Operation/Installation/Service

DETROIT DIESEL®

mtu

Automatic Transfer Switches

Model:

TSC 800

Transfer Switch Controller
Software Version 2.1

DETROIT DIESEL ISO CERTIFIED ORGANIZATION 9001 CORPORATION

MP-6381 7/06a

Product Identification Information

Transfer Switch Identification Numbers

Record the product identification numbers from the transfer switch nameplate.

Product Code _____

Serial Number _____

Accessory	Accessory Description

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Notes

IMPORTANT SAFETY INSTRUCTIONS. Electromechanical equipment, including generator sets, transfer switches, switchgear, and accessories, can cause bodily harm and pose life-threatening danger when improperly installed, operated, or maintained. To prevent accidents be aware of potential dangers and act safely. Read and follow all safety precautions and instructions. SAVE THESE INSTRUCTIONS.

This manual has several types of safety precautions and instructions: Danger, Warning, Caution, and Notice.

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

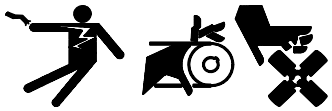
NOTICE

Notice communicates installation, operation, or maintenance information that is safety related but not hazard related.

Safety decals affixed to the equipment in prominent places alert the operator or service technician to potential hazards and explain how to act safely. The decals are shown throughout this publication to improve operator recognition. Replace missing or damaged decals.

Accidental Starting

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

Hazardous Voltage/ Electrical Shock

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open the main circuit breakers of all power sources before servicing the equipment. Configure the installation to electrically ground the generator set, transfer switch, and related equipment and electrical circuits to comply with applicable codes and standards. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

Short circuits. Hazardous voltage/current can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while making adjustments or repairs. Remove all jewelry before servicing the equipment.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Making line or auxiliary connections. Hazardous voltage can cause severe injury or death. To prevent electrical shock deenergize the normal power source before making any line or auxiliary connections.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Heavy Equipment

⚠ WARNING

Unbalanced weight.
Improper lifting can cause severe injury or death and equipment damage.

Use adequate lifting capacity.
Never leave the transfer switch standing upright unless it is securely bolted in place or stabilized.

Moving Parts

⚠ WARNING

Airborne particles.
Can cause severe injury or blindness.

Wear protective goggles and clothing when using power tools, hand tools, or compressed air.

Notice

NOTICE

Hardware damage. The transfer switch may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

NOTICE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. To indicate hardness, American Standard hardware uses a series of markings, and metric hardware uses a numeric system. Check the markings on the bolt heads and nuts for identification.

NOTICE

Foreign material contamination. Cover the transfer switch during installation to keep dirt, grit, metal drill chips, and other debris out of the components. Cover the solenoid mechanism during installation. After installation, use the manual operating handle to cycle the contactor to verify that it operates freely. Do not use a screwdriver to force the contactor mechanism.

NOTICE

Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (about 1 megohm), *not a direct short*, to ground.

This manual provides operation and installation instructions for the Model TSC 800 transfer switch controller.

Information in this publication represents data available at the time of print. The manufacturer of DDC/MTU Power Generation products reserves the right to change this literature and the products represented without notice and without any obligation or liability whatsoever.

Read this manual and carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions and Instructions section at the beginning of this manual. Keep this manual with the equipment for future reference.

The equipment service requirements are very important to safe and efficient operation. Inspect parts often and perform required service at the prescribed intervals. Obtain service from an authorized service distributor/ dealer to keep equipment in top condition.

List of Related Materials

This manual covers operation and installation information for the transfer switch's electrical controls. Verify that the transfer switch model and electrical controls match the models shown on the front cover of this manual before proceeding with operation or installation.

A separate operation and installation manual that covers the transfer switch's power switching device completes the operation and installation instructions for the transfer switch. The following table lists the related operation and installation manual part numbers and other related literature part numbers.

Document Description	Part Number
TS 880 Operation/Installation/Service Manual	MP-6380
Remote Communication System Instructions	TT-1409

Software Revision History

The following information provides a summary of changes made to the controller software.

Software Version	Description
2.1	Enhanced phase balance features
2.0	New features (See Section 1.1)
1.7	Revised transfer fail features and functionality
1.6	Added remote communication
1.5	Unreleased version
1.4	Updated transfer fail operation
1.3	Updated default under/over frequency setpoints, transfer fail programmability, minor logic revisions
1.2	Changed transfer switch fail timer to 30 seconds
1.1	Upgraded frequency setting range
1.0	Original version

- Consult the Yellow Pages under the heading Generators—Electric

For professional advice on generator power requirements and conscientious service, please contact your nearest DDC/MTU Power Generation distributor.

- Visit the DDC/MTU Power Generation website at ddcmtupowergeneration.com

- Look at the labels and stickers on your DDC/MTU Power Generation product or review the appropriate literature or documents included with the product

The TSC 800 controller consists of two parts; a faceplate, mounted externally on the transfer switch door, and a printed circuit board (PCB) mounted inside the transfer switch door.

1.1 Features

The TSC 800 controller utilizes microprocessor-based design technology that provides high accuracy for all voltage sensing and timing functions. The TSC 800 is factory-configured to control the operational functions and display features of the automatic transfer switch. All features of the TSC 800 are fully programmable from the front panel LCD display and are security password protected. The LCD display screen prompts are in plain English, providing a user-friendly operator interface with many display options available. The microprocessor design provides many standard features that were previously only available as add-on optional features. A summary of new and enhanced features provided in Software Version 2.0 Release is as follows:

- On Board Data Logging
  - Total number of transfers
  - Total number of transfers due to source failure
  - Number of hours controller is energized
  - Number of hours load is on utility
  - Number of hours load is on generator
- Timer Bypass Function
  - Faceplate key press can bypass various displayed control timer
  - Timer is automatically reset on next sequence
  - Operator can initiate immediate actions when desired
- Phase Balance Sensing
  - Ensures load is fed from balanced source
  - Programmable voltage tolerance settings
  - Phase balance on both utility and generator sources
- Automatic or Manual Retransfer to Utility
  - User programmable retransfer modes in software
  - Manual retransfer requires operator key press to initiate retransfer to utility once available
  - Manual retransfer is automatically bypassed on generator failure
- Auto Test Timer
  - Transfer switch allows user to initiate an auto test mode and after a preprogrammed time delay, ATS retransfers back to utility
  - 15–240 min. user-programmable timer in software
  - Auto test timer is automatically bypassed on generator exercise timer
- Ranges

Timer	Range
Warmup	0-3000 sec. (was 30 min.)
Cooldown	0-60 min. (was 30 sec.)
Neutral Delay	0-120 sec. (was 60 sec.)
Utility Return	0-60 min. (was 30 sec.)
Pre/Post Transfer Delay	0-300 sec. (was 120 sec.)

- 7-, 14-, 21-, 28-Day Programmable Exercise Timer
  - Single event programmed either weekly, every second week, every third week or once a month
  - Allows exercising on or off load (programmable)
  - All settings stored in non-volatile memory
- Programmable Commit to Transfer Logic
  - Transfer logic can be programmed to either logic scenario:

    Commit to transfer to generator source only after transfer to generator signal has been initiated (existing logic)

    or

    Commit to transfer to generator source only after engine start delay timer has expired (new logic); can be used to prevent multiple engine starts; auto resetting if the generator fails to start in 5 min.
- Neutral Delay Bypass
  - Neutral delay logic can be programmed to either logic scenario:

    a) When disabled, includes the programmed neutral delay time once neutral positioning has been determined (existing logic)

    or

    b) When enabled, only use as much of the

programmed neutral delay time as required in the neutral position until the load bus voltage drops below 20% of the nominal system voltage then completes the transfer to the alternate source (new logic); can be used to reduce the total transfer time while still providing BEMF protection to the connected loads and/or power source; also reduces retransfer times on loss of alternate source by reducing or cancelling the neutral delay time in a safe manner

- Transfer Fail Logic and Alarming
  - More descriptive alarm messaging: utility fail to transfer, generator fail to transfer, utility power switching failed, generator power switching device failed
  - Reduced time to detection of a power switching device failure
  - Closed transition ATS models with alarming in software (fail to sync/close, fail to trip)
- Standard Overvoltage and Frequency Sensing
  - Previously available only as an option
  - 3-phase utility and generator overvoltage and over frequency sensing/protection is now provided as standard
  - Programmable setpoints and transient time delays
- Standard RS422 remote communications port
  - Previously available only as an option
  - Communication port can be used with CIM (for Modbus or THS software) or direct connect previously only as an option
  - Utility source available (within voltage, frequency, and phase balance limits)
  - Generator source available (within voltage, frequency and phase balance limits)
  - ATS not in auto
  - Second engine start output
  - Utility and generator sources available
- Security Access for Keypad Accessible ATS Mode Operation
  - User can select security password prompts to permit access to manually initiated test modes via the keypads
  - Master level password required to change access
- Auto Scrolling and Test Mode Display
  - LCD display will now auto scroll all status display screens when no key presses have been initiated for more than 2 min.
  - Activated test modes will now be displayed in status display screens without need to reenter the test mode menu to view current selection
  - Sleep mode—If no key presses, LCD/VFD display blanks for longer life when no key presses have been initiated for more than 5 min.

For detailed information on all new and enhanced features refer to specific sections within this manual.

1.2 Specifications

POWER SUPPLY:

- 115 or 230 VAC nominal (+10% –30%)
- 50/60 Hz
- 100 mA nominal (no external load connected)

SOURCE VOLTAGE SENSING:

- Direct 120–600 VAC nominal, single or three phase
- 50/60Hz
- ±0.5% accuracy of setting @ 25°C

OPERATING TEMPERATURE:

- –15°C to 50°C (5°F to 122°F)

OUTPUT CONTACTS (Form C, 10 A,120/250 VAC resistive):

- Engine start
- Programmable function (not available with dual source system logic or insulated case transfer switches)

OUTPUT SIGNALS (120/250 VAC resistive load):

- Transfer to utility 10 A
- Transfer to generator 10 A
- Pre/post transfer to utility 3 A
- Pre/post transfer to generator 3 A
- Load on utility 3 A
- Load on generator 3 A

1.3 Faceplate

The faceplate is shown in Figure 1-1. The pushbuttons are connected to the main PCB via plug-in ribbon cable. The main features of the faceplate are described as follows with reference to Figure 1-1.

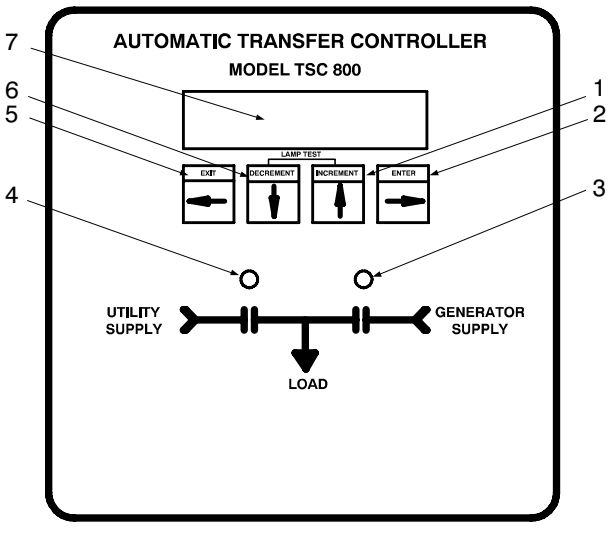
1. INCREMENT pushbutton. The INCREMENT function is used to change a programming value while in the programming mode. When this pushbutton is held down, the displayed value will be incremented to a higher value as desired.

   Note: The longer the pushbutton is held down, the faster the value will be incremented.

2. ENTER pushbutton. The ENTER function is used to scroll forward through the status menus or programming prompts to the next item. The ENTER function is used to enter and accept new programming or operating mode changes after a new value has been selected

   Note: Pressing the EXIT button instead of the ENTER button will reject the newly selected value and retain the original value.

   Note: In the programming mode, the longer the ENTER pushbutton is held down, the faster the next menu prompt will appear.



1. Increment pushbutton
2. Enter pushbutton
3. Load on generator supply LED
4. Load on utility supply LED
5. Exit pushbutton
6. Decrement pushbutton
7. LCD viewing window

Figure 1-1 Faceplate

3. Load on Generator supply LED light viewing window.

4. Load on Utility supply LED light viewing window.

5. EXIT pushbutton. The EXIT function is used to scroll backwards through the status menus or programming prompts to the previous item. Exit the programming menu by holding the EXIT pushbutton for approximately 2 sec. while in the programming mode.

6. DECREMENT pushbutton. The DECREMENT function is used to change a programming value while in the programming mode. When this pushbutton is held down, the displayed value will be decremented to a lower value as desired.

   Note: The longer the pushbutton is held down, the faster the value will be decremented.

7. LCD viewing window. The LCD display is mounted on the main PCB, visible from the faceplate.

   Note: A lamp test feature is provided to test all LED lights as well as the LCD display. To activate the lamp test feature, simultaneously push the INCREMENT and DECREMENT pushbuttons. All LEDs and LCD display pixels should illuminate for approximately 2 sec. and return to their original status. The Lamp Test feature is also used to clear active fault conditions and return the controller to normal operation.

   Note: An active Timer Bypass feature is provided to allow a manual initiated bypass. To activate the feature, simultaneously push the DECREMENT and ENTER pushbuttons. The previously bypassed timer will operate normally during its next cycle. Refer to Section 4.7, Timer Bypass, for related timers.

1.4 Printed Circuit Board

The printed circuit board (PCB) is shown in Figure 1-2. The PCB contains the following user interface items listed in Sections 1.4.1 through 1.4.5.

1.4.1 Power Supply Input Voltage Selection

The controller power supply input voltage level selection is made via two connector plugs that are located on the PCB and are identified as HD1 and HD2. Voltage selection plug assemblies are unique for each power supply input level voltage arrangement and must match the intended voltage level. Controller failure may result if incorrectly configured.

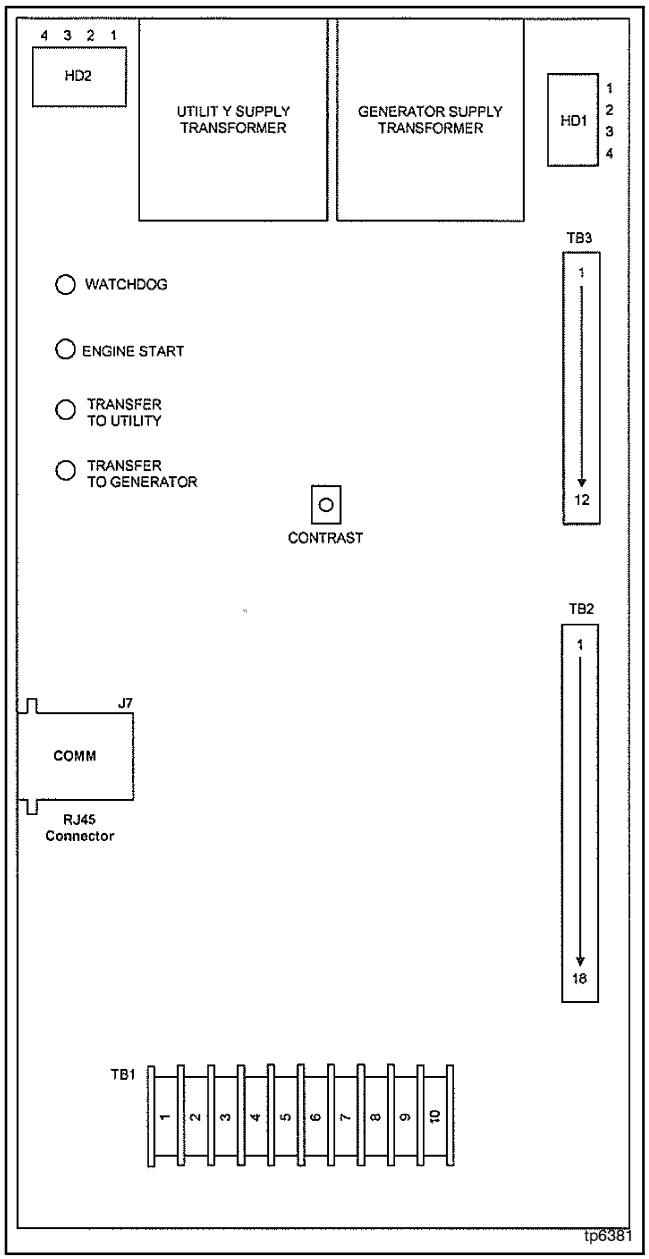


Figure 1-2 Printed Circuit Board

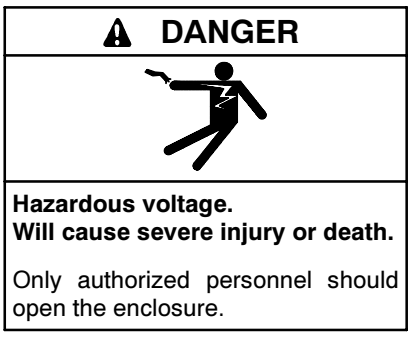
The TSC 800 is factory-configured for a specific power supply voltage input as designated by voltage header plugs labeled as follows: 115V designates a 115V power supply input voltage and 230V designates a 230V power supply input voltage.

1.4.2 Terminal Blocks

Three terminal blocks are located on the PCB as shown in Figure 1-3.

TB	Description
TB1	High voltage sensing terminal block (120–600VAC).
TB2	Transfer control terminal block for output contacts and low voltage inputs.
TB3	Transfer control terminal block for 115/230V input and output circuits.

Figure 1-3 Terminal Blocks



Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

1.4.3 Diagnostic LEDs

The TSC 800 controller provides four diagnostic LED lights that are mounted on the rear of the printed circuit board as shown in Figure 1-2. Their functions are described in Figure 1-4.

Note: All LEDs will be illuminated whenever a lamp test function is performed.

Diagnostic LED	Description
Watchdog	This LED flashes on and off at irregular intervals that indicate that the microprocessor is functioning normally.
Engine Start	This LED is illuminated whenever the TSC 800 is initiating an Engine Start (except when there is no power to the TSC 800 controller).
Transfer to Utility	This LED is illuminated whenever the TSC 800 is initiating a Transfer to Utility signal.
Transfer to Generator	This LED is illuminated whenever the TSC 800 is initiating a Transfer to Generator signal.

Figure 1-4 Diagnostic LEDs

1.4.4 Communication Port

A communication port is provided to interconnect to a remote communication system for remote monitoring and control of the transfer switch. Refer to Section 2.9 for additional information.

1.4.5 Contrast Adjustment

A contrast adjustment potentiometer is located on the PCB and is factory-set for ambient temperatures of 15°C–30°C (59°F–86°F). For different ambient temperatures, consult the factory for adjustment procedures.

Notes

2.1 General Information

Note: Install in accordance with all applicable electrical regulation codes.

The following installation guidelines are provided for general information only pertaining to typical site installations. For specific site installation information, consult the manufacturer as required.

Note: Factory installations of supplied transfer switches that have been tested and proven may deviate from these recommendations.

NOTICE

Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (about 1 megohm), *not a direct short*, to ground.

This equipment contains static sensitive parts. Please observe the following antistatic precautions at all times when handling this equipment. Failure to observe these precautions may cause equipment failure and/or damage.

- Discharge body static charge before handling the equipment. Maintain exposed body contact with a properly grounded surface while handling the equipment. Use a grounding wrist strap.
- Do not touch any components on the printed circuit board with your hands or any other conductive equipment.
- Do not place the equipment on or near materials such as styrofoam, plastic, and vinyl. Place the equipment on properly grounded surfaces and use an antistatic bag only for transporting the equipment.

2.2 Notes to Installer

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Making line or auxiliary connections. Hazardous voltage can cause severe injury or death. To prevent electrical shock deenergize the normal power source before making any line or auxiliary connections.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Note: Only qualified personnel must perform all installation and/or service work.

If the transfer switch has programmable/multitap system voltage capability (refer to electrical schematic), confirm that the transfer switch has been configured for the system voltage.

Note: Failure to confirm and match transfer switch voltage with the system voltage could cause serious equipment damage.

If the transfer switch requires reconfiguring, the TSC 800 controller will also require reprogramming.

2.3 AC Voltage Sensing Input

The TSC 800 can accept direct AC voltage sensing inputs on the generator and utility supplies from 120–600VAC (nominal).

Note: Direct input voltage sensing can only be used when the system utilizes a 3-phase, 4-wire distribution system that has the neutral conductor *solidly grounded.* For 3-phase, 3-wire systems (i.e. no neutral) or high voltage systems, use potential transformers (this is also the case where only one of the two supplies are 3-phase, 3-wire). Refer to Figure 2-1, Figure 2-2, Figure 2-3, and Figure 2-4 for voltage sensing connections.

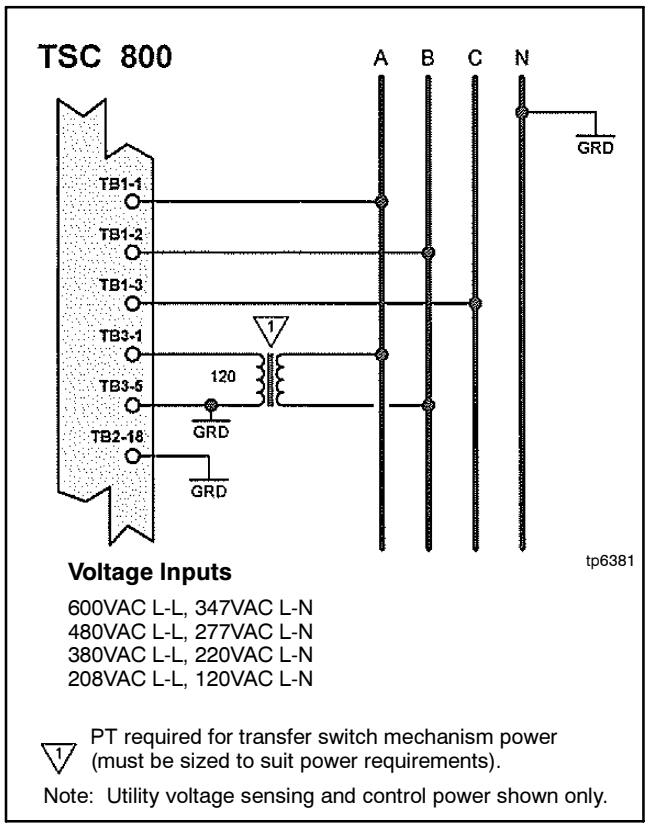


Figure 2-1 3-Phase, 4W 208/380/480/600VAC Direct Sensing

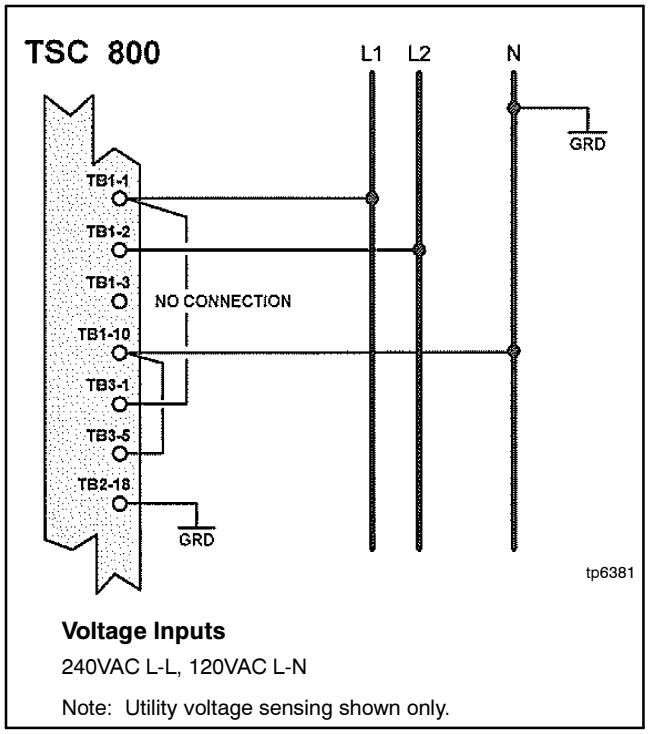


Figure 2-2 1-Phase, 3W 120/240VAC Direct Sensing

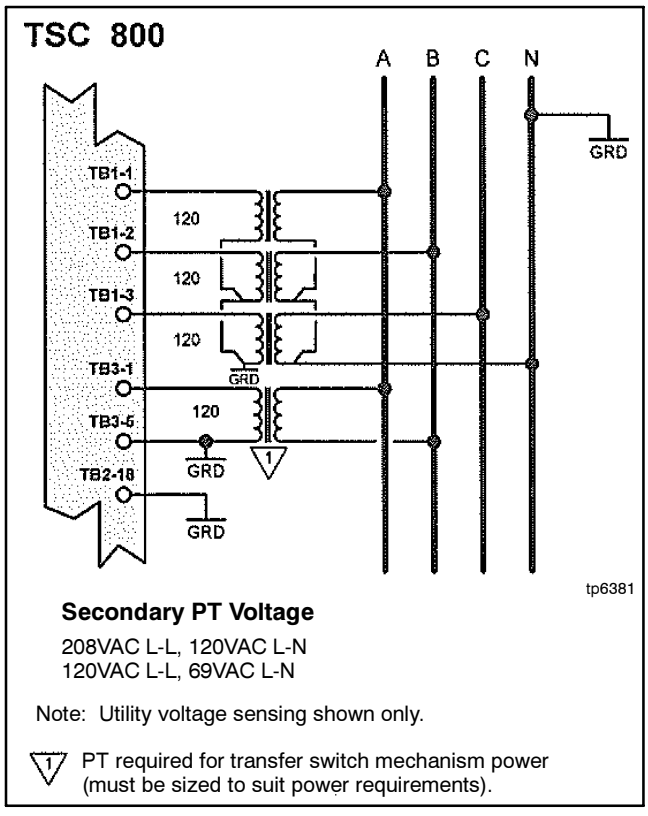
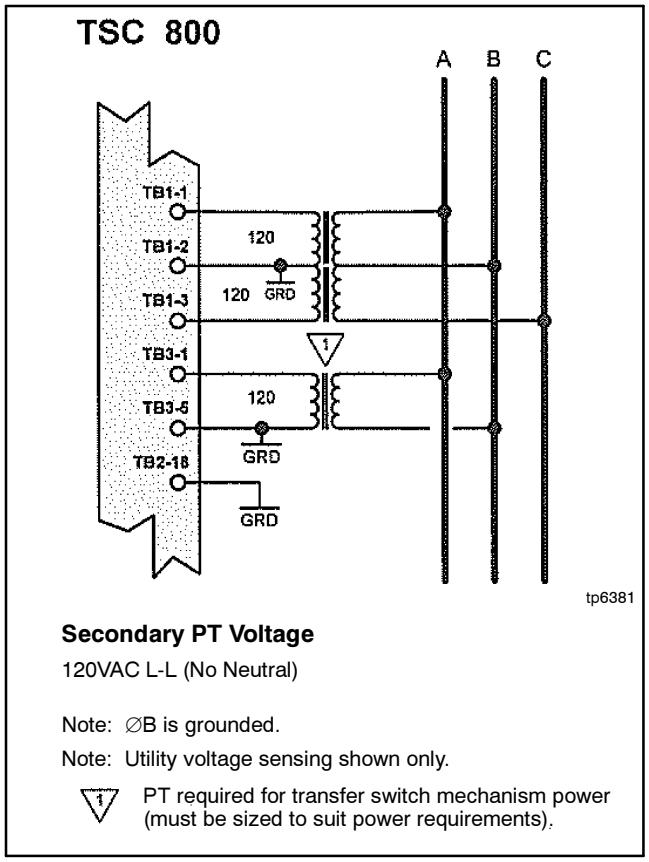


Figure 2-3 3-Phase, 4W Wye PTs



Secondary PT Voltage

120VAC L-L (No Neutral)

Note: ∅B is grounded.

Note: Utility voltage sensing shown only.

1 PT required for transfer switch mechanism power (must be sized to suit power requirements).

Figure 2-4 3-Phase, 3W Delta PTs

2.4 AC Control Power Input

The TSC 800 is factory-supplied for either 115 VAC or 230 VAC (nominal) control power input voltage. Independent AC control power is required from both utility and generator supplies. AC control power is utilized for internal TSC 800 control circuits and external control device loads. The TSC 800 requires approximately 12VA AC power for internal control circuits. The maximum external load is limited by output contact ratings (i.e. 10 A resistive, 120/250VAC). Determine total AC control power requirements for each supply by adding both internal and external load requirements.

2.5 Outputs

The TSC 800 provides the types of output circuits shown in Figure 2-5.

Output Circuit	Specification
Engine Start Contact	Isolated Form C contact (10 A, 250 VAC resistive)
Programmable Output Contact	Isolated Form C contact (10 A, 250 VAC resistive)
Transfer to Utility Output	250 VAC*, 10 A (resistive) powered output contact
Transfer to Generator Output	250 VAC*, 10 A (resistive) powered output contact
Pre/post Transfer to Utility	250 VAC*, 3 A (resistive) powered output contact
Pre/post Transfer to Generator	250 VAC*, 3 A (resistive) powered output contact
Load on Utility	250 VAC*, 3 A (resistive) powered output contact
Load on Generator	250 VAC*, 3 A (resistive) powered output contact
* Output voltage is dependent upon AC control power input voltage (i.e. 120VAC or 230VAC nominal).	

Figure 2-5 Output Contacts

Interposing relays are required between the TSC 800 outputs and the end device if loads exceed the output current rating. Transient suppression devices are required for all inductive devices sharing wiring or if physically located near the transfer switch controller.

For AC-operated relays or solenoids, use a suitably rated metal oxide varistor (MOV) or capacitor/resistor suppressor. MOV selection should typically be equal to or slightly greater than 1.3 times the nominal RMS voltage being applied to the inductive device.

Note: Selecting an MOV of too low a value can cause a sustained short circuit and ultimately lead to equipment failure.

2.6 System Phasing, High Leg Delta Systems

When the transfer switch is connected to 3-phase 4-wire delta systems and no multitap power supply transformers supplied with the ATS, the high leg must be connected to phase B of the utility and/or generator supply inputs to the ATS (phase B, colored orange per NEC 384-3(e) identified as the leg with highest potential with reference to ground). This will ensure the ATS control power that is internally connected between phase A and neutral is maintained at 120VAC. See Figure 2-6 for further details.

Note: Failure to match correct system phasing will result in serious damage to the TSC 800 controller.

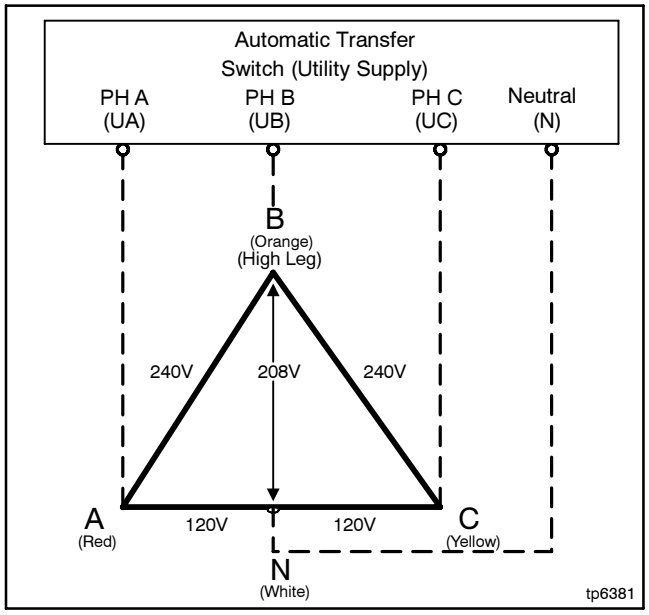


Figure 2-6 System Phasing

2.7 External Panel Control Wiring

As a minimum, all control wiring shall conform to the local regulatory authority on electrical installations. Specific wire sizes listed in Figure 2-7 are for typical circuits of distances up to 150 m (500 ft.). For distances exceeding 300 m (1000 ft.), consult the manufacturer.

Control Circuit	Wire Size
Utility or generator voltage sensing	#14 AWG (2.5 mm^2)
Transfer output signals	#14 AWG (2.5 mm^2)
Remote start contact for engine controls	#14 AWG (2.5 mm^2)

Figure 2-7 Control Circuit Wire Sizes

Note: For long control wire runs or noisy electrical environments, twist the control wires and shield them with a suitable drain wire. Ground the shielded cable drain wire at one end only. The drain wire grounding location may vary as microprocessor controllers generally exist at both ends (engine generator set and transfer switch) and one may be more susceptible depending on the level of induced noise. The most susceptible controller will require the shield ground point as close as possible to the controller. Wire runs from 150–300 m (500–1000 ft.) should be twisted and shielded and increased to #12 AWG where total loop resistance is greater than 5 ohms.

2.8 Remote Start Contact Field Wiring

Field wiring of a remote start contact from a transfer switch to a control panel should conform to the following guidelines to avoid possible controller malfunction and/or damage.

1. Remote start contact wires, two #14 AWG (2.5 mm^2), should be run in a separate conduit (ferromagnetic type) and in all cases separated from any AC wiring.

2. Avoid wiring near AC power cables to prevent pickup of induced voltages.

3. An interposing relay may be required if field-wiring distance is excessively long, i.e. greater than 300 m (1000 ft.), and/or if a remote contact has a resistance of greater than 5 ohms. In extremely noisy environments, the wire run lengths indicated may not provide reliable operation and can only be corrected by the use of an interposing relay. The interposing relay is generally installed at the engine controls and utilizes DC power. It is strongly suggested that the ground return wire of the interposing relay be used for the interface to the TSC 800 remote start contact. This will ensure integrity of the DC power supply to the engine generator set controls in the event of a shorted or grounded wire remote start interface wire.

4. The remote start contact provided is voltage free (i.e. dry contact). Exposing the remote start contact to voltage or current levels in excess of its rating will damage the transfer controller.

2.9 Remote Communication

The TSC 800 transfer switch controller is available with a remote communication feature. The remote communication feature allows a TSC 800 controller to be monitored and controlled from a remote location via serial communication link to a personal computer (PC).

PCs may be connected locally via serial communication cable to the TSC 800 or remotely via modem and telephone systems. Remote communication can be via customer-supplied equipment or with an external communication interface module (CIM).

Note: The CIM module may be located in the engine control panel provided the maximum distance between the CIM and TSC 800 controller is not exceeded. See Figure 2-8 and Figure 2-9.

The CIM module utilizes an internal modem and contains Modbus® protocol to interface with different remote monitoring software programs. Refer to separate literature for detailed information on the CIM module. The TSC 800 communication port utilizes a RS422 data transmission signal that is directly interconnected to the CIM module via an 8 conductor, shielded cable with plug-in RJ45 connectors. Refer to Figure 2-8 and Figure 2-9 for detailed information on direct-connected or remote-connected PC applications with CIM module.

Note: Both phone and serial communications ports cannot be connected at the same time. Doing so will result in no communication and/or possible CIM failure.

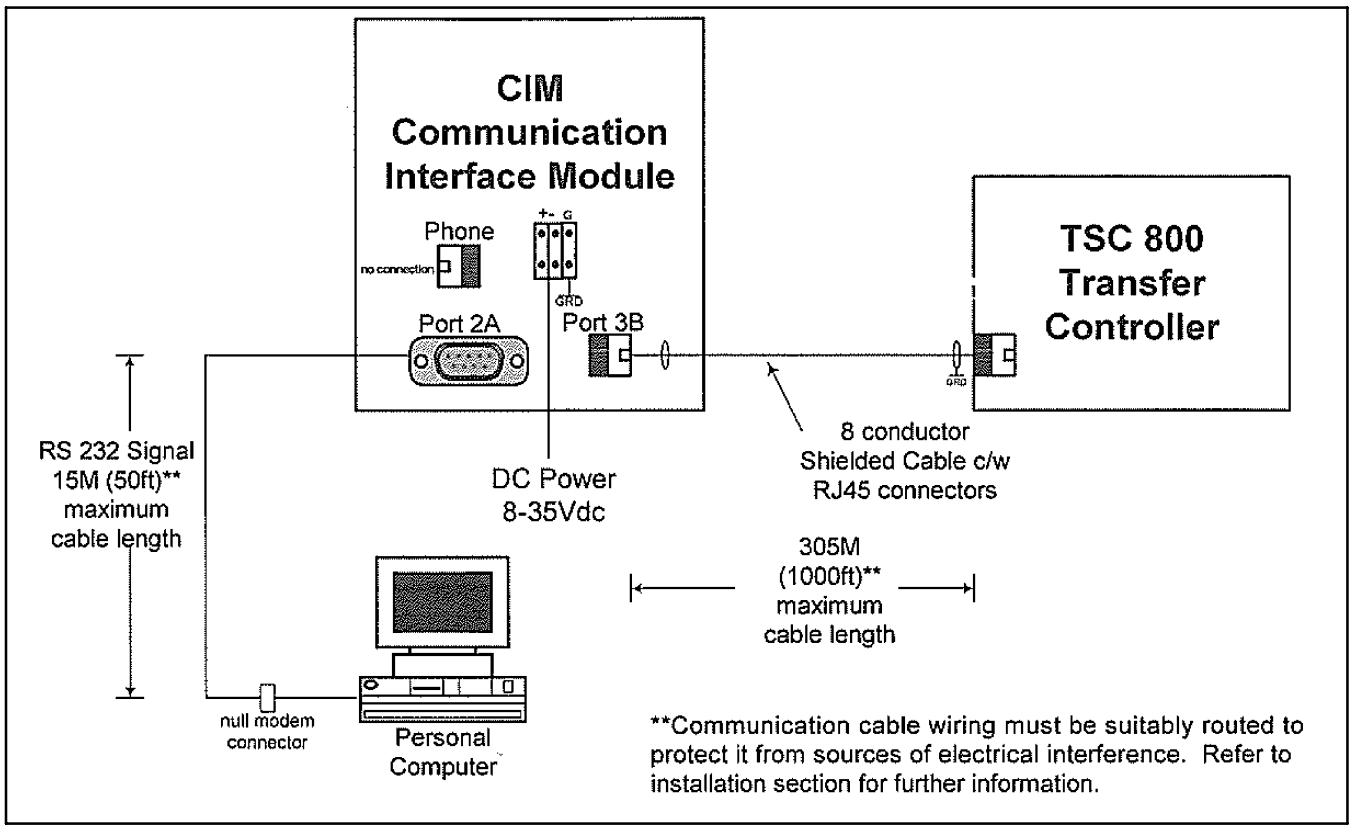


Figure 2-8 TSC 800 with CIM Module and Direct-Connected PC (RS232)

Modbus® is a registered trademark of Schneider Electric.

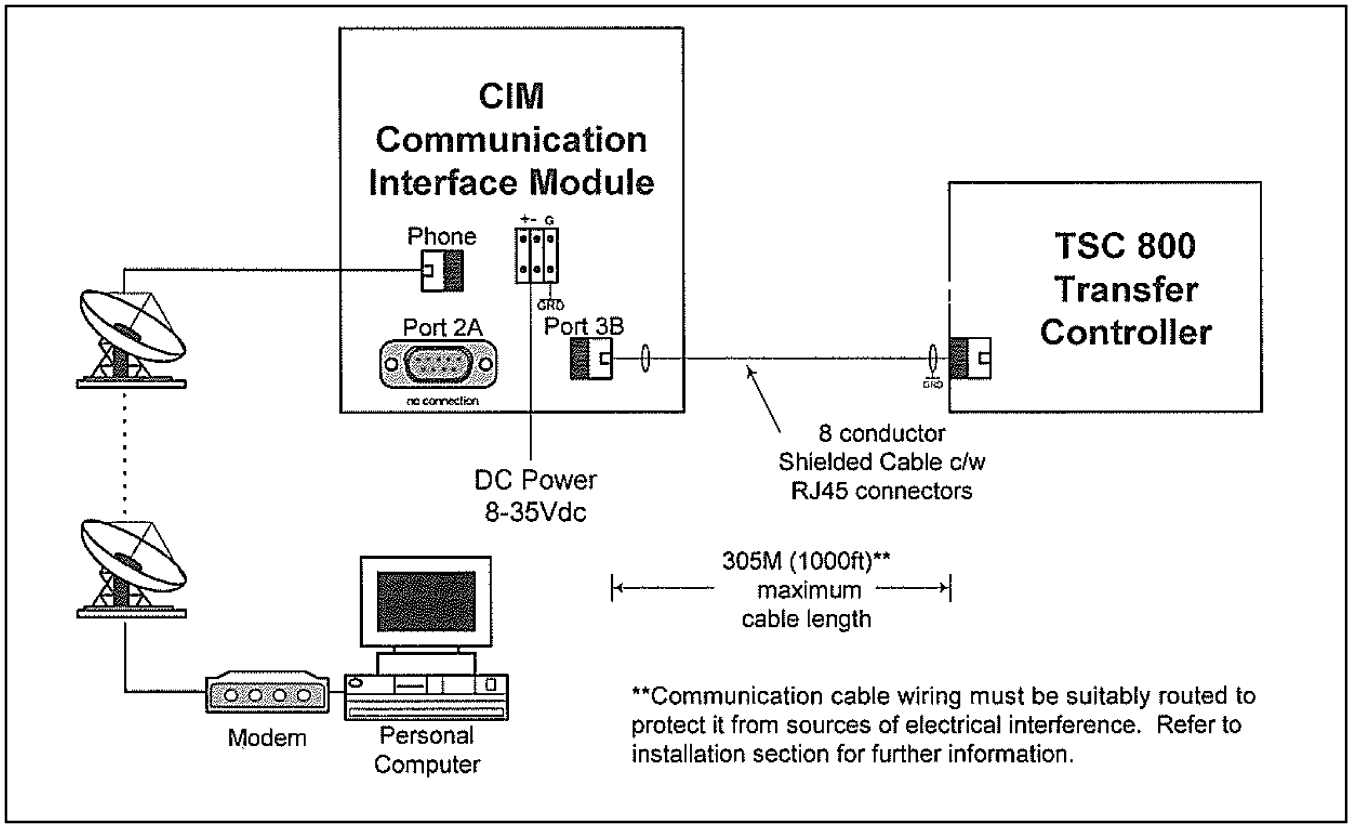


Figure 2-9 TSC 800 with CIM Module and Remote Connected PC

The TSC 800 RS422 communication port allows multiple TSC 800 controllers to be directly interconnected to form a single network system. Up to ten TSC 800 controllers may be interconnected to a single CIM module.

Each TSC 800 controller is programmed with a unique communication node address number for the remote communication system to reference. The network system may be connected to a local PC or to a remote PC via telephone system and CIM module. Refer to Figure 2-10 for a typical TSC 800 network system with CIM module.

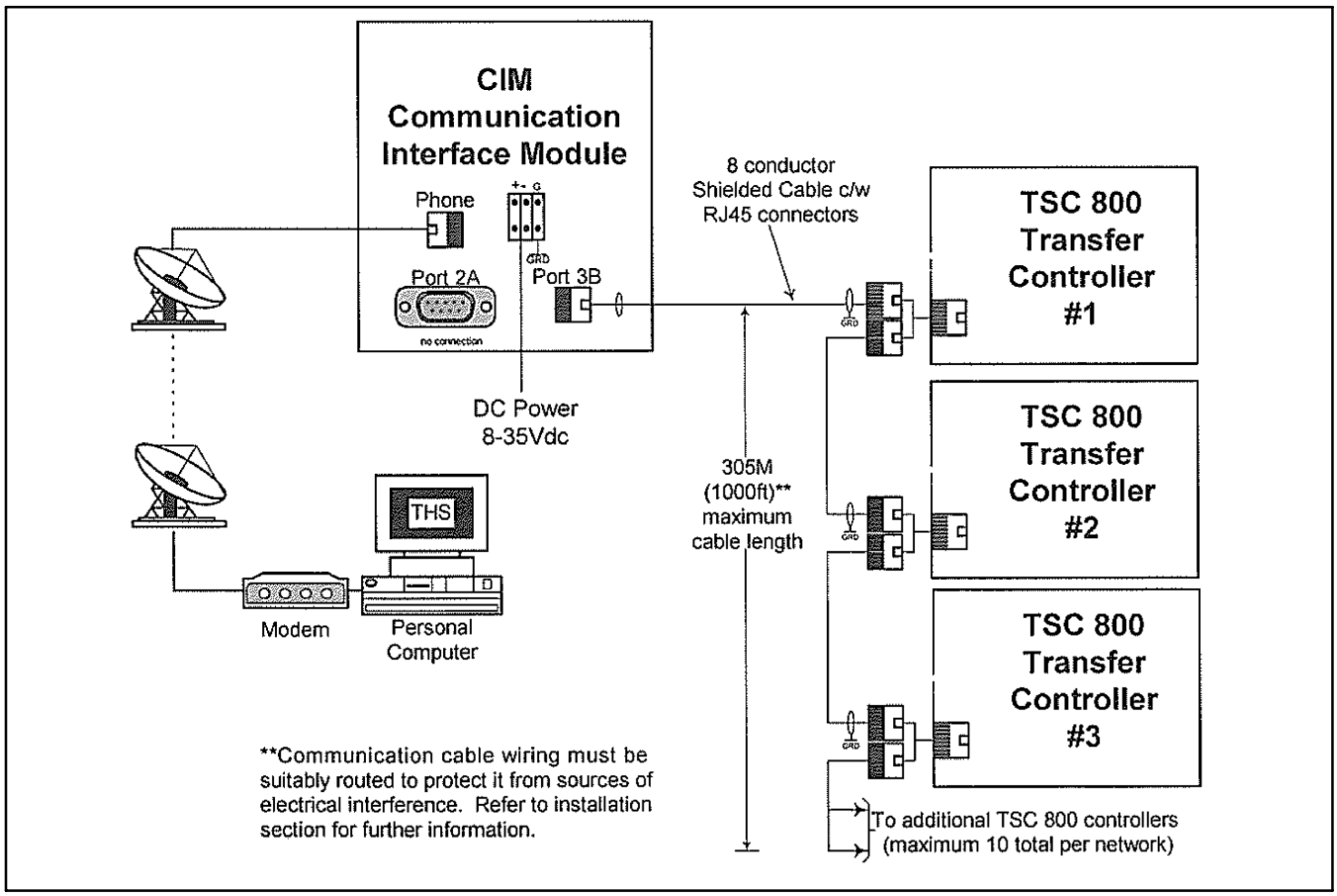


Figure 2-10 TSC 800 Network System with CIM Module and Remote PC

2.10 Communication Cable

Communication cable wiring from the controller's communication port must be suitably routed to protect it from sources of electrical interference. Guidelines for protection against possible electrical interference are as follows:

- Use high quality, 8 conductor shielded cable only with drain wire grounded at the controller end only.
- Route the communication cable at least 3 m (10 ft.) away from sources of electrical noise such as variable speed motor drives, high voltage power conductors, UPS systems, transformers, rectifiers etc.
- Use separate, dedicated conduit runs for all communication cables. Do not tightly bundle communication cables together in the conduit. Conduit should be ferromagnetic type near sources of possible electrical interference. Ground the entire length of conduit to building earth ground.
- When communication cables must cross over low or high voltage AC power conductors, the cables must cross at right angles and not in parallel with the conductors.

For additional information on protection against electrical interference, contact the manufacturer.

2.11 Dielectric Testing

Do not perform any high voltage dielectric testing on the transfer switch with the TSC 800 controller connected into the circuit, as serious damage will occur to the controller. Remove/disconnect all AC control fuses and control circuit isolation plugs connected to the TSC 800 if high voltage dielectric testing is performed on the transfer switch.

The following installation guidelines are provided as general information only pertaining to typical site installations. For specific site installation information, consult the manufacturer as required.

Note: Factory installation of supplied transfer switches that have been tested and proven may deviate from these recommendations.

The TSC 800 contains a liquid crystal display (LCD) that is visible on the front faceplate. The LCD has preprogrammed display menus that are automatically displayed in an auto-scrolling mode or may be selected manually by pressing the *ENTER* or *EXIT* pushbuttons in succession until the desired menu is displayed. The display menu types and the order they are programmed are shown in Figure 3-1.

Note: The following display menus are provided in TSC 800 Software version 2.0 (or higher).

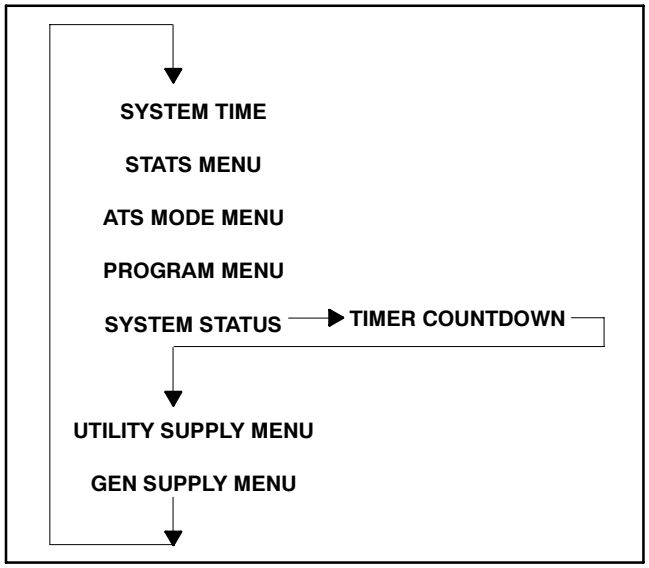


Figure 3-1 Display Menu Types

Note: ATS MODE MENU access may be inhibited. Refer to Section 5, Programming, for further details.

3.1 System Time Menu

The system time menu is used to show current system time and week number. The TSC 800 controller uses its internal timeclock to reference when an automatic exercising operation (if preprogrammed) is to occur. To change the system time, refer to Section 4.3, Timeclock Adjustment.

Note: The following system time menu is provided in TSC 800 Software version 2.0 (or higher).

1. Displays the day of the week (e.g. Monday)
2. Displays the week number (e.g. 1–4)
3. Displays the current time in hours (24-hour clock): hour: min: seconds

Figure 3-2 System Time Menu LCD Display

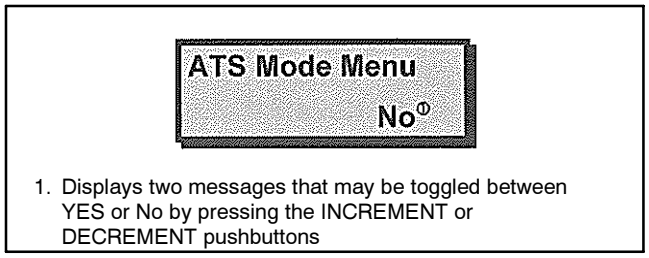
3.2 ATS Mode Menu

The ATS Mode Menu provides manually selectable operating modes which includes On/Off load testing features (comparable features also available via external inputs utilizing an optional FTS4 selector switch).

The Internal and External ATS Mode inputs operate in a parallel fashion; the Mode of Operation will be determined by the highest priority selected by either format. The priority levels are as follows (highest to lowest priority):

1. Off (controller out of service, no control logic applied).
2. On load test.
3. Off load test.
4. Auto.

A utility power failure will override all but Off. In the event of a generator set failure and the utility supply is available and considered normal, the ATS will return to the utility supply except when Off is selected.



1. Displays two messages that may be toggled between YES or No by pressing the INCREMENT or DECREMENT pushbuttons

Figure 3-3 ATS Mode Menu LCD Display

Functions are described as follows: No—status message only, a change is required to gain access, and Yes—the required variable to be entered to gain access and proceed. If the password protect feature is enabled, a prompt will appear requiring a level 2 or greater security code be entered to allow read-write access. Entering a level 1 password will permit a read only access.

Note: The following test menu is provided in TSC 800 software version 2.0 (or higher).

The ATS Mode submenus are organized as shown in Figure 3-4.

The following ATS Mode Menu options are provided:

1. Auto—this is the *Default Selection* and is required to enable all automatic features of the controller. In this mode, the TSC 800 controller will automatically transfer the load to the appropriate source based on availability (the Utility supply is considered the preferred source). The TSC 800 will provide automatic timed testing if enabled in programming. Manual testing is disabled when the Auto ATS mode is selected.

   Note: The external mode inputs will override ATS Mode Menu (selected Auto mode).

2. Offload Test—when the Offload Test prompt is selected and entered, the generator set will immediately start and operate offload and will not permit a load transfer. The test menu will display Continuous Test. To select a timed test, use the *INCREMENT* or *DECREMENT* pushbutton to scroll and select a test duration time, press enter to accept the time (selectable in 15 min. increments from 15–240 min.). The generator set will remain running until a different mode is selected and entered or the timed test duration expires (selecting Auto will immediately terminate the test). On expiry of the timed test the operating mode automatically reverts to Auto.

   Note: If the Utility supply fails during this test mode, the load will automatically transfer to the generator set if within acceptable limits.

3. On Load Test—when the On load Test prompt is selected and entered, the generator set will immediately start and transfer on load. The test menu will display Continuous Test, to select a timed test use the *INCREMENT* or *DECREMENT* pushbutton to scroll and select a test duration time, press enter to accept the time (selectable in 15 min. increments from 15–240 min.). The generator set will remain running until a different mode is selected and entered or the timed test duration expires (selecting Auto will terminate the test after the Utility Return Timer has expired). On expiry of the timed test, the operating mode automatically reverts to Auto.

   Note: Should the generator set fail during the on load test and the Utility supply is available and within acceptable limits, the load will be transferred on expiry of the generator set undervoltage delays.

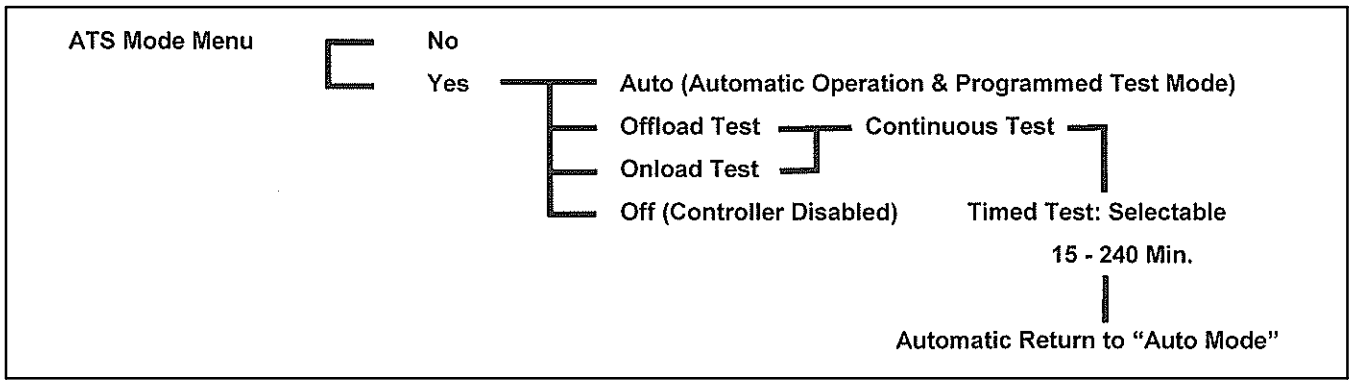


Figure 3-4 ATS Submenus

4. Off—the TSC 800 Controller is considered out of Service. The transfer mechanism logic outputs are dropped out and disabled. The transfer switch will remain in its last position and the remote start removed if previously enabled. Manual and auto test features are disabled. This selection takes precedence over all other modes.

   Note: When this mode is selected, the local generator set controls should also be placed in *OFF*. Failing to do can result in cyclical engine starting. On loss of Utility supply in this state (loss of control power to the TSC 800), the engine start contact will drop out after approximately 4 min. resulting in generator set starting and stopping (the cycle will repeat approximately every 4 min. after the control power is removed).

   Note: On return to normal service, the Engine Start output is inhibited (held up) for approximately 8–10 sec. Requesting another mode of operation during this time, which requires the engine start contact to close, will be ignored.

3.3 Program Menu

The programming menu is used to access the TSC 800's programmable functions such as time delays, voltage/frequency setpoints, calibration, and timeclock adjustments. Access to the programming submenus can only be obtained with a security password number. The submenus are organized as shown in Figure 3-5.

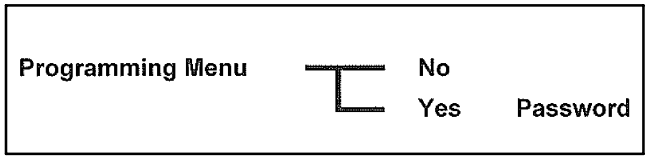


Figure 3-5 Programming Menu

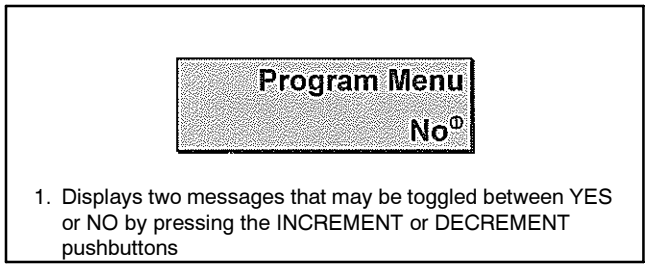


Figure 3-6 Program Menu LCD Display

The functions are described as follows: NO—status message only, a change is required to gain access, and YES—the required variable to be entered to gain access and proceed. The password protection prompt will appear requiring a level 2 or greater security code be entered to provide read-write access. Entering a level 1 password will permit a read-only access.

3.4 System Operation Menu

The system operation menu provides the operator with information as to current status of both the utility and generator set supplies.

Note: The system operation menu screen may be momentarily replaced with a time delay countdown screen when a transfer sequence is initiated. The display will automatically return to the previous menu following expiry of the timing sequence.

The system operation submenus are organized as shown in Figure 3-7.

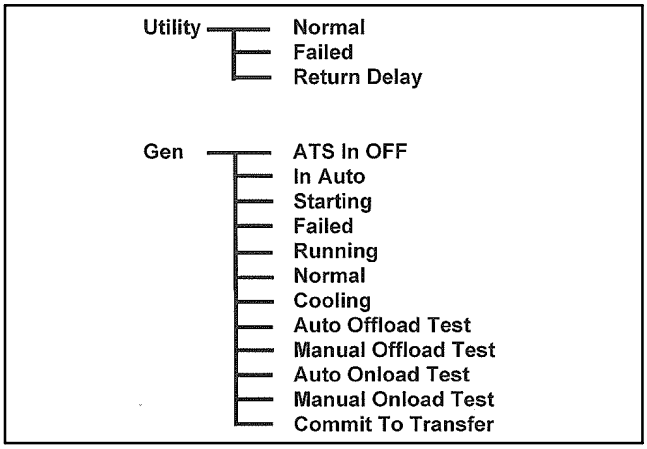


Figure 3-7 System Operation Submenus

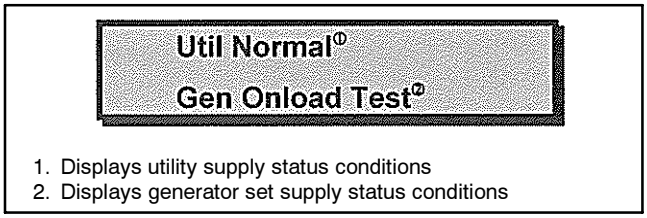


Figure 3-8 System Operation Menu LCD Display

Util Normal—Displays utility supply status, three conditions:

1. Normal—load is on the utility supply and the utility's voltage and frequency is normal.

2. Failed—utility supply voltage and/or frequency are outside the nominal programmed limits (e.g. failed condition).

3. Return Delay—load is on the generator set supply and the utility supply is ready to transfer. This is a temporary condition due to either a test mode being selected or during a utility return time delay.

Gen On load Test—Displays generator set supply status conditions, twelve conditions as follows:

1. ATS In Off—the ATS Mode has been set to OFF via the Internal or External switch input. The Controller will display the message Controller Out of Service.
2. In Auto—the ATS Mode via the Internal ATS Mode Menu has been set to Auto.
3. Starting—engine start signal has been initiated, and the TSC 800 sensors are waiting for generator set voltage to build up.
4. Failed—generator set is signaled to operate; however, voltage and/or frequency is outside the nominal programmed limits (e.g. failed condition).
5. Running—the generator set is running (within programmed limits) but not requested to transfer on load by the controller.
6. Normal—the generator set is running due to a failed utility supply.
7. Cooling—the generator set is running (within programmed limits) during the programmed cooldown delay.
8. Auto Offload Test—the generator set is running off load due to a programmed exercise timer mode.
9. Manual Offload Test—the generator set is running off load due to manually initiated off load test mode via the front panel pushbuttons or external inputs.
10. Auto On load Test—the generator set is running on load due to a programmed exercise timer mode.
11. Manual On load Test—the generator set is running on load due to manually initiated on load test mode via the front panel pushbuttons or external inputs.
12. Commit To Transfer—when enabled, the generator set will be committed to transferring on load if the loss of utility is detected and the engine start issued. The generator set will remain on load for the duration of the power failure and the transfer return time. If the generator set fails to start within 5 min., the commit to transfer request is cancelled.

3.5 Timer Countdown Menus

Timer countdown menus are automatically displayed when a specific time delay function occurs during a transfer sequence. When a time delay begins, the LCD display will indicate the time delay function name (e.g. Gen Start Delay) and the current time remaining in the countdown sequence. When the timing function is complete, the LCD display will automatically change to either the next timing sequence countdown display or return to auto scrolling the system status screens.

1. Displays specific time delay function currently in operation
2. Displays current time in seconds that are left in the specific timing sequence

Figure 3-9 Timer Countdown Menu LCD Display

Note: During a timer countdown sequence, scrolling to a different display screen is possible by pressing either the *ENTER* or *EXIT* pushbuttons.

Timer Countdown Menu LCD Display

The following timer countdown screens are provided and displayed in seconds of time remaining: Gen Start Delay, Gen Warm up Delay, Gen Cooling Delay, Utility Return Delay, Pretransfer Delay, Post Transfer Delay, Finding Neutral, Neutral Delay, PSD Max Open Time, Transferring, and Syncing (Close Transition Feature Only).

3.6 Utility Supply Menu

The utility supply menu allows the operator to view the utility supply voltage and frequency values as shown in Figure 3-10 and described below.

Figure 3-10 Utility Supply Menu LCD Display

1. Displays utility supply frequency in hertz (Hz). The frequency is displayed with a resolution of 1/10 of a hertz.
2. Displays utility supply voltage as follows:
   a. 3-phase system: LINE TO LINE VOLTAGE—Phases A to B
   b. 1-phase system: LINE TO LINE VOLTAGE—Phases L1 to L2
3. Displays utility supply voltage as follows:
   a. 3-phase system: LINE TO LINE VOLTAGE—Phases B to C
   b. 1-phase system: LINE TO NEUTRAL VOLTAGE—Phases L1 to N

4. Displays utility supply voltage as follows:

   a. 3-phase system: LINE TO LINE VOLTAGE—Phases C to A

   b. 1-phase system: LINE TO NEUTRAL VOLTAGE—Phases L2 to N

3.7 Generator Set Supply Menu

The generator set supply menu allows the operator to view the generator set supply voltage and frequency values as shown in Figure 3-11 and described below.

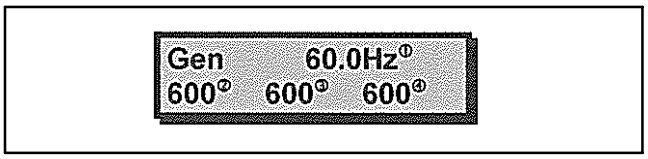


Figure 3-11 Generator Set Supply Menu LCD Display

1. Displays generator set supply frequency in hertz (Hz). The frequency is displayed with a resolution of 1/10 of a hertz.

2. Displays generator set supply voltage as follows:

   a. 3-phase system: LINE TO LINE VOLTAGE—Phases A to B

   b. 1-phase system: LINE TO LINE VOLTAGE—Phases L1 to L2

3. Displays generator set supply voltage as follows:

   a. 3-phase system: LINE TO LINE VOLTAGE—Phases B to C

   b. 1-phase system: LINE TO NEUTRAL VOLTAGE—Phases L1 to N

4. Displays generator set supply voltage as follows:

   a. 3-phase system: LINE TO LINE VOLTAGE—Phases C to A

   b. 1-phase system: LINE TO NEUTRAL VOLTAGE—Phases L2 to N

Note: The load bus voltages are viewable only in the Programming Menu. When selected as 3-phase load sensing, it will be displayed as listed above for 3-phase systems. When selected as 1-phase, only the L1 to L2 voltage will be displayed as a line-to-line value. The 3-phase load sensing can only be selected if all three phases of the load bus are wired to the TSC 800 controller. Most transfer switches manufactured prior to December 2004 will not have the C phase load bus wiring installed and must be set for 1-phase load sensing.

3.8 STATS Menu

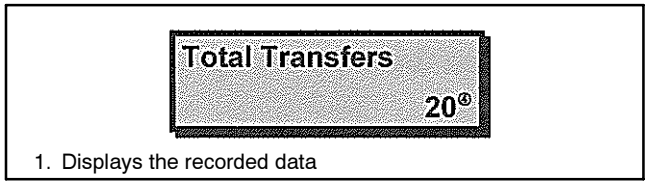
Note: The following stats menu is provided in TSC 800 software version 2.0 (or higher).

The STATS menu displays the recorded data logging for the following events:

- Total number of transfers.
- Total number of transfers due to source failure.
- Number of hours controller is energized.
- Number of hours load is on utility.
- Number of hours load is on generator set.

The TSC 800 data logging has the maximum number of events memory as follows:

- The limit for the Total Transfers and SRC Fail Transfers is 10,000.
- The limit for the total hours, load on SRC1 hour, and load on SRC2 hours is 160,000 hours.



1. Displays the recorded data

Figure 3-12 STATS Menu LCD Display

Note: Zeroing of the statistic records can be accessed by entering the program menu with a master password number.

Notes

To operate the TSC 800 controller and associated transfer switch using the front faceplate pushbuttons, refer to the following detailed operating instruction subsection descriptions.

4.1 Automatic Operation Sequence

4.1.1 Normal Operation Sequence (Open Transition Transfer)

Under normal operating conditions, the transfer switch operates automatically during a failure and restoration of utility power and does not require operator intervention.

Note: Certain conditions may require operator intervention to reset the controller. See Sections 4.5 and 4.10.

When utility supply voltage drops below a preset nominal value (70%–99% of rated adjustable) on any phase, an engine start delay circuit will be initiated. Following expiry of the engine start delay period (0–60 sec. adjustable), an engine start signal (contact closure) will be given.

Once the engine starts, the transfer switch controller will monitor the generator set's voltage and frequency levels. Once the generator voltage and frequency rises above preset values (70%–99% nominal adjustable), a warmup time delay will be initiated. Once the warmup timer (0–3000 sec. adjustable) expires, the transfer to utility supply signal will be removed (i.e. contact opening) and the transfer to generator supply signal (contact closure) will be given to the transfer switch mechanism.

The load will then transfer from the utility supply (i.e. opening the utility power switching device) to the generator supply (closing the generator power switching device) to complete a break-before-make open transition transfer sequence. The generator set will continue to supply the load until the utility supply has returned and the retransfer sequence is completed as follows: When the utility supply voltage is restored to above the present values (70%–99% of rated adjustable) on all phases, a utility return delay circuit will be initiated. Following expiry of the utility return timer (0–60 min. adjustable), the transfer to generator supply signal will be removed (contact opening), the transfer to utility supply signal (contact closure) will be given to the transfer switch mechanism.

The load will then be transferred from the generator supply back to the utility supply. During the utility retransfer sequence, a neutral position delay circuit can be employed that will cause the transfer mechanism to pause in the neutral position (i.e. with both transfer power-switching devices open) for the duration of the neutral delay timer (0–120 sec. adjustable) setting, once the time delay expires, the retransfer sequence will be completed.

The Neutral Delay Bypass feature can also be enabled to detect when all load phase voltages have dropped below 20% of the nominal system voltage, which will cancel any remaining Neutral Delay time and complete the transfer. An engine cooldown timer circuit will be initiated once the load is transferred from the generator supply and determined to have made position by ensuring the load bus is energized and the Utility position indication confirmed.

Following expiry of the cooldown delay period (0–60 min. adjustable), the engine start signal will be removed (remote start contact opened) to initiate stopping of the generator set.

4.1.2 Test Mode Operation Sequence

Test Condition (Open Transition Transfer)

When an operator selects a test mode, it shall signal a simulated utility power fail signal to the transfer switch controller. The transfer switch shall operate as in a normal utility power fail condition. The neutral delay circuit logic will be active during transfer to and from the generator supply (i.e. when both sources of power are available). (For definitions and added features, refer to Section 5.5.12.)

The transfer switch shall remain on generator supply until the test mode is terminated. It will then retransfer back to the utility supply and continue to operate the generator set for its cooldown period, then stop.

4.1.3 Abnormal Operation Sequence

Generator Failure on Load

Should the generator set fail while on load, the transfer switch shall retransfer the load back to the utility supply if within nominal limits. The utility return timer will be bypassed in this condition.

Note: This operating condition applies to a normal utility failure as well as any test condition.

Transfer Switch Fail Alarm Logic

The TSC 800 controller contains logic to detect a transfer mechanism failure. Should a failure be detected, a forced transfer to the alternate supply will be initiated if the TSC 800 is programmed for force transfer. Refer to Section 5.5.14 for further information in Force Transfer operation.

Service Entrance ATS

For service entrance rated transfer switch applications, the transfer switch control logic will include external wiring to signal the transfer switch mechanism to move to the Service Disconnected position when Service Disconnect Operation is required. In this mode, the transfer control outputs and Transfer Fail feature is disabled. On return to Service the TSC 800 will display Resuming Normal Operation and the Power-Switching Device will be closed to the utility supply. Should the utility supply be out of limits, the generator set will be issued a start command and the load transfer to the generator supply once its warmup time has expired. The ATS returns to Auto control and will return to the utility supply as previously described for the appropriate ATS design type.

Note: On return to Normal Service, the Engine Start output is inhibited (held up) for approximately 8–10 sec. Requesting another mode of operation requiring the engine start contact to close will be ignored until this timer expires.

4.2 LCD Display Operation

The TSC 800 LCD display will operate in the following modes:

Note: The following LCD operation is provided in TSC 800 Software version 2.0 (or higher).

- SLEEP Mode: The LCD display will automatically turn off and go in to a sleep mode to preserve operating lifetime. The sleep mode will be activated if a faceplate key press is not activated within a 16 min. time period. Pressing any faceplate key will automatically reactivate the LCD display.

- AUTO SCROLLING Mode: The LCD will automatically scroll through a series of display menu screens at a rate of 1 screen every 3 sec. Pressing any faceplate key while the display is on the desired menu screen will automatically stop the scrolling feature. The autoscrolling feature will be reactivated 120 sec. later if no key presses are made. To view other menus once the auto scrolling has been deactivated, press the *ENTER or EXIT* pushbuttons to scroll to the next available menu. Note that the menu list will automatically loop back to the first menu item when the end of the list is reached.

- BACK LIGHT Mode: The LCD incorporates a back light feature. When any keypad is pressed, the back light will illuminate for 120 sec.

- AUTO EXIT PROGRAMMING Mode: The LCD display will automatically exit the programming menu and return to auto scrolling mode if no keypad is depressed within 5 min.

4.3 Timeclock Adjustment

To adjust the TSC 800 controller's internal timeclock, follow the detailed procedure below.

Note: Normal utility or generator set control power to the controller must be available to permit adjustment.

- Using the *ENTER* or *EXIT* pushbutton, scroll to the Program Menu.

- Using the INCREMENT pushbutton, select the Yes message and press the ENTER pushbutton.

- Press the ENTER pushbutton when the Password message is displayed.

- Using the INCREMENT pushbutton, select the current day of the week message and week number (1–4) and press the ENTER pushbutton.

  Note: Week Number is programmable only if the System Timeclock Rollover period is set longer than 7 days. Refer to Section 5.2, Exercise Timer, for further details.

- Using the *INCREMENT* pushbutton, select the current hour of the day (e.g. 24-hour clock) and press the *ENTER* pushbutton.

- Using the *INCREMENT* pushbutton, select the current minute of the day (e.g. 60 minute) and press the *ENTER* pushbutton.

- Press the *EXIT* pushbutton and hold for 2 sec. to exit the timeclock adjustment mode (automatic exit if no keypad depressed within 5 min.).

4.4 Test Modes

4.4.1 Operator Initiated Utility Power Fail Simulation (Load Test)

To perform a testing operation on the transfer switch using the front faceplate pushbuttons, follow the procedure listed below.

To initiate the load test mode:

- Using the ENTER pushbutton, scroll to the ATS Mode Menu.
- Using the INCREMENT pushbutton, select the Yes message and press the ENTER pushbutton.
- Using the INCREMENT pushbutton, select the On load or Off load test option as required.
- Press the ENTER pushbutton.
- Continuous Test will be displayed (no time out). Using the INCREMENT pushbutton, a timed test can be selected if the desired, duration of Test Mode Time Out is selectable in 15-min. increments from 15–240 min.
- Press the *ENTER* pushbutton.

To exit the test mode:

- Using the ENTER pushbutton, scroll to the ATS Mode Menu.
- Using the INCREMENT pushbutton, select the Yes message and press the ENTER pushbutton.
- Using the INCREMENT pushbutton, select Auto.
- Press the ENTER pushbutton. After the Utility Return Timer has expired the transfer of the load from the generator set to the utility supply will be initiated.

4.4.2 Automatic Plant Exercise Test

To initiate an automatic plant exercise test mode, the TSC 800 must be preprogrammed for the desired start/stop times, frequency of the test, and type of test (i.e. On load, Off load). Refer to Section 5, Programming, for details.

Once the plant exercise timer is programmed, the engine will immediately start at the selected time and transfer on load (if On load is selected) once nominal voltage and frequency levels have been obtained. The engine will remain operating until the stop time is reached, then the load will retransfer back to the utility supply after the utility return timer has expired. The generator set will repeat the test sequence as programmed.

4.4.3 Four Function Remote Test (FTS4 Option)

The function of the Four Position Test Switch Input is to allow operators to select various operating scenarios for test or maintenance purposes, in addition to the use of the faceplate mounted pushbuttons.

Note: When an external FTS4 switch is used, the TSC 800 operation will be based on the highest priority of either the internal ATS Mode or the external FTS4 inputs to the controller.

Mode Priority

The four modes (1 Off, 2 On load Test, 3 Offload Test and 4 Auto) are outlined in Figure 4-1.

Function	Description
Off	Disables the engine start output from the transfer switch (FTS4 only). TSC 800 will display *Controller Out of Service*. All transfer logic outputs are dropped out (disabled). The transfer switch will not provide automatic control in the event of a power failure. Engine start output on the controller is dropped out. (Place generator set controls in *OFF* if continuous running of the generator set is not desired.) **Note:** Moving FTS4 out of *OFF* will display Resuming Normal Operation and the ATS will source the appropriate supply. **Note:** On return to Normal Service the Engine Start output is inhibited (held up) for approximately 8–10 sec. Requesting another mode of operation during this time, which requires the engine start contact to close, will be ignored.
Auto	All automatic functions are enabled.
Engine Start	(Offload Test) An engine start signal will be initiated and will remain on until the FTS4 is placed in another position. The engine will start if the engine's auto start controller is in the Auto mode. If the primary source fails in this mode, and the secondary source is within parameters, the TSC 800 will initiate a transfer to the secondary source.
Test	(On Load Test) A primary source failure is simulated and an engine start signal will be initiated. When the secondary source is within normal limits, the TSC 800 will initiate a transfer to the secondary source. The system will remain in this state until the FTS4 is placed in another position or the secondary supply fails. Upon a secondary supply failure, if the primary supply is available, the TSC 800 will initiate a transfer to the primary supply. The Utility Return time sequence will be initiated when the On Load Test mode is terminated. Once transfer is complete to the primary source the engine cooldown time sequence will be initiated, on expiry, the generator set will stop if no cooldown is included in its design/programming.

Figure 4-1 Mode Priority

4.5 Transfer Fail Fault Reset

To reset a Transfer Fail condition (i.e. When the LCD Display indicates the applicable fault condition and the Press Lamp Test alarm message), press and hold the DECREMENT and INCREMENT keys simultaneously. Once the alarm condition is reset, the load will automatically retransfer back to the original source if within normal limits.

See Section 5.5.14, Transfer Fail, for more information.

4.6 Lamp Test

To initiate a Lamp Test, press and hold the DECREMENT and INCREMENT keys simultaneously until all LEDs and LCD segments illuminate.

4.7 Timer Bypass

The following automatic sequencing time delays can be temporarily bypassed when the time function is active as shown on the TSC 800 LCD display:

- Utility Return Timer
- Cooldown Timer
- Warmup Timer

Note: Timer Bypass feature is provided in TSC 800 Software version 2.0 (or higher).

This feature is typically used when testing to avoid waiting for the complete duration of the time period. To activate the bypass function, simultaneously press the DECREMENT and the ENTER keys during the timer operation.

Note: The Time delay functions will return to the normal time settings on the subsequent automatic operating sequence.

4.8 Manual Utility Retransfer

If the TSC 800 is programmed to provide a Manual Utility Retransfer Sequence, an operator must initiate the retransfer sequence when the utility supply has returned to normal following a utility power failure and TSC 800 LCD message *Util Return – Press Lamp Test.*

Note: Manual Retransfer feature is provided in TSC 800 Software version 2.0 (or higher). Programmed Utility Return Delay Time is not included to ensure stable utility supply prior to retransfer.

4.9 Service Entrance ATS Mode

For transfer switches equipped with the Service Entrance Mode option, the TSC 800 is configured to provide additional logic for the application. When the TSC 800 controller receives an input signal for Service Entrance Mode (contact closing on TB2-15), the TSC 800 will post an alarm message on the LCD display Service Disconnecting when sourcing neutral position and when both Load on Generator and Utility inputs are deenergized and the load bus is deenergized will display Service Disconnected. The control logic required to move the ATS mechanism to the neutral position is controlled by external logic and not by the TSC 800. When in Service Disconnect mode all transfer logic outputs are deenergized. When Service Disconnect mode is removed the controller will display Returning to Service and move to the appropriate source depending on availability within programmed limits.

Note: On return to Normal Service the Engine Start output is inhibited (held up) for approximately 8–10 sec. Requesting another mode of operation during this time, which requires the engine start contact to close, will be ignored.

Note: Service entrance feature is provided in TSC 800 Software version 2.0 (or higher).

4.10 Phase Balance Protection Alarm

When the TSC 800 is programmed with Phase Balance protection enabled, should a transfer occur due to an out of limit phase balance condition, an alarm message will be shown on the TSC 800 LCD display UTIL (or GEN) UNBALANCED. The Phase Balance feature can be user-programmed to provide two different retransfer operating sequences, AUTO or MANUAL retransfer. When the AUTO retransfer mode is selected, the load will be automatically retransferred back to the original source without operator intervention. When the MANUAL retransfer mode is selected, a retransfer back to the original source will not occur until the operator activates the LAMP TEST function and resets the alarm.

See Section 5.3.17, Phase Balance Retransfer.

Note: If the alternate source fails when in the manual retransfer mode, the alarm lockout will not be bypassed inhibiting the load to retransfer back to the original source even if within limits. The reason the retransfer is inhibited is phase unbalance is generally only detected when load is applied to the source and the condition will appear to clear when the load is removed, as such allowing a retransfer to the failed source previously determined to have a phase balance fault will only result in multiple unnecessary transfers of the load between sources. Retransfer is set to lock out and requires operator intervention.

Note: The phase balance feature is provided in TSC 800 Software version 2.0 (or higher).

Notes

5.1 Passwords

Access to the programmable parameters of the TSC 800 transfer controller is via a security password number. Three levels of security passwords are provided as described in Sections 5.1.1 through 5.1.3.

5.1.1 Read-Only Mode

User can view the programmable parameters only and cannot change any values. The factory default number for the read-only mode is 1.

5.1.2 Read/Write Mode

User can view and modify any programming parameter as required. The factory default number for the read/write mode is 2.

5.1.3 Master Read/Write Mode

User can view/modify any programming parameter as well as view/modify the security password level numbers. Consult the manufacturer for master password number, if required. To enter the programming mode, select the Program Menu by scrolling through the display screens using the ENTER or EXIT pushbuttons. When displayed, use the INCREMENT pushbutton to select the YES prompt and push the ENTER button. See Figure 5-1.

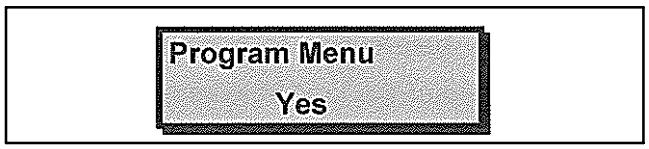


Figure 5-1 Enter Program Mode

Use the INCREMENT or DECREMENT pushbuttons to ramp the displayed number up or down to the desired password access number. Press the ENTER pushbutton when the correct number is displayed. See Figure 5-2.

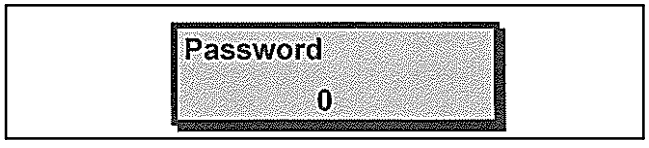


Figure 5-2 Password

Note: If an invalid number is entered, programming access will be limited to timeclock adjustment only. To exit the programming mode, press the EXIT pushbutton and hold for 2 sec. until the display scrolls rapidly.

When the programming mode is accessed, the programming parameters will be displayed in the same order as the Programming Data Sheet provided with the transfer switch. See Section 5.7. To skip over parameters that do not require changes, push and hold the ENTER pushbutton until the desired function is displayed. The EXIT pushbutton may be used to scroll backwards through the programming parameter loop, but only one keystroke at a time, maintaining it longer than 2 sec. will exit the program menu. To change a programmed parameter, use the INCREMENT or DECREMENT pushbuttons to scroll through the available options or to adjust a value up or down to the desired number. When the desired option or number is displayed, press the ENTER pushbutton to accept the new value. Pressing the EXIT pushbutton after a new value is applied will result in the new value being overwritten with the original value.

Note: If the programming mode is terminated before the last change has been entered, the programming parameter will remain unchanged.

To exit the programming mode, press the EXIT pushbutton and hold for 2 sec. until the display scrolls rapidly.

5.2 Exercise Timer

Note: The following exercise timer feature is provided in TSC 800 Software version 2.0 (or higher).

The TSC 800 controller has a built-in programmable exercise timer, which allows up to a 4-week (28-day) exercise time period. The timer is fully programmable for day of week, time of day, duration of the test, and type of test mode (i.e. on load or off load). The exercise timer utilizes the TSC 800's internal timeclock for referencing all timing functions. The timeclock has a 10-min. power reserve feature to retain correct time settings during short duration utility power failures.

Note: During any On Load exercise test mode, the transfer switch will automatically retransfer back to the utility supply if the generator set fails. To program the exercise timer prompts, refer to the following descriptions.

5.2.1 System Time Rollover

Select the number of days (7, 14, 21, 28) in which the system timeclock will rollover for desired operation of the exercise timer. (Example: If a weekly test schedule is required at the same time; a 7-day period may be selected, which will have the test repeat each week at the same time and interval. If the generator set is to be exercised once a month, select a 28-day system rollover.) The week and day of week can be selected from any one of the 4 weeks in the list. The test will then repeat at this selected time and interval.

5.2.2 Auto Test Start Day/Week Number

Select the day of the week (e.g. Monday, Tuesday, etc.) and week number (e.g. 1–4) that the generator set is to be started to begin its exercise period.

Note: Week Number is programmable only if the System Timeclock Rollover period is set longer than 7 days.

5.2.3 Auto Test Start Hour

Select the hour of the day (e.g. 0–23 hour) that the generator set is to be started to begin its exercise period.

5.2.4 Auto Test Start Minute

Select the minute of the day (e.g. 0–59 min.) that the generator set is to be started to begin its exercise period.

5.2.5 Auto Test Stop Day/Week Number

Select the day of the week (e.g. Monday, Tuesday, etc.) and week number (e.g. 1–4) that the generator set is to be stopped following its exercise period. Week Number is programmable only if the System Timeclock Rollover period is set longer than 7 days. Ensure Auto Test Stop Day/Week/Timer occurs after the Auto Test Start Day/Week/Timer setting (generally of the same day/week) otherwise the generator may operate for an extended period of time.

5.2.6 Auto Test Stop Hour

Select the hour of the day (e.g. 0–23 hour) that the generator set is to be stopped following its exercise period.

5.2.7 Auto Test Stop Minute

Select the minute of the day (e.g. 0 to 59 min.) that the generator set is to be stopped following its exercise period.

5.2.8 Auto Test Mode

Select type of test mode desired. Three test modes are available as follows:

- Auto: The exercise test mode is deactivated.
- Off Load: The generator set will be started during the exercise period but no transfer will occur.

  Note: The generator will transfer on load if the utility supply fails during the test period.

- On Load: The generator will be started and will transfer on load.

  Note: During the On Load exercise test mode, the transfer switch will automatically retransfer back to the utility supply if the generator set fails.

5.3 System Configuration

The TSC 800 controller provides a flexible control system to allow specific operation for a wide range of power distribution types. To program the system configuration, refer to the following descriptions:

5.3.1 Firmware Version

Display Only: The Controller's current firmware version number and date of release.

5.3.2 ATS Mode Menu Password (PW)

Note: The following features is provided in TSC 800 Software version 2.0 (or higher). Viewable only in Master Read/Write Mode.

Allows setting of Password Protection restricting access to the ATS Mode Menu as follows:

- ENABLED: Access to initiating/changing any test or operation mode requires a user-entered password. The password required will be the same as a level 2 (e.g. read/write password level or higher).
- DISABLED: The ATS Mode Menu may be entered and changes made/initiated without the use of a security password.

5.3.3 Utility Fail Callout

Note: The following features are viewable only in Master Read/Write Mode in TSC 800 Software version 2.0 (or higher).

When the remote communication option is enabled, this programming prompt will appear. This feature may be enabled or disabled by programming selection:

- ENABLED: The controller will initiate a callout signal via the communication port to a remote connected device when a Utility (Source 1) power failure is detected. The callout signal will be reset when the Utility (Source 1) power returns to normal condition.
- DISABLED: The controller will not initiate a callout when a Utility (Source 1) power failure is detected.

5.3.4 Load On Generator Callout

When the remote communication option is enabled, this programming prompt will appear. This feature may be enabled or disabled by programming selection:

- ENABLED: The controller will initiate a callout signal via the communication port to a remote connected device when the load is connected to the generator supply. The callout signal will be reset when the load transfers back to the utility supply.
- DISABLED: The controller will not initiate a callout when the load transfers to the generator supply.

5.3.5 Transfer Fail Callout

When the remote communication option is enabled, this programming prompt will appear. This feature may be enabled or disabled by programming selection.

- ENABLED: The controller will initiate a callout signal via the communication port to a remote connected device when the transfer switch fails to operate. The callout signal will only reset when the Fail to Transfer alarm is manually reset via local pushbuttons or with the remote communication software.
- DISABLED: The controller will not initiate a callout when a Fail to Transfer alarm condition occurs.

5.3.6 Auto Test Callout

When the remote communication option is enabled, this programming prompt will appear. This feature may be enabled or disabled by programming selection:

- ENABLED: The controller will initiate a callout signal via the communication port to a remote connected device when an automated test is initiated at the controller via the TSC 800 exercise timeclock. The callout signal will reset when the Auto Test condition is terminated.
- DISABLED: The controller will not initiate a callout when an Auto Test condition is initiated.

5.3.7 Man Test Callout

When the remote communication option is enabled, this programming prompt will appear. This feature may be enabled or disabled by programming selection:

- ENABLED: The controller will initiate a callout signal via the communication port to a remote connected device when a manual test is initiated at the controller via the TSC 800 pushbuttons or external control switch. The callout signal will reset when the Manual Test condition is terminated.
- DISABLED: The controller will not initiate a callout when a Manual Test condition is initiated.

5.3.8 Switch Not In Auto Callout

When the remote communication option is enabled, this programming prompt will appear. This feature may be enabled or disabled by programming selection:

- ENABLED: The controller will initiate a callout signal via the communication port to a remote connected device when the TSC 800 controllers' operating mode is Not In Auto as locally selected via the four position external control switch. The callout signal will reset when the control switch is returned to the Auto position.
- DISABLED: The controller will not initiate a callout if the TSC 800 controller is not in the Auto mode of operation.

5.3.9 Node Address

Set to unique controller address (1–255) for use with network connected TSC 800 controllers.

Note: This programming feature is only active when the remote communication option is enabled. Default setting for single TSC 800 applications is 1.

5.3.10 System Voltage

Set to nominal system voltage as expressed in phase to phase voltage. (e.g. A 347/600 volt system would be entered as 600.) The programmable range of values is 120V–15,000V.

5.3.11 Voltage Sensing Ratio

For direct voltage sensing wiring connections from 208 to 600 volts, enter a ratio of 1.0:1. When potential transformers are utilized for voltage sensing, enter the transformer ratio. (e.g. When using a 600:120 transformer, enter a ratio of 5.0:1). The ratio is programmable in tenths to allow minor correction factors to be used for nonstandard potential transformer ratios.

5.3.12 System Frequency

Set to nominal system frequency of either 50 Hz or 60 Hz.

5.3.13 System Phases

Set to match the power distribution system used on the automatic transfer switch (i.e. either single-phase or 3-phase system).

5.3.14 Load Sensing Phases

Note: The following feature is provided in TSC 800 Software version 2.0 (or higher).

Set to match the desired method of load bus voltage sensing required for the application (i.e. either single-phase or 3-phase system).

5.3.15 Phase Balance

Note: The following feature is provided in TSC 800 Software version 2.0 (or higher).

Set to the desired phase balance protection for the utility and generator supply on 3-phase systems. The setting is entered on a percentage basis with a range of 3%–30%. If the monitored supply voltage exceeds the programmed setpoint on any one phase, a transfer to the alternate source will be initiated following the phase balance time delay setting. To disable this feature set the percentage to 30%.

Note: The phase balance feature and program setting is only enabled when 3-phase sensing is selected.

5.3.16 Phase Balance Delay

Set to the desired time delay for the phase balance protection feature. The range of settings is 0–30 sec.

Note: The phase balance feature and program setting is only enabled when 3-phase sensing is selected.

5.3.17 Phase Balance Retransfer

Note: The following feature is provided in TSC 800 Software version 2.1 (or higher).

When the phase balance feature is enabled, this programming prompt will affect operation of the retransfer sequence following an abnormal phase balance condition. Two retransfer modes of operation are selectable as follows:

- AUTO: The controller will automatically initiate a retransfer sequence once the original sources phase balance condition returns within nominal limits as programmed.

  Note: The AUTO mode is the factory default setting for this feature.

- MAN: The controller will *not* automatically initiate a retransfer sequence following a phase balance alarm condition. To initiate a retransfer sequence, an operator must manually reset the phase balance alarm condition by pressing the LAMP TEST function on the controller faceplate (i.e. press and hold the DECREMENT and INCREMENT keys simultaneously) until the condition is reset.

5.4 Voltage Sensing

The TSC 800 controller provides 3-phase overvoltage and undervoltage sensing on both utility and generator supplies. Each sensor is individually programmable for pickup and dropout voltage setpoints (i.e. adjustable hysteresis) in addition to transient time delay settings. The TSC 800 controller also provides under and overfrequency sensing on both utility and generator supplies. Each sensor is individually programmable for pickup and dropout frequency setpoints (i.e. adjustable hysteresis) in addition to transient time delay settings. To program the frequency sensing features, refer to the

following descriptions. To program the voltage and frequency sensing features, refer to the following descriptions.

5.4.1 Utility Undervoltage Sensor Pickup

Set to the desired utility undervoltage setpoint at which the internal voltage sensor picks up (i.e. the sensor energizes to a normal state when all phases of the utility phase voltages are above the setpoint). The setting is entered based on a phase-to-phase voltage value within a range of 70%–99% of nominal system voltage.

Note: The difference between the pickup and dropout setting is considered the dead band or hysteresis value.

5.4.2 Utility Undervoltage Sensor Dropout

Set to the desired utility undervoltage setpoint at which the internal voltage sensor drops out (i.e. the sensor deenergizes to an abnormal state when any one of the utility phase voltages is below the setpoint). The setting is entered based on a phase-to-phase voltage value within a range of 70% to 99% of nominal system voltage.

Note: The difference between the pickup and dropout setting is considered the dead band or hysteresis value.

5.4.3 Utility Undervoltage Sensor Time Delay (Dropout)

Select the desired utility undervoltage time delay setting. The setting is entered in seconds within a range of 0-10 sec. If no delay is required, set this time delay to zero.

Note: The utility Under Voltage time delay function is enabled if the utility voltage drops below the setpoint on one or more phases and the voltage remains between the setpoint and 50% of nominal voltage. If the utility voltage drops below 50% of nominal value on all phases, the programmed time delay is automatically reduced to zero (0) seconds. If a time delay feature is required under any condition, set the utility Under Voltage time delay to zero and set the Generator Start Delay function to the desired time period. See Section 5.5.2, Generator Start Delay, for more information.

5.4.4 Utility Overvoltage Sensor Pickup

Set to the desired utility overvoltage setpoint at which the internal voltage sensor picks up (i.e. the sensor energizes to an abnormal state when any one phase of the utility voltage is above the setpoint). The setting is entered based on a phase-to-phase voltage value within a range of 101%–200% of nominal system voltage.

Note: The difference between the pickup and dropout setting is considered the dead band or hysteresis value.

5.4.5 Utility Overvoltage Sensor Dropout

Set to the desired utility overvoltage setpoint at which the internal voltage sensor drops out (i.e. the sensor deenergizes to a normal state when all phases of the utility voltage are below the setpoint). The setting is entered based on a phase-to-phase voltage value within a range of 101%–200% of nominal system voltage.

Note: The difference between the pickup and dropout setting is considered the dead band or hysteresis value.

5.4.6 Utility Overvoltage Sensor Time Delay (Pickup)

Select the desired utility overvoltage time delay setting. The setting is entered in seconds within a range of 0–5 sec. If no delay is required, set this time delay to zero.

5.4.7 Utility Underfrequency Sensor

Set to the desired utility underfrequency setpoint at which the internal frequency sensor drops out (i.e. the sensor deenergizes to an abnormal state when the utility frequency is below the setpoint). The setting is entered in a frequency value within a range of 25–49.9 Hz (for 50 Hz systems) and 30–59.9 Hz (for 60 Hz systems).

5.4.8 Utility Underfrequency Sensor Time Delay (Dropout)

Select the desired utility underfrequency time delay setting. The setting is entered in seconds within a range of 0–10 sec. If no delay is required, set this feature to zero.

5.4.9 Utility Overfrequency Sensor

Set to the desired utility overfrequency setpoint at which the internal frequency sensor picks up (i.e. the sensor energizes to an abnormal state when the utility frequency is above the setpoint). The setting is entered in a frequency value within a range of 50.1–100 Hz (for 50 Hz systems) and 60.1–120 Hz (for 60 Hz systems).

5.4.10 Utility Overfrequency Sensor Time Delay (Pickup)

Select the desired utility overfrequency time delay setting. The setting is entered in seconds within a range of 0–5 sec. If no delay is required, set this time delay to zero.

5.4.11 Generator Undervoltage Sensor Pickup

Set to the desired generator undervoltage setpoint at which the internal voltage sensor picks up (i.e. the sensor energizes to a normal state when all phases of the generator voltage are above the setpoint). The setting is entered based on a phase-to-phase voltage value within a range of 70%–99% of nominal system voltage.

Note: The difference between the pickup and dropout setting is considered the dead band or hysteresis value.

Note: The generator Under Voltage time delay is enabled if the utility voltage drops below the setpoint on one or more phases and the voltage remains between the setpoint and 50% of nominal voltage. If the utility voltage drops below 50% of nominal value on all phases, the programmed time delay is automatically reduced to zero (0) seconds. This feature reduces total transfer time back to the utility supply if the generator set shuts down or loses total voltage output for any reason.

5.4.12 Generator Undervoltage Sensor Dropout

Set to the desired generator undervoltage setpoint at which the internal voltage sensor drops out (i.e. the sensor deenergizes to an abnormal state when any one phase of the generator voltage is below the setpoint). The setting is entered based on a phase-to-phase voltage value within a range of 70%–99% of nominal system voltage.

Note: The difference between the pickup and dropout setting is considered the dead band or hysteresis value.

5.4.13 Generator Undervoltage Sensor Time Delay (Dropout)

Select the desired generator undervoltage time delay setting. The setting is entered in seconds within a range of 0–10 sec. If no delay is required, set this time delay to zero.

5.4.14 Generator Overvoltage Sensor Pickup

Set to the desired generator overvoltage setpoint at which the internal voltage sensor picks up (i.e. the sensor energizes to an abnormal state when any one phase of the generator voltage is above the setpoint). The setting is entered based on a phase-to-phase voltage value within a range of 101%–200% of nominal system voltage.

Note: The difference between the pick up and drop out setting is considered the dead band or hysteresis value.

5.4.15 Generator Overvoltage Sensor Dropout

Set to the desired generator overvoltage setpoint at which the internal voltage sensor drops out (i.e. the sensor deenergizes to a normal state when all phases of the generator voltage are below the setpoint). The setting is entered based on a phase-to-phase voltage value within a range of 101%–200% of nominal system voltage.

Note: The difference between the pickup and dropout setting is considered the dead band or hysteresis value.

5.4.16 Generator Overvoltage Sensor Time Delay (Pickup)

Select the desired generator overvoltage time delay setting. The setting is entered in seconds within a range of 0–5 sec. If no delay is required, set this time delay to zero.

5.4.17 Generator Underfrequency Sensor

Set to the desired generator underfrequency setpoint at which the internal frequency sensor drops out (i.e. the sensor deenergizes to an abnormal state when the generator frequency is below the setpoint). The setting is entered in a frequency value within a range of 25–49.9 Hz (for 50 Hz systems) and 30–59.9 Hz (for 60 Hz systems).

5.4.18 Generator Underfrequency Sensor Time Delay (Dropout)

Select the desired generator underfrequency time delay setting. The setting is entered in seconds within a range of 0–10 sec. If no delay is required, set this time delay to zero.

5.4.19 Generator Overfrequency Sensor

Set to the desired generator overfrequency setpoint at which the internal frequency sensor picks up (i.e. the sensor energizes to an abnormal state when the generator frequency is above the setpoint). The setting is entered in a frequency value within a range of 50.1–100 Hz (for 50 Hz systems) and 60.1–120 Hz (for 60 Hz systems).

5.4.20 Generator Overfrequency Sensor Time Delay (Pickup)

Select the desired generator overfrequency time delay setting. The setting is entered in seconds within a range of 0–5 sec. If no delay is required, set this time delay to zero.

5.5 Generator Control Logic

The TSC 800 provides control and delay logic specific to the operation of the generator. These are as described in Sections 5.5.1 through 5.5.19.

5.5.1 Commit to Transfer Logic

The TSC 800 transfer switch controller contains a COMMIT TO TRANSFER logic selection feature. This feature is user-programmable and allows 2 different functional settings which are described below:

- DISABLED: The transfer switch will not commit to transfer after the engine start delay has expired.
- ENABLED: The transfer switch will commit to transfer after the engine start delay has expired. Selecting the ENABLED mode will prevent numerous engine starting and stopping sequences if the utility supply is continuously fluctuating beyond the pre-set limits. The feature is automatically cancelled after 5 min. if the generator fails to start or can be manually cancelled by placing the ATS Menu Mode in OFF and then back to AUTO.

5.5.2 Generator Start Delay

The generator (i.e. engine) start signal will be initiated following expiry of the start delay timer. Select desired generator start delay time in seconds. The range of setting is 0–60 sec. If no delay is required, set this time delay to zero.

Note: The output relay is normally energized when the utility power is within limits and deenergizes to start the generator.

5.5.3 Generator Warmup Delay

A transfer to the generator supply will be initiated when the voltage and frequency are within limits and upon expiry of the warmup delay timer. Select desired generator warmup delay time in seconds. The range of settings is 0–3000 sec. If no delay is required, set this time delay to zero.

5.5.4 Generator Cooldown Delay

The generator (i.e. engine) cooldown period will be initiated once the load has transferred from the generator supply. The engine start signal will be maintained until expiry of the cooldown delay timer. Select desired generator cooldown delay time in minutes. The range of settings is 0–60 min. If no delay is required, set this time delay to zero. Cooldown time is posted in 1-sec. decrements when active.

5.5.5 Pretransfer Delay (LDC)

The pretransfer delay period will be initiated upon an impending transfer in either direction from a powered-to-powered source. The pretransfer output relay will momentarily energize (as per the pretransfer time setting) prior to a load transfer and will stay energized until the post transfer delay time commences. Select desired predelay time in seconds. The range of settings is 0–300 sec. If no delay is required, set this time delay to zero.

5.5.6 Post Transfer Delay (LDC)

The post transfer delay period will be initiated expiry of the pretransfer delay (overlapping) in either direction. The post transfer output relays will energize (as per the post transfer time setting) after the load transfer and will stay energized until the post transfer delay time period

expires. Select desired post-delay time in seconds. The range of settings is 0–300 sec. If no delay is required, set this time delay to zero.

5.5.7 Transfer Logic

Note: This feature is user-selectable in TSC 800 software version 1.3 (or greater). The TSC 800 transfer controller software contains a user-selectable function for type of transfer logic required for specific applications. This feature will be factory-set for specific type of application and transfer mechanism used and, therefore, should not require resetting.

Selectable operating logic is as follows:

- MAINTAINED: The TSC 800 transfer output signals will stay in the MAINTAINED energized state upon a source failure and will only deenergize when the alternate source becomes available. The transfer output signal will deenergize upon a total loss of source voltage.
- DROPOUT: The TSC 800 transfer output signals will DROPOUT (or deenergize) when the connected source goes out-of-normal voltage or frequency limits. The transfer output signal will only reenergize when the connected source returns to normal limits.

5.5.8 Load on Utility Programmable Output

Note: The following programmable output features are provided in TSC 800 Software version 2.0 (or higher).

The TSC 800 transfer controller output on terminal TB3-2 may be programmed for different control functions. The powered output is supplied from the Utility supply and must be used accordingly. The following programmable functions are available.

Note: Only one function can be programmed.

- LOAD ON UTILITY: Output energizes when the utility transfer power-switching device is closed.
- UTILITY NORMAL: Output energizes when the utility supply is energized and is within nominal voltage and frequency limits.
- DELAYED TRANSFER: Output will energize X seconds following a Transfer to Utility logic signal. The time period is programmable 0–30 sec.

Note: The delayed transfer output time is bypassed if the original connected source loses voltage.

5.5.9 Load on Generator Programmable Output

The following programmable output features are provided in TSC 800 Software version 2.0 (or higher).

The TSC 800 transfer controller output on terminal TB3-7 may be programmed for different control functions. The powered output is supplied from the Generator supply and must be used accordingly. The following programmable functions are available.

Note: Only one function can be programmed.

- LOAD ON GENERATOR: Output energizes when the generator transfer power-switching device is closed.
- GENERATOR NORMAL: Output energizes when the generator supply is energized and is within nominal voltage and frequency limits.
- DELAYED TRANSFER: Output will energize X seconds following a Transfer to generator logic signal. The time period is programmable 0– 30 sec.

Note: The delayed transfer output time is bypassed if the original connected source loses voltage.

5.5.10 Maximum Find Neutral Delay

The TSC 800 transfer control logic includes an adjustable time delay feature to compensate for the maximum time that a transfer switch mechanism takes to operate when load-sensing voltage is used to detect the neutral position. This time delay is set to a time value, which is greater than the typical time that the transfer mechanism typically takes to operate from one supply position to the neutral position. When the TSC 800 controller is supplied from the factory with a transfer mechanism, the Maximum Find Neutral Delay will be factory-set for correct operation.

When the TSC 800 controller is supplied loose without a transfer mechanism, the Maximum Find Neutral Delay function must be user set for correct operation with the applicable transfer mechanism. For applications using electrically held contactors, the Maximum Find Neutral Delay function must typically be set for 0 sec. for correct operation.

5.5.11 Neutral Delay Timer (NDT)

The neutral delay time period will be initiated once both of the supply power-switching devices are open during a transfer sequence. Select desired neutral delay time in

seconds. The range of settings is 0–60 sec. If no delay is required, set this time delay to zero.

Note: The neutral delay may be bypassed should the operating power fail for longer than the timer setting.

Note: The NDT time period may be reduced if the neutral delay bypass is enabled. See Section 5.5.12 for more information.

5.5.12 Neutral Delay Bypass

The TSC 800 transfer switch controller contains a NEUTRAL DELAY BYPASS logic, which allows a shorter neutral delay period during transfer if the load bus voltage falls to safe levels before the transfer sequence is completed. This feature is user-programmable and allows two different functional settings that are described below:

- DISABLED: The transfer switch neutral delay period will operate as per the Neutral Delay Timer setting.

- ENABLED: The transfer switch neutral delay period will be bypassed if the load bus voltage falls to safe levels before the transfer sequence is completed.

5.5.13 Maximum Transfer Time

The TSC 800 transfer control logic includes an adjustable time delay feature to detect when a transfer switch mechanism fails to operate. This time delay is set to a time value greater than the typical time that the transfer mechanism typically takes to operate from one supply position to the opposite supply position. This feature is factory-set to match the specific transfer switch mechanism as supplied with the unit.

5.5.14 Transfer Fail

The TSC 800 transfer switch controller contains a TRANSFER SWITCH FAIL detection feature. This feature is user-programmable and allows three different functional settings that are described below:

- DISABLED: The TRANSFER SWITCH FAIL feature is disabled in this mode. The TSC 800 controller will not verify that the transfer mechanism has operated correctly.

- HALT TRANSFER: The TSC 800 controller will verify that the transfer switch mechanism has correctly transferred or is in the correct position. If the TSC 800 controller senses an abnormal condition (i.e. load voltage and transfer switch position contacts are not at the normal levels or states) the controller will activate an alarm message to the LCD display.

  Note: The transferring output signals from the controller will be deactivated and the engine start contact will remain in its last state (before the alarm was activated).

  The controller has an internal 30-sec. timer to provide an alarm bypass to enable correct operating sequences. To reset the alarm condition, the lamp test function must be activated.

- FORCE TRANSFER: The TSC 800 controller will verify that the transfer switch mechanism has correctly transferred or is in the correct position. If the TSC 800 controller senses an abnormal condition (i.e. fail to transfer when initiated, load voltage failure due to a tripped transfer power-switching device or transfer switch limit switch failure) the controller will activate an alarm message to the LCD display. The transferring output signals from the controller will be enabled and will force a transfer to the alternate source if available and within nominal limits.

  Note: The transfer switch will remain on the alternate source indefinitely until the Transfer Fail alarm condition is manually reset on the TSC 800 controller.

  The controller has an internal 30-sec. timer to provide an alarm bypass to enable correct operating sequences. To reset the alarm condition, the lamp test function must be activated.

Note: The factory default setting for the TSC 800 Transfer Switch Fail function is FORCE TRANSFER.

5.5.15 Manual Utility Transfer Return

The TSC 800 transfer switch controller contains a MANUAL UTILITY TRANSFER RETURN feature, which allows an operator initiated retransfer sequence to occur when utility power has returned following a power failure. This feature is user-programmable and allows two different functional settings which are described below:

- DISABLED: The transfer switch will automatically retransfer back to the utility supply if within nominal preprogrammed limits and following expiry of the Utility Return Timer.

- ENABLED: The transfer switch will remain on the generator supply until system operators manually initiate the retransfer sequence. Press Lamp Test to initiate the transfer sequence.

Note: The transfer switch will automatically retransfer back to the utility supply if the generator supply fails.

5.5.16 Utility Return Delay

The utility return delay period will be initiated once the utility supply has returned within limits following a utility power failure condition. Select desired utility return delay time in minutes. The range of settings is 0-60 min. If no delay is required, set this time delay to zero.

Note: The utility return delay will be bypassed should the generator fail during the time delay period.

5.5.17 Max Sync Time

The TSC 800 transfer control logic includes an adjustable time delay for maximum synchronizing time for Closed Transition type automatic transfer Switches. If the selected time expires before the transfer switch sources are synchronized, the Transfer Fail logic will be initiated. Select desired time in minutes. The range of settings is 1–10 min. (displays in 1 sec. decrements when timer active). This feature is only operative when the TSC 800 Closed Transition Input (TB2-12) is activated.

5.5.18 Max Power Switching Device Open Time

The TSC 800 transfer control logic includes an adjustable time delay for maximum allowable time both source power-switching devices can remain closed (in parallel) before opening on a Closed Transition type automatic transfer Switch (detects for a fail to separate condition). If the selected time expires before the transfer switch power-switching device opens (sources being separated from), the Transfer Fail logic will be initiated. Select desired time in seconds. The range of settings is 1–999 sec. This feature is only active when the TSC 800 Closed Transition Input (TB2-12) is activated.

5.5.19 Programmable Output

The TSC 800 transfer controller includes a standard programmable output relay signal. The output relay energizes when one of the following conditions occurs. Only one function may be programmed.

- LOAD ON UTIL: Output energizes when the utility transfer power-switching device is closed and load voltage is present.
- LOAD ON GEN: Output energizes when the generator transfer power-switching device is closed and load voltage is present.
- LOAD SHED: Output energizes when generator is on load and frequency drops below underfrequency setpoint for longer than the time delay setting.
- FAIL TO TRANSFER: Output relay energizes when the transfer switch mechanism fails to operate for the given time delay period.

  Note: This output feature is only activated when the TRANSFER SWITCH FAIL feature is set to either Halt or Force transfer settings.

The following programmable output features are provided in TSC 800 Software version 2.0 (or higher).

- UTIL NORMAL: Output relay energizes when the utility supply is energized and is within programmed voltage, frequency and phase balance limits on all phases.
- GEN NORMAL: Output relay energizes when the generator supply is energized and is within programmed voltage, frequency and phase balance limits on all phases.
- ATS NOT IN AUTO: Output relay energizes when the TSC 800 operating mode is not in the AUTO operating mode. This condition will occur when the external switch (e.g. FTS4) or internal Test Modes is programmed in any other mode other than Auto.
- 2nd ENGINE START: Output relay deenergizes when the TSC 800 signal an engine start operation due to a failed Utility supply or activated Test mode.
- UTIL and GEN NORMAL: Output relay energizes when the generator supply and utility supply are both energized and are within programmed voltage, frequency and phase balance limits on all phases.

5.6 Voltage Sensing Calibration

The TSC 800 software program provides voltage-sensing calibration for the utility, generator, and load sensors. All voltage-sensing circuits are factory-calibrated to specific voltage levels prior to shipment of the transfer switch. Recalibration in the field is rare and in most cases only the Span Calibration needs minor adjustment. Zero calibration should only be undertaken by qualified personnel due to the nature of the requirements to achieve proper zeroing.

Factory zero calibration should provide accurate readings with no adjustments required. Zero calibration is only required on first time setup of new software where zero correction factors are unknown. Using the original correction factors determined at the factory as noted on the supplied Program Data Sheets can be reapplied as these values are associated to sensing resistor error factors of the TSC 800 circuit board (not a software offset).

Should field calibration of any voltage-sensing circuitry be required, the following procedure may be used.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

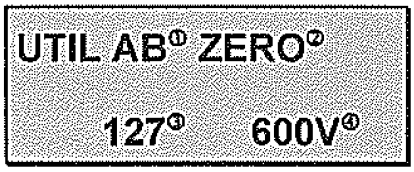
Only authorized personnel should open the enclosure.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

5.6.1 General

1. To access the TSC 800's software programming loop for programming, select the program menu, enter the Yes prompt ,and enter the Read/ Write Security Mode password number (or higher).

2. Once the programming loop has been accessed, scroll to the voltage calibration screens as shown in Figure 5-3.



1. Displays the selected supply's phase voltages to be calibrated.

2. Displays the type of calibration function, either ZERO or SPAN.

3. Displays the calibration correction factor number (0–255) used to obtain the correct voltage reading. **Note:** To correctly calibrate any of the voltage sensors, the ZERO function must be calibrated before the SPAN function. A calibration correction factor number of 127 is typical of no correction offset being applied, decreasing this value will apply a negative offset and increasing this value will apply a positive offset.

4. Displays the actual voltage measurement, which will be the same value as shown on the TSC 800 display menus for generator or utility supplies. This voltage reading may be calibrated higher or lower by changing the correction factor number and compared to a meter of known calibration to be within 0.5% or better and adjusted to match.

Figure 5-3 Voltage Calibration Screen

Note: To accurately calibrate the TSC 800's voltage sensors, an external test voltage meter is required, with an accuracy of 0.5% or better.

5.6.2 Utility Voltage Calibration

To adjust the utility supply voltage sensors, perform the following procedure:

Zero Calibration

1. Energize the generator supply to power up the controller and deenergize the utility supply.

2. Scroll to the desired utility supply voltage phases with the ZERO function selected. The phases being calibrated for zero must have a true zero reference to ground to allow proper calibration. A zero voltage reference should be achieved as a result of a near 0 ohms resistance through the source supply windings through to the neutral star point connection, which in turn is solidly bonded to

the building ground at one point in the system. Where both the step-down sensing and power supply transformers are supplied with the transfer switch, the ground reference is provided by these transformers and no further actions are required. Where this ground reference path does not exist, a true zero voltage reference may not be achievable (upstream breaker ahead of the TSC 800 open in respect to the building utility supply transformer), as this leaves the sensing inputs to the TSC 800 floating. In cases such as this, the TSC 800 sensing inputs for the Utility supply must temporarily be grounded to provide this true zero reference.

Note: Should this work be undertaken, it is imperative that only qualified personnel perform this procedure and that the shorting leads be removed before reenergizing the circuit. Failure to do so will result in catastrophic equipment failure and possible personnel injury and/or death.

3. Use the INCREMENT or DECREMENT pushbuttons to adjust the correction factor number while observing the displayed voltage level. Adjust the correction factor number to obtain 0 VAC on the display.

4. With the correct voltage displayed, press the ENTER pushbutton to accept the correction factor number. Record the correction factor number on the TSC 800 programming sheet for future reference, if required.

Repeat the above procedure for Zero Calibration for all remaining phases of the utility supply as required. Remove any shorting leads that were used for zeroing purposes before proceeding.

Span Calibration

1. Energize the utility supply voltage to the controller at nominal level. The generator supply may be deenergized.

2. In the programming mode, scroll to the desired utility supply voltage phases with the SPAN function selected (do not adjust the Zero calibration function with voltage applied as this will result in nonlinear voltage readings).

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

3. Connect an external AC voltmeter of adequate voltage range and accuracy to the TSC 800 controller terminal associated with the voltage phases to be calibrated.

4. Use the INCREMENT or DECREMENT pushbuttons to adjust the correction factor number while observing the displayed voltage level on the TSC 800. Adjust the correction factor number to obtain an identical voltage reading as measured with the external AC voltmeter. To attain the highest degree of calibration accuracy for the Span, adjust the correction factor to attain a TSC 800 voltage value of 1 volt above and 1 volt below the actual value, in each case note the correction factor number required to attain these values, select the correction number mid point between these two values and apply this value.

5. With the correct voltage displayed, press the ENTER pushbutton to accept the correction factor number. Record the correction factor number on the TSC 800 programming sheet for future reference, if required.

6. Repeat the above procedures for all remaining phases of the utility supply as required.

Note: Once the span calibration setting has been done, do not readjust any zero calibration points as this will cause incorrect voltage readings.

5.6.3 Generator Voltage Calibration

To adjust the generator supply voltage sensors, perform the following procedure:

Zero Calibration

1. Energize the utility supply to power up the controller and deenergize the generator supply.

2. Scroll to the desired generator supply voltage phases with the ZERO function selected. The phases being calibrated for zero must have a true zero reference to ground to allow proper calibration. A zero voltage reference should be achieved as a result of a near 0 ohms resistance through the source supply windings through to the neutral star point connection which in turn is solidly bonded to the building ground at one point in the system. Where both the step-down sensing and power supply transformers are supplied with the transfer switch, the ground reference is provided by these transformers and no further actions are required. Where this ground reference path does not exist, a true zero voltage reference may not be achievable (upstream breaker ahead of the TSC 800 is open with respect to the generator set alternator windings), as this leaves the sensing inputs to the TSC 800 floating. Simply closing the local generator breaker will generally provide the zero voltage reference required. If this is not possible the TSC 800 sensing inputs for the generator must be temporarily grounded to provide this true zero reference.

   Note: Should this work be undertaken, it is imperative that only qualified personnel perform this procedure and that the shorting leads be removed before reenergizing the circuit. Failure to do so will result in catastrophic equipment failure and possible personnel injury and/or death.

3. Use the INCREMENT or DECREMENT pushbuttons to adjust the correction factor number while observing the displayed voltage level. Adjust the correction factor number to obtain 0 VAC on the display.

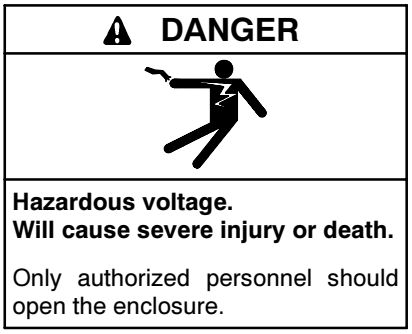
4. With the correct voltage displayed, press the ENTER pushbutton to accept the correction factor number. Record the correction factor number on the TSC 800 programming sheet for future reference, if required.

5. Repeat the above procedure for all remaining phases of the generator supply as required.

Span Calibration

1. Energize the utility supply voltage to the controller at nominal level. The generator supply may be deenergized.

2. In the programming mode, scroll to the desired generator supply voltage phases with the SPAN function selected.



Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

3. Connect an external AC voltmeter of adequate voltage range and accuracy to the TSC 800 controller terminal associated with the voltage phases to be calibrated.

4. Use the INCREMENT or DECREMENT pushbuttons to adjust the correction factor number while observing the displayed voltage level on the TSC 800. Adjust the correction factor number to obtain an identical voltage reading as measured with the external AC voltmeter. To attain the highest degree of calibration accuracy for the Span, adjust the correction factor to attain a TSC 800 voltage value of 1 volt above and 1 volt below the actual value. In each case note the correction factor number required to attain these values, select the correction number midpoint between these two values, and apply this value.

5. With the correct voltage displayed, press the ENTER pushbutton to accept the correction factor number. Record the correction factor number on the TSC 800 programming sheet for future reference if required.

6. Repeat the above procedures for all remaining phases of the generator supply as required. Once the span calibration setting has been done, do not readjust any zero calibration points as this will cause incorrect voltage readings.

5.6.4 Load Voltage Calibration

To adjust the load voltage sensors, perform the following procedure:

Zero Calibration

1. Energize the utility supply but keep the transfer mechanism in the neutral position (i.e. Load Bus Deenergized).

2. Scroll to the desired load supply voltage phases with the ZERO function selected. The phases being calibrated for zero must have a true zero reference to ground to allow proper calibration. A zero voltage reference will not likely be available if there are no connected loads which result of a near 0 ohms resistance through to ground. Where step-down sensing transformers are supplied with the transfer switch, the ground reference is provided by these transformers and no further actions are required. Where this ground reference path does not exist, a true zero may not be achievable, as the load sensing inputs to the TSC 800 will be floating. If this ground path does not exist, the TSC 800 sensing inputs for the load bus must be temporarily grounded to provide this true zero reference.

   Note: Should this work be undertaken, it is imperative that only qualified personnel perform this procedure and that the shorting leads be removed before reenergizing the circuit. Failure to do so will result in catastrophic equipment failure and possible personnel injury and/or death.

3. Use the INCREMENT or DECREMENT pushbuttons to adjust the correction factor number while observing the displayed voltage level. Adjust the correction factor number to obtain 0 VAC on the display.

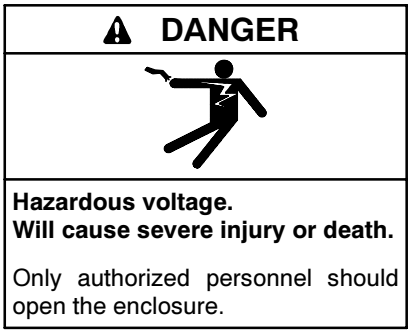
4. With the correct voltage displayed, press the ENTER pushbutton to accept the correction factor number. Record the correction factor number on the TSC 800 programming sheet for future reference if required.

5. Repeat the above procedure for all remaining phases of the generator supply as required.

Span Calibration

1. Energize the utility supply voltage to the controller at nominal level. The generator supply may be deenergized.

2. In the programming mode, scroll to the desired generator supply voltage phases with the SPAN function selected.



Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

3. Connect an external AC voltmeter of adequate voltage range and accuracy to the TSC 800 controller terminal associated with the voltage phases to be calibrated.

4. Use the INCREMENT or DECREMENT pushbuttons to adjust the correction factor number while observing the displayed voltage level on the TSC 800. Adjust the correction factor number to obtain an identical voltage reading as measured with the external AC voltmeter. To attain the highest degree of calibration accuracy for the

Span, adjust the correction factor to attain a TSC 800 voltage value of 1 volt above and 1 volt below the actual value. In each case note the correction factor number required to attain these values, select the correction number midpoint between these two values, and apply this value.

5. With the correct voltage displayed, press the ENTER pushbutton to accept the correction factor number. Record the correction factor number on the TSC 800 programming sheet for future reference if required.

6. Repeat the above procedures for all remaining phases of the generator supply as required.

7. Once the span calibration setting has been done, do not readjust any zero calibration points as this will cause incorrect voltage readings.

5.7 Programming Data Sheets

TSC 800
MICROPROCESSOR TRANSFER SWITCH CONTROLLER
SUMMARY CONFIGURATION DATA SHEET

FIRMWARE VERSION: TSC v2.1 ATS

WORK ORDER:	W-032002	REV.:	0	REV. DATE:	06/02/06
		CUSTOMER:		DEFAULT PROGRAM:	800_V21_M480
INITIATED BY:		PROJECT NAME	N/A		
DATE:	06/02/06	NOTES:			

SYSTEM AC INPUTS

SYSTEM AC VOLTS: 480 PHASES: 3 FREQUENCY: 60

DIGITAL DISPLAY FEATURES

- ☑ GENERATOR A.C VOLTAGE
- ☑ GENERATOR FREQUENCY
- ☑ UTILITY A.C VOLTAGE
- ☑ UTILITY FREQUENCY
- ☑ TIME/CLOCK

STANDARD FEATURES

GENERATOR WARM UP TIMER
GENERATOR START DELAY TIMER
GENERATOR COOLDOWN TIMER
3 PHASE GENERATOR UNDER/OVER VOLTAGE SENSING
GENERATOR UNDER/OVER FREQUENCY SENSING
3 PHASE UTILITY UNDER/OVER VOLTAGE SENSING
GENERATOR OVER VOLTAGE SENSING
UTILITY UNDER/OVER FREQUENCY SENSING
UTILITY RETURN TIMER
3 PHASE UTILITY UNDERVOLTAGE SENSING
NEUTRAL DELAY TIMER
INTERNAL FTS4 SWITCH WITH PW PROTECT
COMMUNICATION
MANUAL TEST
AUTO EXERCISE TIMER

STANDARD PROGRAMMABLE OUTPUTS

OUTPUT NAME	OUTPUT FUNCTION
PROGRAMMABLE OUTPUT	LoadOnGen

Printed 06/03/22 egorjanu ☑ Indicates changes from the default program Page 1 of 4

WORK ORDER: W-012345	REV.: 0	REV. DATE:	06/04/25
	CUSTOMER:	DEFAULT PROGRAM.:	600_V21_M480
INITIATED BY:	PROJECT NAME		
DATE:	NOTES:		

PARAMETER	DESCRIPTION		VALUE	RANGE
FIRMWARE V2.1 06/01/15			V2.1 06/01/15	
ATSMode	ATS MODE	☐	Auto	
ATSModeTimeout	ATS MODE TIMEOUT	☐		
ATSModeMenuPW	ATS MODE MENU PASSWORD	☐	Disabled	
ResetStats	RESET STATISTICS	☐	NO	(Enter 85 to clear)
CALLOUTS				
UtilFailCallout	UTILITY FAIL CALLOUT	☐	Disabled	
LoadOnGenCallout	LOAD ON GENERATOR CALLOUT	☐	Disabled	
TransferFailCallout	TRANSFER FAIL CALLOUT	☐	Disabled	
SwitchNotInAutoCallout	SWITCH NOT IN AUTO CALLOUT	☐	Disabled	
MenuNotInAutoCallout	MENU NOT IN AUTO CALLOUT	☐	Disabled	
AutoTestCallout	AUTO TEST CALLOUT	☐	Disabled	
EXERCISE TIMER				
SystemTimeRollover	SYSTEM TIME ROLLOVER	☐	7 Day	7/14/21/28 Days
AutoTestStartDay	AUTO TEST START DAY	☐	Wednesday1	Day Of Week
AutoTestStartHour	AUTO TEST START HOUR	☐	10	0-23 HOUR
AutoTestStartMin	AUTO TEST START MIN	☐	0	0-59 MIN
AutoTestStoptDay	AUTO TEST STOP DAY	☐	Wednesday1	Day Of Week
AutoTestStopHour	AUTO TEST STOP HOUR	☐	10	0-23 HOUR
AutoTestStopMin	AUTO TEST STOP MIN	☐	30	0-59 MIN
AutoTestMode	AUTO TEST MODE	☐	Auto	Auto/Offload/Onload
SYSTEM CONFIGURATION				
Node Address	NODE ADDRESS	☐	1	0-255 #
SystemVoltage	SYSTEM VOLTAGE	☐	480	120-15,000 VAC
VoltageSensingRatio	VOLTAGE SENSING RATIO	☐	1.0	0.0-209.0 RATIO
SystemFrequency	SYSTEM FREQUENCY	☐	60	50/60
SystemPhases	SYSTEM PHASES	☐	3	1/3
LoadSensingPhases	LOAD SENSING PHASES	☐	3	1/3
PhaseBalance	PHASE BALANCE	☐	6	3-30 %
PhaseBalanceDelay	PHASE BALANCE DELAY	☐	10	0-30 SEC

WORK ORDER: W-012345	REV.: 0	REV. DATE:	06/04/25
	CUSTOMER:	DEFAULT PROGRAM.:	800_V21_M480
INITIATED BY:	PROJECT NAME		
DATE:	NOTES:		

PhaseBalanceReset	PHASE BALANCE RESET	☐	AUTO	Auto/Manual
UTILITY UNDERVOLTAGE				
UtilUnderVoltPU	UTILITY UNDERVOLTAGE SENSORS PICKUP	☐	432	240-479 VAC
UtilUnderVoltDO	UTILITY UNDERVOLTAGE SENSORS DROPOUT	☐	384	240-479 VAC
UtilUnderVoltDODelay	UTILITY UNDERVOLTAGE SENSORS TIME DELAY DROPOUT	☐	1	1-10 SEC
UTILITY OVERVOLTAGE				
UtilOverVoltPU	UTILITY OVERVOLTAGE SENSORS PICKUP	☐	528	481-960 VAC
UtilOverVoltDO	UTILITY OVERVOLTAGE SENSORS DROPOUT	☐	518	481-960 VAC
UtilOverVoltPUDelay	UTILITY OVERVOLTAGE SENSORS TIME DELAY PICKUP	☐	5	0-5 SEC
UTILITY UNDER AND OVER FREQUENCY SENSORS				
UtilUnderFreq	UTILITY UNDER FREQUNCY SENSORS	☐	59.0	30.0-59.9 HZ
UtilUnderFreqDODelay	UTILITY UNDER FREQUNCY SENSORS TIME DELAY DROPOUT	☐	10	0-10 SEC
UtilOverFreq	UTILITY OVER FREQUENCY PICKUP	☐	61.0	60.1-120.0 HZ
UtilOverFreqPUDelay	UTILITY OVER FREQUNCY SENSORS TIME DELAY PICKUP	☐	5	0-5 SEC
GENERATOR UNDERVOLTAGE				
GenUnderVoltPU	GENERATOR UNDERVOLTAGE SENSORS PICKUP	☐	432	240-479 VAC
GenUnderVoltDO	GENERATOR UNDERVOLTAGE SENSORS DROPOUT	☐	384	240-479 VAC
GenUnderVoltDODelay	GENERATOR UNDERVOLTAGE SENSORS TIME DELAY DROPOUT	☐	5	1-10 SEC
GENERATOR OVERVOLTAGE				
GenOverVoltPU	GENERATOR OVERVOLTAGE SENSORS PICKUP	☐	528	481-960 VAC
GenOverVoltDO	GENERATOR OVERVOLTAGE SENSORS DROPOUT	☐	518	481-960 VAC
GenOverVoltPUDelay	GENERATOR OVERVOLTAGE SENSORS TIME DELAY PICKUP	☐	5	0-5 SEC
GENERATOR UNDER/OVERFREQUENCY FREQUENCY SENSORS				
GenUnderFreq	GENERATOR UNDER FREQUENCY SENSORS DROPOUT	☐	57.0	30.0-59.9 HZ
GenUnderFreqDODelay	GENERATOR UNDER FREQUENCY SENSORS TIME DELAY DROPOUT	☐	5	0-10 SEC
GenOverFreq	GENERATOR OVER FREQUENCY SENSORS PICKUP	☐	63.0	60.1-120.0 HZ

WORK ORDER: W-012345	REV.: 0	REV. DATE:	06/04/25
	CUSTOMER:	DEFAULT PROGRAM.:	600_V21_M480
INITIATED BY:	PROJECT NAME		
DATE:	NOTES:		

GenOverFreqPUDelay	GENERATOR OVER FREQUENCY SENSORS TIME DELAY PICKUP	☐	5	0-5 SEC
GENERATOR CONTROL LOGIC				
CommitToTransfer	GENERATOR COMMIT TO TRANSFER	☐	Disabled	
GenStartDelay	GENERATOR START DELAY	☐	2	0-60 SEC
GenWarmupDelay	GENERATOR WARM-UP DELAY	☐	2	0-3,000 SEC
GenCooldownDelay	GENERATOR COOLDOWN DELAY	☐	2.0	0.0-60.0 MIN
ELEVATOR DELAY LOGIC				
PretransferDelay	PRE-TRANSFER DELAY	☐	0	0-300 SEC
PosttransferDelay	POST TRANSFER DELAY	☐	0	0-300 SEC
ATS MECHANISM LOGIC				
TransferOutputLogic	TRANSFER OUTPUT LOGIC	☐	Maintain	
LoadOnUtilOutput	LOAD ON UTILITY OUTPUT	☐	UtilNormal	
UtilTransferDelay	UTILITY TRANSFER DELAY	☐	0.0	0.0-30.0 SEC
LoadOnGenOutput	LOAD ON GENERATOR OUTPUT	☐	GenNormal	
GenTransferDelay	GENERATOR TRANSFER DELAY	☐	0.0	0.0-30.0 SEC
MaxFindNeutralTime	MAXIMUM FIND NEUTRAL TIME	☐	6.0	0.0-20.0 SEC
NeutralDelay	NEUTRAL DELAY	☐	3	0-120 SEC
NeutralDelayBypass	NEUTRAL DELAY BYPASS	☐	Disabled	
MaxTransferTime	MAXIMUM TRANSFER TIME	☐	15	0-30 SEC
Transfer Fail	TRANSFER FAIL	☐	ForceTransfer	
ManualReturn	MANUAL RETURN	☐	Disabled	
UtilReturnDelay	UTILITY RETURN DELAY	☐	2.0	0.0-60.0 MIN
CLOSED TRANSITION LOGIC				
MaxSyncTime	MAXIMUM SYNCHRONIZING TIME	☐	1	0-99 MIN
MaxPSDOpenTime	MAXIMUM POWER SWITCHING DEVICE OPEN TIME	☐	1	1-999 SEC
PROGRAMABLE OUTPUTS LOGIC				
ProgramableOutput	PROGRAMMABLE OUTPUT	☐	LoadOnGen	
VOLTAGE CALIBRATION				

TSC 800
MICROPROCESSOR TRANSFER SWITCH CONTROLLER
CALIBRATION DATA

FIRMWARE VERSION: TSCv2..1 ATS

WORK ORDER: W-012345 REV.: 0 REV. DATE: 06/03/22

CUSTOMER: DEFAULT PROGRAM 800_V21_M480

INITIATED BY: PROJECT NAME:

DATE: NOTES:

CONTROLLER S/N: W-12345405

CALIBRATED BY:

CALIBRATION DATE: 06/02/06

UtilABZero	UTILITY PHASE A-B ZERO	125	0-255
UtilABSpan	UTILITY PHASE A-B SPAN	111	0-255
UtilBCZero	UTILITY PHASE B-C ZERO	125	0-255
UtilBCSpan	UTILITY PHASE B-C SPAN	111	0-255
UtilCAZero	UTILITY PHASE C-A ZERO	125	0-255
UtilCASpan	UTILITY PHASE C-A SPAN	110	0-255
GenABZero	GENERATOR PHASE A-B ZERO	125	0-255
GenABSpan	GENERATOR PHASE A-B SPAN	110	0-255
GenBCZero	GENERATOR PHASE B-C ZERO	125	0-255
GenBCSpan	GENERATOR PHASE B-C SPAN	111	0-255
GenCA Zero	GENERATOR PHASE C-A ZERO	125	0-255
GenCA Span	GENERATOR PHASE C-A SPAN	116	0-255
LoadABZero	LOAD PHASE A-B ZERO	125	0-255
LoadABSpan	LOAD PHASE A-B SPAN	120	0-255
LoadBCZero	LOAD PHASE B-C ZERO	125	0-255
LoadBCSpan	LOAD PHASE B-C SPAN	121	0-255
LoadCAZero	LOAD PHASE C-A ZERO	125	0-255
LoadCASpan	LOAD PHASE C-A SPAN	120	0-255

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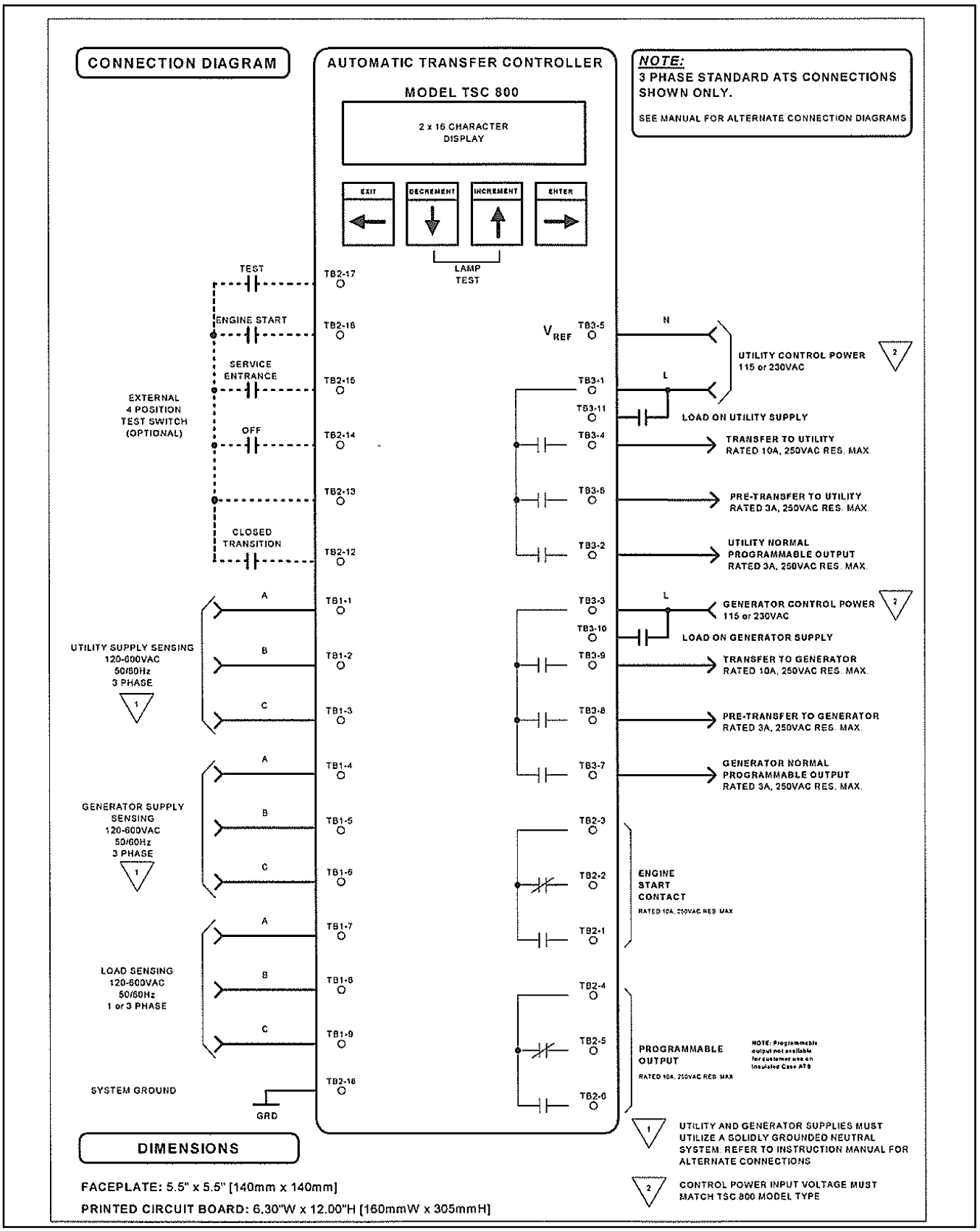
CONNECTION DIAGRAM
AUTOMATIC TRANSFER CONTROLLER
MODEL TSC 800
2 x 16 CHARACTER DISPLAY
EXIT
DECREMENT
INCREMENT
ENTER
LAMP TEST
NOTE:
3 PHASE STANDARD ATS CONNECTIONS SHOWN ONLY.
SEE MANUAL FOR ALTERNATE CONNECTION DIAGRAMS
TEST
ENGINE START
SERVICE ENTRANCE
EXTERNAL 4 POSITION TEST SWITCH (OPTIONAL)
OFF
CLOSED TRANSITION
TB2-17
TB2-16
TB2-15
TB2-14
TB2-13
TB2-12
UTILITY SUPPLY SENSING 120-600VAC 50/60Hz 3 PHASE
GENERATOR SUPPLY SENSING 120-600VAC 50/60Hz 3 PHASE
LOAD SENSING 120-600VAC 50/60Hz 1 or 3 PHASE
A
B
C
TB1-1
TB1-2
TB1-3
TB1-4
TB1-5
TB1-6
TB1-7
TB1-8
TB1-9
SYSTEM GROUND
GRD
TB2-18
VREF
TB3-5
TB3-1
TB3-11
TB3-4
TB3-6
TB3-2
TB3-3
TB3-10
TB3-9
TB3-8
TB3-7
TB2-3
TB2-2
TB2-1
TB2-4
TB2-5
TB2-6
N
L
UTILITY CONTROL POWER 115 or 230VAC
LOAD ON UTILITY SUPPLY
TRANSFER TO UTILITY RATED 10A, 250VAC RES. MAX.
PRE-TRANSFER TO UTILITY RATED 3A, 250VAC RES. MAX.
UTILITY NORMAL PROGRAMMABLE OUTPUT RATED 3A, 250VAC RES. MAX.
GENERATOR CONTROL POWER 115 or 230VAC
LOAD ON GENERATOR SUPPLY
TRANSFER TO GENERATOR RATED 10A, 250VAC RES. MAX.
PRE-TRANSFER TO GENERATOR RATED 3A, 250VAC RES. MAX.
GENERATOR NORMAL PROGRAMMABLE OUTPUT RATED 3A, 250VAC RES. MAX.
ENGINE START CONTACT
RATED 10A, 250VAC RES. MAX
PROGRAMMABLE OUTPUT
RATED 10A, 250VAC RES. MAX
NOTE: Programmable output not available for customer use on Insulated Case ATS
DIMENSIONS
FACEPLATE: 5.5" x 5.5" [140mm x 140mm]
PRINTED CIRCUIT BOARD: 6.30"W x 12.00"H [160mmW x 305mmH]
1 UTILITY AND GENERATOR SUPPLIES MUST UTILIZE A SOLIDLY GROUNDED NEUTRAL SYSTEM. REFER TO INSTRUCTION MANUAL FOR ALTERNATE CONNECTIONS
2 CONTROL POWER INPUT VOLTAGE MUST MATCH TSC 800 MODEL TYPE

Notes

7.1 Troubleshooting

A number of problems can cause the TSC 800 controller to function improperly. Refer to the following list of typical problems. Consult the factory for any detailed information or for any problems not listed.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Service procedures must be undertaken by qualified personnel only.

Symptom	Possible Causes
Will not retransfer to utility source upon restoration	A test mode has been activated (check TSC 800 controller status LCD display).
	Utility voltage or frequency is outside the preprogrammed limits (check utility source for adequate voltage and frequency).
	A loose control connection.
	Faulty contactor auxiliary contact.
	Inoperative utility contactor coil.
	Inoperative TSC 800 controller (verify output signals with circuit board mounted diagnostic LEDs).
	TSC 800 has transfer fail alarm activated (if programmed as force transfer). Determine cause of alarm and rectify before TSC 800 is reset.
	Bad limit or auxiliary switch N/C contact or loose wire termination between the controller and the limit switch.
	TSC 800 programmed for manual retransfer. Press lamp test to initiate retransfer to utility source.
	A phase imbalance condition was detected on the utility supply while on load. The condition may not be readily noticeable with no load on the source. Confirm voltage imbalance condition by viewing alarm state on TSC 800 LCD. In this state, the load is locked to the generator until the TSC 800 is reset.

Symptom	Possible Causes
Will not transfer to generator source upon failure of utility source	Generator set not producing enough voltage/frequency or local generator output circuit breaker open (outside programmed limits of TSC 800).
	Warmup time delay function has not timed out yet (verify TSC 800 timer setting, 0–3000 sec. programmable).
	A loose control wire connection.
	Faulty contactor auxiliary contact.
	Inoperative generator contactor coil.
	Inoperative TSC 800 controller (verify output signals with circuit board mounted diagnostic LEDs) and AC voltage at appropriate TSC 800 controller terminal.
	TSC 800 has transfer fail alarm activated (if programmed as force transfer). Determine cause of alarm and rectify before TSC 800 is reset.
	Bad limit or auxiliary switch N/C contact or loose wire termination between the controller and the limit switch.
	A phase imbalance condition was detected on the generator supply prior to or while on load. The condition may not be readily noticeable with no load on the source. Confirm voltage imbalance condition by viewing alarm state on TSC 800 LCD. In this state, the load is locked to the utility source until the TSC 800 is reset .
	Transfer switch motor brake assembly will not release. Possible interference with field-installed wiring. Only possible on 100 through 250 amp ATS's with exposed mechanical brake.
Transfer to generator source without a power failure in the utility source	A test mode has been activated (check TSC 800 status LCD display, can be via internal or external test inputs).
	Inoperative TSC 800 controller (verify output signals with circuit board mounted diagnostic LEDs).
	Loose or broken wire to the utility voltage sensing terminals on the TSC 800 controller.
	Failed voltage sensing circuit on TSC 800; repair or replace controller.
	Utility supply voltage is slightly above or below voltage sensing setpoints. Compare TSC 800 program voltage setpoints with actual utility voltage displayed on the controller.
	Incorrect voltage calibration providing incorrect readings for utility sensing and being interpreted as being out of limit.
	A transfer fail condition on the utility PSD or limit switch has occurred. Review LCD for alarm condition; press lamp test to reset.
	A phase imbalance condition was detected on the utility supply while on load. The condition may not be readily noticeable with no load on the source. Confirm voltage imbalance condition by viewing alarm state on TSC 800 LCD. Press lamp test to reset.
Generator does not start or stop when it should	Verify remote engine control panel is set for automatic mode and no shutdown faults present.
	Verify remote engine start interconnect wiring properly terminated (not open circuit).
	Engine start relay on TSC 800 has failed or been damaged due to excessive current.
	TSC 800 nonfunctional. Confirm the watch dog LED on rear of circuit board to be flashing (processor healthy) and the engine start LED is on confirming the start request.
No time delay when there should be	Verify time delay function in the TSC 800 program setting as per programming sheets supplied with the transfer switch.
Power is not available at the ATS load terminals but the utility or generator power switching device appears to be closed to a live source	The power switching device's trip unit (service entrance style only) has tripped on a fault on the system and TSC 800 transfer fail is programmed as disabled or halt transfer. Correct the fault and manually reset the power-switching device in the transfer switch by moving it off and then on again with the manual operating handle.
TSC 800 display is blank	Display in sleep mode. Press any keypad to reenergize the display.
	There is no power to the controller. Confirm power to the controller from available supplies. Possible external controller power transformer failed (PT1 and 2) or controller-mounted transformer or internal power supply failed (one or both sources).
	Isolation plug pulled. Confirm correct voltage configuration and/or levels prior to installing the isolation plug.
	Utility power failed and generator running but its local breaker is open.
Transfer switch cycles between sources	Limit switch is not being fully actuated to break the motor circuit during transfer. Limit switch adjustment incorrect (limit switch struck late or not at all on 100A–1200A molded case switch style ATS).
	TSC 800 generator undervoltage and/or underfrequency time delays set too short. Time delays are exceeded on load application causing recycling to utility supply (happens only during an on load test and utility available).
Transfer switch controller indicates the mechanism has made position but does not conduct to the load bus and the PSD is not tripped	Limit switch adjusted to close to yoke arm causing the ATS mechanism to stop before PSD closes (limit switch struck early on 100A–1200A molded case switch style ATS).

Symptom	Possible Causes
Less than programmed neutral delay time (NDT) or none at all administered during transfer between powered sources	Neutral delay bypass feature enabled. Effectively cancels NDT if not required (canceled if load bus voltage for all phases drops below 20% of nominal system voltage) (normal operation).
	Transfer switch incorporates a bypass configuration (currently is bypassing the ATS mechanism) and the test cable connected. No neutral positioning will be detected and no NDT applied as a result (normal condition).
	High residual voltage from the connected loads (neutral position cannot be determined). Contact the manufacturer for possible corrective solutions.
Engine runs for no apparent reason	Verify the TSC 800 has not been set for a manual or auto off load test operation. If yes, select Auto (none in firmware versions 1.7 and earlier).
	Verify the TSC 800 engine start LED is lit on the rear of the controller. If not lit, isolate one of the remote start wires to confirm the start is from the TSC 800 (contact closes to start, open wire should cause generator to stop). Engine start relay coil on TSC 800 failed (drops to issue start, energized to inhibit start).
	Local generator engine controller has built in cool-down function or test features separate from the TSC 800.
	Local generator controls are in manual run.
Oscillating/unstable voltage readings displayed for one or more sources when measured voltage with an independent meter confirms stable voltage	System neutral conductor has not been solidly bonded to ground for one or more of the sources or a 3-phase 3-wire system has been applied to an ATS designed for a 3-phase 4-wire configuration. Isolation transformers will need to be added to create the ground reference to correct the problem. Contact the manufacturer for corrective solutions.
	Inoperative TSC 800 controller. Contact the factory for replacement.
TSC 800 displays voltage value well in excess of actual	The wrong voltage sensing ratio has been programmed.
	Secondary power transformers used for sensing are installed improperly. Polarities of PTs were not observed during installation/replacement. Contact the factory for assistance.
	Inoperative TSC 800 controller. Contact the factory for replacement.
TSC 800 Transfer Fail Displayed	Limit switch or auxiliary contact not closed to signal TSC 800 of ATS in correct position.
	Load bus voltage not sensed at the TSC 800 controller to confirm load bus is energized.
	"Max Transfer Fail Time" or "Max Find Neutral Time" or set too low - Max Transfer Fail Time: Set for 15 seconds or greater on MCS style ATS, or 3 seconds on ICS style ATS - Max Find Neutral Time: Set for 6.0 seconds for MCS style ATS or 0.0 seconds for ICS style ATS.
	On ICS style ATS both NDT and Delayed Transfer Output Timers have time applied. -NDT: set to 0 seconds - Delayed Transfer Output: set to required neutral delay time
	On ICS style ATS both NDT and Delayed Transfer Outputs timers set to 0 seconds. - Delayed Transfer Output: must be set for minimum of 0.2 seconds

7.2 Replacement Parts

Available replacement parts for the TSC 800 controller are listed in Figure 7-1.

When ordering replacement parts, please provide the following information, which can be found on the transfer switch equipment rating plate located on the outside of the ATS door.:

- Transfer switch product (model) code (e.g. TS 843AA0200AS).
- Transfer switch serial number (e.g. W-022345).

Description	Part No.
Controller Board	TBD *
115 V selector plug	TBD *
230 V selector plug	TBD *
Faceplate	TBD *
Rear cover	TBD *
LCD	TBD *
LCD connector	TBD *
LCD gasket	TBD *

* Part numbers to be determined.

Figure 7-1 TSC 800 Parts

Notes

Appendix A Abbreviations

The following list contains abbreviations that may appear in this publication.

A, amp	ampere
ABDC	after bottom dead center
AC	alternating current
A/D	analog to digital
ADC	analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
AHWT	anticipatory high water temperature
AISI	American Iron and Steel Institute
ALOP	anticipatory low oil pressure
alt.	alternator
Al	aluminum
ANSI	American National Standards Institute (formerly American Standards Association, ASA)
AO	anticipatory only
API	American Petroleum Institute
approx.	approximate, approximately
AR	as required, as requested
AS	as supplied, as stated, as suggested
ASE	American Society of Engineers
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
ATS	automatic transfer switch
auto.	automatic
aux.	auxiliary
A/V	audiovisual
avg.	average
AVR	automatic voltage regulator
AWG	American Wire Gauge
AWM	appliance wiring material
bat.	battery
BBDC	before bottom dead center
BC	battery charger, battery charging
BCA	battery charging alternator
BCI	Battery Council International
BDC	before dead center
BHP	brake horsepower
blk.	black (paint color), block (engine)
blk. htr.	block heater
BMEP	brake mean effective pressure
bps	bits per second
br.	brass
BTDC	before top dead center
Btu	British thermal unit
Btu/min.	British thermal units per minute
C	Celsius, centigrade
cal.	calorie
CARB	California Air Resources Board
CB	circuit breaker
cc	cubic centimeter
CCA	cold cranking amps
ccw.	counterclockwise
CEC	Canadian Electrical Code
cert.	certificate, certification, certified
cfh	cubic feet per hour
cfm	cubic feet per minute
CG	center of gravity
CID	cubic inch displacement
CL	centerline
cm	centimeter
CMOS	complementary metal oxide substrate (semiconductor)
cogen.	cogeneration
com	communications (port)
coml	commercial
Coml/Rec	Commercial/Recreational
conn.	connection
cont.	continued
CPVC	chlorinated polyvinyl chloride
crit.	critical
CRT	cathode ray tube
CSA	Canadian Standards Association
CT	current transformer
Cu	copper
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dBA	decibel (A weighted)
DC	direct current
DCR	direct current resistance
deg., °	degree
dept.	department
dia.	diameter
DI/EO	dual inlet/end outlet
DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
DIP	dual inline package
DPDT	double-pole, double-throw
DPST	double-pole, single-throw
DS	disconnect switch
DVR	digital voltage regulator
E, emer.	emergency (power source)
EDI	electronic data interchange
EFR	emergency frequency relay
e.g.	for example (*exempli gratia)*
EG	electronic governor
EGSA	Electrical Generating Systems Association
EIA	Electronic Industries Association
EI/EO	end inlet/end outlet
EMI	electromagnetic interference
emiss.	emission
eng.	engine
EPA	Environmental Protection Agency
EPS	emergency power system
ER	emergency relay
ES	engineering special, engineered special
ESD	electrostatic discharge
est.	estimated
E-Stop	emergency stop
etc.	et cetera (and so forth)
exh.	exhaust
ext.	external
F	Fahrenheit, female
fglass.	fiberglass
FHM	flat head machine (screw)
fl. oz.	fluid ounce
flex.	flexible
freq.	frequency
FS	full scale
ft.	foot, feet
ft. lb.	foot pounds (torque)
ft./min.	feet per minute
g	gram
ga.	gauge (meters, wire size)
gal.	gallon
gen.	generator
genset	generator set
GFI	ground fault interrupter
GND, ⏚	ground
gov.	governor
gph	gallons per hour
gpm	gallons per minute
gr.	grade, gross
GRD	equipment ground
gr. wt.	gross weight
H x W x D	height by width by depth
HC	hex cap
HCHT	high cylinder head temperature
HD	heavy duty
HET	high exhaust temperature, high engine temperature
hex	hexagon
Hg	mercury (element)
HH	hex head
HHC	hex head cap
HP	horsepower
hr.	hour
HS	heat shrink
hsg.	housing
HVAC	heating, ventilation, and air conditioning
HWT	high water temperature
Hz	hertz (cycles per second)
IC	integrated circuit
ID	inside diameter, identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	improved motor starting
in.	inch
in. H_2O	inches of water
in. Hg	inches of mercury
in. lb.	inch pounds
Inc.	incorporated
ind.	industrial
int.	internal
int./ext.	internal/external
I/O	input/output
IP	iron pipe
ISO	International Organization for Standardization
J	joule
JIS	Japanese Industry Standard
k	kilo (1000)
K	kelvin

kA	kiloampere
KB	kilobyte (2^{10} bytes)
kg	kilogram
kg/cm^2	kilograms per square centimeter
kgm	kilogram-meter
kg/m^3	kilograms per cubic meter
kHz	kilohertz
kJ	kilojoule
km	kilometer
kOhm, kΩ	kilo-ohm
kPa	kilopascal
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt ampere
kVAR	kilovolt ampere reactive
kW	kilowatt
kWh	kilowatt-hour
kWm	kilowatt mechanical
L	liter
LAN	local area network
L x W x H	length by width by height
lb.	pound, pounds
lbm/ft^3	pounds mass per cubic feet
LCB	line circuit breaker
LCD	liquid crystal display
ld. shd.	load shed
LED	light emitting diode
Lph	liters per hour
Lpm	liters per minute
LOP	low oil pressure
LP	liquefied petroleum
LPG	liquefied petroleum gas
LS	left side
L_{wa}	sound power level, A weighted
LWL	low water level
LWT	low water temperature
m	meter, milli (1/1000)
M	mega (10^6 when used with SI units), male
m^3	cubic meter
m^3/min.	cubic meters per minute
mA	milliampere
man.	manual
max.	maximum
MB	megabyte (2^{20} bytes)
MCM	one thousand circular mils
MCCB	molded-case circuit breaker
meggar	megohmmeter
MHz	megahertz
mi.	mile
mil	one one-thousandth of an inch
min.	minimum, minute
misc.	miscellaneous
MJ	megajoule
mJ	millijoule
mm	millimeter
mOhm, mΩ	milliohm
MOhm, MΩ	megohm
MOV	metal oxide varistor
MPa	megapascal
mpg	miles per gallon
mph	miles per hour
MS	military standard
m/sec.	meters per second
MTBF	mean time between failure
MTBO	mean time between overhauls
mtg.	mounting
MW	megawatt
mW	milliwatt
μF	microfarad
N, norm.	normal (power source)
NA	not available, not applicable
nat. gas	natural gas
NBS	National Bureau of Standards
NC	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	newton meter
NO	normally open
no., nos.	number, numbers
NPS	National Pipe, Straight
NPSC	National Pipe, Straight-coupling
NPT	National Standard taper pipe thread per general use
NPTF	National Pipe, Taper-Fine
NR	not required, normal relay
ns	nanosecond
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OF	overfrequency
opt.	option, optional
OS	oversize, overspeed
OSHA	Occupational Safety and Health Administration
OV	overvoltage
oz.	ounce
p., pp.	page, pages
PC	personal computer
PCB	printed circuit board
pF	picofarad
PF	power factor
ph., ∅	phase
PHC	Phillips head crimptite (screw)
PHH	Phillips hex head (screw)
PHM	pan head machine (screw)
PLC	programmable logic control
PMG	permanent-magnet generator
pot	potentiometer, potential
ppm	parts per million
PROM	programmable read-only memory
psi	pounds per square inch
pt.	pint
PTC	positive temperature coefficient
PTO	power takeoff
PVC	polyvinyl chloride
qt.	quart, quarts
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
RDO	relay driver output
ref.	reference
rem.	remote
Res/Coml	Residential/Commercial
RFI	radio frequency interference
RH	round head
RHM	round head machine (screw)
rly.	relay
rms	root mean square
rnd.	round
ROM	read only memory
rot.	rotate, rotating
rpm	revolutions per minute
RS	right side
RTV	room temperature vulcanization
SAE	Society of Automotive Engineers
scfm	standard cubic feet per minute
SCR	silicon controlled rectifier
s, sec.	second
SI	*Systeme international d'unites,* International System of Units
SI/EO	side in/end out
sil.	silencer
SN	serial number
SPDT	single-pole, double-throw
SPST	single-pole, single-throw
spec, specs	specification(s)
sq.	square
sq. cm	square centimeter
sq. in.	square inch
SS	stainless steel
std.	standard
stl.	steel
tach.	tachometer
TD	time delay
TDC	top dead center
TDEC	time delay engine cooldown
TDEN	time delay emergency to normal
TDES	time delay engine start
TDNE	time delay normal to emergency
TDOE	time delay off to emergency
TDON	time delay off to normal
temp.	temperature
term.	terminal
TIF	telephone influence factor
TIR	total indicator reading
tol.	tolerance
turbo.	turbocharger
typ.	typical (same in multiple locations)
UF	underfrequency
UHF	ultrahigh frequency
UL	Underwriter's Laboratories, Inc.
UNC	unified coarse thread (was NC)
UNF	unified fine thread (was NF)
univ.	universal
US	undersize, underspeed
UV	ultraviolet, undervoltage
V	volt
VAC	volts alternating current
VAR	voltampere reactive
VDC	volts direct current
VFD	vacuum fluorescent display
VGA	video graphics adapter
VHF	very high frequency
W	watt
WCR	withstand and closing rating
w/	with
w/o	without
wt.	weight
xfmr	transformer

Notes

Notes

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ddcmtupowergeneration.com

MP-6381 7/06a