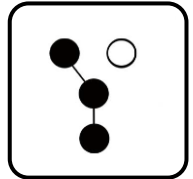


Operation and Installation

Service Entrance Rated Automatic Transfer Switches



Models:

KUS/KUP

70 to 4000 Amperes

Product Identification Information

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

Transfer Switch Identification Numbers

Record the product identification numbers from the transfer switch nameplate.

Model Designation _____

Serial Number: _____

Controller Identification

Record the controller description from the transfer switch operation manual, spec sheet, or sales invoice.

Controller Description _____

Accessories

- Alarm Board
- Controller Disconnect Switch
- Current Monitoring
- Digital Meter
- Engine Start Circuit Monitor
- Heater
- IBC Seismic Certification
- I/O Module, Standard (max. 4) qty: _____
- I/O Module, High Power (max. 4) qty: _____
- Load Shed
- Surge Protection Device (SPD)
- User Interface Cover
- _____
- _____
- _____
- _____

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Safety Precautions and Instructions

Read and follow all safety precautions and instructions. SAVE THESE 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 indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

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

	Accidental starting. Can cause severe injury or death.
	Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

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

(Decision-Maker® 3+ and 550 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.

(APM402, APM603, RDC2, and Decision-Maker® 3000, 3500, and 6000 Controllers)

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

(Decision-Maker® 8000 Controller)

Hazardous Voltage/Moving Parts

 DANGER	Hazardous voltage. Will cause severe injury or death. Disconnect all power sources before opening the enclosure.
	
 DANGER	Hazardous voltage. Will cause severe injury or death. Only authorized personnel should open the enclosure.
	

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

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

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

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



(Decision-Maker® 3+ and 550 Controllers)

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

(APM402, APM603, RDC, DC, RDC2, DC2, Decision-Maker® 3000, 3500 and 6000 Controllers)

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

Heavy Equipment

 WARNING	<p>Unbalanced weight. Improper lifting can cause severe injury or death and equipment damage.</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® Contactor-based Service Entrance Rated Automatic Transfer Switches (ATS):

- Model KUS standard-transition service entrance rated ATS.
- Model KUP programmed-transition service entrance rated ATS.

The transfer switch is equipped with the Kohler® Decision-Maker® MPAC 1500 transfer switch 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 information for transfer switch power switching devices and electrical controls. For replacement parts, refer to the Kohler Power Parts online parts system.

The following table lists the part numbers for related literature.

Literature Item	Part Number
Specification Sheet, Decision-Maker® MPAC 1500 Controller	G11-128
Specification Sheet, Model KUS/KUP ATS	G11-153
Operation Manual, Decision-Maker® MPAC 1500 Controller	TP-6883
Installation Manual, Model KUS/KUP	TP-7280
Wiring Diagram Manual, Model KUS/KUP	TP-7281
Service Manual, Model KUS/KUP	TP-7282

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

- Visit the Kohler Co. website at KOHLERPower.com.
- Look at the labels and decals on your Kohler product or review the appropriate literature or documents included with the product.
- Call toll free in the US and Canada 1-800-544-2444.
- Outside the US and Canada, call the nearest regional office.

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North Asia Regional Office
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Section 1. Product Description

1.1 General Description

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.

Model KUS/KUP automatic transfer switches employ a contactor-based power switching unit and the Kohler Decision Maker® 1500 controller to automatically transfer system load to a generator supply in the event of a utility supply failure. 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. When the Normal (preferred) source returns and stabilizes, the ATS transfers the load back to Normal. After transferring the load back to Normal (preferred), the ATS removes the generator start signal, allowing the generator set to shut down.

Model KUS/KUP service entrance rated transfer switches have integral overcurrent protection with a shunt trip module supplied for the utility source as standard equipment. This allows installation at the point of service entrance and eliminates the need to have a separate upstream utility source circuit breaker or disconnect. Refer to the Overcurrent Protection Section for more information.

Figure 1 shows examples of some typical service entrance rated ATSs. The utility circuit breaker location varies for different models.

Figure 2 shows a typical installation block diagram.

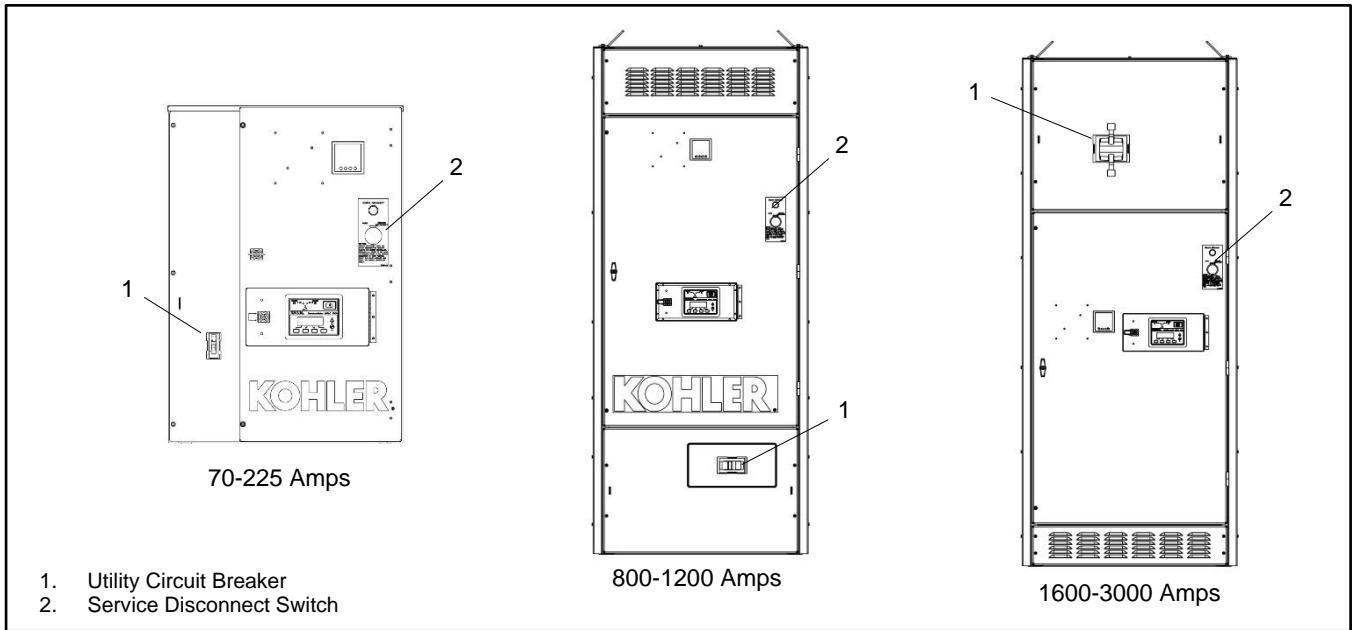


Figure 1 Typical Service Entrance-Rated Automatic Transfer Switches

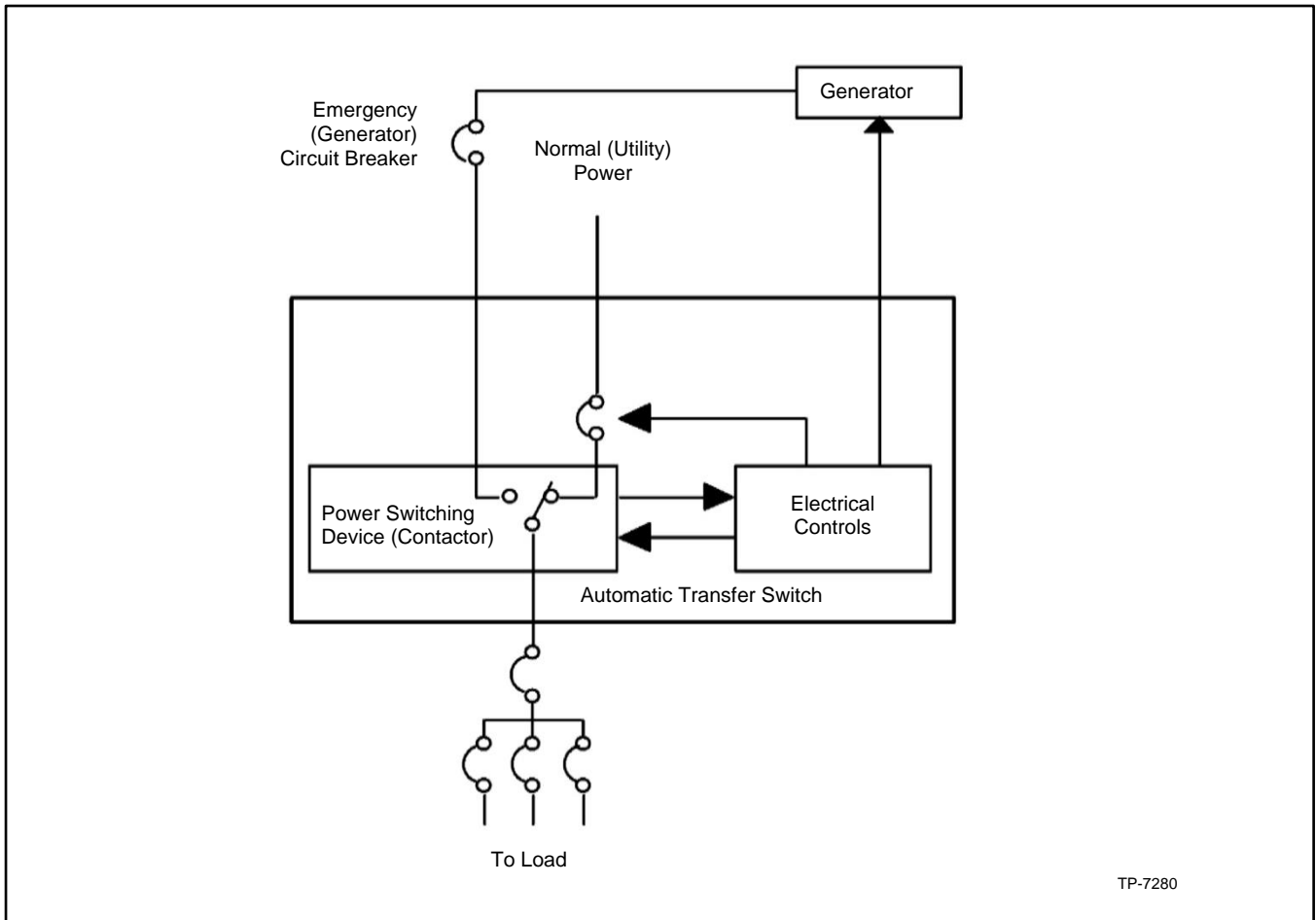


Figure 2 Service Entrance Rated ATS Block Diagram

1.2 Overcurrent Protection

Model KUS/KUP service entrance rated transfer switches have an integral overcurrent protection with shunt trip supplied on the utility source as standard. An upstream overcurrent protection device is required for the generator source. The type of overcurrent protection varies with ATS amperage size and optional features specified. Transfer switches rated 70A through 200A use nonadjustable thermal-magnetic type trip units (standard) or electronic trip units (optional). Transfer switches rated 250A through 4000A use adjustable electronic type with long time and instantaneous trip unit elements. Ground fault protection is standard on 1000 Amp and larger units. See the Model KUS/KUP Specification Sheet for available circuit breaker sizes and trip types.

For overcurrent trip and circuit breaker reset information, see the Operation Section of this document.

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

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

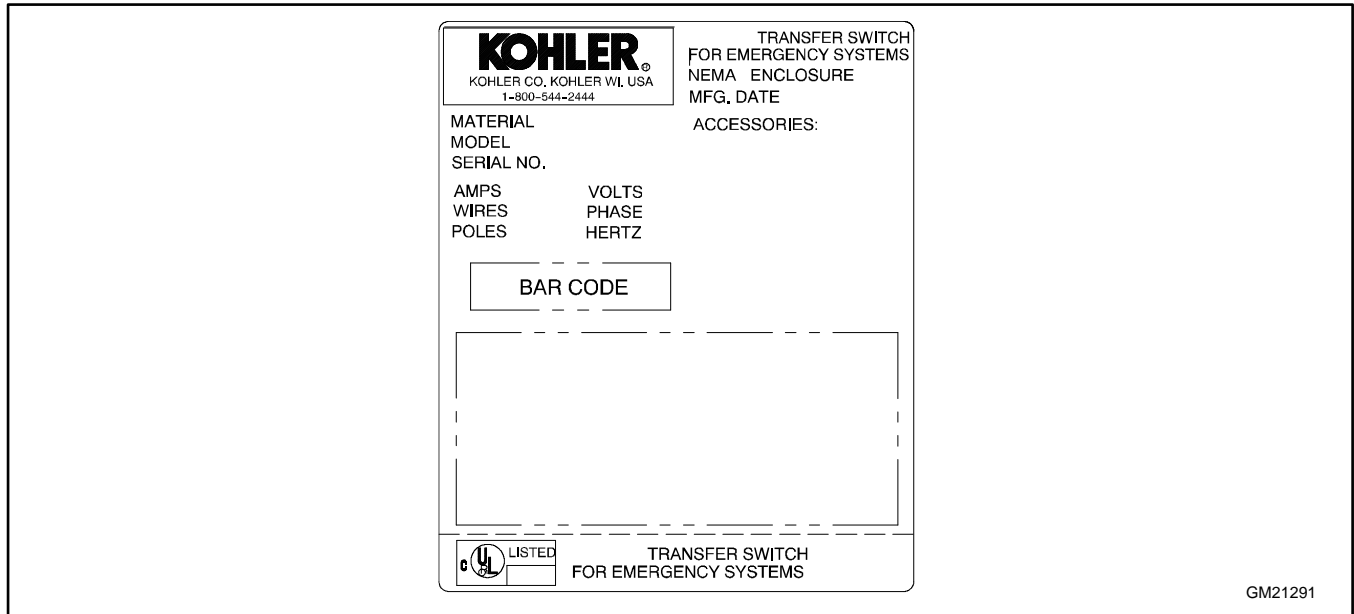
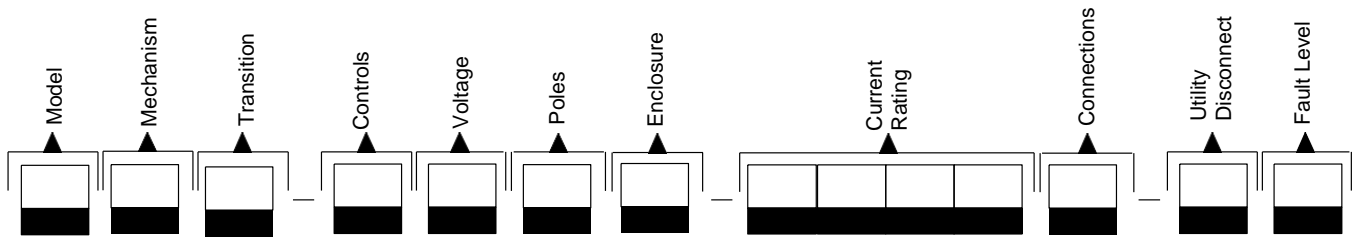


Figure 3 Typical Transfer Switch Nameplate

1.4 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: KUS-DNTA-0400S-XS

Model

K: Kohler

Enclosure

A: NEMA 1

D: NEMA 4

B: NEMA 12

F: NEMA 4X

C: NEMA 3R

Mechanism

U: Service Entrance, Utility

Current, Amps

Transition

S: Standard

P: Programmed

0070 0250 1600

0100 0400 2000

0150 0600 2600

0200 0800 3000

0225 1200 4000

Controller

D: Decision-Maker® MPAC 1500, Automatic

Connections

S: Standard

Voltage/Frequency

C: 208 Volts /60 Hz

D: 220 Volts /50 Hz

F: 240 Volts /60 Hz

G: 380 Volts /50 Hz

H: 400 Volts/50 Hz

J: 416 Volts /50 Hz

K: 440 Volts /60 Hz

M: 480 Volts /60 Hz

N: 600 Volts /60 Hz

P: 380 Volts/60 Hz

R: 220 Volts/60 Hz

S: 400 Volts/60 Hz

Utility Disconnect

U: 80% TM

V: 100% TM

W: 80% ET

X: 100% ET

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

Fault Level

S: Standard

H: High Fault

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 and verify that the installation complies with applicable codes and standards. Switch installation includes the following steps:

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

Protect the switch against damage before and during installation.



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

2.2 Receipt of Unit

2.2.1 Inspection

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

2.2.2 Lifting

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

Refer to Figure 4 for the approximate weight of the transfer switch in a Type 1 enclosure. 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	NEMA Type	Weight kg (lb.)		3-Pole		4-Pole	
			2-Pole					
KUS	70-225	1	66	(145)	67	(148)	69	(151)
		3R	90	(199)	92	(202)	93	(205)
		4X	137	(302)	138	(305)	140	(308)
	225-600	1	223	(492)	227	(500)	232	(511)
		3R	237	(522)	240	(530)	245	(541)
		4X	245	(540)	249	(549)	254	(560)
	800-1200	1	488	(1075)	497	(1095)	519	(1145)
		3R	501	(1105)	510	(1125)	533	(1175)
		4X	517	(1140)	526	(1160)	549	(1210)
	1600-2000	1	—		846	(1865)	875	(1930)
		3R	—		982	(2165)	1011	(2230)
	2500-3000	1	—		891	(1965)	921	(2030)
3R		—		1027	(2265)	1057	(2330)	
4000	1	—		1581	(3485)	1662	(3665)	
	3R	—		1762	(3885)	1844	(4065)	
KUP	150-600	1	230	(507)	234	(515)	188	(526)
		3R	243	(537)	247	(545)	188	(556)
		4X	245	(540)	249	(549)	188	(560)
	800-1200	1	499	(1100)	512	(1130)	238	(1184)
		3R	512	(1130)	526	(1160)	238	(1214)
		4X	528	(1165)	542	(1195)	485	(1249)
	1600-2000	1	—		907	(2000)	556	(2065)
		3R	—		1043	(2300)	1073	(2365)
	2500-3000	1	—		977	(2155)	1007	(2220)
		3R	—		1113	(2455)	1143	(2520)
	4000	1	—		1667	(3675)	1748	(3855)
		3R	—		1848	(4075)	1930	(4255)

Figure 4 Approximate Weights

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 5 for acceptable storage temperatures.

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

Figure 5 Environmental Specifications

2.2.4 Unpacking

Allow the equipment to warm to room temperature for at least 24 hours before unpacking to prevent condensation on the electrical apparatus. Use care when unpacking to avoid damaging transfer switch components. Remove dirt and packing material that may have accumulated in the transfer switch or any of its components.

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.

Check for and remove lag screws that secure the transfer switch to the shipping skid. Lag screws may be found on the outside or the inside of the enclosure.

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.

NOTICE

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. Refer to the applicable enclosure outline drawing for all mounting details including door opening space.

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 IBC seismically certified transfer switches. IBC seismic certification must be requested when the transfer switch is ordered. See the IBC Seismic Certification section and the transfer switch dimension (ADV) drawings for additional installation requirements for transfer switches with IBC seismic certification.

Install the ATS. Mount 70-through 225-amp (except 225A/600V) 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 make it plumb. Verify that the door hinges are vertical to avoid distortion of the enclosure or door.

Bolt 225A/600V and 250-amp or larger 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.

2.3.1 IBC Seismic Certification

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

Abbreviations:

ACI: American Concrete Institute

IBC: International Building Code®

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

R_p: Equipment response modification factor

I_p: Equipment importance factor



a_p: In-structure equipment amplification factor

Refer to the International Building Code® for more information.

General Seismic Installation Notes (for ATS only):

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

2.4 Manual Operation, Model KUS Standard-Transition Switches

 DANGER	Hazardous voltage. Will cause severe injury or death. Disconnect all power sources before opening the enclosure.
	

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

Note:

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

Use the manual operation handle to check the manual operation before energizing the transfer switch. Use the following manual operation procedures to verify that the contactor operates smoothly without binding.

Note:

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

2.4.1 Manual Operation, 70-225 Amp Standard-Transition Switches

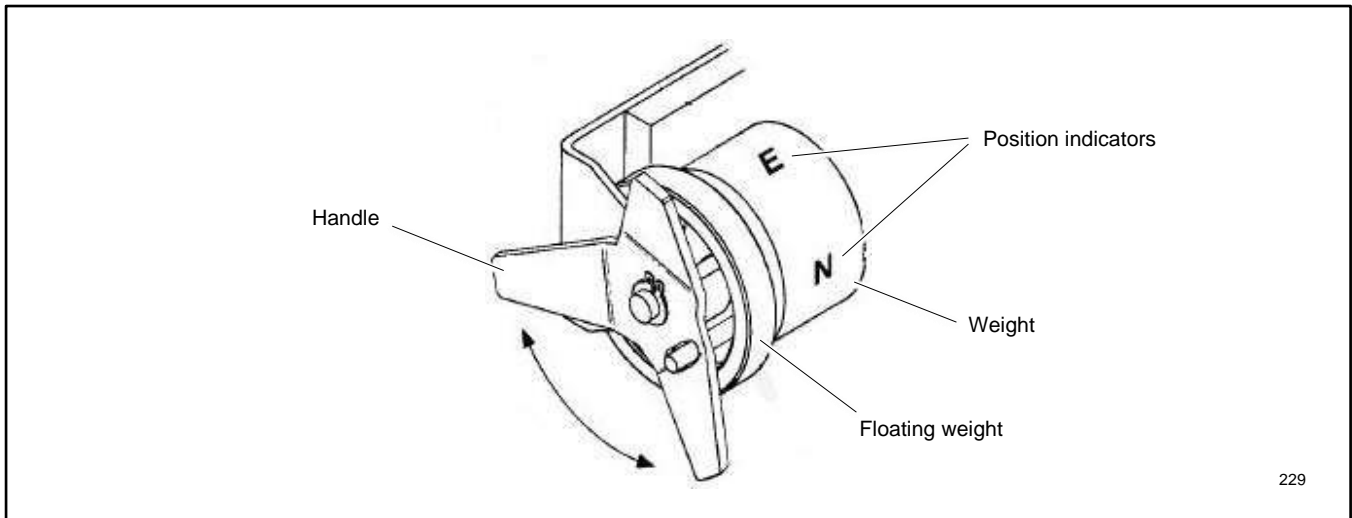
The 70-225 amp standard-transition models have an attached manual operating handle. See Figure 6.

Note:

For 225A/600V models, see the Manual Operation, 225A/600V and 250-4000 Amp Standard-Transition Switches section.

Manual Operation Test Procedure, 70-225 Amp Transfer Switches



1. Disable the generator set to prevent starting, open the line circuit breaker on the generator set, and perform the service disconnect procedure to disconnect all power sources before manually operating the transfer switch.
2. To manually operate the transfer switch, turn the attached handle by hand. See Figure 6. The maintenance handle turns in the opposite direction of the weight. It should operate smoothly without any binding. If it does not, check for shipping damage or construction debris.
3. Return the transfer switch to the Normal position.



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Figure 6 Manual Operation Handle, 70-225 Amp Model KUS

2.4.2 Manual Operation, 225A/600V and 250-4000 Amp Standard-Transition Switches

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

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.

The 250-4000 amp standard-transition models use a detachable manual operating handle.

Manual Operation Test Procedure, 225A/600V and 250-1200 Amp Standard-Transition Transfer Switches

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 the clip(s) on the left side of the transfer switch frame. See Figure 7.
3. **225 (600V) and 250--600 amp switches:** See Figure 8. Insert the maintenance handle into the hole in the shaft on the left side of the operator.
- 800-1200 amp switches:** See Figure 9. Insert the maintenance handle into the hole in the molded hub on the left side of the operator.
4. Move the maintenance handle up or down as shown to manually operate the transfer switch. It should operate smoothly without any binding. If it does not, check for shipping damage or construction debris. See Figure 10.
5. Return the transfer switch to the Normal position.
6. Remove the maintenance handle and store it on the frame in the clips provided.

Note:
 Verify that the maintenance handle has been removed before proceeding.

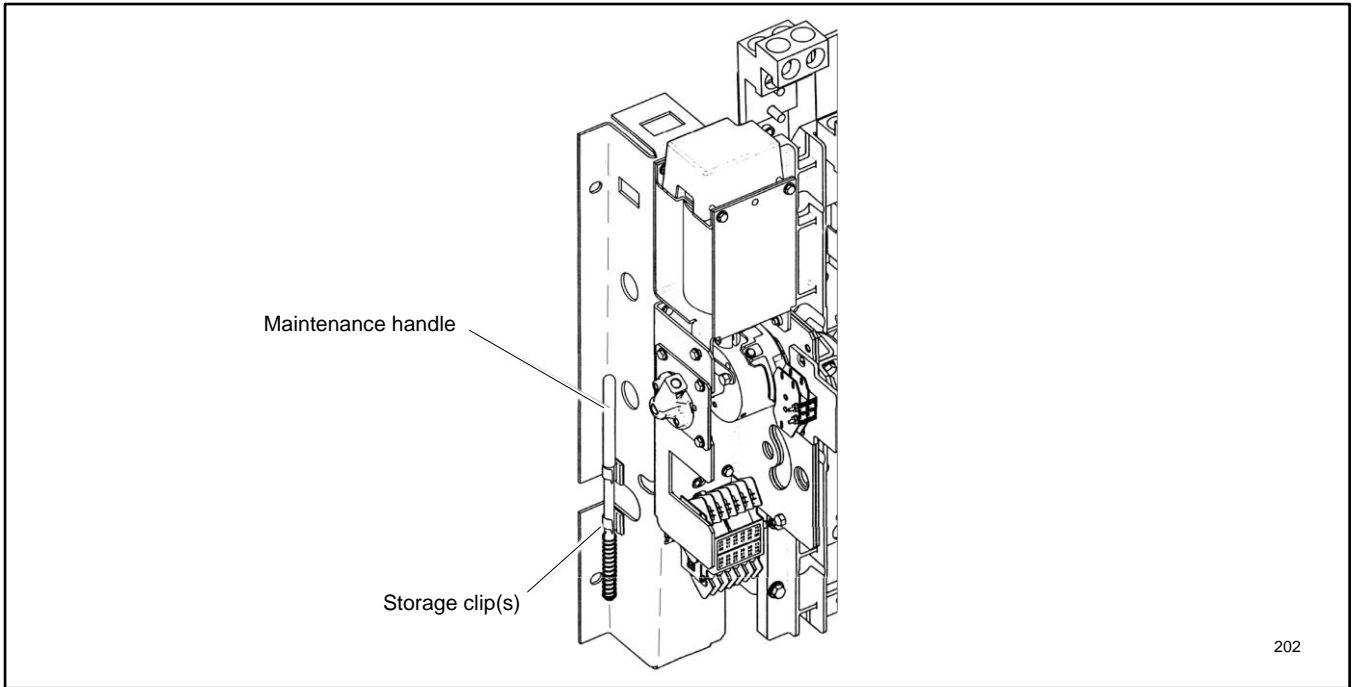


Figure 7 Detachable Handle Storage (typical)

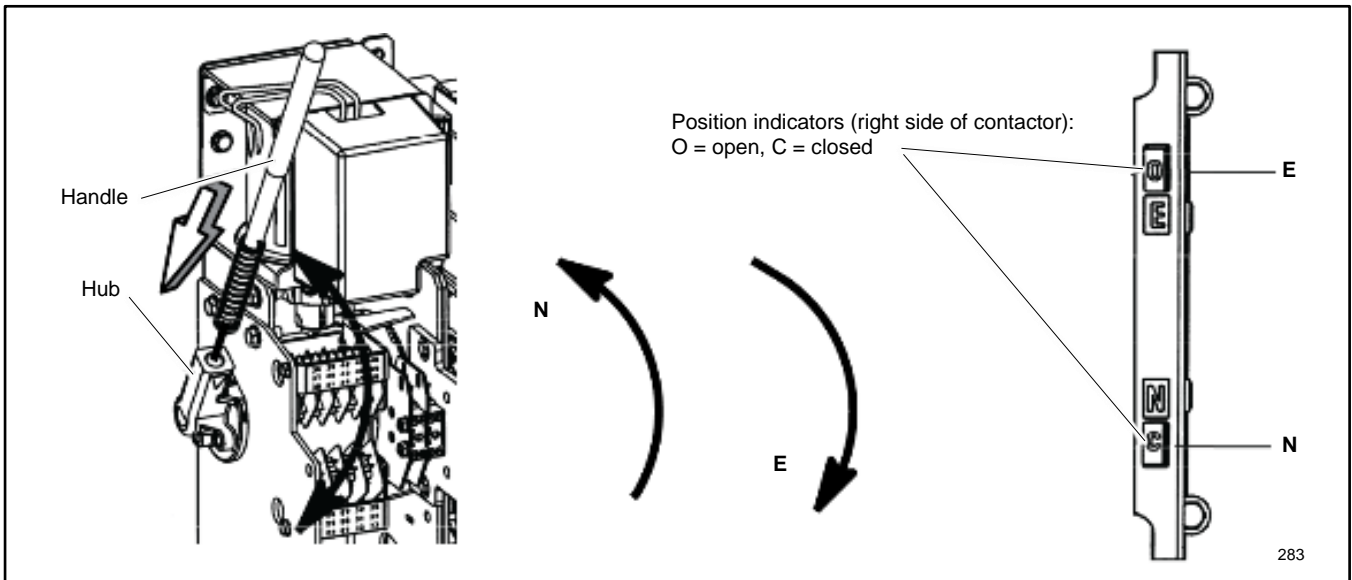


Figure 8 Manual Operation, 250-600 Amp Model KUS

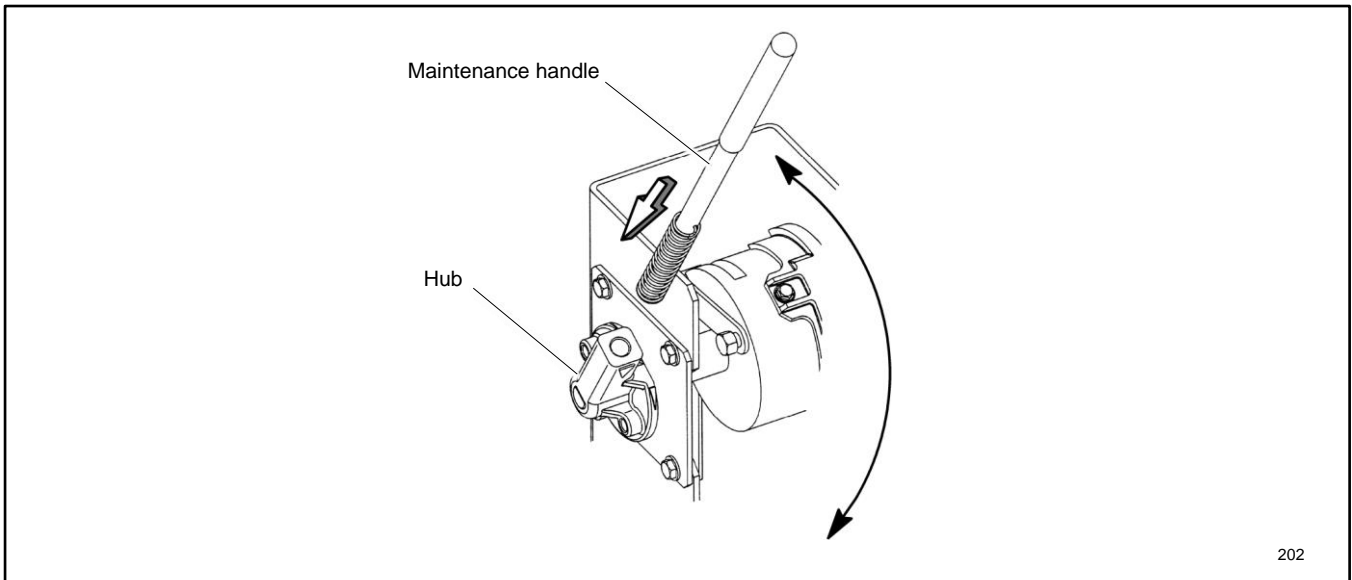


Figure 9 Manual Operation, 800-1200 Amp Model KUS

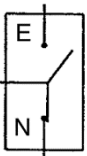

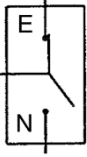

ATS Position	Handle	Indicators
Normal 	Up 	E : O Upper contacts open N : C lower contacts closed
Emergency 	Down 	E : C Upper contacts closed N : O lower contacts open
Note: If Normal and Emergency connections are reversed, this operation is also reversed.		

Figure 10 Maintenance Handle Positions, 260-1200 Amp Model KUS

Manual Operation Test Procedure, 1600-4000 Amp Standard-Transition Transfer Switches

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 the clip(s) on the left side of the transfer switch frame. See Figure 7.
3. **See Figure 11.** Insert the maintenance handle into the hole in the molded hub.
4. Move the maintenance handle as shown to manually operate the transfer switch. It should operate smoothly without any binding. If it does not, check for shipping damage or construction debris.
5. Return the transfer switch to the Normal position.
6. Remove the maintenance handle and store it on the transfer switch in the clips provided.

Note:

Verify that the maintenance handle has been removed before proceeding.

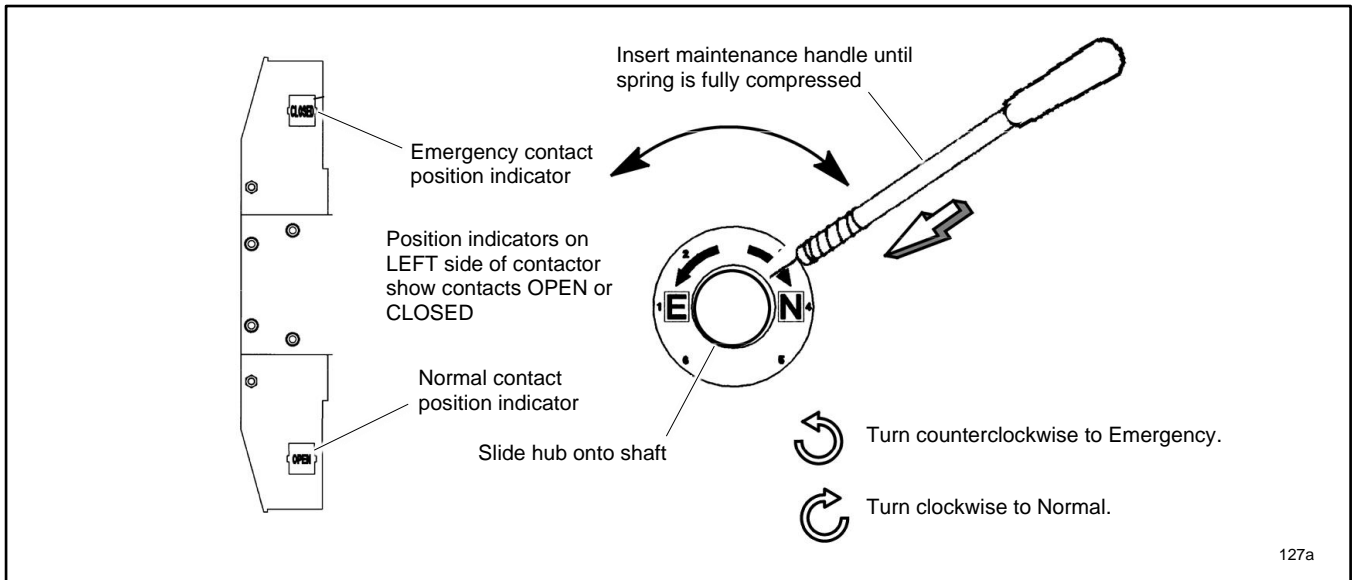



Figure 11 Manual Operation, 1600-4000 Amp Model KUS

2.5 Manual Operation, Model KUP Programmed-Transition Switches

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

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

NOTICE

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

Programmed-transition switches have two operators, Normal and Emergency, on the left side of the contactor assembly. Mechanical interlocks prevent closing both operators at the same time. Refer to Figure 12 for typical locations of the Normal and Emergency operators.

Programmed-transition models use a detachable manual operating handle. Position indicators on the right side of the contactor assembly show the positions of the operators. See the figure titled: Position Indicators.

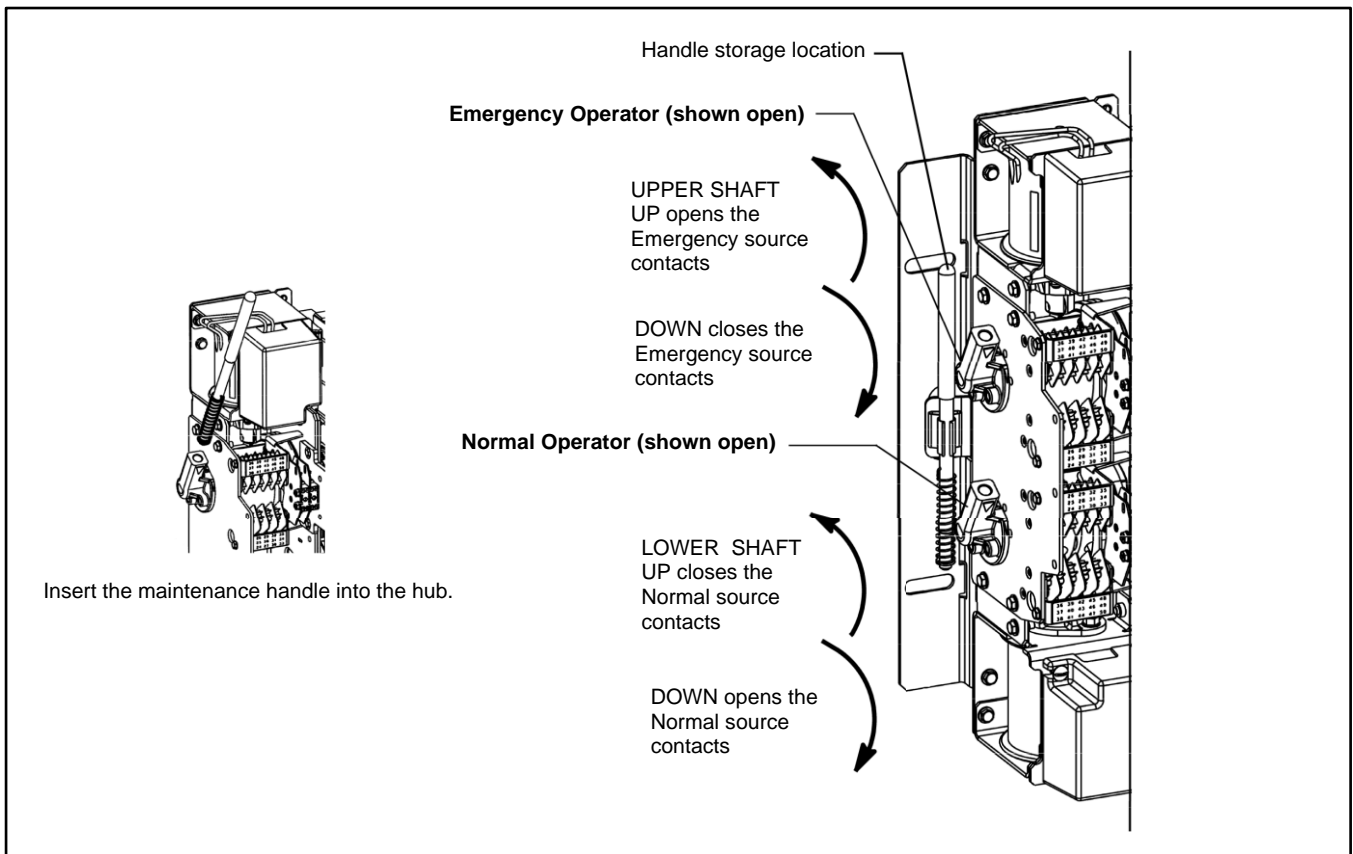


Figure 12 Model KCP Manual Operation (typical)

2.5.1 Manual Operation Test Procedure, 150-1200 Amp Programmed-Transition Transfer Switches

Refer to Figure 13 through Figure 15 during the following procedure.

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

1. Disable the generator set to prevent starting and disconnect all power sources before manually operating the transfer switch.
2. Starting with the contactor in the Normal position, use the maintenance handle to move the Normal operator from the closed to the open position.
3. Move the Emergency operator from the open position to the closed position.
4. Return the Emergency operator to the open position and the Normal operator to the closed position.
5. Remove the maintenance handle and store it in the place provided on the switch.

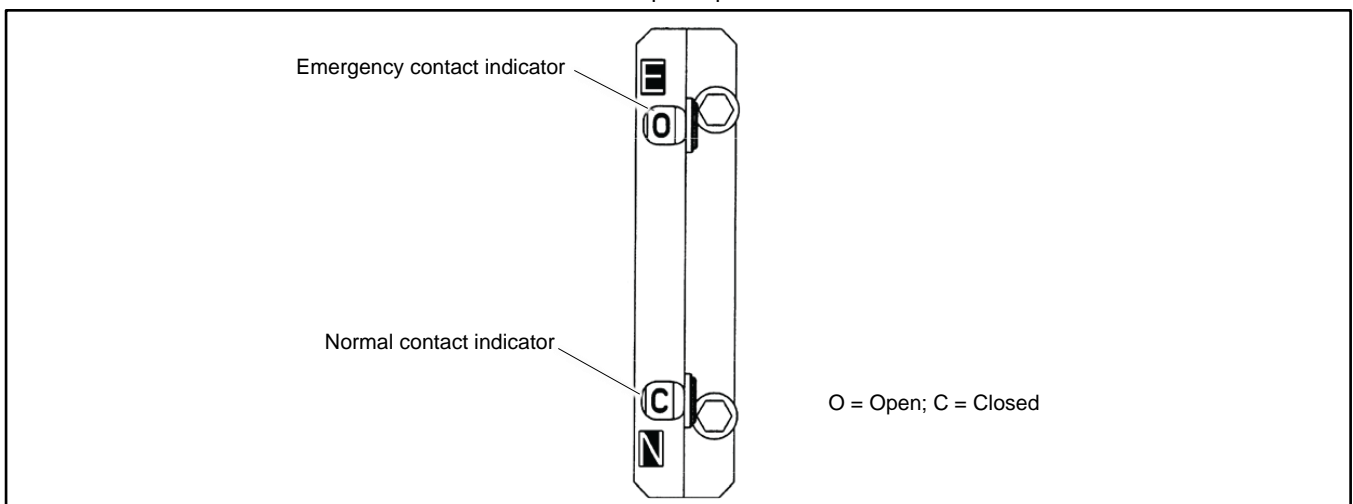


Figure 13 Position Indicators

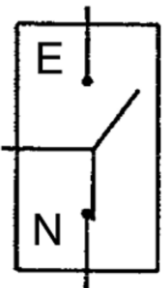
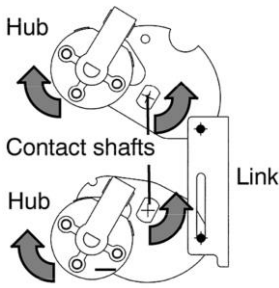


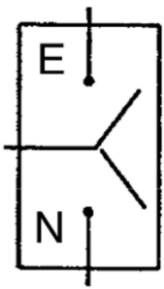
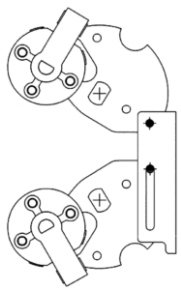


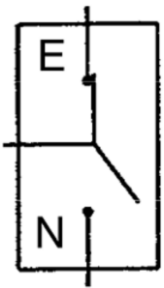
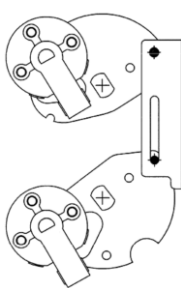


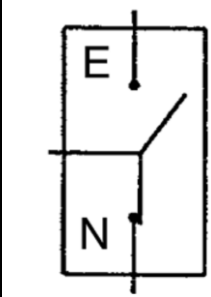
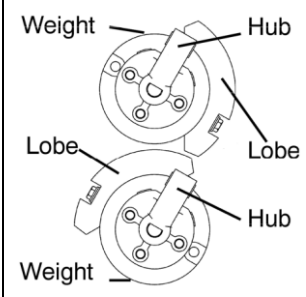


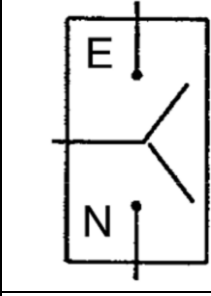
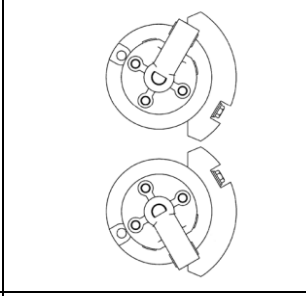


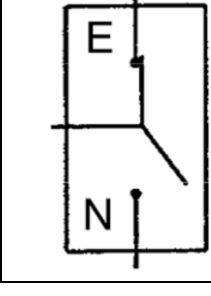
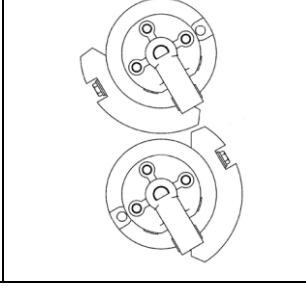


Transfer Switch Position		Interlocked Shafts	Maintenance Handle	Shaft Indicators
Normal				E : O upper contacts open
				N : C lower contacts closed
Load Disconnected				E : O upper contacts open
				N : O lower contacts open
Emergency				E : C upper contacts closed
				N : O lower contacts open
<p>Note: The link between contact shafts prevents closing both N and E contacts. The hub and contact shaft turn in opposite directions through a cam follower mechanism.</p> <p>Note: If Normal and Emergency connections are reversed, this operation is also reversed.</p>				

Figure 14 Maintenance Handle Positions, 150-600 Amp Model KUP Only. **ALL POWER MUST BE OFF !**

Transfer Switch Position		Interlocked Shafts	Maintenance Handle	Shaft Indicators
Normal			Up 	E : O upper contacts open
			Up 	N : C lower contacts closed
Load Disconnected			Up 	E : O upper contacts open
			Down 	N : O lower contacts open
Emergency			Down 	E : C upper contacts closed
			Down 	N : O lower contacts open

Note:
If Normal and Emergency connections are reversed this operation is also reversed.

Note:
The lobes prevent closing both N and E contacts at the same time.

Figure 15 Maintenance Handle Positions, 800-1200 Amp Model KUP Only. **ALL POWER MUST BE OFF !**

2.5.2 Manual Operation Test Procedure, 1600-4000 Amp Programmed-Transition Transfer Switches

Check the operation of both operators by following the instructions below for both the Normal and Emergency operators. Refer to Figure 16 during this procedure.

1. Disable the generator set to prevent starting and disconnect all power sources before manually operating the transfer switch.
2. Install the hub onto the shaft and insert the pin.
3. Insert the manual operating handle into the side hole on the hub until the spring is fully compressed.
4. Push in or pull out the hub to engage the opposite source contacts:
 - a. Pull out the shaft to engage the emergency source contacts.
 - b. Push in the shaft to engage the normal source contacts.
5. Grasp the handle firmly with both hands and rotate down:
 - a. Rotate counterclockwise to open the contacts.
 - b. Rotate clockwise to close the contacts.
6. Repeat steps 4 and 5 on the other transfer switch.
7. Return the CN transfer switch to the C (closed) position. Return the CE transfer switch to the O (open) position. Remove the manual operator handle and store it on the transfer switch in the place provided.

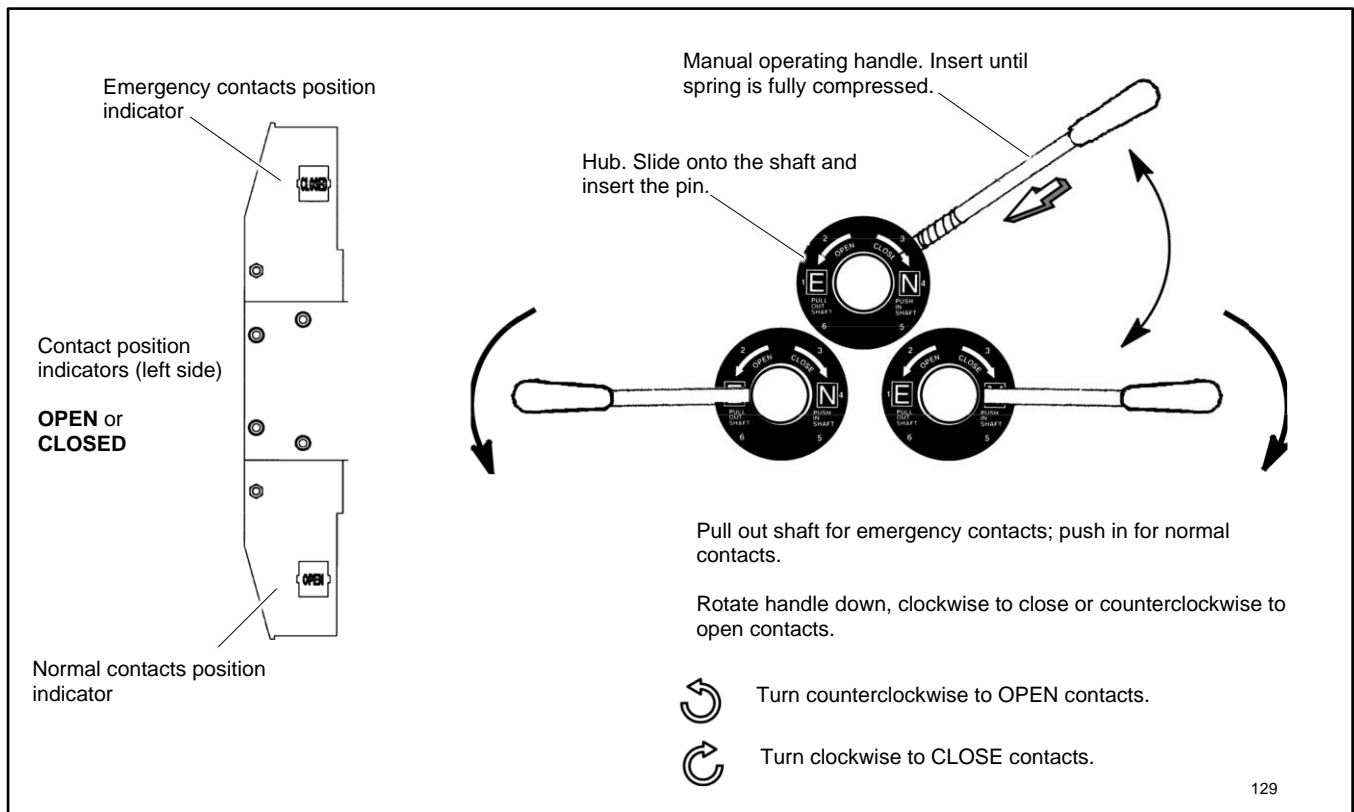



Figure 16 Manual Operation, 1600-4000 Amp Model KUP

2.6 Controller Connections

	<p>DANGER</p> <p>Hazardous voltage. Will cause severe injury or death.</p> <p>Disconnect all power sources before opening the enclosure.</p>
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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 17 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.

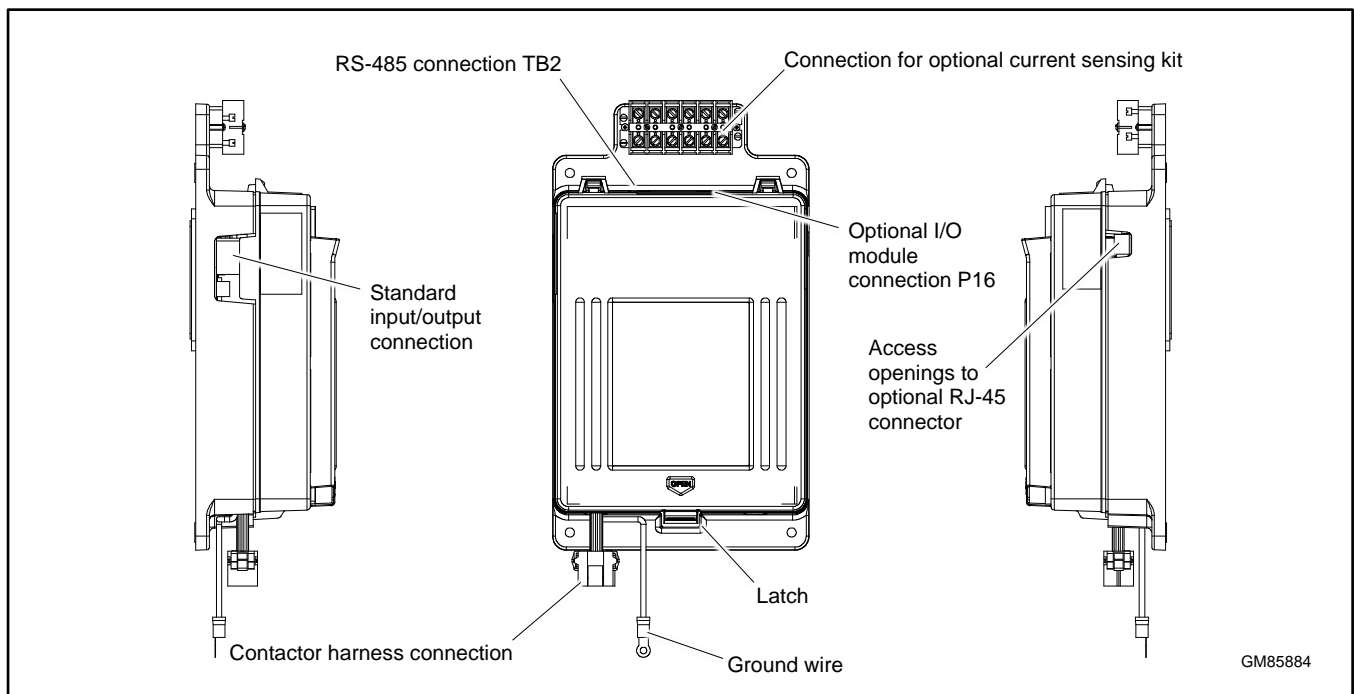


Figure 17 Controller

2.6.1 Controller Input and Output Connections

The controller provides connections for two programmable inputs and two programmable outputs. On service entrance KUS and KUP models, one input and two outputs are factory connected and must not be changed.

Each input has a signal and a return connection. The outputs are C form contacts with ratings of 500 mA @ 120 VAC. See Figure 19 for connections. Use #12-24 AWG wire and tighten the connections to 0.5 Nm (4.4 in. lbs.).

See the controller illustration in a previous section for the connector locations and Figure 18 for the I/O connection specifications. For additional input and output connections, optional input/output modules are available. See the Accessory Modules section 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 18 Main Board I/O Specifications

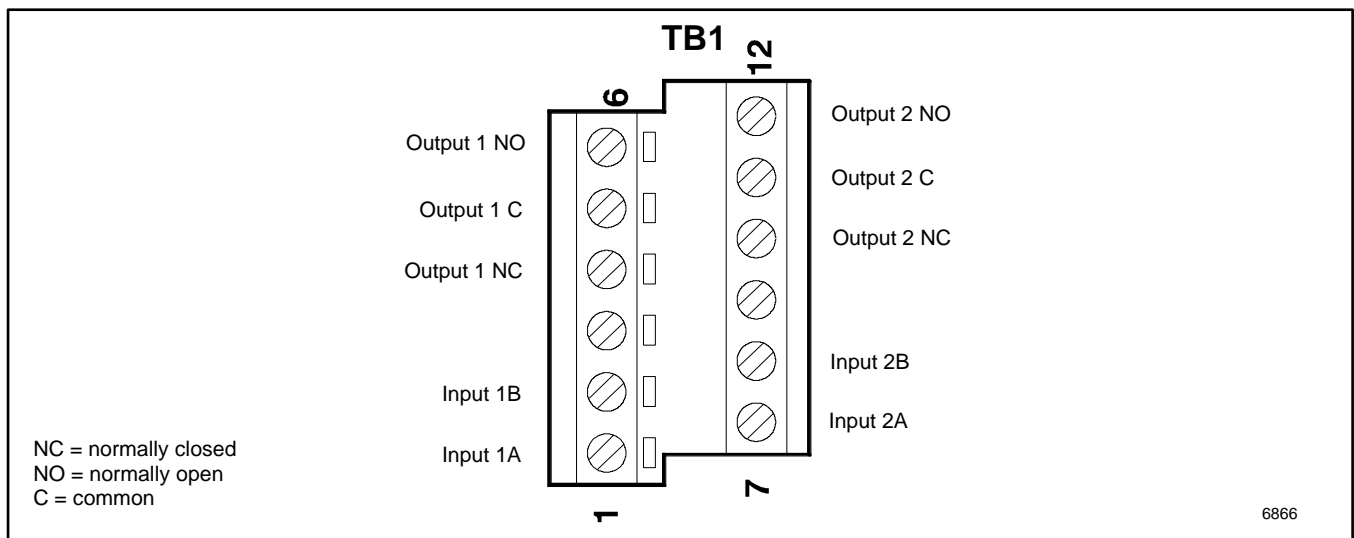


Figure 19 Input and Output Connections

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 the figure titled: Contactor Harness and Controller Ground Connections.

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.

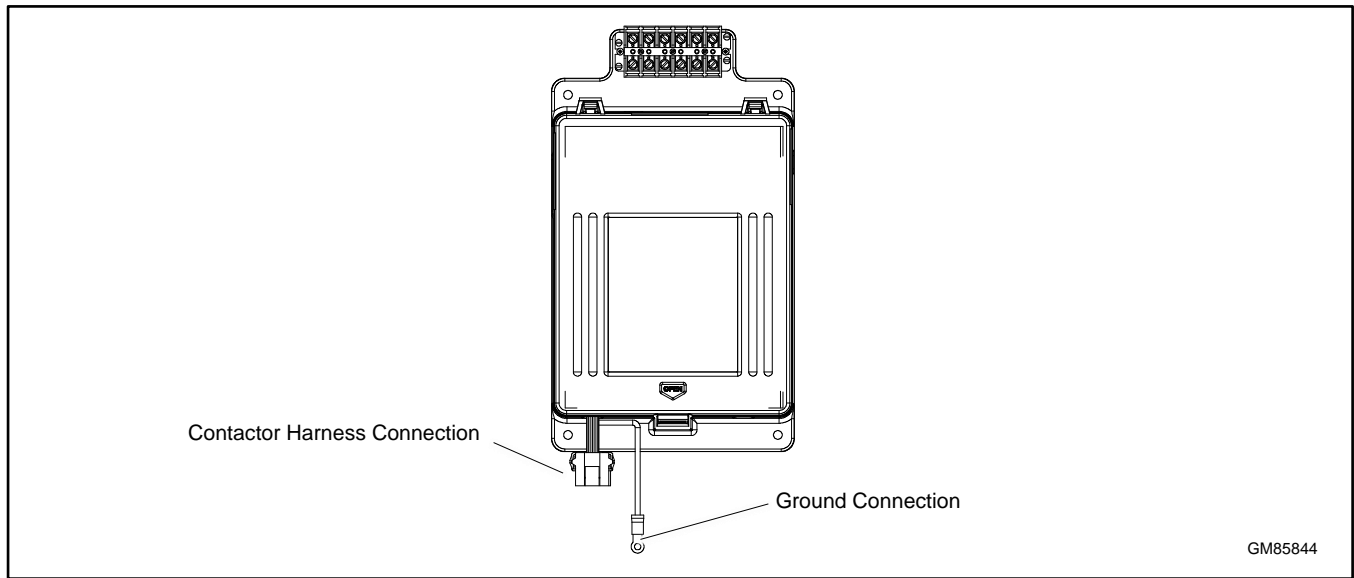


Figure 20 Contactor Harness and Controller Ground Connections

2.7 Service Disconnect Circuit Connections

The External Battery Supply Module is factory-supplied on every unit to maintain power to the controller, provide the proper status indication (Not in Auto, Service Disconnect), and power the Source Disconnect light. The service disconnect circuit is connected to the factory-installed External Battery Supply Module.

The service disconnect circuit terminal block is mounted on the inside of the enclosure door. See Figure 21.

- Connect one 12 VDC battery to the service disconnect circuit terminals 1 and 2; see Figure 22Figure 21. The battery may be the generator set engine starting battery or another battery provided for this purpose. The battery must be connected to a battery charger to ensure that DC power is always available.
- Connect terminals 3 and 4 to the generator set controller's fault relay.
- Terminals 5 through 7 provide additional form C contacts to indicate the state of the service disconnect relay. These connections are for customer-supplied equipment and are optional.

When the operator moves the service disconnect switch to the Service Disconnect position, the ATS controller energizes the shunt trip coil, which trips (opens) the utility circuit breaker. The shunt trip relay is also connected to an input on the ATS controller. When the switch is in the Service Disconnect position, the relay closes to signal a fault which prevents the generator set from starting. The ATS remains in the Normal position.

Turning the service disconnect switch back to AUTO will allow the generator set to be reset (at the generator set controller) and the engine to start. The ATS will transfer the load to Emergency. Then the Utility breaker can be reset. Normal time delays and retransfer to normal would occur. The Utility breaker cannot be reset if the service disconnect switch is not in the AUTO position.

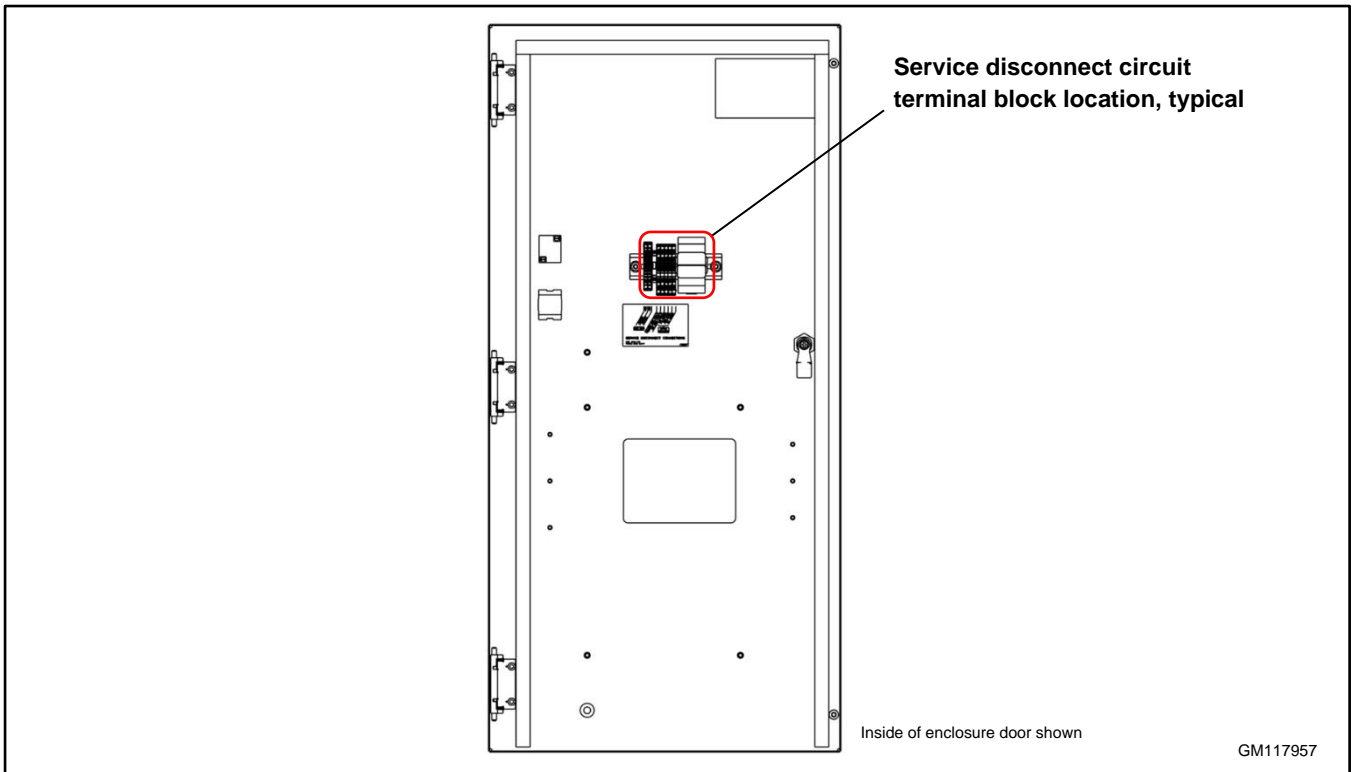


Figure 21 Service Disconnect Circuit Connection Location, Typical (on the inside of the ATS enclosure door)

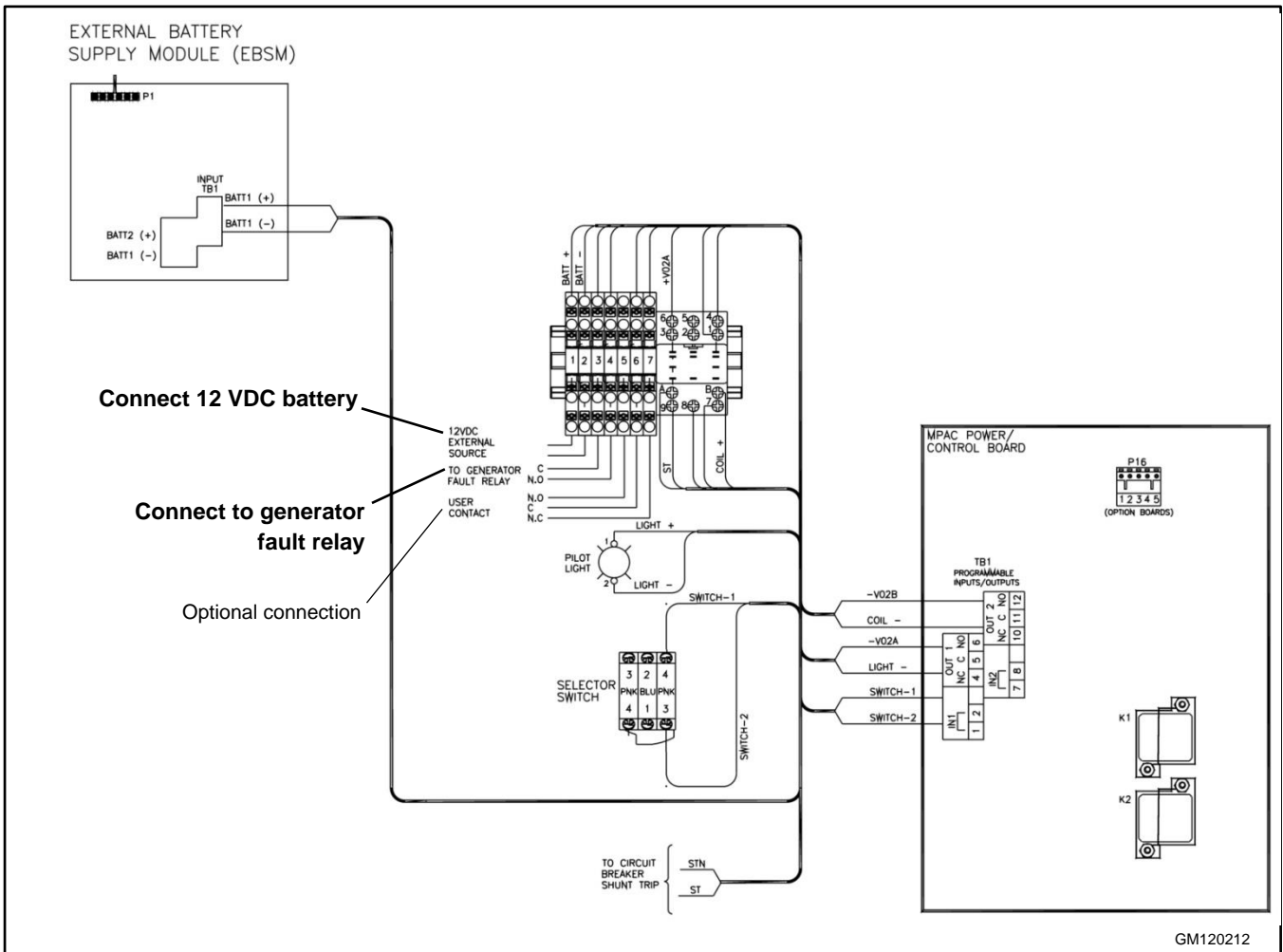


Figure 22 Service Disconnect Circuit Connections

2.8 External Battery Supply Module (EBSM)

The external battery supply module connects to the generator set engine start battery or other battery to provide 12 VDC power to the ATS controller when neither the Normal nor the Emergency source is available. An external battery supply module (EBSM) is standard, factory-installed equipment for the KUS/KUP service entrance transfer switches. The EBSM is factory-connected to the service entrance circuit breaker shunt trip circuit.

The installer must connect a 12 VDC battery (typically the generator set engine starting battery) to the shunt trip circuit as described in the Shunt Trip Circuit Section of this document.

The EBSM produces 2 amps at 12 VDC with 9-36 VDC input. The EBSM input is reverse-polarity protected. If the battery connections are reversed, red LED1 or LED2 will light. See Figure 21 for the location of the LED indicators.

The EBSM outputs a low battery voltage signal when the external battery voltage falls below 11 VDC for a 12-volt system.

The battery voltage selection DIP switch SW11-1 allows selection between 12-volt and 24-volt systems for low battery voltage sensing and indication. See Figure 23 and Figure 21. Confirm that voltage selector switch SW11-1 is set to OFF (12 VDC).

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

Figure 23 Battery Voltage Selection

Note:

The EBSM has no address switches but must be the last accessory module board on the bus. See the Accessory Module Mounting section for more information, if needed.

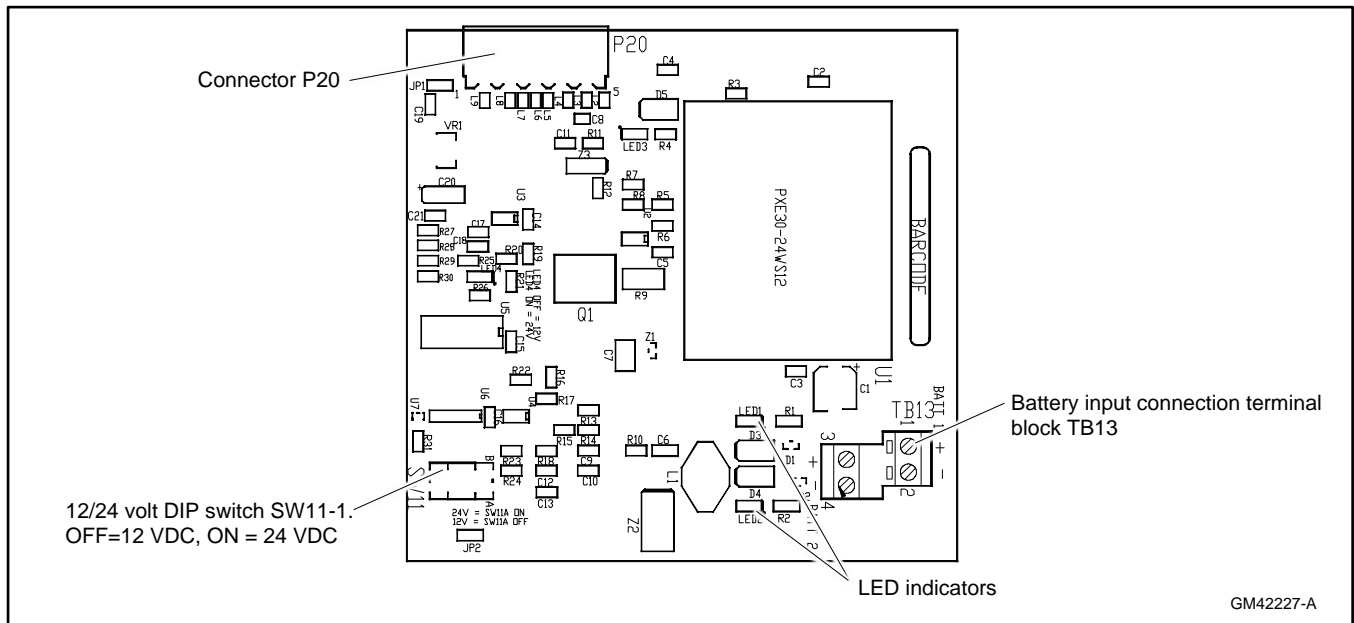


Figure 24 External Battery Supply Module

2.9 Electrical Wiring

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



Note:

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



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

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

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

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

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

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

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

Grounding electrical equipment. Hazardous voltage will cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, 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.

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.

2.9.1 Source and Load Connections

Note:

Refer to the transfer switch dimension drawing to identify the connection points for the Normal and Emergency source and load connections.

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

Drill the entry holes. Cover the transfer switch to protect it from metal chips and construction grit. Then drill entry holes for the conductors at the locations shown on the enclosure drawings. Remove debris from the enclosure with a vacuum cleaner.

Note:

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

Install and test the power cables. Refer to the transfer switch dimension drawing for connecting lug locations. Connect the utility source cables to the service entrance circuit breaker, which is located in a separate compartment from the power switching device. The utility circuit breaker is factory-connected to the Normal source side of the contactor. Connect the emergency source and load cables to the power switching device.

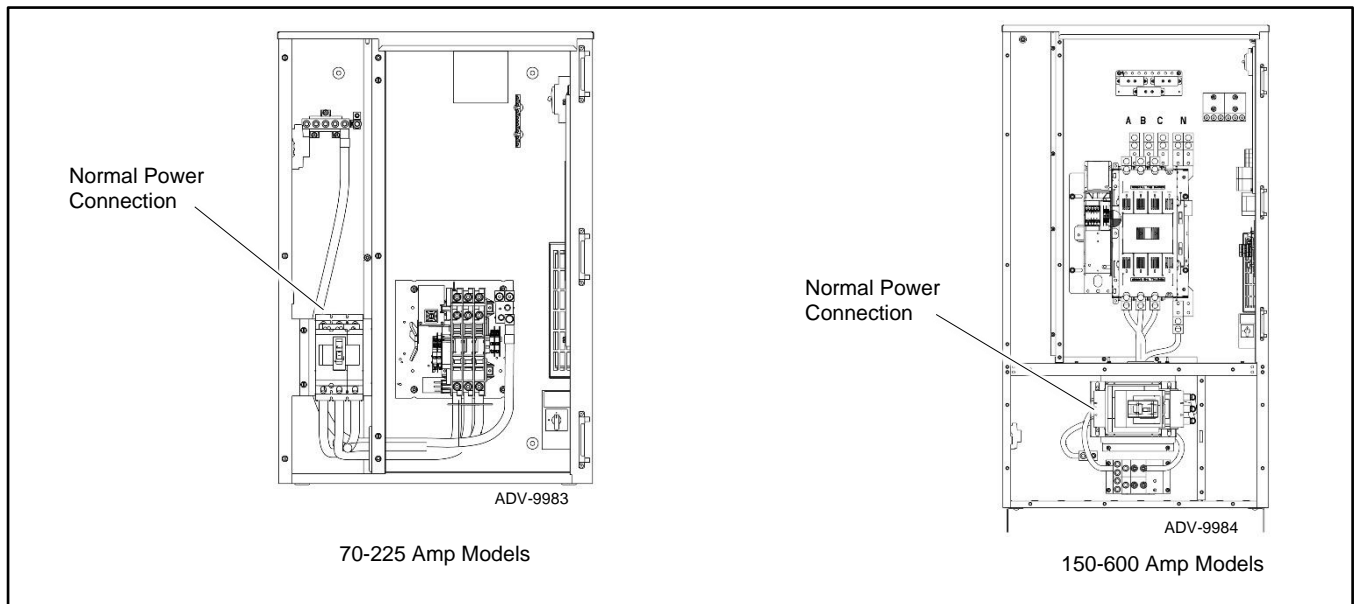


Figure 25 Typical Utility Power Connections to the Service Entrance Circuit Breaker (see the ADV drawing for your model)

Leave sufficient slack in the power leads to reach all of the power connecting lugs on the utility source side circuit breaker and the power switching device. Test the power conductors before connecting them to the transfer switch. Installing power cables in conduit, cable troughs and ceiling-suspended hangers often requires considerable force. Pulling cables can damage insulation and stretch or break the conductor's strands.

Test the cables after pulling them into position and *before* they are connected to verify that they are not defective and that they were not damaged during installation.

Install the cable spacers provided with 70-225 amp KUS transfer switches as shown in Figure 26.

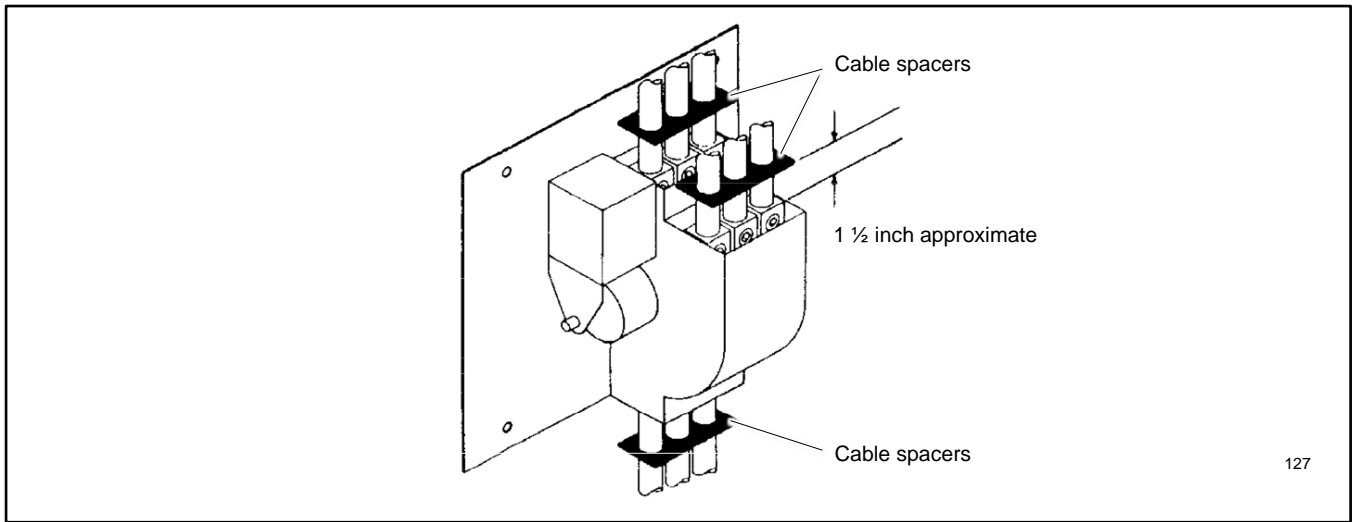


Figure 26 Cable Spacers for 70-225 KUS Amp Switches

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

Refer to 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 the utility source cables to the torque values shown on the circuit breaker. Tighten all emergency source and load cable lug connections to the torque values shown on the label on the transfer switch. (See Figure 28 for a typical rating/torque label.) Carefully wipe off any excess joint compound after tightening the terminal lugs.

For load connections to bus bars, use a compression washer, flat washer, and a minimum grade 5 bolt and torque the connections to the values in Figure 27.

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

Figure 27 Tightening Torque for Bus Bars

SUITABLE FOR CONTROL OF MOTORS, ELECTRIC DISCHARGE AND TUNGSTEN LAMPS. ELECTRIC HEATING EQUIPMENT, WHERE THE SUM OF MOTOR FULL-LOAD AMPS AND AMPS OF OTHER LOADS DOES NOT EXCEED THE SWITCH AMP RATING AND THE TUNGSTEN LOAD DOES NOT EXCEED 100% OF SWITCH RATING, 240V MAX.

WHEN PROTECTED BY A CIRCUIT BREAKER WITHOUT AN ADJUSTABLE SHORT-TIME RESPONSE ONLY OR BY FUSE WITH TRANSFER SWITCH IS RATED FOR USE ON A CIRCUIT CAPABLE OF DELIVERING NOT MORE THAN THE RMS SYMM AMP AT THE VOLTAGE SHOWN.

AMPS X1000	MAX VOLTS	BREAKER/MFR/TYPE	AMPS MAX
35	480	ANY ANY ANY	PERNEC
22	600	ANY ANY ANY	PERNEC

42480GESGL4,SGP4,TB4, THLC4,TLB4	400
SGLA,SGL6,SGP6,TB6	600
SKHA,SKL8,SKP8,TKL	800
42480I-ECJD6,HHJD6, HHJXD6,HJD6,SCJD6,SHJD6	400
CLD6,HHL6,HHLXD6,HLD6, SCLD6,SHLD6	600
CMD6,HMD6,HND6,MD6,MXD6, SCMD6,SHMD6,SMD6,SND6	800
42480SQUAREDLC,LI	600
MH	800
42480WESTHKKD,KDC,LCL, TRI-PACLA	400
HLD	600
TRI-PACNB	800
42480ABBS5	400
S6	800
42480MERLINGERIN CJ600	600
200480FUSE ANY CLASS J	600

USE 75 CMIN. CU/AL WIRE FOR POWER CONNECTIONS. USE 60 CMIN. CU WIRE FOR CONTROLS.

USE COPPER OR ALUMINUM WIRE FOR POWER TERMINALS



RECOMMENDED TIGHTENING TORQUE 600	IN-LBS	483500-007	REV B
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Torque specification

007

Figure 28 Typical Rating/Torque Label

2.9.2 Engine Start Connection

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

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 connections. On 70-200 amp models, the engine start terminals are located on the transfer switch contactor assembly and labeled with a decal. See Figure 29. On larger models, the engine start contacts and auxiliary contacts are located on the field-connection terminal block. See Figure 30 or the transfer switch dimension drawing for the location of the engine start contacts. Refer to the generator set installation manual for wire size specifications.

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

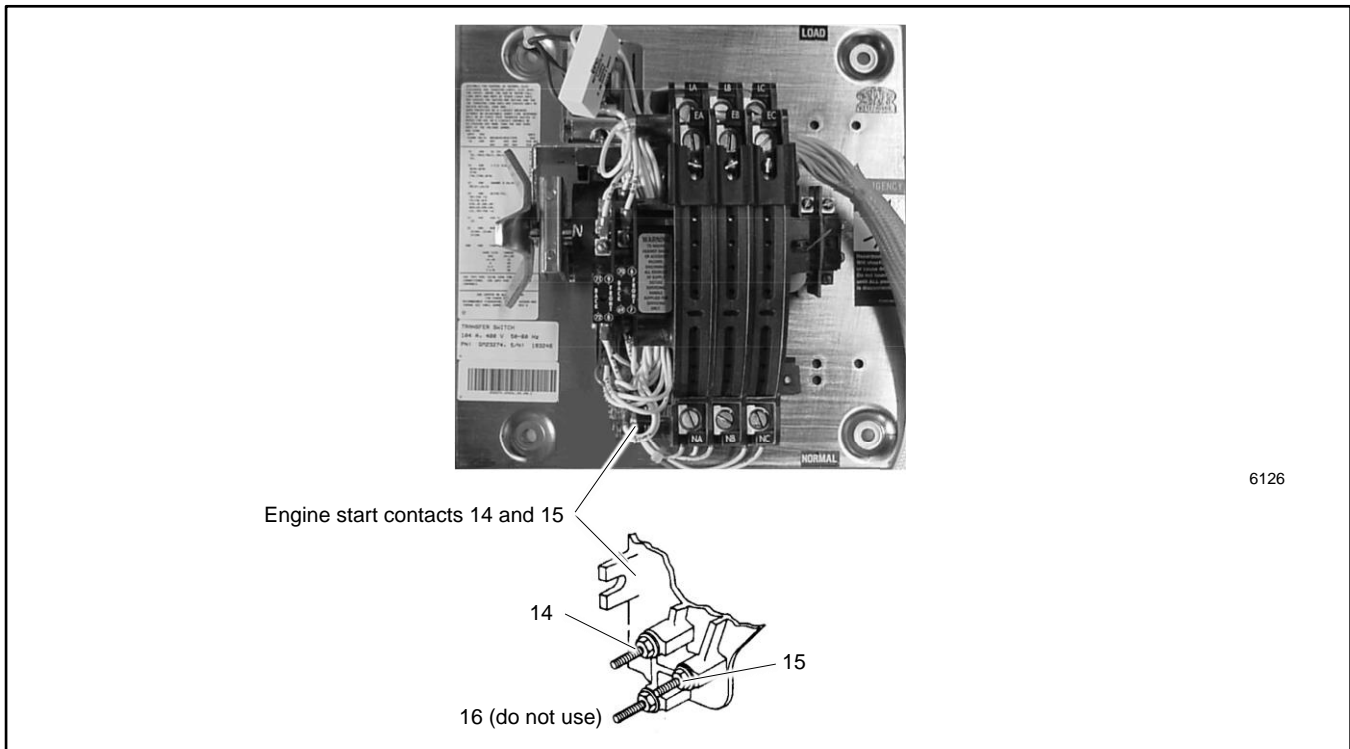


Figure 29 Engine Start Contacts, 70-225 Amp KUS Switches

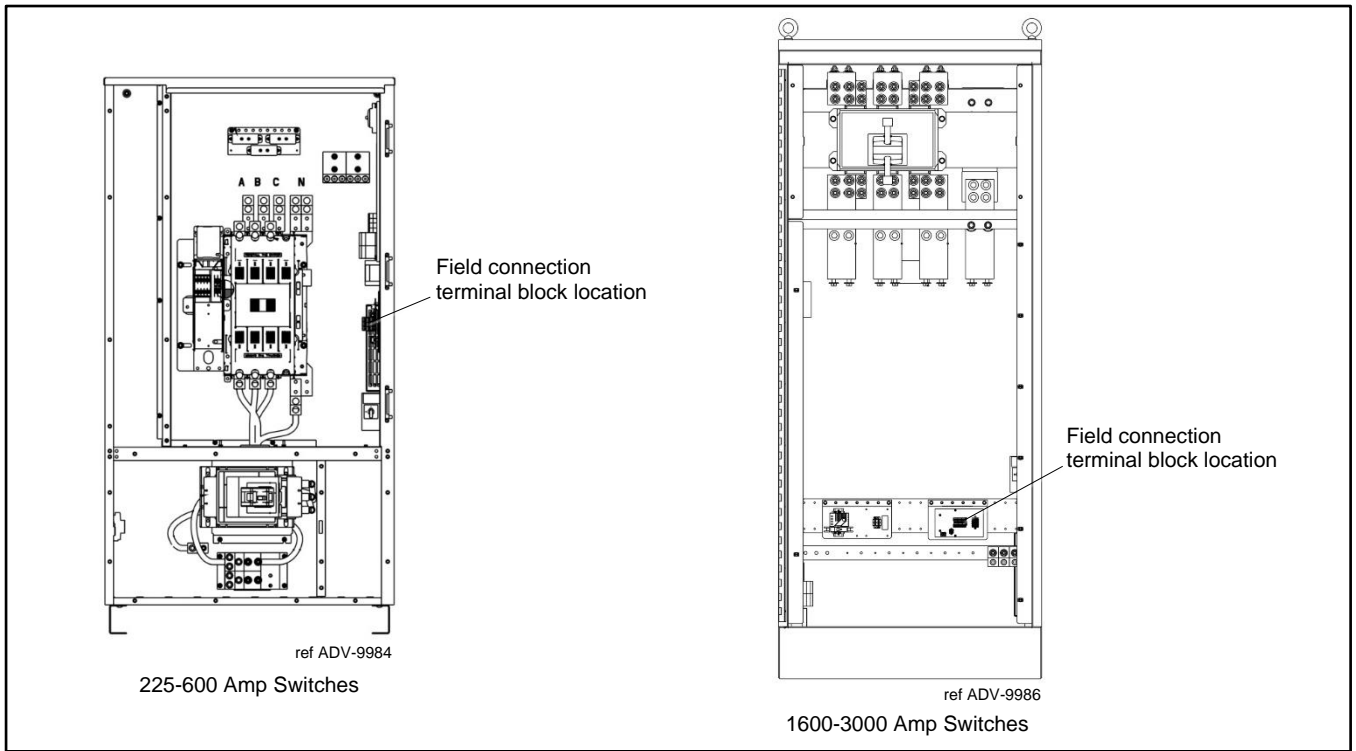


Figure 30 Field Connection Terminal Block Locations, Typical

2.9.3 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.

Figure 31 lists the number of contacts available by ATS model and size (amps).

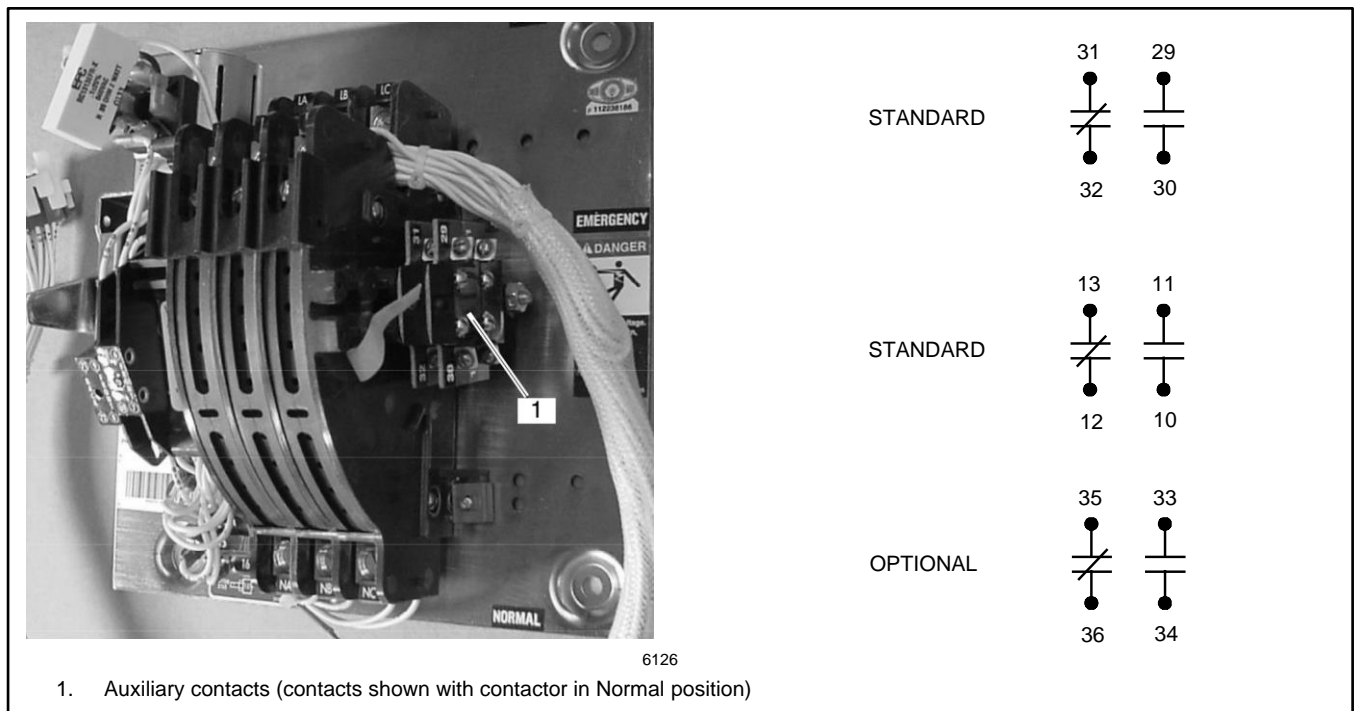
- On 70-225 Amp units, the contacts are located on the right side of the contactor. See Figure 32.
- On 225 A/600 V and 250-4000Amp units, the contacts are located on the field connection terminal block. See the figure titled: Field Connection Terminal Block Locations, Typical. See Figure 34 for typical connections.

Refer to the wiring diagrams provided with the transfer switch for specific auxiliary contact connection information.

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

Auxiliary Position Indicating Contacts (rated 10 amps @ 32 VDC/480 VAC)		
Switch Rating, amps	Number of Contacts Indicating Normal, Emergency	
	KUS	KUP
70-150	2, 2	—
150-225	2, 2	8, 8
225 (600 V)	8, 8	8, 8
260-600	8, 8	8, 8
800-1200	8, 8	8, 8
1600-4000	8, 8	7, 7

Figure 31 Auxiliary Contacts



1. Auxiliary contacts (contacts shown with contactor in Normal position)

Figure 32 Auxiliary Contacts, 70-225 Amp Transfer Switches

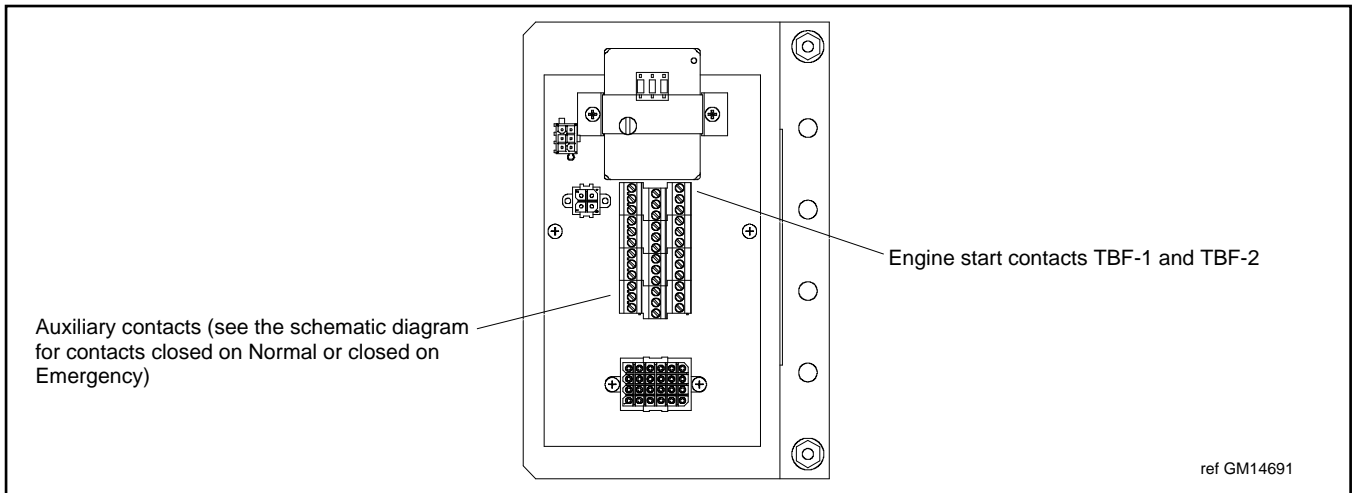


Figure 33 Field Connection Terminal Block

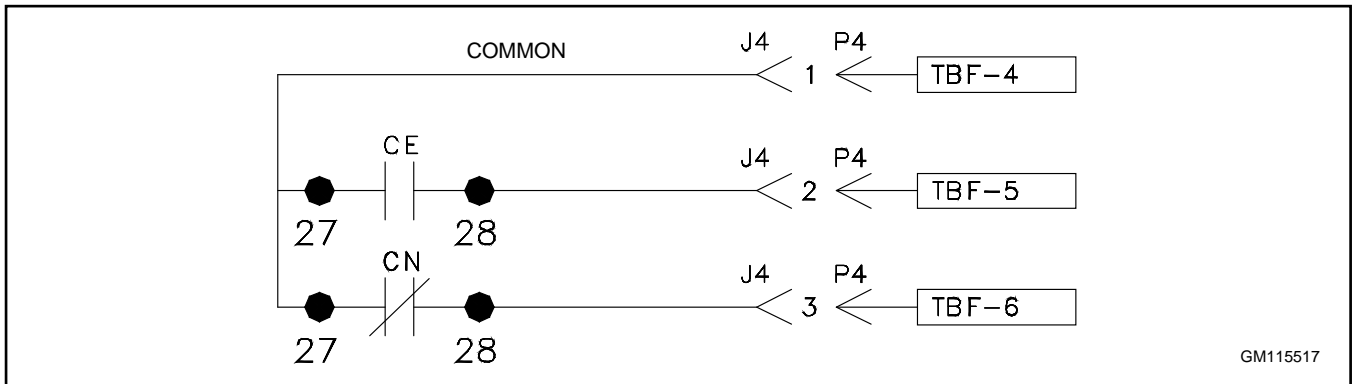


Figure 34 Typical Auxiliary Contact Connection, 225- 4000 Amp Transfer Switches (see schematic diagram)

2.10 Communication and Accessory Connections

See the Communication and Accessory Connections section for accessory and communication connection instructions.

2.11 Functional Tests

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

3.1 Three-Source Systems

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

A three-source system provides the means to connect a utility and two generators to a single load. See the figure titled: Three-Source System Diagram and Operation. Two generators and two transfer switches are required.

Note:

The second transfer switch (ATS2) requires an external battery supply module (EBSM) to provide power to the controller. See the External Battery Supply Module (EBSM) section.

During normal operation, the utility source supplies the load with power. In the event of a utility failure, generator set G1 or G2 will supply the load as described in the Three Source Engine Start Mode and Preferred Source Toggle sections.

3.2 Three Source Engine Start Mode

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

3.2.1 Mode 1

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

3.2.2 Mode 2

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

3.3 Preferred Source Toggle

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

3.4 Three Source System Test and Exercise

3.4.1 Unloaded Test

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

3.4.2 Loaded Test

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

3.4.3 Unloaded Exercise

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

3.4.4 Loaded Exercise

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

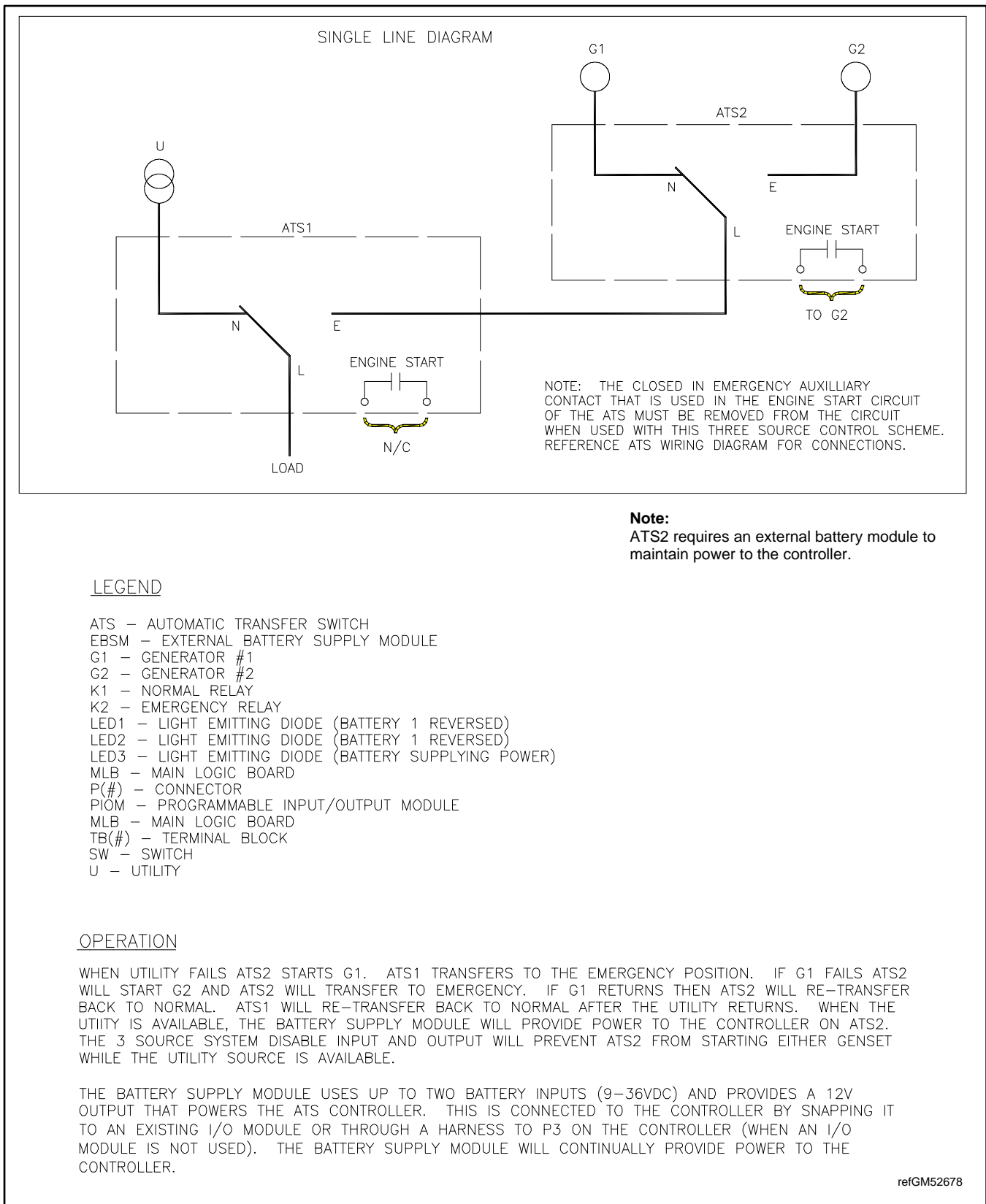
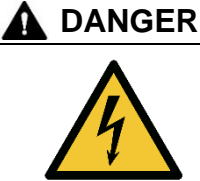



Figure 35 Three-Source System Diagram and Operation

3.5 Three-Source System Connection

 DANGER	Hazardous voltage. Will cause severe injury or death. Disconnect all power sources before opening the enclosure.
	

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

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

See Figure 36 and Figure 37 for connections during the following steps.

1. Connect the power sources to the transfer switches as described below. Refer to the transfer switch operation/installation manual or specification sheet for cable sizes. See Figure 36 for connections.
 - a. Connect the utility power source to the normal side of ATS1.
 - b. Connect the load to the load side of ATS1.
 - c. Connect the emergency side of ATS1 to the load side of ATS2.
 - d. Connect generator set 1 to the normal side of ATS2.
 - e. Connect generator set 2 to the emergency side of ATS2.
2. Three-source systems require the following input/ output connections to control the engine start commands for generator sets 1 and 2. Observe the polarity of all connections shown in Figure 37. Use wire sizes from #14 AWG to #20 AWG for EBSM and I/O module connections.

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

Note:

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

- b. Connect one ATS1 programmable output from the controller to one ATS2 main logic board programmable input as shown in Figure 37. This I/O connection will be set to Three-Source System Disable.
 - c. Connect one ATS2 programmable output from the controller to the engine start connection on generator set 1 (G1). The ATS1 programmable output will be set to Source N Start Signal.
3. Connect battery power. Use #14-28 AWG wire to connect the generator set engine starting battery (or batteries) to the BATT1 terminals on terminal block TB13 on the external battery supply module (EBSM). (Another battery(ies) can be connected to terminals BATT2 but is not required.) Follow the marking on the board for the positive (+) and negative (-) connections. See more details and illustrations for the External Battery Supply Module (EBSM) in the EBSM Section of this manual.

Note:

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

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

Note:

See the External Battery Supply Module (EBSM) section for more information on the EBSM.

5. Assign the ATS1 programmable output connected in step 2b. to Three-Source System Disable.
6. Assign the following inputs and outputs for the second transfer switch.
 - a. Assign ATS2 controller programmable input 1 to Three-Source System Disable.
 - b. Assign the ATS2 controller programmable output connected in step 2c. to Source N Start Signal.

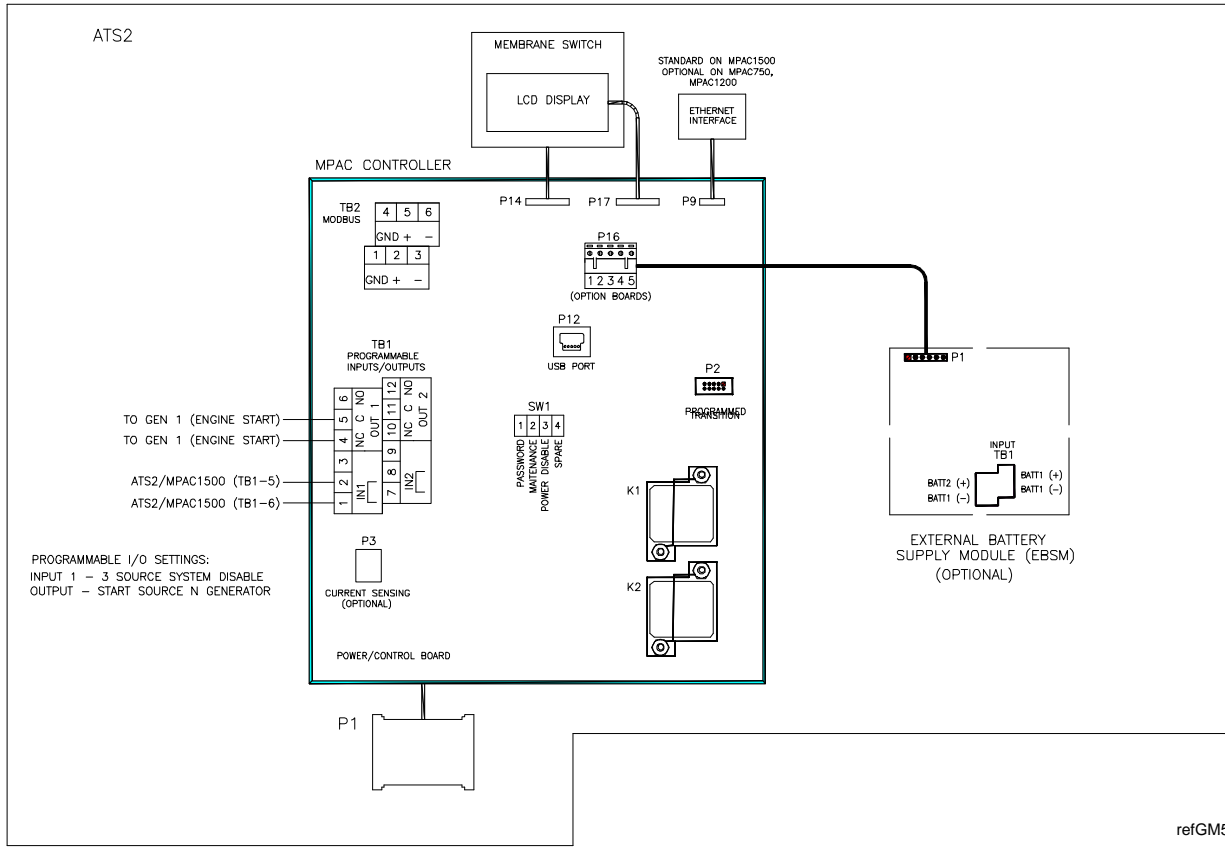
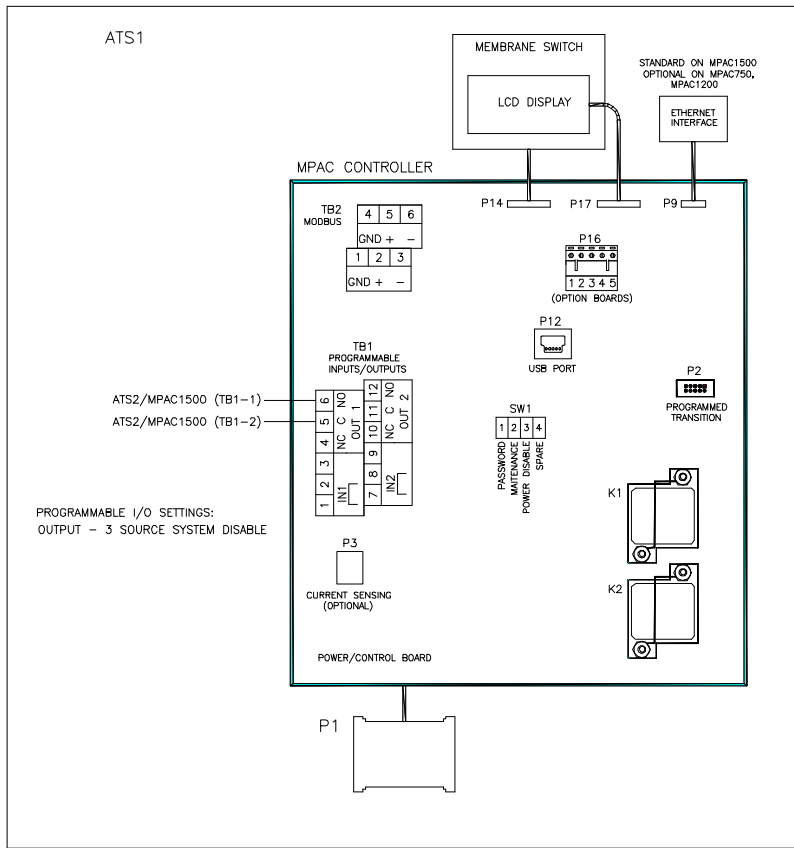


Figure 36 Three-Source System Controller Connections

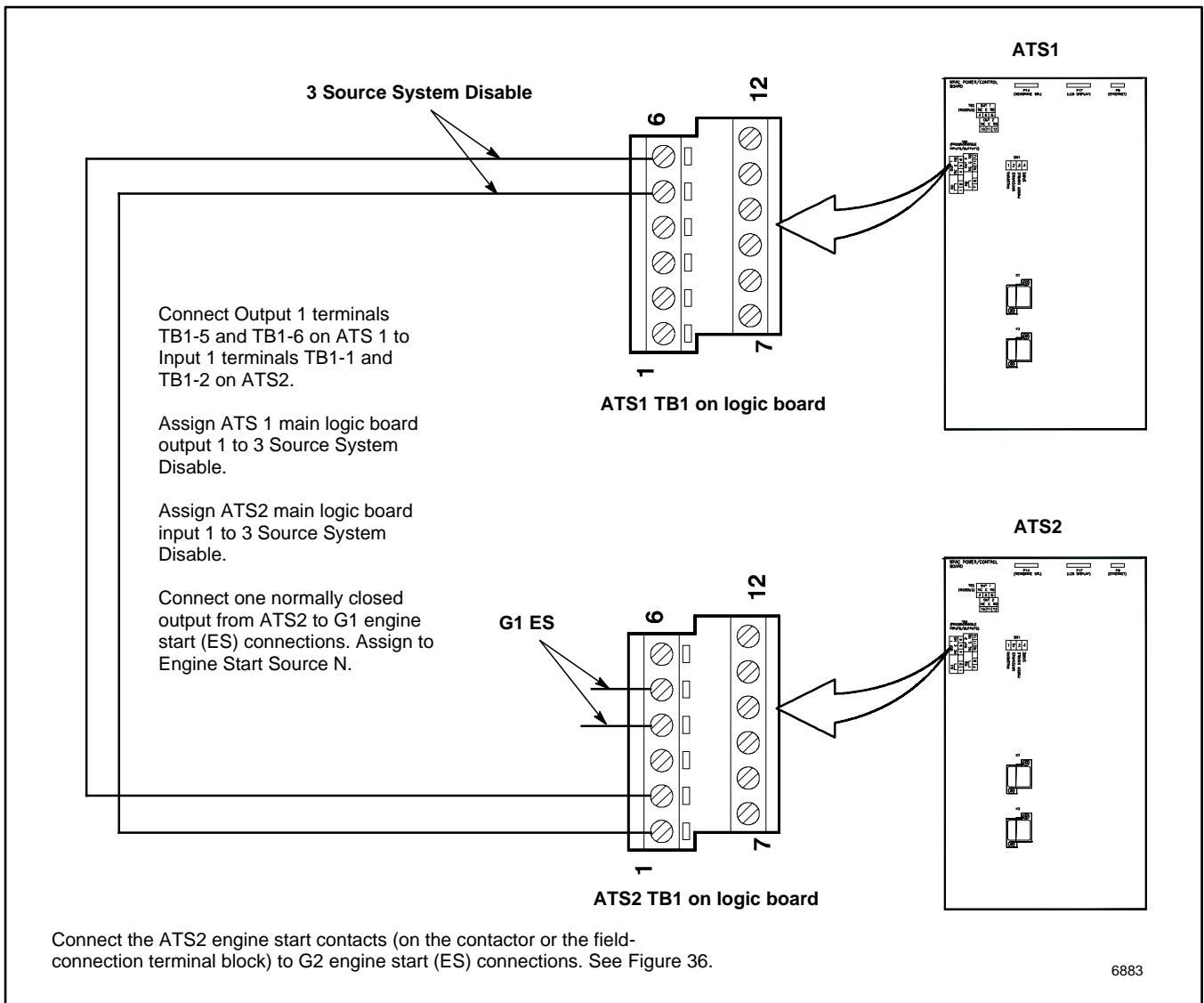


Figure 37 Input and Output Connections for Three-Source Systems

3.6ATS1 and ATS2 System Setup

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

ATS1: Set the Source type to Util-Gen.

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

The transfer switch settings are summarized in Figure 38.

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

Figure 38 Transfer Switch Settings for Three-Source Systems

Section 4. Communication and Accessory Connections

4.1 Introduction

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

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

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

4.2 Communication Connections

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

4.2.1 USB Port SiteTech Connection

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

See Figure 39 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.

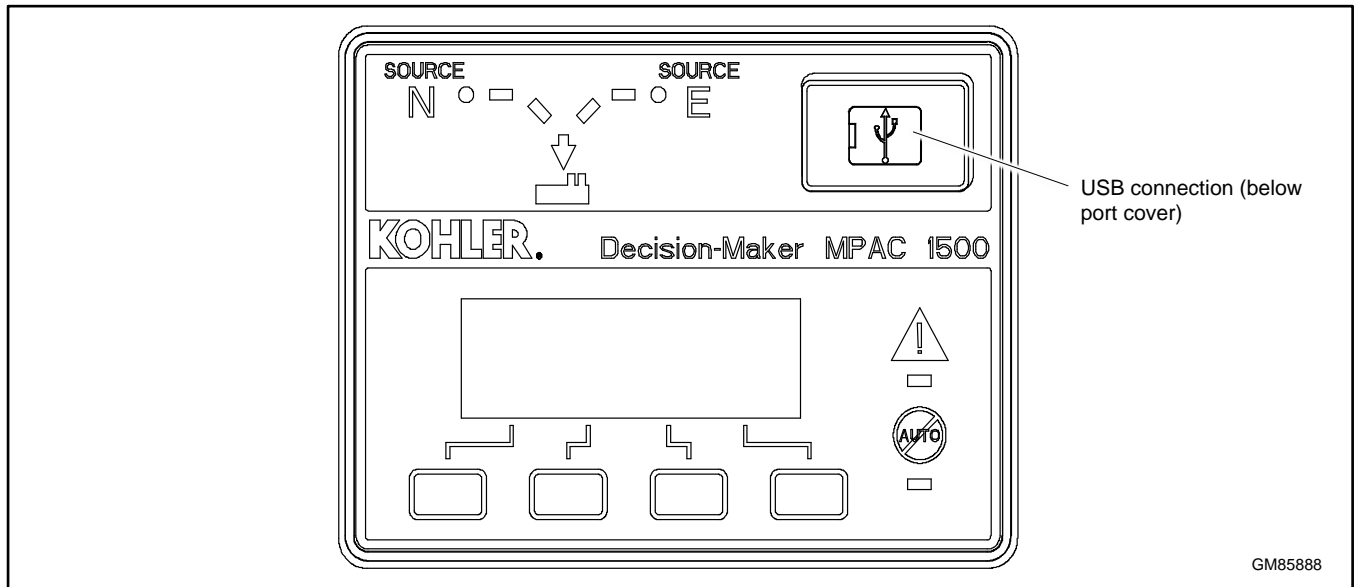




Figure 39 USB Connection for SiteTech (MPAC 1500 controller shown)

4.2.2 Modbus Connection

 DANGER	Hazardous voltage. Will cause severe injury or death. Disconnect all power sources before opening the enclosure.
	

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

See Figure 40 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 42.

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 41. 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.

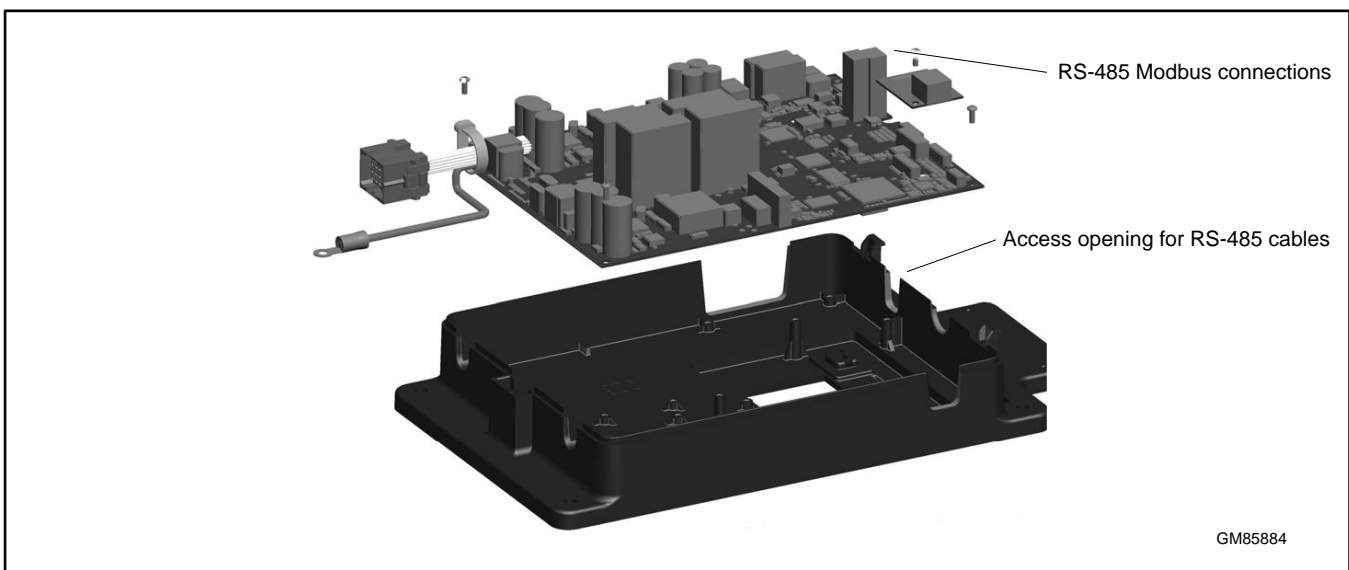


Figure 40 Modbus Connections (controller cover removed for illustration only)

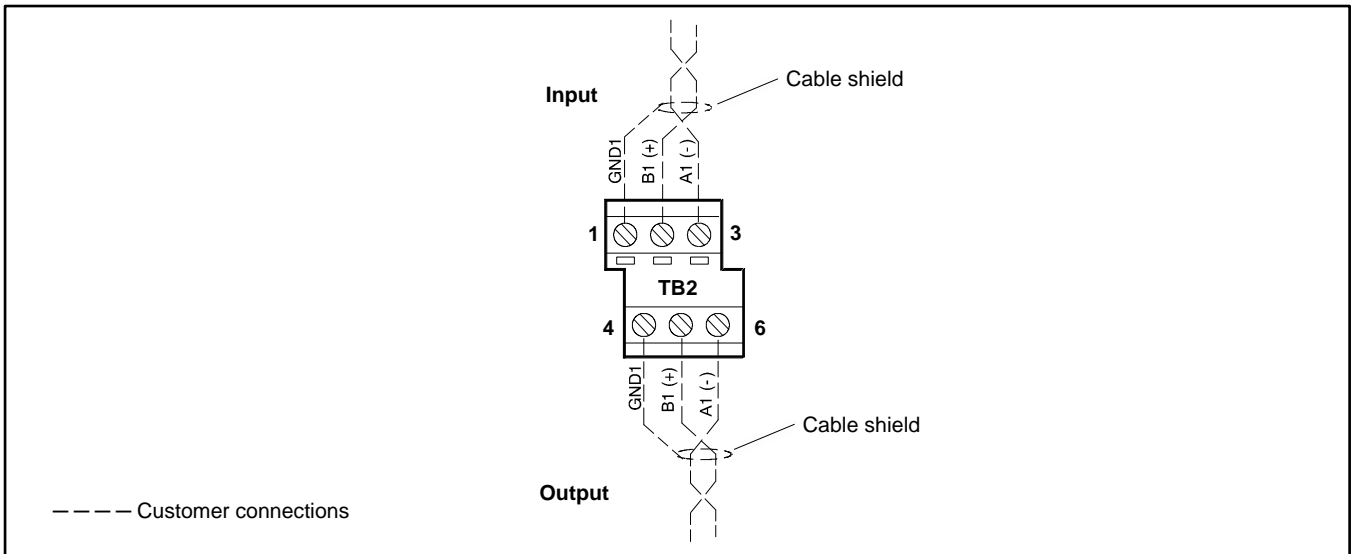
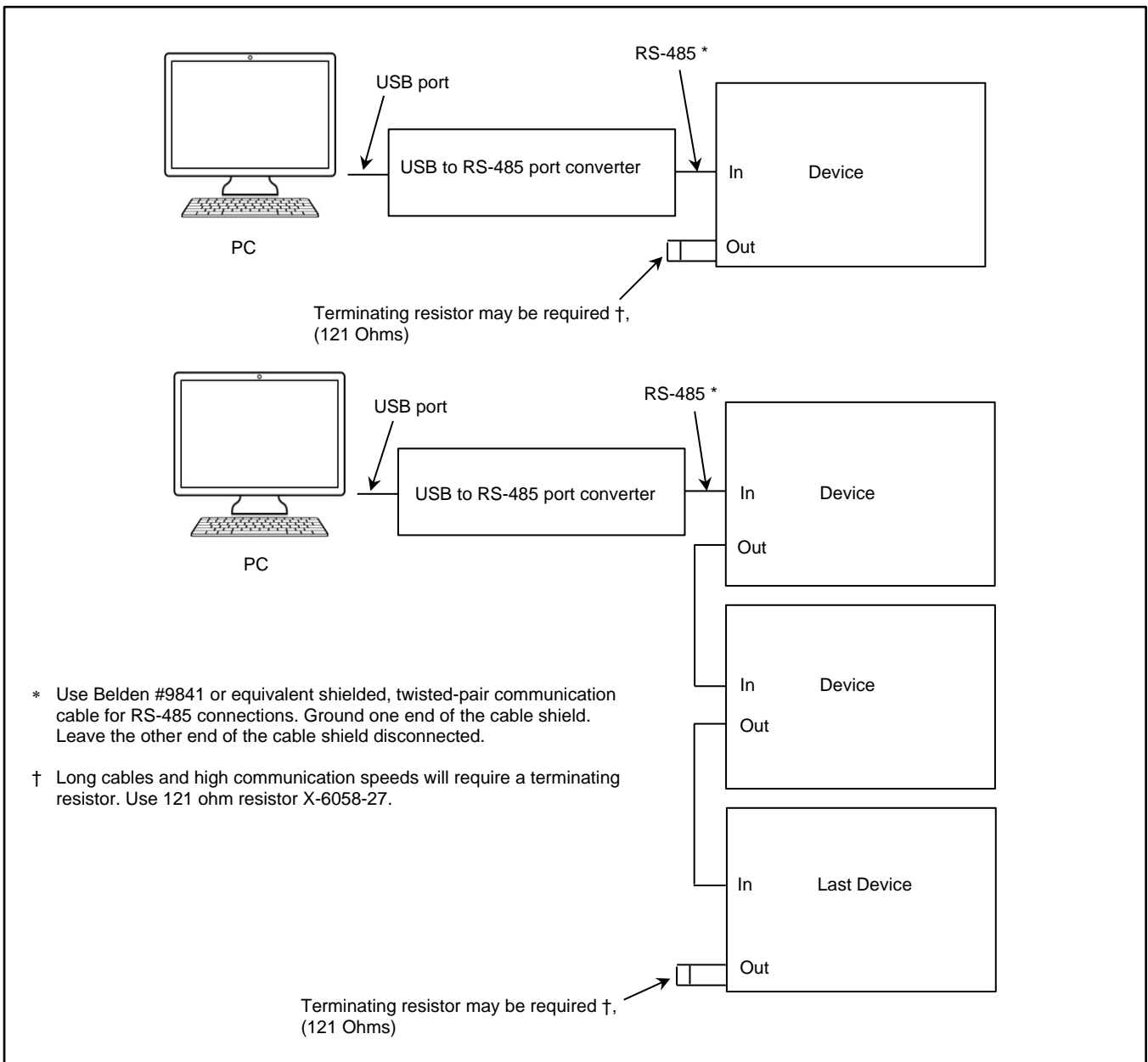




Figure 41 Modbus RS-485 Connections



4.2.3 Ethernet Connection

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

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

The Ethernet communication accessory board is required for connection to the Ethernet. The Ethernet communication board is standard on the MPAC 1500 controller. The communication board connects to the controller board as shown in Figure 43.

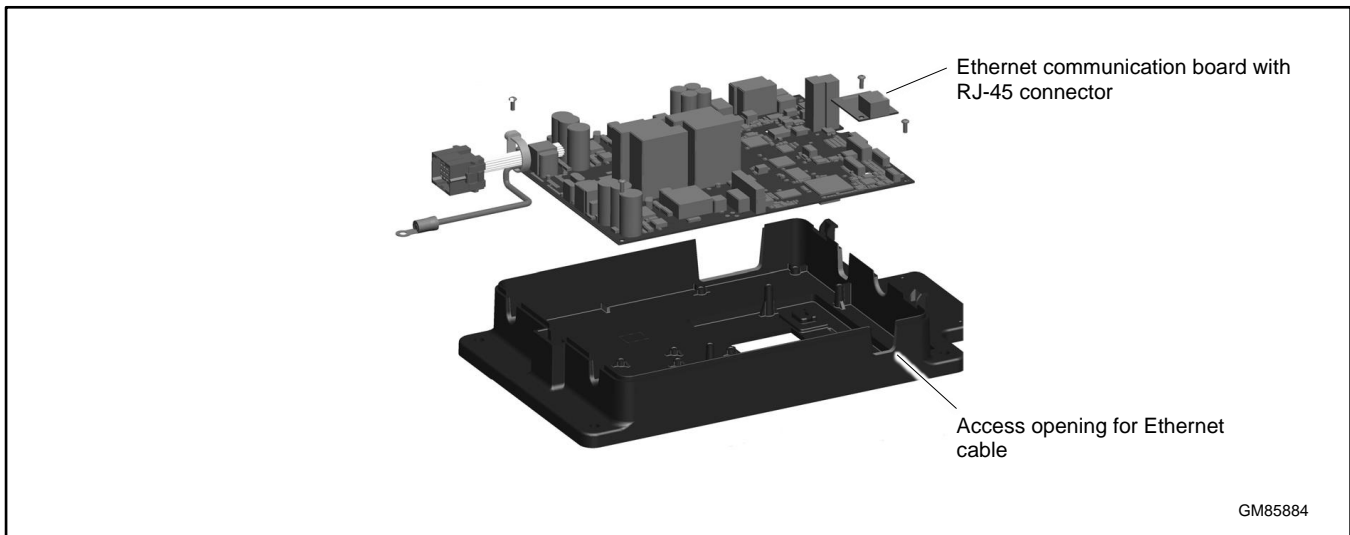


Figure 43 Ethernet Board (controller cover removed for illustration only)

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

Note:

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

Ethernet Port. The ethernet port is a standard RJ-45 jack. See Figure 43 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 44. **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 45 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.

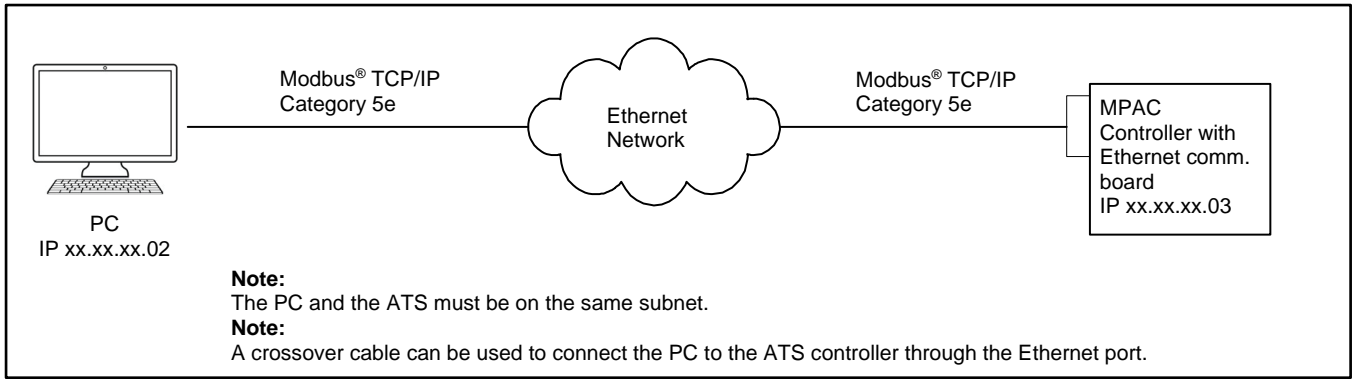


Figure 44 Remote Network (Ethernet) Connection

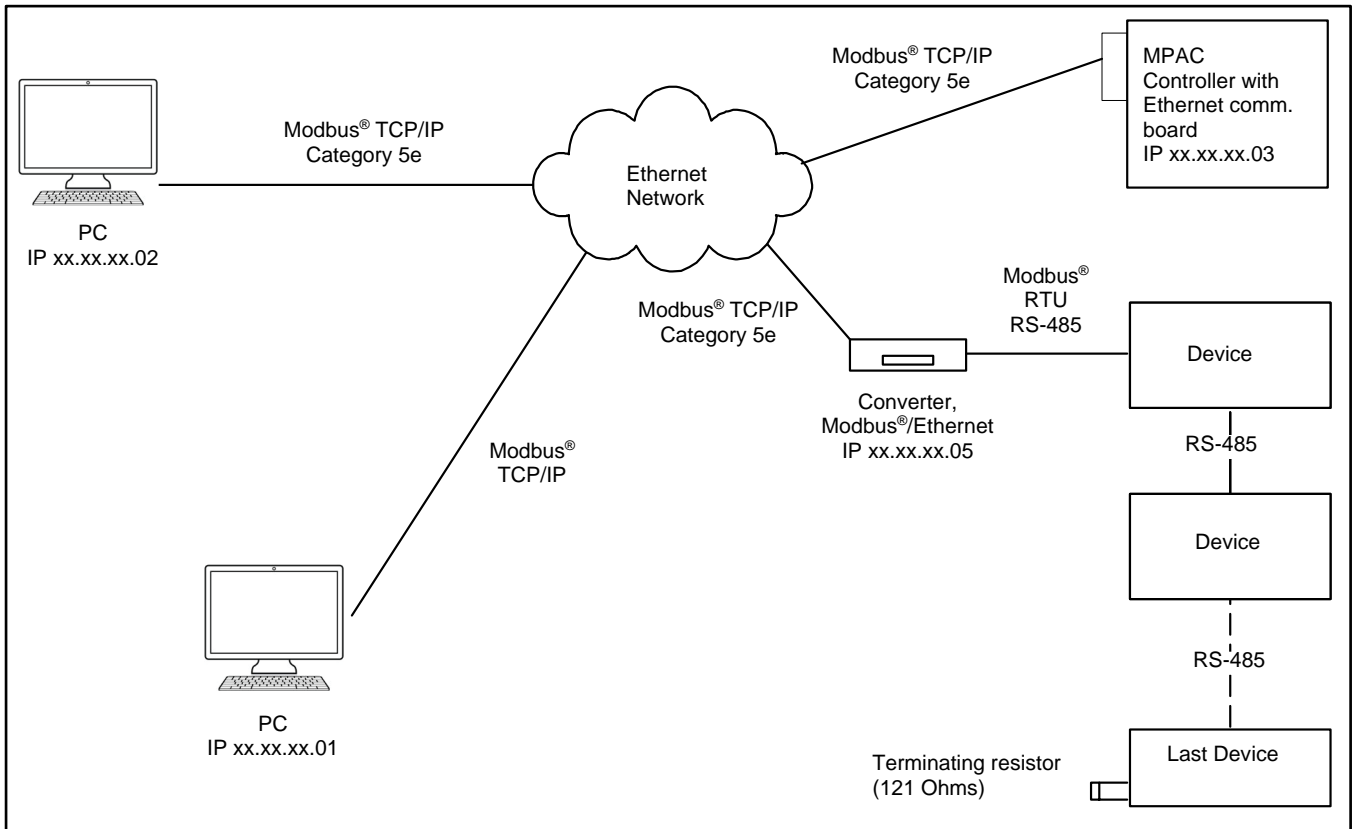




Figure 45 Ethernet Connections to Multiple-Device Network

4.3 Accessory Modules

 DANGER	Hazardous voltage. Will cause severe injury or death. Disconnect all power sources before opening the enclosure.
	

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

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. The total current draw of all modules must not exceed 300 mA. See Figure 46. Add the current draw for every module installed to determine the total current draw. If an External Battery Module is installed and connected to a battery, there is no current restriction. The External Battery Module, if used, must be the last board on the bus.

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

Figure 46 Option Board Types

4.3.1 Accessory Module Mounting

Mount the accessory modules on the module mounting plate. Starting at the end of the module mounting assembly nearest the cable connection, install any I/O modules first, then install the alarm board, if used. The external battery module, if used, must be the last module. See Figure 47. 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.

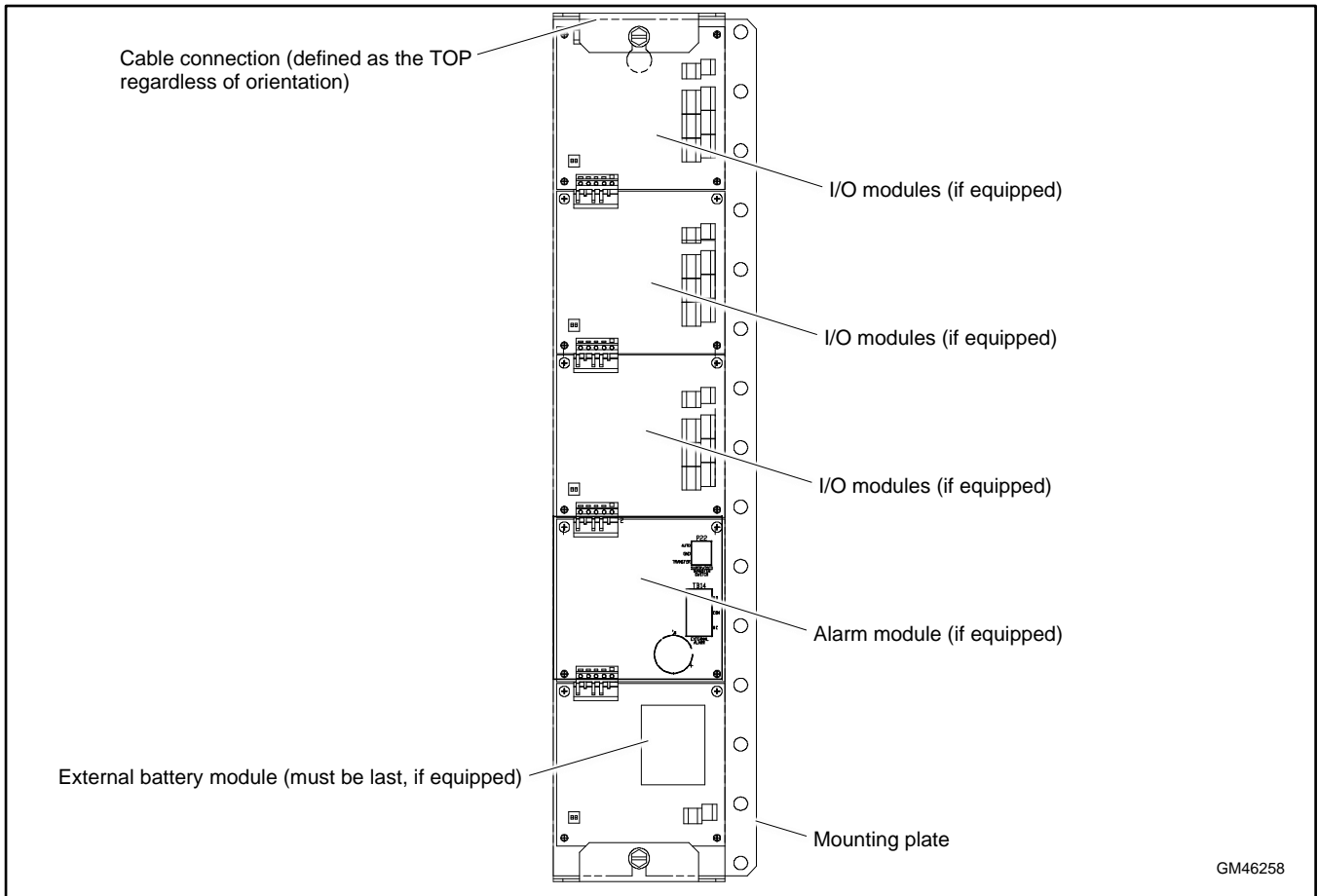


Figure 47 Module Mounting

4.3.2 Input/Output (I/O) Modules

Two types of input/output modules are available. The standard I/O Module has two inputs and six outputs. The high-power I/O module has two inputs and three outputs. See Figure 48 through Figure 51 for I/O module illustrations and specifications.

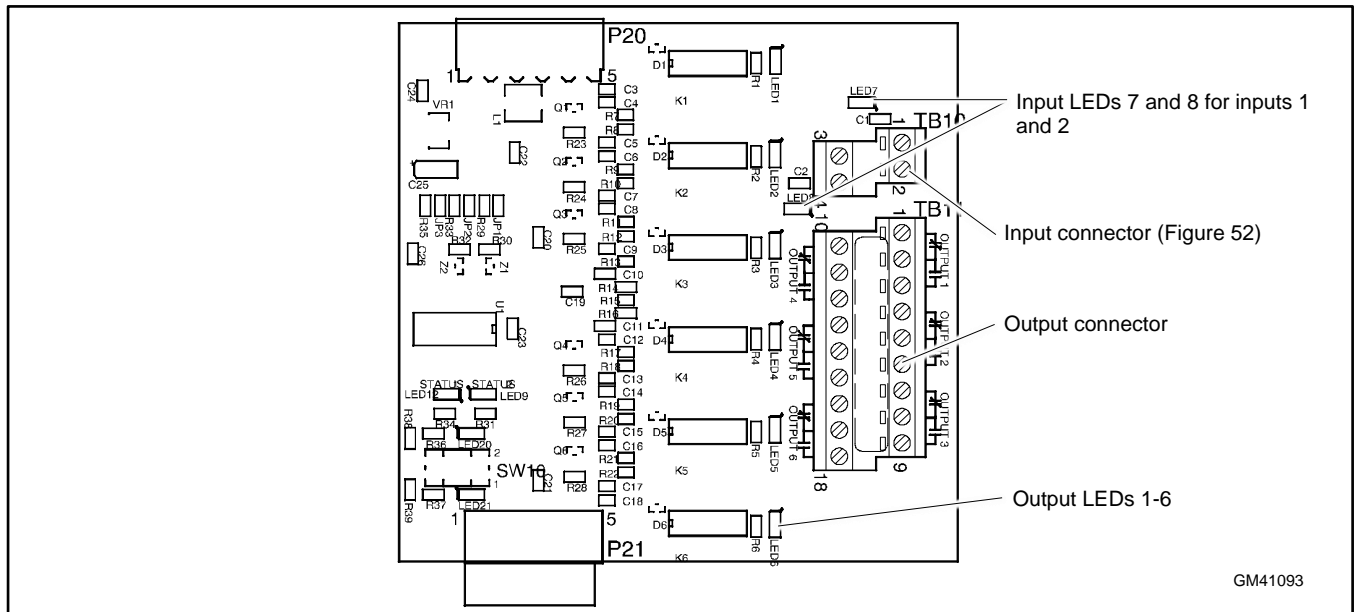


Figure 48 Standard Input/Output Module

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 49 Standard I/O Module Specifications

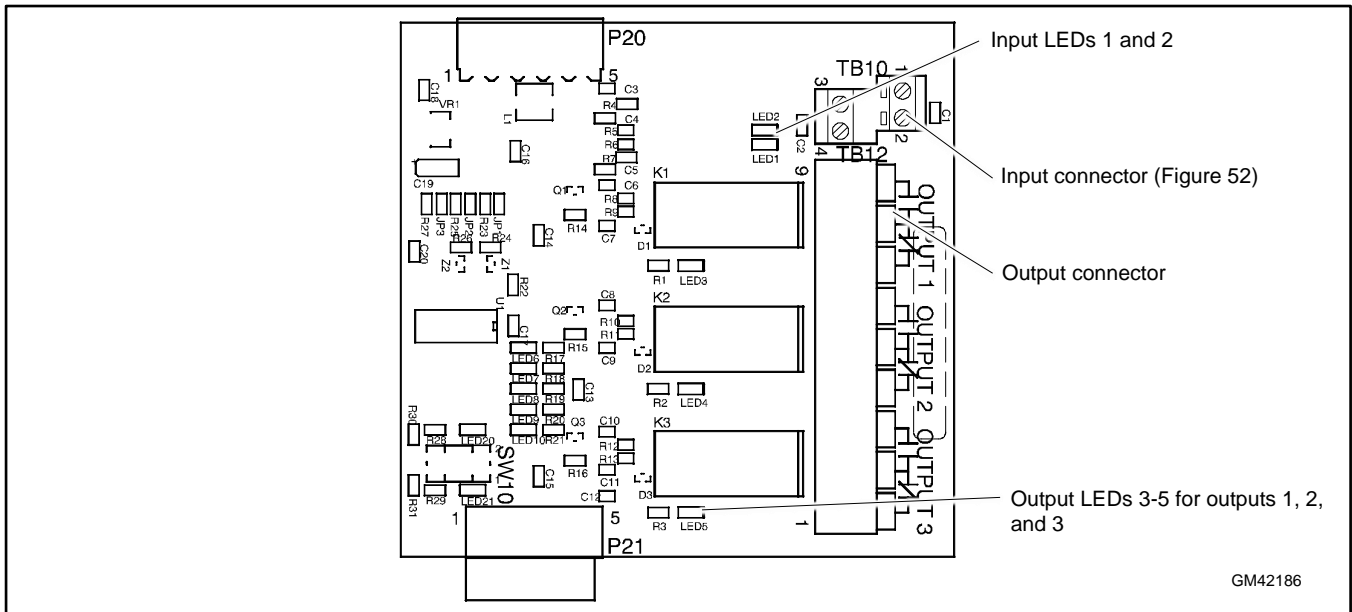


Figure 50 High-Power Input/Output Module

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 (-104°F to 185°F)
Humidity	35% to 85% noncondensing

Figure 51 High-Power I/O Module Specifications

Use 14-24 AWG cable to connect to inputs and outputs. See Figure 52.

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 53. 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.

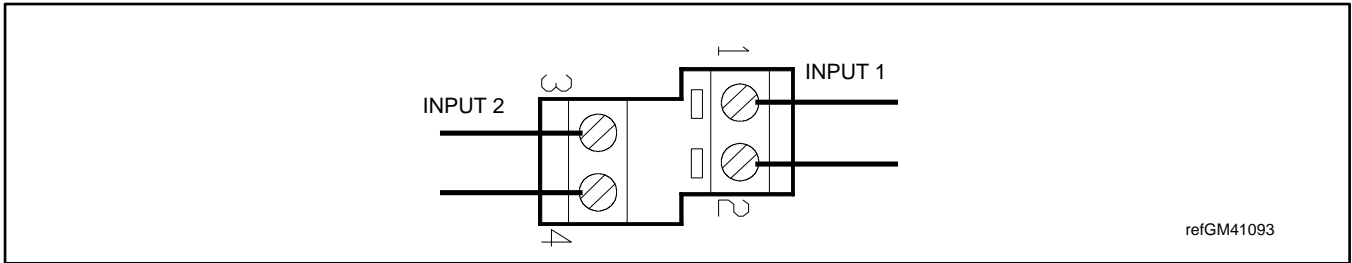


Figure 52 I/O Module Input Connections (TB1 or TB10)

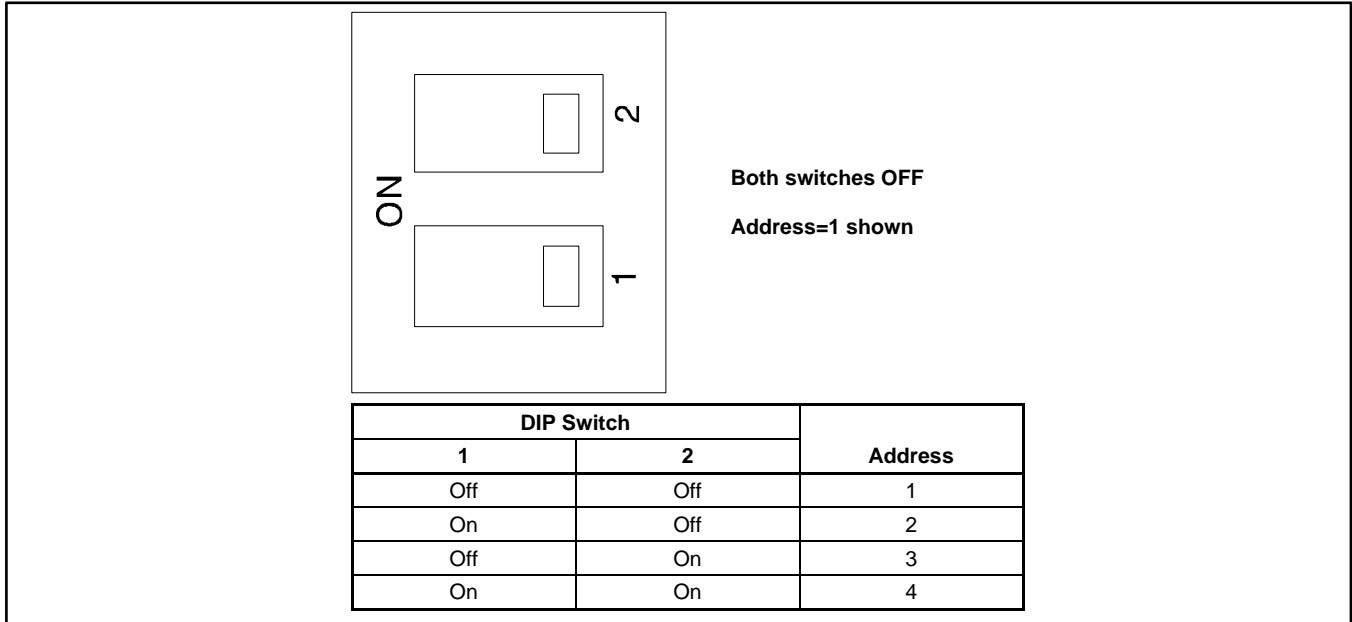


Figure 53 Address DIP Switch Settings

4.3.3 External Battery Supply Module (EBSM)

The External Battery Supply Module is standard factory-installed equipment on Model KUS and KUP service entrance transfer switches. The installer must connect the generator set engine starting batteries or other batteries to the EBSM. See the installation section for instructions.

4.3.4 Alarm Module

See Figure 54 for the optional alarm module. A module mounting kit is required for installation of the alarm module. See the Accessory Module Mounting section.

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 not available for Models KUS/KUP)
- Connection for external alarm

The alarm board has a fixed address = 5.

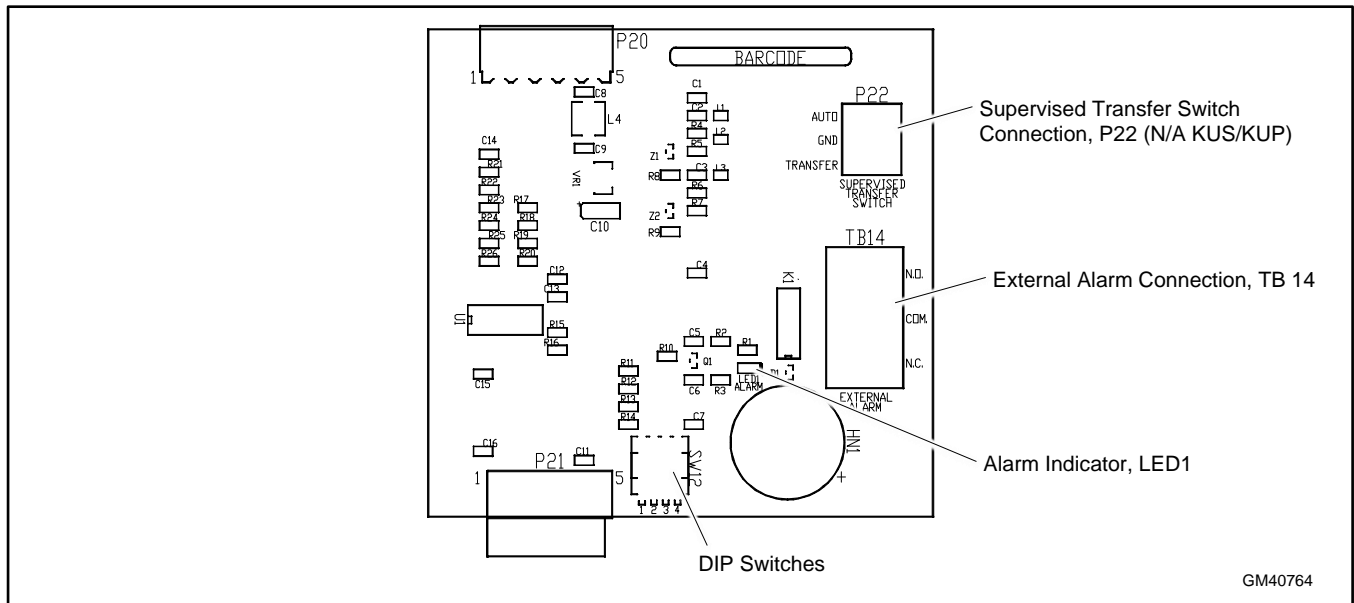


Figure 54 Alarm Module

Alarm Board DIP Switches

There are four DIP switches on the alarm module board. Some of the switches are not used. See Figure 55. 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 55 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 56.

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

Figure 56 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 57. Press the Alarm button to open the Reset menu. Then press the button labeled Reset to silence the alarm.

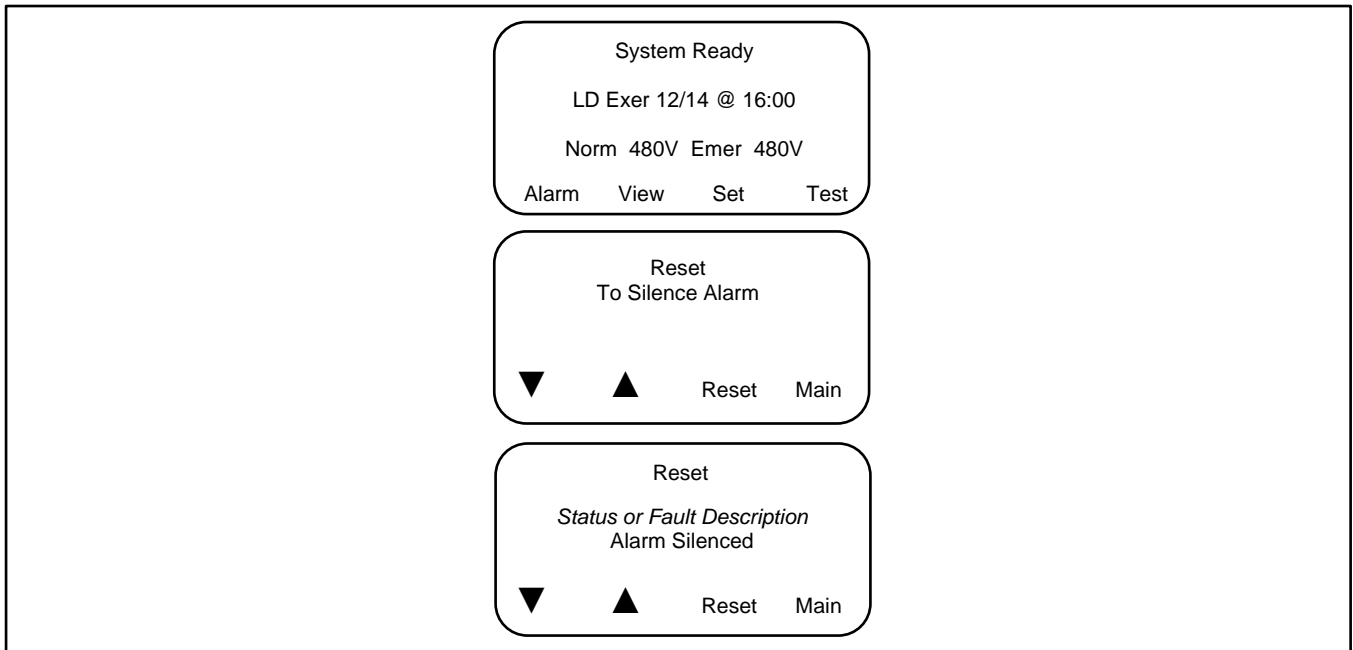




Figure 57 Alarm Silence

4.4 Load Shed (Forced Transfer to OFF)

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

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

The load shed (forced transfer to OFF) accessory is available for programmed-transition and closed-transition transfer switches. The load shed accessory is available factory-installed or as a loose kit. For kit installation, refer to the Installation Instructions provided with the kit.

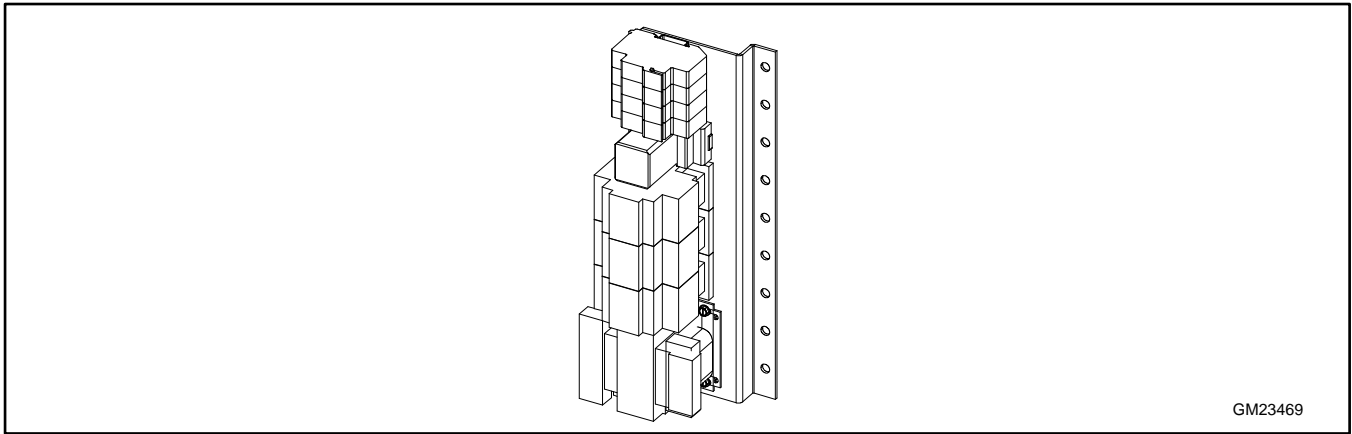
See Figure 58 for an illustration of the load shed accessory.

Connection and Setup

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 59. Use #12-24 AWG wire and tighten to 0.5 Nm (4.4 in. lb.).

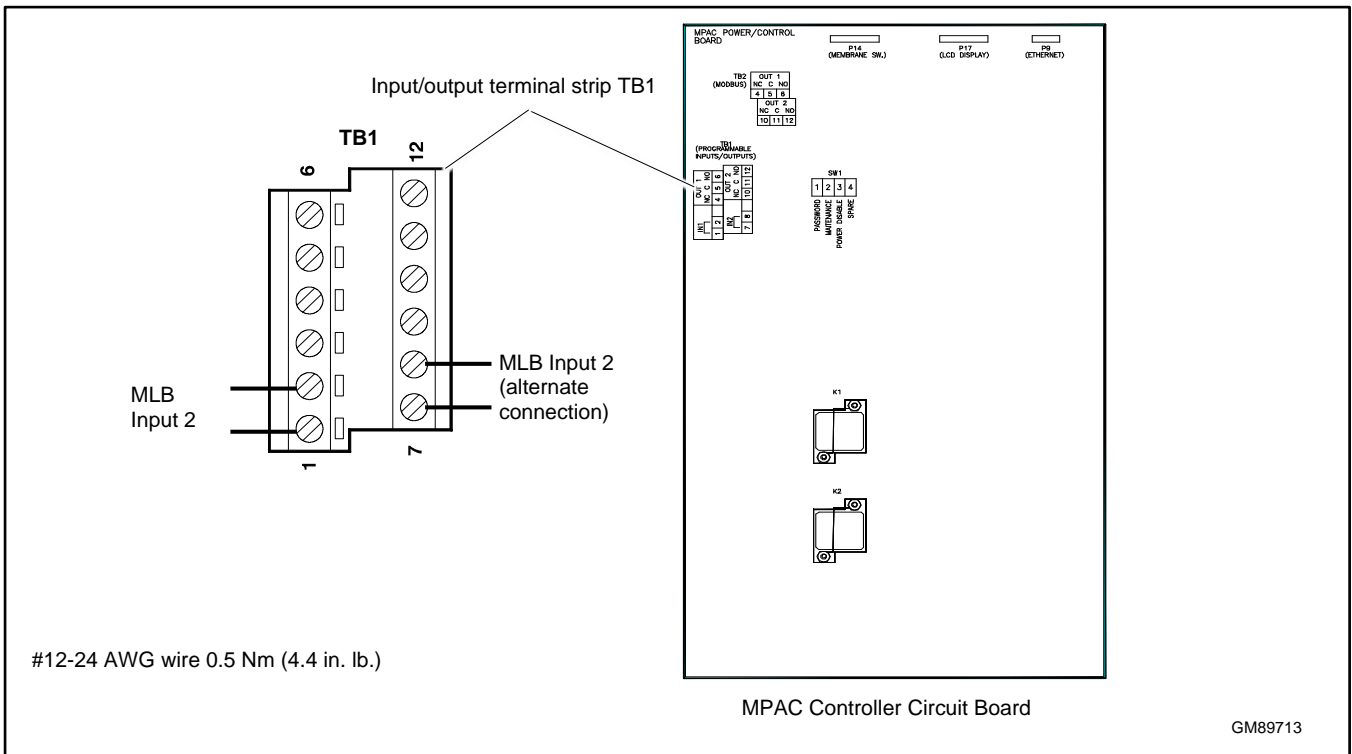
Alternatively, the external contact can be connected to an input connection on an optional I/O module.

Use the Input/Output setup menu or Kohler SiteTech software to assign the connected input (Main Board Input #1 or #2, or an input on the I/O module) to the forced transfer to off function.



GM23469



Figure 58 Load Shed Accessory (for identification)



GM89713

Figure 59 Forced Transfer to Off Input Connection (for factory-installed load shed kits)

4.5 Heater

 DANGER	Hazardous voltage. Will cause severe injury or death. Disconnect all power sources before opening the enclosure.
	

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

An anti-condensation heater kit is available. The strip heater is controlled by a hygrostat to raise the temperature inside the enclosure above the dewpoint to prevent condensation. Figure 60 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 61 and Figure 62. 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.

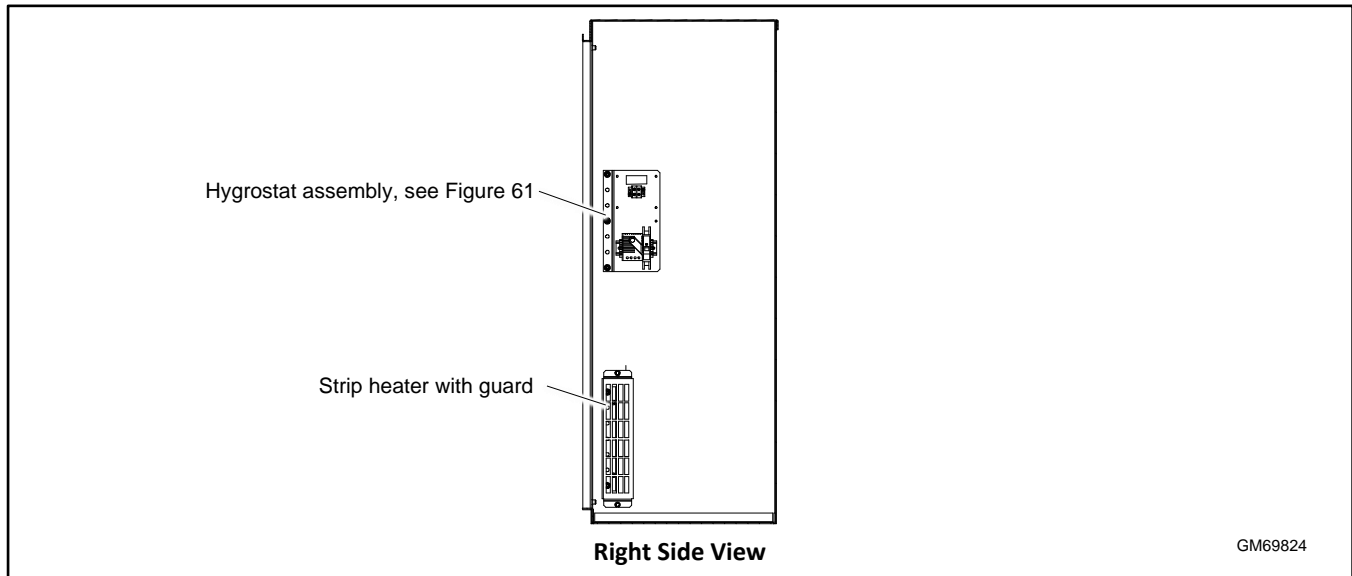


Figure 60 Heater Location, Typical

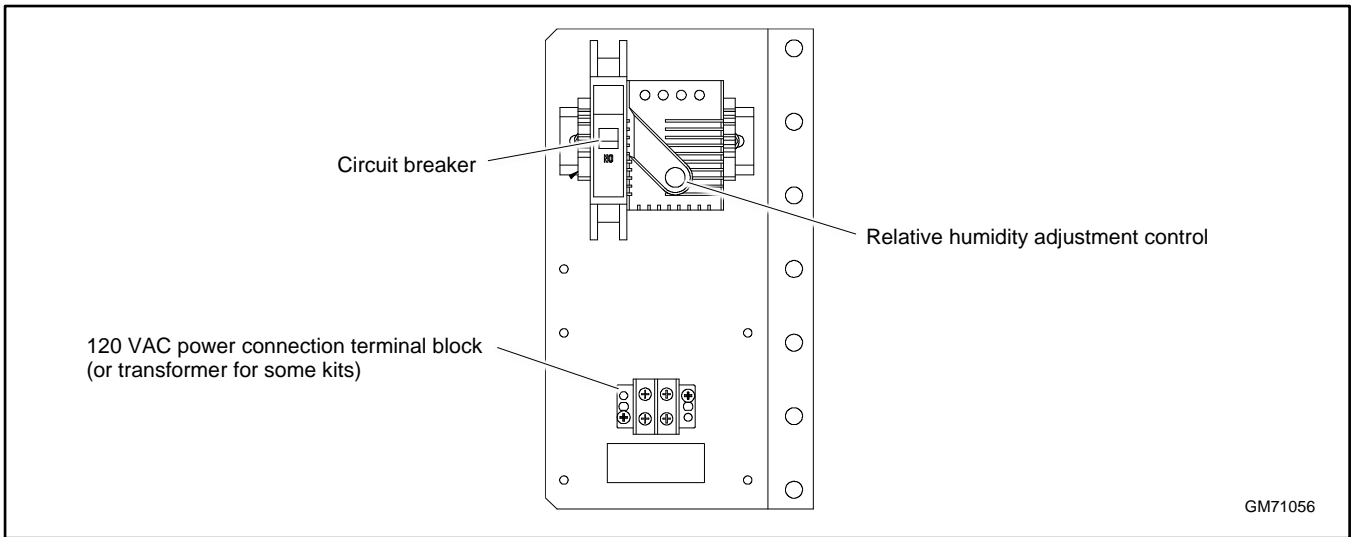


Figure 61 Hygrostat Assembly, Typical

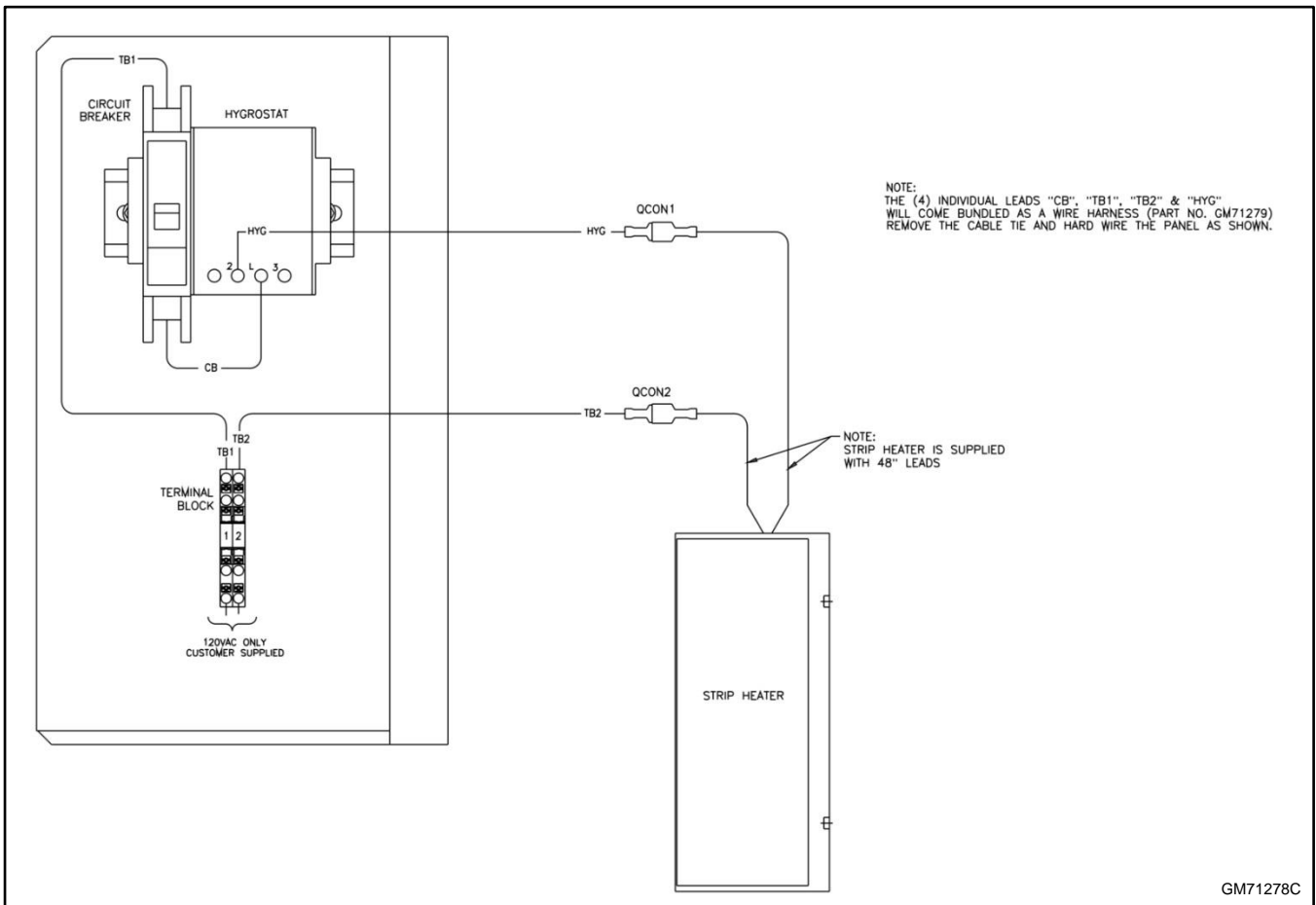


Figure 62 Heater Connections

4.6 Engine Start Circuit Monitoring System

The optional Engine Start Circuit Monitoring System forwards engine start signals while continuously monitoring for wiring faults (open or short circuits) as required by the electrical code NEC 700.10. If the generator module receives an engine start signal or detects any faults, it will send the start signal to the generator and provide an alarm.

See the installation instructions provided with the kit.

4.7 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 5. Scheduled Maintenance

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 see Figure 63 for the Operation Manual part number.

Keep records of all maintenance or service.

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

Figure 63 Operation Manual

Section 6. Functional Tests and Setup

6.1 Introduction

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

The functional tests include the following checks:

- Manual Operation Test
- Voltage Checks
- Lamp Test
- Automatic Operation Test

Note:

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

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

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

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

6.2 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.

6.3 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

 DANGER	Hazardous voltage. Will cause severe injury or death. Only authorized personnel should open the enclosure.
	

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

Voltage Check Procedure

1. If Source N is a generator set, move the generator set master switch to the RUN position. The generator set should start.
2. Close the Source N circuit breaker or switch.
3. Use a voltmeter to check the Source N (normal) phase-to-phase and phase-to-neutral (if applicable) terminal voltages and frequency.
 - a. If Source N is the utility and the measured input does not match the voltage and frequency shown on the transfer switch nameplate, *STOP!* Do not proceed further in installation because the transfer switch is not designed for the application—call your distributor/dealer to order the correct transfer switch.
 - b. If Source N is a generator set and the generator set output voltage and frequency do not match the nominal system voltage and frequency shown on the transfer switch nameplate, follow the manufacturer's instructions to adjust the generator set. The automatic transfer switch will only function with the rated system voltage and frequency specified on the nameplate.
4. Use a phase rotation meter to check the phase rotation at the Source N (normal) terminals. Rewire the transfer switch Source N terminals to obtain the correct phase sequence if necessary.

Note:

The default setting for the phase rotation on the controller is ABC. If the application uses a phase rotation of BAC, refer to the controller Operation Manual for instructions to change the phase rotation setting on the controller.

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

Note:

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

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

6.4 Lamp Test

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

6.5 Automatic Operation Test

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

Note:

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

6.6 System Setup

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

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

Note:

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

6.7 Exerciser Setup

To maximize the reliability of the emergency power system, set the exerciser to start and run the generator set at the intervals and load conditions recommended by the generator set manufacturer. 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.

6.8 User Interface Cover

The gasket-sealed, hinged user interface cover prevents unauthorized access to the transfer switch controls and protects the user interface from harsh environmental conditions. The cover is available as an optional accessory for NEMA 1 enclosures. NEMA 3R enclosures include the cover as standard equipment.

Use a customer-supplied padlock to lock the cover.

6.9 Startup Notification

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

7.1 Transfer Switch Operation

7.1.1 Normal Operation

Under normal conditions, the load is energized from the utility supply. If the utility power fails, the ATS signals the generator to start (engine start contacts close). The generator controller must be in AUTO mode. The load will be energized by the running generator.

When utility power is restored, the load is transferred back to the utility source and the engine start signal is removed (contacts open). If the generator set is in SUTO mode, the engine will stop. There may be a cooldown period before the engine stops. Refer to the controller operation manual for the sequence of operation.

In the normal operating mode, the service disconnect switch must be in the AUTO position. See the Service Disconnect Operation section for service disconnect instructions.

7.1.2 Overcurrent Trip

If the utility source circuit breaker trips open due to an overcurrent condition, the ATS controller will initiate an engine start signal and initiate transfer of the load to the generator supply. A Source1 breaker trip fault will be displayed on the ATS controller. The utility source will be locked out and the load will remain on the generator supply until the fault is manually reset.

Note:

Contact your local distributor/dealer to identify and correct the cause of the overcurrent condition before resetting the fault.

The utility circuit breaker is located on the front of the ATS. On NEMA Type 1 enclosures, the circuit breaker can be reset without opening the ATS enclosure. For other enclosure types, open the outer enclosure door to access the circuit breaker handle. See Figure 64 for typical circuit breaker locations. To reset the circuit breaker, move the handle to OFF (0), and then ON (I). Some breakers have a handle that can fold down when not in use. Lift the handle before moving it to OFF. Fold the handle back down after moving it to ON.

After resetting the tripped breaker, check the controller display for fault messages. See the ATS controller operation manual for instructions to reset the fault. See the List of Related Materials in the Introduction section for the manual part number.

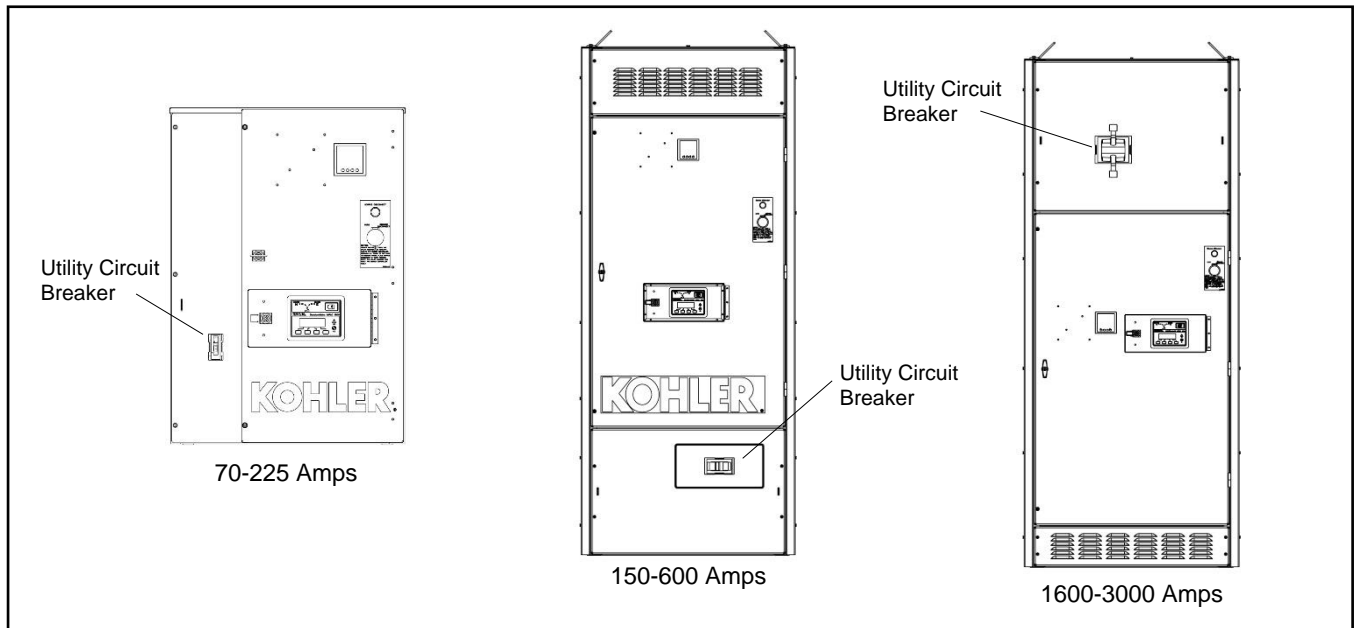




Figure 64 Utility Circuit Breaker Locations, Typical

7.1.3 Energy Reduction Maintenance Setting (ERMS) System

 DANGER	<p>Hazardous voltage. Will cause severe injury or death.</p> <p>This equipment must be installed and serviced by qualified electrical personnel.</p>
	

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

The Energy Reduction Maintenance Setting (ERMS) system is available as optional, factory-installed equipment on 1200 Amp and larger model KUS and KUP service entrance rated automatic transfer switches (ATS). The ERMS system is used to reduce the arc flash incident energy (AFIE) during energized service.

The system can help provide compliance with NEC requirements for arc flash reduction. Refer to the NEC and follow all applicable codes and regulations during the ATS installation.

The ERMS system is available on MicroLogic P or H trip units with the blue ERMS label shown in Figure 65. See the KUS/KUP Specification Sheet for circuit breaker information.

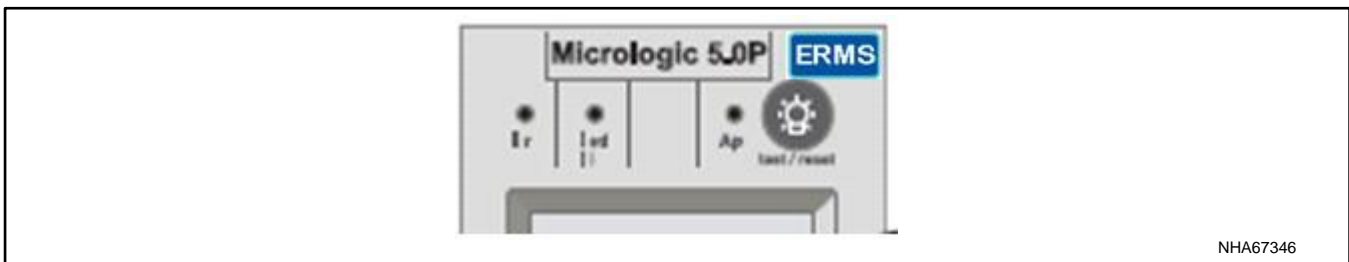


Figure 65 ERMS Label on Circuit Breaker Trip Unit

The ERMS module is manufactured by the circuit breaker manufacturer and is used to reduce the tripping threshold and clearing time. The ERMS is installed and wired at the factory according to the circuit breaker manufacturer's instructions. Factory connections are shown in Figure 67 for reference only. No customer connections to the system are required.

The following components are mounted on the ATS enclosure door as shown in Figure 66.

- ERMS Maintenance Mode ON/OFF selector switch.
- Maintenance mode indicator light. The light is ON when the circuit breaker is in ERMS mode.

The I/O Module factory setting = 3; do not change this setting.

ERMS System Operation Description

When the ERMS switch is “ON” (circuit breaker is in maintenance mode), the circuit breaker’s ERMS instantaneous pickup is set to the pre-programmed level which is less than the normal instantaneous pickup setting as set by the rotary switch setting (li). As a result, the potential for nuisance tripping increases. Nuisance tripping can be caused by a motor starting, transformer inrush, or some other momentary power disturbance.

For more information, refer to the ERMS system manufacturer’s literature included with the transfer switch.

ERMS Operation Instructions

1. Turn the ERMS maintenance mode switch to ON before performing service or maintenance on the transfer switch or downstream equipment.

Note:

Utility source voltage is still present! The ERMS system does not disconnect power or trip/open the utility circuit breaker.

2. After the service procedures are complete, turn the switch OFF for normal system operation.

Note:

Be sure to follow all safety precautions and instructions, including instructions to disconnect power and/or disable the generator set, when performing maintenance and service procedures on the power system or connected equipment.

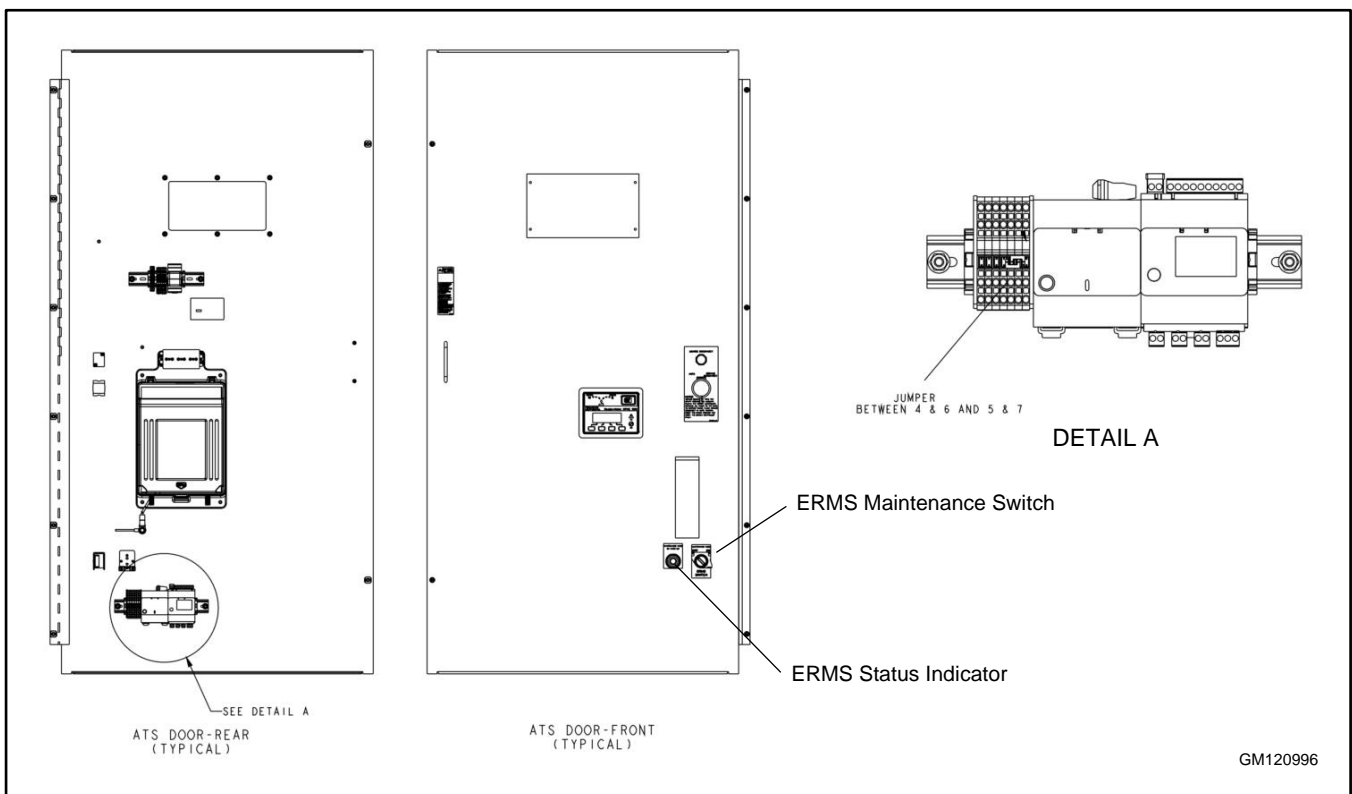


Figure 66 ERMS System Components

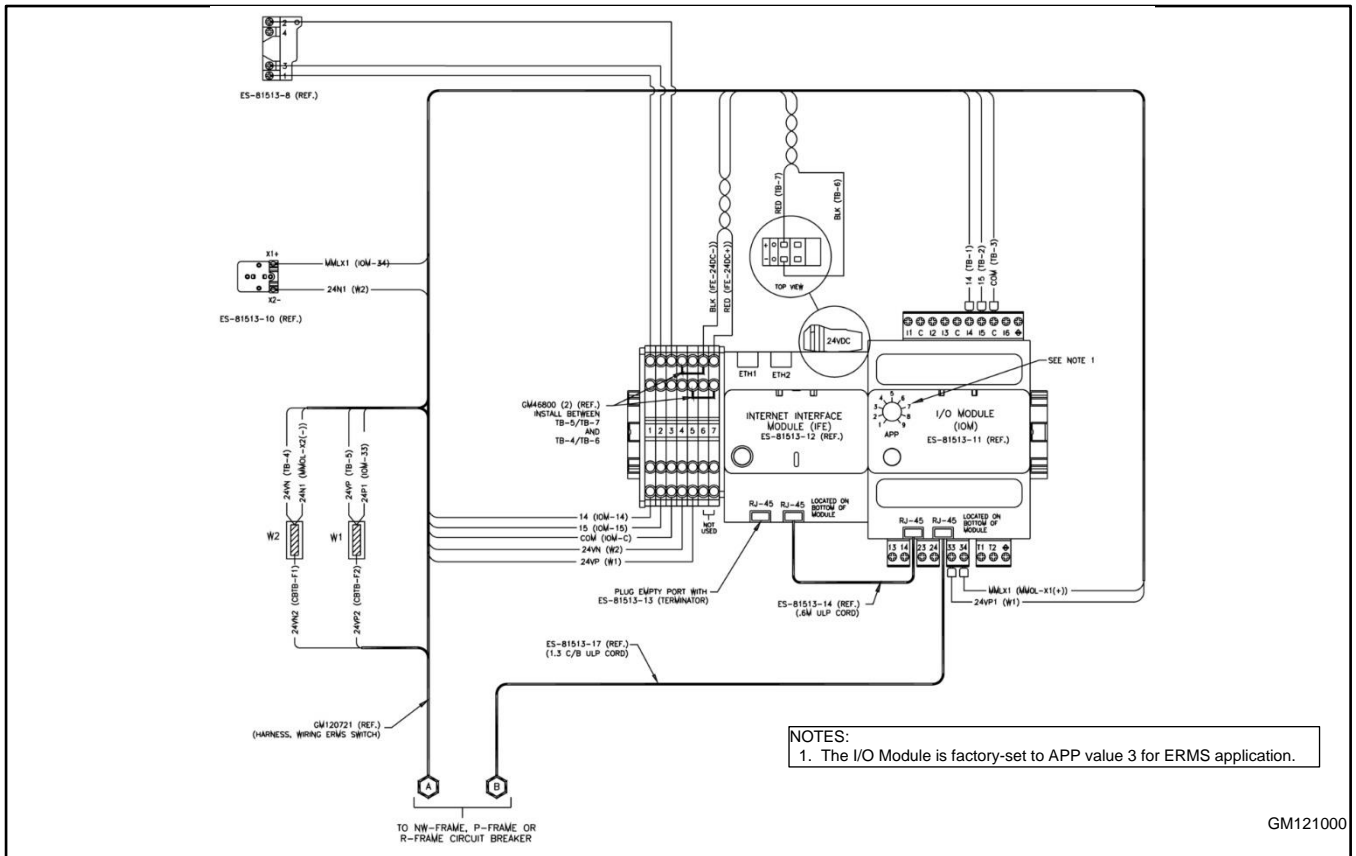


Figure 67 ERMS wiring (factory-installed)

7.2 Service Disconnect Switch Operation

The two-position service disconnect switch trips the utility-side circuit breaker using the shunt trip.

The service disconnect switch and utility disconnected lamp are located on the front door or front panel. See Figure 58 for the typical service disconnect switch location.

The switch has two positions, AUTO and SERVICE DISCONNECT.

- When the switch is in the AUTO position, the ATS is in normal operation mode
- When the switch is in the SERVICE DISCONNECT position, the ATS service entrance breaker is shunt-tripped and open. The lamp is illuminated, and the controller display shows SERVICE DISCONNECT.

Note:

The ATS does not signal the generator set to start when the utility-side breaker is tripped.

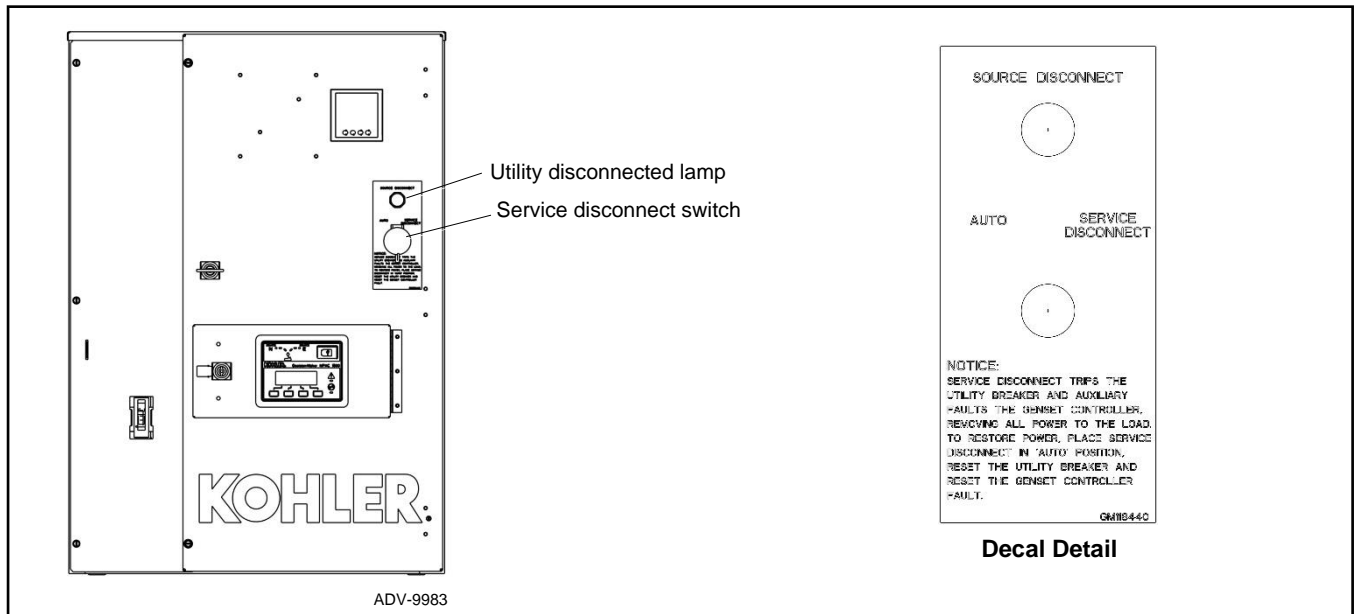








Figure 68 Service Disconnect Switch Location (typical)

Important notes about service disconnect operation:

- On service entrance transfer switches, **the line side lugs are always powered.**
- Service disconnect removes power from the load and transfer is inhibited. Power will not be restored to the load until the switch is returned to AUTO.
- The engine start signal is *not* activated by the service disconnect procedure.
- Moving the switch to the SERVICE DISCONNECT position during a test or exercise sequence ends the test or exercise sequence. The engine stops immediately without running a cooldown cycle.
- **Controller power.** To remove the controller for maintenance or service without interrupting the power to the load, an optional Controller Disconnect Switch is required. See the Controller Disconnect Switch Operation section for instructions.

 DANGER	Hazardous voltage. Will cause severe injury or death. Only authorized personnel should open the enclosure.
	

 WARNING	Accidental starting. Can cause severe injury or death. Disconnect the battery cables before working on the generator set. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery.
  	

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

7.2.1 Service Disconnect Procedure

The service disconnect switch has two positions: AUTO and SERVICE DISCONNECT. Follow the procedures in this section carefully and observe the safety precautions when performing a service disconnect before maintenance or service. Watch the LED indicators on the ATS controller to check the ATS position and source status during the procedures.

Note:

The service disconnect procedure removes power from the load, but utility power is still present at the transfer switch normal side lugs whenever the utility source is available.

Service Disconnect when the Transfer Switch is in NORMAL

Use this procedure if utility power is connected and the transfer switch is in the Normal position.

1. Move the service disconnect control switch located on the door of the transfer switch to the SERVICE DISCONNECT position. This opens the utility circuit breaker through the shunt trip circuit and sends a fault to the generator set controller.
2. Verify the following:
 - The utility (normal) breaker is open.
 - The generator set controller displays a fault message and the generator set is not running.
 - The ATS controller display shows SERVICE DISCONNECTED
 - The Utility Disconnected light is illuminated and the NOT IN AUTO LED is flashing.

Note:

The External Battery Supply Module (EBSM) allows the generator set battery to continue to supply DC power to the ATS controller after the Utility source is disconnected. The EBSM (sometimes referred to as the Battery Option Board, BOB) is factory-installed standard equipment on KUS and KUP models.

3. Attach a safety lockout padlock to the service disconnect control switch to prevent unauthorized reconnection of utility power. Verify the transfer switch door is closed and locked. If the door is not locked, turn and remove the door key.
4. Use a voltmeter to verify that power is disconnected from the load before servicing connected equipment.

Service Disconnect when the Transfer Switch is in EMERGENCY

Use this procedure if the transfer switch is in the Emergency position.

1. Move the service disconnect control switch located on the door of the transfer switch to the SERVICE DISCONNECT position. This opens the utility circuit breaker through the shunt trip circuit and sends a fault to the generator set controller.
2. The engine start signal is removed.
3. Wait for the generator set to shut down. The generator set may continue to run for several minutes to cool the engine.
4. Verify the following:
 - The utility (normal) breaker is open.
 - The generator set controller displays a fault message and the generator set is not running.
 - The ATS controller display shows SERVICE DISCONNECTED
 - The Utility Disconnected light is illuminated and the NOT IN AUTO LED is flashing.

Note:

The External Battery Supply Module (EBSM) allows the generator set battery to continue to supply DC power to the ATS controller after the Utility source is disconnected. The EBSM (sometimes referred to as the Battery Option Board, BOB) is factory-installed standard equipment on KUS and KUP models.

5. Attach a safety lockout padlock to the service disconnect control switch to prevent unauthorized reconnection of utility power. Verify the transfer switch door is closed and locked. If the door is not locked, turn and remove the door key.
6. Use a voltmeter to verify that power is disconnected from the load before servicing connected equipment.

7.2.2 Service Reconnect Procedure

Service reconnect procedure with Normal source available

1. Remove the padlock from the service disconnect control switch and move the service disconnect switch to the AUTO position. The Service Disconnect light on the door should turn off. The MPAC 1500 ATS controller will resume normal operation.
2. Manually reset the utility-side circuit breaker by moving the breaker handle to fully OFF and then ON.
3. If the ATS controller displays shows "FAILURE TO ACQUIRE," proceed to step 4. Otherwise, go to step 5.
4. Reset the fault on the ATS controller. See the Decision-Maker® MPAC 1500 Operation Manual for instructions, if necessary.
5. If the ATS is not in the normal position, it will transfer to the normal source.
6. Reset the fault on the generator set controller. See the generator controller Operation Manual for instructions to reset the fault and prepare the generator set for operation. Then place the generator set controller in AUTO
7. Verify that the ATS controller display shows normal source available and ATS in normal position.

Service reconnect procedure when Normal source is NOT available

1. Remove the padlock from the service disconnect control switch and move the service disconnect switch to the AUTO position. The Service Disconnect light on the door should turn off. The MPAC 1500 ATS controller will resume normal operation.
2. Manually reset the utility-side circuit breaker by moving the breaker handle to fully OFF and then ON.
3. Reset the fault on the generator set controller. See the generator controller Operation Manual for instructions to reset the fault and prepare the generator set for operation. Then place the generator set controller in AUTO.





WARNING



The generator set will start when the controller is placed in AUTO.

4. Reset any faults on the ATS controller. See the Decision-Maker[®] MPAC 1500 Operation Manual for instructions, if necessary.
5. Verify that the ATS controller display shows emergency source available and ATS in emergency position.

7.3 Controller Disconnect Switch Operation

 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.

 DANGER	Hazardous voltage. Will cause severe injury or death. Only authorized personnel should open the enclosure.
	

The optional controller disconnect switch allows disconnection of the power to the controller during maintenance and service. See Figure 69.

Note:

On service entrance models, power is always present on the utility side of the ATS. The service disconnect procedure removes power from the load, but utility power is still present at the transfer switch lugs whenever the utility source is available.

Note:

Disconnecting power to the controls will cause the ATS to send an engine start signal to the generator set. Disable the generator set before using the controller disconnect switch to disconnect power to the ATS controls.

Operation Instructions

The switch has two positions, auto (I) and disconnect (O).

1. Disable the generator set to prevent starting. Refer to the generator set documentation for specific instructions, if necessary.
2. Move the controller disconnect switch to the O position to disconnect power to the ATS controller.
3. After maintenance or service, move the controller disconnect switch to the I position to reconnect power.
4. Follow the instructions in the generator set documentation to reenab the generator set.



Figure 69 Controller Disconnect Switch

Appendix A. Abbreviations

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

A, amp	ampere	CID	cubic inch displacement	FHM	flat head machine (screw)
ABDC	after bottom dead center	CL	centerline	fl. oz.	fluid ounce
AC	alternating current	cm	centimeter	flex.	flexible
A/D	analog to digital	CMOS	complementary metal oxide substrate (semiconductor)	freq.	frequency
ADC	advanced digital control; analog to digital converter	com	communications (port)	FS	full scale
adj.	adjust, adjustment	coml	commercial	ft.	foot, feet
ADV	advertising dimensional	Coml/Re	Commercial/Recreational	ft. lb.	foot pounds (torque)
Ah	amp-hour	conn.	connection	ft./min.	feet per minute
AHWT	anticipatory high water temperature	cont.	continued	ftp	file transfer protocol
AISI	American Iron and Steel	CPVC	chlorinated polyvinyl chloride	g	gram
ALOP	anticipatory low oil pressure	crit.	critical	ga.	gauge (meters, wire size)
alt.	alternator	CSA	Canadian Standards Association	gal.	gallon
Al	aluminum	CT	current transformer	gen.	generator
ANSI	American National Standards Institute (formerly American Standards Association, ASA)	Cu	copper	genset	generator set
AO	anticipatory only	cUL	Canadian Underwriter's Laboratories	GFI	ground fault interrupter
APDC	Air Pollution Control District	CUL	Canadian Underwriter's Laboratories	GND, ⊕	ground
API	American Petroleum Institute	cu. in.	cubic inch	gov.	governor
approx.	approximate, approximately	cw.	clockwise	gph	gallons per hour
APU	Auxiliary Power Unit	CWC	city water-cooled	gpm	gallons per minute
AQMD	Air Quality Management	cyl.	cylinder	gr.	grade, gross
AR	as required, as requested	D/A	digital to analog	GRD	equipment ground
AS	as supplied, as stated, as suggested	DAC	digital to analog converter	gr. wt.	gross weight
ASE	American Society of Engineers	dB	decibel	H x W x D	height by width by depth
ASME	American Society of Engineers	dB(A)	decibel (A weighted)	HC	hex cap
assy.	assembly	DC	direct current	HCHT	high cylinder head
ASTM	American Society for Testing Materials	DCR	direct current resistance	HD	heavy duty
ATDC	after top dead center	deg., °	degree	HET	high exhaust temp., high temp.
ATS	automatic transfer switch	dept.	department	hex	hexagon
auto.	automatic	dia.	diameter	Hg	mercury (element)
aux.	auxiliary	DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)	HH	hex head
avg.	average	DIP	dual inline package	HHC	hex head cap
AVR	automatic voltage regulator	DPDT	double-pole, double-throw	HP	horsepower
AWG	American Wire Gauge	DPST	double-pole, single-throw	hr.	hour
AWM	appliance wiring material	DVR	digital voltage regulator	HS	heat shrink
bat.	battery	E, emer.	emergency (power source)	hsg.	housing
BBDC	before bottom dead center	EBSM	external battery supply module	HVAC	heating, ventilation, and air conditioning
BC	battery charger, battery	ECM	electronic control module, engine control module	HWT	high water temperature
BCA	battery charging alternator	E ² PROM	EEPROM	Hz	hertz (cycles per second)
BCI	Battery Council International	EDI	electrically-erasable programmable read-only memory	IBC	International Building Code
BDC	before dead center	EFR	electronic data interchange	IC	integrated circuit
BHP	brake horsepower	e.g.	emergency frequency relay	ID	inside diameter, identification
blk.	black (paint color), block (engine)	EG	for example (<i>exempli gratia</i>)	IEC	International Electrotechnical Commission
blk. htr.	block heater	EGSA	electronic governor	IEEE	Institute of Electrical and Electronics Engineers
BMEP	brake mean effective pressure	EIA	Electrical Generating Systems Association	IMS	improved motor starting
bps	bits per second	EI/EO	end inlet/end outlet	in.	inch
br.	brass	EMI	electromagnetic interference	in. H ₂ O	inches of water
BTDC	before top dead center	emiss.	emission	in. Hg	inches of mercury
Btu	British thermal unit	eng.	engine	in. lb.	inch pounds
Btu/min.	British thermal units per minute	EPA	Environmental Protection Agency	Inc.	incorporated
C	Celsius, centigrade	EPS	emergency power system	ind.	industrial
cal.	calorie	ER	emergency relay	int.	internal
CAN	controller area network	ERMS	energy reduction maintenance setting	int./ext.	internal/external
CARB	California Air Resources Board	ES	engineering special, engineered	I/O	input/output
CAT5	Category 5 (network cable)	ESD	electrostatic discharge	IP	internet protocol
CB	circuit breaker	est.	estimated	ISO	International Organization for Standardization
CC	crank cycle	E-Stop	emergency stop	J	joule
cc	cubic centimeter	etc.	et cetera (and so forth)	JIS	Japanese Industry Standard
CCA	cold cranking amps	exh.	exhaust	k	kilo (1000)
ccw.	counterclockwise	ext.	external	K	kelvin
CEC	Canadian Electrical Code	F	Fahrenheit, female	kA	kiloampere
cert.	certificate, certification,			KB	kilobyte (2 ¹⁰ bytes)
cfh	cubic feet per hour			KBus	Kohler communication
cfm	cubic feet per minute			kg	kilogram
CG	center of gravity			kg/cm ²	kilograms per square
				kgm	kilogram-meter
				kg/m ³	kilograms per cubic meter
				kHz	kilohertz

kJ	kilojoule	NPSC	National Pipe, Straight-coupling	SPDT	single-pole, double-throw
km	kilometer	NPT	National Standard taper pipe	SPST	single-pole, single-throw
kOhm,	kilo-ohm		thread per general use	spec	specification
kPa	kilopascal	NPTF	National Pipe, Taper-Fine	specs	specification(s)
kph	kilometers per hour	NR	not required, normal relay	sq.	square
kV	kilovolt	ns	nanosecond	sq. cm	square centimeter
kVA	kilovolt ampere	OC	overcrank	sq. in.	square inch
kVAR	kilovolt ampere reactive	OD	outside diameter	SMS	short message service
kW	kilowatt	OEM	original equipment manufacturer	SS	stainless steel
kWh	kilowatt-hour	OF	overfrequency	std.	standard
kWm	kilowatt mechanical	opt.	option, optional	stl.	steel
kWth	kilowatt-thermal	OS	oversize, overspeed	tach.	tachometer
L	liter	OSHA	Occupational Safety and Health	TB	terminal block
LAN	local area network		Administration	TCP	transmission control protocol
L x W x	length by width by height	OV	overvoltage	TD	time delay
lb.	pound, pounds	oz.	ounce	TDC	top dead center
lbm/ft ³	pounds mass per cubic feet	p., pp.	page, pages	TDEC	time delay engine cooldown
LCB	line circuit breaker	PC	personal computer	TDEN	time delay emergency to
LCD	liquid crystal display	PCB	printed circuit board	TDES	time delay engine start
LED	light emitting diode	pF pic	picofarad	TDNE	time delay normal to
Lph	liters per hour	PF	power factor	TDOE	time delay off to emergency
Lpm	liters per minute	ph., Ø	phase	TDON	time delay off to normal
LOP	low oil pressure	PHC	Phillips® head Crimptite®	temp.	temperature
LP	liquefied petroleum		(screw)	term.	terminal
LPG	liquefied petroleum gas	PHH	Phillips® hex head (screw)	THD	total harmonic distortion
LS	left side	PHM	pan head machine (screw)	TIF	telephone influence factor
L _{wa}	sound power level, A weighted	PLC	programmable logic control	tol.	tolerance
LWL	low water level	PMG	permanent magnet generator	turbo.	turbocharger
LWT	low water temperature	pot	potentiometer, potential	typ.	typical (same in multiple
m	meter, milli (1/1000)	ppm	parts per million		locations)
M	mega (106 when used with SI	PROM	programmable read-only	UF	underfrequency
	units), male		memory	UHF	ultrahigh frequency
m ³	cubic meter	psi	pounds per square inch	UIF	user interface
m ³ /hr.	cubic meters per hour	psig	pounds per square inch gauge	UL	Underwriter's Laboratories,
m ³ /min.	cubic meters per minute	pt.	pint	UNC	unified coarse thread (was
mA	milliampere	PTC	positive temperature coefficient	UNF	unified fine thread (was NF)
man.	manual	PTO	power takeoff	univ.	universal
max.	maximum	PVC	polyvinyl chloride	URL	uniform resource locator (web
MB	megabyte (2 ²⁰ bytes)	qt.	quart, quarts		address)
MCCB	molded-case circuit breaker	qty.	quantity	US	undersize, underspeed
MCM	one thousand circular mils	R	replacement (emergency) power	UV	ultraviolet, undervoltage
meggar	megohmmeter		source	V	volt
MHz	megahertz	rad.	radiator, radius	VAC	volts alternating current
mi.	mile	RAM	random access memory	VAR	voltampere reactive
mil	one one-thousandth of an inch	RBUS	RS-485 proprietary	VDC	volts direct current
min.	minimum, minute		communications	VFD	vacuum fluorescent display
misc.	miscellaneous	RDO	relay driver output	VGA	video graphics adapter
MJ	megajoule	ref.	reference	VHF	very high frequency
mJ	millijoule	rem.	remote	W	watt
mm	millimeter	Res/Com	Residential/Commercial	WCR	withstand and closing rating
mOhm,m	milliohm	RFI	radio frequency interference	w/	with
MOhm,M	megaohm	RH	round head	WO	write only
MOV	metal oxide varistor	RHM	round head machine (screw)	w/o	without
MPa	megapascal	rly.	relay	wt.	weight
mpg	miles per gallon	rms	root mean square	xfrm	transformer
mph	miles per hour	rnd.	round		
MS	military standard	RO	read only		
ms	millisecond	ROM	read only memory		
m/sec.	meters per second	rot.	rotate, rotating		
mtg.	mounting	rpm	revolutions per minute		
MTU	Motoren-und Turbinen-Union	RS	right side		
MW	megawatt	RTDs	Resistance Temperature		
mW	milliwatt		Detectors		
µF	microfarad	RTU	remote terminal unit		
N, norm.	Normal (power source)	RTV	room temperature vulcanization		
NA	not available, not applicable	RW	read/write		
nat. gas	natural gas	SAE	Society of Automotive Engineers		
NBS	National Bureau of Standards	s, sec.	second		
NC	normally closed	RW	read/write		
NEC	National Electrical Code	SAE	Society of Automotive Engineers		
NEMA	National Electrical	SI	<i>Systeme internationale d'unites</i> ,		
	Manufacturers Association		International System of Units		
NFPA	National Fire Protection	SI/EO	side in/end out		
	Association	sil.	silencer		
Nm	newton meter	SMTP	simple mail transfer protocol		
NO	normally open	SI/EO	side in/end out		
no., nos.	number, numbers	SNMP	simple network management		
NPS	National Pipe, Straight		protocol		

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