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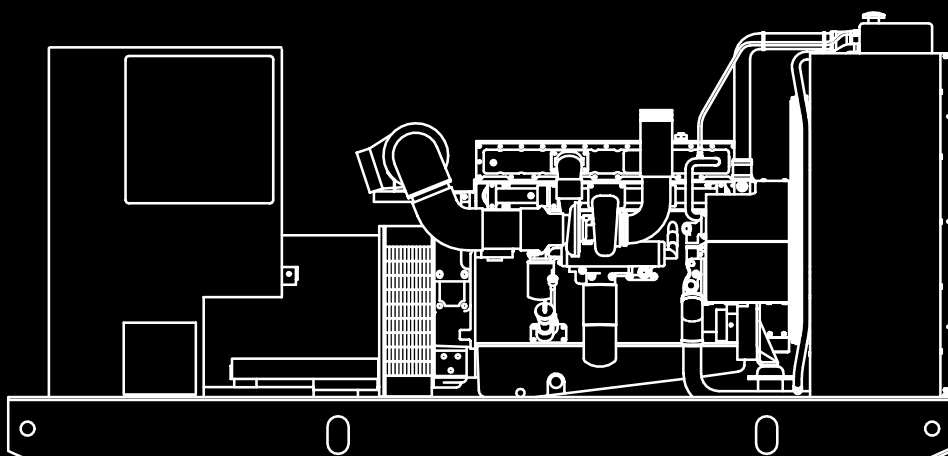


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Service Manual

Detector™ Control

Generator Sets



Models

DFAA, DFAB, DFAC, DFBC, DFBD, DFBE, DFBF,
DFCB, DFCC, DFCE, DFEB, DFEC, DFED, DFFA,
DFFB, DFGA, DFGB, DFGC, DFJA, DFJB, DFJC,
DFJD, DFLA, DFLB, DFLC, DFLD, DFMB, DQAA,
DQAB, DQBA, DQBB

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California

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

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IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS – This manual contains important instructions that should be followed during installation and maintenance of the generator and batteries.

Before operating the generator set (genset), read the Operator's Manual and become familiar with it and the equipment. **Safe and efficient operation can be achieved only if the equipment is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ DANGER *This symbol warns of immediate hazards which will result in severe personal injury or death.*

⚠ WARNING *This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.*

⚠ CAUTION *This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.*

FUEL AND FUMES ARE FLAMMABLE

Fire, explosion, and personal injury or death can result from improper practices.

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use zinc coated or copper fuel lines with diesel fuel.
- Be sure all fuel supplies have a positive shutoff valve.
- Be sure battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.
- Engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect battery charger from its AC source, then disconnect starting batteries, negative (–) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- 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.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can cause an engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. Do not operate a genset where a flammable vapor environment can be created by fuel spill, leak, etc., unless the genset is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the genset are solely responsible for operating the genset safely. Contact your authorized Cummins Power Generation distributor for more information.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment. Do not wear jewelry. Jewelry can short out electrical contacts and cause shock or burning.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag and lock open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

MEDIUM VOLTAGE GENERATOR SETS

(601V to 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training is required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Due to the nature of medium voltage electrical equipment, induced voltage remains even after the equipment is disconnected from the power source. Plan the time for maintenance with authorized personnel so that the equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- 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.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10).
- Make sure that rags are not left on or near the engine.
- Make sure generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.
- 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.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breathe or ingest or come into contact with exhaust gases.
- Do not store any flammable liquids, such as fuel, cleaners, oil, etc., near the generator set. A fire or explosion could result.
- Wear hearing protection when going near an operating generator set.
- To prevent serious burns, avoid contact with hot metal parts such as radiator, turbo charger and exhaust system.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

1. Introduction

ABOUT THIS MANUAL

This manual covers models produced under the Cummins®/Onan® and Cummins Power Generation brand names.

This manual provides troubleshooting and repair information regarding the Detector™ control and generators used on the generator sets listed on the front cover.

Engine service instructions are in the applicable engine service manual. Operation and maintenance instructions are in the applicable Operator's Manual.

This manual does not have instructions for servicing printed circuit board assemblies. After determining that a printed circuit board assembly is faulty, replace it. Do not repair it. Attempts to repair a printed circuit board can lead to costly damage to the equipment.

This manual contains basic (generic) wiring diagrams and schematics that are included to help in troubleshooting. Service personnel must use the actual wiring diagram and schematic shipped with each unit. The wiring diagrams and schematics that are maintained with the unit should be updated when modifications are made to the unit.

Read the **Safety Precautions** and carefully observe all instructions and precautions in this manual.

TEST EQUIPMENT

Most of the test procedures in this manual can be performed with an AC-DC multimeter such as a Fluke model 87. Additional instruments required to service the genset are:

- Battery Hydrometer
- Tachometer or Frequency Meter
- Jumper Leads
- Wheatstone Bridge or Digital Ohmmeter
- Variac
- Load Test Panel
- Megger or Insulation Resistance Meter

HOW TO OBTAIN SERVICE

Always give the complete Model, Specification and Serial number of the generator set as shown on the nameplate when seeking additional service information or replacement parts. The nameplate is located on the side of the generator output box.

⚠ WARNING *Incorrect service or replacement of parts can result in severe personal injury or death, and/or equipment damage. Service personnel must be trained and experienced to perform electrical and mechanical service. Read and follow Safety Precautions, on pages iii and iv.*

CONTROL AND GENERATOR OVERVIEW

General

Read through this manual to identify the control options, and generator type. The control and generator are described in more detail in the control and generator sections.

Periodically review this manual and the Operator's Manual to become familiar with the generator set operation and troubleshooting procedures.

Control Panel

The control panel is located inside the front portion

of the generator output box. The control panel is mounted to the genset with vibration isolators. The control assembly is separated into a DC panel for monitoring the engine and an AC panel for monitoring the generator. See Figures 2-1 and 3-1.

Generator

The generator sets covered in this manual use a Permanent Magnet Generator (PMG).

The generators are controlled by an Automatic Voltage Regulator (AVR). The AVR is mounted on the inside, back wall of the control panel. See Figure 2-3.

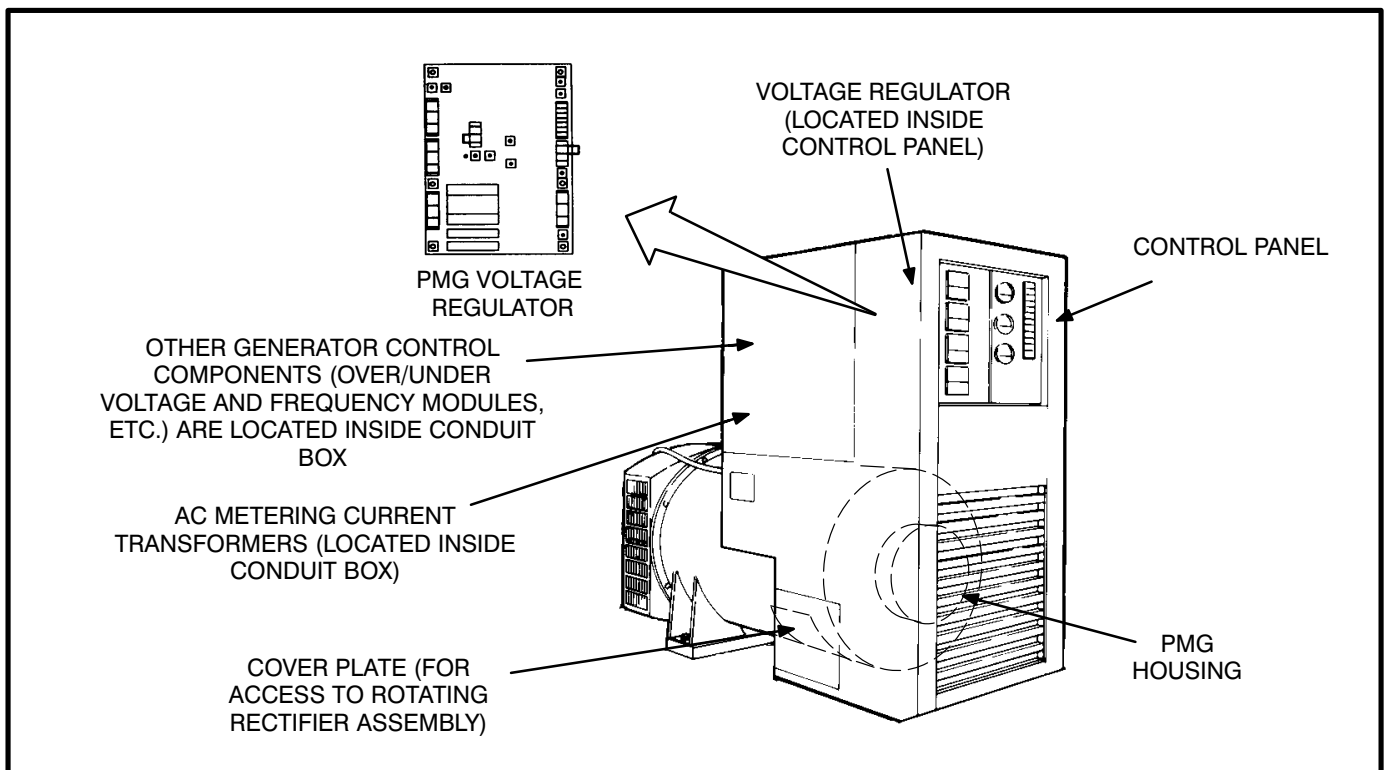


FIGURE 1-1. TYPICAL PMG GENERATOR AND CONTROLS

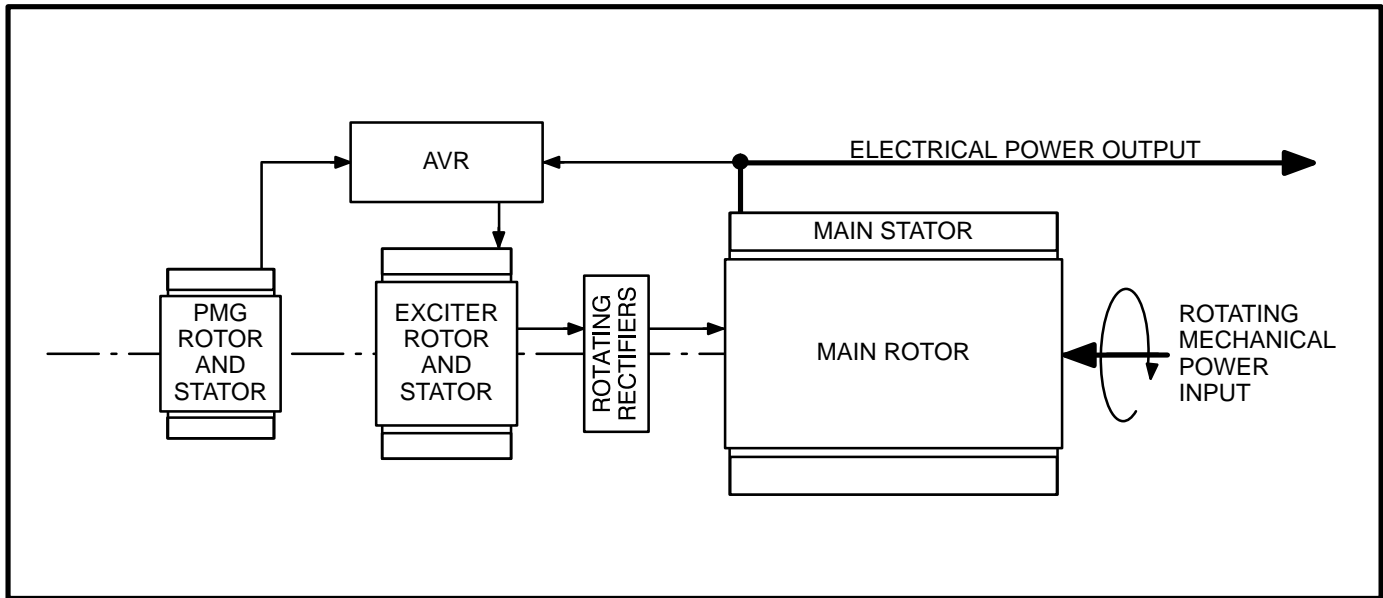


FIGURE 2-2. DIAGRAM OF PMG EXCITED GENERATOR OPERATION

PRINCIPLE OF GENERATOR OPERATION

Refer to Figure 2-2 during the generator operation description.

1. The Permanent Magnet Generator (PMG) provides power for excitation of the exciter field. Output from the PMG is supplied via the automatic voltage regulator (AVR) to the exciter. The PMG consists of a stator and a permanent magnet rotor mounted on the end of the main rotor shaft.
2. The AVR senses a signal from the main stator, compares it with a reference value, and responds by supplying a controlled excitation current to the exciter stator.
3. The exciter field (stator) induces current in the exciter rotor windings. A full wave rectifier bridge (rotating rectifiers), mounted on the exciter rotor, converts exciter output (3-phase AC) to DC. DC output from the rotating rectifiers is supplied to the main rotor.
4. Generator field strength is proportional to the field current supplied by the exciter. Generator output current is proportional to field strength, which is varied to match the load. Output voltage and frequency are held constant by the voltage regulator and engine governor, respectively.

VOLTAGE REGULATOR ADJUSTMENTS

Generator output voltage is adjusted by the optional voltage trimmer rheostat (R21) located on the control front panel and by the voltage regulator located inside the control panel (see Figure 2-3).

Two, similar PMG voltage regulators have been used in permanent magnet exciter generator sets. One is a four position mount, and the newer of the two has six mounting holes (only four are used). Adjustment procedures are the same for both, even though the potentiometers are located differently. Refer to Figure 2-3 to identify which AVR the genset uses.

The generator voltage may be adjusted within ± 5 percent of the rated nameplate voltage via the optional control-panel mounted voltage trimmer rheostat (R21). If the adjustment cannot be made with R21, or if R21 is not installed, adjust the voltage regulator as described under Voltage and Voltage Stability Adjustments in this section.

These measurements and adjustments are done while the set is running and require access to uninsulated high voltage parts in the control and power output boxes.

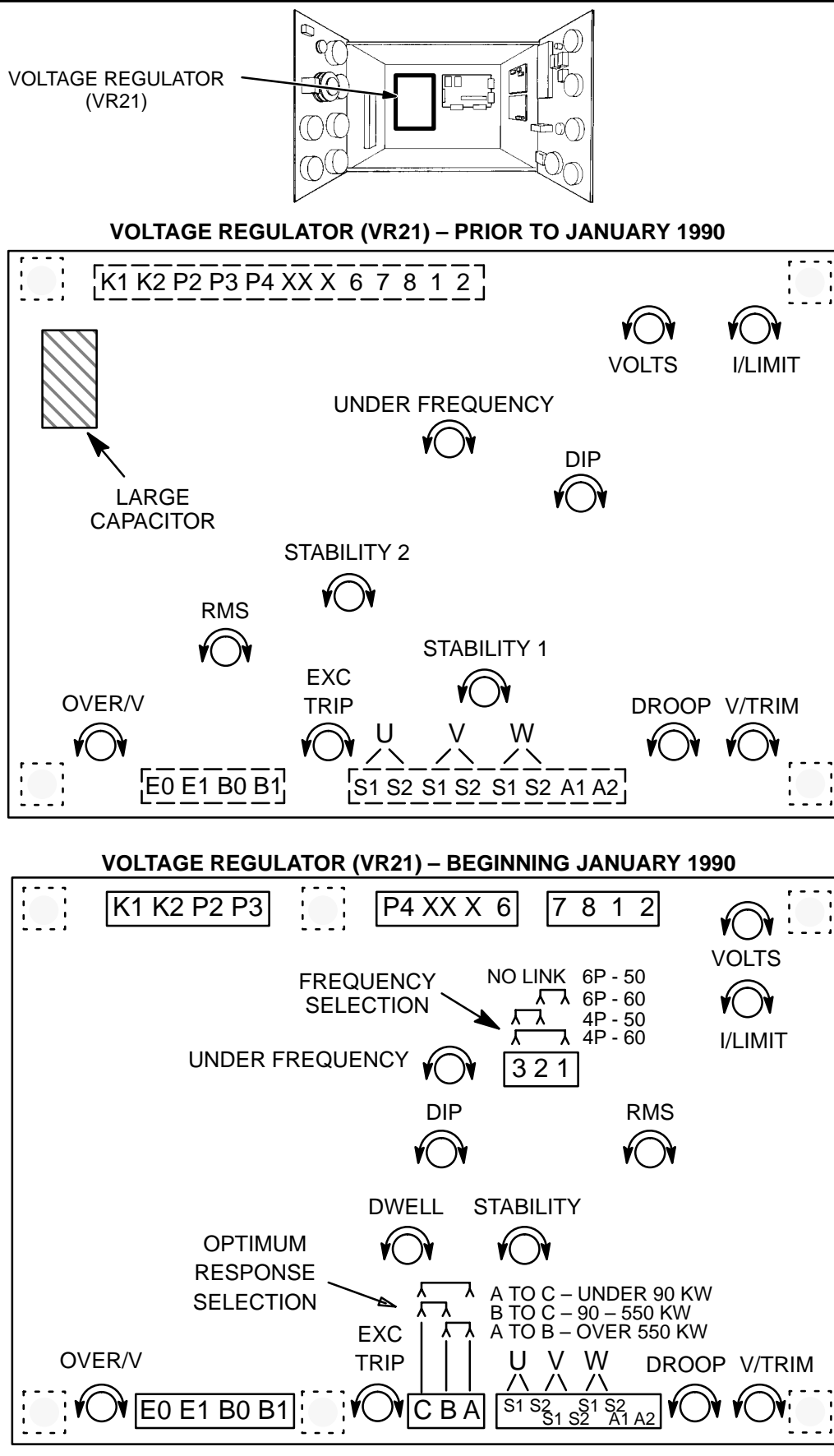


FIGURE 2-3. VOLTAGE REGULATOR ADJUSTMENT POTS AND SELECTION JUMPERS

⚠ DANGER HIGH VOLTAGE. *Touching uninsulated high voltage parts inside the control and power output boxes can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts.*

For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and wear elbow length insulating gloves.

Jumper Reconnections

Jumpers provide for reconnections to adapt the voltage regulator to the application. See Figure 2-3. Reconnect the response jumper, if necessary, so that terminal **B** connects to terminal **C** if generator output is greater than 90 kW but less than 550 kW and **A** to **B** if output is greater than 550kW. Reconnect the frequency jumper, if necessary, to correspond to the application frequency. (Replacement AVR's are preset for 50 Hz operation.)

Voltage and Voltage Stability Adjustments

Use the control panel mounted voltage trimmer, if provided, for small voltage adjustments. Measure generator output voltage while the set is running without load at the nominal frequency. If the trimmer does not provide enough adjustment, lock it at its midpoint. Then turn the **VOLTS** pot fully counterclockwise and the **STABILITY** pot to its midpoint. If the red LED (light emitting diode) on the board lights, refer to Jumper Reconnections and to UFRO Adjustments. Then turn the **VOLTS** pot clockwise until rated voltage is obtained. If voltage becomes unstable when a large load is connected, turn the **STABILITY** pot clockwise until voltage is stable. Check and readjust the **VOLTS** pot, if necessary, each time the **STABILITY** pot is readjusted.

UFRO Adjustments

The voltage regulator has an under-frequency protection circuit having a threshold frequency that can be preset (typically at 59 Hz for 60 Hz applications and 49 Hz for 50 Hz applications). The red LED on the board lights when frequency dips below the threshold. The threshold frequency is preset by turning the **UFRO** (under frequency roll off) pot clockwise to raise it and counterclockwise to lower it. Use an insulated handle screw driver to prevent electrical shock. Set UFRO as follows:

1. Make a note of the no-load frequency.
2. Determine the roll-off frequency by turning the governor speed pot (to lower frequency) until the LED lights. If roll-off frequency is okay, go to step 5. If roll-off frequency is incorrect, go to step 3.
3. Adjust the governor speed pot to the proper roll-off frequency.
4. Turn the **UFRO** pot until LED goes off, then slowly turn it back until the LED just goes on.
5. Adjust the governor speed pot back to the initial frequency setting.

Note that Dip and Dwell adjustments, below, are related.

Dip Adjustments

The **DIP** pot adjusts the voltage vs. frequency slope of the generator for frequencies below the threshold preset by the **UFRO** pot. Turning the **DIP** pot clockwise increases the slope (for greater voltage roll off as frequency drops), making it easier for the engine to pick up a large load, but also increasing the voltage dip. The generator voltage vs. frequency slope is the same above and below the threshold frequency when the pot is turned fully counterclockwise.

Dwell Adjustments

The **DWELL** pot times voltage recovery when frequency dips below the preset threshold. Clockwise adjustment increases dwell time. Full counterclockwise adjustment eliminates dwell, in which case, voltage recovery follows engine speed recovery.

Droop Adjustments

The **DROOP** pot is for adjusting the input signal from the droop compensating CT in paralleling applications. **DROOP** is preset at the factory for five percent droop at full load and zero power factor.

V/Trim Adjustments

The **V/Trim** pot is for adjusting the input signal from a VAR/PF controller in utility paralleling applications. Full clockwise adjustment is normal, resulting in maximum sensitivity. The auxiliary controller has no effect when the pot is turned fully counterclockwise.

EXC, OVER V, I/LIMIT, STAB/1and RMS

These pots are factory preset and do not require adjustment.

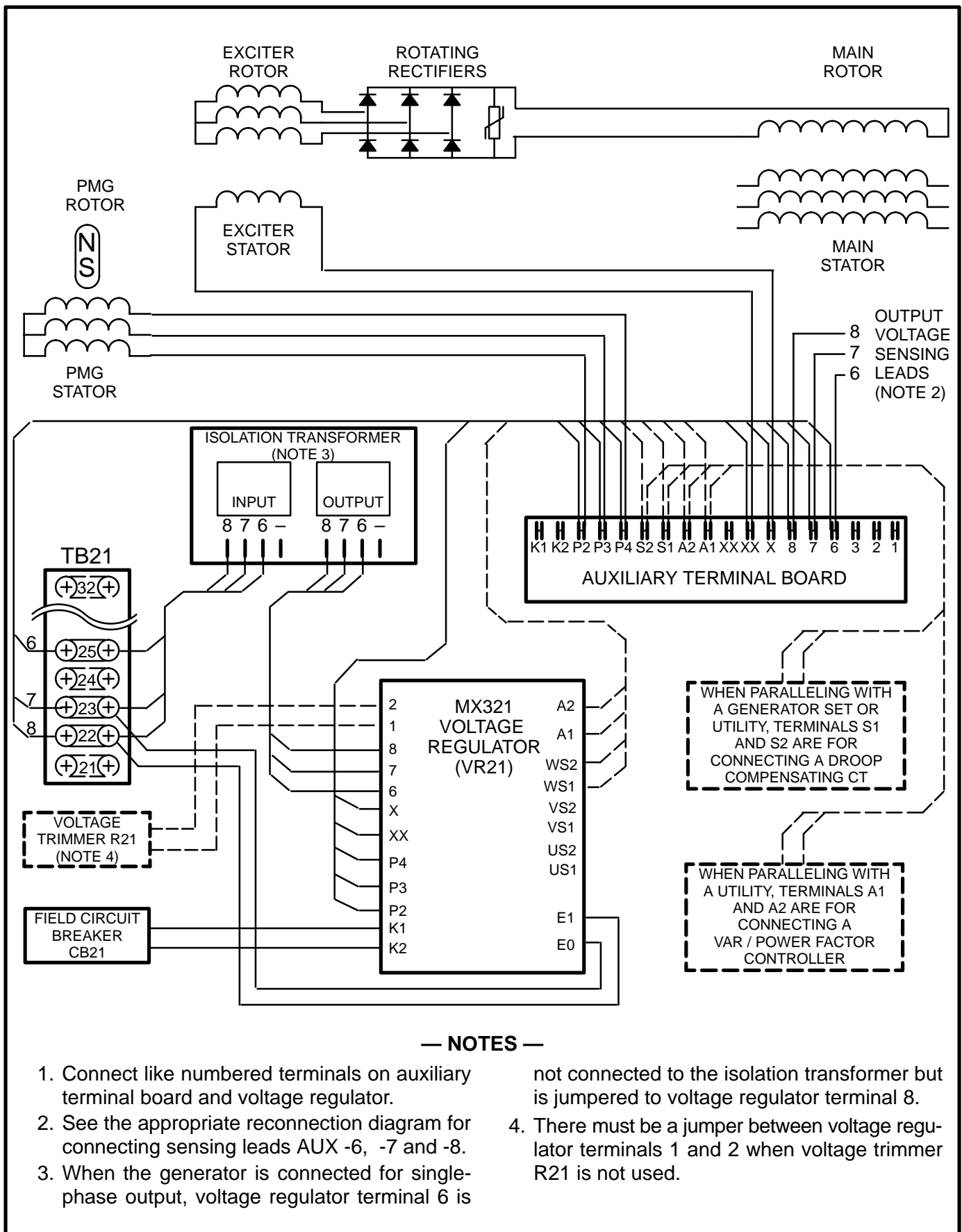


FIGURE 2-4. TYPICAL VOLTAGE REGULATING CIRCUITS FOR PMG-EXCITED GENERATORS

OPTIONAL CIRCUIT BREAKER

Optional circuit breakers are available that can be mounted in the generator AC output box.

Description

Optional breakers are of the thermal and magnetic trip type. Depending on customer requirements, the breaker may also include shunt trip and remote alarm connections. Review the following descriptions and requirements (refer to Figure 2-5).

Generator set output is connected to the load through the circuit breaker.

When an overload or short circuit occurs on any one conductor, a common trip bar will disconnect all three conductors.

The thermal trip action of the breaker is accomplished by bimetal strips. A sustained overcurrent condition will cause a thermal reaction of the bimetal and trip the breaker. Response of the bimetal is proportional to current; high current—fast response, low current—slow response. This action provides a time delay for normal inrush current and temporary overload conditions such as motor starting.

The magnetic trip action of the breaker is caused by an electromagnet, which partially surrounds the internal bimetal strips. If a short circuit occurs, the high current through the electromagnet will attract the bimetal armature and trip the breaker. Some breaker models provide front adjustment of the magnetic trip action. These adjustments are normally set at the factory at the high position, but pro-

vide for individual conductor settings to suit customer needs.

The shunt trip mechanism (if equipped) consists of a solenoid tripping device mounted in the breaker with external lead connections for remote signaling. A momentary signal to the solenoid coil will cause the breaker to trip.

This feature is available in AC or DC voltages, and is normally installed at the factory to meet customer needs. The shunt trip mechanism is most often connected to a common alarm.

Auxiliary contacts (if equipped) are used for local or remote annunciation of the breaker status. They usually have one normally-open and one normally-closed contact (1 form C contacts) to comply with the annunciator requirement.

The trip actuator (if applicable) is for periodic exercise of the breaker to clean and maintain its proper operation. Rotating this actuator mechanically simulates over-current tripping through actuation of linkages not operated by the *On/Off* handle. See Section 7, *Options*, for further information.

Operation of the circuit breaker is determined by site-established procedures. In emergency standby installations, the breaker is often placed to the On position, and is intended for safety trip actuation in the event of a fault condition. If the breaker trips open, investigate the cause and perform remedial steps per the troubleshooting procedures. To close the breaker, the handle must be placed to the Reset position and then to On.

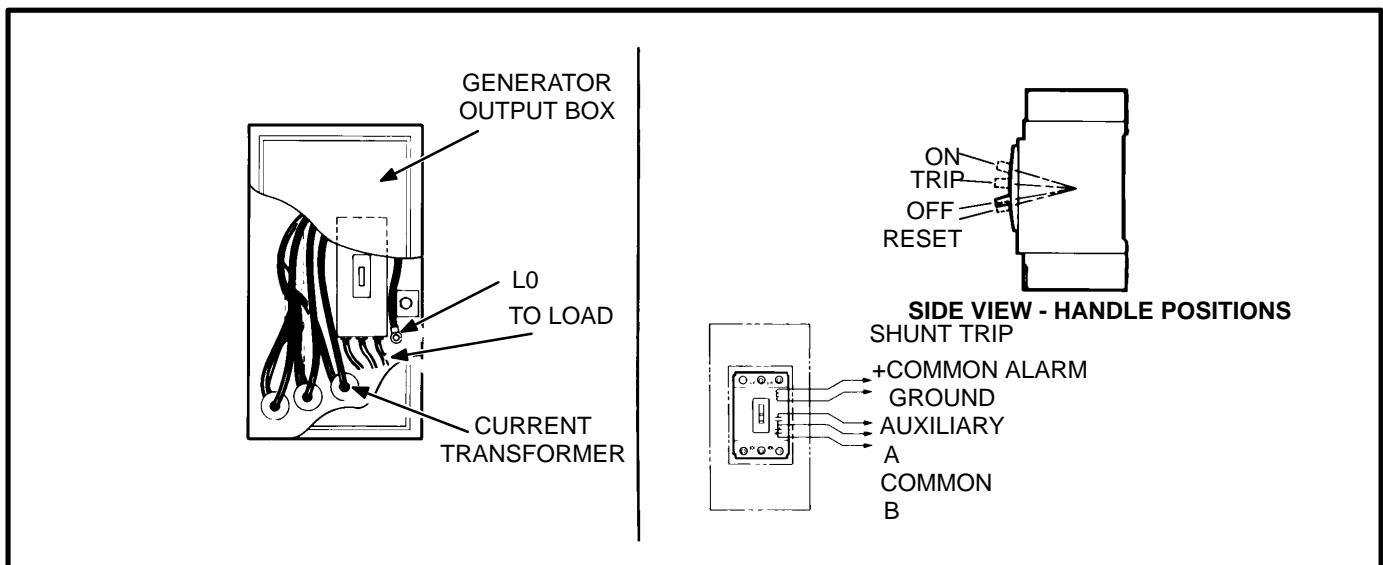


FIGURE 2-5. TYPICAL GENERATOR-MOUNTED CIRCUIT BREAKER

3. Engine Control

GENERAL

The control box is mounted on top of the generator, facing the rear. Figure 3-1 shows the components on the engine control panel.

STANDARD CONTROL PANEL COMPONENTS

Run/Stop/Remote Switch (S12) The switch is pushed to the **Run** position to start and run the generator set and the **Stop** position to stop the set. The **Remote** position allows a remote controller to automatically run the set. The switch must be in the **Stop** position when the reset switch (described next) is used to restore generator set operation following a fault shutdown.

Reset/Lamp Test/Panel Lamp Switch (S11) The switch is pushed to the **Reset** position (momentary

contact) to reset the engine control to restore operation following a fault shutdown. The **Run/Stop/Remote** switch must be in the **Stop** position for reset to occur. On later production controls this switch has a light that illuminates following a fault or emergency shutdown. This light remains lit until the engine control has been reset.

The **Lamp Test** position (momentary contact) lights all the fault indicator lamps. Replace lamps that do not light.

The **Panel Lamp** position lights the panel illumination lamp.

Oil Pressure Gauge (M11) The oil pressure gauge indicates engine oil pressure.

Coolant Temperature Gauge (M12) The coolant temperature gauge indicates engine coolant temperature.

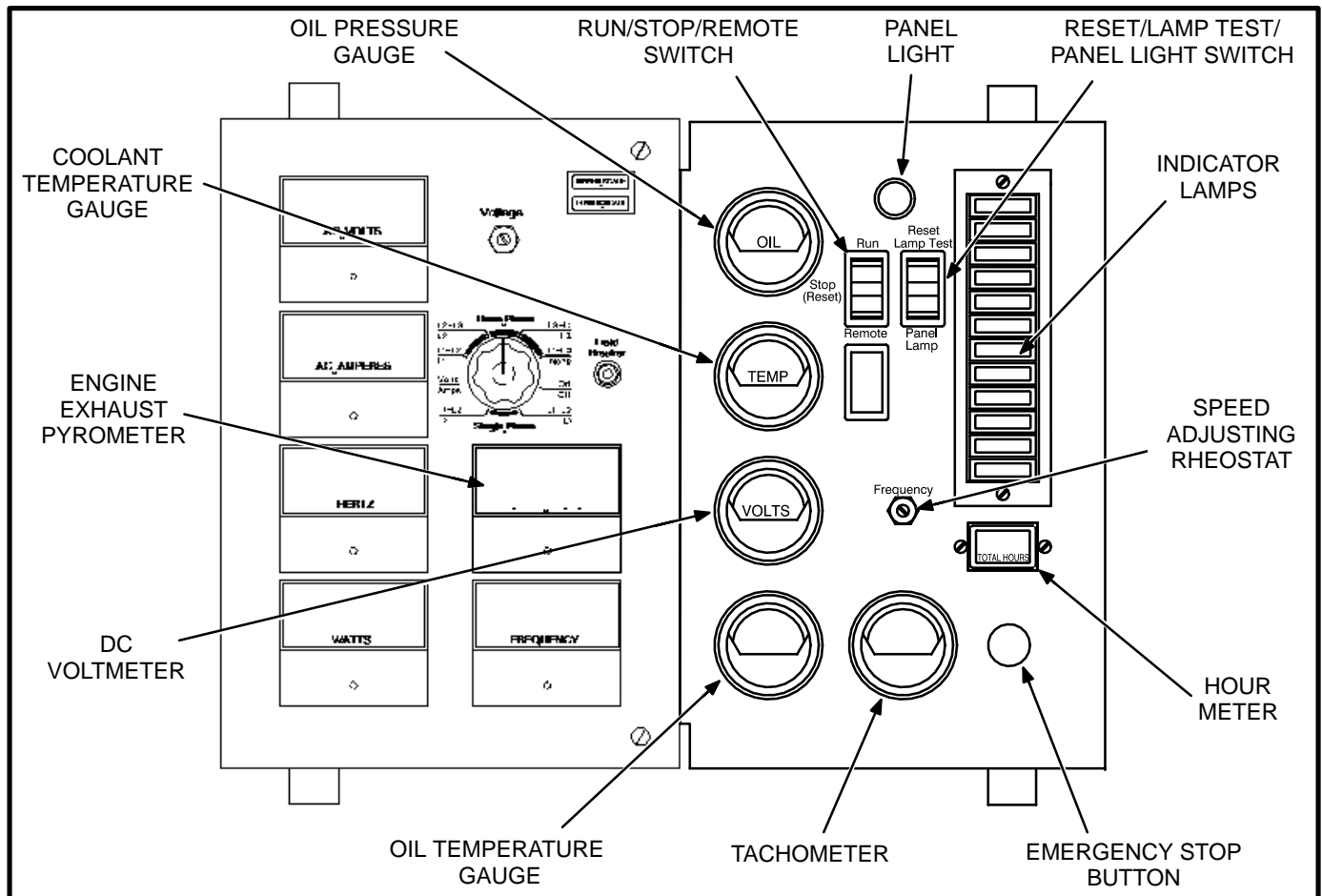


FIGURE 3-1. ENGINE CONTROL PANEL

DC Voltmeter (M13) The DC voltmeter indicates voltage across the battery terminals during operation.

Hour Meter (M14) The hour meter indicates the accumulated number of hours the set has run. It cannot be reset.

Panel Lamp (DS11) The panel lamp illuminates the control panel.

Detector-7 Fault and Status Indicator Lamps (A12)

- **Run (Green)** This lamp indicates that the generator set is running and that the starter has been disconnected.
- **Pre Low Oil Pressure (Yellow)** This lamp indicates that engine oil pressure is abnormally low (less than 20 psi).
- **Low Oil Pressure (Red)** This lamp indicates that the engine shut down because of excessively low engine oil pressure (less than 14 psi).
- **Pre High Engine Temperature (Yellow)** This lamp indicates that engine coolant temperature is abnormally high (greater than 220° F).
- **High Engine Temperature (Red)** This lamp indicates that the engine shut down because of excessively high engine coolant temperature (greater than 230° F).
- **Overspeed (Red)** This lamp indicates that the engine shut down because of overspeed.
- **Overcrank (Red)** This lamp indicates that the engine shut down because it did not start during the timed cranking period (approximately 75 seconds, including two rest periods).

OPTIONAL CONTROL PANEL COMPONENTS

Oil Temperature Gauge (M15) The oil temperature gauge indicates engine oil temperature.

Tachometer (M16) The tachometer indicates engine speed in RPM.

Speed Adjusting Rheostat (R11) The speed adjusting rheostat is used to adjust engine speed from the control panel (an option with the optional electric governor).

Engine Exhaust Pyrometer (M26) The pyrometer indicates engine exhaust gas temperature. On dual exhaust systems, a switch is used to select the sensor to be monitored.

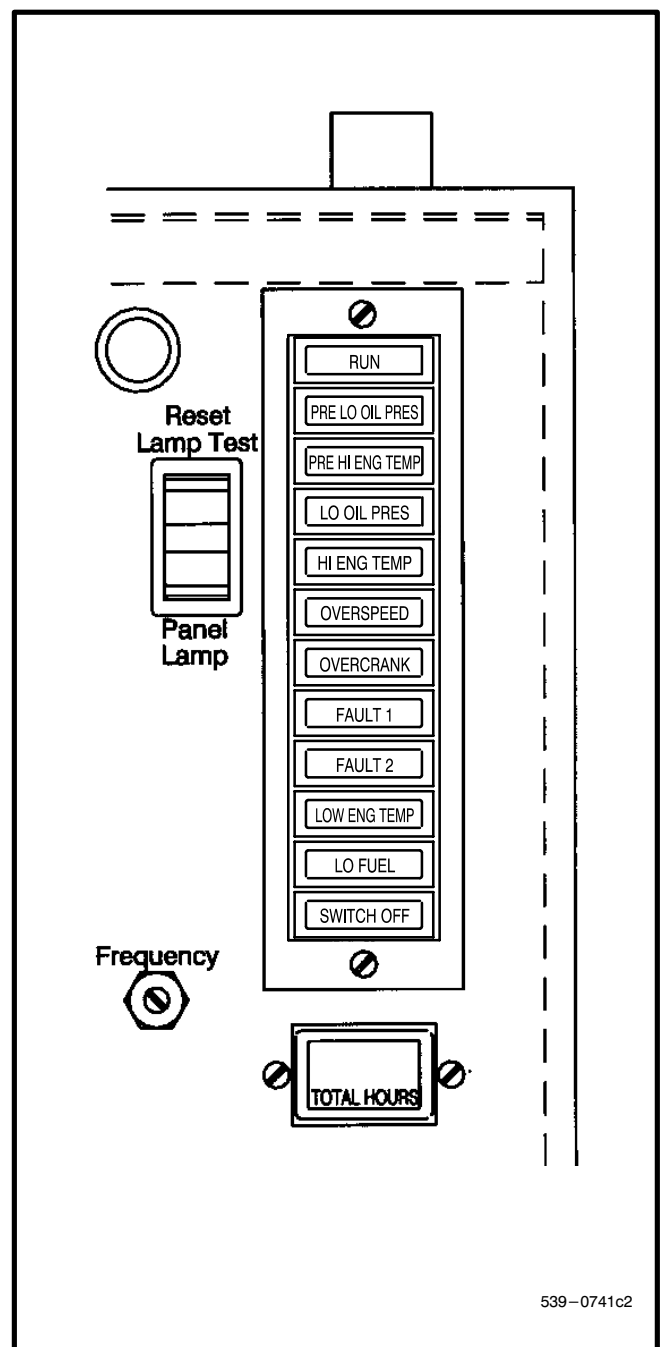


FIGURE 3-2. DETECTOR-12 INDICATOR LAMPS

Emergency Stop Button (S14) The emergency stop button is a red, push-in switch used to stop the engine. The button lights up when it is pushed in. The button has to be pulled out and the engine control reset to restore operation.

Low Coolant Level Cutout Switch (S7) When coolant level in the radiator top tank falls below the switch sensor, the switch closes the circuit to ground. This switch may be connected in parallel with the high engine temperature cutout switch to shut down the engine and light the **High Engine Temperature** lamp or in parallel with the pre-high engine temperature switch to light the **Pre High Engine Temperature** light only.

Detector-12 Fault and Status Indicator Lamps (A12) The Detector-12 control panel has the five following indicator lamps in addition to the standard seven.

- **Fault 1 (Red)** This lamp indicates that the engine shut down because of a system fault. The customer has to make connections to use this lamp. The lamp is a part of a 10 second time delay shutdown circuit. The customer can make reconnections for non-timed shutdown. See Engine Control Monitor (ECM).
- **Fault 2 (Red)** This lamp indicates that the engine shut down because of a system fault. The customer has to make connections to use this lamp. The lamp is part of a non-time delay shutdown circuit. The customer can make reconnections for 10 second time delay shutdown. See Engine Control Monitor (ECM).
- **Low Engine Temperature (Yellow)** This lamp indicates that engine temperature is less than 70° F, and the possibility that the engine might not start.
- **Low Fuel (Yellow)** This lamp indicates that the fuel level in the supply tank has dropped to less than the reserve necessary to run the set at full load for the prescribed number of hours. The customer has to make connections to use this lamp.
- **Switch-off (Flashing Red)** This lamp indicates that the **Run/Stop/Remote** switch is in the **Stop** position, which prevents remote, automatic operation.

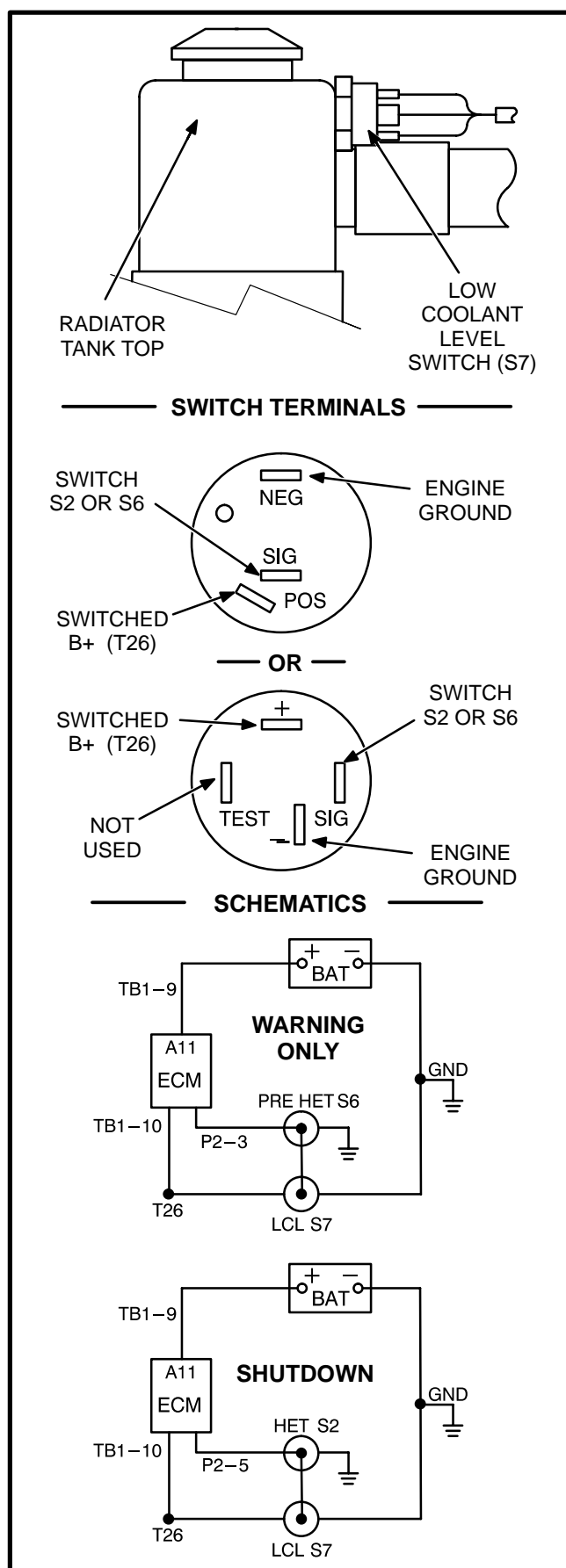
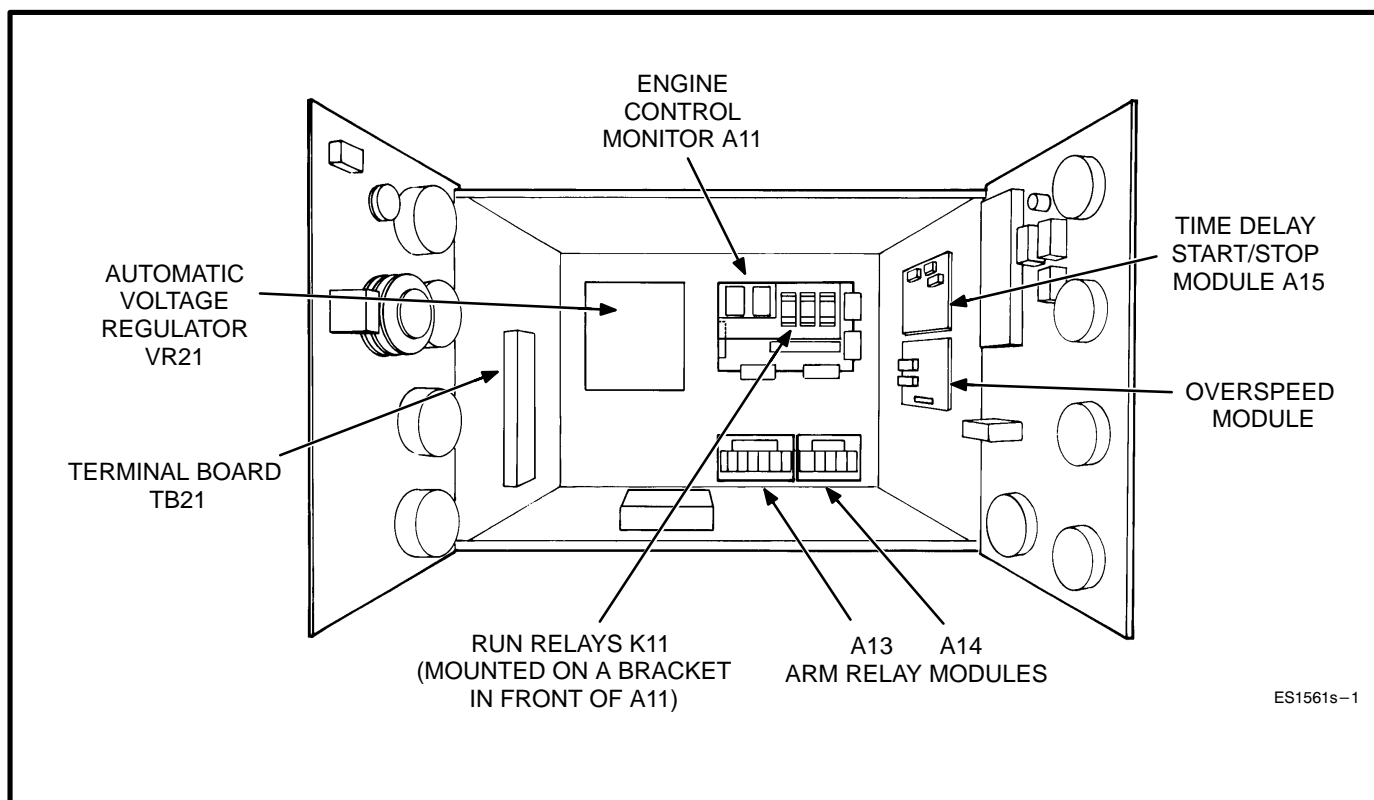


FIGURE 3-3. LOW COOLANT LEVEL SWITCH



**FIGURE 3-4. LOCATION OF COMPONENTS INSIDE CONTROL BOX
(SEE FIGURE 3-9 FOR CONTROL BOX WITH AUXILIARY RELAY BOARD)**

CONTROL BOX INTERIOR

Figure 3-4 shows the arrangement of components inside the control box, including the engine control monitor and some of the auxiliary components under following headings.

ENGINE CONTROL MONITOR (A11)

The heart of the engine control system is the engine control monitor (ECM) (Figure 3-5). It is a printed circuit board assembly mounted on the back wall of the control box. It starts and stops the engine in response to the control panel switches, engine sensors and remote control signals.

Note that there are two versions of the ECM board and that they both perform the same functions. They only differ in that one version contains additional components, which are, LED's (**DS1 – DS9**), terminal board (**TB3**) and function selection jumper **W10**. Figure 3-5 illustrates the ECM version which contains the additional components.

LED's DS1 through DS9

The ECM LED's are provided as an aid in troubleshooting the control circuitry. The LED's indicate the following conditions:

LED	STATUS WHEN ILLUMINATED
DS1	B+ is connected to ECM and fuse F4 is good.
DS2	RUN relay is energized.
DS3	Start Command signal enabled.
DS4	Crank signal enabled.
DS5	DC Starter Disconnect signal enabled.
DS6	AC Starter Disconnect signal enabled.
DS7	LOP/HET signal active (time delay circuit has timed-out).
DS8	Reverse battery voltage.
DS9	Remote Shutdown signal active (grnd at TB2-16)

Terminals and Connectors

See *Section 8* for the appropriate connection and schematic drawings for the DC control system. Also refer to *Section 8* for typical customer connections at terminal boards **TB1** and **TB2** on the ECM and page 9-11 if the set is also equipped with the auxiliary relay board.

Terminal board **TB3** provides an alternative direct connection to the ECM for the RUN/STOP/REMOTE switch for troubleshooting or if desired, customer connection.

TB3-1 = REMOTE

TB3-2 = RUN

TB3-3 = STOP

Fuses

The ECM has five replaceable fuses to protect it from overloads and ground faults. They are:

F1 Starter solenoid circuit, 20 amps.

F2 Fuel solenoid (switched B+) circuits, 20 amps.

F3 Continuous B+ out to remote circuits, 15 amps.

F4 ECM circuits, 5 amps.

F5 Engine gauge circuits, 5 amps.

Function Selection Jumpers

ECM board has seven selection jumpers that can be repositioned to provide the following timed or non-timed warnings or timed or non-timed shutdowns with warnings, and control of the SWITCH OFF indicator:

W1 Jumper Position (jumper **W8** must be in the **B** position):

- A** Non-timed warning under **FLT 2** conditions.
- B** Non-timed shutdown under **FLT 2** conditions.
- C** Timed warning under **FLT 2** conditions.
- D** Timed shutdown under **FLT 2** conditions.

W2 Jumper Position (jumper **W9** must be in the **B** position):

- A** Non-timed warning under **FLT 1** conditions.
- B** Non-timed shutdown and under **FLT 1** conditions.
- C** Timed warning under **FLT 1** conditions.
- D** Timed shutdown under **FLT 1** conditions.

W6 Jumper Position:

- A** Warning under **Pre-High Engine Temperature** conditions.
- B** Shutdown under **Pre-High Engine Temperature** conditions.

W7 Jumper Position:

- A** Warning under **Pre-Low Oil Pressure** conditions.
- B** Shutdown under **Pre-Low Oil Pressure** conditions.

W8 Jumper Position:

- A** Warning while running or during standby under **FLT 2** conditions.
- B** Allows selection of functions with **W1** jumper.

W9 Jumper Position:

- A** Warning while running or during standby under **FLT 1** conditions.
- B** Allows selection of functions with **W2** jumper.

W10 Jumper Position (**SWITCH OFF** Indicator):

- A** Flashing
- B** Constant ON
- C** OFF

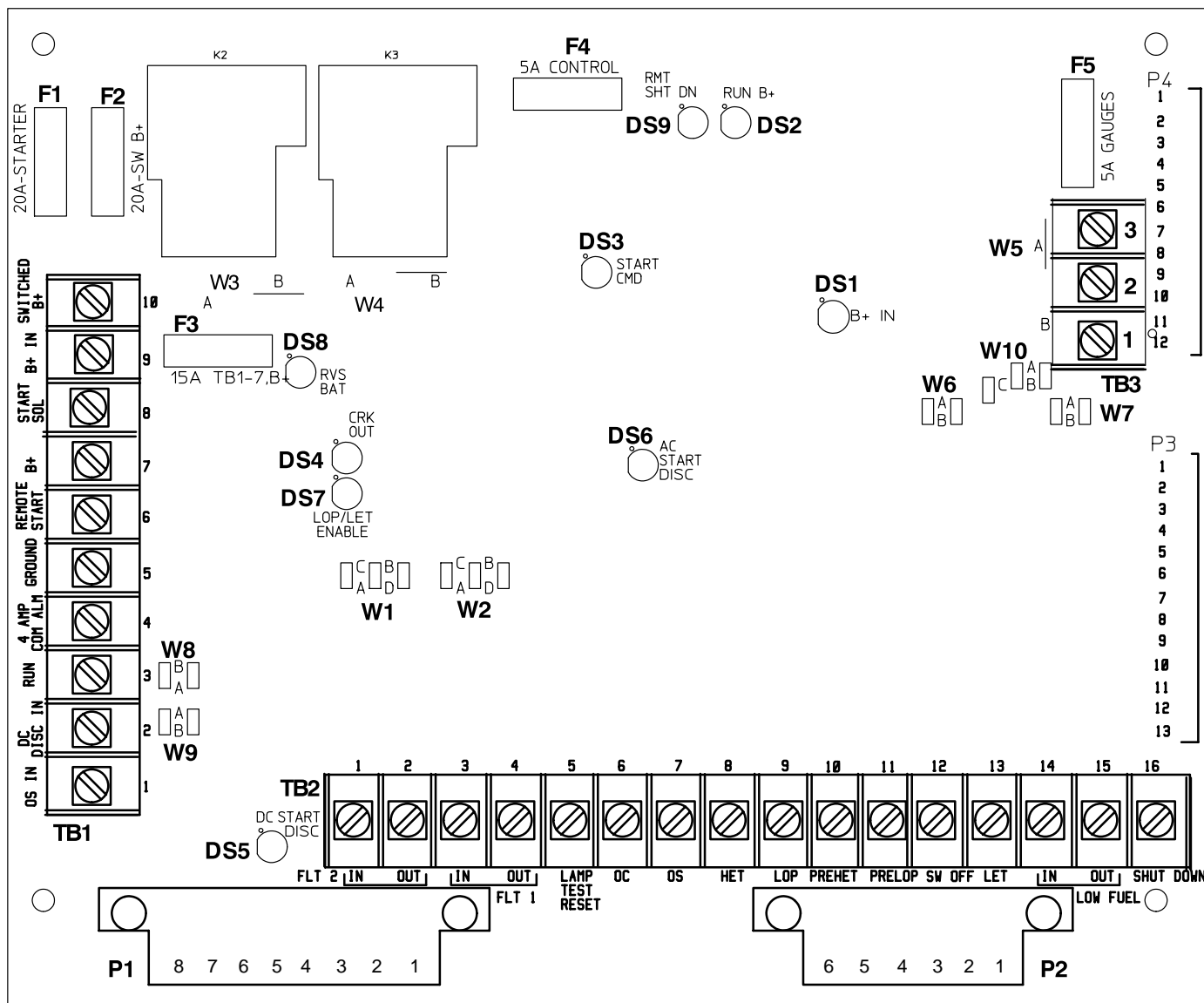


FIGURE 3-5. ENGINE CONTROL MONITOR FUSES AND FUNCTION SELECTION JUMPERS

ENGINE SENSORS

See *Section 8* for the locations of the gauge senders and the coolant temperature and oil pressure sensing switches that the ECM monitors. The switches function by closing the fault or warning circuit to the engine chassis ground (battery negative [-]).

AUXILIARY CONTROL COMPONENTS

The set might be equipped with one or more of the following components.

Overspeed (Frequency Detection Module)

PMG-excited generators are equipped with an electronic overspeed module in the control box (Figure

3-6). The module senses PMG output frequency to determine generator speed (frequency). **Do not adjust the cranking pot.**

Check and adjust the overspeed module as follows. Use an insulated handle screw driver to prevent electrical shock.

1. Make a note of the no-load frequency.
2. Adjust the governor speed pot to the overspeed cutout setting (1800 to 1900 RPM for 50 Hz sets and 2100 to 2200 RPM for 60 Hz sets).
3. If an overspeed fault is indicated, go to step 4. If a fault is not indicated, adjust the overspeed pot until an overspeed fault occurs.
4. Adjust the governor speed pot back to the initial frequency setting.

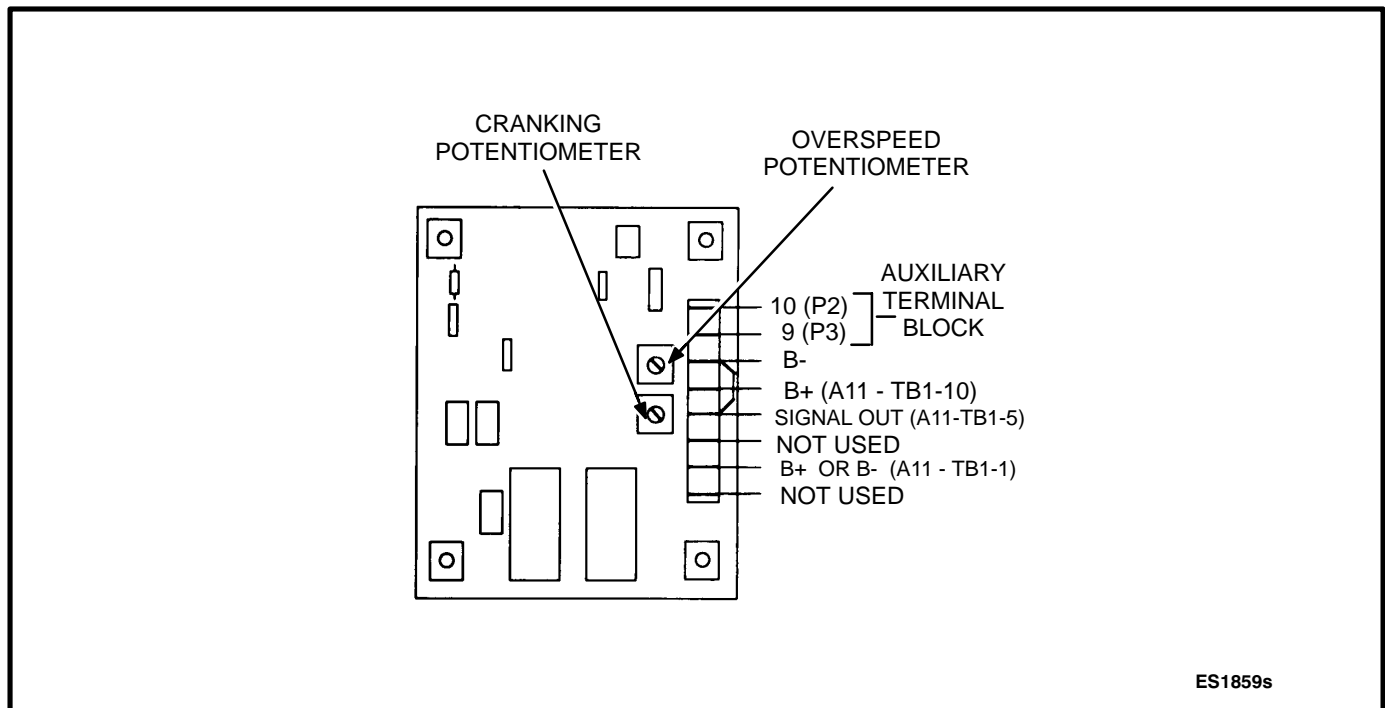


FIGURE 3-6. ELECTRONIC OVERSPEED MODULE

Run Relays (K11)

The set can be equipped with one to three 3-pole, double-throw relays to control auxiliary equipment such as fans, pumps, and motorized air dampers. The relays are mounted on a standoff bracket in front of the ECM.

The contacts are rated:

- 10 amps at 28 VDC or 120 VAC, 80% PF
- 6 amps at 240 VAC, 80% PF
- 3 amps at 480 VAC, 80% PF

The set might instead be equipped with an auxiliary relay board. If so, see Auxiliary Relay Board (ARB).

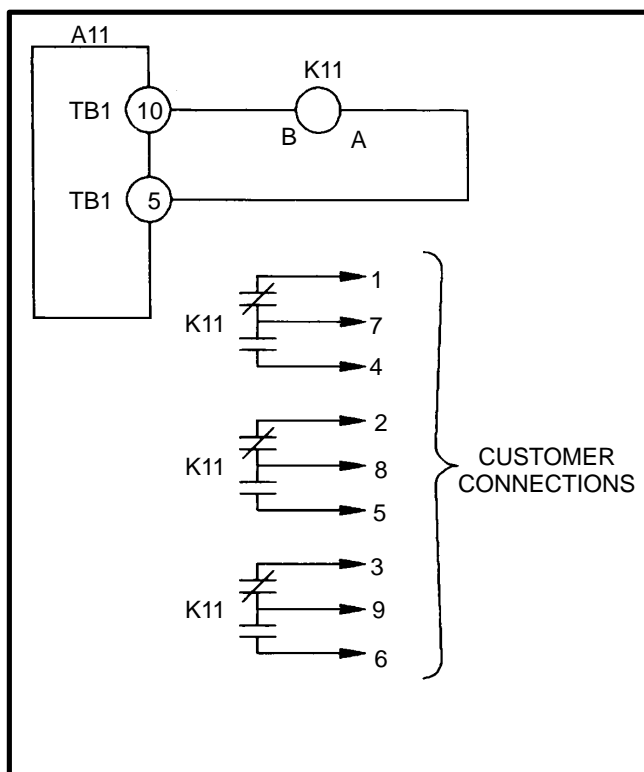


FIGURE 3-7. RUN RELAYS

Alarm Relay Modules (A13 and A14)

The set can be equipped with relay modules to interface with a remote annunciator that is powered independently of the control circuit of the set. Sets with Detector-7 need module A13 and sets with Detector-12, modules A13 and A14.

These are all normally open contacts and they are rated:

- 15 amps at 250 VAC
- 15 amps at 30 VDC

The set might instead be equipped with an auxiliary relay board. If so, see Auxiliary Relay Board (A28).

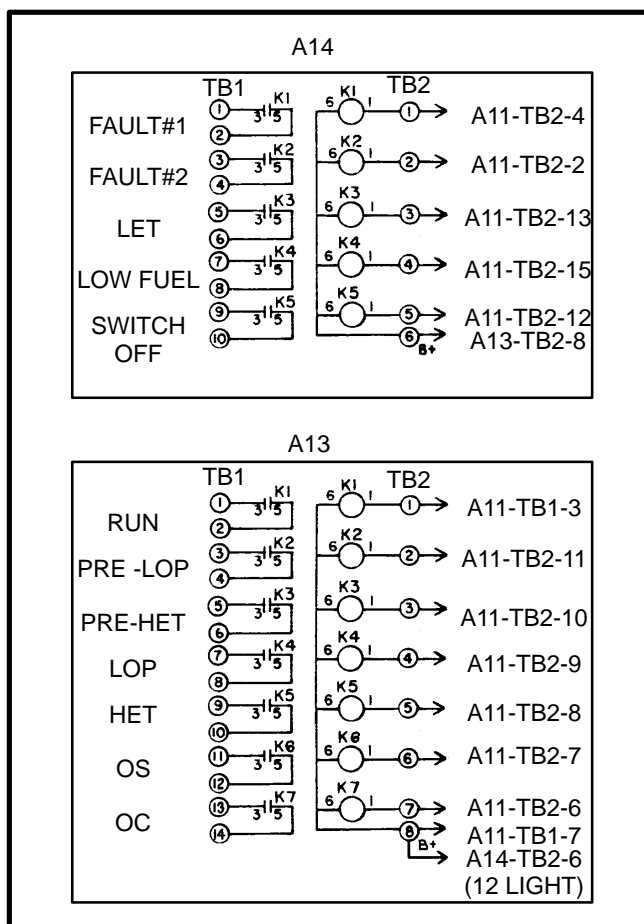


FIGURE 3-8. ALARM RELAY MODULES

Auxiliary Relay Board (A28)

The following describes the design/functional criteria for the auxiliary relay board (ARB) with a Detector-7 or -12 genset control. The board is mounted directly on top of the ECM using standoffs and has access holes for the fuses located on the ECM. There are two versions of the ARB; with and without the set of 12 Fault relays (Figure 3-9). *Section 8* contains a detailed connection diagram for the ARB.

The set might instead be equipped with separate run and alarm relay modules. If so, see Run Relay (K11) and Alarm Relay Modules (A13 and A14).

Terminal Blocks

TB1 – ARB TB1 and ECM TB1 are identically numbered and provide the same remote control connection points. Note that additional terminals are provided for terminals 5, 7, and 10 of ARB TB1.

TB2 through TB5 – Connection points for relays K1 through K3. TB2 provides the N/O and N/C connections (three form 'C' contacts for each relay). TB3 through TB5 provide the common connection points (TB3 for K1, TB4 for K2 and TB5 for K3).

TB6 and TB7 – Connection points for fault relays K4 through K15. Three terminals are provided for each relay, which are labeled COM, N/C, N/O.

Plug-In Relays (K1, K2, K3)

The ARB can be equipped with one to three 3-pole, double-throw relays. These relays (K1, K2, K3) are field changeable plug-in relays for easy field addition and replacement.

The relay contact ratings are:

- 10 amps at 28 VDC or 120 VAC, 80% PF
- 6 amps at 240 VAC, 80% PF
- 3 amps at 480 VAC, 80% PF

Each relay can be operated as a RUN, COMMON ALARM, or ISOLATED COIL with the changing of a jumper.

Jumper Positions for Plug-In Relays

Jumpers W1, W2 and W3 perform the same functions for their respective relays, W1 for relay K1, W2

for relay K2, and W3 for relay K3. They can be located in any of 3 positions (A, B, C) independently of each other.

Jumper Position A (Run): The relay operates as a Run relay, energizing when SW B+ is applied from the ECM.

Jumper Position B (Common Alarm): The relay operates as a Common Alarm relay. The relay energizes any time there is an engine shutdown. This signal is provided from the ECM.

Jumper Position C (Isolated): The relay operates as an Isolated relay. The relay coil is energized by a customer applied B+ signal through the terminal block; TB3-1 for relay K1, TB4-1 for relay K2, and TB5-1 for relay K3.

Jumpers W11, W12, and W13 perform the same functions for their respective relays; W11 for relay K1, W12 for relay K2, and W13 for relay K3. They can be located in two different positions (A, B) independently of one another.

Jumper Position A: The relay operates isolated from the board. The customer provides the circuit completion through terminal block; TB3 for relay K1, TB4-5 for relay K2, and TB5-5 for relay K3. The customer can operate the relay with switched ground logic or use this relay in the middle of more complex logic circuits if needed.

Jumper Position B: The relays operate with the coils connected to ground through the board connections. The coil will require a B+ signal to energize with the jumper in this position.

Fault Relays (K4 through K15)

These optional relay modules are used to operate a remote alarm annunciator that has an independent power source. This allows the use of either AC or DC for alarm drives. The relays are energized through the latching relays on the ECM and provided N/O and N/C contacts for each external alarm connection.

The 12 relays with form 'C' contacts are rated:

- 10 Amp, 120 VAC
- 10 Amp, 30 VDC

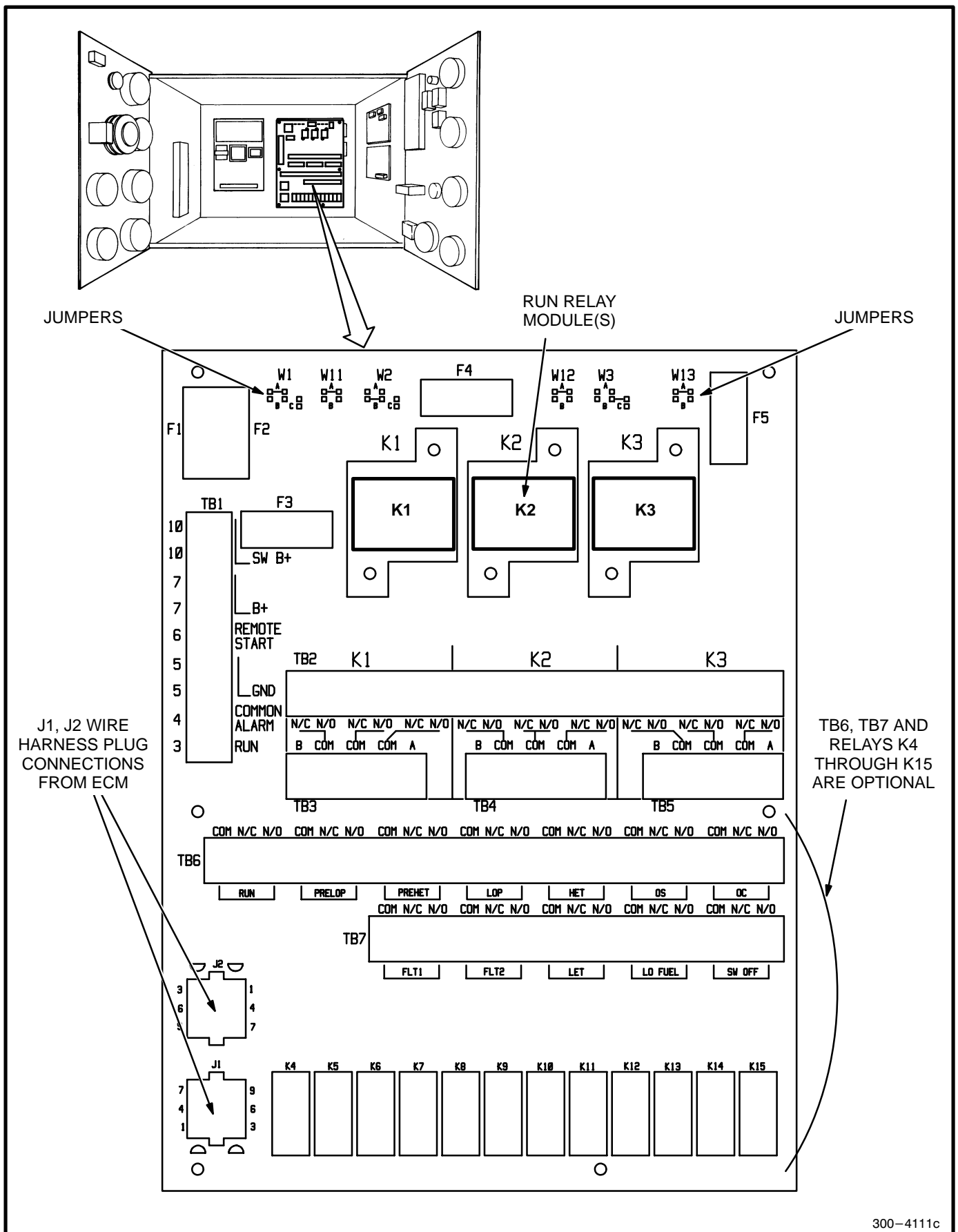


FIGURE 3-9. AUXILIARY RELAY BOARD (ARB)

300-4111c

Over/Under Voltage Module (A17)

The set can be equipped with an adjustable voltage-sensitive relay usually connected into the **Fault 1** circuit (Detector-12 controls only). The module will shut down the set when the output voltage is over or under nominal voltage by the preselected percentage (typically 10 percent over and under).

This module has an adjustable time delay relay (**K17**), used on early production gensets to allow an over/under voltage condition during startup (later production gensets use the engine control monitor delay). An adjustment of 25 percent is equivalent to about 2.5 seconds delay.

Recalibrate the module as follows before installing it on 139/240 VAC or 277/480 VAC sets.

⚠ WARNING *Contact with high voltage can cause severe personal injury or death. Do not touch any exposed wiring or components with any body part, clothing, tool or jewelry. Stand on an insulating mat or dry wood platform when performing these steps.*

1. Remove the two screws that secure the top to the case of the module and withdraw the top assembly.
2. Adjust the **SET** pot for the **UNDER** setpoint on the face of the top assembly to 75 percent.
3. Apply single-phase, 60 Hertz, 104.25 VAC across terminals **L** and **N**.
4. Adjust pot **R25** on the PC board until the relay trips (de-energizes).
5. Adjust the **SET** pot for the **OVER** setpoint on the face of the top assembly to 125 percent.
6. Apply single-phase, 60 Hertz, 173.75 VAC across terminals **L** and **N**.
7. Adjust pot **R26** on the PC board until the relay trips (energizes).
8. Repeat the above steps until no adjustments are necessary.
9. Reassemble the module.
10. On the module nameplate mark out the factory calibration value for monitored voltage (120 V) and write in **139 V**.

Over/Under Frequency Module (A19)

The set can be equipped with an adjustable frequency-sensitive relay to shut down the set when the output frequency (Hz) is over or under nominal frequency by the preselected amount (Figure 3-11).

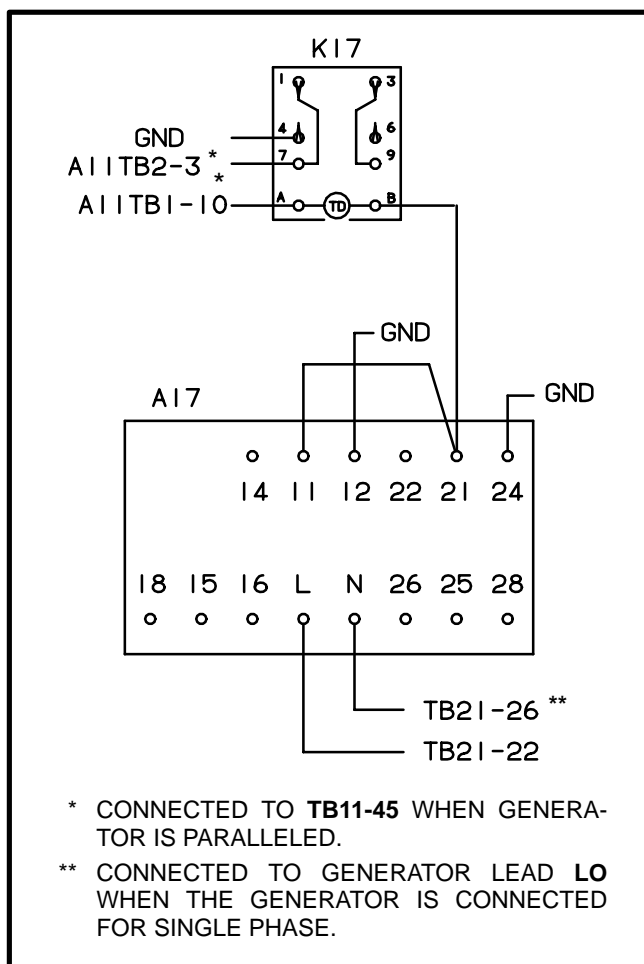


FIGURE 3-10. OVER/UNDER VOLTAGE MODULE

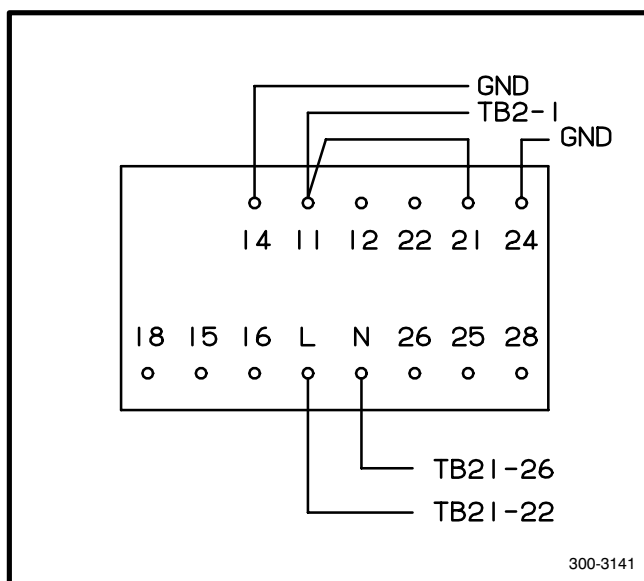


FIGURE 3-11. OVER/UNDER FREQUENCY MODULE

It is usually connected into the **Fault 2** circuit (Detector-12 controls only) if the over / under voltage module is also provided. Set points are typically 5 Hertz over and under nominal frequency (50 or 60 Hertz) and reset points 3 Hertz over and under.

Time Delay Start/Stop Module (A15)

The set can be equipped with a module to delay starting and stopping when the start and stop signals are received from the remote controller. It is adjustable to delay starts from 1 to 15 seconds to prevent nuisance starts in installations where momentary power interruptions are frequent. It is adjustable to delay stops 1 to 30 minutes to allow the gen-set time to cool down after the load is removed.

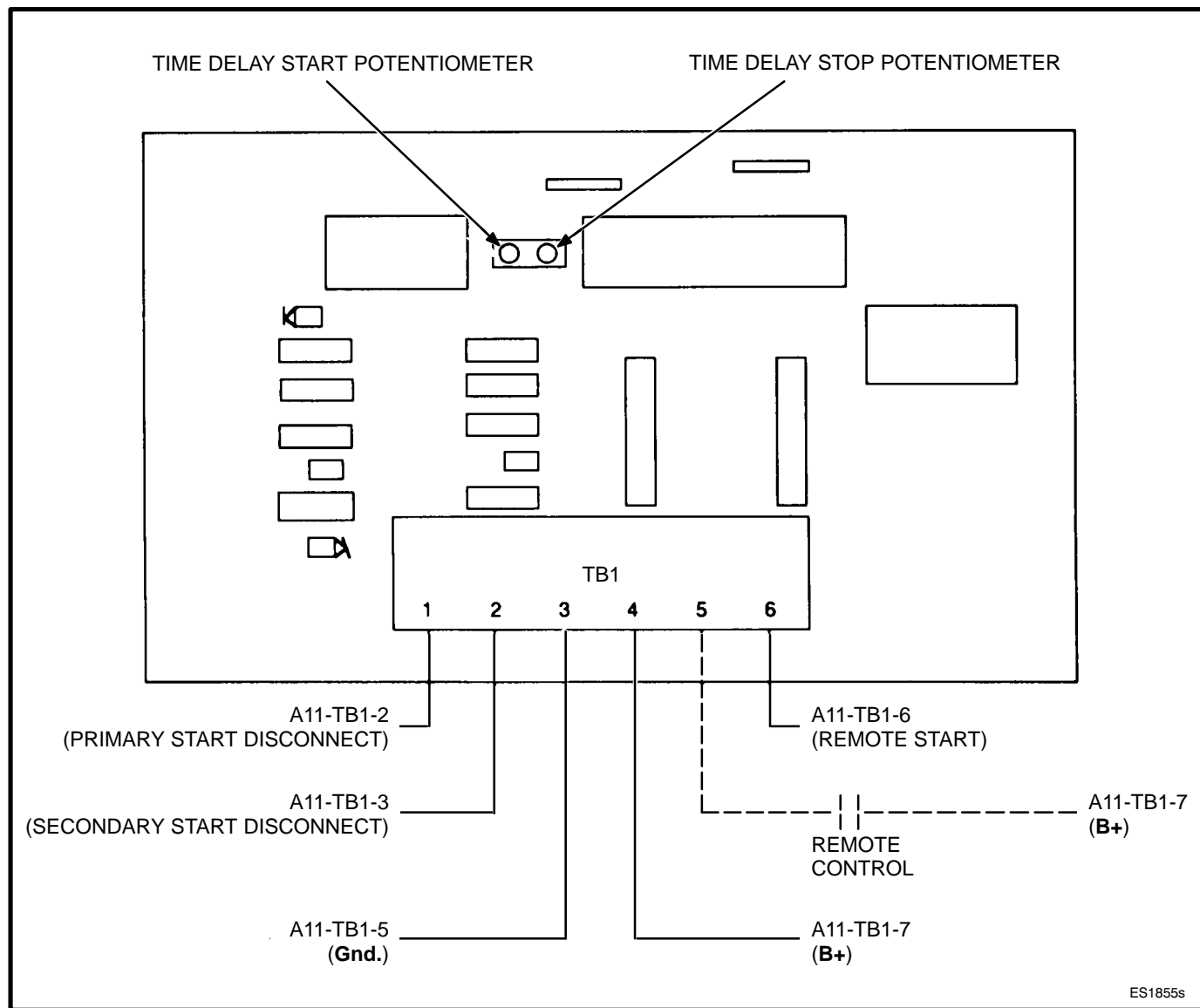


FIGURE 3-12. TIME DELAY START/STOP MODULE

Ground Fault Relay (Optional)

The optional Ground Fault Relay is typically located behind the lower control housing grille. The ground fault relay continuously monitors the neutral to ground connection and activates a fault alarm when the connection is broken. During genset operation, the relay continuously monitors the line to neutral and activates a fault alarm when a ground fault is sensed.

The relay alarm contacts are typically connected to the genset control (terminal 14 to control ground and terminal 15 to A11 TB2-1) to provide a "Ground

Fault Alarm" indication. The auto reset link is set at the factory so the fault condition is cleared at the genset control by pushing the Run/Stop (Reset) /Remote switch to Reset.

Terminals 9 (+) and 10 (–) can be used for percent full scale metering output (0–1 mA full scale).

The relay has a time delay setting of 0 to one second.

The relay has one set of form C contacts rated:

- 1100VA at 250V
- 250 VAC, 5A continuous, 3A breaking

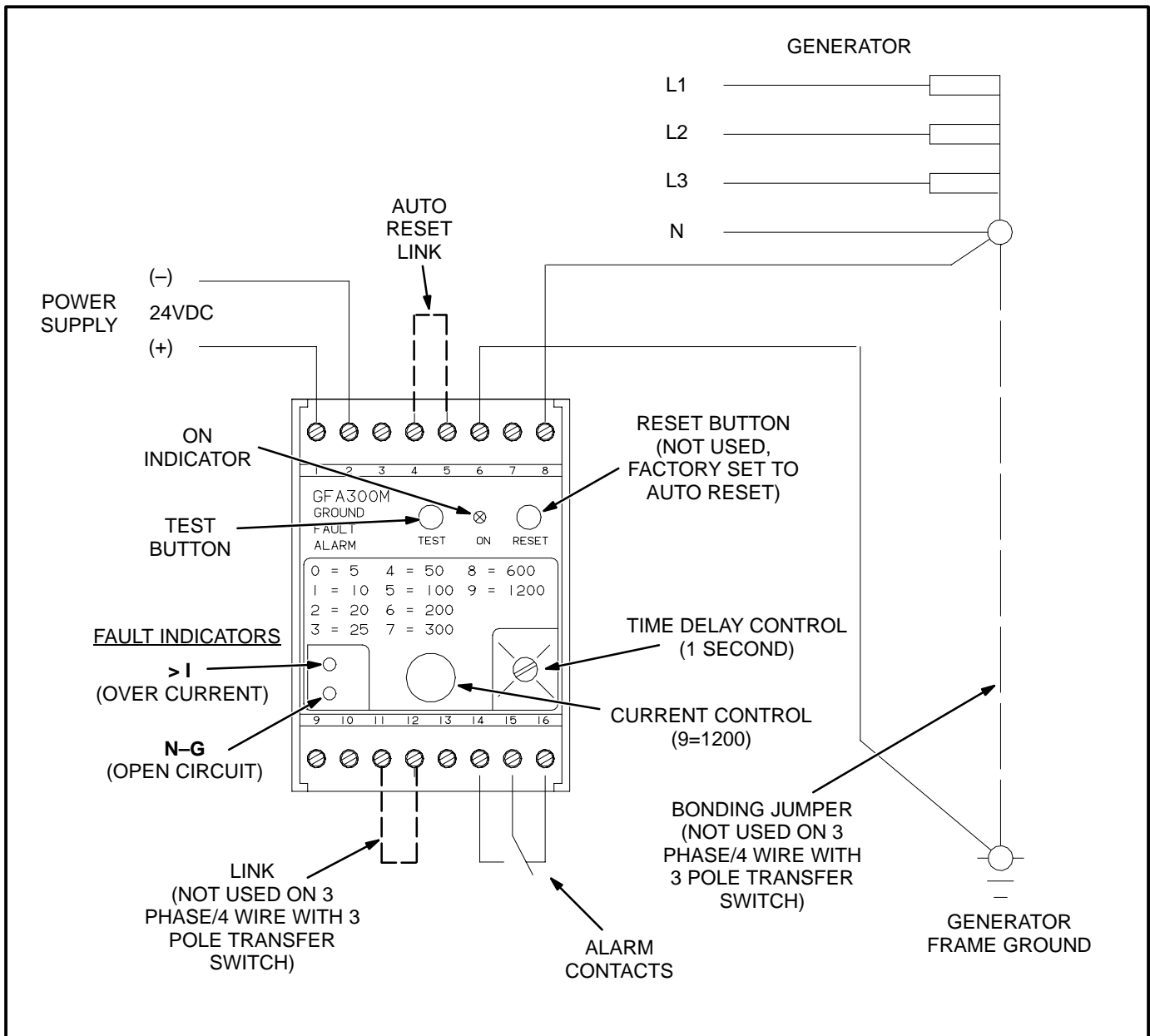


FIGURE 3-13. GROUND FAULT ALARM RELAY (OPTIONAL)

RTD Relay (Optional)

The optional RTD relay is rail mounted inside the accessory box. This relay is used to monitor six separate temperature zones in the generator windings using resistive temperature detectors (RTDs). The relay determines the sensed temperature and acts to isolate, alarm, or initiate corrective action.

The RTD relay compares the six inputs to the predetermined setpoint (temperature setpoint is factory adjusted). If one or more of the inputs exceed the setpoint, the output relay is energized. LED's indi-

cate the state of the output relay (green for normal, red for tripped). Additional red LED's are used to indicate which inputs exceed the setpoint.

The relay terminals 11, 12 and 14 are for customer connection. These terminals can be attached to either of the two Customer Fault inputs on TB1 to provide a warning/shutdown condition or to other customer warning devices.

The contacts are rated:

- 240 VAC, 5 amps non-inductive
- 24 VDC, 25 amps resistive

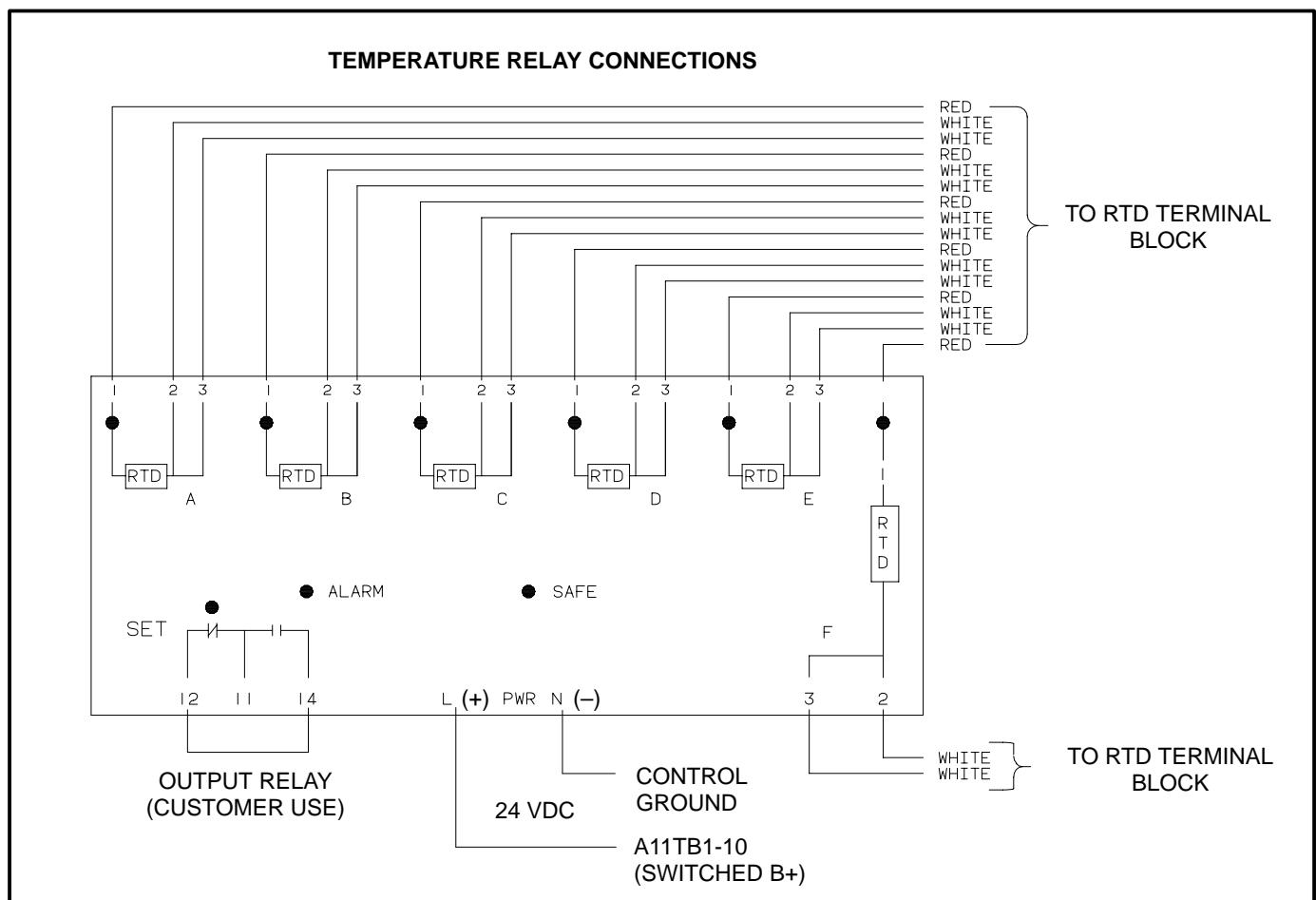


FIGURE 3-14. RTD RELAY (OPTIONAL)

Thermistor Relay (Optional)

The optional thermistor relays are rail mounted inside the accessory box. Each relay monitors three thermistors (one per phase) that are connected in series inside the generator. One series or chain of thermistors are rated at 140° C and the other at 160° C. The 140° C relay is commonly used in a pre-alarm circuit and the 160° C relay in a shut-down cir-

cuit. The relay will energize (trip) when the thermistor chain resistance reaches 3000 ± 500 ohms.

The relay terminals 1, 2 and 3 are for customer connection and are normally connected to a breaker shunt trip or a load shed circuit.

The contacts are rated:

- 3 amps at 250 VAC
- 1 amp at 480 VAC

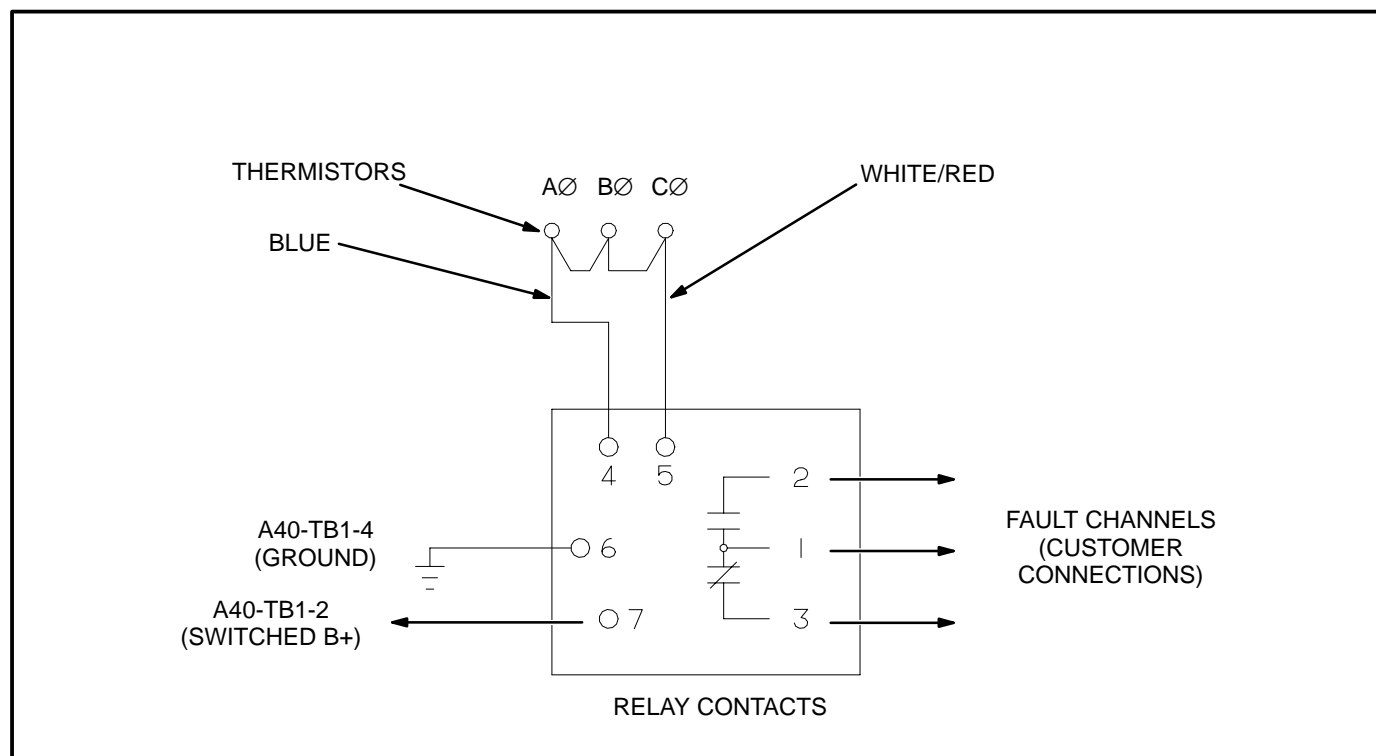


FIGURE 3-15. THERMISTOR RELAY (OPTIONAL)

SEQUENCE OF OPERATION

The sequence of operation is as follows. Refer to the schematic on Page 8-3 or 8-9, as appropriate.

1. The ECM is powered by cranking battery voltage (24 VDC). Terminal **TB1-9** is connected to battery positive (+) and connector **P1-6** to battery negative (-).
2. The starting cycle begins when relay **K7** is powered, either manually by pushing the panel **Run** switch, or automatically by a remote controller connected at terminal **TB1-6**. (The panel switch must be in the **Remote** position for remote, automatic operation.)
3. Relay **K7** powers relays **K2** and **K3**.
4. Relay **K2** powers the engine gauges and terminal **TB1-10**, to which the fuel solenoid, ignition module and electronic governor are connected.
5. Relay **K3** powers terminal **TB1-8** to which starter relay **K4** is connected. Engine cranking begins.
6. The engine starts and runs up to governed speed in a matter of seconds.
7. The starter is disconnected when engine speed gets to about 600 RPM. This is done by relay **K10** or **K14**, whichever acts first to open the circuit powering relay **K3**.
8. Relay **K10** is powered by the generator output voltage (120 VAC) through plug-in connectors **P1-1** and **P1-2**. The remote **Run** indicator lamp should light (connected through terminal **TB1-3**).
9. Relay **K14** is powered by the engine-driven battery charging alternator (24 VDC) through plug-in connector **P1-3**. The panel **Run** indicator lamp should light. Relays **K10** and **K14** are redundant.

10. Relays **K2** and **K3** are deenergized (by latching fault relay **K6**) causing shutdown to occur if the engine does not start within 75 seconds. The **Overcrank** indicator lamp lights and common alarm terminal **TB1-4** is powered.

The ECM has a cycle crank feature whereby the engine is cranked for three 15 second periods alternated with two 15 second rest periods.

11. Relay **K2** is deenergized (by latching fault relay **K6**) causing shutdown to occur during operation when a low oil pressure, high engine temperature or engine overspeed condition is sensed or the optional emergency stop button is pressed. The appropriate fault indicator lamp lights and common alarm terminal **TB1-4** is powered. (There is no fault lamp for emergency stop.)

An oil pressure time delay (12 seconds) prevents the ECM from sensing low oil pressure and high engine coolant temperature until 12 seconds after either start disconnect signal is applied to the ECM.

12. To restore operation after a shutdown fault has been serviced, reset latching relay **K6** by pushing the panel **Stop** switch and then the **Reset** switch. The set should run or be ready to run when the panel switch is pushed to **Run** or to **Remote**.

If the emergency stop switch has been used, the control will have to be reset to restore operation. First pull the emergency stop switch button and then push the panel Stop and Reset switches.

13. The set is stopped manually by pressing the panel **Stop** switch or automatically by a remote controller. (The panel switch must be in the **Remote** position for remote, automatic operation.)

4. Troubleshooting

These troubleshooting charts are designed to help you diagnose generator set problems. To save time troubleshooting, read the entire manual ahead of time to understand the generator set. Go over the options and modifications and review what was

done during the last service call. Look the generator set over for any obvious problems. The problem could be as simple as an empty fuel tank, closed fuel shutoff valve, loose wire, blown fuse or tripped circuit breaker.

THE ENGINE DOES NOT CRANK IN RUN MODE

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The Emergency Stop switch has been used. (The switch button is lit.)	Pull the Emergency Switch button. To reset the engine control, push the Run-Stop-Remote switch to Stop and the Reset switch to Reset . Then push the Run-Stop-Remote switch to Run .
2. A Fault Shutdown is being indicated by one of the red lights on the control panel.	Service the set as necessary. To reset the engine control, push the Run-Stop-Remote switch to Stop and the Reset switch to Reset . Then push the Run-Stop-Remote switch to Run .
3. A LO Shutdown is being indicated on the day tank pump control panel.	Determine the cause and service as necessary (See <i>Section 7</i>). To reset the engine control, push the Run-Stop-Remote switch to Stop and the Reset switch to Reset . Then push the Run-Stop-Remote switch to Run or Remote . Note that the engine control will shut down unless the day tank control has been reset first.
4. Cranking voltage is too low to crank the engine.	<ol style="list-style-type: none"> Clean and tighten or replace the positive (+) and negative (–) battery cable connectors and cables at the battery and the set. Recharge or replace the battery. Specific gravity for a fully charged battery is approximately 1.260 at 80° F (27° C). If the set is in standby service, install a battery charger. Replace the engine-driven battery charging alternator if normal battery charging voltage (24 to 28 VDC) is not obtained.
5. Fuse F1 (see Figure 3-4) on engine monitor board A11 has blown (no voltage [B+] at A11-TB1-8).	The wire between A11-TB1-8 and starter terminal S may be loose and shorting to ground. Repair as necessary and replace the fuse with one of the same type and amp rating (20 A). If fuse continues to blow repair the solenoid or starter as necessary.

THE ENGINE DOES NOT CRANK IN RUN MODE

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
6. The wire between ECM terminal TB1-9 and starter terminal BAT is loose, damaged or missing.	Check for battery voltage (24 VDC) between ECM terminal TB1-9 (B+) and the grounding stud (–) on the floor of the control cabinet. Check, clean and tighten the connectors at both ends and replace the wire if it is damaged.
7. The grounding strap between the control box and the battery negative (–) terminal is loose, damaged or missing.	Check for continuity (zero ohms) between the grounding stud on the bottom of the control box and the battery negative (–) terminal. If there is no continuity or the grounding strap is loose or damaged, repair as necessary.
8. The Run-Stop-Remote switch (S12) or wiring is faulty.	Disconnect pin connector J4 from engine monitor board A11 and check for electrical continuity (zero ohms) between switch terminals 2 and 3 when the switch is in the Run position and between terminals 1 and 2 when it is in the Remote position. Replace the switch if either set of contacts is faulty.
9. Engine monitor board A11 is faulty. (Check fuses F1 and F4 and for B+ at A11-TB1-9 again.)	Push the Run-Stop-Remote switch to Run and check for battery voltage (24 VDC) at terminal A11-TB1-8 . Replace engine monitor board A11 if there is no voltage at A11-TB1-8 but 24 VDC at A11-TB1-9 .
10. The wire between ECM terminal TB1-8 and starter solenoid terminal SW is loose, damaged or missing.	Push the Run-Stop-Remote switch to Run and check for battery voltage (24 VDC) at starter solenoid terminal SW . If there is no voltage repair the wiring as necessary.
11. The starter motor or solenoid is malfunctioning.	Push the Run-Stop-Remote switch to Run and check for battery voltage (B+) at starter solenoid terminal SW . Replace the starter motor if there is voltage but the motor does not function.
12. The Time Delay Start/Stop Module (A15) is malfunctioning.	Check for constant B+ at A15 terminal TB1-4. Check for run signal at A15 TB1-5. Voltage at A15 TB1-6 should be at B+ at the end of the start delay period. Check wiring and connections from A15 TB1-6 to A11 TB1-6.
13. The starter motor or solenoid is malfunctioning.	Push the Run-Stop-Remote switch to Run and check for battery voltage (B+) at starter solenoid terminal SW . Replace the starter motor if there is voltage but the motor does not function.

THE ENGINE DOES NOT CRANK IN REMOTE MODE

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The Run-Stop-Remote switch is at Stop . (The Switch-Off light will be flashing, if provided.)	Push the Run-Stop-Remote switch to Remote .
2. The Emergency Stop switch has been used. (The switch button is lit.)	Pull the Emergency Switch button. To reset the engine control, push the Run-Stop-Remote switch to Stop and the Reset switch to Reset . Then push the Run-Stop-Remote switch to Remote .
3. A Fault Shutdown is being indicated by one of the red lights on the control panel.	Service the set as necessary. To reset the engine control, push the Run-Stop-Remote switch to Stop and the Reset switch to Reset . Then push the Run-Stop-Remote switch to Remote .
4. There is no remote circuit signal (24 VDC at auxiliary relay board A28-TB1-6) because fuse F3 on engine monitor board A11 has blown.	<ol style="list-style-type: none"> Replace the fuse with one of the same type and amp rating (15 A). If fuse F3 blows again, find and repair the fault in the remote control circuit, such as a loose wire that may be shorting to ground or a shorted relay coil or other component. See Section 8 for remote connections.
5. There is no remote circuit signal (24 VDC at auxiliary relay board A28-TB1-6) because the remote circuit is not functioning properly.	Apply 24 VDC to A28-TB1-6 . If the engine cranks, find and repair the fault in the remote control circuit. See Section 8 for remote connections.
6. Auxiliary relay board A28 is not functioning properly.	Check for misconnections (see Section 8) or loose connections and replace auxiliary relay board A28 if there is 24 VDC at terminal A28-TB1-6 but not at A28-J2-6 .
7. Same as Steps 3 through 11 in the RUN mode.	See steps 3 through 11 in the preceding RUN mode.

THE ENGINE CRANKS BUT DOES NOT START

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The engine is not getting fuel.	Open any closed shutoff valve. Fill the main fuel supply tank.
2. Fuse F2 on the engine monitor board A11 has blown.	Replace fuse with one of the same type and amp rating. If fuse F2 blows again, the wire between A11 TB1-10 and engine block terminal T26, or the wire between T26 and fuel solenoid K1 may be loose or shorting to ground.
3. Fuel solenoid K1 does not energize.	<ul style="list-style-type: none"> a. Fuel solenoid not energized by ECM A11. Check for B+ at TB1-10 when cranking. If no voltage present and fuse F2 is good replace ECM. b. Connect B+ to fuel solenoid (K1) terminal BAT. Replace the fuel solenoid if does not “click” when energized. If fuel solenoid is working, check for blocked fuel line or fuel filter.
4. Low engine temperature is causing too low a cranking speed for starting.	<ul style="list-style-type: none"> a. Plug in, repair or install engine coolant and engine oil heaters. b. Replace the engine oil if it is not of the recommended viscosity for the ambient temperature.
5. Cranking voltage is too low to reach required cranking speed.	<ul style="list-style-type: none"> a. While cranking the engine, measure voltage directly across the battery terminals and then immediately across the starter motor terminal and the grounding bolt on the block. Cable, terminal or relay contact resistance is too high if the difference is more than 2 volts. Service as necessary. b. Recharge or replace the battery. Specific gravity for a fully charged battery is approximately 1.260 at 80° F (27° C). c. Replace the engine-driven battery charging alternator if normal battery charging voltage is not between 24 and 28 volts.
6. The air cleaner is blocked.	Service as necessary.
7. Ignition system, fuel system or other engine malfunction.	Service according to the engine service manual.

THE ENGINE RUNS UNTIL FAULT SHUTDOWN

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The OVERSPEED lamp comes on when the engine shuts down.	<ol style="list-style-type: none"> Reset engine monitor board A11 by pushing the Run-Stop-Remote switch to Stop and the Reset switch to Reset and restart the set, monitoring engine speed and adjust the Electronic Overspeed Module (<i>Section 3</i>). Check the governor for binding, repair and adjust the governor as necessary (see <i>Section 6</i>).
2. The LO OIL PRES lamp comes on when the engine shuts down.	<ol style="list-style-type: none"> Check the engine oil level, repair any oil leaks and fill to the proper level. Then reset engine monitor board A11 by pushing the Run-Stop-Remote switch to Stop and the Reset switch to Reset. If the set still shuts down due to low oil pressure, restart the set and observe oil pressure while cranking the engine. Service the lubricating oil system according to the engine service manual if oil pressure is less than 10 psi. Replace the low oil pressure cutout switch if oil pressure is greater than 10 psi. See <i>Section 8</i> to locate the switch.
3. The HI ENG TEMP lamp comes on when the engine shuts down.	<ol style="list-style-type: none"> Check the engine coolant level, repair any coolant leaks and refill as necessary. Then reset engine monitor board A11 by pushing the Run-Stop-Remote switch to Stop and the Reset switch to Reset. If the set still shuts down due to high engine temperature, start the engine and observe coolant temperature as the system heats up. If shutdown occurs before the coolant reaches 200° F (93° C), replace the high engine temperature cutout switch. If coolant temperature exceeds 200° F (93° C), clean and service the entire cooling system as required to restore full cooling capacity. See <i>Section 8</i> to locate the switch.
4. The FAULT 1 or FAULT 2 lamp comes on when the engine shuts down.	<p>Service as required. (The customer has supplied the system fault indication switches. Either fault can be chosen to display the warning only. See <i>Section 3</i>.)</p> <p>If the shutdown was due to low frequency, the set probably ran out of fuel or the governor is out of adjustment.</p> <p>If the shutdown was due to over/under voltage, the voltage regulator may be out of adjustment.</p>

THE ENGINE LACKS POWER OR IS UNSTABLE

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. Fuel delivery to the genset is inadequate.	<ul style="list-style-type: none"> a. Check for clogged fuel lines and filters. b. Check for air in the fuel lines and repair all air leaks. c. Measure the vertical distance between the fuel lift pump on the engine and bottom of the dip tube in the supply tank. The lift must not exceed 6 feet (1.8 meters).
2. The fuel is contaminated.	Connect the set to a supply of good quality fuel and run the set under various loads. Replace the contents of the fuel supply tank if there is a noticeable improvement in performance.
3. The engine air filter element is dirty.	Replace the air filter element.
4. The governor settings or linkage adjustment is incorrect.	<ul style="list-style-type: none"> a. Make governor settings and adjustments according to <i>Section 6, Governor</i>. b. Check the magnetic speed pick-up unit (MPU) clearance with flywheel. Replace the MPU if output voltage at cranking speed is less than 2.5 VDC measured at terminals 10(–) and 11 (+) on the governor controller.
5. The engine fuel system (lift pump, injection pump, injectors, timing) is faulty.	Service the fuel system according to the engine service manual.
6. The engine is worn.	Service the engine according to the engine service manual.

AN AMBER WARNING LAMP IS ON

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The PRE LO OIL PRES lamp comes on while the engine is running.	Shut down the set if possible or disconnect non-critical loads. (Oil pressure will be less than 20 psi but greater than 14 psi.) Service the engine lubricating system according to the engine service manual.
2. The PRE HI ENG TEMP lamp comes on while the engine is running.	Shut down the set if possible or disconnect non-critical loads. (Engine temperature will be greater than 220° F but less than 230° F.) Service the engine cooling system to restore full cooling capacity.
3. The LOW ENGINE TEMPERATURE lamp comes on while the set is in standby.	<ol style="list-style-type: none"> Plug in, repair or install engine coolant and engine oil heaters. If the engine coolant gauge indicates more than 70° F (21° C), replace the gauge board. See Figure 3-4.
4. The LO FUEL lamp comes on.	Fill the main fuel supply tank with the appropriate grade of fuel. (The customer has supplied the fuel level switch to make use of this warning.)
5. The FAULT 1 or FAULT 2 lamp (may be a specifically labeled amber lamp) comes on.	Service as required. (The customer has supplied the system fault indicating switches. By means of selection jumpers, either fault may be chosen to shut down the engine. See <i>Section 3, Engine Control</i> .)

THE GREEN RUN LAMP STAYS OFF BUT THE SET RUNS NORMALLY

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The set mounted RUN lamp does not light, although the starter has disconnected normally and the engine is running. The remote RUN lamp does light (AC start disconnect is okay).	<ol style="list-style-type: none"> Press the panel Lamp Test switch and replace the run lamp bulb if it does not light. If the lamp is good and the set has an older ECM board (one with cartridge-type fuses), this indicates that the DC disconnect circuit (K14 relay on ECM) is not working. Check the DC voltmeter and if there is not at least 24 VDC, Check for loose or missing wiring between the battery charging alternator terminal TB1-2 and pin connector P1-3 on the ECM. See the connection diagram in <i>Section 8</i>. If the connections are good replace the battery charging alternator. If the RUN lamp, wiring connections and battery charging alternator are all good and the RUN lamp does not light, replace the engine monitor board A11.
2. Both the remote and set mounted RUN lamps do not light, although the starter has disconnected normally and the engine is running.	<ol style="list-style-type: none"> Press the panel Lamp Test switch and replace the run lamp bulb if it does not light. Test the remote RUN lamp by suitable means and replace it if it does not light. If both lamps are good, this indicates that the AC disconnect circuit is not working. Check the AC voltmeter to determine whether or not there is generator output voltage and service as necessary. See <i>There Is No Output Voltage in Troubleshooting</i>. If there is generator output voltage, check for 120 VAC across pin connectors P1-1 and P1-2 on engine monitor board A11. If there is no voltage, check for loose or missing leads between the connectors and TB21-21 and TB21-32 inside the control box and service as necessary. Replace engine monitor board A11 if there is 120 VAC across pin connectors P1-1 and P1-2 but neither RUN lamp lights during normal operation.

NO OUTPUT VOLTAGE

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The line circuit breaker is OFF .	Find out why the circuit breaker was turned OFF , make sure it is safe to reconnect power, and then throw the circuit breaker ON .
2. The line circuit breaker has TRIPPED .	Shut down the set and service as necessary to clear the short circuit or ground fault that caused tripping, and then RESET the circuit breaker and start the set.
3. The line circuit breaker is faulty.	Shut down the set, make sure the power output lines from the set have been disconnected from all other sources of power, attempt to RESET the circuit breaker and throw it ON and check for electrical continuity across each line contact. Replace the circuit breaker if there is measurable resistance across any contact.
4. Field circuit breaker CB21 has TRIPPED .	RESET the circuit breaker. If it keeps tripping, troubleshoot according to the chart, <i>Field Circuit Breaker Keeps Tripping</i> .
5. Field circuit breaker CB21 is faulty.	Shut down the set, attempt to RESET the circuit breaker and disconnect either lead. Replace the circuit breaker if there is measurable resistance across the terminals.

NO OUTPUT VOLTAGE (CONT.)

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause

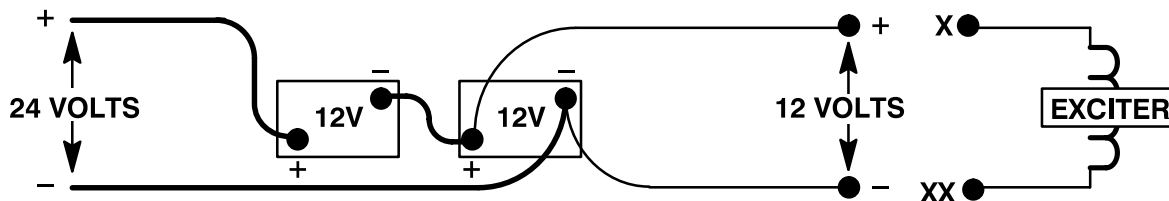
Corrective Action

Determine if the problem is in the voltage regulating or generator circuits as follows:

- a. Throw the line circuit breaker **OFF** and shut down the set.

⚠ CAUTION *This test involves unregulated excitation of the generator. To prevent damage to the generator due to overcurrent, make sure that all loads have been disconnected and that all faults have been cleared from the power output terminals of the generator.*

- b. Open the control panel and disconnect the field leads **X (F1)** and **XX (F2)** from the voltage regulator. See Figure 2-4. Perform the exciter stator winding resistance test (Section 5). The exciter stator resistance must test okay before proceeding.
- c. Prepare to measure output voltage across the generator terminals while the set is running.
- d. Bring two jumpers from a **12 volt battery** for connection to the **X (F1)** and **XX (F2)** leads inside the control box. Connect the jumper from the positive (+) post of the battery to the **F1 (X)** lead. Be prepared to connect the jumper from the negative (–) post of the battery to the **XX (F2)** lead. If one of the 12 volt cranking batteries is used, bring the jumpers from the battery connection on the grounded side of the system to avoid inadvertently imposing 24 volts on the system.



- e. Check polarity again. Polarity must be correct or this test will be inconclusive because the induced and residual magnetic polarities in the exciter stator will be opposed.

⚠ DANGER *HIGH VOLTAGE. Touching uninsulated high voltage parts inside the control box can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts. For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry from your hands and wear elbow length insulating gloves.*

- f. Start the set and connect the jumper wire from the battery negative (–) terminal to the **XX (F2)** lead.
- g. The generator is probably okay if rated output voltage or higher is obtained and the voltages for all phases are balanced when the exciter is powered by the 12 volt battery. Refer to the Voltage Regulator fault chart (step 6) for troubleshooting. (Normal excitation voltage ranges approximately from 10 VDC at no-load to 40 VDC at full-load.)
- h. Use the Generator fault chart. If the output voltages are not balanced, or are less than ninety percent of rated output voltage; the problem is probably in the generator. If the voltages are unbalanced, first troubleshoot the main stator—Step 11. If the voltages are uniformly low, first troubleshoot the exciter and field circuits—Steps 7, 8, 9 and 10.

NO OUTPUT VOLTAGE (CONT.)

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
6. Voltage Regulator VR21 is faulty.	<p>a. Follow the PMG test described in <i>Section 5</i> to determine if it is okay.</p> <p>b. Check all connections against the applicable reconnection diagram (<i>Section 8</i>) and rewire as necessary. Replace the voltage regulator if the PMG checks okay, the wiring is correct and there is no output voltage.</p> <p>⚠ CAUTION <i>Replacing the voltage regulator before servicing other faults can lead to damage to the new voltage regulator.</i></p>
7. The exciter field winding is open.	Shut down the set and check exciter field winding resistance according to <i>Section 5</i> . Replace the exciter field assembly if winding resistance does not meet specifications.
8. The rotating rectifier assembly (diodes CR1 through CR6) is faulty.	Shut down the set and check each diode according to <i>Section 5</i> . Service as necessary.
9. The exciter rotor windings are open.	Shut down the set and check exciter winding resistances according to <i>Section 5</i> . Replace the generator rotor assembly if exciter rotor winding resistances do not meet specifications.
10. The main rotor winding is open.	Shut down the set and check main rotor winding resistance according to <i>Section 5</i> . Replace the generator rotor assembly if main rotor winding resistance does not meet specifications.
11. The stator windings are open.	Shut down the set and check stator winding resistances according to <i>Section 5</i> . Replace the generator stator assembly if stator winding resistances do not meet specifications.

OUTPUT VOLTAGE IS TOO HIGH OR TOO LOW

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. Engine speed is unstable.	Troubleshoot according to the chart, <i>The Engine Lacks Power or is Unstable</i> .
2. The voltage has been adjusted improperly.	Adjust output voltage according to <i>Section 2, AC Control</i> .
3. Improper connections have been made at the generator output terminals.	Shut down the set and reconnect according to the appropriate reconnection diagram. See <i>Section 8</i> .
4. The rotating rectifier assembly (diodes CR1 through CR6) is faulty.	Shut down the set and check each diode according to <i>Section 5, Servicing the Generator</i> . Service as necessary.
5. Voltage Regulator VR21 is faulty.	<p>Replace the voltage regulator.</p> <p>⚠ CAUTION <i>Replacing the voltage regulator before servicing other faults can lead to damage to the new voltage regulator.</i></p>

OUTPUT VOLTAGE IS UNSTABLE

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The voltage has been adjusted improperly.	Adjust output voltage according to <i>Section 2, AC Control</i> .
2. The voltage adjusting rheostat on the control panel is faulty (if provided).	Unlock the voltage adjusting screw on the front of the control panel and disconnect either lead from the rheostat. Measure resistance between terminals 1 and 2 while turning the adjusting screw fully one way and then the other. Replace the rheostat if it is open at any point, or if resistance does not vary smoothly from zero to approximately 2,500 ohms.
3. Voltage Regulator VR21 is faulty.	<p>Replace the voltage regulator.</p> <p>⚠ CAUTION <i>Replacing the voltage regulator before servicing other faults can lead to damage to the new voltage regulator.</i></p>

THE FIELD CIRCUIT BREAKER KEEPS TRIPPING

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The rotating rectifier assembly (diodes CR1 through CR6) is faulty.	Shut down the set and check each diode according to <i>Section 5, Servicing the Generator</i> . Service as necessary.
2. The exciter field winding is shorted.	Shut down the set and check exciter field winding resistance according to <i>Section 5, Servicing the Generator</i> . Replace the exciter field assembly if winding resistance does not meet specifications.
3. The exciter rotor windings are shorted.	Shut down the set and check exciter winding resistances according to <i>Section 5, Servicing the Generator</i> . Replace the generator rotor assembly if exciter rotor winding resistances do not meet specifications.
4. The main rotor winding is shorted.	Shut down the set and check main rotor winding resistance according to <i>Section 5, Servicing the Generator</i> . Replace the generator rotor assembly if main rotor winding resistance does not meet specifications.
5. The stator windings are shorted.	Shut down the set and check stator winding resistances according to <i>Section 5, Servicing the Generator</i> . Replace the generator stator assembly if stator winding resistances do not meet specifications.
6. Voltage Regulator VR21 is faulty.	<p>Replace the voltage regulator.</p> <p>⚠ CAUTION <i>Replacing the voltage regulator before servicing other faults can lead to damage to the new voltage regulator.</i></p>

THE PHASE CURRENTS ARE UNBALANCED

⚠ WARNING *Hazards present in troubleshooting can cause equipment damage, severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Read Safety Precautions page and observe all instructions and precautions in this manual.*

Possible Cause	Corrective Action
1. The connected loads are distributed unevenly among the phases.	Shut down the set and redistribute the loads as evenly as possible.
2. Improper connections have been made at the generator output terminals.	Shut down the set and reconnect according to the appropriate reconnection diagram. See <i>Section 8</i> .
3. The stator windings are faulty (open or shorted).	Shut down the set and check stator winding resistances according to <i>Section 5, Servicing the Generator</i> . Replace the generator stator assembly if stator winding resistances do not meet specifications.
4. A load has a ground fault or short circuit.	Service the faulty equipment as necessary.

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5. Servicing the Generator

TESTING THE GENERATOR

These tests can be performed without removing the generator. Before starting tests, disconnect the battery charger from its AC source. Then disconnect the negative (–) cable from the battery to prevent accidental starting to make sure the engine will not start while performing these tests.

⚠ WARNING Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.

Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (–) cable first and reconnect last.

⚠ CAUTION Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.

⚠ WARNING Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (–) cable from the battery terminal.

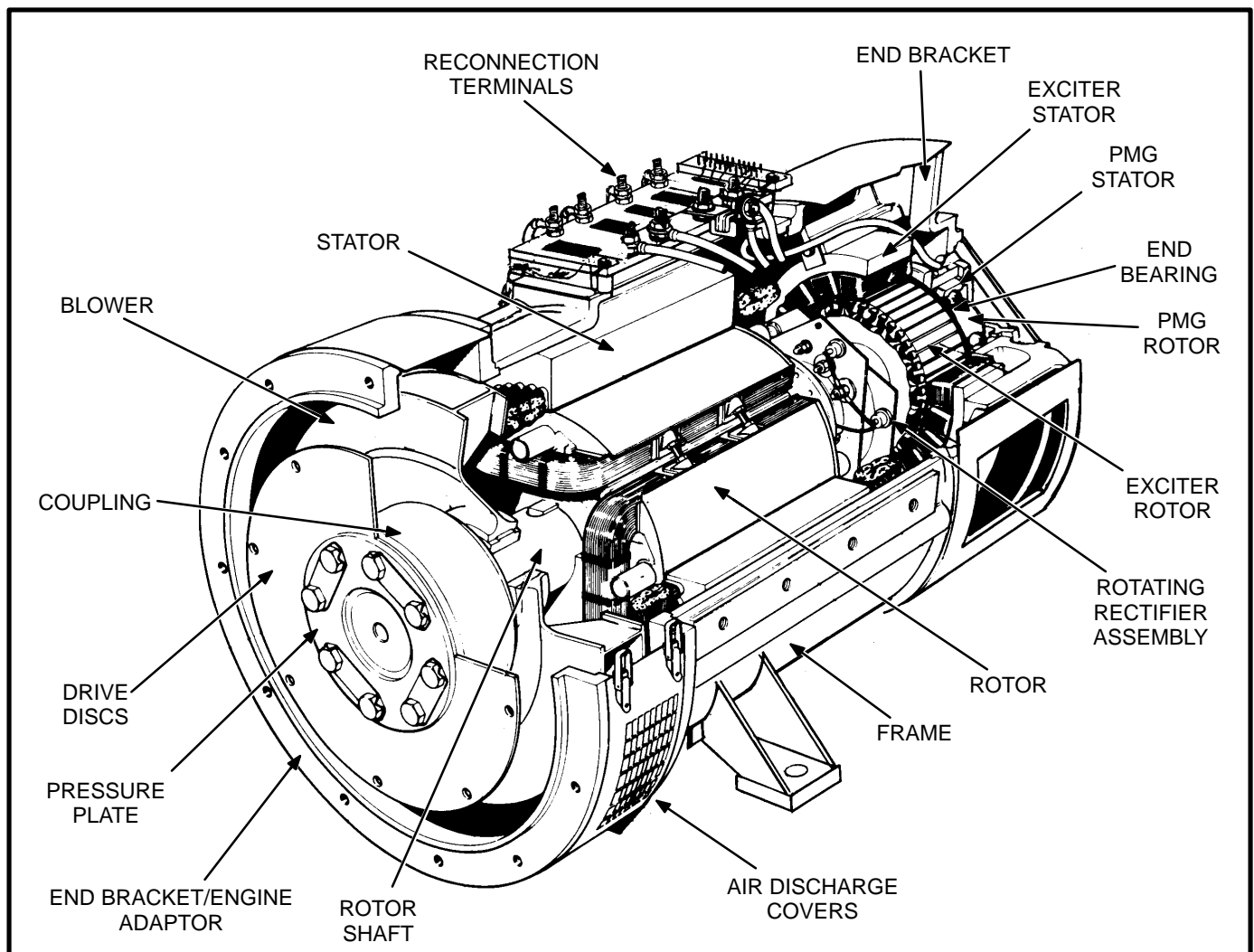


FIGURE 5-1. GENERATOR

G-1185

INSULATION RESISTANCE (MEGGER) & POLARIZATION INDEX (PI) TESTING

Megger and PI testing **must** be performed on all medium voltage (601 through 15,000 volts) generator sets before initial start-up. PI testing for low voltage (less than 600 volts) generator sets is recommended by Cummins Power Generation.

These tests are used to verify that the windings are dry before the generator set is operated and they develop a base line for future test comparison.

Before these tests can be performed on **medium voltage** generator sets, you must first perform the generator grounding procedure.

Generator Set Grounding Procedure

Prior to performing service or inspection procedures that may expose personnel to conductors normally energized with voltages greater than 600 volts, the following generator set grounding procedure must be followed.

⚠WARNING *Do not perform these procedures unless fully trained in medium voltage grounding procedures and have necessary safety equipment. Severe injury or death due to high voltage electrical shock may result.*

1. Open, lock-out and tag-out all sources of power to the immediate work area.
2. Disable the starting system of the generator set:
 - a. Disconnect the battery charger from its AC source.
 - b. Remove the negative battery cable(s) from the battery.
 - c. Install a lockout device on the battery cable(s) end(s). (For engines equipped with an air-powered starting system, close air valve and install valve locking device.)

3. Put on high voltage gloves with leather protectors.
4. Using two pre-tested voltage detection devices (of the proper rating), verify de-energized condition in the work area. (Retest voltage detection devices immediately after verification of de-energized condition.)
5. Remove the metal cover from the generator output box to gain access to generator load terminals.
6. Securely install the Grounding Cluster ground clamp to a verified “grounded” conductor.

⚠WARNING *Hazardous voltage. Can cause severe personal injury or death. After DC voltage from the test equipment has been applied to the windings and ground, there will be a definite static charge on the windings. Reconnect Grounding Cluster to remove static charge from the winding after each generator test.*

7. With the Grounding Cluster in place, you are protected from static and/or induced charges that may have been present in the generator stator.

Leave grounds connected for at least one minute to insure static charge dissipation. Remove ground cluster and perform PI and/or any other tests required on the stator winding. Reconnect grounds if additional generator service is necessary.
8. When work on the generator set is complete, remove the Grounding Cluster in the reverse order of installation.
9. After getting clearance from all personnel involved in the lock-out/tag-out procedure, remove all lock-out devices in reverse order of installation.

Megger and PI Test

⚠WARNING *Medium-voltage, 601 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator or cables. Service personnel must be well-trained/qualified to work with distribution voltages. (See Generator Set Grounding Procedures, page 5-2.)*

⚠WARNING *The windings of medium-voltage (601 through 15,000 volts) generator sets must be dry before the generator is operated. Failure to make sure windings are dry before start-up may result in catastrophic equipment failure, severe personal injury or death.*

Megger Test: The megger test consists of applying voltage for up to one minute (Figures 5-2, 5-4, 5-5 and 5-6). The highest resistance values shown in Table 5-1 should be obtained for a new generator with dry windings. For a set that has been in service, the resistance reading should not be less than the lower value shown.

PI Test: The PI test consists of applying a voltage between the winding and ground for ten minutes and recording resistance values at one minute and

at ten minutes. The PI is the ratio of a ten minute reading in megohms divided by a one minute reading in megohms. A ratio of two or greater is considered good for new and in-service sets (Table 5-1).

1. Perform the *Generator Set Grounding Procedure*.
2. Open the control panel and disconnect the X (F1) and XX (F2) leads from the voltage regulator. Remove all control wiring from the generator output terminals.
3. If the RTD (resistive thermal device) option is installed, ground all six RTD temperature leads. Each RTD has three leads, one red and two white leads. Total of 18 leads must be grounded.
4. Perform the *Winding Resistance Test* procedure for the desired windings as noted in this section.
5. Perform the *Insulation Resistance Test* and *PI Test* procedures for the desired windings as noted in this section.

If low readings are obtained, the cause should be investigated and corrected before the generator set is returned to service.

If moisture is determined to be the cause of low test readings, a winding drying process will be required.

TABLE 5-1. GENERATOR INSULATION RESISTANCE AND POLARIZATION INDEX

GENERATOR VOLTAGE	MEGGER VDC SETTING	MINIMUM RESISTANCE (MEGOHMS)			POLARIZATION INDEX (PI)
		MAIN STATOR	MAIN ROTOR	EXCITOR STATOR/ ROTOR	
600 VAC or less	500	5.0 – 1.0	5.0 – 1.0	5.0 – 1.0	2 or greater
601 thru 5000 VAC	2500	400 – 50			2 or greater
	1000		0.5	0.5	
5001 thru 15000 VAC	5000	1000 – 200			2 or greater
	1000		0.5	0.5	

DRYING THE WINDINGS

If low readings are obtained and moisture is determined to be the problem, the windings should be dried out and the test repeated. Use the generator heaters or blow warm air through the generator with a fan. A more effective way is to use a bolted 3-phase short across the generator terminals. This procedure must be done as described or equipment damage can result. To do this:

1. Bolt the generator three phase output terminals together. See the reconnection diagrams in *Section 8*.
2. Open the control panel and disconnect the X (F1) and XX (F2) leads from the voltage regulator.
3. Connect the positive and negative leads of a variable 12 VDC source as follows:

Positive lead – X (F1)

Negative lead – XX (F2)

⚠ CAUTION *Voltage must begin at zero volts and be gradually increased or equipment damage will result. The current will increase rapidly and it must be monitored to prevent exceeding the generator rating.*

4. Attach a clamp-on ammeter to the generator leads to measure generator current, adjust the 12 VDC source for zero voltage, start the set and very slowly increase the excitation voltage. Obtain the highest current possible without exceeding generator rating.
5. Run the genset for approximately one hour, then repeat the insulation resistance tests. If further drying time is indicated, continue the drying process.

EXCITER STATOR

Testing Winding Resistance: Measure winding resistance with a Wheatstone bridge or digital ohmmeter. Replace the stator if winding resistance is not as specified by Table 5-2.

Before performing the following insulation resistance test, refer to the *Insulation Resistance and Polarization Index Test* procedure at the beginning of this section.

Testing Winding Insulation Resistance: Disconnect exciter stator leads **X (F1)** and **XX (F2)** from their connectors in the AC generator wiring harness and isolate them from ground.

Connect the megger between one of the leads and ground and conduct the test. Refer to Table 5-1 for megger voltage selection and required resistance values.

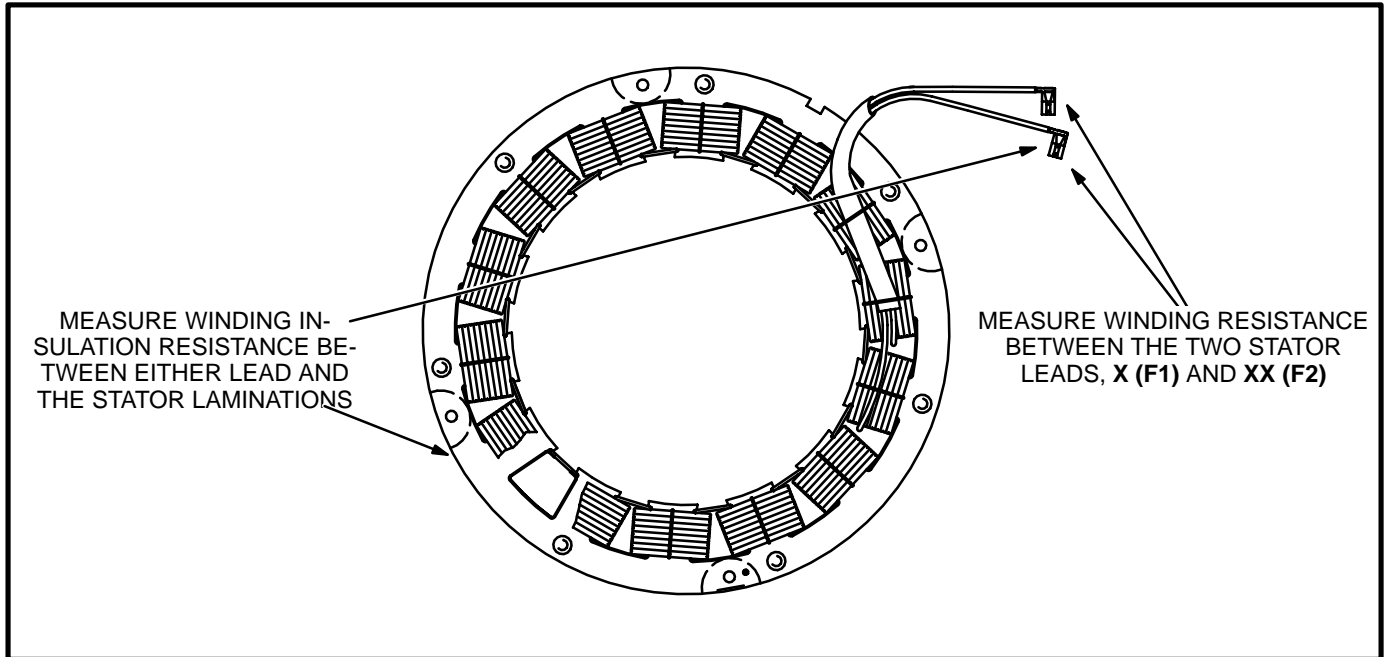


FIGURE 5-2. TESTING THE EXCITER STATOR

EXCITER RECTIFIER BRIDGE (ROTATING RECTIFIER ASSEMBLY)

The exciter rectifier bridge is mounted on the exciter rotor, inboard, facing the main rotor. It consists of a positive plate and a negative plate, split diametrically. Each carries three diodes, three terminal posts for connecting exciter rotor leads to the diode pigtails and a terminal for the main rotor (generator field) lead. A surge suppressor is connected across the two plates to prevent transient voltages that could damage the diodes.

Testing Diodes: Disconnect the diode pigtails from the terminal posts. Using an ohmmeter, measure electrical resistance between each diode pigtail and the plate on which the diode is mounted. Reverse the meter test probes and repeat the tests. The electrical resistance across each diode should be high in one direction and low in the other. If the resistance is high or low in both directions, replace the diode.

Replacing Diodes: Make sure the replacement diode is of the correct polarity. Disconnect the pigtail from the terminal post and unscrew the old diode. Apply heat-sink compound under the head of the diode. Make sure the compound does not get on the threads. Torque the diodes to 36 to 42 in-lbs (4 to 4.8 N•m) and the pigtail terminals to 24 in-lbs (2.7 N•m) when reassembling.

Surge Suppressor Testing and Replacement: Remove the suppresser. Replace the suppresser if it appears to have overheated or if ohmmeter readings indicate less than infinite resistance (end of scale) in both directions. Torque the terminals to 24 in-lbs (2.7 N•m) when reassembling.

CAUTION *Layers of dust can cause diodes to overheat and fail. Brush dust off regularly.*

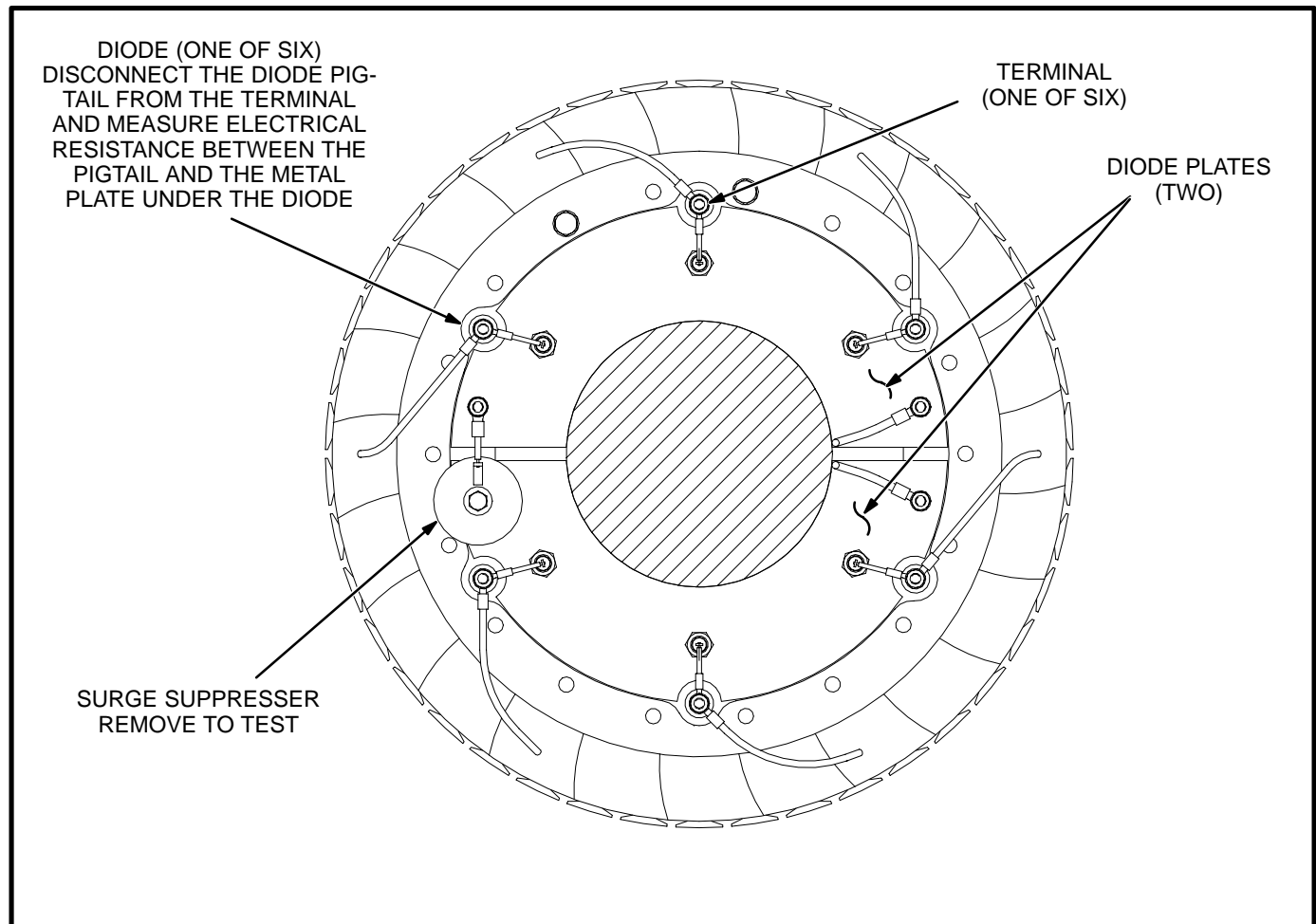


FIGURE 5-3. TESTING THE ROTATING RECTIFIER ASSEMBLY

EXCITER ROTOR

Testing Winding Resistance: Disconnect the six rotor winding leads from the terminal posts on the rectifier assembly. With a Wheatstone bridge, measure electrical resistance across each pair of rotor windings: **U** (CR1 or CR4) and **V** (CR2 or CR5), **V** (CR2 or CR5) and **W** (CR3 or CR6), **W** (CR3 or CR6) and **U** (CR1 or CR4). See the winding schematic. Replace the whole rotor shaft assembly if the resistance of any winding is not as specified in Table 5-2.

Before performing the following insulation resistance test, refer to the *Insulation Resistance and Polarization Index Test* procedure at the beginning of this section.

Testing Winding Insulation Resistance: Disconnect all six exciter rotor leads from diode terminals CR1 through CR6 and isolate them from ground.

Connect the megger between one of the leads and ground and conduct the test. Refer to Table 5-1 for megger voltage selection and required resistance values.

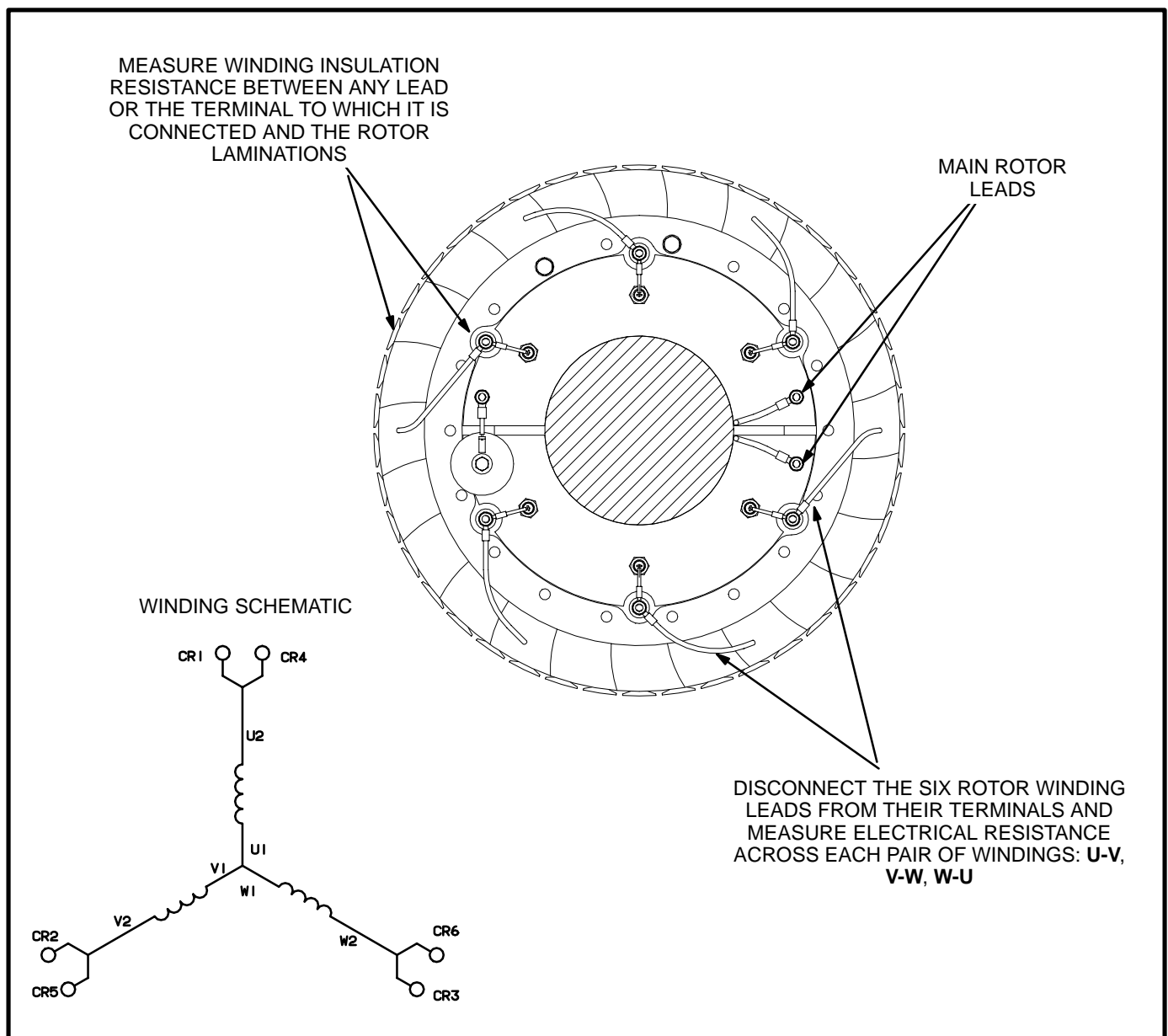


FIGURE 5-4. TESTING THE EXCITER ROTOR

MAIN ROTOR (GENERATOR FIELD)

Testing Winding Resistance: Disconnect the two leads of the main rotor from the terminals on the rotating rectifier assembly. See Figure 5-5. Measure electrical resistance between the two leads with a Wheatstone bridge or digital ohmmeter. Replace the rotor if the resistance is not as specified in Table 5-2. Connect the rotor leads and torque the terminals to 23 in-lbs (3.3 N•m) when reassembling.

Before performing the following insulation resistance test, refer to the *Insulation Resistance and Po-*

larization Index Test procedure at the beginning of this section.

Insulation Resistance and PI Test: Disconnect the main rotor and voltage suppressor leads from terminals **F1+** and **F2-** on the rotating rectifier assemblies and isolate them from ground. Tag and mark each lead with its terminal number (**F1+** or **F2-**).

Connect the megger between one of the rotor leads and ground and conduct the test. Refer to Table 5-1 for megger voltage selection, required resistance values and PI values.

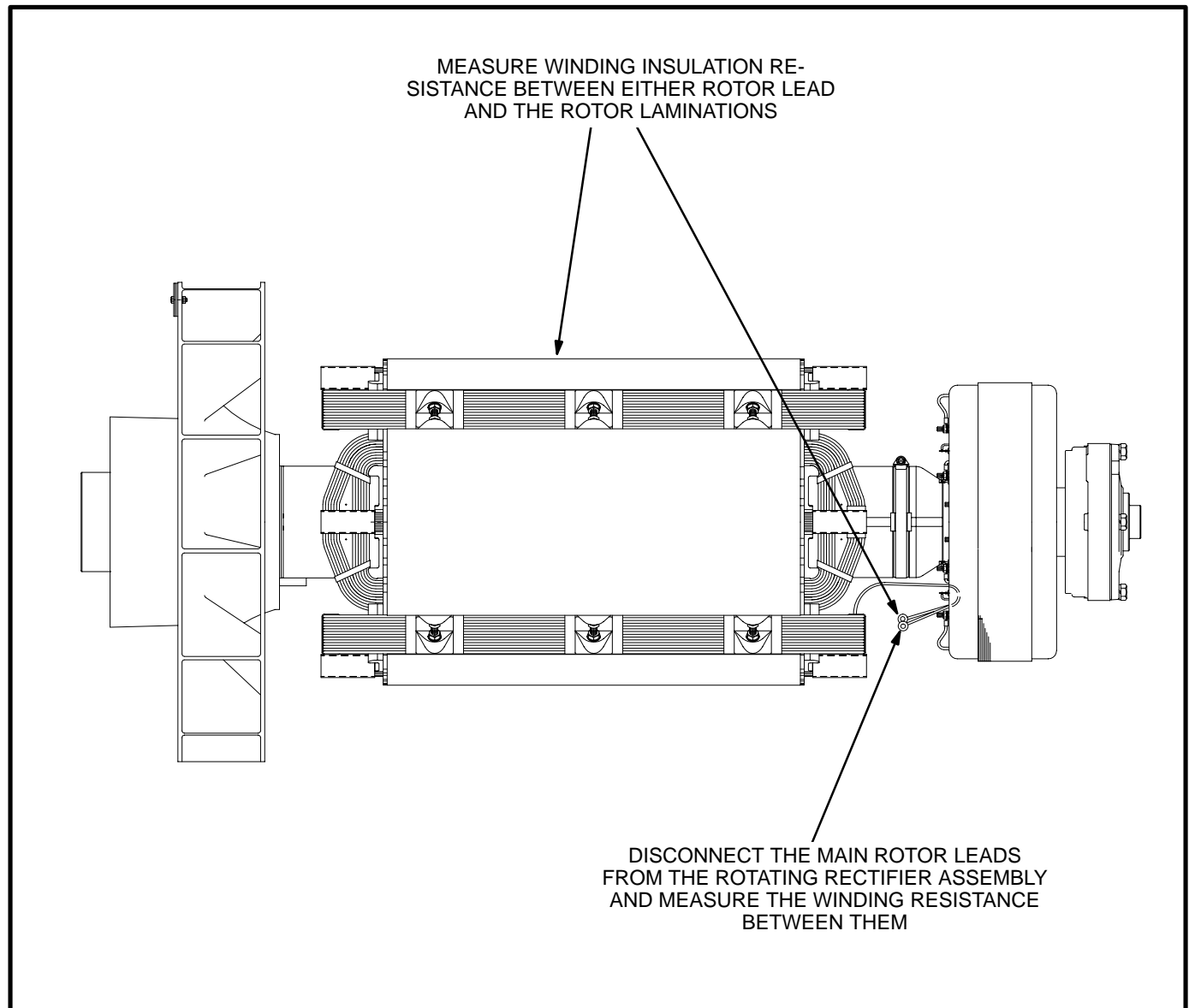


FIGURE 5-5. TESTING THE MAIN ROTOR

MAIN STATOR

Testing Main Stator Winding Resistance: Disconnect all stator leads from the terminals to which they are connected. Using a Wheatstone bridge having at least 0.001 ohm precision, measure electrical resistance across each pair of stator leads: **U1-U2, V1-V2, W1-W2, U5-U6, V5-V6 and W5-W6.** Replace the stator if the resistance of any winding is not as specified in Table 5-2.

Before performing the following insulation resistance test, refer to the *Insulation Resistance and Polarization Index Test* procedure at the beginning of this section.

Insulation Resistance and PI Test: Remove and separate all leads of the generator from the generator load terminal block. Number of neutral leads (three or six) will vary between low and medium voltage generators.

Connect the megger between one phase of the stator and ground while grounding the other two phases and conduct the test. Refer to Table 5-1 for megger voltage selection, required resistance values and PI values.

Repeat this step in turn for the other two phases.

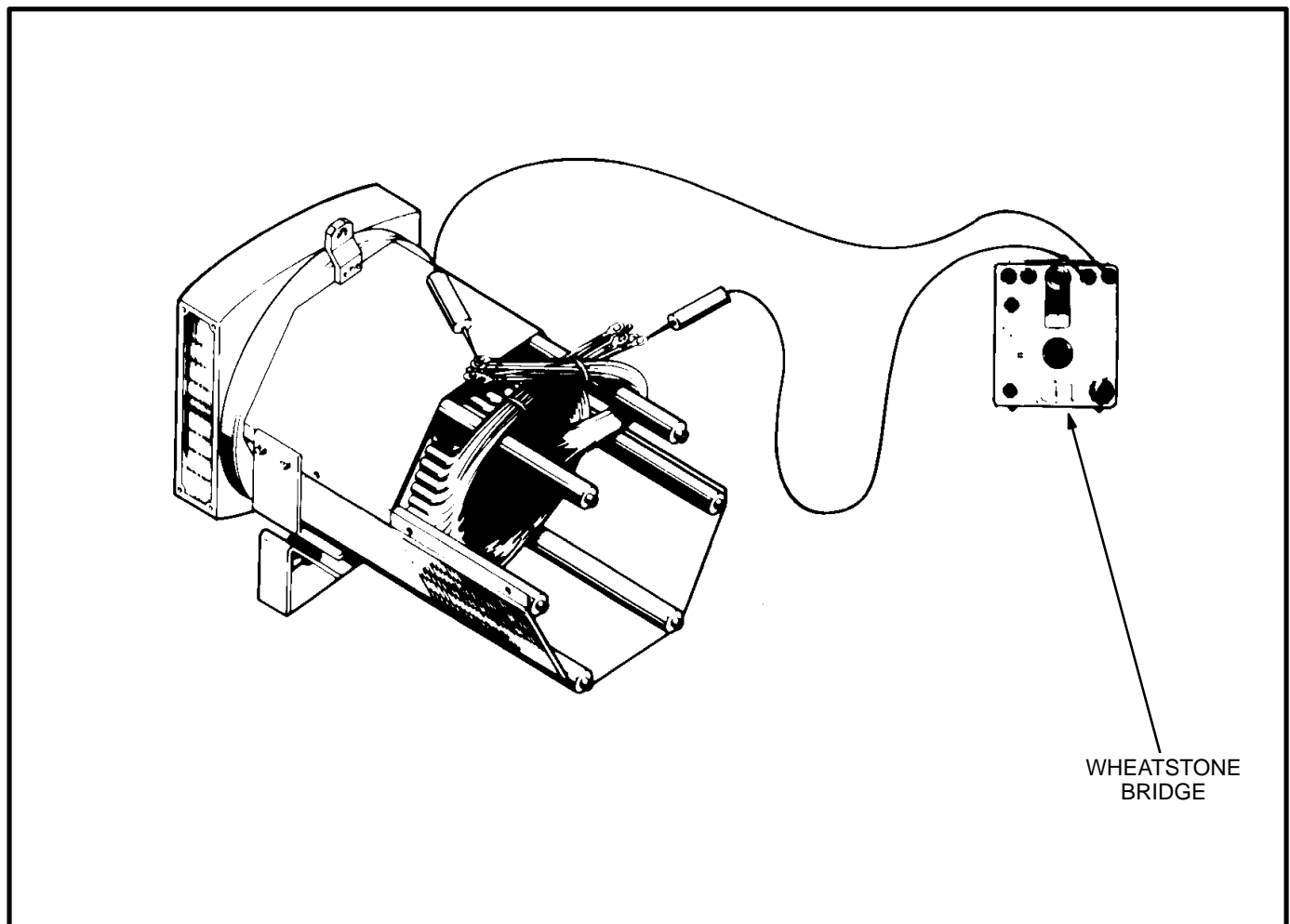


FIGURE 5-6. TESTING THE GENERATOR STATOR

TABLE 5-2. WINDING RESISTANCE VALUES*

FRAME SIZE	EXCITER STATOR	EXCITER ROTOR	MAIN ROTOR	MAIN STATOR			
				WINDING 11	WINDING 12	WINDING 17	WINDING 07
4C	18	0.136	0.91	0.0085	N/A	0.0115	N/A
4D	18	0.136	1.04	0.007	N/A	0.01	N/A
4E	18	0.136	1.17	0.0055	N/A	0.0075	N/A
4F	18	0.136	1.35	0.005	N/A	0.0052	N/A
5C	17	0.174	1.55	0.0068	N/A	0.0105	N/A
5D	17	0.174	1.77	0.0057	N/A	0.0079	N/A
5E	17	0.174	1.96	0.0043	N/A	0.0068	N/A
5F	17	0.174	2.16	0.0037	N/A	0.0049	N/A
6G	17**	0.158	1.44	0.0037	0.0148	N/A	0.011
6H	17**	0.158	1.54	0.0027	0.0108	N/A	0.0072
6J	17**	0.158	1.73	0.0024	0.0096	N/A	0.006
6K	17**	0.158	1.95	0.0019	0.0076	N/A	0.0052
7E	17**	0.096	1.25	N/A	0.0076	N/A	0.0104
7F	17**	0.096	1.4	N/A	0.0056	N/A	0.008
7G	17**	0.096	1.64	N/A	0.0044	N/A	0.006
7H	17**	0.096	1.75	N/A	0.0036	N/A	0.0044

* Resistance figures are approximates, at 68° F (20° C) \pm 10%.

** Units built prior to November, 1989, were 28 ohms.

TESTING THE PMG

⚠ DANGER HIGH VOLTAGE. *Touching uninsulated high voltage parts inside the control and power output boxes will result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts.*

For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and wear elbow length insulating gloves.

1. Start the engine at the set and let the speed stabilize.
3. Measure voltage across auxiliary terminal board leads P2, P3, and P4. Voltage should be approximately 165 VAC for 50 Hz (1500 RPM) and 200 VAC for 60 Hz (1800 RPM). This volt-

age should be approximately the same for each set of leads. If the voltages are low or uneven, check all the leads and connections between the voltage regulator output stage module and the PMG and repair as necessary before disassembling the PMG.

4. Stop the set and measure electrical resistance across lead pairs **P2 & P3**, **P2 & P4**, and **P3 & P4** with a Wheatstone bridge or digital ohmmeter. Refer to Table 5-3 for resistance values and *Generator Reassembly* in this section for frame size.

TABLE 5-3. PMG STATOR RESISTANCE

FRAME SIZE	PMG STATOR RESISTANCE
HC4	4.6
HC5/HC6/HC7	2.6

GENERATOR DISASSEMBLY

The following procedures provide information for removal and reassembly of the generator PMG, control housing, and stator/rotor assemblies. Be sure to read through this section first, before performing procedures listed, to determine the steps most appropriate for the service attention required.

⚠ DANGER *Medium-voltage, 601 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator. Service personnel must be well-trained/qualified to work with distribution voltages. (See Generator Set Grounding Procedures, page 5-2.)*

Permanent Magnet Generator Removal

1. Disconnect the negative (–) battery cable to prevent accidental starting of the generator set while servicing.

⚠ WARNING *Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot*

lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.

Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (–) cable first and reconnect last.

⚠ CAUTION *Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.*

⚠ WARNING *Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (–) cable from the battery terminal.*

2. Remove the control housing grille and access covers (see Figure 5-7).

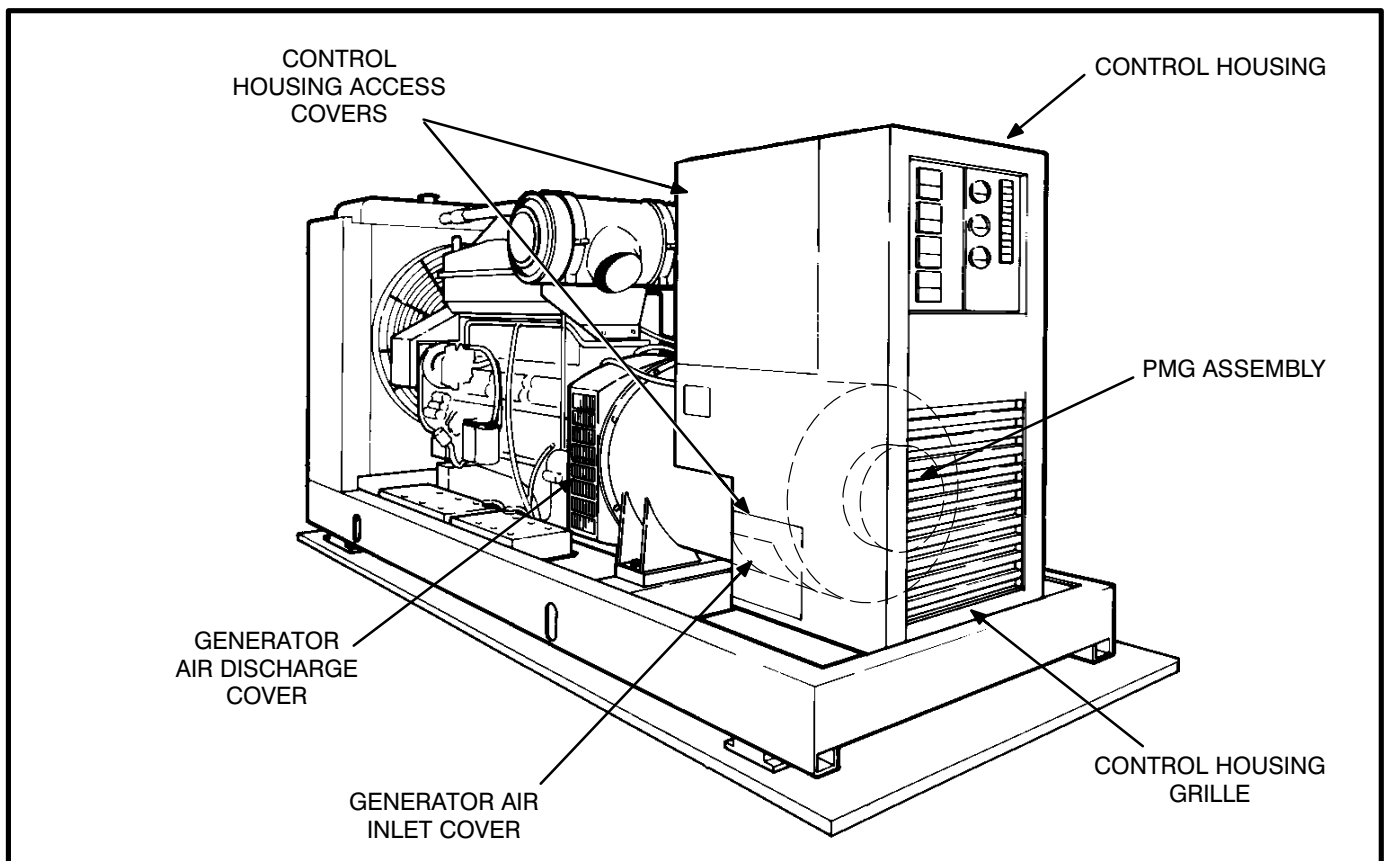


FIGURE 5-7. GENERATOR AND CONTROL HOUSING ASSEMBLY

3. Remove the three M5X12mm capscrews and lockwashers from the PMG cover, and remove cover.
4. Disconnect the PMG wiring harness connector.
5. Remove the four bolts and clamps retaining the exciter stator housing to the endbracket.
6. Tap the stator housing out of its spigot, and carefully remove from generator endbracket.

The highly magnetic rotor will attract the stator

core; care must be taken to avoid any contact which may damage the windings.

7. Remove the hex head through-bolt from the rotor shaft and firmly pull the complete rotor assembly from its location. Keep the rotor clean by avoiding contact with metal dust or particles. Store the rotor in a clean plastic bag until it is reassembled.

⚠ CAUTION *The rotor assembly must not be dismantled, or the magnetic properties will be destroyed.*

Main Stator and Rotor Removal

1. Remove the PMG, refer to *Permanent Magnet Exciter Removal*, earlier this section.
2. Remove the air inlet and discharge panels and access covers from control housing and generator (see Figure 5-7).
3. Crank or bar the engine/generator to position the rotor such that a full pole face is at the bottom of the main stator core. Proper positioning can be viewed through the generator access openings. Refer to engine service manual for proper cranking or barring procedure.
4. Disconnect all load wires from the reconnection terminal block assembly (see Figure 5-8). If equipped with the circuit breaker option, disconnect load wires from circuit breaker. Check that all leads are labeled to ease reassembly.
5. Disconnect all wire leads from the auxiliary terminal block, inside conduit box (see Figure 5-8), that would interfere with control housing removal. (Example: exciter stator leads X and XX.) Before disconnecting, check wire markings for legibility to ease reassembly.
6. Refer to the proper wiring diagram/schematic in *Wiring Diagrams* section and on-site specifics for remote control/monitoring. Open control box doors, and check wire markings for legibility to ease reassembly. Disconnect all engine, generator, and on-site control wire leads from inside control box and conduit box such as:

DC Wiring

- A11/TB1-1 to TB1-10 and TB2 as required.
- Unplug A11/J1 and J2.

AC Wiring

- VR21-X and -XX
- TB21-22 to -30

Arrange leads so they can be easily withdrawn from the control box.

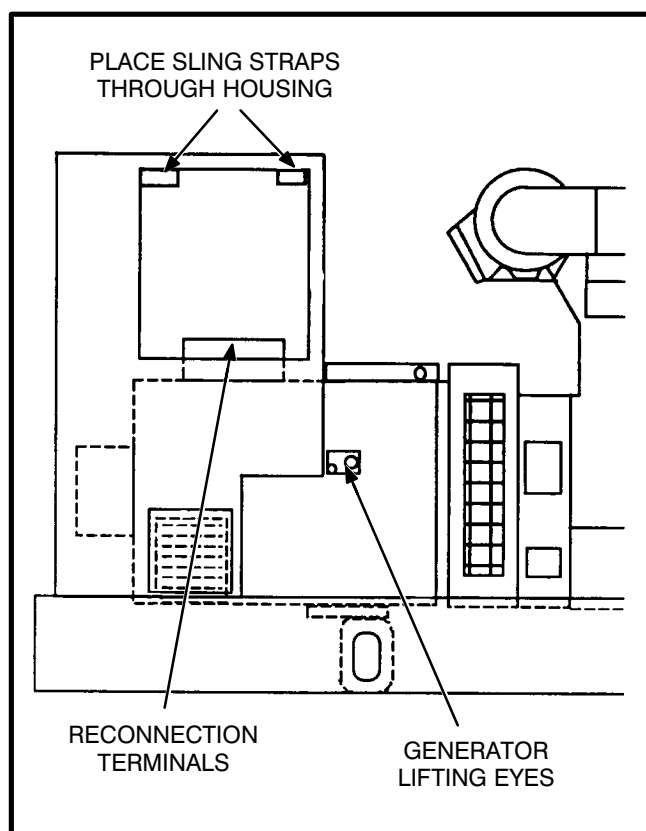


FIGURE 5-8. REMOVING CONTROL HOUSING

7. Use a hoist or similar lifting device to support the control housing assembly (see Figure 5-8).

⚠WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

8. Loosen the fasteners that secure the control housing side and bottom panels to generator. Make sure that hoisting device is controlling weight of control housing assembly.
9. Remove control housing fasteners, and remove the control housing assembly from the generator. Replace panel fasteners to their respectable positions for safe keeping, and tighten finger-tight.
10. Remove control housing mounting brackets from both sides of generator, and assemble lifting eyes to generator.
11. Remove as necessary, air intake components to engine that may interfere with disassembly and reassembly of generator.

To remove the stator and rotor at the same time, refer to *Generator Assembly Removal*, later in this section. To remove the stator and rotor individually, continue with step 12.

12. Remove the four bolts retaining the bearing cartridge housing in the endbracket (outer four bolts).
13. Remove the eight bolts holding the endbracket to the generator housing.
14. Insert two bolts (M10) in the two holes provided for “jacking” purposes, on the endbracket center line. Screw bolts in until endbracket spigot is clear of locating recess.
15. Carefully tap the whole assembly off the bearing cartridge housing, ensuring the endbracket is supported to prevent the exciter stator from damaging the windings on the exciter rotor.

⚠WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

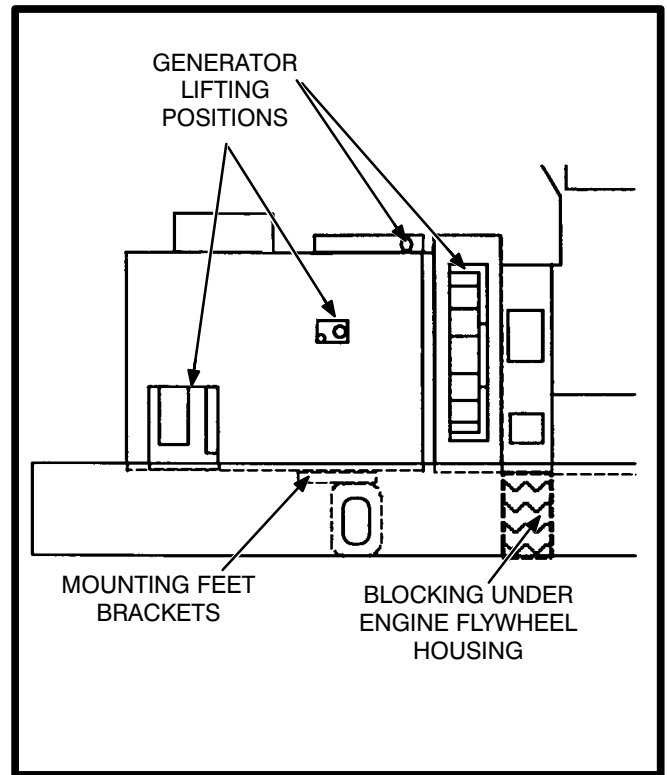


FIGURE 5-9. GENERATOR LIFTING POSITIONS

16. The exciter stator is now accessible for inspection and removal from endbracket/engine adaptor.
17. The end bearing can now be removed if required. Refer to Bearing Removal.
18. Remove the fasteners from the two generator mounting feet brackets.
19. Using an adequate lifting device, lift the generator (at lifting eyes provided, and main stator housing) until the mounting feet brackets are clear of the frame member (see Figures 5-9 and 5-10).

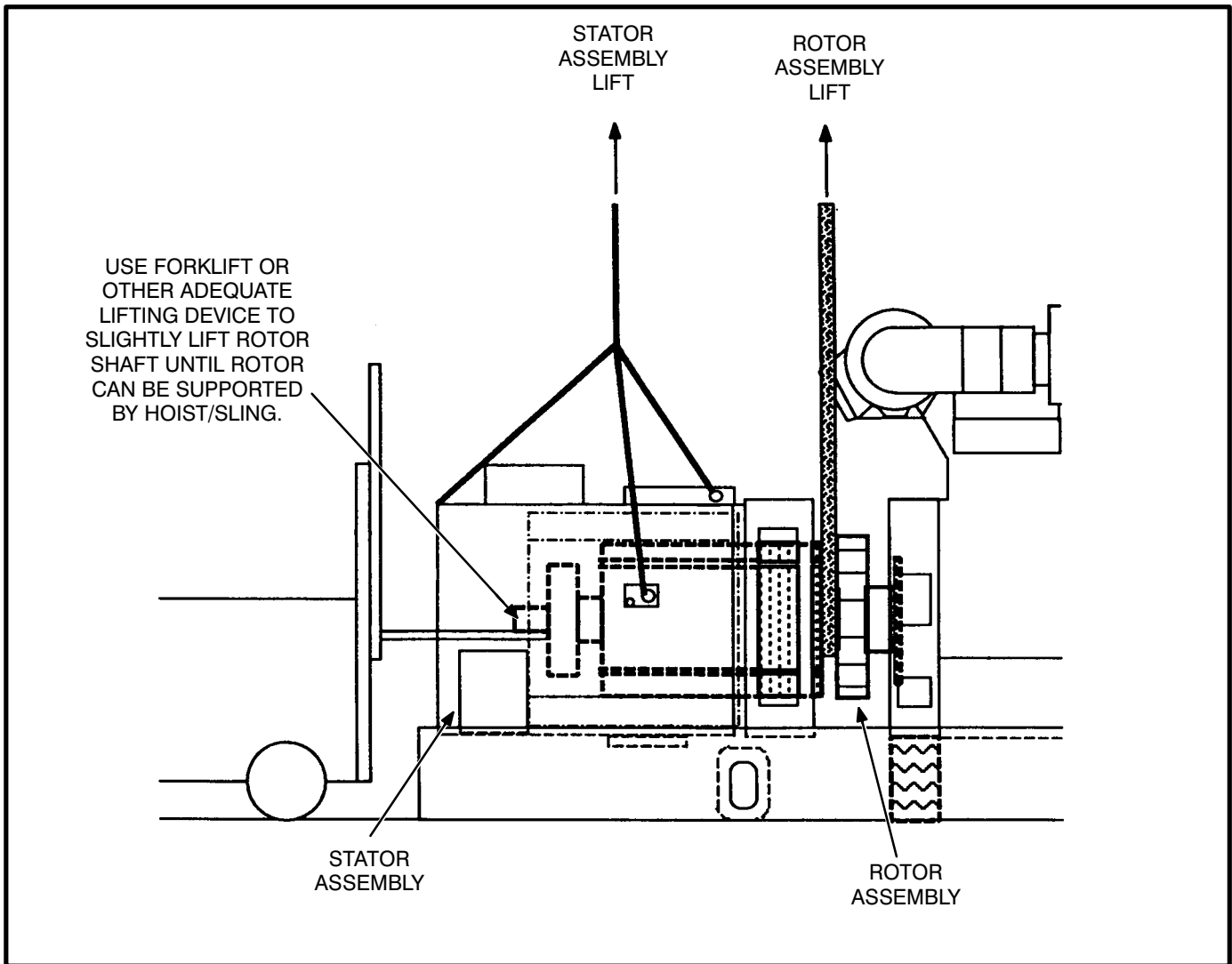


FIGURE 5-10. REMOVING STATOR ASSEMBLY

20. If generator set does not have chassis mounts at generator end (N855 and K19), block the rear of the engine in place by supporting the flywheel housing. A length of steel channel and wooden blocking is required to support the rear of the engine. Place the channel and blocking under the flywheel housing. Lower the generator until most of the set weight is supported by the blocking (see Figure 5-10).
21. Disconnect the grounding strap from the flywheel housing.
22. Using a forklift, position a lifting bar of the forklift (inside and inline with the generator) under the rotor shaft. Lift the rotor shaft slightly so that rotor is not resting on inside of stator assembly. See Figure 5-11.
23. Verify that the stator is adequately supported and then carefully remove the capscrews from the stator attachment ring.

⚠ WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

⚠ CAUTION *Improper stator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the stator assembly alone, by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the stator is adequately hooked/strapped to maintain level control of stator assembly while lifting and moving.*

24. Being careful not to drag the windings on the rotor, move the stator assembly sufficiently away from engine to sling and support the rotor assembly. Do not allow rotor assembly to hang on engine flywheel.

⚠ CAUTION *Drive disc damage can be caused by allowing the rotor assembly to hang on flywheel. Use adequate hoist and sling to support the rotor assembly.*

25. Reposition or add hoist and sling support for the main rotor, and remove the forklift. See Figure 5-11, Rotor Lift detail.

⚠ WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

26. Remove the stator assembly, being careful not to drag the windings on the rotor. Place stator assembly away from the chassis in the horizontal position.
27. Using the hoist and sling to support the rotor, carefully remove the capscrews and flat washers that secure the drive discs to the engine flywheel.

⚠ WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

28. Remove the rotor assembly and place it on wood blocks in the horizontal position. To avoid possible distortion, do not allow the drive discs and fan to rest on anything.

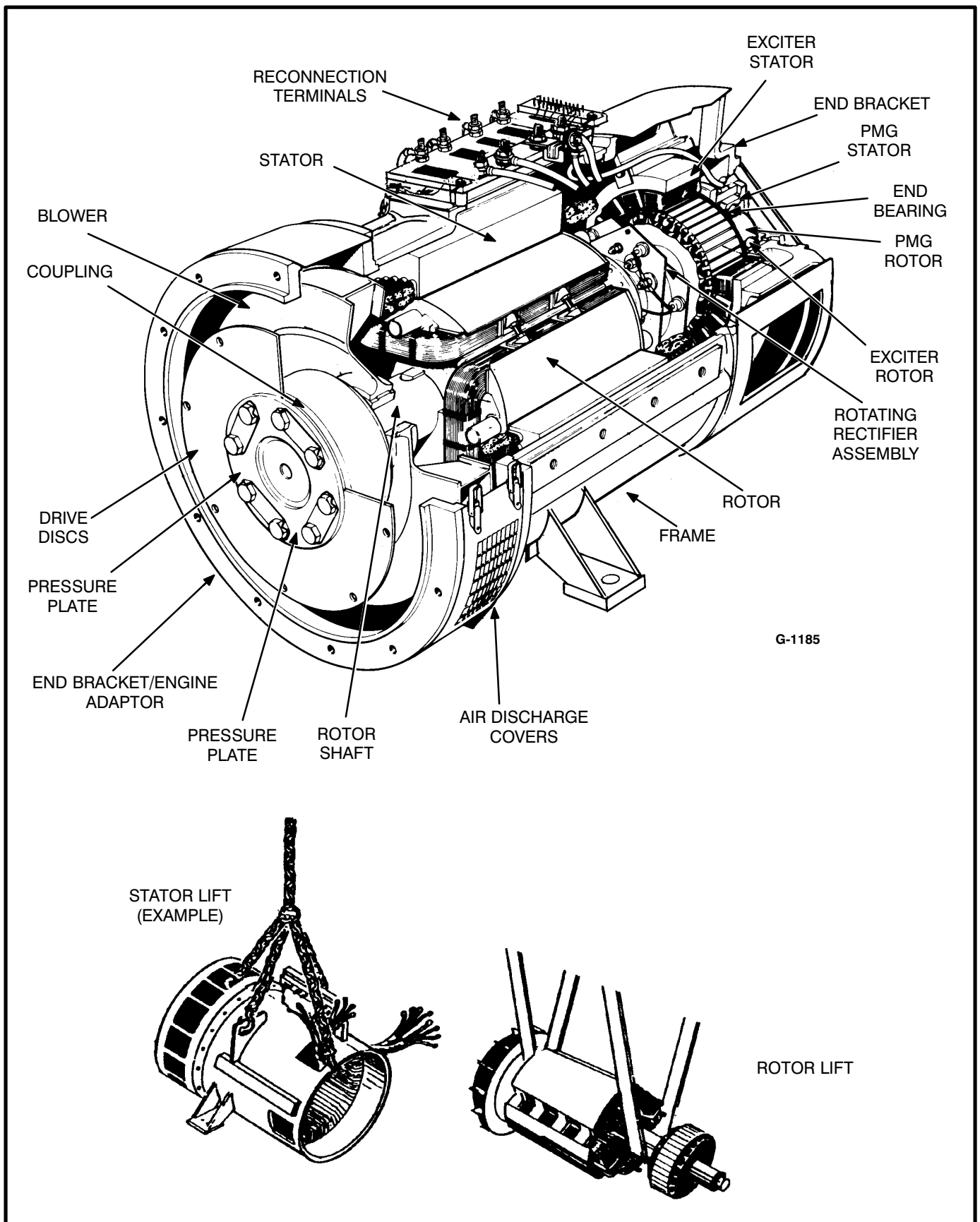


FIGURE 5-11. TYPICAL GENERATOR ASSEMBLY

Generator Assembly Removal

1. Remove the fasteners from the two generator mounting feet brackets.
2. Using an adequate lifting device, lift the generator (at lifting eyes provided, and main stator housing) until the mounting feet brackets are clear of the frame member (see Figures 5-11 and 5-12).
3. If generator set does not have chassis mounts at generator end (N855 and K19), block the rear of the engine in place by supporting the flywheel housing. A length of steel channel and wooden blocking is required to support the rear of the engine. Place the channel and blocking under the flywheel housing. Lower the generator until most of the set weight is supported by the blocking (see Figure 5-12).
4. Disconnect the grounding strap from the flywheel housing.
5. Carefully remove the capscrews and flat washers that secure the drive discs to the engine flywheel.
6. Verify that the generator assembly is adequately supported. Carefully remove the capscrews securing the engine adaptor endbracket to the engine flywheel housing.

⚠ WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

⚠ CAUTION *Improper generator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the generator by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the generator is adequately hooked/strapped to maintain level control of assembly while lifting and moving.*

7. Remove the generator assembly away from engine. Place generator assembly on floor with a piece of wood beneath the stator housing (toward PMG end) to allow for endbracket removal, if desired.

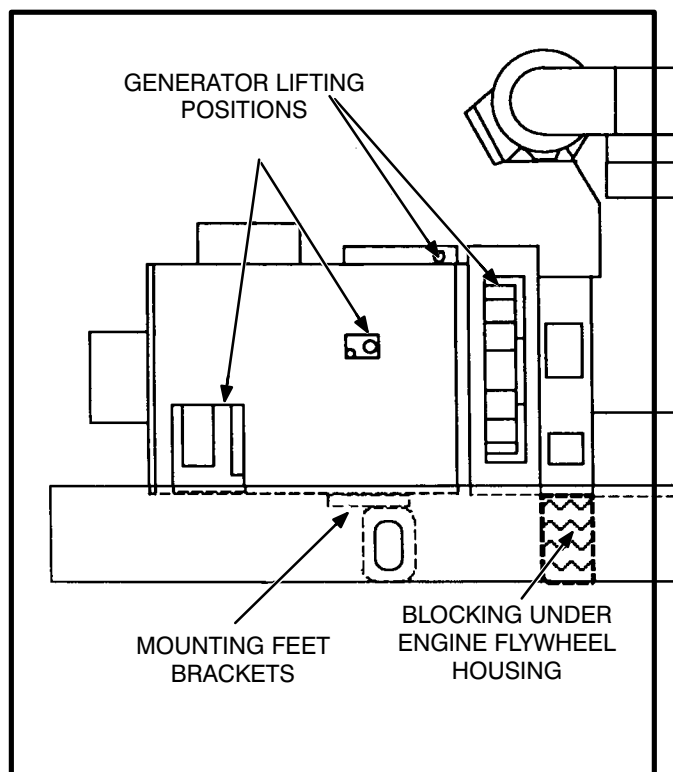


FIGURE 5-12. GENERATOR LIFTING POSITIONS

Bearing Removal

The end bearing is enclosed in a pre-packed cartridge housing and must only be dismantled as necessary for relubrication, replacement, or when a major overhaul is carried out on the generator set.

Removal of the bearing can only be accomplished after removal of the endbracket, as follows:

1. Remove the four screws holding bearing cap.
2. Remove cap.
3. Remove circlip.
4. Remove bearing cartridge housing complete with bearing.

When replacing bearing onto rotor shaft, be sure to apply pressing force to the inner face of the bearing only.

Bearing Lubrication: When re-lubricating or replacing the bearing, review the following.

- Recommended Lubricant: Lithium based grease, Mobilux No. 2 or Shell Alvania R3.
- Temperature Range: -22°F to +248°F (-30°C to +120°C).
- Quantity: 2.74 oz. (81 ml). About a third of the grease should be inserted in the bearing, the bearing cap cavity, and the bearing cartridge cavity.

GENERATOR ASSEMBLY

To assemble the stator and rotor at the same time, continue with step 1. To assemble the stator and rotor individually, skip to step 16.

1. Using an adequate lifting device, locate the generator assembly into position near the engine flywheel housing. Align the holes of the rotor drive discs with the holes of the engine flywheel. Install the capscrews and flat washers that secure the drive discs to the engine flywheel; hand tighten.

⚠ WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

⚠ CAUTION *Improper generator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the generator by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the generator is adequately hooked/strapped to maintain level control of assembly while lifting and moving.*

2. Align the holes of the engine adaptor endbracket with the holes in the flywheel housing and install the capscrews and lock washers. Refer to Figure 5-13 and Table 5-4 for torque specifications.
3. Secure the rotor assembly drive discs to the flywheel. Refer to Figure 5-13 and Table 5-4 for torque specifications.
4. Lift the generator slightly and remove any blocking from under the flywheel housing. Lower the generator (see Figure 5-12).

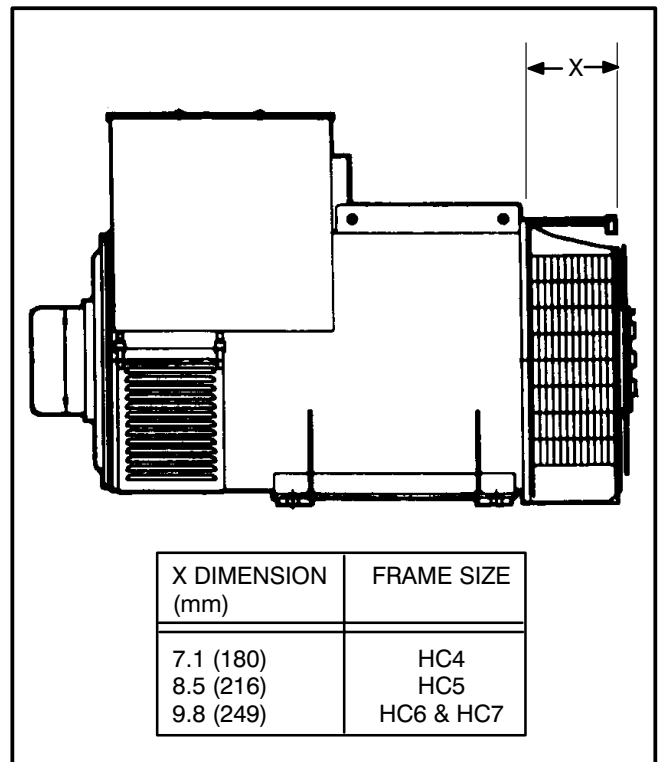


FIGURE 5-13. GENERATOR FRAME SIZE

TABLE 5-4. GENERATOR MOUNTING TORQUE

FRAME SIZE	DRIVE DISCS. TO FLYWHEEL	FLYWHEEL HSG. END BRACKET TO ENGINE ADAPTER
HC4	85 ft-lbs. (115 N•m)	35-38 ft-lbs. (47-52 N•m)
HC5	150-170 ft-lbs. (203-230 N•m)	75-85 ft-lbs. (101-115 N•m)
HC6	190-200 ft-lbs. (257-271 N•m)	95-105 ft-lbs. (129-142 N•m)
HC7	190-200 ft-lbs. (257-271 N•m)	95-105 ft-lbs. (129-142 N•m)

5. Connect the grounding strap to the flywheel housing using a capscrew and EIT locking washer; and tighten securely.
6. Install the mounting feet bracket fasteners; and tighten securely.

If endbracket has been removed, continue with step 7, otherwise skip to step 15.

7. Lift slightly on end of rotor shaft and install wooden shims to hold rotor on center with stator.
8. Press bearing onto rotor shaft, applying force to the inner face of the bearing. Install two threaded studs into end bearing cartridge to aid subsequent procedures. Position the end bearing cartridge assembly close to proper position for hole alignment with end bracket.
9. Assemble exciter stator, if removed, to inside of endbracket. Tighten fasteners to 4.5 ft-lbs. (6 N•m) torque.
10. Install endbracket to the stator frame using the proper capscrews and lock washers, but do not tighten securely as yet.
11. Insert and start the threads of the bearing cartridge fasteners, and remove threaded alignment studs, through the endbracket into the cartridge housing.
12. Lift slightly on endbracket and remove wooden shims holding rotor on center with stator.
13. Securely tighten the endbracket fasteners.
14. Tighten the bearing cartridge fasteners to 4.5 ft-lbs. (6 N•m) torque.
15. Install the PMG assembly, if removed. Refer to Permanent Magnet Installation, later this section.

Perform the 'Aligning Generator with Engine' procedures, later in this section, then return to the following steps.

To assemble the control housing, skip to step 34.

To assemble the stator and rotor individually begin here.

16. If removed, replace exciter rotor and rotating rectifier assembly to main rotor shaft. Reconnect main rotor wire leads to positive and negative terminals of rectifier assembly.
17. If removed, install the drive disc spacer, drive disc and pressure plate on the rotor shaft.

Install the cap screws and flat washers and tighten to 352 ft-lbs. (476 N•m) on discs with eight cap screws or 607 ft-lbs. (822 N•m) on discs with 12 capscrews. Typically frame size HC4 and HC5 use eight cap screws and frame size HC6 and HC7 use 12 cap screws.

18. Using a hoist and sling to support the rotor, align the holes in the drive disc with the corresponding holes in the flywheel.

⚠ WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

19. Secure the rotor assembly drive disc to the flywheel using appropriate capscrews and flat washers. Refer to Figure 5-13 and Table 5-4 for torque specifications. Do not allow rotor assembly to hang on engine flywheel. (Refer to Figure 5-11.)

⚠ CAUTION *Drive disc damage can be caused by allowing the rotor assembly to hang on flywheel. Use adequate hoist and sling to support the rotor assembly.*

20. Reassemble engine adaptor endbracket to stator frame if removed. Using an adequate lifting device, carefully move the stator into position over the rotor assembly, being careful not to drag the windings on the rotor.

⚠ WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

⚠ CAUTION *Improper stator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the stator assembly alone, by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the stator is adequately hooked/strapped to maintain level control of stator assembly while lifting and moving.*

21. Using a forklift, position a lifting bar of the forklift (inside and inline with the generator) under the rotor shaft. Lift the rotor shaft slightly so that rotor is not resting on inside of stator assembly. See Figure 5-11.

22. Remove the hoist/sling support of the rotor assembly. Align the holes of the engine adaptor endbracket with the holes in the flywheel housing and install the capscrews and lock washers. Refer to Figure 5-13 and Table 5-4 for torque specifications.
23. Using an adequate lifting device, slightly raise the generator so that the wooden blocking and steel channel can be removed from under the flywheel housing; then lower the generator so the full weight is resting on the generator mounting feet brackets.

Perform the 'Aligning Generator with Engine' procedures, later in this section, then return to step 24.

24. Reassemble the covers over the generator air discharge openings and fasten securely.
25. Connect the grounding strap to the flywheel housing using a capscREW and EIT locking washer; and tighten securely.
26. Install the mounting feet bracket fasteners; and tighten securely.
27. Press bearing onto rotor shaft, applying force to the inner face of the bearing. Install two threaded studs into end bearing cartridge to aid subsequent procedures. Position the end bearing cartridge assembly close to proper position for hole alignment with endbracket.
28. Assemble exciter stator, if removed, to inside of endbracket. Tighten fasteners to 4.5 ft-lbs. (6 N•m) torque.
29. Install endbracket to the stator frame using the proper capscrews and lock washers, but do not tighten securely as yet.
30. Insert and start the threads of the bearing cartridge fasteners, and remove threaded alignment studs, through the endbracket into the cartridge housing.
31. Lift slightly on endbracket and remove wooden shims holding rotor on center with stator.
32. Securely tighten the endbracket fasteners.
33. Tighten the bearing cartridge fasteners to 4.5 ft-lbs. (6 N•m) torque.
34. Remove generator lifting eyes. Reassemble control housing mounting brackets to sides of generator and fasten securely.
35. Use an adequate lifting device to lift the control housing in position for mounting to the stator frame. Replace the capscrews and lock washers and tighten to 20 ft-lbs. (27 N•m) torque.

⚠WARNING *To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.*

36. Reassemble any engine air intake components removed during generator disassembly.
37. Connect all control wires and generator leads using the proper generator set AC and DC wiring diagram/schematic.
38. Refer to Permanent Magnet Generator Installation.
39. If equipped with the circuit breaker option, reconnect load wires to circuit breaker. Reconnect all lead wires to the terminal block assembly using proper reconnection diagram in Section 8.
40. Verify that all connections are proper and secure and then install the air inlet panel and access covers to control housing (see Figure 5-7).
41. Connect the negative (–) battery cable and test the generator set for operation.

Permanent Magnet Generator Installation

1. Install the complete rotor assembly to the end of the main rotor shaft using the hex head through-bolt. Keep the rotor clean by avoiding contact with metal dust or particles.
2. Carefully locate the stator housing to position on the generator endbracket. Fasten in place using the 4 bolts and clamps, and tighten securely.

The highly magnetic rotor will attract the stator laminations; care must be taken to avoid any contact which may damage the windings.

3. Connect the PMG wiring harness connector.
4. Install the PMG assembly cover using the three M5x12mm capscrews and lock-washers, and tighten securely.

Aligning Generator with Engine

Proper alignment of the generator and engine assemblies is necessary to avoid premature wear and improper operation of the genset. Review the following alignment conditions and procedures for aligning the generator assembly to engine flywheel housing.

Angular Misalignment: Is the result of the generator bearing center axis not aligning with axis of the engine crankshaft. This condition creates an angle between the generator shaft axis and the crankshaft axis. The cause of this type of misalignment is usually shimming error.

Axial Misalignment: Is the result of the generator shaft axis not aligning with engine crankshaft axis. The tolerances in the bolted flywheel and drive disc connection may add up to displace the generator axially relative to the crankshaft axis.

Misalignment Symptoms: If the assembly is allowed to run under these conditions, the discs must flex in alternate directions twice for each engine revolution. It is important to minimize the amount of disc flexing since, if it is excessive, the drive disc will crack. Although perfect bearing alignment is desir-

able, it is more important to keep disc deflection to the minimum possible. This procedure assumes that the pilot bore of the drive discs are in the exact center and the flywheel counterbore (pilot) has no practical runout. Under these conditions, perfect Angular alignment will be attained when no deflection of the disks is measured.

Excessive Axial misalignment will cause more generator vibration than Angular misalignment.

Axial misalignment should be checked only when an objectionable vibration is present.

Either type of misalignment may be present in a generator set assembly, with angular misalignment being the most common problem. Angular alignment may also be effected by set installation conditions and/or mishandling during shipping of the genset.

Angular Alignment Procedure (V28 and larger engine gensets only):

⚠ WARNING Accidental starting of the generator set during this procedure presents the hazard of severe personal injury or death. Make sure to disconnect the negative (-) battery cable(s) before beginning.

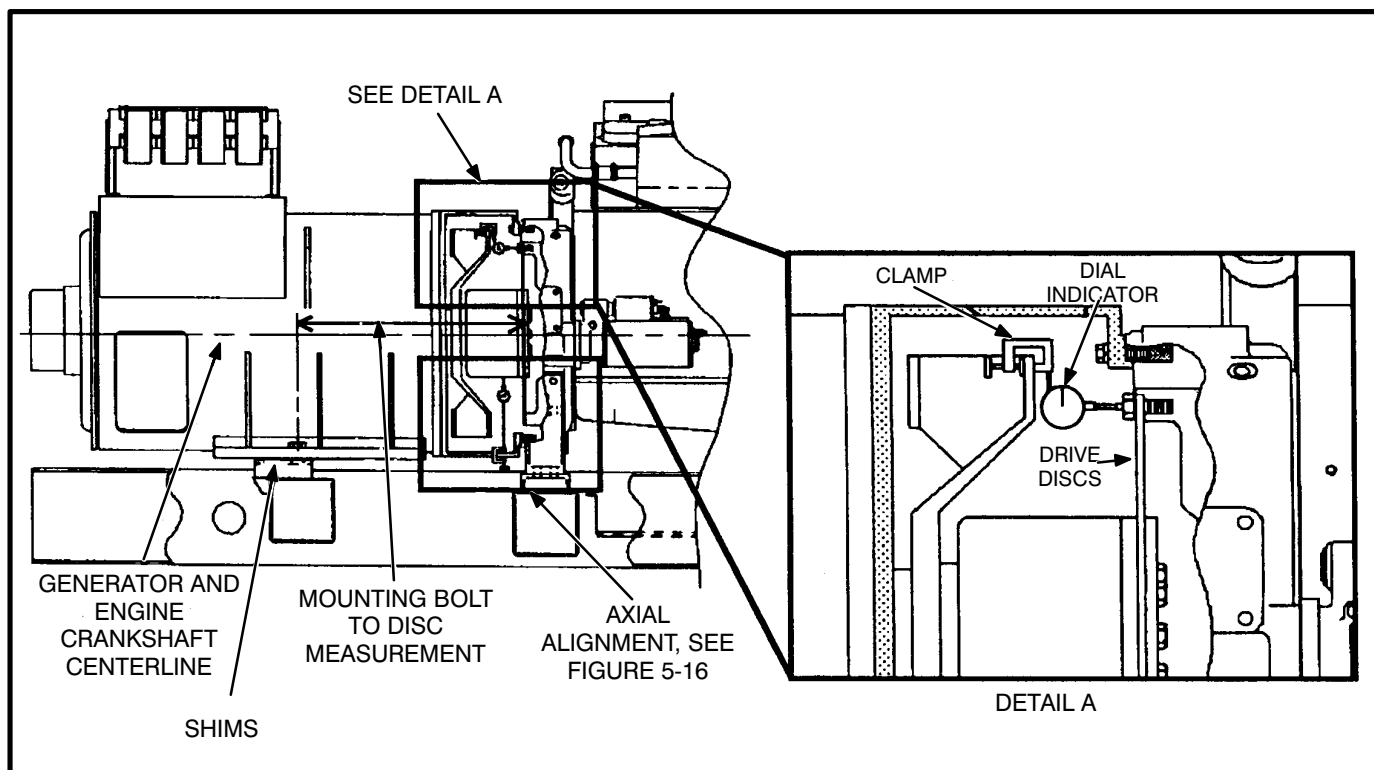


FIGURE 5-14. ANGULAR ALIGNMENT MEASUREMENT

Fasten a dial indicator to either the generator shaft or the cooling fan with the sensing point resting on the capscrew head or the flat surface of the drive disc at the bolt circle diameter, see Figure 5-14. Bar the engine over in a clockwise rotation as viewed from engine flywheel. Do not allow it to roll back on compression at the end of the travel of each reading. It is unnecessary to zero the indicator since the total indicator reading (T.I.R.) of the deflection measurement to the bolt heads is what is required. T.I.R. will be the sum of the maximum positive and negative dial indicator readings as the engine completes one revolution.

Sample Generator Runout Readings: When taking the deflection readings described, make a diagram similar to the example shown in Figure 5-15, where a total indicator reading of .025 inches. (The highest positive value of +.010 and the largest negative value of -.015 inches.) The indicator is closer to the top and further away at the bottom. This example indicates that the generator bearing is high. Since the side readings are equal, the generator is centered side to side. To lower the generator, remove equal shims from under both generator

mounting feet. To approximate the amount of shims to remove or add:

1. Measure the distance between the center of the generator shaft to the point the indicator is measuring at. (For example; a SAE 18 Disc coupling distance is 10.7 inches).
2. Measure the distance from the generator side of the drive discs to the center of the generator mounting bolt, refer to Figure 5-14. (For example; a HC6 Frame's distance is 28.4 inches.)
3. Compare the distance measured in steps 1 and 2. (28.4 inches vs 10.7 inches or a 2.65 to 1 ratio.) Multiply this ratio times one half the T.I.R. (In our example, .025 inches divided by 2 is .0125 inches. This, times 2.65 equals .033 inches. Therefore, remove .033 inches of shims from under both mounting feet.)

In general, the T.I.R. should not be more than .001 inches for each inch of radius (center of shaft to indicator axis). If we use our example of 10.7 inches, then the maximum T.I.R. would be .011 inches. This would only require a correction of .014 inches from the T.I.R. of .025 inches. (A reading of +.002 at the top and -.009 at the bottom would fall within the satisfactory range.)

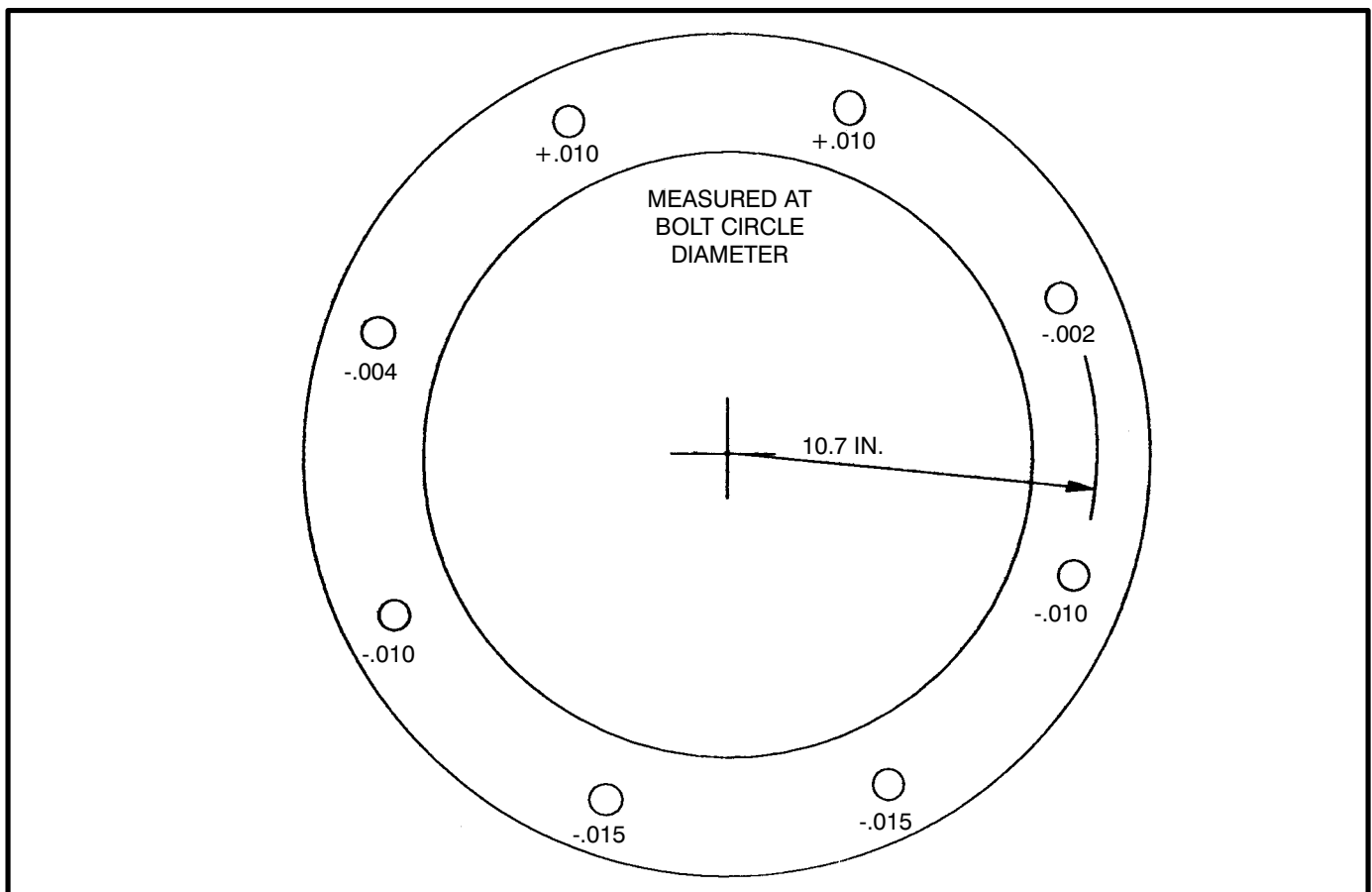


FIGURE 5-15. ANGULAR ALIGNMENT MEASUREMENT READINGS (Example)

Axial Alignment Procedure (all gensets):

Axial misalignment should be checked only when an objectionable vibration is present.

If excessive vibration remains after the angular alignment, check for concentric alignment of the generator shaft/engine crankshaft axes.

Fasten dial indicator holding device to skid base, engine block, or generator shell with a magnetic base or clamp and position so the sensor point of indicator rests on the generator shaft hub, see Figure 5-16. Bar the engine over in a clockwise rotation as viewed from engine flywheel, through a couple of rotations. Record indicator readings in eight equally spaced points around the shaft diameter. This will provide a T.I.R. for Axial shaft misalignment.

The maximum allowable T.I.R. runout is subjective, the optimal T.I.R. for runout would be .000 inches, however that may not be attainable. The recommendation of this procedure will be to reduce the measured T.I.R. runout by one half. Specific out-of-tolerance runout levels are difficult to establish due

to the varying surface quality of the generator shaft's drive disc mountain hub.

The goal of the Axial realignment is to reduce the vibration level of the genset while it is operating. A small improvement in the T.I.R. runout may have dramatic effects in the mechanically measured or physically observed vibration levels.

To correct for an out of tolerance T.I.R. indication, remove the capscrews connecting drive discs and flywheel. Mark the drive discs and flywheel with respect to each other. Rotate either the engine or generator so that drive discs holes are repositioned 180 degrees from their original location. Put the drive discs capscrews back in and retorque. Re-check shaft alignment as before. If shaft T.I.R. runout remains unchanged then the discs should be rotated to either 30, 60, or 90 degrees from original location to correct the out of tolerance condition. If the T.I.R. does not improve after repositioning, a closer inspection of the flywheel pilot and drive disc runouts is required. This will help determine the cause of the Axial misalignment.

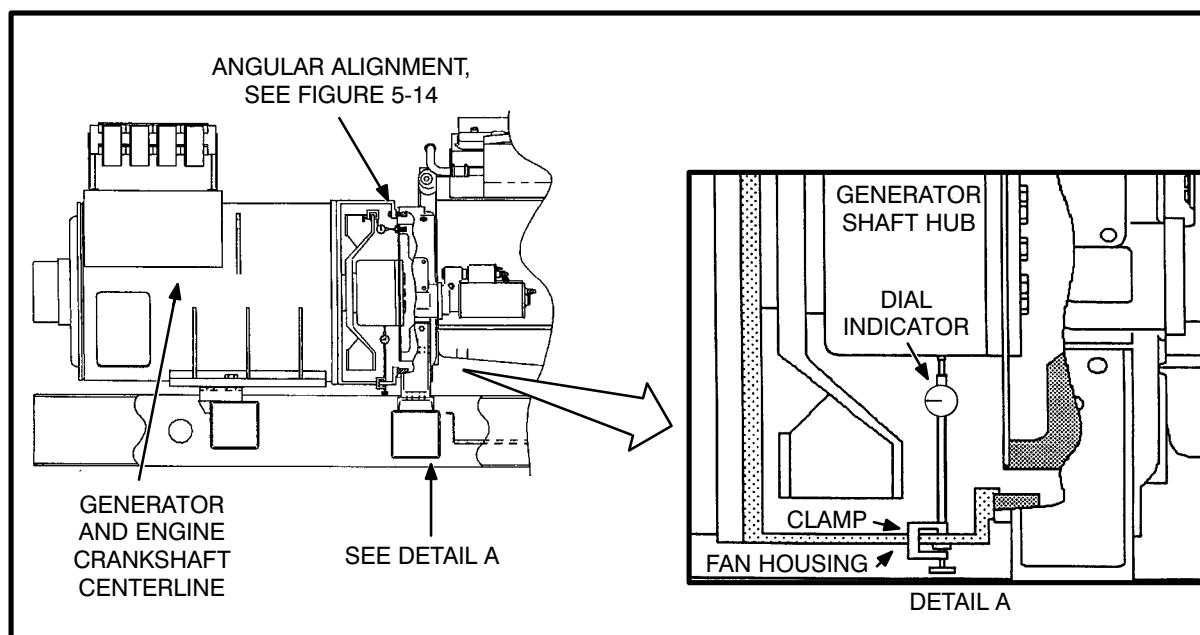


FIGURE 5-16. AXIAL ALIGNMENT MEASUREMENT

6. Governor

ELECTRONIC GOVERNOR

Generator frequency is in direct ratio to engine speed, which is controlled by the governor. The governor control has four potentiometers for making adjustments. See Figure 6-1. Use a frequency meter or tachometer to monitor the unit during adjustment procedure.

Gain: The Gain control is a one-turn potentiometer. It is used to adjust the sensitivity of the governor. A clockwise rotation of the potentiometer will shorten the response time to load changes.

Droop: The Droop control is a one-turn potentiometer. It is adjustable for 0 % (isochronous) to more than 5% speed droop. Fully counterclockwise rotation is 0% speed droop.

Idle Speed: The Idle Speed control is a 20-turn potentiometer for adjusting the idle speed. A clockwise rotation will increase the idle speed.

Run Speed: The Run Speed control is a 20-turn potentiometer for setting the desired no-load governed speed. A clockwise rotation will increase the run speed.

Refer to the following adjustment procedures.

Adjustments

Preliminary Adjustments:

1. Frequency Adjust (engine speed) potentiometer on control panel (if equipped).
 - A. Loosen the locking nut.
 - B. With a screwdriver, turn the potentiometer fully counterclockwise, then fully clockwise, then to mid position.
 - C. Hold mid position setting with screwdriver, and tighten locking nut.
2. **Idle Speed** potentiometer.
 - A. Turn the screw counterclockwise until the clutch slips (noticeable click).
 - B. Turn the screw clockwise 10 turns.
 - C. This will set the idle speed potentiometer to its mid position.

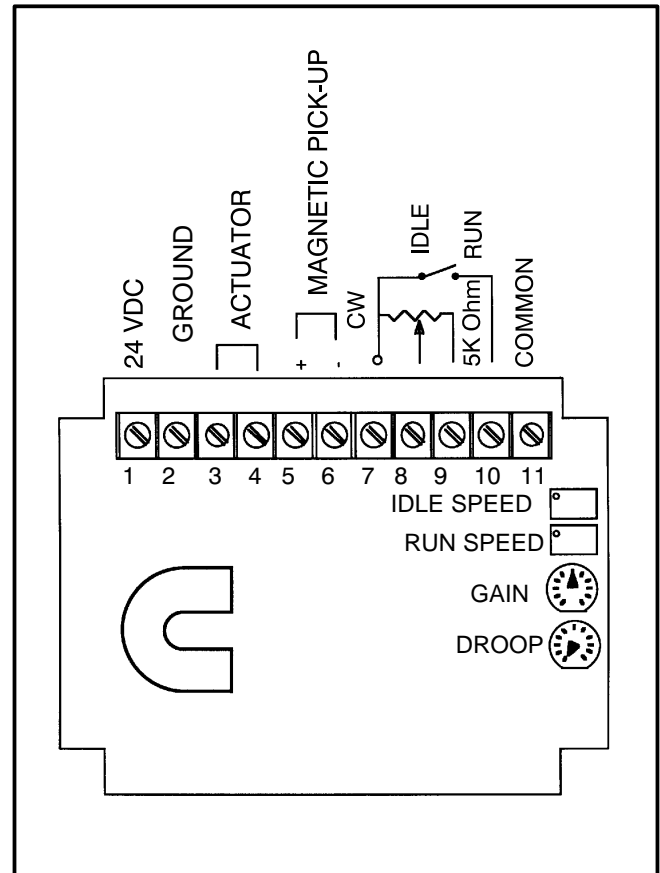


FIGURE 6-1. ELECTRONIC GOVERNOR CONTROL

3. **Run Speed** potentiometer.
 - A. Turn the screw counterclockwise until the clutch slips (noticeable click).
 - B. Turn the screw clockwise 10 turns.
 - C. This will set the run speed potentiometer to its mid position.
4. **Gain** potentiometer.
 - A. Set the Gain adjustment at the third division from zero.
5. **Droop** potentiometer.
 - A. For isochronous operation, the droop potentiometer must be turned fully counterclockwise and will not require any further adjustment.
 - B. Turn the screw to approximately the 40 percent setting to obtain 3 percent droop.
 - C. Turn the screw to approximately the 80 percent setting for 5 percent droop.

Calibration Checks:

1. Start the generator set.
2. For proper full-load generator set operation the engine no-load speed must first be adjusted to the desired allowable speed droop. (For example: isochronous operation set to 60.0 Hz/1800 r/min (50.0 Hz/1500 r/min), for 3% speed droop set to 61.8 Hz/1854 r/min (51.5 Hz/1545 r/min), for 5% speed droop set to 63.0 Hz/1890 r/min (52.5 Hz/1575 r/min).)

With the generator set warmed up to proper operating temperature, adjust the Run Speed potentiometer until the engine is operating at the desired frequency or r/min.

3. With no load connected to the generator set, turn the GAIN adjustment clockwise slowly until the engine speed oscillates. Reduce the GAIN adjustment slowly counterclockwise until the engine speed is stable. Upset the governor by using a jumper wire to momentarily short between terminals 7 and 10 on the governor control. If the engine speed oscillates up to 3 diminishing oscillations and stops, the setting is correct.
4. Apply and remove loads to check generator set response. If generator set operation is satisfactory, the governor is now calibrated. If generator set response is not satisfactory, review Step 3. If electric governor cannot be properly calibrated, contact your service representative for assistance.

Fine Speed Adjustment: After the GAIN adjustment is made, the full load governed Run Speed may require a minor adjustment to equal the desired speed (i.e., 60 Hz, 1800 r/min or 50 Hz, 1500 r/min). Use the SPEED ADJUST potentiometer (when supplied) on the engine instrument panel for fine speed adjustments of less than ± 100 r/min.

Electric Fuel Control (EFC) Governor System Description

The EFC governor system contains a magnetic pickup, electronic control, and the fuel pump actuator. See Figure 6-2.

The magnetic pickup senses engine speed at the flywheel gear and sends an alternating current (AC) electrical signal to the governor control.

The governor control compares the electrical signal from the magnetic pickup with a preset reference point. If there is a difference in the two signals, the control will change the current to the actuator (located on the engine side of the fuel pump).

The change in current in the actuator coil will make the actuator shaft rotate. The fuel flow, and engine speed or power will change when the actuator shaft rotates.

Performance Checks

If the generator set operation is rough or surges, review the following:

1. Start the generator set and check voltage readings at governor control terminals for; magnetic pickup (1.5 VAC minimum at cranking, to 30 VAC maximum at genset operating speed), battery B+ (24 VDC), fuel pump actuator (19-20 VDC).
2. Stop generator set, disconnect the leads to the actuator (see Figure 6-3), and connect battery voltage directly to the actuator studs. An audible click in the actuator should be heard when battery voltage is applied and removed. This check only shows that the actuator is operating (rotating to open and closed position), but not if its binding, further disassembly of fuel pump may be required to inspect/repair O-rings, pump, etc.
3. If further tests and repair is required, contact your Cummins Power Generation distributor for further information, or request a copy of Electric Fuel Control Governor brochure (bulletin no. 3379231-03).

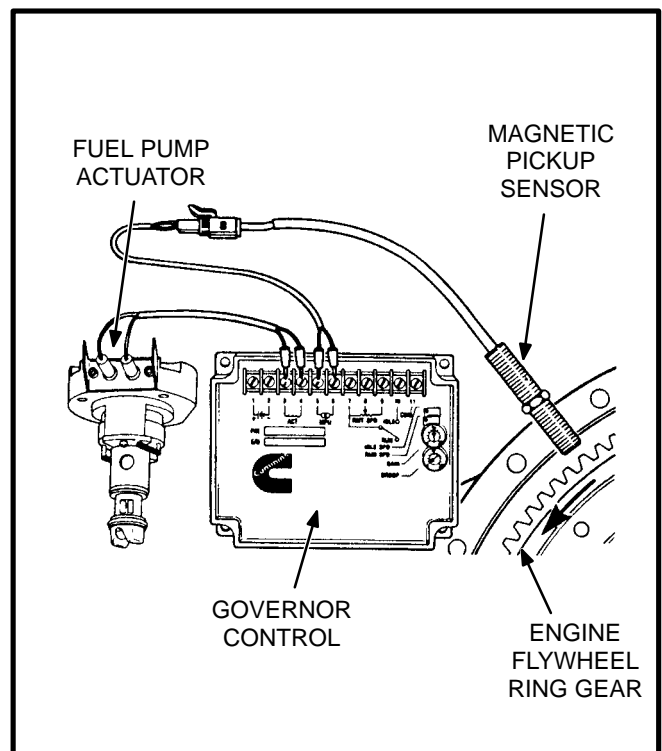


FIGURE 6-2. EFC GOVERNOR SYSTEM

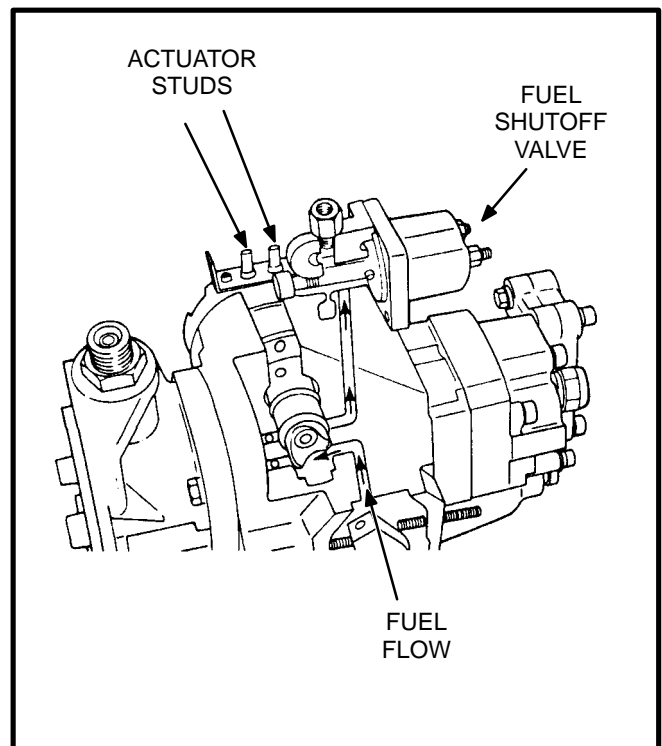


FIGURE 6-3. FUEL PUMP ASSEMBLY

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7. Options

TESTING OPTIONAL AC LOAD CIRCUIT BREAKER

General

The AC circuit breaker does not require any special maintenance other than periodic exercise and a check of conductor mounting. Circuit breaker options vary by customer requirements. Review the Optional Circuit Breaker Description in *Section 2*. A typical breaker diagram is shown in Figure 7-1 for reference. When performing tests and adjustments, avoid accidental start-up by placing the Run/Stop/Remote switch in Stop position and disconnecting the battery negative (-) cable.

⚠ WARNING *Accidental starting of the generator set during service procedures can result in severe personal injury or death. Place the Run/Stop/Remote switch in Stop position, and disconnect the battery negative (-) cable.*

Exercising Breaker: Actuate the breaker handle to the On and Off positions several times. If the breaker is equipped with a Trip Test button, the breaker should be tripped, reset and actuated to On several times. This will remove any dust from the mechanism and latch surfaces.

Checking Insulation Resistance: Disconnect the load and line conductors from the breaker, and place the breaker in the On position. Use an insulation resistance meter that will apply at least 500 volts to the test leads. Measure the insulation resistance between each pole, and to ground. Also test between the line and load terminals with the breaker in the Off position. A resistance reading less than 100,000 ohms indicates a ground. Investigate for possible contamination on the breaker case surfaces, clean if necessary and retest.

Checking Contact Resistance: Extensive operation of the breaker under load may eventually cause contacts to deteriorate. Test by a Resistance Check, or by a Voltage Drop Check across the breaker poles. Except when generator set operation is required for testing, avoid accidental start-up by placing the Run/Stop/Remote switch in Stop position and disconnecting the battery negative (-) cable.

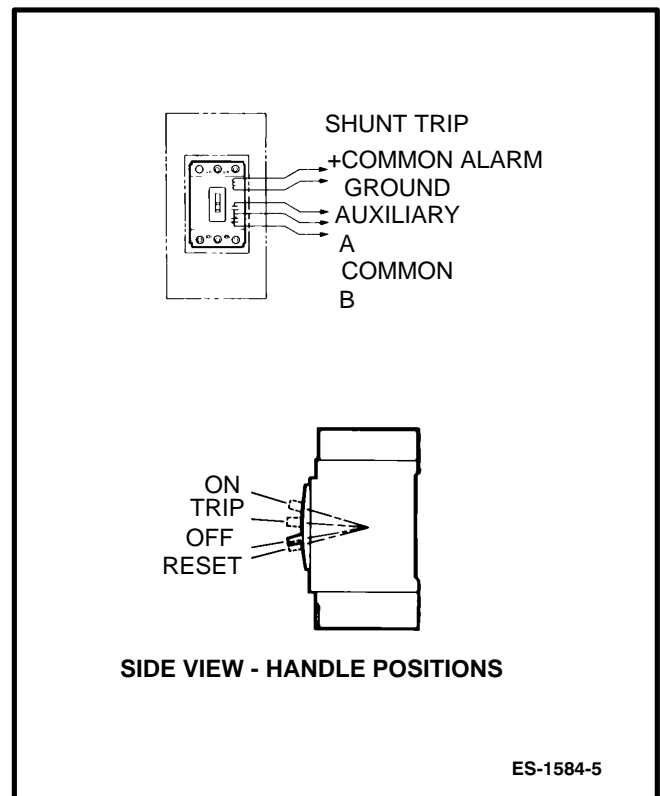


FIGURE 7-1. OPTIONAL CIRCUIT BREAKER
DIAGRAM

⚠WARNING *Accidental starting of the generator set during service procedures can result in severe personal injury or death. Place the Run/Stop/Remote switch in Stop position, and disconnect the battery negative (-) cable.*

Resistance Check:

1. Disconnect the line and load wires from the circuit breaker.
2. Move the breaker handle to the On position and check the resistance across each pole (line to load).
3. Resistance should be very low (near zero) and relatively equal across all poles.

Voltage Drop Check: This test is done with the conductors connected, generator set operating, and load applied. As a precaution against electrical shock, place an insulating mat or a dry wood platform on the floor to stand on when taking measurements.

⚠WARNING *Contact with high voltage can cause severe personal injury or death. Do not touch any exposed wiring or components with any body part, clothing, tool or jewelry. Stand on an insulating mat or dry wood platform when taking measurements.*

1. Operate the generator set with the breaker in the On position and load applied.
2. Take voltage readings at the line connections, then the load connections.
3. There should only be slight variation in the voltage dropped across each pole of the breaker. Unequal or excessive millivolt drops across the complete breaker, or one pole, indicates contaminated contacts or loose connections.
4. Stop the generator set by placing the Run/Stop/Remote switch in Stop position and disconnecting the battery negative (-) cable.

⚠WARNING *Accidental starting of the generator set during service procedures can result in severe personal injury or death. Place the Run/Stop/Remote switch in Stop position, and disconnect the battery negative (-) cable.*

Checking Shunt-Trip Operation: The shunt-trip feature is available in varying AC or DC voltages. The circuit breaker model is selected and installed at the factory to meet customer requirements. Check the shunt-trip function as follows:

1. Refer to the original equipment order, installation wiring diagrams, and unit wire routing to identify and confirm proper AC or DC signal source connections.
2. Apply the appropriate signal voltage (12 VDC; 240, 480-VAC.) The shunt-trip solenoid should energize and trip the breaker.
3. If the breaker did not trip open, remove the signal source. Perform continuity check of interconnect wiring and shunt-trip solenoid lead wires. Replace interconnect wiring if defective.

Checking Auxiliary Contacts: If equipped, the breaker will have three leads for wiring to an internal single-pole, double-throw switch. The switch allows connection of a remote annunciator (see installation wiring diagrams). Perform continuity checks of the switch with the breaker in On and Off positions to confirm operation.

Adjusting Magnetic Trip Operation: If equipped with front-adjustable magnetic trip controls, the short circuit protection feature for each pole of the breaker can be adjusted equally or individually as required. Surge current above the trip settings will actuate the trip mechanism. These adjusters are set equally to the high position at the factory. Consult on-site requirements and adjust to proper position.

DAY TANK FUEL TRANSFER PUMP AND CONTROL

General

A fuel transfer pump and control are available when a sub-base tank is provided. The automatic control operates the fuel pump to maintain a reservoir of fuel in the day tank (Figure 7-2).

⚠ WARNING Diesel fuel is highly combustible. Improper installation of this kit can lead to spillage of large quantities of fuel resulting in loss of life and property damage if the fuel is accidentally ignited. Installation and service must be performed by qualified personnel in accordance with all applicable codes.

Do not smoke near fuel and keep flames, sparks and other sources of ignition well away.

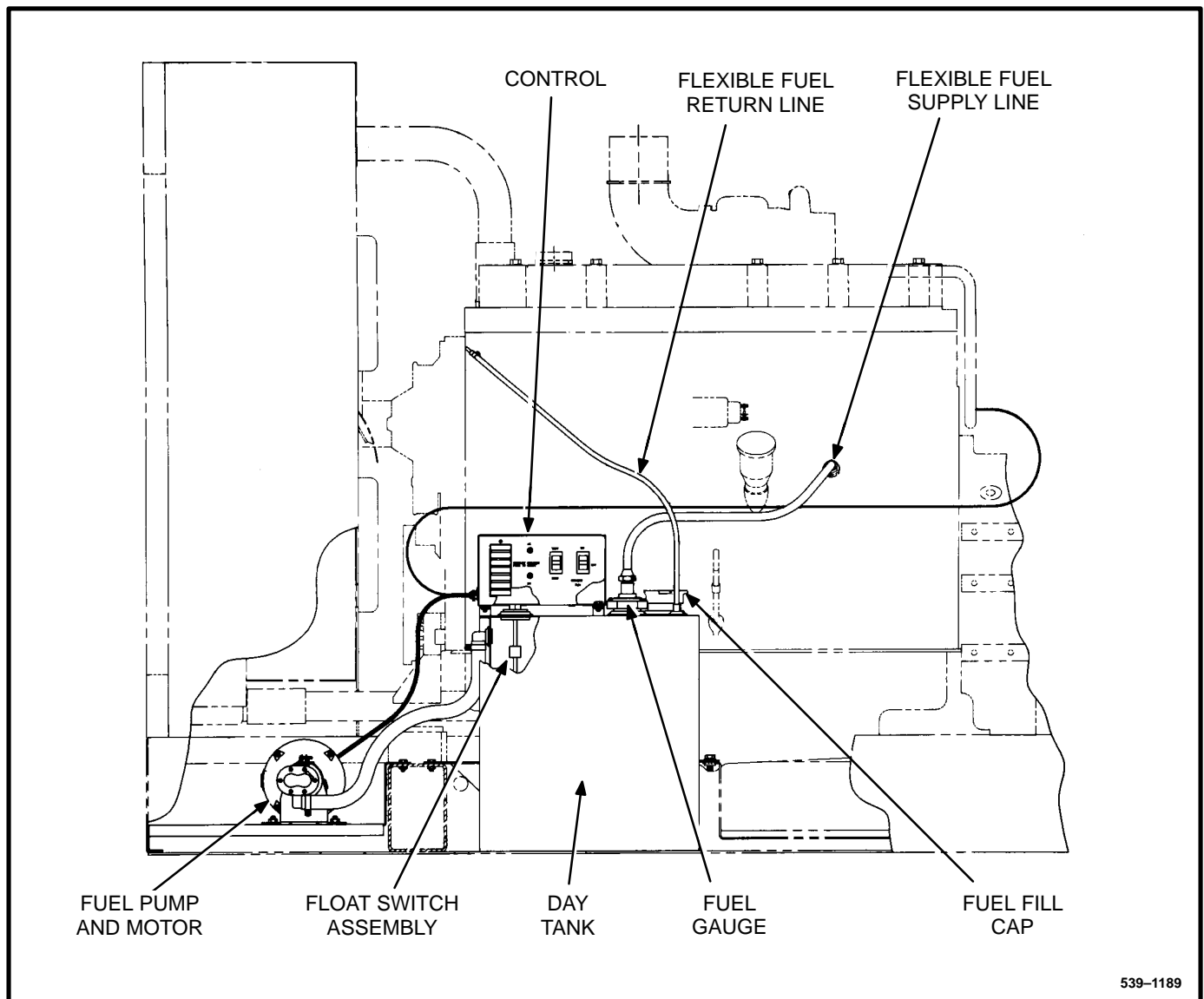


FIGURE 7-2. TYPICAL DAY TANK INSTALLATION

Operation

14. Push the control switch to the **ON** position for automatic operation. The green **SYSTEM READY** light will come on and the pump will fill the tank if AC power is available for pumping and DC power is available for the internal logic circuits. The level of fuel in the tank will be automatically kept between a set of pump-on and pump-off float switches.

When filling an empty tank, the red LO SHUT-DOWN and LO FUEL lights will come on when the control switch is pushed to the ON position. This is normal. Push the panel RESET switch to turn off the red lights after the tank has been filled.

If the SYSTEM READY light does not come on, check for correct AC and DC power connections. See Wiring Connections and Fuel Pump Motor Connections in this section.

15. The green **PUMP ON** light indicates when the pump is running. It will come on and go off as fuel is pumped to maintain the proper level in the tank.
16. Push the control switch to the **EMERGENCY RUN** position (momentary contact) to pump

fuel into the tank if the control fails to operate the pump automatically.

The green PUMP ON light does not come on when the switch is in the EMERGENCY RUN position.

17. The red lights indicate fault conditions and the need for service. The control panel includes the following lights:

- A. **HI FUEL:** The fuel in the tank has reached an abnormally high level, indicating possible failure of the pump-off float switch. The high-fuel float switch takes over as the automatic pump-off switch. The **HI FUEL** light stays on. The light can be **RESET** with the panel switch when the fuel level drops to normal, but will come back on again during the next pumping cycle if the fault remains.

⚠ WARNING Continued operation with a HI FUEL fault present can lead to spillage of large quantities of fuel if the high-fuel float switch fails. Spilled fuel can cause loss of life and property damage if it is accidentally ignited.

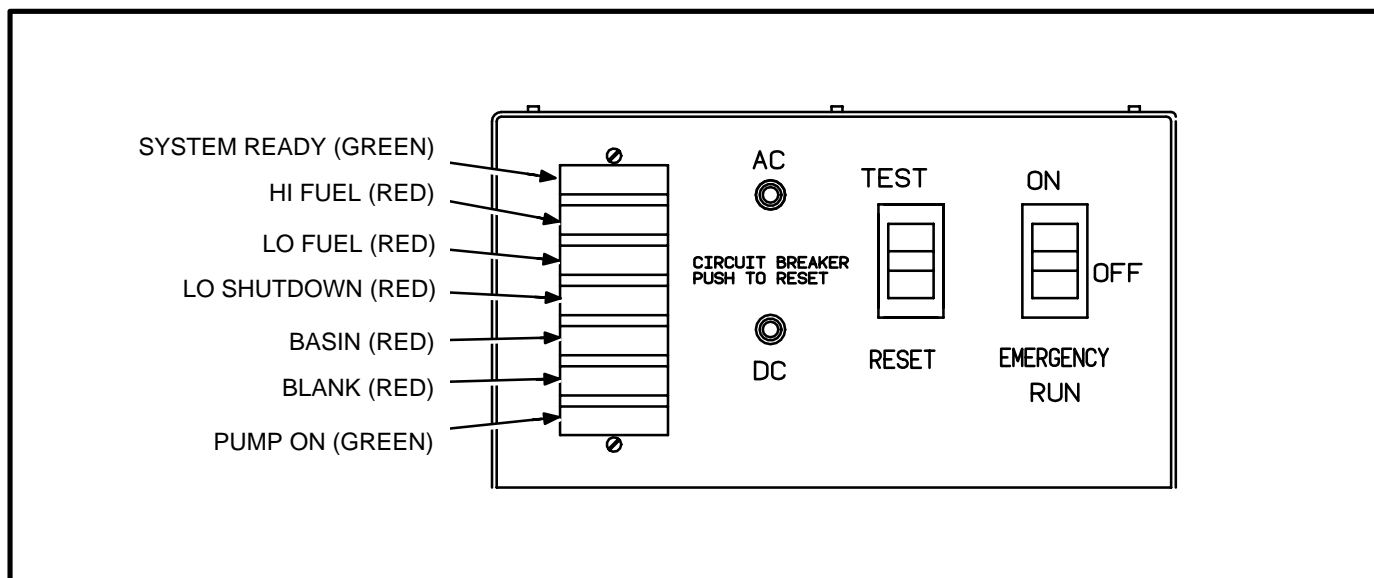


FIGURE 7-3. FUEL PUMP CONTROL PANEL

- B. **LO FUEL:** The fuel in the tank has dropped to an abnormally low level, indicating possible failure of the pump-on float switch. The lo-fuel float switch takes over as the automatic pump-on switch. The **LO FUEL** light stays on. The light can be **RESET** with the panel switch when the fuel level rises to normal, but will come back on again during the next pumping cycle if the fault remains.
- C. **LO SHUTDOWN:** The fuel has dropped to a level near the bottom of the tank, indicating an empty main fuel tank, pump failure or possible failure of both the pump-on and low-fuel level float switches. Further operation will allow air to enter the engine fuel unit, causing shutdown. Connections should have been made to Terminals **TB1-14** and **TB1-15** to shut down the engine automatically (to ground one of two customer fault inputs (**A11 TB2-1** or **A11 TB2-3**)). If the light comes on, check the fuel level in the main fuel tank and fill it if necessary. As the day tank is refilling, **RESET** the light with the panel switch.

To restore engine operation following this fault, both the pump control and the Detector control have to be **RESET**.

- D. **BASIN:** Fuel has overflowed into the rupture basin (if provided), indicating possible failure of both the pump-off and hi-fuel level float switches, or a leak in the day tank. **RESET** the control after the fuel in the basin has been safely disposed of and the cause of the overflow corrected.
- E. **BLANK:** For customer use.

The control fault circuits will trip and latch, requiring **RESET**, even if **AC** power is lost.

18. Press the **TEST** switch to test the indicator lights and pump operating circuits. Replace any light that does not come on. The pump will stop automatically after it has filled the tank to the normal pump-off fuel level.
19. Press the reset button of the **AC** or **DC** circuit breaker if either has tripped.

Wiring Connections

See Day Tank Pump Control Wiring, *Section 8*, when making connections at the control box terminal board. The following should be noted.

1. The control can be powered by 120 VAC or 240 VAC. The control is set up at the factory for connection to 240 VAC.

To convert the day tank controller from 240 VAC to 120 VAC, perform the following steps.

- A. Remove the two jumpers between terminals **TB1-6** and **TB1-7** in the control box and connect one between terminals **TB1-5** and **TB1-6** and the other between terminals **TB1-7** and **TB1-8**.
- B. Move selector switch **S103** on the control PCB to the up position for 120V.
- C. If the control is equipped with a transformer, remove the two jumpers between terminals **H2** and **H3** and connect one between **H1** and **H3** and the other between **H2** and **H4**.

To convert the day tank controller from 120 VAC to 240 VAC, perform the following steps.

- A. Remove the jumpers between terminals **TB1-5** and **TB1-6**, and **TB1-7** and **TB1-8** in the control box and connect the two jumpers between terminals **TB1-6** and **TB1-7**.
- B. Move selector switch **S103** on the control PCB to the down position for 240 VAC.

C. If the control is equipped with a transformer, remove the jumpers between terminals **H1** and **H3**, and **H2** and **H4** and connect the two jumpers between **H2** and **H3**.

2. Attach a tag to the control box indicating the supply voltage.
3. If a two lead wiring harness is provided, the control does not include a power transformer. To provide 24 VDC for the control circuit, connect terminal **TB1-19** to the positive (+) terminal of the 24 V starter motor solenoid and terminal **TB1-20** to the negative (-) terminal.
4. To immediately shut down the engine when the **LO SHUTDOWN** light comes on, connect terminal **TB1-14** to a good grounding point on the engine block and terminal **TB1-15** to **A11 TB2-1** or **A11 TB2-3** (Customer Fault inputs).
5. Terminals **TB1-10** through **TB1-17** and **TB2-23** through **TB2-27** are available for connections to remote annunciators or to either of the two customer fault inputs of the Detector control.
6. Terminal **TB2-22** is available for connection of a grounding signal to activate the blank red light.
7. Terminals **TB1-8** and **TB1-5** are available for connection of a 120 or 240 VAC electric fuel shutoff valve rated not more than 0.5 amps. The voltage rating of the valve must correspond with the voltage utilized for the pump. See Item 2 above.

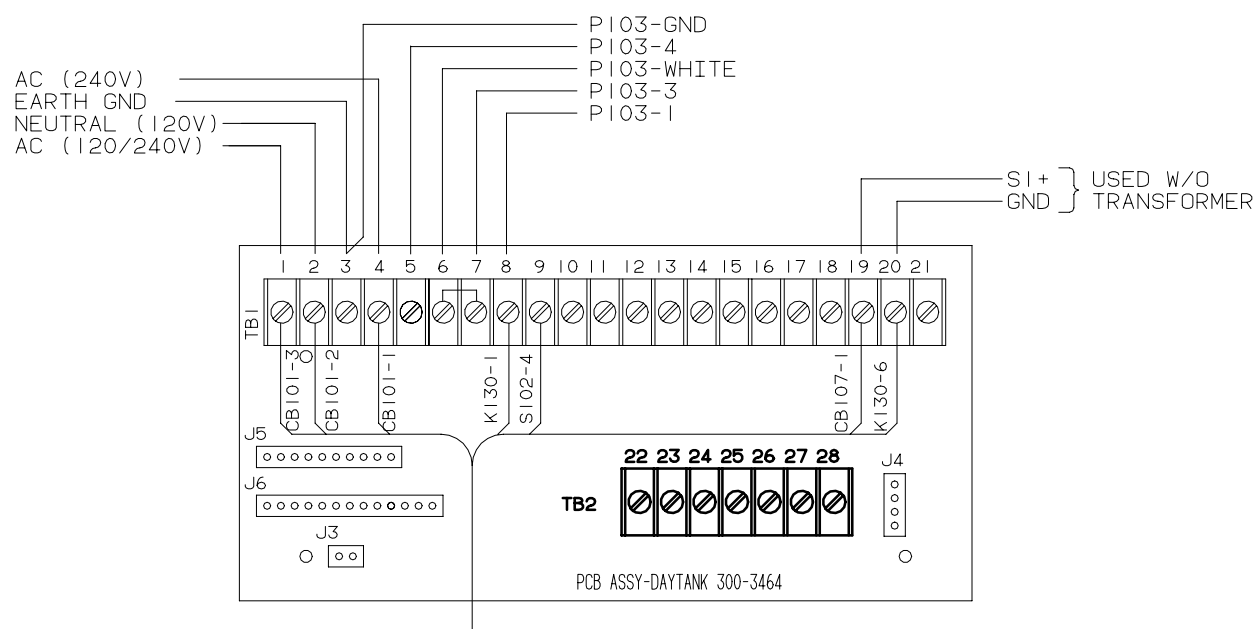


FIGURE 7-4. FUEL PUMP CONTROL TERMINAL BOARD

Fuel Transfer Pump Motor Connections

Connect a replacement fuel transfer pump motor as follows.

1. Remove the end bell cover for access to the motor wiring terminals.
2. Disconnect the brown lead from motor terminal **P103-3** and connect it to terminal **P103-6**. (Terminal **P103-6** is an insulated receptacle for securing the end of the lead so that it cannot move and touch the motor frame or a live terminal and cause a short circuit.)
3. Disconnect the red lead from motor terminal **P103-2**. It will be connected to the piggy-back terminal on the lead connected at motor terminal **P103-3**.
4. Cut the white lead from its ring connector at motor terminal **P103-4**. Strip 1/2 inch (12 mm) of insulation from the end of the white motor lead for splicing to the wire harness lead marked **P103-WHITE**.
5. Connect each lead of the five-lead wiring harness to the motor terminal or lead marked on it.
6. Connect the red motor lead to the piggy-back terminal at motor terminal **P103-3**.
7. Secure the end bell cover.

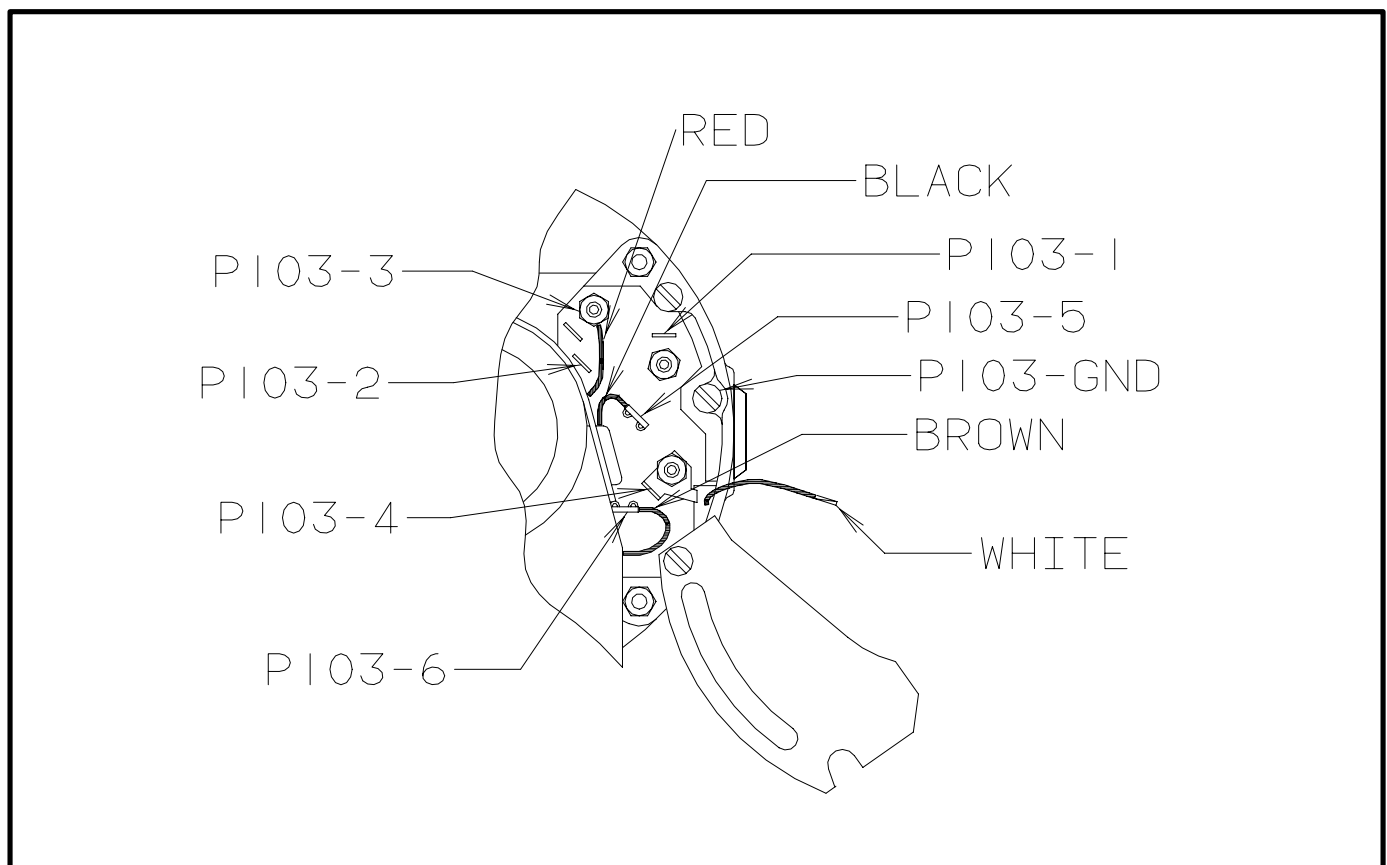


FIGURE 7-5. FUEL TRANSFER PUMP MOTOR CONNECTIONS

Testing The Float Switch Assembly

The float switch assembly consists of 5 switches. Each switch has a pair of color coded leads connected to a common jack.

To test the float switches, remove the fuel pump control cover, disconnect the wiring jack and unscrew the assembly from the top of the day tank. Test as follows:

1. With an ohmmeter, test for electrical continuity (switch closed) between each pair of colored leads, while holding the assembly vertical. Replace the assembly if any switch is open (all the readings should be zero).
2. Lift each float, in turn, to 1/8 inch (3 mm) below the C-clip stop above it (use a feeler gauge) and test for electrical continuity. Replace the assembly if any switch does not open (all the readings should be infinity).
3. Use pipe thread sealant when replacing the assembly.

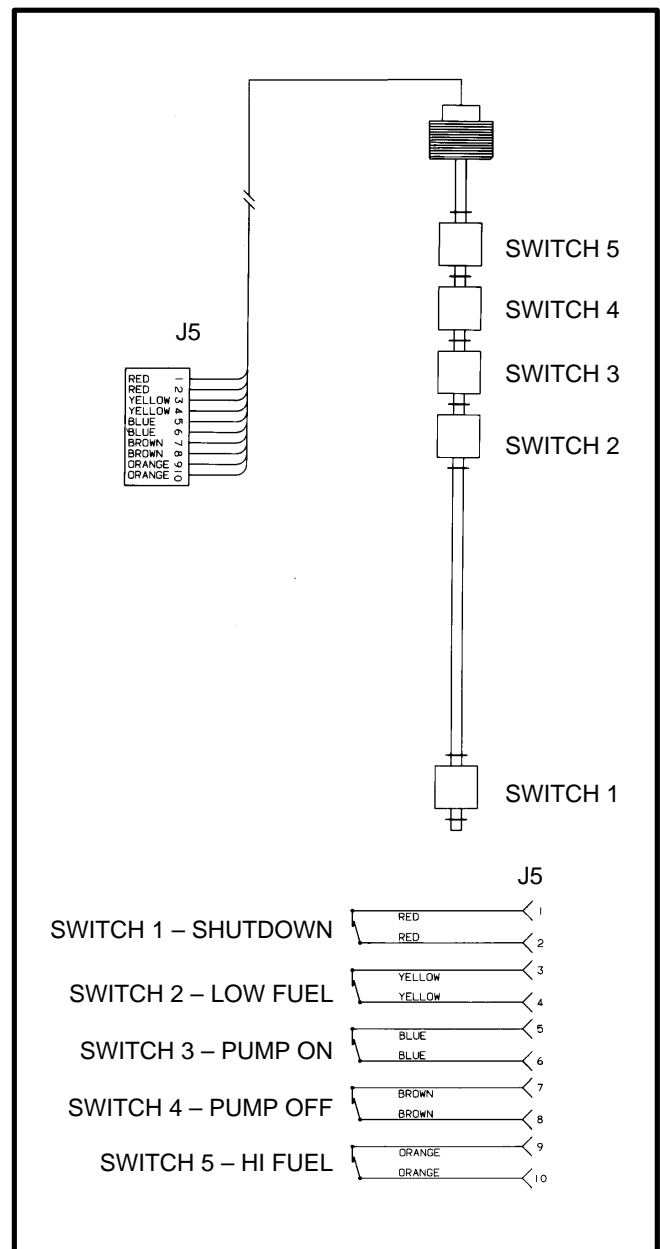


FIGURE 7-6. FLOAT SWITCH ASSEMBLY

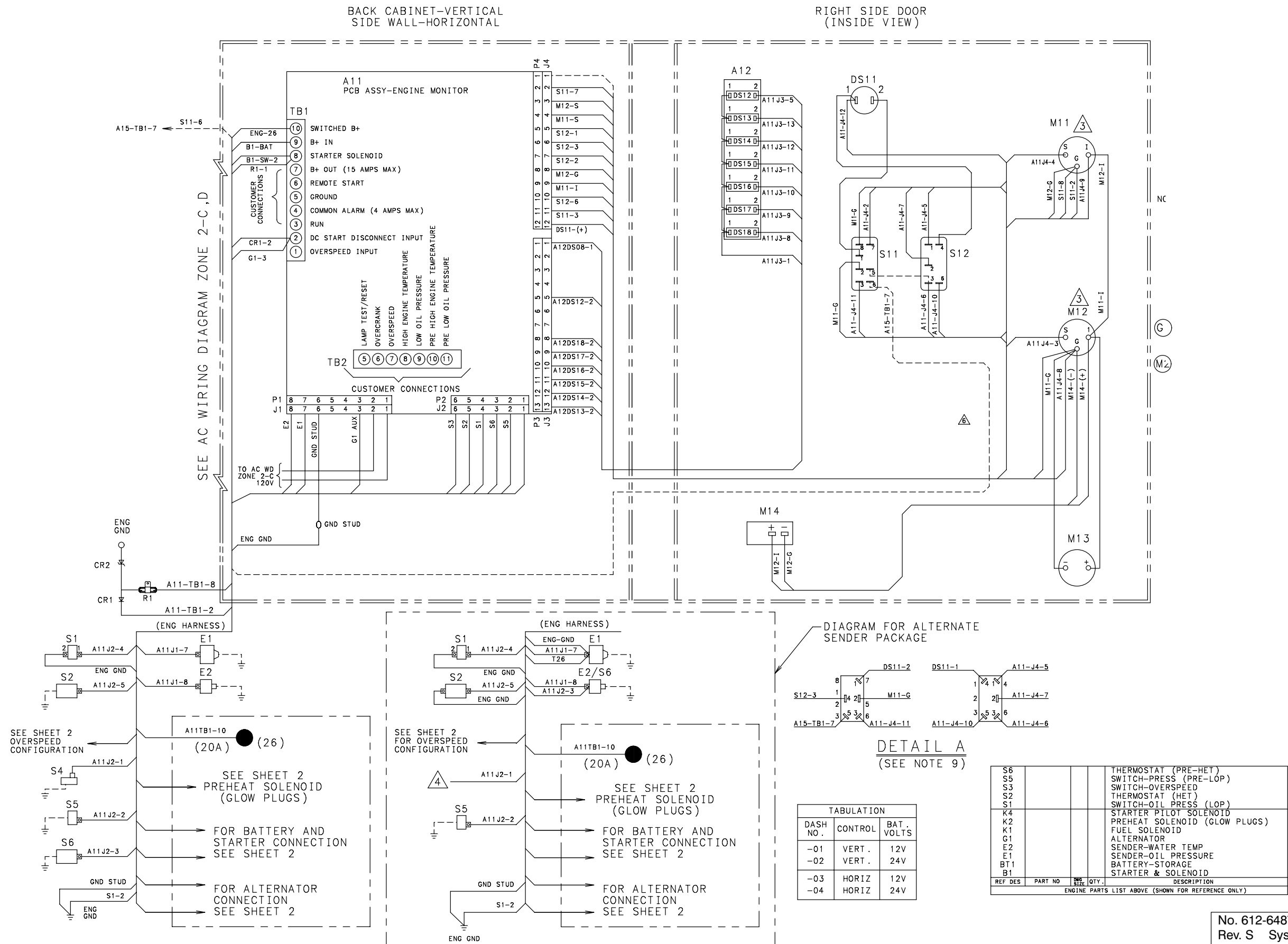
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8. Wiring Diagrams Control/Generator

This section contains the following Wiring Diagrams/Schematics and Engine Sensor Locations:

TITLE	PAGE
DC Wiring Diagram/Schematic (7-Light)	8-2
DC Schematic – Ladder Diagram (7-Light)	8-4
Detector-7 ECM – PCB Assembly	8-6
DC Wiring Diagram/Schematic (12-Light)	8-8
DC Schematic – Ladder Diagram (12-Light)	8-10
Detector-12 ECM – PCB Assembly	8-12
Detector-12 ECM – Functional Diagram	8-14
AC Reconnect Wiring Diagrams	8-15
AC Wiring Diagram/Schematic (W/O Meters)	8-19
AC Wiring Diagram/Schematic (With Meters)	8-20
PMG Voltage Regulator Installation Wiring Diagram	8-21
PMG Voltage Regulator Technical Data	8-22
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Engine Sensor Locations (L10 Series)	8-28
Engine Sensor Locations (NT855 Series)	8-29
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Engine Sensor Locations (KT38 Series)	8-32
Engine Sensor Locations (KT50 Series)	8-33
L10 & M11 Engine Harness Diagram	8-34
NT855 & N14 Engine Harness Diagram	8-35

⚠ CAUTION *Repair of printed circuit board components other than fuses requires well-trained, qualified personnel with the proper equipment; repair of the printed circuit boards is not recommended except by the factory. Application of meters or hot soldering irons to printed circuit boards by other than qualified personnel can cause unnecessary and expensive damage.*



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FIGURE 8-1. DC EIRING DIAGRAM (7-LIGHT)

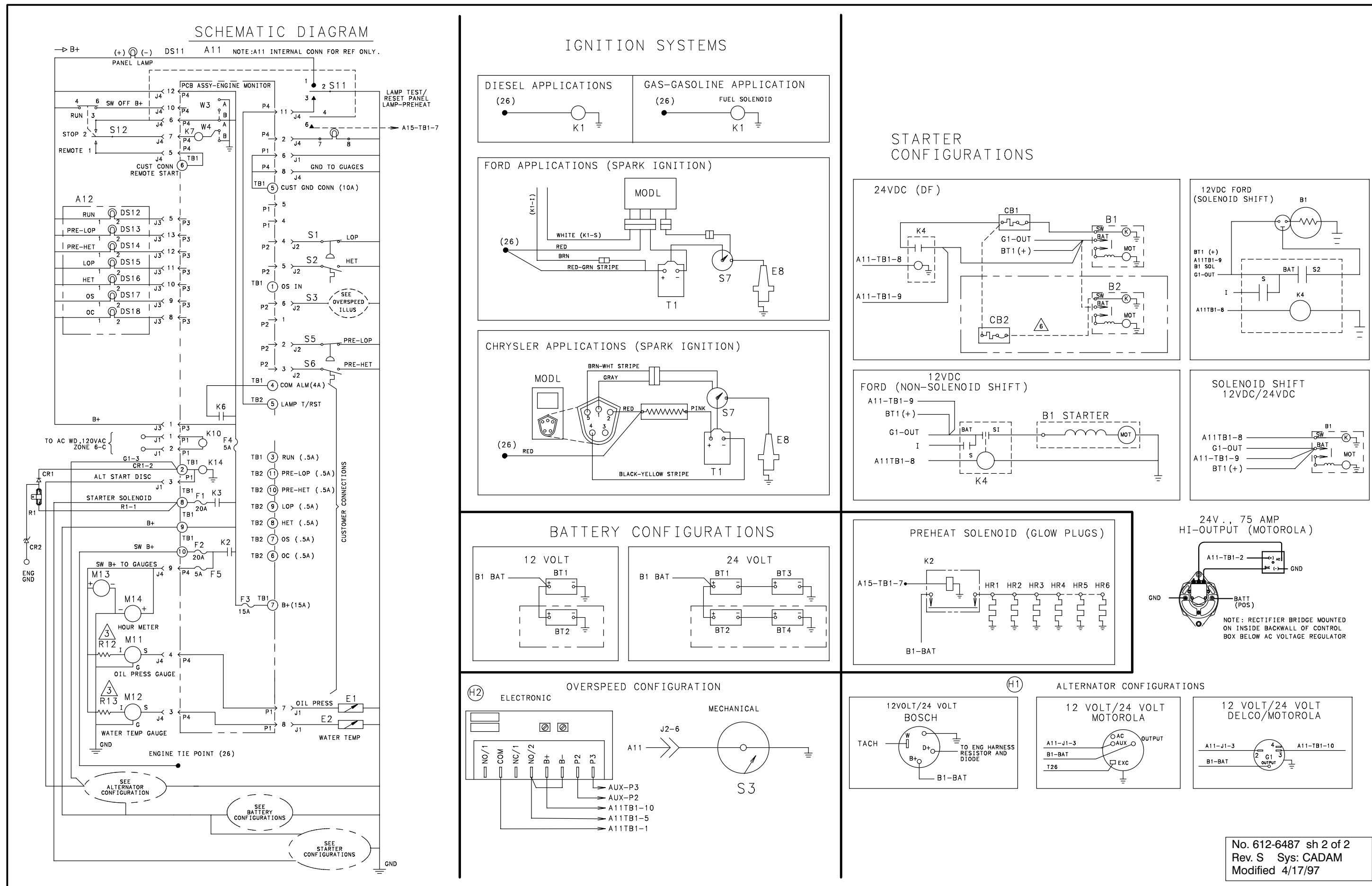
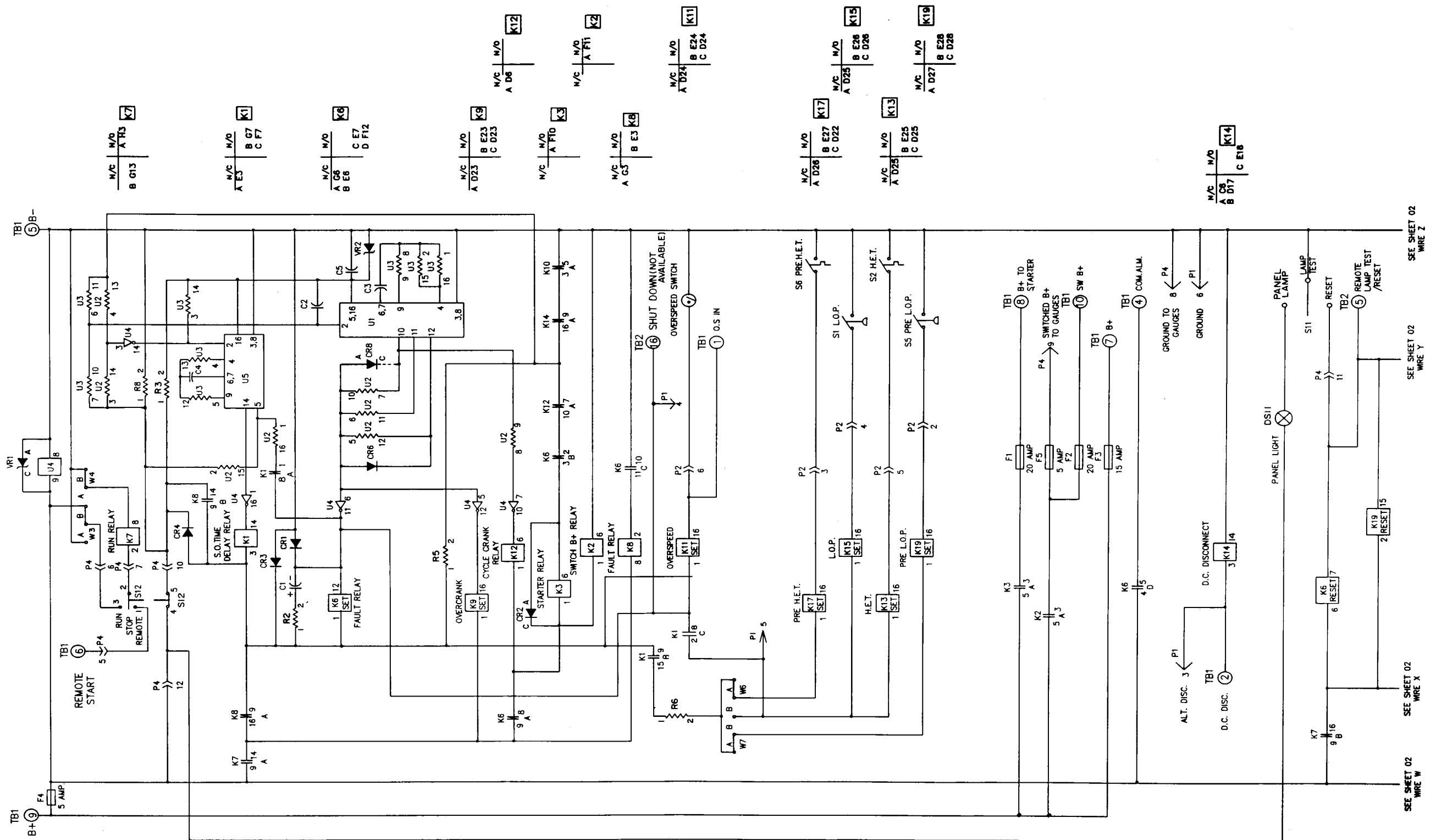
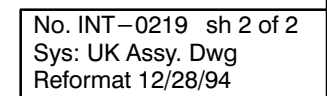


FIGURE 8-2. DC WIRING SCHEMATIC (7-LIGHT)



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FIGURE 8-3. DC SCHEMATIC – LADDER DIAGRAM (7-LIGHT)



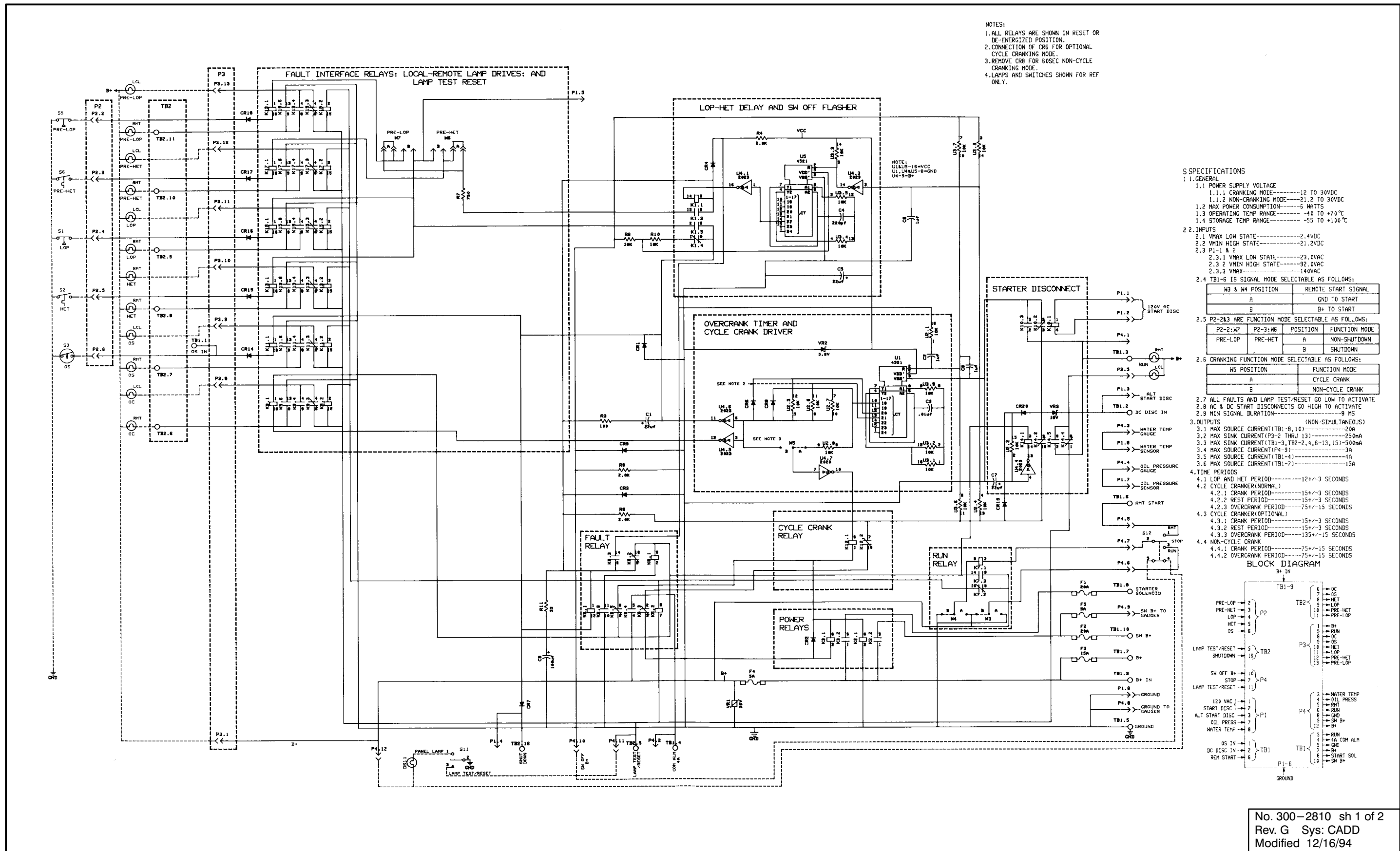
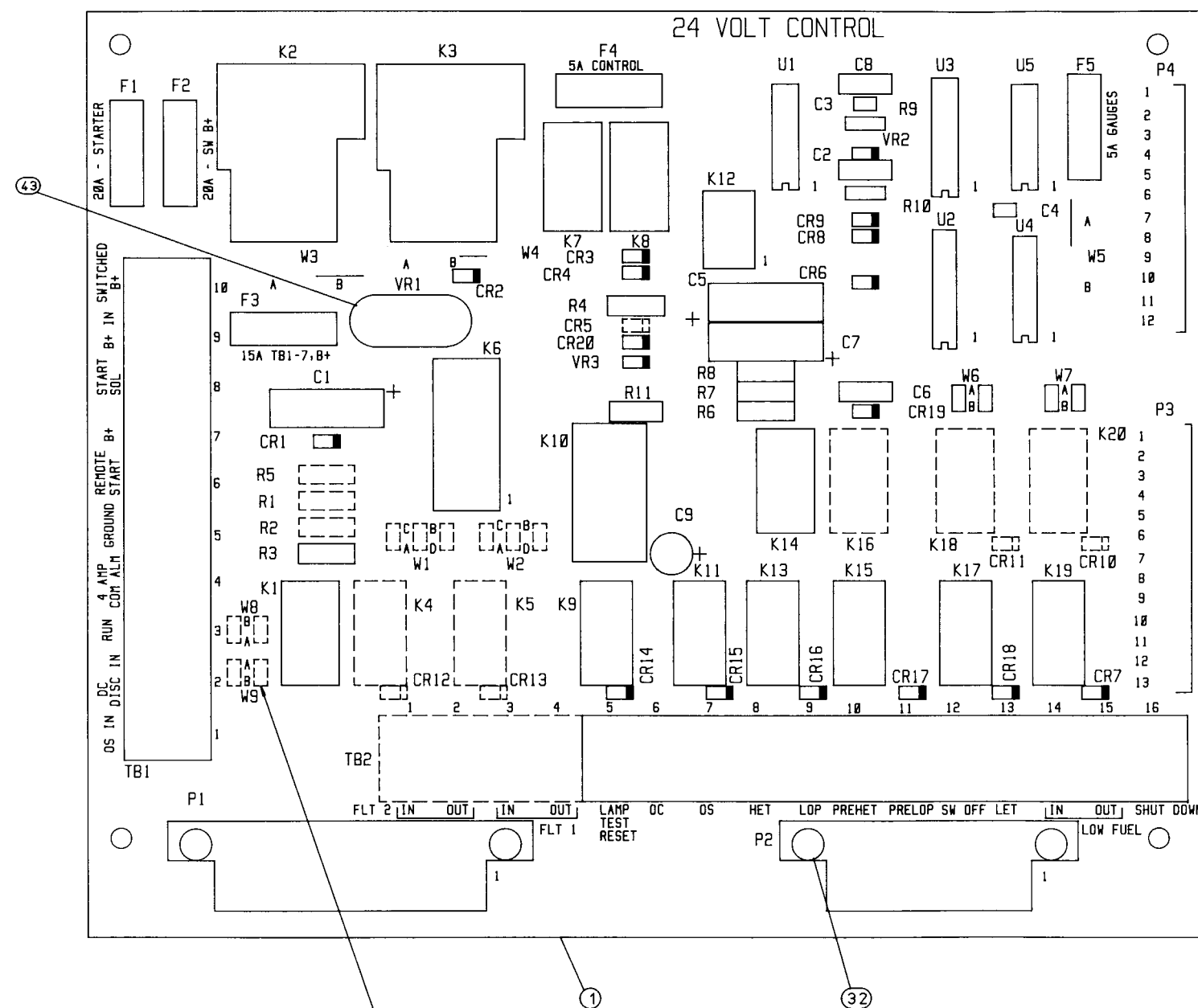


FIGURE 8-5. DETECTOR-7 ECM – PCB ASSEMBLY



R11	50	RESISTOR (22.1/2W,5%)
C9	49	CAPACITOR-ELEC(100μF,50V)
W3,4,5	48	JUMPER-PCB
	47	JUMPER-PCB
W6,7	46	CONNECTOR-HEADER (2 PIN)
VR3	45	DIODE-ZENER (18V)
VR2	44	DIODE-ZENER (5.6V)
	43	COVER-VARISTOR
VR1	42	DIODE-VARISTOR (36V)
U4	41	IC-DRIVER ARRAY (2023)
U2,3	40	IC-RESISTOR(10K,2%)
U1,5	39	IC-24 STA0 FREQ DIV(4521)
TB2	38	TERMINAL BLK (12PL)
TB1	37	TERMINAL BLK (10PL)
R9,10	36	RESISTOR (10K,1/4W,5%)
R4,6,8	35	RESISTOR (2.0K,1/2W,5%)
R3	34	RESISTOR (100,1/2W,5%)
R7	33	RESISTOR (750,1/2W,5%)
	32	RIVET-OVAL HD R-3311x7/32
P4	31	CONNECTOR-HEADER (12 PIN)
P3	30	CONNECTOR-HEADER (13 PIN)
P2	29	CONNECTOR-SOCKET (6 PIN)
P1	28	CONNECTOR-SOCKET (8 PIN)
K12	27	RELAY (SPDT,12V)
K10	26	RELAY (SPST,115VAC)
K7,8	25	RELAY (SPDT,24V)
K6	24	RELAY-LATCHING (12V)
K17,19	23	RELAY-LATCHING(DPDT,12V)
K9,11,13,15,	22	RELAY-LATCHING(DPDT,12V)
K2,3	21	RELAY-POWER (SPDT,24V)
K1,14	20	RELAY-24VDC (DPDT)
	19	CLIP-FUSE
F4,5	18	FUSE (5A,32V)
F3	17	FUSE (15A,32V)
F1,2	16	FUSE (20A,32V)
CR14-20	15	RECTIFIER (1A,800V)
CR1-4,6-9,	14	CAPACITOR (220pF,100V)
C4	13	CAPACITOR (.01μF,100V)
C3	12	CAPACITOR (1μF,50V)
C2,6,8	11	CAPACITOR (1μF,50V)
C1,5,7	10	CAPACITOR (22μF,35V)
SEE NOTE 7	9	LABEL-BARCODE
	8	PRODUCT DESIGN SPEC
	7	STRESS SCREEN TEST
	6	FINAL TEST SPEC
	5	ATE TEST SPEC
	4	RESIN-URETHANE (1N 0ALS)
	3	SOLDER-BAR (1N OUNCES)
	2	PCB-ENGINE MON (24V)
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FIGURE 8-6. DETECTOR-7 ECM – PCB ASSEMBLY

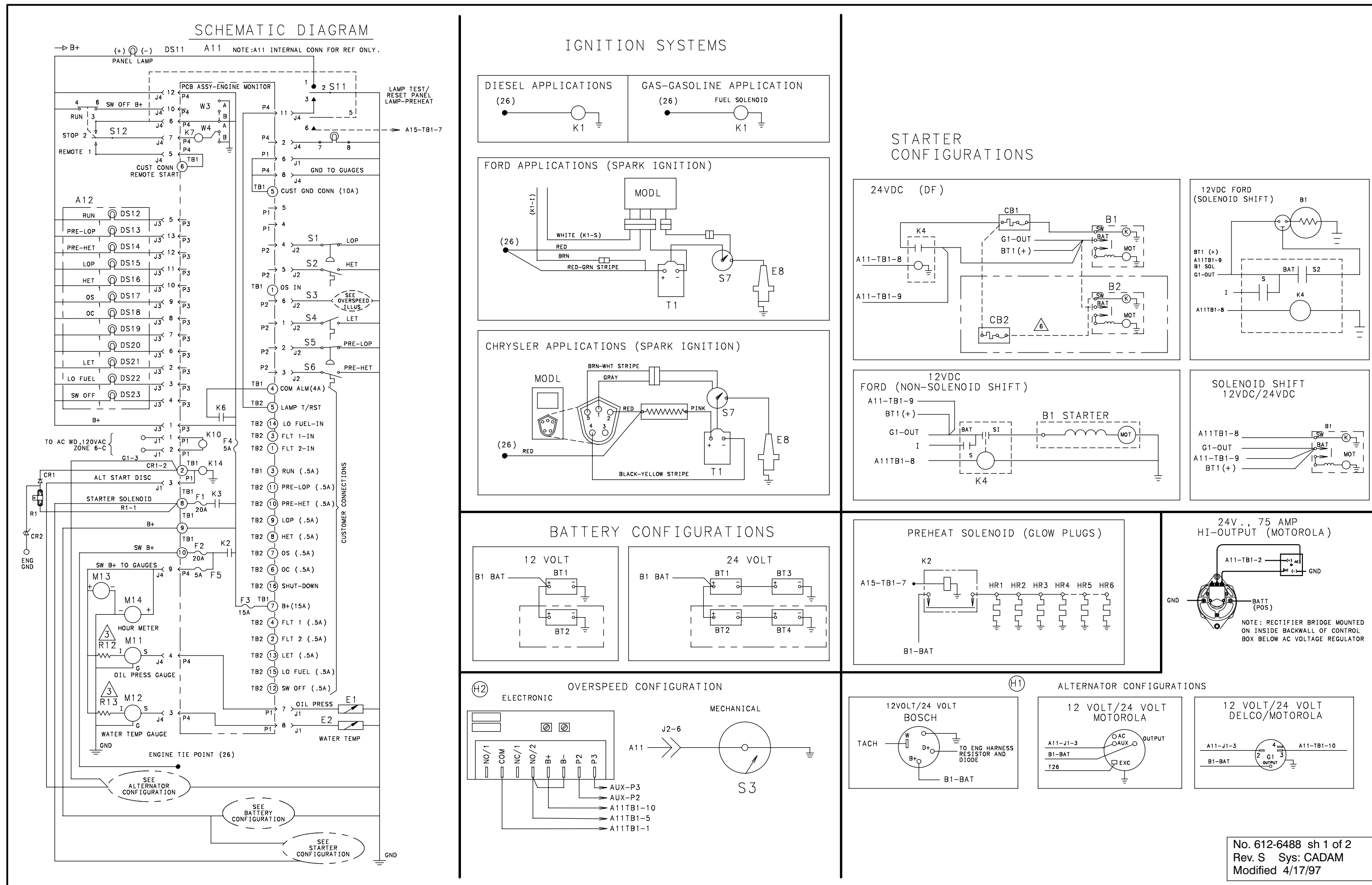
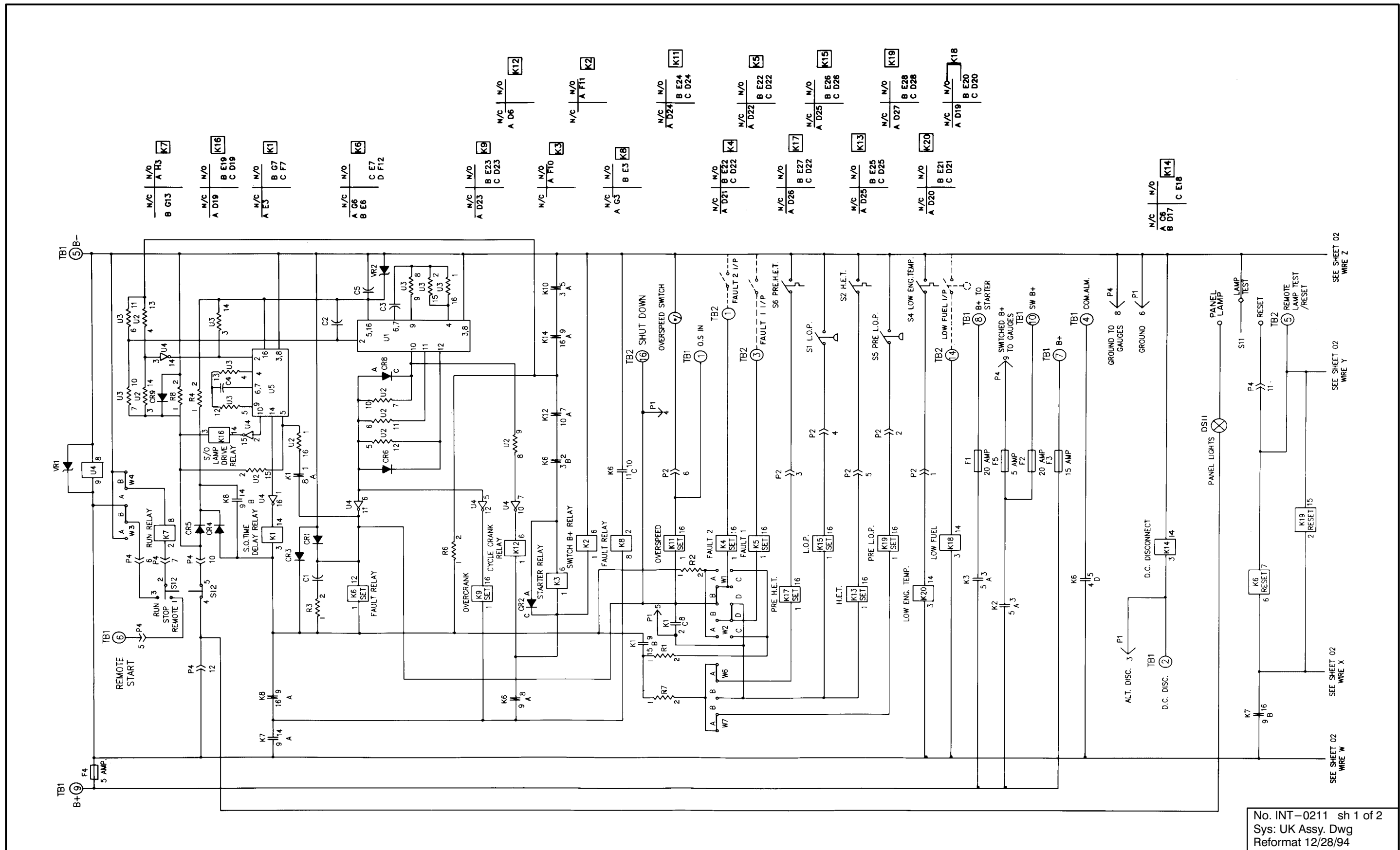


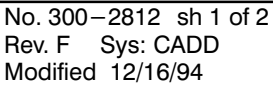
FIGURE 8-9. DC WIRING DIAGRAM (12-LIGHT)



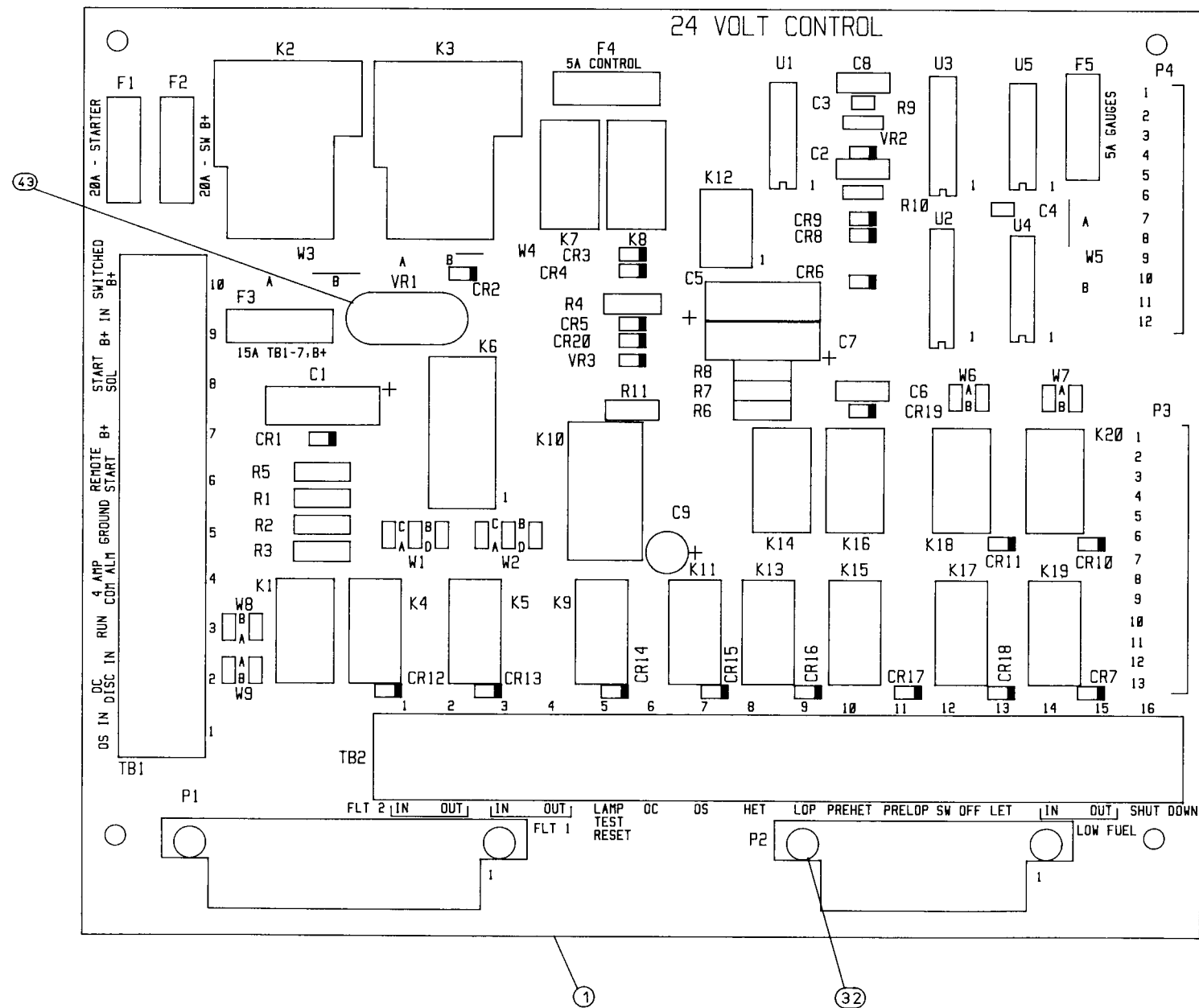
No. INT-0211 sh 1 of 2
Sys: UK Assy. Dwg
Reformat 12/28/94

FIGURE 8-9. DC LADDER DIAGRAM (12-LIGHT)

FIGURE 8-10. DC SCHEMATIC – LADDER DIAGRAM (12-LIGHT)



8-12



R11	50	RESISTOR (22.1/2W,5%)
C9	49	CAPACITOR-ELEC(100μF,50V)
W3,4,5	48	JUMPER-PCB
	47	JUMPER-PCB
W1,2,6-9	46	CONNECTOR-HEADER (2 PIN)
VR3	45	DIODE-ZENER (18V)
VR2	44	DIODE-ZENER (5.6V)
VR1	43	COVER-VARISTOR
	42	VARIATOR-METALOXIDE (36V)
U4	41	IC-DRIVER ARRAY (2003)
U2,3	40	IC-RESISTOR(10K,2%)
U1,5	39	IC-24 STAG FREQ DIV(4521)
TB2	38	TERMINAL BLK (16PL)
TB1	37	TERMINAL BLK (10PL)
R9,10	36	RESISTOR (10K,1/4W,5%)
R4,6,8	35	RESISTOR (2.0K,1/2W,5%)
R3	34	RESISTOR (100,1/2W,5%)
R1,2,5,7	33	RESISTOR (750,1/2W,5%)
	32	RIVET-OVAL HD R-3311x7/32
P4	31	CONNECTOR-HEADER (12 PIN)
P3	30	CONNECTOR-HEADER (13 PIN)
P2	29	CONNECTOR-SOCKET (6 PIN)
P1	28	CONNECTOR-SOCKET (8 PIN)
K12	27	RELAY (SPDT,12V)
K10	26	RELAY (SPST,115VAC)
K7,8	25	RELAY (SPDT,24V)
K6	24	RELAY-LATCHING (12V)
K15,17,19	23	RELAY-LATCHING(DPDT,12V)
K4,5,9,11,13	22	RELAY-LATCHING(DPDT,12V)
K2,3	21	RELAY-POWER (SPDT,24V)
K20	20	RELAY-24VDC (DPDT)
K1,14,16,18,	19	CLIP-FUSE
F4,5	17	FUSE (5A,32V)
F3	16	FUSE (15A,32V)
F1,2	15	FUSE (20A,32V)
CR1-20	14	RECTIFIER (1A,800V)
C4	13	CAPACITOR (220pF,100V)
C3	12	CAPACITOR (.01μF,100V)
C2,6,8	11	CAPACITOR (1μF,50V)
C1,5,7	10	CAPACITOR (22μF,35V)
SEE NOTE 7	9	LABEL-BARCODE
	8	
	7	PRODUCT DESIGN SPEC
	6	STRESS SCREEN TEST
	5	FINAL TEST SPEC
	4	ATE TEST SPEC
	3	RESIN-URETHANE (IN 0ALS)
	2	SOLDER-BAR (IN OUNCES)
	1	PCB-ENGINE MON (24V)

FIGURE 8-12. DETECTOR 12 ECM – PCB ASSEMBLY

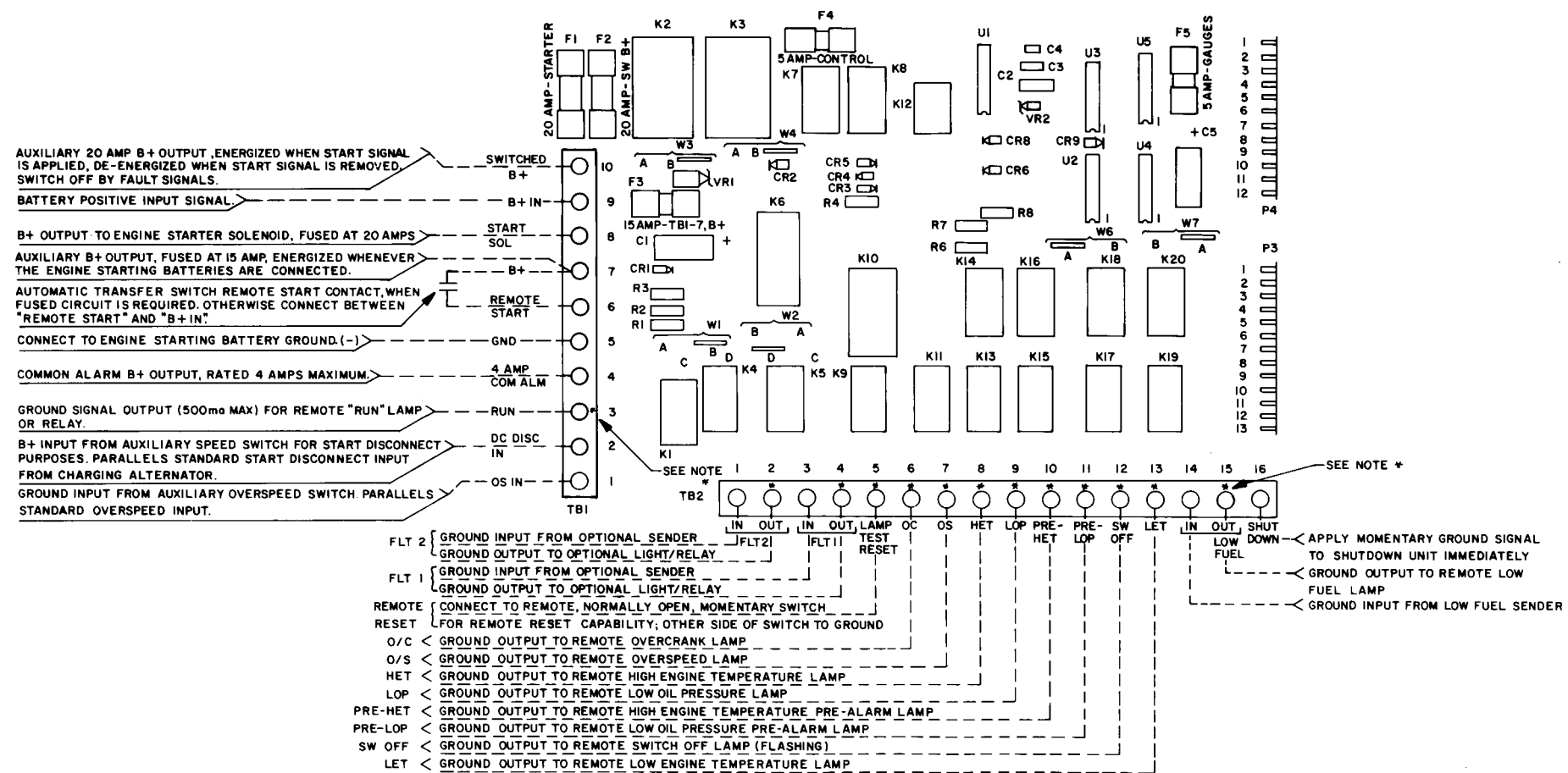
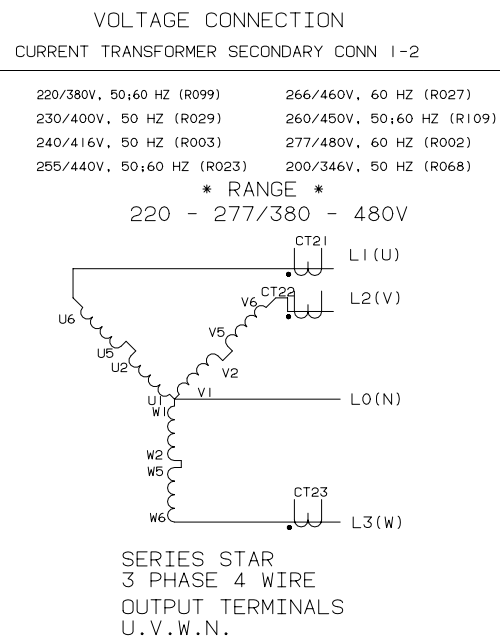
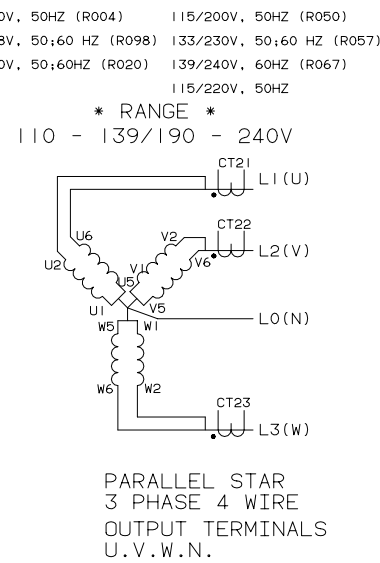
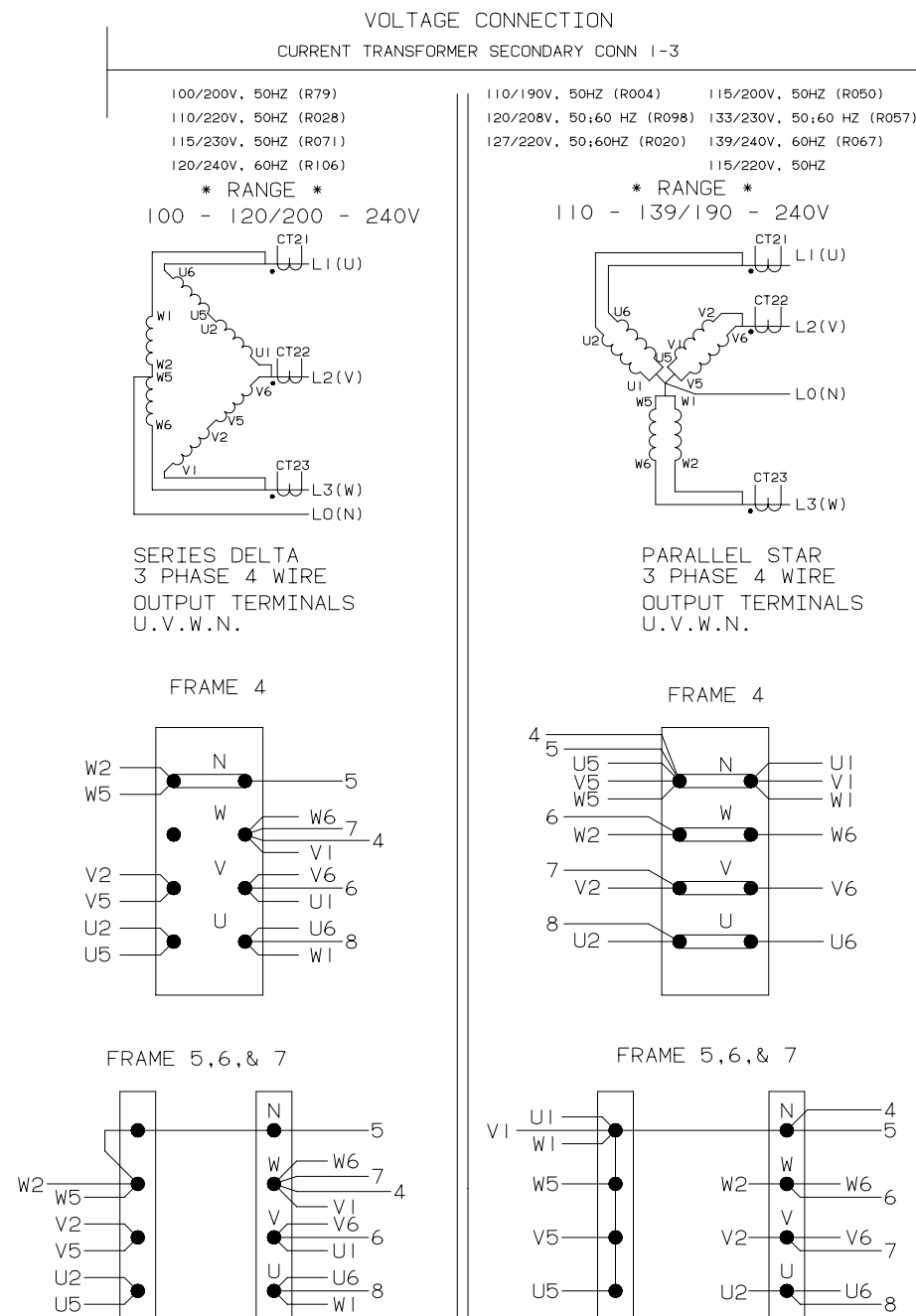


FIGURE 8-13. DETECTOR 12 ECM – FUNCTIONAL DIAGRAM

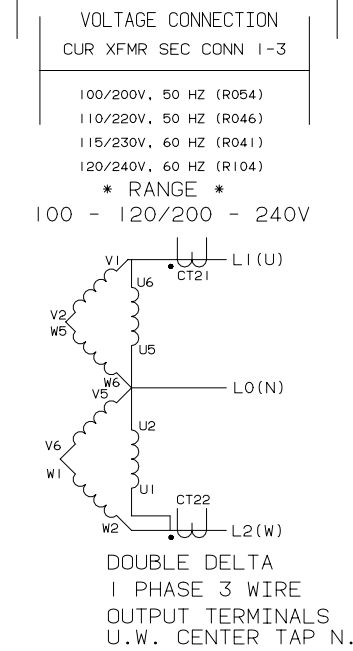
No. INT-0192 sh 1 of 1
Sys: UK Assy, Dwg
Reformat 12/28/94

SC, CC, HC GENERATORS

3 PHASE RECONNECTABLE



1 PHASE RECONNECTABLE



THIS DRAWING APPLIES TO:
MODEL THROUGH
SPEC LETTER

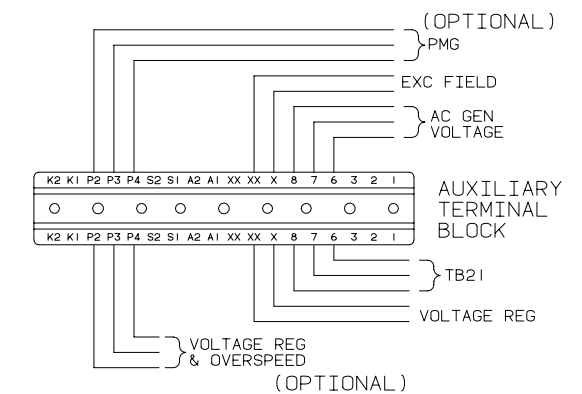
DFAA	D
DFAB	D
DFAC	D
DFBF	K
DFCB	K
DFCC	K
DFEB	J
DFEC	C
DFFB	K
DFGA	D
DFGB	D
DFJA	K
DFJB	K
DFJC	K
DFJD	C
DFLB	K
DFLC	K
DFLD	K
DFMB	K

ALL MODELS WITH PREFIX:
NT, NTA, KTA, KTT, AND VTA

NOTES:

1. UVW PHASE SEQUENCE WITH C.W. ROTATION
FACING DRIVE END.

2. The dot on the side of the current transformer
(CT) must face the generator. A dot is also used to
mark terminal 1. CT terminal 1 connects to the
metering circuit. Terminal 2/3 connects to ground.



CONTROL INPUT					
12 LEAD					
CONTROL INPUT TB21	AUX TERM CON	SERIES DELTA	PARALLEL STAR	SERIES STAR	DOUBLE DELTA
22	8	8	8	8	8
23	7	7	7	7	7
24	4	4	4	4	4
25	6	6	6	6	6
26	5	5	5	5	5
JUMPER	-	-	-	-	-

No. 625-2165 sh 1 of 2
Rev. J Sys:CADAM
Modified 12/21/94

FIGURE 8-14. RECONNECTION DIAGRAM

SC , CC , HC GENERATORS

THIS DRAWING IS FOR REFERENCE ONLY. REFER TO THE RECONNECTION DIAGRAM SUPPLIED WITH THE GENSET.

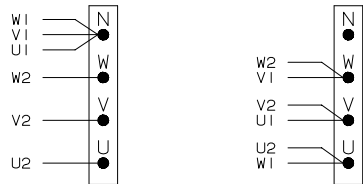
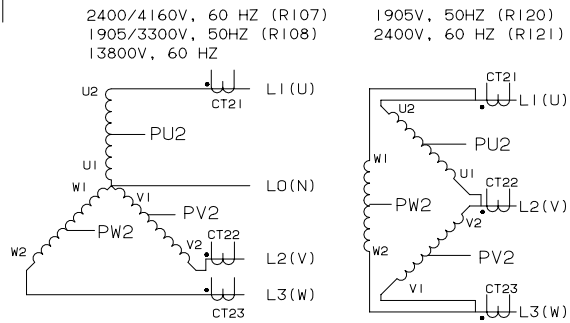
THIS DRAWING APPLIES TO:
MODEL THROUGH
SPEC LETTER

DFAA	D
DFAB	D
DFAC	D
DFBF	K
DFCB	K
DFCC	K
DFEB	J
DFEC	C
DFFB	K
DFGA	D
DFGB	D
DFJA	K
DFJB	K
DFJC	K
DFJD	C
DFLB	K
DFLC	K
DFLD	K
DFMB	K

ALL MODELS WITH PREFIX:
NT, NTA, KTA, KTT, AND VTA

MEDIUM VOLTAGE

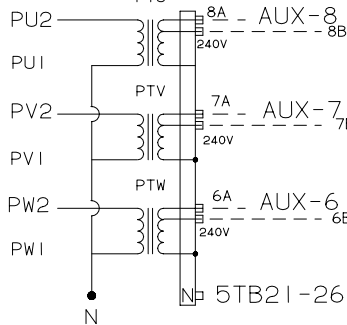
CURRENT TRANSFORMER SECONDARY CONN 1 - 2



PRIMARY JUMPERS

WYE CONNECTIONS:
PVI - PWI - PUI

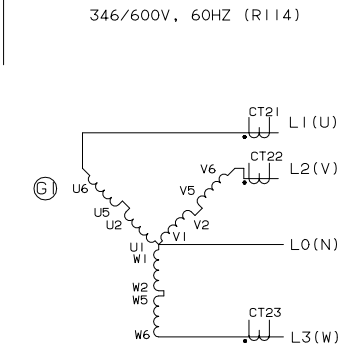
A - 4160 VOLT WYE
B - 3300 VOLT WYE



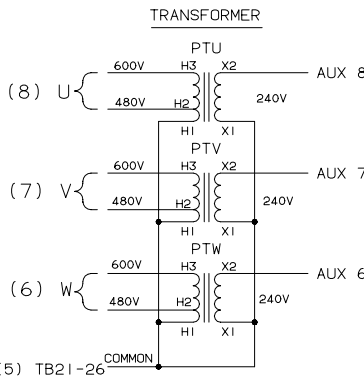
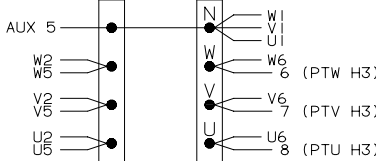
CONTROL INPUT				
6 OR 12 LEAD				
CONTROL INPUT TB21	AUX TERM CON	SERIES STAR	SERIES DELTA	MEDIUM VOLTAGE
22	8	8	8	8
23	7	7	7	7
24	-	-	-	-
25	6	6	6	6
26	-	5	5	5
JUMPER	-	21 - 24	21 - 24	21 - 24

3 PHASE NON-RECONNECTABLE

CURRENT TRANSFORMER SECONDARY CONN 1 - 2



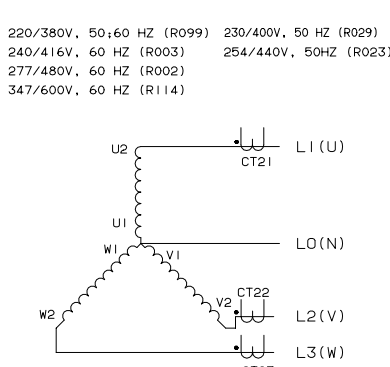
FRAME 4, 5, & 6



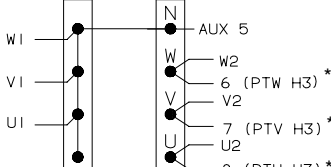
REFERENCE ONLY
P/N 319-1246

NOTE: JUMPER TB21-21 TO TB21-24
IN THE CONTROL

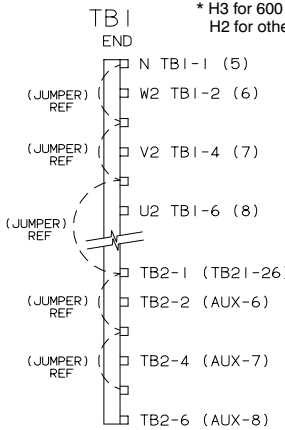
CURRENT TRANSFORMER SECONDARY CONN 1 - 2



FRAME 5, 6, & 7

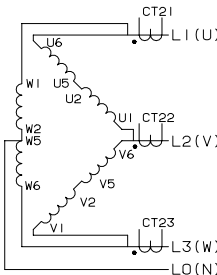


* H3 for 600 volts,
H2 for other voltages

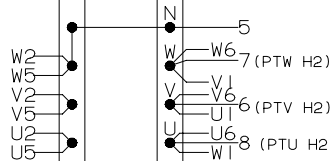


TRANSFORMER CONNECTIONS
ASSEMBLY

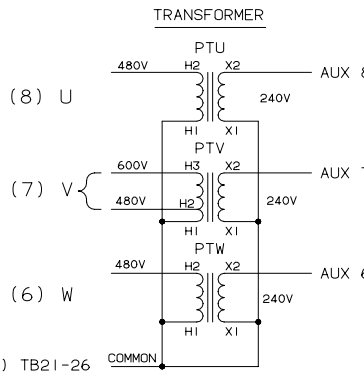
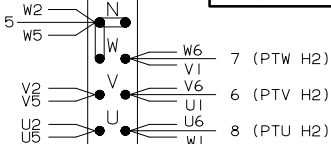
CURRENT TRANSFORMER SECONDARY CONN 1 - 2



FRAME 5, 6, & 7

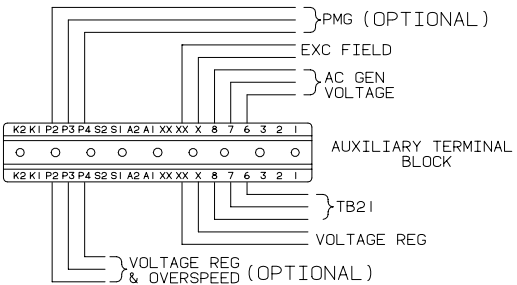


FRAME 4



REFERENCE ONLY
P/N 319-1246

NOTE: JUMPER TB21-21 TO TB21-24
IN THE CONTROL



No. 625-2165 sh 2 of 2
Rev. J Sys: CADAM
Modified 12/23/94

FIGURE 8-15. RECONNECTION DIAGRAM

SC ,CC ,HC GENERATORS

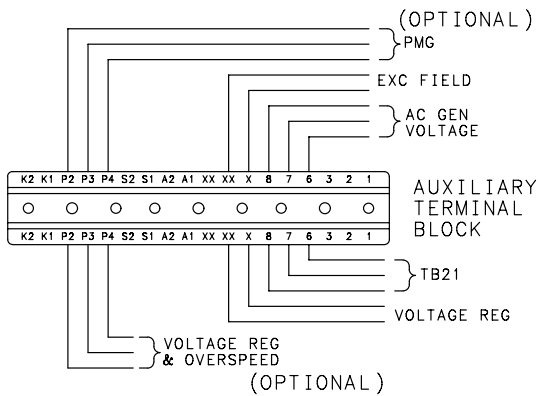
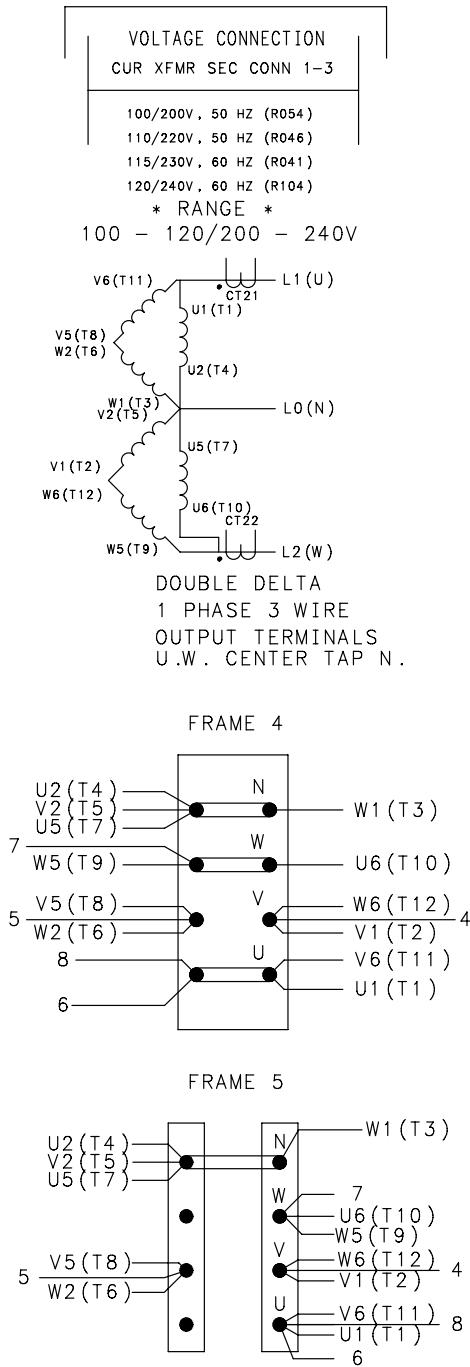
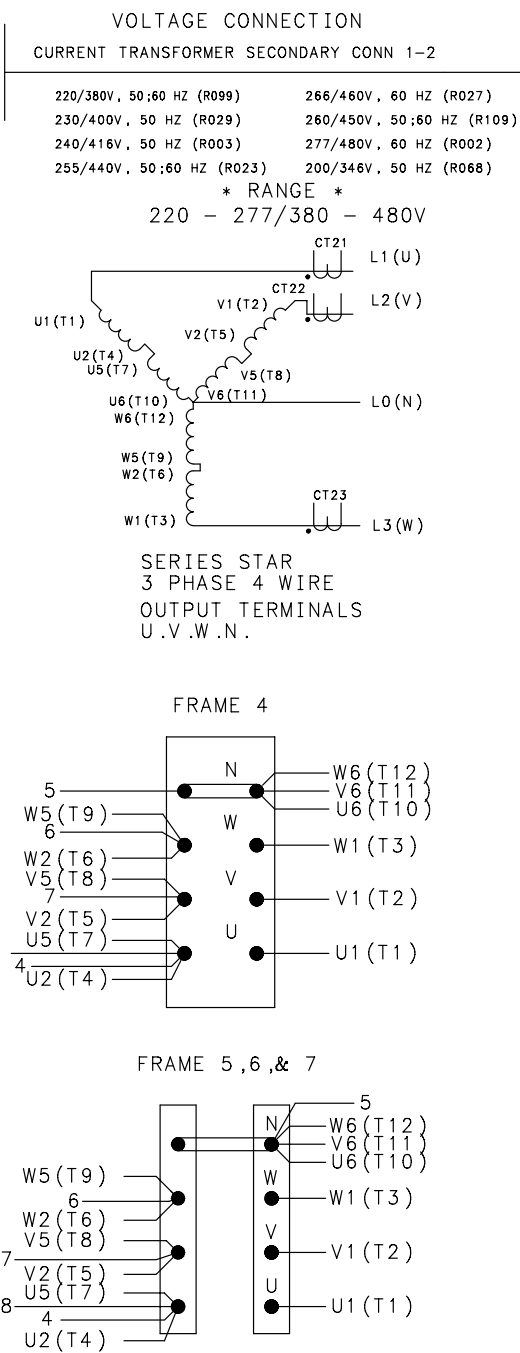
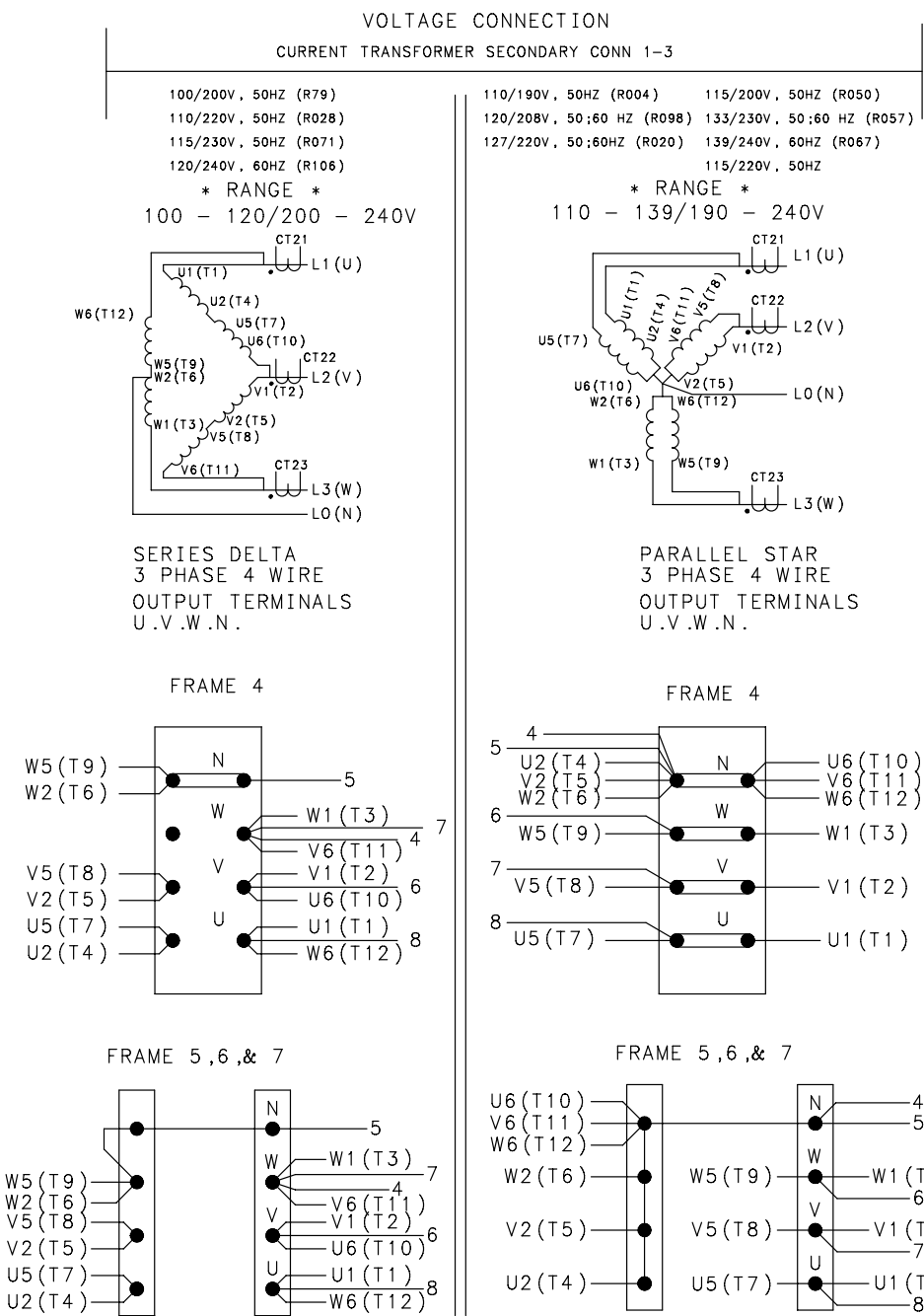
3 PHASE RECONNECTABLE

1 PHASE RECONNECTABLE

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

THIS DRAWING APPLIES TO:
MODEL BEGIN
SPEC LETTER

DFAA	E
DFAB	E
DFAC	E
DFBF	L
DFCB	L
DFCC	L
DFCE	A
DFEB	K
DFEC	D
DFED	A
DFFB	L
DFGA	E
DFGB	E
DFJA	L
DFJB	L
DFJC	L
DFJD	D
DFLB	L
DFLC	L
DFLD	L
DFMB	L
DQAA	A
DQAB	A
DQBA	A
DQBB	A



CONTROL INPUT					
12 LEAD					
CONTROL INPUT TB21	AUX TERM CON	SERIES DELTA	PARALLEL STAR	SERIES STAR	DOUBLE DELTA
22	8	8	8	8	8
23	7	7	7	7	7
24	4	4	4	4	4
25	6	6	6	6	6
26	5	5	5	5	5
JUMPER	—	—	—	—	—

- NOTES:
1. UVW PHASE SEQUENCE WITH C.W. ROTATION FACING DRIVE END.
 2. TIE BACK UNUSED LEADS.
 3. WHEN RECONNECTING GENERATOR LEADS, BOLTS SHOULD BE TORQUED AT 68 ±6 FT-LBS. FOR FRAMES 5, 6 AND 7.
 4. WHEN RECONNECTING GENERATOR LEADS, BOLTS SHOULD BE TORQUED AT 22 ±2 FT-LBS. FOR FRAME 4.

No. 625-3062 sh 1 of 2
Rev. E Sys: Revisio
Modified 4/16/97

FIGURE 8-16. RECONNECTION DIAGRAM

SC , CC , HC GENERATORS

3 PHASE NON-RECONNECTABLE

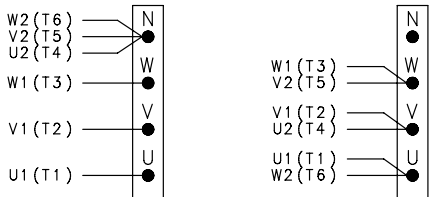
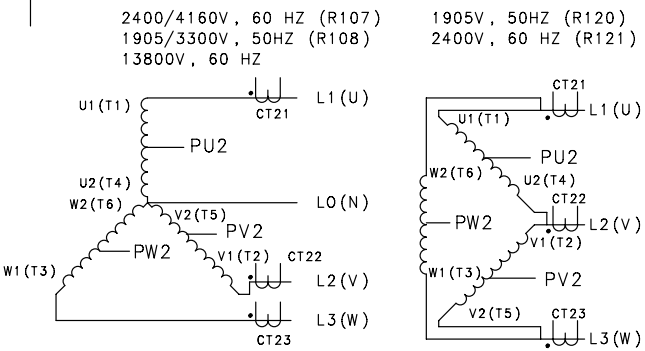
THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

THIS DRAWING APPLIES TO:
MODEL BEGIN SPEC LETTER

DFAA	E
DFAB	E
DFAC	E
DFBF	L
DFCB	L
DFCC	L
DFCE	A
DFEB	K
DFEC	D
DFED	A
DFFB	L
DFGA	E
DFGB	E
DFJA	L
DFJB	L
DFJC	L
DFJD	D
DFLB	L
DFLC	L
DFLD	L
DFMB	L
DQAA	A
DQAB	A
DQBA	A
DQBB	A

MEDIUM VOLTAGE

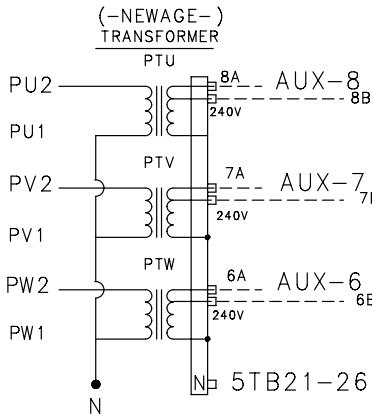
CURRENT TRANSFORMER SECONDARY CONN 1 - 2



PRIMARY JUMPERS

WYE CONNECTIONS;
PV1 - PW1 - PU1

A - 4160 VOLT WYE
B - 3300 VOLT WYE



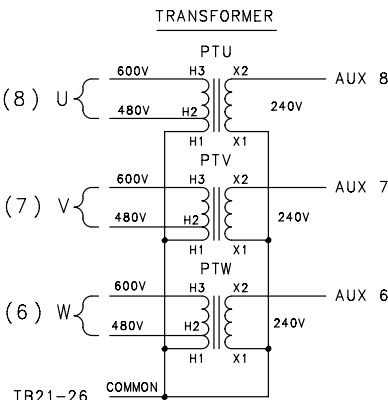
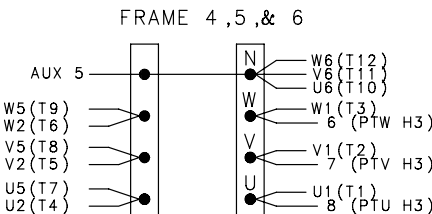
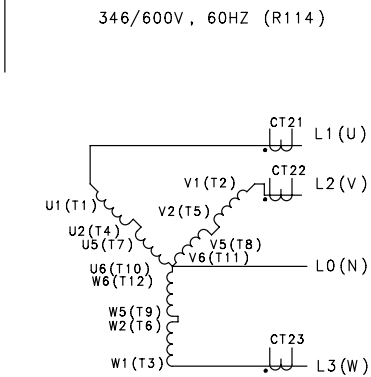
PRIMARY JUMPERS

DELTA CONNECTIONS;
PV1 - PU2
PW1 - PV2
PU1 - PW2

A - 2400 VOLT DELTA

CONTROL INPUT				
6 OR 12 LEAD				
CONTROL INPUT TB21	AUX TERM CON	SERIES STAR	SERIES DELTA	MEDIUM VOLTAGE
22	8	8	8	8
23	7	7	7	7
24	-	-	-	-
25	6	6	6	6
26	-	5	5	5
JUMPER	-	21 - 24	21 - 24	21 - 24

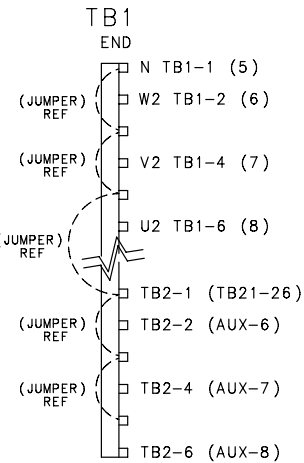
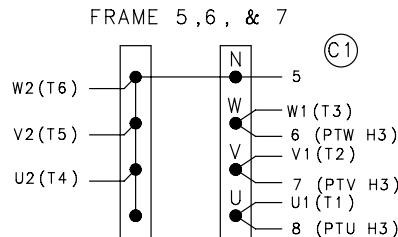
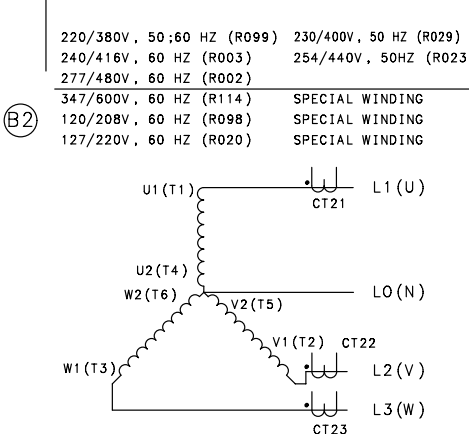
CURRENT TRANSFORMER SECONDARY CONN 1 - 2



REFERENCE ONLY
P/N 319-1246

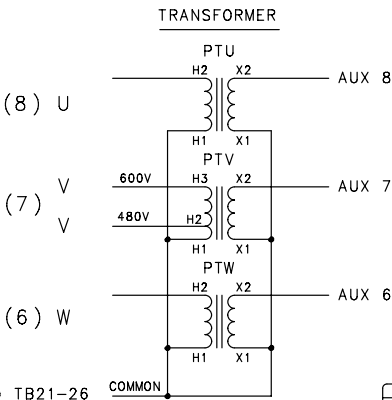
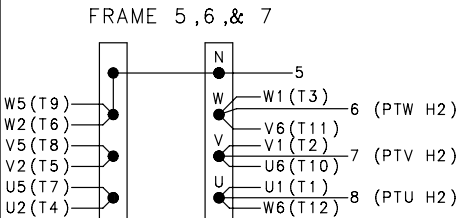
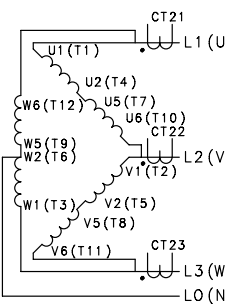
NOTE: JUMPER TB21-21 TO TB21-24
IN THE CONTROL

CURRENT TRANSFORMER SECONDARY CONN 1 - 2



TRANSFORMER CONNECTIONS
ASSEMBLY

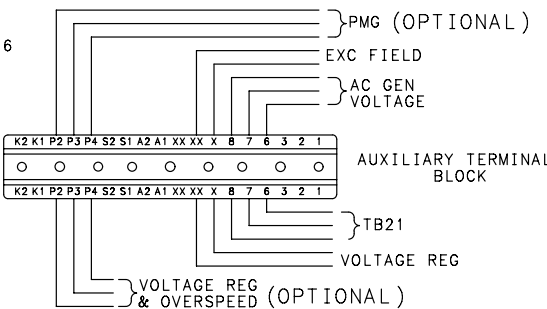
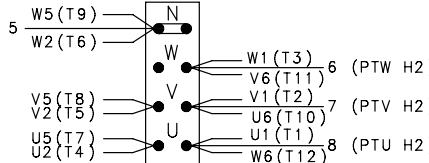
220/440V, 50 HZ (R019)
240/480V, 60 HZ (R119)



REFERENCE ONLY
P/N 319-1246

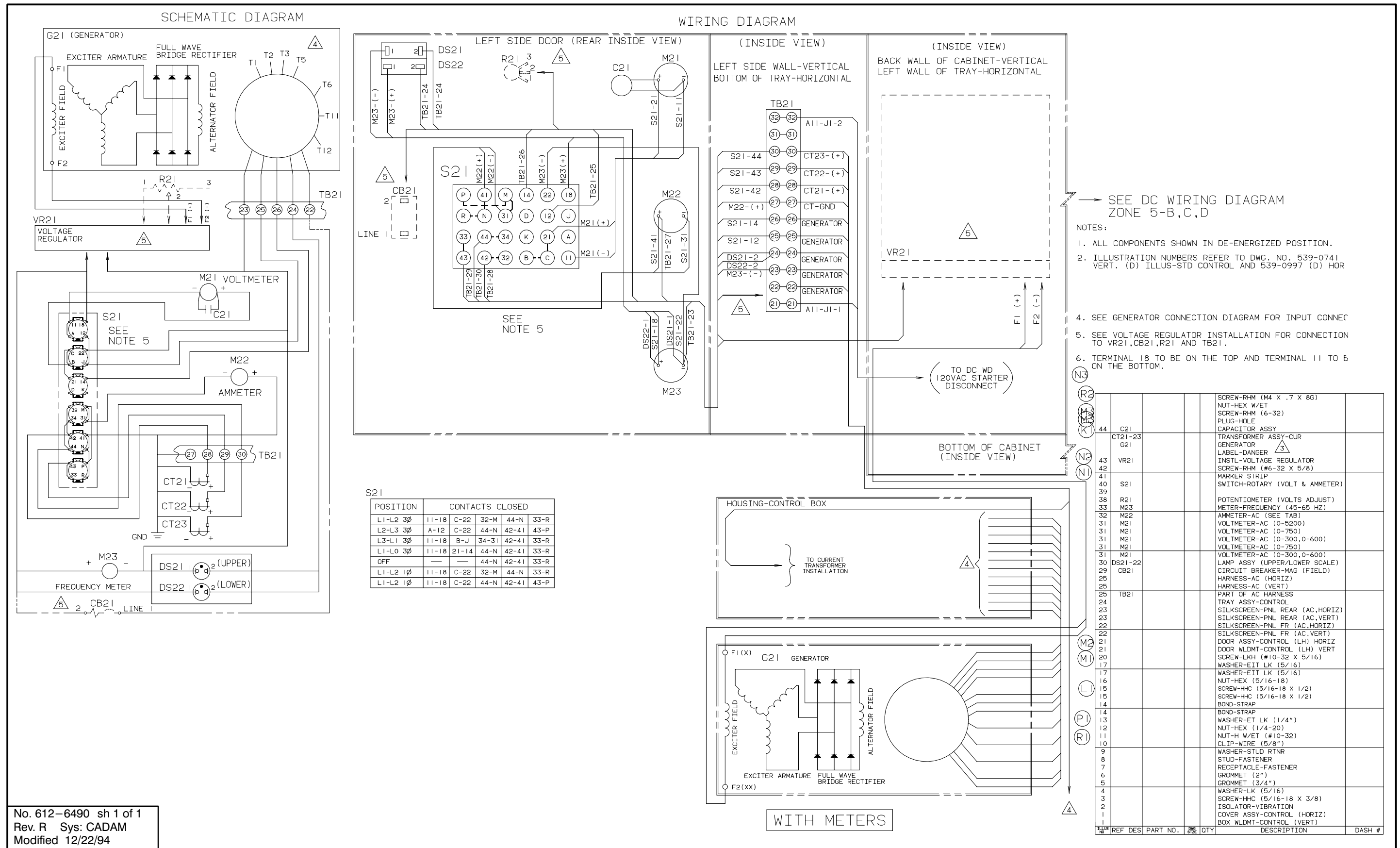
NOTE: JUMPER TB21-21 TO TB21-24
IN THE CONTROL

FRAME 4



No. 625-3062 sh 2 of 2
Rev. E Sys: Revisio
Modified 4/16/97

FIGURE 8-17. RECONNECTION DIAGRAM



TB1-10 (SWITCHED B+ OUTPUT) OUTPUT TO RELAY K12, FUSED AT 20 AMPS, ENERGIZED WHEN THE START SIGNAL IS APPLIED AND DE-ENERGIZED AT SHUTDOWN (NORMAL AND FAULT)

TB1-9 (B+ INPUT) BATTERY POSITIVE (+) CONNECTION

TB1-8 (START SOLENOID) OUTPUT TO RELAY K11, FUSED AT 20 AMPS

TB1-7 (B+ OUTPUT) OUTPUT TO TIME DELAY START/STOP MODULE A15, FUSED AT 15 AMPS, AVAILABLE WHEN THE STARTING BATTERIES ARE CONNECTED

TB1-6 (REMOTE START) CONNECTED TO TIME DELAY START/STOP MODULE A15. CONNECT REMOTE START CONTACT OF THE AUTOMATIC TRANSFER SWITCH TO TERMINAL TB1-5 OF MODULE A15.

TB1-5 (GROUND)

TB1-4 (COMMON ALARM B+ OUTPUT) 4 AMP RATED DEVICE MAXIMUM

TB1-3 (RUN) CONNECTED TO TIME DELAY START/STOP MODULE A15

TB1-2 (DC DISCONNECT) CONNECTED TO TIME DELAY START/STOP MODULE A15

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

TB2-1 (FAULT 2) GROUND INPUT FROM SENDER

TB2-2 (FAULT 2) GROUND OUTPUT TO LIGHT/RELAY*

TB2-3 (FAULT 1) GROUND INPUT FROM SENDER

TB2-4 (FAULT 1) GROUND OUTPUT TO LIGHT/RELAY*

TB2-5 (REMOTE RESET) MOMENTARY CONTACT TO GROUND

TB2-6 (OVERCRANK FAULT) GROUND OUTPUT TO LIGHT/RELAY*

TB2-7 (OVERSPEED FAULT) GROUND OUTPUT TO LIGHT/RELAY*

TB2-8 (HIGH ENGINE TEMPERATURE FAULT) GROUND OUTPUT TO LIGHT/RELAY*

TB2-9 (LOW OIL PRESSURE FAULT) GROUND OUTPUT TO LIGHT/RELAY*

TB2-10 (PRE-HIGH ENGINE TEMPERATURE WARNING) GROUND OUTPUT TO LIGHT/RELAY*

TB2-11 (PRE-LOW OIL PRESSURE WARNING) GROUND OUTPUT TO LIGHT/RELAY*

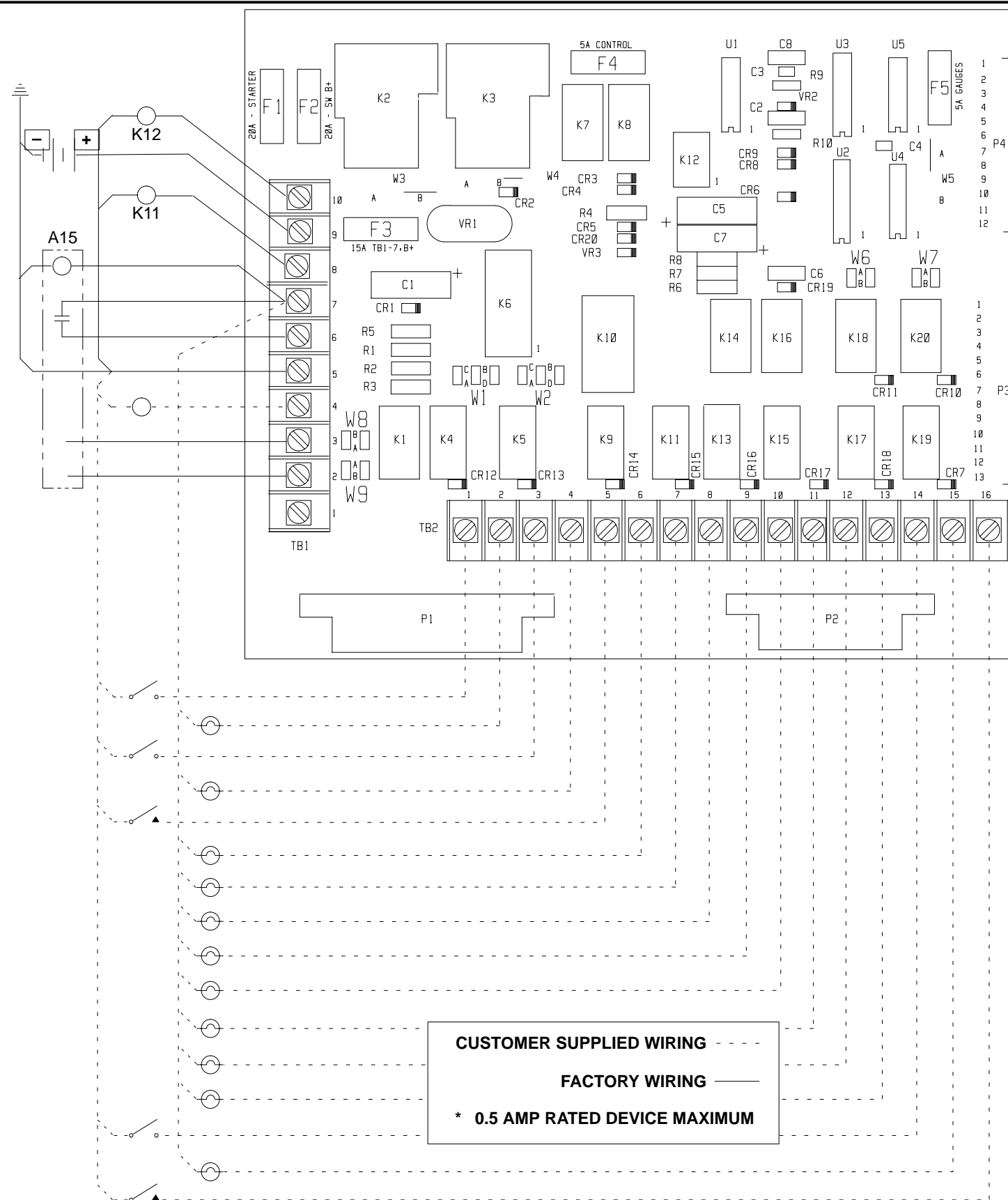
TB2-12 (SWITCH OFF WARNING) GROUND OUTPUT TO LIGHT/RELAY*

TB2-13 (LOW ENGINE TEMPERATURE WARNING) GROUND OUTPUT TO LIGHT/RELAY*

TB2-14 (LOW FUEL WARNING) GROUND INPUT FROM SENDER

TB2-15 (LOW FUEL WARNING) GROUND OUTPUT TO LIGHT/RELAY*

TB2-16 (EMERGENCY SHUT DOWN) MOMENTARY CONTACT TO GROUND



300-2811

FIGURE 8-22. CUSTOMER CONNECTIONS AT THE ENGINE MONITOR BOARD

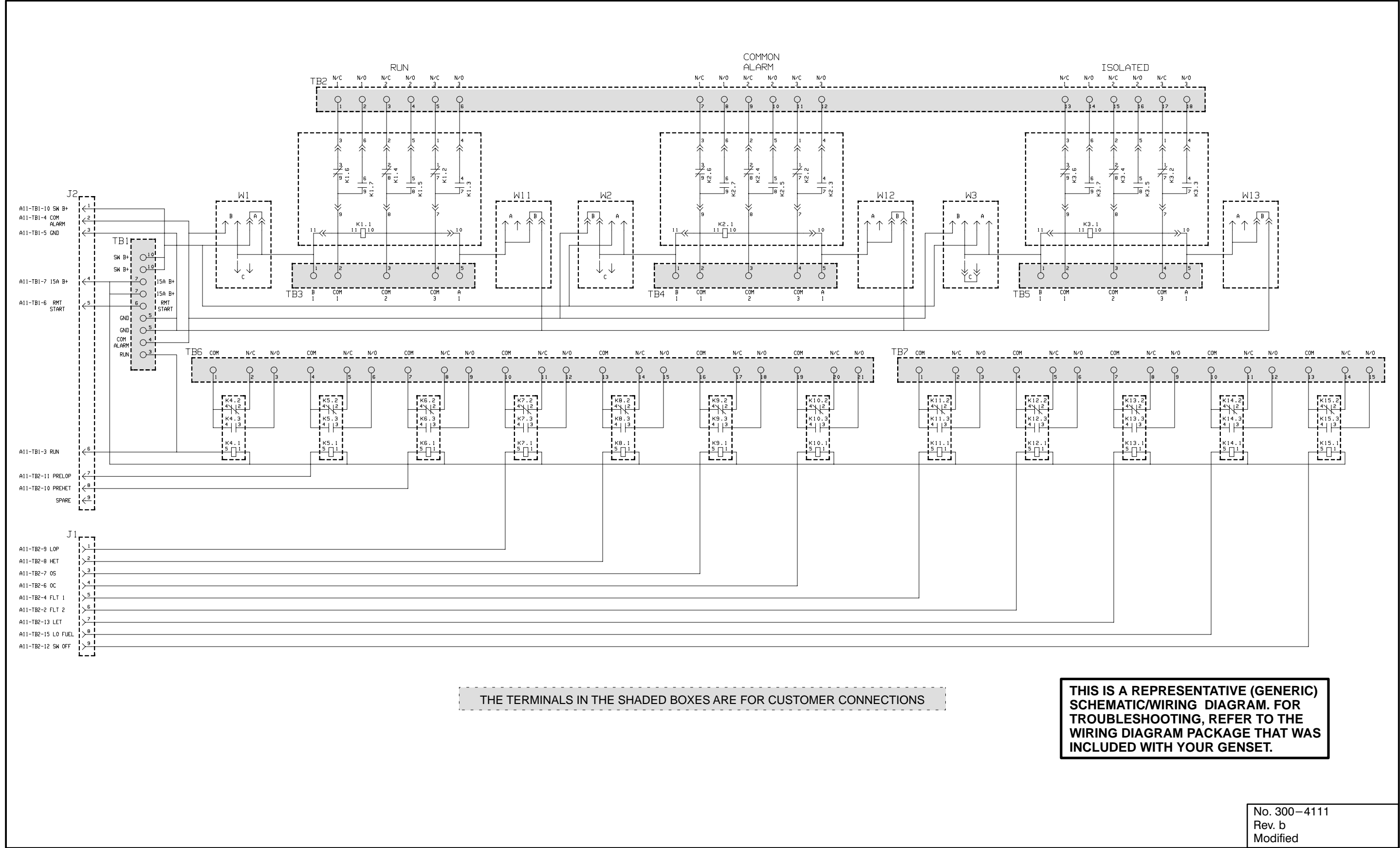
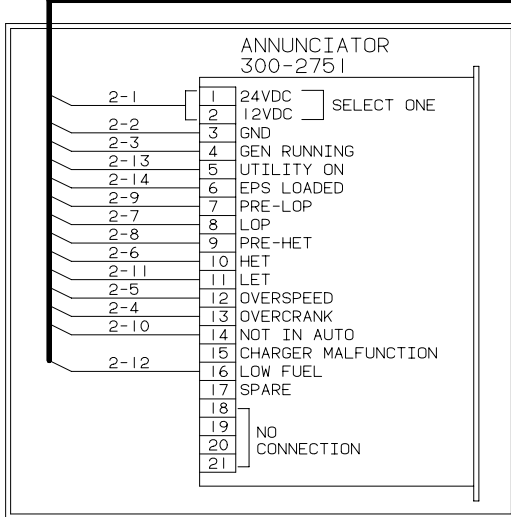
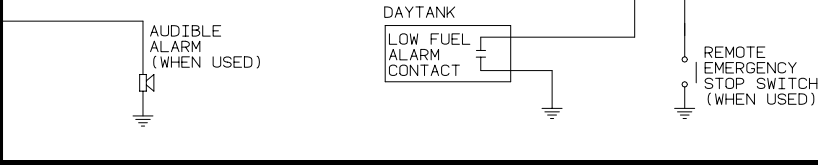
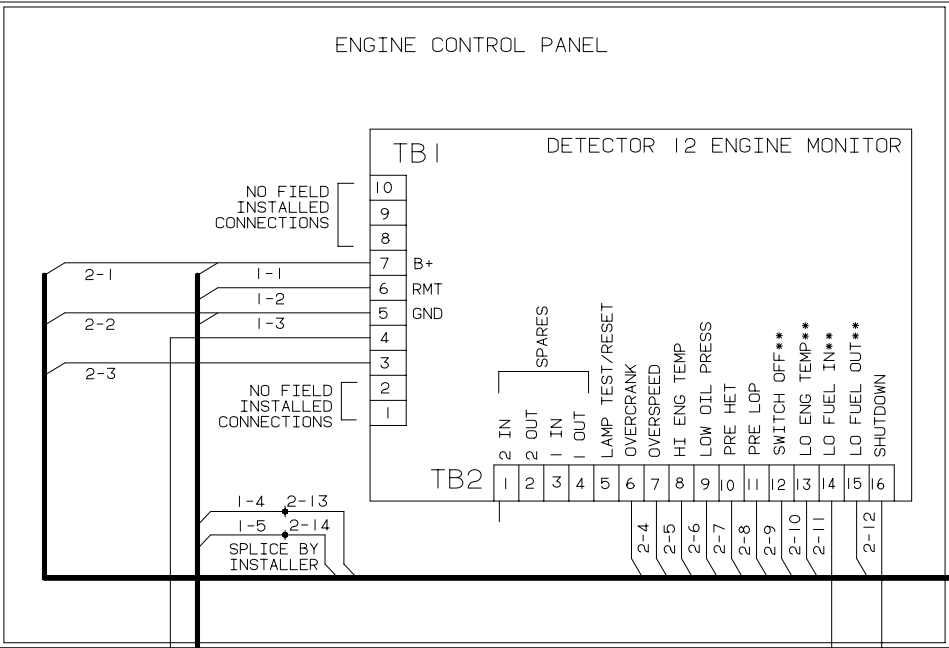


FIGURE 8-23. CUSTOMER CONNECTIONS AT THE AUXILIARY RELAY BOARD

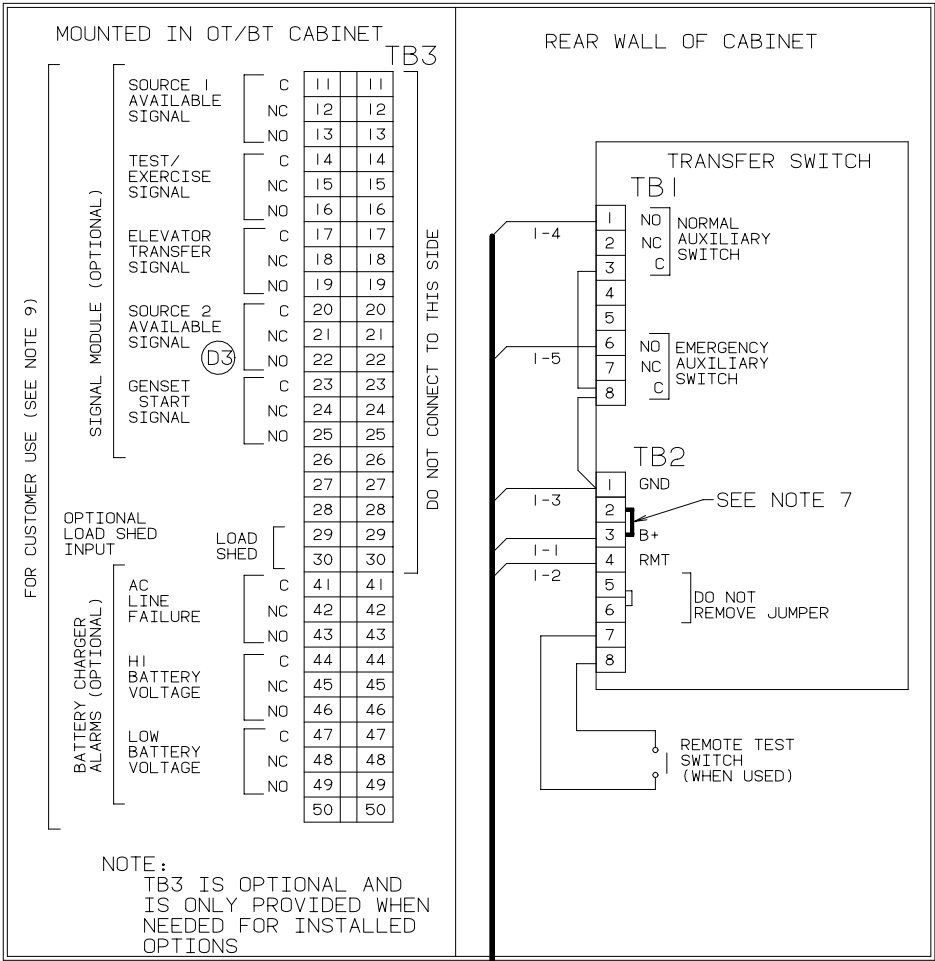
No. 300-4111
Rev. b
Modified

ONAN ENGINE/CUMMINS GENERATOR SET WITH DETECTOR 7
OR DETECTOR 12 CONTROL



WIRE SIZE (AWG)	DISTANCE IN FEET, ONE WAY (MULTIPLY BY 0.3 FOR METERS)		
	A	B	C
16	1000	125	25
14	1600	200	40
12	2400	300	60
10	4000	500	100

OT & BT 2 WIRE START
UTILITY TO GENSET



THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

- NOTES:
1. WIRE SIZES MUST BE AS FOLLOWS:
RUN #1-GENSET TO TRANSFER SWITCH-LEAD SIZE MUST BE INCREASED IF A BATTERY CHARGER IS INSTALLED IN THE SWITCH.
WITH NO BATT CHARGER-LEADS 1-1, -2, -3, -4, -5 USE COL. A
WITH 2 AMP CHARGER-LEADS 1-1 & 1-3, USE COL. B
WITH 10 AMP CHARGER-LEADS 1-1 & 1-3, USE COL. C
 2. RUN #2-GENSET TO ANNUNCIATOR-ALL LEADS, USE COL. A
 3. FOR MULTIPLE TRANSFER SWITCHES, DUPLICATE RUN #1 FOR EACH SWITCH. DAISY CHAIN CONNECTION IS ACCEPTABLE PROVIDED WIRE SIZE & DISTANCE TO THE LAST SWITCH MEET THE SPECS IN NOTE 1.
 - 4.
 - 5.
 6. FUNCTIONS INDICATED BY ** ARE NOT INCLUDED IN THE DETECTOR 7 CONTROL. JUMPER TB2-14 TO TB2-15 FOR LOW FUEL ALARM.
 7. INSTALL JUMPER BETWEEN TB2-2 & TB2-3.
 8. 300-4510-XX ANNUNCIATOR MAY BE USED ALSO. WIRE TB1 AS SHOWN.
 9. CONTACTS RATED: 4 AMPS AT 30 VDC OR 120V MAX.

No. 630-1345 sh 3
Rev. E
Modified

FIGURE 8-24. ACCESSORY INTERCONNECT DIAGRAM

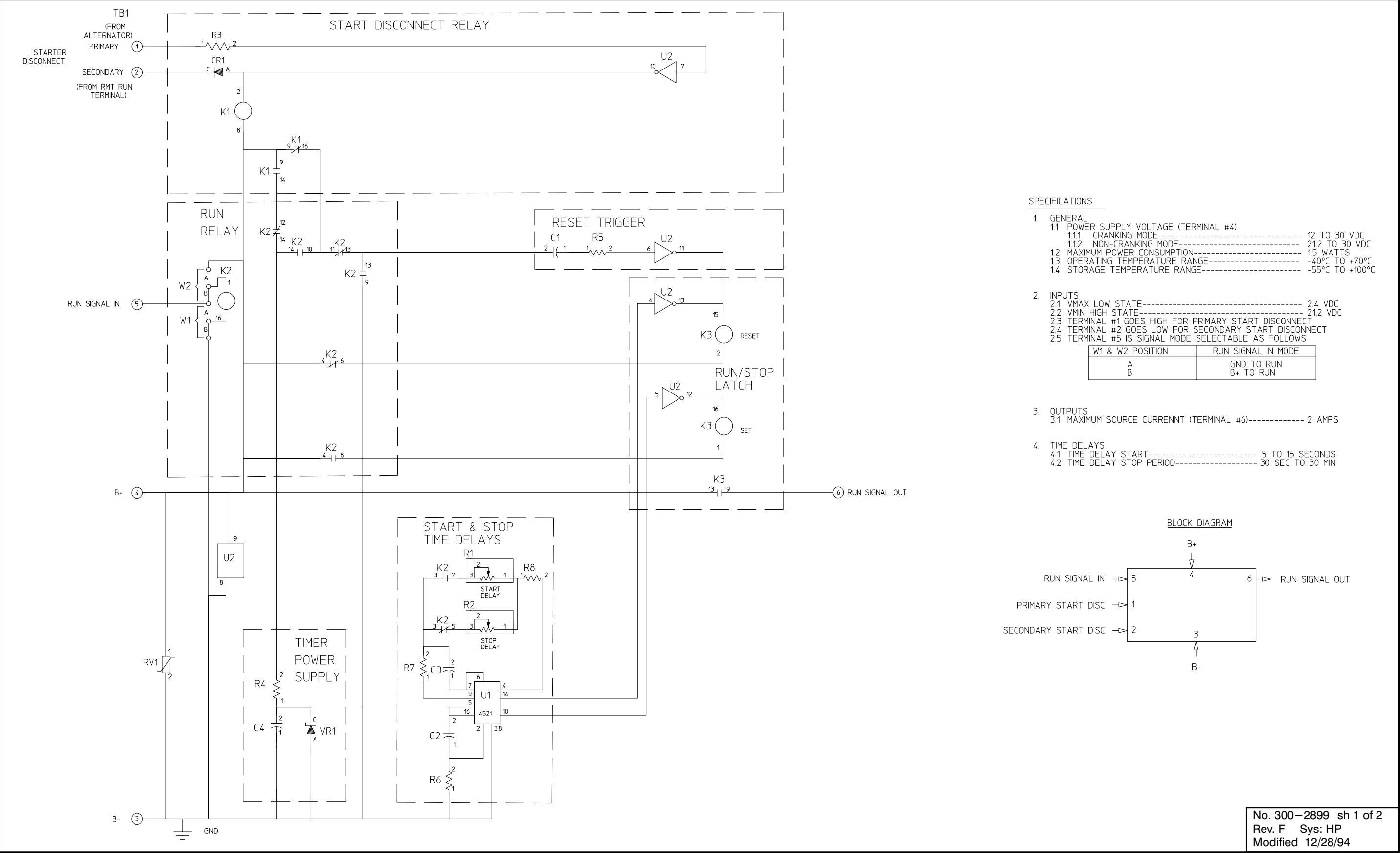


FIGURE 8-25. TIME DELAYED START/STOP MODULE

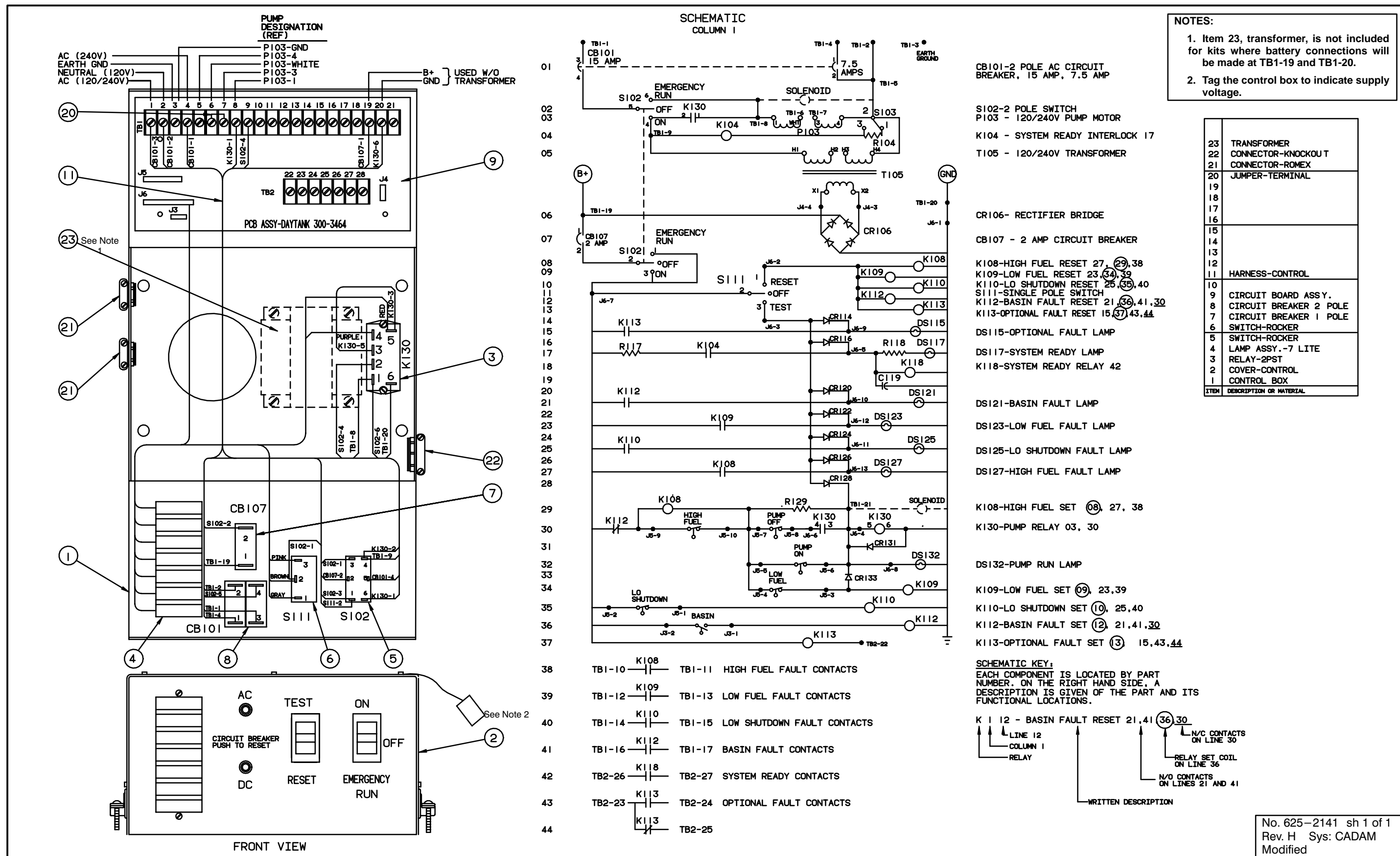
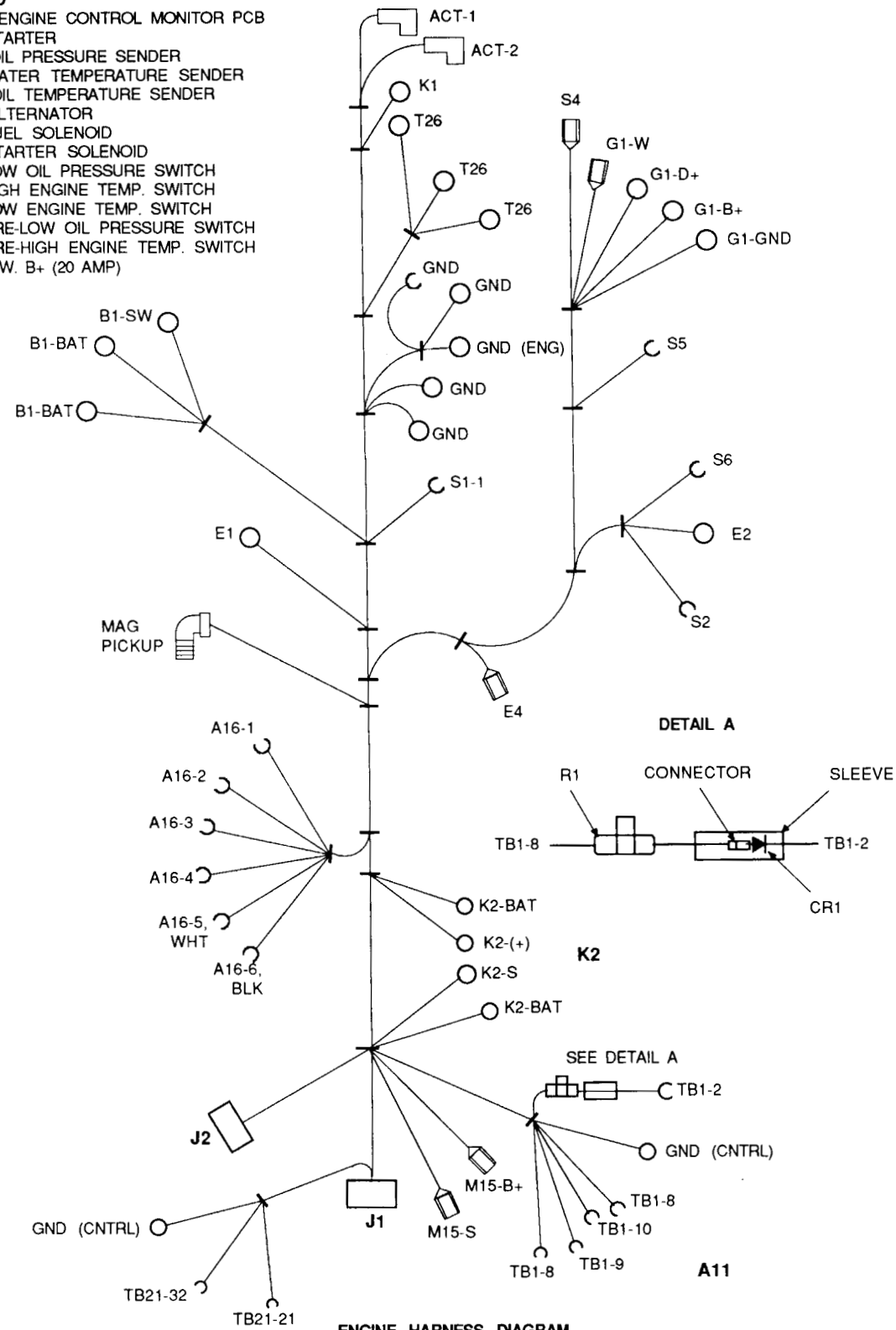


FIGURE 8-26. DAY TANK PUMP CONTROL WIRING

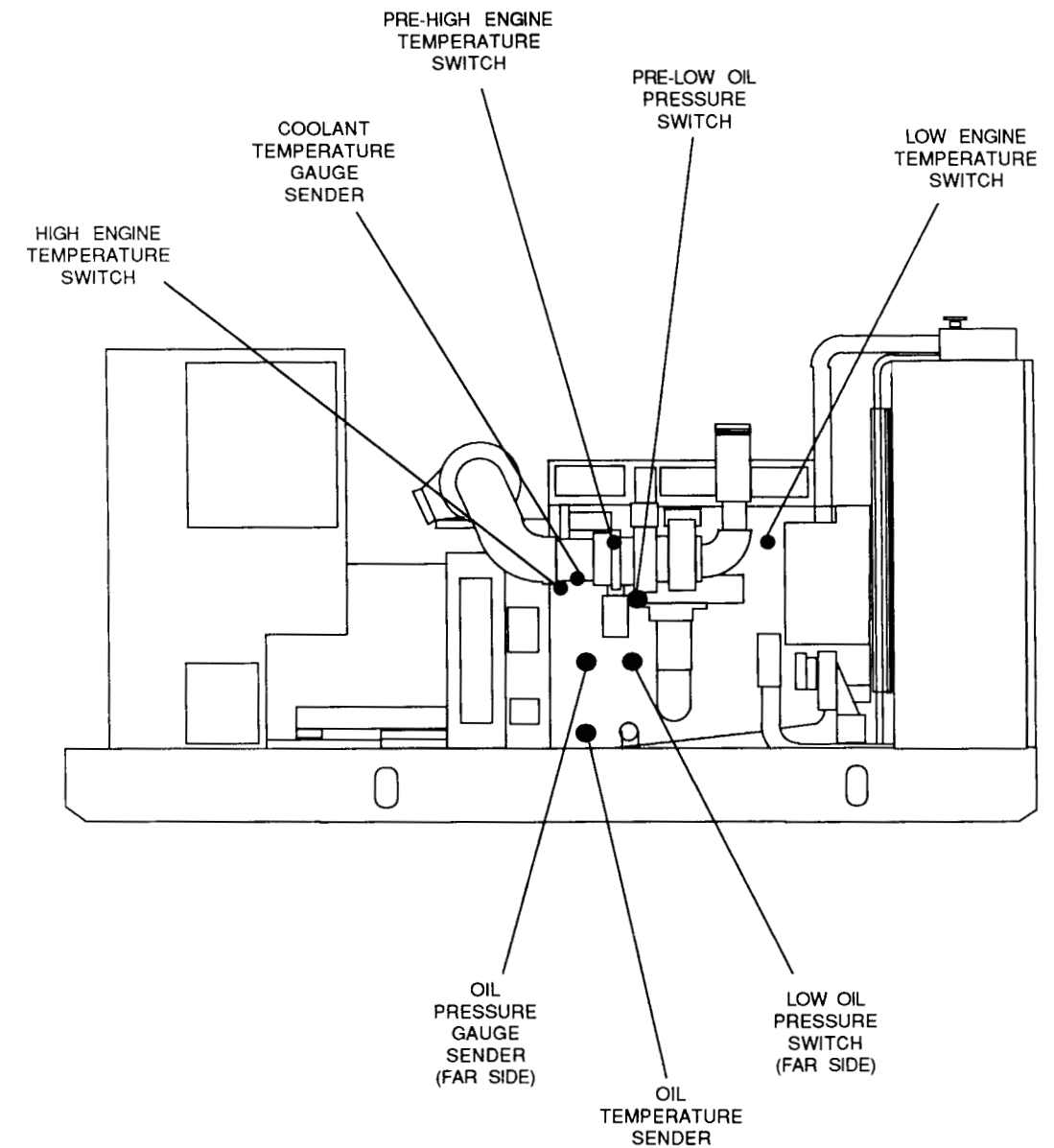
LEGEND

A11 — ENGINE CONTROL MONITOR PCB
 B1— STARTER
 E1 — OIL PRESSURE SENDER
 E2— WATER TEMPERATURE SENDER
 E4 — OIL TEMPERATURE SENDER
 G1— ALTERNATOR
 K1— FUEL SOLENOID
 K2— STARTER SOLENOID
 S1— LOW OIL PRESSURE SWITCH
 S2— HIGH ENGINE TEMP. SWITCH
 S4— LOW ENGINE TEMP. SWITCH
 S5— PRE-LOW OIL PRESSURE SWITCH
 S6— PRE-HIGH ENGINE TEMP. SWITCH
 T26— SW. B+ (20 AMP)



REF. DRWG. NO. 338-2726

ENGINE HARNESS DIAGRAM



Ref. Drawings
 Genset: 500-2781
 Engine Acc: 100-3075

FIGURE 8-27. L10 SERIES ENGINE SENSOR LOCATIONS

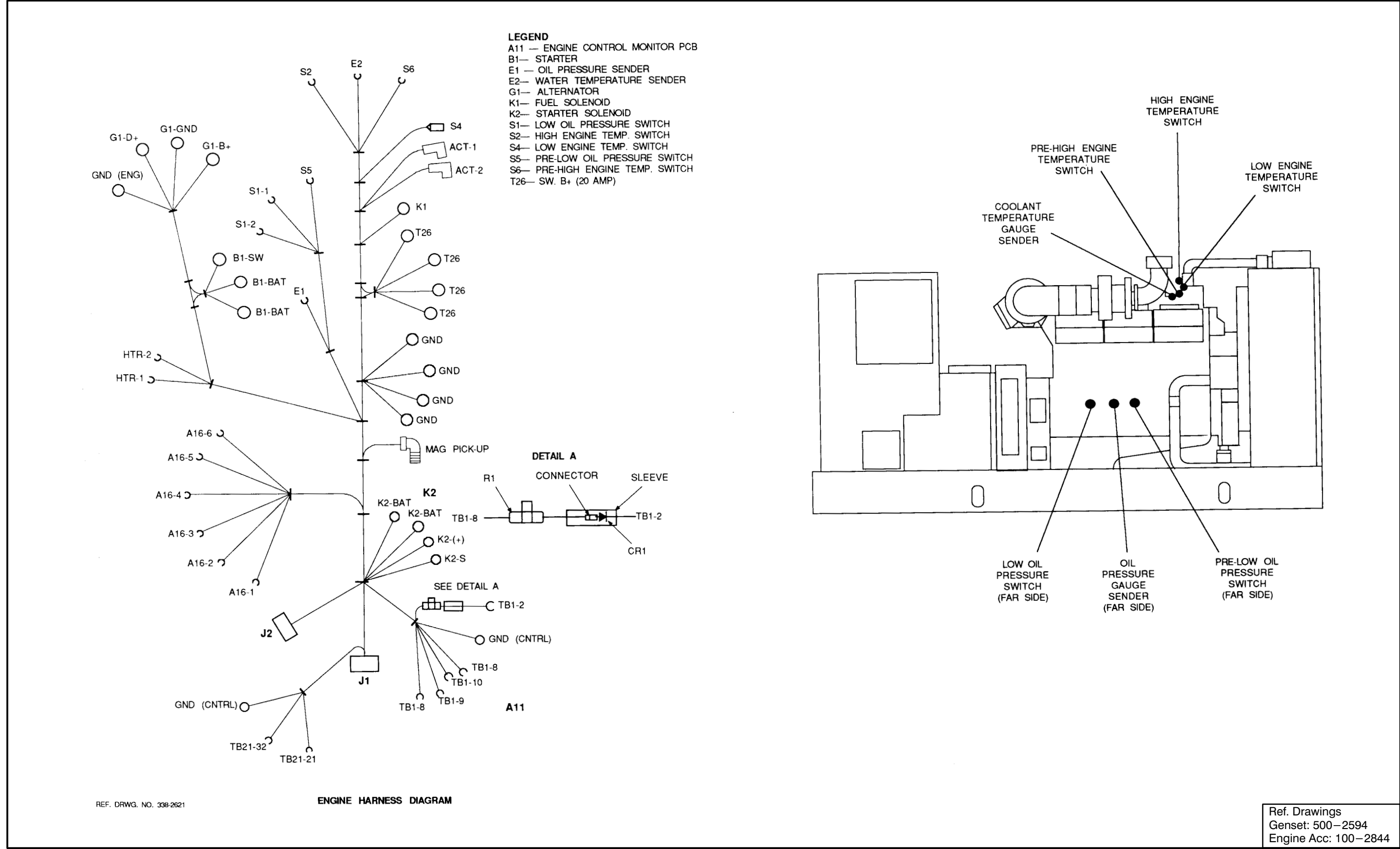
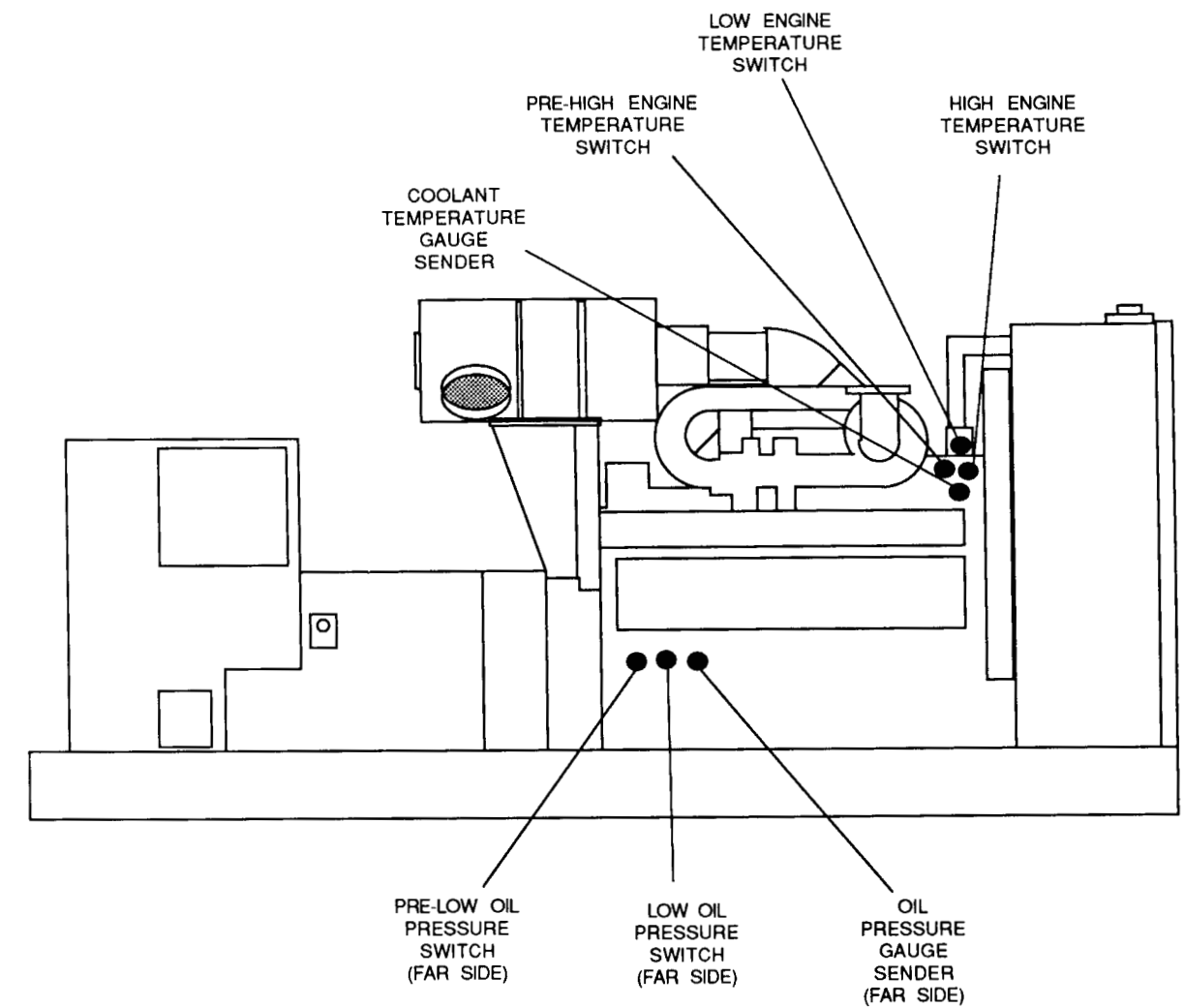
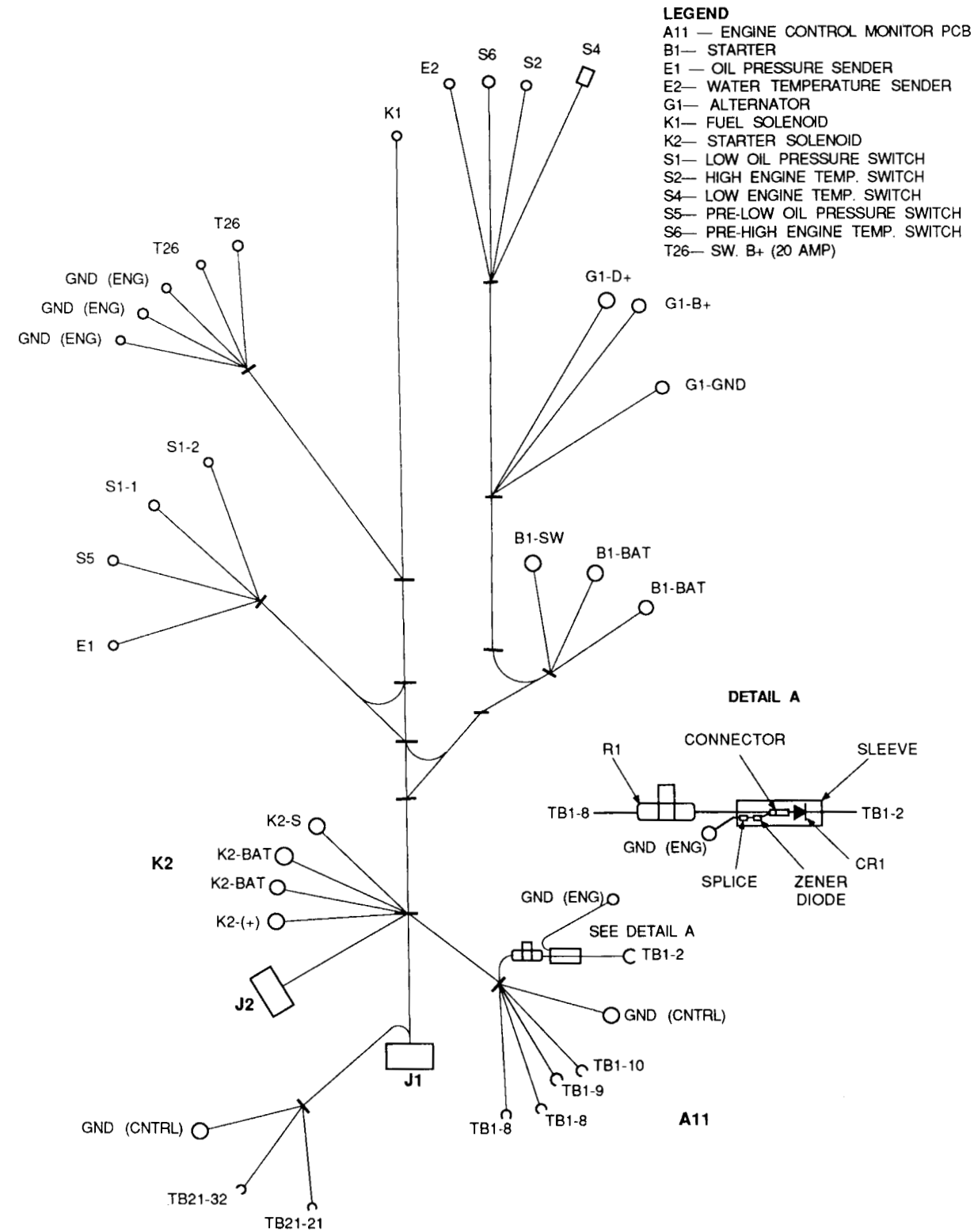


FIGURE 8-28. NT855 SERIES ENGINE SENSOR LOCATIONS



REF. DRWG. NO. 338-2622

ENGINE HARNESS DIAGRAM

Ref. Drawings
Genset: 500-2619 &
500-2649
Engine Acc: 100-2886

FIGURE 8-29. KT19 SERIES ENGINE SENSOR LOCATIONS

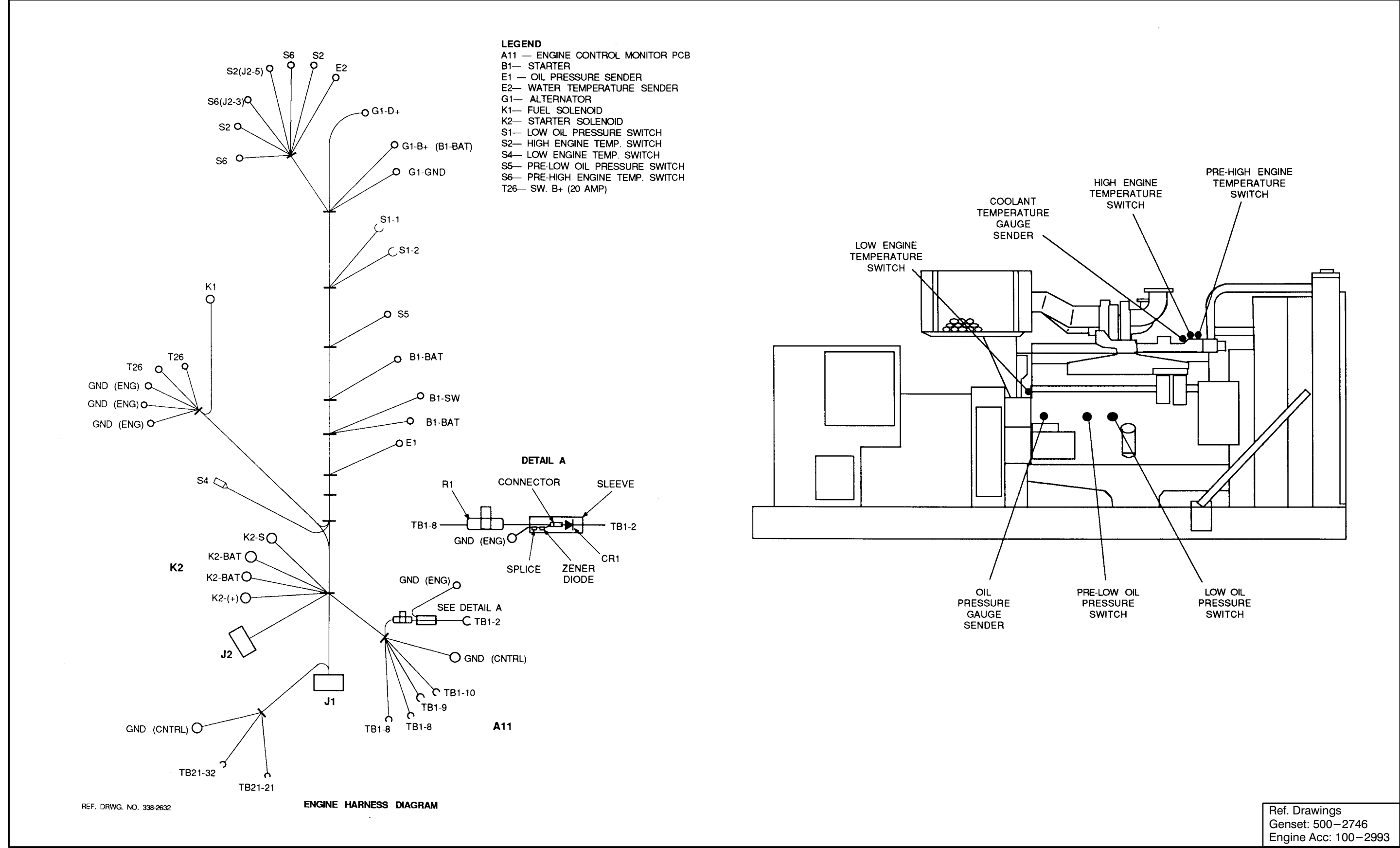
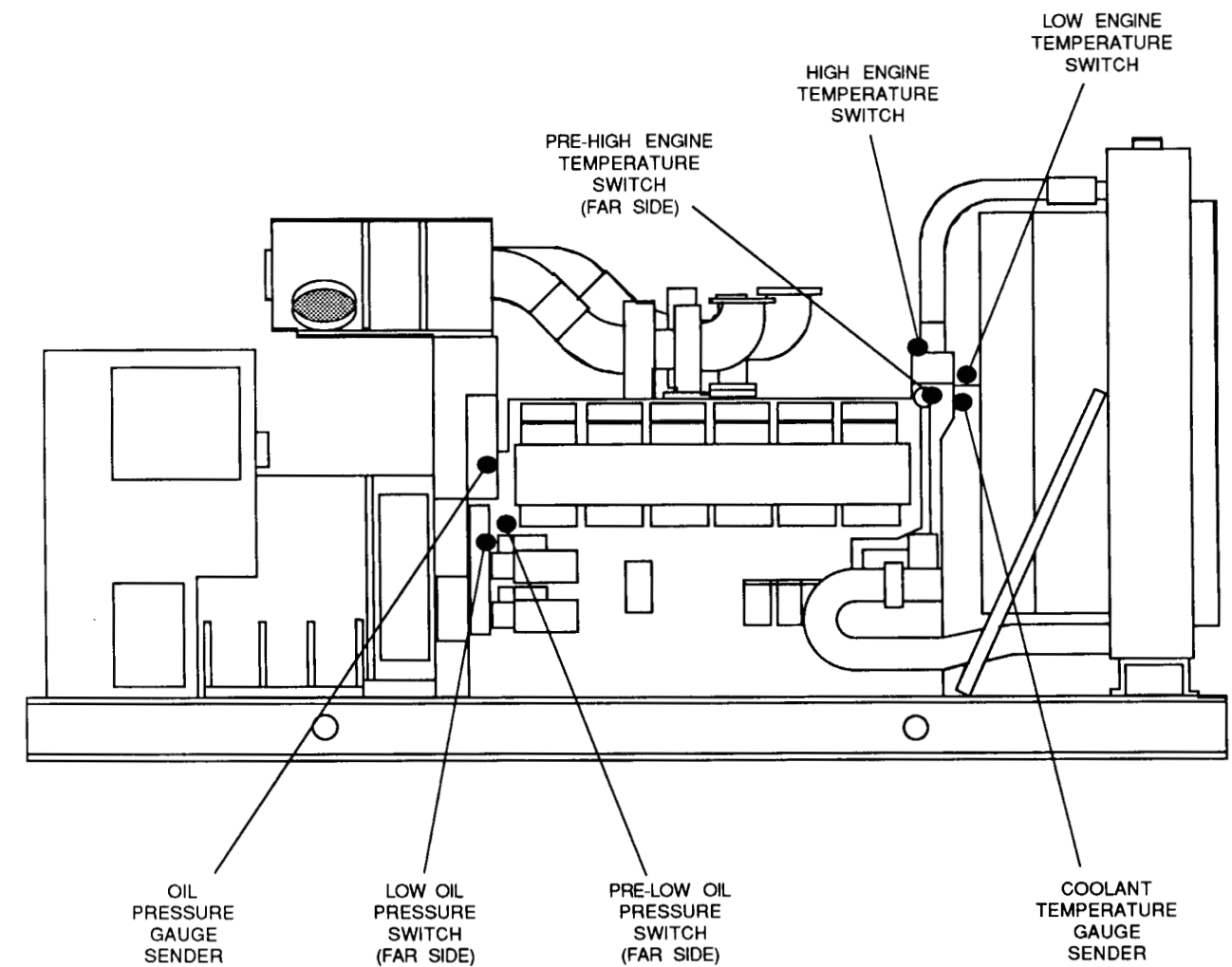
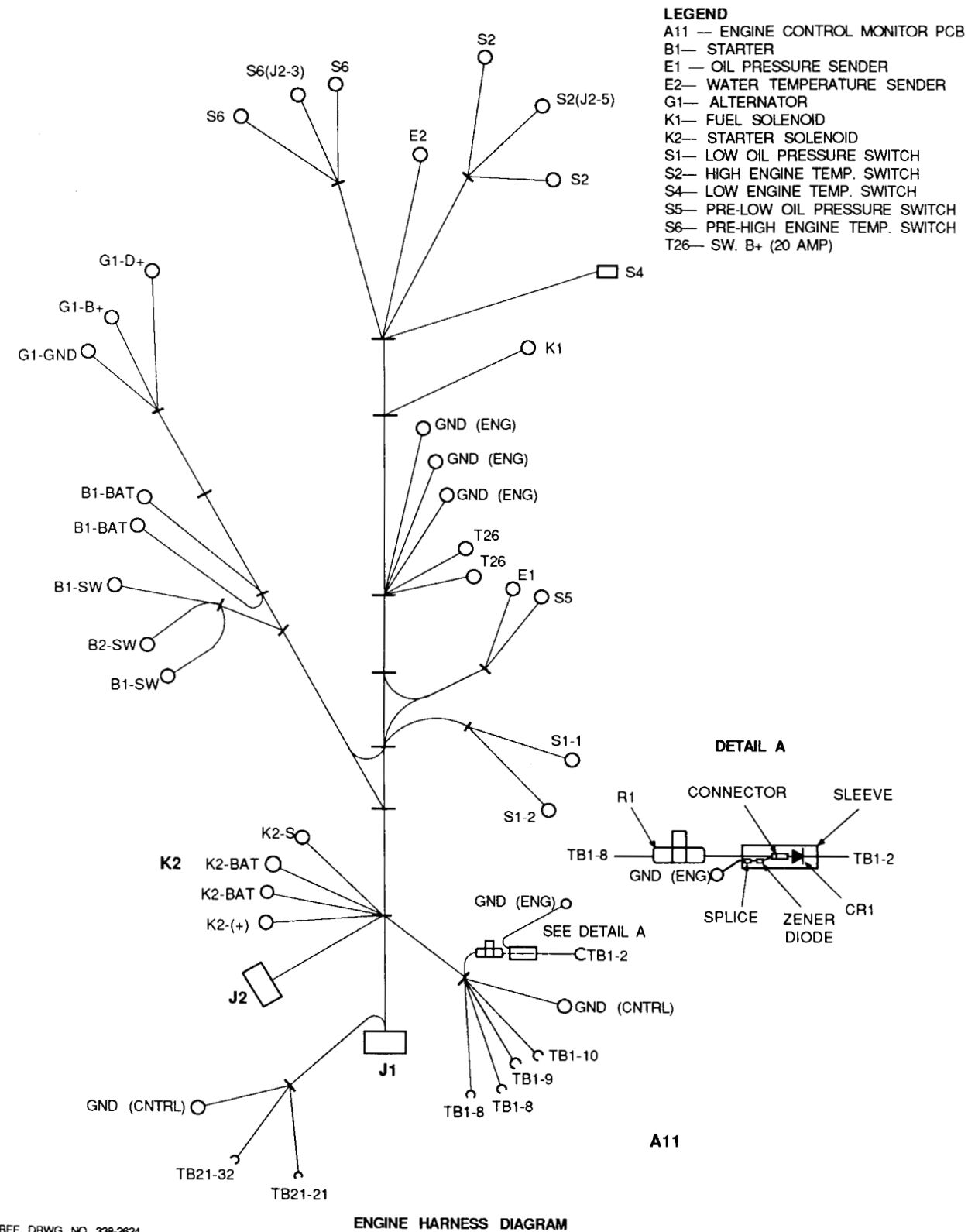


FIGURE 8-30. VT28 SERIES ENGINE SENSOR LOCATIONS



REF. DRWG. NO. 338-2624

Ref. Drawings
Genset: 500-2714
Engine Acc: 100-2925

FIGURE 8-31. KT38 SERIES ENGINE SENSOR LOCATIONS

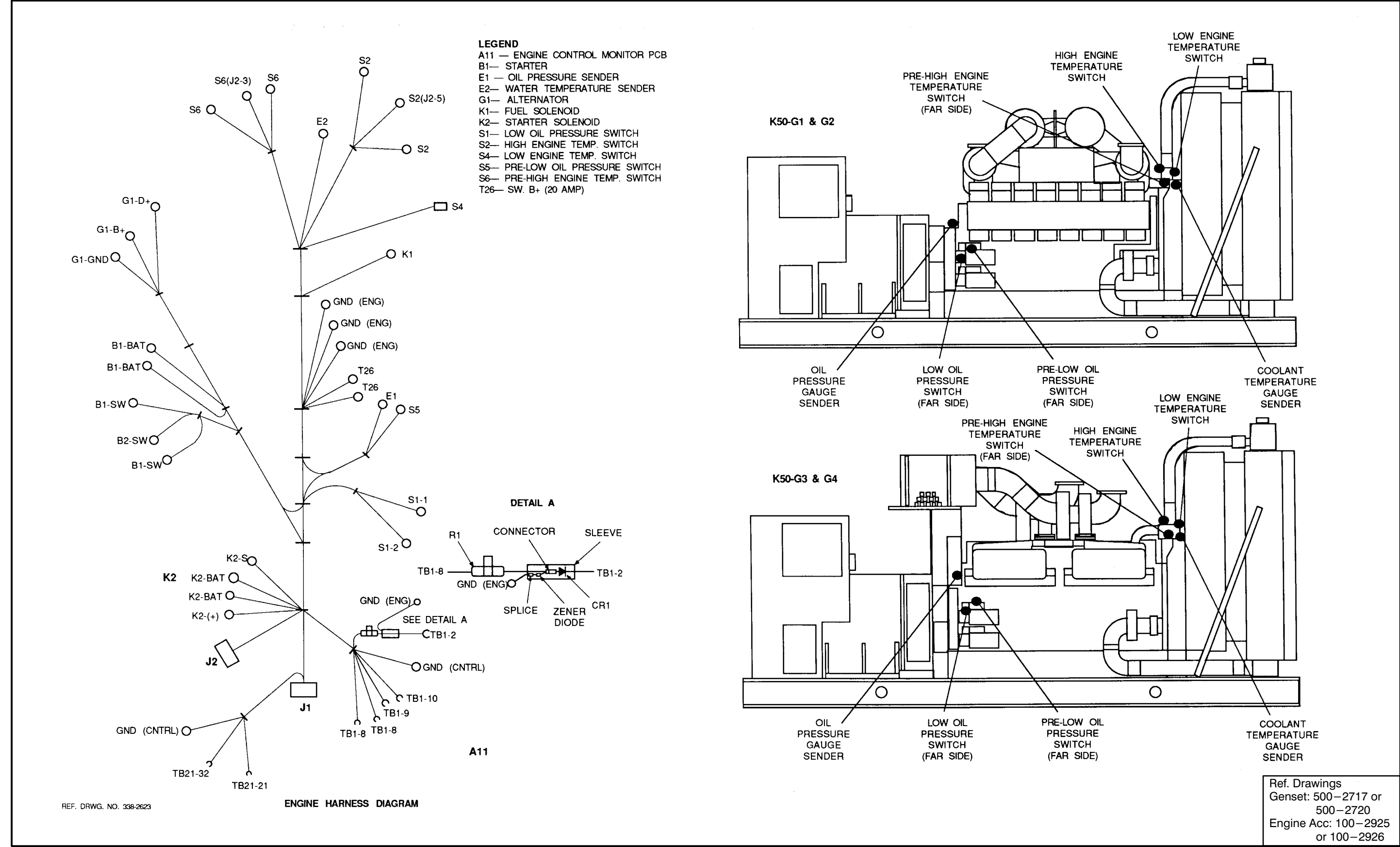
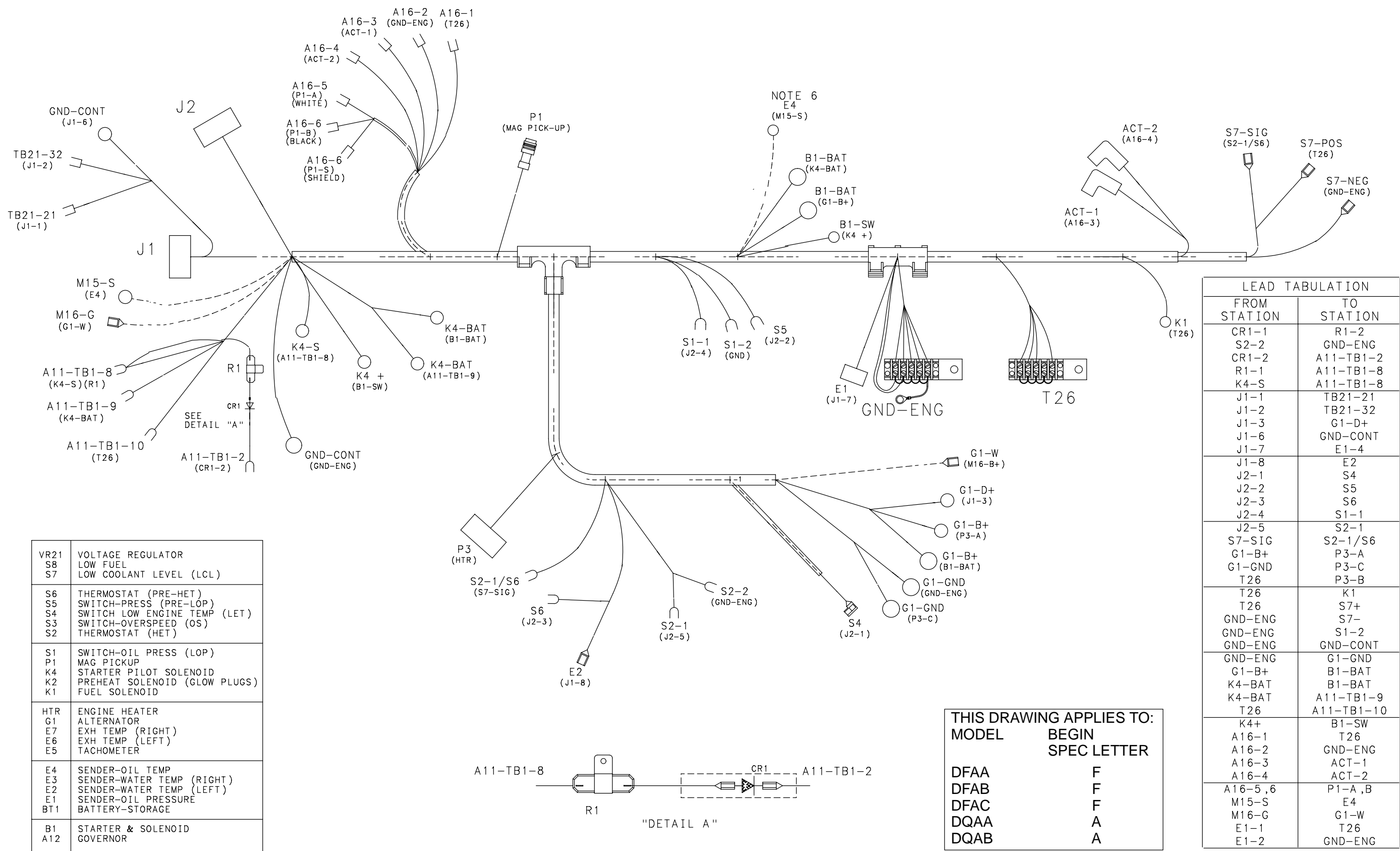
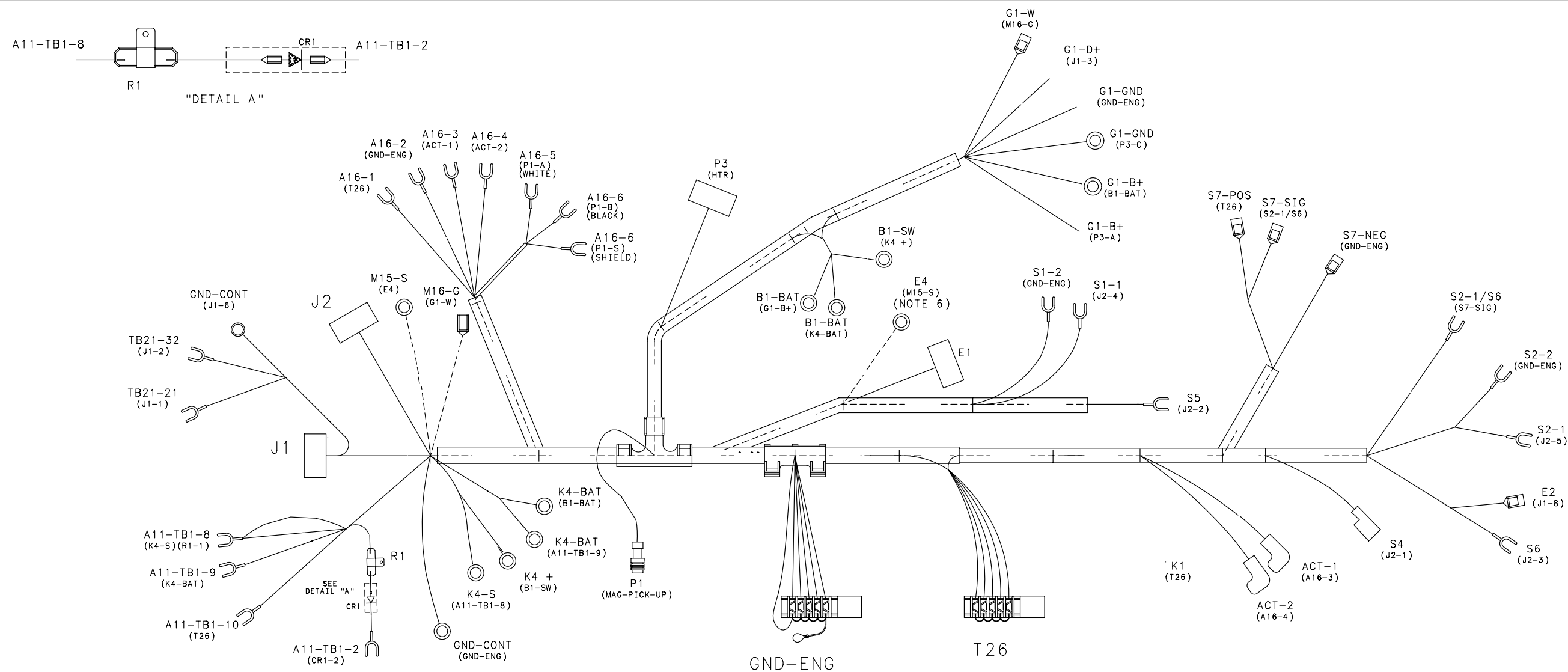


FIGURE 8-32. KT50 SERIES ENGINE SENSOR LOCATIONS



No. 338-3342
 Rev. C Sys: Revisio
 Modified 4/17/97



LEAD TABULATION	
FROM STATION	TO STATION
CR1-1	R1-2
S2-2	GND-ENG
CR1-2	A11-TB1-2
R1-1	A11-TB1-8
K4-S	A11-TB1-8
J1-1	TB21-21
J1-2	TB21-32
J1-3	G1-D+
J1-6	GND-CONT
J1-7	E1-4
J1-8	E2
J2-1	S4
J2-2	S5
J2-3	S6
J2-4	S1-1
J2-5	S2-1
S7-SIG	S2-1/S6
G1-B+	P3-A
G1-GND	P3-C
T26	P3-B

LEAD TABULATION	
FROM STATION	TO STATION
T26	K1
T26	S7+
GND-ENG	S7-
GND-ENG	S1-2
GND-ENG	GND-CONT
GND-ENG	G1-GND
G1-B+	B1-BAT
K4-BAT	B1-BAT
K4-BAT	A11-TB1-9
T26	A11-TB1-10
K4+	B1-SW
A16-1	T26
A16-2	GND-ENG
A16-3	ACT-1
A16-4	ACT-2
A16-5,6	P1-A,B
M15-S	E4
M16-G	G1-W
E1-1	T26
E1-2	GND-ENG

VR21	VOLTAGE REGULATOR
S8	LOW FUEL
S7	LOW COOLANT LEVEL (LCL)
S6	THERMOSTAT (PRE-HET)
S5	SWITCH-PRESS (PRE-LOP)
S4	SWITCH LOW ENGINE TEMP (LET)
S3	SWITCH-OVERSPEED (OS)
S2	THERMOSTAT (HET)
S1	SWITCH-OIL PRESS (LOP)
P1	MAG PICKUP
K4	STARTER PILOT SOLENOID
K2	PREHEAT SOLENOID (GLOW PLUGS)
K1	FUEL SOLENOID
HTR	ENGINE HEATER
G1	ALTERNATOR
E7	EXH TEMP (RIGHT)
E6	EXH TEMP (LEFT)
E5	TACHOMETER
E4	SENDER-OIL TEMP
E3	SENDER-WATER TEMP (RIGHT)
E2	SENDER-WATER TEMP (LEFT)
E1	SENDER-OIL PRESSURE
BT1	BATTERY-STORAGE
B1	STARTER & SOLENOID
A12	GOVERNOR

THIS DRAWING APPLIES TO:	
MODEL	BEGIN SPEC LETTER
DFBF	M
DFCB	M
DFCC	M
DFCE	A
DQBA	A
DQBB	A

No. 338-3343
Rev. C Sys: Revisio
Modified 4/17/97

NT855 & N14 ENGINE HARNESS DIAGRAM

Cummins Power Generation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
1-800-888-6626
763-574-5000 International Use
Fax: 763-528-7229

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