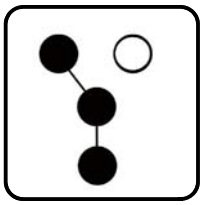
Operation and Installation

Automatic Transfer and Bypass/Isolation Switches



Models:

KBS/KBP/KBC

150 to 4000 Amperes

ISO 9001 KOHLER POWER SYSTEMS NATIONALLY REGISTERED

KOHLER® Power Systems

TP-6835 9/17c

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 _____

Accessories

- ❑ Alarm Board
- ❑ Battery Module
- ❑ California OSHPD Approval
- ❑ Controller Disconnect Switch
- ❑ Current Monitoring
- ❑ Digital Meter
- ❑ Heater
- ❑ I/O Module, Standard (max. 4) qty: _____
- ❑ I/O Module, High Power (max. 4) qty: _____
- ❑ Load Shed
- ❑ Line-Neutral Monitoring
- ❑ IBC Seismic Certification
- ❑ Supervised Transfer Switch
- ❑ Surge Protection Device (SPD)
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Controller Identification

Record the controller description from the generator set operation manual, spec sheet, or sales invoice.

Controller Description _____

Table of Contents

Table of Contents, continued

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***.

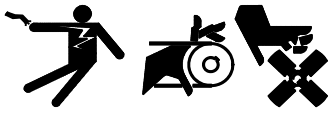
NOTICE

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 equipment connected to the set, 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.

(Decision-Maker® 3+ and 550 Generator Set Controllers)

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or equipment connected to the set, disable the generator set as follows: (1) Press the generator set off/reset button to shut down the generator set. (2) Disconnect the power to the battery charger, if equipped. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent the starting of the generator set by the remote start/stop switch.

(RDC, DC, RDC2, DC2, Decision-Maker® 3000, 3500 and 6000 Generator Set Controllers)

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or equipment connected to the set, disable the generator set as follows: (1) If the controller is not already in the MAN (manual) mode, press the Controller Mode button and then press the MAN mode button. (2) If the generator set is running, press and hold the Manual–Stop button for at least 2 seconds to stop the generator set. (3) Press the Controller Mode button and then press the controller Off mode button. (4) Disconnect the power to the battery charger, if equipped. (5) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent the starting of the generator set by the remote start/stop switch.

(Decision-Maker® 8000 Controller)

Hazardous Voltage/ Moving Parts

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.

Only authorized personnel should open the enclosure.

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

Removing the transfer switch from bypass/isolation models. Hazardous voltage will cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Short circuits. Hazardous voltage/current will 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.

Making line or auxiliary connections. Hazardous voltage will 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 will cause severe injury or death. Deenergize all power sources before servicing. Turn off 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.

(Decision-Maker® 3+ and 550 Generator Set Controllers)

Servicing the transfer switch. Hazardous voltage will cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut down the generator set. (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.

(RDC, DC, RDC2, DC2, Decision-Maker® 3000, 3500 and 6000 Generator Set Controllers)

Testing live electrical circuits. Hazardous voltage or current will 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.

Notice

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 KBS/KBP/KBC Bypass/ Isolation Transfer Switches equipped with the Decision-Maker® MPAC 1500 controller.

A separate manual provided with the transfer switch covers the transfer switch controller operation. See List of Related Materials for the document part number.

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. See the controller Operation manual for the service schedule. Obtain service from an authorized service distributor/ dealer to keep equipment in top condition.

List of Related Materials

A separate covers the transfer switch controller and related accessories. Separate manuals cover service and parts information for transfer switch power switching devices and electrical controls.

The following table lists the part numbers for related literature.

Literature Item	Part Number
Specification Sheet, Decision-Maker® MPAC 1500 Controller	G11-128
Specification Sheet, Model KBS/KBP/KBC	G11-137
Operation Manual, Decision-Maker® MPAC 1500 Controller	TP-6883
Parts Catalog, Transfer Switch and Controller	TP-6433
Service Manual, Models KC/KB	TP-6920

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 KOHLERPower.com.
- Look at the labels and decals 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.

Headquarters Europe, Middle East, Africa (EMEA)
Kohler Power Systems Netherlands B.V.
Kristallaan 1
4761 ZC Zevenbergen
The Netherlands
Phone: (31) 168 331630
Fax: (31) 168 331631

Asia Pacific
Power Systems Asia Pacific Regional Office
Singapore, Republic of Singapore
Phone: (65) 6264-6422
Fax: (65) 6264-6455

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

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.

A bypass/isolation transfer switch allows transfer switch testing and service without interrupting power to the load. The bypass connection is open during normal transfer switch operation. Closing the bypass connection provides a direct connection to either the Normal or Emergency source, bypassing the transfer switch to provide power to the load during transfer switch service. Isolation removes the transfer switch from the power circuit. Procedures in Section 7 explain how to bypass and isolate the transfer switch. Figure 1-1 shows a typical bypass/isolation transfer switch.

Figure 1-2 shows a typical installation block diagram.

Figure 1-1 Bypass/Isolation Switch

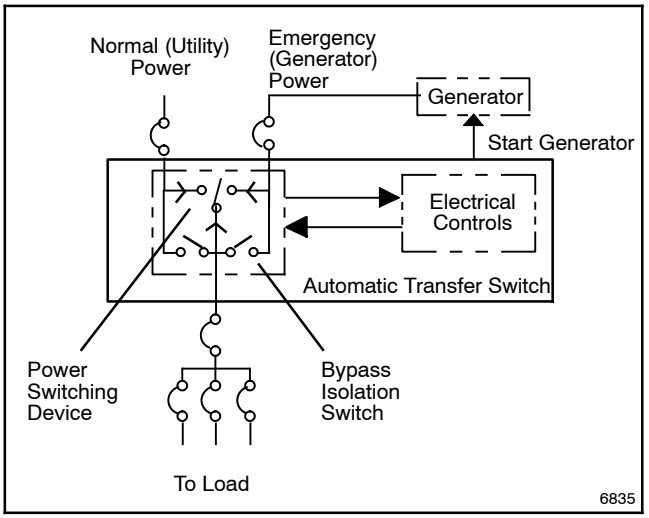


Figure 1-2 Typical ATS Block Diagram

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 1-3. The serial number is also shown on a label inside the transfer switch enclosure.

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.

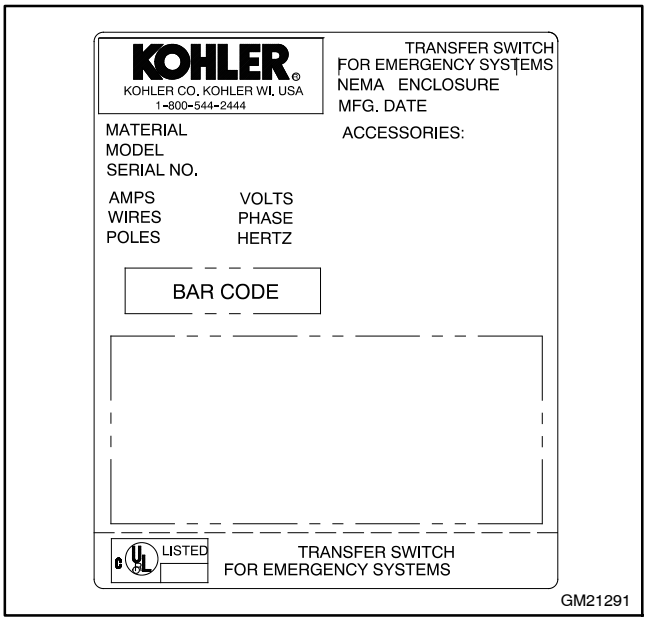
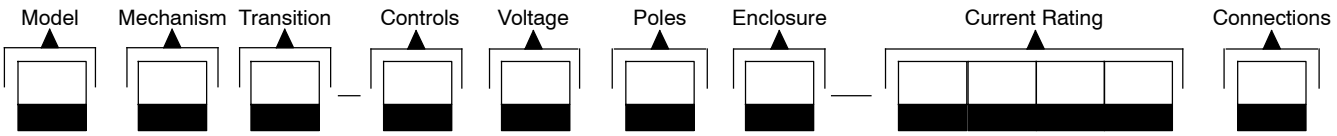


Figure 1-3 Typical Transfer Switch Nameplate

1.3 Model Designation



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

Sample Model Designation: KBS-DMVA-1200S

Model

K: Kohler

Mechanism

B: Bypass/Isolation

Transition

S: Standard

P: Programmed

C: Closed

Controller

D: Decision-Maker® MPAC 1500, Automatic

Voltage/Frequency

C: 208 Volts/60 Hz

D: 220 Volts/50 Hz

F: 240 Volts/60 Hz

G: 380 Volts/50 Hz

H: 400 Volts/50 Hz

J: 416 Volts/50 Hz

K: 440 Volts/60 Hz

M: 480 Volts/60 Hz

N: 600 Volts/60 Hz

P: 380 Volts/60 Hz

R: 220 Volts/60 Hz

Number of Poles/Wires

N: 2 Poles/3 Wires, Solid Neutral

T: 3 Poles/4 Wires, Solid Neutral

V: 4 Poles/4 Wires, Switched Neutral

W: 4 Poles/4 Wires, Overlapping Neutral

Enclosure

A: NEMA 1

Current, Amps *

0150	0800	2600
0225	1000	3000
0260	1200	4000
0400	1600	
0600	2000	

* Some selections are not available on all models.

Connections

S: Standard

F: Front (800 amp only)

Note: Some selections are not available on all models. Contact your Kohler distributor for availability.

2.1 Introduction

An automatic transfer and bypass/isolation switch consists of an upper bypass/isolation switch, a lower transfer switch, and door-mounted controls.

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:

- Unpack and inspect the transfer switch upon receipt.
- Verify that the transfer switch voltage and frequency ratings match the voltages and frequencies of the sources.
- Install the transfer switch.
- Check the manual operation.
- Connect the controller harness and ground lead.
- Connect the generator set engine start leads.
- Connect the normal power source (utility), emergency power source (generator set), and load circuits.
- Connect accessories, if provided.
- Check voltages and operation.

Protect the switch against damage before and during installation.

Note: An approved protective device such as a molded-case circuit breaker or fused disconnect switch MUST be installed on both sources of incoming power for circuit protection and use as a disconnect device.

The functional tests in Section 5 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 or the dimension drawing for the approximate transfer switch weight . 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
150–600	431 (950)	431 (950)	431 (950)
800F	—	635 (1400)	635 (1400)
600–1200S	—	708 (1560)	708 (1560)
1600–2000	—	1070 (2360)	1152 (2540)
2600–3000	—	1240 (2730)	1525 (3360)
4000	—	2087 (4600)	2268 (5000)

Figure 2-1 Approximate Weights with NEMA 1 Enclosures

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 2-2 for acceptable storage temperatures.

Environmental Specifications	
Operating Temperature	-20°C to 70°C (-4°F to 158°F)
Storage Temperature	-40°C to 85°C (-40°F to 185°F)
Humidity	5% to 95% noncondensing

Figure 2-2 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.

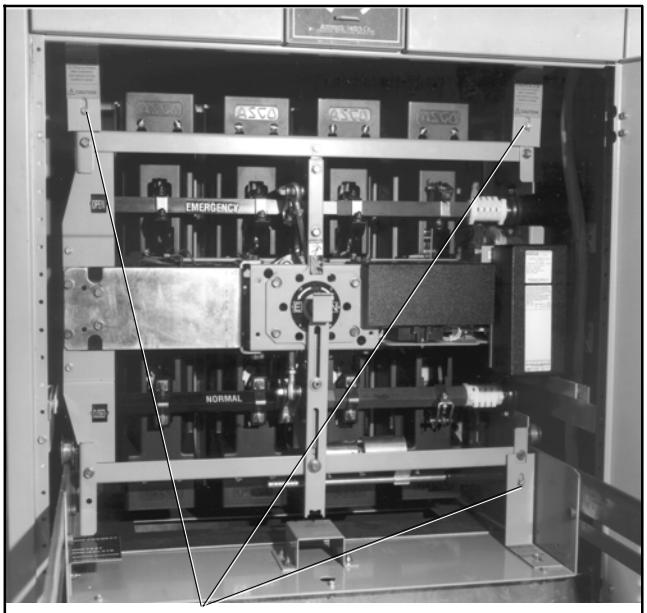
Note: Do not use compressed air to clean the transfer switch. Cleaning with compressed air can cause debris to lodge in the components and damage the switch.

Open the enclosure door to remove the lag screws that secure the enclosure to the wood skid. Remove any shipping angles before attempting to operate the transfer switch.

1600-4000 Amp Models

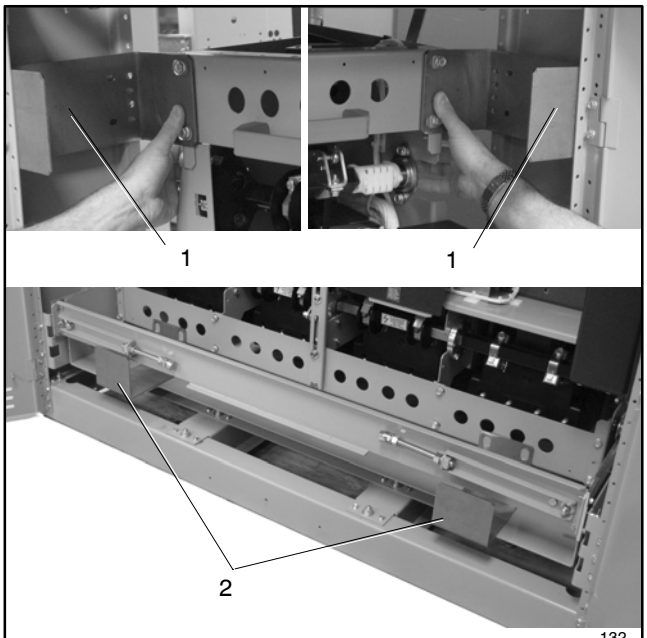
Open the lower front door and remove the two front lag screws that secure the transfer switch to the skid. Then remove the lower panel and remove the two rear lag screws securing the enclosure to the wood skid.

Remove any shipping angles, which are identified by a yellow sticker, before attempting to operate the transfer switch. See Figure 2-3.



1. Shipping angles, qty.3; remove

Figure 2-3 Shipping Angles, 1600-3000 Amp Models



1. Remove two upper shipping brackets
2. Remove two lower shipping brackets

Figure 2-4 Shipping Brackets, 4000 Amp Models

2.3 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.

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 the required clearance for transfer switch drawout. Provide cable bending space and clearance to live metal parts.

Outdoor installations. Transfer switches with NEMA 3R, 4, or 4X enclosures can be installed outdoors. In locations with very high ambient temperatures, installation in a shaded area or a location with the enclosure door facing away from direct sunlight is recommended.

Prepare the foundation. Ensure that the supporting foundation for the enclosure is level and straight. The floor must be flat and level. Refer to the dimension drawing provided with the switch for required clearance. For 1600–4000 amp models, allow at least 0.9 meters (35 inches) to roll out the transfer switch.

For bottom cable entry, if used, install conduit stubs in the foundation. Refer to the enclosure dimension drawing for the conduit stub locations. Provide cable bending space and clearance to live metal parts. When pouring a concrete floor, use interlocking conduit spacer caps or a wood or metal template to maintain proper conduit alignment.

Installation of IBC seismically certified or California OSHPD approved transfer switches. IBC Seismic certification or California OSHPD approval must be requested when the transfer switch is ordered. See Section 2.4 and the ADV drawings for additional installation requirements for transfer switches with IBC seismic certification or California OSHPD approval. Correctly installed transfer switches with California OSHPD approval also have IBC seismic certification.

Install the transfer switch. Refer to the dimension drawing supplied with the switch and mount the transfer switch according to the details and instructions on the drawing.

When drilling entry holes for any conductors, cover the transfer switch components for protection from metal chips and construction grit.

Note: 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.

2.4 IBC Seismic Certification or California OSHPD Approval

Automatic transfer switches with IBC seismic certification or California OSHPD approval must be installed according to the instructions in this section. Also refer to ADV-7456, the Certificate of Compliance provided with the ATS, and the installation (ADV) drawings for the transfer switch.

Abbreviations:

ACI: American Concrete Institute

IBC: International Building Code®

$S_{DS:}$ Design spectral response acceleration at short period, as determined in Section 1615.1.3 of the IBC

R_p: Equipment response modification factor

I_p: Equipment importance factor

a_p: In-structure equipment amplification factor

Refer to the International Building Code® for more information.

General Seismic Installation Notes (for ATS only):

1. Anchors used for seismic installation must be designed in accordance with ACI 355.2–04. Suggested manufacturers include Simpson, Ramset, and Hilti.
2. Anchors must be installed to a minimum embedment of 8x the anchor diameter.
3. Anchors must be installed in minimum 4000 psi compressive strength normal weight concrete. Concrete aggregate must comply with ASTM C33. Installation in structural lightweight concrete is not permitted unless otherwise approved by the structural engineer of record.
4. Anchors must be installed to the required torque specified by the anchor manufacturer to obtain maximum loading.
5. Anchors must be installed to the anchor spacing required to obtain maximum load and edge distance required to obtain maximum load unless otherwise approved by the structural engineer of record.
6. Anchors used for seismic installation must be designed and rated to resist seismic loading in accordance with ACI 355.2–04 and documented in a report by a reputable testing agency (for example, the Evaluation Service Report issued by the International Code Council).
7. Wide washers must be installed at each anchor location between the anchor head and equipment for tension load distribution. See applicable ADV drawing for specific anchor information and washer dimensions.
8. Equipment installed on a housekeeping pad requires the housekeeping pad thickness to be at least 1.5x the anchor embedment depth.
9. All housekeeping pads must be seismically designed and dowelled or cast into the building structure as approved by the structural engineer of record.
10. Rebar reinforcing in the housekeeping pad is required for all installations.
11. Concrete and rebar reinforcing must be designed in accordance with ACI 318–05.
12. Wall-mounted equipment must be installed to a rebar reinforced structural concrete wall that is seismically designed and approved by the engineer of record to resist the added seismic loads from components being anchored to the wall.
13. Floor-mounted equipment (with or without a housekeeping pad) must be installed to a rebar reinforced structural concrete floor that is seismically designed and approved by the engineer of record to resist the added seismic loads from components being anchored to the floor.
14. When installing to a floor or wall, rebar interference must be considered.
15. Equipment attached to any structural floor or wall other than those constructed of structural concrete and designed to accept the seismic loads from the mounted equipment are beyond the scope of this specification.
16. Installation to light-weight concrete over steel decking is beyond the scope of this specification.
17. Installation to concrete block or cinder block walls is beyond the scope of this specification.

2.5 Manual Operation Check

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage will cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut down the generator set. (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.

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.

Disable the generator set to prevent it from starting and disconnect both power sources before manually operating the switch.

Do not place the transfer switch into service if the contactor does not operate smoothly; contact an authorized distributor/dealer to service the contactor.

Remove any shipping angles, which are identified by a yellow sticker, before attempting to operate the transfer switch.

Note: Bypass and isolate the transfer switch before using the maintenance handle. See Section 7 for bypass and isolation procedures.

A detachable manual operator handle is provided on the transfer switch for maintenance purposes only. Use the following manual operation procedures to verify that the contactor operates smoothly without binding. On programmed-transition and closed-transition models, check the operation of both the Normal and Emergency operators.

Note: A contactor in normal and serviceable condition operates smoothly without binding. If the contactor does not operate smoothly, contact an authorized distributor/dealer to service the contactor.

2.5.1 Manual Operation, 150-4000 Amp Standard-Transition Model KBS

1. **Bypass and isolate the transfer switch before using the maintenance handle.** See Section 7 for instructions.

2. Remove the maintenance handle from the clips on the left side of the transfer switch frame on 150–800 amp models, or on the lower part of the transfer switch frame for larger models.

3. Attach the maintenance handle:

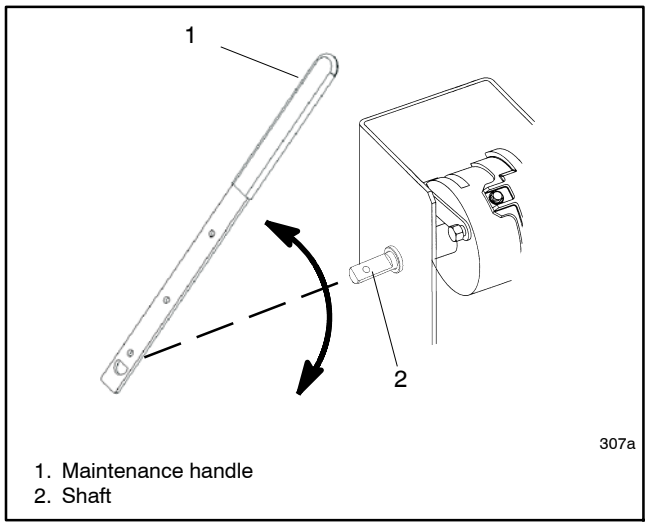
   a. **150-1200 amp switches:** See Figure 2-5 or Figure 2-6. Attach the maintenance handle onto the shaft extension on the left side of the operator.

   b. **1600-4000 amp switches:** See Figure 2-7. Slide the hub onto the shaft and insert the maintenance handle into the hole in the hub.

4. 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.

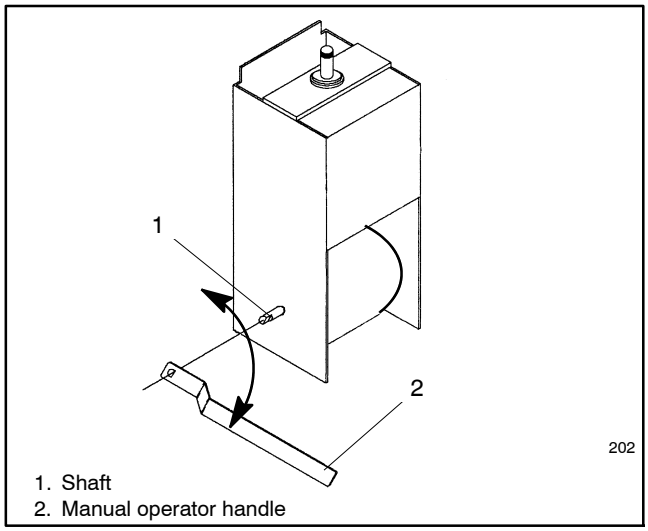
5. Return the transfer switch to the NORMAL position.

6. Remove the maintenance handle and store it on the frame in the clips provided.



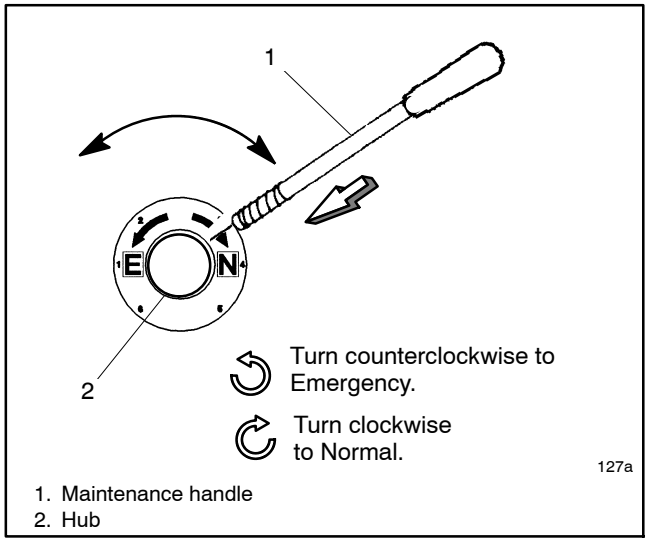
1. Maintenance handle
2. Shaft

Figure 2-5 Manual Operation, 150–600 Amp Standard-Transition Switches



1. Shaft
2. Manual operator handle

Figure 2-6 Manual Operation, 800–1200 Amp Standard-Transition Switches



1. Maintenance handle
2. Hub

Figure 2-7 Manual Operation, 1600–3000 Amp Standard-Transition Switches

2.5.2 Manual Operation, 150–4000 Amp Programmed- and Closed-Transition Models KBP and KBC

1. **Bypass and isolate the transfer switch before using the maintenance handle.** See Section 7 for instructions.

2. Remove the maintenance handle from the clips on the left side of the transfer switch frame on 150–800 amp models, or on the lower part of the transfer switch frame for larger models.

3. Attach the maintenance handle:

   a. **150–1200 amp switches:** See Figure 2-9. Attach the maintenance handle onto the shaft extension on the left side of the operator.

   b. **1600–4000 amp switches:** See Figure 2-8. Slide the hub onto the shaft and insert the pin. Pull out the shaft to operate the Emergency contacts. Push in the shaft to operate the Normal contacts.

   c. Starting with the contactor in the NORMAL position, use the maintenance handle to move the Normal operator from the CLOSED to the OPEN position.

   d. Move the Emergency operator from the OPEN position to the CLOSED position.

   e. Return the Emergency operator to the OPEN position and the Normal operator to the CLOSED position.

   f. Remove the maintenance handle and store it on the frame in the clips provided.

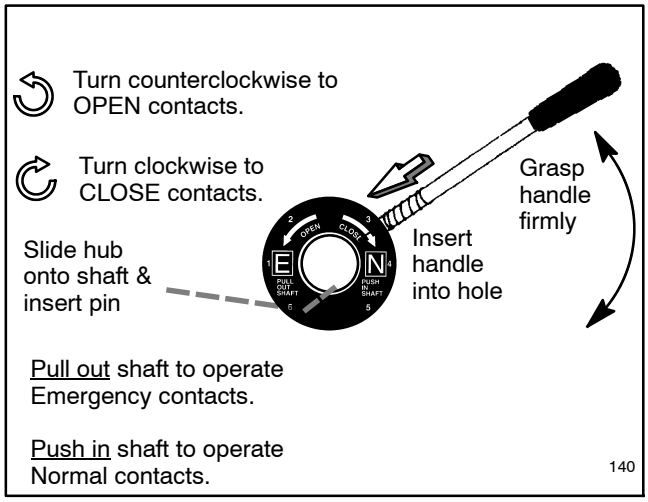


Figure 2-8 Manual Operation, 1000–4000 Amp KBP and KBC

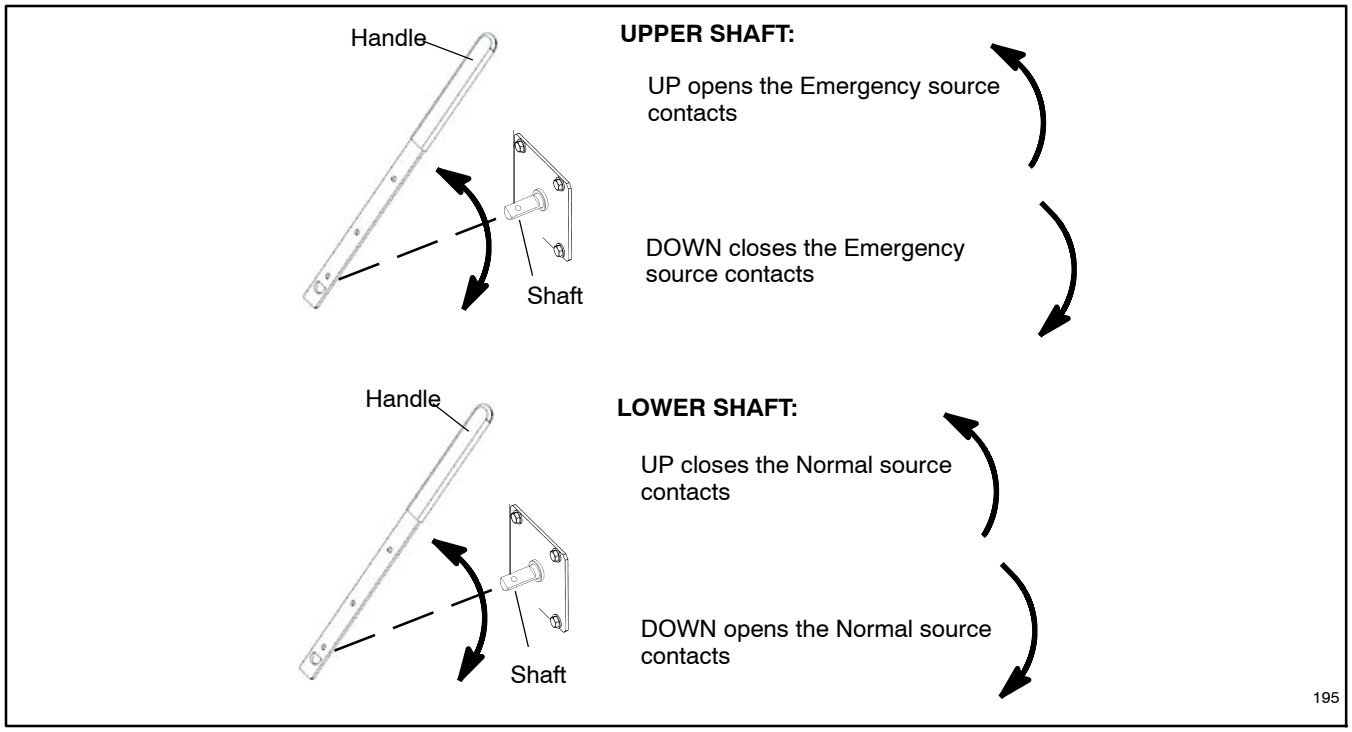


Figure 2-9 Manual Operation, 150–1200 Amp KBP and KBC

2.6 Controller Connections

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

NOTICE

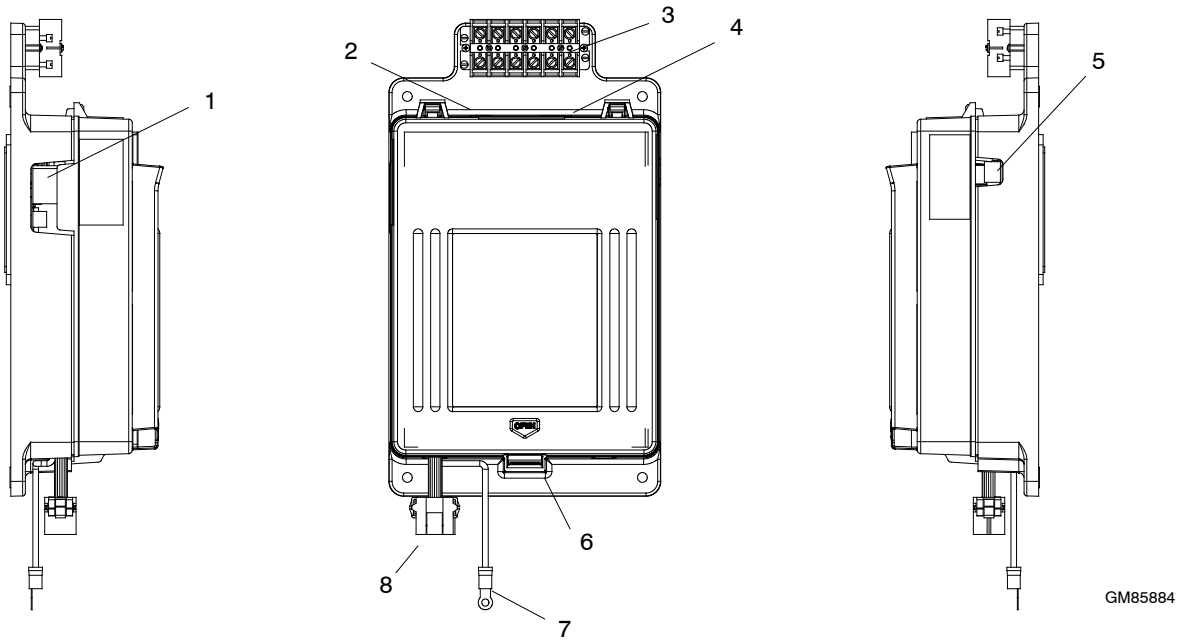
Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance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

The controller is mounted in a plastic housing on the inside of the transfer switch enclosure door.

Figure 2-10 shows the locations of the connectors on the controller. It is not necessary to open the cover to access the Ethernet, Modbus®, and input/output connectors.

Opening the cover. If necessary, 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.

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



1. Standard input/output connection
2. RS-485 connection TB2
3. Connection for optional current sensing kit
4. Optional I/O board connection P16
5. Access openings to optional RJ-45 connector
6. Latch
7. Ground wire
8. Contactor harness connection

Figure 2-10 Controller

Modbus is a registered trademark of Schneider Electric.

2.6.1 Controller Input and Output Connections

The controller provides connections for two programmable inputs and two programmable outputs. See Figure 2-10 for the connector location.

Each input has a signal and a return connection. The outputs are C form contacts with ratings of 500 mA @ 120 VAC. See Figure 2-12 for connections. Use #12–24 AWG wire and tighten the connections to 0.5 Nm (4.4 in. lbs.).

Main Board I/O Specifications	
Output contact type	Isolated form C (SPDT)
Output contact rating	1 amp @ 30 VDC, 500 mA @120 VAC
I/O terminals wire size	#12–24 AWG

Figure 2-11 Main Board I/O Specifications

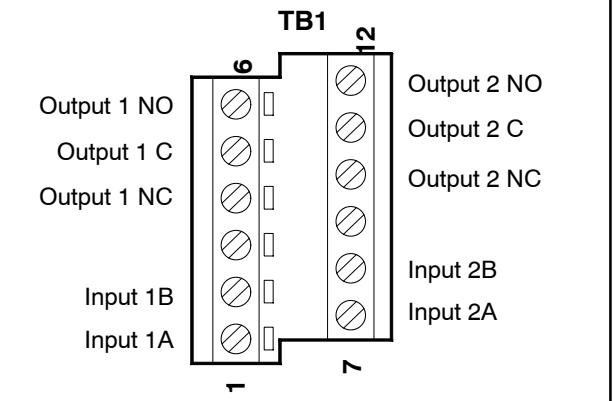


Figure 2-12 Input and Output Connections

2.6.2 Harness Connection

Verify that the contactor harness is connected at the controller base (or at the controller disconnect switch, if equipped). See Figure 2-13.

Note: Verify that the power is disconnected before connecting or disconnecting the contactor harness.

2.6.3 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.

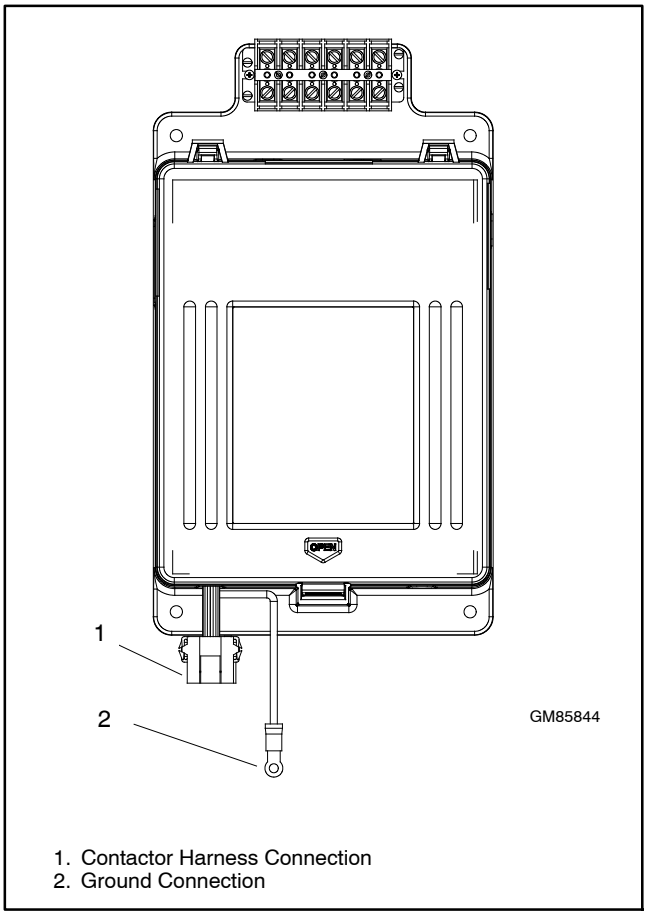


Figure 2-13 Contactor Harness and Controller Ground Connections

2.7 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.

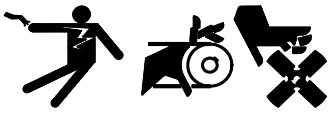
Note: An approved protective device such as a molded-case circuit breaker or fused disconnect switch MUST be installed on both sources of incoming power for circuit protection and used as a disconnect device.

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 separate conduit from AC power wiring.

It is not necessary to remove the barriers from the bypass switch or transfer switch. If you do remove the barriers, 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.

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

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Making line or auxiliary connections. Hazardous voltage will 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 will cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set and related equipment and electrical circuits. Turn off the main circuit breakers of all power sources before servicing the equipment. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

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.

2.7.1 Source and Load Connections

Refer to the wiring diagrams furnished with each transfer switch.

Determine the cable size. Refer to transfer switch dimension drawing to determine the cable size and number of cables required for the transfer switch. Make sure that the cables are suitable for use with the lugs on the transfer switch. Watertight conduit hubs may be required for outdoor use.

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.

Note: 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.

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.

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 conductors. Wipe away any excess compound. If aluminum conductors are used, follow the conductor manufacturer's instructions.

Refer to the wiring diagram provided with the switch.

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.

Tighten the lugs. 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 2-14 for a typical rating/torque label. Carefully wipe off any excess joint compound after tightening the terminal lugs.

Bus connections. For bus connections, use SAE grade 5 hardware to connect the bus to the terminal plates on the bypass switching device. Wipe off the bus surfaces before connecting. Use a non-flammable solvent to clean the surfaces if they are dirty.

Note: For a reliable connection, the joint must be clean and tight.

Use a compression washer, flat washer, and a minimum grade 5 bolt. Torque the connections to the values in Figure 2-15.

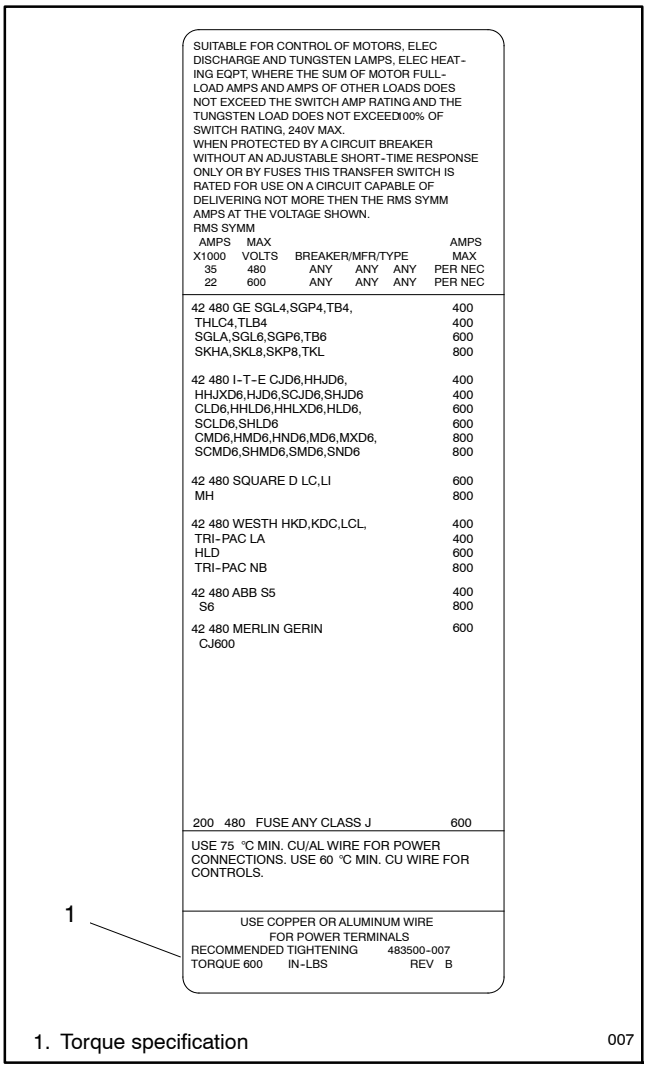


Figure 2-14 Typical Rating/Torque Label

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

Figure 2-15 Tightening Torque for Bus Bars

2.7.2 Extended Transfer Time Relay (Model KBC only)

The extended transfer time relay is standard on closed-transition transfer switches. The relay is provided to prevent paralleling the standby and utility sources for longer than the acceptable time, which is typically 100 ms. The relay is located on the field connection assembly. See Figure 2-17.

The relay starts timing when both sources are connected. If one source fails to disconnect within the set time, the relay energizes and a *Fail to Open Source1 (or Source2)* fault message will display on the ATS controller. Identify and correct the cause of the source disconnect problem before resetting the fault.

Connect the relay to a shunt trip on the emergency source circuit breaker. Provide 12 or 24 VDC power as required for the relay, as shown in Figure 2-18 or Figure 2-21. Connect the DC power, emergency source circuit breaker trip circuit (TR–EMER), and optional alarm (TR-ALARM) to the field-connection terminal block shown in Figure 2-17. See Figure 2-16 for typical connections and refer to the schematic diagram provided with the transfer switch.

The extended transfer time relay uses an adjustment knob or switches to set the time delay. Compare your equipment to Figure 2-17 and Figure 2-20 to identify the relay used on your transfer switch.

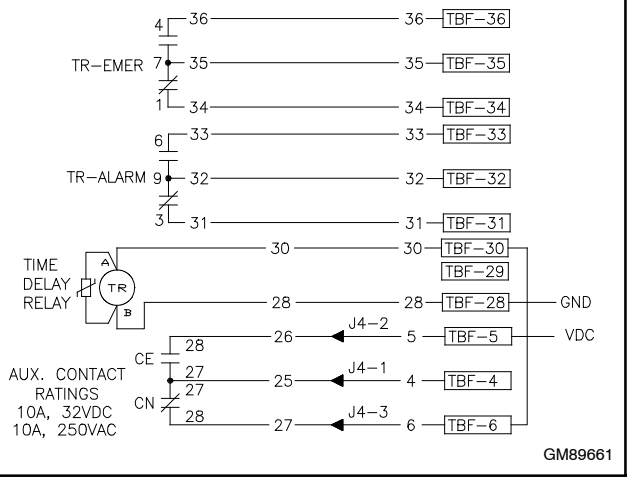


Figure 2-16 Typical Relay Connections (see the schematic diagram for your transfer switch)

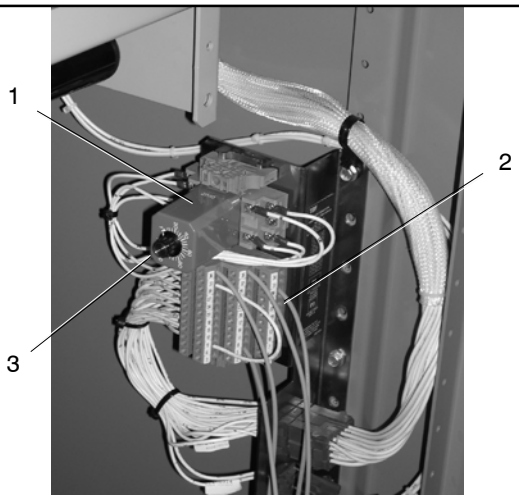
Relay with Time Adjustment Knob

This section applies to the relay equipped with an adjustment knob, shown in Figure 2-17.

Relay specifications are shown in Figure 2-18.

Setting the Time Delay (knob style)

A knob on the relay assembly allows adjustment of the time delay. See Figure 2-17. The relay time delay is adjustable between 100 ms and 10 seconds. The time settings are in percent (%) of the maximum setting, which is 10 seconds, and adjustable in 5% increments. Figure 2-19 shows some sample settings. The typical setting is 1 % = 0.1 seconds (100 ms). If it is necessary to set the relay to a longer time, ensure that the time setting is in accordance with applicable codes.



1. Extended transfer time relay
2. Field connection terminal block
3. Time adjustment

Figure 2-17 Extended Transfer Time Relay (knob style)

Relay Specifications	
Input Power	24 VDC (customer-supplied)
Output Type	Relay contacts, DPDT (2 form C)
Rating	10 amp max. resistive @ 240 VAC 100 mA @ 5 VDC min. load current

Figure 2-18 Relay Specifications (knob style)

Setting*	Time
1 %	0.1 seconds (100 ms)
50 %	5 seconds
100 %	10 seconds
* Settings above 1% are adjustable in 5% increments.	

Figure 2-19 Relay Transfer Time Settings (knob style)

Relays with Time Adjustment Switches

This section applies to relays equipped with switches for time adjustment, shown in Figure 2-20.

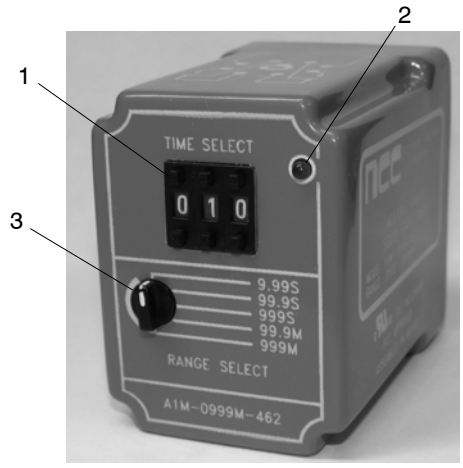
Relay specifications are shown in Figure 2-21.

A three-digit pushbutton switch and a range selection switch on the relay assembly allow adjustment of the transfer time. See Figure 2-20. The relay delay time is adjustable between 0.05 seconds (50 ms)* and 999 minutes. Set the range and the time as shown in Figure 2-22. The recommended setting is 0.10 seconds (100 ms). If it is necessary to set the relay to a longer time, ensure that the time setting is in accordance with applicable codes.

A timing light on the relay flashes during the time delay and turns on continuously after time out.

Setting the Time Delay (adjustment switch style)

To set the time delay, select the range based on seconds or minutes and the numbers after the decimal point. Then use the pushbuttons to set the time. Some examples are shown in Figure 2-23.



IMG_0732

1. Time select pushbuttons
2. Relay timing LED
3. Range selection switch

Note: See Figure 2-17 for relay location on the field connection assembly.

Figure 2-20 Extended Transfer Time Relay (adjustment switch style)

* Settings less than 0.05 s (50 ms) are not recommended.

Relay	12VDC	24VDC
Input Power (customer-supplied)	12 VDC	24 VDC
Relay Marking	A1M-0999M-466	A1M-0999M-462
Output Type	Relay contacts, DPDT (2 form C)	
Rating	10 amp max. resistive @ 240 VAC	

Figure 2-21 Relay Specifications (adjustment switch style)

Time Select	Range Select	Time Setting
001–999	9.99 S	0.01 to 9.99 seconds *
	99.9 S	0.1 to 99.9 seconds
	999 S	1 to 999 seconds
	99.9 M	0.1 to 99.9 minutes
	999 M	1 to 999 minutes
* Settings less than 0.05 s (50 ms) are not recommended.		

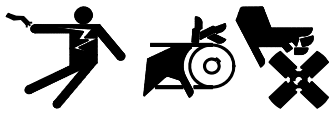
Figure 2-22 Relay Transfer Time Settings (adjustment switch style)

Range	Time Select	Time Setting
9.99 S	010	0.10 seconds (100 ms) †
99.9 S	001	00.1 seconds (100 ms) †
999 S	001	1 second
99.9 M	025	2.5 minutes
999 M	020	20 minutes
† 100 ms is the typical setting. Do not use settings less than 50 ms.		

Figure 2-23 Examples of Transfer Time Settings (adjustment switch style)

2.7.3 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 equipment connected to the set, disable the generator set as follows: (1) Press the generator set off/reset button to shut down the generator set. (2) Disconnect the power to the battery charger, if equipped. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent the starting of the generator set by the remote start/stop switch.

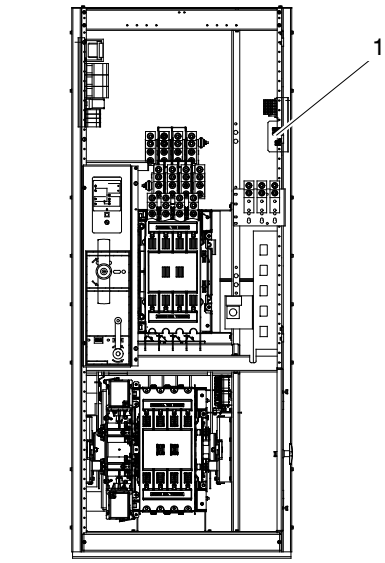
Making line or auxiliary connections. Hazardous voltage will cause severe injury or death. To prevent electrical shock deenergize the normal power source before making any line or auxiliary connections.

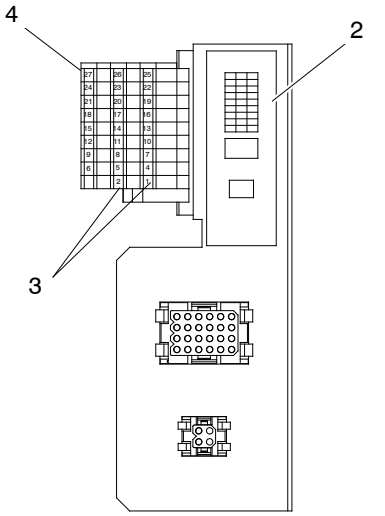
Prevent the generator set from starting by pressing the OFF button on the generator controller; disconnecting power to the generator engine start battery charger, if installed; and disconnecting all generator engine start battery cables, negative (-) leads first.

Connect the generator set remote starting circuit to the engine start connections located on the field connection terminal block. The terminal block is mounted on the upper right side inside the enclosure on most models. See Figure 2-24. Refer to the generator set installation manual for wire size specifications.

The engine start contact rating is shown below.

Engine Start Contacts	
Contact Rating	2 A @ 30 VDC/250 VAC





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

Figure 2-24 Engine Start and Auxiliary Contact Terminal Block (typical)

2.7.4 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.

The auxiliary contact rating is shown below.

Auxiliary Contacts	
Contact Rating	10 amps @ 32 VDC/250 VAC

Figure 2-25 lists the number of auxiliary contacts provided with each transfer switch.

Switch Rating, amps	Number of Auxiliary Contacts Indicating Normal, Emergency		
	KBS	KBP	KBC
150–400	8, 8	6, 6	5, 5
800–1200	8, 8	7, 7	7, 7
1600–4000	2, 2	7, 7	6, 6

Figure 2-25 Number of Auxiliary Contacts Available on Each Switch

Connect to the auxiliary contacts at the field connection terminal block. The terminal block is mounted on the upper right side inside the enclosure on most models. See Figure 2-24. Figure 2-26 shows typical auxiliary contact connections. Refer to the schematic drawing provided with the unit to identify the auxiliary contact terminals for your model transfer switch.

Note: The contacts are shown with the transfer switch in the Normal (Source N) position in all figures and schematic drawings. (Contacts shown closed in the figures are closed on Normal. Contacts shown open in the figures will close on Emergency.)

Follow the wire size and tightening torque specifications shown on the decal on the transfer switch.

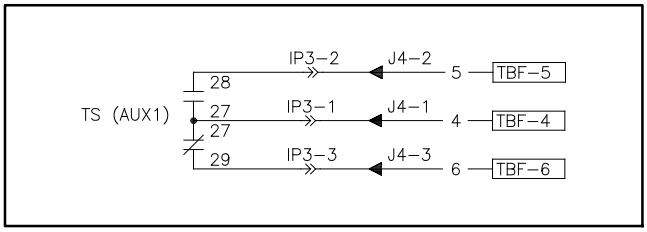


Figure 2-26 Auxiliary Contacts, Typical

2.8 Communication and Accessory Connections

See Section 4 for accessory and communication connection instructions.

2.9 Functional Tests

After completion of the mechanical installation and all electrical connections, perform the functional tests described in Section 5. The procedures in Section 5 are required to complete the installation and startup of the transfer switch.

Notes

3.1 Three-Source Systems

The Decision-Maker® MPAC 1500 controller is required for three-source systems.

A three-source system provides the means to connect a utility and two generators to a single load. See Figure 3-1. Two generators and two transfer switches are required.

Note: The second transfer switch (ATS2) requires an external battery supply module (EBSM) to provide power to the controller. See Section 4.3.3.

During normal operation, the utility source supplies the load with power. In the event of a utility failure, generator set G1 or G2 will supply the load as described in Sections 3.2 and 3.3.

3.2 Three Source Engine Start Mode

There are two modes of operation for three-source engine start. Select Mode 1 or Mode 2 on ATS2 as needed for the application.

3.2.1 Mode 1

In mode 1 there will be an attempt to start only the preferred source generator. If the preferred source does not achieve voltage and frequency within a fail to acquire time period, the standby engine start contact will close. The fail to acquire will be indicated. If the standby source subsequently fails to achieve voltage and frequency, a separate fail to acquire standby will be indicated.

3.2.2 Mode 2

In mode 2 both generators receive a start signal simultaneously. The ATS2 will transfer to the first generator set to reach proper voltage and frequency. If the first source to reach available status is the preferred source, the engine start signal to the standby source will open immediately. If the standby source is the first to reach available status, the contactor will transfer to the standby position. When the preferred source generator output reaches available status, the controller will transfer to the preferred source and open the engine start contacts to the standby generator (after the cooldown delay has elapsed).

3.3 Preferred Source Toggle

The preferred source toggle function alternates between the two generator sets each time the three-source function is activated. If G1 is the preferred source during the first run, then G2 will be preferred during the next run. The preferred source selection will continue to alternate between G1 and G2 for each subsequent run.

3.4 Three Source System Test and Exercise

3.4.1 Unloaded Test

Unloaded testing is possible at each transfer switch. Initiating the unloaded test function at ATS1 starts and runs the preferred generator set attached to ATS2. Initiating the unloaded test function at ATS2 starts and runs the standby generator set.

3.4.2 Loaded Test

Loaded testing is also allowed at each transfer switch. Loaded testing of the standby generator set is only possible during a loaded test from ATS1 because the standby generator can only be connected to the load when ATS1 is connected to emergency. To initiate a loaded test of the standby generator set, first use ATS1 to start a loaded test of the preferred source generator set. Then use ATS2 to start a loaded test of the standby generator set.

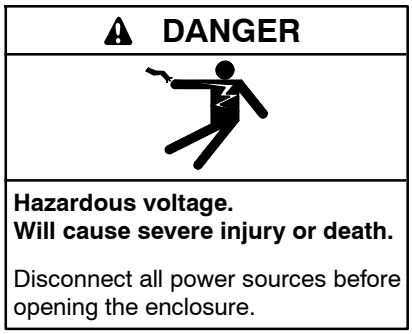
3.4.3 Unloaded Exercise

The exercise program in ATS2 controls the operation of each generator. The exercise function does not require interaction with ATS1. If the utility is lost during an unloaded exercise event, the event is canceled and the load is transferred to the preferred generator set.

3.4.4 Loaded Exercise

The exercise program in ATS2 controls the operation of each generator. The loaded exercise event requires synchronization with a loaded exercise from ATS1. Program the ATS1 exercise to start before the ATS2 exercise. Set the ATS2 exercise to end before the ATS1 exercise ends. If the utility is lost during a loaded exercise event, the event is canceled and the load is transferred to the preferred generator set.

3.5 Three-Source System Connection



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

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

See Figure 3-1 and Figure 3-2 for connections during the following steps.

1. Connect the power sources to the transfer switches as described below. Refer to the transfer switch operation/installation manual or specification sheet for cable sizes. See Figure 3-1 for connections.

   a. Connect the utility power source to the normal side of ATS1.

   b. Connect the load to the load side of ATS1.

   c. Connect the emergency side of ATS1 to the load side of ATS2.

   d. Connect generator set 1 to the normal side of ATS2.

   e. Connect generator set 2 to the emergency side of ATS2.

2. Three-source systems require the following input/output connections to control the engine start commands for generator sets 1 and 2. Observe the polarity of all connections shown in Figure 3-2. Use wire sizes from #14 AWG to #20 AWG for EBSM and I/O module connections.

   a. Connect the ATS2 engine start contacts to the engine start circuit on generator set 2 (G2).

   Note: See the Installation Section for the engine start contact locations. Engine start contacts are labeled with a decal.

   b. Connect one ATS1 programmable output from the controller to one ATS2 main logic board programmable input as shown in Figure 3-2. This I/O connection will be set to Three-Source System Disable.

   c. Connect one ATS2 programmable output from the controller to the engine start connection on generator set 1 (G1). The ATS1 programmable output will be set to Source N Start Signal.

3. Connect battery power. Use #14-28 AWG wire to connect the generator set engine starting battery (or batteries) to the BATT1 terminals on terminal block TB13 on the external battery supply module (EBSM). (Another battery(ies) can be connected to terminals BATT2 but is not required.) Follow the marking on the board for the positive (+) and negative (–) connections. See Figure 4-16 and Figure 4-17.

   Note: If the battery connections are reversed, red LED1 or LED2 will light. Incorrect battery connections can damage the battery module.

4. Set voltage selector switch SW11-1 on the battery module (EBSM) to 12 or 24VDC.

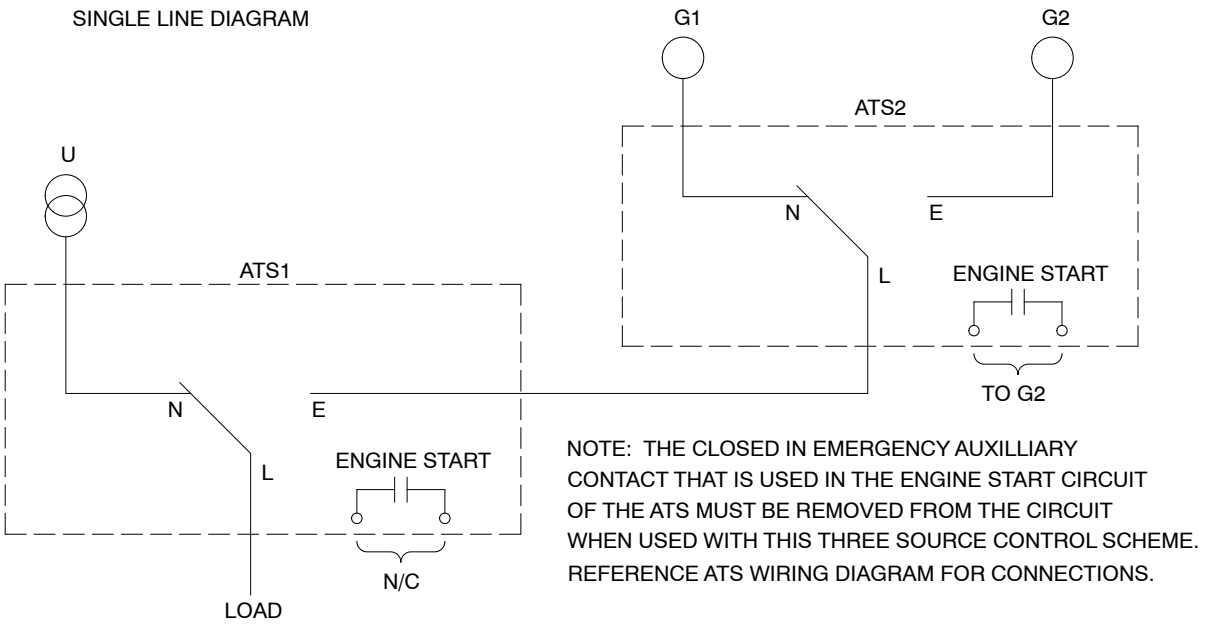
   Note: See Section 4.3.3 for more information on the EBSM.

5. Assign the ATS1 programmable output connected in step 2b. to Three-Source System Disable.

6. Assign the following inputs and outputs for the second transfer switch.

   a. Assign ATS2 controller programmable input 1 to Three-Source System Disable.

   b. Assign the ATS2 controller programmable output connected in step 2c. to Source N Start Signal.



LEGEND

ATS - AUTOMATIC TRANSFER SWITCH
EBSM - EXTERNAL BATTERY SUPPLY MODULE
G1 - GENERATOR #1
G2 - GENERATOR #2
K1 - NORMAL RELAY
K2 - EMERGENCY RELAY
LED1 - LIGHT EMITTING DIODE (BATTERY 1 REVERSED)
LED2 - LIGHT EMITTING DIODE (BATTERY 1 REVERSED)
LED3 - LIGHT EMITTING DIODE (BATTERY SUPPLYING POWER)
MLB - MAIN LOGIC BOARD
P(#) - CONNECTOR
PIOM - PROGRAMMABLE INPUT/OUTPUT MODULE
MLB - MAIN LOGIC BOARD
TB(#) - TERMINAL BLOCK
SW - SWITCH
U - UTILITY

Note: ATS2 requires an external battery module to maintain power to the controller.

OPERATION

WHEN UTILITY FAILS ATS2 STARTS G1. ATS1 TRANSFERS TO THE EMERGENCY POSITION. IF G1 FAILS ATS2 WILL START G2 AND ATS2 WILL TRANSFER TO EMERGENCY. IF G1 RETURNS THEN ATS2 WILL RE-TRANSFER BACK TO NORMAL. ATS1 WILL RE-TRANSFER BACK TO NORMAL AFTER THE UTILITY RETURNS. WHEN THE UTIITY IS AVAILABLE, THE BATTERY SUPPLY MODULE WILL PROVIDE POWER TO THE CONTROLLER ON ATS2. THE 3 SOURCE SYSTEM DISABLE INPUT AND OUTPUT WILL PREVENT ATS2 FROM STARTING EITHER GENSET WHILE THE UTILITY SOURCE IS AVAILABLE.

THE BATTERY SUPPLY MODULE USES UP TO TWO BATTERY INPUTS (9-36VDC) AND PROVIDES A 12V OUTPUT THAT POWERS THE ATS CONTROLLER. THIS IS CONNECTED TO THE CONTROLLER BY SNAPPING IT TO AN EXISTING I/O MODULE OR THROUGH A HARNESS TO P3 ON THE CONTROLLER (WHEN AN I/O MODULE IS NOT USED). THE BATTERY SUPPLY MODULE WILL CONTINUALLY PROVIDE POWER TO THE CONTROLLER UNLESS THE ON/OFF INPUT ON THE BATTERY SUPPLY MODULE IS ENABLED.
THE ON/OFF INPUT ON TB1 OF THE BATTERY SUPPLY MODULE CAN BE USED IN CONJUNCTION WITH THE NORMALLY OPEN CONTACT OF A PROGRAMMABLE OUTPUT FROM AN INPUT/OUTPUT MODULE TO TURN THE BATTERY SUPPLY MODULE OFF WHEN A SOURCE IS AVAILABLE.

GM28627B

Figure 3-1 Three-Source System Transfer Switch and Source Connections

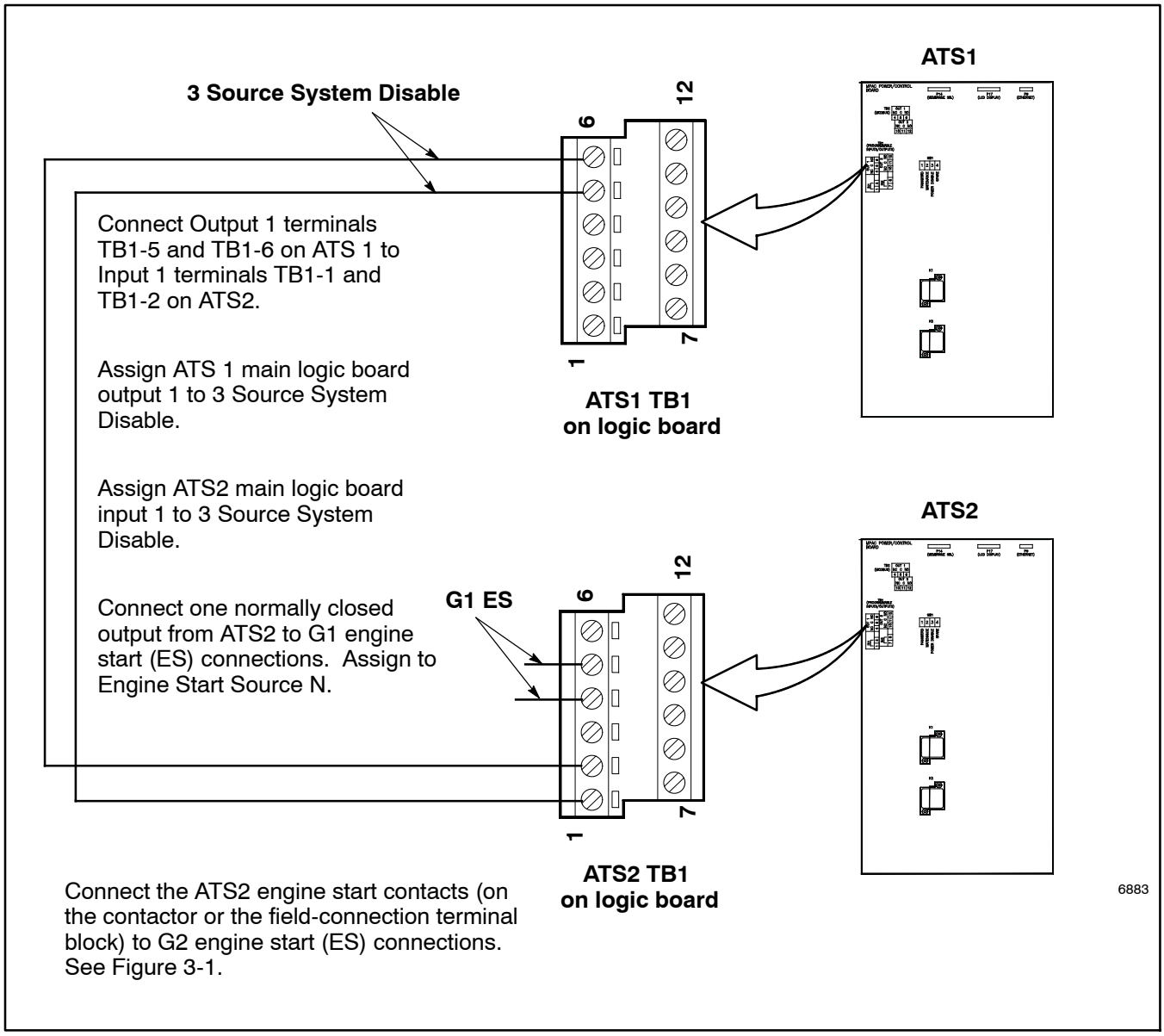


Figure 3-2 Input and Output Connections for Three-Source Systems

3.6 ATS1 and ATS2 System Setup

Use the System Setup Menu on each transfer switch to set the following:

ATS1: Set the Source type to Util-Gen.

ATS2: Set the source type to Util-Gen-Gen. Set the 3 Src Engine Start Mode to Mode 1 or Mode 2 as described in Section 3.2.

The transfer switch settings are summarized in Figure 3-3.

Transfer Switch	Source Type	3 Src Engine Start Mode	Preferred Source Toggle	Inputs	Outputs
ATS1	Util-Gen	Not Required	Not Required	Not Required	Three Source System Disable
ATS2	Util-Gen-Gen	Mode 1 or Mode 2 (See Section 3.2)	Enable or Disable See Section 3.3	Three Source System Disable	Source N Start Signal

Figure 3-3 Transfer Switch Settings for Three-Source Systems

4.1 Introduction

This section explains the connection of communication cables and factory-installed accessories.

Also refer to the following documentation for instructions to install, connect, and operate optional accessories.

- Transfer switch wiring diagrams.
- Installation instructions or diagrams provided with loose accessory kits.

4.2 Communication Connections

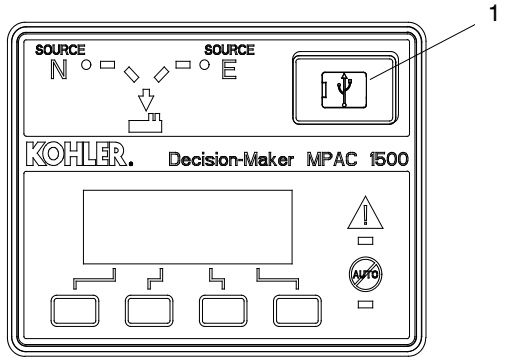
The Decision-Maker® MPAC 1500 controller is equipped with a USB port and a Modbus port with an RS-485 connector. An Ethernet communication board is also standard on the MPAC 1500 controller.

4.2.1 USB Port SiteTech Connection

A personal computer and Kohler® SiteTech™ software can be used for changing controller settings. Use a USB cable to connect the controller to a personal computer.

See Figure 4-1 for the USB port location on the front of the controller assembly. Remove the small port cover and use a USB cable with a mini-B connector to connect the controller's USB port to the computer.

See TP-6701, SiteTech Software Operation Manual, for instructions to use the software. Disconnect the USB cable from the controller and replace the port cover when finished.



1. USB connection (below port cover) GM85888

Figure 4-1 USB Connection for SiteTech

4.2.2 Modbus Connection

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage will cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut down the generator set. (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.

See Figure 4-2 for the RS-485 Modbus connector location.

Use serial connections to TB2 on the controller to connect the transfer switch to a personal computer for system monitoring, the optional remote annunciator, or a Modbus network. See Figure 4-4.

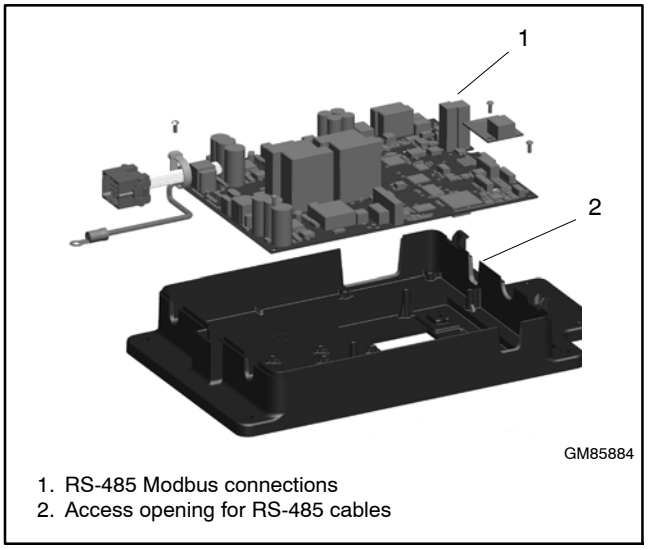
Notice that a 121 ohm terminating resistor is recommended on the last device in a network. If there is only one device, a terminating resistor may be required depending on the cable distance and communication speed. Long cables and high speeds will increase the need for a terminating resistor.

The serial port is an isolated RS-485 port with connection speeds of 9.6, 19.2, and 57.6 kbps. Use shielded twisted-pair cable to connect to the RS-485 connectors on the controller's terminal strip TB2 for serial connections. For connection to a PC, use a USB to RS-485 converter.

Connect the Modbus input and output to the terminals shown in Figure 4-3. Use #12-24 AWG shielded, twisted-pair wire. Belden cable #9841 or equivalent is recommended. Connect one end of the shield to ground. Leave the other end of the shield disconnected. Tighten the connections to 0.5 Nm (4.4 in. lb.).

Use Modbus RTU (remote terminal unit) protocol for communication through the serial port. A map of the Modbus codes for this controller is available. Contact your local distributor/dealer.

Note: Modbus® applications require a Modbus software driver written by a trained and qualified systems programmer.



1. RS-485 Modbus connections
2. Access opening for RS-485 cables

Figure 4-2 Modbus Connections (controller cover removed for illustration only)

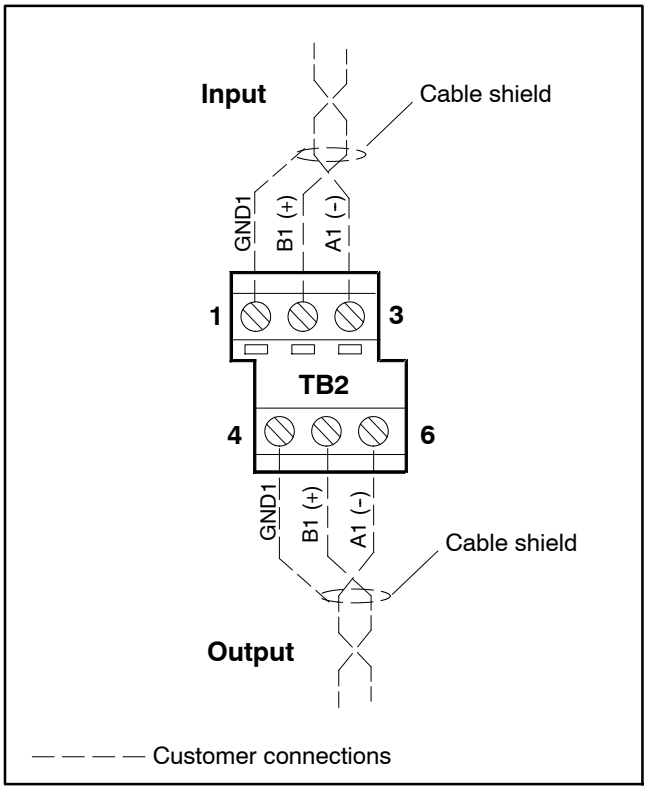
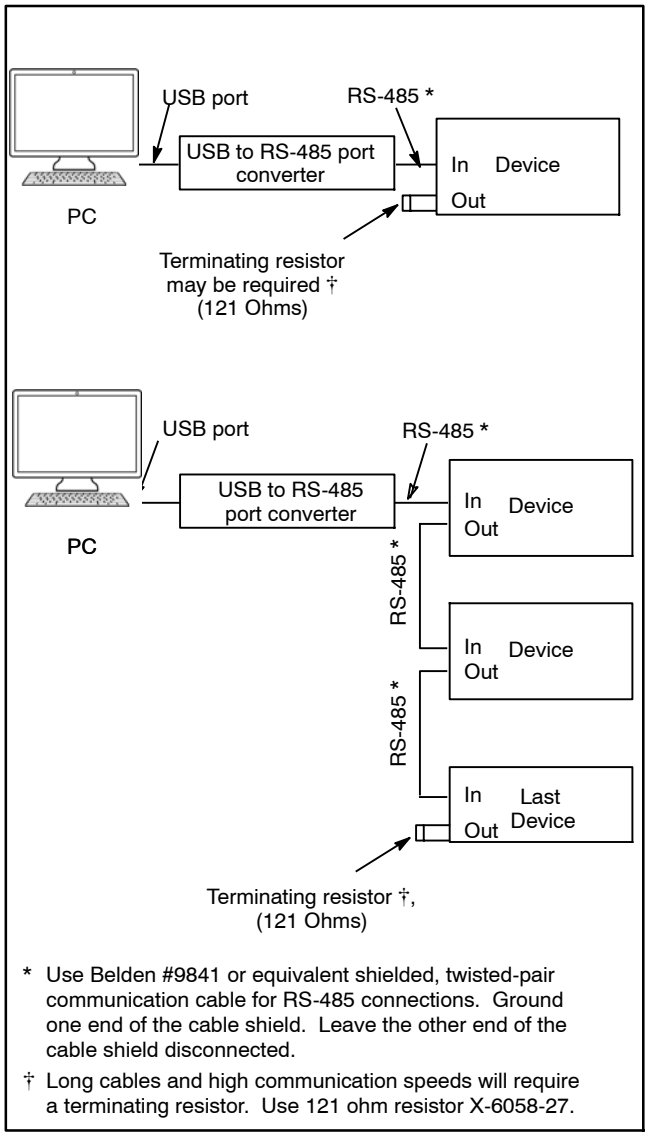


Figure 4-3 Modbus RS-485 Connections



* Use Belden #9841 or equivalent shielded, twisted-pair communication cable for RS-485 connections. Ground one end of the cable shield. Leave the other end of the cable shield disconnected.

† Long cables and high communication speeds will require a terminating resistor. Use 121 ohm resistor X-6058-27.

Figure 4-4 Serial Connections

4.2.3 Ethernet Connection

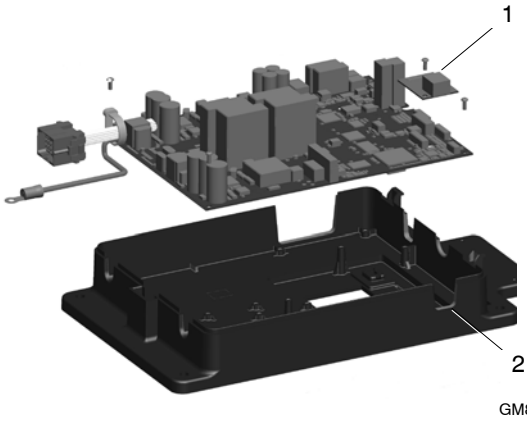
⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage will cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut down the generator set. (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.

The Ethernet communication accessory board is required for connection to the Ethernet. The Ethernet communication board is standard on the MPAC 1500 controller. The communication board connects to the controller board as shown in Figure 4-5.



1. Ethernet communication board with RJ-45 connector
2. Access opening for Ethernet cable

Figure 4-5 Ethernet Board (controller cover removed for illustration only)

The Ethernet communication board allows the transfer switch to be connected to a building's Ethernet network to communicate with personal computers connected to the same subnet.

Note: For an ethernet connection, obtain an IP address and subnet mask number from the local system administrator.

Ethernet Port. The ethernet port is a standard RJ-45 jack. See Figure 4-5 for the location of the Ethernet port. Use Category 5e or better cable to connect the controller to the building's network.

Use the controller's Setup menus or a personal computer connected to the controller's USB port and Kohler SiteTech software to set the communication parameters. The Ethernet communication board may have a default IP address assigned at the factory for test purposes. See Figure 4-6. **Change the IP address to an address owned by the user.** See the controller operation manual for instructions to set the communication parameters.

The transfer switch controller does not operate as a Modbus-to-Ethernet converter for other devices in a network. For multiple device networks connected to the personal computer through the Ethernet, use a Modbus-to-Ethernet converter for the other devices in the network. See Figure 4-7 and instruction sheet TT-1405, provided with the converter, for connection instructions.

The controller can communicate with up to five (5) simultaneous TCP/IP (ethernet) connections. These five connections do not include the RS-485 serial port. In the extreme case, five users may be communicating with the controller via TCP/IP network connections and another may be communicating through the serial port, for a total of six (6) communication channels. As the controller is asked to communicate with more and more outside devices, the communication will slow down.

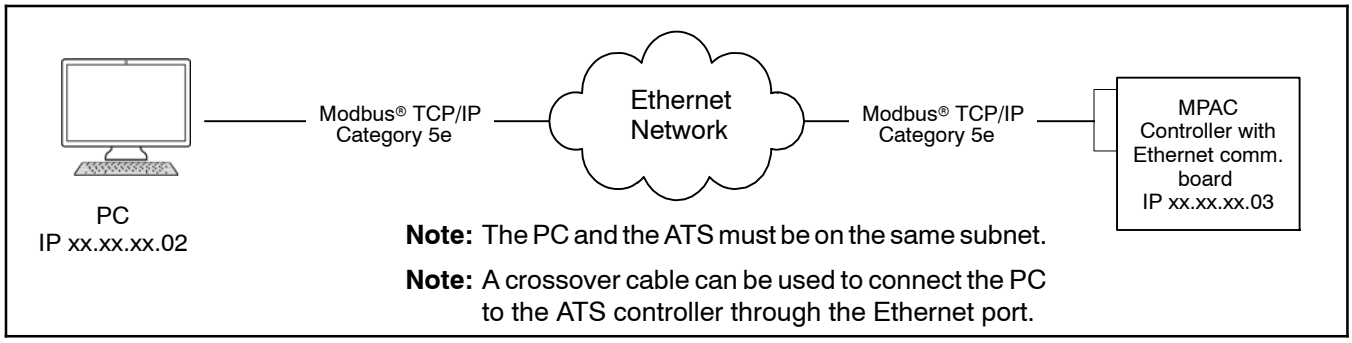


Figure 4-6 Remote Network (Ethernet) Connection

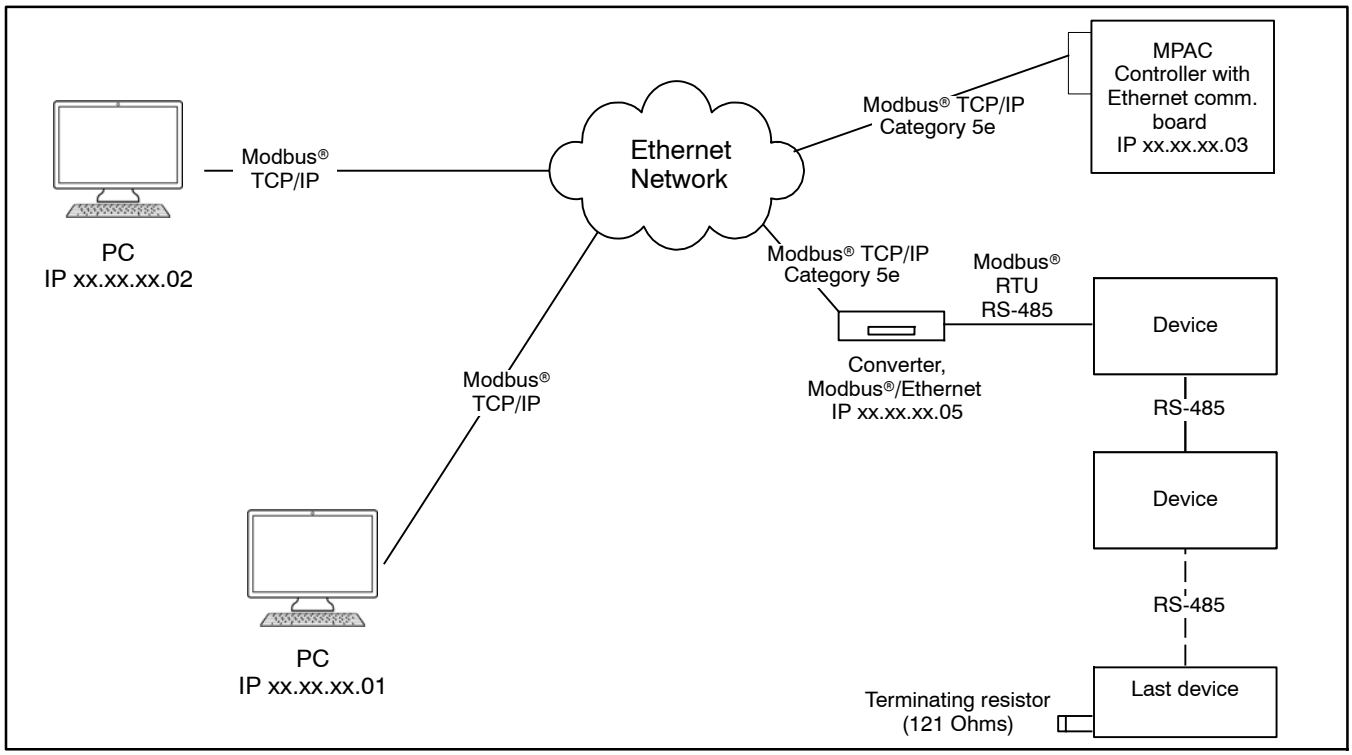


Figure 4-7 Ethernet Connections to Multiple-Device Network

4.3 Accessory Modules

DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage will cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut down the generator set. (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.

The transfer switch uses a standard bus system for connecting accessory modules to the controller. This bus incorporates a standard serial communication interface for passing data back and forth between the main logic board and the assemblies on the expansion bus.

The module mounting kit holds up to five optional modules. The total current draw of all modules must not exceed 300 mA. See Figure 4-8. Add the current draw for every module installed to determine the total current draw. If an External Battery Module is installed and connected to a battery, there is no current restriction. The External Battery Module, if used, must be the last board on the bus.

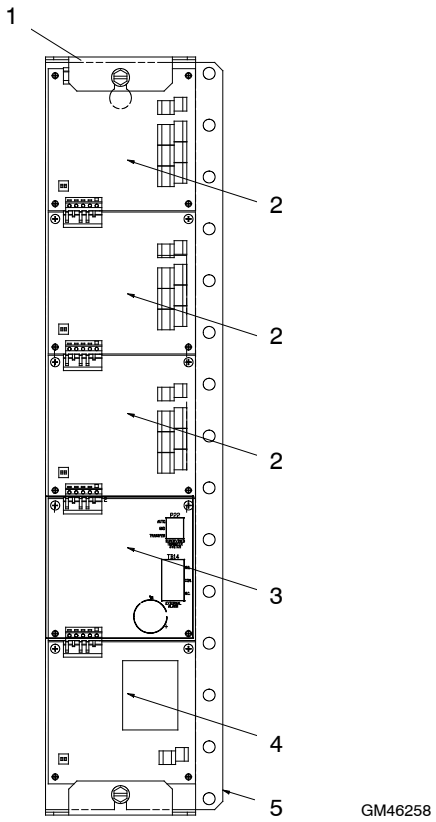
Module Current Draw Specifications, mA	
Alarm Module	75
Standard I/O Module	75
High Power I/O Module	100

Figure 4-8 Option Board Types

4.3.1 Accessory Module Mounting

Mount the accessory modules on the module mounting plate. Starting at the end of the module mounting assembly nearest the cable connection, install any I/O modules first, then install the alarm board, if used. The external battery module, if used, must be the last module. See Figure 4-9. The alarm board has a fixed Modbus address = 5.

Note: Some models may have the I/O module assembly installed with the cable connection end pointing to the side or the bottom. Regardless of the actual orientation of the assembly, the I/O modules must be installed closest to the cable connection, followed by the alarm module and then the external battery module, if used.

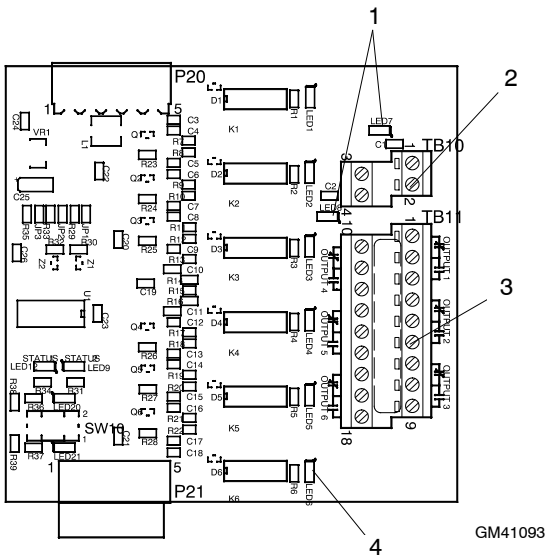


1. Cable connection (defined as the TOP regardless of orientation)
2. I/O modules (if equipped)
3. Alarm module (if equipped)
4. External battery module (must be last, if equipped)
5. Mounting plate

Figure 4-9 Module Mounting

4.3.2 Input/Output (I/O) Modules

Two types of input/output modules are available. The standard I/O Module has two inputs and six outputs. The high-power I/O module has two inputs and three outputs. See Figure 4-10 through Figure 4-13 for I/O module illustrations and specifications.

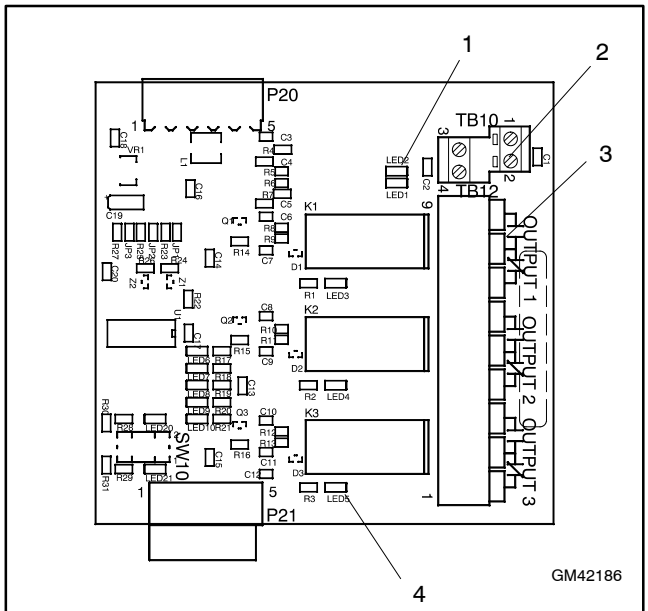


1. Input LEDs 7 and 8 for inputs 1 and 2
2. Input connector (see Figure 4-14)
3. Output connector
4. Output LEDs 1–6

Figure 4-10 Standard Input/Output Module

Inputs	
Available Inputs	2
Input Definition	Contact Closure
Current	5 mA Max
Connection Type	Terminal Strip
Wire Size	#14-24 AWG
Max Distance	700 feet
Outputs	
Outputs Available	6
Contact Type	Form C (SPDT)
Contact Voltage Rating	2 A @ 30 VDC 500 mA @ 125 VAC
Connection Type	Terminal Strip
Wire Size	#14-24 AWG

Figure 4-11 Standard I/O Module Specifications



1. Input LEDs 1 and 2
2. Input connector (see Figure 4-14)
3. Output connector
4. Output LEDs 3–5 for outputs 1, 2, and 3

Figure 4-12 High-Power Input/Output Module

Inputs	
Available Inputs	2
Input Definition	Contact Closure
Current	5 mA Max
Connection Type	Terminal Strip
Wire Size	#14-24 AWG
Max Distance	700 feet
Outputs	
Outputs Available	3
Contact Type	Form C (SPDT)
Contact Voltage Rating	12 A @ 24 VDC 12 A @ 250 VAC 10 A @ 277 VAC 2 A @ 480 VAC
Connection Type	Terminal Strip
Wire Size	#14-24 AWG
Environmental Specifications	
Temperature	–40°C to 85°C (–40°F to 185°F)
Humidity	35% to 85% noncondensing

Figure 4-13 High-Power I/O Module Specifications

Use 14-24 AWG cable to connect to inputs and outputs. See Figure 4-14.

LEDs on the module circuit board light to indicate that each input or output is active.

Note: Each I/O module must have unique address.

Use the address DIP switches on the I/O module to assign a unique (different) address to each module as shown in Figure 4-15. Assign addresses in order from 1 to 4. An LED for each DIP switch lights to indicate that the switch is closed.

The alarm module's fixed address is 5. The battery module's fixed address is 6.

See the controller operation manual for instructions to assign functions to each input and output. Inputs and outputs can also be assigned using a personal computer with Kohler® SiteTech™ software or over Modbus. See TP-6701, SiteTech Operation Manual, or TP-6113, Modbus Protocol Manual.

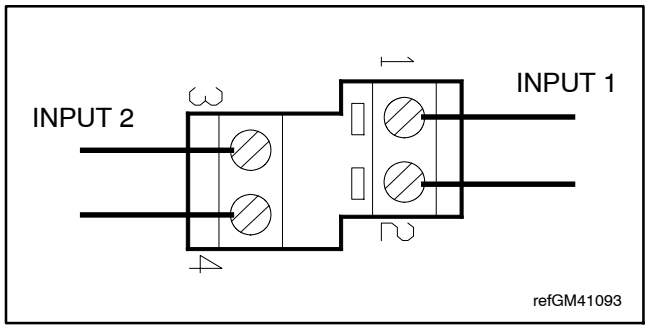
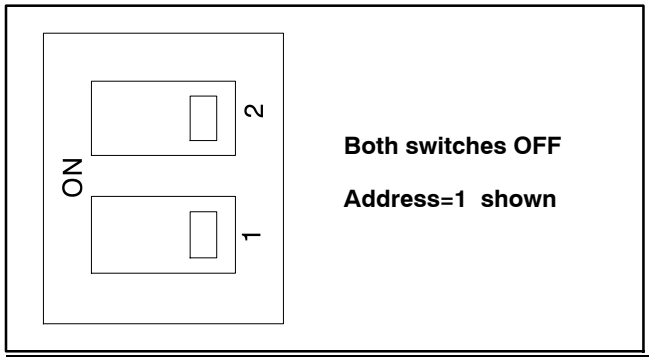


Figure 4-14 I/O Module Input Connections (TB1 or TB10)



DIP Switch		
1	2	Address
Off	Off	1
On	Off	2
Off	On	3
On	On	4

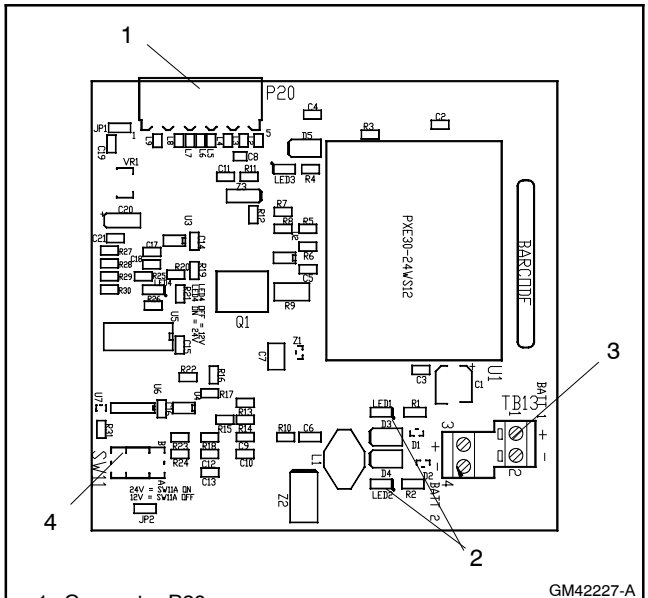
Figure 4-15 Address DIP Switch Settings

4.3.3 External Battery Supply Module (EBSM)

The external battery supply module kit allows connection to the generator set engine start battery(ies) or other batteries to provide 12 VDC power to the ATS controller. The external battery supply module kit is required for the following applications:

- **Systems using extended engine start time delays.** The EBSM provides power to the ATS controller during extended time delays longer than 15 seconds, when neither the Normal nor the Emergency source is available.
- **Installations with frequent utility power outages.** The EBSM provides power to the ATS controller when neither source is available, preserving the controller's backup battery.
- **Three-source systems.** Three-source systems use two transfer switches and two standby power sources in addition to the preferred power source. The EBSM provides power to the second ATS controller when the preferred source (connected to ATS1) is supplying the load. See Section 3.1 for instructions to set up a three-source system.

The external battery supply module kit includes one external battery supply circuit board and the circuit board mounting components. See Figure 4-16.



1. Connector P20
2. LED indicators
3. Battery input connection terminal block TB13
4. 12/24 volt DIP switch SW11-1. OFF=12 VDC, ON = 24 VDC

Figure 4-16 External Battery Supply Module

The EBSM produces 2 amps at 12 VDC with 9–36 VDC input. The EBSM input is reverse-polarity protected. The EBSM outputs a low battery voltage signal when the external battery voltage falls below 11 VDC for a 12-volt system or 22 VDC for a 24-volt system.

A module mounting kit is required for installation of the external battery supply module. See Section 4.3.1. Obtain a module mounting kit if one is not already installed and follow the instructions provided with the kits to install the mounting assembly and modules.

The battery voltage selection DIP switch SW11-1 allows selection between 12-volt and 24-volt systems for low battery voltage sensing and indication. Connect one or two batteries to the external battery supply module. Use a battery charger to maintain the battery(ies) connected to the EBSM.

DIP Switch SW11-1 Setting	Battery Voltage
OFF	12 VDC
ON	24 VDC

Figure 4-17 Battery Voltage Selection

EBSM Connection and Voltage Setting

1. Use #14-28 AWG wire to connect one or two batteries to terminal block TB13. (A second battery can be connected but is not required.) Follow the marking on the board for the positive (+) and negative (–) connections. See Figure 4-16 and Figure 4-17.

   Note: If the battery connections are reversed, red LED1 or LED2 will light. See Figure 4-16.

2. Set voltage selector switch SW11-1 to 12 or 24VDC. See Figure 4-16 and Figure 4-17. Switch SW11-2 is not used.

   Note: The EBSM has no address switches but must be the last board on the bus.

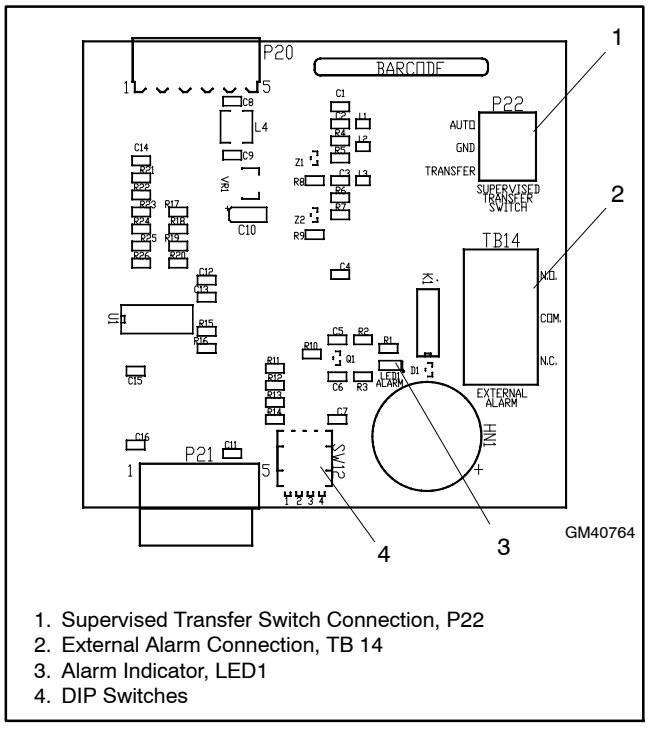
4.3.4 Alarm Module

See Figure 4-18 for the optional alarm module. A module mounting kit is required for installation of the alarm module. See Section 4.3.1.

The functions provided by this board are:

- 90 dB Audible alarm (any alarm function can be programmed to trigger the audible alarm)
- Chicago alarm operation
- Preferred source selection
- Supervised transfer control (supervised transfer control switch required)
- Connection for external alarm

The alarm board has a fixed address = 5.



1. Supervised Transfer Switch Connection, P22
2. External Alarm Connection, TB 14
3. Alarm Indicator, LED1
4. DIP Switches

Figure 4-18 Alarm Module

Alarm Board DIP Switches

There are four DIP switches on the alarm module board. Some of the switches are not used. See Figure 4-19. To enable the preferred source selection, set DIP switch 1 to ON. If the supervised transfer switch is installed on the ATS, set DIP switch 2 to ON.

DIP Switch	Function
1	Preferred source selection
2	Supervised transfer enable
3	Not used
4	Not used

Figure 4-19 Alarm Board DIP Switches

Preferred Source Selection

The alarm module is required for preferred source selection. To enable the preferred source selection, set DIP switch 1 to ON. Then see the controller operation manual for instructions to select Source N or Source E as the preferred source.

External Alarm

A customer-supplied external alarm horn can be connected to the alarm module at terminal block TB14. Connect to the normally open or normally closed contact as recommended by the alarm manufacturer's instructions. See Figure 4-20.

Item	Specification
Wire Size	#12-22 AWG Cu
Contact Voltage Rating	500 mA @ 120 VAC
	250 mA @ 240 VAC

Figure 4-20 External Alarm Connection Specifications

Audible Alarm Setup

The alarm board is equipped with a 90 dB audible alarm. The audible alarm can be set to sound under selected fault conditions. Use the Common Alarms Setup menu to assign functions to the audible alarm. See the controller operation manual for instructions to set Audible Alarm: Y for each function that should trigger the alarm.

Alarm Operation, Normal Mode

In Normal Mode, the horn sounds anytime a fault event happens in the system. The horn continues to sound unless the alarm silence button is pressed. When the fault is cleared, the alarm silence is ended and reset for the next alarm.

Alarm Operation, Chicago Alarm Mode

Chicago Alarm mode requires the horn to sound and a lamp or LED to light when the switch is in the emergency (non-preferred) position. The horn continues to sound unless the alarm silence button is pressed. When the fault is cleared, the alarm silence is ended and reset for the next alarm.

For Chicago Alarm Mode, use the Common Alarm Setup menu to assign the necessary faults and conditions to the audible alarm. See the controller operation manual for instructions to assign common faults. Be sure to assign the Contactor in Standby condition to trigger the audible alarm.

A remote alarm or indicator light can also be connected to the alarm board to indicate the alarm condition, as described previously. See External Alarm.

Alarm Silence Mode

In Alarm Silence Mode, the horn is disabled. Alarm Silenced appears on the display and the system alert LED lights.

The Alarm Silenced condition can be assigned to a programmable output. See the controller operation manual for instructions to assign outputs.

Instructions to Silence the Alarm in Normal and Chicago Alarm Modes

When the alarm is activated, the word Alarm appears on the main display menu above the first button. See Figure 4-21. Press the Alarm button to open the Reset menu. Then press the button labeled Reset to silence the alarm.

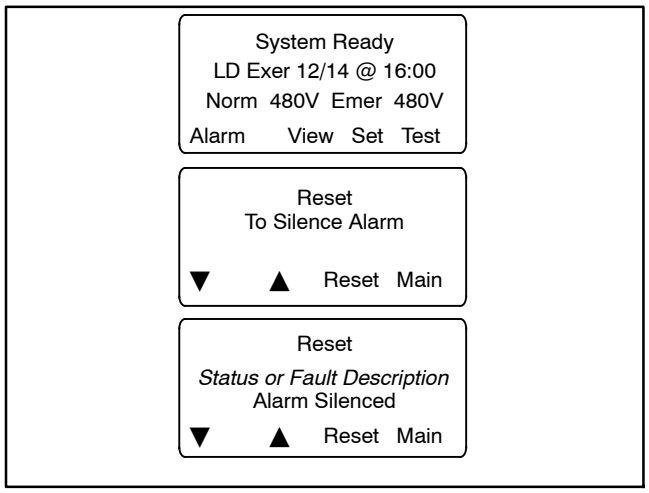


Figure 4-21 Alarm Silence

4.4 Load Shed (Forced Transfer to OFF)

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage will cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut down the generator set. (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.

The load shed (forced transfer to OFF) accessory must be factory-installed. The load shed accessory is available only on programmed-transition transfer switches. See Figure 4-22 for an illustration of the load shed acessory.

The load shed function requires an external signal (contact closure) to initiate transfer to the OFF position. Connect the external contact to input #1 (if available) or input #2 on connector TB1 on the main logic board. See Figure 4-23. Use #12–24 AWG wire and tighten to 0.5 Nm (4.4 in. lb.).

Use the Input/Output setup menu or Kohler SiteTech software to assign the connected input (Main Board Input #1 or #2) to the forced transfer to off function. If the external contact is connected to a different input connection on an optional I/O module, assign the forced transfer to off function to that input.

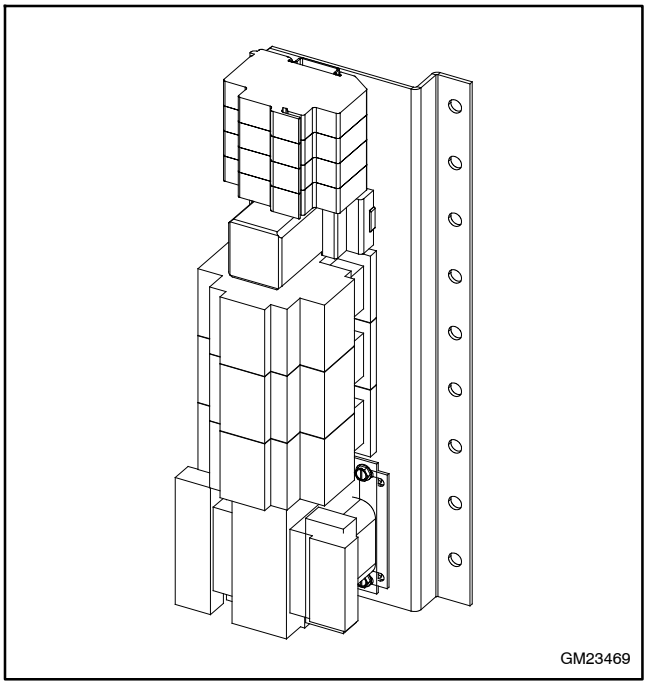
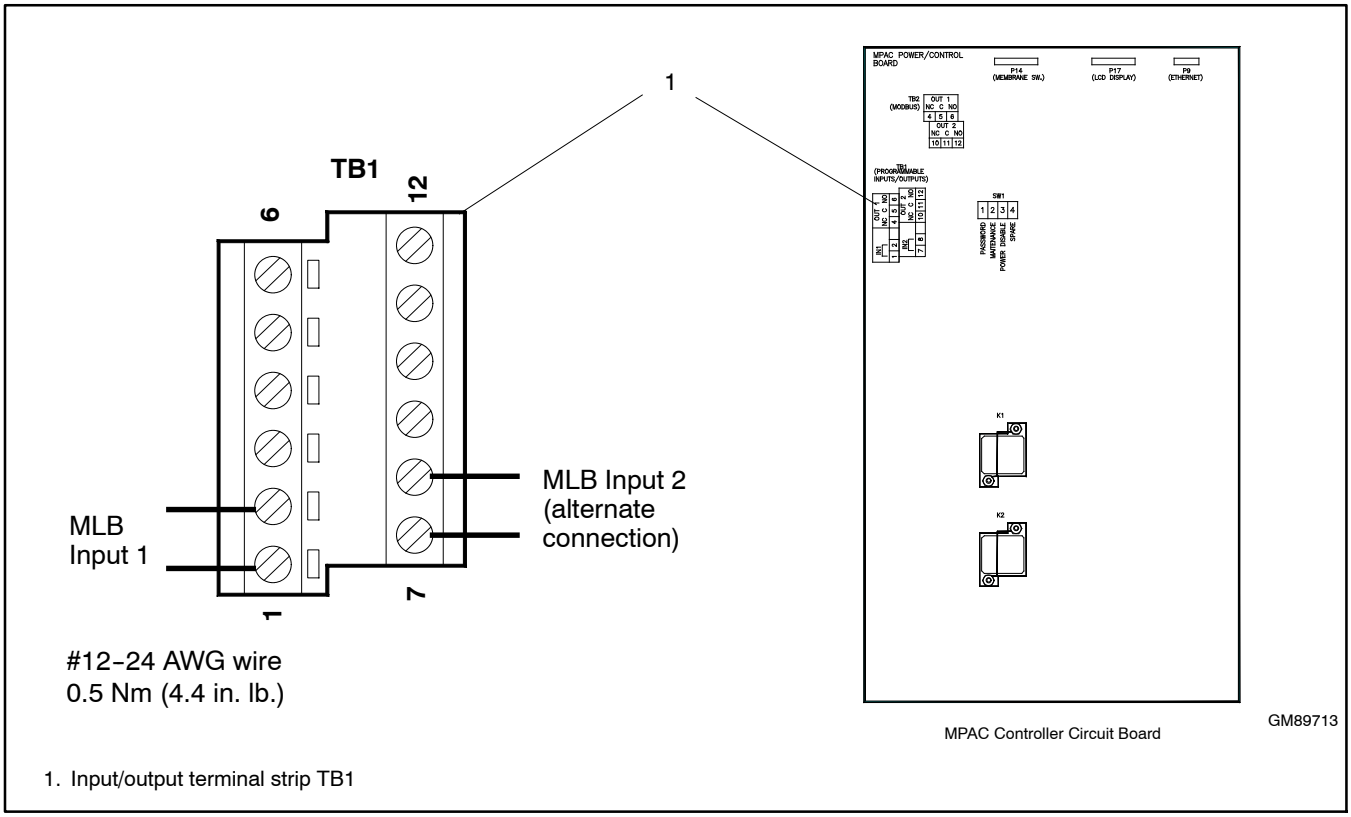


Figure 4-22 Load Shed Accessory (for identification)



1. Input/output terminal strip TB1

Figure 4-23 Forced Transfer to Off Input Connection (for factory-installed load shed kits)

4.5 Heater

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

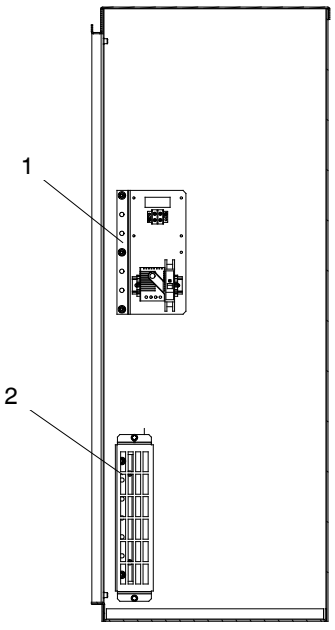
Disconnect all power sources before opening the enclosure.

Servicing the transfer switch. Hazardous voltage will cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut down the generator set. (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.

An anti-condensation heater kit is available. The strip heater is controlled by a hygrostat to raise the temperature inside the enclosure above the dew point to prevent condensation. Figure 4-24 shows a typical location of the heater kit components inside the enclosure.

The installer must connect 120 VAC power to the terminal block near the hygrostat. See Figure 4-25 and Figure 4-26. The heater and hygrostat are connected to power through a 15-amp circuit breaker.

The relative humidity setting on the hygrostat is adjustable from 35% to 95%. A setting of 65% is recommended.

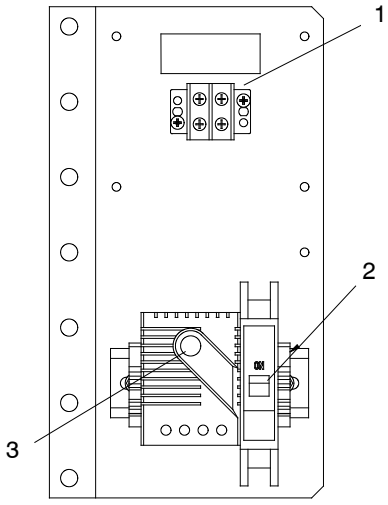


Right Side View

GM69824

1. Hygrostat assembly, see Figure 4-25
2. Strip heater with guard

Figure 4-24 Heater Location, Typical



GM71056

1. 120 VAC power connection terminal block
2. Circuit breaker
3. Relative humidity adjustment control

Figure 4-25 Hygrostat Assembly, Typical

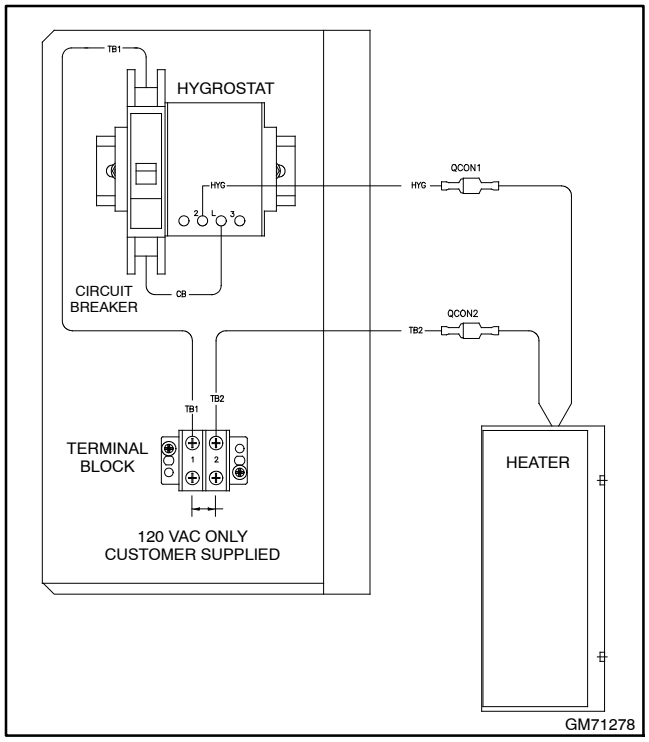


Figure 4-26 Heater Connections

4.6 Other Accessories

Refer to the following documentation for instructions to install, connect, and operate optional accessories.

- Transfer switch wiring diagrams.
- Installation instructions provided with loose accessory kits.
- Controller Operation Manual. See List of Related materials in the Introduction section of this manual for document numbers.

Notes

5.1 Introduction

Be sure to perform all of the functional tests described in this section before putting the transfer switch into operation.

The functional tests include the following checks:

- Manual Operation Test
- Voltage Checks
- Lamp Test
- 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 before proceeding.

To complete the installation, follow the instructions in this section to:

- Set the time, date, and exercise schedule on the controller.
- Perform the system startup procedures listed on the startup form.
- Register the unit using the Kohler® online Warranty Processing System.

5.2 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.

Manual operation instructions are given in Section 7. See the Table of Contents to locate the manual operation instructions for your unit.

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.

5.3 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.

Follow the instructions provided with the generator set to prepare the generator set for operation.

Verify the following before proceeding with the functional tests:

- The bypass handle is in the NORMAL position.
- The isolation handle is in the CONN position.
- The transfer switch Normal contacts are closed.
- The transfer switch Emergency contacts are open.

If the handles are not in the correct positions, follow the instructions for bypassing and isolating the switch. See the Table of Contents. Do not force the handles. Electrical interlocks prevent a wrong sequence of operation.

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. Verify that the source leads are connected to the correct lugs before proceeding.

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 will 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

1. If Source N is a generator set, move the generator set master switch to the RUN position. The generator set should start.
2. Close the Source N circuit breaker or switch.
3. 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.

4. 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 BAC, refer to the controller Operation Manual for instructions to change the phase rotation setting on the controller.

5. If the source is a generator set, stop the generator set by moving the master switch to the OFF position.
6. Disconnect Source N by opening upstream circuit breakers or switches.
7. Repeat steps 1 through 5 for Source E. Then proceed to step 8.
8. Disconnect both sources to the transfer switch by opening the circuit breakers or switches.
9. Close and lock the transfer switch enclosure door.
10. Reconnect both power sources by closing the circuit breakers or switches.
11. 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.

12. Perform the lamp test and then proceed to the automatic operation test.

5.4 Lamp Test

Refer to the controller Operation Manual for instructions to perform a lamp test. Verify that all controller LEDs or lamps light during the test.

5.5 Automatic Operation Test

Check the transfer switch's automatic control system immediately after the voltage check. Refer to the controller Operation Manual for instructions to run the automatic operation test.

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

5.6 System Setup

Set the controller's current time and date. See the controller Operation Manual for instructions.

The transfer switch is factory-set with default settings for time delays and other parameters. See the controller Operation Manual for instructions to view and change settings, if necessary.

Note: Use caution when changing transfer switch settings. The source voltage and frequency settings must match the values shown on the transfer switch nameplate.

5.7 Exerciser Setup

Set the exerciser to start and run the generator set at least once a week. See the controller Operation Manual for instructions.

5.8 User Interface Cover

The gasket-sealed, hinged user interface cover prevents unauthorized access to the transfer switch controls and protects the user interface from harsh environmental conditions. The cover is available as an optional accessory for NEMA 1 enclosures.

Use a customer-supplied padlock to lock the cover.

5.9 Startup Notification

Perform the system startup procedure explained on the Startup Notification Form. The Startup Notification Form covers all equipment in the power system. Complete the Startup Notification Form and register the power system using the Kohler® online Warranty Processing System.

Notes

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.

Have maintenance or service performed by a local authorized distributor/dealer. Maintenance and service must comply with all applicable codes and standards. See the Service Assistance section in this manual for how to locate a local distributor/dealer.

The transfer switch Operation Manual contains the Service Schedule and other maintenance information. Refer to the Operation Manual shipped with the transfer switch, or check which controller is used on your transfer switch and see Figure 6-1 for the Operation Manual part number.

Keep records of all maintenance or service.

Operation Manual	Part Number
Operation Manual, Decision-Maker® MPAC 1500 Controller	TP-6883

Figure 6-1 Operation Manuals

Notes

7.1 Introduction

The bypass and isolation handles allow transfer switch testing and service without interrupting power to the load. Read the information and instructions in Sections 7.1.1 and 7.1.2 before proceeding to the bypass and isolation procedures.

Note: To prevent confusion, set the preferred source selection (available if the ATS is equipped with the optional alarm module) to SOURCE N before beginning the bypass/isolation procedures. See the controller Operation Manual for instructions, if necessary.

7.1.1 Bypassing the Transfer Switch

The bypass handle allows direct connection of the source to the load, bypassing the transfer switch to provide power to the load during transfer switch service.

The bypass connection is open during normal transfer switch operation. Closing the bypass connection provides a direct connection to either the Normal or Emergency source. See Figure 7-1 and Figure 7-2. Check the transfer switch position and bypass to the source that is connected to the automatic transfer switch (ATS) at the time.

Note: Bypass to the source that is connected to the load, as indicated by the Transfer Switch Position indicator. Interlocks prevent bypassing to the wrong source; do not force the bypass handle.

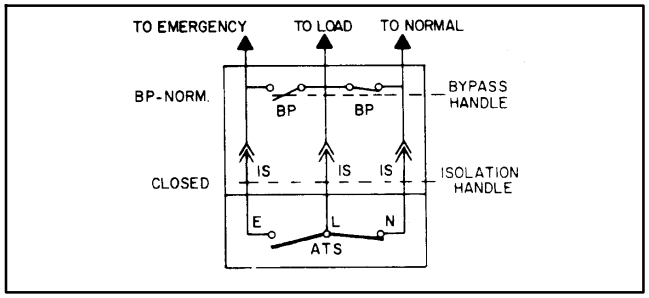


Figure 7-1 Bypass to Normal

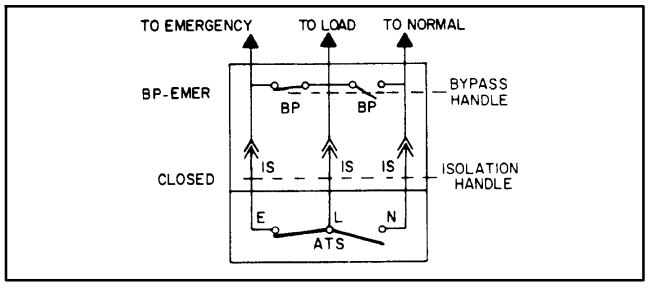


Figure 7-2 Bypass to Emergency

The bypass handle positions are labeled Normal and Emergency. Transfer switches equipped with the alarm module have a preferred source selection that allows selection of either source as preferred. The preferred source selection does *not* affect the bypass handle positions. Do not confuse the *preferred* source with the source connected to the Normal side of the power switching device in the following procedures.

7.1.2 Isolating the Transfer Switch

Isolation removes the transfer switch from the power circuit. Always bypass the transfer switch before moving the isolation handle to the TEST or OPEN position. In the TEST position, the isolation contacts disconnect the transfer switch from the load but maintain transfer switch connections to the sources, allowing transfer switch testing without load. See Figure 7-3. In the OPEN position, the isolation contacts disconnect the transfer switch from the load and from both sources, allowing transfer switch service. See Figure 7-4.

For normal ATS operation, the isolation handle should be in the CLOSED position. In the CLOSED position, the ATS isolation contacts are fully engaged with both sources and the load.

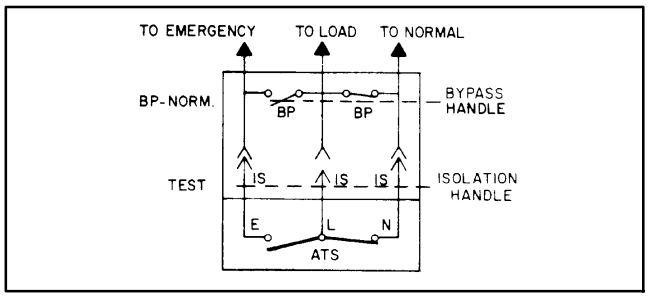


Figure 7-3 Isolate to Test (load contacts are disengaged but sources are connected)

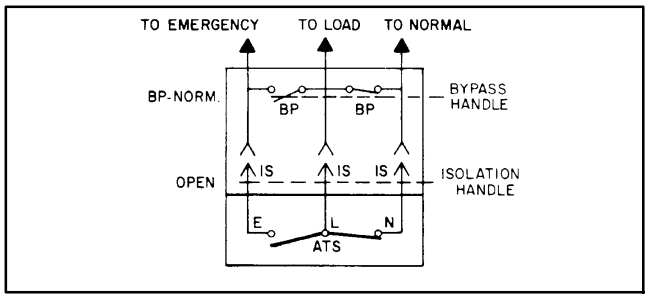


Figure 7-4 Isolate to Open (isolation contacts are all disengaged)

7.2 150–600 Amp Models

Read the information and instructions in Sections 7.1.1 and 7.1.2 before proceeding.

7.2.1 Bypassing the ATS, 150–600 Amp Models

This procedure explains how to bypass the closed transfer switch contacts. Bypassing is required before the transfer switch can be tested or isolated.

- The bypass switch handle must be in the OPEN position (green window indicator). See Figure 7-5.
- The Isolation Handle must be in the CONN (connected) position. Check the position window indicator. See Figure 7-6.
- The TS Connected light must be on. See Figure 7-7 and Figure 7-8.

Note: You can only bypass to the same source that is connected to the transfer switch. A solenoid interlock prevents connection to the wrong source.

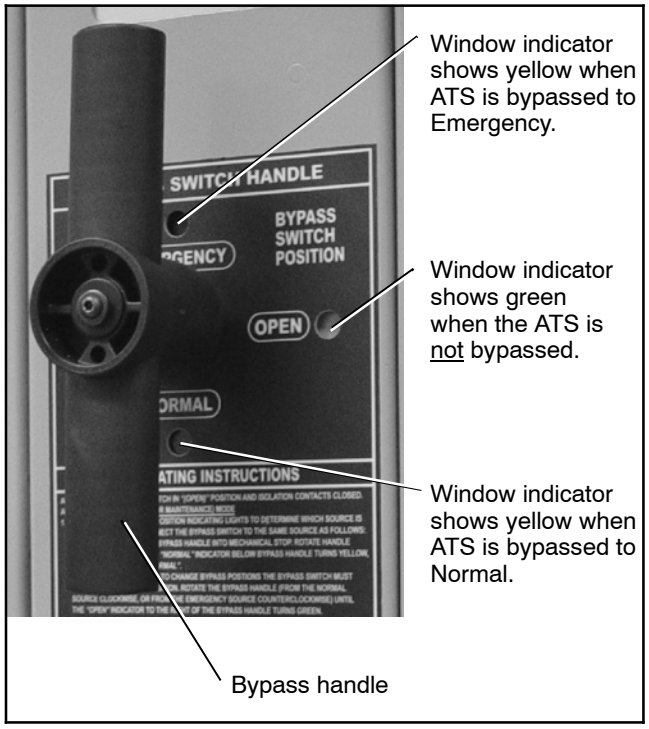


Figure 7-5 Bypass Handle and Three-Position Window Indicators

Figure 7-6 Isolation Handle in CONN Position

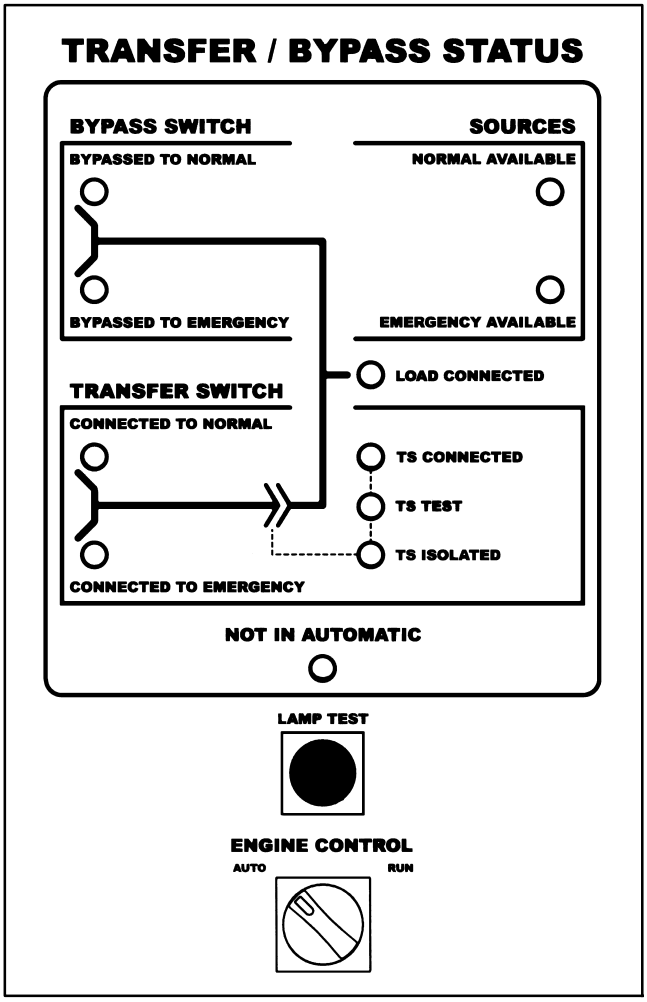


Figure 7-7 Status Lights and Engine Control

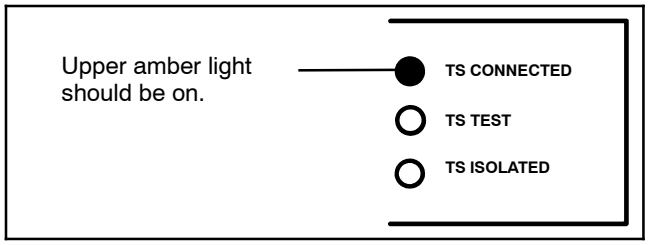


Figure 7-8 Status Lights for Transfer Switch Isolation Contact Position

1. Observe which *Transfer Switch Connected To* light is on (*Normal* or *Emergency)* on the door. This is the position of the transfer switch. See Figure 7-9.

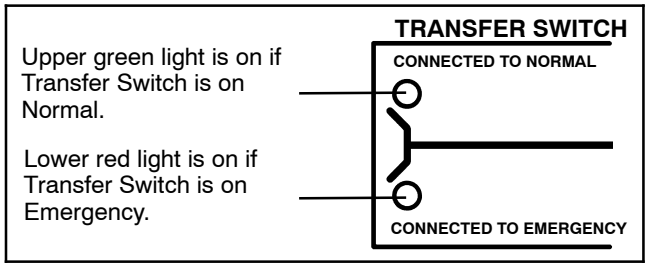


Figure 7-9 Status Lights for Transfer Switch Main Contact Position

2. Use the following procedures to bypass to the same source as connected to the transfer switch (select Normal or Emergency).

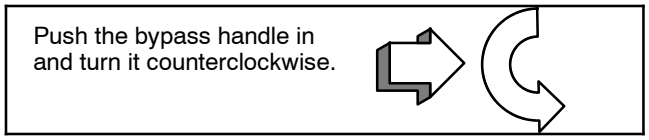
Figure 7-10 shows allowable positions of the bypass switch in relation to positions of the transfer switch (with isolation handle in the *Conn* [connected] position and *TS Connected* light on).

Transfer Switch Position	Bypass Switch can be in either
Normal	Open or Normal
Emergency	Open or Emergency

Figure 7-10 Allowable Bypass Switch Position

Procedure to Bypass to Normal Source (connect load to normal source)

The Transfer Switch Connected To Normal light is on. The Transfer Switch Connected To Emergency light is off.



Push the bypass handle all the way in, then turn it counterclockwise until *Bypass Switch Position* shows closed on NORMAL (yellow window indicator). The green *Bypassed to Normal* light will come on and the amber *Not In Automatic* light will flash. See Figure 7-11 and Figure 7-12.

The automatic transfer switch can now be put in the TEST or OPEN position. See Section 7.2.2, Isolating the Transfer Switch.

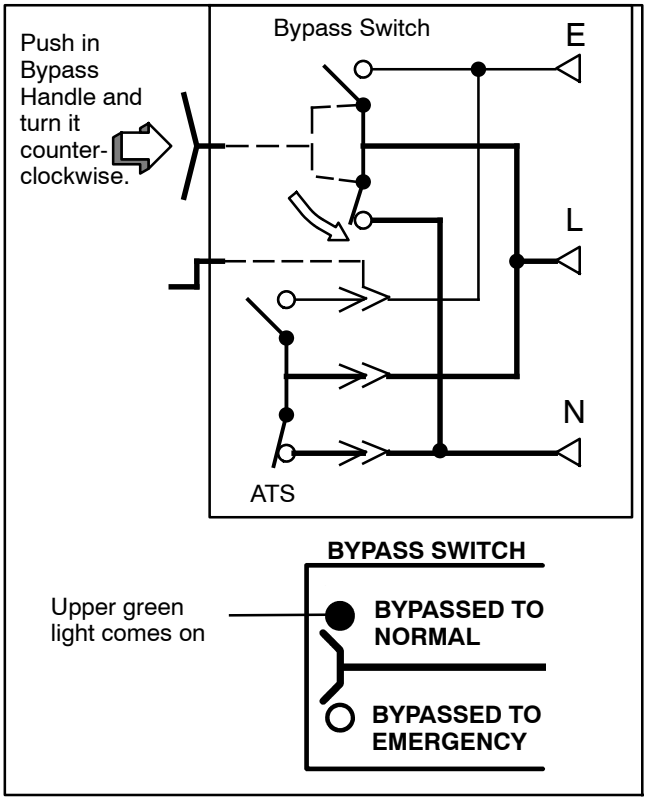


Figure 7-11 Bypass to Normal Diagram

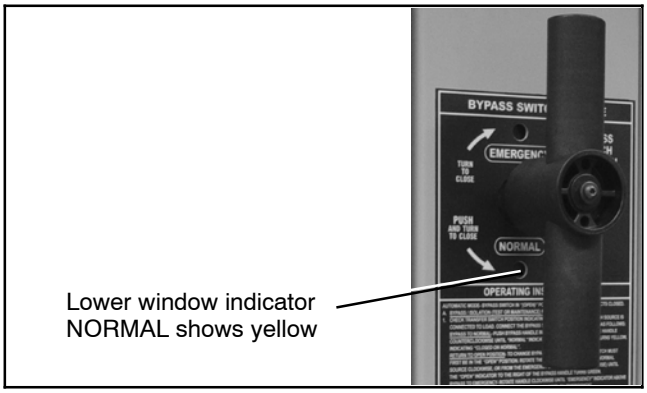


Figure 7-12 Status Light and Window Indicator for Bypassed to Normal Source

Procedure to Bypass to Emergency Source (connect load to emergency source)

The Transfer Switch Connected To Emergency light is on. Transfer Switch Connected To Normal light is off.

Turn the bypass handle clockwise.

Turn the Bypass Handle clockwise until bypass switch position shows closed on EMERGENCY (yellow window indicator). See Figure 7-13 and Figure 7-14. The red Bypassed to Emergency light will come on and the amber Not In Automatic light will flash.

The automatic transfer switch can now be put in *TEST* or *OPEN* position. See Section 7.2.2, Isolating the Transfer Switch.

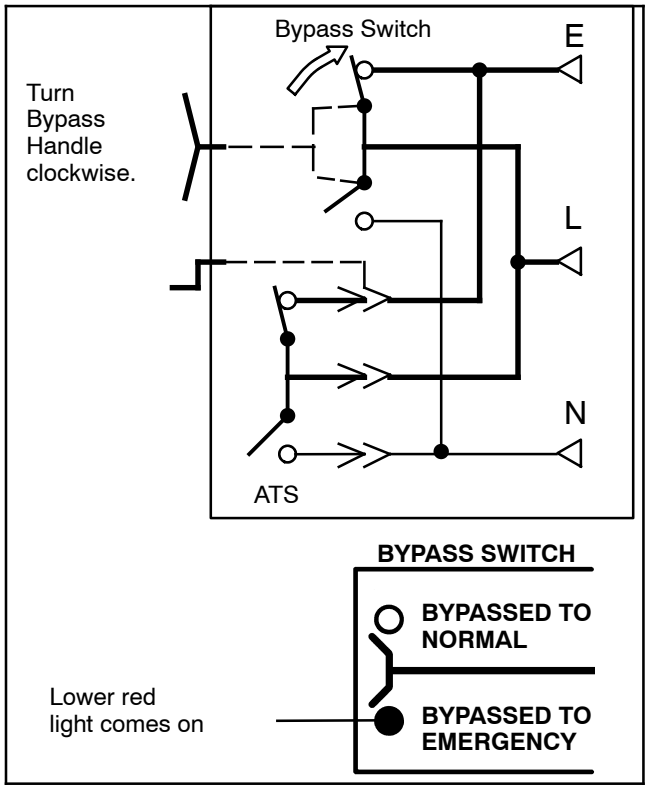


Figure 7-13 Bypass to Emergency Diagram

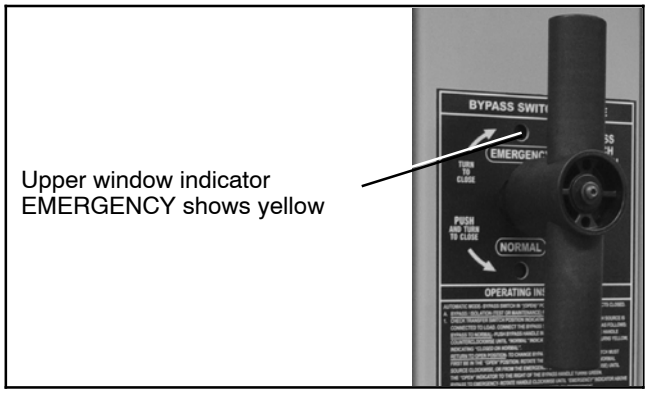


Figure 7-14 Status Light and Window Indicator for Bypassed to Emergency Source

7.2.2 Isolating the Transfer Switch, 150-600 Amp Models

Isolate the transfer switch before performing any service work on the automatic transfer switch (ATS). Refer to Figure 7-15 through Figure 7-18.

1. Bypass the closed automatic transfer switch contacts. See Section 7.2.1, Bypassing ATS.

2. Turn the Isolation Handle counterclockwise (approx. 8 turns) until window shows *TEST*. See Figure 7-15 and Figure 7-16. The *TS Test* amber light should come on (Figure 7-16). The ATS can be tested now without load interruption.

Note: In the TEST position the transfer switch solenoid operator circuit is energized through secondary disconnects.

Figure 7-15 Isolation Handle Turned to TEST

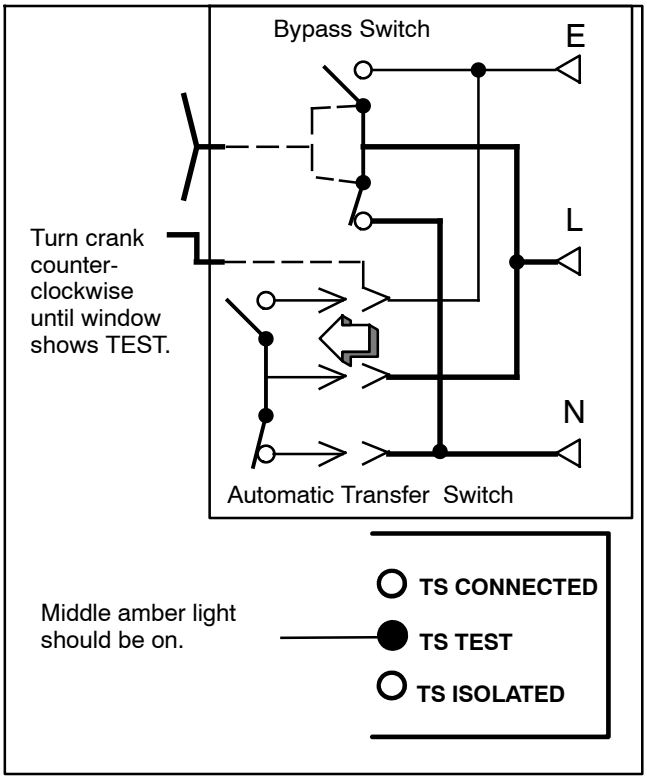


Figure 7-16 CONNECTED to TEST position

3. Continue turning the Isolation Handle counterclockwise (approx. 6 turns) until the window shows ISOLATE. See Figure 7-17. The amber TS Isolated light should come on. See Figure 7-18.

Figure 7-17 Isolation Handle Turned to ISOLATE.

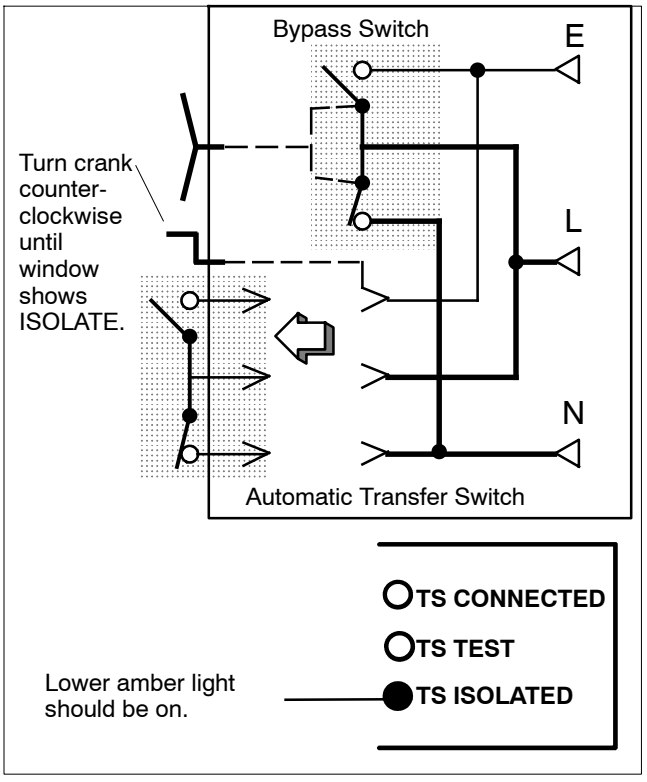


Figure 7-18 From TEST to ISOLATE Position

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage will cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

⚠ 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.

Note: The transfer switch weighs about 55 kg (120 lb.) depending upon the number of poles. Use lifting equipment capable of lifting this weight. Two persons are recommended.

4. Open the lower enclosure door. Pull out both left and right side rails then use the two handles to roll out the transfer switch. It can be safely inspected in this position. The transfer switch can also be removed for easier maintenance operations. See Figure 7-19 or Figure 7-20.

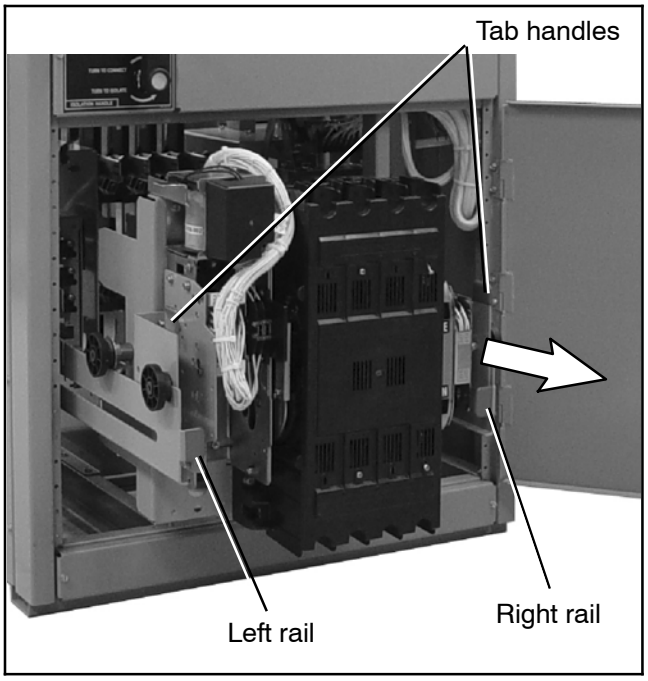


Figure 7-19 Transfer Switch Isolated and Pulled Out for Inspection (standard-transition model)

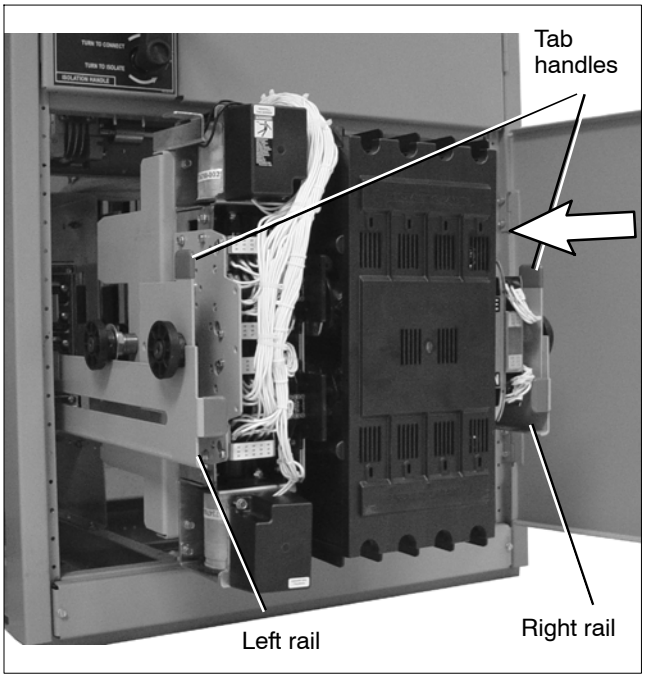


Figure 7-20 Transfer Switch Isolated and Pulled Out for Inspection (programmed- or closed- transition model)

7.2.3 Return to Service, 150–600 Amp Models

This procedure explains how to return the automatic transfer switch (ATS) to service after inspection and maintenance. Observe the bypass switch position indicator and lights.

1. Use the two handles to roll the transfer switch into the enclosure (isolation contacts facing inward) until its crank pins engage the latch plates on both sides. See Figure 7-19 or Figure 7-20. Next push in both side rails and close the enclosure door.

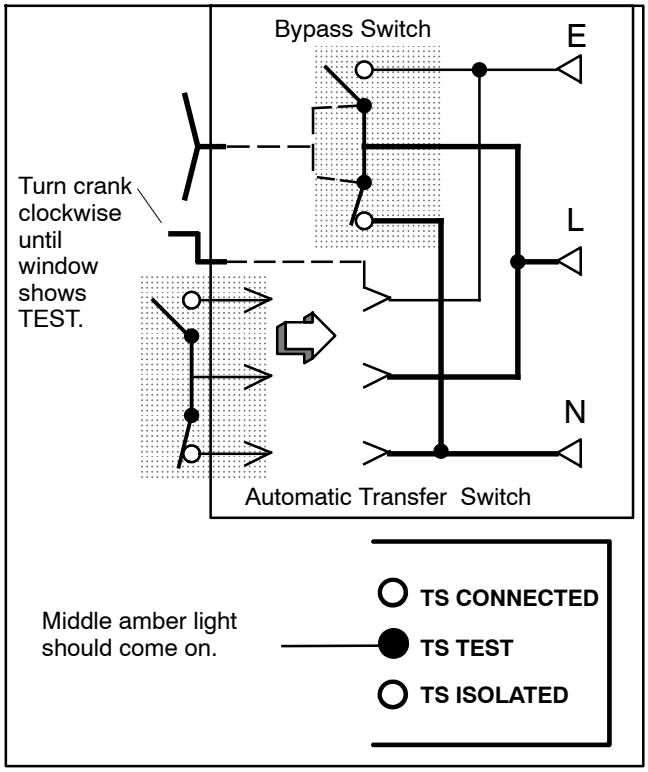


Figure 7-21 From ISOLATE to TEST Position

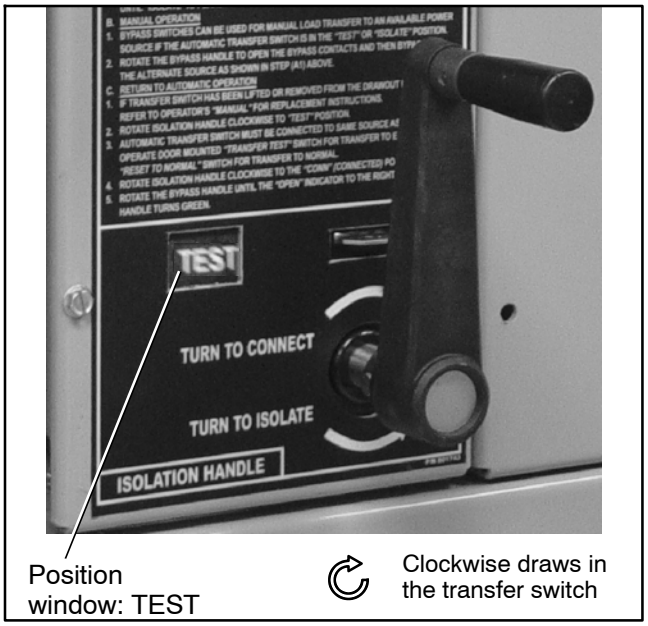


Figure 7-22 Isolation Handle Turned to TEST

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

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

2. Turn the Isolation Handle clockwise (approx. 6 turns) until the window shows TEST and TS TEST light comes on. See Figure 7-21 and Figure 7-22.

   Note: The ATS can be tested now without load interruption.

3. Observe which bypass switch position window indicator is yellow (NORMAL or EMERGENCY) at the bypass switch handle. This indicates the source connected to the load.

   Note: A solenoid interlock prevents you from closing the isolation contacts until the ATS is in the *same* position as the bypass switch.

4. Observe which Transfer Switch Connected To light is on (Normal or Emergency) on the door. This is the position of the transfer switch. If it is *not* in the same position as the bypass handle, change the position of the transfer switch as shown in Figure 7-23.

Operate to NORMAL	Operate to EMERGENCY *
Turn **Transfer Control** switch to Retransfer Delay Bypass.	Turn **Transfer Control** switch to Transfer Test (hold 15 seconds).
Connected To Normal light should come on.	Connected To Emergency light comes on.
* With Normal available, the automatic transfer switch will return to the Normal position after the retransfer time delay.	

Figure 7-23 Changing Transfer Switch Position

   Note: Do not close the isolation contacts unless the transfer switch (ATS) and bypass switch are in the same position!

5. When the transfer switch is in the *same* position as the bypass switch handle, continue turning the isolation handle clockwise (about 8 turns) until the window shows CONN (connected).

Figure 7-24 Isolation Handle Turned to CONN

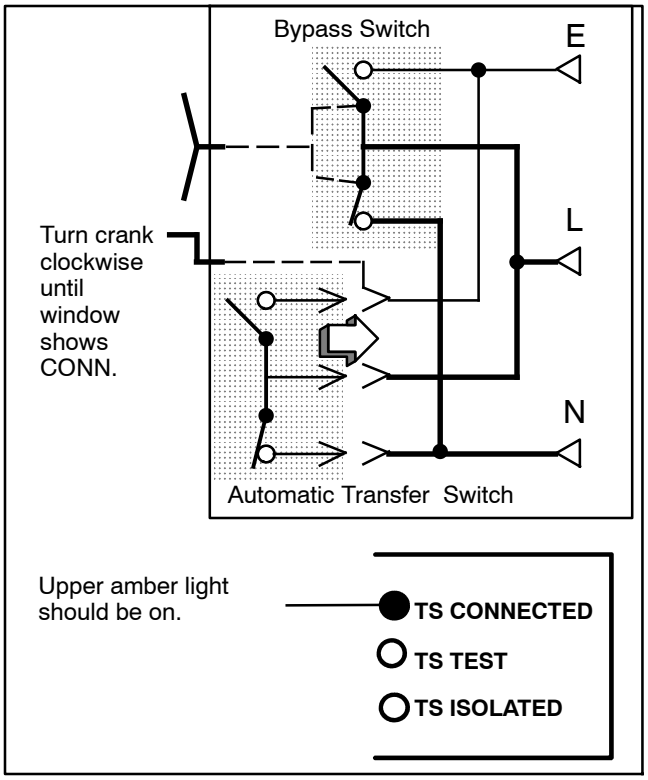


Figure 7-25 TEST to CONN (Connected) Position

7.2.4 Return Bypass Switch to OPEN, 150-600 Amp Models

This procedure explains how to return the bypass switch handle to the OPEN position. The bypass handle must be in the CLOSED position (yellow indicator on NORMAL or EMERGENCY) and the isolation handle must be in the CONN position (window). See Figure 7-26, Figure 7-27, and Figure 7-28.

Note: You can only bypass to the same source that is connected to the ATS. A solenoid interlock prevents incorrect operation.

1. Observe which bypass switch position indicator is yellow (NORMAL or EMERGENCY) at the bypass switch handle. This indicates the source connected to the load. See Figure 7-26.

2. Turn the bypass handle to open the bypass as directed in the following procedures (select Normal or Emergency according to the bypass position indicator).

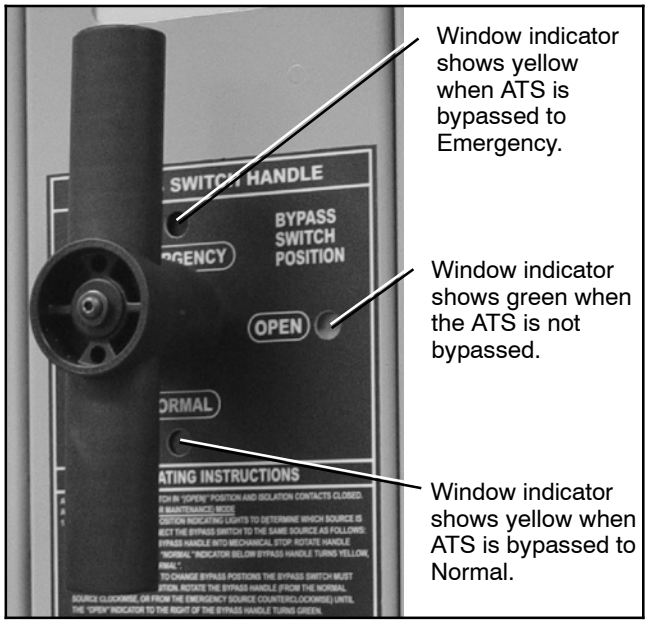


Figure 7-26 Bypass Handle and Position Indicators

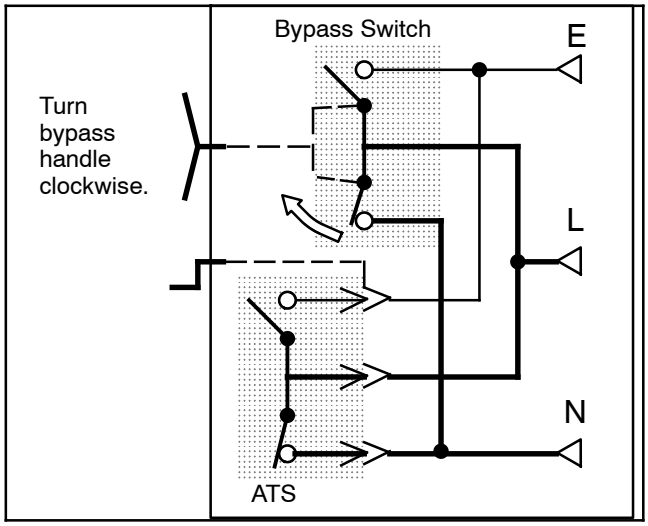


Figure 7-27 Opening Bypass to Normal

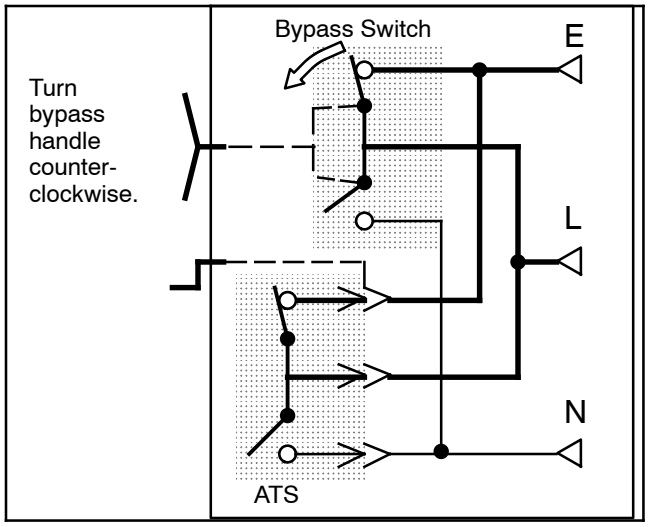
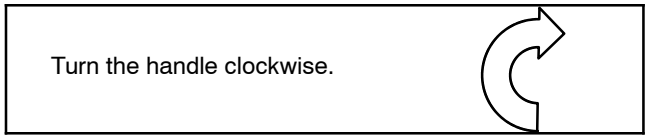


Figure 7-28 Opening Bypass to Emergency

To Open the Bypass when Connected to the Normal Source

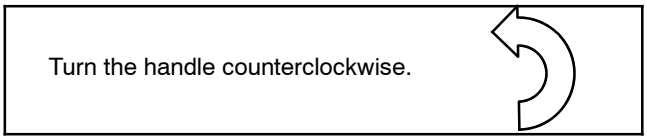
The Transfer Switch Connected To Normal light is on. The Transfer Switch Connected To Emergency light is off.



Turn the bypass handle clockwise until the bypass switch position shows OPEN (green window indicator). See Figure 7-26. The Bypassed to Normal light should go off and the Not In Automatic light should go off. The automatic transfer and bypass/isolation switch should be left in this position.

To Open the Bypass when Connected to the Emergency Source

The Transfer Switch Connected To Emergency light is on. The Transfer Switch Connected To Normal light is off.



Turn the bypass handle counterclockwise until the bypass switch position shows OPEN (green window indicator). See Figure 7-26. The Bypassed to Emergency light should go off and the Not In Automatic light should go off. The automatic transfer and bypass/isolation switch should be left in this position.

7.2.5 Manual Load Transfer, 150–600 Amp Models

The following procedure manually transfers the load to the other source if the transfer switch or controller are out of service.

Note: Close and secure the enclosure door before performing this procedure.

1. Bypass to the connected source. Turn the bypass handle to EMERGENCY or NORMAL. See Section 7.2.1.

2. Turn the isolation handle to the TEST position. See Section 7.2.2.

3. Turn the bypass handle to OPEN, then to the other source. The load will be interrupted.

To return to automatic operation, follow the instructions in Section 7.2.3, Return to Service.

7.3 800–1200 Amp Models

Read the information and instructions in Sections 7.1.1 and 7.1.2 before proceeding.

7.3.1 Bypassing the ATS, 800–1200 Amp Models

This procedure explains how to bypass the closed transfer switch contacts. Bypassing is required before the transfer switch can be tested or isolated.

- The bypass switch handle must be in the OPEN position (green window indicator). See Figure 7-29.
- The Isolation Handle must be in the CONN (connected) position. Check the position window indicator. See Figure 7-31.
- The TS Connected light must be on. See Figure 7-30 and Figure 7-32.

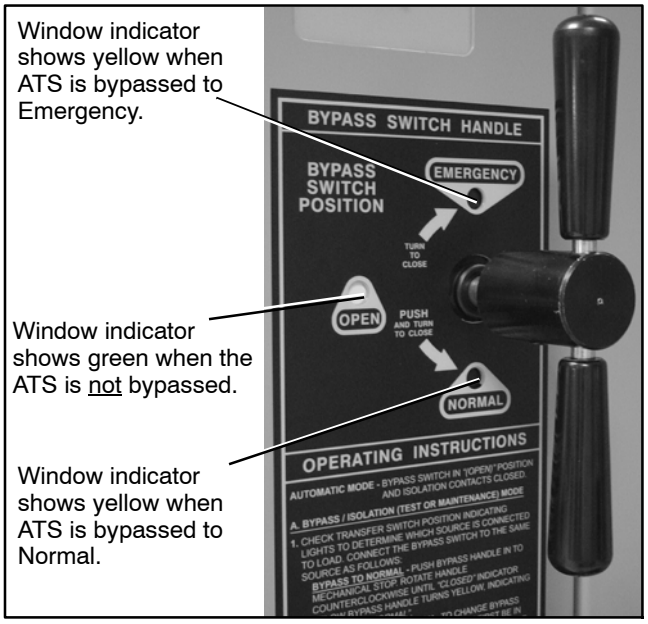


Figure 7-29 Bypass Handle and Three Position Window Indicators

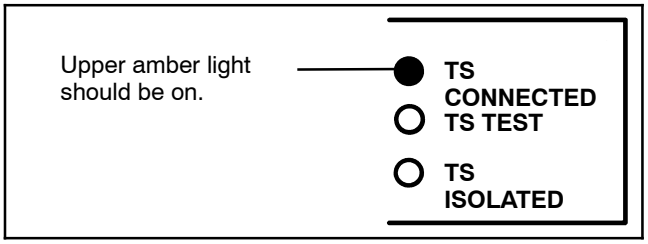


Figure 7-30 Status Lights for Transfer Switch Isolation Contact Position

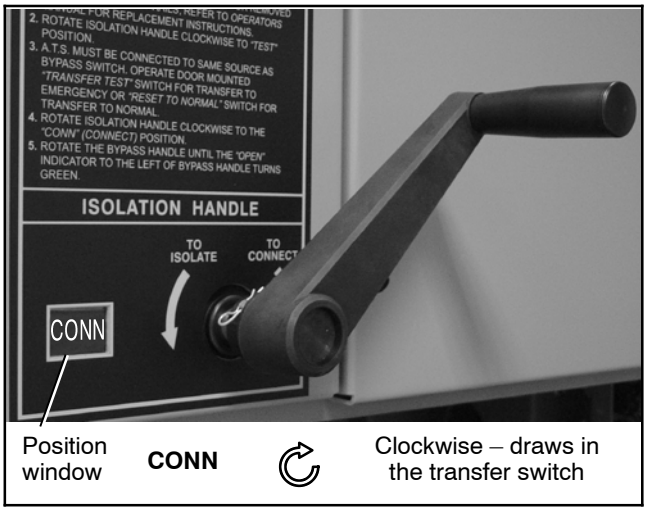


Figure 7-31 Isolation Handle in CONN Position

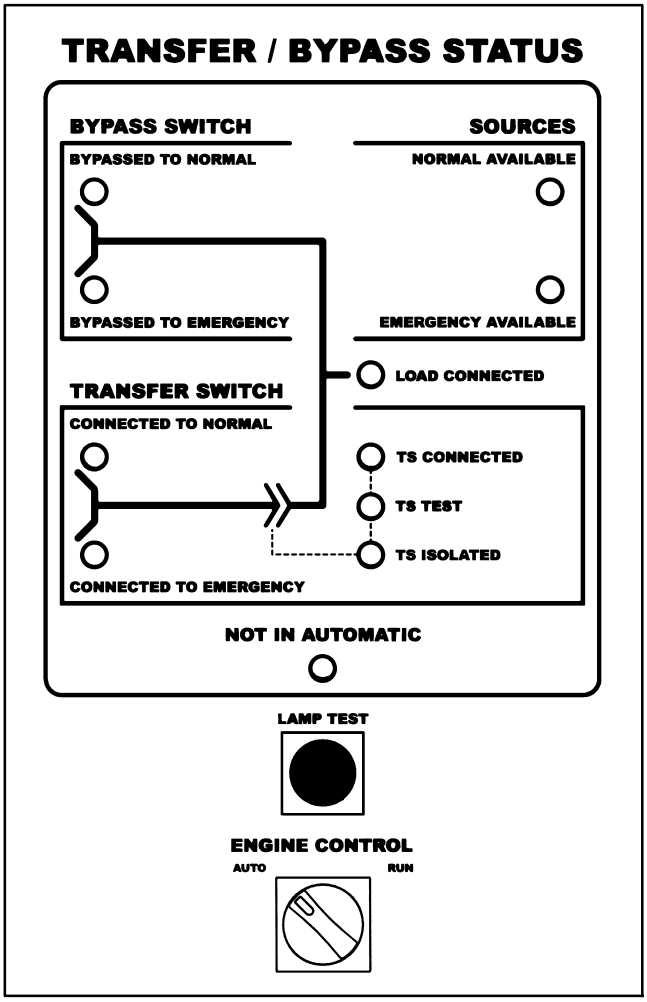


Figure 7-32 Status Lights and Engine Control

Note: You can only bypass to the same source that is connected to the transfer switch. A solenoid interlock prevents connection to the wrong source.

1. Observe which *Transfer Switch Connected To* light is on (*Normal* or *Emergency)* on the door. This is the position of the transfer switch. See Figure 7-33.

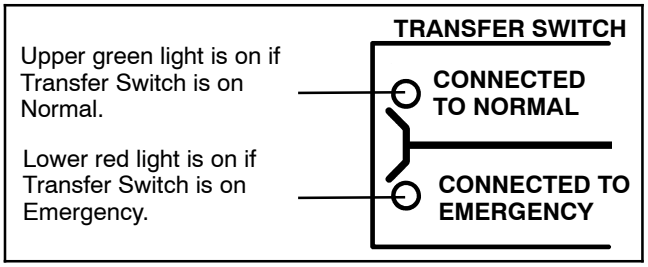


Figure 7-33 Status Lights for Transfer Switch Main Contact Position

2. Use the following procedures to bypass to the same source as connected to the transfer switch (select Normal or Emergency).

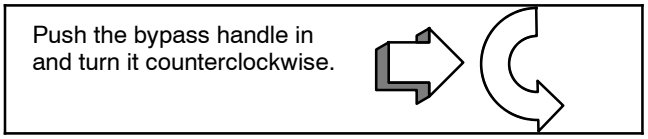
Figure 7-34 shows allowable positions of the bypass switch in relation to positions of the transfer switch (with isolation handle in the *Conn* [connected] position and *TS Connected* light on).

Transfer Switch Position	Bypass Switch can be in either
Normal	Open or Normal
Emergency	Open or Emergency

Figure 7-34 Allowable Bypass Switch Position

Procedure to Bypass to Normal Source (connect load to normal source)

The Transfer Switch Connected To Normal light is on. The Transfer Switch Connected To Emergency light is off.



Push the bypass handle all the way in, then turn it counterclockwise until *Bypass Switch Position* shows closed on NORMAL (yellow window indicator). The green *Bypassed to Normal* light will come on and the amber *Not In Automatic* light will flash. See Figure 7-35 and Figure 7-36.

The automatic transfer switch can now be put in the TEST or OPEN position. See Section 7.3.2, Isolating ATS.

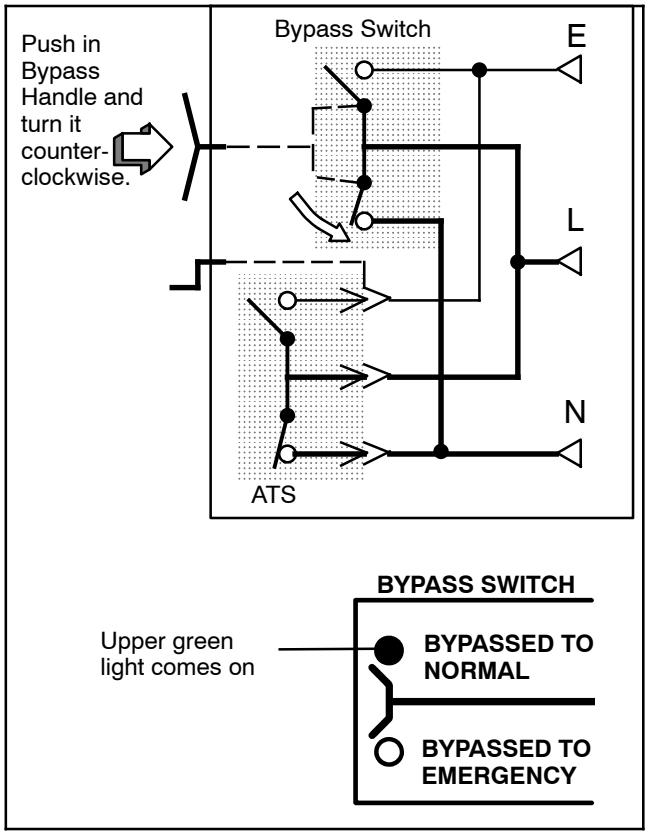


Figure 7-35 Bypass to Normal Diagram

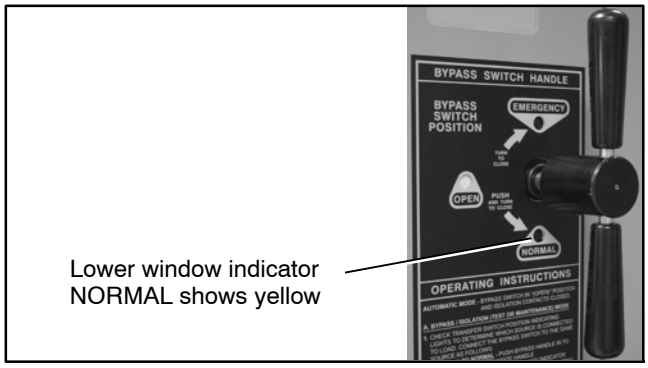


Figure 7-36 Status Light and Window Indicator for Bypassed to Normal Source

Procedure to Bypass to Emergency Source (connect load to emergency source)

The Transfer Switch Connected To Emergency light is on. Transfer Switch Connected To Normal light is off.

Turn the bypass handle clockwise.

Turn the Bypass Handle clockwise until bypass switch position shows closed on EMERGENCY (yellow window indicator). See Figure 7-37 and Figure 7-38. The red Bypassed to Emergency light will come on and the amber Not In Automatic light will flash.

The automatic transfer switch can now be put in *TEST* or *OPEN* position. See Section 7.3.2, Isolating ATS.

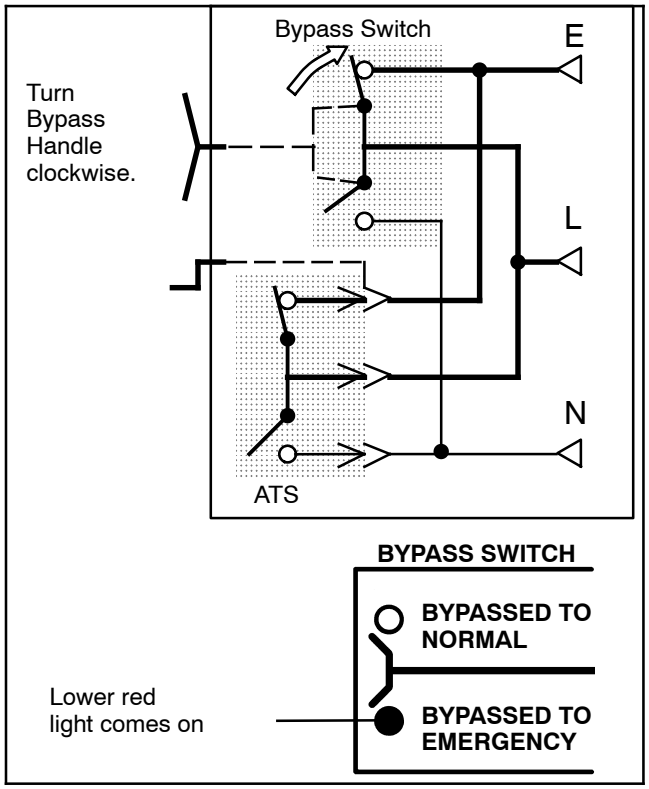


Figure 7-37 Bypass to Emergency Diagram

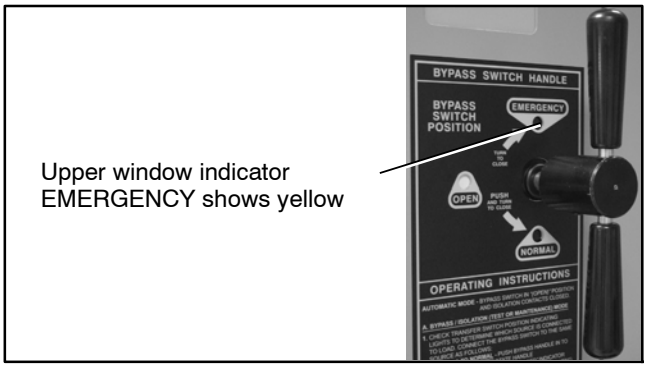


Figure 7-38 Status Light and Window Indicator for Bypassed to Emergency Source

7.3.2 Isolating the ATS, 800–1200 Amp Models

Isolate the transfer switch before performing any service work on the automatic transfer switch (ATS). Refer to Figure 7-39 through Figure 7-42.

1. Bypass the closed automatic transfer switch contacts. See Section 7.3.1 for instructions.

2. Turn the Isolation Handle counterclockwise (approx. 8 turns) until window shows *TEST*. See Figure 7-39. The *TS Test* amber light should come on (Figure 7-40). The ATS can be tested now without load interruption.

Note: In the TEST position the transfer switch solenoid operator circuit is energized through secondary disconnects.

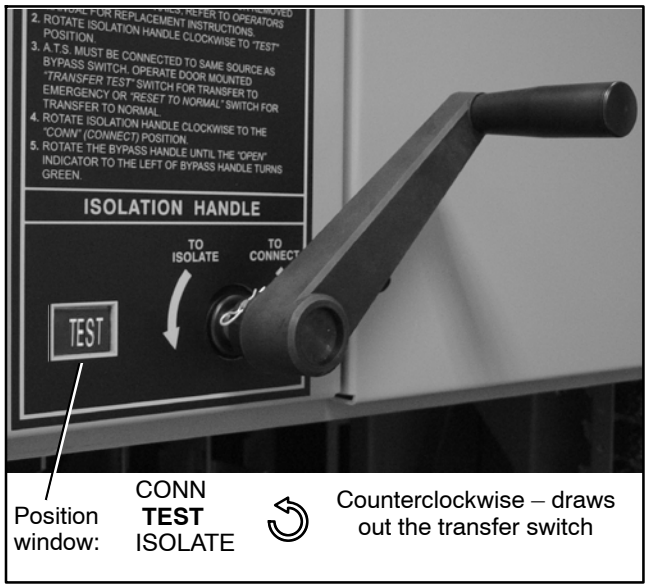


Figure 7-39 Isolation Handle Turned to TEST

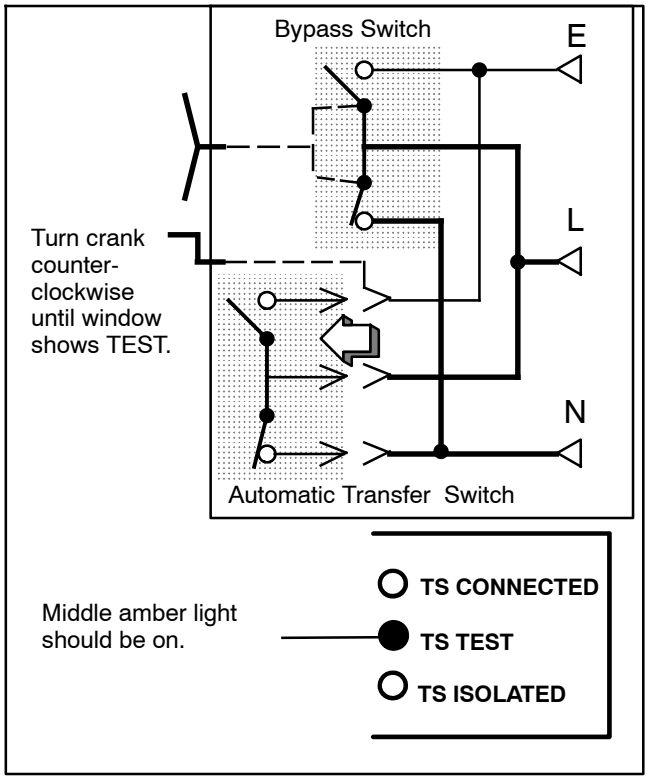


Figure 7-40 CONNECTED to TEST position

3. Continue turning the Isolation Handle counterclockwise (approx. 6 turns) until the window shows ISOLATE. See Figure 7-41. The amber TS Isolated light should come on (Figure 7-42).

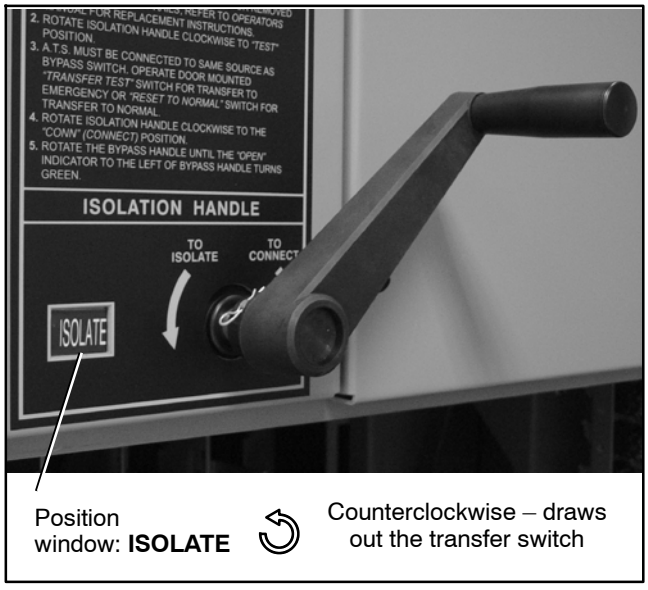


Figure 7-41 Isolation Handle Turned to ISOLATE.

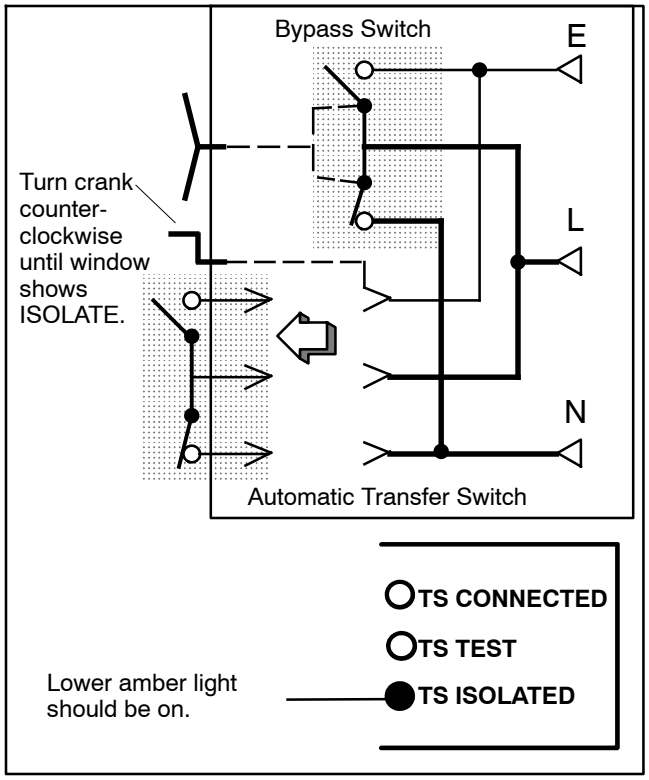


Figure 7-42 From TEST to ISOLATE Position

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Removing the transfer switch from bypass/isolation models. Hazardous voltage will cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

Note: The transfer switch weighs 59–90 kg (130–200 lb.) depending upon the number of poles.

4. Open the lower enclosure door. Pull out both left and right side rails then use the two handles to roll out the transfer switch. It can be safely inspected in this position. See Figure 7-43.

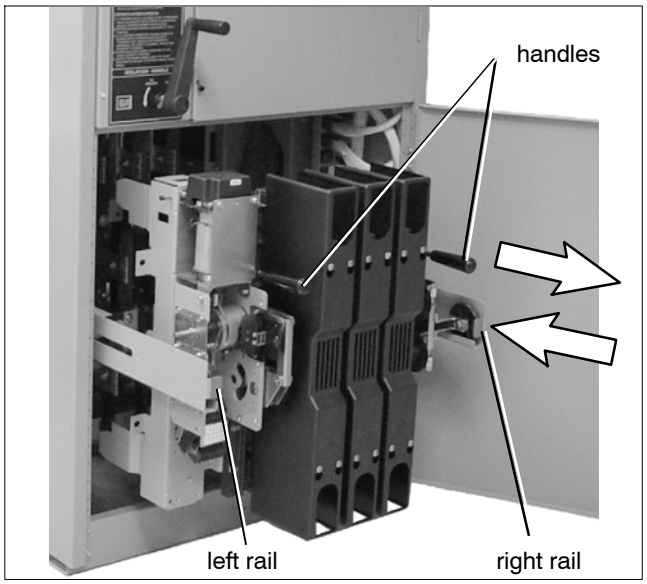


Figure 7-43 Transfer Switch Isolated and Pulled Out for Inspection

⚠ 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.

5. The transfer switch can also be removed for easier maintenance operations. If it is necessary to lift the transfer switch, use lifting equipment capable of lifting the weight. Two persons are recommended.

7.3.3 Return to Service, 800–1200 Amp Models

This procedure explains how to return the automatic transfer switch (ATS) to service after inspection and maintenance. Observe the bypass switch position indicator and lights.

1. Use the two handles to roll the transfer switch into the enclosure (isolation contacts facing inward) until its crank pins engage the latch plates on both sides. See Figure 7-43. Next push in both side rails and close the enclosure door.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

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

2. Turn the Isolation Handle clockwise (approx. 6 turns) until the window shows TEST and TS TEST light comes on. See Figure 7-44 and Figure 7-45.

The ATS can be tested now without load interruption.

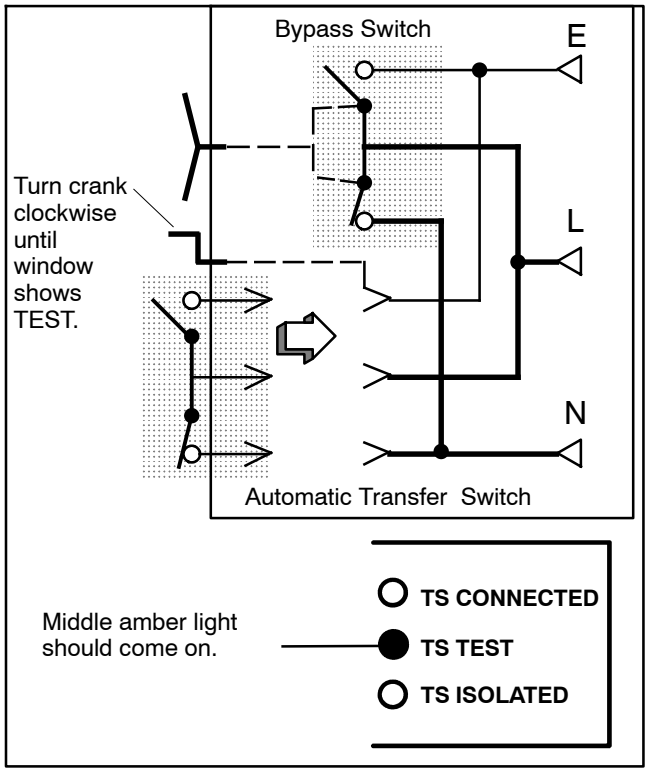


Figure 7-44 From ISOLATE to TEST Position

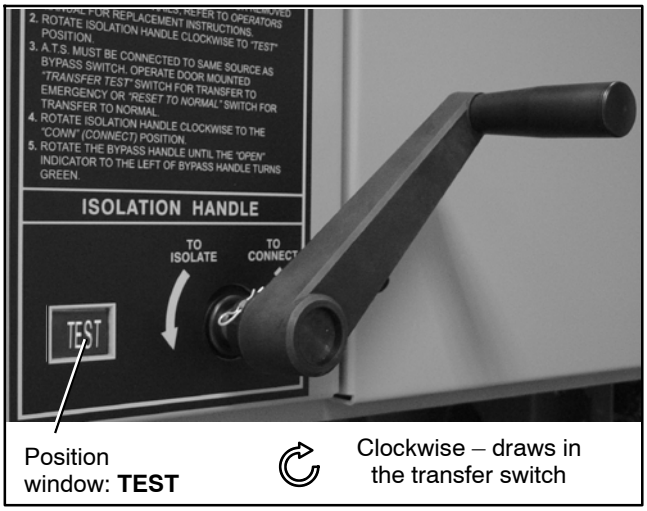


Figure 7-45 Isolation Handle Turned to TEST

3. Observe which bypass switch position window indicator is yellow (NORMAL or EMERGENCY) at the bypass switch handle. This indicates the source connected to the load.

Note: A solenoid interlock prevents you from closing the isolation contacts until the ATS is in the *same* position as the bypass switch.

4. Observe which *Transfer Switch Connected To* light is on (Normal or Emergency) on the door. This is the position of the transfer switch. If it is *not* in the same position as the bypass handle, change the position of the transfer switch as shown in Figure 7-46.

Operate to NORMAL	Operate to EMERGENCY *
Turn **Transfer Control** switch to Retransfer Delay Bypass.	Turn **Transfer Control** switch to Transfer Test (hold 15 seconds).
Connected To Normal light should come on.	Connected To Emergency light comes on.
* With Normal available, the automatic transfer switch will return to the Normal position after the retransfer time delay.	

Figure 7-46 Changing Transfer Switch Position

Note: Do not close the isolation contacts unless the transfer switch (ATS) and bypass switch are in the same position!

5. When the transfer switch is in the *same* position as the bypass switch handle, continue turning the isolation handle clockwise (about 8 turns) until the window shows CONN (connected). See Figure 7-47 and Figure 7-48.

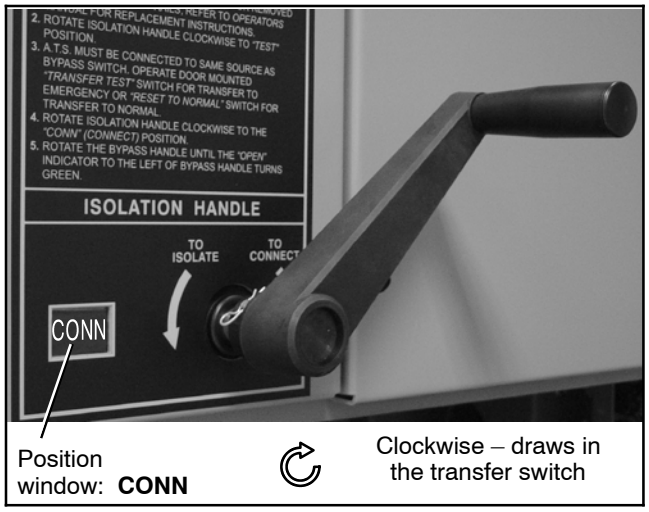


Figure 7-47 Isolation Handle Turned to CONN

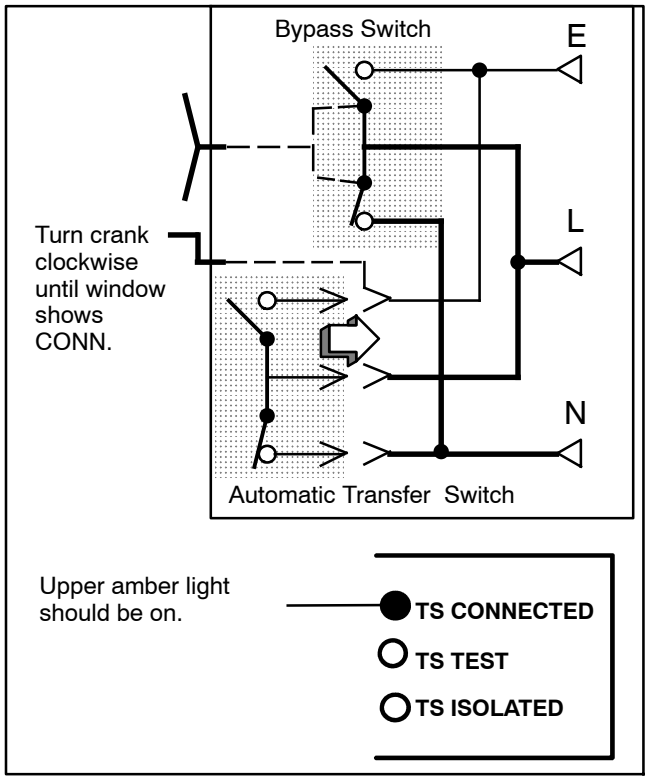


Figure 7-48 TEST to CONN (Connected) Position

7.3.4 Return Bypass Switch to OPEN, 800–1200 Amp Models

This procedure explains how to return the bypass switch handle to the OPEN position. The bypass handle must be in the CLOSED position (yellow indicator on NORMAL or EMERGENCY) and the isolation handle must be in the CONN position (window). See Figure 7-49, Figure 7-50, and Figure 7-51.

Note: You can only bypass to the same source that is connected to the ATS. A solenoid interlock prevents incorrect operation.

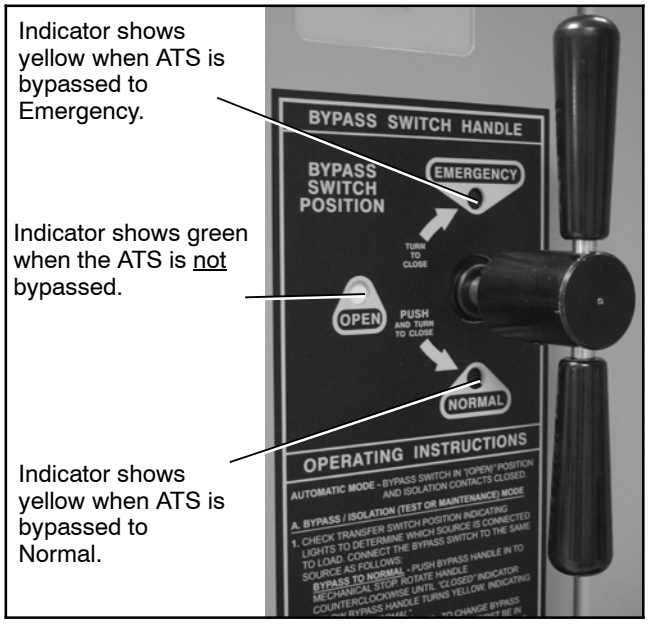


Figure 7-49 Bypass Handle and Position Indicators

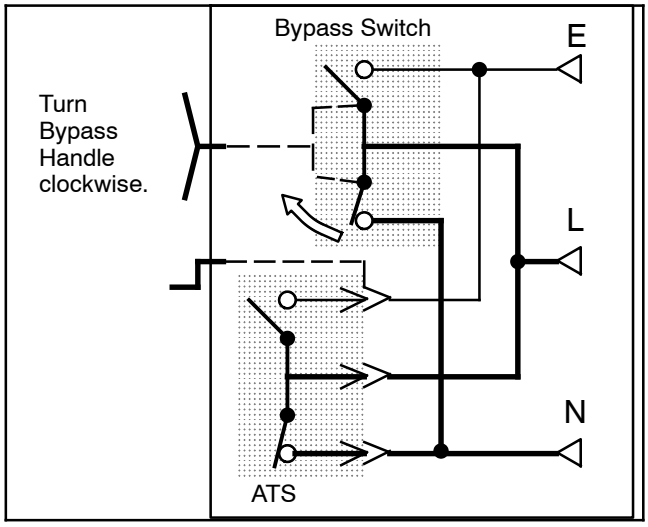


Figure 7-50 Opening Bypass to Normal

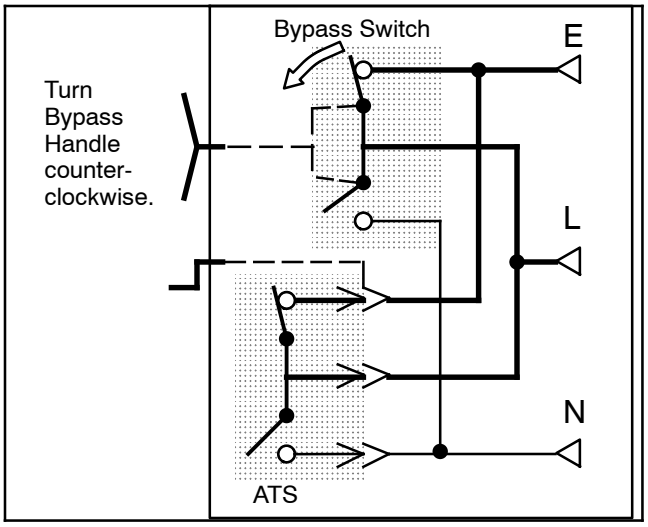


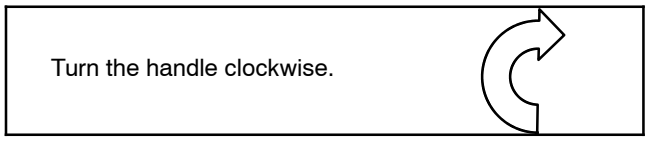
Figure 7-51 Opening Bypass to Emergency

1. Observe which bypass switch position indicator is yellow (NORMAL or EMERGENCY) at the bypass switch handle. This indicates the source connected to the load. See Figure 7-49.

2. Un–Bypass to same source as the bypass switch position as follows (select Normal or Emergency).

To Open the Bypass when Connected to the Normal Source

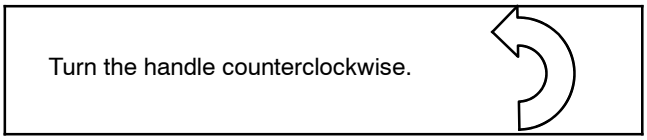
The Transfer Switch Connected To Normal light is on. The Transfer Switch Connected To Emergency light is off.



Turn the bypass handle clockwise until the bypass switch position shows OPEN (green window indicator). See Figure 7-49. The Bypassed to Normal light should go off and the Not In Automatic light should go off. The automatic transfer and bypass/isolation switch should be left in this position.

To Open the Bypass when Connected to the Emergency Source

The Transfer Switch Connected To Emergency light is on. The Transfer Switch Connected To Normal light is off.



Turn the bypass handle counterclockwise until the bypass switch position shows OPEN (green window indicator). See Figure 7-49. The Bypassed to Emergency light should go off and the Not In Automatic light should go off. The automatic transfer and bypass/isolation switch should be left in this position.

7.3.5 Manual Load Transfer, 800–1200 Amp Models

The following procedure manually transfers the load to the other source if the transfer switch or controller are out of service.

Note: Close and secure the enclosure door before performing this procedure.

1. Bypass to the connected source. Turn the bypass handle to EMERGENCY or NORMAL. See Section 7.3.1.

2. Turn the isolation handle to the TEST position. See Section 7.3.2.

3. Turn the bypass handle to OPEN, then to the other source. The load will be interrupted.

To return to automatic operation, follow the instructions in Section 7.3.3, Return to Service.

7.4 1600–4000 Amp Models

Read the information and instructions in Sections 7.1.1 and 7.1.2 before proceeding.

7.4.1 Bypassing the Transfer Switch, 1600–4000 Amp Models

The bypass handle must be in the OPEN position (green indicator) and the isolation handle must be in the CLOSED position (window) at the start of the procedure. See Figure 7-52.

Check the ATS position indicator. Bypass to the connected source (Source N = Normal, Source E = Emergency).

Note: Bypass to the source that is connected to the load, as indicated by the Position LED. Interlocks prevent incorrect operation.

After bypass, the ATS can be put into the Test or Open position. Proceed to Section 7.4.2, Isolating the Transfer Switch.

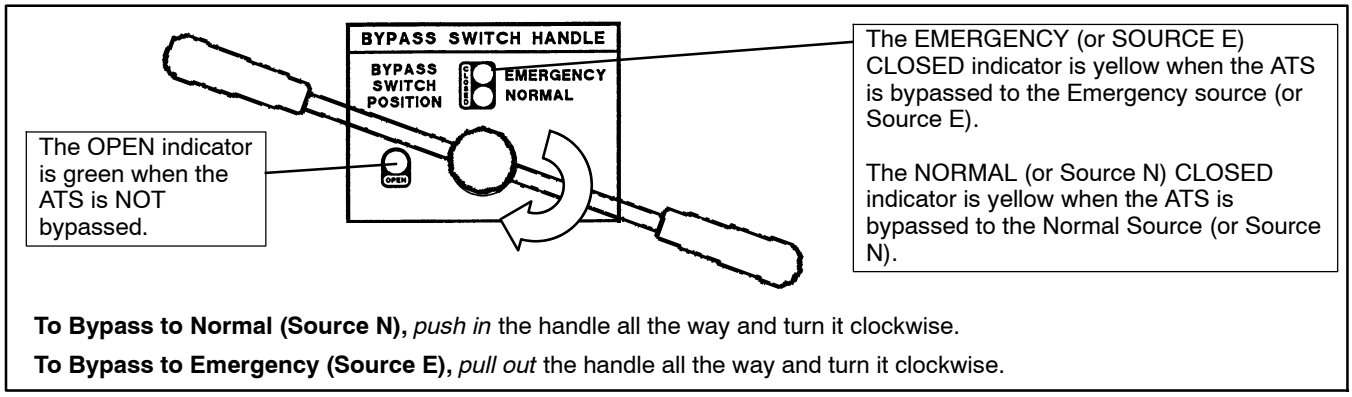


Figure 7-52 Bypass Handle and Position Indicators, 1600–3000 Amp Models

Procedure to Bypass Normal (Source N)

The load is connected to the Normal source. The *Transfer Switch Connected to Normal* light is on; the *Transfer Switch Connected to Emergency* light is off.

1. **Push in** the bypass handle all the way. See Figure 7-52.
2. Turn the bypass handle clockwise until the NORMAL bypass switch position indicator turns completely yellow. The Not In AUTO indicator will flash.

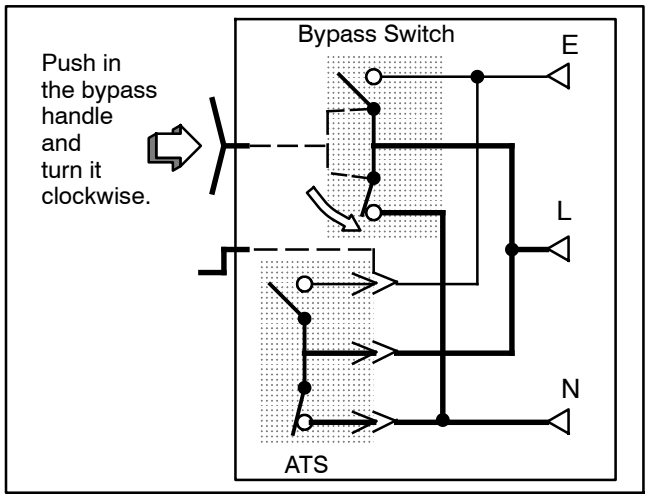


Figure 7-53 Bypass to Normal (Source N)

Procedure to Bypass Emergency (Source E)

The load is connected to Emergency source. The *Transfer Switch Connected to Normal* light is off; the *Transfer Switch Connected to Emergency* light is on.

1. **Pull out** the bypass handle all the way. See Figure 7-52.
2. Turn the bypass handle clockwise until the CLOSED bypass switch position indicator turns completely yellow. The Not In AUTO indicator will flash.

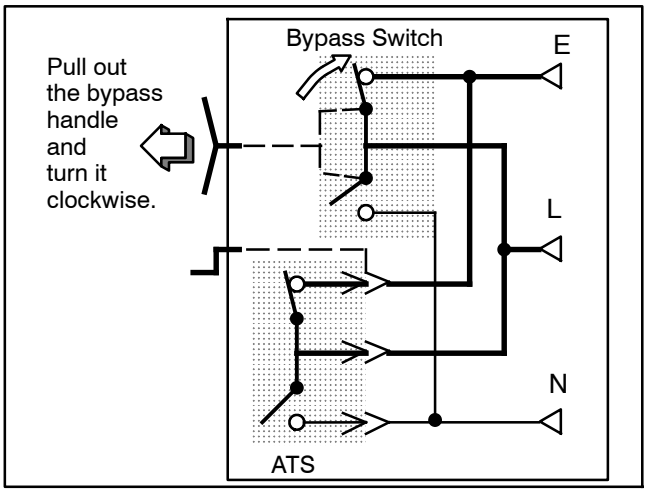


Figure 7-54 Bypass to Emergency (Source E)

7.4.2 Isolating the Transfer Switch, 1600–4000 Amp Models

Bypass the ATS before isolating it. See Section 7.4.1.

Note: Turn the isolation handle until the position shows clearly through the position window. Do not leave the handle in an intermediate position.

1. Turn the isolation handle *counterclockwise* (approximately 16 turns for 1600–3000 amps, 12 turns for 4000 amps) until the position window shows TEST. See Figure 7-55 and Figure 7-56. The ATS can be tested now without load interruption.

   Note: In the TEST position, the power switching device solenoid operator circuit is energized through secondary disconnects.

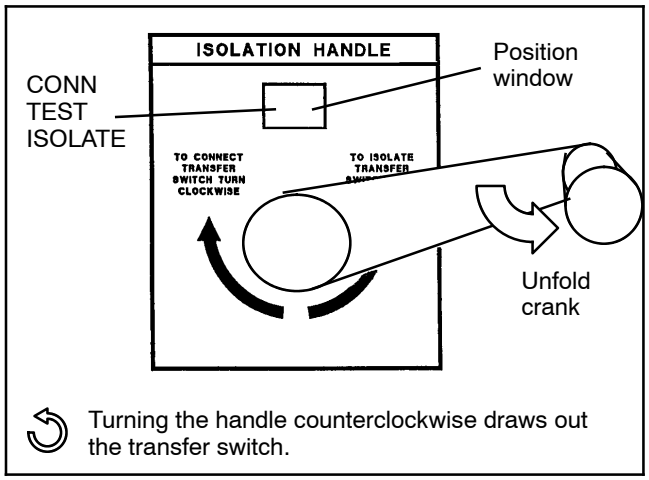


Figure 7-55 Isolation Handle

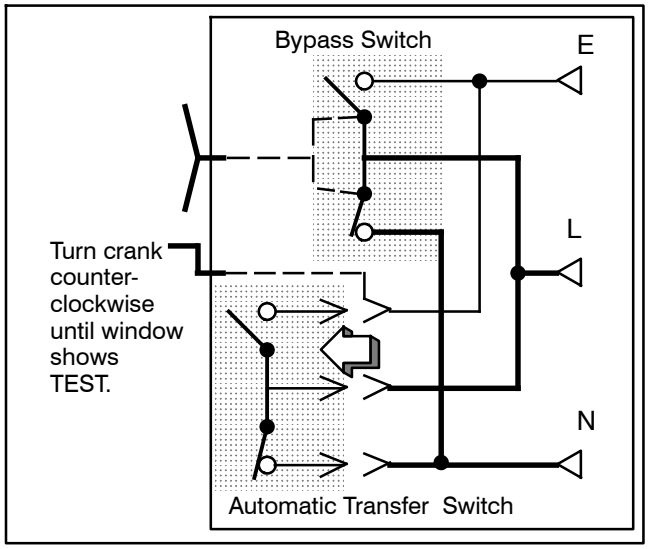


Figure 7-56 From CONNECTED to TEST Position

2. Continue turning the isolation handle *counterclockwise* (approx. 7 turns for 1600–3000 amps, 8 turns for 4000 amps) until the position window shows ISOLATE. See Figure 7-57.

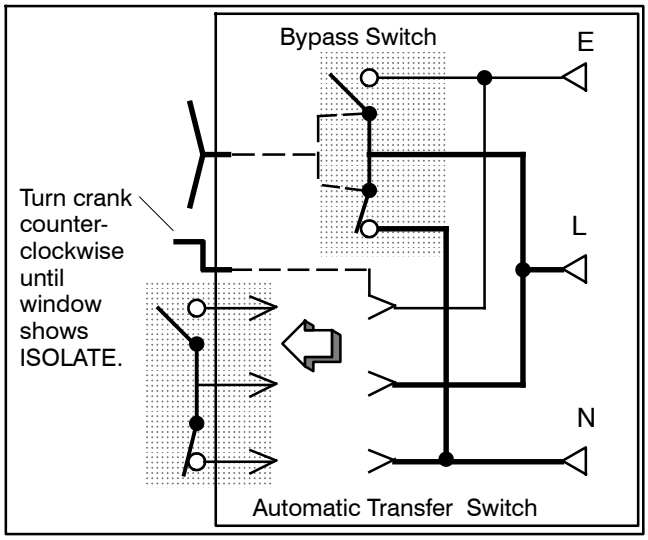


Figure 7-57 From TEST to ISOLATE Position

7.4.3 Removing the Transfer Switch, 1600–4000 Amp Models

After the ATS is bypassed and isolated, it can be removed from the enclosure for inspection or service.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Short circuits. Hazardous voltage/current will 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.

Removing the transfer switch from bypass/isolation models. Hazardous voltage can cause severe injury or death. Bypass and isolate the transfer switch before removing it from the enclosure. The bypass/isolation switch is energized. Do not touch the isolation contact fingers or the control circuit terminals.

⚠ 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.

The transfer switch weights are shown in Figure 7-58. Use an overhead crane or other lifting equipment capable of handling this weight to move the transfer switch.

Size, Amps	Weight, kg (lbs.)
1600–3000	160–205 kg (350–450 lbs.)
4000	272 kg (600 lbs.)

Figure 7-58 Transfer Switch Weights

Procedure to Remove the Transfer Switch, 1600–4000 Amp Models

1. Open the lower enclosure door.
2. Pull out the side rail carriage, then roll out the transfer switch. See Figure 7-59. It can be safely inspected in this position. The transfer switch can also be removed for maintenance operations.

See Section 2.5 for maintenance handle use.

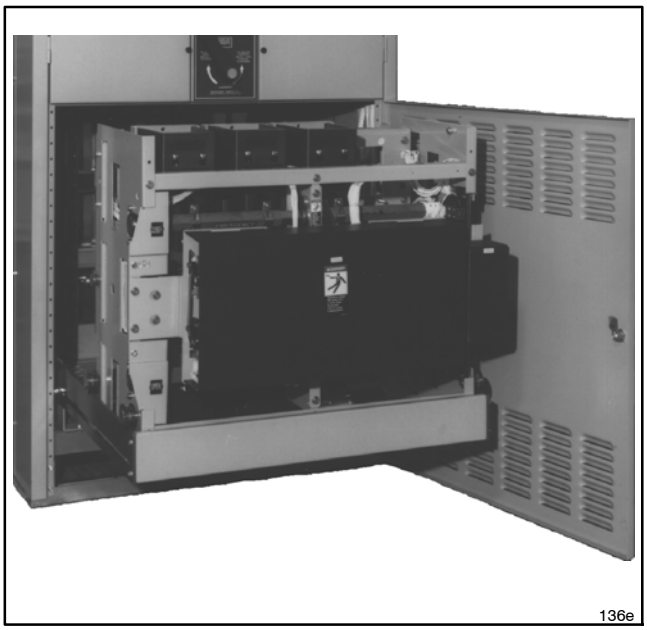
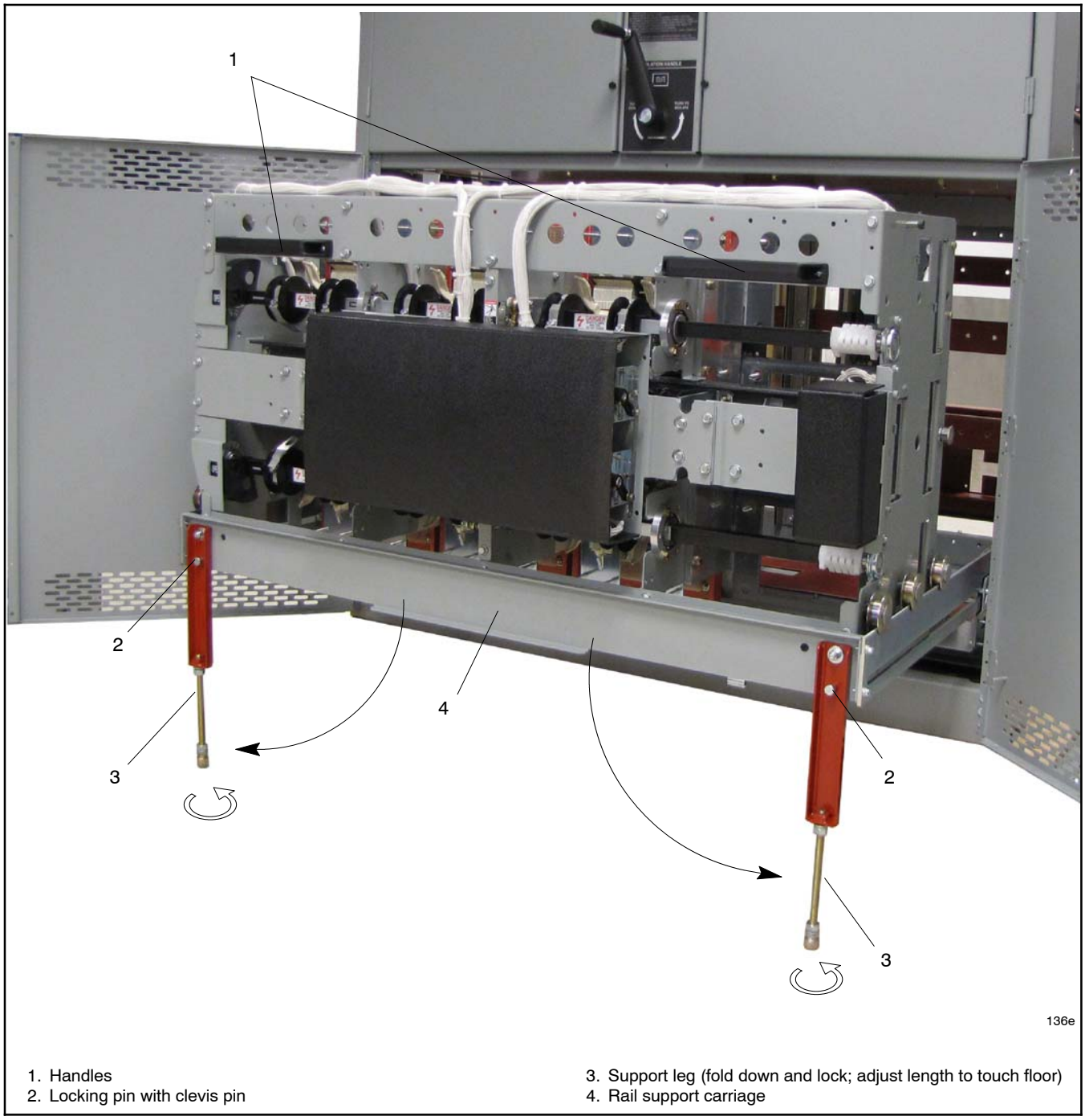


Figure 7-59 1000–4000 Amp Transfer Switch Isolated and Pulled Out for Inspection

Procedure to Remove the Transfer Switch, 4000 Amp Models

3. See Figure 7-60 and follow these steps:
   a. Open both lower doors.
   b. Pull out the rail support carriage all the way.
   c. Remove the left and right clevis and locking pins. Drop two support legs and reinstall locking and clevis pins (to lock in place).
   d. Adjust both legs to extend to the floor.
   e. Stand directly in front of transfer switch. Grasp both handles, and pull straight out.

   Note: Detents on the rails prevent the transfer switch from rolling out unless substantial initial force is applied.
4. The ATS can be safely inspected in this position. The transfer switch can also be removed for maintenance operations.



1. Handles
2. Locking pin with clevis pin
3. Support leg (fold down and lock; adjust length to touch floor)
4. Rail support carriage

Figure 7-60 4000 Amp Transfer Switch Isolated and Pulled Out for Inspection

7.4.4 Return to Operation, 1600–4000 Amp Models

This procedure explains how to return the ATS to operation after inspection or service.

1. Observe which bypass switch position indicator is yellow (NORMAL or EMERGENCY). This indicates the source connected to the load.

2. Slide the transfer switch (ATS) into the enclosure (isolation contacts facing inward) until its crank pins engage the latch plates on both sides. On 4000 amp units, substantial force is required to overcome detents on the rails.

3. 4000 amp models only: Retract the two support legs and lock them into place.

4. Push in the side rail carriage and then close the enclosure door.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

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

5. Turn the isolation handle *clockwise* (approximately 7 turns for 1600–3000 amp units, 8 turns for 4000 amp units) until the window shows TEST. See Figure 7-55 and Figure 7-61. The ATS can be tested now without load interruption.

   Note: Turn the isolation handle until the position shows clearly through the position window. Do not leave the handle in an intermediate position.

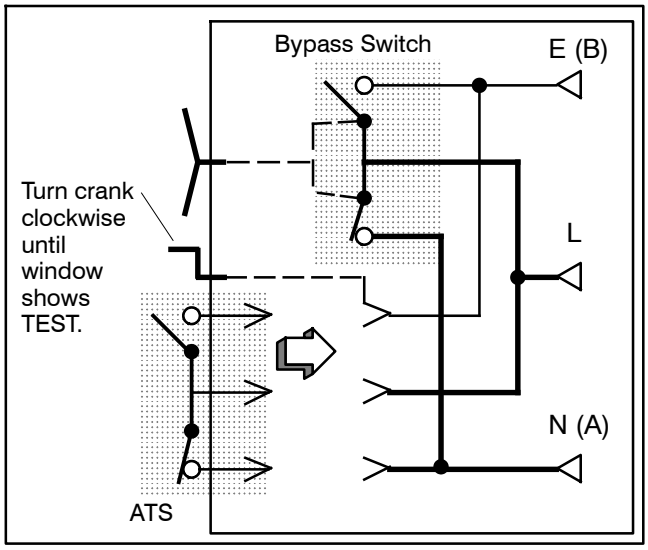


Figure 7-61 Moving from ISOLATE to TEST Position

6. Observe which bypass switch position indicator is yellow (NORMAL or EMERGENCY). This indicates the source connected to the load.

Note: Solenoid interlocks prevent closing the isolation contacts unless the transfer switch is in the same position as the bypass switch. Do not force the isolation handle.

7. Observe which Position LED on the controller is illuminated (Normal or Emergency). This is the position of the transfer switch. If the transfer switch is not in the same position as the bypass handle, check the controller display.

   a. If a test sequence is running, press the End Test button. Wait for the transfer switch to change positions and the test sequence to end.

   b. If the ATS is not under test, do not proceed to close the isolation contacts. Turn the isolation handle *counterclockwise* to the OPEN position and follow the instructions in Section 2.5 to manually operate the transfer switch to match the bypass handle position.

8. When the transfer switch is in the *same* position as the bypass switch handle, turn the isolation handle *clockwise* (about 16 turns for 1600–3000 amps, 12 turns for 4000 amps) until the window shows CONN (connected). See Figure 7-62.

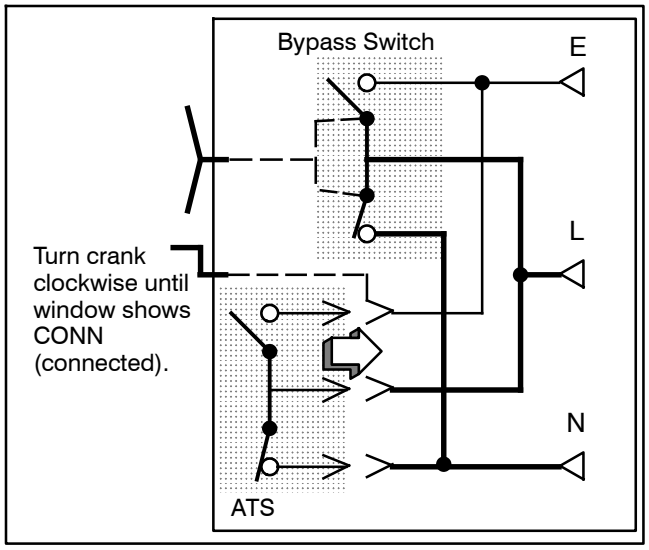


Figure 7-62 Moving from TEST to CONNECTED Position

Now continue with the next instructions to return the bypass handle to the OPEN position.

Opening the Bypass Contacts

This procedure explains how to return the bypass switch handle to the OPEN position, which opens the bypass contacts so that the ATS controls the connections to the sources and the load.

1. Verify that the bypass handle is in the CLOSED position (yellow indicator on NORMAL or EMERGENCY) and the isolation handle is in the CONN position (window) before proceeding. If the handles are not in these positions, go back to Section 7.4.4, Return To Operation.

2. Observe which bypass switch position indicator is yellow (NORMAL or EMERGENCY) at the bypass switch handle. This indicates the source connected to the load.

   Note: Solenoid interlocks prevent moving the bypass handle in the wrong direction. Do not force the bypass handle.

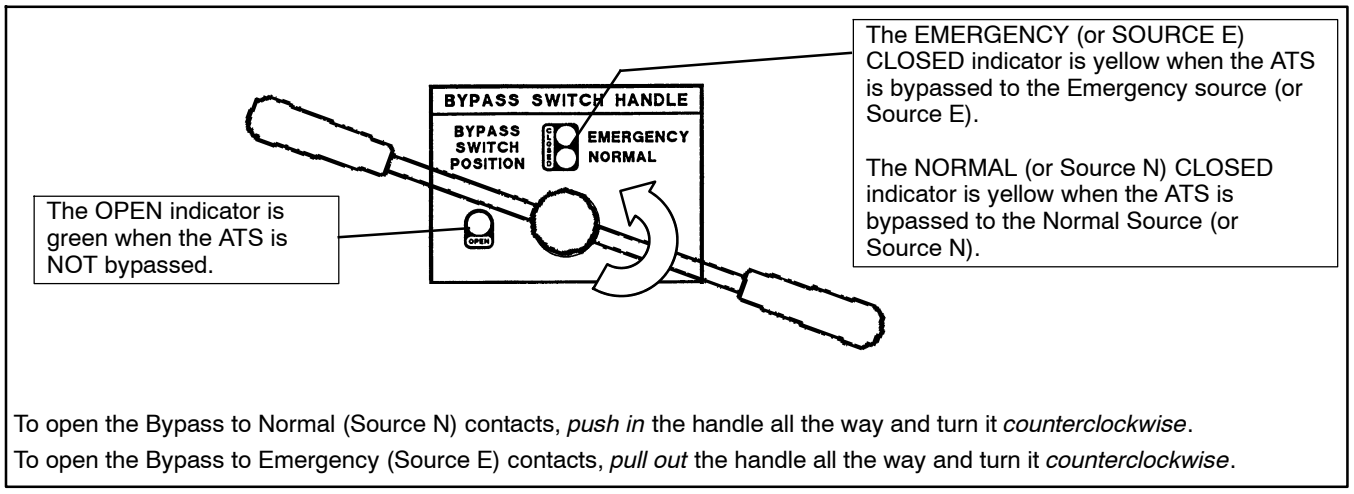


Figure 7-63 Bypass Handle and Position Indicators

3. Open the bypass contacts that are connected to the load as follows (select Normal or Emergency).

   a. **If the load is connected to the NORMAL source**, push in the bypass handle and then turn it counterclockwise until the bypass switch position indicator turns green, showing that the bypass contacts are open. See Figure 7-64 and Figure 7-63. The Not in Auto light should be off.

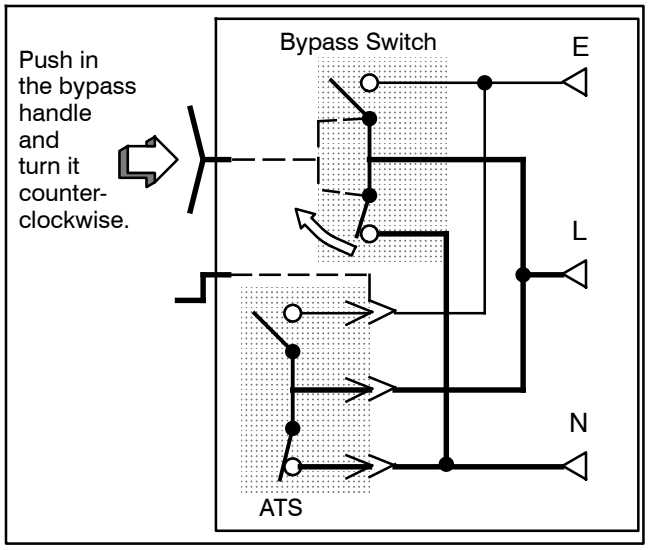


Figure 7-64 Opening Bypass to Normal Contacts

   b. **If the load is connected to the EMERGENCY source,** pull out the bypass handle and then turn it counterclockwise until the bypass switch position indicator turns green, showing that the bypass contacts are open. See Figure 7-65. The Not in Auto light should be off.

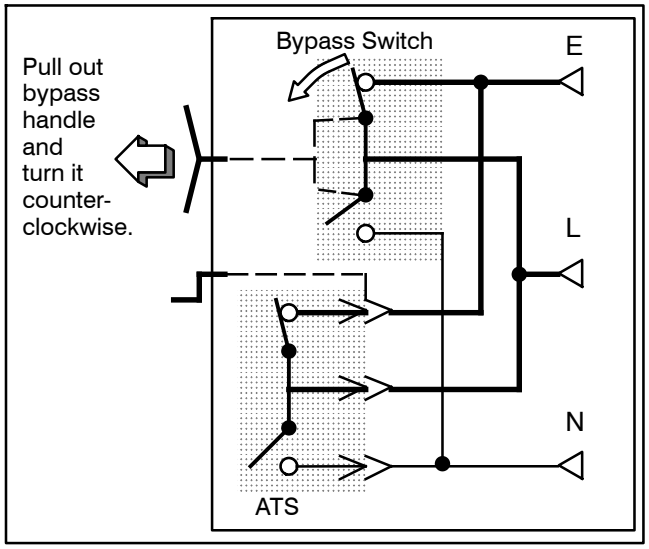


Figure 7-65 Opening Bypass to Emergency Contacts

Leave the bypass and isolation handles in these positions for automatic operation.

7.4.5 Manual Load Transfer, 1600–4000 Amp Models

This procedure manually transfers the load to the other source if the transfer switch or the controller are out of service.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

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

1. Verify that the bypass handle is closed on either Normal or Emergency. See Section 7.4.1.

2. Verify that the isolation handle is in the TEST or ISOLATE position. See Section 7.4.2.

3. Turn the bypass handle counterclockwise to OPEN. Then bypass to the other source. See Figure 7-63.

Notes

Appendix A Abbreviations

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

A, amp	ampere
ABDC	after bottom dead center
AC	alternating current
A/D	analog to digital
ADC	advanced digital control; analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
Ah	amp-hour
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
APDC	Air Pollution Control District
API	American Petroleum Institute
approx.	approximate, approximately
APU	Auxiliary Power Unit
AQMD	Air Quality Management District
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
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
CAN	controller area network
CARB	California Air Resources Board
CAT5	Category 5 (network cable)
CB	circuit breaker
CC	crank cycle
cc	cubic centimeter
CCA	cold cranking amps
ccw.	counterclockwise
CEC	Canadian Electrical Code
cert.	certificate, certification, certified
cfh	cubic feet per hour
cfm	cubic feet per minute
CG	center of gravity
CID	cubic inch displacement
CL	centerline
cm	centimeter
CMOS	complementary metal oxide substrate (semiconductor)
com	communications (port)
coml	commercial
Coml/Rec	Commercial/Recreational
conn.	connection
cont.	continued
CPVC	chlorinated polyvinyl chloride
crit.	critical
CSA	Canadian Standards Association
CT	current transformer
Cu	copper
cUL	Canadian Underwriter's Laboratories
CUL	Canadian Underwriter's Laboratories
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dB(A)	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^2PROM, EEPROM	electrically-erasable programmable read-only memory
E, emer.	emergency (power source)
ECM	electronic control module, engine control module
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
FHM	flat head machine (screw)
fl. oz.	fluid ounce
flex.	flexible
freq.	frequency
FS	full scale
ft.	foot, feet
ft. lb.	foot pounds (torque)
ft./min.	feet per minute
ftp	file transfer protocol
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 temp., high engine temp.
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)
IBC	International Building Code
IC	integrated circuit
ID	inside diameter, identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	improved motor starting
in.	inch
in. H_2O	inches of water
in. Hg	inches of mercury
in. lb.	inch pounds
Inc.	incorporated
ind.	industrial
int.	internal
int./ext.	internal/external
I/O	input/output
IP	internet protocol
ISO	International Organization for Standardization
J	joule
JIS	Japanese Industry Standard
k	kilo (1000)
K	kelvin
kA	kiloampere
KB	kilobyte (2^{10} bytes)
KBus	Kohler communication protocol
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
kWth	kilowatt-thermal
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
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
$m^3/hr.$	cubic meters per hour
$m^3/min.$	cubic meters per minute
mA	milliampere
man.	manual
max.	maximum
MB	megabyte (2^{20} bytes)
MCCB	molded-case circuit breaker
MCM	one thousand circular mils
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
ms	millisecond
m/sec.	meters per second
mtg.	mounting
MTU	Motoren-und Turbinen-Union
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
OSHPD	Office of Statewide Health Planning and Development (California)
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
psig	pounds per square inch gauge
pt.	pint
PTC	positive temperature coefficient
PTO	power takeoff
PVC	polyvinyl chloride
qt.	quart, quarts
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
RDO	relay driver output
ref.	reference
rem.	remote
Res/Coml	Residential/Commercial
RFI	radio frequency interference
RH	round head
RHM	round head machine (screw)
rly.	relay
rms	root mean square
rnd.	round
RO	read only
ROM	read only memory
rot.	rotate, rotating
rpm	revolutions per minute
RS	right side
RTDs	Resistance Temperature Detectors
RTU	remote terminal unit
RTV	room temperature vulcanization
RW	read/write
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
SMTP	simple mail transfer protocol
SN	serial number
SNMP	simple network management protocol
SPDT	single-pole, double-throw
SPST	single-pole, single-throw
spec	specification
specs	specification(s)
sq.	square
sq. cm	square centimeter
sq. in.	square inch
SMS	short message service
SS	stainless steel
std.	standard
stl.	steel
tach.	tachometer
TB	terminal block
TCP	transmission control protocol
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
THD	total harmonic distortion
TIF	telephone influence factor
tol.	tolerance
turbo.	turbocharger
typ.	typical (same in multiple locations)
UF	underfrequency
UHF	ultrahigh frequency
UIF	user interface
UL	Underwriter's Laboratories, Inc.
UNC	unified coarse thread (was NC)
UNF	unified fine thread (was NF)
univ.	universal
URL	uniform resource locator (web address)
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
WO	write only
w/o	without
wt.	weight
xfmr	transformer

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