Operation and Installation

Automatic Transfer Switches

Models:

KCT, KCP

Power Switching Device:
Standard
Open-Transition 30 to 4000 Amps
Programmed-Transition 150 to 4000 Amps

Electrical Controls:
MPAC 1000™

ISO 9001
KOHLER POWER SYSTEMS
NATIONALLY REGISTERED

KOHLER®
POWER SYSTEMS

TP-6126 8/02b

Product Identification Information

Product identification numbers determine service parts. Record the product identification numbers in the spaces below immediately after unpacking the products so that the numbers are readily available for future reference. Record field-installed kit numbers after installing the kits.

Transfer Switch Identification Numbers

Record the product identification numbers from the transfer switch nameplate.

Model Designation ____________________________

Serial Number ________________________________

Accessory Number	Accessory Description

x:in:007:001

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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***.

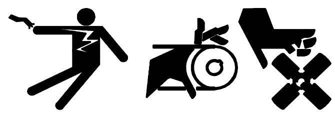
NOTICE

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



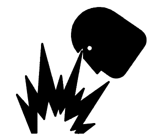
Accidental starting.
Can cause severe injury or death.

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.

Battery

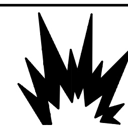
WARNING



Sulfuric acid in batteries.
Can cause severe injury or death.

Wear protective goggles and clothing. Battery acid may cause blindness and burn skin.

WARNING



Explosion.
Can cause severe injury or death.
Relays in the battery charger cause arcs or sparks.

Locate the battery in a well-ventilated area. Isolate the battery charger from explosive fumes.

Battery electrolyte is a diluted sulfuric acid. Battery acid can cause severe injury or death. Battery acid can cause blindness and burn skin. Always wear splashproof safety goggles, rubber gloves, and boots when servicing the battery. Do not open a sealed battery or mutilate the battery case. If battery acid splashes in the eyes or on the skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

Battery acid cleanup. Battery acid can cause severe injury or death. Battery acid is electrically conductive and corrosive. Add 500 g (1 lb.) of bicarbonate of soda (baking soda) to a container with 4 L (1 gal.) of water and mix the neutralizing solution. Pour the neutralizing solution on the spilled battery acid and continue to add the neutralizing solution to the spilled battery acid until all evidence of a chemical reaction (foaming) has ceased. Flush the resulting liquid with water and dry the area.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flames or sparks to occur near a battery at any time, particularly when it is charging. Do not dispose of a battery in a fire. To prevent burns and sparks that could cause an explosion, avoid touching the battery terminals with tools or other metal objects. Remove all jewelry before servicing the equipment. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface away from the battery. To avoid sparks, do not disturb the battery charger connections while the battery is charging. Always turn the battery charger off before disconnecting the battery connections. Ventilate the compartments containing batteries to prevent accumulation of explosive gases.

Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery. Never connect the negative (–) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together.

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.

WARNING

Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

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.

Installing the battery charger. Hazardous voltage can cause severe injury or death. An ungrounded battery charger may cause electrical shock. Connect the battery charger enclosure to the ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect it to the equipment grounding terminal or the lead on the battery charger. Install the battery charger as prescribed in the equipment manual. Install the battery charger in compliance with local codes and ordinances.

Connecting the battery and the battery charger. Hazardous voltage can cause severe injury or death. Reconnect the battery correctly, positive to positive and negative to negative, to avoid electrical shock and damage to the battery charger and battery(ies). Have a qualified electrician install the battery(ies).

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.

Installing accessories to the transformer assembly. Hazardous voltage can cause severe injury or death. To prevent electrical shock disconnect the harness plug before installing accessories that will be connected to the transformer assembly primary terminals on microprocessor logic models. Terminals are at line voltage.

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.

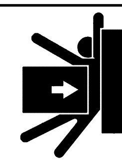
Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the 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.

Servicing the transfer switch controls and accessories within the enclosure. Hazardous voltage can cause severe injury or death. Disconnect the transfer switch controls at the inline connector to deenergize the circuit boards and logic circuitry but allow the transfer switch to continue to supply power to the load. Disconnect all power sources to accessories that are mounted within the enclosure but are not wired through the controls and deenergized by inline connector separation. Test circuits with a voltmeter to verify that they are deenergized before servicing.

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

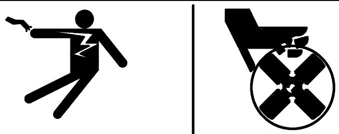


Unbalanced weight.
Improper lifting can cause severe injury or death and equipment damage.

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

Moving Parts

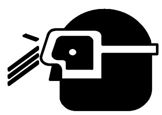
WARNING



Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

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

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

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 Kohler® Model KCT/KCP automatic transfer switches with MPAC 1000™ electrical controls.

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Information in this publication represents data available at the time of print. Kohler Co. 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.

x:in:002:002

List of Related Materials

This manual includes operation and installation information for standard open-transition and programmed-transition transfer switches. Decode the transfer switch model number from the transfer switch nameplate and verify that the it matches the model shown on the front cover of this manual before proceeding with installation.

Separate manuals cover service and parts information. The following table lists the related literature part numbers.

Literature Item	Part Number
Specification Sheet	G11-80
Service Manual	TP-6127
Parts Catalog	TP-6158
MPAC™ Setup Program Operation Manual	TP-6135

Service Assistance

For professional advice on generator power requirements and conscientious service, please contact your nearest Kohler distributor or dealer.

- Consult the Yellow Pages under the heading Generators—Electric
- Visit the Kohler Power Systems website at KohlerPowerSystems.com
- Look at the labels and stickers on your Kohler product or review the appropriate literature or documents included with the product
- Call toll free in the US and Canada 1-800-544-2444
- Outside the US and Canada, call the nearest regional office

Africa, Europe, Middle East
London Regional Office
Langley, Slough, England
Phone: (44) 1753-580-771
Fax: (44) 1753-580-036

Asia Pacific
Power Systems Asia Pacific Regional Office
Singapore, Republic of Singapore
Phone: (65) 264-6422
Fax: (65) 264-6455

China
North China Regional Office, Beijing
Phone: (86) 10 6518 7950
(86) 10 6518 7951
(86) 10 6518 7952
Fax: (86) 10 6518 7955

East China Regional Office, Shanghai
Phone: (86) 21 6288 0500
Fax: (86) 21 6288 0550

India, Bangladesh, Sri Lanka
India Regional Office
Bangalore, India
Phone: (91) 80 3366208
(91) 80 3366231
Fax: (91) 80 3315972

Japan, Korea
North Asia Regional Office
Tokyo, Japan
Phone: (813) 3440-4515
Fax: (813) 3440-2727

Latin America
Latin America Regional Office
Lakeland, Florida, USA
Phone: (863) 619-7568
Fax: (863) 701-7131

X:in:008:001a

1.1 Purpose

An automatic transfer switch (ATS) transfers electrical loads from a normal (preferred) source of electrical power to an emergency (standby) source when the normal source falls outside the acceptable electrical parameters.

When the normal (preferred) source fails, the ATS signals the emergency (standby) source generator set to start. When the emergency (standby) source reaches acceptable levels and stabilizes, the ATS transfers the load from the normal (preferred) source to the emergency (standby) source. The ATS continuously monitors the normal (preferred) source and transfers the load back when the normal (preferred) source returns and stabilizes. After transferring the load back to the normal (preferred) source, the ATS removes the generator start signal, allowing the generator set to shut down.

Figure 1-1 shows a typical installation block diagram.

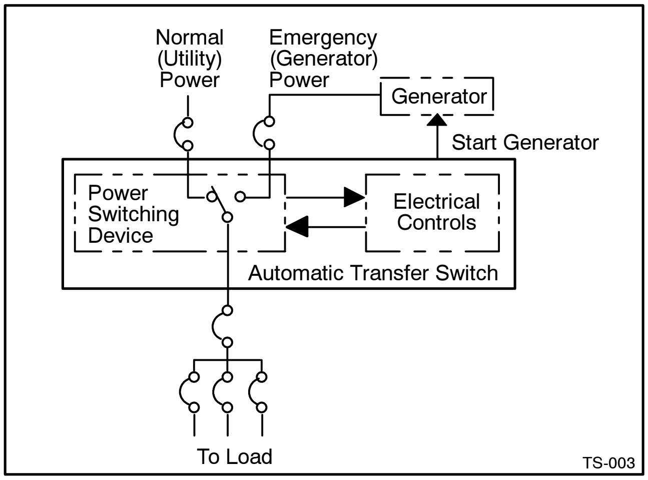


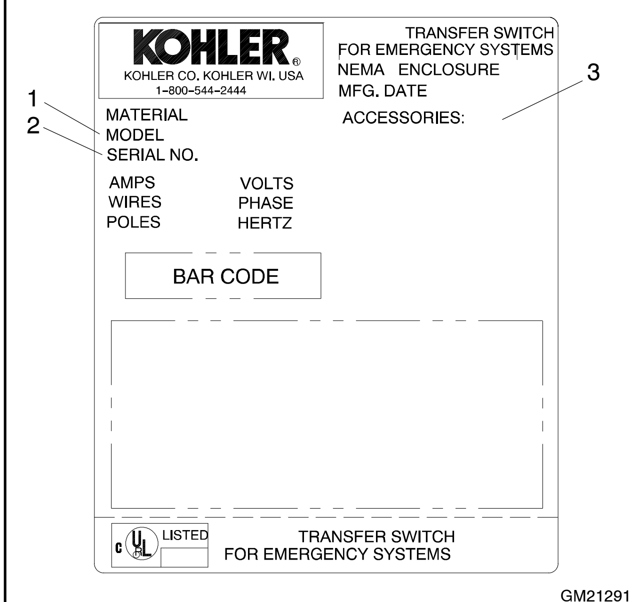
Figure 1-1 Typical ATS Block Diagram

1.2 Nameplate

A nameplate attached to the controller cover on the inside of the enclosure door includes a model designation, a serial number, ratings, and other information about the transfer switch. See Figure 1-2.

Copy the model designation, serial number, and accessory information from the nameplate to the spaces provided in the Product Identification Information section inside the front cover of this manual for use when requesting service or parts. Copy the model designation into the spaces in Section 1.3 and use the accompanying chart to interpret the model designation.

The serial number is also shown on a label inside the transfer switch enclosure.

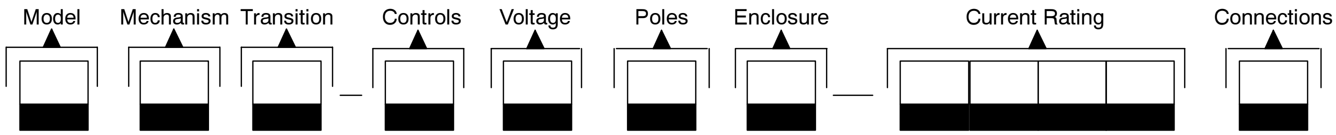


1. Model designation
2. Serial number
3. Factory-installed accessory numbers

Figure 1-2 Typical Transfer Switch Nameplate

1.3 Model Code

Record the transfer switch model designation in the boxes below. The transfer switch model designation defines characteristics and ratings as explained in the accompanying chart.



Kohler® Model Designation Key

This chart explains the Kohler® transfer switch model designation system. The sample model designation shown is for a Model K automatic transfer switch that uses an open-transition contactor with MPAC 1000™ electrical controls rated at 480 volts/60 Hz, 3 poles, 4 wires, and solid neutral in a NEMA 1 enclosure with a current rating of 225 amperes. Not all possible combinations are available.

SAMPLE MODEL DESIGNATION

KCT-AMTA-0225S

Model
K: Model K automatic transfer switch

Mechanism
C: Automatic
B: Bypass Isolation (See G11-81)
N: Non-automatic

Transition
T: Open-Transition
P: Programmed-Transition

Electrical Controls
A: MPAC 1000™ (Microprocessor ATS Controls)

Voltage/Frequency

C:	208 Volts/60 Hz	G:	380 Volts/50 Hz	K:	440 Volts/60 Hz
D:	220 Volts/50 Hz	H:	400 Volts/50 Hz	M:	480 Volts/60 Hz
F:	240 Volts/60 Hz	J:	416 Volts/50 Hz	N:	600 Volts/60 Hz

Number of Poles/Wires
N: 2-pole, 3-wire, solid neutral
T: 3-pole, 4-wire, solid neutral
V: 4-pole, 4-wire, switched neutral
W: 4-pole, 4-wire, overlapping neutral
Z: 3-pole, 4-wire, integral solid neutral*

Enclosure

A: NEMA 1†	C: NEMA 3R‡	F: NEMA 4X‡
B: NEMA 12‡	D: NEMA 4‡	G: Open unit

† Standard on 30-4000 A models
‡ Available to order on 30-800 A models. For larger units, consult the factory.

Current Rating: Numbers indicate the current rating of the switch in amperes:

0030	0200	0600	1200	2600
0070	0225	0800	1600	3000
0104	0260	1000	2000	4000
0150	0400			

Power Connections
S: Standard
F: Front bus (available on 1600 and 2000 A models only)

* Integral solid neutral is a solid neutral mounted on the contactor. (Not available on all amperages.)

2.1 Introduction

Kohler® transfer switches are shipped factory-wired, factory-tested, and ready for installation. Have the equipment installed only by trained and qualified personnel, and verify that the installation complies with applicable codes and standards. Switch installation includes the following steps:

- Unpacking and inspecting the transfer switch upon receipt.
- Verifying that the transfer switch voltage and frequency ratings match the voltages and frequencies of the sources.
- Mounting the transfer switch.
- Checking the manual operation.
- Wiring the normal power source (utility), emergency power source (generator set), and load circuits.
- Wiring the generator set engine start connection.
- Connecting accessories, if provided.
- Connecting and initializing the electrical controls, as required.
- Checking voltages and operation.

Protect the switch against damage before and during installation.

The functional tests in Section 3.7 are a necessary part of the installation. Be sure to perform the functional tests, which include voltage checks and operation tests, before putting the transfer switch into service.

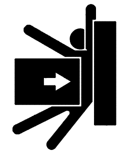
2.2 Receipt of Unit

2.2.1 Inspection

At the time of delivery, inspect the packaging and the transfer switch for signs of shipping damage. Unpack the transfer switch as soon as possible and inspect the exterior and interior for shipping damage. If damage and/or rough handling is evident, immediately file a damage claim with the transportation company.

2.2.2 Lifting

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.

See Figure 2-1 through Figure 2-4 or the dimensional drawing for the weight of the transfer switch. Use a spreader bar to lift the transfer switch. Attach the bar only to the enclosure's mounting holes or lifting brackets; do not lift the unit any other way. Close and latch the enclosure door before moving the unit.

Amps	Weight, kg (lb.)		
	2-Pole	3-Pole	4-Pole
30-200	28 (62)	30 (65)	31 (68)
225-400	52 (115)	56 (123)	59 (131)
600-800	220 (485)	231 (510)	238 (525)
1000-1200	—	356 (785)	379 (835)
1600-2000	—	472 (1040)	494 (1090)
2600-3000	—	649 (1430)	679 (1495)
4000	—	1043 (2300)	1089 (2400)

Figure 2-1 Weights, Open-Transition Models in NEMA 1 Enclosures

Amps	Weight kg, (lb.)		
	2-Pole	3-Pole	4-Pole
150-400	179 (395)	183 (403)	187 (413)
600-800	179 (395)	184 (405)	188 (415)
1000-1200	—	463 (1020)	485 (1070)
1600-2000	—	533 (1175)	556 (1225)
2600-3000	—	735 (1620)	765 (1685)
4000	—	1115 (2457)	1160 (2557)

Figure 2-2 Weights, Programmed-Transition Models in NEMA 1 Enclosures

Amps	Weight kg (lb.)		
	2-Pole	3-Pole	4-Pole
30-200	8 (17)	9 (20)	11 (23)
225-400	17 (37)	21 (45)	24 (53)
600-1200	68 (150)	78 (170)	90 (196)
1600-2000	—	190 (420)	213 (470)
2600-3000	—	213 (470)	243 (535)
4000	—	545 (1200)	590 (1300)

Figure 2-3 Weights, Open Units, Open-Transition Models

Amps	Weight kg (lb.)		
	2-Pole	3-Pole	4-Pole
150-400	21 (45)	24 (53)	28 (63)
600-1200	80 (175)	94 (205)	108 (235)
1600-2000	—	252 (555)	274 (605)
2600-3000	—	300 (660)	329 (725)
4000	—	611 (1347)	657 (1447)

Figure 2-4 Weights, Open Units, Programmed-Transition Models

2.2.3 Storage

Store the transfer switch in its protective packing until final installation. Protect the transfer switch at all times from moisture, construction grit, and metal chips. Avoid storage in low-temperature and high-humidity areas where moisture could condense on the unit. See Figure 2-5 for acceptable storage temperatures.

Item	Specification
Storage Temperature	-40°C to 70°C (-40°F to 158°F)
Operating Temperature	-20°C to 70°C (-4°F to 158°F)
Humidity	5% to 95% noncondensing
Altitude	0 to 3050 m (10000 ft.) without derating

Figure 2-5 Environmental Specifications

2.2.4 Unpacking

Allow the equipment to warm to room temperature for at least 24 hours before unpacking to prevent condensation on the electrical apparatus. Use care when unpacking to avoid damaging transfer switch components. Remove dirt and packing material that may have accumulated in the transfer switch or any of its components. Do not use compressed air to clean the switch. Cleaning with compressed air can cause debris to lodge in the components and damage the switch.

For 600-800 amp transfer switches, remove the lag screws that secure the transfer switch to the shipping skid. For 1000-4000 amp transfer switches, open the enclosure door to remove the lag screws that secure the transfer switch to the skid.

2.3 Mechanical Installation

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

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.

Check the system voltage and frequency. Compare the voltage and frequency shown on the transfer switch nameplate to the source voltage and frequency. Do not install the transfer switch if the system voltage and frequency are different from the nominal normal (utility) source voltage and frequency or the nominal emergency source voltage and frequency shown on the generator set nameplate.

Plan the installation. Use the dimensions given on the enclosure dimension (ADV) drawings. Select a mounting site that complies with local electrical code restrictions for the enclosure type. Mount the transfer switch as close to the load and power sources as possible. Allow adequate space to fully open the enclosure and to service the switch. Provide cable bending space and clearance to live metal parts.

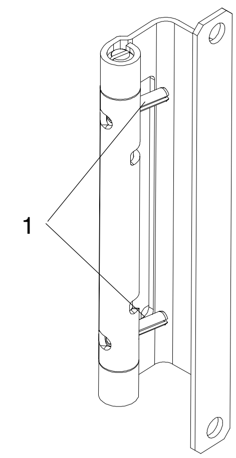
Prepare the foundation. Ensure that the supporting foundation for the enclosure is level and straight. For bottom cable entry, if used, install conduit stubs in the foundation. Refer to the enclosure dimension drawing for the conduit stub locations. When pouring a concrete floor, use interlocking conduit spacer caps or a wood or metal template to maintain proper conduit alignment.

Install the ATS. For easy access during installation and wiring, remove the front door of the enclosure. For 30-200 amp switches, support the door and remove the two screws at the bottom. Slide the door down until the top clears the enclosure. Open the door wide enough to reach the controller wiring on the inside of the door. Disconnect the cable plug that connects the front door components to the internal components and disconnect the grounding wire between the door and the enclosure. Set the door out of the way to protect the controls.

For units with hinged doors, open the door and disconnect the cable plug that connects the front door components to the internal components. Disconnect the grounding wire between the door and the enclosure. Squeeze the release pins on each hinge together and remove the door. See Figure 2-6. Set the door out of the way to protect the controls.

Vertically mount 30- through 400-amp transfer switches to a wall or other rigid vertical supporting structure. Use the template on the shipping carton to locate the mounting holes in the wall. Level the template before marking and drilling the holes. Clearance holes through the back of each enclosure are provided for mounting. Use shims to plumb the enclosure. Verify that the door hinges are vertical to avoid distortion of the enclosure or door.

Bolt 600- through 4000-amp automatic transfer switches directly to floor mounting pads. Shim the enclosure so that the enclosure is plumb.



1. Hinge release pins

Figure 2-6 Hinge

2.4 Manual Operation Check

DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Note: A manual operation handle is provided on the transfer switch *for maintenance purposes only*. Do not use the manual operation handle to transfer the load with the power connected.

Use the manual operation handle to check the manual operation before energizing the transfer switch. On programmed-transition models, check the operation of both the Normal and Emergency operators. Use the following manual operation procedures to verify that the contactor operates smoothly without binding.

Note: A contactor in normal and serviceable condition operates smoothly without binding. Do not place the transfer switch into service if the contactor does not operate smoothly; contact an authorized distributor/dealer to service the contactor.

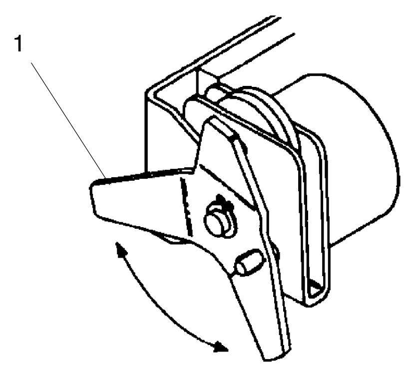
2.4.1 Manual Operation, 30-200 Amp Open-Transition Switches

The 30-200 amp open-transition models have an attached manual operating handle. See Figure 2-7.

Manual Operation Test Procedure, 30-200 Amp Transfer Switches

1. Turn the attached handle to manually operate the transfer switch. It should operate smoothly without any binding. If it does not, check for shipping damage or construction debris.

2. Return the transfer switch to the Normal position.



1. Handle

Figure 2-7 Manual Operation Handle, 30-200 Amp Open-Transition Switches

2.4.2 Manual Operation, 225-4000 Amp Open-Transition Switches

DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

The 225-4000 amp open-transition models use a detachable manual operating handle.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

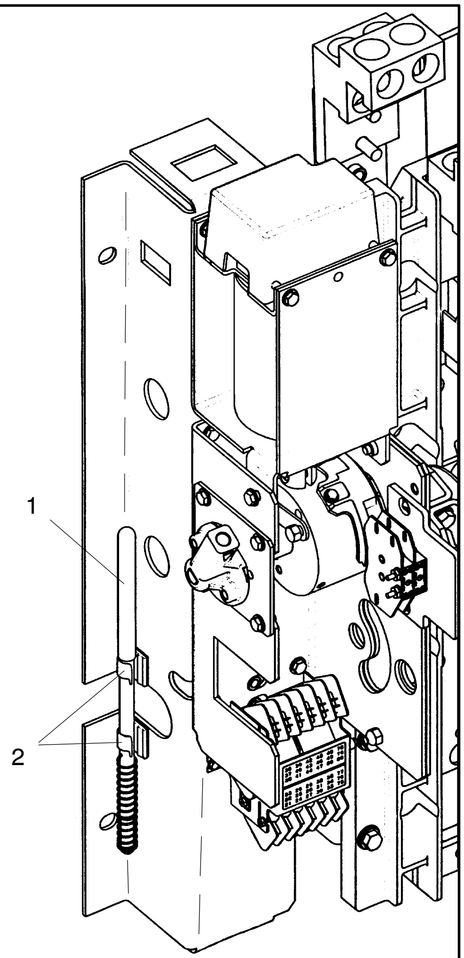
Manual Operation Test Procedure, 225-4000 Amp Open-Transition Transfer Switches

1. Remove the maintenance handle from the clips on the left side of the transfer switch frame. See Figure 2-8.
2. **225-400 amp switches: See Figure 2-9.** Insert the maintenance handle into the hole in the shaft on the left side of the operator.

   600-1200 amp switches: See Figure 2-10. Insert the maintenance handle into the hole in the molded hub on the left side of the operator.

   1600-2000 amp switches: See Figure 2-11. Slide the hub onto the shaft and insert the maintenance handle into the hole in the hub.

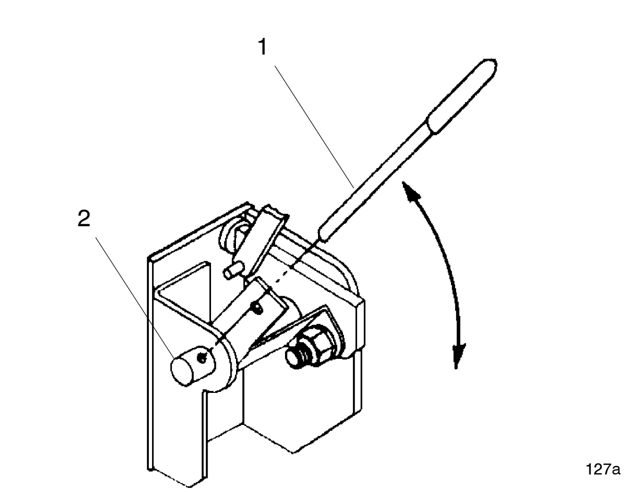
   3000 and 4000 amp switches: See Figure 2-12. Insert the maintenance handle into the hole in the weight.
3. Move the maintenance handle up or down as shown to manually operate the transfer switch. It should operate smoothly without any binding. If it does not, check for shipping damage or construction debris.
4. Return the transfer switch to the Normal position.
5. Remove the maintenance handle and store it on the frame in the clips provided.



1. Maintenance handle
2. Storage clips

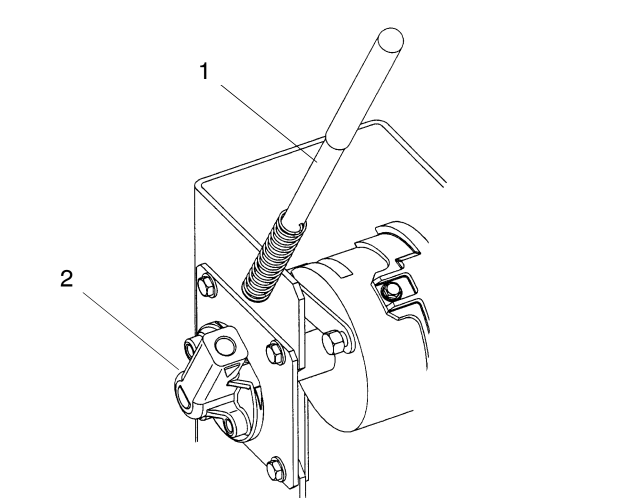
202

Figure 2-8 Manual Handle Storage, 600-1200 Amp Switch Shown



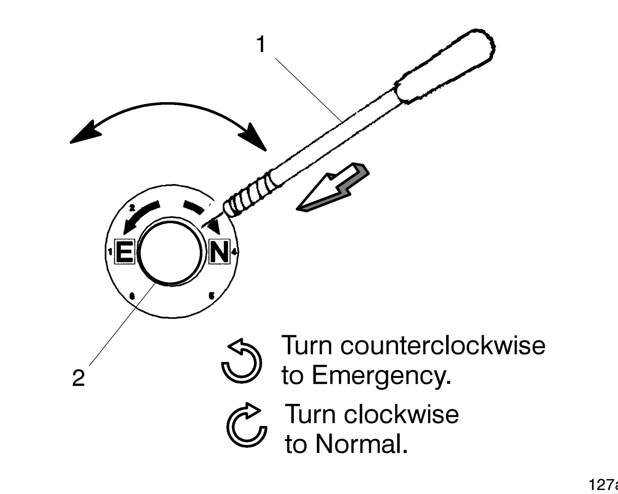
1. Maintenance handle
2. Shaft

Figure 2-9 Manual Operation, 225-400 Amp Open-Transiton Switches and 150-400 Amp Programmed-Transition Switches (one operator shown)



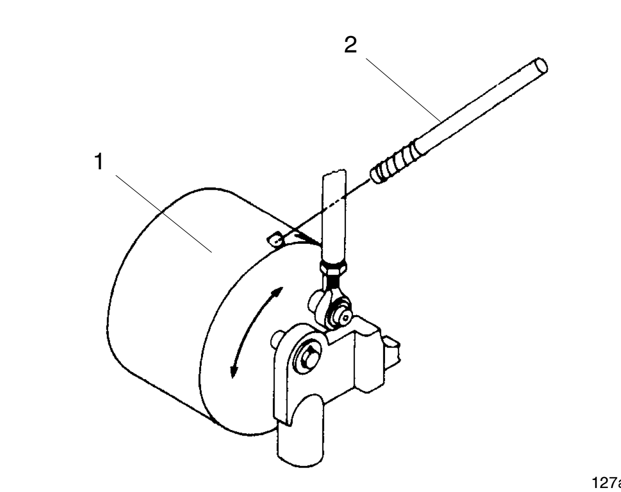
1. Maintenance handle
2. Hub

Figure 2-10 Manual Operation, 600-1200 Amp Switches



1. Maintenance handle
2. Hub

Figure 2-11 Manual Operation, 1600-3000 Amp Switches



1. Weight
2. Maintenance handle

Figure 2-12 Manual Operation, 4000 amp switches

2.4.3 Manual Operation, Programmed-Transition Switches

Programmed-transition switches have two operators, Normal and Emergency, on the left side of the contactor assembly. Mechanical interlocks prevent closing both operators at the same time. Refer to Figure 2-13 for typical locations of the Normal and Emergency operators.

Position indicators on the right side of the contactor assembly show the positions of the operators. See Figure 2-14.

Programmed-transition models use a detachable manual operating handle. Refer to Figure 2-8 through Figure 2-12.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

NOTICE

Improper operator handle usage. Use the manual operator handle on the transfer switch for maintenance purposes only. Return the transfer switch to the normal position. Remove the manual operator handle, if used, and store it in the place provided on the transfer switch when service is completed.

Manual Operation Test Procedure, 150-4000 Amp Programmed-Transition Transfer Switches

Check the operation of both operators by following the instructions in Section 2.4.2 for both the Normal and Emergency operators in the following sequence:

1. Starting with the contactor in the Normal position, use the maintenance handle to move the Normal operator from the closed to the open position. See Figure 2-13 and Figure 2-14.

2. Move the Emergency operator from the open position to the closed position.

3. Return the Emergency operator to the open position and the Normal operator to the closed position.

4. Remove the maintenance handle and store it in the place provided on the switch.

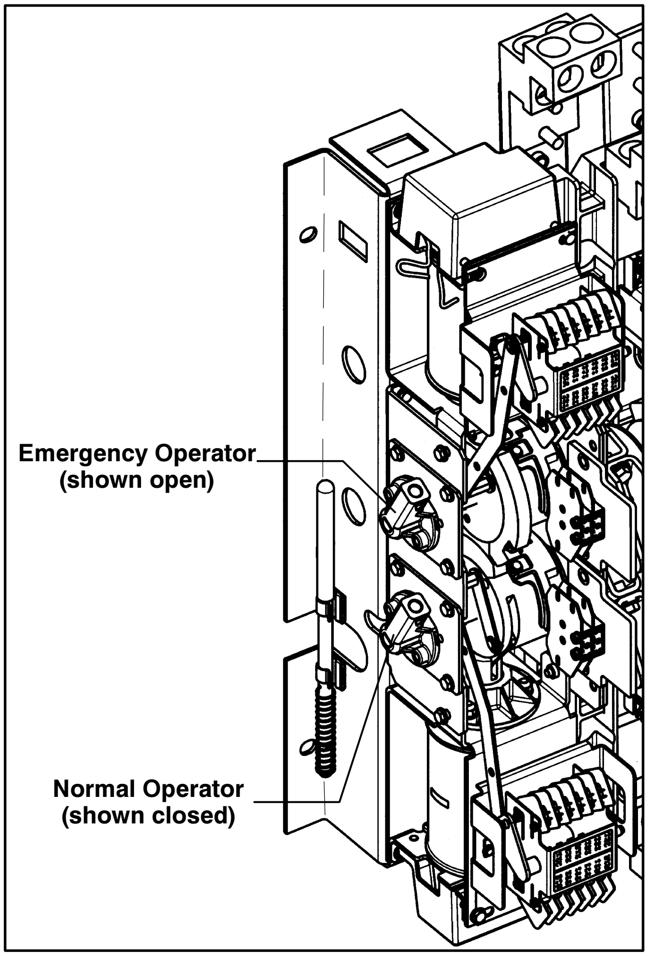
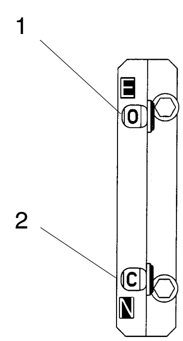


Figure 2-13 Programmed-Transition Switch Normal and Emergency Operators, 600-1200 Amp Model (shown in Normal position)



1. Emergency contact indicator: O is Open, C is closed
2. Normal contact indicator

202

Figure 2-14 Contact Position Indicators (located on the right side of the contactor assembly, shown in Normal position)

2.5 Electrical Wiring

All internal electrical connections are factory-wired and tested. Field installation includes connecting the sources, loads, generator start circuit(s), and auxiliary circuits, if used.

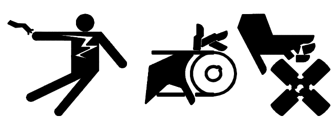
Note: Do not connect the wiring harness to the controller until instructed to do so in the voltage check procedure, Section 3.7.2.

Refer to the wiring diagrams provided with the transfer switch. Observe all applicable national, state, and local electrical codes during installation.

Install DC, control, and communication system wiring in metal conduit separate from AC power wiring.

It is not necessary to remove pole covers from the transfer switch for cabling. If you do remove them, reinstall them carefully.

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.

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.

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.

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 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.

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.

2.5.1 AC Power Connections

Determine the cable size. Refer to the table in Figure 2-15 to determine the cable size and number of cables required for the transfer switch. Make sure the lugs provided are suitable for use with the cables being installed. Watertight conduit hubs may be required for outdoor use.

Note: Use only copper wire for 200 amp models.

UL-Listed Solderless Screw-Type Terminals for External Power Connections		
Normal, Emergency, and Load Terminals		
Switch Rating (Amps)	Maximum Number of Cables per Pole	Range of Wire Sizes, Copper or Aluminum
30, 70, 104	1	#14 AWG to 2/0 AWG
150	1	#8 AWG to 3/0 AWG
200	1	#8 AWG to 3/0 AWG (use copper wire only)
225-400	1	#4 AWG to 600 MCM
	2	#1/0 AWG to 250 MCM
600	3	#2 AWG to 600 MCM
800-1200	4	#1/0 AWG to 750 MCM
1600-2000	6	#1/0 AWG to 750 MCM
2600-3000	12	#1/0 AWG to 750 MCM
4000	Bus Bar	

Figure 2-15 Cable Sizes

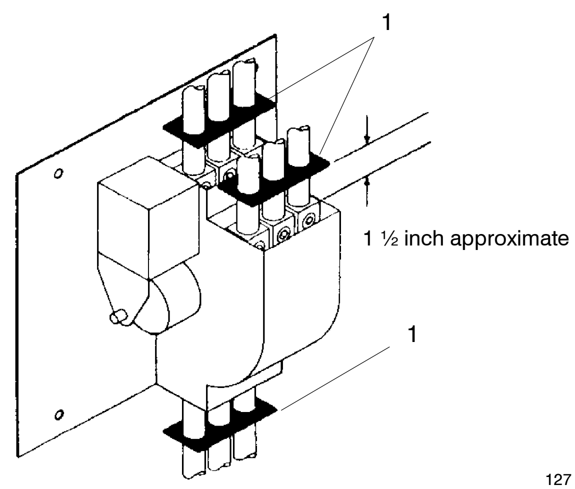
NOTICE

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.

Drill the entry holes. Cover the transfer switch to protect it from metal chips and construction grit. Then drill entry holes for the conductors at the locations shown on the enclosure drawings. Remove debris from the enclosure with a vacuum cleaner. *Do not use compressed air to clean the switch because it can cause debris to lodge in the components and cause damage.*

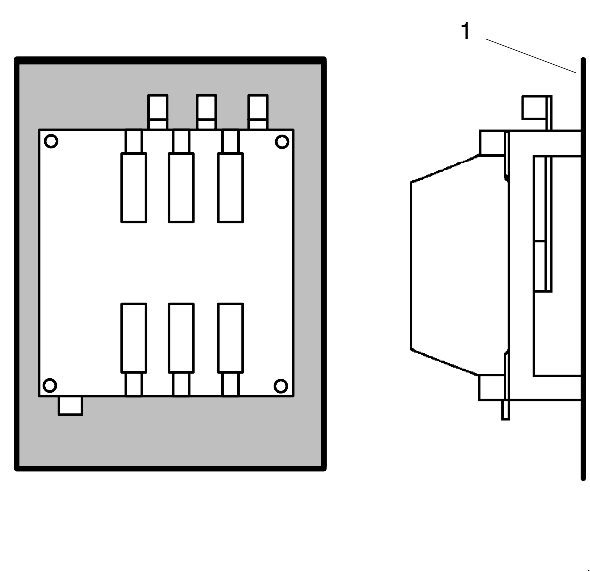
Install and test the power cables. Leave sufficient slack in the power leads to reach all of the power connecting lugs on the power switching device. Test the power conductors before connecting them to the transfer switch. Installing power cables in conduit, cable troughs and ceiling-suspended hangers often requires considerable force. Pulling cables can damage insulation and stretch or break the conductor's strands. Test the cables after pulling them into position and *before* they are connected to verify that they are not defective and that they were not damaged during installation.

Install the cable spacers provided with 30-200 amp switches as shown in Figure 2-16. On 225-400 amp switches, verify that the factory-installed insulator backing piece shown in Figure 2-17 is in place behind the contactor.



1. Cable spacers

Figure 2-16 Cable Spacers for 30-200 Amp Switches



1. Insulator backing piece
2. Contactor

Figure 2-17 Insulator for 225-400 Amp Switches

Connect the cables. Be careful when stripping insulation from the cables; avoid nicking or ringing the conductor. Clean cables with a wire brush to remove surface oxides before connecting them to the terminals. Apply joint compound to the connections of any aluminum conductors.

Refer to Figure 2-20, Interconnection Diagram, and the wiring diagram provided with the switch. A list of the drawing numbers for the wiring diagrams and schematics is given in Appendix B.

The connection points on the contactor are labeled Normal, Emergency, and Load. Be sure to follow the phase markings (A, B, C, and N). For single-phase systems, connect to A and C.

Note: Connect the source and load phases as indicated by the markings and drawings to prevent short circuits and to prevent phase-sensitive load devices from malfunctioning or operating in reverse.

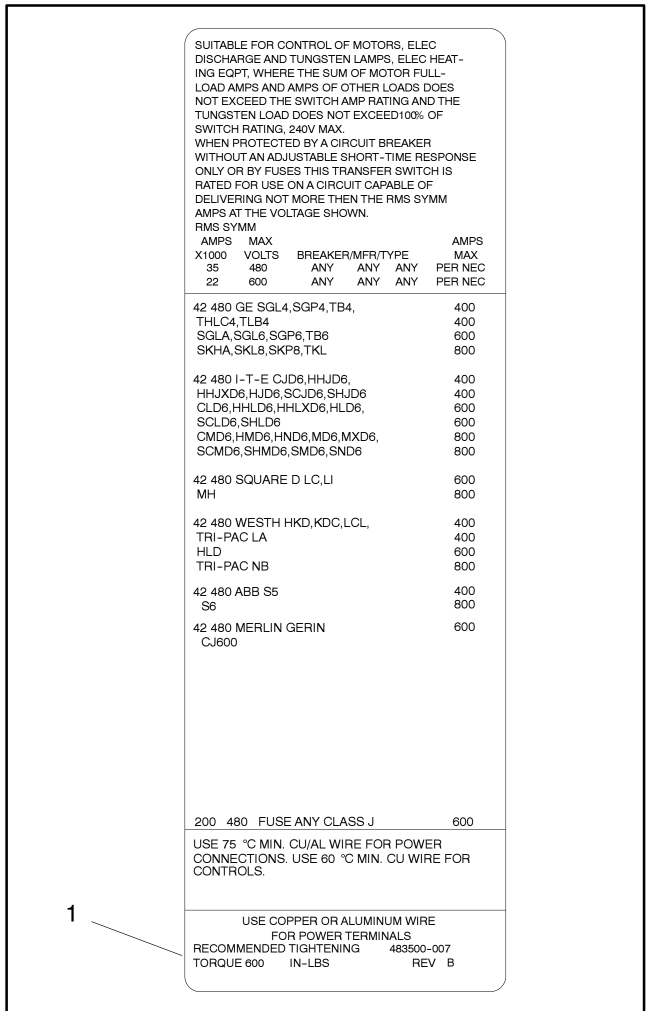
On models equipped with the optional preferred source switch, connect source N to the normal side and source E to the emergency side of the contactor.

Verify that all connections are consistent with drawings before tightening the lugs. Tighten all cable lug connections to the torque values shown on the label on the switch. (See Figure 2-19 for a typical rating/torque label.) Carefully wipe off any excess joint compound after tightening the terminal lugs.

For load connections to bus bars, use a compression washer, flat washer, and a minimum grade 5 bolt and torque the connections to the values in Figure 2-18.

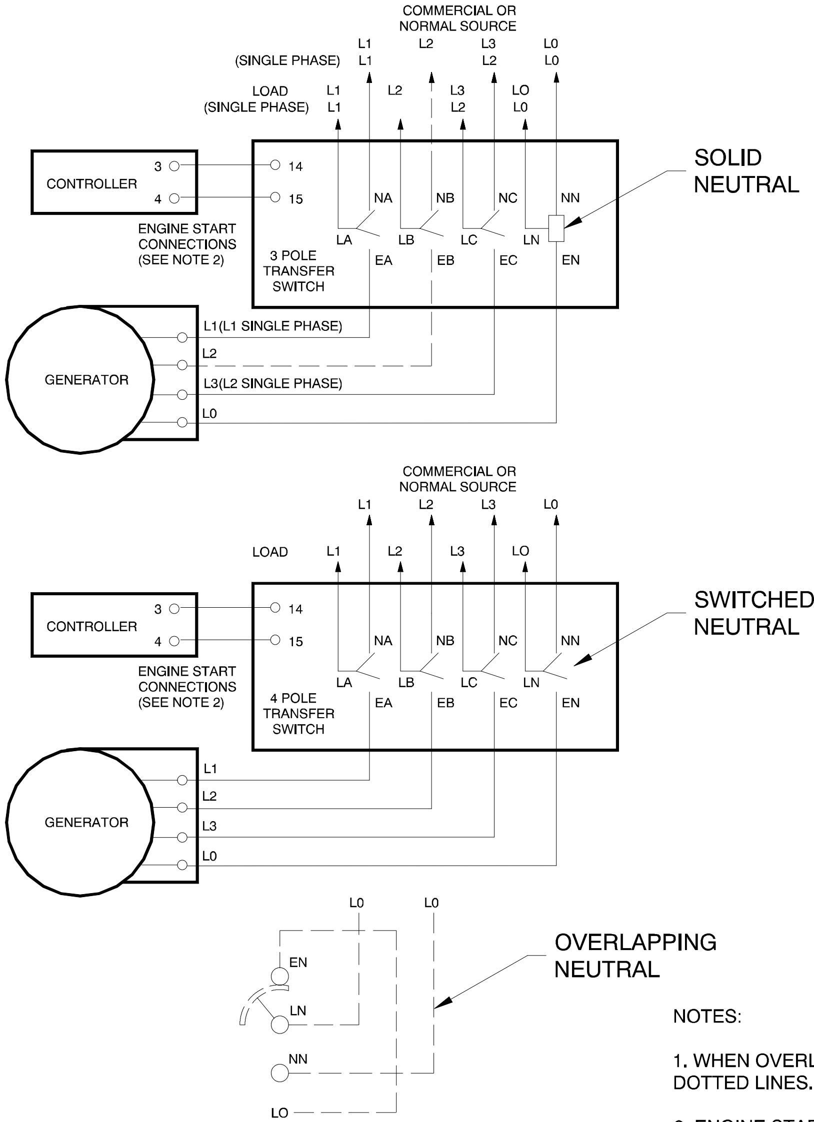
Bolt Size, inches	Bolt Torque	
	ft. lbs.	Nm
1/4	7	9.5
5/16	12	16.3
3/8	20	27.1
1/2	50	67.8
5/8	95	128.8
3/4	155	210.2

Figure 2-18 Tightening torque for bus bars



1. Torque specification

Figure 2-19 Typical Rating/Torque Label



NOTES:

1. WHEN OVERLAPPING NEUTRAL IS USED, WIRE NEUTRAL PER DOTTED LINES.

2. ENGINE START CONNECTIONS ON CONTACTOR LOCATED AS FOLLOWS:
30-200A OPEN TRANSITION: LOWER LEFT SIDE
225-400A OPEN TRANSITION: UPPER LEFT SIDE
600-4000A OPEN TRANSITION & 150-4000A PROGRAMMED TRANSITION: FIELD CONNECTION TERMINAL BLOCK TERMS 1 & 2.

3. CENTER POLE OF 3 POLE CONTACTOR MAY BE USED FOR SWITCHED NEUTRAL IN SINGLE PHASE 3 WIRE APPLICATIONS.

4. POWER CABLES AND CONTROL WIRING MUST BE RUN IN RIGID METAL CONDUIT.

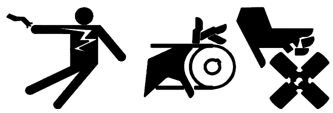
5. MAXIMUM DISTANCE BETWEEN BATTERY CHARGER (OPTIONAL) AND THE BATTERY:
12 AWG WIRE: 4.5M (15 FT)
10 AWG WIRE: 7.5M (25 FT)

ADV-6736

Figure 2-20 Interconnection Diagram

2.5.2 Engine Start Connection

WARNING



Accidental starting.
Can cause severe injury or death.

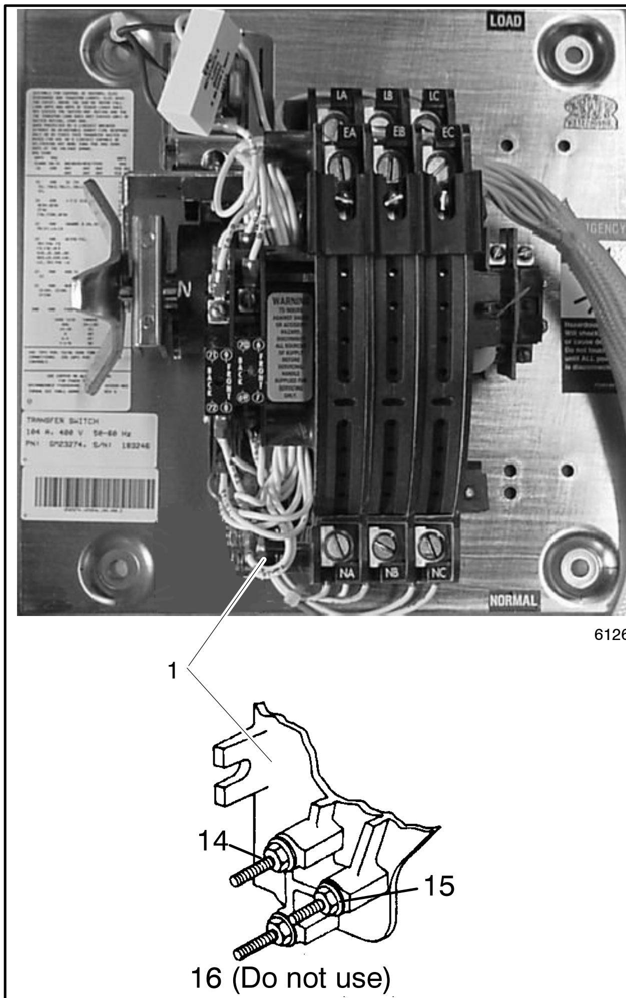
Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

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.

Prevent the generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator engine start battery charger, if installed; and disconnecting all generator engine start battery cables, negative (-) leads first.

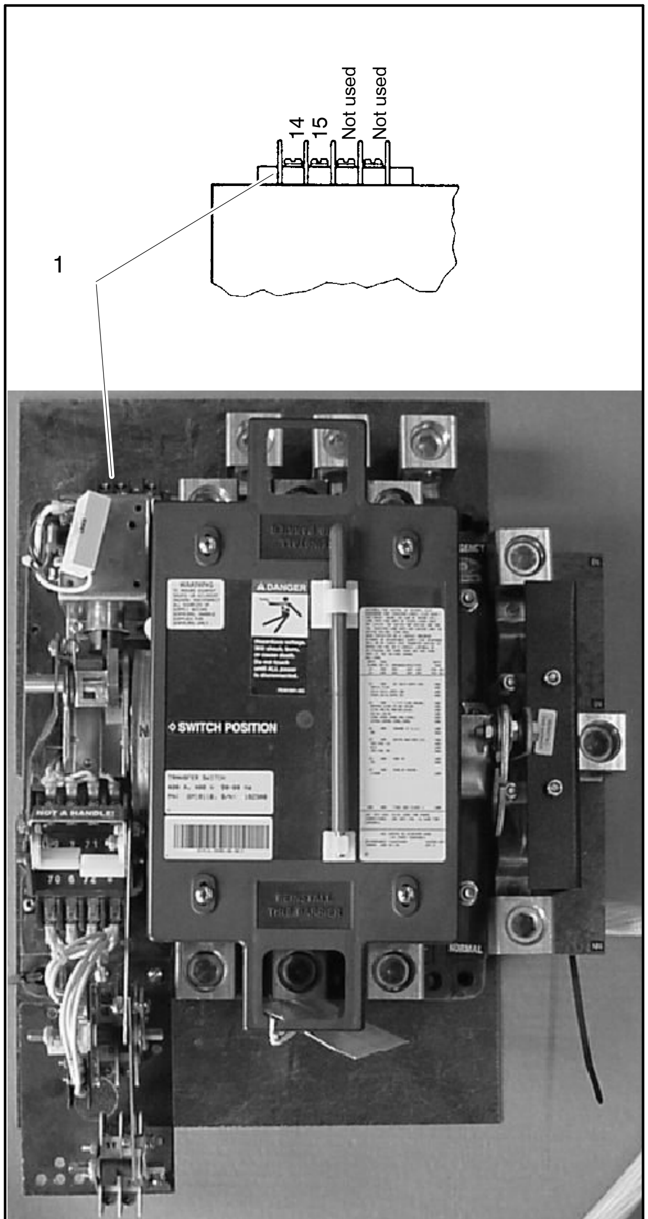
Connect the generator set remote starting circuit to the engine start connections located on the transfer switch contactor assembly. The engine start terminals are labeled with a red decal. See Figure 2-21, Figure 2-22, and Figure 2-23 for the locations of the engine start contacts. Refer to the generator set installation manual for wire size specifications.

The generator engine start contacts are rated 2 amps @ 30 VDC/250 VAC.



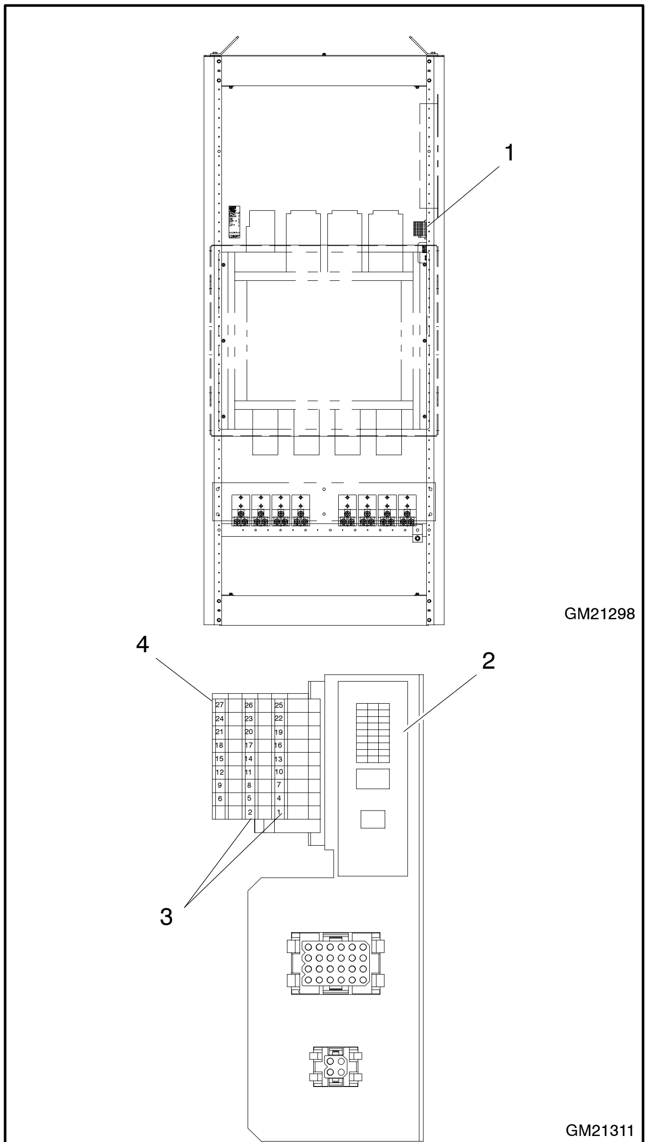
1. Engine start contacts 14 and 15

Figure 2-21 Engine Start Contacts, 30-200 Amp Switches



1. Engine start contacts 14 and 15

Figure 2-22 Engine Start Contacts, 225-400 Amp Open-Transition Models



1. Typical terminal block location
2. Decal
3. Engine start contacts 1 and 2
4. Auxiliary contacts 4-27 (see the schematic diagram for contacts closed on Normal or closed on Emergency)

Figure 2-23 Engine Start and Auxiliary Contact Terminal Block, Programmed-Transition Models and 600-4000 Amp Open-Transition Models

2.5.3 Auxiliary Contacts

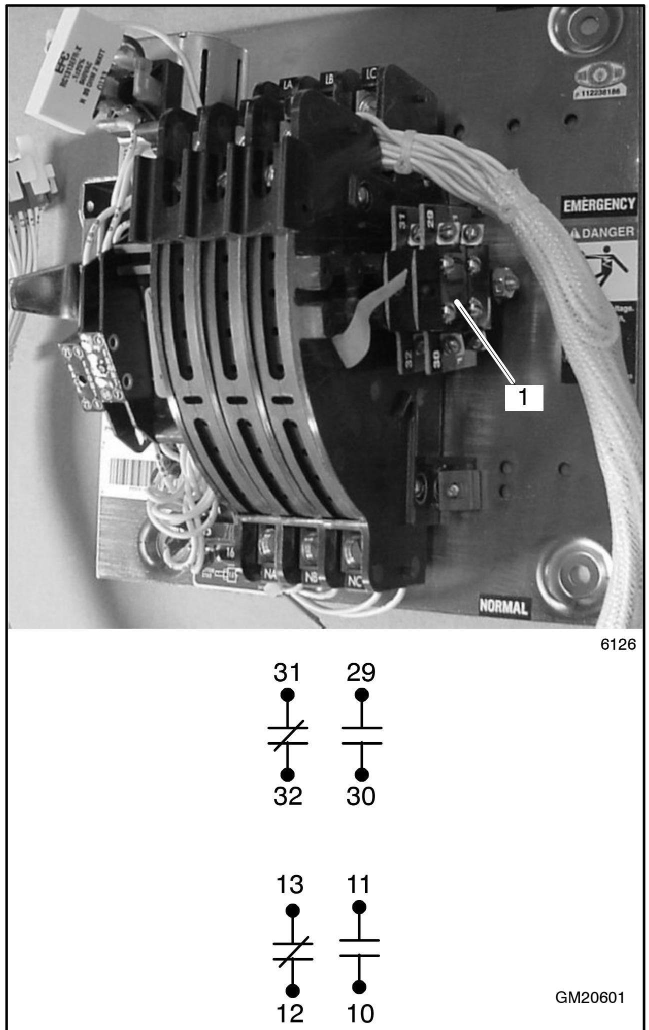
Connect the auxiliary contacts to customer-supplied alarms, remote indicators, or other devices. Auxiliary contacts provide contacts that close when the transfer switch is in the Normal position and contacts that close when the transfer switch is in the Emergency position. Each contact is rated 10 amps at 32 VDC or 250 VAC. The table in Figure 2-24 lists the number of auxiliary contacts provided with each transfer switch.

Figure 2-23, Figure 2-25, and Figure 2-26 show the locations of the auxiliary contacts for different models.

Refer to the schematic diagram provided with the transfer switch to identify which auxiliary contacts are closed on Normal and which are closed on Emergency for 600-4000 amp models. Follow the wire size and tightening torque specifications shown on the decal on the transfer switch.

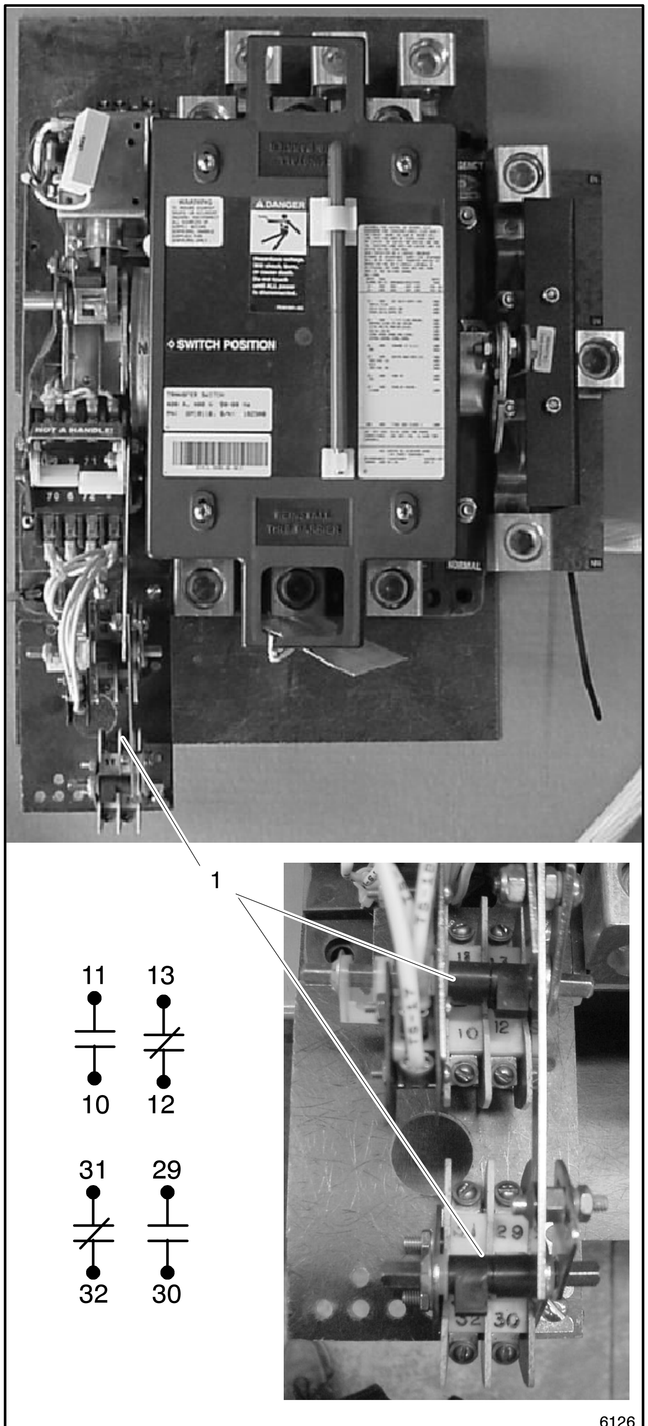
Auxiliary Position Indicating Contacts (rated 10 amps @ 32 VDC/250 VAC)		
	Number of Contacts Closed on Normal, Emergency	
Switch Rating (Amps)	**Open-Transition**	**Programmed-Transition**
30-104	2, 2	—
150-400	2, 2	2, 2
150-400*	—	6, 6
600-800	2, 2	6, 6
1000-3000	8, 8	7, 7
4000	4, 4	4, 3
* Programmed-transition with switched neutral		

Figure 2-24 Number of Auxiliary Contacts Available on Each Switch



1. Auxiliary contacts 10-13 and 29-32 (contacts shown with contactor in Normal position)

Figure 2-25 Auxiliary Contacts, 30-200 Amp Open-Transition Models



1. Auxiliary contacts 10-13 and 29-32 (contacts shown with contactor in Normal position)

Figure 2-26 Auxiliary Contacts, 225-400 Amp Open-Transition Models

2.5.4 Controller Ground

Verify that the grounding wire is connected from the controller's lower left mounting stud to the enclosure. This connection provides proper grounding that does not rely upon the door hinges.

Note: Do not connect the controller harness to the contactor until instructed to do so in the voltage check procedure, Section 3.7.2. Disconnect the power before connecting or disconnecting the controller harness.

3.1 Introduction

This section explains the setup and test of the transfer switch. Follow the instructions in this section after completing the physical installation described in the previous section.

Note: Be sure to perform the functional tests explained in Section 3.7 before putting the transfer switch into operation.

The instructions in this section explain how to set up the system to operate using factory default settings. This section includes:

- User interface panel pushbuttons and LED indicators
- DIP switch functions and settings
- Main logic board input and output connections and default settings
- Communications connections
- Factory default settings for voltage, frequency, and time delay functions
- Functional tests
- Exerciser setup
- Warranty registration

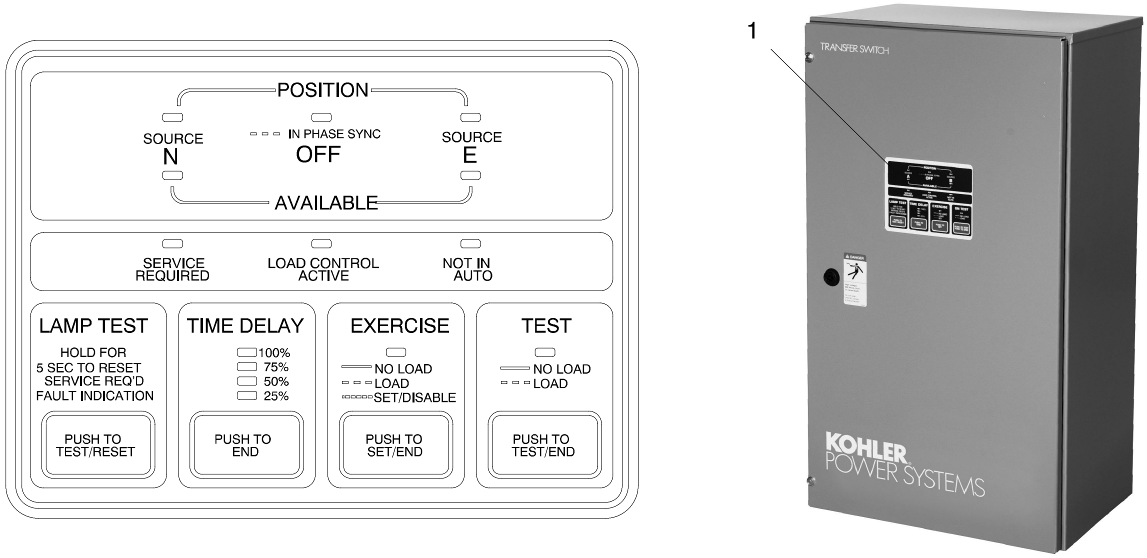
The transfer switch is designed to be set up and operated using the factory settings for time delays, voltage and frequency pickup and dropout, and other system parameters. To view and change the system settings, a personal computer running the MPAC-1000™ Setup Program is required. See TP-6135, Software Operation Manual, for instructions to use the Setup Program.

3.2 User Interface Panel

3.2.1 Pushbuttons and LED Indicators

The user interface panel is located on the transfer switch door. Figure 3-1 shows the user interface pushbuttons and LED indicators. The LEDs light steadily or flash to indicate different ATS conditions. The tables in Figure 3-2 and Figure 3-3 describe the functions of the pushbuttons and LED indicators. Refer to the appropriate section for more details about functions listed in Figure 3-3 and Figure 3-2; see the Table of Contents.

Figure 3-4 lists the fault conditions that cause the Service Required LED to light or flash. Steady illumination indicates that maintenance is needed; flashing indicates that service is required immediately.



1. User interface panel location

GM211077A

Figure 3-1 User Interface Panel

LED Indicator	Color	LED Illumination		
		Steady	Slow Flash	Rapid Flash
Exercise	Amber	Unloaded exercise is running.	Loaded exercise is running.	When exercise button is pressed and held, rapid flashing indicates the exercise has been started and set. Rapid flashing at any other time indicates that the exerciser is inhibited by the DIP switch setting.
Load Control Active	Amber	Pre/post-transfer load control or peak shave functions are operating.	—	—
Not in Auto	Red	—	—	ATS is not set for automatic operation or a load shed (forced transfer to OFF) sequence is active.
Position N	Red	Contactor is in Normal positon.	—	—
Position E	Red	Contactor is in Emergency position.	—	—
Position Off/ In-Phase Sync	Amber	Contactor is in Off position (programmed-transition models only).	—	In-phase monitor is operating (open-transition models only).
Service Required	Red	Fault. Non-emergency is maintenance required.	—	Fault. Immediate maintenance is required.
Source N Available	Green	Source N is available.	—	—
Source E Available	Green	Source E is available.	—	—
Test	Red	Unloaded test is running.	Loaded test is running.	—
Time Delay LED Bar	Amber	LEDs step down to indicate time remaining in an active time delay or exercise period.	—	—

Figure 3-2 User Interface LED Indicators

Pushbutton	Description
Exercise	Start and stop an exercise and set the exercise time.
Lamp Test	Test LEDs or reset the Service Required LED.
Test	Start and stop a test.
Time Delay	End an active time delay. (Does not end the exercise active or programmed-transition time delays.)

Figure 3-3 User Interface Pushbuttons

Service Required LED Illumination	Fault (See Section 4.3)
Flashing	Auxiliary Switch Fault
	Auxiliary Switch Open
	Failure to Acquire Standby Source
	Failure to Transfer
	I/O Module Communications Lost
	I/O Module Not Installed
	I/O Module Not Found
	Phase Rotation Fault
	Remote Common Fault
Steady	External Low Battery

Figure 3-4 Service Required LED

3.2.2 Controller Reset

The controller can be reset without disconnecting power. Use the following procedure.

Controller Reset Procedure

1. Hold the Lamp Test button until the LEDs flash. Do not release the button.

2. Continue to hold the Lamp Test button in and press the End Time Delay button. The LEDs will flash when the controller resets.

3.3 Controller Main Logic Board

DANGER

Hazardous voltage.
Will cause severe injury or death.

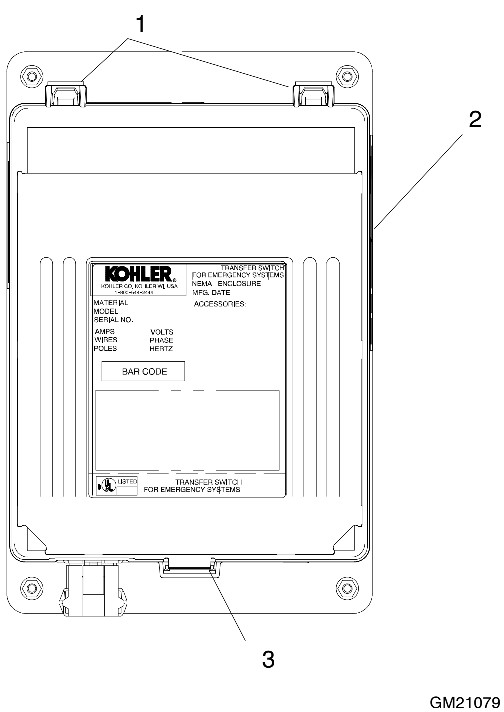
Disconnect all power sources before opening the enclosure.

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.

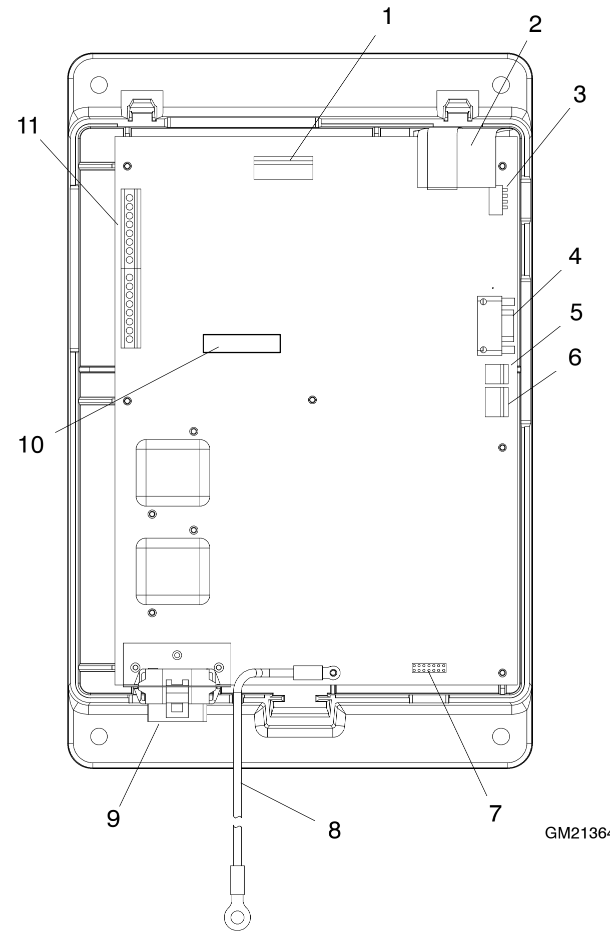
The controller's main logic board is mounted in a plastic housing on the inside of the transfer switch enclosure door. It is not necessary to open the cover to access the DIP switches or the PC connector on the circuit board.

Figure 3-6 shows the locations the DIP switches and connectors on the main logic board.



1. Hinges
2. Access openings to DIP switches and PC connection
3. Latch

Figure 3-5 Controller Housing



1. I/O board connection (P3)
2. User interface connections
3. DIP switches
4. Serial port for PC connection (P6)
5. Preferred source switch connection (P7)
6. Supervised transfer switch connection (P8)
7. Programmed-transition interface board (PTIB) connection (factory connection) (P9)
8. Ground wire
9. Contactor harness connection
10. Serial number decal
11. Terminal strip (inputs, output, Modbus connections) (TB1)

Figure 3-6 Controller Board Component Locations

3.3.1 Main Logic Board DIP Switch Settings

DIP switches on the main logic board control the test and exercise functions. A maintenance DIP switch inhibits transfer during ATS service. The factory settings for the DIP switches are shown in Figure 3-8.

Before opening the transfer switch enclosure to check or change the DIP switch settings, open the circuit breakers to disconnect the power to the transfer switch.

The DIP switches are located on the controller's main logic board on the inside of the enclosure door. Figure 3-6 shows the locations of the switches on the controller circuit board. A decal on the logic assembly housing shows the DIP switch positions and settings (see Figure 3-8). It is not necessary to remove the logic assembly cover to see or adjust the DIP switches. Check the DIP switch settings and adjust if necessary for the application.

Note: Changing the position of the 1 week/2 week exercise DIP switch after the exerciser has been set does not change the time of the *next* scheduled exercise. The new DIP switch setting becomes effective *after* the next scheduled exercise. See Section 4.2.3 for more information about the exerciser.

Close and lock the enclosure door before energizing the transfer switch.

3.3.2 Main Logic Board Inputs and Outputs

The controller main logic board's inputs and outputs are factory-assigned to the functions shown in Figure 3-7.

Pre-Transfer Load Control Output. Assigned to terminals TB1-1 and TB1-2. The load control output operates only during the transfer sequence between two live sources. When the output is activated, the contact opens for the programmed length of time before transfer (default setting=3 seconds) to allow controlled disconnection of selected loads. The contact closes at the time of transfer (default post-transfer time delay setting=0). The contact is not activated if the controller detects no available source.

See Section 4.2.5 for more information about the pre-transfer and post-transfer load control signal operation sequence. The pre- and post-transfer time delays can be adjusted using the optional setup program.

Load Bank Control Output. Assigned to terminals TB1-3–TB1-5 (programmable). The load bank control output can be used to apply a load to the generator set during the exercise. The load bank control output closes or opens a contact that can be used to signal the load bank controller to operate. If the Normal source is lost during an exercise period, the load bank control output is deactivated to remove the load bank and allow the transfer of the building load to the emergency source.

Peak Shave/Area Protection Input. Assigned to terminals TB1-6 and TB1-7 (programmable input #1). Starts the generator set and transfers to the standby source, ignoring the Time Delay Engine Start and Standby-to-Preferred time delays. The system attempts to transfer to the preferred source when the input is removed. The peak shave command is overridden if the standby source fails.

TB1 Input/Output	Factory Setting
Non-programmable output	Pre-transfer load control
Programmable output	Load bank control output
Programmable input #1	Peak shave/Area protection input
Programmable input #2	End time delay input

Figure 3-7 Terminal Strip Input and Output Factory Settings

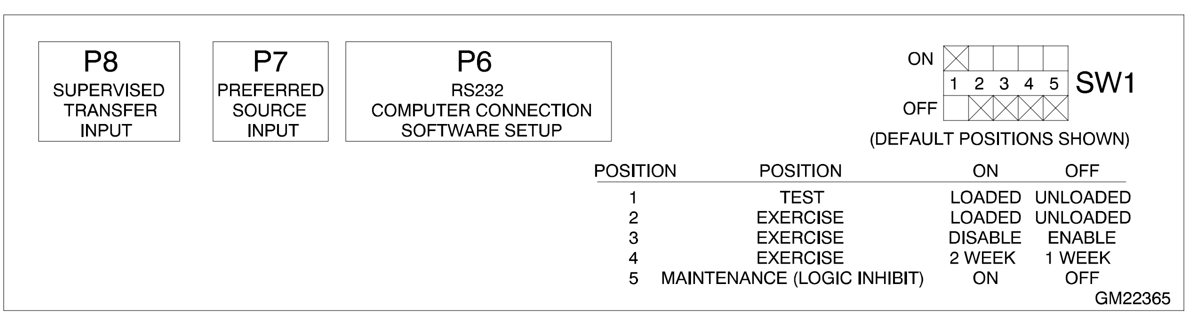


Figure 3-8 Logic Assembly Decal Showing DIP Switch Settings

End Time Delay Input. Assigned to terminals TB1-8 and TB1-9 (programmable input #2). Allows a remote signal to end an active time delay. The signal ends only the time delay that is active at the time the signal is applied. Repeated signals are required to end additional time delays. Does not end the programmed-transition time delays or an exerciser run.

Other Inputs and Outputs. Other input and output functions can be assigned to the programmable TB1 terminals. Refer to Section 6 for lists of available programmable inputs and outputs. Use the Setup Program to change the input and output assignments if necessary.

Connections. Connect input and output leads to the controller terminal strip on the main logic board (MLB). To gain access to the terminal strip, open the plastic housing by pushing up on the latch on the bottom of the cover and swinging the cover up and out. The cover is hinged at the top. Lift the cover off the hinges to remove it completely, if necessary. Refer to the label on the plastic housing or Figure 3-9 for the connections. Use #12–24 AWG wire and tighten the connections to 0.5 Nm (4.4 in. lbs.).

The controller board terminal strip has two programmable inputs. Each input has a signal and a return connection. Connect inputs to terminals 6 and 7 or 8 and 9 on terminal strip TB1. Record the connections on the label provided. Use the setup program to assign the input functions if they are different from the default assignments shown in Figure 3-7.

The main logic board has one programmable output, which is factory-assigned to the load bank control output function. Connect to terminals 3 and 4 or 3 and 5 on terminal strip TB1. Use the setup program to assign the output function if it is different from the default assignment.

Note: Always replace the cover before energizing the transfer switch controls.

3.3.3 Communications Connections

The controller has two communications connections.

Serial Port. For connection to a personal computer to run the Setup Program software. This is a non-isolated RS-232 port with a connection speed of 57.6 kbps.

Modbus® Network Interface (MNI). For connection to building management systems, programmable logic controls, etc. This is a non-isolated RS-485 port with connection speeds of 9.6 kbps and 19.2 kbps. Use RTU (remote terminal unit) protocol for communication through this port.

Connect the Modbus input and output to the terminals shown in Figure 3-9. Use #12–24 AWG twisted-pair wire; Belden cable #9841 or equivalent is recommended. Connect the shield to ground as shown in Figure 3-9. Tighten the connections to 0.5 Nm (4.4 in. lbs.).

Note: Contact Kohler Co. for information about Modbus® communication protocol.

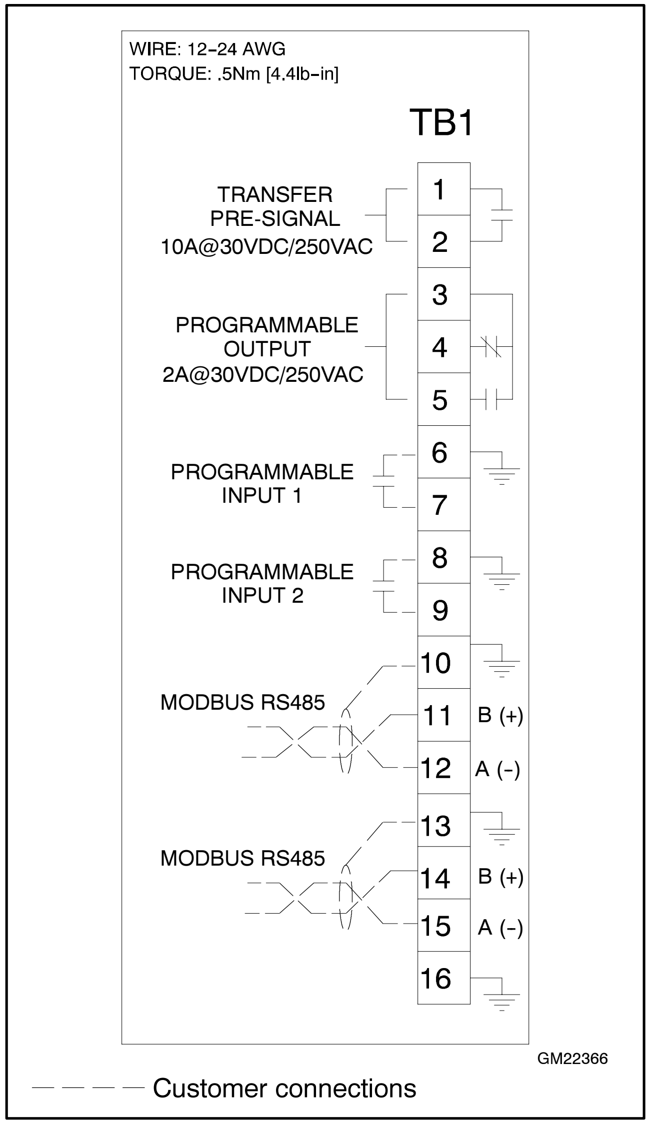


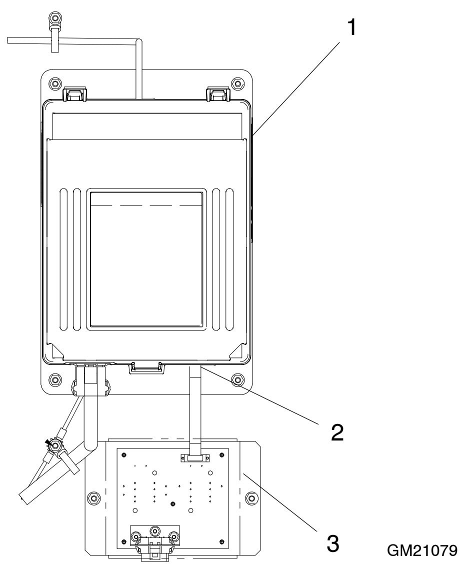
Figure 3-9 Terminal Strip TB1 Connections

Modbus® is a registered trademark of Schneider Electric.

3.4 Programmed-Transition Interface Board (PTIB)

Programmed-transition model transfer switches use a programmed-transition contactor and a programmed-transition interface board (PTIB). The PTIB is mounted on the inside of the enclosure door.

The PTIB is factory-wired and requires no additional wiring in the field. Verify that the PTIB wiring harness is connected to the main logic board. See Figure 3-10 for the PTIB connector location.



1. Controller assembly (located inside the enclosure door)
2. PTIB connection
3. PTIB

Figure 3-10 Programmed-Transition Interface Board (PTIB)

3.5 System Settings and Time Delays

The system can be operated using the factory settings listed in the following sections.

Use the Setup Program to change the controller time delays, pickup and dropout settings, inputs, outputs, and options if necessary.

3.5.1 System Parameters

The system parameter factory settings are shown in Figure 3-11. The controller voltage and frequency sensing are factory-set to the default values shown in Figure 3-12. The voltage and frequency debounce time delays prevent nuisance transfers caused by brief spikes and dips in the power supply.

System Parameter	Factory Setting
Open or programmed transition	Set to order
Single/three phase	Set to order
Operating voltage	Set to order
Operating frequency (50 or 60 Hz)	Set to order
Phase rotation	ABC
Commit to transfer (yes or no)	No
Rated current	Set to order
Operating mode: Generator-toGenerator, Utility-to-Generator, or Utility-to-Utility	Utility-to-Generator
In-phase monitor	Disabled
In-phase monitor transfer angle	0
Transfer mode (automatic or non-automatic)*	Set to order
* The transfer mode (automatic or non-automatic) cannot be changed in the field.	

Figure 3-11 System Parameters

Voltage and Frequency Sensing	
Parameter	**Default**
Undervoltage pickup	90% of nominal
Undervoltage dropout	90% of pickup
Overvoltage dropout	110% of nominal
Overvoltage pickup	95% of dropout
Voltage debounce time	0.5 sec.
Underfrequency pickup	90% of nominal
Underfrequency dropout	99% of pickup
Overfrequency dropout	101% of pickup
Overfrequency pickup	110% of nominal
Frequency debounce time	3 sec.

Figure 3-12 Factory Settings, Voltage and Frequency

3.5.2 Time Delays

The factory settings for the time delays are shown in Figure 3-13.

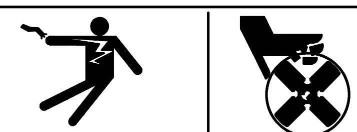
The pre-transfer time delays operate only when both sources are available. These delays allow time to disconnect selected loads before transfer. The load control LED on the user interface lights when the pre-transfer signal is active. The pre-transfer and post-transfer time delays overlap the preferred-to-standby and standby-to-preferred transfer time delays.

Adjustable Time Delays	
Time Delay	**Default**
Engine start	3 sec.
Preferred to standby	1 sec.
Standby to preferred	15 min.
Off to standby (programmed-transition only)	1 sec.
Off to preferred (programmed-transition only)	1 sec.
Failure to acquire standby source	1 min.
Pretransfer to standby signal	3 sec.
Pretransfer to preferred signal	3 sec.
Post-transfer to standby signal	0 sec.
Post-transfer to preferred signal	0 sec.
Engine cooldown	0 min.
In-phase monitor synch	30 sec.

Figure 3-13 Factory Settings, Time Delays

3.6 Generator Set Preparation

WARNING



Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Disconnect all power sources to the transfer switch by opening upstream circuit breakers or switches to the transfer switch.

Prepare the generator set for operation. Check the oil level, coolant level, fuel supply, batteries, and items specified by the generator set installation or operation checklist or manual.

Move the generator set master switch to the OFF position; reconnect the generator engine start battery cables, negative (–) leads last; and reconnect power to the generator engine start battery chargers, if installed.

3.7 Functional Test

The functional test includes three checks:

- Manual Operation Test
- Voltage Checks
- Automatic Operation Test

Note: Perform these checks in the order presented to avoid damaging the ATS.

Read all instructions on the labels affixed to the automatic transfer switch.

3.7.1 Manual Operation Test

If you have not already done so, test the contactor manual operation before proceeding to the voltage check and electrical operation test.

Note: Disable the generator set and disconnect the power by opening the circuit breakers or switches for both sources before manually operating the transfer switch.

Follow the instructions in Section 2.4 to check the transfer switch manual operation.

A contactor in normal and serviceable condition transfers smoothly without binding when operated manually. Do not place the transfer switch into service if the contactor does not operate smoothly without binding; contact an authorized distributor/dealer to service the contactor.

Note: Do not reconnect the power sources at this time. Proceed to the voltage check procedure described in the following section.

3.7.2 Voltage Check

The voltage, frequency, and phasing of the transfer switch and the power sources must be the same to avoid damage to loads and the transfer switch. Compare the voltage and frequency ratings of the utility source, transfer switch, and generator set, and verify that the ratings are all the same.

Use the voltage check procedure explained in this section to verify that the voltages and phasing of all power sources are compatible with the transfer switch before connecting the power switching device and controller wire harnesses together.

Read and understand all instructions on installation drawings and labels on the switch. Note any optional accessories that have been furnished with the switch and review their operation.

Note: Source N is the source connected to the normal side of the contactor. Source E is the source connected to the emergency side of the contactor.

The voltage check procedure requires the following equipment:

- A digital voltmeter (DVM) with electrically insulated probes capable of measuring the rated voltage and frequency
- A phase rotation meter

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)

Voltage Check Procedure

Note: Perform voltage checks in the order given to avoid damaging the transfer switch.

1. Verify that the generator set master switch is in the OFF position and both power sources are disconnected from the transfer switch.
2. Disconnect the power switching device and controller wiring harnesses at the inline disconnect plug, if they are connected.
3. Manually operate the transfer switch to position E. See Section 2.4.
4. If Source N is a generator set, move the generator set master switch to the RUN position. The generator set should start.
5. Close the Source N circuit breaker or switch.
6. Use a voltmeter to check the Source N (normal) phase-to-phase and phase-to-neutral (if applicable) terminal voltages and frequency.
   a. If Source N is the utility and the measured input does not match the voltage and frequency shown on the transfer switch nameplate, *STOP!* Do not proceed further in installation because the transfer switch is not designed for the application—call your distributor/dealer to order the correct transfer switch.
   b. If Source N is a generator set and the generator set output voltage and frequency do not match the nominal system voltage and frequency shown on the transfer switch nameplate, follow the manufacturer's instructions to adjust the generator set. The automatic transfer switch will only function with the rated system voltage and frequency specified on the nameplate.
7. Use a phase rotation meter to check the phase rotation at the Source N (normal) terminals. Rewire the transfer switch Source N terminals to obtain the correct phase sequence if necessary.

   Note: The default setting for the phase rotation on the controller is ABC. If the application uses a phase rotation of CBA, use the Setup Program to change the phase rotation setting on the controller.
8. If the source is a generator set, stop the generator set by moving the master switch to the OFF position.
9. Disconnect Source N by opening upstream circuit breakers or switches.
10. Manually operate the transfer switch to position N.
11. Repeat steps 4 through 8 for Source E. Then proceed to step 17.
12. Disconnect both sources to the transfer switch by opening the circuit breakers or switches.
13. Connect the power switching device and controller wiring harnesses together at the inline disconnect plug.

    Note: Do not connect or disconnect the controller wiring harness when the power is connected.
14. Check the DIP switch settings. Verify that the TEST DIP switch is in the loaded position before proceeding with the next test.
15. Close and lock the transfer switch enclosure door.

16. Reconnect both power sources by closing the circuit breakers or switches.
17. Move the generator set master switch to the AUTO position.

    Note: If the engine cooldown time delay setting is not set to zero (default setting), the generator set may start and run until the Time Delay Engine Cooldown (TDEC) ends.

18. Proceed to the automatic operation test.

3.7.3 Automatic Operation Test

Check the transfer switch's automatic control system immediately after the voltage check. The test sequence simulates a loss of the normal source, starts the generator set, and transfers the load to the emergency source, executing all time delays that are set up to operate during a loss of the normal source. When the test is ended in step 7 of the procedure, the transfer switch transfers the load back to the normal source and removes the engine start signal, executing all appropriate programmed time delays.

Refer to Section 4.2.2 for a description of the test sequence of operation.

Note: If the standby source fails during a test, the ATS will immediately attempt to transfer to the preferred source.

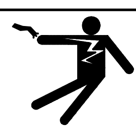
Optional Switches. If the ATS is equipped with a preferred source switch, check the switch position before proceeding with the automatic operation test. The test procedure assumes that Source N is the preferred source.

If the transfer switch is equipped with a supervised transfer switch, verify that it is set to the Auto position.

See Section 6 for more information about optional switches.

Note: Close and lock the enclosure door before starting the test procedure.

⚠ DANGER



Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Automatic Operation Test Procedure

1. Check the controller LED indicators to verify that the Position N and Source N Available indicators are lit.
2. Press the lamp test button and check that all controller LEDs illuminate.
3. Verify that the generator set master switch is in the AUTO position.
4. Press the TEST button on the controller to start the test. The TEST LED flashes to indicate that the ATS controller is set up to transfer the load during the test.
5. Verify that the generator set starts after the engine start delay times out. Check that the Source E Available LED lights.
6. Verify that the switch transfers the load to Source E.
    a. Open-Transition Models: After the preferred-to-standby time delay, verify that the Position N LED goes out and the Position E LED lights, indicating that the switch has transferred the load to Source E.
    b. Programmed-Transition Models: After the preferred-to-off time delay, verify that the Position N LED goes out and the Position OFF LED lights. After the off-to-standby time delay, check that the Position E LED lights, indicating that the switch has transferred the load to Source E.
7. Push the Test button to end the test.
8. Verify that the switch transfers the load back to Source N.
    a. Open-Transition Models: After the standby-to-preferred time delay, verify that the Position E LED goes out and the Position N LED lights, indicating that the switch has transferred the load to Source N.
    b. Programmed-Transition Models: After the standby-to-off time delay, verify that the Position E LED goes out and the Position OFF LED lights. After the off-to-preferred time delay, check that the Position N LED lights, indicating that the switch has transferred the load to Source N.

Note: The generator set may have an engine cooldown time delay that causes the generator set engine to run after the transfer switch engine start signal is removed.

This completes the functional test.

3.8 Exerciser Setup

The installer must activate the exerciser. Press and hold the Exercise button for approximately 3 seconds until it flashes to activate the exerciser, start an exercise run, and set the time and date of the next exercise run. The exercise time is set to the time that the button is pushed.

The default setting for the exerciser run duration is 30 minutes. The time delay LEDs show the time remaining in the exercise run. Press and hold the exercise button again to end the exercise period early, if desired.

Note: Pressing the end time delay button does *not* end an exercise run.

Set the exerciser period (every week or every 2 weeks) and load condition by using DIP switches on the controller circuit board. The factory settings for the exerciser are shown in Figure 3-14.

Exerciser Parameter	Factory Setting
1 week/2 week exercise (DIP switch)	1 week
Disable/enable exercise (DIP switch)	Enable
Load/no load exercise (DIP switch)	No load
Run duration	30 minutes

Figure 3-14 Exerciser Factory Settings

Use the Setup Program to change the exerciser run duration, if desired. See Section 4.2.3 for more information about the exerciser.

The exerciser can be set without starting the generator set, if necessary. Use the following procedure.

Exerciser Setting Procedure

1. Move the disable/enable exercise DIP switch to the DISABLE position and close the enclosure door. The Exercise LED flashes rapidly to indicate that the exerciser is disabled.
2. Press and hold the exercise button until the Exercise LED goes out for approximately 3 seconds and then starts to flash again.
3. Move the disable/enable exercise DIP switch back to the ENABLE position.
4. Close and lock the enclosure door.
5. Verify that the EXERCISE LED is not flashing.

The exerciser time is set to the time that the button is pushed. The exerciser will run in one or two weeks according to the 1 week/2 week DIP switch position.

3.9 Warranty Registration

The transfer switch seller must complete a Startup Notification Form and submit it to the manufacturer within 60 days of the initial startup date. A Startup Notification Form is included with generator sets and covers all equipment in the standby system. Standby systems not registered within 60 days of startup are automatically registered using the manufacturer’s ship date as the startup date.

4.1 Introduction

This section contains descriptions and flowcharts for typical transfer switch operating sequences. This section also describes faults and provides other information related to the controller operation.

On systems not equipped with the preferred source selector switch, the preferred source is the source connected to the Normal side of the power switching device. The source connected to the Emergency side of the contactor is the standby source.

4.2 Sequence of Operation

4.2.1 Automatic Operation, Open- and Programmed-Transition Switches

Typical ATS operation in utility-to-generator set mode is divided into two sequences:

- **Failure of the Normal (preferred) power source** and the resulting load transfer to the Emergency (standby) source.
- **Restoration of the preferred power source** and the resulting load transfer back to the preferred source.

Events such as the failure of the generator set to start can change the sequence of operation.

If the emergency source fails and the normal source is not available, the transfer switch controller powers down until one of the sources returns.

Figure 4-1 Illustrates the transfer sequence when the normal source fails, and Figure 4-2 illustrates the sequence when it returns. Figure 4-3 shows the operation of the user interface LEDs during loss and restoration of the normal source.

Time Delays. Time delays before load transfer prevent nuisance transfers during brief power interruptions. The voltage and frequency debounce time delays prevent nuisance transfers caused by brief spikes and dips in the power supply. See Section 3.5 for the default settings for the time delays and debounce times.

Loss of Phase. If the system detects a loss of phase in the connected source, it attempts to transfer to an alternate source. The system considers a phase lost if its phase is 45 degrees from the rotation setting. The controller logs loss of phase events in the event history.

Programmed-Transition Switches. Programmed transition switches provide an OFF position during transfer between two sources. The adjustable time off period allows residual voltages in the load circuits to decay before connecting to the second source. During the off period, the ATS main contacts are open and neither source powers the load.

The off-to-standby and off-to-preferred time delays control the length of the off period for programmed-transition switches. The time delays are factory-set to the defaults shown in Figure 3-13. The time delays can be changed using the optional Setup Program.

The End Time Delay Button and Remote Bypass command do not override the off-to-standby and off-to-preferred time delays.

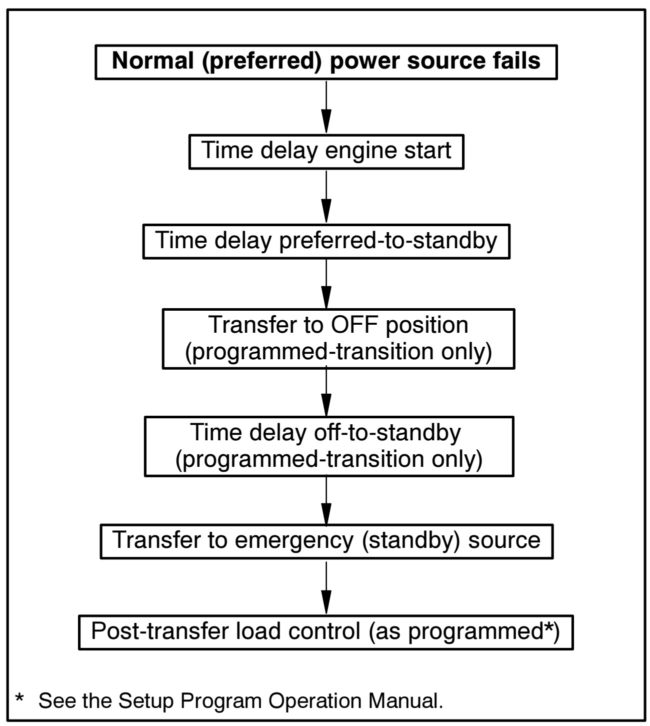
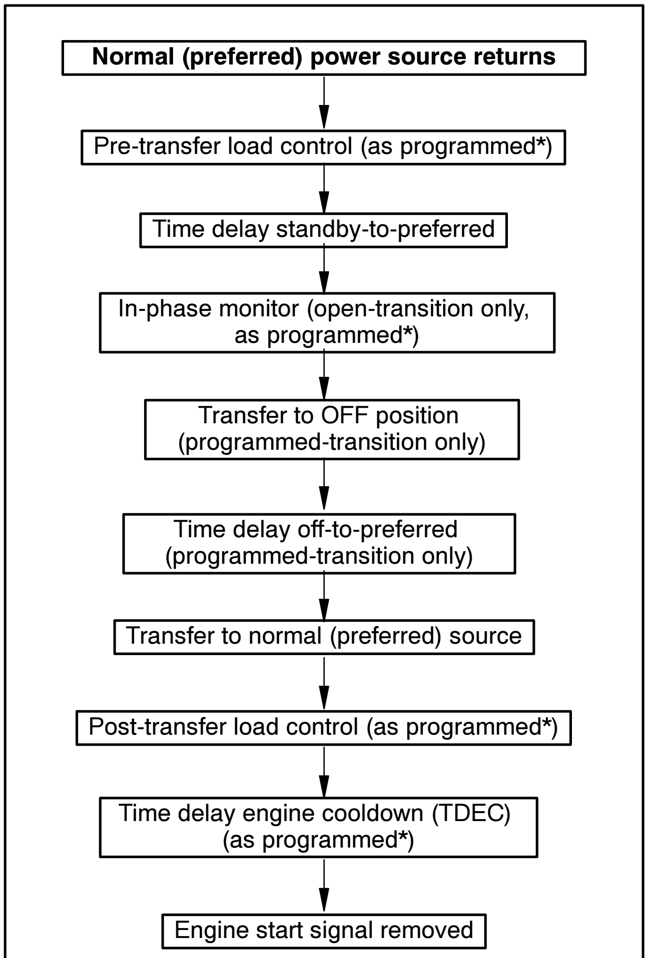


Figure 4-1 ATS Sequence of Operation, Transfer to Emergency (standby source)



* See the Setup Program Operation Manual.

Figure 4-2 ATS Sequence of Operation, Return to Normal (preferred source)

Loss of Normal Source	LED Indicators					
	N Available	N Position	OFF Position	E Available	E Position	Load Control
Engine Start Time Delay						
Preferred-to-Standby Time Delay		X		X		
Post-transfer to Standby Load Control				X	X	X
Standby-to-Preferred Time Delay	X			X	X	
Pre-transfer to Preferred Load Control	X			X	X	X
Off-to-Preferred Time Delay (programmed-transition only)	X		X	X		
Post-transfer to Preferred Load Control	X	X		X		X
Engine Cooldown Time Delay (Default = 0)	X	X		X		

Figure 4-3 User Interface LED Indicators During Loss of Normal Source

4.2.2 System Test

A system test simulates a preferred source failure and performs the transfer sequence. Press and release the test button to start the test. Press and release the test button again to end the test. The test sequence does not start if the ATS is in the standby position.

A test sequence can also be started or ended through the setup software. See the Setup Program Operation manual.

The Test LED flashes to indicate a loaded test or lights steadily to indicate a test without load. Use the test DIP switch to select loaded or unloaded tests. See Section 3.3.1 for DIP switch locations and settings.

Figure 4-4 and Figure 4-5 illustrate the following test sequences. Figure 4-6 shows the operation of the user interface LEDs during the test sequence.

Test without Load. The test without load sequence starts the generator set but does not transfer the load. The generator set continues to run until the test button is pushed again.

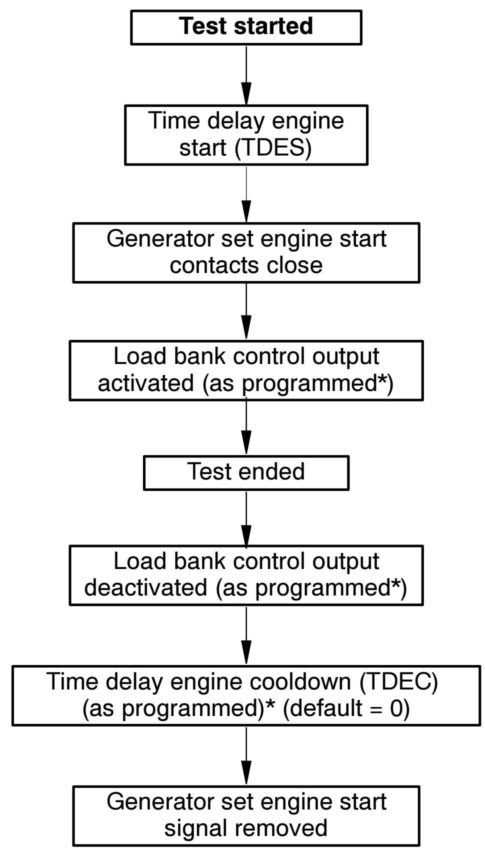
Test with Load. The test with load sequence simulates a preferred source failure and activates the pre- and post-transfer load control sequences as programmed. Refer to Section 4.2.5 for additional information about pre-transfer time delays.

The test remains active until the test button is pushed again or until a remote test signal is received. If the standby source fails during a test cycle, the system immediately transfers back to preferred.

The test sequence executes all time delays that are set up to operate during a normal sequence of operation. Press the End Time Delay button to shorten the time delays while they are running, if desired. (The End Time Delay button does not end programmed-transition time delays.)

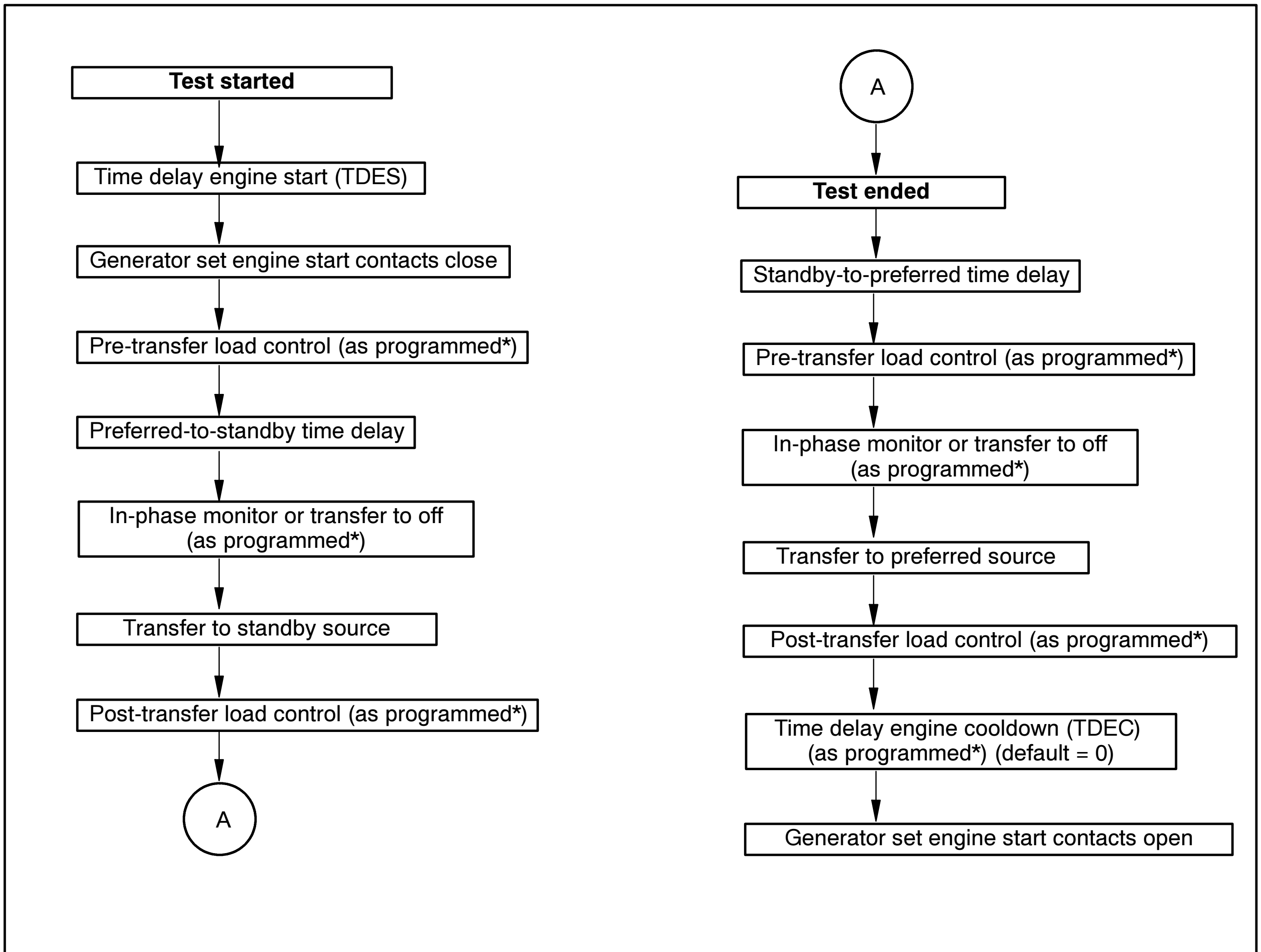
At the start of the test, the ATS simulates a preferred source failure and signals the generator set to start. When the standby source is available and the time delay preferred-to-standby expires, the ATS transfers the load if the test DIP switch is set for a loaded test.

When the test button is pressed again, the ATS transfers the load back to the preferred source, if available, after the standby-to-preferred time delay. The ATS removes the generator engine start signal after the related time delays expire. (The generator set may continue to run if the generator set controller provides an additional engine cooldown time delay.)



* See the Setup Program Operation Manual.

Figure 4-4 Test Without Load Sequence



* See the Setup Program Operation Manual.

Figure 4-5 Test with Load Sequence

System Test	N Available	N Position	OFF Position	E Available	E Position	Load Control	Test (flashing)
Engine Start Time Delay	X	X					X
Preferred-to-Standby Time Delay	X	X		X			X
Pre-transfer to Standby Load Control	X	X		X		X	X
Off-to-Standby Time Delay (programmed-transition only)	X		X	X			X
Post-transfer to Standby Load Control	X			X	X	X	X
Pre-transfer to Preferred Load Control	X			X	X	X	X
Off-to-Preferred Time Delay (programmed-transition only)	X		X	X			X
Post-transfer to Preferred Load Control	X	X		X		X	X
Engine Cooldown Time Delay (Default = 0)	X	X		X			X

Figure 4-6 User Interface LED Indicators During a Loaded Test

4.2.3 Exerciser

Activate the exerciser after ATS installation by pressing and holding the exercise button until the exercise LED flashes quickly. See Figure 3-1 for the location of the Exercise button and LED on the user interface panel.

Press the Exercise button while the exercise is running to end the exercise early, if desired.

Figure 4-7 shows the exerciser factory default settings. The exercise mode is set through the Setup Software. All other settings in Figure 4-7 are set through DIP switches on the contoller's main logic board. See Section 3.3.1.

Figure 4-8 describes the exercise LED operation.

Exerciser Parameter	Factory Setting
1 week/2 week exercise	1 week
Disable/enable exercise	Enable
Load/no load exercise	No load
Run duration	30 minutes
Exercise mode	Switch Input

Figure 4-7 Exerciser Factory Settings

Exerciser LED	Indicates
Steady Illumination	Unloaded exercise active.
Slow Flash (1 Hz)	Loaded exercise active
Rapid Flash (4 Hz)	When exercise button is pressed and held, rapid flashing indicates the exercise has been started and set. Rapid flashing at any other time indicates that the exercise is inhibited by the DIP switch setting.

Figure 4-8 Exerciser LED Indicator

Loaded/Unloaded Exercise. A DIP switch on the controller circuit board allows the selection of loaded or unloaded exercise runs. (See Section 3.3 for DIP switch locations.) Selecting unloaded exercise allows the ATS to start and run the generator set without transfering the building load.

The exercise LED flashes to indicate a loaded exercise. The exercise sequence starts the generator set engine immediately. and activates the pre-transfer load control sequence. The in-phase monitor or programmed-transition time delays operate if programmed. The post-transfer load control sequence operates as programmed after the load is transferred. See Figure 4-9 and Figure 4-10 for the exerciser sequences of operation. Figure 4-11 shows the operation of the user interface LEDs during the exercise run. Refer to Section 4.2.5 for additional information about pre-transfer time delays.

Exercise Mode. The exerciser is factory-set to operate in switch input mode, which uses the Exercise button on the user interface to start, stop, and set the exerciser, and the 1 week/2 week DIP switch to determine the exercise schedule.

Calendar modes with and without override are also available. The Setup Program software is required to select and set up the exerciser calendar modes. See the Setup Program Operation manual.

The calendar mode overrides the exercise button on the user interface. Pressing the exercise button when the exerciser is set for calendar mode will not start an exercise or set the exercise time.

Calendar mode with override allows the starting and setting of the exerciser by pressing the exercise button. Pressing the exercise button while in calendar mode with override resets the exerciser to the switch input mode.

Exercise Schedule. The exercise repeats at the same time each week or every two weeks, depending on the 1 Week/2 Week DIP switch position. See Section 3.3 for the DIP switch location.

Note: The exerciser clock is accurate to within 1 minute per month.

Pressing the exercise button starts the exercise and sets the time for the *next* exercise according to the position of the 1 week/2 week DIP switch. Changing the 1 week/2 week DIP switch position does not change the time of the *next* exercise because it has already been scheduled. The new DIP switch setting becomes effective *after* the next scheduled exercise.

The system skips the exercise period if it is scheduled to start when the ATS is running under the following conditions:

- The ATS is running a test cycle initiated by the Test button on the user interface.
- The ATS is running on the standby source because the preferred source is not available.
- The ATS is running on the standby source because of a peak shave/area protection command.

Exercise Duration. The default (factory) setting for the run duration is 30 minutes. If the generator set fails during an exercise period, the switch immediately transfers back to the preferred source. Use the Setup Program to change the run duration, if desired.

Load Bank Control. The load bank control output can be used to apply a load to the generator set during the exercise. The load bank control output provides a contact closure that can be used to signal the load bank controller to operate. If the Normal source is lost during an exercise period, the load bank control output contact opens to remove the load bank and allow the transfer of the building load to the emergency source. See Section 3.3.2 for the load bank control output connection.

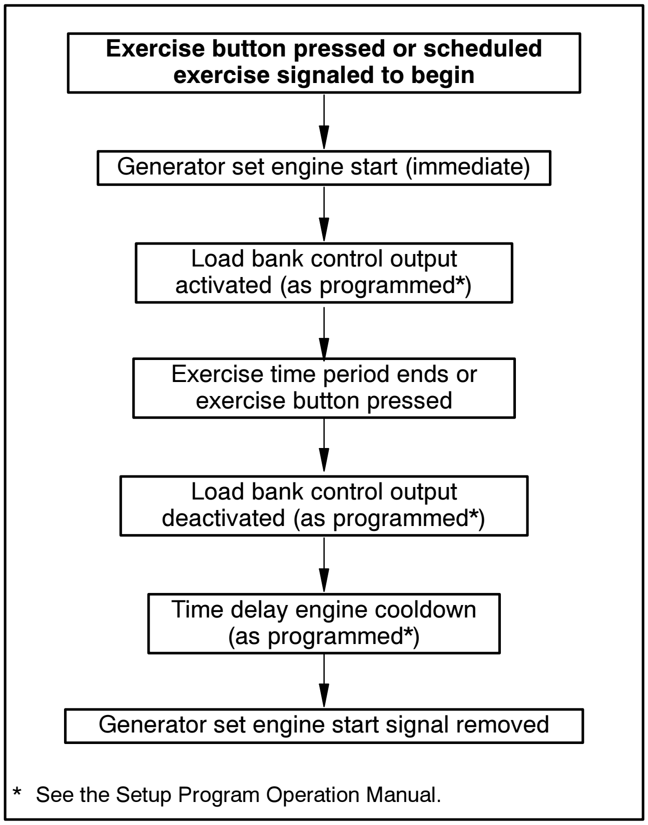


Figure 4-9 Exercise without Load Sequence

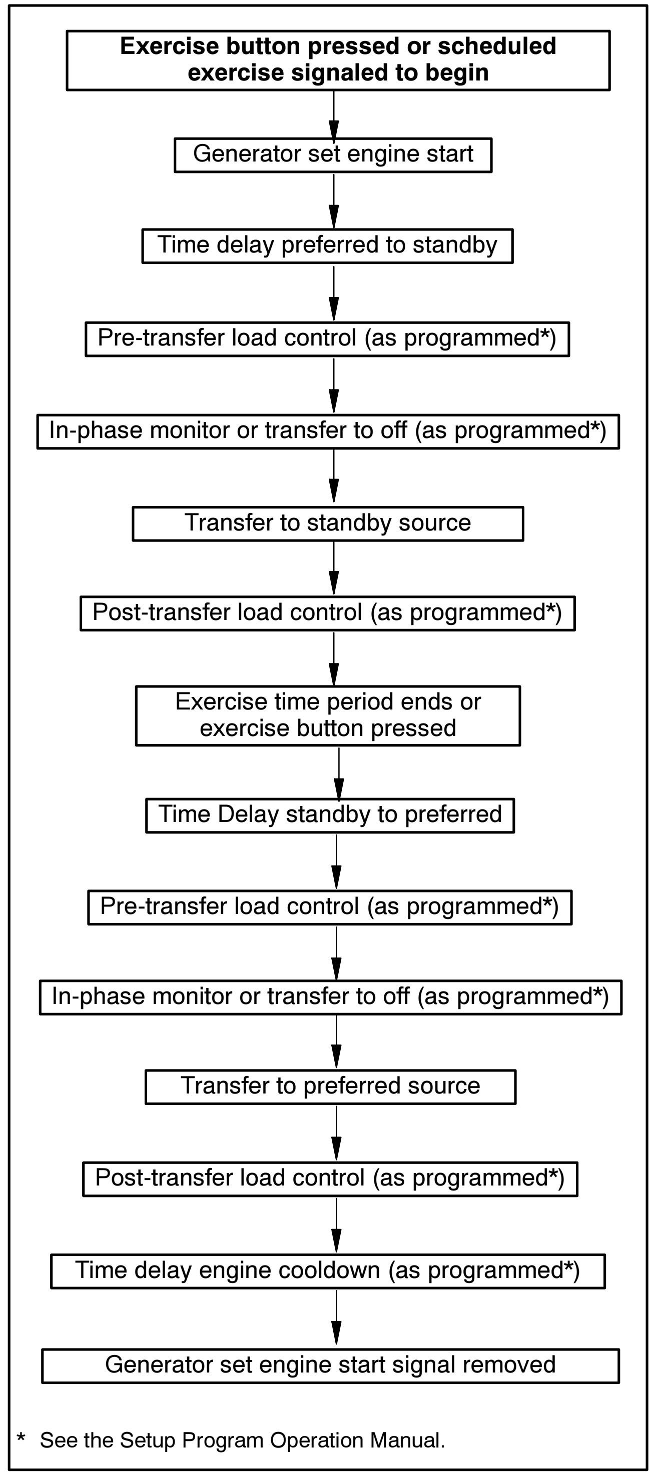


Figure 4-10 Exercise with Load Sequence

Loaded Exercise	LED Indicators						
	N Available	N Position	OFF Position	E Available	E Position	Load Control	Exercise (flashing)
Preferred-to-Standby Time Delay	X	X		X			X
Pre-Transfer to Standby Load Control	X	X		X		X	X
Off-to-Standby Time Delay (programmed-transition only)	X		X	X			X
In-Phase Synch (as programmed; N/A for programmed-transition models.)	X		X (flashing)	X			X
Post-Transfer to Standby Load Control	X			X	X	X	X
Pre-Transfer to Preferred Load Control	X			X	X	X	X
Off-to-Preferred Time Delay (programmed-transition only)	X		X	X			X
Post-Transfer to Preferred Load Control	X	X		X		X	X
Engine Cooldown Time Delay (Default = 0)	X	X		X			X

Figure 4-11 User Interface LED Indicators During a Loaded Exercise

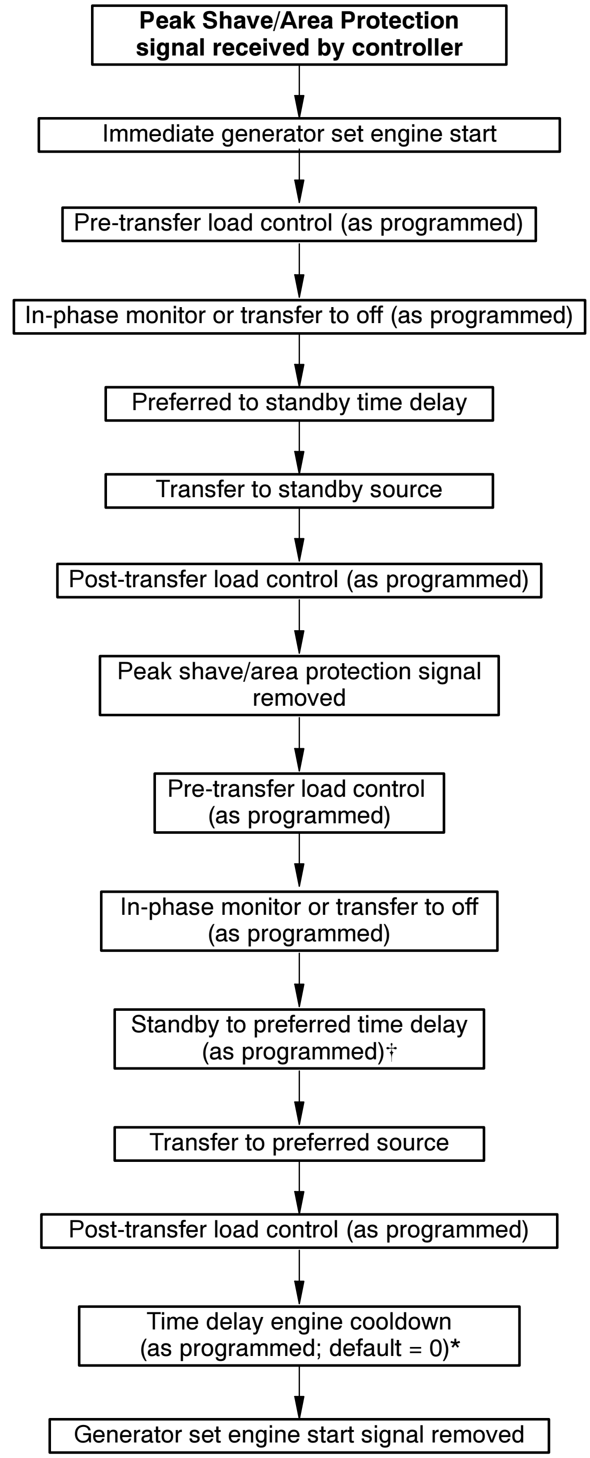
4.2.4 Peak Shave/Area Protection Operation Sequence

The peak shave input signals the transfer switch to start the generator set and transfer to the standby source. The engine start (TDES) time delay is ignored.

When the peak shave input is removed, the system transfers back to preferred (if available) and removes the generator engine start signal. The default setting ignores the standby-to-preferred time delay when transferring back to preferred.

Note: The setup software can be set to bypass or execute the standby-to-preferred time delay during the peak shave sequence. See the Setup Program Operation Manual.

See Figure 4-12 for the sequence of operation.



* See the Setup Program Operation Manual.
† Default settings bypass this time delay

Figure 4-12 Peak Shave/Area Protection Sequence

4.2.5 Pre- and Post-Transfer Load Control Sequence

The pre-transfer and post-transfer load control time delays operate during transfer between two live sources, such as during a loaded test sequence or a loaded exercise. The load control LED lights when the pre- and post-transfer signals are active.

The pre-transfer load control time delays overlap the preferred-to-standby and standby-to-preferred time delays. The longer delay determines the time delay before transfer.

The timelines in Figure 4-13 illustrate the pre-transfer time delay sequence using the default settings. (The default settings for the post-transfer signals are equal to zero.) The default setting for the preferred-to-standby time delay is 1 second, and the default setting for the pre-transfer time delay is three seconds. The time delay before transfer is equal to the longer time delay, which is 3 seconds. When transferring back to the preferred source, the standby-to-preferred time delay is 15 minutes. The pre-transfer signal operates during the final 3 seconds before transfer to the preferred source. The total time delay before transfer back to preferred (using the default settings) is 15 minutes.

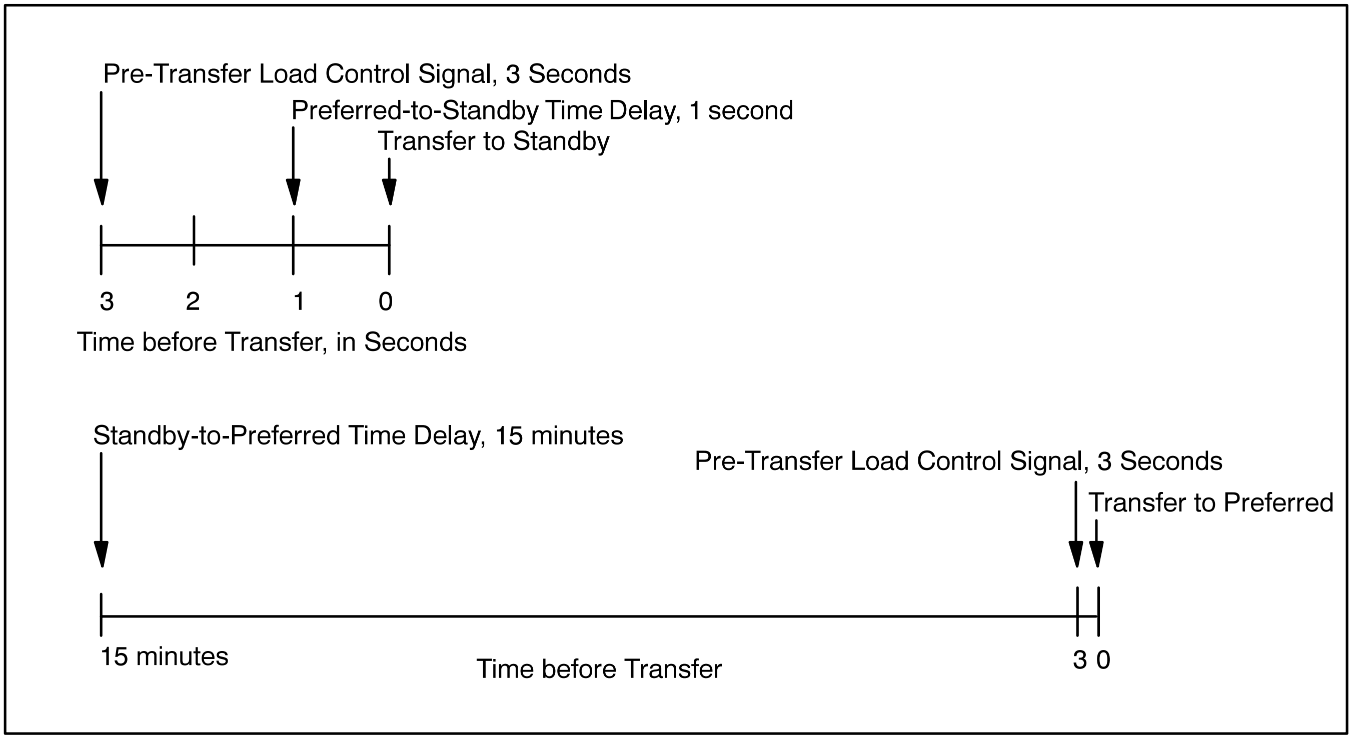


Figure 4-13 Pre-Transfer Time Delay Operation (default settings)

4.3 Faults

4.3.1 Service Required LED

The following faults cause the Service Required LED to flash, indicating that immediate service is required:

- Auxiliary switch fault
- Auxiliary switch open
- Failure to acquire standby source
- Failure to transfer
- Phase rotation fault
- Input/output module faults (see Section 6.5.1)

Find and correct the cause of the fault before trying to reset the controller. The cause of the fault may be shown by the other LEDs on the user interface; check the Source Available, Position, Load Control, Time Delay, Exercise, and Test LEDs to diagnose the cause of the faults. If the LEDs do not reveal the cause of the fault condition, connect a PC to the controller and use the Setup Program to view the event history. The event history lists fault conditions and transfers. See the software operation manual for more information and instructions.

After correcting the fault condition, press the Lamp Test button for approximately 5 seconds until the LEDs flash twice to clear the Service Required LED.

4.3.2 Auxiliary Switch Faults

An Auxiliary Switch Fault occurs if the controller cannot determine the contactor switch position. The Service Required LED flashes.

The fault clears when the controller can detect the switch position. Depress the Lamp Test button until the LEDs flash to clear the Service Required LED.

4.3.3 Failure to Acquire Standby Source

A fault occurs if the unit attempts to start the generator set but the standby source does not appear after the Acquire Standby Source to Failure time delay. The Service Required LED illuminates. Some conditions that may cause this fault are failure of the generator set to start, no voltage output from the generator, or an error in sensing the voltage output from the generator set.

The fault clears when the system acquires a standby source. Depress the Lamp Test button until the LEDs flash to clear the Service Required LED.

4.3.4 Failure to Transfer

If the unit fails to transfer on command, the controller waits 1 second and then initiates another 200 msec attempt to transfer. If the in-phase monitor is operating, the system waits 1 second and then begins monitoring the source phases in preparation for transfer. When the sources are in phase, the system attempts to transfer. After three unsuccessful attempts to transfer, the system stops attempting to transfer and generates a fault. The Service Required LED illuminates.

The fault clears when the contactor transfers successfully. Depress the Lamp Test button until the LEDs flash to clear the Service Required LED.

4.3.5 Phase Rotation Faults

A fault occurs if the phase rotation of an input channel does not match the system's phase rotation direction setting (ABC or CBA). The unit will not transfer to a source if the source's phase rotation does not match the system setting. If the system detects a phase rotation fault in the connected source, it attempts to transfer to an alternate source that has the correct phase rotation. The controller logs phase rotation faults in the event history.

If the system detects phase rotation faults on both sources, the Service Required LED lights. The system does not transfer from the connected source.

4.4 Controller Power Supply

The controller is powered by the sources connected to the transfer switch. The "dark time" is that period of time when neither source is available. During the dark time, capacitors maintain the controller power for about 15 seconds. The capacitors require approximately one hour to completely recharge after a power loss.

The controller's time, date, and all controller settings, including time delays, system parameters, pickups and dropout settings, and input/output assignments, are maintained by a controller battery during power outages.

5.1 Introduction

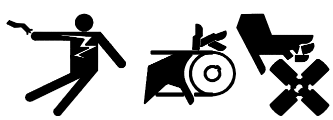
Regular preventive maintenance ensures safe and reliable operation and extends the life of the transfer switch. Preventive maintenance includes periodic testing, cleaning, inspection, and replacement of worn or missing components. Section 5.4 contains a service schedule for recommended maintenance tasks.

A local authorized distributor/dealer can provide complete preventive maintenance and service to keep the transfer switch in top condition. Unless otherwise specified, have maintenance or service performed by an authorized distributor/dealer in accordance with all applicable codes and standards. See the Service Assistance section in this manual for how to locate a local distributor/dealer.

Keep records of all maintenance or service.

Replace all barriers and close and lock the enclosure door after maintenance or service and before reapplying power.

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.

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.

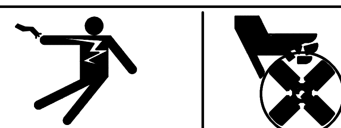
Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

WARNING



Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Grounding the transfer switch. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the 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, as the chance of electrocution increases under such conditions.

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.

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.

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

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

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.

5.2 Testing

5.2.1 Weekly Generator Set Exercise

Use the exerciser or a manual test to start and run the generator set under load once a week to maximize the reliability of the emergency power system. Press the Test button on the controller front panel to start and end the test. The Test LED flashes during a test with load or lights steadily during a test without load. Use the DIP switch to set the system for a loaded test or use a load bank and the load bank control output to run loaded without transferring the building load. See Sections 4.2.2 and 4.2.3 for more information about the exercise and test functions.

5.2.2 Monthly Automatic Control System Test

Test the transfer switch's automatic control system monthly. See Section 3.7.3 for the test procedure.

- Verify that the expected sequence of operations occurs as the switch transfers the load to the emergency source when a preferred source failure occurs or is simulated.
- Observe the indicator LEDs included on the transfer switch to check their operation.
- Watch and listen for signs of excessive noise or vibration during operation.
- After the switch transfers the load to the standby source, end the test and verify that the expected sequence of operations occurs as the transfer switch retransfers to the preferred source and signals the generator set to shut down after a cooldown period.
- On programmed-transition units, verify that the time delay in the OFF position functions during transfer to the standby source and transfer back to the preferred source.

5.3 Inspection and Service

Contact an authorized distributor/dealer to inspect and service the transfer switch annually and also when any wear, damage, deterioration, or malfunction of the transfer switch or its components is evident or suspected.

5.3.1 General Inspection

External Inspection. Keep the transfer switch clean and in good condition by performing a weekly general external inspection of the transfer switch for any condition of vibration, leakage, excessive temperature, contamination, or deterioration. Remove accumulations of dirt, dust, and other contaminants from the transfer switch's external components or enclosure with a vacuum cleaner or by wiping with a dry cloth or brush.

Note: Do not use compressed air to clean the transfer switch because it can cause debris to lodge in the components and damage the switch.

Tighten loose external hardware. Replace any worn, missing, or broken external components with manufacturer-recommended replacement parts. Contact a local authorized distributor/dealer for specific part information and ordering.

Internal Inspection. Disconnect all power sources, open the transfer switch enclosure door, and inspect internal components monthly or when any condition noticed during an external inspection may have affected internal components.

Contact an authorized distributor/dealer to inspect and service the transfer switch if any of the following conditions are found inside the transfer switch.

- Accumulations of dirt, dust, moisture, or other contaminants
- Signs of corrosion
- Worn, missing, or broken components
- Loose hardware
- Wire or cable insulation deterioration, cuts, or abrasion
- Signs of overheating or loose connections: discoloration of metal, melted plastic, or a burning odor
- Other evidence of wear, damage, deterioration, or malfunction of the transfer switch or its components.

If the applicaton does not allow a power interruption for the time required for the internal inspection, have an authorized distributor/dealer perform the internal inspection.

5.3.2 Other Inspections and Service

Have an authorized distributor/dealer perform scheduled maintenance, service, and other maintenance that ensures the safe and reliable operation of the transfer switch. See Section 5.4, Service Schedule, for the recommended maintenance items and service intervals.

Have an authorized distributor/dealer repair or replace damaged or worn internal components with manufacturer-recommended replacement parts.

5.4 Service Schedule

Follow the service schedule below for the recommended service intervals. Have all service performed by an authorized distributor/dealer except for activities designated by an X, which may be performed by the switch operator.

System Component or Procedure	See Section	Visually Inspect	Check	Adjust, Repair, Replace	Clean	Test	Frequency
ELECTRICAL SYSTEM							
Check for signs of overheating or loose connections: discoloration of metal, melted plastic, or a burning odor	5.3.1	X	X				Y
Check the contactor's external operating mechanism for cleanliness; clean and relubricate if dirty *	5.3.1	X			D (clean and lube)		Y
Inspect wiring insulation for deterioration, cuts, or abrasion. Repair or replace deteriorated or damaged wiring	5.3.1	X	D	D			Y
Tighten control and power wiring connections to specifications	2.5		D			D	Y
Check the transfer switch's main power switching contacts' condition; clean or replace the main contacts or replace the contactor assembly as necessary	5.3.2	D		D	D		Y
CONTROL SYSTEM							
Exercise the generator set under load	5.2.1 4.2.3					X	W
Test the transfer switch's automatic control system	5.2.2 3.7.3	X				X	M
Test all indicators (LEDs) and all remote control systems for operation	3.2	D	D	D		D	Y
GENERAL EQUIPMENT CONDITION							
Inspect the outside of the transfer switch for any signs of excessive vibration, leakage, high temperature, contamination, or deterioration *	5.3.1	X			X		M
Check that all external hardware is in place, tightened, and not badly worn	5.3.1	X	X	X			M
Inspect the inside of transfer switch for any signs of excessive vibration, leakage, high temperature, contamination, or deterioration*	5.3.2	D	D		D		Y
Check that all internal hardware is in place, tightened, and not badly worn	5.3.2	X	D	D			Y

* Service more frequently if the transfer switch is operated in dusty or dirty areas.

See Section: Read these sections carefully for additional information before attempting maintenance or service.

Visually Inspect: Examine these items visually.

Check: Requires physical contact with or movement of system components, or the use of nonvisual indications.

Adjust, Repair, Replace: Includes tightening hardware and lubricating the mechanism. May require replacement of components depending upon the severity of the problem.

Clean: Remove accumulations of dirt and contaminants from external transfer switch's components or enclosure with a vacuum cleaner or by wiping with a dry cloth or brush. *Do not use compressed air to clean the switch because it can cause debris to lodge in the components and cause damage.*

Test: May require tools, equipment, or training available only through an authorized distributor/dealer.

Symbols used in the chart:

X=The transfer switch operator can perform these tasks.
D=An authorized distributor/dealer must perform these tasks.
W=Weekly
M=Monthly
Q=Quarterly
S=Semiannually (every six months)
Y=Yearly (annually)

6.1 Introduction

This section describes the installation and/or operation of the following accessories:

- MPAC Setup Program
- Control Switches:
  - Preferred source switch
  - Supervised transfer switch
- In-phase monitor
- Programmable inputs and outputs:
  - Main logic board terminal strip
  - Input/output modules
- Load shed (Forced transfer to OFF)
- Security cover
- Battery charger

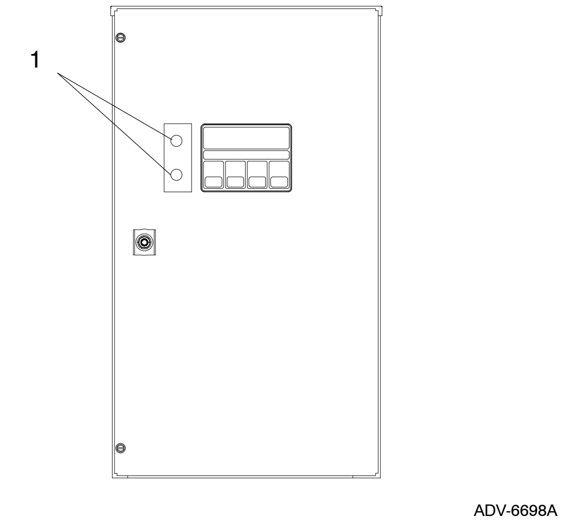
6.2 Setup Program

The optional MPAC Setup Program allows you to use a personal computer to view and adjust system parameters, voltage and frequency pickup and dropout settings, time delays, input and output functions, and other system parameters. The software also includes a time-stamped event log that is useful for system diagnostics and troubleshooting. Refer to the Setup Program Operation Manual for more information.

6.3 Control Switches

Two control switches are available, the preferred source switch and the supervised transfer control switch. The switches are mounted on the enclosure door. See Figure 6-1 for typical switch locations.

Note: Factory-installed switches are factory-wired and require no additional wiring in the field.



1. Preferred source switch and supervised transfer control switch location

Figure 6-1 Control Switch Locations

6.3.1 Preferred Source Switch

The two-position, key-operated preferred source selector switch allows selection of either power source as the preferred source. The key can be removed with the switch in either position, locking the switch into the selected position. The preferred source selection cannot be changed remotely through software or the Modbus® connection. Figure 6-2 shows the preferred source selector switch.

The transfer switch seeks and transfers to the preferred source whenever it is available. Source N is always the source connected to the Normal side of the transfer switch, and Source E is always connected to the Emergency side. Generator engine start relays are assigned to the the source (Source N or Source E). The engine start relays do not change when the preferred source switch position changes. This prevents the need to change the wiring of the engine start relay(s) when the preferred source changes.

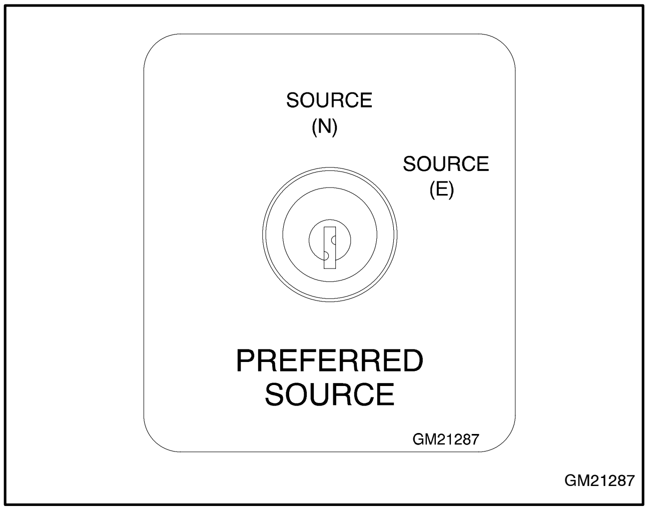


Figure 6-2 Preferred Source Selector Switch

Operating Modes. The transfer switch is factory-set for the generator set-to-utility mode of operation. This mode uses one generator set, which is connected to the Emergency side of the contactor (Source E), and one engine start relay. The engine start relay connections are located on the contactor on 30–400 amp units, and on the customer-connection terminal block on larger units (see Section 2.5.2). The engine start contact is assigned to the connected generator set and does not change assignment when the preferred source switch position is changed. In this mode, if the preferred source switch is set to Source E, then the system operates the generator set indefinitely, transferring to utility power only if the generator set fails.

Use the setup program to change the mode to generator set-generator set or utility-utility if necessary. The generator set-generator set mode uses two generator sets and requires the assignment of a second engine start output. Use the setup program to assign one of the main logic board terminal strip or I/O module outputs to Start Source N Generator, and connect the engine start leads for the Source N generator set to the corresponding terminals on the terminal strip or I/O module terminals. See Sections 3.3.2 and 6.5.2. The programmed engine start output remains tied to the Source N generator set regardless of the position of the preferred source switch.

The utility-utility mode is designed to use utility power for both Source N and Source E. This mode does not use the engine start outputs.

Time Delays and Source Parameters. Engine start relays and time delays, source voltage and frequency trip points, and load shed time delays are assigned to the source (N or E). They do not change assignment when the preferred source switch position is changed.

Note: Source N is always connected to the Normal side of the transfer switch, and Source E is always connected to the Emergency side.

Other time delays are assigned to the source function (preferred or standby). System parameters that are assigned to the function automatically change source when the preferred source selection changes.

Figure 6-3 shows which parameters are assigned to the source and which are assigned to the function. The last two columns of the table show the effect of the preferred source selector switch position on each parameter or time delay.

Item	Assignment	Preferred Source Switch Position	
		N	E
Source N generator engine start relay	Source	N	N
Source E generator engine start relay	Source	E	E
Source N engine start time delay	Source	N	N
Source E engine start time delay	Source	E	E
Source N engine cooldown time delay	Source	N	N
Source E engine cooldown time delay	Source	E	E
Source N voltage and frequency trip points	Source	N	N
Source E voltage and frequency trip points	Source	E	E
Source N load shed time delays	Source	N	N
Source E load shed time delays	Source	E	E
In-phase monitor synch	Source	E	E
Preferred-to-standby time delay	Function	N to E	E to N
Standby-to-preferred time delay	Function	E to N	N to E
Failure to acquire standby source	Function	E	N
Pretransfer to preferred signal	Function	N	E
Pretransfer to standby signal	Function	E	N
Post-transfer to preferred signal	Function	N	E
Post-transfer to standby signal	Function	E	N
Off-to-standby time delay (programmed-transition only)	Function	Off to E	Off to N
Off-to-preferred time delay (programmed-transition only)	Function	Off to N	Off to E

Figure 6-3 Preferred Source Selection Effect on System Parameters and Time Delays

6.3.2 Supervised Transfer Control Switch

The supervised transfer control switch (AUTO/MANUAL/TRANSFER switch) is a three-position, key-operated switch that allows manual control of load transfers. The switch has maintained AUTO and MANUAL positions and a momentary TRANSFER position. The key can be removed in either the AUTO or MANUAL position. The key cannot be removed when the switch is in the TRANSFER position. Figure 6-4 shows the switch.

The manual mode allows the system to run on the standby source indefinitely, even if the preferred source is available. In manual mode, the controller is inhibited from initiating a transfer sequence until the keyswitch is turned to the TRANSFER position.

It is not necessary to hold the switch in the TRANSFER position during the transfer sequence. Turn the switch to TRANSFER and release it to initiate transfer. The transfer sequence will proceed after the switch returns to the MANUAL position, executing all programmed time delays and transferring the load to the other source if it is available.

Automatic and Non-Automatic Transfer Switches. The switch operation differs for automatic and non-automatic switches. An automatic transfer switch transfers automatically to an available source if the connected source is lost. A non-automatic transfer switch does not transfer automatically, even if the connected source is lost. Figure 6-5 summarizes the switch operation.

Note: Transfer switches are built and UL-labeled as automatic or non-automatic by the factory and cannot be converted in the field. The supervised transfer control switch cannot be removed from non-automatic switches in the field.

Test and Peak Shave Operation. When the supervised transfer control switch on an *automatic* system is in the MANUAL position, pressing the Test button or sending a peak shave command causes transfer to the standby source. However, ending the test or removing the peak shave signal will *not* cause a transfer back to the preferred source. Move the supervised transfer control switch to the TRANSFER position to initiate transfer back to the preferred source.

Test and peak shave signals are ignored by *non-automatic* systems when the supervised transfer control switch is in the MANUAL position.

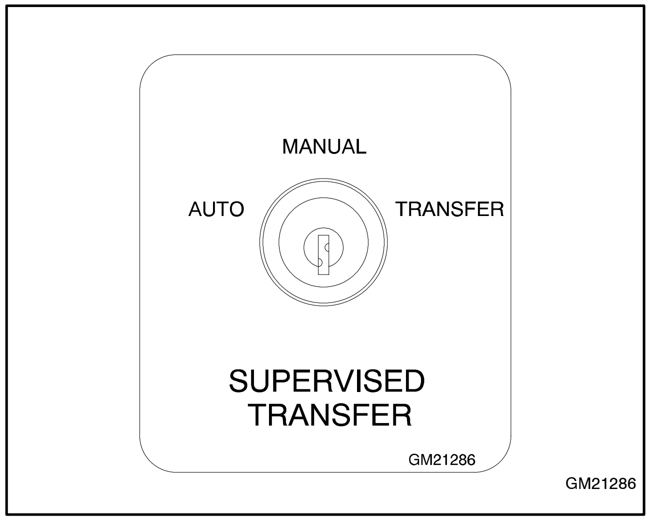


Figure 6-4 Supervised Transfer Control Switch

<table>
<tr><th>Switch Position</th><th>Operation, Automatic Switches</th><th>Operation, Non-Automatic Switches</th></tr>
<tr><td>AUTO</td><td colspan="2">• Automatically transfers to the standby source, when available, if the preferred source is lost
• Transfers back to the preferred source when it becomes available</td></tr>
<tr><td>MANUAL</td><td>• Automatically transfers to an available source if the connected source is lost
• Does not automatically transfer back to preferred when both sources are available</td><td>• Enables the Not-in-Auto indicator
• Transfers only when the switch is manually moved to the TRANSFER position:
  • Does not automatically transfer to an available source when the connected source is lost
  • Does not automatically transfer back to preferred when both sources are available</td></tr>
<tr><td>TRANSFER</td><td>• Can use to transfer when the switch is in the MANUAL position and both sources are available
• Initiates transfer sequence to the other source, if available, including all programmed time delays
• Operates pre- and post-transfer load control time delays if both sources are available</td><td>• Must use for all transfers when the switch is in the MANUAL position
• Initiates transfer sequence to the other source, if available, including all programmed time delays
• Operates pre- and post-transfer load control time delays if both sources are available</td></tr>
</table>

Figure 6-5 Supervised Transfer Control Switch Operation

6.4 In-Phase Monitor

Transfer switches are shipped with the in-phase monitor disabled. The factory settings are shown in Figure 6-6. Use the Setup Program to enable the in-phase monitor and adjust the settings, if necessary. Refer to the Setup Program Operation Manual.

Note: The in-phase monitor is not available on programmed transition switches.

The in-phase monitor operates when both sources are available, such as when transfering from the standby back to the preferred source. The in-phase monitor assures that transfer occurs when the two sources are in phase. The phase angle measuring accuracy is ±5°.

The in-phase monitor does not operate when one source is lost.

The OFF position LED on the user interface panel flashes at 2 Hz when the in-phase monitor is operating.

Synchronization Output. The synchronization output provides a contact closure that can be used to signal some generator set controllers to synchronize the two sources by adjusting the engine speed of a generator set equipped with a variable-speed governor. See the generator set operation manual. The system activates the output after the synch output time delay. See Figure 6-6.

Parameter	Factory setting
Enable/disable	Disable
Phase angle, degrees	0
Synch output time delay, seconds	30

Figure 6-6 In-Phase Monitor Factory Settings

6.5 Programmable Inputs and Outputs

Programmable inputs and outputs are available through the controller main logic board terminal strip and through optional input/output (I/O) modules. Programmable monitoring, control, and fault detection outputs are available through the terminal strip on the controller or through the programmable input/output (I/O) modules.

The main logic board inputs and outputs are factory-assigned to the functions listed in Section 3.3.2. The I/O modules are shipped with the input and output assignments undefined. The Setup Program is required to change the main logic board terminal strip input and output assignments and also to set up and assign inputs and outputs to the optional I/O modules. The table in Figure 6-7 lists the available inputs. Figure 6-8 lists the available programmable outputs.

Programmable Inputs
Low External Battery Fault
Peak Shave/Area Protection
Inhibit Transfer
Remote Bypass Time Delay
Remote Test
Forced Transfer to OFF (programmed-transition models only; requires load shed accessory)
Remote Common Fault

Figure 6-7 Programmable Inputs

Programmable Output	Type
Preferred Source Available	Monitor
Standby Source Available	Monitor
Contactor in Preferred Position	Monitor
Contactor in Standby Position	Monitor
Contactor in OFF position	Monitor
Contactor in Source N Position	Monitor
Contactor in Source E Position	Monitor
Not in Auto	Monitor
Load Control Active	Monitor
Exerciser Active	Monitor
Low Battery on Standby Source	Monitor
Test Active	Monitor
Peak Shave Active	Monitor
Non-Emergency Transfer	Monitor
Load Bank Control	Control
Start Source N Generator	Control
Start Source E Generator	Control
Load Shed Disconnect 0-8	Control
Synchronization Output Command	Control
Common Alarm	Fault
Undervoltage Source N	Fault
Overvoltage Source N	Fault
Loss of Phase Source N	Fault
Phase Rotation Error Source N	Fault
Overfrequency Source N	Fault
Underfrequency Source N	Fault
Undervoltage Source E	Fault
Overvoltage Source E	Fault
Loss of Phase Source E	Fault
Phase Rotation Error Source E	Fault
Overfrequency Source E	Fault
Underfrequency Source E	Fault
Failure to Transfer	Fault
Auxiliary Switch Fault	Fault
Auxiliary Switch Open	Fault
Failure to Acquire Standby Source	Fault
I/O Module Lost	Fault
I/O Module Not Found	Fault
I/O Module Not Installed	Fault
Modbus®-Controlled Relay Driver Output #1	Control
Modbus®-Controlled Relay Driver Output #2	Control
Modbus®-Controlled Relay Driver Output #3	Control
Modbus®-Controlled Relay Driver Output #4	Control

Figure 6-8 Available Programmable Outputs

6.5.1 Programmable Input/Output (I/O) Modules

Programmable Input/Output (I/O) modules provide two inputs and six outputs, numbered 1–6, for controller communications. Up to four modules can be connected to the controller.

The I/O modules are mounted on a DIN rail and covered by a protective cover. See Figure 6-9. Figure 6-10 and Figure 6-11 show typical I/O module locations.

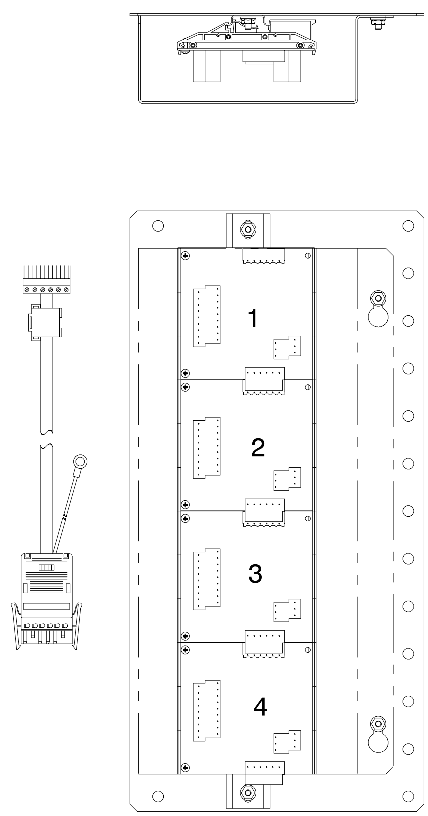


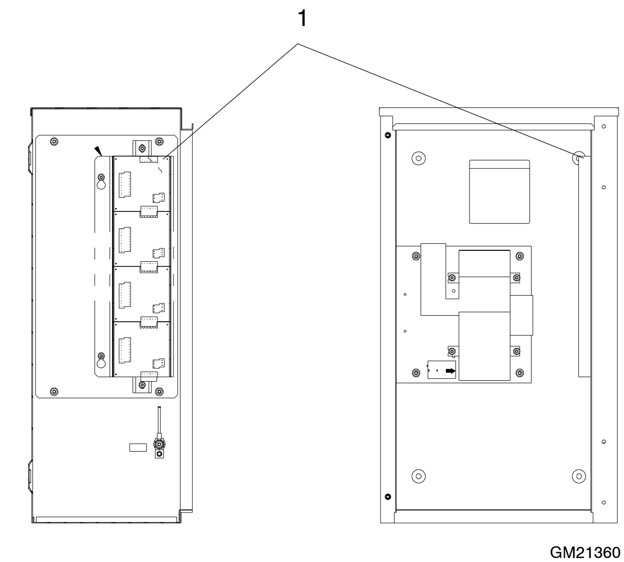
Figure 6-9 Input/Output Modules and Harness (cover is shown transparent to show detail)

6.5.2 I/O Module Connection

Optional input/output (I/O) modules are connected to the controller by a factory-installed harness. Figure 6-12 shows the controller connection.

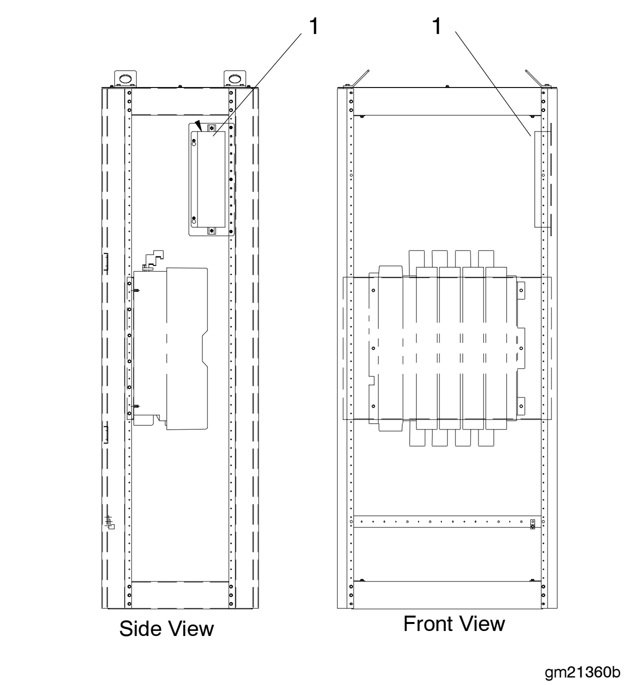
The input and output ratings are shown in Figure 6-13. Figure 6-14 shows an I/O module with its input and output terminal blocks and address DIP switches.

Each I/O Module requires a unique address. Factory-installed I/O module addresses are set at the factory.



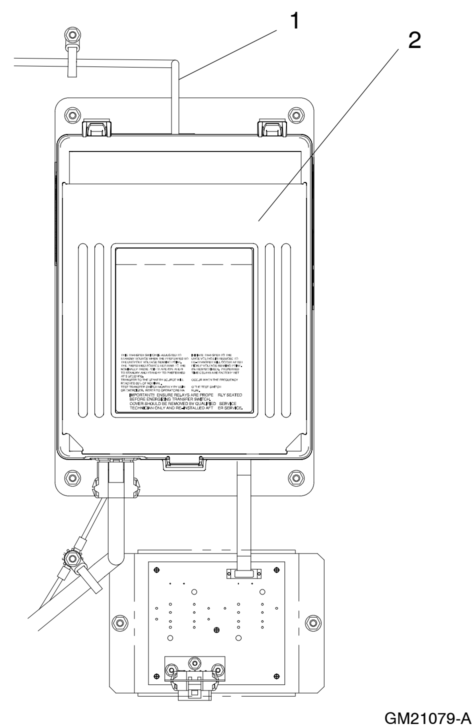
1. I/O modules

Figure 6-10 Typical I/O Module Locations (welded enclosures)



1. I/O module locations (typ.)

Figure 6-11 Typical I/O Module Locations (framework enclosures)

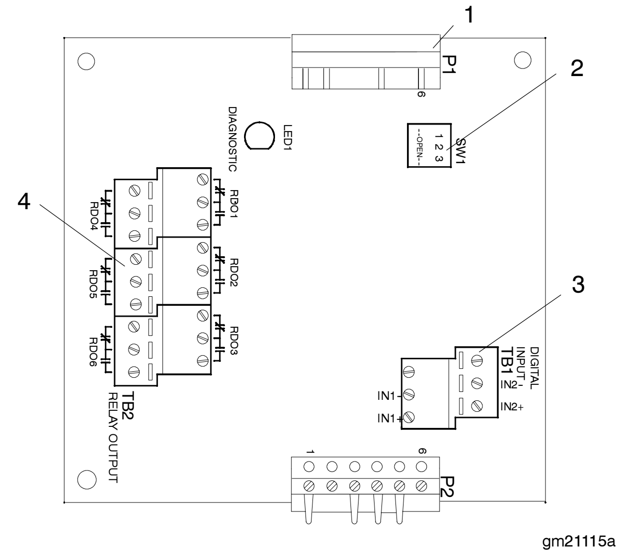


1. I/O module harness GM21341
2. Transfer switch controller

Figure 6-12 I/O Circuit Board Module Harness Connection to Transfer Switch Controller

I/O Module Item	Rating
Input	16 mA@12 VDC
Output	2 A@250 VAC

Figure 6-13 I/O Module Ratings



1. Controller harness connection
2. Address DIP switches
3. Input connections
4. Output connections

Figure 6-14 I/O Module Input and Output Connections

I/O Module Connection Procedure

1. Disconnect power to the transfer switch before connecting to the I/O modules.

2. Remove the I/O module cover and connect devices to the I/O module input terminals on terminal block TB1 or output terminals on terminal block TB2. See Figure 6-14 for the terminla block locations. The output connections on the I/O module are labelled RDO (relay driver output) 1 through 6. Use wire sizes within the specifications in Figure 6-15 for the input and output connections.

3. Tighten the connections to 0.5 Nm (4.4 in. lb.).

4. Record the connections on the label on the cover and replace the cover.

5. Use the Setup Program to set up the I/O board communications and to define the I/O board inputs and outputs. Refer to the Setup Program Operation Manual for instructions.

Component	Number of Wires	Wire Size Range	Tightening Torque
Controller terminal strip I/O terminals	1	#12-24 AWG	0.5 Nm (4.4 in. lb.)
I/O board terminals	1	#14-26 AWG	

Figure 6-15 Input and Output Connection Specifications

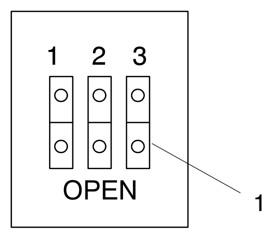
6.5.3 I/O Module Address

Each I/O Module requires a unique address. Factory-installed I/O module addresses are set at the factory.

To check the I/O module addresses, compare the DIP switch settings with Figure 6-16, starting with the module connected to the controller harness. Figure 6-14 shows the address DIP switch location on the I/O module. Push down the end of the DIP switch near the OPEN label to open the switch, or push down the other end to close it. See Figure 6-17.

I/O Module Number	Address DIP Switches		
	1	2	3
1	Closed	Closed	Closed
2	Closed	Closed	Open
3	Closed	Open	Closed
4	Closed	Open	Open

Figure 6-16 I/O Module Address DIP Switches



1. Push this side down to open.

Figure 6-17 I/O Module Address DIP Switches

6.5.4 I/O Module Faults and Diagnostics

When power is applied to the system, the controller attempts to initiate communication with each connected I/O board. The following faults may occur on powerup if the I/O modules are not correctly installed, addressed, or configured in the setup software. Check the LED on each I/O module for diagnostic information in the case of a fault.

Diagnostic LED. Each I/O module has a diagnostic LED that lights or flashes to indicate the I/O board status as described in the table in Figure 6-18.

I/O Module Not Found. If the system does not detect an I/O module at an expected address, the Service Required LED flashes and the software logs the message, "I/O Module Not Found". Check that the number of I/O modules installed matches the number expected by the setup program. Check that the I/O modules are connected and the address DIP switches are set correctly. Check the diagnostic LED to verify that the module is receiving power and communicating with the controller.

I/O Module Not Installed. If the software detects an I/O module that is connected but not expected by the setup program, the Service Required LED flashes and the software logs the message, "I/O Module Not Installed." The system ignores the board if it does not find the setup definition. Check that the number of I/O modules expected in the Setup Program matches the number of modules installed on the transfer switch. Check that the I/O module address DIP switches are set correctly. Check the diagnostic LED.

I/O Module Communications Lost. If communication to an I/O module that was previously installed and working is lost, the Service Required LED flashes and the software logs the message "I/O Module Communications Lost." Check the I/O module connections and diagnostic LED.

I/O board Status	Diagnostic LED
Unpowered	Off
Operating correctly	On, Steady
Power but no communication with control board	Quick Flash (2 Hz)
No defined program at I/O module address	Slow Flash (0.5 Hz)

Figure 6-18 I/O Module Diagnostic LED

6.6 Load Shed (Forced Transfer to OFF)

6.6.1 Description

The load shed (forced transfer to off) accessory allows the removal of non-critical loads from the Source E generator set. The accessory requires an external signal (contact closure) to initiate transfer to the Off position. The load shed (forced transfer to off) accessory is available only for programmed-transition transfer switches.

When the forced transfer to off input is activated (contact closed), the contactor moves from Source E to the OFF position immediately, ignoring all time delays. If the normal source is available when the input is activated, the ATS transfers to the Off position and then to Source N, executing all programmed time delays. If Source N is not available, the ATS remains in the Off position until the input is deactivated. When the input is deactivated, the ATS transfers back to Source N, if available, executing all programmed time delays. If Source N is not available, the ATS transfers to Source E.

The load shed (forced transfer to off) function only sheds loads connected to Source E. The preferred source selector switch position (if equipped) does not affect this function.

6.6.2 Connection

On transfer switches with the factory-installed load shed accessory, the forced transfer to off input is assigned to main logic board terminal strip programmable input #2 (terminals 8 and 9). Connect the forced transfer to off signal from the generator set controller or other customer device to terminals 8 and 9 following the instructions in Section 3.3.2. Use #12-24 AWG wire and tighten the terminals to 0.5 Nm (4.4 in. lb.).

6.7 Security Cover

The gasketed, hinged security cover prevents unauthorized access to the transfer switch controls and protects the user interface from harsh environmental conditions. Use a customer-supplied padlock to lock the cover.

The cover is available with or without a window for NEMA 1 enclosures. NEMA 3R enclosures include a windowless cover as standard equipment.

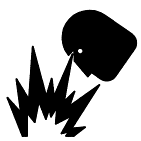
6.8 Battery Charger

The GM22502 is a 3-stage electronic battery charger designed for 12 or 24 VDC systems. It is designed to be used for lead acid batteries (flooded cell or AGM types) and gel cell batteries. The sealed and potted design is rainproof, lightweight, silent, and completely automatic. The charger contains internal, self-resetting short-circuit protection for the outputs and fuses for reversed-polarity protection.

The battery charger produces 12 VDC at 6 Amps or 24 VDC at 3 Amps. Red and green LEDs indicate that the unit is recharging or maintaining the battery.

Figure 6-19 shows the battery charger. Refer to the transfer switch dimension drawing for the location of the battery charger.

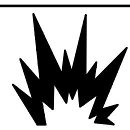
WARNING



Sulfuric acid in batteries.
Can cause severe injury or death.

Wear protective goggles and clothing. Battery acid may cause blindness and burn skin.

WARNING



Explosion.
Can cause severe injury or death.
Relays in the battery charger cause arcs or sparks.

Locate the battery in a well-ventilated area. Isolate the battery charger from explosive fumes.

Battery electrolyte is a diluted sulfuric acid. Battery acid can cause severe injury or death. Battery acid can cause blindness and burn skin. Always wear splashproof safety goggles, rubber gloves, and boots when servicing the battery. Do not open a sealed battery or mutilate the battery case. If battery acid splashes in the eyes or on the skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

Battery acid cleanup. Battery acid can cause severe injury or death. Battery acid is electrically conductive and corrosive. Add 500 g (1 lb.) of bicarbonate of soda (baking soda) to a container with 4 L (1 gal.) of water and mix the neutralizing solution. Pour the neutralizing solution on the spilled battery acid and continue to add the neutralizing solution to the spilled battery acid until all evidence of a chemical reaction (foaming) has ceased. Flush the resulting liquid with water and dry the area.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flames or sparks to occur near a battery at any time, particularly when it is charging. Do not dispose of a battery in a fire. To prevent burns and sparks that could cause an explosion, avoid touching the battery terminals with tools or other metal objects. Remove all jewelry before servicing the equipment. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface away from the battery. To avoid sparks, do not disturb the battery charger connections while the battery is charging. Always turn the battery charger off before disconnecting the battery connections. Ventilate the compartments containing batteries to prevent accumulation of explosive gases.

Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery. Never connect the negative (–) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together.

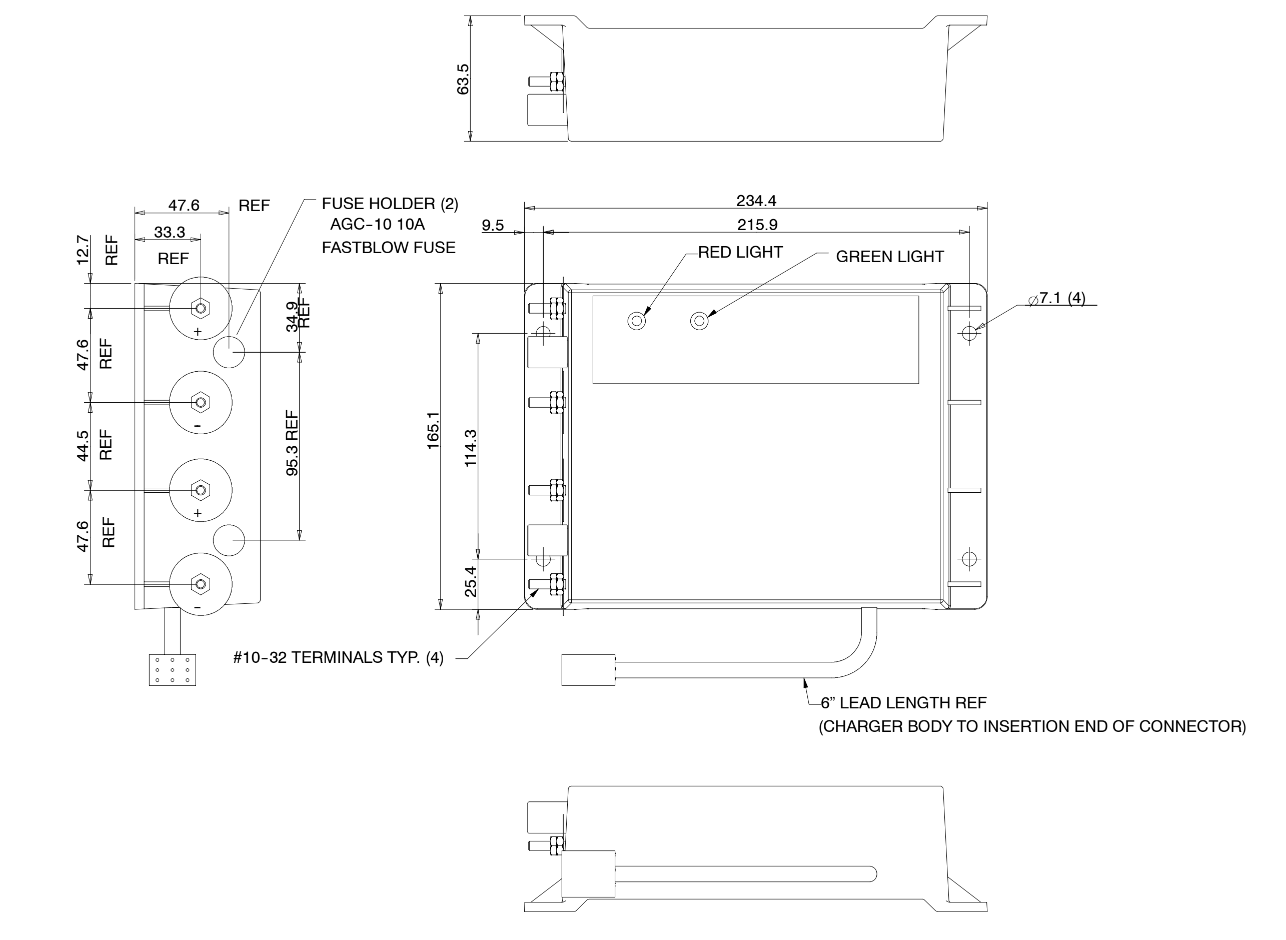


Figure 6-19 Battery Charger

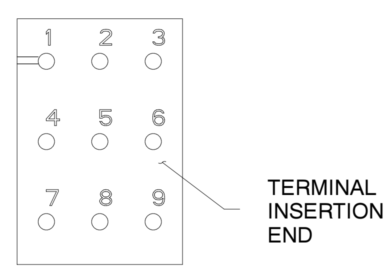
6.8.1 Battery Charger Connection

The battery charger is powered by the load side of the transfer switch contactor through a factory-installed wiring harness with a 9-pin inline connector. Verify that the power to the ATS is disconnected before connecting or disconnecting the 9-pin connector to the battery charger.

Ring terminals for battery charger connections are included with the battery charger.

The installing technician must supply the cable with terminals between the battery charger and the battery. Figure 6-21 provides details regarding cable length and gauge. Using red cable for battery positive (+) and black cable for battery negative (-) is strongly recommended.

Use the following procedure to connect the battery charger.



CONNECTOR PIN-OUT		
PIN	WIRE	FUNCTION
1	1	NEUTRAL INPUT
2	2	208 VAC INPUT
3	-	-
4	3	240 VAC INPUT
5	-	-
6	4	480 VAC INPUT
7	6	EARTH GROUND
8	-	-
9	5	600 VAC INPUT

GM22502

Figure 6-20 Battery Charger Power Connection

Battery Charger Connection Procedure

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Connecting the battery and the battery charger. Hazardous voltage can cause severe injury or death. Reconnect the battery correctly, positive to positive and negative to negative, to avoid electrical shock and damage to the battery charger and battery(ies). Have a qualified electrician install the battery(ies).

1. Verify that power to the ATS is disconnected (switches or circuit breakers to the ATS are open).

2. Verify that the inline connector to the charger is disconnected.

3. Clean the battery terminals and check the battery according to the battery manufacturer's instructions.

4. Determine the length of cable needed to connect the battery to the battery charger and refer to Figure 6-21 for the required wire size. The distances shown are the one-way distances from the charger to the battery.

   Note: Use the recommended wire size to prevent overcharging the battery. Route AC and DC wiring in separate conduits.

5. Remove the boots and ring terminals from the battery charger posts.

Maximum Distance	Wire Size	Battery Charger Terminal Size	Eyelet Terminal Part No.
4.5 m (15 ft.)	12 AWG	No. 10	X-283-11
7.5 m (25 ft.)	10 AWG		

Figure 6-21 Battery Cable and Terminal Specifications

6. Slide a red boot onto the red cable and a black boot onto the black cable. Attach ring terminals and use a crimping tool to crimp the ring terminals tightly.

7. Determine whether the generator set electrical system uses 12 or 24 volts. This information is shown on the generator set nameplate.

8. Connect the jumpers as shown in Figure 6-22 for a12-volt system or Figure 6-23 for a 24-volt system, reconnecting the jumper lead for 24-volt systems as shown. Place the jumper lead terminal between the two flat washers on the battery charger terminal.

   Note: Battery chargers are configured for 12-volt systems at the factory. For 24-volt systems, reconnect the jumper lead as shown in Figure 6-23 and discard the second jumper lead.

9. Connect the battery cables as shown in Figure 6-22 for 12 VDC systems or Figure 6-23 for 24 VDC systems.

   Note: The positive (POS, P, +) battery post usually has a larger diameter than the negative (NEG, N, -) post.

   a. Connect the red POSITIVE terminal of the battery charger to the positive post of the battery.

   b. Connect the black NEGATIVE terminal of the battery charger to the negative post of the battery.

10. Slide the boots over the battery charger posts.

11. Connect the in-line connectors on the battery charger power cord.

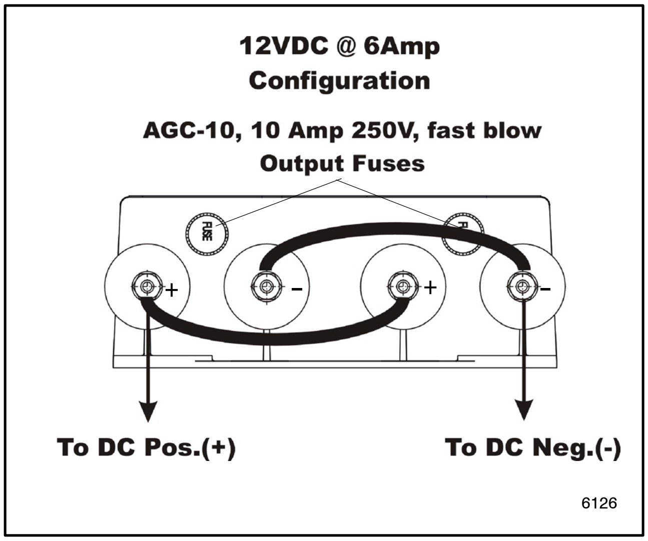


Figure 6-22 12-Volt Battery Charger Connections

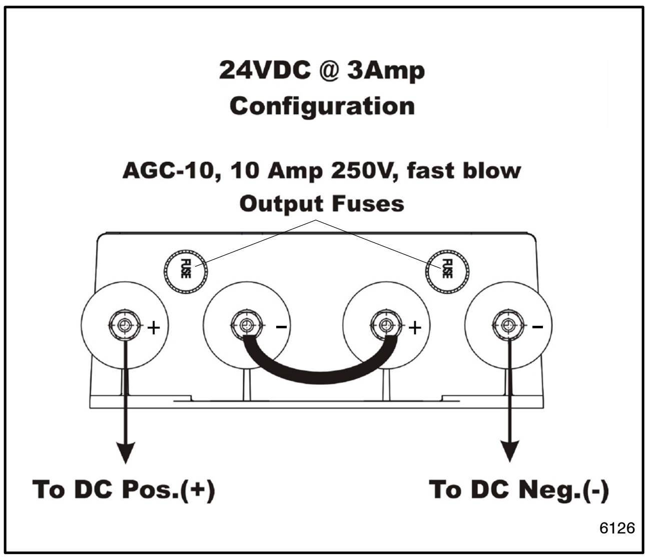


Figure 6-23 24-Volt Battery Charger Connections

12. Connect the charger to the battery according to the generator set or battery manufacturer's instructions, watching the polarity (+/–) of the connections.

13. Close the enclosure door and reconnect power to the transfer switch after the charger connections are complete.

14. Use a voltmeter to check the voltage at the battery and compare the readings to Figure 6-25 or Figure 6-26 to verify charger operation.

Battery Charger Disconnection Procedure

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

1. Before opening the transfer switch enclosure, disconnect power to the transfer switch by opening switches or circuit breakers to the transfer switch.

2. Disconnect the AC power cord at the in-line connector.

3. Remove the black (NEGATIVE) wire from the the battery terminal first.

4. Remove the red (POSITIVE) wire from the battery terminal.

6.8.2 Battery Charger Operation

Red and green LEDs on the charger indicate the charge rate. Refer to Figure 6-24 for a description of the LED indicator operation. Figure 6-25 and Figure 6-26 show the 3-stage charging charging method for 12 VDC and 24 VDC configurations.

LED Indicators		
Red	**Green**	**Operating Condition**
On	Off	The battery is discharged and the charger is recharging at the BULK rate (stage 1). This charging rate is 6 Amps at 12V or 3 Amps at 24V. The measured voltage (with the charger on) is 11.8 to 14 Volts in 12VDC mode or 23.6 to 28VDC 24VDC mode. If the red LED stays on for more than 24 hours, refer to Problem 1 in the troubleshooting section in this manual.
On	On	The charger is charging at an ABSORPTION rate of between 1.5 and 5 Amps (stage 2). This mode of charging gradually “tops off” your battery, and reduces harmful sulfating. While both LED’s are on, the voltage measured (with the charger on) should be approx. 14.0 to 14.5VDC in 12VDC mode or 28.0 to 29.0 in 24VDC mode. If both LED’s stay on longer than 24 hours, refer to Problem 2 in the troubleshooting section in this manual.
Off	On	The charer is charging at a FLOAT or MAINTENANCE rate of less than 1.5 Amps, (stage 3). The battery is now 90% charged and ready for use. This ”float” charging current will gradually decrease to as low as 0.1 Amps as the battery reaches 100% charge. The float rate maintains the battery at full charge without overcharging. If the green LED stays on when your battery is known to be low, refer to Problem 3 in the troubleshooting section in this manual.

Figure 6-24 Charger Operation

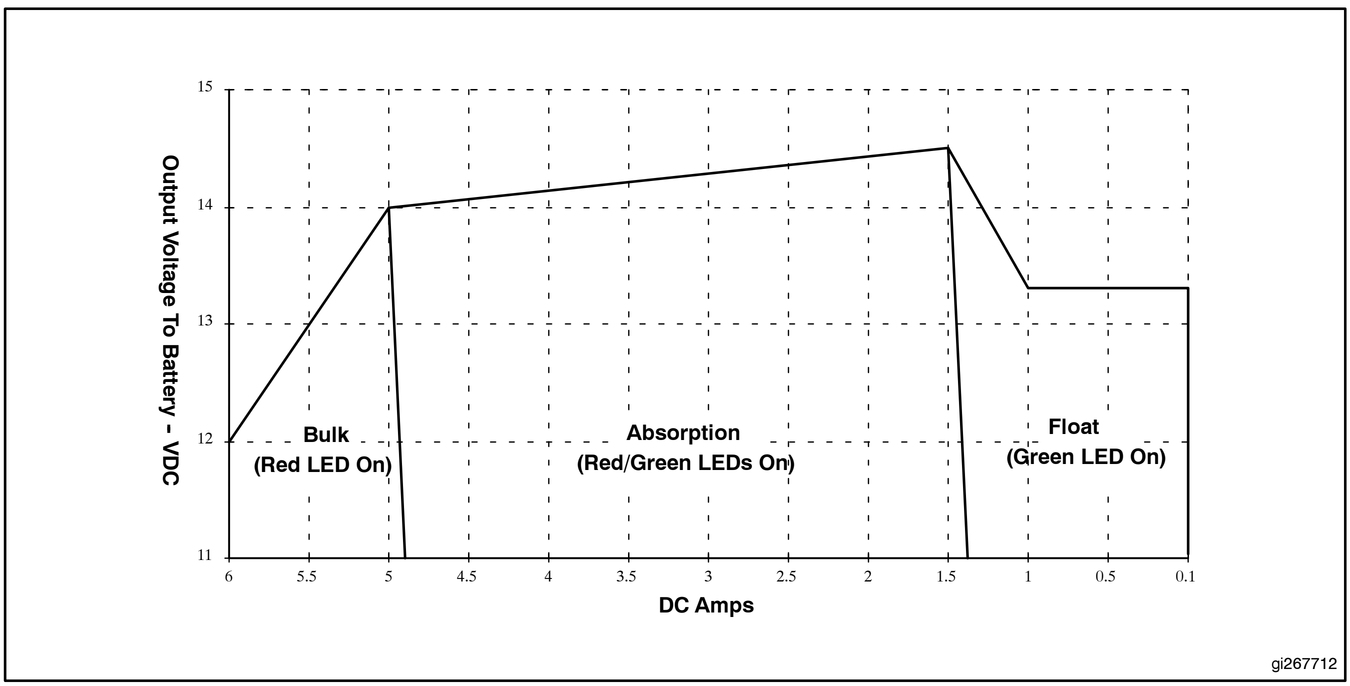


Figure 6-25 Charging Method, 12 VDC, 6 A Configuration

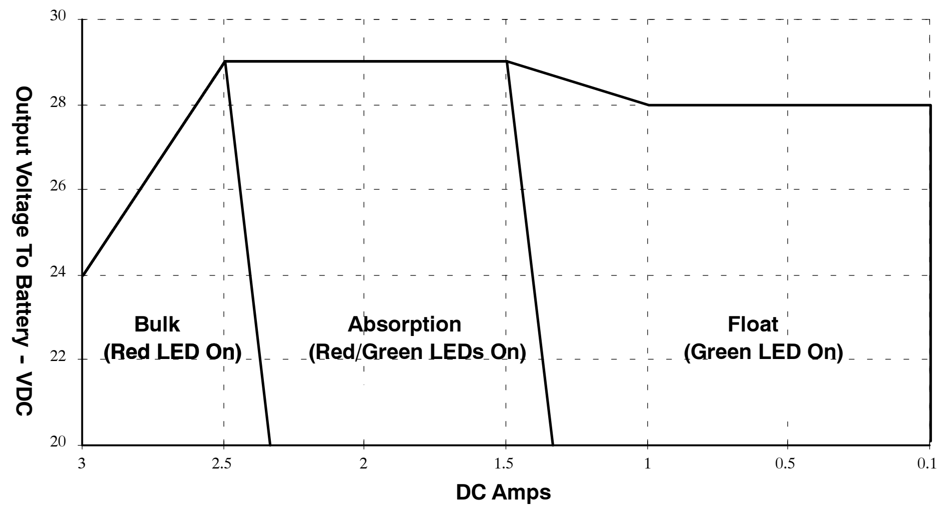


Figure 6-26 Charging Method, 24 VDC 3 A Configuration

6.8.3 Battery Charger Troubleshooting

Problem	Cause	Solution
Red LED stays on for more than 24 hours.	One or more defective or damaged cells.	Load test the battery and replace if necessary.
	Charger has reduced its output voltage below the normal level due to a DC overload or a DC short.	Remove the source of the overload or short. Disconnect the charger's black (NEGATIVE) ring terminal from the battery. Reapply AC power and the green LED only should now light.
	On-board DC systems are drawing more current than the charger can replace.	Turn off excessive DC equipment while charging.
The red and green LEDs stay on for more than 24 hours.	On-board DC systems are drawing between 1.5 – 5A.	Turn off excessive DC equipment while charging.
	One or more defective or damaged cells.	Load test the battery and replace if necessary.
	Extremely low AC voltage at the battery charger.	Apply a higher AC voltage source or reduce the length of the power cord.
Green LED stays on when the battery is known to be low.	Open DC output fuse.	Replace the DC output fuse with a Bussmann AGC-10.
	Faulty or contaminated terminal connections.	Clean and tighten or repair all terminal connections.
	One or more defective or damaged cells.	Load test the battery and replace if necessary.
Neither of the LEDs turn on when the AC power is applied.	No AC power available at the charger.	Connect AC power or reset the AC breaker on the main panel.
	Component failure.	Return charger to the Service Department.

Figure 6-27 Battery Charger Troubleshooting

6.8.4 Battery Charger Specifications

Figure 6-28 lists the battery charger specifications.

Output	
Charging	12 Volts DC (min.) at 6 Amps 24 Volts DC (min.) at 3 Amps
Maintaining	13.30 Volts DC at 0.1 Amps
Input	
Rated AC Voltage	208 VAC, AC connector pin 2 240 VAC, AC connector pin 4 480 VAC, AC connector pin 6 600VAC, AC connector pin 9
Current Draw	@ 50/ 60 Hz, 0.7 Amps Maximum
Maximum Recommended Battery Size	
Recharging	150 Amp-Hours
Maintenance only	300 Amp-Hours
Physical Dimensions	
Height	3.5 in. (8.9 cm.)
Width	6.4 in. (16.3 cm.)
Depth	2.1 in. (5.3 cm.)
Weight	3.5 lb. (1.6 kg)

Figure 6-28 Battery Charger Specifications

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
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)
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. lbs.	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
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. lbs. 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
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
RDO	relay driver output
ref.	reference
rem.	remote
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

Withstand and Closing Ratings, Open- and Programmed-Transition Models

Maximum current in RMS symmetrical amperes when coordinated with customer-supplied fuses or circuit breakers.

<table>
<tr><th colspan="9">Withstand and Closing Current Ratings in RMS Symmetrical Amperes*</th></tr>
<tr><th rowspan="2">Switch Rating, Amps</th><th colspan="3">Any Circuit Breaker</th><th rowspan="2">Specific Circuit Breaker Max. kAmps @ 480 VAC</th><th colspan="4">Current-Limiting Fuses</th></tr>
<tr><th>Cycles @ 60 Hz</th><th>kAmps @ 480 VAC</th><th>kAmps @ 600 VAC</th><th>kAmps</th><th>Volts, Max.</th><th>Fuse Size, Amps</th><th>Type</th></tr>
<tr><td>30†</td><td>1.5</td><td>10</td><td>10</td><td>N/A</td><td>100</td><td rowspan="3">480</td><td>60</td><td rowspan="2">RK1,
J</td></tr>
<tr><td>70†
104†
150†</td><td>1.5</td><td>10</td><td>10</td><td>22</td><td rowspan="2">200</td><td>200</td></tr>
<tr><td>150§</td><td>3</td><td>35</td><td>22</td><td>42</td><td>450</td><td>J</td></tr>
<tr><td>200†</td><td>1.5</td><td>10
(240 VAC max.)</td><td>N/A</td><td>22
(240 VAC max.)</td><td>200</td><td>240</td><td>200</td><td>J</td></tr>
<tr><td>225
260
400</td><td>3</td><td>35</td><td>22</td><td>42</td><td rowspan="5">200</td><td>480</td><td>600</td><td>J</td></tr>
<tr><td>600
800
1000
1200</td><td>3
18 **</td><td>50
36</td><td>50
36</td><td>65</td><td rowspan="3">600</td><td>1600</td><td rowspan="4">L</td></tr>
<tr><td>1600‡
2000‡</td><td rowspan="3">3
30 **</td><td rowspan="3">100
65</td><td rowspan="3">100
65</td><td rowspan="3">N/A</td><td>3000</td></tr>
<tr><td>3000</td><td>4000</td></tr>
<tr><td>4000</td><td>480</td><td>6000</td></tr>
</table>

* All values are available symmetrical RMS amperes and tested in accordance with the withstand and close-on requirements of UL 1008. 200 amp switches are limited to 240 VAC max., copper wire only. Application requirements may permit higher withstand ratings for certain size switches. Contact Kohler Co. for assistance.

† Open-transition models only

§ Programmed-transition models only

‡ Optional front-connected service limited to 85,000 amps for specific and any breaker ratings.

** Withstand rating only. This testing is not defined in UL 1008.

Ratings with Specific Manufacturers' Circuit Breakers

Open- and Programmed-Transition Models

The following charts list power switching device withstand and closing ratings (WCR) in RMS symmetrical amperes for specific manufacturers' circuit breakers. Circuit breakers are supplied by the customer.

Switch Rating, Amps	Molded-Case Circuit Breakers				
	WCR, kA RMS	Voltage, Max.	Manufacturer	Type	Max. Size, Amps
70*	22	480	Square D	FH	80
				FC, FI	100
				KA, KC, KH, KI, LA, LH	250
			GE	TB1	100
				TEL, THED, THLC1, THLC2	150
				TFL	225
			ITE	CED6, ED6, HED4, HED6	125
				CFD6	150
				FD6, FXD6, HFD6	250
			Cutler-Hammer	FCL, Tri-Pac FB	100
				FD, FDC, HFD	150
				HJD, JD, JDB, JDC	250
				HKD, KD, KDB, KDC, LCL, Tri-Pac LA	400
			ABB	S1	125
				S3	150
			Merlin Gerin	CE104, CE106	100
104*	22	480	Square D	FC, FI	100
				KA, KC, KH, KI, LA, LH	250
			GE	TB1	100
				TEL, THED, THLC1, THLC2	150
				TFL	225
			ITE	CED6, ED6, HED4, HED6	125
				CFD6	150
				FD6, FXD6, HFD6	250
			Cutler-Hammer	FCL, Tri-Pac FB	100
				FD, FDC, HFD	150
				HJD, JD, JDB, JDC	250
				HKD, KD, KDB, KDC, LCL, Tri-Pac LA	400
			ABB	S1	125
				S3	150
			Merlin Gerin	CE104, CE106	100
				CF250	250
150*	22	480	GE	TEL, THED, THLC1	150
				TFL, THFK, THLC2	225
				SFL, SFP, TFJ, TFK	250
				SGL4, SGP4, TLB4	400
			ITE	CFD6, FD6, FXD6, HFD6	250
				CJD6, HHJD6, HHJXD6, HJD6, JD6, JXD6, SCJD6, SHJD6, SJD6	400
			Square D	KA, KC, KH, KI	250
				LC, LI	300
				LA, LH	400
			Cutler-Hammer	FD, FDC, HFD	150
				HJD, JD, JDB, JDC	250
				LCL, Tri-Pac LA, HKD, KD, KDB, KDC	400
			ABB	S3	150
			Merlin Gerin	CF250	250
				CJ400	400

* Open-transition models only
† Programmed-transition models only

Ratings with Specific Manufacturers' Circuit Breakers, continued

Switch Rating, Amps	Molded-Case Circuit Breakers				
	WCR, kA RMS	Voltage, Max.	Manufacturer	Type	Max. Size, Amps
150†	42	480	GE	TEL, THED, THLC1,	150
				TFL, THLC2	225
				SFL, SFLA, SFP	250
				SGL4, SGP4, TB4, THLC4, TLB4	400
				SGLA, SGL6, SGP6, TB6	600
			ITE	CFD6, HFD6	250
				CJD6, HHJD6, HHJXD6, HJD6, SCJD6, SHJD6	400
				CLD6, HHLD6, HHLXD6, HLD6, SHLD6	600
			Square D	KC, KI	250
				LC, LI	400
			Cutler-Hammer	HJD, JDC	250
				LCL, Tri-Pac LA, HKD, KDC	400
				HLD	600
				Tri-Pac NB	800
			ABB	S3	150
			Merlin Gerin	CF250	250
				CJ400	400
200*	22	240	GE	TFL, THFK, THLC2	225
				SFL, SFP, TFJ, TFK	250
				SGL4, SGP4, TLB4	400
			ITE	CFD6, FD6, FXD6, HFD6	250
				CJD6, HHJD6, HHJXD6, HJD6, JD6, JXD6, SCJD6, SHJD6, SJD6	400
			Square D	KA, KC, KH, KI	250
				LC, LI	300
				LA, LH	400
			Cutler-Hammer	HJD, JD, JDB, JDC	250
				LCL, Tri-Pac LA, HKD, KD, KDB, KDC	400
			Merlin Gerin	CF250	250
				CJ400	400
225 260	42	480	GE	TFL, THLC2	225
				SFL, SFLA, SFP	250
				SGL4, SGP4, TB4, THLC4, TLB4	400
				SGLA, SGL6, SGP6, TB6	600
				SKHA, SKLB, SKP8, TKL	800
			ITE	CFD6, FD6, FXD6, HFD6	250
				CJD6, HHJD6, HHJXD6, HJD6, JD6, JXD6, SCJD6, SHJD6, SJD6	400
				CLD6, HHLD6, HHLXD6, HLD6, SCLD6, SHLD6	600
				CMD6, HMD6, HND6, MD6, MXD6, SCMD6, SHMD6, SMD6, SND6	800
			Square D	KC, KI	250
				LC, LI	600
				MH	800
			Cutler-Hammer	HJD, JDC	250
				HKD, KDC, LCL, Tri-Pac LA	400
				HLD	600
				Tri-Pac NB	800
			ABB	S5	400
				S6	600
			Merlin Gerin	CF250	250
				CJ400	400

* Open-transition models only
† Programmed-transition models only

Ratings with Specific Manufacturers' Circuit Breakers, continued

Switch Rating, Amps	Molded-Case Circuit Breakers				
	WCR, kA RMS	Voltage, Max.	Manufacturer	Type	Max. Size, Amps
400	42	480	GE	SGL4, SGP4, TB4, THLC4, TLB4	400
				SGLA, SGL6, SGP6, TB6	600
				SKHA, SKL8, SKP8, TKL	800
			ITE	CJD6, HHJD6, HHJXD6, HJD6, SCJD6, SHJD6	400
				CLD6, HHJD6, HHLXD6, HLD6, SCLD6, SHLD6	600
				CMD6, HMD6, HND6, MD6, MXD6, SCMD6, SHMD6, SMD6, SND6	800
			Square D	LC, LI	600
				MH	800
			Cutler-Hammer	HKD, KDC, LCL, Tri-Pac LA	400
				HLD	600
				Tri-Pac NB	800
			ABB	S5	400
				S6	800
			Merlin Gerin	CJ600	600
600 800 1000 1200	65	480	GE	TB8	800
				Microversatrip TKL	1200
			ITE	CLD6, HHLD6, HHLDX6, HLD6, SCLD6, SHLD6	600
				CMD6, HMD6, SCMD6, SHMD6	800
				CND6, HND6, SCND6, SHND6	1200
				CPD6	1600
			Square D	MH Series 2	1000
				SE (LS Trip), SEH (LS Trip)	2500
		600	Cutler-Hammer	Tri-Pac NB	800
				Tri-Pac PB	1600
				RDC	2500
	42	480	ABB	S6	800
				S7	1200
			Merlin Gerin	CJ600	600
				CK1200	1200

* Open-transition models only
† Programmed-transition models only

Environmental Specifications

Environmental Specifications	
Operating Temperature	-20°C to 70°C (-4°F to 158°F)
Storage Temperature	-40°C to 70°C (-40°F to 158°F)
Humidity	5% to 95% noncondensing
Altitude	0 to 3050 m (10000 ft.) without derating

Codes and Standards

The ATS meets or exceeds the requirements of the following specifications:

- Underwriters Laboratories UL 508, Standard for Industrial Control Equipment
- Underwriters Laboratories UL 1008, Standard for Automatic Transfer Switches
- Underwriters Laboratories Inc., listed to Canadian Safety Standards (cUL)
- NFPA 70, National Electrical Code
- NFPA 99, Essential Electrical Systems for Health Care Facilities
- NFPA 110, Emergency and Standby Power Systems
- IEEE Standard 446, IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- NEMA Standard IC10-1993 (formerly ICS2-447), AC Automatic Transfer Switches
- EN61000-4-5 Surge Immunity Class 4 (voltage sensing and programmable inputs only)
- EN61000-4-4 Fast Transient Immunity Severity Level 4
- IEC Specifications for EMI/EMC Immunity:
  - CISPR 11, Radiated Emissions
  - IEC 1000-4-2, Electrostatic Discharge
  - IEC 1000-4-3, Radiated Electromagnetic Fields
  - IEC 1000-4-4, Electrical Fast Transients (Bursts)
  - IEC 1000-4-5, Surge Voltage
  - IEC 1000-4-6, Conducted RF Disturbances
  - IEC 1000-4-8, Magnetic Fields
  - IEC 1000-4-11, Voltage Variations and Interruptions

Diagrams and Drawings

Model	Schematic	Wiring Diagram	Dimension Drawing	
			Enclosure	Drawing Number
30-200A, Open-Transition	GM20611	GM20601	NEMA 1	ADV-6698
			NEMA 12, 4, 4X	ADV-6699
225-400A, Open-Transition	GM20611	GM20615	NEMA 1	ADV-6700
			NEMA 12, 4, 4X	ADV-6701
600-800A, Open-Transition	GM20612	GM20602	NEMA 1	ADV-6702
			NEMA 12, 4, 4X	ADV-6702
1000-1200A, Open-Transition	GM20612	GM20602	NEMA 1	ADV-6663
1600-2000A, Open-Transition	GM20613	GM20604	NEMA 1	ADV-6664
			NEMA 1 Front-Connected	ADV-6684
2500-3000A, Open-Transition	GM20611	GM20605	NEMA 1	ADV-6665
4000A, Open-Transition	GM20611	GM20605	NEMA 1	ADV-6666
150-400A, Programmed Transition	GM20616	GM20606	NEMA 1	ADV-6704
600-800A, Programmed Transition	GM20617	GM20607	NEMA 1	ADV-6702
			NEMA 12, 4, 4X	ADV-6703
1000-1200A, Programmed Transition	GM20619	GM20609	NEMA 1	ADV-6663
1600-2000A, Programmed Transition	GM20619	GM20609	NEMA 1	ADV-6664
			NEMA 1 Front-Connected	ADV-6684
2500-3000A, Programmed Transition	GM20616	GM20610	NEMA 1	ADV-6665
4000A, Programmed Transition	GM20616	GM20610	NEMA 1	ADV-6666

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