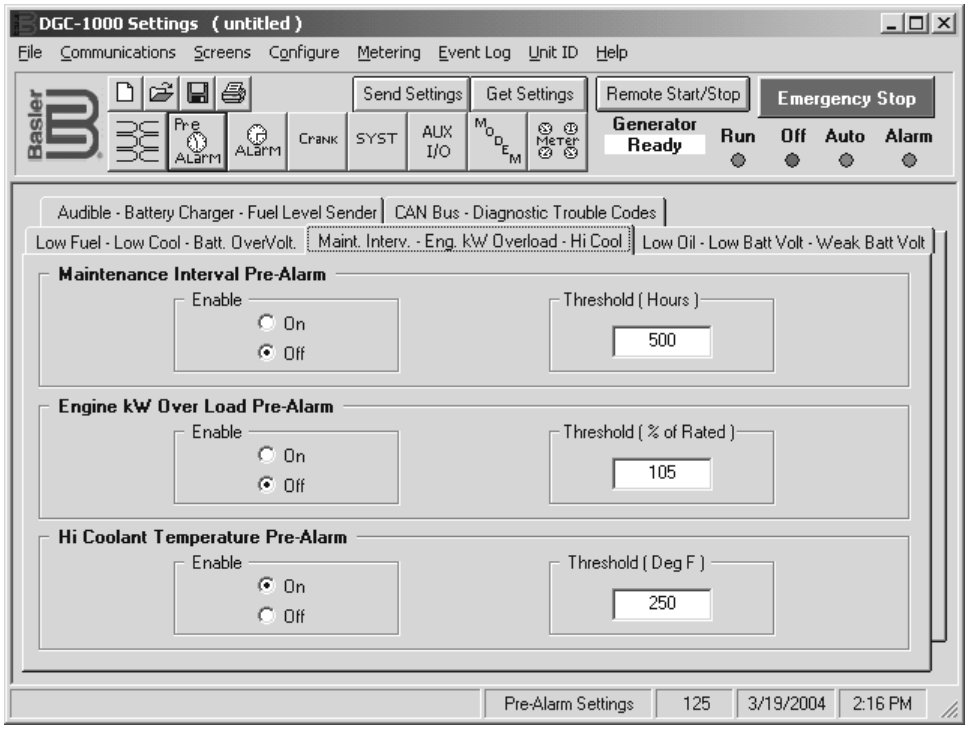

Figure 6-10. Pre-Alarms Screen, Maint. Interv.-Eng. kW Overload-Hi Cool Tab

Maintenance Interval Pre-Alarm – Enable. This setting enables and disables annunciation of a maintenance interval pre-alarm.

Maintenance Interval Pre-Alarm – Threshold (Hours). This setting selects the length of the maintenance interval. An interval of 0 to 5,000 hours may be selected. When a new threshold setting is entered, the Maintenance Interval Timer Reset checkbox of the System Settings screen is selected to apply the new value.

Engine kW Over Load Pre-Alarm – Enable. This setting enables and disables annunciation of an engine kW overload pre-alarm.

Engine kW Over Load Pre-Alarm – Threshold (% of Rated). This setting, expressed as a percentage of the engine rating, selects the generator power level that will trigger an engine kW overload pre-alarm. A threshold setting of 95 to 140 percent may be entered.

Hi Coolant Temperature Pre-Alarm – Enable. This setting enables and disables annunciation of a high coolant temperature pre-alarm. A 60 second activation delay prevents a high coolant temperature pre-alarm from occurring at engine startup.

Hi Coolant Temperature Pre-Alarm – Threshold (Deg). This setting selects the coolant temperature that will trigger a high coolant temperature pre-alarm. A threshold setting of 100 to 280 degrees Fahrenheit or

38 to 138 degrees Celsius may be entered. The unit of measure (Fahrenheit or Celsius) is determined by the Unit System setting of the System screen.

Low Oil-Low Batt Volt-Weak Batt Volt Tab

The Low Oil-Low Batt Volt-Weak Batt Volt Tab settings are shown in Figure 6-11 and described in the following paragraphs.

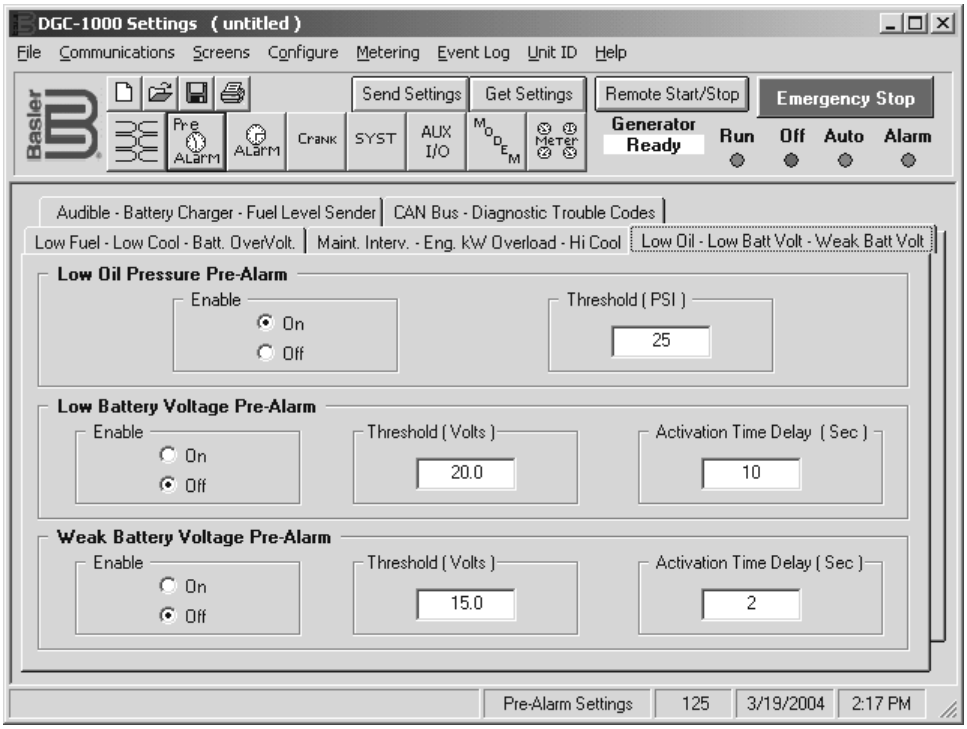

Figure 6-11. Pre-Alarms Screen, Low Oil-Low Batt Volt-Weak Batt Volt Tab

Low Oil Pressure Pre-Alarm – Enable. This setting enables and disables annunciation of a low oil pressure pre-alarm. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Oil Pressure Pre-Alarm – Threshold. This setting selects the oil pressure level that will trigger a low oil pressure pre-alarm. A threshold setting of 3 to 150 psi or 20 to 1035 kPa may be entered. The unit of measure (psi or kPa) is determined by the Unit System setting of the System screen. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Battery Voltage Pre-Alarm – Enable. This setting enables and disables annunciation of a low battery voltage pre-alarm.

Low Battery Voltage Pre-Alarm – Threshold (Volts). This setting selects the voltage level that will trigger a low battery voltage pre-alarm. The threshold is adjustable from 6 to 12 Vdc for 12 Vdc systems and 12 to 24 Vdc for 24 Vdc systems.

Low Battery Voltage Activation Time Delay (Sec). This setting selects the time delay from when low battery voltage is detected until a pre-alarm is annunciated. A time delay of 1 to 10 seconds may be entered.

Weak Battery Voltage Pre-Alarm – Enable. This setting enables and disables annunciation of a weak battery voltage pre-alarm.

Weak Battery Voltage Pre-Alarm – Threshold (Volts). This setting selects the voltage level that will trigger a weak battery voltage pre-alarm. The threshold is adjustable from 4 to 8 Vdc for 12 Vdc systems and 8 to 16 Vdc for 24 Vdc systems.

Weak Battery Voltage Pre-Alarm – Activation Time Delay (Sec). This setting selects the time delay from when weak battery voltage is detected until a pre-alarm is annunciated. A time delay of 1 to 10 seconds may be entered.

Audible-Battery Charger-Fuel Level Sender Tab

The Audible-Battery Charger-Fuel Level Sender Tab settings are shown in Figure 6-12 and described in the following paragraphs.

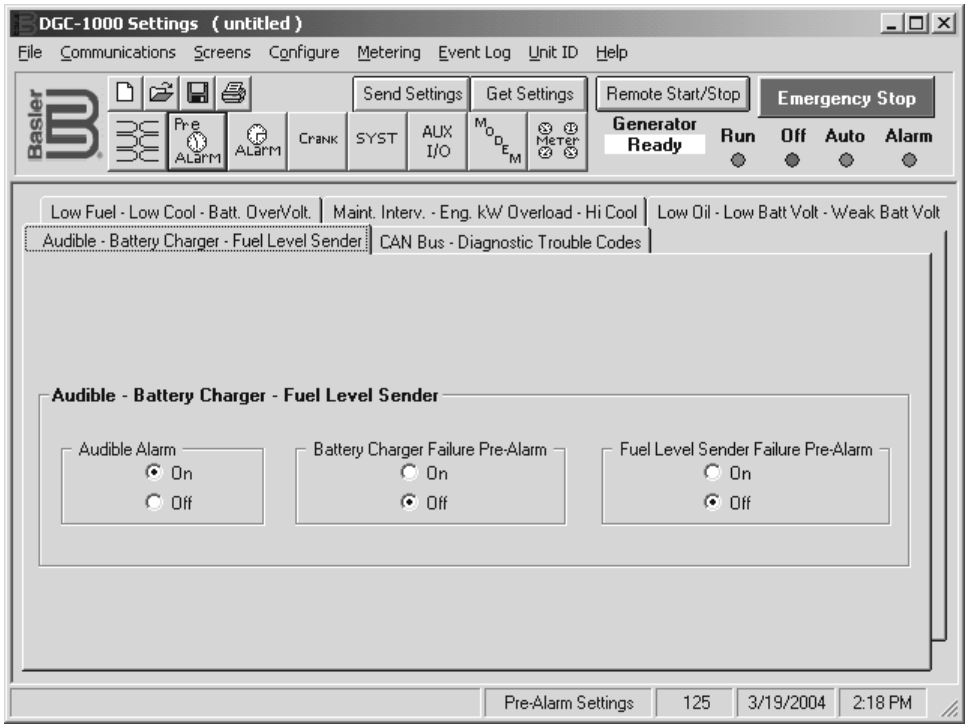

Figure 6-12. Pre-Alarms Screen, Audible-Battery Charger-Fuel Level Sender Tab

Audible Alarm. This setting enables and disables the DGC-1000 horn output.

Battery Charger Failure Pre-Alarm. This setting enables and disables annunciation of a battery charger failure pre-alarm.

Fuel Level Sender Failure Pre-Alarm. This setting enables and disables annunciation of a fuel level sender failure pre-alarm.

CAN Bus – Diagnostic Trouble Codes Tab

The CAN Bus – Diagnostic Trouble Codes Tab settings are shown in Figure 6-13 and described in the following paragraphs.

Loss of ECU Communication – Pre Alarm Selection. This setting enables and disables annunciation of a loss of ECU communication pre-alarm. This pre-alarm can occur only when the DGC-1000 is in Off mode and pulsing the ECU has failed to establish communication with the ECU. For details about ECU support, refer to Section 3, *Functional Description*.

Diagnostic Trouble Code Pre-Alarm – Enable. This setting enables and disables annunciation of diagnostic trouble codes (DTC) pre-alarms as they are received from the ECU.

Alarms

Click the **Alarm** button to access the Alarms screen or click **Screens** on the menu bar and click **Alarm Settings**. The Alarms screen consists of two tabs: Hi Cool-Low Fuel-Low Oil and Overspeed-Sender Fail.

Hi Cool-Low Fuel-Low Oil Tab

The Hi Cool-Low Fuel-Low Oil Tab settings are shown in Figure 6-14 and described in the following paragraphs.

Hi Cool Temperature Alarm – Alarm Enable. This setting enables and disables annunciation of a high coolant temperature alarm and engine shutdown. A 60 second activation delay prevents a Hi Coolant Temperature Alarm from occurring at engine startup.

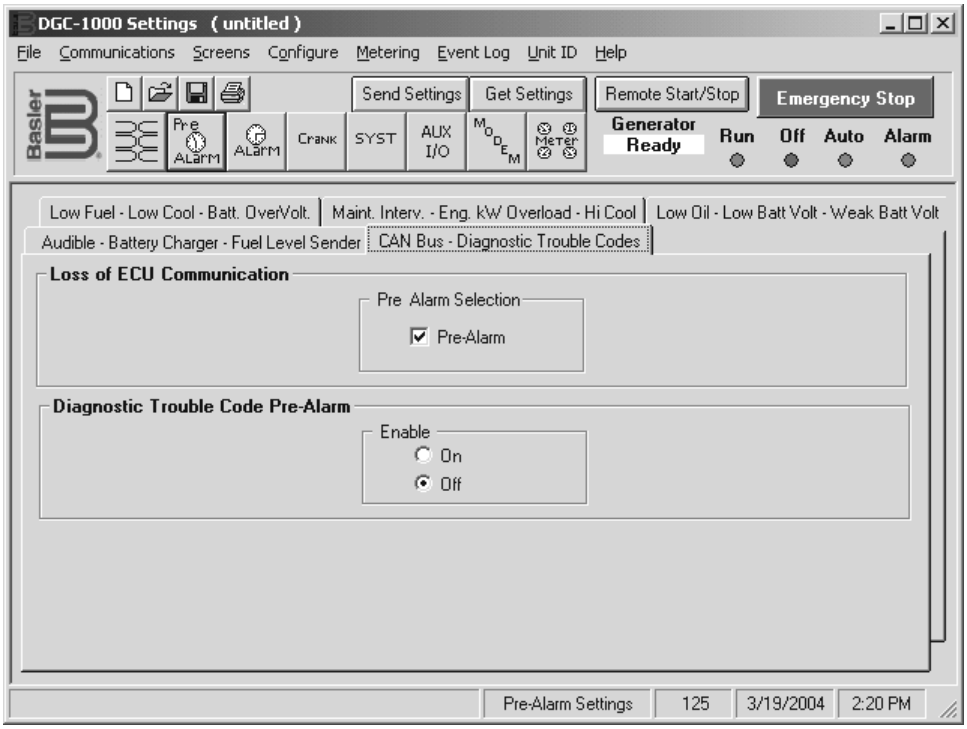

Figure 6-13. Pre-Alarms Screen, CAN Bus-Diagnostic Trouble Codes Tab

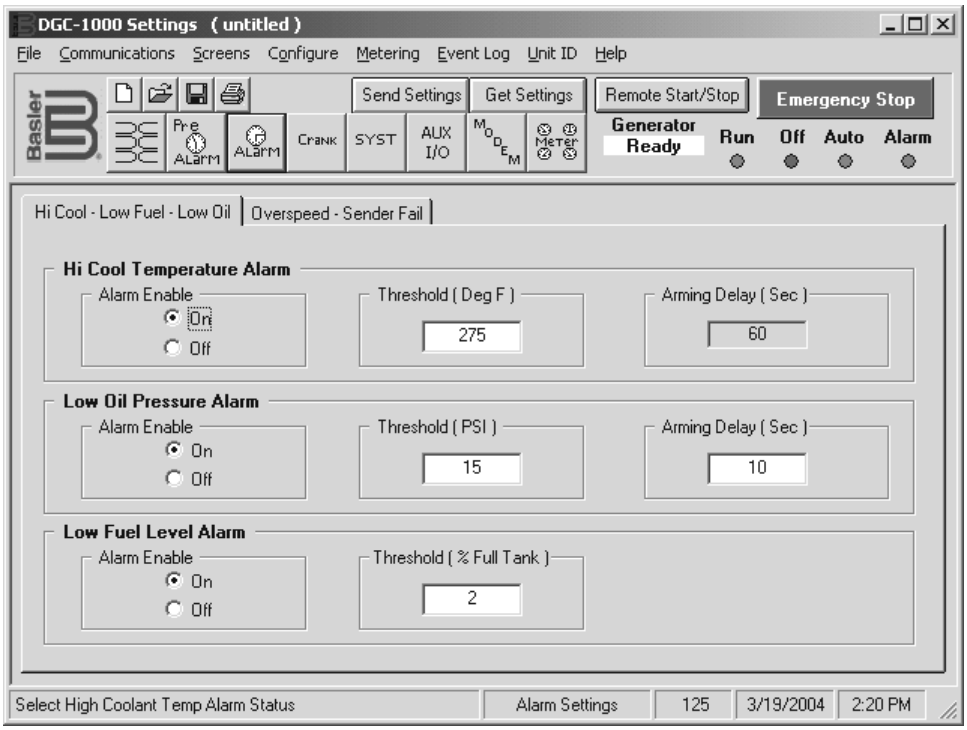

Figure 6-14. Alarms Screen, Hi Cool-Low Fuel-Low Oil Tab

Hi Cool Temperature Alarm – Threshold (Deg). This setting selects the coolant temperature that will trigger a high coolant temperature alarm. A threshold setting of 100 to 280 degrees Fahrenheit or 38 to 138 degrees Celsius may be entered. The unit of measure (Fahrenheit or Celsius) is determined by the Unit System setting of the System screen. A 60 second activation delay prevents a Hi Coolant Temperature Alarm from occurring at engine startup.

Hi Cool Temperature Alarm – Arming Delay (Sec). This read-only setting displays the time delay between when high coolant temperature is detected and an alarm is annunciated and the engine is shut down. The arming delay is fixed at 60 seconds.

Low Oil Pressure Alarm – Alarm Enable. This setting enables and disables annunciation of a low oil pressure alarm and engine shutdown. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Oil Pressure Alarm – Threshold. This setting selects the oil pressure level that will trigger a low oil pressure alarm and engine shutdown. A threshold of 3 to 150 psi or 20 to 1035 kPa may be entered. The unit of measure (psi or kPa) is determined by the Unit System setting of the System screen. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Oil Pressure Alarm – Arming Delay (Sec). This setting selects the time delay between when low oil pressure is detected and an alarm is annunciated and the engine is shut down. A time delay of 5 to 15 seconds may be entered. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Fuel Level Alarm – Alarm Enable. This setting enables and disables alarm annunciation and engine shutdown for a low fuel level.

Low Fuel Level Alarm – Threshold (% Full Tank). This setting selects the fuel level that will trigger a low fuel level alarm. A threshold of 0 to 100 percent may be entered.

Overspeed-Sender Fail Tab

The Overspeed-Sender Fail Tab settings are shown in Figure 6-15 and described in the following paragraphs.

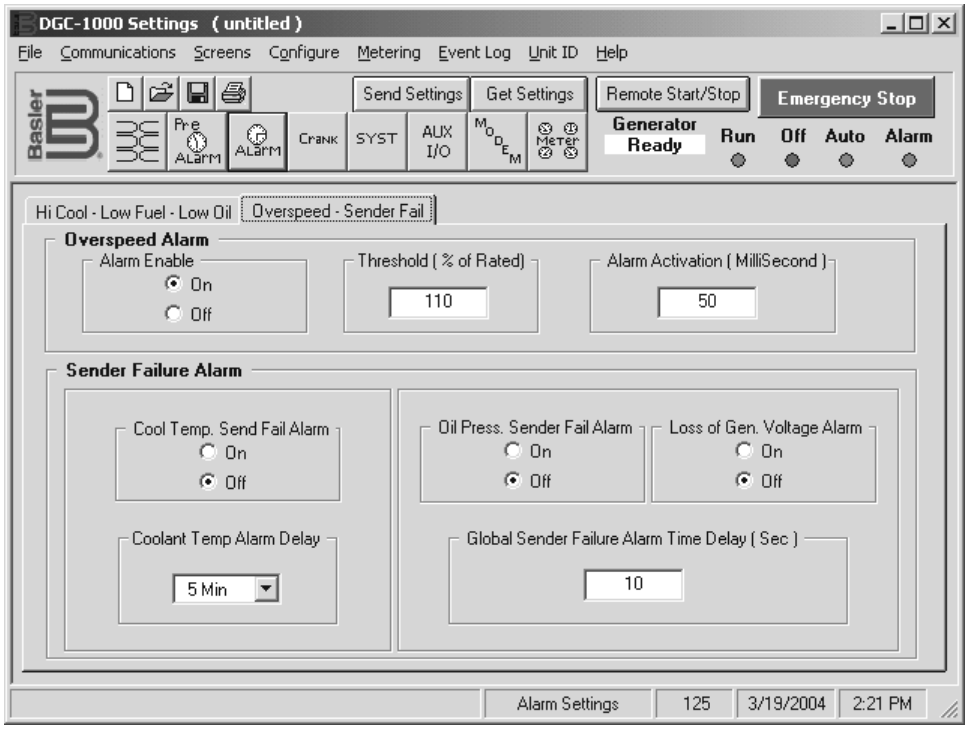

Figure 6-15. Alarms Screen, Overspeed-Sender Fail Tab

Overspeed Alarm – Alarm Enable. This setting enables and disables alarm annunciation and engine shutdown for an overspeed condition.

Overspeed Threshold (% of Rated). This setting selects the percentage of overspeed that triggers an overspeed alarm and engine shutdown. The threshold is adjustable from 105 to 140 percent of nominal speed.

Overspeed Alarm – Alarm Activation (MilliSecond). This setting adjusts the time delay from when an overspeed alarm condition is detected until it is annunciated and the engine is shut down. A time delay of 0 to 500 milliseconds may be entered.

Sender Failure Alarm – Cool Temp. Send Fail Alarm. This setting enables and disables alarm annunciation and engine shutdown for a coolant temperature sender failure.

Sender Failure Alarm – Coolant Temp Alarm Delay. This setting adjusts the time delay from when a coolant temperature sender failure is detected until it is annunciated and the engine is shut down. A time delay of 5, 10, 15, 20, 25, or 30 minutes may be selected.

Sender Failure Alarm – Oil Press. Sender Fail Alarm. This setting enables and disables alarm annunciation and engine shutdown for an oil pressure sender failure. An oil pressure sender failure alarm is annunciated and engine shutdown is initiated when the Global Sender Failure Alarm Time Delay setting expires.

Sender Failure Alarm – Loss of Gen. Voltage Alarm. This setting enables and disables alarm annunciation and engine shutdown for a loss of generator voltage. A loss of generator voltage alarm is annunciated when the generator voltage decreases below 1.5 Vac and the Global Sender Failure Alarm Time Delay expires. This setting does not disable a Sender Failure alarm for the speed signal source when generator frequency is selected as the speed signal source.

Sender Failure Alarm – Global Sender Failure Alarm Time Delay (Sec). This setting selects the time delay between when an oil pressure sender failure, loss of generator voltage failure, or MPU sender failure is detected and alarm annunciation and engine shutdown.

Engine Cranking

Click the **Crank** button to access the Engine Cranking screen or click **Screens** on the menu bar and click **Crank Settings**. Engine cranking settings are shown in Figure 6-16 and are described in the following paragraphs.

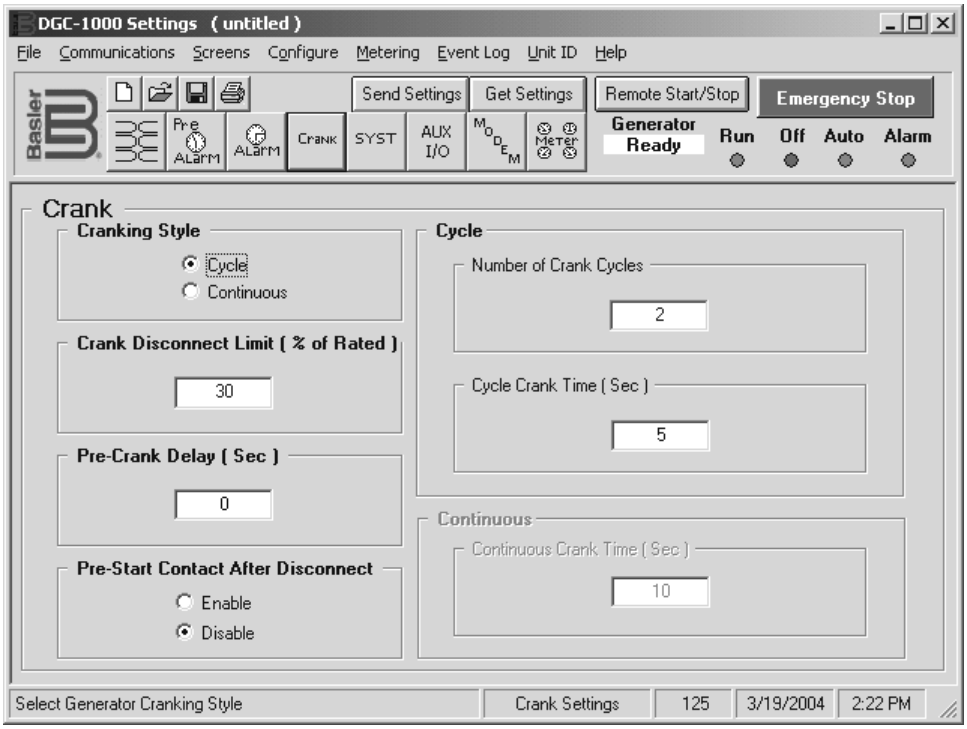

Figure 6-16. Engine Cranking Screen

Cranking Style. This setting selects the engine cranking method as continuous or cycle.

Crank Disconnect Limit (% of Rated). This setting selects the percentage of rated engine speed at which cranking is terminated. A disconnect limit of 10 to 100 percent may be entered.

Crank Disconnect Limit (% of Rated). This setting selects the percentage of rated engine speed at which cranking is terminated. A disconnect limit of 10 to 100 percent may be entered.

Pre-Crank Delay (Sec). This setting adjusts the time delay between initiating engine starting and beginning engine cranking. A delay of 0 to 30 seconds may be entered.

Pre-Start Contact After Disconnect. This setting selects whether or not the pre-start contact remains closed after disconnect occurs.

Cycle – Number of Crank Cycles. This setting, available only if cycle cranking is selected, selects the number of engine cranking attempts before an overcrank condition occurs and cranking is terminated. The crank cycles setting range is 1 to 7.

Cycle – Cycle Crank Time (Sec). This setting, available only if cycle cranking is selected, controls the duration of each cranking cycle. Each cranking period is separated by a resting period of equal length. A crank time of 5 to 15 seconds may be entered.

Continuous – Continuous Crank Time (Sec). This setting, available only if continuous cranking is selected, sets the duration of a single engine cranking attempt before an overcrank condition occurs. A continuous crank time of 1 to 60 seconds may be entered.

System

Click the **SYST** button to access the System Settings screen or click **Screens** on the menu bar and click **System Settings**. System settings are shown in Figure 6-17 and are described in the following paragraphs.

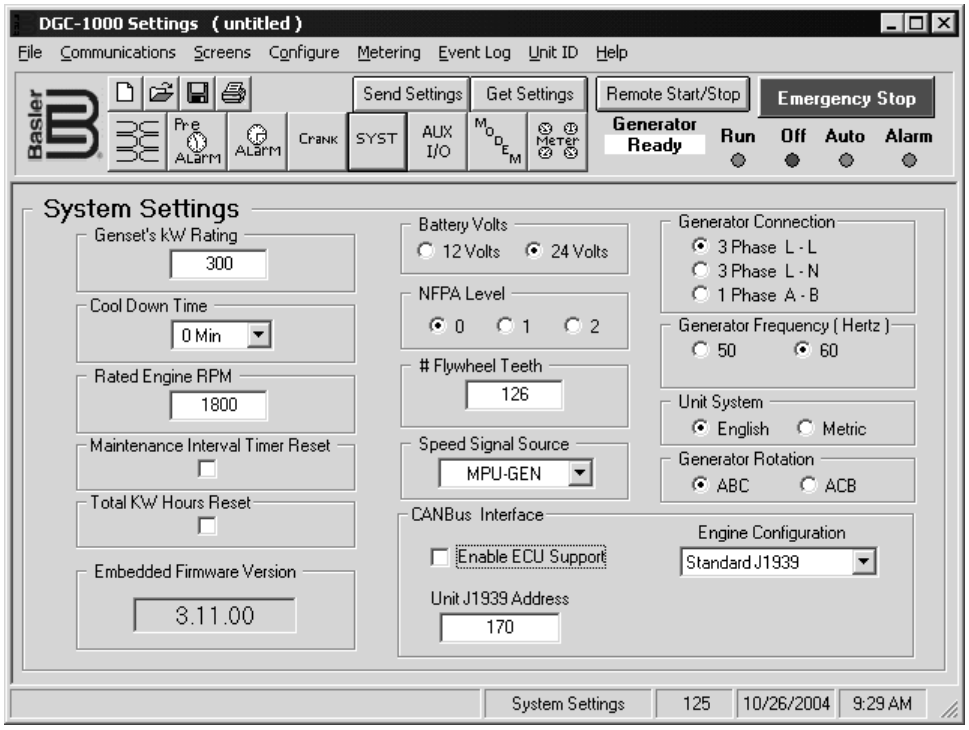

Figure 6-17. System Settings Screen

Genset's kW Rating. The generator power rating is entered in this field. A genset kW rating of 10 to 9,999 may be entered.

Cool Down Time. This setting selects the time between when the generator load is removed and the engine is stopped by a remote shutdown. A cool-down time of 0 to 60 minutes may be entered.

Rated Engine RPM. This setting selects the rated rotating speed of the engine. A value of 750 to 3,600 rpm may be entered.

Maintenance Interval Timer Reset. Selecting this checkbox terminates the maintenance interval pre-alarm and resets the maintenance interval timer back to the programmed value. The **Send Settings** button must be clicked for the reset to take effect.

Embedded Firmware Version. This read-only field displays the DGC-1000 firmware version.

Total kW Hours Reset. Selecting this checkbox resets the accumulated kilowatt-hours to zero. The **Send Settings** button must be clicked for the reset to take effect.

Battery Volts. This setting selects either 12 Vdc or 24 Vdc as the starting battery nominal voltage.

NFPA Level. This setting selects whether or not NFPA (National Fire Prevention Association) requirements are in effect. If NFPA compliance is not required, a setting of 0 can be selected to disable the feature. Selecting NFPA level 1 or 2 affects DGC-1000 operation in the following ways.

- The number of crank cycles is fixed at 3.
- Crank cycle time is fixed at 15 seconds.
- Continuous crank time is fixed at 45 seconds.
- The low coolant temperature pre-alarm setting is fixed at 70°F.

 # Flywheel Teeth. This setting selects the number of teeth on the engine flywheel. A value of 50 to 500 may be entered.

Speed Signal Source. This setting selects from three sources for obtaining the engine speed. The speed signal source can be obtained from the magnetic pickup (MPU), generator frequency, or derived from both the MPU and generator frequency. When both the MPU and generator frequency are selected as the speed signal source, the MPU has priority. If both MPU and generator frequency are selected and the MPU fails, generator frequency is used as the speed signal source and a non-programmable MPU sender failure pre-alarm is annunciated.

Generator Connection. This setting selects the configuration of the generator voltage sensing circuitry. Three-phase line-to-line, three-phase line-to-neutral, or single-phase A-phase to B-phase sensing may be selected.

Generator Frequency. This setting selects either 50 hertz or 60 hertz as the nominal generator frequency.

Unit System. This setting selects either the English or metric unit system for displaying the oil pressure and coolant temperature parameters in BESTCOMS and the DGC-1000 HMI.

NOTE

CANBus Interface settings are disabled (and grayed out) unless OEM-level password access is obtained. See *Password Protection* for information regarding password access levels.

Generator Rotation. This setting selects either ABC or ACB phase rotation.

CANBus Interface – Enable ECU Support. This setting enables and disables the DGC-1000 CAN interface. When enabled, the CAN interface allows the DGC-1000 to communicate with an engine control unit (ECU). The mode of J1939 communication depends on the Engine Configuration setting selected.

CANBus Interface – Engine Configuration. This setting selects one of three CAN interface configurations: Standard J1939, Volvo Penta EDC III, or MTU MDEC.

CANBus Interface – Unit J1939 Address. This setting, enabled only for an Engine Configuration setting of Standard J1939 or Volvo Penta EDC III, selects the address to be used by the DGC-1000 for SAE J1939 communication. A value of 0 to 253 may be entered.

CANBus Interface – Speed Select. This setting, enabled only for an Engine Configuration setting of Volvo Penta EDC III, configures the Volvo Penta EDC III to operate the engine at the primary or secondary base speed. If the engine is configured by Volvo for 60 hertz applications, the primary base speed is 1,800 rpm and the secondary base speed is 1,500 rpm. If the engine is configured by Volvo for 50 hertz applications, the primary base speed is 1,500 rpm and the secondary base speed is 1,800 rpm.

CANBus Interface – Accelerator Position. This setting, enabled only for an Engine Configuration setting of Volvo Penta EDC III, is expressed as a percentage and tells the Volvo Penta EDC III where to set the engine speed (trim) relative to the base speed. The range of the setting is the base speed ±120 rpm. A setting of 0% will cause the engine to run at 120 rpm below the base speed, a setting of 50% will cause the engine to run at the base speed, and a setting of 100% will cause the engine to run at 120 rpm above the base speed. The Accelerator Position setting is linear with a gain of 2.4 rpm/%. This setting is not saved in nonvolatile memory and defaults back to 50% after DGC-1000 operating power is cycled.

CANBus Interface – Module Type. This setting, enabled only for an Engine Configuration setting of MTU MDEC, selects one of four MDEC ECU types: Module 201, Module 302, Module 303, or Module 304.

CANBus Interface – Speed Demand Source. This setting, enabled only for an Engine Configuration setting of MTU MDEC, selects one of six speed demand sources for the MDEC ECU: Analog CAN, Up Down ECU, Up Down CAN, Analog ECU, Frequency, or No CAN Demand.

CANBus Interface – Engine RPM. This setting, enabled only for an Engine Configuration setting of MTU MDEC, selects the rated rpm for the engine.

Input/Output Settings

Click the **AUX I/O** button to access the Input/Output Settings screen or click **Screens** on the menu bar and click **Input/Output Settings**. The Input/Output Settings screen consists of two tabs: Programmable Input Contact Setup and Aux Output Setup.

Programmable Input Contact Setup Tab

The Programmable Input Contact Setup tab settings of the Input/Output Settings screen consists of four identical groups of settings for each of the four programmable inputs. Tab settings are shown in Figure 6-18 and described in the following paragraphs.

Programmable Input – Function. This setting selects the function type that is used to trigger the corresponding programmable input. The functions available for triggering a programmable input are No Function, Auxiliary Input, Single-Phase Override, and 4 Wire Delta.

"4 Wire Delta" refers to the application of a 12-lead generator whose output windings are connected in a delta, and the mid-point of one side of the delta is connected to the voltage neutral terminal on the DGC-1000. For example, if a generator with 120-volt windings were connected to a DGC-1000 in this fashion, and the mid-point between phases B and C is connected to a DGC-1000's voltage neutral terminal, the metered voltages would be as follows: V_{AN} = 208 V, V_{BN} = V_{CN} = 120 V, and V_{AB} = V_{BC} = V_{CA} = 240 V.

Programmable Input – Auxiliary Configuration. Either the Alarm or Pre-Alarm checkbox can be selected to annunciate an alarm or pre-alarm when the selected function triggers the programmable input.

NOTE

In order for the four-wire delta voltage sensing mode to function when an appropriately programmed auxiliary input closes, the Generator Connection setting on the *System Settings* screen must be set for 3 Phase L-N.

Programmable Input – Auxiliary Input Label. This setting field is enabled only when Auxiliary Input is selected as the programmable input function. A user-assigned label (eight characters, maximum) can be entered for the corresponding programmable input.

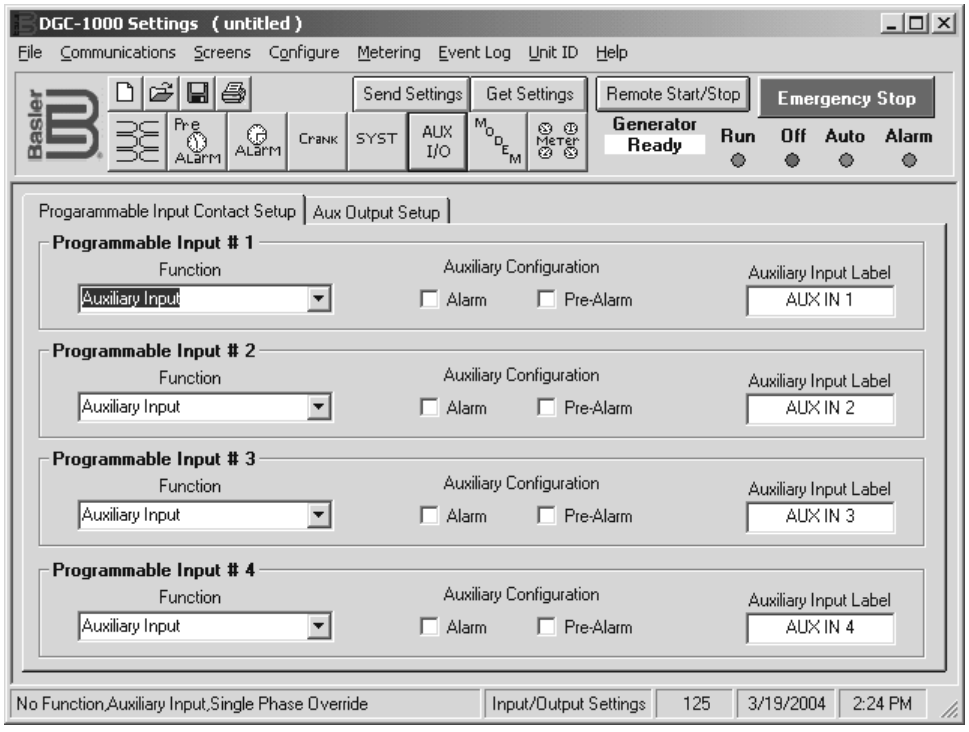

Figure 6-18. Input/Output Settings Screen, Programmable Input Contact Setup Tab

Aux Output Setup Tab

The Aux Output Setup tab settings of the Input/Output Settings screen are shown in Figure 6-19. (Not all settings are visible in the illustration.) The Aux Output Setup tab consists of a list of pre-alarms, alarms, and conditions that can be assigned to close programmable outputs 1 through 8. An output is selected by clicking the checkbox in the appropriate row and column. The following pre-alarms, alarms, and conditions can be assigned to one of the eight programmable outputs.

- High coolant temperature alarm
- Low oil pressure alarm
- Coolant temperature sender failure alarm
- Oil pressure sender failure alarm
- Loss of voltage sender failure alarm
- Speed sender failure alarm
- Low fuel alarm
- Low coolant level alarm
- Overcrank alarm
- Emergency stop alarm
- Overspeed alarm
- Low fuel pre-alarm
- Low coolant temperature pre-alarm
- Battery overvoltage pre-alarm
- kW overload pre-alarm
- High coolant temperature pre-alarm
- Low oil pressure pre-alarm
- Low battery voltage pre-alarm
- Weak battery voltage pre-alarm
- Battery charger failure pre-alarm
- Scheduled maintenance pre-alarm
- Switch not in Auto position
- Fuel leak/sender failure pre-alarm
- Cool down timer active
- Auxiliary input 1 closed
- Auxiliary input 2 closed
- Auxiliary input 3 closed
- Auxiliary input 4 closed
- Load button 1
- Load button 2
- Load button 3
- Load button 4

The last four items of the list are the four programmable load buttons that appear on the metering screen. These four buttons may be configured to operate any combination of the eight auxiliary output contacts. Load buttons 1 and 2 have fixed labels of Load 1 and Load 2. Load buttons 3 and 4 have programmable labels. Each label can consist of six alphanumeric characters, maximum. Refer to the *Metering* paragraphs for more information about using the Load buttons.

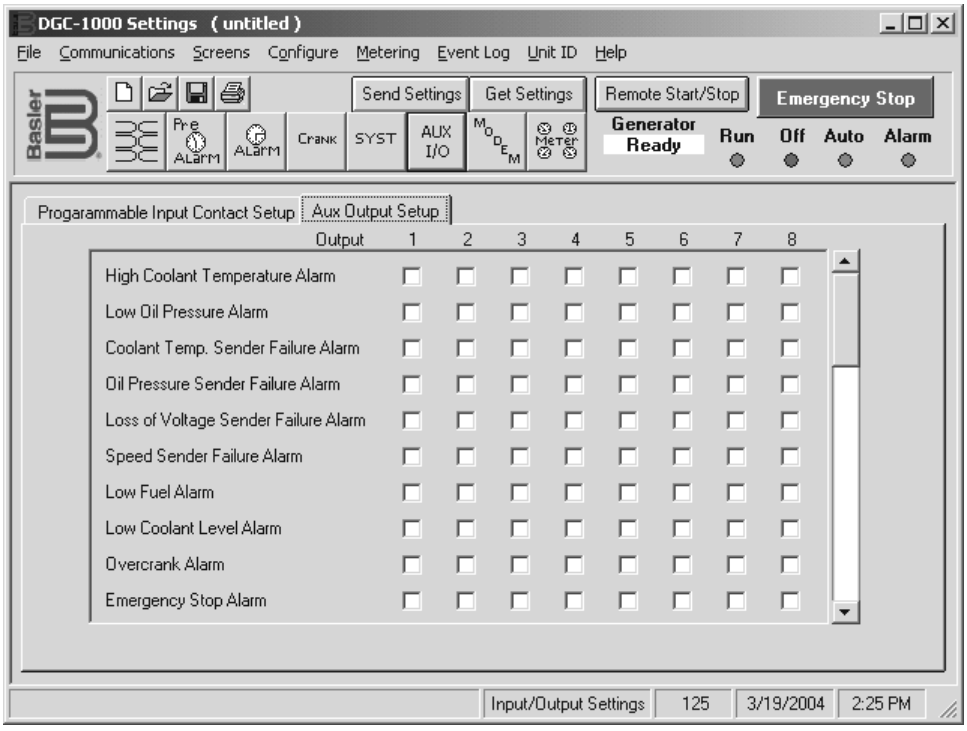

Figure 6-19. Input/Output Settings Screen, Aux Output Setup Tab

Modem Settings

If equipped with a modem (style X1X or X2X), the DGC-1000 can dial an alphanumeric pager when any of the selected inputs are activated or selected events occur. Click the **MODEM** button to access the

Modem Settings screen or click **Screens** on the menu bar and click **Modem Settings**. The Modem Settings screen consists of two tabs: Modem Setup and Modem Dialout Conditions.

NOTE

Upon completion of DGC-1000 setup, communication with BESTCOMS must be closed to enable modem dial-in and dial-out.

When a fault occurs for which dial-out has been programmed, the modem will dial out and send a message. During the dial-out time, neither dial-in nor local RS-232 access is available. Access is available after the message has been sent or during the modem off-line delay. If no access is allowed, removing the fault and cycling the power to the DGC-1000 resets the DGC-1000 and allows access.

Modem Setup Tab

The Modem Setup tab settings are shown in Figure 6-20 and described in the following paragraphs.

Phone Number #1, #2, #3, and #4. These four setting fields contain the telephone numbers that the DGC-1000 dials when the selected input is activated. The numbers are dialed in sequence until a connection is obtained.

Pager ID Number. These four setting fields contain the numbers that identify the specific pager that is being addressed when the corresponding telephone number (Phone Number #1, #2, #3, or #4) is dialed by the DGC-1000.

Site Information. This programmable label identifies the source of the pager message. It is sent to the pager when the dial-out connection is made. Up to eight alphanumeric characters may be entered.

Inter Dialout Time Delay. This setting selects the length of time between dial-out attempts. The delay allows time for the modem to reset. A setting of 15, 30, 60, or 120 seconds may be entered.

Rings for Modem Answer. This setting selects the number of rings allowed before the modem picks up the line and negotiates a connection. Permitting several rings to occur before the modem picks up provides time for an operator to answer a telephone using the same line as the modem. This allows the modem and a telephone to share one line. A setting of 1 to 9 rings may be entered.

Page Buffer Limit. This setting is set equal to, or less than the specific pager buffer size. If the message length exceeds the Page Buffer Limit, another call is made and the message is continued. A setting of 80, 120, 160, or 200 characters may be entered.

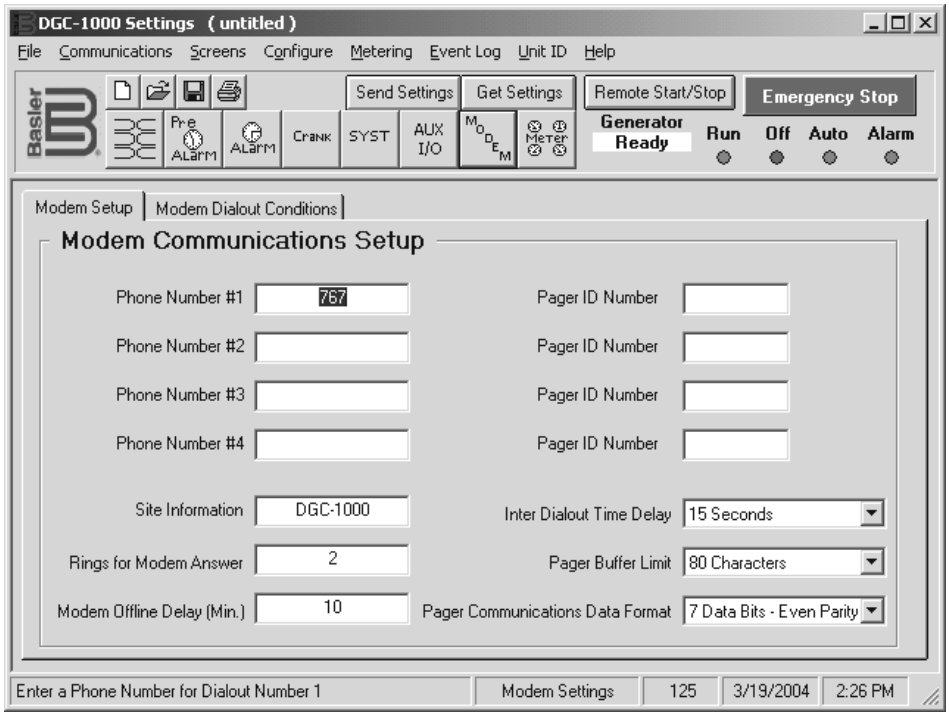

Figure 6-20. Modem Settings Screen, Modem Setup Tab

Modem Offline Delay (Min.). This setting controls the amount of time allowed between DGC-1000 dial-out attempts. The Modem Offline Delay setting allows time for a user to dial into the DGC-1000. A setting of 1 to 240 minutes may be entered.

Pager Communication Data Format. This setting controls the data format for the modem. Telelocator alphanumeric protocol (TAP version 1.7) is implemented by the DGC-1000 for communication with a pager. The protocol specifies seven data bits with even parity. A setting of eight data bits with no parity may also be selected.

Modem Dialout Conditions Tab

The Modem Dialout Conditions tab settings are shown in Figure 6-21. (Not all settings are visible in the illustration.) The Modem Dialout Conditions Tab consists of a list of alarms, pre-alarms, and conditions that can be assigned to cause the DGC-1000 to dial out. An output is selected by clicking the checkbox in the appropriate row. The following alarms, pre-alarms, and conditions can be selected to cause the DGC-1000 to dial out.

- Active DTC pre-alarm
- Auxiliary input 1 closed
- Auxiliary input 2 closed
- Auxiliary input 3 closed
- Auxiliary input 4 closed
- Battery charger failure pre-alarm
- Battery overvoltage pre-alarm
- Coolant temperature sender failure alarm
- Cool-down timer active
- ECU protective shutdown alarm
- Emergency stop alarm
- Fuel leak/sender failure pre-alarm
- High coolant temperature alarm
- High coolant temperature pre-alarm
- kW overload pre-alarm
- Loss of ECU communication alarm
- Loss of ECU communication pre-alarm
- Loss of voltage sender failure alarm
- Low battery voltage pre-alarm
- Low coolant level alarm
- Low coolant temperature pre-alarm
- Low fuel alarm
- Low fuel pre-alarm
- Low oil pressure alarm
- Low oil pressure pre-alarm
- MPU Speed Sender Failure alarm
- Oil pressure sender failure alarm
- Overcrank alarm
- Overspeed alarm
- Scheduled maintenance pre-alarm
- Switch not in Auto position
- Weak battery voltage pre-alarm

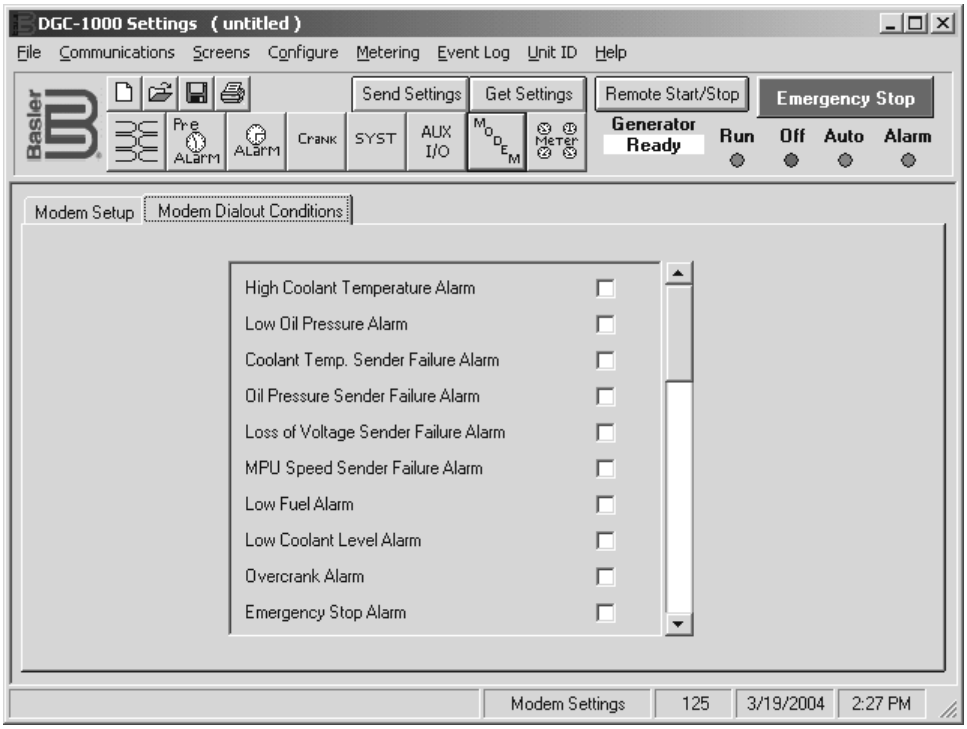

Figure 6-21. Modem Settings Screen, Modem Dialout Conditions Tab

Metering

Click the **Meter** button to access the Metering screen or click **Screens** on the menu bar and click **Metering**. The Metering screen consists of nine tabs.

- System
- Voltage
- Current
- Power
- General
- Summary
- Alarms
- ECU DTC Info
- ECU Data
- MTU MDEC

The ECU DTC Info and ECU Data tabs are visible and enabled only when ECU support is enabled on the BESTCOMS System Settings screen and the Engine Configuration is Standard J1939 or Volvo Penta EDC III.

The MTU MDEC tab is visible and enabled only when ECU support is enabled on the BESTCOMS System Settings screen and the Engine Configuration is MTU MDEC.

When viewing the Metering screen, metering can be enabled and disabled by clicking the **Meter** button. When viewing other screens, metering can be enabled and disabled through the **Metering** menu on the menu bar

System Tab

System tab metering values are shown in Figure 6-22 and described in the following paragraphs.

Coolant Temp. Two metering fields display engine coolant temperature in degrees Fahrenheit and degrees Celsius.

Oil Pressure. Two metering fields display engine oil pressure in pounds per square inch and kilopascals.

Battery Voltage. This metering value indicates the battery voltage level.

Fuel Level. This metering value indicates the percentage of remaining fuel.

Speed. This metering value indicates the rotational speed of the engine in revolutions per minute.

Load. This metering value, expressed as a percentage of the genset power rating, indicates the genset load. The genset power rating is entered through the Genset's kW Rating setting on the System Settings screen.

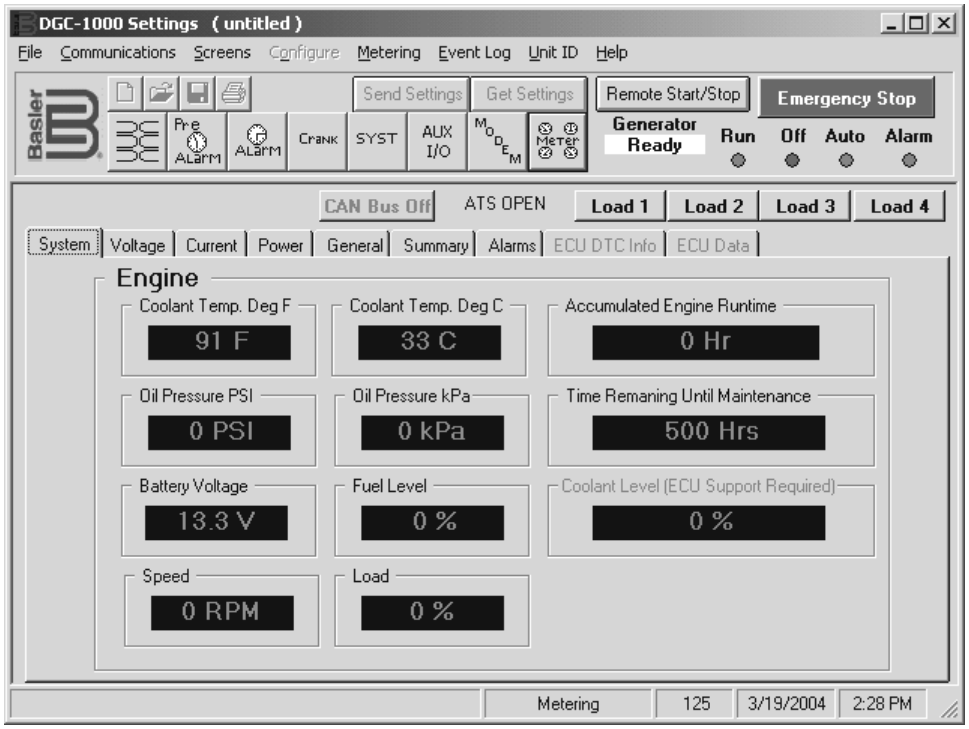

Figure 6-22. Metering Screen, System Tab

Accumulated Engine Runtime. This metering value indicates the total, accumulated hours of engine runtime. Accumulated engine running time can be adjusted by a user with OEM-level password access. See *Run Time and KW Hours* for more information.

Time Remaining Until Maintenance. This value indicates the engine runtime left until the next scheduled maintenance.

Coolant Level. This metering value, expressed as a percentage of total coolant capacity, indicates the fluid level of the engine cooling system. ECU support is required to enable this metering value.

Programmable Buttons

These four buttons, labeled Load 1, Load 2, Load 3, and Load 4, may be configured (through the Input/Output Settings screen Aux Output Setup tab) to operate any combination of the eight auxiliary output contacts. When one of the buttons is clicked, the corresponding auxiliary output changes state. A button's color changes from gray to red when the controlled output is closed and changes from red to gray when the controlled output is opened.

Buttons Load 1 and Load 2 have fixed labels. The labels on buttons Load 3 and Load 4 can be changed to a user-selected label consisting of up to six alphanumeric characters.

If the DGC-1000 is in Off mode or has an alarm, the programmable buttons have no effect on the auxiliary output contacts.

ATS Status Indicator

The ATS status indicator, located to the left of the Load 1 button, displays *ATS OPEN* when the automatic transfer switch contact input is open. *ATS CLOSED* is displayed when the automatic transfer switch contact input is closed.

ECU Status/Control Button

This button indicates the status of ECU communication and is used to pulse the ECU when ECU support is enabled.

When ECU support is disabled, the button is grayed out and indicates *CAN Bus Off*.

When ECU support is enabled (through the System Settings screen) and the ECU is offline, the button indicates *ECU Offline*. When this condition exists and the button is clicked, the ECU is pulsed.

Voltage Tab

Metering values displayed on the Voltage tab (Figure 6-23) depend upon the Generator Connection setting of the System Settings screen.

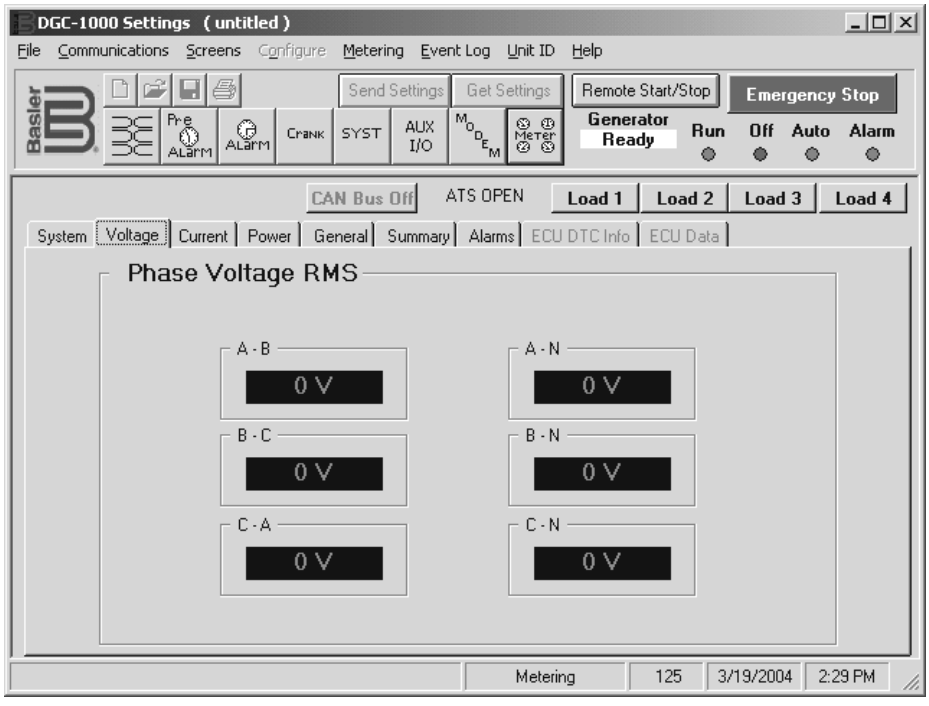

Figure 6-23. Metering Screen, Voltage Tab

When the Generator Connection setting is 3 Phase L-L, the Voltage tab displays rms voltage for A-phase to B-phase, B-phase to C-phase, and C-phase to A-phase.

When the Generator Connection setting is 3 Phase L-N, the Voltage tab displays rms voltage for A-phase to B-phase, A-phase to Neutral, B-phase to C-phase, B-phase to Neutral, C-phase to A-phase, and C-phase to Neutral.

When the Generator Connection setting is 1 Phase A-B, the Voltage tab displays rms voltage for A-phase to B-phase, A-phase to Neutral, and B-phase to Neutral.

Current Tab

Metering values displayed on the Current tab (Figure 6-24) depend upon the Generator Connection setting of the System Settings screen.

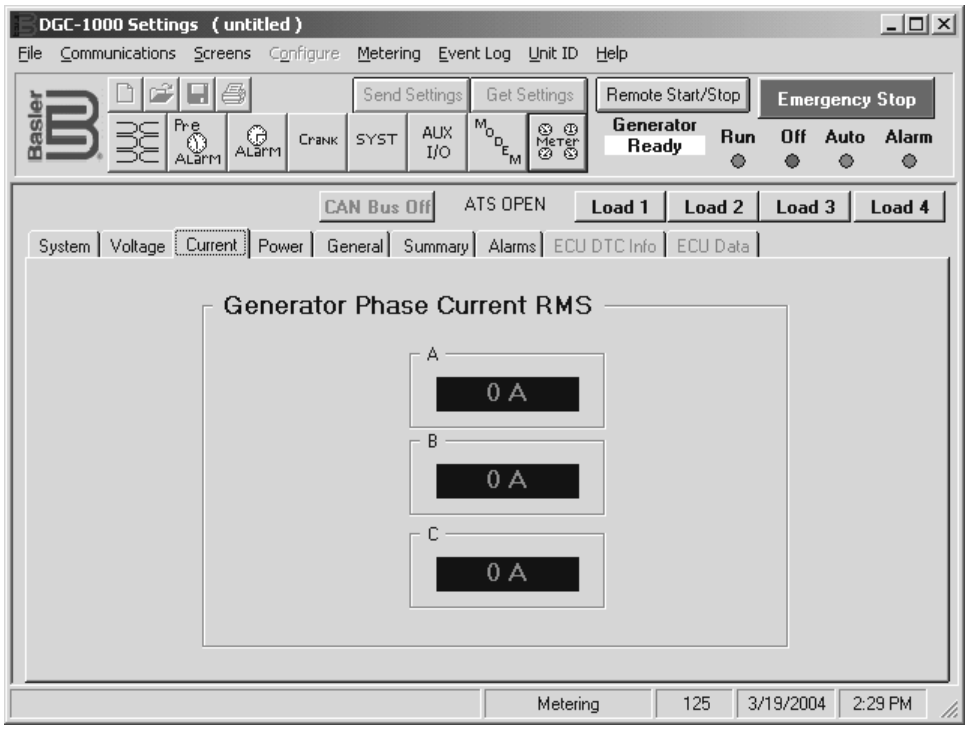

Figure 6-24. Metering Screen, Current Tab

When the Generator Connection setting is 3 Phase L-L or 3 Phase L-N, the Current tab displays rms current for phases A, B, and C.

When the Generator Connection setting is 1 Phase A-B, the Current tab displays rms current for phases A and B.

Power Tab

The Power tab (Figure 6-25) displays generator apparent power (kVA) and generator real power (kW). Metered power values depend upon the Generator Connection setting of the System Settings screen.

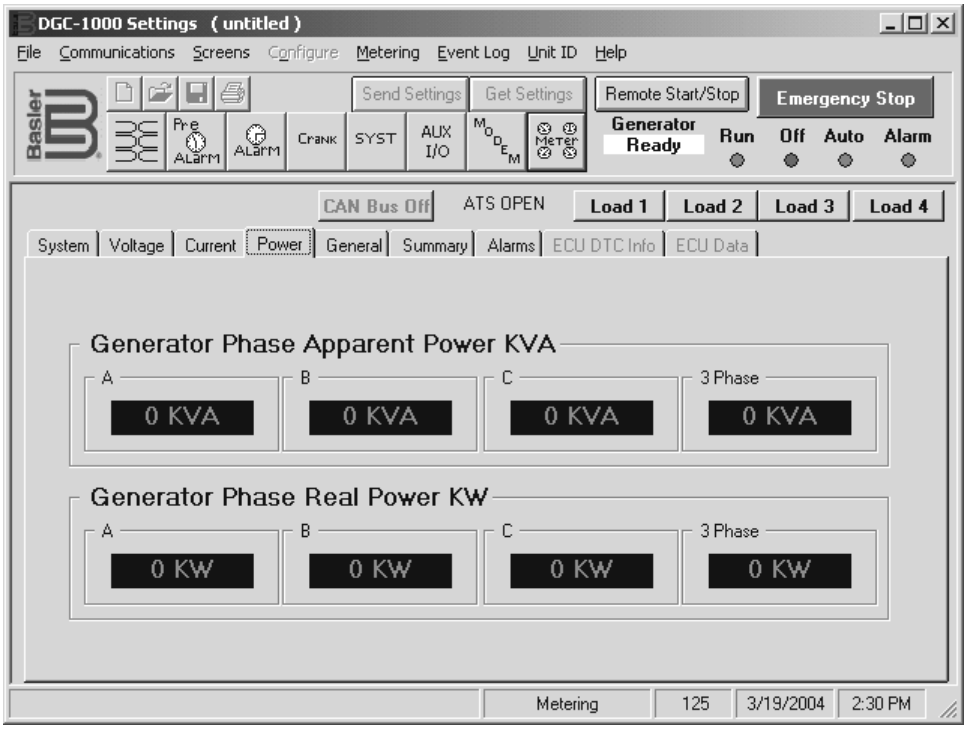

Figure 6-25. Metering Screen, Power Tab

When the Generator Connection setting is 3 Phase L-L or 3 Phase L-N, metered power values are displayed for phases A, B, C, and all phases combined.

When the Generator Connection setting is 1 Phase A-B, metered power values are displayed for phases A, B, and both phases combined.

General Tab

General tab metering values are displayed in Figure 6-26 and described in the following paragraphs.

Power Factor. This value is the calculated result of the real generator power divided by the apparent generator power (W ÷ VA).

Gen Frequency. This metering value indicates the frequency, in hertz, of the monitored generator voltage.

Total KW Hours. This metering value displays the accumulated generator kilowatt-hours. Total kilowatt-hours can be reset through the Total KW Hours Reset checkbox on the System Settings screen. Total kilowatt-hours can also be adjusted by a user with OEM-level password access. See *Run Time and KW Hours for* more information.

Summary Tab

The Summary tab (Figure 6-27) displays all of the metering values contained on the System, Voltage, Current, Power, and General tabs. Voltage, current, and power metering values displayed on the Summary tab depend upon the Generator Connection setting of the System Settings screen.

Alarms Tab

Alarms tab indicators (Figure 6-28) are divided into four categories: Pre-Alarms, Alarms, Sender Failure Alarms, and EPS.

Pre-Alarms, Alarms, and Sender Failure Alarms. When a pre-alarm or an alarm becomes active, the indicator next to the pre-alarm or alarm label changes from gray to green. In order for a pre-alarm to be annunciated, it must be enabled through the settings of the Pre-Alarms screen. In order for an alarm or sender failure alarm to be annunciated, it must be enabled through the settings of the Alarms screen.

EPS – Supplying Load. When the generator is supplying current to the load, this indicator changes from gray to green.

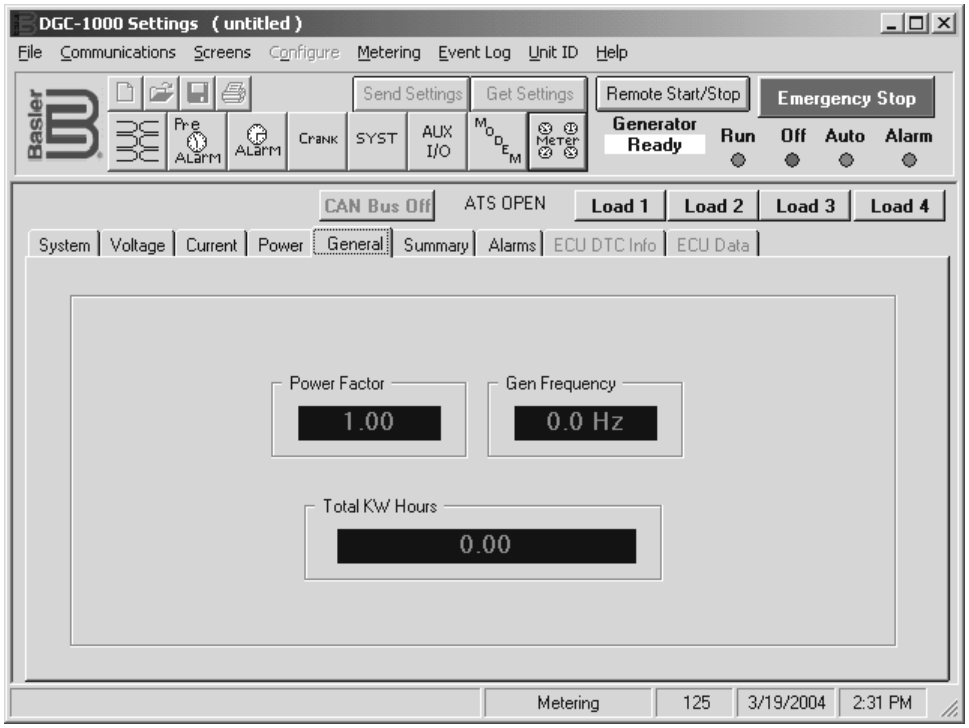

Figure 6-26. Metering Screen, General Tab

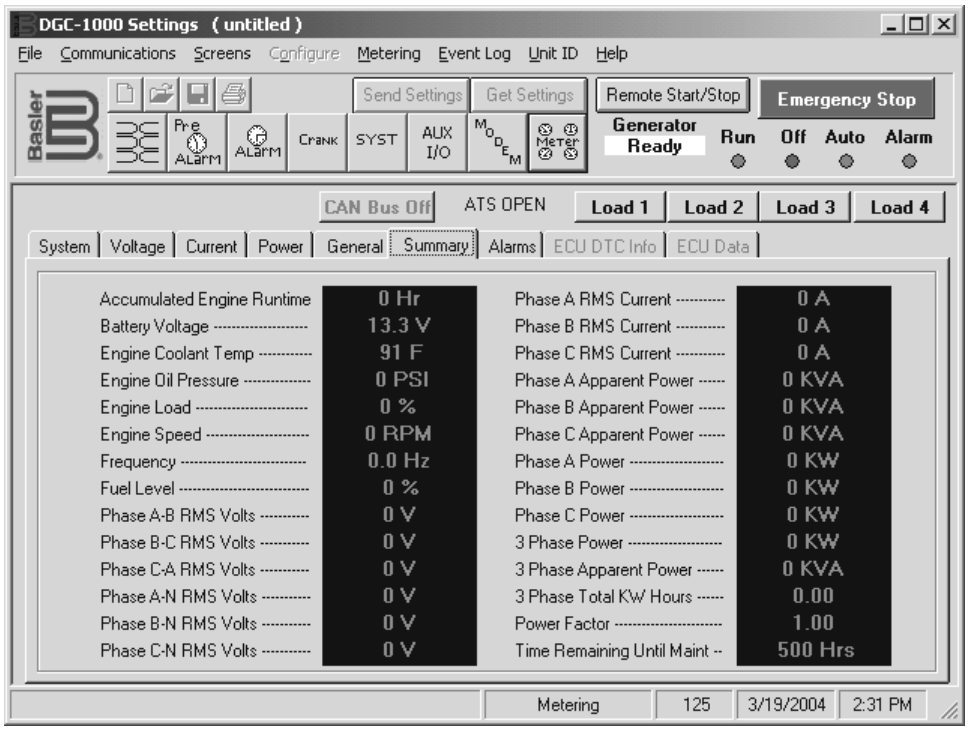

Figure 6-27. Metering Screen, Summary Tab

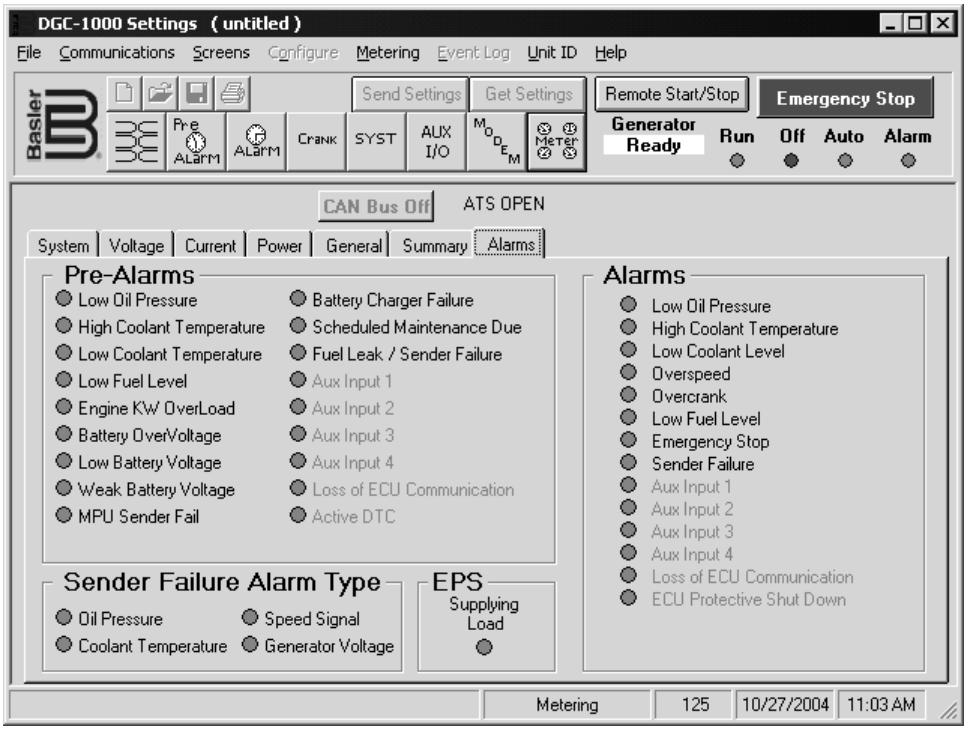

Figure 6-28. Metering Screen, Alarms Tab

ECU Data Tab

The ECU Data tab displays parameters obtained by the ECU (engine control unit) and reported through the SAE J1939 interface to the DGC-1000. Access to the ECU Data tab is enabled only when the Enable ECU Support checkbox of the System Settings screen is selected. Parameters displayed on the ECU Data tab are shown in Figure 6-29.

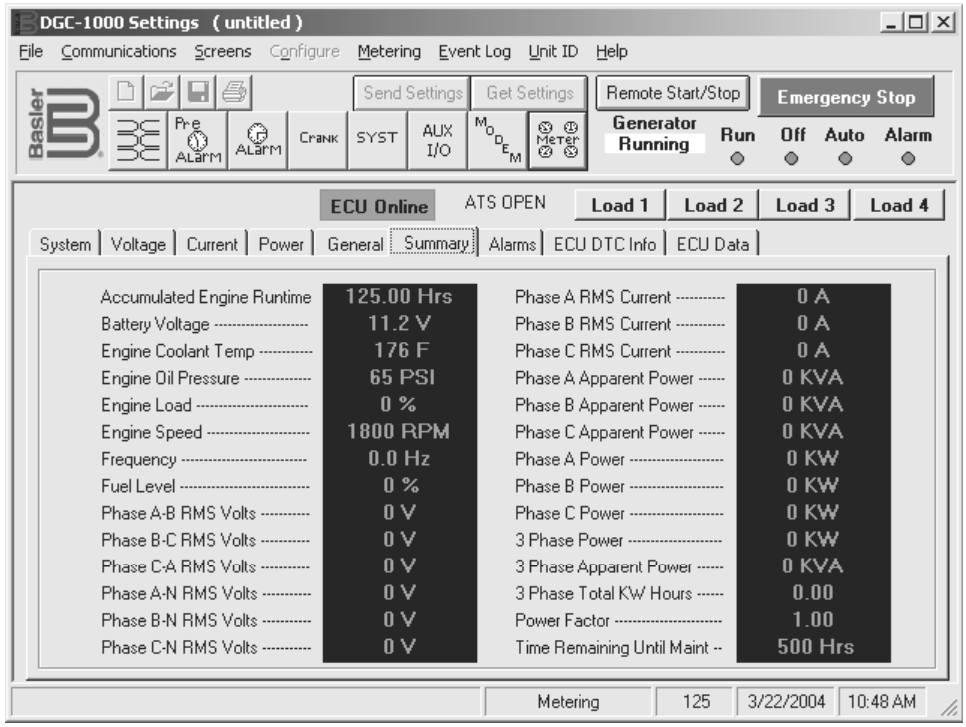

Figure 6-29. Metering Screen, ECU Data Tab

Clicking the **View Engine Configuration** button on the ECU Data tab displays the Engine Configuration screen shown in Figure 6-30. This screen displays a list of specifications that are specific to the engine being controlled by the ECU.

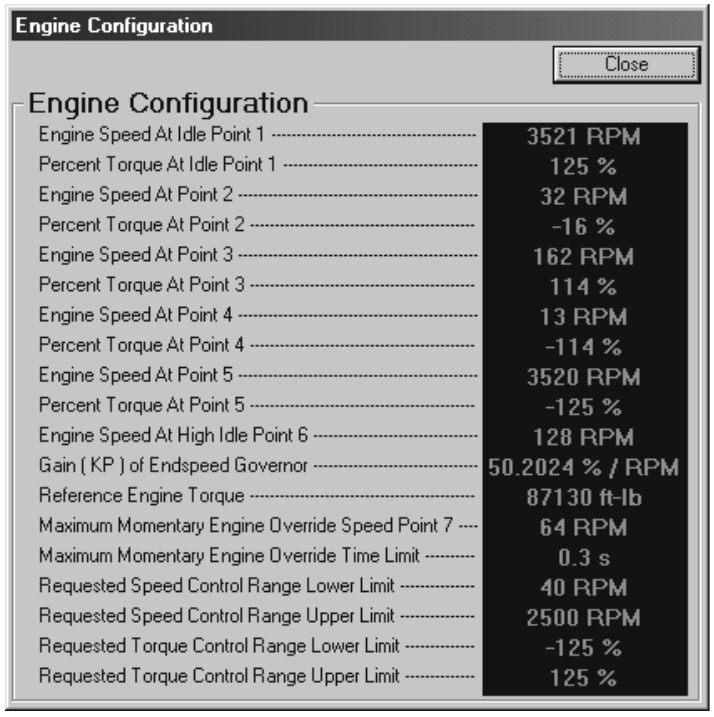

Figure 6-30. Engine Configuration Screen

ECU DTC Info Tab

The ECU DTC Info tab (Figure 6-31) displays both active and previously logged diagnostic trouble codes (DTCs) obtained from the ECU. ECU DTC Info tab indicators and controls are described in the following paragraphs.

Lamp Status – Stop. This indicator lights when DTC information warrants stopping the engine.

Lamp Status – Warning. This indicator lights when DTC information indicates an engine problem that is significant, but does not require immediate shutdown of the engine.

Lamp Status – Malfunction. This indicator lights when an emission related DTC is logged.

Lamp Status – Protect. This indicator lights when DTC information points to a problem that is probably not related to the engine's electronic subsystem.

Clear Previous DTC Information. Clicking this button clears the previously logged DTC information from the ECU DTC Info tab.

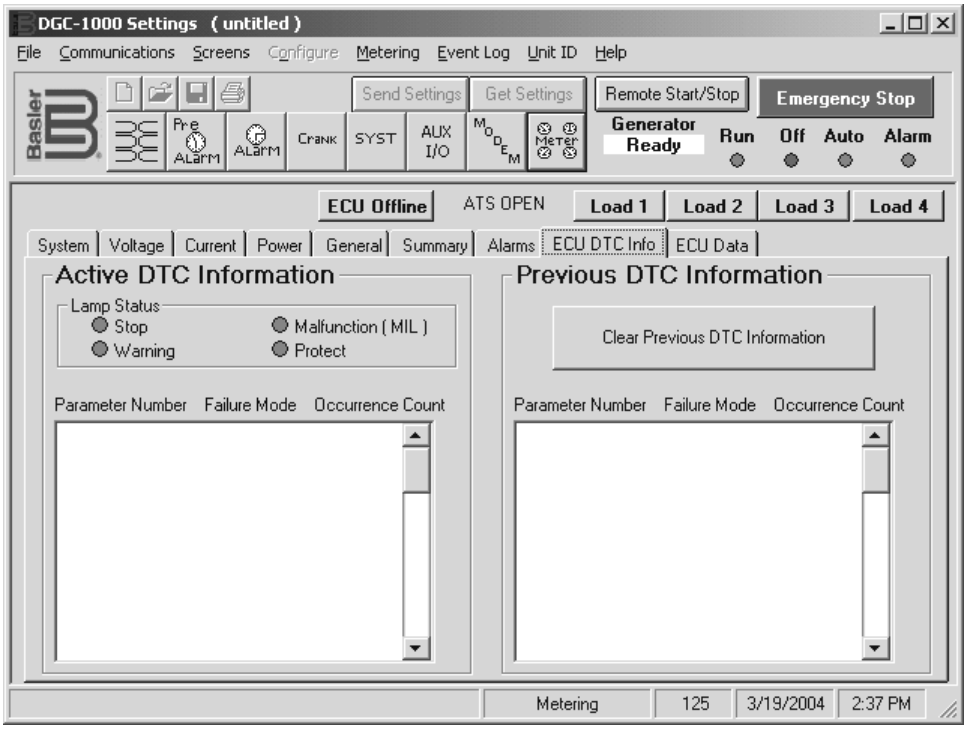

Figure 6-31. Metering Screen, ECU DTC Info Tab

MTU MDEC Tab

The MTU MDEC tab (Figure 6-32) displays pre-alarms, alarms, and fault code messages issued by the MDEC ECU. When the MDEC ECU issues an alarm or pre-alarm, the indicator next to the alarm or pre-alarm label changes from gray to red. Fault code messages issued by the MDEC ECU are displayed in the Active Faults window of the MDEC ECU tab. Clicking the Refresh button updates the Active Faults list by clearing all inactive fault messages. A list of possible fault code messages is provided in Section 3, *Functional Description*. Your MDEC ECU documentation should be consulted when diagnosing ECU fault codes.

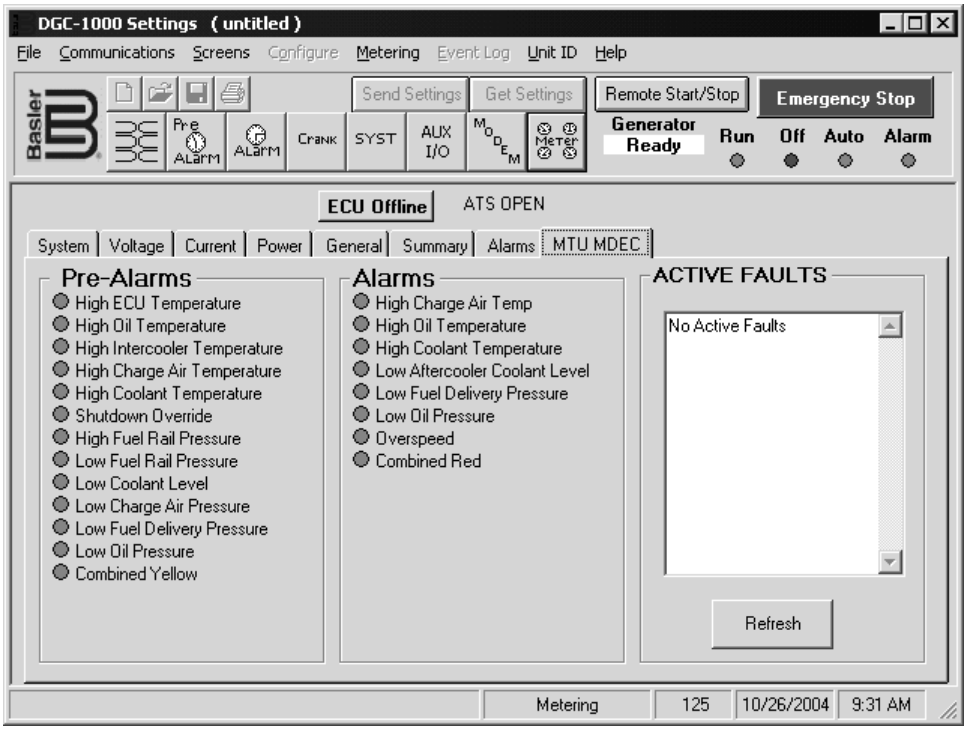

Figure 6-32. Metering Screen, MTU MDEC Tab

REAL-TIME CLOCK

The DGC-1000 real-time clock settings can be adjusted and verified through the Set Real Time Clock dialog box (Figure 6-33). Click **Configure** on the menu bar and click **Real Time Clock**.

To set the DGC-1000 real-time clock with the PC's time and date settings, perform the following steps.

1. Click the **Display PC Date and Time** button. The PC's clock settings are displayed in the date and time fields. (The date and time fields of the Set Real Time Clock dialog box cannot be changed manually.)
2. Select the **Automatically adjust for Daylight Savings Time** checkbox if automatic compensation for daylight savings time is desired.
3. Click the **Send to DGC** button to set the DGC-1000 real-time clock with the PC's time and date.

The DGC-1000 real-time clock settings can be viewed and verified by clicking the **Display DGC Settings** button.

Figure 6-33. Set Real Time Clock Screen

PROGRAMMABLE SENDERS

Click **Configure** on the menu bar and click **Programmable Senders** to access the Programmable Senders screen. (If the Metering screen is being viewed, metering will need to be disabled to access the Configure menu.)

The Programmable Senders screen has three tabs: Coolant Temperature, Oil Pressure, and Percent Fuel Level. Because the setting fields and buttons of each tab are so similar, only the Coolant Temperature tab settings (Figure 6-34) are described here.

Get Cool. Data From DGC. If communication with a DGC-1000 is enabled, clicking this button retrieves the sender data points from the DGC-1000 and refreshes the graph.

Send Cool. Data To DGC. Clicking this button sends the displayed data points to the DGC-1000.

Load Cool. Settings File. Clicking this button displays an Open dialog box where a sender file containing sender data points can be retrieved. Some standard data point files for the three senders are included with BESTCOMS. Coolant temperature sender files have a CS1 extension, oil pressure sender files have an OS1 extension, and fuel level sender files have an FS1 extension.

Create Cool. Settings File. Clicking this button displays a Save As dialog box where the transducer data points created in BESTCOMS can be saved in a sender file. While it is possible to create individual sender files for each transducer, it is not necessary. The data for all three senders is automatically saved with the DGC-1000 configuration file. The *Settings Files* sub-section contains information about creating DGC-1000 configuration files.

Resistance. The 11 resistance points in this column are not adjustable. The DGC-1000 has been factory calibrated at these points to maximize accuracy.

Degrees F/Degrees C. Temperature values entered in this column must always maintain a descending order. If English units are used, adjacent coolant temperature points must be separated by at least 2°F. If metric units are used, adjacent oil pressure points must be separated by at least 7 kPa. The coolant temperature range is 32 to 400°F or 0 to 240°C. The oil pressure setting range is 0 to 250 psi or 0 to 1,725 kPa. The fuel level setting range is 0 to 100%.

Sender Slope. If a sender requires a positive slope, Positive can be selected to invert the values in the Resistance column.

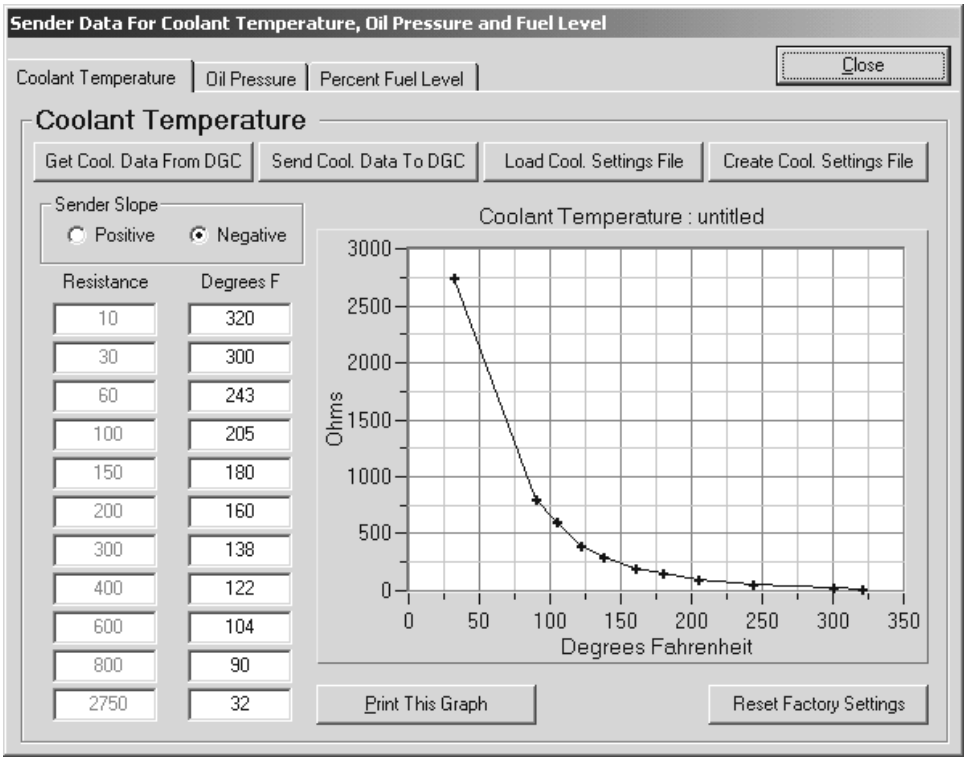

Figure 6-34. Programmable Senders Screen, Coolant Temperature Tab

Print This Graph. Clicking this button displays a print preview screen that allows selection of a printer, page orientation, and graph image magnification. Clicking **Print** sends the graph image to the target printer. Clicking **Close** returns to the Programmable Senders screen.

Reset Factory Settings. Clicking this button restores the factory default data points in the Degrees F/Degrees C column and graph. This does not update the data points in the DGC-1000. the DGC-1000 is updated by clicking the **Send Cool. Data to DGC** button.

NOTE

When metric values are used and changes are made to the oil pressure sender data points, undesirable internal rounding of some data points can occur. For example, select 700 kPa for one data point, create a sender file, and the value is rounded to 697. Rounding that occurs will never be greater than 4 kPa.

RUN TIME AND KW HOURS

The accumulated running time and kilowatt-hours for a genset can be adjusted by accessing the Run Time and KW Hours dialog box shown in Figure 6-35. Click **Configure** on the menu bar and click **Engine Runtime & KW Hours**. Unless access is gained by using the OEM-level password, the Engine Runtime & KW Hours selection will not appear in the Configure pull-down menu.

To adjust the accumulated engine run time, enter the desired time in the Hours and Minutes fields and click the **Update DGC Accumulated Engine Runtime** button.

To adjust the genset total kilowatt-hours, enter the desired value in the KW Hours field and click the **Update DGC Total KW Hours** button.

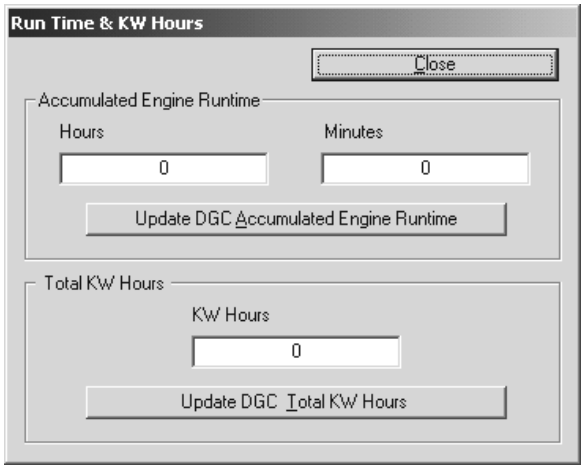

Figure 6-35. Run Time and KW Hours Dialog Box

ENGINE CONTROL UNIT (ECU) INTERFACE

For J1939 applications, the interface between the DGC-1000 and ECU is configurable. First, the output contact used to power up the ECU (for non-continuously powered ECU applications) is selectable. Second, periodic communication with the ECU (also referred to as pulsing the ECU) may be disabled if the application requires it. Third, the timers associated with pulsing the ECU are programmable. The settings used to configure the ECU interface are adjusted through the ECU Control dialog box. This dialog box is accessed by clicking **Configure** on the menu bar and clicking **ECU Control**. The ECU interface settings of the ECU Control dialog box are shown in Figure 6-36 and described below.

ECU Contact Control – Output Select. This setting selects the DGC-1000 output that is used to power up the ECU in J1939 applications where the ECU is not continuously powered. If the pre-start contact is selected, the fuel contact will still close during cranking and running of the genset to provide a separate indication that the genset is running.

ECU Contact Control – Pulsing. In J1939 applications where the ECU is not continuously powered, the DGC-1000 will normally pulse the ECU periodically to update its engine monitoring data. For applications where this periodic pulsing is not desired, this setting allows the pulsing feature to be disabled.

ECU Related Time Values – Engine Shut Down (Sec.). When going from Running to Shut Down, this setting adjusts the length of time that the DGC-1000 stays disconnected from the ECU before starting the first pulse. The Engine Shut Down setting range is 1 to 60 seconds.

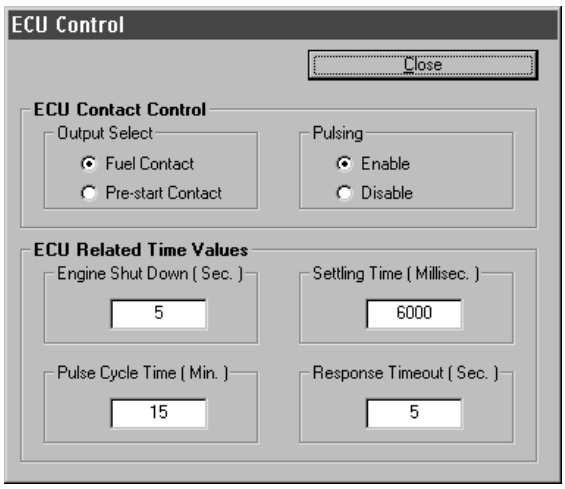

Figure 6-36. ECU Control Dialog Box

ECU Related Time Values - Setting Time (Millisec.). This setting adjusts the time to gather data after connecting to the ECU during the pulsing state. This allows all metered values to be sent and ramp up. Metered values are sent by the ECU at different rates as designated by the SAE J1939 protocol. Values sent by the ECU may be low initially; the ECU takes time to average its own data. The Setting Time setting range is 5,500 to 30,000 milliseconds.

ECU Related Time Values - Pulse Cycle Time (Min.). This setting adjusts the time that the DGC-1000 waits to pulse the ECU again. The Pulse Cycle Time setting range is 1 to 60 minutes.

ECU Related Time Values - Response Timeout (Sec.). This setting controls the time that communication is attempted with the ECU while the DGC-1000 is in the Pulsing or Connect*ing* state. The Response Timeout setting range is 1 to 50 seconds.

EVENT LOG

The event log provides a historical record of events detected by the DGC-1000. Click **Event Log** on the menu bar to access the event log screen (Figure 6-367).

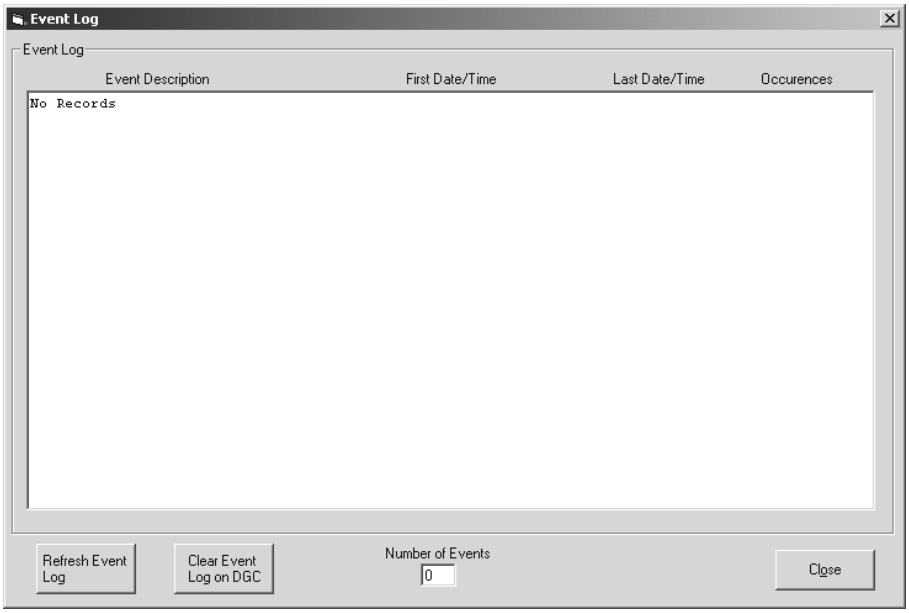

Figure 6-37. Event Log Screen

Any of the conditions in the following list will trigger an event log. Alarms and pre-alarms will not trigger an event log unless enabled through the Alarm Settings and Pre-Alarm Settings screens in BESTCOMS.

- Active DTCs pre-alarm
- ATS closed
- Auxiliary input contact 1 closed
- Auxiliary input contact 2 closed
- Auxiliary input contact 3 closed
- Auxiliary input contact 4 closed
- Battery charger failure pre-alarm
- Battery overvoltage pre-alarm
- BESTCOMS Load 1 button closed
- BESTCOMS Load 2 button closed
- BESTCOMS Load 3 button closed
- BESTCOMS Load 4 button closed
- CAN Bus failure alarm
- CAN Bus failure pre-alarm
- Coolant level sender failure
- Coolant temperature sender failure alarm
- DGC-1000 protective shutdown
- Emergency stop alarm
- Engine start
- Fuel leak/sender failure pre-alarm
- High coolant temperature alarm
- High coolant temperature pre-alarm
- kW overload pre-alarm
- Low battery voltage pre-alarm
- Low coolant level alarm
- Low coolant level alarm
- Low coolant level pre-alarm
- Low coolant temperature pre-alarm
- Low fuel level alarm
- Low fuel pre-alarm
- Low oil pressure alarm
- Low oil pressure pre-alarm
- MPU speed sensor sender failure alarm
- Normal shutdown
- Oil pressure sender failure alarm
- Overcrank alarm
- Overspeed alarm
- Scheduled maintenance pre-alarm
- ECU protective shutdown
- Voltage sender failure alarm
- Weak battery voltage pre-alarm

The event log screen lists the 20 most recent events recorded by the DGC-1000. When 20 events are logged, subsequent events overwrite the oldest events in the list. Each event listed has a description, the number of occurrences for the event, and a date/time stamp for the first and last occurrences of the event.

CHANGING THE COMMUNICATION PARAMETERS

When communication is established between a PC and DGC-1000, changes in BESTCOMS to the communication parameters affect both the PC and DGC-1000. When communication between a PC and DGC-1000 is closed, changes in BESTCOMS to the communication parameters affect only the PC.

Communication parameters are viewed and adjusted through the Communications Configure dialog box. This dialog box is accessed by clicking **Configure** on the menu bar and clicking **RS232**. The Communications Configure dialog box settings are illustrated in Figure 6-378 and described in the following paragraphs.

Baud Rate. This setting selects the communication rate. A baud rate of 1200, 2400, or 9600 may be selected.

Parity. This setting enables and disables summation checking of data transmitted between the PC and DGC-1000. A setting of No Parity, Odd Parity, or Even Parity can be selected.

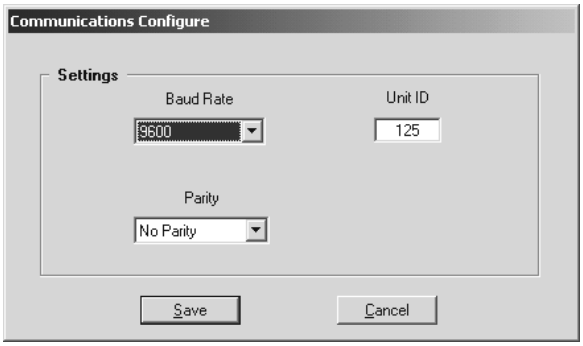

Figure 6-38. Communications Configure Dialog Box

Unit ID. This setting allows an identification number to be assigned to a DGC-1000 for polled communication. A number between 1 and 247 may be selected.

PASSWORD PROTECTION

Password protection guards against unauthorized changing of DGC-1000 settings. DGC-1000 passwords are case sensitive. Three levels of password protection are available. Each level is described in the following paragraphs.

- *Limited Access.* This password level allows all DGC-1000 settings to be read, but prevents any changes to settings. The default, limited-access password is *DGC*.
- *Full Access.* This password level allows all DGC-1000 settings to be read and allows all settings except Accumulated Engine Runtime and Total KW Hours to be changed. The default, full-access password is *DGC1000*.
- *OEM Access.* This password allows all DGC-1000 settings to be read and allows all settings to be changed. It also allows the DGC-1000 embedded firmware to be upgraded. The default, OEM-access password is *OEMLVL*.

Figure 6-39. Change Password Dialog Box

Changing Passwords

Passwords can be changed only after communication between the PC and DGC-1000 is established. Changes to passwords are made through the Change Password dialog box. To access the Change Password dialog box, click **Communications** on the menu bar and click **Change Password**.

The content of the Change Password dialog box depends on the password level used when accessing the dialog box. For example, someone logged in with a full-access password will be able to change only the limited-access and full-access passwords—not the OEM-access password. Figure 6-389 illustrates the Change Password dialog box with all three access levels shown.

A password is changed by selecting the access level, entering the new password, and then re-entering the new password to confirm the entry.

Once a password is changed, it should be stored in a secure location. If a user-defined password is lost or forgotten, contact Basler Electric for instructions on regaining password access.

Third Party Access Level

This setting determines the level of access that third party Modbus programs are allowed to have without going through the logon process. There are three levels of third party access: None (no access), Read Only, and Read/Write. The default level is None. The Third Party Access Level setting is accessible through the Change Password dialog box only when OEM-level access is obtained.

SETTINGS FILES

BESTCOMS software enables you to print a list of DGC-1000 settings, save DGC-1000 settings to a file, and open a settings file and upload those settings to a DGC-1000.

Printing Settings Files

A printout of DGC-1000 settings can be useful for record keeping or comparison purposes. Click the **Print Settings File** button or click **File** on the menu bar and click **Print** to access the Print DGC-1000 Settings screen. This screen contains a print preview pane and settings for selecting the printer, content of the printout, and the printout orientation. DGC-1000 settings are divided into five print sections: General, Auxiliary I/O, Modem, Input Sender, and ECU Timers. Any combination of sections can be selected for printing.

New Settings File

Clicking this button resets the settings displayed in BESTCOMS to the factory default values. The settings displayed in BESTCOMS can also be reset by clicking **File** on the menu bar and clicking **New**. If changes to settings have not been saved, you will be given the opportunity to save the changes in a DGC-1000 settings file.

Saving Settings Files

Saving DGC-1000 settings in a file for uploading to other DGC-1000 units saves setup time when configuring multiple units with the same settings. A settings file can also be created in BESTCOMS without being connected to a DGC-1000. The settings of the desired screens can be changed and these settings can then be saved in a file.

A settings file is created by clicking the **Save Settings File** button or clicking **File** on the menu bar and clicking **Save**. A file properties box appears and allows you to enter genset information and other pertinent notes about the settings. Next, a Save As dialog box prompts you to select the name and location of the settings file. All DGC-1000 settings files are automatically given a DG1 file extension by BESTCOMS.

Opening Settings Files

To open a DGC-1000 settings file, click the **Open Settings File** button or click **File** on the menu bar and click **Open**. An Open dialog box will appear and enable you to select a DGC-1000 settings file (DG1 extension) for retrieval into BESTCOMS.

TERMINATING COMMUNICATION

DGC-1000 communication is terminated by clicking **Communications** on the menu bar and clicking **Close**. If unsaved settings changes were made, you are prompted to save the changes in a new or existing settings file. When you execute the close communication command, with or without saving settings, communication with the DGC-1000 is terminated. If you choose to exit BESTCOMS (by clicking **File** on the menu bar and then **Exit**) without first closing communication, you are still given the opportunity to save any settings changes.

EMBEDDED FIRMWARE

Embedded firmware is the operating program that controls the actions of the DGC-1000. The DGC-1000 stores firmware in nonvolatile flash memory that can be reprogrammed through the RS-232 communication port. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

Updating Firmware

Future enhancements to DGC-1000 functionality may make a firmware update desirable. Because default settings are loaded when DGC-1000 firmware is updated, your settings should be saved in a file prior to upgrading firmware. DGC-1000 firmware can be updated by performing the following steps.

CAUTION

If power is lost or communication is interrupted during file transfer, the DGC-1000 will cease operating and will not recover.

1. Connect a communication cable between the RS-232 connector of the DGC-1000 and the appropriate communication port of your PC. Start BESTCOMS-DGC-1000, open communication, and gain password access with the OEM-access password.
2. Place the DGC-1000 in Off mode. This can be accomplished by double-clicking the **Off** indicator on any of the BESTCOMS screens or by pressing the **Off** button on the DGC-1000 front panel.
3. Click **Configure** on the menu bar and click **Upgrade Embedded Firmware**. The Embedded Firmware Upgrade screen of Figure 6-40 will appear.

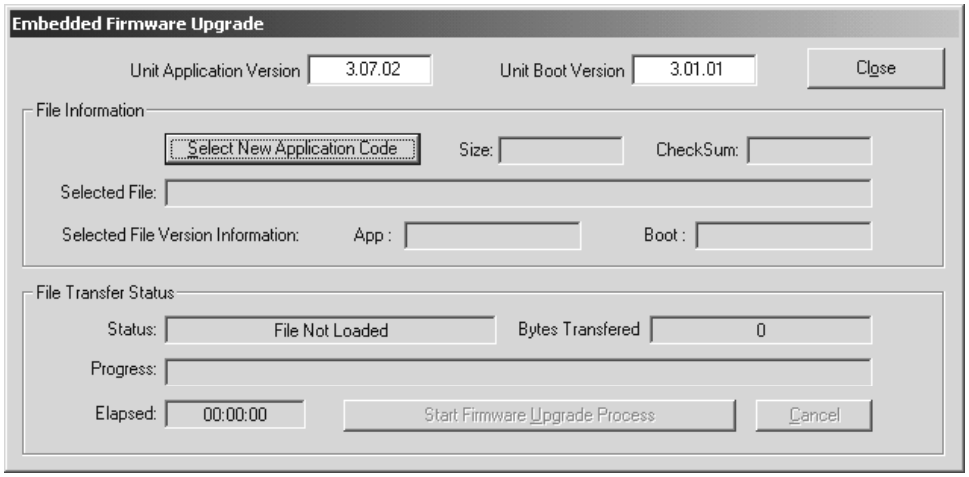

Figure 6-40. Embedded Firmware Upgrade Screen

4. Click the **Select new Application Code** button and then select the file (S19 file extension) to be used for updating the DGC-1000 firmware.
5. Click the **Start Firmware Upgrade Process** button to start the file transfer.
6. Once the file transfer is complete, close the Embedded Firmware Upgrade dialog box, open communication between the PC and DGC-1000, and gain password access to the DGC-1000 with the appropriate password.

APPENDIX A • DGC-1000 SETTINGS RECORD

INTRODUCTION

This appendix lists all DGC-1000 parameter settings and their default values. This listing is in the form of a settings record that may be used to record information relative to your system. These settings sheets may be removed and photocopied.

DGC-1000 SETTINGS RECORD

Genset ID_____ **Date**_____

DGC-1000 Serial Number_____ **Software Version Number**_____

Sensing Transformer Settings

Setting Parameter	Default Setting	User Setting
Generator PT Primary Voltage	480 V	
Generator PT Secondary Voltage	480 V	
Generator CT Primary Current	500 A	

Pre-Alarm Settings

Setting Parameter	Default Setting	User Setting
Low Fuel Pre-Alarm Status	Disabled	
Low Fuel Pre-Alarm Threshold	25% of Full Tank	
Low Coolant Temp Pre-Alarm Status	Disabled	
Low Coolant Temp Pre-Alarm Threshold	50°F	
Battery Overvoltage Pre-Alarm Status	Disabled	
Battery Overvoltage Pre-Alarm Threshold	30.0 V	
Maintenance Interval Pre-Alarm Status	Disabled	
Maintenance Interval Pre-Alarm Threshold	500 h	
Engine kW Overload Pre-Alarm Status	Disabled	
Engine kW Overload Pre-Alarm Threshold	105% of Rated kW	
High Coolant Temp Pre-Alarm Status	Enabled	
High Coolant Temp Pre-Alarm Threshold	250°F	
Low Oil Pressure Pre-Alarm Status	Enabled	
Low Oil Pressure Pre-Alarm Threshold	25 psi	
Low Battery Voltage Pre-Alarm Status	Disabled	
Low Battery Voltage Pre-Alarm Threshold	20.0 V	
Low Battery Voltage Pre-Alarm Time Delay	10 s	
Weak Battery Voltage Pre-Alarm Status	Disabled	
Weak Battery Voltage Pre-Alarm Threshold	15.0 V	
Weak Battery Voltage Pre-Alarm Time Delay	2 s	
Audible Alarm	Enabled	
Battery Charger Failure Pre-Alarm	Disabled	
Fuel Level Sender Failure Pre-Alarm	Disabled	
Active DTC Pre-Alarm	Disabled	
Loss of ECU Communication Pre-Alarm	Disabled	

Alarm Settings

Setting Parameter	Default Setting	User Setting
High Coolant Temp Alarm Status	Enabled	
High Coolant Temp Alarm Threshold	275°F	
High Coolant Temp Alarm Time Delay	60 s	
Low Oil Pressure Alarm Status	Enabled	
Low Oil Pressure Alarm Threshold	15 psi	
Low Oil Pressure Alarm Time Delay	10 s	
Low Oil Pressure Alarm Status	Enabled	
Low Fuel Alarm Status	Enabled	
Low Fuel Alarm Threshold	2% of Full Tank	
Overspeed Alarm Status	Enabled	
Overspeed Alarm Threshold	110% of Rated	
Overspeed Alarm Time Delay	50 ms	
Coolant Temperature Sender Fail Alarm	Disabled	
Coolant Temp Sender Failure Alarm Time Delay	5 m	
Oil Pressure Sender Failure Alarm	Disabled	
Loss of Generator Voltage Alarm	Disabled	
Magnetic Pickup Failure Alarm	Enabled	
Global Sender Failure Alarm Time Delay	10 s	
Loss of ECU Communication Alarm	Disabled	

Cranking Settings

Setting Parameter	Default Setting	User Setting
Generator Cranking Style	Cycle	
Number of Crank Cycles	2	
Cycle Crank Time	5 s	
Continuous Crank Time	10 s	
Crank Disconnect Limit	30% of Rated	
Pre-Crank Delay	0 s	
Pre-Start Contact After Disconnect	Disabled	

System Settings

Setting Parameter	Default Setting	User Setting
Genset kW Rating	300 kW	
No-Load Cool Down Time	0 m	
Generator Engine RPM Rating	1800 rpm	
System Battery Voltage	24 V	

Setting Parameter	Default Setting	User Setting
NFPA Level	0	
Number of Flywheel Teeth	126	
Speed Signal Source	Magnetic Pickup & Gen	
Generator Connection	3 Phase, L-N	
Generator Frequency	60 Hz	
Unit System	English	
Generator Rotation	ABC	
CAN Bus Support	Disabled	
Engine Configuration	Standard J1939	
J1939 Source Address for this Unit	234	
Accelerator Pedal Position	50%	
Volvo Engine RPM Select	Primary	
MDEC Module Type	Module 302	
MDEC Speed Demand Source	Analog CAN	
Engine RPM	1800	

ECU Interface Settings

Setting Parameter	Default Setting	User Setting
ECU Contact Output Select	Fuel Contact	
ECU Pulsing	Enable	
Engine Shutdown Time	15 s	
ECU Settling Time	6000 ms	
ECU Pulse Cycle Time	15 m	
ECU Response Timeout	5 s	

Coolant Temperature Sender Curve Information

Resistance Value in Ohms	Default Setting	User Setting
10	320°F	
30	300°F	
60	242°F	
100	205°F	
150	180°F	
200	160°F	
300	138°F	
400	122°F	
600	104°F	

Resistance Value in Ohms	Default Setting	User Setting
800	89°F	
2750	32°F	

Oil Pressure Sender Curve Information

Resistance Value in Ohms	Default Setting	User Setting
0	150°F	
25	113°F	
50	83°F	
75	68°F	
100	52°F	
125	37°F	
150	26°F	
175	17°F	
200	10°F	
225	6°F	
250	0°F	

Fuel Level Sender Curve Information

Resistance Value in Ohms	Default Setting	User Setting
0	100%	
33	99%	
58	87%	
84	75%	
110	62%	
136	50%	
162	38%	
188	26%	
214	13%	
240	1%	
250	0%	

Programmable Input Contact Setup

	Default Setting	User Setting
Input 1 Function	Auxiliary Input	
Input 1 Auxiliary Configuration	Not Configured	
Input 1 Auxiliary Input Label	AUX IN 1	

	Default Setting	User Setting
Input 2 Function	Auxiliary Input	
Input 2 Auxiliary Configuration	Not Configured	
Input 2 Auxiliary Input Label	AUX IN 2	
Input 3 Function	Auxiliary Input	
Input 3 Auxiliary Configuration	Not Configured	
Input 3 Auxiliary Input Label	AUX IN 3	
Input 4 Function	Auxiliary Input	
Input 4 Auxiliary Configuration	Not Configured	
Input 4 Auxiliary Input Label	AUX IN 4	

Auxiliary Output Setup

Condition to Annunciate	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8
High Coolant Temperature Alarm								
Low Oil Pressure Alarm								
Coolant Temp. Sender Failure Alarm								
Oil Pressure Sender Failure Alarm								
Loss of Generator Voltage Alarm								
Speed Sender Failure Alarm								
Low Fuel Alarm								
Low Coolant Level Alarm								
Over-Crank Alarm								
Emergency Stop Alarm								
Overspeed Alarm								
Low Fuel Pre-Alarm								
Low Coolant Temp. Pre-Alarm								
kW Overload Pre-Alarm								
High Coolant Temp. Pre-Alarm								
Low Oil Pressure Pre-Alarm								
Low Battery Voltage Pre-Alarm								
Weak Battery Voltage Pre-Alarm								
Battery Charger Failure Pre-Alarm								
Scheduled Maintenance Pre-Alarm								
Unit Not in Auto								
Fuel Leak/Sender Failure Pre-Alarm								

Condition to Annunciate	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8
Cooldown Timer Active								
Auxiliary Input 1 Closed								
Auxiliary Input 2 Closed								
Auxiliary Input 3 Closed								
Auxiliary Input 4 Closed								
Load Button 1 Pressed								
Load Button 2 Pressed								
Load Button 3 Pressed								
Load Button 4 Pressed								

Modem/Dial-Out Settings

Setting Parameter	Default Setting	User Setting
First Telephone Number	-	
First Pager ID Number	-	
Second Telephone Number	-	
Second Pager ID Number	-	
Third Telephone Number	-	
Third Pager ID Number	-	
Fourth Telephone Number	-	
Fourth Pager ID Number	-	
Site Information	DGC-1000	
Rings Before Modem Answers	2	
Off-Line Delay	10 m	
Inter-Dial-Out Delay	15 s	
Pager Buffer Size Limit	80 characters	
Pager Communication Data Format	7 data bits, even parity	

Modem Dial-Out Conditions

Condition to Annunciate		Condition to Annunciate	
High Coolant Temperature Alarm		Weak Battery Voltage Pre-Alarm	
Low Oil Pressure Alarm		Battery Charger Failure Pre-Alarm	
Coolant Temp. Sender Failure Alarm		Scheduled Maintenance Pre-Alarm	
Oil Pressure Sender Failure Alarm		Unit Not in Auto	
Loss of Generator Voltage Alarm		Fuel Leak/Sender Failure Pre-Alarm	
Speed Sender Failure Alarm		Cooldown Timer Active	
Low Fuel Alarm		Auxiliary Input 1 Closed	

Condition to Annunciate		Condition to Annunciate	
Low Coolant Level Alarm		Auxiliary Input 2 Closed	
Over-Crank Alarm		Auxiliary Input 3 Closed	
Emergency Stop Alarm		Auxiliary Input 4 Closed	
Overspeed Alarm		Load Button 1 Pressed	
Low Fuel Pre-Alarm		Load Button 2 Pressed	
Low Coolant Temp. Pre-Alarm		Load Button 3 Pressed	
kW Overload Pre-Alarm		Load Button 4 Pressed	
High Coolant Temperature Pre-Alarm		Active Diagnostic Trouble Code Pre-Alarm	
Low Oil Pressure Pre-Alarm		Loss of ECU Communication Alarm	
Low Battery Voltage Pre-Alarm		Loss of ECU Communication Pre-Alarm	
		ECU Protective Shutdown	

KDGC-2000

Digital Genset Controller

Revision II

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SECTION 1 • GENERAL INFORMATION

DESCRIPTION

KDGC-2000 Digital Genset Controllers use microprocessor based technology to provide integrated engine-generator set control, protection, and metering in a single package. Microprocessor based technology allows for exact measurement, set point adjustment, and timing functions. The KDGC-2000 allows for quick and simple operation from the front panel or through serial link communications. Communications uses the Modbus™ protocol. Because of the low sensing burden in the KDGC-2000, neither dedicated potential transformers nor current transformers are required. A wide temperature range LCD display with backlighting allows the display to be viewed under any ambient light condition. This combination of features in the KDGC-2000 yields significant savings in installation and setup costs.

FEATURES

KDGC-2000 Digital Genset Controllers have the following features.

- Packaged in metal cases for improved electromagnetic compatibility.
- Designed for use in harsh environments.
- Resistant to high moisture, salt fog, humidity, dust, dirt, and chemical contaminants.
- Resistant to the entrance of insects and rodents.
- Suitable for mounting in any top mount enclosure.
- Suitable for controlling isolated generating systems or paralleled generating systems.
- Serial link communications and the optional Katolight software package enhances the users access to set-up parameters. The Katolight software package also provides real time monitoring and control. When combined with a modem and a telephone line, monitoring and control is possible from any remote location.

FUNCTIONS

KDGC 2000 Digital Genset Controllers perform the following functions.

1. Engine cranking control
2. Generator voltage metering
3. Bus voltage metering
4. Generator frequency metering
5. Bus frequency metering
6. Generator current metering
7. Engine coolant temperature metering
8. Engine coolant temperature protection
9. Engine oil pressure metering
10. Engine oil pressure protection
11. Fuel level sensing
12. Fuel level protection
13. Engine cool down
14. Watt metering
15. VA metering
16. Fuel Leak Detection
17. Engine rpm metering
18. Power factor metering
19. Watthour metering
20. Engine run time metering
21. Battery voltage metering
22. Battery condition monitoring
23. Engine maintenance monitoring
24. Overload protection
25. Serial communication with Modbus™ protocol
26. Low coolant level

OUTPUTS

There are thirteen isolated form A output contacts. Four are for engine cranking control and the remaining nine are for the various protection features.

SPECIFICATIONS

KDGC-2000 Digital Genset Controllers have the following features and capabilities.

Current Sensing Inputs

Current range	
1 Ampere Input	0.02 to 1 ampere continuously, 2.0 amperes for one second
5 Ampere Input	0.1 to 5 amperes continuously, 10.0 amperes for one second
Accuracy	±2% of reading or ± 2 amperes whichever is greater
Burden	1 volt-ampere

Voltage Sensing Inputs

Range	12 to 576 volts RMS, 50 or 60 hertz contin-uously, 720 volts RMS for one second
Accuracy	±2% of reading or ± 2 volts whichever is greater
Burden	1 volt-ampere

Frequency

Range	4 to 70 hertz
Accuracy	±0.25% of reading or ±0.2 Hz whichever is greater

Contact Sensing Inputs

Emergency Stop	Normally closed dry contact
Fuel Leak	Normally open dry contact
Automatic Transfer	Normally open dry contact
Battery Charger Fail	Normally open dry contact
Low Coolant Level	Normally open dry contact

Engine System Inputs

Fuel Level Sensing	Recommended fuel level transmitter: ISSPRO, part number R-8925
Range	0 to 250 ohms, 0 to 100%
Accuracy	±2%
Coolant Temperature Sensing	Recommended coolant temperature transmitter: Stewart-Warner, part number 334-P
Range	0 to 1000 ohms
Accuracy	From 37°C (99°F) to 115°C (239°F): ±2% of the reading or ±2 degrees whichever is greater
Oil Pressure Sensing	Unit displays 0 below 104 kilopascals (15 PSI). Recommended oil pressure transmitter: Stewart-Warner (part number 441-K or equivalent)
Range	0 to 250 ohms
Accuracy	From 0 to 690 kilopascals: ±2% of reading or ±2 kilopascals whichever is greater From 0 to 100 PSI: ±2% of reading or ±2 PSI whichever is greater

Battery Voltage Sensing

Range	12 or 24 volts nominal, 8 to 32 volts dc, battery dip ride through to 3 volts for 0.75 seconds
Accuracy	±2% of reading or ±0.2 volts whichever is greater
Burden	16 watts maximum

Magnetic Pickup Sensing

Voltage Range	3 volts peak (during cranking) to 35 volts peak continuous into 10 kohms
Frequency Range	32 to 10,000 hertz

Engine Alternator Voltage Sensing

Voltage Range	2 volts peak to 50 volts peak
Frequency Range	100 to 900 hertz nominal

Engine RPM Sensing

Range	750 to 3600 RPM
Accuracy	±2% of reading or ±2 RPM whichever is greater

Output Contacts

Contact Ratings For Engine Cranking Control	The MASTER START, AUXILIARY START, FUEL SOLENOID, and ENGINE RUN relays are rated for 10 amperes at 24 Vdc, make, break, and carry
Contact Ratings For Protection Features	The PRE-START, ALARM, PRE-ALARM, LOW OIL PRESSURE, LOW COOLANT TEMPERATURE, HIGH COOLANT TEMPERATURE, OVERCRANK, OVERSPEED, and FUEL LEAK relays are rated for 2 amperes at 24 Vdc, make, break, and carry

Calculated Data

Power Factor (PF)

Range	+1.0 to -1.0, both leading and lagging
Accuracy	±0.02 PF

Kilo Volt-Amperes

Range	0 to 9,999 kVA
Accuracy	±2% of reading or ±2 kVA whichever is greater

Kilowatts

Range	0 to 9,999 kW
Accuracy	±3% of reading or ±2 kW whichever is greater

Kilowatt Hours

Range	0 to 999,999,999 kWh
Accuracy	±2% of reading or ±2 kWh whichever is greater

Engine Run Time

Range	0 to 99,999 hours
Accuracy	±1% of reading or ±2 hours whichever is greater

Maintenance Interval

Range	0 to 5,000 hours
Accuracy	±1% of reading or ±2 hours whichever is greater

Hardware

Communication Port	
Interface	
Rear RS-232	9600 baud, 8N1 full duplex
Protocols	
Rear RS-232	Modbus™
Isolation	2000 Vac at 50/60 Hz for one minute between ground and voltage sensing inputs. 500 Vac at 50/60 Hz for one minute between any of the following groups • Voltage Sensing - 70mA • Battery, Contact Sensing, and Remote Panel - 42 mA • Current Transformer - 8mA • Communications Port - RS-232 - 6 mA • Contact Outputs - 23 mA
Impulse	Qualified to IEC 255-5
Surge Withstand Capability	
Oscillatory	Qualified to ANSI/IEEE C37.90.1-1989 *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.*
Fast Transient	Qualified to ANSI/IEEE C37.90.1-1989 *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.*
Radio Frequency Interference (RFI)	Type tested using a 5 watt, hand-held trans-ceiver operating at random frequencies centered around 144 and 440 megahertz with the antenna located within 6 inches (15 centimeters) of the device in both vertical and horizontal planes
Environment	
Operating Temperature Range	-40°C to 70°C (-40°F to 158°F)
Storage Temperature Range	-40°C to 85°C (-40°F to 185°F)
Salt Fog	Qualified to ASTM-117B-1989 with the device unpowered for the 100 hour test duration
Vibration	The device withstands 2 g in each of three mutually perpendicular planes, swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep, without structural damage or degradation of performance
Shock	15 g
Weight	Maximum weight 5.75 pounds (2.61 kilograms)

SECTION 2 • HUMAN-MACHINE INTERFACE (Controls And Indicators)

GENERAL

This section provides a description of the KDGC-2000 Digital Genset Controller human machine interface and illustrates the menu tree.

FRONT PANEL DISPLAY

Figure 2-1 shows the front panel human-machine interface (HMI) for a KDGC-2000. Descriptions in Table 2-1 refer to callouts in Figure 2-1.

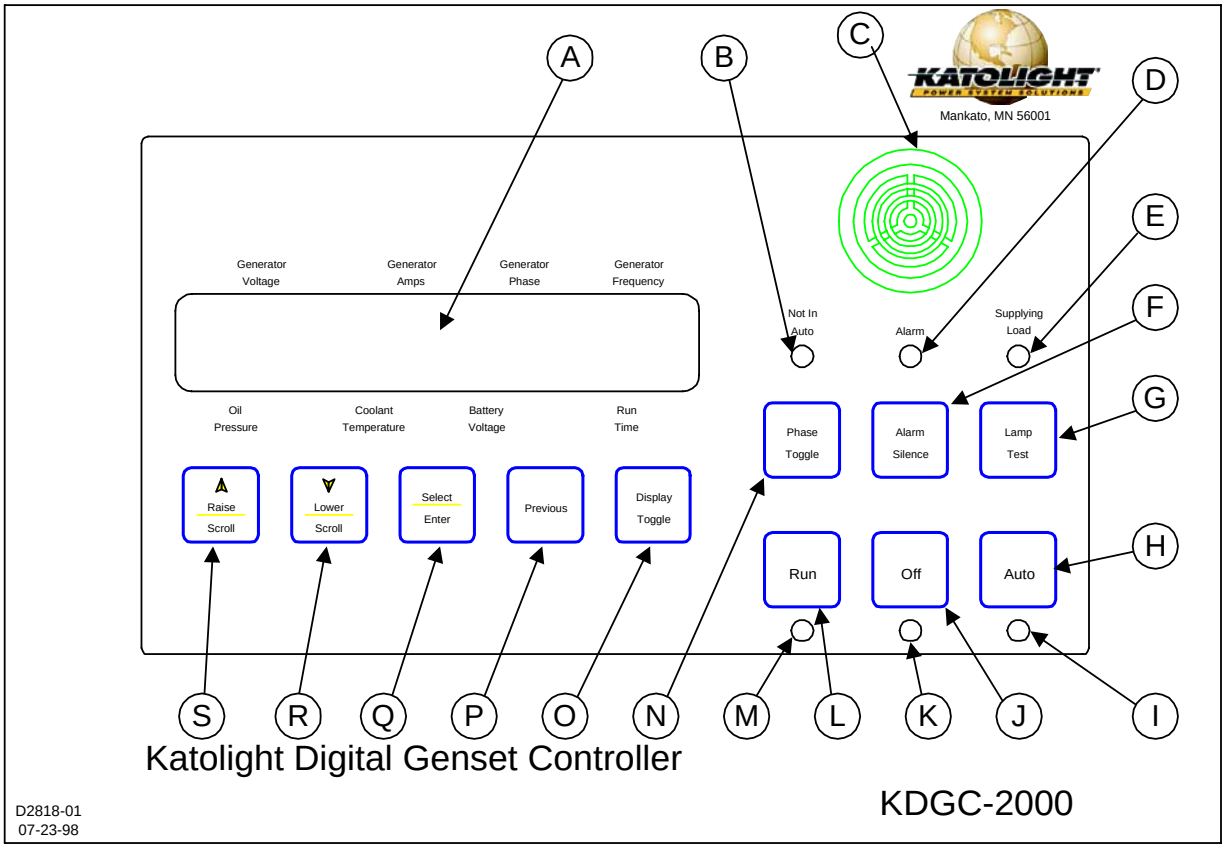

Figure 2-1. KDGC-2000 Front Panel

Table 2-1. KDGC-2000 HMI (Controls And Indicators)

A	Two line by twenty character LCD provides the primary visual interface for metering, alarms, prealarms, and protective functions. In the normal mode, labels appear above and below the display. In the alternate display mode, labels and the displayed value appear on the display.
B	Red LED turns ON when the device is not in the AUTO mode.
C	Audible alarm annunciates when the unit is not in AUTO and when alarms and prealarms occur.

Table 2-1. KDGC-2000 HMI (Continued)

D	Red LED turns ON continuously for all alarm conditions and flashes for prealarm conditions.
E	Green LED turns ON when the generator is supplying more than two percent of rated current.
F	Pushbutton used to silence the audible alarm.
G	Pushbutton used to exercise all segments of the LCD and to illuminate all LED's.
H	Pushbutton used to place the device in AUTO mode.
I	Green LED turns ON when the device is in the AUTO mode.
J	Pushbutton used to place the unit in the OFF mode.
K	Red LED turns ON when the device is in the OFF mode.
L	Pushbutton used to place the device in the RUN mode.
M	Green LED turns ON when the device is in the RUN mode.
N	Pushbutton used to scroll through the displays available in the normal display mode.
O	Pushbutton used to scroll through the display modes.
P	Pushbutton used to scroll through previous menu levels.
Q	Pushbutton used to enter menu sublevels and select set points.
R	Pushbutton used to scroll backward through the menus and to decrement set points.
S	Pushbutton used to scroll forward through the menus and to increment set points.

KDGC-2000 CONNECTIONS

Compression type terminal strips make wiring the KDGC-2000 a simple task. These connections accept one #10 or two #14 AWG wires. These operations are made even easier by user friendly labeling of the terminal strips. Once wired, these terminals can be removed as an assembly and facilitate KDGC-2000 replacement for out of circuit testing or maintenance. Figure 2-2 shows the KDGC-2000 rear panel terminal connections. Descriptions in Table 2-2 refer to callouts in Figure 2-2.

Table 2-2. KDGC-2000 Connections

A	Connection points for the speed sensing inputs.
B	Connection points for voltage sensing inputs.
C	Connection points for current sensing inputs.
D	Connection points for relay output contacts.
E	Connection point for chassis ground.
F	RS-232 serial communication port.
G	Connection points for remote displays in accordance with the National Fire Protection Agency specifications.
H	Connection points for operating power.
I	Connection points for contact sensing inputs.
J	Connection points for sending unit inputs.

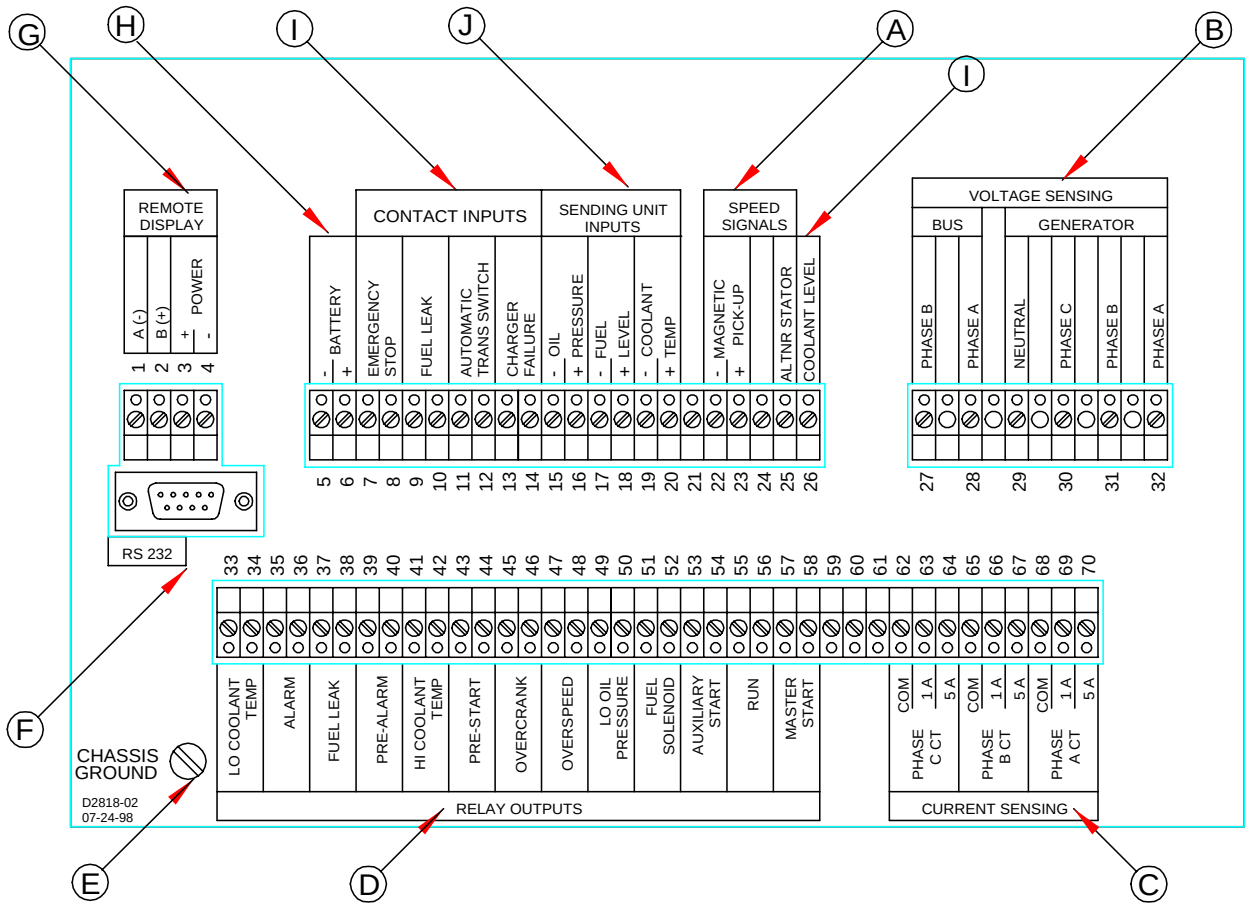

Figure 2-2. KDGC-2000 Digital Genset Controller Rear Panel

SECTION 3 • FUNCTIONAL DESCRIPTION

GENERAL

KDGC-2000 Digital Genset Controllers use microprocessor based technology to provide integrated engine-generator set control, protection, and metering in a single package. Microprocessor based technology allows for exact measurement, set point adjustment, and timing functions. Refer to the following paragraphs for the KDGC-2000 functional description.

Circuit functional description is divided into *Inputs*, *Microprocessor*, *Outputs*, and *Software*. Circuit functions illustrated in Figure 3-1 are described in the following paragraphs.

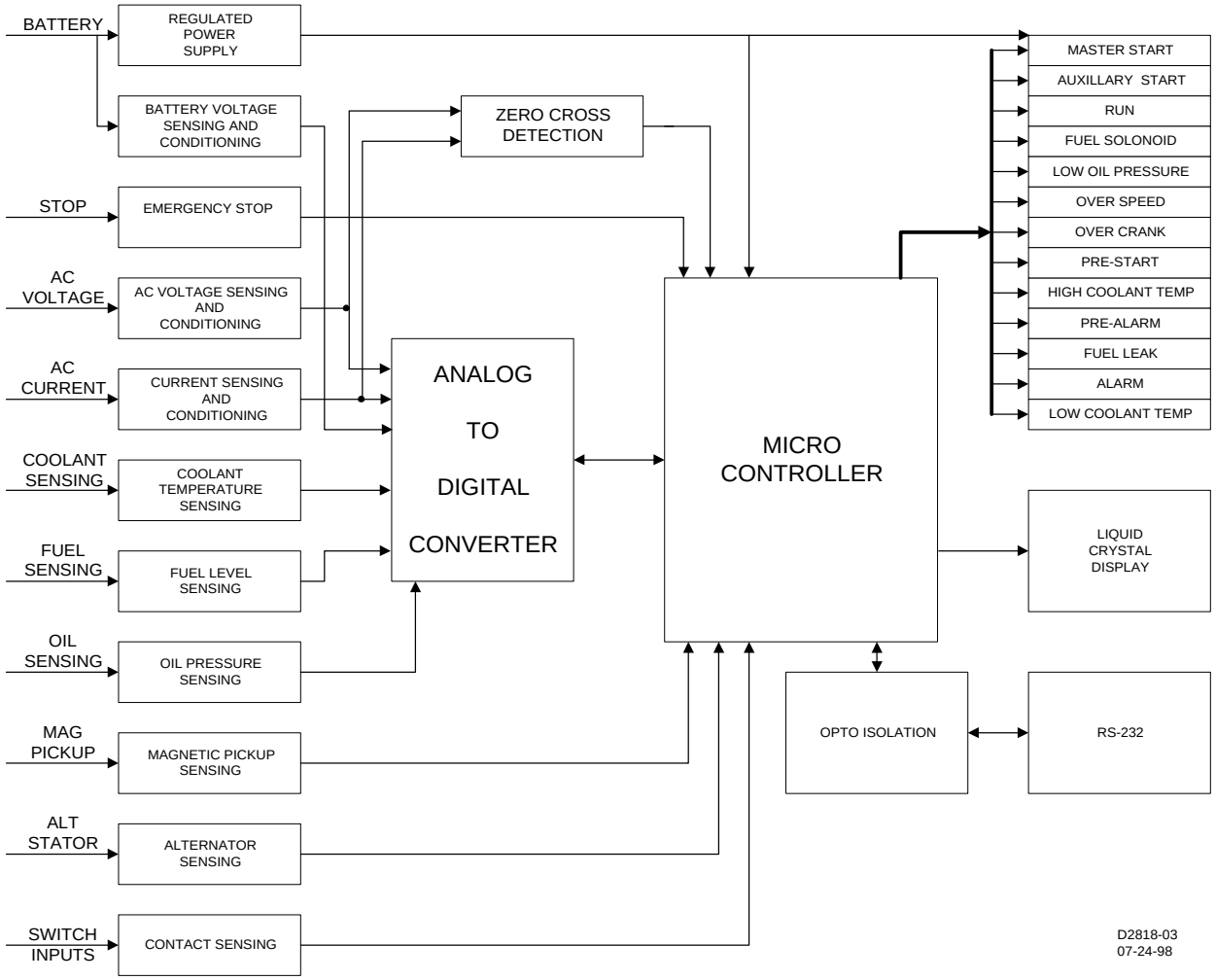

Figure 3-1. KDGC-2000 Functional Block Diagram

INPUTS

There are seven types of inputs to the KDGC-2000 Controller. They are:

- Operating (Battery) DC Power
- Contact Sensing
- Sending Units
- Speed Signals
- Voltage Sensing
- Current Sensing
- Serial Communications RS-232 Port

The following paragraphs describe these inputs.

Battery Operating Voltage

Required operating voltage is a nominal 12 or 24 Vdc. Operating voltage may be in the range of 8 to 32 Vdc. An internal switching power supply uses the battery voltage to generate a +12 Vdc, -12 Vdc, +5 Vdc, a stable +5 Vdc reference, and an isolated +5 Vdc. The isolated +5 Vdc supply is for the RS-232 serial communications port. The dc reference voltage is for internal use.

Battery operating voltage is conditioned (filtered and reduced to a level suitable for microprocessor input) and sensed by the microprocessor.

Contact Sensing Inputs

Five external contact sensing inputs (Emergency Stop, Fuel Leak, Automatic Transfer Switch, Charger Failure, and Low Coolant Level) provide external stimulus to the KDGC-2000 Controller. Nominal voltage(s) of the external dc source(s) must fall within the DC power supply input voltage range.

Emergency Stop

This input is continuously monitored. An open circuit indicates an Emergency Stop. Opening this circuit removes power from all output relays.

Fuel Leak

This input is continuously monitored by the microprocessor and is used to indicate the position of the fuel leak sensor. An open circuit indicates no fuel leak.

Automatic Transfer Switch

This input is continuously monitored by the microprocessor and is used to start the engine when in the auto mode. A closed contact initiates the start sequence.

Charger Failure

This input is continuously monitored by the microprocessor and is used to indicate that ac power is available to the battery charger. An open circuit indicates a failure of the battery charger.

Low Coolant Level

This input is continuously monitored by the microprocessor. When battery (-) potential is connected to this input, a low coolant level is indicated.

Sending Unit Inputs

Coolant temperature

A current of less than two milliamperes is provided to the coolant temperature sending unit. The developed voltage is measured and scaled for use by the internal circuitry.

Oil Pressure

A current of less than 15 milliamperes is provided to the oil pressure sending unit. The developed voltage is measured and scaled for use by the internal circuitry.

Fuel level

A current of less than 15 milliamperes is provided to the fuel level sending unit. The developed voltage is measured and scaled for use by the internal circuitry.

Speed Signal Inputs

Magnetic Pickup

The voltage from the magnetic pickup is scaled and conditioned for use by the internal circuitry as a speed signal source.

Alternator Sensing

The voltage from the engine alternator stator is scaled and conditioned for use by the internal circuitry as a speed signal source.

Voltage Inputs

Monitored generator and bus voltages are sensed and scaled to levels suitable for use by the internal circuitry. Differential amplifiers provide isolation for these inputs. Internal solid state switches select line-to-line, line-to-neutral or single-phase values. Menu selections by the user determine these switch settings.

Current Inputs

Monitored generator currents are sensed and scaled to values suitable for use by the internal circuitry. Internal current transformers provide isolation. Two taps on the primary of these transformers accommodate either one or five ampere circuits.

Serial Communications Input

This serial communications link connects via optically isolated circuitry to the microprocessor. Enhanced access to device functions and real time, remote metering capabilities are available through this port. The KDGC 2000 emulates a subset of the Modicon 984 programmable controller. Katolight custom software provides easy access to these functions.

MICROPROCESSOR

Software programmed in the erasable programmable read-only memory (EPROM) controls the overall functionality of the device and makes all decisions based on programming and system inputs. Formulas that are used to determine the various calculated quantities and circuits related to microprocessor inputs are described in the follow paragraphs.

Formulas

Formulas used in calculating the various quantities are provided in the following paragraphs.

For line-to-neutral (V_{L-N}) voltage sensing: $V_{ab} = \sqrt{V_a^2 + V_a V_b + V_b^2}$

$$V_{bc} = \sqrt{V_b^2 + V_b V_c + V_c^2}$$

$$V_{ca} = \sqrt{V_c^2 + V_c V_a + V_a^2}$$

For all three-phase voltage sensing configurations:

kVA: kVA A Phase = ($V_{ab} \times I_a$) divided by (1000 times square-root of three)
kVA B Phase = ($V_{bc} \times I_b$) divided by (1000 times square-root of three)
kVA C Phase = ($V_{ca} \times I_c$) divided by (1000 times square-root of three)
Total kVA = kVA A Phase + kVA B Phase + kVA C Phase

kW: kW A Phase = kVA A Phase times Power Factor
kW B Phase = kVA B Phase times Power Factor
kW C Phase = kVA C Phase times Power Factor
Total kW = Total kVA × PF

Power Factor (PF) = Cosine of the measured angle between voltage and current zero crossings

Related Circuits

Zero Crossing Detection

The zero crossing of the A phase voltage and the B phase current is detected and used to calculate the phase angle between the current and voltage. This zero crossing is also used to measure the bus and generator frequencies.

Signal Switching

Solid state switches, under microprocessor control, select the voltage or current sensing signal that is applied to the RMS to dc converter. The resulting signal is sent to the twelve bit analog-to-digital converter where it is digitized for use by the microprocessor.

RMS To DC Converter

Scaled and conditioned signals representing the voltage and current sensing inputs are used as the input to the RMS to dc converter. This converter output is a dc level proportional to the RMS value of the input.

Analog To Digital Converter

Signals from the RMS to dc converter, coolant temperature sensing input, fuel level sensing input, and the oil pressure sensing input are digitized by the twelve-bit analog to digital converter. The digitized information is stored in random access memory (RAM). This information is used by the microprocessor for all metering and protection functions.

OUTPUTS

Each output relay is controlled by the microprocessor and the emergency stop contact input. When the emergency stop contact input is open, all output contacts open. When the emergency stop contact input is closed and a signal is given by the microprocessor, the output contacts close. All outputs are electrically isolated from each other and from the internal circuitry. Four outputs (master start, auxiliary start, run, and fuel solenoid) are associated with engine cranking functions. The remaining nine outputs (Figure 3-1) are associated with the various alarms, prealarms, and prestart.

SOFTWARE

Software embedded in the KDGC-2000 controls all aspects of device functionality. This comprises power up initialization, front panel set up and configuration, input contact status monitoring, protective function detection and annunciation, system parameter monitoring, output contact status control, and RS-232 serial communications.

When battery power is first applied, the KDGC 2000 initiates a power up sequence. The version of embedded software is displayed on the LCD and the memory is checked. Then all configuration data stored in non-volatile

EEPROM is brought into main memory. Immediately after this, the LCD display begins the Normal mode. When the Normal mode is displayed, all enabled functions are activated and input monitoring begins.

NOTE

The run time counter, kilowatt-hour meter and maintenance timers are updated in volatile memory every minute. The updated value is saved to non-volatile memory only when auto/off/run mode of operation is changed. This can be changed either from the front panel or through the communications port. Should the battery power source fail during operation these values will not be updated and the change in value incurred since the last change of mode will not be saved. This information is irretrievably lost.

Display Modes

Pressing the **Display Toggle** pushbutton when in the Normal display mode allows the user to scroll through the Normal, Alternate, and Menu display modes. Figure 3-2 shows the top level display modes.

Normal Mode

This displays the various engine and generator parameters as described by the front panel overlay. Pressing the **Phase Toggle** pushbutton after the engine is running scrolls through the voltage and current measurements that are available.

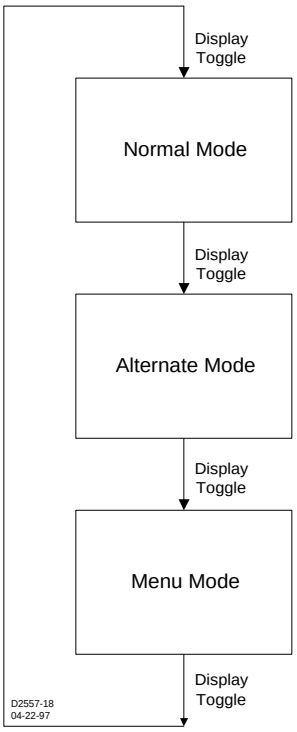

Figure 3-2. Top Level Display Modes

Menu Mode

After pressing the **Display Toggle** pushbutton twice to begin the Menu display mode (first time selects the Alternate mode), pressing **Select/Enter** begins the next level of menus. Pressing the **Raise/Scroll** or **Lower/Scroll** pushbutton (Figure 3-3) allows the user to scroll through the menu display mode screens. Pressing the **Display Toggle** pushbutton returns the display to the Normal mode.

Menu 1. Menu 1 is the alarm and prealarm menu. Pressing **Select/Enter** (Figure 3-4) from this menu begins the 1.x menu level. Pressing **Raise/Scroll** and **Lower/Scroll** from this menu scrolls through the 1.x menu level.

Menu 1.1. Menu 1.1 displays the overspeed alarm. Pressing **Select/Enter** begins the 1.1.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel. Pressing previous goes back to the 1.1.1 level.

Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.1.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.1 level. Pressing **Raise/Scroll** goes to the 1.2 menu level Pressing **Lower/Scroll** goes to the 1.13 menu level.

Menu 1.2. Menu 1.2 displays high coolant temperature alarm. Pressing **Select/Enter** begins the 1.2.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.2.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.2.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the engine crank disconnect speed is exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.2 level. Pressing **Raise/Scroll** goes to the 1.3 menu level Pressing **Lower/Scroll** goes to the 1.1 menu level.

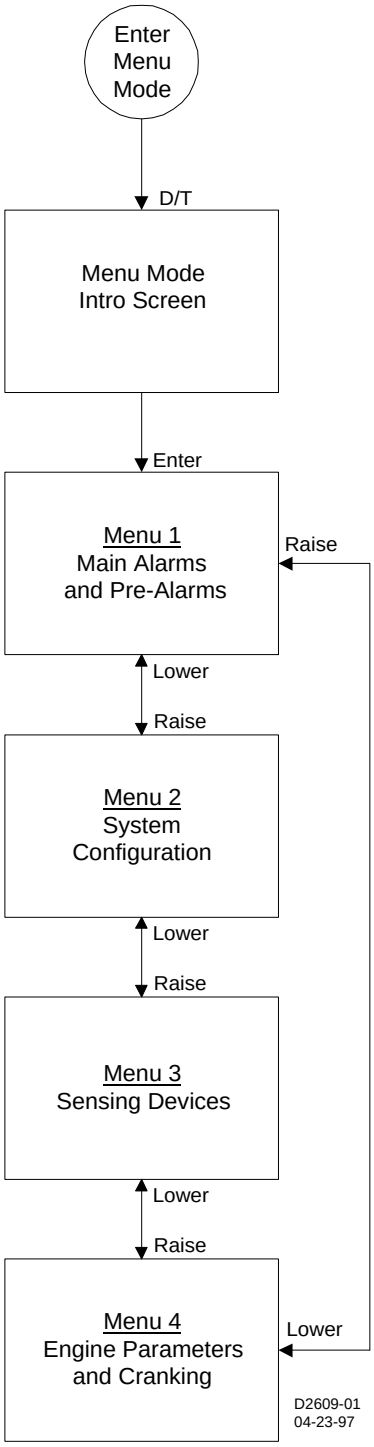

Figure 3-3. Menu Display Modes

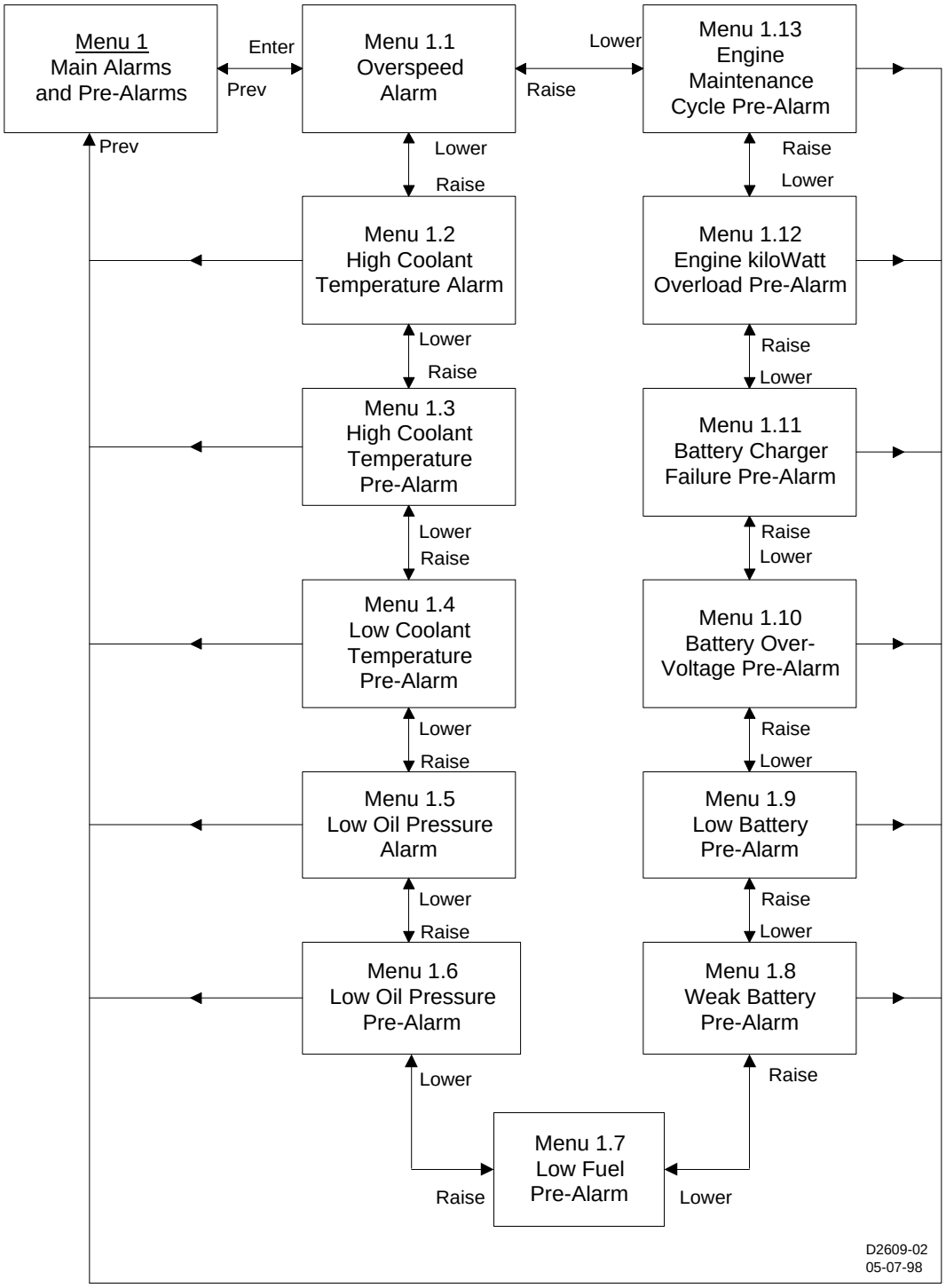

Figure 3-4. Menu 1

Menu 1.3. Menu 1.3 displays high coolant temperature prealarm. Pressing **Select/Enter** begins the 1.3.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.3.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.3.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the engine crank disconnect speed is exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.3 level. Pressing **Raise/Scroll** goes to the 1.4 menu level Pressing **Lower/Scroll** goes to the 1.2 menu level.

Menu 1.4. Menu 1.4 displays low coolant temperature prealarm. Pressing **Select/Enter** begins the 1.4.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.4.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.4.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.4 level. Pressing **Raise/Scroll** goes to the 1.5 menu level Pressing **Lower/Scroll** goes to the 1.3 menu level.

Menu 1.5. Menu 1.5 displays low oil pressure alarm. Pressing **Select/Enter** begins the 1.5.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.5.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.5.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the engine crank disconnect speed is exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.5 level. Pressing **Raise/Scroll** goes to the 1.6 menu level Pressing **Lower/Scroll** goes to the 1.4 menu level.

Menu 1.6. Menu 1.6 displays low oil pressure prealarm. Pressing **Select/Enter** begins the 1.6.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.6.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.6.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the engine crank disconnect speed is exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.6 level. Pressing **Raise/Scroll** goes to the 1.7 menu level Pressing **Lower/Scroll** goes to the 1.5 menu level.

Menu 1.7. Menu 1.7 displays low fuel level prealarm. Pressing **Select/Enter** begins the 1.7.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is adjustable from the front panel.

Pressing **Previous** goes back to the 1.7.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.7.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected, press **Select/Enter** to save the new settings.

Pressing **Previous** twice goes back to the 1.7 level. Pressing **Raise/Scroll** goes to the 1.8 menu level Pressing **Lower/Scroll** goes to the 1.6 menu level.

Menu 1.8. Menu 1.8 displays weak battery prealarm. Pressing **Select/Enter** begins the 1.8.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.8.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.8.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.8 level. Pressing **Raise/Scroll** goes to the 1.9 menu level Pressing **Lower/Scroll** goes to the 1.7 menu level.

Menu 1.9. Menu 1.9 displays low battery prealarm. Pressing **Select/Enter** begins the 1.9.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.9.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.9.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.9 level. Pressing **Raise/Scroll** goes to the 1.10 menu level Pressing **Lower/Scroll** goes to the 1.8 menu level.

Menu 1.10. Menu 1.10 displays battery over voltage prealarm. Pressing **Select/Enter** begins the 1.10.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.10.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.10.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.10 level. Pressing **Raise/Scroll** goes to the 1.11 menu level Pressing **Lower/Scroll** goes to the 1.9 menu level.

Menu 1.11. Menu 1.11 displays battery charger failure prealarm. Pressing **Select/Enter** begins the 1.11.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.11.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.11.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.11 level. Pressing **Raise/Scroll** goes to the 1.12 menu level Pressing **Lower/Scroll** goes to the 1.10 menu level.

Menu 1.12. Menu 1.12 displays kilowatt overload prealarm. Pressing **Select/Enter** begins the 1.12.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.12.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.12.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.12 level. Pressing **Raise/Scroll** goes to the 1.13 menu level Pressing **Lower/Scroll** goes to the 1.11 menu level.

Menu 1.13. Menu 1.13 display engine maintenance prealarm. Pressing **Select/Enter** begins the 1.13.1 level of menus and displays the function activation level. Pressing **Select/Enter** displays the setting. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 1.13.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** begins the 1.13.2 function activation delay level of menus. Pressing **Select/Enter** displays the activation delay time once the level has been exceeded. This is not adjustable from the front panel.

Pressing **Previous** twice goes back to the 1.13 level. Pressing **Raise/Scroll** goes to the 1.1 menu level. Pressing **Lower/Scroll** goes to the 1.12 menu level.

Pressing **Previous** from any 1.x level menu goes to menu 1. Pressing **Raise/Scroll** goes to menu 2. Pressing **Lower/Scroll** goes to menu 4.

Menu 2. Menu 2 system configuration. Pressing **Select/Enter** from this menu (Figure 3-5) begins the 2.x level of menus. Pressing **Raise/Scroll** and **Lower/Scroll** from this menu scrolls through the 1.x levels of menus.

Menu 2.1. Menu 2.1 displays generator voltage sensing connection. Pressing **Select/Enter** begins the 2.1.1 level and displays the sensing configuration. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 2.1 level. Pressing **Raise/Scroll** goes to menu 2.3. Pressing **Lower/Scroll** goes to the 2.1 menu.

Menu 2.2. Menu 2.2 displays options. Pressing **Select/Enter** (Figure 3-6) begins the 2.2.1 level and displays the speed signal source selection. This is not adjustable from the front panel.

Pressing **Previous** goes back to the 2.2.1 level. Pressing **Raise/Scroll** or **Lower/Scroll** goes to menu 2.2.2 and displays metric conversion.

Pressing **Select/Enter** displays the status of this feature. To change to the metric display press **Raise/Scroll** and enter the user keycode followed by the **Select/Enter** key. Press **Raise/Scroll** and then **Select/Enter**. The display will indicate that the new setting has been saved. Press previous twice to go to menu 2.2. Press **Raise/Scroll** to go to menu 2.3. Press **Lower/Scroll** to go to menu 2.1.

Menu 2.3. Menu 2.3 changes user key code. Press **Select/Enter** and then the user keycode followed by **Select/Enter** twice. Press the key sequence for the new key code followed by **Select/Enter** twice. The user will be asked to re-enter the new key code. After entering the new key code followed by **Select/Enter** twice, the display will indicate the new code has been saved.

Pressing **Raise/Scroll** will go to menu 2.4. Pressing **Lower/Scroll** will go menu 2.2.

Menu 2.4. Menu 2.4 prealarm audible alarm enable. Pressing **Select/Enter** will display the status of the prealarm audible alarm. This feature is not adjustable from the front panel. Pressing **Previous** will go to menu 2.4.

Pressing **Raise/Scroll** will go to menu 2.1. Pressing **Lower/Scroll** will go to menu 2.3.

Pressing **Previous** from any 2.x menu will go to menu 2. Pressing **Raise/Scroll** goes to menu 3. Pressing **Lower/Scroll** goes to menu 1.

Menu 3. Menu 3 sensing devices. Pressing **Select/Enter** (Figure 3-7) begins the 3.1 level of menus

Menu 3.1. Menu 3.1 transformer ratios menu. Menu 3.1.1 (Figure 3-8) displays generator potential transformer primary voltage rating. Pressing **Select/Enter** displays the value. This is not adjustable from the front panel. Pressing **Previous** twice goes to menu 3.1. Pressing **Raise/Scroll** goes to menu 3.1.2. Pressing **Lower/Scroll** goes to menu 3.1.5.

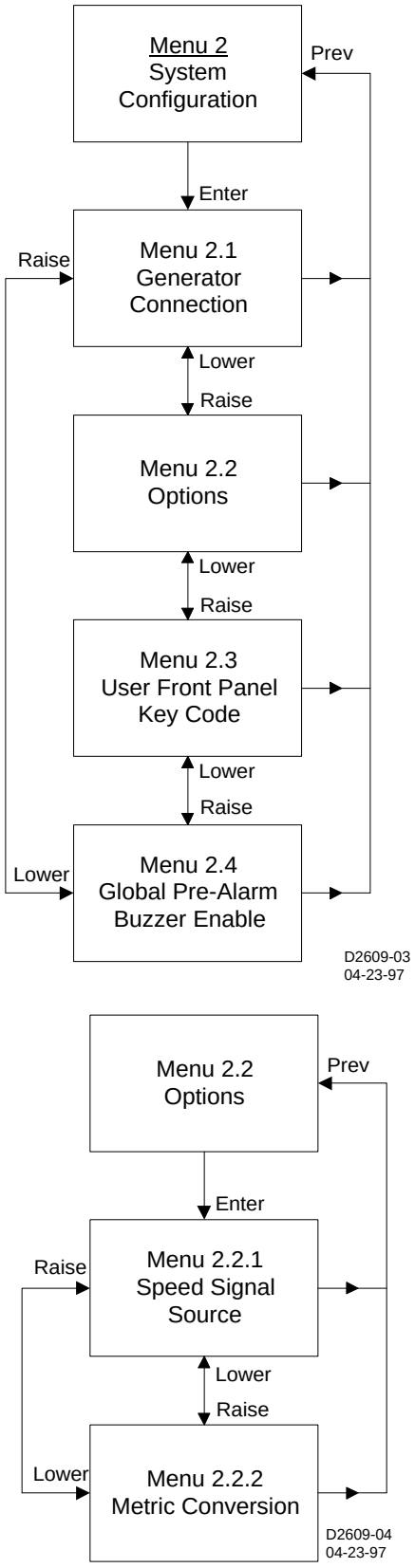

Figure 3-6. Menu 2.2

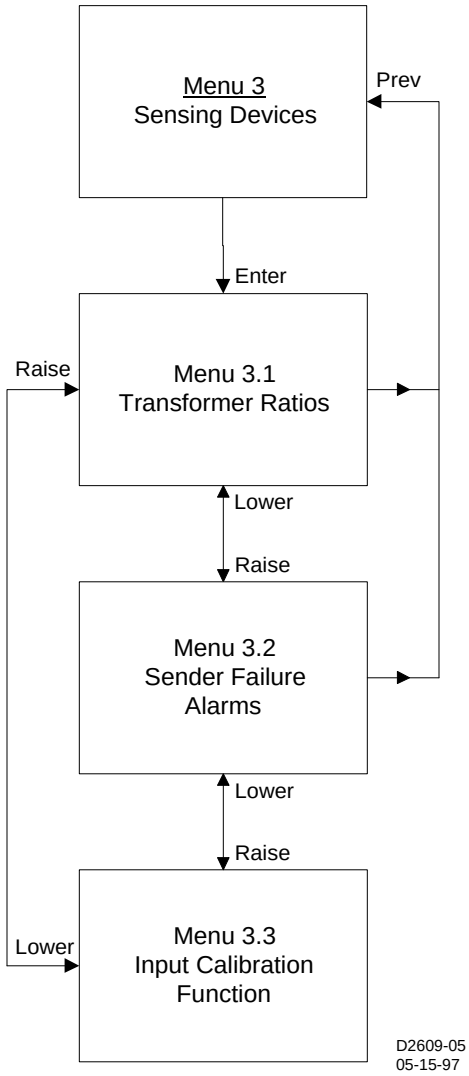

Figure 3-7. Menu 3

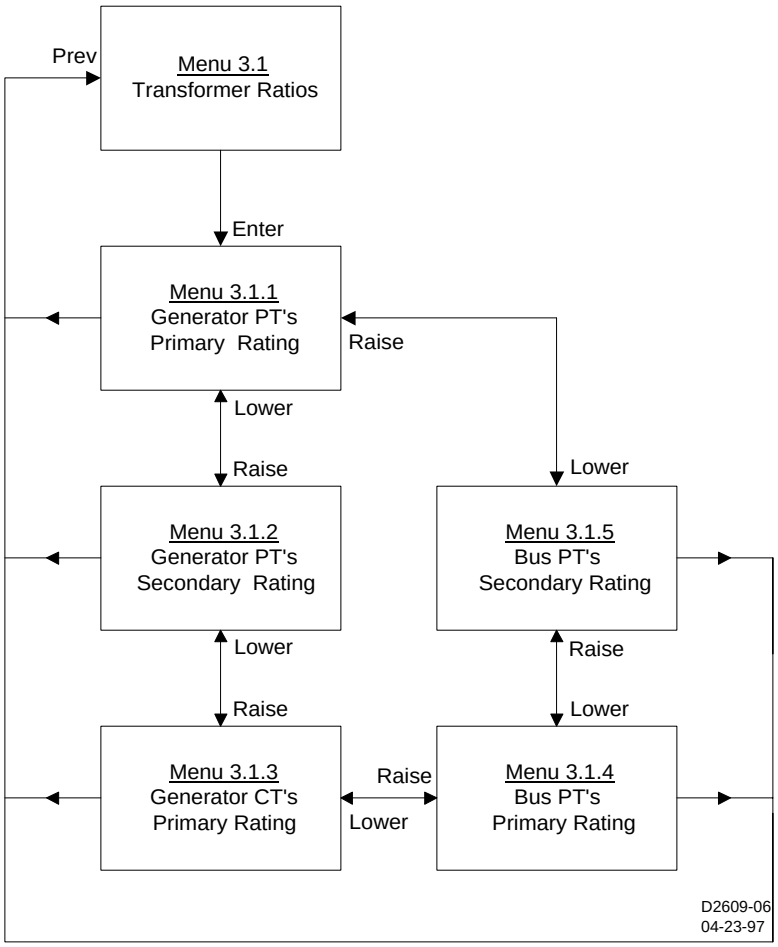

Figure 3-8. Menu 3.1

Menu 3.1.2. Menu 3.1.2 displays the generator potential transformer secondary voltage rating. Pressing **Select/Enter** displays the value. This is not adjustable from the front panel. Pressing previous goes to menu 3.1. Pressing **Raise/Scroll** goes to menu 3.1.3 Pressing **Lower/Scroll** goes to menu 3.1.1.

Menu 3.1.3. Menu 3.1.3 displays the generator current transformer primary current rating. Pressing **Select/Enter** displays the value. This is not adjustable from the front panel. Pressing previous goes to menu 3.1. Pressing **Raise/Scroll** goes to menu 3.1.4. Pressing **Lower/Scroll** goes to menu 3.1.2.

Menu 3.1.4. Menu 3.1.4 displays the bus potential transformer primary voltage rating. Pressing **Select/Enter** displays the value. This is not adjustable from the front panel. Pressing previous goes to menu 3.1. Pressing **Raise/Scroll** goes to menu 3.1.5. Pressing **Lower/Scroll** goes to menu 3.1.3.

Menu 3.1.5. Menu 3.1.5 displays the bus potential transformer secondary voltage rating. Pressing **Select/Enter** displays the value. This is not adjustable from the front panel. Pressing previous goes to menu 3.1. Pressing **Raise/Scroll** goes to menu 3.1.1. Pressing **Lower/Scroll** goes to menu 3.1.4.

Pressing **Raise/Scroll** from menu 3.1 goes to menu 3.2.

Menu 3.2. Menu 3.2 sender failure alarm menu. Pressing **Select/Enter** (Figure 3-9) begins menu 3.2.1

Menu 3.2.1. Menu 3.2.1 displays coolant temperature sensor failure alarm. Pressing **Select/Enter** displays the status of this alarm. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.2.1.

Pressing **Raise/Scroll** goes to menu 3.2.2. Pressing **Lower/Scroll** goes to menu 3.2.5.

Menu 3.2.2. Menu 3.2.2 displays oil pressure sensor failure alarm. Pressing **Select/Enter** displays the status of this alarm. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.2.2.

Pressing **Raise/Scroll** goes to menu 3.2.3. Pressing **Lower/Scroll** goes to menu 3.2.1

Menu 3.2.3. Menu 3.2.3 displays speed signal failure alarm. Pressing **Select/Enter** displays the status of this alarm. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.2.3.

Pressing **Raise/Scroll** goes to menu 3.2.4. Pressing **Lower/Scroll** goes to menu 3.2.2.

Menu 3.2.4. Menu 3.2.4 displays voltage sensing failure alarm. Pressing **Select/Enter** displays the status of this alarm. This is not adjustable from the front panel. Pressing **Previous** goes to menu 3.2.4.

Pressing **Raise/Scroll** goes to menu 3.2.5. Pressing **Lower/Scroll** goes to menu 3.2.3.

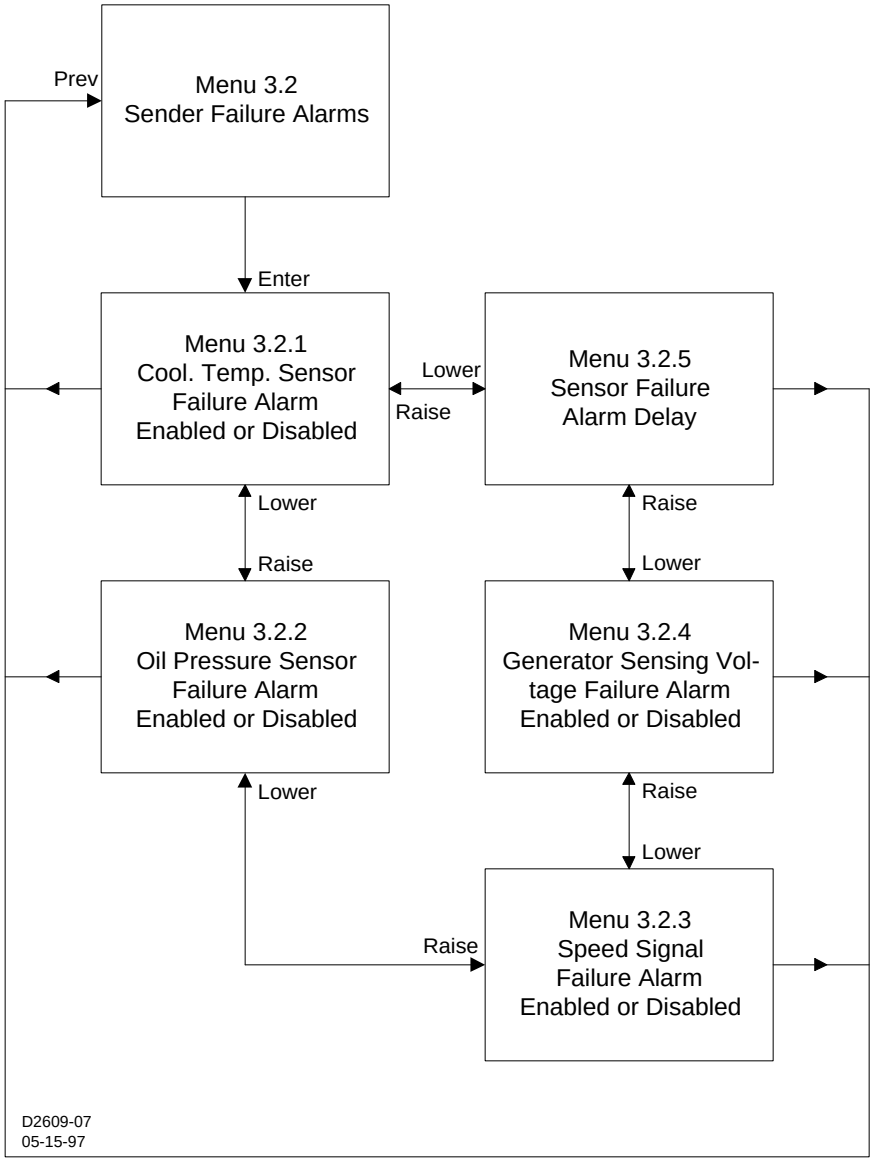

Figure 3-9. Menu 3.2

Menu 3.2.5. Menu 3.2.5 displays sensor failure alarm time delay. Pressing **Select/Enter** displays the delay time. After pressing **Raise/Scroll** or **Lower/Scroll** the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected, press **Select/Enter** to save the new setting. Pressing **Previous** goes to menu 3.2. Pressing **Raise/Scroll** goes to menu 3.2.1. Pressing **Lower/Scroll** goes to menu 3.2.4.

Pressing **Raise/Scroll** from menu 3.2 goes to menu 3.3. Pressing **Lower/Scroll** from menu 3.2 goes to menu 3.1.

Menu 3.3. Menu 3.3 displays the input calibration function. This function is for factory use only.

Pressing **Previous** goes to menu 3. Pressing **Raise/Scroll** from menu 3 goes to menu 4. Pressing **Lower/Scroll** goes to menu 2.

Menu 4. Menu 4 (Figure 3-10) displays engine parameters and cranking. Pressing **Select/Enter** from menu 4 begins menu 4.1.

Menu 4.1. Menu 4.1 displays cool down time. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected, press **Select/Enter** to save the new setting. Pressing **Previous** goes to menu 4.1. Pressing **Raise/Scroll** goes to menu 4.2. Pressing **Lower/Scroll** goes to menu 4.7.

Menu 4.2. Menu 4.2 displays cranking mode. Pressing **Select/Enter** displays the cranking mode selected. This is not adjustable from the front panel. Pressing **Previous** goes to menu 4.2. Pressing **Raise/Scroll** goes to menu 4.3. Pressing **Lower/Scroll** goes to menu 4.1.

Menu 4.3. Menu 4.3 displays the number of crank cycles. Pressing **Select/Enter** displays the number of crank cycles selected. This is not adjustable from the front panel. Pressing **Previous** goes to menu 4.3. Pressing **Raise/Scroll** goes to menu 4.4. Pressing **Lower/Scroll** goes to menu 4.2.

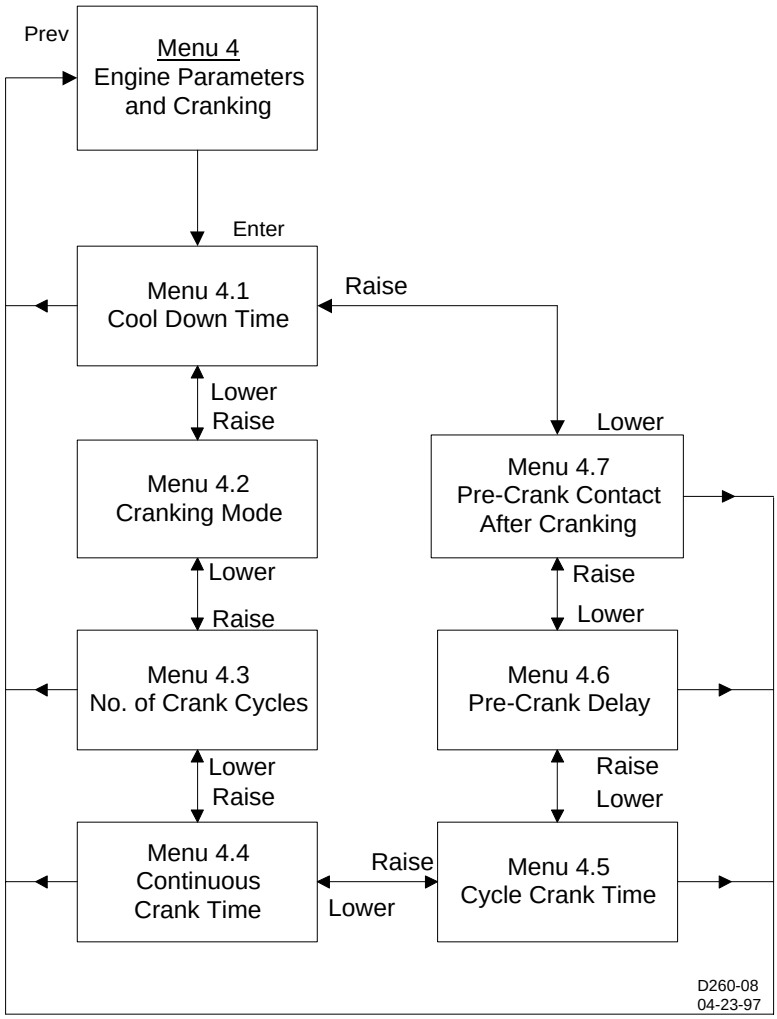

Figure 3-10. Menu 4

Menu 4.4. Menu 4.4 displays continuous crank time. Pressing **Select/Enter** displays the continuous crank time selected. This is not adjustable from the front panel. Pressing **Previous** goes to menu 4.4. Pressing **Raise/Scroll** goes to menu 4.5. Pressing **Lower/Scroll** goes to menu 4.3.

Menu 4.5. Menu 4.5 displays cycle crank time. Pressing **Select/Enter** displays the cycle crank time selected. This is not adjustable from the front panel. Pressing **Previous** goes to menu 4.5. Pressing **Raise/Scroll** goes to menu 4.6. Pressing **Lower/Scroll** goes to menu 4.4.

Menu 4.6. Menu 4.6 displays precrank delay time. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the desired setting has been selected press **Select/Enter** to save the new setting. Pressing **Previous** goes to menu 4.6. Pressing **Raise/Scroll** goes to menu 4.7. Pressing **Lower/Scroll** goes to menu 4.5.

Menu 4.7. Menu 4.7 displays the status of the Precrank contact after cranking. After pressing **Raise/Scroll** or **Lower/Scroll**, the user will be instructed to enter the user key code. After entering the user key code followed by pressing **Select/Enter** twice, the setting will be adjustable with the **Raise/Scroll** and **Lower/Scroll** keys. After the

desired setting has been selected, press **Select/Enter** to save the new setting. Pressing **Previous** goes to menu 4.7. Pressing **Raise/Scroll** goes to menu 4.1. Pressing **Lower/Scroll** goes to menu 4.6.

Pressing **Previous** twice goes to the normal display mode.

Exiting Menu Mode

You may exit Menu mode (from any menu level) by pressing the **Display Toggle** pushbutton. If the **Display Toggle** pushbutton is pressed before a parameter setpoint change has been saved, then the old setpoint value is preserved.

NOTE
Using DISPLAY TOGGLE to exit Menu mode will save the user's place within the menu system so that the next time Menu mode is entered, the display will return to the same screen.

As an alternative, pressing **Previous** allows the user to back out of the menu mode one level at a time so that the next time menu mode is entered, the display will start at the top of the menu structure.

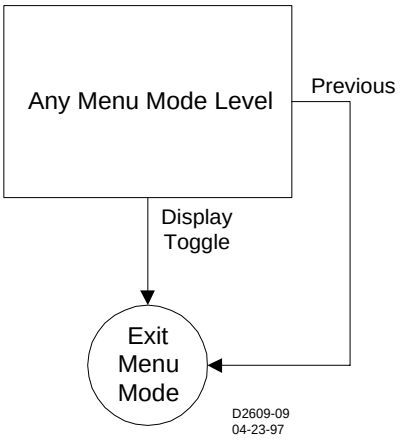

Figure 3-11. Exiting Menu Mode

Modifying Setpoints

To modify an existing setpoint, press the **Select/Enter** pushbutton (Figure 3-12). Press **Raise/Scroll** or **Lower/Scroll** buttons to raise or lower the current parameter setpoint. Press the **Select/Enter** pushbutton to save the modified setpoint value, or press the **Previous** pushbutton to exit the parameter setting screen without changing the value.

Once in the menu mode, the first time an attempt is made to change a setting that is front panel adjustable, the user will be prompted to enter the keycode. Upon successful entry of the keycode, the user may modify any of the adjustable settings without re-entering the keycode during the current menu mode session. The only exception to this is changing the keycode itself. Changing the keycode always requires entry of the existing keycode. Also, whether the keycode is actually changed or not, any further changes to other settings after that will require the keycode to be entered once again. Leaving the Menu mode after an editing session automatically terminates the editing privilege.

Press the **Display Toggle** pushbutton to exit the menu mode.

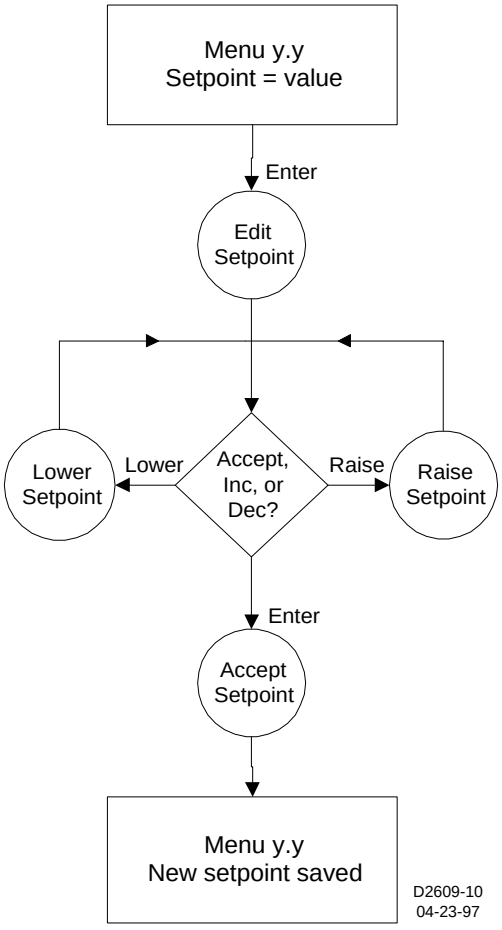

Figure 3-12. Modifying Setpoints

Alternate Display Mode

After pressing the **Display/Toggle** pushbutton to enter the alternate display mode, pressing the **Raise/Scroll** or **Lower/Scroll** pushbutton allows the user to scroll through the alternate display mode screens.

The quantities are displayed in the following order.

- OIL PRESSURE
- COOLANT TEMPERATURE
- FUEL LEVEL
- BATTERY VOLTAGE
- TOTAL KILOWATT LOAD
- HOURS TO NEXT SERVICE
- GENERATOR A-B VOLTAGE
- GENERATOR B-C VOLTAGE (3-PHASE SENSING ONLY)
- GENERATOR C-A VOLTAGE (3-PHASE SENSING ONLY)
- GENERATOR A-N VOLTAGE (3-PHASE L-N SENSING)
- GENERATOR B-N VOLTAGE (3-PHASE L-N SENSING)
- GENERATOR C-N VOLTAGE (3-PHASE L-N SENSING)
- BUS VOLTAGE
- GENERATOR PHASE A CURRENT (3-PHASE SENSING ONLY)
- GENERATOR PHASE B CURRENT (3-PHASE SENSING ONLY)
- GENERATOR PHASE C CURRENT (3-PHASE SENSING ONLY)
- PHASE A kVA (3-PHASE SENSING ONLY)
- PHASE B kVA (3-PHASE SENSING ONLY)
- PHASE C kVA (3-PHASE SENSING ONLY)
- TOTAL kVA
- GENERATOR PHASE A KILOWATTS (3-PHASE SENSING ONLY)
- GENERATOR PHASE B KILOWATTS (3-PHASE SENSING ONLY)
- GENERATOR PHASE C KILOWATTS (3-PHASE SENSING ONLY)
- GENERATOR TOTAL KILOWATT-HOURS
- GENERATOR POWER FACTOR
- GENERATOR FREQUENCY
- BUS FREQUENCY
- TOTAL RUN HOURS
- FUEL LEAK STATUS
- ENGINE SPEED

FACTORY KEY CODE SETTING

Factory preprogrammed key code setting.

1. Raise/Scroll
2. Lower/Scroll
3. Select/Enter
4. Previous
5. Display Toggle
6. Enter
7. Enter

ALLOWABLE KEY CODE PUSHBUTTONS

User key codes are one to eight presses of any of the following acceptable pushbuttons in any order, except **Previous** twice consecutively. When used, the key code must be followed by two presses of the Select/Enter pushbutton.

- Raise/Scroll
- Lower/Scroll
- Select/Enter
- Previous
- Display/Toggle
- Phase Toggle
- Alarm Silence
- Lamp Test

PARAMETERS AND DEFAULT SETTINGS

Front Panel Adjustable Parameters

All settings are viewable at the front panel. The following settings are adjustable at the front panel.

- Sensor failure alarm time delay — From 1 to 10 seconds in 1 second increments
- Metric conversion function — ON or OFF
- Low fuel prealarm level — 10 to 100%
- Precrank contact after cranking — OPEN or CLOSED
- Cool down time — From 0 to 60 minutes in 5 minute increments
- Precrank time delay — From 0 to 30 seconds in 1 second increments

All Parameters

Specific parameters (settings) are not adjustable at either the front panel or through computer communications. These settings are identified in the following list as (not adjustable). All other parameters may be set through computer communications. Only those settings identified in the previous paragraph are adjustable at the front panel. The following list provides the parameters and the default setting.

Metric Conversion (ON, OFF) default is OFF
Generator Connection (3-phase$_{L-L}$ or 3-phase$_{L-N}$, 1-phase$_{A-B}$) default is 3-phase$_{L-N}$
Gen. PT Primary (1 - 15000 V) default is 480 V
Gen. PT Secondary (1 - 480 V) default is 480 V
Gen. CT Primary (1 - 5000 A) default is 500 A
Bus. PT Primary (1 - 15000 V) default is 480 V
Bus. PT Secondary (1 - 480 V) default is 480 V
Cooldown time (0 - 60 minutes) default is 0 minutes
Generator Speed Signal Sources = MPU/Alt/Gen
Overspeed Alarm:
    Threshold (105 - 140%) default is 110%
    Activation Delay (10 - 500 milliseconds) default is 50 milliseconds
High Coolant Temperature Alarm:
    Threshold (100 - 280ºF) default is 275ºF
    Arming Delay (not adjustable) is 60 seconds
High Coolant Temperature Prealarm is OFF:
    Threshold (100 - 280ºF) default is 250ºF
    Arming Delay default is 60 seconds
Low Oil Pressure Alarm:
    Threshold (3 - 100 PSI) default is 15 PSI
    Arming Delay (5 - 15 seconds) default is 10 seconds

Low Oil Pressure Prealarm:
Threshold (3 - 100 PSI) default is 25 PSI
Arming Delay (5 - 15 seconds) default is 10 seconds
Low Coolant Temperature Prealarm is OFF:
Threshold (40 - 100 F) default is 50 F
Arming Delay (0 - 15 seconds) default is 0 seconds
Low Fuel Level Prealarm is OFF:
Threshold (10 - 100 %) default is 25 %
Activation Delay (not adjustable) is 0 seconds
Weak Battery PreAlarm is OFF:
Threshold (4 - 8/8 - 16 V) default is 7.2/15.0 V (for 12/24 V systems)
Activation Delay (1 - 10 seconds) default is 2 seconds
Low Battery Prealarm is OFF:
Threshold (6 - 12/12 - 24 V) default is 9.0/20.0 V (for 12/24 V systems)
Activation Delay (1 - 10 seconds) default is 10 seconds
Battery Overvoltage Prealarm is OFF:
Threshold (14 - 16/24-32 V) default is 15.0/30.0 V (for 12/24 V systems)
Activation Delay (not adjustable) is 0 seconds
Battery Charger Failure Prealarm is OFF:
Activation Delay (not adjustable) is 0 seconds
Global Sender Failure Alarm Delay (1 - 10 seconds) default is 10 seconds:
(This covers the oil pressure sender, generator sensing voltage, and speed signal sources)
Speed Signal Failure Alarm (ON, OFF) default is OFF.
Oil Pressure Sender Failure Alarm (ON, OFF) default is OFF.
Generator Sensing Voltage Failure Alarm (ON, OFF) default is OFF.
Coolant Temperature Sender Failure Alarm (ON, OFF) default is OFF.
Arming Delay (5 - 30 minutes) default is 5 minutes
(Global) Prealarm Buzzer default is ON.
Maintenance Interval Prealarm:
Threshold (0 - 5000 hours) default is 500 hours
Activation Delay (not adjustable) is 0 hours
Engine KW Overload Prealarm is OFF:
Threshold (95 - 140%) default is 105%
Activation Delay (not adjustable) is 0 seconds
Cranking style (CONTINUOUS/CYCLE) is CYCLE
crank cycles (1 - 7 cycles) default is 2 cycles
Cycle crank time (5 - 15 seconds) default is 5 seconds
Continuous crank time (1 - 60 seconds) default is 10 seconds
Precrank delay (0 - 30 seconds) default is 0 seconds
Prestart contact after crank disconnect is OFF (OPEN)

SECTION 4 • INSTALLATION

GENERAL

KDGC-2000 Digital Generator Controllers are delivered in sturdy cartons to prevent shipping damages.If the controller is not installed immediately, store it in the original shipping package in a moisture and dust free environment.

HARDWARE

KDGC-2000 Controllers are packaged in aluminum cases for improved electromagnetic compatibility and are suitable for mounting in any top mount enclosure. The metal case is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants. It also inhibits insect and rodent entrance. KDGC-2000 Controllers are mounted using the permanently attached 10-32 by 5/8 inch (1/2 inch usable) studs.

MOUNTING

Case cutout dimensions are shown in Figure 4-1. Overall dimensions are shown in Figures 4-2 and 4-3.

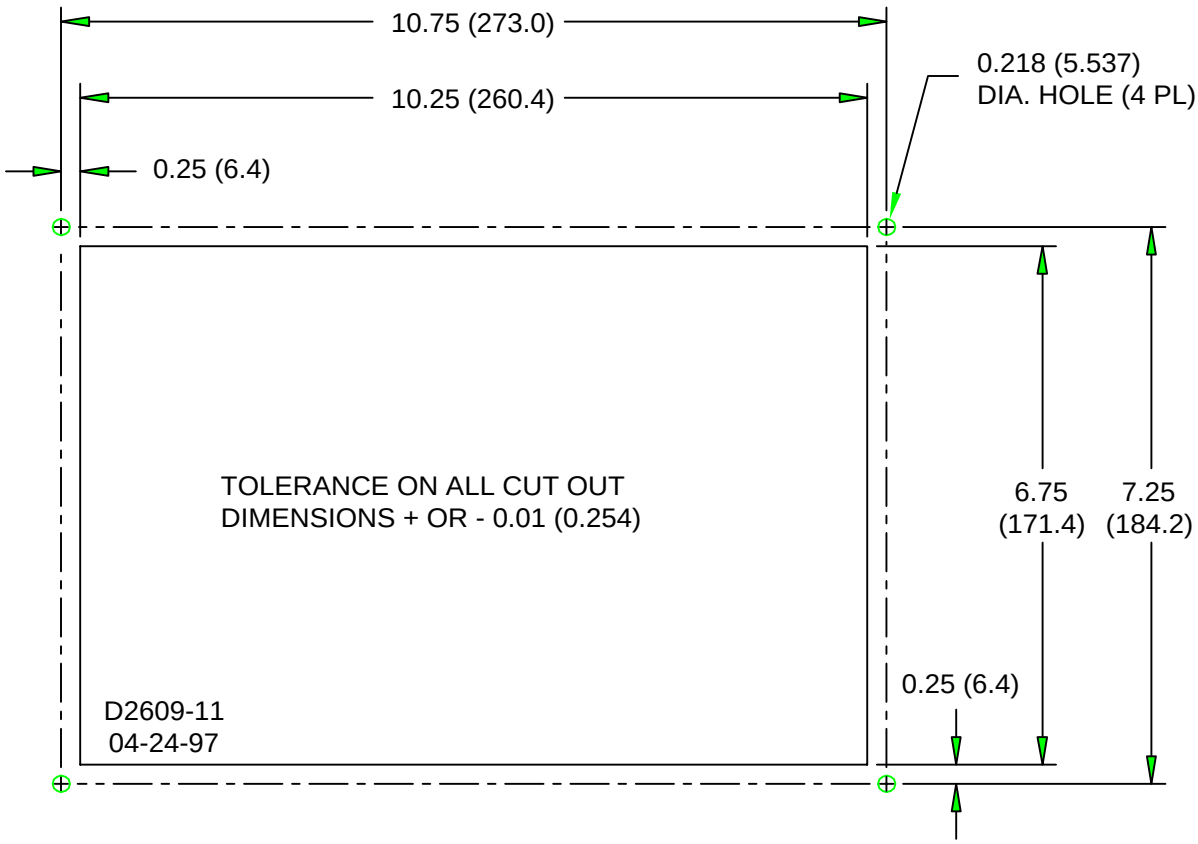

Figure 4-1. Cutout Dimensions In Inches (Millimeters)

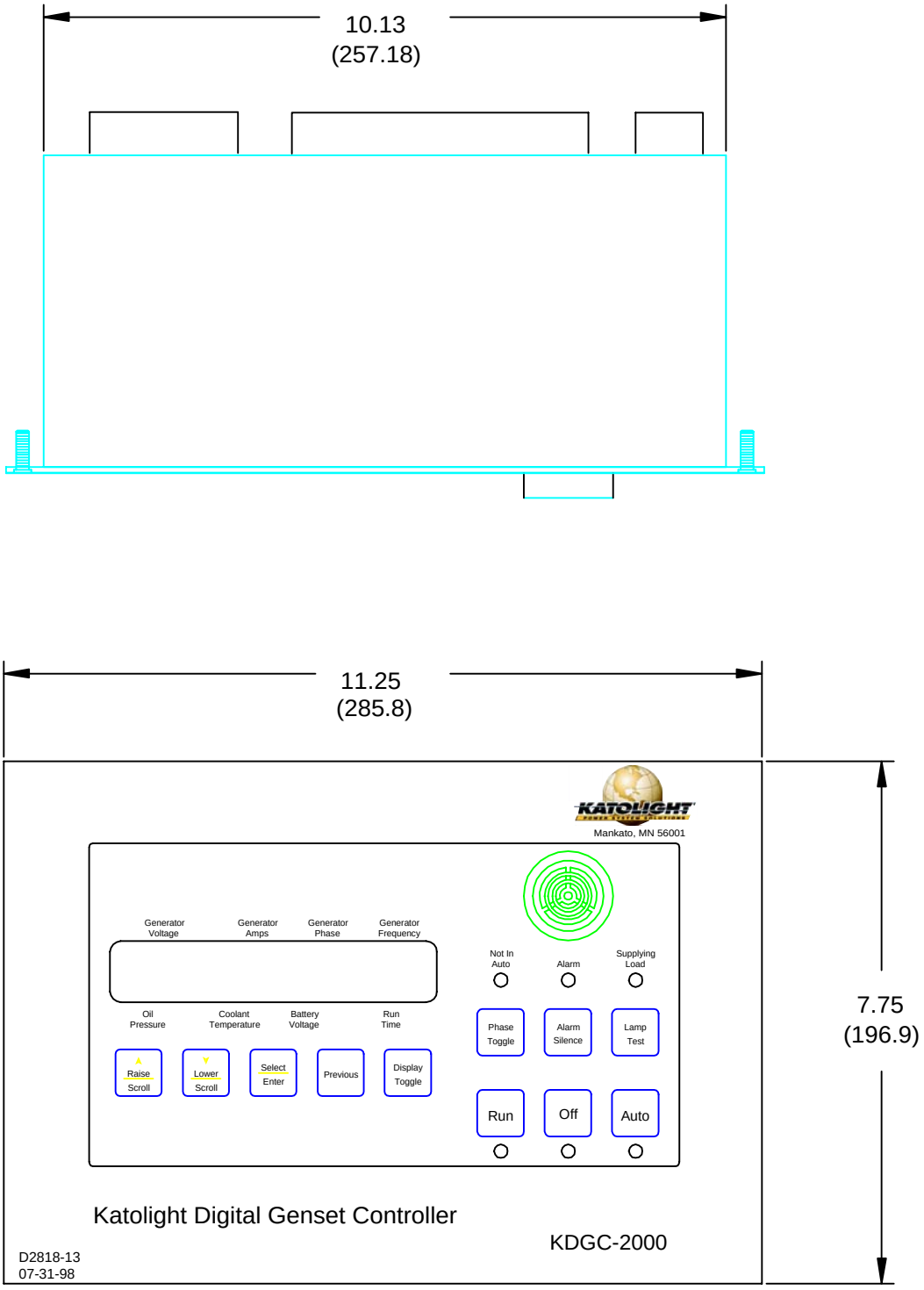

Figure 4-2. KDGC-2000 Overall Dimensions In Inches (Millimeters)

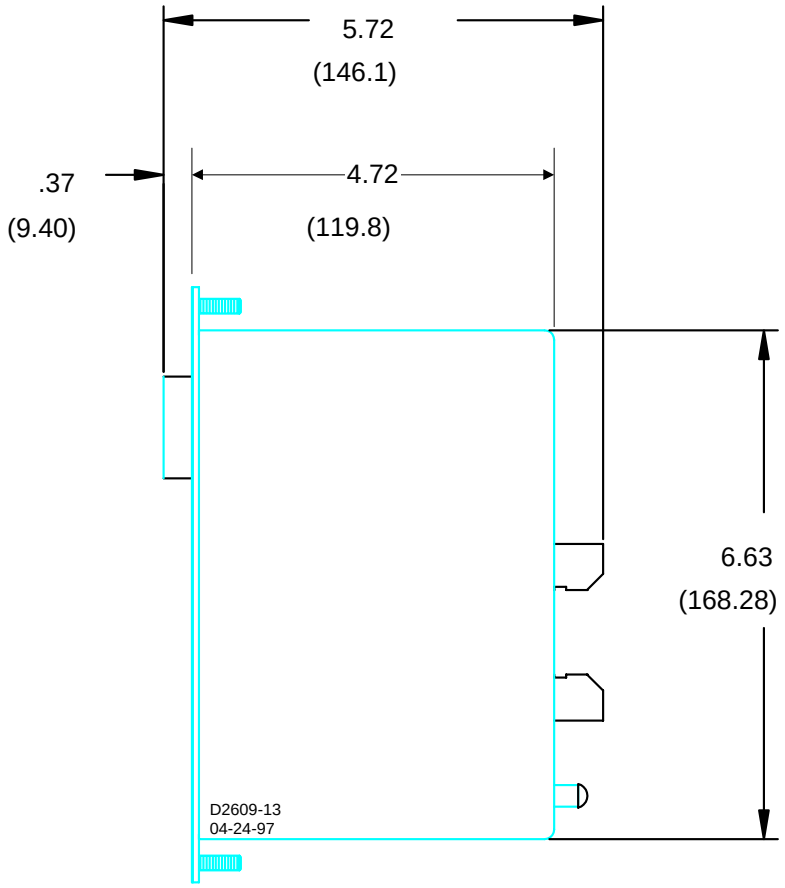

Figure 4-3. KDGC-2000 Overall Dimensions In Inches (Millimeters)

CONNECTIONS

Incorrect wiring may result in damage to the controller.

CAUTION

Be sure the controller battery input polarity is wired correctly. Reverse polarity battery power will damage the controller.

NOTE

Be sure the controller is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the controller case

Except as noted above, connections should be made with minimum wire size of 14 AWG. Be sure to use the correct input power for the power supply. Figure 4-4 is a typical ac connection diagram for direct connected single-phase sensing system. Figure 4-5 is a typical ac connection diagram for direct connected three-phase line to line sensing system. Figure 4-6 is a typical ac connection diagram for direct connected three-phase line to neutral sensing system.

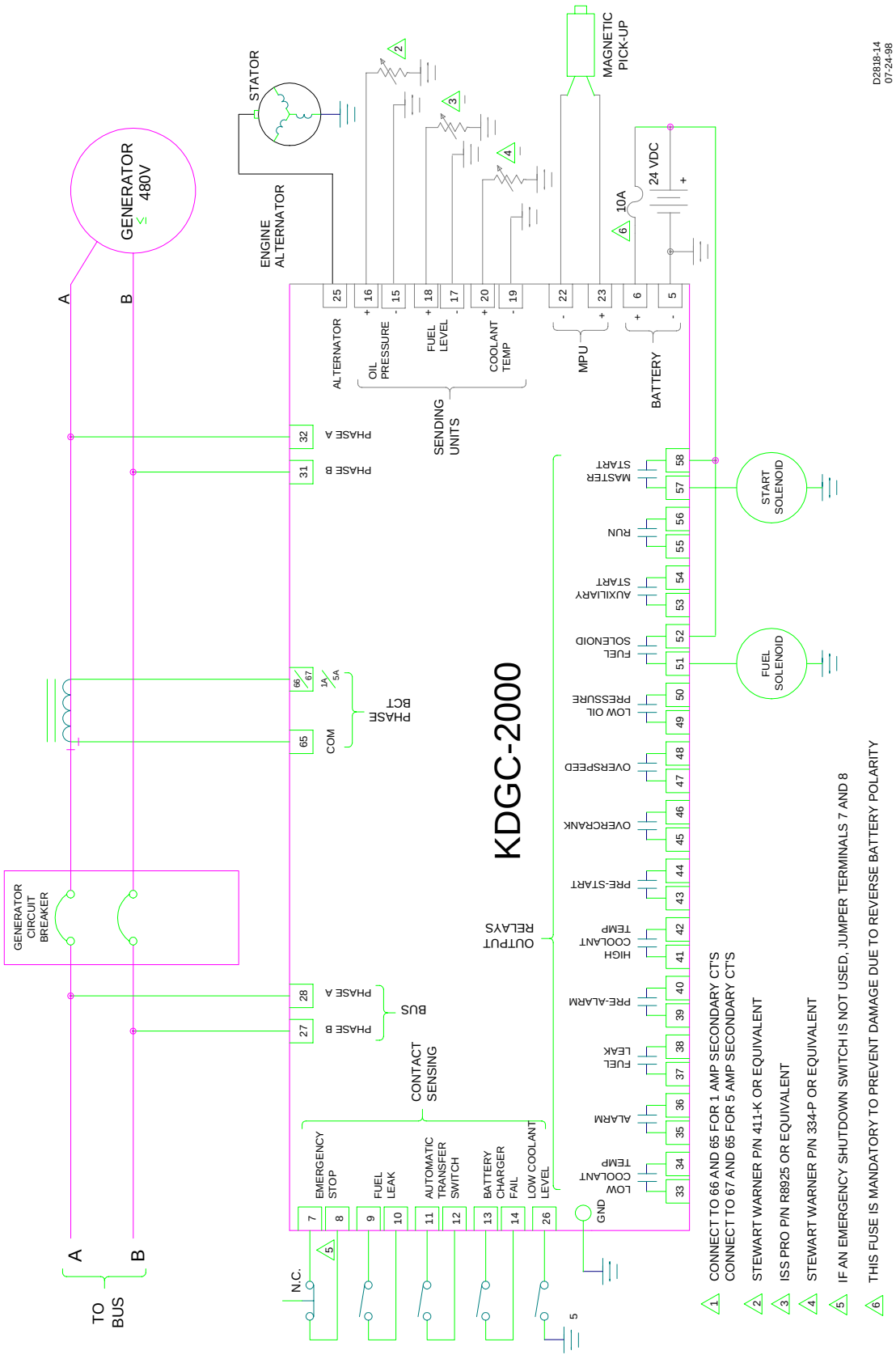

Figure 4-4. KDGC-2000 Direct Connected Single-Phase Sensing

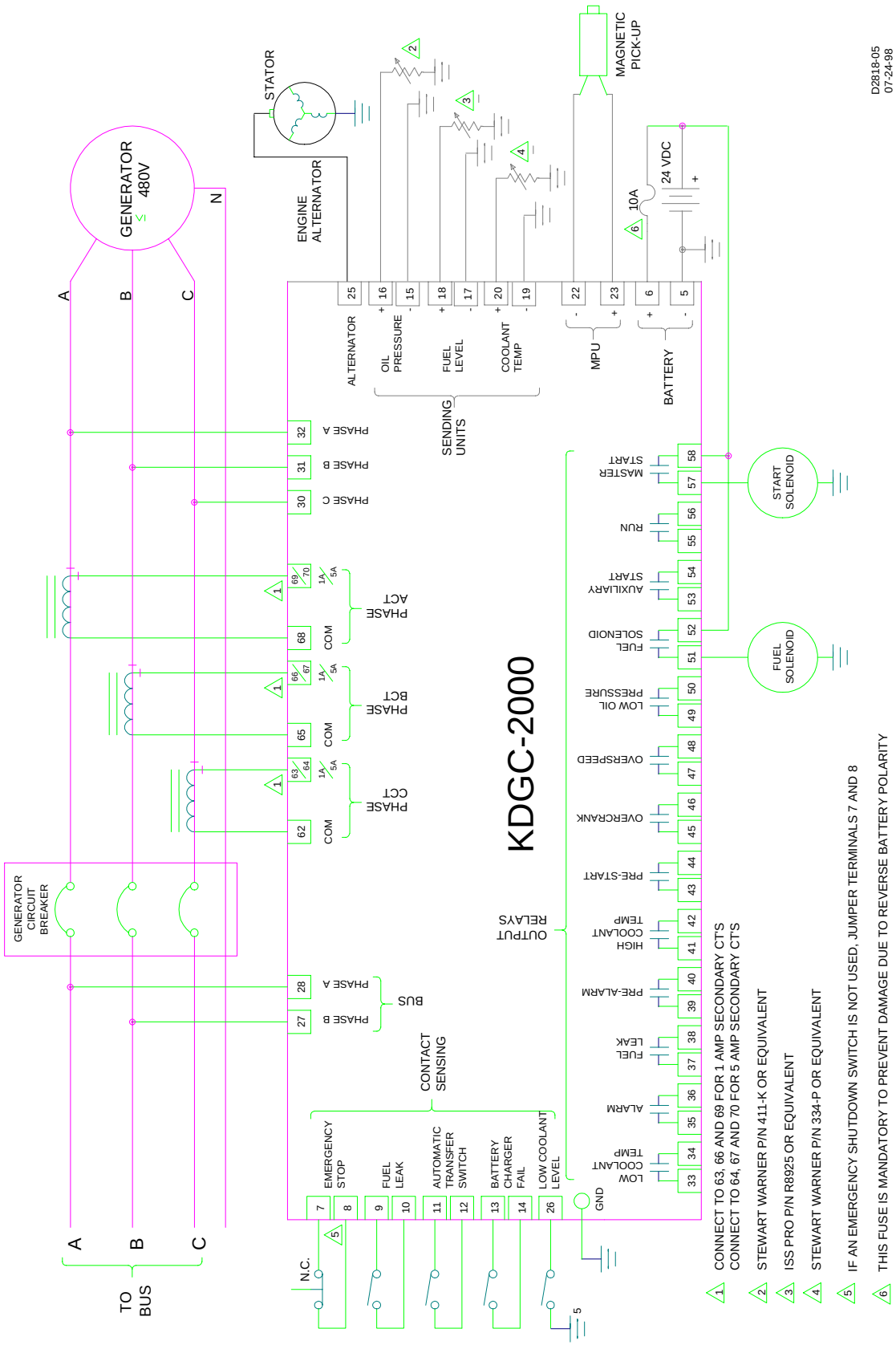

Figure 4-5. KDGC-2000 Direct Connected Three-Phase Line To Line Sensing

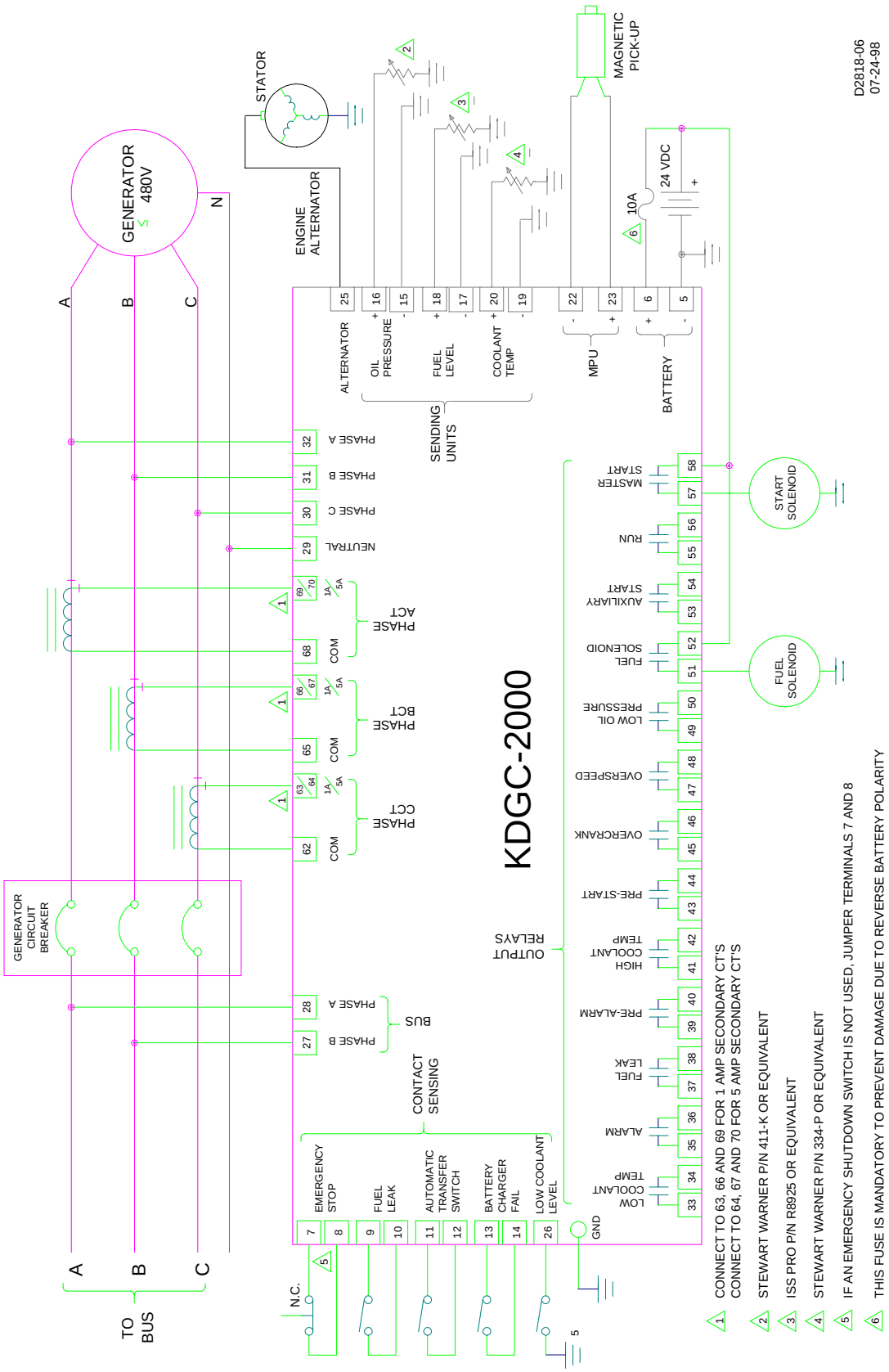

Figure 4-6. KDGC-2000 Direct Connected Three-Phase Line To Neutral Sensing

RS-232 Connector

The RS-232 connector is a DB-9 female connector. Connector pin numbers, functions, names, and signal directions are shown in Table 4-1. Figure 4-7 provides the RS-232 cable connection diagram.

Table 4-1. RS-232 Pinouts

Pin	Function	Name	Direction
1	N/C	----	N/A
2	Transmit Data	(TXD)	From KDGC-2000
3	Receive Data	(RXD)	Into KDGC-2000
4	N/C	----	N/A
5	Signal Ground	(GND)	N/A
6	N/C	----	N/A
7	N/C	----	N/A
8	N/C	----	N/A
9	N/C	----	N/A

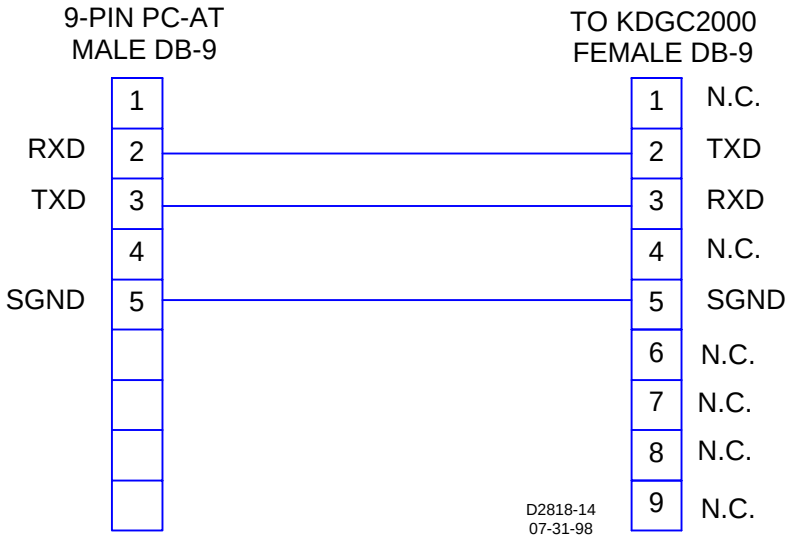

Figure 4-7. Personal Computer To KDGC-2000

Communication Settings

Communication settings are the formal set of conventions controlling the format and relative timing of message exchange between two communications terminals.

Default settings baud rate = 9600, parity = None, and stop bits = 1

SECTION 5 • TESTING

INTRODUCTION

This section provides a procedure for testing the KDGC-2000 using the preset factory default settings.

EQUIPMENT REQUIRED

- DC Power Supply, 24 Volts
- 10 Amp Fuse
- Voltage Source, 60 hertz, 0 to 120V
- Current Source, 60 hertz, 0 to 5A
- Signal Generator, Sine Wave, 0 to 5k hertz, 0 to 5V
- Digital Voltmeter, 4 1/2 Digits (Fluke 8050A or Equivalent)
- Continuity Tester
- Four Single-Pole Switches
- 2 each, 250 ohm variable resistors
- 1 each 2500 ohm variable resistor

INITIAL TEST PROCEDURE

Unless otherwise specified, the test procedures in this manual use the default parameter settings provided in Table 5-1.

Table 5-1. Default Parameter Settings

PARAMETER	SETTING
Comm Baud Rate	9600 Baud
Remote Delay Time	1 Millisecond/10
Comm Parity	None
Device Address	125
Modem Time Delay	9000 Microseconds
Embedded Code Version No.	Ver. No.
Settings Source	User
Generator Connection	3-ph L-N
NFPA Level	0
Unit System	English
Battery Volts	24 Volts
Generator Frequency	60 Hz
Rated Engine RPM	1800 RPM
Number Flywheel Teeth	126
Genset KW Rating	300 kilowatt
No Load Cool Down Time	0 Minutes
Alternator Frequency Rated	600 Hertz
Generator PT Primary Voltage	480 Vac
Generator PT Secondary Voltage	480 Vac
Generator CT Primary Current	500 Aac
Bus PT Primary Voltage	480 Vac
Bus PT Secondary Voltage	480 Vac
Low Fuel Pre-Alarm Enable	OFF
Low Fuel Pre-Alarm Threshold	25 % Full Tank

PARAMETER	SETTING
Low Coolant Temperature Pre-Alarm Enable	OFF
Low Coolant Temperature Pre-Alarm Threshold	50 Degrees F
Battery Overvoltage Pre-Alarm Enable	OFF
Battery Overvoltage Pre-Alarm Threshold	30.0 VDC
Maintenance Interval Pre-Alarm Enable	OFF
Maintenance Interval Pre-Alarm Threshold	500 Hours
Engine KW Overload Pre-Alarm Enable	OFF
Engine KW Overload Pre-Alarm Threshold	105 % of Rated
High Coolant Temperature Pre-Alarm Enable	ON
High Coolant Temperature Pre-Alarm Threshold	250 Degrees F
Low Oil Pressure Pre-Alarm Enable	ON
Low Oil Pressure Pre-Alarm Threshold	25 PSI
Low Battery Voltage Pre-Alarm Enable	OFF
Low Battery Voltage Pre-Alarm Threshold	20.0 VDC
Low Battery Voltage Pre-Alarm Activation Time Delay	10 Seconds
Weak Battery Pre-Alarm Enable	OFF
Weak Battery Pre-Alarm Threshold	15.0 VDC
Weak Battery Pre-Alarm Activation Time Delay	2 Seconds
High Coolant Temperature Alarm Enable	ON
High Coolant Temperature Alarm Threshold	275 Degrees F
High Coolant Temperature Alarm Arming Delay After Crank Disconnect	60 Seconds
Low Oil Pressure Alarm Enable	ON
Low Oil Pressure Alarm Threshold	15 PSI
Low Oil Pressure Alarm Arming Delay After Crank Disconnect	10 Seconds
Overspeed Alarm Enable	ON
Overspeed Alarm Threshold	110% of Rated
Overspeed Alarm Activation Time Delay	50 Millisecond
Coolant Temperature Sender Failure Alarm Enable	OFF
Oil Pressure Sender Failure Alarm Enable	OFF
Speed Failure Alarm Enable	OFF
Loss of Generator Voltage Alarm Enable	OFF
Pre-Alarm Buzzer Enable	ON
Battery Charger Failure Pre-Alarm Enable	OFF
Global Sender Failure Alarm Time Delay	10 Seconds
Coolant Temp. Sender Failure Alarm Activation Time Delay	5 Minutes
Cranking Style	Cycle
Number of Crank Cycles	2
Cycle Crank Time	5 Seconds
Continuous Crank Time	10 Seconds
Crank Disconnect Limit	30 % of Rated
Pre-Crank Delay	0 Seconds
Pre-crank Contact After Crank Disconnect	Open
Generator Speed Mode	MPU/ALT/GEN
Generator Rotation	A-B-C

Step 1. Connect the KDGC-2000 test setup as shown in Figure 5-1.

Step 2. Apply operating voltage to battery voltage terminals.

Result: The LCD displays KDGC 2000 and the software version for approximately one second before switching to the normal display mode and at the same time, the Alarm sounds. The audible alarm will sound continuously when Not In Auto or in Alarm. The audible alarm may be silenced by pressing the Alarm Silence switch on the front panel.

Step 3 Press the Off switch to place the KDGC-2000 in the OFF position.

Step 4. Verify that LEDs Not In Auto and Off are ON, the Alarm LED is flashing, and the LCD backlight is ON with system parameters displayed.

Step 5. Press the Lamp Test switch and verify that all six LEDs are ON (Not In Auto, Alarm, and Off are red; Supplying Load, Run, and Auto are green). All LCD pixels should be visible.

Step 6. Verify Run, Off, and Auto switches, along with their respective LEDs, toggle as each switch is operated. Not In Auto LED should be OFF when Auto is selected.

Step 7. Verify that switches Raise/Scroll, Lower/Scroll, Select/Enter, Previous, and Display/Toggle are functional by scrolling through the unit menus.

METERING TEST PROCEDURES

Metering Battery And Generator Voltages

NOTE

Displayed voltage is equal to the generator potential transformer primary voltage setting times the applied voltage divided by the generator potential transformer secondary voltage setting.

Step 1. Verify that the battery input (terminals 5 and 6) voltage is 24.0 Vdc.

Step 2. Verify that the KDGC-2000 displayed value is 24.0 ±0.5 Vdc.

Step 3. Apply 120.0 Vac, 60.0 hertz to phase A (line to neutral) generator voltage input (terminals 32 and 29).

Step 4. Verify that the KDGC-2000 generator frequency displayed value is 60.0 ±0.2 hertz.

Step 5. Verify that the KDGC-2000 phase A to neutral voltage displayed value is 120.0 ±2.0 Vac.

Step 6. Remove the voltage.

Step 7. Apply 120.0 Vac, 60.0 hertz to phases A and B generator voltage input (terminals 32 and 31).

Step 8. Verify that the KDGC-2000 generator A to B voltage displayed value is 120.0 ±2.0 Vac.

Step 9. Remove the voltage.

Step 10. Apply 120.0 Vac, 60.0 hertz (line to neutral) to phase B generator voltage input (terminals 31 and 29).

Step 11. Verify that the KDGC-2000 line to neutral voltage displayed value is 120.0 ±2.0 Vac.

Step 12. Remove the voltage.

Step 13. Apply 120.0 Vac, 60.0 hertz to phases B and C generator voltage input (terminals 31 and 30).

Step 14. Verify that the KDGC-2000 generator B to C voltage displayed value is 120.0 ±2.0 Vac.

Step 15. Remove the voltage.

Step 16. Apply 120.0 Vac, 60.0 hertz (line to neutral) to phase C generator voltage input (terminals 30 and 29).

Step 17. Verify that the KDGC-2000 line to neutral voltage displayed value is 120.0 ±2.0 Vac.

Step 18. Remove the voltage.

Step 19. Apply 120.0 Vac, 60.0 hertz to phases C and A generator voltage input (terminals 30 and 32).

Step 20. Verify that the KDGC-2000 generator C to A voltage displayed value is 120.0 ±2.0 Vac.

Step 21. Remove the voltage.

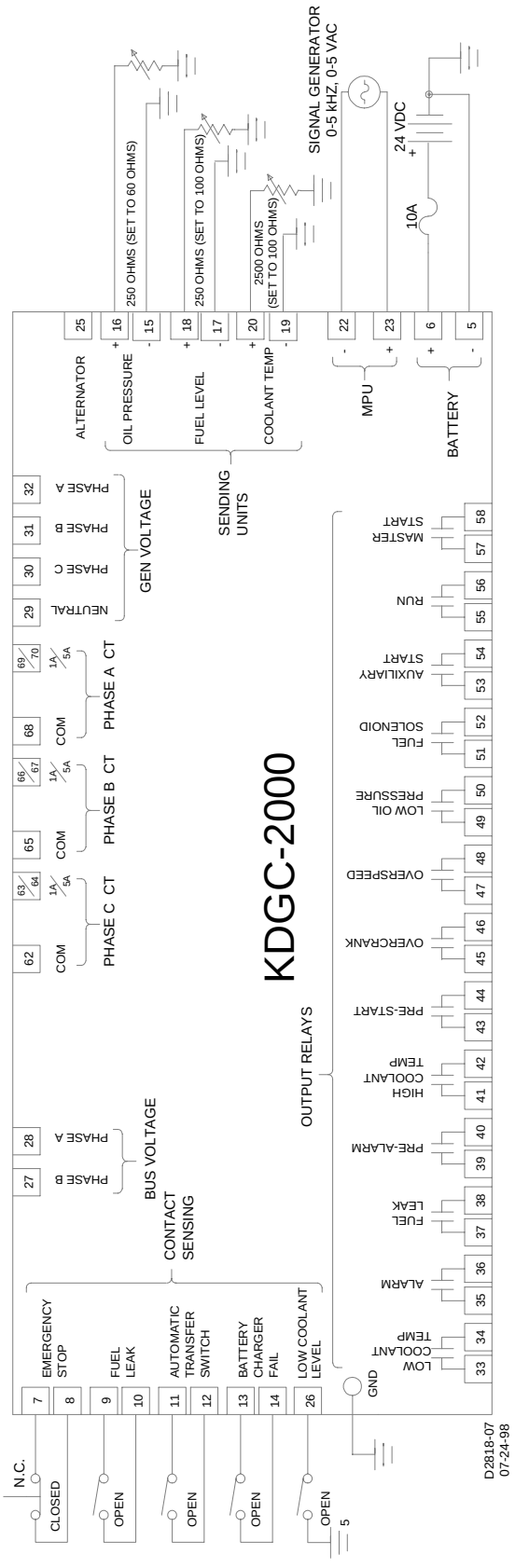

Figure 5-1. Test Set Diagram

Metering Bus Voltages

> **NOTE**
>
> Displayed voltage is equal to the bus potential transformer primary voltage setting times the applied voltage divided by the bus potential transformer secondary voltage setting.

Step 1. Apply 120.0 Vac, 60.0 hertz to phases A and B bus voltage input (terminals 28 and 27).

Step 2. Verify that the KDGC-2000 bus A and B frequency displayed value is 60.0 ±0.2 hertz.

Step 3. Verify that the KDGC-2000 bus A and B voltage displayed value is 120.0 ±2.0 Vac.

Step 4. Remove the voltage.

Metering Generator Current

> **NOTE**
>
> Displayed current is equal to the generator current transformer primary current setting times the applied current divided by one or five (the nominal current value).

Step 1. Apply 1.000 Aac to the KDGC-2000 generator five ampere phase A CT input (terminals 70 and 68).

Step 2. Verify that the KDGC-2000 phase A current displayed value is 100.0 ±2.0 amperes.

Step 3. Remove the current.

Step 4. Apply 1.000 Aac to the KDGC-2000 generator five ampere phase B CT input (terminals 67 and 65).

Step 5. Verify that the KDGC-2000 phase B current displayed value is 100.0 ±2.0 amperes.

Step 6. Remove the current.

Step 7. Apply 1.000 Aac to the KDGC-2000 generator five ampere phase C CT input (terminals 64 and 62).

Step 8. Verify that the KDGC-2000 phase C current displayed value is 100.0 ±2.0 amperes.

Step 9. Remove the current.

Oil Pressure

Step 1. Apply 60 ohms across the Oil Pressure sender input (terminals 16 and 5).

Step 2. Verify that the KDGC-2000 displayed value is 80 ±2.0 PSI.

Coolant Temperature

Step 1. Apply 100 ohms across the Coolant Temperature sender input (terminals 20 and 5).

Step 2. Verify that the KDGC-2000 displayed value is 205 ±4.0° C.

Percent Fuel Level

Step 1. Apply 100 ohms across the Fuel Level sender input (terminals 18 and 5).

Step 2. Verify that the KDGC-2000 displayed value is 40 ±2.0%.

Engine Speed (RPM)

> **NOTE**
>
> RPM as derived from the MPU is equal to [MPU output frequency (hertz) times 60] divided by the number of flywheel teeth.
>
> RPM as derived from the alternator is equal to [alternator output frequency (hertz) times rated RPM] divided by the rated alternator frequency (hertz).
>
> RPM as derived from the generator is equal to [generator output voltage frequency (phase A to neutral in hertz)] divided by the rated generator frequency (hertz).

Step 1. Apply a 5 Vac, 3780 hertz sine wave to the KDGC-2000 magnetic pickup unit inputs (terminals 23 and 22).

Step 2. Verify that the KDGC-2000 displayed value is 1800 ±36 RPM.

Step 3. Remove the voltage.

Generator Power Factor

> **NOTE**
>
> The KDGC-2000 uses phase A voltage and phase B current for Power Factor calculations. Therefore, if this test is performed with the current lagging the voltage by 120 degrees., the displayed Power Factor will be approximately 1.00.

Step 1. Apply 120 Vac to phase A to neutral generator voltage inputs (terminals 32 and 29).

Step 2. Apply 1.0 Aac to phase B current transformer inputs (terminals 67 and 65) in phase with the phase A to neutral voltage.

Step 3. Verify that the KDGC-2000 displayed value is -0.50 ±0.02.

Step 4. Remove voltage and current.

Generator kW And kVA

> **NOTE**
>
> The displayed kW is equal to the kVA times the Power Factor.

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 2. Apply in series and in phase with the voltage 1 Aac to Phase A current transformer input (terminals 69 and 68), Phase B current transformer input (terminals 66 and 65), and Phase C current transformer input (terminals 63 and 62).

Step 3. Verify that the KDGC-2000 displayed value for individual phase kW is -30 ±2 kW.

Step 4. Verify that the KDGC-2000 displayed value for total kW is -90 ±2 kW.

Step 5. Verify that the KDGC-2000 displayed value for individual phase kVA is 60 ±2 kVA.

Step 6. Verify that the KDGC-2000 displayed value for total kVA is within 180 ±5 kVA.

Step 7. Remove voltage and current.

CRANKING TEST PROCEDURES

Crank Cycle

> **NOTE**
>
> The KDGC will go into Overcrank if the Off switch is not pressed before two crank cycles expire. Pressing Off will reset this condition if it occurs.

Step 1. Verify that all output contacts are open.

Step 2. Press the Run switch on the front panel.

Step 3. Verify that the KDGC-2000 displays CRANKING STATUS.

Step 4. Verify that only the Master Start, Auxiliary Start, Fuel Solenoid, and Pre-Start output contacts are closed during CRANKING CYCLE.

Step 5. Verify that only the Pre-Start contact remains closed during RESTING.

Step 6. Press the Off switch on the front panel.

Step 7. Press the Auto switch on the front panel.

Step 8. Apply a contact closure across the Automatic Transfer Switch inputs (terminals 11 and 12).

Step 9. Verify that the KDGC-2000 displays CRANKING STATUS.

Step 10. Verify that only the Master Start, Auxiliary Start, Fuel Solenoid, and Pre-Start output contacts are closed during CRANKING CYCLE.

Step 11. Verify that only the Pre-Start contact remains closed during RESTING.

Step 12. Press the Off switch on the front panel.

Step 13. Open the contact across the Automatic Transfer Switch inputs.

Running

Step 1. Press the Run switch on the front panel.

Step 2. Within 5 seconds of beginning cranking, apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 3. Verify that only the Run and Fuel Solenoid output contacts are closed.

Step 4. Verify that the KDGC-2000 normal mode display now meters the active generator values listed on the front panel instead of displaying READY.

Step 5. Press the Off switch on the front panel.

Step 6. Remove the voltage.

Step 7. Press the Auto switch on the front panel.

Step 8. Apply a contact closure across the Automatic Transfer Switch inputs (terminals 11 and 12).

Step 9. Within 5 seconds of beginning cranking, apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 10. Verify that only the Run and Fuel Solenoid output contacts are closed.

Step 11. Verify that the KDGC-2000 normal mode display now meters the active generator values listed on the front panel instead of displaying READY.

Step 12. Press the Off switch on the front panel.

Step 13. Remove the voltage.

Step 14. Open the contact across the Automatic Transfer Switch inputs.

PROTECTIVE FUNCTIONS

Overcrank

Step 1. Press the Run switch on the front panel.

Step 2. Verify that after two cycles the KDGC-2000 display indicates GEN OVER-CRANK ALARM and that only the Alarm, Fuel Leak, and Overcrank output contacts are closed.

Step 3. Press the Off switch on the front panel and verify that the KDGC-2000 resets to the Ready mode and that all output contacts open.

Overspeed

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 2. Apply a 5 Vac, 4000 hertz sine wave to the KDGC-2000 MPU inputs (terminals 23 and 22).

Step 3. Press the Run switch on the front panel.

Step 4. Slowly increase the frequency to the KDGC-2000 MPU input until an overspeed shutdown occurs.

Step 5. Verify shutdown occurs within 4158 ±83 hertz (1980 ±38 RPM).

Step 6. Verify that the KDGC-2000 display indicates GEN OVERSPEED ALARM and that only the Alarm, Fuel Leak, and Overspeed output contacts are closed.

Step 7. Remove the voltages.

Step 8. Press the Off switch on the front panel and verify that the KDGC-2000 resets to the Ready mode and that all output contacts open.

Low Oil Pressure

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 2. Press the Run switch on the front panel.

Step 3. Wait ten seconds after crank disconnect. Increase the resistance across the Oil Pressure sender input (terminals 16 and 5) until a Pre-Alarm occurs.

Step 4. Verify that the KDGC-2000 display value is 25 ±2 PSI when Pre-Alarm occurs.

Step 5. Verify that the KDGC-2000 displays an alternately flashing dark field in the oil pressure location and that the Pre-Alarm output contact has closed.

Step 6. While monitoring displayed oil pressure, further increase the resistance across the Oil Pressure sender input until a low oil pressure shutdown occurs.

NOTE
Oil Pressure displayed value is 0 below 15 PSI.

Step 7. Verify that the KDGC-2000 displayed value is within 0 to 17 PSI when shutdown occurs.

Step 8. Verify that the KDGC-2000 display indicates LOW OIL PRESSURE ALARM and that only the Alarm, Fuel Leak, and Low Oil Pressure output contacts are closed.

Step 9. Remove the voltage and return the resistance to 60 ohms.

Step 10. Press the Off switch on the front panel and verify that the KDGC-2000 resets to the Ready mode and that all output contacts open.

High Coolant Temperature

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 2. Press the Run switch on the front panel.

Step 3. Wait 60 seconds after crank disconnect. Decrease the resistance across the Coolant Temperature sender input (terminals 20 and 5) until a Pre-Alarm occurs.

Step 4. Verify that the KDGC-2000 display value is 250 ±5 degrees when Pre-Alarm occurs.

Step 5. Verify that the KDGC-2000 displays an alternately flashing dark field in the coolant temperature location and that the Pre-Alarm output contact has closed.

Step 6. While monitoring displayed coolant temperature, further decrease the resistance across the Coolant Temperature sender input until an over temperature shutdown occurs.

Step 7. Verify that the KDGC-2000 displayed value is 275 ±6 degrees when shutdown occurs.

Step 8. Verify that the KDGC-2000 indicates OVER TEMP ALARM and that only the Alarm, Pre-Alarm, Fuel Leak, and High Coolant Temperature output contacts are closed.

Step 9. Remove the voltage and return the resistance to 100 ohms.

Step 10. Press the Off switch on the front panel and verify that the KDGC-2000 resets to the Ready mode and that all output contacts open.

Fuel Leak

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 2. Press the Run switch on the front panel.

Step 3. Apply a contact closure across the Fuel Leak Inputs (terminals 9 and 10).

Step 4. Verify that the KDGC-2000 indicates FUEL LEAK SHUTDOWN (CLOSED) and that the Alarm and Fuel Leak output contacts are closed.

Step 5. Open the contact across the Fuel Leak inputs.

Step 6. Press the Off switch on the front panel and verify that the KDGC-2000 resets to the Ready mode and that all output contacts open.

Step 7. Remove the voltage.

Emergency Stop

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 2. Press the Run switch on the front panel.

Step 3. Open the contact across the Emergency Stop inputs (terminals 7 and 8).

Step 4. Verify that the KDGC-2000 indicates EMERGENCY SHUTDOWN SWITCH PRESSED and that all output contacts are open.

Step 5. Reapply the contact closure across the Emergency Stop inputs.

Step 6. Press the Off switch on the front panel and verify that the KDGC-2000 resets to the Ready mode and that all output contacts open.

Step 7. Remove the voltage.

Low Coolant Level

Step 1. Apply in parallel 120 Vac to phase A to neutral (terminals 32 and 29), phase B to neutral (terminals 31 and 29), and phase C to neutral (terminals 30 and 29).

Step 2. Press the Run switch on the front panel.

Step 3. Close the Low Coolant Level contact.

Step 4. Verify that the KDGC-2000 indicates LOW COOLANT LEVEL and that the Alarm contact is closed.

Step 5. Open the Low Coolant Level contact.

Step 6. Press the Off switch on the front panel and verify that the KDGC-2000 resets to the Ready mode and that all output contacts open.

Step 7. Remove the voltage.

This completes the Test Procedures.

SECTION 6 • MODBUS™ COMMUNICATIONS

GENERAL

This section describes the Modbus™ communications protocol employed by the KDGC-2000 and how to exchange information with KDGC-2000 over a Modbus™ network. The KDGC-2000 communicates by emulating a subset of the Modicon 984 Programmable Controller. Communications allow the operator to monitor the KDGC-2000 Controller from a remote location or change parameter settings. A rear RS-232 port provides a permanent interface for remote communications.

Interface

The rear panel interface uses a standard RS-232 (DB-9) connector. The communications protocol is compatible with readily available modem/terminal software. The RS-232 communication port supports full duplex operation.

For all communication ports :

- The communications baud rate is fixed at 9600.
- The number of data bits is fixed at 8.
- The parity is fixed at NONE (N).
- The number of stop bits is fixed at 1.

Applications

Rear panel communication port may be used to interface terminals, computers, serial printers, modems, and intermediate communication/control interfaces such as RS-232 serial multiplexors. KDGC-2000 communications protocol supports only the RTU mode.

INTRODUCTION TO MODBUS™ PROTOCOL

Modbus™ communications use a master-slave technique in which only the master can initiate a transaction. This transaction is called a query. When appropriate, a slave (KDGC-2000) responds to the query. When a Modbus™ master communicates with a slave, information is provided or requested by the master.

All supported data can be read and written as specified in the register table. Abbreviations are used in the *Register Table* to indicate the register type. Register types are:

Read/Write = RW
Read only = R
Write only = W

KDGC-2000 MODBUS™ PROTOCOL

When a slave receives a query, the slave responds by either supplying the requested data to the master or performing the requested action. A slave device never initiates communications on the Modbus™, and will always generate a response to the query unless certain error conditions occur. The KDGC-2000 is designed to communicate on the Modbus™ only as a slave device.

A master can only query slaves individually. If a query requests actions unable to be performed by the slave, the slave response message contains an exception response code defining the error detected.

Message Structure

Master initiated queries and KDGC-2000 responses share the same message structure. Each message is comprised of four message fields. They are:

- Device Address
- Function Code
- Data Block
- Error Check field

Device Address Field

The device address field contains the unique Modbus™ address of the slave being queried. The addressed slave repeats the address in the device address field of the response message. This field is 1 byte.

The KDGC-2000 device address can be any value in the Modbus™ protocol device address range (1-247). A query with a device address signifies a broadcast message to all slaves. The KDGC-2000 responds only to preset multiple registers broadcast queries.

Function Code Field

The function code field in the query message defines the action to be taken by the addressed slave. This field is echoed in the response message, and is altered by setting the most significant bit (MSB) of the field to 1 if the response is an error response. This field is 1 byte.

The KDGC-2000 maps all parameters into the Modicon 984 holding register address space (4XXXX) and supports the following function codes.

- Function 03 - read holding registers
- Function 08, subfunction 00 - diagnostics: return query data
- Function 16 - preset multiple registers, non-broadcast and broadcast

The only broadcast query supported by the KDGC-2000 is the preset multiple registers query.

Data Block Field

The query data block contains additional information needed by the slave to perform the requested function. The response data block contains data collected by the slave for the queried function. An error response will substitute an exception response code for the data block. The length of this field varies with each query. See the register holding table for interpretation of the data.

Error Check Field

The error check field provides a method for the slave to validate the integrity of the query message contents and allows the master to confirm the validity of response message contents. This field is 2 bytes.

SERIAL TRANSMISSION DETAILS

A standard Modbus™ network offers two transmission modes for communication: ASCII or remote terminal unit (RTU). The KDGC-2000 supports only the RTU mode.

Each 8-bit byte in a message contains two 4-bit hexadecimal characters. The message is transmitted in a continuous stream with the LSB of each byte of data transmitted first. Transmission of each 8-bit data byte occurs with one start bit and one stop bit. Even parity checking is performed. The transmission baud rate is user-selectable, and can be set at installation and altered during real-time operation. If altered, the new baud rate and/or parity will not be enforced until the response message to the current query has been completed. The KDGC-2000 supported baud rate is 9600.

NOTE

KDGC-2000 supports only RS-232 compatible serial interfaces accessible from the rear panel.

MESSAGE FRAMING AND TIMING CONSIDERATIONS

When receiving a message, the KDGC-2000 allows a maximum inter-byte latency of up to 3.5 to 4.0 character times before considering the message complete.

Once a valid query is received, the KDGC-2000 waits a minimum amount of time before responding. This time delay is set in the remote delay time register (40052). This register contains a value from 1 - 20 representing 10 - 200 milliseconds. The default value is 1 (10 milliseconds). The user may set the remote delay time register to 0 to minimize response latency.

Table 6-1 provides the response message transmission time (in seconds) and 3.5 character times (in milliseconds) for various message lengths and baud rate.

Table 6-1. Timing Considerations

Baud Rate	3.5 Character Time (mSec)	Message Tx Time (Sec.)	
		128 Bytes	256 Bytes
9600	4.0104	0.15	0.29

ERROR HANDLING AND EXCEPTION RESPONSES

Any query received that contains a non-existent device address, a framing error, or CRC error is ignored. No response is transmitted. Queries addressed to a KDGC-2000 with an unsupported function code, unsupported register references, or illegal values in the data block result in an error response message with an exception response code. The exception response codes supported by the KDGC-2000 are provided in Table 6-2.

Table 6-2. Supported Exception Response Codes

Code	Name	Meaning
01	Illegal Function	The query Function/Subfunction Code is unsupported; query read of more than 125 registers; query preset of more than 100 registers; query preset without password clearance.
02	Illegal Data Address	A register referenced in the data block does not support queried read/write; query preset of a subset of a numerical register group.
03	Illegal Data Value	A preset register data block contains an incorrect number of bytes or one or more data values out of range.

COMMUNICATIONS HARDWARE REQUIREMENTS

Section 4, *Installation,* illustrates the IBM PC - AT type serial port connections. When using RS-232 communications, pin 8 to pin 7 and pin 4 to pin 6 are internally connected in the KDGC-2000 to satisfy handshaking requirements.

DETAILED MESSAGE QUERY AND RESPONSE

A detailed description of KDGC-2000 supported message queries and responses is provided in the following paragraphs.

Read Holding Registers Query

This query message requests a register or block of registers to be read. The data block contains the starting register address and the quantity of registers to be read. A register address of N will read holding register N+1.

Device Address
Function Code 03 (hex)
Starting Address Hi
Starting Address Lo
No. of Registers Hi
No. of Registers Lo
CRC error check

The number of registers cannot exceed 125 without causing an error response with the exception code for an illegal function.

Queries to read only or unsupported registers result in an error response with exception code for an illegal data address.

Queries to read without valid logon password clearance result in an error response with exception code of illegal function.

Read Holding Registers Response

The response message contains the data queried. The data block contains the block length in bytes followed by the data for each requested register. For each requested register, there is one Data Hi and one Data Lo. Attempting to read an unused register or a register which does not support a read results in an error response with the exception code for an illegal data address.

Device Address
Function Code 03 (hex)
Byte Count
Data Hi (For each requested register, there is one Data Hi and one Data Lo.)
Data Lo
Data Hi
Data Lo
CRC error check

One-Half Of Slave Response Frame Sent Back to Master (Frame Is Continuous)

Address	Function Code Read Multiple Register	Data Output Register Hi 40112	Data Output Register Lo 40112	Data Output Registers Hi 40113
7dh	03h	00	45h	12h

One-Half Of Slave Response Frame Sent Back to Master (Continuation Of First One-Half)

Data Output Registers Lo 40113	Data Output Registers Hi 40114	Data Output Registers Lo 40114	Checksum Hi	Checksum Lo
55h	21h	45h	nn	nn

Return Query Data

This query contains data to be returned (looped back) in the response. The response and query messages should be identical.

Device Address
Function Code 08 (hex)
Subfunction Hi 00 (hex)
Subfunction Lo 00 (hex)
Data Hi
Data Lo
CRC error check

Return Query

A query message requests a register or block of registers to be written. The data block contains the starting address and the quantity of registers to be written, followed by the Data Block byte count and data. The KDGC-2000 will perform the write when the device address is the same as the KDGC-2000 remote address or when the device address is 0. A device address is 0 for a broadcast query.

A register address of N will write Holding Register N+1.

No data will be written if any of the following exceptions occur.

- Queries to write to Read Only or unsupported registers result in an error response with Exception Code of Illegal Data Address.
- Queries attempting to write more than 100 registers cause an error response with Exception Code Illegal Function.
- An incorrect Byte Count will result in an error response with Exception Code of “Illegal Data Value.
- A query to write which is not preceded by a valid Password Clearance query results in an error response with Exception Code of “Illegal Function.
- There are several instances of registers that are grouped together to collectively represent a single numerical (vs. ASCII string) KDGC-2000 register value (DP, FP, TP). A query to write a subset of such a register group will result in an error response with Exception Code “Illegal Data Address.
- A query to write an illegal value (out of range) to a register results in an error response with Exception Code of “Illegal Data Value.

Device Address
Function Code 10 (hex)
Starting Address Hi
Starting Address Lo
No. of Registers Hi
No. of Registers Lo
Byte Count
Data Hi
Data Lo
.
.
.
Data Hi
Data Lo
CRC Error Check

Return Response

The response message echoes the starting address and the number of registers. There is no response message when the query is broadcast.

Device Address
Function Code 10 (hex)
Starting Address Hi
Starting Address Lo
No. of Registers Hi
No. of Registers Lo
CRC Error Check

Preset Multiple Register Query

A Preset Multiple Register query of Holding Register 40253 (Logon Password) containing the ASCII character string for the KDGC-2000 password grants permission to access the KDGC-2000 parameters until a pre-set multiple register query of holding register 40031 (Logoff) occurs.

The device address is 0 for a broadcast query.

The query starting address must be 0076 and as many as 8 characters (4 registers) can be used for the password. Data containing a password of less than 8 characters must include the string termination character (0). For example, if the password is ABCDEFGH, then the query data block would consist of the following 4 registers:

Query Address	Query Data
0252	AB
0253	CD
0254	EF
0255	GH

However, a password of WXYZ would require the following query data:

Query Address	Query Data
0252	WX
0253	YZ
0254	00

A password of WXY would require the following query data:

Query Address	Query Data
0252	WX
0253	Y0

Data in excess of 8 characters or following the string termination character (0) is ignored.

An error response will result only for the following exception: an incorrect Byte Count will result in an error response with Exception Code of Illegal Data Value.

Device Address
Function Code 10 (hex)
Starting Address Hi 00
Starting Address Lo 252
No. of Registers Hi 00
No. of Registers Lo 01 - 04
Password byte count
Password ASCII character 1
.
.
.
Password ASCII character N
CRC Error Check

Preset Multiple Register Response

The response message echoes the starting address and the number of registers. There is no response message when the query is broadcast.

Device Address
Function Code 10 (hex)
Starting Address Hi 00
Starting Address Lo 252
No. of Registers Hi
No. of Registers Lo
CRC Error Check

CHANGING THE LOGON PASSWORD

The current password can be altered by following a Password Clearance query with a general Preset Multiple Register query with starting address in the Remote Password register group (40252 - 40256). The new password can be up to 8 characters in length, beginning with register 40253. All characters subsequent to the initial 8 are ignored. By choosing a starting address other than 40253, a portion of the existing password can be overwritten to form a new password. The string termination character (0) must be included when altering the length of a password unless the new password is 8 characters long.

For example, to change the password from ABCD to ABC, the query data is:

Register Address	Register Data
0253	C0

To change the password from ABCD to WXYZ, the query data is:

Register Address	Register Data
0252	WX
0253	YZ

Finally, to change the password from ABC to ABCD, the query data can be

Register Address	Register Data
0253	CD
0254	00

or could be

Register Address	Register Data
0252	AB
0253	CD
0254	00

DATA FORMATS

Some KDGC-2000 data must be reformatted for transmission over the Modbus network. Parameters whose values can exceed 9999 but not exceed 99,999,999 are represented in double precision format. Parameters whose values can exceed 99,999,999 must be formatted in triple precision. Single byte data resides in the register least-significant byte with the most-significant byte set to zero. Negative values (single and double precision only) are represented by a sign bit (register MSB) and magnitude.

Double Precision Data Format

Modbus double precision data format uses two consecutive registers to represent a data value. The first register contains the high-order 16 bits of double precision data, and is the actual data value divided by 10,000.

The second register contains the low-order 16 bits of double precision data, and is the actual data value modulus 10,000. The format is:

$$Double\ precision = A(10{,}000) + B$$

Triple Precision Data Format

Modbus triple precision data format uses three consecutive registers (A, B, and X) to represent the magnitude of a data value. The first register contains the high-order 16 bits of triple precision data, and is the magnitude of the actual value divided by 100,000,000. The register MSB is the sign bit. The modulus from this operation is divided by 10,000 to arrive at the value of the second register, and the modulus of this last operation is the value of the third register (the low-order 16 bits of triple precision). The format is:

$$Triple\ precision = A(10{,}000)^2 + B(10{,}000) + X$$

The MSB is the sign bit for triple precision values (0 = positive). Negative values are reported as a sign and a magnitude. Triple precision format allows a maximum value of $9.99X10^{11}$. The maximum range of

several holding registers can exceed this value. If in actual operation, the working value is expected to exceed this value, the floating point data format should be used. These holding registers are marked with an asterisk in the paragraphs for the *Register Table*.

Error Check

This field contains a two-byte CRC value for transmission error detection. The master first calculates the CRC and appends it to the query message. The KDGC-2000 recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. If no transmission error has occurred, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

The CRC calculation is performed using all bytes of the device address, function code and data block fields. A 16-bit CRC-register is initialized to all 1's. Then each eight-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted eight times. The CRC-register MSB is zero-filled with each shift. After each shift, the CRC-register LSB is examined. If the LSB IS a 1, the CRC-register is then exclusive-ORed with the fixed polynomial value A001 (hex) prior to the next shift. Once all bytes of the message have undergone the above algorithm, the CRC-register will contain the message CRC value to be placed in the error check field.

Settings Source Register (40081)

Write to this register to select the settings group to be used (Factory, OEM or USER) as the source for retrieving settings and the settings group to be used (OEM or USER only).

Saving Settings Register (40082)

Writing any value to this register causes settings values to be written into the KDGC-2000's non-volatile memory at the settings group specified in the settings source register (OEM or USER only).

MAPPING REGISTERS INTO MODICON ADDRESS SPACE

Conventions

The Data Format column uses the following abbreviations.

DP Double precision
TP Triple Precision

Data formatted in double precision uses a two register group designated (a) and (b) and is defined as follows:

Register (a) - two hi-order bytes
Register (b) - two lo-order bytes

Data which are represented in triple precision format use a group of three registers designated (a), (b), and (x).

Register (a) - two hi-order bytes
Register (b) - two mid-order bytes
Register (x) - two lo-order bytes

Other register groups using the (a), (b), etc. designators are an ordered data group of consecutive ASCII characters or data bytes.

Register Table

The KDGC-2000 maps all parameters into the holding register address space (4XXXX).

NOTE
Query address n will access the holding register n+1.

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
PRODUCT ACCESS INFORMATION					
40252	<Reserved>				
40253	User Ltd Access Password(a)	'A'-'Z', 'a'-'z', '_', '0' - '9'	- W		
40254	User Ltd Access Password(b)		- W		
40255	User Ltd Access Password(c)		- W		
40256	User Ltd Access Password(d)		- W		
40257	<Reserved>				
40006	Front Panel Password(a)	All front panel pushbuttons except for RUN, OFF, AUTO	R -		
40007	Front Panel Password(b)		R -		
40008	Front Panel Password(c)		R -		
40009	Front Panel Password(d)		R -		
40010	<Reserved>				
40011	<Reserved>				
40012	<Reserved>				
40013	<Reserved>				
40014	User Ttl Access Password(a)	'A'-'Z', 'a'-'z', '_', '0'-'9'	- W		
40015	User Ttl Access Password(b)		- W		
40016	User Ttl Access Password(c)		- W		
40017	User Ttl Access Password(d)		- W		
40030	<Reserved>				
40031	Logoff	Data=Don't Care	- W		
40032	<Reserved>				
COMMUNICATION PARAMETERS					
40051	Comm Baud Rate	0	R W	0 =9600	Baud
40052	Remote Delay Time	0-20	R W	0=Min. 1 =10 2 = 20 etc. 20 =200	MilliSec 10
40053	Comm Parity	0-2	R W	0 =None 1 =Odd 2 =Even	
40054	Device Address	1-247	R W		
40055	Modern Time Delay	0-9999	R W		Microseconds
40056	Embedded Code Version No.	100-9999	R -		Version No. x 100
PARAMETER SETTINGS					
40078	Remote (PC) Emergency Stop	0-1	- W	0 =Off 1 = Stop	
40079	Remote Start / Stop	0-1	- W	0 =Stop 1 =Start	
40080	<Reserved>				

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40081	Settings Source	0-2	R W	0 =Factory 1 =OEM 2 =User	
40082	Save Settings	Data=Don't Care	- W		
40083	<Reserved>				
SYSTEM PARAMETERS					
40091	Generator Connection	0-2	R W	0=3ph L-L 1=3ph L-N 2=1ph A-B	
40092	NFPA Level	0-2	R W	0 =Off 1 =Level 1 2 =Level 2	
40093	Unit System	0-1	R W	0=English 1=Metric	
40094	Battery Volts	0-1	R W	0=12 VDC 1=24 VDC	
40095	Generator Frequency	0-1	R W	0=50 HZ 1=60 HZ	
40096	Rated Engine RPM	750-3600	R W		RPM
40097	Rated Engine RPM Minimum	750	R -		RPM
40098	Rated Engine RPM Maximum	3600	R -		RPM
40099	Rated Engine RPM Stepsize	50	R -		RPM
40100	Number Flywheel Teeth	50-500	R W		
40101	Number Flywheel Teeth Minimum	50	R -		
40102	Number Flywheel Teeth Maximum	500	R -		
40103	Number Flywheel Teeth Stepsize	1	R -		
40104	Genset KW Rating	25-9999	R W		KWatt
40105	Genset KW Rating Minimum	25	R -		KWatt
40106	Genset KW Rating Maximum	9999	R -		KWatt
40107	Genset KW Rating Stepsize	1	R -		KWatt
40108	No Load Cool Down Time	0-60	R W		Minutes
40109	No Load Cool Down Time Minimum	0	R -		Minutes
40110	No Load Cool Down Time Maximum	60	R -		Minutes
40111	No Load Cool Down Time Stepsize	5	R -		Minutes
40112	Alternator Frequency Rated	100-900	R W		Hertz
40113	Alternator Frequency Rated Minimum	100	R -		Hertz
40114	Alternator Frequency Rated Maximum	900	R -		Hertz
40115	Alternator Frequency Rated Stepsize	1	R -		Hertz
GENERATOR PT PRIMARY					
40121	Voltage(a)	1-15000	R W	DP	VoltsAC x 10000
40122	Voltage(b)		R W	DP	VoltsAC
40123	Voltage Minimum(a)	1	R -	DP	VoltsAC x 10000
40124	Voltage Minimum(b)		R -	DP	VoltsAC

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40125	Voltage Maximum(a)	15000	R -	DP	VoltsAC x 10000
40126	Voltage Maximum(b)		R -	DP	VoltsAC
40127	Voltage Stepsize(a)	1	R -	DP	VoltsAC x 10000
40128	Voltage Stepsize(b)		R -	DP	VoltsAC
GENERATOR PT SECONDARY					
40129	Voltage	1-480	R W		VoltsAC
40130	Voltage Minimum	1	R -		VoltsAC
40131	Voltage Maximum	480	R -		VoltsAC
40132	Voltage Stepsize	1	R -		VoltsAC
GENERATOR CT PRIMARY					
40133	Current	1-5000	R W		AmpsAC
40134	Current Minimum	1	R -		AmpsAC
40135	Current Maximum	5000	R -		AmpsAC
40136	Current Stepsize	1	R -		AmpsAC
BUS PT PRIMARY					
40141	Voltage(a)	1-15000	R W	DP	VoltsAC x 10000
40142	Voltage(b)		R W	DP	VoltsAC
40143	Voltage Minimum(a)	1	R -	DP	VoltsAC x 10000
40144	Voltage Minimum(b)		R -	DP	VoltsAC
40145	Voltage Maximum(a)	15000	R -	DP	VoltsAC x 10000
40146	Voltage Maximum(b)		R -	DP	VoltsAC
40147	Voltage Stepsize(a)	1	R -	DP	VoltsAC x 10000
40148	Voltage Stepsize(b)		R -	DP	VoltsAC
BUS PT SECONDARY					
40149	Voltage	1-480	R W		VoltsAC
40150	Voltage Minimum	1	R -		VoltsAC
40151	Voltage Maximum	480	R -		VoltsAC
40152	Voltage Stepsize	1	R -		VoltsAC
LOW FUEL PRE-ALARM					
40181	Enable	0-1	R W	0 =Off 1 =On	
40182	Threshold	10-100	R W		% Full Tank
40183	Minimum	10	R -		% Full Tank
40184	Maximum	100	R -		% Full Tank
40185	Stepsize	1	R -		% Full Tank
LOW COOL TEMP PRE-ALARM					
40186	Enable	0-1	R W	0 =Off 1 =On	
40187	Threshold	40-100	R W		DegF
40188	Minimum	40	R -		DegF
40189	Maximum	100	R -		DegF
40190	Stepsize	1	R -		DegF
BATTERY OVERVOLTAGE PRE-ALARM					

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40191	Enable	0-1	R W	0 =Off 1 =On	
40192	Threshold	140-160 (12V) 240-320 (24V)	R W		.1 VoltDC
40193	Minimum	140 / 240	R -		.1 VoltDC
40194	Maximum	160 / 320	R -		.1 VoltDC
40195	Stepsize	1	R -		.1 VoltDC
MAINTENANCE INTERVAL PRE-ALARM					
40196	Enable	0-1	R W	0 =Off 1 =On	
40197	Threshold	0-5000	R W		Hours
40198	Minimum	0	R -		Hours
40199	Maximum	5000	R -		Hours
40200	Stepsize	10	R -		Hours
ENGINE KW OVERLOAD PRE-ALARM					
40201	Enable	0-1	R W	0 =Off 1 =On	
40202	Threshold	95-140	R W		% of Rated
40203	Minimum	95	R -		% of Rated
40204	Maximum	140	R -		% of Rated
40205	Stepsize	1	R -		% of Rated
HIGH COOLANT TEMPERATURE PRE-ALARM					
40206	Enable	0-1	R W	0 =Off 1 =On	
40207	Threshold	100-280	R W		DegF
40208	Minimum	100	R -		DegF
40209	Maximum	280	R -		DegF
40210	Stepsize	1	R -		DegF
LOW OIL PRESSURE PRE-ALARM					
40211	Enable	0-1	R W	0 =Off 1 =On	
40212	Threshold	3-100	R W		PSI
40213	Minimum	3	R -		PSI
40214	Maximum	100	R -		PSI
40215	Stepsize	1	R -		PSI
LOW BATTERY VOLTAGE PRE-ALARM					
40216	Enable	0-1	R W	0 =Off 1 =On	
40217	Threshold	60-120 (12V) 120-240 (24V)	R W		.1 VoltDC
40218	Minimum	60 / 120	R -		.1 VoltDC
40219	Maximum	120 / 240	R -		.1 VoltDC
40220	Stepsize	1 (0.1 VDC)	R -		.1 VoltDC
40221	Pre-alarm Activation Time Delay	1-10	R W		Seconds
40222	Activation Time Delay Minimum	1	R -		Seconds

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40223	Activation Time Delay Maximum	10	R -		Seconds
40224	Activation Time Delay Stepsize	1	R -		Seconds
WEAK BATTERY VOLTAGE PRE-ALARM					
40225	Enable	0-1	R W	0 =Off 1 =On	
40226	Threshold	40-80 (12V) 80-160 (24V)	R W		.1 VoltDC
40227	Minimum	40 / 80	R -		.1 VoltDC
40228	Maximum	80 / 160	R -		.1 VoltDC
40229	Stepsize	1 (0.1 VoltDC)	R -		.1 VoltDC
40230	Pre-alarm Activation Time Delay	1-10	R W		Seconds
40231	Activation Time Delay Minimum	1	R -		Seconds
40232	Activation Time Delay Maximum	10	R -		Seconds
40233	Activation Time Delay Stepsize	1	R -		Seconds
LOGON PASSWORD (40252-7)					
HIGH COOLANT TEMPERATURE ALARM					
40281	Enable	0-1	R W	0 =Off 1 =On	
40282	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40283	Threshold	100-280	R W		DegF
40284	Minimum	100	R -		DegF
40285	Maximum	280	R -		DegF
40286	Stepsize	1	R -		DegF
40287	Arming Delay after Crank Disconnect	60	R W		Seconds
40288	Arming Delay Minimum	60	R -		Seconds
40289	Arming Delay Maximum	60	R -		Seconds
40290	Arming Delay Stepsize	0	R -		Seconds
LOW OIL PRESSURE ALARM					
40291	Enable	0-1	R W	0 =Off 1 =On	
40292	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40293	Threshold	3-100	R W		PSI
40294	Minimum	3	R -		PSI
40295	Maximum	100	R -		PSI
40296	Stepsize	1	R -		PSI
40297	Arming Delay after Crank Disconnect	5-15	R W		Seconds
40298	Arming Delay Minimum	5	R -		Seconds
40299	Arming Delay Maximum	15	R -		Seconds

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40300	Arming Delay Stepsize	1	R -		Seconds
OVERSPEED ALARM					
40301	Enable	0-1	R W	0 =Off 1 =On	
40302	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40303	Threshold	105-140	R W		% of Rated
40304	Minimum	105	R -		% of Rated
40305	Maximum	140	R -		% of Rated
40306	Stepsize	1	R -		% of Rated
40307	Alarm Activation Time Delay	0-500	R W		MilliSec
40308	Activation Time Delay Minimum	0	R -		MilliSec
40309	Activation Time Delay Maximum	500	R -		MilliSec
40310	Activation Time Delay Stepsize	10	R -		MilliSec
SENDER FAIL ALARMS					
40311	Coolant Temperature Sender Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40312	Oil Pressure Sender Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40314	Magnetic Pick-up Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40315	Loss of Generator Voltage Alarm Enable	0-1	R W	0 =Off 1 =On	
40316	Pre-alarm Buzzer Enable	0-1	R W	0 =Off 1 =On	
40317	Battery Charger Failure Pre-alarm Enable	0-1	R W	0 =Off 1 =On	
40318	Global Sender Failure Alarm Time Delay	1-10	R W		Seconds
40319	Coolant Temperature Sender Failure Alarm Activation Delay	5-30 (increment size of 5)	R W		Minutes
CRANKING PARAMETERS					
40351	Cranking Style	0-1	R W	0=Contin. 1=Cycle	
40352	Number of Crank Cycles	1-7	R W		
40353	Number of Crank Cycles Minimum	1	R -		
40354	Number of Crank Cycles Maximum	7	R -		
40355	Number of Crank Cycles Stepsize	1	R -		
40356	Cycle Crank Time	5-15	R W		Seconds
40357	Cycle Crank Time Minimum	5	R -		Seconds
40358	Cycle Crank Time Maximum	15	R -		Seconds
40359	Cycle Crank Time Stepsize	1	R -		Seconds
40360	Continuous Crank Time	1-60	R W		Seconds

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40361	Continuous Crank Time Minimum	1	R -		Seconds
40362	Continuous Crank Time Maximum	60	R -		Seconds
40363	Continuous Crank Time Stepsize	1	R -		Seconds
40364	Crank Disconnect Limit	10-100	R W		% of Rated
40365	Crank Disconnect Limit Minimum	10	R -		% of Rated
40366	Crank Disconnect Limit Maximum	100	R -		% of Rated
40367	Crank Disconnect Limit Stepsize	1	R -		% of Rated
40368	Pre-crank Delay	0-30	R W		Seconds
40369	Pre-crank Delay Minimum	0	R -		Seconds
40370	Pre-crank Delay Maximum	30	R -		Seconds
40371	Pre-crank Delay Stepsize	1	R -		Seconds
40372	Pre-crank Contact after Disconnect	0-1	R W	0=Open 1=Closed	
SYSTEM MONITOR					
40374	Remaining Cooldown Time	0-60	R -		Minutes
40375	<Reserved>				
40376	Active Speed Signal Sources	1-4	R -	1 =MPU 2 =ALT 3 =GEN 4 =NONE	
40377	Sender Failure Alarm Codes		R -	b0=Cool Temp b1=Oil Press b2 Reserved b3=Spd Signal b4=Gen Volt b5-b7 Not Used	
40378	Alarm Codes		R -	b0=Hi Cool Temp b1 Low Coolant Level b2=Fuel Leak b3=E-Stop b4=Sender Fail b5=Over-crank b6=Over-speed b7=Low Oil Press	
40379	Pre-Alarm Codes		R -	b0=Hi Cool Temp b1=Low Cool Temp b2=Weak Batt b3=Low Batt b4 =Batt ov b5=Charger Fail b6=Service Due b7=kW Overload	

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40380	Pre-Alarm Codes, Group 2		R -	b0=Low Oil Press b1=Low Fuel b2 Reserved b3 Reserved b4-b7 Not Used	
40381	Engine Coolant Temperature		R -		DegF
40382	Engine Oil Pressure		R -		PSI
40383	Battery Voltage		R -		.1 VoltDC
40384	Fuel Level		R -		% Full Tank
40385	Time Remaining until Maintenance		R -		Hours
40386	Accumulated Engine Runtime(a)		R -	DP	Minutes x 10000
40387	Accumulated Engine Runtime(b)		R -	DP	Minutes
40388	Accumulated Engine Runtime Warranty(a)		R W	DP	Minutes x 10000
40389	Accumulated Engine Runtime Warranty(b)		R W	DP	Minutes
40390	Engine Speed(a)		R -	DP	RPM x 10000
40391	Engine Speed(b)		R -	DP	RPM
40392	Engine Load(a)		R -	DP	%
40393	Engine Load(b)		R -	DP	%
GENERATOR MONITOR					
40394	Phase a-b RMS Voltage(a)		R -	DP	RMS Volt x10000
40395	Phase a-b RMS Voltage(b)		R -	DP	RMS Volt
40396	Phase b-c RMS Voltage(a)		R -	DP	RMS Volt x10000
40397	Phase b-c RMS Voltage(b)		R -	DP	RMS Volt
40398	Phase c-a RMS Voltage(a)		R -	DP	RMS Volt x10000
40399	Phase c-a RMS Voltage(b)		R -	DP	RMS Volt
40400	Phase a-n RMS Voltage(a)		R -	DP	RMS Volt x10000
40401	Phase a-n RMS Voltage(b)		R -	DP	RMS Volt
40402	Phase b-n RMS Voltage(a)		R -	DP	RMS Volt x10000
40403	Phase b-n RMS Voltage(b)		R -	DP	RMS Volt
40404	Phase c-n RMS Voltage(a)		R -	DP	RMS Volt x10000
40405	Phase c-n RMS Voltage(b)		R -	DP	RMS Volt
40406	Bus RMS Voltage(a)		R -	DP	RMS Volt x10000
40407	Bus RMS Voltage(b)		R -	DP	RMS Volt
40408	Phase a RMS Current		R -		RMS Amps
40409	Phase b RMS Current		R -		RMS Amps
40410	Phase c RMS Current		R -		RMS Amps
40411	Phase a Apparent Power(a)		R -	DP	KVA x 10000
40412	Phase a Apparent Power(b)		R -	DP	KVA
40413	Phase b Apparent Power(a)		R -	DP	KVA x 10000
40414	Phase b Apparent Power(b)		R -	DP	KVA
40415	Phase c Apparent Power(a)		R -	DP	KVA x 10000
40416	Phase c Apparent Power(b)		R -	DP	KVA
40417	3 Phase Apparent Power(a)		R -	DP	KVA x 10000
40418	3 Phase Apparent Power(b)		R -	DP	KVA
40419	Phase a Power(a)		R -	DP	KWatt x 10000

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40420	Phase a Power(b)		R -	DP	KWatt
40421	Phase b Power(a)		R -	DP	KWatt x 10000
40422	Phase b Power(b)		R -	DP	KWatt
40423	Phase c Power(a)		R -	DP	KWatt x 10000
40424	Phase c Power(b)		R -	DP	KWatt
40425	3 Phase power(a)		R -	DP	KWatt x 10000
40426	3 Phase power(b)		R -	DP	KWatt
40427	3 Phase Total KW-Hours(a)		R W	TP	KWH x 10000 x 1000
40428	3 Phase Total KW-Hours(b)		R W	TP	KWH x 10000
40429	3 Phase Total KW-Hours(x)		R W	TP	KWH
40430	Power Factor		R -		.01
40431	<Reserved>				
40432	<Reserved>				
40433	Generator Frequency		R -		.1 Hertz
40434	Bus Frequency		R -		.1 Hertz
40435	<Reserved>				
40436	<Reserved>				
40437	<Reserved>				
CONTIGUOUS WRITE BLOCK (REGROUPED PARAMETERS)					
40441	Generator Connection	0-2	R W	0=3ph L-L 1=3ph L-N 2=1ph A-B	
40442	NFPA Level	0-2	R W		
40443	Unit System	0-1	R W	0=English 1=Metric	
40444	Nominal Battery Voltage	0-1	R W	0=12 VDC 1=24 VDC	
40445	Generator Frequency	0-1	R W	0=50 HZ 1=60 HZ	
40446	Rated Engine RPM	750-3600	R W		RPM
40447	Number Flywheel Teeth	50-500	R W		
40448	Genset KW Rating	25-9999	R W		KWatt
40449	No Load Cool Down Time	0-60	R W		Minutes
40450	Alternator Frequency Rated	100-900	R W		Hertz
40451	Generator Speed Mode	Individual Bits are 0 or 1	R W		Active Speed Signals b0=mag pick-up b1=generator b2=chg. alt. Gen. Phase Rotation b4=0 for A-B-C b4=1 for A-C-B Maintenance Timer b5=0 is active b5=1 to reset
GENERATOR PT PRIMARY					
40452	Voltage(a)	1-15000	R W	DP	VoltsAC x 10000
40453	Voltage(b)		R W	DP	VoltsAC

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
GENERATOR PT SECONDARY					
40454	Voltage	1-480	R W		VoltsAC
GENERATOR CT PRIMARY					
40455	Current	1-5000	R W		AmpsAC
40456	<Reserved>				
BUS PT PRIMARY					
40457	Voltage(a)	1-15000	R W	DP	VoltsAC x 10000
40458	Voltage(b)		R W	DP	VoltsAC
BUS PT SECONDARY					
40459	Voltage	1-480	R W		VoltsAC
LOW FUEL PRE-ALARM					
40460	Enable	0-1	R W	0 =Off 1 =On	
40461	Threshold	10-100	R W		% Full Tank
LOW COOL TEMP PRE-ALARM					
40462	Enable	0-1	R W	0 =Off 1 =On	
40463	Threshold	40-100	R W		DegF
BATTERY OVERVOLTAGE PRE-ALARM					
40464	Enable	0-1	R W	0 =Off 1 =On	
40465	Threshold	140-160 (12V) 240-320 (24V)	R W		.1 VoltDC
MAINTENANCE INTERVAL PRE-ALARM					
40466	Enable	0-1	R W	0 =Off 1 =On	
40467	Threshold	0-5000	R W		Hours
ENGINE KW OVERLOAD PRE-ALARM					
40468	Enable	0-1	R W	0 =Off 1 =On	
40469	Threshold	95-140	R W		% of Rated
HIGH COOLANT TEMPERATURE PRE-ALARM					
40470	Enable	0-1	R W	0 =Off 1 =On	
40471	Threshold	100-280	R W		DegF
LOW OIL PRESSURE PRE-ALARM					
40472	Enable	0-1	R W	0 =Off 1 =On	
40473	Threshold	3-100	R W		PSI
LOW BATTERY VOLTAGE PRE-ALARM					
40474	Enable	0-1	R W	0 =Off 1 =On	
40475	Threshold	60-120 (12V) 120-240 (24V)	R W		.1 VoltDC
40476	Pre-alarm Activation Time Delay	1-10	R W		Seconds

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
WEAK BATTERY VOLTAGE PRE-ALARM					
40477	Enable	0-1	R W	0 =Off 1 =On	
40478	Threshold	40-80 (12V) 80-160 (24V)	R W		.1 VoltDC
40479	Pre-alarm Activation Time Delay	1-10	R W		Seconds
HIGH COOLANT TEMPERATURE ALARM					
40480	Enable	0-1	R W	0 =Off 1 =On	
40481	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40482	Threshold	100-280	R W		DegF
40483	Arming Delay after Crank Disconnect	60	R W		Seconds
LOW OIL PRESSURE ALARM					
40484	Enable	0-1	R W	0 =Off 1 =On	
40485	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40486	Threshold	3-100	R W		PSI
40487	Arming Delay after Crank Disconnect	5-15	R W		Seconds
OVERSPEED ALARM					
40488	Enable	0-1	R W	0 =Off 1 =On	
40489	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40490	Threshold	105-140	R W		% of Rated
40491	Alarm Activation Time Delay	0-500	R W		MilliSec
SENDER FAIL ALARMS					
40492	Coolant Temperature Sender Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40493	Oil Pressure Sender Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40495	Magnetic Pick-up Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40496	Loss of Generator Voltage Alarm Enable	0-1	R W	0 =Off 1 =On	
40497	Pre-alarm Buzzer Enable	0-1	R W	0 =Off 1 =On	
40498	Battery Charger Failure Pre-alarm Enable	0-1	R W	0 =Off 1 =On	
40499	Global Sender Failure Alarm Time Delay	0-10	R W		Seconds
CRANKING PARAMETERS					
40500	Cranking Style	0-1	R W	0=Contin. 1=Cycle	
40501	Number of Crank Cycles	1-7	R W		
40502	Cycle Crank Time	5-15	R W		Seconds
40503	Continuous Crank Time	1-60	R W		Seconds
40504	Crank Disconnect Limit	10-100	R W		% of Rated
40505	Pre-crank Delay	0-30	R W		Seconds
40506	Pre-crank Contact after Disconnect	0-1	R W	0=Open 1=Closed	

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
SYSTEM MONITOR					
40507	Accumulated Engine Runtime Warranty(a)		R W	DP	Minutes x 10000
40508	Accumulated Engine Runtime Warranty(b)		R W	DP	Minutes
CALIBRATION					
40509	Voltage Calibration A(a)		R W	DP	x 10000
40510	Voltage Calibration A(b)		R W	DP	x 1
40511	Voltage Calibration B(a)		R W	DP	x 10000
40512	Voltage Calibration B(b)		R W	DP	x 1
40513	Voltage Calibration C(a)		R W	DP	x 10000
40514	Voltage Calibration C(b)		R W	DP	x 1
40515	Voltage Calibration N(a)		R W	DP	x 10000
40516	Voltage Calibration N(b)		R W	DP	x 1
40517	Current Calibration A(a)		R W	DP	x 10000
40518	Current Calibration A(b)		R W	DP	x 1
40519	Current Calibration B(a)		R W	DP	x 10000
40520	Current Calibration B(b)		R W	DP	x 1
40521	Current Calibration C(a)		R W	DP	x 10000
40522	Current Calibration C(b)		R W	DP	x 1
40523	Current Calibration N(a)		R W	DP	x 10000
40524	Current Calibration N(b)		R W	DP	x 1
40525	Coolant Temperature 0(a)		R W	DP	x 10000
40526	Coolant Temperature 0(b)		R W	DP	x 1
40527	Coolant Temperature 1(a)		R W	DP	x 10000
40528	Coolant Temperature 1(b)		R W	DP	x 1
40529	Coolant Temperature 2(a)		R W	DP	x 10000
40530	Coolant Temperature 2(b)		R W	DP	x 1
40531	Coolant Temperature 3(a)		R W	DP	x 10000
40532	Coolant Temperature 3(b)		R W	DP	x 1
40533	Coolant Temperature 4(a)		R W	DP	x 10000
40534	Coolant Temperature 4(b)		R W	DP	x 1
40535	Coolant Temperature 5(a)		R W	DP	x 10000
40536	Coolant Temperature 5(b)		R W	DP	x 1
40537	Coolant Temperature 6(a)		R W	DP	x 10000
40538	Coolant Temperature 6(b)		R W	DP	x 1
40539	Coolant Temperature 7(a)		R W	DP	x 10000
40540	Coolant Temperature 7(b)		R W	DP	x 1
40541	Coolant Temperature 8(a)		R W	DP	x 10000
40542	Coolant Temperature 8(b)		R W	DP	x 1
40543	Coolant Temperature 9(a)		R W	DP	x 10000
40544	Coolant Temperature 9(b)		R W	DP	x 1
40545	Coolant Temperature 10(a)		R W	DP	x 10000
40546	Coolant Temperature 10(b)		R W	DP	x 1
40547	Coolant Temperature 11(a)		R W	DP	x 10000
40548	Coolant Temperature 11(b)		R W	DP	x 1
40549	Coolant Temperature 12(a)		R W	DP	x 10000
40550	Coolant Temperature 12(b)		R W	DP	x 1
40551	Coolant Temperature 13(a)		R W	DP	x 10000
40552	Coolant Temperature 13(b)		R W	DP	x 1

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40553	Oil Pressure 0(a)		R W	DP	x 10000
40554	Oil Pressure 0(b)		R W	DP	x 1
40555	Oil Pressure 1(a)		R W	DP	x 10000
40556	Oil Pressure 1(b)		R W	DP	x 1
40557	Oil Pressure 2(a)		R W	DP	x 10000
40558	Oil Pressure 2(b)		R W	DP	x 1
40559	Oil Pressure 3(a)		R W	DP	x 10000
40560	Oil Pressure 3(b)		R W	DP	x 1
40561	Oil Pressure 4(a)		R W	DP	x 10000
40562	Oil Pressure 4(b)		R W	DP	x 1
40563	Oil Pressure 5(a)		R W	DP	x 10000
40564	Oil Pressure 5(b)		R W	DP	x 1
40565	Oil Pressure 6(a)		R W	DP	x 10000
40566	Oil Pressure 6(b)		R W	DP	x 1
40567	Oil Pressure 7(a)		R W	DP	x 10000
40568	Oil Pressure 7(b)		R W	DP	x 1
40569	Oil Pressure 8(a)		R W	DP	x 10000
40570	Oil Pressure 8(b)		R W	DP	x 1
40571	Oil Pressure 9(a)		R W	DP	x 10000
40572	Oil Pressure 9(b)		R W	DP	x 1
40573	Oil Pressure 10(a)		R W	DP	x 10000
40574	Oil Pressure 10(b)		R W	DP	x 1
40575	Oil Pressure 11(a)		R W	DP	x 10000
40576	Oil Pressure 11(b)		R W	DP	x 1
40577	Oil Pressure 12(a)		R W	DP	x 10000
40578	Oil Pressure 12(b)		R W	DP	x 1
40579	Oil Pressure 13(a)		R W	DP	x 10000
40580	Oil Pressure 13(b)		R W	DP	x 1
SYSTEM MONITOR - Continuation					
40581	System Configuration	32, 64, 128	R W	32=AUTO 64=OFF 128=RUN	
40582	System State	0-5	R -	0=RESET 1=READY 2=CRANK 3=REST 4=RUN 5=ALARM	
CALIBRATION - Continuation					
40583	Phase angle (a)		R W	DP	
40584	Phase angle (b)		R W	DP	
GENERATOR MONITOR - Continuation					

Holding Register	Parameter	Variable's Allowed Range	Read/Write Supported	Data Format	Units
40585	Power Factor State	0-3	R	0=+LAG 1=-LEAD 2=-LAG 3=+LEAD	

SECTION 7 • KDGC-2000 WINDOWS® SOFTWARE

GENERAL

KDGC-2000 Windows® Software is an application that enhances communication between the personal computer (PC) user and the KDGC-2000. KDGC-2000 Windows® Software serves two main purposes. First, it provides a user friendly environment for changing KDGC-2000 settings. Second, it provides on-screen, real time metering that is updated approximately every one and one-half seconds. The interface software also allows users to save the current setting configurations and data information to a disk. Users can save multiple setups for later use which saves setup time when configuring multiple units. Without KDGC-2000 Windows® Software, users must be familiar with the limited function operations at the KDGC-2000 front panel.

INSTALLATION

KDGC 2000 Windows software contains a setup utility that installs the program on your PC. When it installs the program, an uninstall icon is created that you may use to uninstall (remove) the program from your PC. The minimum operating requirements are listed in the following paragraph.

Operating Requirements

To use KDGC-2000 Windows software, you will need the following:

- IBM compatible PC, 486DX2 or faster, and a minimum of four megabytes of RAM
- Microsoft Windows 95 or Windows 3.1
- 3.5 inch floppy drive
- RS-232 Serial port

Installing The Program On Your PC With Windows® 95

1. Insert disk 1 in the 3.5 inch floppy drive
2. From the Task Bar select **Start** then **Run**
3. Enter **a:\Setup.exe** and press enter or click on Browse and select the A: drive and double click **Setup.exe**.

Installing The Program On Your PC With Windows® 3.1

1. Insert disk 1 in the 3.5 inch floppy drive
2. From Program Manager select **File** menu and then **Run**
3. Enter **a:\Setup.exe** and press enter or select the A: drive and double click **Setup.exe**.

Configuring The System

Communication with a KDGC-2000 unit can be done by a direct cable connection or through a modem. The installation section of the manual has the RS-232 serial link connection pinouts. For direct connection use a standard RS-232 cable. For modem communications connection use a modem to the KDGC RS-232 port and a null-modem cable. Connect another modem to the host computer with a standard RS-232 cable.

INITIALIZING COMMUNICATIONS WITH THE KDGC 2000 Windows Software

Select the KDGC-2000 icon from Program Manger or select KDGC 2000 under the Katolight directory under Programs in the Start Menu. A momentary dialog box (splash screen) opens that displays the Katolight Logo, program name, and revision identification. After the splash screen the initial screen

(Figure 7-1) will follow. Pull down the **Communications** menu select **Open** and then either **RS232** or **Modem** depending on the communication type desired. This will open the Comm Port screen like the one shown in Figure 7-2.

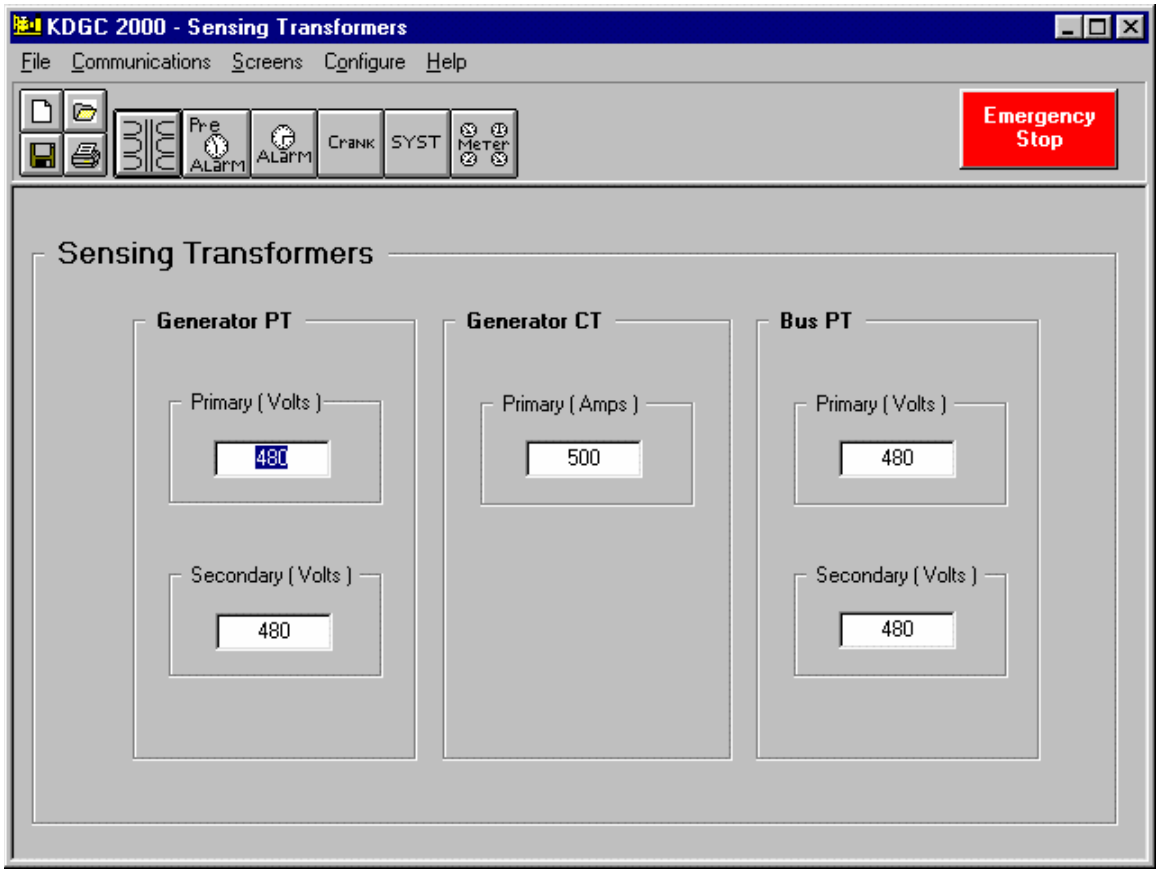

Figure 7-1. Initial Screen

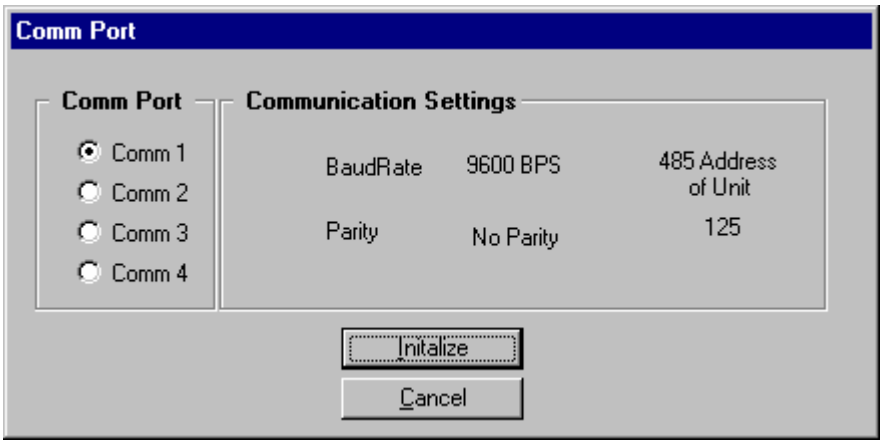

Figure 7-2. Comm Port

This screen shows the currently selected communication parameters if these are correct select the comm port and press the **Initialize** button. If the port is available the Logon Password screen (Figure 7-3) will appear. Type in your password and press OK. If you press Cancel the comm port will be closed and you will have to initialize communications again. If the communication parameter shown on the Comm Port screen are incorrect see the Section on changing the programs communication parameters.

Figure 7-3. Password

(Note : The Full Access password is “KATOLITE” Passwords are case sensitive.)

If modem connection was selected after your press initialize the Phone Book screen (Figure 7-4) will appear. From here you can select the name of the unit you want to call. You can also add or delete items in the phone book. After making a selection press the Dial Number button and the modem will dial the select number. After the modem’s connect the Logon Password screen (Figure 7-3) will appear. Type in your password and press OK.

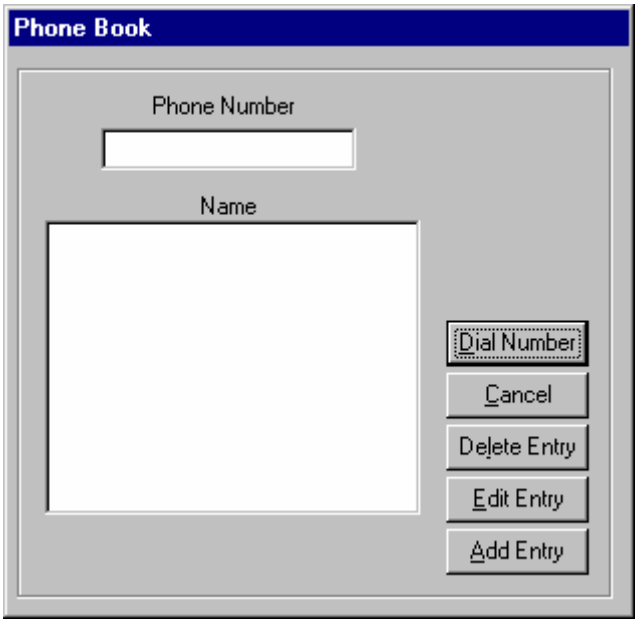

Figure 7-4. Phone Book

CHANGING THE PROGRAMS COMMUNICATION PARAMETERS

The communications parameter can be changed both when you are logged onto a KDGC unit and when you are not logged on. To change the communications parameters, pull down the **Configure** menu and select **RS232** this will bring up the screen shown in Figure 7-5. When you are logged onto a unit and change a parameter, by selecting **Save** you are saving the changes both to the PC and to the KDGC unit. When not logged on the parameters are only saved to the PC. (Note : To change the communications parameters in the KDGC you **must** be logged on with the full access password.)

The Modem Time Delay parameter is only available if you are changing the parameters while logged onto a unit. This parameter allows the user to extend the standard 3.5 millisecond “no character” timeout (for Modbus) by as much as 10 milliseconds (9999). This extra time is used to compensate for the extra time delays that the modem adds.

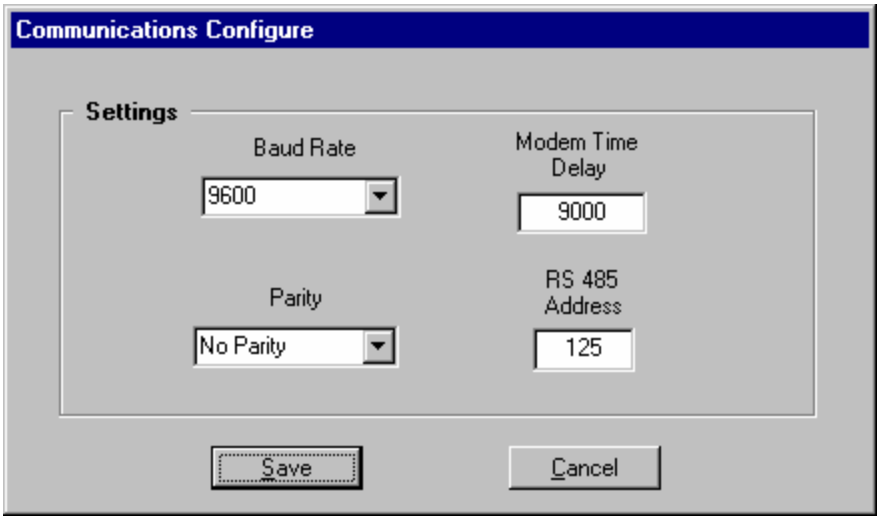

Figure 7-5. Communications Configure Screen

CHANGING LOGON PASSWORDS

To change Logon passwords you must be currently logged onto a KDGC unit. Pull down the **Communication** menu and select **Change Password.** When this is done the Change Password (Figure 7-6) screen will appear. There are two option buttons on the top off the screen. Select the level of the password you wish to change. Note : If you logged in with the limited access password you are only allowed to change the limited access password. Enter the new password in the first text box and repeat it again in the bottom text box. After entering the new password press the OK button, if both passwords you entered match, the new password will be sent to the KDGC. (Note : Passwords are case sensitive)

Figure 7-6. Change Password

REMOTE START AND STOP OF GENERATOR

The KDGC must be in Auto for this function to be enabled. When selected the screen in Figure 7-7 is displayed. To start the generator press the start button, this brings up the screen in Figure 7-8 which shows the status of the start operation. The start operation can be canceled by pressing the **Cancel** button. After the starting process is complete the Remote Starting screen will come back up. To exit press the **Cancel** button. To stop the generator press the **Stop** button. If successful a message box will be displayed.

Figure 7-7. Remote Starting

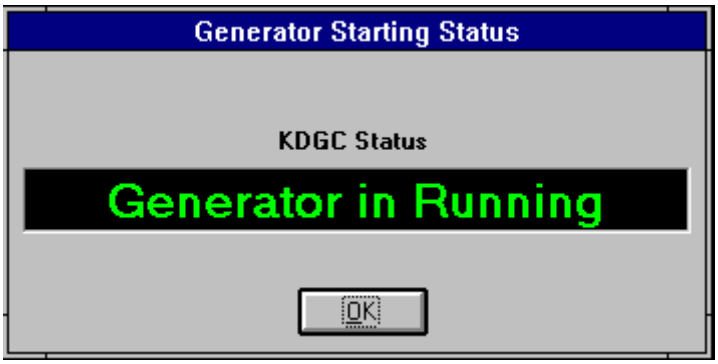

Figure 7-8. Starting Status

CHANGING SETTINGS

Settings are arranged in five groups.

- Sensing Transformers
- Pre-Alarms
- Alarm
- Crank
- System

To change settings, you must first select the screen associated with the setting. When you are logged on with the limited access password you can see all of the current settings in the unit but cannot change all of them. The settings that can not be changed will be disabled so that you can not select them. Double clicking on any white rectangular box will allow you to change (if allowed) that setting. Once all of the settings have been entered, pull down the **Communications** menu and select **Send to KDGC,** this will send the settings to the KDGC and verify them.

MENUS

File Menu

1) **Open** - Opens a saved settings file from a disk.

2) **Save** - Saves the current settings to a file on a disk. The file will be saved with the extension .KDGC.

3) **Print** - Used to print a hard copy of the settings file.

4) **Exit** - Used to exit the program.

Communications Menu

1) **Open** - Used to initiate communications with the KDGC2000.

2) **Close** - Used to terminate communications with the KDGC2000.

3) **Send to KDGC** - Used to send the settings to the KDGC2000.

4) **Get from KDGC** - Used to retrieve the present settings from the KDGC2000.

5) **Change Password** - Used to change the logon passwords. The current level of access determines which passwords may be changed.

6) **Remote Start/Stop** - Used to start and stop the engine when the KDGC2000 is in AUTO.

Screens Menu

1) **Sensing Transformers** - Used to program the sensing transformer ratings.

2) **Pre-Alarms** - Used to program pre-alarm settings.

3) **Alarm** - Used to program alarm settings.

4) **Crank** - Used to program engine cranking settings.

5) **System** - Used to program system parameters.

6) **Meter** - Used to display measured quantities. Metering must be enabled to view the measured quantities.

Configure Menu

1) **RS232** - Used to program communication settings.

2) **Sensor Curve** - *Future addition.*

Help Menu

1) **About** - Displays current software version number.

SETTINGS DEFINITIONS

Definitions for all of the available settings are provided in the following paragraphs.

Sensing Transformers Settings

Refer to Figure 7-9 for the Sensing Transformers Settings definitions.

Generator PT Primary Volts - Rating of the primary side of transformer used to sense generator voltage.

Generator PT Secondary Volts - Rating of secondary side of transformer used to sense generator voltage.

Generator CT Primary Amps - Rating of primary side of transformer used to sense generator current.

Bus PT Primary Volts - Rating of primary side of transformer used to sense bus voltage.

Bus PT Secondary Volts - Rating of secondary side of transformer used to sense bus voltage.

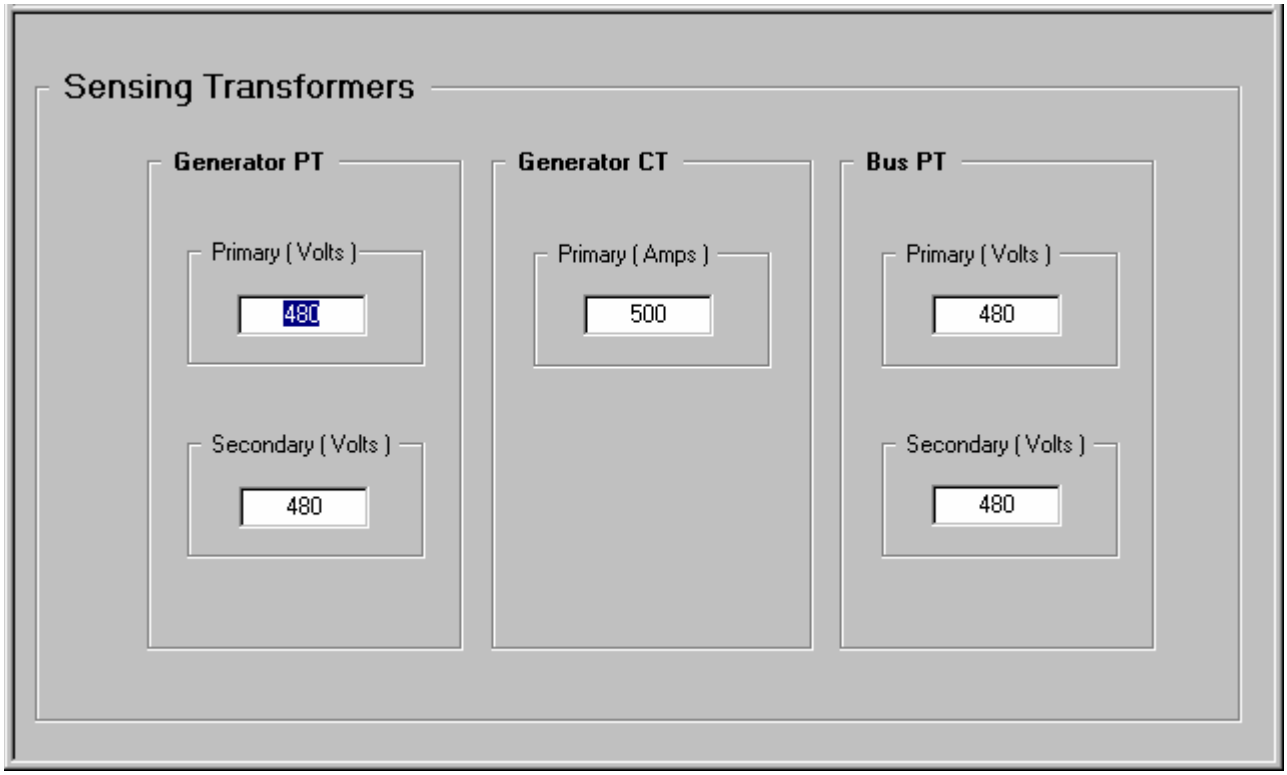

Figure 7-9. Sensing Transformers Screen

Pre-Alarm Settings - Low Fuel - Low Cool - Batt. OverVolt.

Refer to Figure 7-10 for the Pre-Alarm Settings - Low Fuel - Low Cool - Batt. OverVolt. definitions.

Low Fuel Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Pre-Alarm will sound when the fuel level drops below this set level.

Low Cool Temperature Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Pre-Alarm will sound when the coolant temperature falls below this level.

Battery Over Voltage Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Non-adjustable. Threshold is 30 volts for a 24 volt system and 15 volts for a 12 volt system.

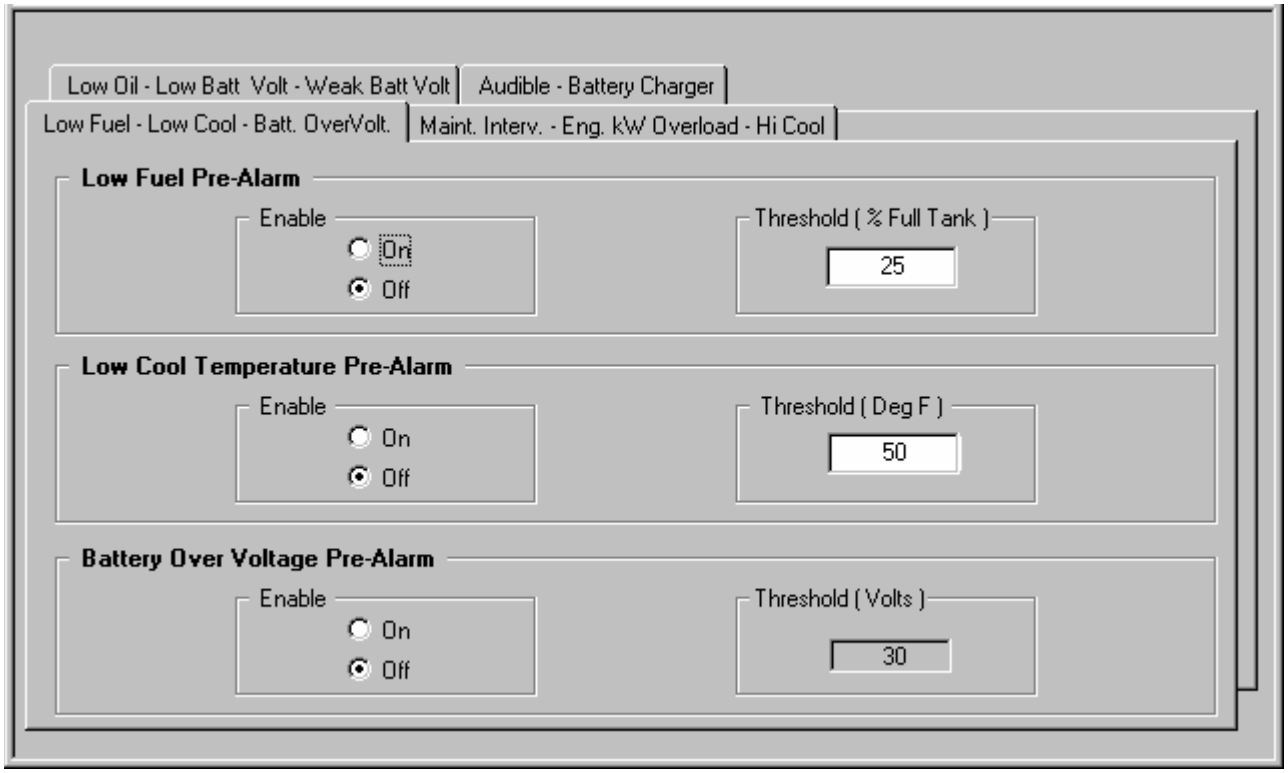

Figure 7-10. Pre-Alarm Settings - Low Fuel - Low Cool - Batt. OverVolt. Screen

Pre-Alarm Settings - Maint. Inter. - Eng. kW Overload - Hi Cool

Refer to Figure 7-11 for the Pre-Alarm Settings - Maint. Inter. - Eng. kW Overload - Hi Cool definitions.

Maintenance Interval Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Sets the amount of time in hours that the next maintenance interval is due.

Engine kW Over Load Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Sets the kilowatt level for the generator that will sound the pre-alarm.

Hi Coolant Temperature Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Pre-Alarm will sound when the coolant temperature rises above this level.

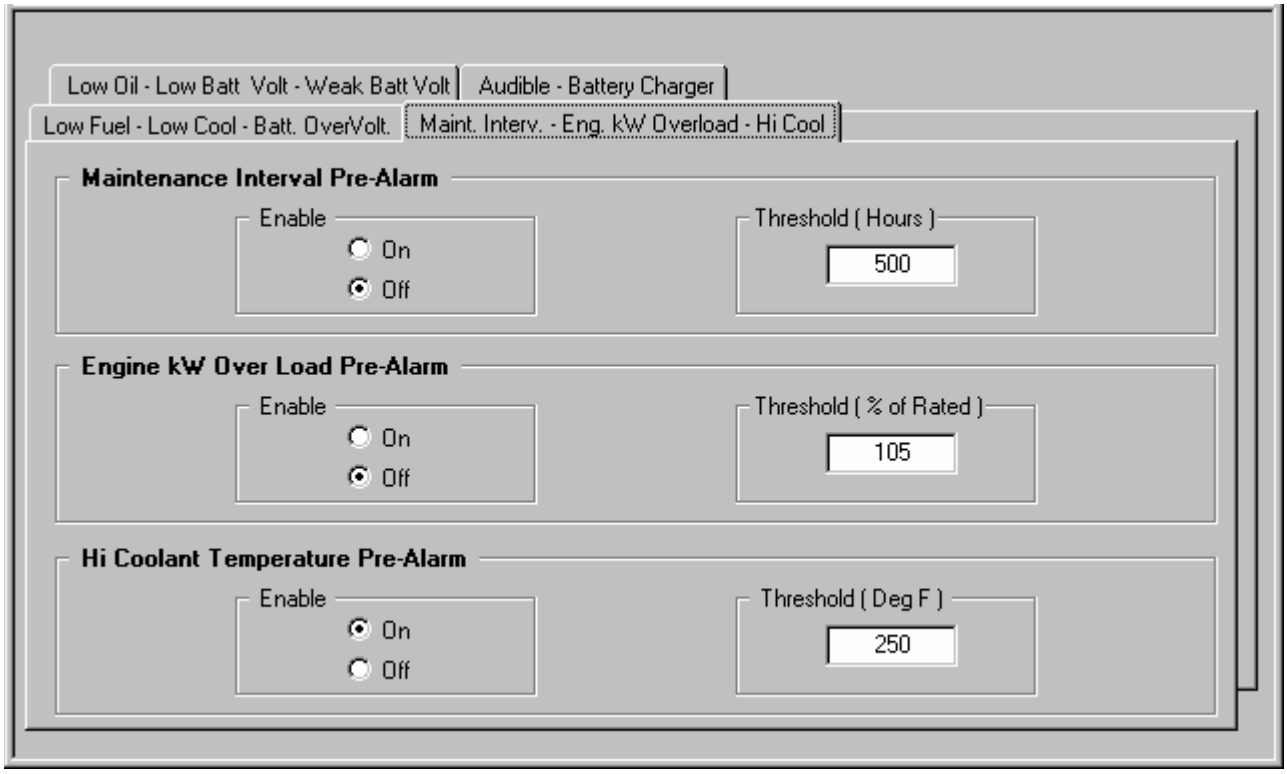

Figure 7-11. Pre-Alarm Settings - Maint. Inter. - Eng. kW Overload - Hi Cool Screen

Pre-Alarm Settings - Low Oil - Low Batt Volt - Weak Batt Volt

Refer to Figure 7-12 for the Pre-Alarm Settings - Low Oil - Low Batt Volt - Weak Batt Volt definitions

Low Oil Pressure Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Pre-Alarm will sound when the Oil Pressure falls below this level.

Low Battery Voltage Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Pre-Alarm will sound when the Battery Voltage falls below this level.

Weak Battery Voltage Pre-Alarm

1) Enable - Used to enable or disable the annunciation of the pre-alarm.

2) Threshold - Pre-Alarm will sound when the Battery Voltage falls below this level during cranking. This is a latching type Pre-Alarm and must be reset from the front panel.

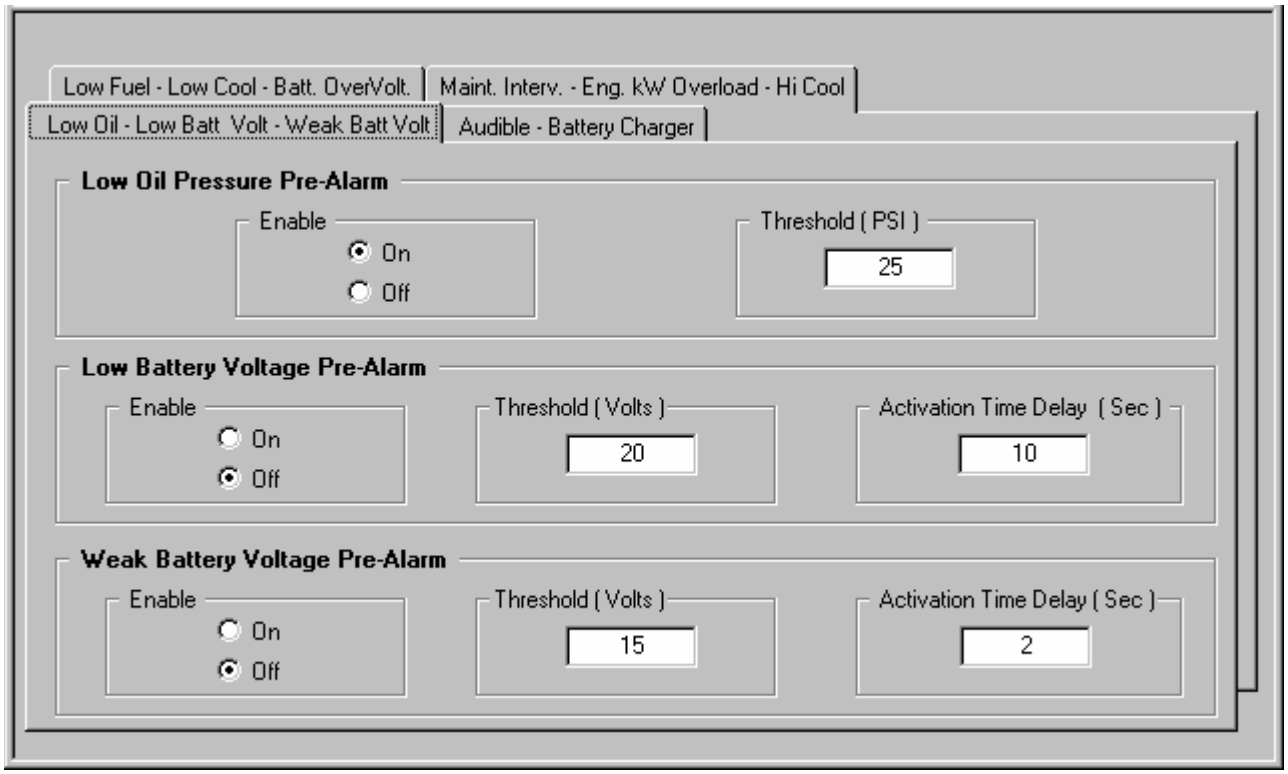

Figure 7-12. Pre-Alarm Settings - Low Oil - Low Batt Volt - Weak Batt Volt Screen

Pre-Alarm Settings - Audible - Battery Charger

Refer to Figure 7-13 for the Pre-Alarm Settings - Audible - Battery Charger definitions.

Audible Alarm

1) Enable - Used to enable or disable the horn on the KDGC2000.

Battery Charger Failure Pre-Alarm

1) Enable - Used to enable or disable the external contact to indicate the battery charger has failed.

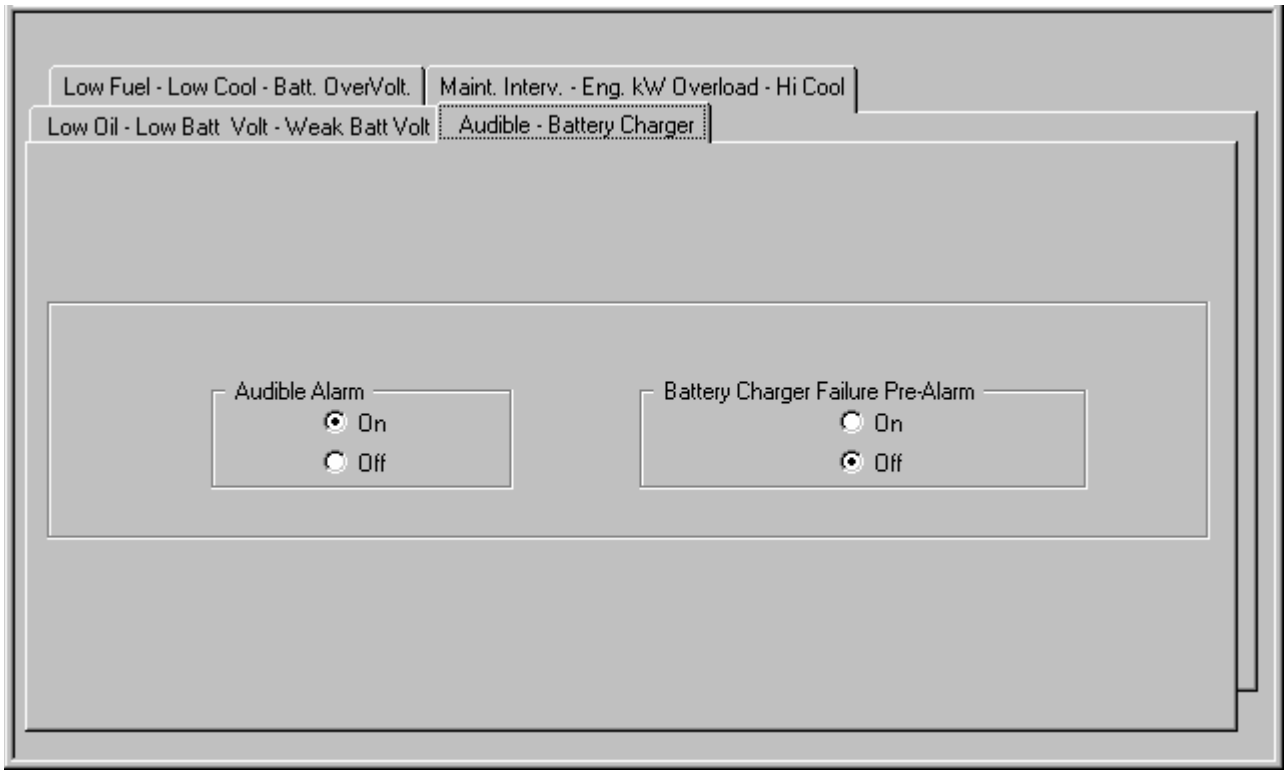

Figure 7-13. Pre-Alarm Settings - Audible - Battery Charger Screen

Alarm Settings - Hi Cool Temp - Low Oil Press

Refer to Figure 7-14 for the Alarm Settings - Hi Cool Temp - Low Oil Press definitions.

Hi Cool Temperature Alarm

1) Enable - Used to enable or disable the annunciation of the alarm.

2) Threshold - Sets the threshold level for the coolant temperature.

3) Arming Delay - Unadjustable - After the coolant temperature is above the threshold for 60 Sec the engine will be shutdown.

Low Oil Pressure Alarm

1) Enable - Used to enable or disable the annunciation of the alarm.

2) Threshold - Sets the threshold level for low oil pressure before engine shutdown occurs.

3) Arming Delay - Sets the amount of time delay, after crank disconnect, before the Oil Pressure Alarm becomes active.

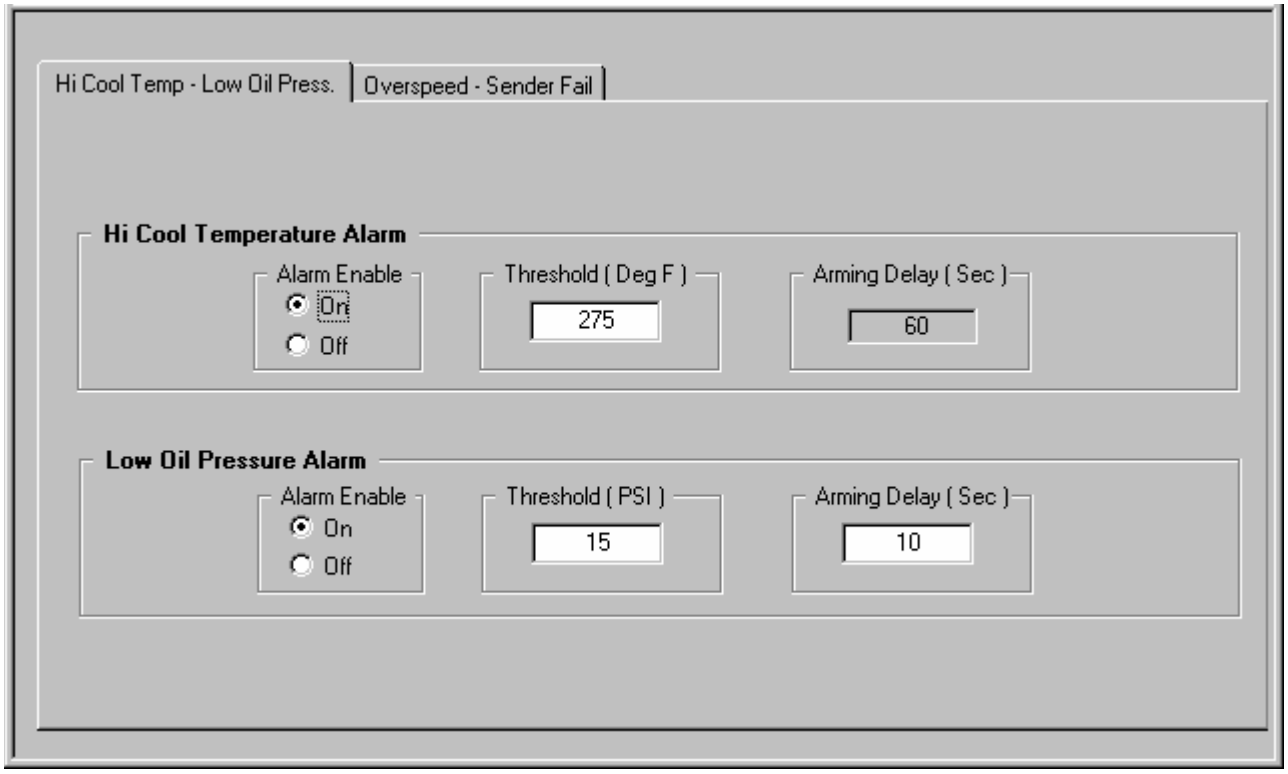

Figure 7-14. Alarm Settings - Hi Cool Temp - Low Oil Press Screen

Alarm Settings - Overspeed - Sender Fail

Refer to Figure 7-15 for the Alarm Settings - Overspeed - Sender Fail definitions.

Overspeed Alarm

1) Enable - Used to enable or disable the annunciation of the alarm.

2) Threshold - Sets the threshold level for engine speed, before shutdown occurs.

3) Alarm Activation - Sets the amount of time the engine speed must be above the threshold before the engine is shutdown.

Sender Failure Alarm

Coolant Temperature Sender:

1) Enable - Used to enable or disable the annunciation of the alarm.

2) Alarm Delay - Sets the amount of time the signal must be lost before the engine is shutdown.

Oil Pressure, Loss of Generator Voltage and Speed Failure

1) Enable - Used to enable or disable the annunciation of the alarm.

2) Global Sender Failure Alarm Time Delay - Sets the amount of time any of the signals (Oil Pressure, Loss of Generator Voltage and Speed Sender Failure) must be lost before the engine is shutdown.

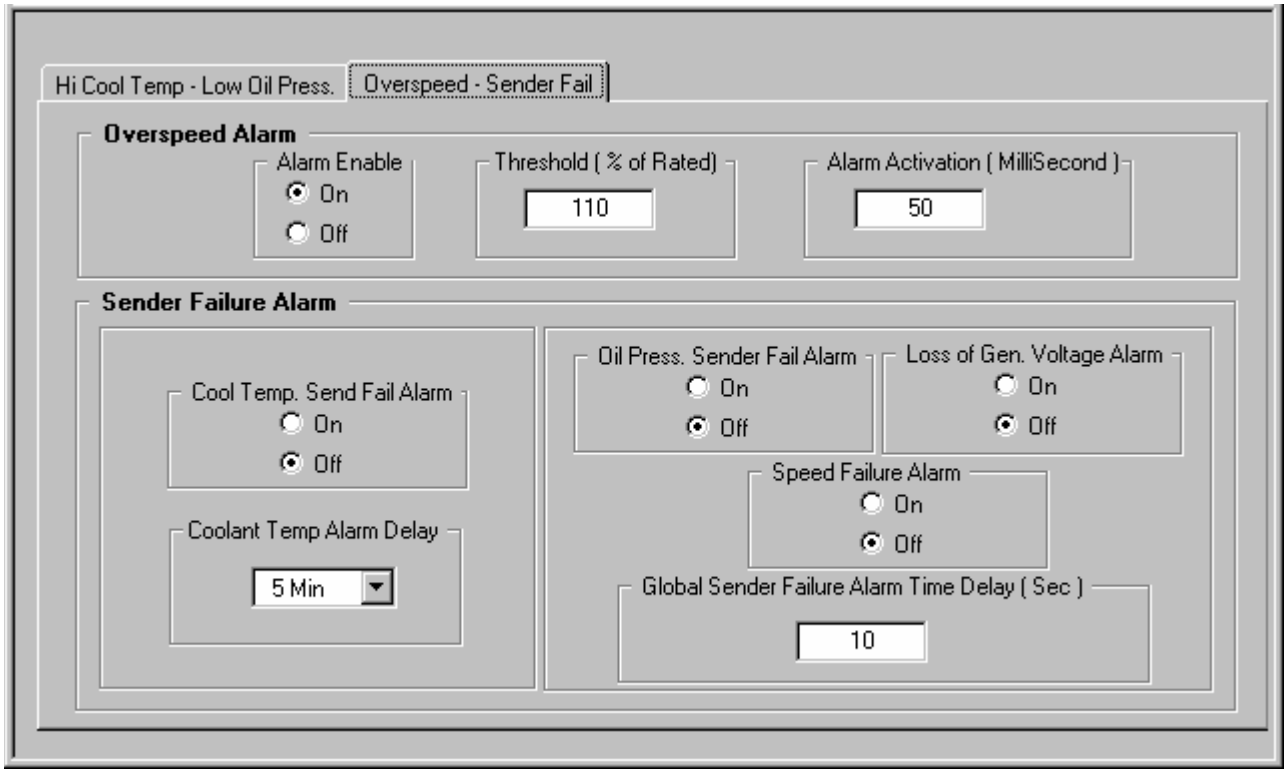

Figure 7-15. Alarm Settings - Overspeed - Sender Fail Screen

Crank Settings

Refer to Figure 7-16 for the Crank Settings definitions.

Cranking Style - Used to select the method of cranking.

Crank Disconnect Limit (% of Rated) - Used to select the engine speed above which the cranking process will be terminated.

Pre-Crank Delay (Sec) - Used to select the time between initiating engine start and actual beginning of engine cranking.

Pre-Start Contact After Disconnect - Used to select whether or not the pre-crank contact will remain closed after disconnect occurs.

Number of Crank Cycles - Used to select the number of times the engine may be cranked before an overcrank condition occurs. (Available only if Cycle Cranking is selected.)

Cycle Crank Time (Sec) - Used to select the duration of each crank attempt for cycle cranking.

Continuous Crank Time (Sec) - Used to select the duration of the single crank attempt before an overcrank condition occurs. (Available only if Continuous Cranking is selected.)

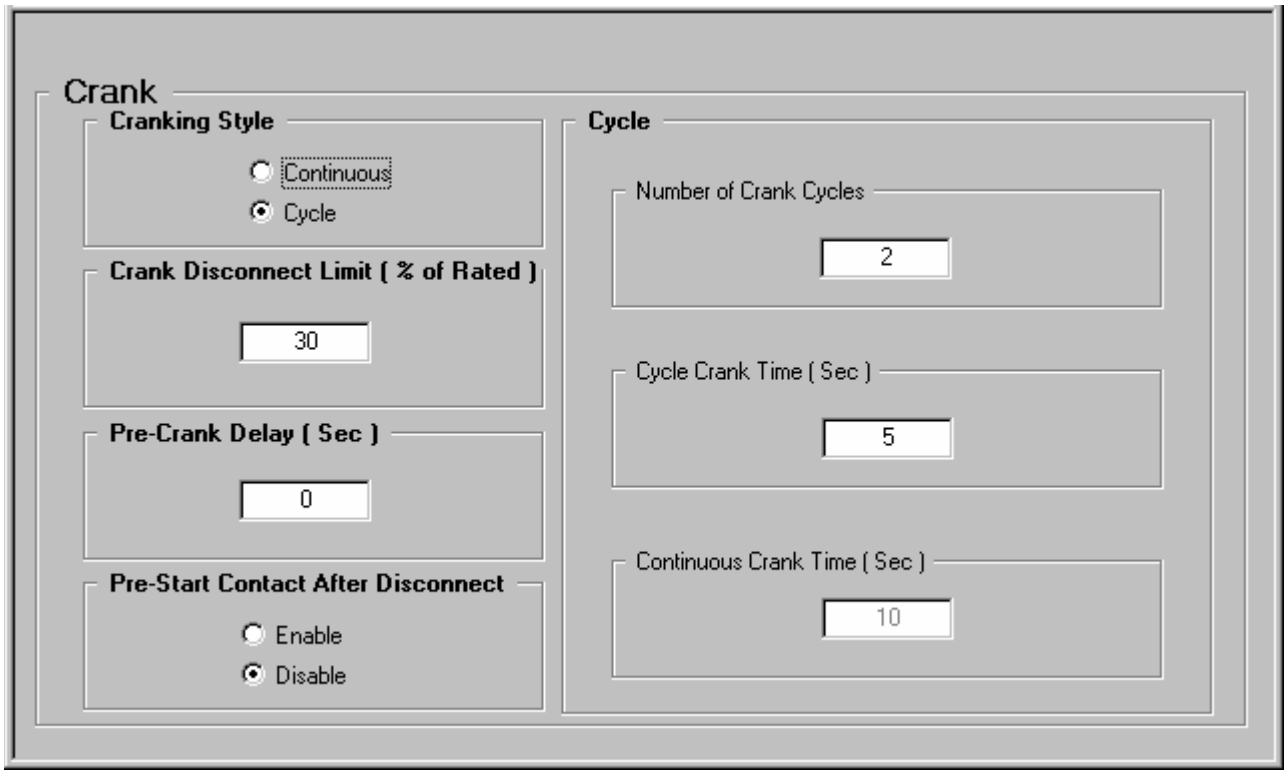

Figure 7-16. Crank Settings Screen

System Settings

Refer to Figure 7-17 for the System Settings definitions.

Genset's kW Rating - Used to enter the generator's kilowatt load rating.

No Load Cool Down Time - Used to select the time between the generator's load being removed and when the engine actually stops on a remote shutdown.

Rated Engine RPM - Used to enter the engine's rated RPM.

Alternator Frequency Rated (Hz) - Used to select the alternator's rated output frequency.

Battery Volts - Used to select the system's starting battery's nominal voltage.

NFPA Level - Used to select whether or not NFPA requirements are in effect.

 # Flywheel Teeth - Used to enter the number of teeth on the engines flywheel.

Generator Speed Mode - Used to select which sources are available for calculating engine speed.

Generator Connection - Used to select the generator connection scheme.

Generator Frequency - Used to select the generator's rated output frequency.

Unit System - Used to select English or Metric unit system for PC settings and front panel display on KDGC2000.

Generator Rotation - Used to select either ABC or ACB phase rotation.

Embedded Software Version - Shows what version the embedded software on the KDGC2000 is. This is only shown for a unit that you are logged onto.

Maintenance Interval Timer Reset - Used to terminate the "Maintenance Due" pre-alarm and reset the maintenance interval timer back to the programmed level. This is done when logged onto a KDGC2000 by clicking the box so a check mark is displayed then open the **Communications** menu and select **Send to KDGC**. After the command is sent to the KDGC the box is then unchecked.

Total kW Hours Reset - used to reset the kilowatt hours to zero. This is done when logged onto a KDGC2000 by clicking the box so a check mark is displayed then open the **Communications** menu and select **Send to KDGC**. After the command is sent to the KDGC the box is then unchecked.

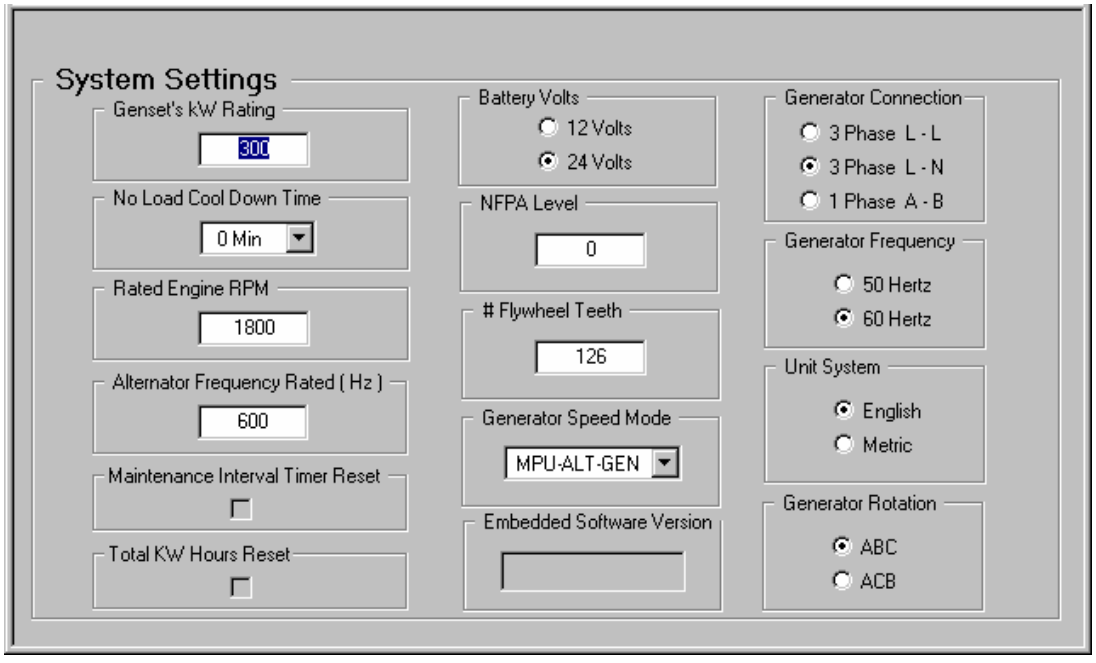

Figure 7-17. System Settings Screen

Metering

KDGC 2000 Windows software provides a means to monitor the metering data and alarm status. The metering data and the alarm status are refreshed approximately every 1.5 seconds.

Metering. The metering is separated into six different screens. There is one screen **Summary** that shows all the available metering values from the KDGC 2000 (Refer to Figure 7-18). The other five screens have a detailed subset of these metering values available. To enable metering you must be logged onto a unit and then open the **Metering** menu and select enable metering. If you are not on the metering screen the program will change to the metering screen and start updating the values. When metering is disabled all of the metering screens will be grayed out showing they are inactive.

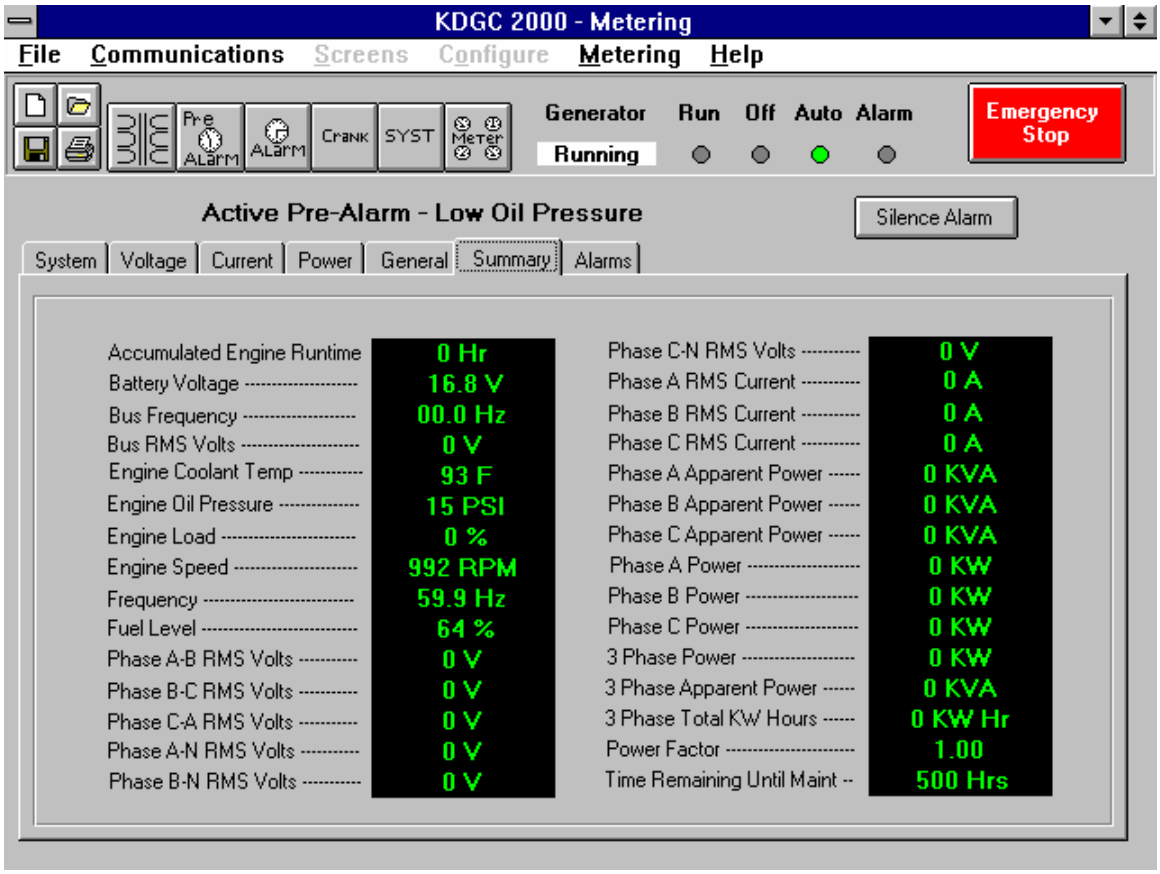

Figure 7-18. Metering Screen

Alarms. The pre-alarms and alarms are all shown on one screen (refer to Figure 7-19). When a pre-alarm becomes active the LED next to the name of the pre-alarm will be green. A description of the alarm will be shown on top of the screen and the computer speaker will begin to beep. The label on top of the screen will contain the same alarm until it goes away and then it will show the next pre-alarm going down the list that is active. When an alarm becomes active the LED next to the name of the alarm will be red. The screen will jump to the alarm tab and the computer speaker will begin to beep. If the alarm type is a Sender Failure the type of sender that failed will be indicated in the Sender Failure type area.

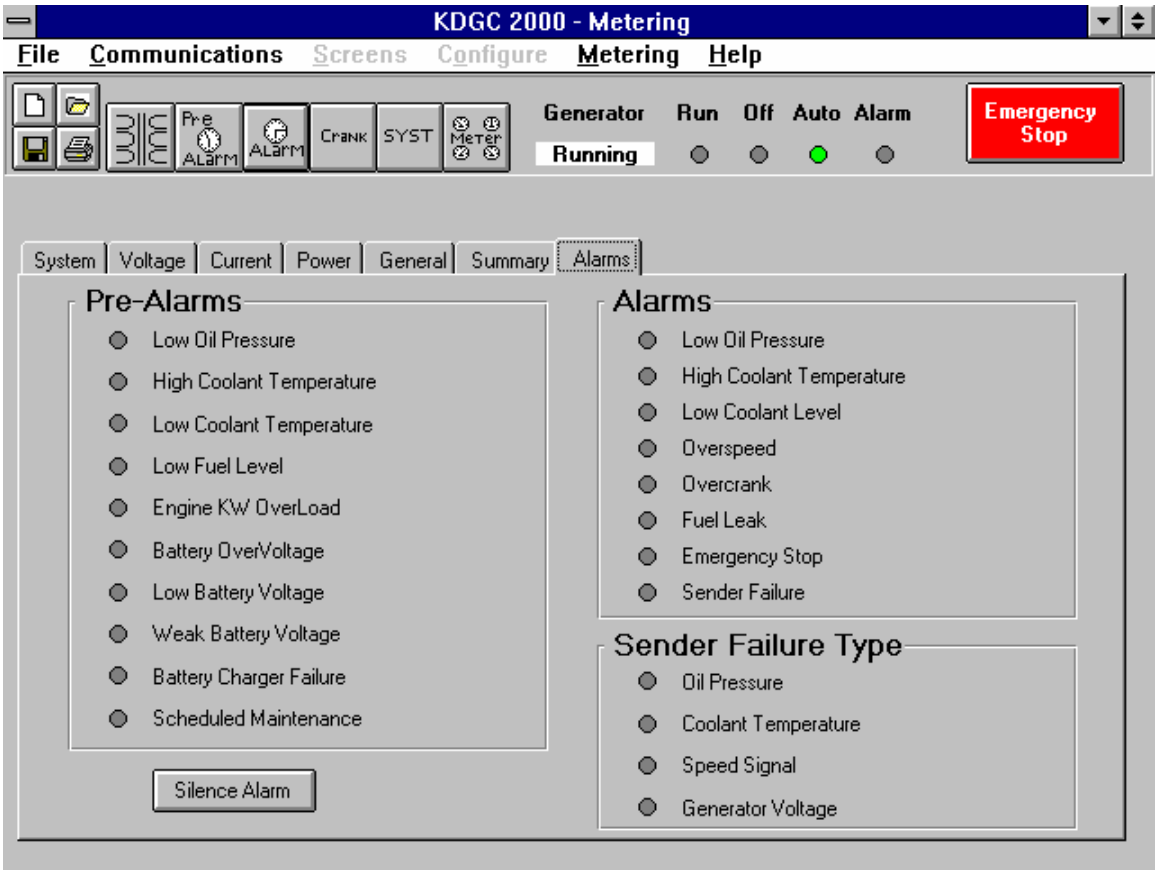

Figure 7-19. Metering - Alarms Screen

Top Portion Of The Screen

This area of the screen contains icon buttons for New File, File Open, Save File, Print File and a button for each screen. Refer to Figure 7-20.

New File - Overwrites the current settings with default settings as a starting point.

File Open - Open a currently saved settings file.

File Save - Saves the settings that are being edited to a settings file.

Print File - Prints a hard copy of the settings.

The Generator Status gives the last received state of the generator if you are logged on. When metering is enabled this is updated continuously along with the other meter readings. When metering is disabled it only checks the generator status when another communication event happens i.e. logon, send settings or get settings).

Emergency Stop button - This button is used to shut the generator down in an emergency. You must be logged onto the KDGC for this button to be active. When this button is selected it will change into an *Emergency Reset button*.

Figure 7-20. Top Portion of Screen

APPENDIX A • KDGC-2000 SETTINGS RECORD

INTRODUCTION

This appendix provides a complete listing of all KDGC-2000 settings. This listing is in the form of a settings record that you may use to record information relative to your system. These settings sheets may be removed and photo copied.

KDGC-2000 SETTINGS RECORD

Genset ID_____ **Date**_____

KDGC-2000 Serial Number_____ **Software Version Number**_____

Parameter	User Setting
FREQUENCY	
BATTERY VOLTAGE	
UNITS	
NFPA LEVEL	
SENSING CONNECTION	
PARITY	
BAUD RATE	
ADDRESS	
GENERATOR PT PRIMARY	
GENERATOR PT SECONDARY	
GENERATOR CT PRIMARY	
BUS PT PRIMARY	
BUS PT SECONDARY	
FLYWHEEL TEETH	
RATED RPM	
COOLDOWN TIME	
GENERATOR RATING	
ALTERNATOR FREQUENCY	
SPEED SIGNAL SOURCE	
PHASE ROTATION	
OVERSPEED ALARM	
THRESHOLD	
DELAY	
HIGH COOLANT TEMP	
ALARM	
THRESHOLD	
DELAY	
HIGH COOLANT TEMP	
PRE-ALARM	
THRESHOLD	

Parameter	User Setting
ARMING DELAY	
LOW OIL PRESSURE	
ALARM	
THRESHOLD	
ARMING DELAY	
LOW OIL PRESSURE	
PRE-ALARM	
THRESHOLD	
ARMING DELAY	
LOW COOLANT TEMPERATURE	
PRE-ALARM	
THRESHOLD	
ARMING DELAY	
LOW FUEL LEVEL	
PRE-ALARM	
THRESHOLD	
WEAK BATTERY	
PRE-ALARM	
THRESHOLD	
ACTIVATION DELAY	
LOW BATTERY	
PRE-ALARM	
THRESHOLD	
ACTIVATION DELAY	
BATTERY OVERVOLTAGE	
PRE-ALARM	
THRESHOLD	
BATTERY CHARGER	
FAILURE PRE-ALARM	

Parameter	User Setting

GLOBAL SENDER	
FAILURE ALARM	
ARMING DELAY	
GLOBAL PRE-ALARM	
BUZZER	
MAINTENANCE INTERVAL	
PRE-ALARM	
THRESHOLD	
ENGINE KILOWATT	
OVERLOAD PRE-ALARM	
THRESHOLD	
CRANKING STYLE	
CRANK CYCLES	
CYCLE CRANK TIME	
CONTINUOUS CRANK TIME	
PRE-CRANK DELAY	
PRE-START CONTACT AFTER DISCONNECT	
CRANK DISCONNECT SPEED	
SAFE RESTART SPEED	

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INSTRUCTION MANUAL

for

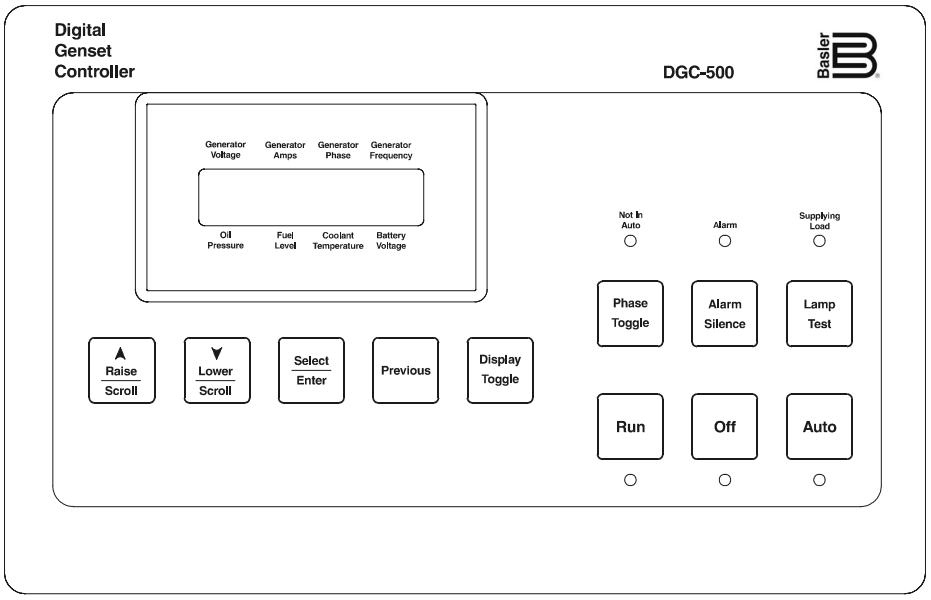
DGC-500

DIGITAL GENSET CONTROLLER

(Katolight equivalent is KDGC-500)

Publication: 9355400990

Revision: F 03/05



Basler Electric

INTRODUCTION

This manual provides information concerning the operation and installation of the Basler DGC-500 Digital Genset Controller. To accomplish this, the following information is provided.

- Specifications
- Functional Description
- Communication Software Description
- Installation Information
- Troubleshooting Information

WARNING!

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures presented in this manual.

First Printing: March 2002

Printed in USA

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March 2005

CONFIDENTIAL INFORMATION

Of Basler Electric. It is loaned for confidential use, subject to return on request, and with the mutual understanding that it will not be used in any manner detrimental to the interest of Basler Electric.

It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Should further information be required, contact Basler Electric.

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PRODUCT REVISION HISTORY

The following information provides a historical summary of the changes made to the embedded firmware, communication software (BESTCOMS), and hardware of this device. The corresponding revisions made to this instruction manual are also summarized. This revision history is separated into four categories: Firmware Version, BESTCOMS Version, Hardware Version, and Manual Version. All revisions are listed in reverse chronological order.

Firmware Version	Summary
3.06.XX - 03/05	• Added configurable ECU contact, pulsing, and sleep mode disables, and single-phase A-C sensing.
3.05.XX - 09/04	• Added generator protection, event log, real-time clock, run statistics, and sleep mode.
2.04.XX - 10/03	• Added Engine Start/Stop Configuration setting to accommodate Volvo Penta EDC applications. Added CANBus Address setting and Genset kW Rating setting.
2.03.XX - 03/03	• Added support for SAE J1939 interface and 400 Hz operation
2.01.XX - 07/02	• Increased the maximum Sender Failure Alarm time delay setting from 10 seconds to 30 seconds.
1.00.XX - 03/02	• Initial release

BESTCOMS Version	Summary
1.05.XX - 03/05	• Added configurable ECU contact, pulsing, and sleep mode disables, and single-phase A-C sensing.
1.04.XX - 09/04	• Added generator protection, event log, real-time clock, and run statistics.
1.03.XX - 10/03	• Added Engine Start/Stop Configuration setting to accommodate Volvo Penta EDC applications. Added CANBus Address setting and Genset kW Rating setting.
1.02.XX - 03/03	• Added settings for support of SAE J1939 interface and 400 Hz operation.
1.01.XX - 07/02	• Increased the maximum setting of the Global Sender Failure Alarm Time Delay from 10 seconds to 30 seconds.
1.00.XX - 03/02	• Initial release

Hardware Version (Standard Order P/N)	Summary
Q - 12/04	• Modified current metering circuitry.
P - 11/04	• BESTCOMS version 1.04.01 released to address compatibility issue with Microsoft® Windows® XP SP2.
O	• Not implemented
N - 09/04	• Implemented a higher-performance microprocessor and added an external memory (EEPROM) chip.
M - 06/04	• Increased moisture resistance by adding conformal coating to the printed circuit board assembly.

Hardware Version (Standard Order P/N)	Summary
L - 10/03	• Implemented firmware version 2.04.XX and BESTCOMS version 1.03.XX
K - 09/03	• Added reference to instruction manual on parts list
J - 07/03	• Implemented firmware version 2.03.XX and BESTCOMS version 1.02.XX
I	• Not implemented
H - 06/03	• Circuit board layout revised to improve manufacturing process
G - 04/02	• Initial release

Hardware Version (Special Order P/N)	Summary
H - 12/04	• Modified current metering circuitry.
G - 11/04	• BESTCOMS version 1.04.01 released to address compatibility issue with Microsoft® Windows® XP SP2.
F - 09/04	• Implemented a higher-performance microprocessor and added an external memory (EEPROM) chip.
E - 06/04	• Increased moisture resistance by adding conformal coating to the printed circuit board assembly.
D - 10/03	• Implemented firmware version 2.04.XX and BESTCOMS version 1.03.XX
C - 09/03	• Added reference to instruction manual on parts list
B - 07/03	• Implemented firmware version 2.03.XX and BESTCOMS version 1.02.XX
A - 06/03	• Circuit board layout revised to improve manufacturing process

Manual Version	Summary
F - 03/05	• Added description of Sleep mode disable setting. • Added information about ECU contact configuration and pulsing settings. • Changed all “Volvo Penta EDC” references to “Volvo Penta EDC III”. • Added J1939 interface parameters to Appendix C, *DGC-500 Settings Record*.
E - 09/04	• Added text and illustrations describing added real-time clock, generator run statistics, event log, and generator protection functions. • Added *Time Overcurrent Characteristic Curves* appendix. • Modified style chart to accommodate generator protection option. • Added torque specification for mounting hardware.
D - 03/04	• Added suitability and warning statements concerning compliance of part numbers 9 3554 00 113 and 9 3554 00 114 with cURus Standard 1604.
C - 09/03	• Added descriptions associated with new settings: CANBus Address, Engine Stop/Start Configuration, and Genset’s kW Rating. • Added information pertaining to DGC Isolator Kits. • Added Volvo Penta EDC application information and diagrams. • Updated Pre-Alarm and Alarm information in Section 3, *Functional Description* to include metric equivalents for settings.

Manual Version	Summary
B - 03/03	• Revised style chart to show NFPA compliance as standard, J1939 support as optional. • Added coverage for part numbers 9 3554 00 111, 112, 113, and 114. • Added information about J1939 interface, ECU support, and state machine operation where appropriate. • Revised BESTCOMS section to accommodate new ECU settings. • Created new appendix of settings list with range for each setting.
A - 07/02	• Added instructions to Section 3, *Functional Description* for viewing firmware version. • Revised the maximum setting of Sender Failure Alarm Time from 10 seconds to 30 seconds in Tables 3-1 and 3-2. • Replaced actual BESTCOMS version number in Figure 4-2 with generic version number.
— - 02/02	• Initial release

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SECTION 1 • GENERAL INFORMATION

DESCRIPTION

The DGC-500 Digital Genset Controller provides integrated engine-generator set control, protection, and metering in a single package. Microprocessor based technology allows for exact measurement, setpoint adjustment, and timing functions. Front panel controls and indicators enable quick and simple DGC-500 operation. Basler Electric communication software (BESTCOMS-DGC500-32) allows units to be easily customized for each application. Because of the low sensing burden in the DGC-500, neither dedicated potential transformers (PTs) nor current transformers (CTs) are required. A wide temperature-range liquid crystal display (LCD) with backlighting can be viewed under a wide range of ambient light and temperature conditions.

An event log retains a history of system events in nonvolatile memory. Up to 30 event types are retained and each record contains a time stamp and the number of occurrences for each event.

Optional, multifunction generator protection guards against generator overvoltage, undervoltage, underfrequency, overfrequency, overcurrent, and phase imbalance. Each generator protection function has an adjustable pickup and time delay setting. Sixteen inverse time curves enable the DGC-500 to offer overcurrent protection in a variety of applications.

An optional, SAE J1939 interface provides high-speed communication between the DGC-500 and the engine control unit (ECU) on an electronically controlled engine. This interface provides access to oil pressure, coolant temperature, and engine speed data by reading these parameters directly from the ECU. When available, engine diagnostic data can also be accessed.

FEATURES

DGC-500 Digital Genset Controllers have the following features.

- Resistant to high moisture, salt fog, humidity, dust, dirt, and chemical contaminants
- Resistant to the entrance of insects and rodents
- Suitable for mounting in any top mount enclosure
- Suitable for controlling isolated generating systems or paralleled generating systems
- Serial link communications and BESTCOMS software eases access to setup parameters
- Compliant with National Fire Prevention Association (NFPA) Standard 110
- Optional SAE J1939 interface provides high-speed communication with the ECU on electronically controlled engines

FUNCTIONS

DGC-500 Digital Genset Controllers perform the following functions.

- Engine cranking control
- Generator voltage metering
- Generator frequency metering
- Generator current metering
- Engine coolant temperature metering
- Engine coolant temperature protection
- Engine oil pressure metering
- Engine oil pressure protection
- Fuel level sensing
- Fuel level sender protection
- Fuel leak detector
- Engine cool down
- VA metering
- Engine rpm metering
- Engine run time metering
- Battery voltage metering
- Battery condition monitoring
- Engine maintenance monitoring
- Engine diagnostic reporting
- Event log stores a history of up to 30 system event types
- Multifunction generator protection (optional)

OUTPUTS

Five isolated, form A output contacts are provided: Engine Crank, Fuel Solenoid, Pre-Start, and two user-programmable outputs.

OPTIONAL EQUIPMENT

An optional Remote Annunciation Display Panel (RDP-110) is available for use with the DGC-500.

Applications that require remote annunciation can use the Remote Display Panel, RDP-110. This display panel annunciates all DGC-500 alarms, pre-alarms, and operating conditions.

STYLE AND PART NUMBERS

Standard-order DGC-500 controllers are identified by a style number. Special-order DGC-500 controllers are specified by ten-digit part numbers

Style Numbers

The electrical characteristics and operational features of a standard-order DGC-500 are defined by a combination of letters and numbers that make up the style number. The model number, together with the style number, describe the options included in a specific device. Figure 1-1 illustrates the DGC-500 style number identification chart.

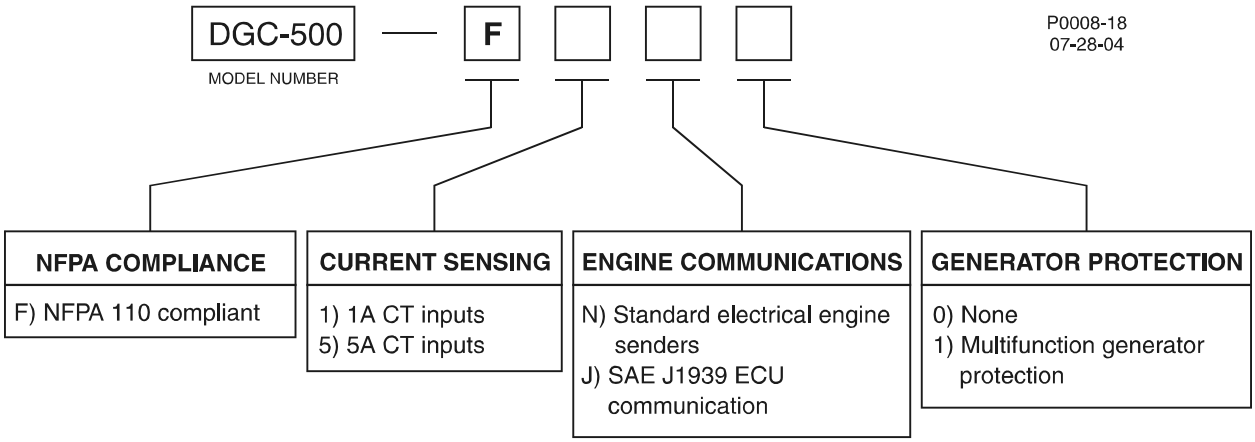

Figure 1-1. DGC-500 Style Number Chart

For example, if a DGC-500 style number is F5J1, the device has the following characteristics and operating features.

F . . . . Compliance to NFPA Standard 110
5 . . . . 5 ampere current sensing inputs
J . . . . ECU communication through the SAE J1939 protocol
1 . . . . Multifunction generator protection

The DGC-500 style number is printed on a label located on the circuit board near the voltage and current input connections. Upon receipt of a unit, be sure to check the style number against the requisition and the packing list to ensure that they agree.

Part Numbers

A ten-digit part number specifies the electrical characteristics and operational features of special-order DGC-500 controllers. Table 1-1 lists the special-order DGC-500 controllers available along with descriptions of their operating features.

Table 1-1. Special-Order DGC-500 Controllers

Part Number	Style Number	Special Features
9355400111	F5J0	400 Hz nominal frequency
9355400112	F1J0	
9355400127	F5J1	
9355400128	F1J1	
9355400113	F5J0	cURus recognized for use in hazardous locations
9355400114	F1J0	
9355400129	F5J1	
9355400130	F1J1	

SPECIFICATIONS

Current Sensing

Accuracy: ±1% of full scale or ±2 A, whichever is greater
Burden: 1 VA
Terminals: P10, P11 (A-phase)
P12, P14 (B-phase)
P15, P17 (C-phase)

1 Ampere Inputs

Continuous Rating: 0.02 to 1.0 A
1 Second Rating: 2 A

5 Ampere Inputs

Continuous Rating: 0.1 to 5.0 A
1 Second Rating: 10 A

Voltage Sensing

Accuracy: ±1% of full scale or ±2 V, whichever is greater
Burden: 1 VA
Range: 12 to 576 V rms, line-to-line
1 Second Rating: 720 V rms
Terminals: P23 (A-phase), P26 (B-phase), P29 (C-phase), P30 (Neutral)

Frequency

Accuracy: ±0.25% of reading or ±0.2 Hz, whichever is greater
Display Range: 4 to 70 Hz
4 to 450 Hz (P/N 9355400111, 9355400112 only)

Contact Sensing

Emergency Stop Input

Type: Normally-closed dry contacts
Terminals: P35, P39

Programmable Inputs (3)

Type: Normally-open dry contacts
Terminals: P2, P21 (Input 1)
P3, P21 (Input 2)
P4, P21 (Input 3)

Engine System Inputs

✳ Stated accuracies are subject to the accuracy of the senders used.

Fuel Level Sensing

Accuracy:	±3% of indication or ±2% ✳
Range:	33 to 240 Ω nominal
Terminals:	P16, P19 (common)

Coolant Temperature Sensing

Accuracy:	±3% of indication (37°C to 115°C (99°F to 239°F))
	±2°, whichever is greater at 25°C (77°F) ✳
Range:	62.6 to 637.5 Ω nominal
Terminals:	P18, P19 (common)

Oil Pressure Sensing

Accuracy:	±3% of indication (0 to 690 kPa) or ±12 kPa, whichever is greater at 25°C (77°F)
	±3% of indication (0 to 100 psi) or ±2 psi, whichever is greater
Range:	34 to 240 Ω nominal
Terminals:	P13, P19 (common)

Battery Voltage Sensing

Accuracy:	±3% of indication or ±0.2 V, whichever is greater
Nominal:	12 or 24 Vdc
Range:	8 to 32 Vdc (battery dip ride-through to 6 Vdc for 0.75 sec)
Burden:	16 W maximum

Magnetic Pickup Sensing

Voltage Range:	3 V to 35 V peak continuous into 13 kΩ (during cranking)
Frequency Range:	32 to 10,000 Hz
Terminals:	P39 (+), P40 (–)

Engine RPM Sensing

Accuracy:	±0.5% of indication or ±2 rpm, whichever is greater at 25°C (77°F)
Range:	750 to 3,600 rpm

Calculated Data

Voltamperes

Accuracy:	±2% of indication or ±2 kVA, whichever is greater
Range:	0 to 9,999 kVA

Engine Run Time

Accuracy:	±0.5% of reading or ±1 hour, whichever is greater at 25°C (77°F)
Range:	0 to 99,999 hours

Maintenance Interval

Accuracy:	±0.5% of reading or ±1 hour, whichever is greater at 25°C (77°F)
Range:	0 to 5,000 hours

Generator Protection Functions

Overvoltage (59) and Undervoltage (27)

Pickup Range:	70 to 576 Vac
Pickup Increment:	1 Vac
Inhibit Frequency Range:	20 to 400 Hz (applies to 27 function only)
Time Delay Range:	0 to 30 s
Time Delay Increment:	0.1 s

Underfrequency (81U) and Overfrequency (81O)

Pickup Range:	45 to 65 Hz (50/60 Hz nominal) 360 to 440 Hz (400 Hz nominal)
Pickup Increment:	0.1 Hz
Inhibit Voltage Range:	70 to 576 Vac (applies to 81U function only)
Time Delay Range:	0 to 30 s
Time Delay Increment:	0.1 s

Overcurrent (51)

Pickup Range:	0.18 to 1.18 Aac (1 A current sensing) 0.9 to 7.75 Aac (5 A current sensing)
Time Dial Range:	0 to 30 s (fixed time delay) 0 to 9.9 (inverse curve time multiplier)
Time Dial Increment:	0.1 s
Inverse Time Curves:	See Appendix A, *Time Overcurrent Characteristic Curves*

Phase Imbalance (47)

Pickup Range:	5 to 100 Vac
Pickup Increment:	1 Vac
Time Delay Range:	0 to 30 s
Time Delay Increment:	0.1 s

Output Contacts

Engine Crank, Fuel Solenoid, and Pre-Start Relays

Rating:	30 A at 28 Vdc, make, break, and carry ✳
Terminals:	K1-N.O., COM (Engine Crank) K2-N.O., COM (Fuel Solenoid) K5-N.O., COM (Pre-Start)

✳ The contact rating is reduced to 3 A for part numbers 9355400113 and 9355400114 when used in a hazardous location.

Programmable Relays (2)

Rating:	2 A at 30 Vdc, make break, and carry
Terminals:	P33, P34 (Output 1) P36, P38 (Output 2)

Horn Output

Voltage:	24 Vdc or battery voltage, whichever is less
Current:	15 mAdc maximum
Compatible Device:	Basler P/N 29760
Terminals:	P24 (+), P25 (–)

Communication Interface

Full Duplex RS-232

Connection:	Female DB-9 connector (J1)
Baud:	1200, 2400, or 9600
Data Bits:	8
Parity:	None, Odd, or Even
Stop Bit:	1

SAE J1939 Interface

Differential Bus Voltage:	1.5 to 3 Vdc
Maximum Voltage:	–32 to 32 Vdc (with respect to negative battery terminal)
Communication Rate:	250 kb/s

Environment

Temperature Range

Operating:	–20 to 60°C (–4 to 140°F)
Storage:	–40 to 85°C (–40 to 185°F)

Type Tests

Shock

15 G in 3 perpendicular planes

Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15 minute sweep consisting of the following:

5 to 29 to 5 Hz:	1.5 G peak for 5 min.
29 to 52 to 29 Hz:	0.036" DECS-A for 2.5 min.
52 to 500 to 52 Hz:	5 G peak for 7.5 min.

Salt Fog

Tested per ASTM-117B-1989

Radio Interference

Type tested using a 5 W, hand-held transceiver operating at random frequencies centered around 144 and 440 MHz with the antenna located within 150 mm (6") of the device in both vertical and horizontal planes.

Dielectric Strength

2,352 Vac at 50/60 Hz for 1 second between voltage sensing inputs and all other circuits.

500 Vac at 50/60 Hz for 1 minute between any of the following groups.

- Current Sensing Inputs: 8 mA
- RS-232 Port: 6 mA

UL Recognition

All DGC-500 controllers are UL recognized per Standard 508, *Standard for Industrial Control Equipment* (UL File E97035).

Part Numbers 9355400113 and 9355400114

cURus recognized per Standard 1604, *Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations*, Class I, Division 2, Groups A, B, C, D, Zone 2, Temperature Code T5.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D, or nonhazardous locations only.

WARNING! – EXPLOSION HAZARD
(9355400113 and 9355400114 only)

Substitution of components may impair suitability for Class I, Division 2.

Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

CSA Certification

Certified per Standard CAN/CSA-C22.2,
Number 14-95, CSA File LR 23131 (excludes P/N 9355400113, 9355400114)

NFPA Compliance

All DGC-500 controllers comply with NFPA Standard 110, *Standard for Emergency and Standby Power Systems*.

Physical

Weight: 680 g (1.5 lb)

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SECTION 2 • HUMAN-MACHINE INTERFACE

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SECTION 2 • HUMAN-MACHINE INTERFACE

INTRODUCTION

This section describes the components of the DGC-500 human-machine interface (HMI). DGC-500 HMI components are located on the front panel (controls and indicators) and the rear panel (terminals and connectors).

FRONT PANEL

Figure 2-1 illustrates the front panel HMI of the DGC-500. Table 2-1 lists the call-outs of Figure 2-1 along with a description of each HMI component.

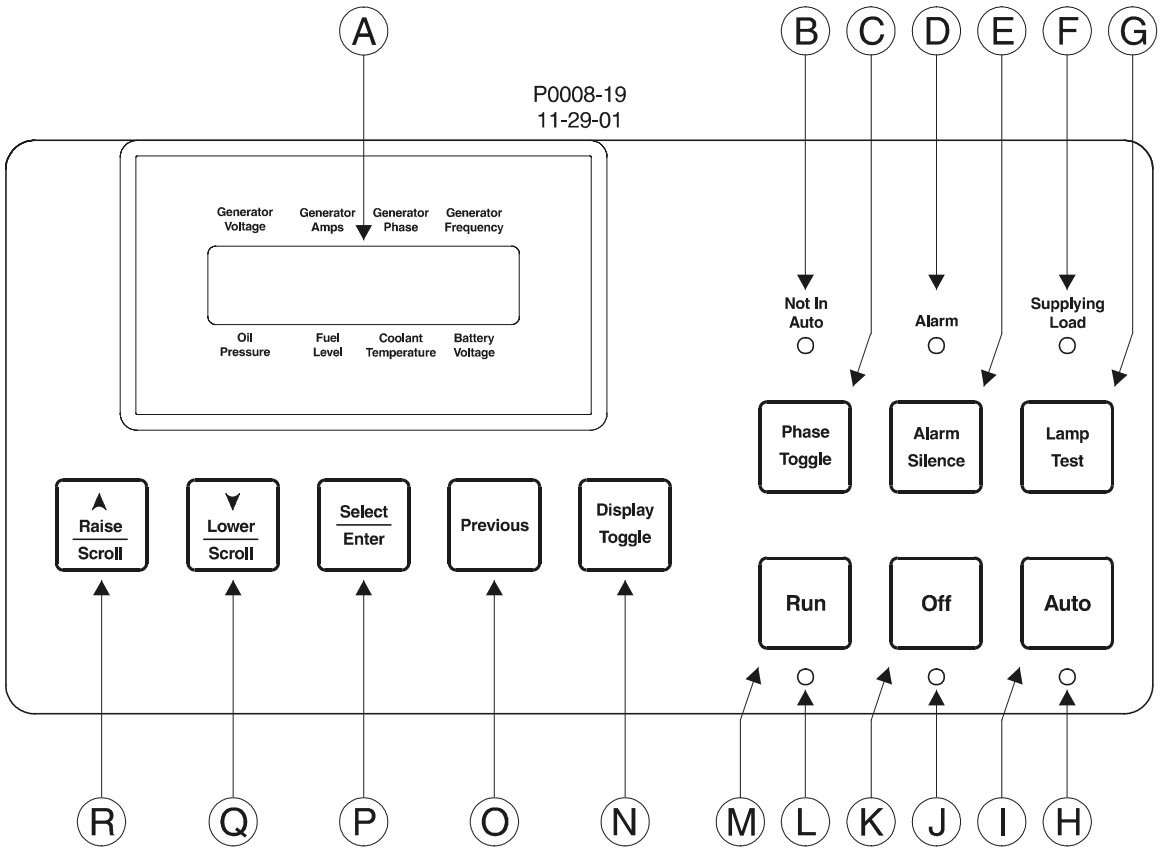

Figure 2-1. DGC-500 Front Panel HMI

Table 2-1. DGC-500 Front Panel HMI Descriptions

Call-Out	Description
A	*Liquid Crystal Display.* The backlit, two line by 16 character LCD is the primary interface for metering, alarms, pre-alarms, and protective functions. The LCD has three standard display modes (Normal, Alternate, and Menu) and one optional display mode (ECU Parameters). In Normal mode, the displayed parameters correspond to one of the eight labels surrounding the LCD. In Alternate mode, the LCD displays parameters and the corresponding labels. In Menu mode, the LCD scrolls through the DGC-500 setup parameters. In the optional ECU Parameters mode, the LCD scrolls through genset parameters (metered from the ECU) and engine configuration parameters.
B	*Not in Auto Indicator.* This red LED lights when the DGC-500 is not operating in Auto mode.
C	*Phase Toggle Pushbutton.* Pressing this control scrolls through the parameters available in Normal display mode.
D	*Alarm Indicator.* This red LED lights continuously during alarm conditions and flashes during pre-alarm conditions.
E	*Alarm Silence Pushbutton.* Pressing this control resets the DGC-500 audible alarm.
F	*Supplying Load Indicator.* This green LED lights when the generator is supplying more than two percent of rated current.
G	*Lamp Test Pushbutton.* Pressing this control tests the DGC-500 indicators by exercising all LCD segments and lighting all LEDS.
H	*Auto Mode Indicator.* This green LED lights when the DGC-500 is operating in Auto mode.
I	*Auto Pushbutton.* Pressing this control places the DGC-500 in Auto mode.
J	*Off Mode Indicator.* This red LED lights when the DGC-500 is in Off mode.
K	*Off Pushbutton.* Pressing this control places the DGC-500 in Off mode.
L	*Run Mode Indicator.* This green LED lights when the DGC-500 is operating in Run mode.
M	*Run Pushbutton.* Pressing this control places the DGC-500 in Run mode.
N	*Display Toggle Pushbutton.* Pressing this control scrolls through the display modes.
O	*Previous Pushbutton.* Pressing this control scrolls through the LCD display modes.
P	*Select/Enter Pushbutton.* This control is pressed to enter menu sub-levels and select setpoints.
Q	*Lower/Scroll Pushbutton.* This control is pressed to scroll backward through menus or decrement setpoints.
R	*Raise/Scroll Pushbutton.* This control is pressed to scroll forward through menus or increment setpoints.

REAR PANEL

All DGC-500 interface terminals are located on the rear panel. DGC-500 units have two types of terminals: quarter-inch, male, quick-connect terminals and a DB9 serial communication connector. Figure 2-2 illustrates the DGC-500 rear-panel HMI. Table 2-2 lists the call-outs of Figure 2-2 along with a description of each rear-panel HMI component.

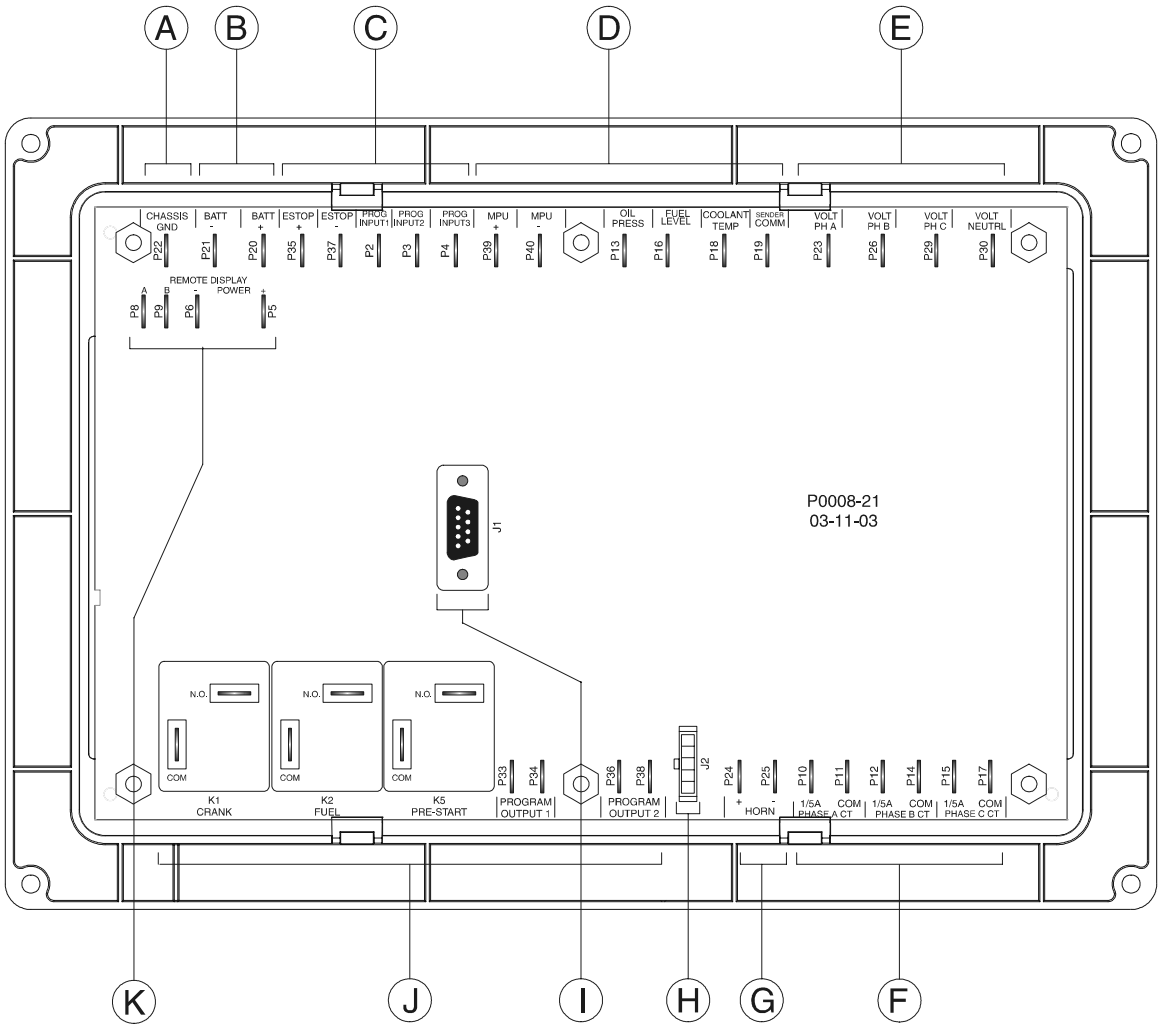

Figure 2-2. DGC-500 Rear Panel HMI

Table 2-2. DGC-500 Rear Panel HMI Descriptions

Call-Out	Terminals	Description
A	P22	*CHASSIS GND.* This terminal provides the chassis ground connection. The DGC-500 must be hard-wired to earth ground with no smaller than 12 AWG copper wire.
B	P20 (+), P21 (–)	*BATT.* DGC-500 operating power is applied to these terminals. The DGC-500 accepts a nominal input of 12 Vdc or 24 Vdc.
C	P35 (+), P37 (–) P2, P3, P4	**Contact Sensing Terminals** *ESTOP.* These terminals function as the Emergency Stop input. Power is removed from all DGC-500 output relays when this input is open. PROG INPUT1, PROG INPUT2, PROG INPUT3. These three inputs can be independently programmed to function as an auto transfer switch input, single-phase override input, low coolant level input, fuel leak detection input, battery charger failure input, or an auxiliary input. The inputs accept normally-open contacts connected between terminals P2 (PROG INPUT1), P3 (PROG INPUT2), or P4 (PROG INPUT3) and terminal P21 (BATT –).

Call-Out	Terminals	Description
D		**Transducer Terminals**
	P39 (+), P40 (–)	*MPU.* These terminals accept the output from a magnetic pickup. Voltage applied to this input is scaled and conditioned for use as a speed signal.
	P13	*OIL PRESS.* The output from an oil pressure transducer is applied to this input. A current signal lower than 5 mA can be applied between terminal P13 and P19 (SENDER COMM).
	P16	*FUEL LEVEL.* The output from a fuel level transducer is applied to this input. The DGC-500 supplies a transducer current signal of less than 30 mA to terminals P13 and P19 (SENDER COMM).
	P18	*COOLANT TEMP.* The output from a coolant temperature transducer is applied to this input. The DGC-500 supplies a transducer current signal of less than 5 mA to terminals P16/P18 and P19 (SENDER COMM).
	P19	*SENDER COMM.* This terminal functions as the common return line for all of the transducer inputs.
E		**Voltage Sensing Terminals**
	P23	*VOLT PH A.* This terminal senses the A-phase generator voltage.
	P26	*VOLT PH B.* This terminal senses the B-phase generator voltage.
	P29	*VOLT PH C.* This terminal senses the C-phase generator voltage.
	P30	*VOLT NEUTRAL.* This terminal connects to the generator Neutral in phase-to-neutral sensing applications.
F		**Current Sensing Terminals**
	P10(1/5A), P11(COM)	*PHASE A CT.* These terminals sense the A-phase generator current.
	P12(1/5A), P14(COM)	*PHASE B CT.* These terminals sense the B-phase generator current.
	P15(1/5A), P17(COM)	*PHASE C CT.* These terminals sense the C-phase generator current.
G	P24 (+), P25(–)	*HORN.* This output supplies power to an external horn. The voltage supplied is 24 Vdc or the battery voltage, whichever is less. A maximum current of 15 mAdc is available.
H	J2	*SAE J1939 Connector.* This connector is enabled on controllers with a style number of FXJ and provides high-speed communication between the DGC-500 and the ECU on an electronically controlled engine.
I	J1	*RS-232 COMMUNICATION PORT.* This DB9 connector uses serial communication to enhance DGC-500 setup. A standard serial cable connects the DGC-500 to a PC.
J		**Output Contact Terminals**
	K1-N.O., K1-COM	*CRANK.* This output is closed when the DGC-500 is initiating engine cranking.
	K2-N.O., K2-COM	*FUEL.* This output closes when engine cranking is initiated and remains closed until a stop command is received by the DGC-500.
	K5-N.O., K5-COM	*PRE-START.* This output closes to energize the glow plugs prior to engine cranking. Depending on system setup, the Pre-Start output may open upon engine startup or stay closed during engine operation.
	P33, P34	*PROGRAM OUTPUT1.* This output closes when a user-programmable condition is detected by the DGC-500.
	P36, P38	*PROGRAM OUTPUT2.* This output closes when a user-programmable condition is detected by the DGC-500.

Call-Out	Terminals	Description
K		**Remote Display Terminals**
	P5 (+), P6 (–)	*Power.* These terminals provide operating power to the optional Remote Display Panel (RDP-110).
	P8 (A), P9 (B)	*Communication.* These terminals provide an RS-485 interface for communication with the optional Remote Display Panel (RDP-110).

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SECTION 3 • FUNCTIONAL DESCRIPTION

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SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

This section describes how the DGC-500 functions and explains its operating features. A detailed description of each function block is provided in the paragraphs under the heading of *DGC-500 Function Blocks*.

DGC-500 operating features are described under the heading of *Software Operation*.

DGC-500 FUNCTION BLOCKS

To ease understanding, DGC-500 functions are illustrated in the block diagram of Figure 3-1. The following paragraphs describe each function in detail.

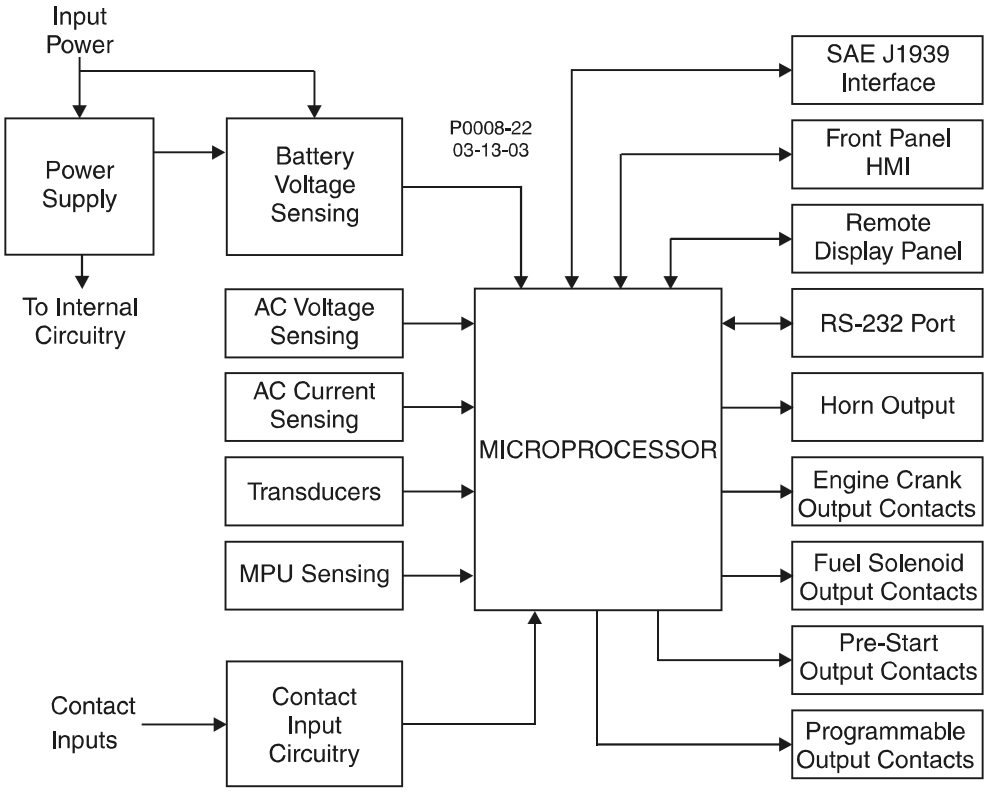

Figure 3-1. DGC-500 Function Block Diagram

Power Supply

The internal, switch-mode power supply uses the applied battery voltage to generate operating power for the internal circuitry of the DGC-500. The power supply accepts a nominal battery voltage of 12 or 24 Vdc and has an operating range of 8 to 32 Vdc. Battery voltage is applied to terminals P20 (+) and P21 (–).

Battery Voltage Sensing

Voltage applied to the power supply is filtered and reduced to a suitable level for sensing by the microprocessor.

Microprocessor

The microprocessor controls the overall functionality of the DGC-500 and makes decisions based on programming and system inputs.

Circuits relating to the microprocessor inputs are described in the following paragraphs.

Zero Crossing Detection

The zero crossing of A-phase to B-phase line voltage is detected and used to calculate the generator frequency.

Analog-to-Digital Converter

Scaled and conditioned signals representing the sensing voltage, sensing current, coolant temperature, fuel level, oil pressure, and battery voltage are digitized by the microprocessor's 10-bit analog-to-digital converter. The digitized information is stored in random access memory (RAM) and used by the microprocessor for all metering and protection functions.

Voltage Sensing Inputs

Generator voltages applied to the voltage sensing inputs are scaled to levels suitable for use by the internal circuitry. Voltage sensing configuration is menu-selectable.

The voltage sensing inputs accept a maximum voltage of 576 Vrms, line-to-line. Sensing voltage is applied to terminals P23 (A-phase), P26 (B-phase), P29 (C-phase), and P30 (Neutral).

Current Sensing Inputs

Generator currents are sensed and scaled to values suitable for use by the internal circuitry. Isolation is provided by internal current transformers (CTs).

DGC-500–X1 units accept a maximum current value of 1 Aac. DGC-500–X5 units accept a maximum current value of 5 Aac. Sensing current is applied to terminals P10 and P11 (A-phase), P12 and P14 (B-phase), and P15 and P17 (C-phase).

Transducer Inputs

Programmable transducer inputs of the give the DGC-500 user the flexibility to select the transducer to be used in an application. Information about programming the transducer inputs is provided in Section 6, *BESTCOMS Software*.

Oil Pressure

A current of less than 30 milliamperes is provided to the oil pressure transducer. The developed voltage is measured and scaled for use by the internal circuitry. Oil pressure transducers that are compatible with the DGC-500 include Isspro model R8919, Stewart-Warner models 279BF, 279C, 411K, and 411M, and VDO models 360025 and 360811. Other senders may be used. BESTCOMS software allows for the programming of sender characteristics. See Section 4, *BESTCOMS Software* for more information.

Oil pressure transducer connections are provided at terminals P13 and P19 (sender common).

Coolant Temperature

A current of less than 1.2 milliamperes is provided to the coolant temperature transducer. The developed voltage is measured and scaled for use by the internal circuitry. Coolant temperature transducers that are compatible with the DGC-500 include Isspro model R8959 and Stewart-Warner 334-P. Other senders may be used. BESTCOMS software allows for the programming of sender characteristics. See Section 4, *BESTCOMS Software* for more information.

Coolant temperature transducer connections are provided at terminals P18 and P19 (sender common).

Fuel Level

A current of less than 5 milliamperes is provided to the fuel level transducer. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the fuel level transducer terminals will cause the DGC-500 to indicate a failed fuel level transducer. Fuel level transducers that are compatible with the DGC-500 include Isspro model R8925. Other senders may be used. BESTCOMS

software allows for the programming of sender characteristics. See Section 4, *BESTCOMS Software* for more information.

Fuel level transducer connections are provided at terminals P16 and P19 (sender common).

Speed Signal Inputs

The DGC-500 uses signals from the voltage sensing inputs and magnetic pickup input to detect machine speed.

Voltage Sensing Inputs

Generator voltage applied to the DGC-500 voltage sensing inputs is used to measure frequency and can be used to measure machine speed.

Sensing voltage is applied to terminals P23 (A-phase), P26 (B-phase), P29 (C-phase), and P30 (Neutral).

Magnetic Pickup Input

The voltage received from the magnetic pickup is scaled and conditioned for use by the internal circuitry as a speed signal source.

Magnetic pickup connections are provided at terminals P39 (+) and P40 (–).

Contact Input Circuitry

The DGC-500 has four contact sensing inputs: Emergency Stop and three programmable inputs.

Emergency Stop Input

This input accepts Form A, dry contacts. An open circuit at this continuously monitored input initiates an emergency stop. An emergency stop removes operating power from all DGC-500 output relays.

Emergency stop contact connections are provided at terminals P35 and P37.

Programmable Inputs

Each programmable input (PROG INPUT1, PROG INPUT2, and PROG INPUT3) can be independently configured as an auto transfer switch input, single-phase override input, low coolant level input, fuel leak detection input, battery charger failure input, or an auxiliary input. By default, each programmable input is disabled.

The programmable inputs accept normally open, Form A contacts. A contact is connected between a programmable input and the negative side of the battery voltage. Through BESTCOMS software, each programmable contact input can be assigned a name (eight characters, maximum) and configured as an alarm input, a pre-alarm input, or neither. The default names for the inputs are AUX IN 1, AUX IN 2, and AUX IN 3. When a programmable contact input is closed, the front panel display shows the name of the closed input if it was programmed as an alarm or pre-alarm input. Alarm inputs are annunciated through the Normal display mode screens of the front panel. Pre-alarm inputs are annunciated through the Alternate display mode screens of the front panel. If neither is programmed, no indication is given. Programming an input as neither is useful when a programmable input is used to close one of the DGC-500's programmable outputs.

Connections for the programmable inputs are provided at terminals P2 (PROG INPUT1), P3 (PROG INPUT2), and P4 (PROG INPUT3). The negative side of the battery voltage (terminal P21) serves as the return connection for the programmable inputs.

Front Panel HMI

The front panel HMI provides a convenient interface for viewing system parameters and for controlling the DGC-500 and generator operation. Front panel HMI components include an LCD (liquid crystal display), LEDS (light emitting diodes), and pushbuttons.

LCD

The backlit LCD provides metering, pre-alarm, and alarm information. Detailed information about the LCD is provided in the *Software Operation* sub-section.

LEDs

The LEDs indicate pre-alarm and alarm conditions along with DGC-500 status and generator status.

Pushbuttons

The pushbuttons are used to scroll through and select parameters displayed on the LCD, change setpoints, start and stop the generator, and reset alarms.

Remote Display Panel

Applications that require remote annunciation can use Basler Electric's Remote Display Panel, RDP-110. Using the RDP-110 with the DGC-500 meets the requirements of NFPA Standard 110. The RDP-110 uses a standard, two-terminal RS-485 interface to communicate with the DGC-500 and receives operating power from the DGC-500. Remote indication of many pre-alarm and alarm conditions is provided by the RDP-110.

The following pre-alarm conditions are indicated by LEDs on the RDP-110 front panel.

- Low coolant temperature
- High coolant temperature
- Low oil pressure
- Low fuel level
- Weak battery
- Battery overvoltage
- Battery charger failure

The following alarm conditions are indicated by LEDs and an audible alarm on the RDP-110 front panel.

- Low coolant level
- High coolant temperature
- Low oil pressure
- Overcrank
- Overspeed
- Emergency stop
- Fuel leak/fuel level sender failure
- Engine sender unit failure

Additionally, the RDP-110 indicates when the DGC-500 is not operating in Auto mode and when the generator is supplying load.

For more information about the RDP-110, request Basler Product Bulletin SNE-2.

RS-232 Communication Port

The communication port, located on the rear panel, consists of an optically isolated female DB-9 connector. The RS-232 connector serves as a communication interface for enhances DGC-500 setup. Communication requires a standard 9-pin serial communication cable connected between the RS-232 communication port and a PC operating with BESTCOMS-DGC500-32. BESTCOMS is a Windows® based communication software package that is supplied with the DGC-500. A detailed description of BESTCOMS is provided in Section 4, *BESTCOMS Software for Windows®* .

SAE J1939 Interface (Optional)

A Controller Area Network (CAN) is a standard interface that allows communication between multiple controllers on a common network using a standard message protocol. DGC-500 controllers with a style number of XXJX have a CAN interface that supports the SAE J1939 message protocol.

Applications using an engine-driven generator set controlled by a DGC-500 may also have an Engine Control Unit (ECU). The CAN interface allows the ECU and DGC-500 to communicate. The ECU reports operating information to the DGC-500 through the CAN interface. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed for monitoring.

The primary use of the CAN interface is to obtain engine operating parameters for monitoring speed, coolant temperature, oil pressure, coolant level, and engine hours without the need for direct connection to individual senders. Table 3-1 lists the ECU parameters and Table 3-2 lists the engine configuration parameters supported by the DGC-500 CAN interface. These parameters are transmitted via the CAN interface at preset intervals. The columns labeled *Update Rate* show the parameter transmission rates. This information can also be transmitted upon user request.

Table 3-1. ECU Parameters Obtained from CAN Interface

ECU Parameter	Metric Units	English Units	Update Rate	Decimal Place	✳ SPN
Throttle (accelerator pedal) position	%	%	50 ms	10th	91
Percent load at current rpm	%	%	50 ms	none	92
Actual engine percent torque	%	%	engine speed dependent	none	513
Engine speed	rpm	rpm	engine speed dependent	none	190
Injection control pressure	MPa	psi	500 ms	none	164
Injector Metering Rail Pressure	Mpa	psi	500 ms	none	157
Total engine hours	hours	hours	requested 1.5 s	100th	247
Trip fuel	liters	gallons	requested 1.5 s	none	182
Total fuel used	liters	gallons	requested 1.5 s	none	250
Engine coolant temperature	°C	°F	1 s	none	110
Fuel temperature	°C	°F	1 s	none	174
Engine oil temperature	°C	°F	1 s	10th	175
Engine intercooler temperature	°C	°F	1 s	none	52
Fuel delivery pressure	kPa	psi	500 ms	10th	94
Engine oil level	%	%	500 ms	10th	98
Engine oil pressure	kPa	psi	500 ms	10th	100
Coolant pressure	kPa	psi	500 ms	10th	109
Coolant level	%	%	500 ms	10th	111
Fuel rate	liter/hr	gal/hr	100 ms	100th	183
Barometric pressure	kPa	psi	1 s	10th	108
Ambient air temperature	°C	°F	1 s	10th	171
Air inlet temperature	°C	°F	1 s	none	172
Boost pressure	kPa	psi	500 ms	none	102
Intake manifold temperature	°C	°F	500 ms	none	105
Air filter differential pressure	kPa	psi	500 ms	100th	107
Exhaust gas temperature	°C	°F	500 ms	10th	173
Battery voltage	Vdc	Vdc	1 s	10th	168
Switched battery voltage (at ECU)	Vdc	Vdc	1 s	10th	158

✳ SPN is Suspect Parameter Number

Table 3-2. Engine Configuration Parameters Obtained from CAN Interface

✳ Engine Configuration Parameter	Metric Units	English Units	Update Rate	Decimal Place	SPN
Engine speed at idle point 1	rpm	rpm	5 s	none	188
Percent torque at idle point 1	%	%	5 s	none	539
Engine speed at point 2	rpm	rpm	5 s	none	528
Percent torque at point 2	%	%	5 s	none	540
Engine speed at point 3	rpm	rpm	5 s	none	529
Percent torque at point 3	%	%	5 s	none	541
Engine speed at point 4	rpm	rpm	5 s	none	530
Percent torque at point 4	%	%	5 s	none	542
Engine speed at point 5	rpm	rpm	5 s	none	531
Percent torque at point 5	%	%	5 s	none	543
Engine speed at high idle point 6	rpm	rpm	5 s	none	532
Gain (KP) of endspeed governor	%/rpm	%/rpm	5 s	100th	545
Reference engine torque	Nm	ft-lb	5 s	none	544
Maximum momentary engine override speed point 7	rpm	rpm	5 s	none	533
Maximum momentary engine override time limit	seconds	seconds	5 s	10th	534
Requested speed control range lower limit	rpm	rpm	5 s	none	535
Requested speed control range upper limit	rpm	rpm	5 s	none	536
Requested torque control range lower limit	%	%	5 s	none	537
Requested torque control range upper limit	%	%	5 s	none	538

✳ Press the Select pushbutton to enter the Engine Configuration submenu. Press the Previous pushbutton to exit the submenu.

CAUTION

When the CAN interface is enabled, the DGC-500 will ignore the following sender inputs: oil pressure, coolant temperature, and magnetic pickup.

Diagnostic Trouble Codes (DTCs)

The DGC-500 obtains the diagnostic condition of the transmitting electronic components. The DGC-500 will receive an unsolicited message of a currently active diagnostic trouble code (DTC). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request. Table 3-3 lists the diagnostic information that the DGC-500 obtains over the CAN interface.

Table 3-3. Diagnostic Information Obtained Over the CAN Interface

Parameter	Transmission Repetition Rate
Active diagnostic trouble code	1 s
Lamp status	1 s
Previously active diagnostic trouble code	on request
Request to clear previously active DTCs	on request
Request to clear active DTCs	on request

DTCs are reported in coded diagnostic information that includes the Suspect Parameter Number (SPN), Failure Mode Identifier (FMI), and Occurrence Count (OC). All parameters have an SPN and are used to display or identify the items for which diagnostics are being reported. The FMI defines the type of failure detected in the subsystem identified by an SPN. The reported problem may not be an electrical failure but a subsystem condition needing to be reported to an operator or technician. The OC contains the number of times that a fault has gone from active to previously active.

Horn Output

This output connects to a user-supplied audible signal device. A change in operating status or an alarm condition energizes the horn output continuously and a pre-alarm condition pulses the horn output on and off. The annunciation continues until the condition subsides or until the front-panel Alarm Silence pushbutton is pressed.

The horn output supplies 15 mAdc maximum at the lesser of 24 Vdc or the battery voltage level. A horn compatible with the DGC-500 is available from Basler Electric as part number 29760. Horn output connections are located at terminals P24 (+) and P25 (–).

Output Contacts

All output contacts are electrically isolated from each other and from the DGC-500 internal circuitry. Output contact operation is controlled by the operating mode of the DGC-500 and the system. The output contacts are also affected by the status of the Emergency Stop contact input. When the Emergency Stop contact input is open (emergency stop condition), all output contacts open. When the Emergency Stop contact input is closed, all output contacts operate normally.

Five output contacts are available: Pre-Start, Engine Crank, Fuel Solenoid, and two Programmable output contacts.

Pre-Start

This output closes to energize the engine glow plugs. The Pre-Start output can be programmed to close up to 30 seconds prior to engine cranking. The Pre-Start output can also be programmed to open upon engine startup or remain closed as long as the engine is operating.

Crank

This output closes when engine cranking is initiated by the DGC-500. The length of time that the contacts remain closed is determined by the cranking style selected (either continuous or cycle). Cranking continues until the magnetic pickup or generator frequency indicates that the engine has started.

Fuel

This output closes when engine cranking is initiated by the DGC-500. The Fuel output remains closed until an off command is issued and the engine stops.

Programmable

Two programmable outputs (PROGRAM OUTPUT1, 2) can be user-configured to close for a variety of conditions.

Either programmable output can be programmed to close during any of the following operating conditions.

- Cooldown timer active
- EPS supplying load
- Pre-start condition in effect
- Switch not in Auto
- Programmable Input 1 closed
- Programmable Input 2 closed
- Programmable Input 3 closed

Either of the programmable outputs can be configured to give a pre-alarm indication by closing during any of the following pre-alarm conditions.

- Battery charger failure
- Battery overvoltage
- Fuel leak
- Fuel leak/sender failure
- High coolant temperature
- Low battery voltage
- Low coolant level
- Low coolant temperature
- Low fuel
- Low oil pressure
- Scheduled maintenance due
- Weak battery voltage

Either of the programmable outputs can be configured to give an alarm indication by closing during any of the following alarm conditions.

- Battery charger
- Coolant temperature sender failure
- Emergency stop
- Fuel leak
- High coolant temperature
- Loss of voltage sender failure
- Low coolant level
- Low fuel
- Low oil pressure
- MPU speed sender failure
- Oil pressure sender failure
- Overcrank
- Overspeed

SOFTWARE OPERATION

Embedded software controls all aspects of DGC-500 operation. DGC-500 software controls power-up initiation, HMI configuration, engine cranking, contact input monitoring, fault detection and annunciation, system parameter monitoring, output contact control, and communication.

Power-Up Sequence

When battery power is applied, the DGC-500 initiates a power-up sequence. During power-up, DGC-500 memory is checked and the LCD displays the embedded software version followed by a prompt to set the real-time clock. Then, all configuration data stored in nonvolatile EEPROM (electronically erasable programmable read-only memory) is brought into main memory and the DGC-500 begins operating in Normal mode. When operating in Normal mode, all enabled functions are active and all inputs are monitored.

NOTE

The run-time counter and maintenance timer values are updated in volatile memory once per minute. Updated values are saved to nonvolatile memory when the Auto/Off/Run mode of operation is changed. Additionally, while the engine is running, the run-time counter value is saved to nonvolatile memory every 15 minutes. If the battery power source fails during DGC-500 operation, these values are not updated and the changes made after the last save operation to nonvolatile memory are irretrievably lost.

Cranking

The DGC-500 can be programmed for either continuous engine cranking or cycle engine cranking.

Continuous Cranking

If desired, engine cranking can be delayed from zero to 30 seconds after initiating engine startup. When continuous engine cranking is initiated, cranking is sustained for a user-adjustable period of one to 60 seconds. A crank disconnect limit setting (10 to 100% of nominal engine speed) selects the desired engine speed above which cranking is terminated.

Cycle Cranking

If desired, engine cranking can be delayed from zero to 30 seconds after initiating engine startup. When cycle engine cranking is initiated, five to 15 seconds of cranking is followed by an equal number of seconds of rest. A maximum of seven cranking cycles (five cycles for NFPA compliant units) are allowed by the DGC-500. A crank disconnect limit setting (10 to 100% of nominal engine speed) selects the desired engine speed above which cranking is terminated.

Pre-Alarms

A pre-alarm is annunciated when a condition programmed to trigger a pre-alarm is met. When a pre-alarm condition exists, the front panel Alarm indicator flashes on and off and the Horn output (if enabled through BESTCOMS) alternates between an energized and de-energized state. The audible alarm is reset by pressing the front panel Alarm Silence pushbutton.

Active pre-alarms for oil pressure, fuel level, coolant temperature, and battery voltage are displayed on the main display of the LCD. The LCD annunciates an active pre-alarm by alternating between the current parameter value and a blacked-out field for that value. All other pre-alarms are displayed in sequence through the alternate mode display.

Each DGC-500 pre-alarm is described in the following paragraphs.

Low Oil Pressure

A low oil pressure pre-alarm occurs when the engine oil pressure decreases below the setpoint programmed in BESTCOMS. The low oil pressure pre-alarm has a setting range of 3 to 150 psi or 20 to 1,035 kPa. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Fuel

A low fuel pre-alarm occurs when the fuel level decreases below the setpoint programmed in BESTCOMS. The low fuel pre-alarm has a setting range of 10 to 100 percent.

High Coolant Temperature

A high coolant temperature pre-alarm occurs when the engine coolant temperature exceeds the setpoint programmed in BESTCOMS. The high coolant temperature pre-alarm has a setting range of 100 to 280°F or 38 to 138°C. A 60 second activation time delay prevents high coolant temperature annunciation during system startup.

Low Coolant Temperature

A low coolant temperature pre-alarm occurs when the engine coolant temperature decreases below the setpoint programmed in BESTCOMS. The low coolant temperature pre-alarm has a setting range of 50 to 100°F or 10 to 38°C.

Battery Overvoltage

A battery overvoltage pre-alarm occurs when the battery overvoltage pre-alarm function is enabled in BESTCOMS and the battery voltage level exceeds 30 Vdc for 24 Vdc system or 15 Vdc for 12 Vdc systems.

Low Battery Voltage

A low battery voltage pre-alarm occurs when the battery voltage decreases below the low battery voltage setpoint for the duration of the low battery voltage time delay setting. Both settings are made in BESTCOMS. The low battery voltage setpoint has a setting range of 12 to 24 Vdc for 24 Vdc systems and 6 to 12 Vdc for 12 Vdc systems. The low battery voltage time delay has a setting range of 1 to 10 seconds.

Weak Battery Voltage

A weak battery voltage pre-alarm occurs when the battery voltage decreases below the weak battery voltage setpoint for the duration of the weak battery voltage time delay setting. Both settings are made in BESTCOMS. The weak battery voltage setpoint has a setting range of 8 to 16 Vdc for 24 Vdc systems and 4 to 8 Vdc for 12 Vdc systems. The weak battery voltage time delay has a setting range of 1 to 10 seconds.

Maintenance Interval

A maintenance interval pre-alarm occurs when the DGC-500 maintenance timer counts down to zero from the maintenance interval setting programmed in BESTCOMS. The maintenance interval duration has a setting range of zero to 5,000 hours.

Battery Charger Failure

A battery charger failure pre-alarm occurs when one of the three DGC-500 programmable contact inputs detects a contact closure due to a battery charger failure. In order for a battery charger failure pre-alarm to occur, the battery charger failure pre-alarm function must be enabled in BESTCOMS and one of the three programmable inputs must be programmed as a battery charger failure pre-alarm input. Refer to Section 4, *BESTCOMS Software* for information about configuring the programmable contact inputs.

Fuel Level Sender Failure

A fuel level sender failure pre-alarm occurs when an open circuit or short circuit is detected across the DGC-500 fuel level transducer terminals and a fuel level sender failure is programmed in BESTCOMS to cause a pre-alarm.

MPU Failure

An MPU (magnetic pickup) failure pre-alarm occurs when MPU-GEN is selected as the generator speed signal source, the MPU signal is lost, and the Global Sender Failure Alarm time delay expires.

Active DTC

When CAN and DTC support are both enabled, an “active DTC” pre-alarm may be enabled (through BESTCOMS) to announce the presence of an condition that is causing a DTC to be sent from the ECU to the DGC-500.

CAN Failure

A CAN failure annunciation may be enabled only when the CAN interface is enabled. The CAN interface is enabled through BESTCOMS. When configured to alarm, annunciation occurs when CAN communication stops due to a lost connection between the DGC-500 and ECU, or an ECU malfunction. If CAN communication is lost and the annunciation is a pre-alarm, a screen stating the pre-alarm will appear in the Alternate Display menu. This screen will be viewable only when the pre-alarm is active.

Audible Alarm

A pre-alarm is annunciated through the DGC-500 Horn output when the audible alarm feature is enabled in BESTCOMS. When the audible alarm is enabled, a pre-alarm condition causes the horn output to alternate between an energized and de-energized state.

Alarms

An alarm is annunciated when a condition programmed to trigger an alarm is detected. When an alarm condition exists, the front panel Alarm indicator lights, the Horn output energizes, and the cause of the alarm is displayed on the LCD.

An alarm condition stops the engine by opening the Fuel output contact.

Each DGC-500 alarm is described in the following paragraphs.

Low Oil Pressure

A low oil pressure alarm occurs when the engine oil pressure decreases below the low oil pressure alarm setpoint for the duration of the low oil pressure time delay setting. Both settings are made in BESTCOMS. When a low oil pressure alarm occurs, the LCD indicates LOW OIL PRESSURE and the current low oil pressure alarm setting. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

The low oil pressure setpoint has a setting range of 3 to 150 psi or 20 to 1,035 kPa and the low oil pressure time delay has a setting range of 5 to 15 seconds.

Low Fuel Level

A low fuel level alarm occurs when the fuel level decreases below the setpoint programmed in BESTCOMS. When a low fuel level alarm occurs, the LCD indicates LOW FUEL LEVEL and the current low fuel level alarm setting.

The low fuel level setpoint has a setting range of zero to 100 percent.

High Coolant Temperature

A high coolant temperature alarm occurs when the coolant temperature exceeds the setpoint programmed in BESTCOMS. When a high coolant temperature alarm occurs, the LCD indicates HIGH COOLANT TEMP and the current high coolant temperature setting. A 60 second activation time delay prevents high coolant temperature annunciation during system startup.

The high coolant temperature setpoint has a setting range of 100 to 280°F or 38 to 138°C.

Overspeed

An overspeed alarm occurs when the engine speed exceeds the overspeed setpoint for the duration of the overspeed time delay. Both settings are made in BESTCOMS. When an overspeed alarm occurs, the LCD indicates OVERSPEED and the current overspeed setting.

The overspeed setpoint has a setting range of 105 to 140 percent and the overspeed time delay has a setting range of zero to 500 milliseconds.

Loss of Generator Voltage

A loss of generator voltage alarm can occur only when the loss of generator voltage alarm is enabled in BESTCOMS. When the sensed generator voltage decreases below 1.5 Vac for the duration of the global sender failure alarm time delay, a loss of generator voltage alarm occurs. The global sender failure alarm time delay is adjustable from 1 to 10 seconds.

Oil Pressure Sender Failure

An oil pressure sender failure alarm occurs when the DGC-500 oil pressure transducer input senses a sender failure for the duration of the global sender failure alarm time delay. The oil pressure sender failure alarm is enabled and the global sender failure alarm time delay is set in BESTCOMS.

Coolant Temperature Sender Failure

A coolant temperature sender failure alarm occurs when the DGC-500 coolant temperature transducer input senses a sender failure for the duration of the coolant temperature alarm delay time. The coolant temperature sender failure alarm is enabled and the coolant temperature alarm delay is set in BESTCOMS. The coolant temperature alarm delay is adjustable from 5 to 30 minutes in 5 minute increments.

Speed Source Failure

A speed source failure can occur for either of two conditions. If MPU (magnetic pickup) is selected as the generator speed signal source and the MPU signal is lost, a speed source failure alarm will occur. If GEN FREQ (generator frequency) is selected as the generator speed signal source and a loss of generator frequency is detected, a speed source failure alarm will occur.

CAN Failure (If Equipped)

A CAN failure annunciation may be enabled only when the CAN interface is enabled. The CAN interface is enabled through BESTCOMS. When configured to pre-alarm, annunciation occurs when CAN communication stops due to a lost connection between the DGC-500 and ECU, or an ECU malfunction. If CAN communication is lost and the annunciation is configured as an alarm, then a normal alarm sequence will occur, including a CANBUS FAILURE message that appears on the HMI display.

Real-Time Clock

The real-time clock supplies time and date information to the event log for the time stamping of events.

Clock data is held in volatile memory; clock settings are lost when DGC-500 operating power is removed. When DGC-500 operating power is restored, the DGC-500 prompts the user to set the real-time clock.

The DGC-500 keeps time in 24-hour mode and uses the HH:MM:SS format. The date format is MM/DD/YYYY. Adjustment for daylight saving time can be enabled or disabled. Clock settings may be viewed and entered in BESTCOMS or at the front panel HMI.

Generator Run Statistics

The DGC-500 compiles statistics for both individual generator run sessions and the cumulative total of all generator run sessions. Generator run statistics are stored in DGC-500 nonvolatile memory and displayed on the Run Statistics screen of BESTCOMS. When the DGC-500 and/or genset are commissioned, a date is entered for the DGC-500 to use as a starting point for tracking generator run statistics. The logs for session run and cumulative run statistics track loaded run hours, unloaded run hours, and total run hours. Additionally, the cumulative run statistics log tracks the number of engine starts and the number of hours remaining until scheduled maintenance.

Event Log

The event log maintains a history of system events in DGC-500 nonvolatile memory and displays the event record on the Event Log screen in BESTCOMS. System events are categorized by the event log into event types. The event log capacity is 30 event types.

Each event type in the log contains an event identifier label, the number of occurrences for the event, and the time stamp of the most recent event occurrence. The time stamp displayed is user-selectable and can be real-time clock data or the elapsed engine hours.

When an event type is logged, it occupies one entry (or row) in the log. If the same event type is logged again, it still only occupies one entry in the log. However, the log entry is updated with the number of occurrences and the Last Date/Time column is updated with the time stamp of the last occurrence.

If the event log contains the maximum of 30 event types and a new event type is logged, the oldest event type in the log is overwritten with the new event type.

The event types monitored by the event log are listed below.

- Active DTC exists pre-alarm
- Auto Start contact closed
- Auxiliary input 1 closed
- Auxiliary input 2 closed
- Auxiliary input 3 closed
- Battery charger failure pre-alarm
- Battery overvoltage pre-alarm
- CAN Bus Failure pre-alarm
- CAN Bus failure alarm
- Coolant level sender failure
- Coolant temperature sender failure alarm
- DGC-500 protective shutdown
- EE memory checksum error
- Emergency stop alarm
- Engine started
- Flash checksum error
- Fuel leak/sender failure pre-alarm
- Generator phase imbalance detected
- Generator overvoltage detected
- Generator undervoltage detected
- Generator overcurrent detected
- Generator underfrequency detected
- Generator overfrequency detected
- High coolant temperature pre-alarm
- High coolant temperature alarm
- Loss of voltage sender failure alarm
- Low coolant level pre-alarm
- Low fuel alarm

- Low coolant level alarm
- Low oil pressure alarm
- Low battery voltage pre-alarm
- Low oil pressure pre-alarm
- Low coolant temperature pre-alarm
- Low fuel pre-alarm
- MPU speed sender failure alarm
- Normal engine shutdown
- Oil pressure sender failure alarm
- Overcrank alarm
- Overspeed alarm
- Scheduled maintenance pre-alarm
- Unknown shutdown (with ECU enabled, engine stops without input from the DGC)
- Weak battery voltage pre-alarm

Generator Protection

Multifunction generator protection is provided on DGC-500 controller with style number XXX1. The DGC-500 can protect a generator against overvoltage, undervoltage, overfrequency, underfrequency, overcurrent, and phase imbalance.

Overvoltage (59)

Two sets of overvoltage settings are provided: one for three-phase generator connections and one for single-phase generator connections.

When the average of the three phase voltages (three-phase mode) or the average of the line-to-line voltage (single-phase mode) increases above the corresponding 59 pickup setting for the duration of the corresponding 59 time delay, an overvoltage condition is annunciated. Both overvoltage pickup settings have a range of 70 to 576 Vac and both overvoltage time delay settings have a range of 0 to 30 seconds.

An overvoltage annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An overvoltage annunciation can also be user-configured to close one or both of the programmable outputs.

When a Single-Phase Override contact input is received, the DGC-500 automatically switches from the three-phase overvoltage settings to the single-phase overvoltage settings.

Undervoltage (27)

Two sets of undervoltage settings are provided: one for three-phase generator connections and one for single-phase generator connections.

When the average of the three-phase voltage (three-phase mode) or the average of the line-to-line voltage (single-phase mode) decreases below the corresponding 27 pickup setting for the duration of the corresponding 27 time delay, an undervoltage condition is annunciated. Both undervoltage pickup settings have a range of 70 to 576 Vac and both undervoltage time delay settings have a range of 0 to 30 seconds.

A frequency-based inhibit setting prevents a 27 trip from occurring during an underfrequency condition associated with system startup. The frequency-based inhibit function has a setting range of 20 to 400 hertz.

An undervoltage annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An undervoltage annunciation can also be user-configured to close one or both of the programmable outputs.

When a Single-Phase Override contact input is received, the DGC-500 automatically switches from the three-phase undervoltage settings to the single-phase undervoltage settings.

Frequency (81)

Two sets of frequency settings are provided: one for underfrequency (81U) protection and one for overfrequency (81O) protection.

When the generator frequency decreases below the 81U pickup setting for the duration of the 81U time delay, an underfrequency condition is annunciated. When the generator frequency increases above the 81O pickup setting for the duration of the 81O time delay, an overfrequency condition is annunciated. For 50/60 hertz sensing, the 81U and 81O functions have a setting range of 45 to 65 hertz. For 400 hertz sensing, the 81U and 81O functions have a setting range of 360 to 440 hertz. The time delay for the 81U and 81O functions has a setting range of 0 to 30 seconds.

A voltage-based inhibit setting prevents an 81U trip from occurring during an undervoltage condition associated with system startup. The voltage-based inhibit function has a setting range of 70 to 576 Vac.

Underfrequency and overfrequency conditions can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An underfrequency and/or overfrequency condition can also be user-configured to close one or both of the programmable outputs.

Overcurrent (51)

Two sets of overcurrent settings are provided: one for three-phase generator connections and one for single-phase generator connections.

When any of the phase currents increase above the 51 pickup setting for the duration of the 51 time delay, an overcurrent conditions is annunciated. Controllers with 1 A current sensing (style X1XX) have an overcurrent pickup range of 0.18 to 1.18 Aac. Controllers with 5 A current sensing (style X5XX) have an overcurrent pickup range of 0.9 to 7.75 Aac. The overcurrent time delay is controlled by a curve setting and time dial setting. The curve setting can be set at F, Fixed, or one of 16 inverse timing characteristic curves can be selected. When the F, Fixed curve setting is selected, the time dial setting (adjustable from 0 to 30 seconds) determines the overcurrent time delay with no regard to the generator current level. When one of the 16 inverse timing characteristics curves are selected, the time dial setting (adjustable from a multiplier of 0 to 9.9) along with the level of measured generator current determines the overcurrent time delay.

The available characteristic curves are listed below and illustrated in Appendix A, Time Overcurrent Characteristic Curves.

- S1, Short Inverse
- S2, Short Inverse
- L1, Long Inverse
- L2, Long Inverse
- D, Definite
- M, Moderately Inverse
- I1, Inverse
- I2, Inverse
- V1, Very Inverse
- V2, Very Inverse
- E1, Extremely Inverse
- E2, Extremely Inverse
- A, Standard Inverse
- B, Very Inverse
- C, Extremely Inverse
- G, Long Inverse

An overcurrent annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An overcurrent annunciation can also be user-configured to close one or both of the programmable outputs.

When a Single-Phase Override contact input is received by the DGC-500, the overcurrent pickup setting automatically switches from the three-phase overcurrent setting to the single-phase overcurrent setting.

Phase Imbalance (47)

When the difference between any of the three phases of generator voltage increases above the 47 pickup setting for the duration of the 47 time delay, a phase imbalance condition is annunciated. The phase imbalance pickup setting has a range of 5 to 100 Vac and the phase imbalance time delay setting has a range of 0 to 30 seconds. A phase imbalance annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). A phase imbalance annunciation can also be user-configured to close one or both of the programmable outputs.

DISPLAY OPERATION

The DGC-500 has three standard display modes: Normal, Alternate, and Menu. The optional ECU Parameters mode is present only on controllers with a style number of XXJX. Pressing the **Display Toggle** pushbutton scrolls through the active screen of each available display mode. Figure 3-2 illustrates the top-level screen of the standard and optional display modes.

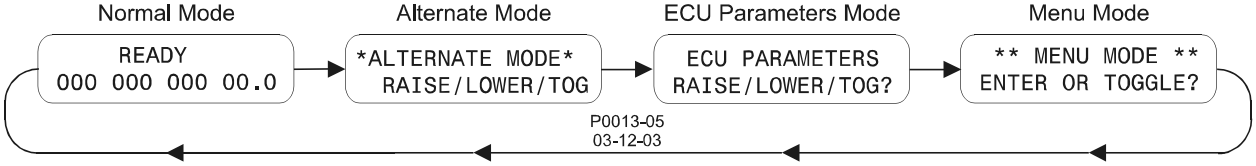

Figure 3-2. Display Mode Navigation

Normal Mode

Normal mode displays various engine and generator parameters. Each parameter is displayed adjacent to the corresponding label on the front panel overlay.

Firmware Version

Normal mode also displays the firmware version of the DGC-500.

The DGC-500 firmware version is viewed in Normal mode by pressing and holding either the **Raise/Scroll** pushbutton or **Lower/Scroll** pushbutton. Releasing either pushbutton returns the display to the current Normal mode screen.

Alternate Mode

Press the **Raise/Scroll** or **Lower/Scroll** pushbuttons while viewing the top-level Alternate mode screen (Figure 3-2) to scroll through the available engine and generator metering values. Figure 3-3 illustrates the Alternate mode screens for a DGC-500 configured for three-phase, line-to-neutral operation. Units configured for three-phase, line-to-line operation do not display the GEN A-N VOLTS, GEN B-N VOLTS, and GEN C-N VOLTS screens. Units configured for single-phase, A-phase to B-phase operation do not display the GEN B-C VOLTS, GEN C-A VOLTS, and GEN C-N VOLTS screens.

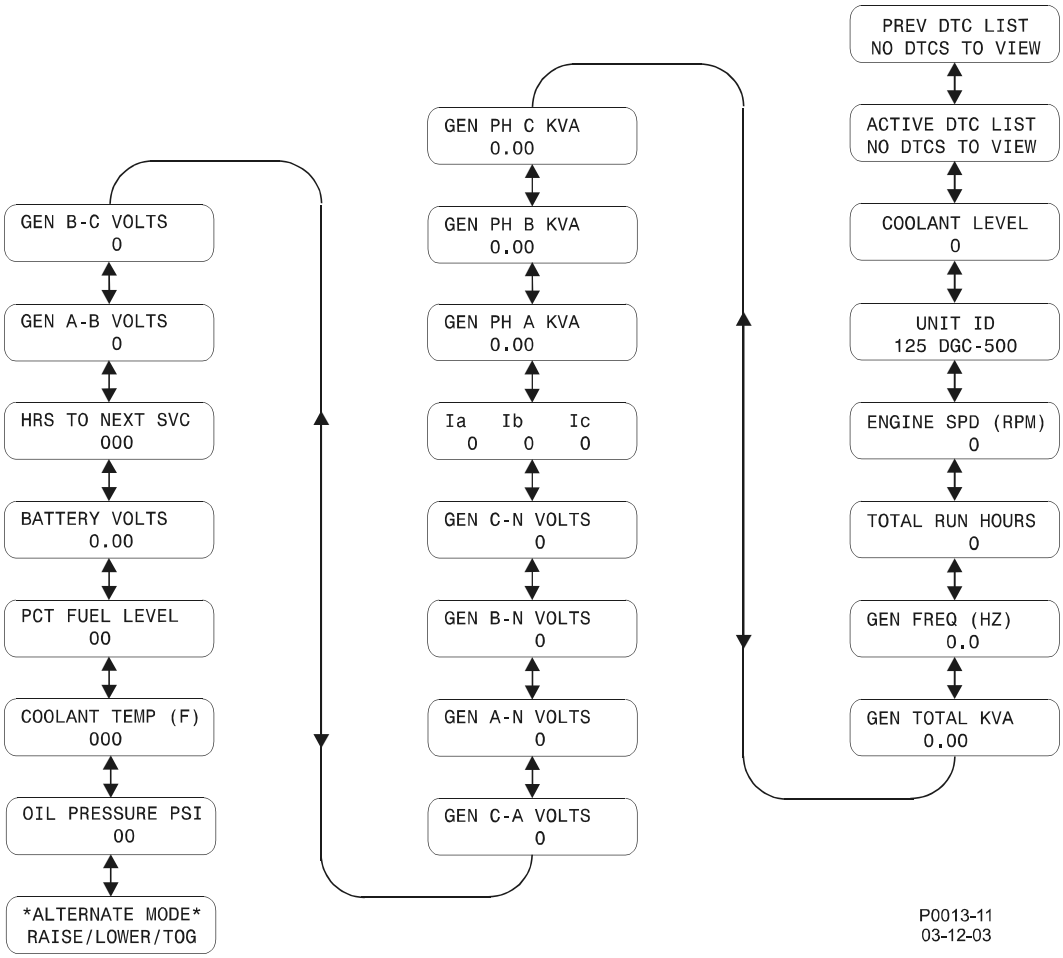

Figure 3-3. Alternate Mode Navigation

Diagnostic Trouble Codes (DTCs)

When the optional SAE J1939 communication is enabled, access to the Diagnostic Trouble Codes (DTCs) is available through the Alternate Display mode. The DTCs are the last two screens in the Alternate mode display list.

If there are no DTCs to be sent to the DGC-500, pressing the **Select/Enter** pushbutton will have no effect, and the messages ACTIVE DTC LIST and NO DTCS TO VIEW will be displayed. If at least one DTC is communicating with the DGC-500, pressing the **Select/Enter** pushbutton will display ACTIVE DTC LIST and VIEW WITH SELECT.

Pressing the **Select/Enter** pushbutton when ACTIVE DTC LIST and VIEW WITH SELECT is displayed places the DGC-500 in DTC mode. The next screen to appear will display the diagnostic lamp status information obtained from the ECU. One of five possible lamp status messages will be displayed. The lamp status messages, in decreasing order of priority, are listed below.

1. ENG STOP LAMP ON
2. WARNING LAMP ON
3. MALFUNC LAMP ON
4. PROTECT LAMP ON
5. NO LAMP IS ON

Only one lamp status will be displayed on the front panel—the highest priority one that is true. An example of the lamp status screen is shown in Figure 3-4. BESTCOMS may also be used to view the status of all lamps.

Figure 3-4. Lamp Status Screen

To be notified that a lamp status exists, the pre-alarm for active DTCs must be enabled through BESTCOMS. When one or more active DTCs exist in the ECU, a lamp status indicating the severity of the combined DTCs should exist. After the pre-alarm is annunciated (by LED indicator, horn, and/or dial-out), the operator will know to check the lamp status, active system DTCs, and what relationship the DTCs have with the parameters. To check the DTC/parameter relationship at the front panel, access the ECU Parameters menu of the HMI. In BESTCOMS, hover the mouse pointer over the DTC to see its related parameter.

To use the HMI to view the list of active DTCs, press the **Raise/Scroll** pushbutton. The next screen to appear will display the first DTC, the number of DTCs, the Suspect Parameter Number (SPN), the Failure Mode Indicator (FMI) and the Occurrence Count (OC).

NOTE
Always refer to the engine manual for the meaning of SPN and FMI combinations, especially for proprietary DTC descriptions.

In the DTC screen example of Figure 3-5, the first DTC of five is displayed. The SPN is 111 (coolant level), the FMI is 1 (low voltage from the sender, thus we have low coolant level), and the OC is 2 (the engine has had a low coolant level twice before). Refer to the engine manufacturer CAN interface documentation for specific descriptions of codes.

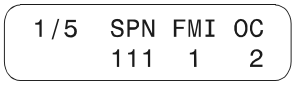

Figure 3-5. DTC Screen Example

After viewing the last DTC, screen 5 of 5, VIEWED ALL ACTIVE and USESELECT TO CLEAR will be displayed. This also applies when viewing previous DTCs.

Clearing the active or previous DTCs, by pressing the **Select/Enter** pushbutton, will give one of four responses.

1. A positive acknowledgment which causes ACTIVE DTC(S) HAVE BEEN ERASED to be displayed.
2. A negative acknowledgment which causes ERROR - NEGATIVE ACK and CANNOT ERASE DTC(S) to be displayed.
3. A timeout for acknowledgment which causes ERROR - ACK TIME OUT and CANNOT ERASE DTC(S) to be displayed. This occurs when approximately two seconds have elapsed with CAN working and no positive or negative acknowledgment received.

4. A CAN communication failure causes ERROR - DISCONNECTED and CANNOT ERASE DTC(S) to be displayed. This occurs when CAN is disconnected or the ECU is not functioning properly.

After viewing the response, the only way to back out of the screen is to press the **Previous** pushbutton. The user is then taken back to the Alternate Display mode. Pressing the **Display Toggle** pushbutton will take the user to the Menu mode screens. This also applies when viewing previous DTCs.

ECU Parameters Mode

When the optional J1939 communication is enabled, access to the ECU Parameters menu is available. This menu displays parameters metered from the ECU. Only parameters related to genset applications are metered from the ECU and displayed here. A submenu for viewing the engine configuration parameters is also accessible from the ECU Parameters menu.

If a parameter is never sent after communication is established, or the ECU has sent information notifying the DGC-500 that the parameter is not supported (non-applicable), then the parameter's screen will be hidden and skipped when scrolling from screen to screen in the ECU Parameters menu.

If a DTC is associated with one of the parameters, then the screens will function like the Pre-Alarm screens of the Alternate mode display. When scrolling through the menu, the user is taken to the new DTC-related screens first. The DTC-related screen will then blink while alternating between the parameter's value and the DTC information.

> NOTE
>
> If no ECU support is required, then parameters are updated within the DGC-500 only when "pulsing" the ECU and while the engine is running.

The following list includes all of the engine system monitoring parameters read from the ECU (if supported) in the order in which they appear when pressing the **Raise/Scroll** pushbutton, having started from the ECU Parameters menu.

1. Throttle position
2. Percent load at current rpm
3. Actual engine percent torque
4. Engine speed
5. Injection control pressure
6. Injector metering rail pressure
7. Total engine hours ✳
8. Trip fuel
9. Total fuel used
10. Engine coolant temperature ✳
11. Fuel temperature
12. Engine oil temperature
13. Engine intercooler temperature
14. Fuel delivery pressure
15. Engine oil level
16. Engine oil pressure
17. Coolant pressure
18. Coolant level
19. Fuel rate
20. Barometric pressure
21. Ambient air temperature
22. Air inlet temperature
23. Boost pressure
24. Intake manifold temperature
25. Air filter differential pressure
26. Exhaust gas temperature
27. Battery voltage ✳
28. Battery voltage (at ECU), switched
29. Active diagnostic codes
30. Previously active diagnostic codes

✳ This parameter may be monitored either directly by the DGC-500 itself or by the DGC-500 and the appropriate analog sender when the SAE J1939 interface is disabled.

Figure 3-6 illustrates the screens of the ECU Parameters menu after the DGC-500 has established communication with the ECU.

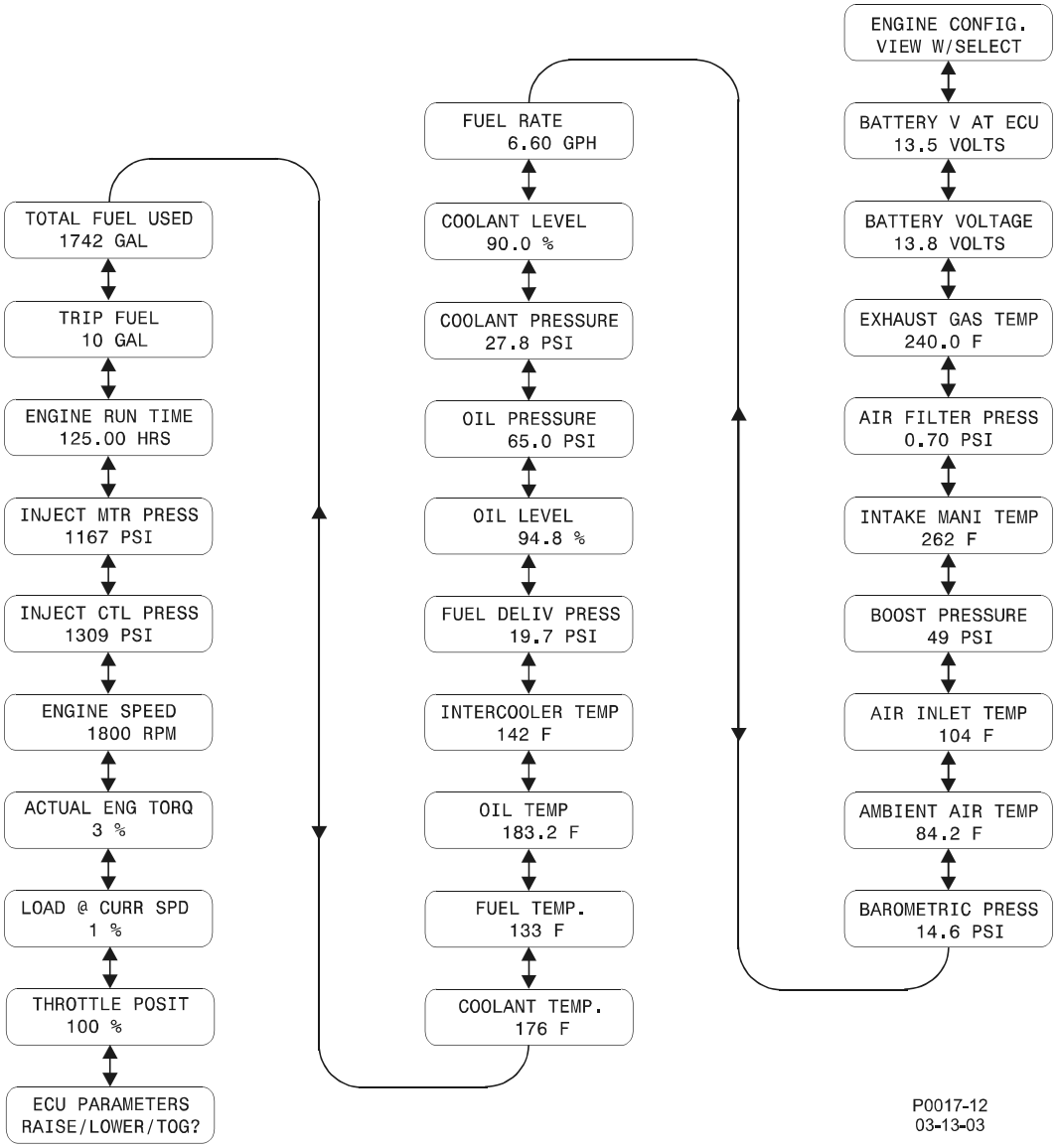

Figure 3-6. ECU Parameters Navigation

Engine Configuration Parameters

Engine configuration parameters can be accessed from the ECU Parameters menu. To view these parameters read from the ECU, press the **Select/Enter** pushbutton while viewing the Engine Configuration (ENGINE CONFIG.) screen. The following list of all engine configuration parameters is presented in the order in which they appear when pressing the **Raise/Scroll** pushbutton.

1. Engine speed at idle, point 1
2. Percent torque at idle, point 1
3. Engine speed at point 2
4. Percent torque at point 2
5. Engine speed at point 3
6. Percent torque at point 3
7. Engine speed at point 4
8. Percent torque at point 4
9. Engine speed at point 5
10. Percent torque at point 5
11. Engine speed at high idle, point 6
12. Gain (KP) of the end-speed governor
13. Reference engine torque
14. Maximum momentary engine override speed, point 7
15. Maximum momentary override time limit
16. Requested speed control range lower limit
17. Requested speed control range upper limit
18. Requested torque control range lower limit
19. Requested torque control range upper limit

Figure 3-7 illustrates the Engine Configuration Parameter menus after the DGC-500 has established communication with the ECU.

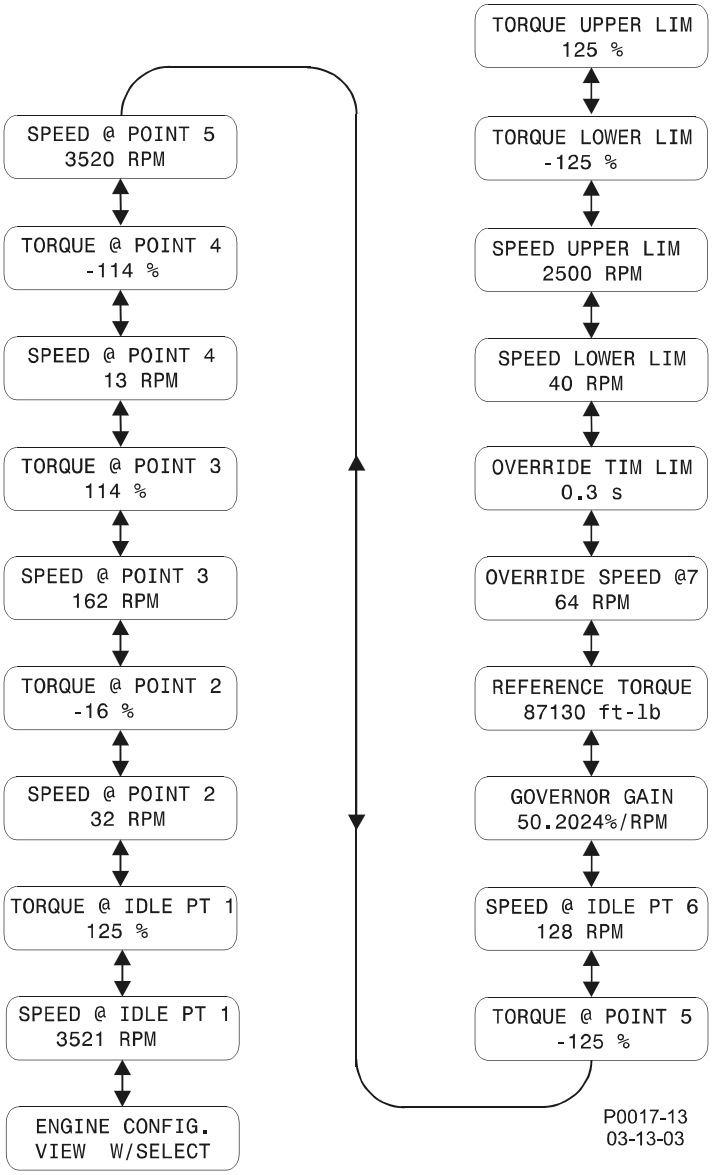

Figure 3-7. Engine Configuration Menu Navigation

Menu Mode

Press the **Select/Enter** pushbutton while viewing the top-level Menu mode screen (shown in Figure 3-2), to access the four menu branches illustrated in Figure 3-8. Press the **Lower/Scroll** or **Raise/Scroll** pushbuttons to view the top of each menu branch. Within Menu 1, 2, 3, 4, or 5, use the **Select/Enter** pushbutton to move right, the **Previous** pushbutton to move left, the **Raise/Scroll** pushbutton to move up, and the **Lower/Scroll** pushbutton to move down.

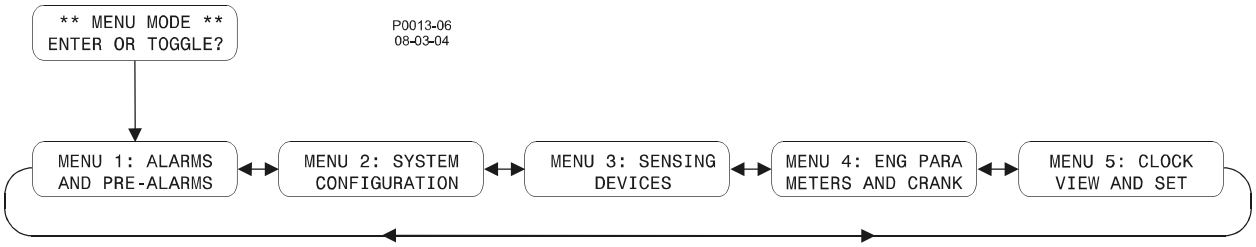

Figure 3-8. Menu Mode Navigation

Menu 1

DGC-500 pre-alarms and alarms are viewed and configured in Menu 1. Figure 3-9 illustrates the Menu 1 screens.

Menu 2

System configuration settings are viewed and configured in Menu 2. Figure 3-10 illustrates the Menu 2 screens.

Menu 3

DGC-500 calibration, transformer ratios, and transducer failure alarms, are viewed and configured in Menu 3. Figure 3-11 illustrates the Menu 3 screens. The menu screens associated with the calibration process are illustrated in Section 5, *Installation, Calibration*.

Menu 4

Engine cool-down time and cranking parameters are viewed and configured in Menu 4. Figure 3-12 illustrates the Menu 4 screens.

Menu 5

Real-time clock settings are viewed and set in Menu 5. Figure 3-13 illustrates the Menu 5 screens.

Exiting Menu Mode

Pressing the **Display Toggle** pushbutton exits the Menu mode from any level and branch. When the **Display Toggle** pushbutton is used to exit Menu mode, the user's place within the menu tree is saved. The display will return to the same screen the next time that Menu mode is entered. If the **Display Toggle** pushbutton is pressed before a new setting is saved, the existing setting is retained.

Using the **Previous** pushbutton to back out of Menu mode ensures that the top-level Menu mode screen is viewed the next time Menu mode is entered.

Sleep Mode

Sleep mode serves as a power saving feature. If the DGC-500 is in Off mode for more than 15 minutes, the front panel LEDs, LCD, and LCD backlight are turned off. The DGC-500 resumes normal display operation when any front panel button is pressed or the genset is started remotely via the ATS input. If needed, Sleep mode can be permanently disabled via BESTCOMS. Refer to Section 4, *BESTCOMS Software* for more information.

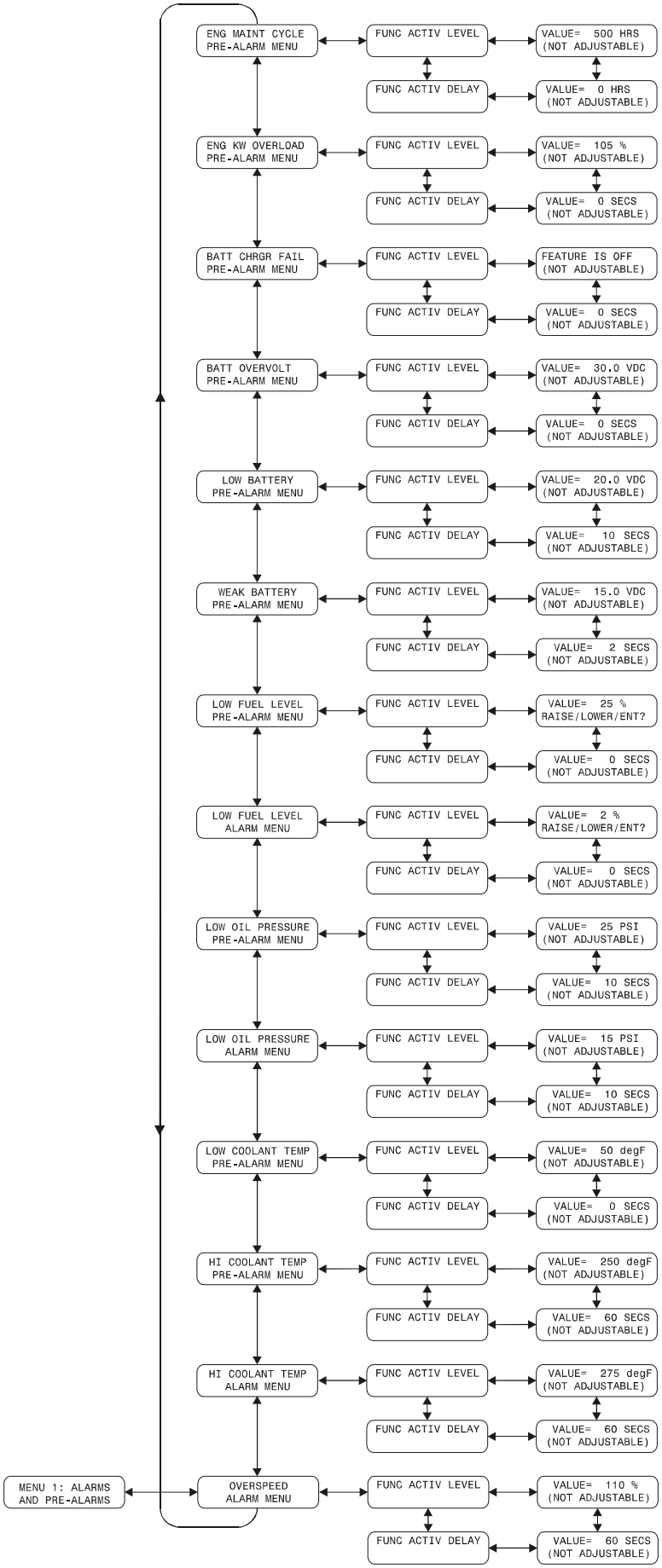

Figure 3-9. Menu 1 Navigation

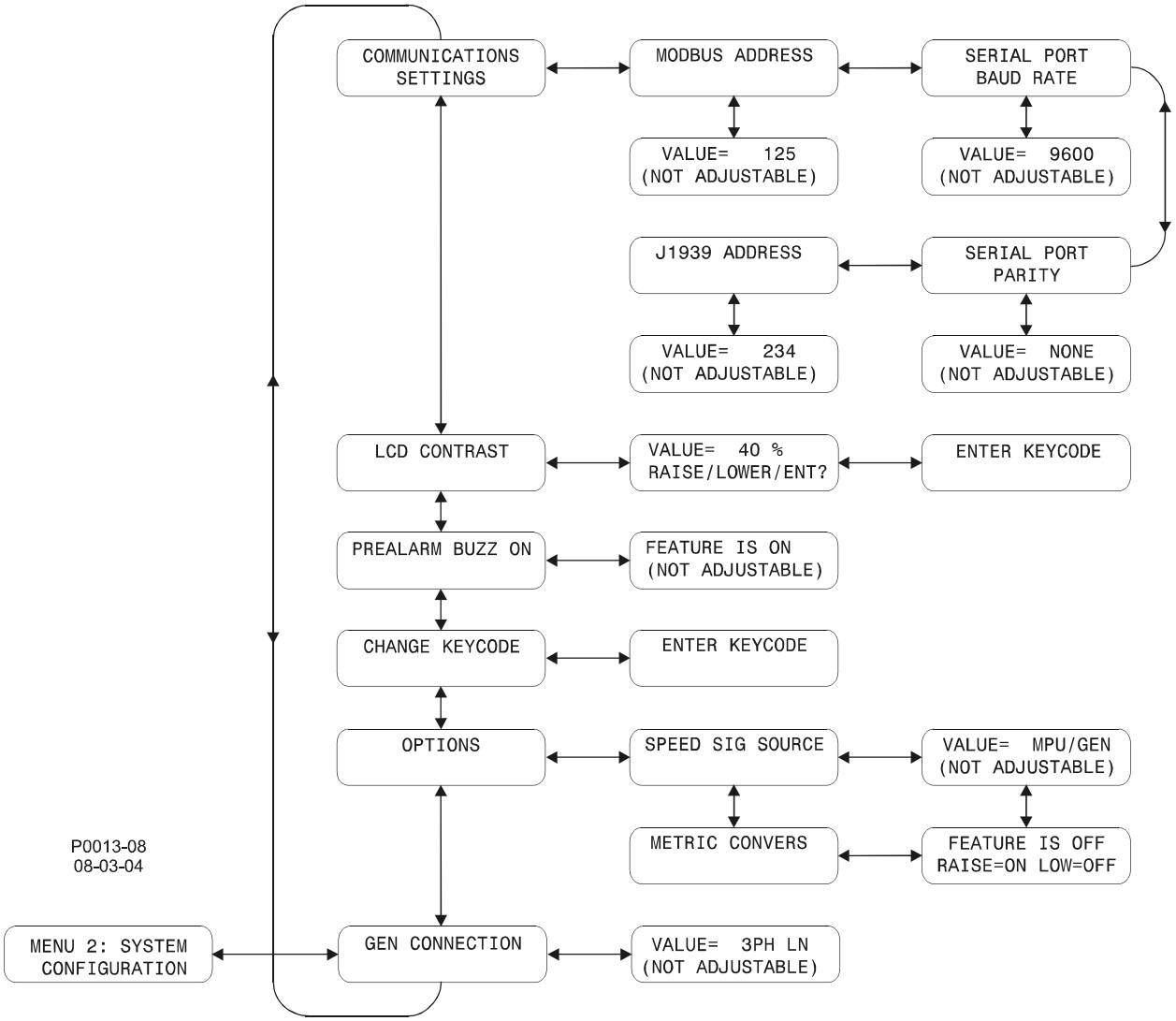

Figure 3-10. Menu 2 Navigation

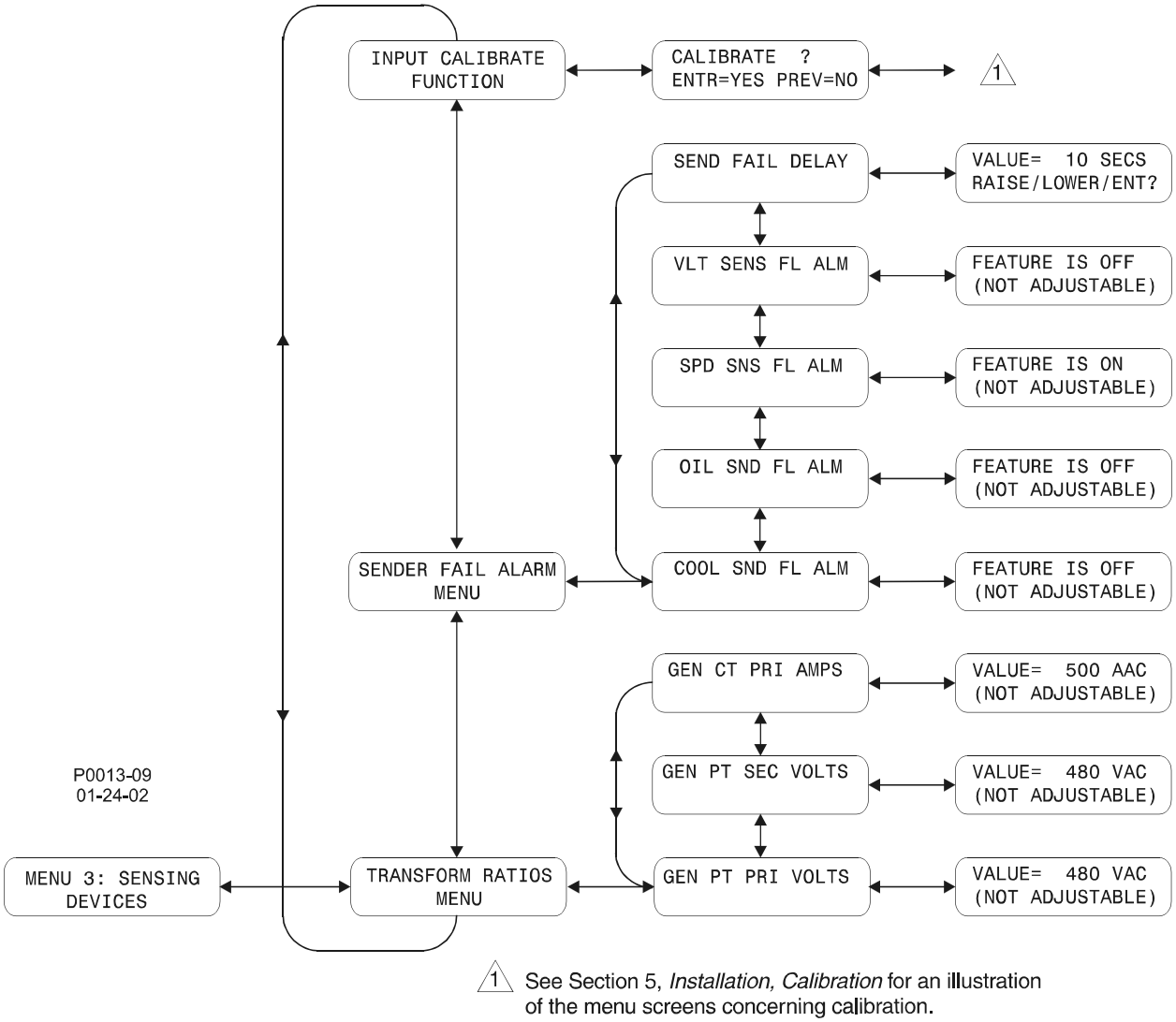

Figure 3-11. Menu 3 Navigation

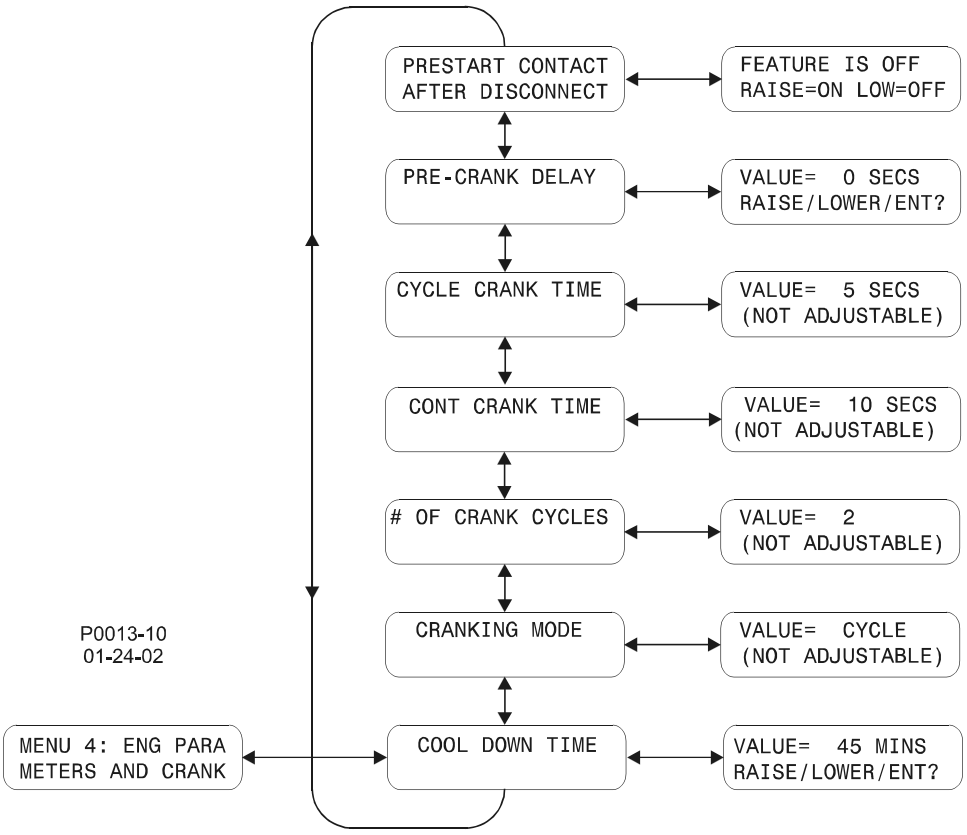

Figure 3-12. Menu 4 Navigation

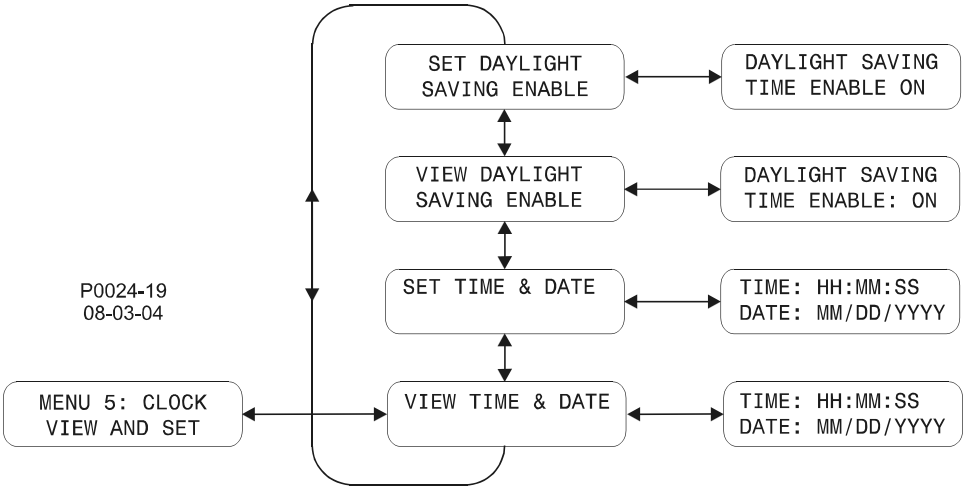

Figure 3-13. Menu 5 Navigation

Changing Settings

A setting change generally consists of the following steps. The number of each step corresponds to the numbered call-outs in the setting change example of Figure 3-14.

1. Use the HMI pushbuttons to navigate to the screen of the setting to be changed.
2. Press the **Select/Enter** key to access the ENTER KEYCODE screen.
3. Enter the key code by pressing the appropriate HMI pushbuttons in the proper sequence. Key code entries appear as asterisks on the ENTER KEYCODE screen. Refer to the *Key Code* paragraph for details about using key codes.
4. Press the **Select/Enter** pushbutton to access the setting to be changed.
5. Use the **Raise/Scroll** and **Lower/Scroll** pushbuttons to increment and decrement the setting as needed.
6. Press the **Select/Enter** pushbutton to save and view the setting change.

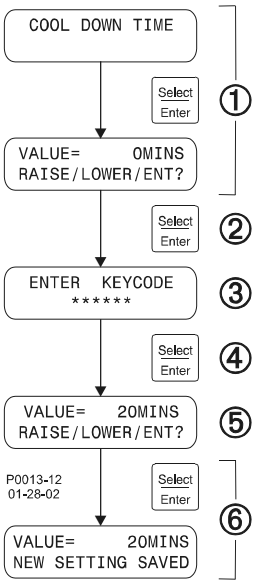

Figure 3-14. Setting Change Example

The procedure for setting the real-time clock at the front panel differs from the above procedure. The following paragraphs describe how the front-panel HMI is used to set the clock.

Setting the Real-Time Clock at the Front Panel

The clock is set at the front panel by entering the menu display mode, scrolling to menu 5 (CLOCK VIEW AND SET), and entering the SET TIME & DATE menu. The SET TIME & DATE menu contains a screen displaying an editable snapshot of the time and date. The hours field will be blinking. The blinking indicates which field will be modified when the Raise/Scroll or Lower/Scroll pushbutton is pressed to change the value.

Pressing Raise/Scroll increments the active value and pressing Lower/Scroll decrements the active value. If the Raise/Scroll or Lower/Scroll pushbutton continues to be pressed, the value of the active field automatically rolls over to the minimum or maximum value. A different field is selected for editing by pressing the Display Toggle button to move right or the Previous button to move left.

The time and date setting screen is exited by pressing Select/Enter. The user can then press Select/Enter to save the settings or Previous to discard the changes.

Key Code

The DGC-500 is delivered with a key code consisting of the following pushbutton sequence.

1. Raise/Scroll
2. Lower/Scroll
3. Select/Enter
4. Previous
5. Display Toggle
6. Select/Enter
7. Select/Enter

The key code can be changed by accessing the CHANGE KEYCODE screen of Menu 2. Observe the following guidelines when changing the key code.

- Allowable key code pushbuttons are Raise/Scroll, Lower/Scroll, Select/Enter, Previous, Display Toggle, Phase Toggle, Alarm Silence, and Lamp Test.
- A key code entry must be followed by two presses of the Select/Enter pushbutton.
- A key code can consist of one to eight presses of the allowable key code pushbuttons.
- A key code cannot contain consecutive presses of the Previous pushbutton.

Front Panel Adjustable Parameters

Most DGC-500 settings can be viewed at the front panel display. The settings that can be adjusted at the front panel are listed in Table 3-4. With the exception of the time and date, all of the listed settings are protected by the front-panel key code.

Table 3-4. Front Panel Adjustable Settings

Parameter	Setting Range, Increment
Sensor Failure Alarm Time Delay	1 to 30 s, 1 s
Metric Conversion	On or Off
Low Fuel Pre-Alarm Level	10 to 100%, 1%
Low Fuel Alarm Level	2 to 50%, 1%
Pre-Crank Contact After Cranking	Open or Closed
Cool-Down Time	0 to 60 m, 1m
Pre-Crank Time Delay	0 to 30 s, 1 s
Time	—
Date	—

ENGINE CONTROL UNIT (ECU) SUPPORT

The following paragraphs describe the support provided by the DGC-500 for operation with an engine control unit (ECU).

Enabling ECU Support

To enable ECU support, the user must access the SYST menu in BESTCOMS and select *Enable ECU Support* under the box entitled *CANBus/J1939 Interface.* After resending the settings, the DGC-500 will ignore the analog inputs for coolant temperature, oil pressure and engine speed, and it will no longer calculate engine run-time. Once the DGC-500 establishes communication with an ECU, the engine run-time, coolant level, coolant temperature, oil pressure, and engine speed will be updated with the ECU values.

NOTE

With *Enable ECU Support* selected, there is a non-programmable Coolant Level Sender Fail alarm that can annunciate when the engine is either off or running.

Coolant level is metered and displayed only when Enable ECU Support is selected in BESTCOMS.

ECU Constraints

An external source cannot always turn the engine off without removing power from the ECU. Removing power from the ECU is the only way to remove fuel from the engine and shut it down. Different ECU manufacturers have their own rpm setpoints for reapplying fuel to an engine. For example, if the ECU is powered up and the engine is still spinning above 60 rpm, the ECU may automatically turn the fuel on.

Not being able to stop the engine without removing power from the ECU causes two problems. The first problem is that the only way to stop the engine is to turn the ECU off and wait for the engine speed to decrease below 60 rpm before reapplying ECU operating power. Otherwise, the engine will resume running. The second problem is that while the ECU is off, you can no longer meter and update coolant level, coolant temperature, oil pressure, and engine speed values, effectively disabling features like low coolant temperature alarm/pre-alarm and crank control.

The DGC-500 Solution

The DGC-500 resolves ECU constraints by using four user-programmable timers that are accessed through BESTCOMS. Each timer setting is described in the following paragraphs.

Pulse Cycle Time. This timer setting establishes the time, in minutes, that the DGC-500 waits before pulsing the ECU again.

Response Timeout. This timer setting defines the length of time, in seconds, that the DGC-500 attempts communication with the ECU when the DGC-500 is in the Pulsing state or Connecting state.

Settling Time. This timer setting controls the length of time, in tenths of seconds, that the DGC-500 gathers data after connecting to the ECU during the Pulsing state. This allows all metered values to be sent and ramped up to their steady state values. Metered values are sent out by the ECU at different rates as designated by the J1939 protocol. ECU values initially sent are low and the ECU takes time to average out its own data values.

Engine Shut Down. This timer setting determines the length of time, in seconds, that the DGC-500 remains disconnected from the ECU when going from Running to Shutdown before starting the first pulse. This timer should allow enough time for the engine to slow down so that when the DGC-500 pulses, the ECU will not restart the engine.

Alarms and Pre-Alarms

If ECU communication is not established during the Connecting state or is lost during the Pre-Start, Cranking, Resting, Running or Cooling states, then a non-programmable ECU Communications Fail alarm is annunciated. If the last pulse was unsuccessful (ECU communication was not established), then the ECU Communications Fail pre-alarm will annunciate. The pre-alarm is checked only after the Pulsing state and is annunciated only during the Ready state.

To clear Coolant Level alarms when ECU power support is needed, the user must first correct the condition causing the alarm and then pulse the ECU to update the data. The user may pulse the ECU remotely through BESTCOMS or locally by pressing the front panel pushbuttons in the ordered sequence of Auto, Off.

Fuel Solenoid Relay

Because there is no external fuel solenoid to connect to, the fuel solenoid relay has been designated to control ECU operating power. For example, Detroit Diesel's ECU applies fuel to the engine only after engine speed rises above 60 rpm. The following timers control the fuel solenoid relay when the engine is not running.

- Pulse Cycle Time - fuel solenoid is open
- Response Timeout - fuel solenoid is closed
- Settling Time - fuel solenoid is closed
- Engine Shut Down - fuel solenoid is open

> NOTE
> When ECU support is enabled during Pre-start and Resting, the fuel solenoid is closed.

Display Values (ECU Support Enabled)

The ECU is able to give the DGC-500 in-depth information about the values it sends. This makes it possible for the DGC-500 to display accurate information when metering these values from the ECU. After successfully pulsing the unit, the last values gathered when powering-off the ECU are displayed until the next pulse. The following is a list of display values:

- Value - the actual value is displayed if the last pulse was successful or the engine is running.
- No Communications (abbreviated as NC) - displayed if the last pulse was unsuccessful.
- Not Applicable (abbreviated as NA) - the ECU does not monitor this data value.
- ECU Data Not Sent (abbreviated as NS) - data was not sent in the time designated by the J1939 protocol.
- Sender Failure (abbreviated as SF) - the ECU has determined a sender failure for that metered value.

ECUs with an External Fuel Solenoid

The DGC-500 supports ECUs that are able to cut-off fuel from the engine without powering the ECU off. The DGC-500 requests engine run-time every minute to keep the ECU from going into a sleep mode. After the Pulse Cycle Timer expires, the DGC-500 checks whether ECU communication exists. If so, the DGC-500 will not pulse the ECU. The same goes for Connecting, except that the DGC-500 remembers if it skipped the Connecting state. If it did, then the DGC-500 will also skip the Engine Shutting Down state when it stops the engine.

For ECUs that have an external fuel solenoid, it is recommended that the Engine Shut Down timer be set to its minimum value. This ensures that, if the DGC-500 temporarily loses power while running, the unit will go straight into the Run state and go to the Shutting Down state when the unit goes to Off. It is also recommended that the Response Timeout Timer be set to its minimum value in order to set the ECU Communications Fail pre-alarm as soon as possible.

The HMI screens shown in Figure 3-15 are displayed if the last attempt to pulse the ECU for an information update was unsuccessful.

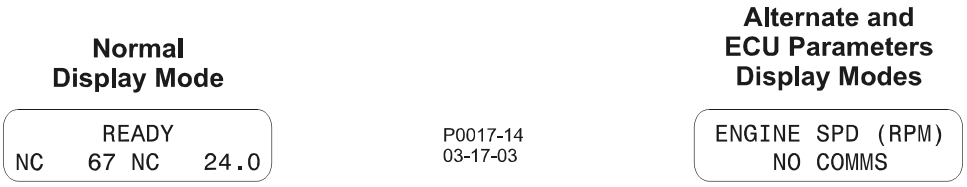

Figure 3-15. Screens Shown Following Unsuccessful Information Update from ECU

STATE MACHINES

A state machine is any device that stores the status of something at a given time. An input change can change the status and/or cause an action or output to occur for any given change. A finite state machine can be used to solve problems and describe the solution for system maintainers. State machine illustration methods range from simple tables to graphically animated illustrations.

The following paragraphs describe how the DGC-500 functions as a state machine.

System Configuration

- RUN, OFF and AUTO are selectable through the front panel HMI and OFF and AUTO are selectable through BESTCOMS. However, for clarity, the term AUTO will not be used in this section. Auto-Run and Auto-Off will be used instead. Auto-Run means the unit is in Auto while the automatic transfer switch (ATS) is closed, or the user started the engine remotely through BESTCOMS. Auto-Off means the unit is in Auto while the ATS is open, or the user stopped the engine remotely through BESTCOMS. The system configuration settings for the DGC-500 are Run, Off, Auto-Run and Auto-Off.
- If BESTCOMS remotely started the engine before a reset occurred or the system configuration goes to Off, then the Remote Start setting in BESTCOMS is set to Stop.
- If ECU support is enabled when the engine is running and the system configuration goes to Off, then the unit will go to the Shut Down state. Otherwise, it will transition to the Ready state and pulse the ECU.
- If ECU support is disabled and system configuration goes to Off, then the unit will always transition to the Ready state.

Operating States

The DGC-500 supports 11 operating states. Each operating state is illustrated by a flowchart later in this section.

- *Restart/Power-Up*. The initial state.
- *Ready*. The DGC-500 is in the Off or Auto-Off mode.
- *Pulsing*. ECU Only—pulses (momentarily powers up) the ECU for updated information.
- *Connecting*. ECU Only—the system configuration just changed to Run or Auto-Run.
- *Pre-Start*. Closes the pre-start relay or pauses the DGC-500 while it is not safe to crank.

- *Cranking*. Cranks the engine until it is above the crank disconnect speed.
- *Resting*. Occurs between crank cycles and does not crank the engine.
- *Running*. The unit is now running and no longer cranking.
- *Cooling*. Cool down running engine if a load is or was applied when going to Auto-Off mode.
- *Shutting Down*. ECU Only—wait for engine to stop rotating before "pulsing".
- *Alarm*. Alarm was triggered, wait for the alarm to clear.

State Transitions

Criteria used for deciding state transitions are based on the following input events.

- System Configuration (Run, Off, in Auto with ATS closed, in Auto with ATS open)
- Analog/ECU sender data (example: Engine Speed)
- Programmable auxiliary inputs
- Switch data (Coolant Level Switch, ATS, Emergency Stop Button)
- ECU-specific data (example clearing/requesting diagnostics)
- Various programmable timers (run-time, cycles, delays, time-out length)
- Programmable I/O settings
- Alarm settings (thresholds, enabling and timers)
- Other settings selectable through BESTCOMS.

Input events are used in deciding the following output events.

- Output relays on the DGC-500 control the generator and other devices connected to the DGC-500.
- LED output is controlled by the system configuration setting, active alarm/pre-alarms, and by the supplying load criteria.
- The LCD is controlled by the value of data being displayed, the state of the DGC-500, and by the viewing mode (Normal, Alternate Display, ECU Parameters, or Menu).
- The horn (or buzzer) is controlled by the Alarm Silence, Run, or Off pushbuttons, and by the Alarm and Pre-Alarm conditions.

Normal Program Control

If an engine does not have an ECU, then ECU Support should be disabled so that the DGC-500 uses analog sender data. An engine with ECU support disabled or ECU support enabled with a constant power supply and accessible fuel solenoid will follow the normal program control flowchart of Figure 3-16.

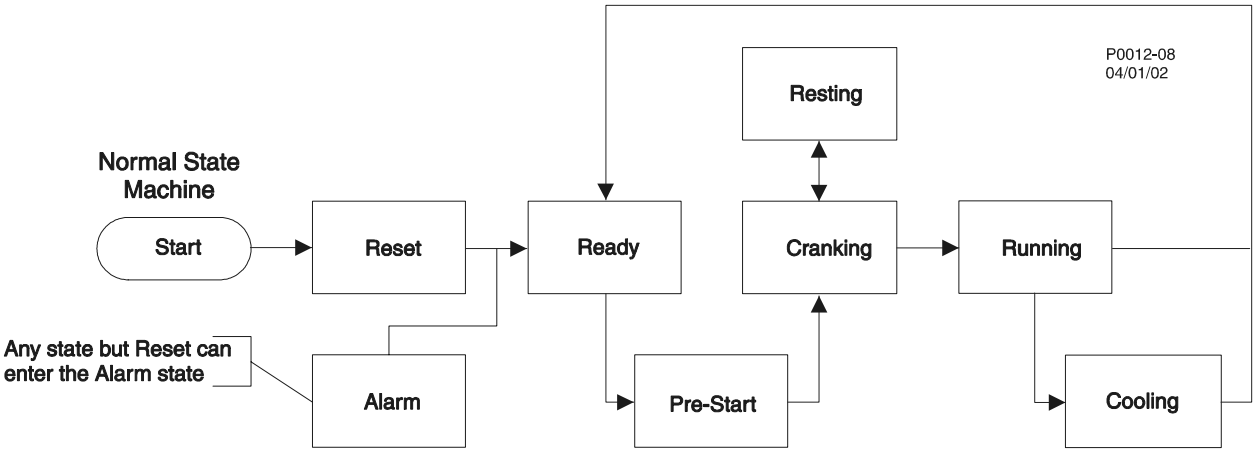

Figure 3-16. Normal Program Control Diagram

ECU Power Support Program Control

If an engine has an ECU, then ECU support should be enabled so that the DGC-500 uses sender data transmitted from the ECU over the J1939 interface. If the engine can be shut down only by powering off the ECU, then the genset will need ECU power support enabled. An engine with ECU support enabled and a need for ECU power support through the fuel solenoid will follow the ECU power support diagram of Figure 3-17.

NOTE

ECU power support is not a selectable option. The DGC-500 will decide between using the fuel solenoid output relay or controlling the fuel to provide ECU power support. This is derived through the following method.

After the Pulse Cycle timer expires, the DGC-500 checks to see if ECU communication is active. If so, then the DGC-500 will not pulse the ECU. The same goes for Connecting, except the DGC-500 remembers if it skipped the Connecting state. If it did, then it will also skip the Engine Shutting Down state when the DGC-500 stops the engine.

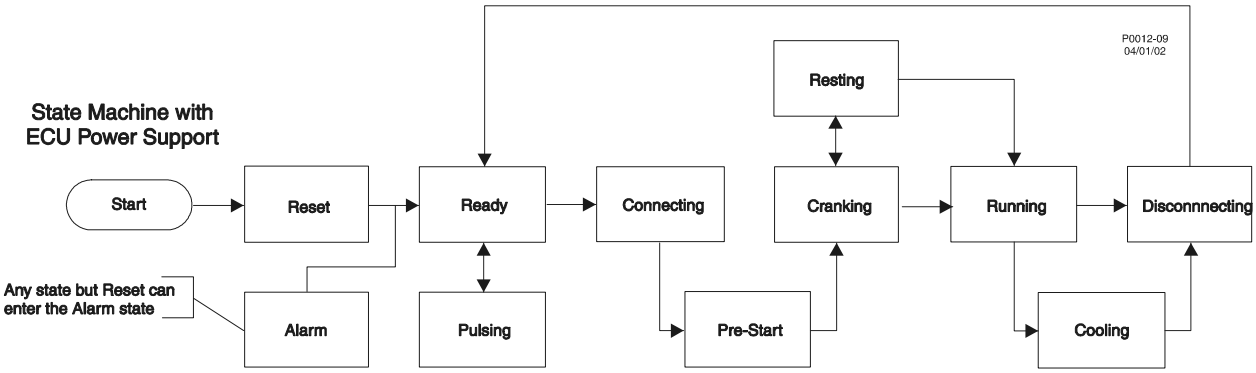

Figure 3-17. ECU Power Support Program Control Diagram

Initial State - Power Up/Reset

This state begins after cycling power to the DGC-500, or after a software reset (i.e. a watchdog timeout) has occurred. The unit will stay in reset for a short time. During this time, the firmware version number appears on the front panel LCD and the DGC-500 averages out enough data counts to calculate accurate analog data. During the Power Up/Reset state, if the previous system configuration was Run or Auto-Run with the ATS closed and ECU support enabled, the fuel solenoid will close. This works to keep the engine running if the unit temporarily losses power, and to gather engine speed data from the ECU to determine if it should go to Off or stay in Run.

After a short time, the old system configuration from the last time the unit was not in reset is checked. If the old system configuration was set to Run or Auto-Run with the ATS closed, then the engine speed is checked against Crank-Disconnect (the rpm value used in deciding when to disengage the starter).

If engine speed is above Crank-Disconnect, then the Power Up/Reset state goes to the Running state.

If the speed is below Crank-Disconnect, the DGC-500 goes to the Ready state and immediately pulses the ECU (if ECU support is enabled). If the previous system configuration was set to RUN, the System configuration will be set to OFF. If the previous system configuration was set to Auto-Run (with the ATS closed), the unit will still go to the Ready state. But then, the Ready state will transition into the Pre-Start state and the Pre-Start state will eventually transition into the Cranking state, and so forth.

Figure 3-18 illustrates the Power Up Reset flowchart.

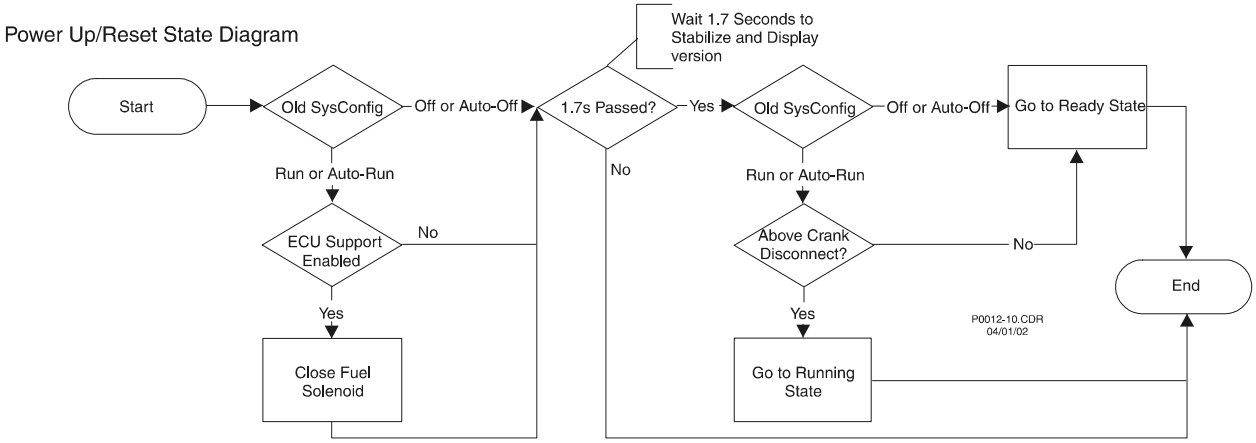

Figure 3-18. Power Up/Reset State Diagram

Ready State

The DGC-500 will be in Ready state when system configuration is Off/Auto-Off. If the system configuration changes to Run/Auto-Run, then it will check to see if it needs to go to the Connecting, Pre-Start or Running state. If ECU support is selected and there is no ECU communication and the Pulse Cycle Timer has expired, the Ready state will transition into Pulsing. The Pulse Cycle Timer can be set to expire and force a Pulsing state. There are three ways to force a pulse.

- When a user logs on to a unit through BESTCOMS, if the unit is in Ready state, a pulse is forced to update the internal variables used to meter ECU data.
- User attempts to clear DTCs from the ECU while the DGC-500 is in Ready (therefore, the ECU is probably powered off).
- Manually force a pulse and update the internal variables. The user can do so in BESTCOMS or locally pulse the ECU by pressing the front panel pushbuttons in the ordered sequence: Auto, Off.

Going to Off or Auto-Off

If the DGC-500 is in the Connecting, Pre-Start, Resting or Cooling state when the unit goes to Off or Auto-Off mode, then the state will transition to the Ready state. If ECU support is enabled, then the unit will go to the Pulsing state immediately after transitioning to the Ready state.

Figure 3-19 illustrates the Ready state flowchart.

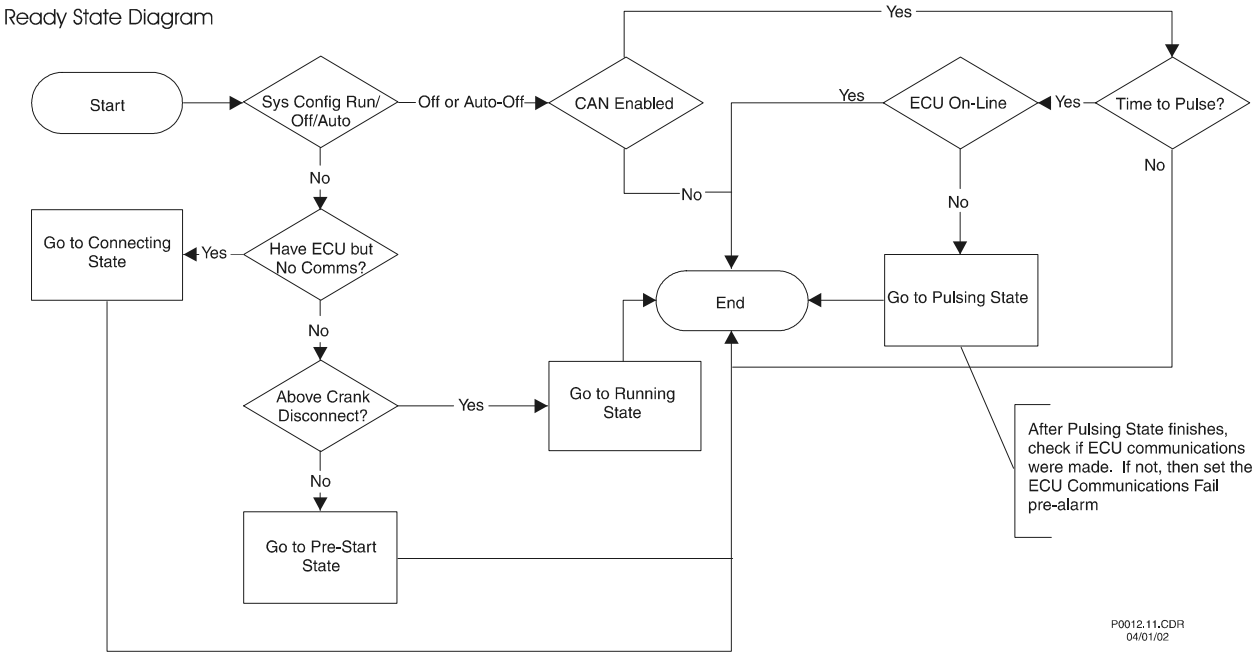

Figure 3-19. Ready State Diagram

Pulsing State

The Pulsing State follows the sequence of events shown in Figure 3-20. The Pulsing state will momentarily power up the ECU to update the DGC-500 internal variables. Once a connection is established with the ECU, GATHERING DATA will appear on the LCD for the duration of the settling time. During settling time, the unit processes any previous request for clearing DTCs from the ECU. The Pulsing state always transitions to the Ready state unless the System configuration changes to Run/Auto-Run. Then, it will transition to the Connecting state as a result of pulsing and will follow the ECU Power Support diagram.

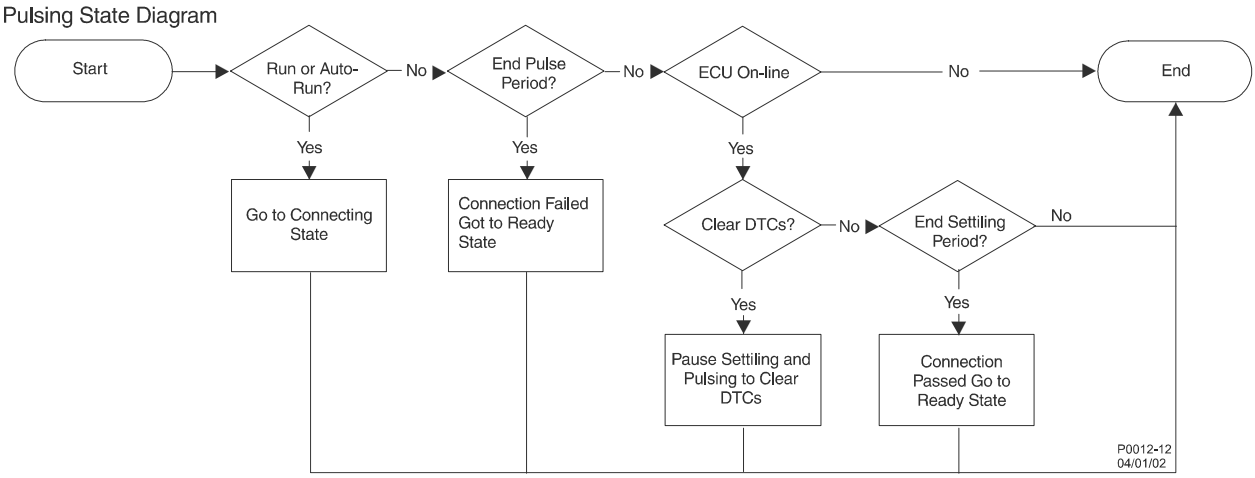

Figure 3-20. Pulsing State Diagram

Connecting State

The Connecting State follows the sequence of events shown in Figure 3-21. If ECU communication is not established by the time the Response Timeout expires, then the ECU Communications Failure Flag is set to trigger the Alarm state. The Connecting state will power up the ECU. Once it reads the engine speed, it checks if it is above Crank-Disconnect. If it is, then it will go to the Running state. Otherwise, it will go to the Pre-Start state.

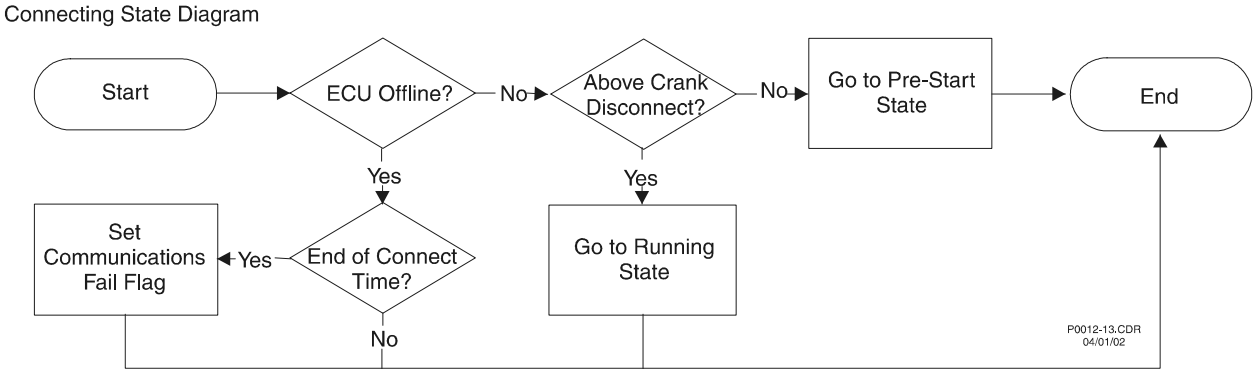

Figure 3-21. Connecting State Diagram

Pre-Start State

This state will transition immediately to the Running state if the engine speed is above Crank-Disconnect. Otherwise, it will wait here and close the Pre-heat relay for the pre-start time delay duration. If engine speed is below Safe-To-Restart (the rpm value used in deciding when to engage the starter) and the Pre-start time delay is expired or set to zero, then it will transition to the Cranking state. If engine speed falls in the range between Crank-Disconnect and Safe-To-Restart, the state will pause and display NOT SAFE TO CRANK along with the rpm value until the engine speed moves out of this range. If it is not safe to crank and there is a pre-start time delay, then the Pre-heat relay will stay closed because it was closed when it was waiting for

the pre-start time delay to expire. If Pre-start time delay was set to zero, then the Pre-heat relay was never closed. Therefore, it would remain open while it is not safe to crank. Figure 3-22 illustrates the Pre-Start state flowchart.

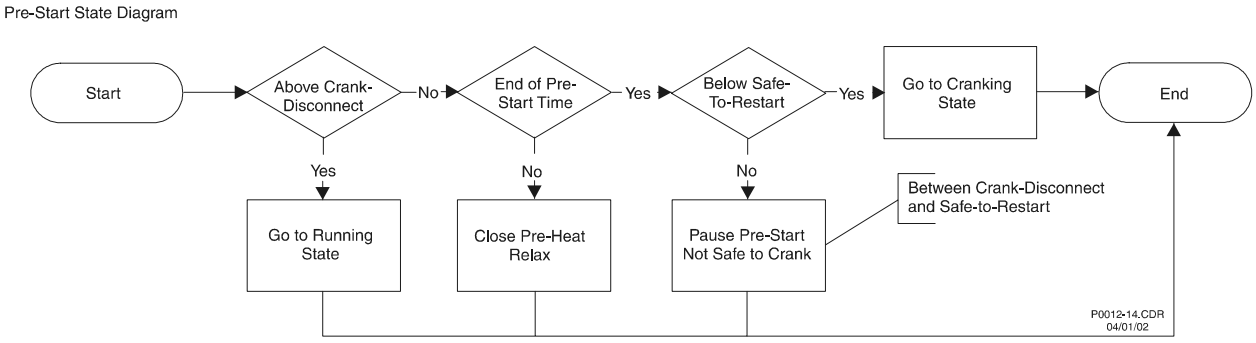

Figure 3-22. Pre-Start State Diagram

Cranking State

This state will engage the starter and transition to the Running state once engine speed is above crank-disconnect. During the Cranking state, the crank-type is checked. If the crank-type is Cycle Crank, then the unit will transition to the Resting state when the crank time expires. If the crank-type is Continuous Crank or is on the last crank cycle when the crank timer expires, then the Over-Crank flag is set to trigger the Alarm state. If system configuration goes to Off/Auto-Off, the unit transitions to the Cooling state. In the Cooling state, if ECU power support is needed, it will go to the Shutting Down state. The Cranking state flowchart is illustrated in Figure 3-23.

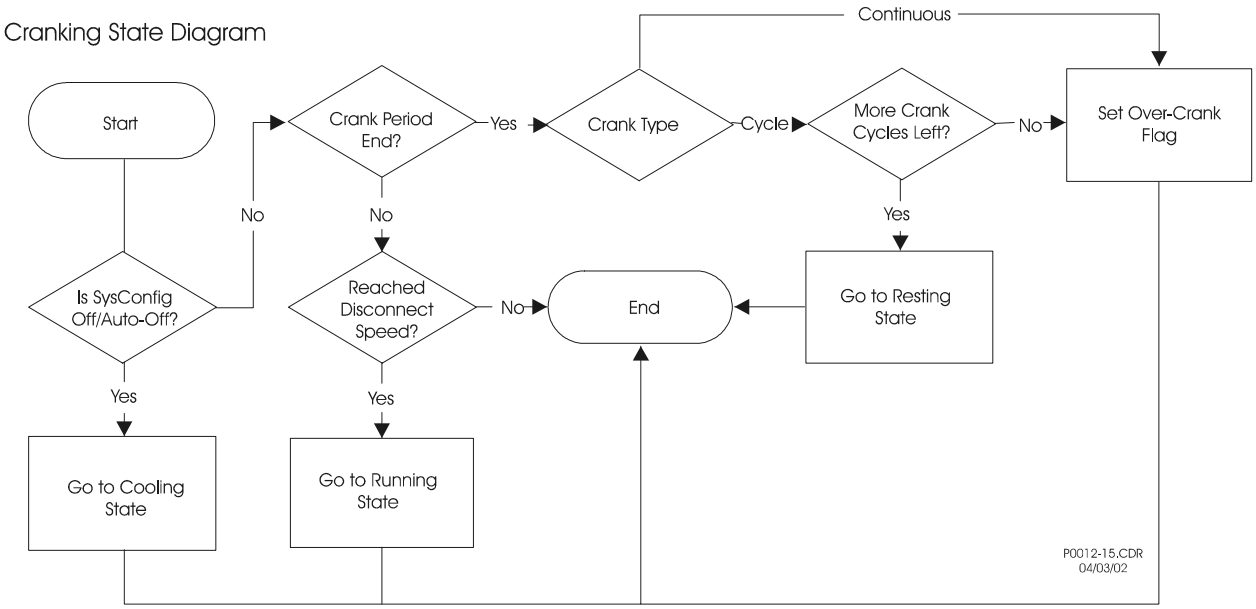

Figure 3-23. Cranking State Diagram

Resting State

If the rest period has ended, the unit will transition back to the Cranking state. If the State Machine is following the ECU Power Support diagram, the Fuel Solenoid relay will be closed during the Resting state. Thus, there is a possibility for the engine to start running during this state. Therefore, when the ECU Power Support diagram is being followed, engine speed is checked to see if it is above crank-disconnect. If it is, the unit will transition into the Running state. Figure 3-24 illustrates the Resting State flowchart.

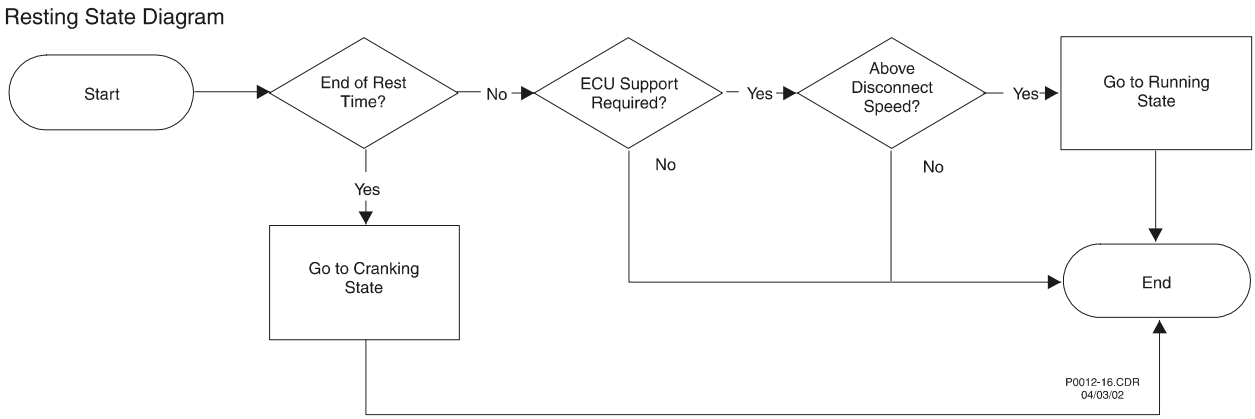

Figure 3-24. Resting State Diagram

Running State

If the System configuration changes to Off/Auto-Off, then the unit transitions to the Cooling state. If System configuration is set to Auto-Run, then the Cool-Down Timer is reset or incremented here if a load is applied and removed from the engine. If Pre-Start Contact After Disconnect was enabled in BESTCOMS, then during the course of this state, the Pre-Start relay will remain closed, otherwise it will be opened. Figure 3-25 illustrates the Running State flowchart.

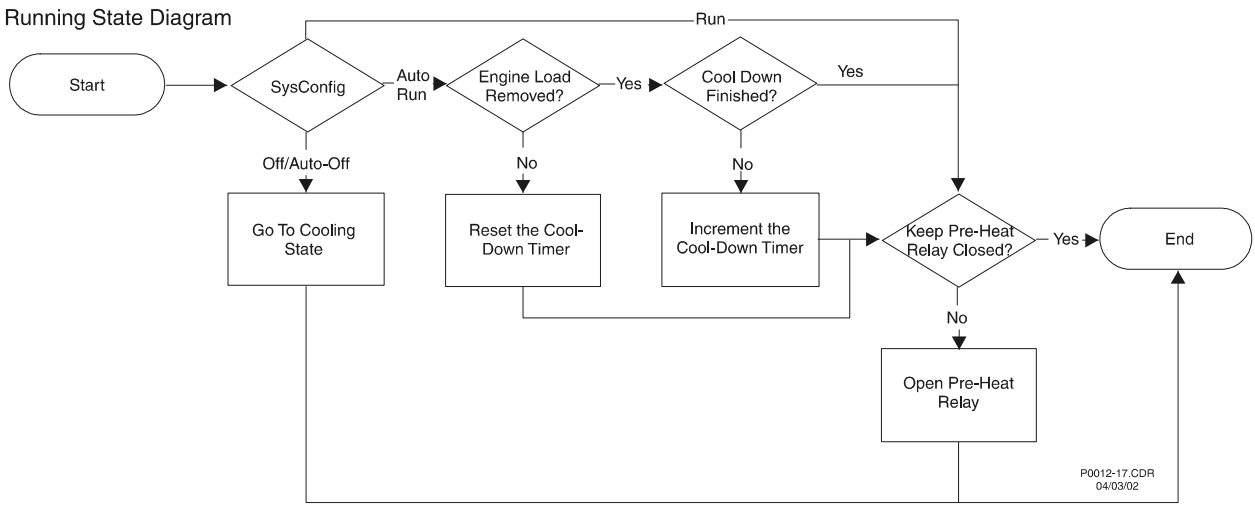

Figure 3-25. Running State Diagram

Cooling State

This state is available only if the unit is in Auto/Off with an unexpired Cool-Down time or if the unit was in the Cranking state when the unit went to Off. If system configuration changes back to Auto-Run, this state will transition straight into the Running state since the engine should already be running while it is in the Cooling state. If System configuration is Off, then the unit was either in the Cranking or Running state and the unit will verify if it should go to the Ready or Shutting Down state. If there is a load applied to the engine or one was applied and then removed, but the engine wasn't running long enough after it was removed to expire the Cool-Down Time, the unit will stay in this state until the Cool-Down timer expires. After the Cool-Down timer expires, if the unit is following the ECU Power Support diagram, the state will transition to the Shutting Down state. Otherwise, it will go to the Ready state. Figure 3-26 illustrates the Cooling state flowchart.

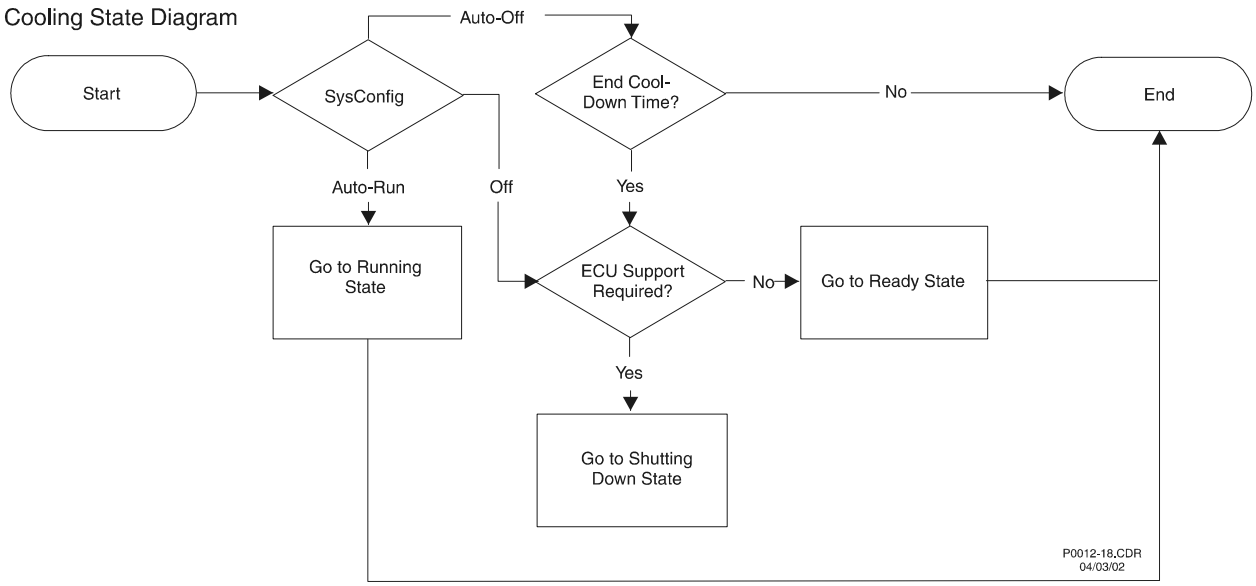

Figure 3-26. Cooling State Diagram

Shutting Down State

The Shutting Down State follows the sequence of events shown in Figure 3-27. If the Engine Shut Down timer expires, the unit transitions to the Ready state. If system configuration changes back to Run/Auto-Run, then this state will transition to the Connecting state, because if the unit is in a Shutting Down state, it will continue to follow the ECU Power Support diagram.

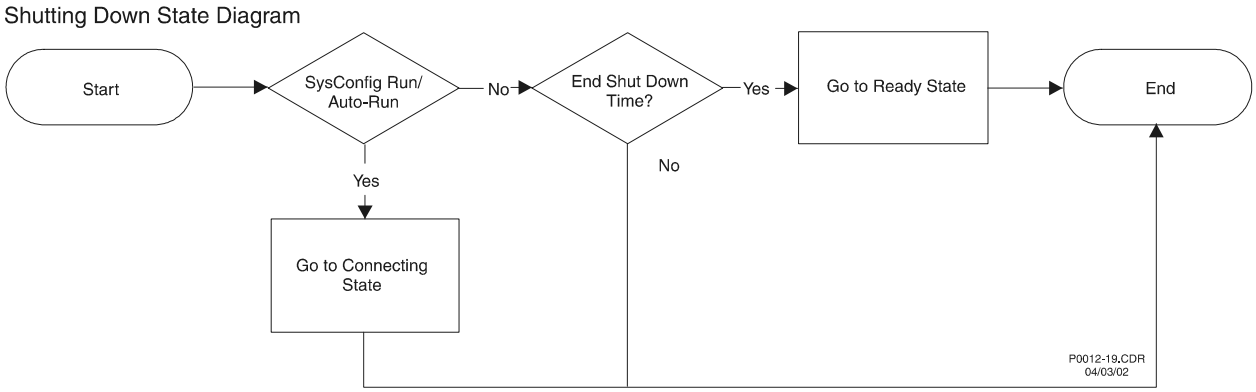

Figure 3-27. Shutting Down State Diagram

Alarm State

All states except Reset can transition to the Alarm state. The State Machine frequently checks for alarms and pre-alarms before running through each state. If an alarm is flagged in the initial alarm check, then the unit goes into an Alarm state and waits there for the alarm to clear. If it is in Run/Auto-Run, then the alarm can be cleared only by going to Off. When the alarm clears, the Alarm state will transition to the Shutting Down state and then go to the Ready state. If ECU Support is enabled, the unit will go to the Pulsing state immediately after transitioning to the Ready state. If in Off/Auto-Off, the alarm can be cleared only if the alarm condition ceases or the user disables the alarm through BESTCOMS. Figure 3-28 illustrates the Alarm State flowchart.

NOTE

With ECU Support enabled, if an alarm was tripped by an ECU value, then it will not clear. This is because in the Alarm state, the fuel solenoid is open, causing the ECU to not have power to update the internal variables. To clear an alarm in this event, the user must remotely place the unit in Off mode through BESTCOMS or go from Auto-Off to Off via the front panel HMI to force a pulse of the ECU.

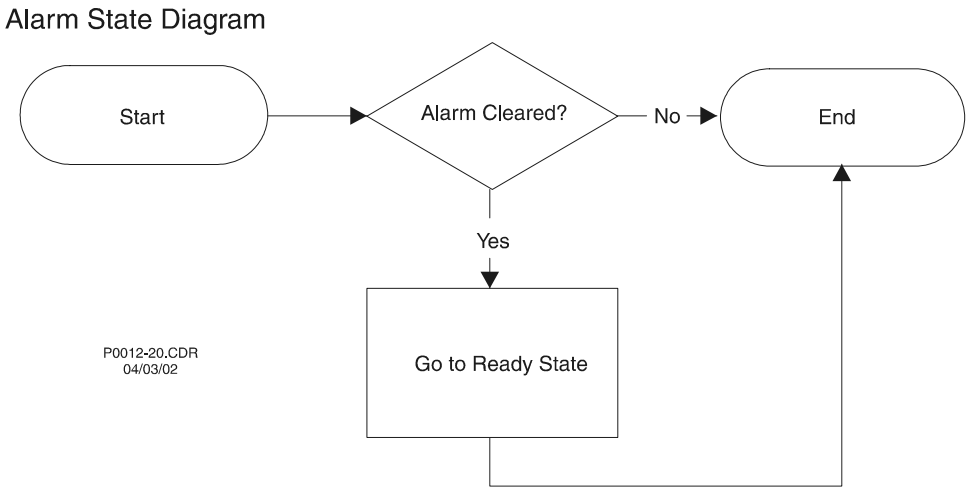

Figure 3-28. Alarm State Diagram

SECTION 4 • BESTCOMS SOFTWARE

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SECTION 4 • BESTCOMS SOFTWARE

INTRODUCTION

DGC-500 BESTCOMS software provides a user-friendly communication link between the DGC-500 and the user. An IBM-compatible PC running BESTCOMS can be used to configure the following parameters.

- Sensing transformer ratios
- Programmable contact inputs and programmable outputs
- Engine and system settings
- Engine cranking type and settings
- Pre-alarm and alarm triggers
- Sender data for coolant temperature, oil pressure, and fuel level
- Communication settings

Within BESTCOMS, DGC-500 settings can be saved in a computer file and used later to configure other controllers with the same settings.

INSTALLATION

DGC-500 BESTCOMS software operates with IBM compatible personal computers (PCs) using Microsoft® Windows® 95 or later operating systems. The minimum recommended operating requirements are listed below.

- IBM compatible PC, 486DX2 or faster (100 MHz or higher microprocessor is recommended)
- One available serial port
- CD-ROM Drive

Installing DGC-500 BESTCOMS

BESTCOMS software contains a setup utility that installs the application on your PC. An uninstall utility is loaded with the program and can be used to remove BESTCOMS from your PC if desired. Use the following procedure to install DGC-500 BESTCOMS.

1. Insert the CD-ROM into the PC CD-ROM drive.
2. When the DGC-500 Setup and Documentation CD menu appears, click the Install button for the BESTCOMS PC Program. The setup utility automatically installs DGC-500 BESTCOMS on your PC.

When BESTCOMS is installed, a Basler Electric folder is added to the Windows® program menu. This folder is accessed by clicking the **Start** button and pointing to **Programs**. As illustrated in Figure 4-1, the Basler Electric folder contains icons for the DGC-500 BESTCOMS program and a utility to remove BESTCOMS.

Figure 4-1. Basler Electric Folder Contents

Connecting the DGC-500 and PC

Connect a communication cable between the rear RS-232 connector of the DGC-500 and the appropriate communication port of the PC. Refer to Figure 2-2 for the location of the DGC-500 RS-232 connector and Figure 5-4 for the required connections between the DGC-500 and a PC.

STARTING BESTCOMS

BESTCOMS is started by clicking the Windows® **Start** button, pointing to **Programs**, the **Basler Electric** folder, and then clicking the **DGC 500** icon. At startup, a dialog box with the program title and version number is displayed briefly (Figure 4-2). After this dialog box is displayed, the Sensing Transformers screen is displayed (Figure 4-5).

Figure 4-2. BESTCOMS Title and Version

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Establishing Communication

Communication between BESTCOMS and the DGC-500 must be established before reading or changing settings. BESTCOMS screen settings are updated only after communication is opened or the communication settings have been changed.

Open the DGC-500 communication port by clicking **Communications** on the menu bar and clicking **Open**. When **Open** is selected, the Communication Initiation screen of Figure 4-3 appears. Select the appropriate communication port for your PC (Comm 1, 2, 3, or 4) and click the **Initialize** button. Information about altering the baud and parity settings is provided in the *RS-232 Configuration* sub-section. When the Password dialog box of Figure 4-4 appears, enter the appropriate password and click **OK**. The DGC-500 is delivered with the following default passwords.

- *DGC*. This limited-access password allows all DGC-500 settings to be read, but prevents any changes to settings.
- *DGC500*. This full-access password allows all DGC-500 settings to be read and allows all settings except Engine Runtime to be changed.
- *OEMLVL*. This OEM-access password allows all DGC-500 settings to be read and allows all settings to be changed. It also allows the DGC-500 embedded firmware to be upgraded.

Passwords are case-sensitive; all default passwords are upper-case. More information about passwords is provided in the Password Protection sub-section.

The Unit ID number displayed in the password dialog box indicates the identification number of the DGC-500. Information about changing the unit ID for polled communication is provided in the RS-232 Configuration sub-section.

Once the password is entered, a dialog box appears and confirms that communication was established and DGC-500 data was received by BESTCOMS.

Figure 4-3. Communication Initiation Screen

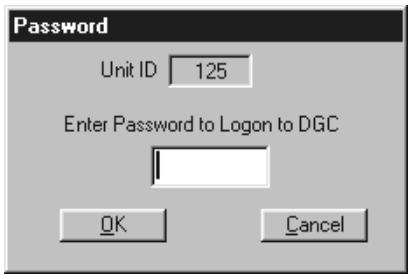

Figure 4-4. Password Dialog Box

CHANGING SETTINGS

DGC-500 settings are arranged into seven groups.

- Sensing Transformers
- Pre-Alarms
- Alarms
- Engine Cranking
- System
- Programmable Inputs and Outputs
- Generator Protection (optional)

Each setting group has a corresponding button (shown in Figure 4-5) that can be selected to access that group of settings. The seven setting groups can also be accessed by clicking **Screens** on the menu bar and then selecting the desired setting group from the list. Once a setting group is accessed, the individual settings of the group can be viewed and changed.

A setting is changed by clicking within the setting field and typing the new setting. If the new setting is outside the prescribed setting range, a dialog box showing the acceptable range appears when another setting field is accessed or when attempting to send the new setting to the DGC-500. The following paragraphs describe how settings are sent to the DGC-500.

SENDING AND RECEIVING SETTINGS

When communication is enabled, DGC-500 settings can be sent or received through BESTCOMS.

Sending Settings

Setting changes are sent to the DGC-500 by clicking the **Send Settings** button. This causes all settings to become the DGC-500 settings. Settings can also be sent to the DGC-500 by clicking **Communications** on the menu bar and clicking **Send to DGC**.

Receiving Settings

DGC-500 settings are retrieved by clicking the **Get Settings** button. This causes the current settings of the DGC-500 to be loaded into BESTCOMS. Settings can also be received from the DGC-500 by clicking **Communications** on the menu bar and clicking **Get from DGC**. Settings are also automatically retrieved when logging on.

SETTING DEFINITIONS

Each of the six setting groups has a corresponding BESTCOMS screen. The settings of each screen are categorized by one or more tabs. In the following paragraphs, settings are arranged and defined according to the organization of the BESTCOMS screens and tabs.

Sensing Transformers

The button with the transformer icon on it is clicked to access the Sensing Transformers screen. The Sensing Transformers screen can also be accessed by clicking **Screens** on the menu bar and clicking **Sensing Transformers**.

Sensing Transformer settings are shown in Figure 4-5 and are described in the following paragraphs.

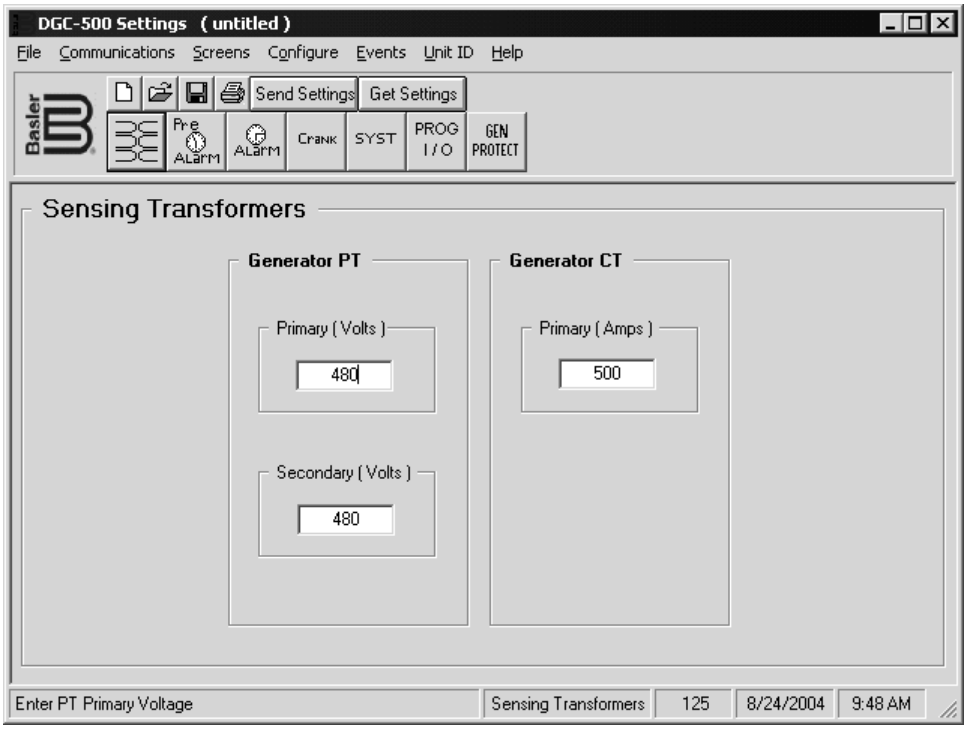

Figure 4-5. Sensing Transformers Screen

Generator PT - Primary (Volts). This setting selects the rating of the primary side of the transformer used to sense generator voltage. The primary voltage setting is adjustable from 1 to 999 Vac.

Generator PT - Secondary (Volts). This setting selects the rating of the secondary side of the transformer used to sense generator voltage. The secondary voltage setting is adjustable from 1 to 480 Vac.

Generator CT - Primary (Amps). This setting selects the rating of the primary side of the transformer used to sense generator current. The primary current setting is adjustable from 1 to 5,000 Aac.

Pre-Alarms

Click the **Pre Alarm** button to access the Pre-Alarms screen or click **Screens** on the menu bar and click **Pre-Alarm Settings**.

The Pre-Alarms screen consists of five tabs: Low Fuel-Low Cool-Batt. OverVolt., Low Oil-Low Batt Volt-Weak Batt Volt, Audible-Battery Charger-Fuel Level Sender, Maint. Interv.-Hi Cool, and CAN Bus - Diagnostic Trouble Codes.

Low Fuel-Low Cool-Batt. OverVolt Tab

The Low Fuel-Low Cool-Batt. OverVolt. tab settings of the Pre-Alarms screen are shown in Figure 4-6. Each tab setting is described in the following paragraphs.

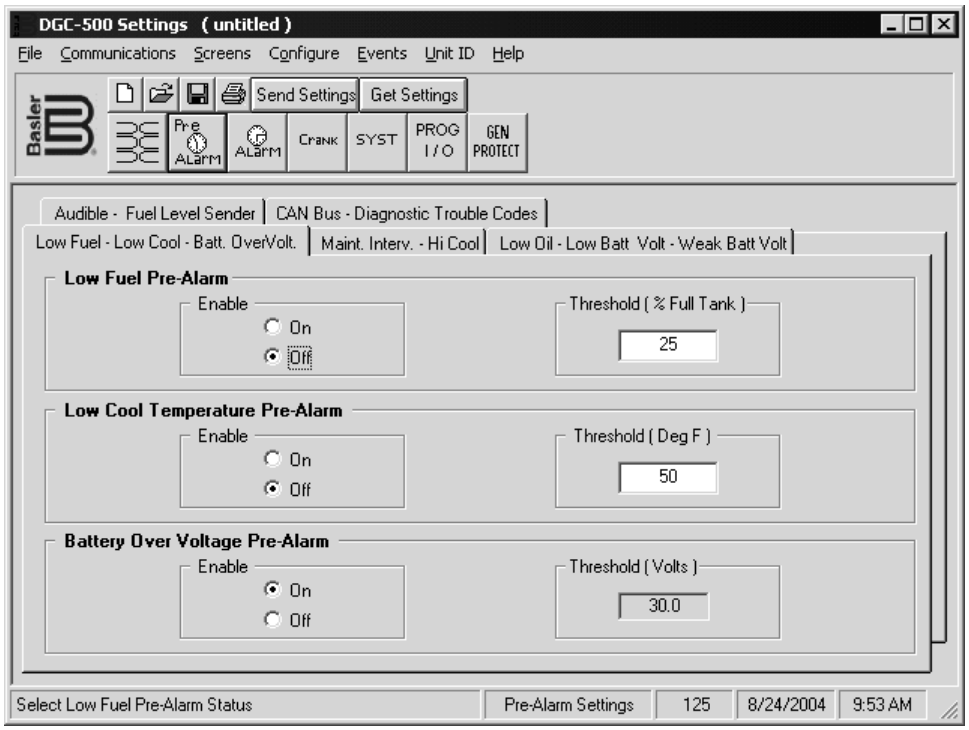

Figure 4-6. Pre-Alarm Screen, Low Fuel-Low Cool-Batt. OverVolt Tab

Low Fuel Pre-Alarm - Enable. This setting enables and disables annunciation of a low fuel pre-alarm. The Low Fuel Pre-Alarm is deactivated when certain fuel types are selected. The Programmable Senders sub-section provides more information about selecting the fuel type.

Low Fuel Pre-Alarm - Threshold (% Full Tank). This setting selects the fuel level that will trigger a low fuel pre-alarm. A threshold setting of 10 to 100 percent may be entered. The Low Fuel Pre-Alarm is deactivated when certain fuel types are selected. The Programmable Senders sub-section provides more information about selecting the fuel type.

Low Cool Temperature Pre-Alarm - Enable. This setting enables and disables annunciation of a low coolant temperature pre-alarm.

Low Cool Temperature Pre-Alarm - Threshold (Deg F). This setting selects the coolant temperature that will trigger a low coolant temperature pre-alarm. A threshold setting of 50 to 100 degrees Fahrenheit or 10 to 38 degrees Celsius may be entered.

Battery Over Voltage Pre-Alarm - Enable. This setting enables and disables annunciation of a battery overvoltage pre-alarm.

Battery Over Voltage Pre-Alarm - Threshold (Volts). This read-only setting displays the voltage level that will trigger a battery overvoltage pre-alarm. The threshold setting is fixed at 15 Vdc for systems operating at 12 Vdc and 30 Vdc for systems operating at 24 Vdc.

Low Oil-Low Batt Volt-Weak Batt Volt Tab

The Low Oil-Low Batt Volt-Weak Batt Volt Tab settings are shown in Figure 4-7. Each tab setting is described in the following paragraphs.

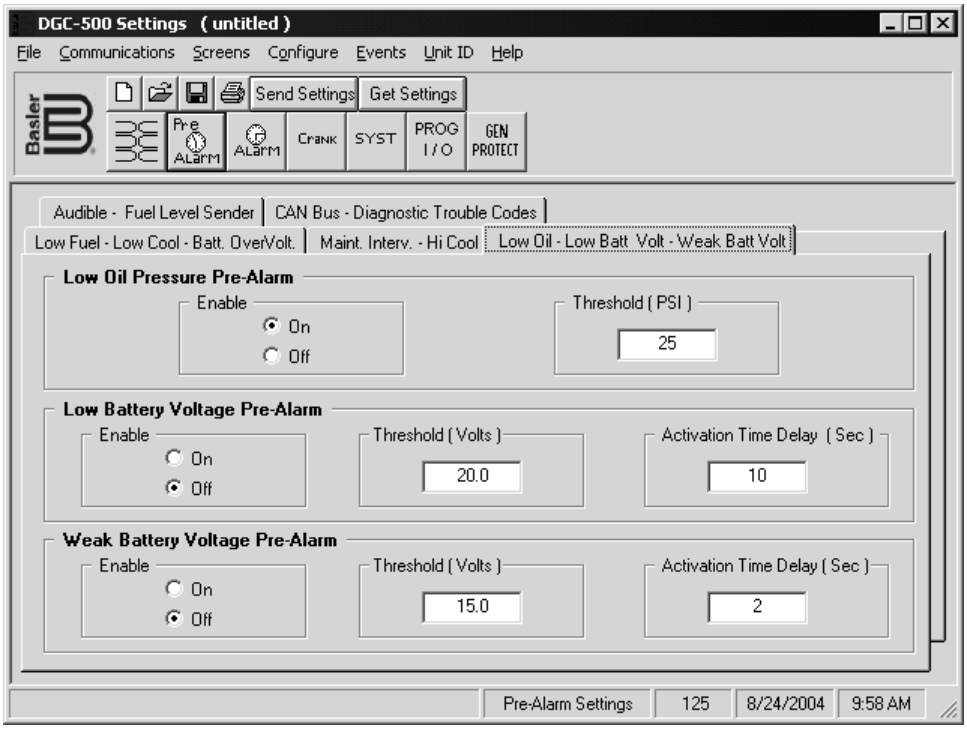

Figure 4-7. Pre-Alarm Screen, Low Oil-Low Batt Volt-Weak Batt Volt Tab

Low Oil Pressure Pre-Alarm - Enable. This setting enables and disables annunciation of a low oil pressure pre-alarm. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Oil Pressure Pre-Alarm - Threshold (PSI). This setting selects the oil pressure level that will trigger a low oil pressure pre-alarm. A threshold setting of 3 to 150 psi or 20 to 1,035 kPa may be entered. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Battery Voltage Pre-Alarm - Enable. This setting enables and disables annunciation of a low battery voltage pre-alarm.

Low Battery Voltage Pre-Alarm - Threshold (Volts). This setting selects the voltage level that will trigger a low battery voltage pre-alarm. The threshold setting is adjustable from 6 to 12 Vdc for 12 Vdc systems and 12 to 24 Vdc for 24 Vdc systems.

Low Battery Voltage Pre-Alarm - Activation Time Delay (Sec). This setting selects the time delay from when low battery voltage is detected until a pre-alarm is annunciated. A time delay of 1 to 10 seconds may be entered.

Weak Battery Voltage Pre-Alarm - Enable. This setting enables and disables annunciation of a weak battery voltage pre-alarm.

Weak Battery Voltage Pre-Alarm - Threshold (Volts). This setting selects the voltage level that will trigger a weak battery voltage pre-alarm. The threshold setting is adjustable from 4 to 8 Vdc for 12 Vdc systems and 8 to 16 Vdc for 24 Vdc systems.

Weak Battery Voltage Pre-Alarm - Activation Time Delay (Sec). This setting selects the time delay from when weak battery voltage is detected until a pre-alarm is annunciated. A time delay of 1 to 10 seconds may be entered.

Audible-Fuel Level Sender Tab

The Audible-Battery Charger-Fuel Level Sender Tab settings are shown in Figure 4-8. Each tab setting is described in the following paragraphs.

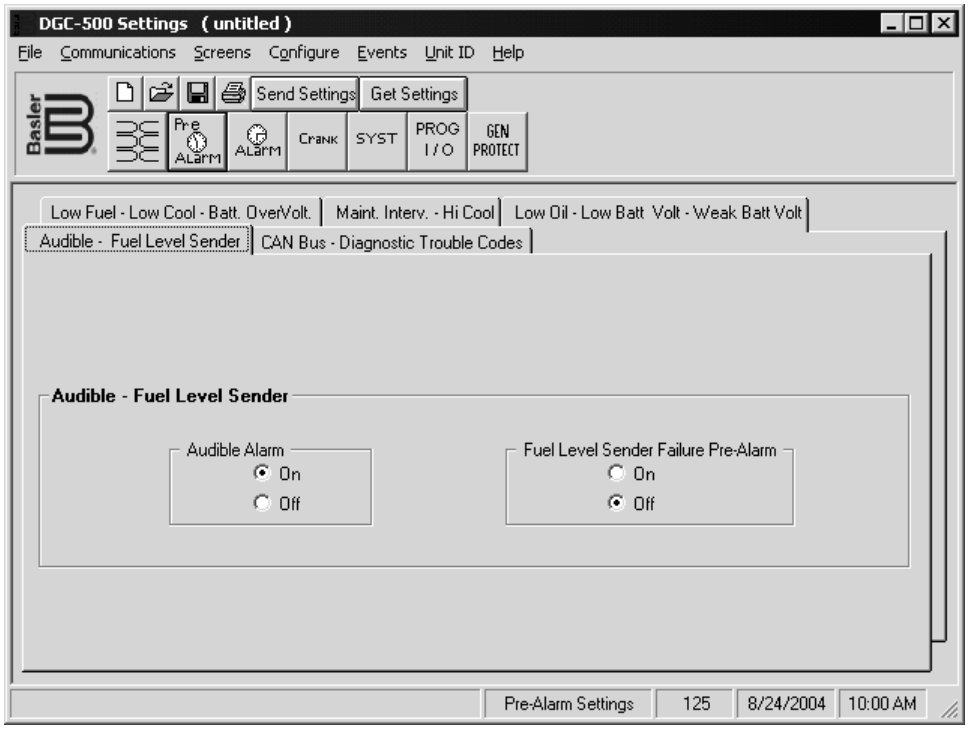

Figure 4-8. Pre-Alarms Screen, Audible-Fuel Level Sender Tab

Audible Alarm. This setting enables and disables an audible pre-alarm and alarm annunciation.

Fuel Level Sender Failure Pre-Alarm. This setting enables and disables annunciation of a fuel level sender failure pre-alarm.

Maint. Interv.-Hi Cool Tab

The Maint. Interv.-Hi Cool Tab settings are shown in Figure 4-9. Each tab setting is described in the following paragraphs.

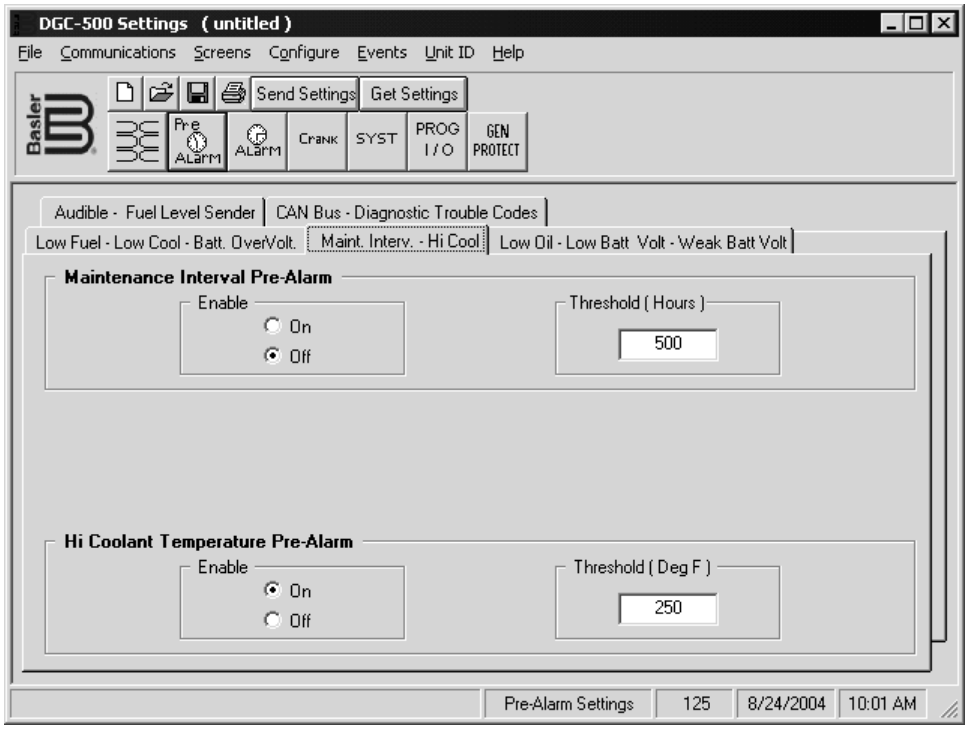

Figure 4-9. Pre-Alarms Screen, Maint. Interv.-Hi Cool Tab

Maintenance Interval Pre-Alarm - Enable. This setting enables and disables annunciation of a maintenance interval pre-alarm.

Maintenance Interval Pre-Alarm - Threshold (Hours). This setting selects the length of the maintenance interval. An interval of zero to 5,000 hours may be selected. Refer to the *Maintenance Interval Timer Reset* paragraph of the *System* sub-section for information about resetting the Maintenance Interval Pre-Alarm.

Hi Coolant Temperature Pre-Alarm - Enable. This setting enables and disables annunciation of a high coolant temperature pre-alarm. A 60 second activation delay prevents a Hi Coolant Temperature Pre-Alarm from occurring at engine startup.

Hi Coolant Temperature Pre-Alarm Threshold (Deg F). This setting selects the coolant temperature that will trigger a high coolant temperature pre-alarm. A threshold setting of 100 to 280 degrees Fahrenheit or 38 to 138 degrees Celsius may be entered. A 60 second activation delay prevents a Hi Coolant Temperature Pre-Alarm from occurring at engine startup.

CAN Bus-Diagnostic Trouble Codes

The CAN Bus-Diagnostic Trouble Codes Tab settings are shown in Figure 4-10. Each tab setting is described in the following paragraphs.

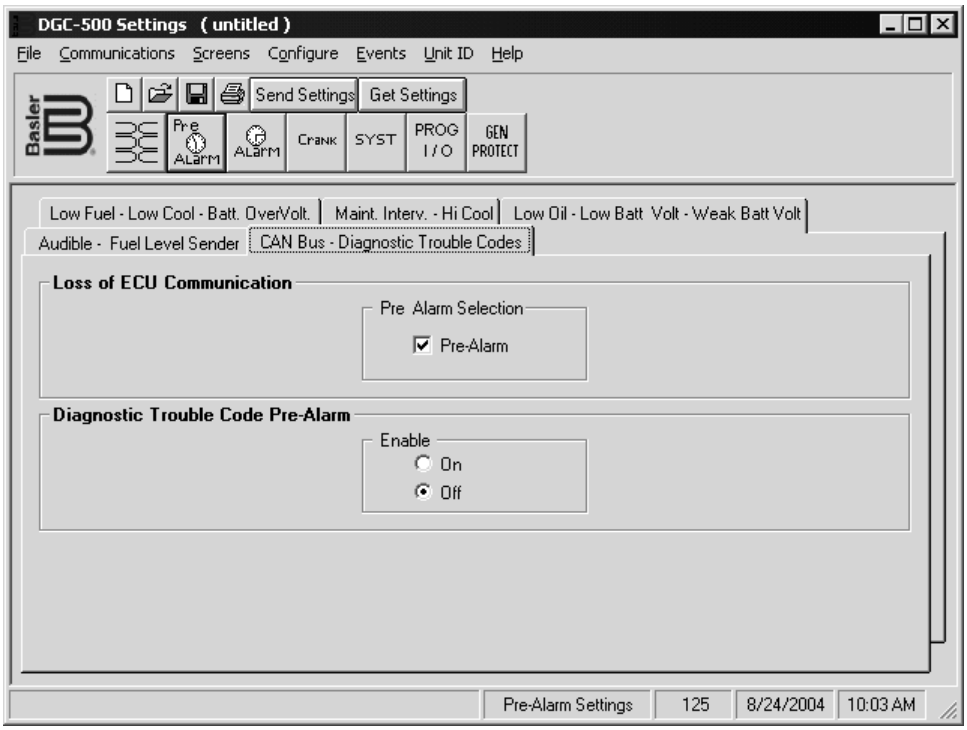

Figure 4-10. Pre-Alarms Screen, CAN Bus-Diagnostic Trouble Codes

Loss of ECU Communication - Pre-Alarm Selection. This setting enables annunciation of a pre-alarm when communication between the DGC-500 and engine control unit (ECU) is interrupted.

Diagnostic Trouble Code Pre-Alarm. This setting enables and disables annunciation of a diagnostic trouble code (DTC) pre-alarm. The DGC-500 receives unsolicited DTCs from the ECU.

Alarms

Click the **Alarm** button to access the Alarms screen or click **Screens** on the menu bar and click **Alarm Settings**.

The Alarms screen consists of two tabs: Hi Cool-Low Fuel-Low Oil and Overspeed-Sender Fail.

Hi Cool-Low Fuel-Low Oil Tab

The Hi Cool-Low Fuel-Low Oil Tab settings are shown in Figure 4-11. Each tab setting is described in the following paragraphs.

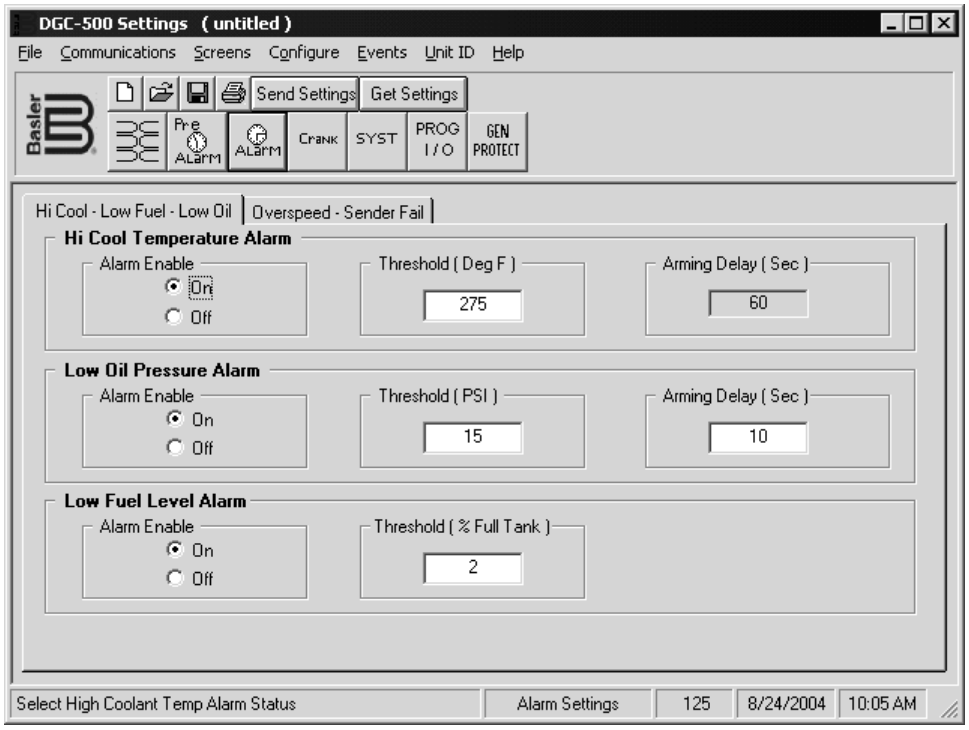

Figure 4-11. Alarms Screen, Hi Cool-Low Fuel-Low Oil Tab

Hi Cool Temperature Alarm - Alarm Enable. This setting enables and disables annunciation of a high coolant temperature alarm and engine shutdown. A 60 second activation delay prevents a Hi Coolant Temperature Alarm from occurring at engine startup.

Hi Cool Temperature Alarm - Threshold (Deg F). This setting selects the coolant temperature that will trigger a high coolant temperature alarm. A threshold setting of 100 to 280 degrees Fahrenheit or 38 to 138 degrees Celsius may be entered. A 60 second activation delay prevents a Hi Coolant Temperature Alarm from occurring at engine startup.

Hi Cool Temperature Alarm - Arming Delay (Sec). This read-only setting displays the time delay between when high coolant temperature is detected and an alarm is annunciated and the engine is shut down. The arming delay is fixed at 60 seconds.

Low Oil Pressure Alarm - Alarm Enable. This setting enables and disables annunciation of a low oil pressure alarm and engine shutdown. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Oil Pressure Alarm - Threshold (PSI). This setting selects the oil pressure level that will trigger a low oil pressure alarm and engine shutdown. A threshold of 3 to 150 psi or 20 to 1,035 kPa may be entered. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Oil Pressure Alarm - Arming Delay (Sec). This setting selects the time delay between when low oil pressure is detected and an alarm is annunciated and the engine is shut down. A time delay of 5 to 15 seconds may be entered. A 10 second activation time delay prevents low oil pressure annunciation during engine startup.

Low Fuel Level Alarm - Alarm Enable. This setting enables and disables alarm annunciation and engine shutdown for a low fuel level.

Low Fuel Level Alarm - Threshold (% Full Tank). This setting selects the fuel level that will trigger a low fuel level alarm. A threshold of zero to 100 percent may be entered.

Overspeed-Sender Fail Tab

The Overspeed-Sender Fail Tab settings are shown in Figure 4-12. Each tab setting is described in the following paragraphs.

Overspeed Alarm - Alarm Enable. This setting enables and disables alarm annunciation and engine shutdown for an overspeed condition.

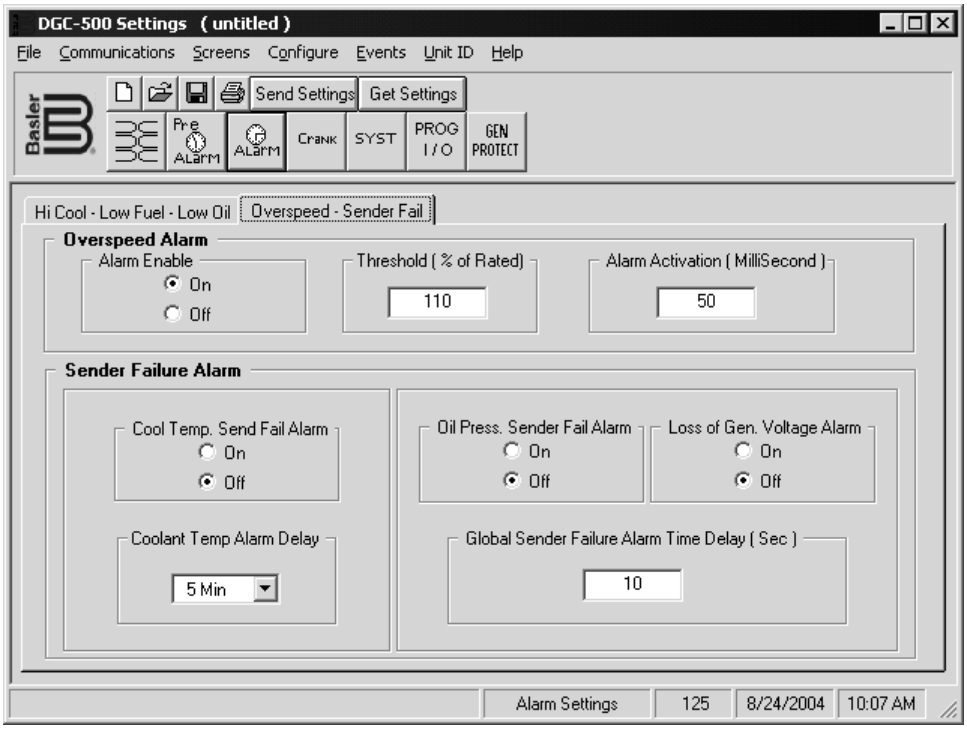

Figure 4-12. Alarms Screen, Overspeed-Sender Fail Tab

Overspeed Alarm - Threshold (% of Rated). This setting selects the percentage of overspeed that triggers an overspeed alarm and engine shutdown. The threshold is adjustable from 105 to 140 % of nominal speed.

Overspeed Alarm - Alarm Activation (MilliSecond). This setting adjusts the time delay from when an overspeed alarm condition is detected until it is annunciated and the engine is shut down. A time delay of zero to 500 milliseconds may be entered.

Sender Failure Alarm - Cool Temp. Send Fail Alarm. This setting enables and disables alarm annunciation and engine shutdown for a coolant temperature sender failure.

Sender Failure Alarm - Coolant Temp Alarm Delay. This setting adjusts the time delay from when a coolant temperature sender failure is detected until it is annunciated and the engine is shut down. A time delay of 5, 10, 15, 20, 25, or 30 minutes may be selected.

Sender Failure Alarm - Oil Press. Sender Fail Alarm. This setting enables and disables alarm annunciation and engine shutdown for an oil pressure sender failure. An oil pressure sender failure alarm is annunciated and engine shutdown is initiated when the Global Sender Failure Alarm Time Delay expires.

Sender Failure Alarm - Loss of Gen. Voltage Alarm. This setting enables and disables alarm annunciation and engine shutdown for a loss of generator voltage. A loss of generator voltage alarm is annunciated when the generator voltage decreases below 1.5 Vac and the Global Sender Failure Alarm Time Delay expires. This setting does not disable a Sender Failure Alarm for the speed signal source when generator frequency is selected as the speed signal source.

Sender Failure Alarm - Global Sender Failure Alarm Time Delay (Sec). This setting selects the time delay between when an oil pressure sender failure, loss of generator voltage failure, or MPU sender failure is detected and alarm annunciation and engine shutdown.

Engine Cranking

Click the Crank button to access the Engine Cranking screen or click **Screens** on the menu bar and click **Crank Settings**.

Engine Cranking settings are shown in Figure 4-13 and are described in the following paragraphs.

Cranking Style. This setting selects the cranking method as either continuous or cycle.

Crank Disconnect Limit (% of Rated). This setting selects the percentage of rated engine speed at which cranking is terminated. A disconnect limit of 10 to 100 percent may be entered.

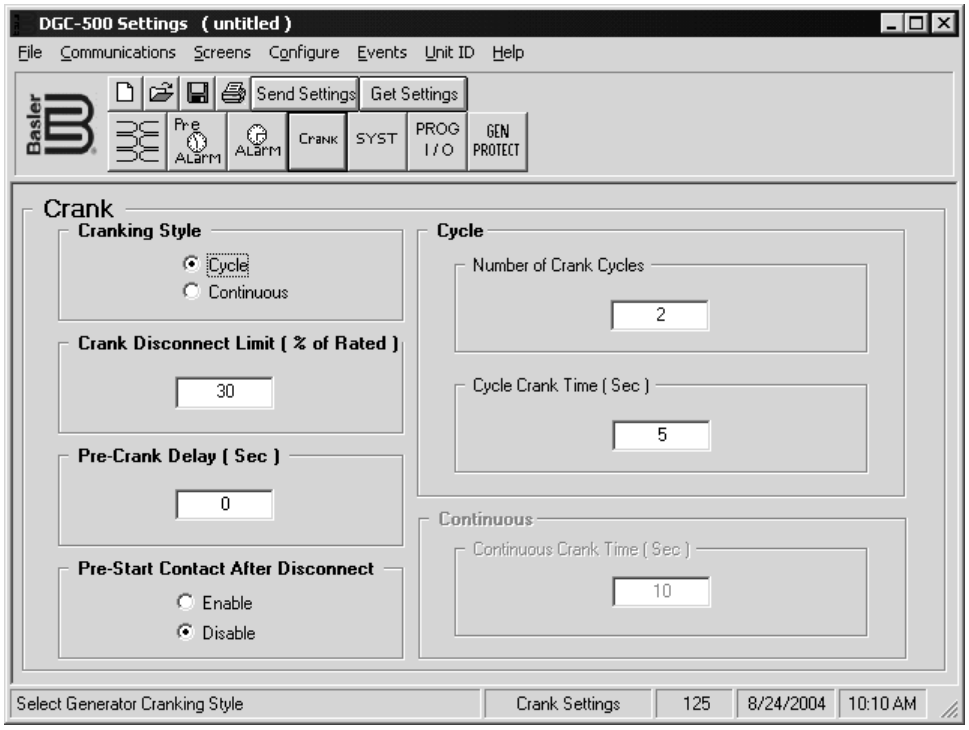

Figure 4-13. Engine Cranking Screen

Pre-Crank Delay (Sec). This setting adjusts the time delay between initiating engine starting and beginning engine cranking. A delay of zero to 30 seconds may be entered.

Pre-Start Contact After Disconnect. This setting selects whether or not the pre-start contact remains closed after disconnect occurs.

Cycle - Number of Crank Cycles. This setting, available only if cycle cranking is selected, selects the number of engine cranking attempts before an overcrank condition occurs and cranking is terminated. The crank cycles setting range is 1 to 7.

Cycle - Cycle Crank Time (Sec). This setting, available only if cycle cranking is selected, controls the duration of each cranking cycle. Each cranking period is separated by a resting period of equal length. A crank time of 5 to 15 may be entered.

Continuous - Continuous Crank Time (Sec). This setting, available only if continuous cranking is selected, selects the duration of a single engine cranking attempt before an overcrank condition occurs. A continuous crank time of 1 to 60 seconds may be entered.

System

Click the **SYST** button to access the System Settings screen or click **Screens** on the menu bar and click **System Settings**.

System settings are shown in Figure 4-14 and are described in the following paragraphs.

Genset's kW Rating. The generator power rating is entered in this field. A genset kW rating of 5 to 9,999 may be entered.

Cool Down Time. This setting selects the time delay time for any of the following three conditions.

- The generator load is removed and engine shutdown is permitted.
- The Auto Transfer Switch is opened while operating in Auto mode and engine shutdown occurs.
- A remote shutdown is initiated and engine shutdown occurs.

A cool-down time of zero (0) to 60 minutes may be entered.

Rated Engine RPM. This setting selects the rated rotating speed of the engine. A value of 750 to 3,600 rpm may be entered.

Maintenance Interval Timer Reset. Selecting this checkbox terminates the maintenance interval pre-alarm and resets the maintenance interval timer back to the programmed value. The Send Settings button must be clicked for the reset to take effect.

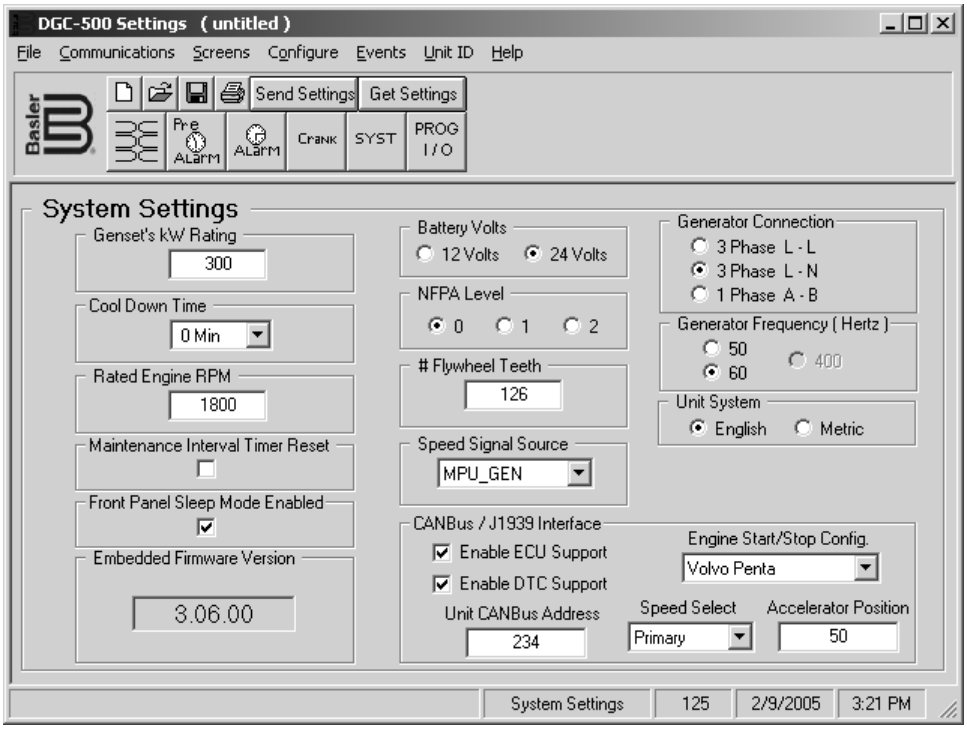

Figure 4-14. System Setting Screen

Front Panel Sleep Mode Enabled. Selecting this checkbox enables the activation of Sleep mode when the DGC-500 is in Off mode for more than 15 minutes. When Sleep mode is active, the front panel LEDs, LCD, and LCD backlight are turned off to reduce power consumption.

Battery Volts. This setting selects either 12 Vdc or 24 Vdc as the starting battery nominal voltage.

NFPA Level. This setting selects whether or not NFPA requirements are in effect. If NFPA (National Fire Prevention Association) compliance is not required, a setting of zero (0) can be selected to disable the feature. Selecting NFPA level one (1) or two (2) affects DGC-500 operation in the following ways.

- The number of crank cycles is fixed at 3.
- Crank cycle time is fixed at 15 seconds.
- Continuous crank time is fixed at 45 seconds.
- The low coolant temperature pre-alarm setting is fixed at 70 F.

 # Flywheel Teeth. This setting selects the number of teeth on the engine flywheel. A value of 50 to 500 may be entered.

Speed Signal Source. This setting selects from three sources for obtaining the engine speed. The speed signal source can be obtained from the magnetic pickup (MPU), generator frequency, or derived from both the MPU and generator frequency. When both the MPU and generator frequency are selected as the speed signal source, the MPU has priority. If both MPU and generator frequency are selected and the MPU fails, generator frequency is used and a non-programmable MPU sender failure pre-alarm is annunciated.

When the CANBus interface is used, the speed signal source setting must be set at MPU or MPU_GEN. This allows the DGC-500 to receive the engine speed data sent by the ECU via the J1939 protocol.

Embedded Firmware Version. This read-only field displays the firmware version of the DGC-500.

Generator Connection. This setting selects the configuration of the generator voltage sensing circuitry. Either three-phase line-to-line, three-phase line-to-neutral, or single-phase A-phase to B-phase sensing may be selected.

Generator Frequency. This setting selects either 50 hertz or 60 hertz as the nominal generator frequency.

Unit System. This setting selects either the English or Metric unit system for displaying the oil pressure and coolant temperature parameters in BESTCOMS, the DGC-500 HMI, and the optional Remote Annunciation Display Panel (RDP-110).

CANBus/J1939 Interface - Enable ECU Support. This setting enables and disables the DGC-500 CAN interface. When enabled, the CAN interface allows the DGC-500 to communicate with the engine control unit (ECU). This setting must be enabled in order to enable DTC support.

CANBus/J1939 Interface - Enable DTC Support. This setting enables and disables the viewing of diagnostic trouble codes (DTCs) reported by the ECU. Both the Enable ECU Support and Enable DTC Support settings must be enabled to view DTCs.

CANBus/J1939 Interface - Unit CANBus Address. This setting selects the address to be used by the DGC-500 for J1939 communication. A value of 0 to 253 may be entered.

CANBus/J1939 Interface - Engine Start/Stop Config. This setting selects one of two engine start/stop configurations. Selecting Volvo Penta configures the DGC-500 for starting and stopping of the engine using the J1939 communication interface. (The Enable ECU Support setting must be enabled.) Selecting Not Configured disables this feature.

CANBus/J1939 Interface - Speed Select. This setting tells the Volvo Penta EDC III to operate the engine at the primary or secondary base speed. If the engine is configured by Volvo for 60 hertz applications, the primary base speed is 1,800 rpm and the secondary base speed is 1,500 rpm. If the engine is configured by Volvo for 50 hertz applications, the primary base sped is 1,500 rpm and the secondary base speed is 1,800 rpm. This setting is enabled only when Volvo Penta is selected as the Start/Stop Config. Setting.

CANBus/J1939 Interface - Accelerator Position. This setting, expressed as a percentage, tells the Volvo Penta EDC III where to set the engine speed (trim) relative to the base speed. The range of the setting is the base speed ±120 rpm. A setting of 0% will cause the engine to run at 120 rpm below the base speed, a setting of 50% will cause the engine to run at the base speed, and a setting of 100% will cause the engine to run at 120 rpm above the base speed. The Accelerator Position setting is linear with a gain of 2.4 rpm/%. This setting in not saved in nonvolatile memory and defaults back to 50% after DGC-500 operation power is cycled. This setting is enabled only when Volvo Penta is selected as the Start/Stop Config. setting.

Programmable Inputs and Outputs

Click the **PROG I/O** button to access the Programmable Inputs and Outputs screen or click **Screens** on the menu bar and click **Input/Output Settings**.

The Programmable Inputs and Outputs screen consists of two tabs: Input Setup and Output Setup.

Input Setup Tab

The Input Setup tab settings of the Programmable Inputs and Outputs screen consist of three identical groups of settings for each of the three programmable inputs. Tab settings are shown in Figure 4-15. Each tab setting is described in the following paragraphs.

Programmable Input - Function. This setting selects the function type that is used to trigger the corresponding programmable input. The functions available for triggering a programmable input are listed below.

- Auto Transfer Switch
- Auxiliary Input
- Battery Charger Fail
- Fuel Leak Detect
- Low Coolant Level
- No Function
- Single-Phase Override

Programmable Input - Alarm/Pre-Alarm. Either of these check boxes can be selected to annunciate an alarm or pre-alarm when the selected function triggers the programmable input. Alarm or pre-alarm annunciation is available only when one the following functions are selected: Auxiliary Input, Battery Charger Fail, Fuel Leak Detect, or Low Coolant Level.

Programmable Input - Auxiliary Input Label. This setting field is active only when Auxiliary Input is selected as the programmable input function. An user-assigned label (eight characters, maximum) can be entered for the corresponding programmable input.

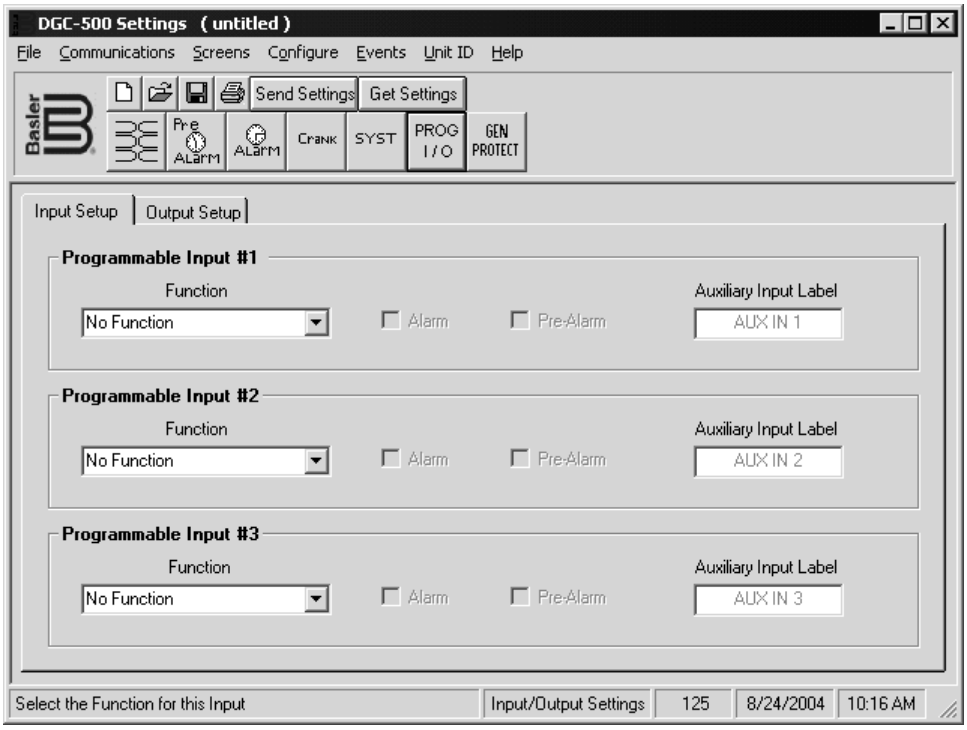

Figure 4-15. Settings Screen, Input Setup Tab

Output Setup Tab

The Output Setup Tab settings of the Settings screen are shown in Figure 4-16. (Not all settings are visible in the illustration.) Each tab setting is described in the following paragraphs.

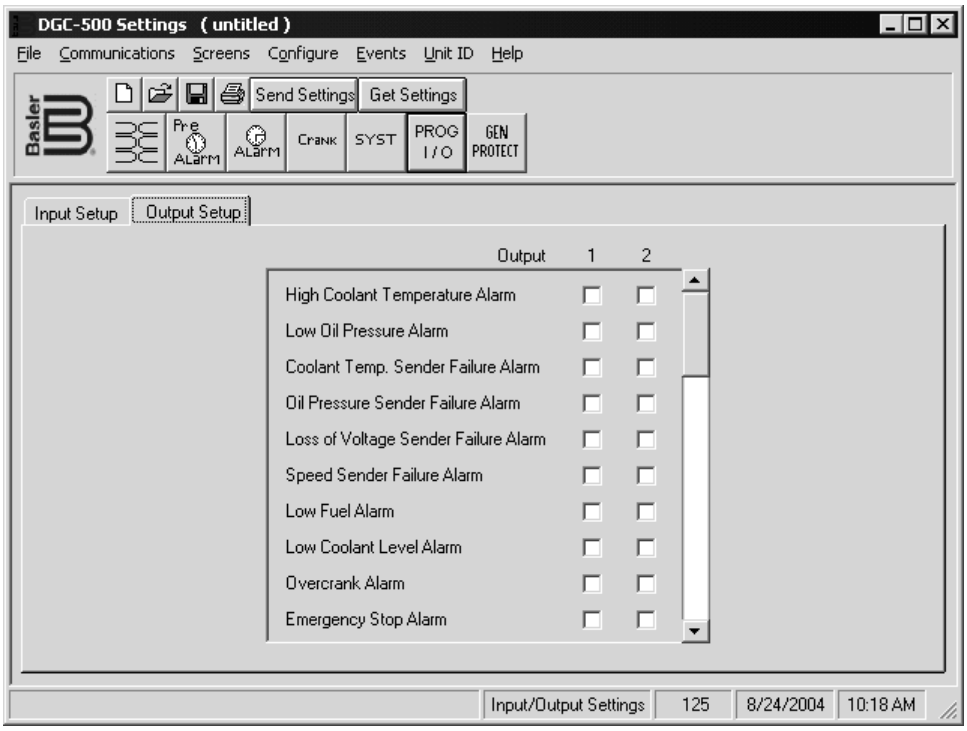

Figure 4-16. Settings Screen, Output Setup Tab

The Output Setup tab consists of a list of pre-alarms, alarms, and conditions that can be assigned to close either Programmable Output 1 or 2. An output selected by clicking the checkbox in the appropriate row and column. The following pre-alarms, alarms, and conditions can be assigned to one of the two programmable outputs.

- Battery Charger Failure Alarm
- Battery Charger Failure Pre-alarm
- Battery Overvoltage Pre-alarm
- Coolant Temperature Sender Failure Alarm
- Cooldown Timer Active
- Emergency Stop Alarm
- EPS Supplying Load
- Fuel Leak Alarm
- Fuel Leak Pre-alarm
- Fuel Sender Failure Pre-alarm
- High Coolant Temperature Pre-alarm
- High Coolant Temperature Alarm
- Loss of Voltage Sender Failure Alarm
- Low Battery Voltage Pre-alarm
- Low Coolant Level Pre-alarm
- Low Coolant Level Alarm
- Low Coolant Temperature Pre-alarm
- Low Fuel Alarm
- Low Fuel Pre-alarm
- Low Oil Pressure Alarm
- Low Oil Pressure Pre-alarm
- Speed Sender Failure Alarm
- Oil Pressure Sender Failure Alarm
- Overcrank Alarm
- Overcurrent (51)
- Overfrequency (81O)
- Overspeed Alarm
- Overvoltage (59)
- Phase Imbalance (47)
- Pre-start Condition in Effect
- Programmable Input 1 Closed
- Programmable Input 2 Closed
- Programmable Input 3 Closed
- Scheduled Maintenance Pre-alarm
- Switch Not in Auto
- Underfrequency (81U)
- Undervoltage (27)
- Weak Battery Voltage Pre-alarm

Generator Protection

Multifunction generator protection is provided on DGC-500 controllers with a style number of XXX1.

Click the **Gen Protect** button to access the Generator Protection screen or click **Screens** on the menu bar and click **Generator Protection**. The Generator Protection screen consists of five tabs: 51, 47, 27, 59, and 81.

51 Tab

The 51 tab contains the time overcurrent settings shown in Figure 4-17 and described in the following paragraphs.

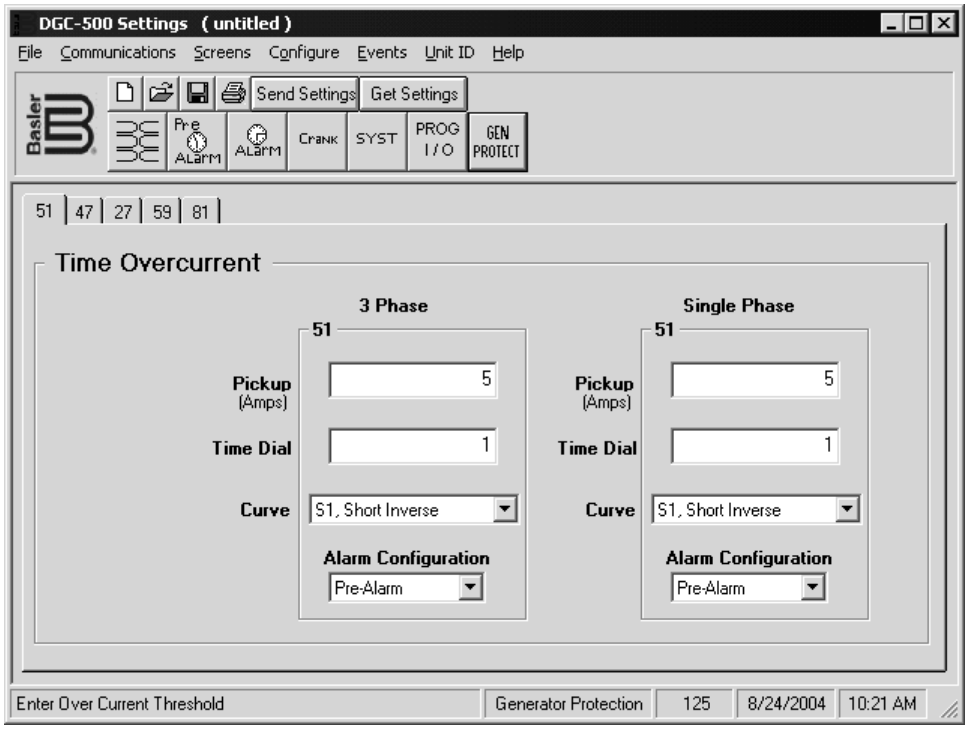

Figure 4-17. Generator Protection Screen, 51 Tab

3 Phase – 51 Pickup. This setting selects the overcurrent pickup threshold for three-phase generator connections. A 51 Pickup setting of 0.18 to 1.18 Aac (style X1X1) or 0.9 to 7.75 Aac (style X5X1) may be entered.

3 Phase – 51 Time Dial. When three-phase generator connections are used, this setting selects the time delay from when an overcurrent condition is detected and an overcurrent annunciation (trip) occurs. The 51 Time Dial setting operates in conjunction with the 51 Curve setting. When the F, Fixed Time curve setting is selected, the 51 Time Dial setting is adjustable from 0 to 30 seconds and determines the overcurrent time delay with no regard to the generator current level. When one of the 16 inverse curve settings are selected, the 51 Time Dial setting (adjustable from a multiplier of 0 to 9.9) along with the level of measured generator current determines the overcurrent time delay.

3 Phase –51 Curve. When three-phase generator connections are used, the 51 Curve setting operates in conjunction with the 51 Time Dial setting. Selecting a 51 Curve setting of F, Fixed Time causes the 51 Time Dial setting to determine the overcurrent time delay with no regard to the generator current level. When one of the 16 inverse curve settings are selected, the 51 Time Dial setting, along with the level of the measured generator current, determines the overcurrent time delay. The overcurrent curve setting selections are listed below.

- A, Standard Inverse
- B, Very Inverse
- C, Extremely Inverse
- D, Definite
- E1, Extremely Inverse
- E2, Extremely Inverse
- F, Fixed Time
- G, Long Inverse
- I1, Inverse
- I2, Inverse
- L1, Long Inverse
- L2, Long Inverse
- M, Moderately Inverse
- S1, Short Inverse
- S2, Short Inverse
- V1, Very Inverse
- V2, Very Inverse

3 Phase – 51 Alarm Configuration. This setting selects how a three-phase overcurrent condition is annunciated. An overcurrent condition can be configured to trigger a pre-alarm, alarm, or no annunciation.

Single Phase – 51 Pickup. This setting selects the overcurrent pickup threshold for single-phase generator connections. A 51 Pickup setting of 0.18 to 1.18 Aac (style X1X1) or 0.9 to 7.75 Aac (style X5X1) may be entered.

Single Phase – 51 Time Dial. When single-phase generator connections are used, this setting selects the time delay from when an overcurrent condition is detected and an overcurrent annunciation (trip) occurs. The 51 Time Dial setting operates in conjunction with the 51 Curve setting. When the F, Fixed Time curve setting is selected, the 51 Time Dial setting is adjustable from 0 to 30 seconds and determines the overcurrent time delay with no regard to the generator current level. When one of the 16 inverse curve settings are selected, the 51 Time Dial setting (adjustable from a multiplier of 0 to 9.9) along with the level of measured generator current determines the overcurrent time delay.

Single Phase – 51 Curve. When single-phase generator connections are used, the 51 Curve setting operates in conjunction with the 51 Time Dial setting. Selecting a 51 Curve setting of F, Fixed Time causes the 51 Time Dial setting to determine the overcurrent time delay with no regard to the generator current level. When one of the 16 inverse curve settings are selected, the 51 Time Dial setting, along with the level of the measured generator current, determines the overcurrent time delay. The overcurrent curve setting selections are listed below.

- A, Standard Inverse
- B, Very Inverse
- C, Extremely Inverse
- D, Definite
- E1, Extremely Inverse
- E2, Extremely Inverse
- F, Fixed Time
- G, Long Inverse
- I1, Inverse
- I2, Inverse
- L1, Long Inverse
- L2, Long Inverse
- M, Moderately Inverse
- S1, Short Inverse
- S2, Short Inverse
- V1, Very Inverse
- V2, Very Inverse

Single Phase – 51 Alarm Configuration. This setting selects how a single-phase overcurrent condition is annunciated. An overcurrent condition can be configured to trigger a pre-alarm, alarm, or no annunciation.

47 Tab

The 47 tab contains the phase imbalance settings shown in Figure 4-18 and described in the following paragraphs.

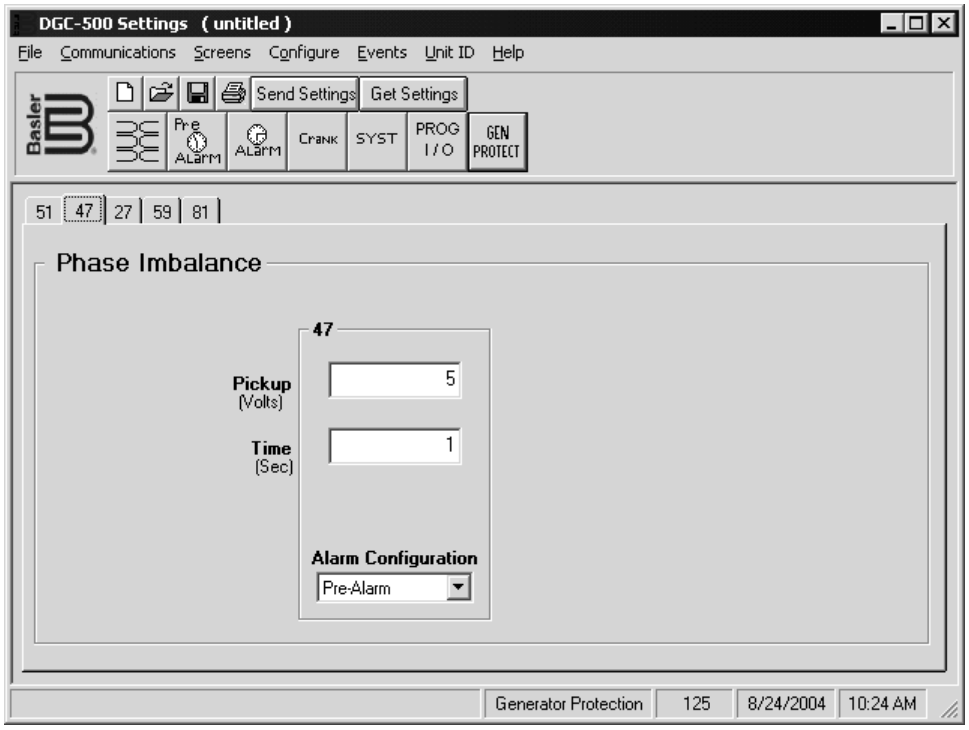

Figure 4-18. Generator Protection Screen, 47 Tab

47 – Pickup. This setting selects the level of voltage imbalance, between generator phases, that will cause a phase imbalance pickup. A Pickup setting of 5 to 100 Vac may be entered.

47 – Time. This setting selects the length of time between when a phase imbalance is detected and annunciated. A Time setting of 0 to 30 seconds may be entered.

47 – Alarm Configuration. This setting selects how a phase imbalance condition is annunciated. A phase imbalance condition can be configured to trigger a pre-alarm, alarm, or no annunciation.

27 Tab

the 27 tab contains the undervoltage settings shown in Figure 4-19 and described in the following paragraphs.

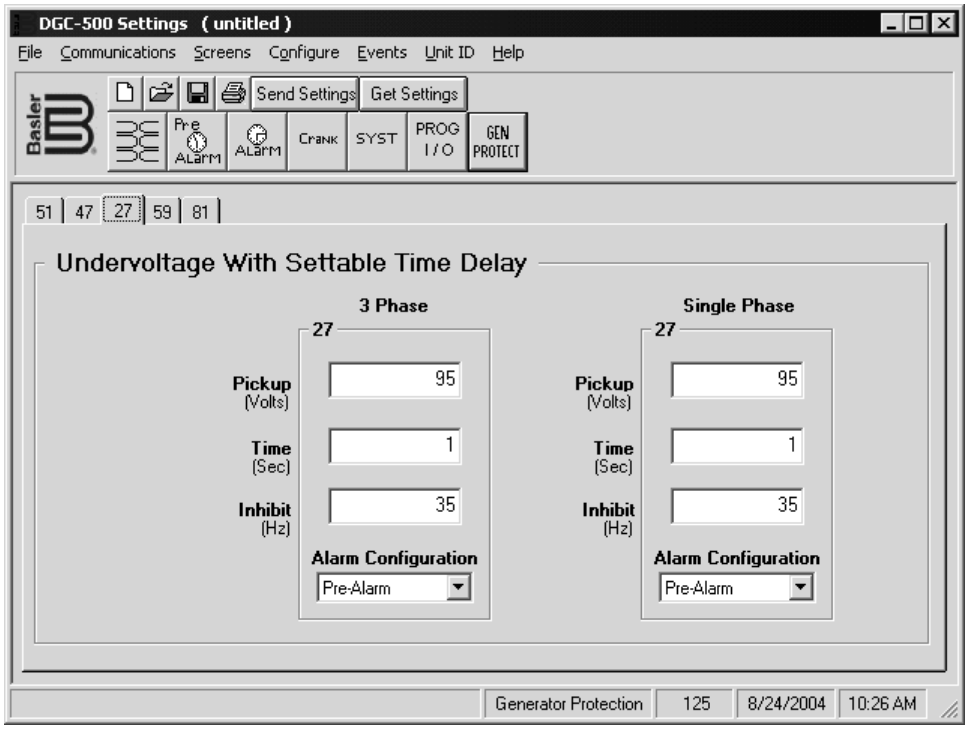

Figure 4-19. Generator Protection Scree, 27 Tab

3 Phase – 27 Pickup. This setting selects the undervoltage pickup threshold for three-phase generator connections. A three-phase undervoltage pickup occurs when the average of the three-phase voltage decreases below the 27 Pickup setting. A three-phase 27 Pickup setting of 70 to 576 Vac may be entered.

3 Phase – 27 Time. This setting selects the length of time between when a three-phase undervoltage condition is detected and an undervoltage annunciation (trip) occurs. A three-phase 27 Time setting of 0 to 30 seconds may be entered.

3 Phase – 27 Inhibit. This setting selects the level of underfrequency that will inhibit the three-phase undervoltage protection function. A three-phase 27 Inhibit setting of 20 to 400 hertz may be entered.

3 Phase – 27 Alarm Configuration. This setting selects how a three-phase undervoltage condition is annunciated. An undervoltage condition can be configured to trigger a pre-alarm, alarm, or no annunciation.

Single Phase – 27 Pickup. This setting selects the undervoltage pickup threshold for single-phase generator connections. A single-phase undervoltage pickup occurs when the average of the line-to-line voltage decreases below the 27 Pickup setting. A single-phase 27 Pickup setting of 70 to 576 Vac may be entered.

Single Phase – 27 Time. This setting selects the length of time between when a single-phase undervoltage condition is detected and an undervoltage annunciation (trip) occurs. A single-phase 27 Time setting of 0 to 30 seconds may be entered.

Single Phase – 27 Inhibit. This setting selects the level of underfrequency that will inhibit the single-phase undervoltage protection function. A single-phase 27 inhibit setting of 20 to 400 hertz may be entered.

Single Phase – 27 Alarm Configuration. This setting selects how a single-phase undervoltage condition is annunciated. An undervoltage condition can be configured to trigger a pre-alarm, alarm, or no annunciation.

59 Tab

The 59 tab contains the overvoltage settings shown in Figure 4-20 and described in the following paragraphs.

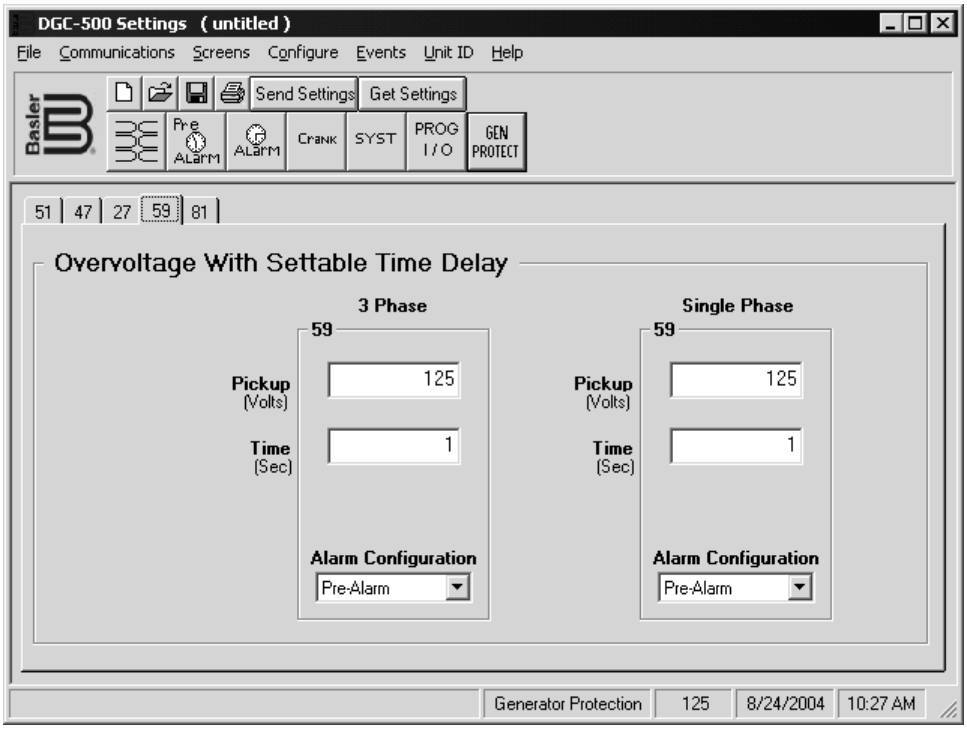

Figure 4-20. Generator Protection Screen, 59 Tab

3 Phase – 59 Pickup. This setting selects the overvoltage pickup threshold for three-phase generator connections. A three-phase overvoltage pickup occurs when the average of the three-phase voltage increases above the 59 pickup setting. a 59 Pickup setting of 70 to 576 Vac may be entered.

3 Phase – 59 Time. This setting selects the length of time between when a three-phase overvoltage condition is detected and an overvoltage annunciation (trip) occurs. A three-phase 59 Time setting of 0 to 30 seconds may be entered.

3 Phase – 59 Alarm Configuration. This setting selects how a three-phase overvoltage condition is annunciated. An overvoltage condition can be configured to trigger a pre-alarm, alarm, or no annunciation.

Single Phase – 59 Pickup. This setting selects the overvoltage pickup threshold for single-phase generator connections. A single-phase overvoltage pickup occurs when the average of the line-to-line voltage increases above the 59 pickup setting. a 59 Pickup setting of 70 to 576 Vac may be entered.

Single Phase – 59 Time. This setting selects the length of time between when a single-phase overvoltage condition is detected and an overvoltage annunciation (trip) occurs. A three-phase 59 Time setting of 0 to 30 seconds may be entered.

Single Phase – 59 Alarm Configuration. This setting selects how a line-to-line overvoltage condition is annunciated. An overvoltage condition can be configured to trigger a pre-alarm, alarm, or no annunciation.

81 Tab

The 81 tab contains the underfrequency and overfrequency settings shown in Figure 4-21 and described in the following paragraphs.

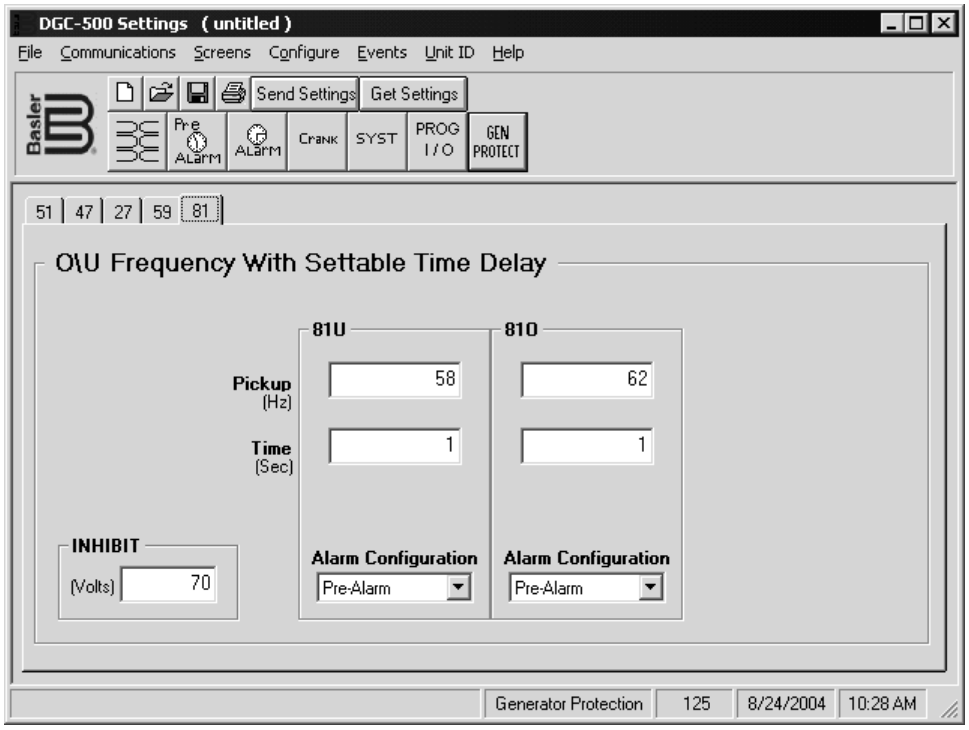

Figure 4-21. Generator Protection Screen, 81 Tab

81U – Pickup. This setting selects the level of frequency that will cause an underfrequency pickup. For 50/60 hertz generator frequency sensing, an 81U Pickup setting of 45 to 65 hertz may be entered. For 400 hertz generator frequency sensing, an 81U Pickup setting of 360 to 440 hertz may be entered.

81U – Time. This setting selects the length of time between when an underfrequency condition is detected and annunciated. An 81U Time setting of 0 to 30 seconds may be entered.

81U Alarm Configuration. This setting selects how an underfrequency condition is annunciated. An 81U condition can be configured to trigger a pre-alarm, alarm, or no annunciation.

Inhibit. This setting selects the undervoltage level that will prevent an underfrequency (81U) trip from occurring. An Inhibit setting of 70 to 576 Vac may be entered.

81O – Pickup. This setting selects the level of frequency that will cause an overfrequency pickup. For 50/60 hertz generator frequency sensing, an 81U Pickup setting of 45 to 65 hertz may be entered. For 400 hertz generator frequency sensing, an 81U Pickup setting of 360 to 440 hertz may be entered.

81O – Time. This setting selects the length of time between when an overfrequency condition is detected and an overfrequency annunciation (trip) occurs. An 81O Time setting of 0 to 30 seconds may be entered.

81O Alarm Configuration. This setting selects how an 81O condition is annunciated. An 81O condition can be configured to trigger a pre-alarm, alarm or no annunciation.

REAL-TIME CLOCK

The DGC-500 real-time clock settings can be adjusted and verified through the Set Real Time Clock dialog box (Figure 4-22). Click **Configure** on the menu bar and click **Real Time Clock**.

To set the DGC-500 real-time clock with the PC's time and date settings, perform the following steps.

1. Click the **Display PC Date and Time** button. The PC clock settings are displayed in the date and time fields. (The date and time fields of the Set Real Time Clock dialog box cannot be changed manually.)
2. Select the **Automatically adjust for Daylight Savings Time** check box if automatic compensation for daylight savings time is desired.
3. Click the **Send Settings to DGC** button to set the DGC-500 real-time clock with the PC's time and date.

The DGC-500 real-time clock settings can be viewed and verified by clicking the **Display DGC Settings** button.

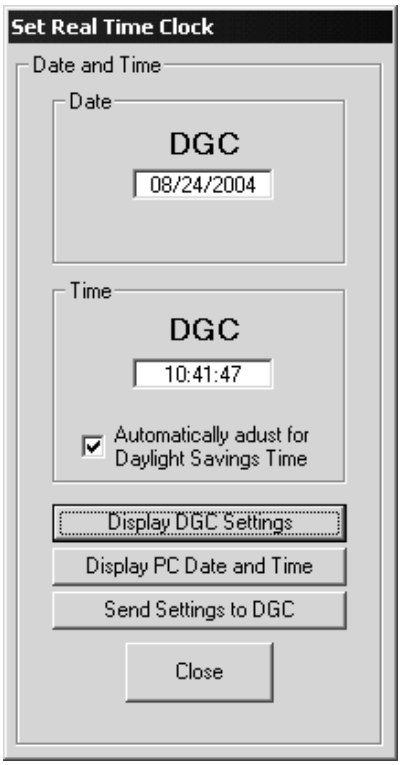

Figure 4-22. Set Real Time Clock Screen

PROGRAMMABLE SENDERS

Click **Configure** on the menu bar and click **Programmable Senders** to access the Programmable Senders screen.

The Programmable Senders screen has three tabs: Coolant Temperature, Oil Pressure, and Percent Fuel Level. Because the setting fields and buttons of each tab are so similar, only the Coolant Temperature tab settings are described here.

The Coolant Temperature tab settings of the Programmable Senders screen are shown in Figure 4-23. Each tab setting is described in the following paragraphs.

Get Cool. Data From DGC. If communication with a DGC-500 is enabled, clicking this button retrieves the sender data points from the DGC-500 and refreshes the graph.

Send Cool. Data to DGC. Clicking this button sends the displayed data points to the DGC-500.

Load Cool. Settings File. Clicking this button displays an Open dialog box where a sender file containing sender data points can be retrieved. Some standard data point files for the three senders are included with BESTCOMS. Coolant temperature sender files have a CS5 extension, oil pressure sender files have an OS5 extension, and fuel level sender files have an FS5 extension.

Create Cool. Settings File. Clicking this button displays a Save As dialog box where the transducer data points created in BESTCOMS can be saved in a sender file. While it is possible to create individual sender files for each transducer, it is not necessary. The data for all three senders is automatically saved with the DGC-500 configuration file. The *Settings Files* sub-section contains information about creating DGC-500 configuration files.

Resistance. The 11 resistance points in this column are not adjustable. The DGC-500 has been factory calibrated at these points to maximize accuracy.

Degrees F/Degrees C. Temperature values entered in this column must always maintain a descending order. If English units are used, adjacent coolant temperature points must be separated by at least 2 F. If metric units are used, adjacent oil pressure points must be separated by at least 7 kilopascals. The coolant temperature setting range is 32 to 400 F or 0 to 240 C. The oil pressure setting range is 0 to 250 psi or 0 to 1,725 kilopascals. The fuel level setting range is 0 to 100 percent.

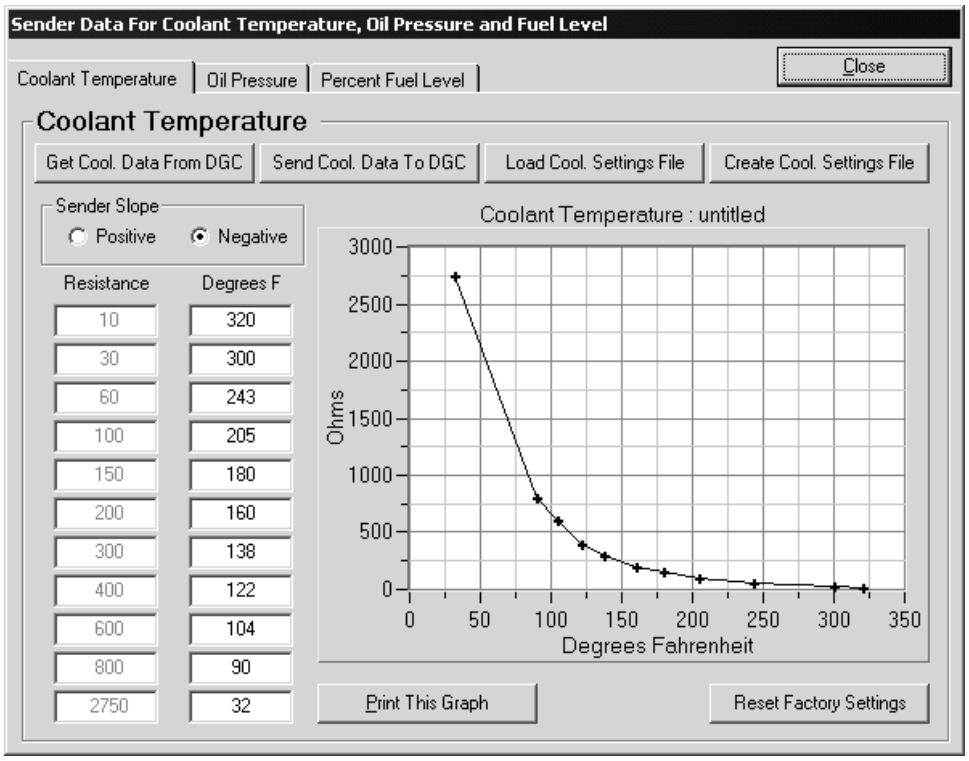

Figure 4-23. Programmable Senders Screen, Coolant Temperature Tab

Sender Slope. If a sender requires a positive slope, Positive can be selected to invert the values in the Resistance column.

Reset Factory Settings. Clicking this button restores the factory-default data points in the Degrees F/Degrees C column and graph. This does not update the data points in the DGC-500. The DGC-500 is updated by clicking the Send Cool. Data to DGC button.

NOTE

When metric values are used and changes are made to the oil pressure sender data points, undesirable internal rounding of some data points can occur. For example, select 700 kilopascals for one data point, create a sender file, and the value is rounded to 697. Rounding that occurs will never be greater than 4 kilopascals.

Fuel Level Type

This setting, located on the Percent Fuel Level tab, allows the selection of four fuel types: Percent, Natural Gas, Propane, and Disabled. Selecting a fuel type other than Percent will disable any fuel level indication, alarm, and pre-alarm and disable the percent fuel level values of the Percent Fuel Level tab.

RUN STATISTICS

The DGC-500 compiles statistics for both individual generator run sessions and the cumulative total of all generator run sessions. Generator run statistics are displayed on the Run Statistics screen (Figure 4-24), which is accessed through the menu bar by clicking **Events**, **Run Statistics**. Run Statistics screen indications and controls are described in the following paragraphs.

Start Date. When the DGC-500 and/or genset are commissioned, a date is selected from the pull-down calendar for the DGC-500 to use as a starting point for tracking generator run statistics. Clicking the **Update DGC Start Date** button sends the selected date to the DGC-500.

Session Run Statistics. This area of the Run Statistics screen displays the start date and total running time for the current run session. The total running hours are additionally split into unloaded running time and loaded running time.

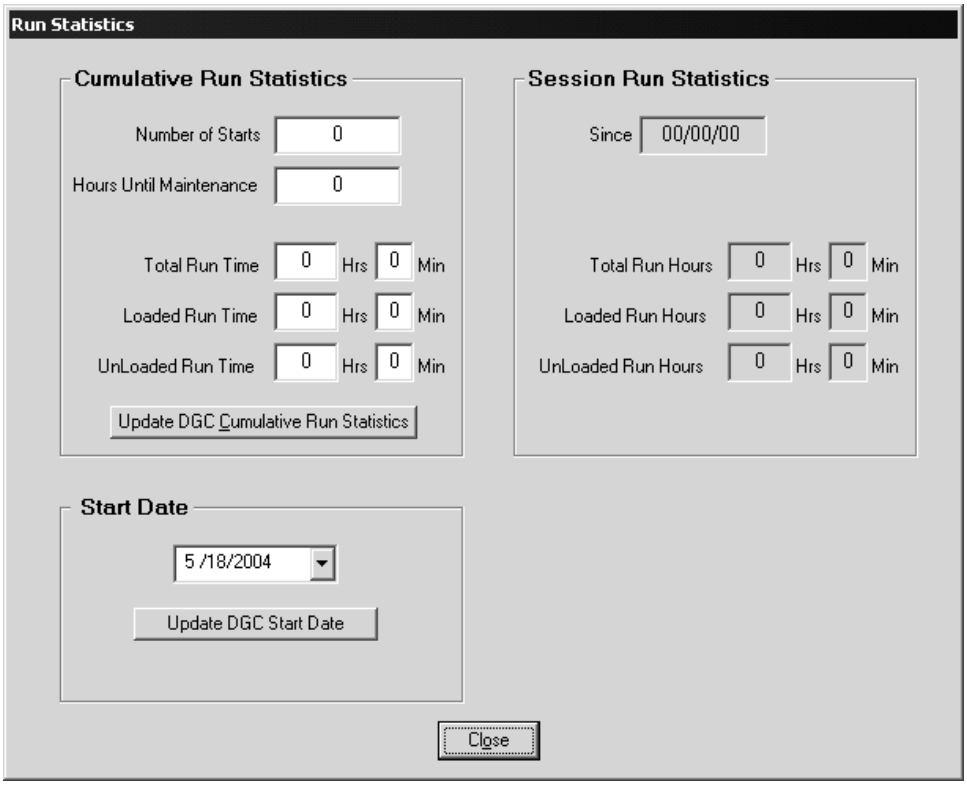

Figure 4-24. Run Statistics Screen

Cumulative Run Statistics. This area of the Run Statistics screen displays the total running time, unloaded running time, and loaded running time since the genset/DGC-500 was commissioned. The number of engine starts and time remaining until maintenance is also displayed. Each field in the Cumulative Run Statistics area can be adjusted by the user and sent to the DGC-500 by clicking the **Update DGC Cumulative Run Statistics** button.

EVENT LOG

The Event Log screen displays a record of system events that are stored in DGC-500 nonvolatile memory. System events are categorized by the event log into event types. The event log capacity is 30 event types.

Each event type in the log contains an event identifier label, the number of occurrences for the event, and the time stamp of the most recent event occurrence. The time stamp displayed is user-selectable and can be real-time clock data or the elapsed engine hours.

When an event type is logged, it occupies one entry (or row) in the low. If the same event type is logged again, it still only occupies one entry in the log. However, the log entry is updated with the number of occurrences and the Last Date/Time column is updated with the time stamp of the last occurrence.

If the event log contains the maximum of 30 event types and a new event type is logged, the oldest event type in the log is overwritten with the new event type.

For event types monitored by the event log, refer to Section 3, *Functional Description, Software Operation, Event Log*.

The Event Log screen is accessed by clicking **Events** on the menu bar and clicking **Event Log**. The Event Log screen is shown in Figure 4-25. Its controls and indicators are described in the following paragraphs.

Refresh Event Log. Clicking this button updates the Event Log screen with any newly acquired system events.

Clear Selected Event(s). clicking this button deletes all highlighted events in the record list.

Number of Events. This field displays the number of events held in the event log.

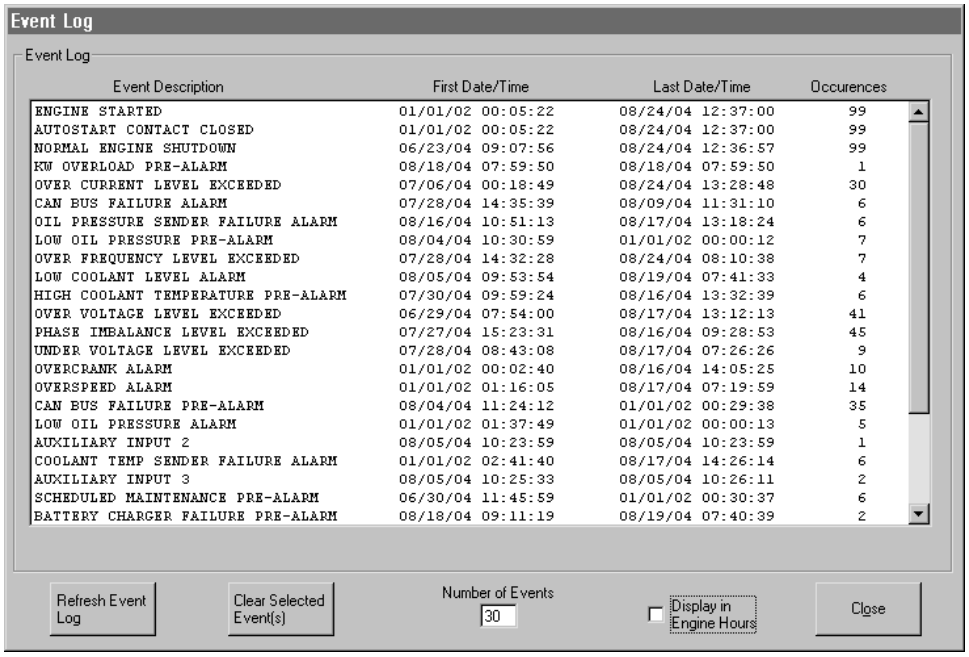

Figure 4-25. Event Log Screen

Display in Engine Hours. Placing a check in this checkbox causes the Event Log screen to display events time-stamped with elapsed engine hours. An empty checkbox causes the Event Log screen to display events time-stamped with real-time clock data.

SETTINGS FILES

BESTCOMS software enables you to print a list of DGC-500 settings, save DGC-500 settings to a file, and open a settings file and upload those settings to a DGC-500.

Printing Settings Files

A printout of DGC-500 settings can be useful for record keeping or comparison purposes. Click the **Print Settings File** button or click **File** on the menu bar and click **Print** to access the Print DGC-500 Settings screen. This print screen contains a print-preview pane and settings for selecting the printer, content of the printout, and printout orientation. DGC-500 settings are divided into three print sections: General Settings, Programmable I/O Settings, and Input Sender Settings. Any combination of sections can be selected for printing.

New Settings File

Clicking this button resets the settings displayed in BESTCOMS to the factory-default values. If changes to settings have not been saved, you will be given the opportunity to save the changes in a DGC-500 settings file.

Saving Settings Files

Saving DGC-500 settings to a file for uploading to other DGC-500 units saves setup time when configuring multiple units to the same configuration. A settings file can also be created in BESTCOMS without being connected to a DGC-500. The settings of the desired screens can be changed and these settings can then be saved to a file.

A settings file is created by clicking the **Save Settings File** button or clicking **File** on the menu bar and clicking **Save**. A file properties box appears and allows you to enter generator information and other pertinent notes about the settings. Next, a Save As dialog box prompts you to select the name and location of the settings file. All DGC-500 settings files are automatically given a DG5 file extension by BESTCOMS.

Opening Settings Files

To open a DGC-500 settings file, click the **Open Settings File** button or click **File** on the menu bar and click **Open**. An Open dialog box will appear and enable you to select a DGC-500 settings file (DG5 extension) for retrieval into BESTCOMS.

RS-232 CONFIGURATION

When communication is established between a PC and DGC-500, changes in BESTCOMS to the communication configuration settings affect both the PC and DGC-500. When communication between a PC and DGC-500 is closed, changes in BESTCOMS to the communication configuration settings affect only the PC.

The communication configuration settings are viewed and adjusted through the Communications Configure dialog box. This dialog box is accessed by clicking **Configure** on the menu bar and clicking **RS232**. The Communications Configure dialog box settings are illustrated in Figure 4-26 and described in the following paragraphs.

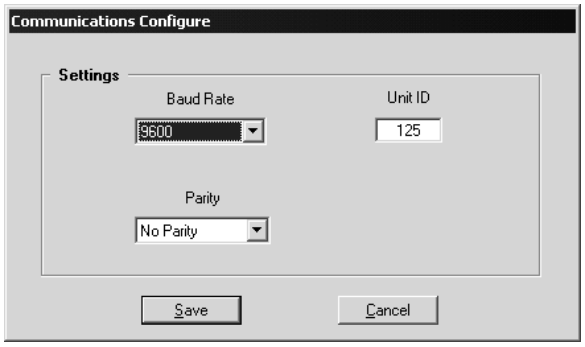

Figure 4-26. Communications Configure Dialog Box

Baud Rate. This setting selects the communication rate. A baud rate of 1200, 2400, or 9600 can be selected.

Parity. This setting enables and disables summation checking of data transmitted between the PC and DGC-500. A setting of No Parity, Odd Parity, or Even Parity can be selected.

Unit ID. This setting allows an identification number to be assigned to a DGC-500 for polled communication. A number between 1 and 247 may be used.

ENGINE CONTROL UNIT (ECU) INTERFACE

For J1939 applications, the interface between the DGC-500 and ECU is configurable. First, the output contact used to power up the ECU (for non-continuously powered ECU applications) is selectable. Second, periodic communication with the ECU (also referred to as pulsing the ECU) may be disabled if the application requires it. Third, the timers associated with pulsing the ECU are programmable. The settings used to configure the ECU interface are adjusted through the ECU Control dialog box. This dialog box is accessed by clicking **Configure** on the menu bar and clicking **ECU Control**. The ECU interface settings of the ECU Control dialog box are shown in Figure 4-27 and described below.

ECU Contact Control – Output Select. This setting selects the DGC-500 output that is used to power up the ECU in J1939 applications where the ECU is not continuously powered. If the pre-start contact is selected, the fuel contact will still close during cranking and running of the genset to provide a separate indication that the genset is running.

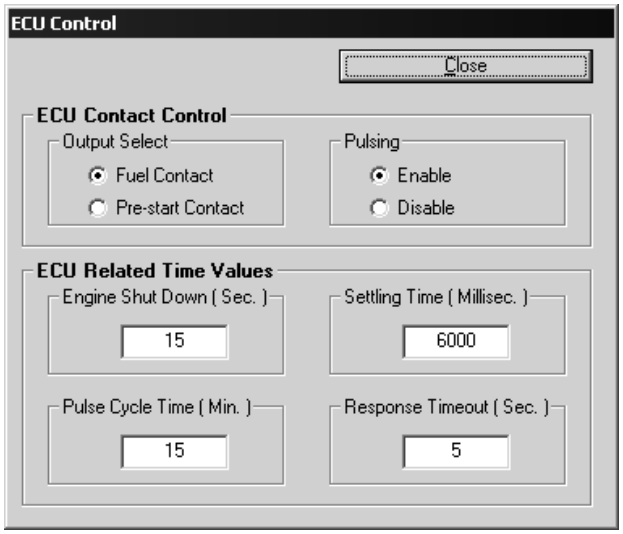

Figure 4-27. ECU Control Dialog Box

ECU Contact Control – Pulsing. In J1939 applications where the ECU is not continuously powered, the DGC-500 will normally pulse the ECU periodically to update its engine monitoring data. For applications where this periodic pulsing is not desired, this setting allows the pulsing feature to be disabled.

ECU Related Time Values – Engine Shut Down (Sec.). When going from Running to Shut Down, this setting adjusts the length of time that the DGC-500 stays disconnected from the ECU before starting the first pulse. The Engine Shut Down setting range is 1 to 60 seconds.

ECU Related Time Values – Setting Time (Millisec.). This setting adjusts the time to gather data after connecting to the ECU during the Pulsing state. This allows all metered values to be sent and ramp up. Metered values are sent by the ECU at different rates as designated by the J1939 protocol. Values sent by the ECU may be low initially; the ECU takes time to average its own data. The Setting Time setting range is 5,500 to 30,000 milliseconds.

ECU Related Time Values – Pulse Cycle Time (Min.). This setting adjusts the time that the DGC-500 waits to pulse the ECU again. The Pulse Cycle Time setting range is 1 to 60 minutes.

ECU Related Time Values – Response Timeout (Sec.). This setting controls the time that communication is attempted with the ECU while the DGC-500 is in the Pulsing or Connecting state. The Response Timeout setting range is 1 to 60 seconds.

PASSWORD PROTECTION

Password protection guards against unauthorized changing of DGC-500 settings. DGC-500 passwords are case-sensitive. Three levels of password protection are available. Each level is described in the following paragraphs.

- Limited Access. This password level allows all DGC-500 settings to be read, but prevents any changes to settings. The default, limited-access password is DGC.
- Full Access. This password level allows all DGC-500 settings to be read and allows all settings except Engine Runtime to be changed. The default, full-access password is DGC500.
- OEM Access. This password allows all DGC-500 settings to be read and allows all settings to be changed. It also allows the DGC-500 embedded firmware to be upgraded. The default, OEM-access password is OEMLVL.

Changing Passwords

Passwords can be changed only after communication between the PC and DGC-500 is established. Changes to passwords are made through the Change Password dialog box. To access the Change Password dialog box, click **Communications** on the menu bar and click **Change Password**.

The content of the Change Password dialog box depends on the password level used when accessing the dialog box. For example, someone logged-in with a full-access password will be able to change only the limited-access and full-access passwords—not the OEM-access password. Figure 4-28 shows the Change Password dialog box with all three access levels shown.

A password is changed by selecting the access level, entering the new password, and then re-entering the new password to confirm the entry.

Once a password is changed, it should be stored in a secure location. If a user-defined password is lost or forgotten, contact Basler Electric for instructions on regaining password access.

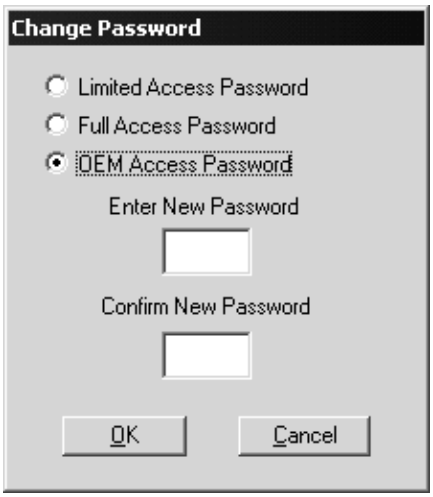

Figure 4-28. Change Password Dialog Box

TERMINATING COMMUNICATION

DGC-500 communication is terminated by clicking **Communications** on the menu bar and clicking **Close**. If unsaved settings changes were made, you are prompted to save the changes in a new or existing settings file. When you execute the close communication command (with or without saving settings), communication with the DGC-500 is terminated. If you choose to exit BESTCOMS (by clicking **File** on the menu bar and then **Exit**) without first closing communication, you are still given the opportunity to save any settings changes.

EMBEDDED FIRMWARE

Embedded firmware is the operating program that controls the actions of the DGC-500. The DGC-500 stores firmware in nonvolatile flash memory that can be reprogrammed through the RS-232 communication port. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

Updating the Firmware

Future enhancements to DGC-500 functionality may make a firmware update desirable. Because default settings are loaded when DGC-500 firmware is updated, your settings should be saved in a file prior to upgrading firmware. DGC-500 embedded firmware can be updated by performing the following steps.

CAUTION

If power is lost or communication is interrupted during file transfer, the DGC-500 will not recover and will cease operating.

1. Connect a communication cable between the rear RS-232 connector of the DGC-500 and the appropriate communication port of your PC. Start BESTCOMS-DGC500-32, open communication, and gain password access with the OEM-access password.
2. Click Configure on the menu bar and click Upgrade Embedded Firmware. When Upgrade Embedded Firmware is clicked, the Embedded Firmware Upgrade dialog box (Figure 4-29) appears.

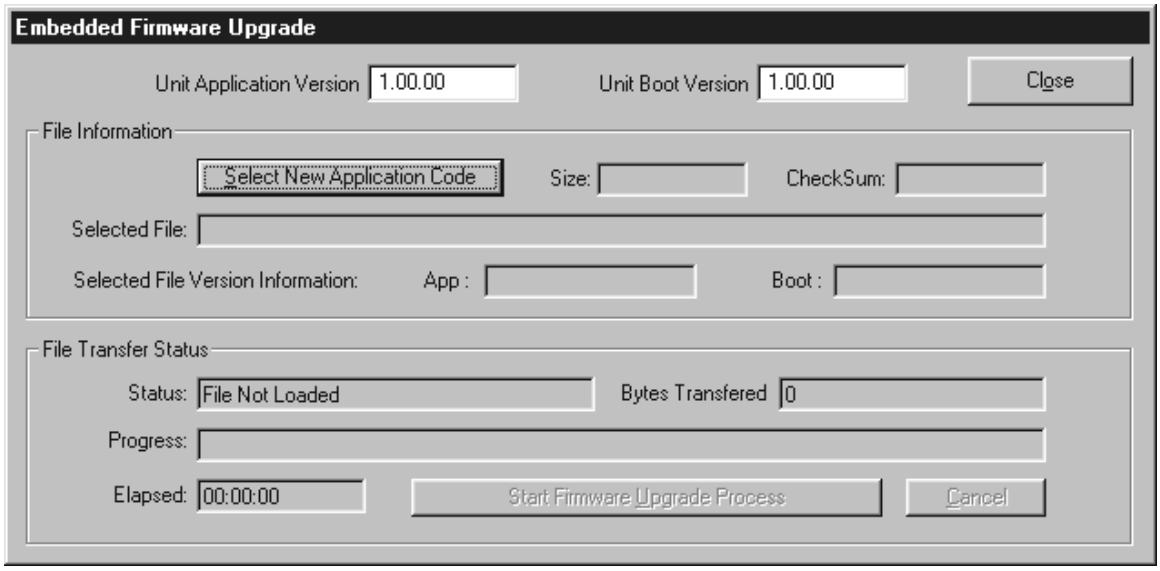

Figure 4-29. Embedded Firmware Upgrade Dialog Box

3. Click the Select New Application Code button and then navigate to and select the file (S19 file extension) to be used for updating the DGC-500 firmware. The file details are displayed in the File Information section of the Embedded Firmware Upgrade dialog box (Figure 4-30).

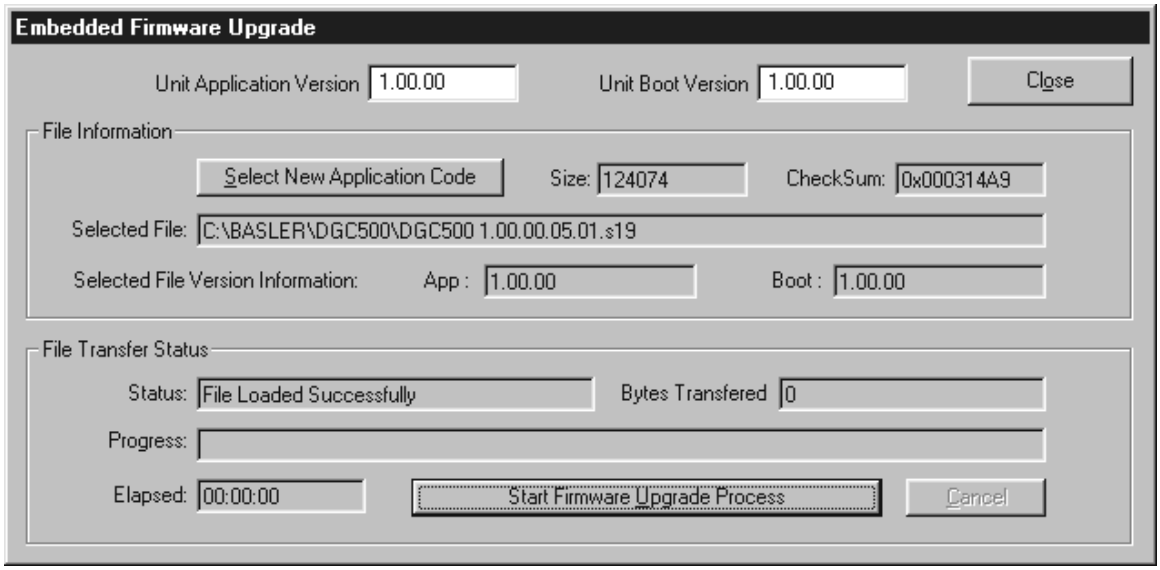

Figure 4-30. Firmware File Information

4. Click the Start Firmware Upgrade Process button. The Erase Application Code!!!! and Save Settings Before You Continue!!!! dialog boxes appear and confirm that you want to continue. Click Yes in both dialog boxes to begin transferring the firmware file to the DGC-500. The file transfer status is displayed in the Embedded Firmware Upgrade dialog box (Figure 4-31).

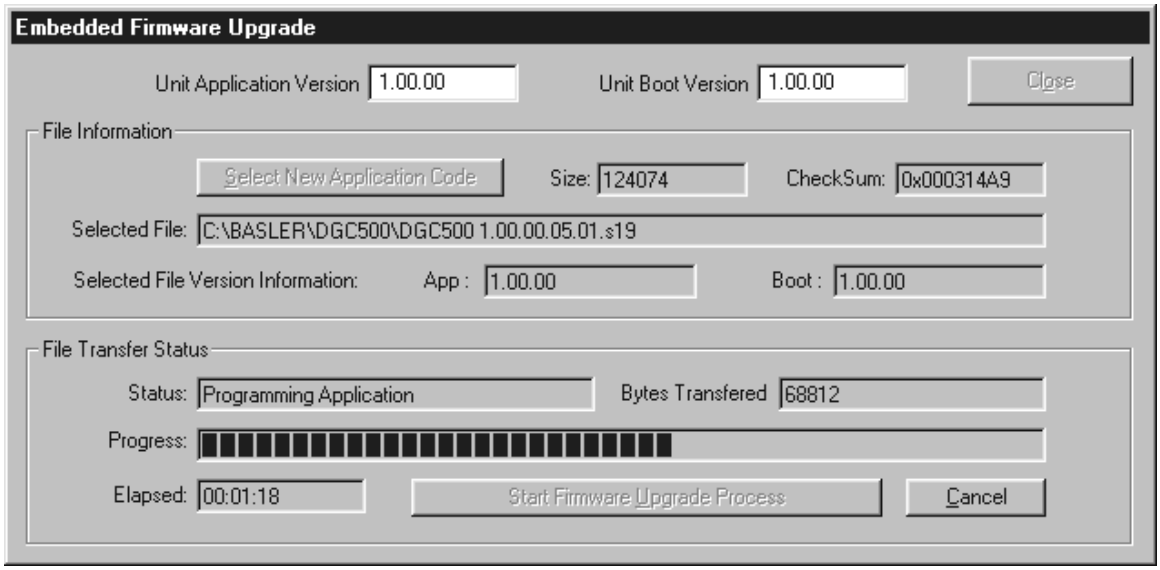

Figure 4-31. File Transfer Status

5. Once the file transfer is complete, close the Embedded Firmware Upgrade dialog box, open communication between the PC and DGC-500, and gain password access to the DGC-500 with the appropriate password.

SECTION 5 • INSTALLATION

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SECTION 5 • INSTALLATION

GENERAL

DGC-500 Digital Genset Controllers are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a system, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric Regional Sales Office, your Sales Representative, or a Sales Representative at Basler Electric, Highland, Illinois.

If the device is not installed immediately, store it in the original shipping package in a moisture and dust-free environment.

PRODUCT REGISTRATION

Registering with Basler Electric enables you to receive important information updates on your product plus new product announcements. Register your product by directing your web browser to http://www.basler.com/Register.

HARDWARE

DGC-500 controllers are packaged for mounting in any top-mount enclosure. The front panel is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants. It also inhibits insect and rodent entrance. DGC-500 controllers are mounted using the four permanently attached 10-32 studs. The torque applied to the mounting hardware should not exceed 30 inch-pounds (3.4 newton meters).

MOUNTING

Case cutout dimensions are shown in Figure 5-1. Overall dimensions are shown in Figures 5-2. All dimensions are shown in inches and millimeters (in parenthesis).

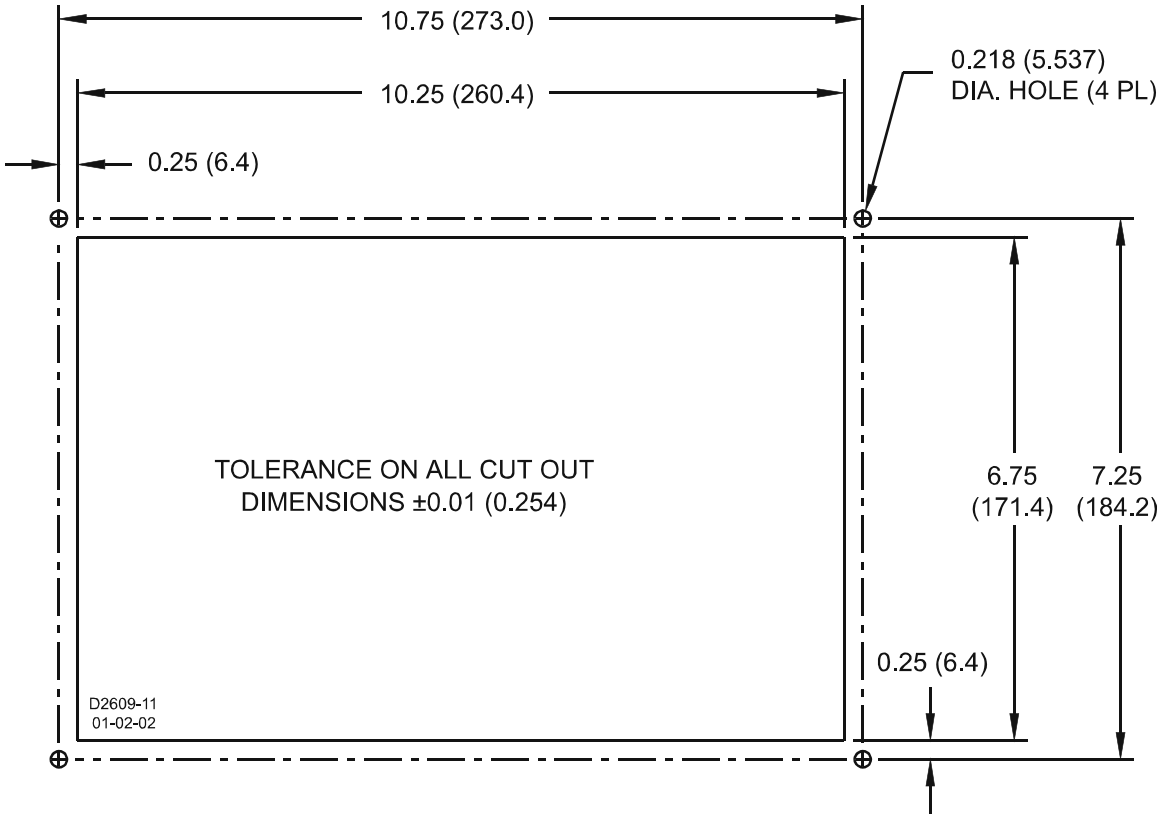


Figure 5-1. DGC-500 Cutout Dimensions

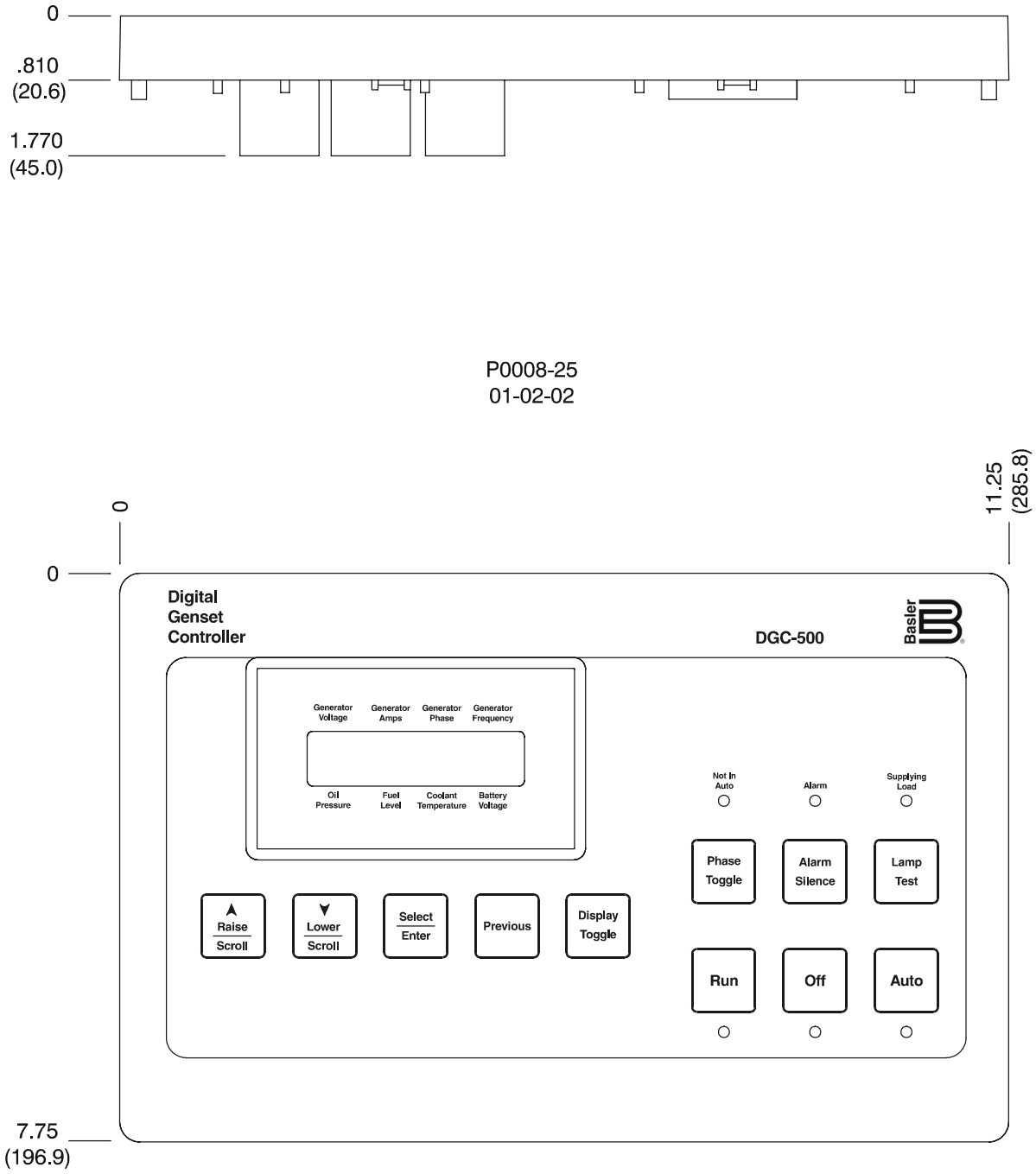


Figure 5-2. DGC-500 Overall Dimensions

DGC-500 Isolator Kit

The optional DGC Isolator Kit provides an economical way to reduce the level of shock and vibration transmitted from a generator to the DGC-500. The DGC Isolator Kit eliminates the need to mount an isolator box on top of the generator conduit box and simplifies wiring considerations. Isolator kits are available with either black- or gray-colored gaskets. Kit part number 9 3554 06 100 is supplied with a black gasket and kit part number 9 3554 06 101 is supplied with a gray gasket.

The DGC Isolator Kit provides vibration dampening at frequencies greater than 48 hertz. Above 90 hertz, vibration transmissibility is less than 10 percent of the input magnitude.

CONNECTIONS

DGC-500 connections are dependent on the application. Incorrect wiring may result in damage to the controller.

> **NOTE**
>
> Be sure that the DGC-500 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal (P22) on the rear of the controller.
>
> Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the DGC-500 will not operate.

DGC-500 Terminations

All DGC-500 terminals are located on the rear panel of the controller. There are three types of interface terminals.

J1, a DB9 connector, is used as a temporary communication interface with IBM compatible PCs.

J2, a five-terminal header, is an SAE J1939 interface used for high-speed communication with a CAN-enabled engine control unit (ECU). J2 is enabled only on DGC-500 controllers with style numbers of F1J or F5J.

All other connections consist of quarter-inch, quick-connect terminals. Amp part numbers 154718-3 (positive-lock receptacle) and 154719-1 (nylon housing) are the recommended components for making connections at the quick-connect terminals. Wires performing common functions, such as voltage sensing leads, should be grouped together.

All connections (except chassis ground and communication) should be made with wire no smaller than 14 AWG.

Serial Communication Port

The RS-232 port on the rear panel uses a DB9 female connector. Figure 5-3 illustrates the pin assignments of the communication port and Table 5-1 identifies the RS-232 connector pin functions. A standard communication cable terminated with a DB9 male connector is used for PC interface with the DGC-500 as shown in Figure 5-4.

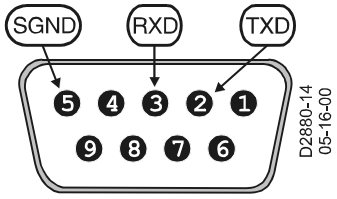


Figure 5-3. DGC-500 Communication Port Pin Assignments

Table 5-1. DGC-500 Communication Port Pin Functions

Pin	Function	Name	Direction
1	N/C	—	N/A
2	Transmit Data	TXD	From DGC-500
3	Receive Data	RXD	To DGC-500
4	N/C	—	N/A
5	Signal Ground	GND	N/A
6, 7, 8, 9	N/C	—	N/A

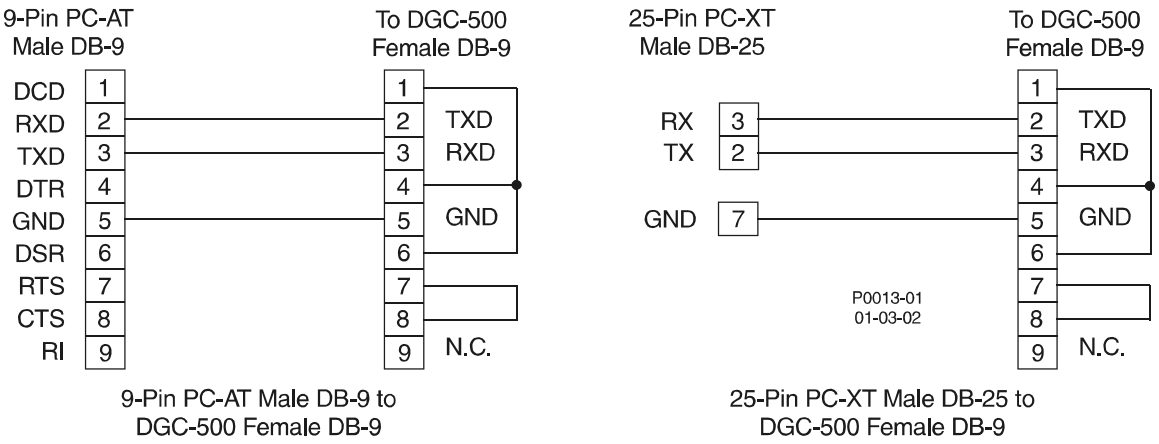


Figure 5-4. Personal Computer to DGC-500 Connections

CAN Connections

The CAN connector (J2) on the rear panel mates with the cable assembly (Basler P/N 9 3589 00 002) provided with the DGC-500. Only units with style numbers F1J AND F5J are supplied with the cable assembly and have connector J2 enabled. The cable assembly is shown in Figure 5-5 and the termination assignments are listed in Table 5-2. Figure 5-6 illustrates typical DGC-500 CAN interface connections.

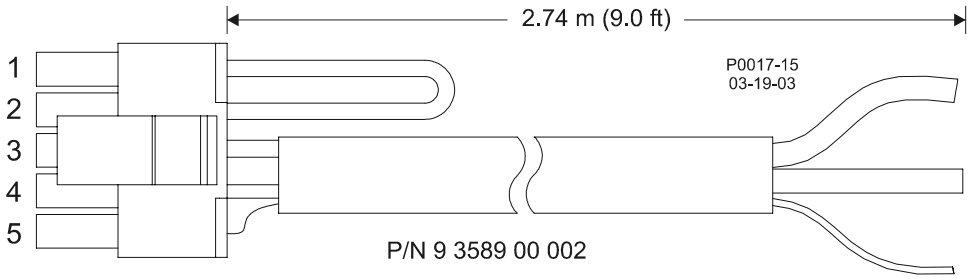


Figure 5-5. CAN Cable Assembly

Table 5-2. CAN Cable Assembly Termination Assignments

J2 Terminations	Function	User Terminations
Pin 1	Termination Resistor	✳
Pin 2		
Pin 3	CAN High	Red Wire
Pin 4	CAN Low	Black Wire
Pin 5	Drain	Uninsulated Wire †

✳ If the DGC-500 is not providing one end of the J1939 backbone, cut the jumper connected across pins 1 and 2 to disconnect the internal terminating resistor.

† The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, cut the drain connection to the DGC-500.

Note: If the DGC-500 is not part of the J1939 backbone, the stub connecting the DGC-500 to the backbone should not exceed 914 mm (3 ft) in length.

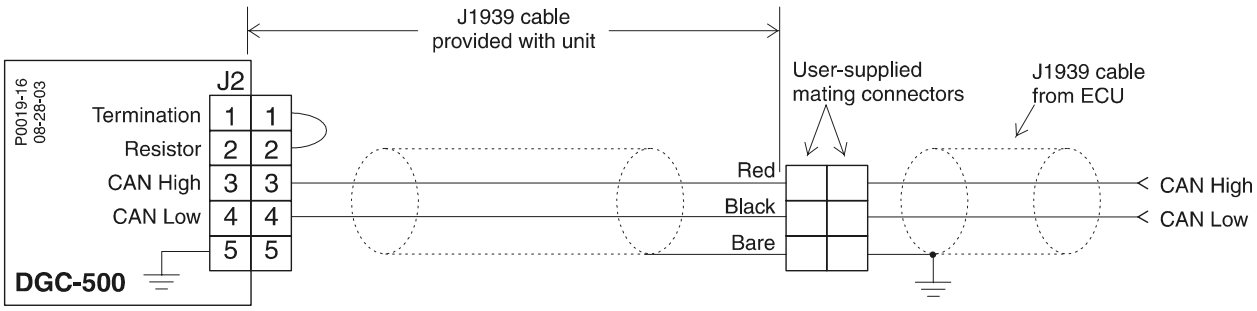


Figure 5-6. Typical DGC-500 CAN Interface Connections

DGC-500 Connections for Typical Applications

Figures 5-7 through 5-9 illustrate typical applications using the DGC-500. Figure 5-7 shows a DGC-500 application using single-phase sensing. Figure 5-8 shows a DGC-500 application using three-phase, delta sensing. Figure 5-9 shows a DGC-500 application using three-phase, wye sensing.

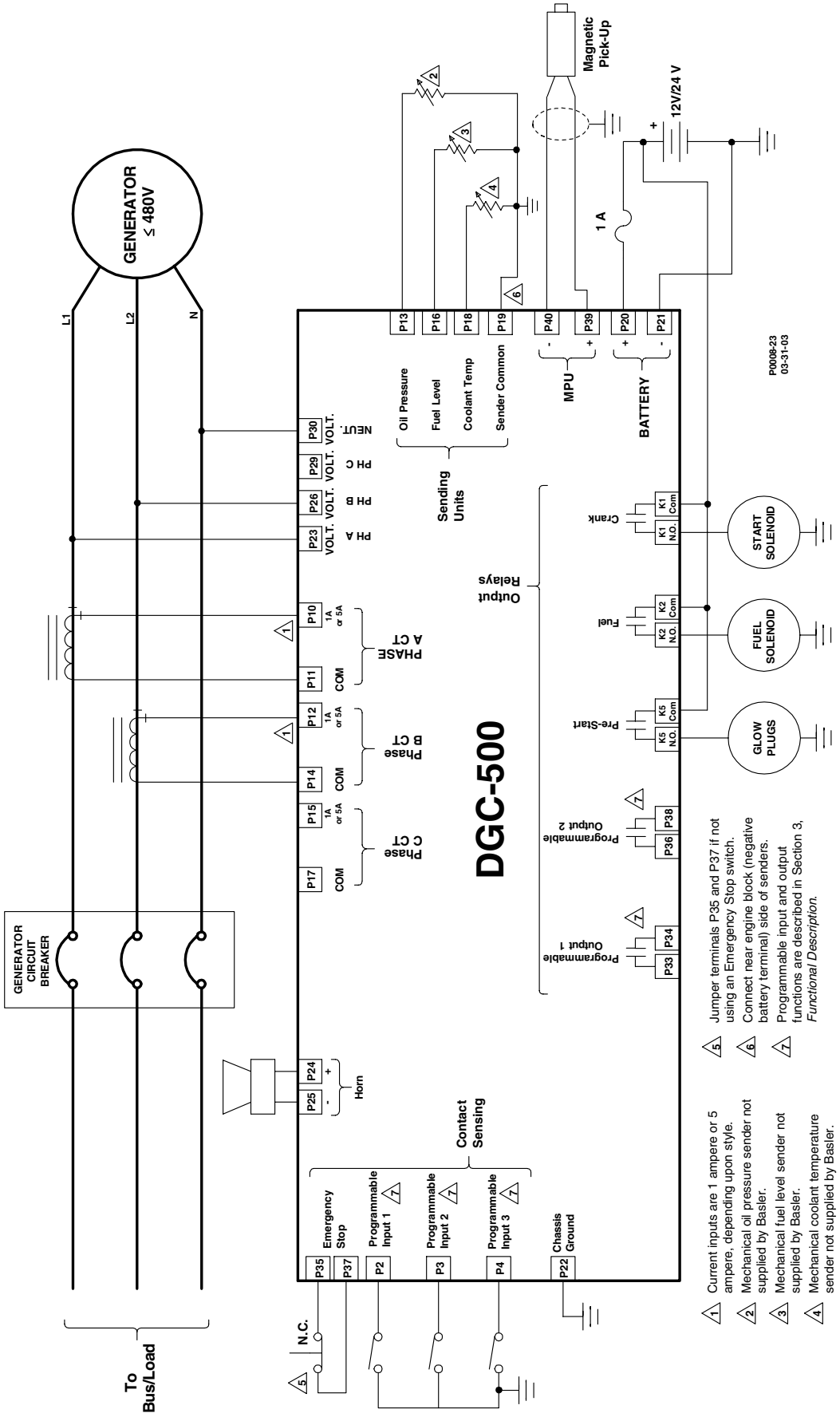


Figure 5-7. DGC-500 Connections, Single-Phase, A-B

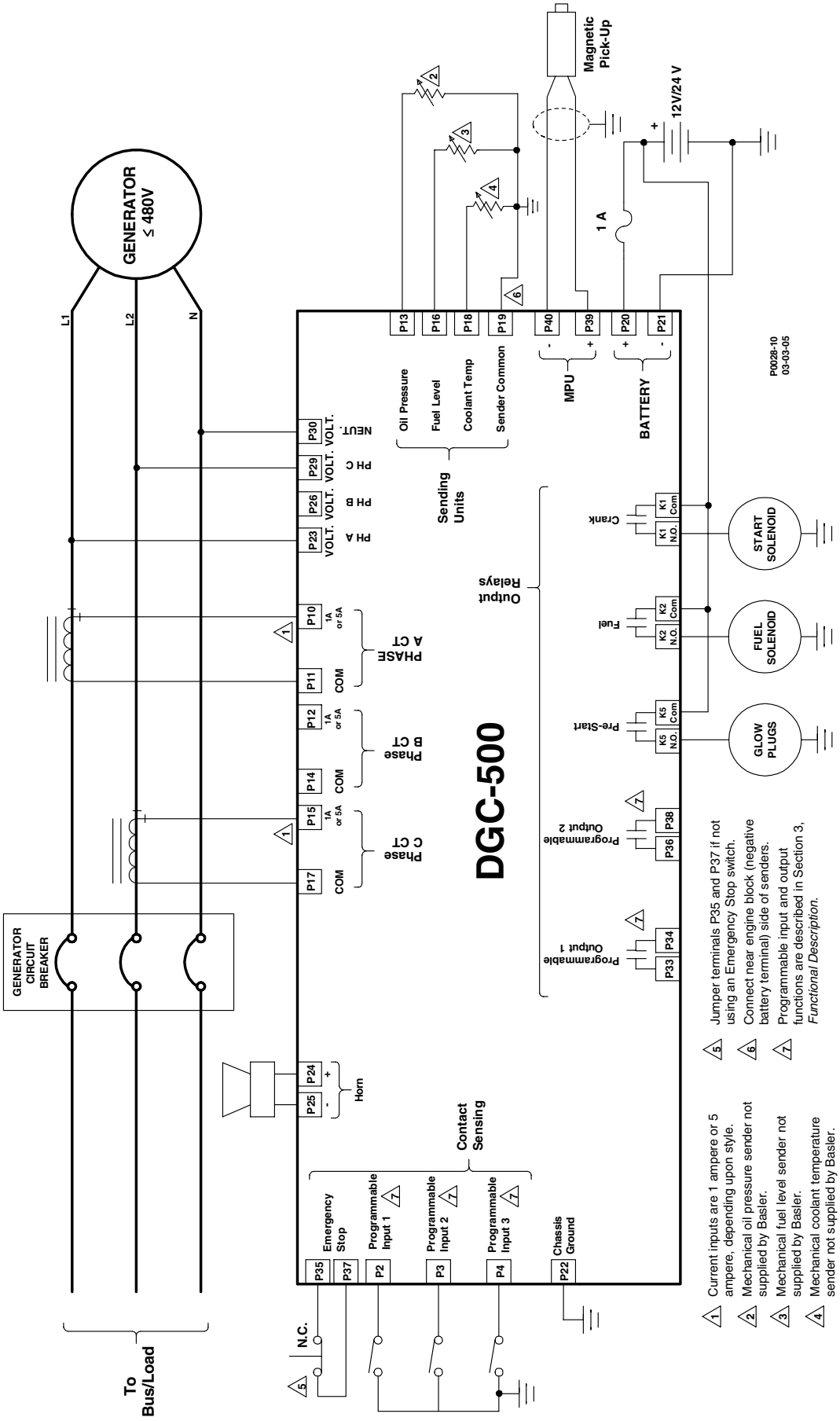


Figure 5-8. DGC-500 Connections, Single-Phase, A-C

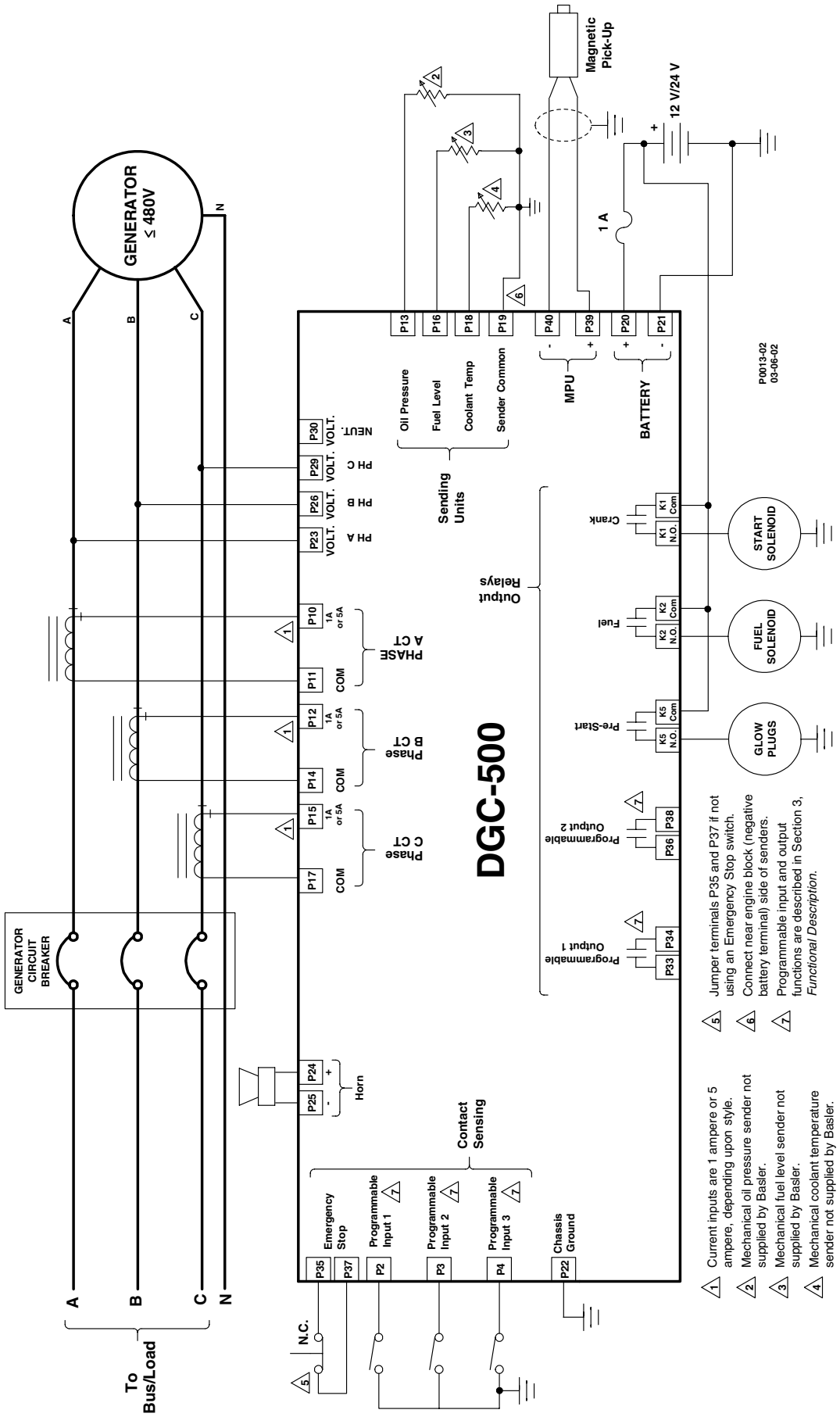


Figure 5-9. DGC-500 Connections, Three-Phase Delta

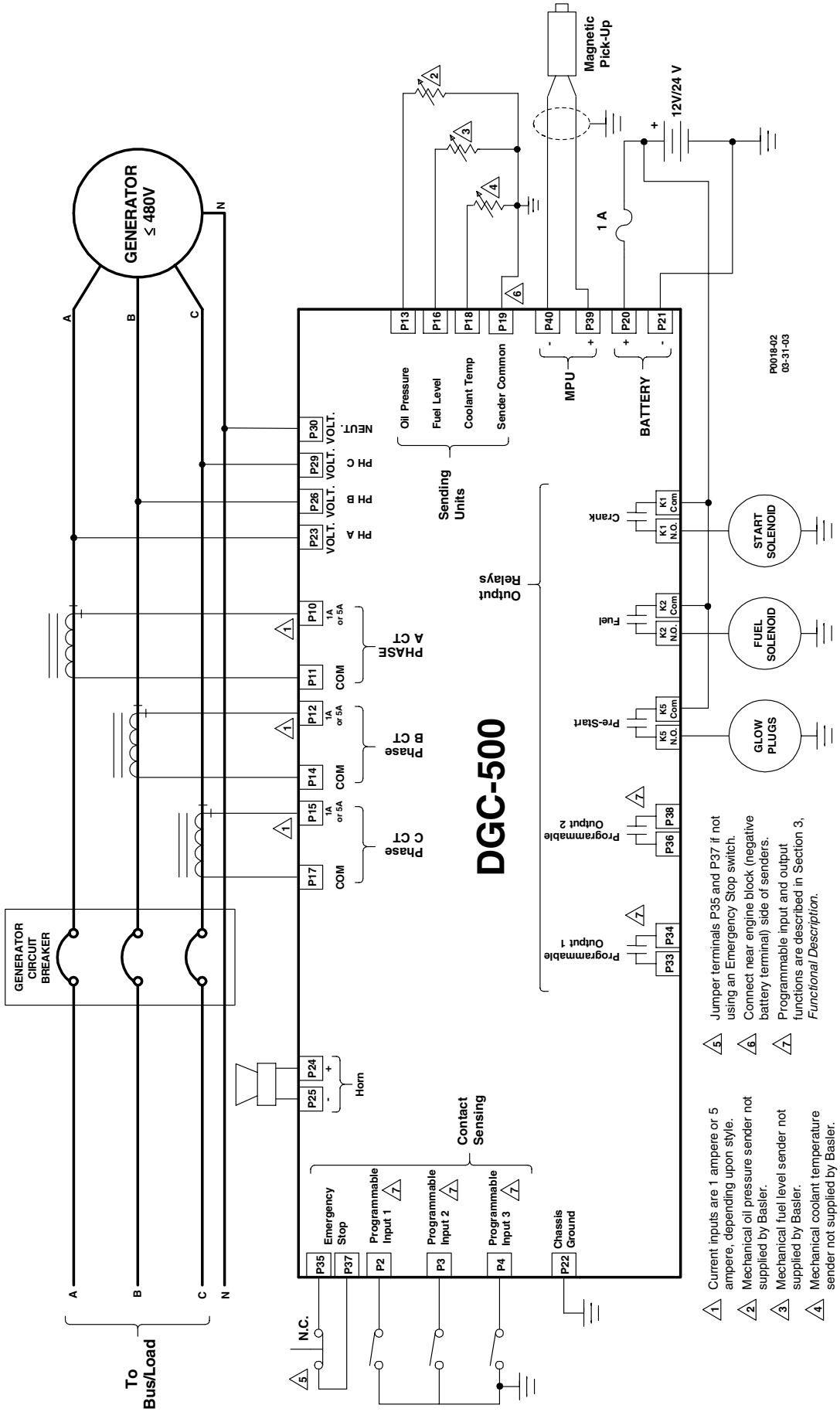


Figure 5-10. DGC-500 Connections, Three-Phase Wye

Volvo Penta EDC III Applications

Engines equipped with Volvo Penta EDC III controllers can receive engine control commands (such as start and stop) from the DGC-500 through the SAE J1939 communication interface. To invoke this feature, the EDC III must receive a J1939 message containing engine control information within one second of waking (exiting sleep mode). If the EDC III does not receive an engine control message within the prescribed time, it will enter the stand-alone mode and ignore any J1939 control messages. If this occurs, the EDC IIImust be forced back into sleep mode by pressing the auxiliary stop pushbutton on the engine or by momentarily disconnecting EDC power.

The interconnection diagrams of Figures 5-11 through 5-14 illustrate the DGC-500 and EDC III connections that allow the DGC-500 to awaken the EDC III and start the engine, or simply acquire engine status information. Wake-up of the EDC III is initiated by using the DGC-500 Fuel output contacts to apply battery power to the EDC. To stop the engine, the DGC-500 issues a sleep command through the J1939 interface to the EDC III and opens the Fuel output contacts. This causes the EDC to stop the engine and enter the sleep mode.

In order for the DGC-500 to communicate with the EDC III, two DGC-500 settings must be changed from their default values.

- The J1939 address of the DGC-500 must be set at 17
- The engine start/stop configuration setting must be set for Volvo Penta

Both settings are configured on the System Settings screen of BESTCOMS. Section 4, *BESTCOMS Software* has information about adjusting DGC-500 settings through BESTCOMS.

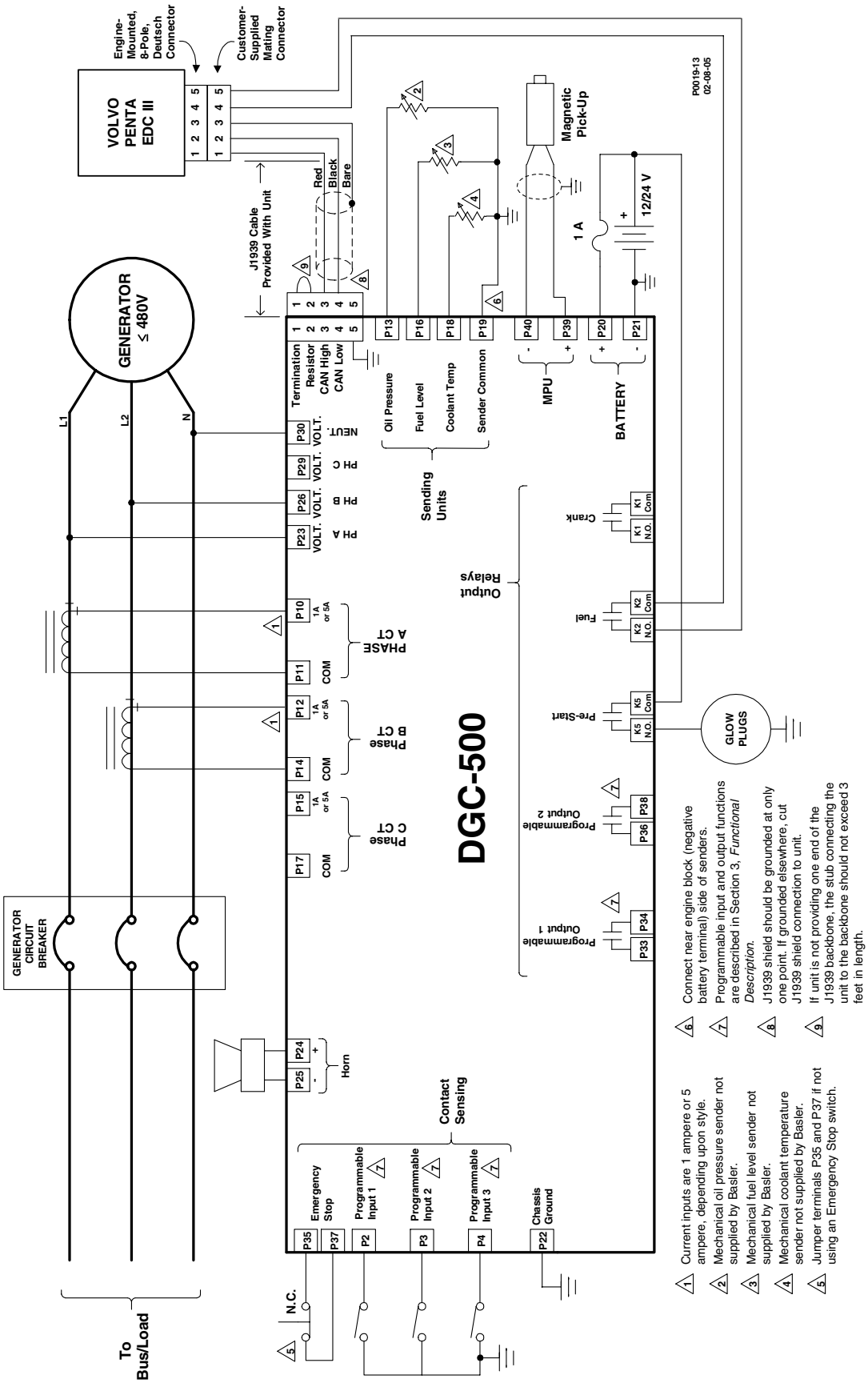


Figure 5-11. Volvo Penta EDC III Application, Single-Phase, A-B Connections,

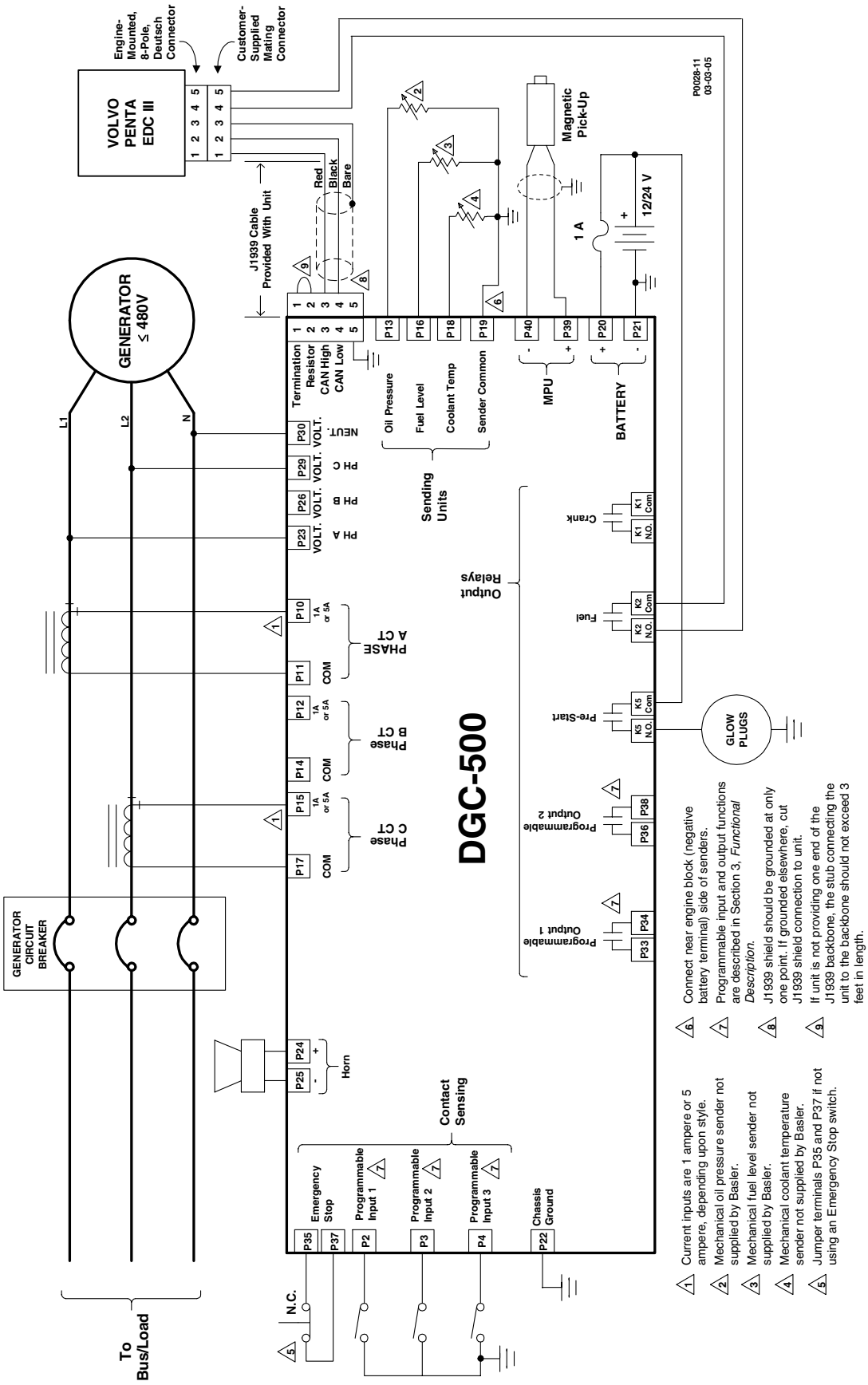


Figure 5-12. Volvo Penta EDC III Application, Single-Phase, A-C Connections

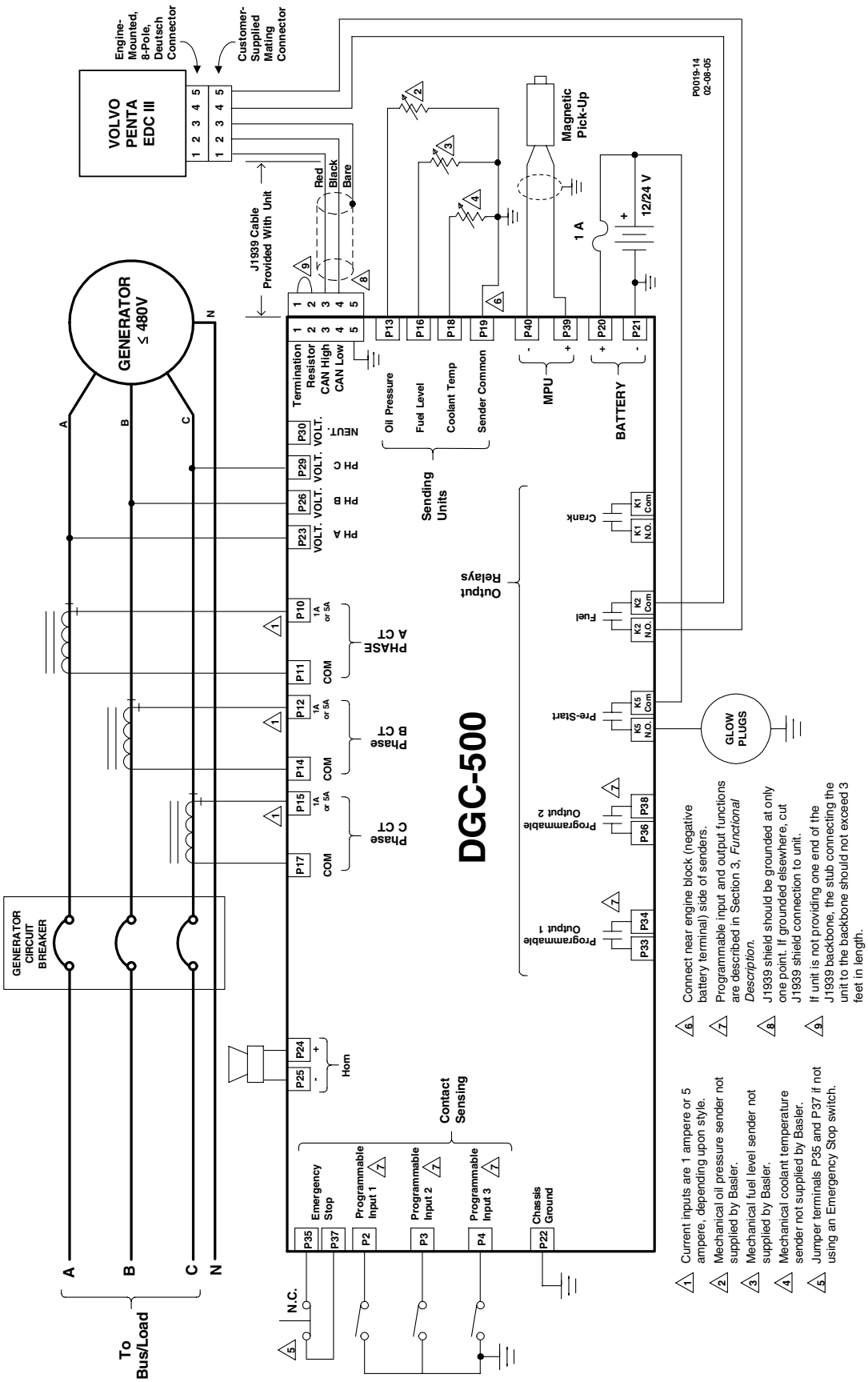


Figure 5-13. Volvo Penta EDC III Application, Three-Phase, Delta Connections

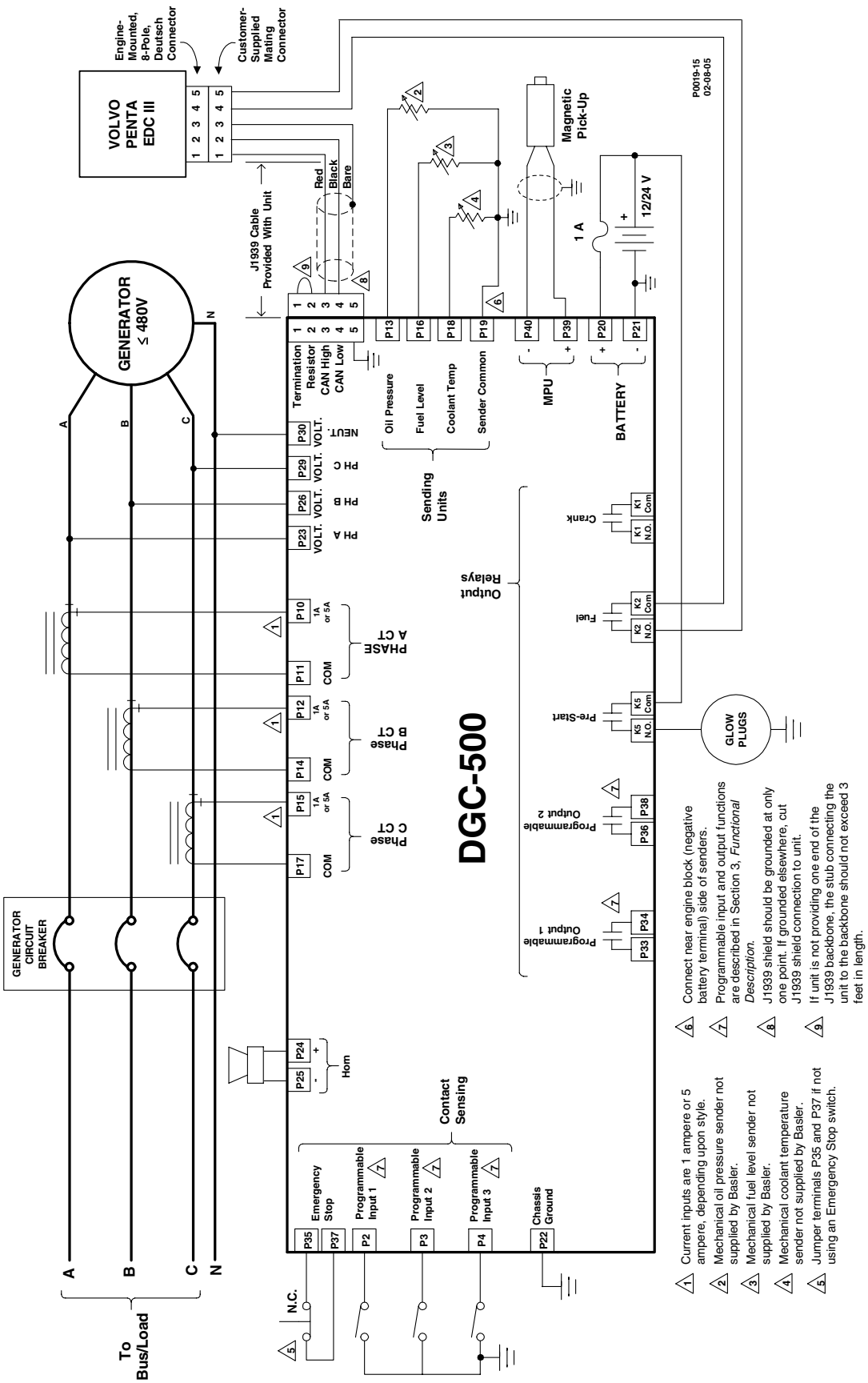
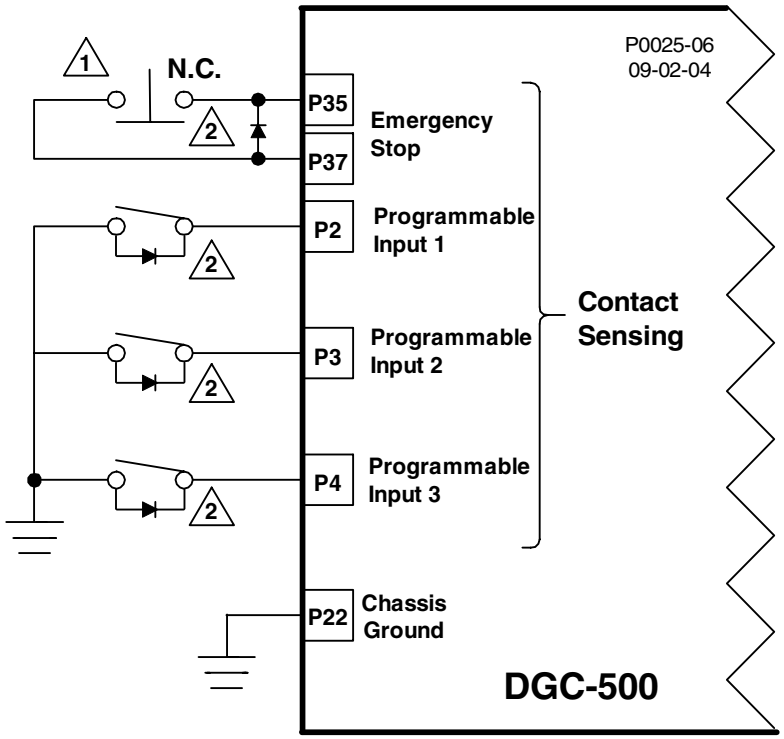


Figure 5-14. Volvo Penta EDC III Application, Three-Phase, Wye Connections

Special Contact Sensing Input Considerations

DGC-500 controllers, with version M or earlier hardware, may require additional protection for the contact sensing inputs when used in environments with high levels of electrical noise. Additional protection can be implemented by connecting external noise suppression diodes across the DGC-500 contact sensing inputs. Schottky diodes, rated at 1 A, 1,000 Vdc or greater, are recommended. Figure 5-15 illustrates how the noise suppression diodes are connected in a typical DGC-500 contact input application.



1 Jumper terminals P35 and P37 if Emergency Stop switch is not used.

2 External noise suppression diodes are rated at 1 A, 1,000 Vdc or greater.

Figure 5-15. Contact Sensing Input Connections with Noise Suppression Diodes

CALIBRATION

Prior to delivery, each DGC-500 is factory calibrated and subjected to thorough testing to ensure quality, accuracy, and performance. DGC-500 units should not require field calibration. However, the following procedure is provided for those users desiring to perform field calibration of their DGC-500.

Equipment Required

- Single-phase 240 Vac source
- Single-phase 2 Aac source
- Resistance box, 25 - 800 ohms

Entering Calibration Mode

Calibration is accomplished by performing the instructions called out on each of the HMI calibration menu screens. The calibration menu screens reside in a branch of Menu 3: Sensing Devices. Figure 5-16 illustrates the process of entering the calibration mode and the following steps describe the process.

1. Navigate to Menu 3: Sensing Devices and scroll up or down to the screen labeled INPUT CALIBRATE FUNCTION.
2. Perform the steps illustrated by Figure 5-16 to enable calibration (screen indicates FEATURE IS ON). Use the Select/Enter pushbutton to move right. Use the Raise/Scroll pushbutton to move up.

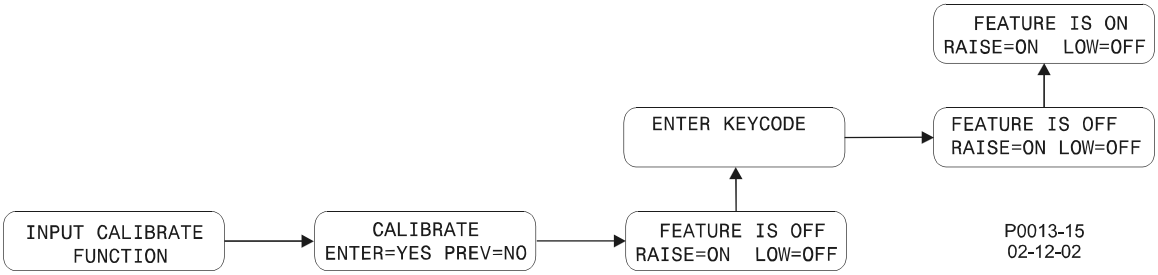


Figure 5-16. Calibration Mode Navigation

Calibration Procedure

Once calibration is enabled, the following steps are performed to calibrate the DGC-500.

After each calibration step is performed, a screen indicating the success of the previous step is displayed. Figure 5-17 shows the screens resulting from a successful calibration step and an unsuccessful calibration step.

Figure 5-17. Successful and Unsuccessful Calibration Screens

1. While viewing the FEATURE IS ON screen (illustrated in Figure 5-16), press the **Select/Enter** pushbutton to begin the calibration process. The first calibration screen (displayed at right) appears. Apply 240 Vac to the voltage sensing inputs for phase A (terminal P23) and Neutral (terminal P30). Press the **Lower/Scroll** pushbutton.

   240 VAC TO A-N
   PRESS LOWER KEY

2. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Apply 240 Vac to the voltage sensing inputs for phase B (P26) and Neutral (P30). Press the **Lower/Scroll** pushbutton.

   240 VAC TO B-N
   PRESS LOWER KEY

3. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Apply 240 Vac to the voltage sensing inputs for phase C (P29) and Neutral (P30). Press the **Lower/Scroll** pushbutton.

   240 VAC TO C-N
   PRESS LOWER KEY

4. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Apply 2 Aac to the current sensing inputs for phase A (P10 and P11). Press the **Lower/Scroll** pushbutton.

   2 AAC TO A CT
   PRESS LOWER KEY

5. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Apply 2 Aac to the current sensing inputs for phase B (P12 and P14). Press the **Lower/Scroll** pushbutton.

   2 AAC TO B CT
   PRESS LOWER KEY

6. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Apply 2 Aac to the current sensing inputs for phase V (P15 and P17). Press the **Lower/Scroll** pushbutton.

   2 AAC TO C CT
   PRESS LOWER KEY

7. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 30 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
30 OHM TO C-T
PRESS LOWER KEY
```

8. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 60 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
60 OHM TO C-T
PRESS LOWER KEY
```

9. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 100 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
100 OHM TO C-T
PRESS LOWER KEY
```

10. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 150 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
150 OHM TO C-T
PRESS LOWER KEY
```

11. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 200 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
200 OHM TO C-T
PRESS LOWER KEY
```

12. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 300 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
300 OHM TO C-T
PRESS LOWER KEY
```

13. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 400 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
400 OHM TO C-T
PRESS LOWER KEY
```

14. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 600 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
600 OHM TO C-T
PRESS LOWER KEY
```

15. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 800 ohms across the coolant temperature sender input (P18 and P19). Press the **Lower/Scroll** pushbutton.

```
800 OHM TO C-T
PRESS LOWER KEY
```

16. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 25 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
25 OHM TO O-P
PRESS LOWER KEY
```

17. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 50 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
50 OHM TO O-P
PRESS LOWER KEY
```

18. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 75 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
75 OHM TO O-P
PRESS LOWER KEY
```

19. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 100 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
100 OHM TO O-P
PRESS LOWER KEY
```

20. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 125 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
125 OHM TO O-P
PRESS LOWER KEY
```

21. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 150 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
150 OHM TO O-P
PRESS LOWER KEY
```

22. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 175 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
175 OHM TO O-P
PRESS LOWER KEY
```

23. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 200 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
200 OHM TO O-P
PRESS LOWER KEY
```

24. Press the **Raise/Scroll** pushbutton. The screen at right is displayed. Connect a resistance of 225 ohms across the oil pressure sender input (P13 and P19). Press the **Lower/Scroll** pushbutton.

```
225 OHM TO O-P
PRESS LOWER KEY
```

After step 24 is completed successfully and the Raise/Scroll pushbutton is pressed, the INPUT CALIBRATE FUNCTION screen appears and signals that calibration is complete.

SECTION 6 • MAINTENANCE AND TROUBLESHOOTING

PREVENTATIVE MAINTENANCE

The only preventative maintenance required on the DGC-500 is to periodically check that the connections between the DGC-500 and the system are clean and tight. DGC-500 units are manufactured using state-of-the-art, surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

TROUBLESHOOTING

If you do not get the results that you expect from the DGC-500, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your genset control system.

Incorrect Display of Battery Voltage, Coolant Temperature, Oil Pressure, or Fuel Level

Step 1. Verify that all wiring is properly connected. Refer to Figures 5-5 through 5-7.

Step 2. Confirm that the SENDER COMM terminal (P19) is connected to the negative battery terminal and the engine-block side of the senders. Current from other devices sharing this connection can cause erroneous readings.

Step 3. If the displayed battery voltage is incorrect, ensure that the proper voltage is present between the BATT+ terminal (P20) and the SENDER COMM terminal (P19).

Step 4. Verify that the correct senders are being used.

Step 5. Verify that the correct sender curves are being used.

Step 6. Ensure that the senders are operating properly.

Incorrect Display of Generator Voltage

Step 1. Verify that all wiring is properly connected. Refer to Figures 5-5 through 5-7.

Step 2. Ensure that the proper voltage is present at the DGC-500 voltage sensing inputs (P23, P26, P29, and P30).

Step 3. Verify that the voltage transformer ratio and sensing configuration is correct.

Step 4. Confirm that the voltage sensing transformers are correct and properly installed.

Incorrect Measurement or Display of Generator Current

Step 1. Verify that all wiring is properly connected. Refer to Figures 5-5 through 5-7.

Step 2. Ensure that the proper current is present at the DGC-500 current sensing inputs (P10 - P17).

Step 3. Verify that the current sensing transformer ratios are correct.

Step 4. Confirm that the current sensing transformers are correct and properly installed.

Incorrect Display of Engine RPM

Step 1. Verify that all wiring is properly connected. Refer to Figures 5-5 through 5-7.

Step 2. Verify that the flywheel teeth setting is correct.

Step 3. Confirm the nominal frequency setting.

Step 4. Verify that the prime mover governor is operating properly.

Step 5. Verify that the measured frequency of the voltage at the MPU input (P39 and P40) is correct.

Step 6. If the MPU is shared with the governor, verify that the polarity of the MPU input to the governor matches the polarity of the MPU input to the DGC-500.

Programmable Inputs Do Not Operate as Expected

Step 1. Verify that all wiring is properly connected. Refer to Figures 5-5 through 5-7.

Step 2. Confirm that the inputs are programmed properly.

Step 3. Ensure that the input at the DGC-500 is actually connected to the BATT– terminal (P21).

Programmable Outputs Do Not Operate as Expected

Step 1. Verify that all wiring is properly connected. Refer to Figures 5-5 through 5-7.

Step 2. Confirm that the outputs are programmed properly.

Communication Port Does Not Operate Properly

Step 1. Verify that the proper port of your computer is being used.

Step 2. Confirm that the correct baud rate is being used.

Step 3. Verify that the connection between the computer and the DGC-500 is correct. Ensure that a straight-through serial cable is being used.

APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES

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APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES

INTRODUCTION

The inverse time overcurrrent characteristic curves provided by the DGC-500 (style XXX1 only) closely emulate most of the common electromechanical, induction-disk, overcurrent relays sold in North America.

CURVE SPECIFICATIONS

Timing Accuracy

Within ±500 milliseconds of indicated operating point

Sixteen inverse time functions, one fixed time function and one programmable time function can be selected. Characteristic curves for the inverse and definite time functions are defined by the following equation:

$$T_T = \frac{A \bullet D}{M^N - C} + B \bullet D + K$$

T_T	=	Time to trip when M ≥ 1.
T_R	=	Time to reset if relay is set for integrating reset when M < 1. Otherwise, reset is 50 milliseconds or less.
D	=	TIME DIAL setting (0.0 to 9.9).
M	=	Multiple of PICKUP setting (0 to 40)
A, B, C, N, K	=	Constants for the particular curve.

This equation complies with IEEE Standard C37.112-1996.

Table A-1 lists the time characteristic curve constants. See Figures A-1 through A-16 for graphs of the characteristics.

Table A-1. Time Characteristic Curve Constants

Curve Selection	BE Curve Name	Trip Characteristic Constants				
		A	B	C	N	K
S1	S, Short Inverse	0.2663	0.03393	1.0000	1.2969	0.0280
S2	S2, Short Inverse	0.029	0.02080	1.0000	0.9844	0.0280
L1	L1, Long Inverse	5.6143	2.18592	1.0000	1.0000	0.0280
L2	L2, Long Inverse	2.3955	0.00000	1.0000	0.3125	0.0280
D	D, Definite Time	0.4797	0.21359	1.0000	1.5625	0.0280
M	M, Moderately Inverse	0.3022	0.12840	1.0000	0.5000	0.0280
I1	I, Inverse Time	8.9341	0.17966	1.0000	2.0938	0.0280
I2	Inverse Time	0.2747	0.10426	1.0000	0.4375	0.0280
V1	V, Very Inverse	5.4678	0.10814	1.0000	2.0469	0.0280
V2	V2, Very Inverse	4.4309	0.09910	1.0000	1.9531	0.0280
E1	Extremely Inverse	7.7624	0.02758	1.0000	2.0938	0.0280
E2	E2, Extremely Inverse	4.9883	0.01290	1.0000	2.0469	0.0280
A	Standard Inverse	0.014	0.00000	1.0000	0.0200	0.0280
B	B, Very Inverse (I^2t)	1.4636	0.00000	1.0000	1.0469	0.0280
C	Extremely Inverse (I^2t)	8.2506	0.00000	1.0000	2.0469	0.0280
G	Long Time Inverse (I^2t)	12.121	0.00000	1.0000	1.0000	0.0280
F	Fixed Time ✳	0	1.00000	1.0000	0.0000	0.0280

✳ Curve F has a fixed delay of one second times the Time Dial setting.

TIME OVERCURRENT CHARACTERISTIC CURVE GRAPHS

Figures A-1 through A-16 illustrate the characteristic curves of the DGC-500. Table A-2 cross-references each curve to existing electromechanical relay characteristics. Equivalent time dial settings were calculated at a value of five times pickup.

Table A-2. Characteristic Curve Cross-Reference

Curve	Curve Name	Similar To
S1	S, Short Inverse	ABB CO-2
S2	S2, Short Inverse	GE IAC-55
L1	L, L1, Long Inverse	ABB CO-5
L2	L2, Long Inverse	GE IAC-66
D	D, Definite Time	ABB CO-6
M	M, Moderately Inverse	ABB CO-7
I1	I, I1 Inverse Time	ABB CO-8
I2	I2 Inverse Time	GE IAC-51
V1	V, V1 Very Inverse	ABB CO-9
V2	V2, Very Inverse	GE IAC-53
E1	E, E1 Extremely Inverse	ABB CO-11
E2	E2, Extremely Inverse	GE IAC-77
A	A Standard Inverse	BS, IEC Standard Inverse
B	B, Very Inverse (It)	BS, IEC Very Inverse (I^2t)
C	Extremely Inverse (I^2t)	BS, IEC Extremely Inverse (I^2t)
G	Long Time Inverse	BS, IEC Long Time Inverse
F	Fixed Time	N/A

Time Dial Setting Cross-Reference

Although the time characteristic curve shapes have been optimized for the DGC-500, the DGC-500 time dial settings are not identical to the settings of electromechanical induction disk overcurrent relays. Table A-3 helps you convert the time dial settings of induction disk relays to the equivalent setting for the DGC-500.

Using Table A-3

Cross-reference table values were obtained by inspection of published electromechanical time current characteristic curves. The time delay for a current of five times tap was entered into the time dial calculator function for each time dial setting. The equivalent DGC-500 time dial setting was then entered into the cross-reference table.

If your electromechanical relay time dial setting is between the values provided in the table, it will be necessary to interpolate (estimate the correct intermediate value) between the electromechanical setting and the Basler Electric setting.

The DGC-500 has a maximum time dial setting of 9.9. The Basler Electric equivalent time dial setting for the electromechanical maximum setting is provided in the cross-reference table even if it exceeds 9.9. This allows interpolation, as noted above.

Basler Electric time current characteristics are determined by a linear mathematical equation. The induction disk of an electromechanical relay has a certain degree of non-linearity due to inertial and friction effects. For this reason, even though every effort has been made to provide characteristic curves with minimum deviation from the published electromechanical curves, slight deviations can exist between them.

In applications where the time coordination between curves is extremely close, we recommend that you choose the optimal time dial setting by inspection of the coordination study. In applications where coordination is tight, it is recommended that you retrofit your circuits with Basler Electric electronic relays to ensure high timing accuracy.

Table A-3. Characteristic Curve Cross-Reference

Curve Name	Equivalent to	Electromechanical Relay Time Dial Setting											
		0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
		Basler Electric Equivalent Time Dial Setting											
S, S1	ABB CO-2	0.3	0.8	1.7	2.4	3.4	4.2	5.0	5.8	6.7	7.7	8.6	9.7
L, L1	ABB CO-5	0.4	0.8	1.5	2.3	3.3	4.2	5.0	6.0	7.0	7.8	8.8	9.9
D	ABB CO-6	0.5	1.1	2.0	2.9	3.7	4.5	5.0	5.9	7.2	8.0	8.9	10.1
M	ABB CO-7	0.4	0.8	1.7	2.5	3.3	4.3	5.3	6.1	7.0	8.0	9.0	9.8
I, I1	ABB CO-8	0.3	0.7	1.5	2.3	3.2	4.0	5.0	5.8	6.8	7.6	8.7	10.0
V, V1	ABB CO-9	0.3	0.7	1.4	2.1	3.0	3.9	4.8	5.7	6.7	7.8	8.7	9.6
E, E1	ABB CO-11	0.3	0.7	1.5	2.4	3.2	4.2	5.0	5.7	6.6	7.8	8.5	10.3
I2	GE IAC-51	0.6	1.0	1.9	2.7	3.7	4.8	5.7	6.8	8.0	9.3	10.6	
V2	GE IAC-53	0.4	0.8	1.6	2.4	3.4	4.3	5.1	6.3	7.2	8.4	9.6	
S2	GE IAC-55	0.2	1.0	2.0	3.1	4.0	4.9	6.1	7.2	8.1	8.9	9.8	
L2	GE IAC-66	0.4	0.9	1.8	2.7	3.9	4.9	6.3	7.2	8.5	9.7	10.9	
E2	GE IAC-77	0.5	1.0	1.9	2.7	3.5	4.3	5.2	6.2	7.4	8.2	9.9	

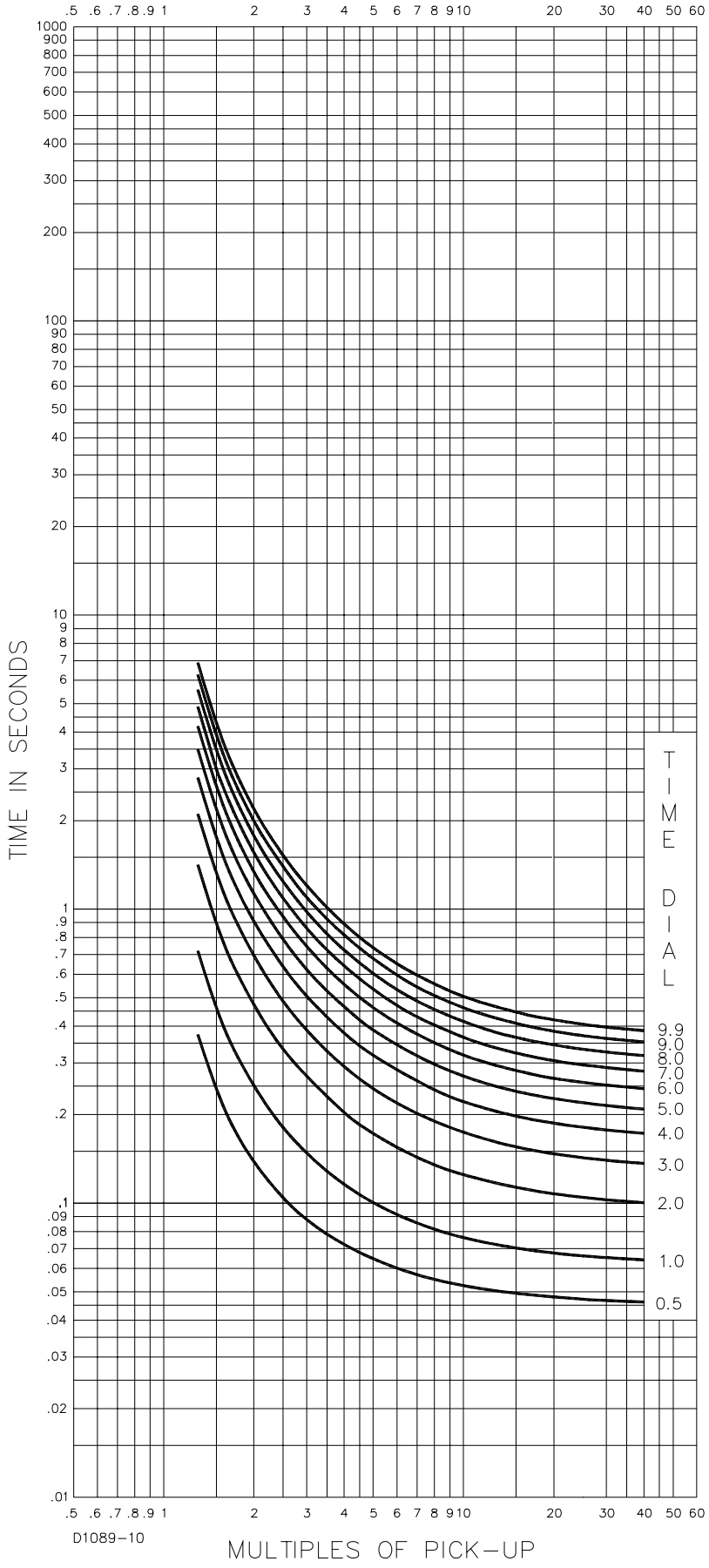


Figure A-1. Time Characteristic Curve S1 Short Inverse (Similar to ABB CO-2)

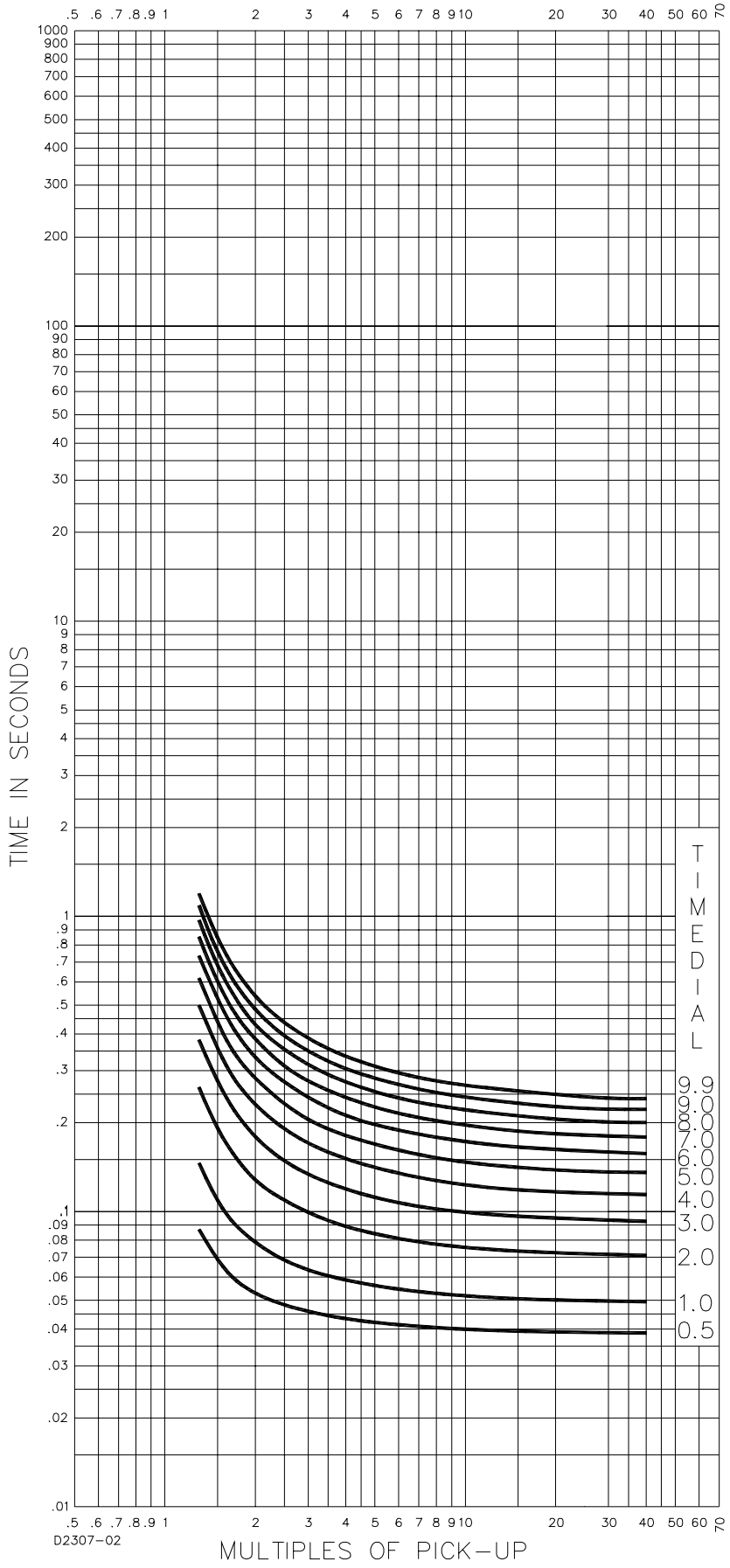


Figure A-2.Time Characteristic Curve S2, Short Inverse (Similar to GE IAC-55)

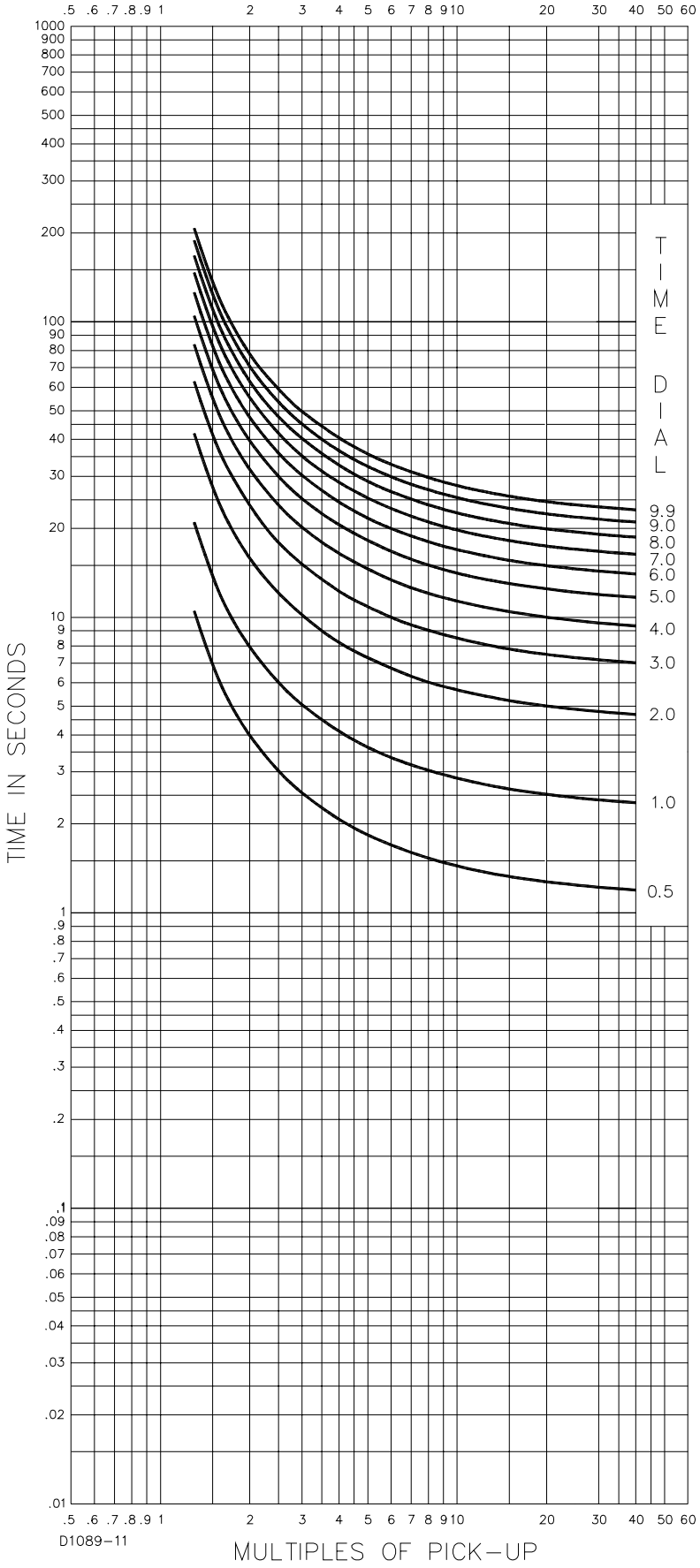


Figure A-3. Time Characteristic Curve L1, Long Inverse (Similar to ABB CO-5)

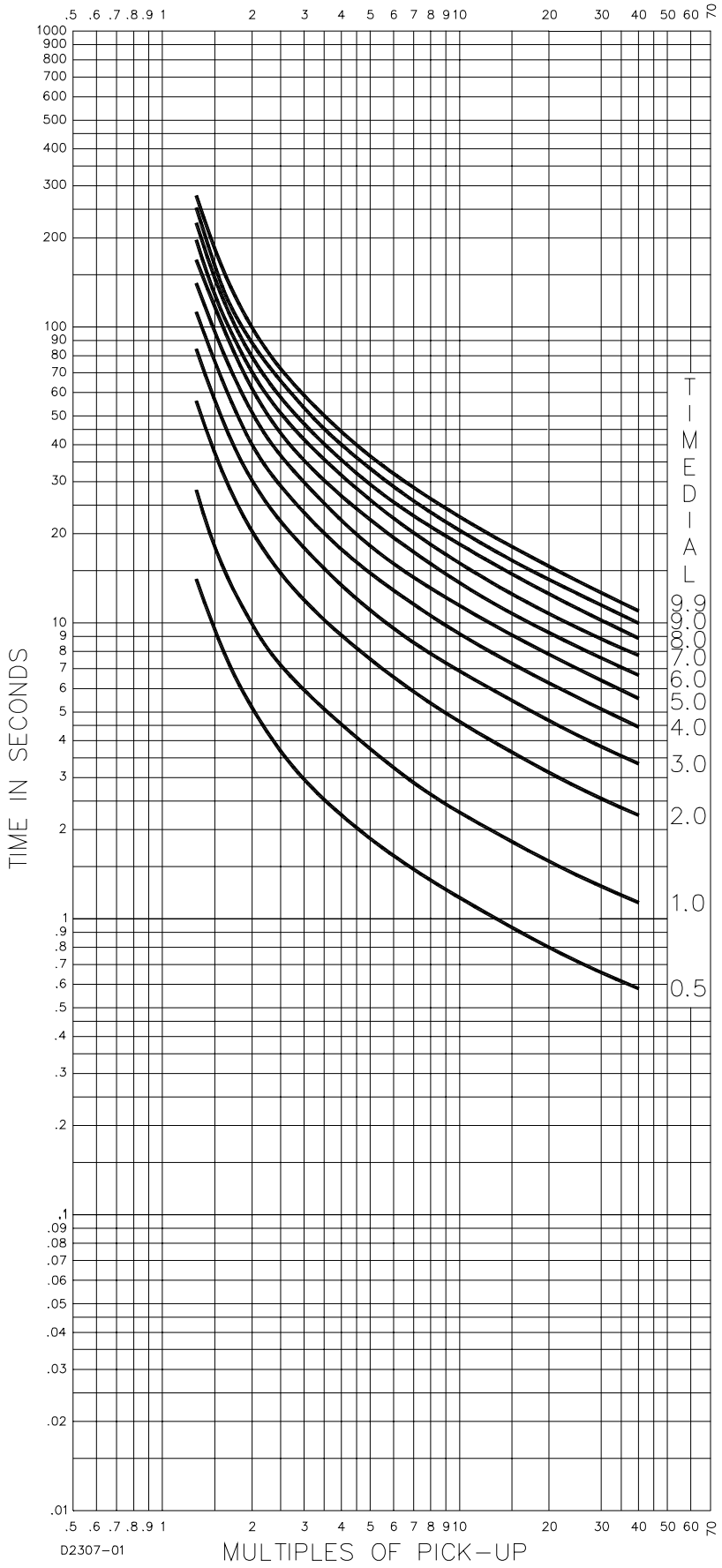


Figure A-4. Time Characteristic Curve L2, Long Inverse (Similar to GE IAC-66)

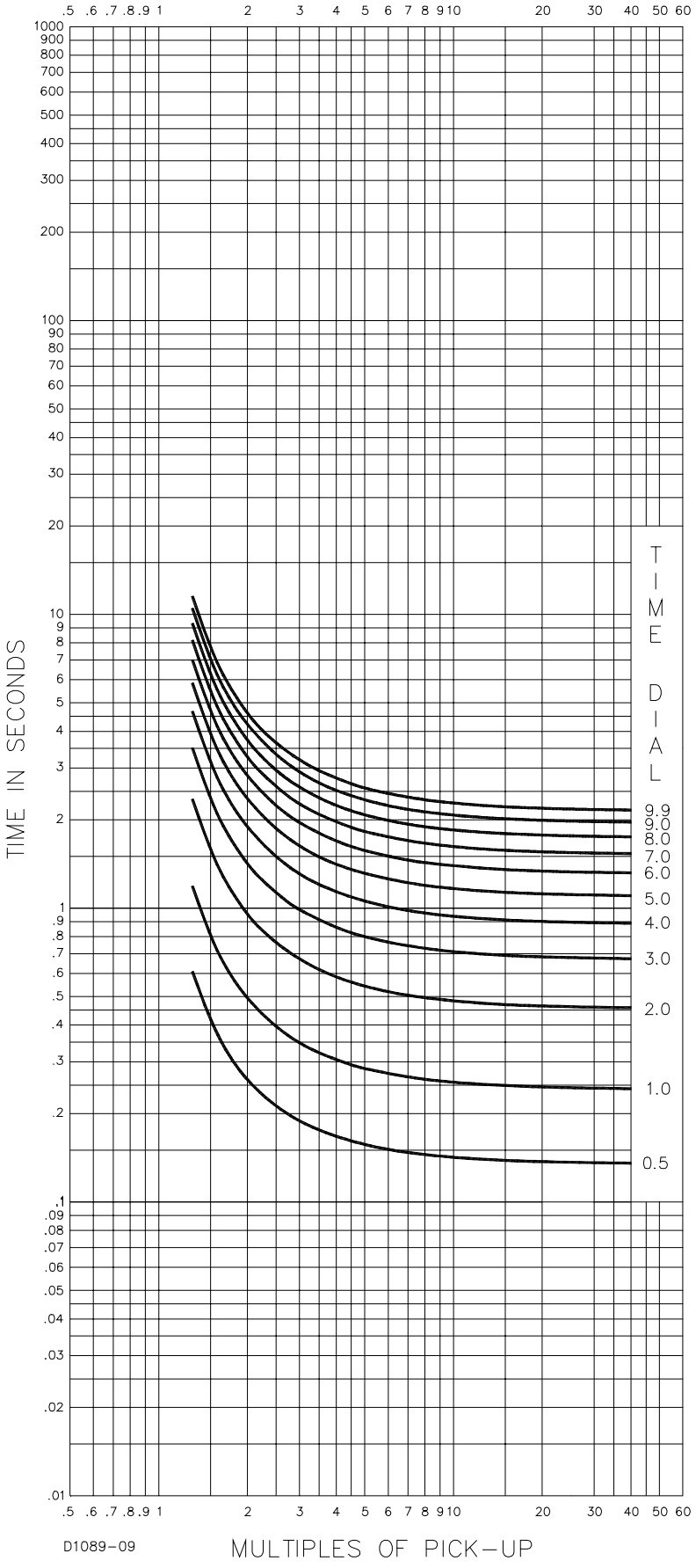


Figure A-5. Time Characteristic Curve D, Definite Time (Similar to ABB CO-6)

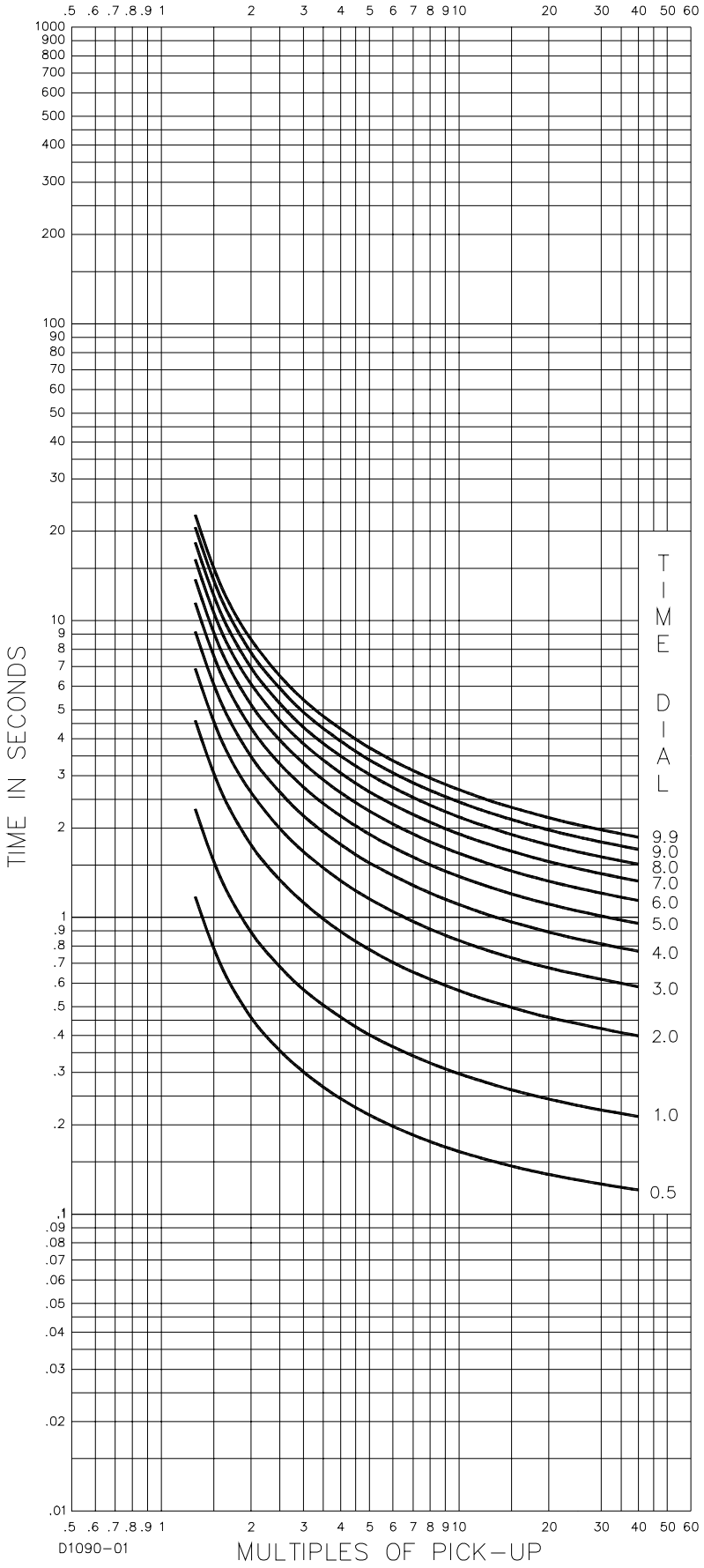


Figure A-6. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7)

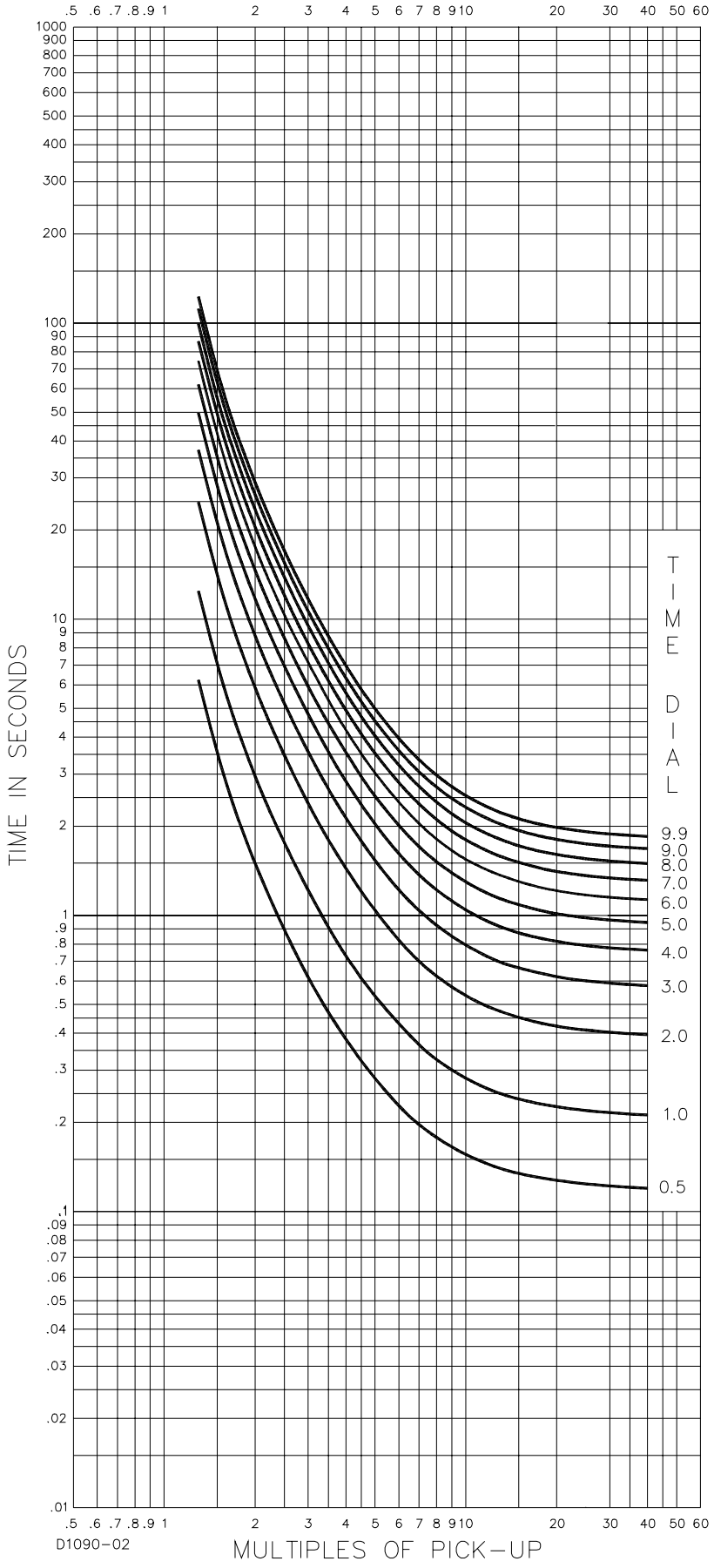


Figure A-7. Time Characteristic Curve I1 Inverse Time (Similar to ABB CO-8)

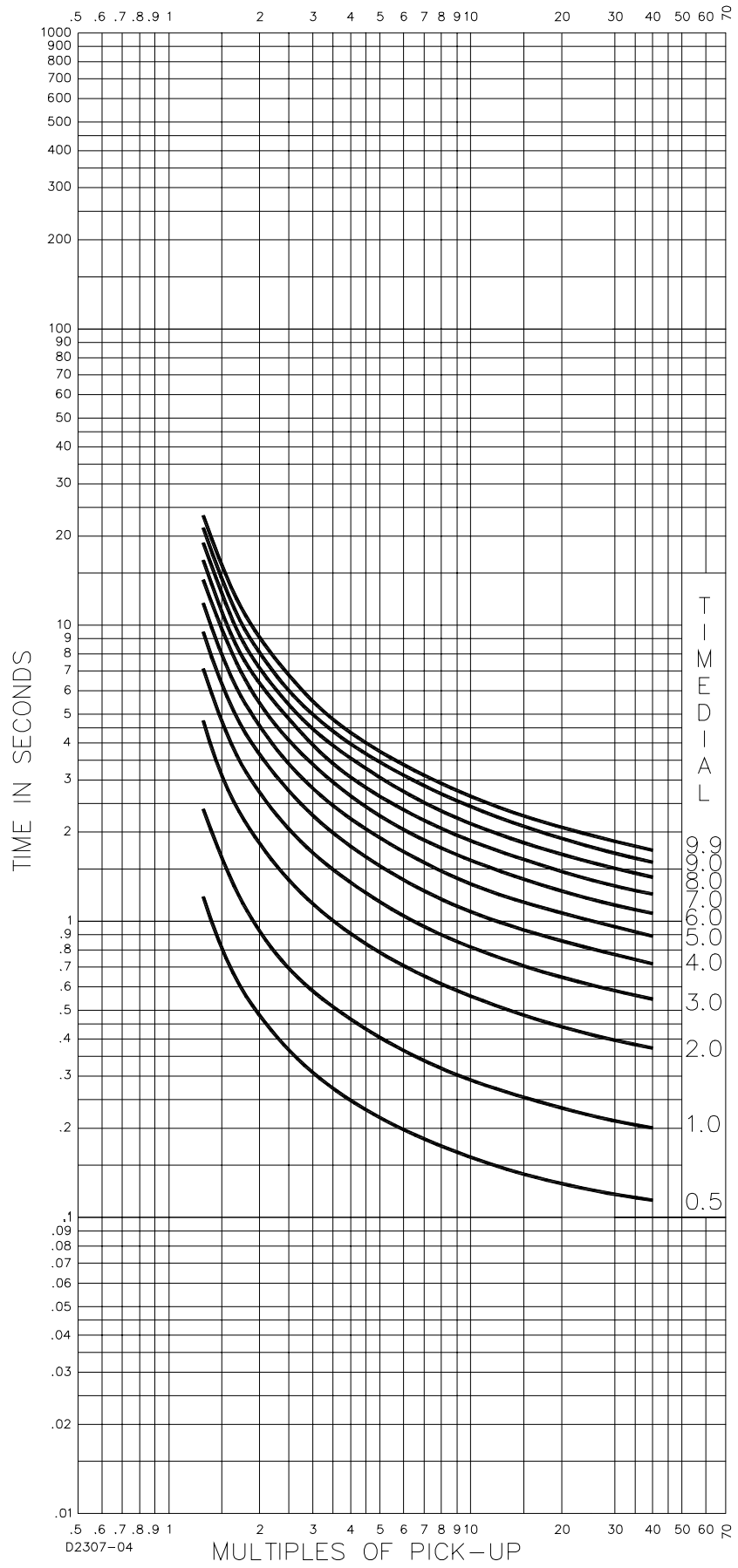


Figure A-8. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51)

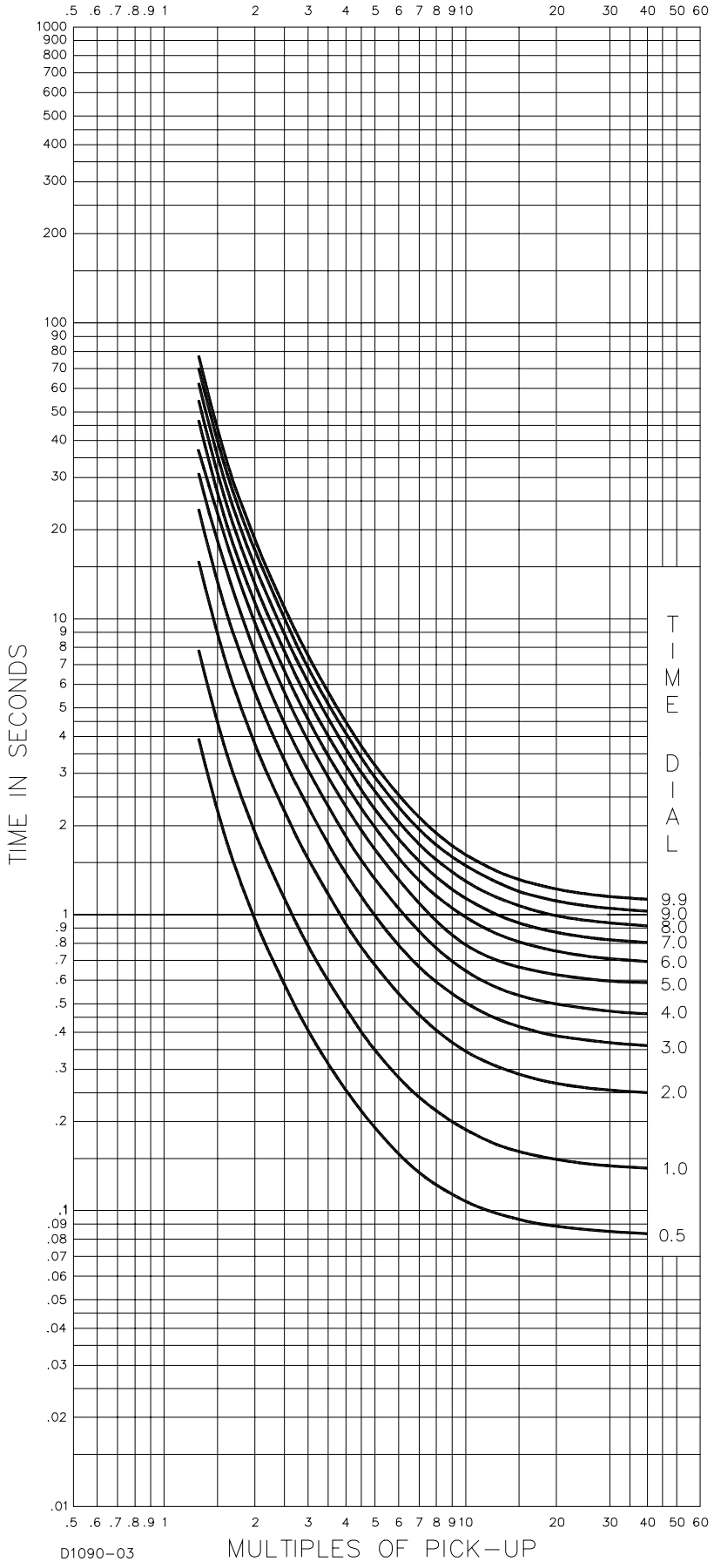


Figure A-9. Time Characteristic Curve V, V1, Very Inverse (Similar to ABB CO-9)

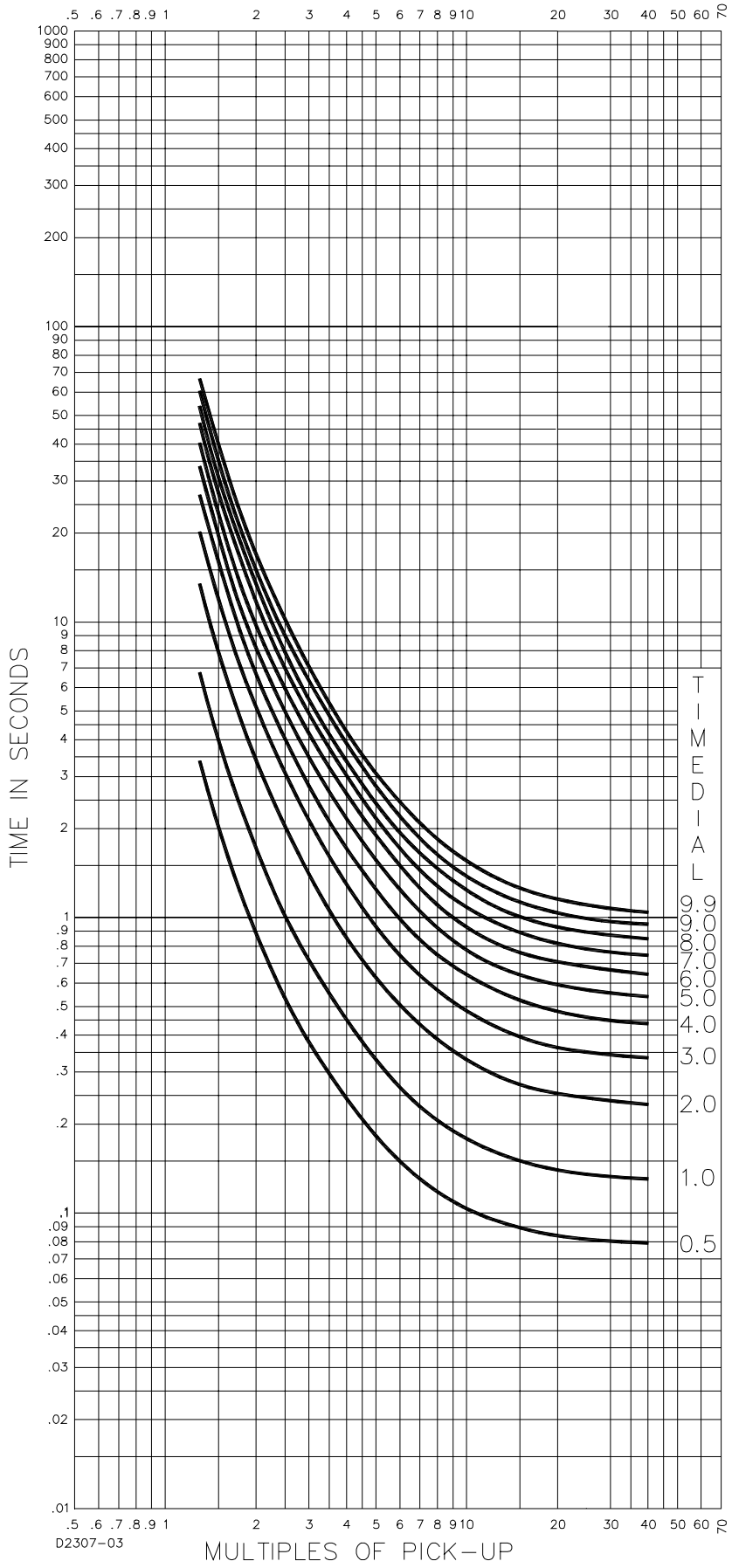


Figure A-10. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53)

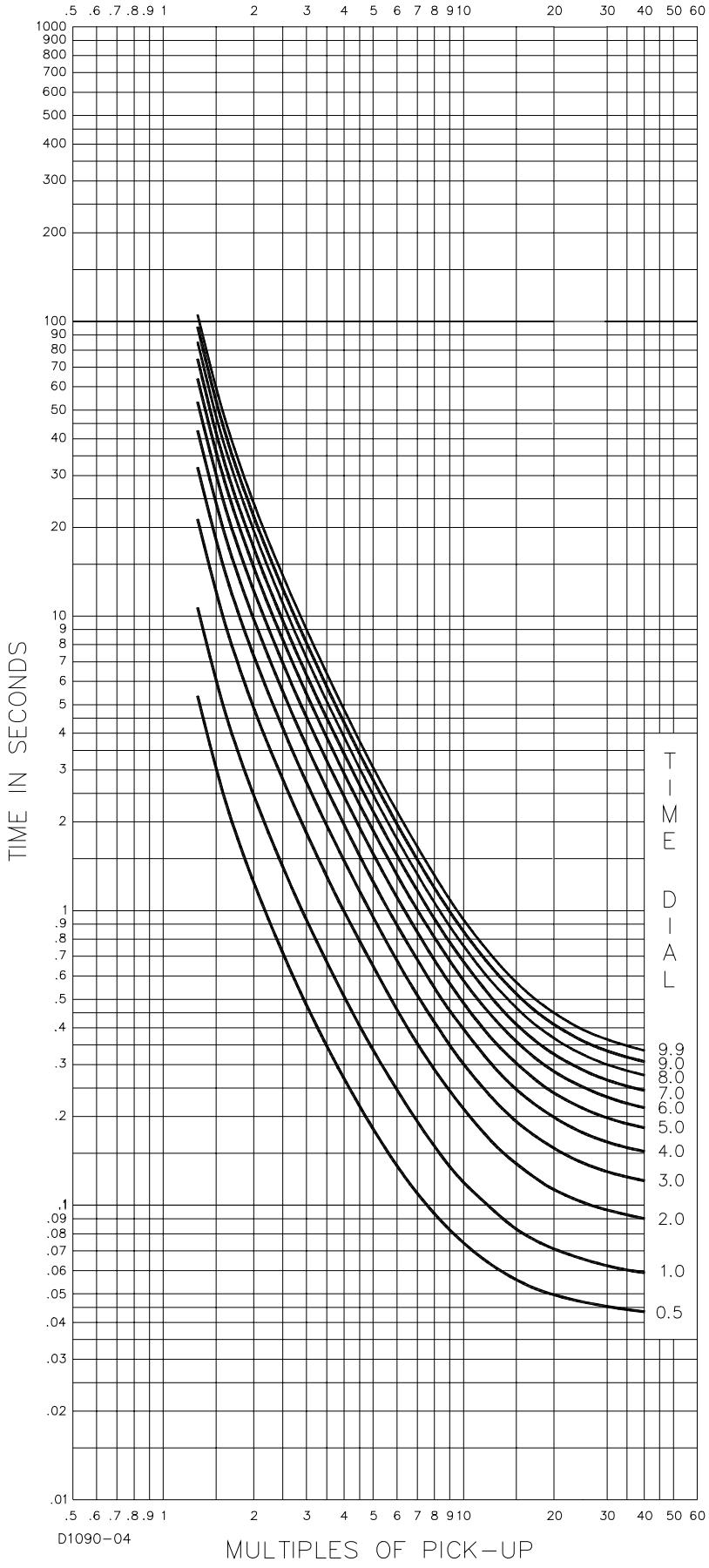


Figure A-11. Time Characteristic Curve E1, Extremely Inverse (Similar to GE IAC-11)

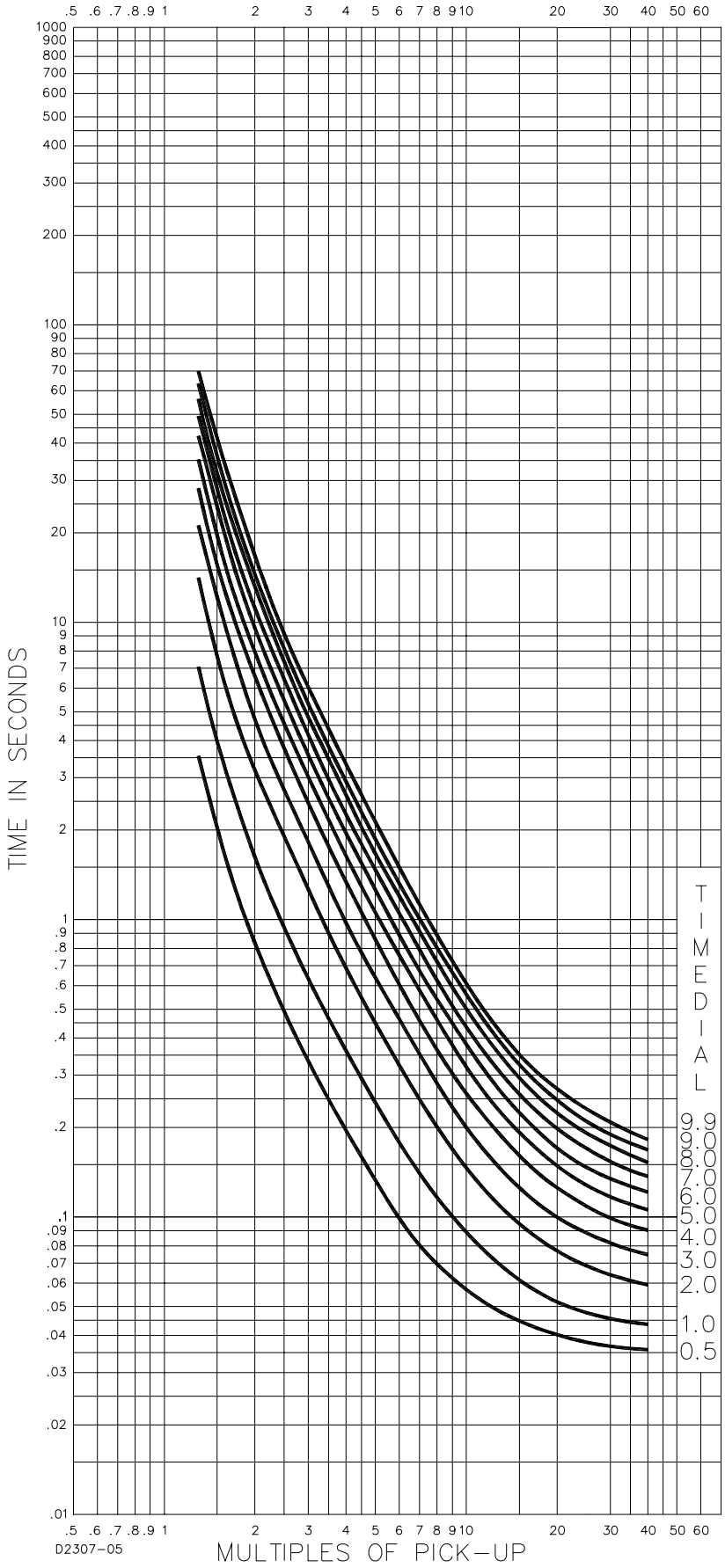


Figure A-12. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77)

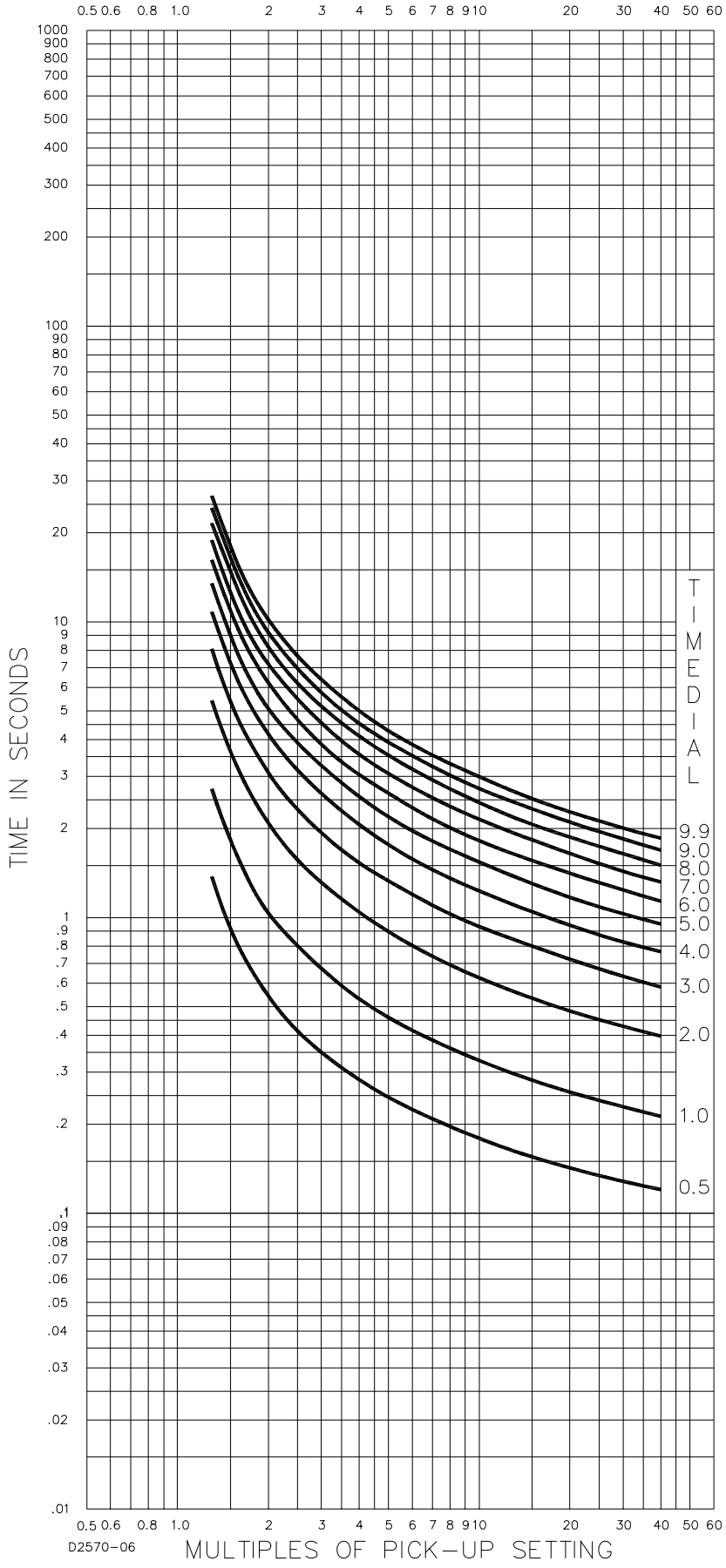


Figure A-13. Time Characteristic Curve A, Standard Inverse

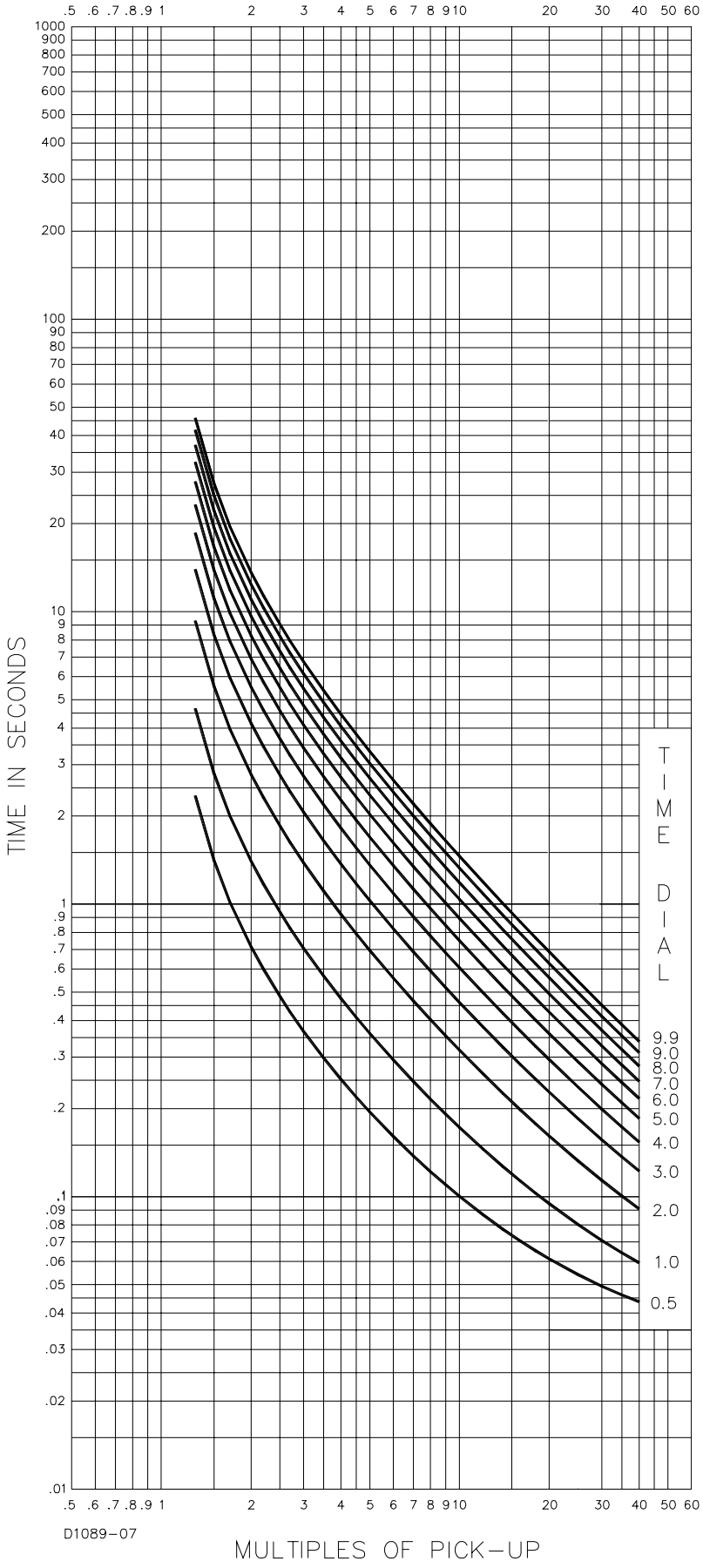


Figure A-14. Time Characteristic Curve B, Very Inverse

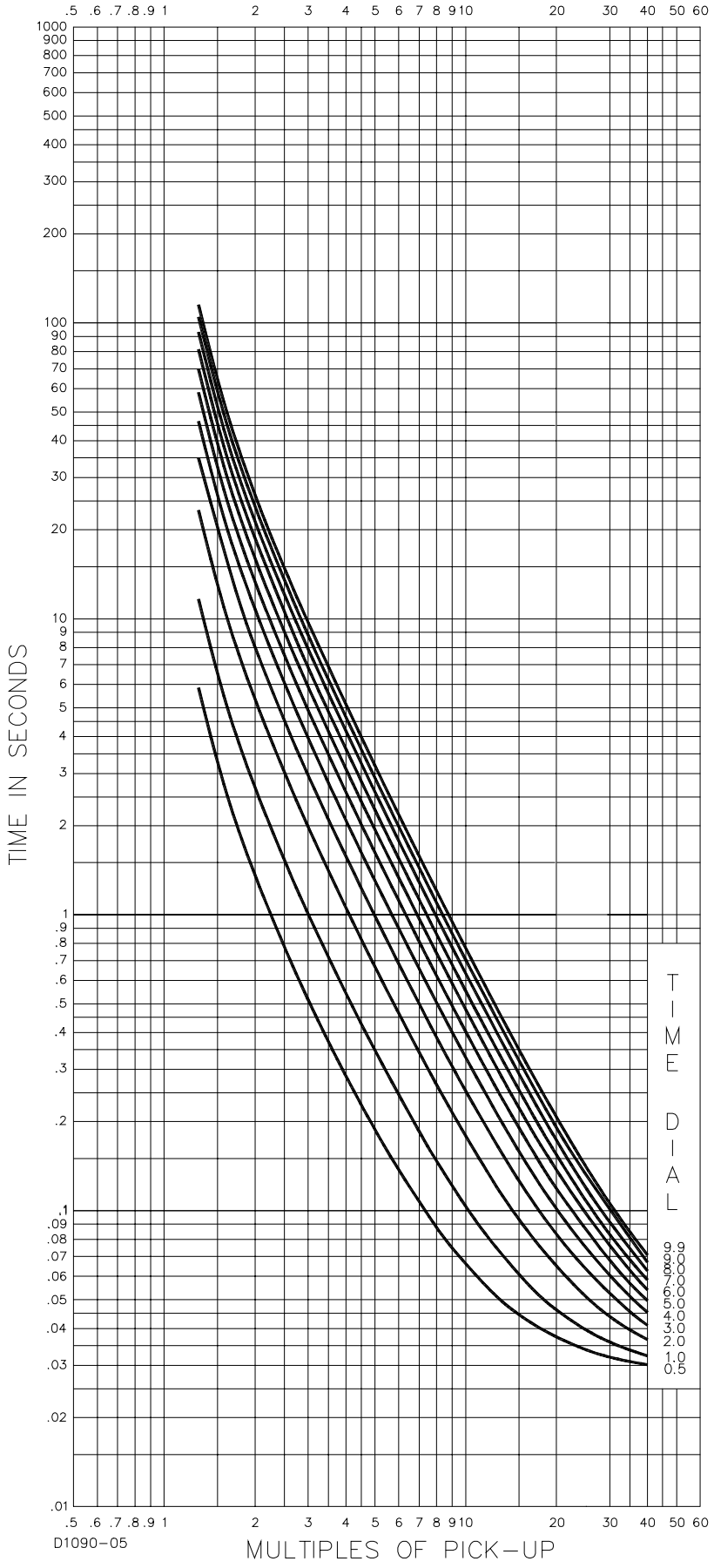


Figure A-15. Time Characteristic Curve C, Extremely Inverse

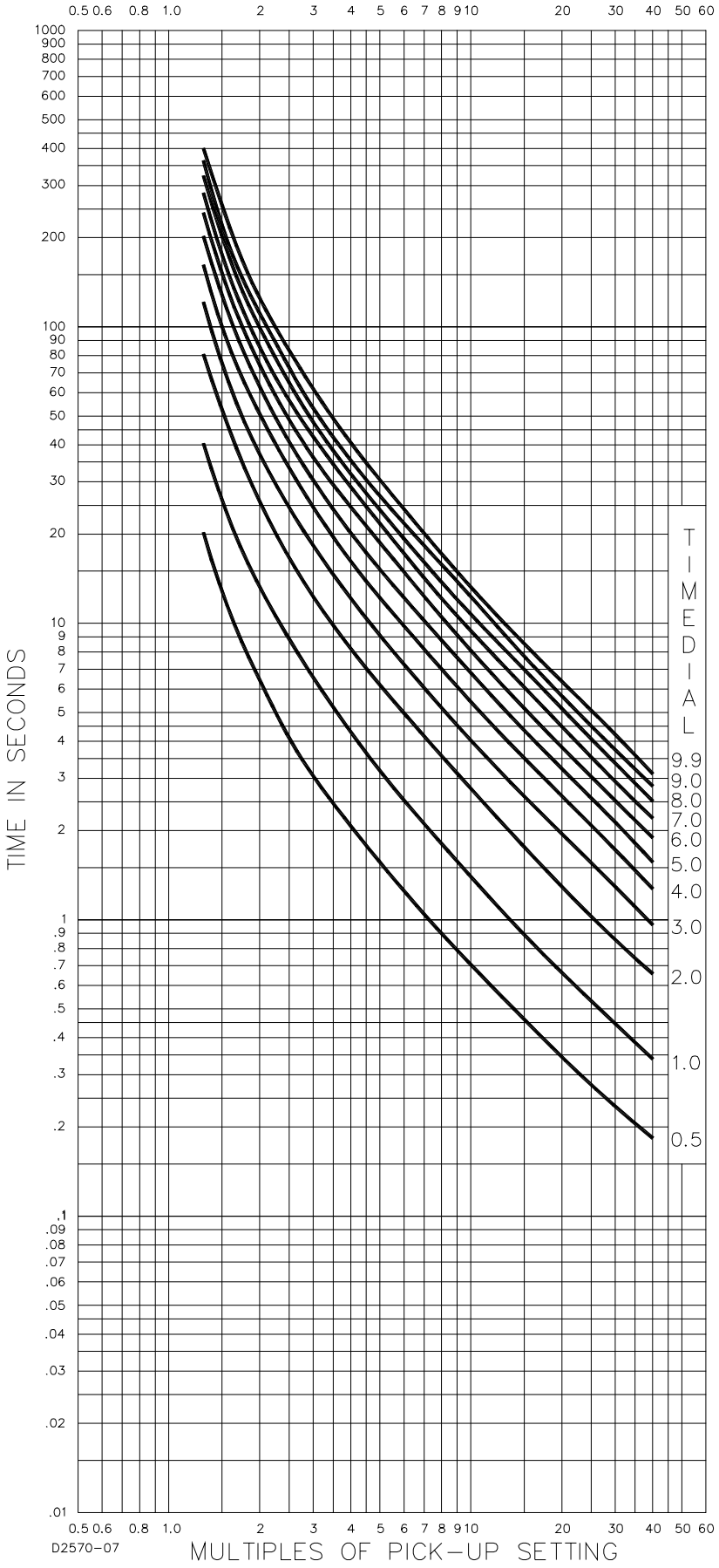


Figure A-16. Time Characteristic Curve G, Long Inverse

APPENDIX B • PARAMETERS AND SETTINGS

INTRODUCTION

This appendix lists all DGC-500 parameters along with the setting range/selections for each parameter.

FRONT PANEL ADJUSTABLE PARAMETERS

Table B-1 lists the DGC-500 settings that can be adjusted through the HMI.

Table B-1. HMI Adjustable Settings

Parameter	Range
Cool-Down Time Delay	0 - 60 min
Date	01/01/2000 - 12/31/2099
Daylight Saving Time	On/Off
Engine Maintenance Cycle Hours Pre-Alarm	Reset/Normal
LCD Contrast	25 - 75%
Low Fuel Alarm	0 - 100%
Low Fuel Pre-Alarm	10 - 100%
Metric Conversion	On/Off
Pre-Crank Time Delay	0 - 30 sec
Pre-Start Contact Status After Disconnect	On/Off
Sender Failure Alarm Time	1 - 30 sec
Time	00:00:00 to 23:59:59

ALL PARAMETERS

Table B-2 lists each DGC-500 parameter in alphabetical order. The setting range or nomenclature used by the HMI and the BESTCOMS interface is listed beside each parameter.

Table B-2 DGC-500 Settings

Parameter	Setting Range
Accelerator Position	0 - 100%
Accumulated Engine Runtime	0 - 99,999 hrs, 59 min
Battery Overvoltage Pre-Alarm Enable	On or Off
Battery Overvoltage Pre-Alarm Threshold	Off, 15 Vdc, or 30 Vdc
Battery Charger Failure Pre-Alarm Enable	Off or On
Battery Voltage	12 Vdc or 24 Vdc
CANBus Address	0 - 253

Parameter	Setting Range
Communication Parity	None, Odd, or Even
Communication Baud Rate	1200, 2400, or 9600
Continuous Crank Time	1 - 60 sec
Coolant Temperature Sender Fail Alarm Enable	Off or On
Coolant Temperature Sender Fail Alarm Delay	5, 10, 15, 20, 25, or 30 min
Crank Disconnect Limit	10 - 100%
Cranking Style	Continuous or Cycle
Cycle Crank Time	5 - 15 sec
DTC Support	On or Off
ECU Control Output Select	Fuel or Pre-Start Contact
ECU Pulsing	Disable or Enable
ECU Pulse Cycle Time	1 - 60 min
ECU Response Time-out	1 - 60 sec
ECU Settling Time	5,500 - 30,000 msec
ECU Support	On or Off
Engine Shutdown Time	1 - 60 sec
Engine Start/Stop Configuration	Not Configured or Volvo Penta
Engine Maintenance Cycle Pre-Alarm Level	0 - 5,000 hrs
Fuel Level Sender Failure Pre-Alarm Enable	On or Off
Generator Rotation	ABC or ACB
Generator CT Primary Amps	1- 5,000 Aac
Generator Frequency	50 Hz or 60 Hz
Generator kW Rating	5 - 9,999 kW
Generator PT Primary Volts	1 - 999 Vac
Generator PT Secondary Volts	1- 480 Vac
Generator Connection	3-phase L-L 3-phase L-N 1-phase A-B 1-phase A-C
Global Sender Failure Alarm Delay	1 - 30 sec
High Coolant Temperature Alarm Enable	On or Off
High Coolant Temperature Pre-Alarm Enable	On or Off
High Coolant Temperature Pre-Alarm Threshold	100 - 280°F
High Coolant Temperature Alarm Delay	60 sec
High Coolant Temperature Alarm Threshold	100 - 280°F
LCD Contrast	25 -75%

Parameter	Setting Range
Loss of Generator Voltage Alarm Enable	On or Off
Low Battery Voltage Pre-Alarm Enable	On or Off
Low Battery Voltage Pre-Alarm Threshold	6 - 12 Vdc or 12 - 24 Vdc
Low Battery Pre-Alarm Delay	1 - 10 sec
Low Coolant Temperature Pre-Alarm Enable	On or Off
Low Coolant Temperature Pre-Alarm Threshold	50 - 100°F
Low Fuel Level Alarm Enable	On or Off
Low Fuel Level Alarm Threshold	0 - 100%
Low Fuel Level Pre-Alarm Enable	On or Off
Low Fuel Level Pre-Alarm Level	10 - 100%
Low Oil Pressure Arming Delay	5 - 15 sec
Low Oil Pressure Pre-Alarm Enable	On or Off
Low Oil Pressure Pre-Alarm Threshold	3 - 150 psi
Low Oil Pressure Alarm Enable	On or Off
Low Oil Pressure Alarm Threshold	3 - 150 psi
Maintenance Interval Pre-Alarm Threshold	0 - 5,000 hrs
Maintenance Interval Pre-Alarm Enable	On or Off
NFPA Level	0, 1, or 2
No-Load Cool-Down Delay	1 - 60 min
Number of Flywheel Teeth	50 - 500
Number of Crank Cycles	1- 7
Oil Pressure Sender Fail Alarm	Off or On
Overcurrent Pickup	0.18 - 1.18 Aac (style X1XX) 0.9 - 7.75 Aac (style X5XX)
Overcurrent Curve	A, B, C, D, E1, E2, F, G, I1, I2, L1, L2, M, S1, S2, V1, V2
Overcurrent Time Dial	0 - 30 s (F curve) 0 - 9.9 (all other curves)
Overcurrent Alarm Configuration	Pre-Alarm, Alarm, None
Overfrequency Time	0 - 30 s
Overfrequency Pickup	45 - 65 Hz (50/60 Hz sensing) 360 - 440 Hz (400 Hz sensing)
Overfrequency Alarm Configuration	Pre-Alarm, Alarm, None
Overspeed Alarm Threshold	105 - 140%
Overspeed Alarm Delay	0 - 500 msec
Overspeed Alarm Enable	On or Off
Overvoltage Time	0 - 30 s

Parameter	Setting Range
Overvoltage Pickup	70 -576 Vac
Overvoltage Alarm Configuration	Pre-Alarm, Alarm, None
Phase Imbalance Pickup	5 - 100 Vac
Phase Imbalance Time	0 - 30 s
Phase Imbalance Alarm Configuration	Pre-Alarm, Alarm, None
Pre-Alarm Buzzer Enable	Off or On
Pre-Crank Time Delay	0 - 30 sec
Pre-Start Contact after Disconnect	Off or On
Rated Engine rpm	750 - 3,600
Sender Failure Alarm Time Delay	1 - 10 sec
Single-Phase Override Sensing Configuration	A-B or A-C
Speed Signal Source	MPU, Gen Freq, or MPU-Gen
Speed Select	Primary/Secondary
Underfrequency Time	0 - 30 s
Underfrequency Inhibit	70 - 576 Vac
Underfrequency Alarm Configuration	Pre-Alarm, Alarm, None
Underfrequency Pickup	45 - 65 Hz (50/60 Hz sensing) 360 - 440 Hz (400 Hz sensing)
Undervoltage Pickup	70 - 576 Vac
Undervoltage Time	0 - 30 s
Undervoltage Alarm Configuration	Pre-Alarm, Alarm, None
Undervoltage Inhibit	20 - 400 Hz
Unit ID	1 - 247
Unit System	English or Metric
Weak Battery Voltage Pre-Alarm Threshold	4 - 8 Vdc or 8 - 16 Vdc
Weak Battery Voltage Pre-Alarm Delay	1 - 10 sec
Weak Battery Voltage Pre-Alarm Enable	On or Off

APPENDIX C • DGC-500 SETTINGS RECORD

INTRODUCTION

This appendix provides a complete list of DGC-500 settings. This list is provided in the form of a settings record that you can use to record information relative to your application. DGC-500 settings are organized in the following groups.

- Sensing Transformers
- System
- Cranking
- Pre-Alarms
- Alarms
- Generator Protection
- Serial Communication
- J1939 Interface
- Miscellaneous

DGC-500 SETTINGS RECORD

Genset ID _____ **Date** _____

DGC-500 Serial Number _____ **Firmware Version** _____

Sensing Transformer Settings

Parameter	Setting
Generator CT Primary Amps	
Generator PT Primary Volts	
Generator PT Secondary Volts	

System Settings

Battery Voltage	
Generator Connection	
Generator Frequency	
Generator kW Rating	
Generator Rotation	
NFPA Level	
No-Load Cool-Down Delay	
Number of Flywheel Teeth	
Rated Engine RPM	
Single-Phase Override Sensing Configuration	
Speed Signal Source	
Unit System	

Cranking Settings

Parameter	Setting
Crank Disconnect Limit	
Cranking Style	
Cycle Crank Time	
Pre-Crank Time Delay	
Pre-Start Contact after Disconnect	

Pre-Alarm Settings

Parameter	Setting
Battery Charger Failure Pre-Alarm Enable	
Battery Overvoltage Pre-Alarm Enable	
Battery Overvoltage Pre-Alarm Threshold	
Engine Maintenance Cycle Pre-Alarm Level	
Fuel Level Sender Failure Pre-Alarm Enable	
High Coolant Temperature Pre-Alarm Enable	
High Coolant Temperature Pre-Alarm Threshold	
Low Battery Pre-Alarm Delay	
Low Battery Voltage Pre-Alarm Enable	
Low Battery Voltage Pre-Alarm Threshold	
Low Coolant Temperature Pre-Alarm Enable	
Low Coolant Temperature Pre-Alarm Threshold	
Low Fuel Level Pre-Alarm Enable	
Low Fuel Level Pre-Alarm Level	
Low Oil Pressure Pre-Alarm Enable	
Low Oil Pressure Pre-Alarm Threshold	
Maintenance Interval Pre-Alarm Enable	
Maintenance Interval Pre-Alarm Threshold	
Pre-Alarm Buzzer Enable	
Weak Battery Voltage Pre-Alarm Delay	
Weak Battery Voltage Pre-Alarm Enable	
Weak Battery Voltage Pre-Alarm Threshold	

Alarm Settings

Parameter	Setting
Coolant Temperature Sender Fail Alarm Enable	
Coolant Temperature Sender Fail Alarm Delay	
Global Sender Failure Alarm Delay	
High Coolant Temperature Alarm Enable	
High Coolant Temperature Alarm Threshold	
Loss of Generator Voltage Alarm Enable	

Alarm Settings – Continued

Parameter	Setting
Low Fuel Level Alarm Enable	
Low Fuel Level Alarm Threshold	
Low Oil Pressure Alarm Enable	
Low Oil Pressure Alarm Threshold	
Oil Pressure Sender Fail Alarm	
Overspeed Alarm Delay	
Overspeed Alarm Enable	
Overspeed Alarm Threshold	
Sender Failure Alarm Time Delay	

Generator Protection Settings

Parameter	Setting
Overcurrent Pickup - 3 Phase	
Overcurrent Pickup - Single Phase	
Overcurrent Time Dial - 3 Phase	
Overcurrent Time Dial - Single Phase	
Overcurrent Curve - 3 Phase	
Overcurrent Curve - Single Phase	
Overcurrent Alarm Configuration - 3 Phase	
Overcurrent Alarm Configuration - Single Phase	
Overfrequency Alarm Configuration	
Overfrequency Time	
Overfrequency Inhibit	
Overvoltage Pickup - Single Phase	
Overvoltage Time - Single Phase	
Overvoltage Alarm Configuration - Single Phase	
Overvoltage Alarm Configuration - 3 Phase	
Overvoltage Pickup - 3 Phase	
Overvoltage Time - 3 Phase	
Phase Imbalance Pickup	
Phase Imbalance Alarm Configuration	

Parameter	Setting
Phase Imbalance Time	
Underfrequency Inhibit	
Underfrequency Time	
Underfrequency Pickup	
Underfrequency Alarm Configuration	
Undervoltage Inhibit - 3 Phase	
Undervoltage Pickup - 3 Phase	
Undervoltage Alarm Configuration - Single Phase	
Undervoltage Pickup - Single Phase	
Undervoltage Time - Single Phase	
Undervoltage Time - 3 Phase	
Undervoltage Inhibit - Single Phase	
Undervoltage Alarm Configuration - 3 Phase	

Communication Settings

Parameter	Setting
Baud Rate	
Parity	
Unit ID	

J1939 Interface

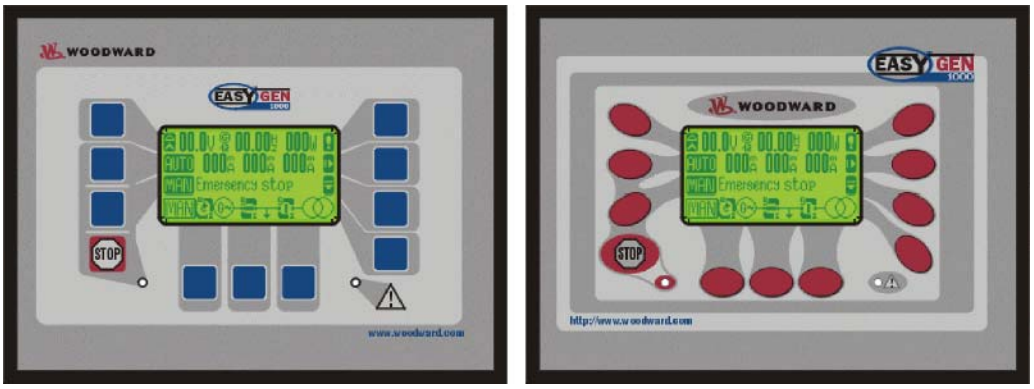
Parameter	Setting
ECU Support	
DTC Support	
CANBus Address	
Engine Start/Stop Configuration	
Speed Select	
Accelerator Position	
ECU Control Output Select	
ECU Pulsing	
Engine Shutdown Timer	
Settling Time	

Parameter	Setting
Pulse Cycle Time	
Response Timeout	

Miscellaneous Settings

Parameter	Setting
Accumulated Engine Runtime	
LCD Contrast	
Daylight Saving Time	

easYgen-1000
Genset Control



KATOLIGHT CORPORATION

Katolight Equivalent: KSGC-i

EASY GEN 1000

Operation
Software Version 1.0xxx

Manual 37181

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

Important definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

indicates a potentially hazardous situation that, if not avoided, could result in damage to equipment.

NOTE

Provides other helpful information that does not fall under the warning or caution categories.

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Chapter 1.
General Information

Linked documents

Type		English	German
easYgen-1000 Series			
easYgen-1000 - Installation		37203	GR37203
easYgen-1000 - Configuration		37204	GR37204
easYgen-1000 - Operation	this manual ⇨	37181	GR37181
easYgen-1000 - Application		37205	GR37205
easYgen-1000 - Interface		37262	GR37262
Additional Manuals			
IKD 1 - Manual		37135	GR37135
Discrete expansion board with 8 discrete inputs and 8 relay outputs that can be coupled via the CAN bus to the control unit. Evaluation of the discrete inputs as well as control of the relay outputs is done via the control unit.			
IKN 1 - Manual		37136	GR37136
20channel NiCrNi temperature scanner that monitors the temperature values for exceeding or falling below a threshold value, measured through senders on the IKN 1. A configured relay on the board of the IKN 1 will trip. The IKN 1 can be coupled with the control unit using the CAN bus to display measuring values as well as alarms.			
LeoPC - Manual		37146	GR37146
PC program for visualization, for configuration, for remote control, for data logging, for language upload, for alarm and user management and for management of the event recorder. This manual describes the use of the program.			
LeoPC - Manual		37164	GR37164
PC program for visualization, for configuration, for remote control, for data logging, for language upload, for alarm and user management and for management of the event recorder. This manual describes the programming of the program.			
GW 4 - Manual		37133	GR37133
Gateway for transferring the CAN bus to any other interface or bus.			
ST 3 - Manual		37112	GR37112
Control to govern the air fuel ratio of a gas engine. The ratio will be directly measured though a Lambda probe and controlled to a configured value.			

Table 1-1: Manual - Overview

Short description

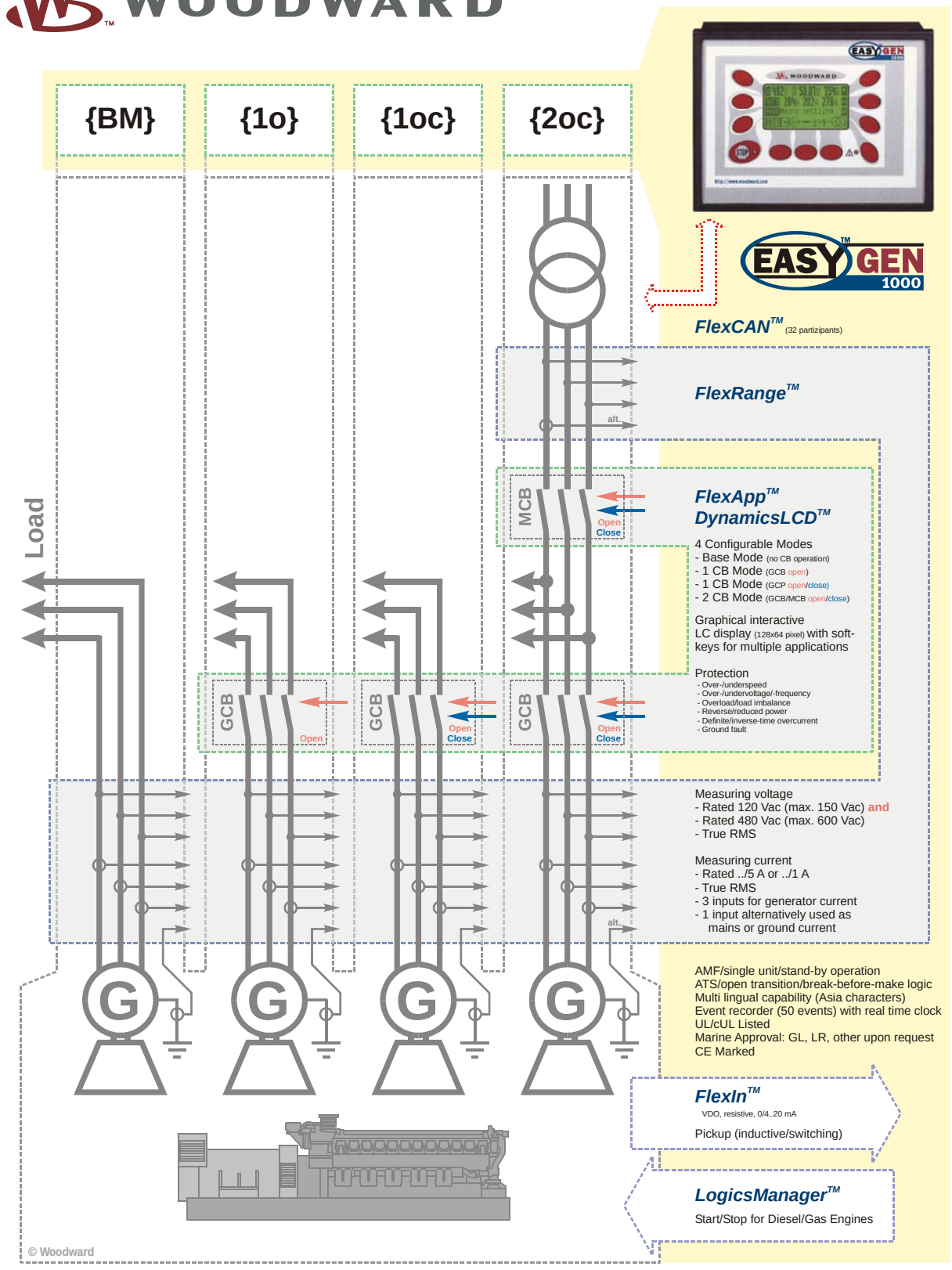
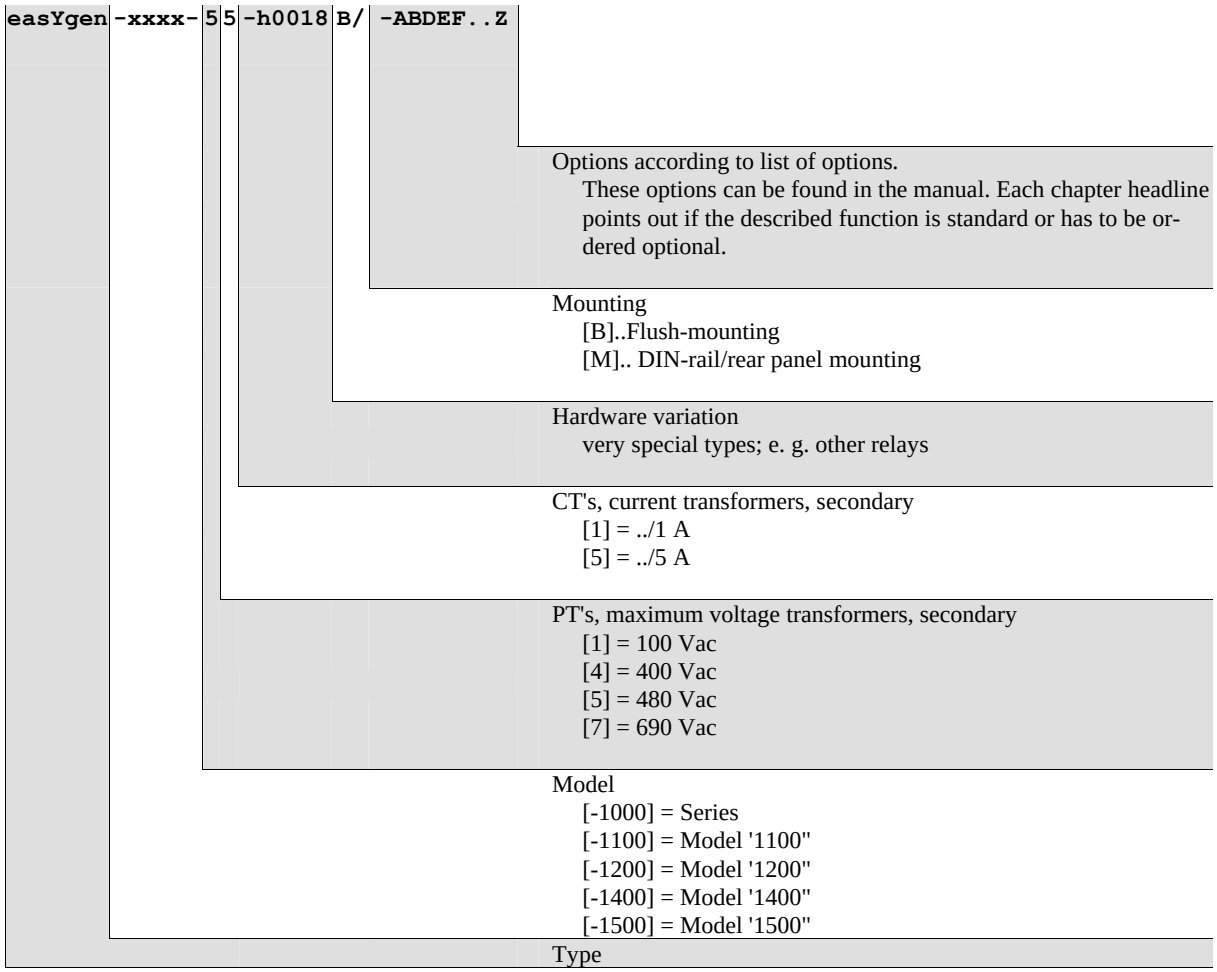


Figure 1-2: Functional overview

The easYgen-1000 Series generator set controllers provide the following functions:

- Gen-set control
- Engine and generator protection
- Engine data measurement -
  - including oil pressure and temperature, coolant temperature, battery voltage, speed, service hours, etc.
- Generator data measurement -
  - including voltage, current, power, kvar, kW, kWh, etc.
- Engine crank sequencing
- Alarm display with circuit breaker trip and engine shutdown
- AMF (automatic mains failure) standby genset control, with automatic engine start on a mains failure detection, with open transition breaker control
- CAN bus communications to engine controllers and plant management systems

Type designation is as follows:



Examples:
EASYGEN-1500-55B (standard unit, 120 & 480 Vac inputs, ../5 A measuring inputs, flush-mounting)
EASYGEN-1500-51B (standard unit, 120 & 480 Vac inputs,. ../1 A measuring inputs, flush-mounting)
EASYGEN-1400-55M (standard unit, 120 & 480 Vac inputs, ../5 A measuring inputs, DIN-rail mounting)
EASYGEN-1400-51M (standard unit, 120 & 480 Vac inputs,. ../1 A measuring inputs, DIN-rail mounting)

Intended Use The unit must only be operated according to the guidelines described in this manual. The prerequisite for a proper and safe operation of the product is correct transportation, storage, and installation as well as careful operation and maintenance.

NOTE

This manual has been developed for an unit fitted with all available options. Inputs/outputs, functions, configuration screens and other details described, which do not exist on your unit may be ignored.

The present manual has been prepared to enable the installation and commissioning of the unit. On account of the large variety of parameter settings, it is not possible to cover every possible combination. The manual is therefore only a guide. In case of incorrect entries or a total loss of functions, the default settings can be taken from the enclosed list of parameters.

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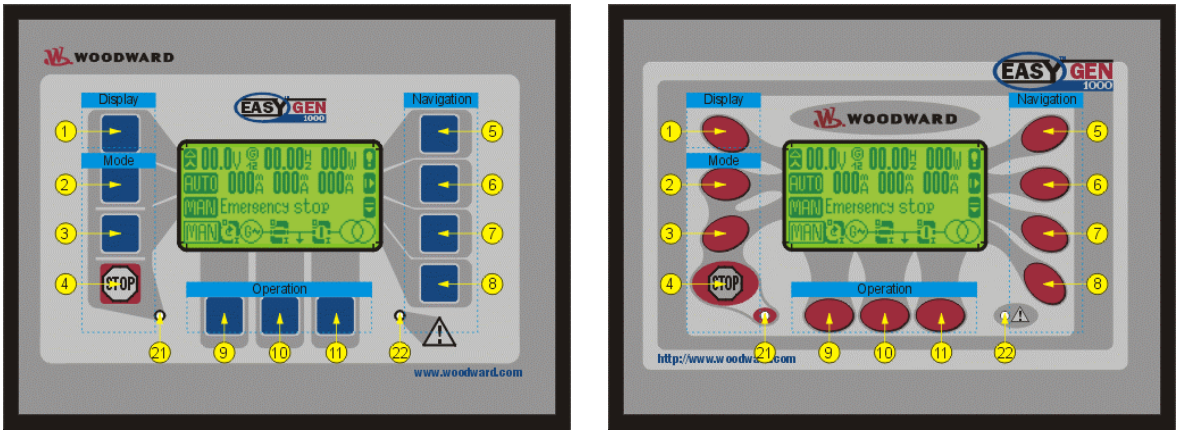
Chapter 2.
Navigation / Operation



easYgen-1000 "BLUE" easYgen-1000 "RED"

Figure 2-1: Front panel and display

Figure 2-1 illustrates the front panel/display which includes push buttons, LED's and the LC display. A short description of the front panel is given below.

NOTE

This push button is ALWAYS active and will stop the engine when pressed.

Fct.-block

Function blocks

Buttons that have the same function within one screen are grouped into function blocks. The function blocks are defined as:

Display..... Change the method of voltage and power calculations displayed (page 16).
Mode..... Change the mode of operation (page 18).
Operation.... Used to perform manual operation of the genset (page 19).
Navigation... Navigation between system and configuration screens, and alarm list (page 19).

1 2 3 4
5 6 7 8
9 10 11

Push buttons

The push buttons on the front panel are assigned to softkeys on the display. Each softkey is assigned to a function depending on the mode of operation.

20

LC display

The display contains softkeys, measuring values, modes of operation and alarms. The structure of the screens as well as the description are detailed in the "Navigation" chapter (page 10).

21 22

LED

The left LED indicates that the unit is in STOP mode. The right LED indicates that alarm messages are present in the unit.

Navigation

Figure 2-2 illustrates an overview for the navigation via the display. This demonstration will help the user through the menus and screens of the easYgen. The following and previous screens are marked in Yellow, the active screen is marked in Red. If submenus are present they are marked in Grey.

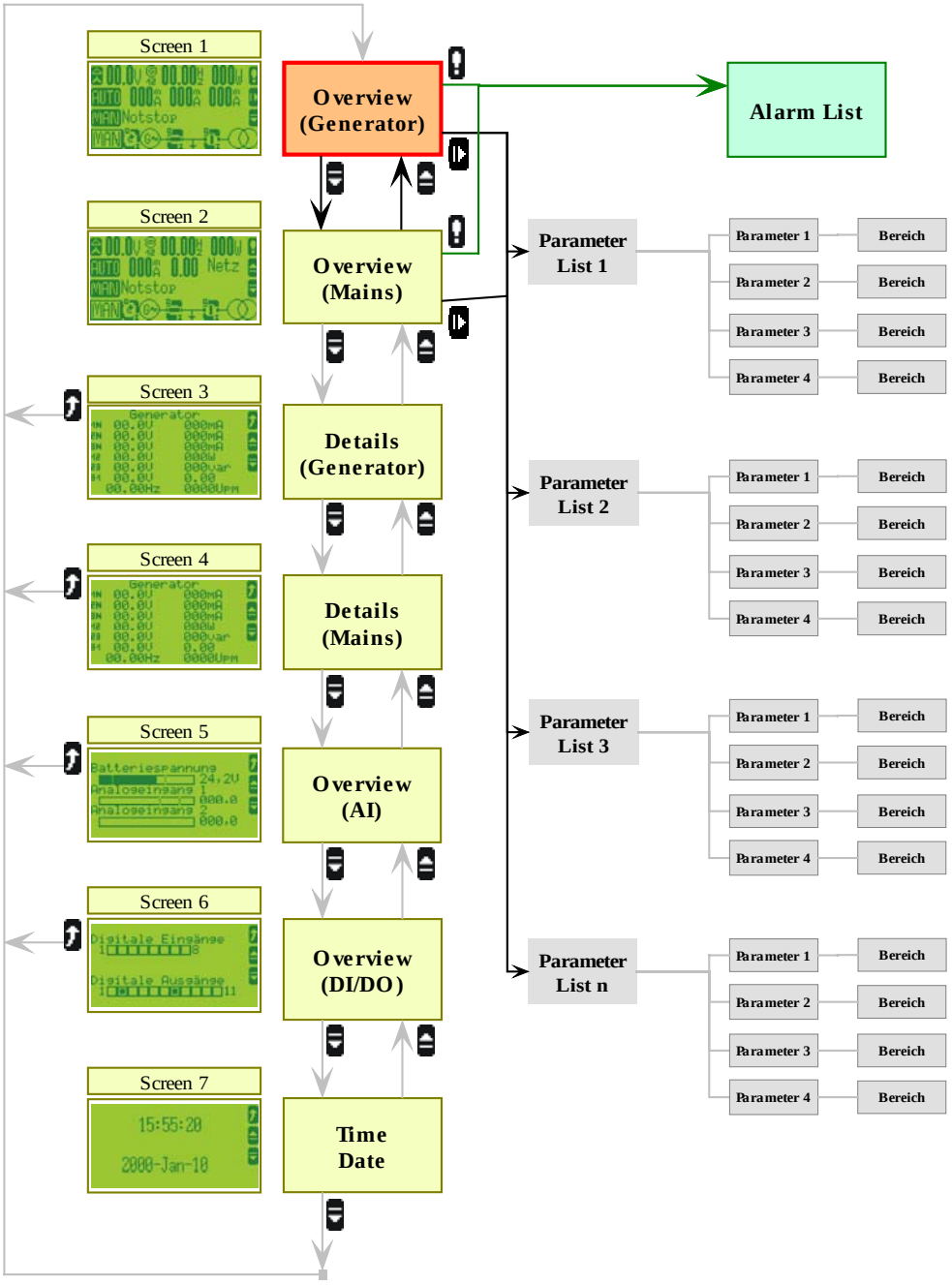
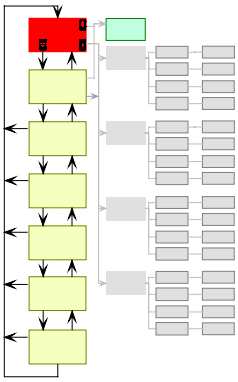


Figure 2-2: Screens and Menus - Overview

Screen "Generator values - overview" / "Starting screen" **[all application modes]**



This screen appears upon startup of the unit. The generator symbol (G) indicates that generator values are displayed.

Navigate to the next screen.

Display the parameters.

Switch the display of the generator voltages (between star and wye voltages).

Display the alarm messages (of the event recorder).

Operating mode MANUAL: start/stop engine.

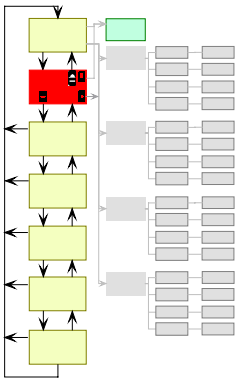
Operating mode MANUAL: GCB(/MCB) open/close.

Change into operating mode AUTOMATIC.

Change into operating mode MANUAL.

Change into operating mode STOP.

Screen "Mains values - overview" **[only application mode {2oc}]**



This screen appears after pressing the softkey once. The mains symbol (M) indicates that the mains measuring values are displayed.

Navigate to the next screen.

Navigate to the previous screen.

Switch the display of the mains voltages (between star and delta voltages).

Display the alarm messages (of the event recorder).

Operating mode MAN: start/stop engine.

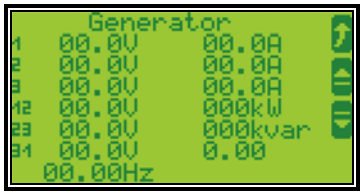
Operating mode MAN: GCB(/MCB) open/closed.

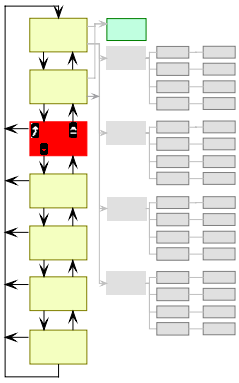
Change into operating mode AUTOMATIC

Change into operating mode MAN.

Change into operating mode STOP.

Screen "Generator values - Details" **[all application modes]**





This screen appears after pressing the softkey again. Here all measured values of the generator are displayed in one screen.

Navigate to the next screen.

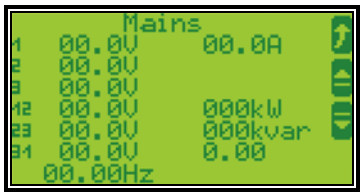
Navigate to the previous screen.

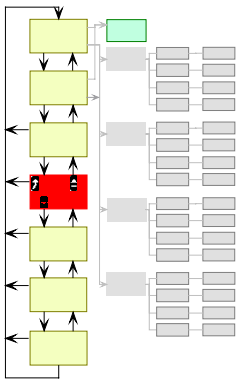
Jump to the start screen.

Change into operating mode STOP.

1 / **2** / **3**.....Generator voltages V_{L1N} / V_{L2N} / V_{L3N} and generator currents I_{L1} / I_{L2} / I_{L3}
12 / **23** / **31**....Gnerator voltages V_{L12} / V_{L23} / V_{L31}
00.00Hz.....Generator frequency
000kW.....Generator real power
000kvar.....Generator reactive power
0.00.....Generator power factor

Screen "Mains values - Details" **[only application mode {2oc}]**





This screen appears after pressing the softkey again. Here all measured values of the mains are displayed in one screen.

Navigate to the next screen.

Navigate to the previous screen.

Jump to the start screen.

Change into operating mode STOP.

1 / **2** / **3**.....Mains voltages V_{L1N} / V_{L2N} / V_{L3N} and mains current I_L
12 / **23** / **31**....Mains voltages V_{L12} / V_{L23} / V_{L31}
00.00Hz.....Mains frequency
000kW.....Mains real power
000kvar.....Mains reactive power
0.00.....Mains power factor

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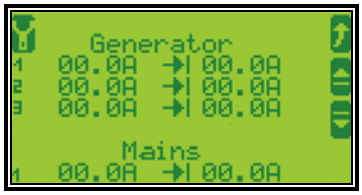
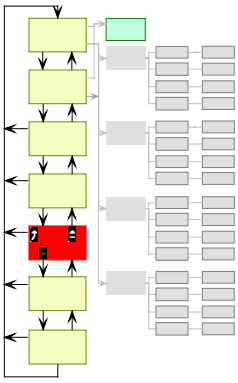
Screen "Slave pointer current" **[all operating modes]**





This screen appears after pressing the softkey again. Here the slave pointers (maximum currents) are displayed.

Navigate to the next screen.

Navigate to the previous screen.

Jump to the start screen.

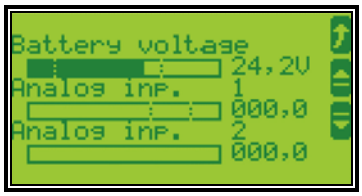
Left of the →| sign: Current value
Right of the →| sign: Maximum values (slave pointer)

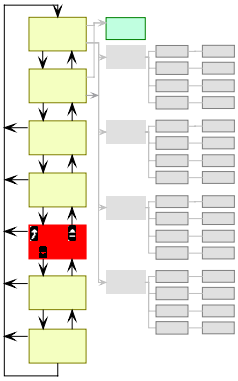
Change to configuration menu and reset the maximum values.

Change into operating mode STOP.

1 / **2** / **3** ..... Generator current I_{L1} / I_{L2} / I_{L3} and mains current I_L

Screen "Analog values - Details" **[all operating modes]**





This screen appears after pressing the softkey again. Here all analog measured values are displayed graphically and numerically.

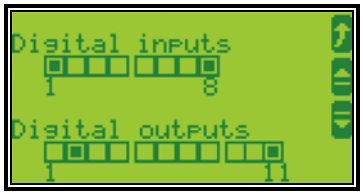
Navigate to the next screen.

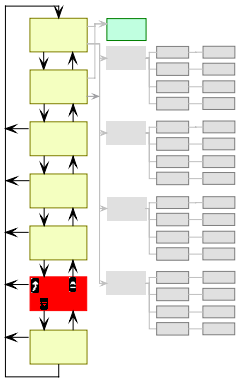
Navigate to the previous screen.

Jump to the start screen.

Change into operating mode STOP.

Screen "Discrete inputs / relay outputs – Status display" **[all application modes]**





This screen appears after pressing the softkey again. Discrete input and relay output status are displayed.

Navigate to the next screen.

Navigate to the previous screen.

Jump to the start screen.

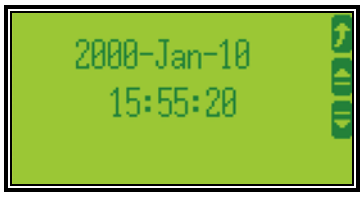
Change into operating mode STOP.

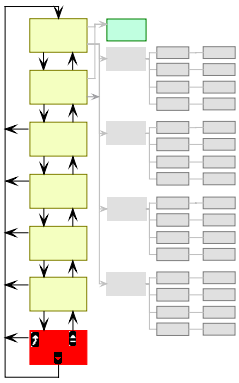
Status display of the discrete inputs and relay outputs.
(Note: Whether a discrete input or a relay output is currently physically closed or not, depends on the adjusted logic "NO/NC". This screen gives information whether the inputs/outputs are logically controlled.

The discrete input/the relay output is not set.

The discrete input/the relay output is set.

Screen "Time / Date" **[all operating modes]**





This screen appears after pressing the softkey once more. Here the time and date are displayed.

Navigate to the next screen

Navigate to the previous screen.

Jump to the start screen.

Change into operating mode STOP.

0000-XXX-00 - Date
0000 = Year
XXX = Month
00 = Day
00:00:00 - Time
00 = Hour
00 = Minute
00 = Second

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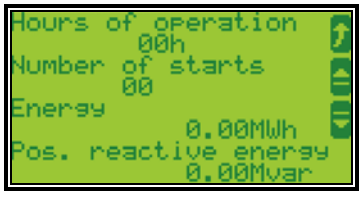
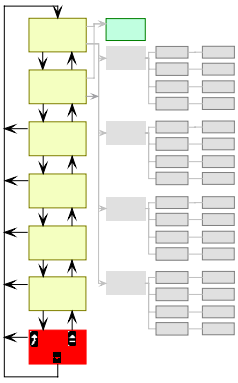
Screen "Counters" **[all operating modes]**





This screen appears after pressing the softkey once more. Here the counters are displayed.

Navigate to the next screen

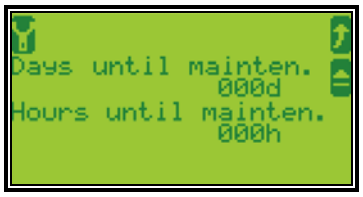
Navigate to the previous screen.

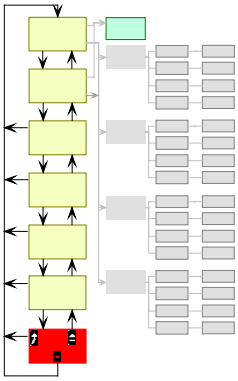
Jump to the start screen.

Change into operating mode STOP.

Hours of operation 00 h - Operating hours counter
00h = Total operating hours (hours in operation)
Number of starts 00 - Start counter
00 = Total number of starts
Energy 0.00 kWh - Generator real energy
0.00MWh = Total generator real energy
Pos. reactive energy 0.00 Mvar - Generator reactive energy
0.00Mvarh = Total generator reactive energy

Screen "Maintenance in ..." **[all operating modes]**





This screen appears after pressing the softkey once more. Here the remaining days/hours to the next maintenance call are displayed.

Navigate to the previous screen.

Jump to the start screen.

Change to configuration menu and reset the maximum values.

Change into operating mode STOP.

Days until mainten. 000d - Remaining maintenance days
000d = Once this days (plus the remaining maintenacnce hours) are exceeded the control will output an alarm message to maintain the genset. With finishing the maintenance the maintenance counters have to be reset.
Hours until maintenc. 000h - Remaining maintenance hours
000h = Once this hours (plus the remaining maintenacnce hours) are exceeded the control will output an alarm message to maintain the genset. With finishing the maintenance the maintenance counters have to be reset.

Operation

To illustrate values the display is partitioned into different levels which give a concentrated overview of all data.

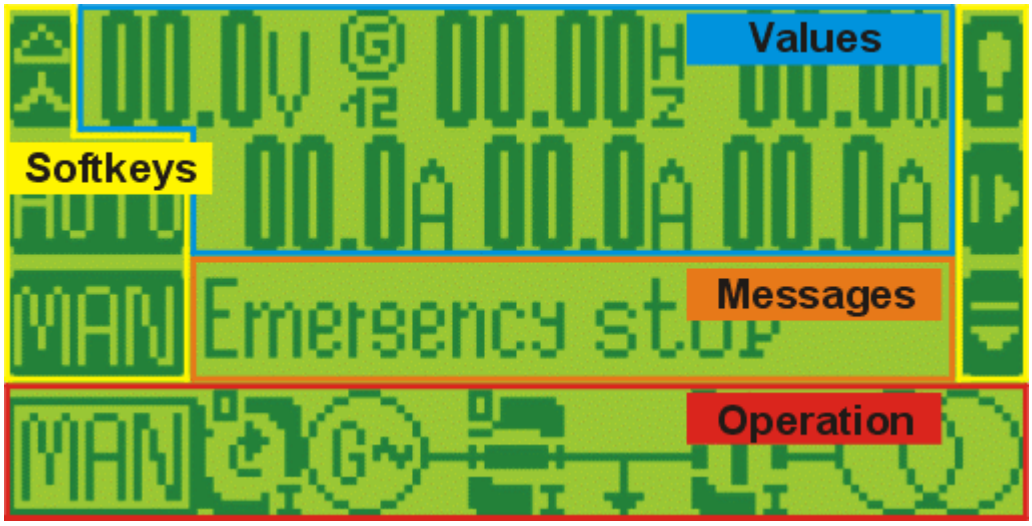
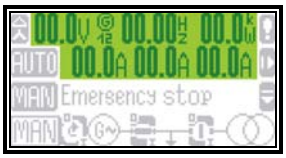


Figure 2-3: Screen - Level overview

"Values"

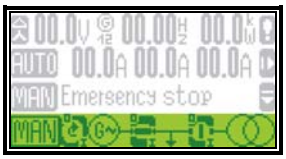


The "values" screen illustrates all power related information including voltages, frequencies, and power values.

"Messages"

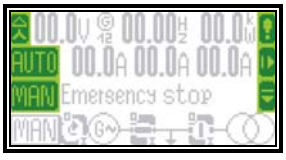
The "message" screen shows all active alarms and operations information.

"Operation"



The "operation" screen illustrates a one line diagram of the system application showing current status of the engine and power circuit breakers. This level is also used for manual operation of the genset.

"Softkeys"



The softkeys permit navigation between screens, levels and functions.

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Display

Softkey "Voltage display"

The voltage display softkey changes the type of power calculations displayed, line-line or line-neutral. The amount of information available from the system depends on the measuring type configured in the control. Table 2-4 illustrates what values are available depending on the configured measurement type.

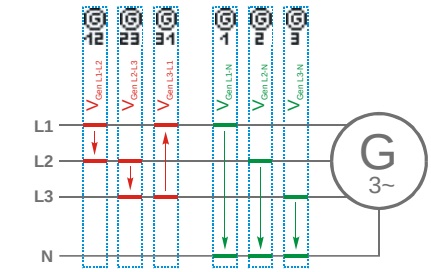
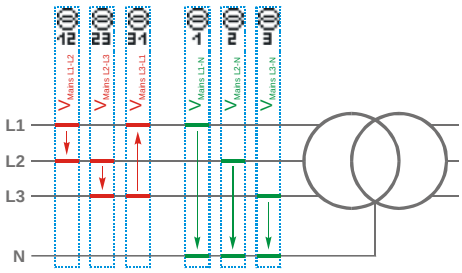
Selection of meas. point	Measuring point	Scroll display	Symbol of' the displayed voltage		Displayed at parameter setting Delta	Wye
0×	Generator 	0× (6×)	Delta	L1-L2	yes	yes
		1×	Delta	L2-L3	yes	yes
		2×	Delta	L3-L1	yes	yes
		3×	Wye	L1-N	---	yes
		4×	Wye	L2-N	---	yes
		5×	Wye	L3-N	---	yes
1×	Mains 	0× (6×)	Delta	L1-L2	yes	yes
		1×	Delta	L2-L3	yes	yes
		2×	Delta	L3-L1	yes	yes
		3×	Wye	L1-N	---	yes
		4×	Wye	L2-N	---	yes
		5×	Wye	L3-N	---	yes

Table 2-4: Display - Measuring values

Mode

Softkeys "Mode"

By pressing the push buttons AUTO, MAN or STOP the operating mode is selected. Corresponding to the selected application mode different softkeys are activated or deactivated on the display. Furthermore in a engine symbol the selected operating mode is displayed. If the operation mode STOP is selected the LED right beside the push button flashes.

Operating mode STOP

When STOP is selected, the engine is stopped.

Operating mode AUTOMATIC

When AUTOMATIC is selected all engine start/stop functionality and circuit breaker

Operating mode MANUAL

When MANUAL is selected, all engine and breaker control is performed manually via softkeys.

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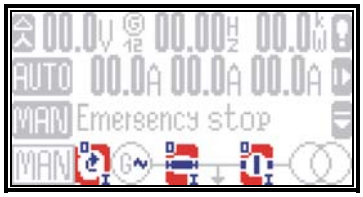
Operation

Softkeys "Mode"



If the unit is in operating mode MANUAL the softkeys are activated for manual operation of the engine and the power circuit breakers. The symbols "0" and "I" indicate additional actions that are processed at the moment.

Engine Start/Stop

Starting process: By pressing this push button the engine is started.
- Successful: If the starting process was successful, the arrow turns within this softkey and the "I" within this softkey lights up.
- Unsuccessful: If the starting process was not successful, the "I" will flash.

Stop process: Pressing the softkey again will stop the engine.
- Successful: If the stop process was successful, the "0" is displayed solidly and the rotating arrow disappears.
- Unsuccessful: If the engine cannot be stopped, the arrow continues to turn and the "0" flashes.

Power circuit breaker open/close (GCB/MCB)

Close: By pressing this push button the circuit breaker is closed.
- Successful: If the closing process was successful, the breaker symbol rotates horizontal and the "I" lights within this softkey.
- Unsuccessful: If the closing process was not successful, the breaker symbol remains vertical and the "I" will flash.

Open: To open this breaker this softkey is pressed as well.
- Successful: If the opening process was successful, the "0" is lit and the breaker symbol rotates vertical.
- Unsuccessful: If the breaker cannot be opened, the breaker symbol remains horizontal and the "0" flashes.

Navigation

Softkeys "Navigation"

For navigation between the main screens the softkeys displayed in the right section are used. The softkeys are assigned with different functions.

Alarm list / read alarm memory

If alarms have occurred during operation this softkey appears. By pressing this softkey the alarm list is called up.

Leave current screen ("Escape" / "ESC")

By pressing this softkey you change from the current screen into the above level. If the Escape key is used to leave the configuration mode any changes made will not be stored.

Changing screen levels

These push buttons are used to switch between screen levels.

Activate configuration mode

To activate configuration mode this softkey is used to enter the configuration menu.

Navigation within the configuration

These push buttons scroll between parameters forward or backward, navigate the cursor position within a parameter, increase or decrease the current digit of the parameter or confirm the modifications.

Increase/decrease display contrast

In the menu "display contrast" these softkeys can be used to increase or decrease the contrast of the display. If the contrast was reduced so much that the display can no longer be seen, press the STOP push button for at least 5 seconds. The contrast will be reset to the standard value.

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Chapter 3.
Functional Description

Overview

	Application Mode							
	{BM}		{1o}		{1oc}		{2oc}	
Operation Mode	MAN	AUTO	MAN	AUTO	MAN	AUTO	MAN	AUTO
Operate the engine								
• Start engine by ...								
... the push buttons (Softkeys)	YES	---	YES	---	YES	---	YES	---
... the discrete inputs	---	YES	---	YES	---	YES	---	YES
... the automatic (emergency power)	---	---	---	---	---	---	---	YES
... the CAN bus	---	YES	---	YES	---	YES	---	YES
• Stop engine by ...								
... the push buttons (STOP push button)	YES	YES	YES	YES	YES	YES	YES	YES
... the push buttons (Softkeys)	YES	---	YES	---	YES	---	YES	---
... the discrete inputs	---	YES	---	YES	---	YES	---	YES
... the automatic (emergency power)	---	---	---	---	---	---	---	YES
... the CAN bus	---	YES	---	YES	---	YES	---	YES
... an alarm	YES	YES	YES	YES	YES	YES	YES	YES
Operate GCB								
• close GCB								
... the push buttons (Softkeys)	---	---	---	---	YES	---	YES	---
... the discrete inputs	---	---	---	---	---	YES	---	YES
... the automatic (emergency power)	---	---	---	---	---	---	---	YES
... the CAN bus	---	---	---	---	---	YES	---	YES
... an alarm (e.g. MCB failure)	---	---	---	---	---	---	---	YES
• open GCB								
... the push buttons (STOP push button)	YES	YES	YES	YES	YES	YES	YES	YES
... the push buttons (Softkeys)	---	---	YES	---	YES	---	YES	---
... the discrete inputs	---	---	---	YES	---	YES	---	YES
... the automatic (emergency power)	---	---	---	---	---	---	---	YES
... the CAN bus	---	---	---	YES	---	YES	---	YES
... an alarm	---	---	YES	YES	YES	YES	YES	YES
Operate MCB								
• open MCB								
... the push buttons (Softkeys)	---	---	---	---	---	---	YES	---
... the discrete inputs	---	---	---	---	---	---	---	YES
... the automatic (emergency power)	---	---	---	---	---	---	---	YES
... the CAN bus	---	---	---	---	---	---	---	YES
... an alarm	---	---	---	---	---	---	YES	YES
• close MCB								
... the push buttons (Softkeys)	---	---	---	---	---	---	YES	---
... the discrete inputs	---	---	---	---	---	---	---	YES
... the automatic (emergency power)	---	---	---	---	---	---	---	YES
... the CAN bus	---	---	---	---	---	---	---	YES
... an alarm	---	---	---	---	---	---	---	YES

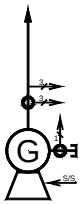
Table 3-1: Functional description - Overview

- **Application Mode** (page 22): depends on the application; defines the number/function of the breakers ({BM}, {1o}, {1oc}, {2oc}).
- **Operating Mode** (page 23): depends on the application; separates between STOP, MANUAL and AUTOMATIC.

Application modes

The application mode can be changed only during configuration with the correct passwords. The most important features of the four application modes are illustrated in the following chapters. The exact description of the functions that are possible during each application mode can be found in the configuration manual (manual 37204). Table 3-1: Functional description - Overview describes which function is available in each application mode.

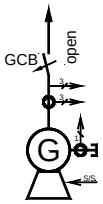
Application mode {BM} - Basic Mode



This application mode provides the following functions:

- the operation of the engine (start/stop) and/or
- the measuring and display of values.

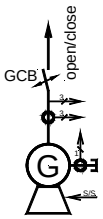
Application mode {1o} – 0 CB mode



Additionally to the application mode {BM} the following functions are possible:

- monitoring of selected values and protection of the generator and the engine as well as
- opening the GCB.

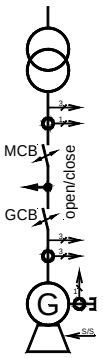
Application mode {1oc} – 1 CB mode



Additionally to the application mode {1o} the following functions are possible:

- closing the GCB and
- deadbus test logic.

Application mode {2oc} – 2 CB mode



Additionally to the application mode {1oc} the following functions are possible:

- operating the MCB (open/close) and
- emergency power (AMF automatic mains failure) operation.

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Operating modes

Operating mode STOP

NOTE

Selecting the operating mode STOP is not the same as an EMERGENCY STOP. In some cases the easYgen will perform additional logic before the engine is stopped. An EMERGENCY STOP discrete input can and should be programmed as a class F alarm.

In the operating mode STOP neither the engine nor any switch can be operated. Dependent on the application mode the engine and the power circuit breakers can not be operated. If the operating mode STOP has been selected while

the engine was already stopped

- the GCB will not be closed.
- The fuel solid relay will not be closed.
- The discrete inputs and CAN bus commands are ignored.
- The push buttons (softkeys) are disabled (depending on the previous operating mode).
- The engine/generator monitoring remains de-activated (exception: all monitoring that is not delayed by the delayed engine speed monitoring).

the engine was running

- The GCB is opened.
  Requirements:
  - The easYgen is at least in application mode {1o} and
  - the GCB is closed.
- The MCB will be closed.
  Requirements:
  - The easYgen is at least in application mode {2oc},
  - the GCB is open,
  - the MCB is enabled and
  - the parameter "close MCB in STOP modus" is configured to YES.
- An engine cooldown will be proceeded.
- The fuel solid relay will be opened.
- The engine/generator monitoring will be de-activated (exception: all monitoring that is not delayed by the delayed engine speed monitoring).
- The screen follows the operating conditions.

Operating mode MANUAL

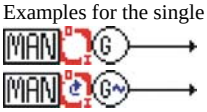
In the operating mode MANUAL (softkey "MAN") the engine and the power circuit breakers are operated via the push buttons in the display (softkeys). All elements that can be operated via the softkeys have a black edge (). All other elements cannot be operated. The single line diagram in the lowest line will change according to the application mode.

The single line diagrams are displayed as follows:

Single line diagram for application mode {BM}.
When operating mode MANUALU is selected a black outline softkey will appear around the engine to indicate that the push buttons below this softkey can be used to start and stop the engine. This is shown below as well highlighted in red for the following functions.

- Start the engine or
- stop the engine.

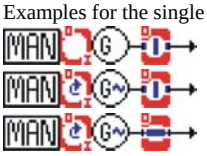
Examples for the single line diagrams



Single line diagram for application mode {1o}.
For a {1o} application both the engine and the GCB softkeys appear with the following functions.

- Start the engine,
- stop the engine or
- open the GCB.

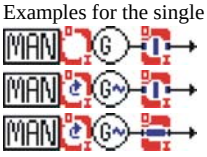
Examples for the single line diagrams



Single line diagram for application mode {1oc}.
For a {1oc} application both the engine and the GCB softkeys appear with the following functions.

- Start the engine,
- stop the engine,
- open the GCB or
- close the GCB.

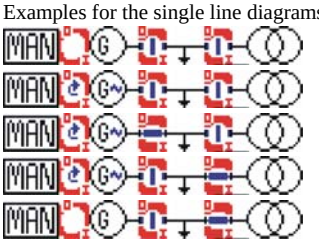
Examples for the single line diagrams



Single line diagram for application mode {2oc}.
For a {2oc} application both the engine, the GCB and the MCB softkeys appear with the following functions.

- Start the engine,
- stop the engine,
- open the GCB,
- close the GCB,
- open the MCB or
- close the MCB.

Examples for the single line diagrams



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Operating mode AUTOMATIC

In the operating mode AUTOMATIC, all engine, GCB and/or MCB are operated either via the discrete inputs, via the CAN bus or automatically (e.g. in case of a mains failure). The function of the easYgen depends on the configuration of the unit and how the external signals are used. The start start /stop sequence of the engine is described in more detail in manual 37204.

In the following the main functions are briefly described.

START ENGINE

Remote start
The engine is started via a remote start signal.

A discrete input start requires.

- The operating mode is set to AUTOMATIC.
- The function "start in AUTO" is assigned via the *LogicsManager* to a discrete input and the conditions are fulfilled (TRUE).
- This discrete input is set (logically HIGH signal).
- No alarms of alarm class C or higher are present (for explanation of the alarm classes please note the manual 37204).
- The engine is ready for operation.
- The GCB (application mode {1o} and higher) is open.

A CAN bus start requires.

- The operating mode is set to AUTOMATIC.
- The necessary CAN bus command of the interface protocol is set (for explanation of the interface protocol please note manual 37204).
- No alarms of the alarm class C or higher are present (for explanation of the alarm classes please note manual 37204).
- The engine is ready for operation.
- The GCB (application mode {1o} and higher) is open.

Mains fault

AMF / Auto mains failure operation (only in application mode {2oc})
If the operating mode set to AUTOMATIC and the application mode is configured to {2oc} (2-breaker logic) and the mains fails, the engine and the power circuit breakers will be operated according to the conditions in the following table.

An AMF start requires.

- The operating mode is set to AUTOMATIC.
- The application mode is set to {2oc}.
- The parameter "Emergency power" is configured to ON.
- The configured mains failure limits are reached.
- The configured delay times are expired.
- No alarms of alarm class C or higher are present (for explanation please note manual 37204).
- The engine is ready for operation.

Status (prior to mains failure)			**Action** (order)		
Engine	**GCB**	**MCB**	**Engine**	**GCB**	**MCB**
0 (stands still)	**0** (open)	**0** (open)	**1** (start)	**2** (close)	---
	0 (open)	**1** (closed)	**1** (start)	**3** (close)	**2** (open)
1 (runs)	**0** (open)	**0** (open)	---	**1** (close)	---
	0 (open)	**1** (closed)	---	**2** (close)	**1** (open)
	1 (closed)	**0** (open)	---	---	---

Table 3-2: Functional description - AMF conditions

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Chapter 4.
Configuration

This chapter provides information "how to configure the unit via the LC display" as well as the description of all parameters that can be changed without password. If you have the right codes to configure the unit (this is verified via passwords) please note manual 37204 for detailed information. Manual 37204 describes all parameters, their setting range and their influence to the operation of the unit.

Structure of the parameters

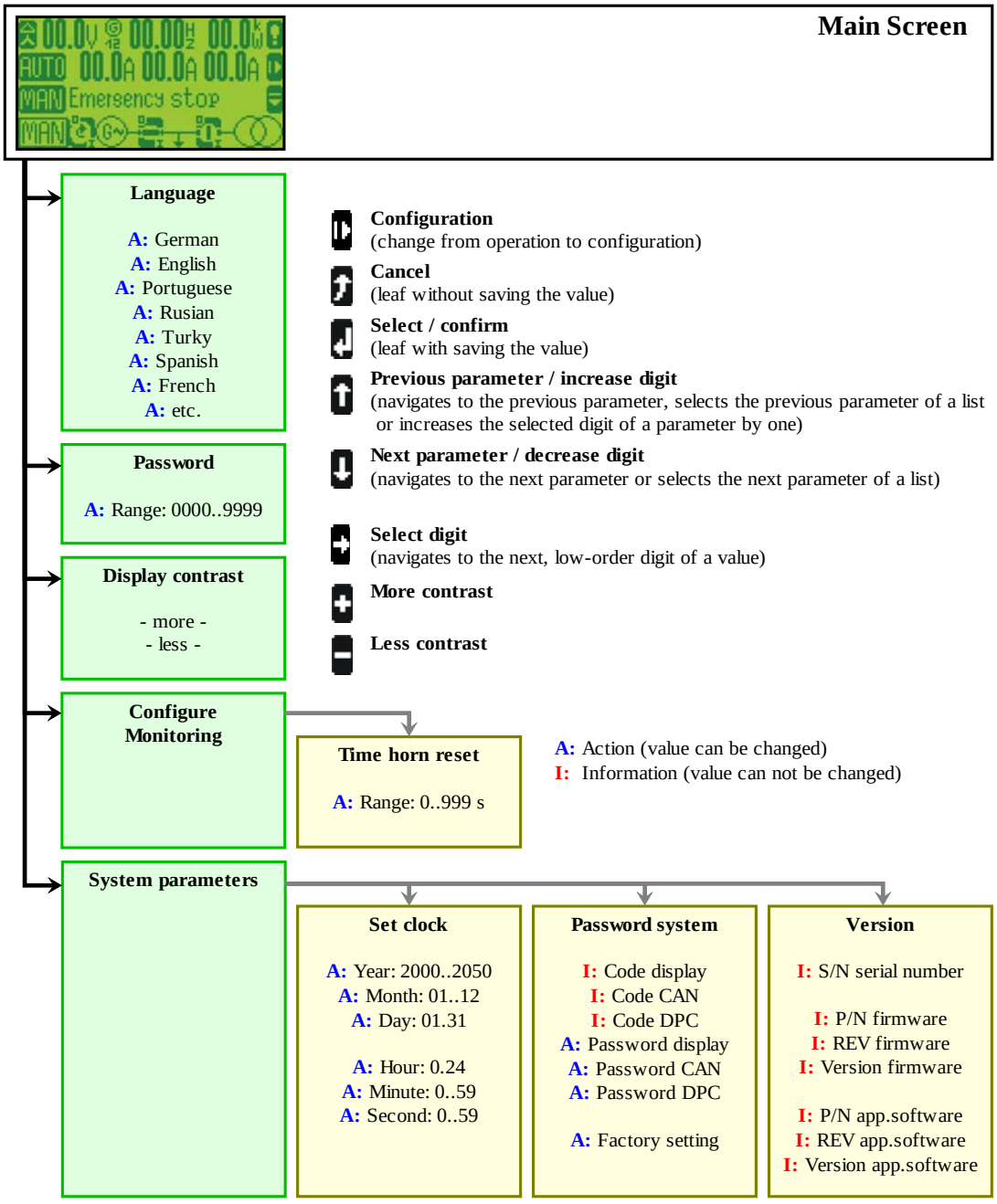

Figure 4-1: Configuration screens (overview)

Change into configuration

To change into configuration please press ▶ in the main screen. Afterwards the list with all parameters gets visible.

Softkeys "Configuration - select parameter"

Navigation through the parameters is carried out using the softkeys ↓ and ↑. To edit the selected parameter press ↵. To save the edited parameter press ↵. To cancel without saving the changes press ESC.

Jump into the display modus (start screen); escape without saving the changes ("Escape")

Navigate ..... Pressing this softkey changes into the screen with measuring values and messages. If you are within a deep level of the configuration menu this softkey navigates you back one level.

Edit ..... If you wish to cancel WITHOUT saving a parameter that has been changed using ↓ or ↑ press this softkey. This softkey also changes from editing to navigation.

Next parameter; increase value

Navigate ..... This softkey navigates to the next parameter (downwards). You only can see/edit that parameters you have access to (verified via passwords). Parameters that require a higher password level are not possible to select. The description of the parameters where no password is required are decribed within this manual further below.

Edit ..... If you have selected the parameter via ↵ and the position you want to change via → or ←, the value of this digit is reduced via ↓ step by step.

Previous parameter, reduce digit

Navigate ..... These push buttons navigate within the parameter list forwards / backwards.

Edit ..... If you have selected the parameter via ↵ and the position you want to change via → or ←, the value of this digit is raised ↑ step by step.

Select parameter, input confirmation ("Enter")

Navigate.....Just as you press this softkey, the highlighted parameter which you have selected before, is for changing written into the lowest line of the screen. There it can be changed accordingly.
Edit.....If you have changed a value, it will be accepted by this button.

Next digit of the selected parameter

If the digits of a parameter can be changed singly (e.g. the password) this softkey is active and the navigation between the digits in direction of the low-order digits / to the right is possible (the selected digit can be changed by oder or saved by).

Previous digit of the selected parameter

Identical equal to but the navigation in direction of the high-order digit / to the left.

Parameters

NOTE

The description of the configuration and of all parameters which can be edited via the display are described in manual 37204.

Language

EN	Language
DE	Language
PT	Language
RU	Language
TU	Language
SP	Language
FR	Language

Change language **{Language}**

{Language}..All texts are monitored in the selected language. This concerns the following texts:

- Texts in operating mode which are not lodged by definition of an input (so e.g. discrete inputs can be lodged with a name),
- Texts of the event logging,
- Parameter which can be changed over the display.

Password

EN	Password
DE	Passwort
PT	Senha
RU	Пароль
TU	Şifre
SP	Consigna
FR	Code d'accès

Password for access via the LCD **0000..9999**

Enter the password for the configuration for this type of access. If you do not enter a password only the displayed parameters can be edited. All other parameters and their desciption can be found in the manual 37204.

Display contrast

EN	Change display contrast
DE	Displaykontrast ändern
PT	Contraste da tela
RU	Изменение контраста дисплея
TU	Kontrastı değiştir
SP	Cambiar contraste pantalla
FR	Config. contraste affichage

Change display contrast + / -

In menu "display contrast" you increase or reduce the display contrast with these softkeys.

+ ..... Increase the display contrast.
- ..... Reduce the display contrast.
STOP ..... If you have changed the display contrast until you cannot see anything on the display, press the STOP button for at least 5 seconds. Then the contrast will be reset onto the standard value.

Acknowledgement of centralized alarm

EN	Time until horn reset
DE	Zeit Hupenreset
PT	Tempo de sirene ativa
RU	Время откл. сирены
TU	Kornayı kes zamansüresi
SP	Tiempo sirena
FR	Durée alarme sonore avant reset

Self acknowledgement of the centralized alarm **0..1.000 s**

After a new alarm has occured the alarm LED flashes and the centralized alarm is issued. After this time has run off the flashing LED changes into a steady light andthe centralized alarm is reset.

Real-time clock - time

EN	Hour
DE	Stunden
PT	Horas
RU	Часы
TU	saat
SP	Horas
FR	Heure

Adjust clock time: hour **0..23**

The current hour of the clock time is set here. Example:
0 ..... 0th hour of the day.
23 ..... 23rd hour of the day.

EN	Minute
DE	Muniten
PT	Minutos
RU	Минуты
TU	dakika
SP	Minutos
FR	Minute

Adjust clock time: minute **0..59**

The current minute of the clock time is set here. Example:
0 ..... 0th minute of the hour.
59 ..... 59th minute of the hour.

EN	Second
DE	Sekunden
PT	Segundos
RU	Секунды
TU	saniye
SP	Segundos
FR	Seconde

Adjust clock time: second **0..59**

The current second of the clock time is set here. Example:
0 ..... 0th second of the minute.
59 ..... 59th second of the minute.

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Real-time clock - date

EN	Day
DE	Tag
PT	Dia
RU	День
TU	gün
SP	Día
FR	Jour

Adjust date: day **1..31**

The current day of the date is set here. Example:
1.....1st day of the month.
31.....31st day of the month.

EN	Month
DE	Monat
PT	Mês
RU	Месяц
TU	ay
SP	Mes
FR	Mois

Adjust date: month **1..12**

The current month of the date is set here. Example:
1.....1st month of the year.
12.....12th month of the year.

EN	Year
DE	Jahr
PT	Ano
RU	Год
TU	yıl
SP	Año
FR	Année

Adjust date: year **0..99**

The current year of the date is set here. Example:
0.....Year 2000.
99.....Year 2099.

Code levels

EN	Code level display
DE	Codeebene Display
PT	Nível senha display
RU	Код. уровень дисплей
TU	Kodseviye Ekran
SP	Nivel consigna pantalla
FR	Niv. code affichage

Code level via LCD **Info**

This value displays the code level which is currently selected for the access via the LCD.

EN	Code level CAN port
DE	Codeebene CAN Schnittstel.
PT	Nível senha CAN
RU	Код.уровень CAN интерфейс
TU	Kodseviye CAN ara birim
SP	Nivel consigna interfaz CAN
FR	Niv. code interfaceCAN

Code level via CAN-Bus **Info**

This value displays the code level which is currently selected for the access via the CAN bus.

EN	Code level serial
DE	Codebene serielle Schnittstel
PT	Nível senha RS232
RU	Код.уров.послед. интерфейс
TU	Kodseviye seriel ara birim
SP	Niv.consigna interf. RS232/DPC
FR	Niv. code interface serielle

Code level via serial RS232 (DPC) interface **Info**

This value displays the code level which is currently selected for the access via the serial RS232 (DPC) interface.

Password

EN	Password
DE	Passwort
PT	Senha
RU	Пароль
TU	Şifre
SP	Consigna
FR	Code d'accès

Password for access via the LCD **0000..9999**

Enter the password for the configuration for this type of access. If you do not enter a password only the displayed parameters can be edited. All other parameters and their desciption can be found in the manual 37204.

EN	Password CAN
DE	Passwort CAN
PT	Senha CAN
RU	Пароль CAN
TU	Şifre CAN
SP	Consigna CAN
FR	Code d'accès CAN

Password for access via the CAN **0000..9999**

Enter the password for the configuration for this type of access. If you do not enter a password only the displayed parameters can be edited. All other parameters and their desciption can be found in the manual 37204.

EN	Password RS232
DE	Passwort RS232
PT	Senha RS232
RU	Пароль RS232
TU	Şifre RS232
SP	Consigna RS232/DPC
FR	Code d'accès RS232

Password for access via the DPC **0000..9999**

Enter the password for the configuration for this type of access. If you do not enter a password only the displayed parameters can be edited. All other parameters and their desciption can be found in the manual 37204.

Factory (default) values

EN	Factory settings
DE	Werkseinstellung
PT	Configuração deusina
RU	Завод. параметры
TU	Fabrika değerler
SP	Configuración de fábrica
FR	Parametres d'usine

Factory setting **YES/NO**

The factory settings (default values) can be loaded. Select YES to enable the following screen to be displayed. It is possible to load the factory settings (default values) for all displayed parameters.

EN	Set default values
DE	Standardwerte
PT	Valores padrão
RU	Стандарт. параметры
TU	Standart değerler
SP	Valores por defectro
FR	Valeurs standards

Set default values **YES/NO**

Entering YES overwrites the currently configured values with the default values.

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Appendix A.
Messages

Status messages

Message in the display	Meaning
Aux.serv.prerun	**Prerun of the auxiliary operation is active** Before the engine is started the signal "aux. services prerun" is set, so that all necessary facilities which are necessary for the operation of the engine can be initialized, started or switched.
Preglow	**Preglow the engine is active** {Diesel engine} The diesel engine is preheated before starting.
Turning	**Purging operation is active** {Gas engine} Before the gas valve opens and the ignition of the gas engine is switched, the remaining gas which could be still in the engine, will be removed by a purging operation. Thereto the engine is turned without ignition by the starter for a specified time. After the purging process the gas valve is opened and the ignition is switched.
Ignition	**Switch on the ignition** {Gas engine} After the purging operation and before the gas valve is opened and before starting the ignition is switched on.
Start	**Start engine is active** After the expiration "Prerun auxiliary operation" the engine is started according to the configured start sequence (Diesel or gas engine). Thereto different relays are set, resp. signals are passed via the CAN bus to a secondary engine control.
Start - Pause	**Start pause while starting the engine is active** The engine could not be started. Before the next start attempt this pause is active.
Crank protect	**Starter protection** To prevent that the starter is destroyed by a turning engine, this time is awaited before a new start, so that the engine can come into idleness.
Cool down	**Coasting of the engine is active** The no load operation of the engine before its stopping is active. Additional the remaining time in no load operation is monitored. The no load operation is used for cooling of the engine.
Aux. services	**Coasting of the auxiliary operation is active** Before the finally stop of the engine the signal "Coasting auxiliary operation" is further sustained, so that all necessary facilities which are necessary for operation of the engine, keep running, e.g.to cool the engine.
Stop engine	**Engine has been stopped.** The engine has been stopped, i.e. that neither speed nor generator frequency is measured/detected. This message is monitored as finalization of the stop process.

Message in the display	Meaning
GCB dead bus cls	**Black start of the GCB** {1oc}, {2oc} The GCB is switched to the de energized busbar. This is released either by absence of the MCB (operation mode {1oc}) or by "Reply: MCB is open". Please attend: If the busbar is actually de-energized, cannot be ascertained. Therefore take guarantee during the commissioning that no other participant can feed into the same busbar.
MCB dead bus cls	**Black start of the MCB** {2oc} The MCB is switched to the de energized busbar. This is released by the "Reply: GCB is open". Please notice Please attend: If the busbar is actually de-energized, cannot be ascertained. Therefore take guarantee during commissioning that no other participant can feed into the same busbar.
Emergency run	**Emergency power operation** {2oc} After recognizing a mains fault and after the expiry of the emergency delay time the engine is either started (or at least not stopped). After that the GCB is opened and the MCB is closed. The supply of the load occurs over the generator.
Mains settling	**Mains settling time is active** {2oc} After a mains fault and after its return the genset remains for a defined time in isolated operation, i.e. for the time the mains settling time is running. If the mains is stable after the expiration of this time (the mains voltage is during this time not fallen below or risen over the adjusted monitoring limits), after the expiration of the mains settling time the change from generator supply to mains supply occurs.
Critical mode	**Critical mode (Sprinkler operation) is active** The sprinkler operation is activated. The exact description of the conditions and effects of the sprinkler operation are described in manual 37204.

Alarm messages

Message in the display	Meaning
Overvoltage lev.1	**Generator overvoltage, limit value 1** The generator voltage has exceeded the limit value 1 for generator overvoltage for at least the indicated time and did not yet fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overvoltage lev.2	**Generator overvoltage, limit value 2** The generator voltage has exceeded the limit value 2 for generator overvoltage for at least the indicated time and did not yet fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Undervoltage lev.1	**Generator undervoltage, limit value 1** The generator voltage has fallen below the limit value 1 for generator undervoltage for at least the indicated time and has not exceeded the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Undervoltage lev.2	**Generator undervoltage, limit value 2** The generator voltage has fallen below the limit value 2 for generator undervoltage for at least the indicated time and has not exceeded the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overfrequency lev.1	**Generator overfrequency, limit value 1** The generator voltage has exceeded the limit value 1 for generator overfrequency for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overfrequency lev.2	**Generator overfrequency, limit value 2** The generator voltage has exceeded the limit value 2 for generator overfrequency for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).

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Message in the display	Meaning
Underfrequency lev.1	**Generator underfrequency, limit value 1** The generator voltage has fallen below the limit value 1 for generator underfrequency for at least the indicated time and has not exceeded the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Underfrequency lev.2	**Generator underfrequency, limit value 2** The generator voltage has fallen below the limit value 2 for generator underfrequency for at least the indicated time and has not exceeded the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overspeed lev.1	**Engine overspeed, limit value 1** The engine speed (measured over pickup) has exceeded the limit value 1 for engine overspeed for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overspeed lev.2	**Engine overspeed, limit value 2** The engine speed (measured over pickup) has exceeded the limit value 2 for engine overspeed for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Underspeed lev.1	**Engine underspeed, limit value 1** The engine speed (measured over pickup) has fallen below the limit value 1 for engine underspeed and has not exceeded the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Underspeed lev.2	**Engine underspeed, limit value 2** The engine speed (measured over pickup) has fallen below the limit value 2 for engine underspeed and has not exceeded the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overload lev.1	**Generator overload, limit value 1** The generator power has exceeded the limit value 1 for generator overload for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overload lev.2	**Generator overload, limit value 1** The generator power has exceeded the limit value 1 for generator overload for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Rev./red. power lev.1	**Generator reverse power, limit value 1** resp. **Generator reduced power, limit value 1** The generator power has exceeded the limit value 1 for generator reverse power resp. generator reduced power for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Rev./red. power lev.2	**Generator reverse power, limit value 2** resp. **Generator reduced power, limit value 2** The generator power has exceeded the limit value 2 for generator reverse power resp. generator reduced power for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Unbalanced load lev.1	**Generator load imbalance, limit 1** The generator power has exceeded the limit value 1 for generator load imbalance (generator imbalance current) for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Unbalanced load lev.2	**Generator load imbalance, limit value 2** The generator power has exceeded the limit value 2 for generator load imbalance (generator imbalance current) for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).

Message in the display	Meaning
Overcurrent lev.1	**Generator overcurrent, limit value 1** The generator current has exceeded the limit value 1 for the generator overcurrent for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overcurrent lev.2	**Generator overcurrent, limit value 2** The generator current has exceeded the limit value 2 for the generator overcurrent for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overcurrent lev.3	**Generator overcurrent, limit value 3** The generator current has exceeded the limit value 3 for the generator overcurrent for at least the indicated time and did not fall below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Undervoltage lev.1	**Battery undervoltage, limit value 1** The battery voltage has fallen below the limit value 1 for battery undervoltage for at least the indicated time and did not exceed the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Undervoltage lev.2	**Battery undervoltage, limit value 2** The battery voltage has fallen below the limit value 2 for battery undervoltage for at least the indicated time and did not exceed the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overvoltage lev.1	**Battery overvoltage, limit value 1** The battery voltage has exceeded the limit value 1 for battery overvoltage for at least the indicated time and did not fall below the value of the hysteresis. has fallen. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Overvoltage lev.2	**Battery overvoltage, limit value 2** The battery voltage has exceeded the limit value 2 for battery overvoltage for at least the indicated time and did not fall below the value of the hysteresis. has fallen. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Lv1:	**Analog input {x}, limit value 1** The analog input has exceeded resp. fallen below the limit value 1 for exceeding resp.negative deviation (depending on the configuration) for at least the indicated time and did not fall below resp. exceed the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Lv2:	**Analog input {x}, limit value 2** The analog input has exceeded resp. fallen below the limit value 2 for exceeding resp.negative deviation (depending on the configuration) for at least the indicated time and did not fall below resp. exceed the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Wb:	**Analog input {x}, wire break** During measurement of the analog input a wire break was detected. This alarm is current at least for the indicated time and the value of the hysteresis is not exceeded/fallen below. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).

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Message in the display	Meaning
Speed detection	**Plausibility alarm frequency/speed measurement** The value of the generator frequency (ascertained by the generator voltage measurement) has differed for at least the indicated time for more than 10 Hz of the engine speed (measured over pickup) and has not fallen below the value of the hysteresis. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Comm. Interface	**Interface alarm** The communication via interface is disturbed and no dates can be received or sent over the bus. Furthermore the alarm was not acknowledged (unless the "Self acknowledgement" is not set NO).
Start failure	**Start alarm of the engine** Three unsuccessful attempts were carried out to start the engine. No more start attempt will be carried out. In Sprinkler operation six start attempts are carried out before this message is monitored.
Shutdown malfunction	**Stop alarm of the engine** It was unsuccessful to stop the engine. 30 seconds after the stop signal still speed was indicated (measured by the generator frequency, the pickup or the discrete input "Dynamo").

We appreciate your comments about the content of our publications.

Please send comments to: icinfo@woodward.com

Please include the manual number from the front cover of this publication.

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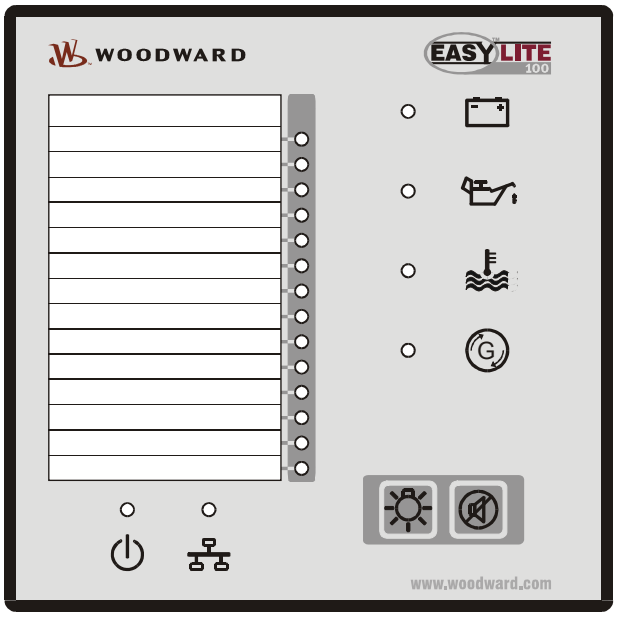
04/2/S

easYlite-100
Annunciator



Instruction Manual
Software Version 1.0xxx

Manual 37307

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

Important definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

indicates a potentially hazardous situation that, if not avoided, could result in damage to equipment.

NOTE

Provides other helpful information that does not fall under the warning or caution categories.

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Revision History

Rev.	Date	Editor	Change
NEW	05-05-09	TP	Release

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Chapter 1.
General Information

Related Documents

Type		English	German
easYlite-100 Series			
easYlite-100 – Manual	this manual ⇨	37307	
easYlite-100 – Brief Manual		37308	
easYgen-1000 Series			
easYgen-1000 – Installation Manual		37320	GR37320
easYgen-1000 – Configuration Manual		37321	GR37321
easYgen-1000 – Operation Manual		37322	GR37322
easYgen-1000 – Interface Manual		37262	GR37262
Additional Manuals			
LeoPC1 – User Manual PC program for configuration, parameter visualization, remote control, data logging, language upload, alarm and user management, and event recorder management. This manual describes the use of LeoPC1 software.		37146	GR37146
LeoPC1 – Engineering Manual PC program for configuration, parameter visualization, remote control, data logging, language upload, alarm and user management, and event recorder management. This manual describes the programming of LeoPC1 software.		37164	GR37164

Table 1-1: Manual - overview

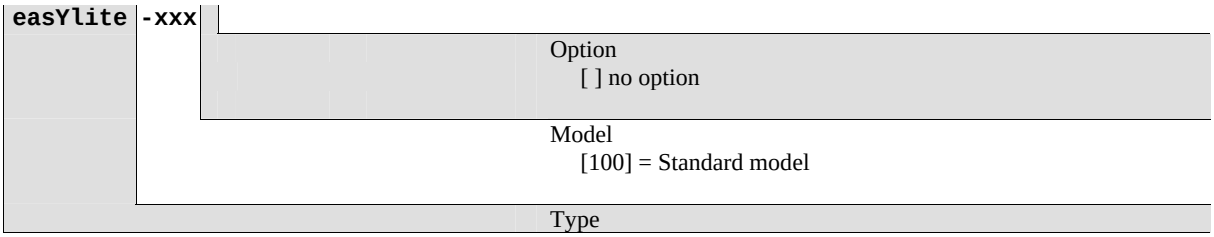
All manuals can be downloaded from the Woodward Publications Server:
http://www.woodward.com/pubs/pubpage.cfm

Overview

The easYlite-100 Series annunciator provides the following functions:

- Genset control status display
- 14 programmable status display LEDs
- 4 pre-assigned status display LEDs
- 1 CAN bus status display LED
- 1 power supply status display LED
- CAN bus communications to genset control

Type designation is as follows:



Examples:
easYlite-100 (standard easYlite 100)

Intended Use The unit must only be operated as described in this manual. The prerequisite for a proper and safe operation of the product is correct transportation, storage, and installation as well as careful operation and maintenance.

NOTE

This manual has been developed for a unit fitted with all available options. Inputs/outputs, functions, configuration screens and other details described, which do not exist on your unit may be ignored.

The present manual has been prepared to enable the installation and commissioning of the unit. Because of the large variety of parameter settings, it is not possible to cover every possible combination. The manual is therefore only a guide. In case of incorrect entries or a total loss of functions, the default settings can be taken from the enclosed list of parameters.

Chapter 2.
Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before performing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. **Opening the control cover may void the unit warranty.**
   Do not remove the Printed Circuit Board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

   - Ensure that the device is completely de-energized (all connectors must be disconnected).
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, connectors, or components with conductive devices with your hands.
   - When replacing a PCB, keep the new PCB in the protective antistatic bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the protective antistatic bag.

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Chapter 3.
Housing

Dimensions / Panel Cut-Out

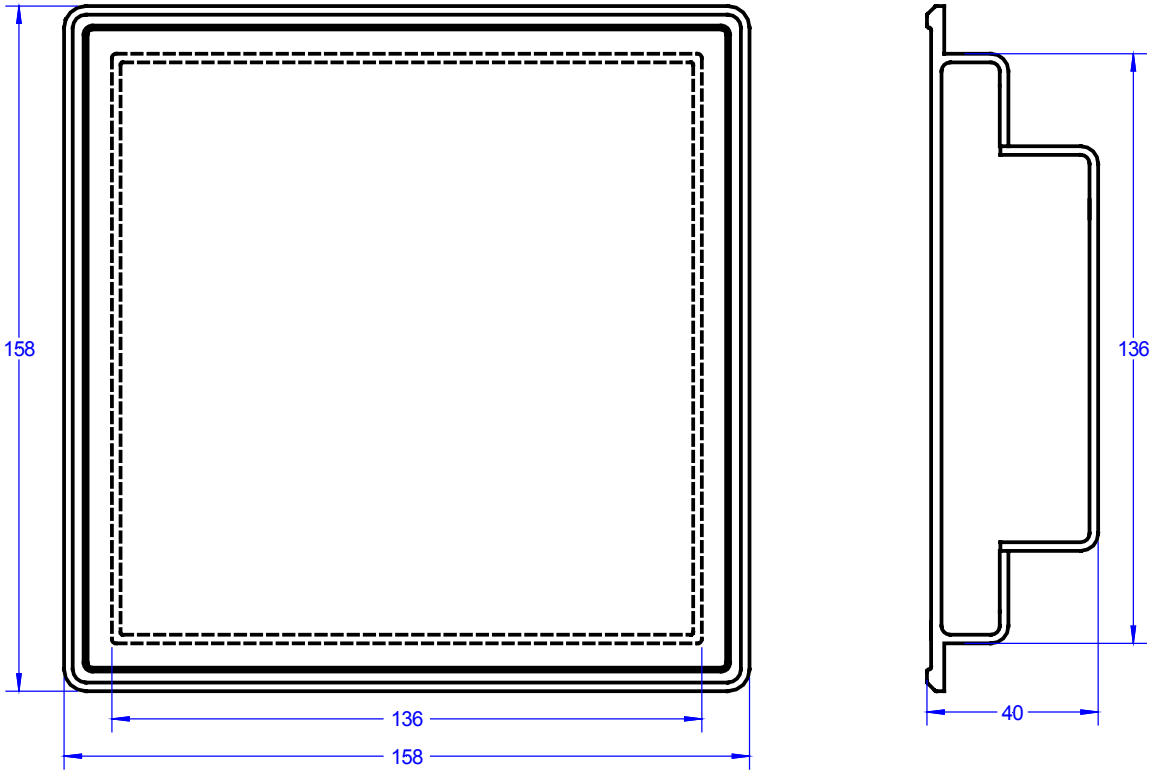


Figure 3-1: Housing - panel cut-out

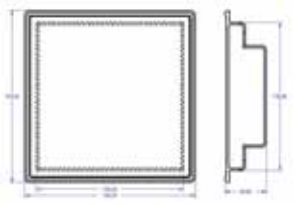
Description		Dimension	Tolerance
Height	Total	158 mm	---
	Panel cut-out	138 mm	+ 1.0 mm
	Housing dimension	136 mm	
Width	Total	158 mm	---
	Panel cut-out	138 mm	+ 1.0 mm
	Housing dimension	136 mm	
Depth	Total	40 mm	---

Table 3-1: Housing - panel cut-out

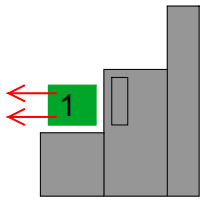
Installation

For installation into a door panel, proceed as follows:

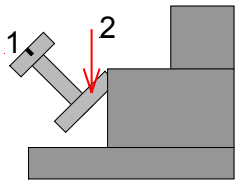
1. **Panel cut-out**
   Cut out the panel according to the dimensions in Figure 3-1.



2. **Remove terminals**
   Loosen the wire connection terminal screws on the back of the unit and remove the wire connection terminal strip if required (1).

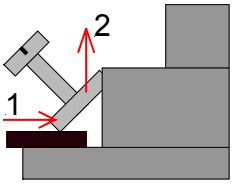


3. **Loosen clamping screws**
   Loosen the four clamping screws (1) until they are almost flush with the clamp inserts and tilt the clamp inserts down by 45° (2) to remove them from the housing. Do not completely remove the screws from the clamp inserts.

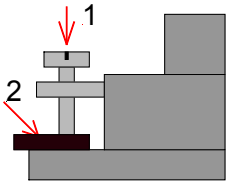


4. **Insert unit into cut-out**
   Insert the unit into the panel cut-out. Verify that the unit fits correctly in the cut-out. If the panel cut-out is not big enough, enlarge it accordingly. Ensure that the gasket is placed properly if used. Ensure that the paper strip is not pinched between gasket and panel to maintain isolation.

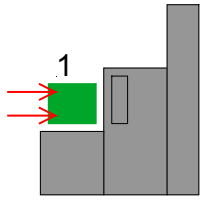
5. **Attach clamp inserts**
   Re-install the clamp inserts by tilting the insert to a 45° angle (1). Insert the nose of the insert into the slot on the side of the housing. Raise the clamp insert so that it is parallel to the control panel (2).



6. **Tighten clamping screws**
   Tighten the clamping screws (1) until the control unit is secured to the control panel (2). Over tightening of these screws may result in the clamp inserts or the housing breaking. Do not exceed the recommended tightening torque of 0.1 Nm.



7. **Reattach terminals**
   Reattach the wire connection terminal strip (1) and secure them with the side screws.



Note: If the gasket is damaged, it needs to be replaced. Use only the original gasket kit (P/N 3050-1057) for replacement.

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Chapter 4.
Wiring Diagram

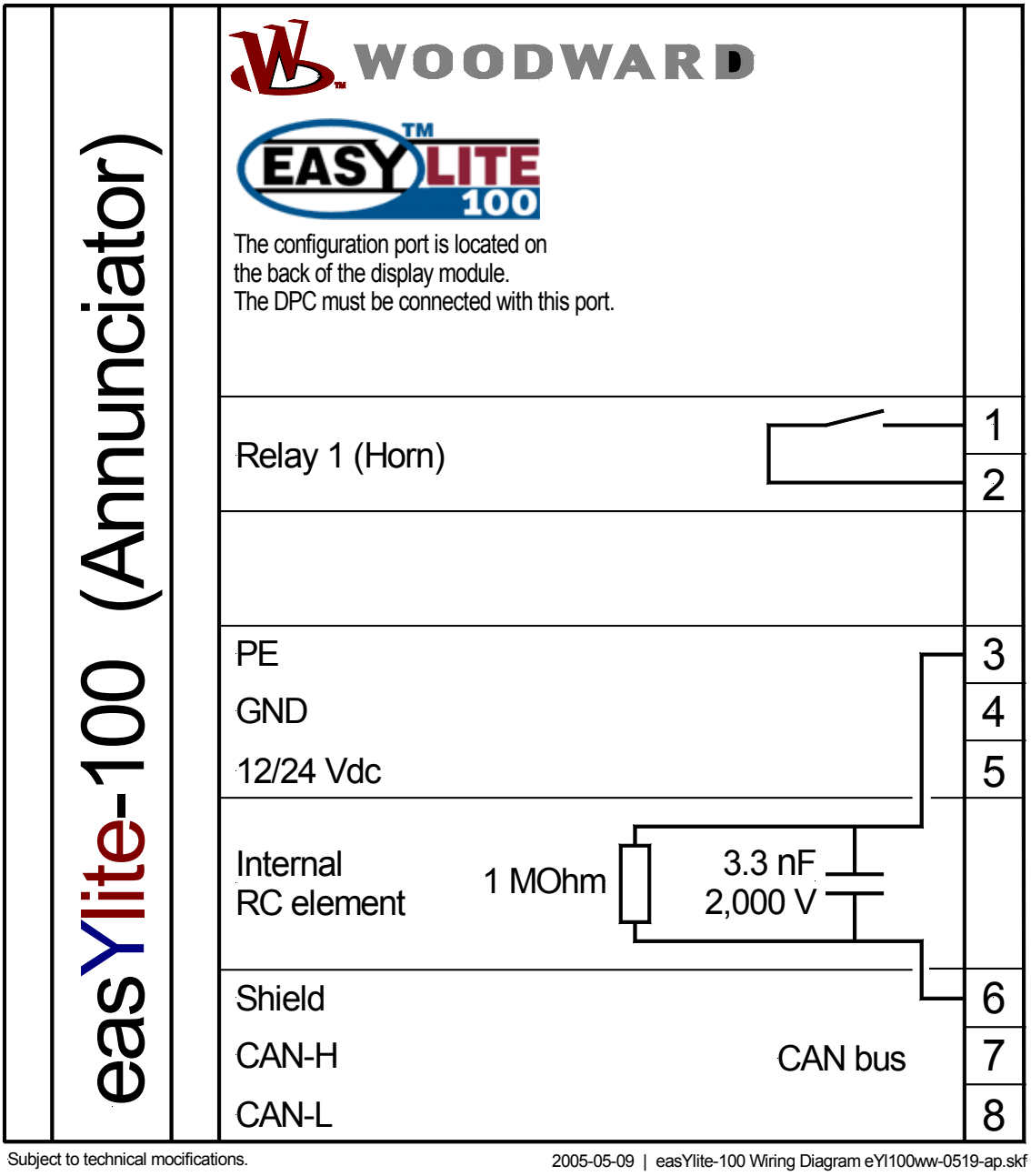

Figure 4-1: Wiring diagram – easYlite-100

Chapter 5.
Connections

Terminal Arrangement

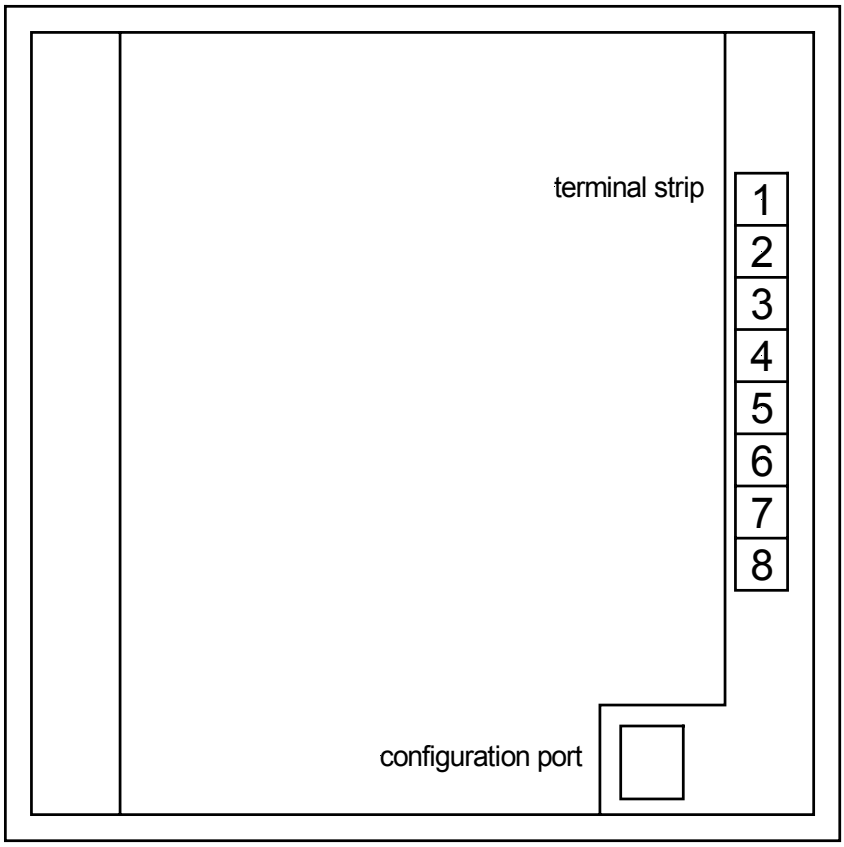

Figure 5-1: easYlite-100 back view - terminal arrangement

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Power supply

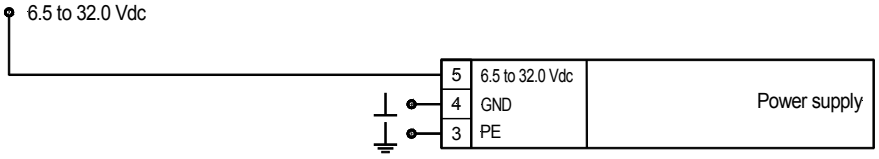

Figure 5-2: Power supply

Terminal	Description	A_{max}
5	12/24 Vdc	2.5 mm²
4	GND	2.5 mm²
3	PE	2.5 mm²

Table 5-1: Power supply - terminal assignment

For a proper operation of the device, a minimum initial voltage of 10.5 Vdc is necessary when switching on the easYlite. After this, a continuous operating voltage between 6.5 and 32.0 Vdc is possible to operate the easYlite safely. The unit is capable of handling voltage drops to 0 V for a maximum of 10 ms.

Relay Output

The easYlite-100 provides one galvanically isolated relay output. The relay output is pre-assigned to the external alarm/horn.

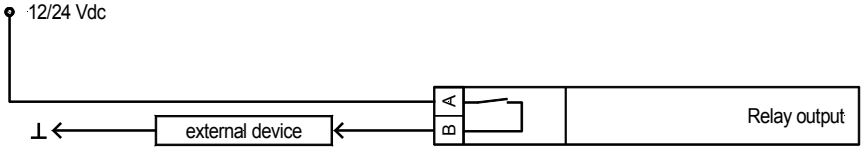

Figure 5-3: Relay outputs

Terminal		Description	A_{max}
Term.	Com.		
A	**B**		
1	2	Relay 1	2.5 mm²

Table 5-2: Relay outputs - terminal assignment

Interfaces

Overview

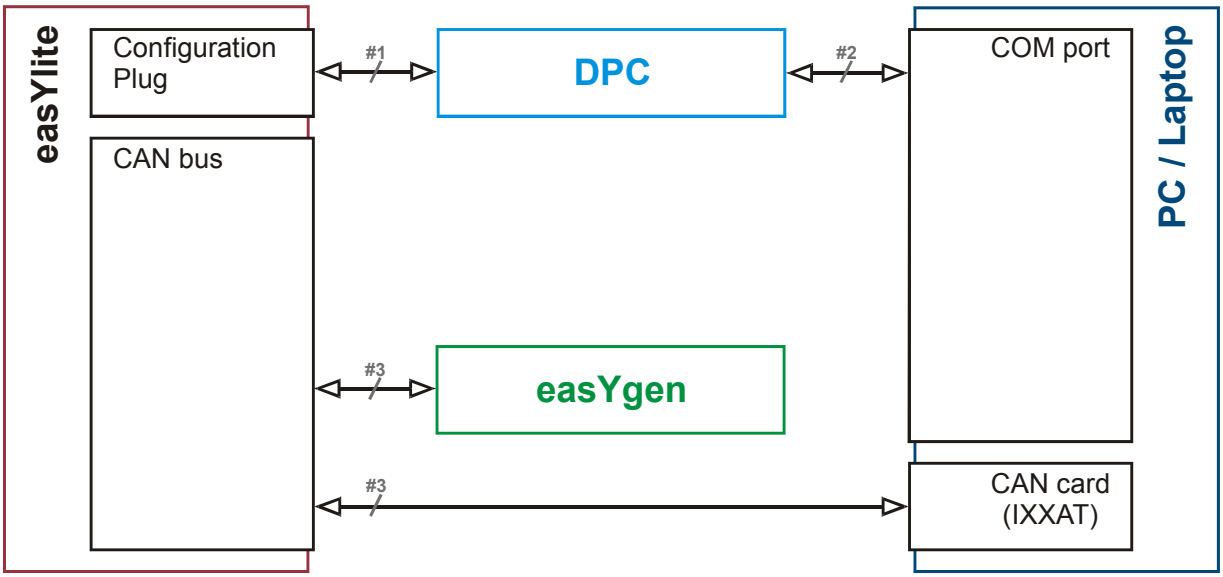

Figure 5-4: Interfaces - overview

No.	Connection from ...	to ...
#1	easYlite [DPC connector]	DPC
#2	DPC	PC [COM-Port]
	PIN 1	---------- PIN 4 (connect with PIN 8)
	PIN 2	---------- PIN 3
	PIN 3	---------- PIN 2
	PIN 4	---------- PIN 1
	PIN 5	---------- PIN 5
	N/A	---------- N/A
	PIN 7	---------- PIN 8 (connect with PIN 4)
	PIN 8	---------- PIN 7
	PIN 9	---------- PIN 9
		Connect PIN4/8
#3	easYlite [CAN terminals]	PC [CAN port, submin-D, 9pole, female]
	Terminal 8 - CAN-L	---------- PIN 7 - CAN-H
	Terminal 7 - CAN-H	---------- PIN 2 - CAN-L
	CAN termination resistor between terminals 8/7	CAN termination resistor between terminals 2/7

Table 5-3: Interfaces - connection overview

NOTE

The DPC cable (P/N 5417-557) is intended for service operation only. Do not operate the easYlite-100 with the DPC plugged into the unit during regular operation.

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CAN Bus

Wiring

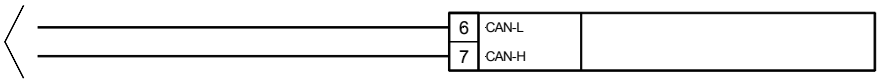

Figure 5-5: Interfaces - CAN bus

Terminal	Description		A_{max}
8	CAN bus	CAN-L	2.5 mm²
7		CAN-H	2.5 mm²
6		Shield	2.5 mm²

Table 5-4: CAN bus - terminal assignment

Shielding

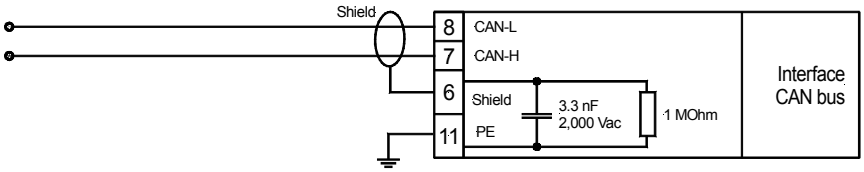

Figure 5-6: Interfaces - CAN bus - wiring of shielding

Please note that the CAN bus must be terminated at each end of the bus! Figure 5-7 is a schematic of the CAN bus with the termination resistors installed.

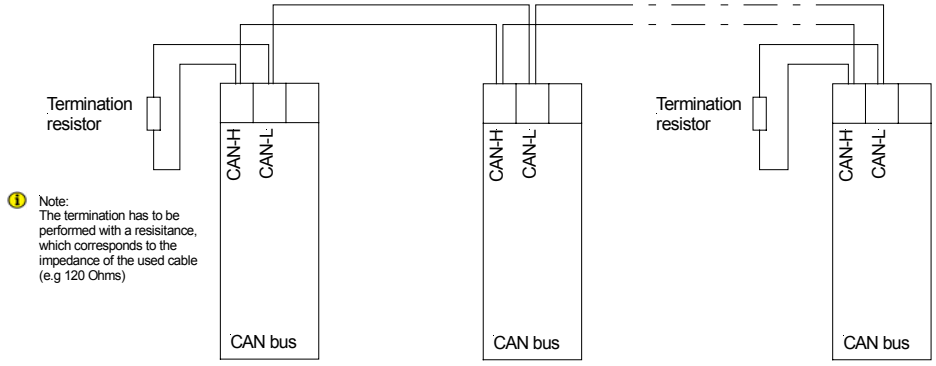

Figure 5-7: Interfaces - CAN bus - schematic wiring and termination

DPC - Direct Configuration Cable

NOTE

Please note that configuration using the direct configuration cable DPC (product number 5417-557) is possible starting with revision B of the DPC (first delivered July 2003). If you have an older model please contact our sales department.

NOTE

The connection cables delivered with the DPC must be used to connect between the control unit and the computer to ensure a proper function of the easYlite. Utilization of an extension or different cable types for the connection between easYlite and DPC can result in a malfunction of the easYlite. This may possibly result in damage to components of the system. If an extension of the data connection line is required, only the serial cable between DPC and notebook/PC may be extended.

Unplug the DPC after configuration to ensure a safe operation!

Chapter 6.
Operation

Front Panel

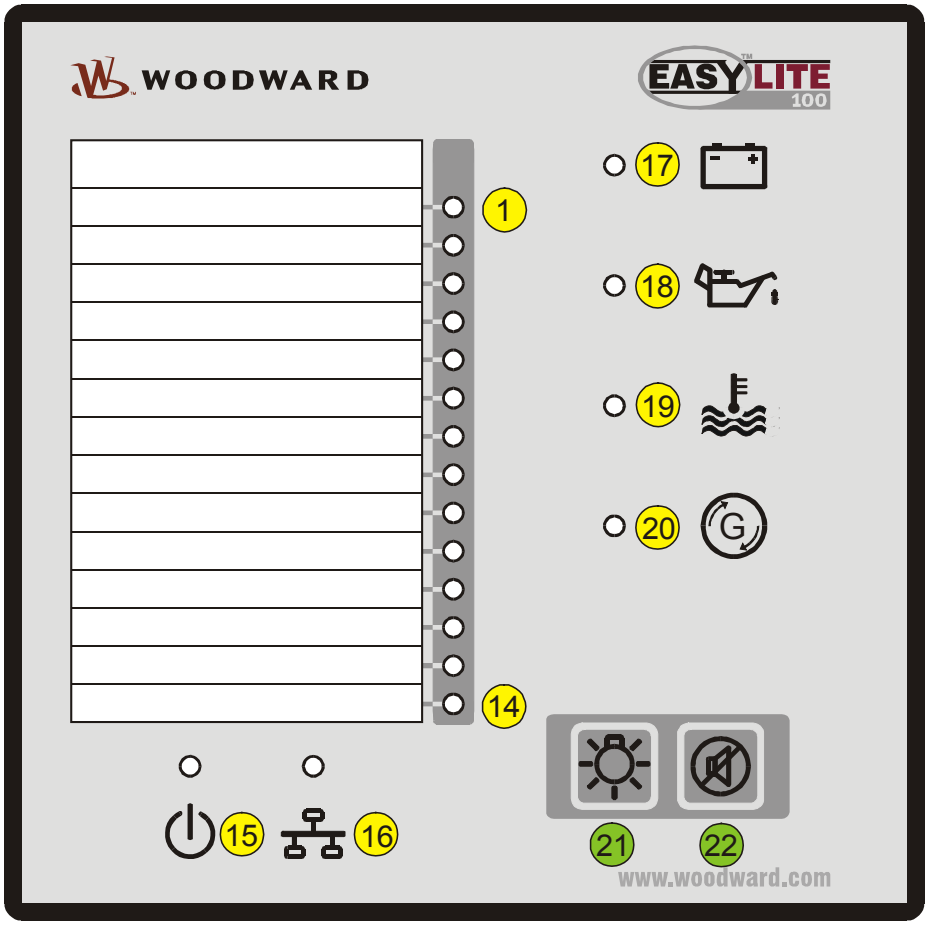

Figure 6-1: Front panel

Figure 6-1 illustrates the front panel which includes push-buttons and LEDs. A short description of the front panel is given below.

1 to 20 **LEDs**

The LEDs indicate operating states of the unit and alarm messages.

21 and 22 **Push-buttons**

The push buttons on the front panel are assigned to fixed functions of the unit.

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Operation and Display

Purpose of the Status LEDs

The easYlite has several status LEDs to indicate the operating state. The LEDs indicate the following conditions:

LEDs 1 to 14: 14 separately configurable alarm, warning, and status LEDs (red)

LED 15: Power LED (green)

LED 16: CAN bus status bicolor LED (green/red) for indication of several CAN bus states:

Color	Mode	CANOpen status	Description
green	single flash	STOPPED	CANOpen bus is stopped
green	flashing	PREOPERATIONAL	CANOpen bus is ready for operation
green	on	OPERATIONAL	CANOpen bus is in operation, a connection to the easYlite is established
red	on	Bus off	No bus connection existing
red	quad flash	No easYgen connected	Bus connection is OK, but no PDOs are received from an easYgen

Table 6-1: CAN bus status LED signals

LED 17: Configurable alarm LED for battery alarm (red)

LED 18: Configurable alarm LED for oil pressure alarm (red)

LED 19: Configurable alarm LED for coolant temperature alarm (red)

LED 20: Configurable alarm LED for EPS supplying load indication (red)

Purpose of the Buttons

The easYlite provides two buttons to operate the unit. The buttons have the following functions:

Button 21: Lamp test

Button 22: Horn silence

Operating the easYlite

- When the easYlite annunciator is powered up, LED 15 is illuminated.
- The CAN bus status is indicated by LED 16.
- If a warning, alarm, or operational state is present, which is configured to one of the LEDs 1 through 14, or 17 through 20, the assigned LED will illuminate.
- If the horn is enabled by an alarm condition, it may be silenced with the horn silence button 22.
- A function test of all LEDs may be conducted by pressing the button 21.

Chapter 7.
Functional Description

Overview

The easYlite annunciator is able to display warning, alarm or status messages of a Woodward genset control remotely (for example in a remote control station). Up to 128 easYlites can be connected to one genset control via a CAN bus. All genset control messages are transmitted permanently to the easYlite via CANopen. One easYlite is able to display 18 different warning, alarm or status messages using freely configurable LEDs.

Furthermore, the easYlite allows to connect a signaling device like a horn via relay 1. The signaling device indicates an alarm issue at the genset and/or a failure of the CAN connection between easYlite and genset control.

Issuing a warning, alarm or status message at the genset control enables the horn bit of the genset control. If the horn bit is assigned to a relay, this relay will be energized when such a message is issued. The relay 1of the easYlite will also be energized if this is configured to "Horn" or "CAN fail or horn".

LED Test

A test of the easYlite LEDs may be performed by pressing button 21. All LEDs must be illuminated in the color indicated under Purpose of the Status LEDs on page 17 while this button is pressed. The bicolor CAN bus status LED 16 must be illuminated yellow (green + red) when it is functioning correctly. The functionality of this button is always enabled.

Silencing the Horn

If a warning, alarm or status message has enabled the horn, this can be silenced by pressing button 22. This disables only the horn bit of the genset control and, if configured, relay 1. A complete acknowledgement of the alarm can only be performed on the genset control. CAN failures, which may result the energizing of relay 1 if configured so, cannot be silenced.

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Function of the Pre-Assigned LEDs

The easYlite has four pre-assigned LEDs which must be configured correctly do indicate the intended warning, alarm or status message. It is not possible to use general standard values since the configuration depends on the individual wiring of the genset control. Therefore, the LEDs have to be configured to the respective discrete or analog inputs using LeoPC1 when commissioning the annunciator.

If the oil pressure sensor is connected to discrete input 3 (refer to Figure 7-1) at the genset control for example, the parameter "Displayed alarm LED18" (LED 18 with oil pressure icon on the front panel, refer to Figure 6-1) must be configured to "Digital input 3" in LeoPC1 (refer to Figure 7-2). Refer to the LeoPC1 manual 37146 for more information.

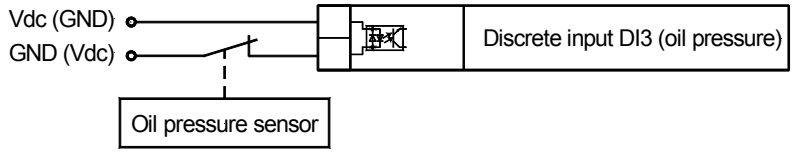

Figure 7-1: Discrete input for oil pressure sensor

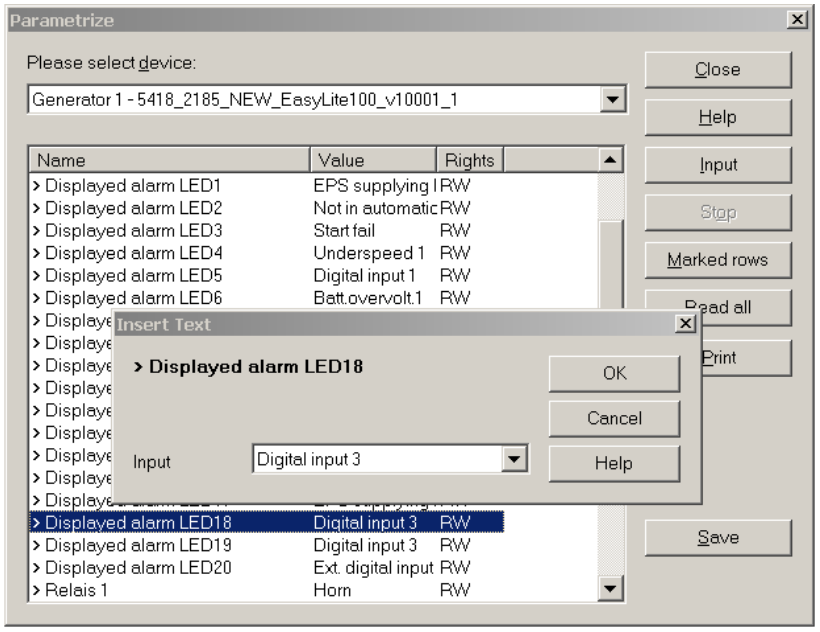

Figure 7-2: LED configuration in LeoPC1

The alarm message indications for battery (LED 17), coolant temperature (LED 19), and EPS supplying load (LED 20) must be configured accordingly.

Chapter 8.
Configuration

Restoring Default Values

I may be desirable to configure the easYlite from a known state if the unit has been previously configured for another application. Restoring factory default settings can be accomplished easily.

Resetting Via LeoPC1

Connect the easYlite with your PC and start LeoPC1 as described in Configuration Using the PC on page 21.
Set the parameter Factory settings to YES.
Set the parameter Set default values to YES.
The factory default values have been restored.
This can be verified by reading out the values from the unit with the "Read all" button.

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Configuration Using the PC

CAUTION

For the configuration of the unit via a PC please use the LeoPC1 software with the following software version:

LeoPC1 3.1 or higher

NOTE

Please note that configuration using the direct configuration cable DPC (product number 5417-557) is possible starting with revision B of the DPC (first delivered July 2003). If you have an older model please contact our sales department.

For configuration of the unit via PC program please proceed as follows:

- Install the LeoPC1 program on your notebook/PC according to the provided user manual 37146. Consider the options that are given during the installation.
- Prior to the completion of the installation you will be prompted to select the language with which you want to start the PC program. The language of LeoPC1 may be changed at any time. The selection of the language refers only to language with which the menus and subprograms that LeoPC1 program works with. This setting will not change the configured language of the control unit.
- After the installation of LeoPC1 has been completed it is necessary to reboot your notebook/PC.
- Establish a connection between your notebook/PC and the control unit via the DPC cable. Insert the RJ45 plug into the RJ45 port on the unit (see DPC - Direct Configuration Cable on page 15 for details) and the serial cable to the COM1 port of your notebook/PC.
- You can now start the PC program as follows:
  - by "Start/Program/Woodward/LeoPC1" (version 3.1 or higher) and opening the respective cfg file, or
  - by a double click on the respective file ending ".cfg" in the subdirectory "/LeoPC1".
  The cfg files differ in their language used. Use the file on the enclosed floppy disk or CD with the language you want, i.e. US for US English or DE for German.
- After the LeoPC1 program has started, establish communication by pressing the F2 button or selecting Communication -> Connect from the menu. This will establish a data link between the control unit and the notebook/PC.
- Start the configuration routine by pressing the F3 button or selecting Devices -> Parameterize from the menu and adjust the parameter of the unit to your application using this manual.

NOTE

Detailed information about LeoPC1 and the utilization of the software may be found in the user manual 37146 belonging to it.

NOTE

The connection cables delivered with the DPC must be used to connect it to ensure a proper function of the easYlite. An extension or utilization of different cable types for the connection between easYlite and DPC may result in a malfunction of the easYlite. This may further result in damage to components of the system. If an extension of the data connection line is required, only the serial cable between DPC and notebook/PC may be extended.

NOTE

Unplug the DPC after configuration to ensure a safe operation! If the DPC remains plugged into the easYlite100 unit, a safe operation of the unit cannot be guaranteed.

Configuration of the Genset Controller

easYlite-100 and easYgen-1500

Setting the Bus Parameters:

Configure both devices to the following settings:

Parameter	Setting in easYlite	Setting in easYgen
Device number	65	1
Protocol	---	CAN Open
Baudrate	125 kBd	125 kBd
CAN Open Master	---	YES

Table 8-1: Configuration settings for easYlite-100 and easYgen-1500 - bus parameters

NOTE

The baud rate must be configured the same for all participants on one bus.
Each participant must have an individual device number.
The CAN Open Node-ID of the device is the device number.

After a correct CAN bus connection between the easYlite and the easYgen has been established and the same baud rate has been configured, the CAN bus status LED at the easYlite flashes green four times to indicate the missing PDOs.

Data Transmission Settings

Configure the easYlite for CAN Open RPDO (receive PDO) and the easYgen for CAN Open TPDO (transmit PDO) 1, 2, 3, or 4 (default setting 3) according to the following settings:

Parameter	Setting in easYlite	Setting in easYgen
COB-ID	897 dec / 381 hex	897 dec / 381 hex
Transmission type	---	255
Event timer	---	20 ms
1. mapped object	---	3196
2. mapped object	---	0
3. mapped object	---	0
4. mapped object	---	0

Table 8-2: Configuration settings for easYlite-100 and easYgen-1500 - transmission parameters

NOTE

A different COB-ID may be used but the same COB-ID must be used for all devices.

If the above settings have been configured correctly, the easYlite CAN bus status LED will illuminate green. The CAN bus status LED does not indicate whether the data transmitted with the PDO is correct. It only indicates that a PDO is received. In order to test whether the data is correct, energize a discrete input at the easYgen and check the indication of this DI at the easYlite.

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Horn Silencing

Configure the easYlite for CAN Open RPDO (receive PDO) according to the following settings:

Parameter	Setting in easYlite	Setting in easYgen
1st Client->Server COB-ID	1537 dec / 601 hex	---
1st Server->Client COB-ID	1409 dec / 581 hex	---
1st Node-ID of the Server	1	---
Max answer time ext. devices	3.0 s	---

Table 8-3: Configuration settings for easYlite-100 and easYgen-1500 - transmission parameters

The COB-IDs are calculated as follows:
1st Client->Server COB-ID = 600 hex + Node-ID (device number) of the easYgen
1st Server->Client COB-ID = 580 hex + Node-ID (device number) of the easYgen

Examples:	Node-ID	1st Client->Server COB-ID	1st Server->Client COB-ID
	1	601 hex	581 hex
	2	602 hex	582 hex
	3	603 hex	583 hex
	and so on …		

After setting these parameters, the horn may be silenced.

easYlite-100, easYgen-1500, and a PLC

The PLC may receive or send data with PDOs to the easYgen.
This enables the PLC to send start/stop signals with a PDO (for details refer to manual 37262).
It is not recommended to write or read easYgen data with the SDO (1st Client->Server COB-ID) because this is used by the easYlite.

The PLC is Not the CAN Open Master

The easYgen starts the communication by setting all devices on the CAN bus to an operational state.
(easYgen setting CAN-Open Master must be configured YES)

The PLC is the CAN Open Master

The PLC must set the easYgen and the easYlite to an operational state.
(easYgen setting CAN-Open Master must be configured NO)

Chapter 9.
Parameters

The following is a description of the easYlite parameters. Note that these parameters may only be viewed and/or changed through LeoPC1.

Main Menu

NOTE

The following parameter is not configurable. It may be viewed using LeoPC1 for information purposes only.

Random number for password	**display only**

This is a randomly generated number which can be used to calculate the password if it is lost.

The unit is equipped with a multi-level code and configuration hierarchy, which allows different user access to the control. A distinction is made between:

User Level
This code level allows for monitoring of the system and does not permit access to the parameters. Configuration is blocked.

Commissioning Level
Allows direct access to all parameters (displaying and changing). In addition, the user may also set the password for the code levels. This password expires two hours after entering the password and the user is returned to the user level.

Temporary Commissioning Level
Allows direct access to all parameters (displaying and changing). This password expires two hours after entering the password and the user is returned to the user level.

NOTE

Once the code level is entered, access to the configuration menus will be allowed for two hours or until another password is entered into the control. If a user needs to exit a code level then user code level should be entered. This will block any configuration of the control. A user may return to user code level by allowing the entered password to expire after two hours or by changing any one digit on the random number generated on the password screen and entering it into the unit.

By entering "0000" the current password level remains active until another password is entered into the control unit.

Password CAN	**0000 to 9999**

The password for enabling access through the CAN interface must be entered here.

Password RS232/DPC	**0000 to 9999**

The password for enabling access through the serial interface or direct configuration must be entered here.

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Application

Display alarm LED [x] **one message from list**

One warning/alarm/status message from the message list in Table 9-1 can be assigned to the alarm LED [x] here. The LED [x] will be illuminated if the assigned warning/alarm/status is detected.

[x] = 1 to 14

Display alarm LED 17 **one message from list**

One warning/alarm/status message from the message list in Table 9-1 can be assigned to the alarm LED 17 here. The LED 17 will be illuminated if the assigned warning/alarm/status is detected.

Note: A battery related alarm must be configured to this LED to comply with the battery icon on the front panel.

Warning/alarm/status message	Description
EPS supplying load	Genset is running and breaker is closed
Not in automatic mode	easYgen is not in automatic mode
CAN fail	A CAN connection failure occurred
Horn	An alarm is triggered at the genset control
Centralized alarm	easYgen alarm classes B to F
Stopping alarm	easYgen alarm classes C to F
Warning alarm	easYgen alarm classes A and B
Gen.overfreq. 1	Alarm messages of the generator monitoring
Gen.overfreq. 2	
Gen.underfreq. 1	
Gen.underfreq. 2	
Gen.overvolt. 1	
Gen.overvolt. 2	
Gen.undervolt. 1	
Gen.undervolt. 2	
Gen. overcurr. 1	
Gen. overcurr. 2	
Gen. overcurr. 3	
Gen. Rv/Rd pow.1	
Gen. Rv/Rd pow.2	
Gen. Overload 1	
Gen. Overload 2	
Unbal. load 1	
Unbal. load 2	
Gen. asymmetry	
Ground fault 1	
Ground fault 2	
Gen. phase rot. misw.	
Inv.time ov.curr.	
Timeout dead bus start	
Mains phase rot. misw.	Genset alarm message of the mains monitoring
GCB fail to close	Various alarm bits of the genset
GCB fail to open	
MCB fail to close	
MCB fail to open	
Overspeed 1	
Overspeed 2	
Underspeed 1	
Underspeed 2	
Speed det. alarm	
Start fail	
Shutdwn malfunct.	
Unintended stop	

Warning/alarm/status message	Description
Batt.undervolt.1	Alarm bits of the analog inputs
Batt.undervolt.2	
Batt.overvolt.1	
Batt.overvolt.2	
CAN Open Fault	Various alarm bits of the genset
CAN-Fault J1939	
Digital input 1	Alarm messages triggered by discrete inputs at the genset
Digital input 2	
Digital input 3	
Digital input 4	
Digital input 5	
Digital input 6	
Digital input 7	
Digital input 8	
Ext. digital input 1	Alarm messages triggered by external discrete inputs at the genset by connecting IKDs
Ext. digital input 2	
Ext. digital input 3	
Ext. digital input 4	
Ext. digital input 5	
Ext. digital input 6	
Ext. digital input 7	
Ext. digital input 8	
Ext. digital input 9	
Ext. digital input 10	
Ext. digital input 11	
Ext. digital input 12	
Ext. digital input 13	
Ext. digital input 14	
Ext. digital input 15	
Ext. digital input 16	
Mainten. days exceeded	Various alarm bits of the easYgen
Mainten. hours exceeded	
Lv1: Analog inp. 1	Alarm messages triggered by analog inputs at the genset
Lv2: Analog inp. 1	
Lv1: Analog inp. 2	
Lv2: Analog inp. 2	
Wb: Analog inp. 1	
Wb: Analog inp. 2	
Firing speed	

Table 9-1: Configurable warning/alarm/status messages

A detailed description of these warning/alarm or status messages can be found in the easYgen-1000 Operation manual 37181 in Appendix A.

Display alarm LED 18 **one message from list**

One warning/alarm/status message from the message list in Table 9-1 can be assigned to the alarm LED 18 here. The LED 18 will be illuminated if the assigned warning/alarm/status is detected.

Note: An oil pressure related alarm must be configured to this LED to comply with the oil pressure icon on the front panel.

Display alarm LED 19 **one message from list**

One warning/alarm/status message from the message list in Table 9-1 can be assigned to the alarm LED 19 here. The LED 19 will be illuminated if the assigned warning/alarm/status is detected.

Note: An coolant temperature related alarm must be configured to this LED to comply with the oil temperature icon on the front panel.

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Display alarm LED 20 **one message from list**

One warning/alarm/status message from the message list in Table 9-1 can be assigned to the alarm LED 20 here. The LED 20 will be illuminated if the assigned warning/alarm/status is detected.

Note: EPS supplying load must be configured to this LED to comply with the coolant temperature icon on the front panel.

Relay 1 **Horn / CAN fail / CAN fail or horn**

The functionality of relay 1 is configured here.

Horn..... The relay 1 will be energized when an alarm is issued at the genset control.
CAN fail..... The relay 1 will be energized when a CAN connection failure occurs.
CAN fail or horn.... The relay 1 will be energized when an alarm is issued at the genset control or a CAN connection failure occurs.

NOTE

If the relay is configured to "Horn" or "CAN fail or horn", relay 1 will be energized with any occurring genset alarm regardless whether the alarm is assigned to an easYlite LED or not. It is recommended to assign the configurable alarm message "Horn" to one of the easYlite LEDs to prevent an enabling of the horn without an alarm indication at the easYlite!

Comm. Interfaces

CAN Interfaces

Device number	1 to 128

The CAN bus device number is configured here. Each participant on the CAN bus needs an individual device number.

Baudrate	20/50/100/125/250/500/800/1000 kBd

The CAN bus baud rate is configured here. The baud rate must be configured the same for all participants on the CAN bus.

Producer heartbeat time	0 to 65530

The producer heartbeat time is configured here.

CAN Open RPDO 1

COB-ID	1 to 4294967295

The CAN ID on which the data is received is configured here. The same ID must be configured as TPDO (Transmit PDO) in the easYgen (refer to Configuration of the Genset Controller starting on page 22).

Additional C-SDO

1st Client->Server COB-ID	1408 to 4294967295

The 1st client -> server COB ID is configured here.

1st Server->Client COB-ID	1408 to 4294967295

The 1st server -> client COB ID is configured here.

1st Node-ID of the Server	1 to 127

The 1st node ID of the server is configured here.

Max answer time ext. devices	1 to 99

The maximum answer time of external devices is configured here. If the acknowledge message of the easYlite is not replied within this time, it will be repeated.

NOTE

Refer to Configuration of the Genset Controller on page 22 for detailed information about the configuration of the easYlite and the connected genset controller.

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System

Codes

Code level CAN port **display only**

This value displays the code level which is currently selected for the access via the CAN bus.

Code level serial port / DPC **display only**

This value displays the code level which is currently selected for the access via the serial RS-232 (DPC) interface.

NOTE

The following passwords are valid for all access possibilities (via serial RS-232 (DPC) interface and via CAN bus). The passwords can be used for the access control systems of the different configuration access methods.

Commissioning level code **0000 to 9999**

The password for the commissioning code level is configured here.

Temp. commissioning level code **0000 to 9999**

The password for the temporary commissioning code level is configured here. The temporary commissioning code level allows the same configurations like the commissioning code level except the change of passwords.

Factory settings **YES/NO**

This parameter enables the easYlite to have the factory default setting restored.

YES.....The unit will be prepared for resetting to factory settings.
NO.....The unit will not be prepared for resetting to factory settings.

Set default values **YES/NO**

This parameter restores the factory default settings.

YES.....The unit will be reset to factory settings.
NO.....The unit will not be reset to factory settings.

Version

NOTE

The following parameters are not configurable. They may be viewed using LeoPC1 for information purposes only.

Serial number	**display only**

This is the serial number of the easYlite and identifies the unit.

Boot item number	**display only**

This is the item number of the firmware, which is stored on the easYlite.

Boot revision	**display only**

This is the revision of the firmware, which is stored on the easYlite.

Boot version	**display only**

This is the version (Vx.xxxx) of the firmware, which is stored on the easYlite.

Program item number	**display only**

This is the item number of the application software of the easYlite.

Program revision	**display only**

This is the revision of the application software of the easYlite.

Program version	**display only**

This is the version (Vx.xxxx) of the application software of the easYlite.

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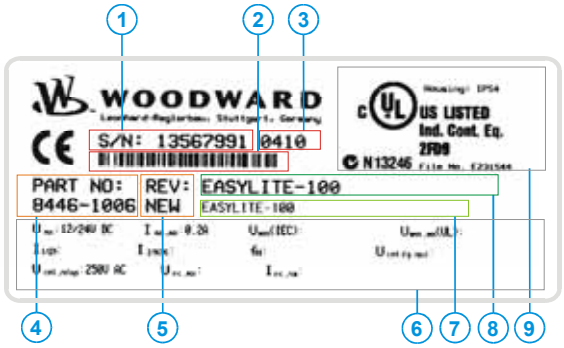
Chapter 10.
Technical Data

Name plate



(Example for a typical name plate)

1	S/N	Serial number (numerical)
2	S/N	Serial number (Barcode)
3	S/N	Date of production (YYMM)
4	P/N	Item number
5	REV	Item revision number
6	Details	Technical data
7	Type	Unit name
8	Type	Extended description
9	UL	UL sign (pending)

Ambient variables

- Power supply ..... 12/24 Vdc (6.5 to 32.0 Vdc)
- Intrinsic consumption ..... max. 3 W
  Battery minus must be grounded
- Ambient temperature
  Storage ..... -20 to +85 °C / -4 to +185 °F
  Operation ..... -20 to +70 °C / -4 to +158 °F
- Ambient humidity ..... 95 %, non condensing

Relay outputs ---------- potential free

- Contact material ..... AgCdO
- General purpose (GP) ($V_{Cont, relay output}$) DC ..... 2.00 Adc@24 Vdc
- Pilot duty (PD) ($V_{Cont, relay output}$) DC ..... 1.00 Adc@24 Vdc

Interface

Service interface ..... **non isolated**

- Version RS-232
- Signal level 5V
  Level conversion and insulation by using DPC (P/N 5417-557)

CAN bus interface ..... **isolated**

- Insulation voltage ..... 500 Vdc
- Version ..... CAN bus
- Internal line termination ..... not available
- Internal cable screen connection with Ground (terminal 3) ..... RC element (1MΩ; 3.3 nF)

Housing ----------

- Type ..... Woodward easYpack 158x158
- Dimensions (W × H × D) ..... 158 × 158 × 40 mm
- Front cutout (W × H) ..... 138 [+1.0] × 138 [+1.0] mm
- Connection ..... screw and plug terminals 2.5 mm²
- Recommended tightening torque
  Connectors ..... 0.5 Nm
  Housing clamps ..... 0.1 Nm
  use only 60/75 °C copper leads
  use only class 1 cables (or similar)
- Weight ..... approx. 450 g

Protection ----------

- Protection system ..... IP54 from front with proper installation with gasket pending
- Front folio ..... insulating surface

Approvals ---------- **pending**

- EMC test (CE) ..... tested according to applicable EN guidelines
- Listings ..... CE (pending); UL listing for ordinary locations (pending)
- Type approval ..... UL/cUL (pending), Ordinary Locations, File No.: 231544

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Appendix A. Common

Alarm Classes

The easYlite does not generate alarms. It only displays alarms generated by the easYgen genset control. The easYgen distinguishes between the following alarm classes:

Alarm class	Visible in the display	LED "Alarm" & horn	Relay "Command: open GCB"	Shut-down engine	Engine blocked until ack. sequence has been performed
A	**yes**	**no**	**no**	**no**	**no**
	Warning Alarm This alarm does not interrupt the unit operation. A message output without a centralized alarm occurs: ⇨ Alarm text.				
B	**yes**	**yes**	**no**	**no**	**no**
	Warning Alarm This alarm does not interrupt the unit operation. An output of the centralized alarm occurs: ⇨ Alarm text + flashing LED "Alarm" + Relay centralized alarm (horn).				
C	**yes**	**yes**	**following power reduction** not available in the easYgen-1000	**after cooling phase**	**yes**
	Responding Alarm With this alarm the GCB is opened and the engine is stopped. Coasting occurs. ⇨ Alarm text + flashing LED "Alarm" + Relay centralized alarm (horn) + Coasting + GCB open + Engine stop.				
D	**yes**	**yes**	**immediately**	**after cooling phase**	**yes**
	Responding Alarm With this alarm the GCB is opened and the engine is stopped. Coasting occurs. ⇨ Alarm text + flashing LED "Alarm" + Relay centralized alarm (horn) + Coasting + GCB open + Engine stop.				
E	**yes**	**yes**	**following power reduction** not available in the easYgen-1000	**immediately**	**yes**
	Responding Alarm With this alarm the GCB is opened immediately and the engine is stopped. ⇨ Alarm text + flashing LED "Alarm" + Relay centralized alarm (horn)+ GCB open + Engine stop.				
F	**yes**	**yes**	**immediately**	**immediately**	**yes**
	Responding Alarm With this alarm the GCB is opened immediately and the engine is stopped. ⇨ Alarm text + flashing LED "Alarm" + Relay centralized alarm (horn)+ GCB open + Engine stop.				

Appendix B.
Front Customization

The easYlite-100 series is designed to be adapted to any desired language and can be customized to your demands using a paper strip. The paper strip is intended for labeling the configurable LEDs.

The paper strip is divided into 14 lines, one for each LED. You can customize the paper strip to reflect the warning/alarm/status message configured to the respective LED in the desired language.

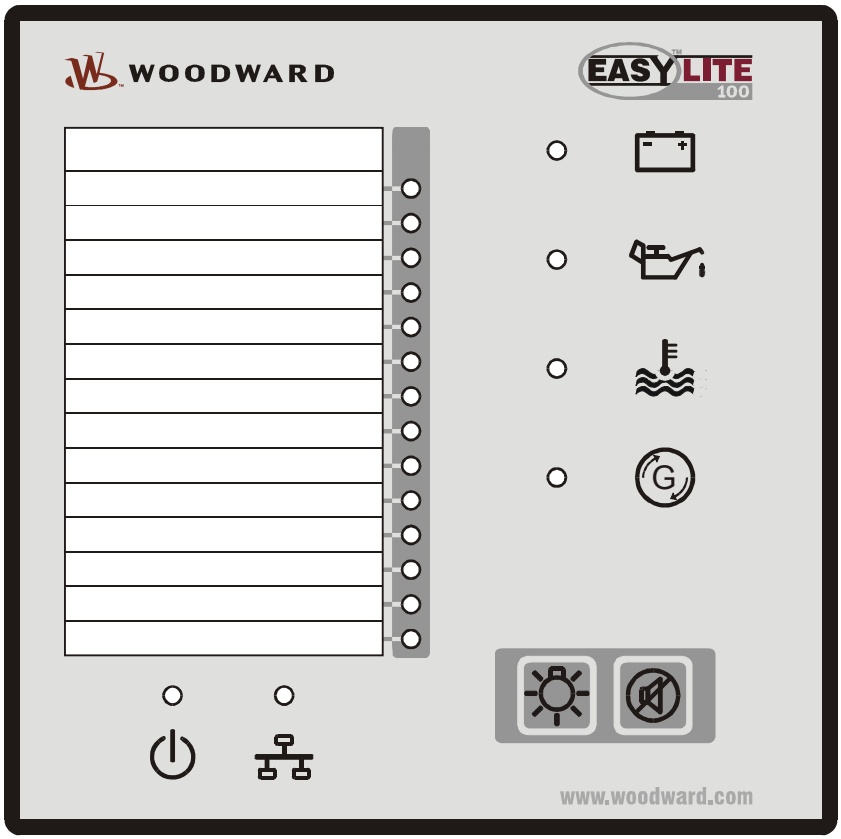

Figure 10-1: Front panel with paper strip

The unit is delivered with an English paper strip with the factory default messages which are assigned to the LEDs.

Templates for paper strips in different languages can be found in the "Paper Strips" directory on the CD delivered with the unit. The templates are in Microsoft Word format and can be customized to your requirements. Please note that the paper strip size must not be modified in the templates. Just edit the text for the paper strips, print them out, cut out the paper strips where indicated, and insert them into the openings at the side of the unit.

Appendix C. Troubleshooting

If problems are encountered while commissioning or operating the easYlite-100, please refer to the troubleshooting table below and LeoPC1 prior to contacting Woodward for technical assistance. The most common problems and their solutions are described in the troubleshooting table. If problems are encountered between the easYlite-300 and its wiring and the engine or other devices, refer to the respective manuals for solving the problem.

Symptom	Possible cause	Possible solution	Verify
Unit does not power up (power LED is not illuminated).	Power supply outside operating range.	With power supply voltage connected to terminals 5(+) and 4(-) of the easYlite-100, measure the voltage at these terminals.	Voltage must be no less than 6.5 Volts and no greater than 32 Volts.
	Power supply polarity reversed.	With power supply voltage connected to terminals 5(+) and 4(-) of the easYlite-100, measure the voltage at these terminals.	Voltage measurement reads (+) polarity when meter is connected to terminal 5(+) and 4(-).
	Power supply not connected.	Connect the correct power supply to terminals 5(+) and 4(-).	Check for proper connection of the power supply.
	The LED is defective.	Press the LED test button to check all LEDs.	Check that all LEDs illuminate. Return the unit to Woodward for repair if any LEDs fail to illuminate.
Horn does not sound with the occurrence of an alarm	Horn is not connected to the relay output terminals 1 and 2.	Connect the horn to the relay output terminals 1 and 2.	Check for proper connection of the horn.
	Power supply to the horn not connected.	Connect the horn power supply between horn and relay output terminals 1 and 2.	Check for proper connection of the horn power supply.
An LED does not illuminate when it should be.	The LED is defective.	Press the LED test button to check all LEDs.	Check that all LEDs illuminate. Return the unit to Woodward for repair if any LEDs fail to illuminate.
	The LED is misconfigured.	Configure the LED to the desired warning/alarm/status.	Check the configuration of the LED in LeoPC1.
The CAN status LED is not illuminated green or illuminated red (refer to Purpose of the Status LEDs on page 17 for details on the status indication.).	The LED is defective.	Press the LED test button to check all LEDs.	Check that all LEDs illuminate. Return the unit to Woodward for repair if any LEDs fail to illuminate.

Appendix D.
List of Parameters

Unit number P/N _____ Rev _____

Version easYlite- _____

Project _____

Serial number S/N _____ Date _____

Parameter	Setting range	Default value	Customer setting	
MAIN MENU				
Random number for password	Info	---		
Password CAN	0000 to 9999	0000		
Password DPC	0000 to 9999	0000		
APPLICATION				
Displayed alarm LED1	from message list *	EPS supplying load		
Displayed alarm LED2	from message list *	Not in automatic mode		
Displayed alarm LED3	from message list *	Start fail		
Displayed alarm LED4	from message list *	Underspeed 1		
Displayed alarm LED5	from message list *	Digital input 1		
Displayed alarm LED6	from message list *	Batt.overvolt 1		
Displayed alarm LED7	from message list *	Batt.undervolt 1		
Displayed alarm LED8	from message list *	Horn		
Displayed alarm LED9	from message list *	Digital input 3		
Displayed alarm LED10	from message list *	Digital input 3		
Displayed alarm LED11	from message list *	Digital input 3		
Displayed alarm LED12	from message list *	Digital input 3		
Displayed alarm LED13	from message list *	Digital input 3		
Displayed alarm LED14	from message list *	Digital input 3		
Displayed alarm LED17	from message list *	Digital input 3		
Displayed alarm LED18	from message list *	Digital input 3		
Displayed alarm LED19	from message list *	Digital input 3		
Displayed alarm LED20	from message list *	Digital input 3		
Relay 1	Horn CAN fail CAN fail or horn	Horn	☐ Horn ☐ CAN fail ☐ CAN / horn	☐ Horn ☐ CAN fail ☐ CAN / horn
COMM. INTERFACES				
CAN INTERFACES				
Device number	1 to 128	065		
Baudrate	20/50/100/125/250/ 500/800/1000 kBd	125 kBd		
Producer heartbeat time	0 to 65530	02000 ms		
CAN OPEN RPDO 1				
COB-ID	1 to 4294967295	0000000897		
ADDITIONAL C-SDO				
1st Client->Server COB-ID	1408 to 4294967295	0000001537		
1st Server->Client COB-ID	1408 to 4294967295	0000001409		
1st Node-ID of the Server	1 to 127	001		
Max answer time ext. devices	1 to 99	3.0 s		

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Parameter	Setting range	Default value	Customer setting	
SYSTEM				
CODES				
Code level CAN port	Info	0		
Code level serial port / DPC	Info	5		
Commissioning level code	0000 to 9999	0003		
Temp. commissioning level code	0000 to 9999	0200		
Factory settings	YES / NO	No	☐ YES / ☐ NO	☐ YES / ☐ NO
Set default values	YES / NO	No	☐ YES / ☐ NO	☐ YES / ☐ NO
VERSION				
Serial number	Info	---		
Boot item number	Info	---		
Boot revision	Info	---		
Boot version	Info	---		
Program item number	Info	---		
Program revision	Info	---		
Program version	Info	---		

* refer to Table 9-1 for the messages which may be configured here

Appendix E.
Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed. If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Returning Equipment For Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the unit(s), attach a tag with the following information:

- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part numbers (P/N) and serial number (S/N);
- description of the problem;
- instructions describing the desired type of repair.

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors
- antistatic protective bags on all electronic modules
- packing materials that will not damage the surface of the unit
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material
- a packing carton with double walls
- a strong tape around the outside of the carton for increased strength

Return Authorization Number RAN

When returning equipment to Woodward, please telephone and ask for the Customer Service Department in Stuttgart [+49 (0) 711 789 54-0]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the unit(s) to be repaired. No work can be started until a purchase order is received.

NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at +49 (0) 711 789 54-0 for instructions and for a Return Authorization Number.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part numbers P/N (XXXX-XXX) that is on the enclosure nameplate
- the unit serial number S/N, which is also on the nameplate

How To Contact Woodward

Please contact following address if you have questions or if you want to send a product for repair:

Woodward Governor Company
Leonhard-Reglerbau GmbH
Handwerkstrasse 29
70565 Stuttgart - Germany

Phone: +49 (0) 711 789 54-0 (8:00 - 16:30 German time)
Fax: +49 (0) 711 789 54-100
eMail: sales-stuttgart@woodward.com

For assistance outside Germany, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Facility	Phone number
USA	+1 (970) 482 5811
India	+91 (129) 230 7111
Brazil	+55 (19) 3708 4800
Japan	+81 (476) 93 4661
The Netherlands	+31 (23) 566 1111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility. [For worldwide directory information, go to **www.woodward.com/ic/locations**.]

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Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by e-mail, or through the Woodward website.

- Technical support
- Product training
- Field service during commissioning

Technical Support is available through our many worldwide locations, through our authorized distributors, or through GE Global Controls Services, depending on the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical engineering support, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference technical support.

Product Training is available on-site from several of our worldwide facilities, at your location, or from GE Global Controls Services, depending on the product. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***customer training***.

Field Service engineering on-site support is available, depending on the product and location, from our facility in Colorado, or from one of many worldwide Woodward offices or authorized distributors. Field engineers are experienced on both Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***field service***.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Contact

Your company_____

Your name_____

Phone number _____

Fax number _____

Control (see name plate)

Unit no. and revision: P/N:_____ REV: _____

Unit type easYlite- _____

Serial number S/N _____

Description of your problem

_____

_____

_____

_____

_____

_____

Please be sure you have a list of all parameters available. You can print this using LeoPC1. Additionally you can save the complete set of parameters (standard values) and send them to our Service department via e-mail.

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We appreciate your comments about the content of our publications.

Please send comments to: stgt-documentation@woodward.com

Please include the manual number from the front cover of this publication.

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Leonhard-Reglerbau GmbH
Handwerkstrasse 29 - 70565 Stuttgart - Germany
Phone +49 (0) 711 789 54-0 • Fax +49 (0) 711 789 54-100
sales-stuttgart@woodward.com

Homepage

http://www.woodward.com/smart-power

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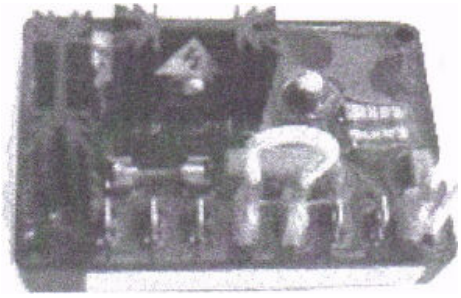
Complete address/phone/fax/e-mail information for all locations is available on our website (www.woodward.com).

05/5/S

KAVC63-4 Voltage Regulator

HIGHLIGHTS

- Integrated circuitry for compact size, simplicity, reliability
- Extremely rugged
- Exciter field current 4A continuous, 7 A forcing
- Regulation accuracy better than + 1.0% no load to full load
- Fast response
- EMI suppression
- CSA approved, File #LR23131
- UL Recognized, File #E97035



DESCRIPTION

The KAVC63-4 model of voltage regulator maintains generator line voltage on brushless generators from 5 KW to over 100 KW in size. The voltage regulator senses generator average voltage to maintain a precise regulation band within + 1%. This is accomplished by converting a 240 VAC single phase power input to a controlled DC signal to the generator's exciter field. The solid-state voltage build-up circuit will enable automatic generator line voltage build-up with a voltage input to the regulator of at least 6 VAC. Customer accessible stability, underfrequency and range adjusts enable fine tuning of the voltage regulator to the generator in use.

The over-excitation feature assists in protecting the voltage regulator during an over-excitation fault condition. During this mode, a shutdown signal is sent to the power stage, turning the regulator off. This feature will reset when the voltage input is removed (less the 6 VAC for a minimum of 2 seconds) to the regulator.

Figure 1 demonstrates the underfrequency characteristics of the voltage regulator during prime mover low speed conditions. Customer curve selection matches the voltage regulator to 50 or 60 Hz systems.

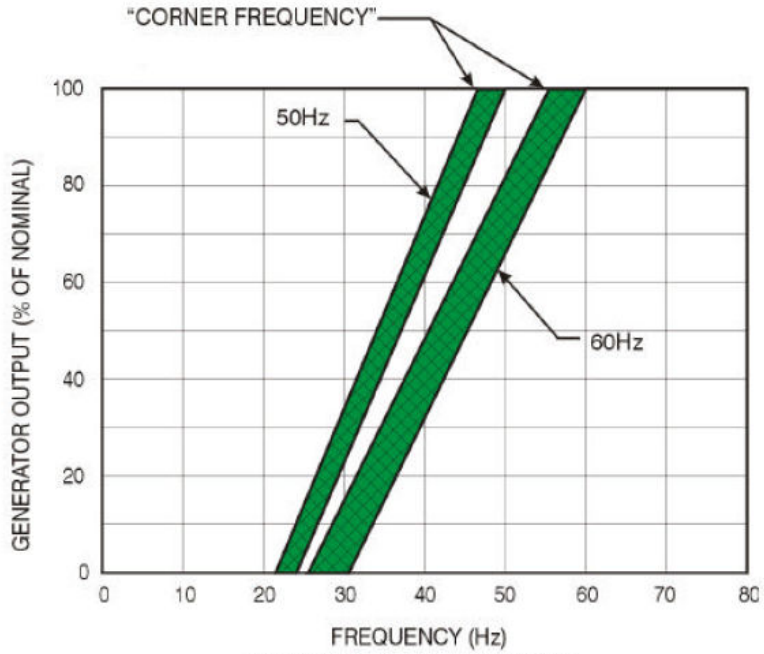


Figure 1 Frequency Compensation Characteristic

KAVC63-4 Voltage Regulator

SPECIFICATIONS

DC Output				Exciter Field Resistance		Sensing/Power Input	
Max. Cont.		Max. Forcing 1 Min. (240Vac Input)		Min. OHMS@ 25° C	Max. OHMS	Single Phase Voltage Range	Burden
AMP	VOLT	AMP	VOLT				
4	63	7	100	15	100	171-264 Vac	500VA

- DC Output Power: 4 Adc at 63 Vdc maximum continuous, 7 Adc at 100 Vdc one minute forcing. (Forcing with 240 Vac nominal input.)
- Exciter Field DC Resistance: 15 ohms minimum; 100 ohms maximum.
- AC Sensing/Power Input: Operating range: 190-240 Vac single phase, 50/60 Hz ± 10%. Burden 500VA.
- Voltage Adjust Range: 171 - 264 Vac.
- Regulation Accuracy: Better than + 1.0% no load to full load.
- Response Time: Less than 1.5 cycles for + 5% change in sensing voltage.
- EMI Suppression: Internal electromagnetic interference filtering.
- Over-excitation Shutdown: Field voltage shuts down after time delay if exciter field voltage exceeds 100 Vdc + 5%. The time delay is inversely proportional to the magnitude of the detected overvoltage condition up to the 135 Vdc point, thus allowing nominal forcing for approximately 1 minute. Beyond 135 Vdc, the field voltage is removed within 2.0 seconds.
- Voltage Buildup: Internal provisions for automatic voltage buildup from generator residual voltages as low as 6 Vac.
- Terminations: 1/4" "Fast-On" Terminals.
- Power Dissipation: 15 Watts maximum.
- Operating Temperature: -40°C (-13°F) to +60° C (140°F).
- Storage Temperature: -40°C (-40°F) to +85°C
- Vibration: Withstands 1.2 Gs at 5 to 26 Hz; 0.036" double amplitude at 27 to 52 Hz; and 5 Gs at 53 to 500 Hz.
- Shock: Withstands up to 15 Gs in each of three mutually perpendicular axes.
- Weight: 8 oz. (0.22 kg) Net.

DIAGRAM

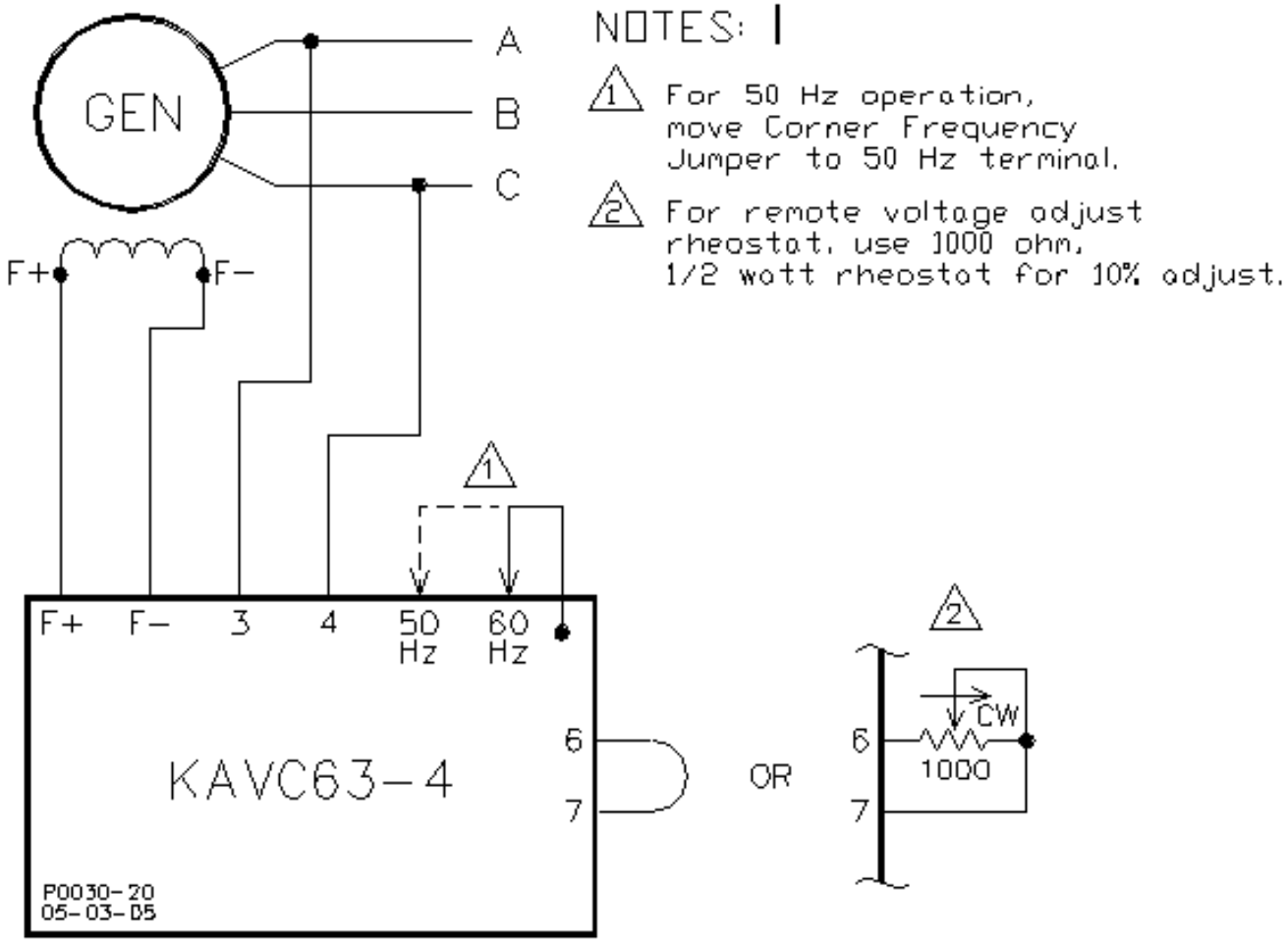


Figure 2: Typical Interconnection Diagram
Interconnection Diagram, 208/240 Vac Nominal.

DRAWING

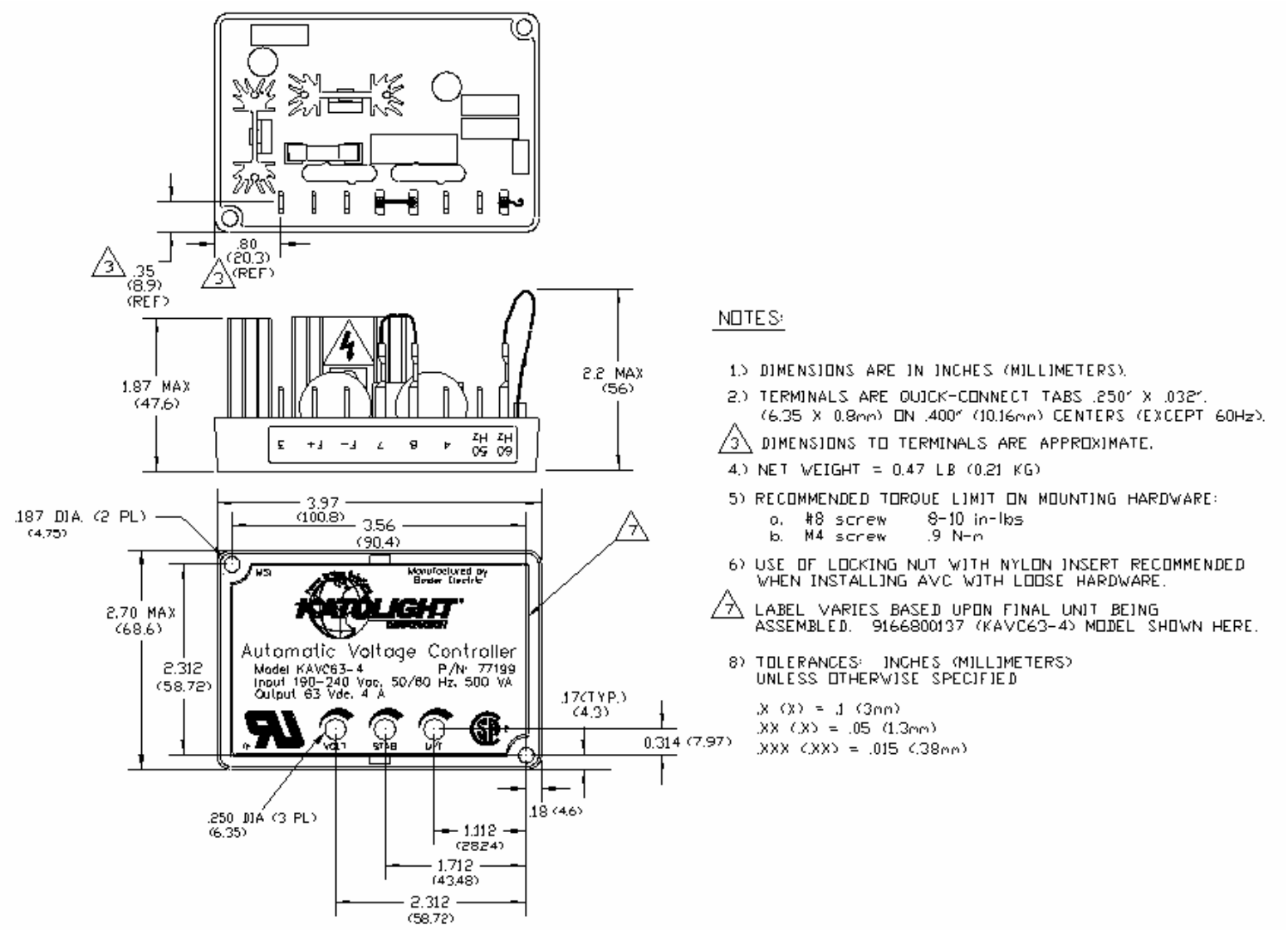


Figure 3: Outline Drawing

Materials and specifications subject to change without notice.
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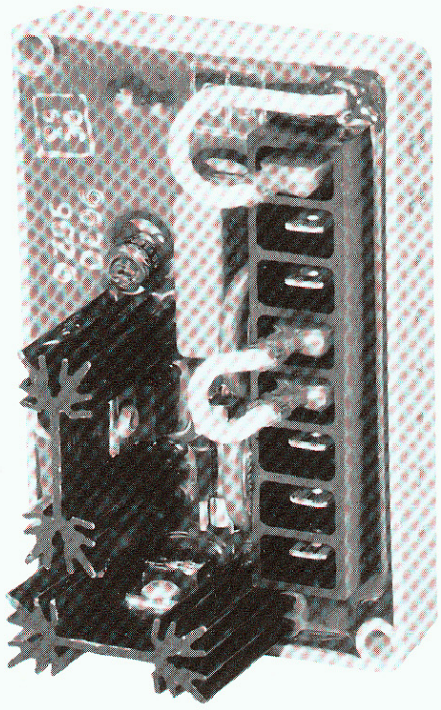
SE350
VOLTAGE REGULATOR
INSTRUCTION MANUAL



KATOLIGHT®
CORPORATION

INTRODUCTION

The SE350 voltage regulator is an encapsulated electronic voltage regulator which controls the output of a brushless AC generator by regulating the current into the exciter field.

SPECIFICATION	SE350 REGULATOR
Sensing & Power Input	190-240 Vac
Burden	500 VA
Output Power - Continuous	73 Vdc at 3.5 Adc (255w)
Output Power - Forcing (240 Vac Input Power)	105 Vdc at 5 Adc (525w)
Regulation	1.0%
Remote Voltage Adjustment Range	±10% with 2000 ohm rheostat ±5% with 1000 ohm rheostat
Frequency Compensation	Adjustable
Roll Off Frequency	54-61 Hz for 60 Hz Operation 45-51 Hz for 50 Hz Operation
Weight	6.5 oz.
Operating Temperature	-40°C to +60°C
Storage Temperature	-65°C to +85°C
Power Dissipation	8 watts maximum
Size	3.94" L X 2.66" W X 2.20" H
Voltage Buildup	Internal provisions for automatic voltage build up from generator residual voltage as low as 10 Vac.
EMI Suppression	Internal electromagnetic interference filter (EMI Filter).

WARNING

TO PREVENT PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED PERSONNEL SHOULD INSTALL, OPERATE, OR SERVICE THIS DEVICE.

CAUTION: DO NOT megger or high-pot the generator with the regulator connected. DO NOT high-pot the regulator.

INSTALLATION

MOUNTING

The SE 350 voltage regulator can be mounted in any plane. See Figure 1 for mounting dimensions.

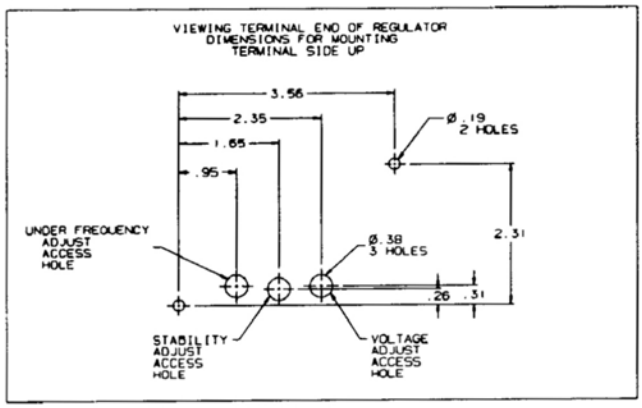


Figure 1

EXCITER POWER CIRCUIT

Connect the regulator wire F+ to the generator F+ or F1 field terminal. Connect the regulator wire F- to the generator F- or F2 field terminal. See Figure 2 for typical connection diagram.

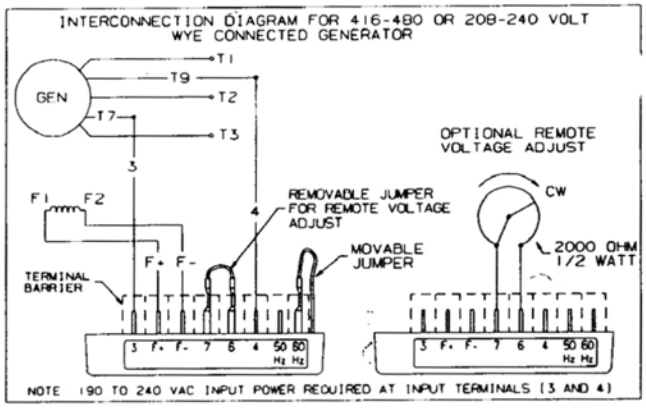


Figure 2

SENSING/POWER INPUT CIRCUIT

Input power and sensing is achieved through terminals 3 and 4. The **voltage input requirement of the SE350 is 190 to 240 Vac.**

See Figure 2 for typical connection diagram

FUSE

A 4 Amp 250V - 5 X 20 mm fuse is supplied with the regulator (Part A-527066). See Figure 3 for location of fuse.

VOLTAGE ADJUST

The screwdriver adjustable potentiometer adjusts the generator output voltage. Adjustment clockwise increases the generator output voltage.
When using a remote voltage adjust rheostat, remove the jumper wire across terminals 6 and 7 and install a 2000 ohm 1/2 watt (minimum) rheostat. (See Figure 2.) This will give ±10% voltage variation from the nominal. (For ±5% voltage variation use a 1000 ohm 1/2 watt rheostat).

STABILITY ADJUST

System stability is the ability of the generator to respond to load transients. Decreasing the stability makes the generator less sluggish and faster to respond to toad transients. If the stability of the regulator is decreased too much, the generator will tend to hunt under steady state conditions.
The screwdriver adjustable potentiometer adjusts the system stability. Adjustment clockwise increases the stability. Increasing the stability increases the response time of the generator. Conversely, decreasing the stability decreases the response time of the generator.

V/HZ ROLL-OFF FREQUENCY SELECTION

The roll off point is the frequency where the generator voltage starts to decrease. This reduces the Kilowatt load to the engine, which allows the engine to recover in speed under any load transient condition.
Use jumper to select 50 HZ or 60 Hz. The screwdriver adjustable potentiometer sets the roll-off frequency from 54-61 Hz in the 60 Hz setting or from 45-51 Hz in the 50 Hz setting.

The 5E350 has the roll-off point preset to 58 Hz in the 60 Hz mode and 48 Hz in the 50 Hz mode. To change the roll-off point, adjust engine speed to the desired rated speed. (50 or 60 Hz). Set the voltage to the desired setting at rated speed. Adjust engine speed to the desired roll-off point. Turn the potentiometer counterclockwise until the voltage starts to drop off. Then adjust the potentiometer clockwise until the voltage returns to rated. Re-adjust engine speed to rated speed.

PRELIMINARY SET-UP

Ensure the voltage regulator is correctly connected to the generator. Refer to the specific connection diagram supplied with the generator.
Set the regulator voltage adjust to full counter-clockwise (minimum voltage level).
Set the remote voltage adjust (if used) to the center position.
Set the stability control full clockwise (maximum stability level).
Connect the positive lead of a 100 V D.C. voltmeter to Fl and the negative lead of the voltmeter to F2 or use an appropriate AC voltmeter on the generator output leads.

SYSTEM START-UP

Start and run the generator at no load and rated speed. The generator voltage should build up to a minimum level. (Actual level is dependent upon connection). If it does not build up, refer to field flashing section in generator manual.
Slowly adjust the voltage control until the generator voltage reaches the nominal value. If used, adjust the remote voltage rheostat to set the generator voltage to the exact value desired.
Turn the stability adjust counter-clockwise until instability is shown on either of the voltmeters mentioned in the “PRELIMINARY SET-UP” section. With the system operating in an unstable condition, slowly adjust the stability control clockwise until generator stability is reached. Interrupt regulator power for a short time (approximately 1-2 seconds).
If the generator remains stable, no further adjustment is necessary. If the generator does not remain stable, increase the stability slightly and interrupt regulator power again.
This procedure should be repeated until system stability is reached and maintained.

TROUBLESHOOTING

Symptom	Cause	Action
Residual Voltage No Output	Residual voltage at regulator power input wires 3 & 4 below 10 V ac.	Check wiring diagram for proper connections. Flash generator field. Refer to field flashing section in generator manual.
	Acceleration time to rated speed too long.	Reduce acceleration time. Interrupt power input to regulator after achieving rated speed.
	Field leads Fl, F2 not connected.	Connect field leads Fl, F2.
	Power input leads not connected.	Connect power-input leads 3,4.
	Blown or missing fuse.	Replace fuse.
	Defective regulator.	Replace regulator.
	Defective generator.	Consult generator manual.
Output Voltage Low	Incorrect connections.	Check wiring diagram for proper connections.
	Voltages adjust turned down.	Rotate voltages adjust CW until desired voltage is reached.
	Remote voltage adjust is turned down.	Rotate remote voltages adjust CW until desired voltage is reached.
	Defective regulator.	Replace regulator.
Output Voltage High	Voltages adjust turned too high.	Rotate voltages adjust CCW until desired voltage is reached.
	Remote voltage adjust is turned too high.	Rotate remote voltages adjust CCW until desired voltage is reached.
Output Voltage High No Adjustment	Defective regulator.	Replace regulator.
Remote Voltage Adjust Operates Backwards	Voltages adjust wire backwards.	Reverse the wiring of the remote voltage adjust.
Generator Output Voltage Hunting	Stability adjusts not set properly.	Rotate the stability adjusts in a CW direction until hunting stops.
Poor Regulation	Defective regulator.	Replace regulator.

SE350_Brochure_KL_3-17-04

MAGNAMAX^{DVR}

DIGITAL VOLTAGE REGULATOR

TECHNICAL MANUAL

MODEL DVR®2000 AND DVR®2000C

MARATHON® ELECTRIC

A Subsidiary of Regal-Beloit Corporation

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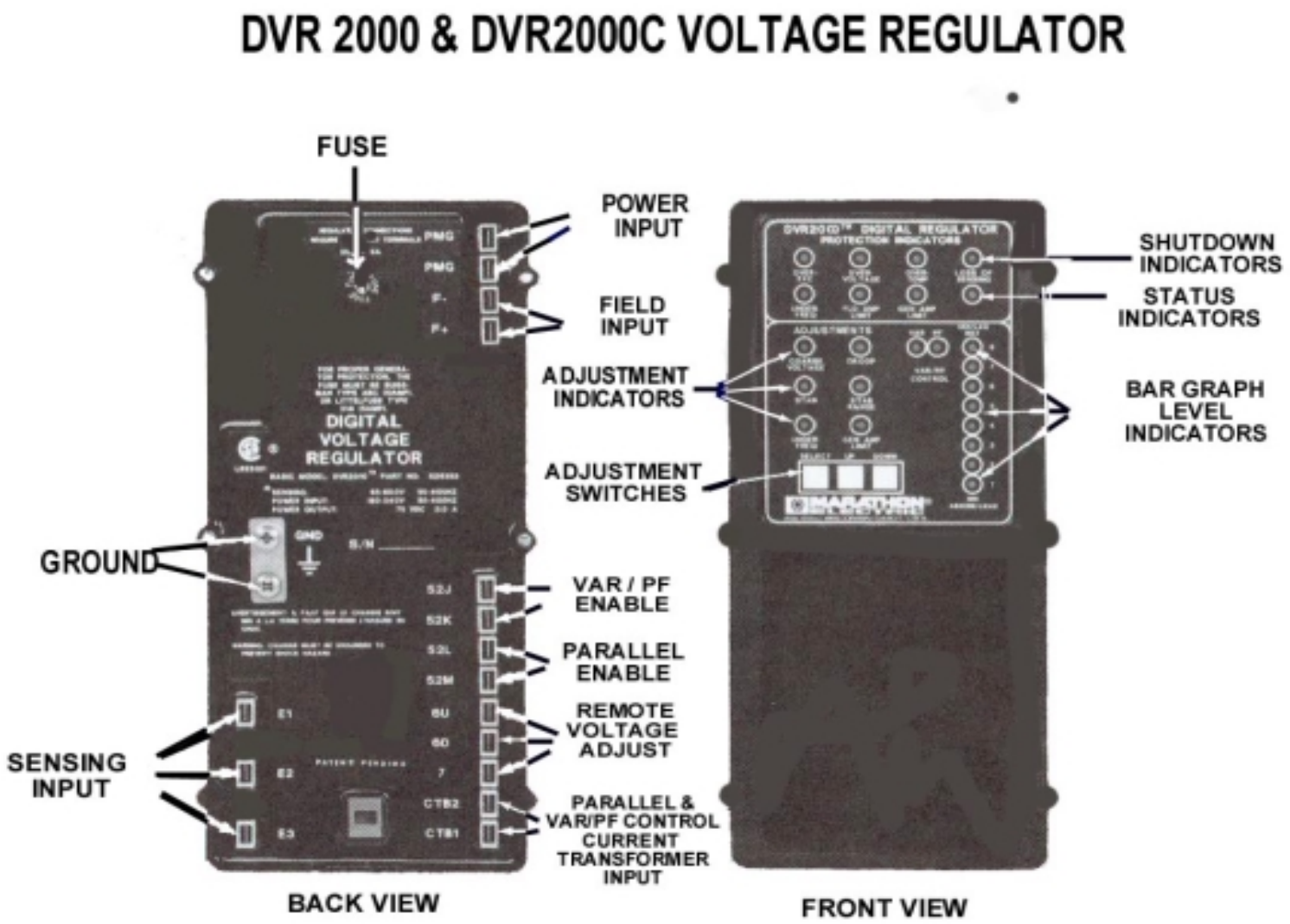
FIGURE 1 - FRONT AND REAR VIEW OF VOLTAGE REGULATOR



SECTION 1- INTRODUCTION

GENERAL DESCRIPTION

The DVR2000 Automatic Voltage Regulator is a sealed electronic solid state microprocessor based digital voltage regulator, which control the output of a brush less ac generator by regulating the current into the exciter field. Unlike most regulators, the input power is from a multi-pole high frequency permanent magnet generator (PMG) incorporated within the main generator.

There is one basic model, the DVR2000 and one other model available, which is a DVR2000C.The "C" suffix indicates "VAR" or "PF" control is available.

SPECIFICATIONS

	DVR2000 & DVR2000C
Sensing	95-600v, 25-420Hz
Sensing Mode	RMS (1 or 3 Phase)
Input Requirements	180-240v, 250-300Hz
Continuous Output	75 Vdc at 3.0 Adc
Max Output 1-mm	150 Vdc at 7.5 Adc
Hot Field Resistance	18-25 Ohms
Regulation	0.25%
Response	Less than 7 msec
Operating Temp.	-40°C to +70°C
Storage Temperature	-40°C to +85°C
Size	10.4 L x 5.0 W x 2.8 D (26.4 x 12.7 x 7.l cm)
Weight	5.5 Lbs. (2.5 Kg)
Fuse Size and Type	25x 1.25 5-amp Littelfuse 314005 or Bussman ABC-5
Accessory Input	Not Available

FEATURES

-See Figure 1 for location of features on face of regulator

Sensing Voltage

The DVR2000 Digital Regulator is equipped for either 3-phase or 1-phase sensing. The sensing voltage is adjustable over the entire range of 95-600v without the need for resetting transformer taps.

Single phase sensing is achieved by connecting terminal E2 and E3 to the same generator terminal.

Parallel Operation

Provisions are included in the regulator to allow the paralleling of two or more generators using either reactive droop or reactive differential (cross current) compensation with the addition of an external 5 amp 5va current transformer.

Under Frequency Operation

The under frequency function allows the generator to operate with a constant volts per hertz characteristic (a linear relationship of voltage with respect to frequency). The transition frequency is adjustable from 40 Hz to 70 Hz.
See Figure 2 for typical characteristics.

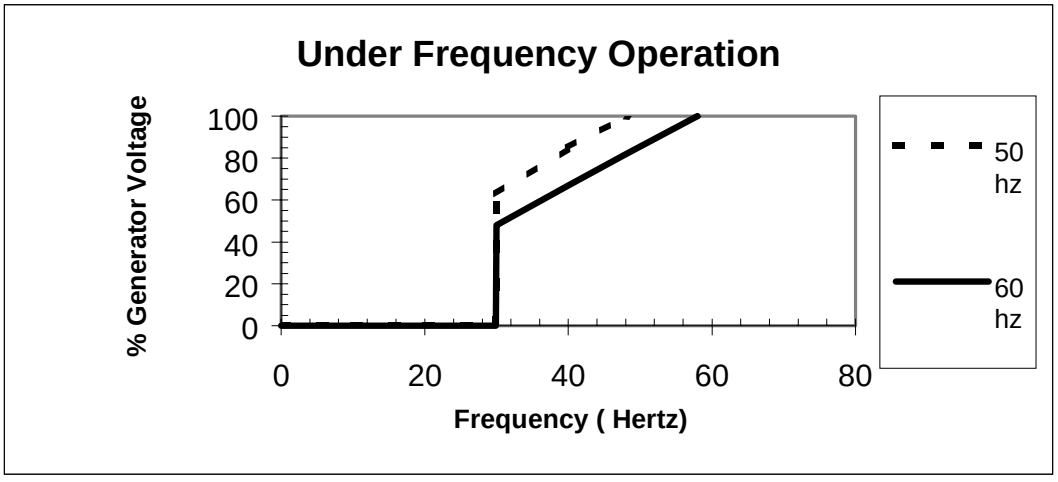


Figure 2 Under frequency operation.

FEATURES

Over-Excitation

The over excitation function monitors the regulator output voltage and causes the regulator to shutdown when the output voltage exceeds the preset trip level of 80 volts for 15 seconds.

Over-Voltage Protection

The over-voltage function monitors the regulator sensed voltage and causes the regulator to shutdown when this sensed voltage exceeds the preset trip level of 115% for 0.75 second.

Over-Temperature Protection

The regulator is equipped with a sensor that monitors the ambient temperature and will turn itself off when the temperature exceeds 70° C.

Loss of Sensing

The loss of sensing function causes the regulator to shutdown if an open circuit occurs in one or more of the sensing leads.

Field Current Limit

The field current limit function monitors regulator output current and limits this current should a heavy load or short circuit occur across the field output terminals.

Environmental Protection

The DVR2000 Digital Voltage Regulator is a totally encapsulated design to limit application problems in harsh environments. The ability of the regulator to withstand harsh environments has been verified through hundreds of hours of testing. This testing includes salt fog tests (ASTM B 17-73), humidity tests, (MIL-STD-705B Method 711-1C), thermal cycles (-40°C to +70°C), shock tests (20 G's in all three planes), and vibration tests (0.035 in. at 20-60 Hz).

EMI Suppression

The DVR2000 Digital Voltage Regulator meets MILSTD-461C Part 9 for electromagnetic conducted and radiated emissions and radiated susceptibility when mounted in the generator conduit box.

WARNING
READ AND UNDERSTAND THIS MANUAL COMPLETELY BEFORE OPERATING THE REGULATOR. BE SURE THE GENERATOR IS OFF BEFORE MAKING ANY REGULATOR CONNECTIONS. REGULATOR DAMAGE OR PERSONAL INJURY MAY RESULT FROM IMPROPER OPERATION.

See Section 2 for detailed description and operation of the features.

SECTION 2 - OPERATION INSTRUCTIONS

MAIN REGULATOR

Front Panel

The DVR2000 Digital Voltage Regulator panel is divided into two (2) areas. The upper area displays the protection indicators and the lower area displays the adjustment indicators. The protection indicators are divided into two (2) rows. The upper row of indicators has protection features that, if activated, will cause the regulator to shutdown either instantaneously or after a time delay. (See “PROTECTIVE FEATURES” in this section of the manual for a more detailed description of each feature.) The lower row of indicators has protection features that do not shutdown the regulator. The DVR2000 has two (2) unmarked protection indicators in the lower row. These indicators are not used on the DVR 2000 regulator.

The lower, or adjustment, area of the regulator panel has three groups of indicators. There are eight (8) indicators that comprise the bar graph, six (6) indicators that identify the standard adjustments and two (2) indicators associated with the VAR/PF feature. The bar graph indicates the relative level of adjustment. When none of the adjustment indicators are lit, the bar graph shows the relative level or setting of fine voltage adjustment. When one of the adjustment indicators is lit, the bar graph shows the relative level or setting of that particular adjustment.

Of the six (6) indicators comprising the standard adjustments the DVR2000 has one (1) unmarked indicator. This indicator is not used on this model. As the select button is pressed, the individual adjustment indicators will be sequentially lit skipping over any unmarked indicator. With the last indicator lit, the next press of the select button will turn off all of the adjustment indicators leaving only the bar graph indicator lit. This again is the mode for fine voltage adjustment. If none of the buttons are pressed (Select, Up, or Down), after one (1) minute, the regulator will automatically switch to the fine voltage adjustment mode.

The VAR/PF adjustment indicators are only used on the “C” model. This model has the VAR/PF control feature available. Unless a “C” model regulator is used, VAR control or PF control is not available and these indicators will not light. With a “C” model regulator, when the VAR or PF adjustment is selected, that indicator will blink when the control feature is not active, and that indicator will be on steady when the control feature is active.
VAR or PF control is not active when regulator terminals 52J and 52K are shorted. VAR or PF control is active when regulator terminals 52J and 52K are open.

Power-up Self Test

Upon applying power to the DVR2000, along with the controlled voltage buildup, the Digital Voltage Regulator performs a self-diagnostics test. This test is completed with the sequencing of the LED display panel. The visual sequencing occurs about 5-6 seconds after power is applied.
If during start-up this LED sequencing does not occur, see Section 5 of this manual.

Once the LED's have sequenced, all of the LED's will be off for a period of 1 second. After that time one (1) LED on the bar graph will be lit. This LED indicates the relative setting of the fine voltage adjustment.

If the regulator was shutdown from a protective feature, when restarted, during the 1 second time period, the LED of the protective feature that commanded shutdown will be lit before indicating the fine voltage setting. The regulator remembers a protective shutdown and indicates the cause of the shutdown during the next start-up.

Parallel Operation

The regulator is equipped with provisions to allow the paralleling of two or more generators using either reactive droop or reactive differential (cross current) compensation with the addition of an external 5 amp 5va current transformer. The paralleling input terminals are labeled CTB1 and CTB2.

PROTECTIVE FEATURES

Over-Excitation

The over-excitation protection feature monitors the regulator output voltage and activates when the output voltage exceeds 80vdc. When activated, the over-excitation LED will light. If the output voltage exceeds this level for 15 seconds, the regulator will turn off. The generator voltage will go to a residual level and the over-excitation LED will remain lit. The generator must be stopped or the input power must be removed for a minimum of 10 seconds to reset the circuit and restore normal operation. Upon start-up, after the LED sequence scan, the over-excitation LED will turn on for one (1) second before entering the fine voltage adjust mode as an indication that the regulator over-excitation function commanded a shutdown.

Over-Voltage

The over-voltage protection feature monitors the regulator-sensed voltage and activates when the sensed voltage exceeds 115% of the adjusted voltage. When activated, the over-voltage LED will light. If the regulator sensed voltage remains above this level for .75 seconds, the regulator will turn off. The generator voltage will go to a residual level and the over-voltage LED will remain lit. The generator must be stopped or the input power must be removed for a minimum of 10 seconds to reset the circuit and restore normal operation. Upon startup, after the LED sequence scan, the over-voltage LED will turn on for one (1) second before entering the fine voltage adjust mode as an indication that the regulator over-voltage function commanded a shutdown.

Over-Temperature

The over-temperature protection feature monitors the regulator temperature and activates when the ambient temperature exceeds 70°C. When activated, the over-temperature LED

will light and the regulator will turn off. The generator voltage will go to a residual level and the over-temperature LED will remain lit. The generator must be stopped or the input power must be removed for a minimum of 10 seconds to reset the circuit and restore normal operation. Upon start-up, after the LED sequence scan, the over-temperature LED will turn on for one (1) second before entering the fine voltage adjust mode as an indication that the regulator over-temperature function commanded a shutdown.

Loss-Of-Sensing

The loss-of-sensing protection feature monitors the continuity of the sensing circuit. If an open circuit occurs in one of the sensing leads, the regulator will shut down and the loss-of-sensing LED will light. The generator voltage will go to a residual level and the loss-of-sensing LED will remain lit. The generator must be stopped or the input power must be removed for a minimum of 10 seconds to reset the circuit and restore normal operation. Upon start-up, after the LED sequence scan, the loss-of-sensing LED will turn on for one (1) second before entering the fine voltage adjust mode as an indication that the regulator loss-of-sensing function commanded a shutdown.

The loss of sensing function will not activate under a generator short circuit condition but rather the regulator will turn full on and deliver maximum forcing power for a minimum of 10 seconds.

CAUTION: Whenever a potential transformer is used for sensing, a break on the primary side of the transformer will cause maximum forcing from the regulator, and the loss of sensing function will not activate.

Under Frequency Operation

The under frequency function allows the generator to operate with a constant volts per hertz characteristic (a linear relationship of voltage with respect to frequency). When not in the under frequency mode, the regulator has flat regulation, constant voltage independent of frequency. The transition frequency is adjustable from 40 Hz to 70 Hz. When in the under frequency mode the under frequency protection indicator will be lit. Adjusting the bar graph down towards minimum reduces the transition frequency.

Field Current Limit

The regulator output is protected with a field current limit feature. Should a heavy load or short circuit occur across the field output terminals, the regulator will limit the output current to 7.5 amps, and the field limit LED along with the over-excitation LED will light. The limiting current automatically resets itself when the output current drops below 7.5 amps. This current limit set point is not adjustable. If the output current does not drop below the current limit set point in 15 seconds the regulator will shutdown. The generator voltage will go to a residual level and the field amp limit and over-excitation LED will remain lit. The generator must be stopped, or the input power must be removed for a minimum of 10 seconds to reset the circuit and restore normal operation. Upon startup, after the LED sequence scan, the field amp limit and over-excitation LED will turn on for one (1) second before entering the fine voltage adjust mode as an indication that the regulator over-excitation function commanded a shut down.

SECTION 3 - INSTALLATION

MOUNTING

The DVR2000 Voltage Regulator is normally located in the generator conduit box, but is also designed to operate in remote switch gear cabinets with convection cooling. When remote mounting, the regulator may either be mounted on the cabinet door with the regulator panel accessible from the front of the cabinet or on the inside panel with the optional remote panel mounting kit, (Part Number BS526434). See Figure 4.

WARNING
THE REGULATOR MUST BE PROPERLY CONNECTED TO A SUITABLE POWER SYSTEM GROUND TO PREVENT THE POSSIBILITY OF ELECTRICAL SHOCK HAZARD AND PROPER OPERATION

CAUTION: DO NOT megger or hi-pot the generator with the regulator connected. DO NOT megger or hi-pot the regulator.

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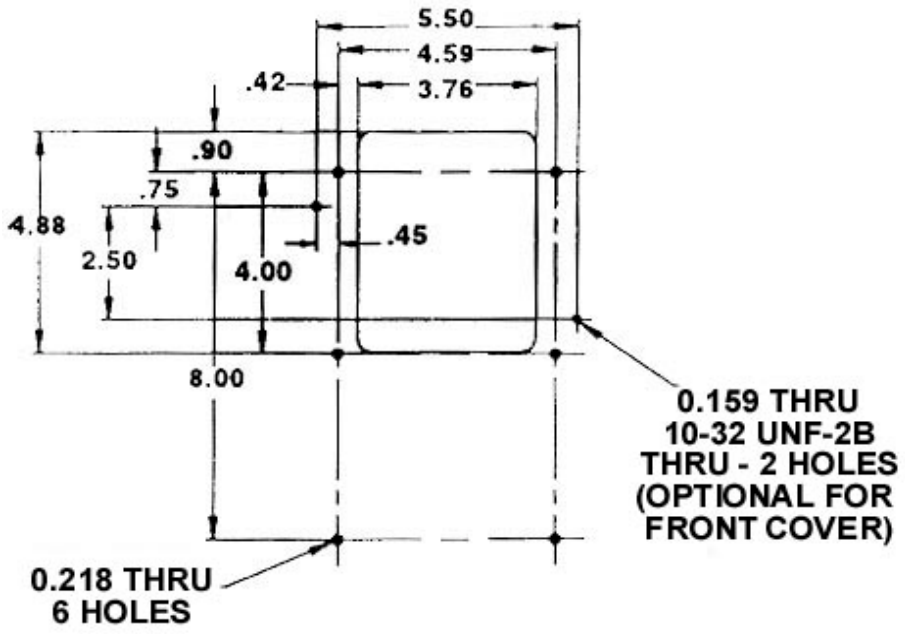


FIGURE 4 - REGULATOR MOUNTING DIMENSIONS

INTERCONNECTIONS

WARNING
BE SURE GENERATOR IS STOPPED AND ALL POWER IS OFF BEFORE MAKING ANY CONNECTIONS.

For typical wiring diagrams see “Outline Drawings and Diagrams” (Section 7).

CAUTION: For use on generator with output voltages greater than 600v, An external potential transformer must be used.

Whenever a potential transformer is used for sensing, an open circuit on the primary side of the transformer will cause maximum forcing from the regulator, and the loss of sensing circuit will not activate. Assure that all connections on the primary side of the transformer are tight and secured from possible vibration.

REMOTE VOLTAGE ADJUST

If a remote voltage adjust is required, a single pole double throw spring return center off toggle switch rated for 240v 1 amp is best suited as a remote adjust. To connect this switch for operation, the center pole or common terminal must be connected to regulator terminal 7. The other two (2) poles or terminals are connected to regulator terminals 6U and 6D. Care is required because “Input Power” voltages are present between 6U, 6D, and 7. This connection can be made using any wire gauges from 12 AWG-22 AWG. The remote voltage adjust can be mounted up to l50 ft from the regulator.

SENSING VOLTAGE

The DVR2000 Digital Voltage Regulator comes equipped for 3-phase sensing as standard. It can optionally be used with single phase sensing by connecting generator terminal T1 to regulator sensing terminal El and generator terminal T3 to regulator terminals E2 & E3.

POWER OUTPUT

The power output terminals of the regulator are labeled F+ and F-. These terminals are connected to the generator field leads respectively. Power Input

The two power input terminals of the regulator are labeled PMG. The leads of the Permanent Magnet Generator are connected to these terminals.

PARALLELING INPUT

The DVR2000 Digital Voltage Regulator comes equipped with parallel provisions as standard. The Paralleling input terminals are labeled CTB1 and CTB2. If paralleling is desired, connect the leads from a standard 5 amp 5va current transformer to these terminals.

The standard generator phase rotation is A-B-C to T1 -T2-T3 with CCW rotation when facing the conduit box or opposite drive end.
With this phase rotation and 3-phase sensing, connect generator lead

T1 to regulator terminal El,
T2 to regulator terminal E2, and
T3 to regulator terminal E3

The paralleling transformer must be in the generator T2 lead with the H1 towards the generator and the XI to regulator terminal CTB2.

With single phase sensing, connect the generator sensing leads:

T1 to regulator terminal El,
T3 to regulator terminal E2, and, E3

The paralleling transformer must be in the generator T2 lead with the H1 towards the generator and the Xl to regulator terminal CTB1.

CAUTION: The polarity and phasing of the current transformer and sensing connections must be observed or improper operation will result.
See Section 7 for typical connection diagrams.

To determine if the paralleling function is operating properly, see Section 4.

If a paralleling switch is desired, this switch or contacts are connected to regulator terminals 52L and 52M. Paralleling is activated when regulator terminals 52L and 52M are open. Paralleling is deactivated when regulator terminals 52L and 52M are shorted.

CAUTION: “Power Input” voltages are present between 52L and 52M.
The paralleling switch **DOES NOT** short the CT terminals.
Note: Regulator terminal 52M is internally common with terminal 7.

The current transformer used for paralleling may also be used for generator current metering.

FIELD FLASHING

A permanent magnet generator powers the "DVR2000 Digital Voltage Regulator" and field flashing is not required or necessary.

SECTION 4 - ADJUSTMENTS AND START-UP PROCEDURE

CAUTION: Read and understand this section completely before attempting any adjustments and starting the generator. If the adjustments do not produce the specified results, proceed to the "Troubleshooting" section.

GENERAL

The new DVR2000 Digital Voltage Regulator is designed such that all adjustments are made outside of the conduit box.

In the adjustment section there are eight (8) LED's that indicate the adjustment feature, eight (8) LED's that comprise the bar graph level indicator, and three (3) push buttons.

The three, (3), push buttons are:
1.) "Select" - Systematically selects the adjustment feature by successive presses of the button.
2.) "Up" - Increases the level of the selected adjustment feature.
3.) "Down" - Decreases the level of the selected adjustment feature.

Successive presses of the "Select" button will step through the various adjustment features. Once the desired adjustment feature is lit the "Up/Down" buttons will increase or decrease the level of the adjustment feature indicated. Once the proper level is reached, the "select" button must be pressed once more in order to save the new level in memory.

While in the "Select" mode, if no button is pressed for a period of one (1) minute, the regulator will automatically save the new level in memory. However, if regulator power is interrupted before the automatic save feature is commanded, that level of adjustment will be lost and the regulator will recall the last previously stored level.
The "Select" button must be pressed in order to step through the adjustment features. The "Up! Down" buttons may be successively pressed to increase or decrease the level, or if held down, the level will automatically increase or decrease at a rate of 2-increments per second. If at any time both the "Up" and the "Down" button are pressed simultaneously the "Up" button takes precedence.
When stepping through the adjustment features, only those features available can be selected. Only regulators with a "C" in the model number will allow the VAR Control or PF Control to be selected. Those models without a "C" in the model number will not allow the VAR Control or PF Control to be selected, and they will be skipped over.

There are up to eight (8) adjustments available on the DVR2000 Digital Voltage Regulator. They are:

1.) Fine Voltage
2.) Coarse Voltage
3.) Stability Range
4.) Stability
5.) Under Frequency
6.) Droop
7.) Power Factor Control
8.) VAR Control

INITIAL ADJUSTMENTS

CAUTION: Read and understand the operation of the individual adjustments before attempting any initial adjustments.

Before starting the generator, the following should be done ;
Remove the 5-amp fuse before starting the generator the first time. Perform all preliminary engine governor adjustments without the regulator energized.

After initial governor adjustments are complete, reinstall the 5-amp fuse and connect only the power input leads or PMG leads to the regulator. Remove all other regulator connections that may be present and temporarily insulate them.

Start and run the generator at rated speed. The regulator will perform the self-test and enter a shut down mode. At this time initial adjustments can be made. To do this, step through each adjustment using the "select" button. For each adjustment press the "up" or "down" button to obtain the level of the LED bar graph as shown in Table 1.

Table 1- LED settings

Adjustment	Voltage	Frequency	Frame	LED
Fine Voltage	All	60/50	All	5
Coarse Voltage	600	60/50	All	7
	480-415	60/50	All	5
	380	60/50	All	3
	240-208	60/50	All	2
	120	60/50	All	1
Stability Range	All	50	430	*1*
	All	60/50	430	2
	All	50	570	3
	All	60/50	570	4
	All	50	740	5
	All	60/50	740	6
	All	60/50	360	7
	Reserved for future use			8
Stability Initial value	Set from "Stability range"			
Droop	All	60/50	All	1
Under Frequency	All	60	All	5
		50	All	3
VAR/PF Control	All	60/50	All	5

After the initial adjustments are made, shut down the generator and connect the remaining regulator leads. The generator may be started and final adjustments may be performed on the regulator.

FINE VOLTAGE ADJUSTMENT

When none of the adjustment features are selected, the “Up/Down” buttons act as the “Fine Voltage” adjustment and the bar graph is a relative indication of that adjustment. Every Up/Down adjustments of the fine voltage adjust feature will increase or decrease the sensed voltage about 0.5 volts. The range of the “Fine Voltage” adjustment is +/- 60v or 120v (min. to max.) of the sensed voltage (See Table 2). After adjustment is made, the “Select” button must be pressed in order to save new level. If no button is pressed for a period of one (1) minute, the regulator will automatically save the setting. If regulator power is interrupted before one (1) minute has passed, the new setting will be lost.

COARSE VOLTAGE ADJUSTMENT

To select “Coarse Voltage” press the “Select” button until the “Coarse Voltage” LED is lit. When selected, the “Up/Down” buttons act as the coarse voltage adjustment and the bar graph is a relative indication of that adjustment. Every Up/Down adjustments of the "Coarse Voltage" adjust will increase or decrease the sensed voltage about 6 volts. The range of the coarse voltage adjustment is 95 - 600v (See Table 2). After adjustment is made, the “Select” button must be pressed in order to save new level. If no button is pressed for a period of one (1) minute, the regulator will automatically save the setting. If regulator power is interrupted before one (1) minute has passed, the new setting will be lost.

REMOTE VOLTAGE ADJUSTMENT

There is a third voltage adjustment, which is not located on the front panel. It is the remote voltage adjustment. The remote voltages adjust functions by remotely changing the fine voltage adjustment setting at the rate of 1 volt / sec. of switch contact. Unlike the regulator pushbuttons, the remote voltages adjust only functions when none of the adjustment features are selected. When any of the adjustment features are selected the remote voltage adjust is disabled. After adjustment is made, the “Select” button must be pressed in order to save the new level. If no button is pressed for a period of one (1) minute, the regulator will automatically save the setting. If regulator power is interrupted before one (1) minute has passed, the new setting will be lost.

The remote voltage adjust is connected to terminals 6U, 6D and 7, respectively. A single pole double throw spring return, with center off, toggle switch rated for 240v lamp is best suited as a remote adjusts. To connect this switch for operation, the center pole or common terminal must be connected to regulator terminal 7. The other two (2) poles or terminals are connected to regulator terminals 6U and 6D. Care is required because “Input Power” voltages are present between 6U & 7 and 6D & 7.

STABILITY RANGE ADJUSTMENT

The “Stability Range” selects the proper control parameters for the frame size generator and excitation system used. There are eight possible ranges. With the “Stability Range” LED lit every push of the “Up” or “Down” button will increase or decrease the bar graph one (1) LED.

To select “Stability Range” press the “Select” button until the “Stability Range” LED is lit. The LED bar graph will indicate the present stability range level. If this is the proper range for the frame size as shown in Table I, then proceed on to the next adjustment. If another stability range level is desired then press the “Up” or “Down” button until the proper LED of the bar graph is lit. Press the “Select” once more to exit “Stability Range” and save the new value. If no button is pressed for a period of one (1) minute the regulator will automatically save the setting. If regulator power is interrupted before one (1) minute has passed the new setting will be lost.
After selecting “Stability Range” as indicated, the regulator will automatically select a stability level that is acceptable for most applications (See “Stability Adjustment”)

See Table 2 for range and resolution of the “Stability Range” adjustment.

TABLE 2

Adjustment	Range	Resolution	Increments per LED
Fine Voltage	128v	0.5v	32
Coarse Voltage	95 to 600v	6.0v	12
Stability Range	1 to 8	1	1
Stability	—	—	32
Droop	0 to 10%	0.25%	5
Under Frequency	40 -70 Hz	0.15 Hz	28
VAR Control	-30% to 100%	1.0%	28
PF Control	-70% to 60% (-45 to 60)	1.0% Max (0.5)	30

Adjusting the stability up or down decreases or increases the gain of the voltage regulator which in turn increases or decreases the response time of the system. Increasing the level of stability will increase the response time. Decreasing the level of stability will decrease the response time.

To select “Stability” press the “Select” button until the “Stability” LED is lit. The LED bar graph will indicate the present stability level. If another stability level is desired, press the “Up” or “Down” button until the proper LED of the bar graph is lit.

Instability is best observed by monitoring the generator output voltage. DO NOT try to monitor stability by monitoring the DC field voltage. Even when stable, a DC voltmeter will show a small amount of fluctuation in the field voltage. If instability is seen in the generator output voltage, press and hold the “Up” button until the generator is stable again. Apply load. If the generator remains stable, no further adjustment is needed. If the generator is unstable, press and hold the “Up” button until the generator is stable again. Reject and apply the load one (1) to two (2) more times. The generator should remain

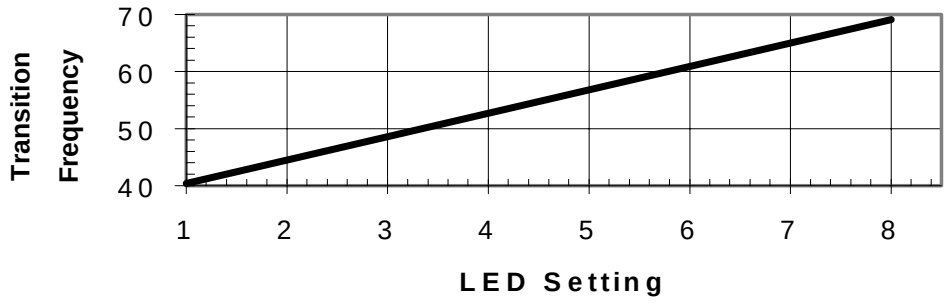
stable. If the generator is not stable or if the response is too slow, then either increase or decrease the stability level as desired one (1) to two (‘2) increments at a time applying and rejecting load between each adjustment until optimum performance is achieved. Press the “Select” once more to exit “Stability” and save the new value. If no button is pressed for a period of one (1) minute, the regulator will automatically save the setting. If regulator power is interrupted before one (1) minute has passed, the new setting will be lost.

UNDER FREQUENCY ADJUSTMENT

The “Under Frequency” adjustment changes the frequency at which the regulator begins to operate on a constant volts/hertz ramp. Increasing this adjustment increases the transition frequency. Decreasing this adjustment decreases the transition frequency.

To select “Under Frequency” press the “Select” button until the “Under Frequency” LED is lit. The LED bar graph
will indicate the present transition level. If another transition level is desired, then press the “Up” or “Down” button until the proper LED of the bar graph is lit (See Figure 5).

Figure 5
Under Frequency Adjustment



To set the transition level to a known frequency, either of two (2) methods of adjustment may be used.

The first method is to:

A.) Select the “Under Frequency Adjust mode”.
B.) Slow the engine speed down until the generator output frequency is the transition frequency.
C.) Adjust the under frequency level until the “Under Frequency” LED in the “Protection Indicators” section of the front panel just lights.
D.) Press the “Select” button to save the new value. If no button is pressed for a period of one (1) minute, the regulator will automatically save the setting. If regulator power is interrupted before one (1) minute has passed, the new setting will be lost.
E.) Restore the generator to normal operating speed.

The second method is to:

A.) Select the “Under Frequency Adjust mode”:
B.) Adjust the under frequency level until the “Under Frequency” LED in the “Protection Indicators” section of the front panel just lights.
C.) Adjust the under frequency level one (1) increment down. The “Under Frequency” LED in the “Protection Indicators” section of the front panel should turn off. If the LED does not turn off, keep adjusting the under frequency down one (1) increment at a time until the LED does turn off.
D.) Determine the transition frequency, and subtract it from the running frequency.
E.) Divide the difference by 0.15.
F.) Round the answer to the nearest whole number.
G.) Press the “Down” button the number of times calculated in step F.
H.) Press the “Select” button to save the new value. If no button is pressed for a period of one (1) minute, the regulator will automatically save the setting. If regulator power is interrupted before one (1) minute has passed, the new setting will be lost.

See Table 2 for range and resolution of the “Under Frequency” adjustment.

DROOP ADJUSTMENT

The “Droop” control feature is used when paralleling generators. Increasing the level of the “Droop” adjustment increases the amount of generator voltage droop with application of reactive load. A five amp signal from a 5a 5va CT into terminal CTB1 and CTB2 will give at least 10% voltage droop with the application of a 0.8 PF load and the adjustment level set to maximum.
Two (2) states or conditions exist with the “Droop” control feature. They are:

1.) Inactive - The feature is available but not functioning.
2.) Active - The feature is available and functioning.

The “Droop” control is activated when regulator terminals 52L and 52M are open. The Droop control is de-activated when regulator terminals 52L and 52M are shorted.

CAUTION: “Power Input” voltages are present between 52L and 52M.

NOTE: Regulator terminal 52M is internally common with terminal 7.

To select “Droop” press the “Select” button until the “Droop” LED is lit. The LED bar graph will indicate the relative level of droop adjustment. If another level is desired, press the “Up” or “Down” button until the proper LED of the bar graph is lit.

The best way to set the droop is to run each generator individually, and apply rated or near rated current at 0.8 PF. The amount of droop can then be set directly.

There is an alternate method of adjusting the generator droop. With the droop CT installed in the generator T2 lead (See Section 7), temporarily connect generator-sensing lead
El to generator lead T2
E2 & E3 to generator lead T1.

WARNING: BE SURE GENERATOR IS STOPPED
AND ALL POWER IS OFF BEFORE MAKING ANY CONNECTIONS.

Run each generator individually and apply rated or near rated current at unity PF. The amount of droop can then be set by adjusting the "Droop" adjustment as needed for the application

If when adjusting generator droop the generator output voltage does not decrease with application of load, recheck the CT polarity and the sensing lead connections.

After the adjustments are complete, reconnect the regulator sensing leads as outlined in Section 7. When the generators are operated in parallel they will share load equally. If no reactive load is present, the generator voltage should not droop. If it does droop, recheck sensing connections, CT connections, and CT polarity. If necessary repeat the adjustment procedure.

Droop can also be set by adjusting to the LED level shown in Figure 6 for the amount of droop required.

See Table 2 for range and resolution of the Droop" adjustment.

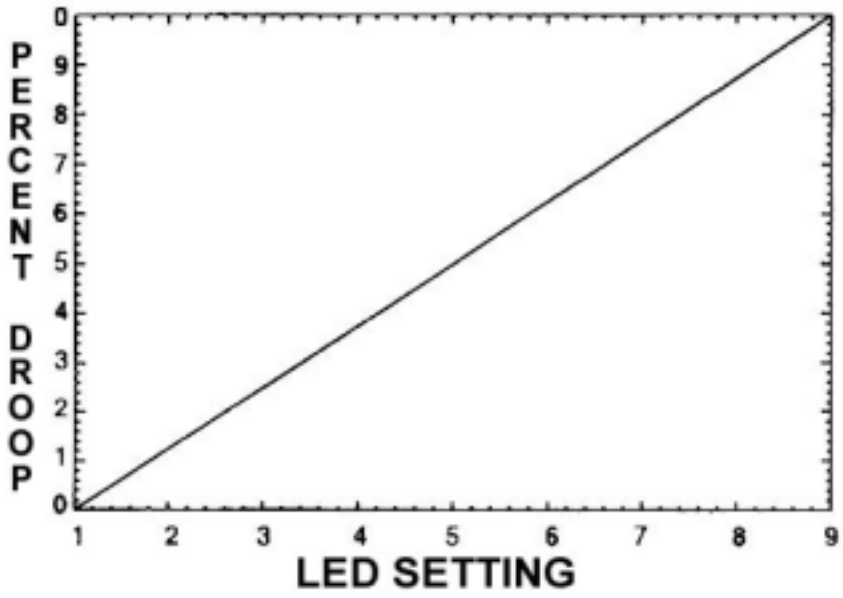


FIGURE 6 - DROOP ADJUSTMENT

After the droop adjustment is complete, press the "Select" button to save the new value. If no button is pressed for a period of one (1) minute the regulator will automatically save the setting. If regulator power is interrupted before one (1) minute has passed, the new setting will be lost.

REACTIVE DIFFERENTIAL (CROSS CURRENT) ADJUSTMENT

With the cross current loop disabled, set up the generators for satisfactory simple droop operation. Then reconnect the cross current loop retaining all settings. Operate the system to verify satisfactory performance.

When operating in parallel reactive differential mode (cross current), attention must be paid to the use of the burden resistor shown on the connection diagram. The burden resistor should have a value approximately ten (10) times the cross current loop resistance for proper differential operation. The value of 0.1 ohm is a suggested minimum value. The volt-ampere (VA) capacity of the paralleling Current Transformers should be considered after sizing the burden resistor.

VAR/PF ADJUSTMENT

The “VAR/PF” control feature is used when paralleling a generator to utility. “VAR” or “PF” control is only available on “C” model regulators. Increasing the level of the “VAR” or “PF” adjustment increases the amount of field excitation. Decreasing the level of the “VAR” or “PF” adjustment decreases the amount of field excitation.

Two (2) states or conditions exist with the “VAR” or “PF” control feature. They are:

1.) Inactive - The feature is available but not functioning.
2.) Active - The feature is available and functioning.

The VAR or PF control is activated when regulator terminals 52J and 52K are open.
The VAR or PF control is de-activated when regulator terminals 52J and 52K are shorted.
CAUTION: “Power Input” voltage are present between 52J and 52K.
NOTE: Regulator terminal 52K is internally common with terminal 7.

To select "VAR" control or "PF" control, press the "Select" button until the proper LED is lit. The led bar graph will indicate the relative level of adjustment. If another level is desired, press the "Up" or "Down" button until the proper LED of the bar graph is lit. See Figure 7A or 7B for adjustment settings.

To switch or toggle between "VAR" Control and "PF" Control select and **HOLD** the “Select” button down. While holding the select button, successive pressing of the “Up” button will alternate control between "VAR" and "PF". When the proper control is selected, release the “Select” button. With the “Select” button released, the level of control can be adjusted using the “Up” “Down” buttons. After the control level is djusted, pressing the “Select” button once more will store the selection and adjustment level in memory.
The “VAR/PF” control feature is the only feature where the adjustment LED does indicate more than just a selected or deselected function.
When not selected, the “VAR/PF’ LED's are always “OFF”.

When “VAR/PF” control feature is not available, the “VAR/PF” LED's cannot be selected. Only when "VAR" or "PF" control is available can the “VAR/PF” LED's be selected.
When selected but not active, the “VAR” or “PF” LED will blink and the bar graph will indicate the relative level of control.
When selected and active, the “VAR” or “PF” LED will be on steady and the bar graph will indicate the relative Level of control.

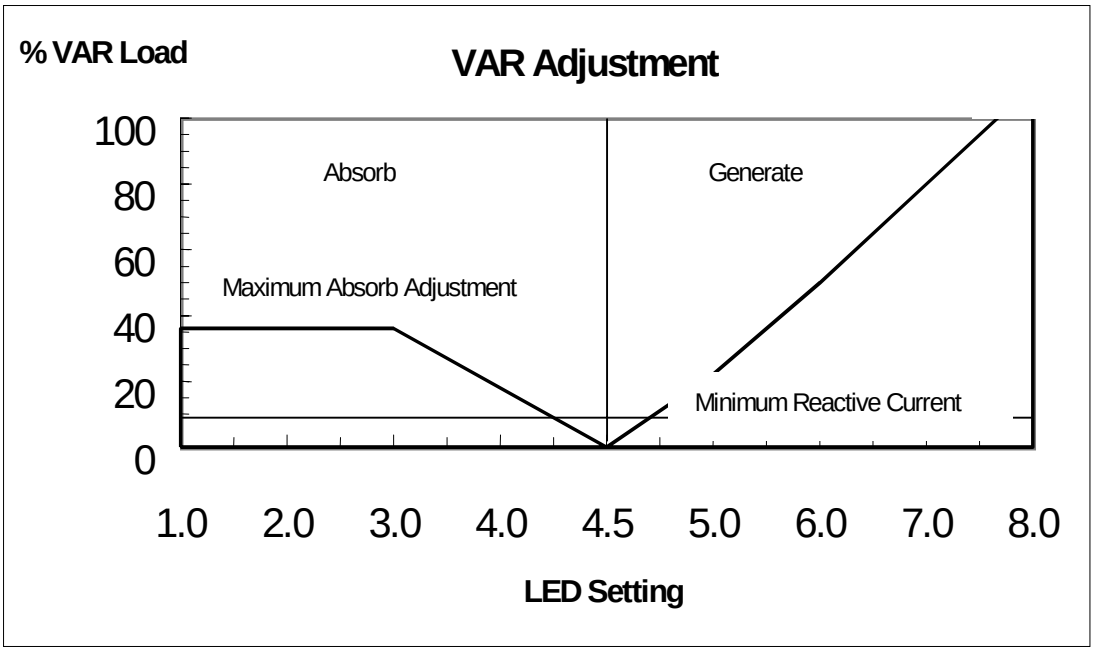


FIGURE 7A- VAR ADJUSTMENT

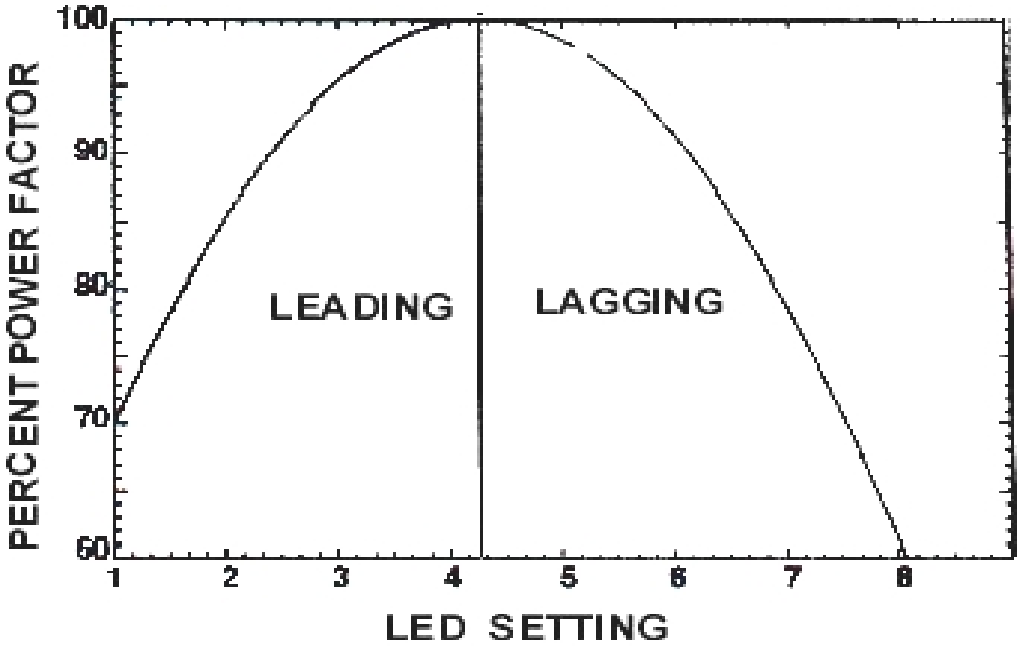


FIGURE 7B - POWER FACTOR ADJUSTMENT

SECTION 5 - TROUBLE SHOOTING

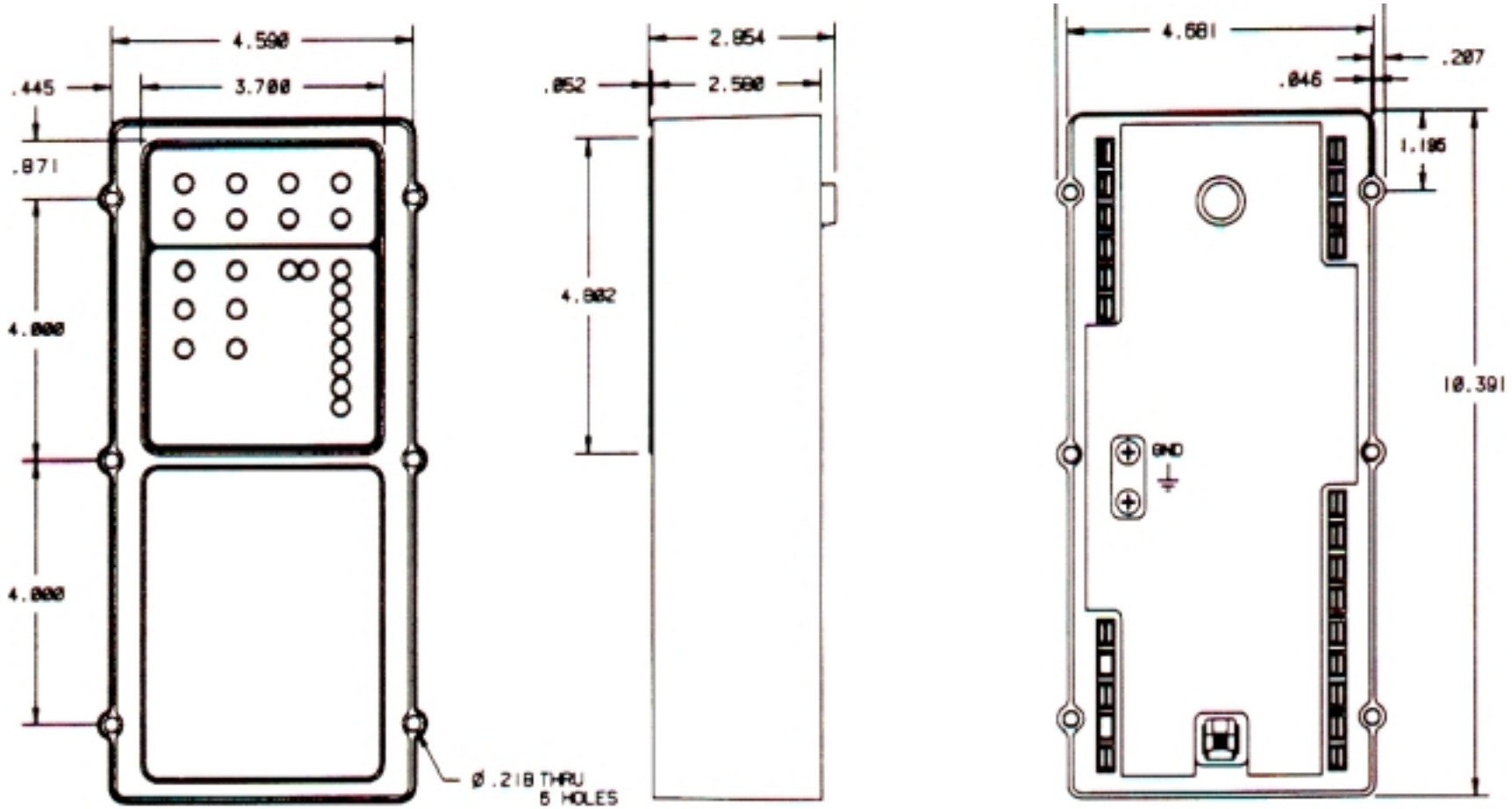
Symptom	Cause	Action
No voltage buildup	F1, F2 leads not connected	Connect field leads Fl and F2.
	Input Power leads not connected.	Connect PMG leads.
	No PMG voltage- Possible shorted 7.5uf capacitor or defective PMG. (Refer to generator manual for PMG replacement procedure)	Check PMG voltage. Normally 180-200v with 7.5uf capacitor connected and 150-160v without capacitor connected.
	Fuse blown.	Replace fuse with Littelfuse type 314005 or Bussman type ABC-5.
	Generator is not up to speed.	Increase generator speed (Consult prime mover manual).
	Coarse voltages adjust set to minimum.	Increase coarse voltage adjust (See Section 4).
	Over-excitation LED on.	Exciter field voltage exceeds 80v. Check generator and/or load conditions. Interrupt input power to regulator or shut down generator for a minimum of 10 seconds.
	L.O.S. LED on.	Loss of sensing - check sensing leads for proper connections. Interrupt input power to regulator or shut down generator for a minimum of 20 seconds.
	Over-voltage LED on.	PMG and field leads grounded. Isolate both PMG and field leads from ground. Generator voltage exceeded 115% for 3/4 sec. Interrupt input power to regulator or shut down generator for a minimum of 10 seconds.
	Over-temperature LED on.	Regulator temperature too high. Increase cooling air to regulator or let ambient cool down. Interrupt input power to regulator or shut down generator for a minimum of 10 seconds.
	Defective generator.	Consult generator manual.

Symptom	Cause	Action
Output Voltage Low	Coarse Voltage Adjust set low. Fine Voltage Adjust set low.	Increase Coarse Voltage Adjustment (Section 4). Increase Fine Voltage Adjustment (Section 4).
Output Voltage High	Coarse Voltage Adjust set high. Fine Voltage Adjust set high.	Decrease Coarse Voltage Adjustment (Section 4). Decrease Fine Voltage Adjustment (Section 4).
Generator does not respond as adjustments are made.	Regulator software is locked.	Reset regulator. Interrupt input power to regulator or shut down generator for a minimum of 10 seconds.
Poor Voltage Regulation	Regulator not properly grounded. Field leads grounded. PMG leads grounded.	Ground regulator. Check field leads and isolate from ground. Check PMG leads and isolate from ground.
Remote Voltage Control Operates Backwards.	Control wired backwards.	Reverse the wiring on the remote voltage control (Section 3).
Remote Voltage Control functions in one direction only.	Center terminal reversed with end terminal, One terminal not wired. Both “6U” and “6D” are being connected to “7” at the same time.	Recheck the wiring on the remote voltage control (Section 3).
Generator Voltage Hunting	Stability Range not set properly. Stability not set properly. Intermittent connection to PMG terminals. Intermittent connection to sensing terminals.	Adjust Stability Range Adjust Stability (Section 4). Check wiring to PMG terminals. Check wiring to sensing terminal

Symptom	Cause	Action
Under Frequency LED on.	Operating at reduced speed. Under Frequency incorrectly adjusted. Intermittent connection to PMG terminals.	Increase generator speed. Adjust Under Frequency (Section4). Check wiring to PMG terminals.
Over-excitation LED on.	Generator overloaded. Generator defective.	Reduce generator load. Check exciter rotor winding resistance. (See generator manual). Check exciter field winding resistance. (See generator manual) Check rotating rectifier for shorted diodes. (See generator manual) Check main rotor winding resistance. (See generator manual)
Field Limit LED on. **(Over-excitation LED on).**	Regulator operating in field current limit.	Check for F+ F- short. Check exciter field winding resistance. (See generator manual) Check exciter rotor winding resistance. See generator manual) Check rotating rectifier for shorted diodes. (See generator manual) Check main rotor winding resistance. (See generator manual)
No Droop Control or Negative Droop (Generator does not share load).	Open connection to terminals CTB1& CTB2. Droop transformer connected back-wards. Droop transformer is in the wrong phase Sensing connections incorrect.	Check connection to terminals CTBI & CTB2 and paralleling transformer. Reverse connections to terminals CTBI & CTB2. Refer to Section 3 and Section 7 for proper installation. Refer to Section 3 and Section7 for proper sensing connections

Symptom	Cause	Action
No LED scans during power up or long time for LED scans to be accomplished.	Regulator improperly connected.	Check connections to regulator.
All LED's off but regulator working.	Regulator software is locked.	Reset regulator. Interrupt input power to regulator for minimum of 10 seconds.
Long time for LED scan to be accomplished,	Exciter field (F-, F+) circuit is open, or has high resistance.	Check exciter field terminals and resistance.
Voltage does not build up after engine is idled.	Regulator software locks up during engine idle.	Add additional contacts to idle/run switch to open PMG power during idle.
Regulator fails immediately after replacement	Shorted diode on exciter.	Check and replace shorted diode.

DIMENSIONS OF THE DVR2000 & DVR2000C



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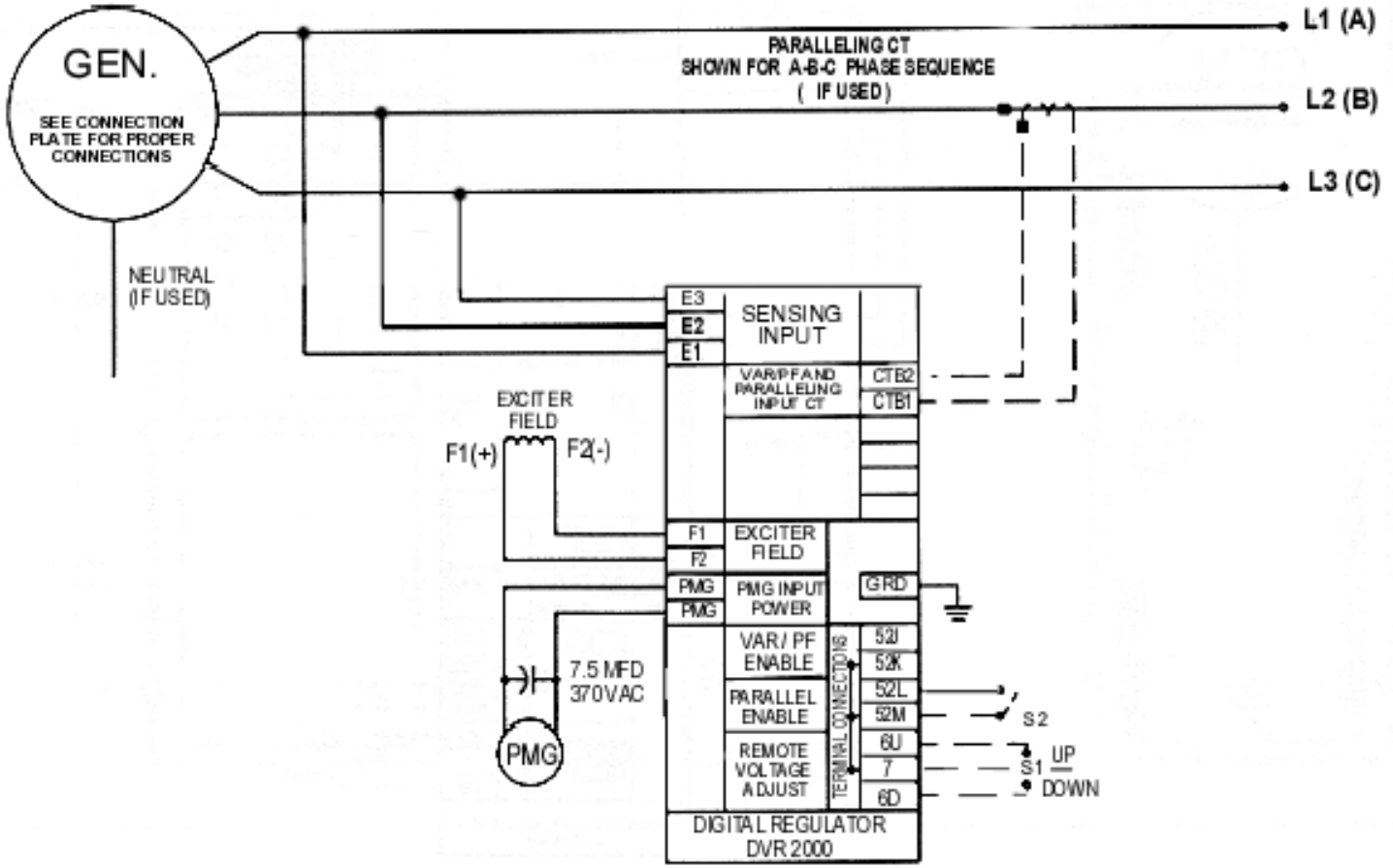
TYPICAL CONNECTION - THREE PHASE SENSING (95-600 VOLTS)



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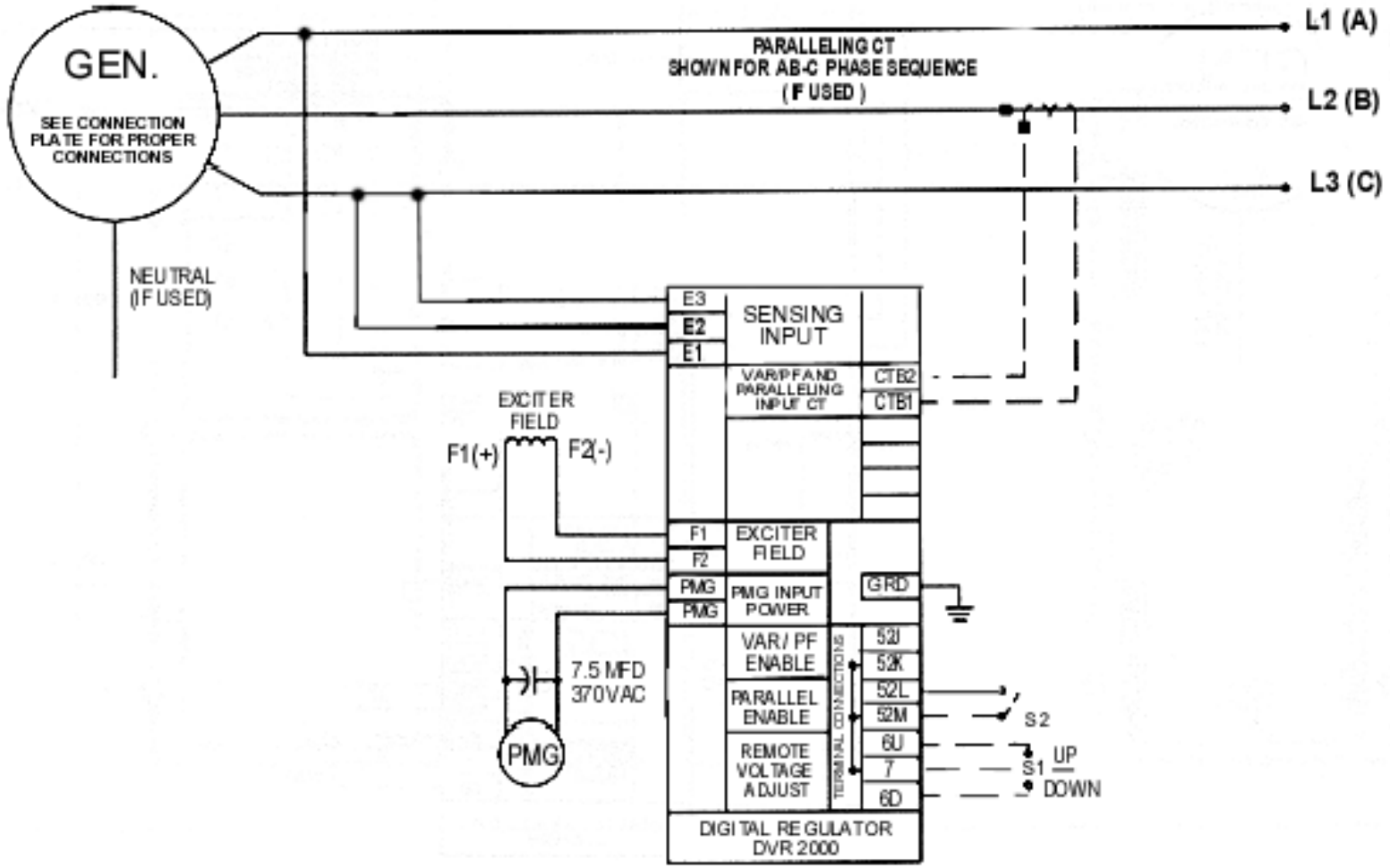
TYPICAL CONNECTION - SINGLE PHASE SENSING (95-600 VOLTS)



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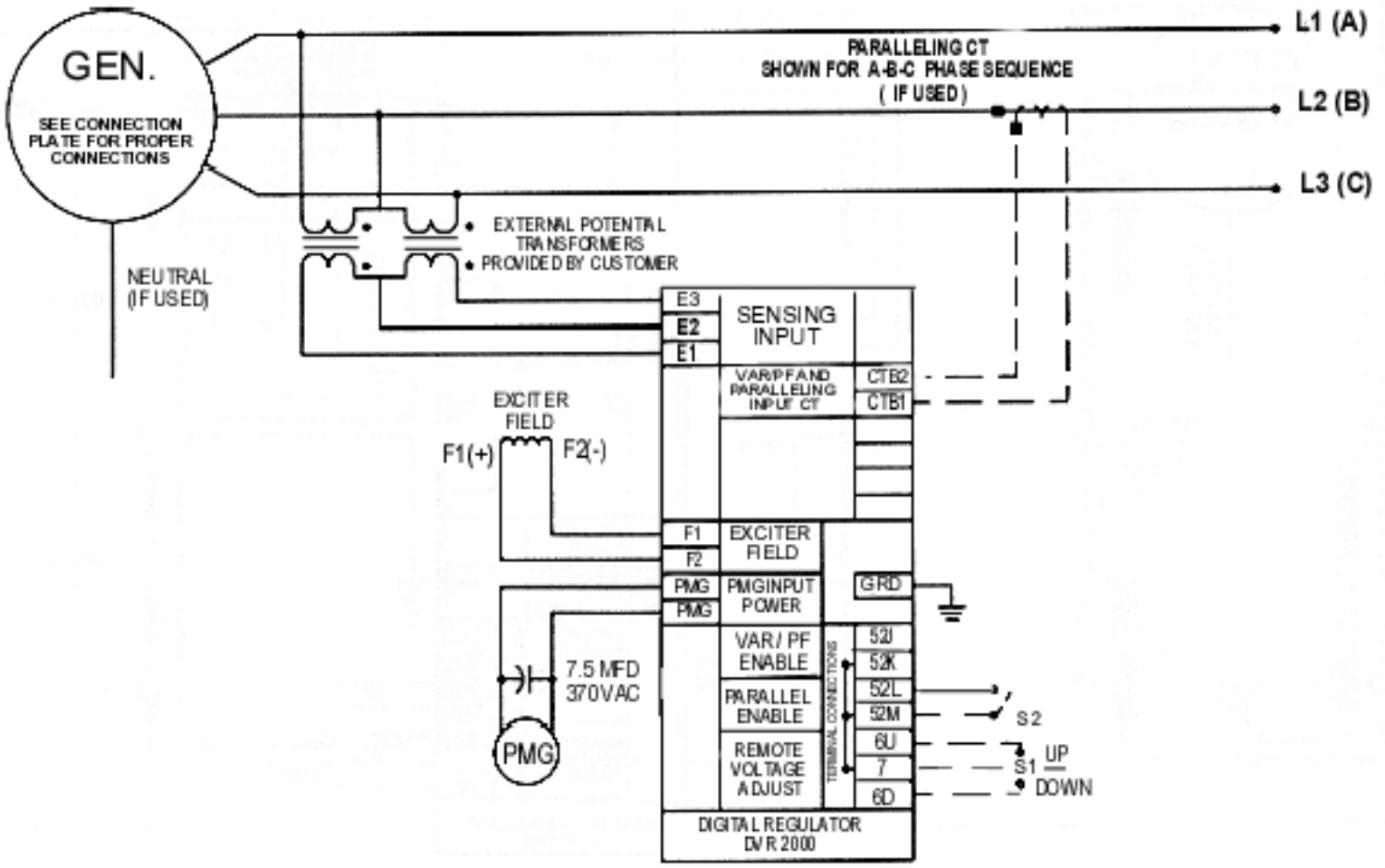
TYPICAL CONNECTION - THREE PHASE SENSING (601-6600 VOLTS)



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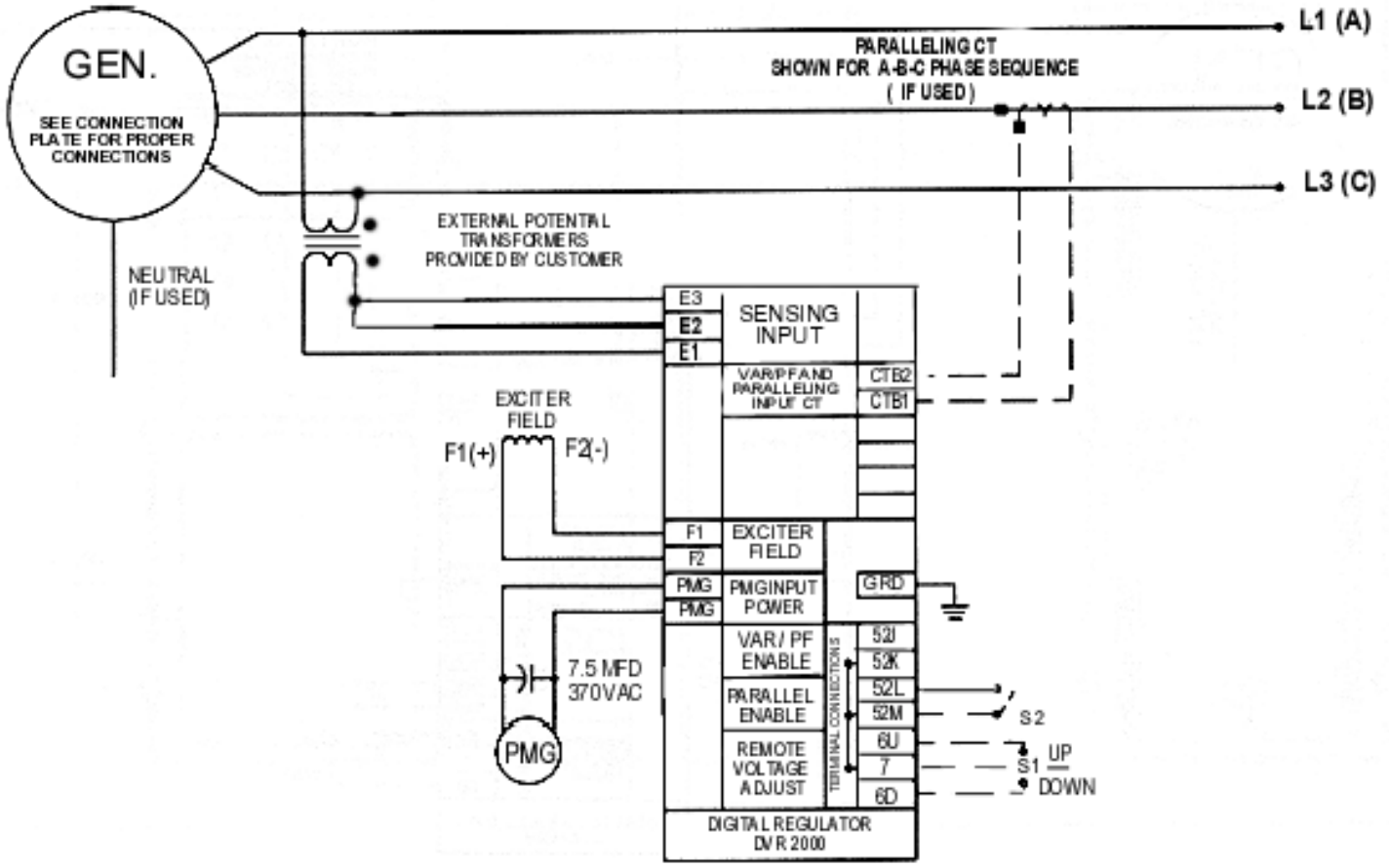
TYPICAL CONNECTION - SINGLE PHASE SENSING (601-6600 VOLTS)



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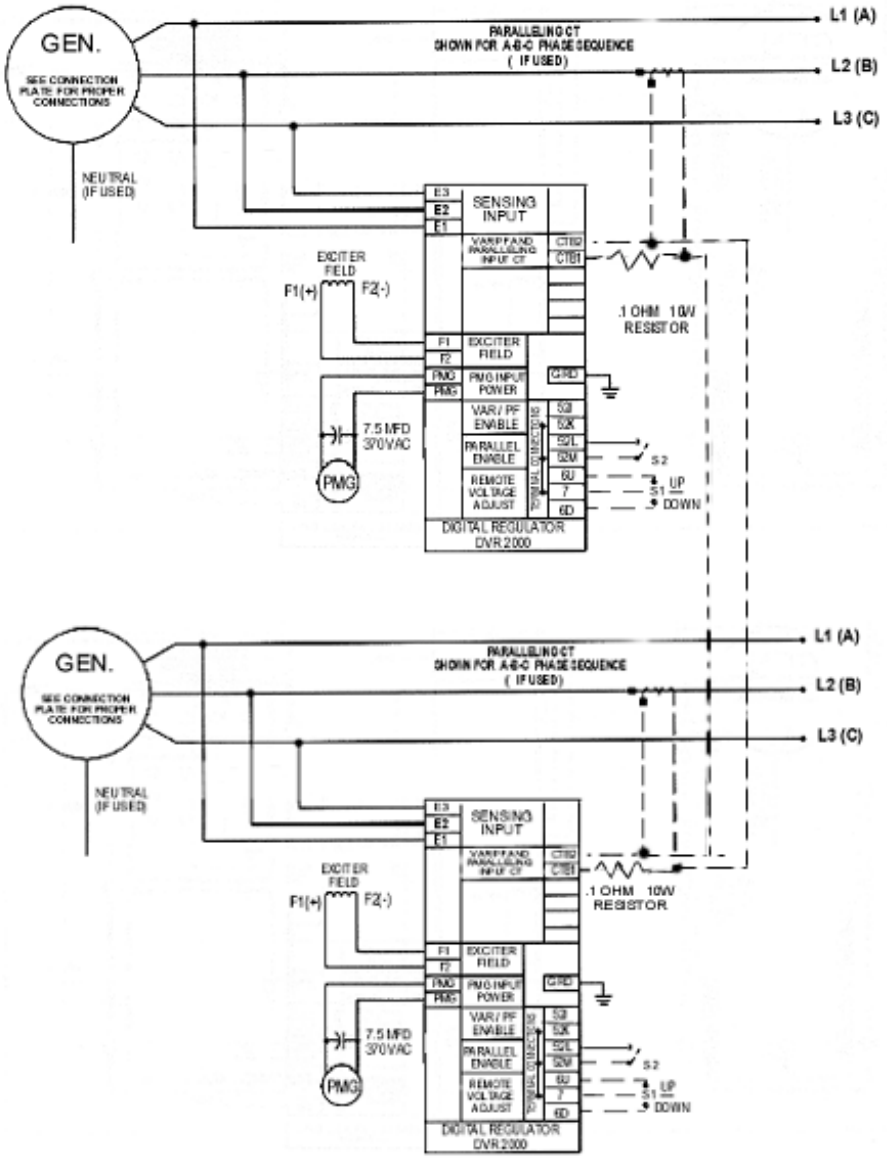
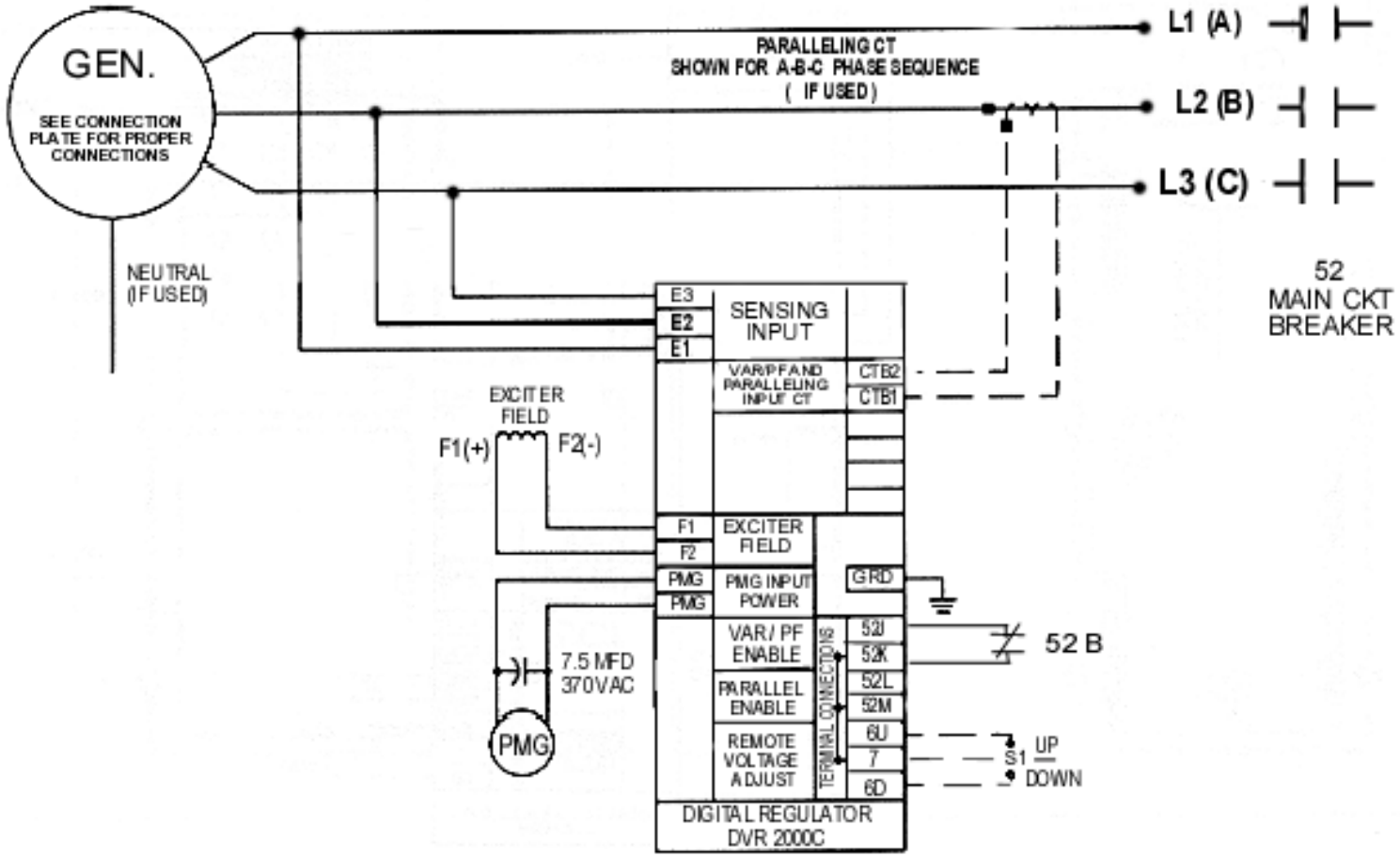
TYPICAL CONNECTION WITH REACTIVE DIFFERENTIAL PARALLELING

THREE PHASE SENSING (95-600 VOLTS)



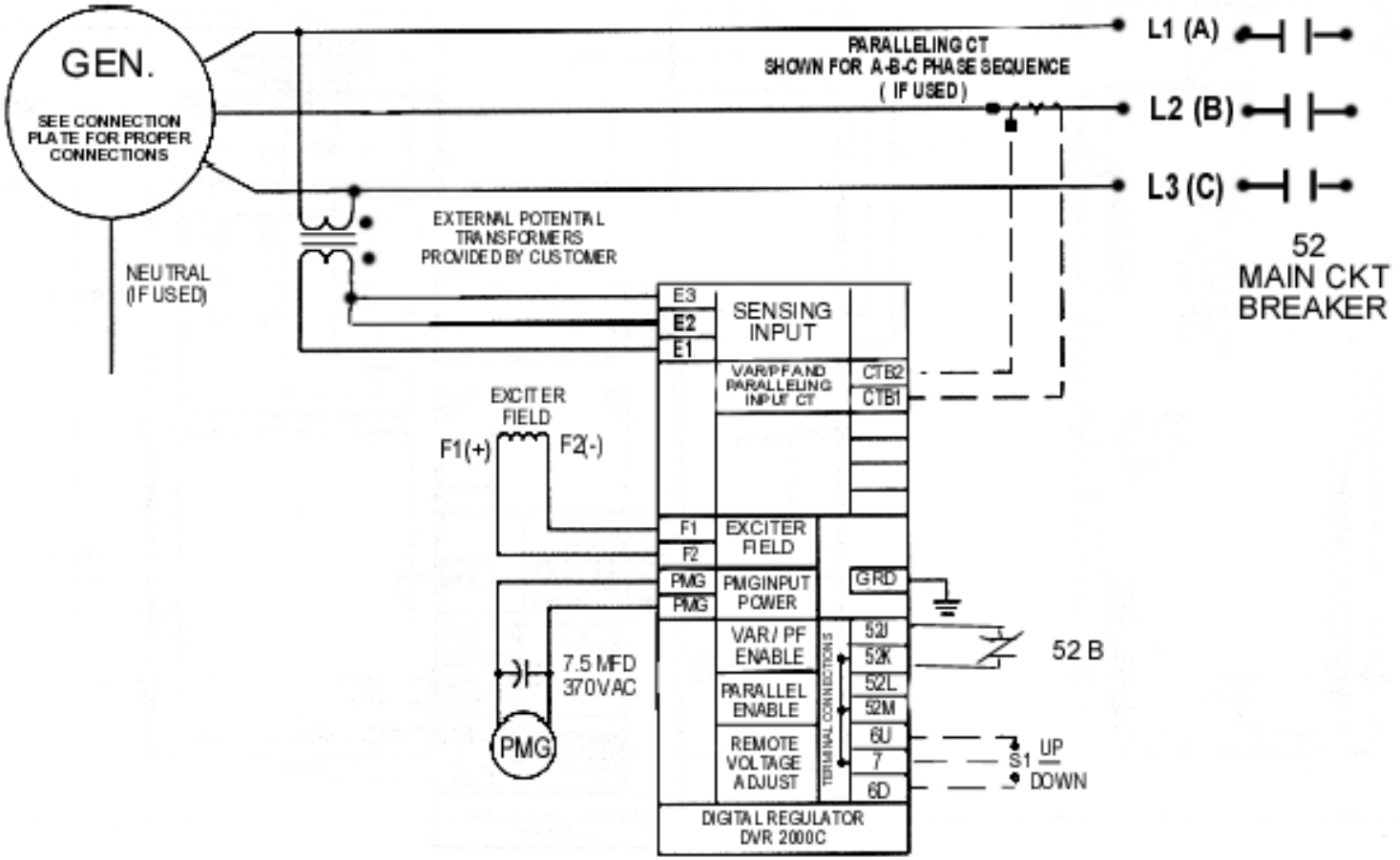
TYPICAL CONNECTION WITH VAR / PF CONTROL

THREE PHASE SENSING (95-600 VOLTS)



TYPICAL CONNECTION WITH VAR / PF CONTROL

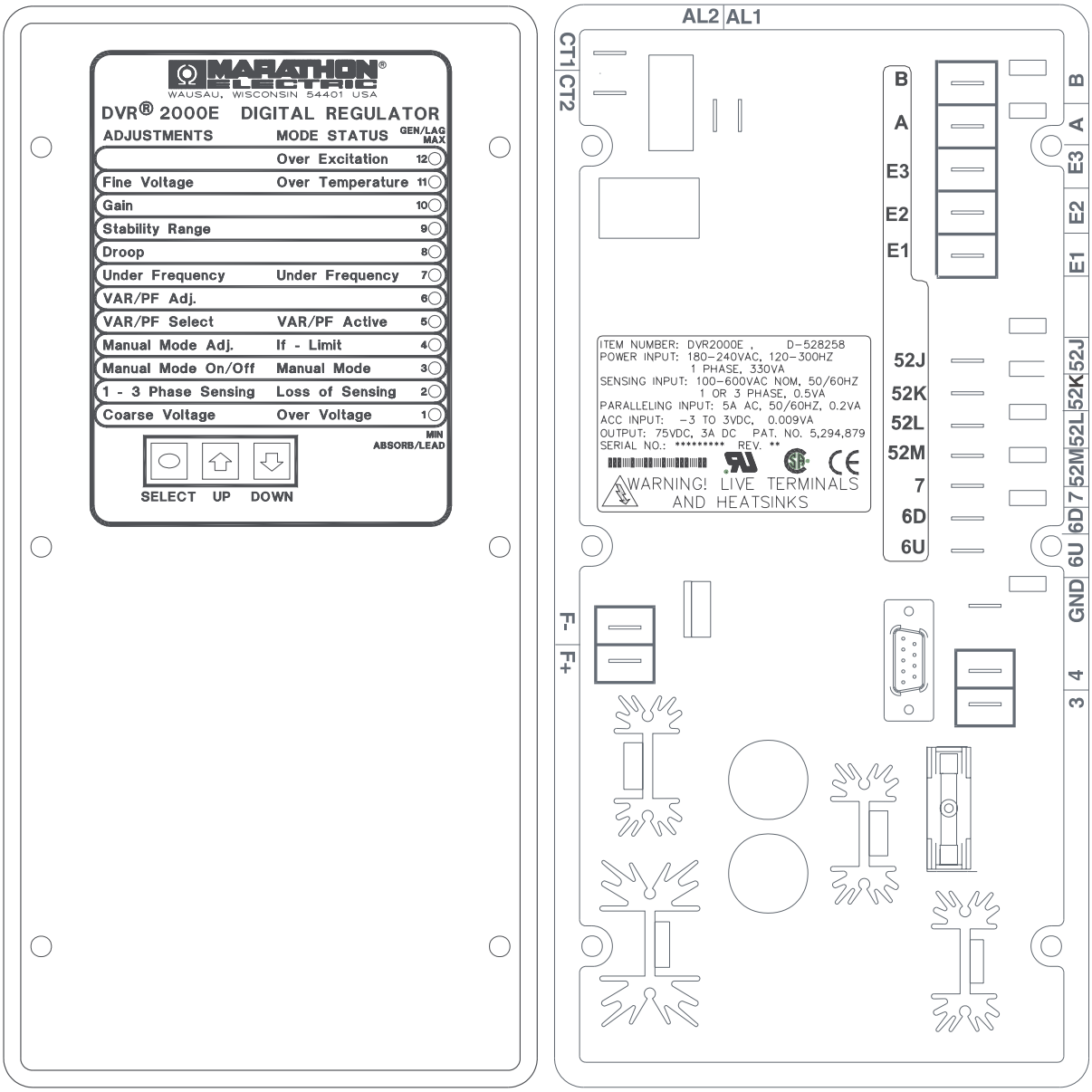
SINGLE PHASE SENSING AND ISOLATION TRANSFORMER



KATOLIGHT CORPORATION

DVR®2000E

Installation, Operation, and Maintenance Manual



INTRODUCTION

This manual provides information concerning the operation and installation of the DVR2000E, Digital Voltage Regulator. To accomplish this, the following is provided:

- General Information and Specifications
- Human-Machine Interface
- Functional Description
- Installation
- Software for Windows Operating System
- Software for the Palm Operating System Platform
- Maintenance and Troubleshooting

WARNING!

DVR2000E presents an electric shock risk. Terminals and heat sinks are live at potentially lethal voltages. This high voltage may cause electrical shock that could result in injury or death.

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures presented in this manual.

CAUTION

Meggers and high potential test equipment should be used with extreme care. Incorrect use of such equipment could damage components contained in the device.

It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice.

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SECTION 1 • GENERAL INFORMATION

Section 1

GENERAL

The DVR2000E is an electronic, solid-state, microprocessor-based control device. The DVR2000E regulates the output voltage of a brushless, ac generator by controlling the current into the generator exciter field. Input power to the DVR2000E is from a multi-pole, high-frequency, permanent magnet generator (PMG).

The DVR2000E is supplied in an encapsulated package designed for behind-the-panel mounting. The DVR2000E is held in place by thread-forming screws that thread into its plastic shell. Front panel indicators (LEDs) annunciate regulator status and system conditions. DVR2000E connections are made through quarter-inch, quick-connect terminals on the rear panel. A 9-pin DB-9 type connector on the rear panel provides communication between the DVR2000E and an IBM compatible PC.

FEATURES

DVR2000E units have the following features and capabilities.

- Four control modes: automatic voltage regulation (AVR), manual or field current regulation (FCR), power factor (PF) regulation, and reactive power (Var) regulation.
- Programmable stability settings.
- Soft start control with an adjustable time setting in AVR control mode.
- Overexcitation (OEL) limiting in AVR, Var, and PF control modes.
- Underfrequency (volts/hertz) regulation.
- Crowbar circuitry protects the field.
- Overtemperature protection.
- Three-phase or single-phase generator voltage (RMS) sensing/regulation in AVR mode.
- Single-phase generator current sensing for metering and regulation purposes.
- Field current and field voltage sensing.
- Four contact sensing inputs for system interface.
- One common output relay for alarm indication and trip functions.
- Six protection functions (overexcitation shutdown, generator overvoltage shutdown, DVR overtemperature shutdown, loss of generator sensing shutdown, overexcitation limiting and crowbar shutdown).
- Generator paralleling with reactive droop compensation and reactive differential compensation.
- Front-panel human-machine interface (HMI) indicates system and DVR2000E status and gives the ability to make setting changes at the front panel.
- Rear RS-232 communication port for personal computer communication using DVR2000E-32 Windows® based software for fast, user-friendly, setup and control.

SPECIFICATIONS

DVR2000E electrical and physical specifications are listed in the following paragraphs. The adjustment increments shown apply to the PC software. Adjustment increments for the Front Panel Controls are listed in Section 2.

Operating Power

Single-Phase:	180 to 240 Vac
Frequency Range:	200 to 360 Hz
Burden:	350 VA
Terminals:	3, 4

Generator Voltage Sensing

Type:	1-phase/3-phase, 4 ranges, 50/60 Hz
Terminals:	E1, E2, E3
Burden:	<1 VA per phase
Range 1:	120 Vac (100 to 140 Vac)
Range 2:	240 Vac (200 to 280 Vac)
Range 3:	480 Vac (400 to 560 Vac)
Range 4:	600 Vac

Generator Current Sensing

Type:	1-phase (BØ), 50/60 Hz
Rating:	5 Aac maximum continuous
Burden:	<0.1 VA
Terminals:	CT1, CT2

Contact Input Circuits

Type:	Dry Contact
Interrogation Voltage:	13 Vdc
Terminals	
Unit/Parallel Control:	52L, 52M
Raise:	6U, 7
Lower:	6D, 7
Var/PF Enable	52J, 52K

Common Alarm Output

Type:	Form A
Rated Load:	7 Aac/7 Adc continuous
Make:	30 Aac/30 Adc, carry for 0.2 sec
Break:	7 Aac/0.1 Adc
Operating Voltage:	240 Vac/250 Vdc maximum
Terminals:	AL1, AL2

Field Output

Continuous Rating:	75 Vdc, 3.0 Adc
10 Second Forcing Rating	
200 Vac Power Input:	150 Vdc, 7.5 Adc
Field Resistance:	18 Ω minimum
Terminals:	F+, F-

AVR Operating Mode

Adjustment Range:	See generator voltage sensing
Voltage Regulation:	±0.25% over load range at rated power factor and constant generator frequency.
Temperature Drift:	±0.5% for a 40°C change
Response Time:	≤1 cycle
Underfrequency (V/Hz)	
Characteristic:	Slope from 1 to 3PU is adjustable in 0.01 increments.
Range:	40 to 65 Hz
Increment:	0.01 Hz

FCR (Manual) Operating Mode

Adjustment Range:	0 to 3 Adc
Increment:	0.01 A

Var Operating Mode (Optional)

Adjustment Range:	100% to –100%
Increment:	0.1%

PF Operating Mode (Optional)

Adjustment Range:	0.6 lead to 0.6 lag
Increment:	0.001

Parallel Compensation

Modes:	Reactive Droop and Reactive Differential (cross-current)*
Droop	
Adjustment Range:	0 to 10%
Increment:	0.01%

*Burden can exceed 1 VA if external resistors are added to the CT circuit.

Communication Port

Interface:	Full Duplex RS-232
Connection:	DB-9 connector on rear panel
Baud:	4800
Data Bits:	8
Parity:	None
Stop Bit:	1

Field Overvoltage Protection

Pickup:	0 -250 Vdc
Time Delay:	15 seconds (fixed)

Field Overcurrent Protection

Pickup	
Adjustment Range:	0 to 7.5 Adc
Increment:	0.001 Adc
Time Delay	
Adjustment Range:	0 to 10 seconds
Increment:	1 second

Generator Overvoltage Protection

Pickup	
Range:	105 to 120% of setpoint
Increment:	1.0%
Time Delay	
Fixed Setting:	0.75 seconds

Soft-Start Function

Time Adjust Range:	1 to 120 seconds
Increment:	1 second

Analog (Auxiliary) Input

Voltage Range:	-3 Vdc to +3 Vdc
Setpoint Range:	-30% to +30% shift
Burden:	1 kΩ
Terminals:	A, B

Metering

Accuracy of all metering values assumes 25°C, 50/60 Hz and less than 20% THD.

Generator Voltage

Range:	10 V to 79 kV
Accuracy:	0.5%

Generator Current

Range:	0.1 to 5,000 A (5 A CTs)
Accuracy:	0.5%

Frequency

Range:	40 to 65 Hz
Accuracy:	0.2 Hz

Field Voltage

Range:	0 to 200 Vdc
Accuracy:	5.0%

Field Current

Range:	0 to 8.0 Adc
Accuracy:	0.5%

Power (Apparent, Real and Reactive)

Range:	0 to 99 MVA, MW and MVar
Accuracy:	3.0%

Power Factor

Range:	-1.0 to –0.6, +0.6 to +1.0
Accuracy:	0.02

Phase Angle

Range:	0 to 360°
Accuracy:	2.0°

Environment

Operating Temp.:	-40°C to +70°C (-40°F to +158°F)
Storage Temp.:	-40°C to +85°C (-40°F to +185°F)

Type Tests

Shock:	20 Gs in 3 perpendicular planes
Vibration:	1 G at 5 to 26 Hz 0.036” double amplitude (27 to 52 Hz) 5 Gs at 53 to 500 Hz
Salt Fog:	Tested per MIL-STD-810E

Physical

Weight:	1.52 lb. (690 g)

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SECTION 2 • HUMAN-MACHINE INTERFACE

GENERAL

The DVR2000E human-machine interface (HMI) consists of front panel controls and indicators and a rear panel communication port.

FRONT PANEL CONTROLS AND INDICATORS

Section 2

DVR2000E front panel controls and indicators consist of 12 red LEDs and three pushbuttons. Figure 2-1 illustrates the front panel controls and indicators of the DVR2000E. The LEDs indicate control mode and status conditions and are also used when adjusting settings at the front panel.

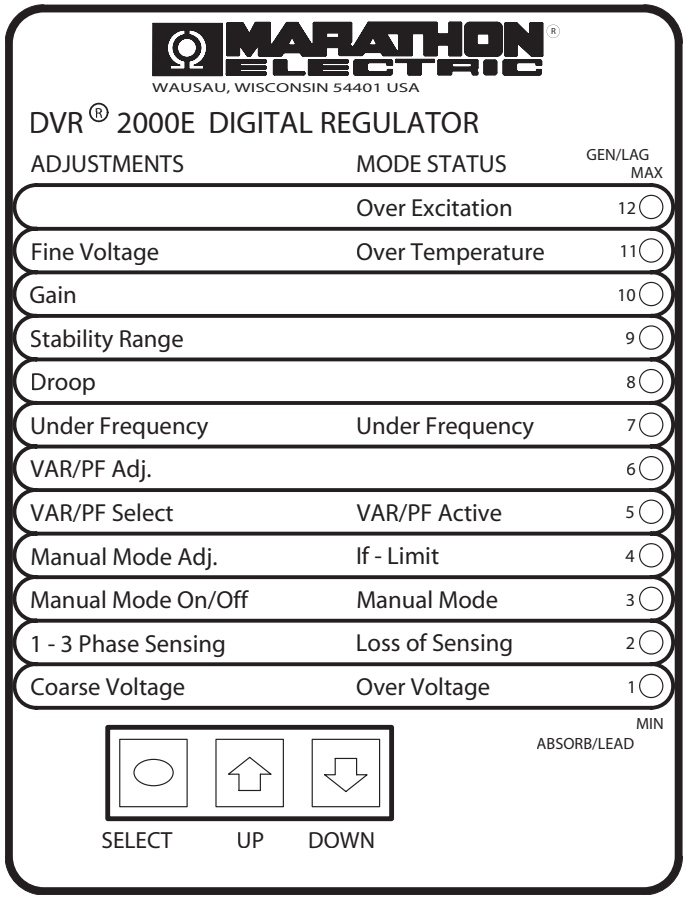

Figure 2-1. DRV2000E Front Panel Indicators

Table 2-1. DVR2000E Front Panel Control Descriptions

Control	Description
SELECT	This pushbutton selects a function for adjustment. Successive presses of the SELECT pushbutton scrolls through the list of DVR2000E functions to be adjusted.
UP	This pushbutton increases the setting level of the function being adjusted.
DOWN	This pushbutton decreases the setting level of the function being adjusted.

Table 2-2. DVR2000E Front Panel Mode Status Indicator Descriptions

Indicator	Description
Over Excitation LED #12	This LED blinks rapidly when the Overexcitation Protection feature is enabled and the field voltage exceeds the setpoint (80 V default) for 15 seconds. The DVR2000E will shut down when an overexcitation condition is detected. The Over Excitation LED blinks for 5 seconds when the DVR2000E is powered up following an overexcitation condition.
Over Temperature LED #11	This LED blinks rapidly when the internal temperature of the DVR2000E has exceeded its limit and causes the unit to shut down.
Under Frequency LED #7	This LED blinks rapidly during an under frequency condition.
Var/PF Active LED #5	This LED blinks rapidly when operating in Var or Power Factor mode.
If – Limit LED #4	This LED blinks rapidly when the field current exceeds the programmed overexcitation limit. It will continue to flash until the overexcitation condition ceases or the overexcitation time delay expires and the DVR2000E shuts down. The Overexcitation Limiting LED flashes for 5 seconds when the DVR2000E is powered up following an overexcitation limiting condition.
Manual Mode LED #3	This LED blinks rapidly when operating in Manual mode.
Loss of Sensing LED #2	This LED blinks rapidly when a loss of generator sensing voltage is detected. The DVR2000E will shut down. The Loss of (Generator) Sensing LED flashes for 5 seconds when the DVR2000E is powered up following shutdown for loss of generator sensing condition.
Over Voltage LED #1	This LED blinks rapidly when the generator output voltage exceeds the setpoint for 0.75 seconds. The DVR2000E will shut down when a generator overvoltage condition is detected. The (Generator) Overvoltage LED flashes for 5 seconds when the DVR2000E is powered up following a generator overvoltage condition.

INITIAL ADJUSTMENTS

CAUTION

Read and understand the operation of the individual adjustments before attempting any initial adjustments.

Before starting the generator, the procedures in the following paragraphs should be performed.

Remove the 5 ampere fuse before starting the generator for the first time. Perform all preliminary engine governor adjustments without the regulator energized.

After initial governor adjustments are complete, reinstall the 5 ampere fuse and connect only the power input leads or PMG leads to the regulator. Remove all other regulator connections that may be present and temporarily insulate them.

Start and run the generator at rated speed. The regulator will perform the self-test and enter a shutdown mode. At this time, initial adjustments can be made. To do this, step through each adjustment using the “SELECT” button. For each adjustment, press the “UP” or “DOWN” button to obtain the desired level on the LED bar graph.

After the initial adjustments are made, shut down the generator and connect the remaining regulator leads. The generator may be started and final adjustments may be performed on the regulator.

MAKING SETTINGS CHANGES

The following paragraphs describe how the HMI is used to make setting changes.

Front Panel Operation

The LEDs indicate control mode and status conditions and are also used when adjusting settings at the front panel. Repeatedly pressing the “SELECT” button steps through the various adjustments, starting with the “Course Voltage” adjustment and progressing through to the “Fine Voltage” adjustment. The next press of the “SELECT” button exits the adjustment mode.

When in the adjustment mode, only the adjustment LEDs will be lit. All mode status LEDs will be turned off. Adjustment LEDs are of two types. The first type is the LED that indicates the function being adjusted. This LED blinks slowly (approximately once per second). The second type is the LED that indicates the level of adjustment. This LED is on steady. The level of adjustment is changed by pressing the “UP” or “DOWN” button. When an adjustment level LED (on steady) overlaps the function LED (slow blinking), the LED will remain in the slow blinking mode. If no button is pressed for a period of one minute, the regulator saves the settings and exits the adjustment mode. If regulator power is interrupted before the automatic save feature is commanded, that level of adjustment will be lost.

When the regulator is not in the adjustment mode and either the “UP” or “DOWN” button is pressed, the regulator enters the “Fine Voltage” adjustment mode and changes the generator fine voltage set point by 0.1V. Successive presses of the “UP” or “DOWN” button shall continue to adjust the fine voltage setting. Pressing the “SELECT” button causes the regulator to exit the adjustment mode. Mode status LEDs blink approximately twice per second.

Table 2-3. DVR2000E Front Panel Adjustment Indicator Descriptions

Indicator	Description
Fine Voltage LED #11	This LED blinks slowly when the “Fine Voltage” level is selected for adjustment via the front panel push buttons.
Gain LED #10	This LED blinks slowly when the “Gain” adjustment is selected for fine tuning of loop gain via the front panel push buttons.
Stability Range LED #9	This LED blinks slowly when selecting the desired “Stability Range” via the front panel push buttons.
Droop LED #8	This LED blinks slowly when the “Droop” percentage level is selected for adjustment via the front panel push buttons.
Under Frequency LED #7	This LED blinks slowly when the “Under Frequency” knee point is selected for adjustment via the front panel push buttons.
VAR/PF Adjust LED #6	This LED blinks slowly when the level of the programmed mode (VAR or Power Factor) is selected for adjustment via the front panel push buttons (DVR2000EC only).
VAR/PF Select LED #5	This LED blinks slowly when selecting the programmed mode (VAR, Power Factor, or none(AVR)) via the front panel push buttons. When in this adjustment mode, LED #1 is on solid for none(AVR), LED #2 is on solid for Power Factor mode, and LED #3 is on solid for VAR mode (DVR2000EC only).
Manual Mode Adj. LED #4	This LED blinks slowly when the “Manual Mode” (field current) regulation set point is selected for adjustment via the front panel push buttons.
Manual Mode On/ Off LED #3	This LED blinks slowly when selecting or deselecting “Manual Mode” (field current regulation) as the active operating mode via the front panel pushbuttons. When in this adjustment mode, LED #1 is on if Manual Mode is off, LED #2 is on if Manual Mode is on.

1 - 3 Phase Sensing LED #2	This LED blinks slowly when selecting single or three phase sensing via the front panel push buttons. When in this adjustment mode, LED #1 is on if single phase sensing is selected, LED #3 is on if three phase sensing is selected.
Coarse Voltage LED #1	This LED blinks slowly when the “Coarse Voltage” level is selected for adjustment via the front panel push buttons.

Setting Level Indication

Indication of a setting level is provided by the 12 front panel LED indicators. The upper limit of a setting range is represented by the top LED which is labeled GEN/LAG and MAX. The lower limit of a setting range is represented by the bottom LED which is labeled MIN and ABSORB/LEAD. The setting range for each LED is summarized in Tables 2-4 through 2-15. LEDs in the tables are numbered from 1 to 12 with 1 being the lowermost LED (labeled MIN/ABSORB/LEAD) and 12 being the uppermost LED (labeled GEN /LAG/MAX.

Table 2-4. Coarse Voltage Adjust Setting Ranges

Coarse Voltage – LED 1 Blinking Slowly Maximum Adjustment Range Increment: 6 Vac				
	Increase		Decrease	
LED	Minimum Value	Maximum Value	Minimum Value	Maximum Value
12	563	600	558	600
11	521	557	516	552
10	479	515	474	510
9	437	473	432	468
8	395	431	390	426
7	353	389	348	384
6	311	347	306	342
5	269	305	264	300
4	227	263	222	258
3	185	221	180	216
2	143	179	138	174
1	95	137	95	132

Table 2-5. Sensing Mode (Single-phase/Three-phase) Select

Single-phase/Three-phase select – LED #2 Blinking Slowly	
LED	MODE
12	N/A
11	N/A
10	N/A
9	N/A
8	N/A
7	N/A
6	N/A
5	N/A
4	N/A
3	Three-phase
2	N/A
1	Single-phase

Table 2-6. Manual Mode (On/Off) Select

Manual Mode On/Off – LED 3 Blinking Slowly	
LED	MODE
12	N/A
11	N/A
10	N/A
9	N/A
8	N/A
7	N/A
6	N/A
5	N/A
4	N/A
3	N/A
2	ON
1	OFF

Table 2-7. Manual Mode (If – Limit) Adjustment Ranges

Manual Mode Adjust – LED 4 Blinking Slowly Adjustment Range: 0 to 3 Adc Increment: 0.01 Adc		
LED	Minimum Value	Maximum Value
12	2.75	3
11	2.50	2.74
10	2.25	2.49
9	2.00	2.24
8	1.75	1.99
7	1.50	1.74
6	1.25	1.49
5	1.00	1.24
4	0.75	0.99
3	0.50	0.74
2	0.25	0.49
1	0	0.24

Table 2-8. On-Line Operating Mode (AVR (OFF)/VAR/PF) Select *

AVR (OFF) / VAR / PF Select – LED #5 Blinking Slowly	
LED	MODE
12	N/A
11	N/A
10	N/A
9	N/A
8	N/A
7	N/A
6	N/A
5	N/A
4	N/A
3	Var
2	PF
1	AVR

* Var/PF control is available only on DVR2000EC.

Table 2-9. VAR Control Adjustment Ranges *

VAR Control Adjust – LED 6 Blinking Slowly Maximum Adjustment Range: –100% (absorb) to +100% (generate) Increment: 1.0%		
LED	Minimum Value †	Maximum Value †
12	84	100
11	67	83
10	51	66
9	34	50
8	17	33
7	1	16
6	-16	0
5	-33	-17
4	-49	-34
3	-66	-50
2	-83	-67
1	-100	-84

* Var/PF control is available only on DVR2000EC.

† Minimum and maximum values may differ from the Table 2-9 values if the value has been changed in DVR2000E-32 software. DVR2000E-32 software has 0.5 percent resolution compared to the 1.0 percent resolution of the HMI.

Table 2-10. Power Factor Control Adjustment Ranges *

Power Factor Control Adjust – LED 6 Blinking Slowly Maximum Adjustment Range: +0.6 (lag) to –0.6 (lead) Increment: 0.01		
LED	Minimum Value †	Maximum Value †
12	0.66	0.60
11	0.73	0.67
10	0.80	0.74
9	0.86	0.81
8	0.93	0.87
7	1.0	0.94
6	-0.94	-0.99
5	-0.87	-0.93
4	-0.80	-0.86
3	-0.74	-0.79
2	-0.67	-0.73
1	-0.60	-0.66

* Var/PF control is available only on DVR2000EC.

† Minimum and maximum values may differ from the Table 2-10 values if the value has been changed in DVR2000E-32 software. DVR2000E-32 software has 0.001 resolution compared to the 0.01 resolution of the HMI.

Table 2-11. Underfrequency Adjustment Ranges

Underfrequency Adjust – LED 7 Blinking Slowly Maximum Adjustment Range: 40 to 65 Hz Increment: 0.1 Hz		
LED	Minimum Value	Maximum Value
12	63.0	65.0
11	60.9	62.9
10	58.8	60.8
9	56.7	58.7
8	54.6	56.6
7	52.5	54.5
6	50.5	52.4
5	48.4	50.4
4	46.3	48.3
3	44.2	46.2
2	42.1	44.1
1	40.0	42.0

Table 2-12. Droop Adjustment Ranges

Droop Adjust – LED 8 Blinking Slowly Adjustment Range: 0 to 10% Increment: 0.25%		
LED	Minimum Value *	Maximum Value *
12	9.25	10.00
11	8.5	9.00
10	7.75	8.25
9	6.75	7.50
8	6.00	6.50
7	5.25	5.75
6	4.25	5.00
5	3.5	4.00
4	2.75	3.25
3	1.75	2.5
2	1	1.5
1	0	0.75

* Minimum and maximum values may differ from the Table 2-12 values if the value has been changed in DVR2000E-32 software. DVR2000E-32 software has 0.01% resolution compared to the 0.25 percent resolution of the HMI.

Table 2-13. Stability Range Selection Settings

Stability Range Select – LED 9 Blinking Slowly Adjustment Range per LED: 1		
Frame/Poles	LED	Range Selected
	12	N/A
	11	N/A
	10	N/A
	9	N/A
Programmable	8	21
1,000/6	7	7
740/6	6	6
1,000/4	5	5
740/4	4	4
570/4	3	3
430/4	2	2
360/4	1	1

Table 2-14. Gain Adjustment Ranges

Gain Adjust – LED 10 Blinking Slowly Maximum Adjustment Range: 0.5 to 4.5 kg for AVR and 0 to 100 kg for FCR				
When the unit is operating in AVR, PF, and var modes, gain adjustments are made to AVR kg. When in FCR mode, gain adjustments are made to FCR kg. Front Panel increments: AVR kg = 0.01 FCR kg = 0.1				
	Minimum Value *		Maximum Value *	
LED	AVR	FCR	AVR	FCR †
12	4.17	11.1	4.50	12
11	3.84	10.1	4.16	11
10	3.50	9.1	3.83	10
9	3.17	8.1	3.49	9
8	2.84	7.1	3.16	8
7	2.50	6.1	2.83	7
6	2.17	5.1	2.49	6
5	1.84	4.1	2.16	5
4	1.50	3.1	1.83	4
3	1.17	2.1	1.49	3
2	0.85	1.1	1.16	2
1	0.5	0	0.84	1

* Minimum and maximum values may differ from the Table 2-14 values if the gain value has been changed in DVR2000E-32 software.

† DVR2000E-32 software allows a maximum FCR kg setting of 1,000 kg. A kg setting of 12 or more entered in DVR2000E-32 software will be reduced to 12 with the first push of the HMI "DOWN" pushbutton when adjusting FCR kg via the front panel.

Table 2-15. Fine Voltage Adjust Setting Ranges

Fine Voltage Adjust – LED #11 Blinking Slowly Maximum Adjustment Range: -15% to +15% Increment: 0.1V
The adjustment range for Fine Voltage Adjust is based on the fine voltage adjustment band setting. The default adjustment range is –10% to +10%. See Section 5, DVR2000E-32 Software for Windows® OS, Setting Definitions, Setting Adjustments for information about the Fine Voltage Adjustment Band Setting.

COMMUNICATION PORT

A communication port is located on the rear panel and consists of a female RS-232 (DB-9) connector. The communication port serves as an interface for programming (setup) of the DVR2000E. Figure 2-2 illustrates the location of the communication port.

Programming requires a standard 9-pin serial communication cable connected between the DVR2000E and an IBM-compatible PC or handheld computer operating with DVR2000E-32 software. DVR2000E-32 is a Windows® 98/NT based communication software package that is supplied with the DVR2000E. A detailed description of DVR2000E-32 software is provided in Section 5, DVR2000E-32 Software.

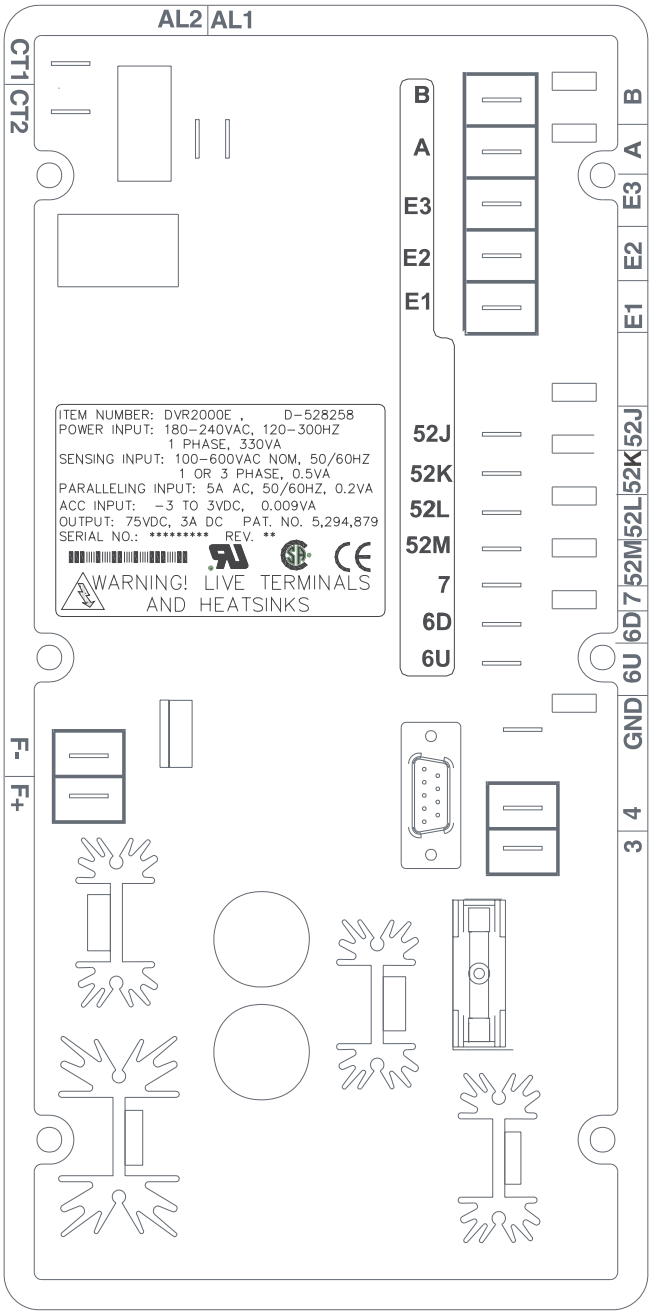

Figure 2-2. DVR2000E Communication Port Location

SECTION 3 • FUNCTIONAL DESCRIPTION

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Section 3

SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

This section describes how the DVR2000E functions and explains its operating features. To ease understanding, DVR2000E functions are illustrated in the block diagram of Figure 3-1. A detailed description of each function block is provided in the paragraphs under the heading of DVR2000E Function Blocks.

DVR2000E operating features include four operating modes, four protective functions, startup provisions, reactive droop compensation, underfrequency compensation, and an auxiliary analog input. A detailed description of each operating feature is provided in the paragraphs under the heading of DVR2000E Operating Features.

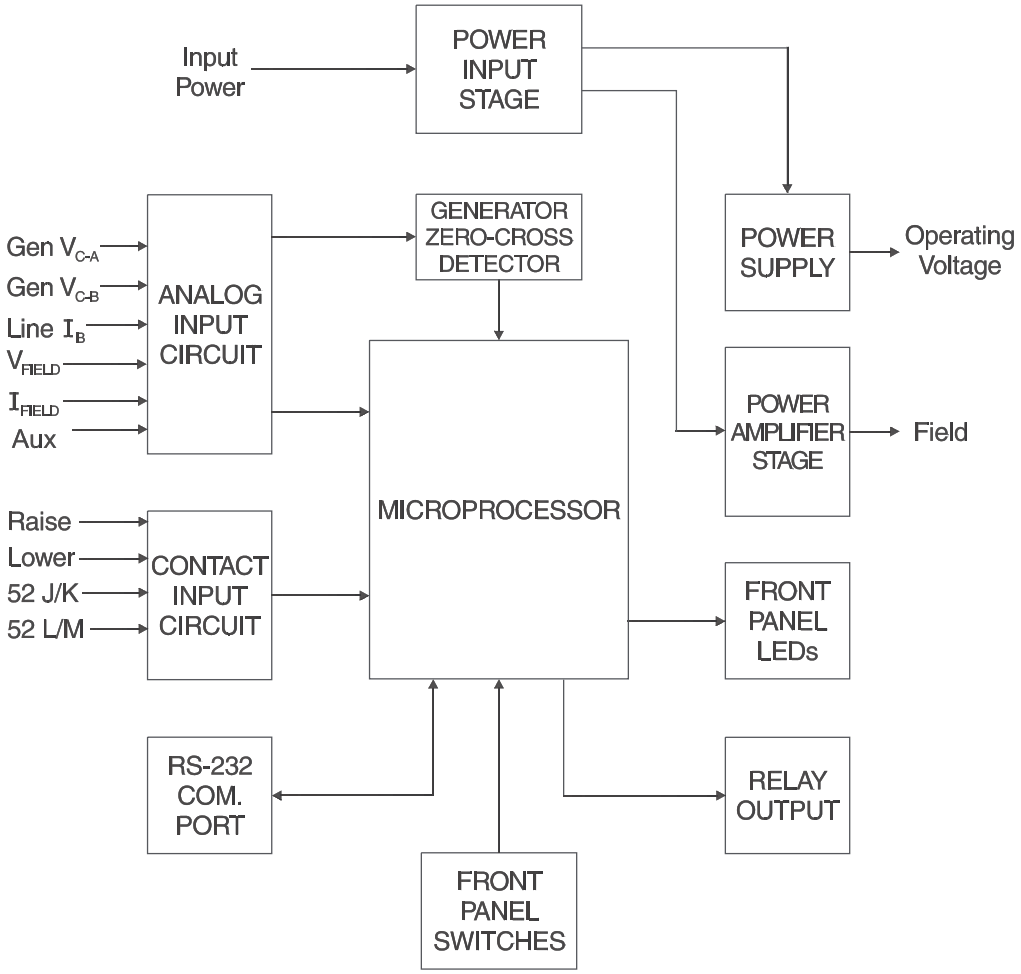

Figure 3-1. Simplified Block Diagram

DVR2000E FUNCTION BLOCKS

The following paragraphs describe each of the function blocks illustrated in Figure 3-1. The function of each block is explained along with the operation of all function block inputs and outputs.

Analog Inputs

Six analog voltage and current inputs may be sensed and brought to the DVR2000E input.

Generator Voltage

Generator voltage is monitored at terminals E1 (A-phase), E2 (B-phase), and E3 (C-phase). Nominal voltages of up to 600Vac may be sensed at these terminals. Voltage applied to these inputs is scaled and conditioned before being applied to the input of the ADC. The voltage signal from phase C and A (V_{C-A}) of the generator is used by the ADC to calculate the rms value of generator voltage across phases C and A. Likewise, the voltage signal from phase C and B (V_{C-B}) of the generator is used by the ADC to calculate the rms value of generator voltage across phases C and B. The rms value of generator phase B to phase A voltage (V_{B-A}) is calculated by the microprocessor from the phase C to phase A signal (V_{C-A})and the phase C to phase B (V_{C-B}) signal.

Additionally, the generator phase C to phase A (V_{C-A}) signal is applied to a filtered zero cross detector circuit. This signal is applied to the microprocessor and is used to calculate generator frequency.

Phase B Line Current

The phase B line current (I_B) signal is developed through a customer supplied current transformer (CT) and monitored through terminals CT1 and CT2. Current up to 5 amperes rms may be monitored at these terminals. The current monitored at these terminals is scaled and conditioned by an internal current transformer and active circuitry for use by the ADC. The signal applied to the ADC is used to calculate the rms value of phase B line current.

Additionally, the phase angle between phase B line current and phase C to phase A generator voltage is calculated for use during Droop and Var/Power Factor operation.

CAUTION

The DVR2000E CT connections are reversed from the DVR2000.

Field Voltage (V_{FIELD})

Voltage across the regulator field output terminals, F+ and F-, is monitored, scaled, and conditioned before being applied to the ADC. This signal is used to calculate the dc value of field voltage for use in system protection.

Field Current (I_{FIELD})

Current through the main power output switch is converted to a proportional voltage level. This voltage signal is scaled and conditioned before being applied to the input of the ADC. The result is used to calculate the dc value of field current for use in the Manual mode of operation as well as protection of the system.

Analog (Auxiliary) Input

CAUTION

If the DC voltage is removed from the Analog (Auxiliary) Input, the operating setpoint will return to the original value.

This input allows adjustment of the DVR-2000E regulation setpoint by the application of a positive or negative dc voltage across terminals A and B. Voltage up to +3 Vdc may be applied at this input. The circuit induces a 1,000-ohm burden on the dc source. The application of a +3 Vdc signal corresponds to a +30 percent change in setpoint.

Contact Input Circuits

Four contact input circuits powered from an internal 13 Vdc supply provide input control from user-supplied contacts.

Raise

Closing a contact across terminals 6U and 7 causes the active operating setpoint to increase. This function is active as long as the contact is closed.

Lower

Closing a contact across terminals 6D and 7 causes the active operating setpoint to decrease. This function is active as long as the contact is closed.

Var/Power Factor Control (52J/K) Option

Closing a contact across terminals 52J and 52K disables var/power factor control. An open contact enables the DVR2000E(C) to control the generator reactive power in either the var or the power factor mode. The contact has no effect when this option is not present. For more information, refer to the Parallel Generator Compensation (52L/M) contact input.

Parallel Generator Compensation (52L/M)

Closing a contact across terminals 52L and 52M disables parallel operation. An open contact enables parallel operation and the DVR2000E operates in reactive droop compensation mode.

If the Var/Power Factor Control option is present, the 52J/K input has priority. Therefore, if the 52J/K and the 52L/M inputs are both open, the system operates in var/power factor mode.

Communication Port

The communication port provides the interface for user programming (setup) of the DVR2000E. Connection is made to the female RS-232 (DB-9) connector with a user-supplied, standard 9-pin cable. The communication port is optically isolated and is powered from a transformer-isolated supply.

Microprocessor

The microprocessor is the heart of the DVR2000E and performs measurement, computation, control, and communication functions by the use of its embedded programming and the nonvolatile settings stored in its memory.

Power Input Stage

Input power is applied to terminals 3 and 4 from the PMG. It is rectified and filtered before being applied to the power amplifier and the power supply. Input power is single-phase in the range of 180 to 240 Vac at a frequency of 200 to 360 hertz.

Power Supply

The internal switch-mode power supply receives power from the power input stage and supplies power at the required dc voltage levels to the internal circuitry of the DVR2000E.

Power Amplifier Stage

The power amplifier receives power from the power input stage and supplies a controlled amount of power to the exciter field via terminals F+ and F-. The amount of power supplied to the exciter field is based on gating pulses received from the microprocessor. The power amplifier uses a solid state power switch to provide the required power to the exciter field. Power amplifier output to the field is rated up to 75 Vdc at 3 Adc continuous and 150 Vdc at 7.5 Adc for 10 seconds.

Front Panel Indicators

Twelve front panel LED indicators light to indicate various operating modes, protective functions, and adjustments. Section 2, Human-Machine Interface provides more information about the front panel indicators.

Front Panel Switches

Changes to settings can be made at the front panel using the three pushbutton switches. These push-buttons are labeled Select, Up, and Down. Section 2, Human-Machine Interface provides more in-formation about the front panel switches.

Relay Output

A common alarm output contact is provided through terminals AL1 and AL2. This normally open, form A contact annunciates alarm or generator trip conditions and closes in the event of a protective shutdown or transfer. The relay output is non-latching.

DVR2000E OPERATING FEATURES

The following paragraphs describe the characteristics of each DVR2000E operating feature.

Operating Modes

The DVR2000E provides up to four modes of operation selectable through Windows® or Palm OS® communication software. Automatic voltage regulation mode and Manual mode are standard features. Var and Power Factor modes are an option.

Automatic Voltage Regulation Mode

In Automatic Voltage Regulation (AVR) mode, the DVR2000E regulates rms generator output voltage. This is accomplished by sensing generator output voltage and adjusting dc output excitation current to maintain voltage at the regulation setpoint. The regulation setpoint is adjusted by the Raise and Lower contact inputs, front panel switches, or through Windows® or Palm OS® communication software. The regulation point may also be modified by the Droop function or the Underfrequency function under certain conditions.

Manual Mode

In Manual mode, also known as Field Current Regulation (FCR) mode, the DVR2000E maintains dc excitation current at a set level. The current-level setpoint is adjustable from 0 to 3 Adc by the Raise and Lower contact inputs, front panel switches, or through Windows® or Palm OS® communication software.

WARNING!

The Manual mode excitation level must be evaluated prior to enabling this feature. If the level of excitation current is inappropriate for the generator, severe damage to the generator may occur.

For initial startup, if the regulator is in Manual mode and set at 0.25 amperes, the generator should come up to approximately half-voltage. This allows wiring and sensing leads to be checked before the regulator is switched to AVR mode. Increasing the field current to 0.5 amperes will bring the generator up to approximately rated, no-load voltage.

Var Control Mode (Optional)

In Var Control mode, the DVR2000E(C) maintains generator vars (volt-amperes, reactive) at a set level when paralleling with an infinite bus. The DVR2000E(C) calculates generator vars using the sensed generator output voltage and current quantities and then adjusts the dc excitation current to maintain vars at the setpoint. Var control is enabled and disabled through the front panel switches, Windows® or Palm OS® communication software. When the software is turned on, var control is enabled or disabled through the Var/Power Factor Control (52J/K) contact input circuit. The var setpoint is adjustable from 100 percent absorb to 100 percent generate through the Raise and Lower contact inputs, front panel switches, or through Windows® or Palm OS® software.

Power Factor Control Mode (Optional)

In Power Factor Control mode, the DVR2000E(C) maintains generator power factor at a set level when paralleling

with an infinite bus. The DVR2000E(C) calculates generator power factor using the sensed generator output voltage and current quantities and then adjusts the dc excitation current to maintain power factor at the setpoint. Power factor control is enabled or disabled through the front panel switches, Windows® or Palm OS® software. When the software is turned on, it is enabled or disabled through the Var/Power Factor Control (52J/K) contact input circuit. The power factor setpoint is adjustable between 0.6 lag and 0.6 lead through the Raise and Lower contact inputs, front panel switches, or through Windows® or Palm OS® communication software.

Reactive Droop Compensation

The DVR2000E provides a reactive droop compensation feature to assist in the sharing of reactive load during parallel generator operation. When this feature is enabled, the DVR2000E calculates the reactive portion of the generator load using the sensed generator output voltage and current quantities and then modifies the voltage regulation setpoint accordingly. A unity power factor generator load results in almost no change in generator output voltage. A lagging power factor generator load (inductive) results in a reduction of generator output voltage. A leading power factor generator load (capacitive) results in an increase of generator output voltage. Droop is adjustable up to 10 percent with rated, nominal B-phase line current (5 amperes applied through terminals CT1 and CT2) and 0.8 power factor. The droop feature is enabled and disabled through the Parallel Generator Compensation contact input circuit (terminals 52L and 52M). If the Var/Power Factor option is present, the 52J/K input must also be closed to disable droop.

Underfrequency

Generator Underfrequency

When generator frequency drops below the selected knee frequency setpoint, the voltage setpoint is automatically adjusted by the DVR2000E so that generator voltage follows the selected PU (per unit) V/Hz curve. When operating on the selected PU V/Hz curve, the Underfrequency Active indicator flashes on the front panel and in DVR2000E-32. The knee frequency is adjustable from 40 to 65 hertz and the PU V/Hz curve may be set to a slope from 1 to 3 in increments of 0.01 through the Windows® or Palm OS® communication software. The default is 59 Hz and a slope of 1.

Engine Unloading

The Engine Unloading feature modifies the underfrequency curve. This feature becomes active when the generator frequency decreases a programmable amount (Unloading Activation – Frequency) below the knee frequency setpoint, and when the speed change rate is greater than the Unloading Activation - Rate. The amount of droop while Engine Unloading is active is adjusted by the Unloading Droop - Percentage (%) setting. The amount of time Engine Unloading is active is set by Unloading Droop - Time (sec.).

Engine unloading adjustments are made through the Windows and Palm OS communication software.

Unloading Activation – Frequency (Hz) is entered as a value below the underfrequency corner where the engine unloading feature may be activated. A frequency value of 0.9 to 9.0 hertz can be entered in 0.1 hertz increments. The default value is 0.9 hertz.

Unloading Activation – Rate (Hz/25 msec) of 0 to 25.5 hertz per 25 milliseconds can be entered in 0.1 hertz per 25 millisecond increments. The engine unloading feature is activated when the frequency rate of change exceeds the setting of this field. The default value is 0.1.

Unloading Droop – Percentage (%) field defines the percent drop in generator output voltage for each 1.5 percent decrease in generator frequency when operating in the Engine Unloading mode. The Unloading Droop Percentage is adjustable from 1 to 20 percent in 1 percent steps. The default value is 10 percent.

Unloading Droop – Time (sec) value defines the length of time that the Engine Unloading mode may be active before control is passed to the normal Underfrequency mode of operation. Droop time is adjustable from 1 to 5 seconds in 1 second increments. The default value is 1 second.

Protection

The DVR2000E has the six protective functions listed below:

- Overexcitation shutdown
- Generator overvoltage shutdown
- DVR overtemperature shutdown
- Loss of generator sensing shutdown
- Overexcitation limiting
- Crowbar shutdown

Each function, except Crowbar Shutdown, has a corresponding front panel indicator that lights when the function is active. An active function (except Crowbar Shutdown) is also annunciated through the Windows® or Palm OS® communication software.

Overexcitation Shutdown (Field Voltage)

This function is enabled or disabled through DVR2000E-32 software. When enabled, if field voltage exceeds the setpoint (80 Vdc default), the Overexcitation Shutdown indicator flashes on the front panel and in the Windows® or Palm OS® communication software, the relay output closes after 15 seconds and the DVR2000E shuts down. When the DVR2000E is powered up following an over-excitation shutdown, the Overexcitation Shutdown indicator will flash for 5 seconds.

Generator Overvoltage Shutdown

The DVR2000E monitors the sensed generator output voltage. If it exceeds the overvoltage setpoint (a percent of nominal) for 0.75 seconds, the Generator Overvoltage indicator flashes on the front panel LED and in the Windows® and Palm OS® communication software, the relay output closes and the DVR2000E shuts down. When the DVR2000E is powered up following a generator overvoltage shutdown, the Generator Overvoltage indicator will flash for 5 seconds. The default setpoint is 120 percent of nominal.

DVR Overtemperature Shutdown

A temperature sensor within the DVR2000E continually monitors the temperature of the device. If the temperature exceeds 70°C (158°F), the DVR Overtemperature indicator flashes on the front panel and in the Windows® and Palm OS® communication software, the relay output closes and the DVR2000E shuts down.

Loss of Generator Sensing Shutdown

The DVR2000E monitors the sensed generator output voltage and takes protective action if a loss of sensing voltage is detected. For single-phase sensing, a sensed voltage of less than 50 percent of nominal is interpreted as a loss of sensing. For three-phase sensing, the total loss of a sensed phase or an imbalance between phases of more than 20 percent nominal is interpreted as a loss of sensing. When sensing input continuity is not lost, an adjustable time delay of 0 to 25 seconds is present when a loss of sensing condition is detected. If sensing input continuity is lost, the time delay is disabled.

If a loss of sensing occurs, the Loss of Generator Sensing indicator flashes on the front panel and in the Windows® and Palm OS® communication software, the relay output closes, and the DVR2000E shuts down. When the DVR2000E is powered up following a loss of generator sensing shutdown, the Loss of Sensing indication will flash for 5 seconds.

This function is disabled when a generator short circuit condition is detected or when sensed frequency drops below 12Hz. A generator short-circuit is determined when the phase B CT current exceeds 3PU (>15 Aac sensing current). Loss of sensing is not active during soft start time.

Overexcitation Limiting (Field Current)

The DVR2000E has a field current limit that is factory preset at 6.5 amperes. The limit is adjustable from 0 to 7.5 amperes with an adjustable time delay that has a range of 0 to 10 seconds. Both settings are made through the Windows® and Palm OS® communication software. When the overexcitation limit is exceeded, the Overexcitation Limiting indicator flashes on the front panel and in the Windows® and Palm OS® communication software. When the adjustable time delay expires, the relay output closes and the DVR2000E shuts down. When the DVR2000E is powered up following overexcitation limiting, the Overexcitation Limiting indicator will flash for 5 seconds.

Crowbar Shutdown

The Crowbar Shutdown Circuit protects the generator rotor from overcurrent damage resulting from a shorted DVR2000E power switch. During operation, if the field voltage exceeds the setpoint and the power stage receives no gating pulses for 1.5 seconds, the Crowbar Circuit activates and places a short-circuit across the DVR2000E input power terminals. This protects the generator by blowing the input power fuse and removing operating power from the device.

Generator Soft Start

The DVR2000E incorporates an adjustable soft start feature that controls the time for generator voltage to ramp to the regulation setpoint. The ramp rate is adjustable from 1 to 120 seconds in 1 second increments through the Windows® and Palm OS® communication software. The underfrequency feature is also active during soft start and takes priority in control of the generator voltage. The default setting is 7 seconds.

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SECTION 4 • INSTALLATION

GENERAL

The DVR2000E is delivered in a sturdy carton to prevent shipping damage. Upon receipt, check the part number against the requisition and packaging list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify your sales representative or a sales representative at Katolight.

If the unit is not installed immediately, store it in the original shipping package in a moisture and dust free environment.

MOUNTING

The DVR2000E is normally located in the generator conduit box. It is designed for behind the panel mounting and requires a cutout for front panel viewing and access. Mounting hardware consists of six customer supplied, #12 thread-forming screws that pass through mounting holes in the conduit box and thread into the plastic shell of the DVR2000E. The unit must be mounted where the ambient temperature does not exceed the allowable environmental conditions called out in Section 1, General Information, Specifications. DVR2000E package dimensions are shown in Figure 4-1. Cutout and drilling dimensions are shown in Figure 4-2.

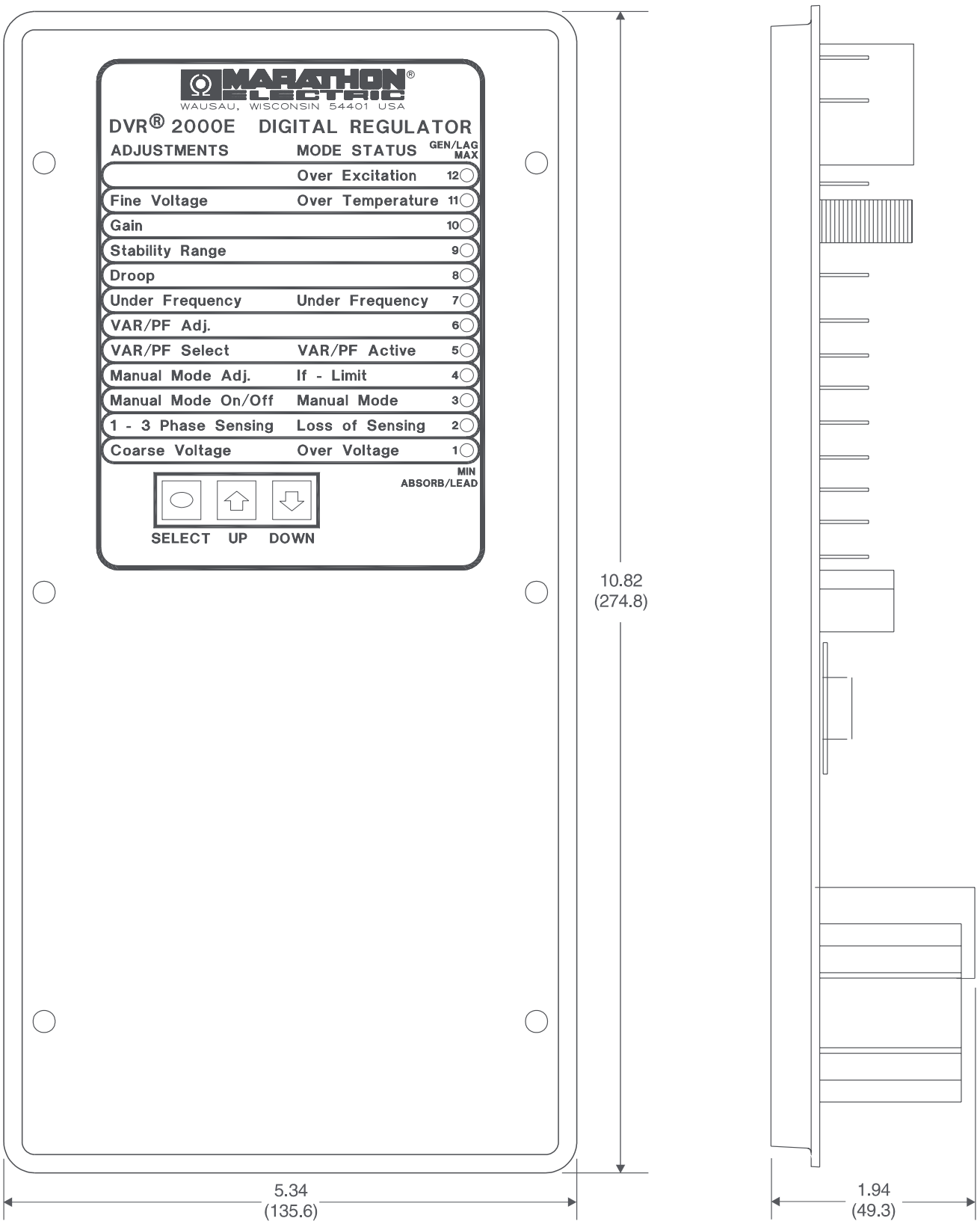

Figure 4-1. DVR2000E Dimensions

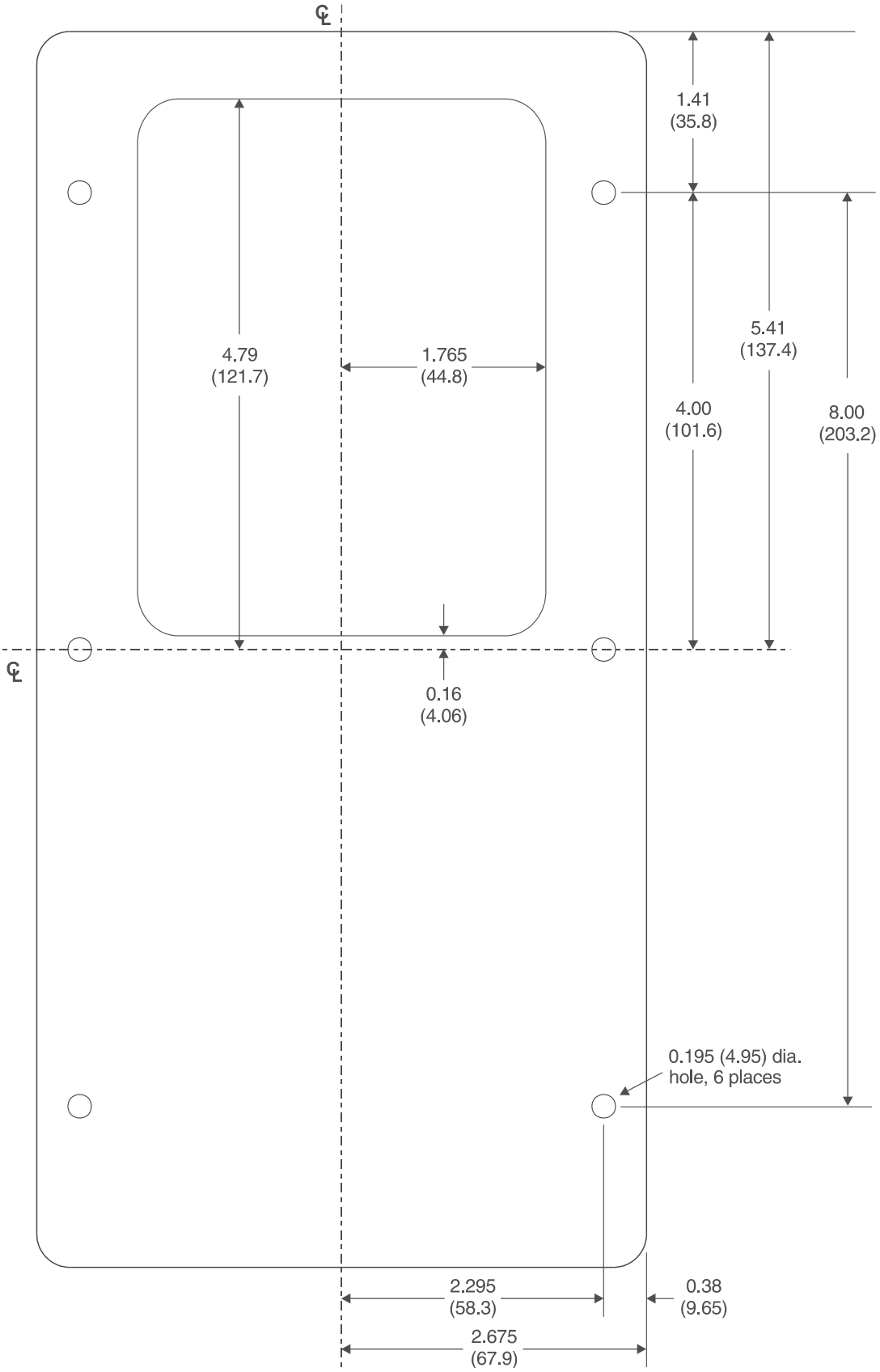

Figure 4-2. Cutout and Drilling Dimensions

CONNECTIONS

DVR2000E connections are dependent on the application. Incorrect wiring may damage the unit.

> NOTE
>
> Be sure that the DVR2000E is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the unit case. When the unit is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each device.

DVR2000E Terminations

DVR2000E units have two types of interface terminals (Figure 4-3). One type is quarter-inch, quick-connect terminals and the other is a 9-pin DB9 connector. All terminals are located on the rear of the unit. The quarter-inch, quick-connect terminal labels are located on the rear of the case. Wires performing common functions, such as voltage sensing leads, should be grouped together. The 9-pin DB-9 type connector is used for temporary interface with both IBM compatible PCs and hand-held computers.

Figure 4-3 shows the terminal connections located on the rear panel of the DVR2000E. Except as noted above, connections should be made with minimum wire size of 14 AWG.

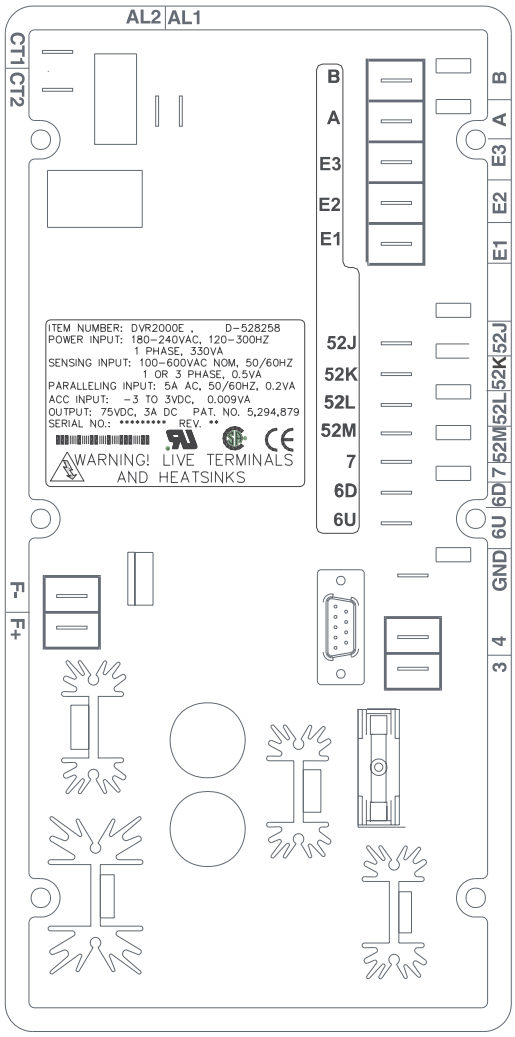

Figure 4-3. DVR2000E Rear Panel Terminals

Generator Voltage Sensing Inputs

The generator voltage sensing terminals are labeled E1, E2, and E3. A single-phase sensing connection is obtained by connecting the C-phase sensing input to terminals E2 and E3. Table 4-2 lists the terminal assignments for three-phase and single-phase generator voltage sensing.

Table 4-1. Generator Voltage Sensing Terminals

Sensing	GeneratorPhase	Terminal
3-Phase	A	E1
	B	E2
	C	E3
1-Phase	A	E1
	C	E2, E3

Phase B Line Current Sensing Input

Generator line current is stepped down through a user-supplied current transformer (CT). Secondary current from that transformer is applied to terminals labeled CT1 and CT2.

Raise and Lower Contact Inputs

Remote setpoint adjustment may be accomplished by connecting a single-pole, double-throw (SPDT), spring return, center-off switch to the terminals labeled 6U, 7, and 6D. To connect this switch, the center pole, or common terminal, must be connected to terminal 7. The other two terminals are connected to terminals 6U and 6D. This remote adjust switch may be mounted up to 150 feet away from the DVR2000E when using twisted, shielded cable.

Var/Power Factor Control Contact Input

A customer supplied enable/disable contact for this function connects to the terminals labeled 52J and 52K. This function is disabled by a closed contact.

Parallel Generator Compensation

A customer supplied enable/disable contact for this function connects to the terminals labeled 52L and 52M. This function is disabled by a closed contact.

Analog (Auxiliary) Adjust

CAUTION
If the DC voltage is removed from the Analog (Auxiliary) Input,
the operating setpoint will return to the original value.

This input allows adjustment of the DVR2000E regulation setpoint by the application of a positive or negative DC voltage across terminals A and B. Voltage up to +3 Vdc may be applied at this input. The circuit induces a 1,000-ohm burden on the dc source. The application of a +3 Vdc signal corresponds to a +30 percent change in setpoint.

Power Supply Inputs

Power input terminals are labeled 3, and 4.

Chassis Ground

The chassis ground terminal is labeled GND.

Power (Field) Output

The field output terminals for connection to the generator exciter field are labeled F+ and F-.

Relay Output

The common alarm relay output contact may be accessed at the terminals labeled AL1 and AL2. The relay output is normally open.

Communication Port

The RS-232 port on the rear panel uses a DB-9 female connector. Figure 4-4 Illustrates the pin assignments of the communication port and Table 4-3 identifies the RS-232 connector pin functions. A standard communication cable terminated with a DB-9 male connector is used for PC or hand-held computer interface with the DVR2000E as shown in Figure 4-5.

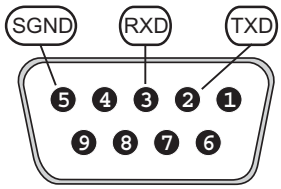

Figure 4-4. Communication Port Pin Assignments

Table 4-2. Communication Port Pin Functions

Pin	Function	Name	Direction
1	N/C	----	N/A
2	Transmit Data	TXD	From DVR2000E
3	Receive Data	RXD	To DVR2000E
4	N/C	----	N/A
5	Signal Ground	GND	N/A
6	N/C	----	N/A
7	N/C	----	N/A
8	N/C	----	N/A
9	N/C	----	N/A

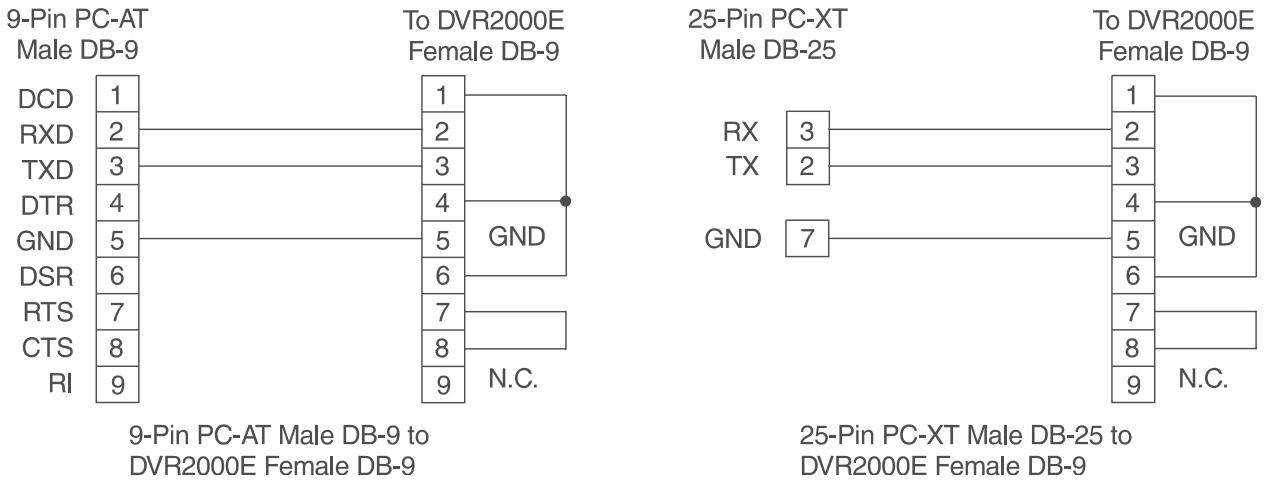

Figure 4-5. Personal Computer to DVR2000E Connections

DVR2000E Connections for Typical Applications

Figures 4-6 through 4-9 illustrate typical applications using the DVR2000E. Figure 4-6 shows an application where the DVR2000E is connected for three-phase voltage sensing. Figure 4-7 shows an application with single-phase voltage sensing while Figure 4-8 illustrates an application with a single-phase generator.

Figure 4-9 illustrates the connection of two DVR2000E devices used in a Cross-Current (Reactive Differential) application. Note that the .1 ohm resistor shown may have to vary. When operating in parallel reactive differential mode (cross current), attention must be paid to the use of the burden resistor shown in Figure 4-9. The burden resistor should have a value approximately 10 times the cross current loop resistance for proper differential operation. The value of 0.1 ohm is a suggested value. The volt-ampere (VA) capacity of the paralleling current transformers should be considered after sizing the burden resistor.

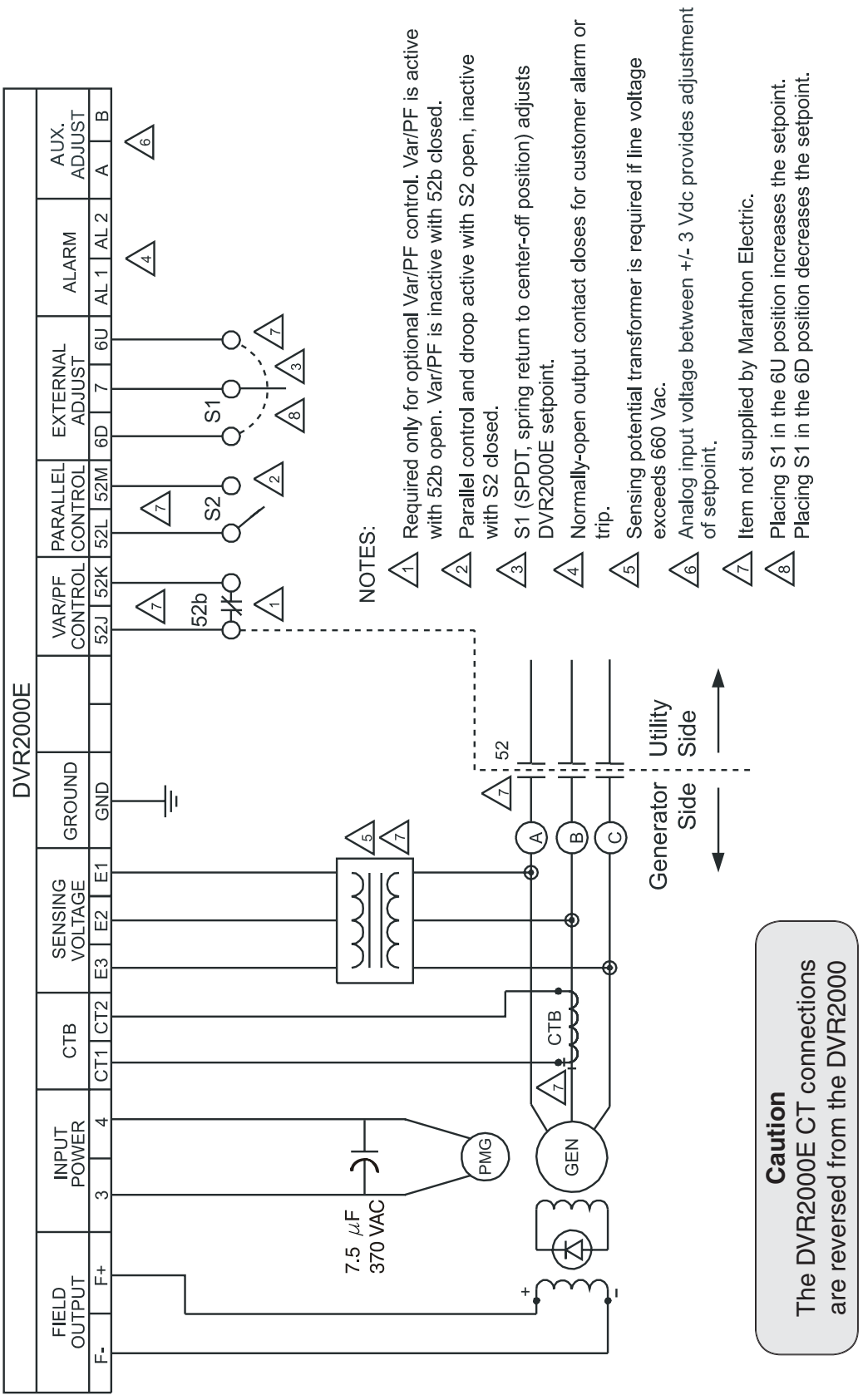

Figure 4-6. Typical Connections with ABC Rotation and Three-Phase Sensing

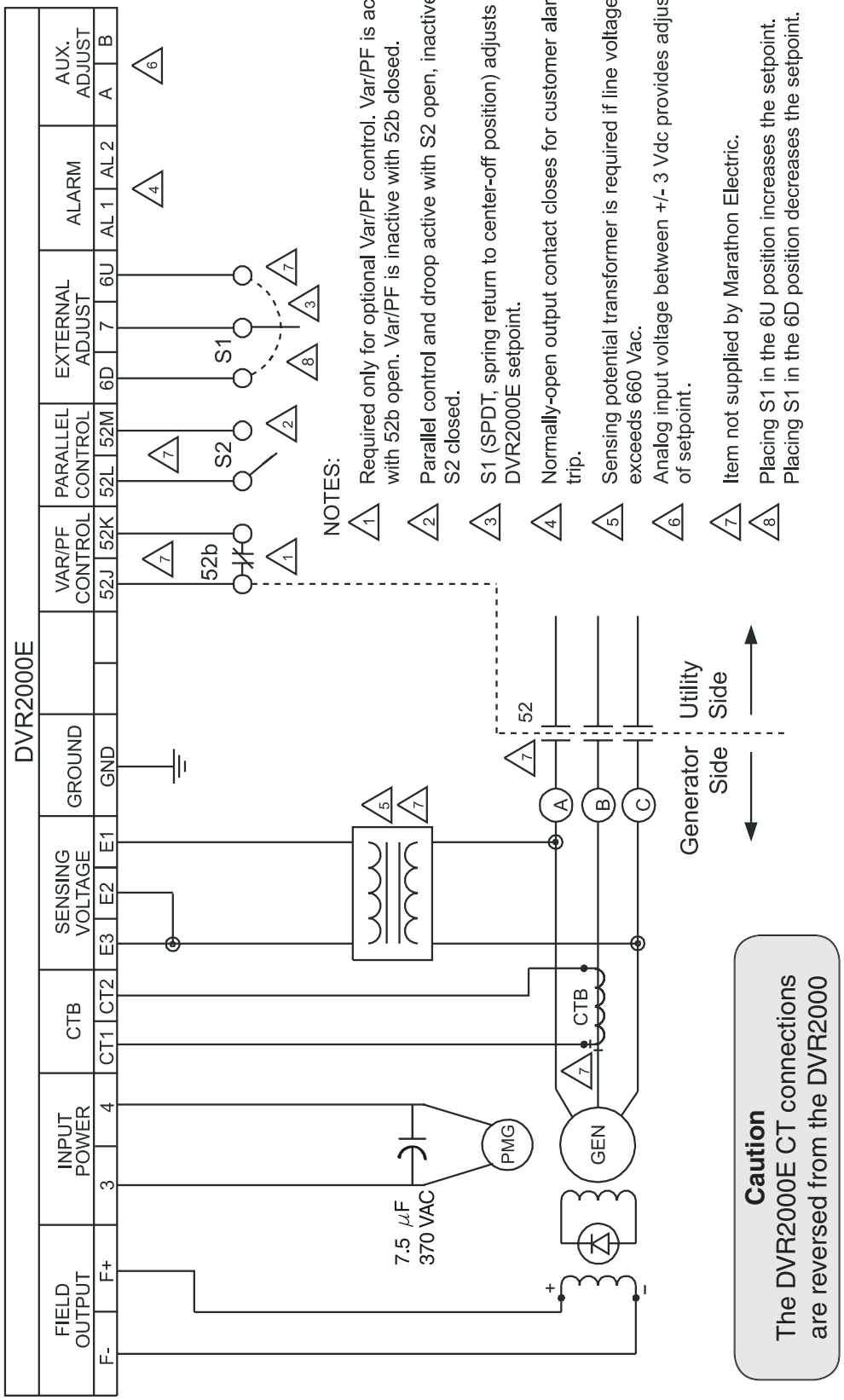

Figure 4-7. Typical Connections with ABC Rotation and Single-Phase Sensing

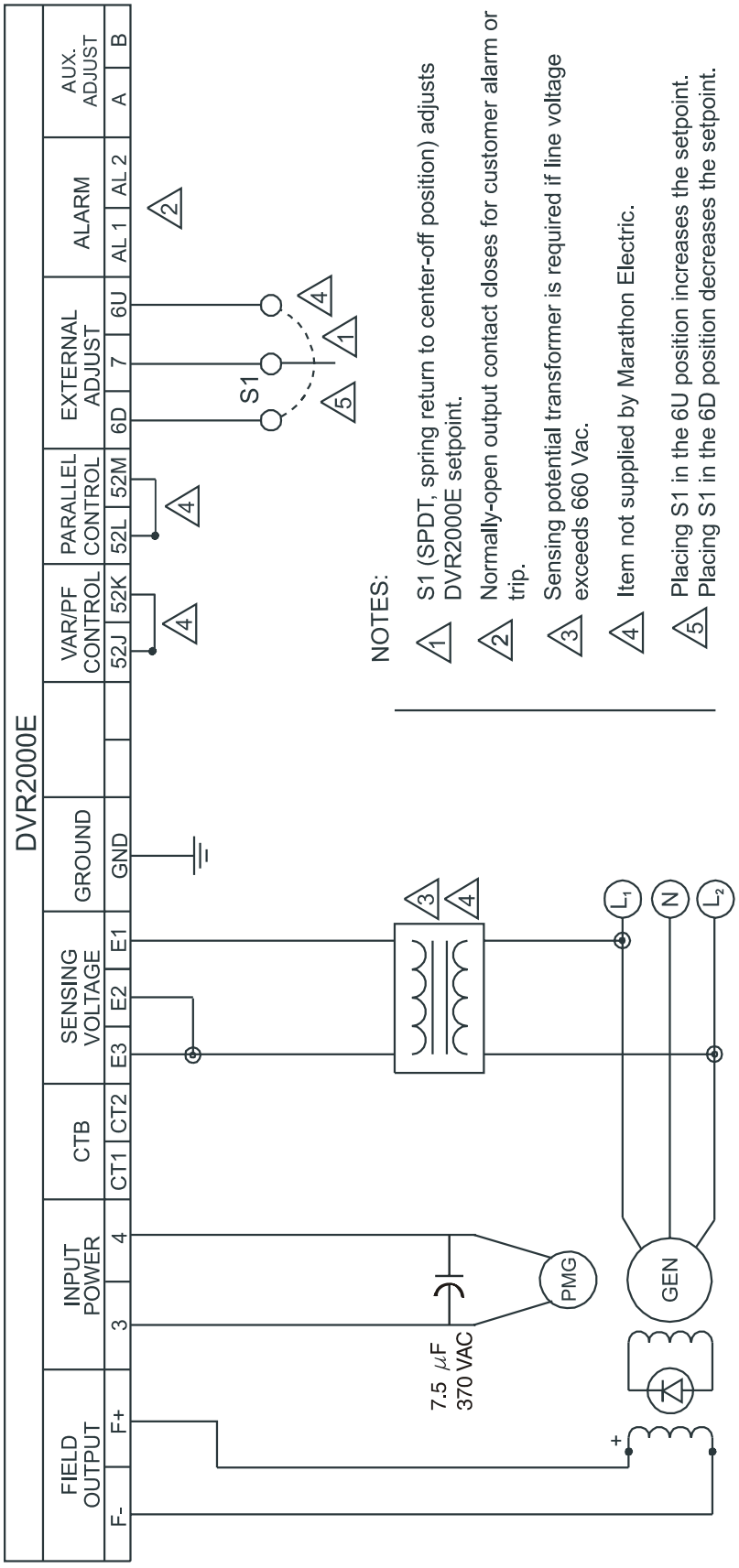

Figure 4-8. Typical Connections to a Single-Phase Generator

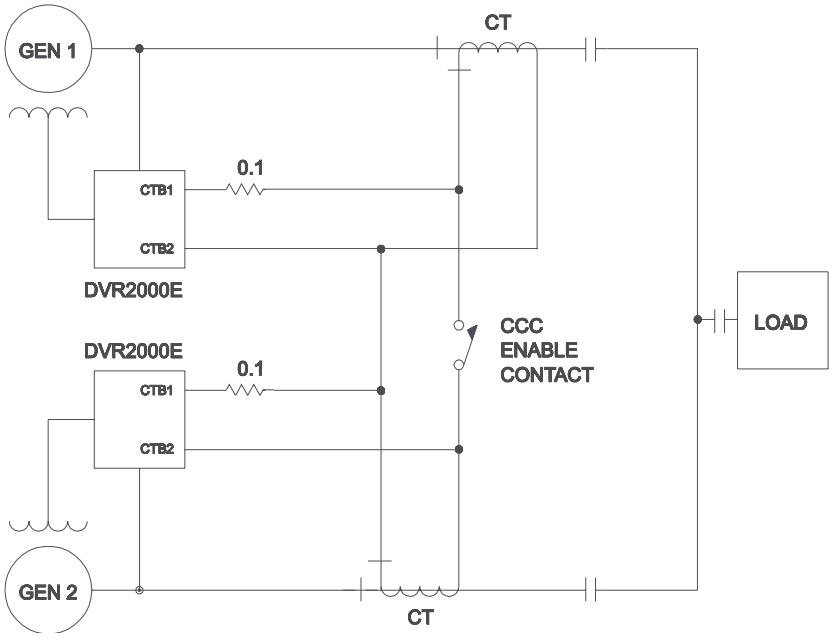

Figure 4-9. Cross-Current (Reactive Differential) Connections for Two Generators

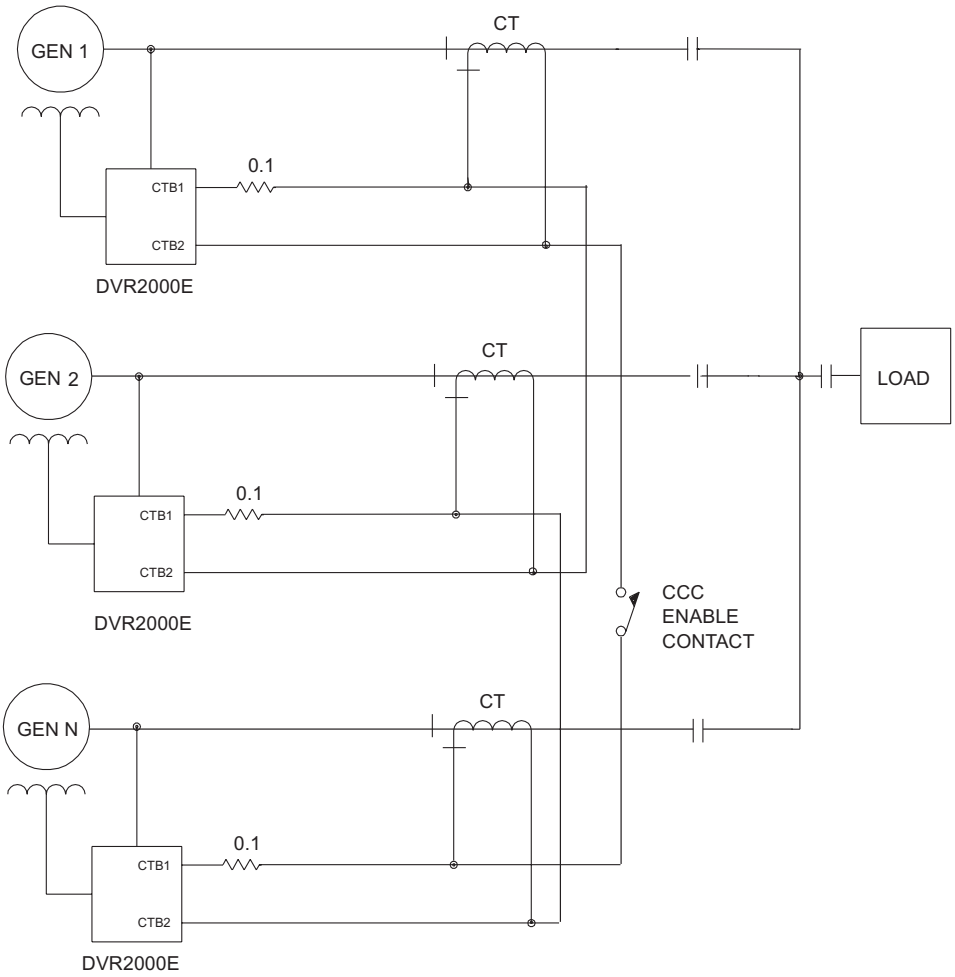

Figure 4-10. Cross-Current (Reactive Differential) Connections for Three or More Generators

PRELIMINARY SETUP

WARNING!

Use caution when working around the rear of the DVR2000E.

Dangerous voltage levels are present at the exposed heatsinks when the unit is energized.

Before starting the generator and DVR2000E for the first time, proceed as follows.

a. Tag and disconnect all wiring to the DVR2000E. Be sure to insulate the wire terminals to prevent a short.

b. Start the prime mover and perform all engine governor adjustments.

c. After all initial governor adjustments have been made, shut down the prime mover.

d. Connect only the power input terminals of the DVR2000E to an auxiliary power source in the specified power input range.

e. Perform all initial DVR2000E settings by using the front panel HMI, connecting a handheld operating with DVR2000E software, or connecting a PC operating with DVR2000E software to the rear commun-ications port of the DVR2000E.

f. Connect the rest of the DVR2000E leads using the tagged identification.

g. Start the prime mover/generator and perform the final adjustments at rated speed and load.

h. After the initial startup, the DVR2000E should not require any further adjustments unless there is a change in the system.

ADJUSTMENTS

All adjustments are made using external switching, the front panel HMI or with DVR2000E software via the rear panel communication port. See Section 5, DVR2000E-32 Software for Windows® OS for more information about making adjustments with DVR2000E software.

SECTION 5 • DVR2000E-32 SOFTWARE FOR WINDOWS® OS

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SECTION 5 • DVR2000E-32 SOFTWARE FOR WINDOWS® OS

INTRODUCTION

DVR2000E-32 software provides a communication link between the DVR2000E and the user. This software enables the user to enter all DVR2000E settings and read all system metering values through an easy to use graphical interface. PID (Proportional + Integral + Derivative) software within the application enables the user to establish proper PID parameters based on a specified generator and/or exciter time constants. Within DVR2000E-32, unit settings can be saved in a computer file and used later to configure other units with the same settings.

INSTALLATION

DVR2000E-32 software operates with IBM compatible personal computers (PCs) using Microsoft® Windows® 95, 98 or NT operating systems. The minimum recommended operating require-ments are listed below.

- IBM compatible PC, 486DX2 or faster (100 MHz or higher microprocessor is recommended)
- CD-ROM drive
- One available serial port

Installing DVR2000E-32

DVR2000E-32 software contains a setup utility that installs the program on your PC. An uninstall utility is loaded with the program that can be used to remove the software from your PC if desired. Use the following procedure to install DVR2000E-32.

1. Insert the CD-ROM into the PC CD-ROM drive.
2. Select Start, then Run in Windows. In the “Open:” box, type d:\setup.exe, where d is the letter designator for your CD-ROM drive. Press the Enter key. The setup utility automatically installs DVR2000E-32 on your PC.

When the software is installed, a folder is added to the Windows® program menu. This folder is accessed by clicking the Start button and pointing to Programs. As illustrated in Figure 5-1, the folder contains icons for the DVR2000E-32 program and a DVR2000E-32 uninstall utility.

Figure 5-1. Folder

Connecting the DVR2000E and PC

Connect a communication cable between the rear RS-232 connector of the DVR2000E and the appropriate communication port of the PC. Refer to Figure 2-2 for the location of the DVR2000E RS-232 connector and Figure 4-5 for the required connections between the DVR2000E and a PC.

STARTING THE DVR2000E-32 APPLICATION

The DVR2000E-32 application is started by clicking the Windows® Start button, pointing to Programs, the folder, and then clicking the DVR2000E-32 icon. At startup, a dialog box with the program title and version number is displayed briefly (Figure 5-2). After this dialog box is displayed, the System Configuration screen is displayed (Figure 5-3).

Figure 5-2. DVR2000E - Title and Version

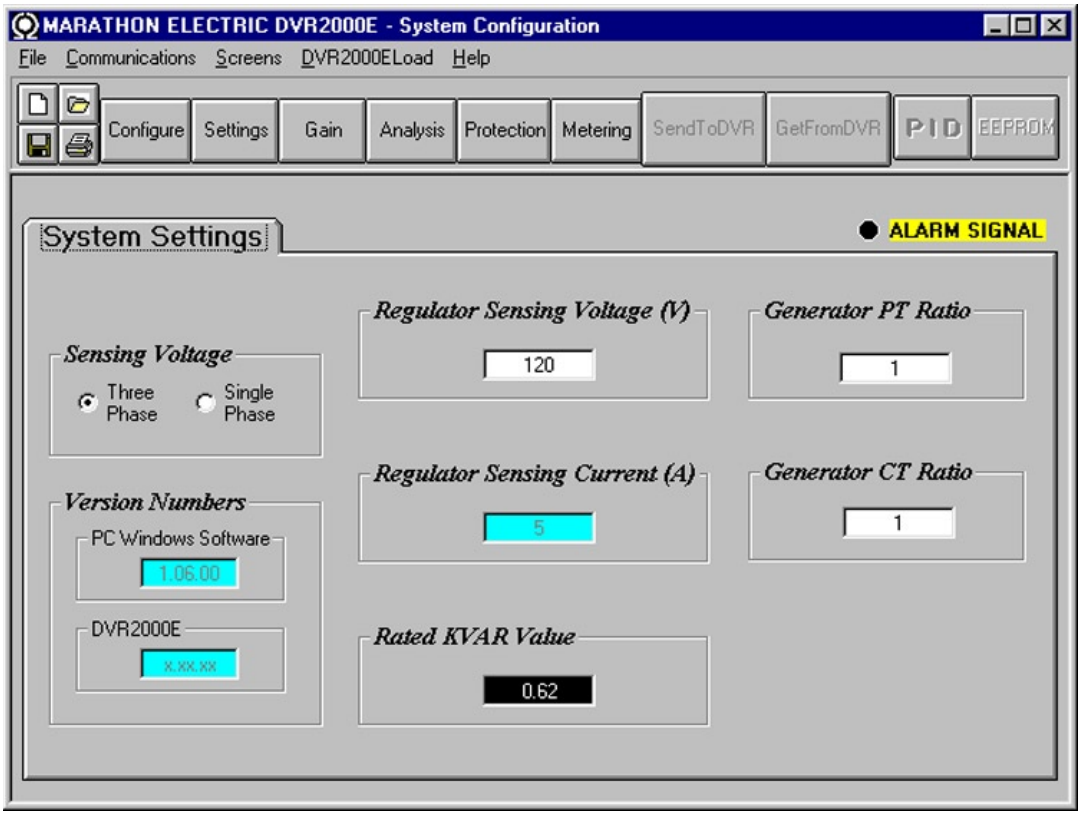

Figure 5-3. System Configuration Screen

Initial Adjustments

CAUTION

Read and understand the operation of the individual adjustments before attempting any initial adjustments.

Before starting the generator, the procedures in the following paragraphs should be performed.

Remove the 5 ampere fuse before starting the generator for the first time. Perform all preliminary engine governor adjustments without the regulator energized.

After initial governor adjustments are complete, reinstall the 5 ampere fuse and connect only the power input leads or PMG leads to the regulator. Remove all other regulator connections that may be present and temporarily insulate them.

Start and run the generator at rated speed. The regulator will perform the self-test and enter a shutdown mode. At this time, initial adjustments can be made.

After the initial adjustments are made, shut down the generator and connect the remaining regulator leads. The generator may be started and final adjustments may be performed on the regulator.

Establishing Communication

Communication between DVR2000E-32 and the DVR2000E must be established before viewing metering values or reading or changing settings. DVR2000E-32 screen settings are updated only after communication is opened or the communication settings have been changed.

Open the DVR2000E communication port by clicking on Communications on the menu bar, hovering the mouse pointer over Open Comm Port, and clicking RS-232 Port. Figure 5-4 illustrates the menu selections for opening the DVR2000E communication port.

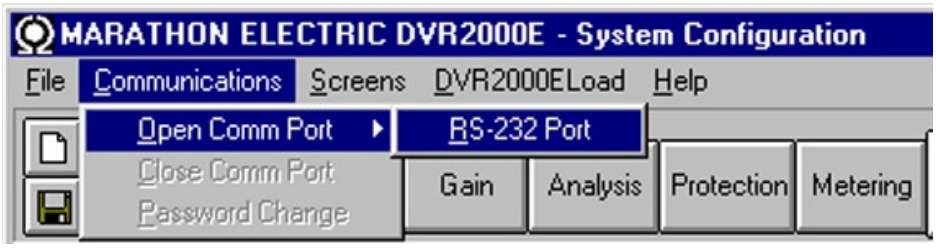

Figure 5-4. Communications Port Menu Selection

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When RS-232 Port is selected, the Password dialog box of Figure 5-5 appears and prompts you to enter a password. Each DVR2000E is delivered with “dvr” as the default password. See the Password Protection sub-section for information about changing the password.

After the correct password is entered, the Communication Initialization screen of Figure 5-6 is displayed. Select Comm1, Comm2, Comm3 or Comm4 as the active communication port on your PC and click the Initialize button. DVR2000E-32 initializes communication by obtaining the configuration settings from the DVR2000E.

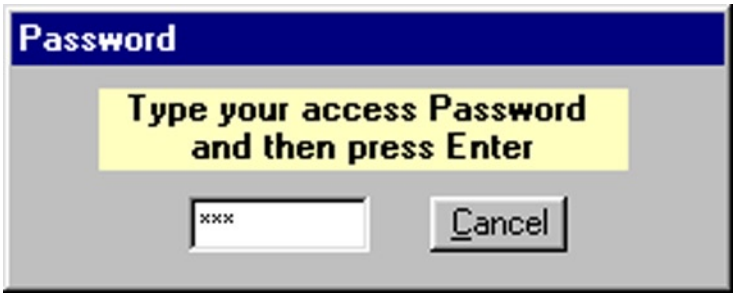

Figure 5-5. Password Dialog Box

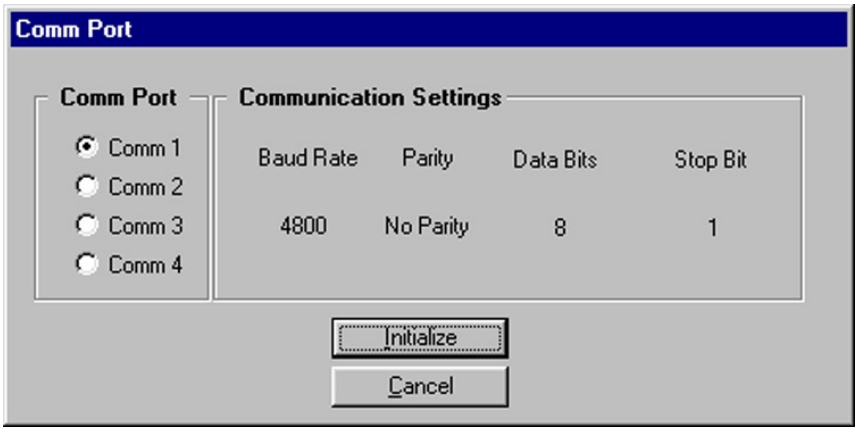

Figure 5-6. Communication Initialization Screen

NOTE

DVR2000E-32 may display the dialog box of Figure 5-7 when initializing DVR2000E communication, obtaining DVR2000E configuration settings or performing other tasks. It's important to wait until the box disappears before trying to execute communication commands. Issuing commands while the Wait dialog box is present may disrupt communication between DVR2000E-32 and the DVR2000E.

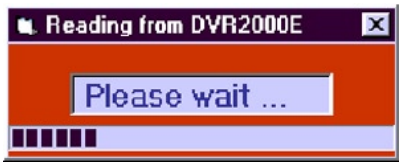

Figure 5-7. Wait Dialog Box

Section 5

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CHANGING SETTINGS

CAUTION

Do not disconnect the communications cable while the DVR2000E and PC are communicating

Settings are arranged into six groups.

- System Configuration
- Setting Adjustments
- Control Gain
- Analysis
- Protection Settings
- Metering, Operation, and Alarms

Each setting group has a corresponding button that can be selected to access that group of settings. The six setting groups can also be accessed by clicking Screens on the menu bar and then selecting the desired setting group from the list. Once a setting group is accessed, the individual settings of the group can be viewed and changed.

A setting is changed by clicking within the setting field and typing the new setting. The range limit of a setting can be viewed by double-clicking the setting. Any setting changes made on a setting group screen must be sent to the DVR2000E before viewing other screens. Otherwise, the setting changes will be lost. A single setting change can be sent to the DVR2000E by pressing the Enter key on your PC keyboard. Multiple setting changes can be sent to the DVR2000E by clicking the SendToDVR button. Settings can also be sent to the DVR2000E by clicking Communications on the menu bar and clicking Send To DVR.

SENDING AND RECEIVING SETTINGS

When communication is enabled, DVR2000E settings can be sent or received through DVR2000E-32.

Sending Settings

Settings changes are sent to the DVR2000E by clicking the SendToDVR button. This causes the settings displayed on the current settings screen to become the DVR2000E settings. Settings can also be sent to the DVR2000E by clicking Communications on the menu bar and clicking Send To DVR. Individual setting changes can be sent to the DVR2000E by pressing the Enter key on your PC keyboard after changing the setting.

Receiving Settings

DVR2000E settings are retrieved by clicking the GetFromDVR button. This causes the DVR2000E settings to be displayed on the settings screen. Settings can also be received from the DVR2000E by clicking Communications on the menu bar and clicking Get From DVR.

Saving Settings to DVR2000E Memory

Settings are saved in nonvolatile memory (EEPROM). In the event of a power loss, these are the settings that are active at power up. If settings are changed and sent to the DVR2000E but not sent to EEPROM, the changed settings are lost if DVR2000E operating power is lost. When exiting DVR2000E-32 or closing communication, you are asked if you want to save the settings to EEPROM. This question is asked even if no settings changes were made.

When communication is enabled, setting changes are saved to EEPROM by clicking the EEPROM button. The opportunity to save settings to EEPROM is also given through a dialog box when exiting DVR2000E-32 or closing communication.

SETTING DEFINITIONS

Each of the six setting groups has a corresponding DVR2000E-32 screen. The settings of each screen are categorized by one or more tabs. In the following paragraphs, settings are arranged and defined according to the organization of the DVR2000E-32 screens and tabs.

System Configuration

The System Configuration screen consists of one tab labeled System Settings. Click the Configure button to access the System Configuration screen or click Screens on the menu bar and click System Configuration.

System Settings

System settings are shown in Figure 5-8 and are described in the following paragraphs.

Sensing Voltage. This setting is used to configure the DVR2000E for either single-phase or three-phase sensing voltage.

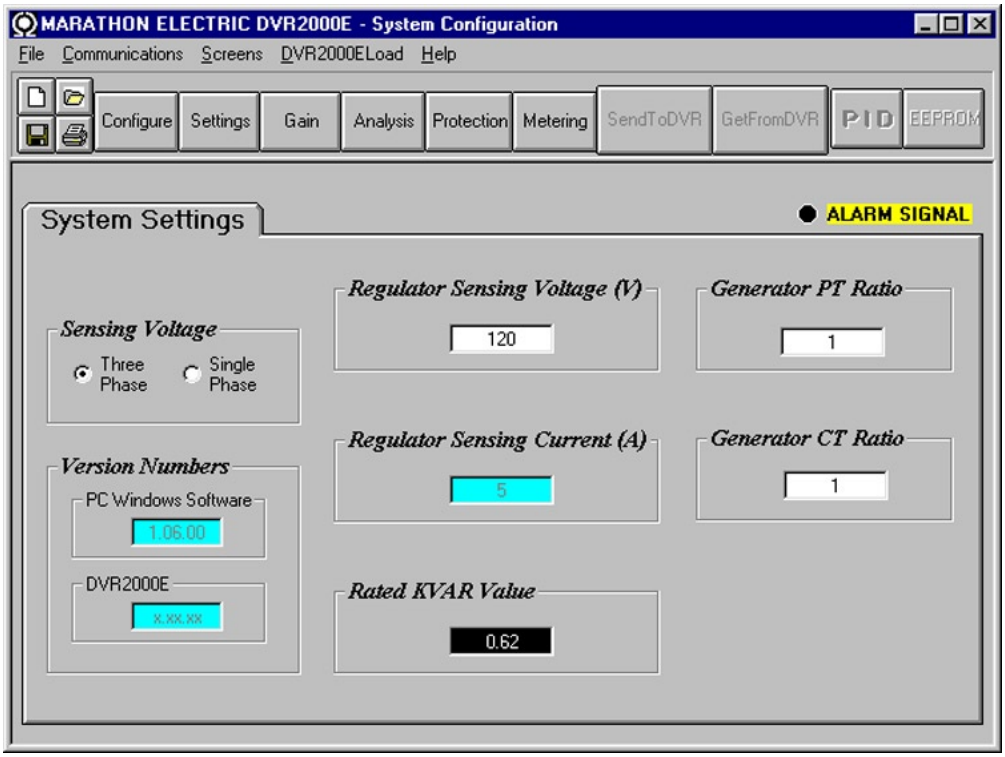

Figure 5-8. System Configuration Screen

Regulator Sensing Voltage (V). The nominal generator line-to-line ac voltage obtained from the generator sensing transformer is entered in this setting field. Voltages within the ranges of 100 to 140 Vac, 200 to 280 Vac, or 340 to 560 Vac may be entered in 0.1 Vac increments. A setting of 600 Vac is also possible.

Regulator Sensing Current (A). This read-only field indicates the rated output of the current transformer (CT) that supplies the DVR2000E with B-phase generator line current.

Version Numbers. These two version numbers are read-only. They indicate the DVR2000E-32 software version and the DVR2000E embedded software version. If a DVR2000E version number is not shown, then the PC and software have not communicated with the DVR2000E. The DVR2000E version number is indicated only when communication between the DVR2000E andDVR2000E-32 occurs.

Generator PT Ratio. The ratio of the generator sensing transformer is entered in this setting field. This ratio allows the voltage displayed through DVR2000E-32 to match the actual generator output voltage. A ratio of 1 to 150 may be entered in increments of 0.01.

Generator CT Ratio. The ratio of the generator B-phase current transformer is entered in this setting field. This ratio allows the current displayed by the DVR2000E to match the actual B-phase generator output current. A ratio of 1 to 1,000 may be entered in increments of 0.1. Note: A 500:5 CT has a ratio of 100.

Rated KVAR Value. This read-only field displays the rated KVAR value.

Setting Adjustments

The Setting Adjustments screen consists of three tabs: Setpoint, Startup, and Engine Unloading.

Setpoint Tab

The Setpoint tab settings of the Setting Adjustments screen are shown in Figure 5-9. Each setting of the Setpoint tab is described in the following paragraphs.

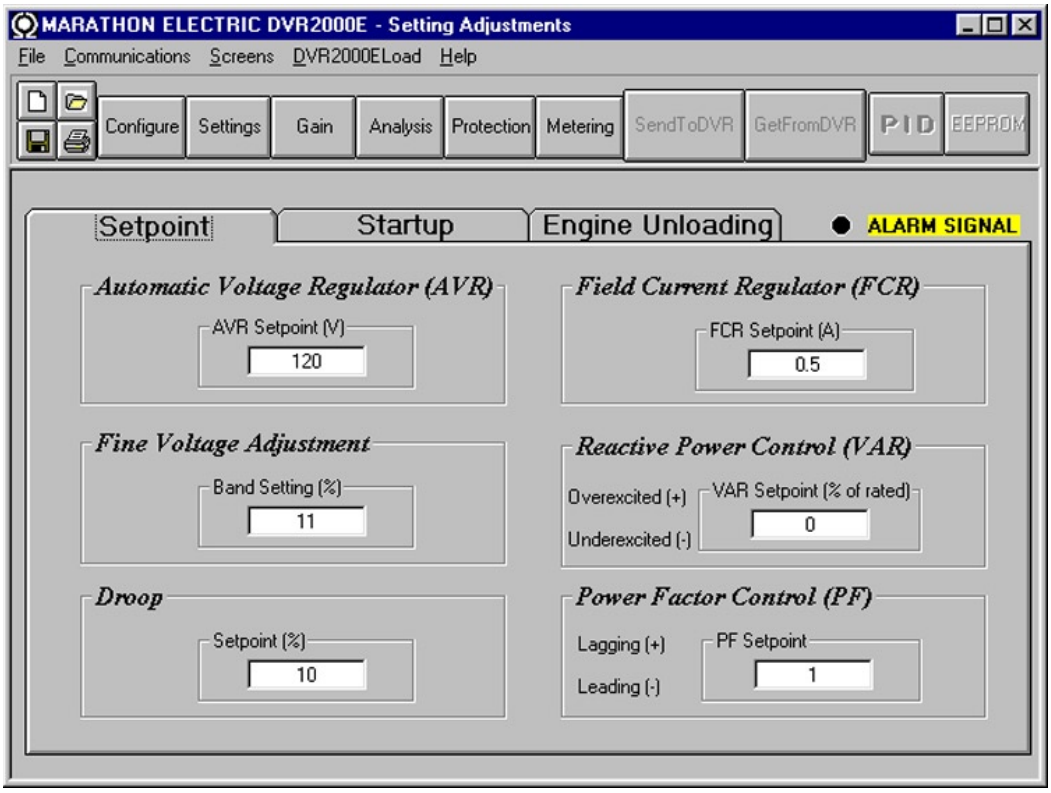

Figure 5-9. Setting Adjustments Screen, Setpoint Tab

Automatic Voltage Regulator (AVR) - AVR Setpoint (V). This setting field is used to enter the desired generator output terminal voltage. The AVR setpoint value range depends on the regulator sensing voltage and band setting.

Fine Voltage Adjustment - Band Setting (%). The Band Setting determines the minimum and maximum adjustment allowed to the AVR Setpoint. This value is expressed as a percentage of the Regulator Sensing Voltage (see Figure 5-8). Band Setting values are entered as a percentage over a range of 0 to 15 percent in 0.1 percent increments.

Droop - Setpoint (%). This setting controls the reactive droop compensation feature of the DVR2000E. The setpoint value is based on a 0.8 power factor load and determines the amount of change permitted in the generator voltage setpoint when the DVR2000E responds to a reactive load. The setpoint value is adjustable from 0 to 10 percent in increments of 0.01 percent.

Field Current Regulator (FCR) - FCR Setpoint (A). This setting defines the field current setpoint when operating in Manual mode. The FCR Setpoint field accepts a value of 0 to 3 Adc in increments of 0.01 Adc

Reactive Power Control (VAR) - VAR Setpoint (% of nom.). The VAR Setpoint determines the level of generator vars maintained by the DVR2000E when operating in Var Control mode. Values from -100 to +100 percent in 1.0 percent increments may be entered in the VAR Setpoint field.

Power Factor Control (PF) - PF Setpoint. The PF Setpoint determines the level of generator power factor maintained by the DVR2000E when operating in Power Factor Control mode. PF Setpoint values are adjustable from -0.6 to -1 (1) or 0.6 to +1 in 0.001 increments.

Startup Tab

The Startup-tab settings of the Setting Adjustment screen are shown in Figure 5-10. Each setting of the Startup tab is described in the following paragraphs.

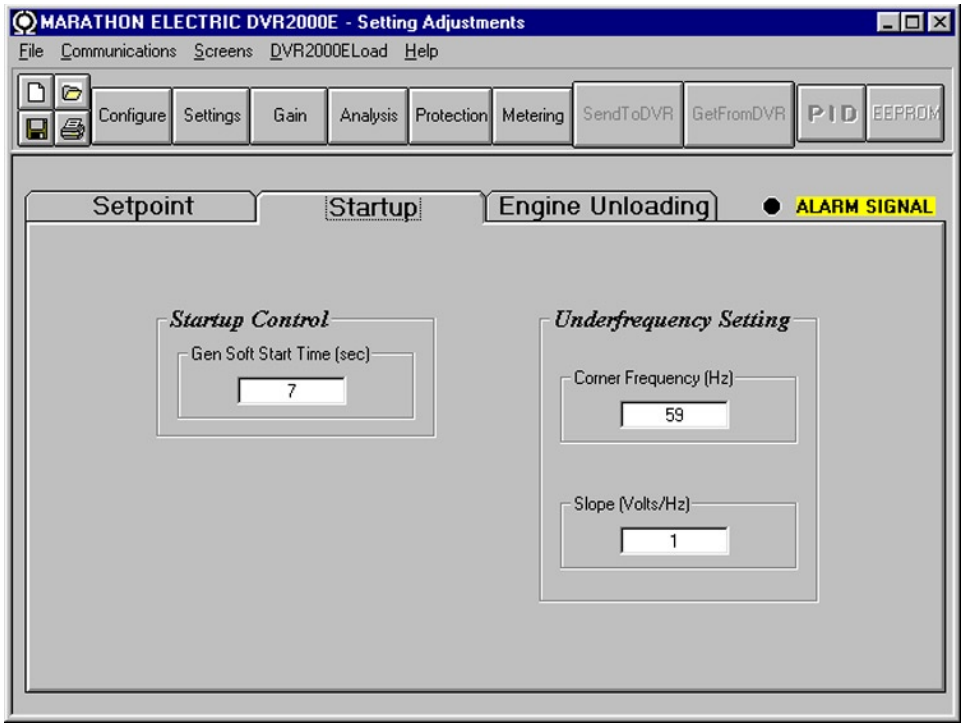

Figure 5-10. Setting Adjustments Screen, Startup Tab

Startup Control - Gen Soft Start Time (sec). This setting defines the time limit for the generator soft-start voltage offset. The soft-start time can be set from 1 to 120 seconds in 1 second increments.

Underfrequency Setting - Corner Frequency (Hz). The Corner Frequency setting defines the value of frequency that causes the DVR2000E to adjust the voltage setpoint so that the generator voltage follows the selected volts per hertz slope. A value of 40 to 65 hertz can be entered in this setting field in 0.01 increments.

Underfrequency Setting - Slope (Volts/Hz). The slope for generator underfrequency protection is selected with this setting. A slope setting of 1 to 3.00 can be entered in increments of 0.01. The slope is a per-unit setting.

Engine Unloading Tab

The Engine Unloading tab settings of the Setting Adjustments screen are shown in Figure 5-11. Each setting of the Engine Unloading tab is described in the following paragraphs.

Unloading Activation – Frequency (Hz). This frequency is entered as a value below the underfrequency corner where the engine unloading feature may be activated. A frequency value of 0.9 to 9.0 hertz can be entered in 0.1 hertz increments.

Unloading Activation – Rate (Hz/25 msec). The engine unloading feature is activated when the frequency rate of change exceeds the setting of this field. An unloading activation rate of 0 to 25.5 hertz per 25 milliseconds can be entered in 0.1 hertz per 25 millisecond increments.

Unloading Droop – Percentage (%). The value in this field defines the percent drop in generator output voltage for each 1.5 percent decrease in generator frequency when operating in the Engine Unloading mode. The Unloading Droop Percentage is adjustable from 1 to 20 percent in 1 percent steps.

Unloading Droop – Time (sec). This value defines the length of time that the Engine Unloading mode may be active before control is passed to the normal Underfrequency mode of operation. Droop time is adjustable from 1 to 5 seconds in 1 second increments.

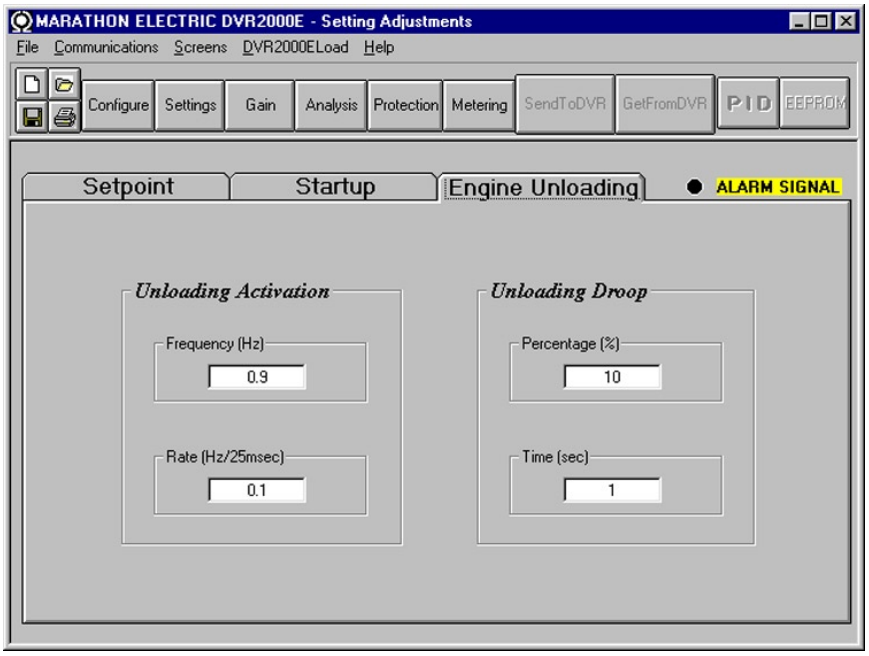

Figure 5-11. Setting Adjustments Screen, Engine Unloading Tab

Control Gain

The Control Gain screen consists of one tab labeled Control Gain. Click the Gain button to access the Control Gain screen or click Screens on the menu bar and click Control Gain.

Control Gain Tab

Control gain settings are shown in Figure 5-12 and are described in the following paragraphs.

Stability Range. This setting selects one of 7 preset stability ranges within the DVR2000E. A guide for selecting the stability range is provided in Table 5-1. A setting of 21 enables the entry of custom stability settings through the DVR2000E-32 PID window. Information about the PID window is provided later under the heading of PID Window. When the Stability Range is set at 21, the PID button may be selected to access the PID window. A Stability Range setting of 1 through 7 disables the PID button and prevents access to the PID window.

Table 5-1. DVR2000E Stability Range Settings

Frame/Poles	Time Constants		Stability Range
	Generator (T'do)	Exciter (Texc)	
360/4	1.0	0.17	1
430/4	1.5	0.25	2
570/4	2.0	0.33	3
740/4	2.5	0.42	4
1,000/4	3.0	0.50	5
740/6	3.5	0.58	6
1,000/6	4.0	0.67	7

AVR/FCR - Proportional Gain KP. This setting selects the proportional constant (KP) stability parameter. The DVR2000E supplies a value that is equivalent to KP multiplied by the error between the voltage setpoint and the actual generator output voltage. KP values of 0 to 1,000 may be entered in increments of 0.01.

Observe the following guidelines when tuning the KP value. If the transient response has too much overshoot, then KP should be decreased. If the transient response is too slow, then KP should be increased.

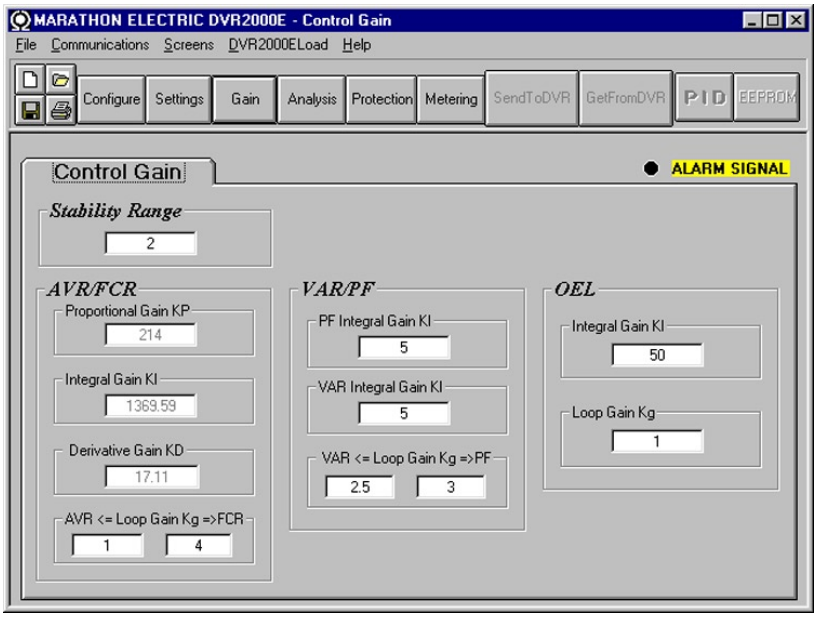

Figure 5-12. Control Gain Screen

AVR/FCR - Integral Gain KI. This setting selects the integral constant (KI) stability parameter. The DVR2000E supplies a value that is equivalent to KI multiplied by the integral of the error between the voltage setpoint and the actual generator output voltage. KI values of 0 to 2,000 may be entered in increments of 0.01.

Increasing the value of KI decreases the time required to reach steady state.

AVR/FCR - Derivative Gain KD. This setting selects the derivative constant (KD) stability parameter. The DVR2000E provides an output value that is equivalent to KD multiplied by the derivative of the error between the voltage setpoint and the actual generator output voltage. KD values of 0 to 1,000 may be entered in increments of 0.01.

Increasing the value of KD reduces transient response ringing.

AVR/FCR - Loop Gain Kg=>AVR. This setting adjusts the loop-gain level of the PID algorithm for AVR . Loop Gain values of 0.5 to 4.5 may be entered for AVR operation in increments of 0.01.

AVR/FCR - Loop Gain Kg=>FCR. This setting adjusts the loop-gain level of the PID algorithm for FCR . Loop Gain values of 0 to 1,000 may be entered FCR operation in increments of 0.01.

VAR/PF - PF Integral Gain KI. This setting adjusts the integral gain and determines the characteristic of the DVR2000E(C) dynamic response to a changed PF setting. PF KI values of 0 to 1,000 may be entered in increments of 0.01.

VAR/PF - Var Integral Gain KI. This setting adjusts the integral gain and determines the characteristic of the DVR2000E(C) dynamic response to a changed var setting. Var KI values of 0 to 1,000 may be entered in increments of 0.01.

VAR/PF - VAR<=Loop Gain Kg=>PF. This setting adjusts the loop-gain level of the PI algorithm for var or power factor control. Loop Gain values of 0 to 1,000 may be entered for var and power factor operation in increments of 0.01.

OEL - Integral Gain KI. This setting controls the rate at which the DVR2000E responds during an overexcitation event. KI values of 0 to 1,000 may be entered in increments of 0.01.

OEL - Loop Gain Kg. This setting adjusts the loop-gain level of the PID algorithm for the over-excitation limiting function. Loop Gain values of 0 to 1,000 may be entered in increments of 0.01.

Analysis

Click the Analysis button or click Screens on the Menu bar and click Analysis to view the Analysis screen. The Analysis screen consists of four tabs: VAR, PF, AVR, and FCR. Each of the tabs displays four metered sensing values and has six alarm signal indicators. Metered sensing values include Vrms (rms voltage), Ifd (dc field current), reactive power (vars), and power factor (PF). Alarm signal indicators include Overexcitation Shutdown, Generator Overvoltage, DVR Overtemperature, Loss of Generator Sensing, Overexcitation Limiting, and Underfrequency Active.

The operating status and control mode of the DVR2000E determine which tabs of the Analysis screen are enabled and can be accessed by the user. Table 5-2 lists the DVR2000E operating status and control modes that enable the four tabs of the Analysis screen.

Table 5-2. Analysis Screen Tab Combinations

Control Mode	Operating Status	Tab Enabled
AVR	OFF	AVR
AVR	PF	AVR, PF
AVR	VAR	AVR, VAR
FCR	N/A	FCR

Control mode and operating status selections are made at the Operation tab of the DVR2000E-32 Metering screen and are discussed later in this section.

AVR Tab

Figure 5-13 illustrates the settings, sensing values, and alarm signal indicators of the AVR tab. The settings of the AVR tab make it possible to increment and decrement the AVR setpoint of the DVR2000E. The sensing values and alarm signal indicators of the AVR tab are also displayed by the other tabs of the Analysis screen.

Voltage Step Response - AVR Setpoint (V) (Nominal). This read-only field indicates the AVR setpoint. (The AVR setpoint is set by using the Setpoint tab of the Setting Adjustments screen). The voltage displayed in the AVR Setpoint field is selected by clicking the adjacent button. Clicking this button sends the AVR Setpoint value to the DVR2000E and changes the color of the button from gray to red.

Voltage Step Response - Increment of AVR Setpoint (V). These two fields indicate the increase that occurs to the AVR setpoint when the corresponding Increment button is clicked. The “% increase” field is used to set and indicate the percentage that the AVR setpoint is increased when the Increment button is clicked. The “AVR Setpoint =” field indicates the value of voltage that corresponds to the “% increase” field. Any setpoint value within range and higher than setpoint value be can also be typed into the “AVR Setpoint =” field which updates the “% increase” field also. The AVR setpoint changes to this value when the adjacent button is clicked. When clicked, the Increment button changes from gray to red to indicate that the AVR setpoint has increased to the value in the “AVR Setpoint =” field.

Voltage Step Response - Decrement of AVR Setpoint (V). These two fields indicate the change that will occur to the AVR setpoint when the corresponding Decrement button is clicked. The “% decrease” field is used to set and indicate the percentage that the AVR setpoint is decreased when the Decrement button is clicked. The “AVR Setpoint =” field indicates the value of voltage that corresponds to the “% decrease” field. Any setpoint value within range and lower than setpoint value can also be typed into the “AVR Setpoint =” field which updates the “% decrease” field also. The AVR setpoint changes to this value when the adjacent button is clicked. When clicked, the Decrement button changes from gray to red to indicate that the AVR setpoint has decreased to the value in the “AVR Setpoint =” field.

Voltage Step Response - Meter. The meter in the AVR tab shows the value selected. If an AVR setpoint value is sent by increase, decrease or setpoint button the meter shows the corresponding value and meter value text box also displays it. Any value within the range can either be input to meter value text box or selected by dragging the pointer in the meter using mouse. This value can then be sent to the unit by pressing Send button.

The setpoint value currently set in the unit by any of the above methods is displayed in the current setpoint textbox. To return to the nominal setting the button adjacent to AVR Setpoint (V) (Nominal) should be pressed. If the AVR analysis screen is left without returning to nominal setpoint, a message box (Figure 5-14) is shown which allows the user to return to nominal setpoint by pressing YES or remain at the current setpoint by pressing NO.

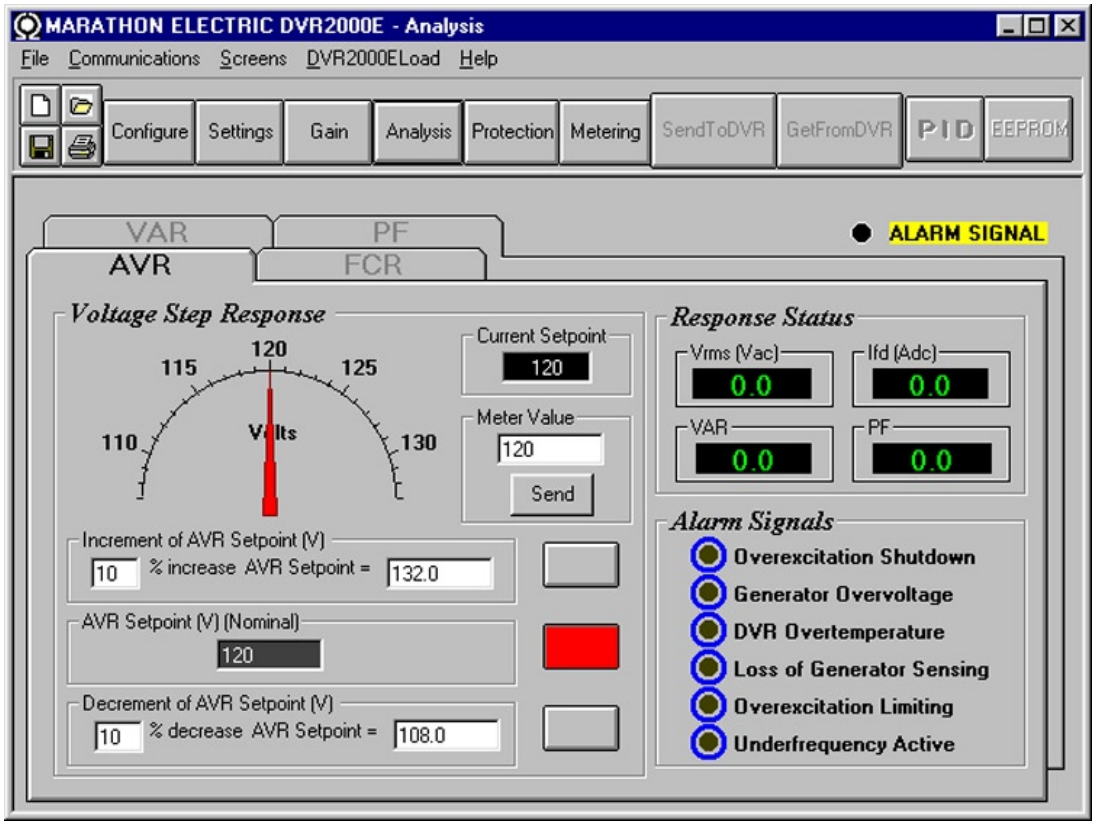

Figure 5-13. Analysis Screen, AVR Tab

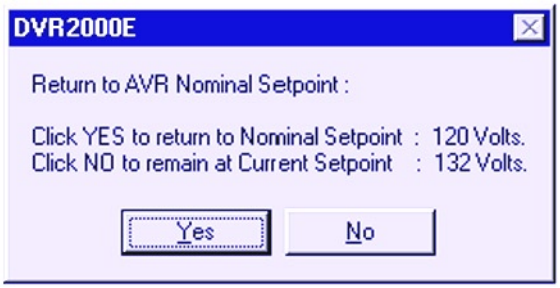

Figure 5-14. Message Box - Return to AVR Nominal Setpoint

FCR Tab

Figure 5-15 illustrates the settings, sensing values, and alarm signal indicators of the FCR tab. The settings of the FCR tab make it possible to increment and decrement the FCR setpoint of the DVR2000E. The sensing values and alarm signal indicators of the FCR tab are also displayed by the other tabs of the Analysis screen.

Field Current Step Response - FCR Setpoint (A). This read-only field indicates the FCR setpoint. (The FCR setpoint is set by using the Setpoint tab of the Setting Adjustments screen). The current displayed in the FCR Setpoint field is selected by clicking the adjacent pushbutton. Clicking this button sends the FCR Setpoint value to the DVR2000E and changes the color of the pushbutton from gray to red.

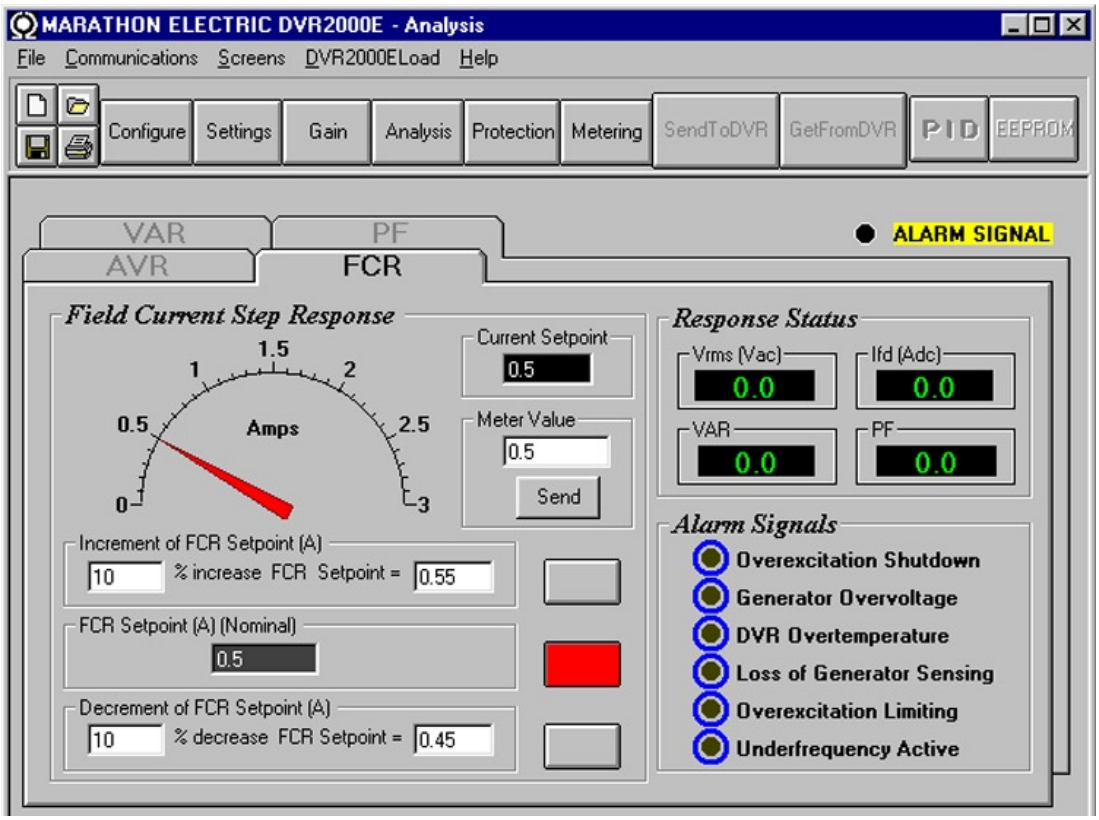

Figure 5-15. Analysis Screen, FCR Tab

Section 5

Field Current Step Response - Increment of FCR Setpoint (A). These two fields indicate the increase that occurs to the FCR setpoint when the corresponding Increment button is clicked. The "% increase" field is used to set and indicate the percentage that the FCR setpoint is increased when the Increment button is clicked. The "FCR Setpoint =" field indicates the value of current that corresponds to the "% increase" field. Any setpoint value within range and higher than setpoint value can also be typed into The "FCR Setpoint =" field which updates the "% increase" field also. The FCR setpoint changes to this value when the adjacent button is clicked. When clicked, the Increment button changes from gray to red to indicate that the FCR setpoint has increased to the value in the "FCR Setpoint =" field.

Field Current Step Response - Decrement of FCR Setpoint (A). These two fields indicate the change that will occur to the FCR setpoint when the corresponding Decrement button is clicked. The "% decrease" field is used to set and indicate the percentage that the FCR setpoint is decreased when the decrement button is clicked. The "FCR Setpoint =" indicates the value of current that corresponds to the "% decrease" field. Any setpoint value within range and lower than setpoint value can also be typed into The "FCR Setpoint =" field which updates the "% decrease" field also. The FCR setpoint changes to this value when the adjacent button is clicked. When clicked, the Decrement button changes from gray to red to indicate that the FCR setpoint has decreased to the value in the "FCR Setpoint =" field.

Field Current Step Response - Meter. The meter in the FCR tab shows the value selected. If an FCR setpoint value is sent by increase, decrease or setpoint button the meter shows the corresponding value and meter value text box also displays it. Any value within the range can either be input to meter value text box or selected by dragging the pointer in the meter, using mouse. This value can then be sent to the unit by pressing Send button.

The setpoint value currently set in the unit by any of the above methods is displayed in the current setpoint textbox. To return to the nominal setting the button adjacent to FCR Setpoint (I) (Nominal) should be pressed. If the FCR analysis screen is left without returning to nominal setpoint a message box is shown (Figure 5-16) which allows the user to return to nominal setpoint by pressing YES or remain at the current setpoint by pressing NO.

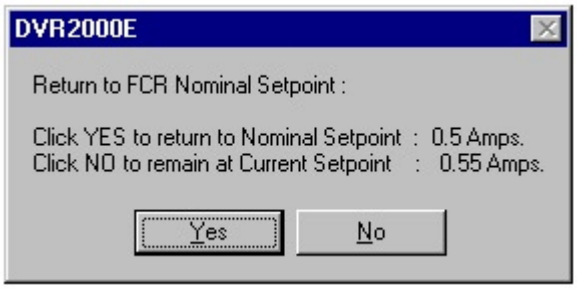

Figure 5-16. Message Box to Return to FCR Nominal Setpoint

PF Tab (Available on DVR2000EC only)

Figure 5-17 illustrates the settings, sensing values, and alarm signal indicators of the PF tab. Each setting of the PF tab is described in the following paragraphs.

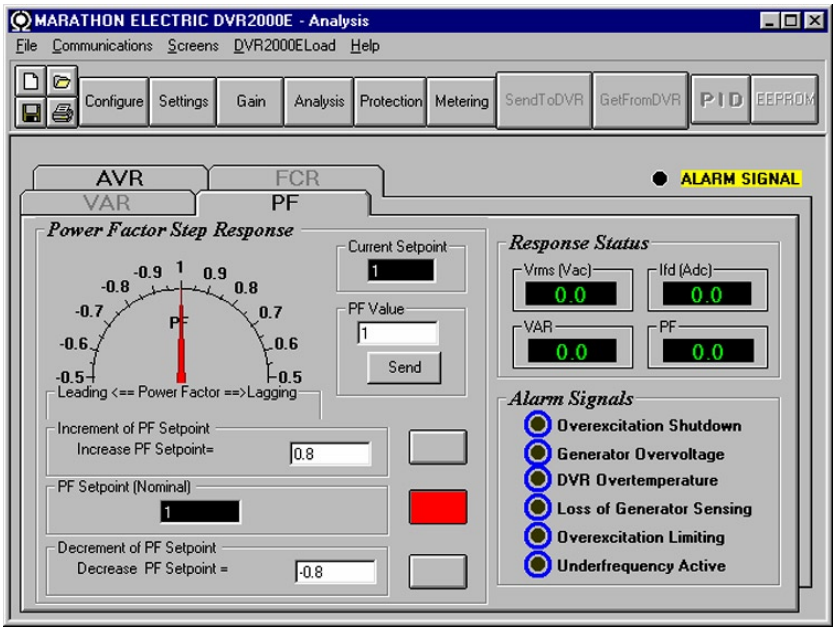

Figure 5-17. Analysis Screen, PF Tab

Power Factor Step Response - Power Factor Setpoint (Nominal). This read-only field indicates the PF setpoint. (The PF setpoint is set by using the Setpoint tab of the Setting Adjustments screen). The value displayed in the PF Setpoint field is selected by clicking the adjacent button. Clicking this button sends the PF Setpoint value to the DVR2000E and changes the color of the button from gray to red.

Power Factor Step Response - Increment of PF setpoint. This field indicate the increase that occurs to the PF setpoint when the corresponding increment button is clicked. Any setpoint value within the range and higher than setpoint value can be input to this filed. The PF setpoint changes to this value when the adjacent button is clicked. When clicked, the Increment button changes from gray to red to indicate that the PF setpoint has increased to the value in the field.

Power Factor Step Response - Decrement of PF setpoint. This field indicate the decrease that occurs to the PF setpoint when the corresponding decrement button is clicked. Any setpoint value within the range and lower than setpoint value can be input to this filed. The PF setpoint changes to this value when the adjacent button is clicked. When clicked, the Increment button changes from gray to red to indicate that the PF setpoint has decreased to the value in the field.

Power Factor Step Response - Meter. The meter in the PF tab shows the value selected. If an PF setpoint value is sent by increase, decrease or setpoint button the meter shows the corresponding value and meter value text box also displays it. Any value within the range can either be input to meter value text box or selected by dragging the pointer in the meter using mouse. This value can then be sent to the unit by pressing Send button.

The setpoint value currently set in the unit by any of the above methods is displayed in the current setpoint textbox. To return to the nominal setting the button adjacent to PF Setpoint (Nominal) should be pressed. If the PF analysis screen is left without returning to nominal setpoint a message box is shown (Figure 5-18) which allows the user to return to nominal setpoint by pressing YES or remain at the current setpoint by pressing NO.

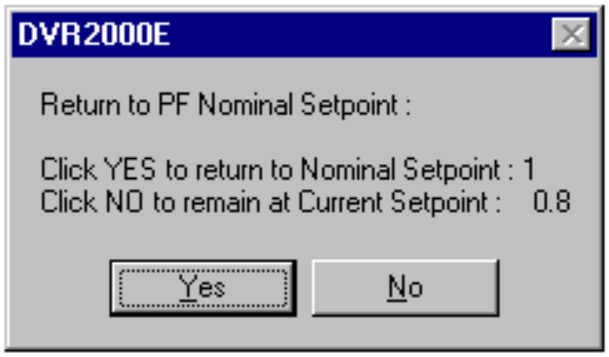

Figure 5-18. Message Box to Return to PF Nominal Setpoint

VAR Tab (Available on DVR2000EC only)

Figure 5-19 illustrates the settings, sensing values, and alarm signal indicators of the VAR tab. Each setting of the VAR tab is described in the following paragraphs.

VAR Step Response - VAR Setpoint (Nominal). This read-only field indicates the VAR setpoint. (The VAR setpoint is set by using the Setpoint tab of the Setting Adjustments screen). The value displayed in the VAR Setpoint field is selected by clicking the adjacent button. Clicking this button sends the VAR Setpoint value to the DVR2000E and changes the color of the button from gray to red.

VAR Step Response - Increment of VAR setpoint. This field indicate the increase that occurs to the VAR setpoint when the corresponding increment button is clicked. Any setpoint value within the range and higher than setpoint value can be input to this filed. The VAR setpoint changes to this value when the adjacent button is clicked. When clicked, the Increment button changes from gray to red to indicate that the VAR setpoint has increased to the value in the field.

VAR Step Response - Decrement of VAR setpoint. This field indicate the decrease that occurs to the VAR setpoint when the corresponding decrement button is clicked. Any setpoint value within the range and lower than setpoint value can be input to this filed. The VAR setpoint changes to this value when the adjacent button is clicked. When clicked, the Increment button changes from gray to red to indicate that the VAR setpoint has decreased to the value in the field.

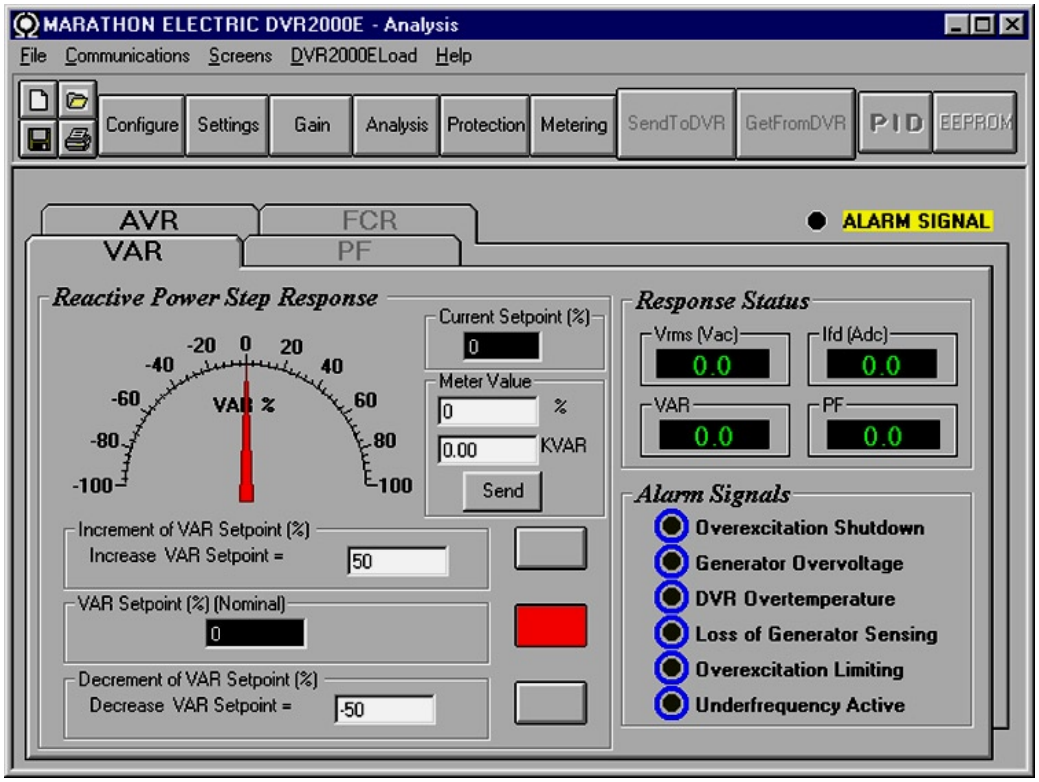

Figure 5-19. Analysis Screen, VAR Tab

VAR Step Response - Meter. The meter in the VAR tab shows the value selected. If an VAR setpoint value is sent by increase, decrease or setpoint button the meter shows the corresponding value and meter value text box also displays it. Any value within the range can either be input to meter value text box or selected by dragging the pointer in the meter using mouse. This value can then be sent to the unit by pressing Send button.

The setpoint value currently set in the unit by any of the above methods is displayed in the current setpoint textbox. To return to the nominal setting the button adjacent to VAR Setpoint (Nominal) should be pressed. If the VAR analysis screen is left without returning to nominal setpoint a message box is shown which allows the user to return to nominal setpoint by pressing YES or remain at the current setpoint by pressing NO.

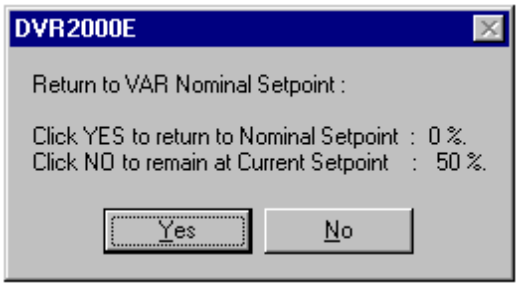

Figure 5-20. Message box to return to VAR Nominal Setpoint

Protection and Relay Settings

The Protection and Relay Settings screen consists of one tab labeled Protection. Click the Protection button to access the Protection screen or click Screens on the menu bar and click Protection/Relay.

Protection Tab

Protection settings are shown in Figure 5-21 and are described in the following paragraphs.

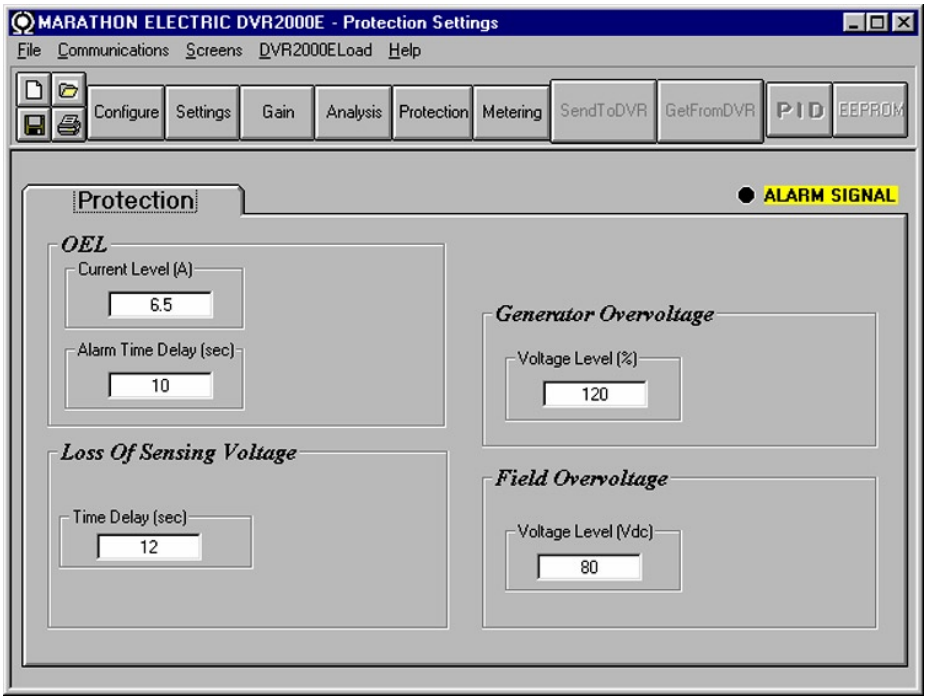

Figure 5-21. Protection Settings Screen Remove

OEL - Current Level (A). The value of current in this field determines the excitation level that will cause the DVR2000E to issue an overexcitation limit alarm. A current level of 0 to 7.5 A may be entered in 0.001 increments. When the level of field current increases above the value of this field, the OVEREXCITATION SHUTDOWN LED on the front panel lights and the OEL time delay starts timing down.

OEL - Alarm Time Delay (sec). The value of this field determines the time delay between when the DVR2000E recognizes an overexcitation condition and the DVR2000E Alarm output (terminals AL1, AL2) closes. A time delay of 0 to 10 seconds may be entered in 1 second increments.

Field Overvoltage - Voltage Level (Vdc). The voltage value in this field determines the field voltage level that will cause the DVR2000E to issue an overexcitation limit alarm. When the field voltage increases above the value of this field, the OVEREXCITATION SHUTDOWN LED on the front panel lights. If the alarm condition exists for more than 15 seconds, the DVR2000E Alarm output (terminals AL1, AL2) closes.

Loss of Sensing Voltage - Time Delay (sec). The value of this field determines the time delay between when a loss of sensing voltage is recognized and the DVR2000E responds according to the Hardware Shutdown and LOS Option options selected. A time delay of 0 to 25 seconds may be entered in 1 second increments.

Generator Overvoltage - Voltage Level (%). The value of this field is expressed as a percentage and determines the level of generator voltage required to initiate a generator overvoltage condition. An overvoltage percentage value of 105 to 120 percent may be entered in 1 percent increments. A generator overvoltage condition lights the GENERATOR OVERVOLTAGE LED on the front panel and closes the Alarm output at DVR2000E terminals AL1 and AL2 after a delay of .75 seconds.

Metering, Operation and Alarms

The Metering, Operation and Alarms screen is viewed by clicking the Metering button or by clicking Screens on the Menu bar and clicking Metering/Operation. Information displayed on the Metering, Operation and Alarms screen can be frozen by clicking the Metering button while viewing the screen or by clicking Metering on the Menu bar and clicking Disable Metering. Metering can be resumed by clicking the Metering button or by clicking Metering on the Menu bar and clicking Enable Metering. The Metering, Operation and Alarms screen consists of two tabs: Operation and Alarm/Status.

Operation Tab

Operation tab metering values, setpoint values and control functions are illustrated in Figure 5-22.

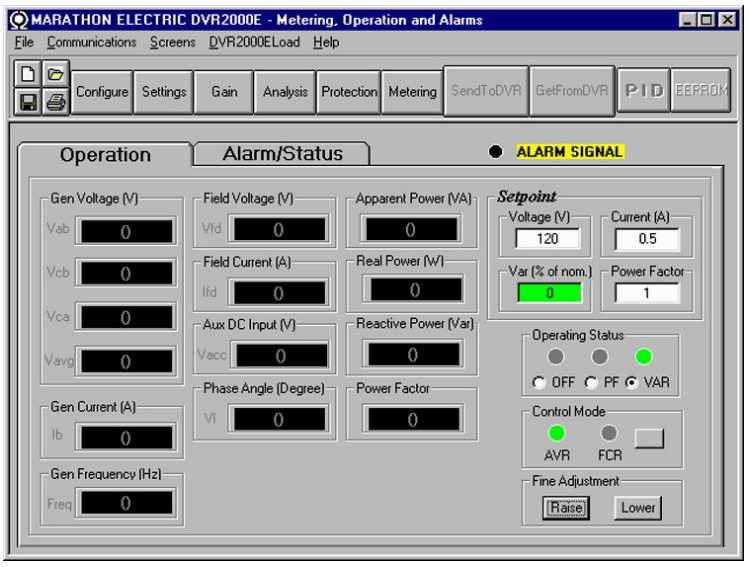

Figure 5-22. Metering, Operation and Alarms - Operation Tab

Gen Voltage (V). These metering values report the status of the V_{A-B}, V_{C-B}, V_{C-A}, and V_{AVG} generator voltages and are the products of the voltage sensed at terminals E1, E2, and E3 and the Generator PT ratio. All metering values are updated once each second. When single-phase sensing is used (System Configuration screen, Sensing Voltage) and the DVR2000E sensing voltage terminals (E1, E2, and E3) are connected as shown in Figure 4-7, all of the generator voltage metering values will be identical.

Gen Current (A). This metering value indicates the level of the B-phase generator current and is the product of the current input to CT1 and CT2 and the CT ratio. Generator current is monitored through DVR2000E terminals CT1 and CT2.

Gen Frequency (Hz). This metering value indicates the frequency of the monitored generator voltage.

Field Voltage (V). This metering value indicates the value of voltage being supplied from the DVR2000E output (terminals F+ and F-) to the generator field.

Field Current (A). This metering value indicates the amount of current flowing from the DVR2000E output (terminals F+ and F-) to the generator field.

Aux DC Input (V). This metering value indicates the level of dc control voltage applied from a remote device to DVR-2000E terminals A and B. The displayed value correlates to the generator voltage setpoint.

Phase Angle (Degree). This metering value indicates the phase angle difference (in degrees) between the generator voltage and the generator current.

Apparent Power (VA). This value is the calculated product of the metered generator voltage (V_{AVG}), metered generator current (Ib), and the square root of 3. See Equation 5-1.

$$VA = V_{AVG} \times I_B \times \sqrt{3}$$

Equation 5-1. Apparent Power Formula

Real Power (W). This value is the calculated product of the metered generator voltage(V_{AVG}), metered generator current (I_B), square root of 3 and the cosine of the metered phase angle. See Equation 5-2.

$$W = V_{AVG} \times I_B \times \sqrt{3} \times \cos\Phi$$

Equation 5- 2. Real Power Equation

Reactive Power (var). This value is the calculated product of the metered generator voltage (VAVG), metered generator current (I_B) square root of 3 and the sine of the metered phase angle. See Equation 5-3.

$$VAR = V_{AVG} \times I_B \times \sqrt{3} \times \sin\Phi$$

Equation 5- 3. Reactive Power Equation

Power Factor. This value is the calculated result of dividing the Real Power (W) value by the Apparent Power (VA) value. See Equation 5-4.

$$PF = W \div VA = COS\Phi$$

Equation 5- 4. Power Factor Equation

Operating Status. The Operating Status controls and indicators include three buttons and three corresponding indicators. Operating Status buttons are labeled PF, VAR, and OFF. Clicking the PF button changes the color of the adjacent PF indicator to green and causes the DVR2000EC to maintain the desired power factor regulation point. The power factor regulation point can be set within the range of 0.6 lead to 0.6 lag. Clicking the VAR button changes the color of the adjacent VAR indicator to green and causes the DVR2000EC to maintain the desired var regulation point. The var regulation point can be set within the range of 100 percent absorb to 100 percent generate. Clicking the OFF button changes the color of the adjacent OFF indicator to red and disables power factor and var regulation.

Operation of the Operating Status controls is determined by the status of the contacts connected across the DVR2000EC Var/PF Control terminals (52J, 52K). When these contacts are open, the Operating Status controls are enabled. Closing the contacts at terminals 52J and 52K disables the Operating Status controls and interrupts regulation of vars or power factor until the contacts are opened again.

Setpoint - Voltage (V). This setting field can be used to enter the desired generator output terminal voltage. The voltage setpoint can also be entered at the Setting Adjustments screen, Setpoint tab, Automatic Voltage Regulator (AVR) - AVR Setpoint (V). The background color of this field is green when operating in AVR mode and power factor and var regulation is disabled.

Setpoint - Current (A). This setting defines the field current setpoint when operating in FCR mode. The current setpoint can also be entered at the Setting Adjustments screen, Setpoint tab, Field Current Regulator (FCR) - FCR Setpoint. Current values from 0 to 3 Adc may be entered in increments of 0.01 Adc. The background color of this field is green when operating in FCR mode.

Setpoint - Var (% of nom.). This setting determines the level of generator vars maintained by the DVR2000EC when operating in var mode. The var setpoint can also be entered at the Setting Adjustments screen, Setpoint tab, Reactive Power Control (VAR) - VAR Setpoint (% of nom.). The background color of this field is green when the DVR2000EC is operating in AVR mode and is regulating the var setpoint.

Setpoint - Power Factor. This setting determines the level of power factor regulation maintained by the DVR2000EC. The power factor setpoint can also be entered at the Setting Adjustments screen, Setpoint tab, Power Factor Control (PF) - PF Setpoint. Power Factor setpoint values are adjustable from -0.6 to -1 (1) or 0.6 to +1 in 0.001 increments. The background color of this field is green when the DVR2000EC is operating in AVR mode and is regulating the power factor setpoint.

Control Mode. Clicking the AVR button changes the color of the adjacent AVR indicator to green and enables the AVR operating mode. When operating in AVR mode, the DVR2000E regulates the generator output voltage at the AVR setpoint. Clicking the FCR button changes the color of the adjacent FCR indicator to green and enables the FCR operating mode. When operating in FCR mode, the DVR2000E maintains the field current at the FCR setpoint.

Fine Adjustment. Raise and Lower buttons control the fine adjustment of the operating setpoint. (The fine adjustment through the front panel push buttons only controls the voltage setpoint.) Raise and Lower buttons perform the same function as closing the appropriate set of contacts connected to the External Adjust terminals (6D and 7 to decrease, 6U and 7 to increase) of the DVR2000E. In AVR mode, each click of the Raise button increases the voltage setpoint 0.1 volts; each click of the Lower button decreases the voltage setpoint 0.1 volts. The minimum and maximum limits for fine adjustment of the voltage setpoint are controlled by the Regulator Sensing Voltage setting (System Configuration screen) and the Fine Voltage Adjustment - Band setting (Setting Adjustments screen). Fine adjustment of the voltage setpoint can be increased/decreased no higher/lower than

the Regulator Sensing Voltage setting plus/minus the Band setting. For example, a Regulator Sensing Voltage setting of 100 volts and a Band setting of 10 percent allows the Fine Adjustment function to increase the voltage setpoint to a maximum of 110 volts and decrease the voltage setpoint to a minimum of 90 volts. For VAR, PF or FCR modes, the Raise and Lower buttons allow fine adjustment over the entire adjustment range.

Alarm/Status Tab

The Alarm/Status tab indicators provide the status of DVR2000E protection functions, control modes, and contact inputs. Alarm/Status tab indicators are illustrated in Figure 5-23 and are described in the following paragraphs.

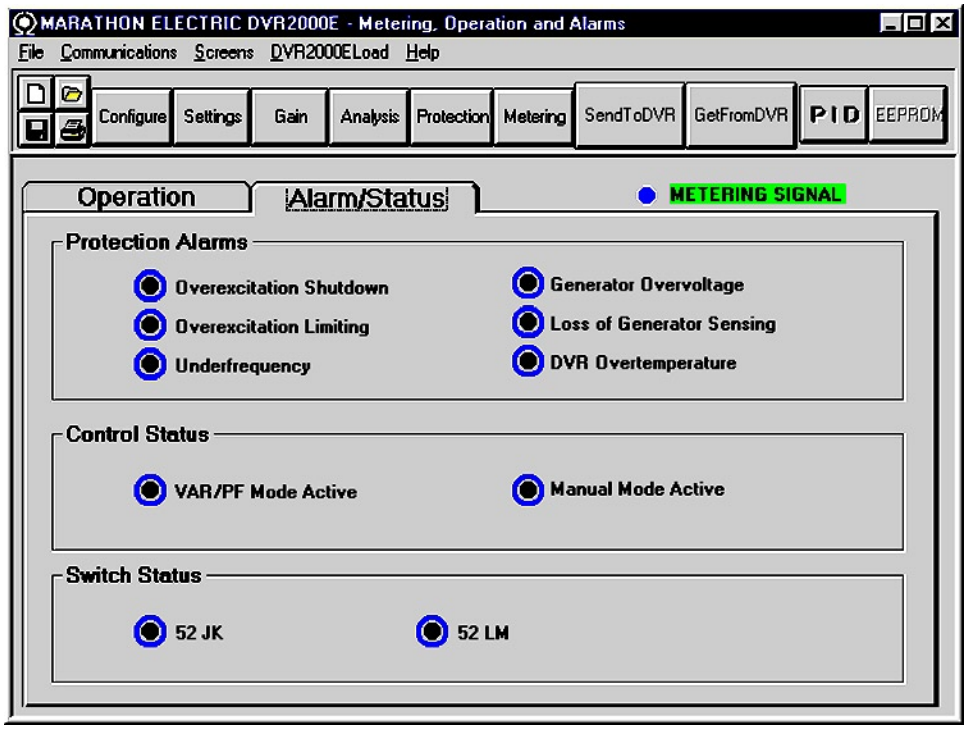

Figure 5-23. Metering, Operation and Alarms - Alarm/Status Tab

Protection Alarms. Six Protection Alarm indicators provide the status of DVR2000E protection functions. Alarm indicators include Overexcitation Shutdown, Overexcitation Limiting, Underfrequency, Generator Overvoltage, Loss of Generator Sensing, and DVR Overtemperature. When a DVR2000E protection function detects an alarm condition, the appropriate indicator changes from black to red.

Control Status. Two Control Status indicators indicate when the VAR/PF and Manual modes are active. The Manual Mode Active indicator changes from black to red when the FCR control mode is active. The VAR/PF Mode Active indicator changes from black to red when the DVR2000EC is operating in AVR mode and correction of power factor or vars is selected.

Switch Status. Three Switch Status indicators indicate when the DVR2000E control inputs are open or closed. The 52JK switch open indicator changes from black to red when the user-supplied contacts at terminals 52J and 52K are closed. When this control input is open, selection of PF or VAR mode can be made on the Operation tab of the Metering, Operation, and Alarms screen. The 52LM switch closed indicator changes from black to red when the user-supplied contacts at terminals 52L and 52M are closed. When this control input is closed, parallel control and droop is inactive.

Metering Signal. The Metering Signal indicator of the Alarm/Status tab flashes to indicate when metering is active. When the Metering button is clicked or Metering on the Menu bar is clicked followed by Disable Metering, the Metering Signal indicator stops flashing and the metering functions stop being updated.

PID DATA

DVR2000E-32 enables generator stability to be set through the automatic calculation of PID parameters. PID stands for Proportional, Integral, Derivative. The word proportional means that the response of the DVR2000E output is proportional or relative to the amount of change that is observed. Integral means that the DVR2000E output is proportional to the amount of time that a change is observed. Integral action eliminates offset. Derivative means that the DVR2000E output is proportional to the required rate of excitation change. Derivative action avoids excitation overshoot.

DVR2000E-32 automatically calculates PID values after the user selects the generator frequency, generator time constant (T'do), and exciter time constant (Texc). With DVR2000E-32, the user may generate new PID numbers, add to a PID list file, and update the AVR gain settings.

The PID window (Figure 5-24) is accessed by clicking the PID button. The PID button can be clicked only when the Stability Range setting of the Control Gain screen is set at a value of 21. (A setting of 21 enables the entry of custom stability settings through the PID window.) Then, when a field of the Control Gain screen is changed or selected, the PID button changes from gray to yellow and the button can be clicked to view the PID window. After the PID numbers are modified, calculated, and updated, the PID window is closed by clicking the Update Setting Screen button. The modified PID values are then shown on the Control Gain screen.

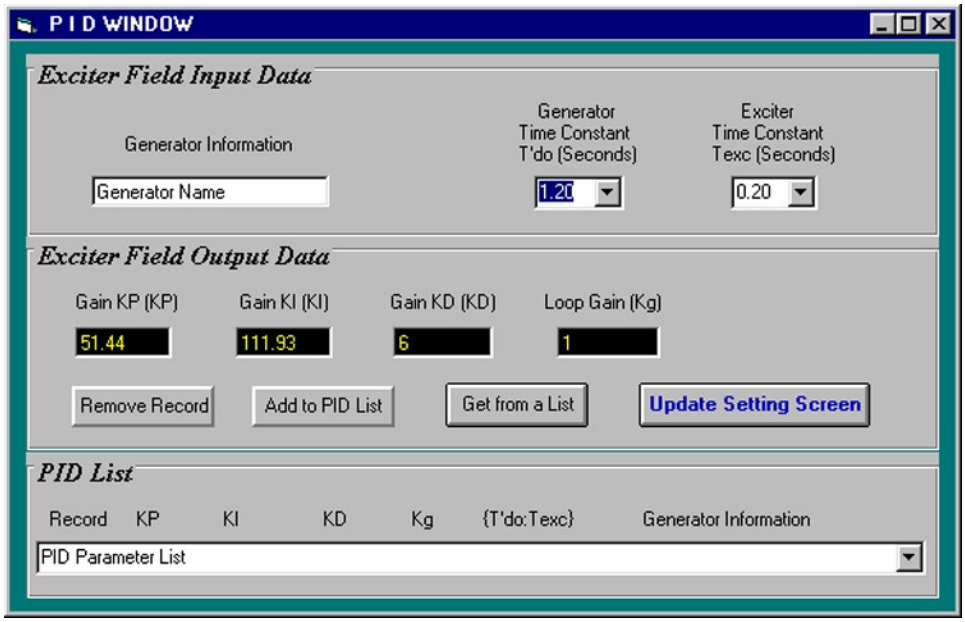

Figure 5-24. PID Window

PID Calculation Based on Input Values

The available range for the exciter time constant depends on the value entered for the generator time constant. (The default value for the exciter time constant is the generator time constant divided by 6.) The generator time constant value selected must be in the range of 1.00 to 15.00 seconds and in 0.05 increments. When the generator time constant value is 1.00, the available exciter time constant range is 0.03 to 0.50 in 0.01 second increments. When the generator time constant value is 15.00, the available exciter time constant range is 0.30 to 3.00 in 0.01 second increments.

For example, when T'do is set at 2.0 seconds, Texc is 0.33. After specifying the input values, a set of PID parameters (output data) is generated automatically. If T'do is set at 5.00 seconds, then Texc is 0.83 seconds. The calculated KP is 155.47, KI is 138.72, KD is 48, and Kg is 1.

PID parameters can be directly removed from, added to, or modified in the PID List Data. PID parameters may also be saved into a file (pidlist.dat).

Adding to the PID List

CAUTION

Improper PID numbers will result in poor system performance or system damage.

PID parameters can be added to a list and recalled for operation and comparison. To add to the list, type a name for the generator (or other appropriate information) in the generator information box. Select the generator time constant. Observe the PID gain parameters in the Field Output Data fields. If these gain parameters are appropriate, click the Add to PID List button. Check for the new parameters by pulling down the PID List (click the Down arrow). The new gain and time constant parameters should be displayed.

Removing a PID List Record

PID parameters can also be removed from the list. To remove a list (record), pull down the PID List and select the record or list so that the gain and time constant parameters are displayed. Click the Remove Record button and the listed record is deleted.

Retrieving Existing Data from the PID List

To retrieve existing data, pull down the PID List and select the record or list so that the gain and time constant parameters are displayed and highlighted. Click the Get from a List button and the listed record input and output data displays in the boxes.

SETTINGS FILES

DVR2000E-32 software enables you to print a list of DVR2000E settings, save DVR2000E settings to a file, and open a settings file and upload those settings to a DVR2000E. a settings file may also be opened and edited within any text editing software.

Printing Settings Files

A printout of DVR2000E settings can be useful for record keeping or comparison purposes. DVR2000E settings are printed by clicking the print icon or clicking File on the Menu bar and then clicking Print. When the print command is given, a print dialog box prompts you to select a printer. Once the printer is selected, a second dialog box (Figure 5-25) provides the opportunity to add a title, unit information, and comments to the settings list. Each entry is limited to a maximum of 60 characters. After this information is entered, OK is clicked and the report is printed.

Saving Settings Files

Saving DVR2000E settings to a file for uploading to other DVR2000E units saves setup time when configuring multiple units to the same configuration. A settings file can also be created in DVR2000E-32 without being connected to a DVR2000E. The settings of the desired screens can be changed and these settings can then be saved to a file. Once a settings file is created, it can be edited using any text editing software, and then saved for uploading.

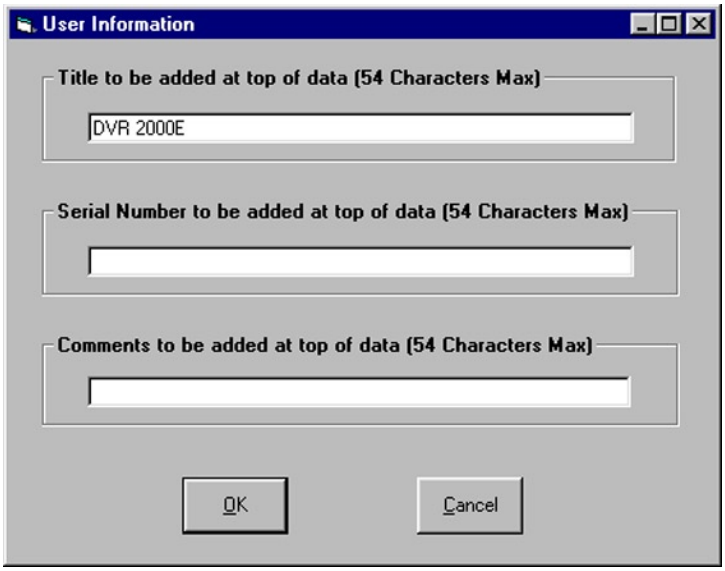

Figure 5-25. User Information Dialog Box for Settings List

A settings file is created by clicking the save icon or by clicking File on the Menu bar and then clicking Save. When the file command is given, a dialog box asks if you want to save the current settings into a DVR2000E data file. Clicking Yes displays a Save As dialog box where the settings are assigned a file name and then saved. All DVR2000E settings files are automatically given a .de1 extension by DVR2000E-32.

Uploading Settings Files

A DVR2000E settings file downloaded from a DVR2000E or created within DVR2000E-32 can be uploaded to multiple DVR2000E units. Only a DVR2000E settings file with a .de1 extension can be uploaded to a DVR2000E unit. Before uploading a file, communication must be initiated with the DVR2000E that is to receive the settings. Refer to the paragraphs under the headings Starting DVR2000E-32, Establishing Communication.

CAUTION

Before uploading a settings file, remove operating power from the DVR2000E, disconnect the field wiring from terminals F+ and F- and re-apply operating power to the DVR2000E.

The upload process is started by clicking the open icon or clicking File on the menu bar and then clicking Open. A dialog box is then displayed (Figure 5-26) reminding you that the DVR2000E should be off-line before uploading settings. Clicking Yes loads the settings into DVR2000E memory.

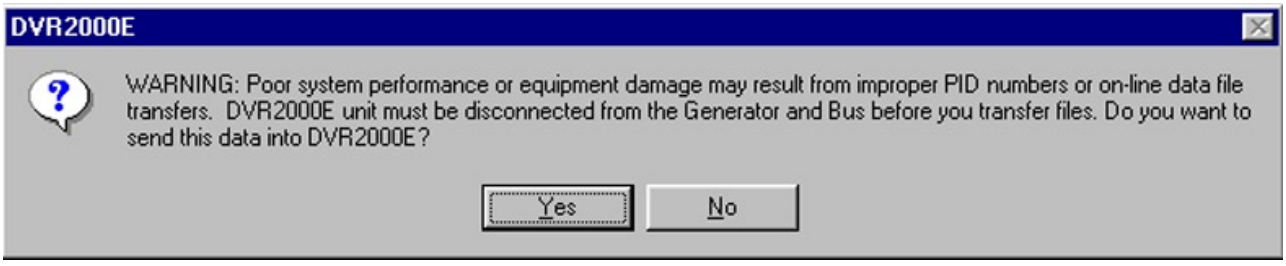

Figure 5-26. Settings Upload Dialog Box

PASSWORD PROTECTION

Password protection guards against unauthorized changing or viewing of DVR2000E settings. A single password protects all DVR2000E settings. The DVR2000E is delivered with a default password of dvr. Changing the password provides security against unauthorized changes to settings. Once changed, the password should be stored in a secure location. If the user-defined password is lost or forgotten, DVR2000E-32 must be reloaded to restore the default password.

Changing the Password

> NOTE
>
> A password change can be made only after communication between DVR2000E-32 and the DVR2000E is established.

A new password can be programmed by performing the following steps.

1. Click Communications on the menu bar and click Password Change on the drop-down menu. The Change Password dialog box of Figure 5-27 appears.
2. Type the current password in the “Enter your access password” field of the Change Password dialog box and press the Enter key on your keyboard.
3. Another dialog box will appear with instructions for making the password change. Click the OK button and type a new password (8 alphanumeric characters, maximum) in the “Enter your new password” field.
4. Press the Enter or Tab key on your keyboard to advance the cursor into the field labeled “Re-enter your new password”. Type the new password again to confirm the changed password and press the Enter key. When the Enter key is pressed, the new password is enabled and a dialog box appears to remind you to keep your password in a secure location.

Figure 5-27. Password Dialog Box

UPDATING EMBEDDED FIRMWARE

The DVR 2000E uses non-volatile flash memory for storing its embedded firmware (operating program) and can be reprogrammed by connecting the RS-232 port, located on the on the back of the device, to a Windows®

compatible PC running the Embedded Program Loader software. It is not necessary to physically replace EPROM chips to update the program.

The process of updating the embedded firmware can be started by clicking DVR2000ELoad on the menu bar and clicking Uploading Embedded Software. A warning window, Figure 5-28, will be displayed. The DVR 2000E should be disconnected from the generator and bus before continuing with this procedure and the current settings file should be backed up since uploading may replace some settings with defaults. Clicking No will cancel this procedure.

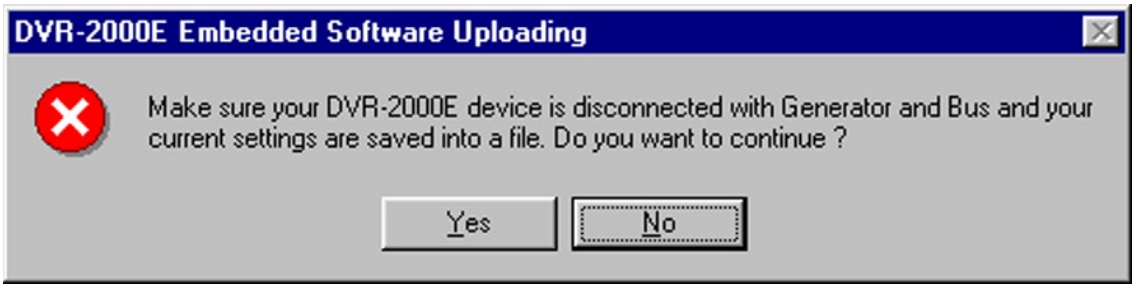

Figure 5-28. Embedded Software Uploading

Click Yes to proceed with software uploading. When Yes is clicked, the following screen is shown to select the communication port. When Initialize is selected, PC Software reads , checks within ranges and saves all settings. The following progress bar is shown while in process.

Figure 5-29. Communication Settings

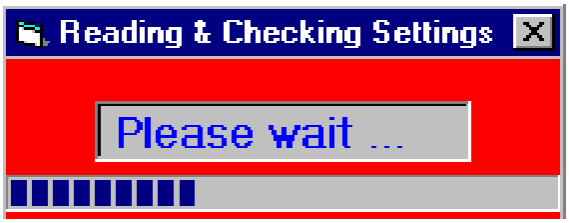

Figure 5-30. Comm Port

The DVR2000E Embedded Program Loader (Figure 5-31) will be displayed by clicking Yes.

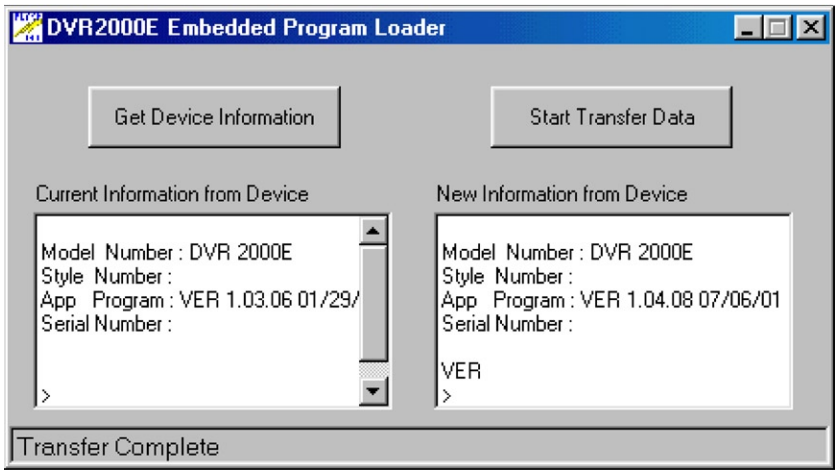

Figure 5-31. DVR2000E Embedded Program Loader

Clicking the Get Device Information button displays the current device's model number, style number, application program version and serial number in the lower left hand corner of Figure 5-31.

CAUTION

If power is lost or communication is interrupted during transfer, the unit will not recover and will no longer be operational.

Clicking the Start Transfer Data button displays the Settings File Saved? window (Figure 5-32). Clicking No in the Settings File Saved window will return the user to the DVR2000E Embedded Program Loader screen (Figure 5-29). Clicking Yes will display the Open Dialog box (Figure 5-33).

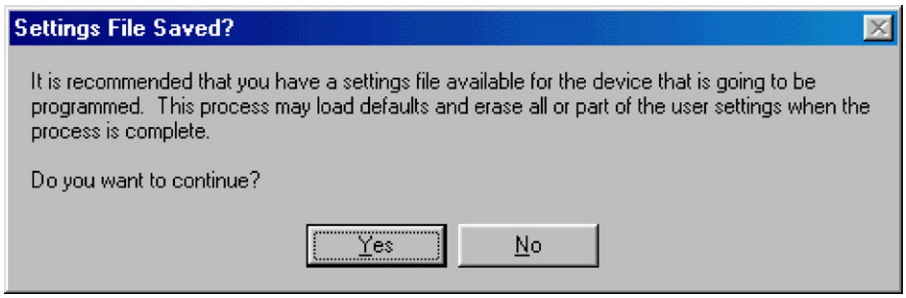

Figure 5-32. Settings File Saved Dialog Box

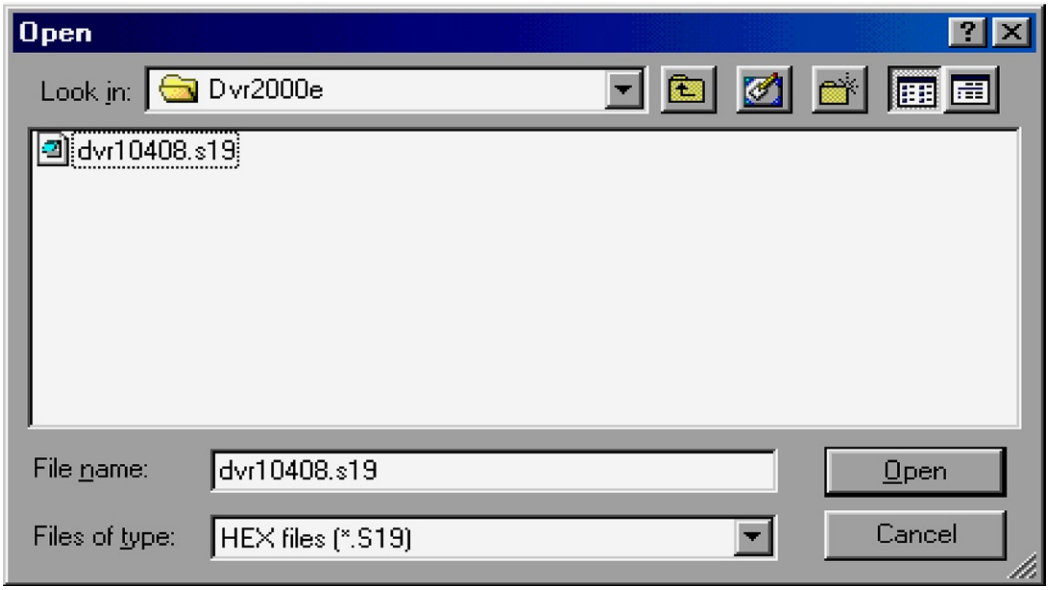

Figure 5-33. Open Dialog Box

Select the location of the embedded firmware update file, select the file, and click Open. The embedded firmware will begin transferring from the PC to the DVR 2000E. A progress bar, as displayed in Figure 5-34 marks the progress of the transfer.

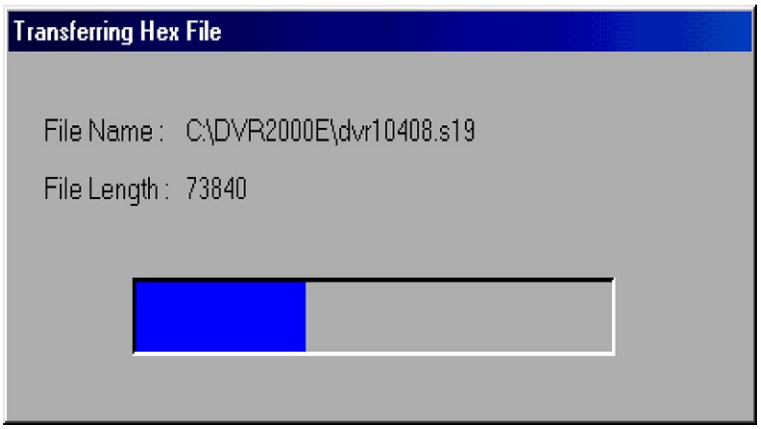

Figure 5-34. Transferring Hex File Dialog Box

The DVR 2000E unit will reboot automatically upon completion of the transfer. The new information from the device will be displayed in the lower right hand corner of the Embedded Program Loader dialog box. See Figure 5-31. Close the DVR2000E Embedded Program Loader. PC software then loads the default settings. The saved settings will be loaded back into the unit (Figure 5-35) and checked again (Figure 5-36).

TERMINATING COMMUNICATION

DVR2000E communication is terminated by clicking on Communications on the menu bar, and clicking Close Comm Port. You are asked if you want to save the settings to EEPROM. This question is asked even if no changes were made to the DVR2000E settings. When you execute the Close command (with a Yes or No to save settings to EEPROM), communication with the DVR2000E is terminated. If you choose to exit DVR2000E-32 (by clicking File on the menu bar and then Exit) without first closing communication, you are still given the opportunity to save the settings to EEPROM.

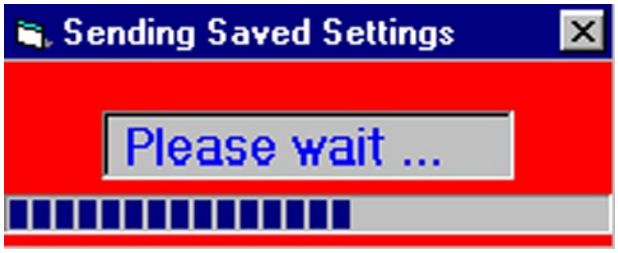

Figure 5-35. Sending Saved Settings

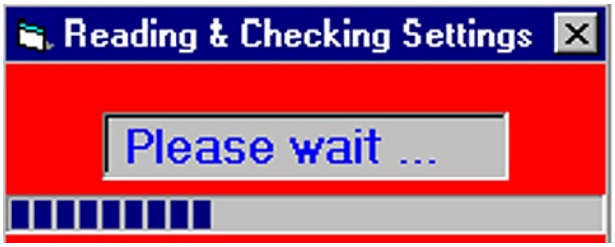

Figure 5-36. Reading & Checking Settings

SECTION 6 • DVR2000E SOFTWARE FOR THE PALM OS® PLATFORM

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Section 6

SECTION 6 • DVR2000E SOFTWARE FOR THE PALM OS® PLATFORM

INTRODUCTION

Software for the Palm OS® platform provides a portable communication link between the DVR2000E and the user. The software enables the use of a Palm OS® handheld or personal digital assistant (PDA) to view and change DVR2000E settings and create a settings file that can be uploaded to DVR2000E units.

INSTALLATION

Software for the Palm OS® platform has the following minimum recommended installation and operating requirements.

- IBM-compatible personal computer (PC)
  - 486DX2 or faster microprocessor
  - Microsoft Windows® 95, 98, ME or NT 4.0 operating system
  - CD-ROM drive
  - One available serial port
  - Palm™ Desktop software, version 3.0.1 or later
- Palm OS® handheld
  - Palm OS® version 3.3 or later
- HotSync® cable or cradle

Installing The Software

Software for the Palm OS® platform is comprised of a series of files that run as a single application on the handheld. A setup utility automatically loads the files into the Palm Desktop application Install Tool on the PC. The software is installed on the handheld during the next HotSync® operation.

Use the following procedure to install the software on the handheld.

Section 6

> NOTE
>
> The Palm™ Desktop software supplied with the handheld must be installed on the PC before the software's setup utility is run.
>
> The handheld must have a unique user identification in order for the installation of the software to be successful. This is accomplished by performing a HotSync® operation before installing the software.

1. Insert the software installation CD into the CD-ROM drive of the PC.
2. When the DVR2000E Setup and Documentation CD menu appears, click the Install button for the Palm OS® Program. The setup utility starts and displays the Welcome Screen of Figure 6-1. Click the Next> button to view the Select Destination Directory Screen (Figure 6-2).

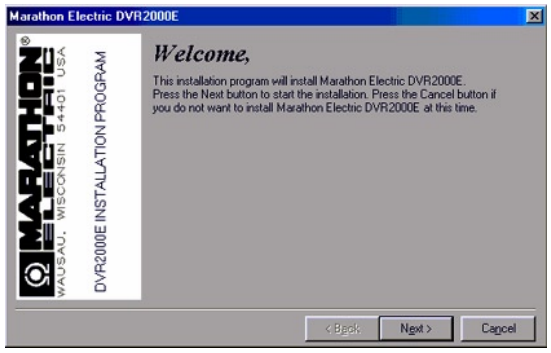

Figure 6-1. Welcome Screen

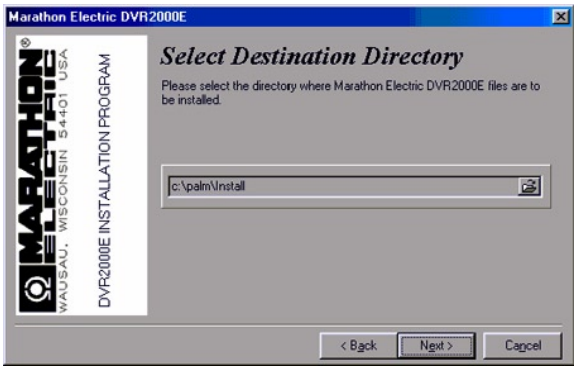

Figure 6-2. Selection Destination Directory Screen

3. Accept the default installation location by clicking Next> or change the location to the desired folder and click Next>. The Modules Selection Screen (Figure 6-3) appears.

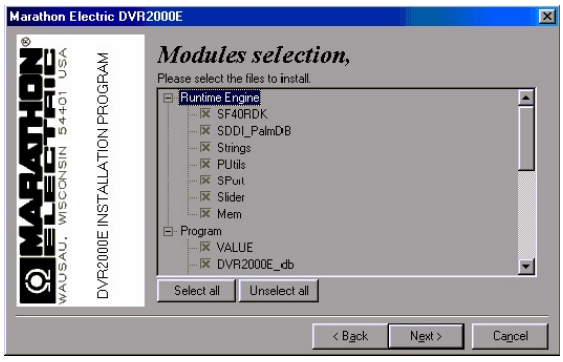

Figure 6-3. Modules Selection Screen

4. Select all of the software files for installation by clicking the Select all button. Click the Next> button to proceed to the Select A User Screen (Figure 6-4).

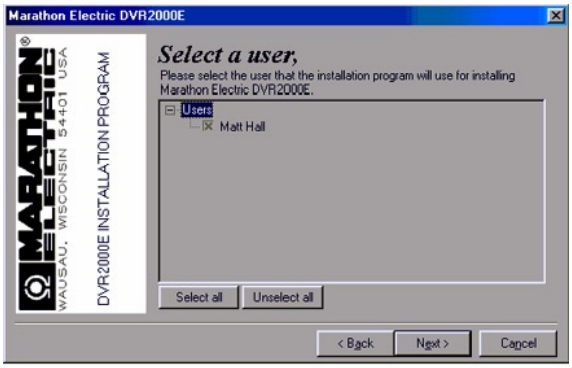

Figure 6-4. Select A User Screen

5. Click the check box next to the desired user or click the Select all button to make the software available to all users. Click the Next> button to complete the installation. The Installation Complete Screen (Figure 6-5) appears and confirms that the software was installed successfully. Click the Quit button to exit the setup utility.

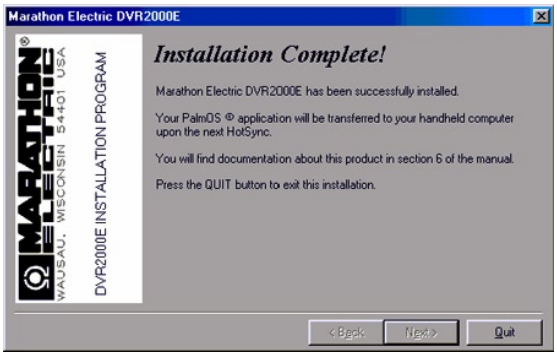

Figure 6-5. Installation Complete Screen

6. Connect the handheld and PC using a HotSync® cable or cradle and perform a HotSync® operation to load the software on the handheld.

Section 6

Connecting the DVR2000E and Handheld

Communication between the DVR2000E and the handheld requires the proper connections. A 9-pin, male-to-male, null-modem adapter can be used to connect the handheld to the DVR2000E in series with a HotSync® cable.

STARTING THE SOFTWARE

The software is started by tapping the DVR2000E icon on the Main Menu Icons Screen (Figure 6-6) of the handheld. The Please Enter Password Screen appears (Figure 6-7). The default password is “DVR.” Tap “OK” after entering the password. If the password entered is incorrect, the Password Is Incorrect Screen (Figure 6-8) appears. Tapping “OK” will close the application. The password can be entered by using your stylus and Graffiti® script in the writing area of your handheld. An alternative method is to bring up the keyboard display and tap out the alphabetic code using the stylus followed by a tap to “DONE.” The keyboard can be displayed by tapping the “abc” symbol in the lower left side of the handheld screen.

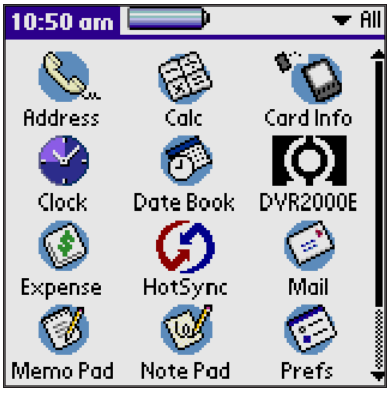

Figure 6-6. Main Menu Icons Screen

Figure 6-7 Please Enter Password Screen

Figure 6-8. Password Is Incorrect Screen

If the password entered is correct, the Software Startup Screen (Figure 6-9) appears briefly followed by the Which Mode Screen (Figure 6-10) asking if you want to work on-line or off-line.

NOTE

Ensure that the handheld is connected to the DVR2000E with the correct cable before attempting to work in the On-Line mode. If the communication cable is not connected, the handheld will lock up and require a soft reset.

Figure 6-9. Software Startup Screen

Figure 6-10. Which Mode Screen

Section 6

INITIAL ADJUSTMENTS

CAUTION

Read and understand the operation of the individual adjustments before attempting any initial adjustments.

Before starting the generator, the procedures in the following paragraphs should be performed.

Remove the 5 ampere fuse before starting the generator for the first time. Perform all preliminary engine governor adjustments without the regulator energized.

After initial governor adjustments are complete, reinstall the 5 ampere fuse and connect only the power input leads or PMG leads to the regulator. Remove all other regulator connections that may be present and temporarily insulate them.

Start and run the generator at rated speed. The regulator will perform the self-test and enter a shutdown mode. At this time, initial adjustments can be made.

After the initial adjustments are made, shut down the generator and connect the remaining regulator leads. The generator may be started and final adjustments may be performed on the regulator.

SOFTWARE OPERATING MODES

The software has two modes of operation: On-Line and Off-Line. On-Line mode enables direct com-munication with the DVR2000E. In On-Line mode, DVR2000E settings can be viewed and changed, and system alarms and status indicators can be verified. The Off-Line mode can be used to view and edit settings files when the handheld is not connected to the DVR2000E. The handheld can then be connected to the DVR2000E and the settings file uploaded.

The following paragraphs describe how each software operating mode is accessed.

On-Line Mode

Tapping the On-Line button in the Which Mode Screen (Figure 6-10) establishes communication between the software and the DVR2000E. When communication is established, the software downloads the settings from the DVR-2000E so that they can be viewed and edited on the handheld. The screen shown in Figure 6-12 is displayed when the software is downloading settings from the DVR2000E.

Off-Line Mode

Tapping the Off-Line button in the Which Mode Screen (Figure 6-10) displays the Settings Selection Screen (Figure 6-11) that asks the user Which Settings? The user is prompted to select either the factory-default DVR2000E settings (Default button) or a user-created settings file (Open… button) from a list of settings files stored on the handheld.

Figure 6-11. Settings Selection Screen

Tapping the Default button causes the software to retrieve the factory-default settings from the handheld so that they can be viewed and edited. A screen similar to the one shown in Figure 6-12 is displayed while the software retrieves the factory-default settings.

Figure 6-12. Downloading Progress

Tapping the Open button displays the File Operations Screen of Figure 6-13. One of 10 user-created settings files or the factory-default settings file can be selected from the list displayed on this screen. When the settings file name is tapped, the settings are retrieved. A screen similar to the one shown in Figure 6-12 is displayed while the software retrieves the factory-default settings or user-created settings file. When the settings file has been retrieved, a dialog box appears and confirms that the settings were loaded. Tapping the OK button displays the Main Screen shown in Figure 6-14.

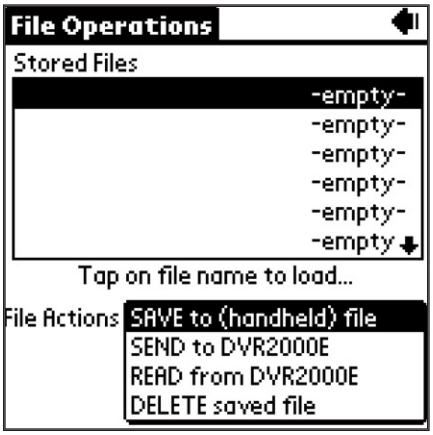

Figure 6-13. File Operations Screen

More information about the File Operations Screen is provided in the software File Operations Screen subsection.

CAUTION

Do not disconnect the communications cable while the DVR2000E and handheld are communicating.

NOTE

The Save to DVR button of the main screen, system status screen, and all of the settings group screens, is not always present. See Figure 6-14. It is displayed only in On-Line mode when settings have been changed but not saved to the DVR2000E. If the software is exited (either by turning off the handheld or switching to another application) without tapping the Save to DVR button, setting changes are not saved in the DVR2000E and may be erased if the DVR2000E loses operating power.

MAIN SCREEN

The software Main Screen of Figure 6-14 is the gateway to other software screens where settings changes can be made. The status of DVR2000E alarms, outputs and system parameters can be viewed, the software version level is stated, and contact information is provided.

Figure 6-14. Main Screen

Change Password

The password can be changed without having to re-enter the existing password. From the Main Screen, tap the Menu silk screen button or the title bar, “MARATHON DVR2000E.” The Change Password Dialog Box Screen (Figure 6-15) appears. Tapping “Change Password” displays the Enter NEW Password Screen (Figure 6-16). “Cancel” returns you to the Main Screen. Enter the new password and tap “OK.” The New Password Is Screen (Figure 6-17) appears indicating the clear-text password that was accepted. Remember the new password. If forgotten, the software will have to be reinstalled. Tapping “OK” returns you to the Main Screen.

Figure 6-15.Change Password Dialog Box Screen

Figure 6-16.Enter New Password Screen

Figure 6-17.New Password Is Screen

Navigating Through the Setting Groups

DVR2000E settings are divided into the seven groups/screens listed below. Each setting group/screen is accessed from the main screen.

- Configuration
- Settings
- Control
- Limiter
- AVR/FCR Gain
- Protection
- Var/PF Gain

A group of settings is accessed by tapping the group name listed on the main screen. A summary of the individual settings available at each screen is provided in Table 6-1.

Table 6-1. Settings Group Summary

Configuration Screen Sensing Mode Rated Sensing Voltage Generator PT Ratio Generator CT Ratio Fine Voltage Adj. Band	AVR/FCR Gain Screen Stability Range AVR Kp AVR Ki AVR Kd AVR Kg FCR Kg
Settings Screen Voltage Setpoint (AVR) Field Current Setpoint (FCR) Var Setpoint PF Setpoint	Protection Screen OEL Shutdown Time Delay Generator Overvoltage Level Field Overvoltage Level LOS Time Delay
Control Screen Soft Start Time Underfrequency Kneepoint Volts/Hertz Slope Droop Setpoint Eng. Unload Activation Freq. Eng. Unload Droop Pct. Eng. Unload Droop Time Eng. Unload Activation Rate	Var/PF Gain Screen Var Ki Var Kg PF Ki PF Kg
	Limiter Screen Overexcitation Limiter OEL Ki OEL Kg

Changing Settings

When a setting screen is selected and displayed, the description for each setting is listed in the Item column. The value for each setting is listed in the Value column. And the range for the highlighted setting is listed in the Settings Range box.

To change a setting, highlight the desired setting by tapping it. Ensure that the cursor is on the Change to: line and enter the new value in the Graffiti® writing area of the handheld. In the example of Figure 6-18 (Setting Change – Part 1 Screen), the Control screen Soft Start Time setting of 20 seconds is being replaced with a new setting of 50 seconds. Once the new value is entered in the Change to: line, the Update button is tapped to send the setting to the DVR2000E. When the handheld confirms the DVR2000E setting change, the handheld emits a two-tone beep, the new setting is displayed in the Value column, and the Save to DVR button appears in the lower, right-hand corner of the screen. See Figure 6-19, Setting Change – Part 2 Screen.

Figure 6-18. Settings Change - Part 1 Screen

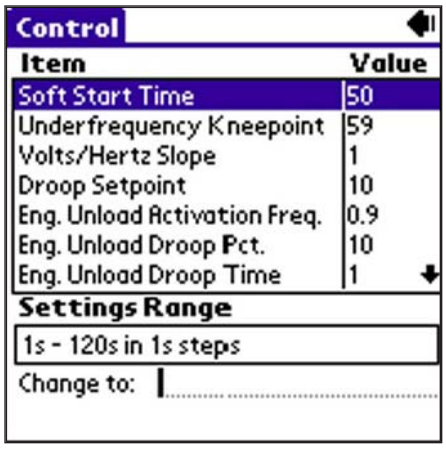

Figure 6-19.Setting Change – Part 2 Screen

Multiple changes can be made before saving the DVR2000E settings. Settings are saved by tapping the Save to DVR button on any of the screens that display the button.

Alarm and Contact Input Status

The Alarm/Contact Status Screen (Figure 6-20) is accessed from the software Main Screen (Figure 6-14). Tap the down arrow (▾) on the Other Pages: line and then select Alarm/Contact Status from the drop-down menu. Figure 6-21 (Reading Data Screen) shows how the screen will look while the Palm is polling the DVR2000E for data.

Figure 6-20 (Alarm/Contact Status Screen) shows how the screen appears after all polling is complete. The screen displays the status of the DVR2000E front panel LEDs. An alarm condition is indicated by a checked box (☒). The screen also indicates the position of the DVR2000E 52 LM, and 52 JK contact inputs. To refresh the status of the Alarm/Contact Status indicators, tap the Update button. To return to the Main Screen, tap the Back icon ◂).

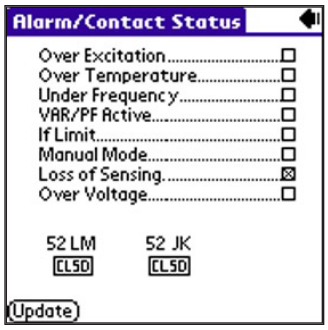

Figure 6-20.Alarm/contact Status Screen

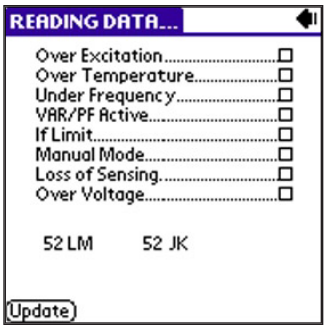

Figure 6-21.Reading Data Screen

System Status

The System Status Without Operating Mode Screen shown in Figure 6-22 is accessed from the Main Screen (Figure 6-14) by tapping the arrow on the Other Pages: line and then tapping System Status. The System Status Screen displays the current mode setting.

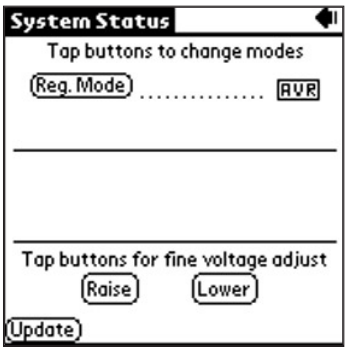

Figure 6-22. System Status Without Operating Mode Screen

Regulation Mode Button

Tapping the Reg. Mode button toggles between Field Current Regulation (FCR) mode and Automatic Voltage Regulation (AVR) mode.

Operating Mode Buttons

If the Var/PF option is installed, the Systems Status Screen may be different than that of Figure 6-22. This is illustrated in Figure 6-23, System Status With Operating Mode Screen. The Operating Mode segment of the System Status Screen (Figure 6-23) has three buttons labeled OFF, PF and VAR. A box around the Operating Mode's OFF, PF and VAR buttons indicates which mode is selected. A checked box below the buttons indicate which of the three modes the DVR2000E is currently operating in. The figure also shows that the selected operating mode is VAR while the DVR2000E is operating in OFF (AVR mode). Tapping the PF button places the DVR2000E in the power factor operating mode and causes a checked box (☒) to appear below the PF button. Tapping the VAR button places the DVR2000E(C) in the VAR operating mode and causes a checked box to appear below the VAR button. Tapping the OFF button disables both power factor and var regulation and places a checked box below the OFF button. The example of Figure 6-23 shows that power factor and var regulation are disabled.

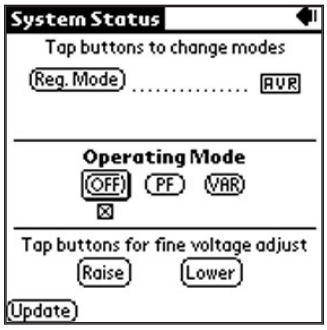

Figure 6-23. System Status With Operating Mode Screen

Operation of the Operating Mode controls is determined by the status of the contacts connected across the DVR2000E(C) Var/PF Control terminals (52J, 52K). When these contacts are open, the Operating Status controls are enabled. Closing the contacts at terminals 52J and 52K disables the Operating Status controls and interrupts regulation of vars or power factor until the contacts are opened again.

If a setting change is attempted and the requested feature or capability is not installed, then This command is not available message will be displayed after tapping the Update button. Figure 6-24, Command Not Available Screen illustrates this event. Tap OK to return to the previous screen.

Figure 6-24. Command Not Available Screen

Fine Adjust Buttons

Fine adjustments to the operating setpoint are made by tapping the Raise and Lower buttons of the System Status Without Operating Mode Screen (Figure 6-22). (The fine adjustment through the front panel push buttons only controls the voltage setpoint.) An arrow serves as a reminder of which button was last tapped. In AVR mode, a single tap of the Raise or Lower buttons increments or decrements the generator voltage by 0.1 volts and the range of which is constrained by the Generator Rated Voltage and the Generator Voltage Adjust Band settings. For

SECTION 7 • MAINTENANCE AND TROUBLE-SHOOTING

PREVENTATIVE MAINTENANCE

The only preventive maintenance required on the DVR2000E is to periodically check that the connections between the DVR2000E and the system are clean and tight. DVR2000E units are manufactured using state-of-the-art, surface-mount technology. As such, Katolight recommends that no repair procedures be attempted by anyone other than Katoligh personnel.

TROUBLESHOOTING

If you do not get the results that you expect from the DVR2000E, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your excitation system.

Generator Voltage Does Not Build

Step 1. Verify that all wiring is properly connected. Refer to Figures 4-6 through 4-10.

If wiring is improperly connected or loose, reconnect wiring properly.

If wiring connections are correct, proceed to Step 2.

Step 2. Verify that the generator is spinning at rated speed.

If the generator is not up to rated speed, increase generator speed to the rated value.

If the generator is spinning at rated speed, proceed to Step 3.

Step 3. Check for correct input power to the DVR2000E. Refer to Section 1, General Information, Specifications for input power requirements.

If voltage is not present, refer to the generator manual for repair procedures.

If voltage is present, proceed to Step 4.

Step 4. Verify that the fuse is not open.

Replace any open fuse.

If no fuses are open, proceed to Step 4.

Step 5. Verify that the front panel OVEREXCITATION SHUTDOWN indicator is not lit.

If the front panel OVEREXCITATION SHUTDOWN indicator (field voltage) is lit, check the generator and/or load conditions. Interrupt input power or shut down the generator for a minimum of one minute.

If the front panel OVEREXCITATION SHUTDOWN indicator is not lit, proceed to Step 6.

Step 6. Verify that the front panel OVEREXCITATION LIMITING indicator is not lit.

If the front panel OVEREXCITATION LIMITING indicator is lit, check the generator and load conditions. Also check the field current limit setpoint for the correct level. Interrupt input power or shut down the generator for a minimum of 1 minute.

If the front panel OVEREXCITATION LIMITING indicator is not lit, proceed to Step 7.

Step 7. Verify that the DVR2000E soft start settings are correct. Too long of a soft start setting may give the appearance of no buildup.

Figure 6-27. Numeric Settings Screen

SOFTWARE FILE OPERATIONS SCREEN

The File Operations Screen (Figure 6-13) displays a list of 10 user-created settings files and one factory-default settings file. When less than 10 user-created settings files exist, placeholders labeled "– empty –" occupy unused locations in the list. Tapping the name of a user-created file or the default settings file loads the file settings into software.

A drop-down menu is accessed by tapping the down arrow (▾) on the File Actions line. Selections from the drop-down menu enable you to create a settings file, send a settings file to the DVR2000E, retrieve settings from the DVR2000E and delete user-created settings files from the file list on the File Operations Screen.

Creating a Settings File

A settings file can be created with software in either On-Line or Off-Line mode. In On-Line mode, the existing DVR2000E settings can be downloaded from the DVR2000E and then modified to create a settings file. The factory-default settings or a user-created settings file can be retrieved and modified in either On-Line mode or Off-Line mode to create a new settings file. When editing of the settings is complete, the following steps are used to save the settings file with a unique name.

1. On the software main screen, tap the down arrow (▾) on the Other Pages: line.
2. Select File Operations from the drop-down menu and then tap the Open… button in the "Which Settings?" dialog box to access the File Operations Screen.
3. Tap the down arrow (▾) on the File Actions: line of the File Operations Screen.
4. Select SAVE to (handheld) file from the drop-down menu.
5. Use the handheld Graffiti® writing area to enter a name for the file. Up to 50 alphanumeric characters can be used. Note that no more than approximately 13 characters are shown in the Save As: field when entering a file name. Upon saving, a date/time stamp will be added to the end of the filename.

Sending a Settings File to the DVR2000E

An existing settings file can be sent to the DVR2000E by using the following procedure.

1. On the software main screen, tap the down arrow (▾) on the Other Pages: line.
2. Select File Operations from the drop-down menu and then tap the Open… button in the Which Settings? dialog box to access the File Operations Screen.
3. Select the desired settings file from the list on the File Operations Screen to load the settings into software.
4. Tap the OK button to acknowledge that the settings were loaded.
5. Repeat Steps 1 and 2 to access the File Operations Screen.
6. Tap the down arrow (▾) on the File Actions: line and select SEND to DVR2000E from the drop-down menu.
7. Ensure that the proper data cable is connected between the DVR2000E and the handheld.
8. Tap the OK button in the Connect Cable dialog box to send the file.
9. Tap the OK button to acknowledge that the settings were sent to the DVR-2000E.
10. To save the settings in DVR2000E memory, tap the Save to DVR2000E button which is accessible from

any of the software screens.

11. Tap OK to acknowledge that the settings were saved to DVR2000E memory.

Reading Settings from the DVR2000E

DVR2000E settings are read into the software on your handheld by performing the following steps.

1. On the software Main Screen, tap the down arrow (▾) on the Other Pages: line.
2. Select File Operations from the drop-down menu and then tap the Open button in the Which Settings? dialog box to access the File Operations Screen.
3. Tap the down arrow (▾) on the File Actions: line and then select READ from DVR2000E from the drop-down menu.
4. Ensure that the proper data cable is connected between the DVR2000E and the handheld.
5. Tap the OK button in the Connect Cable dialog box to read the DVR2000E settings into the software.
6. Once the settings are read, tap the OK button to acknowledge that the DVR2000E settings were read into the software.

Deleting User-Created Settings Files

Perform the following steps to delete a user-created settings file.

1. On the software Main Screen, tap the down arrow (▾) on the Other Pages: line.
2. Select File Operations from the drop-down menu and then tap the Open button in the Which Settings? dialog box to access the File Operations Screen.
3. Tap the down arrow (▾) on the File Actions: line and then select Delete saved file.
4. Tap the name of the settings file that to be deleted.
5. Tap the Delete button to remove the selected settings file from the handheld.

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Section 7

SECTION 7 • MAINTENANCE AND TROUBLE-SHOOTING

PREVENTATIVE MAINTENANCE

The only preventive maintenance required on the DVR2000E is to periodically check that the connections between the DVR2000E and the system are clean and tight. DVR2000E units are manufactured using state-of-the-art, surface-mount technology. As such, Katolight recommends that no repair procedures be attempted by anyone other than Katolight personnel.

TROUBLESHOOTING

If you do not get the results that you expect from the DVR2000E, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your excitation system.

Generator Voltage Does Not Build

Step 1. Verify that all wiring is properly connected. Refer to Figures 4-6 through 4-10.

If wiring is improperly connected or loose, reconnect wiring properly.

If wiring connections are correct, proceed to Step 2.

Step 2. Verify that the generator is spinning at rated speed.

If the generator is not up to rated speed, increase generator speed to the rated value.

If the generator is spinning at rated speed, proceed to Step 3.

Step 3. Check for correct input power to the DVR2000E. Refer to Section 1, General Information, Specifications for input power requirements.

If voltage is not present, refer to the generator manual for repair procedures.

If voltage is present, proceed to Step 4.

Step 4. Verify that the fuse is not open.

Replace any open fuse.

If no fuses are open, proceed to Step 4.

Step 5. Verify that the front panel OVEREXCITATION SHUTDOWN indicator is not lit.

If the front panel OVEREXCITATION SHUTDOWN indicator (field voltage) is lit, check the generator and/or load conditions. Interrupt input power or shut down the generator for a minimum of one minute.

If the front panel OVEREXCITATION SHUTDOWN indicator is not lit, proceed to Step 6.

Step 6. Verify that the front panel OVEREXCITATION LIMITING indicator is not lit.

If the front panel OVEREXCITATION LIMITING indicator is lit, check the generator and load conditions. Also check the field current limit setpoint for the correct level. Interrupt input power or shut down the generator for a minimum of 1 minute.

If the front panel OVEREXCITATION LIMITING indicator is not lit, proceed to Step 7.

Step 7. Verify that the DVR2000E soft start settings are correct. Too long of a soft start setting may give the appearance of no buildup.

If the soft start settings are incorrect, adjust the settings.

If the soft start settings have no effect, proceed to Step 8.

Step 8. Replace the DVR2000E unit.

If replacing the DVR2000E unit does not correct the malfunction, then the generator is defective. Consult with the generator manufacturer.

Low Generator Output Voltage

Step 1. Verify that the voltage adjustment is not set too low.

If the voltage adjustment is too low, adjust it to the correct setpoint.

If the voltage adjustment is correct, proceed to Step 2.

Step 2. Verify that the underfrequency knee setpoint is not greater than the generator frequency.

If the underfrequency setpoint is too high, adjust the setpoint below the rated generator frequency.

If the underfrequency setpoint is correct, proceed to Step 3.

Step 3. Verify that the generator is spinning at rated speed.

If the generator is not up to rated speed, increase the generator speed to the rated level.

If the generator is spinning at rated speed, proceed to Step 4.

Step 4. Check for correct input power to the DVR2000E. Refer to Section 1 (General Information, Specifications) for input power requirements.

If the DVR2000E input voltage is low, refer to the PMG manual for PMG.

If the voltage is at the required level, proceed to Step 5.

Step 5. Verify that the sensing potential transformer (if used) has the correct turns ratio and is operating correctly.

If the turns ratio of the sensing potential transformer is incorrect, replace the sensing potential transformer.

If the sensing potential transformer is operating correctly, proceed to Step 6.

Step 6. Verify that the front panel OVEREXCITATION LIMITING indicator is not lit.

If the front panel OVEREXCITATION LIMITING indicator is lit, check the generator and/or load conditions. Also check the field-current limit setpoint for the correct level. Interrupt input power or shut down the generator for a minimum of one minute.

If the front panel OVEREXCITATION LIMITING indicator is not lit, proceed to Step 7.

Step 7. Low generator output voltage may occur when operating in droop mode with an inductive load.

If the low voltage condition is not caused by the droop function, proceed to Step 8.

Step 8. Replace the DVR2000E unit.

High Generator Output Voltage

Step 1. Verify that the voltage adjustment is not set too high.

If the voltage adjustment is too high, adjust it to the correct setpoint.

If the voltage adjustment is correct, proceed to Step 2.

Step 2. Verify that the sensing potential transformer (if used) has the correct turns ratio.

If the turns ratio of the sensing potential transformer is incorrect, replace the sensing potential transformer with the correct one.

If the sensing potential transformer is correct, proceed to Step 3.

Step 3. High generator output voltage may occur when operating in droop mode with a capacitive load.

If the high voltage condition is not caused by the droop function, proceed to Step 4.

Step 4. Replace the DVR2000E unit.

Poor Voltage Regulation

Step 1. Verify that the case of the DVR2000E is properly grounded.

If the DVR2000E is not properly grounded, connect a dedicated ground wire to the quarter-inch fast-on connector labeled GND on the rear of the DVR2000E case.

If the DVR2000E is properly grounded, proceed to Step 2.

Step 2. Check for grounded field leads.

If the field leads are grounded, isolate them from ground.

If the field leads are not grounded, proceed to Step 3.

Step 3. Check for grounded PMG leads.

If the PMG leads are grounded, isolate them from ground.

If the PMG leads are not grounded, proceed to Step 4.

Step 4. Verify that the generator frequency is not dropping below the DVR2000E underfrequency setpoint when load is applied to the generator.

If the generator frequency is dropping below the underfrequency setpoint, reduce the setpoint if possible. Also check the prime mover and generator for proper sizing in relation to the applied load.

If poor regulation is not related to DVR2000E underfrequency operation, proceed to Step 5.

Step 5. Verify that regulation is not being affected by normal droop operation.

If droop operation is not affecting regulation, proceed to Step 6.

Step 6. Replace the DVR unit.

Generator Output Unstable (Hunting)

Step 1. Verify that the governor for the prime mover is operating properly.

If the governor is not operating properly, troubleshoot using the manufacturer's suggested procedures.

If the governor is operating properly, proceed to Step 2.

Step 2. Verify that the sensing and input power leads are connected securely.

If the sensing or input power leads are not connected securely, tighten the connections.

If the sensing or input power lead connections are secure, proceed to Step 3.

Step 3. Verify that the DVR2000E Stability Range is set to the proper range.

If the Stability Range setting is incorrect, reset the Stability Range.

If the Stability Range setting is correct, proceed to Step 4.

Step 4. Verify that the Stability Level is properly set.

If the Stability Level is not properly set, reset the Stability Level.

OVEREXCITATION SHUTDOWN Indicator Is Annunciating

Step 1. Verify that the field overvoltage setpoint is adjusted properly.

If not properly adjusted, readjust the field overvoltage setpoint.

If properly adjusted, proceed to Step 2.

Step 2. Check for generator overloading.

If the generator is operating with a larger than rated load, shed load.

If the generator is operating with a rated or less than rated load, proceed to Step 3.

Step 3. Replace the DVR2000E.

If replacing the DVR2000E does not correct the malfunction, proceed to Step 4.

Step 4. Refer to the generator manual. Generator is defective.

LOSS OF GENERATOR SENSING Indicator Is Annunciating

Step 1. Verify that the voltage sensing leads are properly connected.

If the sensing leads are not properly connected, correct the connections.

If the sensing lead connections are correct, proceed to Step 2.

Step 2. For single-phase sensing, verify that E2 and E3 are connected.

If E2 and E3 are not connected, connect them both to phase C sensing voltage.

If E2 and E3 are properly connected, proceed to Step 3.

Step 3. Verify that the sensing potential transformer (if used) has the correct turns ratio and is functioning properly.

If the sensing potential transformer has the wrong turns ratio or is malfunctioning, replace it.

If the sensing potential transformer is correct and functioning properly, proceed to Step 4.

Step 4. Verify that the generator output voltage is present on all phases.

If the generator is missing a phase, refer to the generator manual. Generator is defective.

If generator output voltage is balanced on all phases, proceed to Step 5.

Step 5 Replace the DVR2000E.

OVEREXCITATION LIMITING Indicator Is Annunciating

Step 1. Check for generator overloading.

If the generator is operating with a larger than rated load, shed load.

If the generator is operating with a rated or less than rated load, proceed to Step 2.

Step 2. Verify that the DVR2000E output (field) current limit is not set too low.

If the output current limit setpoint is too low, adjust for the proper setting.

If the output current limit is set properly, proceed to Step 3.

Step 3. Verify that the generator exciter field is not shorted.

If the generator exciter field is shorted, replace the generator.

If the generator exciter field is not shorted, proceed to Step 4.

Step 4. Replace the DVR2000E.

If replacing the DVR2000E does not correct the malfunction, proceed to Step 5.

Step 5. Refer to the generator manual. Generator is defective.

UNDERFREQUENCY ACTIVE Indicator Is Annunciating

Step 1. Verify that the generator is operating at rated speed.

If the generator is not operating at rated speed, adjust the generator speed.

If the generator is operating at the rated speed, proceed to Step 2.

Step 2. Verify that the underfrequency setpoint is correct.

If the underfrequency setpoint is incorrect, adjust it to the correct value.

No Droop

Step 1. Verify that the DVR2000E 52L/M contact input is open.

If the 52L/M contact input is not open, it must be opened to enable the droop function.

If the 52L/M contact input is open, proceed to Step 2.

Step 2. Verify that the DVR2000E 52J/K contact input (if present) is closed or the Var/PF function is disabled via the Windows® software. Var/PF operation must be disabled for droop operation. If Var/PF operation is disabled, proceed to Step 3.

Step 3. Verify that the DVR2000E droop setting is not adjusted to 0% droop.

If the droop setting is adjusted to 0% droop, increase the setpoint above 0%.

If the droop setting is adjusted to above 0%, proceed to Step 4.

Step 4. Check for an open in the circuit connected to DVR2000E CT1 and CT2.

If there is an open circuit, repair as necessary.

If there is no open circuit, proceed to Step 5.

Step 5. Verify that all connections are correct according to Figures 4-6 and 4-7.

If connections are incorrect, correct the problem.

If connections are correct, proceed to Step 6.

Step 6. Verify that the load being applied to the generator for droop testing is not purely resistive.

If only a resistive load is being applied to the generator, apply an inductive load and retest.

If the load being applied to the generator is inductive, proceed to Step 7.

Step 7. Verify that your DVR2000E is compatible with the current sensing transformer (5 A secondary) being used. For example, a current sensing transformer with a 1 ampere output rating would produce very little droop since your DVR2000E has a 5 ampere current transformer input.

If the current transformer input is incorrect, replace the current sensing transformer for compatibility.

If the current transformer input is correct, proceed to Step 8.

Step 8. If the above steps fail to correct the malfunction, replace the DVR2000E unit.

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www.katolight.com

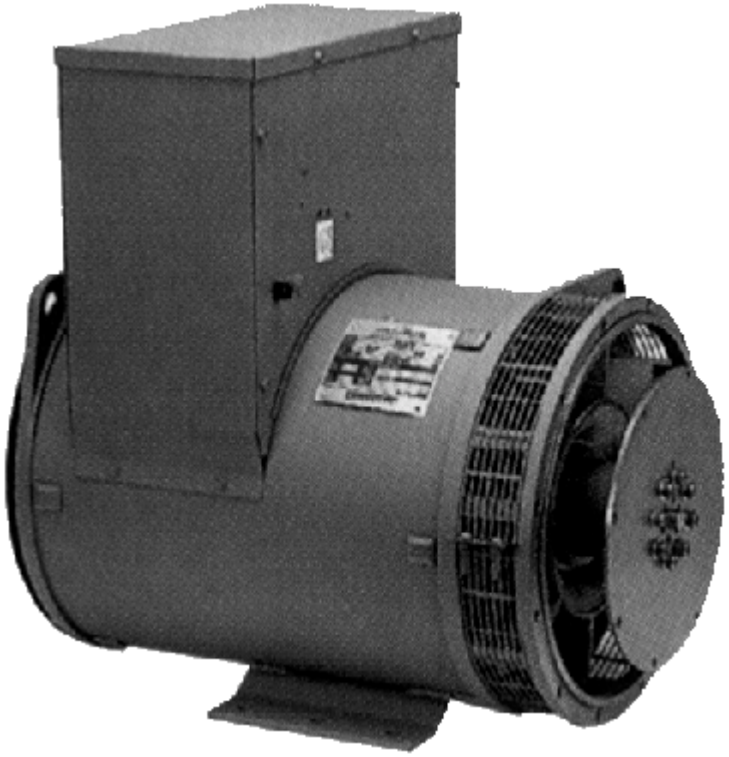
Printed in USA

DVR2000E_Manual_KL 3-12-04

KATOLIGHT CORPORATION

MAGNAPLUS GENERATOR

280 -- 430 Frame
Installation, Operation and Maintenance Manual



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SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures contained herein, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of your MagnaPLUS generator. Each section of this manual has caution and warning messages. These messages are for your safety, and the safety of the equipment involved. If any of these cautions or warnings is not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and lock out all controls to prevent an unexpected start-up of the generator set driver. Proper grounding (earthing) of the generator frame and distribution system in compliance with local and national electrical codes and specific site requirements must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving your MagnaPLUS generator are pointed out in the installation and maintenance sections. Incorrect lifting or moving can result in personal injury or damage to the unit.

Prior to start-up of the unit ensure that all generator leads are properly connected to the generator link board located inside the connection box. Always assume that there will be voltage present at the generator terminals whenever the generator's shaft is rotating**,** and proceed accordingly. Residual voltage is present at the generator terminals and at the automatic voltage regulator panel connections even with the regulator fuse removed. Caution must be exercised, or serious injury or death can result.

This manual is not intended to be a substitute for properly trained personnel. Installation and repairs should only be attempted by qualified, trained people. The cautions and warnings point out known conditions and situations that are potentially hazardous. Each installation may well create its own set of hazards

When in doubt, ask. Questions are much easier to handle than mistakes caused by a misunderstanding of the information presented in this manual.

RECEIVING AND STORAGE

RECEIVING AND STORAGE

Upon receipt of the generator, it is recommended that it be carefully examined for possible shipping damage. The generator was given to the freight carrier in good condition; thus, the carrier is responsible for the product from the factory dock to the destination. Any damage should be noted on the freight bill before accepting the shipment. Any claims for damage must be promptly filed with the delivering carrier.

UNPACKING AND HANDLING

Carefully read all instruction tags shipped with the unit. When lifting, attach an overhead crane to the lifting lug(s) on the generator frame. Apply lifting forces in a vertical direction. When transporting single bearing generators, the generator's rotor must be adequately supported to prevent damage.

WARNING

THE LIFTING LUG (S) ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT A COMPLETE GENERATOR AND DRIVER ASSEMBLY BY MEANS OF LIFTING LUG (S) ON THE GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

STORAGE

In the event that the generator is not immediately installed on its prime mover, it is recommended that the unit be stored indoors in a clean, dry area, which is not subject to rapid changes in temperature and humidity. If the generator is stored for a long period of time, the generator should be tested, cleaned and dried as required before being put into service. See the maintenance section of this manual for further information. If the unit has been stored in an area where it has been subject to vibration, it is recommended that the bearing(s) be inspected and replaced as necessary.

PRINCIPLES OF OPERATION

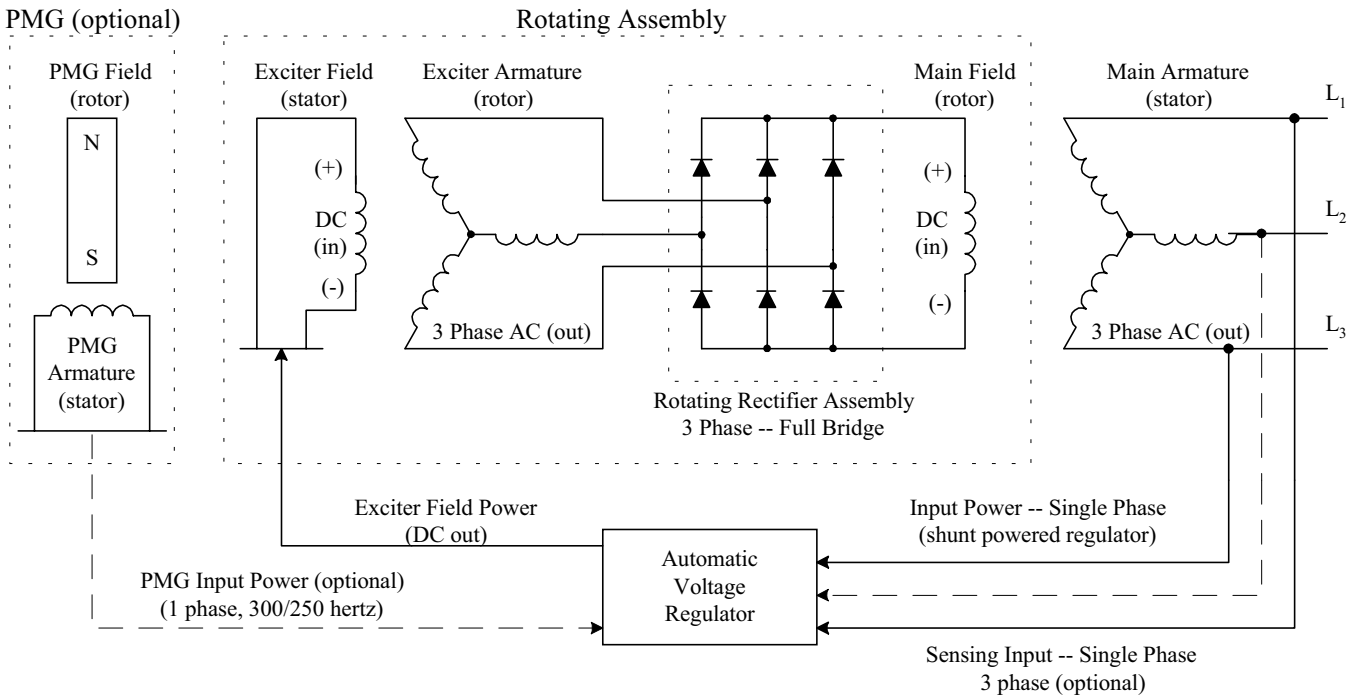


FIGURE 1 -- MagnaPLUS Circuit Diagram

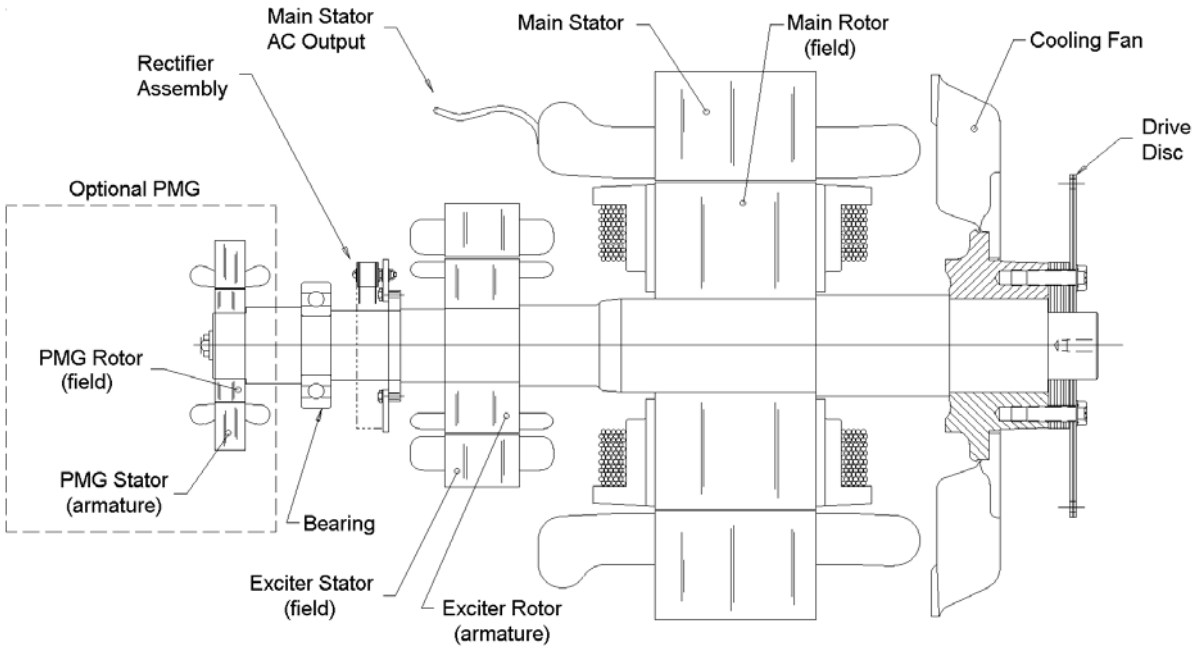


FIGURE 2 -- Typical MagnaPLUS Layout Diagram

PRINCIPLE OF OPERATION

MagnaPLUS generators are a brushless, self excited, and externally voltage regulated, synchronous AC generator. The generator is made up of six major components: main stator (armature), main rotor (field), exciter stator (field), exciter rotor (armature), rectifier assembly, and voltage regulator. In understanding the above terminology, note the following: stators are stationary, rotors rotate, a field is an electrical input, and an armature is an electrical output. These system components are electrically interconnected as shown in figure 1 and physically located as shown in figure 2.

The generator's exciter consists of a stationary field and a rotating armature. The stationary field (exciter stator) is designed to be the primary source of the generator's residual magnetism. This residual magnetism allows the exciter rotor (armature) to produce AC voltage even when the exciter stator (field) is not powered. This AC voltage is rectified to DC by the rotating rectifier assembly and fed directly to the main rotor (field). As the generator shaft continues to rotate, the main rotor (field) induces a voltage into the generator's main stator (armature). At rated speed, the main stator's voltage produced by the residual magnetism of the exciter allows the automatic voltage regulator to function. The regulator provides voltage to the exciter resulting in a build-up of generator terminal voltage. This system of using residual magnetism eliminates the need for a special field flashing circuit in the regulator. After the generator has established the initial residual voltage, the regulator provides a controlled DC field voltage to the exciter stator resulting in a controlled generator terminal voltage.

Voltage Regulation

In the standard configuration (shunt excited), the automatic voltage regulator receives both its input power and voltage sensing from the generator's output terminals (See Figure 1). With the optional PMG configuration, the regulator receives input power from the PMG. The regulator automatically monitors the generator's output voltage against an internal reference set point and provides the necessary DC output voltage to the exciter field required to maintain constant generator terminal voltage. Adjusting the regulator's reference set point changes the generator's terminal voltage. Consult the regulator manual for specific adjustment and operating instructions.

MOTOR STARTING

When a motor is started, the motor draws a large surge of current. This starting current is equivalent to the motors locked rotor or stall current and is 5 to 10 times' normal full load current. When the generator supplies this in-rush of starting current, the generator voltage dips temporarily. If the motor is too large for the generator, the generator's voltage dips greater than 30 percent. This may result in the motor starter de-energizing or the motor stalling. MagnaPlus generators generally supply .3 to .4 horsepower per generator kW in motor starting capability. For specific data contact Katolight.

PARALLEL OPERATION

All MagnaPlus generators are built with 2/3 pitch main stator windings and full amortisseur (damper) windings. These features make the MagnaPlus generators suitable for parallel operation when equipped with the proper voltage regulators and voltage regulator accessories. Consult with the factory for further information relative to parallel operations.

NONLINEAR LOADING

Solid state electronic control devices (variable frequency drives, precision motor controls, battery chargers, etc.) utilize electronic switching circuits (thyristors, SCRs, Diodes, etc.). These switching circuits introduce high frequency harmonics, which distort the normal waveform of the generator. This creates additional heat in the generator windings and may cause the generator to over-heat. Problems that can occur are not limited to the generator. Poor wave shape may adversely effect various loads connected to the generator. Consult Katolight for further information relative to nonlinear loads.

INSTALLATION

PREPARATION FOR USE

Although the generator has been carefully inspected and tested in operation prior to shipment from the factory, it is recommended that the generator be thoroughly inspected. Check all bolts for tightness and examine the insulation on lead wires for chafing prior to proceeding with installation. Remove all shipping tapes, bags, skids and rotor support blocking. For two bearing units, rotate the shaft by hand to ensure that it rotates smoothly without binding.

WARNING

DISABLE AND LOCKOUT ANY ENGINE CRANKING DEVICES BEFORE ATTEMPTING TO INSTALL OR SERVICE THE GENERATOR. FOR ELECTRIC START SETS, DISCONNECT THE CRANKING BATTERY. FOR AIR START, DISCONNECT THE AIR SUPPLY. FOR MOTOR GENERATOR SETS, OPEN THE POWER SUPPLY TO THE DRIVE MOTOR. FAILURE TO COMPLY WITH THESE SAFETY PROCEDURES COULD RESULT IN SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE.

NEVER "BAR OVER" THE ENGINE GENERATOR SET USING THE GENERATOR'S FAN. THE FAN IS NOT DESIGNED FOR THIS PURPOSE. BARRING OVER THE SET WITH THE FAN COULD DAMAGE THE FAN AND RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

GENERATOR MOUNTING

Single Bearing Units.

Single bearing units are provided with an SAE flywheel housing adapter flange and flexible drive discs. Coupling the generator's shaft to the engine flywheel is accomplished with special steel drive discs bolted to the shaft. In addition to the drive discs, there may be a hub spacer, spacer discs, or a combination of hub spacer and spacer discs inserted between the drive discs and the shaft to achieve the proper shaft extension ("G" dimension per SAE J620c). Holes are provided in the periphery of the coupling discs, which correspond to tapped holes in the prime mover's flywheel. The outside diameter of the drive discs fit in a rabbet in the flywheel so that concentricity is assured.

Grade 8 place bolts and hardened washers are recommended to mount the drive discs to the flywheel. DO NOT USE SPLIT TYPE LOCK WASHERS**.** Split lock washers when biting into the drive disc cause stress risers, which may result in the disc fracturing.

The SAE flywheel housing adapter ring and the engine flywheel housing are designed to match each other with no further alignment necessary. Use grade 5 or greater mounting bolts. MagnaPLUS generator frames are constructed with two or three boltholes per foot. The feet should be shimmed where necessary to obtain solid contact with the sub-base. With the frame securely bolted to the engine flywheel housing, there is no side thrust or pull on the generator frame, thus no real need to secure the feet with more than one bolt per foot.

GENERATOR MOUNTING

Two Bearing Generators -- Direct Drive

Two bearing generators are provided with a keyed shaft extension. For direct drive generators, the assembler furnishes a flexible coupling, which is installed between the driver and the generator's shaft. Aligning the generator and its driver as accurately as possible will reduce vibration, increases bearing life, and ensure minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Secure the feet of the generator with grade 5 or greater bolts through the holes provided in the mounting feet. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

GENERATOR MOUNTING

Two Bearing Units -- Belt Driven

Two bearing MagnaPLUS generators can be belt driven provided belts are sized and applied correctly. Please refer to your supplier of belts and sheaves for correct sizing and tensioning specifications. A bearing life calculation should be performed. Katolight recommends a minimum B-10 life of 40,000 hours. If cog type belts are used, a vibration may be introduced which could lead to premature failure of the bearings.

END PLAY TESTING

Refer to the engine manual for recommended endplay specifications and measurement procedures. If endplay is not to specification, it is an indication that the generator shaft is not moving freely in the assembly, and normal life of the thrust bearing could be impaired. Probable causes of this problem are:

1. Improper seating of drive discs in the flywheel resulting in misalignment.

2. Improper mating of generator frame to engine flywheel housing resulting in misalignment.

3. Improper "G" dimension per SAE J620c on either the engine or generator.

TORSIONAL VIBRATION

Torsional vibrations are generated in all rotating shaft systems. In some cases, the amplitude of these vibrations at critical speeds may cause damage to the generator, its driver, or both. It is therefore necessary to examine the torsional vibration effect on the entire rotating system. IT IS THE RESPONSIBILITY OF THE GENERATOR SET ASSEMBLER TO ASSURE THE TORSIONAL COMPATIBILITY OF THE GENERATOR AND ITS DRIVER. Drawings showing pertinent dimensions and weights of the rotating assembly will be supplied by Katolight upon request.

ENVIRONMENTAL CONSIDERATIONS

The MagnaPLUS generator is designed for heavy-duty industrial applications; however, dirt, moisture, heat and vibrations are enemies of rotating electrical machinery. Excessive exposure to the elements may shorten generator life. The temperature of the cooling air entering the intake openings of the generator should not exceed the ambient temperature shown on the generator's nameplate. Generators intended for outdoor application should be protected with housings having adequate ventilation. Although the standard insulation systems are moisture and humidity resistant, space heaters are recommended for extreme conditions. If the generator is to be installed in an area where blowing sand and dust are present, the enclosure should be fitted with filters. Filters reduce erosion on the generator's insulation by blocking high velocity abrasive particles generated by the flow of cooling air through the generator. Consult the factory for appropriate filters and generator deratings required.

WIRING CONNECTIONS

Wiring of the generator and accessories should be done in accordance with good electrical practices. Follow government, industry and association standards.

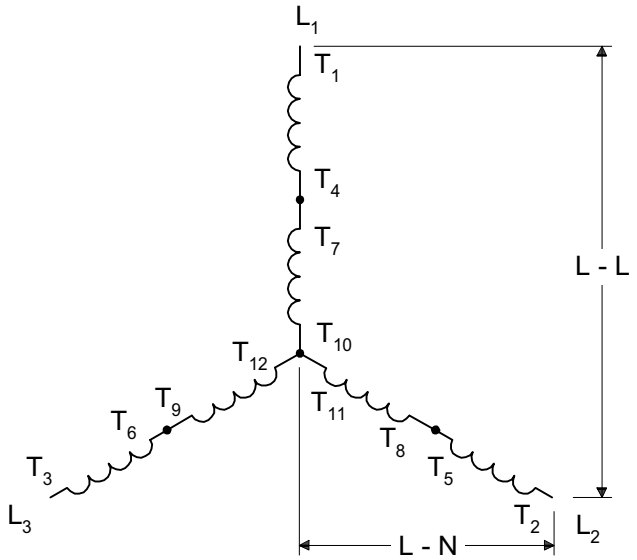
The generator conduit box construction allows cable entry from multiple sides. A hole saw or other appropriate tool may be used to provide for conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit. To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical entrance to the generator conduit box.

All MagnaPLUS generators are equipped with link boards (terminal strips) for both internal and external connections. All connections made to the studs of the link board should be made with high quality ring terminals. Ring terminal sizes are 6 mm (280 Series Frames) and 10 mm (360 and 430 Series Frames). Torque link board connections to the following specifications: 280 frame -- 5.4 NM (4 Ft LB); 360 & 430 frame -- 27 NM (20 Ft LB).

Refer to the connection diagram supplied with the generator and / or the proper diagrams shown in this manual. Install all inter-component and external wiring in accordance with national and local electrical codes. The neutral in the following connection diagrams shown below may be either grounded (earthed) or left above ground potential (floating). See national and local codes and / or the system distribution wiring schematic diagram for the proper connection of the neutral.

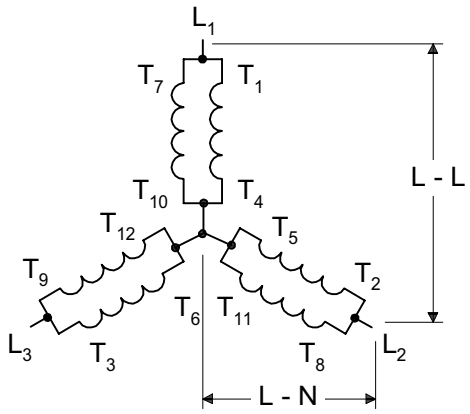
The following connection diagrams are shown for twelve lead generators. Ten lead generators have the same terminal designations except for leads T10, T11, and T12. These three leads are internally connected inside the generator and brought out as a single lead (T0). Ten lead generators can only be connected in a wye configuration

HIGH WYE CONNECTION



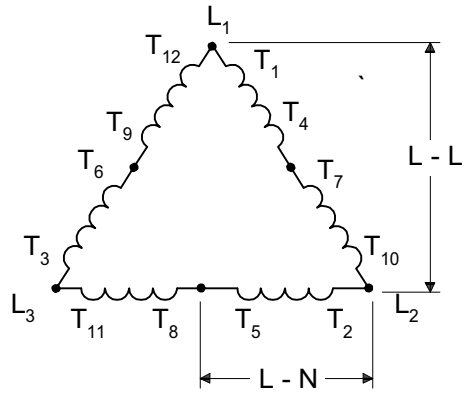
VOLTAGE (HIGH WYE)		
Hz	L-L	L-N
60	480	277
	460	266
	440	254
	416	240
	380	219
50	416	240
	400	231
	380	219

LOW WYE CONNECTION



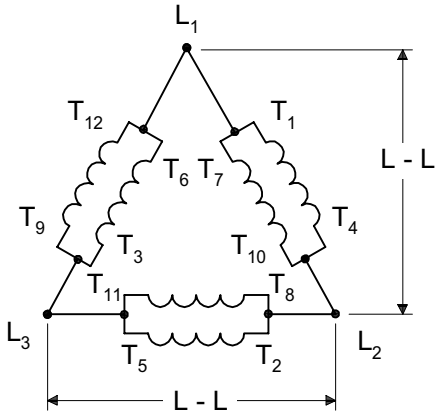
VOLTAGE (LOW WYE)		
Hz	**L-L**	**L-N**
60	240	139
	230	133
	220	127
	208	120
	190	110
50	208	120
	200	115
	190	110

HIGH DELTA CONNECTION



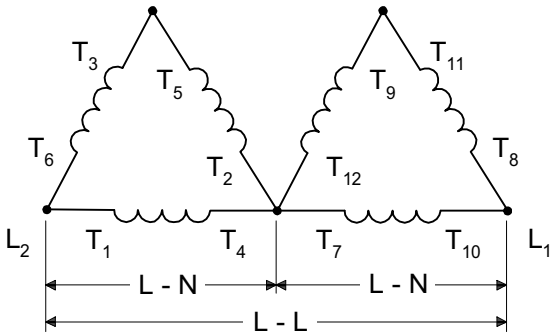
VOLTAGE (HIGH DELTA)		
Hz	**L-L**	**L-N**
60	277	139
	240	120
50	240	120
	220	110
	200	100

LOW DELTA CONNECTION



VOLTAGE (LOW DELTA)		
Hz	**L-L**	**L-N**
60	120	NA
	110	NA
50	110	NA
	100	NA

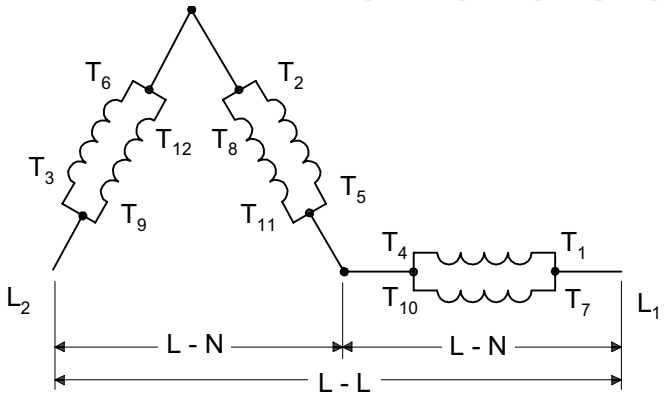
DOUBLE DELTA -- SINGLE PHASE CONNECTION



VOLTAGE (DOUBLE DELTA)		
Hz	**L-L**	**L-N**
60	240	120
	220	110
50	220	110

Note: Single-phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

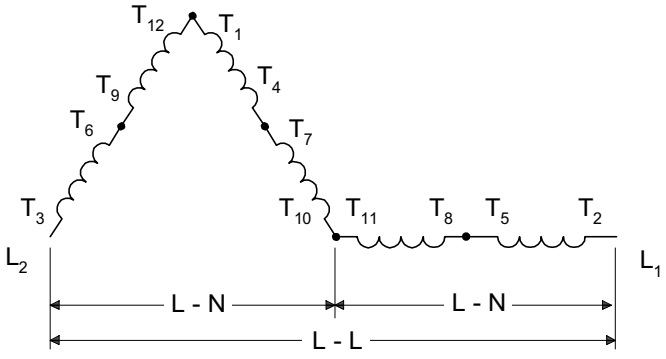
LOW ZIG ZAG -- SINGLE PHASE CONNECTION



VOLTAGE (LOW ZIGZAG)		
Hz	**L-L**	**L-N**
60	240	120
	220	110
50	220	110
	200	100

Note: Single-phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

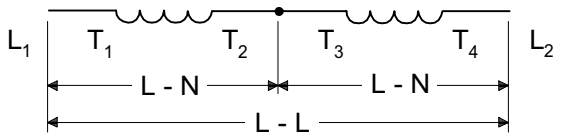
HIGH ZIG ZAG -- SINGLE PHASE CONNECTION



VOLTAGE (HIGH ZIGZAG)		
Hz	**L-L**	**L-N**
60	480	240
	460	220
50	415	208
	380	190

Note: Single-phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

DEDICATED SINGLE PHASE CONNECTION



VOLTAGE (DEDICATED)		
Hz	L-L	L-N
60	240	120
	220	110
50	220	110
	200	100

OPERATION

PRE-START INSPECTION

Before starting the generator for the first time, the following inspection checks are recommended:

1. A visual inspection should be made for any loose parts, bad connections, or foreign materials.

2. Bar the set over by hand for at least 2 revolutions to be sure that there is no interference and that the set turns freely. If the set does not turn freely, check for clearance in the generator and exciter air gap.

3. Check all wiring against the proper connection diagrams, and ensure that all connections and terminations are tight and properly insulated.

WARNING

MAGNAPLUS GENERATORS MAY HAVE VOLTAGE PRESENT AT THE LEAD TERMINALS WHEN THE SHAFT IS ROTATING. DO NOT PERMIT OPERATION OF THE GENERATOR UNTIL ALL LEADS HAVE BEEN CONNECTED AND INSULATED. FAILURE TO DO THIS MAY RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE

4. Verify that all equipment is properly grounded (earthed).

5. Clear the surrounding area of any materials that could be drawn into the generator.

6. Check all fasteners for tightness.

7. Check all access plates, covers, screens and guards. If they have been removed for assembly or inspection, reinstall and check for security.

8. Review all prime mover prestart-up instructions, and ensure that all recommended steps and procedures have been followed.

9. Remove any masking materials affixed during painting. Inspect the generator, prime mover, and any accessory equipment to ensure that nameplates, and all safety warning / caution signs and decals provided with the equipment are in place and clearly visible.

Note: It is strongly recommended that the authority having jurisdiction over the installation site be consulted to determine if any additional warning or caution notices, or additional safety devices are required by local codes / standards. Any such required notices or devices should be installed prior to initial startup.

START-UP

The following procedure should be followed when starting the generator set for the first time.

1. The generator output must be disconnected from the load. Be sure that the main circuit breaker or fused disconnect is in the open position.

2. Open the input power to the automatic voltage regulator. Remove the fuse or disconnect and insulate one of the regulator input power leads. (See separate regulator manual)

3. Verify that all prime mover start-up procedures have been followed.

4. If the unit is provided with space heaters, ensure that they are de-energized. In some installations, a set of auxiliary contacts on the main circuit breaker or transfer switch will automatically open the space heater circuit when the generator is connected to the load.

5. Start the prime mover, and adjust it for proper speed. See generator nameplate.

6. The purpose of this initial test with the regulator out of the circuit is to detect any wiring mistakes without exposing the unit to undue risk. Check all line to line and line to neutral voltages for balanced voltage. If voltages are balanced shut down the set and reconnect the regulator. If voltages are unbalanced, shut down the equipment and check for improper wiring. If the problem persists, consult the factory.

   With the regulator de-energized, the residual voltage should be 10 - 25% of rated value. It is recommended that this residual voltage and driver RPM be recorded for use as a future troubleshooting benchmark.

WARNING

QUALIFIED ELECTRICAL PERSONNEL MUST CONDUCT THE FOLLOWING TEST. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

7. Start the set and adjust the terminal voltage to the desired value by means of the regulator voltage adjustment. If the regulator is equipped with a stability adjustment, follow the instructions in the regulator manual to adjust the stability. Again, check all line to line and line to neutral voltages for balance. It is recommended practice to record the no load excitation (DC voltage to the exciter stator), generator terminal voltage, and driver speed as a benchmark for future troubleshooting.

8. Close the main circuit breaker to the load.

9. Monitor the generator output current to verify that it is at or below nameplate value.

10. Check generator speed (frequency) under load. Adjust as necessary. (Refer to prime mover or governor manuals)

SHUTDOWN PROCEDURE

There are no specific instructions for shutting down the generator; however, several good practices should be observed to prolong equipment life.

1. It is advisable to disconnect all loads (open main circuit breaker or disconnect) prior to shutdown. This is especially important if loads can be damaged by low voltage or low frequency conditions during generator "coast down".

2. Isolate all conditions that could apply voltage to the generator terminals while the generator is at rest. Failure to comply could result in personnel injury or equipment damage.

3. If the unit is equipped with space heaters, verify that the heater circuit is energized.

MAINTENANCE

The following maintenance procedures should be followed to ensure long equipment life and satisfactory performance. Maintenance intervals will depend upon operating conditions.

1. Routinely check intake and exhaust air screens to ensure that they are clean and free of debris. Clogged intake air screens will reduce cooling airflow and result in higher operating temperatures. This will reduce generator life and may result in generator damage.

2. All MagnaPLUS generators are equipped with double shielded ball bearings lubricated for the life of the bearing. Every 1,000 hours check the bearing(s) for smooth, quiet operation. For continuous duty generators, recommended practice is to replace the bearing during major overhauls of the engine.

3. Periodically inspect the unit for any buildup of contamination (dirt, oil, etc.) on the windings. If the wound components have become coated with heavy concentrations of oil and grime, the unit should be disassembled and thoroughly cleaned. This operation is not one that can be accomplished effectively on site, but rather one that should be conducted by an authorized service center equipped with the appropriate apparatus and solvents necessary to properly clean and dry the generator.

WARNING

QUALIFIED ELECTRICAL PERSONNEL MUST CONDUCT THE FOLLOWING TEST. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

4. Every 2,000 operating hours or in conjunction with scheduled engine maintenance check the DC no load excitation voltage per item #7 in the startup procedure. Compare this voltage with the value recorded during initial startup. If this value of no load excitation voltage is markedly higher than the benchmark reading, it is an indication of problems in the exciter, main field, or the rotating rectifier assembly. Ensure that RPM is the same as initial test.

5. Monitor and record insulation resistance with a 500 volt mega-ohm meter. The minimum acceptable reading is 2 mega-ohms. If the reading drops below the minimum, the generator should be cleaned and dried at an authorized service shop. Consult Katolight for more information.

DRYING WINDINGS

Generators in service may inadvertently have their windings exposed to splashing or sprayed water. Units that have been in transit or storage for long periods of time may be subjected to extreme temperature and moisture changes causing excessive condensation. Regardless of the source of moisture, wet windings should be thoroughly dried out before operating the unit. If this precaution is not taken, serious damage to the generator can result. The following procedures may be utilized in drying the generator's windings. Winding wetness and situation limitations will influence the method selected.

Space Heaters

An electric heater may have been supplied with the generator. When energized from a power source other than the generator, the heater will gradually dry the generator. Enclosing the unit with covering and inserting additional heating units can accelerate this process. A hole should be left at the top of the covering to permit the escape of moisture. Care should be taken not to overheat various accessory equipment mounted with the generator.

Forced Air

Another method to dry the generator is to run the set with no excitation (see startup procedure item #2). The natural flow of ambient air through the generator will tend to dry the windings. This method can be accelerated by adding a source of heat at the air intake to the generator. Heat at point of entry should not exceed 80 °C (180 °F).

TESTING

Visual Inspection

Remove covers and look for any obvious problems: burnt windings, loose connections, broken wires, frayed insulation, cracked brackets, missing hardware, etc. Check for foreign objects that may have been drawn into the generator. Verify that the generator's air gaps (main rotor and exciter) are free from obstructions. If possible, rotate the generator manually to ensure free rotation. Never "bar over" the engine generator set using the generator fan.

WARNING

QUALIFIED ELECTRICAL PERSONNEL MUST CONDUCT THE FOLLOWING TEST. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

Constant Excitation Test
(12V BATTERY TEST)

The generator "no load" voltage is dependent on exciter input voltage and generator speed. With the generator operating at rated speed and 12 volts dc applied to the exciter field, the generators terminal voltage will be near rated value.

1. Shutdown the generator set and connect a voltmeter on the generator terminals.

2. Disconnect the regulator's F+ (F1) and F- (F2) leads and connect them to a 12V battery. Caution should be taken to ensure that the battery is not exposed to any potential arcing.

3. With no load on the generator (main breaker open) run the generator at rated speed. Measure the generator's terminal voltage and compare this value with values recorded during installation.

If voltage readings are normal, the main generator and excitation are operating properly. Troubleshooting should continue with the regulator. If readings are not normal the problem is in the generator. Continue testing diodes, surge suppressor, and windings.

Continuity / Resistance Test

The generator has four components that can be checked using an ohmmeter: exciter stator, exciter rotor, main stator and main rotor. Each of these components is comprised of various windings that form a complete electrical path of relatively low resistance. Using an ohm meter measure the loop resistance of each component. Compare these measured values with the values listed in the specification section of this manual. Note that very small resistance values require precision equipment to make accurate measurements; however, a standard ohmmeter will provide a good indication of winding continuity.

Insulation Test

Insulation resistance is a measure of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or be degraded by contaminants: dust, dirt, oil, grease, and especially moisture. Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shutdown

Insulation resistance is measured with a megger (mega-ohm meter). A megger measures insulation resistance by placing 500 volts between the winding and the frame of the generator. Caution must be taken to remove all electronic devices (regulators, diodes, surge protectors, capacitors, protective relays, etc.) from the winding circuit before checking the insulation. Winding insulation can be checked on the main stator, main rotor, exciter stator, and exciter rotor. Minimum resistance is 2 mega-ohms. If the winding resistance is low it must be dried (see maintenance section) or repaired.

DIODE TESTING

If the generator is close coupled to an engine, it may be necessary to "bar over" the engine in order to gain access to a given area of the rectifier assembly. **NEVER** use the generator's fan as a fulcrum to accomplish this. Use the engine manufacturer's recommended practice to manually turn over the engine. To prevent possible injury to personnel, and damage to the equipment, ensure that the engine cannot start during this procedure.

Remove the two main rotor leads and the three exciter rotor leads from the rectifier assembly (figure 4). The rectifier assembly is now electrically isolated from the generator. The diodes remain mounted and the diode leads remain connected to the terminal posts. Using an ohmmeter or a battery light continuity tester, place one test probe on the diode lead terminal post. In succession, touch the other test probe to the lead screw hole in each heat sink. Reverse the probes and repeat the procedure. You have now tested the three diodes connected to this terminal post in both the forward and reverse direction. Repeat the procedure using the other diode terminal post.

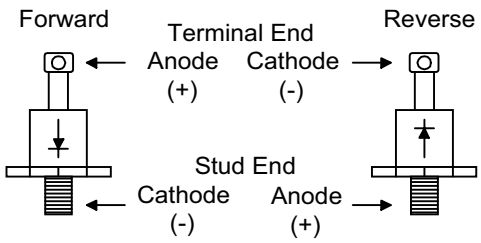


FIGURE 3: DIODE POLARITY

When the positive test probe is connected to the diode's anode and the negative test probe is connected to the diode's cathode (forward biased), the diode will switch on and conduct electricity (figure 3). This is observed by a low resistance reading when using an ohm meter or the lighting of the bulb when using a battery light continuity tester. Reversing the test leads (reverse biased) will result in the diode switching off and no electricity will be conducted. The results of these tests should indicate one of three conditions:

1. **Good diode:** Will have a much greater resistance in one direction than the other. Typical reverse biased resistance will be 30,000 ohms or greater, while forward biased resistance will be less than 10 ohms. The battery-light tester will have the light "on" in one direction and "off" in the other.

2. **Shorted condition:** Ohmmeter reading will be zero, or very low in both directions. The continuity tester will have the light "on" in both directions.

3. **Open condition:** Ohmmeter will have a maximum (infinity) reading in both directions. Continuity tester light will be off in both directions.

Diode failure after a 25 hour "run-in" period is generally traceable to external causes such as a lightning strike, reverse current, line voltage spikes, etc. All 6 diodes are essentially in the same circuit. When a diode is stressed to failure, there is no easy method to determine remaining life in the other diodes. To avoid possible continued failures, it is recommended that the entire rectifier assembly be replaced rather than replacing individual diodes.

SERVICE

GENERAL

The service procedures given in this section are those which can reasonably be conducted on-site with a minimum number of special tools and equipment. Qualified maintenance personnel should conduct all service procedures. Replacement parts may be ordered through an authorized service center or directly from the factory**.**

FIELD FLASHING

Restoring Residual Magnetism
(not applicable on PMG equipped generators)

To restore residual magnetism to the generator, connect a 12 volt battery to the exciter field while the generator using the following procedure:

1. Shutdown the generator set. Remove the exciter field leads F+ and F- from the regulator.

CAUTION:
Failure to remove the exciter field leads from the automatic voltage regulator during flashing procedures may destroy the regulator.

2. Connect the F+ and F- leads to the battery's corresponding positive and negative terminals. This should be done using an appropriate length of lead wire to separate the battery from the point of connection (batteries may explode when exposed to an electric arc). After 3 to 5 seconds, remove the F- lead. An inductive arc should result. If no arc is drawn, repeat the procedure.

3. Reconnect the F+ and F- leads to the regulator. Restart the generator and verify that terminal voltage is developed. If terminal voltage does not develop, repeat the field flashing procedure and / or consult the trouble shooting section.

Bearing Removal

Prior to performing this operation, it is suggested that the alternator's shaft be rotated until two of the main rotor poles are in a vertical position. Once the bearing bracket is backed out, the rotor will drop on the main stator core. Having the rotor in this position will limit the amount of rotor drop to that of the air gap. Visually inspect the bearing bore for damage or wear. If worn or damaged, replace prior to reassemble.

Opposite Drive End Bearing Bracket Removal.
Prior to proceeding with bracket removal, disconnect exciter field leads F+ and F- from the automatic voltage regulator and ensure that they are free to move when the bearing bracket is removed. Remove the bearing bracket retaining bolts. Using a pair of screw drivers, wedge the bracket off the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame and will drop until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore and o-ring (if equipped) for damage or wear. If worn or damaged, repair or replace prior to reassembly.

Drive End Bearing Bracket Removal,
Two Bearing Units.
Remove any drive arrangement from the generator shaft extension. Remove the bearing lock ring retaining screws. There is no o-ring in the drive end bearing bracket. The shaft extension must be supported before proceeding further. A hoist and sling, jack, or some other means of support with a capacity of 2 tons should be used.

Remove the bearing bracket retaining cap screws. Using a flat bladed screw driver or chisel, pry the bracket back from the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame. Lower the shaft extension until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore for damage or wear. If worn or damaged, sleeve or replace prior to reassembly.

Reassembly note: Before the bearing bracket is seated against the frame, a threaded rod may be used to help align the inner bearing cap with the bearing bracket.

BEARING REPLACEMENT

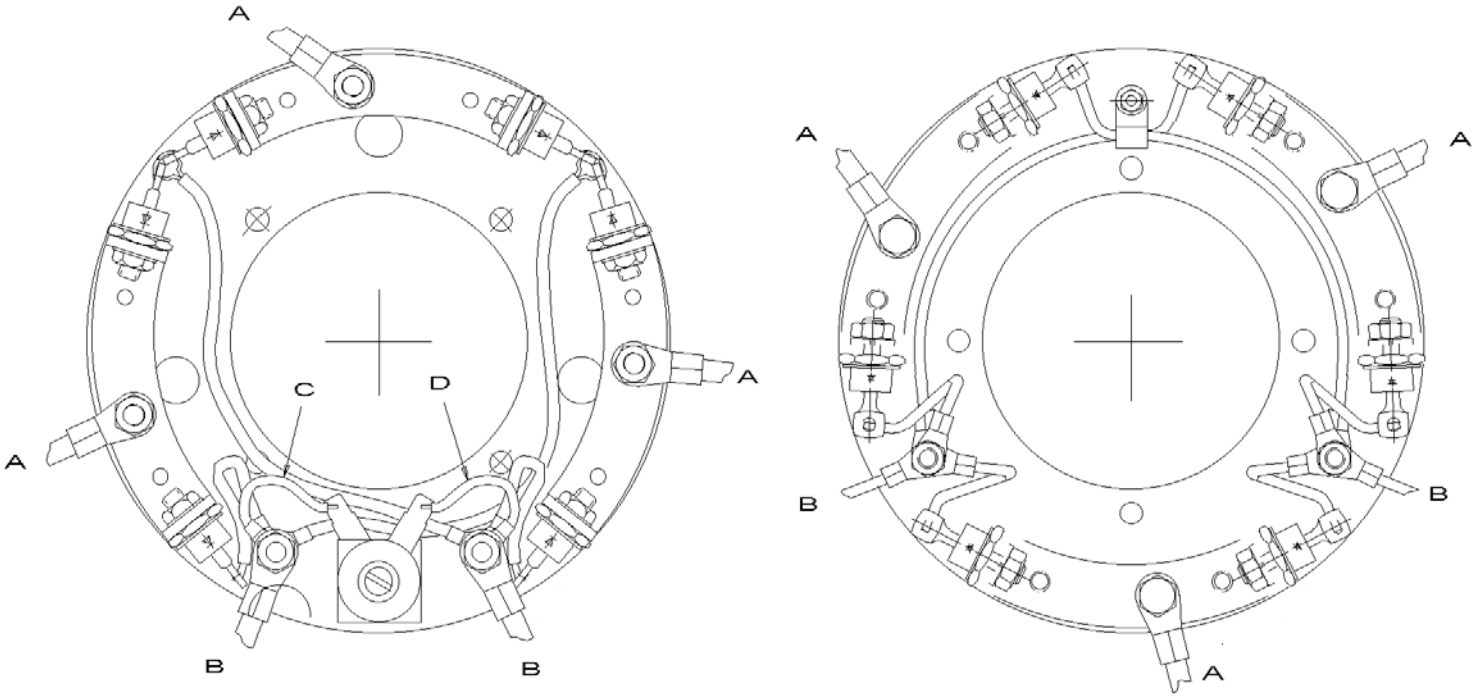
Using a bearing puller, remove the existing bearing. It is strongly recommended that the bearing be replaced any time it is removed from the shaft. **ALWAYS** install the same type and size bearing that was supplied as original equipment. Order by part number from the parts list, and include the unit serial number and part number when ordering. Heat the bearing to a maximum of 100°C (212°F) in an oven. Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. The bearing should slide on the shaft and be seated without excessive force. Should the bearing bind on the shaft prior to being seated against the shoulder, a piece of tubing slightly larger than the press fit area can be used to drive the bearing to its final position. Using light taps with a soft mallet, apply pressure to the inner race only.

Rectifier Assembly Removal

The rectifier assembly cannot be removed until the opposite drive end bearing bracket and bearing have been removed (see bearing removal procedure). Remove the three exciter rotor leads from the heat sinks and the two main rotor leads from the main rotor posts (see Figures 4). Remove the screws securing the rectifier assembly and pull the assembly free from the shaft.

Diode Replacement

Prior to installing a replacement diode on the heat sink, apply a thin film of conductive heat sink compound around the base of the diode (do not coat the threads). When installing a diode on the heat sink, care should be taken not to over torque the retaining nut, which could cause damage to the device. Torque to 28 pound-inches. If not damaged, the existing diode lead wire may be unsoldered from the failed diode, and resoldered on the replacement.



430 FRAME **280 / 360 FRAME**

A - Exciter Rotor Lead, B - Main Rotor Lead, C - Red (+) Suppressor Lead, D - Black (-) Suppressor Lead

FIGURE 4: ROTATING RECTIFIER ASSEMBLY

RETURNED GOODS

Contact Katolight Corporation for authorization before returning any product. We can not be responsible for any items returned without authorization.

CAUTION

Single bearing generators must have their rotor assembly properly secured to prevent damage during transit to the factory, or to an authorized service center.

TROUBLESHOOTING

This section is intended to suggest a systematic approach to locating and correcting generator malfunctions. The section is arranged according to the symptoms of the problem. The steps have been arranged in an attempt to do the easy checks first and prevent further damage when troubleshooting a disabled machine.

The first step of troubleshooting is to gather as much information as is possible from operating personnel and individuals present during the failure. Typical information includes: how long the unit had been operating; what loads were on line; weather conditions; protective equipment that did or did not function. In addition, information as to the operating condition of the generator's prime mover is vital. Has the prime mover been maintaining constant speed? If not, have there been extended periods of under speed operation? Has the prime mover experienced an over-speed condition? If yes, what was the maximum speed, and how long did the unit operate at that elevated speed?

The generator speed should be maintained at rated nameplate value during all operating tests. The frequency of the generator depends upon rotational speed. Most regulators used with MagnaPLUS generators have built in under frequency protection such that if the speed is reduced more than 5%, the voltage will drop off rather rapidly with further reductions in speed.

WARNING

HIGH VOLTAGES MAY BE PRESENT AT THE GENERATOR'S TERMINALS WHEN THE UNIT IS RUNNING. SOME ACCESSORY EQUIPMENT SUCH AS SPACE HEATERS MAY BE ENERGIZED FROM AN OUTSIDE POWER SOURCE WHEN THE UNIT IS AT REST. TOOLS, EQUIPMENT, CLOTHING AND YOUR BODY MUST BE KEPT CLEAR OF ROTATING PARTS AND ELECTRICAL CONNECTIONS. SPECIAL PRECAUTIONS MUST BE TAKEN DURING TROUBLESHOOTING SINCE PROTECTIVE COVERS AND SAFETY DEVICES MAY BE REMOVED OR DISABLED TO GAIN ACCESS AND PERFORM TESTS. BE CAREFUL. SERIOUS PERSONAL INJURY OR DEATH CAN RESULT FROM THESE HAZARDS. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

GENERATOR PRODUCES NO VOLTAGE

CAUSE	CHECK AND REMEDY
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for loose connections, open circuits, grounds, and short circuits.
Loss of residual	Flash the field. Refer to field flashing in the service section. If the generator is equipped with a PMG, field flashing is not necessary -- check regulator fuse and input power from the PMG.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator protection operating	Adjust regulator. Consult regulator manual.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE, NO LOAD

CAUSE	CHECK AND REMEDY
Underspeed operation	Check speed using a tachometer or frequency meter.
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for grounds, open circuits and short circuits.
Loss of regulator power	Check regulator fuse and input power. Input power is produced by the generator's residual voltage or from an optional PMG.
Regulator adjustment	Adjust regulator settings. Consult regulator manual.
Regulator incorrectly connected	Review the generator connection diagram or reference the regulator manual.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE WHEN LOAD APPLIED

CAUSE	CHECK AND REMEDY
Excessive load	Reduce load. The load on each leg should be evenly balanced, and rated current should not be exceeded on any leg.
Large motor starting or low load power factor	Motor starting currents are too large for the generator. When starting multiple motors, sequence the motors and start the largest motors first. Reduce lagging power factor load.
Driver speed droop or belt slip	Check driver. If belt driven, check belt tension. Check under frequency setting on regulator. Under frequency voltage roll-off may be activated.
Reactive droop	If the generator is equipped for parallel operation, some droop is normal as reactive load increases. When operating as a single unit, the parallel CT can be shorted to eliminate this effect. Refer to Regulator manual.
Line drop	If voltage is proper at generator terminals but low at load terminals, increase external wire size.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.

GENERATOR PRODUCES FLUCTUATING VOLTAGE

CAUSE	CHECK AND REMEDY
Fluctuating engine speed	Check engine and governor systems for malfunctions. Check load for fluctuation.
Regulator stability	Adjust Regulator stability. Refer to Regulator manual.
Regulator external rheostat	Replace defective or worn rheostat. Use shielded cable to minimize electrical noise.
Defective rectifier assembly	Check assembly for loose connections. Test the diodes as specified in the test section.
Loose terminal or load connections	Improve connections both mechanically and electrically.
Defective regulator	Replace regulator.

GENERATOR PRODUCES HIGH VOLTAGE

CAUSE	CHECK AND REMEDY
Faulty metering	Check voltage with separate meter at generator terminals.
Incorrect connections	Verify generator connections. Refer to drawings supplied with the generator or connection diagrams in this manual.
Regulator adjustments	Adjust regulator. Consult regulator manual.
Leading power factor	Check the power factor of the load. If power factor is leading, change load configuration. Excessive leading power factor (capacitors) can cause voltage to climb out of control.
Incorrect regulator connection	Verify regulator voltage sensing is connected correctly. Consult regulator manual.
Defective regulator	Replace regulator.

GENERATOR BUILDS VOLTAGE FROM STARTUP, THEN GOES TO LOW (RESIDUAL) VOLTAGE

CAUSE	CHECK AND REMEDY
Regulator protective circuit operating	Check indicators on regulator. Correct problems and adjust regulator as is required. Refer to regulator manual.

GENERATOR IS OVERHEATING

CAUSE	CHECK AND REMEDY
Generator is overloaded	Reduce load. Check with ammeter and compare with nameplate rating.
Clogged ventilating screens	Clean air passages.
High room temperature or altitude	Improve ventilation or reduce load.
Insufficient circulation of cooling air	Generator location and enclosure design must provide adequate airflow and minimize recirculation of hot air.
Unbalanced load	The load on each leg should be as evenly balanced as possible and should not exceed rated current on any one leg.

GENERATOR PRODUCES MECHANICAL NOISE

CAUSE	CHECK AND REMEDY
Defective bearing	Replace bearing.
Loose or misaligned coupling	Tighten, realign, or replace coupling.
Belt slap or loose guards	Check belt tensioning. Check belt guard fasteners.

EQUIPMENT RUNS NORMALLY ON UTILITY POWER, BUT WILL NOT RUN ON GENERATOR

CAUSE	CHECK AND REMEDY
Distorted voltage waveform	Analyze load. Excessive SCR (thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Refer to Katolight.
Improper generator voltage or frequency	Check nameplates of devices comprising the load. Compare required voltage and frequency with that of the generator. Adjust driver speed and/or generator voltage as necessary to match generator output to load requirements.

CAUTION: Compare required voltage, frequency, and kVA with generator nameplate to ensure adequate generator capacity. If in doubt, consult Katolight for information regarding generator capacity.

SPECIFICATIONS

MODEL / FRAME SIZE	EXCITER RESISTANCE STATOR	ROTOR
281, 282, 283, 284	23.0	.120
361, 362, 363 -- three phase	23.5	.120
361, 362, 363 -- dedicated single phase	23.0	.135
431, 432, 433 -- three phase	20.33	.076
431, 432 -- dedicated single phase	18.0	.105

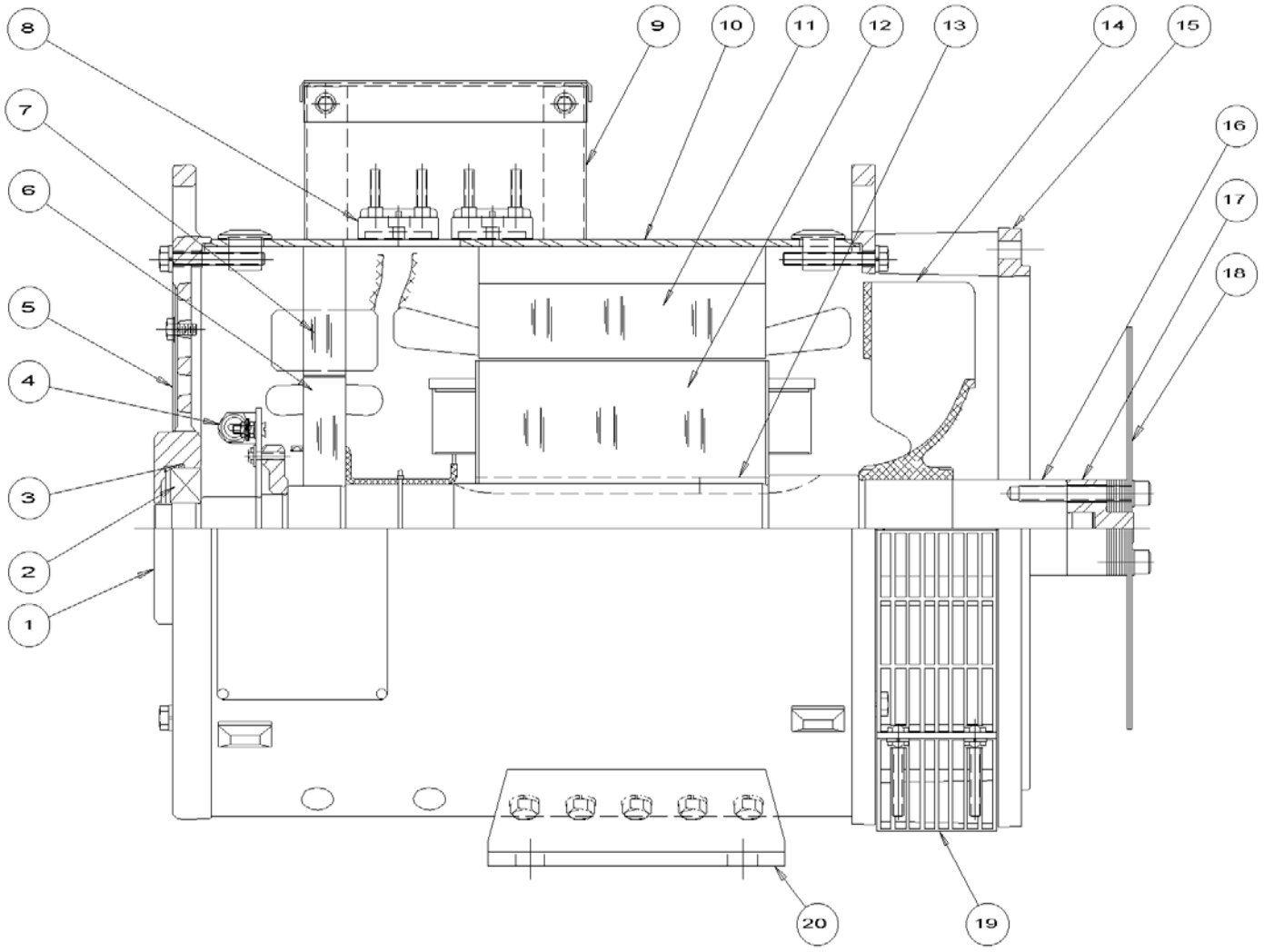
MODEL	GENERATOR RESISTANCE STATOR*	ROTOR	EXCITER FIELD NO LOAD VOLTS 480 V / 60 HZ	NO LOAD TERMINAL VOLTAGE WITH 12 VDC FIXED EXCITATION HIGH WYE / 60 HZ	HIGH WYE / 50 HZ
281PSL1500	4.20	.400	11.0	485	400
281PSL1501	4.15	.400	11.0	490	404
281PSL1502	3.20	.439	9.0	528	435
282PSL1503	2.00	.470	10.4	500	415
282PSL1504	1.51	.512	11.3	490	400
282PSL1505	1.00	.575	10.1	515	415
283PSL1506	.681	.654	11.0	495	400
283PSL1507	.480	.758	12.0	480	390
284PSL1508	.346	.875	12.0	480	375
361PSL1600	.381	.750	11.8	485	400
361PSL1601	.264	.810	12.5	475	385
361PSL1602	.181	.990	14.1	460	370
362PSL1604	.138	1.05	12.2	480	380
362PSL1606	.0980	1.20	10.8	500	405
363PSL1607	.0692	1.37	12.2	475	380
431PSL6202	.0214	.8114	15.1	440	360
431PSL6204	.0477	.6373	13.6	455	385
431PSL6206	.0371	.6793	13.82	455	370
431PSL6208	.0133	.715	12.20	475	390
432PSL6210	.0214	.8114	15.1	440	360
432PSL6212	.0226	.8656	14.1	445	385
433PSL6216	.01215	1.0672	16.2	425	345
433PSL6220	.01214	.9743	15.6	430	350

* Stator resistance measured line to line in a high wye connection.

DEDICATED SINGLE PHASE	GENERATOR RESISTANCE STATOR	ROTOR	EXCITER FIELD NO LOAD VOLTS / 60 HZ
281PSL1511	1.420	.381	8.3
281PSL1512	1.106	.395	8.1
281PSL1513	.632	.430	8.7
282PSL1514	.436	.450	9.2
282PSL1515	.240	.520	9.7
283PSL1516	.160	.620	13.3
284PSL1517	.0918	.760	12.2
284PSL1518	.0610	.857	16.6
361PSL1611	.0695	.750	17.5
361PSL1612	.0434	.857	16.1
361PSL1613	.0369	.926	13.6
362PSL1615	.0191	1.20	17.0
363PSL1617	.0119	1.35	23.0
431PSL1811	.0248	.516	9.9
431PSL1813	.0129	.615	13.8
432PSL1814	.00931	.643	15.1
432PSL1815	.00723	.852	11.2

PARTS LIST – SINGLE BEARING

Typical Generator Cross Section

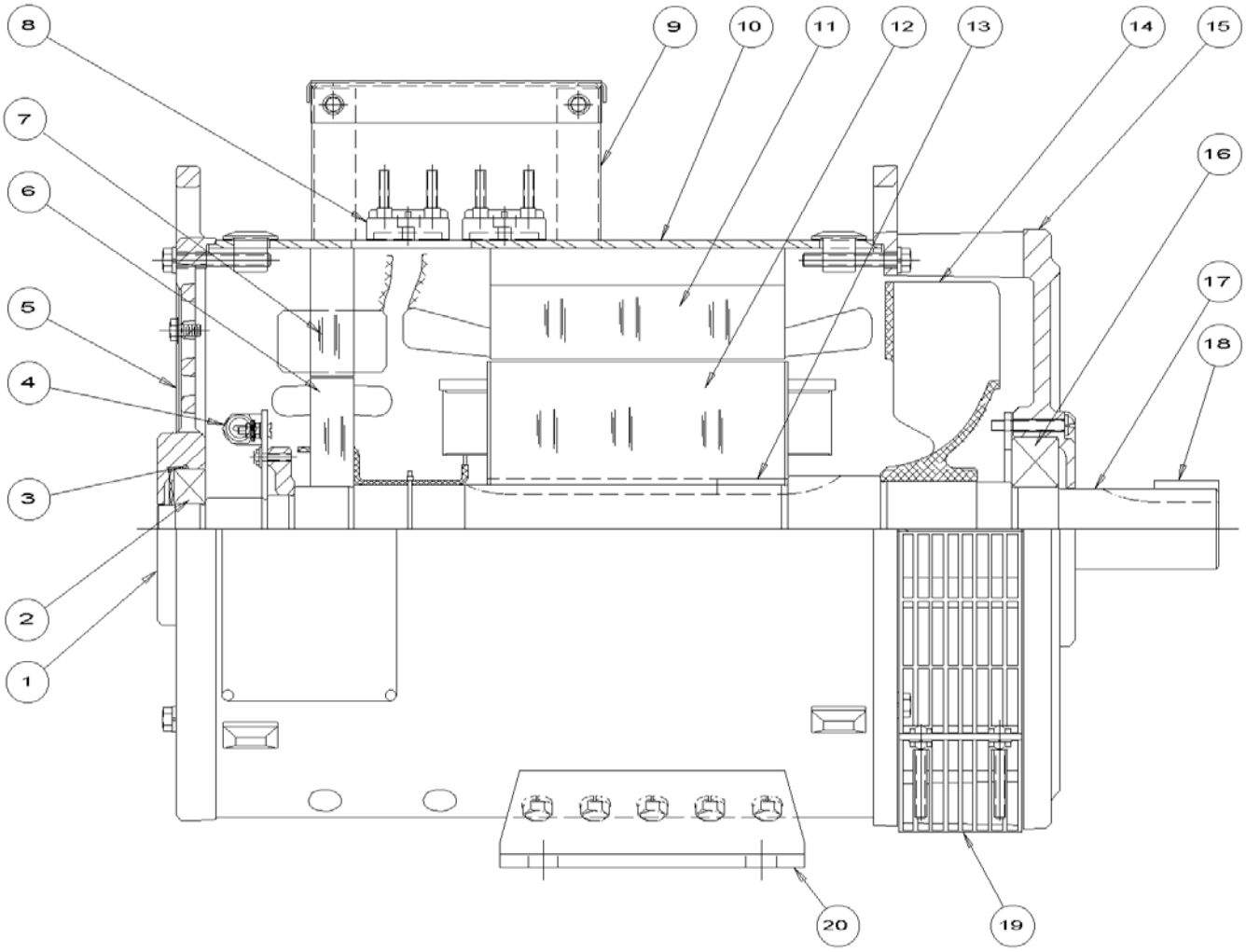


Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing	12	Main Rotor
3	O-ring (280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	Mounting Adapter (SAE)
6	Exciter Rotor	16	Shaft
7	Exciter Stator	17	Drive Hub
8	Link Board (terminal block)	18	Drive Disk (SAE)
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus. Other Frame sizes are typical. Optional PMG not shown.
The generator model and serial numbers are required when ordering parts.

PARTS LIST – DUAL BEARING

Typical Generator Cross Section



Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing (nondrive end)	12	Main Rotor
3	O-ring (280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	End Bracket (drive end)
6	Exciter Rotor	16	Bearing (drive end)
7	Exciter Stator	17	Shaft
8	Link Board (terminal block)	18	Key
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus. Other Frame sizes are typical. Optional PMG not shown.
The generator model and serial numbers are required when ordering parts.

KATOLIGHT CORPORATION

MAGNAMAXDVR® GENERATOR

INSTALLATION OPERATION, AND MAINTENANCE MANUAL

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SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of your generator.

Each section has caution and warning messages. These messages are for your safety and the safety of the equipment involved. If any of the cautions or warnings is not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and, where appropriate, lock out all controls, to prevent an unexpected start-up of the generator set. Proper grounding in compliance with local and national electrical codes must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving the generator are pointed out in the installation and service sections; incorrect lifting or moving can result in personal injury or property damage.

Whenever the generator is running, always assume and proceed as if voltage is present. Residual voltage is present at the generator leads and at the regulator panel connections, even with the regulator fuse removed. Caution must be observed, or serious personal injury or death can result.

Whenever solvents, cleaners, or flammable liquids are present, adequate ventilation must be available to avoid fire, explosion, and health hazards. Always avoid breathing vapors and use suitable personal protective equipment to prevent personal injuries. (Such as eyes, face, and hand protection.)

This manual is not intended to be a substitute for properly trained personnel. Only qualified trained people should attempt repairs. The cautions and warnings point out known conditions that are potentially dangerous. Each installation will create its own set of circumstances. No manual can cover every possible situation.

When in doubt, ask. Don’t be embarrassed to ask, “dumb questions”. Remember that dumb questions are much easier to handle than dumb mistakes.

GENERAL INFORMATION

MECHANICAL DESIGN

General

All single and two bearing units are manufactured with cast iron end brackets and adapters, and fabricated steel frames. Flexible drive discs and SAE adapters are machined to SAE standards. Pre-lubricated, regreasable, shielded ball bearings are used on MagnaMAX^{DVR} generators. Standard units are fully guarded. Drip proof shields are available as an option.

Conduit Box

The large end mounted conduit box is constructed of formed sheet steel that will allow the addition of top mounted control packages. Refer to Katolight for top mounted controls of more than 240 lbs. There is ample room inside the conduit box for a circuit breaker (through 800A Frame) and other options. The conduit box cover properly directs outside ventilating air through the generator.

MagnaMAX^{DVR} Unirotor^{TM} Construction

An aluminum die cast rotor core affords high mechanical integrity and low vibration at operating speeds. Amortisseur winding and coil supports are die cast as an integral part of the rotor. Laminations are 4-pole, one piece laminations which are shrunk fit and keyed to the shaft. No dovetails, cross bolts or other pole to shaft connecting devices are used. The cast unidirectional aluminum alloy ventilation fan provides even air distribution to maximize cooling and generator efficiency.

Adapters and Drive Discs

All single bearing units are available with several adapters and drive disc arrangements. These can be shipped to order or can be changed in the field with standard shop tools. When changing flexible drive discs, spacers are used between the discs and the cast iron hub to maintain SAE standard dimensions.

ELECTRICAL DESIGN

All standard products have 2/3 pitch main windings to eliminate the third harmonic. This serves to lower operating temperatures, give lower harmonic content and better waveform, and extend the overall life of the generator.

Temperature Rise

All ratings and frame sizes are based on NEMA and CSA Class F and Class H temperature rises on both the rotor and stator windings. Ratings for British, German, French, IEC and all popular marine agencies are available.

Standby Generator Ratings

Synchronous generators used on emergency backup power can have temperature rises up to 25°C above those for continuous operation. (NEMA MG1 -22.40 and MG 1-22.84).

Premium Insulation System

All MagnaMAX^{DVR} generators are built with Class H or better insulation materials. All standard generators are suitable for continuous duty at Class F temperature rise and will give equivalent or better winding life expectancy to generators supplied with Class A or B insulation systems operated within their temperature limits. The varnishes and epoxies used are synthetic, non-hygroscopic. Multiple dip and bake cycles of the main winding, plus a final coat of epoxy, make the standard winding moisture and fungus resistant. The MagnaMAX^{DVR} rotor is wet wound with thermo-setting epoxy applied between each layer, plus a final coating of epoxy for moisture and abrasion resistance.

MagnaMAX^{DVR} generators can be ordered with an epoxy vacuum pressure impregnated insulation system as an option. (MagnaMAX^{DVR} generators with form wound coils include VPI as standard.)

Power Factor

All standard generators are designed for operation at rated kVA at 0.8 lagging power factor but can be operated at rated kVA over the 0.8 to 1 .0 power factor range.

MagnaMAX^{DVR} Voltage Regulator

The standard voltage regulator is a fully encapsulated, static types with a solid state build up circuit. Standard features include 3-phase RMS sensing, paralleling, adjustable under frequency protection, and over excitation protection. The regulator meets EMI suppression to Mil Std-461C, part 9. An optional feature is adjustable armature current limiting. See the regulator manual for more information.

HOW TO READ A MODEL NUMBER

It is extremely important to properly identify the machine when requesting parts or service. Always have the generator model number and serial number when requesting information from the factory. We cannot help you without this information.

An Example For MagnaMAX^{DVR} Generators ***431RSL 4009***

Character	Category	Description
1st three characters	Frame Number	
4th character	Winding type	R—Random Wound F—Form Wound
5th character	Bearing arrangement	S—1 Bearing D—2 Bearings
6th character	Voltage range	L—Up to 480 volts M—1000-6600 volts S—600 volts
7th Character	Product style	4-Magna
8th Character	Type	
9th & 10th Character	Wk2 Code	
11th Character	Modification	A-Z assigned sequentially
12th Character	Mounting Arrangement	A-Y see chart figurer 2-1
13th, 14th & 15th characters	Modification numbers	For internal use only

Arrangement	Adapter SAE Size	Drive Disc SAE Size
A	3	11-1/2
B	2	11-1/2
C	4	8
D	3	10
E	1	11-1/2
F	1	14
G	4	7-1/2
H	1	Delco
J	1/2	14
K	2	10
L	1/2	Delco
M	0	14
N	2	Small Delco
0	None	None
P	0	18
S	0	Delco
U	00	18
V	4	6-1/2
W	00	21
Y	4	10

Figure 2-1

INSTALLATION

RECEIVING YOUR MAGNAMAX^{DVR} GENERATOR

Upon receipt of the generator, it is recommended that it be carefully examined for possible damage incurred in shipment. The generator was given to the Freight Company in good condition, and they are responsible for the product from our dock to yours. Any damage should be noted on the freight bill before accepting the shipment. Claims for damages must be promptly filed with the Freight Company.

UNPACKING AND HANDLING

Read all instruction cards carefully. When lifting, attach an overhead crane to the lifting lugs on the generator frame. Apply lifting forces in a vertical direction.

WARNING
THE LIFTING LUGS ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT COMPLETE GENERATOR SET BY MEANS OF LIFTING DEVICES ON THE GENERATOR. PERSONAL INJURY OR QUIPMENT DAMAGE MAY OCCUR.

STORAGE

In the event that the generator is not to be installed on the prime mover immediately, it is recommended that it be stored in a clean, dry area that is not subject to rapid changes in temperature and humidity. See "STORAGE INSTRUCTIONS" for more information.

PREPARATION FOR USE

Although the generator is carefully inspected and tested in operation before it leaves the factory, it is recommended the unit be thoroughly inspected. The insulation on the wire should be inspected and all bolts should be checked for tightness.

Remove all shipping tapes, bags, blocks, and skids, which are used to prevent vibration and rotor movement during shipment. Dry, low-pressure compressed air of approximately 30 PSI (206 KPA) can be used to blow out the interior of the generator. In the case of two bearing machines, it is possible to turn the rotor by hand to make sure that it rotates smoothly without binding.

If the machine has been in storage for a year or longer it is recommended that it be lubricated according to the lubrication instructions and chart supplied in the maintenance section.
If the machine has been exposed to damp, humid conditions the insulation resistance should be checked. Refer to the instructions supplied in this manual.

GENERATOR MOUNTING - SINGLE BEARING

Single bearing generators are provided with an SAE flywheel adapter and flexible drive discs. Very close tolerances are maintained in the manufacture of the generator so that the alignment procedure is extremely simple. A coupling hub of nodular iron is shrunk on the shaft and special steel drive discs are bolted to the hub. Holes are provided in the periphery of the coupling disc, which correspond to tapped holes in the flywheel. The outside diameter of the discs fits in a rabbet in the flywheel so that concentricity is assured in all cases.

WARNING
DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFITNG OR FOR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE

CAUTION: GRADE 8 CAPSCREWS OR GRADE 8 PLACE-BOLTS AND HARDENED WASHERS ARE REC-OMMENDED TO MOUNT THE DRIVE DISCS TO THE FLYWHEEL.DO NOT USE HELICAL OR OTHER LOCKING DEVICES UNLESS APPROVED.

The SAE adapter and the flywheel housing are designed to match each other with no further alignment necessary. Shims may be necessary under the feet of the generator to insure a solid mounting. See THE SERVICE SECTION for more information.

GENERATOR MOUNTING-TWO BEARING

Two bearing generators are provided with a shaft extension and key way. For direct-coupled sets the assembler furnishes a flexible coupling which is installed between the driver and the generator shaft.

IMPORTANT: Aligning the two machines as accurately as possible will reduce vibration, increase-bearing life, and insures minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

BELT DRIVE

Please refer to Katolight for applications involving belt driven installations.

ENVIRONMENTAL CONCERNS

Dirt, moisture, heat, and vibration are enemies of electrical equipment. The ambient temperature should not exceed the value shown on the generator nameplate. Generators for outdoor application should be protected from the elements by housings with proper openings for ventilation. This protection should be designed to prevent the direct contact of wind driven rain, snow, or dust with the generator. In moist or humid areas, such as the Tropics and marine serv-ice, additional protection is recommended. Although the standard windings are humidity and moisture resistant, special insulation and accessories such as space heaters can increase generator life. In extremely dirty and dusty environments a means of providing filtered cooling air to the generator is recommended. Please refer to Katolight for filter kits that are available.

ELECTRICAL CONNECTIONS

The generator conduit box construction allows conduit to enter the top, bottom, or either side of the box. A hole-saw or any suitable tool can be used to provide for the conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit.

To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical cable entrance to the generator.

Refer to the connection diagram supplied with the generator and / or the proper diagrams shown in this section. Install all intercomponent and external wiring in accordance with the regulations of the national and local electrical codes. Clean all contact surfaces to assure good electrical bonding with the generator lugs or bus bars. Use heavy-duty terminal lugs or good quality clamps for making all connections. Insulate all connections in accordance with national and local regulations.

Be sure the generator frame is grounded to all the other components of the system with a ground wire in accordance with national and local regulations.

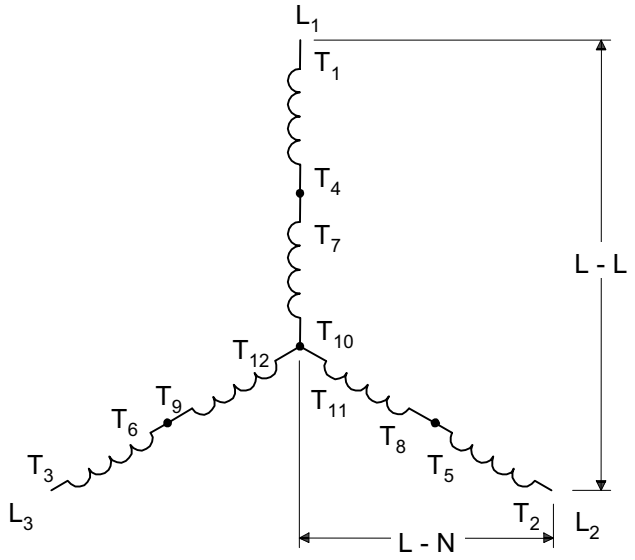
GENERATOR LEAD CONNECTIONS

The electrical connections in the conduit box should be made in accordance with the appropriate “connection diagram.” Use the diagram appropriate for the number of leads and voltage range required. Refer to the drawings supplied with the generator and to drawings in this section.

The final voltage setting is established within the selected range by an adjustment of the voltage regulator.

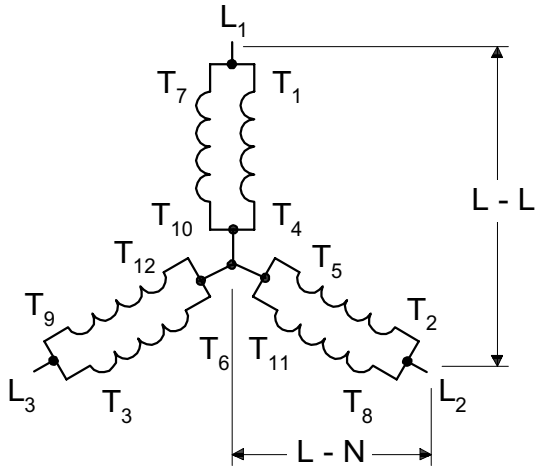
CAUTION: SOME GENERATORS HAVE MULTIPLE, IDENTICALLY MARKED, CABLES FOR EACH LEAD. CONNECT ALL IDENTICALLY MARKED CABLES TOGETHER WHEN MAKING CONNECTIONS.

12 LEAD HIGH WYE CONNECTION



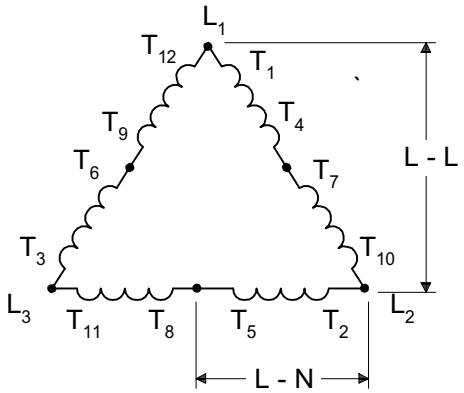
VOLTAGE		
	L-L	L-N
60 HZ	480 460 440 416 380	277 266 254 240 219
50 HZ	416 400 380	240 231 219

12 LEAD LOW WYE CONNECTION



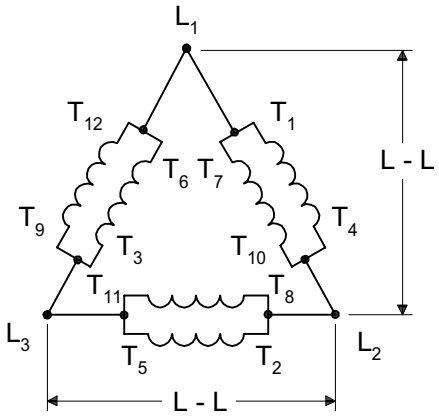
VOLTAGE		
	L-L	L-N
60 HZ	240 230 220 208 190	139 133 127 120 110
50 HZ	208 200 190	120 115 110

12 LEAD HIGH DELTA CONNECTION



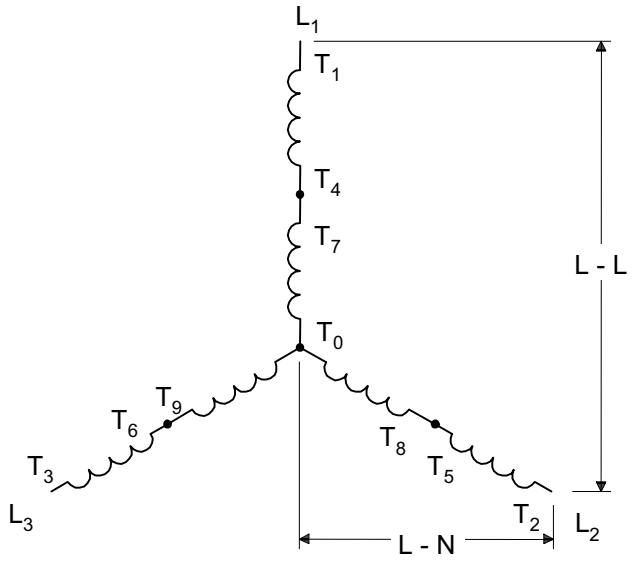
VOLTAGE		
	L-L	L-N
60 HZ	240 277	120 139
50 HZ	200 220 240	100 110 220

12 LEAD LOW DELTA CONNECTION



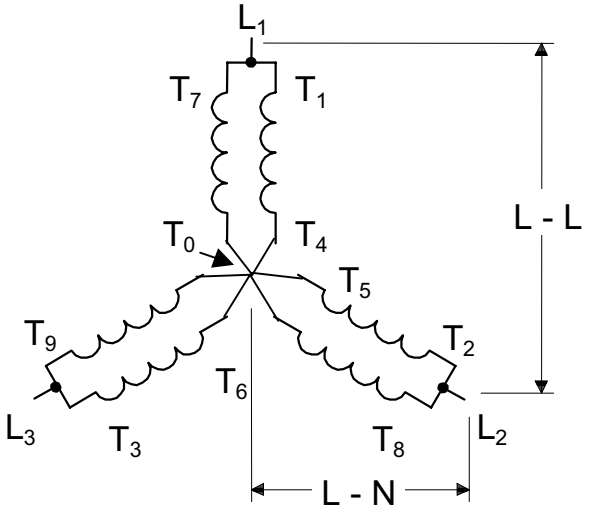
VOLTAGE		
	L-L	L-N
60 HZ	120 139	NA
50 HZ	100 120	NA

10 LEAD HIGH WYE CONNECTION



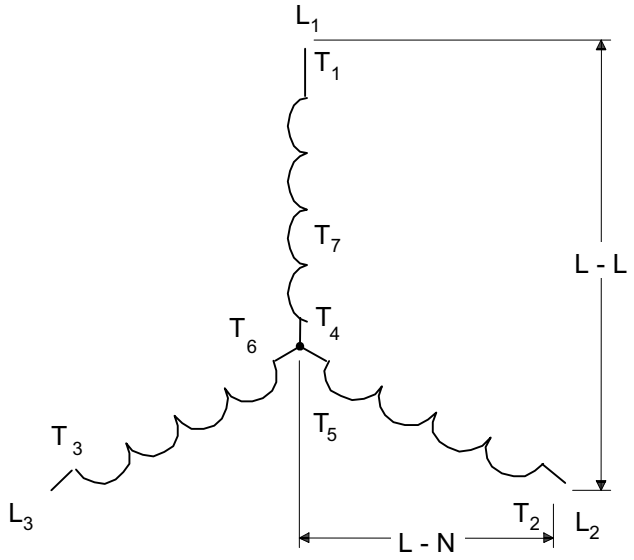
VOLTAGE		
	L-L	L-N
60 HZ	480 460 440 416 380	277 266 254 240 219
50 HZ	416 400 380	240 231 219

10 LEAD LOW WYE CONNECTION



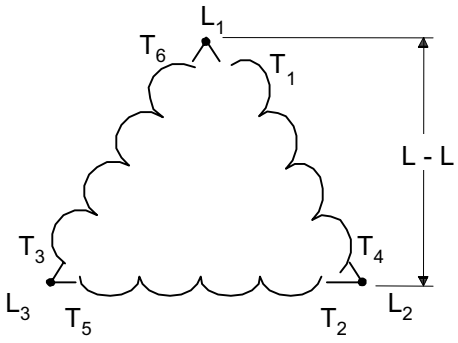
VOLTAGE		
	L-L	L-N
60 HZ	240 230 220 208 190	139 133 127 120 110
50 HZ	208 200 190	120 115 110

6 LEAD WYE CONNECTION



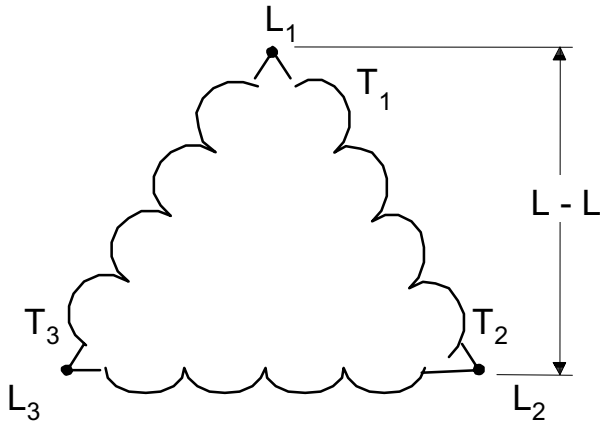
VOLTAGE		
	L-L	L-N
60 HZ	13800 6600 4160 3300 240 230 220 203 190	7967 3811 2400 1905 139 1363 127 120 110
50 HZ	11000 6600 3300 208 200 190	6351 3811 1905 120 115 110

6 LEAD DELTA CONNECTION



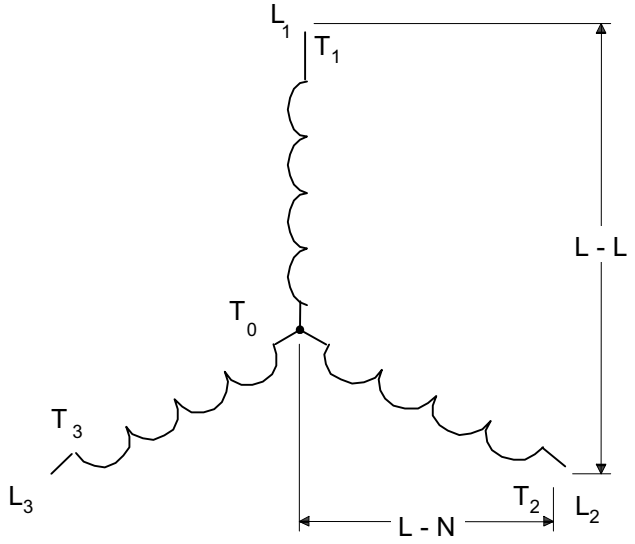
VOLTAGE		
	L-L	L-N
60 HZ	7967 2400	NA
50 HZ	6351 1905	NA

3 LEAD DELTA CONNECTION



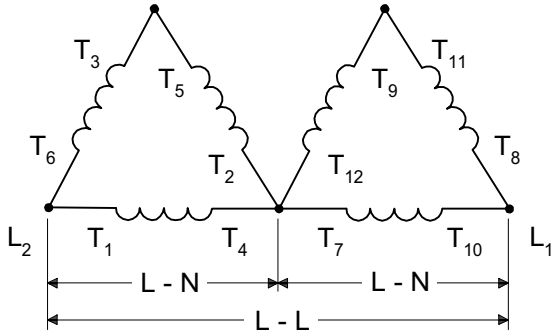
VOLTAGE		
	L-L	L-N
60 HZ	7967 2402	NA NA
50 HZ	6351 1905	NA NA

4 LEAD WYE CONNECTION



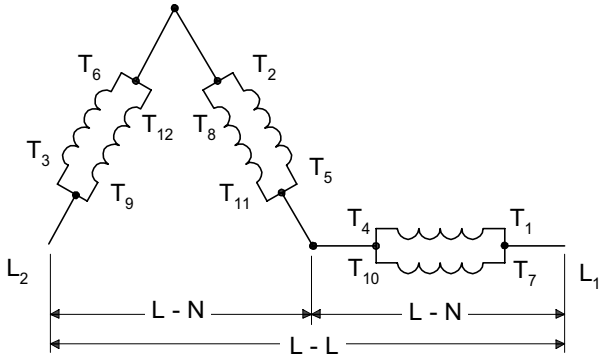
VOLTAGE		
	L-L	L-N
60 HZ	13800 6600 4160 3300 2400 600 480 380	7967 3811 2400 1905 1386 346 277 219
50 HZ	11000 6600 3300 416 400 380	6351 3811 1905 240 231 219

DOUBLE DELTA -- SINGLE PHASE CONNECTION



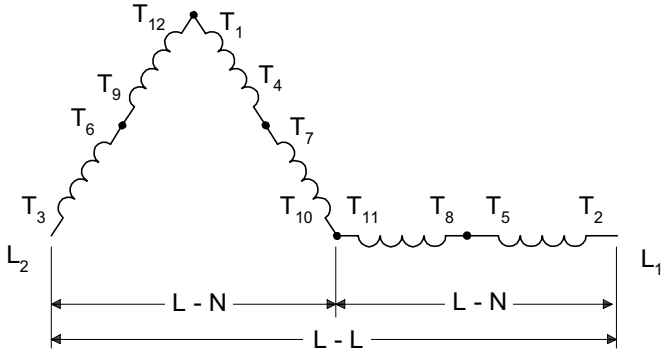
VOLTAGE		
	L - L	L - N
60 HZ	240	120
	220	110
	200	100
50 HZ	220	110
	200	100

LOW ZIG ZAG -- SINGLE PHASE CONNECTION



VOLTAGE		
	L - L	L - N
60 HZ	240	120
	220	110
	200	100
50 HZ	220	110
	200	100

HIGH ZIG ZAG -- SINGLE PHASE CONNECTION



VOLTAGE		
HZ	L - L	L - N
60	480	240
	440	220
50	440	220
	400	200

PARALLELING OPERATIONS

MagnaMAX^{DVR} generators come standard with amortisseur windings die cast as an integral part of the rotor. This exclusive, Unirotor^{TM}, construction makes all MagnaMAX^{DVR} generators suitable for paralleling operations when the proper control equipment is added. Paralleling with other generator sets and / or with the utility power grid offers a number of advantages. Multiple unit installations increase power capacity; they can be added or removed from the line depending on the load requirements; they can be better maintained and repaired (since single source breakdown would mean total loss of power), and they often provide more reliable, efficient, and economical operation.

Successful parallel operation means that the generators deliver power to the external system without delivering power to each other, or accepting power from the load bus or power grid. Additional equipment is necessary to insure safe and successful operation.

PRIME MOVER

The prime mover provides the speed and torque which will be necessary to keep the machines in synchronized operation. A governor controls the prime mover's speed. The governor will directly control the watt or kW output and frequency of the unit. The governor must have special paralleling provisions to permit parallel operation with the other machines.

VOLTAGE REGULATOR

The voltage regulator controls the generator output voltage and the reactive power supplied by the generator. When two or more ac generators operate in parallel, the voltage regulator must have paralleling provisions (either internally or external to the regulator) to control the reactive or VAR load while it is in parallel operation. A separate paralleling current transformer is required to sense the reactive current and signal the voltage regulator. This additional paralleling circuitry is absolutely necessary to control the reactive current flowing between the generator sets.

SWITCHGEAR

There are additional relays and breaker controls that are necessary to insure safe, trouble free operation of paralleled units. Reverse power relays monitor the direction of power flow to insure that the generator is delivering power, not accepting it. These power relays control breakers, which are a means of connecting and disconnecting the generator from the load. The total system can include over-voltage, over-current protection, under frequency protection, power factor correction provision and a variety of associated control equipment from manual switchgear to microprocessors. The amount of control gear and level of sophistication will be determined by the needs and requirements of the particular application.

PARALLELING BASICS

The following points are basic criteria which must be met before two units can be paralleled. **THIS IS NOT MEANT TO BE SPECIFIC INSTRUCTIONS FOR PARALLELING OPERATION.**

1. Additional paralleling circuitry
   - A. Voltage regulator-paralleling provisions
   - B. Paralleling current transformer(s)
   - C. Paralleling provisions on governor controls
   - D. Switchgear

2. The voltage and frequency must be the same for all sets with voltages in phase.

3. The voltage regulation characteristics of the individual generators should be similar.

4. The generators must have the same phase rotation.

5.The driving engines should have the same speed regulation characteristics and the governors should be adjusted to give the same speed regulation.

Before operating generator sets in parallel, each set should be checked by starting, operating, and adjusting the sets as individual units before attempting paralleling.

REACTIVE LOAD CONTROL

When two identical generators are operating together in parallel and an unbalance occurs in field excitation, circulating currents begin to flow between the generators. This current will appear as a lagging power factor or inductive load to the highly excited generator, and as a leading power factor or capacitive load to the generator with the lower field current. This is known as the reactive circulating current and there are two methods of controlling it in parallel operation:

1. Reactive droop compensation. (Formerly known as parallel droop compensation.) The bus voltage droops, or decreases, as the reactive lagging power factor load is increased.

2. Reactive differential compensation. (Formerly known as cross current compensation.) The reactive differential compensation circuit allows parallel generators to share reactive loads with no decrease or droop in generator voltage.

The circuit must meet the following criteria:

A. All paralleling current transformers for all the generators being paralleled must be included in the secondary interconnection loop.

B. When different size generators are paralleled all paralleling current transformers must have the same proportional ratios that give approximately the same secondary current.

C. Voltage regulator paralleling circuitry must be the same.

D. Current transformer secondary and the generator lines must be isolated electrically.

E. It is also desirable to have an auxiliary contact on the main generator breaker to short the parallel CT secondary when that breaker is open (not connected to the load bus).

Because of the above criteria, reactive differential compensation cannot be used when paralleling with the utility power grid. There is no limit, however, in the number of generators that can be included in this type of circuit.

PARALLELING CIRCUITRY

Because of the number of variables involved in paralleling generator sets, every installation will have its own circuitry and methods or procedure of bringing paralleled units on line. There are numerous ways of connecting paralleled units and an almost unlimited variety of applications and associated equipment.

When parallel operation is desired, it is important that the control manufacturer, the generator manufacturer, and the systems engineer work together to insure the proper selection of all components. Please refer to Katolight for application assistance.

THYRISTOR OR SCR LOADING

Solid state electronic control devices which utilize thyristors or SCR firing circuits (such as variable frequency induction motor controls, precision motor speed controls, no-break powered battery chargers, etc.) can introduce high frequency harmonics which adversely affect or destroy the normal waveform of the generator. This creates additional heat in the generator stator and rotor, and can cause overheating. These devices can and do present problems to non-utility power generating equipment or any limited power bus system. The problems that can occur are not limited to the generator itself, but can effect the solid state control device, the equipment it controls, other associated loads, monitoring devices or a number of combinations over the entire system.

MagnaMAX^{DVR} generators can supply power to thyristor or SCR loads when properly applied. The standard voltage regulator is PMG powered and senses 3 phase RMS voltages for maximum stability against severely distorted waveforms. SCR type applications such as cranes, shovels, etc., require special consideration of the generator insulation system due to greater dielectric stress and severe environmental conditions. It is important that the control manufacturer, the generator manufacturer, and the systems engineer work together to insure the proper selection of all components. Please refer to Katolight for application assistance.

OPERATION

PRE-START INSPECTION

Before operating the generator for the first time, the following checks are recommended.

1. A visual inspection should be made to check for any loose parts, connections, or foreign materials

2. Check for clearance in the generator and exciter air gap. Be sure the generator set turns over freely. Bar the generator over by hand at least 2 revolutions to be sure there is no interference.

WARNING
DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFITNG OR FOR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE

3. Check all wiring against the proper connection diagrams and make sure all connections are properly insulated. Support and tie leads to keep them from being damaged by rotating parts or by chafing on sharp corners.

4. Be sure the equipment is properly grounded.

5. Inspect for any remaining packing materials and remove any loose debris, building materials, rags, etc. that could be drawn into the generator.

6. Check fasteners for tightness.

7. Check to be sure no tools or other hardware have been left inside or near the machine.

8. Install and check to be sure all covers and guards are in place and secure.

WARNING
RESIDUAL VOLTAGE IS PRESENT AT THE GENERATOR LEADS AND AT THE REULATOR PANEL CONNECTIONS EVEN WITH THE REGULATOR FUSE REMOVED. CAUTION MUST BE OBSERVED OR SERIOUS PERSONAL INJURY OR DEATH CAN RESULT.

STARTING-UP THE GENERATOR

The following procedure should be followed for starting-up the generator for the first time:

1.The generator output must be disconnected from the load. Be certain that the main circuit breaker is open.

2.Disable the voltage regulator by removing the fuse.

WARNING
DO NOT OVERSPEED THE GENERATOR. EXCESSIVE CENTRIFUGAL FORCES COULD DAMAGE THE ROTATING FIELDS. BE PREPARED FOR AN EMERGENCY SHUTDOWN.

3.Follow the manufacturer's instructions and start the prime mover. Check the speed and adjust to the RPM shown on the generator nameplate.

4. Replace the regulator fuse and adjust the voltage to the required. Check all line to line and line to neutral voltages to be sure they are correct and balanced. If the voltages are not correct shut down immediately and recheck all connections.

5. Close the main circuit breaker and apply the load.

6. Monitor the generator output current to verify it is at or below nameplate amps.

7. Adjust engine speed at full load to 1800 rpm for 60 hertz, 1500 rpm for 50 hertz. (Refer to prime mover/governor instruction manuals.)

8. Before stopping the engine, remove the load by tripping the main circuit breaker.

FIELD FLASHING

The standard MagnaMAX^{DVR} generator is supplied with a PMG (permanent magnet generator). **It will never require field flashing.** In rare cases where a special generator may be furnished without a PMG, refer to the factory for more detailed information. Include the complete generator model and serial number.

VOLTAGE ADJUSTMENTS

The voltage regulator controls the generator output voltage. There is a cover to access the control panel on the side of the generator conduit box

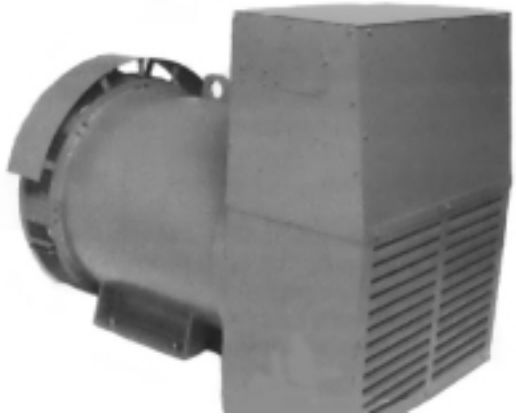


Figure 4-1

Figure 4-2 Regulator Access

Refer to the regulator manual for detailed information. In cases where special or remote mounted regulators are used, refer to instructions supplied by the generator set assembler and to the voltage regulator manual.

OTHER ADJUSTMENTS

Depending upon application, adjustments to other protective and control gear may be required. Refer to instructions provided by the by the supplier of the generator set.

The standard MagnaMAX^{DVR} voltage regulator also has many protective and control circuits.

It is imperative that the set up instructions for any regulator supplied be followed.

MAINTENANCE

GENERAL INFORMATION

Dirt, heat, moisture, and vibration are common enemies of a generator. Keeping the generator clean and dry, maintaining proper alignment of the generator and its prime mover, and preventing overloads will result in efficient operation and long life.

Generators that are outdoors should be protected from the elements by suitable houses or enclosures.

Dirt and dust will conduct electricity between points of different electrical potential. Moisture will aggravate the problem further. Insulation system failure can result if corrective action is not taken. Measuring insulation resistance can test the condition of the insulation system.
(See Generator Testing.).

Insulation resistance should be checked when putting the generator into service after it has been in storage and anytime contamination by moisture and dirt is suspected.

Normally, moisture buildup is not a problem while the generator is running, since heat produced internally will tend to keep it dry but can collect in the generator when it is shut down. The problem will be worse in humid environments or in areas where extreme temperature changes cause condensation (dew) to form inside the generator.

Space heaters, air filters, and premium insulation systems, such as our VPI process, should be considered in difficult environments.

Accumulations of dust and dirt not only contribute to insulation breakdown, but they can also increase temperature by restricting the dissipation of heat. Materials such as talc, lint, rock dust, or cement dust may obstruct the ventilation.

The most harmful types of foreign materials include carbon black, metallic dust and similar substances that not only impede ventilation, but also form a conductive film over the insulation, increasing the possibility of insulation failure.

Machines operating in dirty places should be disassembled and cleaned periodically.

AIR INTAKE AND EXHAUST

Check the area around the air intake and exhaust openings to be sure they are unobstructed.

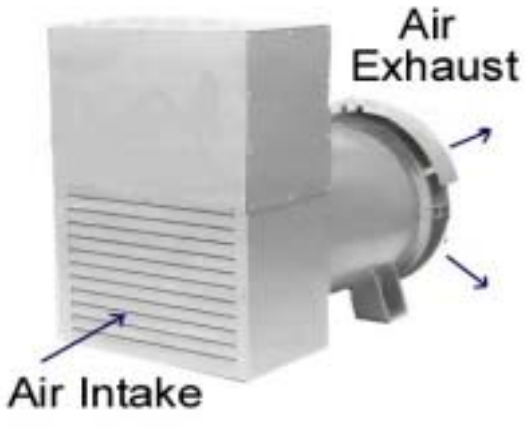


Figure 5-1

ELECTRICAL CONNECTIONS, WINDINGS

Inspect for loose or contaminated connections Check wires for cracked or frayed insulation. Tighten connections and replace defective or oil soaked insulation.

If inspection shows that varnish coatings on the windings have deteriorated, they should be coated with insulating varnish.

Please refer to Katolight for insulation system requirements.

LUBRICATION

All generators are lubricated before leaving the factory and are ready for operation. As a general rule, bearings should be re-lubricated annually or at the indicated intervals in table 5-3, whichever occur first.

Unusually severe operating conditions, such as high ambient or dusty environments, require more frequent lubrication (every six months or one half the table intervals, whichever occurs first).

Use Chevron SRI or equivalent anti-friction type high quality, grease with a lubrication temperature' range of -22° to +350° F (-30° to +175° C)

To add or renew grease, proceed as follows:

1. Stop unit.

2. Wipe the grease plugs and surrounding parts to insure they are clean.

3. Remove both the fill and drain plugs. See figure 5-2

4. Insert 1/8" N.P.T. grease fitting in fill pipe.

5. Free the drain holes of any hard grease, using a piece of wire it necessary.

6. Using a low-pressure grease gun, add grease according to the amounts in table 5-3.

7. Start unit with drain plug removed - fill pipe may be open or closed. Allow unit to run 15 minutes to allow excess grease to drain.

8. Stop unit, wipe off any drained grease, and replace filler and drain plugs.

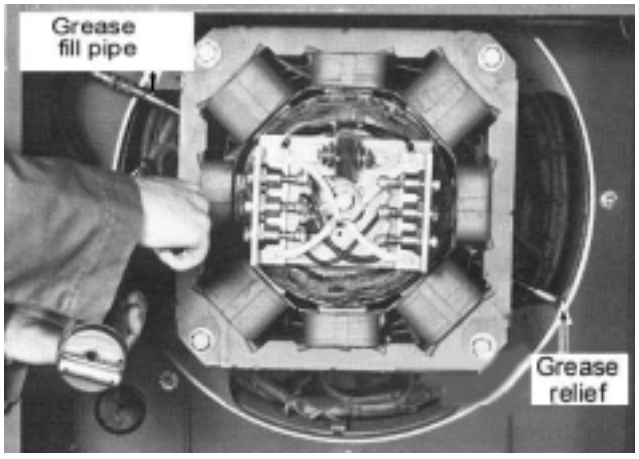


Figure 5-2

The amount of grease added is very important! Only enough grease should be added to replace the grease used by the bearing.

CAUTION: TOO MUCH GREASE CAN BE AS HARMFUL AS INSUFFICIENT GREASE. USE THE PROPER AMOUNT.

Type	Frame Size	Bearing Size	Amount of Grease			Intervals --- Max. hours or annually	
			Ounces	Cubic Inches	Teaspoons	60 Hz	50 Hz
Single Bearing Units	431,432, 433	314	1.2	2.1	7.0	6500	8400
	571,572, 573, 574	316	1.5	2.6	8.3	5600	7200
	741, 742, 743,744	322	2.4	4.2	14.0	3000	4500
Double Bearing Units	431,432	318	1.7	3.0	9.9	4600	6200
	571, 572, 573, 574	318	1.7	3.0	9.9	4600	6200
	741, 742, 743, 744	322	2.4	4.2	14.0	3000	4500

TABLE 5-3

During an overhaul, the grease reservoir should b thoroughly cleaned and new grease added. The reservoir should be 1/3 to 1/2 filled with new grease

DRYING ELECTRICAL INSULATION

Electrical components must be dried before placing in operation if tests indicate that the insulation resistance is below a safe value. (See Generator testing for test procedure.)

Machines that have been idle for sometime in unheated and damp locations, may have absorbed moisture. Sudden changes in temperature can cause condensation or the generator may have become wet by accident. Windings should be dried out thoroughly before being put into service. The following are recommended drying methods.

Space Heaters

Electric space heaters can be installed inside of the generator. When energized (from a power source other than the generator) they will heat and dry the inside of the generator. If an alternate source of electricity is not available, enclose the generator with a covering and insert heating units to raise the temperature 15-18 degrees F (8-10 degrees C) above the temperature outside of the enclosure. Leave a hole at the top of the enclosure to permit the escape of moisture.

Oven

Place the machine in an oven and bake it at a temperature not to exceed 194 F (90°C). The voltage regulator and any electronic component accessories must be removed from the generator when using this method.

Forced Air

A portable forced air heater can be used by directing heat into the air intake (conduit box) and running the generator with no load and without excitation (this can be accomplished by removing the regulator fuse). Heat at point of entry should not exceed 150° F (66° C).

"Short Circuit" Method

Using this method can dry out the generator quickly and thoroughly.

WARNING:
BE SURE THAT ALL OF THE FOLLOWING STEPS ARE PERFORMED AND ALL PRECAUTIONS TAKEN AS PERSONAL INJURY OR SERIOUS DAMAGE TO THE GENERATOR COULD RESULT.

1. Disconnect exciter leads Fl and F2 from the regulator.

2. Connect a battery or other dc power source approximately 20-35 volts to the exciter lead Fl and F2. An adjustable voltage source desirable, however, a rheostat (rated approximately 2 amps) in series with the dc power source will work.

3. Short circuit the generator output lead wires to each other (L1 to L2 to L3). If using jumpers, be sure they are large enough to carry full load amps.

4. Start the generator and measure the current through the output leads with a clip-on ammeter.

5. Adjust the voltage source to produce approximately 80% of the rated ac nameplate current but in no case exceed nameplate amps. If a adjustable source is not available and current is excessive, use a lower dc source voltage or larger resistor in series with the source.

Running time will be determined by the amount of moisture present in the machine. Insulation resistance checks should be taken every one to four hours until a fairly constant value obtained. (See section -

Generator testing for instructions on measuring insulation resistance.)

6. After the generator is dry and the insulation resistance is brought up to specification remove the short circuit from the line lead disconnect the dc source and reconnect the F and F2 leads at the regulator. Be sure all connections are tight and correct before attempting to run the generator.

CLEANING METHODS

When electrical components get dirty, the insulation must be cleaned. There are a number of acceptable methods for cleaning the generator, each of which will necessitate disassembly of the unit. The kind of dirt, and when the unit must be returned to service will determine the method of cleaning. Drying after cleaning is necessary.

Whenever the generator is disassembled, the windings should be given a thorough inspection and the insulation cleaned, if necessary. The inspection should include the connection of the windings, insulation, and varnish coverage. Check the winding ties and coil supports. Look for any signs of coil movement or looseness and repair as required.

An electric motor repair shop in your area can normally assist with the proper cleaning of the generator windings. They may also be experienced in special problems (such as seacoast, marine, oilrig, mining, etc.) that may be peculiar to a certain area.

Solvents

A solvent is usually required to remove accumulated soil containing oil or grease. Only petroleum distillates should be used for cleaning electrical components. Petroleum solvents of the safety type with a flash point greater than 100° F (38° C) are recommended. **CAUTION: A SOLVENT THAT DOES NOT ATTACK EPOXY OR POLYESTER BASED MATERIALS SHOULD BE USED.**

Apply the solvent with a soft brush or rag. Be careful not to damage the magnet wire or insulation on the windings.
Dry components thoroughly with moisture-free, low pressure compressed air.

Cloth and Compressed Air

Cleaning with a dry cloth may be satisfactory when components are small, the surfaces are accessible and only dry dirt is removed. Blowing dirt out with compressed air is usually effective particularly when the dirt has collected in places that cannot be reached with a cloth. Use clean dry air at 30 PSI (206 KPA).

Brushing and Vacuum Cleaning

Dry dust and dirt may be removed by brushing with bristle brushes followed by vacuum cleaning. Do not use wire brushes. Vacuum cleaning is an effective and desirable method of removing dry and loose dirt.

Shell Blasting

Air blasting with ground nut shells may be satisfactory for removal of hard dirt deposits from insulation. Use mild abrasives such as 12-20 mesh ground walnut shells.

Steam Cleaning

If the generator is completely disassembled, including bearings and electronic components, steam cleaning of the major parts and windings is very effective. However, the machine must be thoroughly dried in an oven to remove all moisture before the generator can be put back into service.

DISASSEMBLY

REMOVAL FROM PRIME MOVER

BE SURE ALL POWER IS OFF BEFORE SERVICING. FAILURE TO FOLLOW ALL SAFETY INSTRUCTIONS CAN RESULT IN SERIOUS INJURY OR DEATH.

NOTE: Before disconnecting any electrical wiring, be sure it is marked and can be identified for reinstallation. Re-label as required.

1. Remove conduit box covers (Figure 6-1 and 6-2)

Figure 6-1

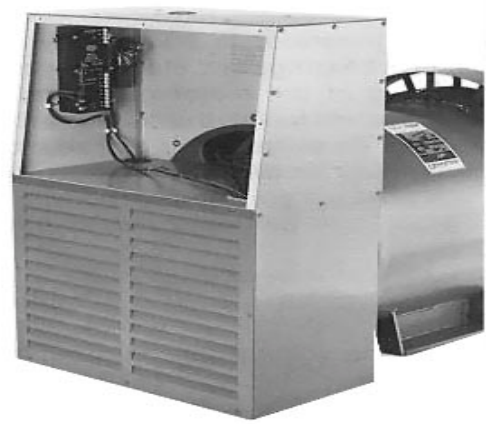


Figure 6-2

2. Disconnect all external wiring from the generator leads inside the conduit box.

3. Remove all conduits or ducting from the conduit box.

4. Attach a suitable hoist to the generator lifting

5. For single bearing generators, remove the bolts mounting the screen assembly to the SAE adapter and remove the screen. (Figure 6-3.)

Figure 6-3

(NOTE: Do not remove the drip cover from the screen assembly if so equipped)Remove the cap screws attaching the drive discs to the flywheel and remove the cap screws attaching the SAE adapter to the flywheel housing.

For two-bearing generators, disconnect the coupling or sheave and belts between the generator and prime mover. (Follow the coupling manufacturer's instructions for direct connection.)

WARNING
DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR

CONDUIT BOX REMOVAL

1. Note the location and markings (re-mark as required) and remove connections from voltage regulator (Figure 6-4), capacitor (Figure 6-5), and any other conduit box mounted controls.

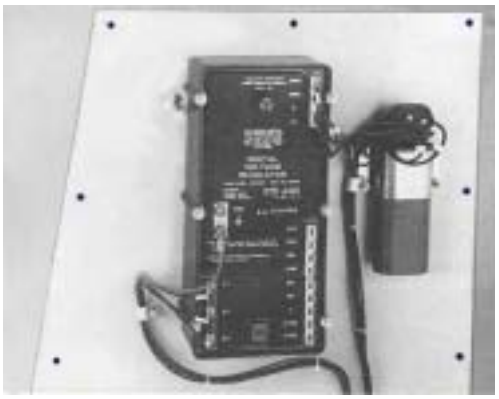


Figure 6-4

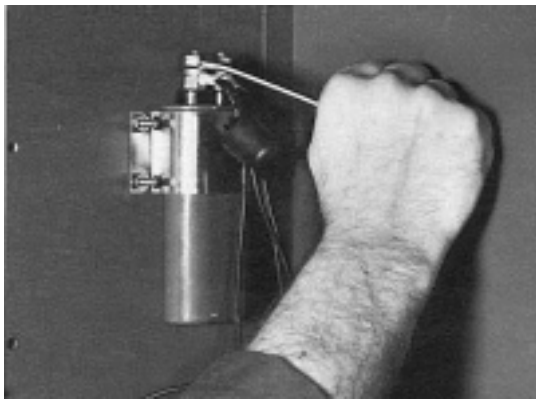


Figure 6-5

2. On generators equipped with bus bars, mark all connections and disassemble main stator (power) leads from the generator side of the bus bars.

3. Remove bolts holding conduit box in place. (Figure 6-6.)

Figure 6-6

4. Remove conduit box. (Figure 6-7).

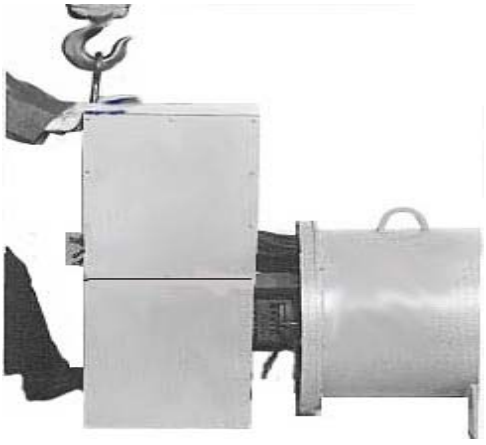


Figure 6-7

EXCITER STATOR (FIELD) REMOVAL

1. Disconnect Fl and F2 leads from the corresponding Fl and F2 terminals on the regulator.

2. Remove all cable ties so the Fl and F2 leads can be removed with the exciter stator. Remove the four cap screws and Belleville washers holding the exciter stator in place. (Figure 6-8.)

Figure 6-8

Remove the exciter stator. Using a lifting strap or fixture. (Figure 6-9.)

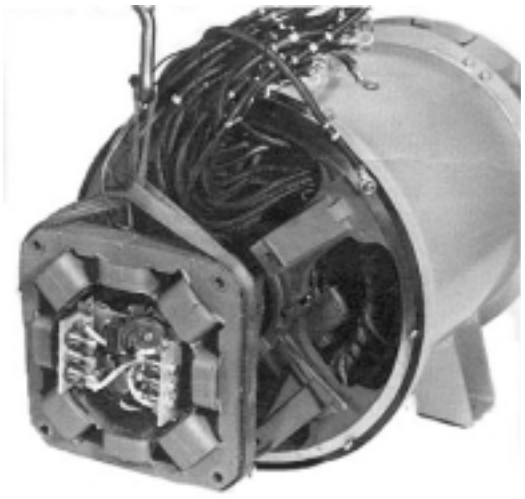


Figure 6-9

EXCITER ARMATURE (ROTOR) REMOVAL

1. Note markings and disconnect the main rotor leads coming out of the lead hole of the aluminum standoff plate from the rectifier aluminum angle. (Figure 6-10.)

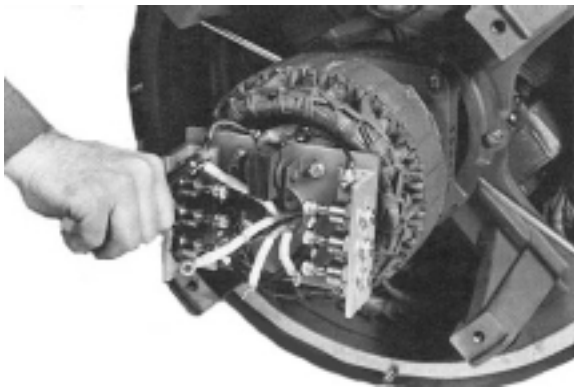


Figure 6-10

2. Remove the cap screw and Belleville washer that holds the exciter (rotor) armature to t generator shaft. (Figure 6-11.)

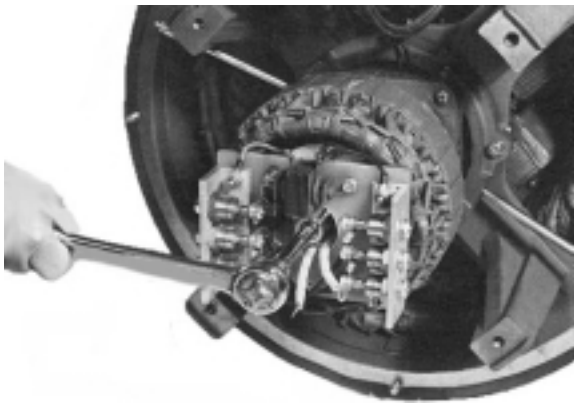


Figure 6-11

3.Use a six inch, 3/4-16NF, cap screw for a puller (See section 9.) The hole that the mounting bolt goes through is threaded. Screw the pull bolt into the hole and it will push against the end of the shaft. (Figure 6-12.)

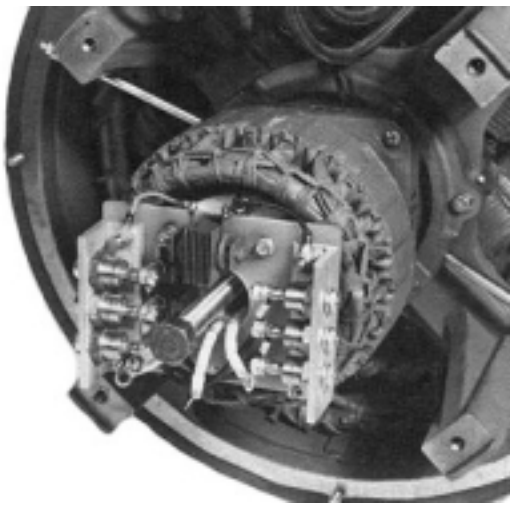


Figure 6-12

Carefully feed the main rotor leads through the hole as the exciter armature is removed. (Figure 6-13.)

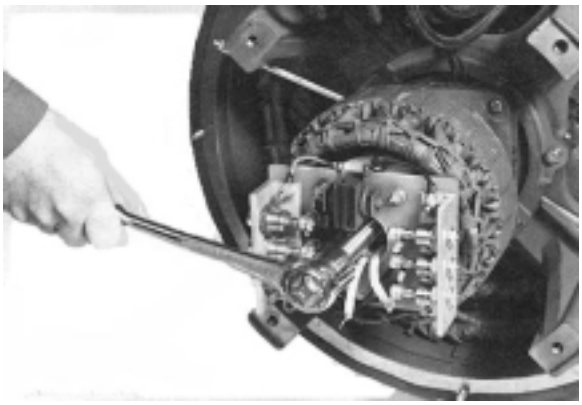


Figure 6-13

CAUTION:
DO NOT TIGHTEN THE PULLER BOLT BEYOND THE END OF THE THREADS. IF A BOLT WITH SUFFICIENT THREAD LENGTH CANNOT BE FOUND, USE A PIECE OF THREADED ROD WITH A NUT WELDED ON THE END.

PMG STATOR REMOVAL

1. Remove exciter armature. (Follow instructions found earlier in this section.)

2. Remove the PMG output leads from the capacitor (Figure 6-14) and loosen all cable ties so the leads can be removed with the PMG stator.

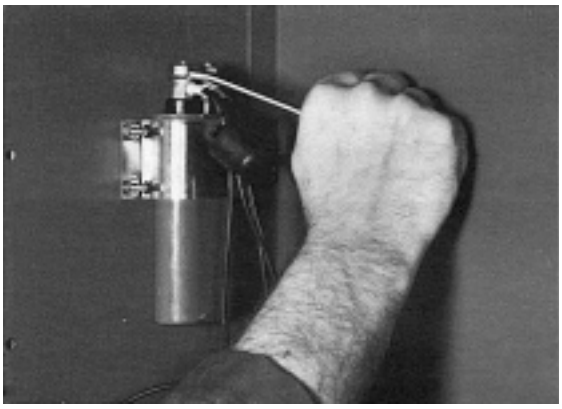


Figure 6-14

3. Note the position of the PMG stator leads that exit at the left inboard side or mark the stator so it can be reinstalled in the same position.

4. Remove the four mounting cap screws. (See Figure 6-15.)

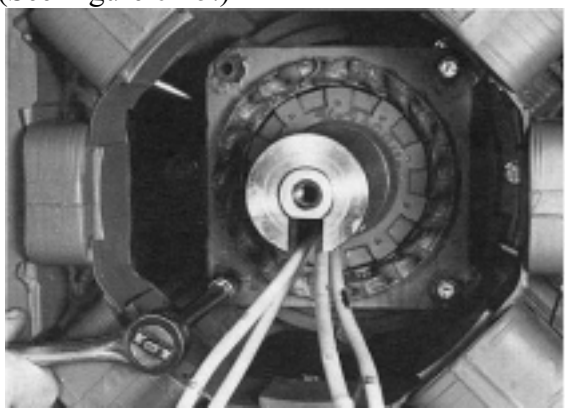


Figure 6-15

5. Carefully remove the PMG stator from its mounting pads and slide over the PMG rotor. The magnets used in the PMG are very strong and will resist removal of the PMG stator. (Figure 6-16.)

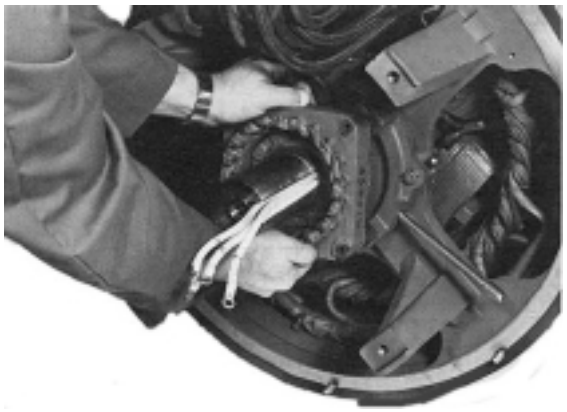


Figure 6-16

PMG ROTOR REMOVAL

1. Remove the exciter armature and PMG stator. (Follow instructions found earlier in this section.)

2. Remove the snap ring that holds the PMG rotor in place on the shaft. (Figure 6-17 and 6-18.)

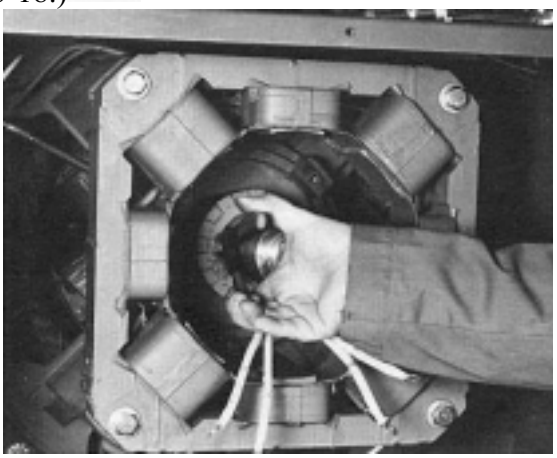


Figure 6-17

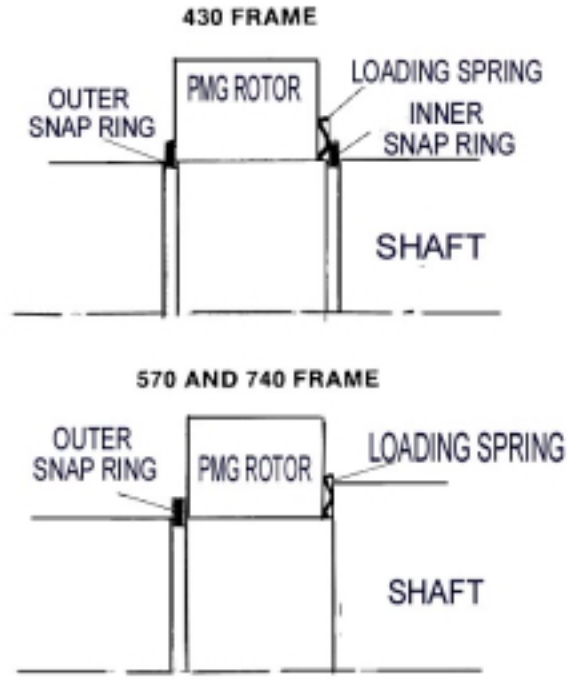


Figure 6-18

3. Slide the PMG rotor off of the shaft. (Figure 6-19.)

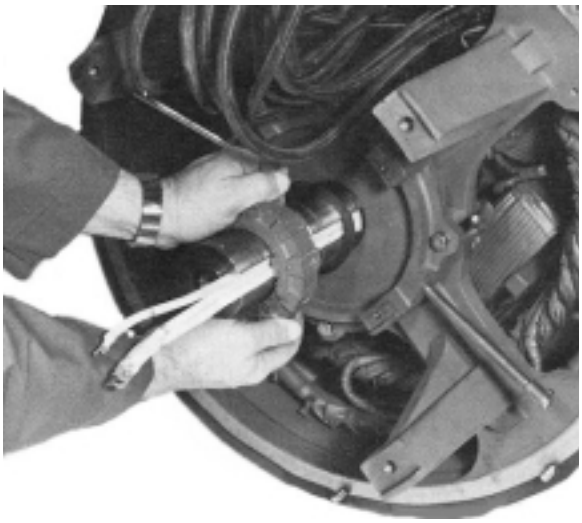


Figure 6-19

4. Remove the loading spring. (if the loading spring is not on the shaft, check to see if it is stuck on the back of the PMG rotor.).

5. On 430 frame generators a second snap ring is used inboard of the PMG rotor. (Larger generators have a step on the shaft.)

This snap ring must be removed before the generator main rotor can be removed. (Figure 6-20.)

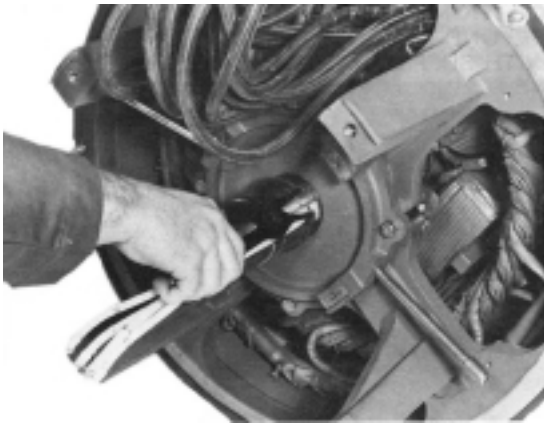


Figure 6-20

MAIN ROTOR REMOVAL

1. Remove the exciter armature and PMG.

2. For single bearing generators, remove the four cap screws holding the bearing caps to the front-end bracket. (Figure 6-21.) Remove the outer cap. (Figure 6-22.)

For two-bearing generators, remove the drive coupling or sheave and key from the shaft extension. Remove the four cap screws holding the bearing lock to the drive end bracket. (Figure 6-23.) Remove the four cap screws holding the bearing caps to the front-end bracket. (Figure 6-21.) Remove the outer cap. (Figure 6-22.)

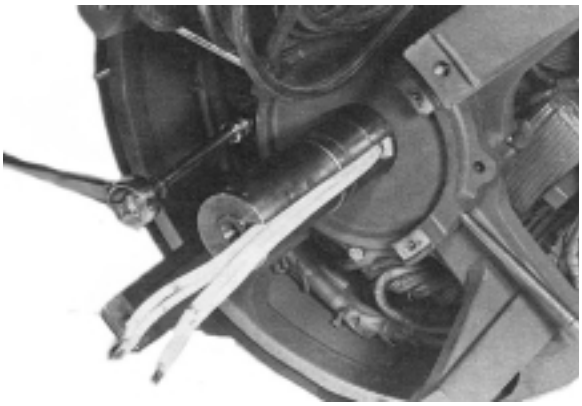


Figure 6-21

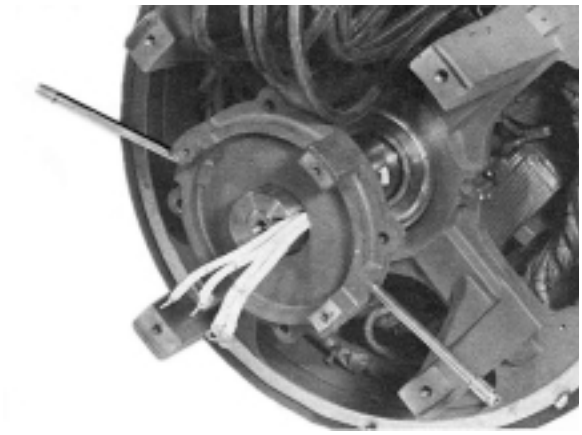


Figure 6-22

Figure 6-23

3. If the screen assembly is still mounted, remove bolts securing the screen assembly to the drive end bracket or the SAE adapter and remove the screen assembly. (Figure 6-24.) (NOTE: Do not remove the drip cover from the screen assembly if so equipped.)

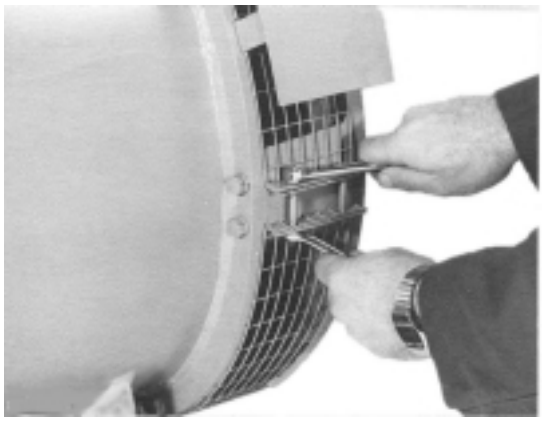


Figure 6-24

4. For single bearing generators, remove the cap screws and hardened washers holding the drive discs to the drive hub. (Figure 6-25.) Remove all drive discs (and spacers if any).

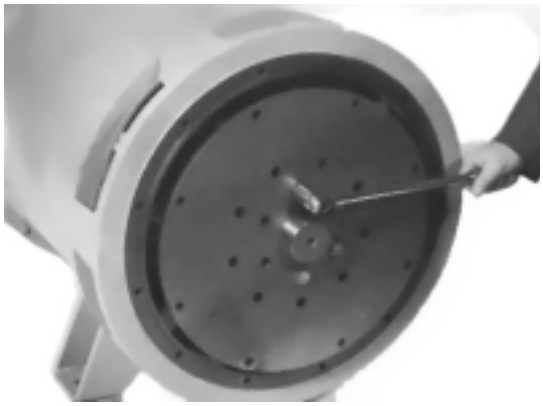


Figure 6-25

5. For single bearing generators, remove the cap screws holding the SAE adapter to the generator and remove the adapter. (Figure 6-26 and 6-27.)

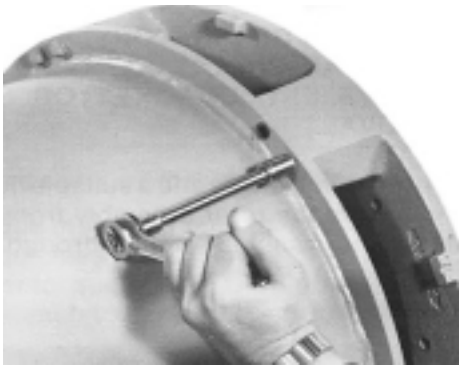


Figure 6-26

Figure 6-27

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN DRIVE END BRACKET OR SAE ADAPTOR REMOVAL

For two bearing generators remove the cap screws holding the drive end bracket to the generator and remove the bracket (Figures 6-26 and figure 6-28)

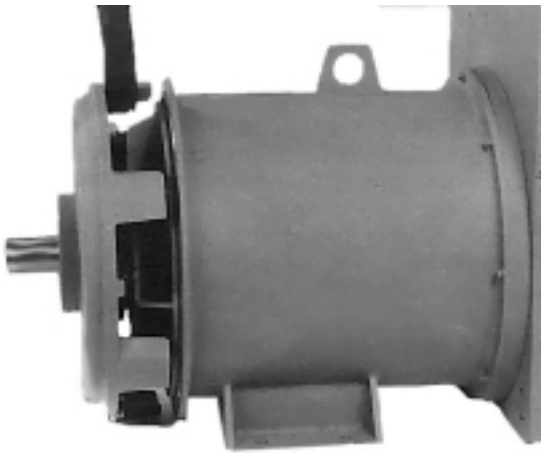


Figure 6-28

6. Using a rotor lifting fixture and a suitable hoist, carefully remove the rotor assembly from the main stator and frame assembly through the drive end. (Figure 6-29.)

CAUTION:
SPECIAL CARE SHOULD BE TAKEN WHEN REMOVING THE MAIN ROTOR, WINDING DAMAGE COULD RESULT IF THE ROTOR IS ALLOWED TO HIT THE MAIN STATOR.

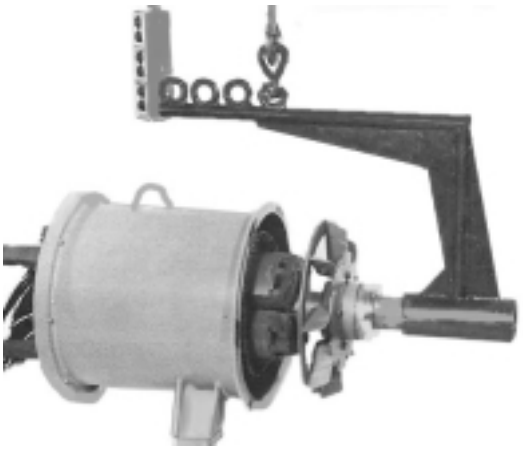


Figure 6-29

WARNING
DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

FRONT END BRACKET REMOVAL

1. Remove front bracket mounting screws. (Figure 6-30.)

2. Remove the front-end bracket from the main stator assembly. (Figure 6-31.)

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN THE FRONT END BRACKET REMOVAL

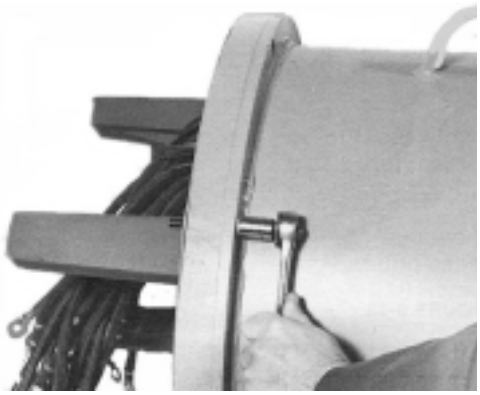


Figure 6-30

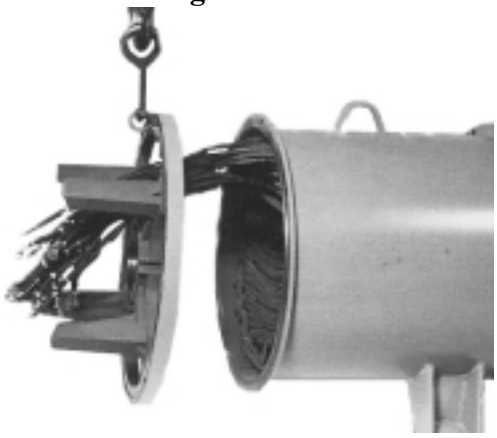


Figure 6-31

EXCITER INSPECTION

EXCITER STATOR

1. Clean dust and dirt from the exciter stator winding. (Figure 6-32.) (See section 5.)

Figure 6-32

2. Check the exciter stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance. (See section 8.)

Repair or replace as necessary. If field repair of the winding is necessary, contact Katolight for special winding procedures and materials.

3. Look for score marks in the bore of the exciter core caused by rubbing. (This could indicate bearing or assembly problems and should be investigated.)

EXCITER (ROTOR) ARMATURE

1. Clean dust and dirt from and rectifier assembly. (Figure 6-33) (See Section 5)

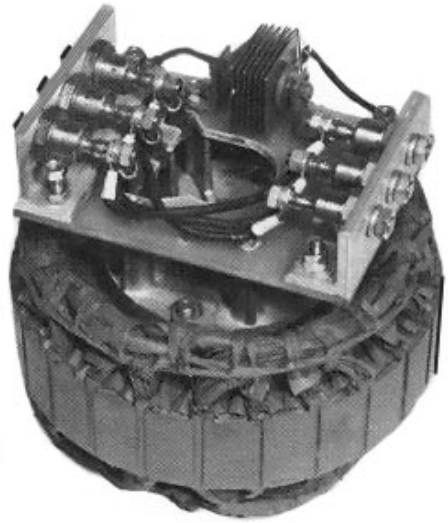


Figure 6-33

2. Check the exciter armature for burrs on the mating surfaces.

3. Check the rectifiers and surge protector for proper operation. Replace defective parts.

CAUTION: THREE FORWARD AND THREE REVERSE POLARITY DIODES ARE USED. BE SURE THE CORRECT PART IS INSTALLED IN THE CORRECT LOCATION. THE SURGE SUPRESSOR IS POLARIZED. OBSERVE POLARITY MARKINGS WHEN CHANGING THE SURGE SUPRESSOR

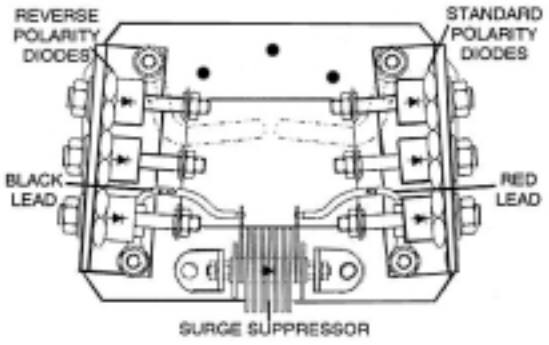


Figure 6-34

Torque mounting nuts to 80 in-lb. Torque lead terminal nuts to 25 in-lb. Never torque against the diode terminal - use a 7/16-in. wrench to support the terminal.

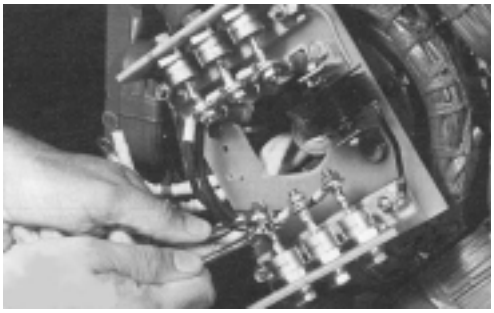


Figure 6-35

4. Check the exciter armature and rectifier assembly for loose, frayed, or burnt winding or loose connections. Measure winding resistance and insulation resistance. DO NOT megger diodes or surge suppressor. Repair or replace as necessary. If field repair of the winding is necessary, contact Katolight for special winding procedures and materials.

5. Look for score marks on the outside diameter of the armature core caused by rubbing. (This could indicate bearing or assembly problems and should be investigated.)

PMG INSPECTION

PMG STATOR

1. Clean dust and dirt from the PMG stator winding.

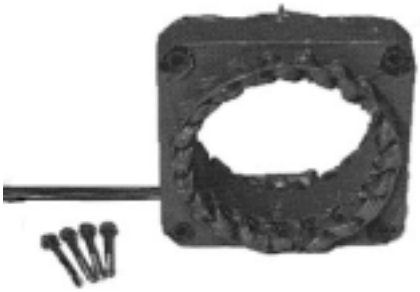


Figure 6-36

2. Check PMG stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance. (See section 8.) Repair or replace as necessary. Contact Katolight for special winding procedures and materials.

3. Look for score marks in the bore caused by rubbing.

PMG ROTOR

WARNING
THE PMG ROTOR USES VERY STRONG MAGNETS. KEEP AWAY FROM IRON AND STEEL PARTS THAT COULD BE DRAWN TO THE MAGNETS AS WELL AS OTHER COMPONENTS THAT CAN BE DAMAGED BY MAGNETIC FIELDS.

Figure 6-37

1. Clean dust and dirt from the PMG rotor.

2.Check to be sure all magnets are tightly bonded to the PMG rotor.

3.Check the bore and keyway of the PMG rotor for burrs or corrosion.

4.Look for score marks on the outside diameter caused by rubbing. (This could indicate bearing or assembly problems and should be investigated.)

5. Inspect snap rings and loading spring, replace as required.

MAIN ROTOR INSPECTION

BEARING

1. Check the bearing for damage or wear. Clean old grease from the bearing cap, and fill bearing cap grease cavity 1/3 to 1/2 full of r Chevron SRI (or equivalent).

CAUTION: If the bearing needs to be removed any reason, always install a new bearing.

2. If the bearing is to be replaced, remove with suitable puller. (Figure 6-38.)

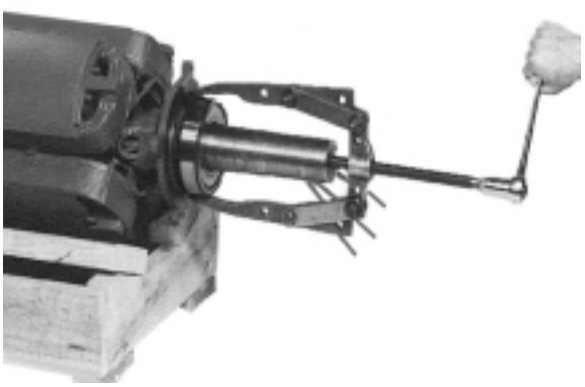


Figure 6-38

3.Be sure the inner bearing cap is on the shaft before installing the new bearing.

4. Heat the new bearing in an oven to a maximum temperature of 212°F (100°C). Apply a thin coat of clean lubricating oil to the press-fit area of rotor shaft. Install the bearing over the end of the shaft until it seats against the shaft shoulder as shown in Figure 6-39. The bearing should slide on the shaft and seated without excessive force. If the bearing binds on the shaft before being fully seated a piece of tubing, slightly larger than the press area, can be used to drive the bearing into place. Using light taps with a soft mallet, apply pressure to the inner race only.

CAUTION:
UNDER NO CIRCUMSTANCES SHOULD PRESSURE BE APPLI ED TO THE OUTER RACE OF THE BEARING, AS PERMANENT BEARING DAMAGE COULD RESULT.

Figure 6-39

Allow the bearing to cool for one hour before attempting to assemble the generator.

FAN

1. Check the fan for cracks or broken blades. Replace the fan if defective.

2. Mark the hub and fan for alignment, this is necessary to be sure the balance weights will be in the same position when the fan is reinstalled.

3. For single bearing generators. Remove the fan mounting cap screws (Figure 6-40) and slide the fan off the shaft. (Figure 6-41.) For two-bearing generators, remove the drive end bearing and bearing cap. (See bearing removal instructions.) Remove the fan mounting cap screws and slide fan off the shaft. (Figure 6-40 and 6-41.)

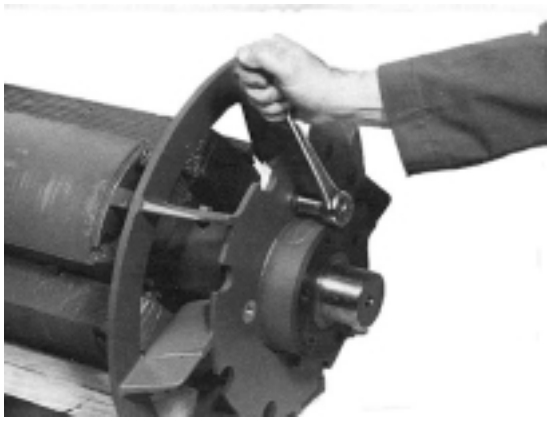


Figure 6-40

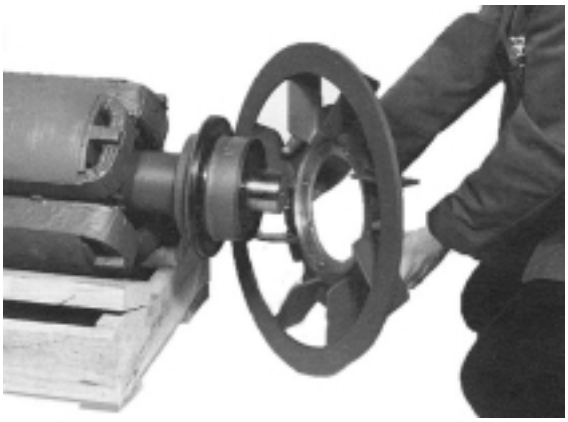


Figure 6-41

4. To reinstall, slide the fan on the shaft making sure the fan-mounting surface is toward the drive hub. Align reference marks (this is important for assembly balance) and mount the fan to the drive hub with the cap screws and Belleville washers. (Figure 6-42.) Torque the cap screws to 60 ft-lb. (81 N-m).

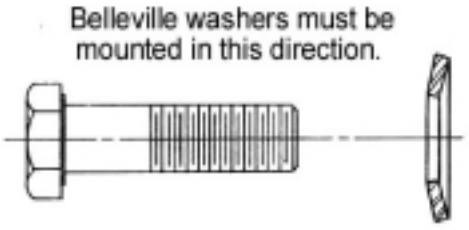


Figure 6-42

5. NOTE: Balance weights on the fan are for balance of the complete rotor assembly. The rotor assembly should be rebalance if a new fan has been installed.

6. On two-bearing generators, install bearing cap and new bearing according to the bearing assembly instructions. (Item A.)

Drive Hub (Single Bearing Generators)

1. Check the drive hub for cracks or stripped drive disc mounting holes. Replace the hub if defective.

2. If the hub is to be replaced, remove the fan (See Item B) and install a suitable puller to the hub. Remove the two set screws in the hub over the key. Using a torch, rapidly heat the hub at the outer diameter while tightening the puller. (This must be done rapidly before the heat can expand the shaft.) Remove the hub. (Figure 6-43)

Figure 6-43

3. To insure proper fan location, mark the new hub in the same place as the old hub relative to the keyway. Install key in shaft. Heat the new hub in an oven to 500°-600°F (260°-316°C). Use suitable heat resistant gloves, slide the hub over the key in the shaft until it seats against the shaft shoulder. (Figure 6-44.)

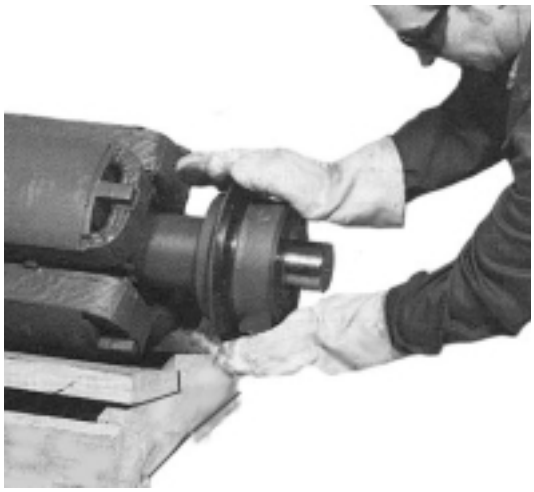


Figure 6-44

4. Allow the hub to cool for one hour. After the hub has cooled, tighten the set screws in the hub to 50 ft-lbs. (68 N.M.) torque. Match the alignment marks on the fan and hub and mount the fan. (See item B.)

5. Rebalancing the rotor assembly is not necessary if only the hub is replaced and the fan is mounted in the same location relative to the hub and shaft.

MAIN ROTOR CORE AND WINDINGS

1. Clean all parts. Remove dust and dirt from the rotor winding air passages with low-pressure, moisture-free air.

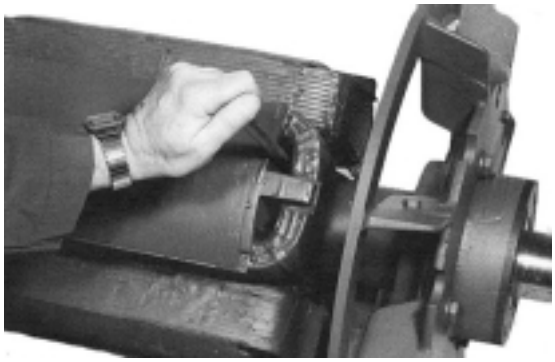


Figure 6-45

2. Check the rotor for loose, frayed, or burned windings. Measure winding resistance an insulation resistance. Test for shorted turns using an A-C impedance test A defective rotor winding must be rewound The rotor assembly must be rebalanced after any rework or repair has been completed.

DRIVE DISCS (SINGLE BEARING GENERATORS ONLY)

1. Inspect the drive discs for distorted or bent edges. (Figure 6-46) Inspect for worn mounting holes. Replace all defective discs as necessary.

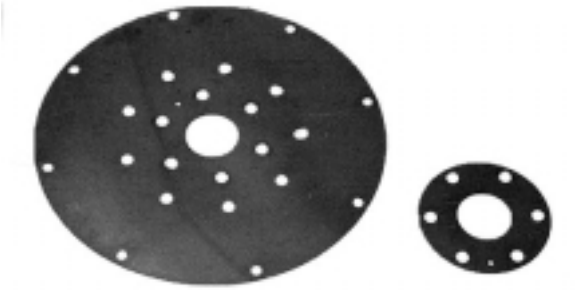


Figure 6-46

2. Inspect the drive disc mounting cap screws for damaged threads. Replace cap screws if damaged.

FRONT (EXCITER) END BRACKET INSPECTION

1. Remove the filler and drain grease pipes and the grease plugs from outer bearing cap. (Figure 6-47.)

Figure 6-47

2. Clean the end bracket, outer bearing cap, grease pipes, and cap screws to remove all dust, dirt, and grease.

3. Inspect the cap screws for stripped threads and replace if defective.

4. Inspect the end bracket for stripped threads, cracks, and burred or rough mating surfaces. Inspect the bearing bore for burrs or wear. If the bracket shows excessive bearing bore wear, it should be repaired or replaced. (Figure 6-48.)

Figure 6-48

5. Inspect the mounting pads for the PMG stator and exciter stator. Be sure they are smooth, clean, and free of any burrs or rust. That could interfere with proper alignment. (Figure 6-47 and 6-48.)

6. Re-assemble the grease pipes and fittings to the bearing cap.

DRIVE END BRACKET OR SAE ADAPTER INSPECTION

1. For two-bearing generators, remove the grease plugs from the bracket.

2. Clean the bracket or adapter, cap screws and screen assembly to remove all dust, dirt, and grease.

3. Inspect the cap screws for stripped threads and replace if defective.

4. Inspect the bracket or adapter for stripped threads, cracks, and burred or rough mating surfaces. (Figure 6-49 and 6-50.)

Figure 6-49

Figure 6-50

5. For two-bearing generators, inspect the bearing bore for burrs or wear. If the drive end bracket shows excessive bearing bore wear, it should be repaired or replaced.

MAIN STATOR INSPECTION

1. Clean dust and dirt from the stator frame and winding. (Figure 6-51.) (See section 5.)

Figure 6-51

2. Inspect the frame for stripped threads, cracks, burred mating surfaces, or other damage.

3. Inspect the stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance. (See section 8.) Repair or replace as necessary.

FRONT END BRACKET INSTALLATION

1.Install two guide pins (threaded rod can be used) into the generator side of the end bracket mounting holes. Align the guide pins with the holes in the generator frame and slide the bracket onto the frame. (Figure 6-52.) Install bracket mounting cap screws. (Figure 6-53.)

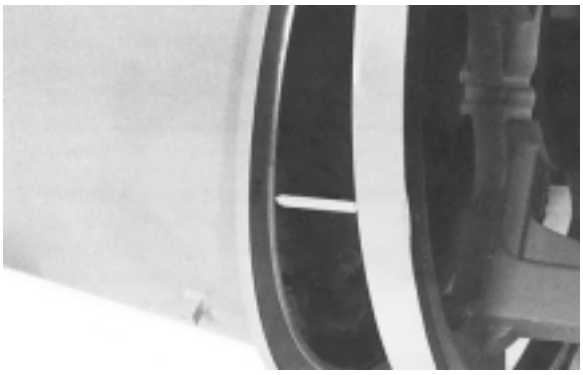


Figure 6-52

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN THE FRONT END BRACKET INSTALLATION.

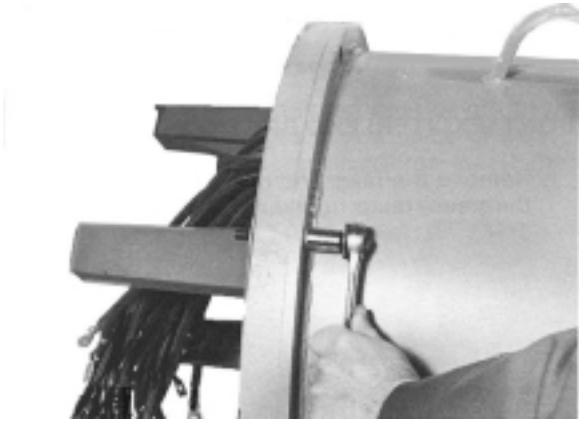


Figure 6-53

2. Remove the two guide pins and insert the remaining cap screws and torque to specifications given in section 12.

MAIN ROTOR INSTALLATION

1. Grease bearing cavity and bearing with Chevron SRI (or equivalent) grease.

2. Using a rotor lifting fixture and a suitable hoist, carefully install the rotor assembly into the main stator assembly through the drive end. (Figure 6-54.) Carefully feed the rotor leads through the front-end bracket shaft hole as the rotor is installed.

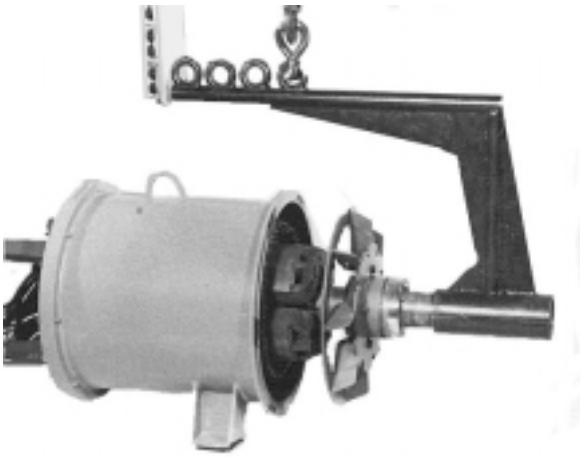


Figure 6-54

CAUTION:
SPECIAL CARE SHOULD BE TAKEN WHEN INSTALLINGTHE ROTOR ASSEMBLY. WINDING DAMAGE COULD RESULT IF THE ROTOR IS ALLOWED TO HIT THE MAIN STATOR.

WARNING
DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

3. For single bearing generators, slide the SAE adapter over the fan and secure to the main stator and frame assembly with cap screws torqued per section 12. (Figure 6-55 and 6-56.) It may be necessary to raise the rotor assembly slightly to allow the mounting of the SAE adapter.

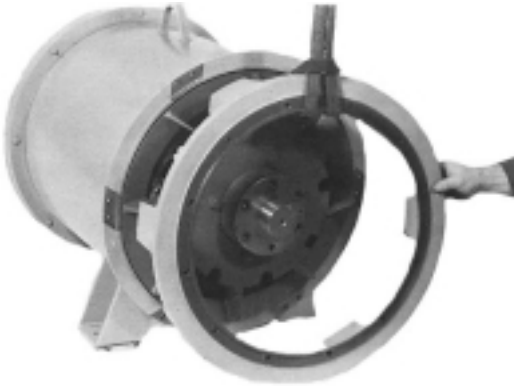


Figure 6-55

Figure 6-56

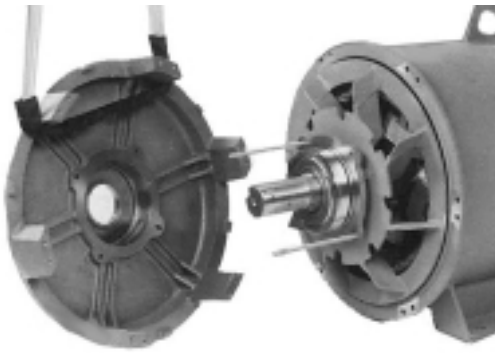


Figure 6-57

For two-bearing generators, insert two guide pins in the rear bearing lock holes. (Figure 6-57.) Fill the grease cavity of the drive end bracket 1/3 to 1/2 full of Chevron SRI (or equivalent) grease. Assemble all grease plugs in the bracket. Mount the bracket on the bearing and guide the bearing lock pins through the bracket holes. (Figure 6-58.)

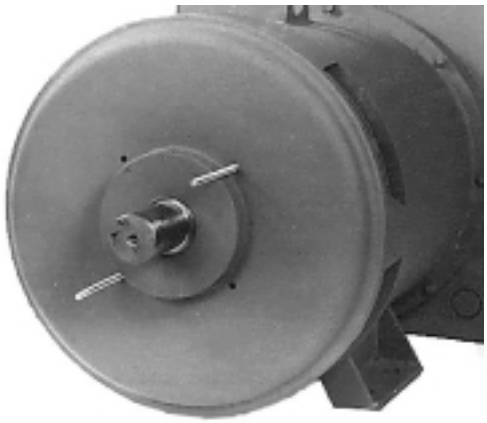


Figure 6-58

Align the drive end bracket and mount with the cap screws. (Figure 6-59.) Insert two cap screws with lock washers into the bearing lock and tighten. Remove the guide pins and replace with the remaining two cap screws with lock washers. Torque bearing cap screws to 25 lb.-ft (34 NM). Torque bracket mounting cap screws per specifications given in section 12.

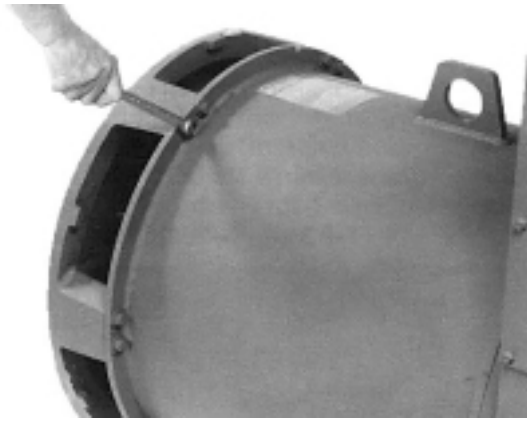


Figure 6-59

CAUTION:
ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TOASSIST IN THE DRIVE END BRACKET OR THE SAE ADAPTER ASSEMBLY.

4. For single bearing generators, insert a guide stud into the drive hub. Position all spacers (if any), then all drive discs, one at a time until all discs are installed. (Figure 6-61.)

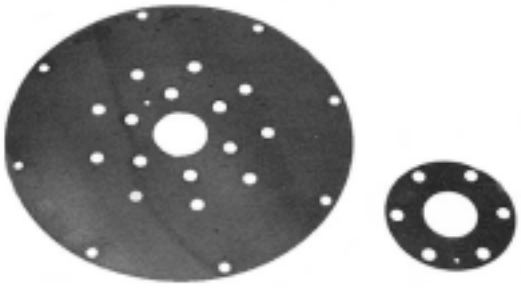


Figure 6-61

Make sure that all disc mounting holes at the inner and outer diameter are properly aligned. Secure the discs with the grade eight 5/8-18 cap screws and hardened washers. Torque to 192 ft-lb. (260 N-m). Torque the bolts in sequence according to Figure 6-62.

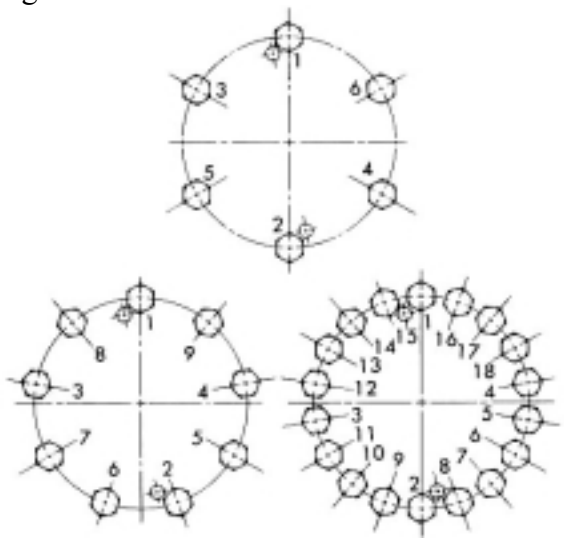


Figure 6-62

5. Install the outer bearing cap on the exciter end. (Figure 6-63.) Align holes in inner and outer bearing cap and install cap screws. Torque to 25 lb.-ft (34 N-M) (Figure 6-64.)

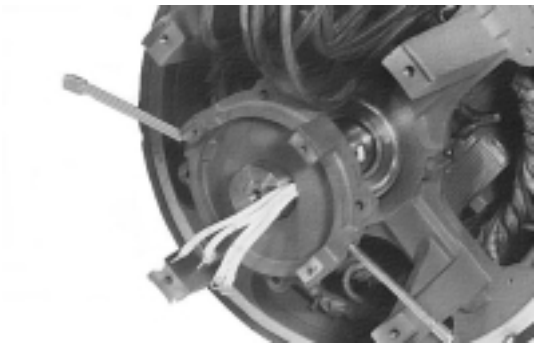


Figure 6-63

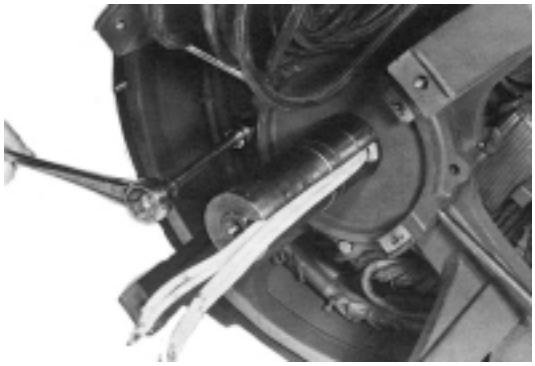


Figure 6-64

PMG INSTALLATION

1. Install inboard snap ring, where supplied, and loading spring on shaft. (Figure 6-65.)

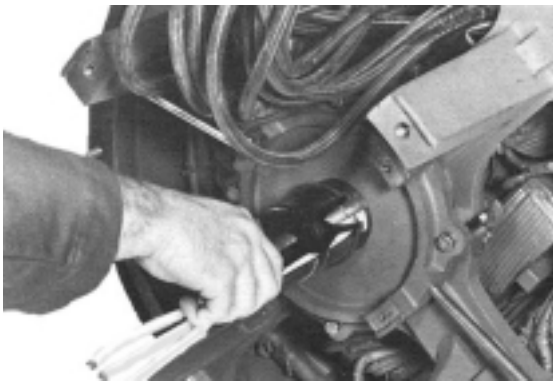


Figure 6-65

2. Slide PMG rotor onto shaft. (Figure 6-66.)

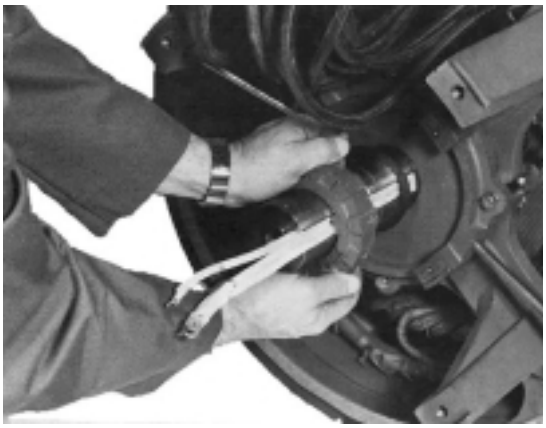


Figure 6-66

3. Install snap ring. (Figure 6-67.) Use a piece of pipe slightly larger than the shaft (2-3/4 inches) to push the rotor back against the loading spring until the snap ring seats in the slot. (Figure 6-68.)

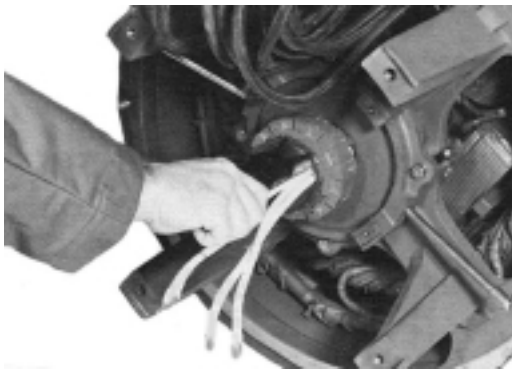


Figure 6-67

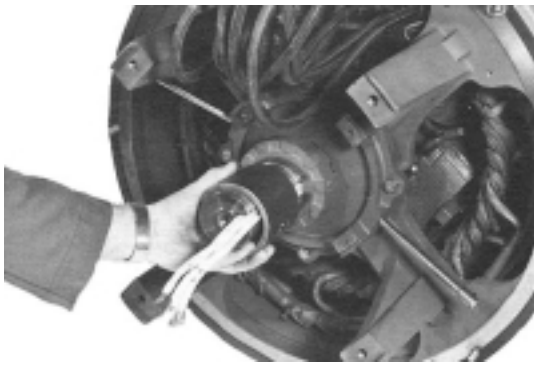


Figure 6-68

4. Install the PMG stator on its mounting pads, with the leads in the left (9:00 o'clock) inboard position, and secure with the four

mounting cap screws and Belleville washers. (Figure 6-69 and 6-72.)
Torque to 4 ft-lb. (5 N-M).

Figure 6-69

5. Route and secure PMG moving parts.

EXCITER INSTALLATION

1. Attach a wire to the main rotor leads and feed the wire through the armature bore and the lead hole in the aluminum standoff plate. On larger exciters, it will be helpful to install a guide pin in the end of the shaft to support the armature while fishing the rotor leads through. (Figure 6-70.)

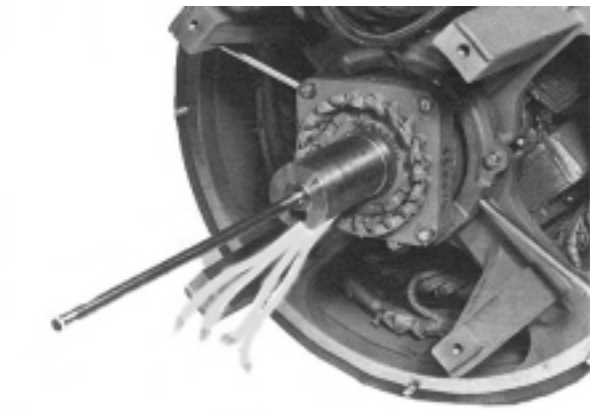


Figure 6-70

Align the key in the armature bore to the keyway in the shaft. Slide the armature on the shaft while feeding the main rotor leads through the lead hole in the aluminum standoff plate. (Figure 6-71.)

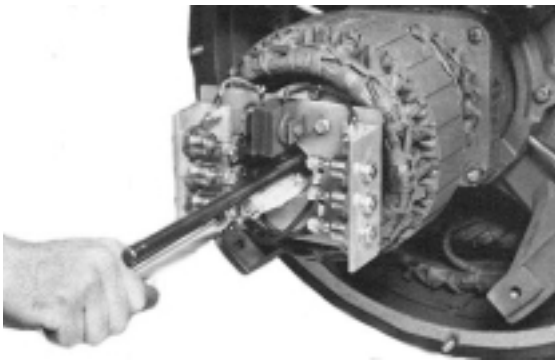


Figure 6-71

Insert the cap screw and Belleville washer (Figure 6-72.) through the mounting hole in the aluminum standoff plate and secure to the shaft (Figure 6-73). Tighten the cap screw until the armature seats on the shaft. Torque to 84 lb.-ft (114 N-M).

Figure 6-72

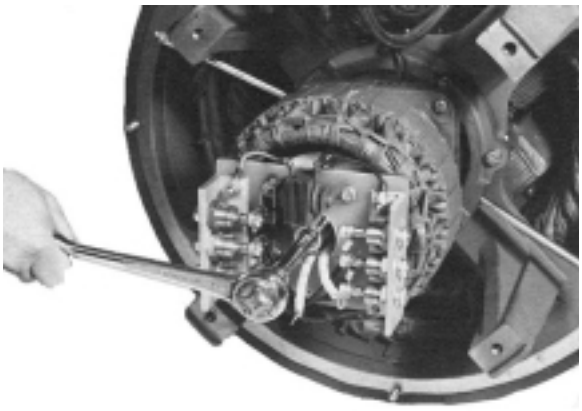


Figure 6-73

2. Observe the polarity markings and connect the main rotor leads to the rectifier

assembly. (Figure 6-74.) Torque the nuts to 4 ft-lb. (5.4 N-M).

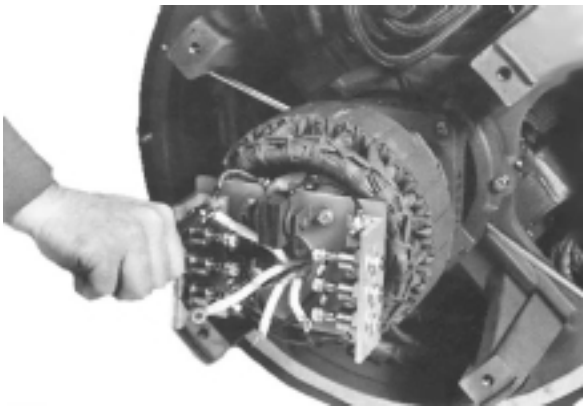


Figure 6-74

3. Position the exciter field leads at the left (9:o'clock) inboard position. Using a suitable lifting device, mount the exciter stator on the front e bracket mounting pads and align the mounting holes. (Figure 6-75.) Mount the cap screws with Belleville washers. (Figure 6-72.) Torque t cap screws to 60 ft-lb. (81 N-M). Route and secure the exciter stator leads away from any moving parts.

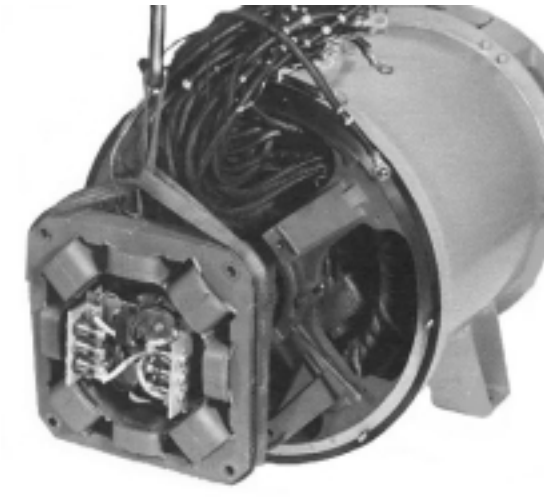


Figure 6-75

CONDUIT BOX INSTALLATION

1. Install the conduit box over the main stator leads (be sure the leads are in the upper compartment and secure with bolts and lock washers. (Fig 6-76 and 6-77.)

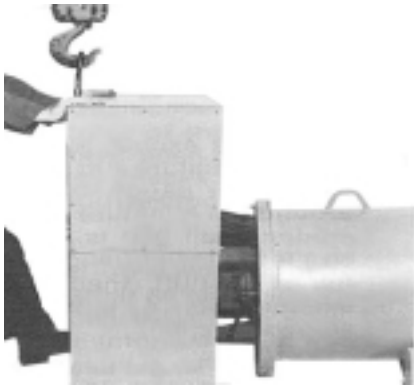


Figure 6-76

Figure 6-77

2. On generators with bus bar assemblies, reassemble main stator leads and insulating blocks to bus bars. (Figure 6-78.)

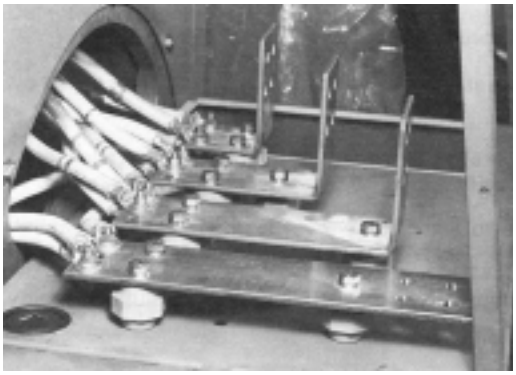


Figure 6-78

3. Reconnect exciter leads, PMG leads and other accessories according to the connection prints and markings installed before disassembly.

ASSEMBLY TO PRIME MOVER

1. Attach a suitable hoist to the generator lifting lugs, and move the generator until the generator foot mounting holes are aligned with the base and slightly above.

2. For single bearing generators, if the screen assembly is mounted on the adapter, remove the mounting bolts and remove the screen. (Figure 6-79.)

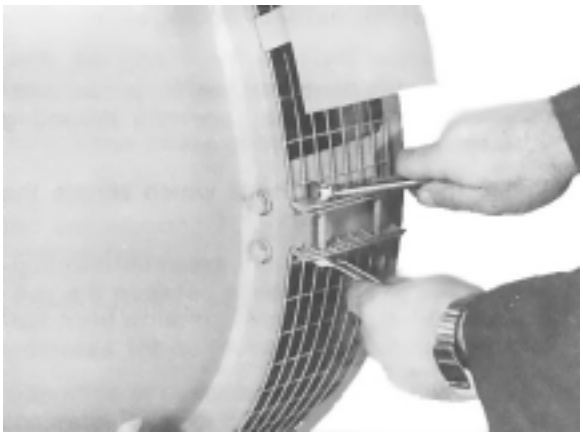


Figure 6-79

(NOTE: Do not remove the drip cover from the screen assembly if so equipped.) Insert two guide pins in the flywheel and two in the flywheel housing. Adjust the generator position until the drive discs are piloted in the flywheel. Remove the guide pins and secure the discs with Grade 8 place bolts and hardened washers or Grade 8 cap screws and heavy series lockwashers.

Torque per specifications given in section 12.

Position the generator so that the SAE adapter mates with the flywheel housing.

WARNING
DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJUY OR EQUIPMENT DAMAGE.

CAUTION:
DO NOT FORCE THE ALIGNMENT OFTHE UNITS. SHIFT THE GENERATOR FROM SIDE TO SIDE OR RAISE OR LOWER WITH A LIFTING DEVICE AS NECESSARY.

It may be necessary to use shims under the mounting feet of either the generator or the prime mover to obtain proper alignment. Use the same shims as removed under disassembly or proceed as follows: Using the extreme bottom four cap screws, mount the SAE adapter to the flywheel housing.

With a .0015 to .002 inch feeler gauge at the extreme top of the adapter to flywheel housing fit, raise the generator or lower the prime mover until the gauge is snug. Relieve just enough to release the feeler gauge and torque the remaining SAE adapter cap screws to the flywheel housing.

Mount the screen assembly and tighten the mounting bolts.

For two-bearing generators, align the coupling halves or sheaves between the generator and the prime mover by adding shims under the feet.

3. Shim under the generator feet for proper support, ensuring that the generator mounting surfaces are level.

4. Install the mounting bolts that secure the generator to the base.

5. For two bearing generators, assemble the coupling halves or sheave belts between the generator and the prime mover. (Follow the coupling manufacturer's instructions for assembly and alignment.)

6. Connect all conduits and ducting to the conduit box.

7. Connect all external wiring to the generator inside the conduit box.

8. Check the exciter air gap (the gap between exciter armature and stator) by inserting a .010 inch feeler gauge in the gap and rotating around the armature diameter to ensure the minimum air gap is available. (See Figure 80.) If the feeler gauge cannot be rotated full revolution, then check for a "cocked" exciter stator or loose stator mounting screws.

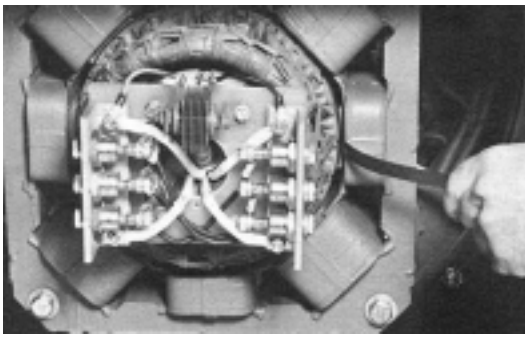


Figure 6-80

NOTE: On single bearing units, the exciter air gap cannot be checked properly until the generator is mounted to the prime mover.

9. Install the conduit box covers.

TROUBLESHOOTING

INTRODUCTION

This section is intended to suggest a systematic approach to locating and correcting generator or regulator malfunctions. The sections are arranged according to the symptoms of the problem. The steps in each section have been arranged in an attempt to do the easy checks first then to prevent further damage when troubleshooting a disabled machine.

The first and perhaps most important step of troubleshooting should be to gather as much information as possible from personnel who may have been present during the failure. Information on how long the generator had been running, what loads were on the line, weather conditions, what protective equipment operated, etc., can help isolate the problem.

Always make a thorough visual inspection to check for any obvious problems before attempting to run the generator.

WARNING
HIGH VOLTAGES CAN BE PRESENT AT THE GENERATOR AND REGULATOR TERMINALS. HIGH RESIDUAL VOLTAGES CAN BE PRESENT EVEN WITH THE REGULATORDISCONNECTED OR ITS FUSES REMOVED. SOME EQUIPMENT (SUCH AS SPACEHEATERS) MAY BE ENERGIZED WHEN THE GENERATOR IS OFF. TOOLS, EQUIPMENT, CLOTHING, AND YOUR BODY MUST BE KEPT CLEAR OF ROTATING PARTS AND ELECTRICAL CONNECTIONS.

SPECIAL CAUTION MUST BE TAKEN DURING TROUBLESHOOTING SINCE PROTECTIVE COVERS AND SAFETY DEVICES MAY BE DISABLED TO GAIN ACCESS AND MAKE TESTS.

BE CAREFUL. SERIOUS PERSONAL INJURY OR DEATH CAN RESULT FROM THESE HAZARDS. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

SYMPTOM:		
NO VOLTAGE OR RESIDUAL VOLTAGE	Regulator Fuse Blown Check fuse with ohmmeter.	Replace bad fuse.
	Voltmeter Off	Check to be sure meter phase selector switch is not in the off position.
	Defective Voltmeter	Verify proper operation of panel meter with another meter that is known to be accurate.
	Incorrect Connections	Verify generator connections.
	Defective Connections/Wiring	Inspect all wiring for grounds, open circuits & short circuits.
	No Regulator Input	Measure voltage at regulator input (PMG output)
	Defective Diodes, Surge Suppressor	Test generator with constant excitation (12 volt battery test) refer or Generator Windings
	Voltage Regulator Protective Shutdown Circuits are Operating	Correct problem and adjust regulator. Refer to regulator manual.
	Voltage Regulator Inoperative	Adjust or replace regulator. Refer to regulator manual.

LOW VOLTAGE - NO LOAD	Under speed Operation	Check speed using tachometers and/or frequency meters.
	Defective Voltmeter	Verify operation of panel meter with another meter that is known to be accurate.
	Residual Voltage	Disconnect Fl and F2 leads at the voltage regulator. If voltage goes down continue on to next step, if voltage does not change refer to troubleshooting for symptoms of "No Voltage - No Residual Voltage".
	Incorrect Generator Connections	Verify generator connections refer to drawings supplied V generator set and section 3.
	Defective Connections / Wiring	Inspect all wiring for grounds, open circuits, short circuits, and loose and dirty connections.
	Regulator Adjustments	Adjust regulator. Refer to regulator manual. Check exciter field volts.
	Defective Diodes, Surge Suppressor, Generator Windings	Test generator with constant excitation (12 volt battery test)
	Voltage Regulator not Operating	Adjust or replace regulator. Refer to regulator manual. Properly

LOW VOLTAGE WHEN LOAD IS APPLIED	Overload	Measure amps and verify that the load does not exceed nameplate rating of the generator
	Defective Ammeter	Verify operation of ammeter by using a separate meter known to be accurate
	Droop Circuit	If the generator set is equipped for paralleling, some voltage droop is normal as load increases. Refer to the regulator instruction manual
	Continue troubleshooting for symptoms "Generator Produces Low Voltage - No Load".	Continue troubleshooting for symptoms "Generator Produces Low Voltage - No Load".
HIGH VOLTAGE	Defective Voltmeter	Verify operation of panel meter with another meter that is known to be accurate
	Incorrect Operating Speed	Verify speed with tachometer or frequency meter.
	Incorrect Connections	Verify generator connections Refer to drawings supplied with generator set
	Defective Connections / Wiring	Inspect all wiring for grounds, open circuits, and short circuits.
	Regulator Adjustments	Adjust regulator. Refer to regulator manual
	Diode Polarity Incorrect	Check diodes, verify proper diodes are installed and polarity is correct.
	Voltage Regulator not Operating	Adjust or replace regulator. Refer to regulator instruction manual.

VOLTAGE IS FLUCTUATING	Incorrect Speed	Verify speed with tachometer or frequency meter.
	Unstable Speed	Verify governor stability.
	Voltage Regulator Stability	Adjust regulator stability. Refer to regulator manual.
	Defective / Loose Connections	Inspect all wiring for loose or dirty connections.
	Defective Diodes, Surge Suppressor or Generator Windings	Test generator with constant excitation (12-volt battery test).
	Remote Voltage Adjust	Check operation. Refer to regulator manual.
	Defective Regulator	Replace regulator. Refer to regulator manual.
OPERATES SATISFACTORILY WHEN COLD, BUT SHUTS DOWN WHEN WARM	Regulator Shutdown on Over Temperature	Correct cooling problems. Refer to regulator manual.
BUILDS VOLTAGE FROM STARTUP,THEN GOES TO LOW (RESIDUAL) VOLTAGE	Regulator Protective Circuit is Operating	Check indicators on regulator. Correct problems and adjust as required. Refer to regulator manual.
EQUIPMENT RUNS NORMALLY ON UTILITY POWER, BUT WILL NOT RUN ON GENERATOR SET	Voltage Waveform is Distorted	Analyze load. Excessive SCR (Thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Refer to Katolight.

GENERATOR TESTING

VISUAL INSPECTION

Whenever testing and troubleshooting a generator set, it is always a good practice to make a thorough visual inspection. Remove covers and look for any obvious problems. Burnt windings, broken connectors, leads, mounting brackets, etc., can usually be identified. Look for any loose or frayed insulation, loose or dirty connections, broken wires. Be sure all wiring is clear of rotating parts.

Verify that the generator is connected for the voltage required this is especially important on new installations.

Check for any foreign objects, loose nuts, bolts, and electrical connectors. Clear paper, leaves, building materials, etc., that could be sucked into the generator. (Generators are air-cooled. Air enters the lower portion of the conduit box.) Check the air gap for clearance or obstructions (main generator and exciter).

If possible, rotate the generator rotor by hand to be sure it turns freely.

If serious problems can be identified before attempting to operate the machine, additional damage can be avoided.

CONSTANT EXCITATION (12V BATTERY) TEST

THEORY: The generator output voltage is dependent on generator speed, generator design, load, and exciter input current. If the generator speed and exciter input are known, the output voltage at no load can be measured and compared to the design value. Problems can be isolated to either the generator or regulator system by using this test.

TEST PROCEDURE:

1. Shut the generator set down.

2. Connect a voltmeter to the generator output.

3. Disconnect the Fl and F2 leads at the regulator.

4. Connect a 12-volt battery capable of supplying 1 amp to the Fl and F2 leads. Fl is plus **(+),** F2 is minus (—).

CAUTION: Beware of arcing when connecting leads. Stay clear of battery vents. Escaping hydrogen gas can explode. If hazardous conditions exist - use a suitable switch to connect or disconnect the battery.

5. With no load on the generator, (main breakers open) run generator at rated speed.

6. Measure the generator output voltage.

7. Shut generator down.

8. Disconnect battery (see Caution - Step 3).

9. Compare voltage reading with value shown in section 12.

Conclusion: If voltage readings are normal, the main generator and exciter are operating properly. Troubleshooting should continue with the regulator. If readings are not normal the problem is in the generator. Continue testing diodes, surge suppressor, windings.

MEASURING VOLTAGES

When testing the generator and regulator, the most frequent (and usually easiest) measurement will be a voltage. The generator will need to be running at rated speed and may have some of the protective guards and covers removed. BE CAREFUL. Keep yourself and your test leads out of the way. It is best to shut the unit down when connecting meters. When using alligator clips or push on terminals, be sure the leads re supported so vibration does not shake them loose when running the generator set.

See figure 8-1 for measurement points and expected meter range settings.
When in doubt, start with a higher range and work down.
Consult meter instruction manual to verify its operation and limitations.

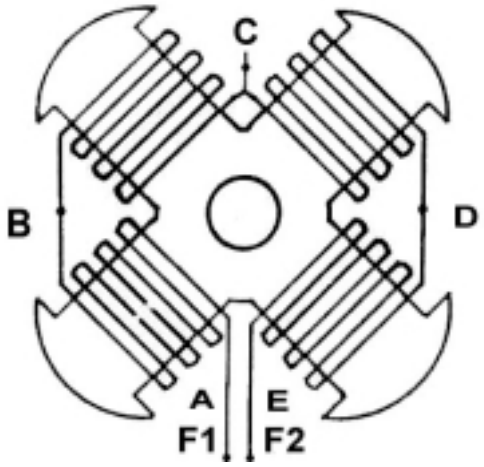


Figure 8-1

TYPICAL VOLTAGE MEASUREMENTS

Voltage Measurement	Test Point	Meter/Range Selection Requirement
Generator Output Voltage	Output "T" leads or bus bars, also main circuit breaker "line" side.	System voltage - volts AC See generator nameplate and connection diagram.
Regulator Output (Exciter Stator Input)	Fl and F2 terminals at the regulator.	200 volts D.C. range. Fl is plus (+), F2 if minus (—
Regulator Sensing	El, E2, E3 terminals at the Voltage the regulator.	Usually the same as the system voltage (generator output volts). However, in some cases, sensing taken from winding center taps or instrument potential transformers. Maximum 600 volts AC **Example:** Center tap of 480-volt system would give 240 volts El, E2, or E3. **Example:** A 4160-volt system must use a transformer to step voltage down below 600 volts. See the connection diagram supplied with generator set.
Regulator Input Volts (PMG Output Volts)	"PMG" leads at the regulator or capacitor.	200-240 VAC 300 Hz @ 1800 rpm 180-220 VAC 250 Hz @ 1500 rpm

CURRENT (AMP) MEASUREMENTS

Current measurement (AC) can be easily taken with a clamp on type meter.
NOTE: Most clamp type ammeters will not measure D.C.

When measuring generator output current, be sure the clamp is around all cables for each phase. If the physical size of the conductors or the capacity of the meters will not permit all cables to be measured at once, Each one can be measured individually. Add the individual readings together to get the total. Compare readings to the generator nameplate (nameplate ratings are always given per phase).

Amperage should never exceed the nameplate rating when running the intended load. (Amperage may go above nameplate momentarily when starting large motors.) When measuring exciter field amps (Fl and F2 leads) a D.C. meter is required. The maximum field current under full regulator forcing is 6.5 amps D.C.

MEASURING RESISTANCE

The generator windings can be measured and compared to the values shown in the service specifications.

Main Stator

The main stator winding resistance is very low. A meter capable of readings in the milliohm range would be required. However, a standard V.O.M. can be used to check for continuity, shorts, or grounds.

Example: With leads disconnected, a measurement from T1 to T4 should be very low (continuity most V.O.M's). Measured from T1 orT4 to any other lead should be infinite. Measure from the 'T' lead the generator frame to check for grounds (reading should be infinite).

Normal full load reading is approximately 3 amps.

The exciter stator resistance is measured by disconnecting the Fl and F2 leads at the regulator. Measure the resistance between the leads (this value is 22-24 ohms on standard generators). Measure from the leads to the frame to check for grounds.

Note markings and disconnect the main rotor leads (Fl leads and F2 leads) from the rectifier assembly. Measure the resistance of the main rotor winding. Compare reading to value shown in service specification section 12. Measure from the leads to the exciter-mounting bolt to check for grounds.

Exciter Rotor

Disconnect the exciter rotor leads at the diodes (leave leads disconnected if proceeding to check diodes). Measure resistance between phases. Compare value to service specification section 12. Measure from the leads to the exciter-mounting bolt to check for grounds.

TESTING DIODES (RECTIFIERS)

Diodes perform the function of an "electrical check valve". They conduct in one direction only and are used to "rectify" ac current into dc current. To test, measure the resistance first in one direction and then reverse the leads and test in the other direction. The reading should be high in the reverse direction and low in the forward direction. A shorted diode will read low in both directions. An open diode will read high in both directions.

NOTES:
1. Two different polarities of diodes are used. The only difference is in the way the device is mechanically placed in the case. When changing diode, be sure the correct polarity is used.
Refer to section 6 figure 6-34.

2. Some meters do not have enough voltage output from their internal batteries to turn the diode on (about 0.6 volts is required), and the voltage can change with different

range settings. Consult the instruction manual for your meter.
3. Polarities supplied by the meters internal battery may or may not correspond to the (+) (—) markings on the meter.

INSULATION RESISTANCE - *GENERAL*

Insulation resistance is a measurement of the integrity of the insulating materials that separate the electrical windings from the generators steel core. This resistance can degrade over time or due to contaminants (dust, dirt, oil, grease, and especially moisture). Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shut down. The problem can be corrected simply by drying out the windings. Section 5.

Normally the resistance of the insulation system is on the order of millions of ohms. It is measured with a device called a “megger” which is a megohm meter (Meg is for million) and a power supply. The power supply voltage varies, but the most common is 500 volts. A megger voltage over 500 is not recommended except for measuring medium voltage (2400/4160) stators only.

CAUTION: First disconnect any electronic components, regulators, diodes, surge protectors, protective relays, etc., will be destroyed if subjected to the high megger voltages.

To measure insulation resistance, connect the red or positive megger lead to the leads for the winding to be tested, connect the back or negative megger lead to the generator frame. Be sure the leads of the part being tested are not touching any metal parts of the generator. (If the neutral is grounded, it must be disconnected.) Take megger reading (refer to the manual for the megger).

INSULATION RESISTANCE - MAIN STATOR

CAUTION: Be sure the regulator, and any other electronic components, metering, protective relays, etc., are disconnected before meggering. High megger voltages will destroy these parts. All stator leads must be isolated from ground and connected together (on most systems with grounded neutrals - the neutral can be isolated from ground and used as a test point). Connect the positive megger lead to the main stator leads. Connect the negative megger lead to the generator grounding stud. Take the megohm reading (refer to instructions for the megger).

GENERATOR TESTING

The minimum acceptable value can be calculated using the following formula.
Minimum Insulation Resistance = Gen. Voltage + 1 (Megohms) / 1000
Example:
For a 480 volt generator
480 + 1 = 1.48 Megohms
If the reading is below the recommended value, the winding must be dried out or repaired.

INSULATION RESISTANCE - MAIN ROTOR

Disconnect the main rotor leads from the diode bridge on the exciter rotor. Connect the leads together with the positive megger lead. Connect the negative megger lead to a good ground on the rotor assembly such as the exciter mounting bolt. Take the megohm

reading (refer to instructions for the megger).
The minimum acceptable value is 1.5 megohms.

If the reading is low, the winding must be dried out or repaired.

INSULATION RESISTANCE - EXCITER STATOR

Disconnect the exciter leads Fl and F2 from the regulator. Never subject the regulator to a megger. Connect Fl and F2 together with the positive megger lead. Connect the negative megger lead to the ground stud. Take the megohm reading (refer to instructions for the megger).

The minimum value is 1.5 megohms.

If the reading is low, the winding must be dried out or repaired.

INSULATION RESISTANCE - EXCITER ROTOR

Disconnect the exciter rotor windings (6 leads from the diodes). Connect all leads together with the positive megger lead. Connect he negative megger lead to a good ground on the rotor assembly such as the mounting bolt. Take the megohm reading (refer to the instructions for the megger).

The minimum acceptable value is 1.5 megohms.

If the reading is low, the winding must be dried out or repaired.

MAIN ROTOR FIELD AC IMPEDANCE TEST

THEORY: The main rotor resistance can be measured with a very accurate meter that is able to measure low (1 ohm) resistance but it is difficult to determine if there are turn to turn shorts in the field pole windings. One shorted turn would only change a resistance reading on the order of one half of one percent.

The ac impedance test measures the impedance (inductance and resistance) of the field pole coils. Shorted turns in the field pole windings change the coil inductance to a much greater degree than the resistance.

PROCEDURE:

Step 1: The rotor must be supported on a non-magnetic surface such as a wooden skid. Do not use a steel table that would create a magnetic “short circuit” between the poles.

Step 2: Apply 120 volts ac to disconnected main rotor leads Fl and F2.

Step 3: Measure and record voltages pole. Between points “A” and “C”, “C” and “D”, “D” and “E” across each “B”, “B” and (Figure 8-1).

Step 4: The voltage readings should balance within one volt.

RESULTS: If the ac voltages are not balanced (30v ± lv ac with 120v ac input) across each pole, the winding has shorted turns and should be rewound.

Refer to Katolight for further information.

MAGNAMAX EXPLODED VIEW

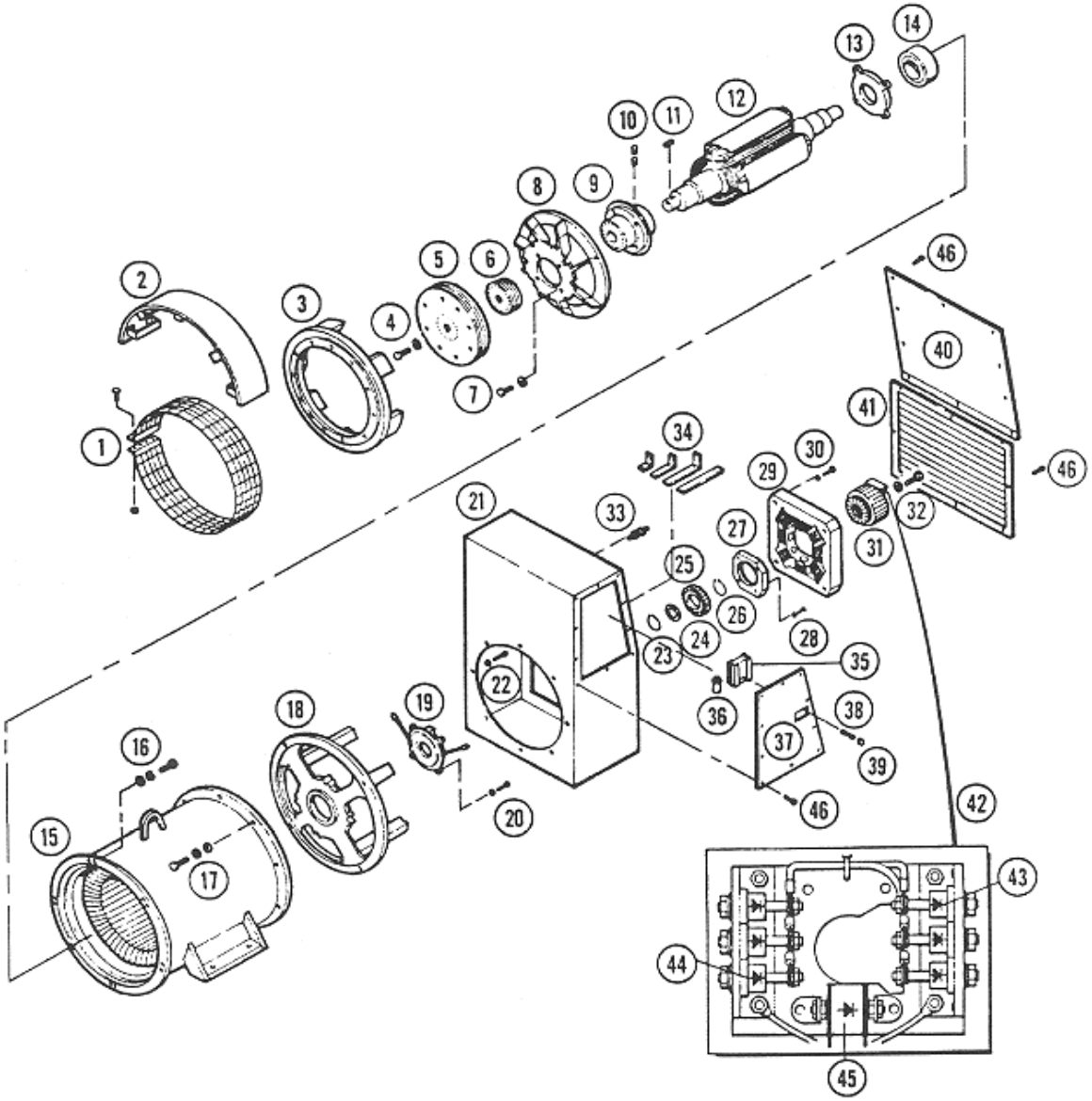


TABLE 9-1 *PARTS LIST*
NOTE: The parts in this list are subject to change, model number and serial number must accompany any parts order or inquiry.

TABLE 9-1 PARTS LIST **NOTE: The parts in this list are subject to change, model number and serial number must accompany any parts order or inquiry.**							
Item	**Part Description**	**430 Frame Series**		**570 Frame Series**		**740 Frame Series**	
		Part Number	**Qty.**	**Part Number**	**Qty.**	**Part Number**	**Qty.**
1	Screen Assembly						
	Screen	B-525565-1	1	B-525565-2	1	B-525565-3	1
	Screen Mounting Bolt Screen	A-9646-200	2	A-9646-200	2	A-9646-200	2
	Mounting Nut	A-7551-18	2	A-7551-18	2	A-7551-18	2
2	Drip Cover assembly	B-525566-1	1	B-525566-2	2	B-525566-3	1
3	Adapter						
	#3Adapter	B-525512A	1				
	#2Adapter	B-525512B	1				
	#1 Adapter	B-525513A	1	B-525618A	1		
	#1/2 Adapter	B-525514B	1	B-525616A	1		
	#0 Adapter	B-525514A	1	B-525603A	1	B-525720A	1
	#00 Adapter (#18 Disc)			B-525617A	1	B-525721A	1
	#00 Adapter (#21 Disc)			B-526228A	1	B-52572 1A	1
4	Disc Mounting Fasteners						
	Cap screw for #11-1/2	A-9674-200	6				
	Cap screw for #14	A-9674-150	6	A-9674-150	9		
	Cap screw for #18	A-9674-150	6	A-9674-150	9	A-9674-200	18
	Cap screw for #21					A-9674-150	18
	Cap screw for Delco	A-9674-150	6	A-9674-150	9	A-9674-200	18
	Hardened Washer	A-9667-1	6	A-9667-1	9	A-9667-1	18
5	Drive Discs						
	#11-1/2 Disc	A-525506	5	—	—	—	—
	#14 Disc	A-525508	5	A-525508	5	—	—
	#18 Disc	B-525975	4	A-525579	5	A-525579	10
	#21 Disc	—	—	A-525580	5	A-525580	10
	Delco Disc (17.75” 0.0.)	A-525507	5	A-525507	5	A-525507	10
6	Spacers						
	For #11-1/2 Disc	A-525567	14	—	—	—	—
	For #14 Disc	A-525567	5	A-525503	6	—	—
	For#18 Disc	—	—	—	—	A-525503	10
	For #21 Disc	—	—	—	—	—	—
	For Delco Disc	—	—	A-525503	1	A-525503	12
7	Fan Mounting Fasteners						
	Cap screw	A-9626-150	4	A-9626-150	8	A-9626-1 50	8
	Cap screw (2 Brg. Only)	A-9626-150	4	A-9626-200	8	A-9626-200	8
	Belleville Washer	A-9682-1	4	A-9682-1	8	A-9682-1	8
8	Fan	B-525510A	1	B-525604A	1	B-525719A	1

TABLE 9-1 PARTS LIST
NOTE: The parts in this list are subject to change, model number and serial number must accompany any parts order or inquiry.

Item	Part Description	430 Frame Series		570 Frame Series		740 Frame Series	
		Part Number	Qty.	Part Number	Qty.	Part Number	Qty.
9	Hub						
	Drive Hub [Sgl Brg. Only)	B-525509A	1	B-525606A	1	B-525726A	1
	Fan Hub (2 Brg. Only)	A-525568A	1	B-525694A	1	B-525750A	1
10	Drive Hub Set Screws		—	A-9675-50	2	A-9675-50	2
11	Drive Hub Key	A-25658-30	1	A-25658-30	1	A-25658-46	1
12	Main Rotor Assembly with Windings	REFER TO FACTORY					
13	Front Bearing Cap	B-525519A	1	B-525613A	1	B-525743A	1
14	Front Ball Bearing	A-7812R-70	1	A-7812R-80	1	A-7812R-110	1
15	Main Body Assembly	REFER TO FACTORY					
16	Adapter Mounting Fasteners	-					
	Cap screw	A-9680-125	12	A-9680-125	16	A-9626-150	16
	Lock Washer	A-7653-3	12	A-7653-3	16	A-7653-4	16
	Flat Washer	A-7656-8	16	A-7656-8	16	A-9667-1	16
17	Bracket Mounting Fasteners	-		-	-	-	-
	Cap screw	A-9680-1 25	8	A-9680-125	8	A-9626-150	8
	Lock Washer	A-7653-3	8	A-7653-3	8	A-7653-4	8
	Flat Washer	A-7656-8	8	A-7656-8	8	A-9667-1	8
18	Front Bracket	B-525518A	1	B-525605A	1	B-525739A	1
19	PMG Bearing Cap	B-525520A	1	B-525612A	1	B-525742A	1
20	Bearing Cap Fasteners	-	-	-	-	-	-
	Cap screw	A-9680-350	4	A-9680-400	4	A-9680-450	4
	Lock Washer	A-7653-3	4	A-7653-3	4	A-7653-3	4
21	Conduit Box	D-525673	1	D-525680	1	D-525771	1
22	Conduit Box Mtg. Fasteners						
	Cap screw	A-9680-75	8	A-9680-75	8	A-9626-75	8
	Lock Washer	A-7675-2	8	A-7675-2	8	A-7675-4	8
23	Snap Ring - Inner	A-7610-275	1			—	—
24	Loading Spring	A-7661-45	1	A-7661-45	1	A-7661-45	1
25	PMG Rotor	A-526816	1	A-526816	1	A-526816	1
26	Snap Ring-Outer	A-7610-275	1	A-7610-275	1	A-7610-275	1
27	PMG Stator	A-525548-1	1	A-525548-1	1	A-525548A-1	1
28	PMG Stator Mtg. Fasteners						
	Cap screw	A-9812-200	4	A-9812-200	4	A-9812-200	4
	Belleville Washer	A-9682-2	4	A-9682-2	4	A-9682-2	4
29	Exciter Stator	A-400N-200A	I	A-400N-300A	I	See Table 9-2	1
30	Exciter Stator Fasteners	-	-	-	-	-	-
	Cap Screw	A-9626-300	4	A-9626-400	4	See Table 9-2	4
	Belleville Washer	A-9682-1	4	A-9682-1	4	A-9682-1	4
31	Exciter Rotor Assy. (IncI. 42)	-	-	-	-	See Table 9-2	
	430 Frame - All	B-526483-2	I	—	—		
	570 Frame - Low Voltage	—	—	B-526483-3	1		
	570 Frame - Med. Voltage	—	—	B-526483-10	1		

TABLE 9-1 PARTS LIST
NOTE: The parts in this list are subject to change, model number and serial number must accompany any parts order or inquiry.

Item	Part Description	430 Frame Series		570 Frame Series		740 Frame Series	
		Part Number	Qty.	Part Number	Qty.	Part Number	Qty.
32	Exciter Rotor Fastener	-	-	-	-	-	-
	Cap screw	A-9670A-200	1	A-9670A-200	1	A-9670A-200	1
	Belleville Washer	A-9682-1	1	A-9682-1	1	A-9682-1	1
33	Grounding Stud Assembly	-	-	-	-	-	-
	Stud	A-26937-300	1	A-26937-300	1	A-525574-400	I
	Washer	A-9787-1	2	A-9787-1	2	A-9787-3	2
	Nut	A-9786-1	1	A-9786-1	2	A-9786-3	2
34	Bus Bar Assembly	REFER TO FACTORY					
35	DVR2000 AVR	D-526352	1	D-526352	1	D-526352	1
36	Capacitor (DVR2000)	A-66377-45	1	A-66377-45	1	A-66377-45	1
37	Side Panels Blank	B-525679A	1	B-525686A	1	B-525707A	1
	Machined for (DVR2000)	B-525679AE	I	B-525686AN	1	B-525707W	1
38	Fuse	A-525698-1	1	A-525698-1	1	A-525698-1	1
39	Fuse Holder Cap	A-525893	1	A-525893	1	A-525893	1
40	Solid Cover	B-525676	1	B-525687	1	B-525706	1
41	Louvered Cover	C-525562	1	C-525647	1	C-525670	1
42	Exciter Rectifier Assy. (Includes 43,44,45)	B-525528A	1	B-525528A	1	B-525528B	1
43	Diode Standard Polarity	B-525570-1	3	B-525570-1	3	B-525570-2	3
44	Diode Reverse Polarity	B-525571-1	3	B-525571-1	3	B525571-2	3
45	Surge Suppressor	B-526482-1	1	B-526482-1	1	B-526482-2	1
46	Cover Mtg. Screws	A-9646-75	33	A-9646-75	33	A-9646-75	33

TABLE 9-2 : EXCITER ASSEMBLIES

Frame	Type	Insulation	Exciter Stator	Exciter Stator Mtg. Cap screws	Exciter Rotor
572	RSL	Standard	A-400N-250A	A-9626-350	B-526483-24
573.574	RSL	Standard	A-400N-300A	A-9626-400	B-526483-3
572	RSL	VPI	A-400N-250AA	A-9626-350	B-526483-25
573.574	RSL	VPI	A-400N-300AA	A-9626-400	B-526483-9
573,574	FSM	VPI	A-400N-300AA	A-9626-400	B-526483-10
741, 742	RSL	Standard	A-400N-500A	A-9626-600	B-526483-5
741, 742, 743	RSL	VPI	A-400N-500A	A-9626-600	B-526483-11
741, 742	FSM	VPI	A-400N-500A	A-9626-600	B-526483-11
743	FSM	VPI	A-400N-600A	A-9626-700	B-526483-12
744	RSL	VPI	A-400N-600A	A-9626-700	B-526483-12
744	FSL	VPI	A-400N-650A	A-9626-750	B-526483-13

STANDARD TOOLS

The MagnaMAX generator is assembled with American standard SAE hardware. All fasteners should be properly torqued. (See section 12). Torque wrenches ranging from 25 in-lb. through 200 ft-lb. should be available.

Electrical test equipment should include a voltmeter or multimeter (VOM), clamp on ammeter, accurate frequency meter or tachometer, and a megohmmeter. See section Generator Testing for more information.

SPECIAL TOOLS

In addition to the standard tools mentioned above, the following special tools would facilitate removal and installation of large and/or special parts. These tools can be obtained from the Katolight parts department.

Exciter stator lifting fixture (Figure 10-1).

Figure 10-1

In cases where the exciter stator is to be serviced without removing the generator conduit box this fixture can be used with overhead rigging to remove and reinstall the exciter stator.

Exciter rotor puller bolt (Figure 10-2). The exciter rotor has a built in pulling system. With the use of this bolt, the rotor can be easily removed from the shaft without damage to the winding.

Figure 10-2

The PMG rotor is installed to the generator shaft with a snap ring.

The nominal shaft diameter is 2-3/4 inches and the ring must be spread approximately 3/4 inches for removal. To install the snap ring, use a piece of pipe with a 2-3/4 inch I.D. (Figure 10-4). Push the PMG rotor and snap ring onto the shaft until the ring snaps into the groove.

Figure 10-4

Rotor lifting fixture (Figure 10-5). The main generator rotor is heavy (approximately 1/2 the weight of the generator) and difficult to handle. The proper fixture should be used whenever removing or installing the main rotor into the main stator. Without proper care and equipment, the windings can be easily damaged.

Figure 10-5

MISCELLANEOUS

A selection of wiring devices such as electric connectors, tape, cable ties, crimping and stripping tools, etc., should also be a part of the generator service tool kit. The standard regulator uses flat 1/4 inch female insulated terminals for AWG #14 wire.

PREPARATION FOR SHIPMENT OR EXTENDED STORAGE

SHIPPING INSTRUCTIONS

Shipping and handling will be much easier if the generator is fastened to a suitable shipping skid that will allow handling by a forklift. The skid should extend beyond the generator in all directions. If the original skid is available it should be used. Katolight will supply shipping skid drawings upon request.

Overseas shipping may require special export crating. Check with your freight carrier.

When installed, single bearing generator rotors are supported on the drive end by the drive discs bolted to the engine flywheel. When the engine is removed, the rotor must be supported by an appropriate fixture to prevent main rotor, main stator or exciter damage (Figure 11-1). Before shipping any single bearing generator, the main rotor must be supported by the adapter using an appropriate fixture.

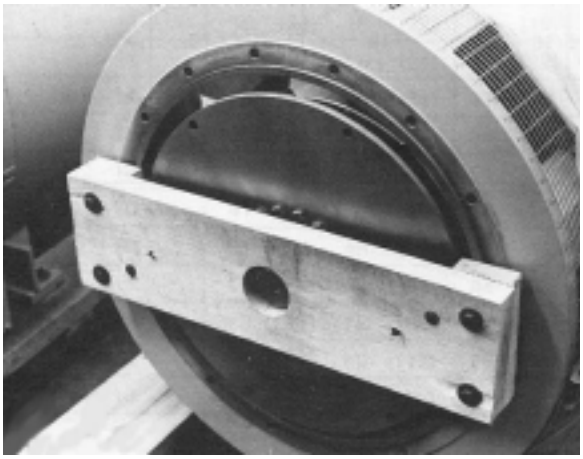


Figure 11-1

STORAGE INSTRUCTIONS

If the generator is placed in storage, the following precautions should be taken to protect it:

A. Equipment must be kept clean.

1. Store indoors.

2. Keep covered to eliminate airborne dust and dirt.

3. Cover openings for ventilation, conduit connections, etc. to prevent entry of rodents, snakes, birds, and insects, etc.

B. Equipment must be kept dry.

1. Store in a dry area indoor.

2. Temperature swings should be minimal to prevent condensation.

3. If stored in an unheated or damp building, space heaters will be required to prevent internal condensation.

4. Treat unpainted flanges, shafts, drive discs, and fittings with a rust inhibitor.

5. Check insulation resistance of all windings before starting the generator. If readings are low, the windings must be dried.

C. Keep bearings lubricated.

1. Every six months rotate shaft several turns to distribute grease in bearings.

2. If unit has been stored more than one year, add grease before start-up.

D. Review and follow instructions in Sections 3 and 4 before putting the gen-set into service.

CAUTION
DO NOT ATTEMPT TO TRANSPORT ANYGENERATOR WITHOUT PROPER ROTOR SUPPORT, EXTENSIVE EQUIPMENTDAMAGE CAN OCCUR.

TABLE 12-1: MAGNA MAX - FASTENER AND TORQUE SPECIFICATIONS

Part Description	Fastener Spec.®	430-570 Frames		740 Frames	
		Size Dia.-Thread	Torque Ft-Lb.	Size Dia.-Thread	Torque Ft-Lb.
Front Bracket	Grade 5 cap screws with flat and lock washers	3/8 - 16	25	1/2 - 13	60
Bearing Caps	Grade 5 cap screws with lock washers	3/8 - 16	25	3/8 - 16	25
Drive Disc	Grade 8 cap screws with hardened washers	5/8 - 18	192	5/8 - 18	192
Adapter (or rear bracket)	Grade 5 cap screws with flat and lock washers	3/8 - 16	25	1/2-13	60
Conduit Box	Grade 5 cap screw with star type lock washer	3/8 - 16	25	1/2-13	60
PMG Stator	Grade 5 cap screws with Belleville washers	1/2-13	4	1/2-13	4
Exciter Stator	Grade 5 cap screws with Belleville washers	1/2-13	60	1/2-13	60
Exciter Armature (rotor)	Grade 8 cap screw with Belleville washer	1/2-13	84	1/2-13	84
Cooling Fan	Grade 5 cap screws with Belleville washers	1/2-13	60	1/2-13	60
Main Rotor Coil Supports	Grade 8 cap screws with Belleville washers	5/16-18	19	3/8 - 16	35
Rectifier Assembly Mounting	Grade 5 cap screws	1/4-20	4	1/4-20	4
Drive Hub Set Screw	Socket head set screw 1/4 in. hex key	1/2-13	50	1/2-13	50

NOTES: For table 12-1
All fasteners are SAE (American) standard.
All torque values are for plated hardware that is standard on the MagnaMAX.
If hardware is replaced with non-plated, refer to Table 12-2.
Always use quality hardware of the grade specified.
Main Rotor Coil Supports 570 and 740 frame only. Not used on 430 frames.

TABLE 12-2: CAPSCREW TORQUE VALUES

NOTES: Cap screws threaded into aluminum may require reductions in torque of 3O% or more.

	Cap screw Diameter and Ultimate Tensile Strength (PSI)								
	To 1/2 - 69,000 PSI To 3/4 - 64,000 PSI To 1 - 55,000 PSI			To 3/4 - 120,000 PSI To 1 - 115,000 PSI			150,000 PSI		
SAE Grade	1 OR 2			5			8		
Size (Inches) - (Thread)	Torque Ft-LB (N-M)			Torque Ft-Lb. (N-M)			Torque Ft-LB (N-M)		
	Dry	Oiled	Plated	Dry	Oiled	Plated	Dry	Oiled	Plated
1/4-20	5(7)	4.5 (6)	4(5)	8 (11)	7 (9)	6 (8)	12 (16)	11 (15)	10 (14)
1/4-28	6(8)	5.4 (7)	4.8 (6)	10 (14)	9 (12)	8 (11)	14 (19)	13 (18)	11 (15)
5/16-18	11 (15)	10 (14)	9 (12)	17 (23)	15 (20)	14 (19)	24 (33)	22 (30)	19 (26)
5/16-24	13 (18)	12 (16)	10 (14)	19 (26)	17 (23)	15 (20)	27 (37)	24 (33)	22 (30)
3/8-16	18 (24)	16 (22)	14 (19)	31 (42)	28 (38)	25 (34)	44 (60)	40 (54)	35 (47)
3/8- 24	20 (27)	18 (24)	16 (22)	35 (47)	32 (43)	28 (38)	49 (66)	44 (60)	39 (53)
7/16 - 14	28 (38)	25 (34)	22 (30)	49 (66)	44 (60)	39 (53)	70 (95)	63 (85)	56 (76)
7/16-20	30 (41)	27 (37)	24 (33)	55 (75)	50 (68)	44 (60)	78 (106)	70 (95)	62 (84)
1/2-13	39 (53)	35 (47)	31 (42)	75 (102)	68 (92)	60 (81)	105 (142)	95 (129)	84 (114)
1/2-20	41 (56)	37 (50)	33 (45)	85 (115)	77 (104)	68 (92)	120 (163)	108 (146)	96 (130)
9/16-12	51 (69)	46 (62)	41 (56)	110 (149)	99(134)	88(119)	155 (210)	140 (190)	124 (168)
9/16-18	55 (75)	50 (68)	44 (60)	120 (163)	108 (146)	96 (130)	170 (230)	153 (207)	136 (184)
5/8-11	83 (113)	75 (102)	66 (89)	150 (203)	135 (183)	120 (163)	210 (285)	189 (256)	168 (228)
5/8-18	95 (129)	86 (117)	76 (103)	170 (230)	153 (207)	136 (184)	240 (325)	216 (293)	192 (260)
3/4-10	105 (142)	95 (130)	84 (114)	270 (366)	243 (329)	216 (293)	375 (508)	338 (458)	300 (407)
3/4-16	115 (156)	104 (141)	92 (125)	295 (400)	266 (361)	236 (320)	420 (569)	378 (513)	336 (456)
7/8-9	160 (217)	144 (195)	128 (174)	395 (535)	356 (483)	316 (428)	605 (820)	545 (739)	484 (656)
1-14	175 (237)	158 (214)	140 (190)	435 (590)	392 (531)	348 (472)	675 (915)	608 (824)	540 (732)
1 -8	235 (319)	212 (287)	188 (255)	590 (800)	531 (720)	472 (640)	910 (1234)	819 (1110)	728 (987)
1- 14	250 (339)	225 (305)	200 (271)	660 (895)	594 (805)	528 (716)	990 (1342)	891 (1208)	792 (1074)

TABLE 12-3:EXCITATION DATA -60 HZ - 1800 RPM

Model Number Low Volts	Exciter Field Resistance-Ohms @25°C	Exciter Field Volts Fl and F2 at regulator No Load 240/480 Volts	No Load Output Voltage With Fixed Excitation High Wye Connection®	
			12V DC	24V DC
431RSL4005	22.5	13.3	460	550
431RSL4007	22.5	14.2	450	545
432RSL4009	22.5	15.3	445	535
432RSL4011	22.5	13.5	460	550
432RSL4013	22.5	11.3	490	580
432RSL4015	22.5	13.1	440	530
432RSL4017	22.5	14.4	450	545
433RSL4019	22.5	16.9	430	525
433RSL4021	22.5	13.7	450	550
572RSL4024	23.0	16.1	440	520
572RSL4027	23.0	16.1	440	520
572RSL4028	23.0	17.5	425	510
572RSL4030	23.0	15.2	440	530
573RSL4032	23.0	15.0	445	530
573RSL4034	23.0	17.0	430	520
574RSL4036	23.0	18.2	420	510
574RSL4038	23.0	15.0	440	540
741RSL4042	22.0	14.8	445	540
741RSL4044	22.0	15.2	440	540
741RSL4046	22.0	15.6	430	540
742RSL4048	22.0	17.4	410	525
743RSL4050	22.0	13.7	460	565
743RSL4052	22.0	19.4	400	510
744RSL4054	22.1	18.6	400	510
744FSL4060	22.1	15.1	420	570
744FSL4062	22.1	16.6	410	535
Model Number Medium Volts	Exciter Field Resistance-Ohms @25°C	Exciter Field Volts Fl and F2 at Regulator No Load 4160 Volts	No Load Output Voltage With Fixed Excitation Wye Connection	
			12V DC	24V DC
573FSM4352	23.0	23.5	3100	4200
573FSM4354	23.0	20.3	3300	4400
574FSM4356	23.0	20.7	3200	4300
574FSM4358	23.0	17.3	3500	4600
741FSM4360	22.0	16.7	3600	4600
742FSM4364	22.0	15.4	3700	4700
742FSM4366	22.0	16.3	3600	4600
743FSM4368	22.1	17.7	3200	4600
743FSM4370	22.1	17.0	3500	4600

For rated load exciter field volts - see generator nameplate.
For low wye connection: divide value shown in table by 2.
For high delta connection: divide value shown in table by 1 .732.
For delta connection: divide value shown in table by 1 .732.

TABLE 12-4:EXCITATION DATA -50 HZ - 1500 RPM

Model Number Medium Volts	Exciter Field Resistance-Ohms @25°C	Exciter Field Volts Fl and F2 at Regulator No load @ 415 Volts	No Load Output Voltage With Fixed Excitation High Wye Connection	
			1 2V DC	24V DC
431RSL4005	22.5	15.6	380	460
431RSL4007	22.5	17.1	370	450
432RSL4009	22.5	18.0	360	445
432RSL4011	22.5	16.0	380	455
432RSL4013	22.5	13.1	400	480
432RSL4015	22.5	18.7	360	440
432RSL4017	22.5	17.4	370	450
433RSL4019	22.5	20.7	340	430
433RSL4021	22.5	16.7	360	450
572RSL4024	23.0	19.8	360	430
572RSL4027	23.0	20.0	355	430
572RSL4028	23.0	21.2	370	430
572RSL4030	23.0	18.4	360	440
573RSL4032	23.0	18.9	360	440
573RSL4034	23.0	20.7	350	430
574RSL4036	23.0	21.6	345	425
574RSL4038	23.0	17.7	365	450
741RSL4042	22.0	17.8	360	450
741RSL4044	22.0	18.1	360	450
741RSL4046	22.0	18.7	350	445
742RSL4048	22.0	20	340	440
743RSL4050	22.0	16.1	370	470
743RSL4052	22.0	22.9	330	420
744RSL4054	22.1	22.6	320	420
744FSL4060	22.1	17.0	350	470
744FSL4062	22.1	19.5	330	440
Model Number Medium Volts	Exciter Field Resistance-Ohms @25°C	Exciter Field Volts Fl and F2 at Regulator No load®3300 Volts	No Load Output Voltage With Fixed Excitation High Wye Connection	
			1 2V DC	24V DC
573FSM4352	23.0	21.2	2600	3400
573FSM4354	23.0	18.2	2700	3600
574FSM4356	23.0	18.4	2700	3600
574FSM4358	23.0	15.7	2800	3800
741FSM4360	22.0	15.4	3000	3800
742FSM4364	22.0	14.5	3000	3900
742FSM4366	22.0	15.6	2800	3800
743FSM4368	22.1	15.5	2800	3900
743FSM4370	22.1	15.5	2900	3800

For rated load exciter field volts - see generator nameplate.
For low wye connection: divide value shown in table by 2.
For high delta connection: divide value shown in table by 1 .732.For delta connection: divide value shown in table by 1 .732.

TABLE 12-5: RESISTANCE VALUES - MAIN WINDINGS

NOMINAL COLD (25°C) RESISTANCE IN OHMS

Base Model Low Voltage	Winding H-SG-	Main Stator	Main Rotor
431RSL4005	430049	.0855	.153
431RSL4007	430048	.0648	.173
432RSL4009	430046	.0418	.190
432RSL4011	430018	.0410	.186
432RSL4013	430015	.0370	.189
432RSL4015	430017	.0260	.225
432RSL4017	430016	.0240	.226
433RSL4019	430042	.0140	.286
433RSL4021	430039	.0137	.297
572RSL4024	570078	.0132	.376
572RSL4027	570072	.0126	.398
572RSL4028	570080	.0092	.423
572RSL4030	570074	.0089	.426
573RSL4032	570075	.0074	.472
573RSL4034	570076	.0059	.507
574RSL4036	570077	.0049	.584
574RSL4038	570069	.0048	.601
741 RSL4042	740040	.0045	.677
741 RSL4044	740041	.0039	.708
742RSL4046	740042	.0036	.748
742RSL4048	740043	.0030	.776
743RSL4050	740051	.0023	.889
743RSL4052	740045	.0018	.979
744RSL4054	740046	.0015	1.100
744FSL4060	740306	.0026	.892
744FSL4062	740307	.0018	1.044
Base Model Medium Voltage	Winding H-SG-	Main Stator®	Main Rotor
573FSM4352	570213	1.030	.383
573FSM4354	570214	.854	.411
574FSM4356	570215	.568	.508
741FSM4360	740230	.277	.667
742FSM4364	740204	.233	.768
742FSM4366	740206	.151	.888
743FSM4368	740207	.127	.954
743FSM4370	740208	.101	1.053

Main stator values shown are line to line on the high wye connection. For low wye connection divide value shown in table by 4.

TABLE 12-6: RESISTANCE VALUES - EXCITER WINDINGS

NOMINAL COLD (25°C) RESISTANCE IN OHMS

Low Voltage	Exciter Stator (Field)	Exciter Rotor (Armature)	PMG Stator
430 Frames	22.5	0.022	2.1
570 Frames	23.0	0.045	2.1
741 Frames	22.0	0.043	2.1
742 Frames	22.0	0.043	2.1
743 Frames	22.0	0.043	2.1
744 Frames	22.1	0.048	2.1
Medium Voltage	Exciter Stator (Field)	Exciter Rotor (Armature)	PMG Stator
570 Frames	23.0	0.070	2.1
741 Frames	22.0	0.043	2.1
742 Frames	22.0	0.043	2.1
743 Frames	22.1	0.048	2.1

Basic Electricity

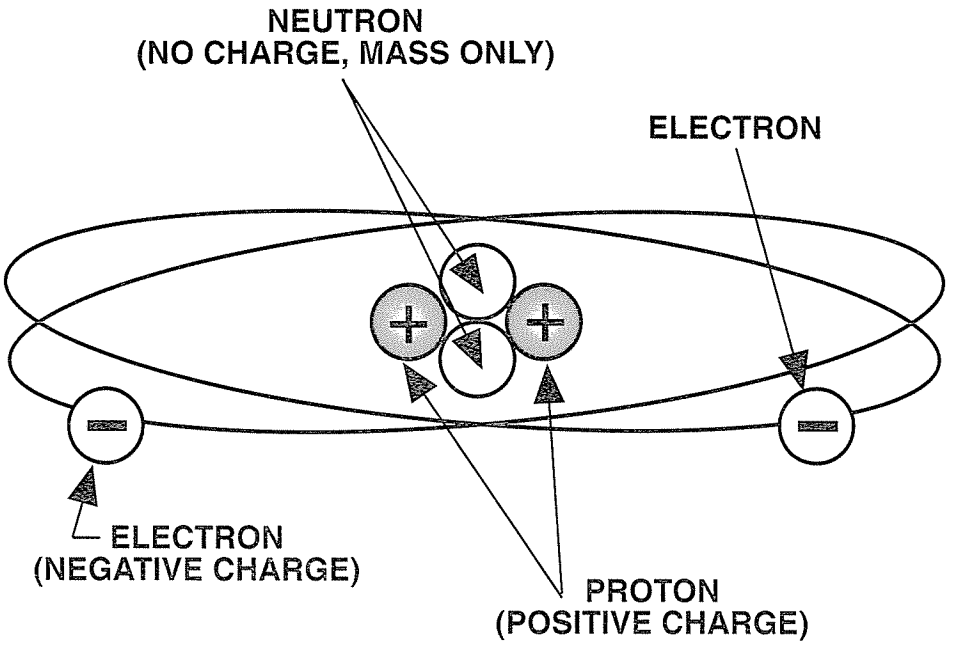
What you'll learn

As you read this, electricity is flowing through glass tubes overhead, exciting the gas molecules they contain and causing them to give off energy in the form of room light. An electric motor somewhere is operating a compressor chilling the Freon that cools the coils in the air conditioner. Microscopic switches in your computer record your keystrokes and produce characters on the monitor by aiming an electric beam at the phosphorus coating on the inside of the screen.

And unless you are reading this on some uninhabited island, you can be sure that electrical energy is being harnessed all around you in hundreds of ways, in applications as varied as the mechanism in your watch, the pump that delivers water to the lavatory sink, and the ignition system in your car.

This primer will help you understand in basic terms how all of this electrical energy is generated and used, and give you a foundation for studying electricity and its applications in more detail in other GE ED&C InVision™ modules.

If you are already familiar with all of this material, move on to another Basics Module in an area where you have more to learn. Other Basics Modules include such specific technologies as circuit breakers, panelboards and switchboards, load centers, transformers and controls, with additional modules to cover specific product lines within those technology groups. All are available through your local GE ED&C sales office.



BE.1.2.1

The nucleus carries a positive charge.

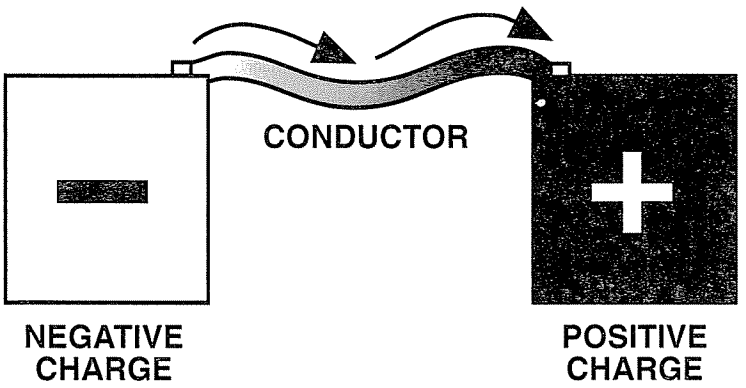
- *Electrons carry a negative charge.*
- *Free electrons are loosely held outer electrons that can be bumped free by other free electrons.*

Electrons in motion

Electricity is a **form of energy**. Other energy forms include **light** energy, **thermal** (or heat) energy, **sound** and **mechanical** (or motion) energy. Unlike these other energy forms, however, electricity can be easily and inexpensively transferred over wire, and converted into other useful energy forms by using **appliances** such as electric lights, electric heaters or electric motors.

When talking about electricity, we use the term **current** just as we do when talking about flowing water. Water current involves water molecules in motion, electric current involves **electrons** in motion.

Electrons are negatively charged particles that orbit the nucleus of an atom. In most atoms, the negative charge in the electrons is balanced by a positive charge in the nucleus. However, in the case of certain materials known as **conductors**, the outer electrons can be easily displaced by other electrons. These are called **free electrons**, and once they are set in motion, they can create a chain reaction current by displacing other electrons in adjacent atoms, which in turn displace other electrons farther down the line.



BE.1.4.2

- *Electrons flow from negatively charged (-) bodies to positively charged (+) bodies.*
- *A positive charge arises when a conductor has fewer than its normal share of free electrons.*
- *A negative charge arises when a conductor has more than its normal share of free electrons.*

Negative and positive charge

Even though a conductor, such as copper wire, may carry a steady flow of free electrons bouncing from copper atom to copper atom, an individual copper atom in the wire will always have the same number of electrons in its orbit. As one bounces in, another bounces out.

Certain events, however, can cause some atoms to end up with more than their normal number of electrons. This upsets the electrical balance between the nucleus and the electrons and gives the atom a **negative charge**. If an atom ends up with fewer than its normal number of electrons, the electrical balance is tipped in favor of the nucleus, and it takes on a **positive charge.**

In short, a negative charge in a body means too many electrons, and a positive charge means too few electrons. If we attach a conductor between two such bodies, electrons will naturally flow from the negative to the positive. That is the nature of all electrical current, to flow from the negative to the positive.

	Water	Electricity
Pressure (E)	Pounds per square inch	Volts
Flow/Current (I)	Gallons per minute	Amps
Resistance (R)	Friction	Ohms

BE.1.6.3

- *Volts indicate the force with which electrons move through a current.*
- *Amps indicate the volume of electrons moving through a circuit.*
- *Ohms indicate the friction the circuit presents to the flow of current.*

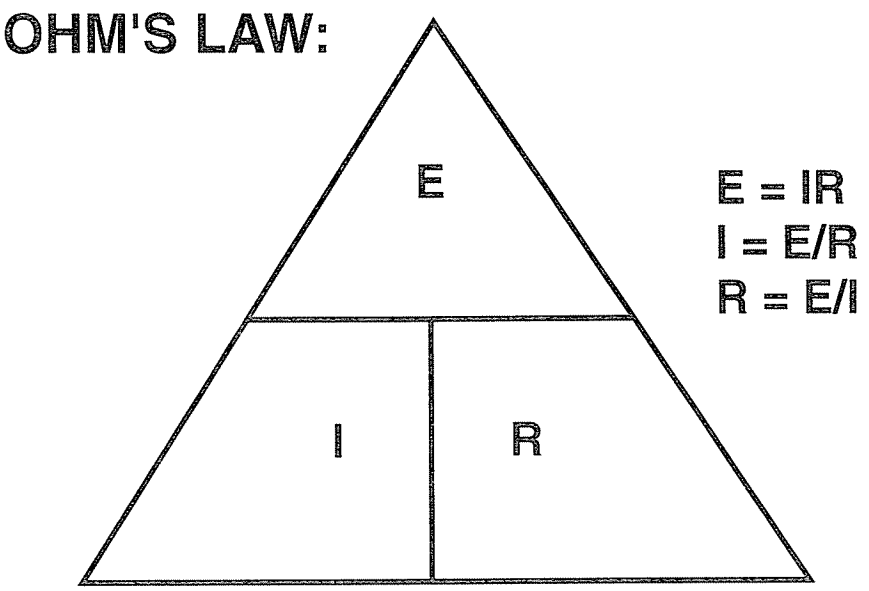
Potential for action

Not all electrons move with the same force. That is determined by the **potential difference** — the difference in charge between the two bodies. If the negative body has a relatively high number of free electrons and the positive body is short a large number of free electrons, the potential difference will be great, and the flow will be very powerful. If, on the other hand, the negative body has only a slight negative charge and the positive body has only a slight positive charge, the potential difference (and the flow) will be very weak.

To return to our water analogy, the higher the potential difference, the higher the pressure in the pipe, or conductor. Plumbers measure water pressure in psi (pounds per square inch), electricians measure electrical pressure in **electromotive force**, or **volts**.

Plumbers also measure current, the rate at which water flows through a pipe in gallons per minute. Electricians measure the flow (or current) of electrons in **amps**. One amp equals one **columb** (6,300,000,000,000,000,000 electrons) passing a single point every second.

Lastly, plumbers consider how much friction will limit the amount of water they can pass through a pipe based on its length and cross section. Electricians consider **resistance**, measured in **ohms**, when determining how much electricity they can send through a conductor in a given period of time. As a rule of thumb: the longer the conductor, the more resistance; the wider the conductor, the less resistance.



BE.1.8.4

Ohm's Law

- *Voltage equals amps times ohms – E = IR*
- *Amps equal volts divided by ohms – I = E/R*
- *Ohms equal volts divided by amps – R = E/I*

Conducting electricity

Materials such as gold, silver, aluminum and copper have many free electrons, so electricity flows through them very easily, and we call them **conductors**. Materials such as wood, plastic, vinyl and paper have few free electrons and resist the flow of others, so we call these **insulators**.

Even the best conductors present some resistance to the flow of electricity. So for electrical current to flow, it must have sufficient pressure (voltage) to overcome the resistance (ohms). When voltage far exceeds the minimum necessary to overcome resistance in a conductor, the current (amps) will be very high. When voltage just barely exceeds the minimum necessary to overcome the resistance, the current will be relatively low.

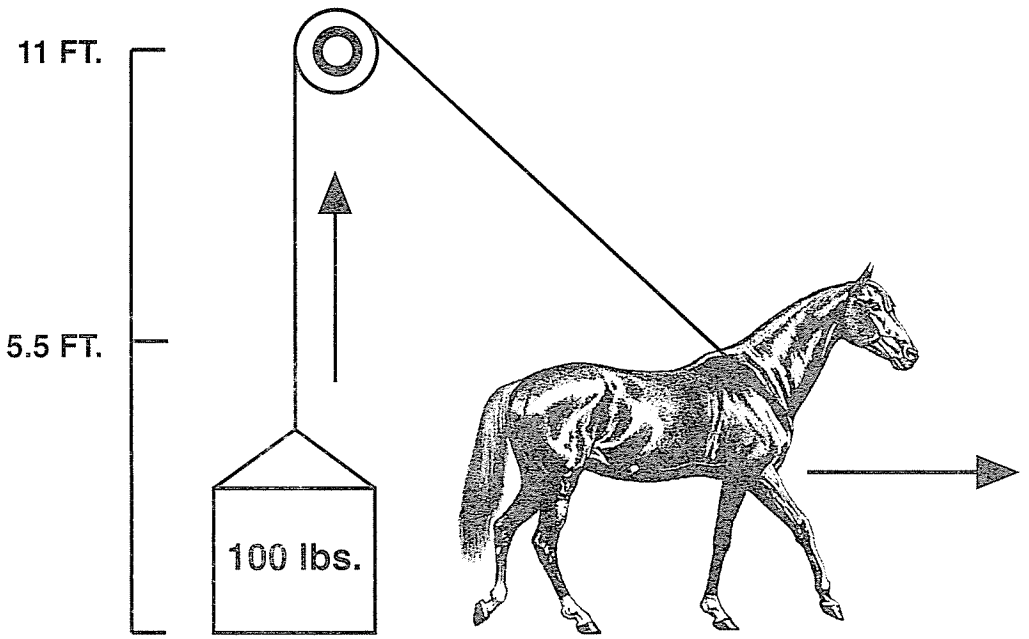
This relationship is defined by **Ohm's Law**:

E=IR

E=Voltage
I=Current (amps)
R=Resistance (ohms)

The triangle illustration on the facing page shows you how to use any two of these values to determine the other in a given circuit. If you need to find current, cover the "I" with your finger and you'll have E/R (volts divided by ohms). If you want to determine resistance, cover the "R" and you'll have E/I (volts divided by amps).

- **Work** involves moving an object over a distance.
- 100 lbs. lifted 10 ft. equals 1,000 **ft-pounds** of work.
- **Power** defines work performed in a given time period.
- One **horsepower** equals 550 ft-pounds per second.



BE.1.10.5

If the horse lifts the load 5.5 ft. in one second, it will have generated one horsepower.

$$\frac{100 \text{ lbs.} \times 5.5 \text{ ft.}}{1 \text{ sec.}} = \frac{550 \text{ ft-pounds}}{1 \text{ sec.}} = 1HP$$

If it lifts the same load 11 ft. in one second, it will have generated two horsepower.

$$100 \text{ lbs.} \times 11 \text{ ft.} = \frac{1,100 \text{ ft-pounds/sec.}}{550 \text{ ft-pounds/sec.}} = 2HP$$

Work and power

We've talked about the relationships that govern the movement of electricity through a conductor. Now we want to put that electrical energy to work.

In technical terms, **work** is defined as a **force** moving a **mass** over a distance. So units used to quantify work have both a distance and a weight element. In the U.S., we measure work in **ft-pounds**. If the horse in the illustration on the opposite page were to lift the 100 lb. box one foot, it will have performed 100 ft-pounds of work. If it were to lift the box 10 ft., it will have performed 1,000 ft-pounds of work.

Now imagine two horses, each with its own box to lift, working side by side. One quickly lifts its box to 11 ft., while the other plods forward, taking twice as long to do the same job. Even though they both did the same amount of work, the first horse seems to have done more than the second horse. That's where the notion of **power** comes into play. Power adds an element of time to the measurement of work.

In mechanical applications, we measure power output in **horsepower** — the ability to perform 550 ft-pounds of work in one second. So if the fast horse lifted the 100 lbs. 11 ft. in one second it will have generated two horsepower:

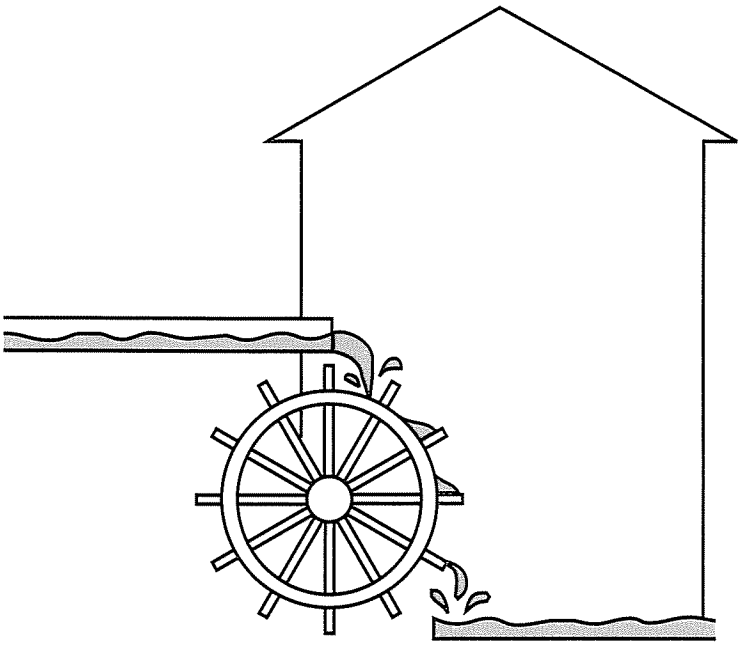
$$100 \text{ lbs.} \times 11 \text{ ft.} = 1{,}100 \text{ ft-pounds}/1 \text{ second}$$

$$\frac{1{,}100 \text{ ft-pounds}}{1 \text{ second}} \Big/ \frac{550 \text{ ft-pounds}}{1 \text{ second}} = 2 \text{ hp} = 1$$

The other horse, however, took two seconds to perform the same work, generating only one horsepower:

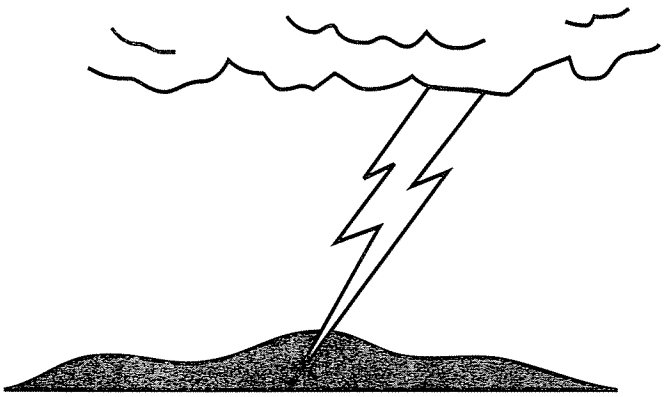
$$100 \text{ lbs.} \times 11 \text{ ft.} = 1{,}100 \text{ ft-pounds}/2 \text{ seconds}$$

$$\frac{1{,}100 \text{ ft-pounds}}{2 \text{ seconds}} \Big/ \frac{550 \text{ ft-pounds}}{1 \text{ second}} = 2 = 1 \text{ hp} = 2 = 1$$



BE.1.12.6

Even though the constant action of a small hydroelectric generator offers the potential to accomplish a substantial amount of work over the long term, it generates only a few hundred watts.



BE.1.12.7

A lightning storm may generate millions of kilowatts of power, but it lasts only an instant of a second.

- *Potential difference is the electrical equivalent of the mechanical term, "work."*
- *Watts is the electrical equivalent of horsepower.*
- *Both watts and horsepower measure how much work can be done in a given period of time.*
- *Watts = amps x volts (P=IE).*

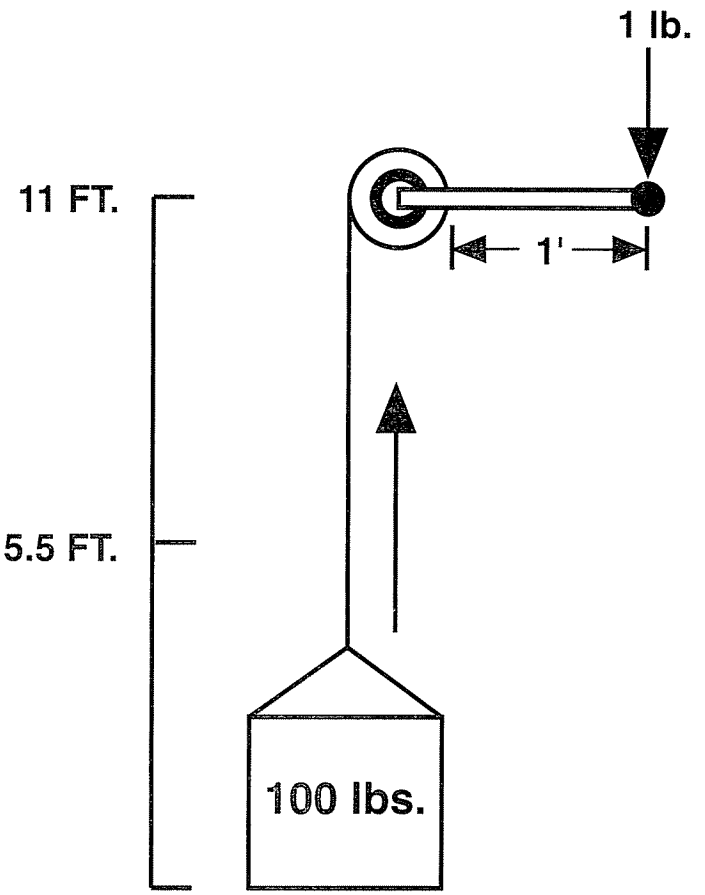
Electrical power

It's fairly clear to see how terms such as ft-pounds and horsepower apply to the mechanical act of lifting a box. While the results of electrical energy are not always as visible, we use a similar set of terms to define the same relationships.

Potential difference is the electrical equivalent of work, and is measured in volts instead of ft-pounds. Like ft-pounds, volts of potential difference are an indication of raw capacity to work with no indication of how quickly the work will get done.

Watts is the electrical equivalent of horsepower (in fact a watt is the equivalent of 1/746th of a horsepower). It is the amount of energy expended by one ampere of current (6.3×10^{18} electrons per second) at one volt of potential change. A **kilowatt** is one thousand watts.

In electrical terms, a hydroelectric generator on a small stream may carry the potential for work of all the rainwater that will run off its hillside for many years. Yet at any given moment, it produces only a few hundred watts of *power*. A thundercloud, on the other hand, may perform work for only an instant, but it will generate millions of kilowatts of *power* during that time.



BE.1.14.8

- *When energy is expended in a rotational direction, it is called torque.*
- *A ft-pound of torque represents one pound of pressure applied to a wheel one foot from its center of rotation.*
- *Ft-pounds of torque and linear ft-pounds are not the same.*
- *A ft-pound of torque performs approximately 6.29 linear ft-pounds of work for every rotation of a wheel.*
- *Horsepower = $\frac{\text{ft-pounds of torque x revolutions per minute}}{5{,}250}$*

Rotational energy

Until now, we've been talking about mechanical and electrical energy as two separate subjects. Over the next several pages we will begin to discuss how we use mechanical energy to generate electrical energy, and electrical energy to generate mechanical energy.

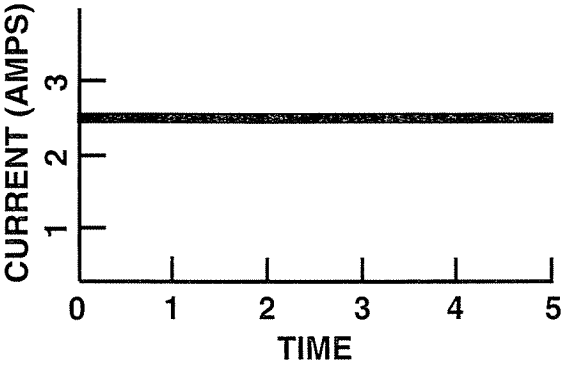
Much of this interaction involves a unit of work called **torque**. Torque is the form of mechanical energy created by a rotating shaft or wheel, such as a waterwheel, windmill or electric motor. Any value for torque must have two elements: the unit of force applied to (or received from) a wheel, and how far from the center of the wheel the force is applied (or received).

Both of these elements are necessary because any wheel creates a mechanical advantage that increases as you move farther and farther from its center of rotation. For instance, it's much more difficult to turn a bicycle wheel by the axle than it is to turn it by pushing along the tire.

In the U.S., we measure torque in **ft-pounds of torque**. A ft-pound of torque is equivalent to one pound of force applied to a wheel one foot from the center of rotation. Do not confuse ft-pounds of torque with the linear ft-pounds we discussed earlier. A ft-pound of torque performs 6.29 linear ft-pounds of work for every rotation of an axle.

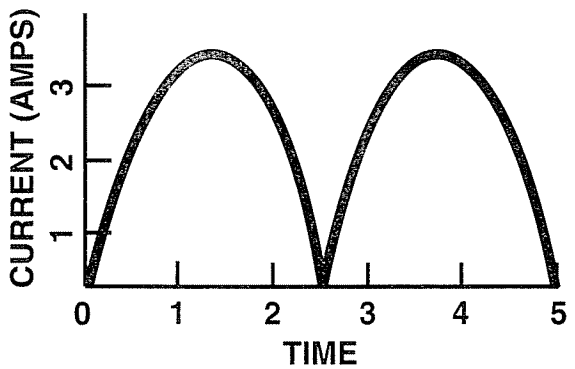
To determine horsepower, we multiply the ft-pounds of torque by the revolutions per minute (rpm) of the axle and divide by the number 5,250. If we were to apply 75 ft-pounds of work to the crank in the illustration on the facing page, and sustain a rate of 70 revolutions per minute, that would generate one horsepower.

$$\frac{\text{75 ft-pounds of torque x 70 revolutions per minute}}{5{,}250} = \frac{5{,}250}{5{,}250} = 1 \text{ hp}$$



BE.1.16.9

The potential difference in a storage battery remains relatively constant over time, producing a constant current when connected to a circuit.



BE.1.16.10

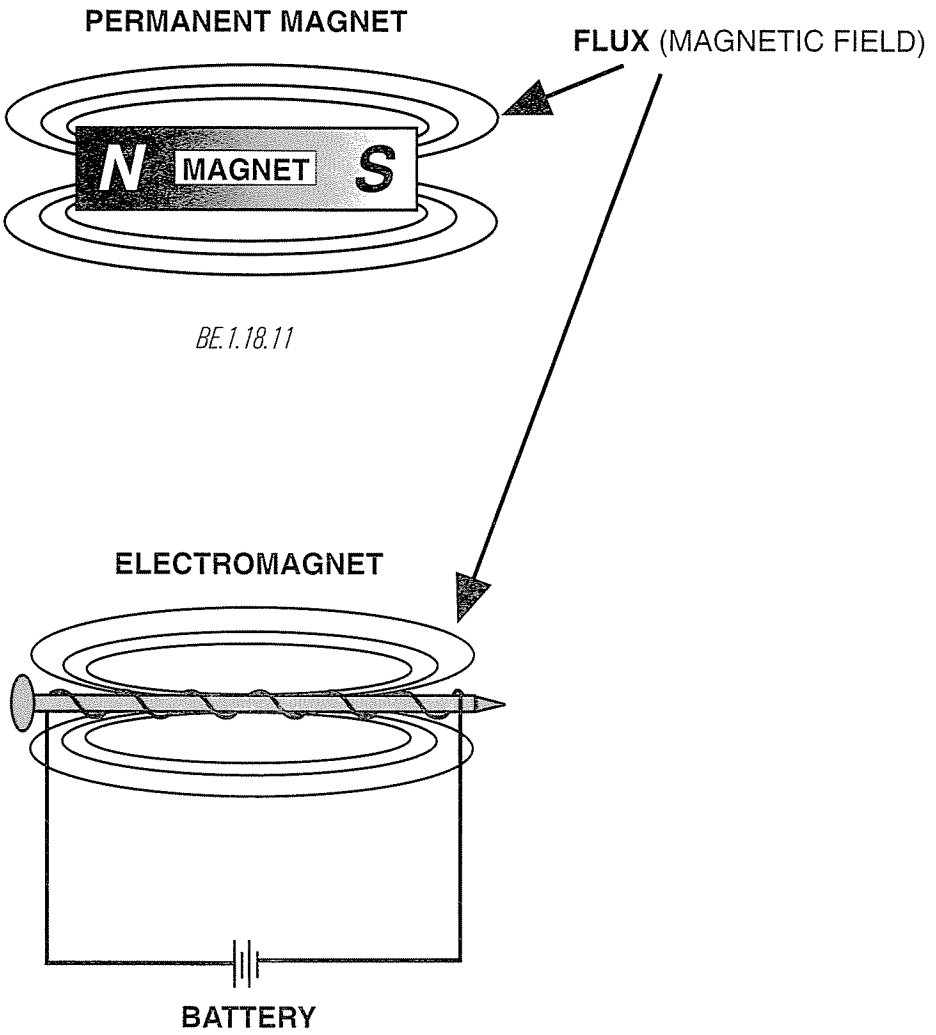
The potential difference of a generator rises and falls as the armature moves through its cycle, creating a pulsating direct current.

Direct current

As we said earlier, all current arises from a potential difference between a body with an excess of free electrons and a body with a shortage of free electrons. Electrical current continues as long as the potential difference exists. When the direction of the current remains constant, as in a battery, it's called **direct current** (**DC**).

Direct current is typically generated in two ways. **Storage batteries** use a chemical reaction to accumulate surplus electrons at the negative output (**anode**). This results in a fairly constant potential difference and, when a circuit is formed, constant current (see figure BE.1.16.9 on the facing page).

Generators, which we will discuss in greater detail in a few pages, are built around a rotating shaft. In most generators, the potential difference created and the current generated rises and falls with each turn of the shaft (see figure BE.1.16.10). This is called **pulsating direct current**.



BE.1.18.11

BE.1.18.12

- *Electricity flowing through a coil of wire creates a magnetic field.*
- *A bar of steel or iron placed within such a magnetic field will become magnetized as long as electricity continues to pass through the coil.*
- *Magnetism remaining in a metal bar after the electrical current has stopped is called residual magnetism.*

Magnets and electromagnetism

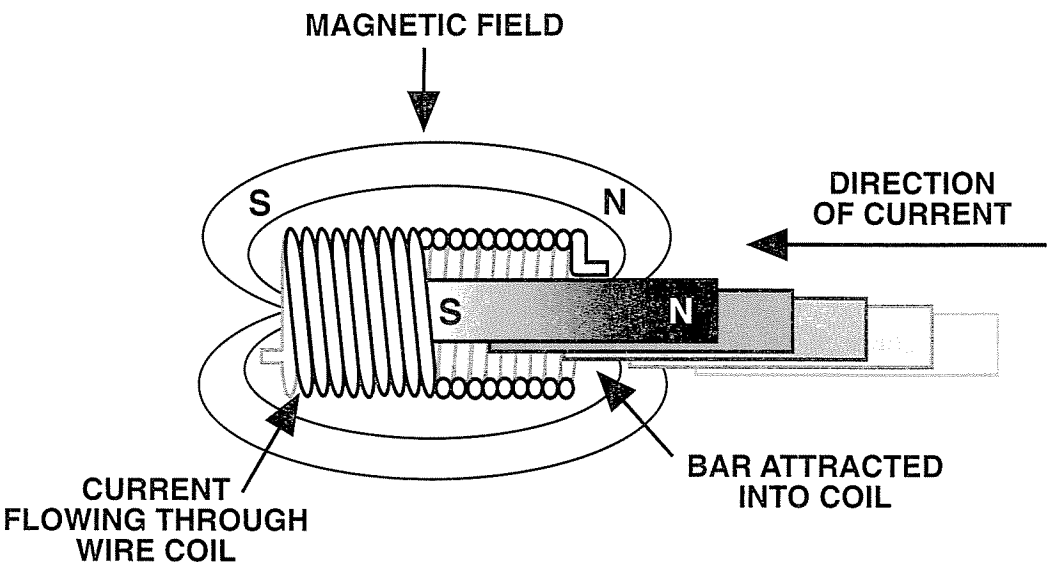
A **magnet** is an object (usually made of iron or steel) that attracts iron or steel. Magnetic attraction is not uniform around an entire magnet, but is instead concentrated at opposite ends called **poles**, labeled north and south to correspond with the earth's magnetic field.

Areas where magnetism is present around a magnet or between two magnets are called **magnetic fields**, and the magnetism itself is called **flux**. The stronger the magnetic field, the greater the amount of flux.

If you've ever handled two magnets, you've seen how the like magnetic poles repel and the opposite poles attract. A compass is simply a small magnet that is allowed to spin freely until its south pole (typically labeled with the letter "N") points towards the earth's north pole.

Most of the magnets we see are **permanent magnets**. They have been magnetized and retain their ability to attract steel and iron indefinitely. **Electromagnets** can be magnetized and demagnetized at will. They are created by placing a coil of insulated wire around a piece of iron or steel, such as a common nail.

When current passes through the coil, it induces a magnetic field which magnetizes the nail. When the current is shut off, the magnetic field collapses and the nail loses its magnetism. The magnetism that remains in the nail when the current is shut off is called **residual magnetism**.



BE.1.20.13

Solenoids

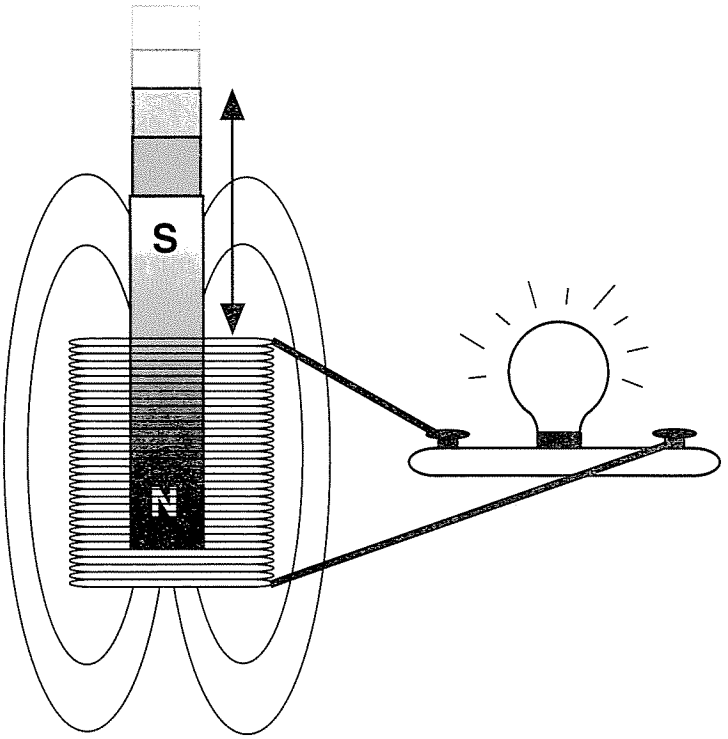
When an iron or steel bar is placed near either end of the magnetic field created around a coil of wire, the magnetic field will try to pull the bar into the center of the coil. This is one of the most fundamental ways electrical energy can be converted to mechanical energy.

Electricity at work — solenoids

Magnets and electromagnetism are the key to converting electrical energy into mechanical energy and vice versa. We've already discussed how magnetism can both attract and repel. And in talking about the electromagnet, we saw how we can create a magnetic field by passing a current through a coil of insulated wire.

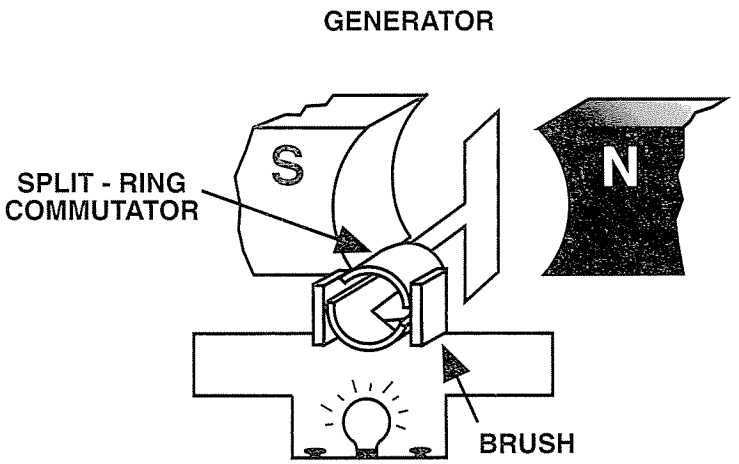
By combining these two ideas, we can create the most fundamental electro-mechanical device: **the solenoid**. A solenoid is similar to an electromagnet in the respect that it requires both a coil of wire and a steel or iron bar. However, unlike an electromagnet, the bar in a solenoid is allowed to move freely, instead of being fixed within the coil.

When current is passed through the coil, a magnetic field is created that pulls the bar until it is centered within the coil. As a result, electrical energy in the coil is converted into the linear mechanical force of the moving bar. Depending on where the bar is placed and what it is connected to, a solenoid can be used to create a pushing or pulling force.



BE.1.22.14

Just as electrical current in a coil of wire can create a magnetic field, moving a magnetic field through a coil of wire can induce electrical current in the coil.



BE.1.22.15

- *Generators use a mechanical energy source such as steam or falling water to rotate a coil of wire (or armature) within a magnetic field and induce the flow of electrical current through the wire.*
- *Induced current is greatest when coil moves through lines of flux at a 90° angle.*
- *No current flows when coil moves parallel to lines of flux.*

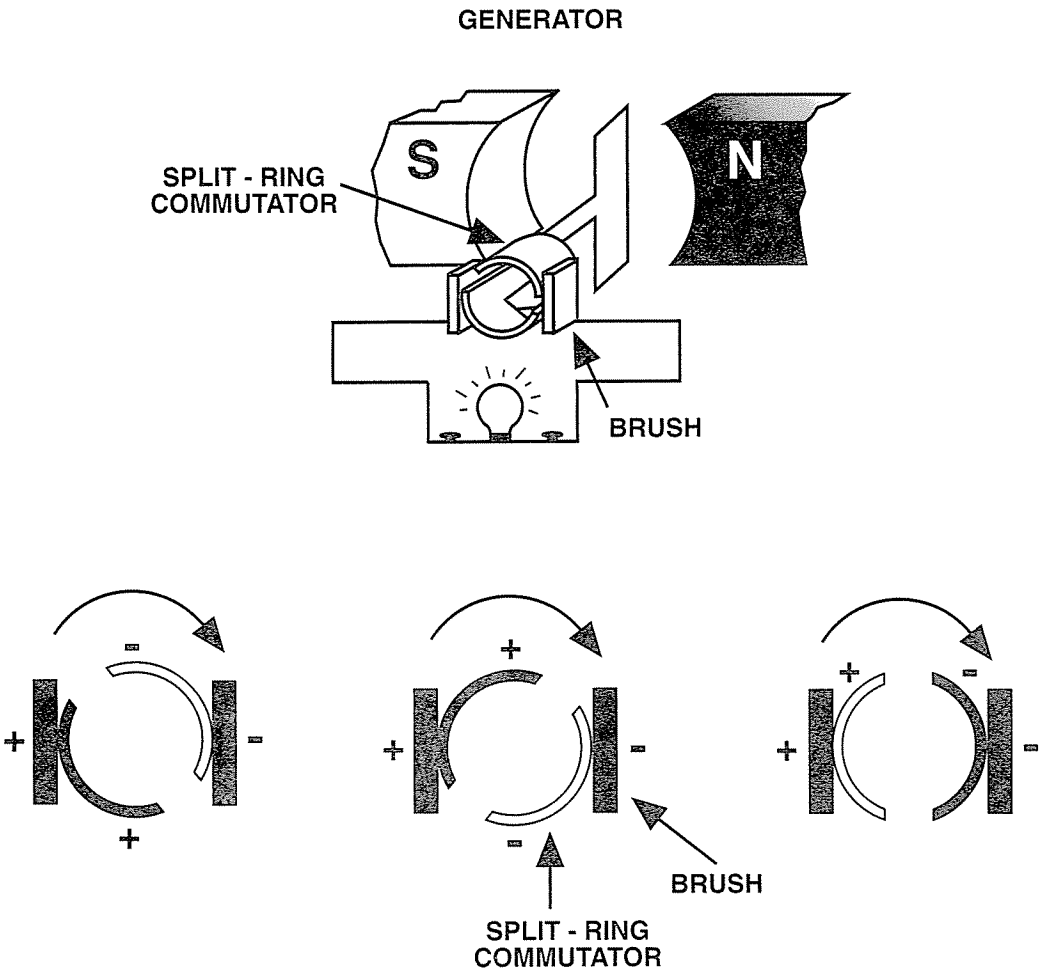
Electrical generation — direct current

We've seen that electrical current can create a magnetic field used to make electromagnets and solenoids. However, the opposite is also true, that a magnetic field can be used to induce current in a conductor. If we pass a magnet through a coil of wire, or move a coil of wire over a magnet, the magnetic field will induce the flow of current within the coil.

In most commercial generators, the magnet stands still and the coil of wire (called an **armature**) rotates within its magnetic field. As the armature cuts through the lines of flux that flow between the poles of the magnet, current is induced in the wire.

Unlike the constant potential of a battery, this type of generator creates an ongoing series of current fluctuations as the graph in figure BE.1.16.10 shows. This is known as **pulsating direct current**.

For each half rotation of the armature, the current starts at zero with the wire moving parallel to the lines of flux. The current increases to its maximum level at the point where the wire cuts through the lines of flux at a 90° angle. The current then returns to zero a quarter of a rotation later when the wire again moves parallel to the lines of flux.



BE.1.24.16

Split-ring commutators pass current to a different brush every half rotation of the armature. This ensures that the current flowing to the brushes doesn't change direction when the loop is "upside down" for half of every cycle.

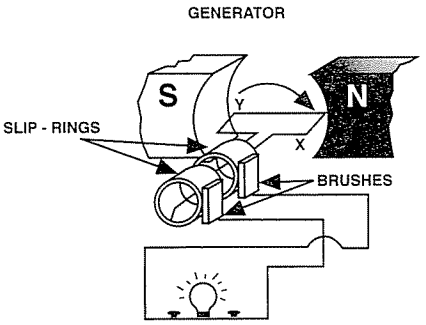
Direct current generation (cont'd.)

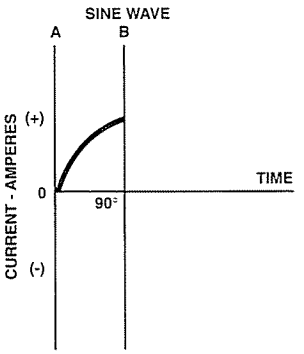
At this point, the armature has completed one half rotation through the magnetic field, starting at zero current, moving to its maximum current and then returning to zero. Now, however, things get a little tricky as the rotor begins its second half of a rotation.

The wire loop, through which current passed in one direction during the first half rotation, will now be "upside down" relative to the magnetic field for the next half of rotation. So the forces that induced current to flow through it in one direction during the first half rotation will now be pushing current in the opposite direction for the second half rotation.

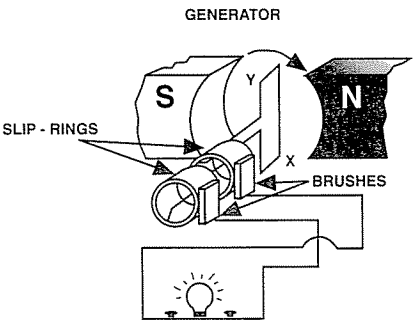
If this sounds confusing, hold out your hand and picture a magnetic field inducing current to flow from your thumb to your small finger, just as it would in the wire loop. Now rotate your wrist half a turn and you'll see that the same magnetic field will now induce current to flow through your hand in the opposite direction, from your small finger to your thumb.

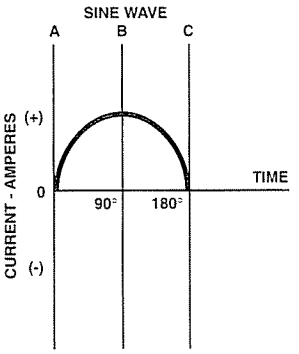
As a result, DC generators require special **split-ring commutators** for drawing current from the end of the wire loop as the armature rotates. These pass current to a different contact (or **brush**) for each half of the armature cycle. That is, each brush makes contact with each end of the wire for only half a rotation. So current reaching each brush is always flowing in the same direction, regardless of the position of the armature.



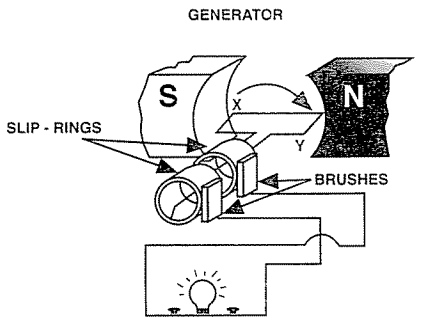


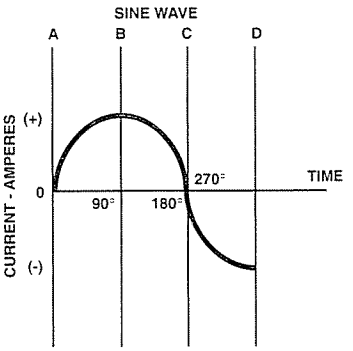
Current increases as armature cuts through lines of flux.





Current decreases to zero when armature moves parallel to lines of flux.





Current increases again. But since armature is "upside-down" for the second half of the rotation, current flows through wire in the opposite direction.

BE.1.26.17

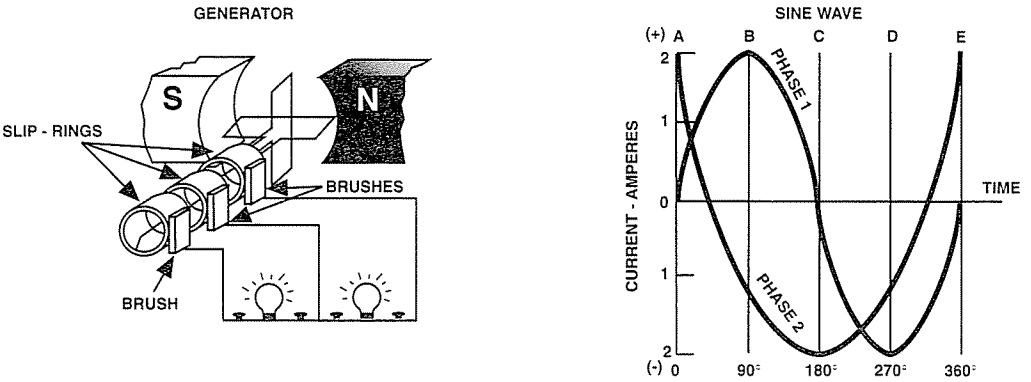
Alternating Current is the natural product of rotating a wire loop within a magnetic field. The current alternates because it's induced to flow in one direction for half of the rotation and in the opposite direction for the remainder of the rotation.

Electrical generation — alternating current

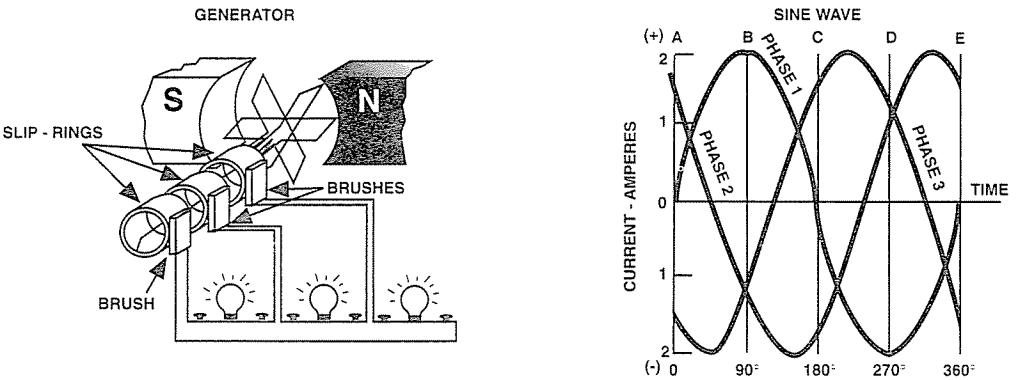
As we saw in the discussion about generating direct current, when an armature rotates through a fixed magnetic field, current moves through the armature coil in different directions at different points in its rotation.

If we were to continually draw power off the same end for an entire rotation of the armature, we would see current increase for the first 90° of its rotation and decrease for the second 90° of rotation. It would then repeat the exact same pattern for the next half rotation, with the current flowing in the opposite direction.

The result is **alternating current** — current that changes the direction of its flow every half turn (or half cycle) of the armature. If we graph AC current, we use both sides of the horizontal zero line to show that each time the current rises to its maximum level and returns to zero, it does so in the opposite direction. A matched pair of up and down curves reflects one rotation of the armature coil, and is called one **cycle**. One cycle per second is called one **Hertz**, and abbreviated as 1 **Hz**.



In a two-phase system, the current graph for one phase will always be 90° ahead or behind the other phase.



In a three-phase system, the current from any two phases should be equal and opposite to the current in the third phase.

BE.1.28.18

In a multi-phase system, several coils are spaced evenly around the armature to maintain a more consistent flow of current throughout each rotation of the armature.

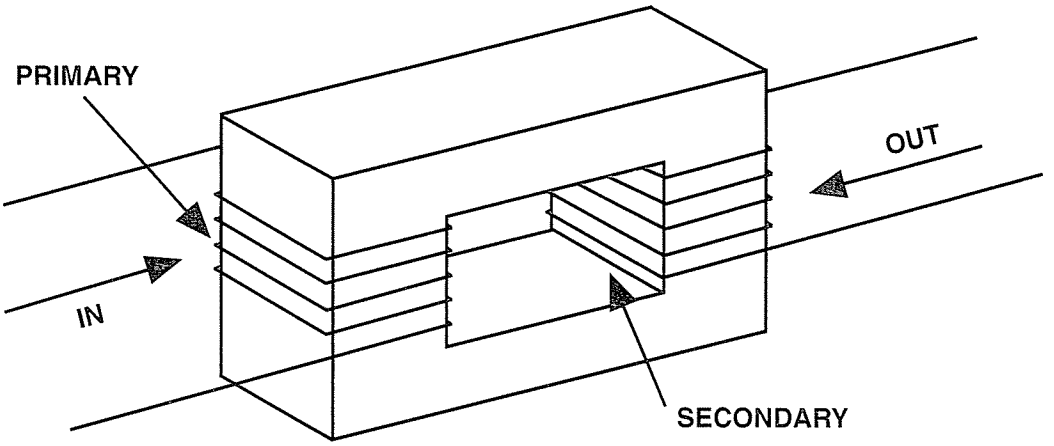
Multi-phase systems

Both the AC and DC generators that we have discussed produce a pulsating supply of current that continually increases and decreases as the armature rotates.

We can eliminate these fluctuations by attaching more than one coil to the armature. With two coils, the flow of current from one coil will always be 90° ahead or behind the other. This is called a **two-phase system**.

With three coils in a **three-phase system**, the current in one coil will always be equal to the opposite of the current in the other two coils combined. For instance, if one coil is producing a current of two amps in one direction, the other two will each be producing a current of one amp in the other. If one coil is at the zero line, the other two will be at equal amplitudes but in opposite directions.

Utilities distribute three-phase electrical power for use in large industrial motors that operate off the three synchronized 60 Hz current cycles. Most homes use single 60 Hz service.



BE.1.30.19

A transformer converts the pulsating AC current in the primary coil into a magnetic field that expands and contracts. As the field expands and contracts, it induces current in the secondary coil, where its voltage can be either stepped up or down, depending on the ratio of turns in the secondary windings compared to the number of turns in the primary windings.

Example:

A primary winding with 200 coils and an input of 12 volts will induce 60 volts in a secondary winding with 1,000 turns. If the secondary winding has only 100 turns, it will produce only 6 volts.

$$1{,}000/200 = 5 \times 12 = 60$$

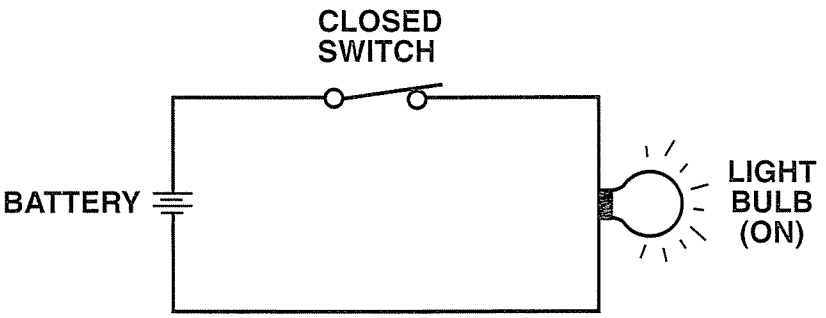
$$100/200 = 0.5 \times 12 = 6$$

Using transformers to increase or decrease voltage

A **transformer** uses electromagnetic principles to increase or reduce the voltage in a circuit. A typical transformer consists of a ring, or **core**, of iron with a coil of wire (called the **primary winding**) connected to a primary power source wound around one side, and a second coil of wire, the **secondary winding**, wound around the opposite side.

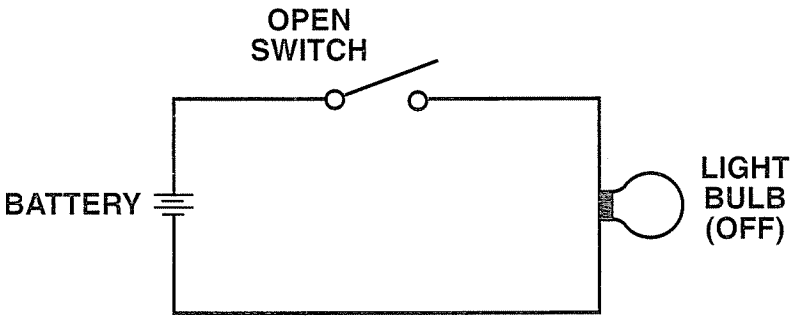
When the primary winding is connected to an AC power source, it generates a magnetic field that pulses and changes direction with each alternation in current. The iron core focuses this magnetic field around the loop and induces a corresponding current in the secondary winding. As the number of turns on the secondary winding increases, *current decreases* and *voltage increases.*

We can calculate exactly how much the voltage will be increased (**stepped up**) or decreased (**stepped down**) based on the ratio of turns in the secondary winding compared to the number of turns in the primary winding. If the secondary winding has twice as many turns as the primary winding, the voltage will be doubled. If the secondary winding has half as many turns, the voltage will be cut in half.



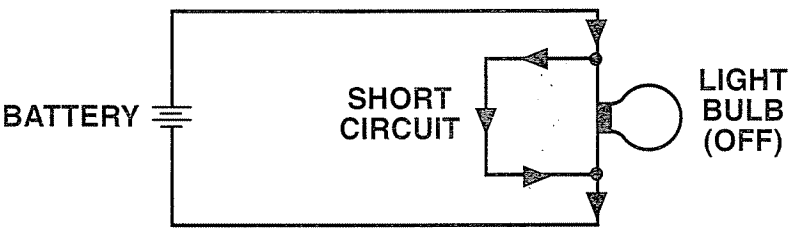
BE.1.32.20

A closed circuit allows current to flow without interruption.



BE.1.32.21

An open circuit interrupts the flow of electricity, shutting off the power.



BE.1.32.22

A short circuit is the result of a break in insulation or contact with another conductor, and causes the current to flow in unintended directions.

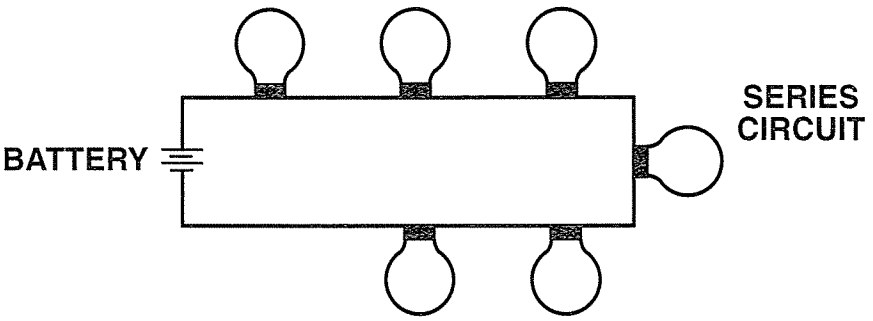
Some simple circuit terminology

Before we complete this module on Basic Electricity, we should return briefly to the core fact behind our business; **Electricity exists only in a moving circuit.** A battery or thundercloud may contain a significant potential, but neither produces any electrical energy until its potential is allowed to flow.

As you continue to learn about electricity, you will be expected to know the following terms used to describe different types of circuits. They are illustrated by the simple battery-powered DC circuit illustrations on the facing page.

A **closed circuit** allows current to flow without interruption. In lay person's terms, we would say the circuit is "on." An **open circuit** has a break in it (typically at a switch) that interrupts the flow of electricity. When a circuit is open, the power is "off."

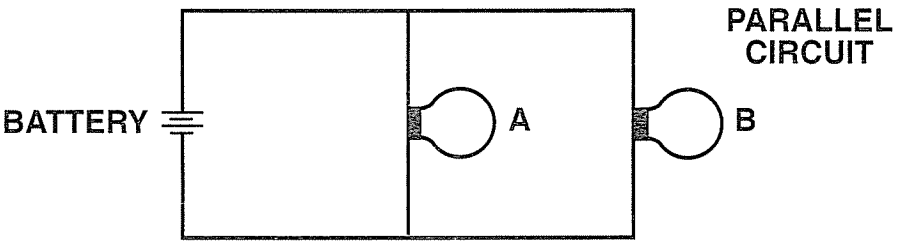
A **short circuit** occurs when a break in insulation or contact with another conductor provides an additional return path, usually with lower impedance than the intended circuit. So the current flows in directions or ways you didn't intend. In illustration BE.1.32.22, the short circuit bypasses the light so the bulb stays off. In more serious cases, a short circuit will draw more current than the wiring and switches in a circuit are rated for, resulting in damage to the circuit or an electrical fire.



Series Circuit

- *Voltage decreases as current passes through each bulb.*
- *If one bulb goes out, they all go out.*

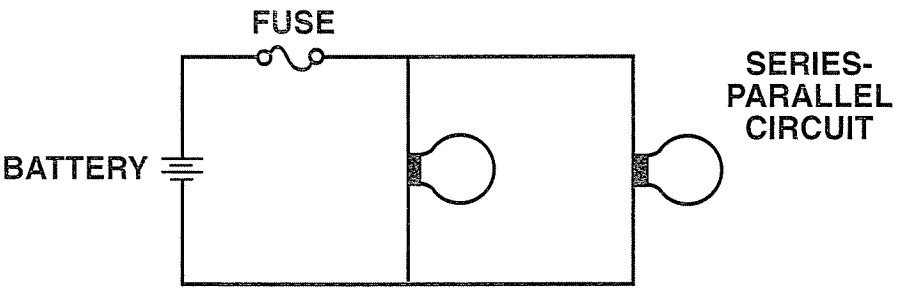
BE.1.34.23



In a Parallel Circuit

- *Each bulb receives the same current and voltage.*
- *If one bulb burns out, the other stays lit.*

BE.1.34.24



In a Series - Parallel Circuit

- *The fuse is in series to protect both circuits.*
- *The bulbs are in parallel, so the operation of one will not affect the operation of the other.*

BE.1.34.25

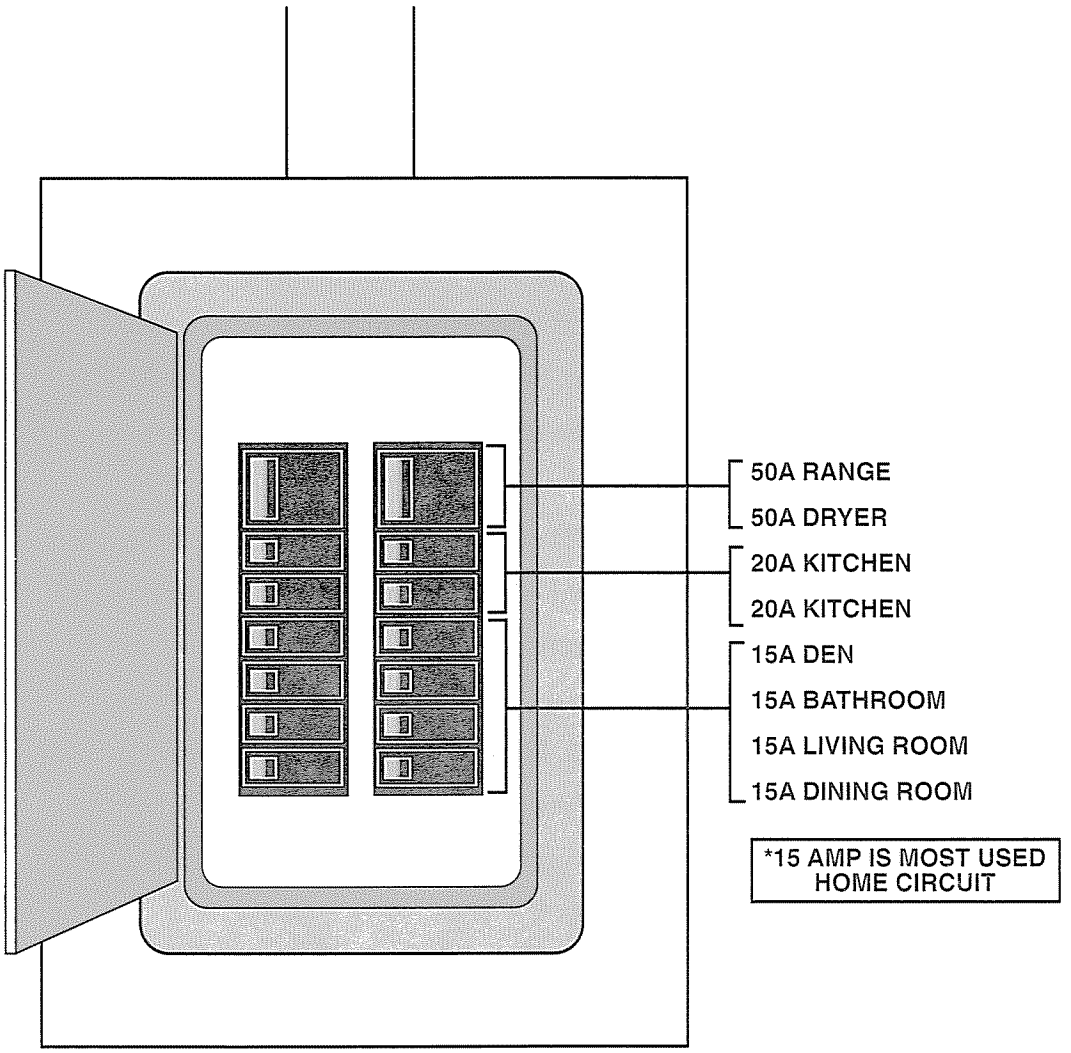
Circuit terminology (cont'd.)

When a circuit serves more than one power user, such as two light bulbs, it may be set up either one of two ways.

The light bulbs in figure BE.1.34.23 are in a **series** circuit, which means that all bulbs receive the same current, but each receives only one-sixth of the line voltage. If one bulb burns out, the circuit is broken and the entire series will go out.

The light bulbs in figure BE.1.34.24 are in a **parallel** circuit so all receive the same voltage, but the current is divided evenly between the two. If one burns out, the circuit containing the other remains closed, and the light will stay lit.

Finally, we have a hybrid circuit that contains both parallel and series circuitry as shown in figure BE.1.34.25. Here, the lights are installed in parallel so they will operate independently of each other. The fuse, on the other hand, is installed in series so all current flowing through the circuit must pass through it, and it can protect the entire circuit.



SERVICE ENTRANCE LOAD CENTER

BE.1.36.26

Some common voltages are

120V - Operates lights and small appliances
240V - Small motors, range, dryer, etc.
480V - Industrial voltage for larger motors and equipment

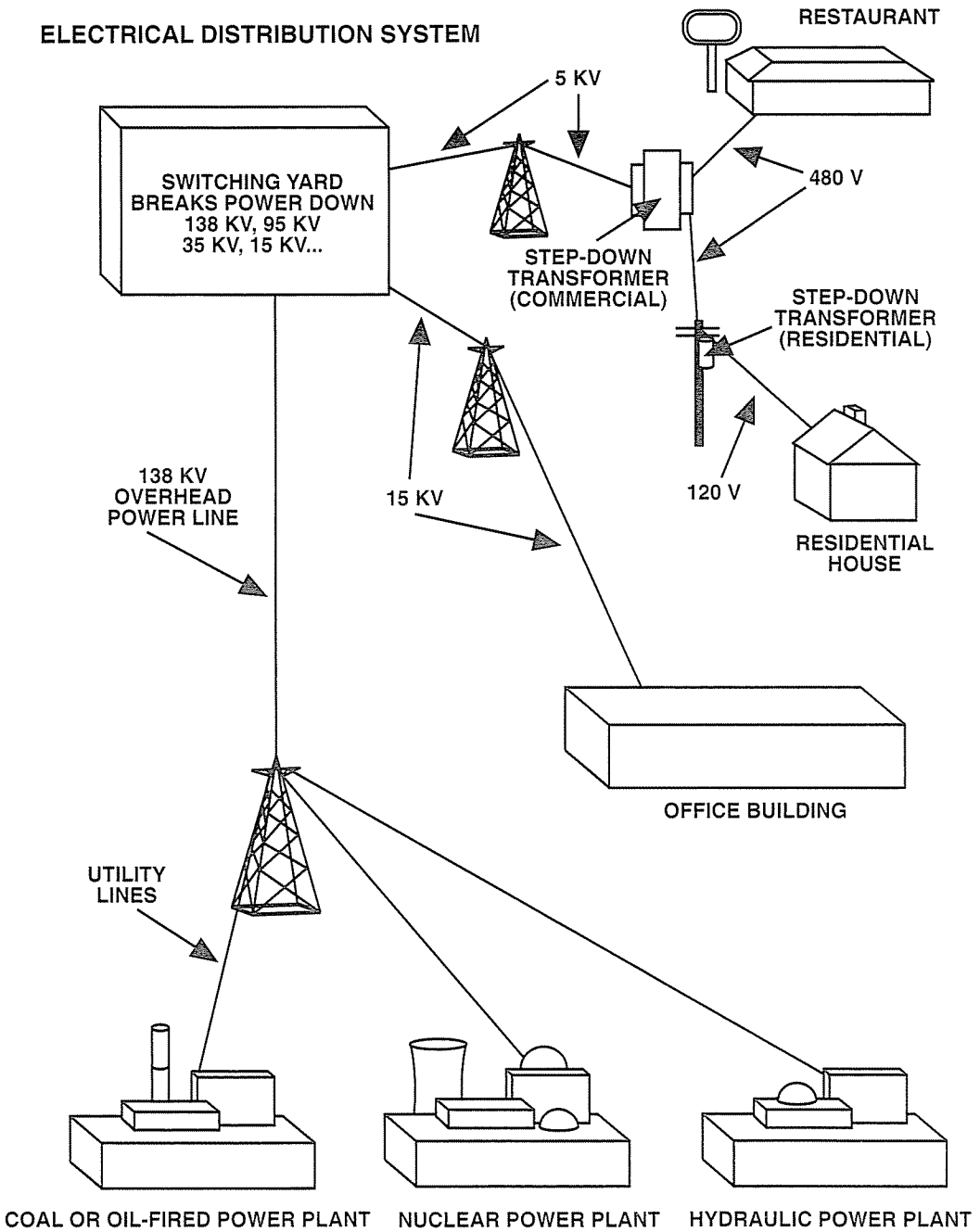
Electricity in your home

Most homes are served by two separate 120 volt circuits that are distributed from the load center or fuse box in a series of parallel circuits. The two main circuits are combined to deliver 240 volt 50 amp service to your electric range and clothes dryer. The rest of the applications in your home are served by individual 120 volt circuits with 15 - 20 amp capacities.

In most cases, kitchens will require at least two 20 amp capacity circuits because of the high resistance heating devices and the compressor motor on the refrigerator. Bedrooms and office areas will require less capacity for serving lamps, clocks and radios.

We can determine how many amps a circuit will require by adding up the power consumed by each of the appliances it serves. For this, we use a version of the power equation on page BE.1.12, that tells us that current is equal to watts divided by voltage (I=P/E).

In a bedroom, you may have four lamps drawing a total of 360 watts and a couple of clock radios drawing 60 watts each. The maximum current for the circuit will equal 480 watts/120 volts, or 4 amps, far less than the capacity of a typical 15 amp circuit breaker. However, if we add a bathroom to the circuit with four more 60 watt lamps, a fan motor drawing 60 watts and then plug in a hair dryer drawing 1,200 watts, the equation changes to 1,980 watts/120 volts or 16.5 amps. Such an arrangement would require either two separate 10 or 15 amp circuits or a single 20 amp circuit.


ELECTRICAL DISTRIBUTION SYSTEM
RESTAURANT
5 KV
SWITCHING YARD
BREAKS POWER DOWN
138 KV, 95 KV
35 KV, 15 KV...
480 V
STEP-DOWN
TRANSFORMER
(COMMERCIAL)
STEP-DOWN
TRANSFORMER
(RESIDENTIAL)
138 KV
OVERHEAD
POWER LINE
15 KV
120 V
RESIDENTIAL
HOUSE
OFFICE BUILDING
UTILITY
LINES
COAL OR OIL-FIRED POWER PLANT
NUCLEAR POWER PLANT
HYDRAULIC POWER PLANT

BE.1.38.27

Electricity in your town

The load center or fuse box in your home is the last step in a long distribution network that stretches all the way back to the utility's generators. The hundreds and thousands of miles of wire in this network pose a huge potential resistance problem for the utilities. As we said on page BE.1.7, resistance increases as the length of the conductor increases. And conductors with enough cross section to offer a significant resistance advantage over such long distances would be too heavy and expensive to use.

Utilities deal with this by stepping up the voltage on their long distance transmission lines as high as 745,000 to 1 million volts. That's because, as long as the total power output (watts) stays constant, the more the voltage increases, the more the amperage will go down. This is just a twist on the original power equation on page BE.1.12 that said: P[watts] = E[volts] x I[amps]. And since resistance increases in direct proportion to current, the lower the amperage in a circuit, the less of a problem resistance becomes.

This high-voltage strategy allows utilities to transmit large amounts of power over relatively thin conductors without significant power loss. Transformers then step down the voltage and step up the amperage for transmission over larger local distribution cable. The power that leaves the generating station at up to a million volts may step down to 34,500 volts for transmission to individual substations. The substations then step the voltage down to 2,400 volts for neighborhood distribution.

Large industrial machines may use the power at 2,400 volts while medium-size equipment typically uses 480 volt service. Commercial buildings typically distribute power at 480 volts and 208y/120 volts. Residential transformers reduce voltage to 240 volts, and they use two secondary windings to split 240 volt service into two 120 volt lines to power most lights and appliances found in the home.

Course Review

1) Electricity is a form of _____.

2) Other forms of energy include _____, _____ and _____.

3) Electricity flow consists of _____ in motion.

4) Materials with loosely held free electrons that can be induced to carry electrical current are called _____.

5) Bodies with more than the normal number of electrons carry a _____ charge.

6) Bodies with fewer than normal electrons carry a _____ charge.

7) It is the nature of all electrical current to flow from _____ charged bodies to _____ charged bodies.

8) The electrical equivalent of pounds per square inch in a water pipe is _____.

9) The electrical equivalent of gallons per minute in a water pipe is _____.

10) The electrical equivalent of friction in a water pipe is _____.

11) Materials with few free electrons that resist the flow of current are called _____.

12) According to Ohm's Law:

Voltage equals _____ X_____.

Amps equal _____ /_____.

Ohms equal _____ /_____.

13) Work consists of a _____ moving a mass over a _____.

14) In the U.S., we measure work in _____.

15) Power adds the element of _____ to work.

16) Horsepower is the ability to perform _____ of work in _____.

17) A machine that lifted 3,300 pounds 10 feet in 15 seconds will generate _____ horsepower.

18) A machine that generates 10 horsepower can lift a 2,750 pound block _____ feet in 10 seconds.

19) _____ is the electrical equivalent of work.

20) _____ is the electrical equivalent of horsepower.

21) In the equation P=IE, P represents _____, I represents _____ and E represents _____.

22) _____ is energy moving in a rotational direction.

23) Any measurement of the previous answer must include both a unit of _____ and how far from _____ it's applied.

24) In the U.S., we measure this in units of _____.

25) Horsepower equals _____ times _____ divided by 5,250.

26) A motor turning with 25 ft-pounds of torque and rotating at 2,100 rpm is generating _____ horsepower.

27) When the current flowing from a power source moves in only one direction, it's called _____.

28) When current flowing from a generator moves only in one direction, but rises and falls with each half turn of the generator, it's called _____.

29) Electrical current flowing through a coil of wire creates a _____.

30) The energy in a magnetic field is called _____.

31) A solenoid is one of the most basic ways to convert _____ into _____.

32) When an electromagnetic field is created by passing current through a coil and an iron bar is placed at one end of the coil, the electromagnetic force will _____.

33) Just as electrical current flowing through a coil can create a magnetic field, a magnetic field moving over a coil of wire can induce _____.

34) Induced current is greatest when a wire crosses a magnetic field at an angle of _____.

35) When an armature rotates in a magnetic field, the flow of current increases from zero to the maximum current output and back to zero every _____ rotation(s).

36) When a coil rotates in a magnetic field, the induced current will _____ every half rotation.

37) A split-ring commutator passes current from the end of the armature coil to a different _____ every half rotation.

38) When current from a generator flows in one direction for half a rotation and in the other direction for the other half rotation, it is called _____.

39) Each time current in this circuit flows first in one direction and then in the other, it has completed one _____.

40) One cycle per second is called one _____ .

41) When an armature in a generator holds two separate coils mounted perpendicular to each other, it is called a _____ system.

42) When an armature holds three evenly spaced coils, it is called a _____ system.

43) Utilities distribute _____ power for use by _____.

44) Most home applications use only _____ power.

45) A transformer consists of two separate wire coils, the _____ and the _____, joined by a ring of iron called the_____.

46) Alternating current flowing through the primary winding creates a pulsating _____ that changes _____ with each alternation in current.

47) The pulsating magnetic field created by the primary winding induces a _____ in the secondary winding.

48) This induced _____ in the secondary winding is determined by the ratio of _____ in the secondary winding versus the primary winding.

49) When the voltage leaving the secondary winding is higher than the voltage in the primary winding, the transformer is called a _____ transformer.

50) When the voltage leaving the secondary winding is lower than the voltage in the primary winding, the transformer is called a _____ transformer.

51) A transformer with 500 turns in the primary winding and 1,000 turns in the secondary winding will convert 12 volts of input into _____ volts of output.

52) A transformer with 1,728 windings in the primary coil and 288 in the secondary coil will convert 60 volts of input to _____ of output.

53) When a circuit is _____ current is flowing through it.

54) When a circuit is _____, no current is flowing.

55) In a short circuit, current flows _____.

56) When bulbs are wired in a series circuit and one bulb burns out, the other bulbs _____.

57) When bulbs are wired in a parallel circuit and one bulb burns out, the other bulbs _____.

58) In a series circuit, each bulb reduces the _____ available to each successive bulb.

59) In a parallel circuit, each bulb receives _____ current.

60) The current in a circuit can be determined by the total _____ divided by the _____.

61) A 120 volt circuit serving six 60 watt lamps and a 600 watt TV set requires a minimum _____ capacity.

62) Could a 1,200 watt hair dryer, 300 watt fan and four 75 watt bulbs operate on the same 120 volt, 15 amp circuit?

63) By stepping up the voltage that passes through their long-distance transmission lines, power companies reduce the level of _____.

64) As current in a conductor increases, _____ also increases.

BE.1.53

Name _____

Company _____

Address _____

_____

Answer Sheet - Basic Electricity

1) _____

2) _____

3) _____

4) _____

5) _____

6) _____

7) _____ _____

8) _____

9) _____

10) _____

11) _____

12) _____

13) _____ _____

14) _____

15) _____

16) _____ _____

17) _____

18) _____

19) _____

20) _____

21) _____ _____ _____

22) _____

23) _____ _____

24) _____

25) _____ _____

26) _____

27) _____

Answer Sheet - Basic Electricity

28) _____

29) _____

30) _____

31) _____ _____

32) _____

33) _____

34) _____

35) _____

36) _____

37) _____

38) _____

39) _____

40) _____

41) _____

42) _____

43) _____ _____

44) _____

45) _____ _____ _____

46) _____ _____

47) _____

48) _____ _____

49) _____

50) _____

51) _____

52) _____

53) _____

54) _____

Answer Sheet - Basic Electricity

55) _____

56) _____

57) _____

58) _____

59) _____

60) _____ _____

61) _____

62) _____

63) _____

64) _____

Please mail or Fax your answers to:
GE ED&C Training Dept.
41 Woodford Ave., Plainville, CT 06062
FAX: 860-747-7831

Glossary

AC power - power from an alternating current generator.
actuator - rotor-mounted element of a centrifugal starting switch.
AIC (ampere interrupting capacity) - the amount of short-circuit current safely handled by a circuit breaker or fuse.
air core transformer - a transformer in which the magnetic field generated by the coil passes through air to reach the second coil.
air circuit breaker - a circuit breaker normally housed in switchgear, where air is the medium in which circuit interruption takes place.
alternating current - an electric current that reverses direction each half cycle.
ammeter - a device that measures the magnitude of electric current.
ampere (amp) - a unit of electric current; a measure of the flow (or current) of electrons.
ampacity - the maximum continuous current capacity of an electrical device expressed in amperes.
anode - the negatively charged terminal of a primary cell or storage battery.
ANSI - American National Standards Institute.
armature - the moveable part of an electromagnetic device.
automatic transfer switch - equipment for automatically transferring one or more load conductor connections from one power source to another.
BIL rating (Basic Impulse Level) - indicates the ability of electrical equipment to withstand high-voltage waves often caused by lightning strikes.
bi-metal strip - a fabrication of dissimilar flat metal strips with different co-efficients of expansion.When heat is applied the strip bends, similar to thermostat operation.
branch circuit - the last circuit in a distribution system: in a home; leading to outlets: in industry; leading to motors, etc.
brush - a conductor used to maintain an electric connection between stationary and moving parts of a machine or apparatus.
bucket (draw-out unit) - a two-sided steel drawer that holds electrical components.
bus (busbar) - a copper or aluminum conductor used as a common connector at two or more joints.
busbar stabs - attachment points on a busbar that connect the busbar and a branch protector.
bus plug - a device that houses a protective device that attaches to busway.
cable drop - a free-hanging cable, unprotected by conduit and not fixed to a wall or ceiling, typically dropped from a bus plug to feed a load.
cathode - the positively charged terminal of a primary cell or storage battery.
center tap box - a tap box installed in the middle of a busway run to serve branch cable circuits.
circuit breaker - a device designed to open and close a circuit by non-automatic (manual) means, and to open the circuit automatically on a predetermined overload of current, without injury to itself when properly applied within its rating.
circuit breaker frame - a physical-size designation for a circuit breaker.
circuit overload - an excess current load beyond the ampacity rating of the device.
circuit protection device - a device that automatically disconnects the circuit in the event of an overload or short circuit, (i.e., a circuit breaker or fuse).

closed circuit - an electric circuit without an interruption in the current flow.
closed position - in a disconnect device, a state where the current is flowing without interruption.
coulomb - a unit of energy equivalent to one amp per second passing a point.
combination elbow - a preassembled section of busway, similar to an offset, but designed to change busbar orientation and direction into a third plane.
component - a term identifying each device used in a circuit.
conductor - a substance or medium, such as gold, silver, aluminum or copper that has many free electrons allowing electricity to flow very easily.
contact - a conducting part that co-acts with another conducting part to make or break a circuit.
contactor - a device for repeatedly establishing and interrupting an electric power circuit; a control device without circuit protection.
control circuit - the circuit that carries the electric signals directing the performance of a control device, but which does not carry the main power circuit.
control devices - individual devices used to execute a function.
control relays - relays that open and close circuits in industrial systems.
convenience receptacle - an outlet for the connection of a single attachment plug.
core - iron laminations in a transformer that provide a path for the magnetic field produced by the windings.
core and coil transformer - a specific type of transformer that is provided without a housing for OEM applications.
critical point - the point at which the current in a conductor exceeds the temperature rating of its insulation.
crosses - one of a series of premeasured and preassembled parts of a busway that add two additional circuits either up-and-down or right-and-left at 90 degrees to the original busway.
current - a flow of electricity, or the amount of electrons flowing past a specified circuit point per unit of time.
current limiting reactor - a coil or winding that limits the current that can flow in a circuit under short-circuit or other operating conditions.
current rating (continuous) - the amount of current a device or busbar can conduct on a continuous basis without exceeding its rated temperature. May or may not equal ampere rating.
cutout - an assembly of a fuse support with either a fuseholder, fuse carrier or disconnecting blade.
cycle - a period of time in which a full set of events takes place. In an AC power system, 60 cycles/sec. or 60 Hertz.
db - refers to transformer sound ratings; given in decibels.
delta connection - in three-phase transformers, three coils connected in a series to form a triangle, like the Greek letter "delta."
delta-wye transformer - a configuration of primary and secondary windings.
direct current (DC) - an electric current flowing in one direction.
disconnect - a device that allows circuits to be manually opened and closed.

disconnect device - an electrical switch that disconnects conductors from their source of voltage.
distribution panelboard - a panelboard in which 10% or less of the branch circuit breakers are rated for 30 amperes or less.
distribution section (feeder section) - a section of switchboard in which the main circuit is subdivided into feeder circuits; also houses disconnect or overcurrent devices.
distribution switchboard - a switchboard that divides the power from the feeder into branch circuits, each with its own power requirements and separate circuit breaker.
distribution transformer - a transformer used for transferring electrical energy from a primary to a secondary distribution circuit or consumer service circuit.
downstream load center - a subpanel to the principal load center.
draw-out unit (bucket) - an electrical assembly such as a circuit breaker or contactor that is mounted on a sliding rail assembly and disconnects via sliding, spring-loaded members rather than being "hard-wired."
driptight enclosure (NEMA 12) - an enclosure constructed to protect against falling drops of liquid or solid particles; for indoor applications.
dust-tight enclosure (NEMA 12) - an enclosure constructed so that dust will not enter the enclosing case; for indoor applications.
elbow - a premeasured, preassembled part of busway containing a single angle.
electromagnet - a soft-iron core wound with a current-carrying coil of insulated wire; can be magnetized or demagnetized by applying current.
electromagnetic coil - the coil that helps to form an electromagnet.
electromotive force - the energy per unit charge that is converted into electrical energy in a conversion device such as a battery or generator; measured in volts.
electron - a particle that orbits the nucleus of an atom and contains a negative electrical charge.
end box - a box placed at the end of busway to protect the busbar ends.
end tap box - a tap box at the end of a busway run transitioning a cable feed to busway.
energy - a capacity for work or action. Typical forms of energy are light, heat, sound and mechanical.
fast-acting fuse - a fuse that does not contain special time-delay elements.
fault current - an abnormally high current flowing as a result of a downstream short circuit.
feeder - a conductor that carries power from the main service to other distribution equipment or to a single large load such as a motor, transformer or run of busway.
feeder busway - busway sections used for transmission runs when no take-off accessories are required.
feeder section (distribution section) - section of a switchboard in which the main circuit is subdivided into feeder circuits; also houses disconnect or overcurrent devices.
flux - the rate of flow of energy in a magnetic field.
force - the capacity to do work or cause change.
free electron - one not bound to an atom; especially in a conductor where outer electrons can be easily displaced by other electrons and move in a current.
ft-pound - a measurement of work equal to the movement of one pound of mass for one foot.

ft-pound of torque - a measurement of torque equivalent to one pound of force applied to a wheel one foot from the center of rotation.
full load current - see current rating.
full neutral - a neutral cable or bus with current rating equal to phase cable or bus rating.
fuse pullers - a tool designed to remove fuses from fusible devices.
fusible device - a disconnect with fuseholders.
fusible disconnect - a type of disconnect that uses fuses to protect conductors and load devices from overloads and short circuits.
fusible main load center - a load center in which the main is a fusible puller disconnect.
fusible puller disconnect - a cartridge containing a fuse for each conductor.
gasketed enclosure (NEMA 1 Gasketed) - an indoor enclosure identical to NEMA 1 with the addition of rubber gaskets on the doors, door frames and cutouts to make it dust-resistant.
general duty disconnect - a disconnect used in residential and light commercial applications, and rated 240 VAC and/or 250 VAC maximum.
general purpose enclosure (NEMA 1) - an enclosure designed for standard indoor general-purpose applications.
generator - a machine containing a rotating shaft that converts mechanical energy into electrical energy.
GFCI (ground fault circuit interrupter) - a device that protects circuits and/or people from faults to ground.
ground - a conducting path (accidental or deliberate) through which current is transmitted to the earth. If deliberate, grounding is accomplished by connecting a cable or the third (grounding) wire in a cable between the load device and a metal rod in the earth.
ground fault - a fault between a live conductor and ground or enclosure or conduit.
ground fault protection - a device designed to monitor current between a live line and ground, and trip when a preset level is exceeded.
heater element - a part of a thermal overload relay that is connected to the motor power circuit and generates heat as the motor draws more current, and opens the circuit to prevent motor damage.
heavy duty disconnect - a disconnect of rugged construction designed for use in industrial applications. May be rated 240V or 600 VAC.
Hertz (Hz) - a unit of frequency; one cycle per second equals one Hz.
High-pressure contact switch - a fusible disconnect switch that provides high current-carrying capacity without sacrificing high interrupting fault performance, via Class C current-limiting fuses.
hold-in circuit - a part of a three-wire control that prevents the equipment being controlled from restarting until the start button is pushed again.
horsepower - a unit of power: 33,000 foot-pounds per minute or 550 foot-pounds per second.
hot phase conductor - any ungrounded conductor.
interlock - a mechanical or electrical device that ensures that one set of contacts is opened before another is closed.
insulator - materials that have few free electrons such as wood, fiber, plastic, vinyl, glass and paper, and therefore resist the flow of electricity.

interrupting capacity - the maximum value of short-circuit current which can be safely interrupted by a circuit breaker or fuse.
interrupting rating - a rating based on the highest current that the device is able to interrupt under the conditions specified.
isolation barrier - an insulator that supports and isolates a busbar and busbar stab from the metal walls of an enclosure.
isolation transformer - a multiple-winding transformer with the primary and secondary windings physically separated, which inductively couples its secondary winding to the primary winding.
joule - a unit of energy equal to the work done when a current of 1 ampere is passed through a resistance of 1 ohm for 1 second.
kilowatt - one thousand watts.
knockout - a circular hole partially punched out of an enclosure which, when punched out, allows conduit to be connected to the enclosure.
kVA - refers to power ratings stated in thousands of volt-amperes.
ladder diagram - a control schematic consisting of ladder-like lines.
lighting circuit - the circuit that carries power to lighting devices.
lighting panelboard - a panelboard with individual circuits wired to a single-phase conductor to create 120-volt or 277-volt single-phase circuits; one in which more than 10% of the branch circuit breakers are rated for 30 amperes or less.
limit switches - mechanism for controlling circuits; can be mechanically or pressure-operated as well as photoelectric and proximity types.
line side - terminals for power source connection.
line voltage - the voltage between the lines (phases) of the supplying power system.
load - the power demand created by electrical devices on a circuit.
load center - a sheet metal or non-metallic enclosure that contains main connections and circuit protective devices for residential applications.
load side - terminals for connecting conductors to the load.
low voltage power circuit breaker - a switchgear iron-frame air circuit breaker used in industrial and utility applications of 600 volts or less.
lug - a cable fitting attached to the line or load side of a breaker or disconnect.
magnet - a metal body that attracts iron and certain other materials by virtue of a surrounding field of force produced by the motion of its electrons and the alignment of its atoms.
magnetic controls - remotely controlled devices such as relays that use an electromagnet to pull the contacts closed and complete the controlled circuit.
magnetic field - area surrounding a magnetic pole; characterized by the existence of a magnetic force at every point.
magnetic motor starter - a motor starter that includes a coil and moveable armature that can be opened or closed by energizing the coil.
magnetic pole - two limited regions at which the magnetic field is most intense, designated by the approximate geographic direction to which it is attracted (north and south).
magnetism - a property of matter and electric current associated with a field of force.
main - the first conductor in a system; the first or principal device.

main circuit breaker load center - a load center that uses a circuit breaker as the main disconnect.
main circuit - the circuit in a distribution system that carries the largest current load.
main disconnect - a disconnect that feeds all other devices.
main lugs - connection devices used to accept line side cables.
main lug load center - a load center containing line lugs rather than a main circuit breaker or fuses.
main section (service section) - that portion of a switchboard into which the main service enters; may also include provisions for metering, disconnect and overcurrent protection devices.
maintained contact push button - a push button with no return spring - once pushed it stays in the off or on position until pushed again.
manual motor starter - a manual device consisting of a start/stop switch and a thermal overload relay, used to start and stop a motor.
manual switch - a manual device for opening and closing contacts.
mass - a unified body of matter.
master element - a hand-operated initiating device, such as a switch, used to place equipment in or out of operation.
mechanical interlock - a device that ensures that if one set of contacts is closed, another set of contacts cannot be closed.
metal clad switchgear (medium voltage) - medium-voltage circuit breakers inside an enclosure built to specified standards; serves as a distribution assembly.
metal enclosed switchgear (low voltage) - low-voltage power circuit breakers inside metallic enclosures built to specified standards; serves as a distribution assembly.
meter center - an enclosure that contains utility metering equipment as well as distribution and circuit protective devices; used in multi-family and apartment applications.
meter socket - jaws that hold the terminals of a plug-in watthour meter.
microcomputer - a small computer built around a microprocessor.
momentary contact push button - in both normally opened and normally closed push buttons, the effect of pushing the button lasts only as long as the button is held down.
motor circuit - the circuit that carries power to a motor.
motor circuit contactor - a heavy-duty relay rated for the high currents used in industrial motor applications.
motor conductor - see conductor.
motor control - an industrial control application involving the starting and stopping of electrical motors; the most common industrial control application.
motor control center - a metal enclosure housing motor controls and protective circuitry for many motors in one location.
motor control center wiring (Type A, B ,C; Class I, II) - the type and class designations for wiring motor control centers; refers to the degree to which wiring is performed at the factory by the manufacturer or on-site by the customer.
motor starter - a device used to start and stop motors; includes a switch or relay and an overcurrent protection device.
moveable contacts - contacts that move with the action of the switch or relay to open or close the controlled circuit.

MVA - refers to power rating stated in millions of volt-amperes.
negative charge - an upset in the electrical balance between the nucleus and the electrons that occurs in atoms with more than their normal number of electrons.
NEMA - National Electrical Manufacturers Association.
NEMA 1 enclosure (general purpose) - an enclosure rated for standard indoor general-purpose applications.
NEMA 2 enclosure (drip-proof) - an enclosure designed to be used indoors where dripping water or falling dirt may be present.
NEMA 3R enclosure (weather-resistant) - an enclosure designed for semi-protected, outdoor applications to provide a degree of protection against rain, sleet and external ice formation.
NEMA 4 enclosure (water-tight) - an enclosure specified anywhere non-corrosive fluids are moved in large quantities or hoses are present.
NEMA 12 enclosure (oil and dust-tight) - intended for indoor use to provide protection against dust, falling dirt and dripping, non-corrosive liquids.
neutral bus - in 3-phase 4-wire service, or in single-phase 3-wire service, a neutral bus can be located adjacent to the horizontal ground bus and is generally rated at one-half the main bus ampere rating or "full neutral," the same as the main power bus. The neutral carries the single-phase currents back to the source.
neutral lead - a fourth lead added at the junction of the three coils of the wye winding.
non-fusible disconnect - a disconnect device without fuses.
normally closed push button contacts - contacts which permit current to flow through a circuit unless the button is pushed.
normally opened push button contacts - contacts which prevent current from flowing through a circuit until the button is pushed.
ohm - a unit of resistance to the passage of a current.
Ohm's law - the relationship of voltage to current (amps) and resistance (ohms) in an electric circuit.
off-set - one of a series of premeasured and preassembled parts of busway that allow shifting of the busway up or down and left or right.
off position - when a device's moveable contact or blade is not in contact with the stationary contact.
on position - moving a disconnect to the on position, allows a completed circuit and enables current to flow from the line to the load.
open circuit - an electric circuit with an interruption in the current flow.
open position - in a disconnect device, a situation where current cannot flow.
operating current rating - see current rating.
overcurrent - any current in excess of the rated current of equipment or the ampacity of a conductor.
overcurrent protective device - a device to protect circuits from overload and short-circuit currents.
overload - loading in excess of the normal rated capacity of a circuit.
over travel - the brief, but continued movement of the operating arm in a limit switch after the contacts are closed.

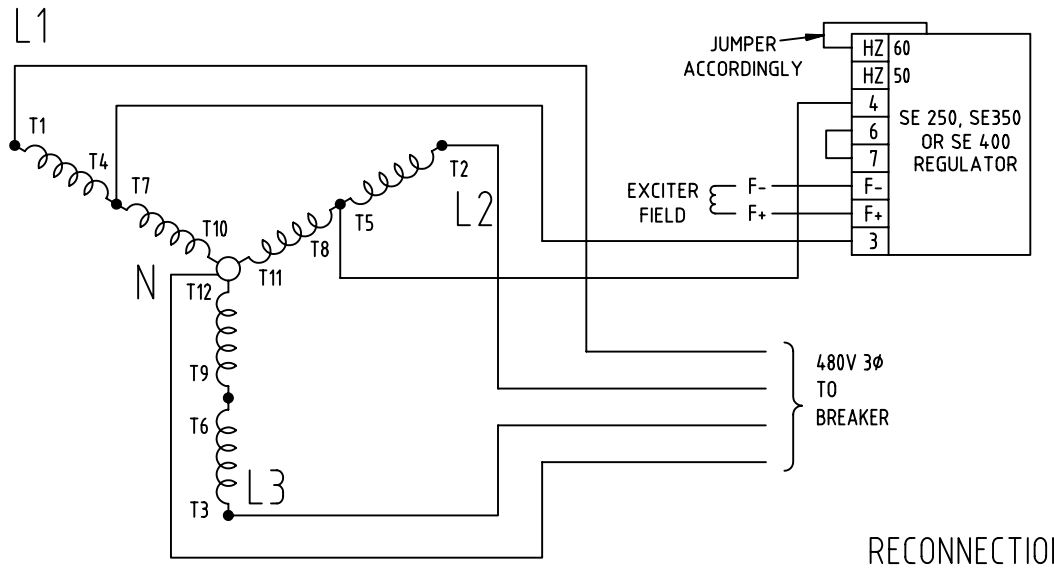
panelboard - one or more panel units assembled in a single enclosure and used as the service for medium-duty commercial and industrial applications; handles current levels to 1,200 amperes.
parallel circuit - a circuit in which current divides in its flow from one point to another.
permanent magnet - a material that retains its magnetic properties after being removed from a magnetic field.
phase unbalance - uneven current flow in a multi-phase circuit.
pilot light - indicates whether or not a device is energized.
plug-in busway - busway with conveniently spaced plug outlets for installing bus plugs; allows the connection of new equipment or circuitry.
pole - in a disconnect device, a hinged, moveable contact resembling a knife blade; in a circuit breaker, the number of ungrounded conductors the breaker will handle.
positive charge - an upset in the electrical balance between the nucleus and the electrons that occurs in atoms with fewer than their normal number of electrons.
potential difference - the electrical equivalent of work measured in volts instead of ft-pounds; also the difference in charge between two bodies.
power - the rate at which work is done; measured in units such as watts or horsepower.
pressure contact - the force exerted by one contact against the mating contact.
pressure switch - a pilot device with application in the control systems of hydraulic and pneumatic equipment.
pre-travel - in a limit switch, the movement of the operating arm before the secondary arm pushes the moveable contacts.
primary coil - the transformer coil connected to the power source.
primary switch - a switch feeding the primary or line side of a transformer.
protective equipment - the envelope containing circuit breakers or fusible devices.
pull section (modular metering) - an area in a meter center which houses lugs for connecting to the utility feed.
pull section (switchboard) - optional section of a switchboard used to accommodate underground entrances of utility service.
rectifier - a converter that changes alternating to direct current.
recording instrument - a device that makes a graphic record of the value of one or more quantities as a function of another variable, such as time.
relay - a device used to open or close contacts either automatically or by remote control.
residual magnetism - magnetism that is retained after an electromagnet's current is shut off.
resistance - the characteristic of a substance that inhibits the flow of electrons.
reverse current - current that flows in reverse of its normal flow.
riser - a vertical busbar.
schematic - the electrical blueprint of the components in an electrical circuit.
secondary coil - the transformer coil connected to the load.
secondary distribution switchboard - a switchboard fed by the secondary of a power transformer.
series circuit - a circuit in which the same current passes through each device in a series.
series connected rating - a rating based on the tested interrupting capacity of a combination of main and branch breakers.

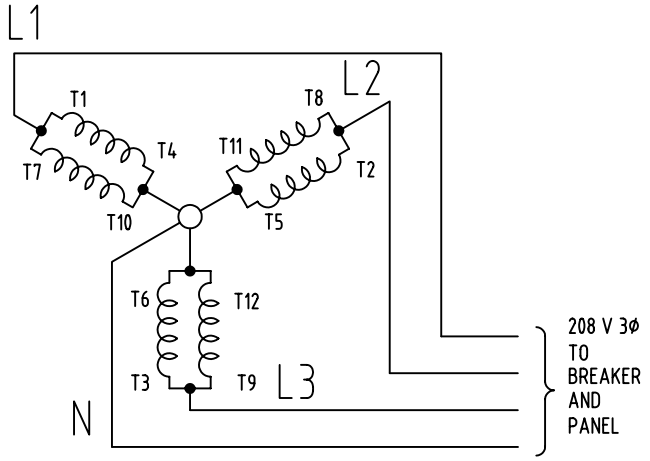
series connection - the arrangement of cells in a battery made by connecting the positive terminal of each successive cell to the negative terminal of the next adjacent cell so that their voltages are additive; or in equipment, the connection of a main breaker feeding a branch breaker.
service entrance - the point inside a building where a utility's power supply is connected to the building's electrical distribution system.
service section - that portion of a switchboard into which the main service enters; also may include provisions for metering, disconnect and overcurrent protection devices.
sheet metal enclosure - a metal box shaped to hold a variety of electrical distribution devices.
short circuit - an unintentional connection between two elements in an electric circuit that allows current to flow in unintended paths.
short circuit duty current rating - a rating that specifies the maximum short circuit current level that a protector must withstand without damage if a fault occurs.
shunt trip coil - a device that, when energized, trips the breaker and opens the circuit.
single-phase circuit - an alternating-current circuit with two conductors.
single pole double throw (SPDT) - a disconnect with one pole and two positions.
solid state programmer - an electronic current-sensing device.
solenoid - an electromagnet with wire coil and metal core.
splice-bar joint - a busway connection that uses busbars cut and shaped to connect end to end.
splits - units of one, two or three vertical sections of a motor control center or switchboard packaged for shipping.
split-ring commutator - a commutator that produces direct current by causing the armature brush to make contact for only one half of the cycle.
starting currents - a typically high initial flow of current in AC motors.
stationary contact - part of an electrical device that completes the circuit in conjunction with a moveable contact.
step-down - a power transformation from a higher to a lower voltage.
step-down transformer - a transformer with a turns ratio where the primary turns outnumber the secondary turns, resulting in decreased voltage.
step-up - a power transformation from a lower to a higher voltage.
step-up transformer - a transformer with a turns ratio where the secondary turns outnumber the primary turns, resulting in increased voltage.
storage battery - a rechargeable electrochemical cell, using lead-acid or nickel-cadmium, or other materials.
straight section - one of a series of premeasured and preassembled parts of a busway.
sub-feed lug configuration - a panelboard design in which the double main lug is attached to the main feed end of the busbars on the first panelboard.
sub-feeder - a secondary feeder.
subsystem - a part of a system containing two or more integrated components which do not fully perform the specific function of a system but can be isolated for design, test or maintenance.
substation - a group of equipment for switching power circuits and to transform power from one voltage to another.

switch - a device used to break, or open, an electric circuit.
switchboard - a sheet metal enclosure that contains distribution and control devices; performs similar functions to load centers and panelboards.
switch contacts - see contacts.
switching duty breakers (SWD) - breakers rated to control 120-volt fluorescent lighting.
switchgear - general term referring to switching and interrupting apparatus with control, metering and protective devices.
take-off accessory - an accessory to busway that allows circuits to be added or removed by simply plugging or unplugging them anywhere along the run.
tap - an available connection that permits changing the active portion of a device in a circuit.
tap boxes - an interchange between the busway, cable and conduit serving anything from a local circuit to a single machine.
tee - one of a series of premeasured and preassembled parts of busway.
terminal - the conducting element of a circuit intended for connection to an external conductor.
terminal block - an insulating base with terminals for connecting secondary and control wiring.
terminal lug - see terminal.
thermal overload relay - a heat-activated circuit protector; cuts current automatically in the event of a circuit overload by causing the starter to open.
thermostat - a temperature operated switch.
three phase motor circuit - an alternating current circuit with three ungrounded conductors.
three pole switches - switches that must open and close three ungrounded conductors simultaneously.
three step distribution system - a system containing a main circuit and feeder, subfeeder and branch circuits.
three wire control - a motor control with two momentary contact push buttons.
through-feed lugs - in a main breaker panelboard, these lugs are mounted on the phase bus at ends opposite the main breaker and feed a second panelboard section.
thru-bolt joint - a connector using a single thru-bolt with a belleville spring washer, used to connect busway sections end to end.
time delay fuse - a fuse that allows a disconnect to handle high starting current for a short period of time.
torque - a form of energy created by a turning or twisting force, such as in an electric motor.
transfer switch - permits the transfer of a conductor connection from one circuit to another.
transformer - a device used to raise or lower the voltage in an electrical distribution system.
transmission voltage - voltage at which power is carried over a long distance.
two pole switch - a switch with two sets of contacts.
two wire control - a control circuit consisting of one wire on either side of the push button contacts.

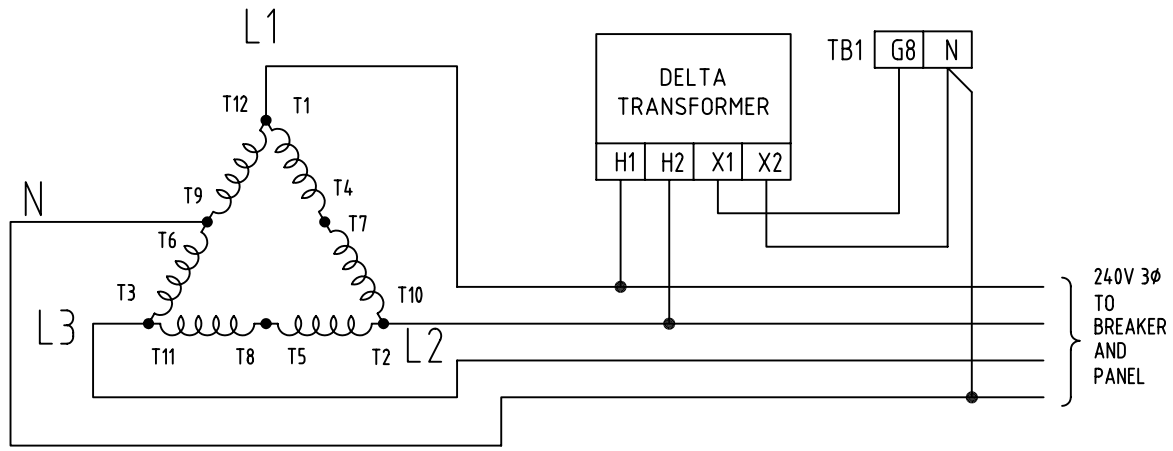
turns ratio - the relationship of the number of loops in the primary coil to the number of loops in the secondary coil in a transformer.
turns - coils in the winding of a transformer.
type of service - the voltage rating of the power entering a home or building.
unit substation - a substation consisting of one or more transformers connected mechanically or electrically with switchgear at the same location.
vacuum circuit breaker - a breaker whose contacts interrupt a circuit in a vacuum.
vertical sections - an independent unit of a motor control center or switchboard containing busbars, plug-in motor starters, and related auxiliary control devices.
volt - the International System unit of electric potential and electromotive force, equal to the difference of electric potential between two points on a conducting wire carrying a constant current of one ampere when the power dissipated between the points is one watt.
voltage rating - voltage that can be applied to an electrical device; may be nominal or maximum value.
voltmeter - an instrument for measuring voltage.
water-tight motor control enclosure (NEMA 4) - an enclosure designed for locations with large quantities of liquids or where hosedown may occur.
watt - a unit of electric energy in the International System equal to one joule per second.
watthour - a unit of electric energy equal to the energy of one watt acting for one hour; equivalent to 3,600 joules.
watthour meter - a device mounted outside a building that measures kilowatt (energy) usage.
weather-resistant motor control enclosure (NEMA 3R) - constructed with solid steel bottoms and tops and an overhanging sloping roof to protect components from wind, rain, snow and dust.
winding (primary) - a coil of wire wound around one side of a transformer core which receives the incoming AC power.
winding (secondary) - a coil of wire wound around one side of a transformer core which connects to the outgoing load.
wireway - a sheet metal trough that routes and protects electric wires and cable.
work - the effect of a force on a mass.
wye connection - in three-phase transformers, three coils with one lead from each joined at the center to form the letter "Y." This center position is the neutral conductor.

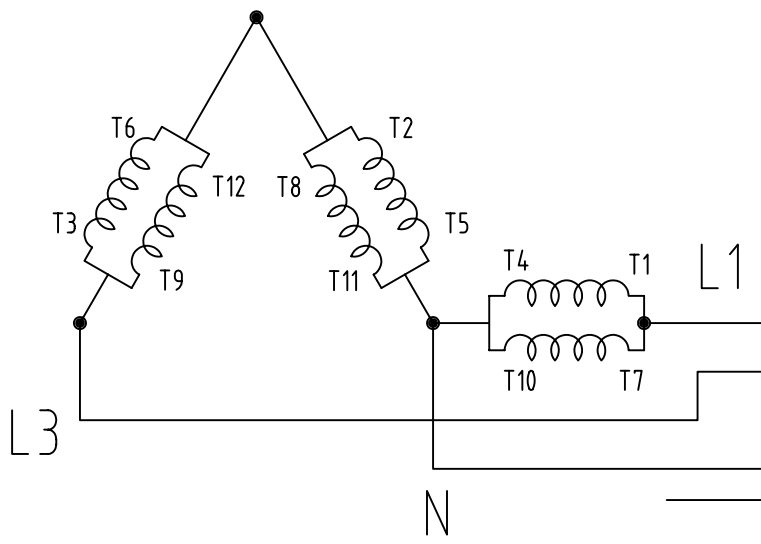
BE.1 1090 MAMJ





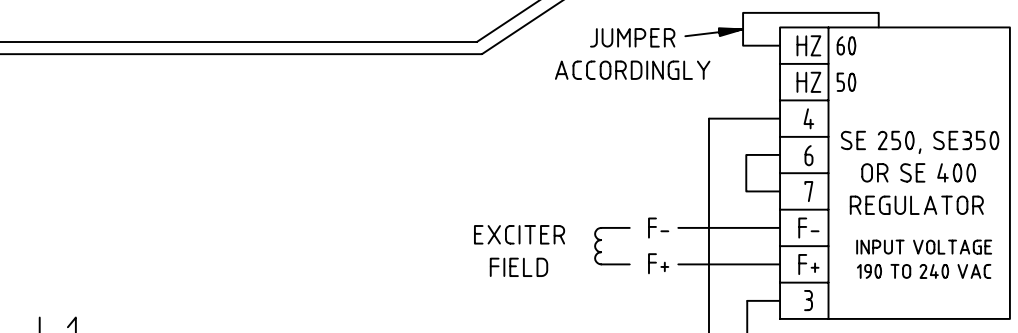
RECONNECTION DIAGRAMS



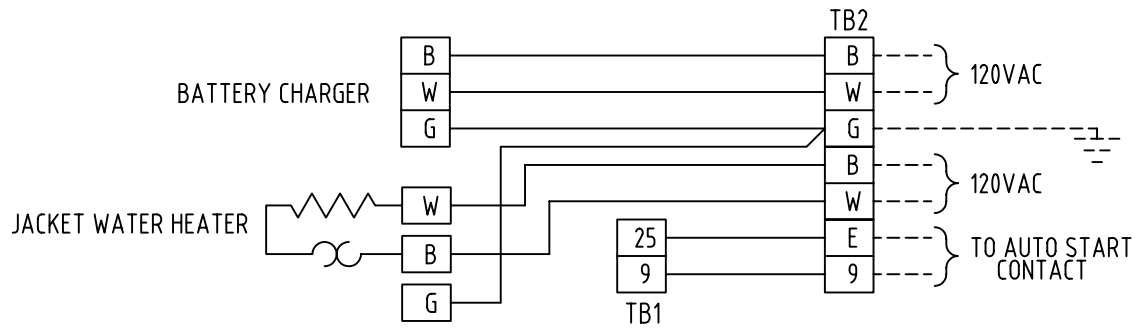


GENERATOR OUTLET BOX

NOTE:
1. TB2 IS LOCATED IN THE GENERATOR OUTLET BOX NEXT TO THE MAIN LINE CIRCUIT BEAKER.

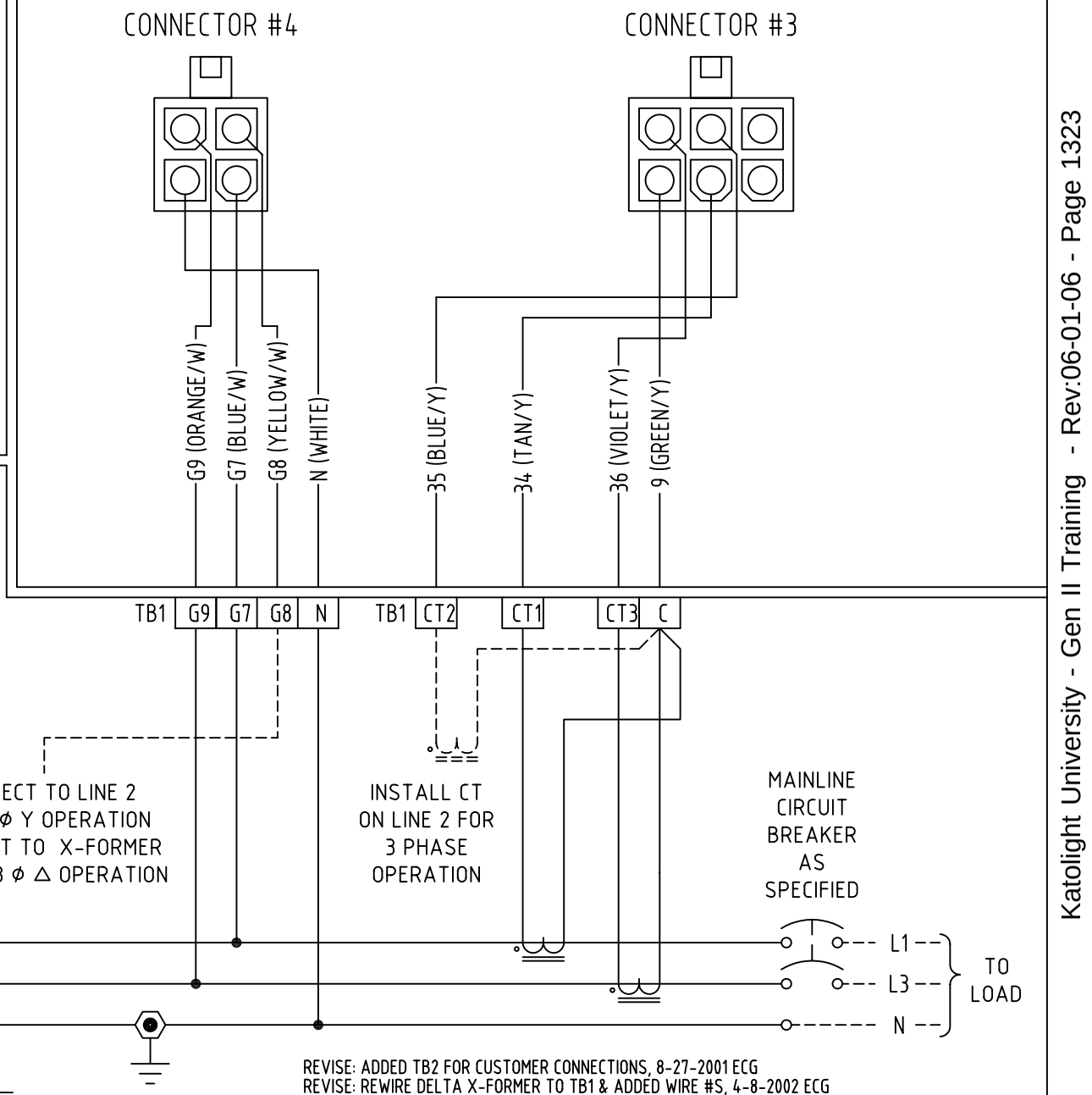


CUSTOMER CONNECTIONS



CONTROL PANEL

NOTE:
1. YELLOW/W WIRE IS CONNECTED TO LINE 2 WHEN UNIT IS WIRED FOR 3 PHASE OPERATION.
2. LT. BLUE/W WIRE IS CONNECTED TO LINE 2 CT WHEN UNIT IS WIRED FOR 3 PHASE OPERATION.
3. WIRE TRACE COLORS ARE AS FOLLOWS
   /R = RED STRIPE
   /Y = YELLOW STRIPE
   /W = WHITE STRIPE



REVISE: ADDED TB2 FOR CUSTOMER CONNECTIONS, 8-27-2001 ECG
REVISE: REWIRE DELTA X-FORMER TO TB1 & ADDED WIRE #S, 4-8-2002 ECG

KATOLIGHT
MANKATO, MINNESOTA

AC DIAGRAM

SIZE	DATE	DWG NO
B	7-27-2001	819-B-10775

DESCRIPTION	"SP" SERIES	DWN BY	ECG	SHEET	1 OF 1

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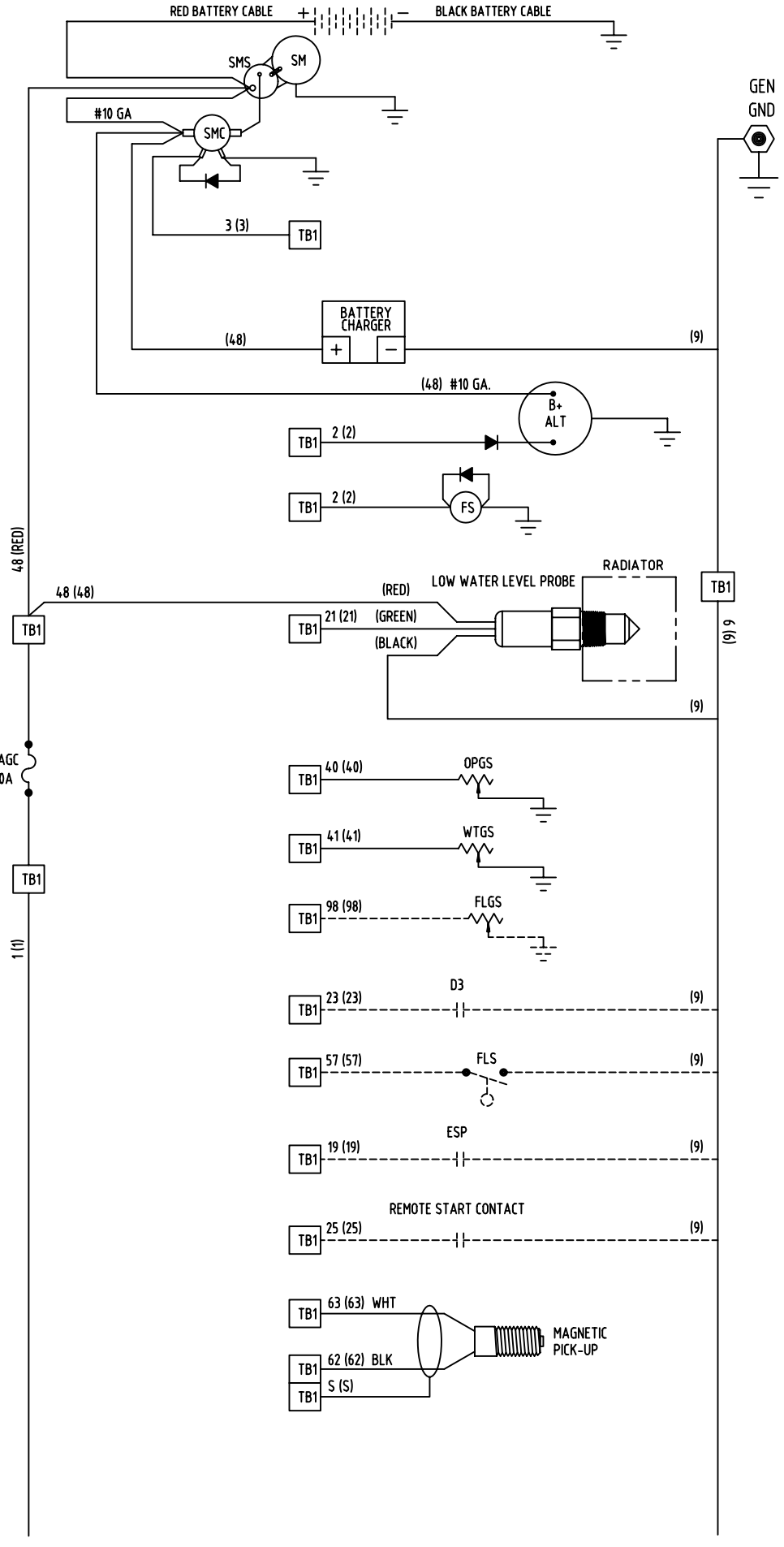

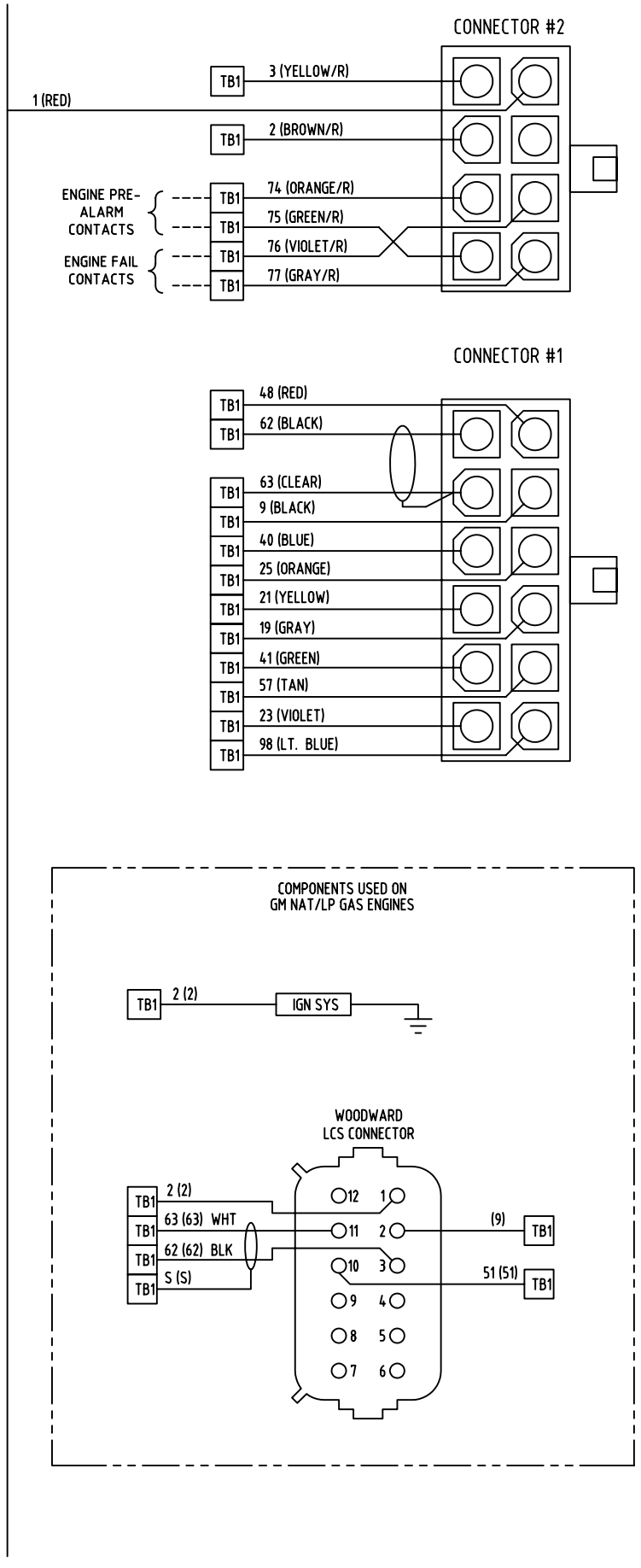

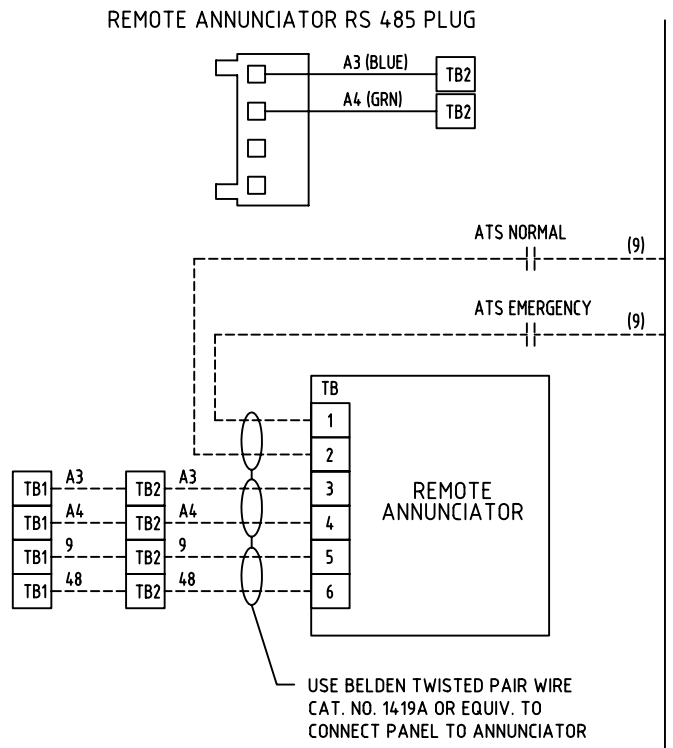

LEGEND

ALT	ALTERNATOR
D3	SPARE ALARM INPUT CONTACT
ESP	EMERGENCY STOP PUSHBUTTON
FS	FUEL SOLENOID
LWL	LOW WATER LEVEL PROBE
OPGS	OIL PRESSURE GAUGE SENDER
SM	STARTER MOTOR
SMC	STARTER MOTOR COIL PILOT RELAY
SMS	STARTER MOTOR SOLENOID
TB1	TERMINAL BOARD 1
WTGS	WATER TEMPERATURE GAUGE SENDER

CONTROL WIRING LOGIC:

48 (RED)	UNFUSED BATTERY POSITIVE
2	ENERGIZED TO RUN
3	ENERGIZED TO START
19	EMERGENCY STOP
25	REMOTE START
9	GROUND
51	GM ENGINE IDLE PROGRAM ACTIVATION TERMINAL

NOTE:
1. WIRE NUMBERS ARE IN PARENTHESIS.
2. ENGINE WIRING IS #16 GA UNLESS OTHERWISE SPECIFIED.
3. SHORT DASHED LINES (------) INDICATE CUSTOMER CONNECTION OR OPTIONAL EQUIPMENT.
4. DIESEL UNITS CONNECT FS AND DIODE, NATURAL GAS OR LP UNITS CONNECT IGN SYS. CUSTOMER MUST CONNECT FS.

REVISE: CORRECT ERROR ON PLUG 2 WIRING, 9-24-2001 ECG
REVISE: ADDED REMOTE ANNUNCIATOR 10-8-2001 ECG

KATOLIGHT
MANKATO, MINNESOTA

DC LADDER DIAGRAM

SIZE	DATE	DWG NO	
B	7-27-2001	819-B-10776	
DESCRIPTION	POWER PAK	DWN BY ECG	SHEET 1 OF 1

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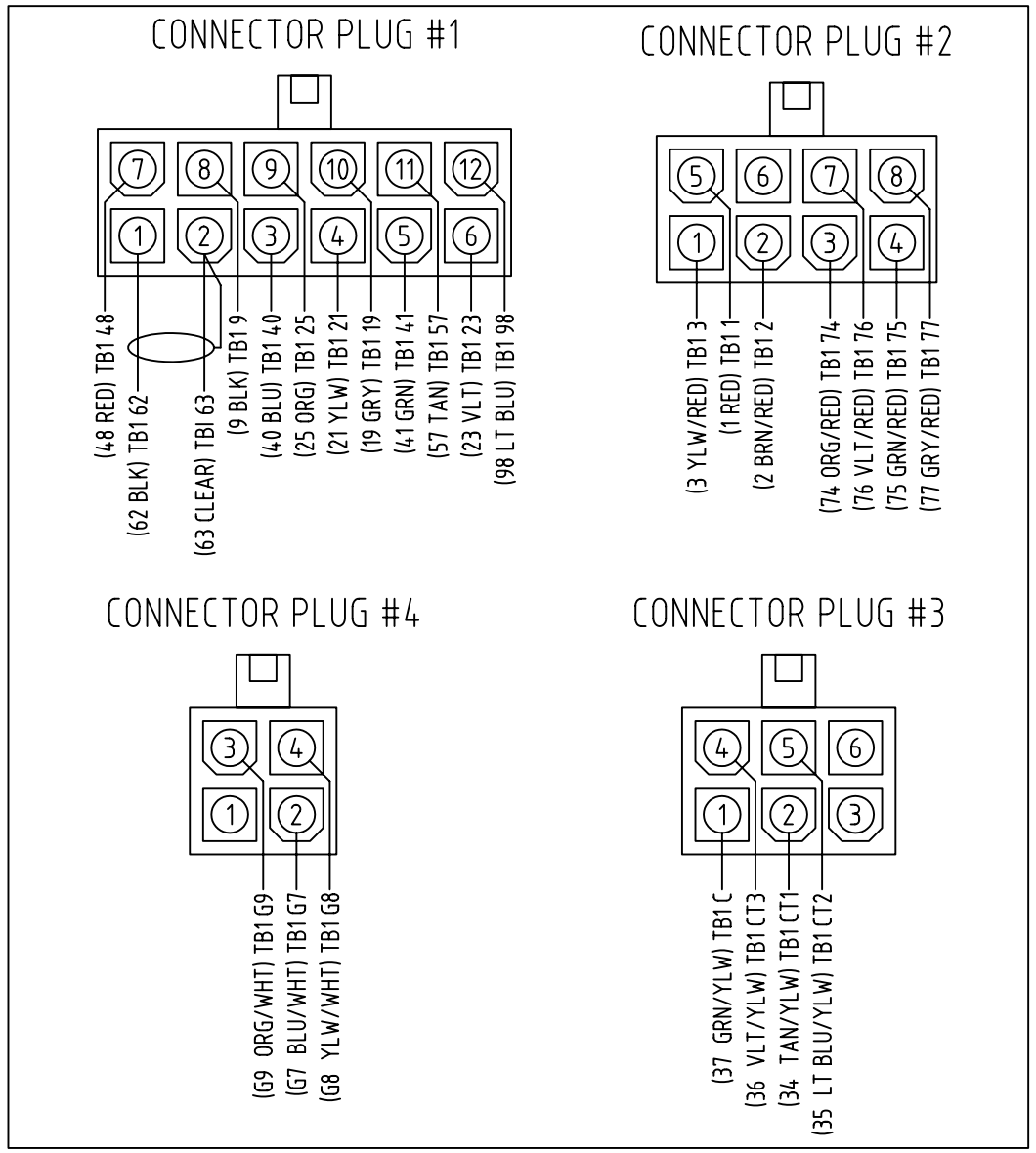

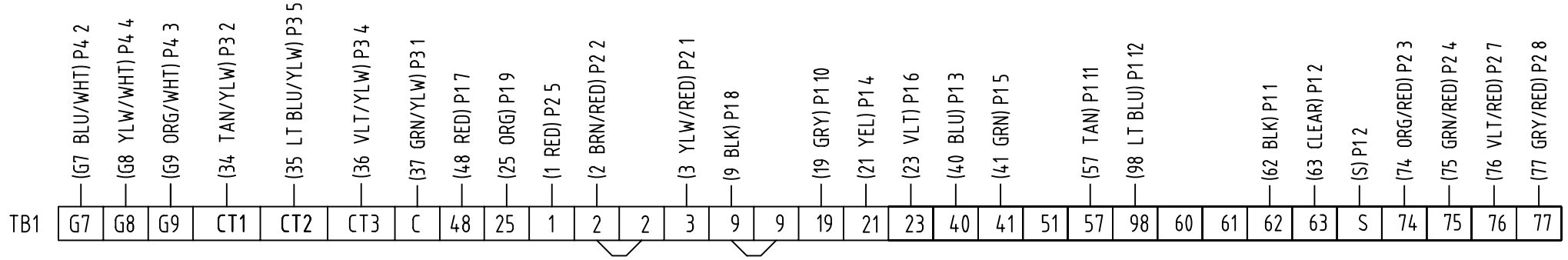

REVISE: ADDED WIRE NUMBERS; RENUMBER TB1 22 AS 21 & TB1 24 AS 23, 8-14-2001 ECG

KATOLIGHT
MANKATO, MINNESOTA

POINT TO POINT DIAGRAM

SIZE	DATE	DWG NO
B	7-27-2001	819-B-10777

DESCRIPTION	DWN BY	SHEET
POWER PAK	ECG	1 OF 1

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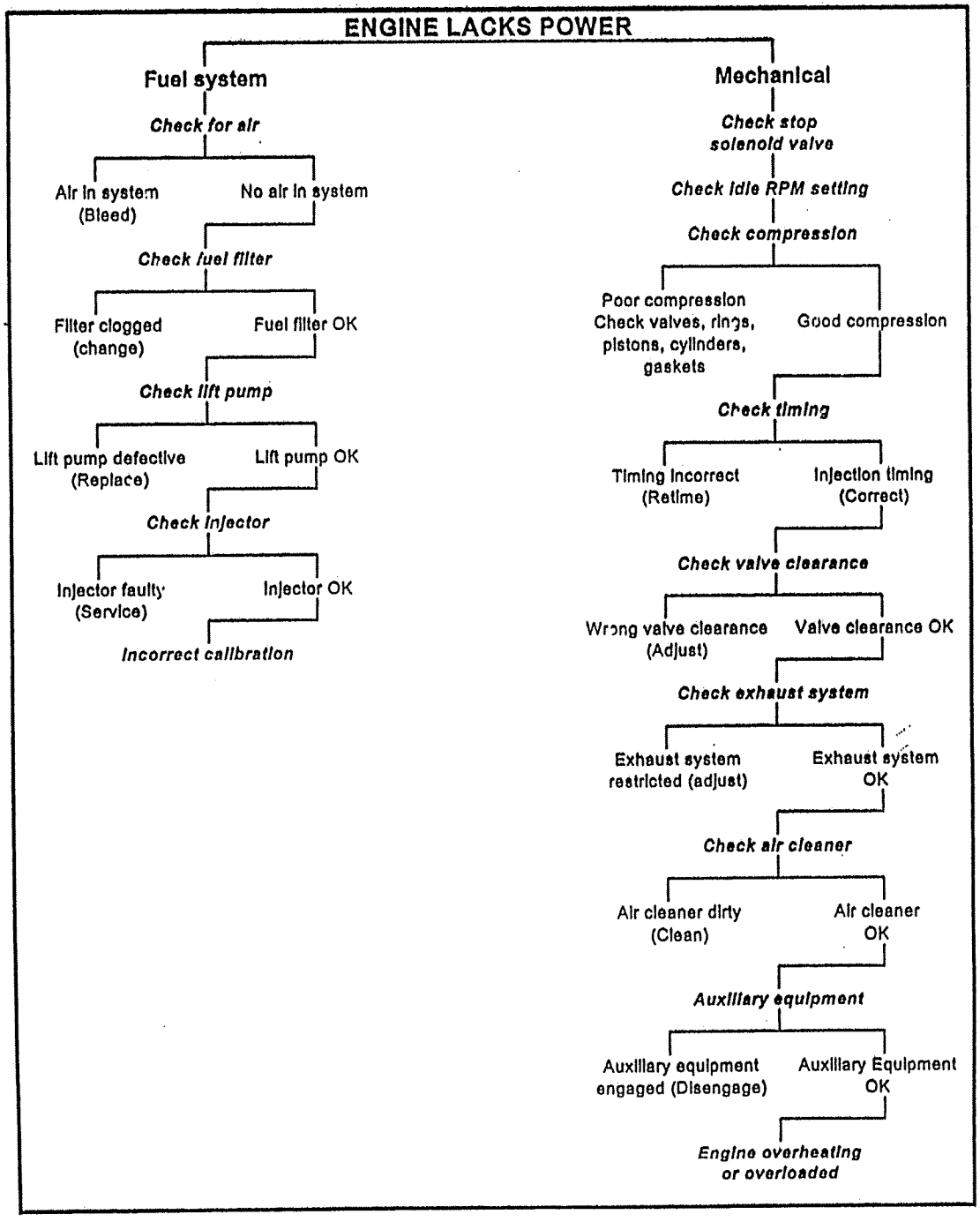
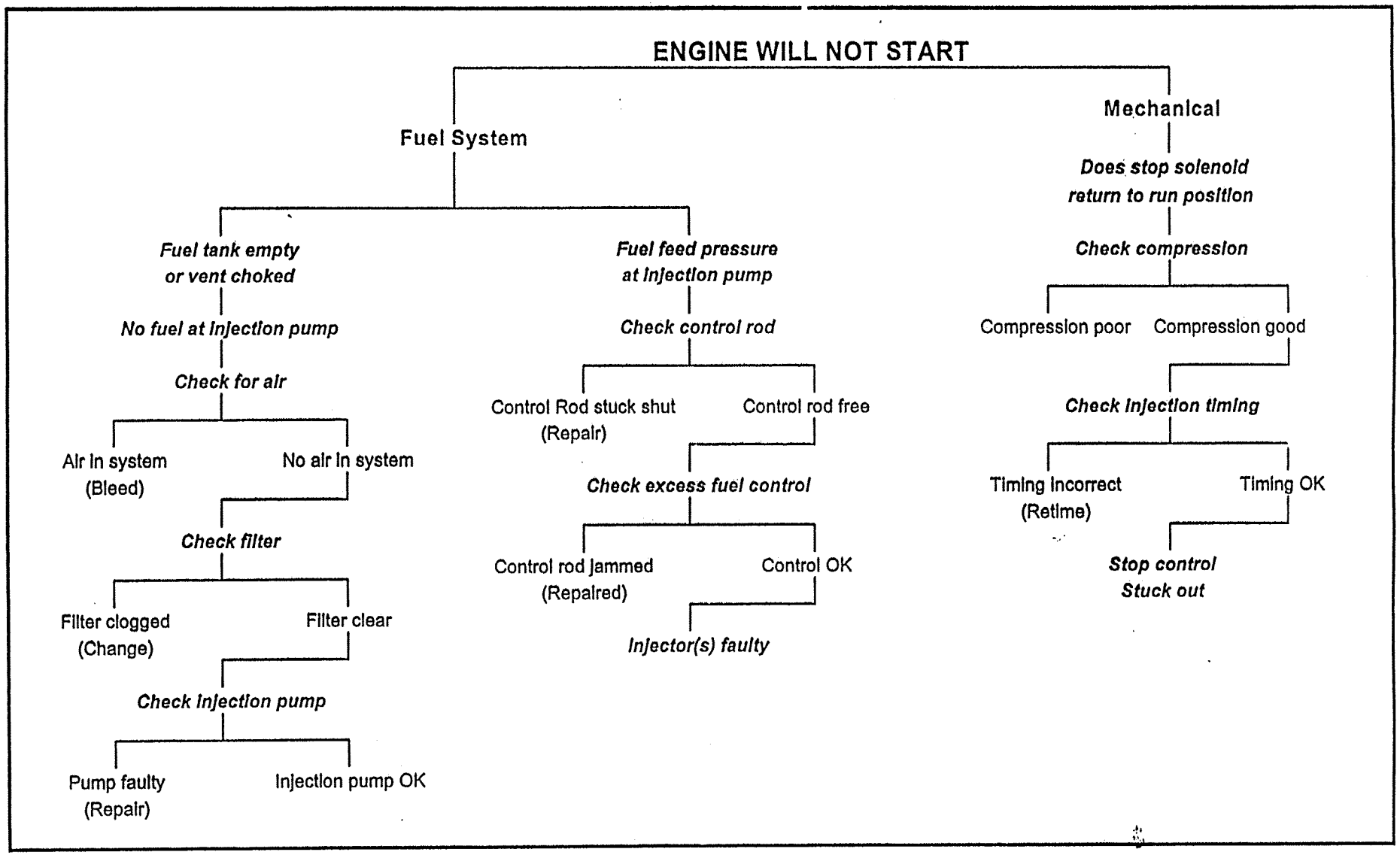
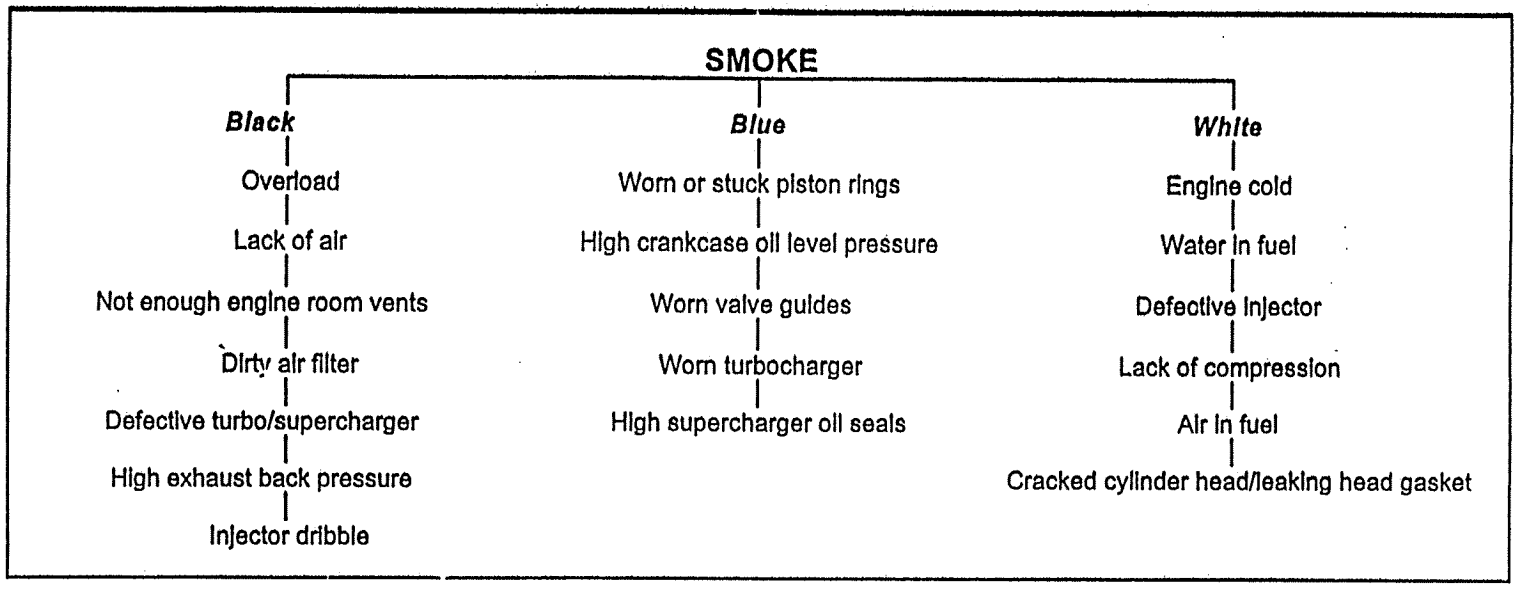

ENGINE LACKS POWER
Fuel system
Check for air
Air in system (Bleed)
No air in system
Check fuel filter
Filter clogged (change)
Fuel filter OK
Check lift pump
Lift pump defective (Replace)
Lift pump OK
Check injector
Injector faulty (Service)
Injector OK
Incorrect calibration
Mechanical
Check stop solenoid valve
Check idle RPM setting
Check compression
Poor compression Check valves, rings, pistons, cylinders, gaskets
Good compression
Check timing
Timing incorrect (Retime)
Injection timing (Correct)
Check valve clearance
Wrong valve clearance (Adjust)
Valve clearance OK
Check exhaust system
Exhaust system restricted (adjust)
Exhaust system OK
Check air cleaner
Air cleaner dirty (Clean)
Air cleaner OK
Auxiliary equipment
Auxiliary equipment engaged (Disengage)
Auxiliary Equipment OK
Engine overheating or overloaded


ENGINE WILL NOT START
Fuel System
Fuel tank empty or vent choked
No fuel at injection pump
Check for air
Air in system (Bleed)
No air in system
Check filter
Filter clogged (Change)
Filter clear
Check injection pump
Pump faulty (Repair)
Injection pump OK
Fuel feed pressure at injection pump
Check control rod
Control Rod stuck shut (Repair)
Control rod free
Check excess fuel control
Control rod jammed (Repaired)
Control OK
Injector(s) faulty
Mechanical
Does stop solenoid return to run position
Check compression
Compression poor
Compression good
Check injection timing
Timing incorrect (Retime)
Timing OK
Stop control Stuck out


SMOKE
Black
Overload
Lack of air
Not enough engine room vents
Dirty air filter
Defective turbo/supercharger
High exhaust back pressure
Injector dribble
Blue
Worn or stuck piston rings
High crankcase oil level pressure
Worn valve guides
Worn turbocharger
High supercharger oil seals
White
Engine cold
Water in fuel
Defective injector
Lack of compression
Air in fuel
Cracked cylinder head/leaking head gasket

TROUBLESHOOTING GUIDE FOR ALL DIESEL ENGINES

	Poor starting	Low compression	Lack of fuel	Low cranking speed	Knocks	Black smoke	Blue smoke	White smoke	Misfiring	Hunting	Poor idle	Overheating	Loss of power	High exhaust back pressure	Low oil pressure	Rising oil level	Excessive oil consumption	Seizure
Throttle closed	•		•															
Lift pump diaphragm holed	•		•										•					
Plugged fuel filters	•		•						•		•		•					
Air in fuel lines	•		•		•			•	•		•		•					
Empty fuel tank	•		•															
Dirty fuel	•		•		•	•		•	•		•		•					
Defective injectors	•				•	•			•		•		•					
Poor fuel quality	•				•	•			•		•		•					
Injection pump leaking by	•		•						•		•		•					
Injection timing advanced	•				•	•			•		•		•					
Too much fuel injected						•						•						
Piston blow-by	•	•					•	•	•		•		•				•	
Dry cylinder walls	•	•						•	•		•		•					
Valve blow-by	•	•						•	•		•	•	•					
Decompressor levers on	•	•						•	•		•		•					
Valve clearances wrong	•	•						•	•		•		•					
Valves sticking in guides	•	•						•	•		•		•					
Plugged air filter	•					•			•				•					
Plugged exhaust/turbocharger	•												•	•				
Kink in exhaust hose	•												•	•				
Oil level low												•			•			•
Wrong viscosity oil				•											•		•	•
Diesel dilution of oil															•	•		•
Dirt in oil pressure relief valve															•			
Defective pressure gauge																		
Governor sticking/loose linkage										•	•							
Governor idle spring too slack											•							
Defective water pump												•						•
Defective pump valves												•						•
Air bound water lines												•						•
Closed sea cock												•		•				•
Plugged cooling system								•	•			•				•		•
Blown head gasket/cracked head	•	•										•						•
Uneven load on cylinders												•						•
Warn bearings	•	•		•									•					
Seized piston	•											•						
Auxiliary equipment engaged	•			•									•					
Battery low/loose connections	•			•														
Engine overload/rope in prop																		•

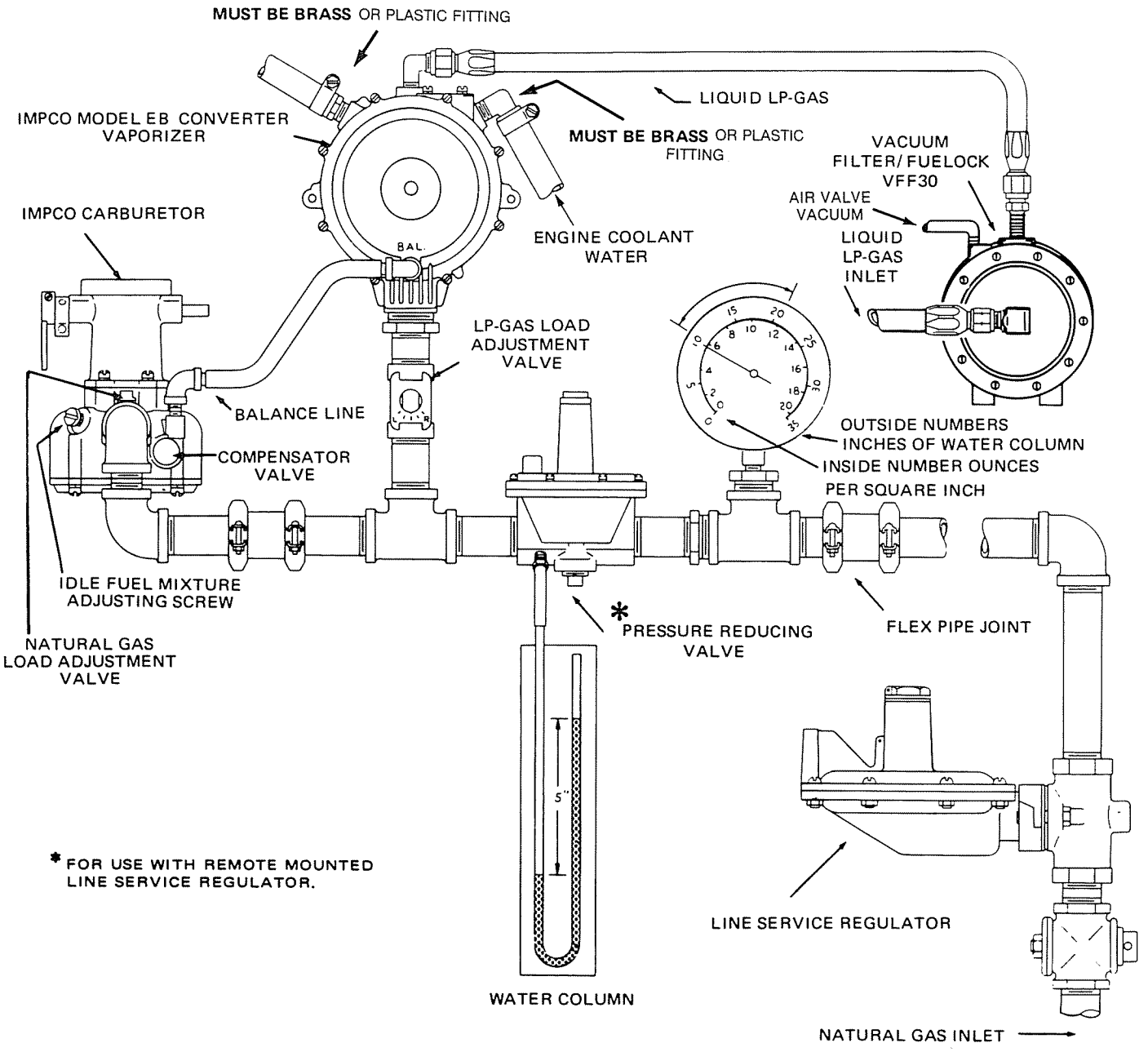
Dual Fuel Natural and LP-Gas Model 100 Series Carburetor

Illustrated is schematic diagram showing use of LP-Gas as emergency stand-by fuel and to secure favorable interrupted service rates on natural gas.

Automatic changeover is accomplished by the use of two regulators — a line pressure regulator for natural gas and a vacuum operated regulator for propane. The difference in pressures compensates for the greater BTU value of propane.

During operation on natural gas, a 5'' water column pressure exists in the common line to the carburetor. This pressure closes propane regulator. Cut-off of natural gas pressure creates a partial vacuum in the line and the propane regulator opens to admit propane to the system.

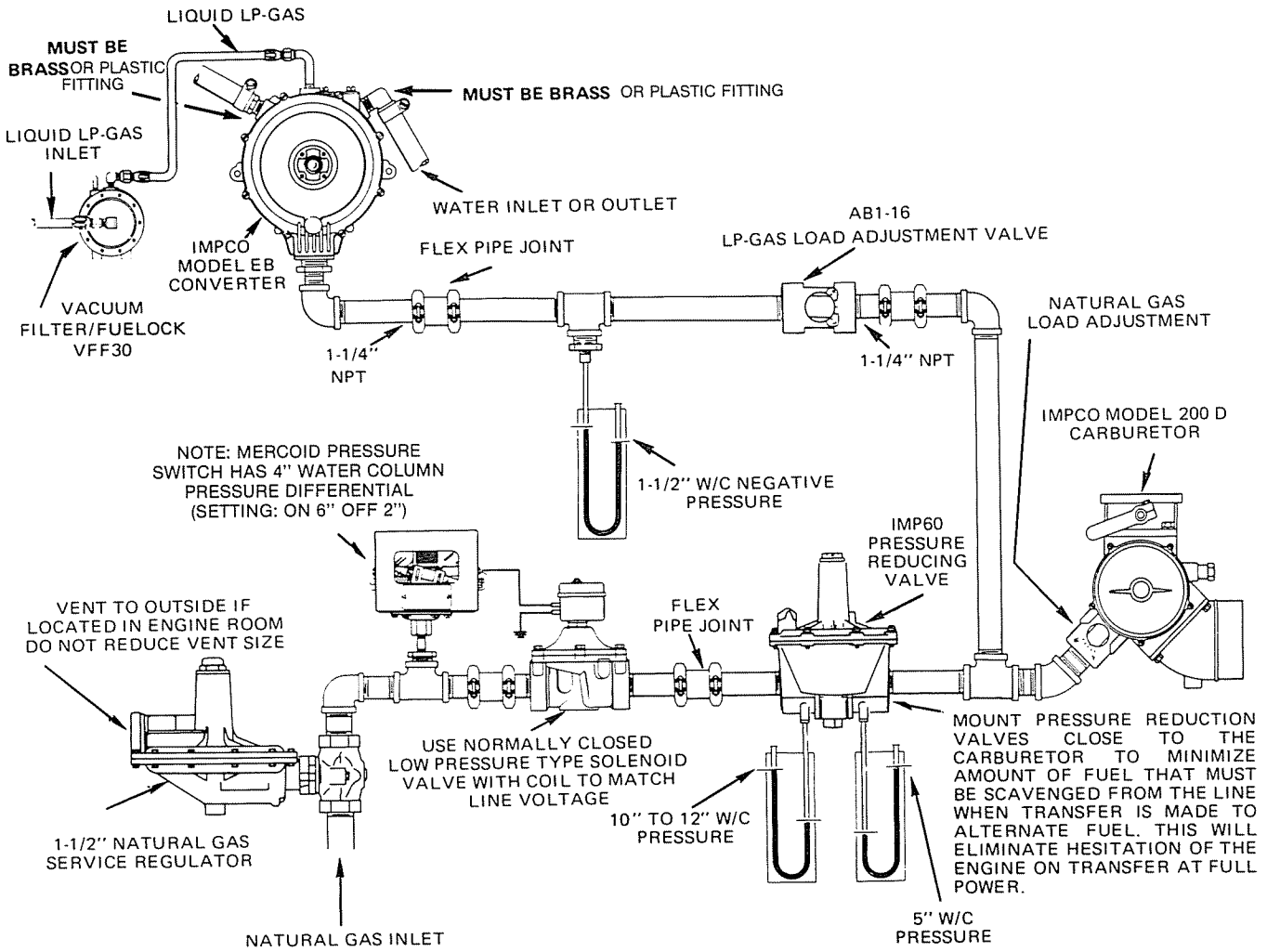
A separate power mixture adjustment in the propane line allows precise setting of air fuel ratios on each fuel. Changeover is entirely automatic with engine in operation.



Dual Fuel Natural Gas and LPG (Model EB Converter)

With the 1½'' natural gas service regulator the following list of orifice sizes and springs must be used to obtain the required pressure to the IMP 60 pressure reducing valve.

Inlet Line Pressure	Orifice Size	Spring Color	Outlet Pressure To Reducing Valve
3 to 12 lbs.	3/4''	Gray	6 ounces
13 to 50 lbs.	1/2''	Gray	6 ounces



Dual Fuel Natural Gas and LPG (Model PE Converter)

IMPCO dual fuel applications use a pressure differential between two fuels to compensate for the difference in heat values between the fuels.

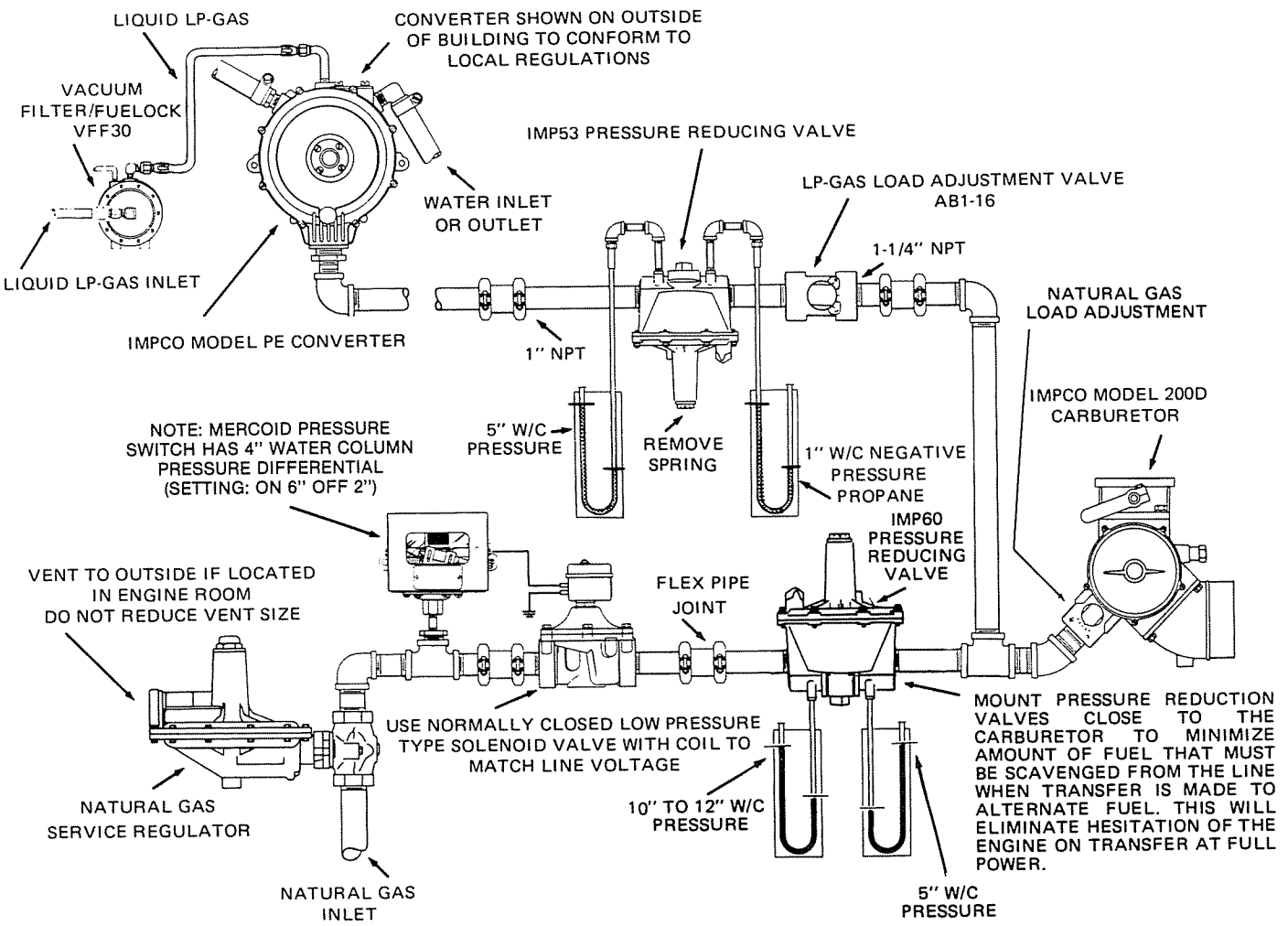
Natural gas of 1050 BTUs per cubic foot is fed to the IMPCO carburetor through an IMPCO pressure reduction valve at 5" of water column pressure (approx. 3 ounces).

Propane gas of 2300 BTUs per cubic foot is fed through a second pressure reduction valve at −1" (negative) pressure.

As long as the natural gas pressure is maintained, the propane pressure reduction valve will remain closed. When pressure drops to −1" (negative) upon failure of the natural gas supply, the propane valve will open automatically and the engine will continue to operate without interruption.

No adjustments or attendant are necessary — the engine will transfer from one fuel to the other or back again under full power. With the 1½" natural gas service regulator, the following list of orifice sizes and springs must be used to obtain the required pressure to the carburetor.

Inlet Line Pressure	Orifice Size	Spring Color	Outlet Pressure To Reducing Valve
3 to 12 lbs.	3/4"	Gray	6 ounces
13 to 50 lbs.	1/2"	Gray	6 ounces



Dual Fuel Natural Gas and Propane Vapor

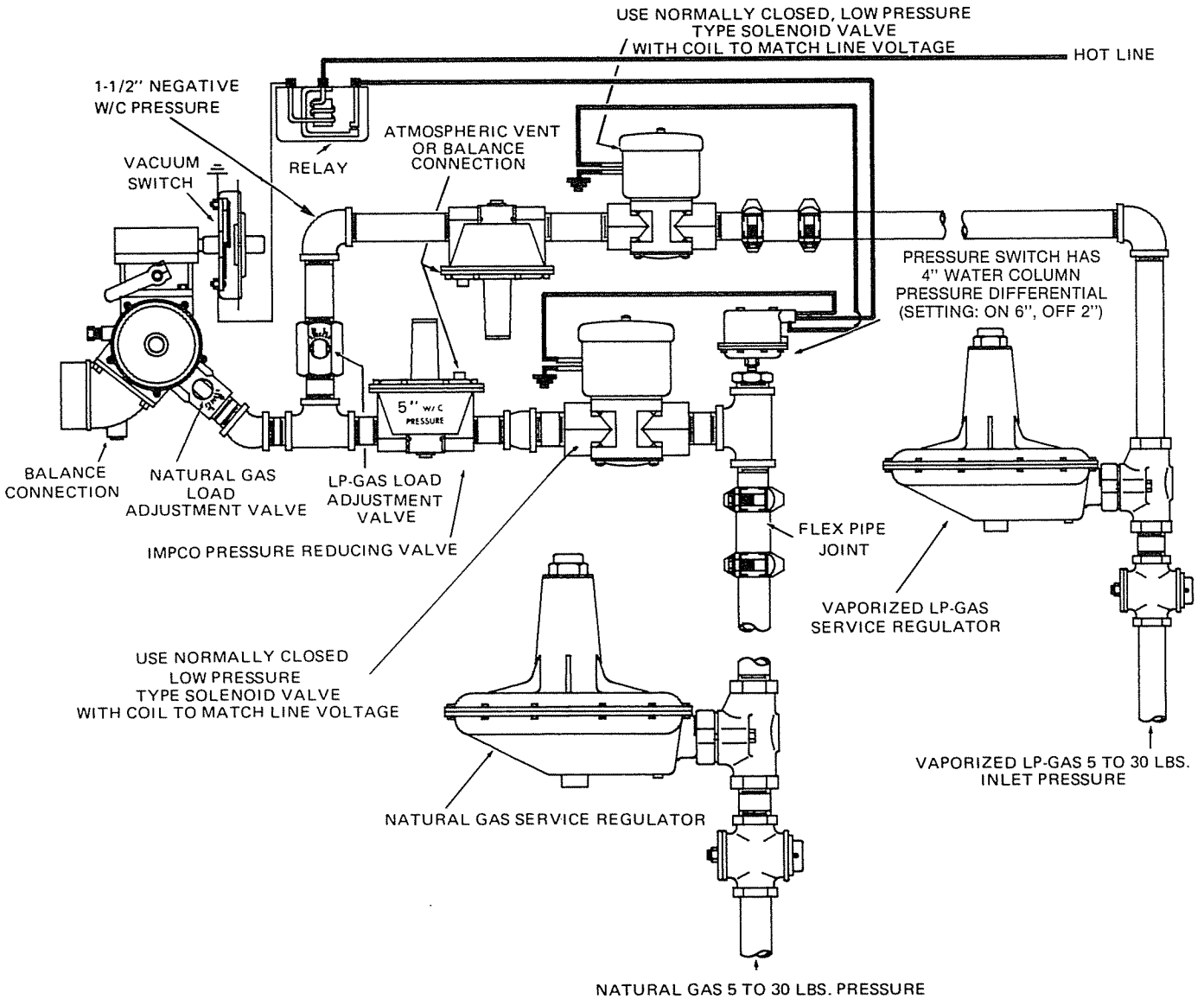
This illustration shows two solenoid operated valves as required in an enclosed area. Manual valves may be substituted outdoors. IMPCO dual fuel applications use a pressure differential between two fuels to compensate for the difference in heat values between the fuels.

Natural gas of 1050 BTU's per cubic foot is fed to the IMPCO carburetor through an IMPCO pressure reduction valve at 5'' of water column pressure (approx. 3 ounces).

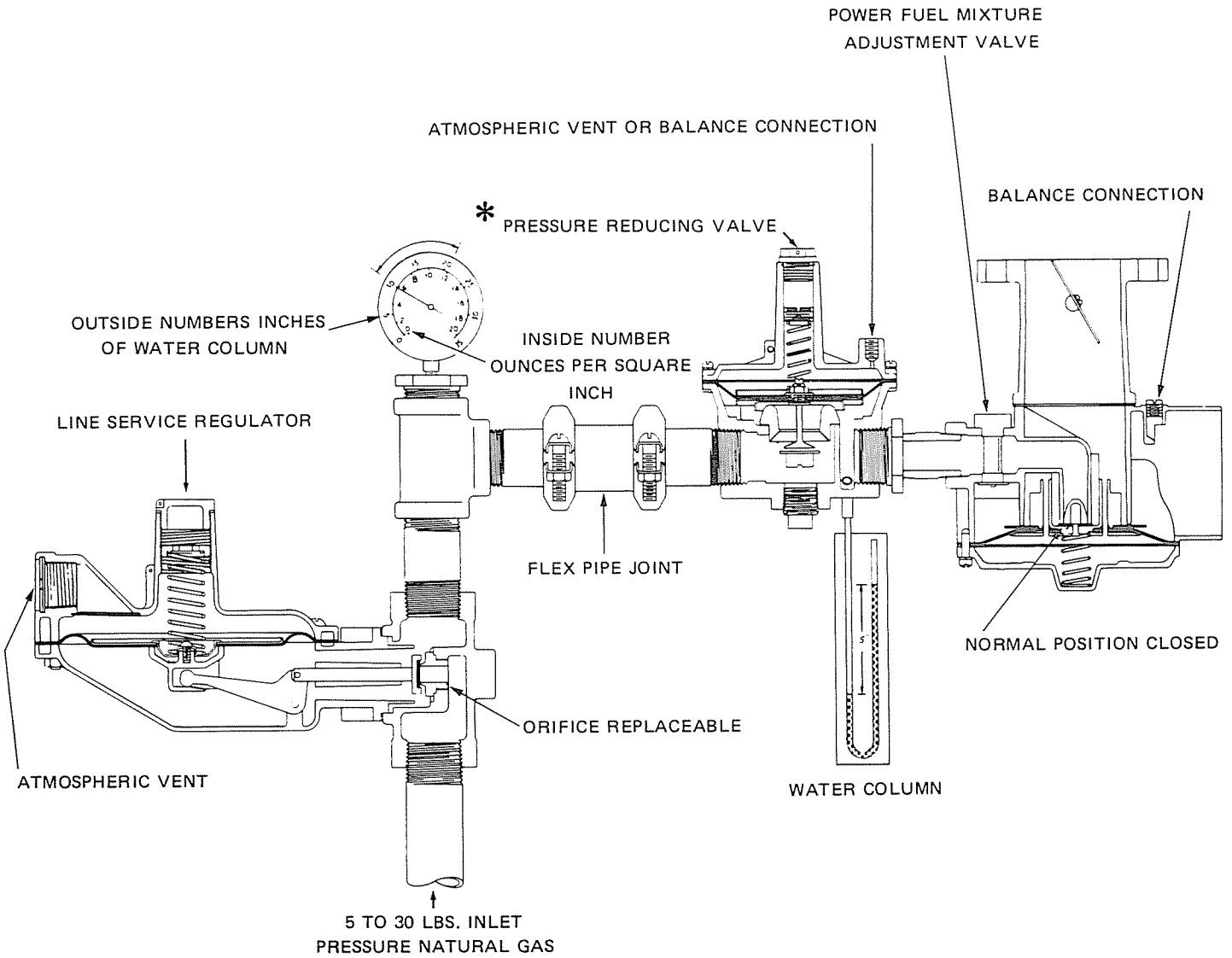
Propane gas of 2300 BTU's per cubic foot is fed through a second pressure reduction valve at -1½'' (negative) pressure. As long as the natural gas pressure is maintained, the propane pressure reduction valve will remain closed. When pressure drops to -1½'' (negative) upon failure of the natural gas supply, the propane valve will open automatically and the engine will continue to operate without interruption.

No adjustments or attendants are necessary — the engine will transfer from one fuel to the other or back again under full power.

Mount pressure reduction valves close to the carburetor to minimize amount of fuel that must be scavenged from the line when transfer is made to alternate fuel. This will eliminate hesitation of the engine on transfer at full power.



Model 200 Series Carburetors
Natural Gas Stationary
Industrial Engine Application



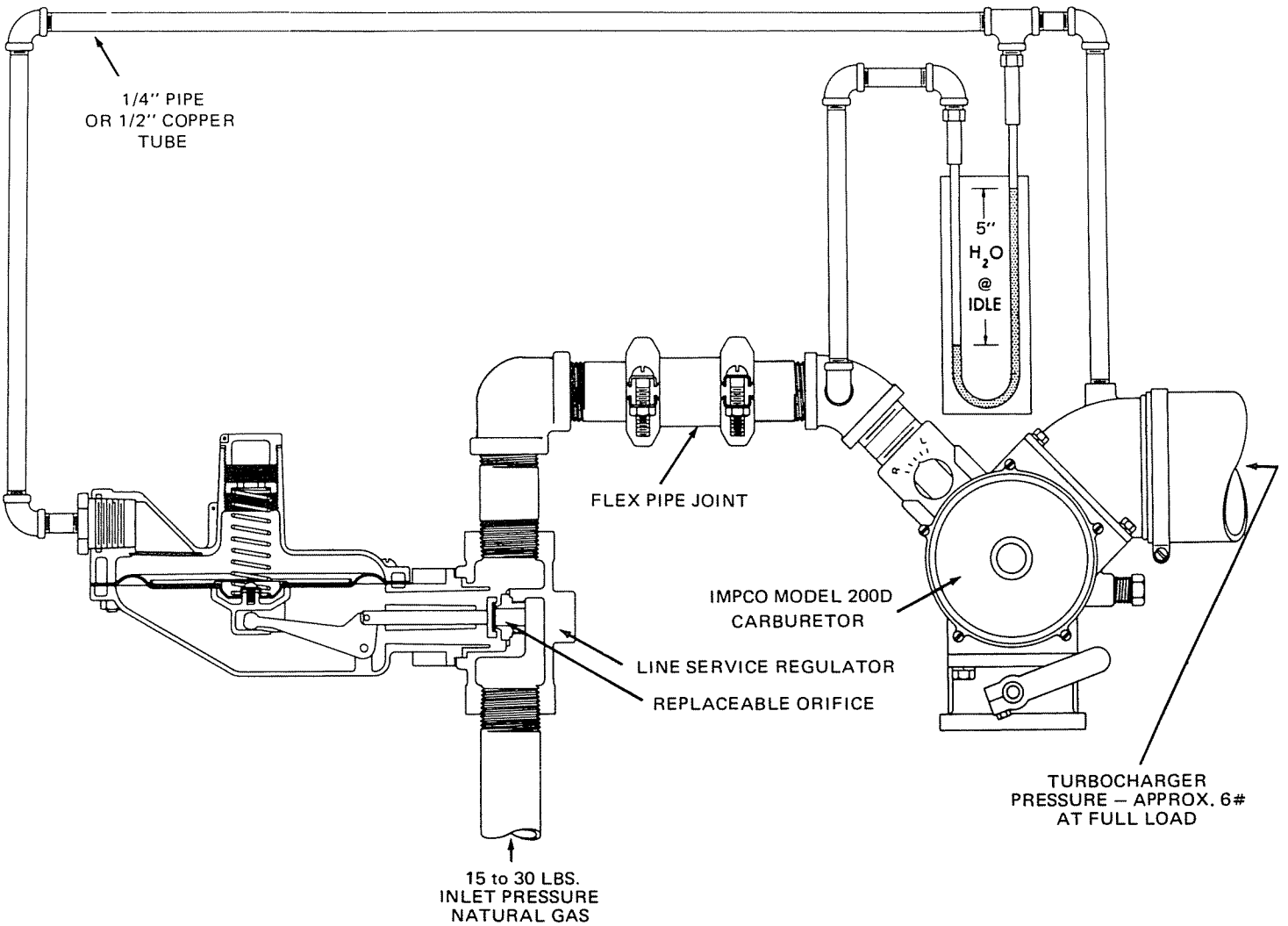
*FOR USE WITH REMOTE MOUNTED LINE SERVICE REGULATOR.

Turbocharged Natural Gas Model 200D Carburetor

As in all IMPCO carburetion systems, an initial natural gas pressure of 5'' water column is required to the carburetor gas inlet at idle.

Using the same pipe fitting sizes indicated for the naturally aspirated engine, add a balance line as shown from the carburetor air horn to the vent hole of the regulator.

The gas pressure will then rise with the air pressure as the engine accelerates. The difference in the gas and air pressure will remain the same as in naturally aspirated carburetion systems.

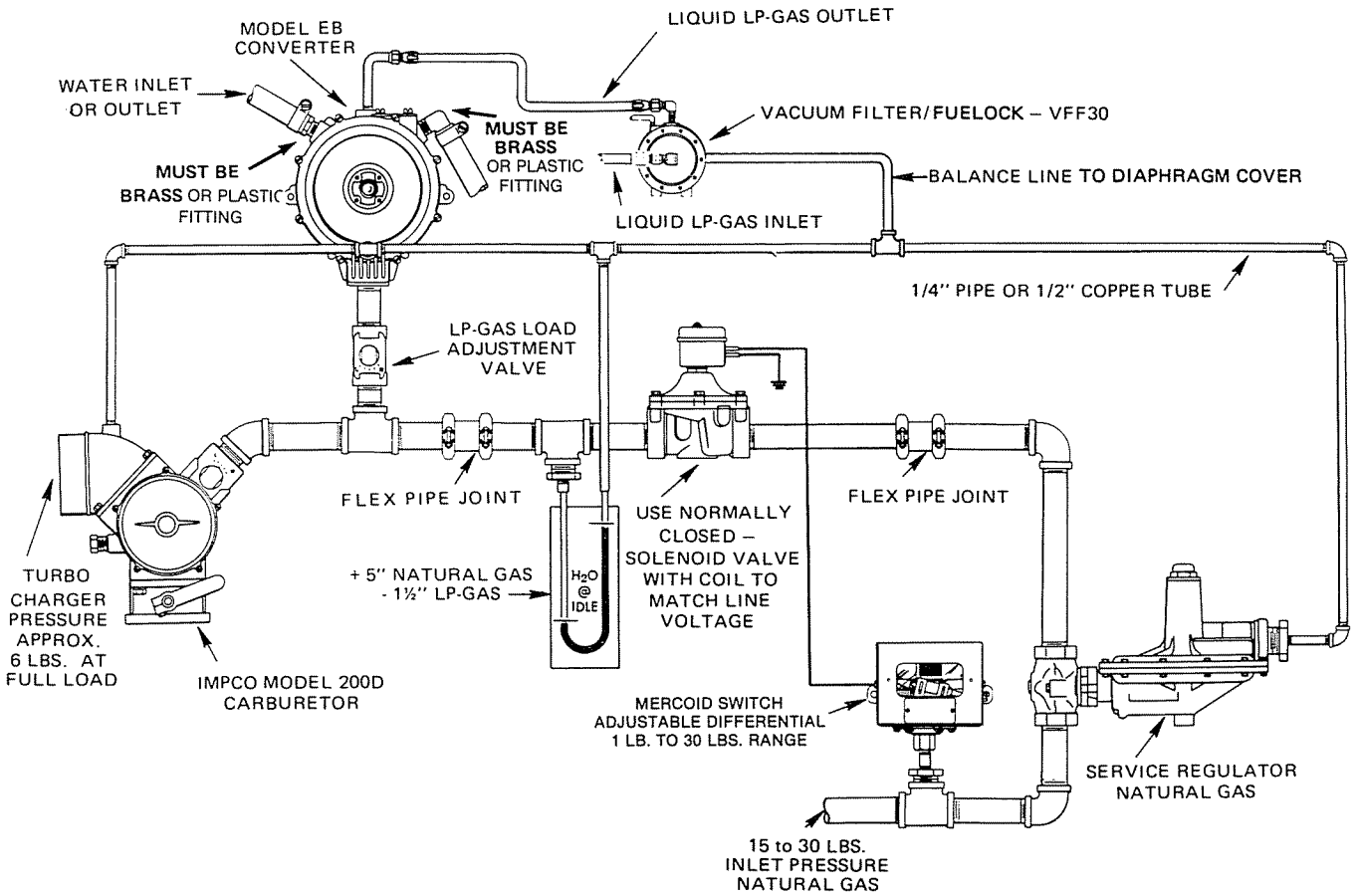


Turbocharged Natural and LP-Gas Model 200D Carburetor

As in all IMPCO carburetion systems, an initial gas pressure of 5'' water column is required to the carburetor gas inlet at idle. LP gas pressure is -1.5'' (negative) water column at idle.

Using the same pipe fitting sizes indicated for the naturally aspirated engine, add a balance line as shown from the carburetor air horn to the vent holes of the regulator and fuelock. Separate balance lines to each regulator are preferable.

The gas pressure will then rise with the air pressure as the engine accelerates. The difference in the gas and air pressure will remain the same as in naturally aspirated carburetion systems.



FOR VAPORIZED PROPANE

SCHEMATIC DRAWING FOR USE OF IMPCO PRESSURE REDUCTION VALVE AS ATMOSPHERIC REGULATOR

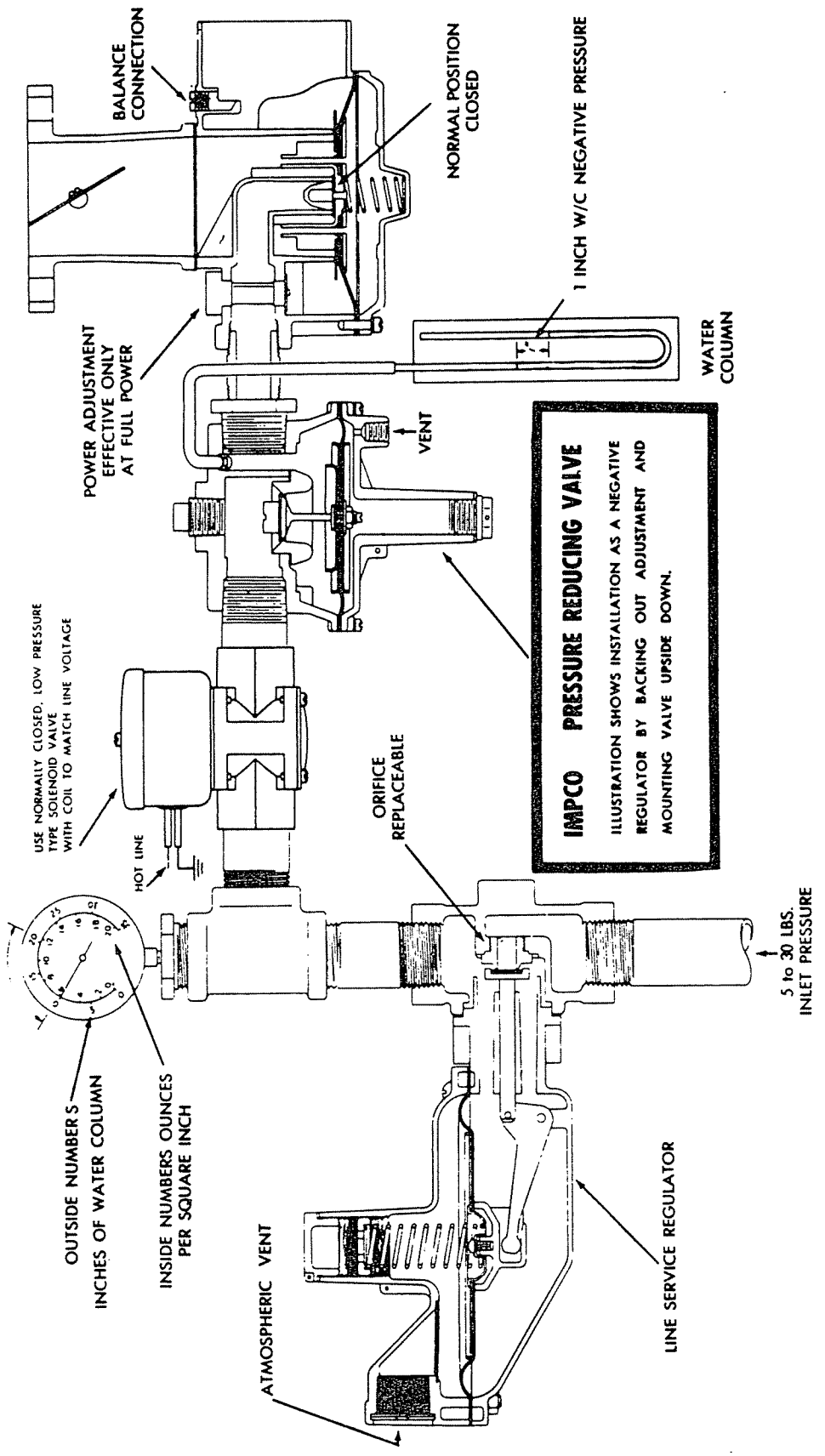
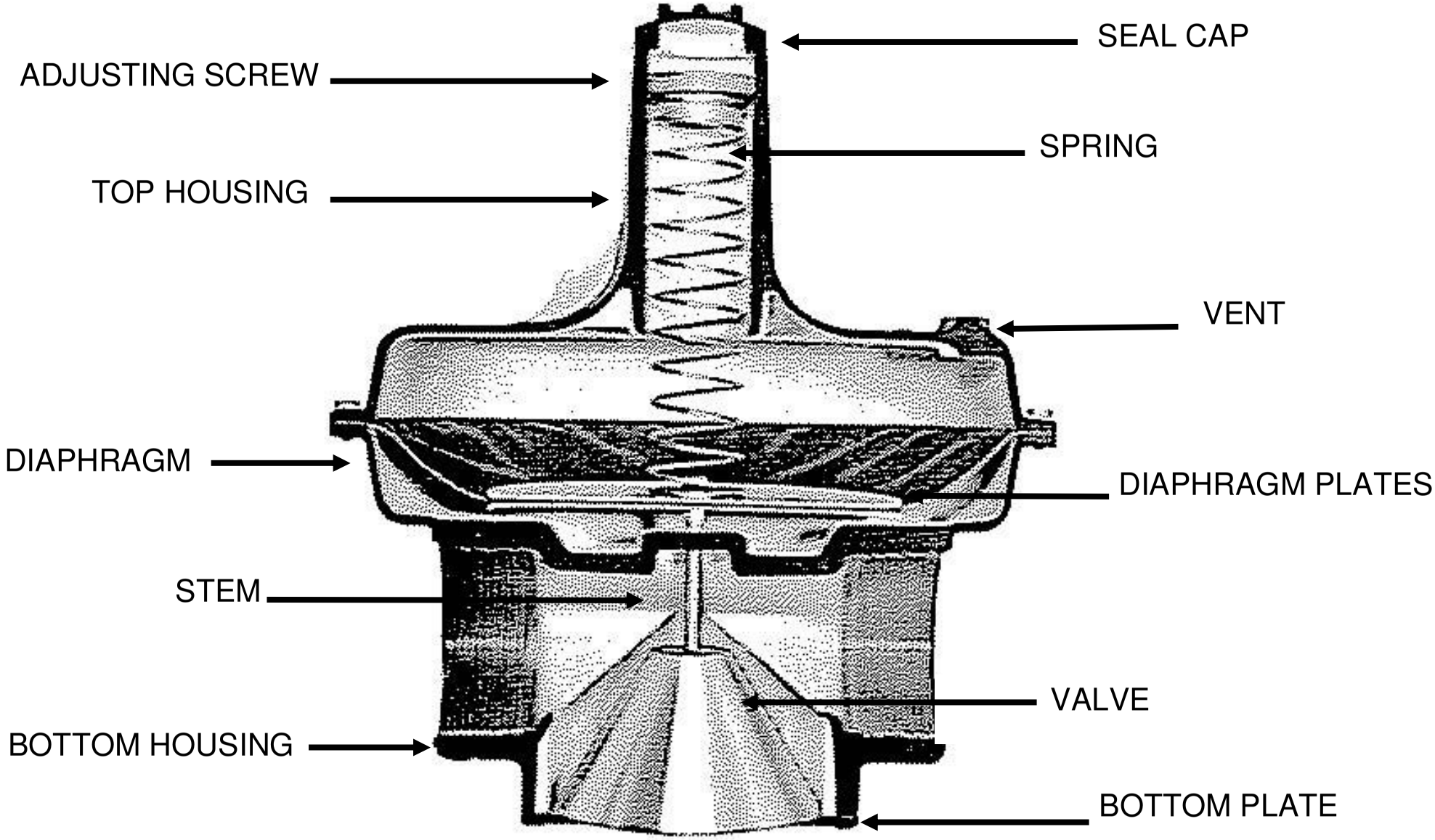


Fig. #10

Straight-Thru-Flow Design

Main burner only…



MAXITROL company

Sizing A Regulator

In order to select the proper size regulator, one must know:

1. Available *inlet* pressure.
2. Desired *outlet* pressure.
3. Required maximum flow rate in Btu/h, ft^3/h or m^3/h.
4. *Pipe size*.

You should also know:

1. If regulator will be used for main burner and pilot application or main burner only.
2. If regulator must provide positive dead-end lock-up.
3. Requires zero governor application (indicated by model number ending in Z - e.g. R500SZ).

The capacity of any regulator is *not* an absolute value but will vary with the application depending on the prevailing differential.

Sizing Examples

Lever Acting — for main burner and pilot load applications requiring positive dead-end lock-up.

Example: to select a 325 Series regulator of ample capacity to handle flow —

Known:
Desired flow rate 145,000 Btu/h; pipe size 1/2"; inlet pressure 2 psi; outlet pressure 7" w.c.

Solution:
Check capacity chart on 325 Series sales bulletin . . . The 325-3's pressure drop at a flow rate of 145,000 Btu/h is 7" w.c., well below the available differential of 1-3/4 psi. The 325-3 (1/2"), used with a 4" to 12" spring will give you the desired outlet pressure of 7" w.c. and is the correct regulator to use for the application.

Poppet Models — for main burner and pilot load applications.

Example: To select an RV type regulator of ample capacity to handle flow —

Known:
Single burner with flow rate of 150,000 Btu/h; pipe size 1/2"; inlet pressure 7" w.c.; outlet pressure 4" w.c.

Solution:
Check capacity chart on RV (poppet) Series sales bulletin . . . the RV48 (1/2") has a maximum capacity of 230,000 Btu/h and a maximum individual load of 160,000 Btu/h. The pressure drop at a flow rate of 150,000 Btu/h is 0.4", well below the available differential of 3" w.c. The RV48 (Non "L" fixed orifice) is the correct regulator to use for the application.

Straight-Thru-Flow — for main burner only applications not requiring a lock-up type regulator.

When sizing the S-T-F Series, it is recommended that pressure drop not exceed 1/2 of available differential pressure.

Example: To select an RV type regulator of ample capacity to handle flow —

Known:
Desired flow rate 2,000,000 Btu/h; pipe size 1-1/4"; inlet pressure 9" w.c.; outlet pressure 5" w.c.

Solution:
Check capacity chart on RV (S-T-F) Series sales bulletin . . . the RV81 (1-1/4") has a maximum capacity of 4,500,000 Btu/h. The pressure drop at a flow of 2,000,000 Btu/h is 0.78" w.c. The RV81 (1-1/4") is the correct regulator to use with this application. The pressure drop of the RV61 (1-1/4") at a flow rate of 2,000,000 Btu/h is 2.58" w.c. This is within the available differential but exceeds the recommended 50% maximum.

Balanced Valve — for main burner and pilot load applications requiring a lock-up type regulator or zero governor usage.

Example: To select a 210 or R/RS Series regulator of ample capacity to handle flow —

Known:
Desired flow rate 6,000,000 Btu/h; pipe size 1-1/2"; inlet pressure 1 psi; outlet pressure 9" w.c.

Solution:
Check capacity chart on 210 or R/RS Series sales bulletin . . . the 210E (1-1/2") has a maximum capacity of 10,000,000 Btu/h (the 210D (1-1/2") has a capacity of only 6,000,000 Btu/h). Therefore, the 210E (1-1/2") used with a 5" to 12" spring will give you the desired outlet pressure of 9" w.c.

LP Applications: When dealing with standard A.G.A. gases — to convert from (LP) 25000 Btu, 1.53 sp gr gas to (Nat) 1000 Btu, 0.64 sp gr gas — multiply by .621.

The brief descriptions contained in this catalog are designed to provide you with a quick reference to the complete line of Maxitrol's gas appliance pressure regulators. For additional information please contact Maxitrol Company or one of our representatives.

Special Warning: No untrained person should attempt to install, maintain, or service a gas pressure regulator.

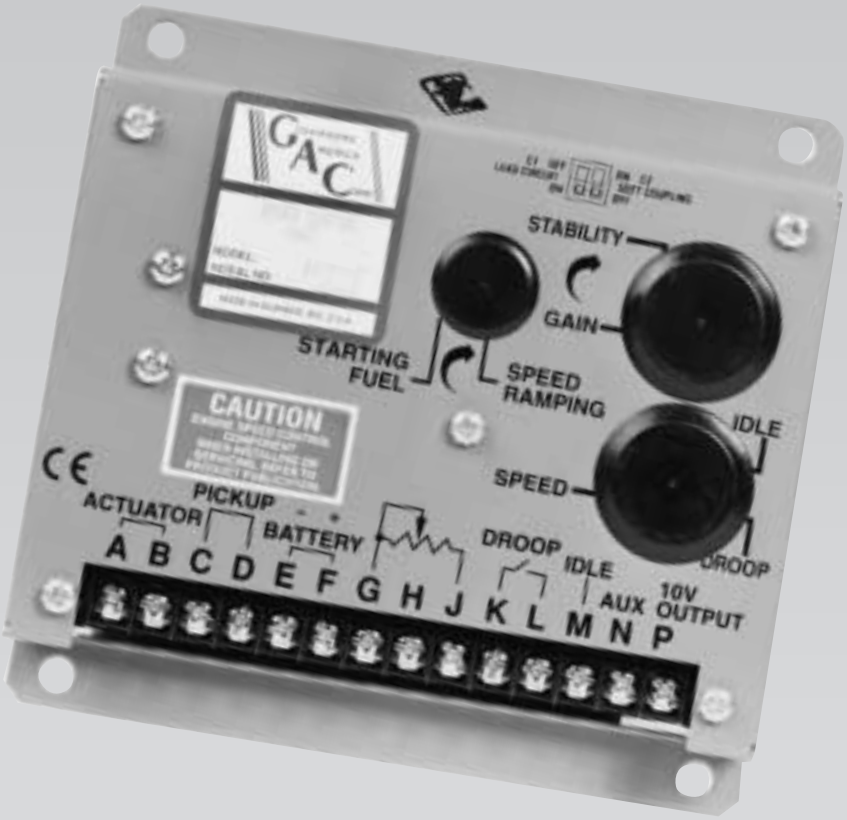
All products, including gas pressure regulators, used with combustible gas MUST be installed and used strictly in accordance with instructions of the manufacturer, with government codes and regulations, and plumbing codes and practices.

Maxitrol gas appliance pressure regulators should be installed and operated in accordance with our "Safety Warning Bulletin".

GOVERNORS AMERICA CORP.

ENGINE GOVERNING SYSTEMS

ESD5500E SERIES



SPEED CONTROL UNIT

MEMBER
EGSA Electrical Generating Systems Association

GOVERNORS AMERICA CORP. • 720 Silver Street • Agawam, MA 01001-2907, USA

ESD5500E SERIES SPEED CONTROL UNIT

PRODUCT TECHNICAL INFORMATION

PTI 1002E

JUNE 2000

MPC

INTRODUCTION

The ESD5500E Series speed control unit is an all electronic device designed to control engine speed with fast and precise response to transient load changes. This closed loop control, when connected to a proportional electric actuator and supplied with a magnetic speed sensor signal, will control a wide variety of engines in an isochronous or droop mode. It is designed for high reliability and built ruggedly to withstand the engine environment.

Simplicity of installation and adjustment was foremost in the design. Non-interacting performance controls allow near optimum response to be easily obtained.

The primary features of the ESD5500E Series speed control unit are the engine STARTING FUEL and SPEED RAMPING adjustments. The use of these features will minimize engine exhaust smoke experienced prior to attaining engine operating speed.

Other features include adjustable droop and idle operation, inputs for accessories used in multi-engine or special applications, protection against reverse battery voltage, transient voltages, accidental short circuit of the actuator and fail safe design in the event of loss of speed sensor signal or battery supply.

The ESD5500E Series speed control unit is compatible with all GAC proportional actuators except the ACB2000 electric actuator. When the ESD5500E Series speed control unit is used with a ADC100 Series electric actuator, the DROOP adjustment range will be less due to this actuator's low current demand.

DESCRIPTION

Engine speed information for the speed control unit is usually received from a magnetic speed sensor. Any other signal generating device may be used provided the generated frequency is proportional to engine speed and meets the voltage input and frequency range specification. The speed sensor is typically mounted in close proximity to an engine driven ferrous gear, usually the engine ring gear. As the teeth of the gear pass the magnetic sensor, a signal is generated which is proportional to engine speed.

Signal strength must be within the range of the input amplifier. An amplitude of 0.5 to 120 volts RMS is required to allow the unit to function within its design specifications. The speed signal is applied to Terminals C and D of the speed control unit. Between these terminals there is an input impedance of over 33,000 ohms. Terminal D is internally connected to Terminal E, battery negative. Only one end of the shielded cable should be connected.

When a speed sensor signal is received by the controller, the signal is amplified and shaped by an internal circuit to provide an analog speed signal. If the speed sensor monitor does not detect a speed sensor signal, the output circuit of the speed control unit will turn off all current to the actuator.

A summing circuit receives the speed sensor signal along with the speed adjust set point input. The speed range has a ratio of 8:1 and is adjusted with a 25 turn potentiometer. The output from the summing circuit is the input to the dynamic control section of the speed control unit. The dynamic control circuit, of which the gain and stability adjustments are part, has a control function that will provide isochronous and stable performance for most engine types and fuel systems.

The speed control unit circuit is influenced by the gain and stability performance adjustments. The governor system sensitivity is increased with clockwise rotation of the gain adjustment. The gain adjustment has a range of 33:1. The stability adjustment, when advanced clockwise, increases the time rate of response of the governor system to match the various time constants of a wide variety of engines. The speed control unit is a P I D device, the “D”, derivative portion can be varied when required. (See Instability section.)

During the engine cranking cycle, STARTING FUEL can be adjusted from an almost closed, to a nearly full fuel position. Once the engine has started, the speed control point is determined, first by the IDLE speed set point and the SPEED RAMPING circuit. After engine speed ramping has been completed, the engine will be at its governed operating speed. At the desired governed engine speed, the actuator will be energized with sufficient current to maintain the desired engine speed, independent of load (isochronous operation).

The output circuit provides switching current at a frequency of about 500 Hz. to drive the actuator. Since the switching frequency is well beyond the natural frequency of the actuator, there is no visible motion of the actuator output shaft. Switching the output transistors reduces its internal power dissipation for efficient power control. The output circuit can provide current of up to 10 amps continuous at 25˚C for 12 and 24 VDC battery systems. The actuator responds to the average current to position the engine fuel control lever.

In standard operation, the speed control unit performance is isochronous. Droop governing can be selected by connecting terminals K and L and the percent of droop governing can be varied with the droop adjustment control. The droop range can be decreased by connecting Terminals G and H.

The speed control unit has several performance and protection features which enhance the governor system. A speed anticipation circuit minimizes speed overshoot on engine start-up or when large increments of load are applied to the engine. Engine idle speed can be remotely selected and is adjustable. Accessory inputs to achieve variable speed operation and multi-engine control can be accepted by the ESD5500E Series speed control unit from GAC load sharing modules, automatic synchronizers, ramp generators and other accessory engine control modules. Protection against reverse battery voltage and transient voltages is provided. The design is fail-safe in the event of loss of speed sensor signal or battery supply.

ESD 5500E SERIES SPEED CONTROL UNITS

ESD 5500E ..... Standard Unit ESD 5520E ..... Suitable for low inertia actuators

SPECIFICATIONS

PERFORMANCE

Isochronous Operation/Steady State Stability ..... ± 0.25% or better
Speed Range/Governor ..... 1K–7.5K Hz continuous
Speed Drift with Temperature ..... ± 1% Maximum
Idle Adjust CW ..... 60% of set speed
Idle Adjust CCW ..... Less than 1200 Hz.
Droop Range ..... 1 – 5% regulation*
Droop Adj. Max. (K-L Jumpered) ..... 400 Hz., ± 75 Hz. per 1.0 A change
Droop Adj. Min. (K-L Jumpered) ..... 15 Hz., ± 6 Hz. per 1.0 A change
Speed Trim Range ..... ± 200 Hz.
Remote Variable Speed Range ..... 500 – 7.5 Hz. or any part thereof
Terminal Sensitivity
- J ..... 100 Hz., ± 15 Hz / Volt @ 5.0 K Impedance
- L ..... 735 Hz., ± 60 Hz / Volt @ 65 K Impedance
- N ..... 148 Hz., ± 10 Hz / Volt @ 1 Meg. Impedance
- P ..... 10 VDC Supply @ 20 ma Max.

ENVIRONMENTAL

Ambient Operating Temperature Range ..... -40˚ to +180˚F (-40˚ to +85˚C)
Relative Humidity ..... up to 95%
All Surface Finishes ..... Fungus Proof and Corrosion Resistant

INPUT POWER

Supply ..... 12 or 24 VDC Battery Systems (Transient and Reverse Voltage Protected)**
Polarity ..... Negative Ground (Case Isolated)
Power Consumption ..... 50 ma continuous plus actuator current
Actuator Current Range @ 77°F (25°C) - (Inductive Load) ..... Min. 2.5 Amps ..... Max. 10 Amps continuous***
Speed Sensor Signal ..... 0.5–120 Volts RMS

RELIABILITY

Vibration ..... 1G @ 20–100 Hz.
Testing ..... 100% Functionally Tested

PHYSICAL

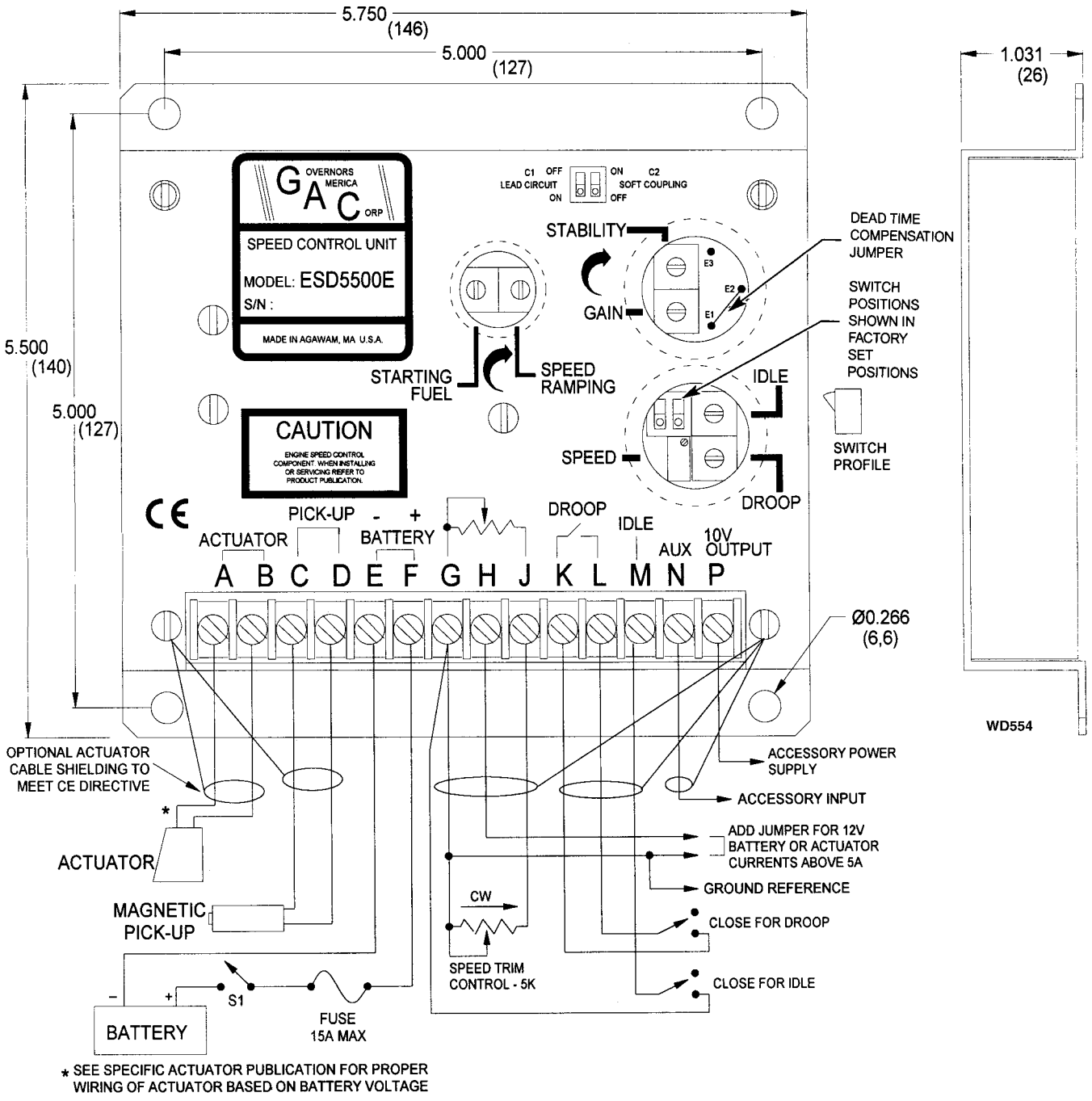
Dimensions ..... See Outline (FIGURE 1)
Weight ..... 1.2 lbs (545 grams)
Mounting ..... Any Position, Vertical Preferred

*Droop is based on a speed sensor frequency of 4000 Hz. and an actuator current change of 1 amp from no load to full load. Applications with higher speed sensor signals will experience less percentage of droop. Applications with more actuator current change will experience higher percentages of droop. See droop description for specific details on operation of droop ranges. When used with the ADC100 actuator the droop percentage will be less due to the actuators low current consumption.

**Protected against reverse voltage by a series diode. A 15 amp fuse must be installed in the positive battery lead.

***Protected against short circuit to actuator (shuts off current to actuator), unit automatically turns back on when short is removed.

DIAGRAM 1. ESD5500E Series Wiring Diagram and Outline



APPLICATION AND INSTALLATION INFORMATION

The speed control unit is rugged enough to be placed in a control cabinet or engine mounted enclosure with other dedicated control equipment. If water, mist, or condensation may come in contact with the controller, it should be mounted vertically. This will allow the fluid to drain away from the speed control unit.

Extreme heat should be avoided.

WARNING

An overspeed shutdown device, independent of the governor system, should be provided to prevent loss of engine control which may cause personal injury or equipment damage. Do not rely exclusively on the governor system electric actuator to prevent overspeed. A secondary shutoff device, such as a fuel solenoid must be used.

WIRING

Basic electrical connections are illustrated in Diagram 1. Actuator and battery connections to Terminals A, B, E, and F should be #16 AWG (1.3 mm sq.) or larger. Long cables require an increased wire size to minimize voltage drops.

The battery positive (+) input, Terminal F, should be fused for 15 amps as illustrated.

Magnetic speed sensor connections to Terminals C and D **MUST BE TWISTED AND/OR SHIELDED** for their entire length. The speed sensor cable shield should be ideally connected to terminal D. The shield should be insulated to insure no other part of the shield comes in contact with engine ground, otherwise stray speed signals may be introduced to the speed control unit. With the engine stopped, adjust the gap between the magnetic speed sensor and the ring gear teeth. The gap should not be any smaller than 0.020 in. (0.45 mm). Usually, backing out the speed sensor 3/4 turn after touching the ring gear tooth will achieve a satisfactory air gap. The magnetic speed sensor voltage should be at least 1 VAC RMS during cranking.

ADJUSTMENTS

Before Starting Engine

Check to insure the **GAIN** and **STABILITY** adjustments, and if applied, the external **SPEED TRIM CONTROL** are set to mid position.

Preset the ESD5500E as follows:

STARTING FUEL ..... FULL CW (Maximum Fuel)
SPEED RAMPING ..... FULL CCW (Fastest)

Start Engine

The speed control unit governed speed setting is factory set at approximately engine idle speed. (1000 Hz., speed sensor signal)

Crank the engine with DC power applied to the governor system. The actuator will energize to the maximum fuel position until the engine starts. The governor system should control the engine at a **low idle** speed. If the engine is unstable after starting, turn the **GAIN** and **STABILITY** adjustments counterclockwise until the engine is stable.

Governor Speed Setting

The governed speed set point is increased by clockwise rotation of the **SPEED** adjustment control. Remote speed adjustment can be obtained with an optional 5K Speed Trim Control. (See Diagram 1.)

Governor Performance

Once the engine is at operating speed and at no load, the following governor performance adjustment can be made.

A. Rotate the **GAIN** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment one division further counterclockwise to insure stable performance.

B. Rotate the **STABILITY** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment one division further to insure stable performance.

C. Gain and stability adjustments may require minor changes after engine load is applied. Normally, adjustments made at no load achieve satisfactory performance. A strip chart recorder can be used to further optimize the adjustments.

If instability cannot be corrected or further performance improvements are required, refer to the section on **SYSTEM TROUBLESHOOTING**.

Starting Fuel Adjustment

The engine's exhaust smoke at start-up can be minimized by completing the following adjustments.

1. Place the engine in idle by connecting Terminals M & G.

2. Adjust the **IDLE** speed for as low a speed setting as the application allows.

3. Adjust the **STARTING FUEL CCW** until the engine speed begins to fall. Increase the **STARTING FUEL** slightly so that the idle speed is returned to the desired level.

4. Stop the engine.

One of two methods of operation for the ESD5500E may now be selected.

Method 1: Start the engine and accelerate directly to the operating speed (Gen Sets, etc.).

or

Method 2: Start the engine and control at an idle speed for a period of time prior to accelerating to the operating speed. This method separates the starting process so that each may be optimized for the lowest smoke emissions.

Method 1

Remove the connection between Terminals M & G. Start the engine and adjust the **SPEED RAMPING** for the least smoke on acceleration from idle to rated speed. If the starting smoke is excessive, the STARTING FUEL may need to be adjusted slightly CCW. If the starting time is too long, the STARTING FUEL may need to be adjusted slightly CW.

Method 2

Replace the connection between Terminals M & G with a switch, usually an oil pressure switch. Start the engine. If the starting smoke is excessive, the STARTING FUEL may need to be adjusted slightly CCW. If the starting time is too long, the STARTING FUEL may need to be adjusted slightly CW.

When the switch opens, adjust the SPEED RAMPING for the least amount of smoke when accelerating from idle speed to rated speed.

Idle Speed Setting

If the IDLE speed setting was not adjusted as detailed in "Starting Fuel Adjustment" section, then place the optional external selector switch in the IDLE position. The idle speed set point is increased by clockwise rotation of the IDLE adjustment control. When the engine is at idle speed, the speed control unit applies droop to the governor system to insure stable operation.

Speed Droop Operation

Droop is typically used for the paralleling of engine driven generators.

Place the optional external selector switch in the DROOP position, DROOP is increased by clockwise rotation of the DROOP adjustment control. When in droop operation, the engine speed will decrease as engine load increases. The percentage of droop is based on the actuator current change from engine no load to full load. A wide range of droop is available with the internal control. Droop level requirements above 10% are unusual.

If droop levels experienced are higher or lower than those required, contact the factory for assistance.

After the droop level has been adjusted, the rated engine speed setting may need to be reset. Check the engine speed and adjust the speed setting accordingly.

Accessory Input

The **AUX**ilary Terminal N accepts input signals from load sharing units, auto synchronizers, and other governor system accessories, GAC accessories are directly connected to this terminal. It is recommended that this connection from accessories be shielded as it is a sensitive input terminal.

If the auto synchronizer is used alone, not in conjunction with a load sharing module, a 3 M ohm resistor should be connected between Terminals N and P. This is required to match the voltage levels between the speed control unit and the synchronizer.

When an accessory is connected to Terminal N, the speed will decrease and the speed adjustment must be reset.

When operating in the upper end of the control unit frequency range, a jumper wire or frequency trim control may be required between Terminals G and J. This increases the frequency range of the speed control to over 7000 Hz.

Accessory Supply

The + 10 volt regulated supply, Terminal P, can be utilized to provide power to GAC governor system accessories. Up to 20 ma of current can be drawn from this supply. Ground reference is Terminal G. **Caution:** a short circuit on this terminal can damage the speed control unit.

Wide Range Remote Variable Speed Operation

Simple and effective remote variable speed can be obtained with the ESD5500E Series control unit.

A single remote speed adjustment potentiometer can be used to adjust the engine speed continuously over a specific speed range. Select the desired speed range and the corresponding potentiometer value. (Refer to TABLE 1.) If the exact range cannot be found, select the next higher range potentiometer. An additional fixed resistor may be placed across the potentiometer to obtain the exact desired range. Connect the speed range potentiometer as shown in Diagram 2.

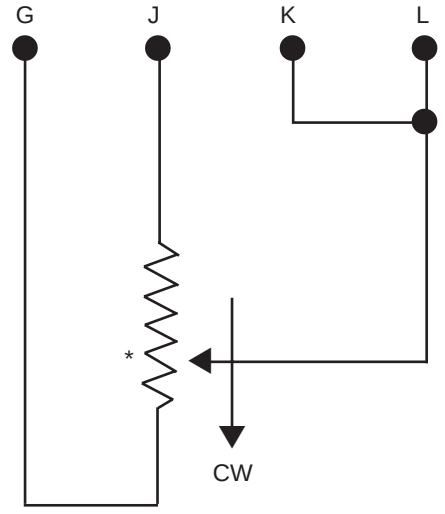
To maintain engine stability at the minimum speed setting, a small amount of droop can be added using the DROOP adjustment. At the maximum speed setting the governor performance will be near isochronous, regardless of the droop adjustment setting.

Contact the factory for assistance if difficulty is experienced in obtaining the desired variable speed governing performance.

TABLE 1. Variable Speed Range Potentiometer Value

Speed Range	Potentiometer Value
900 Hz.	1K
2,400 Hz.	5K
3,000 Hz.	10K
3,500 Hz.	25K
3,700 Hz.	50K

DIAGRAM 2.



*Select Proper Potentiometer Value from Table 1.

SYSTEM TROUBLESHOOTING

SYSTEM INOPERATIVE

If the engine governing system does not function, the fault may be determined by performing the voltage tests described in Steps 1, 2, 3, and 4. (+) and (-) refer to meter polarity. Should normal values be indicated as a result of following the trouble shooting steps, the fault may be with the actuator or the wiring to the actuator. See the actuator publication for testing details.

STEP	TERMINALS	NORMAL READING	PROBABLE CAUSE OF ABNORMAL READING
1	F(+) & E(-)	Battery Supply Voltage (12 or 24 VDC)	1. DC battery power not connected. Check for blown fuse. 2. Low battery voltage. 3. Wiring error.
2	C & D	1.0 VAC RMS min., while cranking	1. Gap between speed sensor and gear teeth too great. Check gap. 2. Improper or defective wiring to the speed sensor. Resistance between terminals C and D should be 30 to 1200ohms. 3. Defective speed sensor.
3	P(+) & G(-)	10 VDC, Internal Supply	1. Short on terminal P. (This will cause a defective unit.) 2. Defective Speed Control.
4	F(+) & A(-)	1.0 - 2.0 VDC while cranking	1. **SPEED** adjustment set too low. 2. Short/open in actuator wiring. 3. Defective speed control. 4. Defective actuator. See Actuator Troubleshooting.

UNSATISFACTORY PERFORMANCE

If the governing system functions poorly, perform the following tests.

SYMPTOM	TEST	PROBABLE FAULT
Engine overspeeds	1. **Do not crank.** Apply DC power to the governor system	1. Actuator goes to full fuel. Then, disconnect speed sensor at Terminals C & D. If actuator still at full fuel – speed control unit defective. If actuator at minimum fuel position - erroneous speed signal. Check speed sensor data.
	2. Manually hold the engine at the desired running speed. Measure the DC voltage between Terminals A (-) & F(+) on the speed control unit.	1. If the voltage reading is 1.0 to 2.0 VDC, a) **SPEED** adjustment set above desired speed. b) Defective speed control unit. 2. If the voltage reading is above 2.0 VDC, a) Actuator or linkage binding. 3. If the voltage reading is below 1.0 VDC, a) Defective speed control unit. 4. Gain set too low.
Actuator does not energize fully.	1. Measure the voltage at the battery while cranking.	1. If the voltage is less than 7V for a 12V system, or 14V for a 24V system, replace the battery if it is weak or undersized.
	2. Momentarily connect Terminals A and F. The actuator should move to the full fuel position.	1. Actuator or battery wiring in error. 2. Actuator or linkage binding. 3. Defective actuator. See actuator troubleshooting. 4. Fuse opens. Check for short in actuator or actuator wiring harness.
Engine remains below desired governed speed.	1. Measure the actuator output. Terminals A & B, while running under governor control.	1. If voltage measurement is within approximately 2 volts of the battery supply voltage, then fuel control restricted from reaching full fuel position. Possibly due to interference from the mechanical governor, carburetor spring or linkage alignment. 2. Speed setting too low.

SYSTEM TROUBLESHOOTING

Insufficient Magnetic Speed Sensor Signal

A strong magnetic speed sensor signal will eliminate the possibility of missed or extra pulses. The speed control unit will govern well with 0.5 volts RMS speed sensor signal. A speed sensor signal of 3 volts RMS or greater at governed speed is recommended. Measurement of the signal is made at Terminals C and D.

The amplitude of the speed sensor signal can be raised by reducing the gap between the speed sensor tip and the engine rind gear. The gap should not be any smaller than 0.020 in (0.45 mm). When the engine is stopped, back the speed sensor out by 3/4 turn after touching the ring gear tooth to achieve a satisfactory air gap.

Electromagnetic Compatibility (EMC)

EMI SUSCEPTIBILITY – The governor system can be adversely affected by large interfering signals that are conducted through the cabling or through direct radiation into the control circuits.

All GAC speed control units contain filters and shielding designed to protect the units sensitive circuits from moderate external interfering sources.

Although it is difficult to predict levels of interference, applications that include magnetos, solid state ignition systems, radio transmitters, voltage regulators or battery chargers should be considered suspect as possible interfering sources.

If it is suspected that external fields, either those that are radiated or conducted, are or will affect the governor systems operation, it is recommended to use shielded cable for all external connections. Be sure that only one end of the shields, including the speed sensor shield, is connected to a single point on the case of the speed control unit. Mount the speed control unit to a grounded metal back plate or place it in a sealed metal box.

Radiation is when the interfering signal is radiated directly through space to the governing system. To isolate the governor system electronics from this type of interference source, a metal shield or a solid metal container is usually effective.

Conduction is when the interfering signal is conducted through the interconnecting wiring to the governor system electronics. Shielded cables and installing filters are common remedies.

As an aid to help reduce the levels of EMI of a conductive nature, a battery line filter and shielded cables are conveniently supplied by GAC in KT130. To reduce the levels of EMI of a radiated nature, a shielded container P/N CA114 can be sourced from GAC and its distributors.

In severe high energy interference locations such as when the governor system is directly in the field of a powerful transmitting source, the shielding may require to be a special EMI class shielding. For these conditions, contact GAC application engineering for specific recommendations.

Instability

Instability in a closed loop speed control system can be categorized into two general types. **PERIODIC** appears to be sinusoidal and at a regular rate. **NON-PERIODIC** is a random wandering or an occasional deviation from a steady state band for no apparent reason.

Switch C1 controls the “Lead Circuit” found in the ESD5500. The normal position is “ON.” Move the switch to the “OFF” position if there is fast instability in the system.

Switch C2 controls an additional circuit added in the ESD5500 that is designed to eliminate fast erratic governor behavior, caused by very soft or worn couplings in the drive train between the engine and generator. The normal position is “OFF.” Move to the “ON” position if fast erratic engine behavior due to a soft coupling is experienced.

The **PERIODIC** type can be further classified as fast or slow instability. Fast instability is a 3 Hz. or faster irregularity of the speed and is usually a jitter. Slow periodic instability is below 3 Hz., can be very slow, and is sometimes violent.

If fast instability occurs, this is typically the governor responding to engine firings. Raising the engine speed increases the frequency of instability and vice versa. In this case, placing switch C1 in the “OFF” position will reduce the speed control unit’s sensitivity to high frequency signals. Readjust the GAIN and STABILITY for optimum control. Should instability still be present, the removal of E1 to E2 jumper may help stabilize the engine. Post locations are illustrated in Diagram 1. Again, readjust the GAIN and STABILITY for optimum control. Interference from powerful electrical signals can also be the cause. Turn off the battery chargers or other electrical equipment to see if the system disappears.

Slow instability can have many causes. Adjustment of the **GAIN** and **STABILITY** usually cures most situations by matching the speed control unit dynamics. If this is unsuccessful, the dead time compensation can be modified. Add a capacitor from posts E2 to E3 (negative on E2). Post locations are illustrated in Diagram 1. Start with 10 mfds. and increase until instability is eliminated. The control system can also be optimized for best performance by following this procedure.

If slow instability is unaffected by this procedure, evaluate the fuel system and engine performance. Check the fuel system linkage for binding, high friction, or poor linkage. Be sure to check linkage during engine operation. Also look at the engine fuel system. Irregularities with carburetion or fuel injection systems can change engine power with a constant throttle setting. This can result in speed deviations beyond the control of the governor system. Adding a small amount of droop can help stabilize the system for troubleshooting.

NON-PERIODIC instability should respond to the **GAIN** control. If increasing the gain reduces the instability, then the problem is probably with the engine. Higher gain allows the governor to respond faster and correct for disturbance. Look for engine misfirings, an erratic fuel system, or load changes on the engine generator set voltage regulator. If the throttle is slightly erratic, but performance is fast, move switch C1 to the “OFF” position. This will tend to steady the system.

If unsuccessful in solving instability, contact the factory for assistance.

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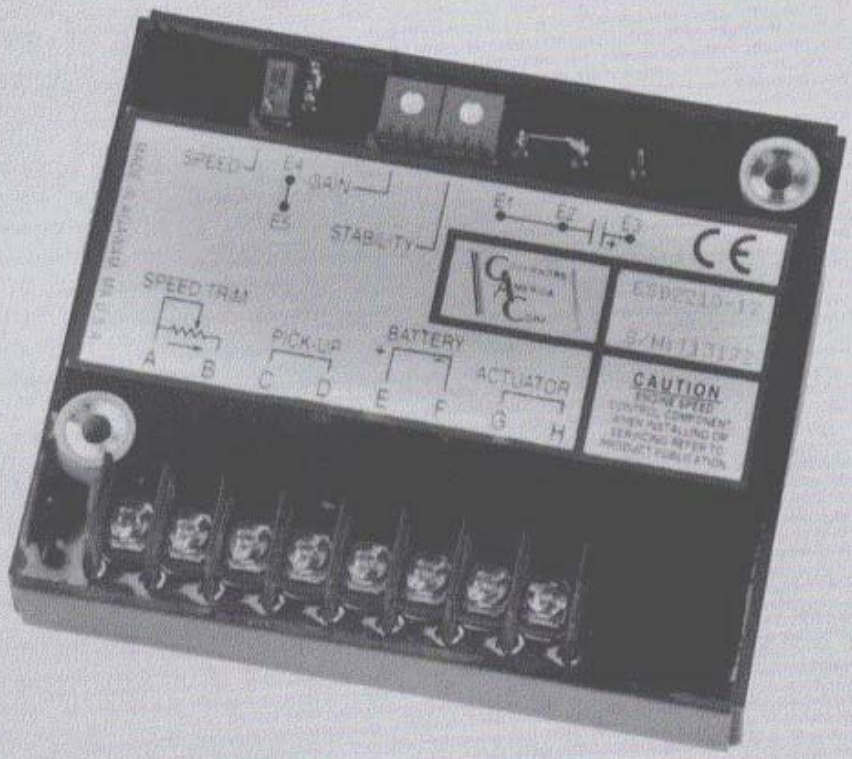
GOVERNORS AMERICA CORP.

ENGINE GOVERNING SYSTEMS

ESD2200 SERIES



SPEED CONTROL UNIT

MEMBER EGSA Electrical Generating Systems Association

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ESD2200 SERIES SPEED CONTROL UNIT

PRODUCT TECHNICAL INFORMATION

PTI 1022

JUNE 2000
MPC

INTRODUCTION

The ESD2000 SERIES speed control unit is an all electronic device designed to control engine speed with fast and precise response to transient load changes. This closed loop control, when connected to a proportional electric actuator and supplied with a magnetic speed sensor signal, will control a wide variety of engines in an isochronous mode. It is designed for high reliability and its hard potted design will withstand the engine environment.

Simplicity of installation and adjustment was foremost in the design. Two non interacting performance controls allow near optimum response to be easily obtained.

Other features include protection against reverse battery voltage and transient voltages, and fail-safe design in the event of loss of speed sensor signal or battery supply.

DESCRIPTION

Engine speed information for the speed control unit is usually received from a magnetic speed sensor. Any other signal generating device may be used provided the generated frequency is proportional to engine speed and meets the voltage input and frequency range specification. The speed sensor is typically mounted in close proximity to an engine driven ferrous gear, usually the engine ring gear. As the teeth of the gear pass the magnetic sensor, a signal is generated which is proportional to engine speed.

Signal strength must be within the range of the input amplifier. An amplitude of 0.25 to 50 volts RMS is required to allow the unit to function within its design specifications. The speed signal is applied to Terminals C and D of the speed control unit. Between these terminals there is an input impedance of over 5,000 ohms. Terminal D is internally connected to Terminal F, battery negative. Termination of the speed sensor shield may be made at Terminal D. The ideal connection of the speed sensor shield is as shown in Diagram 1. Only one end of the cable shield should be connected.

When a speed sensor signal is received by the controller, the signal is amplified and shaped by an internal circuit to provide an analog speed signal. If the speed sensor monitor does not detect a speed sensor signal, the output circuit of the speed control unit will turn off all current to the actuator. A summing circuit receives the the speed sensor signal along with the speed adjust set point input. The speed range has a ratio of 7:1 and is adjusted with a 25 turn potentiometer. The output from the summing circuit is the input to the dynamic control section of the speed control unit. The dynamic control circuit, of which the gain and stability adjustments are part, has a control function that will provide isochronous and stable performance for most engine fuel systems.

The speed control unit output circuit is influenced by the integral gain and stability performance adjustment. The governor system sensitivity is increased with clockwise rotation of the gain adjustment. The gain adjustment has a nonlinear range of 33:1. The stability adjustment, when advanced clockwise, increases the time rate of response of the governor system in order to match various time constants of a wide variety of engines. Since the speed control unit is a PID device, the "D," derivative portion can be varied when required (See instability section).

During engine cranking, the actuator is fully energized and will move to the maximum fuel position. The actuator will remain in that state during engine cranking and acceleration. While the engine is at steady load, the actuator will be energized with sufficient current to maintain the governor speed setpoint.

The output circuit provides switching current at a frequency of about 500 Hz. to drive the actuator. The switching frequency is well beyond the natural frequency of the actuator, thus there is no visible motion of the actuator output shaft. Switching of the output transistor reduces its internal power dissipation for efficient power control. The output circuit can provide current of up to 10 amps continuous at 25°C at battery voltages up to 32 VDC to drive an actuator. The actuator responds to the average current to position the engine fuel control lever.

The speed control unit has several performance and protection features which enhance the governor system. A speed anticipation circuit will minimize speed overshoot on engine start-up or when large increments of load are applied to the engine.

The ESD2000 Series speed control units are compatible with Governors America Corp. proportional actuators as well as some of those of other manufacturers.

ESD 2200 SERIES SPEED CONTROL UNITS

ESD 2210-12 . . . . . Standard Unit, 12V ESD 2210-24 . . . . . Standard Unit, 24V

SPECIFICATIONS

PERFORMANCE

- Isochronous Operation / Steady State Stability . . . . . ± 0.25% or better
- Speed Range/Governor . . . . . 1K - 7.5K Hz continuous
- Speed Drift With Temperature . . . . . ±1% maximum
- Speed Trim Range . . . . . ±250 Hz Typical
- Terminal A Sensitivity . . . . . 130 Hz., ± 15 Hz / Volt @ 5.1K impedance

ENVIRONMENTAL

- Ambient Operating Temperature Range . . . . . -40° to + 180°F (-40° to +85°C)
- Relative Humidity (Noncondensing) . . . . . up to 100%
- All Surface Finishes . . . . . Fungus proof and corrosion resistant

INPUT POWER

- Supply . . . . . -12; 8-20VDC, -24; 16-32 VDC (transient and reverse voltage protected)*
- Polarity . . . . . Negative ground (case isolated)
- Power Consumption . . . . . 60 ma continuous plus actuator current
- Maximum Actuator Current at 25°C (77°F) . . . . . 10 Amps continuous
- Speed Sensor Signal . . . . . 0.25-50 Volts RMS

RELIABILITY

- Vibration . . . . . 5 G @ 20-500 Hz.
- Testing . . . . . Functionally tested

PHYSICAL

- Dimensions . . . . . See outline (Diagram 1)
- Weight . . . . . 12 oz. (347 grams)
- Mounting . . . . . Any position, vertical preferred

*Reverse voltage is protected against by a parallel diode. A 15 amp fuse must be installed in the positive battery lead. See Diagram 1.

APPLICATION AND INSTALLATION INFORMATION

The speed control unit is hard potted and rugged enough to be placed in a control cabinet or engine mounted enclosure with other dedicated control equipment. Extreme heat should be avoided.

WARNING

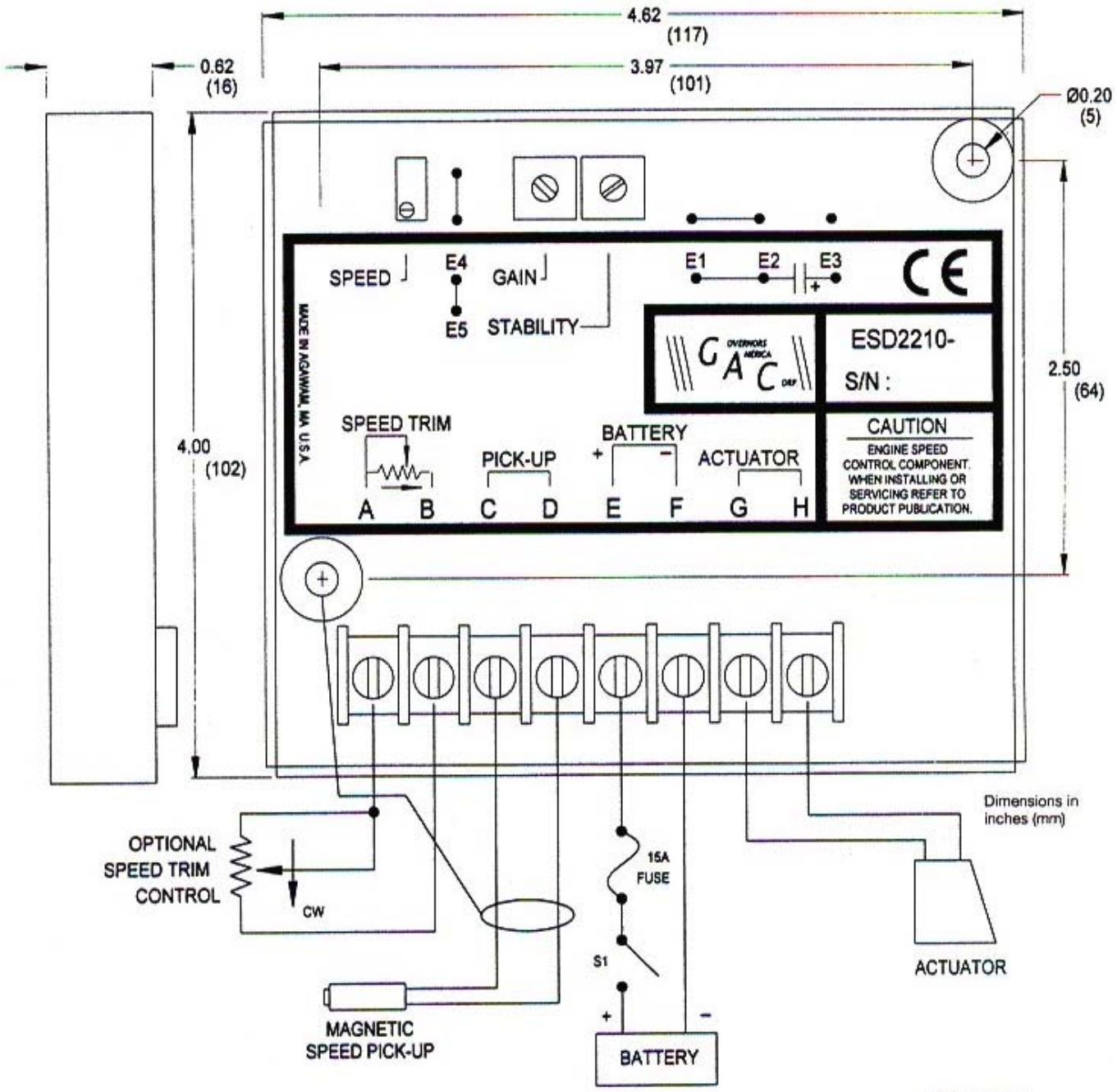
An overspeed shutdown device, independent of the governor system, should be provided to prevent loss of engine control which may cause personal injury or equipment damage.

WIRING

Basic electrical connections are illustrated in Diagram 1. Battery and actuator connections to Terminals E, F, G, and H should be #16 AWG (1.3mm sq.) or larger. Long cables require an increase in the wire size to minimize voltage drops. The battery positive (+) input, Terminal E, should be fused for 15 amps as illustrated in Diagram 1.

Magnetic speed sensor connections to Terminals C and D **MUST BE TWISTED AND/OR SHIELDED** for their entire length. The speed sensor cable shield should ideally be connected as shown in Diagram 1. The shield should be insulated to insure no other part of the shield comes in contact with engine ground, otherwise stray signals may be introduced into the speed control unit. With the engine stopped, adjust the gap between the magnetic speed sensor and the ring gear teeth. The gap should not be any smaller than 0.020 in. (0.45 mm). Usually, backing out the speed sensor 3/4 turn after touching the ring gear tooth will achieve a satisfactory air gap. The magnetic speed sensor output voltage should be at least 1 VAC RMS during cranking.

Diagram 1. SYSTEM WIRING/OUTLINE



If wire leads are longer than 3 meters (10 ft.), a shielded cable should be used. Ground shield at one end only.

See specific actuator publication for proper wiring of actuator connector for battery voltage used.

ADJUSTMENTS

Before Starting Engine

Check to insure the **GAIN** and **STABILITY** adjustment, and if applied, the external **SPEED TRIM CONTROL** are set to mid position.

Start Engine

The controller is factory set to operate at approximately engine idle speed. (1000 HZ. speed sensor signal)

Crank the engine with D.C. power applied to the governor system. The actuator will energize to the maximum fuel position until the engine starts. The governor system should be controlling the engine at a *low idle* speed. If the engine is unstable after starting, turn the gain and stability adjustments counterclockwise until the engine is stable.

Governor Speed Setting

The governed speed set point is increased by clockwise rotation of the **SPEED** adjustment control. Remote speed adjustment can be obtained with an optional Speed Trim Control. (See Diagram 1)

Governor Performance

Once the engine is at operating speed and at no load, the following governor performance adjustments can be made:

A. Rotate the **GAIN** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment 1/8 of a turn further counterclockwise to insure stable performance.

B. Rotate the **STABILITY** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment 1/8 of a turn further counterclockwise to insure stable performance.

C. Gain and stability adjustments may require minor changes after engine load is applied. Normally, adjustments made at no load achieve satisfactory performance. A strip chart recorder can be used to optimize the adjustments further.

If instability cannot be corrected or further performance improvements are required, refer to the instability section under SYSTEM TROUBLESHOOTING.

SYSTEM TROUBLESHOOTING

System Inoperative

If the engine governing system does not function, the fault may be determined by performing the voltage tests described in steps 1 through 6. Positive (+) and negative (-) refer to meter polarity. Should normal values be indicated during troubleshooting steps, then the fault may be with the actuator or the wiring to the actuator. Tests are performed with the battery power on, engine off except where noted. See actuator publication for testing details.

Step	Terminals	Normal Reading	Probabale Cause of Abnormal Reading
1	E (+) & F(-)	Battery Supply Voltage (12 or 24 VDC)	1. DC battery power not connected. Check for blown fuse. 2. Low battery voltage. 3. Wiring error.
2	A(+) & B(-)	0-3.9 with speed trim 7.1-7.9 without speed trim	1. Speed trim shorted or miswired. 2. Defective unit.
3	C(+) & D(-)	1.0 VAC RMS min., while cranking	1. Gap between speed sensor and gear teeth too great. Check gap. 2. Improper of defective writing to the speed sensor. Resistance between C and D should be 300 to 1200 ohms. 3. Defective speed sensor.
4	E(+) & H(-)	0.8-1.5 V while cranking	1. Wiring error to actuator. 2. Defective speed control unit. 3. Defectve actuator.

Unsatisfactory Performance

If the governing system functions poorly, perform the following tests.

Symptom	Test	Probable Fault
Engine overspeed	1. Do Not Crank, Apply DC power to the governor system	1. Actuator goes to full fuel. Then disconnect speed sensor Terminals C and D If actuator still at full fuel–speed control unit defective. If actuator at minimum fuel position–erroneous speed signal. Check speed sensor cable.
	2. Manually hold the engine at the desired running speed. Measure the DC voltage between Terminals E(+) and H(-) on the speed control unit.	1. If the voltage reading is 1.0 to 1.5 VDC, a) **SPEED** adjustment set above desired speed, turn CCW. b) Defective speed control unit. 2. If the voltage reading is above 1.5 VDC, actuator or linkage binding. Replace actuator. 3. Set point of overspeed shutdown device set too low. 4. If the voltage reading is below 0.8 VDC, defective speed control unit.
Actuator does not energize fully while cranking.	1. Measure the DC voltage between Terminals E(+) and H(-) on the speed control unit. Should be 0.8 to 1.5 volts, if not:	1. Replace the battery if weak or undersized. 2. Actuator wiring incorrect. 3. If voltage is greater than 1.5V, SPEED set too low.
	2. Momentarily connect the Terminal E to H. The actuator should move to the full fuel position.	1. Actuator or battery wiring in error. 2. Actuator or linkage binding. 3. Defective actuator.
Engine remains below desired governed speed	1. Measure the actuator output, Terminals G & H, while running under governor control.	1. If voltage measurement is within 1.5 volts or more of the battery supply voltage level, then fuel control restricted from reaching full fuel position. Possibly due to mechanical governor, carburetor spring, or linkage interference. 2. If not, increase speed setting.

Insufficient Magnetic Speed Sensor Signal

A strong magnetic speed sensor signal will eliminate the possibility of missed or extra pulses. The speed control unit will govern well with 0.5 volts RMS speed sensor signal. A speed sensor signal of 3 volts RMS or greater at governed speed is recommended. Measurement of the signal is made at Terminals C and D.

The amplitude of the speed sensor signal can be raised by reducing the gap between the speed sensor tip and the engine ring gear. The gap should not be any smaller than 0.020 in. (0.45 mm). When the engine is stopped, back the speed sensor out by 3/4 turn after touching the ring gear tooth to achieve a satisfactory air gap.

Electromagnetic Compatibility (EMC)

EMI SUSCEPTIBILITY—The governor system can be adversely affected by large interfering signals that are conducted through the cabling or through direct radiation into the control circuits.

All GAC speed control units contain filters and shielding designed to protect the unit's sensitive circuits from moderate external interfering sources.

Although it is difficult to predict levels of interference, applications that include magnetos, solid state ignition systems, radio transmitters, voltage regulators or battery chargers, should be considered suspect as possible interfering sources.

If it is suspected that external fields, either those that are radiated or conducted, are or will affect the governor systems operation; it is recommended to use shielded cable for all external connections. Be sure that only one end of the shields including the speed sensor shield, is connected to a single point on the case of the speed control unit. Mount the speed control unit to a grounded metal back plate or place it in a sealed metal box.

Radiation is when the interfering signal is radiated directly through space to the governing system. To isolate the governor system electronics from this type of interference source, a metal shield or a solid metal container is usually effective.

Conduction is when the interfering signal is conducted through the interconnecting wiring to the governor system electronics. Shielded cables and installing filters are common remedies.

As an aid to help reduce the levels of EMI of a conductive nature, a battery line filter and shielded cables is conveniently supplied by GAC in KT310. To reduce the levels of EMI of a radiated nature, a shielded container P/N CA114 can be sourced from GAC and its distributors.

In severe high energy interference locations such as when the governor system is directly in the field of a powerful transmitting source, the shielding may require to be a special EMI class shielding. For these conditions, contact GAC application engineering for specific recommendations.

Instability

Instability in a closed loop speed control system can be categorized into two general types. **PERIODIC** appears to be sinusoidal and at a regular rate. **NON-PERIODIC** is a random wandering or an occasional deviation from a steady state band for no apparent reason.

The **PERIODIC** type can be further classified as a fast or slow instability. Fast instability is a 3 Hz. or faster irregularity of the speed and is usually a jitter. Slow periodic instability is below 3 Hz., can be very slow, and is sometimes violent.

If fast instability occurs, this is typically the governor responding to engine firings. Raising the engine speed increases the frequency of instability and vice versa. If this is the case, cutting the jumper from E1 to E2 will reduce this tendency. In extreme cases, the removal of the E1 to E2 jumper may not take all the jitter out of the system. A second jumper, E4 to E5, may be removed to further stabilize the system. Post locations are illustrated in Diagram 1. Interference from powerful electrical signals can also be the cause. Turn off the battery chargers or other electrical equipment to see if the symptom disappears.

Slow instability can have many causes. Adjustment of the **GAIN** and **STABILITY** usually cures most situations by matching the speed control unit dynamics. If this is unsuccessful, the dead time compensation can be modified. Add a capacitor from posts E2 to E3 (negative on E2). Post locations are illustrated in Diagram 1. Start with 10 mfds. and increase until instability is eliminated. The control system can also be optimized for best performance by following this procedure.

If slow instability is unaffected by this procedure, evaluate the fuel system and engine performance. Check the fuel system linkage for binding, high friction, or poor linkage. Be sure to check linkage during engine operation. Also look at the engine fuel system. Irregularities with carburetion or fuel injection systems can change engine power even with a constant throttle setting. This can result in speed deviations beyond the control of the governor system. Adding a small amount of droop can help stabilize the system for troubleshooting.

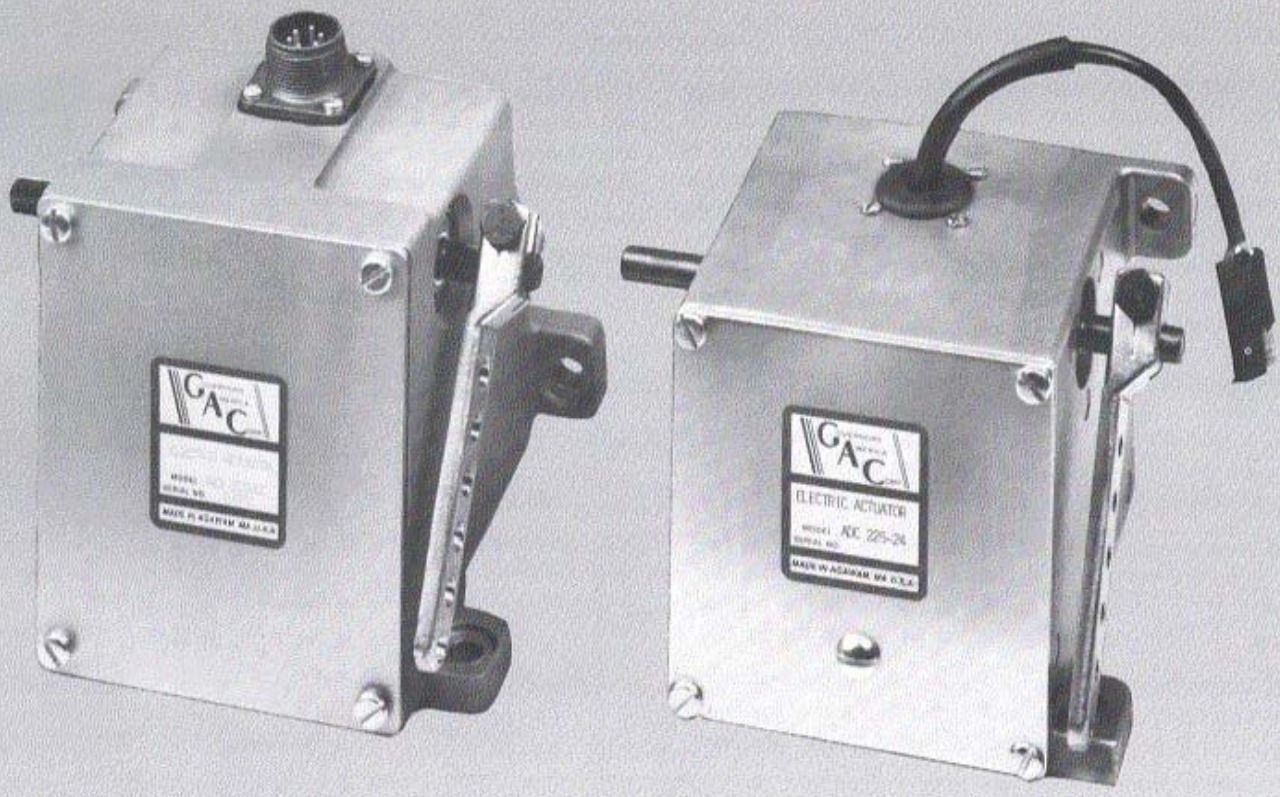
NON-PERIODIC instability should respond to the **GAIN** control. If increasing the gain reduces the instability, then the problem is probably with the engine. Higher gain allows the governor to respond faster and correct for the disturbance. Look for engine misfirings, an erratic fuel system, or load changes on the engine generator set voltage regulator. If the throttle is slightly erratic, but performance is fast, removing the jumper from E4 to E5 will tend to steady the system.

If unsuccessful in solving instability, contact your nearest factory authorized service center for assistance.

GOVERNORS AMERICA CORP.

ENGINE GOVERNING SYSTEMS

225 SERIES



ELECTRIC ACTUATOR

INCLUDES MODELS: ACB 225 ADB 225 ADC 225 ADB 225F

MEMBER EGSA Electrical Generating Systems Association

GOVERNORS AMERICA CORP. • 720 Silver St. • Agawam, MA 01001-2907, USA

225 SERIES ELECTRIC ACTUATOR

PRODUCT TECHNICAL INFORMATION

PTI 2000

SEPTEMBER 1997

MPC

INTRODUCTION

The 225 Series electric actuator is a rotary output, linear torque, proportional servo. This electromechanical actuator is typically used as an engine fuel control positioning device. An internal spring provides fail safe operation by forcing the actuator to the fuel shut off position when the actuator is de-energized. This design combines fast operation, multi voltage usage, wider rotation angles, and proven reliability. The actuator can operate directly from 12, 24, or 32 volt battery supplies.

The speed of operation of the actuator is typically faster than competitive units, thus it provides more stable and rapid response to transient conditions.

Applications include most block pumps, with or without mechanical governors, distributor type pumps, and medium sized carbureted engines. The 25 degrees of rotation expands the application to a wider variety of engines.

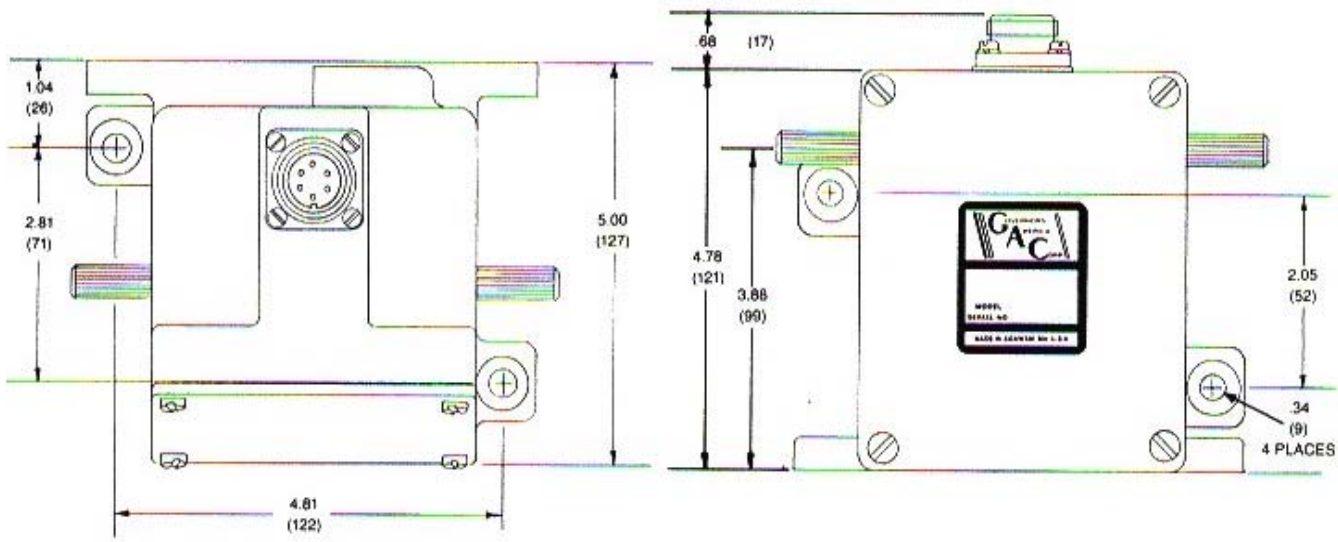
DESCRIPTION

The actuator is an electromagnetic servo device which can be integrated into a closed loop control system. An engine control system can be described as follows. An electrical signal is generated by a magnetic speed sensor which is proportional to engine speed. This signal is sent into the electronic speed control unit which compares it to the preset engine speed setting. If the magnetic speed sensor signal and the preset engine speed setting are not equal, a change in current from the speed control unit to the actuator will change the magnetic force in the actuator.

The rotation of the actuator shaft will then adjust the fuel to the engine and cause the engine speed to be equal to the preset engine speed setting. Shaft rotation is proportional to the amount of actuator current and counterbalanced by the internal spring.

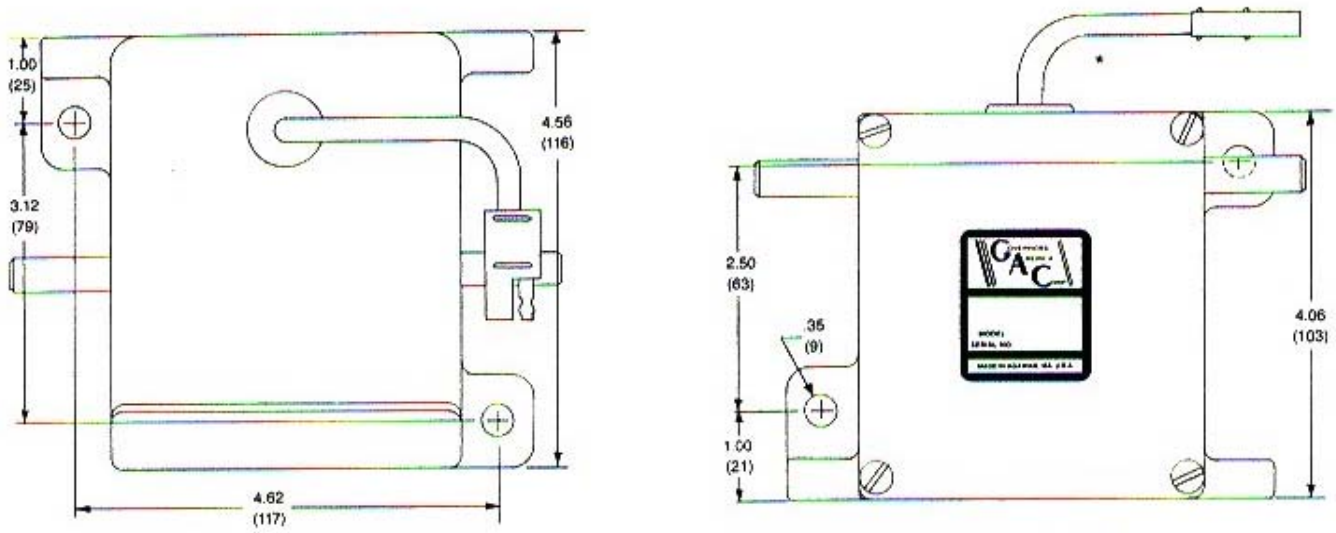
Since the design has no sliding parts and is totally sealed, outstanding reliability results. A single compression spring is used to improve reliability. No maintenance is necessary.

DIAGRAM 1a



ACB
Actuator Outline Dimensions
Dimensions in: Inches (mm)

DIAGRAM 1b



* ADC only

ADB and ADC Actuator Outline Dimensions

SPECIFICATIONS

PERFORMANCE
- Available Torque ..... See Diagram 2. ..... Max 2.2 lb-ft (2.7 Nm)
- Maximum Operating Shaft Angular Travel ..... 25 ± 1 degree CW/CCW

POWER INPUT
- Operating voltage ..... 12, 24, or 32 VDC
- Normal Operating Current ..... 3 A at 12 VDC
  ..... 1.5 A at 24/32 VDC
- Maximum Current-Continuously Rated ..... 8 A at 12 VDC, 9 A for HOS
  ..... 4 A at 24/32 VDC

ENVIRONMENTAL
- Temperature Range ..... -65° to +200° F (-54° to +95° C)
- Relative Humidity ..... up to 100%
- All Surface Finishes ..... Fungus proof and corrosion resistant

PHYSICAL
- Dimensions ..... See Diagram 1
- Weight ..... 8.25 lbs. (3.75 kg)
- Mounting ..... Any position, electrical connector at the top preferred

RELIABILITY
- Vibration ..... up to 20 G @ 50-500 Hz.
- Testing ..... 100% Tested

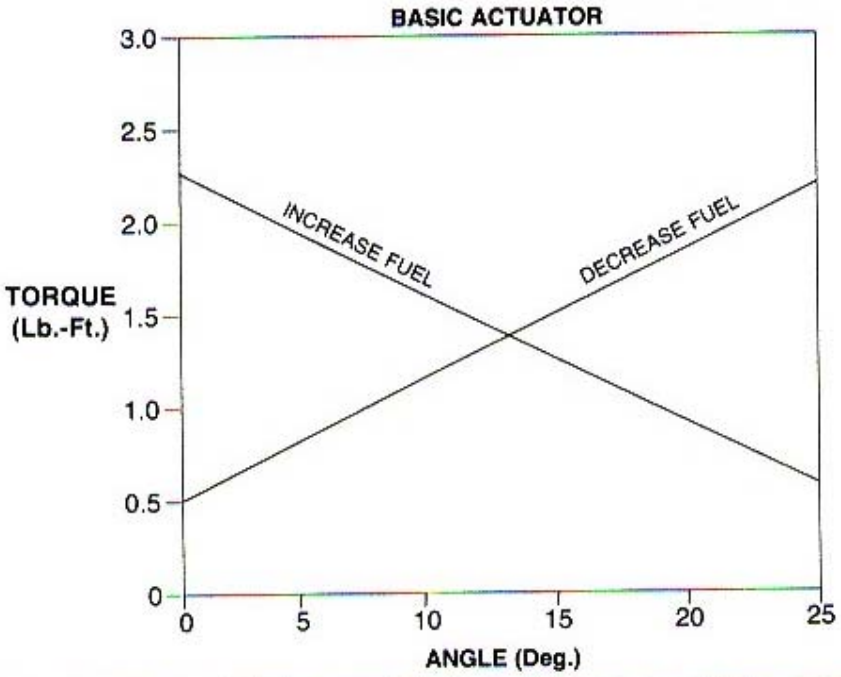
MATING HARDWARE
- Connector ACB 225/ADB 225 ..... EC1000/MS3106R 14S-6S (6 pins)
  ADC 225 ..... Supplied with Actuator
- Lever ..... ACB 225/ADB 225/ADC225S LE1400-2
  ..... ADC 225 ..... LE1500-2
- Rod End Bearings (to attach a 1/4-28THD linkage rod to the lever) ..... BR 200 (right hand)
  BR 201 (left hand)
- Wiring Harness ADC 225 ..... Supplied with Actuator
  ACB 225/ADB 225 ..... Various Lengths available from GAC

225 SERIES ACTUATOR VARIATIONS

ACB 225/ADB 225 ..... MS3102R 14S-6P CONNECTOR ADC 225 ... COMMERCIAL CONNECTOR 12 or 24 VOLTS

DIAGRAM 2

Graph of Actuator Torque



INSTALLATION

The actuator must be rigidly mounted as close as possible to the fuel control lever of the engine. Vibration from the engine will not affect the operation of the actuator. The preferred mounting is with the electrical connector at the top. Applications with the actuator upside down, on its back, or sideways should be avoided.

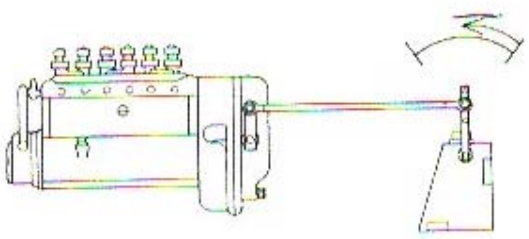
Linkage arrangement of any actuator system is always important. High quality rod end bearings should be used. Rod end bearings that have high friction can cause instability and require servicing.

Levers and linkage should be sturdy yet low in mass for the fastest speed of response conditions.

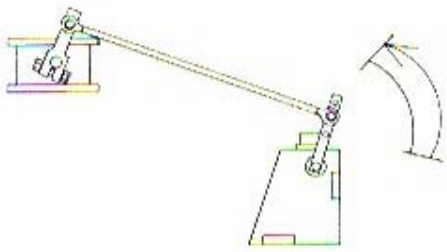
Arrangement of the linkage for actuation of the engine fuel control is an important application consideration. For proportional actuators to operate with linear control systems, it is important to obtain a linear relationship between actuator stroke and fuel delivery. The linkage configuration for diesel fuel systems is typically as illustrated in Diagram 3. The lever on the actuator should be nearly parallel to the pump lever at the mid fuel position for linear fuel control.

For proportional actuators to operate with non-linear systems, it is important to obtain a non-linear relationship between actuator stroke and fuel delivery. Carbureted, PT Pumps (CUMMINS), or other non-linear fuel systems require a non-linear fuel linkage configuration as illustrated in Diagram 4. A non-linear fuel system results when more engine power is developed for a given stroke at positions of low fuel settings than at high fuel settings. In this case the levers should be parallel at full load.

In general, the linkage should be adjusted so that the fuel control lever minimum and maximum fuel stops are used rather than the actuator internal mechanical stops. The actuator should be adjusted so that it operates over at least one half (12 degrees) of its available travel.



Fuel Control Lever At Mid Fuel Position
DIAGRAM 3



Carburetor Fuel Valve At Full Fuel Position
DIAGRAM 4

Wiring

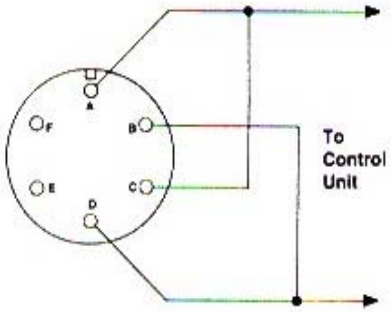
The ADC is prewired for 12 or 24V. Use the included harness to connect the actuator to the speed control. Do not use an ADC on a 32V system.

If an ACB or ADB is used, the mating electrical connector must be wired in a configuration dependent on the system voltage supply. The maximum wire size that will fit into the actuator mating half connector is #16 AWG (1.3 mm sq.). Cable CH 1203, a pre-wired actuator cable harness, is available. It is 12 feet (4 Meters) in length and suitable for use on 12 or 24 volt systems.

For 12 volt applications, note that it is preferable to connect four cables, one to each of the coil wires and wire per Diagram 5. Maximum current is 8 Amps. The recommended wire size is at least #16 AWG (1.3 mm sq.).

DIAGRAM 5
12 Volt Operation

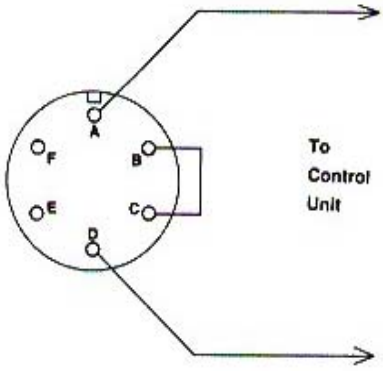
A to C
B to D
A & D to output terminals of speed control unit



For 24 volt applications, a simple jumper wire between pins B and C at the mating half connector can be made. The remaining two pins, A and D, can be extended to the required length. Maximum current is 4 Amps. The recommended wire size is at least #18 AWG (1.0 mm sq.). See Diagram 6.

DIAGRAM 6
24 Volt Operation

B to C
A & D to output terminals of speed control unit



For 32 volt applications, connect the actuator electrical connector as illustrated for 24 Volt operation. A resistor that will drop the remaining voltage above 32 Volts is needed. A 1.5 ohm, 25 watt resistor should be placed in series with pin A of the actuator and the output of the speed control unit. Maximum current is 4 Amps.

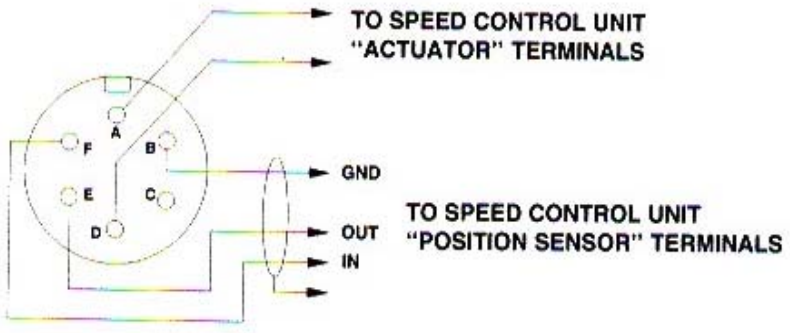
Actuator cable harnesses with lengths greater than 10 ft. (3 meters) from the actuator to the speed control unit may introduce current losses which can restrict full rotation of the actuator. In this case, use of a larger gauge wire is required.

For applications where EMI is of concern, shielded cable for the actuator is recommended. Twisting of the cable alone will substantially reduce EMI.

ADB225F Wiring

The ADB225F version of the actuator includes a position sensor. A GAC speed control unit that includes fuel management electronics is required to interface with this sensor.

See the appropriate speed control unit literature for complete wiring information.



ADJUSTMENTS

WARNING

An overspeed shutdown device, independent of the governor system, should be provided to prevent loss of engine control which may cause personal injury or equipment damage.

Reconfirm that the linkage is not binding and that friction is minimal. Before starting the engine, push the actuator to the full fuel position and release. It should return instantly to the no fuel position without any binding. Once the engine has been started, the linkage can be optimized by temporarily inserting an ammeter in one of the wires between the speed control unit and the actuator or by measuring the voltage across the actuator. Measure the actuator current or voltage at no load and full load. The range and the starting current or voltage are important for optimizing the linkage system. Typical values are shown in the table below for 12 volt and 24 volt systems.

To increase the range of the actuator voltage or current, move the linkage to a lower hole on the actuator lever. A lower range of actuator current than suggested can cause instability or poor performance.

To increase or decrease the no load current or voltage, adjust the length of the link between the actuator and the engine fuel control.

Smaller angles of actuator travel may improve transient performance, but will reduce available force at the fuel control lever. Allowing the actuator to operate through at least one half (12 degrees) of its stroke will usually provide near optimum response.

Actuator Current/Voltage Range Chart

	12 Volts	24 Volts
No Load	2.5 Amps, 4 Volts	1.5 Amps, 12 Volts
Full Load	4 Amps, 6 Volts	2.5 Amps, 18 Volts

TROUBLESHOOTING

If the governor system fails to operate, make the following tests at the actuator mounted connector while moving the actuator through its stroke.

Measure the Resistance

ACB 225/ADB 225	
A to B	2.5 ohms
C to D	2.5 ohms
A to C	Infinity
A to Housing	Infinity
C to Housing	Infinity

ADC 225	
Red to white (12V)	1.25 ohms
Red to white (24V)	5.0 ohms
Red to housing	Infinity
White to housing	Infinity

Energize the actuator to full fuel (follow steps in control unit publication) and manually move the actuator through its range. No binding or sticking should occur.

If the actuator passes these tests, the problem is elsewhere in the system. Refer to the control unit troubleshooting publication.

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WOODWARD

Installation and Operation Manual

L-Series Integrated Speed Control

Manual 26250A

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

IMPORTANT DEFINITIONS

WARNING—indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION—indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment.

NOTE—provides other helpful information that does not fall under the warning or caution categories.

Revisions—Text changes are indicated by a black line alongside the text.

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Regulatory Compliance Notes and Warnings

The L-Series is suitable for use in Class I, Division 2, Groups A, B, C, D per CSA for Canada and U.S. or non-hazardous locations only.

Wiring must be in accordance with North American Class I, Division 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field wiring must be suitable for at least 105 °C.

The actuator should be protected from exposure to sunlight and rain.

These listings are limited only to those units bearing the CSA agency identification.

WARNING

Explosion hazard–Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Explosion Hazard–Substitution of components may impair suitability for Class I, Division or Zone applications.

AVERTISSEMENT

Risque d'explosion–Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

Risque d'explosion–La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division ou Zone.

Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.

CAUTION
To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Chapter 1.
General Information

Purpose and Scope

The purpose of this manual is to provide the necessary background information for applying the L-Series integrated speed control to diesel and gas/gasoline reciprocating engines. Topics covered include mechanical installation, electrical wiring, software programming, and troubleshooting. While this manual is primarily targeted at OEM customers, OEMs themselves may find it useful to copy some of the information from this manual into their application user manuals.

How to Use This Manual

The following summarizes how to install an L-Series speed control into a new or existing system:

- Unbox and inspect the hardware.
- Mount and wire the hardware following the procedures and recommendations in Chapters 2–3.
- Configure the control using the Service Tool (Chapter 6). Not required if pre-configured by OEM.
- Stroke the valve and verify/tune dynamics and functionality (Chapter 7). Not required if set up by OEM.
- Troubleshooting guidelines are provided in Chapter 8.
- Specifications are provided in Appendix B.

Intended Applications

The L-Series speed control is a suitable replacement for mechanical systems that need more flexibility in control strategy, like dual dynamics, idle rated dynamics, and gain curves. The L-Series control is designed for industrial applications ranging from generators and mechanical drives to pumps and compressors.

Key environmental characteristics of these applications include extended industrial operating temperatures (–40 to +105 °C/–40 to +221 °F), industrial EMC requirements, electrical transients, and lower operating voltages (12/24 V).

The L-Series is CSA approved for Class I, Division 2, Groups A, B, C and D hazardous locations and is designed for on-engine mounting.

Introduction

The Woodward L-Series combines the L-Series electric actuator with integrated speed control software to control the speed of a diesel or gaseous engine. The L-Series is a microprocessor-based control that is incorporated into the actuator, creating a single integrated package. This eliminates the need for an additional driver box and speed control box.

The control uses state-of-the-art speed sensing and control algorithms. The L-Series also performs comprehensive diagnostics for easy troubleshooting. It can be configured and tuned using the L-Series Service Tool.

The L-Series provides a building block approach to total engine management. The modular bi-directional actuator design easily attaches to fuel pumps, mixers, or throttle bodies. For information on Woodward throttle body applications, refer to manual 26249 (ITB and LC-50).

Woodward also offers L-Series actuator versions for Position Control and Process Control, like Air/Fuel Ratio control, applications. Refer to manuals 26237 (Position Control) or 26251 (Process Control).

The L-Series speed control accepts a speed signal (ignition or MPU), compares this to the speed setpoint, and drives the 0–60 degree output shaft to the commanded position based on an internal shaft position sensor. The high-efficiency torque motor delivers 0.34 N·m (0.25 lb-ft) nominally over 60° travel range to operate fuel or air control devices. See the specifications (Appendix B) for more details.

There are 4 AUX inputs for I/O functions, configurable as digital inputs, analog inputs, or RS-232 Service Tool communications. The functions available for AUX input configuration are:.

- Isochronous Loadsharing analog input
- Remote Speed Setpoint analog input
- MAP/Boost Fuel limit analog input
- Rated 1 / Rated 2 (50/60 Hz) digital input
- Raise Speed Setpoint digital input
- Lower Speed Setpoint digital input
- Isoch/Droop digital input
- Idle/Rated digital input
- Alternate Dynamics digital input
- Run Enable digital input

For status purposes, a relay driver output is available on the L-Series control which changes state whenever a fault or error condition is experienced by the L-Series control.

If the system so requires, the L-Series provides a direct position output signal in the form of a dc voltage. The throttle position (TPS) output represents full counterclockwise (CCW) to clockwise (CW) rotation of the actuator shaft, and thus gives the operator an external position indication after installation and while the unit is operating.

WARNING

When included with an ITB, the actuator depends solely on the return spring inside the throttle body assembly to drive toward minimum fuel when not powered. Therefore other positive shutdown devices like fuel shut-off solenoids are recommended to ensure shutdown on loss of signal to the control system. Also, separate overspeed trip devices are always mandatory.

Basic Control Options

Position control with software support for:
- CW / CCW (clockwise/counterclockwise) direction control
- Field calibration options

Speed control with software selectable:
- Speed setpoints
- Dynamics
- Fuel Limiting
- Start / Stop behavior
- Input/Output definitions

WARNING
The actuator must be properly set up using the L-Series Service Tool prior to starting the prime mover.

NOTE
The Service Tool is not included, but can be downloaded from the Woodward Internet website (www.woodward.com/software).

Programmable Features

Control setup and tuning is accomplished through the use of a PC (personal computer), Woodward Service Tool software, and a programming harness. The features identified below are described in Chapters 2 and 4. Briefly, the programmable features include:
- Speed Signal Setup Parameters
- General Setup Parameters
  - Fail Direction (CCW or CW)
  - Min Position Direction (CCW or CW)
- Valve Position Control Parameters
- Speed Setpoint Setup Parameters
  - Functionality Settings
  - Idle/Rated 1/Rated 2 Speed Settings
  - Acceleration and Deceleration Rates
  - Droop / Isoch
  - Biasing Behavior and Rates
- Speed Control Setup Parameters
  - Behavior
  - Start Speed settings and Rates
  - Engine Stopping Settings
  - Speed Error Detection Settings
  - Dynamics Settings
- Fuel Limiting
  - Behavior
  - Settings and Rates
- Discrete Output Settings
- Discrete Input Settings
- Fault Settings
- Security Settings

Service Tool Software

The L-Series Service Tool software is a Microsoft Windows® based GUI (graphic user interface). The Service Tool Software is compatible with Windows 95/98/NT/2000/Me/XP and gives the OEM the ability to:

- Configure product settings based on application requirements
- Tune the control with the engine running during application development
- Create configuration files for downloading into multiple controls
- Download configuration files
- Extract and view fault codes for field diagnosis
- Update control dynamics during field service
- Calibrate the control for user stops

In addition, the Service Tool can be configured to incorporate security to control access to and protect application settings where needed.

Detailed descriptions of software features and installation are available in Chapters 4–7.

Chapter 2.
Mechanical Installation

Introduction

This chapter provides instructions on how to mount and connect the L-Series control into a system. Hardware dimensions are provided for mounting the device to a specific application.

WARNING
Due to typical noise levels in turbine or engine environments, hearing protection should be worn when working on or around the L-Series.

Burn Hazard—The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

CAUTION
Explosion Hazard—External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

CAUTION
Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figure 3-4).

WARNING
Explosion hazard–Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Explosion Hazard–Substitution of components may impair suitability for Class I, Division or Zone applications.

General Installation, Operation Notes and Requirements

WARNINGS
Use an independent device for positive shutdown, such as a fuel shut off valve is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

Use of an external spring to return to minimum fuel is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

Use of a predicted min fuel shutdown procedure is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

Unpacking

Be careful when unpacking the actuator. Check the unit for signs of damage, such as bent or dented panels, scratches, and loose or broken parts. Notify the shipper and Woodward if damage is found.

Mechanical Installation

Mounting Location

Locate the L-Series control a distance from sources of extreme radiant heat, such as exhaust manifolds or turbochargers. The operating temperature range of the control is –40 to +105 °C (–40 to +221 °F). In spark-ignited applications, make sure the L-Series is located away from the ignition coil, and that harness wires are not routed next to the spark plug wires.

As shown in the specifications, the L-Series control has been designed for and verified to a given accelerated life vibration test level at the mounting surface of the actuator. The user should be aware that in any application, bracket design can significantly change the vibration levels at the actuator. Therefore, every effort should be made to make the bracket as stiff as possible so that engine vibrations are not amplified, creating an even more severe environment at the actuator. Additionally, when possible, orienting the actuator shaft parallel to the crankshaft of the engine will often reduce the vibration load on the actuator's rotor system in reciprocating engine applications.

Mounting the L-Series Actuator with an ITB

Typical mounting of a L-Series actuator with an ITB is accomplished by fastening the throttle to the inlet and outlet pipes. Ensure that the pipes can support the weight of the L-Series actuator and the throttle body.

Output Shaft

The L-Series actuator has 58–62° of available travel. The max fuel direction of this travel is software configurable in the clockwise or counterclockwise direction through the Service Tool.

Mounting Orientation

While it is not a requirement, it is good practice to orient the connector feature on the control in a horizontal or downward orientation to minimize fluid accumulation between the enclosure and the mating connector’s gasket.

Actuator Configuration

The L-Series actuator utilizes a 2.0” (50.8 mm) square mounting bolt pattern and is intended to fit within an envelope of 2.618 x 2.618 x 2.540” (66.50 x 66.50 x 64.52 mm) with the short dimension along the shaft axis. Two shaft seal configurations are available, an internal lip seal and an external lip seal with spring backup (Figure 2-3). In addition, six independent output shaft configurations are available (Figure 2-4). Consult Woodward applications engineering for the application appropriate seal and shaft configuration.

Mounting Hardware

Use M5 or #10 fasteners torqued to 4 N·m (35 lb-in) to attach the L-Series control to the mounting bracket. The bracket and attaching hardware must be designed to hold the weight and to withstand the vibration associated with prime mover mounting. Use the appropriate fasteners for securing the mounting bracket to the engine.

Mechanical (Fuel Position) Stops

Diesel Stops—Diesel installations will generally use the fuel system minimum and maximum position stops. Diesel engine applications are normally designed to provide the minimum and maximum stops without binding. The actuator's stops must not prevent the actuator from driving the fuel linkage to the minimum and maximum positions. The linkage should be designed to use as much actuator travel as possible, without preventing minimum and maximum fuel positions.

Gas Engine Stops—Butterfly valves in carburetors will often bind if rotated too far toward minimum or maximum. For this reason, hard stops in the throttle body or associated linkage should be used at both minimum and maximum positions. The engine must always shut down when the actuator is at the minimum stop.

Linkage

Proper design and installation of the linkage from the actuator to the engine is necessary for the unit to provide the best control possible. The characteristics of the engine fuel system and the control dictate the linkage design. Most diesel fuel pumps have a linear relationship between metering valve or fuel rack position and the amount of fuel delivered to the engine. Throttle bodies have a non-linear relationship between throttle angle and air/fuel flow. Because the L-Series is a linear control, a linkage designed for diesel applications tends to maintain a 1:1 relationship between actuator shaft angle and rack position throughout the range of travel. A linkage designed for gas or gasoline applications tends to start with a 3:1 relationship transitioning to a 1:3 relationship between actuator shaft angle and throttle angle throughout the range of travel. This non-linear linkage design essentially compensates the throttle body so the air/fuel flow looks linear from the control's perspective. Woodward recommends that linkages use approximately 40 degrees of actuator shaft rotation, centered in the full 60-degree range. This maximizes the resolution of the actuator control loop, making the engine easier to govern. Refer to Figure 2-1 for examples of typical linkage designs.

To increase the amount of actuator rotation, move the rod end closer to the actuator shaft or farther away from the shaft controlling the fuel flow. To decrease the amount of actuator rotation, move the rod end farther from the actuator shaft or closer to the throttle shaft.

Once installed, manually stroke the fuel-control linkage from stop to stop as if the actuator were moving it. The linkage must move freely, without friction and backlash. Lubricate or replace worn linkage or fuel control parts as required.

Always make sure the fuel delivery device (fuel pump or throttle body) has a return spring that pulls towards minimum fuel when no power is applied to the control. Size the return spring so that the actuator output shaft sees no more than 0.07 N·m (0.05 lb-ft) of torque at maximum loading conditions.

In addition to a return spring, always make sure the application includes a secondary overspeed protection device as a backup to the main governor's overspeed detection function.

CAUTION

The actuator's maximum slew rate can place stress on the fuel system stops and on the linkage between the actuator and the fuel system. The maximum actuator speed is 1100 degrees per second in both increase and decrease fuel directions under normal operating conditions. Exceeding the control input voltage requirements may cause a unit shutdown in which the actuator speed may exceed 3500 degrees per second.

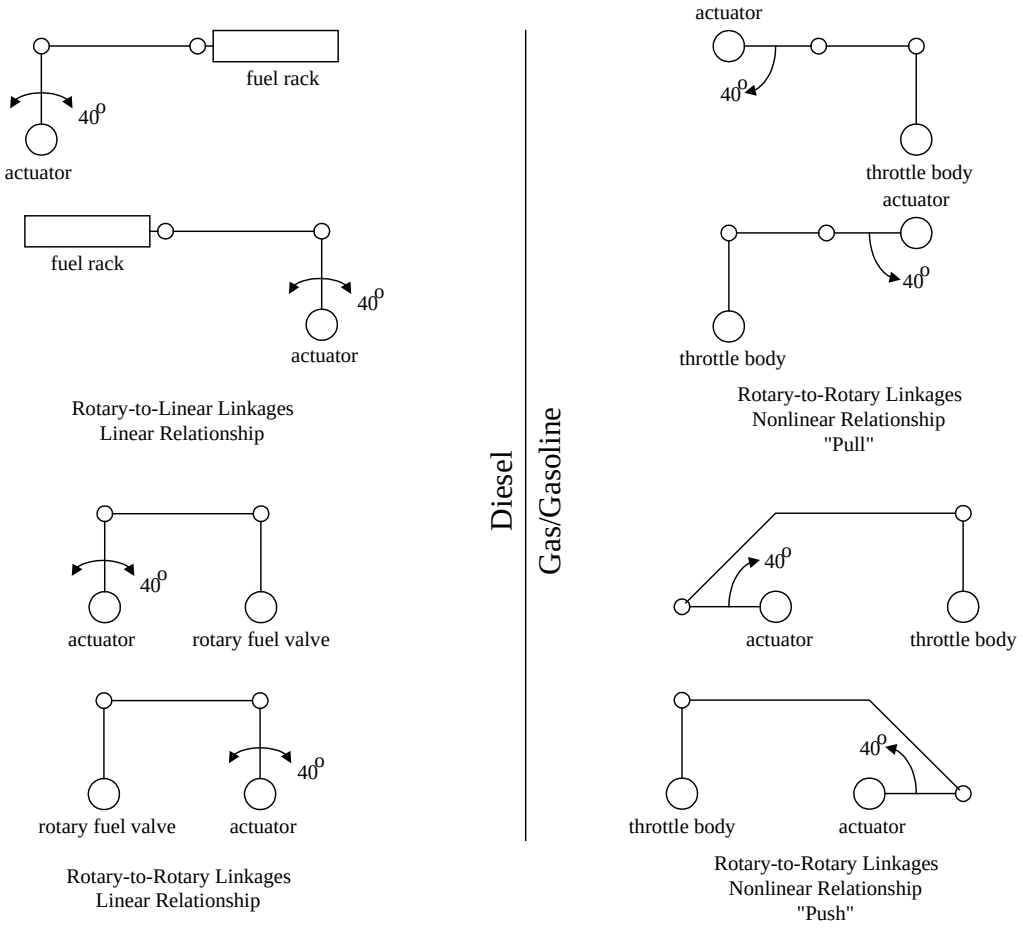
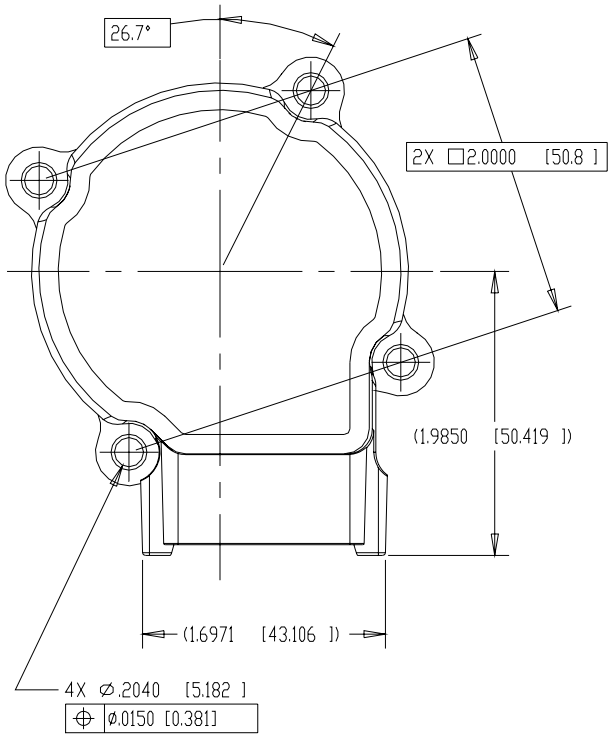


Figure 2-1. Linkage Design Examples

The Mass Moment of Inertia (MMOI) for the L-Series actuators is 1.48 E-5 kg-m² (1.57E-3 lb-in-s²). External fuel system stops should be used and must be adequate to absorb the actuator MMOI in addition to the linkage inertia without damage.

Use of good rod-end connectors with as little free play as possible is essential. Select rod ends that will remain tight and wear well during the nearly constant movement associated with precise speed control. The link connecting the actuator lever to the fuel-control lever must be short and stiff enough to prevent flexing while the engine is running.

Typically, in a linkage system, there may be links and levers which are supported by customer-supplied bearings. Additionally, there will typically be a section of the linkage where the mass is supported fully by the actuator output shaft. Minimizing the mass the actuator is required to support is essential in that excessive mass or vibration levels may damage the actuator's rotor system and shorten the life of the actuator.



NOTES:

1. MOUNTING HARDWARE TO BE SOCKET HEAD CAP SCREWS -- #10(.190)-24, M5, OR EQUIVALENT. NO WASHERS TO BE USED. RECOMMENDED SCREW TORQUE = 35 IN-LB [4 N-M].
2. FOR BRACKET-MOUNT APPLICATION, A BRACKET OUT-OF-FLATNESS OF .010 [0.25] MAXIMUM IS RECOMMENDED.
3. FOR CONNECTOR INFORMATION, REFER TO CONNECTOR TABLE AND APPROPRIATE WIRING DIAGRAM.
4. USE OF INTERNAL ACTUATOR STOPS IN APPLICATION NOT RECOMMENDED. TORQUE AGAINST STOPS NOT TO EXCEED 200 IN-OZ.
5. DIMENSIONS ARE SHOWN IN INCHES [MM].
6. DETAILS SHOWN HERE ARE COMMON TO ALL ACTUATOR ASSEMBLIES. HENCE, NEITHER COVERS NOR SHAFTS ARE SHOWN IN THESE VIEWS. SEE COVER AND SHAFT DETAILS ELSEWHERE IN THIS MANUAL.

INTEGRATED DEUTSCH CONNECTOR (REF: DT04-12PA)		
ITEM	*RECOMMENDED*	*OPTIONAL*
MATING CONNECTOR	DT06-12SA-P012	DT06-12SA
SECONDARY LOCK	W12S-P012	W12S
SOCKETS	0462-201-16141	0462-201-16141
WIRING HARNESS STRESS RELIEF SUPPORT	WITHIN 16 INCHES FROM CONNECTOR	
NOTE: IN THE EVENT A WIRE IS NOT USED FOR EACH OF THE 12 PINS ON THE CONTROL, A DEUTSCH 114017 PLUG MUST BE USED IN PLACE OF EACH MISSING WIRE TO ENVIRONMENTALLY SEAL THE CONTROL.		

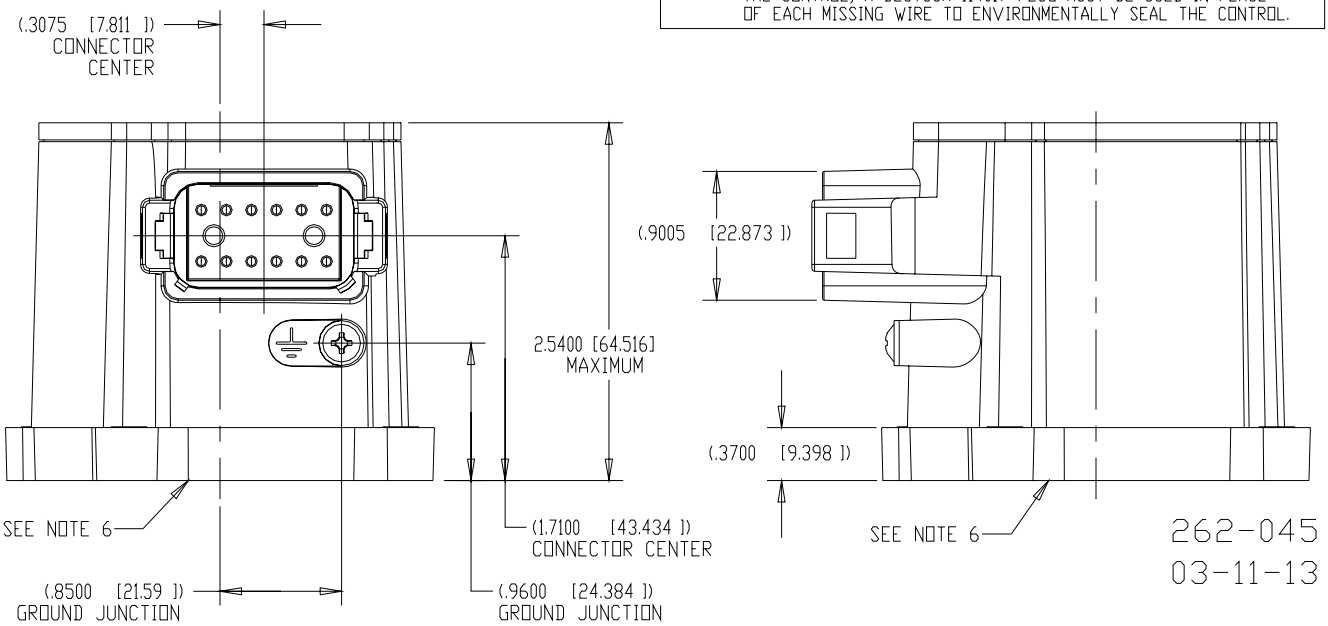


Figure 2-2. L-Series Outline Drawing

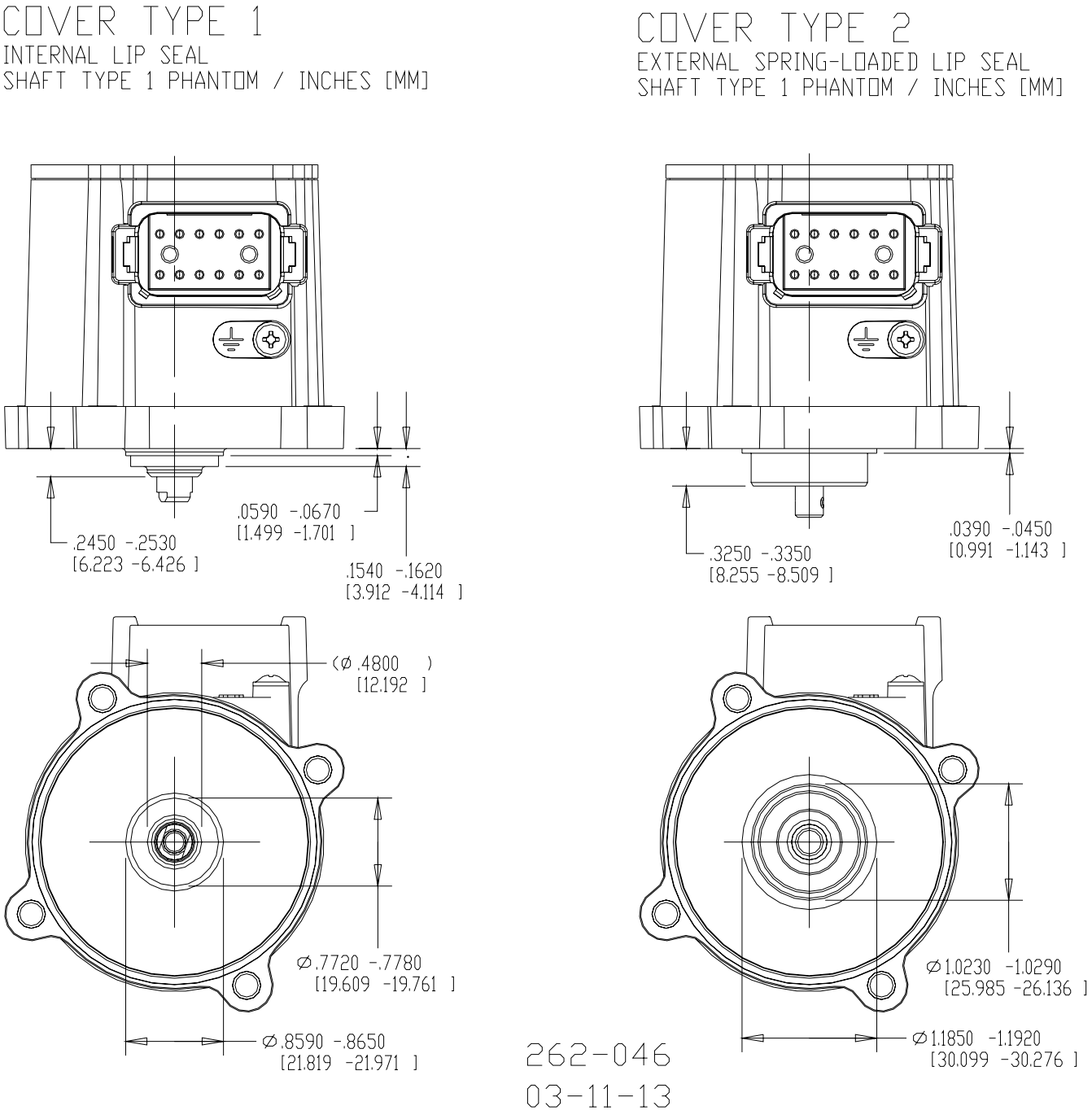


Figure 2-3. L-Series Cover Types

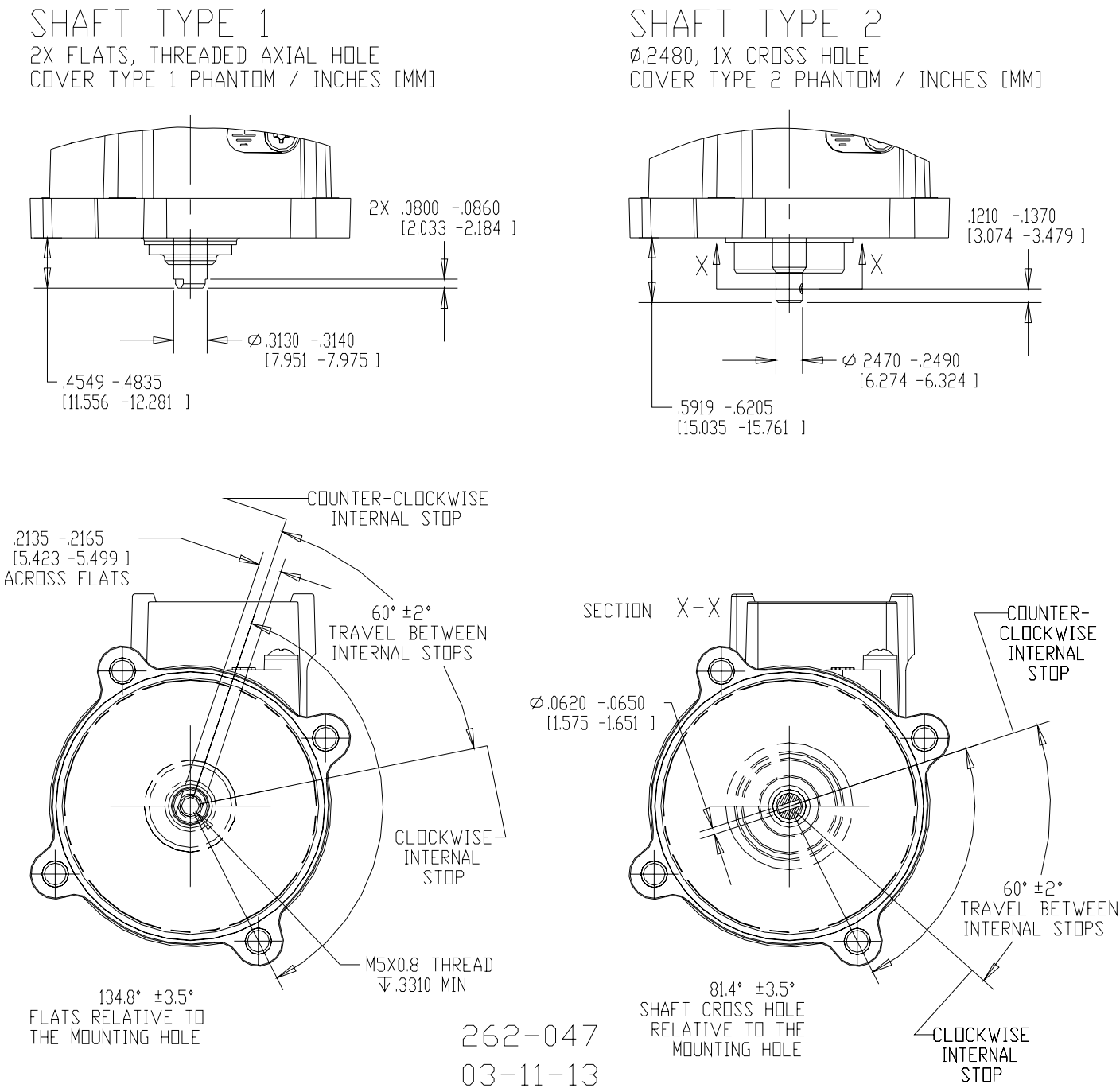


Figure 2-4a. L-Series Shaft Types

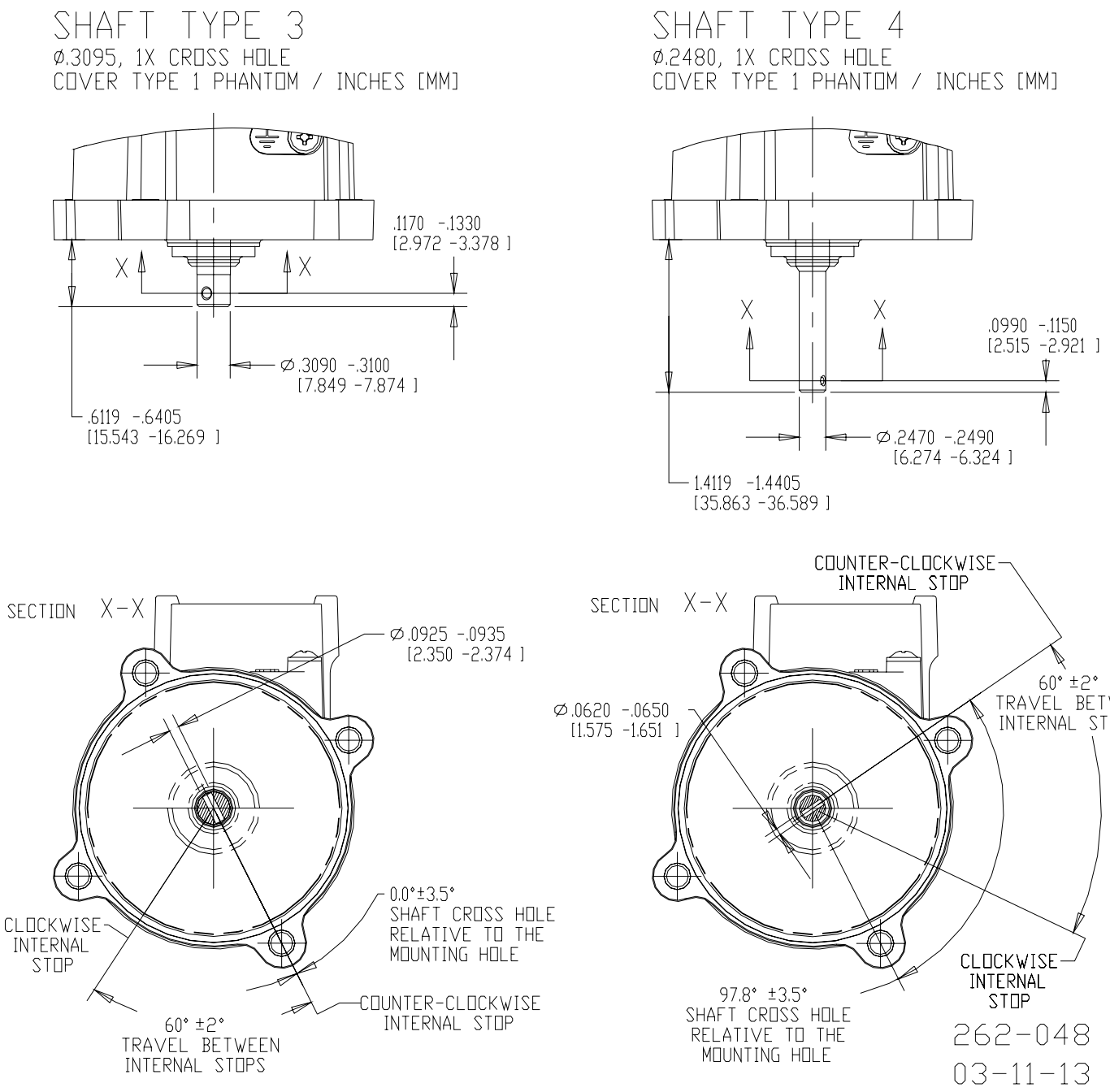


Figure 2-4b. L-Series Shaft Types

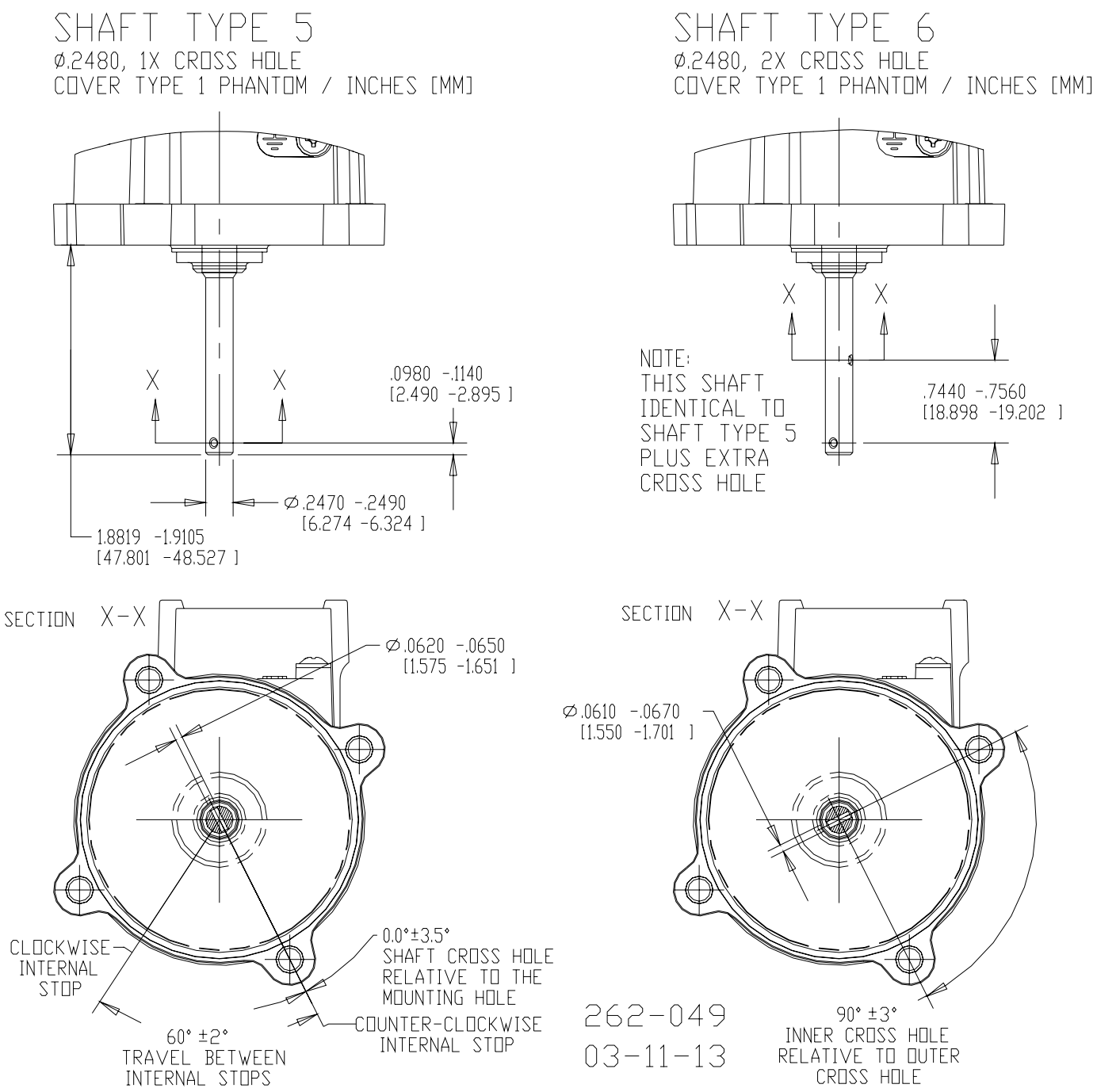


Figure 2-4c. L-Series Shaft Types

Chapter 3.
Electrical Installation

Introduction

This chapter provides instructions on how to connect the L-Series control into a system. A wiring pinout of the L-Series control, as viewed by looking into the control's connector feature, is shown in Figure 3-1. Typical connections to external devices are also shown.

The L-Series has an operating voltage range of 10 to 32 Vdc with nominal voltages of 12 or 24 Vdc. The power supply is reverse polarity protected, and consumes 32 W maximum power at a peak current of 1 A (32 V) assuming 4 Ω stator resistance at 25 °C. These assumptions are based on the fact that the software limits the power to the rotary actuator to 25 W at any given time and input voltage (in the valid range).

The control system should be protected with a 6 A fuse in the voltage supply lines. Typical max average current is 2.1 A, or max 25 W at 12 V. The application should be configured to turn on power to the actuator when the engine is first cranked.

Shielded Wiring

The use of cable with individually shielded-twisted pairs is required where indicated by the control wiring diagram (Figure 3-1). Cable shields must be terminated as indicated in the control wiring diagram using the installation notes described below. DO NOT attempt to directly ground the shield at both ends or an undesired ground loop condition may occur. If it becomes necessary to terminate the shield at the end opposite of the L-Series, it must be done through a high-frequency capacitor.

Installation Notes

- Wires exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches).
- The shield termination wire (or drain wire) should be kept as short as possible, not exceeding 50 mm (2 inches), and where possible the diameter should be maximized.
- Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information.

Failure to provide shielding can produce future conditions which are difficult to diagnose. Proper shielding at the time of installation is required to assure satisfactory operation of the product.

Electrical Connections

WARNING
Explosion hazard–Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Explosion Hazard–Substitution of components may impair suitability for Class I, Division or Zone applications.

Prior to installation, refer to the wiring diagrams and the representative I/O interfaces schematic in this chapter. Also, review the hardware I/O specifications in Appendix B.

WARNING
The control will only meet ingress protection specifications while the Deutsch connector is installed in the unit. As such, the unit should not be exposed to operating environments unless the mating connector is installed. In addition, if a wire is not used for each of the 12 pins on the control, a Deutsch 114017 plug must be used in place of each missing wire. Failure to adhere to these guidelines may result in product failure or decreased life.

Use 1 to 1.5 mm² (16 to 18 AWG) stranded copper wire with insulation that meets temperature requirements in the harness design. A wiring harness stress relief within 400 mm (16”) of the control’s connector is recommended. Limit all I/O and signal lines to less than 30 m (98 ft). Also limit input power (B+/B–) connections to an earth grounded battery or conditioned power interface to less than 10 m (33 ft) from the L-Series product.

NOTE
A conditioned power interface is an interface which offers equivalent common mode and differential mode conditioning of that of a grounded 24 V lead acid battery.

Dress the harness with wire loom to contain it in a single bundle. Use grommets when passing the harness through metal panels.

Connector

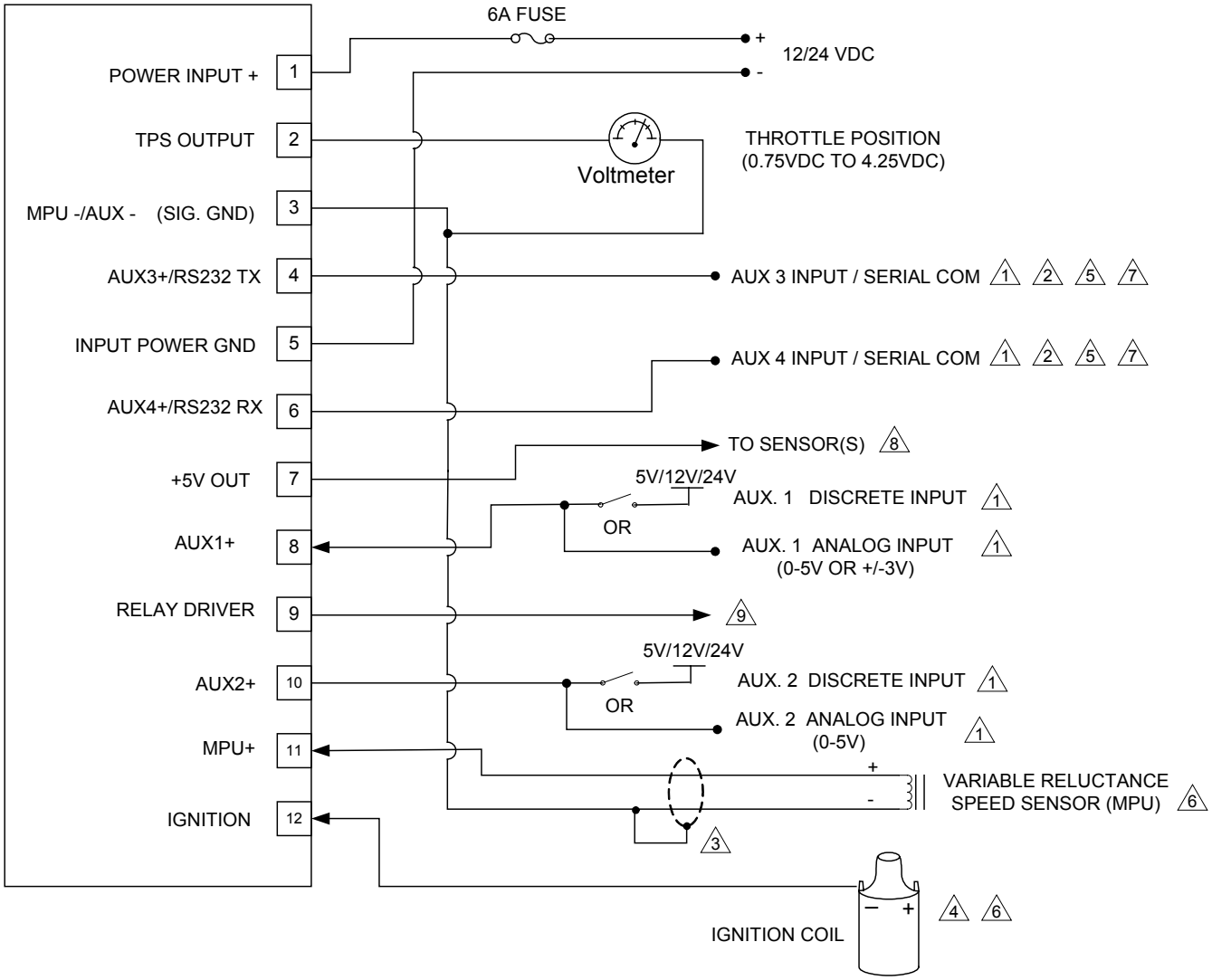
The following Deutsch connector components are recommended for harness designs:

	Recommended	Optional
Mating Connector	DT06-12SA-P012	DT06-12SA
Secondary Lock	W12S-P012	N/A
Sockets	0462-201-16141	0462-201-16141

For convenience, Woodward part number 8928-396 is a kit that provides all the necessary Deutsch components.

CAUTION
Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Figure 3-1a, 3-1b).



NOTES:

1. REFERENCE ALL DISCRETE AND ANALOG INPUTS TO PIN 3 (SIG.GND).
2. AUX.3 AND AUX.4 CAN ALSO BE CONFIGURED AS DISCRETE OR ANALOG INPUTS IN A SIMILAR MANNER AS AUX.1 AND AUX.2, BUT ARE NOT FUNCTIONAL WHILE SERIAL COMMUNICATIONS ARE CONNECTED.
3. ALL SHIELD TIES ARE TO BE *NO LONGER THAN 2"* BETWEEN THE CABLE AND GROUND.
4. IF USING IGNITION SPEED INPUT OPTION, CONNECT PIN 12 OF THE L-SERIES SPEED CONTROL TO THE NEGATIVE TERMINAL OF THE IGNITION COIL. THE IGNITION SYSTEM COMMON MUST BE REFERENCED TO THE L-SERIES SPEED CONTROL GROUND (PIN 3 OR PIN 5).
5. USE WOODWARD KIT 8923-1061 TO CONNECT TO A COMPUTER FOR USE WITH THE SERVICE TOOL.
6. SPEED INPUT IS ACCOMPLISHED BY USING EITHER THE MPU OR THE IGNITION INPUT. DO NOT CONNECT WIRES TO BOTH INPUTS SIMULTANEOUSLY.
7. WHEN CONFIGURED AS AN ANALOG INPUT, THE RANGE IS 0-5V.
8. THE 5V OUTPUT IS PROVIDED FOR POWERING EXTERNAL SENSORS. RATED AT 10mA MAX.
9. LOW-SIDE DRIVE OUTPUT DESIGNED TO DRIVE A RELAY, LAMP, OR OTHER STATUS INDICATOR. MAXIMUM CURRENT ALLOWED THROUGH THE COIL OR LAMP IS 500mA. MAXIMUM VOLTAGE ALLOWED AT THIS TERMINAL IS 32VDC.

Figure 3-1a. Typical L-Series Speed Control Application Wiring

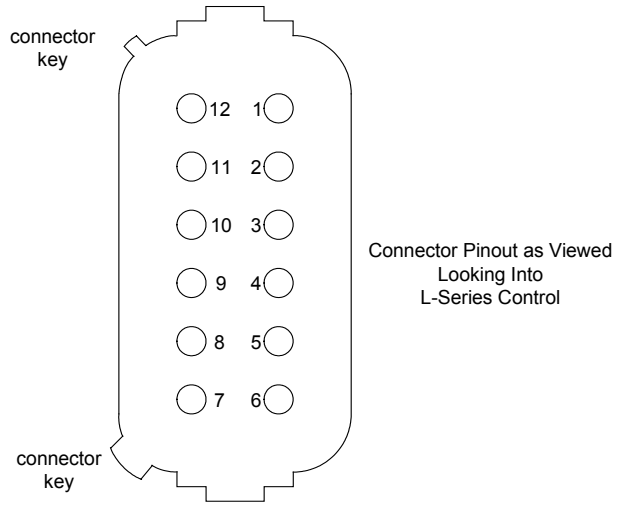


Figure 3-1b. L-Series Speed Control Connector Pin Arrangement

Connector Pin #	Description	Comment
1	+12V/24 Vdc Input Power	Supply power
2	TPS Signal Output	Direct position feedback output indication
3	AUX – (Sig Gnd)	Ground for AUX inputs
4	Aux Input 3 / RS-232 transmit	Combination Aux 3 and Service Tool input
5	Input Power Ground	Ground for the 12 V/24 V input power
6	Aux Input 4 / RS-232 receive	Combination Aux 4 and Service Tool input
7	5 V Out	Power for external sensors (10 mA max)
8	Aux Input 1	Aux1 input
9	Relay Driver Output	Status / fault detection output
10	Aux Input 2	Aux2 input
11	MPU +	MPU Speed signal input
12	Ignition Input	Ignition speed signal input

Description of Electrical I/O

Representative circuitry for the L-Series inputs/outputs is provided in Figure 3-5 below.

Power Supply Input (+12 Vdc/24 Vdc at pin 1, ground at pin 5)
The L-Series will handle a voltage range of 10 to 28 Vdc at full specified torque. The actuator is functional in the range of 8 to 32 Vdc, but accuracy and/or torque can be diminished at the extreme ends of this range.

The power supply terminals are reverse polarity protected, and in the case that a reverse polarity condition exists, the L-Series actuator will not power-up and will remain at the minimum stop if attached to a throttle body with an internal return spring.

Woodward recommends using a 6 A fuse on the power supply line feeding pin 1 of the L-Series actuator.

The supply voltage failure levels are below 6.25 V and above 33 V. The unit can be configured to either alarm or shut down upon detection of a supply voltage fault.

WARNING
The input power must be fused. Failure to fuse the L-Series could, under exceptional circumstances, lead to personal injury, damage to the control valve, and/or explosion.

Take special care when wiring the L-Series control.

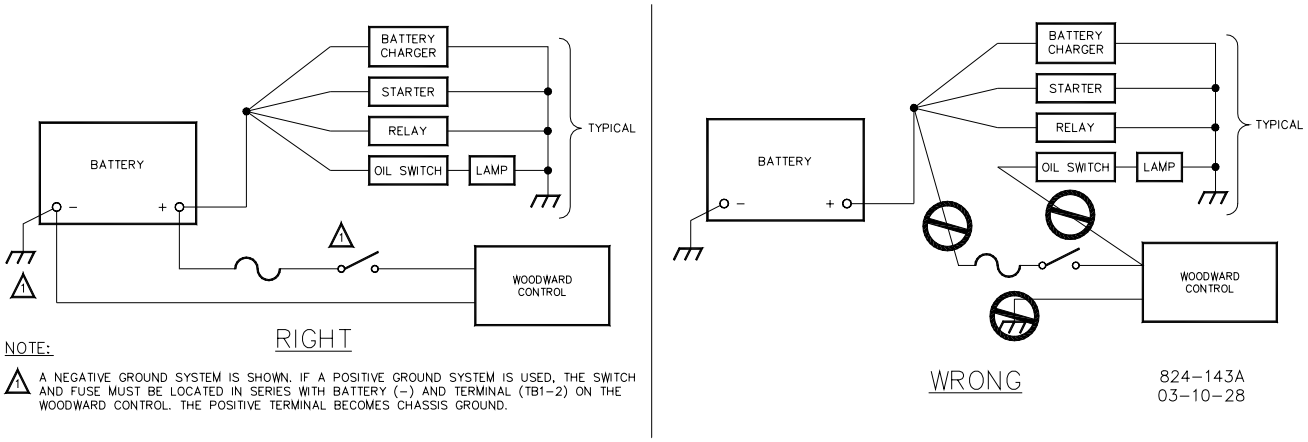


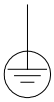
Figure 3-2. Correct and Incorrect Wiring to Power Supply

Ground Symbol Conventions

= **Internal Circuit Board Common**
Used to show equipotentials in electronic circuits, normally internal to a control system.

= **Earth Ground**
Represents a connection to “Earth” Ground.

= **Chassis Ground**
Sometimes used as symbol for system ground. Normally associated with connection to engine skid or vehicle frame. In the case of the L-Series, it also represents system ground.



= **Protective Earth Ground**.
Normally used as a safety ground in high-voltage (> 42V) systems.
(Not applicable to L-Series Controls)

The control will continue to function down to a supply voltage of 8 V, to withstand a prime mover start from the same battery system, however the control will not function completely within specifications. During the low voltage, the L-Series will **not** meet the transient response times or the max torque output.

Speed Input
The L-Series speed input can be either from a magnetic pick-up (MPU) or from ignition system pulses. The input must be wired to the appropriate input and must be configured properly using the Service Tool prior to operation.

See Woodward manual 82510, *Magnetic Pickups and Proximity Switches for Electronic Controls*, for information about MPUs and installation of the pickup unit.

MPU Input (+MPU at pin 11, –MPU at pin 3)
The L-Series MPU input will accept speed signals from variable reluctance (VR) devices in the range of 1 Hz to 12 kHz. The acceptable amplitude range is from 1 to 42 Vrms.

This function expects engine speed pulses present on pins 11 (MPU+) and 3 (MPU–). The number of flywheel or gear teeth that pass the magnetic pickup for one crankshaft revolution must be programmed for proper speed signal detection.

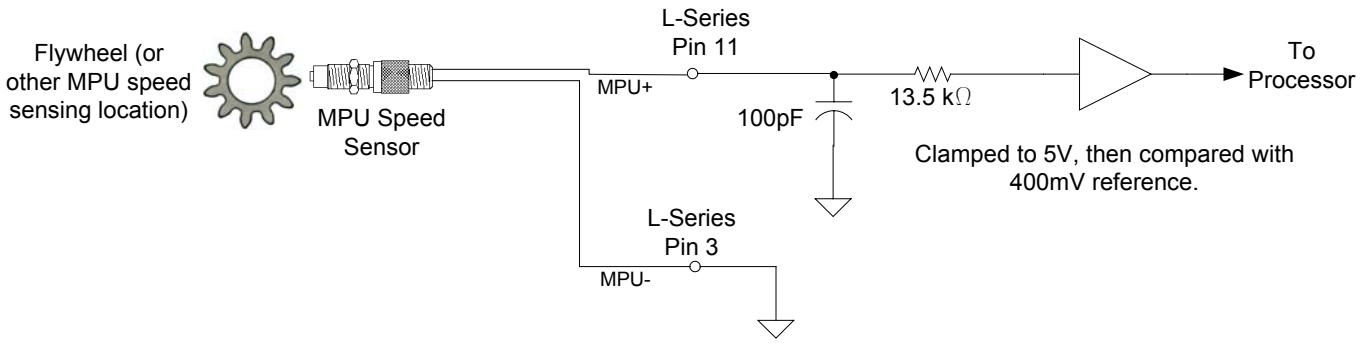


Figure 3-3. MPU Speed Sensing Input

IGN (ignition) Input (+IGN at pin 12, –IGN at pin 3)
The L-Series control will accept a 1–480 Hz signal from an ignition input of a 2- or 4-cycle 1–20 cylinder engine. For standard coil ignition, the source may be the negative terminal of the coil primary. For distributorless or DIS (Direct Ignition System) systems, the source for the ignition pulses may be two ignition leads from the spark control connected to IGN+ (pin 12) and IGN– (pin 3). Take care not to reverse IGN+/– on a DIS system, or no speed will be sensed.

This function requires engine speed pulses present on pin 12 (IGN) of the control. The type of engine (2-stroke or 4-stroke) and the number of cylinders (1 to 20) must also be programmed.

** This is a typical ignition input setup. For DIS applications, refer to instructions in text above.**

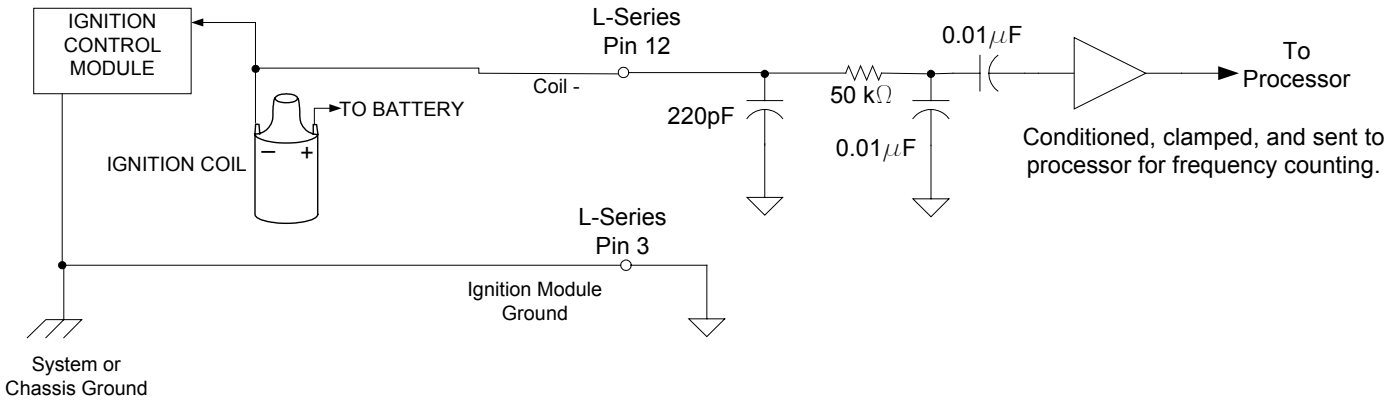


Figure 3-4. Ignition Speed Sensing Input

WARNING
It is recommended that the actual engine speed be used to externally verify that the speed command matches the command signal sent. Failure to comply with this recommendation can result in undetected system faults.

TPS Output (pin 2, referenced to either pin 3 or pin 5)
The L-Series provides a 0–5 V signal representing actual shaft rotational position, where 0.5 V and 4.5 V correspond to full counterclockwise to clockwise rotation, respectively. This signal is fed directly off the position sensor to ensure no delays are introduced by the processor. However, this signal is also uncorrected, so the difference between this signal and actual position can vary up to ±10% over the operating temperature range. This gives the end user an indication of throttle position.

NOTE
This output is meant for an approximate indication of shaft position only. The unconditioned output accuracy must be considered when using this signal externally. Refer to the specifications section for TPS accuracy.

WARNING
Do not try to inject signals *into* the TPS output, as it will negatively impact the performance of the L-Series actuator. This output is meant to be used with a high impedance device, such as a voltmeter. Do not tie pin 2 directly to battery or ground. If the application does not use this output, leave it open.

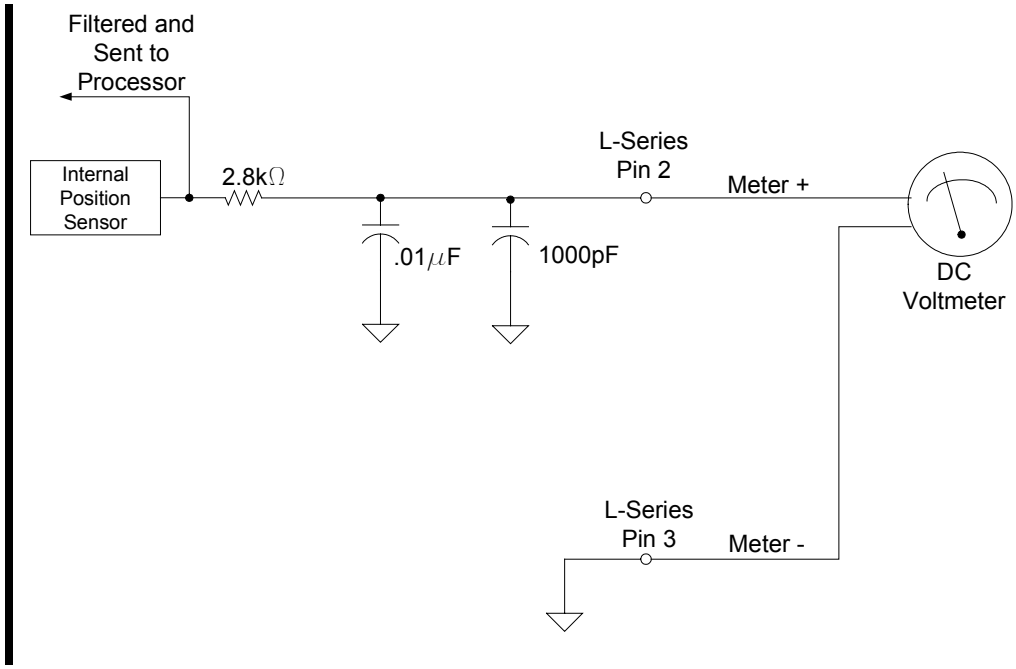


Figure 3-5. TPS Output

Relay Driver Output (pin 9)
A discrete output is provided to serve as a status indicator. This switchable discrete output is a closure to ground capable of sinking 250 mA with an output voltage rise of less than 1.5 V, and it is available to power external relays for devices such as alarms or fuel shutoff solenoids. The circuit is protected internally against over-current and inductive spikes, so external clamping is not necessary.

This output can be configured to be either normally on/closed (preferred failsafe setting) or normally off/open. In addition, the faults that drive the relay status can be configured individually. For details, refer to Chapter 4 (Service Tool). By default, this circuit will be configured in a failsafe manner, meaning it will be active (conducting) when no fault exists, but if power is lost or a fault is detected by the L-Series actuator, the circuit will open. See Figure 3-6 below for typical usage of this feature.

There are two conditions that will prevent the discrete output from operating correctly. The first is if battery positive is accidentally connected to it, and the second is if it is shorted to ground. The circuit will protect itself in the event of a mis-wire, but it will hold the output open(floating) until the fault is removed.

WARNING
It is recommended that the Relay Output be configured for the failsafe 'Normally On' mode, to ensure maximum fault protection and annunciation. Failure to follow these guidelines could, under exceptional circumstances, lead to personal injury and/or property damage.

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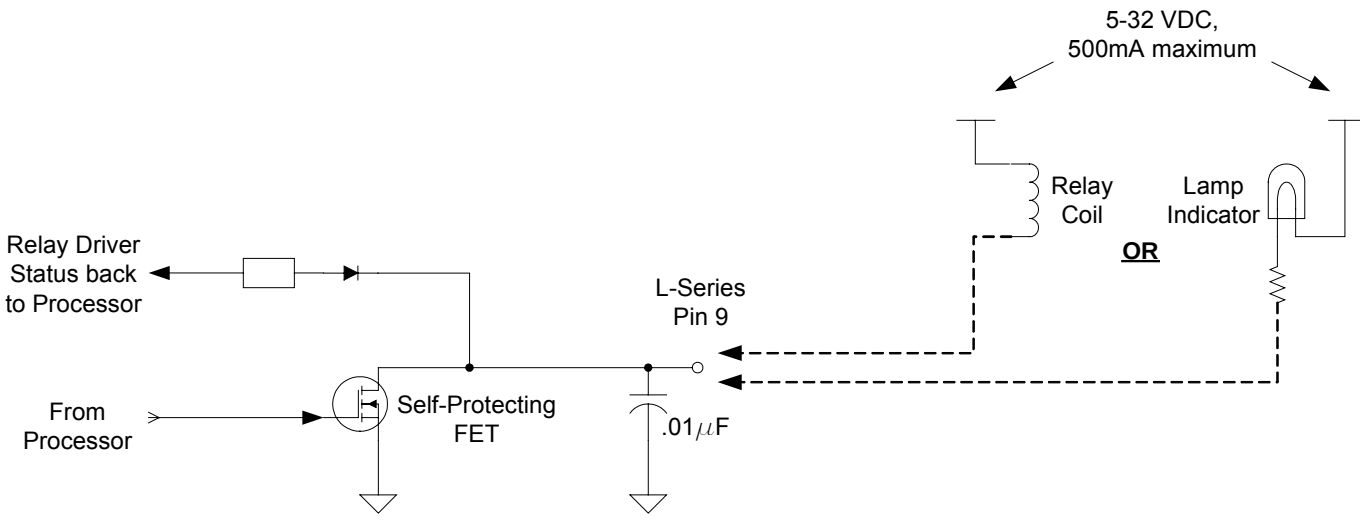


Figure 3-6. Relay Driver Output

5V Output (pin 7, referenced to pin 3)
A 5 Vdc output has been provided on the L-Series actuator to power external sensors, if necessary. The 5 V output is limited to 10 mA, but this is sufficient for most light-duty ratiometric sensors

NOTE
All connector pins are short-circuit protected to ground and power except pins 3 and 5, which are not protected against shorts to battery positive. Installation of a fuse on the power ground wire to pin 5 would provide protection to these pins but does not mean a fuse is not needed in the power connection. Pin 1 (B+) still needs protection against a short to ground.

AUX INPUTS (+ at pins 4, 6, 8, and 10; ground at pin 3)
There are four auxiliary inputs on the L-Series control, all of which are capable of both analog and discrete functions. The Aux functions (below) are mapped to Aux inputs using the Service Tool. If desired, multiple functions can be mapped to a single Aux input. For added flexibility, discrete functions can be programmed to be always on or always off as well as open or closed for the selected function. Analog inputs can also be inverted (direction reversed).

Although they are very flexible, two Aux inputs are shared with the serial communications, and will be unavailable if the L-Series is connected to the Service Tool. However, a means of simulating these inputs is provided for test purposes through the Service Tool interface.

The functions available for AUX input configuration are:
- Isochronous Loadsharing analog input
- Remote Speed Setpoint analog input
- MAP/Boost Fuel limit analog input
- Rated 1 / Rated 2 (50/60 Hz) digital input
- Raise Speed Setpoint digital input
- Lower Speed Setpoint digital input
- Isoch/Droop digital input
- Idle/Rated digital input
- Alternate Dynamics digital input
- Run Enable digital input

The Service Tool communicates over RS-232 using Aux inputs 3 and 4. Whenever connected, the configured Aux input is bypassed (ignored).

Aux X Input Options
Aux1 (0–5 V analog, ±3 V analog, discrete input)
Aux2 (0–5 V analog, discrete input)
Aux3 (0–5 V analog, discrete input, service tool RS-232 or CAN)
Aux4 (0–5 V analog, discrete input, service tool RS-232 or CAN)

Connecting an auxiliary input pin to battery positive voltage activates it, assuming the input is configured for Active Closed. Removing battery voltage from an input pin or shorting the pin to ground deactivates the input. If not using battery voltage with the auxiliary digital inputs, it is recommended that at least 3 V be present on an input pin in order to change its state from inactive to active. For AUX2, AUX3, and AUX4, greater than 2.5 Vdc is considered high, and less than 0.8 Vdc is considered low. For the AUX1 discrete input only, the input must exceed 3 V to activate the discrete state. AUX3 and AUX4 are also used for digital communications such as RS-232 (service tool) or CAN (if the CAN option was purchased). RS-232 and CAN will NOT run simultaneously.

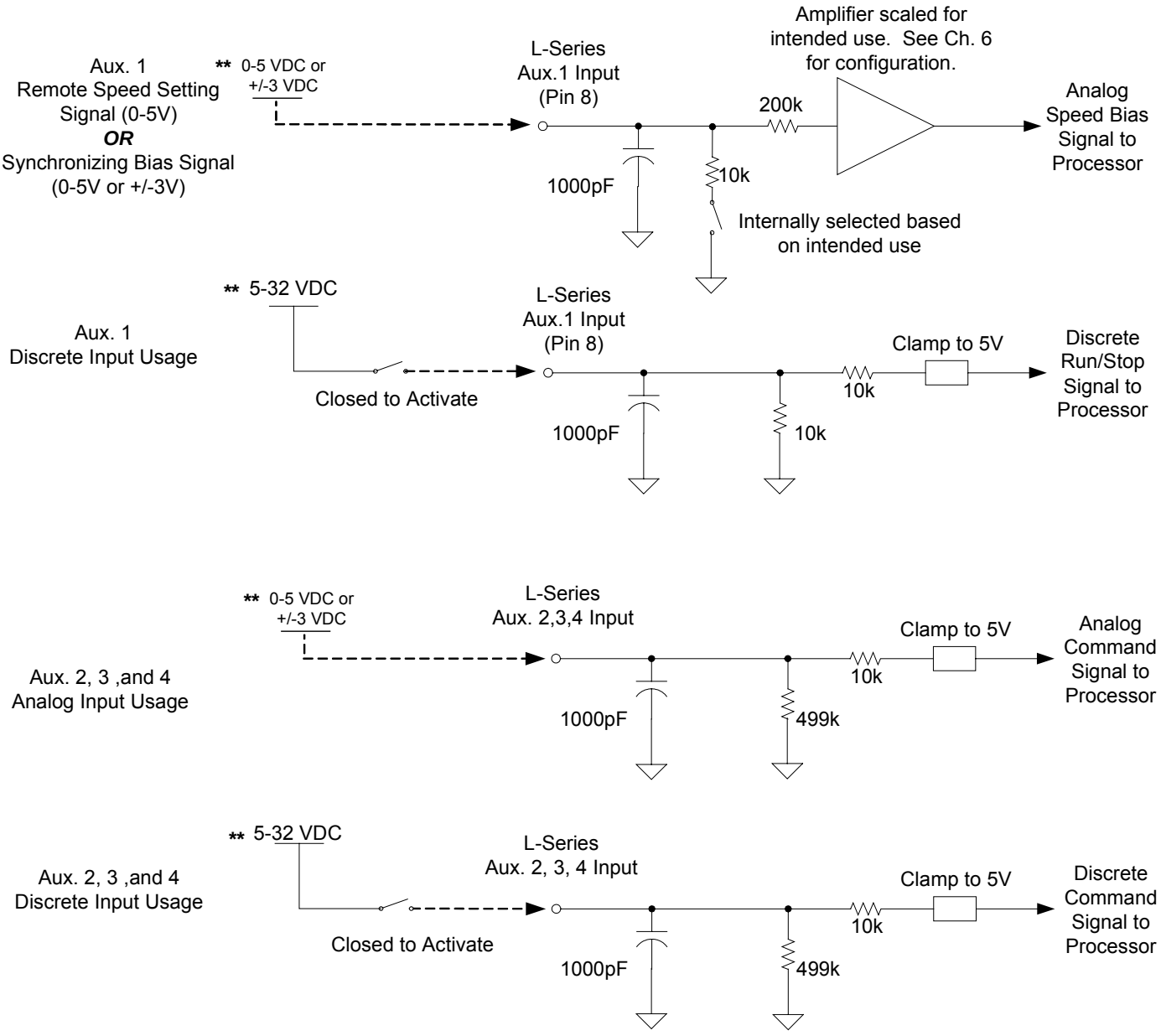
Figure 3-7 shows the most typical usage of the various auxiliary inputs.

NOTE
Aux inputs 3 and 4 are used as service port connections, but can also be used as either discrete or analog inputs, much the same as Aux 2. When used as a service port, the analog and discrete functions will not work. Woodward recommends that the service port not be connected during normal use. It is intended for system setup and troubleshooting only.

Communications

RS-232 communications are available on the L-Series when used with an external transceiver connected to pins 4 and 6. Serial communications allow for the use of a service and configuration tool with the L-Series actuator. The simplest way to establish this interface is to use Woodward kit # 8923-1061.

Functions available through this port include tuning, monitoring, and configuration of the position control. Detailed driver status information is also available.



****** Reference all analog or discrete inputs to L-Series signal ground (Pin 3)

Figure 3-7. Typical AUX Input Usage

Any RS-232 wiring must meet the requirements in the EIA RS-232 Standard document. The RS-232 standard states that the length of the RS-232 cable between the driver and the PC must be less than 50 ft (15 m) with a total capacitance less than 2500 pF. The RS-232 data rate is fixed at 19.2 kbps. The communication port is non-isolated and susceptible to both EMI noise and ground loops related to PC connections and typical industrial environments.

RS-232 Connections (pin 4 and pin 6)
These pins are for serial communication with the L-Series actuator. An external RS-232 transceiver is necessary to make communications possible with the Woodward L-Series Service Tool. A connectivity kit can be purchased from Woodward to accomplish this. Further instructions for using this connectivity kit are provided in Chapter 4.

It is recommended that the OEM or packager provide a breakout cable that is connected to the L-Series service port and run to an easily accessible area on the engine. The service port is absolutely necessary to set up and troubleshoot the L-Series.

CAN Connections (pin 4 and pin 6)
At the time of printing of this manual, CAN is not currently available in speed control applications of the L-Series actuator. When this function is available, the manual will be updated and will include detailed instructions for properly connecting CAN communications to the L-Series actuator.

NOTE
The service port is not isolated and is not intended to function while the prime mover is in normal operation. The service port is provided for configuration and setup only.

Ground Junction (see Figure 3-8)
This grounding junction is provided for joining external ground wires. THERE IS NOT AN INTERNAL CONNECTION TO CIRCUIT GROUND. Terminal pins 3 and 5 must be used for access to the circuit ground. This junction point is completely electrically isolated from the L-Series actuator's electronics, and is solely for convenience during installation.

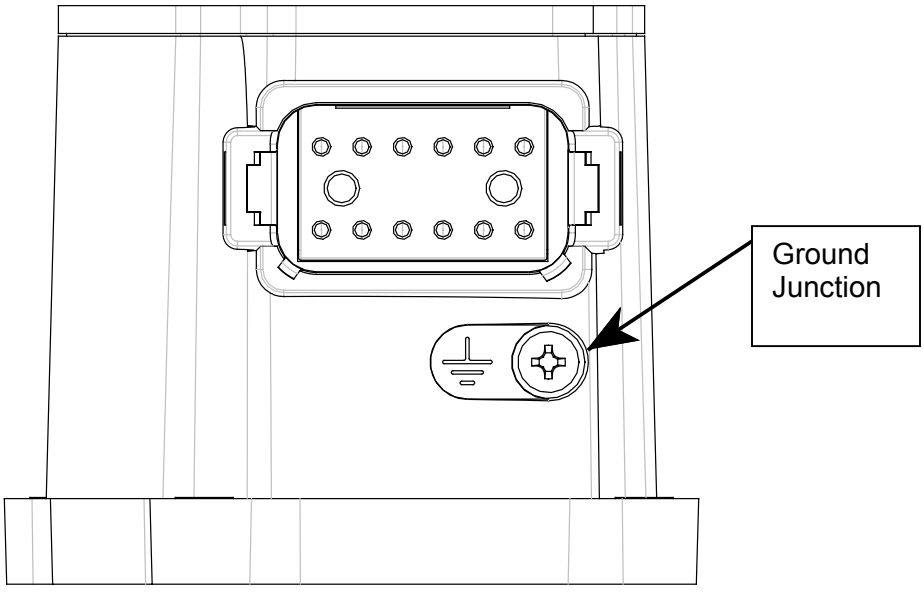


Figure 3-8. Ground Junction Point

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Chapter 4.
Description of Operation

General

The L-Series Speed Control is an electric actuator with position feedback and an integrated digital speed control. The actuator output shaft connects to the fuel gas valve, intake throttle or fuel oil pump rack shaft of a reciprocating engine. The output shaft maximum rotation is 60 degrees and is configurable for CW or CCW rotation. A manual mode is provided to facilitate setting up the actuator system.

The speed setpoint can be adjusted by a remote 0–5 Vdc analog input or by discrete inputs (such as Idle/Rated, 50/60 Hz selection, 3-Speed, or Raise/Lower).

For generator applications, isochronous load sharing and synchronizing capability is available by a ±3 Vdc analog input in place of the remote 0–5 Vdc analog input. A compatible load sharing/synchronizer device is needed to provide the load sharing/synchronizer input bias signal. Droop operation can also be configured.

Control adjustments are made using the L-Series Service Tool. The Service Tool is a Windows based software tool used to configure, monitor, adjust, and troubleshoot a L-Series speed control system. It runs on a personal computer and communicates with the L-Series speed control through a serial connection. The L-Series Service Tool includes optional password protection to provide security against tampering.

The speed sensor input contains a software-configurable filter that minimizes the effects of firing torsionals that occur normally in reciprocating engines. This filter ensures the actuator will not react to speed sensor input changes produced by firing torsionals. This provides exceptionally smooth steady-state speed control and allows matching the control dynamics solely to the engine rather than detuning dynamics for firing torsional frequencies.

The control has a switching power supply with excellent spike, ripple, and EMI (electromagnetic interference) rejection. Discrete inputs are capable of rejecting EMI and variable resistance in switch or relay contacts. Analog inputs are differential type with extra filtering for common-mode noise rejection.

The control provides one discrete output, which changes states based on pre-defined alarm or status conditions. The control also provides one 0–5 V analog output which provides a position feedback indication. This analog output may be used with an analog meter, recorder, or as input to a computer.

The control provides a communications port which can be used as an RS-232 serial interface or a CAN communication connection. The RS-232 port is the service port used by the L-Series Service Tool to configure and tune the L-Series system. CAN communications is a future option, contact your Woodward representative for availability and options.

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System Operation

The L-Series actuator is ready for operation immediately (within 0.25 second) when the power supply is connected. Power may be connected to the control at the same time the engine starter motor is engaged.

On an engine shutdown command, the independent engine shutdown solenoid or solenoid valve in the fuel supply should be de-activated and the power supply disconnected from the speed control. This shutdown signal should be sent directly from the engine control panel and should be independent and separate from the L-Series control.

WARNING
The L-Series control should not be used as the primary means of shutting down the engine.

Starting the Engine

A typical engine starting sequence will look like this, if no shutdown faults are detected:

When powered-up, the L-Series control will be in position control at the configured min position. If a Run Enable discrete input is configured, it must be closed. When the starter is engaged, the speed will increase above the Start Speed 1 Threshold, and the control will position the shaft to the Start Fuel position demand. If two Start Fuel positions are used and speed increases above the Start Speed 2 Threshold, the control will position the shaft to the Start Fuel 2 position setting. Once the engine speed is above the Run Speed Threshold, the control will switch from start fuel demand to the fuel demand from the speed control PID. At this point, the unit is in speed control and will control the engine to the speed setpoint. The PID position during starting is tracking the start fuel values, providing a bumpless transfer to speed control. At this point, the speed setpoint increases to the configured or selected setting—Idle, Rated, Rated 1, or Rated 2.

If a shutdown fault is detected, the control will drive the output to the configured fail direction position.

Control Features Description

As you review the following features, keep in mind that most applications will only require a few of the functions to be activated. The choices are available to provide maximum flexibility in a single package. The user must set up the actuator direction, speed input, setpoint logic, and desired I/O. From the dynamics functions area, the user can set as many or as few as is necessary for stable operation. The user can choose all or none of the fuel limiter functions, speed setpoint modifiers, alarm/shutdown functions, security and logic functions depending on the application.

The control I/O consists of input power, a speed input, 4 configurable aux inputs, a status output, and an actual position indication (see Figure 4-1).

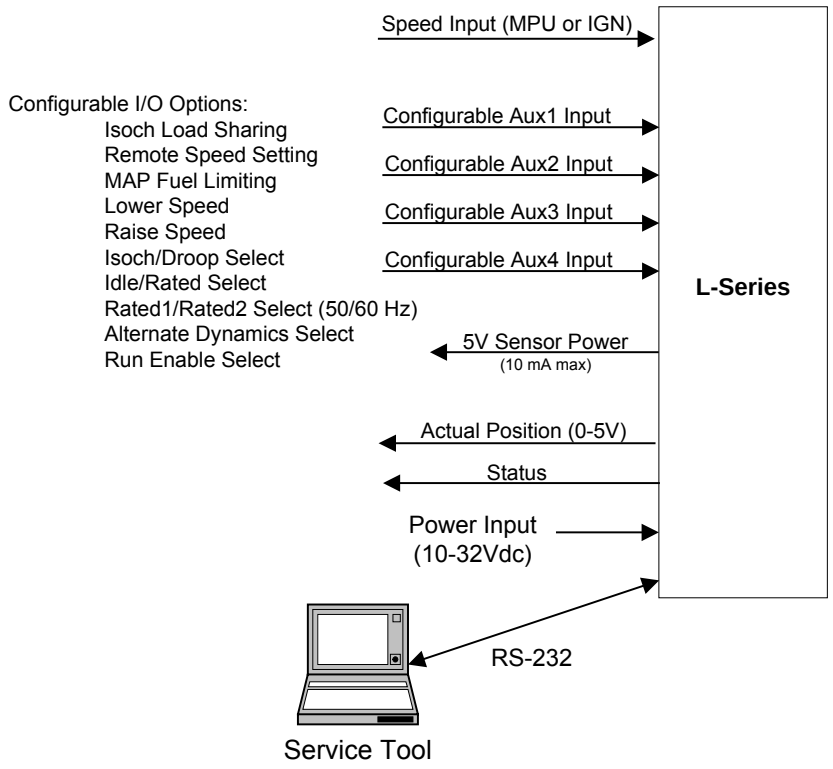

Figure 4-1 Overview of L-Series Inputs/Outputs

Speed Control Functions

The speed control consists of a speed input, speed setting logic, speed biasing logic, and speed dynamics options.

Speed Input

The L-Series control accommodates one speed input, from either a magnetic speed pickup (MPU) or ignition input, which provides a speed signal to the control. A digital type of detection with firing torsional filtering is used for detecting engine speed. This digital detection method senses speed very quickly for rapid response to speed changes. The input frequency is converted to engine speed based on the gear teeth (if MPU) or number of cylinders and 2-/4-stroke settings (if ignition) configured.

Speed Settings and Ramps

The L-Series provides for local speed setpoint control by discrete raise and lower inputs. A 0 to 5 Vdc analog input provides for remote speed setpoint control. A ±3 Vdc analog input provides for isochronous load-sharing and synchronizer control. Input function must be configured to activate the desired setpoint function.

Speed Setting and Ramp Functions

The control provides run, idle, and two rated speed set points with a lower and raise limit, plus accel and decel ramps, raise and lower ramps, and a ramp to idle rate. All ramp rate settings are in rpm/s, and all speed setpoint changes are ramped for smooth setpoint transition. For emergency standby applications, a very high ramp rate effectively cancels the ramp function to provide rapid starting. The Ramp to Idle determines how fast speed is increased from run to idle speed. Accel rate determines how fast speed is increased from idle to rated speed. Decel rate determines how fast speed is decreased from rated speed to idle speed. The accel and decel rates are used when transferring between rated 1 and rated 2 speeds. Raise and lower rates determine how fast speed is increased or decreased by the raise and lower command inputs. Max Analog Rate is the maximum rate the speed can be increased or decreased by the remote speed setpoint input.

The Run Speed setting must be above cranking speed, but below the speed attained when running the start fuel limit position. The speed control activates at run speed by grabbing the current operating speed as the initial speed setpoint, then ramping the setpoint up to the idle speed setting at the ramp to idle rate. If the idle/rated input is set in the rated position, acceleration will pass seamlessly through idle speed to the selected speed setpoint (remote, rated 1 or rated 2) at the accel rate.

Speed Setting Options

The following section describes the various speed setting modes.

Single Speed (Rated) Select—If no speed biasing functions are enabled, the engine will run at one set speed. With this configuration, there is no external speed adjustment. Speed is held constant at the rated speed setting. However, the fuel limiters, run speed setting, and accel ramp are provided and active for light-off and acceleration control up to rated speed.

50/60 Hz (Rated 1/Rated 2) Select—This feature allows the user to switch the speed set point between a primary and secondary engine rated speed. A user-definable discrete input, configured as Rated1/Rated2, is used to toggle between the two set speeds. The input can be configured to select Rated 2 on either opening (active open) or closing (active closed) of the contact input. This mode can be configured for start-up select or runtime select.

Runtime Select—The user can toggle between the two speed settings at any time during operation. The transition rate between the two speeds is determined by the configured acceleration and deceleration rates. If the setpoint is increasing it will use the acceleration rate. If decreasing, the deceleration rate is used.

Start-up Select—When run speed is reached speed setpoint will ramp to Rated 1 or Rated 2 setpoint depending on the state of the Rated 1/Rated 2 discrete input. After run speed is reached the Rated 1/Rated 2 discrete input will have no effect until speed is below the stopping speed.

Idle/Rated Select—This feature allows the user to toggle the speed set point between an idle and a rated speed. A user-definable discrete input, configured as Idle/Rated, is used to toggle between the two set speeds. The input can be configured to select Rated on either opening (active open) or closing (active closed) of the contact input. The user can toggle between the two speed settings at any time during operation. During transitions, the acceleration and deceleration rates are used.

Idle/Rated is commonly used to provide an idle speed set point for engine warm-up or cool-down cycles. The Idle speed setting is independent of the lower limit set point and may be set at a lower speed. Idle speed cannot be changed except by adjustment of the software set point. The idle speed set point is selected during starting when engine speed exceeds the run speed setting or while running whenever the idle/rated contact is open (assuming an active closed configuration). Closing the idle/rated contact ramps the speed set point from idle to rated. The raise and lower commands increase and decrease engine speed based on the raise and lower rate settings. Closing either the Raise or Lower contacts while ramping from idle to rated immediately cancels the idle to rated ramp and speed follows the raise or lower commands for variable speed control. The raise and lower commands will not adjust the speed setpoint above the raise limit nor below the lower limit. The control ramps the remote setpoint at the raise or lower rate settings. Closing both the raise and the lower contacts enables the analog input for remote variable speed setpoint control, if configured. In Analog Mode the Analog Rate Limit is used.

Three-Speed Select—Some refrigeration applications may find it useful to have three engine speeds available: a highest speed for quick cool-down when warm goods are put into a container, a lowest speed to maintain the load's temperature once it has been cooled, and an intermediate speed for increased cooling if the container door is opened to move goods in or out. Typically, the discrete inputs for each of these speeds will come from an automatic thermostat, and only one will be high at a time. Mobile access platform (scissor lift) applications may also require three engine speeds, which correspond to three basic operating modes: static lift, transient lift, and mobile vehicle travel.

To provide this feature, two user-definable discrete inputs must be configured as Idle/Rated and Rated1/Rated2. The Idle/Rated input has the higher priority, if Idle is selected the setpoint will move to the idle speed setting. The Rated1/Rated2 input will determine the selected speed when the Idle/Rated input is selecting 'rated'. During transitions, the acceleration and deceleration rates are used.

Example: If the inputs are configured as follows, Idle/Rated = Aux3 (active closed) and Rated1/Rated2 = Aux4 (active closed), then the following summarizes the 3-speed selection.

Aux 3 (Idle/Rated)	Aux 4 (Rated 1/ Rated 2)	Selected Speed
Open	Open	Speed 1 (Idle)
Open	Closed	Speed 1 (Idle)
Closed	Open	Speed 2 (Rated 1)
Closed	Closed	Speed 3 (Rated 2)

Up to a five-speed select can be used if the Raise and Lower commands are configured and used as position selectors. When using Raise or Lower selections, the control ramps the remote setpoint at the raise or lower rate settings. This option may be desirable if another rate is needed.

Raise/Lower Adjust—This feature allows the user to change the speed set point with external discrete inputs. If both the raise and lower discrete inputs are closed, the lower has priority.

Lower— A user-definable discrete input, configured as Lower, acts directly on the internal speed set point within the L-Series control, and will progressively decrease the speed set point down to a programmable lower limit at the programmed lower rate for as long as the input is in a high state (assuming the input is configured as active closed). When this input goes low, the speed reference will remain fixed at the last setting reached the instant the input went low.

Raise— A user-definable discrete input, configured as Raise, acts directly upon the internal speed set point within the L-Series control, and will progressively increase the speed reference up to a programmable upper limit at the programmed raise rate for as long as the input is in a high state (assuming the input is configured as active closed). When this input goes low, the speed reference will remain fixed at the last setting reached the instant the input went low.

SPEED BIASING

Isochronous (Droop OFF)—This is the default speed biasing function if none of the other speed biasing functions are selected. This maintains the engine at one speed setting throughout operation regardless of load.

Droop—This feature allows for a change in speed set point with a change in load. This feature is primarily used when the generator is connected to a utility bus or paralleled with another genset on an isolated bus. In this situation, the utility will determine the frequency of the alternator.

Droop is a tunable value that decreases the speed setting when load increases as determined by the actuator output position. Droop is set as a percentage of rated speed (or Hz). Actuator positions must be entered for no-load and full load to correlate the speed setting to load. A setting of 0% droop disables the Droop function.

The desired engine speed reduces with the following formula:

$$\frac{\text{speed reference} * \text{droop percentage} * (\text{actual position} - \text{no load actuator position})}{(\text{full load actuator position} - \text{no load actuator position})}$$

The speed offset calculated is determined by the user-configured droop percentage, no load actuator position, and full load actuator position parameters.

Droop is off at start-up, and is enabled at speeds above Idle.

A user-definable discrete input, configured as Droop, can optionally be used to transfer between droop and isochronous control.

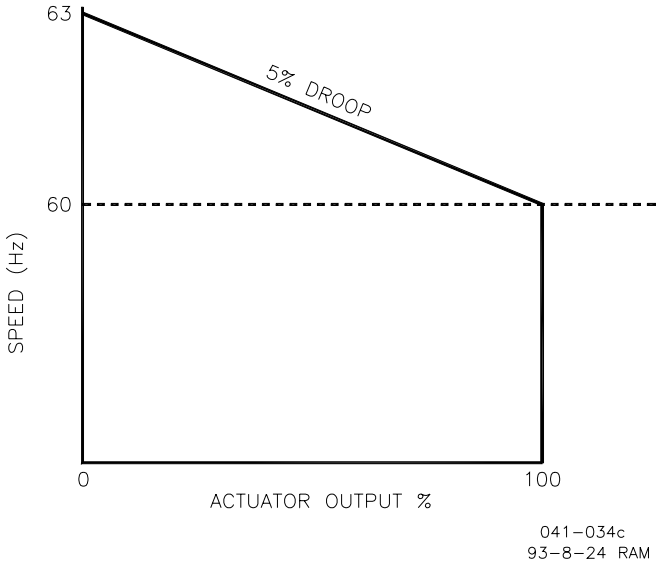

Figure 4-2. 5% Droop Example

Analog Biasing—This feature allows the user to alter the speed setpoint with an external signal. The input can be configured to function as a Remote Speed Setting or for Load Share / Sync operation. The only difference between these modes is how they affect the speed setpoint. The Remote Speed Setpoint will adjust the speed within the define range such that a 0 V input signal corresponds to the Low limit, and a 5 V input corresponds to a High Limit setpoint (assuming a non-inverted input). If configured as Load Share / Sync, a mid voltage input signal will provide no setpoint bias. Assuming a non-inverted input, a min voltage input will give max negative bias and a max input voltage will give a max positive bias. The bias range is defined as a user-configurable percentage of speed setpoint.

Remote Speed Setpoint Mode

The Remote Speed setpoint input typically operates from 0 to 5 Vdc; however, it can be configured as a ±3 V input. A direct or reverse-acting remote speed setting can be configured, using a normal or inverted input selection. Between 0 and 5 Vdc, the control determines the speed setpoint based on a straight line between the Low Limit and High Limit speed settings configured (see Figure 4-3).

WARNING

It is recommended that the actual engine speed be used to externally verify that the speed command matches the command signal sent. Failure to comply with this recommendation can result in undetected system faults.

Load Share / Sync Operation

When the generator breaker is open, the analog input is used for synchronizing. When the generator breaker is closed, this analog input is used for isochronous load sharing within a generator system. An isochronous load sharing module/synchronizer must be connected to provide the isochronous load sharing/synchronizer functions.

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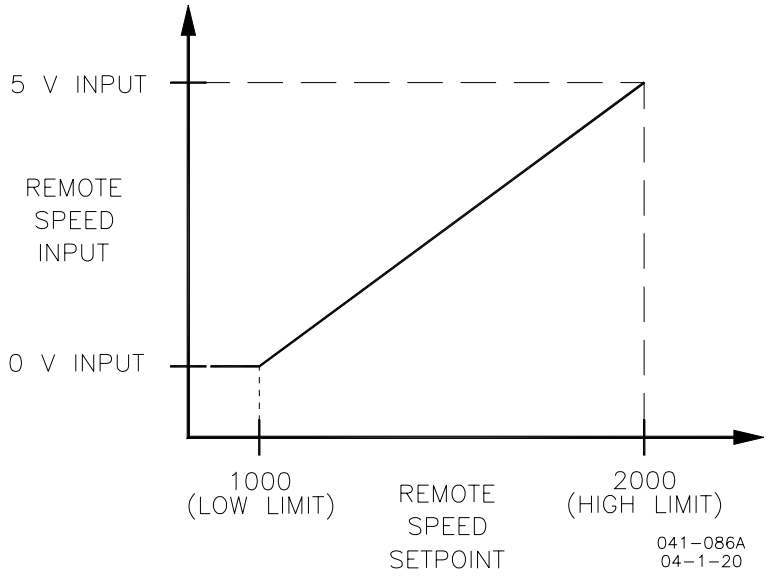

Figure 4-3 Remote Speed Setpoint

The typical Woodward Isochronous Load Sharing/Synchronizer analog input operates from –3 to + 3 Vdc. This voltage input signal biases the speed setpoint directly and is not ramped like the speed setpoint sources, however, a user-configurable max analog rate is available to provide a max adjustment rate. A positive voltage input increases the speed setpoint. A negative voltage input decreases the speed setpoint. At zero voltage input the speed setpoint is held constant.

The adjustable analog input must be scaled to match the Load Sharing Module/Synchronizer used for these purposes. A DSLC™ load sharing control typically requires a 3% of rated rpm speed setpoint change per volt. An SPM-A synchronizer typically requires a 0.667% of rated rpm speed setpoint change per volt. Other load sharing controls may need different settings.

If configured for Aux1 input, it is programmable as either a 0–5 V input or ±3 V input. Aux 2–4 inputs are limited to 0–5 V signals only.

The bias percentage is a programmable value. When configured as a 0–5 V input, 5 V corresponds to the full bias percentage in a positive direction; 0 V corresponds to the full bias percentage in a negative direction; and 2.5 V corresponds to no bias (assuming the input is not configured with the invert option). This analog input should be provided by a voltage transmitter via twisted, shielded wire pairs.

When configured as a ±3 V input, +3 V corresponds to the full bias percentage in a positive direction; –3 V corresponds to the full bias percentage in a negative direction (assuming the input is not configured with the invert option). This analog input will be available to interface with Woodward's standard Load Sharing Module. This auxiliary input acts directly on the L-Series speed reference and biases it by a programmable amount up to approximately ±7% in direct proportion to the ±3.0 Vdc signal. This input will be active only when the L-Series is selected for isochronous operation and should be provided via twisted, shielded wire pairs.

Combination Analog Biasing and Raise/Lower—This feature allows both an analog speed set point and raise/lower setpoint commands. To use this mode requires aux inputs to be configured for a Raise, a Lower, and an Analog input. When a Raise command is activated, the setpoint increases, and when a Lower command is activated, the setpoint decreases. The Analog input is selected when both the Raise and Lower inputs are activated.

General Speed Setpoint Comments—If Idle/Rated is configured, the selection of idle setpoint has priority over the raise/lower and analog setpoints. The idle setpoint must be unselected (rated setpoint selected) to activate the raise/lower and analog setpoints. If configured, the analog setpoint has priority over the rated setpoint. If the analog setpoint is selected when the idle/rated input is switched to the rated position, the setpoint will ramp to the analog setpoint rather than the rated setpoint.

Speed Control Dynamics

The control algorithms used in the L-Series control are designed specifically for reciprocating engine applications. The L-Series speed control offers a powerful set of dynamics that closely match a wide variety of fuel delivery systems and applications. The following configuration choices are offered.

Rated Dynamics
If configured for Rated Dynamics, the gain remains constant as entered and does not vary with engine speed or load. These are simplest dynamics and suit most constant speed applications. Rated dynamics are typically used on engines that operate continuously at rated speed or on variable speed engines that tend to be stable at all speeds with constant dynamic settings.

Idle/Rated Dynamics
If configured, Idle/Rated Dynamics vary the gain with engine speed. Idle gain applies when operating at idle speed. Rated gain applies when operating at rated speed. The gain varies linearly at intermediate speeds and is limited by the idle and rated gain setting at speeds below idle and above rated. Idle/Rated dynamics are useful for variable speed engines that tend to be less stable at idle speed with optimum rated speed dynamic settings.

Rated Dynamics Curve
A Rated Dynamics Curve varies the rated gain value with fuel demand (actuator position). Fuel demand is roughly proportional to load but not necessarily in a linear manner. A 5-breakpoint gain curve is provided to map gain versus fuel demand. Gain is applied linearly between breakpoints. A common gain setting is also provided to shift all gain curve gains higher or lower. This gain curve is particularly useful for non-linear fuel systems (such as intake butterfly valves).

Idle/Rated Dynamics Curve
When using an Idle/Rated Dynamics Curve, gain varies with both engine speed and fuel demand (actuator position). Two separate 5-breakpoint gain curves are provided to map gain versus fuel demand. The Idle Gain Curve applies when the engine is operating at idle speed. The Rated Gain Curve applies when operating at rated speed. The gain varies linearly at intermediate speeds and is limited by the idle and rated gain curve settings at speeds below idle and above rated. Separate common gain settings are provided for each curve to shift all gain curve gains higher or lower. Idle/Rated Dynamics Curve is useful for non-linear fuel systems that tend to be less stable at reduced speed and load operation with optimum rated dynamic curve settings.

For all dynamic configurations the Integral and Derivative settings are constant and do not vary with either engine speed or load.

Cold Start Timer
In demanding genset applications that require ‘G3’ performance but are also intolerant of cold start instability, the L-Series control offers a cold start timer function that sets the gain of the control to a lower-than-normal value until a programmable amount of time expires. This gives an engine time to warm up slightly before switching to a normal gain value. The cold start timer can be bypassed by programming a time of 0 seconds.

Dual Gain Settings
Gain Window and Gain Ratio settings further modify the applied gain. These Dual Gain Dynamic settings can improve both steady state and transient load performance by automatically switching between two gain settings. A low gain setting is applied during steady-state operation. A high gain setting is applied during load transients. Dual Gain Dynamics are available for all gain configurations.

During steady-state loaded operation, the control uses the primary gain setting (rated gain, idle /rated gain, etc.). In this region, gain is set to prevent the control from responding to minor speed fluctuations inherent with reciprocating engines. This essentially eliminates harmful jiggle of the actuator output and the fuel system linkage during steady-state loaded operation.

During load transients, should the speed error exceed the adjustable Gain Window width, the primary gain setting is multiplied by the gain ratio setting to temporarily increase the applied gain. This higher gain produces a faster fuel response to quickly restore engine speed to the speed setting. Speed error is the difference between actual engine speed and the engine speed setting. The primary gain setting is restored once the control senses a return to steady-state operation (see Figure 4-4). Setting the gain ratio to 1 disables the function.

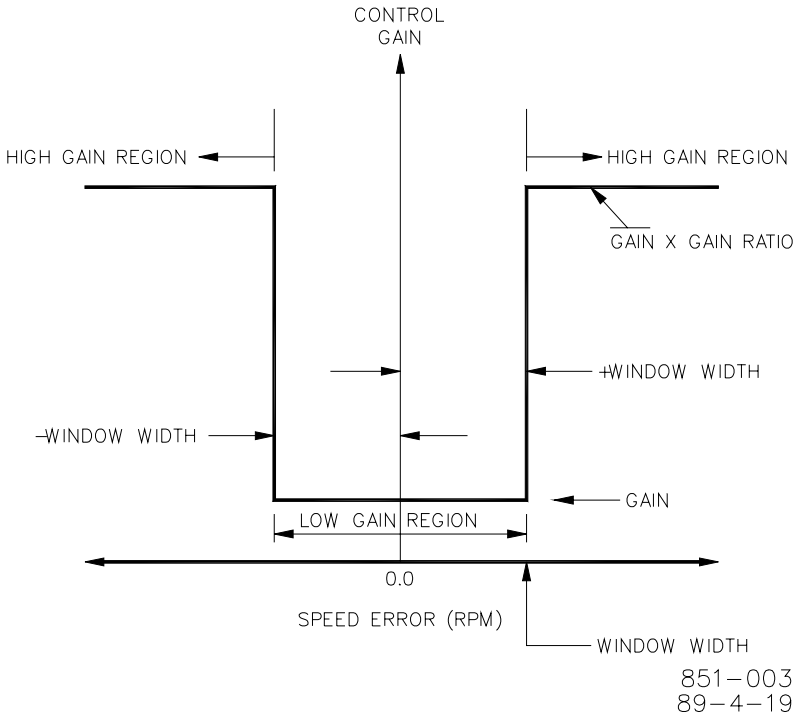

Figure 4-4. Dual Gain Settings

Dual Dynamics

The L-Series speed control also provides a second set of dynamic adjustments (Dual Dynamics) that are selected by activating the 2nd Dynamics discrete input. The control must be configured for Dual Dynamics to make these settings available. Two sets of dynamics are useful for engines where operating modes change, such as in dual-fuel or in island/parallel generator applications. Delay settings are available to delay switching dynamics when the 2nd Dynamics discrete input changes state.

Start Fuel Limiting

The Start Fuel Limit (SFL) is an adjustable limiter on the fuel demand that prevents overfueling during engine starting. Two configurable start fuel limiters are available:

- Single Start Fuel Limit
- Dual Start Fuel Limit

The single Start Fuel Limit is suitable for most applications. With this configuration, the fuel demand immediately switches to the adjustable SFL1 Limit setting when the engine is cranking at the adjustable Start1 Speed setting. The SFL1 Limit is removed and Runtime Fuel Limiting is activated once the engine accelerates to the Run Speed. At the Run Speed the fuel is controlled by the speed control setpoint and ramping functions. The Run Speed setting must be set below the speed reached with the SFL1 Limit setting. See Figure 4-5.

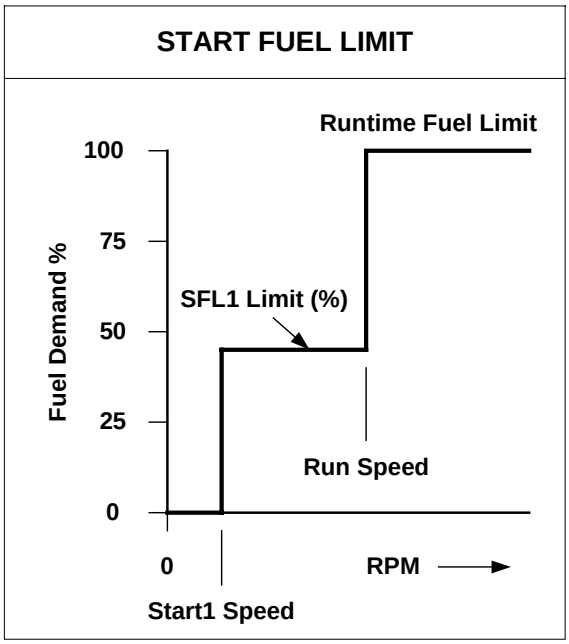

Figure 4-5. Single Start Fuel Limit

The Dual Start Fuel Limit is appropriate for engines that need a rather high fuel setting to start the engine, but a much lower setting immediately thereafter to minimize speed overshoot, black smoke, or prevent an overspeed shutdown. In addition, the SFL2 Limit can be set to increase at a controlled rate, once the engine is operating at the Start2 Speed setting. This can be a useful aid for starting cold engines. The Dual start Fuel Limit is appropriate for engines that need this ramping function.

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With this configuration, the Dual Start Fuel Limiter works just like two sequential start fuel limiters plus a ramp between them. Extra settings Start2 Speed and SFL2 Limit w/Ramp provide the second limiter function between the Start1 Speed and Run Speed. Once Start1 Speed is reached, the limiter ramps the SFL2 Limit setting at the configured ramp rate. Setting the rate to its maximum value effectively eliminates the ramp. Start2 Speed must be set higher than the Start1 Speed setting. The SFL2 Limit can be set lower or higher than the SFL1 Limit setting. See Figure 4-6.

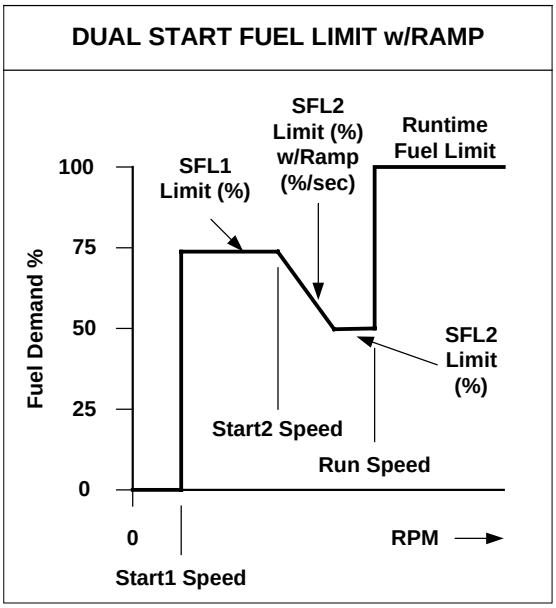

Figure 4-6. Dual Start Fuel Limiters

Runtime Fuel Limiting

The Runtime Fuel Limit is a maximum position limiter on the fuel demand that prevents overfueling/overloading after the engine has reached the run speed setting. Four configurable options are available:

- Maximum Fuel Limit
- Maximum Fuel Limit with Transients
- Boost (External) Fuel Limit Curve
- Runtime (Speed-based) Fuel Limit Curve

Maximum Fuel Limit
The Maximum Fuel Limit setting places a maximum limit on the fuel demand (actuator position). It is generally adjusted to prevent engine overloading at rated speed or to merely limit fuel delivery to the engine for other situations (such as, to prevent detonation). Adjusting the Max Fuel Limit to 100 percent disables the function.

Transient Fuel Limit
The Transient Fuel Limit setting allows a temporary increase to the fuel demand above the maximum (steady-state) fuel limit setting for a set transient time period. This can improve a load-on transient response by allowing a momentarily higher fuel demand. The fuel limits are restored once the Transient Fuel Limit time period expires. The transient fuel limit cannot be increased above 100 % fuel demand. The Transient Fuel Limit is not active below the Run Speed setting.

Boost (External) Fuel Limit Function

External fuel limit is a software adjustable five-breakpoint curve based on an external transmitter analog input signal. Manifold Air pressure (MAP) is typically used for the external fuel limiter signal. The purpose of the manifold air pressure fuel limiter is to prevent over fueling during loading to significantly reduce black smoke in diesel engine exhaust and unburned hydrocarbons in spark gas engine exhaust. A fuel demand (actuator position) limit is set for each specific air manifold pressure breakpoint.

The limiting value is linear between breakpoints as shown in Figure 4-7. The engineering units for each breakpoint are in percent and user set input units. The limiter must be carefully set since excessive fuel limiting can degrade the loading response. On occasion, exhaust temperature or other engine parameters are used for the external fuel limiting function. The external fuel limiter is not active below the run speed setting. With this mode the Maximum Fuel limit setting is still active.

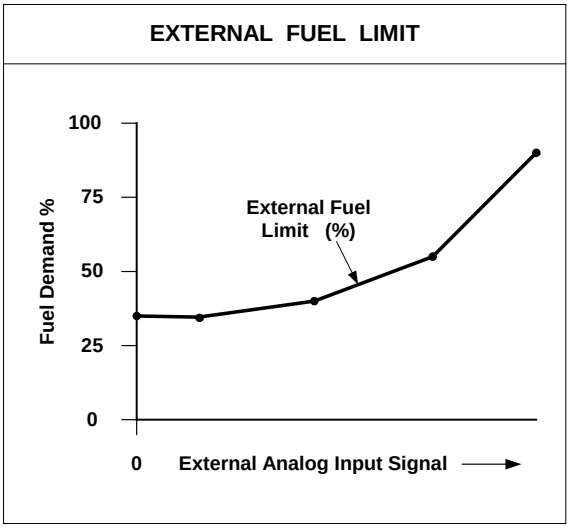

Figure 4-7. Boost (External) Fuel Limit Curve

Runtime Fuel Limit Curve

Runtime Fuel Limit is a software adjustable five-breakpoint curve based on engine speed. The purpose of this fuel limiter is to prevent engine overload during variable speed operation by mapping a fuel limit over the entire speed operating range. The speed input provides the signal for this limiter function. A fuel demand (actuator position) limit is set at each specific engine speed breakpoint. The limiting value is linear between breakpoints as shown in Figure 4-8. The engineering units for each breakpoint are in percent and rpm. Each speed entry must be equal to or higher than the previous entry. The limiter must be carefully set since excessive fuel limiting reduces load-carrying capability. The runtime fuel limiter is not active below the run speed setting.

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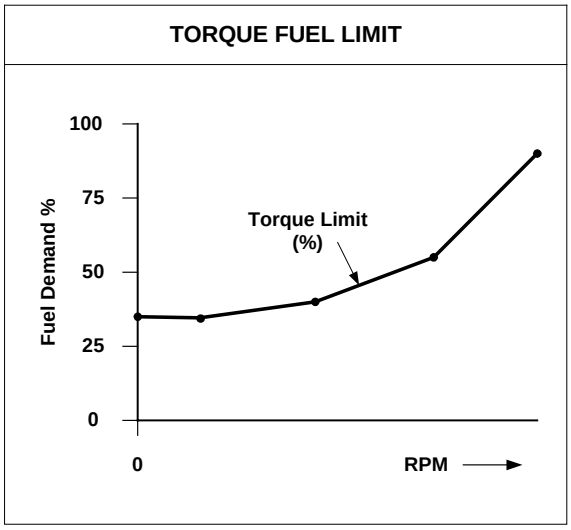


Figure 4-8. Runtime Fuel Limit Curve

Temperature Sensing

The L-Series has an on-board temperature sensor to monitor board temperatures and protect the unit from overtemperature. This temperature is monitored and a fault is annunciated if the set point is exceeded.

Current Limiting based on Temperature

The control provides actuator current limiting based on the electronics temperature. Dependent on board and actuator thermal models, the software reduces current as necessary to avoid conditions that would damage the device due to extreme temperatures.

Current limiting based on temperature begins when the combined current and temperature environment causes board temperatures greater than 117 °C. The limit curve is a linear derate from full current at 117 °C down to zero current at 125 °C. At 125 °C, an OverTemp fault is annunciated. Depending on the current (actuator torque) and ambient operating temperatures, the unit may never reach a reduced level.

Control Modes

The Service Tool displays the state of the L-Series control, the present mode of the unit. Options include:

- Stopping
- Engine Stopped
- Powered Down
- Start Fuel 1
- Start Fuel 2
- Ramping to Idle
- Running Idle
- Ramping
- Running Rated 1
- Running Rated 2

Stopping
The stopping state indicates the control has a shutdown fault and is driving the output shaft position to the closed position. Once speed has reached zero rpm, the control transfers to the stopped state.

Engine Stopped
In this state, the engine is stopped and the control is ready to begin the start-up cycle if there are no active shutdowns. After the Stopped State Delay, the holding current is applied to the actuator to limit the current draw and prevent battery drain.

Powered Down
In this state, the actuator position control is turned off and the holding current is applied to the actuator to limit the current. This state is only used if the engine is stopped and the run enable discrete input is not active.

Start Fuel 1
The Start Fuel 1 state is selected if the engine speed is higher than the Start Speed 1 threshold. In this state, the actuator position is set to the Start Fuel 1 value.

Start Fuel 2
The Start Fuel 2 state is selected if the engine speed is higher then the Start Speed 2 threshold. In this state, the actuator position is ramped to the Start Fuel 2 value. This state is only used if two start fuels are selected.

Ramping to Idle
Indicates the speed setpoint in ramping up to idle speed setpoint during a start sequence. Ramping to idle is only entered if configured to use an Idle / Rated speed set point. This state is selected if the engine speed is higher than the run speed threshold. At the moment this state is entered, the speed setpoint is set to the engine speed and then ramped to the idle set point using the ramp to idle ramp rate.

Running Idle
Indicates the speed setpoint is at the configured Idle speed setting. To leave this state, the rated command must be issued.

Ramping
The ramping state is used to ramp from one set point to another set point. If the setpoint is switched between Idle and Rated or Rated 1 and Rated 2, we will use this state to ramp with the acceleration or deceleration ramp rate. If Raise or Lower are momentarily selected (halt), the ramp will stop and the setpoint will remain at the last position. The setpoint can be adjusted from this point using the Raise/Lower commands. If the halt command is selected when ramping from idle to rated and the setpoint is below the normal adjustment range, the setpoint will continue to ramp and then halt at the minimum setting of the speed adjustment band.

Running Rated 1
Indicates the unit is running at the Rated 1 set point or the changed Rated 1 set point if raise, lower, or analog control is used.

Running Rated 2
Indicates the unit is running at the Rated 2 set point or the changed Rated 2 set point if raise, lower, or analog control is used.

Fault Detection and Annunciation

Faults can be configured to either alarm or shutdown on occurrence. An alarm basically does nothing but annunciate the fault. A shutdown forces the actuator to a predetermined position regardless of the demanded position. The L-Series can be programmed to fail in the CW or CCW direction. When the shutdown condition no longer exists, the L-Series is returned to a non-shutdown state. Faults can be globally set as either latching or non-latching. When set to latching, either a reset command or a power-cycle is required to clear the fault and allow the unit to start again. If non-latching, the fault is automatically cleared without any reset.

Faults

Faults are separated into two categories: Logged Faults and Current Faults. The Current Faults are volatile and reset every time power is applied. The Current Faults annunciate faults that are presently active/detected. All Logged Faults are latched and written to the EEPROM. They must be cleared through the Service Tool.

Faults can be globally configured as either latching or non-latching. This is a general setting that applies to all faults, unless otherwise noted. When configured as non-latching, a Reset is not needed. If latching mode is configured, a Reset or power-cycle is required to clear the fault and resume positioning. A Reset command can be accomplished by opening and closing a Run Enable discrete input (if configured) or using the Service Tool.

A parameter is available to configure each fault to either an alarm or a shutdown. Each fault can also independently be set to change the state of the discrete output. The shutdown action performed is fault-dependent. Some faults are dedicated as alarms or shutdowns and cannot be configured—they are identified as such below.

Each possible fault is described below.

Watchdog Reset
Watchdog Reset is true if a watchdog timer timeout occurred which resulted in a reset of the microprocessor. This is a hard-coded alarm. If detected, the control will attempt to continue normal operation. This fault is always latching, and a reset is required to clear it.

Brownout Reset
Brownout Reset is true if CPU Voltage drops below 4.2 V but not below 1 V. The brownout detect circuit will reset the CPU. This is a hard-coded alarm. If detected, the control will attempt to continue normal operation. This fault is always latching, and a reset is required to clear it.

EEPROM Fail
EEPROM Fail indicates failure or corruption of the internal non-volatile memory. If the CRC is not correct for the EEPROM data, this fault will be set true. This is a hard-coded internal shutdown. If detected, the control output will go limp. This fault is always latching and a reset is required to clear it.

Position Sense Fail
This indicates a failure of the internal Position Sensor. This is a hard-coded internal shutdown. If detected, the control output will drive to the Fail Direction using current control.

Failure levels: >4.75 V and < 0.25 V
Persistence: 650 ms

Voltage Sense Fail
Indicates an out-of-range signal on the input power. Could indicate input power out of range or a fault in the supply voltage sense circuitry.

Failure levels: >33 V and <6.25 V
Persistence: 650 ms

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using current control) if this fault is detected. If configured as an alarm, the control will internally default to an assumed 32 V power supply voltage (decreased torque at lower actual voltages) and attempt to continue normal operation if this fault is detected. The value displayed on the Service Tool will show sensed value, not default.

Temp Sense Fail
Indicates a failure of the internal on-board Temperature Sensor.

Failure levels: >150 °C and <–45 °C
Persistence: 650 ms
Hysteresis: 5 °C (<145 °C or >–40 °C to clear)

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will internally default to 25 °C and attempt to continue normal operation if this fault is detected. The value displayed on the Service Tool will show sensed value, not default.

OverTemp
If the on-board temperature sensor reads above 125 °C, this error will be set. Above 125 °C, the processor can fail in an unpredictable manner, so this fault is recommended as a shutdown. The Current Limiting based on temperature will effectively make the output "limp" by reducing the drive current to zero.

Failure levels: >125 °C
Persistence: 650 ms
Hysteresis: 5 °C (<120 °C to clear)

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will go limp if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

Position Error
Position Error detection logic will indicate a difference between commanded position and actual position exceeded for longer than the set delay. The error magnitude and duration are customer-configurable parameters.

Failure levels: Set by customer variable, Error > |PosErrorMax|
Persistence: Set by customer variable, Position Error Delay.
Hysteresis: none
Override: Whenever the current is being limited to a factor of 1/2 normal maximum or less. This would be because of high temperature (see section on Temp Sensing and Current Limiting) or a shutdown that causes the output to go "limp".

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

Relay Output Shorted
The relay driver is thermally protected against wiring errors. If incorrectly wired, the output will turn off and then set the Error Bit.

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

Speed Input Failed
Speed input signal failed indication.

Dedicated shutdown. The control will drive to Fail Direction (using position control) if this fault is detected. The control must return to a safe condition, determined as the powered-down or stopped state, prior to resuming operation.

Failure levels: < (Start Speed / 2)
Persistence: 13.0 ms

Overspeed
Indication that speed was above the configured overspeed level.

Dedicated shutdown. The control will drive to Fail Direction (using position control) if this fault is detected. The control must return to a safe condition, determined as the powered-down or stopped state, prior to resuming operation.

Failure levels: > Overspeed level configured value
Persistence: 6.5 ms

Governing Error High
Indication that speed was above the high error level for longer than the configured delay.

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

If faults are set to non-latching, this fault will not automatically reset until the control is return to a safe condition, determined as the powered-down or stopped state.

Failure levels: > Governing Error High configured level
Persistence: Governing Error High Delay configured value

Governing Error Low

Indication that speed was below the low error level for longer than the configured delay.

Can be configured as an alarm or shutdown. If configured as a shutdown, the control will drive to Fail Direction (using position control) if this fault is detected. If configured as an alarm, the control will attempt to continue normal operation if this fault is detected.

If faults are set to non-latching, this fault will not automatically reset until the control is return to a safe condition, determined as the powered-down or stopped state.

Failure levels: < Governing Error Low configured level
Persistence: Governing Error Low Delay configured value

Max Start Timeout

A failure to start indication. Run speed not attained prior to max start timeout. This is a hard-coded shutdown. If detected, the control output will drive to the closed position. The control must return to a safe condition, determined as the powered-down or stopped state, prior to resuming operation.

Failure level and persistence: starting time > configured max start timeout

Run Enable Shutdown

Run Enable discrete input is opened, only active when this input is configured for use. This is a hard-coded shutdown.

Chapter 5.
Service Tool

Introduction

This chapter covers the process of installing and servicing the control via the L-Series Service Tool. It is assumed that the control has already been installed on the engine.

NOTE
Many applications are delivered pre-configured, calibrated, and tuned. These units do not require the use of the Service Tool.

Description

The Service Tool software is used to configure, tune, and troubleshoot the L-Series control. This chapter describes installation and use of the Service Tool. It identifies the parameters available that can be viewed. It also provides detailed information on configuring and setting up the L-Series to the customer-specific field application.

The Service Tool software resides on a PC (personal computer) and communicates to the L-Series through connector pins 4 and 6. An external RS-232 transceiver is necessary to make communications possible with the Woodward L-Series service tool. A connectivity kit (Woodward # 8923-1061) can be purchased from Woodward to accomplish this.

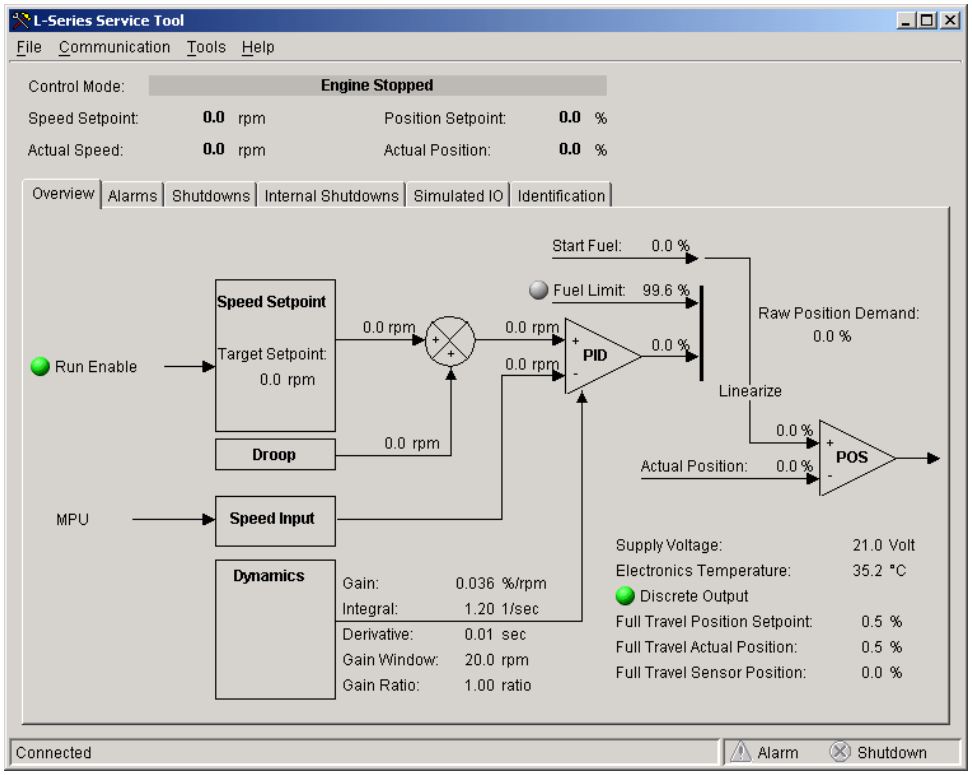


Figure 5-1. Example Service Tool Screen

The following hardware is required to work with the L-Series control:

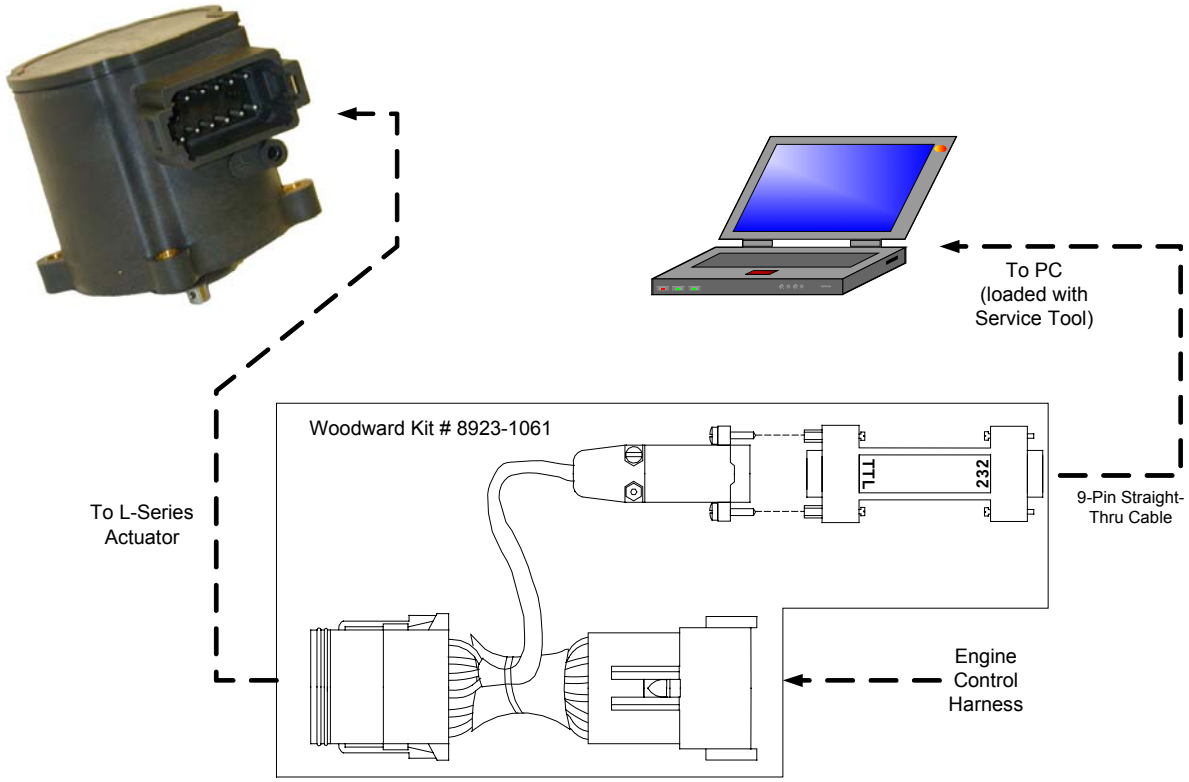
- PC-compatible laptop or desktop computer* with at least one available serial communications port, and Windows 95/98/2000/NT/Me/XP as the operating system.
- Programming/datalink harness as shown in Figure 5-2.

In addition to the hardware, the following are the distributions of tool software needed to communicate with the control:

- Woodward part number 9927-1222, L-Series Service Tool

***—CAUTION**

There is a potential for serial port damage when communicating with the L-Series control. This is caused by a difference in ac voltage between neutral and earth ground. If the PC RS-232 port ground is referenced to ac neutral, and the L-Series control is referenced to battery ground (ac earth ground), a large amount of current can be experienced. To avoid this situation, we strongly recommend placing an isolation transformer between the ac outlet and the PC.



Pinouts Viewed Looking into Control Connector and Computer Connector

Figure 5-2a. Programming Harness Connections

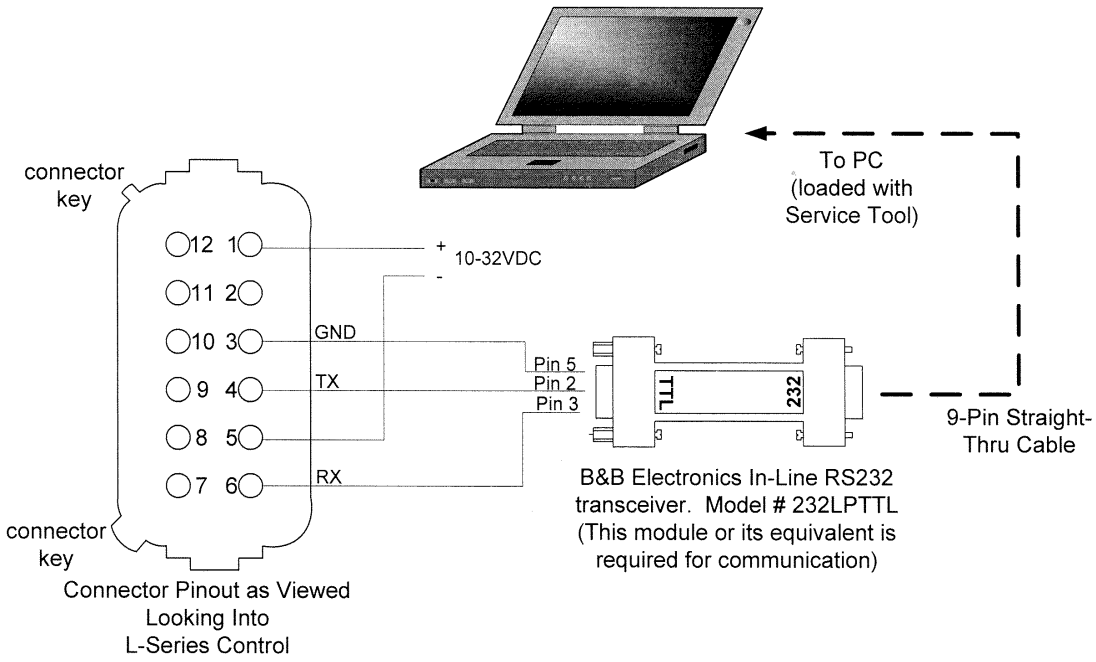


Figure 5-2b. Programming Harness Wiring

Getting Started

Installation Procedure

The Service Tool software can be downloaded and installed from the Woodward internet site (**www.woodward.com/software**).

What to do next

After the software is installed, connect a serial communications cable between the RS-232 connections on the L-Series control and an unused serial port on your computer. Run the Service Tool program and select the appropriate comm port. Once connected to the control, the status bar will display ‘connected’ and the Service Tool screen will populate with monitor parameters.

CAUTION
An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

Service Tool Help

More help on using Service Tool is available and included with the installation of the Service Tool product. Service Tool Help can be accessed from the Service Tool ‘Contents’ drop-down window selection under the Help menu located on the Main Window.

Software Version Identification

The Service Tool software version can found by selecting ‘About’ under the Help menu. The software version is identified as the ‘Software Part Number’ on the Service Tool screen. The Service Tool and Control must be connected to view this information. Refer to this version information in any correspondence with Woodward.

Service Tool Security

Various levels of security are available to protect application settings. One password is available which provides the ability to inhibit tampering of control settings. The individual protection settings include a general password protection on configuration reading (from the control), configuration loading (to the control), position calibration, position PID tuning, and speed PID tuning.

Monitoring the Driver

The Service Tool has six different tab sheets to monitor driver parameters. The tab sheet screens include:

- Overview (see Figure 5-3)
- Alarms (see Figure 5-4)
- Shutdowns (see Figure 5-5)
- Internal Shutdowns (see Figure 5-6)
- Simulated I/O (see Figure 5-7)
- Identification (see Figure 5-8)

Each screen will display the L-series control mode, actual speed, speed setpoint, position setpoint, and actual position values.

Control Mode

Displays the state of the L-Series control, the present mode of the unit. Options include:

- Powered Down
- Engine Stopped
- Stopping
- Start Fuel 1
- Start Fuel 2
- Running Idle
- Ramping
- Running Rated 1
- Running Rated 2
- Ramping to Idle

Speed Setpoint

Displayed value of the speed setpoint - in rpm.

Actual Speed

Displayed value of the actual speed – in rpm.

Position Setpoint

Displayed value of the position demand - in percent.

Actual Position

Displayed value of the actual position - in percent.

Status Bar Indications

At the bottom of the Service Tool window is a status bar. The status bar has two sections. The bottom left section displays communication status and bottom right section displays alarm & shutdown status.

Communication Status

This section of the status bar shows the status of communication between the service tool and the L-Series.

- **Connected**—The Service Tool is connected to and communicating with the driver.
- **Not Connected**—The Service Tool is not connected to the driver.
- **Connecting**—The Service Tool is attempting to connect to the driver. This message is displayed when Connect is selected from the Communications menu or when attempting to re-establish communication to the driver. If the connection is lost it will continuously attempt to re-connect.

Alarm Status

One or more alarms on the Alarms screen is active.

Shutdown Status

One or more shutdowns on the Shutdowns or Internal Shutdowns screen is active.

Overview Parameters Screen

To monitor the overview parameters, go to the Overview page on the main window. This screen dynamically populates based on the unit's configuration. If a function is not programmed, then it will not appear.

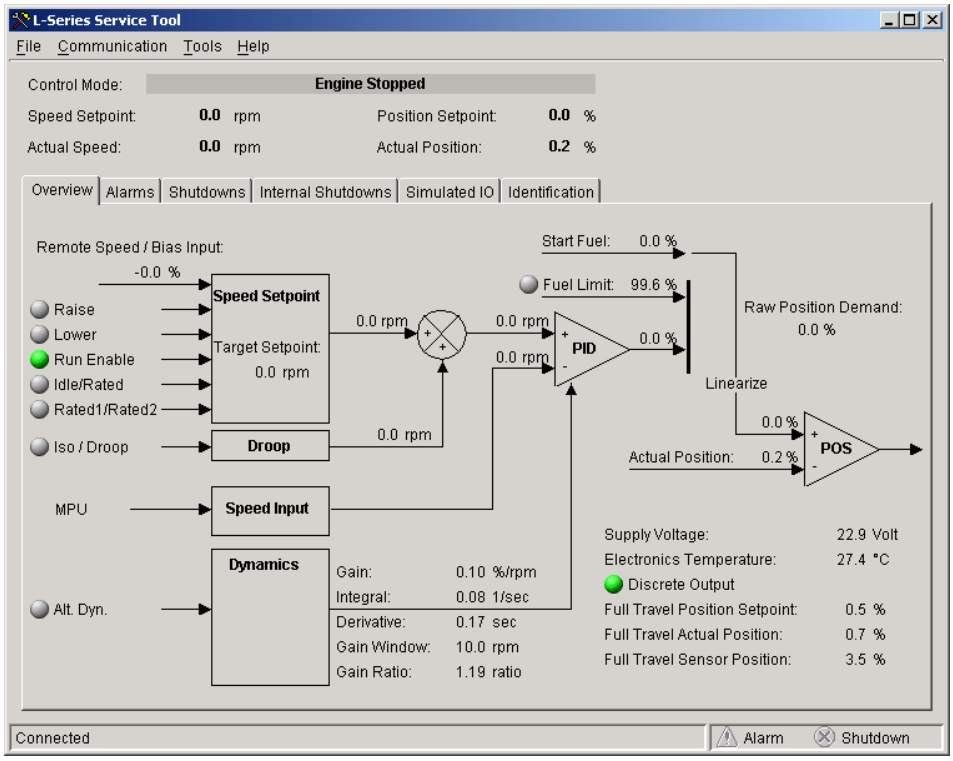


Figure 5-3. Service Tool—Overview Tab

Supply Voltage

Displayed value of the input power, in volts, as read by the processor.

Electronics Temperature

Displayed value of the electronics temperature sensor, in degrees Celsius, as read by the processor. The temperature sensor is physically located between the electronics module and the LAT motor.

Discrete Output

On/Off status of the discrete output command. The indicator is illuminated when the channel is commanded to ON and grayed-out when the command signal is OFF.

Full Travel Position Setpoint

Indication of the position setpoint in terms of total overall unit travel. Useful if a less than full-travel user-calibrated range is used.

Full Travel Actual Position

Indication of the actual position in terms of total overall unit travel. Useful if a less than full-travel user-calibrated range is used.

Full Travel Sensor Position

Indication of the position in terms of total overall unit travel before linearization. This value will match the TPS output.

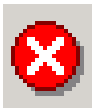
Shutdown and Alarm Indications

The Shutdown and Alarm screens display the status of both active and logged fault conditions. The logged indications provide a history of events even after the unit has been power-cycled or run again.

Indicates a logged alarm condition.

Indicates an active alarm condition.

Indicates a logged shutdown condition.

 Indicates an active shutdown condition.

An active fault is one that is currently active or latched in the control. The latching/non-latching faults configuration setting factors into this indication. If the fault is latching, then an active fault could either be one that is still present or one that occurred but has not been reset. Latched faults can be cleared by cycling power on the L-Series control or by selecting the ‘Reset Alarms and Shutdowns’ button on any of the Alarm or Shutdown screens.

A logged fault is one that occurred but is no longer currently active or latched in the control. Logged faults are permanently cleared by selecting the ‘Reset Logged Alarms and Shutdowns’ button on any of the Alarm or Shutdown screens.

Alarms Screen

To monitor the alarm conditions, go to the Alarms page on the main window. The values displayed on this screen dynamically change with the fault configuration. Refer to Chapter 4 for a complete listing and details of all the faults.

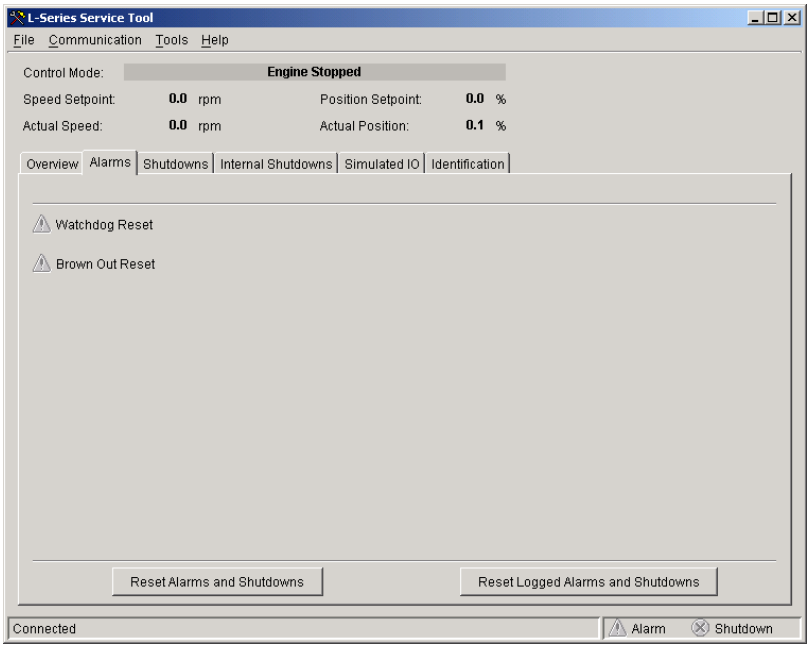


Figure 5-4. Service Tool—Alarms Tab

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Shutdowns and Internal Shutdowns Screens

To monitor the shutdown conditions, go to the Shutdowns and the Internal Shutdowns pages (figures 5-5 and 5-6) on the main window. The values displayed on the Shutdowns screen dynamically change with the fault configuration. Refer to Chapter 4 for a complete listing and details of all the faults.

A reset command is available on these screens to clear any current alarms, if they are latched on. If a fault condition occurred but is no longer present, it will remain as a logged fault until cleared. The 'Reset Logged Alarms and Shutdowns' command will clear all logged faults.

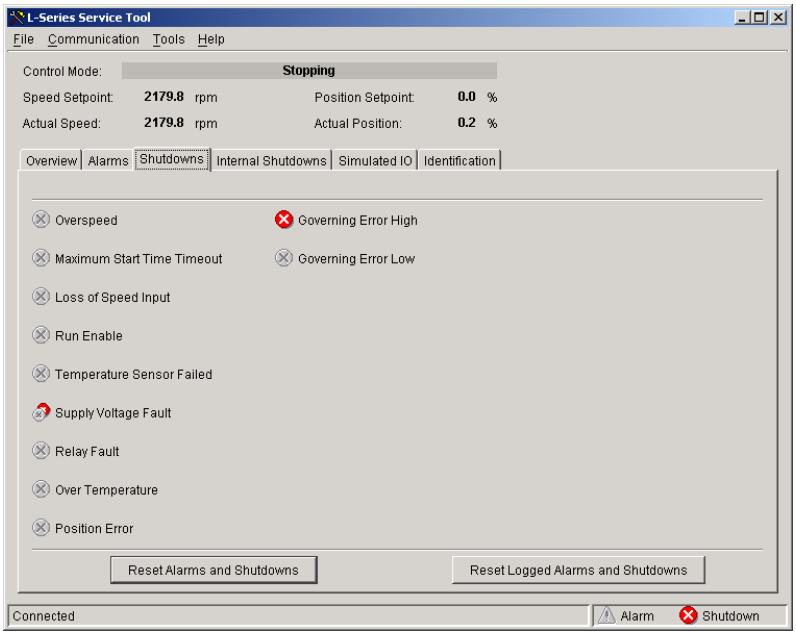

Figure 5-5. Service Tool—Shutdowns Tab

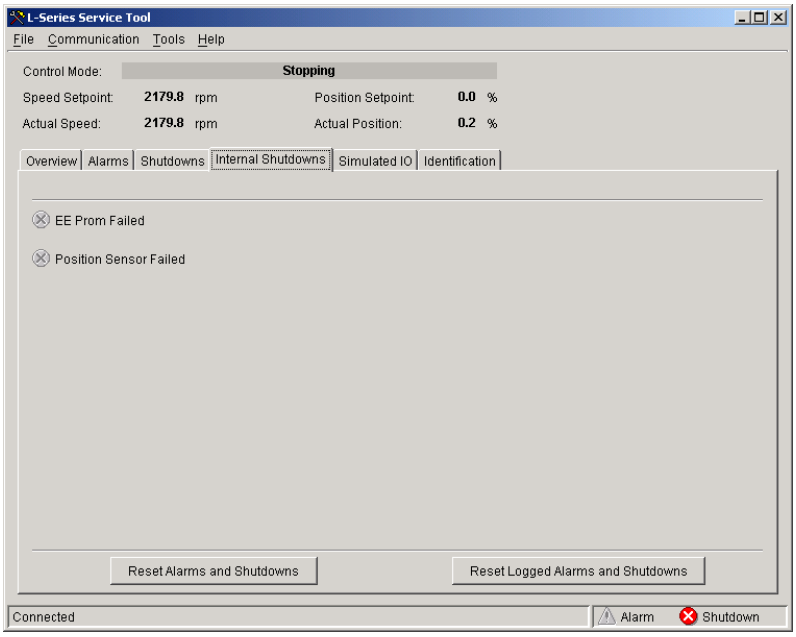

Figure 5-6. Service Tool—Internal Shutdowns Tab

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Simulated I/O Screen

While communicating to the service tool, Aux 3 and Aux 4 inputs are not functional since these input pins are used for both Input (analog or discrete) and for serial communications. This screen is provided to facilitate operational testing while connected to the Service Tool. The Aux 3 & 4 Simulated Analog inputs simulate a fixed-value analog input signal, in percentage, and the discrete inputs can be simulated as closed (checked) and open (unchecked) using the Simulated Discrete Input checkboxes.

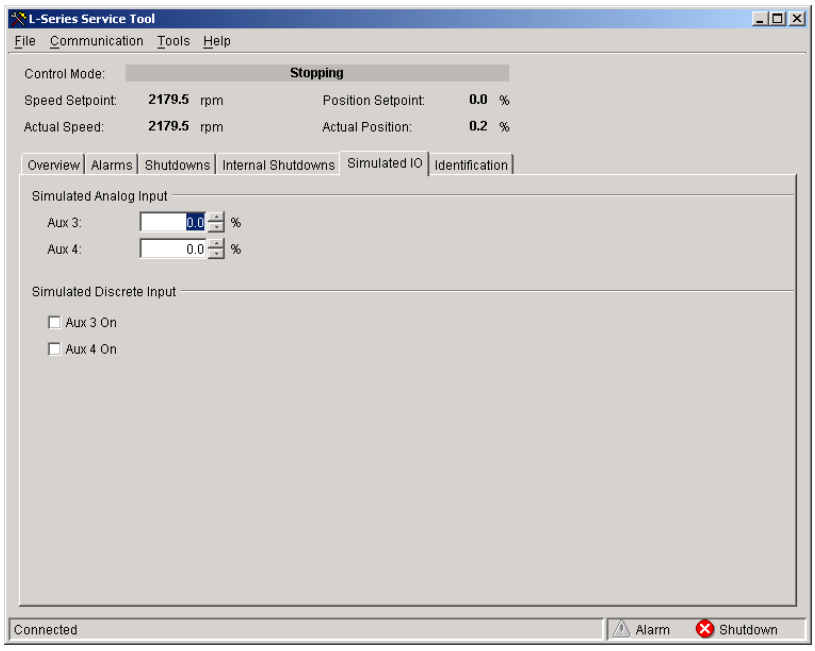

Figure 5-7. Service Tool—Simulated I/O Tab

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Identification Screen

To monitor the L-Series product identification, go to the Identification page on the main window. Information displayed includes the part number of the embedded L-Series software, the serial number of the unit, the configuration filename, and the date of the last configuration change.

The Software Part Number identifies the embedded firmware part number and revision. The Serial Number is a Woodward tracking tool and is set at the factory.

The Configuration Identifier displays the first 8 characters of the loaded configuration file, and the Date of Last Configuration Change can be used to track changes to product configuration settings.

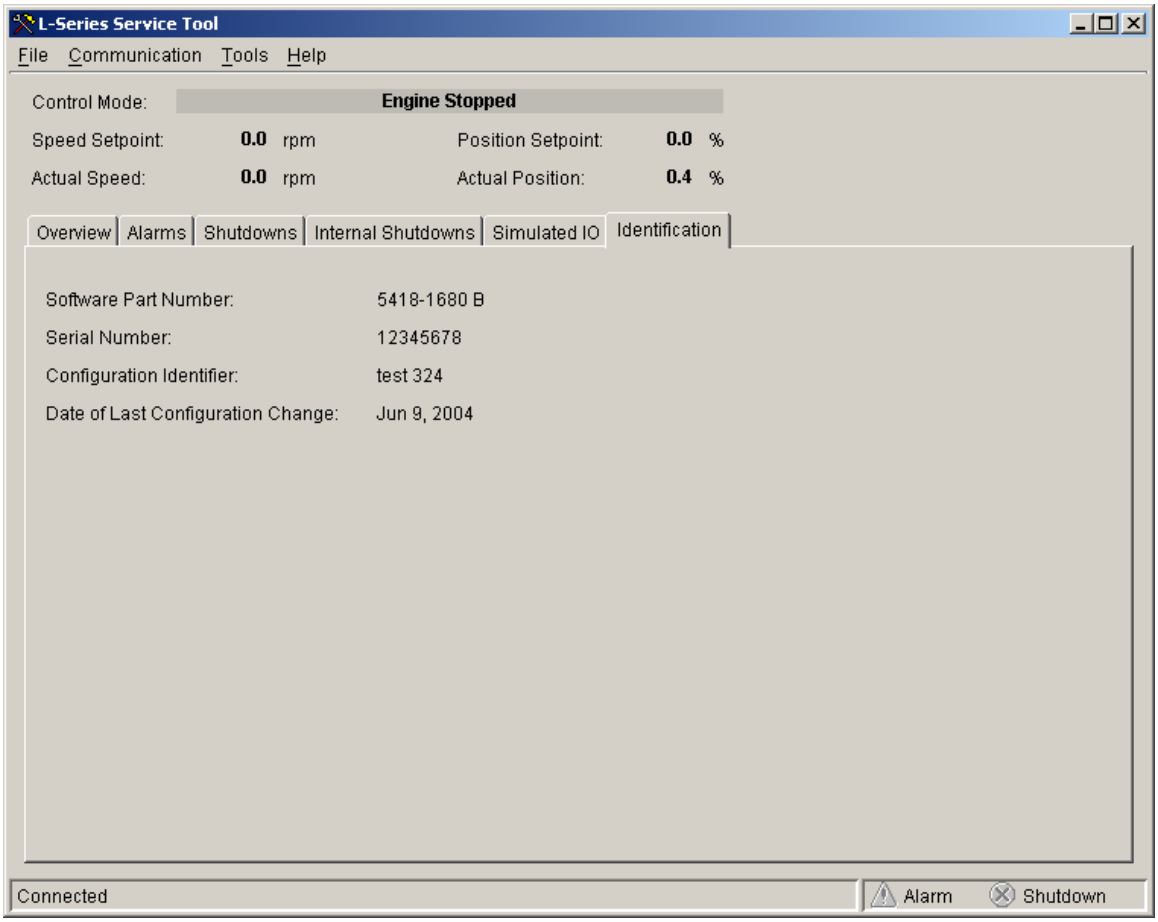

Figure 5-8. Service Tool—Identification Tab

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Chapter 6.
Configuration

Overview

The L-Series is configured using the Service Tool. Refer to Chapter 5 for Service Tool installation and connection instructions.

The L-Series can be configured either on-line or off-line. On-line configuration can only be performed when the Service Tool is connected to and communicating with the L-Series control. Off-line configuration can be done at any time, however, settings will not take effect until they are loaded into the control.

NOTE
Many applications are delivered pre-configured, calibrated, and tuned. These units do not require the use of the Service Tool.

NOTE
Configuration reading and loading can be individually password protected for security purposes. If security is applied, these features will not be accessible without the password.

CAUTION
An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

The current L-Series control configuration settings can be viewed at any time when connected to the control by opening the Configuration Editor (File/Open Control Configuration), assuming password protection is not active. See Figure 6-1.

NOTE
If using dynamics curves or fuel limiting curves, control power must be cycled after loading a new configuration before the new settings will take effect.

OEM Configuration File Data

The OEM can save configuration file specific data with the service tool by selecting Properties under the File menu pull down. This is a text field and can be used to store data such as:

- Customer
- Engine Type
- Application Type
- Notes

Configuring the Unit—On-Line

Unit configuration is summarized as follows:

1. Open the Configuration Editor Dialog by selecting ‘File/Open Control Configuration’.
2. Edit the configuration settings.
3. Load the configuration to the L-Series control.

NOTE
As changes are made to Configuration parameters, they are not used by the driver until a 'load' command is issued. Selecting the 'Cancel' button closes the Configuration Editor and does not make any changes to the driver.

Configuring the Unit—Off-Line

Unit configuration is summarized as follows:

1. Open the Configuration Editor Dialog using the File/New or File/Open options.
2. Edit the configuration settings.
3. Save the configuration to a file. At a later date simply open the configuration and load it into the control.

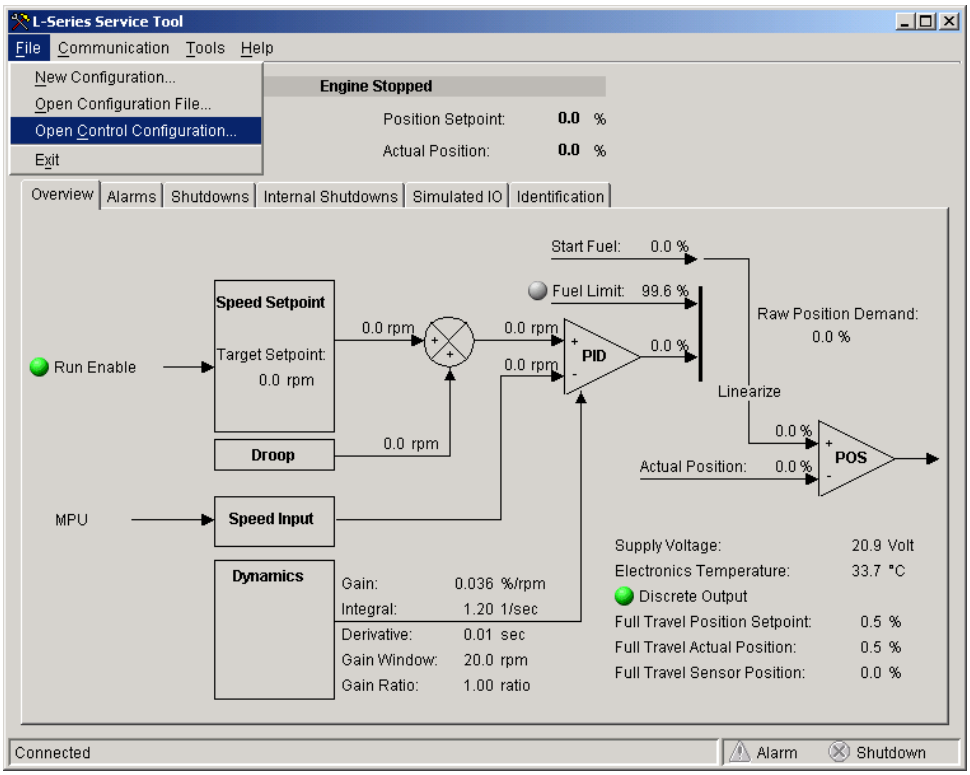

Figure 6-1. Configuration Selection Options

Configuration Parameters

There are 9 different screens that display the configuration settings in the L-Series speed control: Overview, Setpoint, Control, Modifiers, Fuel Limiting, Dynamics, Discrete I/O, Alarm/Shutdown, and Security.

Overview Tab

The overview tab provides speed sensing and position control configuration settings.

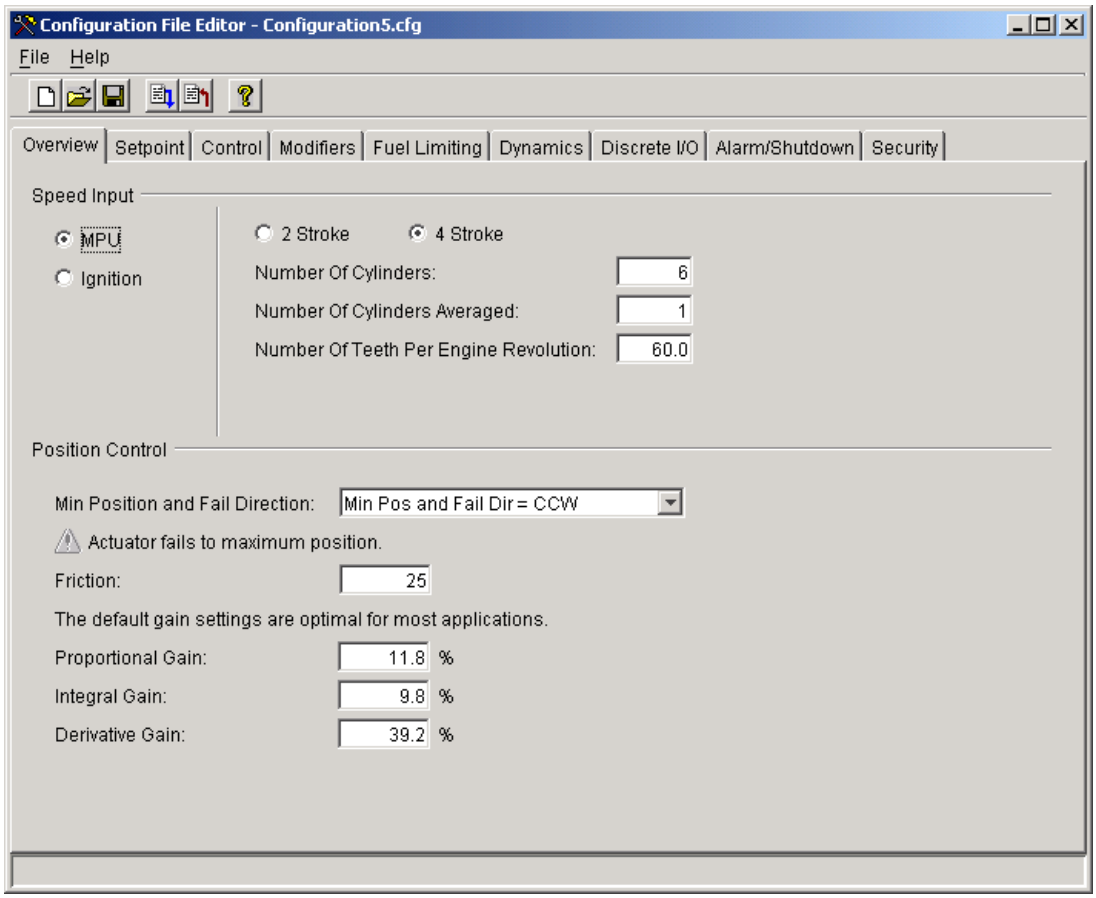

Figure 6-2. Configuration Editor—OVERVIEW TAB

Speed Input Configuration Settings

These settings are used to determine the conversion from speed input pulses to engine rpm, as well as engine torsional filtering. Based on the security settings, the speed input configuration settings (with the exception of the sensor type) can also be modified from the Edit Speed Settings selection under the Tools menu (refer to Chapter 7, Editing of Speed Settings).

Sensor Type
Set to either MPU or Ignition. This function requires engine speed pulses present on either the ignition pin input (pin 12) or the MPU pin input (pin 11).

Engine Type
Set to either 2-stroke or 4-stroke.

Number of Cylinders
Sets the number of cylinders. From the sample table below, select the value that corresponds to the number of crankshaft degrees between ignition pulses.
Allowed values: 1—20

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# cylinders	Degrees between pulses (4-stroke engines)	Degrees between pulses (2-stroke engines)
1	720	360
2	360	180
3	240	120
4	180	90
5	144	72
6	120	60
8	90	45

Number of Cylinders Averaged
Sets the number of cylinders to be averaged by the speed sensing algorithm. This setting is used as a filter to minimize the effects of firing torsionals that occur normally in reciprocating engines. A lower value gives less filtering, increases steady-state speed variation but allows for better transient response. A higher value reduces steady-state speed variation but slows transient response. If unsure, set this to either '1' or half the 'Number of Cylinders' for a 4-stroke. On a 2-stroke engine, '1' or 'Number of Cylinders' are good choices.

For uneven firing patterns, 'Number of Cylinders Averaged' should be set to eliminate repeating torsionals.

Allowed values: 1 to 'Number of Cylinders'.

Number of Teeth per Engine Revolution
Sets the number of teeth seen by the speed sensor during one engine revolution. This value is used to calculate the engine speed based on MPU frequency. This value is not displayed when 'Ignition' is configured. Allowed values: 1–720.

Position Control Configuration Settings

The position control controls the position of the shaft based on the position command setting from the speed control logic.

NOTE
For most applications, the default gains do not need to be changed; however, Min Position and Fail Direction should be checked.

Min Position and Fail Direction
Sets the direction for minimum position and fail direction. An alert is displayed (Actuator fails to maximum position.) to warn the user should the fail direction and min fuel direction be opposite.

Friction/Dither Setting
Sets the position control's friction and dither values. This parameter should be set to zero (no effect) while tuning the PID and then increased for optimum response. Increasing this setting increases both the dither amount and a non-linear output component. If unsure, typical values would be between 10 and 25. Allowed values: 0–100.

Proportional Gain
Sets the position control PID's proportional gain. Increased gain corresponds to increased PID output (higher proportional = faster response). This setting can also be dynamically adjusted using the PID Tuning screen. If unsure, a typical value would be 11.8 . Allowed values: 0–100%

Integral Gain
Sets the position control PID's integral gain. Increased gain corresponds to increased PID output (higher integral = faster response). This setting can also be dynamically adjusted using the PID Tuning screen. If unsure, a typical value would be 9.8 . Allowed values: 0–100%

Derivative Gain
Sets the position control PID's derivative gain. Increased gain corresponds to increased PID output (higher derivative = faster response). This setting can also be dynamically adjusted using the PID Tuning screen. If unsure, a typical value would be 39.2 . Allowed values: 0–100%

Setpoint Tab

The setpoint tab provides the speed setpoint configuration settings. Based on the security settings, the speed setpoint configuration settings (with the exception of the mode) can also be modified from the Edit Speed Settings selection under the Tools menu (refer to Chapter 7, Editing of Speed Settings).

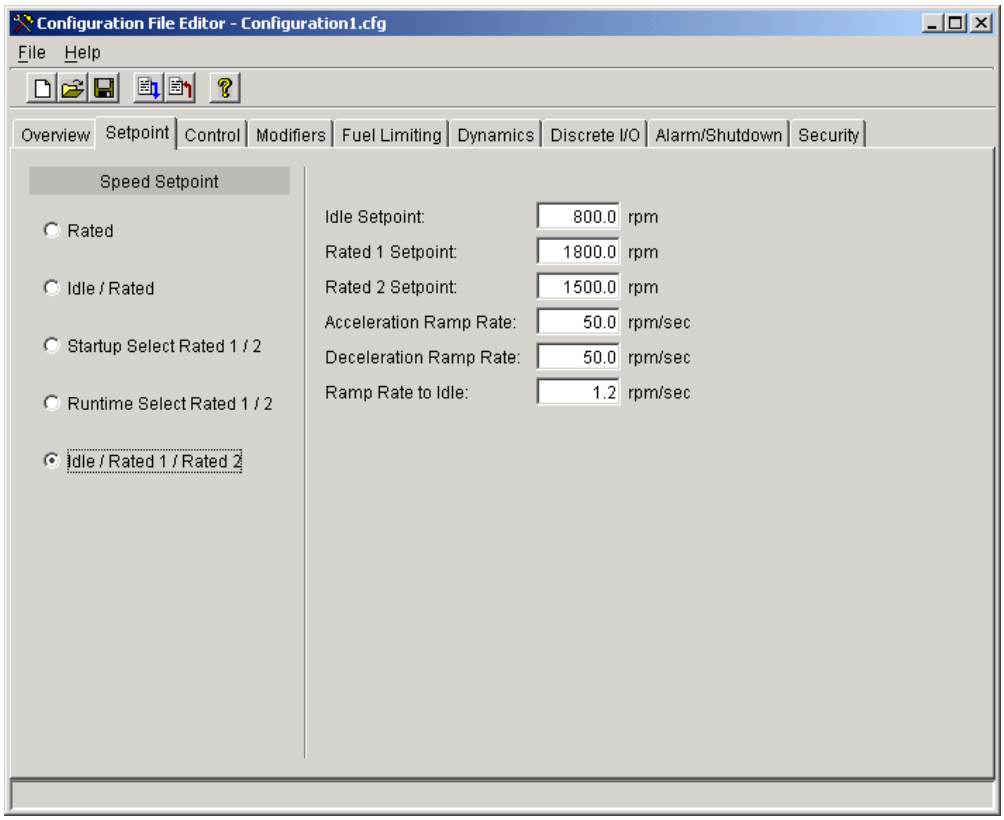


Figure 6-3. Configuration Editor—SETPOINT TAB

Mode
The Mode determines how the speed setpoint will function. This setting determines the display of additional configuration parameters.

Rated—Single speed setpoint control—at rated speed.
Idle / Rated—Two speed setpoint control, idle and rated. Must configure an Idle/Rated discrete input to provide this function (see Discrete I/O tab).
Start-up Select Rated 1/2—Setpoint uses 2 rated speeds, selected on unit start-up. Must configure a Rated2 discrete input to provide this function (see Discrete I/O tab).

Runtime Select Rated 1/2—Setpoint uses 2 rated speeds, selectable at any time. Must configure a Rated2 discrete input to provide this function (see Discrete I/O tab).
Idle / Rated 1/ Rated 2—Three speed setpoint control, idle and rated 1 and rated 2. Must configure an Idle/Rated discrete input and a Rated2 discrete input to provide this function (see Discrete I/O tab).

Idle Setpoint
Sets the Idle Setpoint. Only displayed if Idle is used. Allowed values: 0–4000 rpm, but must be less than Rated.

Rated (or Rated 1) Setpoint
Sets the Rated (Rated 1) Setpoint. Allowed values: 0–4000 rpm, but must be greater than Idle.

Rated 2 Setpoint
Sets the Rated 2 Setpoint. Only displayed if Rated 2 is used. Allowed values: 0–4000 rpm, but must be greater than Idle.

Acceleration Ramp Rate
Setpoint ramp rate, in rpm/sec, when increasing to a rated setpoint. Allowed values: 1–1000 rpm/s.

Deceleration Ramp Rate
Setpoint ramp rate, in rpm/sec, when decreasing to a rated setpoint. Allowed values: 1–1000 rpm/s.

Ramp Rate to Idle
Setpoint ramp rate, in rpm/sec, when idle speed is selected. Only displayed if Idle is used. Allowed values: 1–1000 rpm/s.

Control Tab

The control tab provides engine start and stop configuration settings.

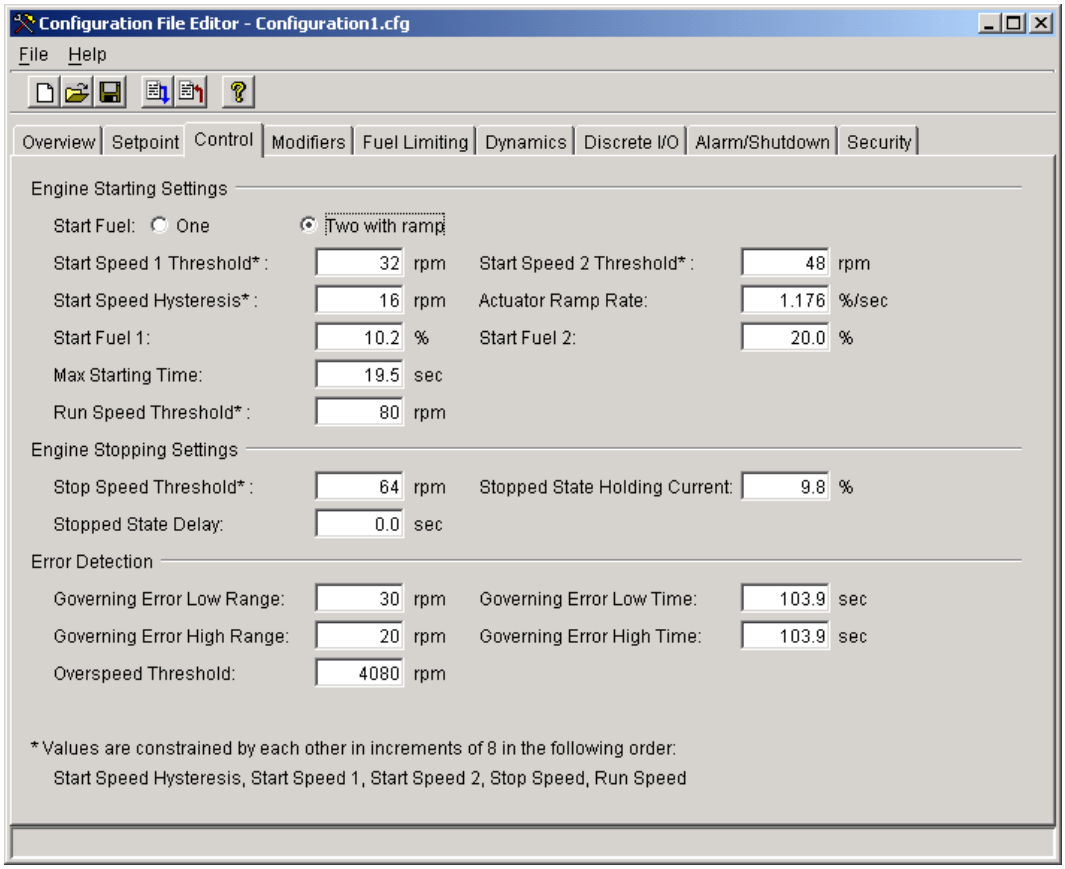
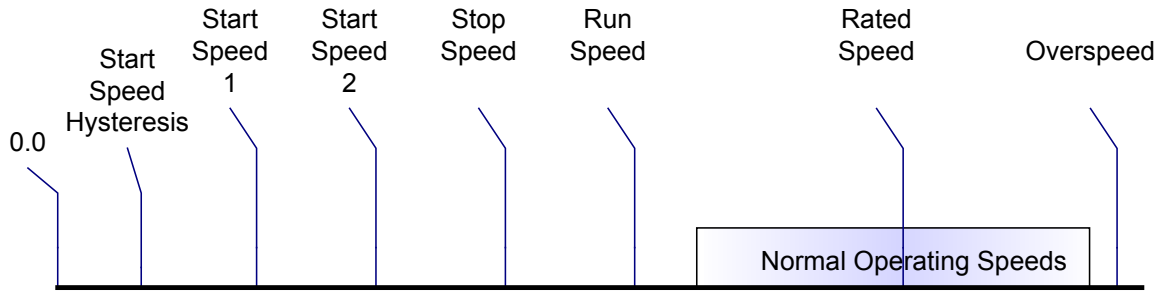


Figure 6-4. Configuration Editor—CONTROL TAB

The L-Series speed settings must follow the following general order.



Starting the Engine

The engine starting sequence will look like this, if no errors are detected:

While in power down, enable the control by the Run enable input. The actuator will go into position control and the control is ready. Start the engine. The engine speed will increase above the Start Speed 1 Threshold, and will go to the Start Fuel position demand. The control is still running open loop, the speed control PID is not controlling to the actuator position. Once the engine speed is above the run speed threshold, the control will switch from start fuel demand to the fuel demand from the speed PID. At this point the unit is in speed control and will control the engine to the speed setpoint. The PID position during starting will be trimmed to the start fuel values, therefore the switch from start fuel to PID control will be performed without a jump in position. If the speed setpoint jumps, the PID position could jump depending on the Gain, Integral, and Derivative settings of the speed PID.

If an error is detected, the control will go to the stopping state. Once the engine speed decreases to zero rpm and the stopping delay is timed out, the unit will be in the stopped state.

Engine Starting Settings

Start Fuel

Set to either one start fuel setting or 2 start fuel settings with a ramp between the settings. A single start fuel is suitable for most applications. With this configuration, the fuel demand immediately switches to the Start Fuel 1 setting when the engine speed has exceeded the Start1 Speed setting.

Dual start fuel configuration is appropriate for engines that need a rather high fuel setting to start the engine, but a much lower setting immediately thereafter to minimize speed overshoot, minimize black smoke, or to prevent an overspeed shutdown.

Start Speed 1 Threshold

Start Speed 1 Threshold is set below the starter speed. Once this threshold is exceeded, the control determines a start is in progress and opens the actuator to the start fuel setting. At this point the governor state changes from ‘Stopped’ to ‘Start Fuel 1’. Typical value is 64 rpm to detect engine cranking.

Allowed values: 16–4000 in 8 rpm increments but must be less than ‘Start Speed 2 Threshold’ (if used) and less than the ‘Stop Speed Threshold’.

Start Speed Hysteresis is provided for the start speed threshold to ensure that a normal amount of variance in engine speed while in the Start Fuel State does not cause the control to enter the Stopping state. After the control has reached the Start Fuel state, it will go to the Stopping state if engine speed drops below the (Start Speed 1 Threshold – Start Speed Hysteresis) value.

Allowed values: 50% of Start Speed 1 to ‘Start Speed 1 Threshold’ in 8 rpm increments.

Start Fuel 1

Specifies the maximum permitted shaft position when the governor state is ‘Start Fuel 1’. Typical value is the same as the full load actuator position.

Allowed values: 0–100%

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Start Speed 2 Threshold
Specifies the speed at which the Governor State changes from ‘start1’ to ‘start2.’ Typical value is 50% of the lowest speed reference. Only displayed if two start fuel limits are configured.

Allowed values: Must be between ‘Start Speed 1 Threshold’ and the ‘Stop Speed Threshold’, in 8 rpm increments.

Start Fuel 2
Specifies the maximum permitted shaft position when the governor state is ‘Start Fuel 2’. Only displayed if two start fuel limits are configured.

Allowed values: 0–100%

Actuator Ramp Rate
Specifies the rate, in %/s, the control will move the actuator position from the Start Fuel 1 to the Start Fuel 2 position once the speed exceeds the Start Speed 2 Threshold. If the ramp rate is set to its maximum value, the change to the second start fuel setting is nearly instantaneous, essentially eliminating the ramp feature. Only displayed if two start fuel limits are configured.

Allowed values: 0.235–200%/s

Max Starting Time
This is the maximum time the engine is allowed to stay within the Start Fuel state. This is used to make sure that if there is a problem starting the engine, it will be stopped after a reasonable amount of time.

Allowed values: 0–400 s

Run Speed Threshold
Specifies the speed at which the Governor State changes from ‘Start Fuel’ to ‘running.’ Typical value is 90% of the lowest speed reference. If the engine speed is above the Run Speed Threshold, the control will switch to one of the running states and start using the speed control to drive the actuator position demand.

Allowed values: Must be greater than ‘Stop Speed Threshold’ and less than 4000, in 8 rpm increments.

Engine Stopping Settings

Stop Speed Threshold
Specifies the speed at which the Governor State changes from ‘Stopping’ to ‘Stopped’. If the engine is stopped by a shutdown, the control will go to the Stopping state and the engine must stop before proceeding to any other state. If the engine is stopped by the Run Enable input, the control will again go to the Stopping state. In this case, however, if engine speed is still above the Stop Speed Threshold, making the Run Enable switch active again will allow the control to go directly back to the running state. Below the Stop Speed Threshold, the control will not allow the engine to restart.

Allowed values: Must be greater than ‘Start Speed Threshold’ and less than ‘Run Speed Threshold’, in 8 rpm increments.

Stop State Delay
The Stopped State Delay setting delays the change from the Stopping state to the Engine Stopped state (where the engine can be started again). This is done to prevent starting the engine when it is still turning and the speed input has failed. This time should be set to the time it will take the engine to come to a full stop from the Start Speed 1 Threshold. Above the Start Speed 1 Threshold, the speed signal loss will result in a speed sensor failure, and the engine will not restart until the control is reset.

Allowed values: 0–400 s

Stopped State Holding Current
In the stopped state the control will drive the actuator closed with the Stopped State Holding Current. This is a percent value of steady state current of the actuator. This acts like a return spring (electrical return spring) if the power to the actuator is still there. This will help with diesel pump application or throttle application where it is important to keep the actuator at the closed position if the engine is stopped.

Allowed values: 0–100%

Error Detection Settings

Governing Error Low Range
Maximum error setting to trigger a Governing Error Low fault.

Allowed values: 0–4000 rpm

Governing Error Low Time
Governing Error Low speed range persistence, in seconds, prior to indicating a fault.

Allowed values: 0–400 s

Governing Error High Range
Maximum error setting to trigger a Governing Error High fault.

Allowed values: 0–4000 rpm

Governing Error High Time
Governing Error High speed range persistence, in seconds, prior to indicating a fault.

Allowed values: 0–400 s

Overspeed Threshold
Specifies the speed level that will trigger an overspeed shutdown fault.

Allowed values: 0–4080 rpm, but must be greater than Rated

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Modifiers Tab

The modifiers tab provides droop and speed setpoint biasing configuration settings.

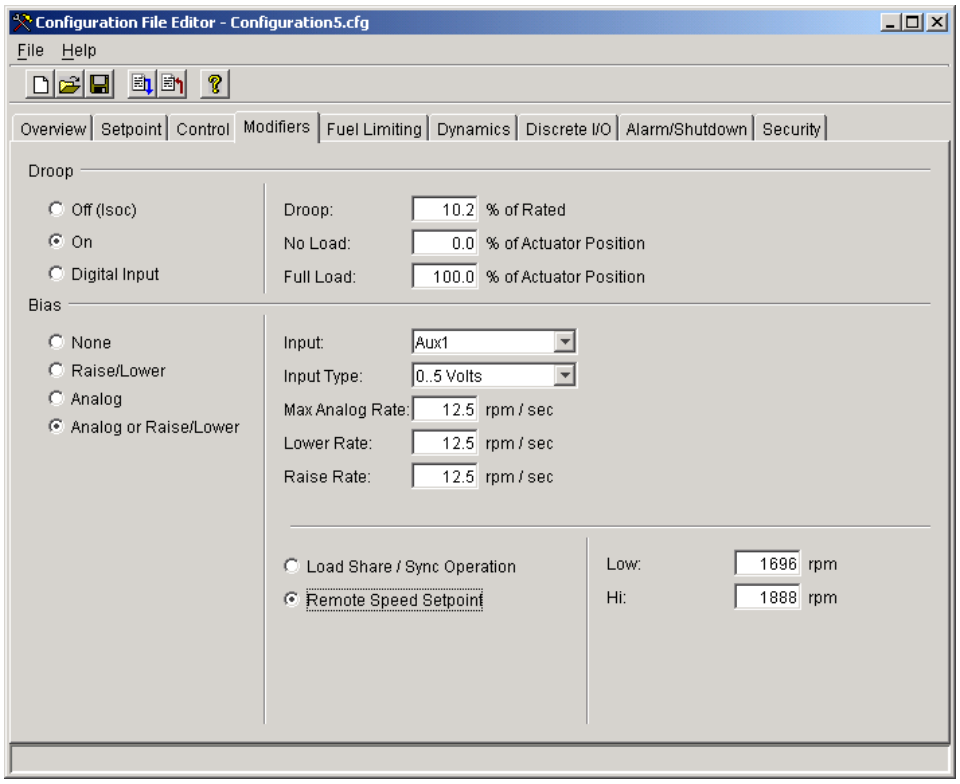

Figure 6-5. Configuration Editor—Modifiers Tab

Droop Settings

Droop Mode

Determines what methods of adjustment of the speed setpoint are to be allowed.

Off–no droop is used, unit to remain in isochronous speed control.

On–actuator position droop is always enabled and active above Idle speed.

Digital Input–actuator position droop is enabled based on the droop discrete input. If this is selected, a digital input must be configured for this function (see Discrete I/O tab).

Droop

Sets the percentage of actuator position droop when droop is enabled.

Allowed values: 0–100%

No Load

Sets the no load actuator position percentage for the droop function. Below this actuator position the droop is zero.

Allowed values: 0% up to the ‘Full Load’ setting

Full Load

Sets the full load actuator position percentage for the droop function.

Allowed values: From the ‘No Load’ setting up to 100%

Bias Settings

Bias Mode

Determines what methods of adjustment of the speed setpoint are to be allowed.

None–no biasing of the speed setpoint is used.
Raise/Lower–raise and lower setpoint adjustment commands are used. Must configure raise and lower discrete I/O points to provide this function (see Discrete I/O tab).
Analog–analog biasing of the speed setpoint is used.
Analog or Raise/Lower–a combination of raise/lower and analog biasing are used to adjust the speed setpoint. Must configure raise and lower discrete I/O points to provide this function (see Discrete I/O tab).

Analog Input Selection

Configures the analog input to the AUX hardware input. A 'normal' input is scaled such that 0 V input provides the minimum speed setting and a 5 V input corresponds to the maximum setting as defined by the Bias Limit or Low/High Limit settings. An 'inverted input' selection is available to reverse the direction, resulting in a 5 V minimum and a 0 V maximum speed setpoint command.

Max Analog Rate

Specifies the maximum ramping rates allowed for the speed setpoint Analog adjust function. Only displayed if Analog is configured.

Allowed values: 1–1000 rpm/s

NOTE
It is recommended the Max Analog Rate setting be set to a value that will prevent overshoot and possible overspeed on enabling of the Remote Input.

Lower Rate

Specifies the ramping rate for the speed setpoint Lower function. Only displayed if the Raise/Lower function is configured.

Allowed values: 1–1000 rpm/s

Raise Rate

Specifies the ramping rate for the speed setpoint Raise function. Only displayed if the Raise/Lower function is configured.

Allowed values: 1–1000 rpm/s

Analog Operational Mode

Determines how the analog input range will be applied to the speed setpoint.

Load Share / Sync Operation–biasing is based on a percentage band around the speed setpoint (±10%).
Remote Speed Setpoint–biasing values are set to a specific speed range (1000 to 2000 rpm).

Bias Limit

Specifies the maximum desired speed band possible, as a percentage of Rated, possible with the Raise/Lower Adjust or Analog functions.

Allowed values: 0–100% of speed setpoint

Low Limit
Specifies the lowest desired speed setpoint possible with the Raise/Lower Adjust or Analog functions.

Allowed values: From zero rpm to the 'High Limit'.

High Limit
Specifies the highest desired speed setpoint possible with the Raise/Lower Adjust or Analog functions.

Allowed values: From the 'Low Limit' up to 4000 rpm.

NOTE
Due to a limitation of the Aux1 analog input, the Low Limit may need to be set to a value about 3% below the desired minimum speed setting when using AUX1. Aux 2–4 do not exhibit this limitation.

Fuel Limiting Tab

The fuel limiting tab provides run time and boost fuel limiting configuration settings.

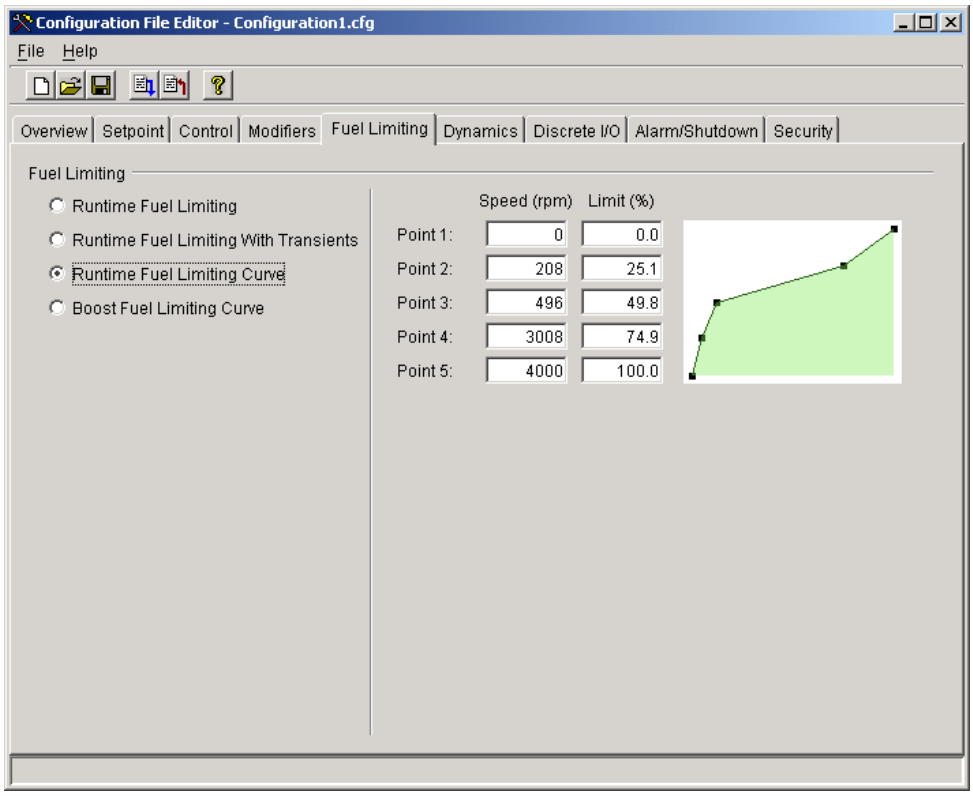

Figure 6-6. Configuration Editor—Fuel Limiting Tab

Fuel Limiting Settings

Mode
Determines the runtime fuel limiting mode.

Runtime Fuel Limiting–a max actuator position will be used to limit commanded fuel position.
Runtime Fuel Limiting with Transients–a steady-state and a transient fuel limit will be used.
Runtime Fuel Limiting Curve–a speed-based curve will be used to determine the fuel limit percentage.
Boost Fuel Limiting Curve–a speed-based curve will be used to determine the fuel limit percentage.

Maximum Fuel Limit
Sets the maximum permitted shaft position. Only displayed if the mode is set to either Runtime Fuel Limiting or Boost Fuel Limiting Curve.

Allowed values: 0–100%

Steady State Fuel Limit
Sets the maximum permitted actuator commanded position during steady state conditions. Only displayed if the mode is set to Runtime Fuel Limiting with Transients.

Allowed values: 0–100%

Transient Fuel Limit
Sets the maximum actuator position during a transient where the fuel demand is above the Steady State Fuel Limit. Only displayed if the mode is set to Runtime Fuel Limiting with Transients.

Allowed values: 0–100%

Transient Fuel Limit Time
Determines the length of time the Transient Fuel Limit will be applied during a transient. Only displayed if the mode is set to Runtime Fuel Limiting with Transients.

Allowed values: 0–400 s

Speed (rpm)
Allowed values: Each point [5] must be larger than the previous and less than the next value, in increments of 16 rpm.

Limit (%)
Sets the maximum actuator positions [5] based on the current speed.

Allowed values: 0–100%

NOTE
If the Boost or Runtime fuel limiting curve inputs are changed, control power must be cycled before the changes will take effect.

Boost Fuel Limiting Curve Settings

These settings are only displayed if the fuel limiting mode is set to Boost Fuel Limiting Curve.

Analog Input
Configures the boost/map analog input to the AUX hardware input. A 'normal' input is scaled such that 0 V input provides a 0% boost signal and a 5 V input corresponds to a 100% boost signal. An 'inverted input' selection is available to reverse the direction, resulting in a 5 V minimum and a 0 V maximum boost input signal.

If Aux1 input is used, the input can be configured as either 0–5 V or ±3 V. If configured as ±3 V, replace 0 V by –3 V and 5 V by +3 V in the above discussion.

Input Type
Only displayed if the Input is selected as 'Aux1'. Set to either 0–5 V or ±3 V.

Boost (%)
Allowed values: Each point [5] must be larger than the previous and less than the next value, in increments of 1.2 percent.

Limit (%)
Sets the maximum actuator positions [5] based on the boost analog input.

Allowed values: 0–100%

Dynamics Tab

The dynamics tab provides speed control dynamics settings. The dynamic settings can also be adjusted from the Edit Speed Dynamics screen during run-time.

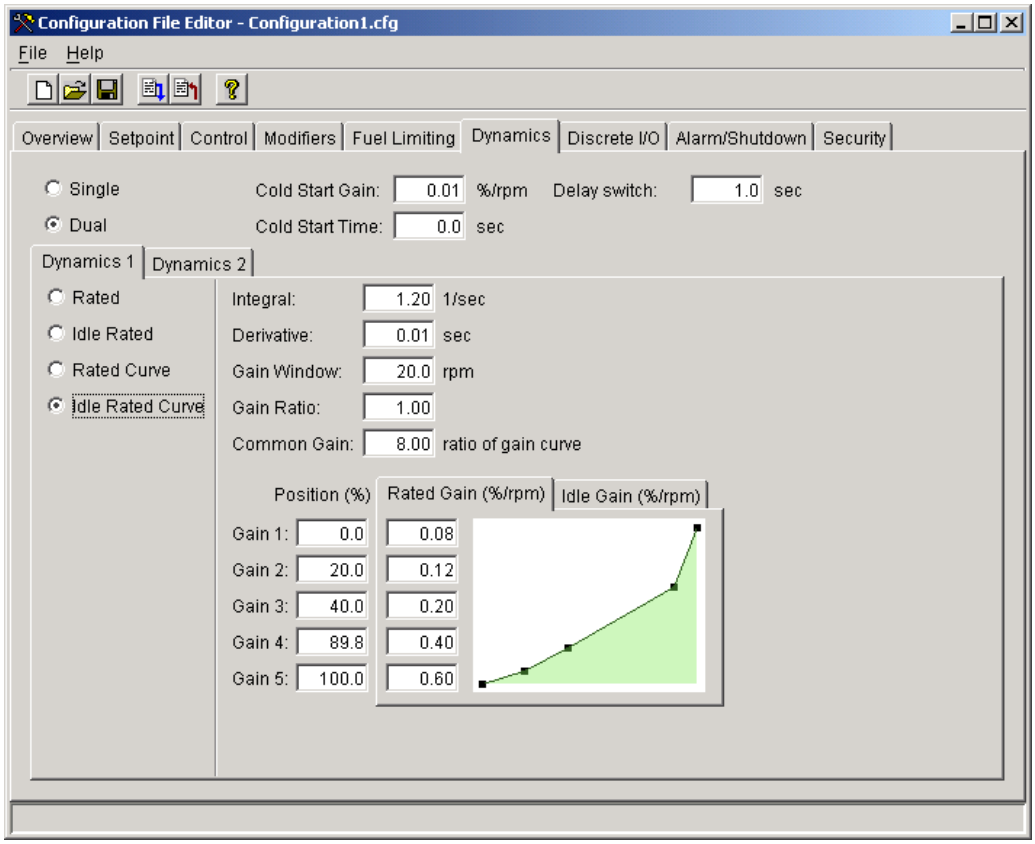

Figure 6-7. Configuration Editor—Dynamics Tab

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Dynamics Settings

Overall Mode

Set to Single or Dual dynamics. If 'Dual' is selected, must configure a Dual Dynamics discrete input to provide this function (see Discrete I/O tab).

Cold Start Gain

Sets the gain to be used during a start. Typically this is set to a lower than normal gain value. To disable the Cold Start Gain, set the Cold Start Gain Timer to zero.

Allowed values: 0–0.778 %/rpm

Cold Start Gain Timer

Sets the number of seconds the Cold Start Gain is used during a start. To disable the Cold Start Gain, set the Timer to zero.

Allowed values: 0–300 s

Delay switch (between Dyn 1 and Dyn 2)

The delay, in seconds, before the dynamics actually changes to the selected set (either from dynamics 1 to dynamics 2 or vice versa).

Allowed values: 0–425 s

Mode (Dynamics 1 and 2)
Sets the functional mode for the P-gain term of the PID. This can be individually set for both sets of dynamics, if used.

Rated–a single speed gain term is used which remains constant and does not vary with engine speed or load. These are simple dynamics that suit most constant speed applications. Rated dynamics are typically used on engines that operate continuously at rated speed or on variable speed engines that tend to be stable at all speeds with constant dynamic settings.

Idle Rated–the gain term will be changed linearly between Idle and Rated speed. Idle gain applies when operating at idle speed. Rated gain applies when operating at rated speed. The gain varies linearly between the two settings at intermediate speeds and is limited by the idle and rated gain setting at speeds below idle and above rated. Idle/Rated dynamics are useful for variable speed engines that tend to be less stable at idle speed with optimum rated speed dynamic settings. Must configure an Idle/Rated discrete input to provide this function (see Discrete I/O tab).

Rated Curve–the gain term will be adjusted based on actuator position using a 5-pt curve. Fuel demand is roughly proportional to load but not necessarily in a linear manner. A 5-breakpoint gain curve is provided to map gain versus fuel demand. Gain is applied linearly between breakpoints. A common gain setting is also provided to shift all gain curve gains higher or lower. This gain curve is particularly useful for non-linear fuel systems (for example, intake butterfly valves).

Idle Rated Curve–the gain will be adjusted using both by actuator position and speed. Must configure an Idle/Rated discrete input to provide this function (see Discrete I/O tab).

NOTE
Selection of Dynamics 2 curve options is only allowed if Dynamics 1 is also set to a curve option.

Integral
Speed control PID integral term in repeats per second.

Allowed values: 0–19.16 repeats/s

Derivative
Speed control PID derivative term in seconds.

Allowed values: 0–1.66 s

Gain Window
Speed control PID gain window, in rpm. When the speed error is greater than the window, the Gain is multiplied by the Gain Ratio.

Allowed values: 0–255 rpm

Gain Ratio
Speed control PID gain ratio. When the speed error is greater than the window, the Gain is multiplied by the Gain Ratio. To disable the dual gain window, set the Gain Ratio to 1.

Allowed values: 1–15

Position (%)
Position breakpoints for the gain curve.

Allowed values: Each point [5] must be larger than the previous and less than the next value, in increments of 0.4 percent. Range: 0–100%

Gain (%/rpm)
Sets the gain value [5] based on the position.

Allowed values: 0–0.778 %/rpm

Common Gain
Speed control PID common gain. This setting is a multiplier on the entire gain curve settings. A Common Gain setting of 1 provides no bias.

Allowed values: 0–8

Discrete I/O Tab

The Discrete I/O tab provides discrete input and discrete output configuration settings.

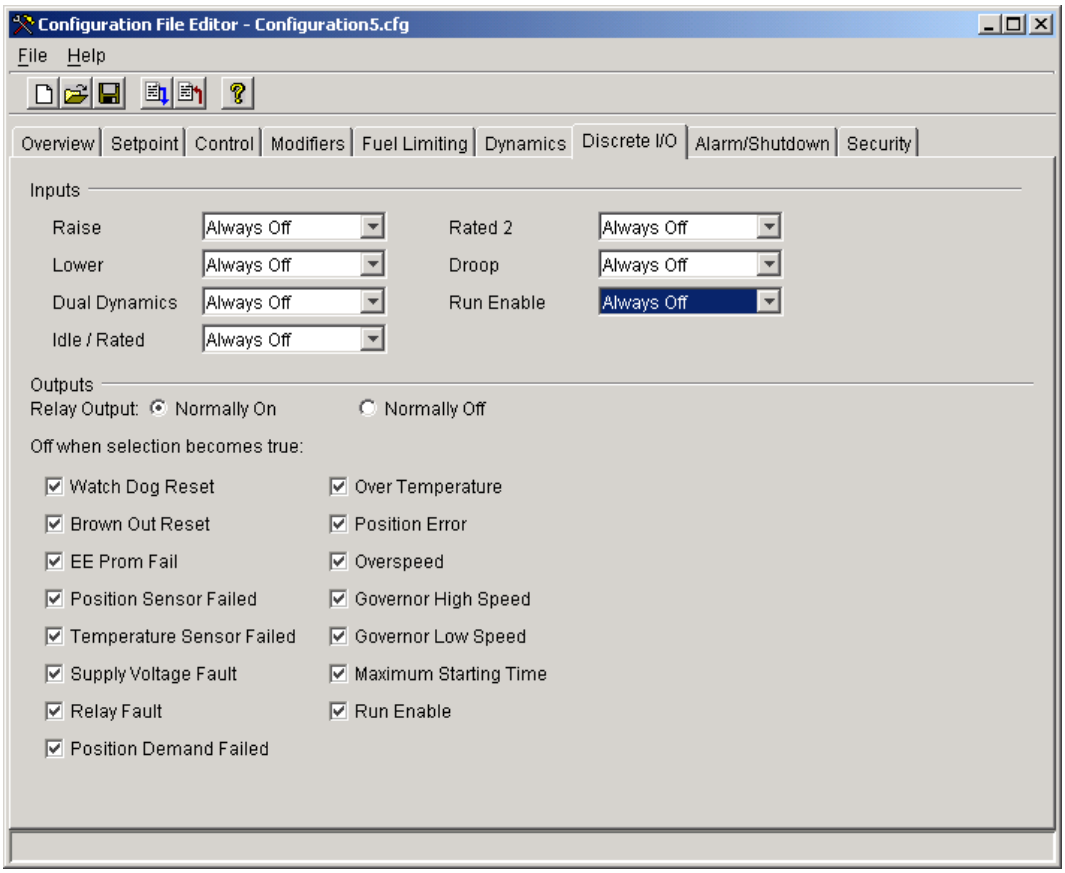

Figure 6-8. Configuration Editor—Discrete I/O Tab

Input Configurations

This section facilitates the mapping of the control functions to the desired Aux input. Options include:

- Always Off
- Aux1 (active closed)
- Aux2 (active closed)
- Aux3 (active closed)
- Aux4 (active closed)
- Aux1 (active open)
- Aux2 (active open)
- Aux3 (active open)
- Aux4 (active open)
- Always On

Any unused function is typically turned off by selecting ‘Always Off’, the exception to this is the Run Enable which requires an ‘Always On’ selection or the control will never run.

Selecting ‘Active Closed’ for a function will activate a function whenever the aux input voltage is above the ON threshold (refer to the Specifications section for On and Off thresholds). Likewise, selecting ‘Active Open‘ will activate the function when the aux input is below the OFF threshold. An “Active Closed’ setting is recommended.

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Input Configuration Settings

Raise
Select the desired input for this function.

Lower
Select the desired input for this function.

Dual Dynamics
Select the desired input for this function.

Idle / Rated
Select the desired input for this function.

Rated 2
Select the desired input for this function.

Droop
Select the desired input for this function.

Run Enable
Select the desired input for this function.

WARNING
It is recommended that all inputs be configured for the failsafe 'Active Closed' mode, to ensure maximum fault protection.

Output Settings

Relay Output Configuration
The relay output can be configured to one of the following:

Normally On–Sets the relay driver to a normally on mode that turns off for any of the faults selected. This is the preferred, failsafe output configuration.

Normally Off–Sets the relay driver to a normally off mode that turns on for any of the faults selected.

WARNING
It is recommended that the Relay Output be configured for the failsafe 'Normally On' mode, to ensure maximum fault protection and annunciation. Failure to follow these guidelines could, under exceptional circumstances, lead to personal injury and/or property damage.

Relay Output Fault Selections
The list of faults displayed can be individually selected to activate the relay output. Any of the selected faults will either turn the output off if configured for Normally On or turn the output on if configured for Normally Off.

WARNING
It is recommended that all faults be configured to activate the discrete output, this ensures maximum fault annunciation.

Alarm / Shutdown Tab

The Alarm/Shutdown tab provides alarm and shutdown configuration settings.

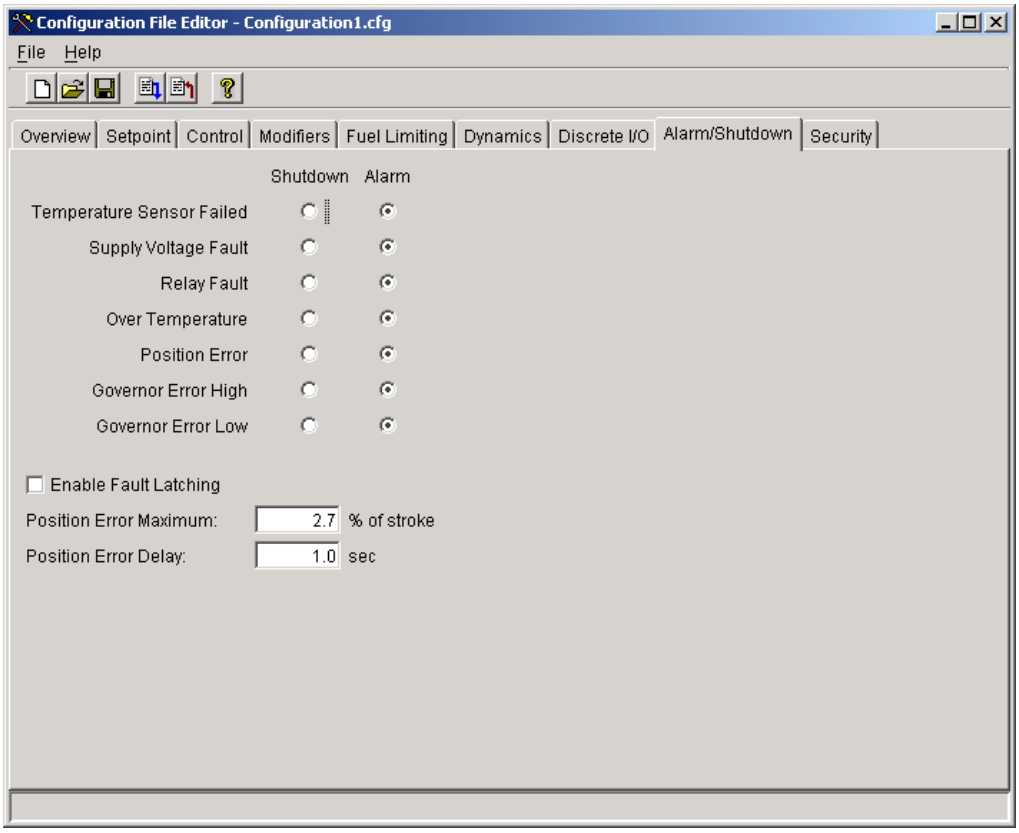

Figure 6-9. Configuration Editor— Alarm/Shutdown Tab

Alarm / Shutdown Fault Settings

Fault Selection (Shutdown or Alarm)

Set the desired action for each of the faults from the list. Setting the selection to a Shutdown will position the output to the configured Fault Direction (see Overview tab). Setting the selection to an Alarm will allow the unit to attempt to continue running. For details on each of these fault conditions, refer to the Fault section in the manual (Chapter 4).

- Temperature Sensor Failed
- Supply Voltage Fault
- Relay Fault
- Over Temperature
- Position Error
- Governor Error High Speed
- Governor Error Low Speed

The following conditions are dedicated shutdown conditions.

- EE Prom Fail
- Position Sensor Failed
- Overspeed
- Max Starting Time
- Loss of Speed Input
- Run Enable

The following conditions are dedicated alarm conditions.

- Watch Dog Reset
- Brown Out Reset

WARNING

It is recommended that all faults be configured as shutdowns and selecting 'Enable Fault Latching', this ensures maximum fault protection and prevent erratic on/off fault behavior.

Enable Fault Latching
Set to either latching (checked) or non-latching. When set to latching, a reset command or a power cycle must be issued to clear the fault. When non-latching is configured, as the fault condition goes away the control will be ready for operation. The fault log will indicate any faults that have occurred and subsequently cleared.

Position Error Maximum
Sets the magnitude of the position error fault.

Allowed values: 0–100% of stroke

Position Error Delay
Sets the delay that the position error must persist before indicating a position error fault.

Allowed values: 0–10 s

Security Tab

The security tab provides the security configuration settings. To use any security, the Read Configuration security must be configured for use. Once selected, the Security Password must be set (Figure 6-11). One common password is used for all security selections. The password entry is prompted (Figure 6-12) whenever a secured function is selected by the user.

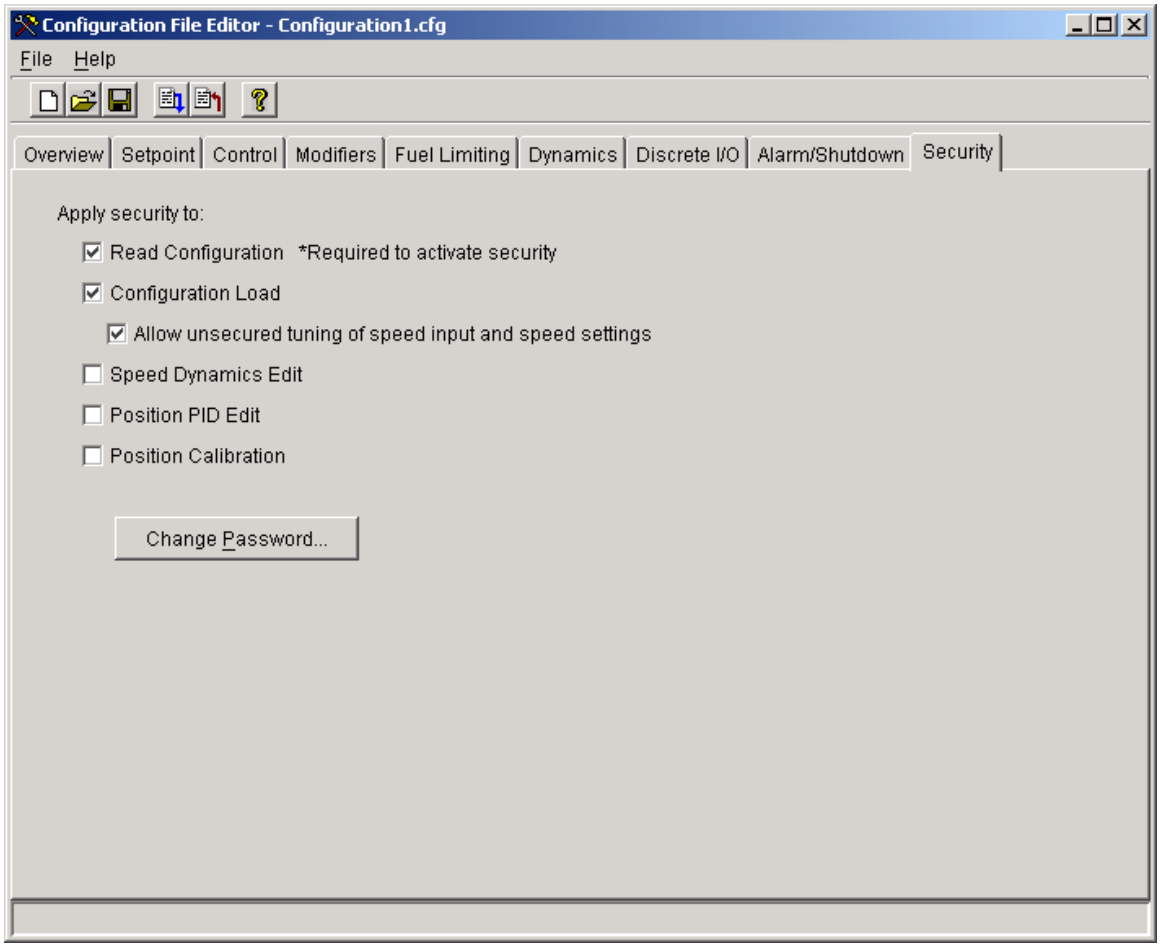

Figure 6-10. Configuration Editor—Security Tab

Security Configurations

All checked features will have the security password enforced prior to allowing the function. Unchecked features will not be prompted with a password.

Read Configuration

When checked, requires a password before the configuration can be read from the L-Series control (protects Open From Control execution).

This is the minimum level of protection and is required in order to use any other security option.

Configuration Load

When checked, requires a password before a configuration can be loaded into the L-Series control (protects Load to Control execution).

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Allow unsecured tuning of speed input and speed settings
When checked, allows password-free access to speed and speed setpoint adjustments from the Edit Speed Settings menu item. To use this feature, the Configuration Load security option must be selected.

Speed Dynamics Edit
When checked, requires a password before allowing tuning to the speed PID (protects Edit Speed Dynamics screen).

Position PID Edit
When checked, requires a password before allowing tuning to the position PID (protects Edit Position PID screen).

Position Calibration
When checked, requires a password before the position calibration mode can be entered (protects Manual and Automatic Position Calibration screens).

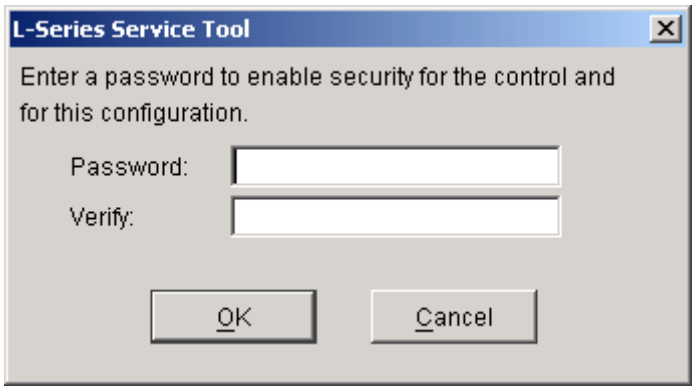

Figure 6-11. Security Tab Set Password Pop-up

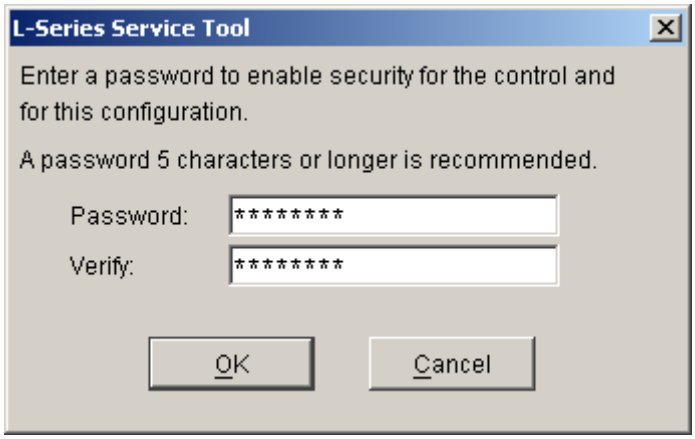

Figure 6-12. Password Entry Prompt

Loading the Configuration (Save)

Select the File/'Load to Control' option from the menu or Blue Arrow icon on the Configuration Editor to load the changes into the control. The L-Series speed must be zero prior to allowing a 'Load' command. This feature can be optionally password protected.

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Configuration Checks

Whenever a configuration is saved or loaded to the control, some basic checks are performed. This check cannot determine is the values are realistic, but it makes sure that values are loaded into the required parameters. If an error is found, the Service Tool will not allow the load or save function to be performed until the error is corrected. Warnings are displayed for the purpose of configuration confirmation, but they will not inhibit the save or load function.

Configuration Errors

1. **Speed Setpoint has not been selected**–A speed setpoint mode must be configured prior to use. See Setpoint tab.
2. **Speed Input has not been configured**–The speed settings must be configured prior to use. See Speed Input section on Overview tab, specifically check the 2 Stroke or 4 Stroke selection.
3. **Improperly configured speed settings (Overspeed setting, Number of Cylinders, or Stroke)**–The speed settings have been configured beyond the sensing limits of the L-Series input capability. This only affects speed inputs configured as ignition. See the Control (for overspeed threshold) and Overview (for speed settings) tabs.
4. **Overspeed threshold must be greater than idle setpoint**–A properly set speed configuration is detected. The Overspeed Threshold must be set to a level higher than the Idle speed setpoint. See the Setpoint and Control tabs.
5. **Overspeed threshold must be greater than rated setpoint**–A properly set speed configuration is detected. The Overspeed Threshold must be set to a level higher than the Rated speed setpoint. See the Setpoint and Control tabs.
6. **Overspeed threshold must be greater than rated 1 setpoint**–A properly set speed configuration is detected. The Overspeed Threshold must be set to a level higher than the Rated1 speed setpoint. See the Setpoint and Control tabs.
7. **Overspeed threshold must be greater than rated 2 setpoint**–A properly set speed configuration is detected. The Overspeed Threshold must be set to a level higher than the Rated2 speed setpoint. See the Setpoint and Control tabs.
8. **Rated setpoint must be greater than the idle setpoint**–A properly set speed configuration is detected. The Rated speed setpoint must be set to a level higher than the Idle speed setpoint. See the Setpoint and Control tabs.
9. **Rated 1 setpoint must be greater than the idle setpoint**–A properly set speed configuration is detected. The Rated1 speed setpoint must be set to a level higher than the Idle speed setpoint. See the Setpoint tab.
10. **Rated 2 setpoint must be greater than the idle setpoint**–A properly set speed configuration is detected. The Rated2 speed setpoint must be set to a level higher than the Idle speed setpoint. See the Setpoint tab.
11. **Password must be set when security is enabled**–To use security, a password must be selected. See Security tab.
12. **Configured Run-Enable discrete in as Always Off**–The Run Enable discrete input cannot be Always Off or the unit will never run. See the Discrete I/O tab.
13. **When dynamics 2 is set to rated-curve mode, dynamics 1 must be in rated-curve or idle-rated-curve mode**–An incompatibility between the Dynamics modes has been detected. To use the Rated curve dynamics option for dynamics 2, the Rated curve or Idle/Rated curve option must be selected for dynamics 1. See the Dynamics tab.

14. **When dynamics 2 is set to idle-rated-curve mode, dynamics 1 must be in idle-rated-curve mode**–An incompatibility between the Dynamics modes has been detected. To use the Idle/Rated curve dynamics option for dynamics 2, the Idle/Rated curve option must also be selected for dynamics 1. See the Dynamics tab.
15. **Configured Dual Dynamics but no Dual-Dynamics discrete in**–An incompatibility between the Dynamics mode and Dual Dynamics discrete input is detected. To use the Idle/Rated dynamics option, the Dual Dynamics discrete input cannot be Always Off. See the Dynamics and Discrete I/O tabs.
16. **Configured Idle/Rated Dynamics but no Idle/Rated discrete in**–An incompatibility between the Dynamics mode and Idle/Rated discrete input is detected. To use the Idle/Rated dynamics option, the Idle/Rated discrete input cannot be Always Off. See the Dynamics and Discrete I/O tabs.
17. **Configured Idle/Rated Dynamics Curve but no Idle/Rated discrete in**–An incompatibility between the Dynamics mode and Idle/Rated discrete input is detected. To use the Idle/Rated curve dynamics option, the Idle/Rated discrete input cannot be Always Off. See the Dynamics and Discrete I/O tabs.
18. **Configured Idle/Rated Speed Setpoint but no Idle/Rated discrete in**–An incompatibility between the Speed setpoint mode and Idle/Rated discrete input is detected. To use the Idle/Rated option, the Idle/Rated discrete input cannot be Always Off. See the Setpoint and Discrete I/O tabs.
19. **Configured Rated1/Rated2 Speed Setpoint but no Rated2 discrete in**–An incompatibility between the Speed setpoint mode and Rated2 discrete input is detected. To use the Rated1/Rated2 option, the Rated2 discrete input cannot be Always Off. See the Setpoint and Discrete I/O tabs.
20. **Configured Idle/Rated1/Rated2 Speed Setpoint but no Idle/Rated discrete in**–An incompatibility between the Speed setpoint mode and Rated2 discrete input is detected. To use the Idle/Rated1/Rated2 option, the Rated2 discrete input cannot be Always Off. See the Setpoint and Discrete I/O tabs.
21. **Configured Idle/Rated1/Rated2 Speed Setpoint but no Rated2 discrete in**–An incompatibility between the Speed setpoint mode and Rated2 discrete input is detected. To use the Idle/Rated1/Rated2 option, the Rated2 discrete input cannot be Always Off. See the Setpoint and Discrete I/O tabs.
22. **Configured Droop Digital Input but no Droop discrete in**–An incompatibility between the Droop mode and Droop discrete input is detected. To use the Droop Discrete input option, the Droop discrete input cannot be Always Off or Always On. See the Modifiers and Discrete I/O tabs.
23. **Configured Raise/Lower Bias but no Raise discrete in**–An incompatibility between the Speed setpoint and Raise Speed discrete input is detected. To use the Speed Setpt Raise/Lower, the Raise discrete input cannot be Always Off or Always On. See the Setpoint and Discrete I/O tabs.
24. **Configured Raise/Lower Bias but no Lower discrete in**–An incompatibility between the Speed setpoint and Lower Speed discrete input is detected. To use the Speed Setpt Raise/Lower, the Lower discrete input cannot be Always Off or Always On. See the Setpoint and Discrete I/O tabs.
25. **Configured Analog or Raise/Lower Bias but no Raise discrete in**–An incompatibility between the Speed setpoint and Raise Speed discrete input is detected. To use the Speed Setpt Analog or Raise/Lower option, the Raise discrete input cannot be Always Off or Always On. See the Setpoint and Discrete I/O tabs.
26. **Configured Analog or Raise/Lower Bias but no Lower discrete in**–An incompatibility between the Speed setpoint and Lower Speed discrete input is detected. To use the Speed Setpt Analog or Raise/Lower option, the Lower discrete input cannot be Always Off or Always On. See the Setpoint and Discrete I/O tabs.

27. **Rated Speed Setpoint mode selected and Idle Rated Dynamics selected**–An incompatibility between the Speed setpoint and Speed Dynamics is detected. See the Setpoint and Dynamics tabs.
28. **Rated Speed Setpoint mode selected and Idle Rated Curve Dynamics selected**–An incompatibility between the Speed setpoint and Speed Dynamics is detected. See the Setpoint and Dynamics tabs.
29. **Startup Select Rated 1/2 mode selected and Idle Rated Dynamics selected**–An incompatibility between the Speed setpoint and Speed Dynamics is detected. See the Setpoint and Dynamics tabs.
30. **Startup Select Rated 1/2 mode selected and Idle Rated Curve Dynamics selected**–An incompatibility between the Speed setpoint and Speed Dynamics is detected. See the Setpoint and Dynamics tabs.
31. **Runtime Select Rated 1/2 Mode selected and Idle Rated Dynamics selected**–An incompatibility between the Speed setpoint and Speed Dynamics is detected. See the Setpoint and Dynamics tabs.
32. **Runtime Select Rated 1/2 Mode selected and Idle Rated Curve Dynamics selected**–An incompatibility between the Speed setpoint and Speed Dynamics is detected. See the Setpoint and Dynamics tabs.

Configuration Warnings

1. **Multiple functions configured for Aux1 input**–This indication is provided to make sure the Aux1 input was configured as expected.
2. **Multiple functions configured for Aux2 input**–This indication is provided to make sure the Aux2 input was configured as expected.
3. **Multiple functions configured for Aux3 input**–This indication is provided to make sure the Aux3 input was configured as expected.
4. **Multiple functions configured for Aux4 input**–This indication is provided to make sure the Aux4 input was configured as expected.

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Chapter 7.
Setup and Tuning

Introduction

The L-Series is configured using the Service Tool, refer to Chapter 5 for Service Tool installation and connection instructions. This chapter covers the process of tuning and servicing the control via the L-Series Service Tool. It is assumed that the control has already been installed on the engine.

An application requires the following setup steps. In many applications these steps have already been performed by the OEM.

- Configure the L-Series control (configuration is covered in Chapter 6).
- Tune the Speed control loop PID.

The following optional features are also available:

- Calibrate the Position Feedback range.
- Verify Position feedback calibration.
- Tune the Position control loop PID. For most applications, the default gains do not need to be changed.
- Modify speed and speed setpoint settings.

NOTE
Setup and tuning features can be individually password protected for security purposes. If security is applied, these features will not be accessible without the password.

NOTE
Many applications are delivered pre-configured, calibrated, and tuned. For most applications, the default gains do not need to be changed. Min Position and Fail Direction should be checked.

CAUTION
An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

Tuning the Speed PID

The Service Tool can be used to tune the Speed PID or to just trend/monitor the speed PID output. The Speed PID Dynamics screen (Figure 7-1) is opened by selecting ‘Edit Speed Dynamics’ under the ‘Tools’ menu.

Pressing the Properties button pops open the Properties Window. From this window the user can adjust the trending window properties including the speed range, update rate and display range.

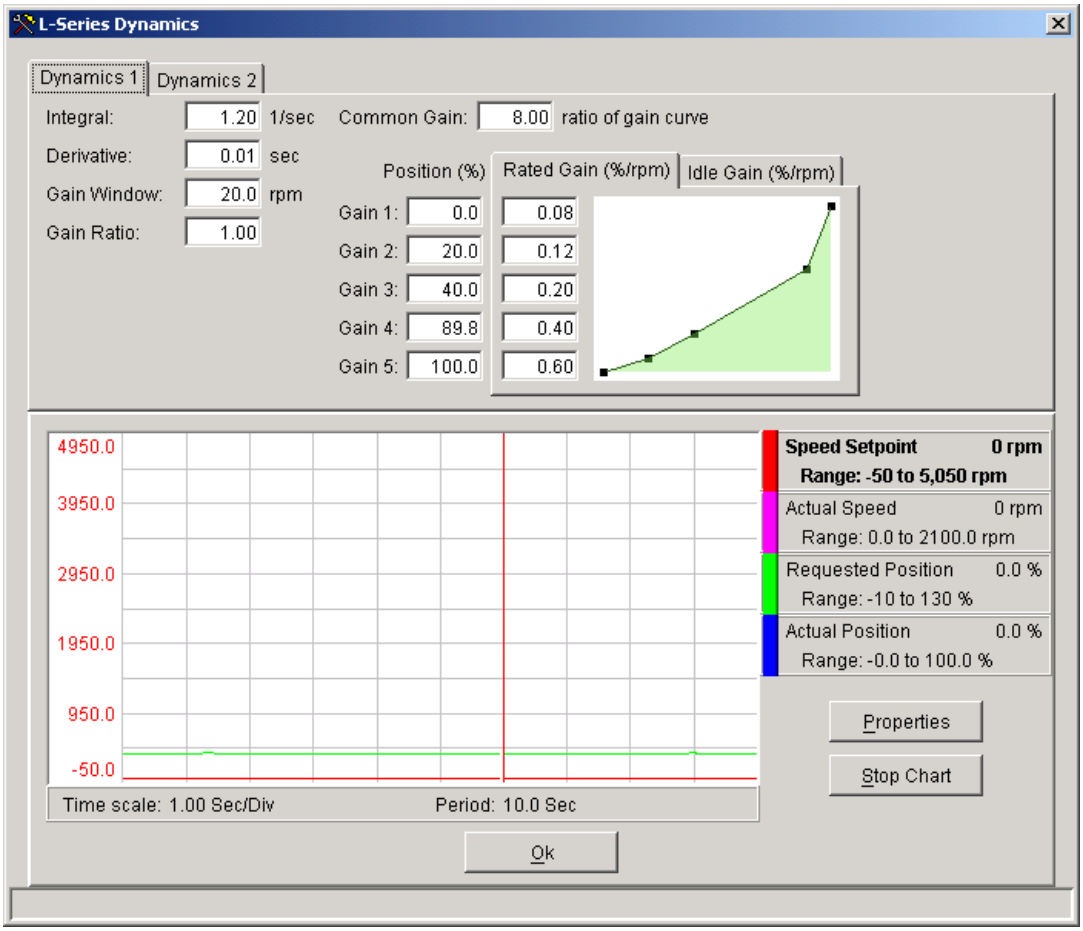

Figure 7-1. Service Tool–Speed Dynamics

Editing of Speed Settings

If configured, a window (Figure 7-2) is selectable under that Tools menu that allows editing of various speed settings. The settings in this window are a subset of the complete configuration and are not password protected. When this feature is used, the complete configuration is typically password protected.

The settings in this window can only be changed while connected to the control (on-line) and when the engine is stopped (speed is zero). This option is only available if the 'Allow unsecured tuning of speed input and speed settings' is selected on the Security tab in the Configuration Editor.

For details on the parameters that appear in this window, refer to Chapter 6.

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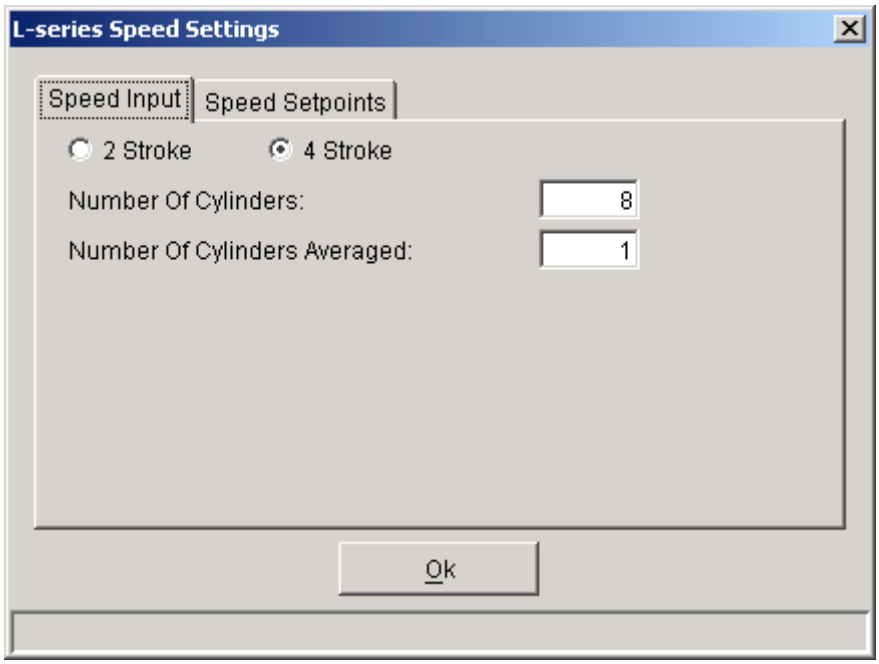

Figure 7-2. Speed Input Window

Tuning the Position PID

The Position PID tuning screen (Figure 7-3) is opened by selecting 'Edit Position PID' from the 'Tools' menu. The Service Tool can be used to tune the Position PID or to just trend/monitor the position PID output. In addition, the L-Series control can be put into a manual control mode from this screen by selecting the "Enable Manual Position Tuning' checkbox. Once in manual mode, the position setpoint box is highlighted and the value displayed is actively positioning the output. Use this command to create step changes for the PID and monitor the response using the displayed trend.

Pressing the Properties button pops open the Properties Window (Figure 7-4). From this window the user can adjust the trending window properties including the update rate and display range.

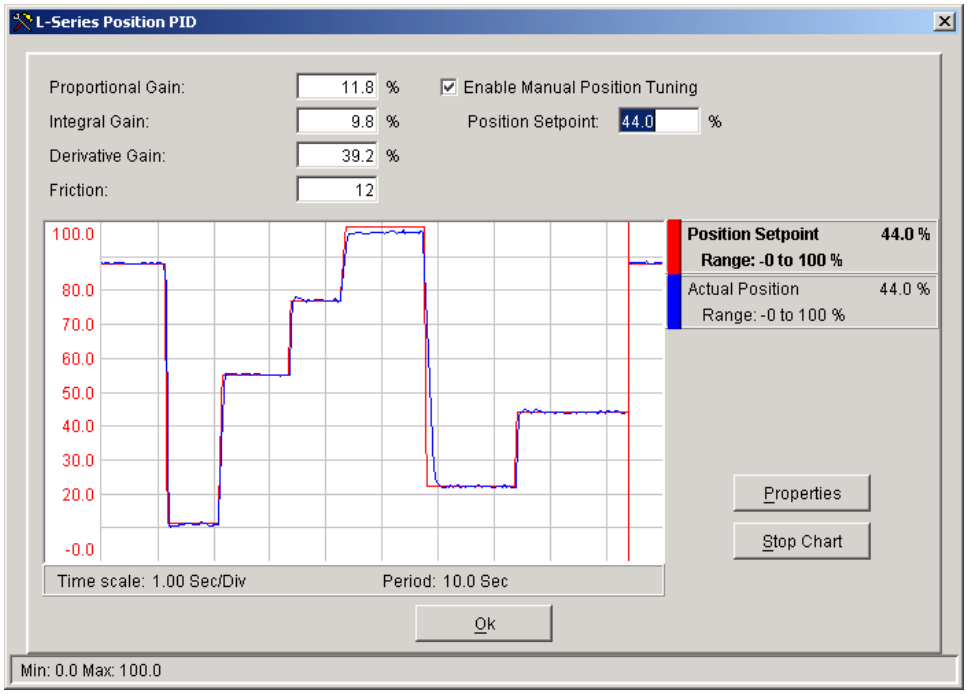

Figure 7-3. Service Tool–PID Tuning Window

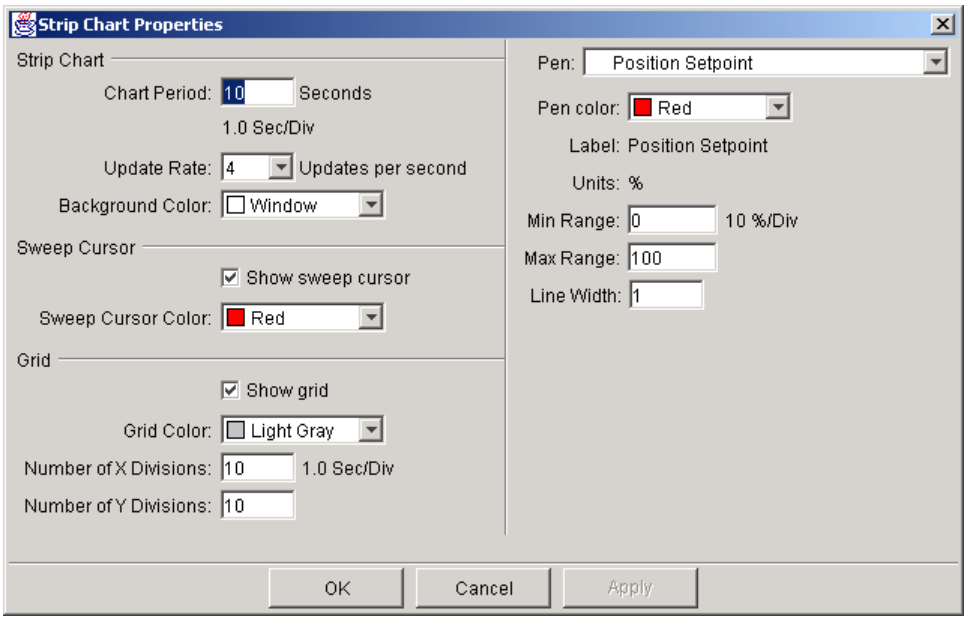

Figure 7-4. Service Tool–PID Tuning Properties Window

Position Calibration and Verification

Position calibration is available to map the position command input to the actual rotational travel of the unit. It is only used when the full travel of the actuator is constrained or limited such that 0 to 60 degrees of travel is not used. For example, an application-specific position calibration could map 0–100% position command to 10–40 degrees actual rotation.

There are two methods available to perform a position calibration: Automatic or Manual. If the application has hard stops that correspond to the actual min/max travel, then either Auto or Manual methods can be used—although auto is easier. If hard stops are not available, then the auto method will give invalid results and the manual method must be followed.

The Service Tool can be used to calibrate the control to end user stops (physical or soft) or to verify the position calibration. To get to the Position Calibration screens select the desired function from Position Calibration under the Tools menu selection.

NOTE
Position Calibration is only used when the full travel of the actuator is constrained or limited such that 0 to 60 degrees of travel is not used.

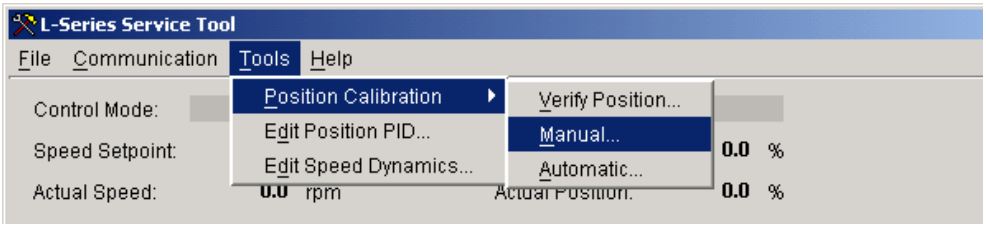

Figure 7-5. Service Tool–Manual Position Calibration selection

Calibration Sequence Overview

The following outlines the basic steps required to execute the position calibration.

Automatic Mode
1. Select Automatic Position Calibration Mode.
2. Select CW or CCW Direction.
3. L-Series automatically rotates in both CW and CCW directions until the stops are detected. The values are then captured and stored.
4. When completed, cycle the power on the L-Series.
5. It is recommended that a Position Verification be performed to confirm the calibration is correct. See Position Verification below.

Manual
1. Determine the rotational travel limits. This can be done by positioning the unit to the minimum and maximum positions and recording the position settings.
2. Select Manual Position Calibration Mode.
3. Select Direction.
4. Enter the pre-determined rotational travel limits values.
5. When completed, cycle the power on the L-Series.
6. It is recommended that a Position Verification be performed to confirm the calibration is correct. See Position Verification below.

Position Verification

The Position Verification screen (Figure 7-6) is opened by selecting 'Verify Position' from the 'Position Calibration' drop-down under the 'Tools' menu. When the Verify Position screen is entered, the control is put into position control and the position is set to the position the control was at when the screen was entered. The screen displays the "User" Requested Position, Actual Position, Minimum Position, and Maximum Position. These User Positions are calculated from the user-calibrated stops.

The Full Travel Actual Position is the full stroke factory position without user stops after software linearization. The Full Travel Sensor Position is the full stroke factory position without user stops before software linearization. The Full Travel Sensor Position will match the TPS Output Signal.

The Verify Position screen can be used to check the calibration or to get the minimum and maximum position values for the manual calibration. If the Enable Requested Position Tuning box is checked the valve can be positioned anywhere from 0 to 100% of the user minimum and maximum stops by entering a value into the Requested Position. If the Enable Requested Position Tuning box is unchecked the valve will go limp and can be physical positioned by hand.

NOTE
If the full factory position calibration range is not being used (the Manual or Automatic Calibration has been performed) and the minimum position direction is changed, the calibration must be run again for the Verify Position mode to work correctly.

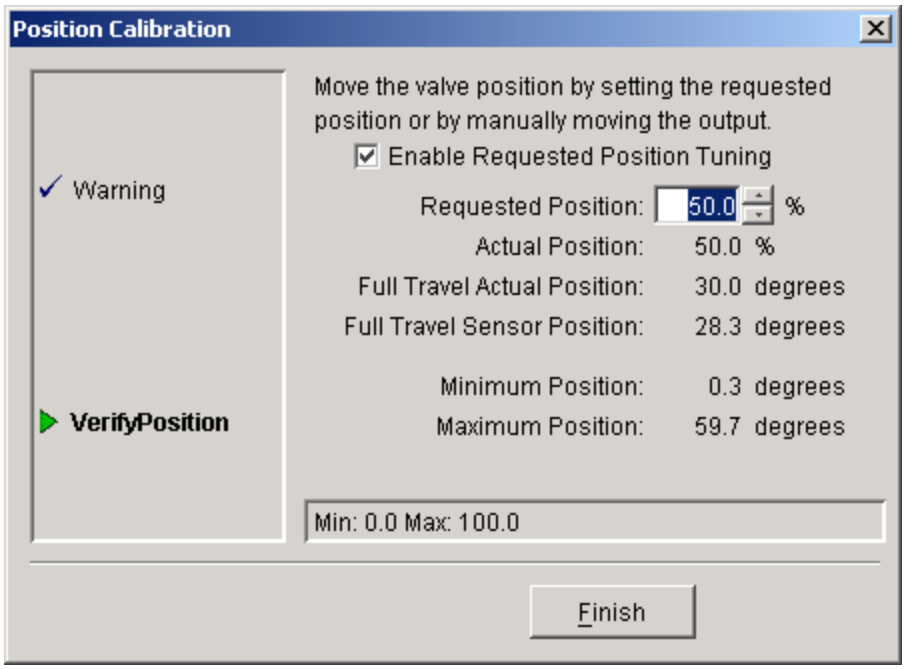

Figure 7-6. Service Tool—Verify Position Calibration

Manual

The Manual position calibration screen (figure 7-7) is opened by selecting 'Manual' from the 'Position Calibration' drop-down under the 'Tools' menu. The manual calibration mode is used to set the minimum position and fail direction and to calibrate the valve to user soft stops (inside of any physical stops). The first screen to appear when entering the manual mode is used to set the minimum position and fail direction. This setting must be correct before manually calibrating the valve.

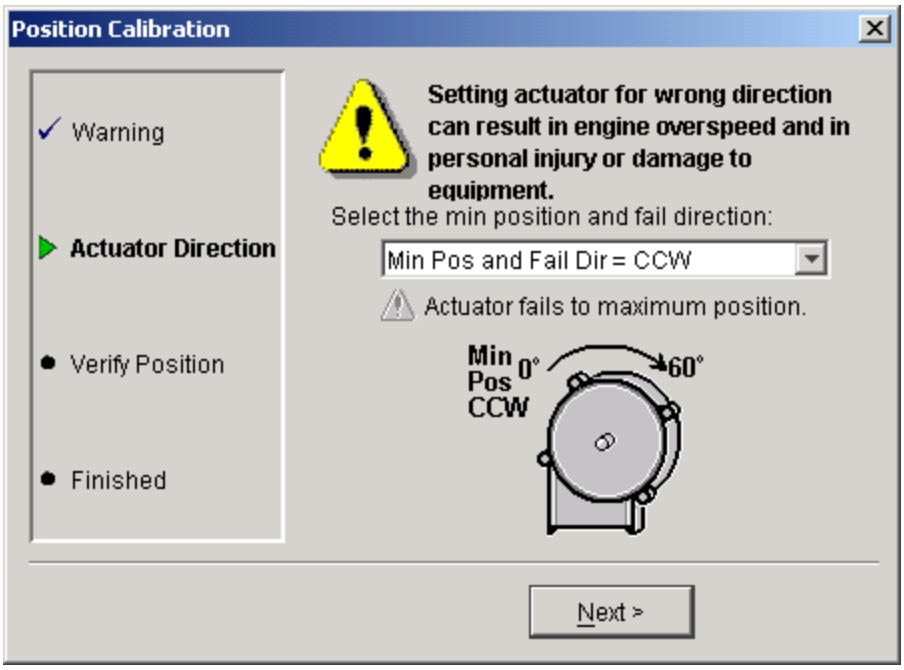

Figure 7-7. Service Tool—Manual Position Calibration

The next screen is used to set the minimum and maximum positions for the user soft stops. To find the minimum and maximum soft stops use the verify position mode described above to position the valve and use the Full Travel Actual Position reading for minimum and maximum position values.

NOTE
After leaving this mode, power must be cycled for the new settings to take effect.

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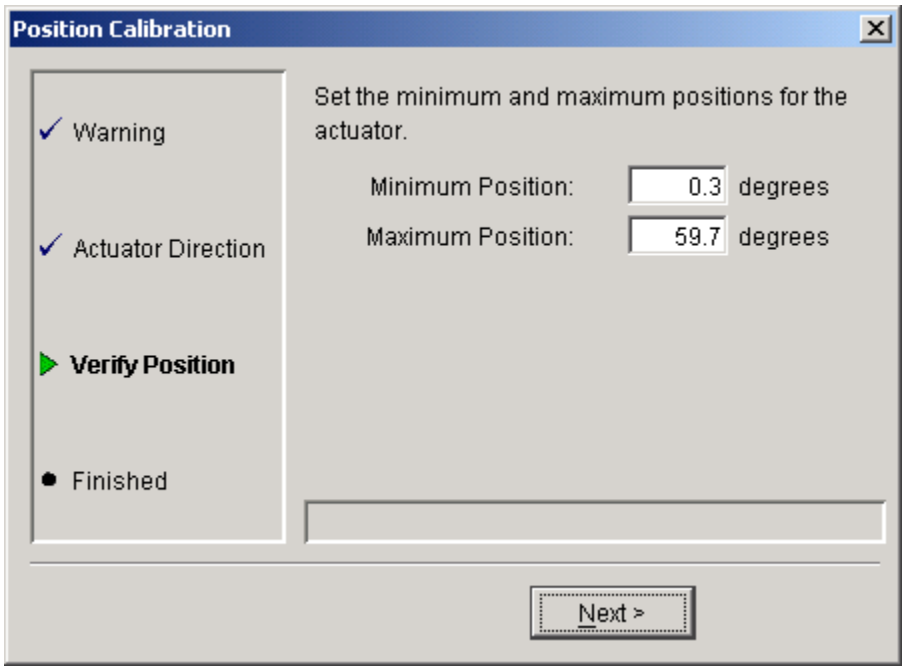

Figure 7-8. Service Tool—Manual Position Calibration Settings

Automatic

The Automatic position calibration screen (Figure 7-9) is opened by selecting 'Automatic' from the 'Position Calibration' drop-down under the 'Tools' menu. The automatic calibration mode is used to set the minimum position and fail direction and to calibrate the valve to user physical stops (mechanical hard stops). Like the manual mode, the first screen to appear is used to set the minimum position and fail direction. This setting must be correct before automatic calibration is performed.

After setting minimum position and fail direction the screen below will appear. The control is now moving first to the CCW stop and then to the CW stop to get the physical minimum and maximum positions.

NOTE
After leaving this mode, power must be cycled for the new settings to take effect.

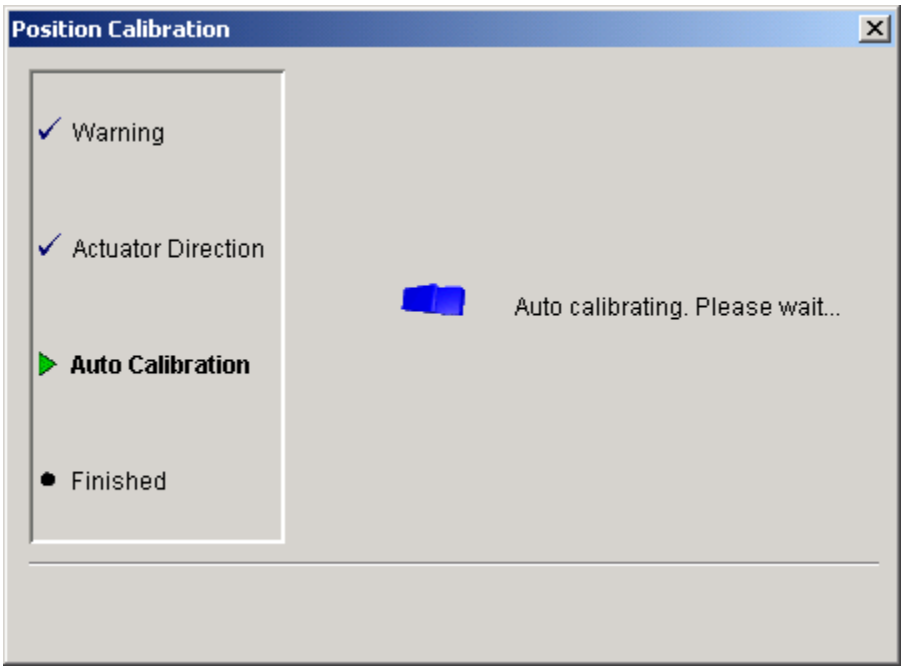

Figure 7-9. Service Tool–Auto Position Calibration

Chapter 8. Troubleshooting

Introduction

This chapter presents several broad categories of application failures typically experienced in the field, possible causes, and some tests used to verify the causes. Because the exact failure experienced in the field is the product of the mechanical/electrical failure combined with the configuration file resident in the control, it is left as the OEM's responsibility to create a more detailed troubleshooting chart for the end user. Ideally, this end-user troubleshooting chart will contain information about mechanical, electrical, engine, and load failures in addition to the possible governor failures. For more detailed information about governor system failure modes and effects, contact Woodward for a copy of the system DFMEA.

The troubleshooting scenarios listed below assume that the end user has a digital multimeter at his disposal for testing voltages and checking continuity, and assume that the application has been engineered and tested thoroughly.

There are four parts to the troubleshooting section:

- General Troubleshooting
- Engine/Generator Troubleshooting
- Troubleshooting Alarm/Shutdown Diagnostic Flags
- Input/Output (I/O)Troubleshooting

WARNINGS

The actions described in this troubleshooting section are not always appropriate in every situation. Always make sure that any action taken will not result in loss of equipment, personal injury, or loss of life.

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

The L-Series is used on prime movers that typically have a high noise level. Always use appropriate hearing protection while working around the L-Series.

The L-Series wiring must be in accordance with North American Class I, Division 2 or Zone 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

General System Troubleshooting Guide

The following is a general troubleshooting guide for areas to check which may present potential difficulties. By making these checks appropriate to your engine/turbine before contacting Woodward for technical assistance, your system problems can be more quickly and accurately assessed.

- Is the wiring correct?
- Is the direction of the stroke correct?
- Is the direction of the failsafe shutdown correct?
- Does the valve move through its proper stroke smoothly?
- Does the valve travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the valve fully seat (close)?
- Does the valve fully open?

Engine/Generator Troubleshooting

Problem	Possible Cause	Suggested Test/Correction
Engine does not start	Stuck throttle/frozen shaft	Move throttle by hand. Assess smoothness, friction, and return spring force.
	Power not applied to control	Disconnect starter motor solenoid. Disconnect harness from governor. Test for +12/24 V between +12/24 V pin and ground pin.
	Run Enable not closed	Verify status of input. Measure input. Verify input and configuration using Service Tool.
	Incorrect configuration in control.	Using Service Tool, read configuration from control and evaluate parameters for correction.
	Fault detected in control.	Using Service Tool, read faults from control. Verify/correct any shutdown conditions.
	MPU gap too large	Remove and reinstall MPU per OEM's instructions. Rotate engine manually to check for interference.
	MPU signal connection open	Disconnect harness from governor. Test for at least 1 Vrms between MPU+ pin and MPU– pin while the flywheel is spinning.
	Ignition signal connection open	Disconnect harness from governor. Test for bouncing voltage between IGN pin and ground pin while the engine is starting/firing.

Problem	Possible Cause	Suggested Test/Correction
The actuator is not opening the fuel control valve during engine cranking.	The control is configured for the wrong opening direction.	Check CW/CCW min fuel direction configuration.
	The Run Enable input is not enabled. See overview screen on service tool.	Make sure the run enable input is made active. Check wiring.
	The control has detected a shutdown situation and has not been reset.	Reset the control by cycling power to the control, hitting reset on the Service Tool, or toggling the run enable switch.
	There is no power supplied to the control.	Check fuse, wiring, and battery voltage.
	The control does not read any speed. Speed sensor defect, wiring defect, or incorrect speed sensor installation.	Fix or replace speed sensor, fix wiring or install speed sensor correctly according to the speed sensor manual.
	The control reads an actual engine speed below the start speed threshold.	Start speed is set too high. Lower start speed threshold.
	The Start fuel 1 and or 2 setup is incorrectly set.	Set up the Start Fuel to the correct value for this engine.
The engine overspeeds on start-up.	An overshoot in speed is caused by an excessive speed setpoint acceleration.	Acceleration ramp rate is set too high.
	The overspeed trip level is configured incorrectly.	Verify the overspeed trip setting configuration.
	Incorrect speed input configuration.	Verify the input speed configuration settings (number of teeth). Check the sensed speed compared to an external engine speed indicator.
	Gains not set properly for transients	If overspeed occurs on transient, raise common gain to reduce overshoot.
	Start Fuel Limit not set properly	Lower rpm run threshold or lower start fuel position.
	Speed sensing error	Follow instructions for MPU or ignition signal intermittent under Speed Sensor Error.
Engine starts, but shuts down on error	Speed sensing error	Follow instructions for MPU or ignition signal intermittent under Speed Sensor Error.
	Error detected by control.	Verify the exact cause of the error using the Service Tool.
Incorrect mode of operation (speed, speed bias function, dynamics)	AUX inputs shorted or open	Disconnect starter motor solenoid. Disconnect harness from governor. Check for correct voltage level between AUX pin(s) under question and ground pin for known application modes.

Problem	Possible Cause	Suggested Test/Correction
The engine will not go to rated speed.	The Idle Rated input wiring is defective. See overview screen for input position.	Check wiring.
	The high, low, and active open or closed selection for the Idle Rated input is selected incorrectly.	Set up the correct input modes.
	The Control is not configured for Idle Rated operation.	Configure the Control for Idle Rated operation if that is the desired operation mode.
The engine will not go to idle speed.	The Idle Rated input wiring is defective. See overview screen for input position.	Check wiring.
	The high, low, and active open or closed selection for the Idle Rated input is selected incorrectly.	Set up the correct input modes.
	The Control is not configured for Idle Rated operation.	Configure the Control for Idle Rated operation if that is the correct operation mode.
The engine will not raise the speed setpoint.	The Raise input wiring is defective. See overview screen for input position.	Check wiring.
	The high, low, and active open or closed selection for the Raise input is selected incorrectly.	Set up the correct input modes.
	The Control is not configured for Raise Lower operation.	Configure the Control for Raise Lower operation or Raise Lower and Analog if that is the correct operation mode.
	The Lower input is also active and the Analog Raise Lower is configured.	Set up the lower input to the correct state. The engine will not lower the speed setpoint.
	The lower is active and only Raise Lower is selected. The Control will lower the speed if Raise and Lower are selected at the same time.	Set up the lower input to the correct state. The engine will not lower the speed setpoint.
The engine will not lower the speed setpoint.	The Lower input wiring is defective. See overview screen for input position.	Check wiring.
	The high, low, and active open or closed selection for the Raise input is selected incorrectly.	Set up the correct input modes.
	The Control is not configured for Raise lower operation.	Configure the Control for Raise Lower operation or raise lower and analog if that is the desired operational mode.
	The Raise input is also active and the analog Raise Lower is configured. The control is in analog mode.	Set the lower input to the correct state. The engine will not lower the speed setpoint.

Problem	Possible Cause	Suggested Test/Correction
Engine unstable	Improperly tuned speed or position PID dynamics.	Using Service Tool, tune the position dynamics. In most cases the default dynamics are appropriate. Using Service Tool, tune the speed dynamics.
	Intermittent or incorrect speed signal.	Verify speed signal shielding recommendations (chapter 3) have been followed. Verify speed input is wired correctly. Ignition and MPU cannot be wired simultaneously.
	Dual dynamics discrete input shorted or open	Disconnect starter motor solenoid. Activate application. Check for correct voltage level between dual dynamics AUX pin and ground pin for known application mode.
Poor frequency control	Improperly tuned dynamics.	Using Service Tool, tune the speed control dynamics.
	Improperly tuned dynamics.	Using Service Tool, tune the position dynamics. In most cases the default dynamics are appropriate.
	Friction improperly set.	Using Service Tool, adjust the Friction setting.
Unable to develop full power	Non-indexed linkage slipped on shaft. Fault detected in control. Shorted/bad MAP sensor signal	Manually verify full travel of throttle plate. Using Service Tool, view status of fault codes. Take appropriate action for active faults. If using MAP fuel limiting, disconnect starter motor solenoid. Verify the input voltage matches expected voltage for known atmospheric conditions.
Discrete output not working	Wiring fault.	Check the wiring leading to pin 9 for open connections or misconnections. Verify that pin 9 is not connected directly to input power or ground.
	Configuration.	Using the Service Tool, verify that the faults and shutdowns are selected properly and that the output is configured for expected operation (either normally “on” or normally “off”).
Service Tool not communicating–‘Not Connected’ status indicated	Wiring fault. The Service tool is disconnected. The wrong communication port has been selected.	Check AUX3 and AUX4 for loose or misconnected connections. Verify harness setup and connections (see Chapter 4). Check that Service Tool is running. Verify the port setting is correct. Check fuse, wiring, and battery voltage. Connect the service tool by using the connect menu.

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Problem	Possible Cause	Suggested Test/Correction
Service Tool not communicating–'Error message displayed on PC when trying to connect	Old version of Service Tool or file corruption or bad install.	Re-install Service Tool, get the latest version from the Woodward web site (www.woodward.com/software)
Service Tool will not accept password	Cap Lock is on.	Password is case sensitive, make sure you enter the password correctly using upper and lower case. If password is lost contact the OEM for retrieval.

Troubleshooting Diagnostic Fault Flags

Error Flag	Description	Possible Source	Possible Action
Supply Voltage Failure	The power supply voltage is higher than the diagnostic limits. The Power supply voltage is lower than the diagnostic limits.	Bad or damaged battery. Defective battery charging system. Incorrect setting of power supply voltage level. Power supply wiring to long or to thin. Control will flag low voltage during higher power uses.	Replace battery. Fix battery charging system. Set correct voltage levels on power supply. Make sure wiring is of the correct thickness and length according to manual.
Temperature Sense Failed	This error is set if the temperature inside the control is higher or lower than allowed by the specifications.	Control has been placed in an environment that is too hot or too cold. The internal temperature sensor is defective. This can be determined by checking the temperature of the unit and comparing this to the service tool value of the electronics temperature.	Lower temperature by adding cooling, heat shielding, moving the unit, etc. Increase temperature by adding heat. Return unit to Woodward for repair.
Governor High Speed	This error is set if the actual speed if higher than the speed setpoint plus a configured limit for longer than the configured time.	The actuator is not capable of closing the fuel control valve (max torque). The fuel control valve is jammed or stuck. The actuator is setup incorrectly. Zero percent position will not completely close the fuel valve. The linkage is moved or disconnected. The engine is not responding correctly. The detection margins are set too low. The detection time is set up too short. A normal load transient will trigger this error.	Check the torque needed to close the fuel valve against the available torque. Fix or replace valve. Run the position setup wizard to set up the actuator correctly. 0% will close fuel valve. Fix or replace linkage. Check with the engine troubleshooting manual. Set the margins to an acceptable level. Set the detection time to an acceptable level.

Error Flag	Description	Possible Source	Possible Action
Governor Low Speed	This error is set if the actual speed if lower than the speed setpoint minus a configured limit for longer than the configured time.	The actuator is not capable of opening the fuel control valve (max torque).	Check the torque needed to open the fuel valve against the available torque.
		The fuel control valve is jammed or stuck.	Fix or replace valve.
		The actuator is set up incorrectly. 100% position will not completely open the fuel valve.	Run the position setup wizard to set up the actuator correctly. 100% will open fuel valve.
		The linkage is moved or disconnected.	Fix or replace linkage.
		The engine is not responding correctly.	Review the engine troubleshooting manual.
		The fuel supply to the engine is restricted.	Open restriction in fuel supply, check filters.
		The load on the engine is too high.	Reduce load on the engine to an acceptable limit for this engine.
		The detection margins are set too low.	Set the margins to an acceptable level.
		The detection time is set up too short. A normal load transient will trigger this error.	Set the detection time to an acceptable level.
Max Starting Time	The max staring time error will be set if the engine is not above run speed within a configured amount of time.	Start fuel is set to low. Engine will not reach run speed.	Set start fuel limit to a level where the engine will reach run speed or lower run speed if a possible.
		Low temperature of engine will not start engine at start fuel selected.	Select two start fuels with ramp to ramp to more or less fuel during the engine start.
		Engine is defective and will not start.	Check with the engine troubleshooting manual.

Error Flag	Description	Possible Source	Possible Action
Overspeed	This diagnostic flag will be set if the actual engine speed is higher than the overspeed threshold.	The overspeed parameter has not been set. Factory default is zero rpm.	Set the correct overspeed value.
		Engine dynamics are set up too slow for a sudden load reject.	Increase the gains, decrease gain window, or increase gain ratio.
		The actuator is not capable of closing the fuel control valve (max torque).	Check the torque needed to close the fuel valve against the available torque.
		The fuel control valve is jammed or stuck.	Fix or replace valve.
		The actuator is set up incorrectly. Zero percent position will not completely close the fuel valve.	Run the position setup wizard to set up the actuator correctly. 0% will close fuel valve.
		The linkage is moved or disconnected.	Fix or replace linkage.
		The engine is not responding correctly.	Check with the engine troubleshooting manual.
Speed Sensor Failed	This diagnostic flag will be set if the speed input pulses have not been detected.	Damaged, loss of speed or wiring.	Fix wiring or replace.
			Verify speed signal shielding recommendations (chapter 3) have been followed.
			Verify speed input is wired correctly. Ignition and MPU cannot be wired simultaneously.
		Damaged connector.	Fix connector or replace.
		Incorrect installation of speed sensor.	Correct the speed sensor installation. See speed sensor installation manual.
		Incorrect configuration of speed sensor.	Verify configuration settings.
		Missing pulses on speed gear.	Make sure speed gear wheel is not missing any teeth.
		MPU gap too large	Remove and reinstall MPU per OEM's instructions. Rotate engine manually to check for interference.
		MPU signal connection open	Disconnect harness from governor. Test for at least 1 Vrms between MPU+ pin and MPU– pin while the flywheel is spinning.
		Ignition signal connection open	Disconnect harness from governor. Test for bouncing voltage between IGN pin and ground pin while the engine is starting/firing.

Error Flag	Description	Possible Source	Possible Action
Position Error	Indicates demanded position and the actual position are outside the configured limits.	Incorrect position control dynamics or friction setting. Binding or excessive friction in the actuator linkage, or stops are set inside the desired range of travel.	Check/tune position dynamics using the Service Tool. Perform a position calibration. Check all mechanical linkages and stops. Verify Configuration errors settings.
Position Sensor Failure	If the internal position sensor is outside the diagnostic limits.	Internal failure of position sensor.	Return unit to Woodward.
Internal Shutdown	All internal shutdowns will set this flag.	The Control is defective.	Return unit to Woodward.
EEPROM Failure	The software can't write to the EEPROM. The software can't read from the EEPROM.	The Control is defective.	Return unit to Woodward.
Brown Out Reset	The power up reset flag will be set every time power to the Control has been lost and is restored.	Normal power up of the Control. Loss of power or intermittent power supply wiring. Power supply wiring to long or to thin. ISC will reset during transient power uses.	No action needed. Possibly reset control. Check wiring for bad or lost connection. Make sure wiring is of the correct thickness and length according to manual.
Watchdog Reset	The watchdog has reset the Control.	After software update, the software watchdog will reset the Control. The software is disrupted by EMI or an internal component failure.	This is a normal situation. Reset the error code and reset the stored errors. This is an abnormal situation. Return the unit to Woodward.
Overtemperature	High internal temperature.	Detection of high of temperature.	Check ambient temperature around Control. Verify temperature reading using service tool. If the temperatures seem normal, could indicate a problem with the temperature sensor.
Relay Fail Short	Control detected a fault in the discrete out wiring.	Incorrect or intermittent wiring problem.	Check wiring for bad or lost connection.
Run Enable Shutdown	Control detected that the Run Enable discrete in is not active.	Incorrect or intermittent wiring problem. Incorrect configuration.	Check wiring for bad or lost connection. Verify configuration. Check Run Enable setting, verify proper Active Open or Active Closed setting.

Electrical Troubleshooting Guide

MPU Speed Input

If the speed input is not functioning properly, verify the following:

- Measure the input voltage and frequency.
- Check the values seen by the L-Series driver using the Service Tool and verify that is matches the input signal.
- Check the wiring. Look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly.

Ignition Speed Input

If the speed input is not functioning properly, verify the following:

- Measure the input voltage and frequency.
- Check the values seen by the L-Series driver using the Service Tool and verify that is matches the input signal.
- Check the wiring. Look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly.

Analog Input

If an Analog Input is not functioning properly, verify the following:

- Measure the input voltage.
- Verify the input is properly configured.
- Check the values seen by the L-Series driver using the Service Tool and verify that it matches the input signal.
- Verify that there are no or minimal ac components to the Analog Input signal. AC components can be caused by improper shielding.
- Check the wiring. If the inputs are reading 0 or the engineering units correspond to 0 V, look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly as the Demand Source.

Discrete Input

If a discrete input is not functioning properly, verify the following:

- Measure the input voltage on the terminal block. It should be in the range of 10–28 Vdc.
- Check the status of the input from the Overview screen of the Service Tool.
- Check the wiring, looking for loose connections or misconnected cables.
- Verify the input is properly configured.

Alarm or Shutdown Conditions

If the L-Series control has any alarm or shutdown conditions, refer to Chapter 4 for details on the exact cause of the condition. The Service Tool must be used to determine the cause of any shutdown or alarm condition.

Discrete Output

If the discrete output is not functioning properly, verify the following:

- Measure the output voltage on the terminal block. It should be in the range of 10–28 Vdc when the output is off/false. The voltage will be in this range only if all shutdowns are false, assuming it is configured as Off for Fault. This can be verified through the Service Tool.
- Check the wiring, looking for loose connections or disconnected / misconnected cables.
- Verify the configuration of the output.

Service Tool

If the service tool is not functioning properly, review the installation information in Chapter 5. Verify the following:

- Check the wiring, looking for loose connections or disconnected / misconnected cables.
- Check that Service Tool is running. Verify the Port setting is correct.
- Follow on-screen error messages. Re-install software as needed. The latest version of software is available for download from the Woodward web site (www.woodward.com/software).

Chapter 8.
Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Replacement/Exchange

Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is also a flat rate structured program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Woodward facility as explained below (see “Returning Equipment for Repair” later in this chapter).

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]

Return Shipment Authorization Label. To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

Flat Rate Repair

Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture

Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the item(s), attach a tag with the following information:

- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

Return Authorization Number

When returning equipment to Woodward, please telephone and ask for the Customer Service Department [1 (800) 523-2831 in North America or +1 (970) 482-5811]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the item(s) to be repaired. No work can be started until a purchase order is received.

NOTE
We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at 1 (800) 523-2831 in North America or +1 (970) 482-5811 for instructions and for a Return Authorization Number.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

How to Contact Woodward

In North America use the following address when shipping or corresponding:

Woodward Governor Company
PO Box 1519
1000 East Drake Rd
Fort Collins CO 80522-1519, USA

Telephone—+1 (970) 482-5811 (24 hours a day)
Toll-free Phone (in North America)—1 (800) 523-2831
Fax—+1 (970) 498-3058

For assistance outside North America, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Facility	Phone Number
Brazil	+55 (19) 3708 4800
India	+91 (129) 230 7111
Japan	+81 (476) 93-4661
The Netherlands	+31 (23) 5661111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility.

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Contact information:

Telephone—+1 (970) 482-5811
Toll-free Phone (in North America)—1 (800) 523-2831
Email—icinfo@woodward.com
Website—**www.woodward.com**

Technical Support is available through our many worldwide locations or our authorized distributors, depending upon the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical support, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Technical Support***.

Product Training is available at many of our worldwide locations (standard classes). We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Product Training***.

Field Service engineering on-site support is available, depending on the product and location, from one of our many worldwide locations or from one of our authorized distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Technical Support***.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

General

Your Name_____
Site Location_____
Phone Number_____
Fax Number_____

Prime Mover Information

Engine/Turbine Model Number_____
Manufacturer_____
Number of Cylinders (if applicable)_____
Type of Fuel (gas, gaseous, steam, etc)_____
Rating_____
Application_____

Control/Governor Information

Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number _____

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number _____

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number _____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix A. Acronyms/Abbreviations

AUX	auxiliary
CRC	cyclic redundancy check
DFMEA	design failure modes and effects analysis
EEPROM	electrically-erasable programmable read-only memory
EMC	electro-magnetic compatibility
GUI	graphic user interface
I/O	inputs/outputs
IGN	ignition speed signal
Isoch	isochronous
ITB	integrated throttle body
L-Series	Woodward electronic engine governor that contains both a rotary actuator and a control circuit board
MPU	magnetic pick up
OEM	original equipment manufacturer
PWM	pulse-width modulated
rpm	revolutions per minute
RS-232	a communications standard
TPS	throttle position sensor

Appendix B.
L-Series Control Specifications

	Specifications
Power Supply	12/24 V systems (10–32 Vdc) reverse polarity protection, 2.5 A max
Power Consumption	32 W maximum
Torque	Nominal: 0.34 N·m (0.25 lb-ft) Minimum Transient (up to 105 °C): 0.28 N·m (0.21 lb-ft) Minimum Continuous (up to 105 °C): 0.20 N·m (0.15 lb-ft)
Mass/Weight	425 g (15 oz)
Power-Up to Operation Time	<250 ms
	Performance
Speed Control Accuracy	MPU Input: ±0.25% of rated speed on gasoline, diesel, or gaseous engines IGN Input: ±0.5% of rated speed on gasoline or gaseous engines
Transient Behavior	Gasoline: <10% at 100% load shed, <-10% at 100% load pick-up Gaseous: <10% at 100% load shed, <-10% at 100% load pick-up Diesel: <10% at 100% load shed, <-7% at 100% load pick-up ***NOTE**: The specifications above are for naturally aspirated engines. Turbo-diesel applications can vary in the amount of load that can be picked-up within these specifications. Contact Woodward or consult ISO3046-4 and/or ISO8528-5 with questions about turbo specifications.*
Recovery Time	3 seconds
	Environment
Ambient Operating Temperature	–40 to +105 °C (–40 to +221 °F)
Storage Temperature	–40 to +125 °C (–40 to +257 °F)
EMI/RFI	EN50081-1 (emissions) EN50082-2 (immunity)
Humidity	US MIL-STD 810E, Method 507.3, Procedure III
Salt Spray	US MIL-STD 810E, Method 509.3, Procedure I
Shock	MS1-40G 11 ms sawtooth
Random Vibration	Random: 0.3 G²/Hz, 10–2000 Hz (22.1 Grms) 3 h/axis Sine: 5 G 2.5 mm peak-to-peak, 5–2000 Hz, 3 h/axis, 90 min dwells, 1 octave/min
Drop	SAE J1211, Paragraph 4.8.3 (modified)
Thermal Shock	SAE J1455, Paragraph 4.1.3.2
Ingress Protection	IP56 per EN60529
Electrical Load Power Connection Electrical Transient	2 J per SAE J1455, Paragraph 4.11.2.2.1

Regulatory Compliance

European Compliance for CE Marking:
These listings are limited only to those units bearing the CE Marking.

EMC Directive:	Declared to 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility.

Other European Compliance:
Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking.

Machinery Directive: Compliance as a component with 98/37/EC COUNCIL DIRECTIVE of 23 July 1998 on the approximation of the laws of the Member States relating to machinery.

North American Compliance:
These listings are limited only to those units bearing the CSA agency identification.

CSA: CSA Certified for Class I, Division 2, Groups A, B, C & D, T3C at 105 °C Ambient for use in Canada and the United States.
Certificate #1380416

This product is certified as a component for use in other equipment. The final combination is subject to acceptance by CSA International (Or UL) or local inspection.

Reliability and Quality Goals

The L-Series control system has a reliability target of 17 500 hours MTBF. It also has a quality goal of less than 25 PPM when measuring out-of-the-box defects. This quality goal is a target based on continuous improvement.

AUX 1 Analog Input

Parameter	Value
Input Type	0–5 V or ±3V DC Input
Input Scaling	0 V = 0% and 5 V = 100% range in 0-5V mode. -3V = 0% and 3V = 100% range in ±3V mode.
Max Input (Full Scale)	5 V ± 1% or 3V ±1%
Min Input	0.1 V ± 1% of Full Scale or –2.88V ±1% of Full Scale
Isolation	None
3db Circuit Bandwidth	~10 kHz
Transient Protection	According to EMC norm
Input Impedance	300 kΩ in 0–5 V synchronizing mode 10 kΩ in 0–5 V remote speed set mode 10 kΩ in ±3 V synchronizing mode
Anti-Aliasing Filter	1 anti-aliasing pole at 1 ms (159 Hz)
Resolution	10 bits
Accuracy	±1.6% of full scale over the temperature range of –40 to +125 °C, including drift
I/O Latency	6.5 ms
Calibration Method	2-point linear software calibration
Out of Range Signal	none
Overvoltage Protection	Input protected against 32 Vdc steady state

AUX 2–4 Analog Input

Parameter	Value
Input Type	0–5 V, Single-Ended Input
Input Scaling	0 V = 0% and 5 V = 100% range
Max Input (Full Scale)	5 V ± 1%
Min Input	0 V ± 1% of Full Scale
Isolation	None
3db Circuit Bandwidth	~10 kHz
Transient Protection	According to EMC norm
Input Impedance	499 kΩ
Anti-Aliasing Filter	1 anti-aliasing pole at 0.01 ms (15.9 kHz)
Resolution	10 bits
Accuracy	±1.3% of full scale over the temperature range of –40 to +125 °C, including drift
I/O Latency	6.5 ms
Calibration Method	2-point linear software calibration
Out of Range Signal	none
Overvoltage Protection	Input protected against 32 Vdc steady state

MPU Input

Parameter	Value
Input Magnitude	1–42 Vrms
Frequency Range	1 Hz – 12 kHz
Isolation	None
Input Impedance	113 kΩ
Accuracy	±0.25% of point (controlled engine speed in rpm) over the temperature range of –40 to +125 °C, including drift for gasoline, diesel, and gaseous engines.
I/O Latency	6.5 ms
Out of Range Frequency	12 kHz is maximum sensed frequency. Out of range is determined by user–configured overspeed and start speed settings. See Chapter 6 for configuration.

IGN Input

Parameter	Value
Input Magnitude	–200 to +250 V Max. (–100 to +150 V Min.)
Frequency Range	1–480 Hz
Isolation	None
Input Impedance	44–113 kΩ
Accuracy	±0.5% of point (controlled engine speed in rpm), over the temperature range of –40 to +125 °C, including drift, for both gasoline and gaseous applications.
I/O Latency	6.5 ms
Out of Range Frequency	480 Hz. Max (will not sense above this) Out of range is determined by user–configured overspeed and start speed settings. See Chapter 6 for configuration.

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Discrete Input

Parameter	Value
Aux 1 Input Current	0.5 mA @ 5 Vdc
Aux 2,3,4 Input Current	10 µA @ 5 V
Input Type	Ground referenced discrete input
Delay Time for Shutdown	< 200 ms for system to recognize shutdown if used for run/stop input.
Delay Time for Reset Detection	< 1 s for valves to move to minimum position if used for run/stop input.
Max Voltage from + Connection	32 V (power input voltage)
Isolation	None, Intended for use with external relay or other dry contact
Input Threshold (AUX 1)	> 3.1 Vdc = “ON”; < 0.8 Vdc = “OFF”
Input Thresholds (AUX 2-4)	> 2 Vdc = “ON”; < 0.8 Vdc = “OFF”
Input Impedance	Aux 1: 10 kΩ; Aux 2,3,4: 499 kΩ

Discrete Output

Parameter	Value
Output Type	Low-side output driver
Max Contact Voltage (Open)	32 V
Max Current	0.5 A
Max Contact Voltage at 0.5 A (Closed)	1.5 V
Max Delay Time for Opening Contact	6.5 ms
Default at Power Up	Configurable in software
Error Condition	Configurable in software
OK Condition	Configurable in software
Driving Inductive Loads	Yes, internally protected low-side switch
Protection	Utilizes circuitry that will open the contact when output contacts are short-circuited. Self-resetting when fault is removed

TPS Output

Parameter	Value
Output Type	0–5 V, single-ended
Output Scaling	0.75 V = full CCW position and 4.25 V = full CW position
Isolation	None
3 db Circuit Bandwidth	100 Hz>—>130 Hz
Transient Protection	According to EMC norm
Output Impedance	2.8 kΩ (±1%)
Accuracy	±15% of full scale, @ 25 °C
Temperature Drift	±0.4% over the full temperature range
I/O Latency	6.5 ms
Calibration Method	Sensor-in-place factory calibration. 2-point linear
Out of Range Signal	< 0.25 V or > 4.75 V
Overvoltage Protection	Output protected against 32 Vdc, steady-state; if >28 V is applied to pin 2, a position-related error will be annunciated

RS-232 Serial Communication Service Port

Parameter	Value
Isolation	None
Baud Rate	Fixed 19.2 Kbaud
Electrical Interface	Outputs are TTL level. Requires external transceiver for conversion to RS-232 levels for proper communication !!
Pinout	Tx = pin 4, Rx = pin 6, Gnd = pin 3
Maximum Cable Length	10 m (33 ft), not meant for permanent connection (for service only)
Cable Type	Straight-through (no crossover)

Electronics Temperature Sensor

Parameter	Value
Accuracy	±2 °C at 25 °C ambient ±3 °C over full range (–40 to +125 °C)
I/O Latency	6.5 ms

Software Execution Rates

Software Routine	Nominal Software Execution Rate
Position Control Algorithms	1.9 ms
Speed Input & Control Algorithms	6.5 ms
Analog Input Logic	6.5 ms
Serial Port	background task
Discrete Inputs	6.5 ms
Discrete Output	6.5 ms
Diagnostics	6.5 ms

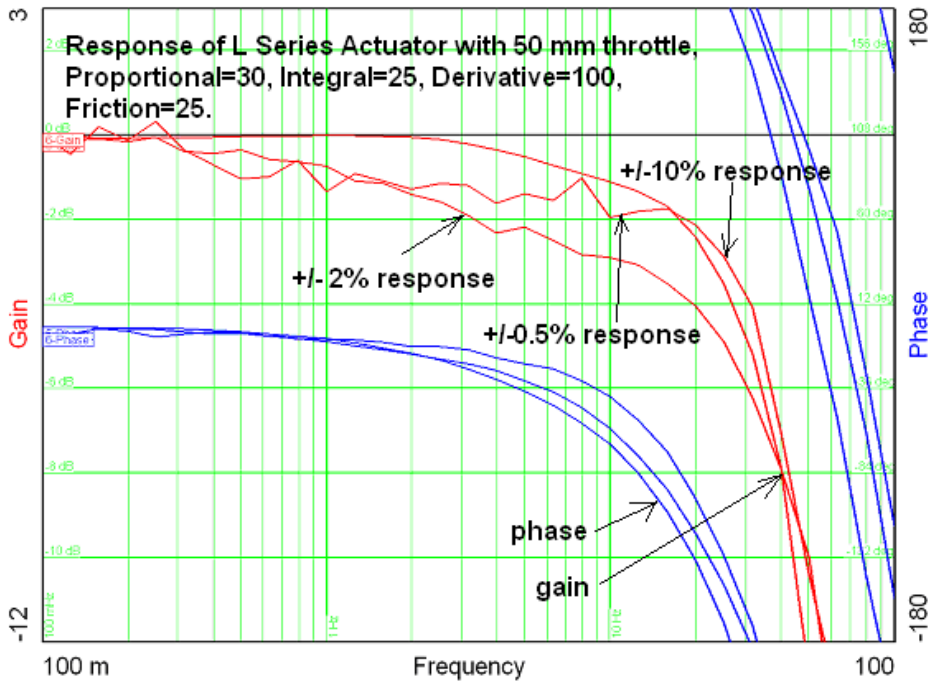


Figure B-1. Bode Plot of L-Series Response

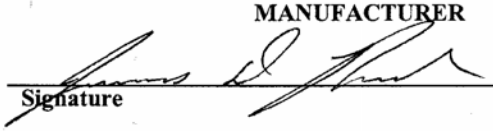
DECLARATION OF CONFORMITY

According to EN 45014

Manufacturer's Name:	WOODWARD GOVERNOR COMPANY (WGC) Industrial Controls Group
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525
Model Name(s)/Number(s):	L-Series Speed Controller 8404-1002
Conformance to Directive(s):	89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility
Applicable Standards:	EN 61000-6-4, 2001: EMC Part 6-4: Generic Standards – Emission for Industrial Environments EN 61000-6-2, 2001: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER



Signature

James D. Rudolph

Full Name

Engineering Manager

Position

WIC, Fort Collins, CO, USA

Place

1/15/04

Date

Declaration of Incorporation

Woodward Governor Company
1000 E. Drake Road
Fort Collins, Colorado 80525
United States of America

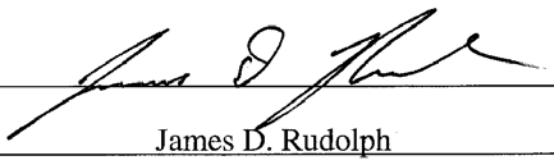
Product: L-Series Actuator
Part Number: 6300-1005 and similar

The undersigned hereby declares, on behalf of Woodward Governor Company of Loveland and Fort Collins, Colorado, that the above-referenced product is in conformity with the following EU Directives as they apply to a component:

98/37/EEC (Machinery)

This product is intended to be put into service only upon incorporation into an apparatus/system that itself will meet the requirements of the above Directives and bears the CE mark.

MANUFACTURER



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Place

11/13/07
Date

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04/9/F

WOODWARD

LCS ITB
LC-50

Installation, Programming, & Troubleshooting Manual for OEM/Dealer

Manual 26135D

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

IMPORTANT DEFINITIONS

WARNING—indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION—indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment.

NOTE—provides other helpful information that does not fall under the warning or caution categories.

Revisions—Text changes are indicated by a black line alongside the text.

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Chapter 1.
General Information

Purpose and Scope

The purpose of this manual is to provide OEMs with the necessary background information for applying the LCS ITB and LC-50 control to gas/gasoline reciprocating engines. Topics covered include mechanical installation, electrical wiring, software programming, and troubleshooting. While this manual is primarily targeted at OEM customers, OEMs themselves may find it useful to copy some of the information from this manual into their application user manuals.

Intended Applications

The LCS ITB and LC-50 controls are designed primarily for various industrial applications, including but not limited to generator sets, welders, portable refrigeration units, irrigation pumps, chipper shredders, and mobile industrial gas or gasoline reciprocating engines. Key environmental characteristics of these applications include industrial operating temperatures (–40 to +85 °C/–40 to +185 °F), European CE EMC requirements (10 V/m), minimal electrical transients (2 J load dump), and lower operating voltages (12 V) (must be fed from a Class 2 power source).

Introduction

The LCS ITB and LC-50 provide a building block approach to total engine management. The modular designs consist of a die-cast aluminum throttle body, a mixer, and a fully programmable integrated digital speed control and bi-directional actuator. The LCS ITB incorporates the Woodward LCS speed control with a throttle plate. The LC-50 adds a venturi style annular ring mixer to the LCS ITB. The units provide a number of speed setting, speed biasing, control, fuel limiting, diagnostic, and datalink functions. The controller is available in two versions, one for generator applications (G version) and one for industrial applications (I version).

A simplified block diagram of the control's functionality is shown in Figure 1-1. In most applications, the OEM will enable at least one function from each category of functions to create a valid control configuration. The functionality and characteristics of the control can be tailored using a laptop computer loaded with the Woodward Service Tool software.

The functions available are briefly described below. Chapter 2 contains a detailed description of each function and feature.

Speed setting functions include:

- Single speed select—Sets the speed set point to a single initial speed when power is first applied
- 50/60 Hz select—Selects between two speed set points when power is first applied to the governor (G version only)
- Idle/rated select—Selects, ramps, and delays between two speed set points while the engine is running
- Three-speed select—Selects and ramps between three speed set points while the engine is running (I version only)
- Raise/lower adjust—Ramps between two speed limits based on signal inputs while the engine is running (G version only)

Speed biasing functions include:

- Isochronous—Does not bias the current speed set point in any way
- Droop—Biases the current speed set point by a negative percentage based on actuator position (G version only)
- Aux biasing—Biases the current speed set point by a percentage based on an analog input voltage
- Isoch/droop select—Selects between isochronous and droop operation when power is first applied (G version only)
- Aux bias/droop select—Selects between aux biasing and droop operation when power is first applied (G version only)

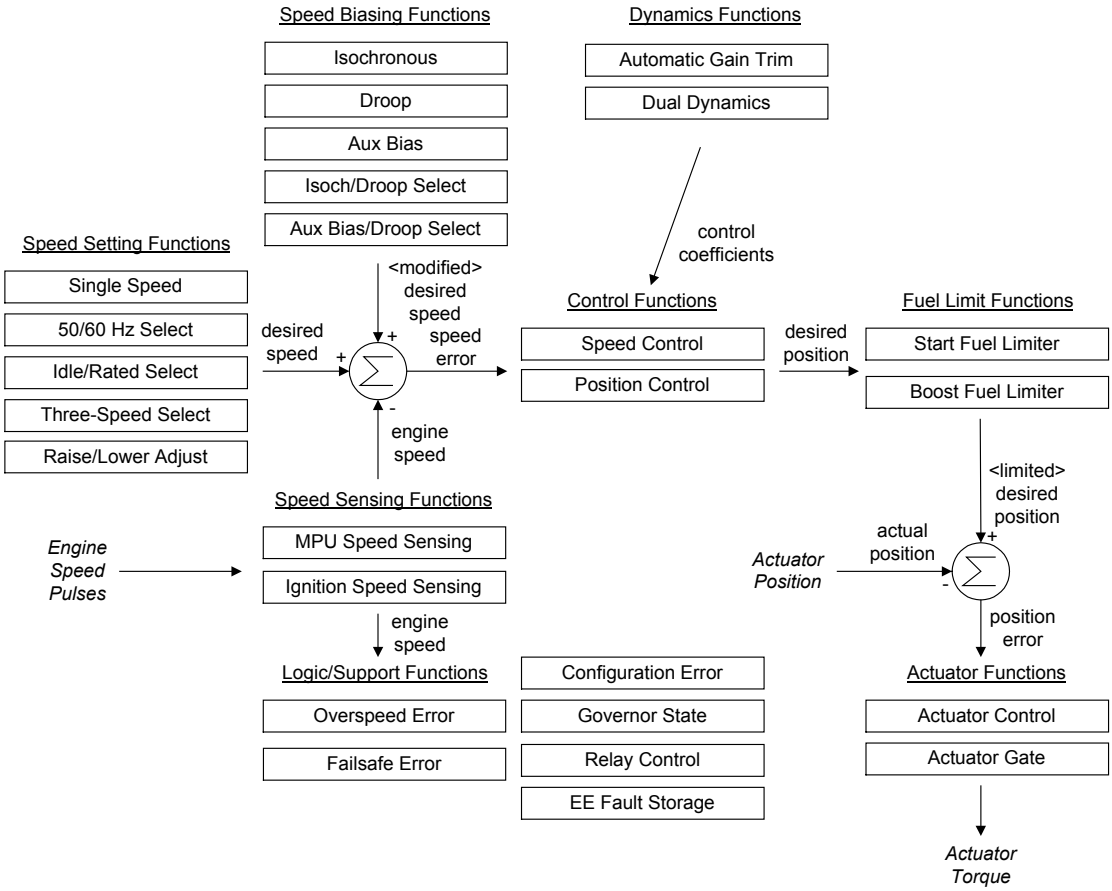

Figure 1-1. Block Diagram of LCS Integrated Speed Control

Speed sensing functions include:

- MPU speed sensing—Converts flywheel or gear speed pulses into engine speed in rpm
- Ignition speed sensing—Converts ignition coil fly back pulses into engine speed in rpm

Control functions include:

- Speed control—Commands a desired actuator position based on the set point versus engine speed error
- Position control—Commands a desired actuator position based on an analog input voltage

Dynamics functions include:

- Dual dynamics select—Selects between two sets of speed control coefficients while the engine is running
- Automatic gain trim—Monitors engine performance and trims speed control gain settings based on programmable criteria

Fuel limiter functions include:

- Start fuel limiter—Limits the desired actuator position during engine cranking and initial acceleration
- Boost fuel limiter—Limits the desired actuator position based on an analog voltage from a MAP sensor (G version only)

Actuator control functions include:

- Actuator control—Commands an actuator torque based on the desired versus actual actuator position
- Actuator gate—Overrides the actuator control during power up or error conditions

Logic and support functions include:

- Overspeed error—Detects when the actual engine speed exceeds a threshold
- Failsafe error—Detects a loss of the speed signal input
- Configuration error—Detects when a configuration has not been downloaded into the control
- Relay control—Controls the relay output driver during error conditions
- Fault storage—Stores a fault code in EEPROM whenever an error condition has occurred
- Governor state—Tracks the state of the engine (off, crank, start, run, or error) based on error detection functions and actual engine speed

Service Tool Software

Because the LCS ITB and LC-50 are digital control systems with no externally accessible adjustments, a suite of companion software tools is available to help the OEM with every phase of application development, manufacturing, and field service. The LCS ITB and LC-50 Service Tool Software is a Microsoft Windows based GUI (graphic user interface). The Service Tool Software is compatible with Windows 95/98/NT/00 and gives the OEM the ability to:

- Tune the control with the engine running during application development
- Create configuration files for downloading into multiple controls
- Download configuration files during the manufacturing process
- Extract and view fault codes for field diagnosis
- Update control dynamics during field service

One distribution of the software service tool is available from Woodward (software part number 9927-1000). This part number defaults to the dealer distribution—tools need for field support only. The OEM distribution—tools for development, manufacturing, and field support—is available by obtaining a license (part number 8928-5002). Detailed descriptions of software installation are available in Chapter 4.

Chapter 2.
System Description / Application Overview

System Operation

The LCS ITB and LC-50 controls are ready for operation immediately (within 0.25 second) when the power supply is connected. Power may be connected to the control at the same time the engine starter motor is engaged. Upon starting, the engine will immediately go to the speed value determined by the features that have been enabled by the Configuration Table. The actuator will drive the throttle to maintain adequate steady state and transient speed control performance.

Upon an engine shutdown command, the engine shutdown solenoid or solenoid valve in the gas fuel supply should be de-activated and the power supply disconnected from the speed control. The signal to this solenoid should be sent directly from the engine control panel and should be independent of the LCS ITB or LC-50 control.

Overview of Control Application Process

Figure 2-1 shows the typical application process used with the LCS ITB and LC-50 control. There are essentially three phases of application—development, production, and field support.

During the development phase, the OEM's engineers create a specification that calls out the features, functions, and desired performance of the final application. Then various online data gathering exercises are performed to collect critical dynamics, load, and position data from the governor. This data, along with pre-determined parameter enable, is put into an application configuration file, and the file is downloaded into a sample set of prototype assemblies. Various application tests are carried out to check the robustness of the empirical data prior to releasing it for production. The empirical data obtained to this point is specific to a given engine/driven load combination. Once, known, all other parameters can be set up in an office environment using the GUI tools.

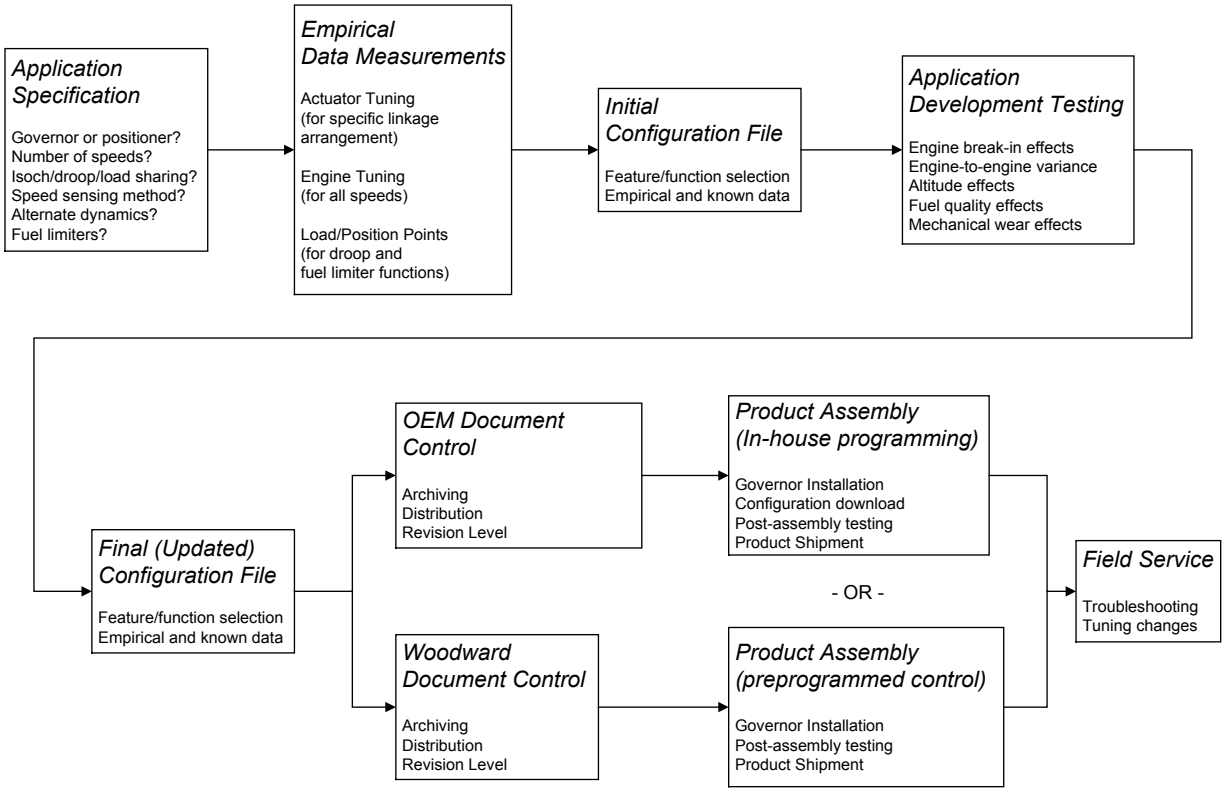

Figure 2-1. Typical Governor Application Process

The OEM can choose either to download configuration files at the OEM's facility, or to purchase pre-programmed governors from Woodward. If the choice is to download the configuration files at the OEM's facility, the OEM is responsible for all aspects of controlling the data. If the choice is to purchase a pre-programmed control, Woodward has responsibility for controlling the data in its document control system, and the OEM will be responsible for communicating software modifications to Woodward.

After the application is assembled, it is tested, shipped, and installed at its final destination. If any additional field service is required, a dealer network uses the dealer distribution of the tool set to check fault codes or update dynamics settings.

Hardware Configuration Application Process

The first step is to choose the appropriate hardware for the application. An ITB, a mixer, and a version of the actuator must be selected. The ITBs and mixers come in five different sizes.

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For both the LCS ITB and LC-50, the user must choose the appropriately sized ITB for the application. The chart below illustrates how to choose the proper size. The intersection of the operating rpm and the engine displacement will fall in a specific ITB band. For example, a 4.0 L engine that will run at 2000 rpm, would need a 43 mm ITB, as that point falls between the two lines for the 43 mm (square marker lines.)

If the application will have multiple speed set points, some judgment needs to be used to appropriately size the throttle. In general, the highest speed where the engine will spend any significant percentage of its time, or the highest speed where efficiency (or power) is important, should be used for sizing.

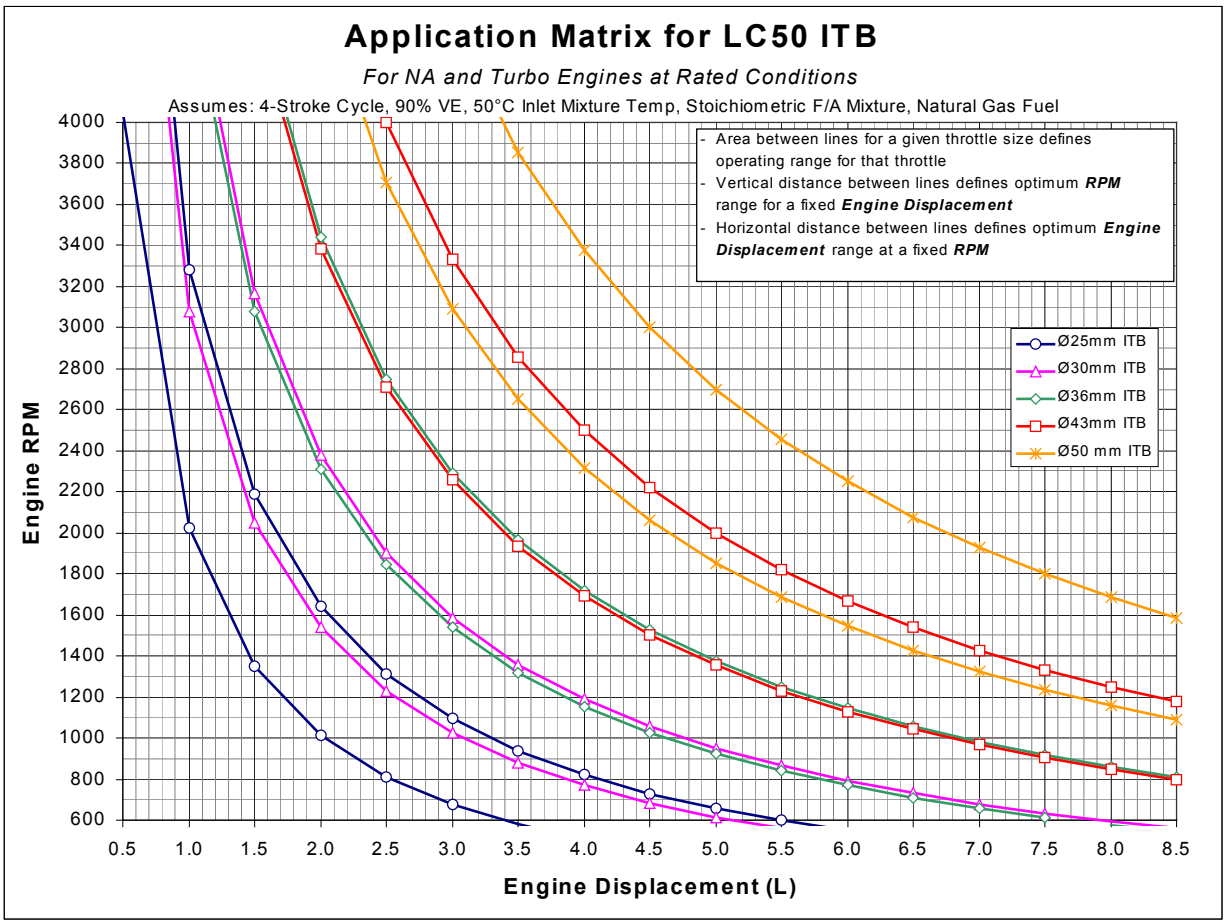


Figure 2-2. Application Matrix

If the application is an LC-50 product, there are appropriately sized mixers for each throttle size. A complete gaseous fuel delivery system requires:

- a fixed main adjustment screw (MAS) or closed-loop trim valve
- a zero-pressure regulator (ZPR)
- a fuel shut-off valve

The mixer supplied with the LC-50 is a venturi style mixer. By locally increasing the air speed in a pipe, the static pressure at the location of the restriction will be lower than the pressure before this restriction. When a number of orifices are made in the circumference of the venturi, the medium to be mixed (natural gas) will be drawn into the venturi throat. If the pressure of the gas is kept equal to the pressure before the venturi, the gas will be mixed with the air in a constant ratio. The pressure is kept equal to the air pressure directly before the mixer, by means of a zero pressure regulator and a compensation line. The venturi mixer is maintenance free.

A main adjustment screw or closed-loop trim valve is provided to adjust the required air/fuel ratio by means of an adjustable restriction in the fuel line between the zero pressure regulator and the venturi mixer.

The compensation line ensures that the gas pressure is kept equal to the air pressure before the venturi mixer. When no compensation line is used, the outlet pressure of the ZPR will not be balanced as the air filter becomes dirty. As the air filter gets dirty, there is an increased pressure drop after the air filter, and the air/fuel ratio will become richer.

Controller Selection

Once the ITB and mixer have been selected, an actuator/controller version must be chosen. The LCS control has an electrical connector with a 12 pin Deutsch DT configuration (reference DT04-12PA) integrally molded into its housing. Seven pins are assigned to specific functions and cannot be changed. The OEM can define the remaining five pins through the Configuration File. There is a limited amount of flexibility to provide analog input, discrete input, or output functionality. The features available are described in detail on the following pages.

The tables below show the possible assignments for each auxiliary-based function in the control. An X indicates that a particular auxiliary is always used when the function is enabled. A P or an A for a specific function denotes a primary or alternate auxiliary input assignment for the function. This P and A arrangement is intended to maximize flexibility in the feature set.

Generator Version

Function	Aux 1 Pins 8 & 5	Aux 2 Pin 10	Aux 3 Pin 4	Aux 4 Pin 6
Isochronous Load Sharing	X			
Remote Speed Setting	X			
MAP Fuel Limiting	X			
50/60 Hz Select	A			P
Lower Speed		X		
Raise Speed			X	
Isoch Speed Ctrl/Droop Select		A		P
Aux Bias / Droop Select	X	A		P
Dual Dynamics Select			A	P
Idle/Rated Select		X		

Industrial Version

Function	Aux 1 Pins 8 & 5	Aux 2 Pin 10	Aux 3 Pin 4	Aux 4 Pin 6
Isochronous Load Sharing	X			
Remote Speed Setting	X			
Dual Dynamics Select			A	P
Idle/Rated Select		X		
Three Speed Select		X	X	X

Controller Features Description

As you review the following features, keep in mind that most applications will only require a few of the functions to be activated. The choices are available to provide maximum flexibility in a single package. The user will at a minimum pick one feature from each of the following areas: speed setting, speed biasing, speed sensing, and control functions. From the dynamics functions area the user can set as many or as few as is necessary for stable operation. The user can choose all or none of the fuel limiter functions, actuator control functions, and logic functions depending on the application.

SPEED SETTING
Single Speed Select—This is the default setting for the controller. If no other features are enabled, the engine will run at one set speed.

50/60 Hz Select (G version only)—This feature allows the user to switch the speed set point between a primary and secondary engine rated speed. A discrete input is used to toggle between the two set speeds. The user can define whether this input comes into AUX1 or AUX4. When the engine is started with the input at the low state (ground), the controller controls to the primary speed setting and uses dynamics for the primary speed. When the engine is started with the pin in the high state (12V), the controller will run at the secondary speed setting with the corresponding second speed dynamics. Any state changes on the AUX pin will be ignored once the engine is running. The state is determined only when power is first applied to the governor.

Related configuration file parameters: 50/60 Hz select, 50/60 Hz Aux, speed 1, speed 2, and primary dynamics for both speeds

Idle/Rated Select (G version only)—This feature allows the user to toggle the speed set point between an idle and a rated speed. The toggle is accomplished through an input into AUX2. When the AUX pin is in its low state, the engine runs at idle speed with the primary set of dynamics. When the AUX pin is in the high state, the engine runs at the higher rated speed with the corresponding dynamics. The user can toggle between the two speed settings at any time during operation. Transition rates between the two speeds can be controlled at a user defined ramp rate if desired. If the user defined ramp rate is 0, the new set speed is instantly engaged. When the AUX pin transitions from high to low (rated to idle), a programmable time delay is executed before the desired speed is ramped from rated to idle. For example in welder applications it may be desirable to have a time delay before decelerating from rated to idle (to allow some time to change the welding rod).

Related configuration file parameters: idle/rated select, rated to idle delay, speed 1, speed 2, primary dynamics for both speeds, speed decrease rate, speed increase rate

Three-Speed Select (I version only)—Some refrigeration applications may find it useful to have three engine speeds available: a highest speed for quick cool down when warm goods are put into a container, a lowest speed to maintain the load's temperature once it has been cooled, and an intermediate speed for increased cooling if the container door is opened to move goods in or out. Typically, the discrete inputs for each of these speeds will come from an automatic thermostat, and only one will be high at a time. Mobile access platform (scissor lift) applications may also require three engine speeds, which correspond to three basic operating modes: static lift, transient lift, and mobile vehicle travel.

AUX2, AUX3, and AUX4 are used to select between three speeds. If none of the inputs are tied to +12 V, the current speed and control dynamics are used by the Speed Control function. If AUX2 is tied to +12 V, the desired speed is speed 1 with the corresponding gain dynamics. If AUX3 is high, the desired speed is speed 2 with the corresponding gain dynamics. If AUX4 is tied to +12V, the desired speed is speed 3 with the third set of gain dynamics. Transition rates between the three speeds can be controlled at a user defined ramp rate if desired. Any ramp rate set at 0 causes the desired speed to be set to the speed reference instantly. AUX2, AUX3, and AUX4 must be associated with the lowest, middle, and highest engine speeds, respectively. If more than one AUX input is tied to +12 V, the lower of the two speeds is selected.

Related configuration file parameters: 3 speed select, speed 1, speed 2, speed 3, primary dynamics for all speeds, speed decrease rate, speed increase rate

Raise/Lower Adjust (G version only)—This feature allows the user to change the speed set point with external discrete inputs.

Related configuration file parameters: raise / lower speed, speed decrease rate, speed increase rate, speed adj lower limit, speed adj upper limit

Lower—This AUX2 discrete input acts directly on the internal speed set point within the LCS ITB and LC-50, and will progressively decrease the speed set point down to a programmable lower limit at a programmable rate for as long as the input is in a high state. When this input goes low, the speed reference will remain fixed at the last setting reached the instant the input went low.

Raise—This AUX3 discrete input acts directly upon the internal speed set point within the LCS ITB and LC-50, and will progressively increase the speed reference up to a programmable upper limit at a programmable rate for as long as the input is in a high state. When this input goes low, the speed reference will remain fixed at the last setting reached the instant the input went low.

SPEED BIASING

Isochronous—This is the default speed biasing function if none of the other speed biasing functions are selected. This maintains the engine at one speed setting throughout operation regardless of load.

Droop—This feature allows for a change in speed set point with a change in load. This feature is primarily used when the generator is connected to a utility bus or paralleled with another genset on an isolated bus. In this situation, the utility will determine the frequency of the alternator. Should the governor speed reference be less than the utility frequency, power in the utility bus will flow to the alternator and motor the unit. If the governor speed is even fractionally higher than the frequency of the utility, the governor will go to full load in an attempt to increase the bus speed. Since the definition of a utility is a frequency that is too strong to influence, the engine will remain at full fuel.

Isochronous governor control is impractical when paralleling with a utility because a speed setting above utility frequency, by however small an amount, would call for full fuel since the actual speed could not reach the reference speed. Similarly, if the setting were even slightly below actual speed, the fuel would go to fuel off position.

Droop provides one solution to this problem. Droop causes the governor speed reference to decrease as load increases. An actuator position feedback device is employed within the LCS ITB and LC-50 to monitor actuator position. Setting Droop to 0% means the control will provide isochronous operation. The desired engine speed reduces with the following formula:

$$\frac{\text{speed reference} * \text{droop percentage} * (\text{actual position} - \text{no load actuator position})}{(\text{full load actuator position} - \text{no load actuator position})}$$

The speed offset calculation requires valid information in the droop percentage, no load actuator position, and full load actuator position parameters.

Related configuration file parameters: constant droop, droop percentage, no load act pos, full load act pos

Aux Biasing (Isochronous Load Sharing)—This feature allows the user to alter the speed set point with an external signal. This input comes into AUX1, and is programmable as either a 0–5 V input or ±3V input. This function modifies the desired engine speed with the following formula:

speed reference * bias percentage * offset AUX1 input voltage

The bias percentage is a programmable value up to approximately ±7%. When AUX1 is configured as a 0–5 V input, 5 V corresponds to the full bias percentage in a positive direction; 0 V corresponds to the full bias percentage in a negative direction; and 2.5 V corresponds to no bias. This analog input should be provided by a voltage transmitter via twisted, shielded wire pairs.

When AUX1 is configured as a ±3 V input, +3 V corresponds to the full bias percentage in a positive direction; –3 V corresponds to the full bias percentage in a negative direction. This analog input will be available to interface with Woodward's standard Load Sharing Module. This auxiliary input acts directly on the LCS ITB and LC-50 speed reference and biases it by a programmable amount up to approximately ±7% in direct proportion to the ±3.0 Vdc signal. This input will be active only when the LCS ITB and LC-50 is selected for isochronous operation and should be provided via twisted, shielded wire pairs.

Isochronous Speed Control/Droop Select—This discrete input toggles between the Isochronous and Droop features. The function looks at the state of AUX4 or AUX2 (user-defined) at power up, as well as the state of the input as defined by the user. The state of this AUX input is evaluated when power is first applied. Any state changes after the engine is running are ignored.

The user can program the aux input state that enables droop. This is done by programming droop polarity to aux high (12 V) or aux low (ground). For example, if droop polarity is programmed to aux high, then droop will be active when the aux pin is in the high state.

Related configuration file parameters: aux bias, bias percentage, aux 1 type, aux 1 level

Aux Bias/Droop Select—This discrete input toggles between auxiliary biasing (also known as isochronous load sharing) and droop. The function looks at the state of AUX4 or AUX2 (user-defined) at power up, as well as the state of the input as defined by the user.

The user can program the aux input state that enables droop. This is done by programming droop polarity to aux high (12 V) or aux low (ground). For example, if droop polarity is programmed to aux high, then droop will be active when the aux pin is in the high state.

Related configuration file parameters: aux bias / droop select, droop percentage, aux biasing percentage, no load act pos, full load act pos, droop polarity, droop aux, aux 1 type, aux 1 level

SPEED SENSING

Magnetic Pickup (MPU)—The MPU input has been designed for variable reluctance speed sensors and not Hall-effect devices. The frequency range of the MPU input is: 100 Hz to 12 000 Hz (designed to accept at least 14 000 Hz to provide a margin of safety). The required minimum peak-to-peak voltage is 2 V @ 100 Hz and 25 V @ 12 kHz.

This function expects engine speed pulses present on pins 11 (MPU+) and 3 (MPU–). The number of flywheel or gear teeth that pass the magnetic pickup for one crankshaft revolution must be programmed into events per engine rev in the configuration file.

Related configuration file parameters: mpu, flywheel teeth

Ignition—The LCS ITB and LC-50 control will accommodate a 2–333 Hz signal from an ignition input for 1, 2, 3, 4, 5, 6, and 8 cylinder engines with speed set points between 1200 and 3600 rpm. The LCS ITB and LC-50 controls can accommodate 2- and 4-cycle engines. For standard coil ignition, the source may be the negative terminal of the coil primary. For distributorless or DIS (Direct Ignition System) systems, the source for the ignition pulses may be two ignition leads from the spark controller connected to MPU+ (pin 11) and MPU– (pin 3). Take care not to reverse MPU+/– on a DIS system, or no speed will be sensed.

This function requires engine speed pulses present on pin 12 (IGN) of the control. The type of engine (2-stroke or 4-stroke) and the number of cylinders (1 to 8) must also be programmed in this parameter byte.

Related configuration file parameters: ignition, cylinders count, strokes

CONTROL FUNCTIONS

Speed Control—This function is the governor function. It calculates the difference between the desired speed and the actual measured engine speed, and adjusts the desired actuator position as a result. Speed setting functions and alternate dynamics functions are responsible for selecting the active speed set point and set of dynamics for this function. The user must choose either this function or the position control function. They cannot both be enabled.

Position Control—Commands a desired actuator position based on an analog input voltage. This function requires AUX1 is configured as a 0–5 V analog input. This function also requires that the Actuator Control and Actuator Gate functions are turned on. This function does not require the Governor State function to be enabled. The Position Control function essentially overrides the Governor State function and translates a 0–5 V input into a desired position for the Actuator Control function.

NOTE

The accuracy of the internal LCS position sensor is nominally ±10% of full travel, and under some conditions can be ±20% of full travel. If you are not using the full stroke of the actuator, this will magnify the existing error of the LCS position sensor. Position-based features need to be used cautiously and calibrated carefully. In summary, if you need better than ±10 degrees of accuracy for position-based features, mechanical alternatives should be considered.

Related configuration file parameters: position control, aux 1 type, aux 1 level

DYNAMICS FUNCTIONS

A variety of dynamics or gains are available for tuning the engine and throttle response. The user can use as few or as many as desired. The response of the throttle blade, or position control, is controlled by PID (proportional, integral, and derivative) control terms. The speed control of the engine is controlled by reset, gain, and compensation terms. Multiple sets of speed control dynamics parameters are available for each engine speed. For the generator version, four distinct sets of dynamics are available. The industrial version of the software has 6 sets of dynamics available.

Three-Point Gain Curve—The engine speed control gain is set up as a three-point gain curve versus position to adjust for linearity of the throttle body and engine response. For example, at low throttle positions a small change in throttle angle can cause a large kW change, while at high throttle positions it can take a large change in throttle angle to produce a relatively small change in kW out. The three-point gain curve corrects for this characteristic. The position breakpoints are common for all speeds and dynamics. Typical values are

Gain 1	25
Gain 2	40
Gain 3	100
Gain Position 1	25
Gain Position 2	30
Gain Position 3	40

Related configuration file parameters: gain 1, gain 2 and gain 3 for primary and alternate dynamics as required, gpos 1, gpos 2, gpos 3

Dual Dynamics—This feature allows for toggling between two sets of user-defined dynamics or gains. The two sets of gains are referred to as the primary and alternate dynamics. This feature is mainly used for dual fuel engine applications where engine response can change from operation on one gaseous fuel to another. This feature may also be used for generator sets to allow different dynamics for standalone and parallel operation. When this input is low, the primary set of dynamics is used. When this input goes high, the dynamic set points will immediately change to alternate dynamics and remain there until the input is returned to the low state. When this feature is active, the LCS ITB and LC-50 react to state changes at the user defined AUX3 or AUX4 while the engine is running. Primary and alternate dynamics exist for each speed setting.

Related configuration file parameters: alternate reset and gains for each speed being used

Automatic Gain Trim—To correct for engine power variation and its effect on governor performance, the LCS includes an automatic gain adjustment function that trims the gain of the controller based on steady-state and transient engine speed performance measurements. Based on performance criteria programmed into the LCS and the stability or load transient performance of the engine, the function will increase or decrease the currently active gain setting. This function can be used to combat the effects of engine break-in, engine-to-engine variance, altitude, temperature, and fuel quality. This function is not intended to mask serious engine faults, like broken spark plugs, large vacuum leaks, or other such failures. The automatic gain adjustment function can be disabled.

This function continuously monitors the speed of the engine relative to the currently active speed reference. If this function observes a steady-state speed band that exceeds a programmable set point, then the currently active gain parameter is decremented by a programmable amount until a programmable minimum gain setting is reached. If this function observes a transient offspeed that exceeds a programmable set point, then the currently active gain parameter is incremented by a programmable amount until a programmable maximum gain setting is reached.

Related configuration file parameters: gain decrement, gain increment, minimum gain, maximum gain, steady state, transient

The auto gain feature requires significant testing to configure properly. For details on how to complete this testing, please contact Woodward.

NOTE
Enabling the auto gain feature without performing the proper testing can cause engine instability.

FUEL LIMITER FUNCTIONS

NOTE
The accuracy of the internal LCS position sensor is nominally ±10% of full travel, and under some conditions can be ±20% of full travel. Position-based features need to be used cautiously and calibrated carefully.

Start Fuel Limiter—A Start Fuel Limiter feature is included within the LCS control. It sets the throttle valve partially open during cranking and while the engine is accelerating to its desired speed set point in order to minimize overshoot of the speed set point. The action of this start fuel limiter is as follows:

When power is applied to the LCS system, its actuator remains in the minimum fuel position until the starter is engaged and actual engine speed exceeds a user defined start speed threshold. As soon as the engine speed exceeds this threshold, the actuator will position at the start fuel limit. The engine continues to accelerate. When the actual engine speed exceeds the user defined run speed threshold, the start fuel limit is removed, the governor is free to use the entire position range, and the failsafe and overspeed limiters are activated. The run speed threshold is typically 75% to 90% of the minimum desired operating speed.

The Start Fuel Limiting function is automatically reset whenever power is removed from the LCS control. The Start Fuel Limit feature can be disabled in the Configuration Table so that the feature is not used.

Related configuration file parameters: start fuel limiter, start spd thresh, start fuel limit

Boost Fuel Limiter (MAP fuel limiting)—This analog input should come from a manifold air pressure (MAP) or turbo boost pressure transducer so that the fuel delivered to the engine can be limited as a function of pressure. A two-slope Fuel Limit vs. Transducer Voltage (air pressure) curve—having three definable points—can be programmed into the Configuration Table to provide the desired fuel limit functionality. Note that the transducer should be powered from the LCS control to avoid a ratiometric calibration issue that would affect the accuracy of this function. Pressure transducers can be obtained from Woodward.

This feature can be useful when using a non-wastegated turbo to avoid overloading the engine. As the MAP reaches an overboost condition, the LCS will close the throttle down as indicated in the figure. A MAP sensor can be more economical than a waste-gated turbo; however, a wastegated turbo may spool up faster.

Related configuration file parameters: boost fuel limiter, boost pressure 1-3, boost fuel limit 1-3

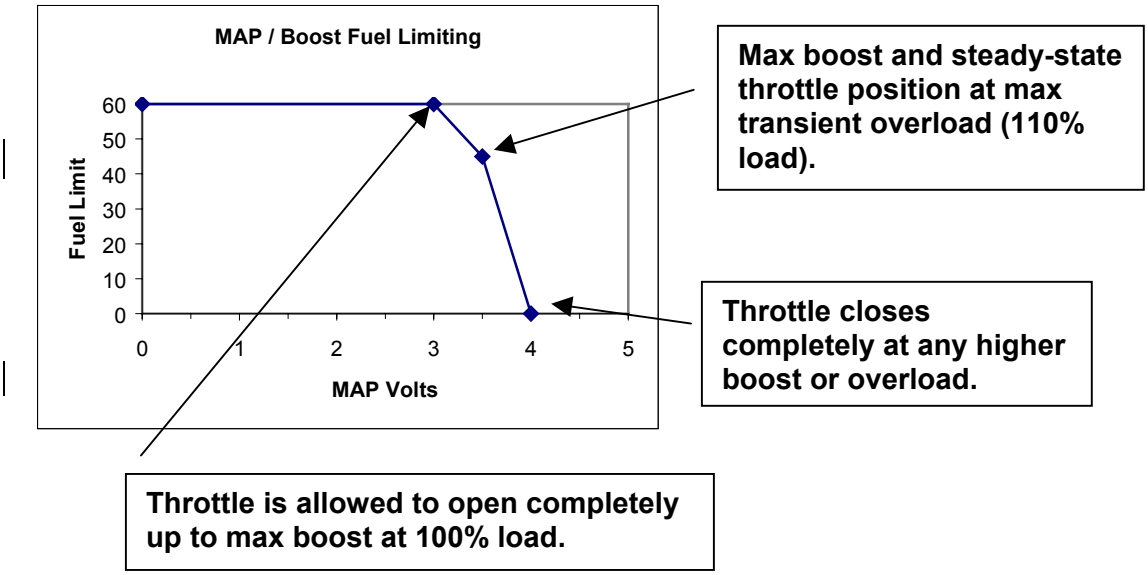


Figure 2-3. MAP/Boost Fuel Limiting

ACTUATOR CONTROL FUNCTIONS

Actuator Control—This function calculates the difference between the desired position and the actual measured actuator position, and adjusts the actuator torque as a result. Proportional, derivative, and integral parameters are referenced by this function. This is the position control loop.

Actuator Gate—When the governor state is 'powerup,' this function overrides the output of the Actuator Control function and prevents the actuator from developing any torque. When the governor state is 'start' or 'run,' this function passes the torque command of the Actuator Control function directly to the actuator. When the governor state is 'error' this function overrides the output of the Actuator Control function and drives the actuator to minimum fuel, which is dependent on the direction setting in the configuration. These gates control the start fuel limit and fault conditions.

LOGIC AND SUPPORT FUNCTIONS

Overspeed Error—The LCS control has an overspeed function that can be set by the OEM to shut down the engine at a speed that is typically 110% of rated speed. When the control senses this speed, it will drive the throttle to minimum position, turn on the relay contact output (if enabled), and the software will store a fault bit in EEPROM (if fault storage is enabled). Cycling power to the LCS will restore normal operation, but the fault bit will remain in non-volatile memory until reset.

WARNING

The LCS control should never be used as the primary overspeed protection device.

Related configuration file parameters: overspeed, EE fault storage, relay control, overspeed thresh

Failsafe Error—To protect the engine against overspeed upon loss of the speed input signal, the control will drive the actuator to minimum throttle anytime the control senses a missing speed input for a programmable amount of time not to exceed 0.5 second. The relay contact output will also be turned on (if enabled) and the software will store a fault bit in EEPROM (if fault storage is enabled). Cycling power to the LCS will restore normal operation, but the fault bit will remain in non-volatile memory until reset.

Related configuration file parameters: Failsafe, Failsafe timeout period, EE fault storage, relay control

Configuration Error—The Configuration Error function is permanently enabled to check for the presence or absence of a configuration file in the control during power-up. If a configuration error is detected, software sets the configuration error flag, activating the relay output and rendering the control inoperable until the power is cycled.

Relay Control—This switchable, discrete output is a closure to ground capable of sinking 250 mA with an output voltage rise of less than 1.5 V, and is available to power external relays for devices such as fuel shutoff solenoids. It has an internal protection diode, so it is not necessary to provide one externally. This output is normally floating with a very weak resistor to an internal +5V, but when an error condition occurs (overspeed, configuration, failsafe), this output sinks up to 250 mA to ground.

There are two conditions that will prevent this output from operating. The first is if battery positive is accidentally connected to it, and the second is if it is shorted to ground. If this output is intended to drive a fault light, these conditions will not be obvious.

Fault Storage—Enabling this bit turns on the EE Fault Storage function when the governor state is ‘error’. When the governor state transitions to ‘error,’ the source of the error (configuration, overspeed, or failsafe) is stored as a set bit in the control fault register of the LCS’s EEPROM.

Governor State—This function sets an internal state variable to one of four values (powerup, start, run, or error) based on the current engine speed and error function data. When power is first applied to the governor, its state is ‘powerup.’ As the engine is cranking and its speed exceeds the start speed threshold, the state of the governor changes to ‘start’. When the engine speed exceeds the run speed threshold, the state of the governor changes to ‘run’. If any of the speed error functions (overspeed, failsafe) are enabled, and they detect a speed error, then the state of the governor transitions to ‘error’ and remains there until power to the control is cycled. This function is required for all speed governor applications; it is not required for positioner applications.

Password Protection—This feature allows an OEM to password protect the configuration files. This prevents unauthorized dealers or competitors from reading configuration, dynamics, or fault information from the OEM’s controls. In general the OEM should only use one security key for all LCS applications; otherwise multiple copies of service tools and security key files will be required. If you choose to put a value in this parameter, then you will also have to generate companion encrypted security key file using the software tools and distribute this key file with the dealer service tools.

If an OEM decides to put a value into the OEM SECURITY KEY field, and downloads that configuration file into a control, the OEM must supply an encrypted security key file called ACCESS.KEY when giving the OEM dealer network a copy of the dealer service tools. If a dealer tries to work with an LCS control and does not have a ACCESS.KEY file, the tool will not permit access to the control’s data.

Related configuration file parameters: OEM Security Key, Make Key function

Chapter 3.
Installation

Mechanical Installation

Locate the LCS control a distance from sources of extreme radiant heat, such as exhaust manifolds or turbochargers. The operating temperature range of the control is –40 to +85 °C (–40 to +185 °F). In spark-ignited applications, make sure the LCS is located away from the ignition coil, and that harness wires are not routed next to the spark plug wires.

While it is not a requirement, it is good practice to orient the connector feature on the control in a horizontal or downward orientation to minimize fluid accumulation between the enclosure and the mating connector's gasket.

The 25, 30, and 36 mm throttles mount with 5 mm fasteners in a 43 mm square bolt pattern. The 43 and 50 mm throttles use 6 mm mounting screws in a 57 mm square pattern.

The LCS actuator has a rotation of 0–60 degrees. To get full blade rotation on the ITB, a mechanical linkage exists inside the ITB that converts 0 to 60 degrees actuator rotation to 3 to 85 degrees blade position.

The LC-50 mixer can be mounted in any of three orientations of the ITB to allow convenient fuel system connections. The LCS ITB and LC-50 are intended to be used with gaseous fuels from low quality pipeline natural gas to HD-5 LPG. The quality of this range of fuel varies from a lower heating value of 850 BTU/SCF (34.0 MJ/m³) to 2325 BTU/SCF (93.0 MJ/m³), and the specific gravity varies from 0.55 to 1.56 relative to air. When using a Woodward supplied ZPR, fuel pressure should be 0.25 psi (7" water column) (1.7 kPa [178 mm water column]) to 1 psi (28" water column) (6.9 kPa [711 mm water column]). Pressure supply range is 4–14" water for the R500Z, and 4–28" water for the R600Z.

The LC-50 mixer has two inlet sizes for air filter attachment. The smaller throttles (25, 30, and 36 mm) have a 2.0-inch (50.8 mm) inlet. The larger throttles (43 and 50 mm) have a 2.5 inch (63.5 mm) inlet.

We recommend installing all components of the gas system, such as air filter, main adjustment screw, and throttle valve in a symmetric way to minimize possibility of unequal mixture distribution.

Curved pipes should not be installed closer to the venturi than 3D (where D is the diameter of the venturi at the air inlet side).

Woodward recommends that you install a compensation line between the ZPR and the air inlet to maintain consistent air/fuel ratio throughout the life of the system. If a compensation line is not installed, the air/fuel ratio will be affected by the changing restriction of the air cleaner as it accumulates dirt.

If the Maxitrol ZPR is obtained from Woodward, the following installation instructions apply. If another brand of ZPR is used, consult that manufacturer for installation guidelines. The ZPR should be mounted with the spring tower up. If it is not, the weight of the diaphragm and spring can offset the pressure setting. The ZPR should be mounted as close to the MAS as possible to prevent pressure drop across excessively long pipe lengths. This pressure drop and associated system lag can cause stability and response issues with the mixer air/fuel ratio control.

On a turbo-charged engine, the mixer should be located before the turbo compressor. This will yield very high mixture homogeneity as well as allowing the use of a standard ZPR and the ability to use low-pressure gas. To increase safety, some engine manufacturers have mounted flame arrestors between the inlet manifold and the cylinder head, ensuring that a backfire does not lead to an explosion in the inlet manifold, aftercooler, etc., which are filled with ignitable mixture.

The initial settings for the MAS and ZPR are indicated in the table below. These settings should provide the ability to consistently start and run at an approximately stoichiometric air/fuel ratio. The procedure for adjusting these settings for optimum air/fuel ratio will be described in the air/fuel ratio tuning section (Chapter 4). The main adjustment screw (MAS) settings are measured from the MAS valve body (not the jam nut) to the exterior end of the MAS screw. The zero-pressure regulator settings are measured from the top of the spring adjustment screw to the top of the spring tower.

For dual-fuel configurations, the standard NG fuel set up should have a tee added between the ZPR and MAS. The side-leg of the tee should then have the MAS and ZPR for the LP fuel. The initial settings for dual-fuel NG and LP are the same as the single-fuel settings below. The final air/fuel ratio adjustments should be done on NG first, then LP, using the procedure in Chapter 4 for each fuel.

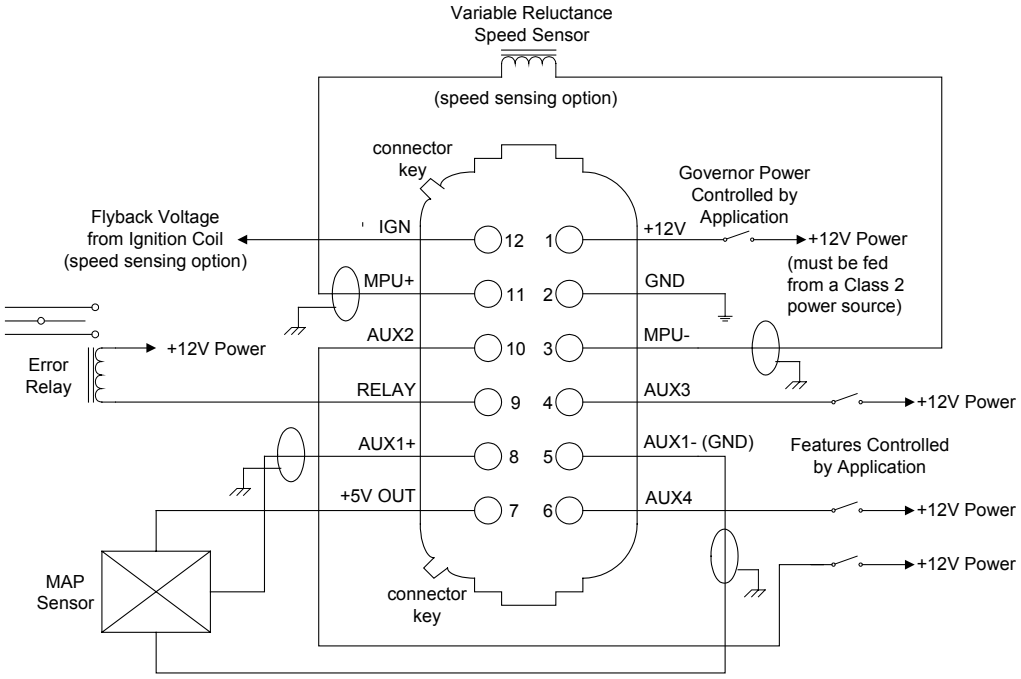
MAS and ZPR Initial Settings

ITB Size	Natural Gas	Propane
50 mm	**Screw Setting Position (mm)**	
MAS	19	16
ZPR	16	14
43 mm		
MAS	17	15
ZPR	16	14
36 mm		
MAS	11	9.5
ZPR	14	14
30 mm		
MAS	11	9
ZPR	14	14
25 mm		
MAS	10	8
ZPR	14	14

Electrical Installation

A pinout of the LCS control, as viewed by looking into the control's connector feature, is shown in Figure 3-1. Typical connections to external devices are also shown.

The LCS has an operating voltage range of 8 to 16 Vdc with a nominal voltage of 13.5 V. The power supply is load dump and reverse polarity protected, and consumes 64 W maximum power at a peak current of 4 A (16 V) assuming 4 Ω stator resistance at 25 °C. The control system should be protected with a 6 A fuse in the voltage supply lines. Typical max average current is 1.8 A, or max 29 W at 16 V. The application should be configured to turn on power to the governor when the engine is first cranked. Power should be removed just before the engine is shut off so that the actuator loses torque and the return spring can move the throttle to a minimum fueling position.



note: AUX1+ and AUX1- can also be used as a +/-3V load sharing input
note: AUX1+ can also be used as a digital input like AUX2, AUX3, and AUX4

Pinout as Viewed Looking Into LCS Control

Figure 3-1. Typical LCS Application Wiring

Several speed sensing options are supported. The LCS can sense speed from ignition coils, DIS modules, or variable reluctance magnetic pickups (MPU). When using the LCS with an ignition coil, attach the IGN input to the switched side of the coil's primary; typically this is the negative (–) terminal of the coil. Do not rely on the condenser connections to determine which side of the primary coil is the switched side—use a tachometer or frequency meter to check for engine speed.

When interfacing the LCS to a DIS module, connect the LCS control's MPU+ (pin 11) and MPU– (pin 3) input pins to the DIS module's signal and ground input pins. Be careful not to accidentally swap the connections; otherwise the engine will not start.

When using a variable reluctance magnetic pickup, make sure the gap between the pickup and the flywheel or gear teeth is sufficiently small so that the sensor output voltage meets or exceeds the voltage threshold curve shown in Figure 3-2 for the full range of engine speeds. The resistance of the MPU must be less than 900 Ω.

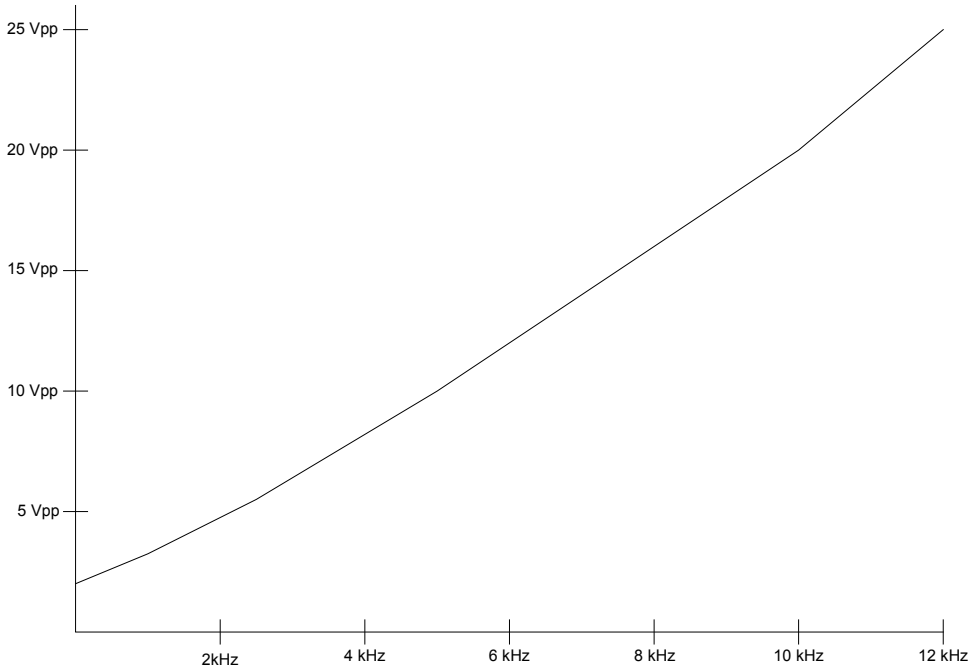


Figure 3-2. Voltage Threshold Curve

The relay output driver is activated any time the governor detects an error condition (overspeed, failsafe, or configuration error). The driver sinks up to 250 mA of current through an external device powered from +12 V. This driver is internally protected against inductive flyback.

The +5 Vdc Power Output is intended to power the pressure transducer used with the manifold air pressure-biased fuel limiter function. The maximum output current is 10 mA. If the external wire associated with this function is shorted to ground, the actuator will lose its power and the ITB return spring will close the throttle. If the short persists, the control's internal regulator may go into thermal shutdown but should not be permanently damaged. If the short is cleared, the 5 V supply will return after the regulator chip cools down. Use special care when routing wire to this pin. Use well-insulated wire, and be sure to grommet any holes in sheet metal through which it may be routed.

The LCS has three dedicated digital inputs (AUX2, AUX3, and AUX4) used to activate various features of the control. Shorting an input pin to +12 V activates it. Removing +12 V from an input pin or shorting the pin to ground deactivates the input. At least 4 volts must be present on an input pin in order to change its state from inactive to active. All discrete inputs will be the same voltage as the system power supply and will be active only while the input is in a high state. Greater than 4 Vdc is considered high, and less than 1 Vdc is considered low.

All connector pins are short-circuit protected to ground and power except pins 2, 3, and 5, which are not protected against shorts to battery positive. Installation of a fuse on the power ground wire to pin 2 would provide protection to these pins but does not mean one is not needed in the power connection. Pin one (B+) still needs protection against a short to ground.

A combination analog/digital input (AUX1) is available on the LCS. When AUX1 is configured as a digital input, it must be grounded (not opened) to deactivate, but otherwise the AUX1+ pin is treated the same way as AUX2, AUX3, and AUX4. When the pin is used as a discrete input, it will have minimum impedance of 10 kΩ, and when configured as an analog input, it would have minimum impedance of 100 kΩ. When AUX1 is configured as a ±3 V analog input, the LCS may be interfaced to other Woodward load sharing equipment through the AUX1+ and AUX1– inputs. When AUX1 is configured as a 5 V analog input, +5V OUT, AUX1+, and AUX1– may be used to sense manifold absolute pressure or bias engine speed with a potentiometer.

The following Deutsch connector components are recommended for harness designs:

	Recommended	**Optional**
Mating Connector	DT06-12SA-P012	DT06-12SA
Secondary Lock	W12S-P012	N/A
Sockets	0462-201-16141	0462-201-16141

Woodward part number 8928-396 is a kit that provides all the necessary Deutsch components.

Use 16 to 18 AWG (1 to 1.5 mm²) stranded copper wire with insulation that meets temperature requirements in the harness design. In the event a wire is not used for each of the 12 pins on the control, a Deutsch 114017 plug should be used in place of each missing wire to environmentally seal the connector from the elements. A wiring harness stress relief within 16 inches (406 mm) of the control's connector is recommended. The maximum recommended harness length is 20 feet (6 m). Dress the harness with wire loom to contain it in a single bundle. Use grommets when passing the harness through metal panels. Ground the MPU signal wire shielding at the control, but do not ground the MPU signal wire shielding at the MPU.

When using the ignition signal as the speed input, connect a two inch (51 mm) insulated 18 AWG (1 mm²) wire between pins 3 and 11 (MPU+ and MPU-) of the 12 pin Deutsch connector.

Also use twisted pair, shielded wires for the AUX1 input when configured for Isoch Load Sharing, 0–5 Vdc Remote Speed Setting, or MAP Fuel Limiting. Ground this shielding on the engine near the control.

Chapter 4.
Software Programming

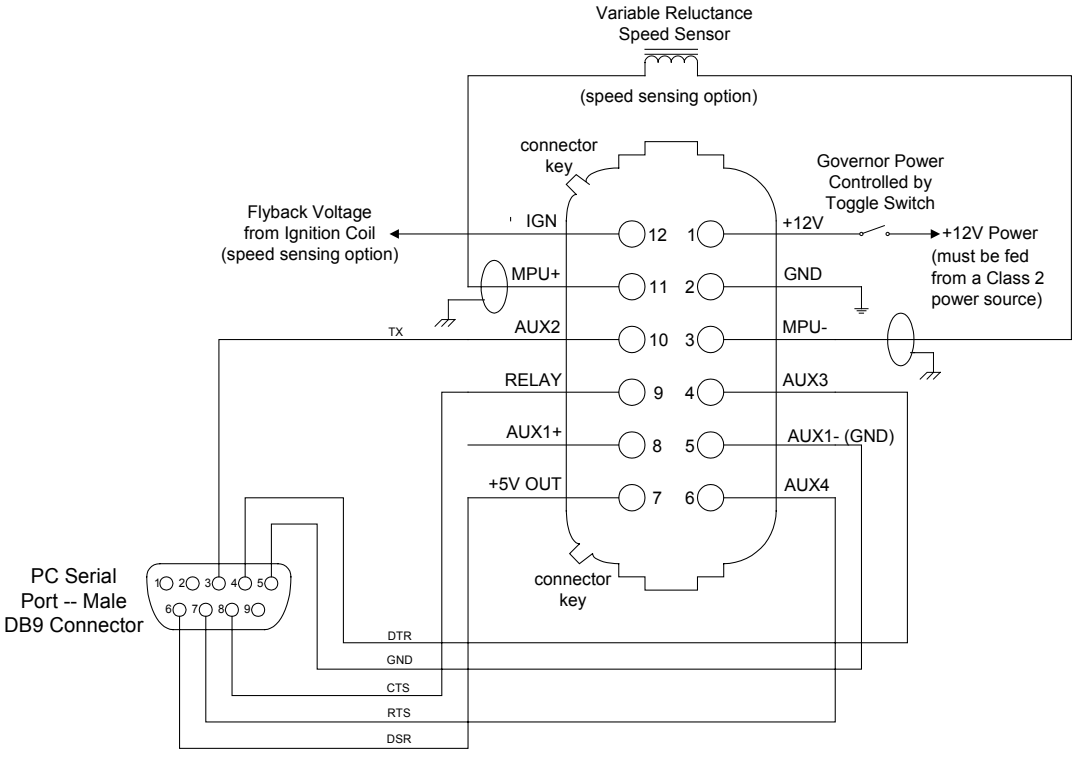
This chapter covers the process of tuning, configuring, and servicing the control via the LCS Service Tool Software Suite. It is assumed that the control has already been installed on the engine.

The following hardware is required to work with the LCS control, regardless of whether an application is being developed by engineering, a configuration file is being downloaded in production, or the application is being serviced in the field:

- PC-compatible laptop or desktop computer* with at least one available serial communications port, and Windows 95/98/00/NT as the operating system.
- Programming/datalink harness (part number 02-0004-174) as shown in Figure 4-1.

***—CAUTION**

There is a potential for serial port damage when communicating with the LCS control. This is caused by a difference in ac voltage between neutral and earth ground. If the PC RS-232 port ground is referenced to ac neutral, and the LCS control is referenced to battery ground (ac earth ground), a large amount of current can be experienced. To avoid this situation, we strongly recommend placing an isolation transformer between the ac outlet and the PC.



Pinouts Viewed Looking into Control Connector and Computer Connector

Figure 4-1. Typical Programming Datalink Harness Wiring

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In addition to the hardware, the following are the distributions of tool software needed to communicate with the control:

- Woodward part number 9927-1000, LCS Service Tools, Dealer Distribution
- Woodward part number 9927-1000, LCS Service Tools, OEM Distribution (license Woodward part number 8928-5002)

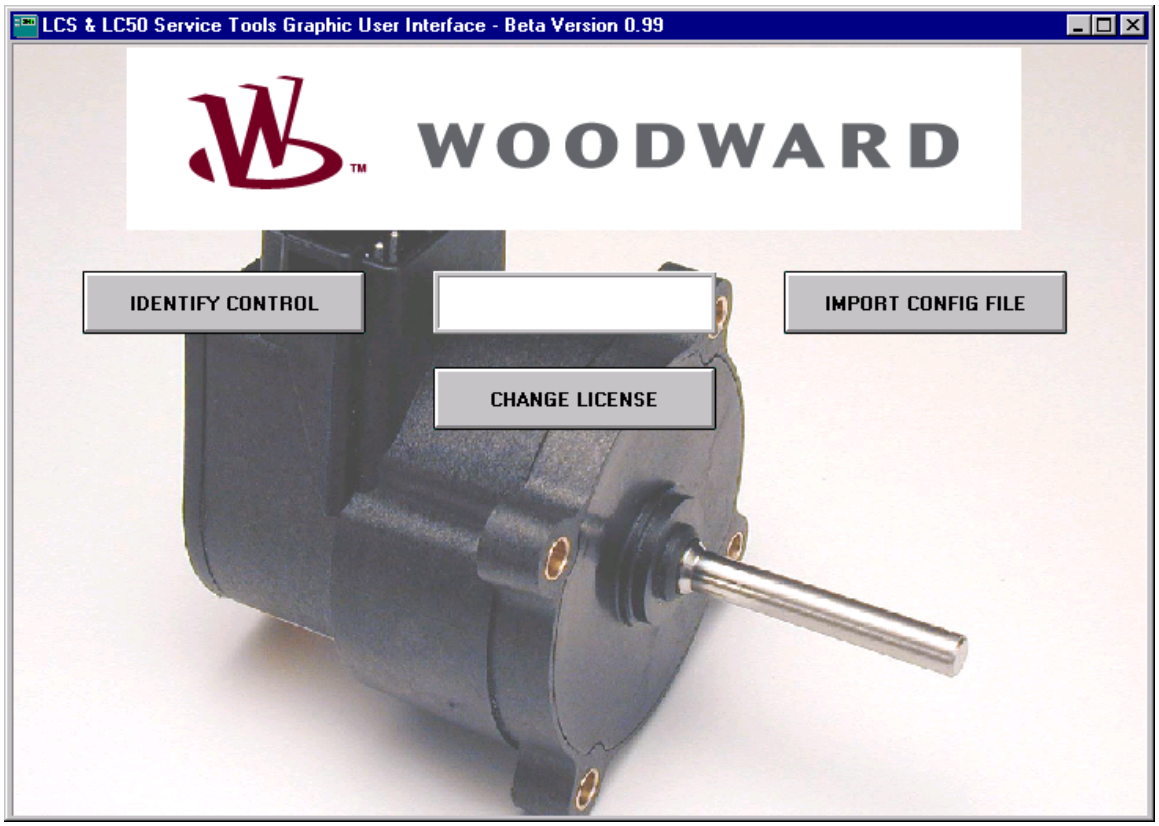
The dealer distribution is required to update control dynamics and read out fault codes. The OEM distribution is required to configure, tune, and secure the control; it also includes the utilities from the dealer distribution.

Software Installation

The software tool is available for download form Woodward's website:

www.woodward.com/ic/software/software.cfm

Select the LCS Control from the pull-down menu. Then select GO. A new screen will appear with information about the product as well as installation instructions. To download the software, press the DOWNLOAD button.



Before you can download, you will be prompted to log on to the Woodward site. If you have never downloaded Woodward software, you will have to complete a new registration.. Press this icon and fill out the information requested. If you have already registered, enter your e-mail address and press Login. The registration information is required so that we can alert you of updates to the software tools.

Once you have downloaded the software, double-click on the file (setupLCv1-0-A.exe) and follow the on-screen prompts. The defaults install is a dealer distribution in the default directory of LC-ctrl. To activate the OEM version, a license authorization must be obtained. This can be obtained from the same website.

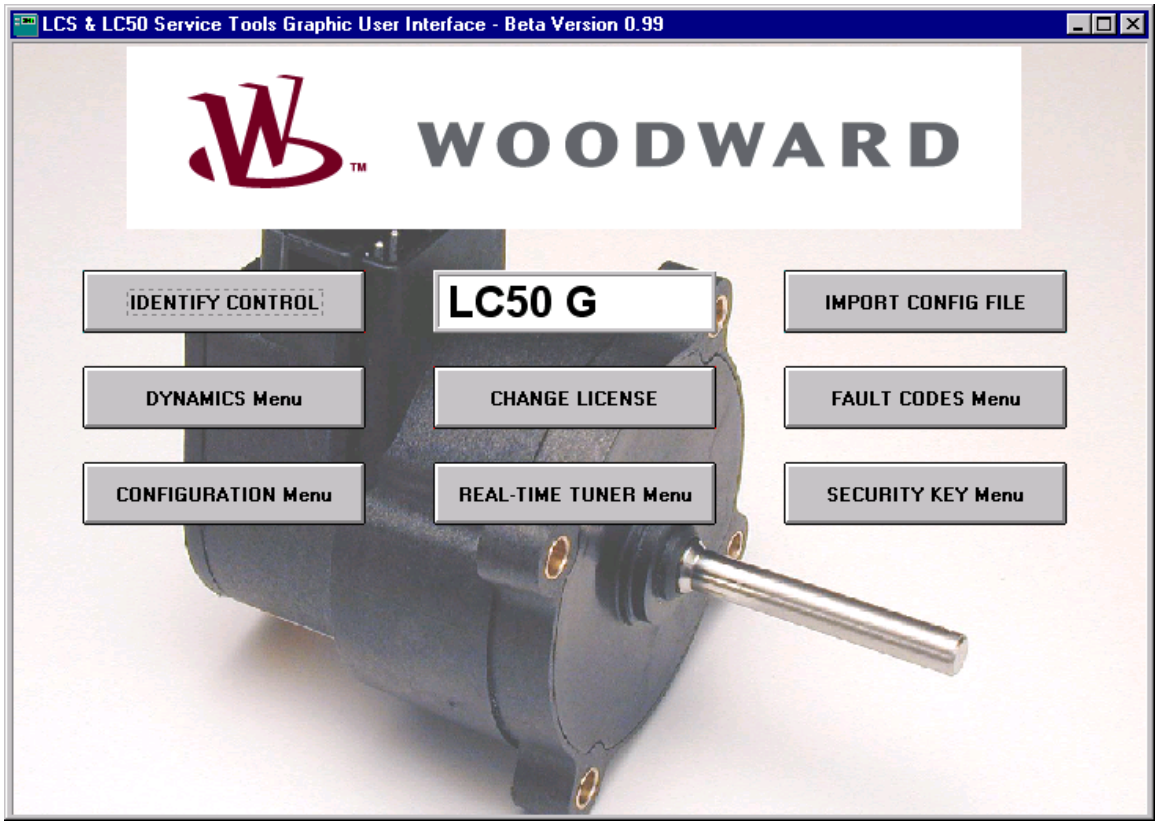
You will need a serial number (obtained from your account manager) and a site code (obtained by pressing Change License) on the LC Control Software.

This is the first screen that appears when the GUI is initialized. To use the GUI Service tools, the user must have either an LCS with a supported firmware revision or the user must have access to a valid configuration file. This feature can also be used to identify the firmware revision of a particular configuration file.

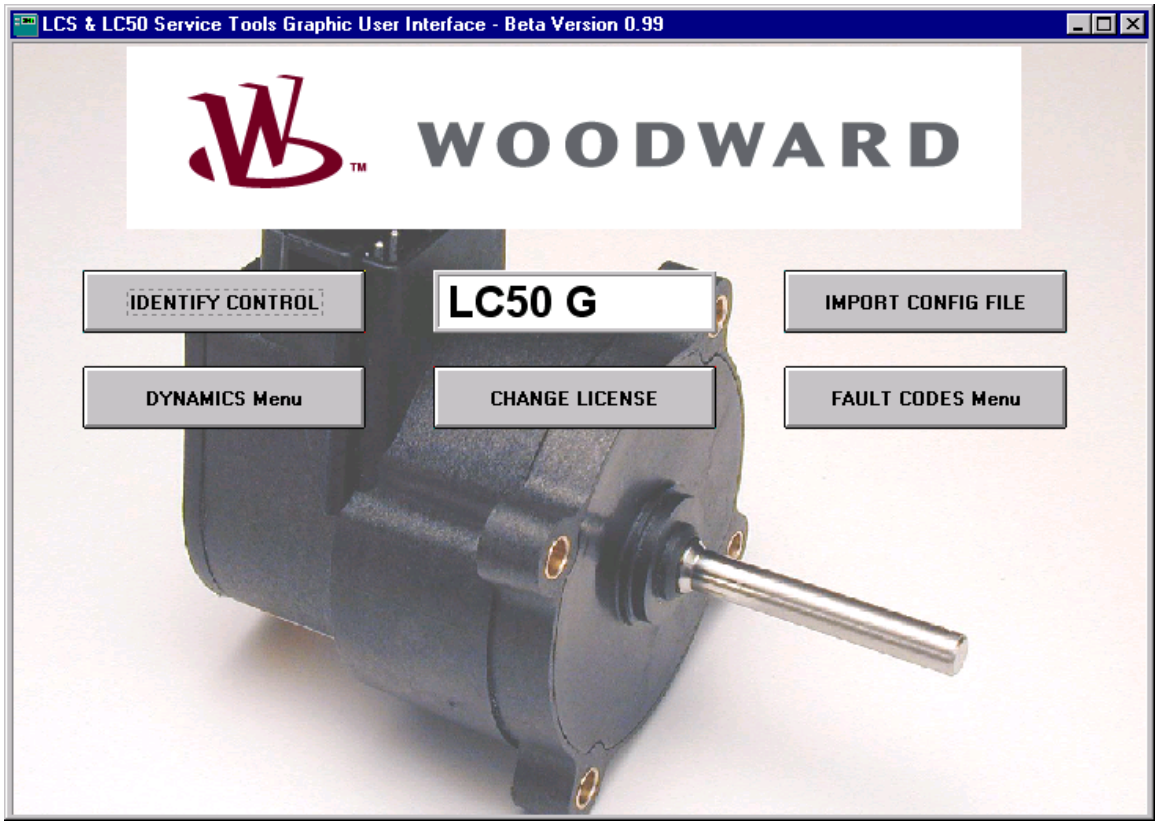
The GUI supports several firmware revisions. The dialog box in the center of the screen will indicate “LCS B/C”, “LCS D”, “LC-50G”, or “LC-50I” configuration format will be used. This manual covers the LC-50G and LC-50I versions. If your system comes up as B/C or D configuration format, contact Woodward for the appropriate manuals.

- **IDENTIFY CONTROL**—Identifies which version of firmware an LCS has. This requires that an LCS be connected to your laptop with a programming harness.
- **IMPORT CONFIG FILE**—Opens an existing config file. Select the desired file using the browser (config files use a *.lcs extension). Template files are available to get started.

Once a valid file or valid LCS has been identified, the screen below is displayed. The box in the center of the screen identifies which version of LCS is being used.



OEM Version of Main Screen

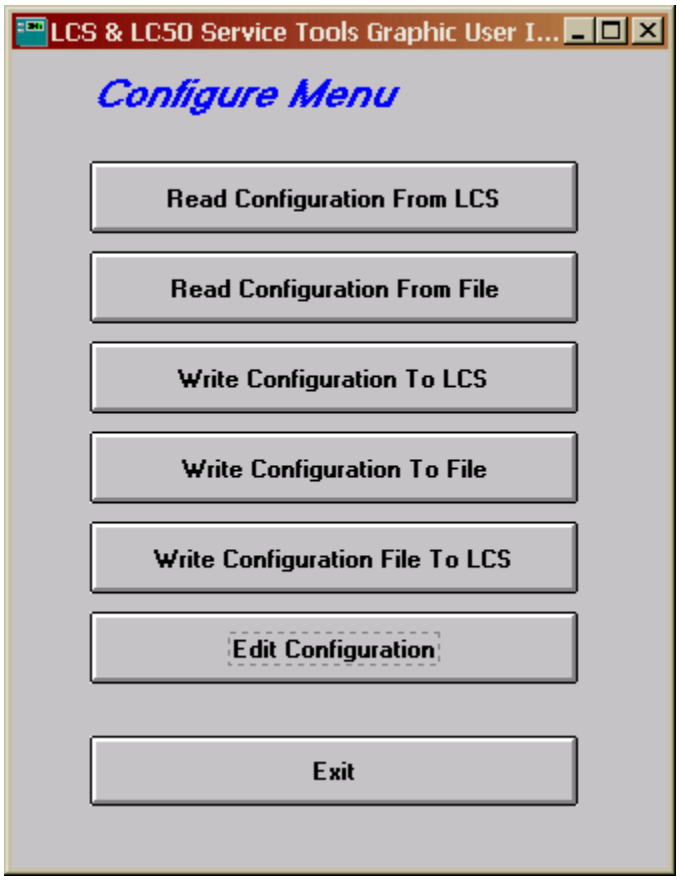


Dealer Version of Main Screen

CONFIGURATION Menu—Gives the user access to the configuration file handling options: edit config file, write to an LCS, read from an LCS, etc.
REAL-TIME TUNER Menu—Gives a user access to critical speed, dynamics, and position information for tuning. Both GAIN and Engine RPM can be monitored automatically by asserting the respective button. All data items must be read or written to by the GET and SET buttons, respectively.
SECURITY KEY Menu—Creates a security password and associated key to prevent other OEMs from viewing your *.lcs file.
FAULT CODES Menu—Fault codes can be viewed and reset from this menu.
DYNAMICS Menu—Provides access to a subset of the config file for dealers or field service.

Working with Configuration Files

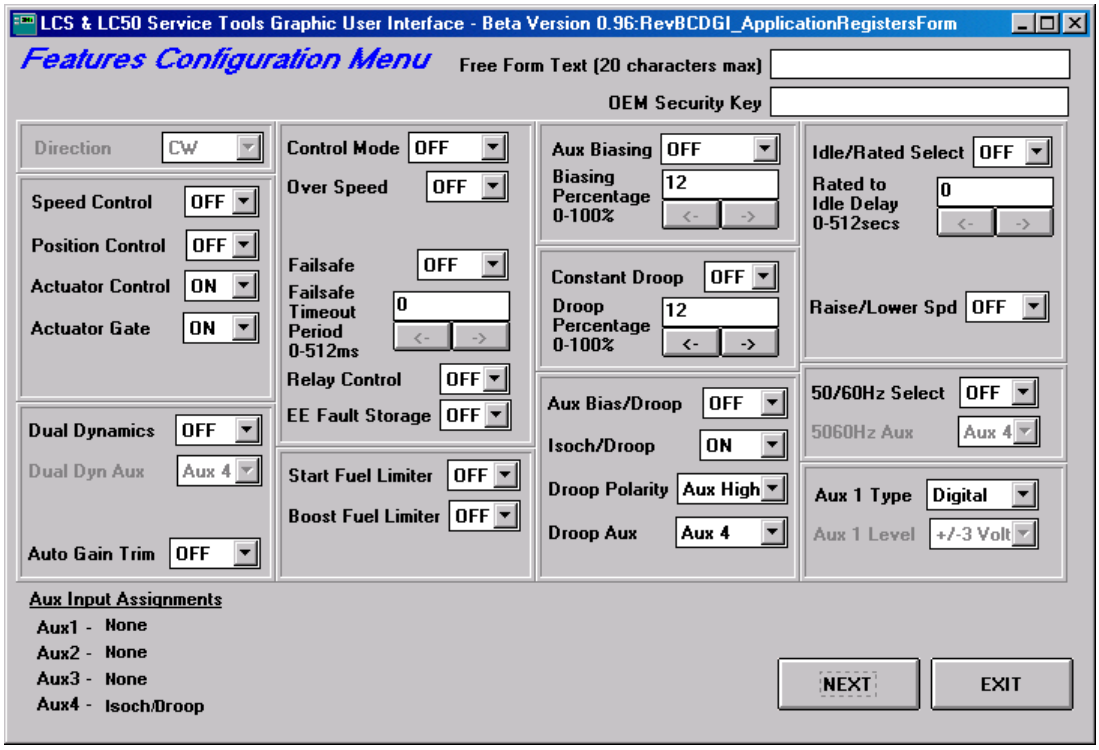
This is the menu that is displayed when the CONFIGURATION Menu button is pressed. Six options are available. After the configuration file or LCS has been validated, its data is loaded into GUI's memory.



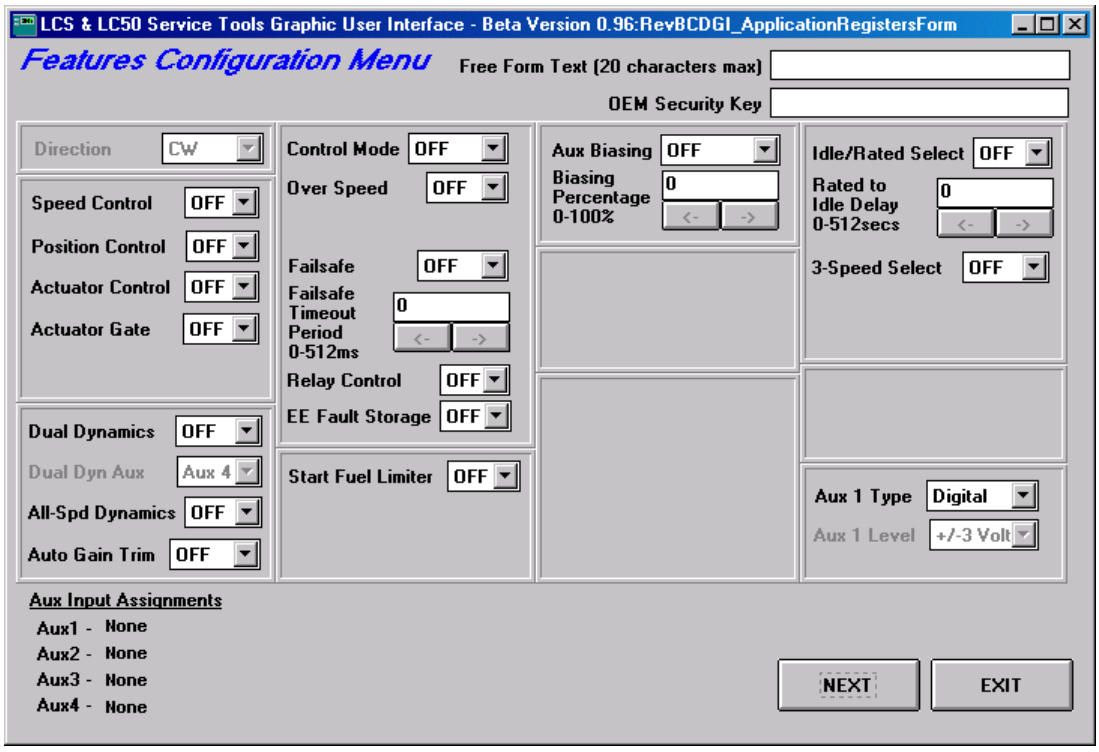
Read Configuration From LCS: Loads the config file from a LCS to the GUI. This requires that an LCS be connected to the computer through a programming harness. When you select this option, you will be asked to turn power on to the controller. Power is controlled by a toggle switch in the programming harness (see beginning of chapter for harness description).
Read Configuration From a File: Opens a Windows browser and allows the user to open an existing *.lcs file.
Write Configuration To LCS: Writes the active config file stored in the GUI to the LCS EEPROM. This requires an LCS be connected to the computer through a programming harness. When you select this option, you will be asked to turn power on to the controller. Power is controlled by a toggle switch in the programming harness (see beginning of chapter for harness description).
Write Configuration To File: Saves the active config file stored in the GUI to the location of your choosing.
Write Configuration File To LCS: Writes configuration file from hard drive or disk to the LCS.
Edit Configuration: Presents the LCS configuration file in a graphical format.
Exit: Returns to the main menu.

EDIT Configuration—Screen 1

On all screens numerical values can be entered by directly typing them in the field, or by pressing the up and down arrows to increase or decrease the value.



Features Configuration Menu—Generator Version



Features Configuration Menu—Industrial Version

This first screen allows the user to select the options to be enabled. See the Controller Features Description section of Chapter 2 for detailed explanations of each of the features.

The Free Form Text box allows the user to have a unique description for each configuration file. This text is stored in non-volatile EEPROM for future identification.

The OEM Security Key box is where the password is entered, if desired.

A feature is enabled or disabled by selecting ON or OFF from the pull down menu next to that feature.

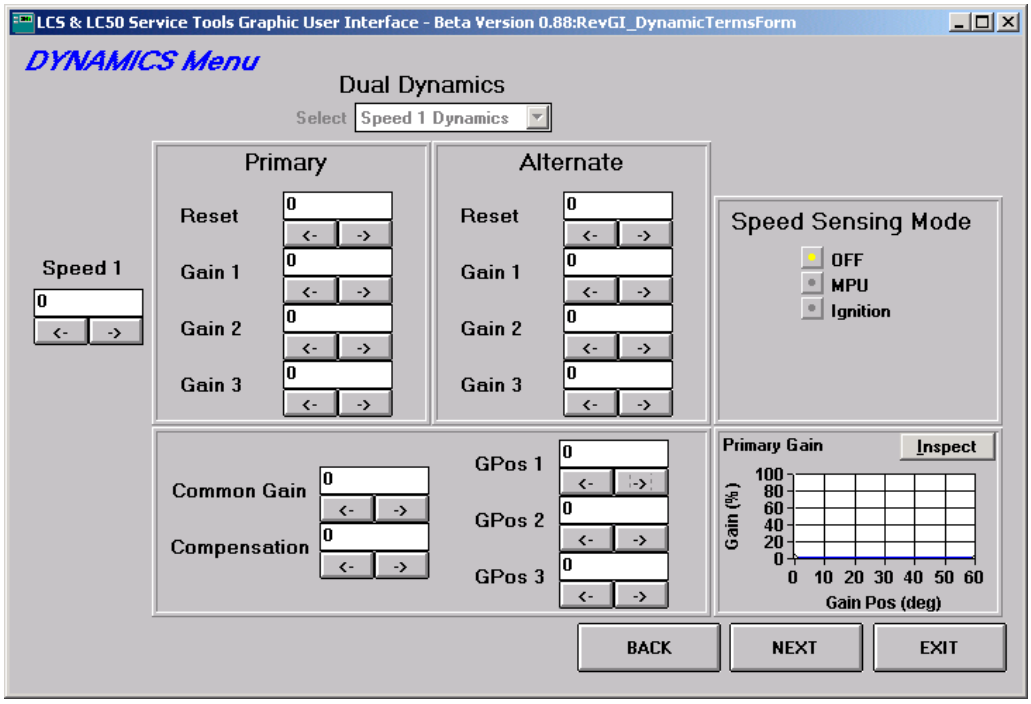
For features that can be programmed to come in on a choice of multiple pins, a status of each AUX input is displayed on the lower left of the screen. If the user tries to put two features on the same AUX input, the status area will indicate that with red text and the words CONFLICT Exists.

If a feature is not turned on, the associated parameters cannot be edited. For example, if Droop is not turned on, the dialog box underneath asking for a droop percentage, cannot be edited.

EDIT Configuration—Screen 2

When you press NEXT from the FEATURES CONFIGURATION Menu, the DYNAMICS Menu appears.

This is where the engine governing speed control gains are configured. If the LCS is being used as a positioner, no information is needed on this screen.



Dynamics Menu—Generator & Industrial Versions

If the LCS is being used as a governor, then the control dynamics, speed sensing, and speed settings will be entered on this screen.

Primary and alternate refer to the dual dynamics function. If the dual dynamics option was selected on the first screen, then values should be entered for both primary and alternate gains.

Speed 1 box on the left is the primary speed setting. If 50/60 Hz, idle/rated, or three-speed was selected, the pull-down menu at the top of the screen becomes accessible. This allows you to enter the speed settings and dynamics for the various functions.

Common gain, compensation, GPOS1, GPOS2, GPOS3 are common for all speed settings and both primary and alternate dynamics.

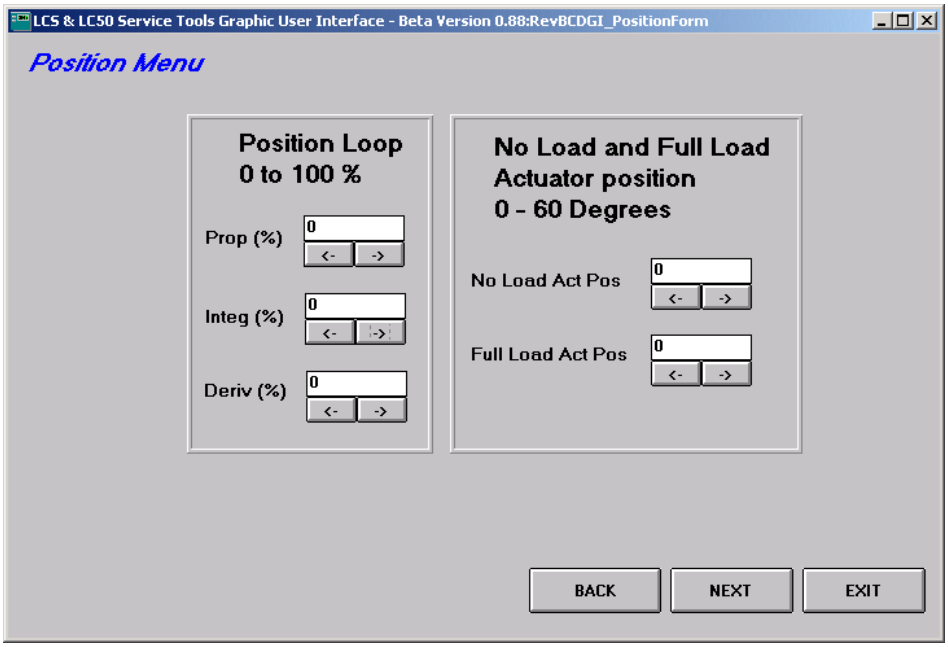
The graph on the bottom right will show a plot of the primary dynamics for the speed setting reflected in the speed select box.

The speed sensing mode is also defined here. If MPU is selected, an option drops down for number of flywheel teeth. If ignition is selected, drop down menus appear requesting inputs for number of cylinders and type of engine.

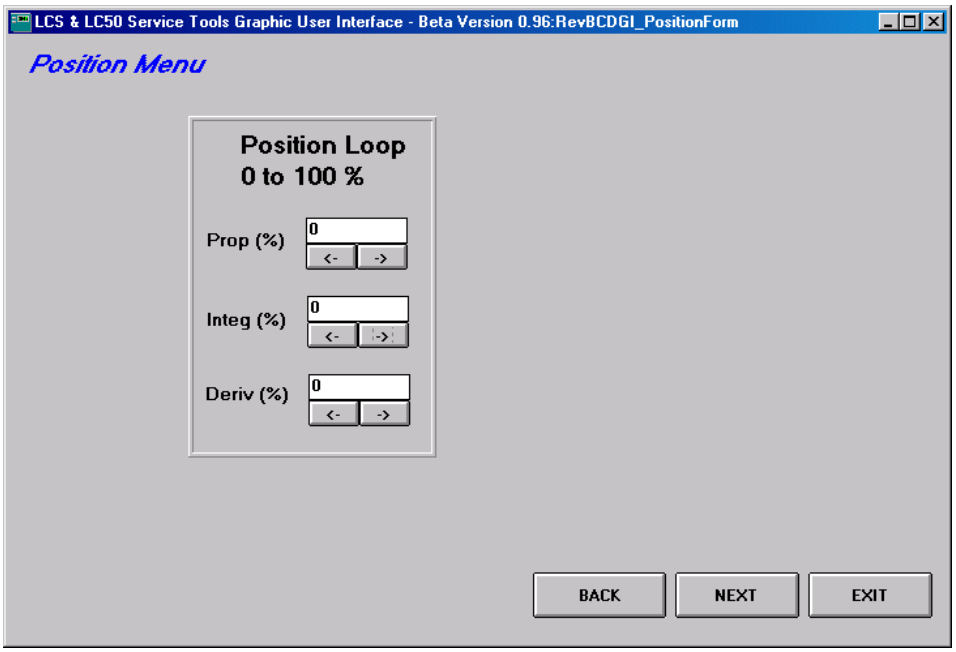
EDIT Configuration—Screen 3

The third screen in the configuration file editor is the positioner screen. The proportional, integral, and derivative terms control the response of the throttle blade. Typical values for throttle body applications are: proportional = 25 to 40, integral = 15 to 25, derivative = 0 to 30.

No load and full-load actuator positions are used by the droop function. If droop is not being used, no information is needed here.



Position Menu—Generator Version



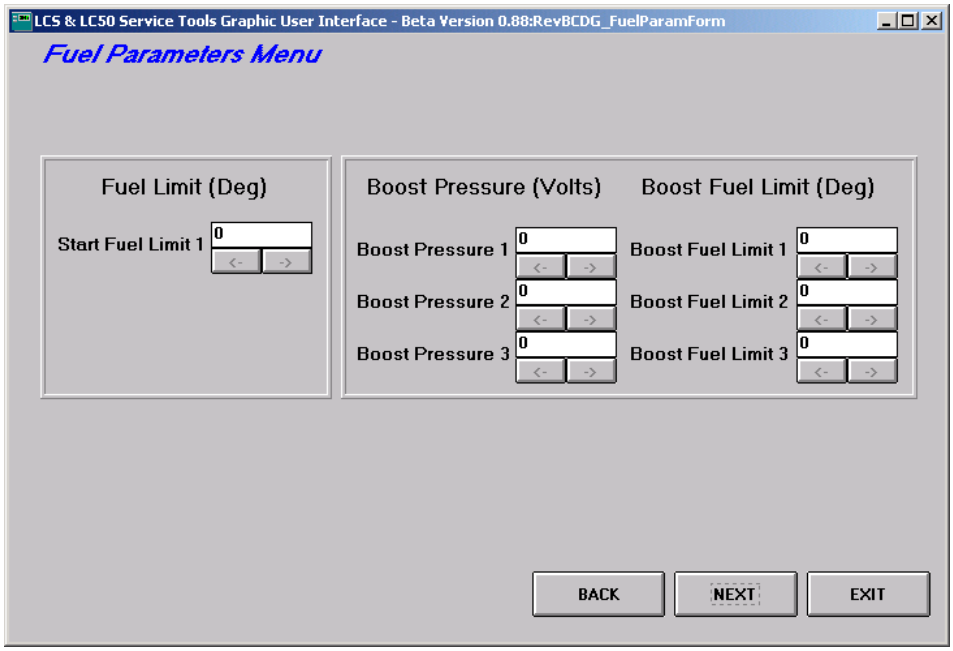
Position Menu—Industrial Version

EDIT Configuration—Screen 4

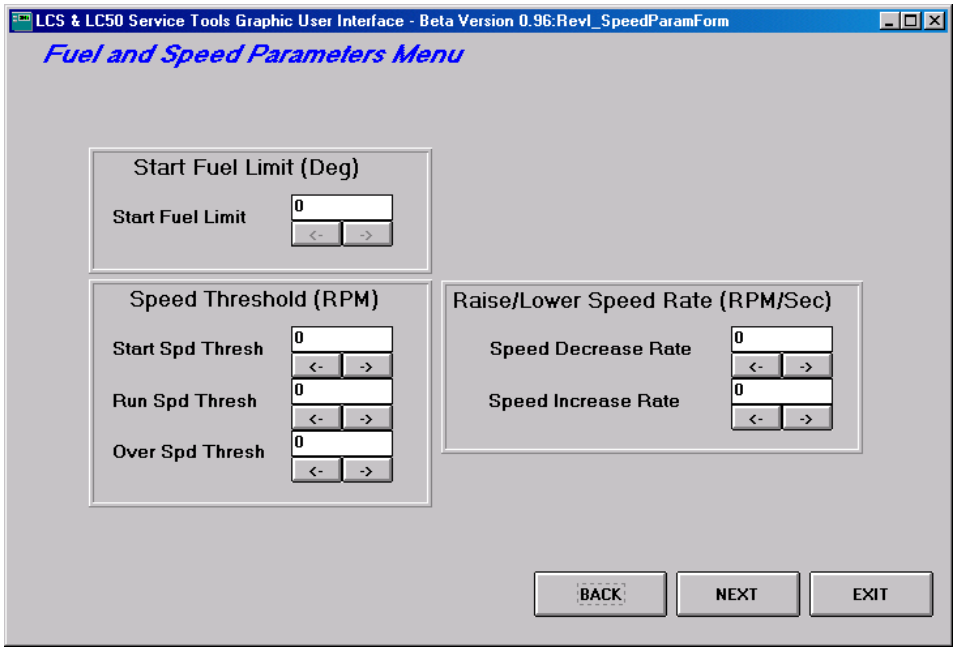
The Fuel Parameters Menu is the fourth screen. This screen is where the fuel limiting parameters are entered. If start fuel limiting and boost fuel limiting are not being used, this screen can be skipped.

If start fuel limiting is being used, enter the actuator position limit on this screen. The RPM threshold is entered on the next screen.

If boost fuel limiting is being used, enter the parameters here. These points act as a three-point curve, with linear interpolation between points.



Fuel Parameters Menu—Generator Version

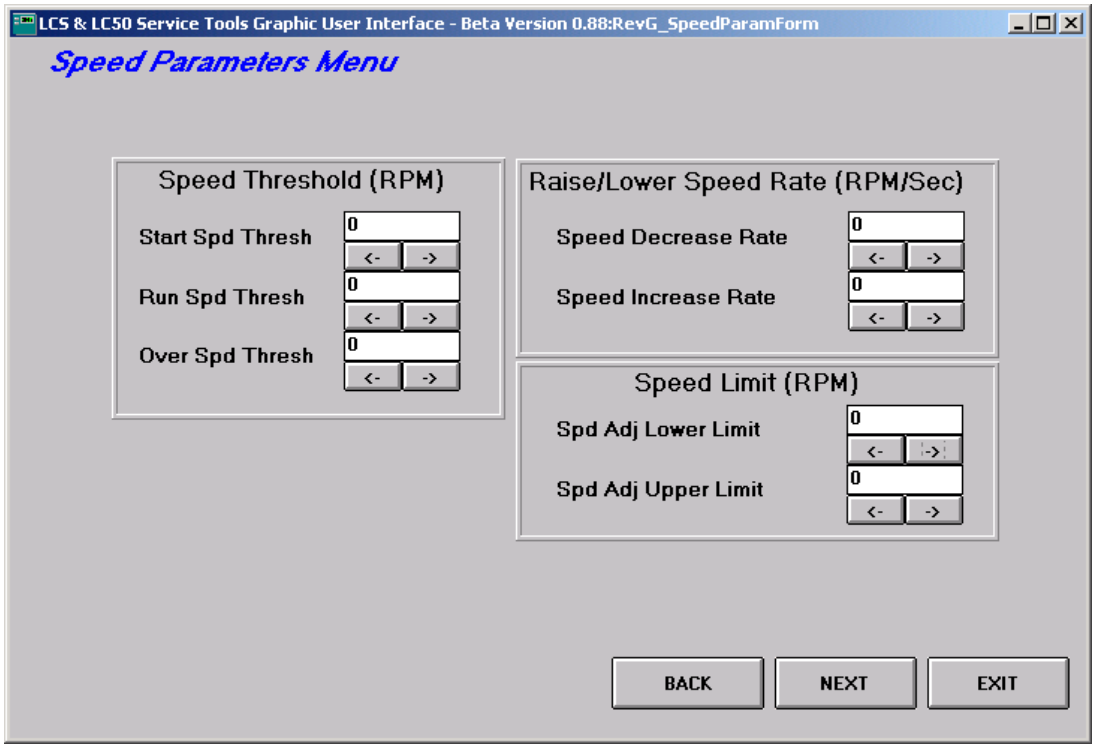


Fuel Parameters Menu—Industrial Version

EDIT Configuration—Screen 5

The fifth screen presents the Speed Parameters Menu. The start speed threshold, run speed threshold, and overspeed threshold are entered here.

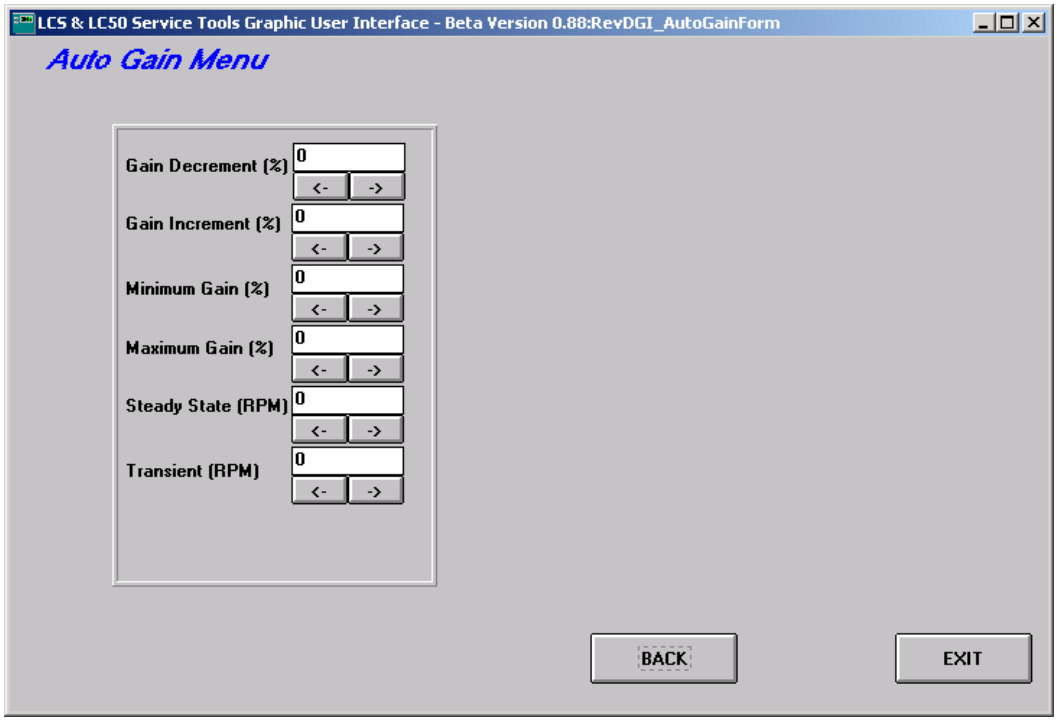
If the raise/lower function has been enabled, enter the ramp rates in speed decrease rate and speed increase rate. The upper and lower limits for the raise/lower function are also entered here. The ramp rates are also used by the idle/rated function and the three-speed function. The speed will transition between the various set speeds at these rates.



Speed Parameters Menu—Generator Version

EDIT Configuration—Screen 6

This is the final screen in the EDIT Configuration Menu. This screen is where the auto gain parameters are entered. The GAIN DECREMENT and GAIN INCREMENT indicate how much the gain should be altered when the system is determined to be unstable. Minimum Gain and Maximum Gain are the limits for any changes in the gain. Steady State (rpm) and Transient (rpm) are the windows to determine instability. If the system is operating in a steady state mode, then if the RPM varies by more than this amount the gain will be decremented by the amount indicated in Gain Decrement. Likewise, during a transient event, if the RPM varies outside the transient RPM window, the control will increment gain.

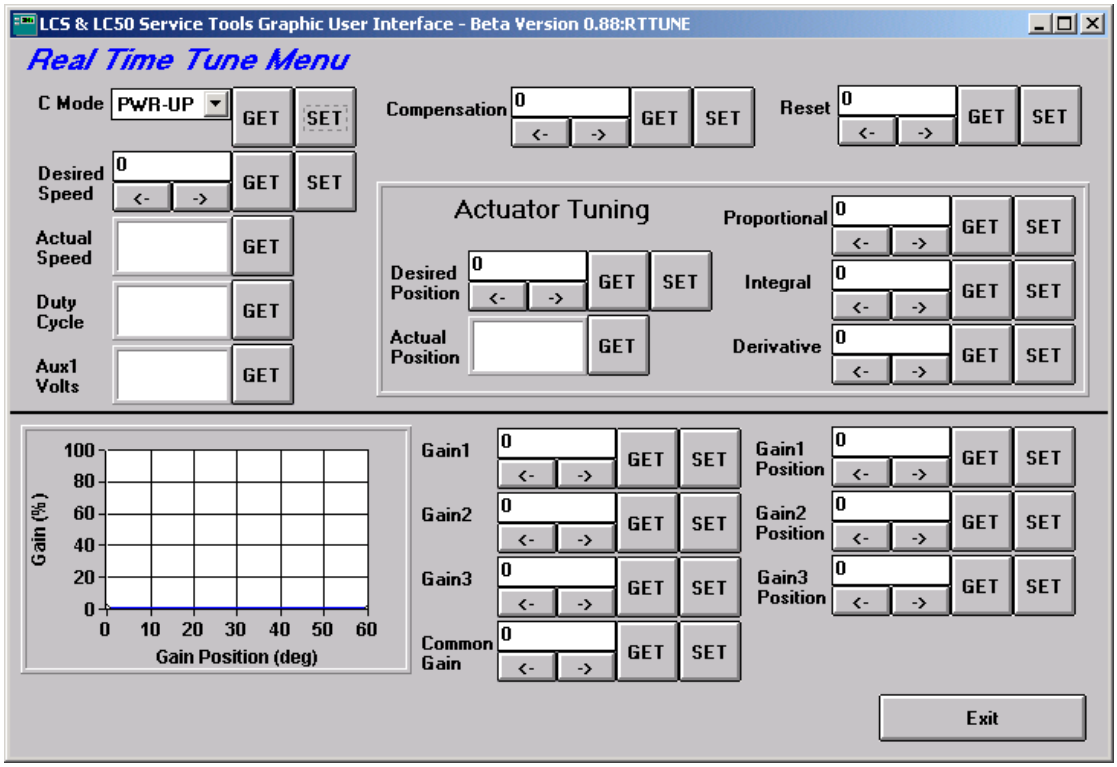


Real-Time Tuner

The OEM utility REAL-TIME TUNER is designed to give application engineers the ability to tune an LCS control's actuator position control loop and engine speed control loop.

The program initializes the control for real-time communications while the main control loops are executing. Because the real-time tuning software uses AUX2, AUX3, AUX4, and the relay output to communicate, no auxiliary product features can be enabled. Use of this feature requires an LCS be connected to the computer through a programming harness. When you select this option, you will be asked to turn power on to the controller. Power is controlled by a toggle switch in the programming harness (see beginning of chapter for harness description).

Examples of how this tool is used are contained in the sections of this manual dealing with actuator tuning and engine tuning.



Working with Security Keys

If an OEM decides to make use of the password protection feature, this is where the password is entered and the associated key is created. This screen is accessed from the Main menu by pressing Security Key Menu. Enter the password you would like to use in the text input box. Then press the Make Key button. A file called “access.key” is created that must then be present in the working directory any time you attempt to communicate with the LCS.

Viewing and Resetting Fault Codes

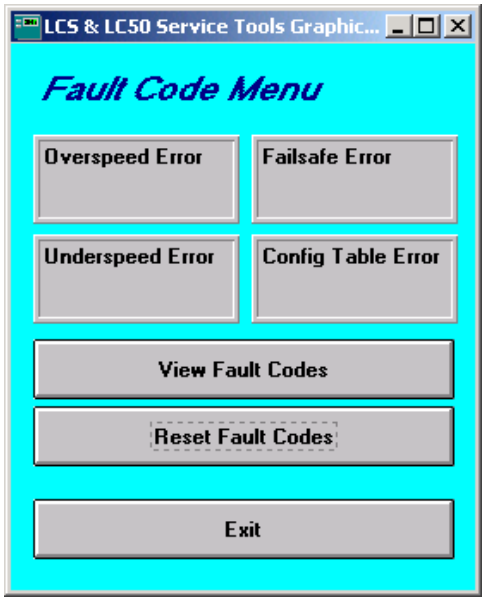
VIEW Fault Codes

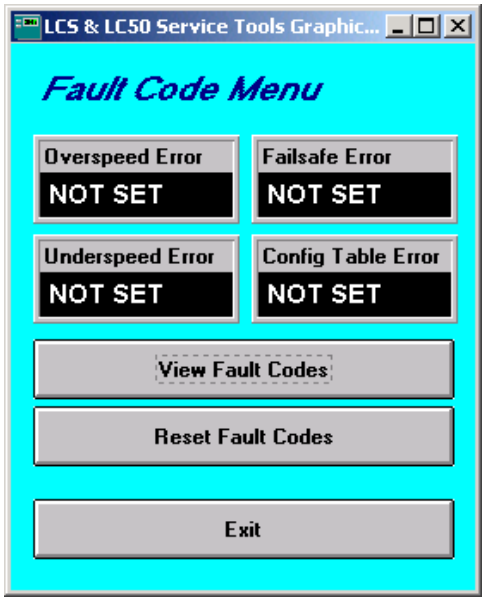
To view the contents of a control’s fault register, press the VIEW FAULT CODES button located in the FAULT CODES Menu.

The program will display which of the error bits are set within the register (configuration error, overspeed error, or failsafe error). A configuration error is the result of not downloading a configuration file into a new control. Overspeed, and failsafe errors all relate to issues with the MPU or connection to an ignition system. The underspeed fault does not apply to the LC50 ITB versions of the LCS.

RESET Fault Codes

To clear the contents of the control fault register, press the RESET FAULT CODES button. The program will reset the state of all error bits.



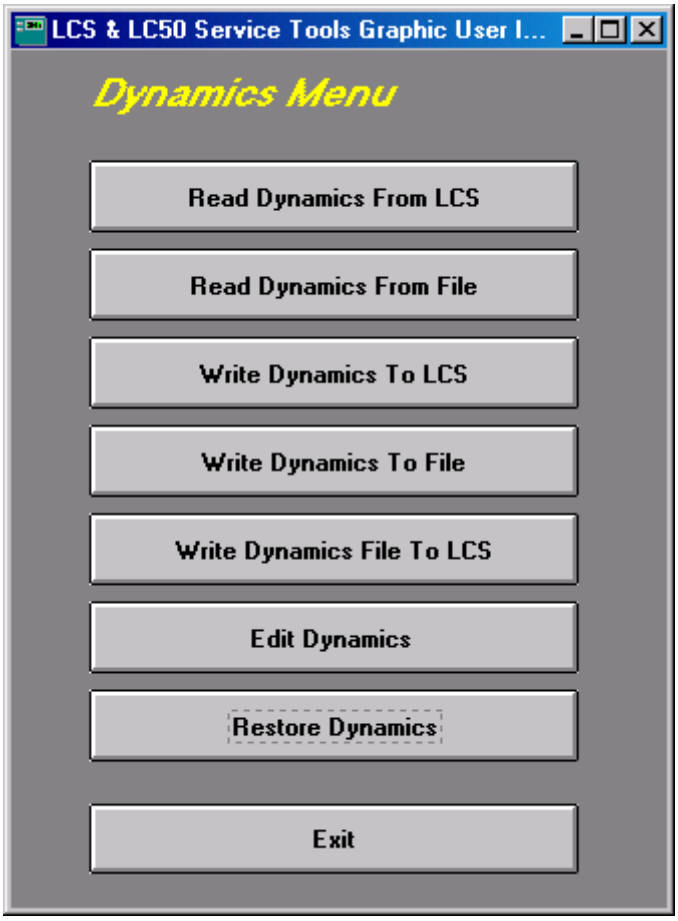


Messages
In working with the LCS, the power must be cycled from time to time. The user will be prompted to turn power on or off. If the power is not cycled in 10 seconds, a message will appear which allows a retry or the cancellation of the current activity.

Dynamics Menu

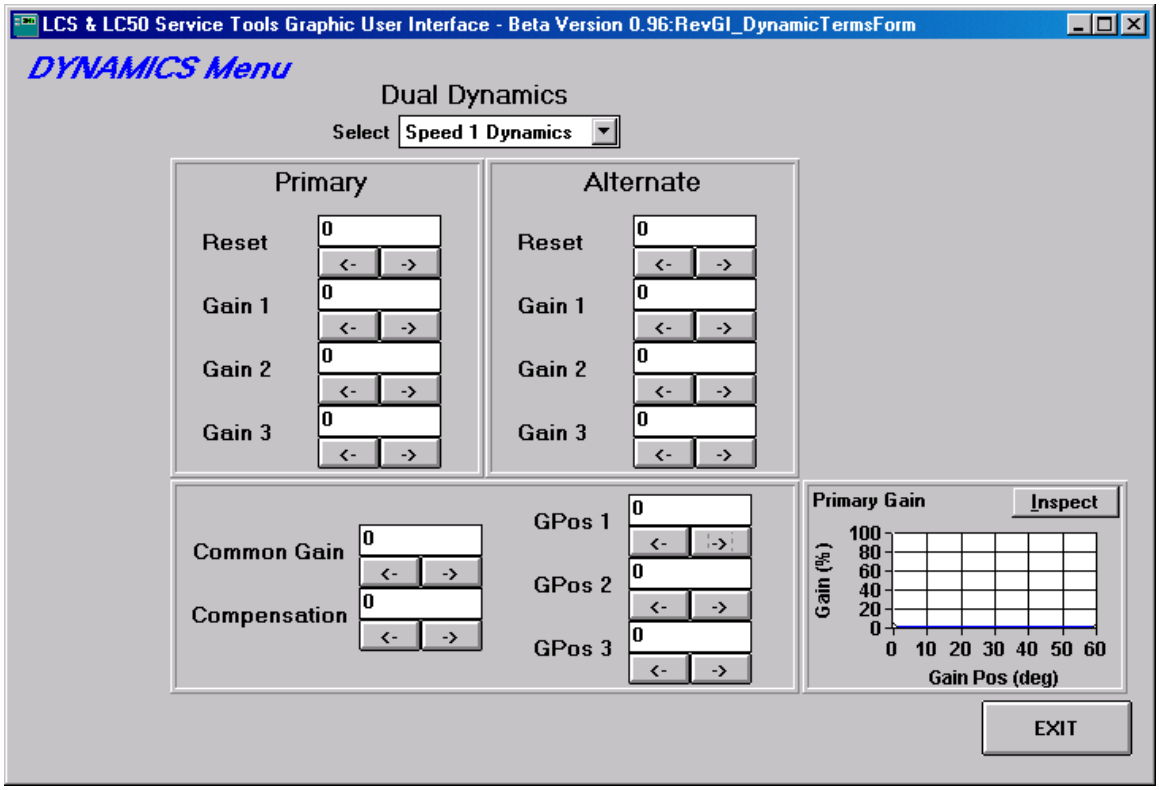
This is the menu displayed after pressing Dynamics menu. It allows access to a subset of the entire configuration file. Dealers or field service personnel can access all of the dynamics associated with the controller including: primary and alternate reset, gain 1, gain 2, gain 3, and compensation for all speeds.

Read Dynamics From LCS—Loads the dynamics file from a LCS to the GUI. This requires that an LCS be connected to the computer through a programming harness. When you select this option, you will be asked to turn power on to the controller. Power is controlled by a toggle switch in the programming harness.
Read Dynamics From File—Opens a Windows browser and allows the user to open an existing *.dyn file
Write Dynamics To LCS—Writes the active dynamics file stored in the GUI to the LCS controller. This requires that an LCS be connected to the computer through a programming harness. When you select this option, you will be asked to turn power on to the controller. Power is controlled by a toggle switch in the programming harness.



Write Dynamics To File—Saves the active dynamics file stored in the GUI to the location of your choosing.
Write Dynamics File To LCS—Writes a dynamics file from the hard drive or disk to the LCS.
Edit Dynamics—Presents the LCS dynamics file in a graphical format for editing.
Restore Dynamics—Restores the original OEM settings. If a user writes dynamics changes to the LCS and decides that they are not effective, pressing restore will copy the original settings from backup memory area on the controller.
Exit

When Edit Dynamics is pressed, the following screen is displayed.



Controller Tuning

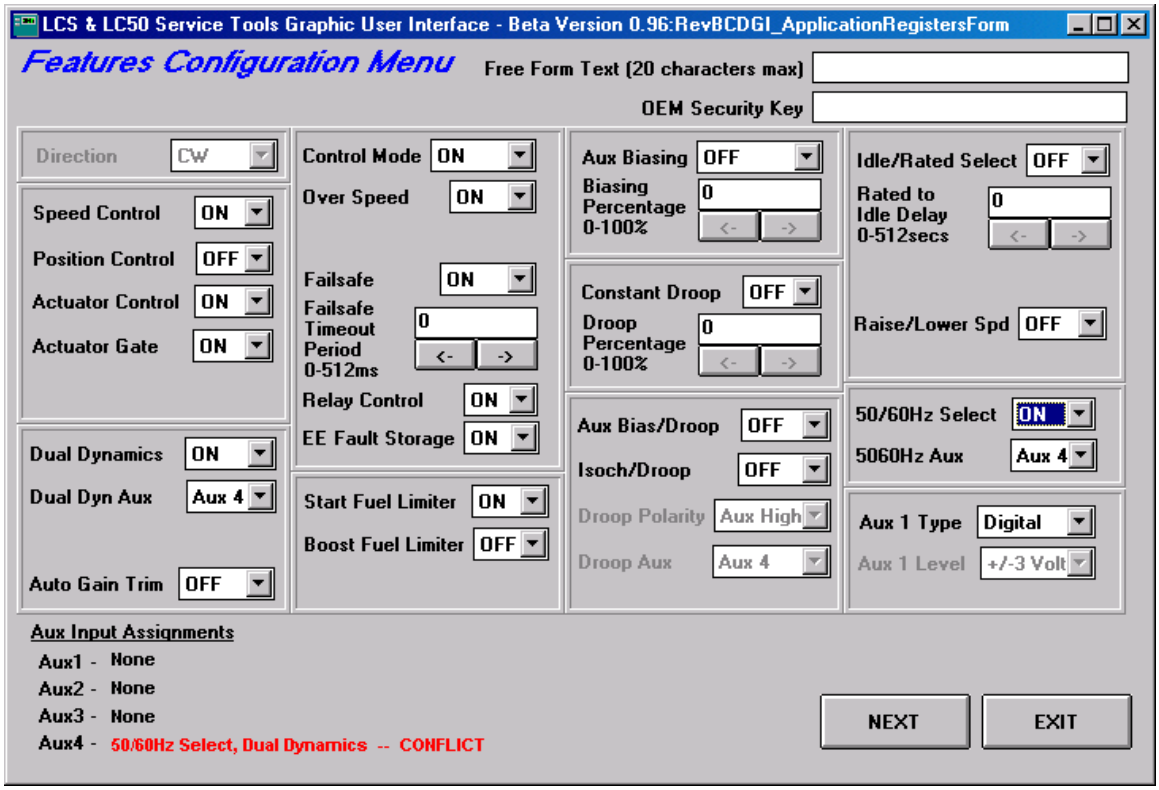
Before continuing, the OEM should already have in mind which speed setting, speed biasing, speed sensing, alternate dynamics, fuel limiting, and support logic features should be enabled. For more information on the features available, see the Features Description section of Chapter 2.

Initial File Construction

An initial configuration file must be created for every application. This file can either be created from scratch or an existing file can be modified. The steps below outline how to create the initial file.

1. Start the GUI program by selecting it from the Windows Start Programs menu.
2. Select IMPORT CONFIG FILE.
3. An existing config file can be used if the application is similar to one already developed. If this is the case, choose Config files from the file type drop down and then select the appropriate file from the Windows browser. If this is a new application, a template file can be opened. Select Template files from the drop down menu and then select the template that matches your version of LCS controller.

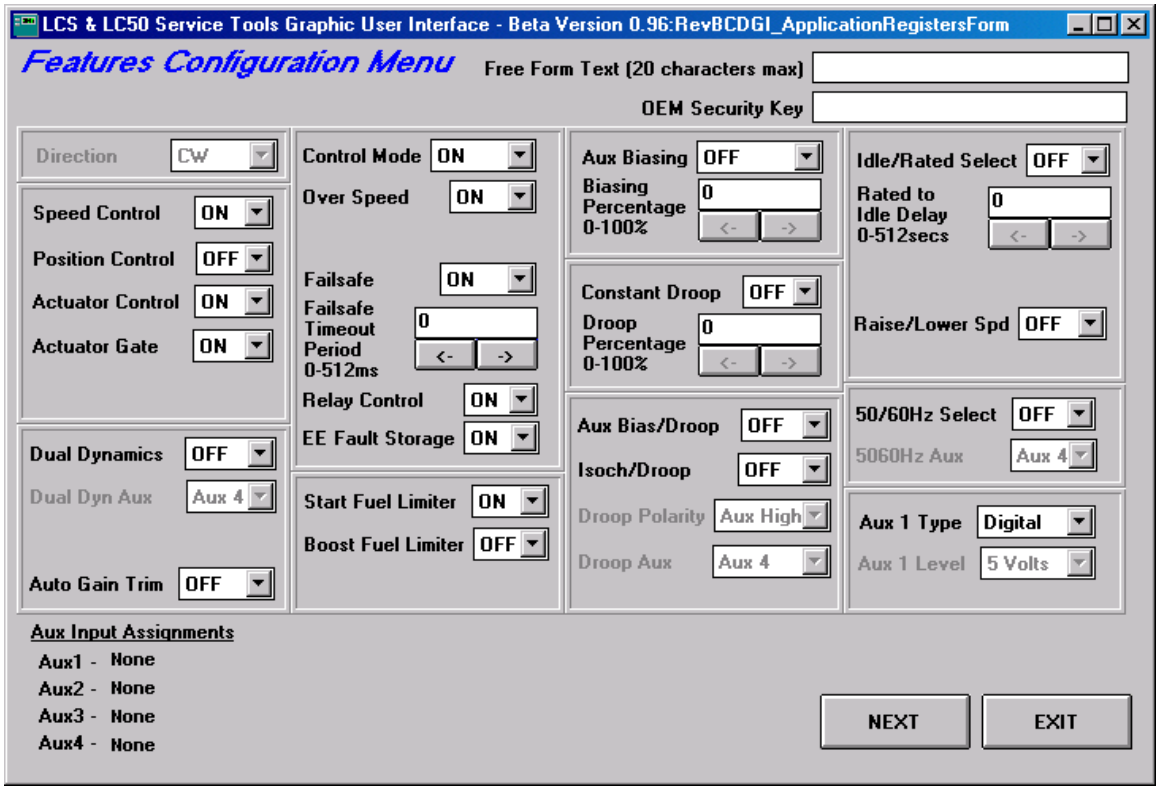
4. Select the file by double-clicking on it, or single-clicking and then pressing OPEN.
5. Once the file is opened, you are returned to the MAIN Menu.
6. To edit the configuration file, press the CONFIGURATION Menu button.
7. Then press the EDIT Configuration button.
8. You are taken to the first screen of the Configuration Menu. In this screen select the features you have determined you would like enabled.
9. If inputs are selected on the AUX pins, the bottom left of the screen indicates which inputs are associated with the AUX inputs. If a conflict exists, the text will turn red. Make sure that all inputs are coming in on a unique Aux input before continuing.



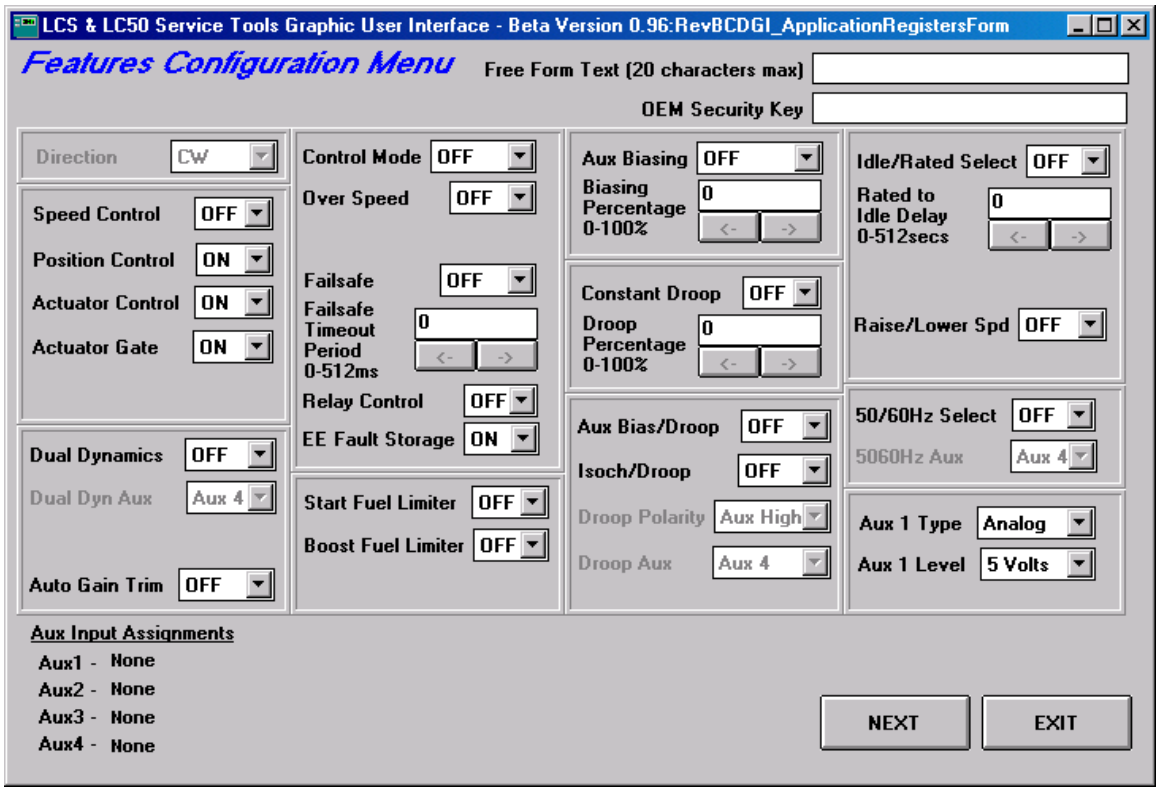
AUX Input Assignment Conflict Designation

10. For initial tuning, the AUTO-GAIN feature should be turned off.

11. When all the features are selected press NEXT.

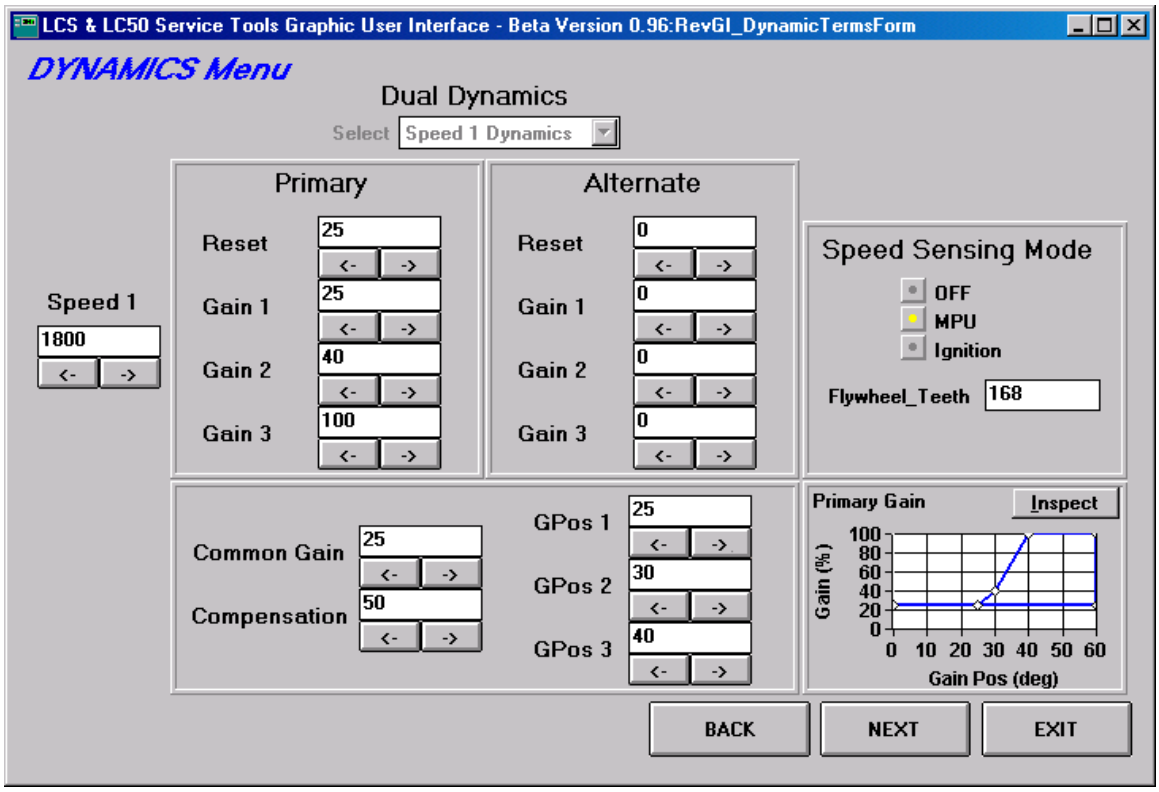


Initial Speed Governor Feature Settings



Initial Positioner Settings

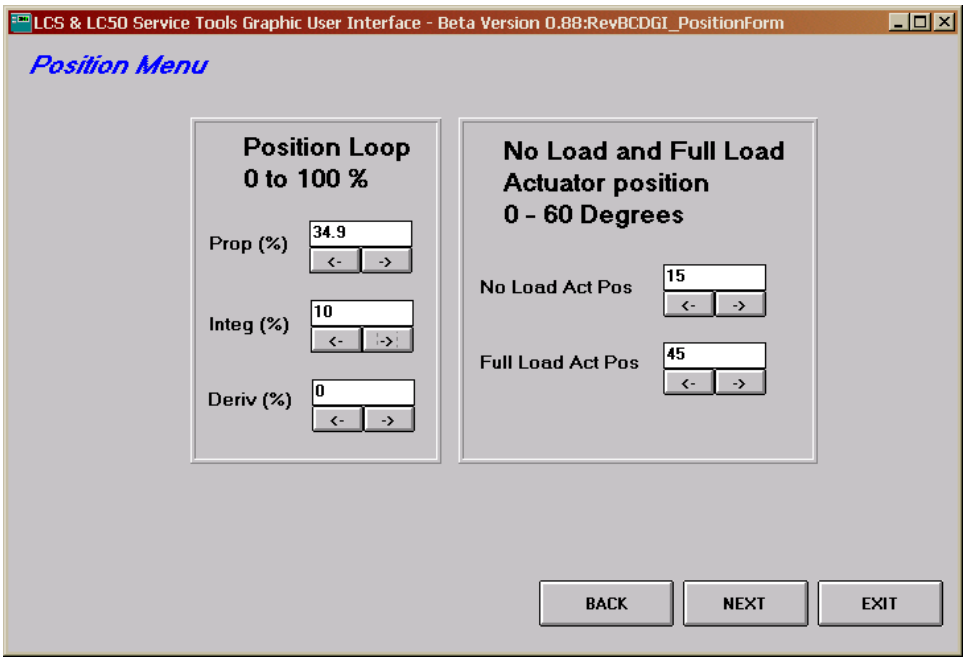
12. The next screen asks for dynamics information. If this is a new application, reset, compensation, and gain can all be set to the values shown initially. A common gain setting of 20 will give steady speed control for initial start-up and air/fuel ratio tuning. The controller may not respond will to large transients however. If this is for a positioner application, the values on this screen will be ignored.



Initial Dynamics Settings for Speed Governor Applications

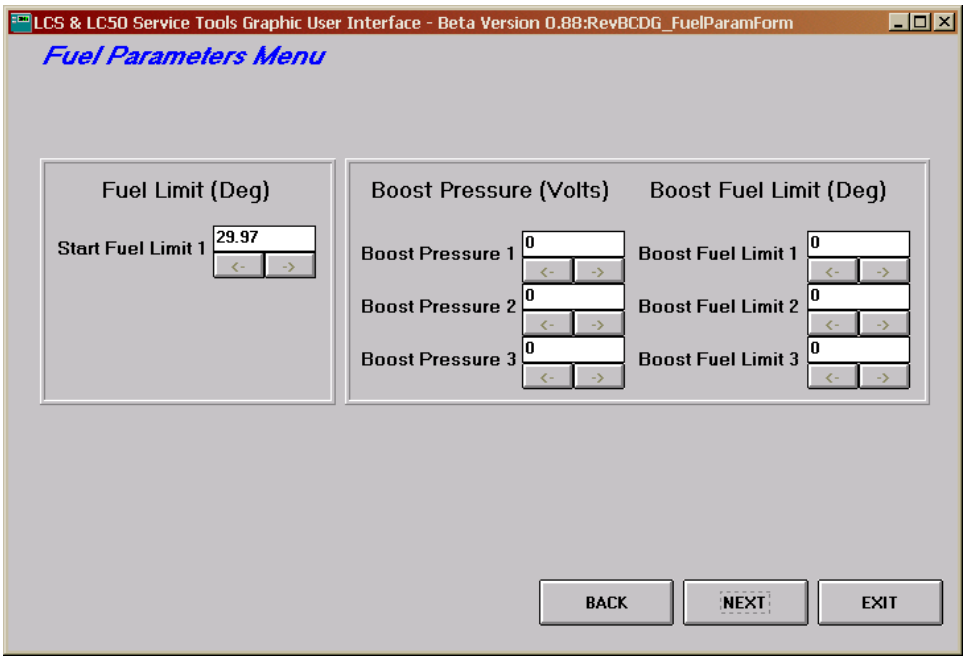
13. The appropriate speed setting should be entered on this screen.
14. The speed sensing mode is also entered here.
15. After entering these values, press NEXT.

16. The POSITION Menu is displayed. Appropriate initial values for the PID terms are: proportional = 35, integral = 10, derivative = 0.

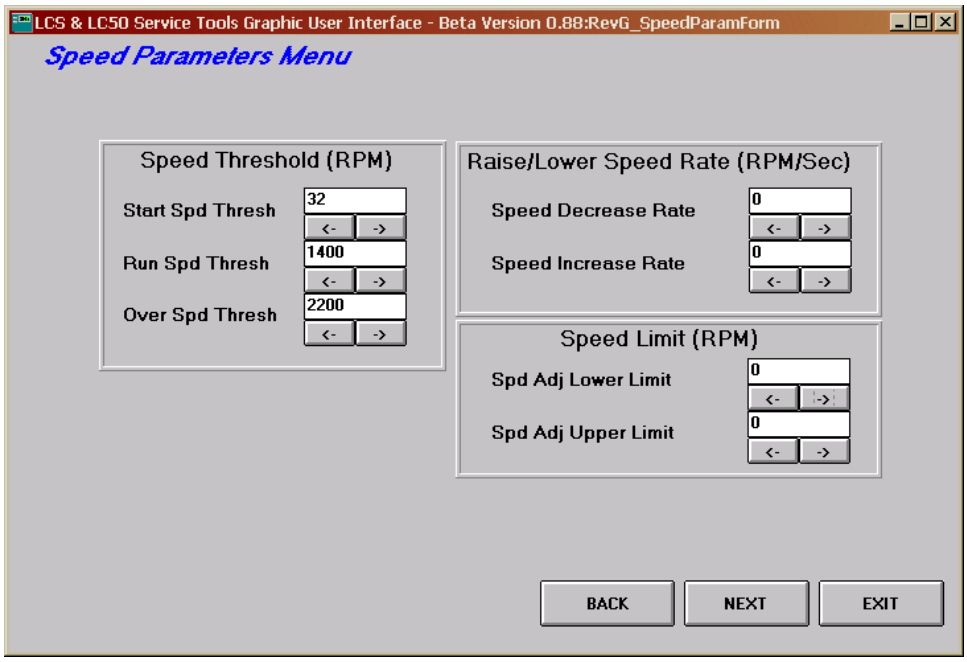


Typical Speed Governor and Positioner Values

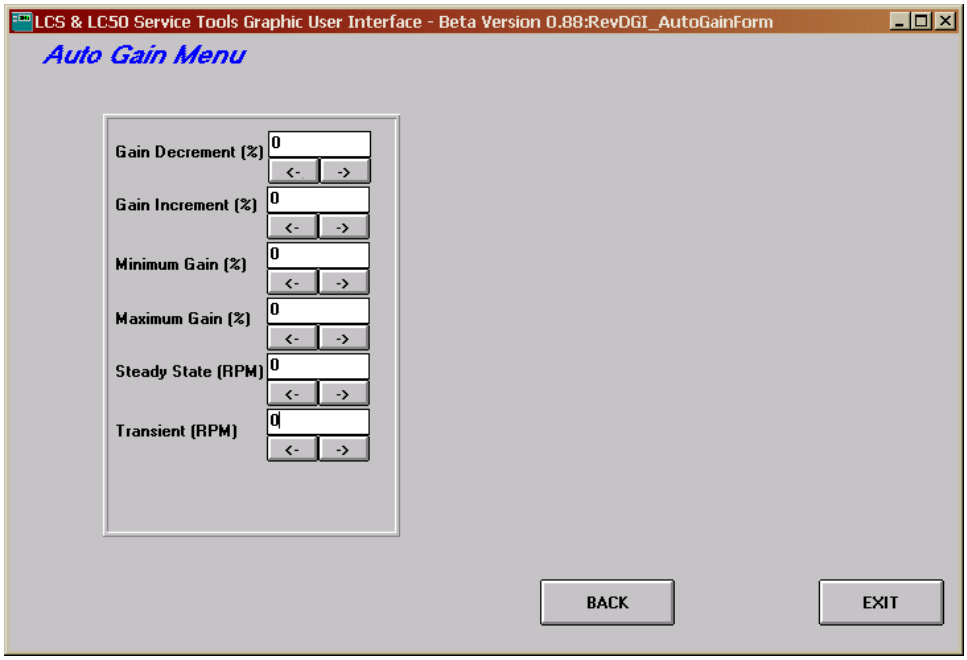
17. If droop is being used, full-load and no-load actuator positions will need to be determined and entered here. (This can be after initial tuning.) Typical values are approximately 15° at no load and 50° at full load.
18. Press NEXT.
19. The FUEL PARAMETERS Menus is displayed. Enter any desired values here. The start fuel limit will help to avoid over-speed on start-up. Typical values are 20° to 30°. Boost fuel limit function is discussed in Chapter 2.



20. Press NEXT.
21. The SPEED PARAMETERS Menus is displayed. Enter start speed threshold, run speed threshold, and overspeed threshold here. Also enter any desired raise/lower values here.



22. Press NEXT.
23. The AUTO-GAIN parameters Menu is displayed. This feature should be turned off for initial tuning. So, these values should be zero.



24. Press EXIT.
25. You are returned to the Main Menu. Press Write Configuration To File to save your initial configuration file to a file. Press Write Configuration To LCS to write the file to the controller and begin tuning.

LC-50 Applications (Mixer Applications)

After the initial program is configured, the air/fuel ratio should be optimized before extensive engine speed governor tuning is done. Start with low gain values and step slowly through load changes until the air/fuel ratio is tuned.

Initial settings are described in the hardware installation section of the INSTALLATION chapter. These settings should get the gensets up and running for final adjustment with an oxygen sensor or exhaust analyzer.

WARNING
Know in advance how to safely shut off the engine during normal and emergency stop conditions. Shutting off power to the governor does not always guarantee a controlled shutdown; it depends on the final application. Safety needs to be the overriding thought during this procedure.

Air/Fuel Ratio Tuning

1. Insert an oxygen sensor or exhaust gas analyzer into the exhaust stream as directed by the manufacturer of the sensor or analyzer.
2. Ensure a configuration file has been downloaded into the LCS controller (See initial configuration file section.)
3. With LCS power off, press **Start Real Time Tuner Menu** and turn power on.
4. Start the engine.
5. If the engine overspeeds and shuts down, perform the following
   - Exit Real Time Tuner Menu
   - Remove power from the control.
   - Go to the EDIT Configuration Menu, then go to screen 4, and adjust the start fuel limit to a lower value.
   - Repeat steps 3 through 5.
6. Start the engine and allow it to warm up for about 15 minutes.
7. Apply 75% to 90% load to the engine. With initial, low gain values in the speed control loop, the load may need to be applied gradually to avoid under and overspeed conditions.
8. Adjust the MAS to achieve the desired air/fuel ratio. Figures below show characteristic response of oxygen sensors and exhaust gas. Clockwise rotation of the MAS will cause the air/fuel ratio to become more lean. Counter-clockwise rotation will cause the air / fuel ratio to become more rich.

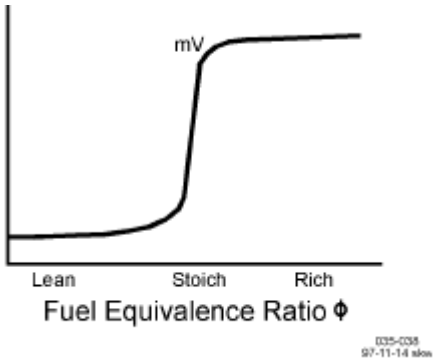


Figure 4-2. Zirconia Oxygen Sensor Response

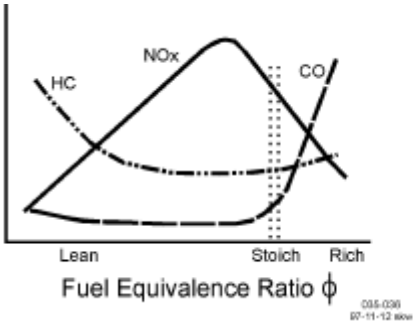


Figure 4-3. Pre-Catalyst Emissions

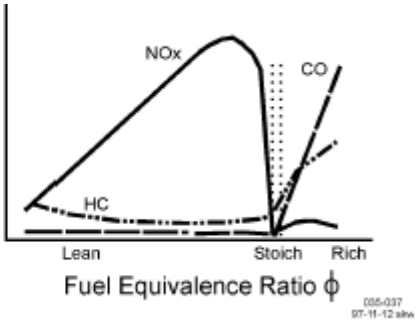


Figure 4-4. Post-Catalyst Emissions

9. The ZPR should then be adjusted at no-load. Clockwise rotation of the screw will cause the mixture to become richer, counter-clockwise rotation will cause the mixture to become leaner. When the cover is removed from the ZPR, extra air leakage is introduced into the system. So, a final setting cannot be determined until the ZPR spring tower is covered.
10. One or two more iterations at full load for the MAS and no load for the ZPR should provide the correct air/fuel ratio over the entire operating range.

Speed Governor Applications

WARNING
Know in advance how to safely shut off the engine during normal and emergency stop conditions. Shutting off power to the governor does not always guarantee a controlled shutdown; it depends on the final application. Safety needs to be the overriding thought during this procedure.

Speed governor applications require that the speed control loop be tuned for load transients and steady-state stability. Use this procedure to derive the values of the speed control coefficients (reset, gain, and compensation) for a fixed engine speed. The speed control coefficients are described below:

GAIN determines how fast the control responds to an error in speed when the speed reference is changed or a load disturbance occurs. A value too high will result in sustained, fast oscillations in speed. A value too small will result in poor control performance and possibly slower oscillations.

RESET prevents slow hunting at steady state and controls damping when speed error returns to zero after a speed disturbance. A value too high will result in large, low frequency oscillations in engine speed. The actuator will tend to "bang" from stop-to-stop. A value slightly too high is indicated by an over-damped condition, or the speed error returning too slowly to zero. A value slightly too low is indicated by an under-damped condition, or the speed value overshooting the reference and returning, possibly with several damped oscillations. A value too low will result in slow, low amplitude hunting of speed about the speed reference.

COMPENSATION term compensate for actuator lag. It adjusts the rate of change in actuator output when a load disturbance occurs. A value too low will result in slow and under-damped control. A value too high will result in excessive high frequency actuator movement.

Because the dynamics of an engine depends on its speed of operation, some of this tuning process must be repeated more than once. This procedure assumes the following:

- The LCS ITB or LC-50 is already installed on the application.
- A programming harness is connected between the LCS, computer, power source, and speed pickup.
- The OEM distribution of the service tools is already installed on the computer.
- The air/fuel ratio tuning has been done. Therefore, a valid configuration file is in the LCS.
- The generator is connected to a load bank with strip-chart recording capability.

1. With LCS power off, press Real Time Tuner Menu and turn power on.
2. Start the engine.
3. If the actuator is rapidly oscillating (> 5 Hz) around a position and the engine is making barking/chattering noises, lower the proportional term by 5% decrements until the oscillation stops. (Use the P-Term slider and SET button.)
4. If the actuator is limit cycling (~2 Hz) and the engine speed is oscillating along with it, lower the common gain term by 5% decrements until the limit cycling stabilizes. (Use the Common gain box and SET button.)
5. If the actuator is slowly hunting (< 0.5 Hz) and the engine speed is slowly hunting with it, increase the reset term by 5% increments until the hunt is minimized. Increasing the reset term too much will cause the actuator to start limit cycling. When the switchover from hunting to limit cycling occurs, reduce the reset term to eliminate the limit cycling.
6. If no good compromise can be found between hunting and limit cycling while adjusting the reset term, lower the gain term by 5% and repeat the adjustments on the reset term. Repeat lowering the gain if the reset adjustments fail to yield a stable engine.

7. Assuming the engine speed is fairly stable at this point, disturb the load on the engine (or the speed setting) slightly, and observe how the engine speed recovers. If the recovery has some ringing (oscillations with decreasing amplitude) to it, reduce the gain term and increase the reset term. Repeat the tap test until the recovery looks and sounds critically damped.
8. Attach a chart recorder to the engine to monitor its speed versus time.
9. Load and unload the engine in varying amounts. Observe the engine speed response on the chart recorder. Based on the shape of the response to changing load, change the reset and gain settings in one of three combinations as shown in Figure 4-5.

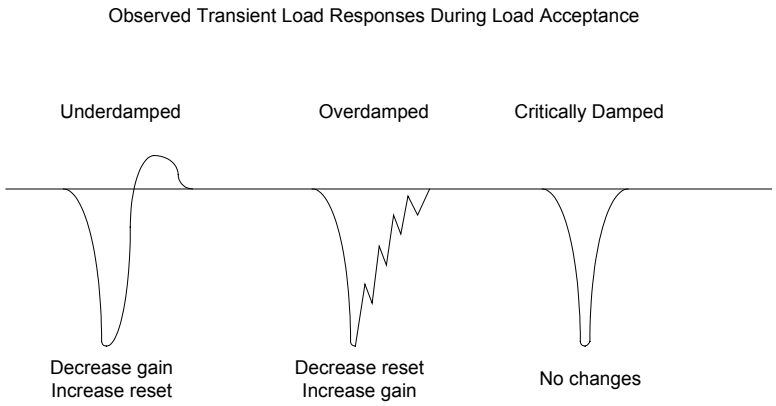
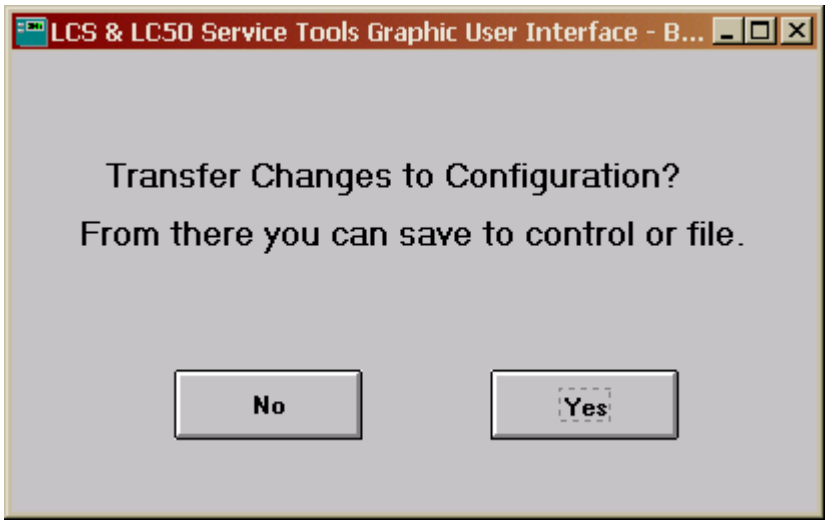


Figure 4-5. Recommended Control Setting Changes

10. The goal is to obtain the tightest possible critically damped response to load transients, at least initially. The gain term affects how quickly the governor reacts to a speed difference between the set point and the actual speed. The reset term affects the damping (or anticipation) of the governor. In general, the highest gain and lowest reset that still has good steady-state load stability will give the best transient response to large load changes.
11. When the governor and engine have been tuned optimally. Press EXIT. The following screen will appear. Press Yes and the changes will be saved to the current configuration parameters. The changes are not resident in the LCS at this time. As soon as you cycle power to the unit, the changes are erased from the controller's memory. To permanently change them, go to the Configuration Menu and Write Config File To LCS. It is also a good idea at this time to Write Config File To File, so that you have a record of the changes.



12. If the final application uses more than one engine speed or more than one fuel, tuning values should be obtained with these settings.
13. Press the Real Time Tuner Menu selection. Set a different engine speed by entering the value next to DESIRED SPEED, and press SET. Repeat the tuning process as outlined in steps 9 through 11. Or run the engine with the different fuel.
14. When optimal tuning is achieved, manually write down the reset and gain values. Common gain and compensation are common to all speed settings and dynamics so they should be optimized for all settings. DO NOT ACCEPT THE TRANSFER CHANGES TO CONFIGURATION option when you exit the real time tuner. This option will overwrite the values you established for the primary fuel and speed setting 1. You will need to manually enter these values in the appropriate places on SCREEN 2 of the EDIT Configuration Menu.
15. If the final application uses droop, run the engine at no-load and full-load conditions. Note the shaft position at both load conditions using the GET APOS (actuator actual position) button.
16. Shut down the engine safely.
17. Remove power from the control.
18. Exit the REAL-TIME TUNER menu.

Application Development Testing

The actuator tuning and engine tuning exercises outlined earlier in this manual yield control loop settings that are optimized for a specific instance of a fuel system, engine, and load. Due to fuel system tolerances, changing fuel quality, engine-to-engine output power variations, load changes, environmental changes, and long-term mechanical wear, it is NOT recommended that an initial configuration file be put into production without some sort of application development testing.

The LCS has been engineered to provide highly repeatable performance from unit to unit; therefore, a configuration file must be robust enough to account for all of the possible variations in an engine's power output. A recommended, but not comprehensive, list of tests might include:

- Cold start, warm start, and hot start tests
- Sea-level and high-altitude tests
- Fuel quality variation tests
- Engine break-in tests
- Long-term (endurance) tests
- Multiple engine application tests

The intention of such testing is to identify scenarios where the governor goes unstable due to changes in the application. An actuator might rapidly oscillate after some long-term wear testing due to the friction changes. In certain environmental, fuel quality, or engine break-in tests the engine may actually develop more or less power than during the tuning exercises, in which case the governor may become unstable. In all cases of high-frequency instability, the appropriate control coefficient must be reduced. This action must also be balanced against basic performance requirement imposed on the application.

Chapter 5. Troubleshooting

This chapter presents several broad categories of application failures typically experienced in the field, possible causes, and some tests used to verify the causes. Because the exact failure experienced in the field is the product of the mechanical/electrical failure combined with the configuration file resident in the control, it is left as the OEM's responsibility to create a more detailed troubleshooting chart for the end user. Ideally, this end-user troubleshooting chart will contain information about mechanical, electrical, engine, and load failures in addition to the possible governor failures. For more detailed information about governor system failure modes and effects, contact Woodward for a copy of the system DFMEA.

The troubleshooting scenarios listed below assume the end user has a digital multimeter at his disposal for testing voltages and checking continuity, and assume that the application has been engineered and tested thoroughly.

Engine/Generator Troubleshooting

Problem	Possible Cause	Suggested Test/Correction
Engine does not start	Stuck throttle/frozen shaft	Move throttle by hand. Assess smoothness, friction, and return spring force.
	Power not applied to control	Disconnect starter motor solenoid. Disconnect harness from governor. Activate application. Test for +12 V between +12V pin and ground pin.
	+5V output shorted to ground	Disconnect starter motor solenoid. Activate application. Test for +5 V between +5V OUT pin and AUX1– pin.
	MPU gap too large	Remove and reinstall MPU per OEM's instructions. Rotate engine manually to check for interference.
	MPU signal connection open	Disconnect harness from governor. Activate application. Test for at least 1.5 Vrms between MPU+ pin and MPU– pin during cranking.
	Ignition signal connection open	Disconnect harness from governor. Activate application. Test for bouncing voltage between IGN pin and ground pin during cranking.

Problem	Possible Cause	Suggested Test/Correction
Engine does not start (cont.)	No configuration file or incorrect configuration file in controller	Disconnect harness from governor. Attach programming harness to computer. Read configuration file from controller and evaluate parameters for correction.
Engine starts, but shuts down on error	MPU gap too large	Remove and reinstall MPU per OEM's instructions. Rotate engine manually to check for interference.
	MPU signal intermittent	Disconnect harness from governor. Continuously check resistance between MPU+ pin and MPU– pin while inspecting harness and connectors during cranking.
	Ignition signal intermittent	Disconnect harness from governor. Continuously check continuity between IGN pin and ignition coil primary while inspecting harness and connectors during cranking.
Engine starts, runs, but is unstable	Dual dynamics AUX shorted or open	Disconnect starter motor solenoid. Activate application. Check for correct voltage level between dual dynamics AUX pin and ground pin for known application mode.
	Dynamics values not tuned	Follow engine governor tuning procedure.
	Air/fuel ratio not correct	If using LC-50 mixer, MAS, & ZPR, follow air/fuel ratio tuning guidelines in Chapter 4. Otherwise, follow fuel system manufacturer's guidelines.
Incorrect mode of operation (speed, speed bias function, dynamics)	AUX inputs shorted or open	Disconnect starter motor solenoid. Disconnect harness from governor. Activate application. Check for correct voltage level between AUX pin(s) under question and ground pin for known application modes.

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Problem	Possible Cause	Suggested Test/Correction
Unable to develop full power	Non-indexed linkage slipped on shaft	Manually verify full travel of throttle plate.
	Shorted MAP sensor input	Disconnect starter motor solenoid. Activate application. Verify AUX1+ voltage matches expected voltage for known atmospheric conditions.
	Fault code set	Disconnect harness from governor. Attach programming harness. view status of fault codes. Take appropriate action for active faults.
Overspeed Error	Gains not set properly for transients	If overspeed occurs on transient, raise common gain to reduce overshoot.
	Start Fuel Limit not set properly	Lower rpm run threshold or lower start fuel position.
	Speed sensing error	Follow instructions for MPU or ignition signal intermittent under Failsafe Error.
Failsafe Error	MPU signal intermittent	Disconnect harness from governor. Continuously check resistance between MPU+ pin and MPU– pin while inspecting harness and connectors during cranking.
	Ignition signal intermittent	Disconnect harness from governor. Continuously check continuity between IGN pin and ignition coil primary while inspecting harness and connectors during cranking.
	Engine running at extremely low speed	Increase failsafe timeout period.
Configuration Error	No configuration file written to controller.	Disconnect harness from governor. Attach programming harness to governor. Write appropriate configuration file to controller using the software tools.

Programming Troubleshooting

Problem	Possible Cause	Suggested Test/Correction
Error message: Missing ACCESS.KEY file	Configuration file has OEM security key written to it	Make an access key with the software tools.
Error message: The configuration data is the wrong format. Try converting the data to the current LCS Firmware Rev	Configuration file not same version as actuator	Obtain proper configuration file.
Error message: Timed Out!	No power to actuator	Check connections and retry.
Error message: Unable to establish link. Exit real time tuner?	No power to actuator	Check connections and retry.

Chapter 6.
Service Options

How to Contact Woodward

In North America use the following address when shipping or corresponding:

Woodward Governor Company
PO Box 1519
1000 East Drake Rd
Fort Collins CO 80522-1519, USA

Telephone—+1 (970) 482-5811 (24 hours a day)
Toll-free Phone (in North America)—1 (800) 523-2831
Fax—+1 (970) 498-3058

For assistance outside North America, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Facility	Phone Number
Australia	+61 (2) 9758 2322
India	+91 (129) 523 0419
Japan	+81 (476) 93-4661
The Netherlands	+31 (23) 5661111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility. [For worldwide directory information, go to **www.woodward.com/ic/locations**.]

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by e-mail, or through the Woodward website.

- Technical Support
- Customer Training
- Field Service

Contact information:

Telephone—+1 (970) 482-5811
Toll-free Phone (in North America)—1 (800) 523-2831
E-mail—icinfo@woodward.com
Website—**www.woodward.com/ic**

Technical Support is available through our many worldwide locations, through our authorized distributors, or through GE Global Controls Services, depending on the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical engineering support, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***technical support***.

Customer Training is available on-site from several of our worldwide facilities, at your location, or from GE Global Controls Services, depending on the product. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***customer training***.

Field Service engineering on-site support is available, depending on the product and location, from our facility in Colorado, or from one of many worldwide Woodward offices or authorized distributors. Field engineers are experienced on both Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***field service***.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

General

Your Name_____
Site Location_____
Phone Number_____
Fax Number_____

Prime Mover Information

Engine/Turbine Model Number_____
Manufacturer_____
Number of Cylinders (if applicable)_____
Type of Fuel (gas, gaseous, steam, etc)_____
Rating_____
Application_____

Governor Information

Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number_____

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number_____

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number_____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix A. Acronyms/Abbreviations

A/F	air/fuel ratio
Isoch	isochronous
CLI	command line interface
DIS	distributorless ignition system
EEPROM	electrically-erasable programmable read-only memory
EMC	electro-magnetic compatibility
GUI	graphic user interface
ITB	integrated throttle body
LC-50	Woodward system that incorporates LCS with an ITB and mixer
LCS	Woodward electronic engine governor that contains both a rotary actuator and a controller circuit board
MAP	manifold air pressure
MAS	main adjustment screw
MPU	magnetic pick up
OEM	original equipment manufacturer
stoichiometric	chemically balanced air/fuel ratio
ZPR	zero pressure regulator

Appendix B.
Configuration File

The GUI Tool presents the configuration files in a graphical format for editing and saving. This tool also creates a text file version of the configuration file that can be viewed and edited with any text editor. If there is ever any need to review the files in this form, this appendix presents the format. Consult the features description section for a more thorough review of the following parameters. This Appendix is intended only to be a decoder for the text version of the configuration file.

A configuration file contains 60 parameter entries spread across three major groupings—documentation/security, feature enable bits, and feature parameters. All parameter entries use the following format:

```
;
; parameter number:
; parameter name:
; comment:
; lower bound:
; upper bound:
;
actual value
```

Each line starting with a semicolon is considered a comment, and is ignored during a download. Parameter number relates a parameter's location in the file to a known memory address inside the control. Never change the order of parameters within a file—incorrect data may be downloaded into the control as a result. Parameter name is a mnemonic name given to a parameter so it is easier to identify. Parameter names typically reflect the name stored inside the control itself. A comment field is included with all parameters; this field of information helps explain the meaning of a parameter's value. Lower bound and upper bound are limits placed on a parameter's value. If the actual value of a parameter falls outside the lower or upper limits, then the file will not be downloadable into the control. Lines that do not start with a semicolon, and contain either a numeric or single-quoted ('xxx') string, are considered actual parameter values.

Generator Version Format (LC-50G)

Documentation and security parameters include:

- **Parameter #0: oem_free_form_text**: The OEM may use this parameter to record a configuration part number and revision level up to 20 characters in length. If the parameter is not used, the parameter value must still contain a set of single quotes ('').
- **Parameter #1: oem_security_key**: The OEM may use this parameter to key his controls to his distribution of dealer service tools.. If the OEM decides to not key his configuration files, then this parameter must still contain a set of single quotes ('').

Feature enable parameters include:

- **Parameter #2: hardware_configuration_register**: This parameter is used to select the direction of actuator rotation, configure AUX1 for analog or digital operation, and assign functions to alternate AUX input pins if necessary. The value of hardware_configuration_register is the sum of the bit values for each enabled option, as listed below:
  - **Bit 7** (value=128): rsvd, Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 6** (value=64): A1anlg: when enabled, makes Aux 1 an analog
  - **Bit 5** (value=32): A1-5v: If AUX1 is an analog input and this bit is enabled, AUX1 is a 0–5 V input instead of a ±3 V input
  - **Bit 4** (value=16): 5060A1: If the 50/60 Hz select function is enabled, and this bit is enabled, then the selection function is based on the state of AUX1 instead of AUX4 when power is first applied to the governor.
  - **Bit 3** (value=8): isdpA2: If either the isoch/droop function or the aux bias/droop function is enabled, and this bit is enabled, then droop will be selected based on the polarity programmed into bit 1, and on the state of AUX2 instead of AUX4 when power is first applied to the governor.
  - **Bit 2** (value=4): ddA3: If the dual dynamics function is enabled, and this bit is enabled, then the function is based on the state of AUX3 instead of AUX4.
  - **Bit 1** (value=2): dpolLOW: If either the isosch/droop function or the aux bias/droop function is enabled, and this bit is enabled, then droop will be selected whenever the appropriate AUX input is left open or grounded. If this bit is not enabled, then droop will be selected whenever the AUX input is shorted to +12 V.
  - **Bit 0** (value=1): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
- **Parameter #3: feature_enable1**: This parameter is one of three used to turn on different functions within the control. Refer to Figure 1-1, the system block diagram, to see the relationship between bits, function names, and where they are within the control loop. The value of feature_enable1 is the sum of the bit values for each enabled option, as listed below:
  - **Bit 7** (value=128): cmode: Enabling this bit turns on the Governor State function. This function is required for all speed governor applications; it is not required for positioner applications.
  - **Bit 6** (value=64): ovspd: Enabling this bit turns on the Overspeed Error protection function when the governor state is 'run'.
  - **Bit 5** (value=32): fsafe: Enabling this bit turns on the Failsafe Error protection function when the governor state is 'run'.
  - **Bit 4** (value=16): rsvd, Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 3** (value=8): relay: Enabling this bit turns on the Relay Control function when the governor state is 'error'.
  - **Bit 2** (value=4): fltst: Enabling this bit turns on the EE Fault Storage function when the governor state is 'error'.
  - **Bit 1** (value=2): actgt: Enabling this bit turns on the Actuator Gate function.

- **Bit 0** (value=1): servo: Enabling this bit turns on the Position Control function. The Position Control function essentially overrides the Governor State function and translates a 0–5 V input into a desired position for the Actuator Control function.

NOTE

The Configuration Error function does not have a bit in any feature_enable byte; it is permanently enabled to check for the presence or absence of a configuration file in the control during power up.

Parameter #4: feature_enable2: This parameter is one of three used to turn on different functions within the control. Refer to Figure 1-1, the system block diagram, to see the relationship between bits, function names, and where they are within the control loop. The value of feature_enable2 is the sum of the bit values for each enabled option, as listed below:

- **Bit 7** (value=128): hzsel: Enabling this bit turns on the 50/60 Hz Select function when power is first applied to the governor.
- **Bit 6** (value=64): idlrt: Enabling this bit turns on the Idle/Rated Select function.
- **Bit 5** (value=32): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
- **Bit 4** (value=16): rslwr: Enabling this bit turns on the Raise/Lower Adjust function .
- **Bit 3** (value=8): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
- **Bit 2** (value=4): droop: Enabling this bit turns on the Droop function.
- **Bit 1** (value=2): auxbs: Enabling this bit turns on the Aux Bias function.
- **Bit 0** (value=1): isodp: Enabling this bit turns on the Isoch/Droop Select function when power is first applied to the governor.

NOTE

The Single Speed function does not have a bit in any feature_enable byte; it is the default speed setting function if none of the other speed setting functions are selected.

The Isochronous function does not have a bit in any feature_enable byte; it is the default speed biasing function if none of the other speed biasing functions are selected.

Parameter #5: feature_enable3: This parameter is one of three used to turn on different functions within the control. Refer to Figure 1-1, the system block diagram, to see the relationship between bits, function names, and where they are within the control loop. The value of feature_enable3 is the sum of the bit values for each enabled option, as listed below:

- **Bit 7** (value=128): bsdrp: Enabling this bit turns on the Aux Bias/Droop Select function when power is first applied to the governor.
- **Bit 6** (value=64): duald: Enabling this bit turns on the Dual Dynamics function.
- **Bit 5** (value=32): spgov: Enabling this bit turns on the Speed Control function.
- **Bit 4** (value=16): adapt: This enables the auto-gain algorithm.
- **Bit 3** (value=8): sfuel: Enabling this bit turns on the Start Fuel Limiter.
- **Bit 2** (value=4): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
- **Bit 1** (value=2): bfuel: Enabling this bit turns on the Boost Fuel Limiter function.
- **Bit 0** (value=1): actrl: Enabling this bit turns on the Actuator Control function.

Parameter #6: speed_sensing_mode: This parameter is used to turn on different speed sensing functions within the control. Refer to Figure 1-1, the system block diagram, to see the relationship between bits, function names, and where they are within the control loop. The value of speed_sensing_mode is the sum of the bit values for each enabled option, as listed below:

- **Bit 7** (value=128): ignition: Enabling this bit turns on the Ignition Speed Sensing function.
- **Bit 6** (value=64): 2-stroke: Enabling this bit tells the Ignition Speed Sensing function that the ignition pulses present on pin 12 (IGN) are from a 2-stroke engine. Disabling this bit tells the ignition speed sensing function that the pulses are coming from a 4-stroke engine.
- **Bit 5** (value=32): mpu: Enabling this bit turns on the MPU Speed Sensing function.
- **Bits 2–0** (values 0-6): #cylinders: This set of bits specifies the number of cylinders for the Ignition Speed Sensing function.

Feature parameters include:
Parameter #7: failsafe_timeout_period: Specifies a timeout period for the Failsafe Error function between 0 and 512 milliseconds. Typical timeout value is 128 milliseconds.
Parameter #8: droop_percentage: Specifies the percentage reduction in engine speed for the Droop function when the actuator position equals full_load_actuator_position. Typical value is 10%.
Parameter #9: biasing_percentage: Specifies the percentage reduction/increase in engine speed for the Aux Bias function when the input voltage on AUX1 is –3 V, +3 V, 0 V, or 5 V. Typical value is 7%.
Parameter #10: start_fuel_limit: Specifies the maximum permitted shaft position when the Start Fuel Limiter function is enabled and the governor state is 'start1.' Typical value is same as full_load_actuator_position.
Parameter #11, #12, and #13: boost_pressure_volt1, boost_pressure_volt2, and boost_pressure_volt3: Specifies the x-points on the Boost Fuel Limiter curve.
Parameter #14, #15, and #16: boost_fuel_limit1, boost_fuel_limit2, boost_fuel_limit3: Specifies the y-points on the Boost Fuel Limiter curve.

Parameter #17: start_speed_threshold: Specifies the speed at which the Governor State changes from 'powerup' to 'start1.' Typical value is 64 rpm to detect engine cranking.
Parameter #18: run_speed_threshold: Specifies the speed at which the Governor State changes from 'start2' to 'run.' Typical value is 90% of the lowest speed_reference.
Parameter #19: overspeed_threshold: Specifies the speed threshold for changing the Governor State from 'run' to 'error' via the Overspeed Error function. Typical value is 10% to 20% above the highest speed_reference.
Parameter #20: reset1,: Primary set of dynamics for speed_reference1. Reset helps stabilize the engine/governor loop. Typical initial value is: reset=25%.
Parameter #21, #22, #23, gain11, gain12, gain13: Primary set of dynamics for speed_reference1. Gain affects engine load transient response and frequency of engine hunting. These are the y-points for the three point gain curve. The x-points are parameters #38, 39, 40.
Parameter #24: alternate_reset1,: Secondary set of dynamics for speed_reference1. Reset helps stabilize the engine/governor loop. Typical initial value is: reset=25%.
Parameter #25, #26, #27, alternate_gain11, alternate_gain12, alternate_gain13: Primary set of dynamics for speed_reference1.
Parameter #28: reset2, : Primary set of dynamics for speed_reference2.
Parameter #29, #30, #31, gain21, gain22, gain23: Primary set of dynamics for speed_reference2. These are the y-points for the three point gain curve. The x-points are parameters #38, 39, 40.
Parameter #32: alternate_reset2: Secondary set of dynamics for speed_reference2.
Parameter #33, #34, and #35: alternate_gain21, alternate_gain22, and alternate_gain23: Alternate set of dynamics for speed_reference2.
Parameter #36: compensation: Dynamic term common to all speed settings and **dynamics.**
Parameter #37: common_gain: Common to all speed settings and dynamics.
Parameter #38, #39, #40: gain_position1, gain_position2, gain_position3: Y-points for the three point gain curve. Common for all speed settings and all dynamics.
Parameter #41: gain_decrement: Used by auto-gain algorithm to decrement the gain by a predefined amount.
Parameter #42: gain_increment: Used by auto-gain algorithm to increase the gain by a predefined amount.
Parameter #43: min_gain: Used by auto-gain algorithm as lower limit.
Parameter #44: max_gain: Used by auto-gain algorithm to upper limit.
Parameter #45: rated_to_idle_delay: Specifies the amount of time to delay before ramping from rated speed (speed_reference2) to idle speed (speed_reference1) for the Idle/Rated Select function.
Parameter #46: speed_adjust_lower_limit: Specifies the lowest desired speed possible with the Raise/Lower Adjust function.
Parameter #47: speed_adjust_upper_limit: Specifies the highest desired speed possible with the Raise/Lower Adjust function.
Parameter #48, #49, and #50: proportional, derivative, and integral: Control coefficients for the Actuator Control function.

Parameter #51: events_per_engine_rev: Specifies the number of flywheel or gear teeth that pass the face of a MPU for one revolution of the engine's crankshaft.
Parameter #52, #53: speed_reference1, speed_reference2: Specifies the desired engine speeds depending on the enabled speed select function. Speed_reference1 is the default speed setting.
Parameter #54: steady_state: Used by auto-gain algorithm
Parameter #55: transient: Used by auto-gain algorithm.
Parameter #56, #57: speed_decrease_rate, speed_increase_rate: Specifies the ramping rates for the Raise/Lower Adjust function.
Parameter #58, #59: no_load_actuator_position, full_load_actuator_position: Specifies the 0% engine load and 100% engine load actuator positions for the Droop function.

Industrial Version Format (LC-50I)

An industrial configuration file contains 58 parameter entries.

Documentation and security parameters include:

- **Parameter #0: oem_free_form_text**: The OEM may use this parameter to record a configuration part number and revision level up to 20 characters in length. If the parameter is not used, the parameter value must still contain a set of single quotes (‘’).
- **Parameter #1: oem_security_key**: The OEM may use this parameter to key his controls to his distribution of dealer service tools.. If the OEM decides to not key his configuration files, then this parameter must still contain a set of single quotes (‘’).

Feature enable parameters include:

- **Parameter #2: hardware_configuration_register**: This parameter is used to select the direction of actuator rotation, configure AUX1 for analog or digital operation, and assign functions to alternate AUX input pins if necessary. The value of hardware_configuration_register is the sum of the bit values for each enabled option, as listed below:
  - **Bit 7** (value=128): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 6** (value=64): A1anlg: If enabled, AUX1 is an analog input instead of a digital input.
  - **Bit 5** (value=32): A1-5v: If AUX1 is an analog input and this bit is enabled, AUX1 is a 0–5 V input instead of a ±3 V input
  - **Bit 4** (value=16): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 3** (value=8): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 2** (value=4): ddA3: If the dual dynamics function is enabled, and this bit is enabled, then the function is based on the state of AUX3 instead of AUX4.
  - **Bit 1** (value=2): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.

  - **Bit 0** (value=1): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.

- **Parameter #3: feature_enable1**: This parameter is one of three used to turn on different functions within the control. Refer to Figure 1-1, the system block diagram, to see the relationship between bits, function names, and where they are within the control loop. The value of feature_enable1 is the sum of the bit values for each enabled option, as listed below:
  - **Bit 7** (value=128): cmode: Enabling this bit turns on the Governor State function. This function is required for all speed governor applications; it is not required for positioner applications.
  - **Bit 6** (value=64): ovspd: Enabling this bit turns on the Overspeed Error protection function when the governor state is 'run'.
  - **Bit 5** (value=32): fsafe: Enabling this bit turns on the Failsafe Error protection function when the governor state is 'run'.
  - **Bit 4** (value=16): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 3** (value=8): relay: Enabling this bit turns on the Relay Control function when the governor state is 'error'.
  - **Bit 2** (value=4): fltst: Enabling this bit turns on the EE Fault Storage function when the governor state is 'error'.
  - **Bit 1** (value=2): actgt: Enabling this bit turns on the Actuator Gate function.
  - **Bit 0** (value=1): servo: Enabling this bit turns on the Position Control function. The Position Control function essentially overrides the Governor State function and translates a 0–5 V input into a desired position for the Actuator Control function.

NOTE

The Configuration Error function does not have a bit in any feature_enable byte; it is permanently enabled to check for the presence or absence of a configuration file in the control during power up.

- **Parameter #4: feature_enable2**: This parameter is one of three used to turn on different functions within the control. Refer to Figure 1-1, the system block diagram, to see the relationship between bits, function names, and where they are within the control loop. The value of feature_enable2 is the sum of the bit values for each enabled option, as listed below:
  - **Bit 7** (value=128): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 6** (value=64): idlrt: Enabling this bit turns on the Idle/Rated Select function.
  - **Bit 5** (value=32): 3-spd: Enabling this bit turns on the Three-Speed Select function.
  - **Bit 4** (value=16): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 3** (value=8): rsvd: Reserved; this feature is not supported at this time. The bit should not be enabled.
  - **Bit 2** (value=4): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.

- **Bit 1** (value=2): auxbs: Enabling this bit turns on the Aux Bias function.
- **Bit 0** (value=1): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.

NOTE

The Single Speed function does not have a bit in any feature_enable byte; it is the default speed setting function if none of the other speed setting functions are selected.

The Isochronous function does not have a bit in any feature_enable byte; it is the default speed biasing function if none of the other speed biasing functions are selected.

- **Parameter #5: feature_enable3**: This parameter is one of three used to turn on different functions within the control. Refer to Figure 1-1, the system block diagram, to see the relationship between bits, function names, and where they are within the control loop. The value of feature_enable3 is the sum of the bit values for each enabled option, as listed below:
  - **Bit 7** (value=128): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 6** (value=64): duald: Enabling this bit turns on the Dual Dynamics function.
  - **Bit 5** (value=32): spgov: Enabling this bit turns on the Speed Control function.
  - **Bit 4** (value=16): adapt: This enable the auto-gain algorithm.
  - **Bit 3** (value=8): sfuel: Enabling this bit turns on the Start Fuel Limiter.
  - **Bit 2** (value=4): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 1** (value=2): rsvd: Reserved; setting this bit either way has no effect on the controller's operation.
  - **Bit 0** (value=1): actrl: Enabling this bit turns on the Actuator Control function.
- **Parameter #6: speed_sensing_mode**: This parameter is used to turn on different speed sensing functions within the control. Refer to Figure 1-1, the system block diagram, to see the relationship between bits, function names, and where they are within the control loop. The value of speed_sensing_mode is the sum of the bit values for each enabled option, as listed below:
  - **Bit 7** (value=128): ignition: Enabling this bit turns on the Ignition Speed Sensing function.
  - **Bit 6** (value=64): 2-stroke: Enabling this bit tells the Ignition Speed Sensing function that the ignition pulses present on pin 12 (IGN) are from a 2-stroke engine. Disabling this bit tells the ignition speed sensing function that the pulses are coming from a 4-stroke engine.
  - **Bit 5** (value=32): mpu: Enabling this bit turns on the MPU Speed Sensing function.
  - **Bits 2-0** (values 0-6): #cylinders: This set of bits specifies the number of cylinders for the Ignition Speed Sensing function.

Feature parameters include:

- **Parameter #7: failsafe_timeout_period**: Specifies a timeout period for the Failsafe Error function between 0 and 512 milliseconds. Typical timeout value is 128 milliseconds.
- **Parameter #8: biasing_percentage**: Specifies the percentage reduction/increase in engine speed for the Aux Bias function when the input voltage on AUX1 is –3 V, +3 V, 0 V, or 5 V. Typical value is 7%.
- **Parameter #9: start_fuel_limit**: Specifies the maximum permitted shaft position when the Start Fuel Limiter function is enabled and the governor state is 'start1.' Typical value is same as full_load_actuator_position.
- **Parameter #10: start_speed_threshold**: Specifies the speed at which the Governor State changes from 'powerup' to 'start1.' Typical value is 64 rpm to detect engine cranking.
- **Parameter #11: run_speed_threshold**: Specifies the speed at which the Governor State changes from 'start2' to 'run.' Typical value is 90% of the lowest speed_reference.
- **Parameter #12: overspeed_threshold**: Specifies the speed threshold for changing the Governor State from 'run' to 'error' via the Overspeed Error function. Typical value is 10% to 20% above the highest speed_reference.
- **Parameter #13: reset1**: Primary set of dynamics for speed_reference1. Reset helps stabilize the engine/governor loop. Typical initial value is: reset=25%.
- **Parameter #14, #15, #16, gain11, gain12, gain13**: Primary set of dynamics for speed_reference1. Gain affects engine load transient response and frequency of engine hunting. These are the y-points for the three point gain curve. The x-points are parameters #38, 39, 40.
- **Parameter #17: alternate_reset1**: Secondary set of dynamics for speed_reference1. Reset helps stabilize the engine/governor loop. Typical initial value is: reset=25%.
- **Parameter #18, #19, #20, alternate_gain11, alternate_gain12, alternate_gain13**: Primary set of dynamics for speed_reference1. Gain affects engine load transient response and frequency of engine hunting. These are the y-points for the three point gain curve. The x-points are parameters #38, 39, 40.
- **Parameter #21 : reset2**: Primary set of dynamics for speed_reference2. Reset helps stabilize the engine/governor loop. Typical initial value is: reset=25%.
- **Parameter #22, #23, #24, gain21, gain22, gain23**: Primary set of dynamics for speed_reference2. Gain affects engine load transient response and frequency of engine hunting. These are the y-points for the three point gain curve. The x-points are parameters #38, 39, 40.
- **Parameter #25: alternate_reset2**: Secondary set of dynamics for speed_reference2. Reset helps stabilize the engine/governor loop. Typical initial value is: reset=25%.
- **Parameter #26, #27, and #28: alternate_gain21, alternate_gain22, and alternate_gain23**: Alternate set of dynamics for speed_reference2. Gain affects engine load transient response and frequency of engine hunting.
- **Parameter #29: reset3**: Primary set of dynamics for speed_reference3. Reset helps stabilize the engine/governor loop. Typical initial value is: reset=25%.

- **Parameter #30, #31, and #32: gain31, gain32, and gain33**: Primaru set of dynamics for speed_reference3. Gain affects engine load transient response and frequency of engine hunting.
- **Parameter #33: alternate_reset3**: Secondary set of dynamics for speed_reference3. Reset helps stabilize the engine/governor loop. Typical initial value is: reset=25%.
- **Parameter #34, #35, and #36: alternate_gain31, alternate_gain32, and alternate_gain33**: Alternate set of dynamics for speed_reference3. Gain affects engine load transient response and frequency of engine hunting.
- **Parameter #37: compensation**: Compensation nulls out the lag effect of the actuator control loop. Typical initial value is: 50%.
- **Parameter #38: common_gain**:
- **Parameter #39, #40, #41: gain_position1, gain_position2, gain_position3**: Y-points for the three point gain curve. Common for all speed settings and all dynamics.
- **Parameter #42: gain_decrement**: Used by auto-gain algorithm to decrement the gain by a predefined amount.
- **Parameter #43: gain_increment**: Used by auto-gain algorithm to increase the gain by a predefined amount.
- **Parameter #44: min_gain**: Used by auto-gain algorithm as lower limit.
- **Parameter #45: max_gain**: Used by auto-gain algorithm to upper limit.
- **Parameter #46: rated_to_idle_delay**: Specifies the amount of time to delay before ramping from rated speed (speed_reference2) to idle speed (speed_reference1) for the Idle/Rated Select function.
- **Parameter #47, #48, and #49: proportional, derivative, and integral**: Control coefficients for the Actuator Control function.
- **Parameter #50: events_per_engine_rev**: Specifies the number of flywheel or gear teeth that pass the face of a MPU for one revolution of the engine's crankshaft.
- **Parameter #51: speed_reference1**: Specifies the desired engine speeds depending on the enabled speed select function. Speed_reference1 is the default speed setting.
- **Paramter #52: speed_reference2, speed_zone_1_to_2**: Secondary speed reference. Uses dynamics gain2x and alternate gain2x and reset 2
- **Parameter #53: speed_reference3, speed_zone_1_to_3**
- **Parameter #54: steady_state**: Used by auto-gain algorithm
- **Parameter #55: transient**: Used by auto-gain algorithm.
- **Parameter #56, #57: speed_decrease_rate, speed_increase_rate**: Specifies the ramping rates for the Raise/Lower Adjust function.

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Appendix C.
Dynamics File Format

A dynamics file contains five parameter entries for the five available speed control gains. All parameter entries use the following format:

```
;
; parameter number:
; parameter name:
; comment:
; lower bound:
; upper bound:
;
actual value
```

Each line starting with a semicolon is considered a comment, and is ignored during a download. Parameter number relates a parameter's location in the file to a known memory address inside the control. Never change the order of parameters within a file—incorrect data may be downloaded into the control as a result. Parameter name is a mnemonic name given to a parameter so it is easier to identify. Parameter names typically reflect the name stored inside the control itself. A comment field is included with all parameters; this field of information helps explain the meaning of a parameter's value. Lower bound and upper bound are limits placed on a parameter's value. If the actual value of a parameter falls outside the lower or upper limits, then the file will not be downloadable into the control. Lines that do not start with a semicolon and contain a number are considered actual parameter values.

LCS Control Specifications

Specifications

Power Supply	12 V systems (8–16 Vdc) reverse polarity protection; must be fed from a Class 2 power source
Power Consumption	64 W maximum
Torque	0.34 N·m (0.25 lb-ft)
Mass/Weight	425 g (15 oz)

Control Characteristics

Speed Input and Range	Magnetic pickup, ignition coil input, or DIS input
MPU input	100 to 12 000 Hz
IGN input	1, 2, 3, 4, 5, 6, & 8 cylinder engines with rated speeds of 1200–4000 rpm
Engine Type	2-cycle or 4-cycle gasoline, diesel, or gaseous fuel
Target speed	Programmable
Actuator Torque	High-efficiency torque motor delivers 0.34 N·m (0.25 lb-ft) (standard model) over 60° travel range to operate fuel or air control

Steady State Speed Regulation	**Fuel Type:**	**Gasoline**	**Diesel**	**Gaseous**
	MPU Input:	±0.35%	±0.25%	±0.35%
	Ignition Input:	±0.50%	n/a	±0.50%

Functions/Auxiliary Inputs

Function Options	Isochronous speed (50 or 60 Hz), multiple speeds, two or three speed, droop, dual dynamics, adjustable max fuel stop, manifold air pressure-biased fuel limiter
Programmable	Through 12-pin Deutsch connector
Aux1 Options	Auxiliary load sharing, remote speed setting, MAP fuel limiting, 50/60 Hz select, isochronous load sharing/droop select
Aux2 Options	Lower speed, isochronous speed control/droop select, isochronous load sharing/droop select, idle/rated select, three speed select
Aux3 Options	Raise speed, dual dynamics select, three speed select
Aux4 Options	50/60 Hz select, isochronous speed control/droop select, isochronous load sharing/droop select, dual dynamics select, three speed select
Aux5 Options	Is permanently configured as an output to drive a relay

Environment

Ambient Operating Temperature	–40 to +85 °C (–40 to +185 °F)
Storage Temperature	–40 to +125 °C (–40 to +257 °F)
EMI/RFI	EN50081-1 (emissions) EN50082-2 (immunity)
Humidity	US MIL-STD 810E, Method 507.3, Procedure III
Salt Spray	US MIL-STD 810E, Method 509.3, Procedure I
Shock	US MIL-STD 810E, Method 516.4, Procedure I
Random Vibration	US MIL-STD 202F, Procedure 214A, Test Condition ID
Drop	SAE J1211, Paragraph 4.8.3 (modified)
Thermal Shock	SAE J1455, Paragraph 4.1.3.2
Dust	SAE J1455, Paragraph 4.7
Pressure Wash	A modified SAE J1455, Paragraph 4.5
Fluid Resistance	A modified SAE J1455, Paragraph 4.4
Electrical Load Power Connection	
Electrical Transient	2 J per SAE J1455, Paragraph 4.11.2.2.1

Compliance

UL/cUL	Listed (UL requires a Class 2 power source)
CE	Compliant
Other	89/392/EEC Machinery Directive

Reliability and Quality Goals

The LCS control system has a reliability target of 17 500 hours MTBF. It also has a quality goal of less than 25 PPM when measuring out-of-the-box defects. This quality goal is a target based on continuous improvement.

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Please include the manual number from the front cover of this publication.

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FM 57982
BS EN ISO 9001:1994
6 March 2001

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