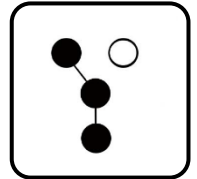


Operation and Installation

Automatic Transfer Switches



Models:

KCS/KCP/KCC

30 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
- ☐ Battery Module
- ☐ California OSHPD Approval
- ☐ Controller Disconnect Switch
- ☐ Current Monitoring
- ☐ Digital Meter
- ☐ Heater
- ☐ IBC Seismic Certification
- ☐ I/O Module, Standard (max. 4) qty: _____
- ☐ I/O Module, High Power (max. 4) qty: _____
- ☐ Load Shed
- ☐ Line-Neutral Monitoring
- ☐ Supervised Transfer Switch
- ☐ Surge Protection Device (SPD)
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

Table of Contents

Safety Precautions and Instructions	5
Introduction	9
Service Assistance.....	10
Section 1. Product Description.....	11
1.1 Purpose.....	11
1.2 Nameplate.....	12
1.3 Model Designation	13
Section 2. Installation	15
2.1 Introduction	15
2.2 Receipt of Unit.....	15
2.2.1 Inspection.....	15
2.2.2 Lifting	16
2.2.3 Storage	16
2.2.4 Unpacking.....	16
2.3 Installation	17
2.4 IBC Seismic Certification or California HCAI (OSHDPD) Approval.....	18
2.5 Manual Operation, Model KCS Standard-Transition Switches	19
2.5.1 Manual Operation, 30-230 Amp Standard-Transition Switches	20
2.5.2 Manual Operation, 230A/600V and 260-4000 Amp Standard-Transition Switches.....	21
2.6 Manual Operation, Model KCP Programmed-Transition Switches.....	24
2.6.1 Manual Operation Test Procedure, 150-1200 Amp Programmed-Transition Transfer Switches.....	25
2.6.2 Manual Operation Test Procedure, 1600-4000 Amp Programmed-Transition Transfer Switches.....	28
2.7 Manual Operation, Model KCC Closed-Transition Switches	29
2.7.1 Manual Operation Test Procedure, 150-1200 Amp Model KCC	30
2.7.2 Manual Operation Procedure, 1600-4000 Amp Model KCC	32
2.8 Controller Connections.....	33
2.8.1 Controller Input and Output Connections	34
2.8.2 Harness Connection	34
2.8.3 Controller Ground	35
2.9 Electrical Wiring	36
2.9.1 Source and Load Connections.....	37
2.9.2 Extended Transfer Time Relay (Model KCC only)	39
2.9.3 Engine Start Connection	42
2.9.4 Auxiliary Contacts	43
2.10 Communication and Accessory Connections	45
2.11 Functional Tests.....	45
Section 3. Three-Source Systems	47
3.1 Three-Source Systems.....	47
3.2 Three Source Engine Start Mode.....	47
3.2.1 Mode 1	47
3.2.2 Mode 2.....	47
3.3 Preferred Source Toggle.....	47
3.4 Three Source System Test and Exercise	48
3.4.1 Unloaded Test.....	48
3.4.2 Loaded Test.....	48
3.4.3 Unloaded Exercise.....	48
3.4.4 Loaded Exercise	48
3.5 Three-Source System Connection	50
3.6 ATS1 and ATS2 System Setup	53

Section 4.	Communication and Accessory Connections	55
4.1	Introduction	55
4.2	Communication Connections	55
4.2.1	USB Port SiteTech Connection	55
4.2.2	Modbus Connection	56
4.2.3	Ethernet Connection	58
4.3	Accessory Modules	60
4.3.1	Accessory Module Mounting	61
4.3.2	Input/Output (I/O) Modules	62
4.3.3	External Battery Supply Module (EBSM)	65
4.3.4	Alarm Module	66
4.4	Load Shed (Forced Transfer to OFF)	69
4.5	Heater	70
4.6	Other Accessories	73
Section 5.	Scheduled Maintenance	75
Section 6.	Functional Tests and Setup	77
6.1	Introduction	77
6.2	Manual Operation Test	77
6.3	Voltage Check	77
6.4	Lamp Test	79
6.5	Automatic Operation Test	79
6.6	System Setup	79
6.7	Exerciser Setup	79
6.8	User Interface Cover	79
6.9	Startup Notification	79
Appendix A.	Abbreviations	81

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

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

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

(Decision-Maker® 3+ and 550 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	Unbalanced weight. Improper lifting can cause severe injury or death and equipment damage.
	Use adequate lifting capacity. Never leave the transfer switch standing upright unless it is securely bolted in place or stabilized

Notice

NOTICE

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

NOTICE

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

NOTICE

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

Notes

This manual provides operation and installation instructions for the following Rehlko Automatic Transfer Switches (ATS):

- Model KCS standard-transition any breaker ATS.
- Model KCP programmed-transition any breaker ATS.
- Model KCC closed-transition any breaker ATS.

The transfer switch is equipped with one of the following Rehlko transfer switch controllers:

- Decision-Maker® MPAC 1200 controller.
- Decision-Maker® MPAC 1500 controller.

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

Information in this publication represents data available at the time of print. Discovery Energy, LLC and its affiliates dba Rehlko 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 Rehlko Power Parts online parts system.

The following table lists the part numbers for related literature.

Literature Item	Part Number
Specification Sheet, Decision-Maker® MPAC 1200 Controller	G11-127
Specification Sheet, Decision-Maker® MPAC 1500 Controller	G11-128
Specification Sheet, Model KCS/KCP/KCC	G11-142
Operation Manual, Decision-Maker® MPAC 1200 Controller	TP-6866
Operation Manual, Decision-Maker® MPAC 1500 Controller	TP-6883
Service Manual, Model KC/KS	TP-6920
Wiring Diagram Manual, Model KC/KSSB	TP-7195

Service Assistance

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

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

Headquarters Europe, Middle East, Africa (EMEA)

EMEA Headquarters
Netherlands B.V.
Kristallaan 1
4761 ZC Zevenbergen
The Netherlands
Phone: (31) 168 331630
Fax: (31) 168 331631

Asia Pacific

Asia Pacific Headquarters
Singapore, Republic of Singapore
Phone: (65) 6264-6422
Fax: (65) 6264-6455

China

North China Regional Office, Beijing

Phone: (86) 10 6518 7950
(86) 10 6518 7951
(86) 10 6518 7952

Fax: (86) 10 6518 7955

East China Regional Office, Shanghai

Phone: (86) 21 6288 0500
Fax: (86) 21 6288 0550

India, Bangladesh, Sri Lanka

India Regional Office

Bangalore, India

Phone: (91) 80 3366208
(91) 80 3366231

Fax: (91) 80 3315972

Japan, Korea

North Asia Regional Office

Tokyo, Japan

Phone: (813) 3440-4515
Fax: (813) 3440-2727

1.1 Purpose

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

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

Figure 1 Shows a typical ATS. Figure 2 shows a typical installation block diagram.



Figure 1 Automatic Transfer Switch

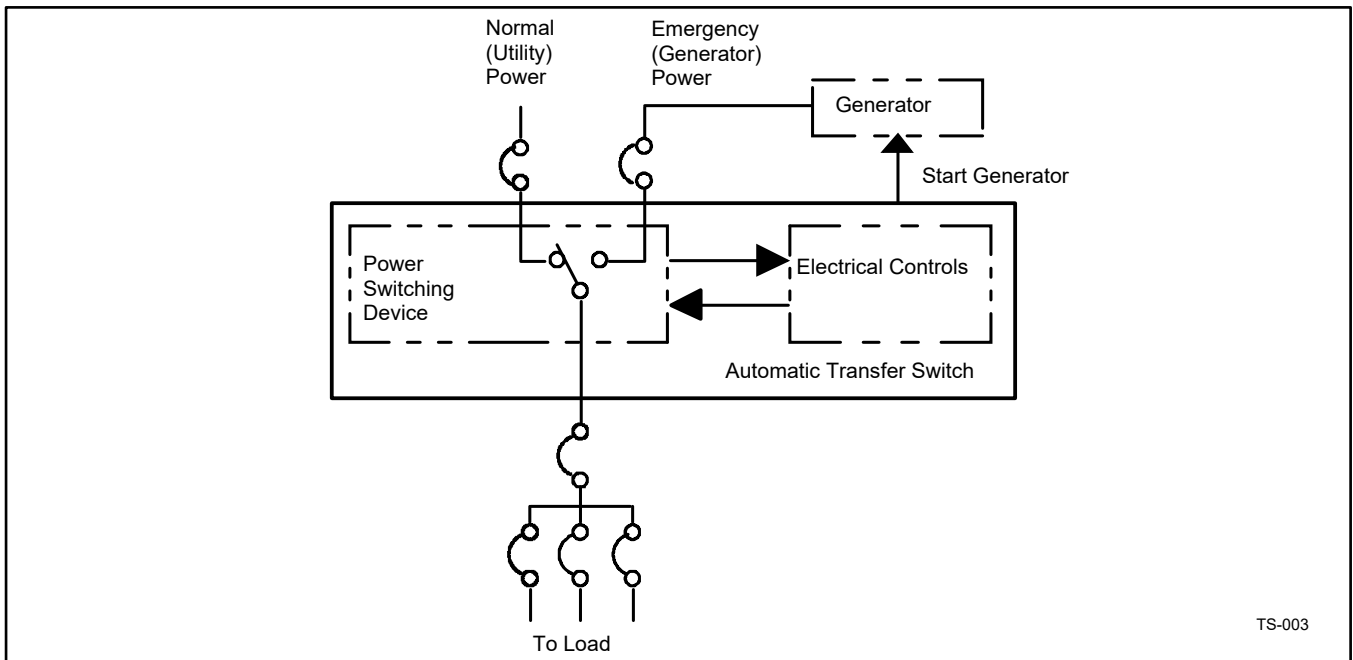


Figure 2 Typical ATS Block Diagram

1.2 Nameplate

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

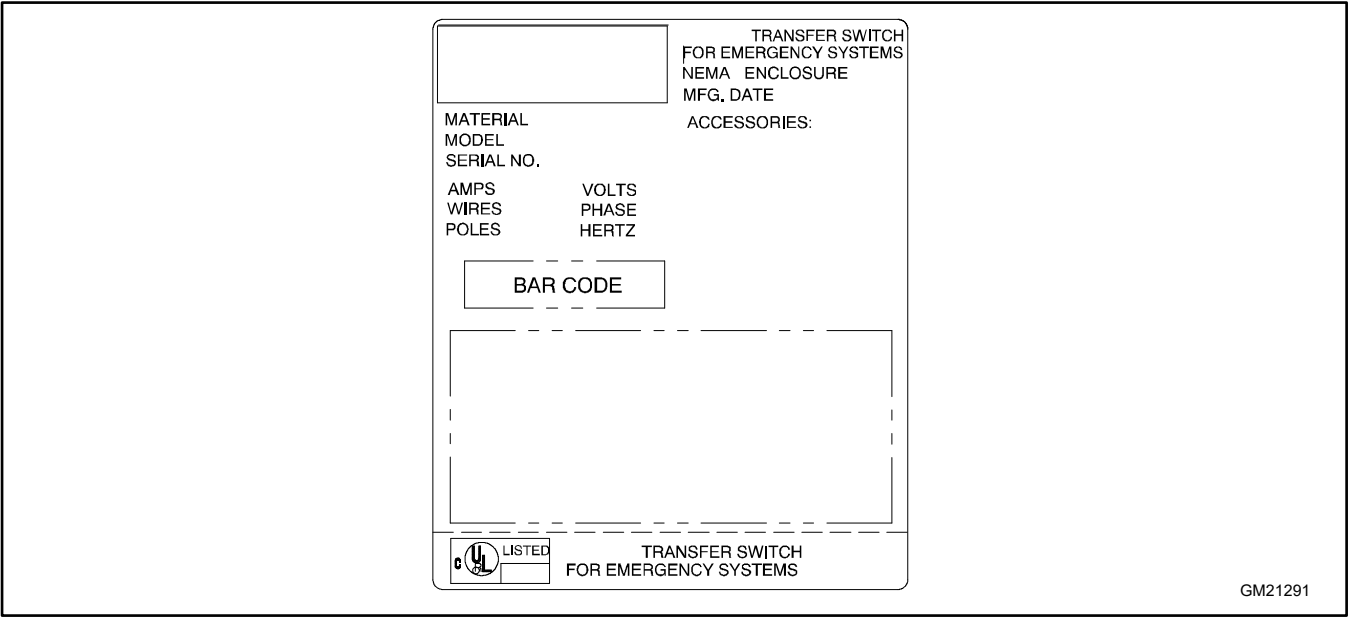
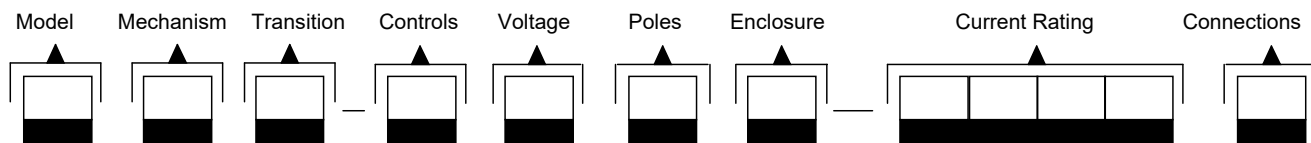


Figure 3 Typical Transfer Switch Nameplate

1.3 Model Designation



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

Sample Model Designation: KCS-DNTA-0400S

Model

K

Mechanism

C: Standard (Any Breaker)

Transition

S: Standard
P: Programmed
C: Closed

Controller

A: Decision-Maker® MPAC 1200, Automatic
B: Decision-Maker® MPAC 1200, Non-Automatic *
D: Decision-Maker® MPAC 1500, Automatic
F: Decision-Maker® MPAC 1500, Non-Automatic *
* Non-automatic controls are available on Models KCS and KCP only.

Voltage/Frequency

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

Number of Poles/Wires

N: 2 Poles/3 Wires, Solid Neutral
T: 3 Poles/4 Wires, Solid Neutral
V: 4 Poles/4 Wires, Switched Neutral
W: 4 Poles/4 Wires, Overlapping Neutral

Enclosure

A: NEMA 1	D: NEMA 4
B: NEMA 12	F: NEMA 4X
C: NEMA 3R	G: Open Unit

Current, Amps

0030	0230	1200
0070	0260	1600
0104	0400	2000
0150	0600	2600
0200	0800	3000
0225	1000	4000

Connections

S: Standard
F: Front (1600 and 2000 amp only)

Note:

Some selections are not available for every model. Contact your Rehko distributor for availability.

Notes

2.1 Introduction

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

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

Protect the switch against damage before and during installation.

Note:

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.

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

Refer to Figure 4 for the approximate weight of the transfer switch in a Type 1 enclosure. For open units and other enclosures, refer to the dimension drawing. Use a spreader bar to lift the transfer switch. Attach the bar only to the enclosure's mounting holes or lifting brackets; do not lift the unit any other way. Close and latch the enclosure door before moving the unit.

Amps	Weight kg (lb.)		
	2-Pole	3-Pole	4-Pole
Model KCS			
30-200	28 (62)	30 (65)	31 (68)
230	52 (115)	56 (123)	59 (131)
260-600	179 (395)	183 (403)	188 (414)
800-1000	220 (485)	231 (510)	238 (525)
1200	—	356 (785)	379 (835)
1600-2000	—	472 (1040)	494 (1090)
2600-3000	—	649 (1430)	679 (1495)
4000	—	975 (2149)	1056 (2328)
Models KCP and KCC			
150-600	179 (395)	183 (403)	188 (414)
800-1000	220 (485)	231 (510)	238 (525)
1200	—	463 (1020)	485 (1070)
1600-2000	—	533 (1175)	556 (1225)
2600-3000	—	735 (1620)	765 (1685)
4000	—	975 (2149)	1056 (2328)

Figure 4 Approximate Weights, Type 1 Enclosures

2.2.3 Storage

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

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

2.3 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 or California HCAI (formerly OSHPD) approved transfer switches. IBC seismic certification or California HCAI (OSHPD) approval must be requested when the transfer switch is ordered. See the IBC Seismic Certification or California HCAI (OSHPD) Approval section and the transfer switch dimension (ADV) drawings for additional installation requirements for transfer switches with IBC seismic certification or California HCAI (OSHPD) approval. Correctly installed transfer switches with California HCAI (OSHPD) approval also have IBC seismic certification.

Install the ATS. Mount 30-through 230-amp (except 230A/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 230A/600V and 260-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.

2.4 IBC Seismic Certification or California HCAI (OSHPD) Approval

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

Abbreviations:

ACI: American Concrete Institute

IBC: International Building Code®

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

R_p: Equipment response modification factor

I_p: Equipment importance factor

a_p: In-structure equipment amplification factor

Refer to the International Building Code® for more information.

General Seismic Installation Notes (for ATS only):

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

2.5 Manual Operation, Model KCS 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.

2.5.1 Manual Operation, 30-230 Amp Standard-Transition Switches

The 30-200 amp standard-transition models have an attached manual operating handle. See Figure 6.

Note:

For 230A/600V models, see the Manual Operation, 230A/600V and 260-4000 Amp Standard-Transition Switches section.

Manual Operation Test Procedure, 30-230 Amp Transfer Switches

1. Disable the generator set to prevent starting and 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.

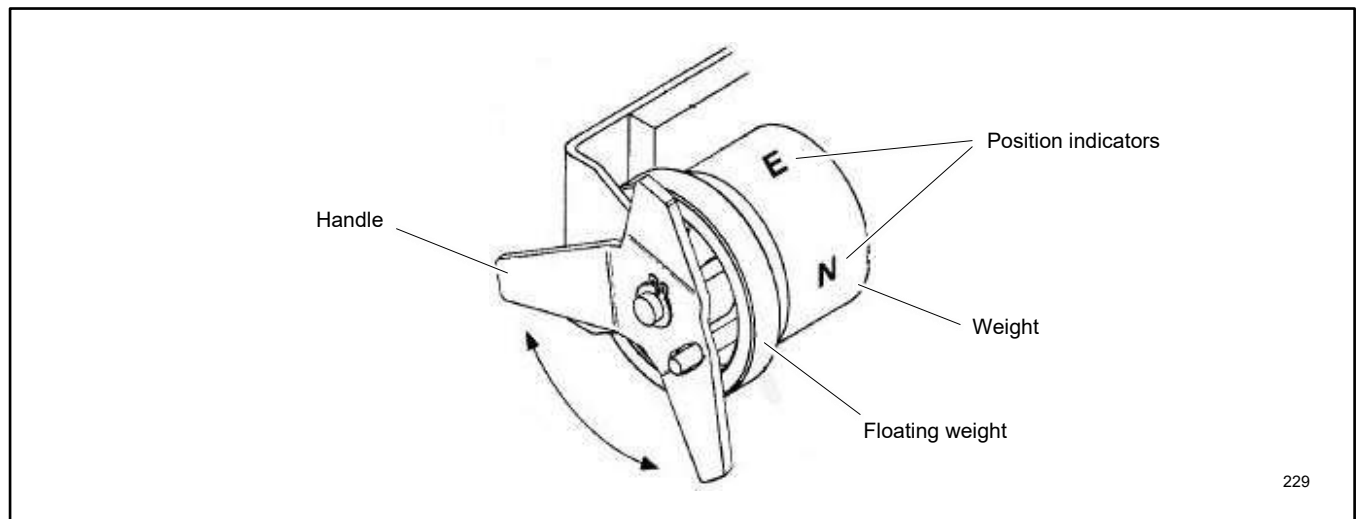


Figure 6 Manual Operation Handle, 30-230 Amp Model KCS

2.5.2 Manual Operation, 230A/600V and 260-4000 Amp Standard-Transition Switches

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

NOTICE

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

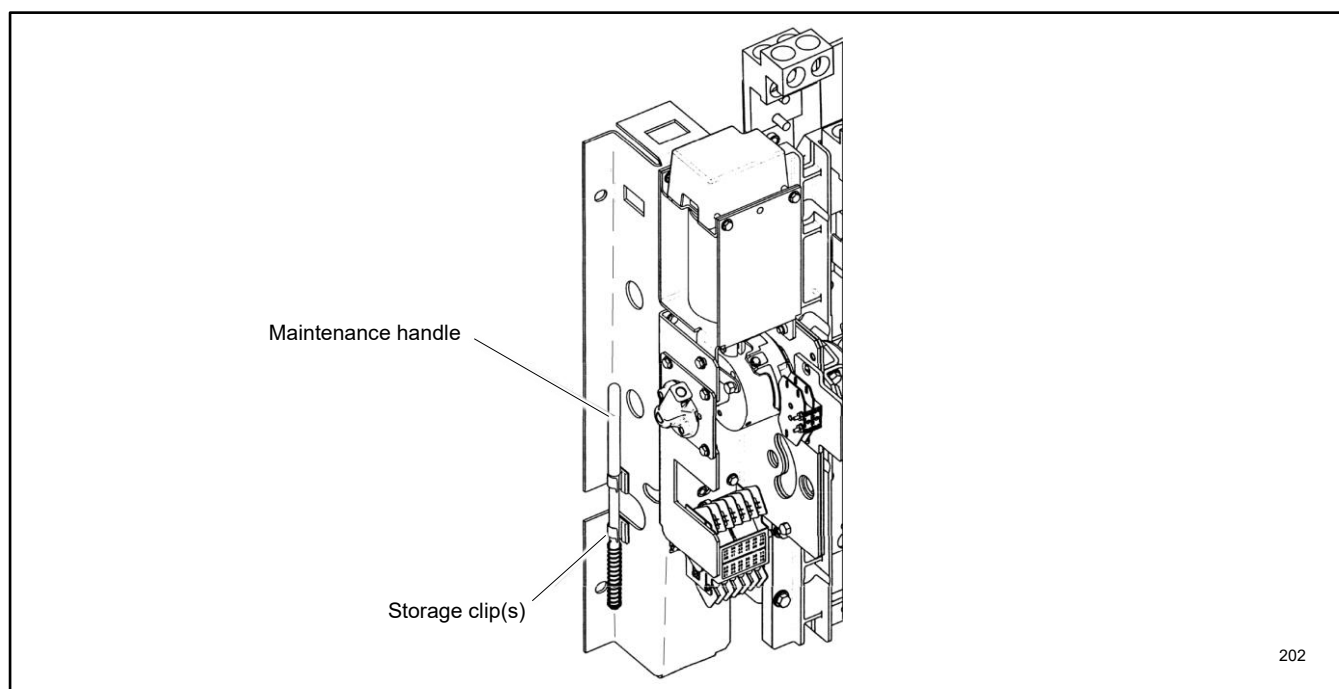
The 260-4000 amp standard-transition models use a detachable manual operating handle.

Manual Operation Test Procedure, 230A/600V and 260-1200 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. **230-600 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.



202

Figure 7 Detachable Handle Storage (typical)

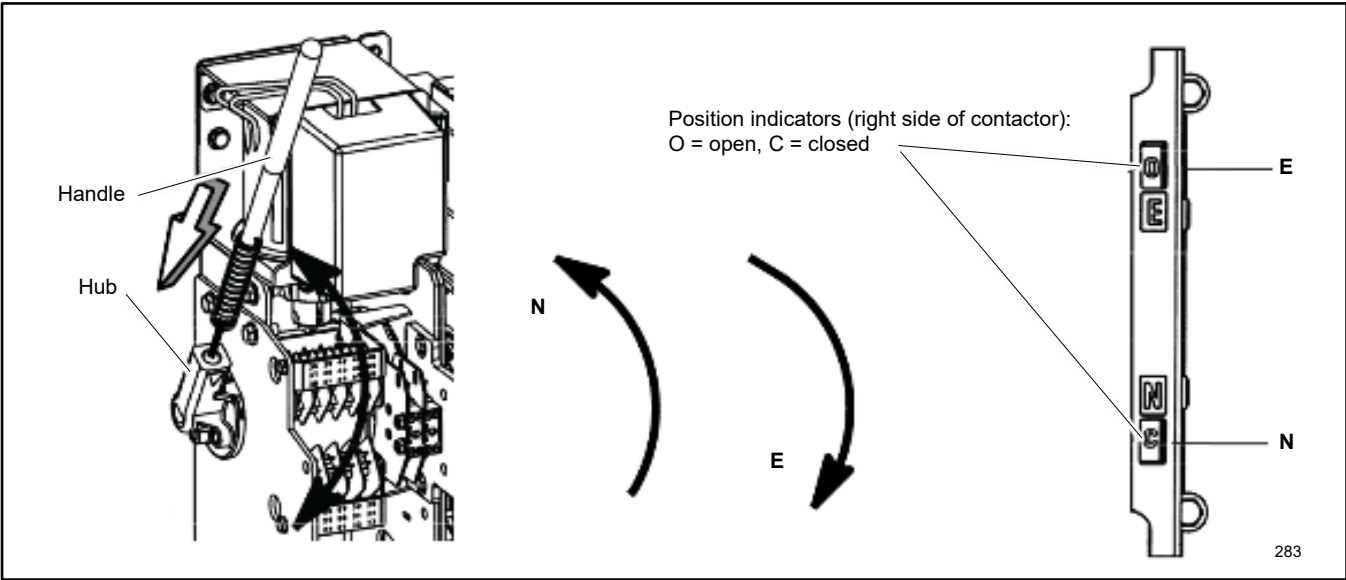


Figure 8 Manual Operation, 260-600 Amp Model KCS

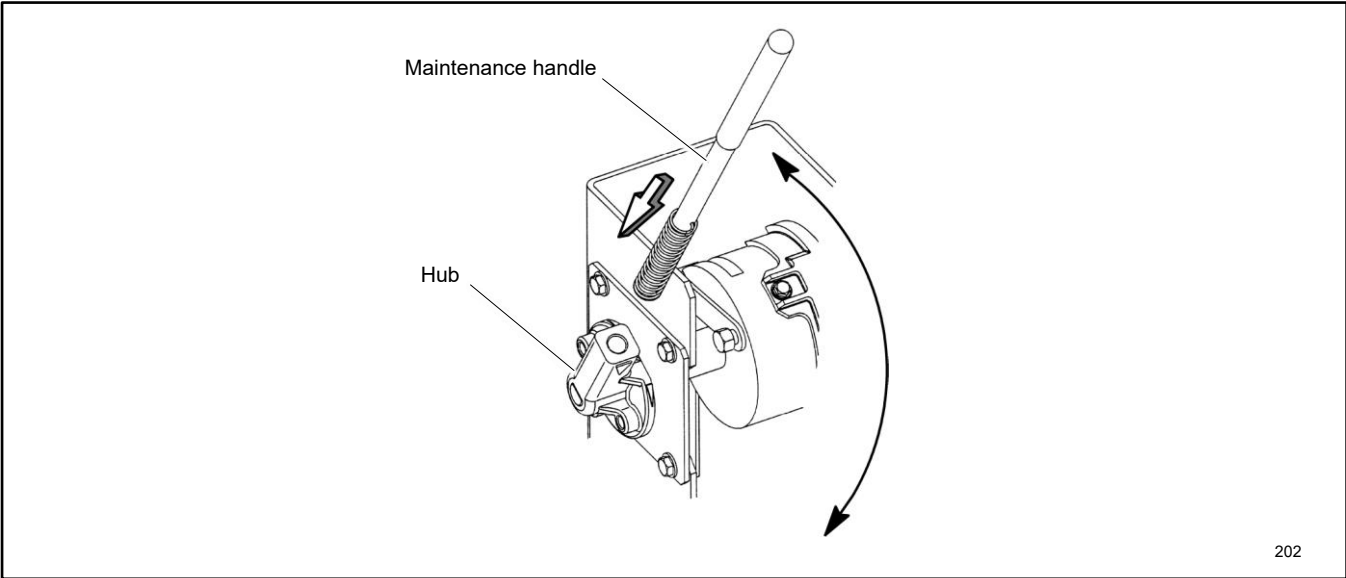


Figure 9 Manual Operation, 800-1200 Amp Model KCS

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 KCS

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.

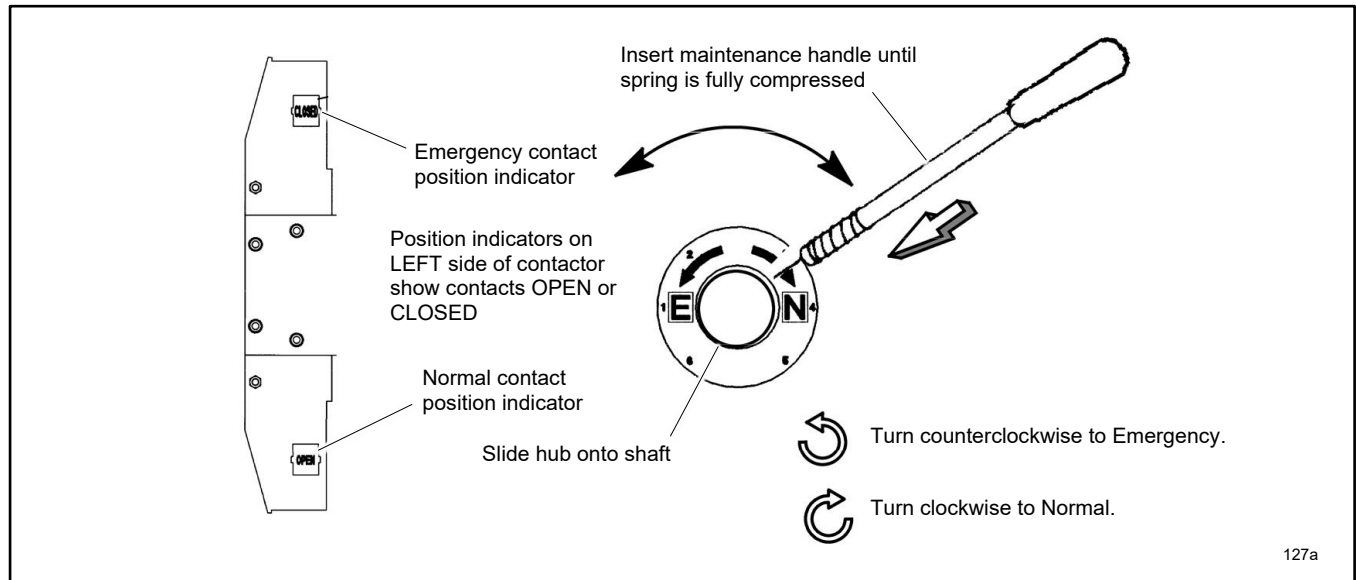


Figure 11 Manual Operation, 1600-4000 Amp Model KCS

2.6 Manual Operation, Model KCP Programmed-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.

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.

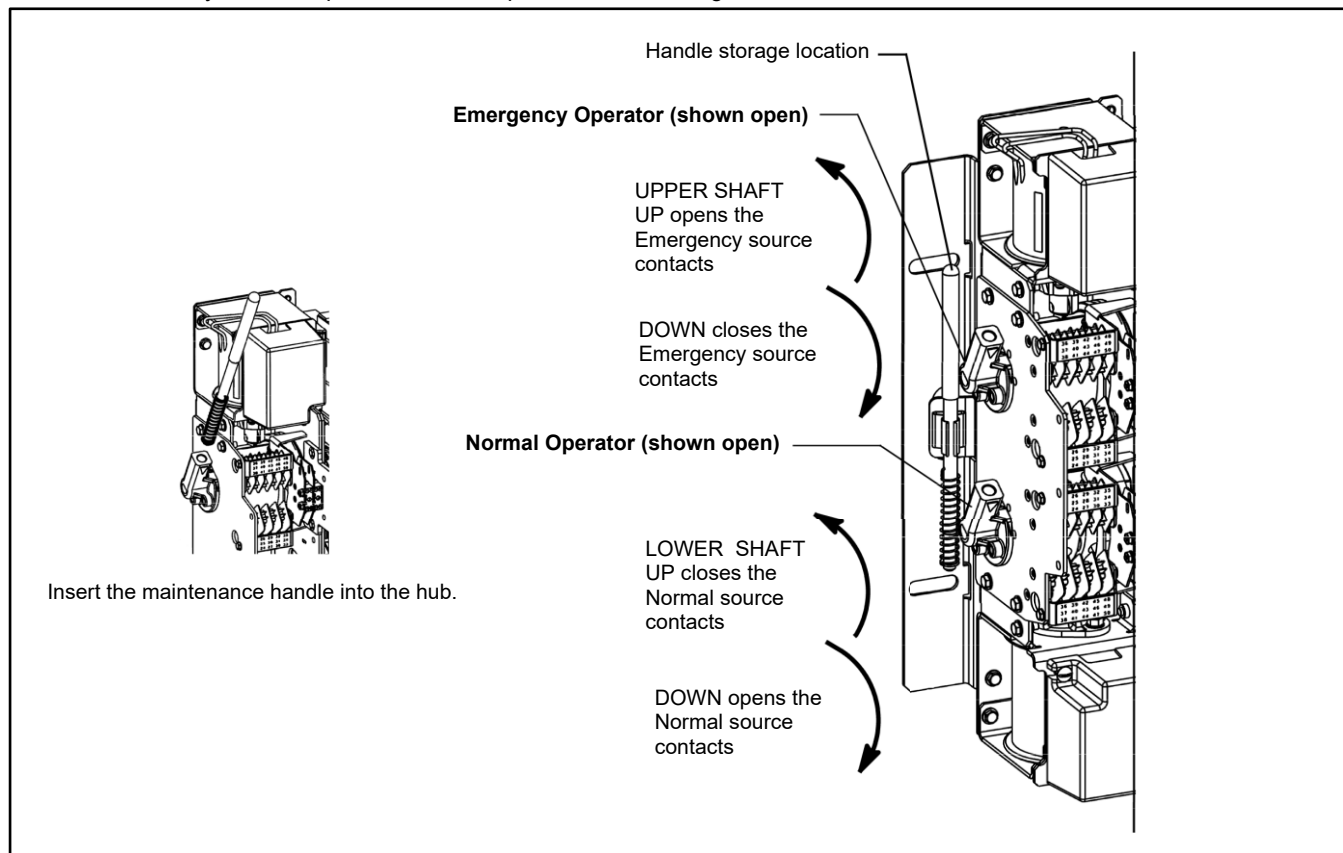


Figure 12 Model KCP Manual Operation (typical)

2.6.1 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.

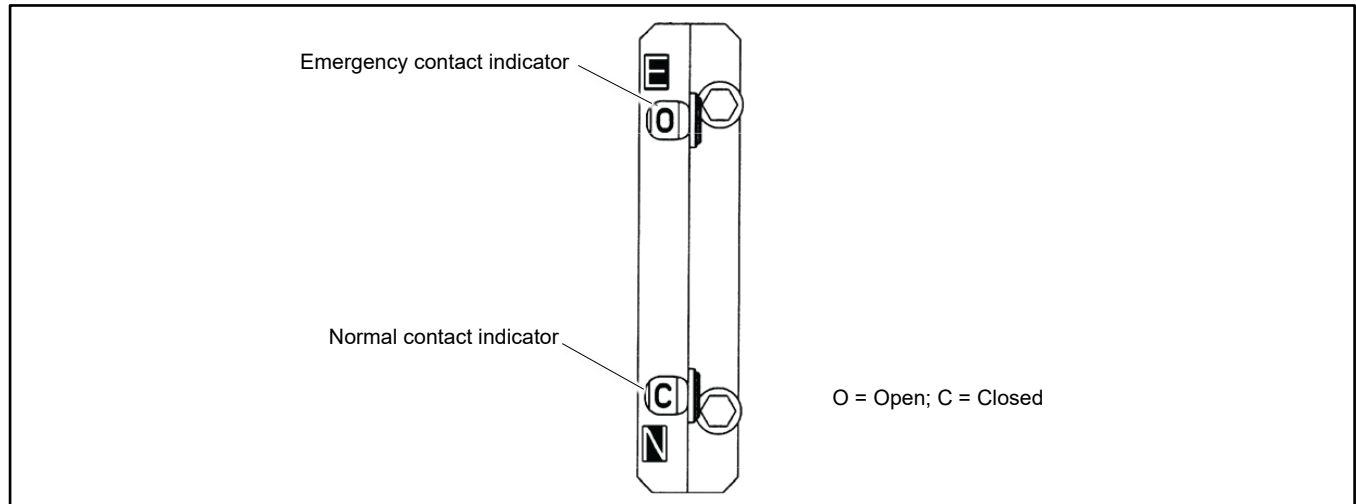
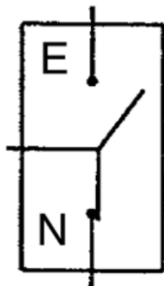
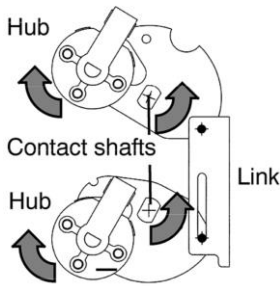
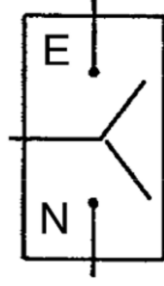
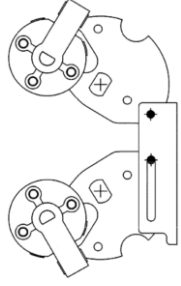
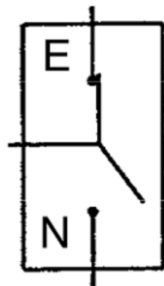
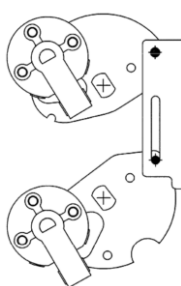


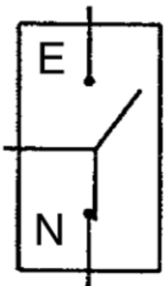
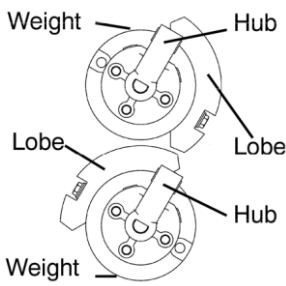
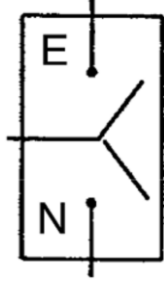
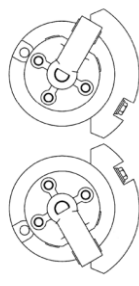
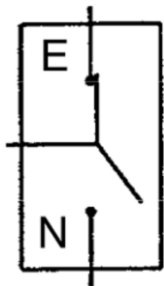
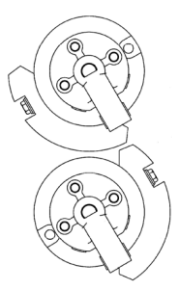
Figure 13 Position Indicators

Transfer Switch Position		Interlocked Shafts	Maintenance Handle	Shaft Indicators
Normal			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:
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.

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

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

2.6.2 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.

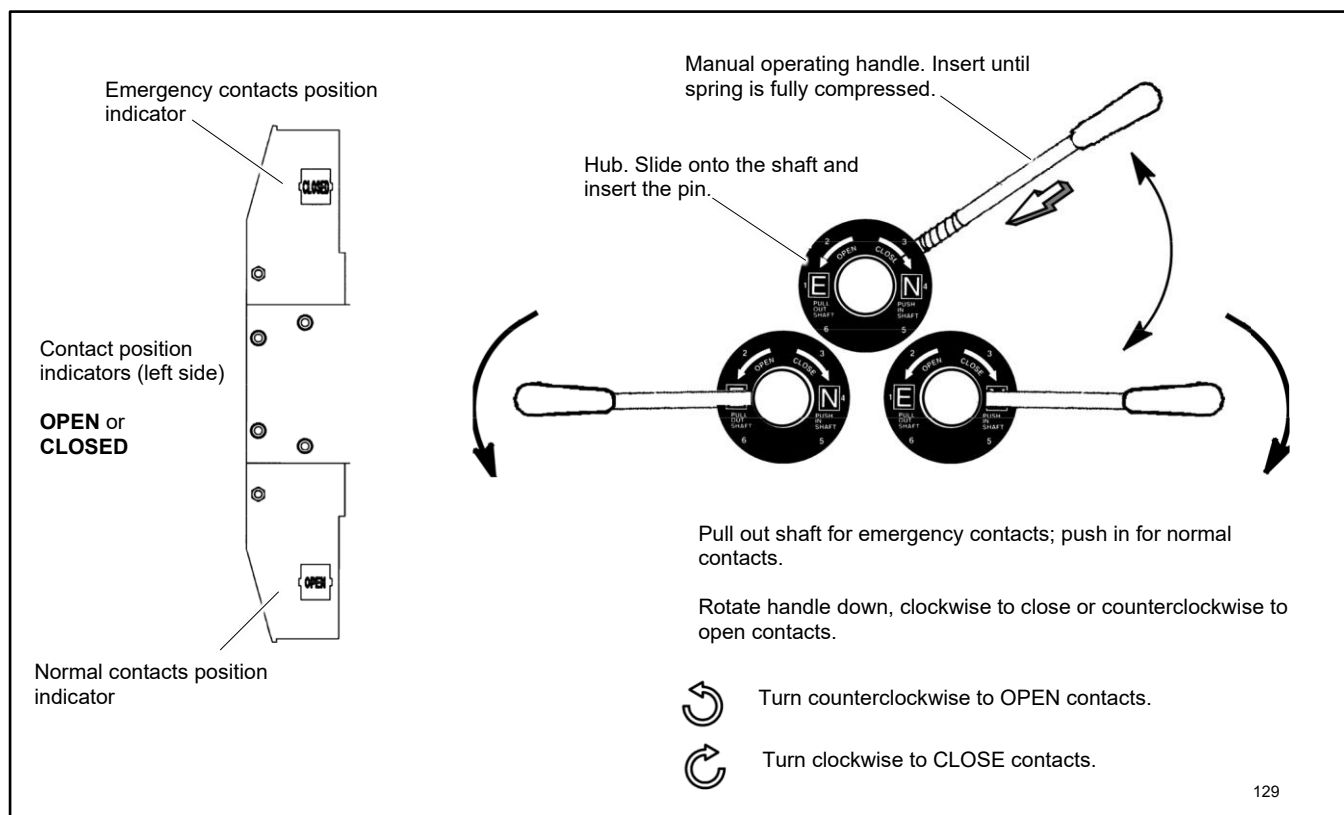


Figure 16 Manual Operation, 1600-4000 Amp Model KCP

2.7 Manual Operation, Model KCC Closed-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.

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.

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. Check the operation of both the Normal and Emergency operators.

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.

Closed-transition switches have two operators, Normal and Emergency. Refer to the figure titled: Model KCP Manual Operation (typical) for typical locations of the Normal and Emergency operators.

Position indicators on the right side of the contactor assembly show the positions of the operators.

2.7.1 Manual Operation Test Procedure, 150-1200 Amp Model KCC

Refer to Figure 17 through Figure 19 during the following procedure.

Check the operation of both operators for both the Normal and Emergency contacts in the following sequence:

6. Disable the generator set to prevent starting and disconnect all power sources before manually operating the transfer switch.
7. Locate the maintenance handle stored on the left side of the transfer switch frame.
8. Starting with the contactor in the Normal position, use the maintenance handle to move the Normal operator from the closed to the open position.
9. Move the Emergency operator from the open position to the closed position.
10. Return the Emergency operator to the open position and the Normal operator to the closed position. Observe that the window indicators show the upper shaft **O** (emergency open) and the lower shaft **C** (normal closed). See Figure 17.
11. Remove the maintenance handle and store it in the clips provided on the switch.

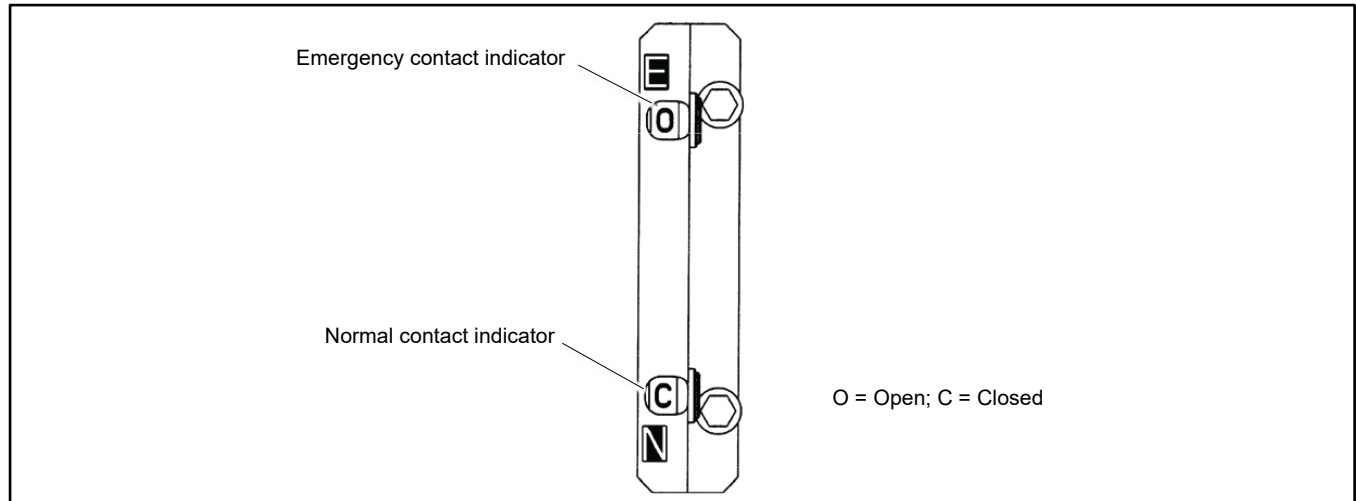


Figure 17 Indicators, Model KCC

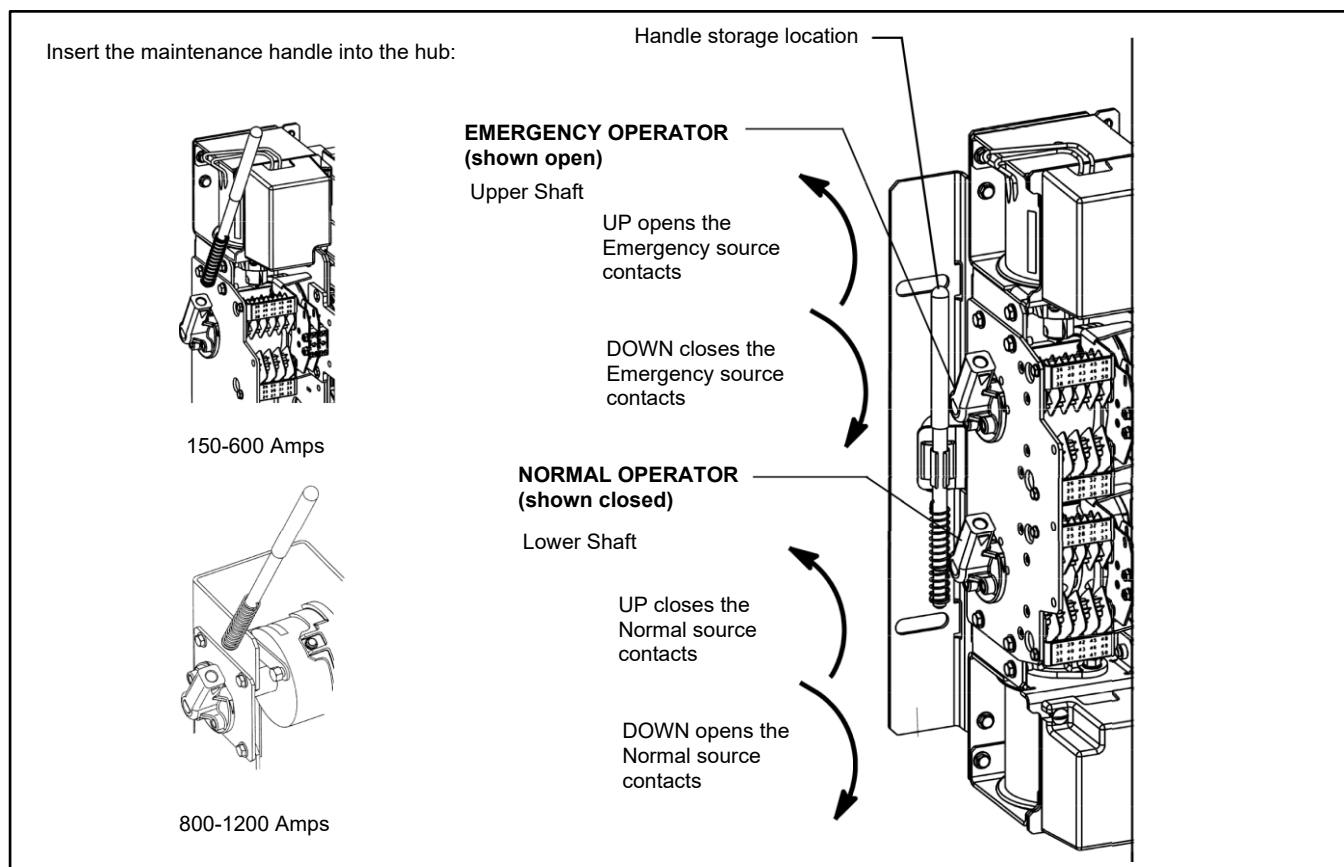


Figure 18 Transfer Switch Manual Operation, 150-1200 Amp Model KCC (typical)

ATS Position		Handle	Indicators
Normal		Up	E = O upper contacts open
		Up	N = C lower contacts closed
Emergency		Down	E = C upper contacts closed
		Down	N = O lower contacts open

Figure 19 Maintenance Handle Positions, Model KCC. **ALL POWER MUST BE OFF !**

2.7.2 Manual Operation Procedure, 1600-4000 Amp Model KCC

Check the operation of both operators by following the instructions below for both the Normal and Emergency operators. Refer to Figure 20 during this procedure.

8. Disable the generator set to prevent starting and disconnect all power sources before manually operating the transfer switch.
9. Install the hub onto the shaft and insert the pin.
10. Insert the manual operating handle into the side hole on the hub until the spring is fully compressed.
11. 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.
12. Grasp the handle firmly with both hands and rotate down:
 - a. Rotate counterclockwise to open the contacts.
 - b. Rotate clockwise to close the contacts.
13. Repeat steps 4 and 5 on the other transfer switch.
14. 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.

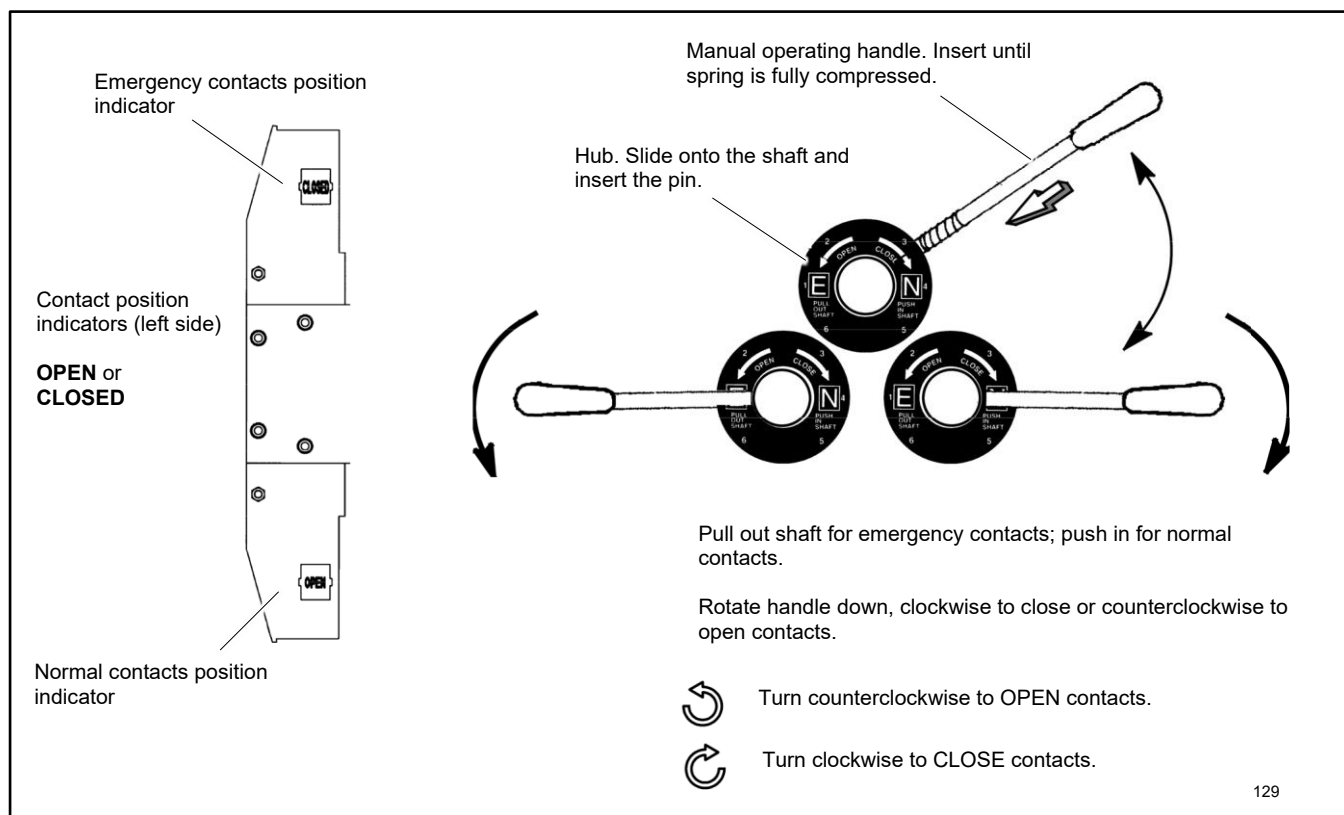


Figure 20 Transfer Switch Manual Operation, 1600-4000 Amps

2.8 Controller Connections

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

NOTICE

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

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

Figure 21 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.

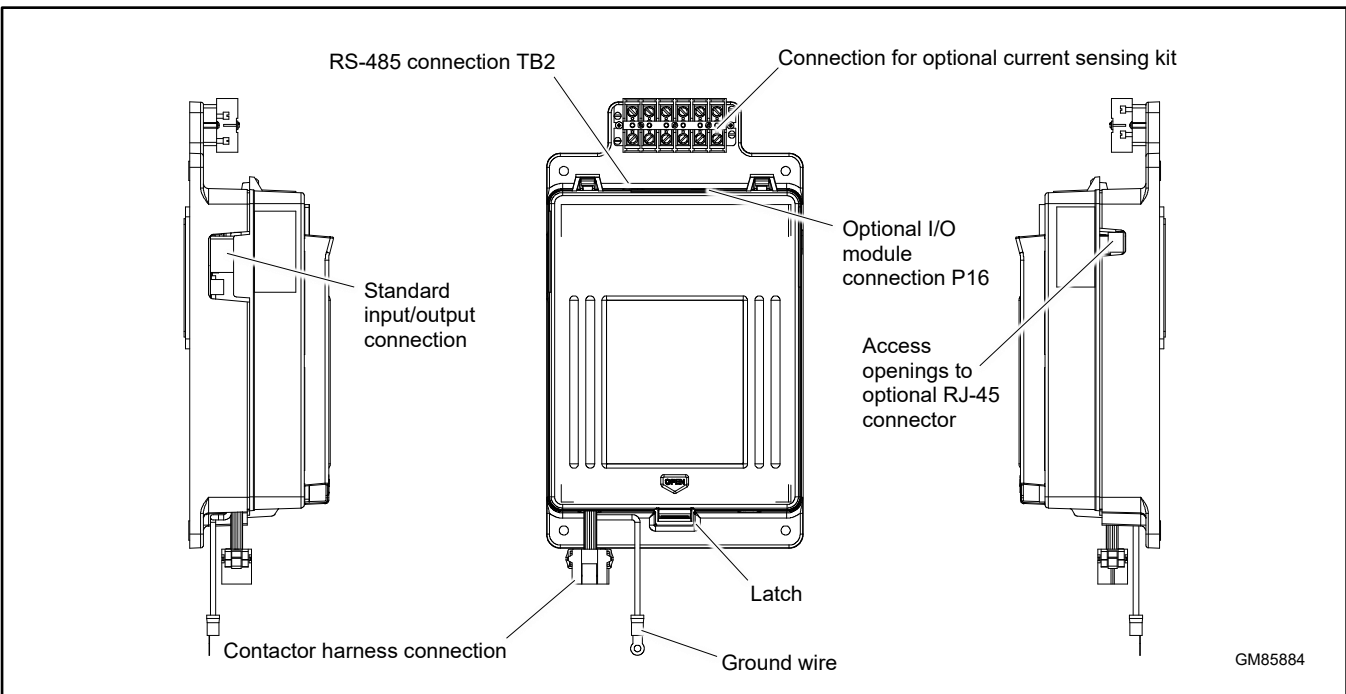


Figure 21 Controller

2.8.1 Controller Input and Output Connections

The controller provides connections for two programmable inputs and two programmable outputs. See the figure titled: Controller for the connector location and Figure 22 for the I/O connection specifications.

Each input has a signal and a return connection. The outputs are C form contacts with ratings of 500 mA @ 120 VAC. See Figure 23 for connections. Use #12-24 AWG wire and tighten the connections to 0.5 Nm (4.4 in. lbs.).

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 22 Main Board I/O Specifications

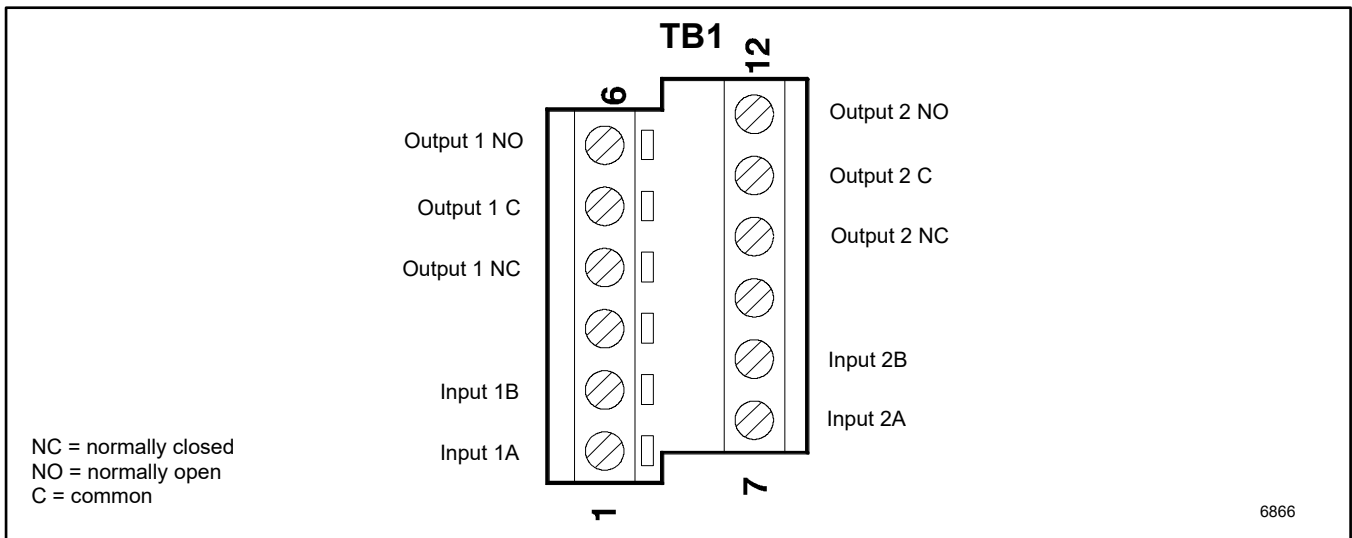


Figure 23 Input and Output Connections

2.8.2 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.

2.8.3 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.

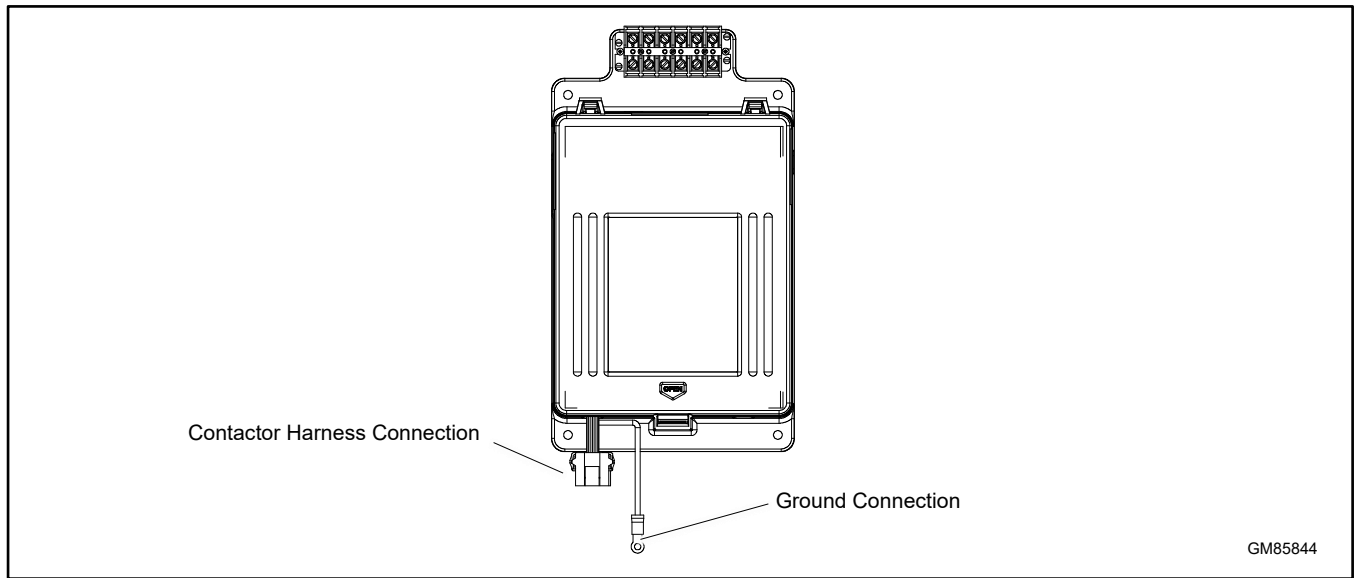


Figure 24 Contactor Harness and Controller Ground Connections

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

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

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

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

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

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

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

Install the cable spacers provided with 30-200 amp switches as shown in Figure 25.

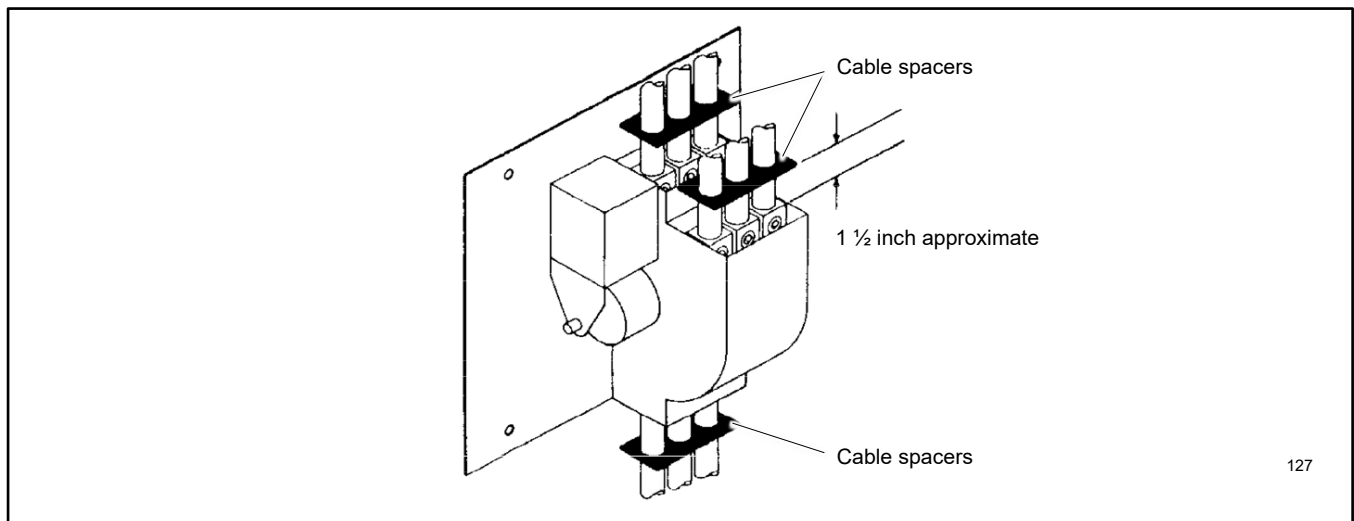


Figure 25 Cable Spacers for 30-200 Amp Switches

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 all cable lug connections to the torque values shown on the label on the switch. (See Figure 27 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 26.

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 26 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 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, THIS TRANSFER SWITCH IS RATED FOR USE ON A CIRCUIT CAPABLE OF DELIVERING NOT MORE THAN THE RMS SYMMETRIC AMPERES 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, 400
THLC4,TLB4 400
SGLA,SGL6,SGP6,TB6 600
SKHA,SKL8,SKP8,TKL 800

42480I-T-ECJD6,HHJD6, 400
HHJXD6,HJD6,SCJD6,SHJD6 400
CLD6,HHLD6,HHLXD6,HLD6, 600
SCLD6,SHLD6 600
CMD6,HMD6,HND6,MD6,MXD6, 800
SCMD6,SHMD6,SMD6,SND6 800

42480SQUAREDLC,LI 600
MH 800

42480WESTHHKD,KDC,LCL, 400
TRI-PACLA 400
HLD 600
TRI-PACNB 800

42480ABBS5 400
S6 800

42480MERLINGERIN 600
CJ600

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

Torque specification

007

Figure 27 Typical Rating/Torque Label

2.9.2 Extended Transfer Time Relay (Model KCC only)

The extended transfer time relay is standard on closed-transition transfer switches. The relay is provided to prevent paralleling the standby and utility sources for longer than the acceptable time, which is typically 100 ms. The relay is located on the field connection assembly. See Figure 29.

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

Connect the relay to a shunt trip on the emergency source circuit breaker. Provide 12 or 24 VDC power as required for the relay, as shown in Figure 30 or Figure 33. Connect the DC power, emergency source circuit breaker trip circuit (TR-EMER), and optional alarm (TR-ALARM) to the field-connection terminal block shown in Figure 29. See Figure 28 for typical connections and refer to the schematic diagram provided with the transfer switch.

The extended transfer time relay uses an adjustment knob or switches to set the time delay. Compare your equipment to Figure 29 and Figure 32 to identify the relay used on your transfer switch.

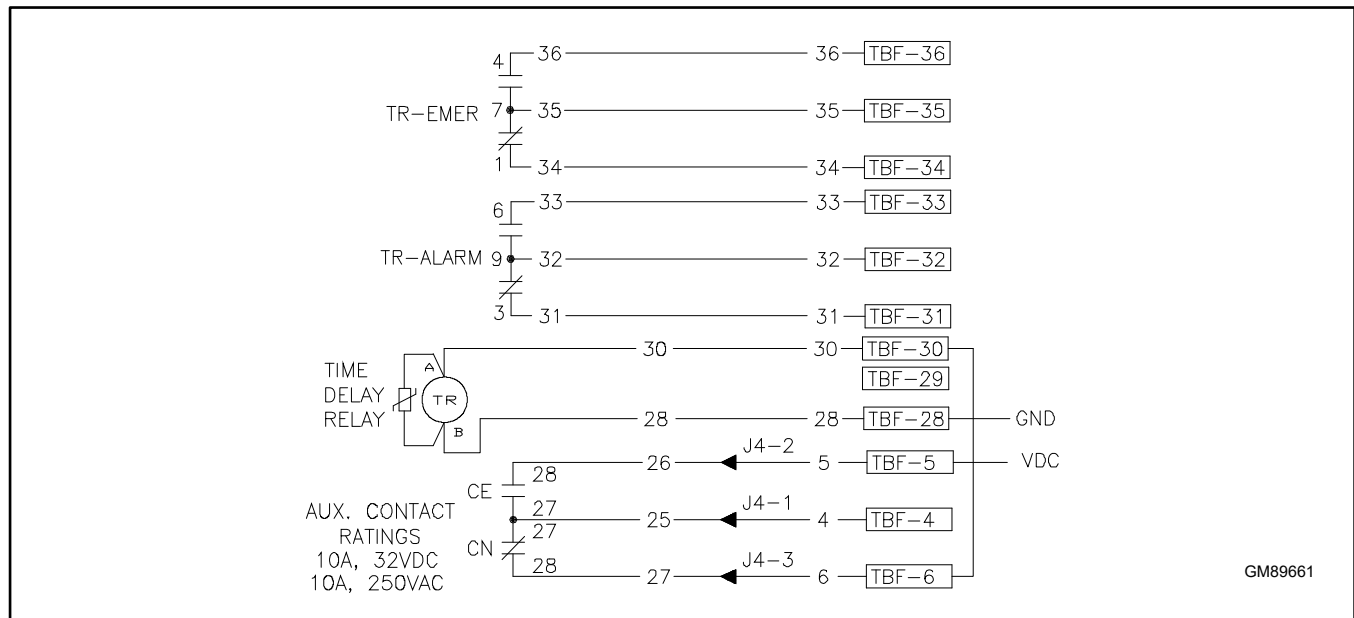


Figure 28 Typical Relay Connections (see the schematic diagram for your transfer switch)

Relay with Time Adjustment Knob

This section applies to the relay equipped with an adjustment knob, shown in Figure 29. Relay specifications are shown in Figure 30.

Setting the Time Delay (knob style)

A knob on the relay assembly allows adjustment of the time delay. See Figure 29. The relay time delay is adjustable between 100 ms and 10 seconds. The time settings are in percent (%) of the maximum setting, which is 10 seconds, and adjustable in 5% increments. Figure 31 shows some sample settings. The typical setting is 1% = 0.1 seconds (100 ms). If it is necessary to set the relay to a longer time, ensure that the time setting is in accordance with applicable codes.

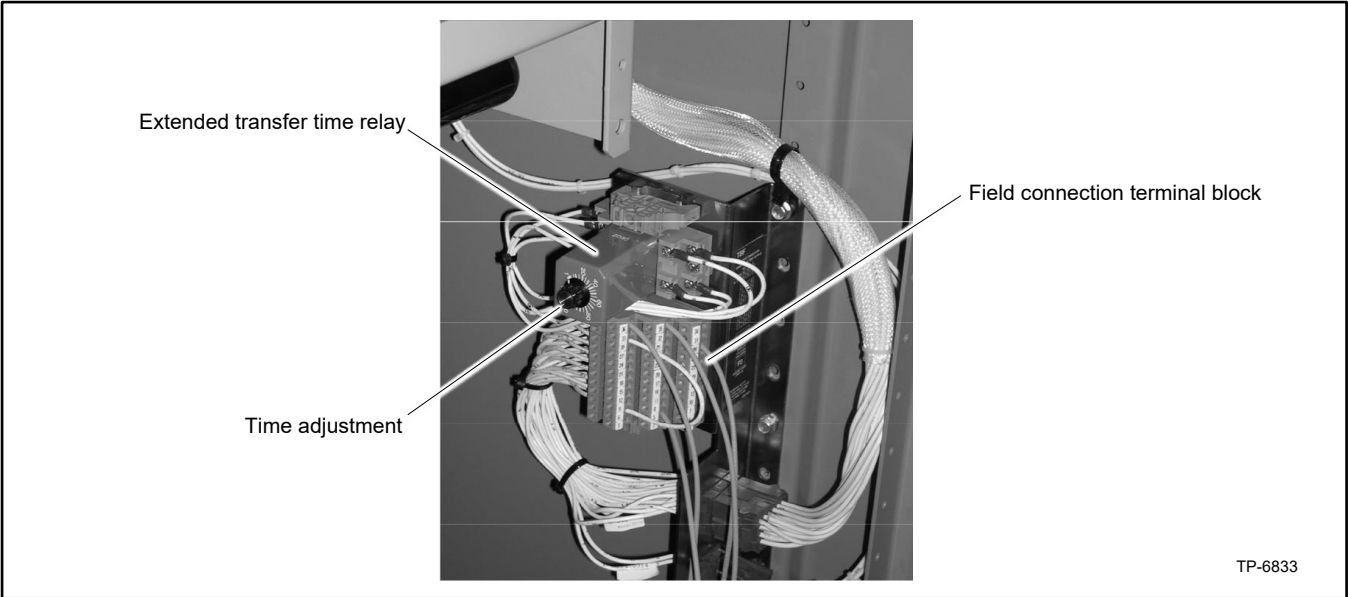


Figure 29 Extended Transfer Time Relay (knob style shown)

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

Figure 30 Relay Specifications (knob style)

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

Figure 31 Examples of Transfer Time Settings (knob style)

Relays with Time Adjustment Switches

This section applies to relays equipped with switches for time adjustment, shown in Figure 32. Relay specifications are shown in Figure 33.

A three-digit time selection switch and a range selection switch on the relay assembly allow adjustment of the time delay. See Figure 32. The relay time delay is adjustable between 0.05 seconds (50 ms)† and 999 minutes. Set the range and the time as shown in Figure 34. The typical setting is 0.10 seconds (100 ms). If it is necessary to set the relay to a longer time, ensure that the time setting is in accordance with applicable codes.

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

Setting the Time Delay (adjustment switch style)

To set the time delay, select the range based on seconds or minutes and the numbers after the decimal point. Then use the pushbuttons to set the time. Some examples are shown in Figure 35.

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

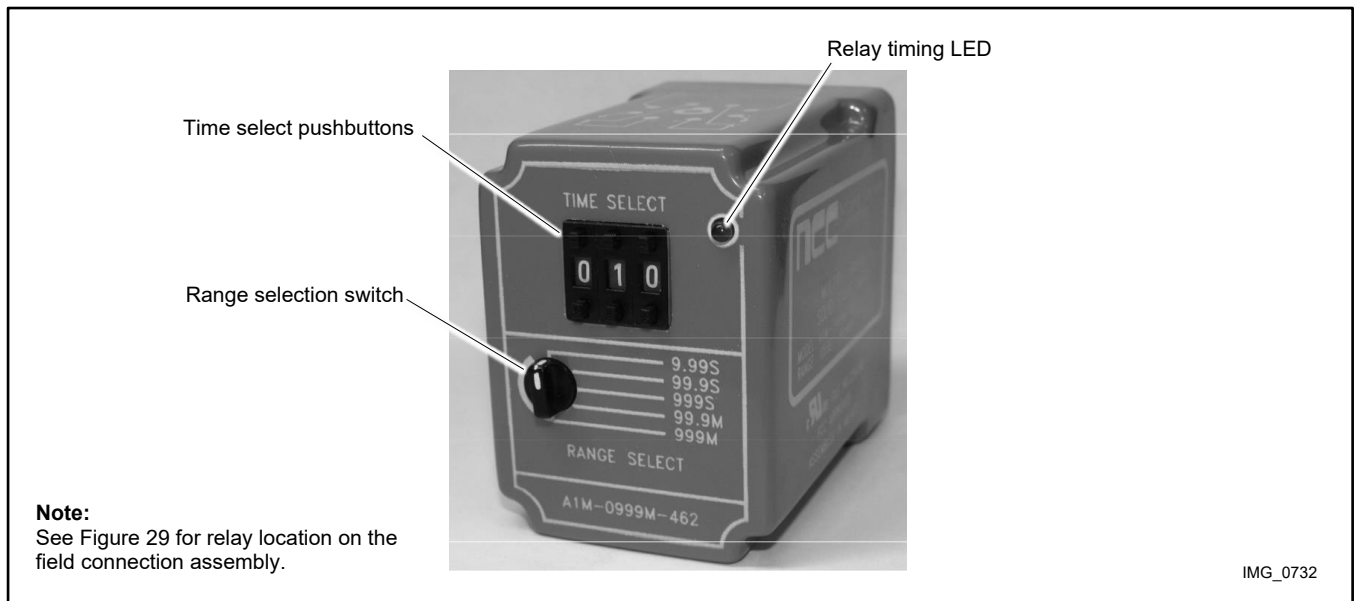


Figure 32 Extended Transfer Time Relay (adjustment switch style)

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

Figure 33 Relay Specifications (adjustment switch style)

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

Figure 34 Relay Transfer Time Settings (adjustment switch style)

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

Figure 35 Examples of Transfer Time Settings (adjustment switch style)

2.9.3 Engine Start Connection

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

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

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 30-200 amp models, the engine start terminals are located on the transfer switch contactor assembly and labeled with a decal. See Figure 36. On larger models, the engine start contacts and auxiliary contacts are located on the field-connection terminal block. See Figure 37 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

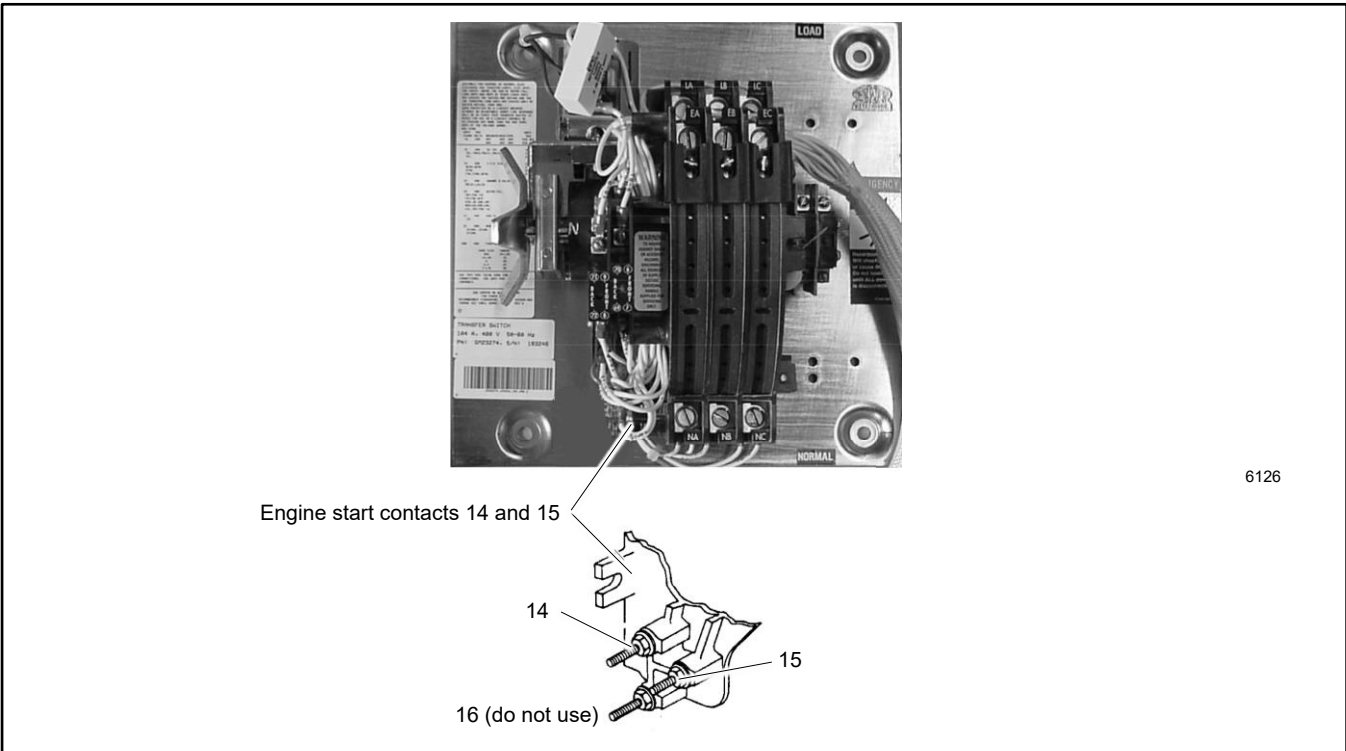


Figure 36 Engine Start Contacts, 30-200 Amp Switches

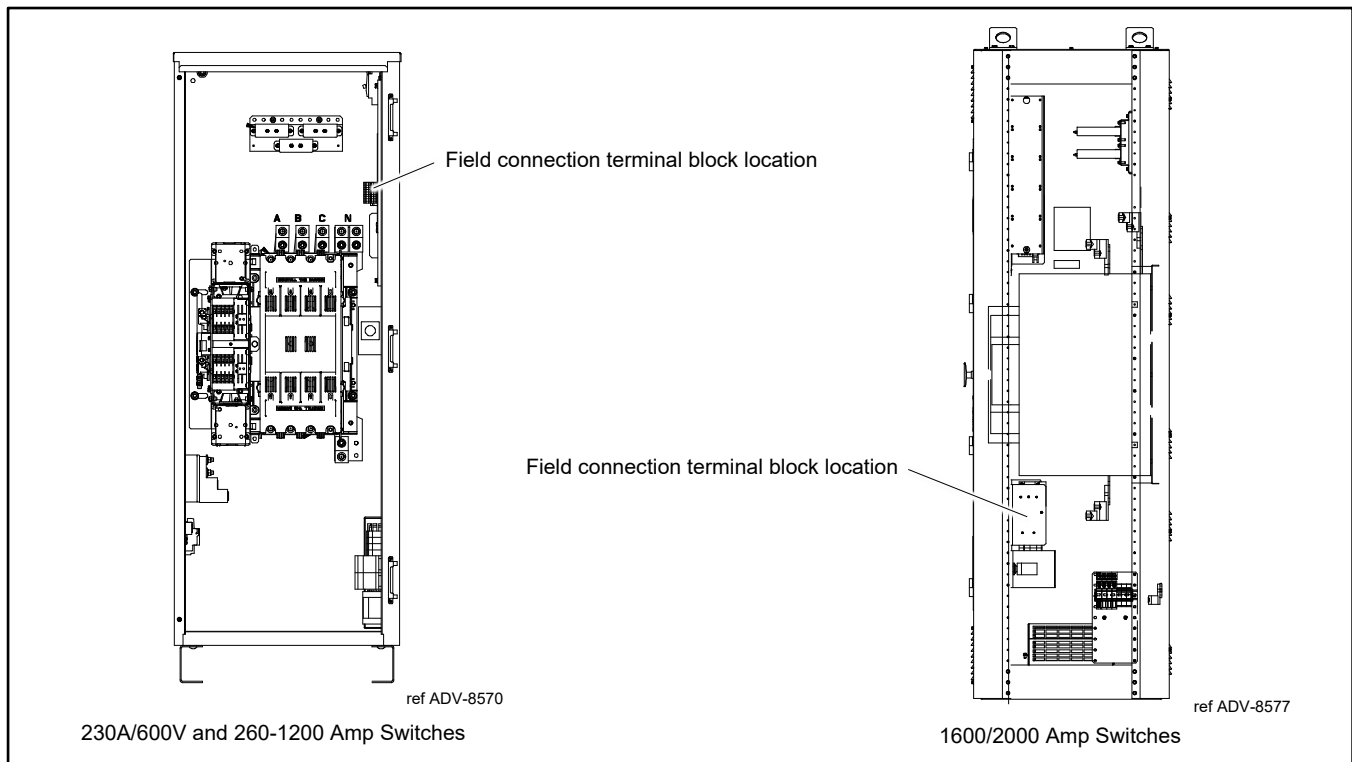


Figure 37 Field Connection Terminal Block Locations, Typical

2.9.4 Auxiliary Contacts

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

Figure 38 lists the number of contacts available by ATS model and size (amps).

- On 30-230Amp units, the contacts are located on the right side of the contactor. See Figure 39.
- On 230A/600V and 260-4000Amp units, the contacts are located on the field connection terminal block. See the figure titled: Field Connection Terminal Block Locations, Typical. See Figure 41 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		
	KCS	KCP	KCC
30-150	2, 2	—	—
150-230	2, 2	8, 8	8, 8
230 (600 V)	8, 8	8, 8	8, 8
260-600	8, 8	8, 8	8, 8
800-1200	8, 8	8, 8	8, 8
1600-4000	8, 8	7, 7	7, 7

Figure 38 Auxiliary Contacts

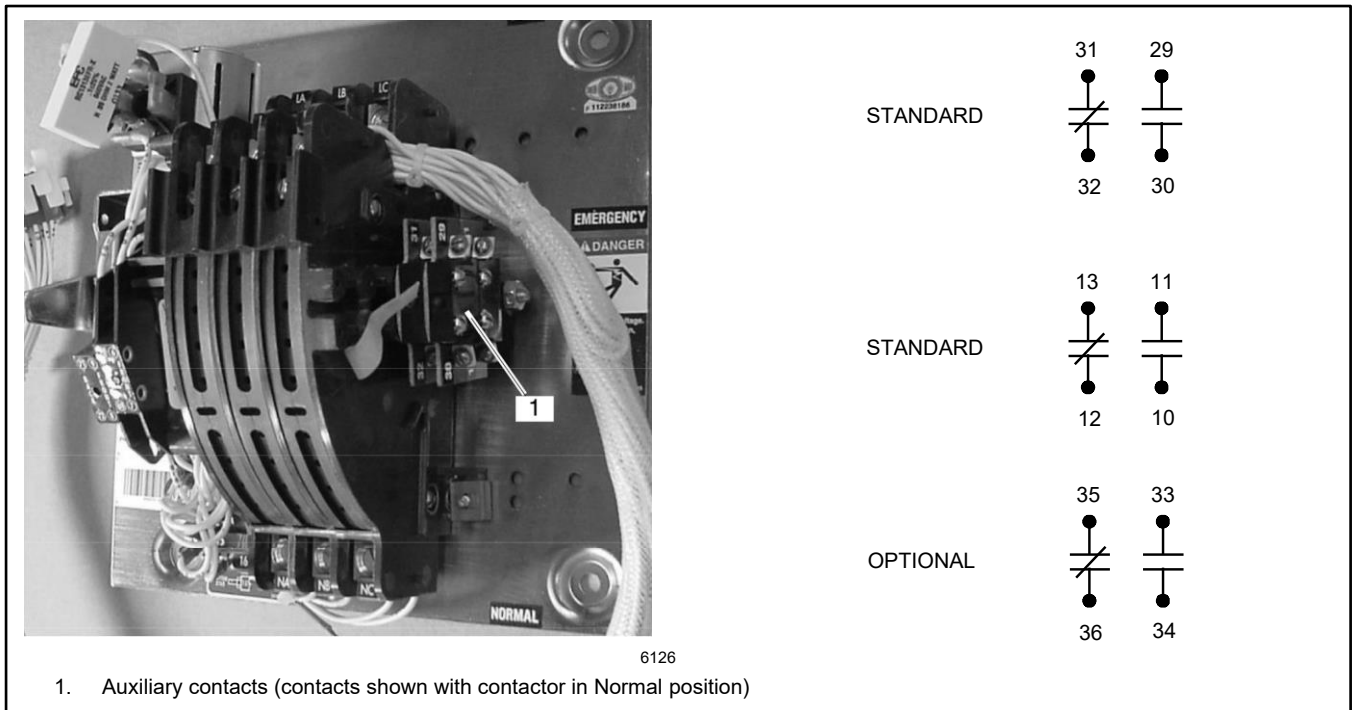


Figure 39 Auxiliary Contacts, 30-230 Amp Transfer Switches

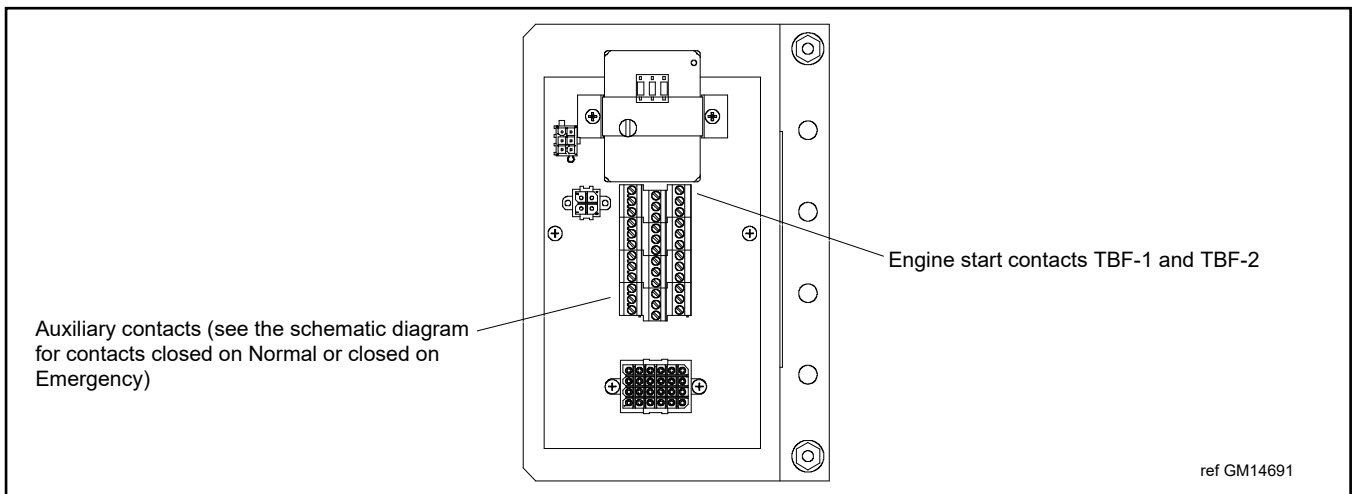


Figure 40 Field Connection Terminal Block

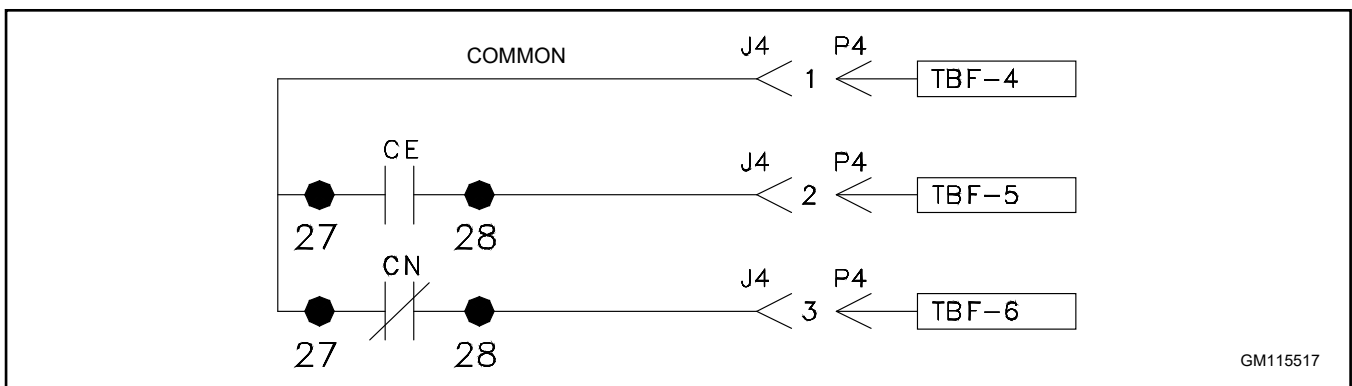


Figure 41 Typical Auxiliary Contact Connection, 230- 4000 Amp Transfer Switches (see schematic diagram)

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.

Notes

3.1 Three-Source Systems

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

A three-source system provides the means to connect a utility and two generators to a single load. See 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.

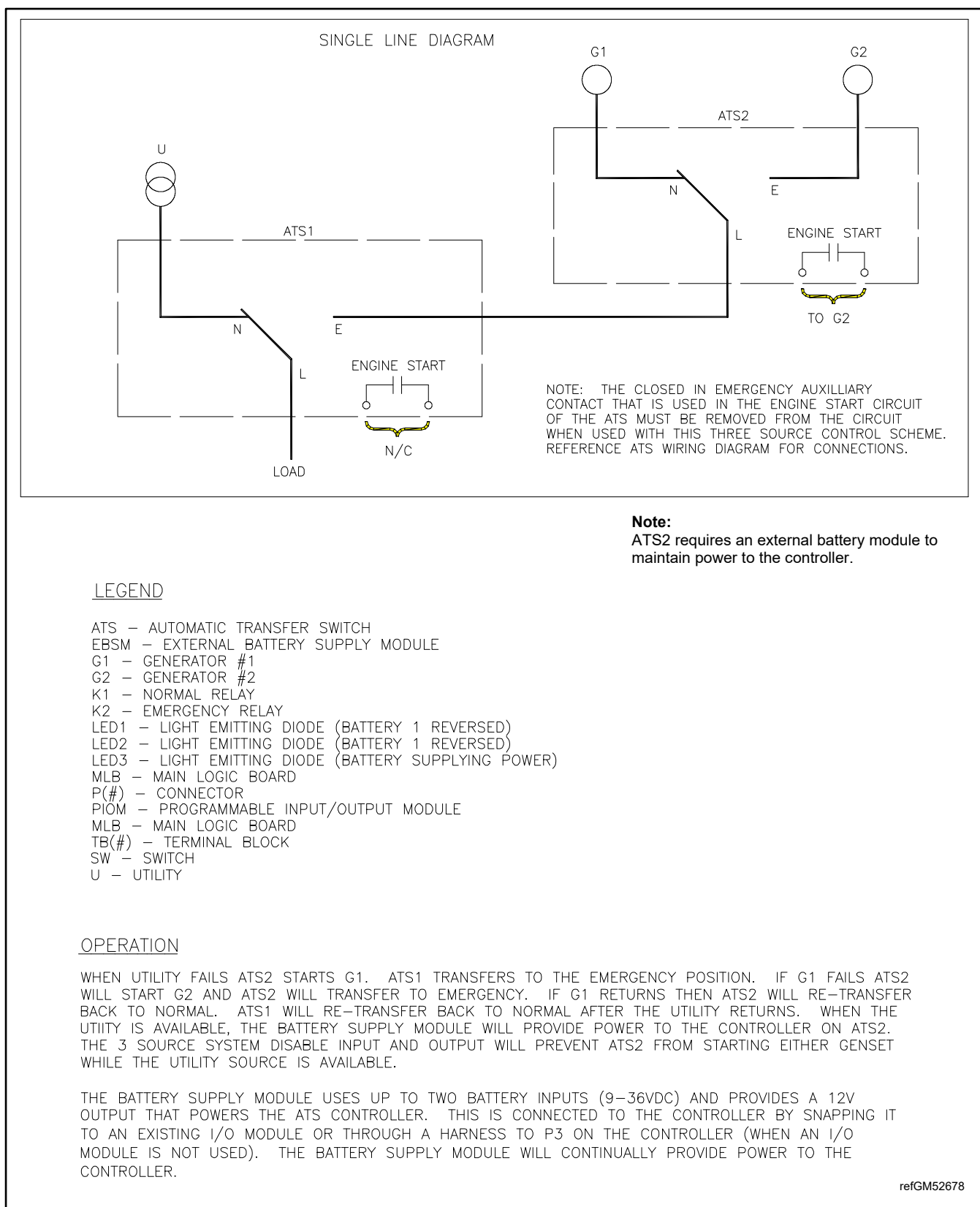


Figure 42 Three-Source System Diagram and Operation

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 43 and Figure 44 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 43 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 44. 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 44. 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:

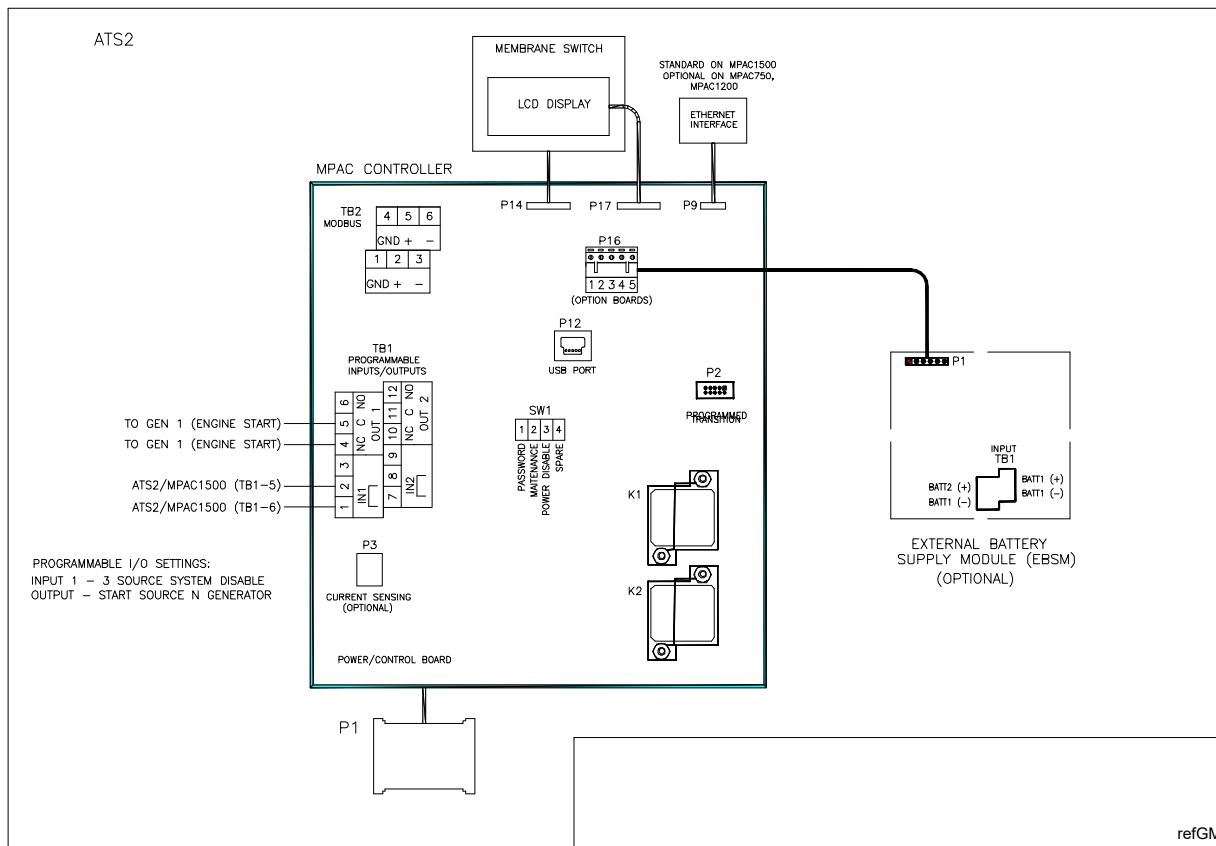
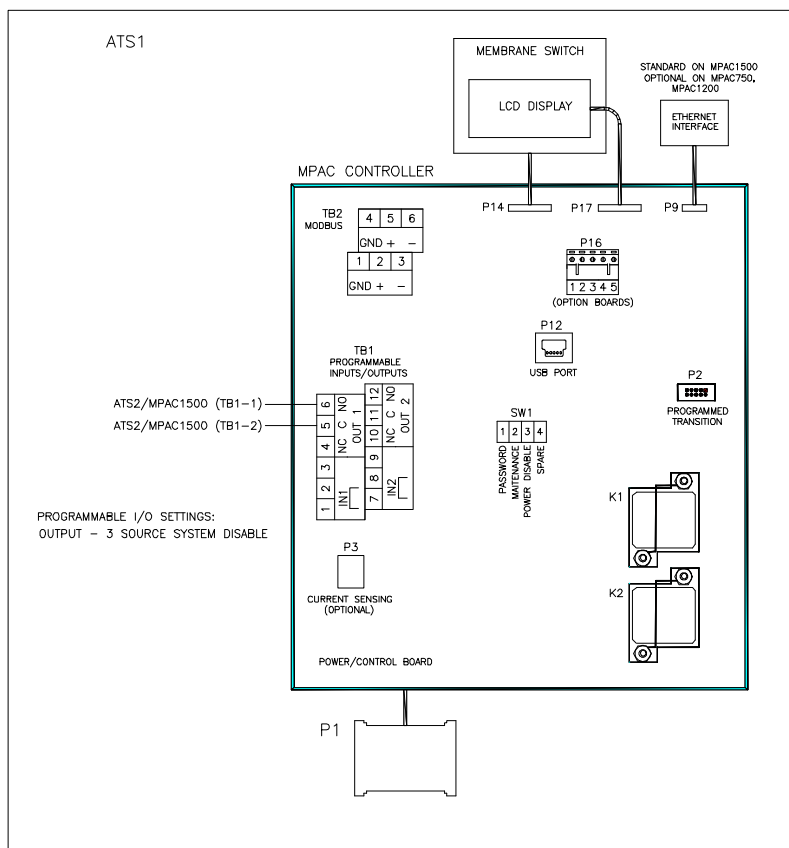
If the battery connections are reversed, red LED1 or LED2 will light. Incorrect battery connections can damage the battery module.

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.



refGM52678

Figure 43 Three-Source System Controller Connections

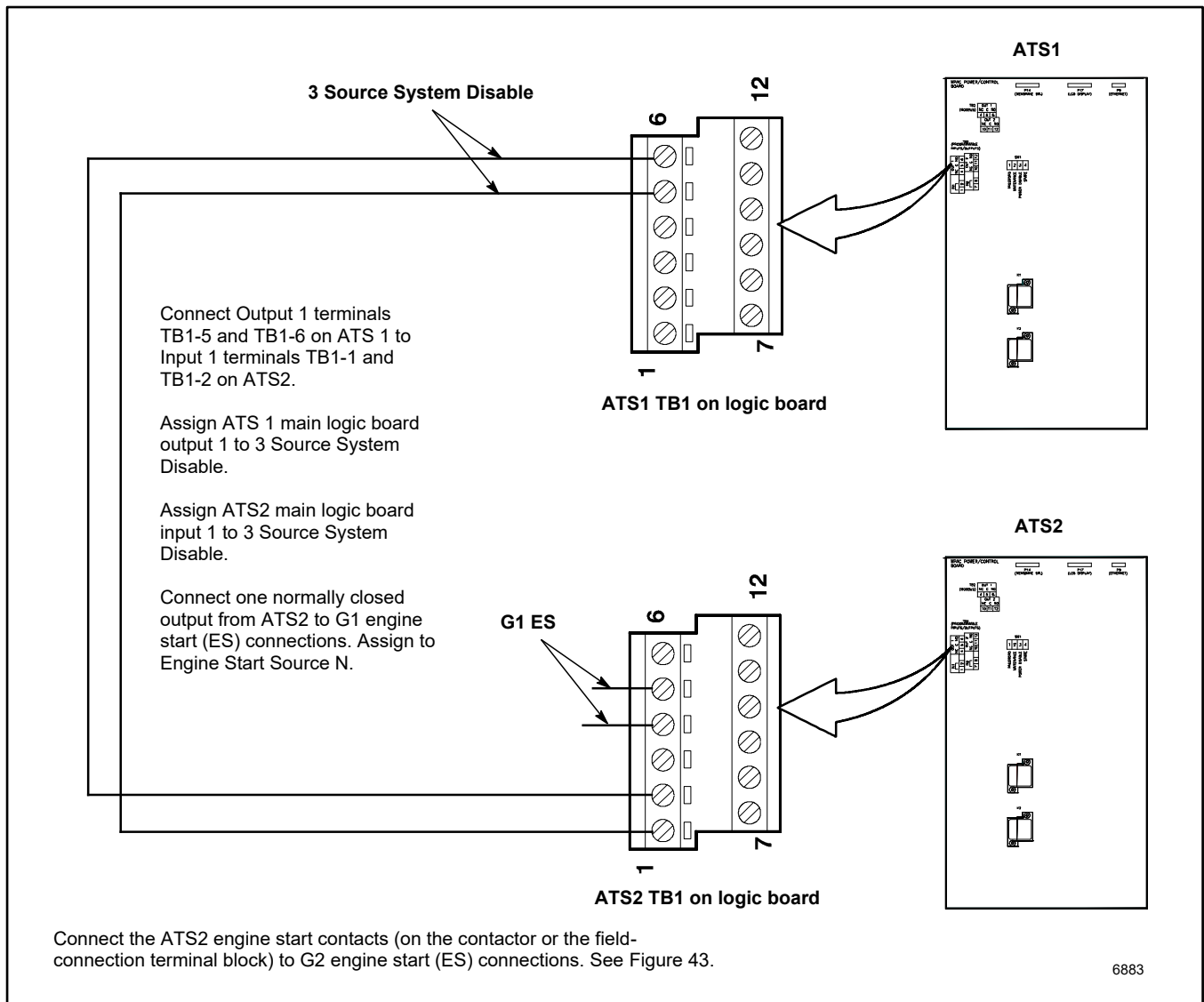


Figure 44 Input and Output Connections for Three-Source Systems

3.6 ATS1 and ATS2 System Setup

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

ATS1: Set the Source type to Util-Gen.

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

The transfer switch settings are summarized in Figure 45.

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 45 Transfer Switch Settings for Three-Source Systems

Notes

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 1200 and MPAC 1500 controllers are equipped with a USB port and a Modbus port with an RS-485 connector. An Ethernet communication board is standard on the MPAC 1500 controller and optional on the MPAC 1200 controller.

4.2.1 USB Port SiteTech Connection

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

See Figure 46 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 46 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 47 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 49.

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 48. 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.

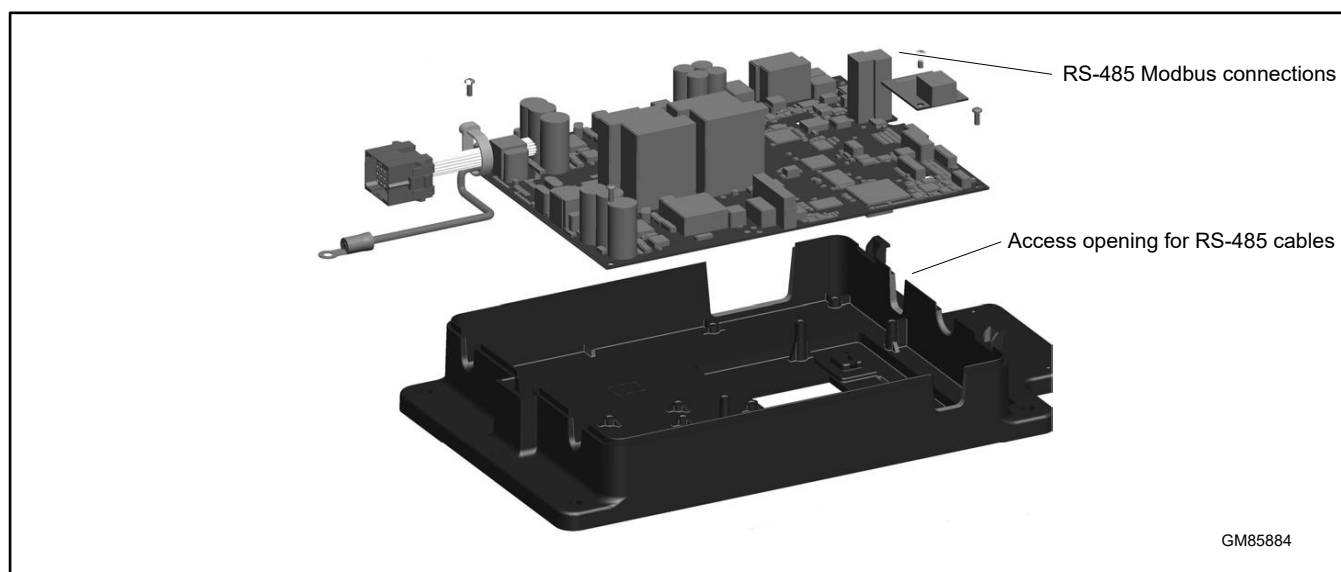


Figure 47 Modbus Connections (controller cover removed for illustration only)

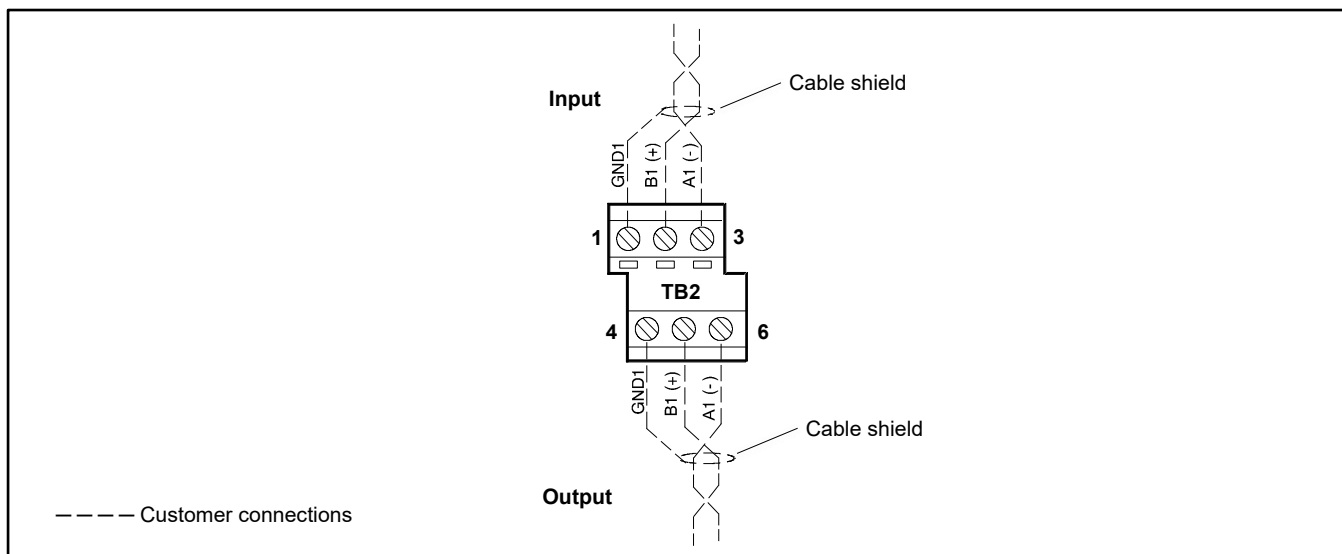
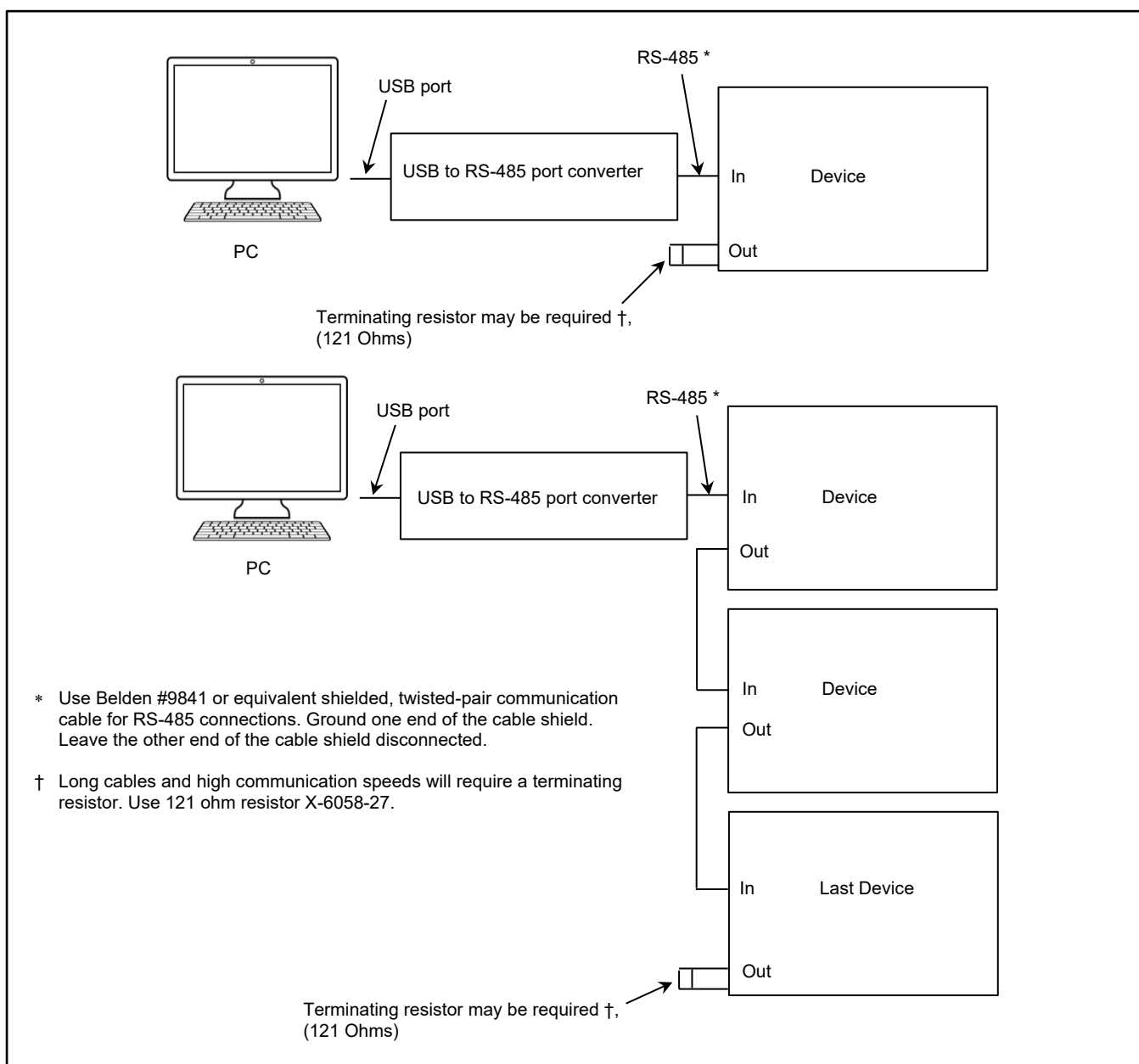


Figure 48 Modbus RS-485 Connections



4.2.3 Ethernet Connection

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

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

The Ethernet communication accessory board is required for connection to the Ethernet. The Ethernet communication board is standard on the MPAC 1500 controller. It is an optional accessory for the MPAC 1200 controller. The communication board connects to the controller board as shown in Figure 50.

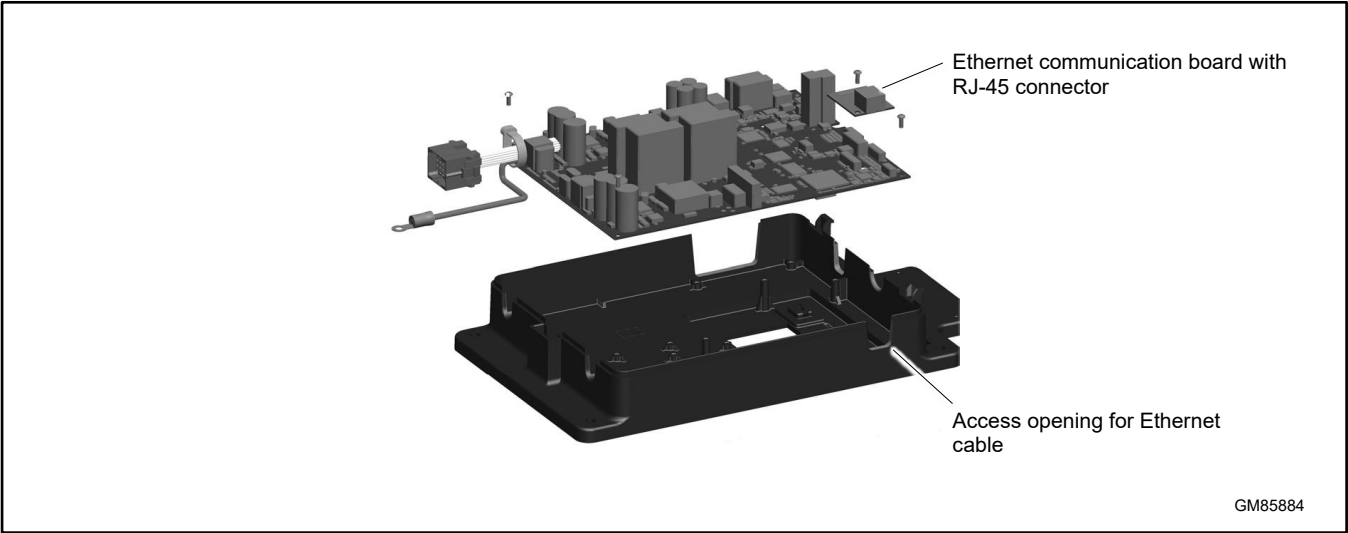


Figure 50 Ethernet Board (controller cover removed for illustration only)

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 50 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 Rehiko 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 51. **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 52 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.

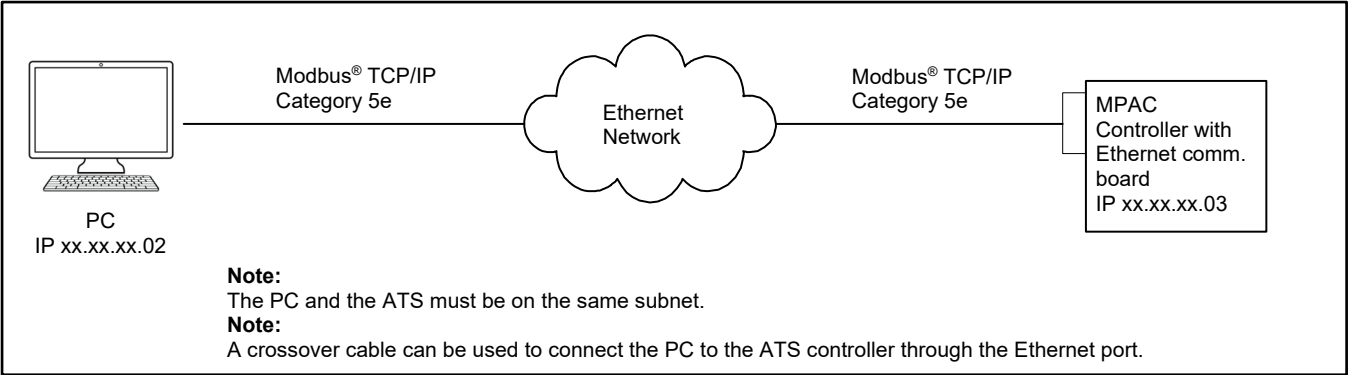


Figure 51 Remote Network (Ethernet) Connection

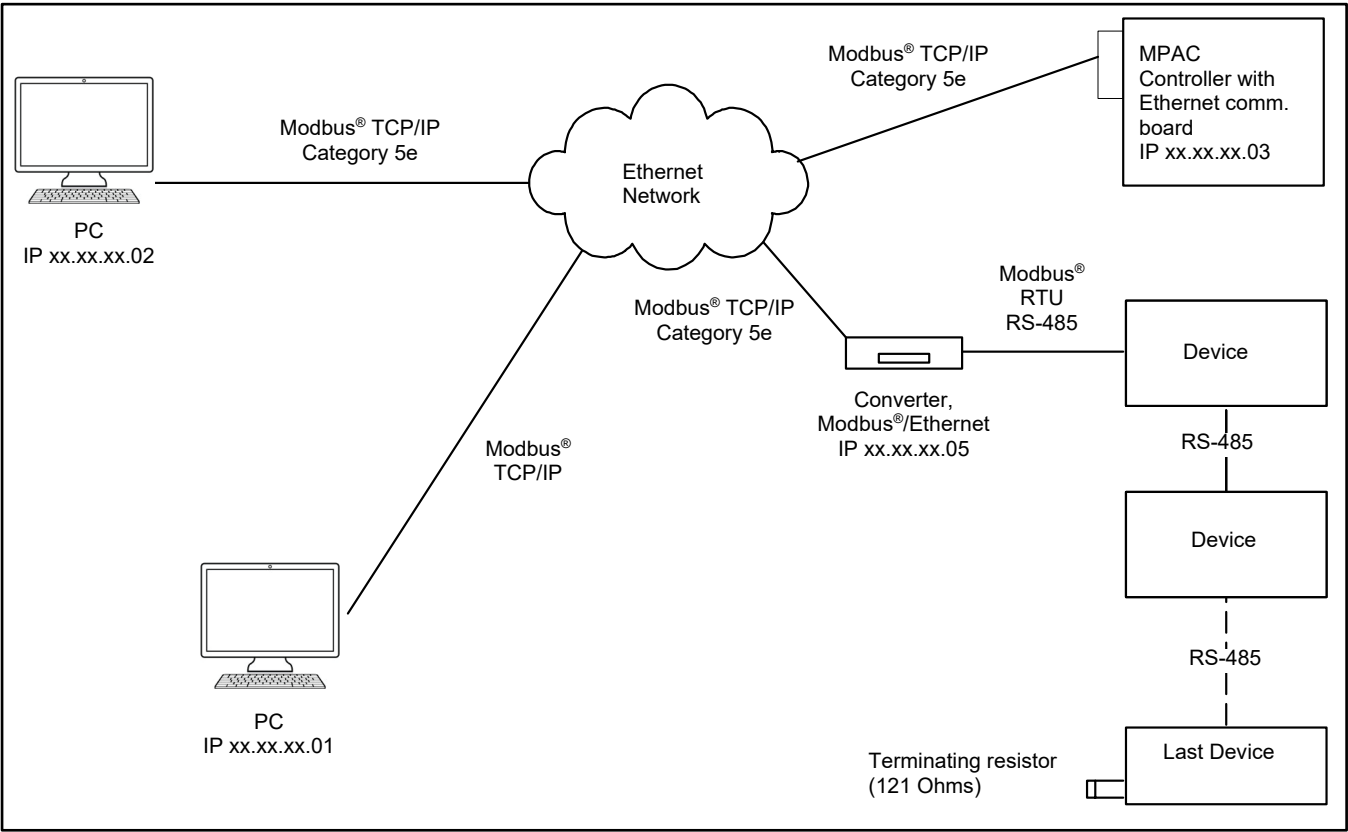


Figure 52 Ethernet Connections to Multiple-Device Network

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 53. 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 53 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 54. 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.

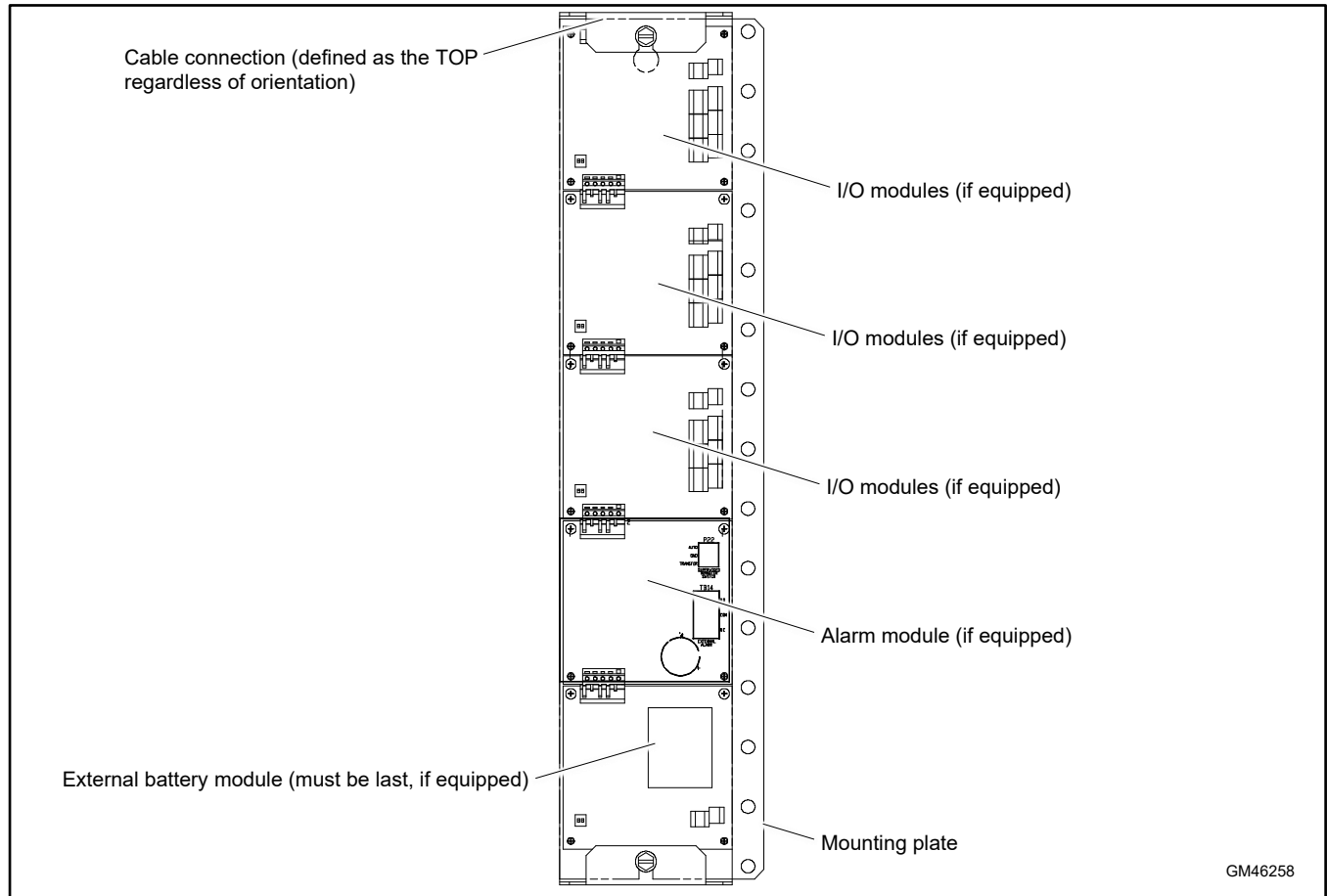


Figure 54 Module Mounting

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 55 through Figure 58 for I/O module illustrations and specifications.

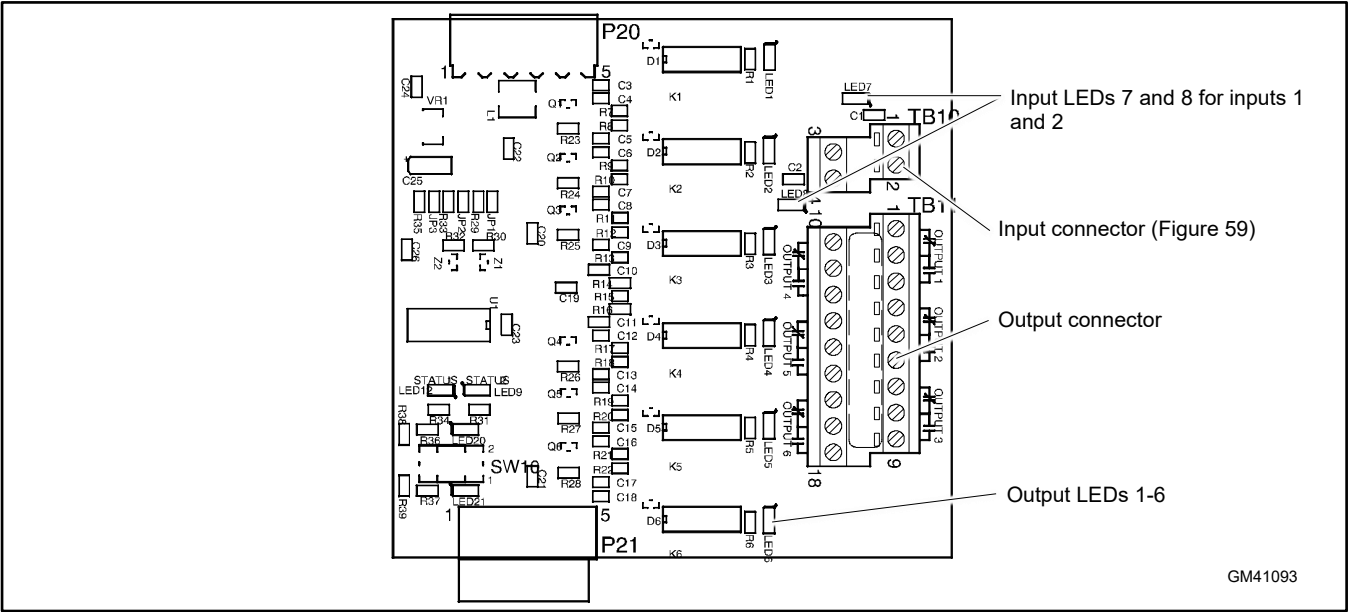


Figure 55 Standard Input/Output Module

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 56 Standard I/O Module Specifications

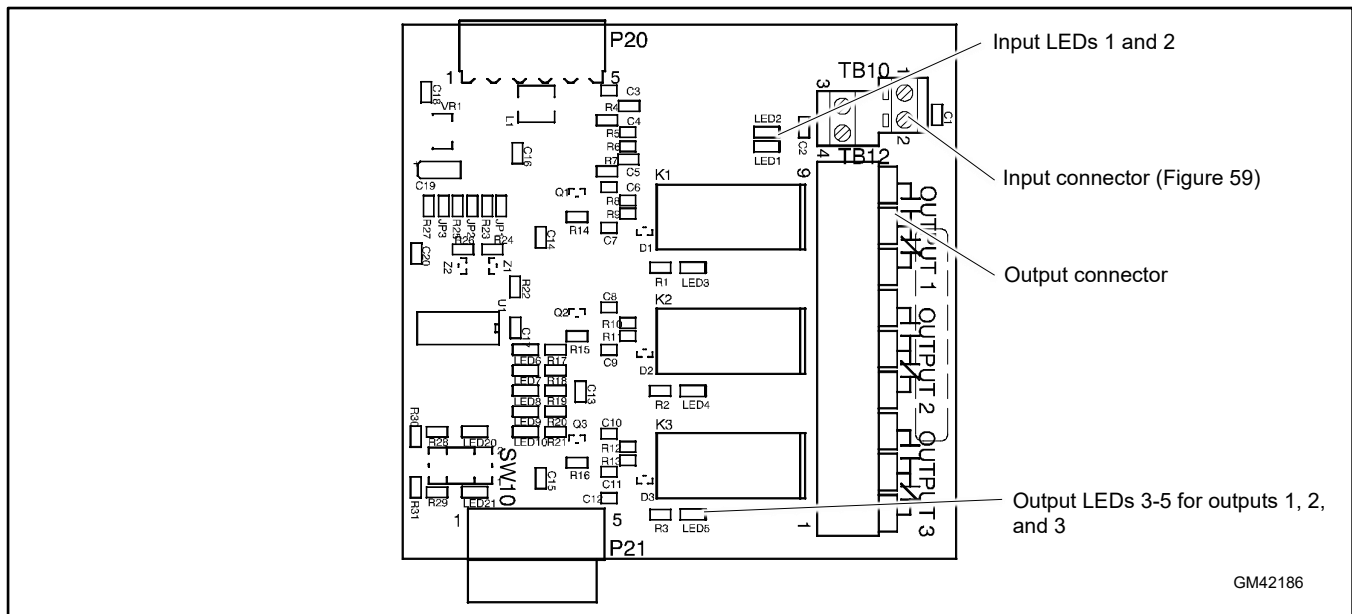


Figure 57 High-Power Input/Output Module

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 58 High-Power I/O Module Specifications

Use 14-24 AWG cable to connect to inputs and outputs. See Figure 59.

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 60. 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 Rehlko SiteTech™ software or over Modbus. See TP-6701, SiteTech Operation Manual, or TP-6113, Modbus Protocol Manual.

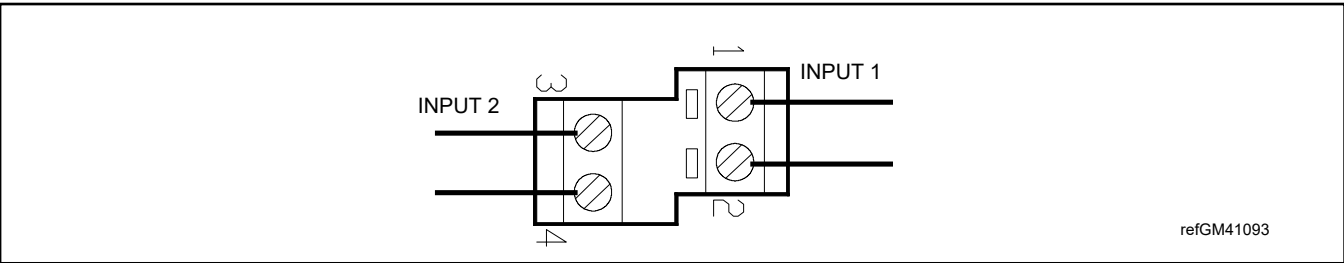


Figure 59 I/O Module Input Connections (TB1 or TB10)

Both switches OFF
Address=1 shown

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

Figure 60 Address DIP Switch Settings

4.3.3 External Battery Supply Module (EBSM)

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

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

The external battery supply module kit includes one external battery supply circuit board and the circuit board mounting components. See Figure 61.

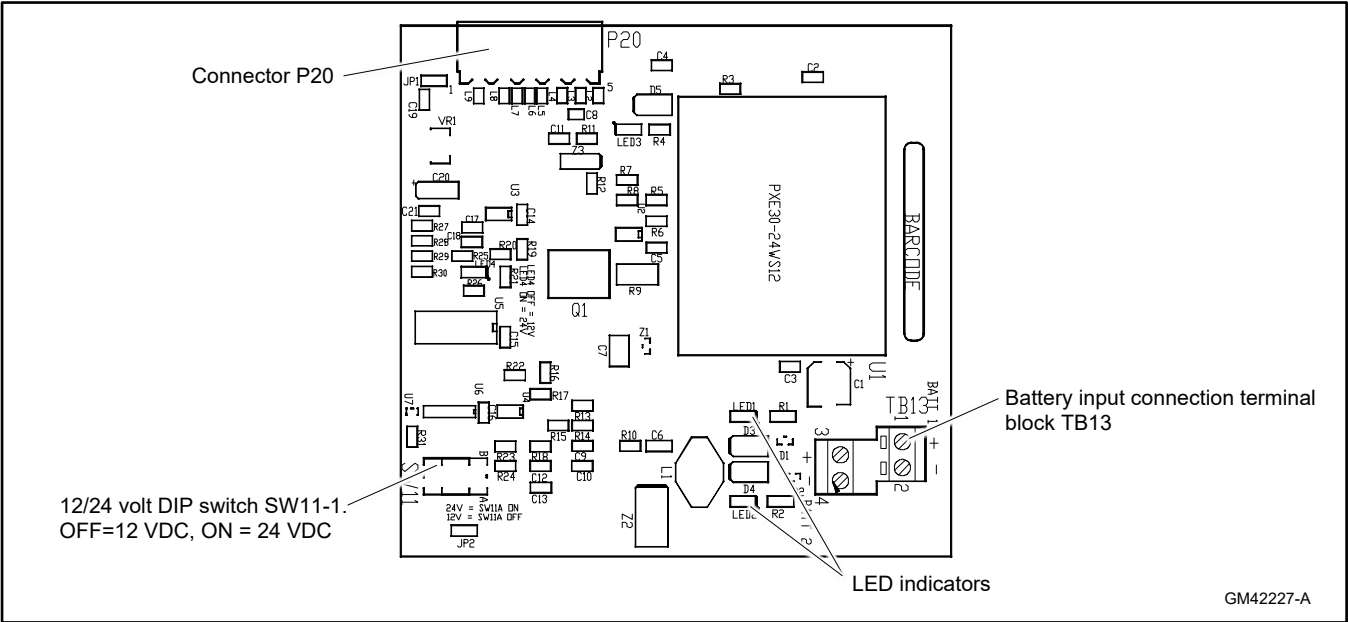


Figure 61 External Battery Supply Module

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

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

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

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

Figure 62 Battery Voltage Selection

EBSM Connection and Voltage Setting

1. Use #14-28 AWG wire to connect one or two batteries to terminal block TB13. (A second battery can be connected but is not required.) Follow the marking on the board for the positive (+) and negative (-) connections. See Figure 61 and Figure 62.

Note:

If the battery connections are reversed, red LED1 or LED2 will light. See Figure 61.

2. Set voltage selector switch SW11-1 to 12 or 24VDC. See Figure 61 and Figure 62. Switch SW11-2 is not used.

Note:

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

4.3.4 Alarm Module

See Figure 63 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 required)
- Connection for external alarm

The alarm board has a fixed address = 5.

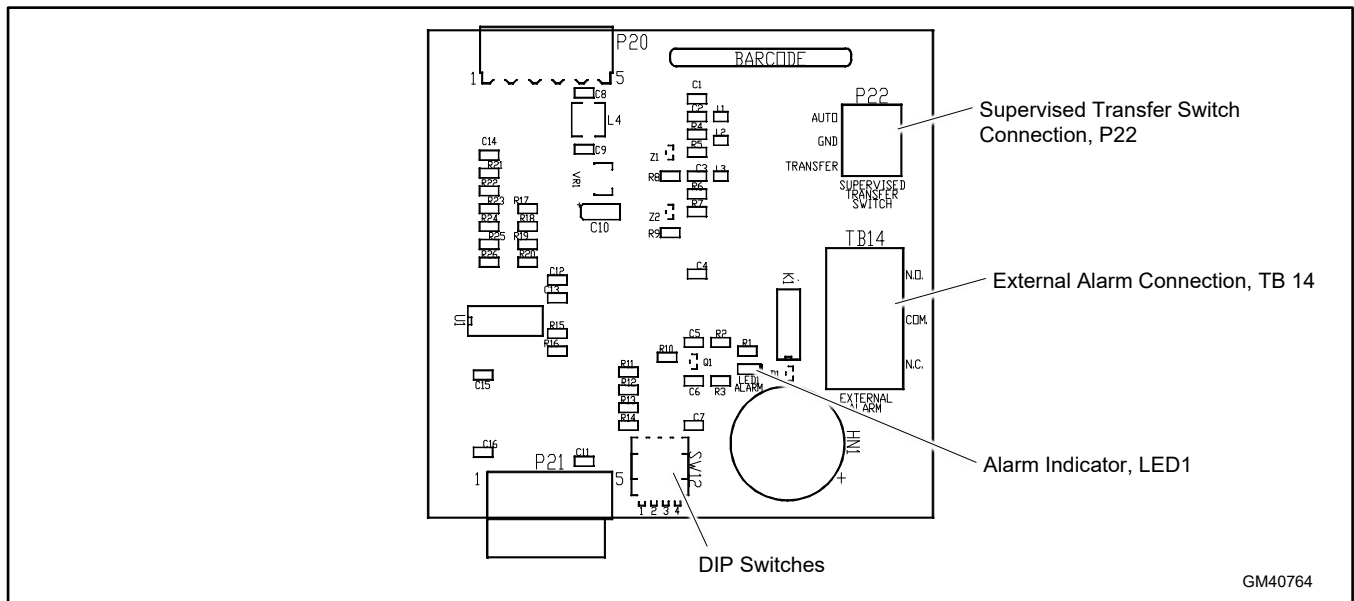


Figure 63 Alarm Module

Alarm Board DIP Switches

There are four DIP switches on the alarm module board. Some of the switches are not used. See Figure 64. 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 64 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 65.

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

Figure 65 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 66. Press the Alarm button to open the Reset menu. Then press the button labeled Reset to silence the alarm.

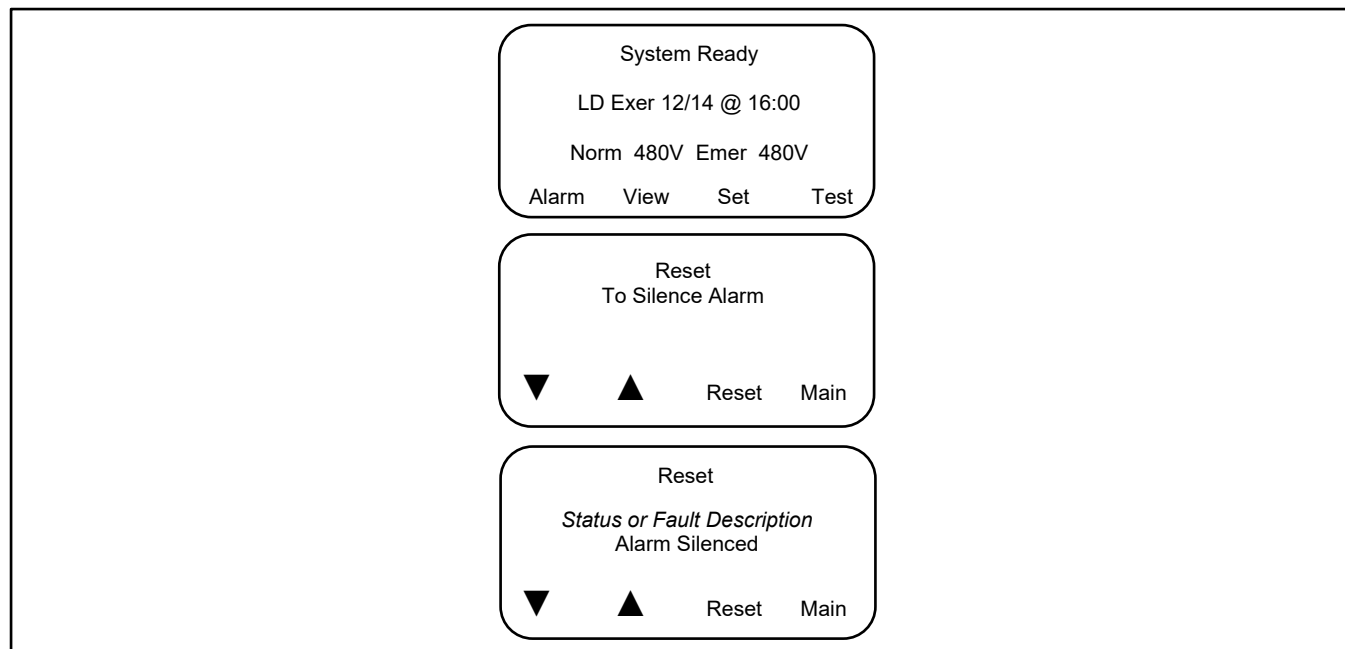


Figure 66 Alarm Silence

4.4 Load Shed (Forced Transfer to OFF)

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

Servicing the transfer switch. Hazardous voltage will cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) 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 67 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 68. 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 Rehlko 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.

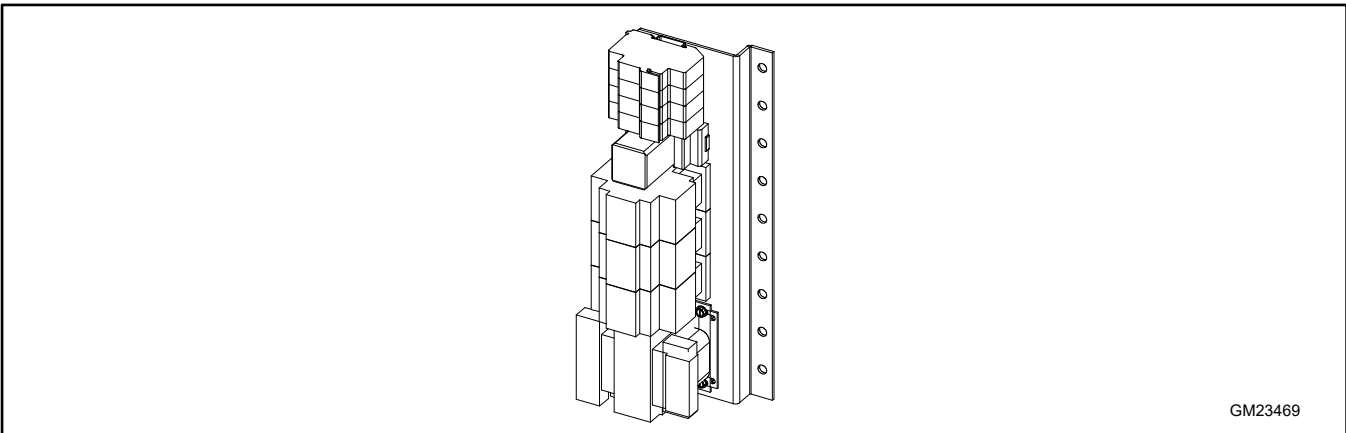


Figure 67 Load Shed Accessory (for identification)

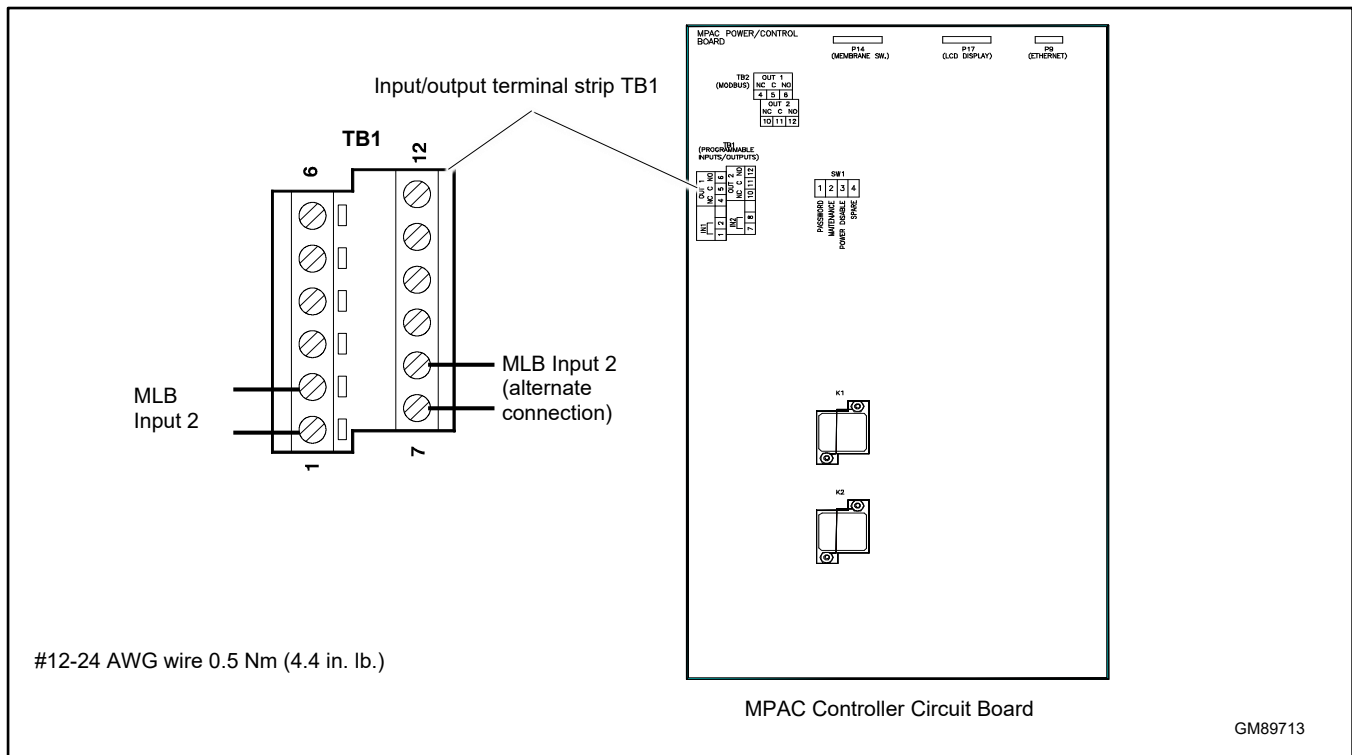


Figure 68 Forced Transfer to Off Input Connection (for factory-installed load shed kits)

4.5 Heater

 DANGER	Hazardous voltage. Will cause severe injury or death. Disconnect all power sources before opening the enclosure.
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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 69 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 70 and Figure 71. The heater and hygrostat are connected to power through a 15-amp circuit breaker.

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

Because of space limitations in the smaller enclosures, 30-200 Amp Model KCS switches can include either an enclosure heater or a surge protection device (SPD), but not both.

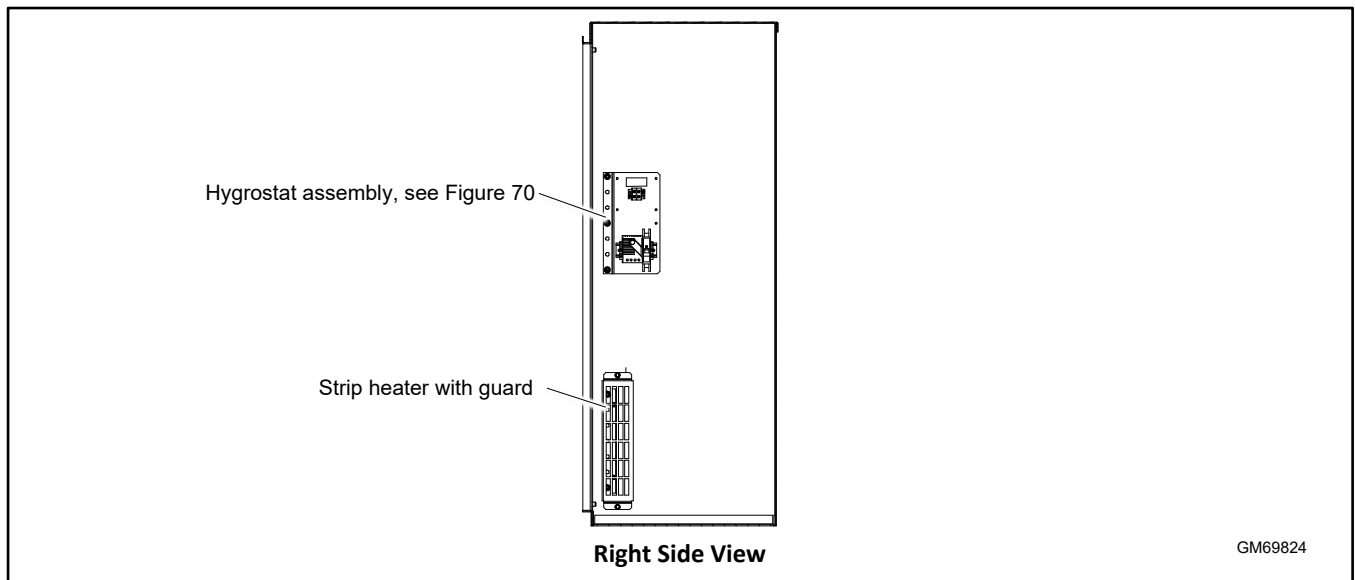


Figure 69 Heater Location, Typical

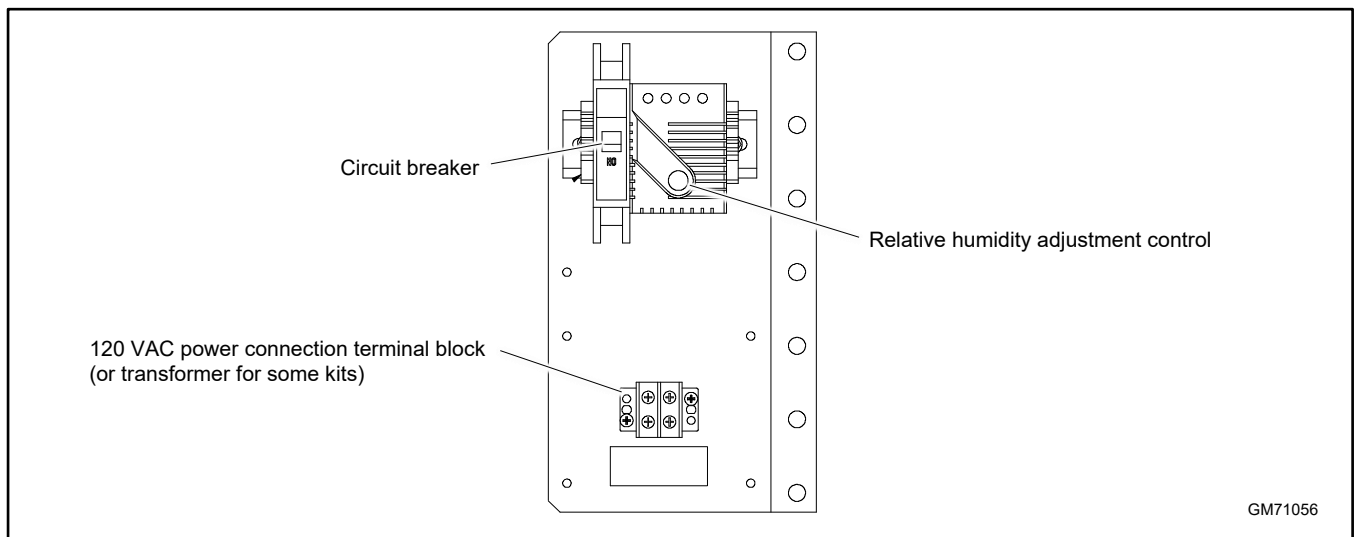


Figure 70 Hygrostat Assembly, Typical

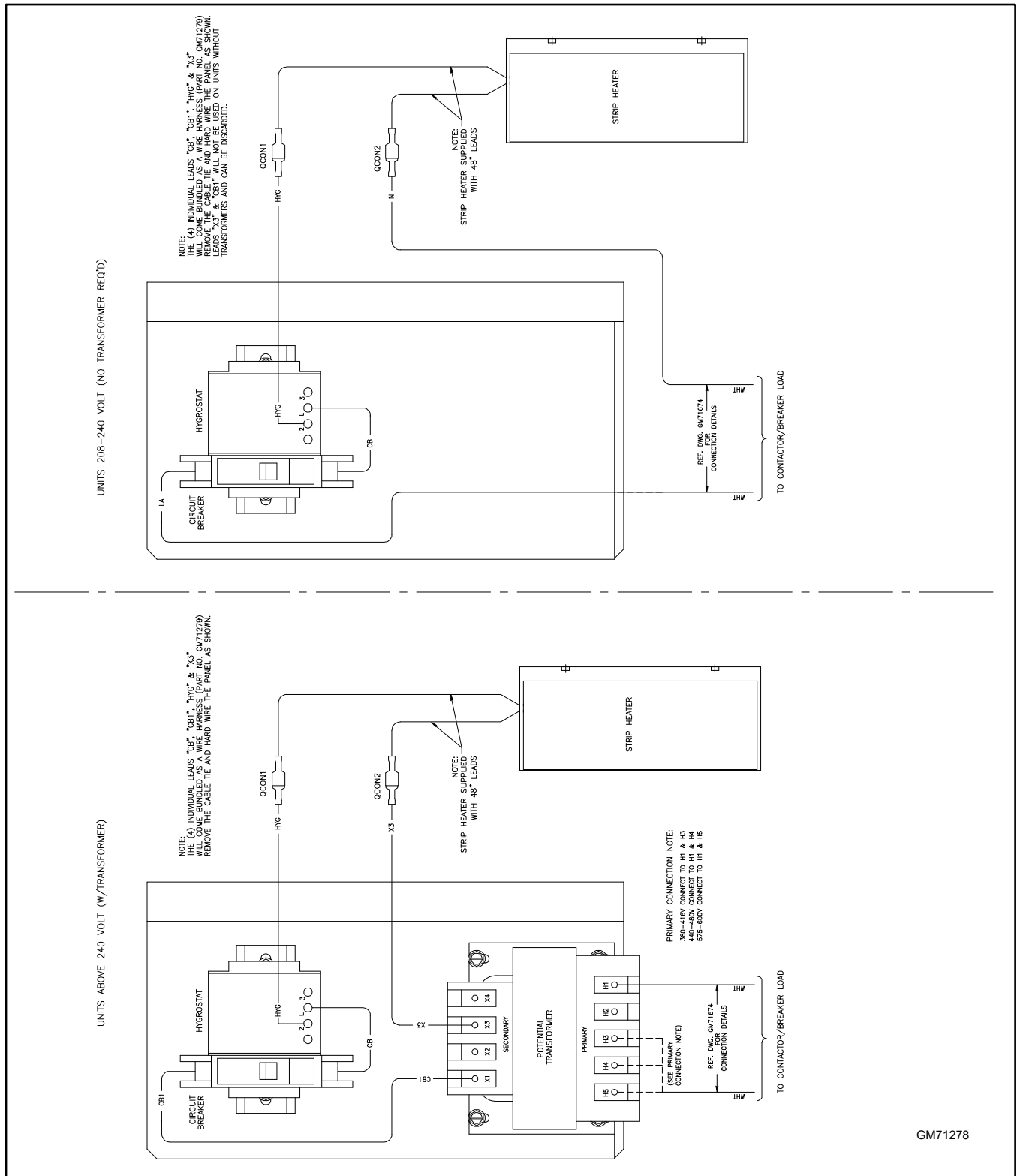


Figure 71 Heater Connections

4.6 Other Accessories

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

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

Notes

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 check which controller is used on your transfer switch and see Figure 72 for the Operation Manual part number.

Keep records of all maintenance or service.

Operation Manual	Part Number
Operation Manual, Decision-Maker® MPAC 1200 Controller	TP-6866
Operation Manual, Decision-Maker® MPAC 1500 Controller	TP-6883

Figure 72 Operation Manuals

Notes

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 Rehlko 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.

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

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

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

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 Rehiko online Warranty Processing System.

Notes

Appendix A. Abbreviations

A, amp	ampere	blk. htr.	block heater	DAC	digital to analog converter
ABDC	after bottom dead center	BMEP	brake mean effective pressure	dB	decibel
AC	alternating current	bps	bits per second	dB(A)	decibel (A weighted)
A/D	analog to digital	br.	Brass	DC	direct current
ADC	advanced digital control; analog to digital converter	BTDC	before top dead center	DCR	direct current resistance
adj.	adjust, adjustment	Btu	British thermal unit	DEF	diesel exhaust fluid
ADV	advertising dimensional drawing	Btu/min.	British thermal units per minute	deg., °	degree
AGM	absorbent glass mat	C	Celsius, centigrade	dept.	department
Ah	amp-hour	cal.	Calorie	dia.	Diameter
AHWT	anticipatory high water temperature	CAN	controller area network	DI/EO	dual inlet/end outlet
AISI	American Iron and Steel Institute	CARB	California Air Resources Board	DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
ALOP	anticipatory low oil pressure	CAT5	Category 5 (network cable)	DIP	dual inline package
alt.	alternator	CB	circuit breaker	DPDT	double-pole, double-throw
Al	aluminum	CC	crank cycle	DPST	double-pole, single-throw
ANSI	American National Standards Institute (formerly American Standards Association, ASA)	cc	cubic centimeter	DS	disconnect switch
AO	anticipatory only	CCA	cold cranking amps	DVR	digital voltage regulator
APDC	Air Pollution Control District	ccw.	Counterclockwise	E2PROM, EEPROM	electrically-erasable programmable read-only memory
API	American Petroleum Institute	CEC	Canadian Electrical Code	E, emer.	emergency (power source)
approx.	approximate, approximately	cert.	certificate, certification, certified	EATS	Exhaust Aftertreatment System
APU	Auxiliary Power Unit	cfh	cubic feet per hour	ECM	electronic control module, engine control module
AQMD	Air Quality Management District	cfm	cubic feet per minute	EDI	electronic data interchange
AR	as required, as requested	CG	center of gravity	EFR	emergency frequency relay
AS	as supplied, as stated, as suggested	CID	cubic inch displacement	e.g.	for example (exempli gratia)
ASE	American Society of Engineers	CL	centerline	EG	electronic governor
ASME	American Society of Mechanical Engineers	cm	centimeter	EGSA	Electrical Generating Systems Association
assy.	Assembly	CMOS	complementary metal oxide substrate (semiconductor)	EIA	Electronic Industries Association
ASTM	American Society for Testing Materials	com	communications (port)	EI/EO	end inlet/end outlet
ATDC	after top dead center	coml	commercial	EMI	electromagnetic interference
ATS	automatic transfer switch	Coml/Rec	Commercial/Recreational	emiss.	Emission
auto.	Automatic	conn.	Connection	eng.	Engine
aux.	auxiliary	cont.	continued	EPA	Environmental Protection Agency
avg.	average	CPVC	chlorinated polyvinyl chloride	EPS	emergency power system
AVR	automatic voltage regulator	crit.	Critical	ER	emergency relay
AWG	American Wire Gauge	CRM	Common Rail Manifold	ES	engineering special, engineered special
AWM	appliance wiring material	CSA	Canadian Standards Association		
bat.	Battery	CT	current transformer	ESD	electrostatic discharge
BBDC	before bottom dead center	Cu	copper	est.	estimated
BC	battery charger, battery charging	cUL	Canadian Underwriter's Laboratories	E-Stop	emergency stop
BCA	battery charging alternator	cu. in.	cubic inch	etc.	et cetera (and so forth)
BCI	Battery Council International	cw.	Clockwise	exh.	exhaust
BDC	before dead center	CWC	city water-cooled	ext.	external
BHP	brake horsepower	cyl.	Cylinder	F	Fahrenheit, female
blk.	black (paint color), block (engine)	D/A	digital to analog	FDS	Fluid Dosing System

FHM	flat head machine (screw)	in.	inch	Lpm	liters per minute
fl. oz.	fluid ounce	in. H ₂ O	inches of water	LOP	low oil pressure
flex.	flexible	in. Hg	inches of mercury	LP	liquefied petroleum
freq.	frequency	in. Lb.	inch pounds	LPG	liquefied petroleum gas
FS	full scale	Inc.	incorporated	LS	left side
ft.	foot, feet	ind.	Industrial	L _{wa}	sound power level, A weighted
ft. lb.	foot pounds (torque)	int.	internal	LWL	low water level
ft./min.	feet per minute	int./ext.	internal/external	LWT	low water temperature
ftp	file transfer protocol	I/O	input/output	m	meter, milli (1/1000)
g	gram	IP	internet protocol	M	mega (10 ⁶ when used with SI units), male
ga.	gauge (meters, wire size)	ISO	International Organization for Standardization	m ³	cubic meter
gal.	gallon	J	joule	m ³ /hr.	cubic meters per hour
gen.	generator	JIS	Japanese Industry Standard	m ³ /min.	cubic meters per minute
genset	generator set	k	kilo (1000)	mA	milliampere
GFI	ground fault interrupter	K	kelvin	man.	manual
GND, 	ground	kA	kiloampere	max.	maximum
gov.	governor	KB	kilobyte (2 ¹⁰ bytes)	MB	megabyte (2 ²⁰ bytes)
gph	gallons per hour	KBus	Communication protocol	MCCB	molded-case circuit breaker
gpm	gallons per minute	kg	kilogram	MCM	one thousand circular mils
gr.	grade, gross	kg/cm ²	kilograms per square centimeter	meggar	megohmmeter
GRD	equipment ground	kgm	kilogram-meter	MHz	megahertz
gr. wt.	gross weight	kg/m ³	kilograms per cubic meter	mi.	mile
H x W x D	height by width by depth	kHz	kilohertz	mil	one one-thousandth of an inch
HC	hex cap	kJ	kilojoule	min.	minimum, minute
HCHT	high cylinder head temperature	km	kilometer	misc.	miscellaneous
HD	heavy duty	kOhm, kΩ	kilo-ohm	MJ	megajoule
HET	high exhaust temp., high engine temp.	kPa	kilopascal	mJ	millijoule
hex	hexagon	kph	kilometers per hour	mm	millimeter
Hg	mercury (element)	kV	kilovolt	mOhm, mΩ	milliohm
HH	hex head	kVA	kilovolt ampere	MOhm, MΩ	megohm
HHC	hex head cap	kVAR	kilovolt ampere reactive	MOV	metal oxide varistor
HP	horsepower	kW	kilowatt	MPa	megapascal
hr.	hour	kWh	kilowatt-hour	mpg	miles per gallon
HS	heat shrink	kWm	kilowatt mechanical	mph	miles per hour
hsg.	Housing	kWth	kilowatt-thermal	MS	military standard
HVAC	heating, ventilation, and air conditioning	L	liter	ms	millisecond
HWT	high water temperature	LAN	local area network	m/sec.	meters per second
Hz	hertz (cycles per second)	L x W x H	length by width by height	mtg.	mounting
IBC	International Building Code	lb.	pound, pounds	MTU	Motoren-und Turbinen-Union
IC	integrated circuit	lbm/ft ³	pounds mass per cubic feet	MW	megawatt
ID	inside diameter, identification	LCB	line circuit breaker	mW	milliwatt
IEC	International Electrotechnical Commission	LCD	liquid crystal display	μF	microfarad
IEEE	Institute of Electrical and Electronics Engineers	LED	light emitting diode	μF	microfarad
IMS	improved motor starting	Lph	liters per hour		

N, norm.	normal (power source)	PMG	permanent magnet generator	SCR	silicon controlled rectifier (electrical), selective catalytic reduction (exhaust emissions)
NA	not available, not applicable	pot	potentiometer, potential	s, sec.	second
nat. gas	natural gas	ppm	parts per million	SI	<i>Système international d'unités</i> , International System of Units
NBS	National Bureau of Standards	PROM	programmable read-only memory	SI/EO	side in/end out
NC	normally closed	psi	pounds per square inch	sil.	Silencer
NEC	National Electrical Code	psig	pounds per square inch gauge	SMTP	simple mail transfer protocol
NEMA	National Electrical Manufacturers Association	pt.	pint	SN	serial number
NiCd	nickel cadmium	PTC	positive temperature coefficient	SNMP	simple network management protocol
NFPA	National Fire Protection Association	PTO	power takeoff	SPDT	single-pole, double-throw
Nm	newton meter	PVC	polyvinyl chloride	SPST	single-pole, single-throw
NO	normally open	PVC	polyvinyl chloride	spec	specification
no., nos.	number, numbers	PWM	pulse width modulated, pulse width modulation	specs	specification(s)
NPS	National Pipe, Straight	qt.	quart, quarts	sq.	square
NPSC	National Pipe, Straight-coupling	qty.	quantity	sq. cm	square centimeter
NPT	National Standard taper pipe thread per general use	R	replacement (emergency) power source	sq. in.	square inch
NPTF	National Pipe, Taper-Fine	rad.	radiator, radius	SMS	short message service
NR	not required, normal relay	RAM	random access memory	SS	stainless steel
Ns	nanosecond	RDO	relay driver output	std.	standard
OC	overcrank	ref.	reference	stl.	Steel
OD	outside diameter	rem.	Remote	tach.	Tachometer
OEM	original equipment manufacturer	Res/Co ml	Residential/Commercial	TB	terminal block
OF	overfrequency	RFI	radio frequency interference	TCP	transmission control protocol
opt.	option, optional	RH	round head	TD	time delay
OS	oversize, overspeed	RHM	round head machine (screw)	TDC	top dead center
OSHA	Occupational Safety and Health Administration	rly.	Relay	TDEC	time delay engine cooldown
OSHPD	Office of Statewide Health Planning and Development (California)	rms	root mean square	TDEN	time delay emergency to normal
OV	overvoltage	rnd.	Round	TDES	time delay engine start
oz.	ounce	RO	read only	TDNE	time delay normal to emergency
p., pp.	page, pages	ROM	read only memory	TDOE	time delay off to emergency
PC	personal computer	rot.	rotate, rotating	TDON	time delay off to normal
PCB	printed circuit board	rpm	revolutions per minute	temp.	temperature
pF	picofarad	RS	right side	term.	Terminal
PF	power factor	RTDs	resistance temperature detectors	THD	total harmonic distortion
ph., ø	phase	RTU	remote terminal unit	TIF	telephone influence factor
PHC	Phillips® head Crimptiter (screw)	RTV	room temperature vulcanization	tol.	Tolerance
PHH	Phillips® hex head (screw)	RW	read/write	turbo.	Turbocharger
PHM	pan head machine (screw)	SAE	Society of Automotive Engineers	typ.	typical (same in multiple locations)
PLC	programmable logic control	scfm	standard cubic feet per minute	UF	underfrequency

UHF	ultrahigh frequency
UIF	user interface
UL	Underwriter's Laboratories, Inc.
UNC	unified coarse thread (was NC)
UNF	unified fine thread (was NF)
univ.	universal
URL	uniform resource locator (web address)
US	undersize, underspeed
UV	ultraviolet, undervoltage
V	volt
VAC	volts alternating current
VAR	voltampere reactive
VDC	volts direct current
VFD	vacuum fluorescent display
VGA	video graphics adapter
VHF	very high frequency
W	watt
WCR	withstand and closing rating
w/	with
WO	write only
w/o	without
wt.	weight
xfmr	transformer

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Original Instructions (English)

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