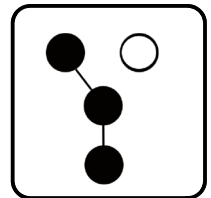


# Operation and Installation

## Automatic Transfer Switches



Models:

**KSS/KSP**

40 to 1000 Amperes

**KOHLER®**

Power Systems \_\_\_\_\_

**9001**  
**KOHLER**  
POWER SYSTEMS  
NATIONALLY REGISTERED

TP-6834 4/14a

# Product Identification Information

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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
- ☐ Controller Disconnect Switch
- ☐ Digital Meter
- ☐ Heater
- ☐ IBC Seismic Certification
- ☐ I/O Module, Standard (max. 4) qty: \_\_\_\_\_
- ☐ I/O Module, High Power (max. 4) qty: \_\_\_\_\_
- ☐ Load Shed
- ☐ Line-Neutral Monitoring
- ☐ 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 \_\_\_\_\_

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# Safety Precautions and Instructions

**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


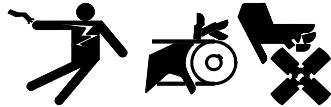
Caution indicates the presence of a hazard that **will or can cause minor personal injury or property damage.**

## 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

 <b>WARNING</b>

<b>Accidental starting.</b> <b>Can cause severe injury or death.</b>  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

 <b>DANGER</b>

<b>Hazardous voltage.</b> <b>Will cause severe injury or death.</b>  Disconnect all power sources before opening the enclosure.

 <b>DANGER</b>

<b>Hazardous voltage.</b> <b>Will cause severe injury or death.</b>  Only authorized personnel should open the enclosure.

**Grounding electrical equipment. Hazardous voltage can cause severe injury or death.** Electrocution is possible whenever electricity is present. 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.

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

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

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

## Heavy Equipment

<p><b>⚠ WARNING</b></p> 
<p><b>Unbalanced weight. Improper lifting can cause severe injury or death and equipment damage.</b></p> <p>Use adequate lifting capacity. Never leave the transfer switch standing upright unless it is securely bolted in place or stabilized.</p>

## 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 the following Kohler® Automatic Transfer Switches (ATS):

- Model KSS standard-transition specific breaker ATS equipped with the Decision-Maker® MPAC 750 controller.
- Model KSS standard-transition specific breaker ATS equipped with the Decision-Maker® MPAC 1200 controller.
- Model KSP programmed-transition specific breaker ATS equipped with the Decision-Maker® MPAC 1200 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 Literature

A separate manual covers the transfer switch controller and related accessories. Separate manuals contain 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 750 Controller	G11-126
Specification Sheet, Decision-Maker® MPAC 1200 Controller	G11-127
Specification Sheet, Model KSS/KSP	G11-130
Operation Manual, Decision-Maker® MPAC 750 Controller	TP-6865
Operation Manual, Decision-Maker® MPAC 1200 Controller	TP-6866
Parts Catalog, Transfer Switch and Controller	TP-6433
Service Manual, Model KSS/KSP/KGS/KGP	TP-6921

# Service Assistance

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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 stickers on your Kohler product or review the appropriate literature or documents included with the product.
- Call toll free in the US and Canada 1-800-544-2444.
- Outside the US and Canada, call the nearest regional office.

## **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



## Section 1 Product Description

### 1.1 Purpose

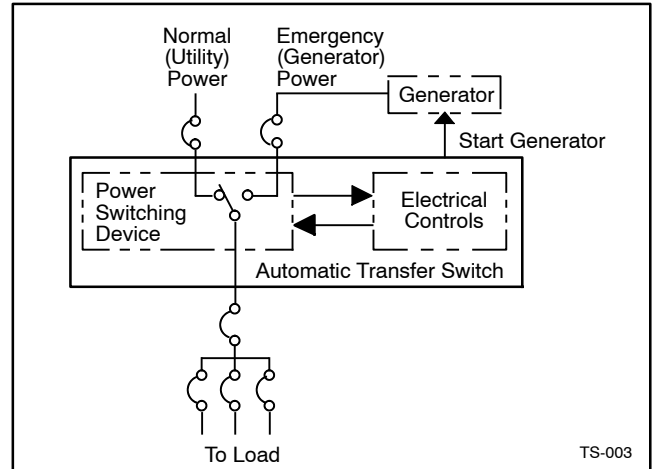
An automatic transfer switch (ATS) transfers electrical loads from a normal (preferred) source of electrical power to an emergency (standby) source when the normal source falls outside the acceptable electrical parameters.

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

Figure 1-2 shows a typical installation block diagram.




**Figure 1-1** Automatic Transfer Switch



### 1.2 Nameplate

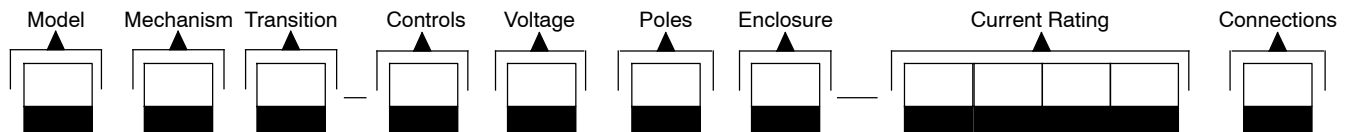
A nameplate attached to the controller cover on the inside of the enclosure door includes a model designation, a serial number, ratings, and other information about the transfer switch. See Figure 1-3. The serial number is also shown on a label inside the transfer switch enclosure.

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.

<b>KOHLER</b> KOHLER CO., KOHLER WI, USA 1-800-544-2444		TRANSFER SWITCH FOR EMERGENCY SYSTEMS NEMA ENCLOSURE MFG. DATE	
MATERIAL		ACCESSORIES:	
MODEL			
SERIAL NO.			
AMPS	VOLTS		
WIRES	PHASE		
POLES	HERTZ		
BAR CODE			
<div></div>			
 LISTED		TRANSFER SWITCH FOR EMERGENCY SYSTEMS	
GM21291			

**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: KSS-JCNA-0100S**

### Model

K: Kohler

### Mechanism

S: Standard (Specific-Breaker)

### Transition

S: Standard

P: Programmed

### Controller

A: Decision-Maker® MPAC 1200, Automatic

B: Decision-Maker® MPAC 1200, Non-Automatic

J: Decision-Maker® MPAC 750, Automatic

### Voltage/Frequency

C: 208 Volts/60 Hz

J: 416 Volts/50 Hz

D: 220 Volts/50 Hz

K: 440 Volts/60 Hz

F: 240 Volts/60 Hz

M: 480 Volts/60 Hz

G: 380 Volts/50 Hz

P: 380 Volts/60 Hz

H: 400 Volts/50 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

### Enclosure

A: NEMA 1

D: NEMA 4

B: NEMA 12

F: NEMA 4X

C: NEMA 3R

G: Open Unit

### Current, Amps

0040 0200 600

0080 0225 800

0100 0260 1000

0150 0400

### Connections

S: Standard

**Note:** Some selections are not available for every model.  
Contact your Kohler distributor for availability.

## 2.1 Introduction

Kohler® transfer switches are shipped factory-wired, factory-tested, and ready for installation. Have the equipment installed only by trained and qualified personnel. Verify that the installation complies with applicable codes and standards. 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 used as a disconnect device.

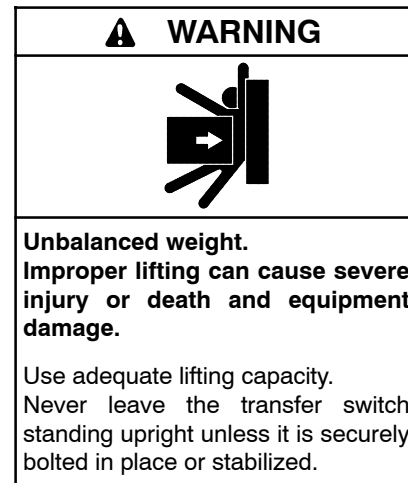
The functional tests in Section 5 are a necessary part of the installation. Be sure to perform the functional tests, which include voltage checks and operation tests, before putting the transfer switch into service.

## 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



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

Model	Amps	Weight kg (lb.)		
		2-Pole	3-Pole	4-Pole
KSS	40-225	28 (62)	30 (65)	31 (68)
	260-400	52 (115)	56 (123)	59 (131)
	600	179 (395)	183 (403)	186 (410)
	800	N/A	226 (498)	236 (520)
	1000	N/A	231 (509)	241 (531)
KSP	100-200	52 (115)	56 (123)	59 (131)
	400	52 (115)	56 (123)	59 (131)
	600	179 (395)	183 (403)	186 (410)

**Figure 2-1** Approximate Transfer Switch Weights, NEMA Type 1 and 3R 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.

Item	Specification
Storage temperature	-40°C to 70°C (-40°F to 158°F)
Operating temperature	-20°C to 85°C (-4°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 switch. Cleaning with compressed air can cause debris to lodge in the components and damage the switch.

## 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.

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

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

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

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

**Installation of seismically certified transfer switches.** See Section 2.4 and the transfer switch dimension (ADV) drawings for additional installation requirements.

**Install the ATS.** Mount 40- through 400-amp transfer switches to a wall or other rigid vertical supporting structure. Clearance holes through the back of each enclosure are provided for mounting. Level the enclosure and use shims if needed to plumb the enclosure. Verify that the door hinges are vertical to avoid distortion of the enclosure or door.

Bolt 600- through 1000-amp automatic transfer switches directly to floor mounting pads. Use shims if needed to plumb the enclosure. Verify that the door hinges are vertical to avoid distortion of the enclosure or door.

## 2.4 Seismic Certification

Automatic transfer switches with seismic certification must be installed according to the instructions in this section. Also refer to the Certificate of Compliance and the installation 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.

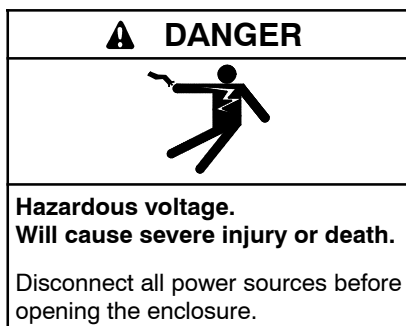
### General Seismic Installation Notes:

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 with spacing 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 (ex. 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. Rebar reinforcement in concrete 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 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



**Servicing the transfer switch. Hazardous voltage can 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.

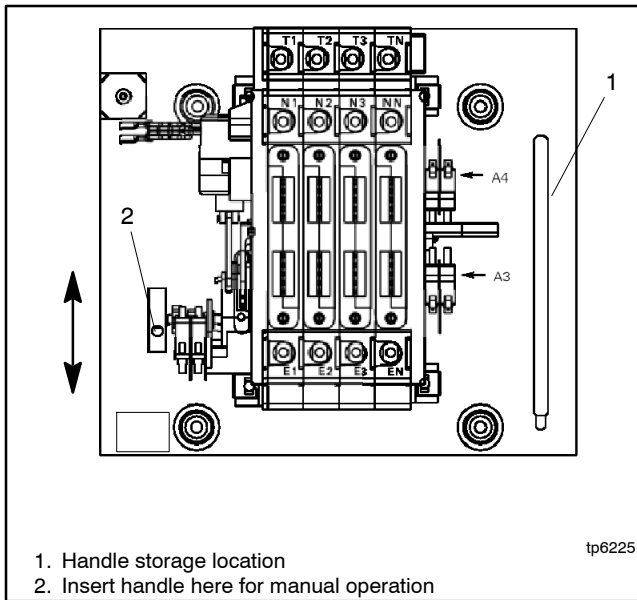
A manual operation handle is provided with the transfer switch *for maintenance purposes only*. Use the manual operation handle to check the manual operation before energizing the transfer switch. Use the following manual operation procedures to verify that the contactor operates smoothly without binding.

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

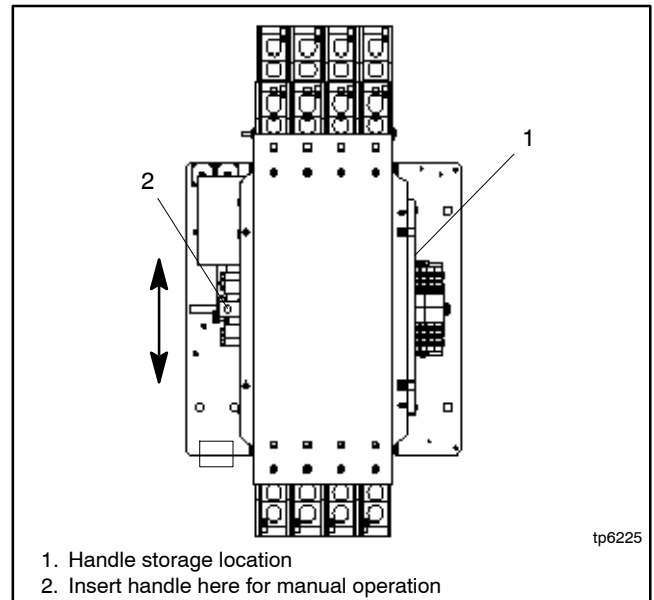
### 2.5.1 Manual Operation, Model KSS Standard-Transition Switches

**Note:** Never use the maintenance handle to transfer the load with the power connected. Disconnect both power sources before manually operating the switch.

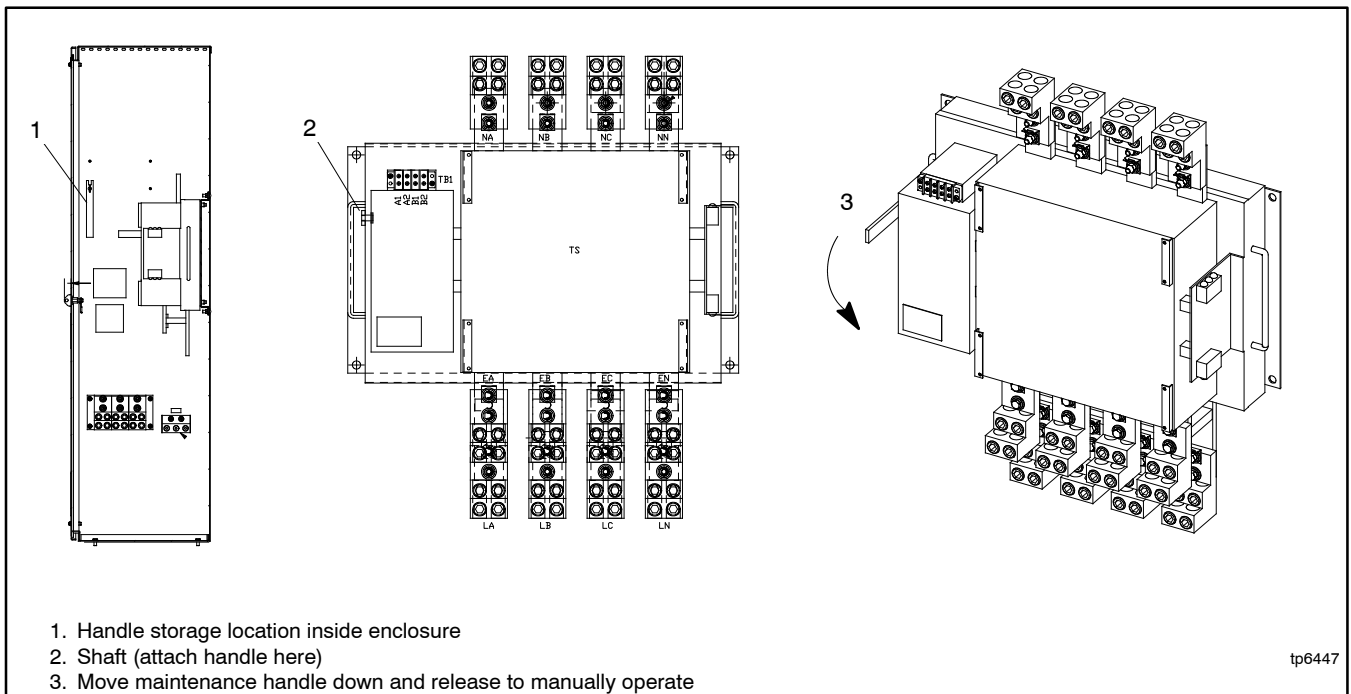
1. Disable the generator set to prevent starting and disconnect all power sources before manually operating the transfer switch.
2. Remove the maintenance handle from its storage location inside the enclosure. See Figure 2-3 through Figure 2-5.
3. Attach the maintenance handle:
  - a. 40–600 Amp switches: Insert the maintenance handle into the hole in the shaft on the left side of the operator as shown in Figure 2-3 or Figure 2-4.
  - b. 800–1000 Amp switches: Slide the maintenance handle over the square shaft on the left side of the operator as shown in Figure 2-5.
4. Move the maintenance handle up or down as shown in the corresponding figure 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 return it to the storage location.



**Figure 2-3** Manual Operation, 40–260 Amp Standard-Transition Switches



**Figure 2-4** Manual Operation, 400–600 Amp Standard-Transition Switches

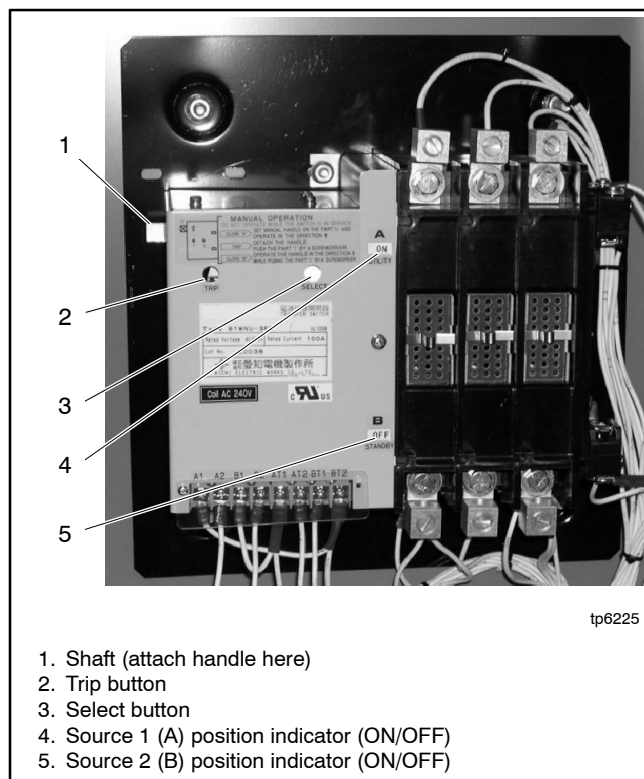


**Figure 2-5** Manual Operation, 800–1000 Amp Standard-Transition Switches

## 2.5.2 Manual Operation, Model KSP Programmed-Transition Switches

**Note:** Never use the manual operation handle to transfer the load with the power connected. Disconnect both power sources before manually operating the switch.

1. Disable the generator set to prevent starting and disconnect all power sources before manually operating the transfer switch.
2. Check the contactor position, indicated by the A and B position indicators. See Figure 2-6. One position indicator will display ON to indicate the source position. If both indicators display OFF, the transfer switch is in the OFF position.



**Figure 2-6** Manual Operation, Programmed-Transition Switches (handle not shown)

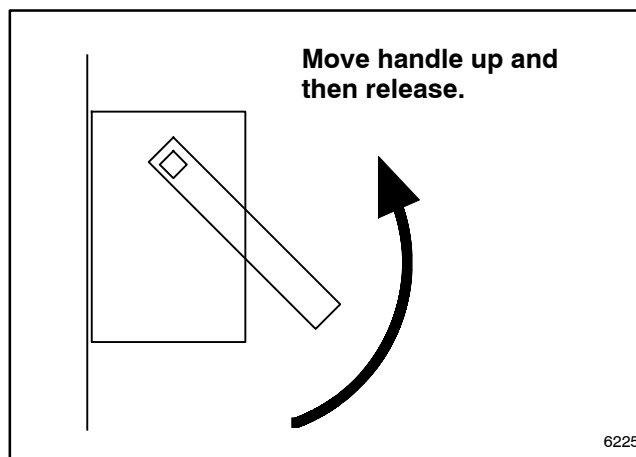
3. If the transfer switch is not in the OFF position, use a screwdriver or other tool to push the TRIP button.

See Figure 2-6. Check that both position indicators display OFF.

4. Slide the manual operating handle (provided with the switch) over the shaft on the left side of the switch. See Figure 2-6.
5. Move the switch to the A (Source 1) or B (Source 2) position as follows:
  - a. To move the switch to position A (Source 1), move the manual operation handle up and then release the handle. Verify that the A position indicator displays ON.
  - b. To move the switch to position B (Source 2), use a screwdriver or other tool to push the SELECT button. Hold the SELECT button in and move the manual operation handle up and then release the handle. Verify that the B position indicator displays ON.

**Note:** Always move the manual operation handle UP and then release it.

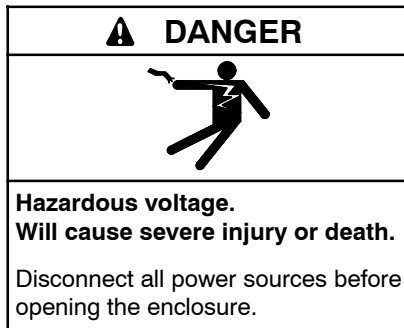
6. Remove the manual operation handle and store it in a convenient location.



**Figure 2-7** Manual Operating Handle, Programmed-Transition Switches



## 2.6 Controller Connections



### NOTICE

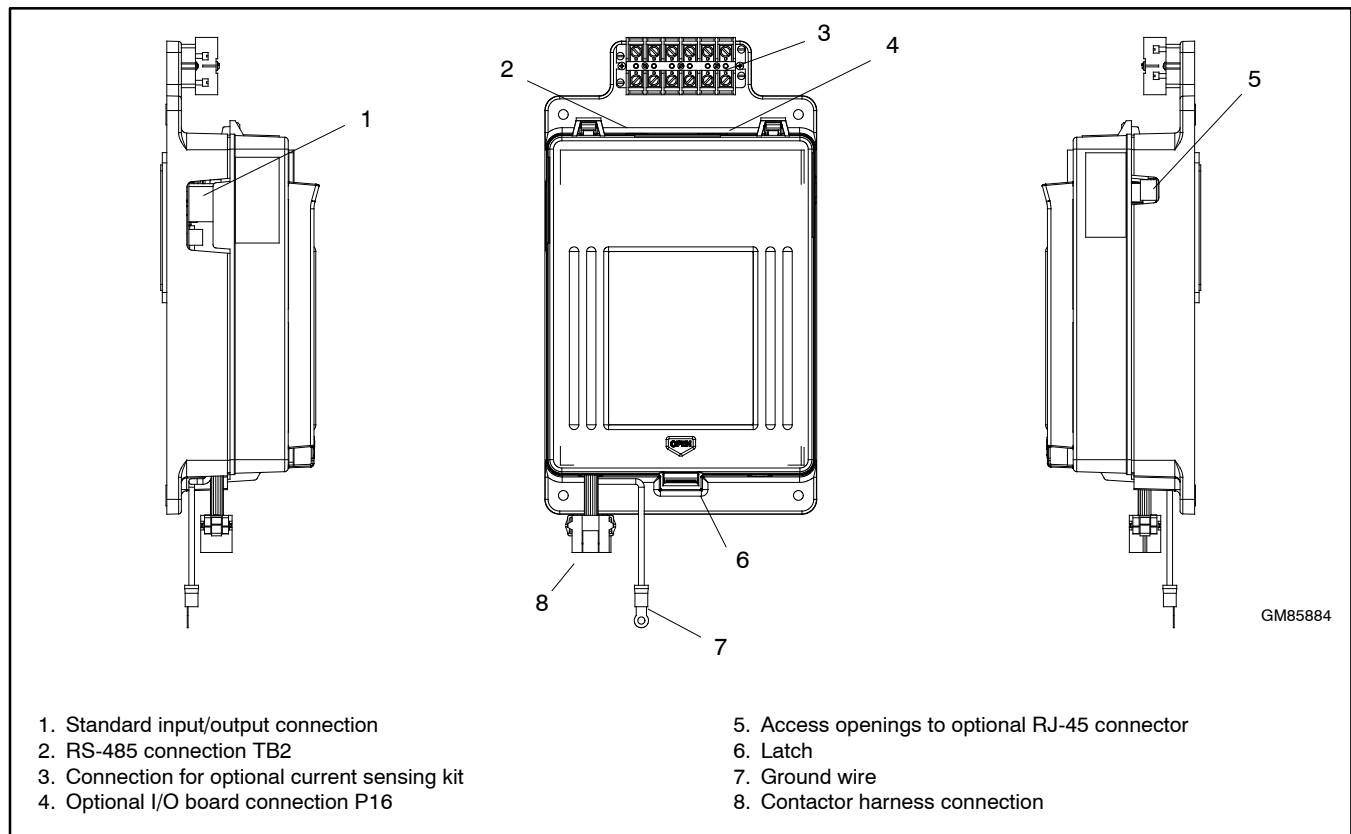
**Electrostatic discharge damage.** Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (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 2-8 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.



**Figure 2-8** Controller

## 2.6.1 Controller Input and Output Connections

The controller provides connections for two programmable inputs and two programmable outputs. See Figure 2-8 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 2-10 for connections. Use #12–24 AWG wire and tighten the connections to 0.5 Nm (4.4 in. lbs.).

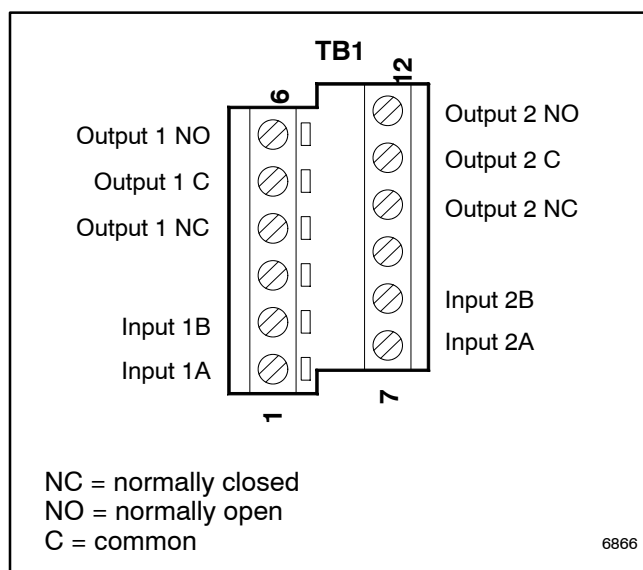
See the transfer switch controller operation manual for instructions to assign inputs and outputs.

Transfer switches equipped with the MPAC 750 controller may also include the optional programmable exerciser. This accessory uses one input connection, which must be assigned to Remote Test. Refer to the instructions provided with the exerciser kit for more information.

Transfer switches equipped with the MPAC 1200 controller can use optional input/output modules for additional input and output connections. See Section 3.3 for instructions.

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 2-9** Main Board I/O Specifications



**Figure 2-10** Input and Output Connections

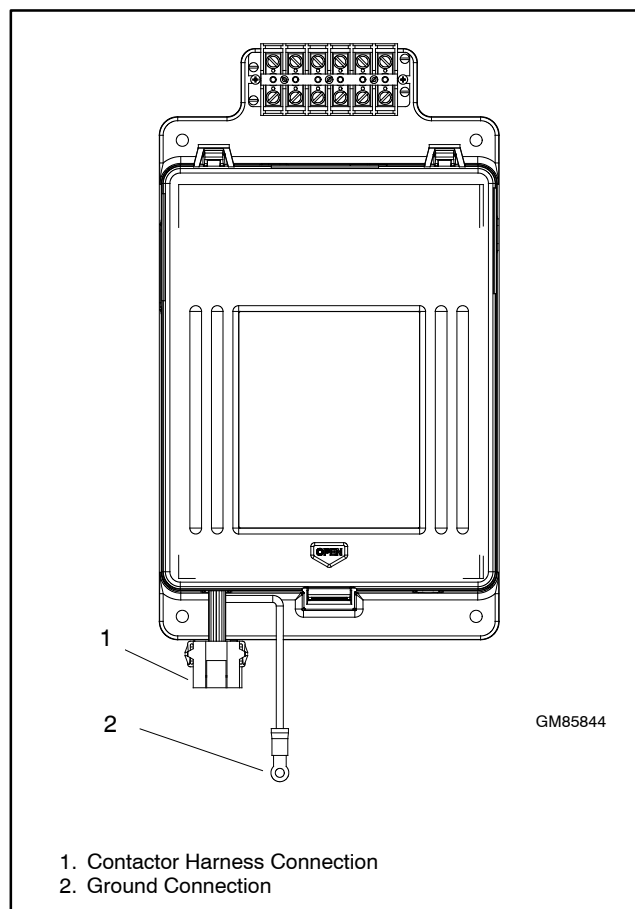
## 2.6.2 Harness Connection

Verify that the contactor harness is connected at the controller base (or at the controller disconnect switch, if equipped). See Figure 2-11.

**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 2-11** Contactor Harness and Controller Ground Connections

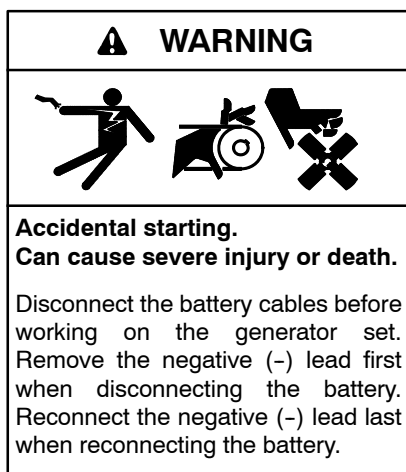
## 2.7 Electrical Wiring

The transfer switch is factory-wired and tested. Field installation includes connecting the sources, loads, generator start circuit(s), and auxiliary circuits, if used.

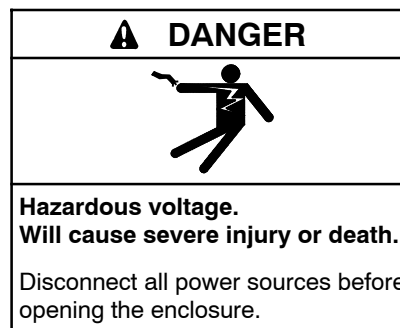
**Note:** An approved protective device such as a molded-case circuit breaker or fused disconnect switch **MUST** be installed on both sources of incoming power for circuit protection and used as a disconnect device.

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.



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

**Grounding electrical equipment. Hazardous voltage can cause severe injury or death.** Electrocutation 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

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

**Drill the entry holes.** Cover the internal components of the ATS to protect them 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 connections of any aluminum conductors.

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.

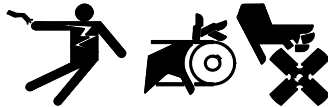
**Tighten the lugs.** Verify that all connections are consistent with drawings before tightening the lugs. Tighten all lug connections to the torque values shown in Figure 2-12. Carefully wipe off any excess joint compound after tightening the terminal lugs.

Socket Size Across Flats, in.	Bolt Torque	
	Nm	Ft. lb.
1/8	5	4
5/32	11	8
3/16	14	10
7/32	16	12
1/4	23	17
5/16	31	23
3/8	42	31
1/2	57	42
9/16	68	50

**Figure 2-12** Tightening Torque for Lugs

## 2.7.2 Engine Start Connection

**⚠ WARNING**



**Accidental starting.  
Can cause severe injury or death.**

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

**Disabling the generator set. Accidental starting can cause severe injury or death.** Before working on the generator set or 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.

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 terminals located on the transfer switch contactor assembly. See Figure 2-14 through Figure 2-19 for the locations of the engine start terminals, which are labeled on the unit with a red decal. Refer to the generator set installation manual for wire size specifications.

The engine start contact ratings are shown in Figure 2-13.

### 2.7.3 Auxiliary Contacts

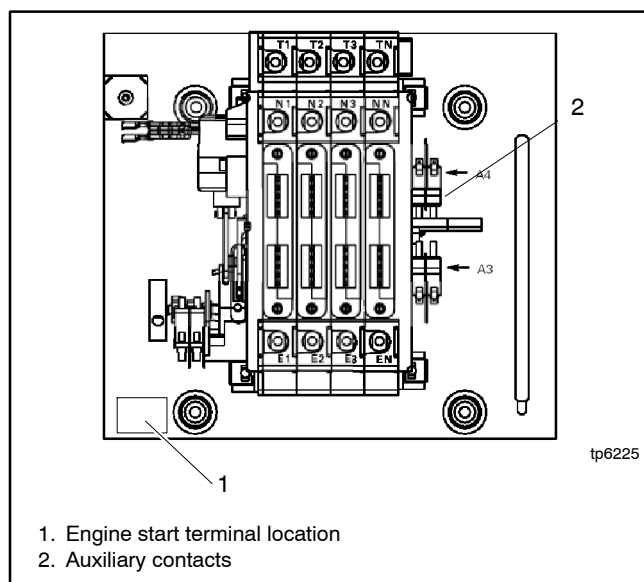
Connect the auxiliary contacts to customer-supplied alarms, remote indicators, or other devices. Auxiliary contacts provide contacts that close when the transfer switch is in the Normal position and contacts that close when the transfer switch is in the Emergency position.

Refer to the schematic diagram provided with the transfer switch to identify which auxiliary contacts are closed on Normal and which are closed on Emergency.

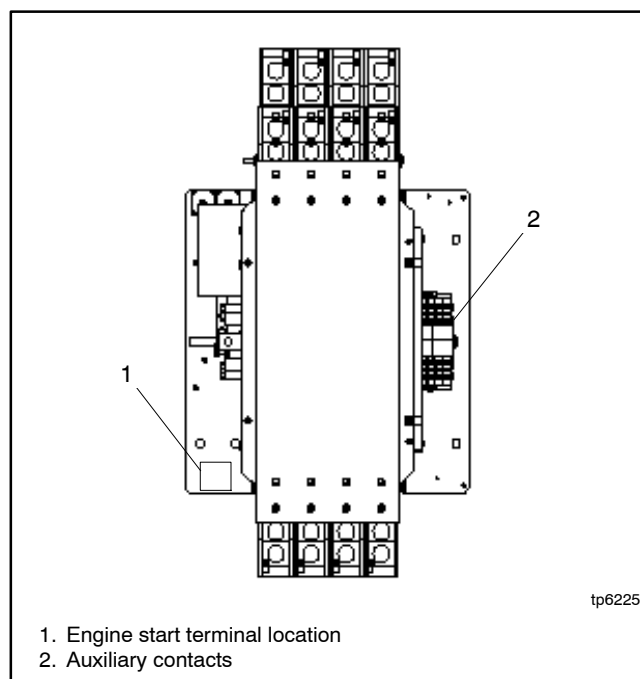
The auxiliary contact ratings are shown in Figure 2-13. Figure 2-14 through Figure 2-19 show the locations of the auxiliary contacts for different models.

Contacts	Resistive Load	Inductive Load	Motor Load	
			NC	NO
Engine Start Contacts	2 A @ 30 VDC	N/A	N/A	N/A
Auxiliary Contacts, KSS (40-600A)	15 A @ 250 VAC	N/A	N/A	N/A
Auxiliary Contacts, KSS (800-1000A)	15 A @ 480 VAC	15 A @ 250 VAC; 6 A @ 500 VAC	5 A @ 125 VAC; 3 A @ 250 VAC; 1.5 A @ 500 VAC	2.5 A @ 125 VAC; 1.5 A @ 250 VAC; 0.75 A @ 500 VAC
Auxiliary Contacts, KSP	15 A @ 480 VAC	15 A @ 250 VAC; 6 A @ 500 VAC	5 A @ 125 VAC; 3 A @ 250 VAC; 1.5 A @ 500 VAC	2.5 A @ 125 VAC; 1.5 A @ 250 VAC; 0.75 A @ 500 VAC

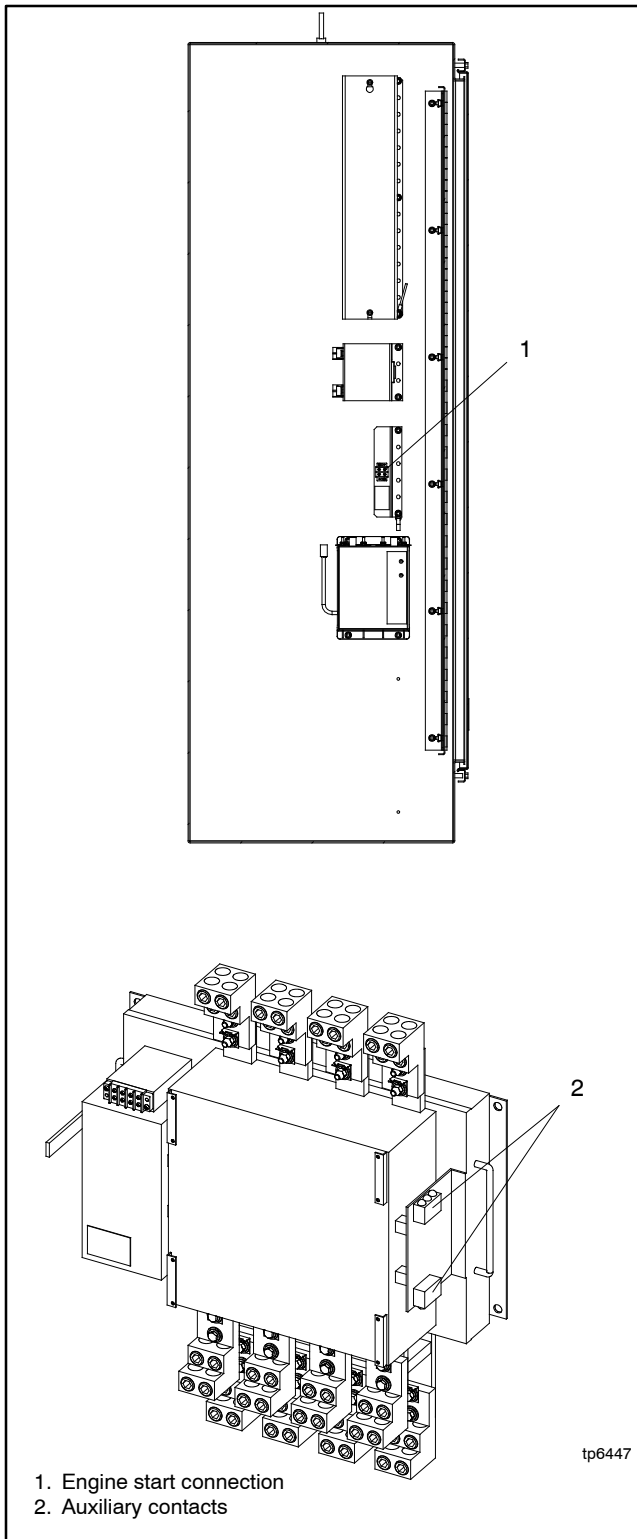
**Figure 2-13** Contact Ratings



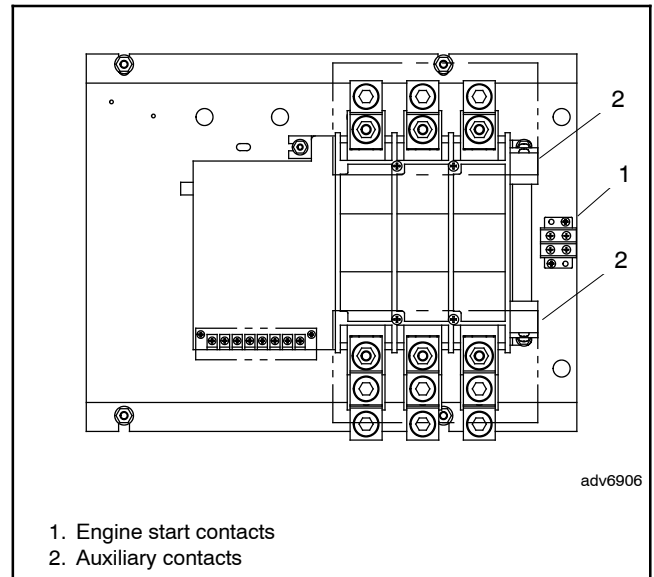
**Figure 2-14** Engine Start and Auxiliary Contact Locations, 40-225 Amp Standard-Transition Switches



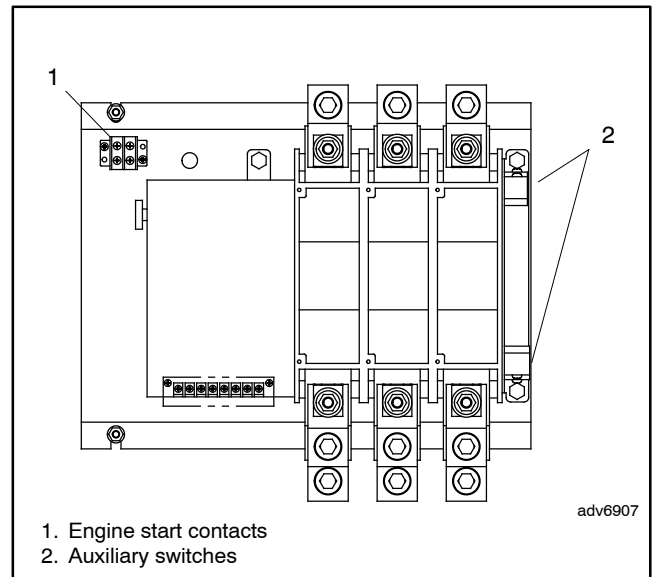
**Figure 2-15** Engine Start and Auxiliary Contact Locations, 400-600 Amp Standard-Transition Switches



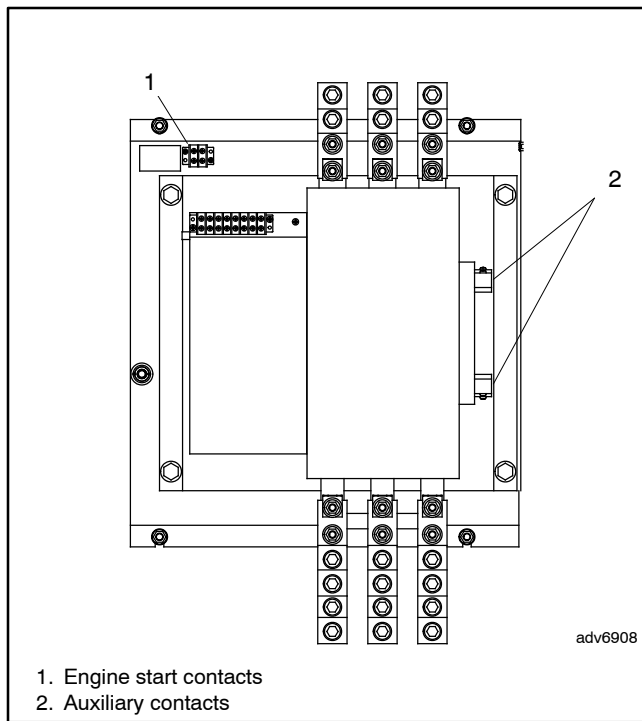
**Figure 2-16** Engine Start and Auxiliary Contact Locations, 800-1000 Amp Standard-Transition Switches



**Figure 2-17** Engine Start and Auxiliary Contact Locations, 100-200 Amp Programmed-Transition Switches



**Figure 2-18** Engine Start and Auxiliary Contact Locations, 400 Amp Programmed-Transition Switches



**Figure 2-19** Engine Start and Auxiliary Contact Locations, 600 Amp Programmed-Transition Switches

## 2.8 Communication and Accessory Connections

See Section 3 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



## Section 3 Communication and Accessory Connections

### 3.1 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.

### 3.2 Communication Connections

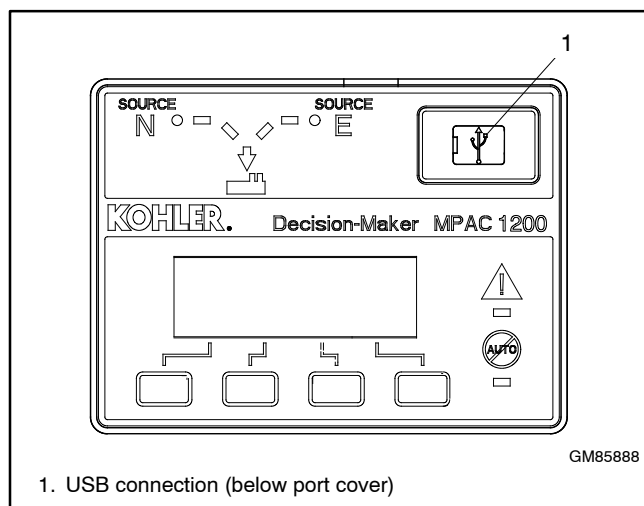
The Decision-Maker® MPAC 750 and MPAC 1200 controllers are equipped with a USB port and a Modbus port with an RS-485 connector. An Ethernet communication board is optional.

#### 3.2.1 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.

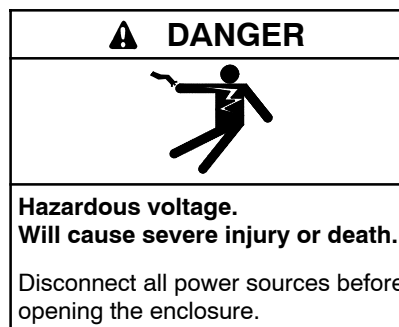
See Figure 3-1 for the USB port location on the front of the controller assembly. Remove the small port cover and use a USB cable with a mini-B connector to connect the controller's USB port to the computer.

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.



**Figure 3-1** USB Connection for SiteTech (MPAC 1200 controller shown)

#### 3.2.2 Modbus Connection



**Servicing the transfer switch. Hazardous voltage can 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 3-2 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 3-4.

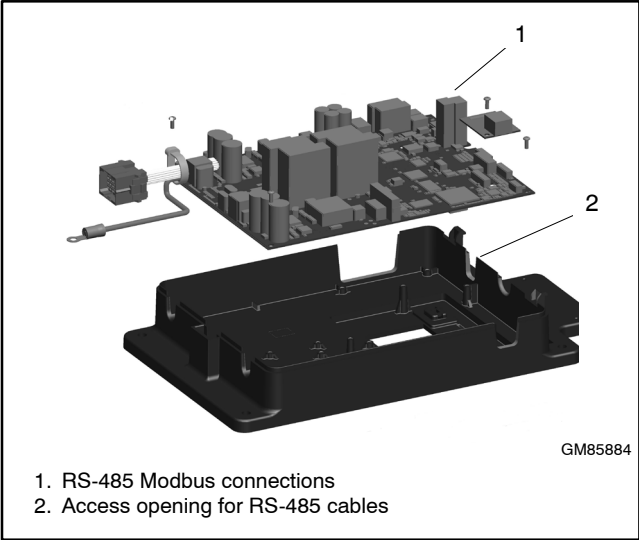
Notice that a 121 ohm terminating resistor is recommended on the last device in a network. If there is only one device, a terminating resistor may be required depending on the cable distance and communication speed. Long cables and high speeds will increase the need for a terminating resistor.

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.

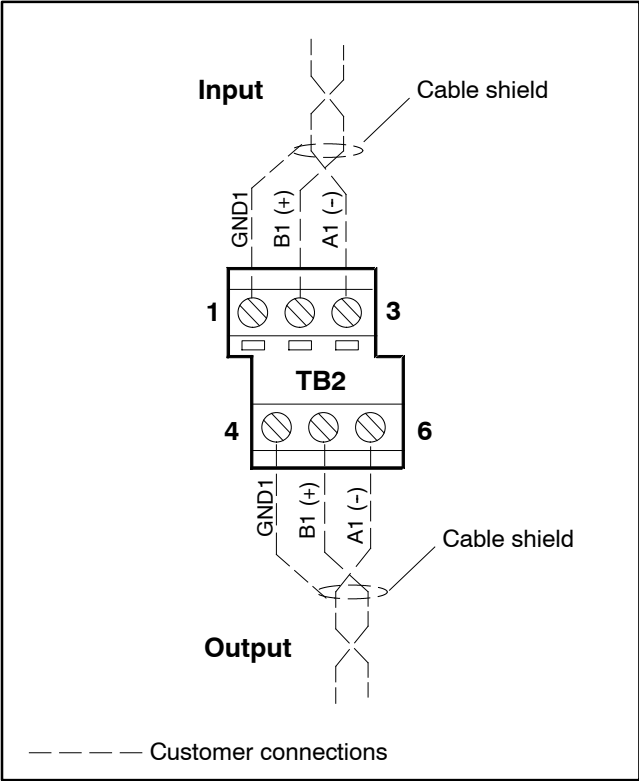
Connect the Modbus input and output to the terminals shown in Figure 3-3. Use #12-24 AWG shielded, twisted-pair wire. Belden cable #9841 or equivalent is recommended. Connect one end of the shield to ground. Leave the other end of the shield disconnected. Tighten the connections to 0.5 Nm (4.4 in. lb.).

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.

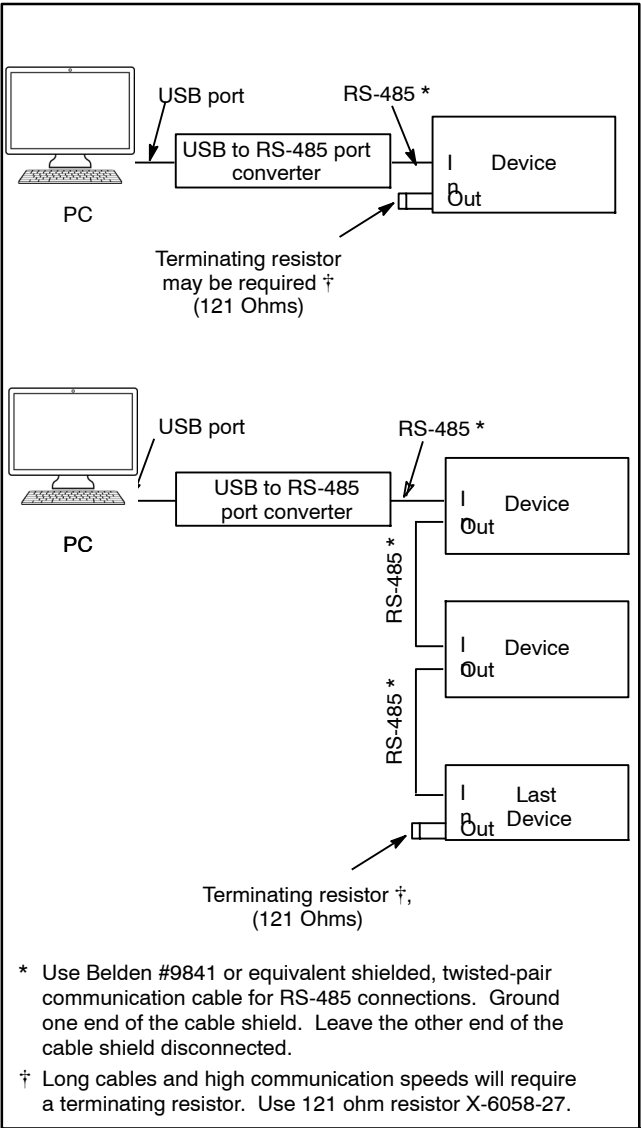
**Note:** Modbus® applications require a Modbus software driver written by a trained and qualified systems programmer.



**Figure 3-2** Modbus Connections (controller cover removed for illustration only)

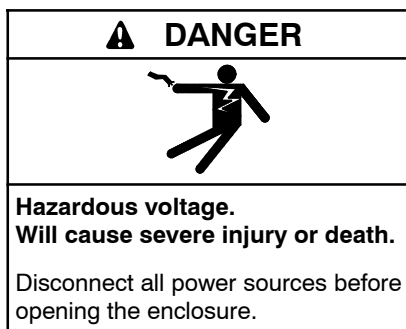


**Figure 3-3** Modbus RS-485 Connections



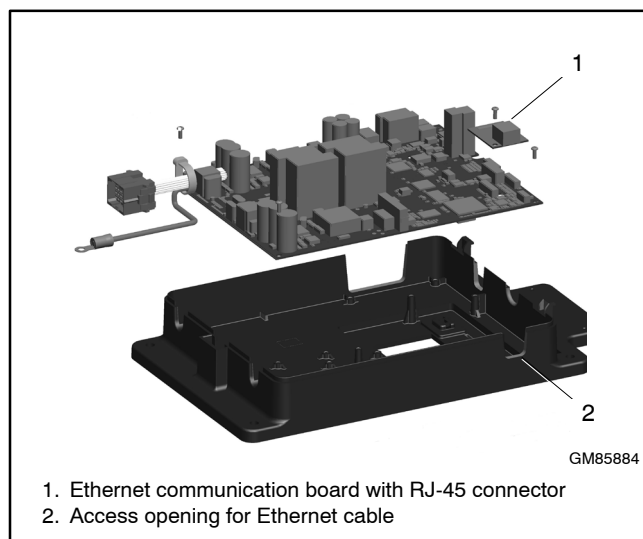
**Figure 3-4** Serial Connections

### 3.2.3 Ethernet Connection



**Servicing the transfer switch. Hazardous voltage can 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 an optional accessory for the MPAC 750 and MPAC 1200 controllers. The communication board connects to the controller board as shown in Figure 3-5.



**Figure 3-5** Ethernet Board (controller cover removed for illustration only)

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

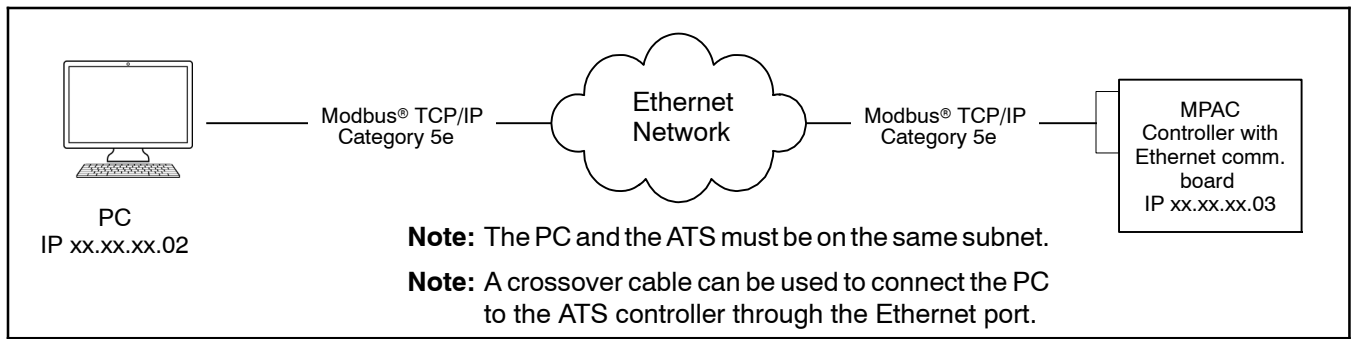
**Note:** For an ethernet connection, obtain an IP address and subnet mask number from the local system administrator.

**Ethernet Port.** The ethernet port is a standard RJ-45 jack. See Figure 3-5 for the location of the Ethernet port. Use Category 5e or better cable to connect the controller to the building's network.

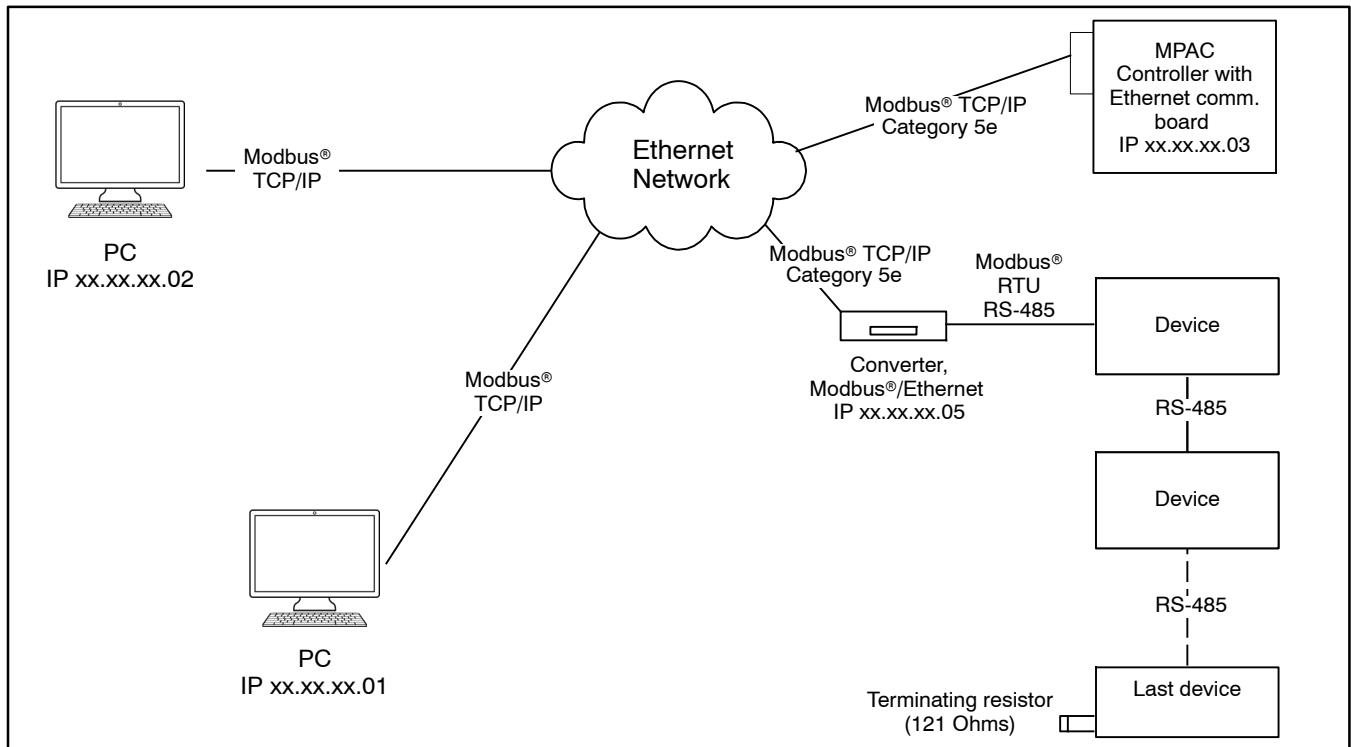
Use the controller's Setup menus or a personal computer connected to the controller's USB port and Kohler SiteTech software to set the communication parameters. The Ethernet communication board may have a default IP address assigned at the factory for test purposes. See Figure 3-6. **Change the IP address 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 3-7 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.

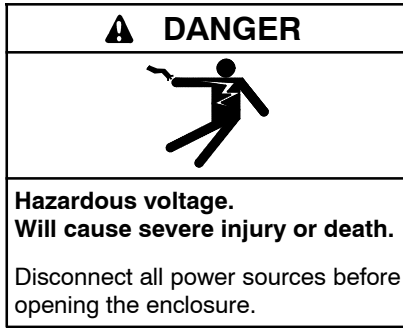


**Figure 3-6** Remote Network (Ethernet) Connection



**Figure 3-7** Ethernet Connections to Multiple-Device Network

### 3.3 Accessory Modules (MPAC 1200 only)



**Servicing the transfer switch. Hazardous voltage can 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.

Accessory modules are available with the MPAC 1200 controller. This section provides specifications and field connection information for factory-installed accessory modules. If the modules are not factory-installed, follow the instructions provided with the kits to install the mounting assembly and modules.

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. Add the current draw for all modules installed to determine the total current draw. See Figure 3-8. The total current drawn by all modules must not exceed 300 mA. 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.

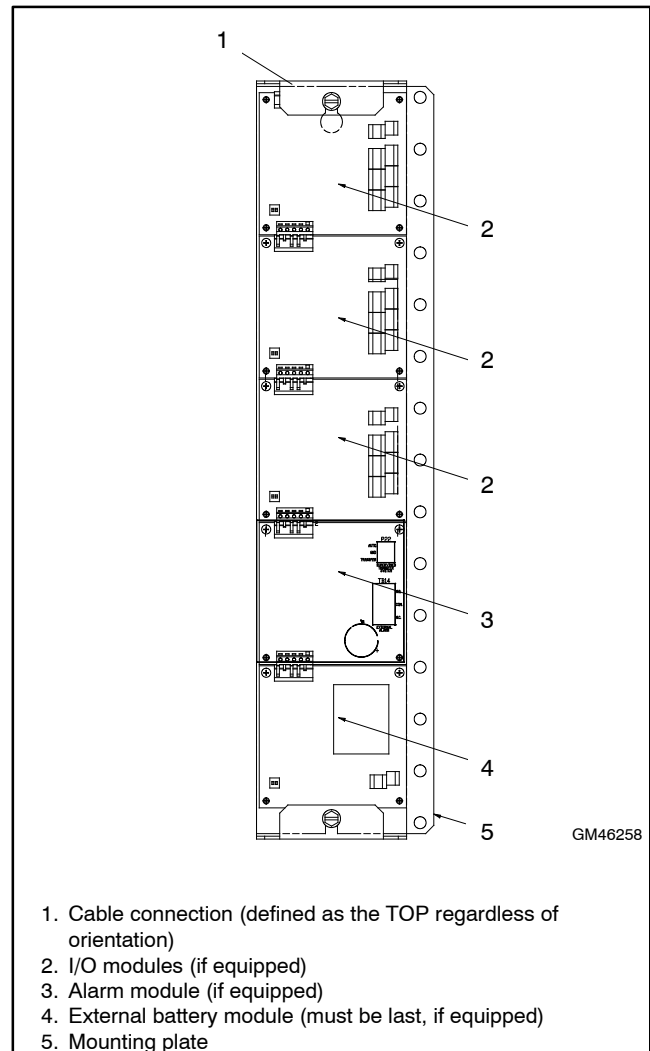
Module Current Draw Specifications, mA	
Alarm Module	75
Standard I/O Module	75
High Power I/O Module	100
<b>Note:</b> EBSM required if total current is higher than 300 mA.	

**Figure 3-8** Module Current Requirements

#### 3.3.1 Accessory Module Mounting

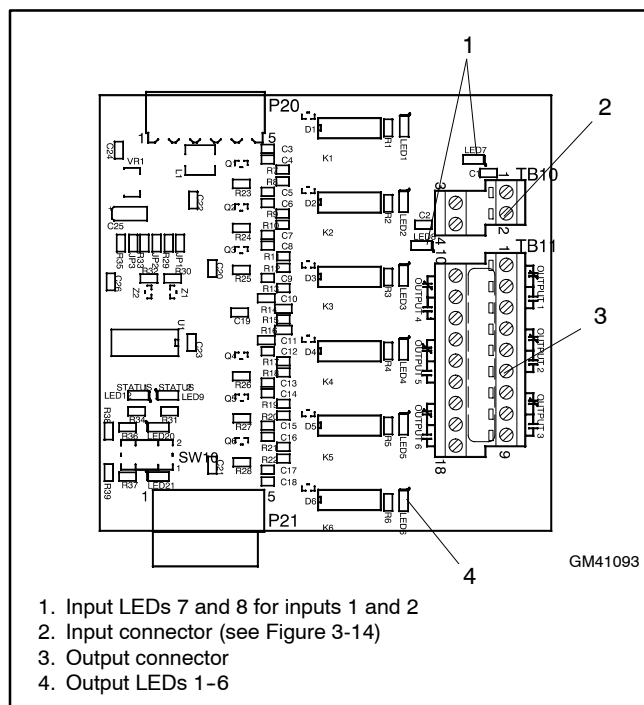
Mount the accessory modules on the module mounting plate. Starting at the end of the module mounting assembly nearest the cable connection, install any I/O modules first, then install the alarm board, if used. The external battery module, if used, must be the last module. See Figure 3-9. The alarm board 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.



**Figure 3-9** Module Mounting

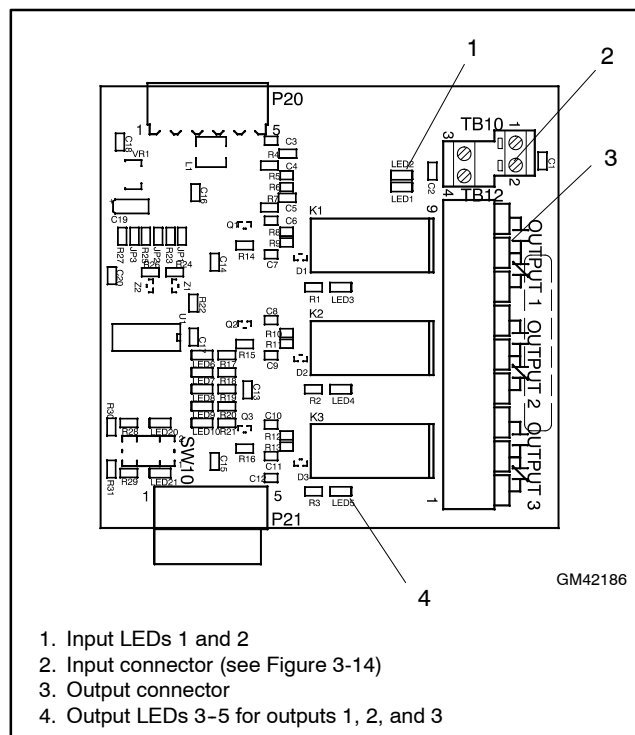
Two types of input/output modules are available. The standard I/O Module has two inputs and six outputs. The high-power I/O module has two inputs and three outputs. See Figure 3-10 through Figure 3-13 for I/O module illustrations and specifications.



**Figure 3-10** 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 3-11 Standard I/O Module Specifications



**Figure 3-12** 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 3-13 High-Power I/O Module Specifications

Use 14-24 AWG cable to connect to inputs and outputs. See Figure 3-14.

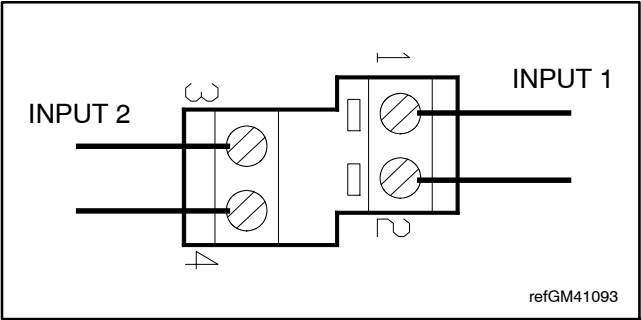
LEDs on the module circuit board light to indicate that each input or output is active.

**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 3-15. 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 3-14** I/O Module Input Connections (TB1 or TB10)

ON

2

1

Both switches OFF  
Address=1 shown

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

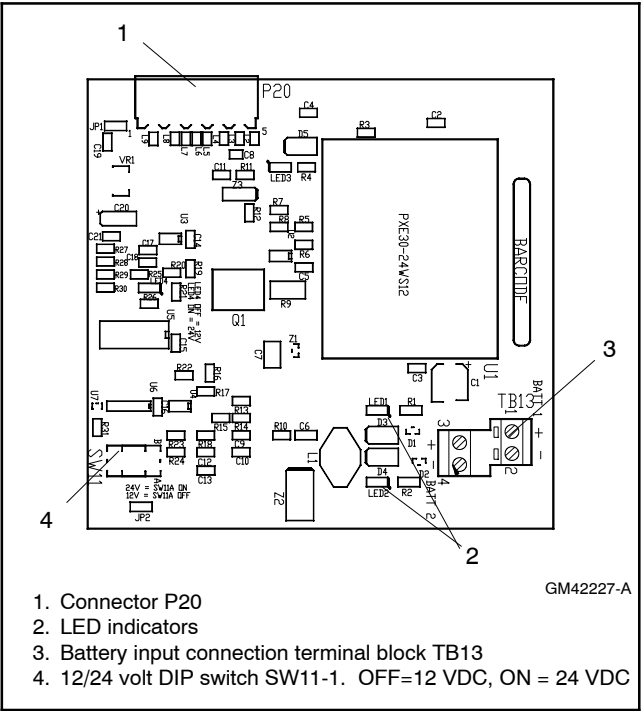
**Figure 3-15** Address DIP Switch Settings

### 3.3.3 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.
- **Transfer switches equipped with multiple accessory modules that require a total of more than 300 mA current.** See Figure 3-8.

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. The module is shown in Figure 3-16.



**Figure 3-16** External Battery Supply Module

The external battery supply module kit includes one external battery supply circuit board and the circuit board mounting components. A module mounting kit is required for installation of the external battery supply module. See Section 3.3.1. 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 3-17** 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 3-16 and Figure 3-17.

**Note:** If the battery connections are reversed, red LED1 or LED2 will light. See Figure 3-16.

2. Set voltage selector switch SW11-1 to 12 or 24VDC. See Figure 3-16 and Figure 3-17. Switch SW11-2 is not used.

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

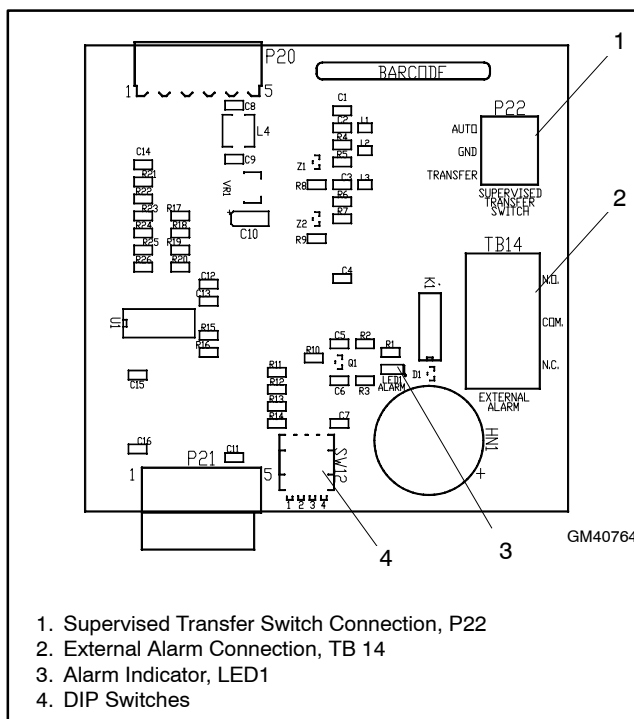
### 3.3.4 Alarm Module

See Figure 3-18 for the optional alarm module. A module mounting kit is required for installation of the alarm module. See Section 3.3.1.

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.



**Figure 3-18** 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 3-19. 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 3-19** 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 3-20.

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

**Figure 3-20** 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 3-21. Press the Alarm button to open the Reset menu. Then press the button labeled Reset to silence the alarm.

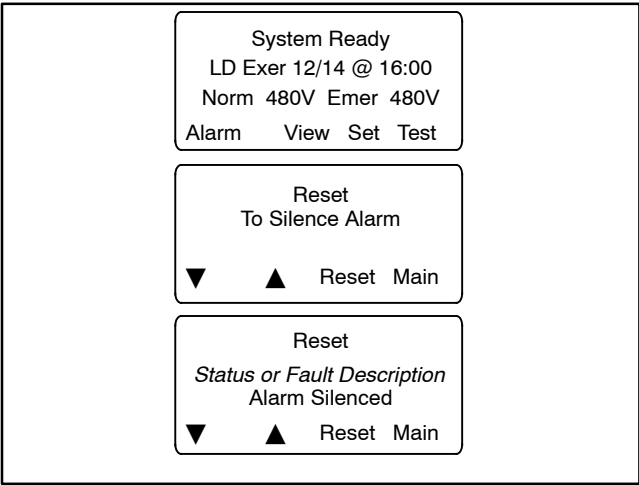
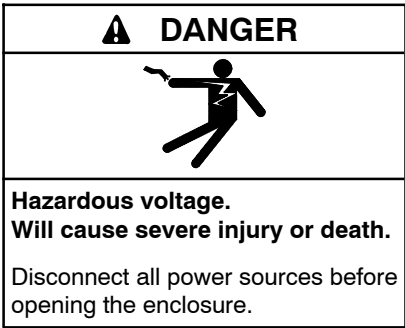


Figure 3-21 Alarm Silence

3.4 Heater



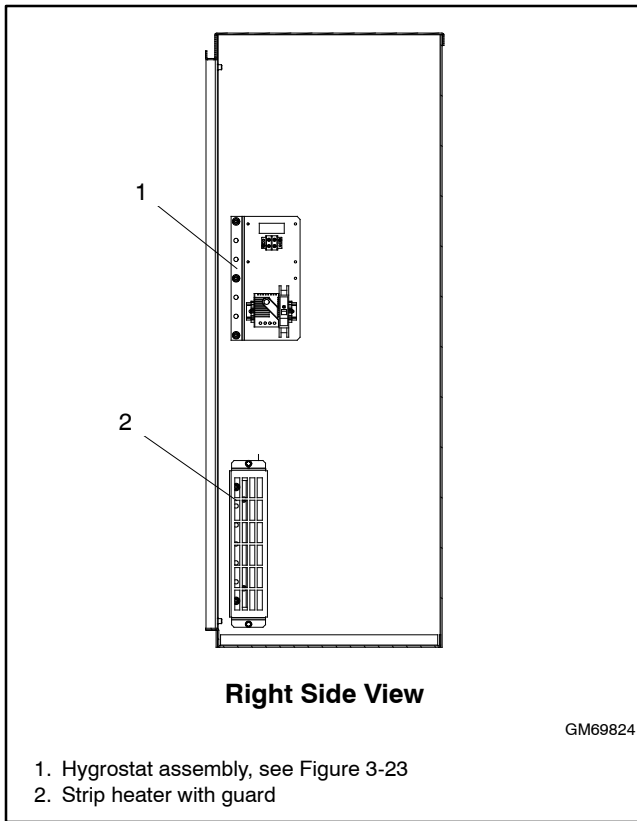
**Servicing the transfer switch. Hazardous voltage can cause severe injury or death.** Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut 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 3-22 shows a typical location of the heater kit components inside the enclosure.

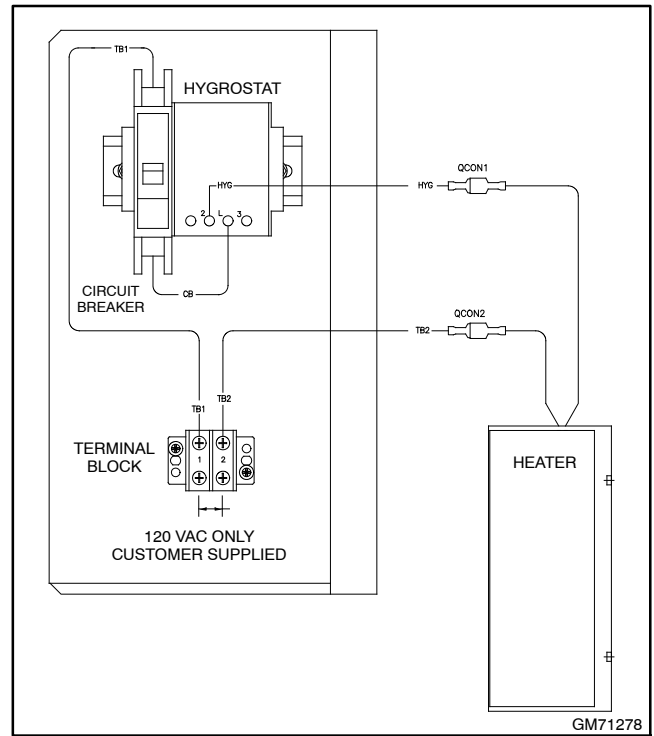
The installer must connect 120 VAC power to the terminal block near the hygrostat. See Figure 3-23 and Figure 3-24. The heater and hygrostat are connected to power through a 15-amp circuit breaker.

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

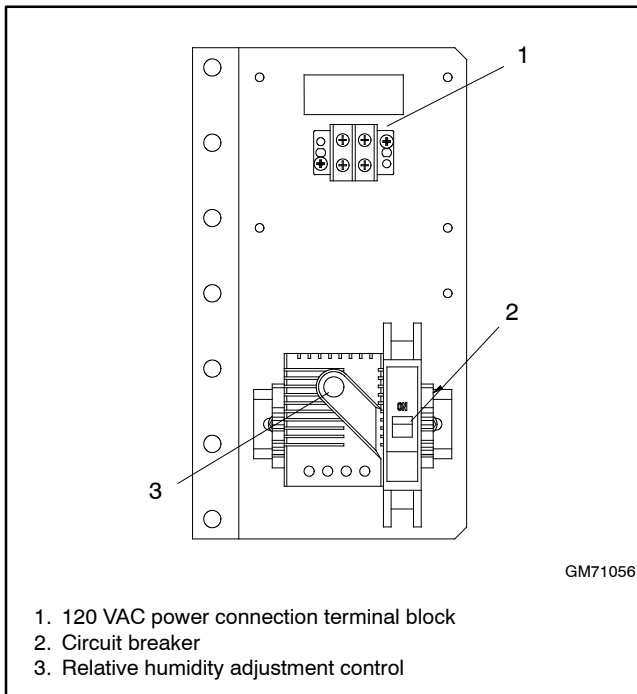
Because of space limitations in the smaller enclosures, 30-225 Amp Model KSS switches can include either an enclosure heater or a surge protection device (SPD), but not both.



**Figure 3-22** Heater Location, Typical

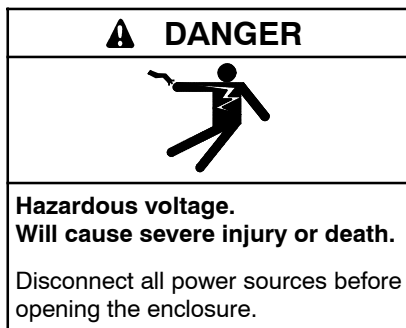


**Figure 3-24** Heater Connections



**Figure 3-23** Hygrostat Assembly, Typical

### 3.5 Load Shed (Forced Transfer to OFF, KSP with MPAC 1200 only)



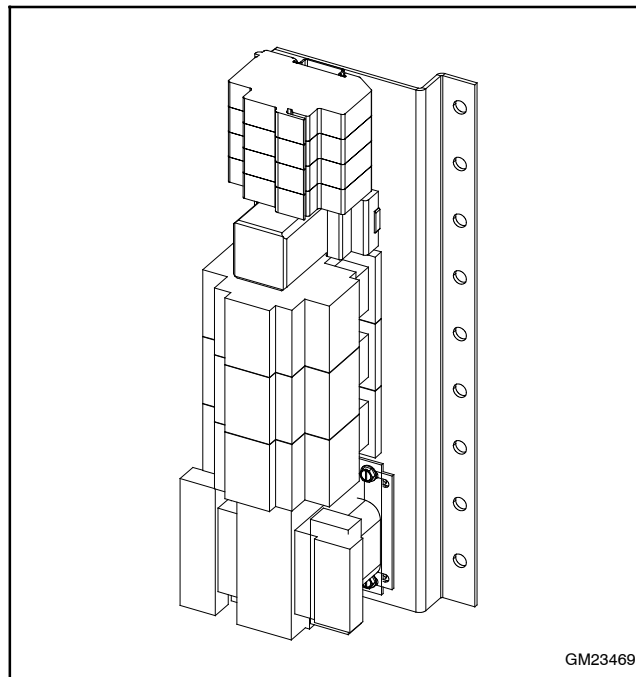
**Servicing the transfer switch. Hazardous voltage can cause severe injury or death.** Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Press the generator set off/reset button to shut 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 with the MPAC 1200 controller. See Figure 3-25 for an illustration of the load shed accessory.

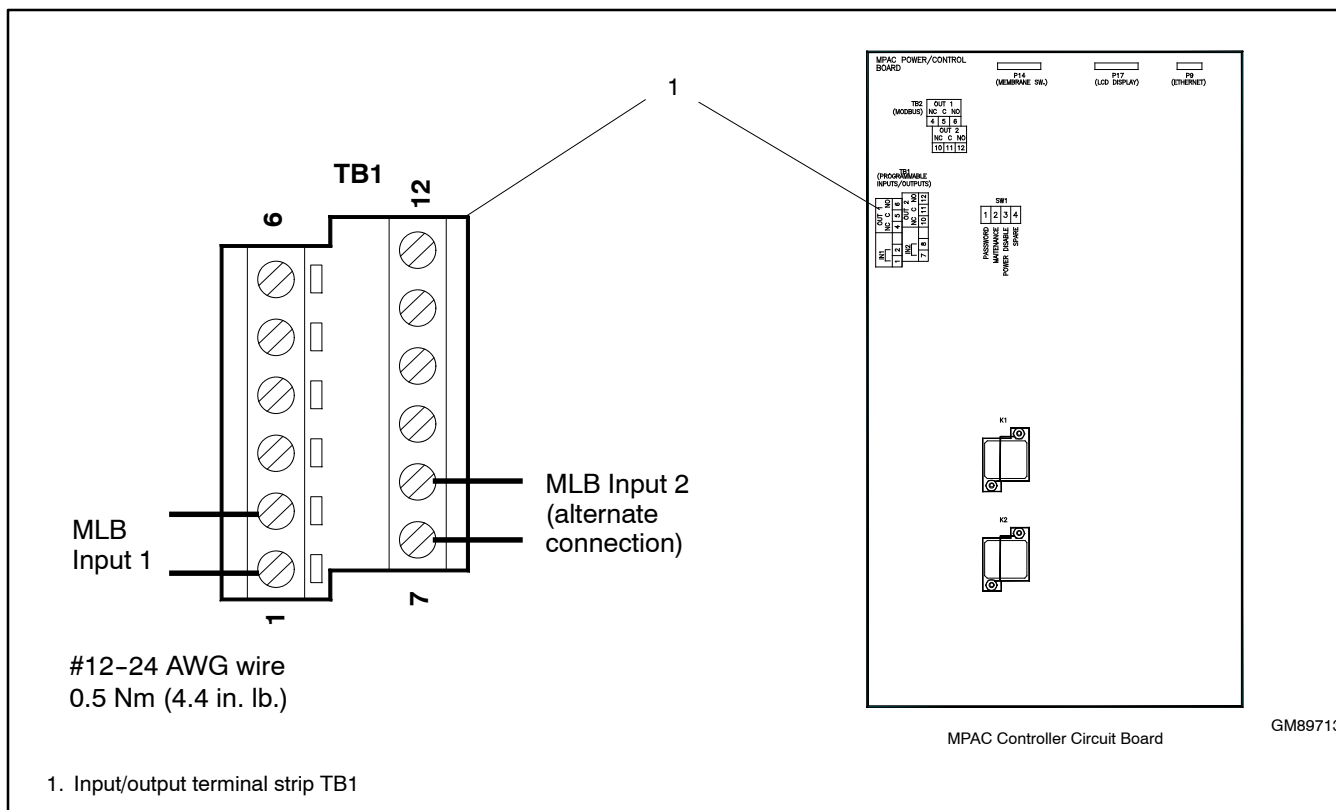
The load shed function requires an external signal (contact closure) to initiate transfer to the OFF position.

Connect the external contact to input #1 (if available) or input #2 on connector TB1 on the main logic board. See Figure 3-26. 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 3-25** Load Shed Accessory (for identification)



**Figure 3-26** Forced Transfer to Off Input Connection (for factory-installed load shed kits)

### 3.6 Programmable Exerciser

An optional programmable exerciser is available for transfer switches equipped with the Decision-Maker® MPAC 750 controller.

The optional programmable exerciser is a 7-day timer that allows programming of up to 8 on/off events per day. See Figure 3-27. Use the exercise timer to schedule weekly loaded or unloaded exercise runs in addition to the exercise time set through the ATS controller. The timer is installed inside the ATS enclosure.

The programmable exerciser uses the Remote Test input to the transfer switch controller. Refer to the instruction sheet provided with the exerciser for installation, connection, loaded/unloaded test selection, and programming instructions. See Section 2.6.1 for input connection information.

A personal computer and Kohler® SiteTech™ software are required to set up the remote exerciser. SiteTech software is available to Kohler-authorized distributors and dealers.



**Figure 3-27** Programmable Exerciser

### 3.7 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.

## Section 4 Scheduled Maintenance

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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 controller 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 4-1 for the Operation Manual part number.

Keep records of all maintenance or service.

Operation Manual	Part Number
Operation Manual, Decision-Maker® MPAC 1200 Controller	TP-6866
Operation Manual, Decision-Maker® MPAC 750 Controller	TP-6865

**Figure 4-1** Operation Manuals

## Notes



## Section 5 Functional Tests and Setup

### 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
- 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.

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

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

### 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.

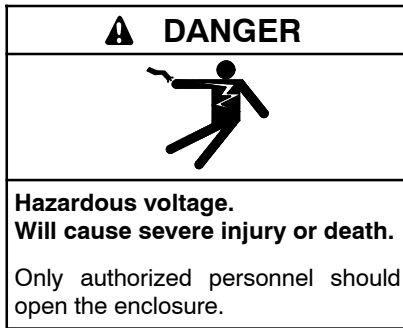
Follow the instructions provided with the generator set to prepare the generator set for operation.

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



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

### Voltage Check Procedure

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 Engine Cooldown Time Delay ends.
12. Perform the lamp test and then proceed to the automatic operation test.

## 5.4 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.

## 5.5 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.

## 5.6 Exerciser Setup

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

Transfer switches equipped with the Decision-Maker® MPAC 750 controller may also use the optional programmable exerciser. Refer to the instructions provided with the exerciser to schedule additional loaded or unloaded exercise runs.

## 5.7 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. NEMA 3R enclosures include the cover as standard equipment.

Use a customer-supplied padlock to lock the cover.

## 5.8 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

# Appendix A Abbreviations

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

A, amp	ampere	cfm	cubic feet per minute	exh.	exhaust
ABDC	after bottom dead center	CG	center of gravity	ext.	external
AC	alternating current	CID	cubic inch displacement	F	Fahrenheit, female
A/D	analog to digital	CL	centerline	FHM	flat head machine (screw)
ADC	advanced digital control; analog to digital converter	cm	centimeter	fl. oz.	fluid ounce
adj.	adjust, adjustment	CMOS	complementary metal oxide substrate (semiconductor)	flex.	flexible
ADV	advertising dimensional drawing	com	communications (port)	freq.	frequency
Ah	amp-hour	coml	commercial	FS	full scale
AHWT	anticipatory high water temperature	Coml/Rec	Commercial/Recreational	ft.	foot, feet
AISI	American Iron and Steel Institute	conn.	connection	ft. lb.	foot pounds (torque)
ALOP	anticipatory low oil pressure	cont.	continued	ft./min.	feet per minute
alt.	alternator	CPVC	chlorinated polyvinyl chloride	ftp	file transfer protocol
Al	aluminum	crit.	critical	g	gram
ANSI	American National Standards Institute (formerly American Standards Association, ASA)	CSA	Canadian Standards Association	ga.	gauge (meters, wire size)
AO	anticipatory only	CT	current transformer	gal.	gallon
APDC	Air Pollution Control District	Cu	copper	gen.	generator
API	American Petroleum Institute	cUL	Canadian Underwriter's Laboratories	genset	generator set
approx.	approximate, approximately	CUL	Canadian Underwriter's Laboratories	GFI	ground fault interrupter
APU	Auxiliary Power Unit	cu. in.	cubic inch	GND, ⊕	ground
AQMD	Air Quality Management District	cw.	clockwise	gov.	governor
AR	as required, as requested	CWC	city water-cooled	gph	gallons per hour
AS	as supplied, as stated, as suggested	cyl.	cylinder	gpm	gallons per minute
ASE	American Society of Engineers	D/A	digital to analog	gr.	grade, gross
ASME	American Society of Mechanical Engineers	DAC	digital to analog converter	GRD	equipment ground
assy.	assembly	dB	decibel	gr. wt.	gross weight
ASTM	American Society for Testing Materials	dB(A)	decibel (A weighted)	H x W x D	height by width by depth
ATDC	after top dead center	DC	direct current	HC	hex cap
ATS	automatic transfer switch	DCR	direct current resistance	HCHT	high cylinder head temperature
auto.	automatic	deg., °	degree	HD	heavy duty
aux.	auxiliary	dept.	department	HET	high exhaust temp., high engine temp.
avg.	average	dia.	diameter	hex	hexagon
AVR	automatic voltage regulator	DI/EO	dual inlet/end outlet	Hg	mercury (element)
AWG	American Wire Gauge	DIN	Deutsches Institut für Normung e. V. (also Deutsche Industrie Normenausschuss)	HH	hex head
AWM	appliance wiring material	DIP	dual inline package	HHC	hex head cap
bat.	battery	DPDT	double-pole, double-throw	HP	horsepower
BBDC	before bottom dead center	DPST	double-pole, single-throw	hr.	hour
BC	battery charger, battery charging	DS	disconnect switch	HS	heat shrink
BCA	battery charging alternator	DVR	digital voltage regulator	hsg.	housing
BCI	Battery Council International	E <sup>2</sup> PROM, EEPROM	electrically-erasable programmable read-only memory	HVAC	heating, ventilation, and air conditioning
BDC	before dead center	E, emer.	emergency (power source)	HWT	high water temperature
BHP	brake horsepower	ECM	electronic control module, engine control module	Hz	hertz (cycles per second)
blk.	black (paint color), block (engine)	EDI	electronic data interchange	IBC	International Building Code
blk. htr.	block heater	EFR	emergency frequency relay	IC	integrated circuit
BMEP	brake mean effective pressure	e.g.	for example ( <i>exempli gratia</i> )	ID	inside diameter, identification
bps	bits per second	EG	electronic governor	IEC	International Electrotechnical Commission
br.	brass	EGSA	Electrical Generating Systems Association	IEEE	Institute of Electrical and Electronics Engineers
BTDC	before top dead center	EIA	Electronic Industries Association	IMS	improved motor starting
Btu	British thermal unit	EI/EO	end inlet/end outlet	in.	inch
Btu/min.	British thermal units per minute	EMI	electromagnetic interference	in. H <sub>2</sub> O	inches of water
C	Celsius, centigrade	emiss.	emission	in. Hg	inches of mercury
cal.	calorie	eng.	engine	in. lb.	inch pounds
CAN	controller area network	EPA	Environmental Protection Agency	Inc.	incorporated
CARB	California Air Resources Board	EPS	emergency power system	ind.	industrial
CAT5	Category 5 (network cable)	ER	emergency relay	int.	internal
CB	circuit breaker	ES	engineering special, engineered special	int./ext.	internal/external
CC	crank cycle	ESD	electrostatic discharge	I/O	input/output
cc	cubic centimeter	est.	estimated	IP	internet protocol
CCA	cold cranking amps	E-Stop	emergency stop	ISO	International Organization for Standardization
ccw.	counterclockwise	etc.	et cetera (and so forth)	J	joule
CEC	Canadian Electrical Code			JIS	Japanese Industry Standard
cert.	certificate, certification, certified			k	kilo (1000)
cfh	cubic feet per hour			K	kelvin

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



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