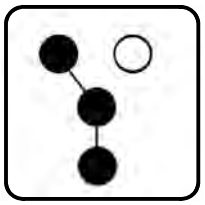
Service

Automatic Transfer Switches



Models:

KSS/KSP/KGS/KGP

Power Switching Device:
Standard and Bypass/Isolation
30 to 4000 Amperes

Electrical Controls:

MPAC™ 1500

ISO 9001
KOHLER POWER SYSTEMS
NATIONALLY REGISTERED

KOHLER®
POWER SYSTEMS

TP-6461 1/08

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Notes

IMPORTANT SAFETY INSTRUCTIONS. Electromechanical equipment, including generator sets, transfer switches, switchgear, and accessories, can cause bodily harm and pose life-threatening danger when improperly installed, operated, or maintained. To prevent accidents be aware of potential dangers and act safely. Read and follow all safety precautions and instructions. SAVE THESE INSTRUCTIONS.

This manual has several types of safety precautions and instructions: Danger, Warning, Caution, and Notice.

⚠ DANGER

Danger indicates the presence of a hazard that ***will cause severe personal injury, death***, or ***substantial property damage***.

⚠ WARNING

Warning indicates the presence of a hazard that ***can cause severe personal injury, death,*** or ***substantial property damage***.

⚠ CAUTION

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

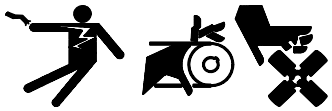
NOTICE

Notice communicates installation, operation, or maintenance information that is safety related but not hazard related.

Safety decals affixed to the equipment in prominent places alert the operator or service technician to potential hazards and explain how to act safely. The decals are shown throughout this publication to improve operator recognition. Replace missing or damaged decals.

Accidental Starting

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

Hazardous Voltage/ Electrical Shock

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

This equipment must be installed and serviced by qualified electrical personnel.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

⚠ WARNING

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

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

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

Welding on the generator set. Can cause severe electrical equipment damage. Before welding on the generator set perform the following steps: (1) Remove the battery cables, negative (–) lead first. (2) Disconnect all engine electronic control module (ECM) connectors. (3) Disconnect all generator set controller and voltage regulator circuit board connectors. (4) Disconnect the engine battery-charging alternator connections. (5) Attach the weld ground connection close to the weld location.

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

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

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

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

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

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

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

Heavy Equipment

⚠ WARNING

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

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

Moving Parts

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Disassembling the solenoid. Spring-loaded parts can cause severe personal injury or property damage. The spring in the solenoid assembly exerts substantial force on the coil. Hold the coil assembly securely when removing the screws.

Notice

NOTICE

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

NOTICE

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 service information for Kohler® Model KSS/KSP and KGS/KGP transfer switches with MPAC™ 1500 electrical controls. It includes operation, troubleshooting, repair, and maintenance procedures for the transfer switches and electrical controls.

The information included in this manual is intended solely for use by trained and qualified service personnel of authorized service distributors/dealers.

Information in this publication represents data available at the time of print. Kohler Co. reserves the right to change this literature and the products represented without notice and without any obligation or liability whatsoever.

Read this manual and carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions and Instructions section at the beginning of this manual. Keep this manual with the equipment for future reference.

The equipment service requirements are very important to safe and efficient operation. Inspect parts often and perform required service at the prescribed intervals. Obtain service from an authorized service distributor/ dealer to keep equipment in top condition.

List of Related Materials

Figure 1 lists the part numbers for related literature. Separate operation and installation manuals contain operation and installation information not provided in this manual. Refer to the parts catalog for instructions to obtain replacement parts.

Document	Document Part Number
Model KSS/KSP ATS Operation and Installation Manual	TP-6447
Model KGS/KGP Bypass/Isolation Switch Operation and Installation Manual	TP-6449
Model KSS/KSP/KGS/KGP Parts Catalog	TP-6433
Model KCS/KCP/KSS/KSP Wiring Diagram Manual	TP-6434
Model KBS/KBP/KGS/KGP Wiring Diagram Manual	TP-6452
Monitor III Software Operation Manual	TP-6347
Modbus Protocol Manual	TP-6113

Figure 1 Related Materials

Service Assistance

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

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

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Kohler Power Systems
3 rue de Brennus
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France
Phone: (33) 1 49 178300
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Power Systems Asia Pacific Regional Office
Singapore, Republic of Singapore
Phone: (65) 6264-6422
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China
North China Regional Office, Beijing
Phone: (86) 10 6518 7950
(86) 10 6518 7951
(86) 10 6518 7952
Fax: (86) 10 6518 7955

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

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

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

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

1.1 Introduction

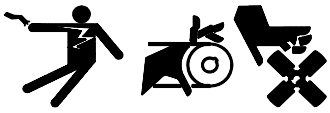
Regular preventive maintenance ensures safe and reliable operation and extends the life of the transfer switch. Preventive maintenance includes periodic testing, cleaning, inspecting, and replacing of worn or missing components. Section 1.4 contains a service schedule of recommended maintenance tasks.

A local authorized distributor/dealer can provide complete preventive maintenance and service to keep the transfer switch in top condition. Unless otherwise specified, have maintenance or service performed by an authorized distributor/dealer in accordance with all applicable codes and standards.

Keep records of all maintenance or service.

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

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before opening the enclosure.

(600 volts and under)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

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

(600 volts and under)

⚠ WARNING

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

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

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

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

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

(600 volts and under)

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

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

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

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

NOTICE

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

NOTICE

Screws and nuts are available in different hardness ratings. To indicate hardness, American Standard hardware uses a series of markings and metric hardware uses a numeric system. Check the markings on the bolt heads and nuts for identification.

NOTICE

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.

1.2 Inspection and Service

1.2.1 General Inspection

External Inspection. Inspect the transfer switch weekly.

- Look for signs of vibration, leakage, excessive noise, high temperature, contamination, or deterioration.
- Remove accumulations of dirt, dust, and other contaminants from the transfer switch's exterior with a vacuum cleaner or by wiping with a dry cloth or brush. *Do not use compressed air to clean the switch because it can cause debris to lodge in the components and damage the switch.*
- Replace any worn, missing, or broken external components with manufacturer-recommended replacement parts. Contact a local authorized distributor/dealer for part information and ordering.
- Tighten loose external hardware.

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

1.2.2 Internal Inspections and Maintenance

Internal Inspection. Have an authorized distributor/dealer perform an annual inspection of the transfer switch. Inspect the switch more frequently if it is located in a dusty or dirty area or when any condition noticed during an external inspection may have affected internal components. Disconnect all power sources, open the transfer switch enclosure, and inspect internal components. Look for:

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

Cleaning. Use a vacuum cleaner or a dry cloth or brush to remove contaminants from internal components. *Do not use compressed air to clean the switch because it can cause debris to lodge in the components and damage the switch.*

Lubrication. Maintain the transfer switch lubrication. If the transfer switch is subject to extremely dusty or abnormal operating conditions, relubricate all movements and linkages yearly. Relubricate the solenoid operator if the TS coil is replaced. Do not use oil; order the lubrication kit shown in the Parts Catalog.

Disconnect power and manually operate the transfer switch mechanism to verify that it operates smoothly without binding. If lubricating the outer mechanism of the transfer switch does not eliminate binding, replace the transfer switch assembly.

Periodically oil the enclosure door locks and screws.

Part Replacement and Tightening. Replace worn, missing, broken, deteriorated, or corroded internal components with manufacturer-recommended replacement parts. Contact a local authorized distributor/dealer for part information and part ordering. Tighten loose internal hardware.

Terminal Tightening. Loose connections on the power circuits can lead to overheating or explosion. Tighten all lugs to the torque values shown on the label on the switch. Tighten engine start, input/output, and auxiliary connections to the torque indicated on the decals affixed to the unit.

Signs of Overheating. Replace components damaged by overheating and locate the cause of the overheating. Overheating could be caused by loose power connections, overloading, or a short circuit in system. After tightening the power terminals, perform a millivolt drop test to locate areas with high contact resistance. See Section 1.3.3. Check the line circuit breakers in the system to be sure that they do not allow the load to exceed the switch rating. Use the controller troubleshooting and schematics to locate a control circuit short.

Wire Repair or Replacement. Replace wiring when there is any doubt about its condition or when there is extensive damage or deterioration. If the damaged or deteriorated wires are part of a wiring harness, replace the entire wiring harness.

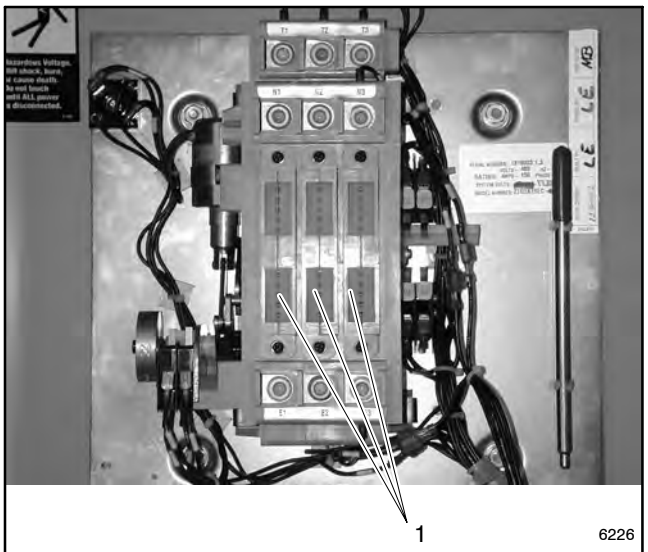
Power Circuit Wiring. Have damage to line voltage and power circuit wiring evaluated and repaired or replaced by a qualified electrician.

Control Circuit Leads. Repair minor damage to leads in low power and control circuits operating up to 250 volts. Carefully splice and insulate the connections. Tape minor control circuit wire insulation cuts or abrasions. Repair moderately damaged leads, where conductors are cut or insulation is damaged over sections shorter than about 100 mm (4 in.) or less than about 25% of the length of the wire, by cutting out the damaged section and splicing in wire of the same type. Use UL-listed insulated (250 V minimum) connectors and follow the connector manufacturer's instructions. Fabricate new leads using the same type of wire and UL-listed insulated (250 V minimum) connectors and follow the connector manufacturer's instructions.

Transfer Switch Inspection. Remove the arc chute assemblies or covers at the front of the transfer switch and inspect the main contacts inside the transfer switch. See Figure 1-1 or Figure 1-2.

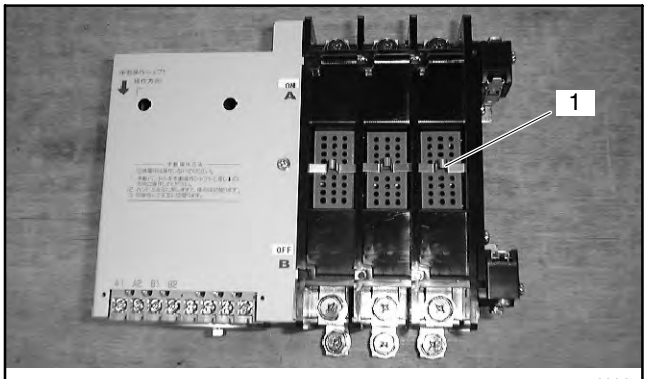
Note: A clamp or fixture must be attached before removing the arc chutes on 600-amp Model KSP programmed-transition switches. See Section 7.3.7 for complete instructions.

Remove surface deposits with a clean cloth. *Do not use an emery cloth or a file.* Discoloration of the contact surface does not affect performance. If the contacts are pitted, show signs of overheating, or are worn, replace the contacts. The contacts are worn if the contact surface material, a layer of silvery-colored metal, is worn through to the metal below. Check the condition of the arc chutes. If arc chutes show signs of disintegration, replace the arc chute assembly.



1. Arc chute assemblies

Figure 1-1 Typical Arc Chute Assemblies, Model KSS



1. Arc chute retainer clips

Figure 1-2 Typical Arc Chute Assemblies, Model KSP

1.3 Testing

Periodic testing is important in any transfer switch application. It helps to ensure that the generator set will start and the transfer switch mechanisms and control circuits will operate when needed.

1.3.1 Weekly Generator Set Exercise

Use the plant exerciser to start and run the generator set once a week to maximize the reliability of the emergency power system. See the transfer switch operation and installation manual for additional information about the exerciser.

1.3.2 Monthly Automatic Operation Test

Test the transfer switch's automatic control system monthly. See Section 4.5.4 or the transfer switch operation and installation manual for the test procedure. Verify that the expected sequence of operations occurs as the switch transfers the load to the emergency source when a normal source failure occurs or is simulated. After the switch transfers the load to the emergency source, end the test and verify that the expected sequence of operations occurs as the transfer switch retransfers to the available normal source and signals the generator set to shut down after a cooldown period.

Note: The ATS will not transfer the load during the test sequence if the test DIP switch is set to the unloaded position.

1.3.3 Other Tests

Every Year

Measure the voltage drop to help locate high-resistance contacts in the ATS. The test procedure measures the voltage drop across a contact and the current in the circuit, then uses those measured values to find the contact resistance.

The purpose of the test is to locate any contact that has significantly higher resistance than others. An unusually high voltage across one set of contacts may signal unacceptably high resistance in the contacts.

Run the test with the ATS under a moderate and balanced load. Use the following procedure to take voltage measurements and calculate resistances for each phase of both Source N and Source E.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Only authorized personnel should open the enclosure.

(600 volts and under)

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

Millivolt Drop Test Procedure

1. Apply a balanced load of at least 10% of the switch rating. (Currents of 10 amps or greater will give more accurate results than lower currents.)

2. Carefully measure the voltage on each phase of both sources from the source lug to the load lug. Take several readings to ensure accuracy. The readings may be erratic because of the small voltage measured, load fluctuations, and meter circuit contact resistances.

   Note: To obtain accurate readings, keep the meter as far as possible from current-carrying conductors and the meter leads as short, direct, and at right angles to current-carrying conductors as possible. This minimizes the effect of induced voltages (transformer effect) in the vicinity of the current-carrying conductors.

3. Use an ammeter to measure the current flow through the circuit.

4. Calculate the contact resistance using the following formula:

   R = V ÷ I

   Where:
   V = measured voltage in *millivolts*
   I = measured current in amps
   R = calculated resistance in milliohms

Compare the calculated values for resistance (R) to the values in the table in Figure 1-3. If the calculated resistance is significantly higher (2 times larger or more) than the value shown in the table, disconnect power, check the connections and lug torques, and repeat the test. If the second measurement also indicates that the resistance is too high, replace the contact. See the ATS parts catalog for replacement part ordering information. Refer to the table of contents in the front of this manual to locate the contact replacement procedure for your switch.

Transfer Switch Rating, Amps	Maximum Contact Resistance, Milliohms (mΩ)
30–200	0.250
225–400	0.200
600–800	0.175
1000–1200	0.085
1600–3000	0.050

Figure 1-3 Maximum Contact Resistance

Every Three Years

Test the wire insulation. Use the following procedure to check for insulation breakdown and replace any faulty components.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Only authorized personnel should open the enclosure.

(600 volts and under)

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

Wire Insulation Breakdown Test Procedure

1. Disconnect all power sources by opening upstream circuit breakers or switches to the transfer switch. Disconnect the load from the transfer switch by opening circuit breakers or switches leading from the transfer switch. Disconnect the transfer switch wiring harness from the controller at connector P1.

2. Use a hi-pot tester or meggar to check the insulation resistance phase-to-phase and phase-to-neutral, and phase-to-ground if neutral and ground are isolated. For a hi-pot tester, the maximum potential is 500 VAC and the maximum test time is 1 second.

3. Verify that the measured insulation resistance exceeds 1.24 megohms (MΩ).

4. If the hi-pot tester indicates wire insulation breakdown or if the measured resistance is less than 1.24 MΩ, isolate the leakage current using an instrument designed for this purpose. Replace the faulty components.

   Note: You may need to disconnect power conductors from the lugs to isolate the problem. If you disconnect the power conductors, see transfer switch operation and installation manual for reconnection instructions.

Every Five Years

Check the normal and emergency source setpoint calibration according to the procedures in Section 2.4, System Settings.

1.4 Service Schedule

Follow the service schedule in Figure 1-4 for the recommended service intervals. The transfer switch operator can perform tasks marked by an X. Have an authorized distributor/dealer inspect the switch annually and perform all service marked by a D.

System Component or Procedure	See Section	Visually Inspect	Check	Adjust, Repair, or Replace	Clean	Test	Interval
Electrical System							
Check for signs of overheating or loose connections: discoloration of metal, melted plastic, or a burning odor.	1.2.2	X	X				Y
Check the transfer switch's external operating mechanism for cleanliness. Clean and relubricate if dirty.*	1.2.2	X		D	D		Y
Check wiring insulation for deterioration, cuts, or abrasion. Repair or replace wiring to regain the properties of the original wiring.	1.2.2	X					Y
		D	D	D			Y
Check the transfer switch's main power switching mechanisms' mechanical operation and integrity.	1.2.2	D	D			D	Y
Tighten control and power wiring connections to specifications.	1.2.2		D	D			Y
Check the transfer switch's main power switching contacts' condition. Clean or replace the main contacts or replace the transfer switch assembly as necessary.	1.2.2	D		D	D		Y
Perform a millivolt drop test to check for high contact resistances on power circuits. Tighten connections, clean main contacts, or adjust or replace main contacts or transfer switch assembly to eliminate high contact resistances.	1.3.3		D	D	D	D	Y
Test wire and cable insulation for electrical breakdown.	1.3.3					D	Every 3 Years
Check calibration of voltage-sensing circuitry and setpoints, and recalibrate circuitry as necessary.	1.3.3		D			D	Every 5 Years
Control System							
Test the transfer switch's automatic control system.	O/I/M	X				X	M
Test all LED indicators, time delays, and remote control systems for operation.	O/I/M	D	D	D		D	Y
General Equipment Condition							
Inspect the outside of the transfer switch for any signs of excessive vibration, leakage, high temperature, contamination, or deterioration.*	1.2.1	X			X		M
Check that all external hardware is in place, tightened, and not badly worn.	1.2.1	X	X	X			M
Inspect the inside of the transfer switch for any signs of vibration, leakage, noise, high temperature, contamination, or deterioration. Check for metal discoloration, melted plastic, or a burning odor.*	1.2.2	X					M
		D	D		D		Y
Check that all internal hardware is in place, tightened, and not badly worn.	1.2.2	X					M
		D	D				Y

***** Service more frequently if the ATS operates in extremely dusty or dirty areas.

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

Visually Inspect: Examine these items visually.

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

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

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

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

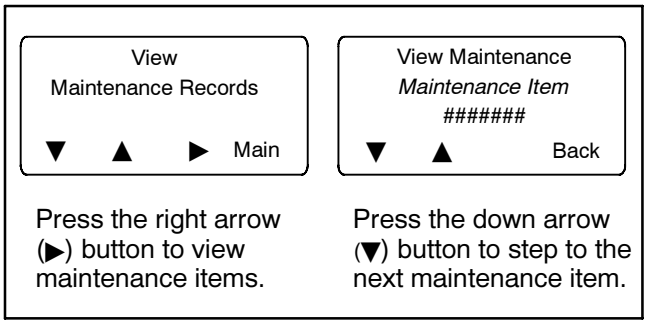
Symbols used in the chart:

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

Figure 1-4 Service Schedule

1.5 View Maintenance Records

Navigate to the View Maintenance Records screen to check the last transfer switch maintenance dates and operation information. See the transfer switch Opertion/Installation manual for instructions to navigate to the view screens.



Maintenance Items	
Reset Min Not Pref	Reset Fail Transfer
Total Min in Standby	Total Loss Pref Tran
Reset Min in Standby	Reset Loss Pref Tran
Total Min Operation	Transfer Time N>E
Reset Min Operation	Transfer Time E>N
Total Transfers	System Start Date
Reset Transfers	Last Maint Date
Total Fail Transfer	Last Loss Date/Time
Total Min not in Pref	Last Loss Duration

1.6 Reset Data

Be sure to read and understand the information in this section before resetting.

1.6.1 Reset Maintenance Records

Reset Maintenance Records updates the last maintenance date and totals since reset that are displayed in the View Maintenance Records screens. See Section 1.5. Reset the maintenance records after transfer switch service.

1.6.2 Reset Event History

Reset Event History clears the events from the event history log. The event history can be saved to a file before reset. See Section 1.6.5, File Maintenance.

Note: The event history contains information that may be helpful for troubleshooting. Review the event history and/or save it to a file before resetting it. See Section 2.3.

1.6.3 Reset Default Parameters

Check the system voltage and frequecy before selecting Reset Default Parameters. Resetting to the default parameters will reset **all** parameters, **including the system voltage and frequency**, to a factory default setting.

The default system voltage and frequency settings may not be appropriate for your application. The transfer switch will not operate correctly if the system voltage and frequency do not match the sources. Use the Set Sources screen to set the system voltage and frequency after resetting. See the Operation/Installation Manual for instructions.

1.6.4 Reset and Disable Test Password

Reset Test Password returns the test password to the default, 0000.

Disable Test Password allows any user to start a test without entering a password.

Note: Disable the test password only during service unless the transfer switch is installed in a secure location.

1.6.5 File Maintenance

Use the File Maintenance screens to remove unneeded files or save the event history. See Figure 1-5 and Figure 1-6.

Files can also be transfered to a mass storage device connected to the USB port on the logic board. Refer to the transfer switch Operation/Installation Manual for instructions to transfer files.

File name	Description
MPAC1500_#######.cfg	Parameter settings (configuration)
present*yymmdd*.his	Event history
alarm_settings.alm	Common alarms
MPAC1500_cal.cal	Calibration
history_param.hstp	Internal use only
Param_back.bak	Internal use only
present*yymmdd*.raw	Internal use only
history_pback.hbak	Internal use only

Figure 1-5 Files listed under File Maintenance>Delete Files

1.6.6 Reset Data Procedure

Use the Reset Data menus to set records or parameters back to factory default settings. See Figure 1-6.

1. Use the black arrow buttons to step to the desired screen. See the following sections for information about each reset screen.
2. Press the open up arrow button to toggle Yes or No until Yes is displayed.
3. Press Save to reset the displayed records to the factory defaults. Pressing Back exits the screen without resetting.

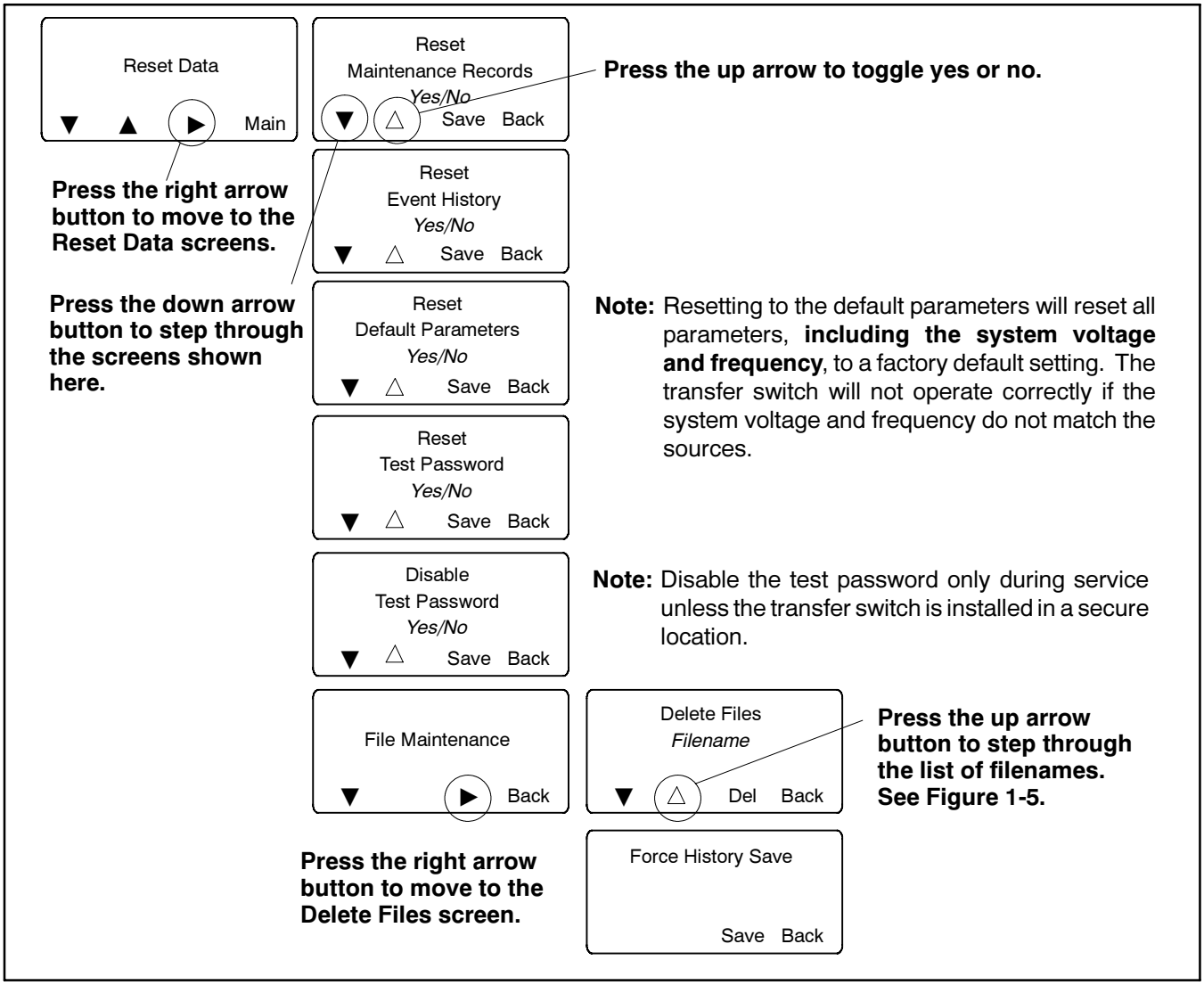


Figure 1-6 Reset Data

Notes

This section contains troubleshooting information for the transfer switch controls. When troubleshooting a power system problem, also refer to Section 3, Transfer Switch Troubleshooting, and to the troubleshooting information in the generator set service documentation.

2.1 Initial Checks

When troubleshooting a problem with the transfer switch operation , check the following things first.

- Check the Service Required LED and the transfer switch controller display for fault or warning indications. If a fault or warning is indicated, proceed to Section 2.8.
- Check the system settings and time delays. See Section 2.4, System Settings. Many transfer problems can be traced to inappropriate controller settings.
- Check the event history log. The log lists the 100 most recent transfer switch events, including transfers and DIP switch setting changes as well as faults and alarms. See Section 2.3 for instructions to view the event history log.
- If the transfer switch display is off, check for power to the transfer switch. If the utility source is not available, check for emergency power. Follow the voltage check procedure in Section 3.3.2, Voltage, Frequency, and Phase Rotation Checks, to check voltage at the Source N (normal) or Source E (emergency) lugs.
- If the utility source is available but the transfer switch display is off, check for open source circuit breakers or switches. Disconnect power and verify that the transfer switch wiring harness is connected to the controller. See Section 3.3.
- Disconnect all power to the transfer switch and check for loose connections. Check the source lugs, controller harnesses, and generator set engine start connection.

Read and follow all safety precautions in this manual and on labels on the switch. Only trained and qualified personnel should service the transfer switch and connected equipment.

Refer to the wiring diagrams provided with the switch or the Wiring Diagram Manual when troubleshooting the transfer switch and controller.

⚠ 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.

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

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

2.2 Controller Backup Battery

The transfer switch controller uses a backup battery for power when no source is available. A Low Backup Battery message on the screen indicates that this

battery needs to be replaced. See Section 4.3.2 for instructions.

See Section 3.3 for other transfer switch power information.

2.3 View Event History

When troubleshooting, check the event history for faults, transfer attempts, or other events leading to the current condition. The history lists the 100 most recent transfer switch events, including transfers and DIP switch setting changes as well as faults and alarms.

From the main screen, step to View Event History and display recent events as shown in Figure 2-1. Possible event descriptions are listed in Figure 2-2.

If a fault condition or alarm is displayed, proceed to Section 2.8.

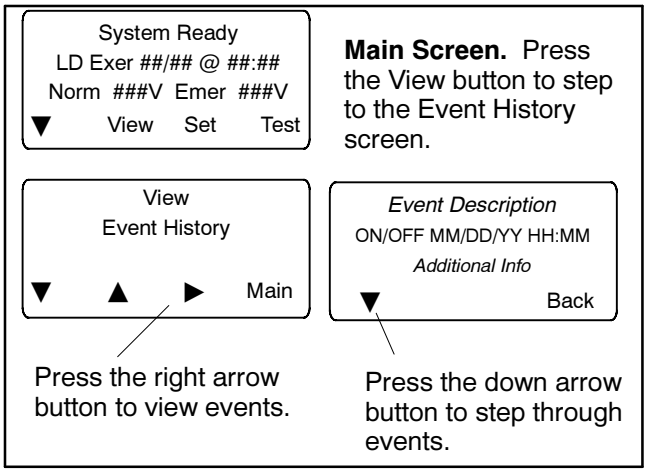


Figure 2-1 Viewing Event History

Event Description	The Controller Has Detected the Following Condition
End Time Delay Btn	End delay button pressed.
Test Btn	Test button pressed.
Exercise Btn	End exercise button pressed during exercise run.
Lamp Test	Lamp test button pressed.
Service Req'd Reset	Reset button pressed to clear a fault that triggered the system alert LED.
Maint DIP Switch	Maintenance DIP switches closed (transfer inhibited for service).
Pwd DIP Switch	Password disable DIP switch closed.
Manual Option Switch	Supervised transfer switch changed position.
New Module	New I/O, alarm, or battery supply module detected.
Contactor in Off	Transfer switch moved to the OFF position (programmed-transition models only).
Contactor in Src N	Transfer switch moved to the Source N position.
Contactor in Src E	Transfer switch moved to the Source E position.
Low Battery	Output to indicate low voltage on the external battery (connected to the EBSM).
Exerciser Active	Scheduled exercise sequence running.
Fail to Acquire Pref	Preferred source not within acceptable voltage or frequency range.
Fail to Acquire Stby	Standby source not within acceptable voltage or frequency range.
Fail to Transfer	Transfer switch failed to transfer when signaled, according to position switches.
I/O Module Lost Comm	Communication with an installed I/O module has been lost.
Aux Switch Fault	The main shaft auxiliary switches indicate that the ATS is in more than one position, or the position changed when no signal was sent to initiate the change.
Aux Switch Open	The main shaft auxiliary switches indicate that the ATS is in neither position (all inputs are open).
Battery Backup Low	Transfer switch controller battery voltage is low. Battery needs to be replaced.
Rem End Time Delay	Remote input assigned to remote end time delay is active (contact closed). The time delay running at the time of the signal ends.
Forced Trans to Off	Remote input assigned to forced transfer to OFF for load shed function (programmed-transition models only) is active (contact closed).
Peak Shave Mode	Peak shave mode is active (initiated by the forced transfer to OFF input).

Event Description	The Controller Has Detected the Following Condition
Inhibit Transfer	Remote input assigned to inhibit transfer function is active (contact closed). Prevents transfer for maintenance or service.
Remote Test	External signal (contact closure) connected to a programmable input assigned to remote test. Signals the transfer switch to start a test sequence.
Low Battery Voltage	External battery (connected to the EBSM) voltage is low.
Remote Common Alarm	One or more conditions assigned to the common alram is active.
Bypass Contactor Dis	Bypass/Isolation switches only.
3 Src System Disable	A 3-Source System Disable input signal is active.
Over Frequency	Source frequency is above the over frequency dropout setting.
Under Frequency	Source frequency is below the under frequency dropout setting.
Phase Loss	One or more phases not detected.
Phase Rotation Error	Source ABC or BAC rotation does not match system setting.
Over Voltage L1-L2	Source voltage across L1 and L2 is above the over voltage dropout setting.
Over Voltage L2-L3	Source voltage across L2 and L3 is above the over voltage dropout setting.
Over Voltage L3-L1	Source voltage across L3 and L1 is above the over voltage dropout setting.
Under Voltage L1-L2	Source voltage across L1 and L2 is below the undervoltage dropout setting.
Under Voltage L2-L3	Source voltage across L2 and L3 is below the undervoltage dropout setting.
Under Voltage L3-L1	Source voltage across L3 and L1 is below the undervoltage dropout setting.
Voltage Imbalance	Source voltage imbalance detected.
Save History To File	Event history saved to a file.
Auto Loaded Test End	The auto load test sequence timer has expired, ending the test sequence.
Test Loaded Changed	The remote test loaded/unloaded setting was changed.
Pref Source Changed	The preferred source selection has been changed (optional accessory).
Reload Dflt Params	The system has been reset to the factory default settings (see Reset Data screen)
MODBUS Peak Shave	A peak shave command has been received through Monitor III or other Modbus application.
MODBUS Forced to OFF	A Transfer to OFF command has been received through Monitor III or other Modbus application.
MODBUS System Test	A Test command has been received through Monitor III or other Modbus application.
Battery Control Out	Battery control command turns off the battery 20 seconds after power is lost to preserve the controller's battery.
USB Connected	A device has been connected to the controller's USB port.
USB Disconnected	A device has been disconnected from the controller's USB port.

Figure 2-2 Event History Messages

2.4 System Settings

If the ATS does not recognize the source, check that the source voltage and frequency settings on the controller match the actual source parameters.

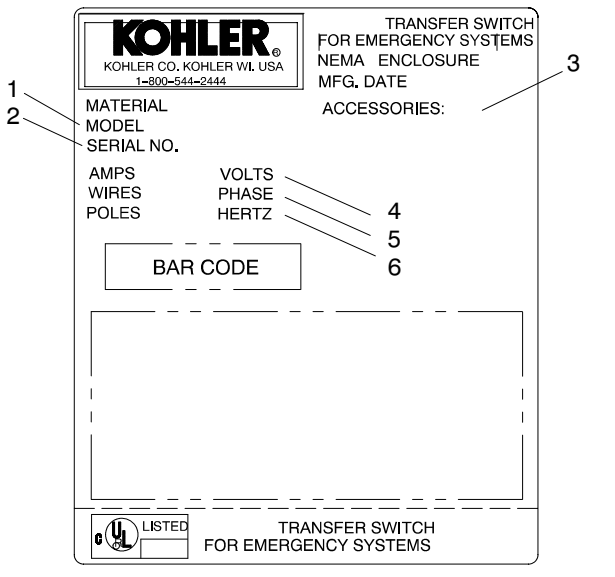
Compare the controller settings to the ratings on the ATS nameplate and to the measured source parameters using the following instructions.

2.4.1 Controller Source Settings

Check the controller's source voltage, frequency, and phase settings. See the transfer switch Operation and Installation Manual for instructions.

Check the controller settings and compare them to the voltage rating, frequency rating, and number of phases shown on the ATS nameplate. The nameplate is attached to the cover of the controller assembly, which is mounted on the inside of the transfer switch door. See Figure 2-3 for an illustration of the nameplate.

Note: The system voltage and frequency shown on the ATS nameplate must match the Source N and Source E voltage and frequency settings. Do not enter settings that do not match the nameplate ratings of the ATS.



1. Model designation
2. Serial number
3. Factory-installed accessory numbers
4. Voltage rating
5. Frequency rating
6. Number of phases (single or three)

Figure 2-3 Typical Transfer Switch Nameplate

Use the procedure in Section 3.3.2 to measure the source voltage, frequency, and phase rotation, and compare the measured values to the controller settings. Follow the instructions in the transfer switch Operation and Installation manual to change the controller settings if they do not match the measured source parameters.

2.4.2 Voltage and Frequency Pickup and Dropout Settings

Figure 2-4 illustrates the relative values of the voltage pickup and dropout settings. Typical frequency pickup and dropout settings relate to the nominal source frequency in a similar way.

If the source voltage rises above the overvoltage dropout setting or falls below the undervoltage dropout setting for a time longer than the debounce time, the controller will consider the source as failed. The source voltage must return to a level within the range of the pickup values for the controller to recognize the source as restored.

Choose pickup and dropout settings that allow a tolerable variation in the source parameters to prevent nuisance transfers caused by small changes in the source voltage and frequency.

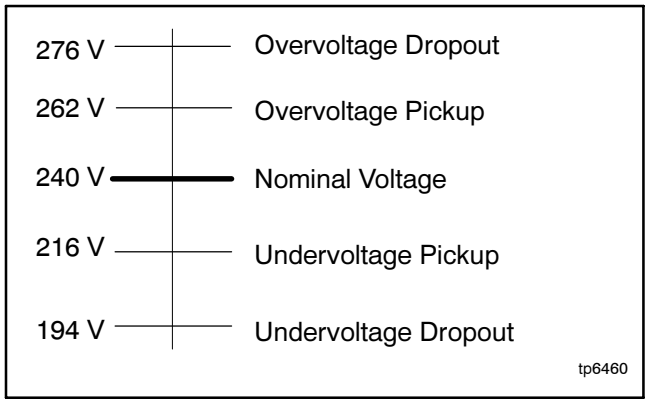


Figure 2-4 Relationship Between Voltage Pickup and Dropout Settings (default settings for 240 V system shown)

Voltage and Frequency Sensing		
Parameter	**Default**	**Adjustment Range**
Undervoltage dropout	90% of pickup	75%–98%
Undervoltage pickup	90% of nominal	85%–100%
Overvoltage dropout *	115% of nominal*	106%–135%
Overvoltage pickup	95% of dropout	95%–100%
Unbalance enable	Disable	Enable/Disable
Unbalance dropout	20%	5%–20%
Unbalance pickup	10%	3%–18%
Voltage dropout time	0.5 sec.	0.1–9.9 sec.
* 690 volts, maximum. Default = 110% for 600 volt applications.		

Figure 2-5 Voltage Settings

Parameter	**Default**	**Adjustment Range**
Underfrequency dropout	99% of pickup	95%–99%
Underfrequency pickup	90% of nominal	80%–95%
Overfrequency dropout	101% of pickup	101%–115%
Overfrequency pickup	110% of nominal	105%–120%
Frequency dropout time	3 sec.	0.1–15 sec.

Figure 2-6 Frequency Settings

2.5 Time Delays

Check the time delays when troubleshooting problems with transfer switch operation.

Use the View Time Delays screen to check the settings for the adjustable time delays. Figure 2-7 shows the factory settings and adjustment ranges for the adjustable time delays.

Observe the controller's display to identify which time delay is executing at any given time. Initiate a test and observe as each programmed time delay executes. Compare the operation to the test sequence illustrated in the flowcharts in Figure 4-8 or Figure 4-9.

Adjustable Time Delays		
Time Delay	**Default**	**Adjustment Range**
Emergency source engine start	3 sec.	0–6 sec.†
Normal source engine start (gen/gen mode)	0 sec.	0–60 min. †
Emergency source engine cooldown	5 sec.	
Normal source engine cooldown (gen/gen mode)	2 sec.	
Failure to acquire standby source	1 min.	
Preferred to standby	1 sec.	
Standby to preferred	15 min.	
Pretransfer to preferred signal	0 sec.	
Post-transfer to preferred signal	0 sec.	
Pretransfer to standby signal	0 sec.	
Post-transfer to standby signal	0 sec.	
Failure to synchronize	1 min.	
Off (preferred to standby, programmed-transition only)	1 sec.	
Off (standby to preferred, programmed-transition only)	1 sec.	
Auto load test duration	30 min.	1–60 min. ‡
† Adjustable in 1 second increments. Engine start can be extended to 60 minutes with an External Battery Supply Module Kit.		
‡ 1 minute increments.		

Figure 2-7 Factory Settings, Time Delays

2.6 Common Alarms

Any of the functions listed in Figure 2-8 can be assigned to Common Alarms 1 and 2. Common alarms 1 and 2 can then be assigned to output functions which activate when any of the conditions assigned to the common alarm are present. Common Alarms 1 and 2 can also be set to sound the alarm horn on the optional Alarm Module.

If the common alarm is activated, the specific condition that triggered the alarm will be shown on the ATS controller display screen. Check the display to identify the problem and then refer to the troubleshooting tables in Sections 2.8 and 3.2.

Use the View Common Alarms screen to identify which functions have been assigned to each common alarm. See the Operation and Installation Manual for instructions to check the view screens and to change the settings, if necessary.

Selected functions as noted in Figure 2-8 are grouped into the Critical Service Required and Non-Critical Service Required functions. The Critical Service Required and Non-Critical Service Required functions can be assigned to activate the alarm horn on the optional Alarm Module. If any of the conditions included in the Critical Service Required or Non-Critical Service Required function occurs, the alarm horn will sound. The message on the ATS display will identify which condition (for example, Fail to Acquire Standby) triggered the alarm and caused the horn to sound.

Functions that can be Assigned to Common Alarms	
Aux Switch Fault *	Src E Over Freq
Aux Switch Open *	Src E Over Voltage
Battery Backup Low *	Src E Rotation Err *
Contactor in Off	Src E Under Freq
Contactor in Pref	Src E Under Voltage
Contactor in Src E	Src E Voltage Unbal
Contactor in Src N	Src N Loss of Phase
Contactor in Stby	Src N Over Freq
Exerciser Active	Src N Over Voltage
Fail to Acquire Pref *	Src N Rotation Err *
Fail to Acquire Stby *	Src N Under Freq
Fail to Transfer *	Src N Under Voltage
IPM Synching	Src N Voltage Unbal
Load Bank Control	Stby Src Available
Load Control Active	System Ready
Low Battery *†	Test Mode Active
Non-Emergency Trans	Critical Service Required
Not in Auto	Man Transfer Waiting
Peak Shave Active †	Module Lost Comm *
Pref Src Available	Non-Critical Service Req
Remote Common Alarm *	Source E Available
Remote Monitor In #1–4	Source N Available
Src E Loss of Phase	Modbus-Controlled RDO #1–4
* Assigned to Critical Service Required	
† Assigned to Non-Critical Service Required	

Figure 2-8 Common Alarm Functions

2.7 Warnings and Faults

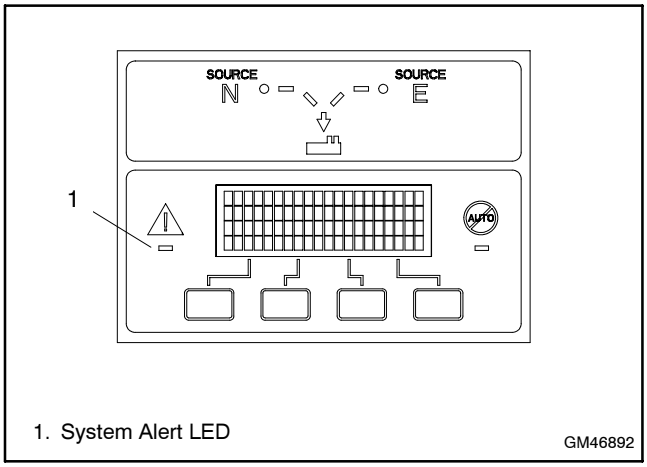
When a fault exists, the System Alert indicator lights, a designated output and the common fault output are turned on, and an appropriate message is displayed to indicate the fault. See Figure 2-9 for the location of the System Alert indicator.

ATS warnings and faults are shown in Figure 2-10. There are three types of warning/fault conditions:

Warning. Warnings automatically reset with a source availability change or a transfer request.

Fault Requiring Manual Reset. Under these conditions, normal ATS operation is halted. Active modes are turned off. If the contactor is in the preferred source position, the engine cooldown time delay executes and the engine start contacts open, allowing the generator set to shut down. See Section 2.7.1 for instructions to reset faults.

Self Resetting Faults. Under these conditions, active modes are turned off. If the contactor is in the preferred source position, the engine cooldown time delay executes and the engine start contacts open, allowing the generator set to shut down. When the fault condition is corrected, the fault is automatically cleared from the controller and normal ATS operation continues.



1. System Alert LED

GM46892

Figure 2-9 Fault Indication

Condition	Type	Description
Failure to Acquire Standby Source	Warning	The source voltage did not reach the acceptable range within a set time (see Time Delays). For example, the standby source generator set did not start.
Failure to Acquire Preferred Source	Warning	
IPM Synching (In-Phase Monitor Synching)	Warning (status)	The two sources did not come into phase within the Fail to Synchronize time delay. **NOTE:** If the sources do become in phase, the warning is automatically cleared and normal ATS operation continues.
Battery Backup Low	Warning	The ATS backup battery voltage is low. Replace the battery on the main logic board. See Section 4.3.2.
External Battery Low	Warning	The voltage of the battery connected to the external battery supply module (EBSM) is low.
Failure to Transfer	Warning	The signal to transfer is sent to the contactor and the main shaft auxiliary switch fails to indicate a complete ATS position change. The controller will attempt to transfer the unit three times before the fault is indicated.
Auxiliary Switch Fault	Manual Reset Fault	The main shaft auxiliary switches indicate that the ATS is in more than one position, or the position changed when no signal was sent to initiate the change.
Auxiliary Switch Open	Manual Reset Fault	The main shaft auxiliary switches indicate that the ATS is in neither position (all inputs are open).
Src N (or Src E) Rotation Err	Self-Resetting Fault	The detected phase rotation of one or both sources does not match the pre-selected setting.
I/O Module Lost Comm	Self-Resetting Fault	An I/O device has stopped communicating or does not have a correct address specified. Fault resets if communication is reestablished.
Module Status Change	Self-Resetting Fault	An accessory module has been disconnected OR a new module is detected. See Section 2.7.2 to reset.
Module Status Conflict	Self-Resetting Fault	An accessory module has been replaced with a different type of module. See Section 2.7.3 to correct.
External Fault (Remote Common Alarm)	Self-Resetting Fault	The input contact assigned to the remote common alarm input function is closed.

Figure 2-10 Warnings and Faults

2.7.1 Fault Reset

To clear a fault or warning condition and reset the System Alert LED, go to the Main screen and press the down arrow button to open the Reset screen. See Figure 2-9 and Figure 2-11. Then press the button labelled Reset. A fault reset does not change the controller settings.

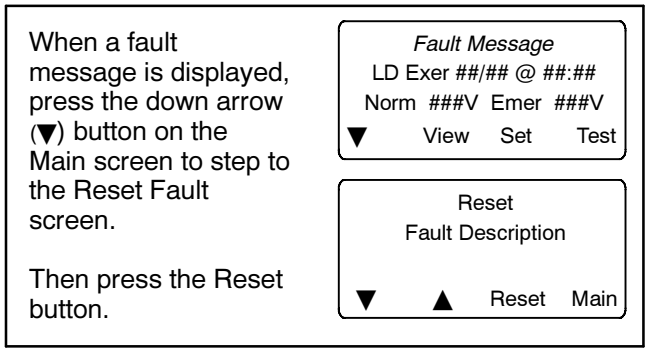


Figure 2-11 Fault Reset

2.7.2 Module Status Change

If the Module Status Change message appears on the controller display, first verify that the cable from the controller to the accessory module assembly is not loose or disconnected.

The Module Status Change message automatically clears if the fault condition is corrected (self-resetting fault).

Module Connection (new or reconnected module)

Installing or reconnecting one or more accessory modules triggers the "Module Status Change" message.

1. If the ATS display shows the "Module Status Change," press the Reset button. See Figure 2-12.
2. The ATS display will show "Reset New Module." Press the Reset button from that screen. The controller recognizes the module type(s).
3. Navigate to the Set Input/Outputs>Set Aux I/O screen to check that the controller has recognized the connected modules. See Figure 2-14.

See the transfer switch Operation/Installation Manual for instructions to assign programmable inputs and outputs to I/O modules or assign functions to the audible alarm for an Alarm Module.

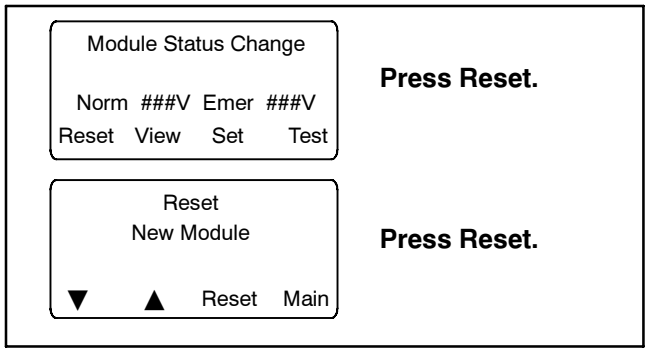


Figure 2-12 Screens after Module Connection

Disconnected Module

If one or more accessory modules are disconnected from the controller, the message "Module Status Change" appears. See Figure 2-13. Pressing the Reset button displays the message "Check Module Setup to Clear Fault."

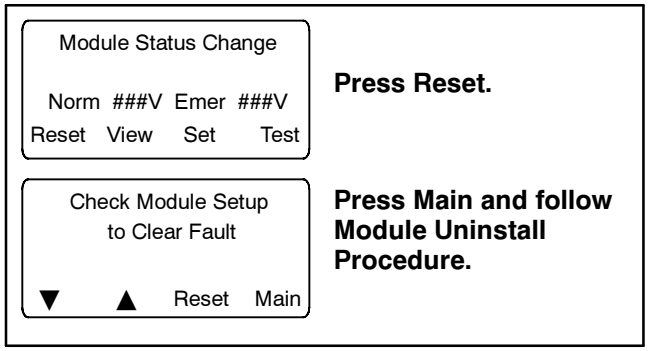


Figure 2-13 Screens after Module Disconnection

When modules are physically disconnected from the transfer switch, they must be uninstalled through the controller keypad. Use the following procedure to uninstall modules after disconnection.

Module Uninstall Procedure

1. If the ATS display shows "Module Status Change," press the button labelled Reset.
2. If the ATS display shows "Check Module Setup to Clear Fault,", press Main to return to the main screen.
3. Press Set to enter setup mode.
4. Enter the setup password.
5. Press the down arrow to step to the Set Inputs/Outputs screen. See Figure 2-14.

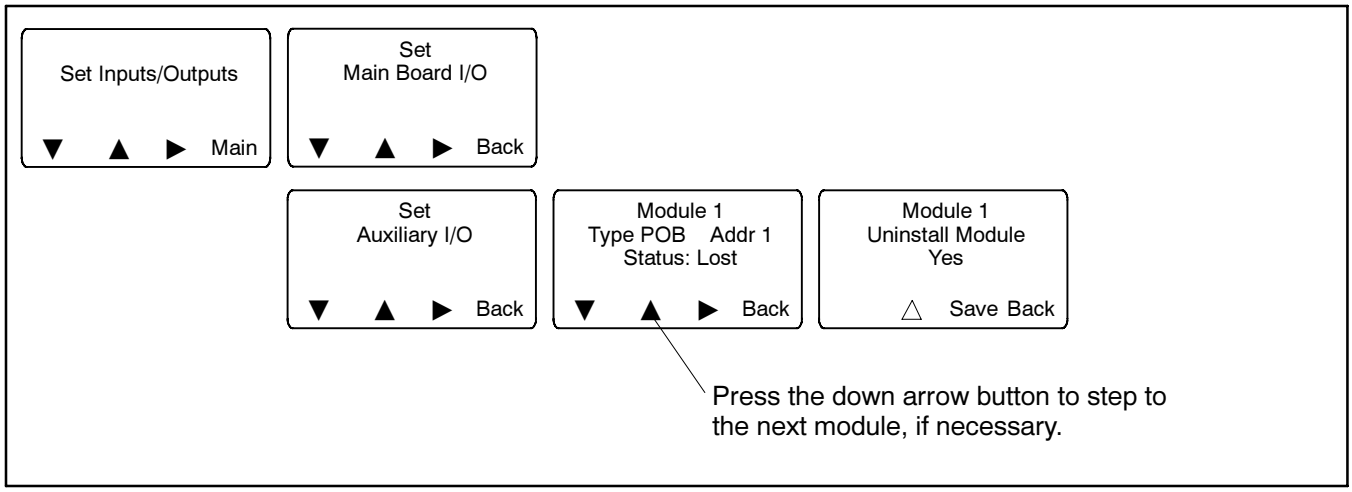


Figure 2-14 Uninstall Module

6. Navigate to the Set Auxiliary I/O screen. See Figure 2-14. Press the right arrow button to see the status of module 1. Press the down arrow to step to the next module, if necessary, until the screen shows Status: Lost.

7. Press the right arrow button to move to the Uninstall Module screen. Verify that the screen says Uninstall Module Yes. (Press the open arrow button to toggle no/yes, if neccessary.)

8. When Yes is displayed, press Save to uninstall the module.

9. Repeat the uninstall procedure for additional modules, if necessary.

Other Module Status Change Conditions

A "Module Status Change" message that cannot be cleared as described above may indicate a failure of the controller's real-time clock. Carefully follow the procedures above to attempt to reset the fault. If the fault cannot be reset, replace the controller's logic board. See Section 4.14.

2.7.3 Module Status Conflict

The message "Module Status Conflict" appears if one type of module is replaced with another type of module that has the same address. Follow the procedure below to resolve the conflict.

Procedure to Clear a Module Status Conflict

1. Disconnect power to the transfer switch.

2. Disconnect the module.

3. Close the enclosure door and reconnect power to the ATS. The display will show "Module Status Change."

4. Press the button labelled Reset. The display will show Check Module Setup to Clear Fault.

5. Follow the procedure in Section 2.7.2 to uninstall the module through the ATS controller keypad.

6. Disconnect power to the ATS.

7. Connect the new module.

8. Close the enclosure door and reonnect power to the ATS. The display will show "Module Status Change." See Figure 2-12.

9. Press the button labeled Reset to display "Reset New Module." Press the reset button from that screen. The controller will now recognize the new module type.

10. Navigate to the Set Auxiliary I/O screen to check the status and settings for the new module. See Figure 2-14. Press the right arrow button to see the status of module 1. Press the down arrow to step to the next module, if necessary,

See the transfer switch Operation/Installation Manual for instructions to assign programmable inputs and outputs to I/O modules or assign functions to the audible alarm for an Alarm Module.

2.8 Events and Faults

The following tables list the faults and alarms that may be shown on the controller's display screen or listed in the event history log. The tables also list the possible causes for each problem and suggested procedures to identify and correct the source of the problem.

The event history log also lists transfers and other normal events not shown in these tables. The event history log can be saved to an electronic file. Refer to the transfer switch Operation/Installation Manual for instructions to save the event log to a file.

Fault or Event Message	Possible Cause	Check	See Section
Overfrequency, Underfrequency	Frequency settings	Check that the system frequency setting matches the actual source frequency (50 or 60 Hz).	2.4
		Check the over/underfrequency pickup and dropout settings. See Section 2.4.2 and the Setup Program Operation Manual.	2.4
		Check that the frequency debounce setting is long enough to prevent nuisance faults caused by brief frequency variations.	2.4
	Source availability, stability	Check that the source frequency matches the nominal system frequency and stays within the range of the pickup and dropout settings.	3.3.2 2.4
	Source connections	Check for loose connections. Check wiring.	W/D
Overvoltage, Undervoltage	Voltage settings	Check that the system voltage setting matches the actual source voltage.	3.3.2 2.4
		Check the over/undervoltage pickup and dropout settings.	2.4 2.4.2
		Check that the voltage debounce setting is long enough to prevent nuisance faults caused by brief voltage dips or spikes.	2.4
	Source availability, stability	Check that the source voltage matches the nominal system voltage and stays within the range of the pickup and dropout settings.	3.3.2 2.4
	Source connections	Check for loose connections. Check wiring.	W/D
	Calibration error	Check the ATS calibration.	4.9
Loss of Phase	Single/three phase setting does not match source	Check that the controller single/three phase setting matches the source.	2.4
	One phase of the source has been lost	Check that all phases of the source are available.	3.3.2
	Source connections	Check for loose connections.	
Source Rotation Error	Phase rotation setting (ABC or BAC) does not match source	Check that the controller phase rotation setting matches the source phase rotation (ABC or BAC). Check the source connections to the transfer switch and verify that A,B, and C are connected to the appropriate lugs. Change the controller phase rotation setting or rewire the source connections if necessary.	2.4
Failure to Transfer	Transfer switch mechanism problem	See Section 3.2, Troubleshooting.	3.2

Fault or Event Message	Possible Cause	Check	See Section
Auxiliary Switch Fault or Auxiliary Switch Open	Controller cannot determine the transfer switch position	Check wiring and connections to position microswitches. See the schematic drawing for connections.	W/D
		Test position microswitch operation. Replace microswitch if necessary.	
		Transfer switch in intermediate position. Manually operate the transfer switch, following safety precautions and instructions for your model. See the Table of Contents for manual operation procedures for your unit.	TOC
		Check the control contact operation. Inspect for signs of coil damage or overheating and replace coil if necessary. See the Table of Contents for coil control contact test procedures for your unit.	TOC
Failure to Acquire Standby	Generator set did not start	See “Failure to Start Generator Set,” below.	
	Open circuit breaker	Check and close ATS source and generator set circuit breakers.	—
	ATS does not recognize the standby source	Check source voltage, frequency, phase rotation settings and compare to actual values.	3.3.2 2.4
		Check for loose source connections. Check the labels on the switch for tightening torques.	1.2.2
		Check for open switch or circuit breaker to the source.	—
		Check ATS calibration.	4.9
Failure to Acquire Preferred	Open circuit breaker	Check and close ATS source and generator set circuit breakers.	
	ATS does not recognize the source	Check source voltage, frequency, phase rotation settings and compare to actual values.	3.3.2 2.4
		Check for loose source connections. Check the labels on the switch for tightening torques.	1.2.2
		Check for open switch or circuit breaker.	—
		Check ATS calibration.	4.9
External Battery Low	Low generator set engine starting battery voltage	Check battery connections and voltage. Charge or replace battery if voltage is low.	Generator set manuals
Battery Backup Low	Controller backup battery voltage is low	Replace the controller battery.	4.3.2
Inphase Monitor (IPM) Synching	The two sources did not come into synch within the Fail to Syncronize time delay. The ATS will continue to monitor for synchronization	Adjust inphase monitor angle.	ATS O/I/M
		It may be necessary to adjust the generator set frequency in order to achieve source synchronization.	Generator set manuals

Fault or Event Message	Possible Cause	Check	See Section
Module Status Change	A new accessory module is detected	Press the reset button to open Reset New Module screen. Then press Reset again.	2.7.2
	A module has been disconnected	Check connections from the controller to the I/O module assembly and at the top of each I/O module. Verify that the module is securely installed. If a module has been removed, go to Set Inputs/Outputs screen and uninstall the module.	2.7.2
	Communication to an installed I/O module has been lost	Check I/O module connections.	2.7.2
	Real-time clock failure on logic board	If the procedures in Section 2.7.2 fail to clear the error message, replace the controller's logic board.	2.7.2 4.14
Module Status Conflict	One type of module was replaced with another type of module that has the same address	Follow the procedure in Section 2.7.3 to uninstall the old module and then install the new module.	2.7.3
External Fault	Fault condition in customer-supplied equipment connected to external input	Identify and correct the cause of the fault condition.	Manuals for connected equipment
	Looose or faulty connection	Check connection to external input.	ATS OIM

2.9 Controller Troubleshooting Table

Also see the transfer switch troubleshooting tables in Section 3.

Problem	Possible Cause	Check	See Section
No LEDs illuminated and/or display is blank	No power to the transfer switch	Check that source switches or circuit breakers are closed.	—
		Verify that at least one source is available. Check for utility or gen set voltage to the ATS.	3.3.2
		Check source connections.	
	No power to the controller	Check that the transfer switch harness is connected to the controller.	3.3.1 Figure 4-5
		Check the harness for loose connections or broken leads (continuity check).	W/D
	One or more faulty LEDs	Press the Lamp Test button to check the operation of all LEDs.	4.1.3
		Replace the controller if one or more LEDs do not light during the lamp test.	4.14
		If no LEDs light during the lamp test, troubleshoot power and connections to the controller.	4.3
Source available LED off when Source is available	Malfunctioning LED	Press the Lamp Test button to check the operation of all LEDs. Replace the controller if one or more LEDs do not light. If no LEDs light, troubleshoot power and connections to the controller.	4.1.3
	Source settings do not match actual source parameters	Check settings.	2.4
	Incorrect ATS meter calibration	Check calibration.	4.9
Position LED not lit	Position microswitch malfunction	Check the operation of the position microswitches.	4.10
	Transfer switch in intermediate position	Manually operate the transfer switch and check the position LED operation.	TOC
		Check the control contact operation.	TOC
		Check for evidence of solenoid coil damage. Test solenoid coil resistance and operation.	3.6
		Replace the coil if necessary.	TOC
	LEDs not functioning	See “No LEDs illuminated” in this table.	—
Inphase monitor does not operate	Inphase monitor function not enabled	Check that the inphase monitor option on the ATS controller is selected.	ATS O/I/M
	Transfer angle setting	Check the transfer angle setting.	ATS O/I/M
	Inphase monitor option not available (programmed-transition models)	Not available on programmed-transition models. Center-OFF position makes the inphase monitor option unnecessary.	—

O/I/M= Operation and Installation Manual; O/M = Operation Manual; TOC = Table of Contents, this manual; W/D = Wiring Diagrams

Notes

3.1 Initial Checks

When troubleshooting the transfer switch mechanism, always check for simple causes first: broken or loose wires, corroded contacts, exposure to dirt or foreign material, etc.

Check the time delays, source settings, and other system parameters as described in Sections 2 and 4 before concluding that there is a mechanical problem with the transfer switch. Many transfer problems can be traced to inappropriate controller settings.

Verify that the voltage on the nameplate matches the actual nominal source voltage. Use the procedure in Section 3.3.2 to measure the source voltage. Observe safety precautions when taking voltage measurements. Verify that the measured voltage matches the transfer switch rated voltage.

3.2 Transfer Switch Troubleshooting Table

The following table lists potential problems with possible causes and suggested remedies. Section numbers in the last column refer to other sections of this manual. TOC refers to the Table of Contents in this manual; see the table of contents for service procedures for your transfer switch.

Also see the controller troubleshooting table in Section 2.9.

Always follow the safety precautions at the beginning of this manual when troubleshooting and servicing the transfer switch.

Problem	Possible Cause	Check	See Section
Generator set engine does not start	Engine start time delay is running	Check for active time delays on the controller display. Press End Delay button to end the delay, if necessary.	2.5
		Use View Time Delay screen to check time delay settings.	ATS O/I/M
	Loose engine start connection	Check connections. Tighten connections and/or replace wiring if necessary.	ATS O/I/M
	No engine start signal from the ATS	Test the engine start contact operation.	4.7
	Generator set master switch not in the AUTO position	Move generator set master switch to the AUTO position.	Generator manuals
	Generator set problem	Troubleshoot the generator set.	
O/I/M= Operation and Installation Manual; O/M = Operation Manual; TOC = Table of Contents, this manual; W/D = Wiring Diagrams			

Problem	Possible Cause	Check	See Section
Generator set engine runs when it should not	ATS does not recognize the Normal source	Check connections. Check voltage and frequency settings, phase rotation, calibration. Check for open switches or circuit breakers.	— 2.4
	ATS not in the expected position	Check the ATS position LEDs. Check the position of the preferred source selector switch, if equipped.	4.1
	Exerciser is running	Check the controller display for Exerciser Active message. Press the END button to end an exercise run, if necessary.	ATS O/I/M
	Test sequence is running	Check the controller display for indication that a test sequence is active. Press the END TEST button to end a test sequence, if necessary.	ATS O/I/M
	Engine cooldown time delay operating	Check for Engine Cooldown message on the controller display. Press End Delay button to end the cooldown delay, if necessary. Check the ATS controller engine cooldown time delay setting.	2.5 ATS O/I/M
		Check generator set controller engine cooldown setting, if applicable.	Generator O/M
	Engine start connection closed	Check wiring and connections.	ATS O/I/M W/D
		Check that the 40-pin ribbon cable connector between the logic and power boards on the ATS controller is connected.	4.2 Figure 4-5
		Test the engine start contact operation.	4.7
	Generator set master switch not in AUTO	Move the generator set master switch to the AUTO position. Wait for the generator set engine cooldown delay, if necessary.	Generator set manuals
	Other generator set problem	Disconnect the engine start leads from the ATS. If the engine continues to run, troubleshoot the generator set.	
Exerciser does not start generator set	Exerciser not set	Use View Exercise Setup screen to check exerciser settings.	ATS O/I/M
	Check that exercise run duration is not set to zero	Use View Exercise Setup screen to check exerciser settings.	ATS O/I/M
	Loose or open engine start connection	Check wiring and connections.	ATS O/I/M
	Engine start problem	Test engine start operation. Also see “Generator set engine does not start,” in this table.	4.7

O/I/M= Operation and Installation Manual; O/M = Operation Manual; TOC = Table of Contents, this manual; W/D = Wiring Diagrams

Problem	Possible Cause	Check	See Section
Exerciser does not run regularly or at all	Exerciser not set	Use View Exercise Setup screen to check exerciser settings.	ATS O/I/M
	Maintenance DIP switch SW1B closed	Check for Maintenance Mode message on controller display.	—
		Check the DIP switch setting.	4.8
	Exercise interval different than expected	Use View Exercise Setup screen to check exerciser settings.	ATS O/I/M
Failure to transfer	Alternate source is not available	Check source connections.	1.2.2
		Check source voltage and frequency.	3.3.2
		Check source settings.	2.4
	Unloaded exercise selected	Use View Exercise Setup screen to check exerciser settings.	ATS O/I/M
	Unloaded test sequence selected	Press the End Test button, wait for the test sequence to stop, and then select a Loaded or Auto Loaded test sequence.	ATS O/I/M
	Pre-transfer time delays operating	Check controller display for time delay indication. See Section 4.4 for information on time delays during normal operation.	4.4
		Check the time delay settings.	2.5
	Maintenance DIP switch enabled	Check DIP switch setting.	4.8
	Connected source available	Check the Source Available LEDs.	4.1
	Preferred source selection set to emergency and emergency source is available	Check the preferred source selection and the Source Available LEDs.	—
	Supervised transfer control switch (optional) in manual position	Check the position of the supervised transfer control switch, if equipped. Move the switch to the TRANSFER or AUTO position, as appropriate for the application.	ATS O/I/M
Failure to transfer: Transfer switch mechanical binding	Jammed or damaged solenoid	Inspect and test solenoid coil.	3.6
	Faulty or worn core spring	Inspect and replace damaged parts.	TOC
	Bent main contact shaft	Inspect and replace damaged parts.	TOC
	Jammed main contacts	Check for foreign object.	
	Contact lever or pushbutton jammed against solenoid counterweight	Test control contacts. See the Table of Contents for test procedures for your model transfer switch.	TOC
	Loose hardware.	Check for and tighten loose hardware.	1.2.2
	Accumulation of dirt or other foreign material	Clean. Lubricate if necessary.	1.2.2

O/I/M= Operation and Installation Manual; O/M = Operation Manual; TOC = Table of Contents, this manual; W/D = Wiring Diagrams

Problem	Possible Cause	Check	See Section
Failure to transfer: Transfer switch electrical malfunction	Damaged or wrong coil	Check for signs of overheating. Measure the coil resistance to check for damaged coil. Replace the coil if it is damaged. Verify that the coil voltage rating matches the transfer switch voltage rating and source voltage. Replace with coil that has the correct rating.	3.6
	Damaged or wrong resistor (Not used on all models. See the coil replacement procedures for your model to identify resistor.)	Inspect/test resistor (not used on all models). Replace resistor if damaged.	TOC
	Corroded or fused contacts	Inspect contacts. Clean or replace. Do not use an emery cloth or file. See the Table of Contents for contact replacement procedures for your model.	1.2.2 TOC
	Coil control contact operation	Test coil control contact operation. See the Table of Contents for control contact test procedures for your model transfer switch.	TOC
	Faulty connections	Check leads and harnesses for loose connections, broken leads, or incorrect connections.	W/D
	Wrong voltage	Check system voltage, controller system voltage and over/undervoltage pickup and dropout settings, and controller meter calibration.	2, 4
Chattering noise when attempting to transfer	Coil control contact operation	See the Table of Contacts for control contact test procedures for your model transfer switch.	TOC
	Low voltage	Check source voltage and connections.	3.3.2
	Incorrect spring	See the Table of Contents for coil replacement instructions for your model transfer switch.	TOC
	Wrong coil	Check coil voltage rating and verify that it matches the transfer switch voltage rating.	—
Contactor transfers then hums or burns out solenoid	Auxiliary switches misaligned	Realign switches.	TOC
	Auxiliary switches failed	Replace switches.	TOC

O/I/M= Operation and Installation Manual; O/M = Operation Manual; TOC = Table of Contents, this manual; W/D = Wiring Diagrams

3.3 System Power

3.3.1 Verify Power to the ATS

If the transfer switch display is off, check for power to the transfer switch. If the utility source is not available, check for emergency power. Follow the voltage check procedure in Section 3.3.2, Voltage, Frequency, and Phase Rotation Checks, to check voltage at the Source N (normal) or Source E (emergency) lugs.

If utility power is not available and the emergency generator set is not running, check that the generator set master switch is in the AUTO position. Verify that the generator set runs when the master switch is moved to the RUN position. If the engine does not start, troubleshoot the generator set as described in the generator set documentation. Otherwise, check the engine start circuit. See Section 4.7.

If the utility source is available but the transfer switch display is off, check for open source circuit breakers or switches. Disconnect power and verify that the transfer switch wiring harness is connected to the controller at connector P1. See Figure 4-5.

An LED on the controller power board lights to indicate power to the board. See Figure 4-5.

3.3.2 Source Voltage, Frequency, and Phase Rotation Checks

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.

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 transfer switch. Source E is the source connected to the emergency side of the transfer switch.

The voltage check procedure requires the following equipment:

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

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

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

Voltage, Frequency, and Phase Rotation Measurement Procedure

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

1. Verify that the generator set master switch is in the OFF position and both power sources are disconnected from the transfer switch.
2. Disconnect the power switching device and controller wiring harnesses at the inline disconnect plug, if they are connected.
3. Manually operate the transfer switch to position E. See the Transfer Switch Operation and Installation Manual for manual operation instructions.
4. If Source N is a generator set, move the generator set master switch to the RUN position. The generator set should start.
5. Close the Source N circuit breaker or switch.
6. Use a voltmeter to check the Source N (normal) phase-to-phase and phase-to-neutral (if applicable) terminal voltages and frequency.
   a. If Source N is the utility and the measured input does not match the voltage and frequency shown on the transfer switch nameplate, *STOP!* The transfer switch does not match the application—order the correct transfer switch.
   b. If Source N is a generator set and the generator set output voltage and frequency do not match the nominal system voltage and frequency shown on the transfer switch nameplate, follow

the manufacturer's instructions to adjust the generator set. The automatic transfer switch will only function with the rated system voltage and frequency specified on the nameplate.

7. Use a phase rotation meter to check the phase rotation at the Source N (normal) terminals. Rewire the transfer switch Source N terminals to obtain the correct phase sequence if necessary.

   Note: The default setting for the phase rotation on the controller is ABC. If the application uses a phase rotation of CBA, use the Set Sources screen to change the phase rotation setting on the controller. See the Operation/Installation Manual for instructions.

8. If the source is a generator set, stop the generator set by moving the master switch to the OFF position.
9. Disconnect Source N by opening upstream circuit breakers or switches.
10. Manually operate the transfer switch to position N.
11. Repeat steps 4 through 8 for Source E. Then proceed to step 12.
12. Disconnect both sources to the transfer switch by opening the circuit breakers or switches.
13. Connect the power switching device and controller wiring harnesses together at the inline disconnect plug.

    Note: Do not connect or disconnect the controller wiring harness when the power is connected.

14. Close and lock the transfer switch enclosure door.
15. Reconnect both power sources by closing the circuit breakers or switches.
16. Move the generator set master switch to the AUTO position.

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

3.4 Contacts

Use the millivolt drop test in Section 1.3.3 to identify damaged contacts. If the contacts are damaged or have high resistance, replace the power panel assembly. See the table of contents for service procedures for your transfer switch.

3.5 Rectifier Test

Use an ohmmeter or a diode checker to test the rectifiers when necessary. See Section 6.6 for instructions to test rectifiers on Model KSS switches.

Note: The rectifiers on model KSP programmed-transition switches are built into the solenoid coils and are not accessible for testing.

Disconnect all leads to the bridge rectifier and test each rectifier (diode) in the bridge individually using an ohmmeter (R x 1 scale) or diode checker. See Figure 3-1 and Figure 3-2. The diodes should exhibit a reverse resistance of at least 100 times the forward resistance. If the reverse resistance is low, replace the damaged rectifier assembly.

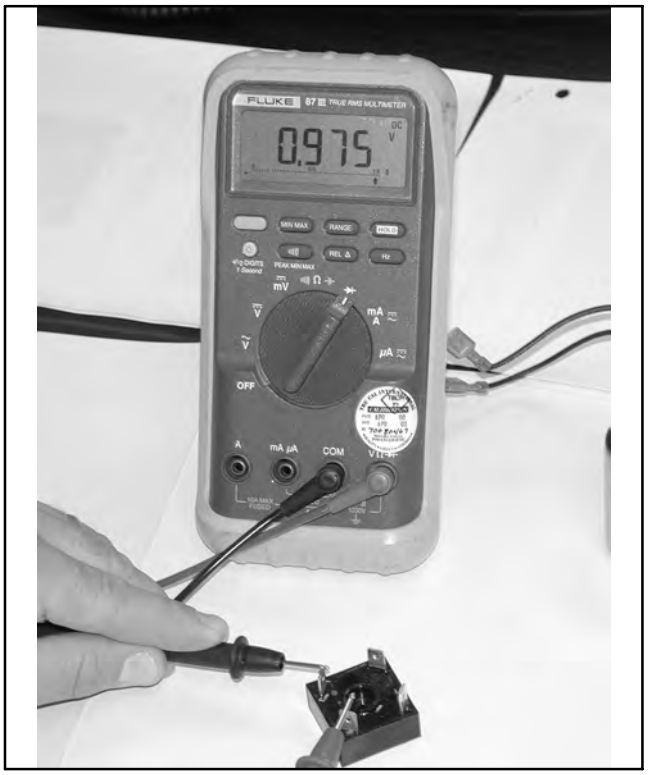
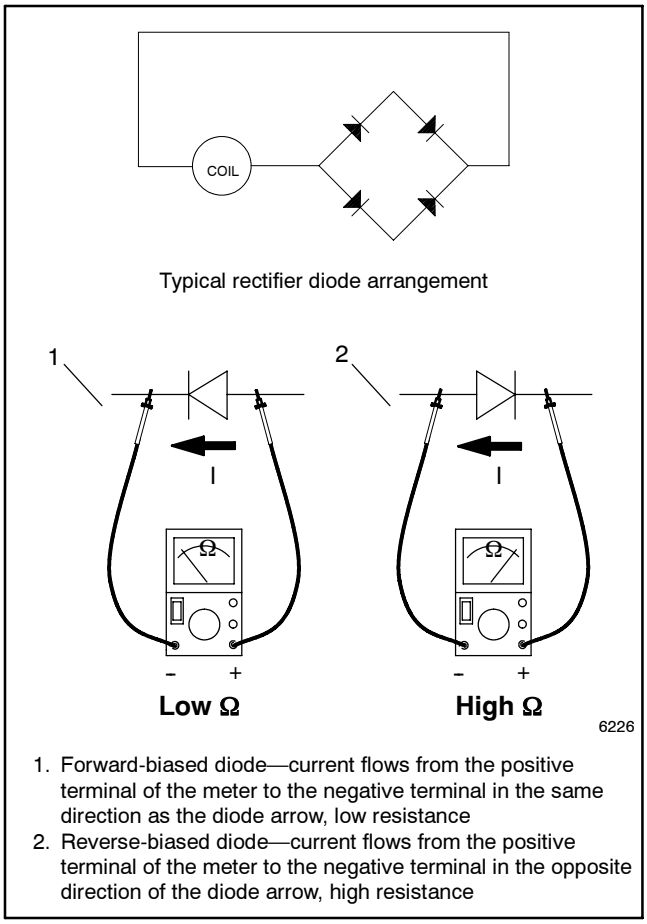


Figure 3-1 Checking Rectifier Diode Operation



1. Forward-biased diode—current flows from the positive terminal of the meter to the negative terminal in the same direction as the diode arrow, low resistance
2. Reverse-biased diode—current flows from the positive terminal of the meter to the negative terminal in the opposite direction of the diode arrow, high resistance

Figure 3-2 Testing Diodes

3.6 Solenoid Tests

3.6.1 Solenoid Coil Resistance

Use an ohmmeter to measure the coil resistance. Most damaged coils will result in an open circuit (very high resistance) or a shorted coil (near zero resistance).

Note: Because coils for model KSP programmed-transition switches have integral rectifiers, the coil resistance on those units cannot be easily measured. Check coil operation according to the diagrams in Section 3.6.2. If the coil does not operate correctly, replace it.

See Section 6.6 for instructions to test coils on Model KSS switches. Replace the coil if an open circuit or a short circuit is found.

3.6.2 Solenoid Operation

This section contains descriptions and diagrams of the solenoid coil operation. For complete diagrams, refer to the schematic diagrams provided with the transfer switch.

The ATS controller monitors the connected source and detects source failure, either a complete loss of the source or a source parameter that is outside the acceptable range. The controller starts the engine start time delay. If power is restored before the time delay ends, the controller resets the time delay and continues to monitor the source. If the source failure persists and the time delay ends, the controller closes the engine start contacts to signal the Source E generator set to start.

When Source E (or the standby source) becomes available, the controller starts the preferred-to-standby time delay (if not set to zero). When the time delay ends, relay K2 (ER) in the controller closes, applying power to the solenoid coil and initiating transfer.

When Source N (or the preferred source) is restored, the controller starts the standby-to-preferred time delay. When the time delay ends, the controller's K1 (NR) relay closes, applying power to the solenoid coil and initiating transfer back to Source N (or the preferred source).

Note: The K1 (NR) and K2 (ER) relays are energized for only 250 milliseconds to initiate transfer.

On 40–225 amp model KSS standard-transition switches, control contacts SCN and SCE control the amount of time that power is applied to the solenoid coil. The contacts open before the operating mechanism reaches Top Dead Center (TDC). Inertia carries the mechanism through TDC, and a spring in the solenoid assembly moves the mechanism into the Source E (or standby) position.

Model KSP programmed-transition models stop in the OFF position for a programmed length of time during transfer. The transfer-to-OFF sequence is controlled by the NR1 and ER1 relays on the programmed-transition interface board (PTIB).

The controller K1 and K2 relays and the PTIB relays are replaceable.

Note: Always check all wiring and connections before replacing parts.

The solenoid power circuits vary for different ATS models. The following sections describe and illustrate the transfer sequence for the different models.

Figure 3-3 explains the notation used in the solenoid operation diagrams in the following coil operation diagrams.

ATS1:	Trip switch, Normal *	NR, ER:	Controller relays. Energized for 250 milliseconds to initiate transfer.
AX:	Coil clearing switch, Normal *	NR1, ER1:	Programmed-transition interface board relays. *
BTS1:	Trip switch, Emergency *	SCN, SCE:	Coil control contacts (microswitches)
BX:	Coil clearing switch, Emergency *	SC:	Select coil *
CC:	Closing coil *	S1:	Bridge rectifier *
EA, EC:	Emergency source	TC:	Trip coil *
LS:	Line select switch *		
NA, NC:	Normal source		

Power through the coil circuit.

= closed contacts

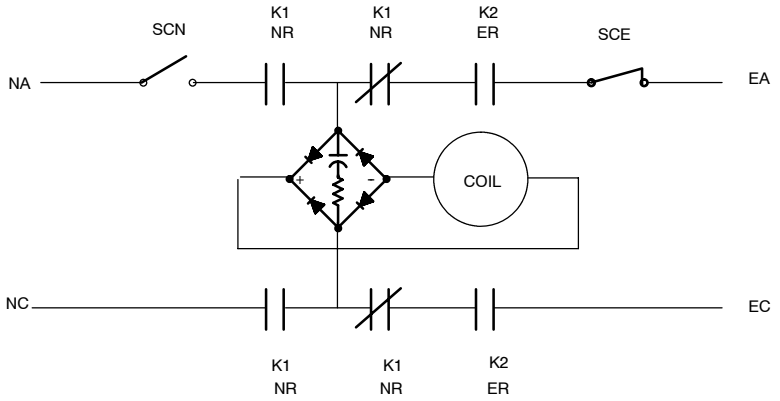
= open contacts

* Used on programmed-transition switch diagrams

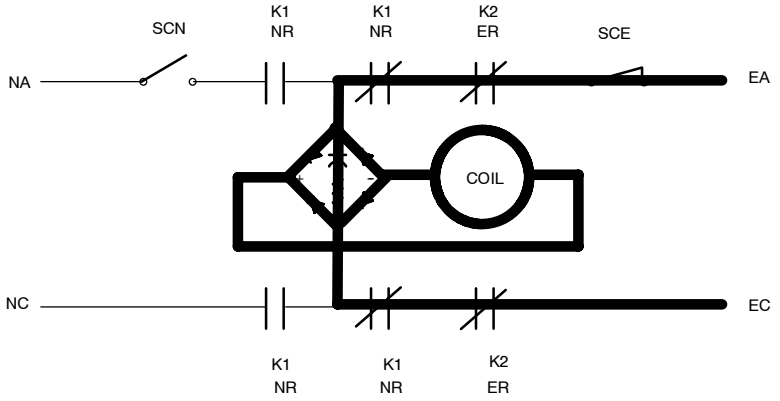
Figure 3-3 Legend for Solenoid Operation Diagrams

3.6.3 Solenoid Operation Diagrams, 40–225 Amp Model KSS Standard Transition Switches

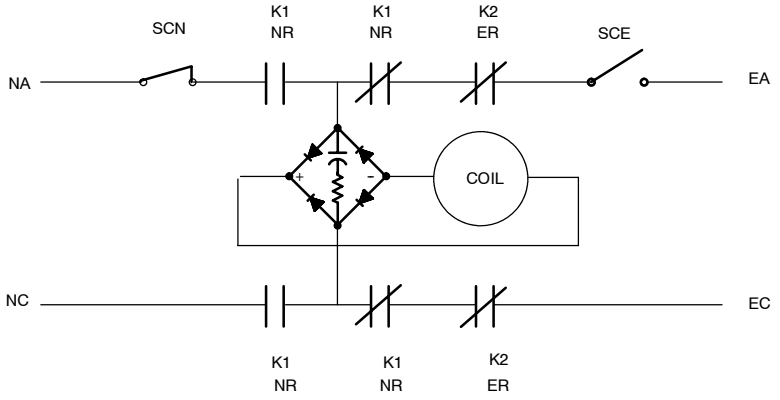
Source N position, Source N available. The solenoid coil is not energized.



Source N position, Source N lost. The coil is energized if Source E is available. The transfer switch is ready to transfer to Source E.



Source E position, Source E available. The solenoid coil is not energized.



Source E position, Source N available. The controller is calling for transfer to Source N. The coil is energized and the transfer switch will transfer to Source N.

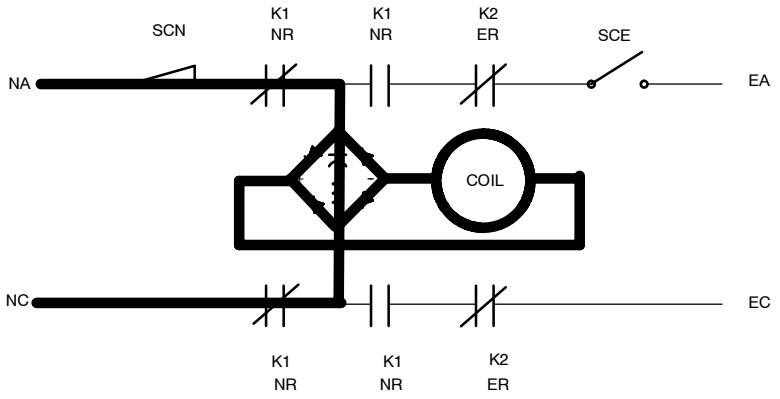
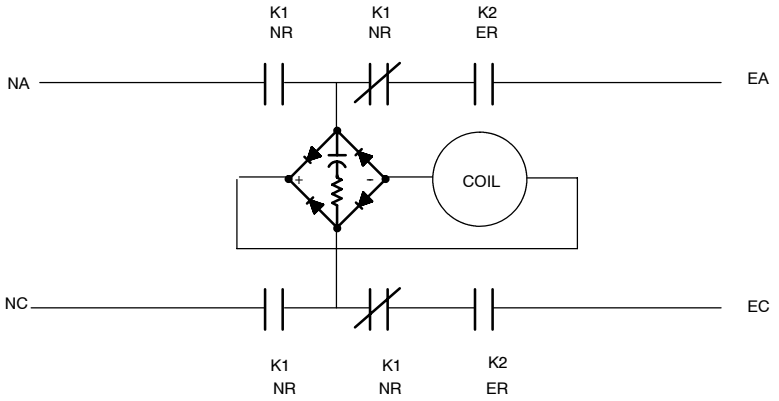


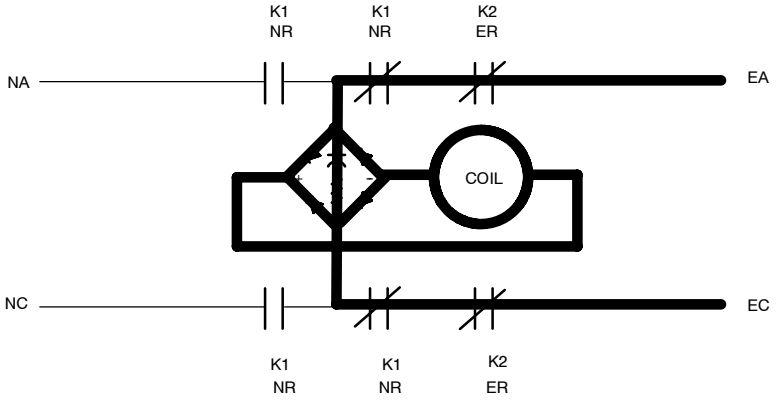
Figure 3-4 40–225 Amp Model KSS Standard-Transition Switches, Solenoid Operation

3.6.4 Solenoid Operation Diagrams, 400–600 Amp Model KSS Standard Transition Switches

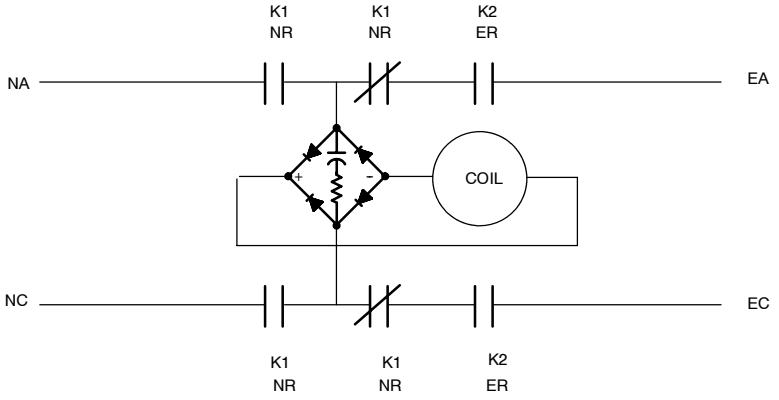
Source N position, Source N available. The solenoid coil is not energized.



Source N position, Source N lost. The coil is energized if Source E is available. The transfer switch is ready to transfer to Source E.



Source E position, Source E available. The solenoid coil is not energized.



Source E position, Source N available. The controller is calling for transfer to Source N. The coil is energized and the transfer switch will transfer to Source N.

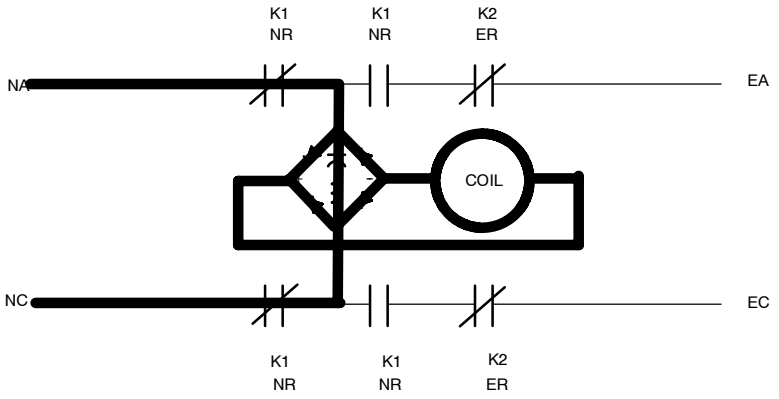


Figure 3-5 400–600 Amp Model KSS Standard-Transition Switches, Solenoid Operation

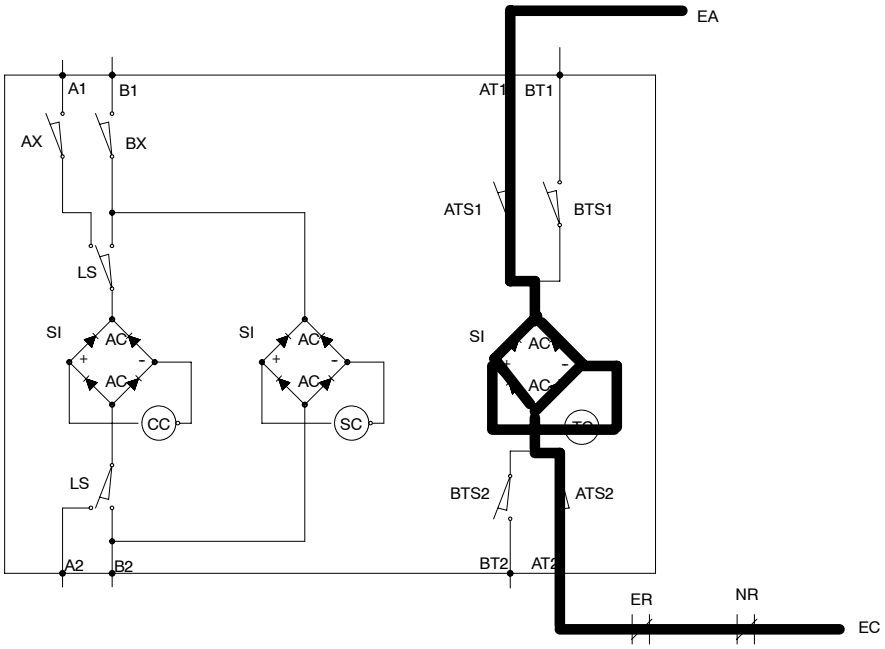
3.6.5 Solenoid Operation Diagrams, Model KSP Programmed-Transition Models

Normal to OFF

Source N position
Source N is lost
Emergency available

ER is pulsed for 250 ms to energize trip coil TC.

ATS1 AND ATS2:
Closed in Normal
Open in OFF



OFF to Emergency

ER1 is pulsed for 250 ms to energize select coil SC. SC picks up LS, which energizes closing coil CC

BX:
Closed in OFF
Open in Emergency

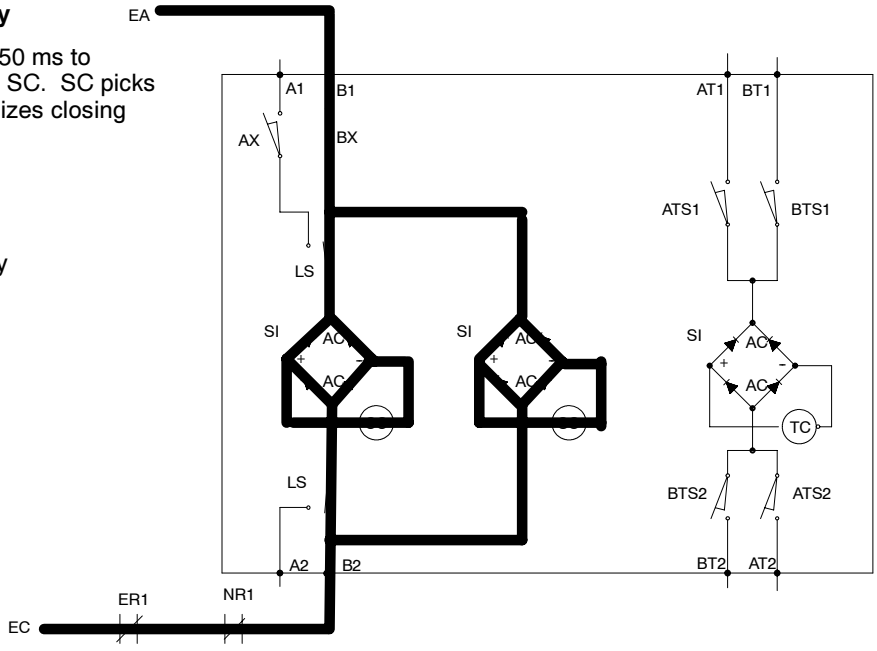
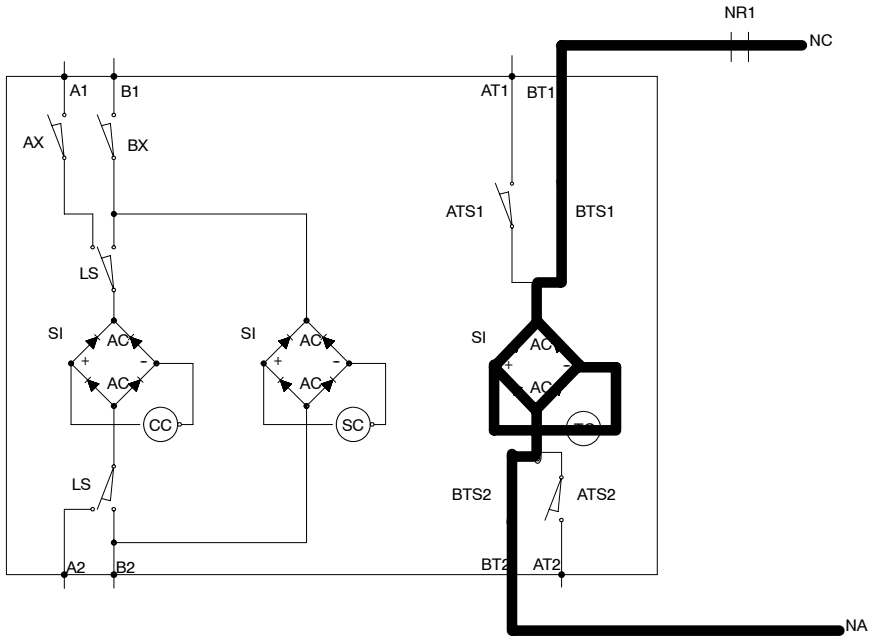


Figure 3-6 Model KSP Programmed-Transition Switches, Transfer from Normal to Emergency

Emergency to OFF

NR1 is pulsed for 250 ms to energize trip coil TC.

BTS1 and BTS2: Closed in Emergency Open in OFF



OFF to Normal

NR is pulsed for 250 ms to energize closing coil CC.

AX is closed in OFF.

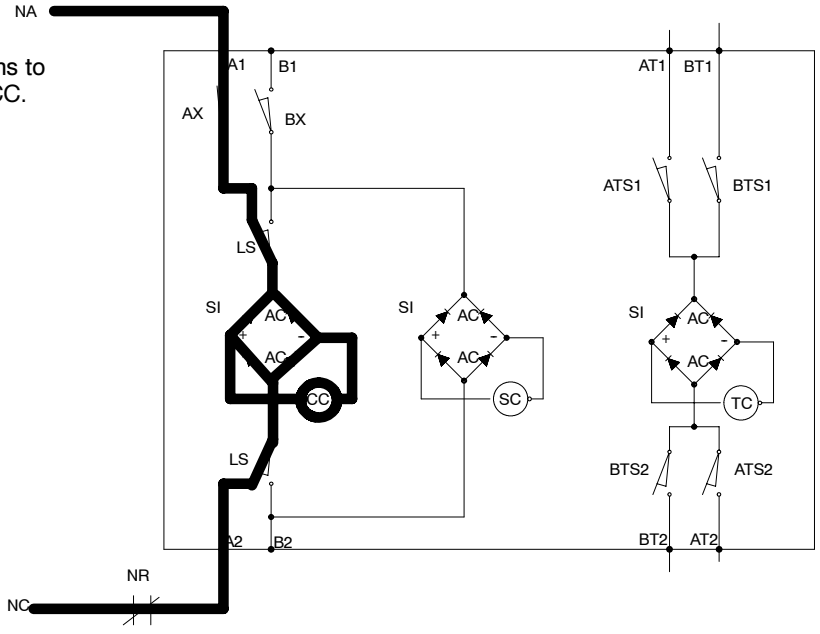
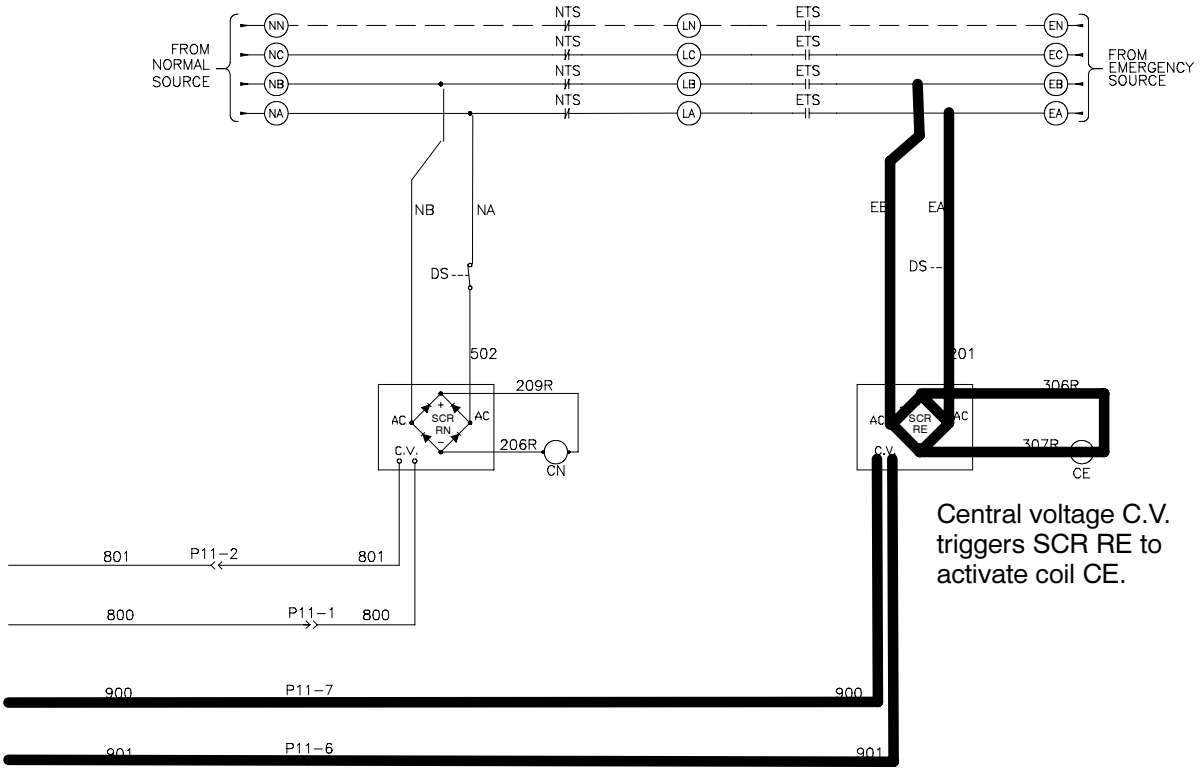


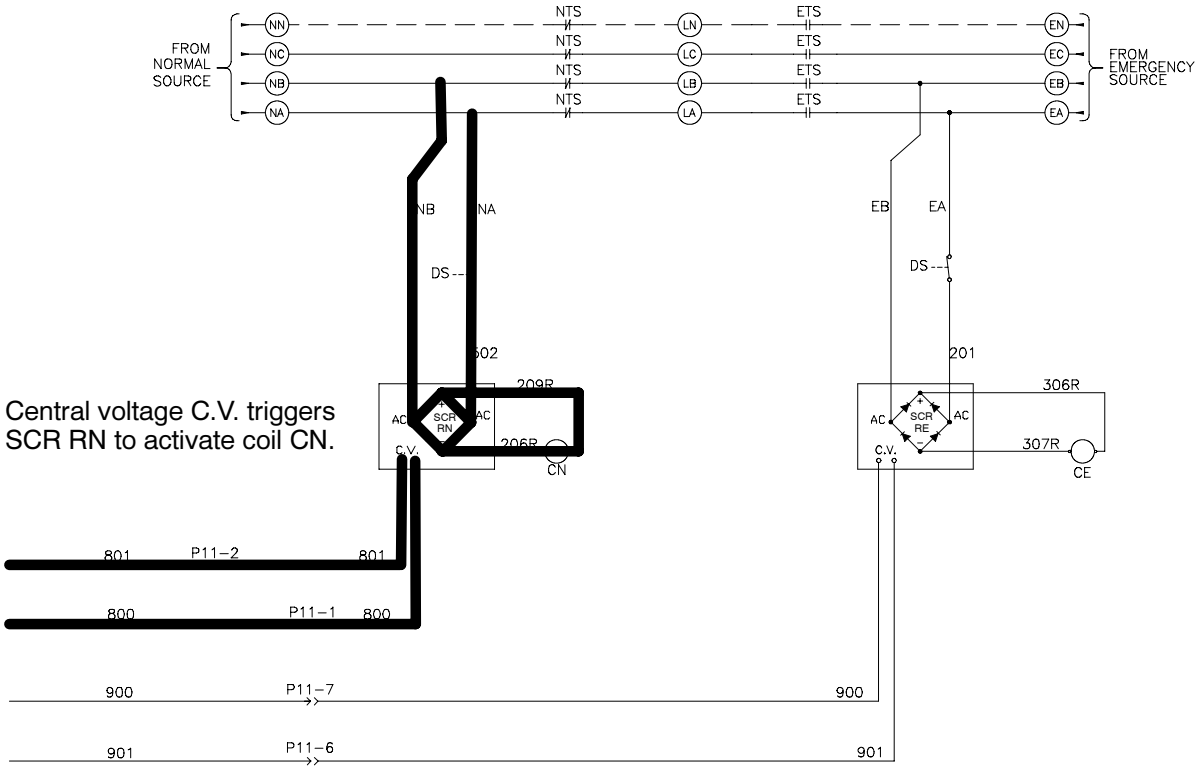
Figure 3-7 Model KSP Programmed-Transition Switches, Transfer from Emergency to Normal

3.6.6 Solenoid Operation Diagrams, Model KGS Open Transition Bypass/Isolation Switches

Normal to Emergency

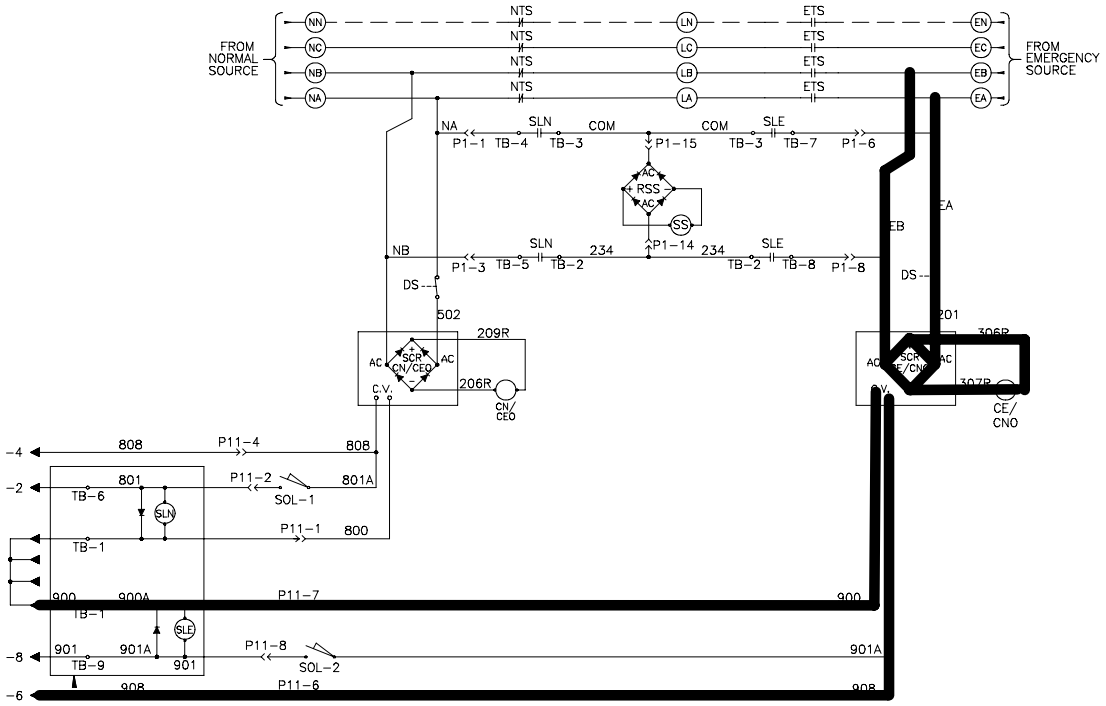


Emergency to Normal

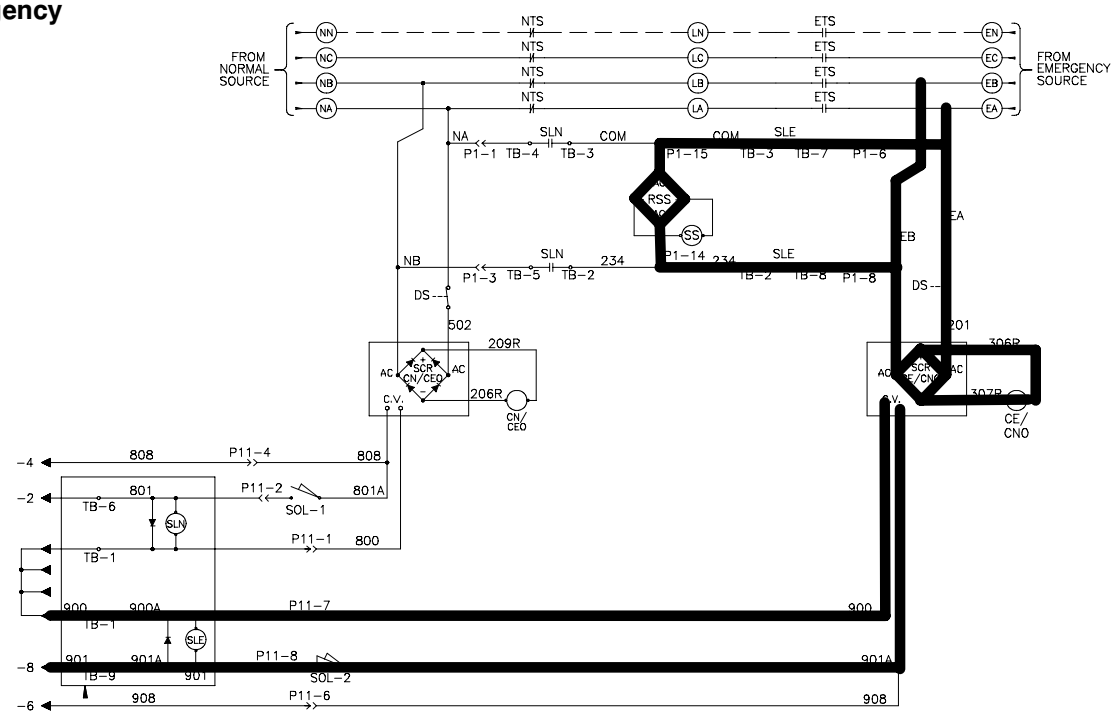


3.6.7 Solenoid Operation Diagrams, 150–400 Amp Model KGP Programmed-Transition Bypass/Isolation Switches

Normal to Off



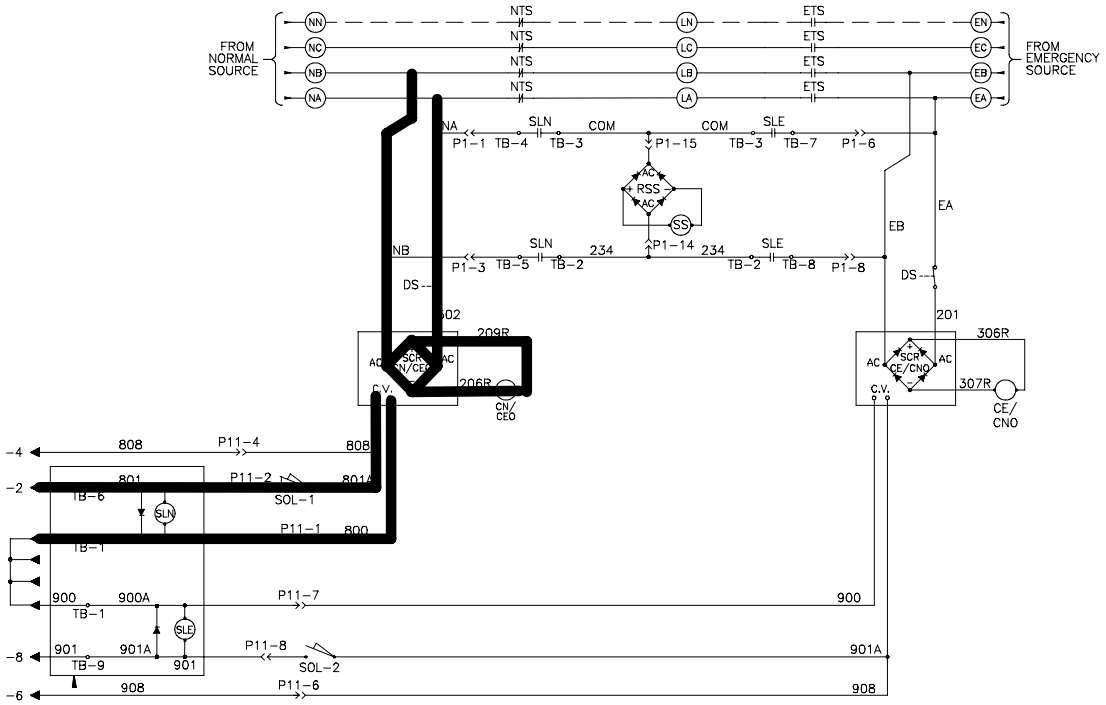
Off to Emergency



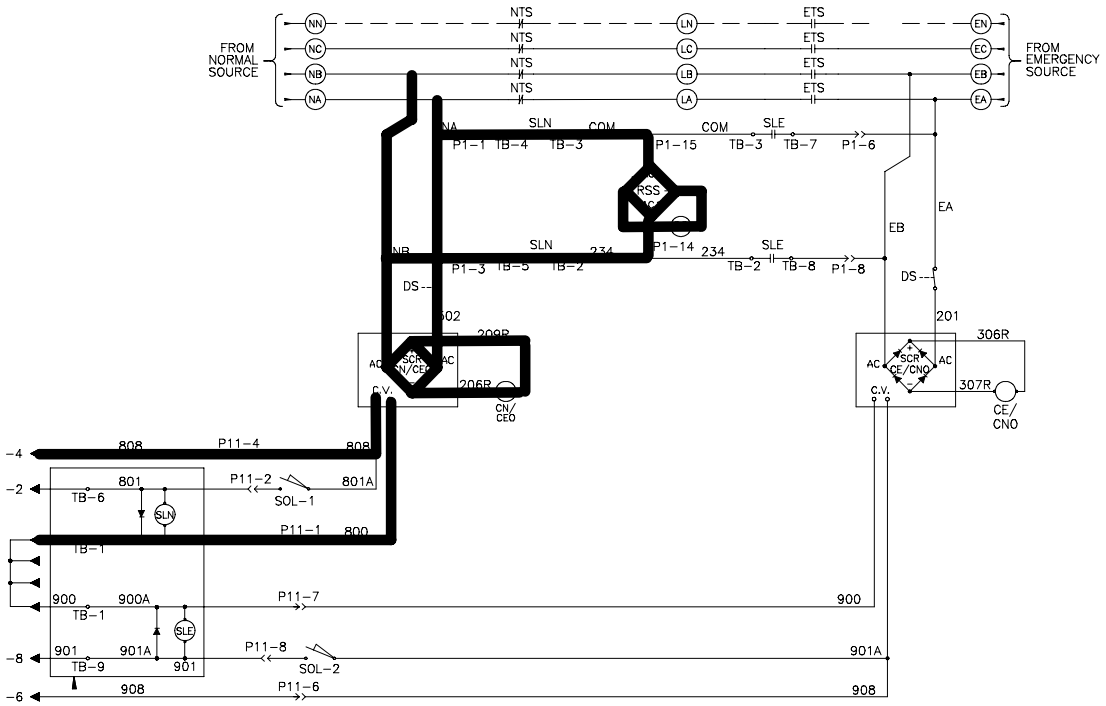
GM46248

Solenoid Operation Diagrams, 150–400 Amp Model KGP Programmed-Transition Bypass/Isolation Switches, continued

Emergency to Off



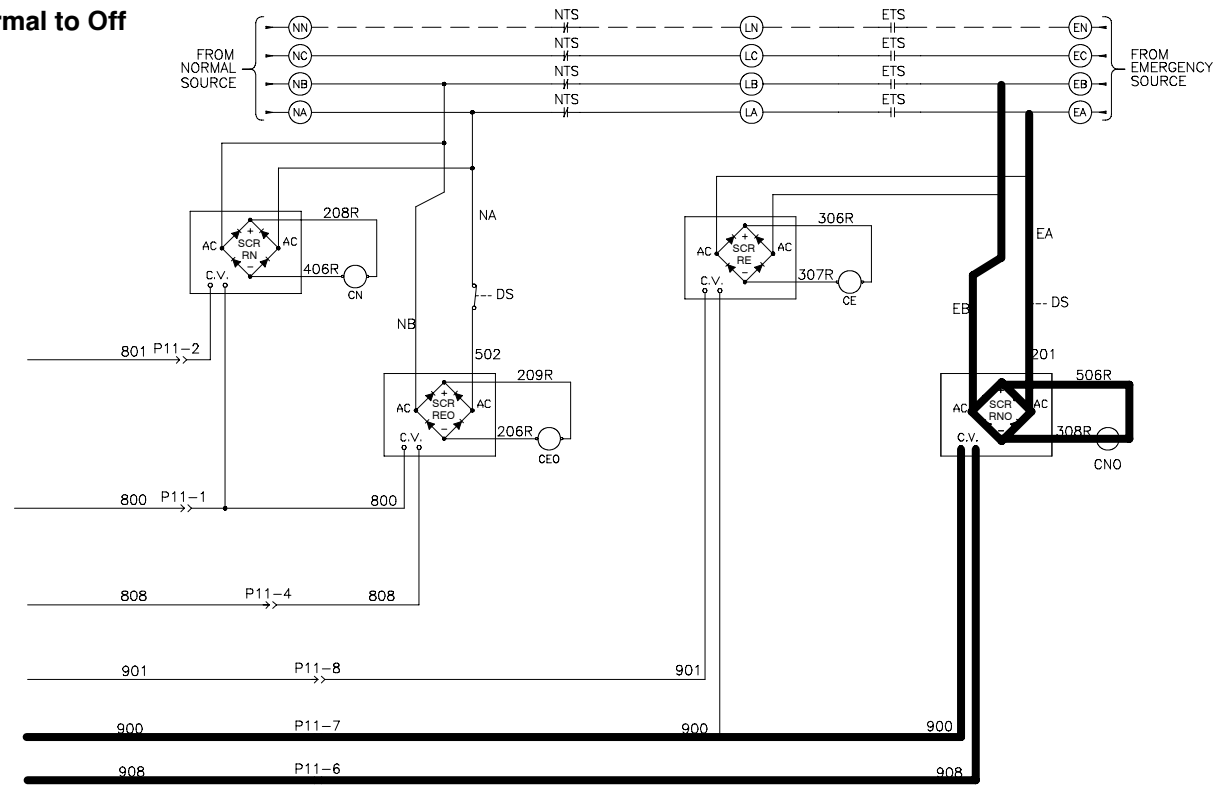
Off to Normal



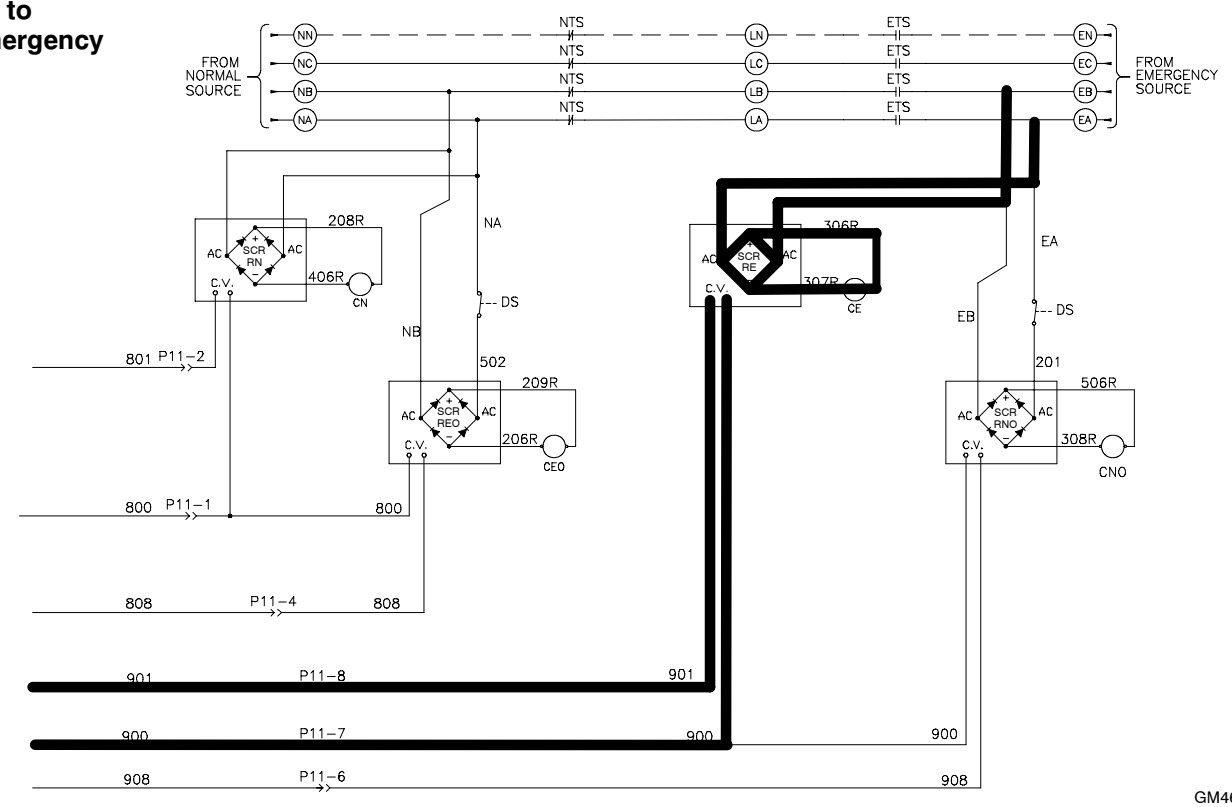
GM46248

3.6.8 Solenoid Operation Diagrams, 600–3000 Amp Model KGP Programmed-Transition Bypass/Isolation Switches

Normal to Off



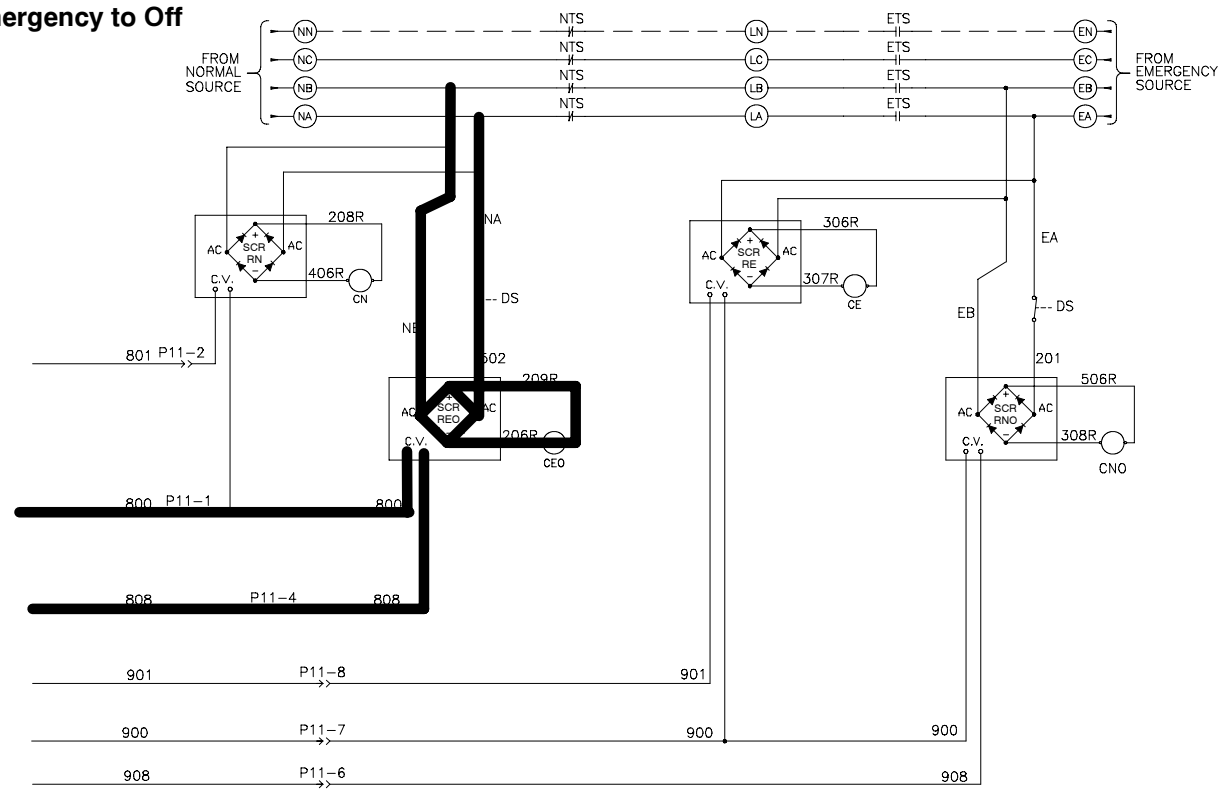
Off to Emergency



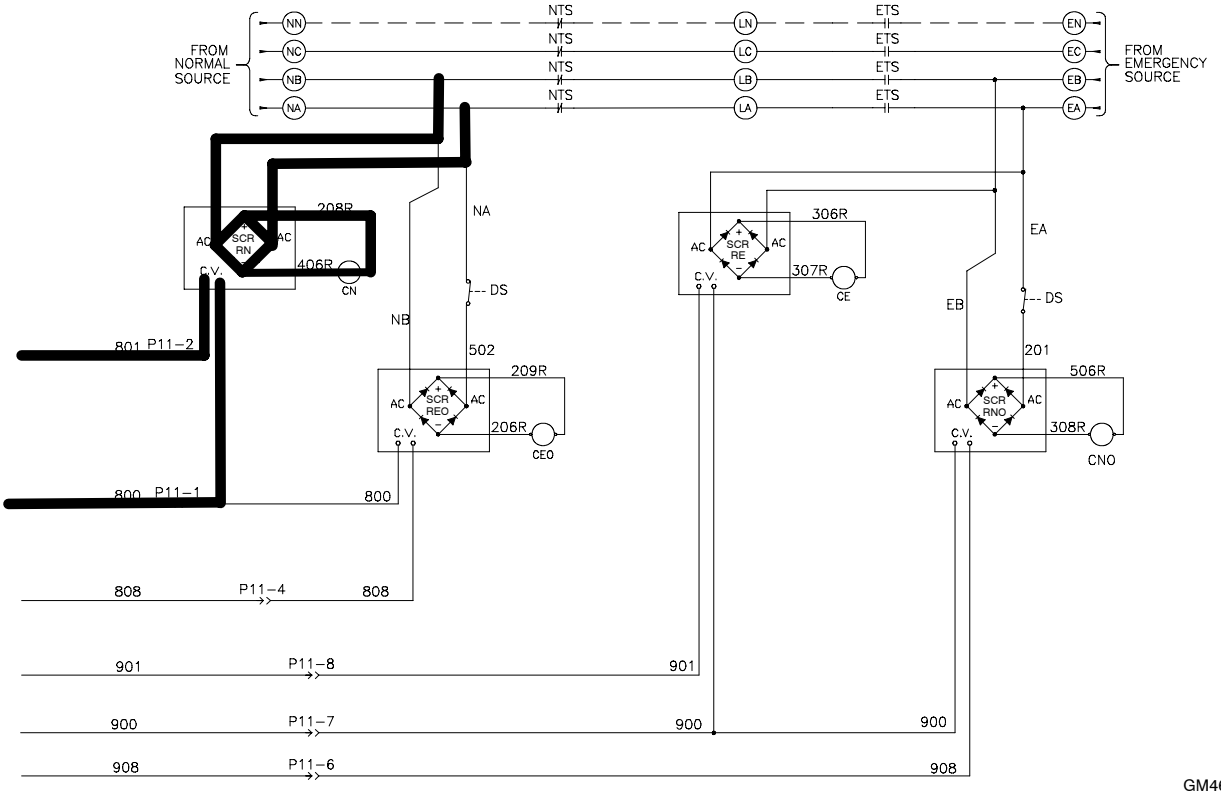
GM46249

Solenoid Operation Diagrams, 600–3000 Amp Model KGP Programmed-Transition Bypass/Isolation Switches, Continued

Emergency to Off



Off to Normal



GM46249

Notes

4.1 User Interface Panel

The user interface panel is located on the transfer switch door. Figure 4-1 shows the user interface pushbuttons and LED indicators.

4.1.1 Display

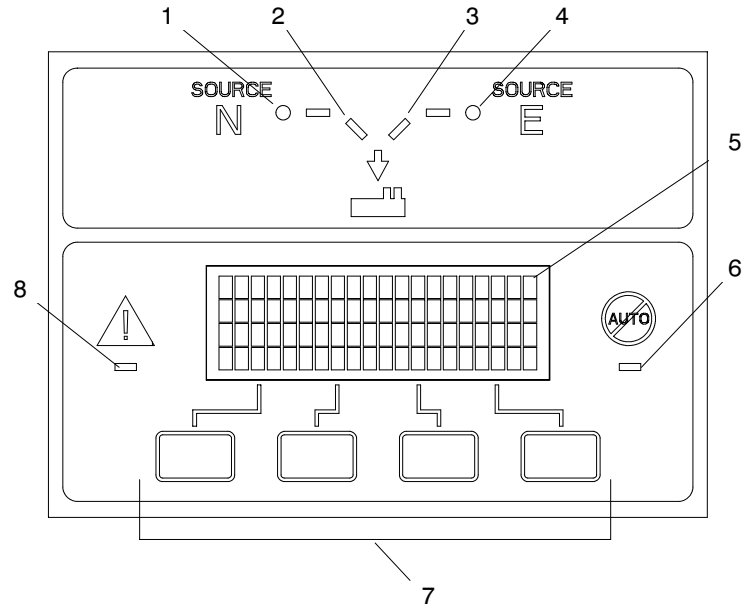
The four-line display indicates transfer switch status and setup, including the following:

- System status
- Faults and warnings
- Active time delays
- Source voltages
- Source frequency (Hz)
- Current (amps)
- Source setup information
- Time and date
- Time and date of next scheduled exercise

The display also identifies the pushbutton functions, which can change from screen-to-screen.

4.1.2 LED Indicators

LEDs on the user interface indicate contactor position, source availability, faults, and other conditions. Figure 4-2 describes the functions of the LED indicators. See Section 2.7 for more information about warnings and faults.



1. Source N Available LED
2. Source N Position LED
3. Source E Position LED
4. Source E Available LED
5. Display
6. Not in Auto LED
7. Pushbuttons (4)
8. System Alert LED

Figure 4-1 User Interface Panel

LED Indicator	Condition
Source N Available, Green	Source N is available.
Source E Available, Red	Source E is available.
Position A, Green	Contactor is in Normal positon.
Position B, Red	Contactor is in Emergency position.
System Alert, Red	Fault. Identify and correct the cause of the fault condition, then reset faults at the controller. See Section 2.7.
	Input active: Low Battery Voltage or Remote Common Alarm.
Not in Auto, Red	ATS is not set for automatic operation or a load shed (forced transfer to OFF) sequence is active.
	Flashes for manual transfer waiting.
	Input active: Inhibit Transfer or Forced Transfer to OFF.

Figure 4-2 User Interface LED Indicators

4.1.3 Lamp Test

To test the LEDs on the controller's user interface, go to the Main screen. Press the down arrow button once, then press the Lamp Test button and verify that all 6 LEDs on the user interface illuminate. See Figure 4-3.

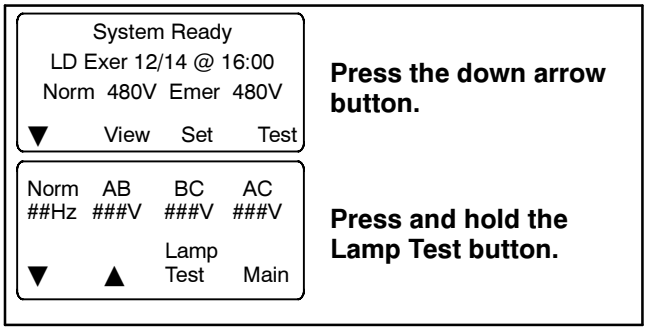


Figure 4-3 Lamp Test

4.1.4 Pushbuttons

The user interface panel has four pushbuttons below the display. Pushbutton functions are shown above each button in the last line of the display and can change from screen-to-screen.

The pushbutton functions are defined in Figure 4-4.

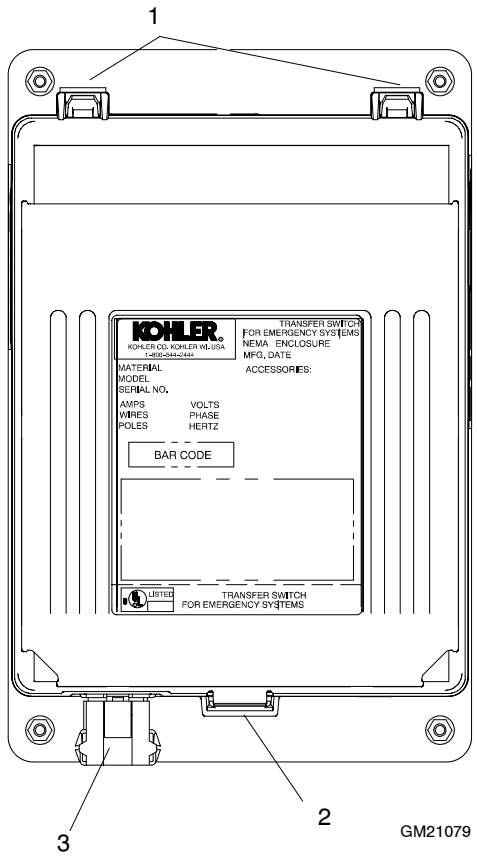
▼	Down arrow (closed). Step down to the next screen or scroll through a list.
▲	Up arrow (closed). Step back to the previous screen.
▶	Right arrow (closed). Move to the next submenu.
△	Up arrow (open). Increases the selected numerical value.
▽	Down arrow (open). Decreases the selected numerical value.
▷	Right arrow (open). Steps to the next digit in a selected numerical value.
Back	Steps back to the previous screen or submenu.
End Delay	Ends the current time delay.
End Test	Ends an active test sequence. See Section 4.5.5.
OK	Enters the displayed numerical value (password or setting).
Main	Returns to the main screen.
Next	Steps to the next parameter in an item with multiple settings (for example, in Exerciser Setup).
Reset	Reset the fault condition shown on the display, or reset an accessory module after connection.
Save	Saves settings shown on the display.
Set	From the main screen, moves to the first setup screen.
Start	From the Test screen, starts the test sequence.
Test	From the main screen, moves to the test sequence screens.
View	From the main screen, moves to the first view screen.

File transfer commands (USB device connected):

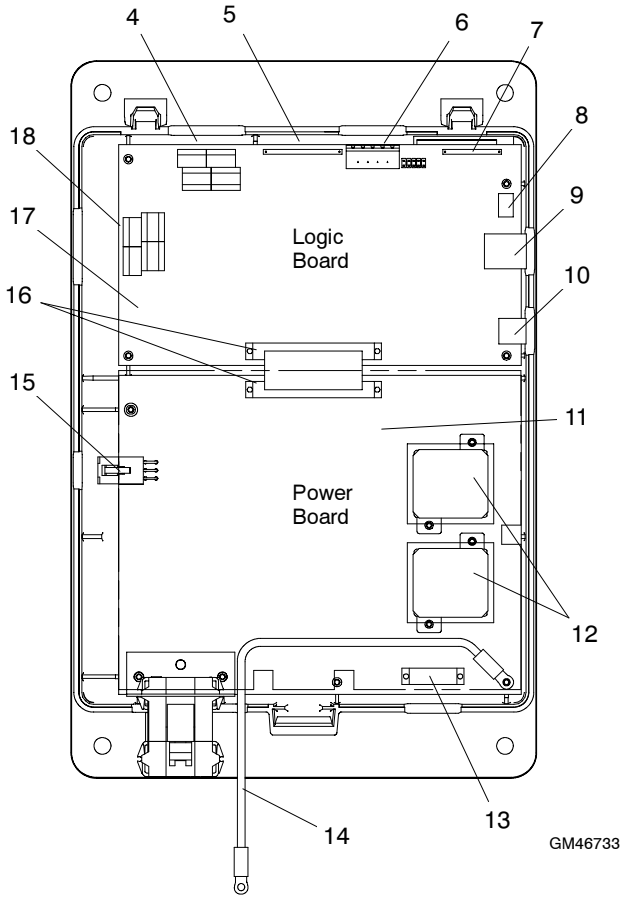
Sel	Select the displayed file.
Del	Delete the displayed file.
Upload	Load the displayed file to the USB device.
Download	Load the displayed file to the controller.

Figure 4-4 Pushbutton Functions

4.2 Controller Circuit Boards and Connectors



With Cover

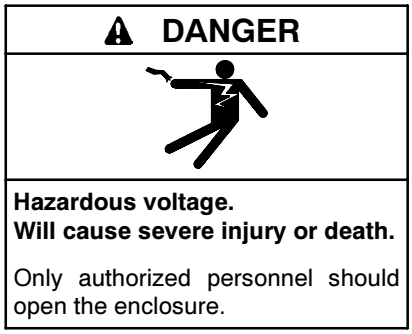


Cover Removed

1. Hinges
2. Latch
3. Transfer switch harness connection P1
4. RS-485 Modbus connections TB2
5. User interface LCD display connection P17
6. Accessory module assembly connection P16
7. User interface connection P14
8. DIP switches SW1
9. Ethernet connector P13
10. USB port P12
11. LED1 (ON = 12VDC)
12. Relays
13. Programmed-transition interface board (PTIB) connection P2 (factory connection)
14. Ground wire
15. Current sensing kit connection P3 (optional)
16. Ribbon cable connection
17. Controller backup battery
18. Logic board input and output connections TB1

Figure 4-5 Controller

4.3 Controller Power



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

4.3.1 Controller Power Supply

The controller power board converts AC line voltage to DC voltage for the logic board. Line voltage or DC voltage from an external battery connected through an External Battery Supply Module (EBSM) will cause LED1 on the controller's power board to light. See Figure 4-5 for the LED location.

- If the Normal or Emergency source is available but the controller display is dark, check LED1 on the controller power board. LED1 lights when voltage is available for the logic board.

- If the transfer switch is equipped with an EBSM, disconnect the I/O module assembly at connector P16 on the controller to remove the external battery supply. Then check LED1 with the Normal or Emergency source available.

- If LED1 lights but the controller display is dark, check the ribbon cable connections between the controller's power board and logic board and from the logic board to the display.

- If LED1 does not light when the Normal or Emergency source is available, check for line voltage to the controller using the following procedure:

Check for Line Voltage to the Controller

1. Disconnect power to the transfer switch by opening circuit breakers or switches.

2. Disconnect the transfer switch wiring harness from the controller at the 24-pin connector.

3. Reapply power to the transfer switch.

4. Check for voltage across the wiring harness pins. Observe all Safety Precautions when checking the voltage.

   a. If Source N is available, check for line voltage across pins 4 and 12 of the transfer switch wiring harness connector.

   b. If Source E is powering the transfer switch, check for line voltage across pins 6 and 7 of the connector.

If there is no power to the pins checked in step 4, check the wiring harness continuity. Replace the harness if necessary.

If there is power to the pins checked in step 4 but LED1 on the power board does not light when power is connected, replace the power board.

Note: Model KGS/KGP transfer switches use a different power board than other models with MPAC 1500 controls. Refer to Parts Catalog TP-6433 for the correct part numbers.

4.3.2 Controller Backup Battery

DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

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

Note: Disconnect power to the controller before installing or replacing the battery.

The transfer switch controller uses a 4.1-volt backup battery for power when no source is available. A Low Backup Battery message on the screen indicates that this battery needs to be replaced. See Figure 4-5 for the battery location.

Note: Do not use a standard AA battery; the voltage is not correct and the specifications are not adequate for this equipment. Obtain replacement battery GM47057 from the manufacturer.

Note: Do not use a metal tool to remove or install the battery.

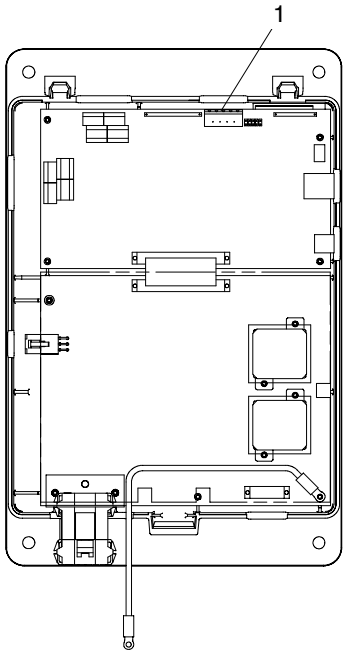
When installing the battery, follow the polarity (+/-) markings on the circuit board.

Set the controller's current time and date after installing the battery. See the transfer switch Operation and Installation Manual for instructions.

4.3.3 Powering the Controller Directly (Service Kit GM52407)

On occasion it is necessary to supply 120 VAC power directly to the controller for testing. Service Kit GM52407 contains a cable with a transformer to supply power to the controller from a 120 VAC wall outlet. Disconnect the controller from the transfer switch. Disconnect the I/O module assembly (if equipped) and connect the cable to the controller's P16 connector. See Figure 4-6. The cable can also be connected to the I/O module assembly, if desired. Plug the cable into a 120 VAC wall outlet to power the controller during testing.

Note: Do not connect 120 VAC power to any other location on the controller.



1. Connect service kit power cable to controller connector P16 (I/O module connection)

Figure 4-6 Service Kit GM52407 Connection (controller cover removed for illustration only)

4.4 Sequence of Operation

4.4.1 Controller Powerup Reset Sequence of Operation

Following is an explanation of the sequence of operation for the MPAC™ 1500 ATS Controller when power is initially applied to the controller or a controller reset occurs.

1. Controller self test is executed.
2. System parameters are downloaded from non-volatile memory.
3. Contactor position and source availability are determined.
4. If neither source is acceptable, the contactor does not change position.
5. If both sources are available, the controller immediately transfers the contactor to the preferred source.
6. If only one source is available, the controller immediately transfers the contactor to that source, executing only the off-position and load control time delays.

   If the available source is the preferred source, and the contactor was in the standby position, the contactor transfers to preferred, the engine cooldown time delay runs, and then the engine start contacts open.

   If the available source is the preferred source and the contactor was already in the preferred position, the engine start contacts open immediately, bypassing the engine cooldown time delay.

4.4.2 Preferred Source Loss and Return

Following is an explanation of the sequence of operation for MPAC™ 1500 ATS Controller when Preferred Source failure is detected.

Preferred Source Fails:

1. Load control contacts open.
2. Time delay engine start times out.
3. The generator is signaled to start.
4. The generator starts and the standby source becomes available.
5. Time delay preferred-to-standby times out.
6. Contactor transfers to standby.
7. Post-transfer load control sequences time out.
8. Load control contacts close.

Preferred Source Returns:

1. Time delay standby-to-preferred and pre-transfer load control sequences time out.
2. Load control contacts open.
3. Contactor transfers to preferred source.
4. Post-transfer load control sequences and time delay engine cooldown time out.
5. Load control contacts close.
6. The generator is signaled to stop.

4.5 System Test

Use the system test feature to:

- Start and run the generator set, or
- Simulate a preferred source failure, resulting in a transfer to the standby source.

A password is required to activate the system test, ensuring that only authorized personnel can start a test. Pressing the Test pushbutton signals the controller to initiate the system test sequence.

An Auto-Loaded test executes for a set length of time and then ends automatically. Press the End Test pushbutton to end a Loaded or Unloaded test. Time delays will execute as programmed after the end test button is pressed. Pressing the End Delay button will end the currently displayed time delay.

To check the source voltage and frequency while a test is running, press the Main button. Press the Test button to return to the test sequence screens.

During a system test, if the emergency source becomes unavailable based on its preset operating parameters, the fail to acquire standby signal is indicated immediately, and the test is terminated. If the contactor is in the standby position, it transfers immediately to the preferred position.

4.5.1 Unloaded System Test

When an unloaded test is initiated, the controller immediately signals the generator to start, without waiting for time delay engine start to timeout. The contactor does not change position during an unloaded test, but if the normal source should fail, the contactor will transfer to the emergency source. The unloaded test feature will be available only with the Util-Genset and Genset-Genset modes of operation.

4.5.2 Loaded System Test

A loaded test actually simulates a preferred source failure, except that the engine start time delay is bypassed. The generator set is signaled to start immediately upon test activation. Load control signals are issued prior to transfer with their associated time delays. Since the loaded test transfer will be between two live sources, the in-phase monitor will be activated if it is enabled. If the preferred source is lost during a loaded test with the contactor in the standby position, the test will continue to be active, even on restoration of preferred. If the standby source is lost and the preferred source is available, the test will be terminated, and the transfer switch will immediately transfer to the preferred source position, bypassing all time delays except the off-position requirements in a programmed-transition system.

When a loaded test is terminated normally, the retransfer sequence will be as though the preferred source has been restored after a failure. All time delays will be executed and an in-phase transfer will occur if enabled. The loaded test feature will be available with the Util-Genset, Util-Util and Genset-Genset modes of operation.

4.5.3 Auto-Loaded System Test

The auto-loaded test feature is a timed loaded test. The auto-loaded time delay determines how long after the transfer to standby to terminate the test and transfer back to the preferred source. The time is defaulted to 30 minutes and can be adjusted from 1 minute to 60 minutes.

4.5.4 Test Procedure

Use the following procedure to run a test to check the transfer switch operation. Watch the LEDs on the controller's user interface as the time delays run and Source E becomes available when the generator set starts. For a loaded test, watch the position LEDs to verify that the ATS transfers the load.

The test sequence simulates a loss of the normal source, starts the generator set, and transfers the load to the emergency source (loaded test), executing all time delays that are set up to operate during a loss of the normal source. When the test is ended in step 8 of the procedure, the transfer switch transfers the load back to the normal source and removes the engine start signal, executing all programmed time delays.

Refer to Figure 4-8 and Figure 4-9 for flowcharts showing the test sequence of operation without and with load.

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

Check the preferred source selection. The test procedure assumes that Source N is the preferred source.

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

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

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

Automatic Operation Test Procedure

1. Check the controller LED indicators to verify that the Position N and Source N Available indicators are lit.

2. Verify that the generator set master switch is in the AUTO position.

3. Refer to Figure 4-7. From the main screen, press the Test button. Enter the test password when prompted and press OK.

4. Press the down arrow button to display Type of Test Loaded.

5. Press the Start button.

6. Verify that the generator set starts and the Source E Available LED lights.

7. Verify that the switch transfers the load to Source E.

   a. Open-Transition Models: After the preferred-to-standby time delay, verify that the Position N LED goes out and the Position E LED lights, indicating that the switch has transferred the load to Source E.

   b. Programmed-Transition Models: After the preferred-to-off time delay, verify that the Position N LED goes out. After the off-to-standby time delay, check that the Position E LED lights, indicating that the switch has transferred the load to Source E.

8. Press the End Test button.

9. Verify that the switch transfers the load back to Source N.

   a. Open-Transition Models: After the standby-to-preferred time delay, verify that the Position E LED goes out and the Position N LED lights, indicating that the switch has transferred the load to Source N.

   b. Programmed-Transition Models: After the standby-to-off time delay, verify that the Position E LED goes out. After the off-to-preferred time delay, check that the Position N LED lights, indicating that the switch has transferred the load to Source N.

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

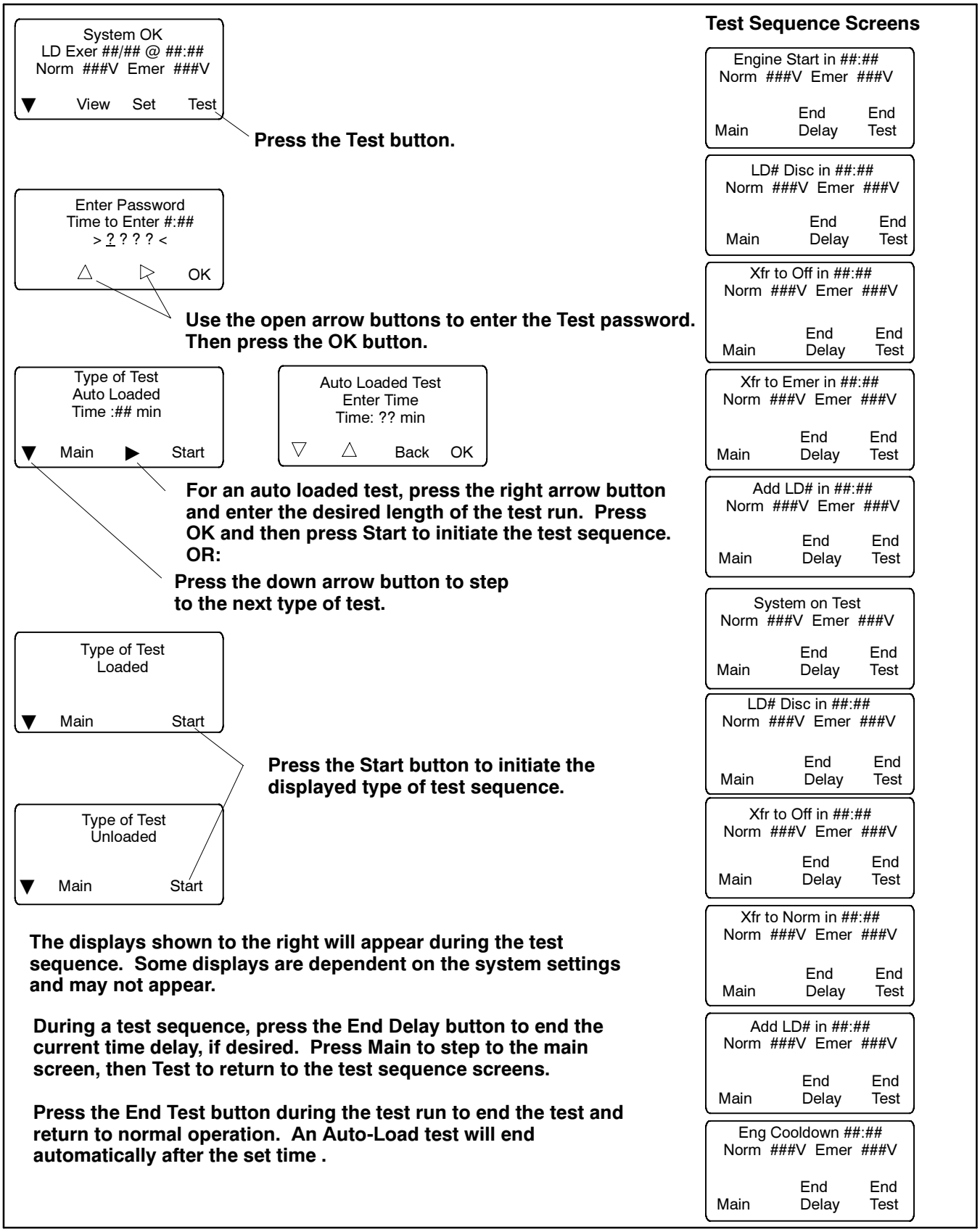


Figure 4-7 Test Sequence Screens

4.5.5 Test Sequence of Operation

Test Function is Activated (Unloaded)

1. The generator set is signaled to start.
2. The generator starts and the standby source becomes available.
3. The load bank control is activated.

Test Function is Deactivated (Unloaded)

1. The load bank control is deactivated.
2. Time delay engine cooldown times out.
3. The generator is signaled to stop.

Test Function is Activated (Loaded)

1. The generator is signaled to start.
2. The generator starts and the standby source becomes available.
3. Time delay preferred-to-standby and pre-transfer load control sequences time out.
4. Load control contacts open.
5. Contactor transfers to standby.
6. Post-transfer load control sequences time out.
7. Load control contacts close.

Emergency Source Fails (Normal Source is available)

1. Test function is de-activated.
2. Load control contacts open.
3. Contactor immediately transfers to preferred.
4. Immediate failure to acquire standby alarm.
5. Post-transfer load control sequences and time delay engine cooldown time out.
6. Load control contacts close.
7. Engine start contacts open.

Test Function is Deactivated (Loaded)

1. Time delay standby-to-preferred and pre-transfer load control sequences time out.
2. Load control contacts open.
3. Contactor transfers to preferred.
4. Post-transfer load control sequences and time delay engine cooldown time out.
5. Load control contacts close.
6. The engine start contacts open, signalling the generator to stop.

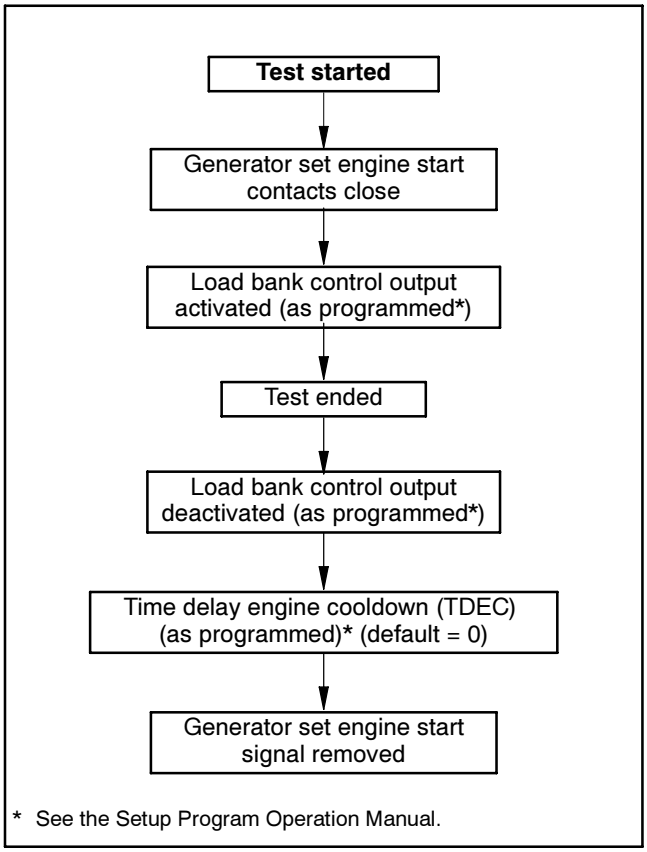


Figure 4-8 Test Without Load Sequence

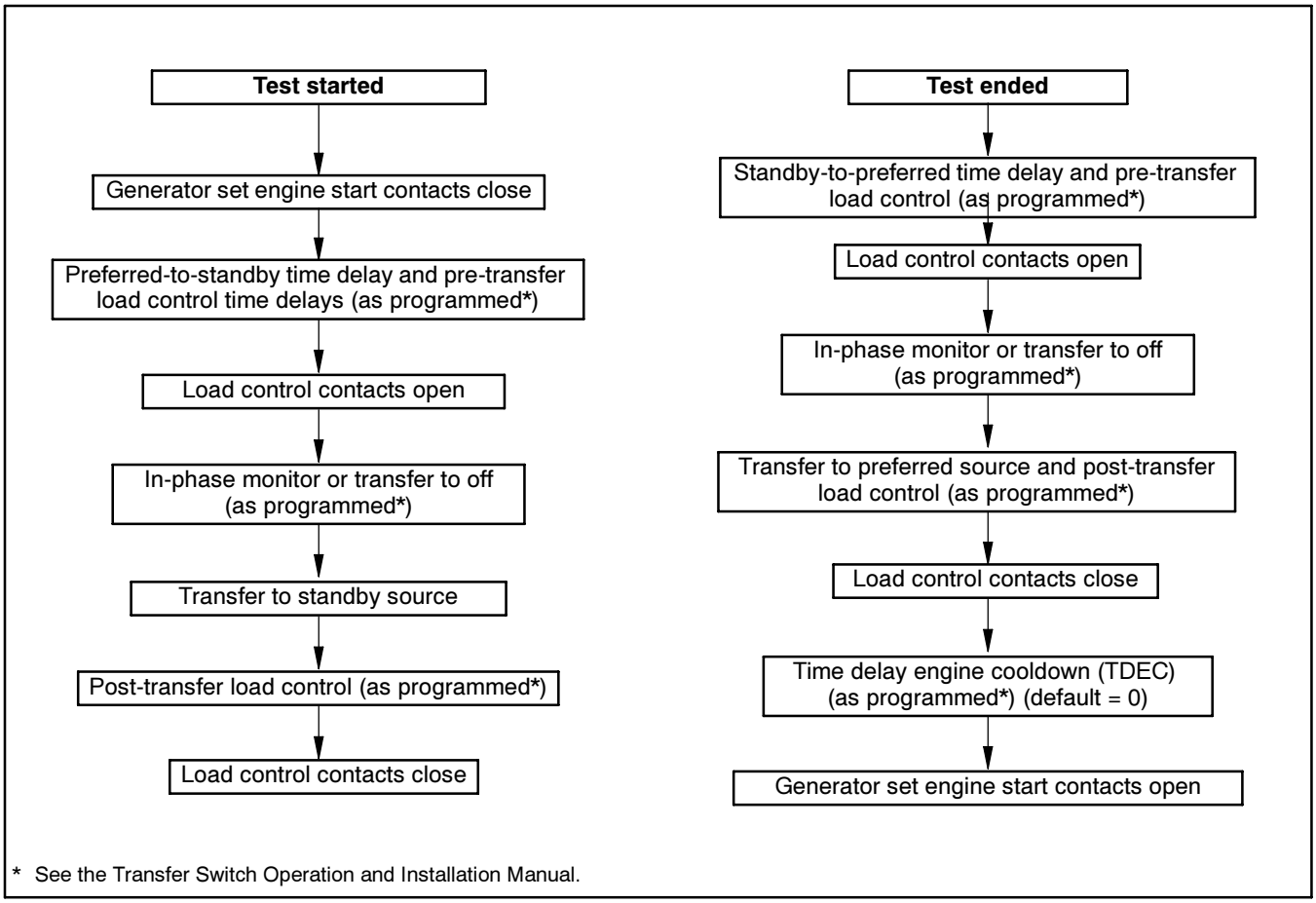


Figure 4-9 Test with Load Sequence

4.6 Exercise

Schedule exercise runs through the Set Exercise screen. See the transfer switch Operation and Installation Manual for instructions. To run the generator set at a time other than a scheduled exercise sequence, use the Test function. See Section 4.5 for instructions.

When a scheduled exercise is running, the screens shown in Figure 4-10 appear. Press Main to return to the main screen, if desired. Press the End button to end the exercise sequence before the scheduled stop time, if necessary.

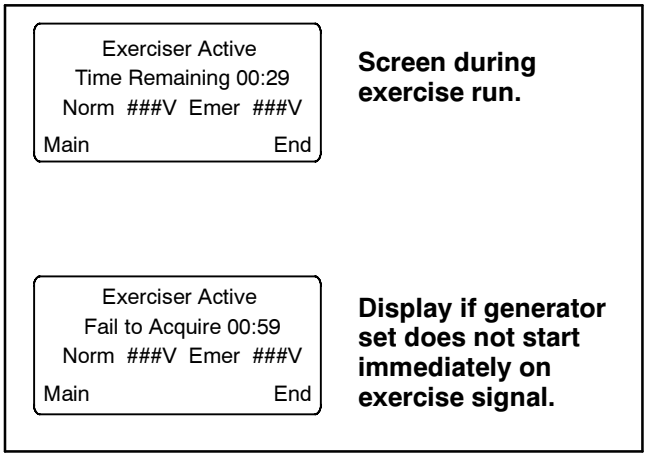


Figure 4-10 Exercise Sequence Screens

4.6.1 Exerciser Sequence of Operation

Exerciser Accessory is activated (Unloaded)

1. Exerciser timer begins.
2. The generator is signaled to start.
3. The generator starts and the standby source becomes available.
4. The load bank control is activated.

Exerciser Accessory is de-activated (Unloaded)

1. The load bank control is de-activated.
2. Time delay engine cooldown times out.
3. The generator is signaled to stop.

Exerciser Accessory is activated (Loaded)

1. Exerciser timer begins.
2. The generator is signaled to start.
3. The generator starts and the standby source becomes available.
4. Time delay preferred-to-standby and pre-transfer load control sequences time out.
5. Load control contacts open.
6. Contactor transfers to standby.
7. Post-transfer load control sequences time out.
8. Load control contacts close.

Emergency Source Fails (Normal Source is available)

1. Exerciser is deactivated.
2. Load control contacts open.
3. Contactor immediately transfers to preferred.
4. Immediate failure to acquire standby alarm.
5. Post-transfer load control sequences and time delay engine cooldown time out.
6. Load control contacts close.
7. Engine start contacts open.

Exerciser Accessory is deactivated (Loaded)

1. Pre-transfer load control sequences time out.
2. Load control contacts open.
3. Contactor transfers to preferred.
4. Post-transfer load control sequences and time delay engine cooldown time out.
5. Load control contacts close.
6. The generator is signaled to stop.

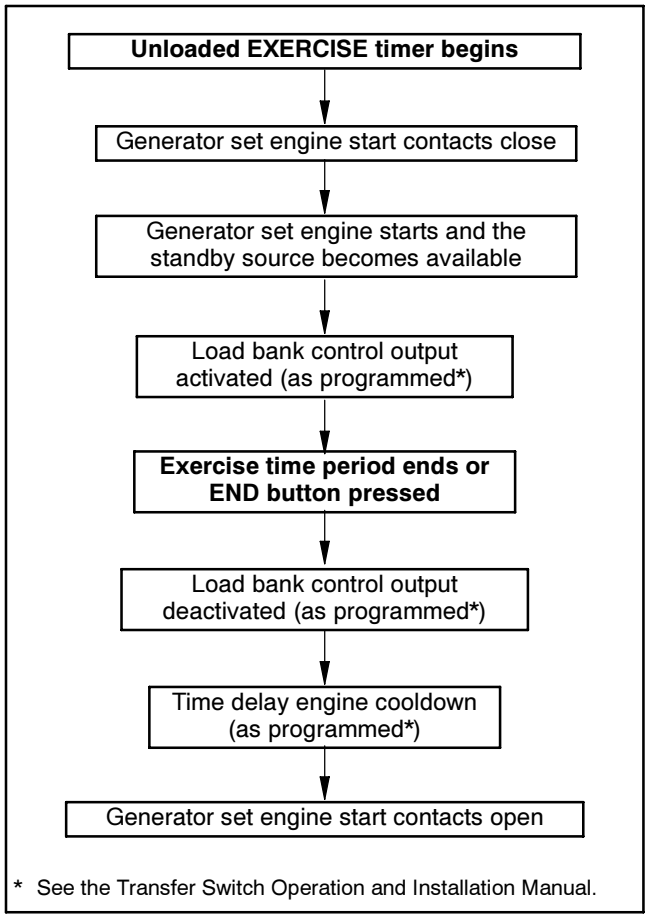


Figure 4-11 Exercise without Load Sequence

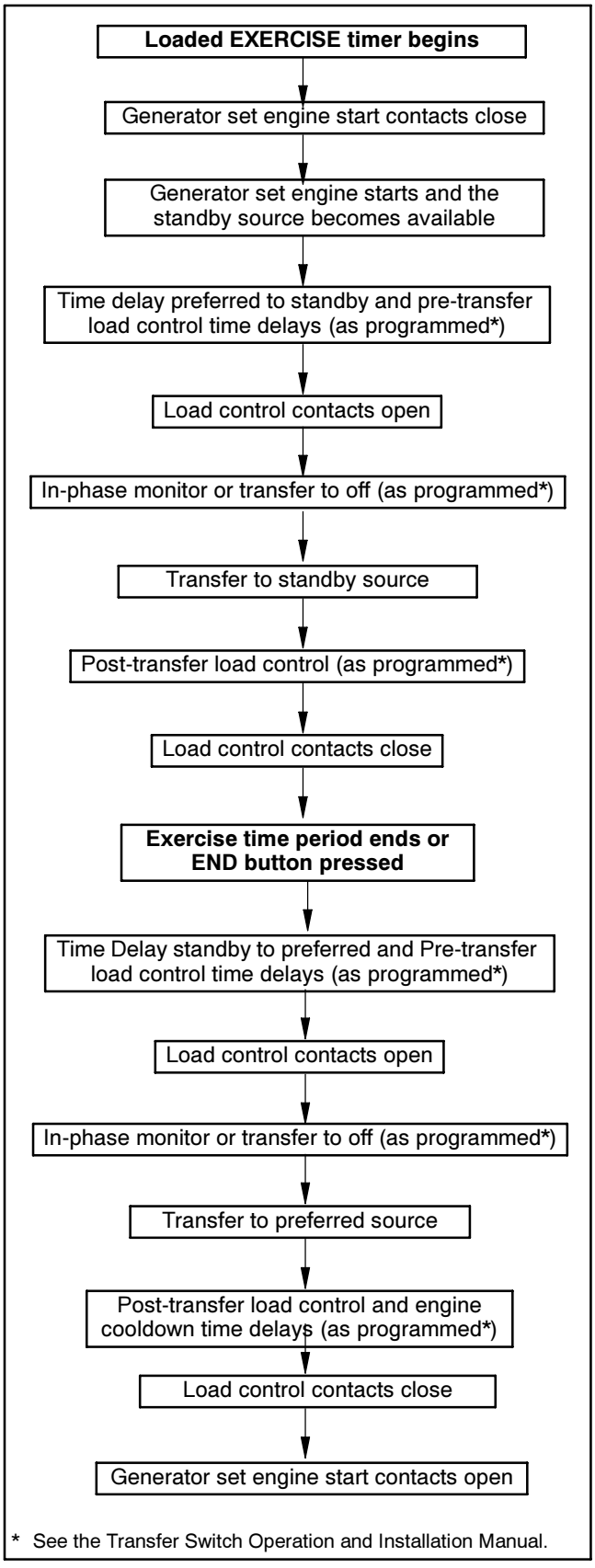


Figure 4-12 Exercise with Load Sequence

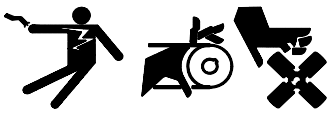
4.7 Engine Start

The engine start contacts should close when the Normal source is lost and when the ATS controller starts a test or exercise sequence. The engine start contacts are labeled with a decal. Check the Operation/Installation Manual or the dimension drawing for the contact location, if necessary.

Use the following procedure to check for continuity across the engine start contacts when the Normal source is disconnected and during a test sequence. Allow time for the engine start and engine cooldown time delays during the test. Refer to the sequence of operation in Sections 4.4 and 4.5 for the applicable time delays.

Be sure to read and follow the safety precautions when performing the test procedure.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

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

Engine Start Test Procedure

Start with the transfer switch in the Source N position.

1. Connect an ohmmeter or test lamp across the engine start contacts at one of the following locations:

   a. Pins 8 and 9 of connector J1 (the transfer switch harness-to-controller connection). See Figure 4-13.

   b. The engine start contacts on the transfer switch contactor or field-connection terminal block. See the decal on the transfer switch or the transfer switch Operation and Installation Manual for the engine start contact location.

   c. The generator set engine start leads. See the generator set documentation for engine start lead identification and location.

2. Disconnect Normal power from the transfer switch and verify that the engine start contacts close.

3. Reconnect Normal power to the transfer switch and verify that the engine start contacts open after applicable time delays.

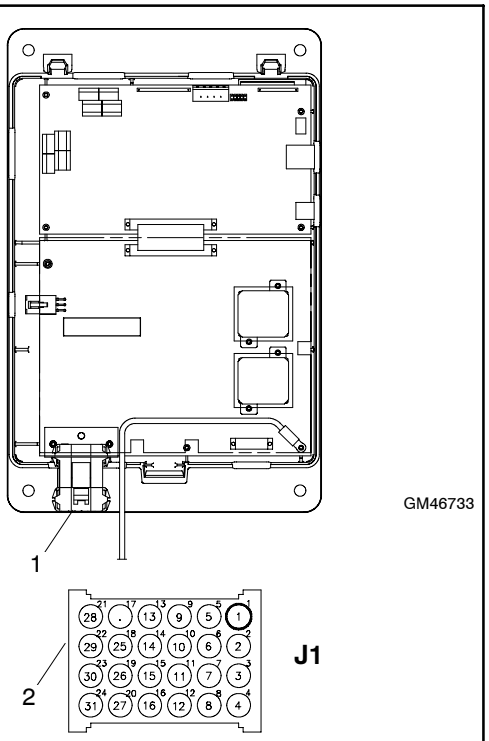
4. If the engine start contacts do not operate as indicated in steps 2 and 3 when power id disconnected and reconnected, replace the ATS controller's power board. See Section 4.14.

5. Press the Test button to initiate a test sequence and verify that the engine start contacts close.

6. Press the End button to end the test. Verify that the engine start contacts open after the engine cooldown time delay (which may be set to zero).

7. If the ATS engine start contacts do not close during the Test Procedure, replace the ATS controller's logic board. See Section 4.14.

If the generator set engine does not start, check the engine start connections to the generator set. Verify that the generator set master switch is in the AUTO position. Troubleshoot the generator set if the engine start connections are good but the engine does not start.



1. Transfer switch harness connection, P1
2. Connector J1 pin numbering

Figure 4-13 Transfer Switch Harness-to-Controller Connection

4.8 Controller DIP Switches

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Two DIP switches on the main logic board are assigned functions. Switches 3 and 4 are not used. The DIP switches are located on the controller's main logic board on the inside of the enclosure door. Figure 4-14 shows the locations of the switches on the controller circuit board. It is not necessary to remove the logic assembly cover to see or adjust the DIP switches.

SW1-1, Password Disable. Closing the password disable DIP switch SW1-1 disables the setup password and resets it to the factory defaults. When the switch is closed, system setup and programming is allowed without the need to enter a password.

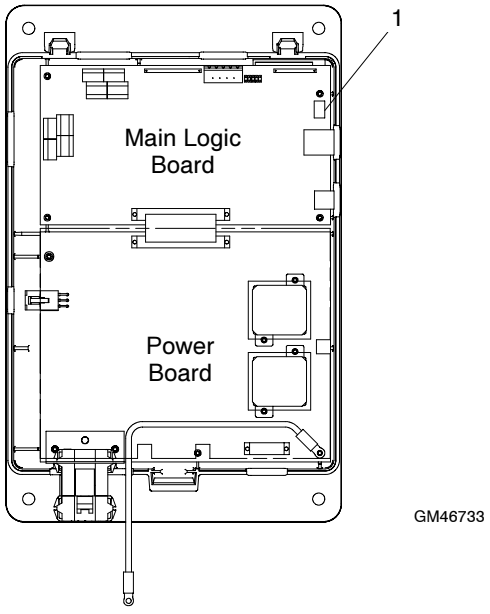
Note: Disable the setup password only during service unless the transfer switch is installed in a secure location.

Closing and then reopening DIP switch SW1-1 resets the password to the default value, 0000.

The test password is not affected by this DIP switch. Use the Reset Data screen to disable the test password.

SW1-2, Maintenance. The maintenance DIP switch inhibits transfer during ATS service. When this switch is in the closed position, contactor functions are disabled. The "Not in Auto" LED flashes red and the message "Maintenance Mode" is indicated on the LCD screen. In addition, a programmable digital output is turned on and an entry in the event log indicates that the maintenance mode has been activated. System monitoring and setup are allowed while in maintenance mode.

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



1. DIP switches SW1

Figure 4-14 DIP Switch Location (cover removed for illustration only)

4.9 Calibration

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Only authorized personnel should open the enclosure.

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

The transfer switch controls are calibrated at the factory and should not require recalibration in the field. However, if recalibration is necessary, measure the source voltages as instructed in Section 3.3.2, record the measured values, and use the Setup Screen–Calibration to enter the measured values. See Figure 4-15.

The current sensing accessory is required in order for the transfer switch to measure and display the current values. Use a clamp-on current sensing meter to measure the current and enter the measured values through the Setup Screen–Calibration shown below.

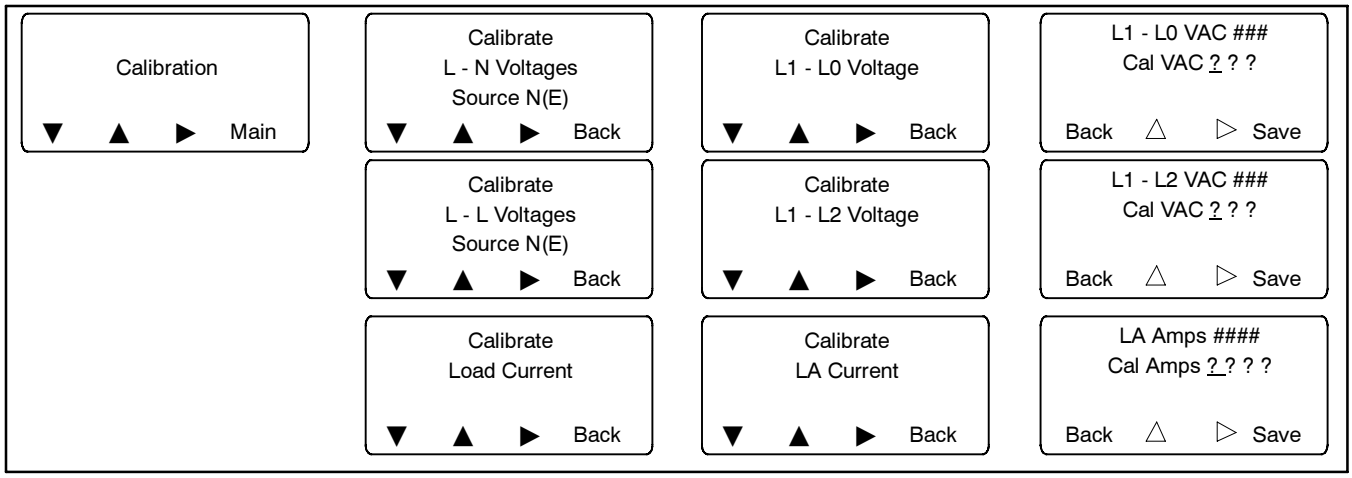


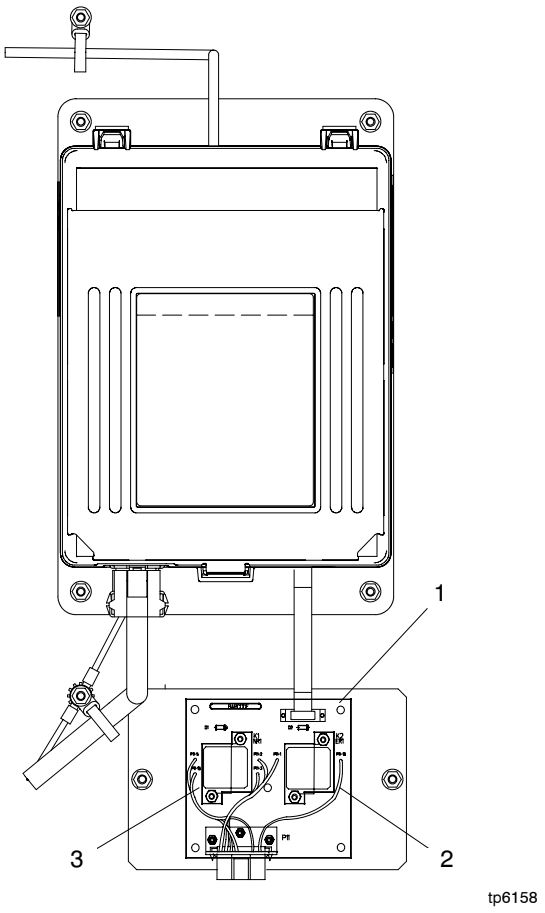
Figure 4-15 Calibration

4.10 Position Microswitch Test

Disconnect power to the transfer switch and use an ohmmeter or test lamp to check the operation of the position microswitches. Manually operate the switch and check for continuity across pins 10 and 13 of the connector P1 for Source E and pins 10 and 14 for Source N.

4.11 Programmed-Transition Interface Board

The programmed-transition interface board (PTIB) contains two replaceable 10-amp relays, K1 (NR1) and K2 (ER1). See Figure 4-16. Refer to the operation sequence diagrams in Section 3.6.2 and to the schematic diagram provided with the transfer switch to troubleshoot the relays.



1. Programmed-Transition Interface Board (PTIB)
2. K2 (ER1) Relay
3. K1 (NR1) Relay

Figure 4-16 Programmed-Transition Interface Board

4.12 File Transfer through the USB Port

The Universal Serial Bus (USB) port on the main logic board allows file transfer to and from a USB mass storage device (removeable drive). Figure 4-17 shows a typical device. The removeable drive must be compatible with the USB 2.0 and USB Mass Storage Device Class specifications.

The controller application code can be updated through the USB port. Parameter settings, event history, and other information files can be saved to the storage device.

The controller recognizes the types of files shown in Figure 4-18.

4.12.1 Configuration files

The configuration (.cfg) file contains the transfer switch settings, including:

- System setup
- Source setup, including voltage and frequency pickup and dropouts
- Time delays
- Inputs and outputs
- Communications settings
- Calibration factors

Configuration files from one transfer switch can be saved to a mass storage device and then loaded onto other transfer switches for quick setup of multiple switches. Serial numbers and descriptions entered through Monitor III software (or other Modbus application) are not changed by downloading configuration files to a transfer switch.

Check the settings and run a test sequence after loading the configuration file to verify correct operation. Refer to the ATS Operation and Installation Manual for instructions to view settings. See Section 4.5 for instructions to run a test.

Loading Settings when Controller is Replaced

If the controller needs to be replaced, the configuration file from the old controller (if available) can be loaded onto the new controller for quick setup.

Note: Operation problems can be caused by incorrect controller settings. Do not load the old configuration file onto the new controller unless you are certain that all the settings in the file are correct.

Note: When replacing the ATS controller, record the contactor and ATS serial numbers from the old controller before removing it, or from the ATS decals.

Serial numbers are not transferred through the configuration file and cannot be entered through the controller's user interface. Use Monitor III (or a customer-provided Modbus driver designed for the system) to enter the contactor and ATS serial numbers after the new controller is installed. A distributor-level password is required to enter serial numbers. Refer to the Monitor III Operation Manual or the Modbus Protocol Manual for instructions, if necessary. Do not attempt to change the controller serial number.

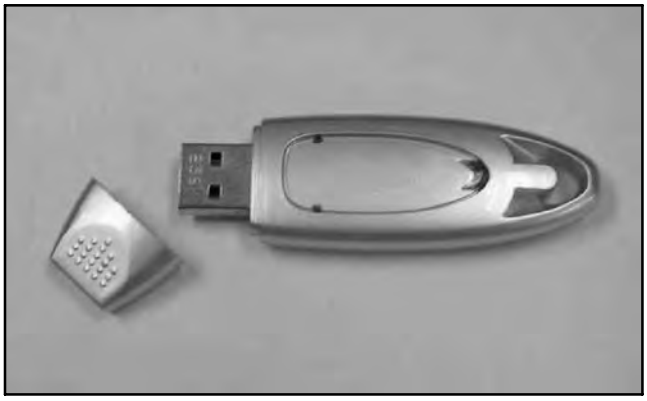


Figure 4-17 Typical Mass Storage Device

File name	Description	Size (approx.)	Download to Control	Upload to USB
MPAC1500v###.bin	Controller application program	950 KB	X	
MPAC1500_#######.cfg	Configuration (parameter settings)	3 KB	X	X
present*yymmdd*.his	Event history	varies		X
alarm_settings.alm	Common alarms	1 KB		X
MPAC1500_cal.cal	Calibration	1 KB		X
history_param.hstp	Internal use only	—		X
Param_back.bak	Internal use only	—		X
present*yymmdd*.raw	Internal use only	—		X
history_pback.hbak	Internal use only	—		X

Figure 4-18 Recognized File Types

4.12.2 File Transfer

The USB Access screen opens automatically when a device is connected to the controller's USB port. See Figure 4-19. Select Upload or Download as described below.

Procedure to Transfer Files

1. Insert the USB mass storage device into the USB port on the controller's main logic board. See Figure 4-5 for the port location.
2. Press the Download button to load new files from a memory device to the controller. Or, press the Upload button to load files from the controller through the USB port to a memory device.
3. Use the down button to scroll through the list of available files.
4. When the desired file is displayed, press the Sel button to select the file and start transferring the file.

   Note: Do not disconnect the device from the USB port during file transfer.

   A message on the display indicates when file transfer is complete.
5. Wait for the message indicating that file transfer is coplete before removing the mass storage device from the USB port.

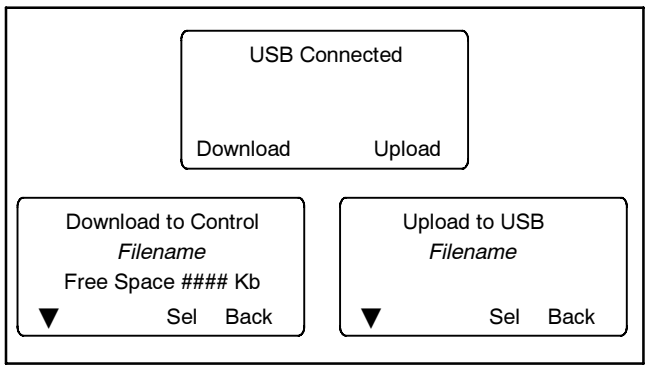


Figure 4-19 USB Access Screens

4.13 Controller Application Program

The manufacturer occasionally releases new versions of the controller application code. The new code can be downloaded from the Tech Tools section of the Kohlernet website (www.Kohlernet.com) and loaded onto the controller through the USB port.

Program Loader software is *not* required for loading code onto the 1500 controller.

To downlod the latest version of the controller application code:

1. Use your SecurID to go to www.Kohlernet.com and click on Tech Tools.
2. Click on Software and then ATS Controllers.
3. Click on MPAC™ 1500 controller and then click on the link to download the latest software version. The file name will be of the form MPAC1500v####.bin, with v#### indicating the version number. For example, MPAC1500v105.bin contains version 1.05 of the application code.
4. Copy the file onto a mass storage device through the computer's USB port.
5. Load the application code file onto the controller as described in Section 4.12.2, File Transfer.

Loading new code does not change the system settings. After loading a new version of code, check the system settings, input/output assignments, time delays, and other parameters to verify that they are correct for the application.

After loading new code, run a loaded test to verify that the system operates correctly. See Section 4.5, System Test.

4.14 Controller Replacement

Always check for open switches or circuit breakers, loose connections, or faulty wiring before replacing any parts. Replace the controller only if the troubleshooting and test procedures in this manual indicate conclusively that the controller is damaged or inoperative.

The controller contains two circuit boards, the logic board and the power board, which can be replaced individually. The entire controller and plastic housing can also be obtained as a complete assembly. Save the old controller's plastic cover, which includes the transfer switch nameplate, for use with the new controller.

4.14.1 Controller Configuration (Settings)

New controllers are shipped with the factory default settings for the system settings, including voltage, frequency, number of phases, phase rotation, and other user-adjustable settings. After installation, the system parameters must be set for the application.

If the old controller is operable, it may be possible to save the configuration file (MPAC1500_######.cfg) to a USB storage device before removing the controller from the transfer switch. The configuration file contains the system parameter settings, including system setup, source setup, time delays, input and output assignments, and communications settings. The configuration file can be loaded onto the new controller after it is installed. See Section 4.12 for instructions to download and upload files through the controller's USB port.

Note: Operation problems can be caused by incorrect controller settings. Do not load the old configuration file onto the new controller unless you are certain that all the settings in the file are correct.

If the configuration settings file is not available, use the controller user interface to check and adjust the system settings for the application. Refer to the Transfer Switch Operation and Installation Manual for instructions.

4.14.2 Circuit Board and Electronic Component Handling

Improper removal, installation, transportation, storage, or service can damage sensitive electronic components. Observe the following guidelines to prevent damage when working with circuit boards or electronic components.

Circuit Board and Electronic Component Handling

- Keep circuit boards or electronic components inside the antistatic, cushioned factory packaging until installation.
- Store circuit boards or electronic components in a clean environment away from moisture, vibration, static electricity, corrosive chemicals, and solvents.
- Disconnect all power sources before removing or installing circuit boards or electronic components.
- Wear an approved, grounded, antistatic wrist strap when handling circuit boards or electronic components.
- Carefully hold the circuit board by its edges and not by any of its components or electrical contacts.
- Do not drop the circuit board or electronic components.
- Do not bend the circuit board, electronic components, or electronic component leads.
- Do not strike the circuit board or electronic components using or against a hard object.
- Clean dusty or dirty circuit boards with a vacuum cleaner or soft, dry brush.
- Never attempt circuit board repairs, adjustments, or modifications other than replacing plug-in service parts or performing manufacturer-approved installation or service procedures.

4.14.3 Replacement Procedure

Before removing the old controller, refer to Section 4.14.1. It may be possible to download the system settings from the controller to a file that can later be loaded onto the new controller for more efficient system setup.

Disconnect power to the transfer switch before starting to disconnect the controller. Observe the following safety precautions to avoid injury or equipment damage.

Note: Model KGS/KGP transfer switches use a different power board than other models with MPAC 1500 controls. Refer to Parts Catalog TP-6433 for the correct part numbers.

⚠ 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.

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

Controller Replacement Procedure

1. Move the generator set master switch to the OFF position.
2. Disconnect the generator set engine starting battery, negative (-) lead first.
3. Disconnect power to the transfer switch by opening switches or circuit breakers to the switch.

Remove the old controller.

4. Open the transfer switch enclosure.
5. Check the voltage at the source lugs to verify that the power is off.
6. Disconnect the transfer switch harness at the P1 connector at the bottom of the controller. See Figure 4-5.
7. Disconnect the programmed-transition board, if equipped, from the controller at connector P2.
8. Disconnect the controller ground wire at the ring terminal on the enclosure door.
9. Disconnect the accessory module assembly at connector P16 at the top of the controller, if connected.
10. Remove the plastic cover from the old controller and save it to install on the new controller assembly.

    Note: The cover includes the transfer switch nameplate, which must remain with the transfer switch.

    To remove the cover, depress the latch at the bottom of the cover. Swing the cover open on its hinges and lift it off.

11. Label and then disconnect any input and output leads connected to terminal strip TB1 on the logic board. See Figure 4-5.
12. Label and then disconnect the RS-485 communication cable from terminal strip TB2 on the logic board (if connected). See Figure 4-5.
13. Disconnect any other communications connections to the ethernet port or the USB port. See Figure 4-5 for connector identification.
14. Disconnect the current sensing accessory at connector P3, if equipped.

15. **To replace the entire controller assembly:**

    a. Support the controller assembly and remove four nuts at the corners.

    b. Carefully remove the entire controller assembly, including the user interface panel, which is part of the assembly.

    c. Replace the entire assembly with a new controller. Secure the four nuts at the corners and tighten them to no more than 6.8 Nm (5 ft. lbs. or 60 in lbs.) torque.

    d. Proceed to step 18.

16. **To replace the logic circuit board:**

    a. Disconnect the ribbon cable connecting the two circuit boards.

    b. Disconnect the ribbon cables to the user interface at connectors P14 and P17.

    c. Remove the four mounting screws near the corners of the board and pull the circuit board straight off the carrier.

    d. Set the new circuit board in placeand secure with four mounting screws.

    e. Reconnect the ribbon cables.

    f. Proceed to step 18.

17. **To replace the power board:**

    Note: Model KGS/KGP transfer switches use a different power board than other models with MPAC 1500 controls. Refer to Parts Catalog TP-6433 for the correct part numbers.

    a. Disconnect the ribbon cable connecting the two circuit boards.

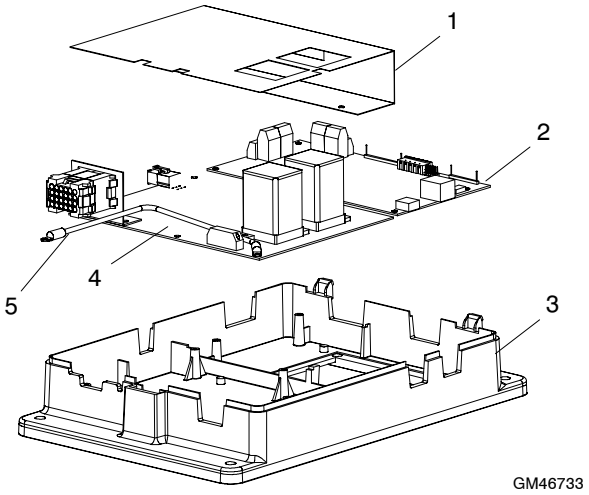
    b. Remove the three mounting screws plus the P1 connector bracket screws and four screws securing the power relays must be removed.

    c. Set the new power board and insulating cover in place. Install the mounting screws, making sure to reinstall the ground lead and the P1 connector with mounting bracket.

    Note: Be sure to reinstall the insulating cover for the power board. See Figure 4-20.

    d. Reconnect the ribbon cable between the boards.

    e. Proceed to step 18.



1. Insulator, power board
2. Logic board
3. Carrier
4. Power board
5. Ground lead

Figure 4-20 Controller Circuit Board Assembly

Reconnect the controller assembly.

18. Connect the controller ground wire to the terminal on the enclosure door. See Figure 4-5.

19. Connect the programmed-transition board, if equipped, to the controller at connector P2. See Figure 4-5.

20. Connect the I/O leads to logic board terminal strip TB1, using the labels attached in step 11 to connect the leads to the appropriate terminals. See Figure 4-5.

21. Connect RS-485 communication cable, if used, to logic board terminal strip TB2, using the labels attached in step 12 to connect the leads to the appropriate terminals. See Figure 4-5.

22. Connect the accessory module assembly (if equipped) at connector P16.

23. Reconnect any other items that were disconnected from the controller. See Figure 4-5 for connector identification.

24. Connect the transfer switch harness to the connector on bottom of the controller.

25. Check the controller's DIP switch settings and adjust them if necessary. See Section 4.8, Controller DIP Switches.

26. Close and lock the transfer switch enclosure door.

27. Reconnect power to the transfer switch by closing circuit breakers or switches.

    Note: Power to the controller is required in order to check and adjust the controller settings. If all the power sources are generator sets, reconnect the normal source generator set engine starting battery and move the generator set master switch to the AUTO position.

Set up the new controller.

28. If the configuration settings (.cfg) file for the transfer switch was downloaded from the old controller, load it onto the new controller through the USB port. See Section 4.14.1. See Section 4.12 for instructions to load the file.

29. If the configuration settings file cannot be loaded through the USB port, use the controller user interface to check and adjust the system settings for the application. Refer to the Transfer Switch Operation and Installation Manual for setup instructions.

    Note: Contactor and ATS serial numbers can only be entered through Modbus using Monitor III or a customer-supplied Modbus driver and the distributor-level password.

Check settings and verify operation.

30. Check the system settings and adjust them, if necessary. Check the system voltage, frequency, number of phases, phase rotation, time delays, and other user-adjustable settings. Refer to the Transfer Switch Operation and Installation Manual for instructions.

31. Reconnect the generator set engine starting battery, negative (–) lead last.

32. Move the generator set master switch to the AUTO position.

33. From the main screen, press the down arrow button and then press the LAMP TEST button to verify that all LEDs light.

34. Run a loaded test to check the system operation. See Section 4.5, System Test.

Notes

5.1 Introduction

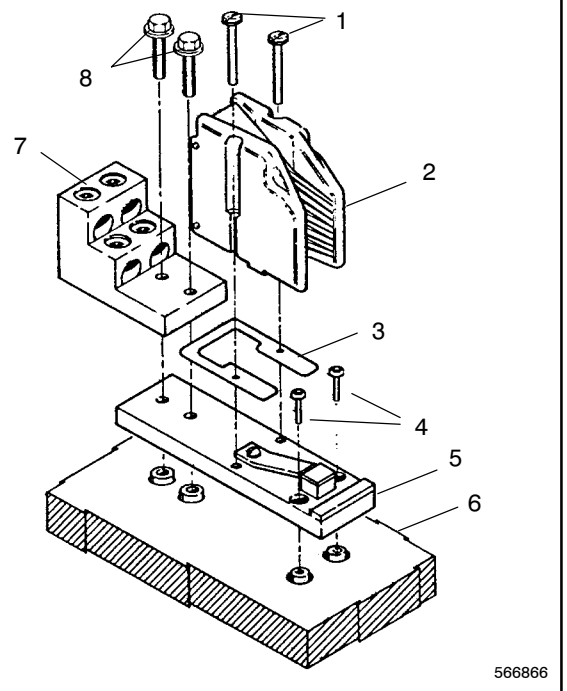
This section contains component removal and replacement procedures for Model KGS/KGP bypass/isolation switches. This section contains information available at the time of publication.

5.2 Contact Assembly Removal and Replacement

5.2.1 800–1200 Amp Models

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the generator set master switch to STOP and disconnect the negative (–) battery cable from the generator set starting battery. Locate the generator set master switch on the generator set control panel.

Refer to Figure 5-1 and Figure 5-2 for the following procedure.

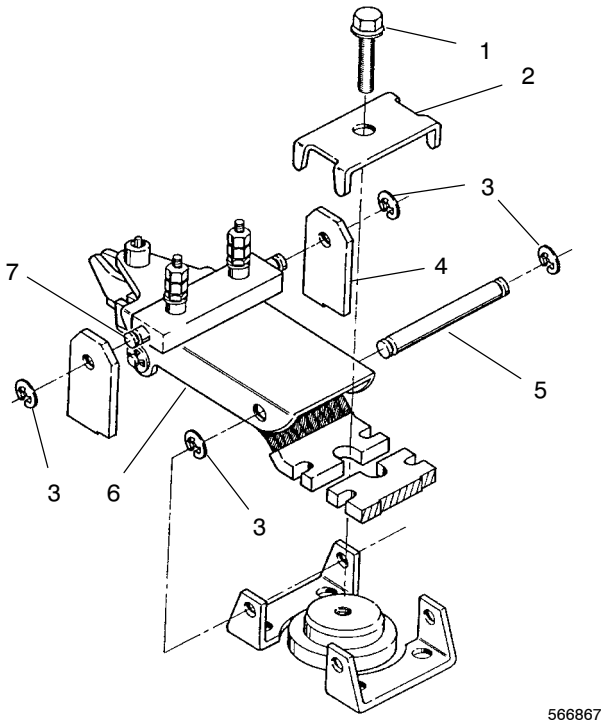


1. Arc chute retaining screws
2. Arc chute
3. Arc chute pad
4. Machine screws
5. Stationary contact assembly
6. Transfer switch panel
7. Lug terminal
8. Hex head cap screw

Figure 5-1 Stationary Contact, 800–1200 Amp

Removing Contact Assemblies, 800–1200 Amp Models

1. Remove the machine screws and flat washers that secure the blue plastic switch cover.
2. Remove the cover.
3. Manually place the movable contact assembly in the open position.
4. Remove the screws that secure the arc chute.
5. Remove the arc chute and arc chute pad.
6. Remove the two retaining rings and slide the actuator arms from the contact posts.
7. Remove one of the retaining rings from the pivot pin.



1. Bus stub bolt
2. Clamp bracket
3. Retaining ring
4. Actuator arms
5. Pivot pin
6. Movable contact assembly
7. Contact posts

Figure 5-2 Movable Contact, 800–1200 Amp

8. Slide out the pivot pin.

9. Remove the bus stud bolt, compression washer, and clamp bracket.

10. Remove the movable contact assembly.

11. If replacing the stationary contact, proceed to step 12. If not replacing the stationary contact, proceed to the replacement procedure.

12. Remove the hex head cap screws and the compression washers (2) that secure the lug terminal.

13. Remove the machine screws (2) that secure the other end of the stationary contact to the transfer switch panel.

14. Remove the stationary contact.

Replacing Contact Assemblies, 800–1200 Amp Models

Refer to Figure 5-1, Figure 5-2, Figure 5-4, Figure 5-3, and Figure 5-5 for the following procedure:

1. If replacing the stationary contact, position the new stationary contact on the transfer switch panel.

2. Secure the new stationary contact and the lug assembly using hex head cap screws, compression washers, and machine screws (2).

3. Torque the cap screws to 31.2 Nm (23 ft. lb.) and the machine screws to 13.6 Nm (10 ft. lb.).

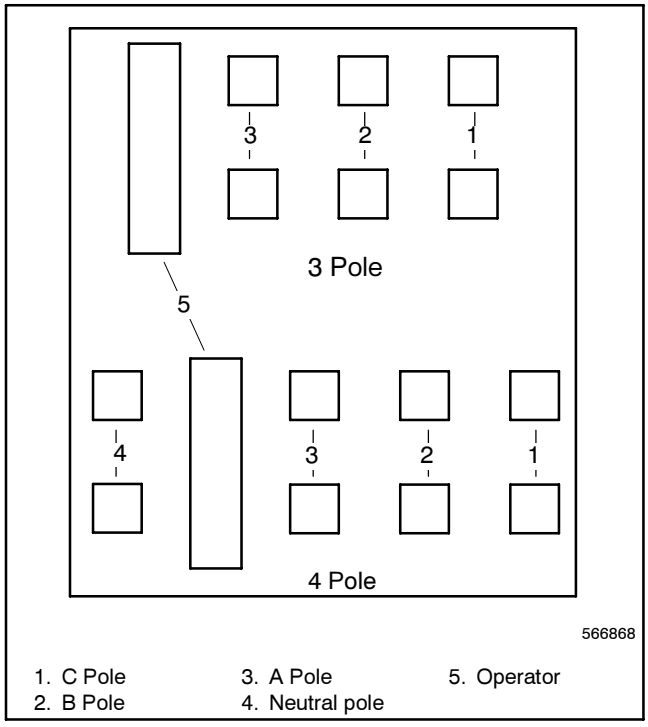
4. Using the new hardware supplied with the contact assemblies kit secure the new movable contact assembly with the bus stud bolt, compression washer, and clamp bracket.

5. Torque the bus stud bolt to 31.2 Nm (23 ft. lb.)

6. Install the pivot pin and secure with the retaining ring.

7. Connect the actuator arms to the contact posts and secure with the two retaining rings. See Figure 5-2.

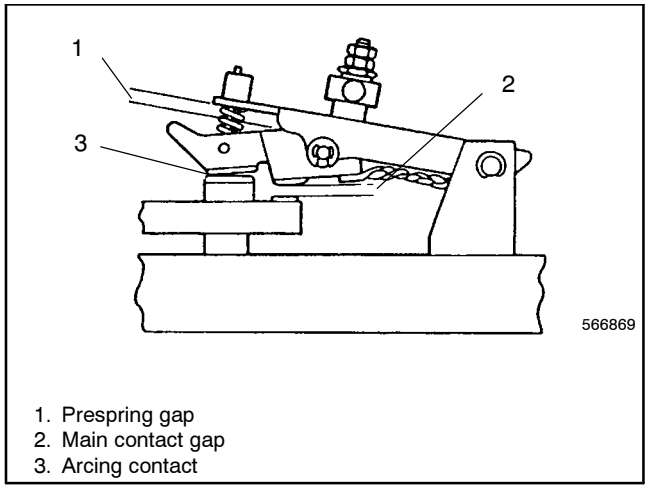
8. Adjust the contacts (steps 9, 10, 12, and 13) in the sequence shown in Figure 5-3. For 3-pole switch all contacts should close at approximately the same time. For 4 pole switches poles A, B, and C should close at approximately at the same time. The neutral pole should close approximately 12.7 mm (1/2 in.) before the other three poles.



1. C Pole
2. B Pole
3. A Pole
4. Neutral pole
5. Operator

Figure 5-3 Contact Adjustment Order

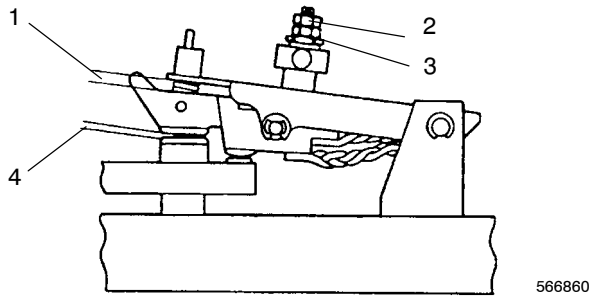
9. Manually close the contacts until the arcing contacts touch. See Figure 5-4. The main contacts should have a 1.59 mm (1/16 in.) minimum gap. If they do not, reject the contact assembly. Measure and record the prespring gap.



1. Prespring gap
2. Main contact gap
3. Arcing contact

Figure 5-4 Contact Adjustment Part 1

10. Close the contacts fully. See Figure 5-5.



1. Spring gap
2. Locknuts
3. Adjustment screw
4. arcing contacts 0.003 gap

Figure 5-5 Contact Adjustment Part 2

11. Rock the arcing contact from toe to heel and verify that there is a 0.0762 mm (0.003 in.) minimum gap at the arcing contacts. The feeler gauge must enter 1.59 mm (1/16 in.) past the edge of the silver.

12. Adjust the spring gap dimension to 3.175 mm (1/8 in.) maximum to 1.59 mm (1/16 in.) minimum deflection on the mains less than the prespring gap, measured in step 9, bias to 1.59 mm (1/16 in.)

13. Turn the adjustment screw by hand to set the spring gap dimension.

14. Lock the setting by tightening the locknuts.

15. Check both sides of the main contacts to ensure they are level. Recheck the arc contact to make sure that it has not changed.

16. Secure the arc chute and arc chute pad with the two machine screws.

17. Check the operation of the transfer switch by manually opening and closing the switch assemblies.

18. Reinstall and secure the blue plastic cover.

19. Close cabinet door.

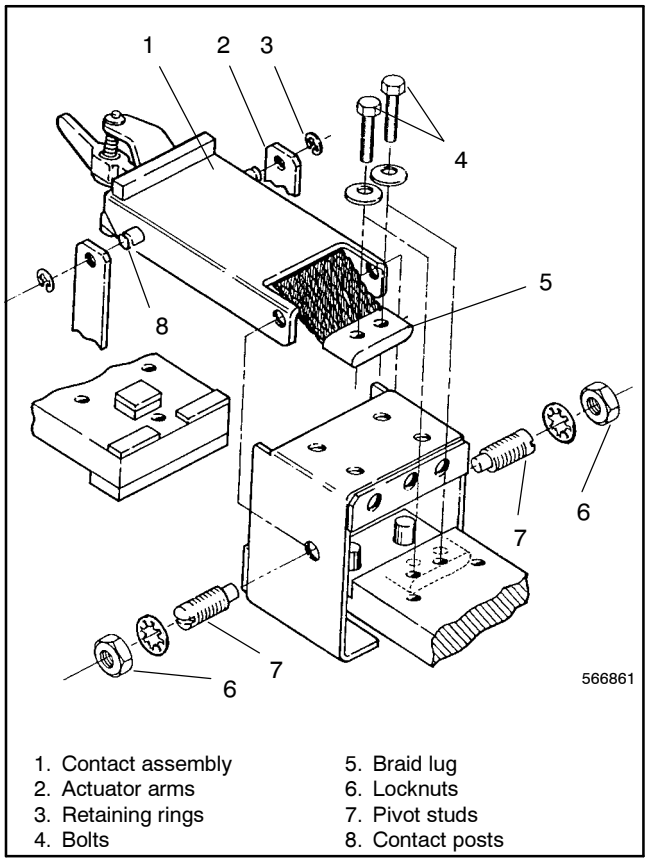
20. Reconnect the normal power source and the emergency power source. If a generator set is the emergency power source, connect the negative (-) battery cable to the starting battery and place the generator set master switch in its original position.

21. Test the switch for proper operation.

5.2.2 1600-2000 Amp Models

Removing Contact Assembly, 1600-2000 Amp Models

Refer to Figure 5-1 and Figure 5-6 for the following procedure:



1. Contact assembly
2. Actuator arms
3. Retaining rings
4. Bolts
5. Braid lug
6. Locknuts
7. Pivot studs
8. Contact posts

Figure 5-6 Movable Contact, 1600-2000 Amp

1. Remove the machine screws and flat washers that secure the blue plastic switch cover.

2. Remove the cover.

3. Remove the screws that secure the arc chute.

4. Remove the arc chute and arc chute pad.

5. Manually place the movable contact assembly that will be removed in the open position.

6. Remove the two retaining rings and slide the actuator arms from the contact posts. See Figure 5-6.

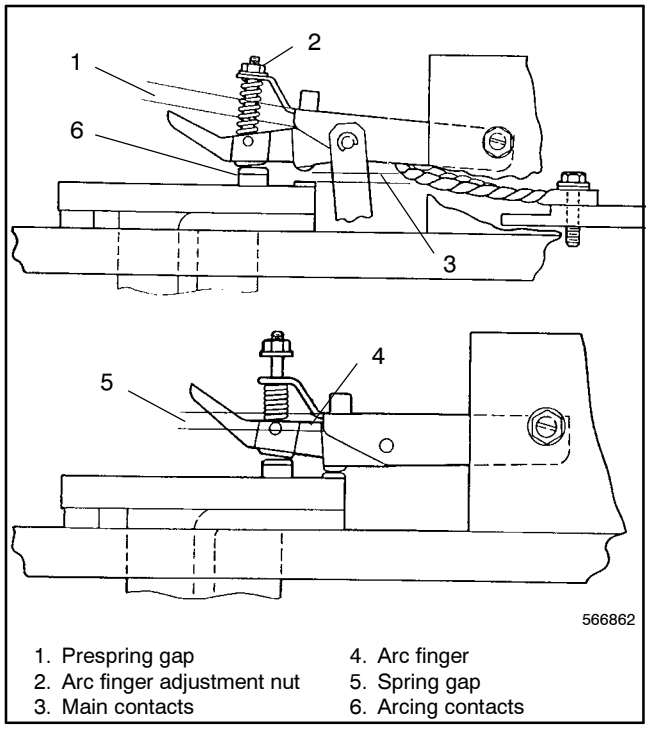
7. Remove the bolts and compression washers (2) from the braid lug.

8. Loosen the locknuts and remove the pivot studs.

9. Remove the contact assembly.

Replacing Contact Assembly 1600-2000 Amp Models

Refer to Figure 5-6 and Figure 5-7 for the following procedure:



1. Prespring gap
2. Arc finger adjustment nut
3. Main contacts
4. Arc finger
5. Spring gap
6. Arcing contacts

Figure 5-7 Contact Adjustment

1. Secure the new movable contact assembly with the pivot studs, locknuts, and lock washers.
2. Torque the locknuts to 13.6 Nm (10 ft. lb.).
3. Secure the braid lug with the braid lug bolts and compression washers.
4. Torque the bolts to 31.2 Nm (23 ft. lb.).
5. Connect the actuator arms to the contact posts and secure with the two retaining rings.
6. Manually close the contacts slowly until the arcing contacts touch. The main contacts should have 6.35 mm (1/4 in.) minimum gap. If not, adjust the arc finger adjustment nut as required. If the contacts cannot be brought within specifications, reject the contact assembly.
7. Measure and record the gap at the prespring gap.
8. Close the contacts fully.
9. Rock the arcing contact from toe to heel and verify that there is a 0.0762 mm (0.003 in.) minimum gap at the arcing contacts. The feeler gauge must enter 1.59 mm (1/16 in.) past the edge of the silver.
10. The spring gap dimension must be 1.59 mm (1/16 in.) less than prespring gap measured in step 7. If the contacts are not within specs, reject the contact assembly.
11. Check that the contact pressure of each of the three outside main contacts is between 1.7-2 kg (3.75-4.5 lb.).
12. Check that the contact pressure of the arc finger is between 4-6.4 kg (9-14 lb.).
13. Check that both main and arc contact fingers are not bottomed out when closed.
14. Secure the arc chute and arc chute pad with the two machine screws.
15. Check the operation of the transfer switch by manually opening and closing the switch assemblies.
16. Reinstall and secure the blue plastic cover.
17. Close cabinet door.
18. Reconnect the normal power source and the emergency power source. If a generator set is the emergency power source, connect the negative (-) battery cable to the starting battery and place the generator set master switch in its original position.
19. Test the switch for proper operation.

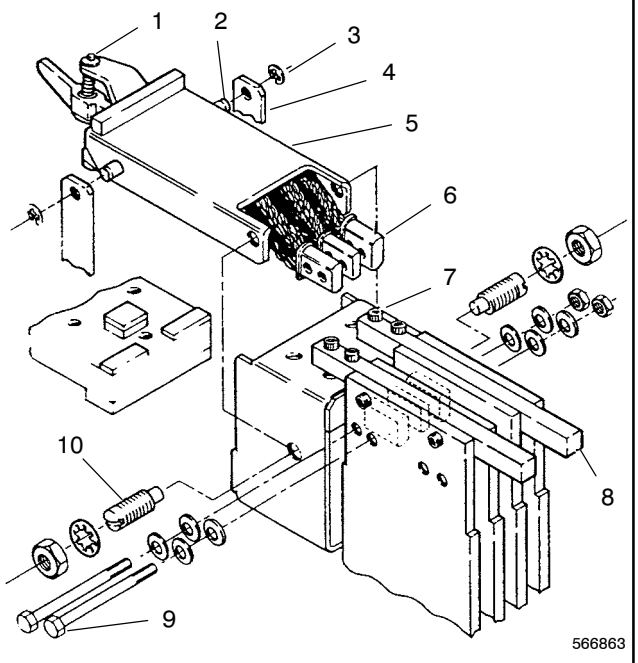
5.2.3 3000 Amp Model

Removing Contact Assembly, 3000 Amp Model

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the generator set master switch to OFF/RESET and disconnect the negative (–) battery cable from the generator set starting battery. Locate the generator set master switch on the generator set control panel.

Note: Replace the B-phase contact assembly only by first removing two bolts from the adjacent C-phase contact assembly. Refer to step 7b. for this replacement procedure.

Refer to Figure 5-1 and Figure 5-8 for the following procedure:



1. .Arc finger adjustment nuts
2. Contact post
3. Retaining rings
4. Actuator arms
5. Contact assembly
6. Braid lug
7. Socket head cap screws
8. Anchor bars
9. Braid lug bolts
10. Pivot studs

Figure 5-8 Movable Contact A or C Phase, 3000 Amp

1. Remove the machine screws and flat washers that secure the blue plastic switch cover.
2. Remove the cover.
3. Remove the screws that secure the arc chute.
4. Remove the arc chute and arc chute pad.
5. Manually place the movable contact assembly that will be removed in the open position.
6. Remove the two retaining rings and slide the actuator arms from the contact posts.
7. Remove the twelve 1/4-20 socket head cap screws from the load bus assembly and lift out the anchor bars. The longer cap screws are used on the sides.

   a. To remove an A-phase, C-phase, or neutral contact assembly: Remove the bolts, nuts, and compression washers that secure the braid lugs to the bus bars. To remove a B-phase contact assembly follow the procedure described in step 7b.

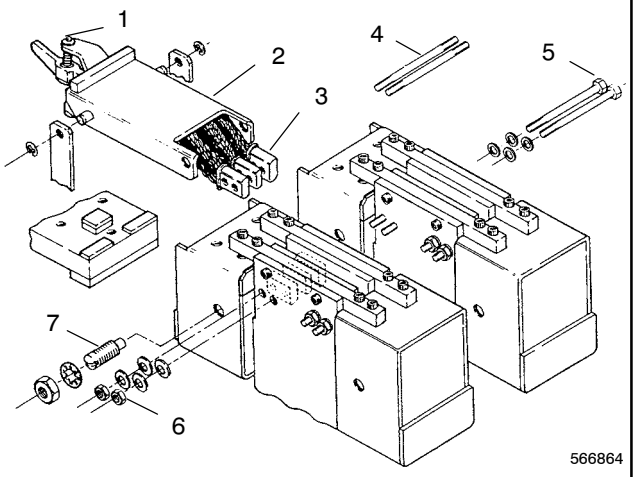
   b. To remove a B-phase contact assembly:

   - Remove the nuts and compression washers from the ends of the braid lug studs.
   - Remove the nut and washers from the lower bolt on the C-phase braid lug.
   - Remove the bolt.
   - Slide the lower B-phase threaded stud into the hole where the C-phase bolt had been.
   - Repeat this procedure with the upper C-phase bolt and corresponding upper B-phase stud. Keep the threaded studs in the C-phase assembly to hold the C-phase braid lugs in position.

8. Loosen the locknuts and remove the pivot studs.
9. Remove the contact assembly.

Replacing Contact Assembly, 3000 Amp Model

Refer to Figure 5-7, Figure 5-8, and Figure 5-9 for the following procedure:



1. Arc finger, adjustment nut
2. Contact assembly
3. Braid lug
4. B-Phase braid lug studs
5. C-Phase braid lug bolts
6. Braid lug nuts and washers
7. Pivot stud

Figure 5-9 Movable Contact B Phase, 3000 Amp

1. Secure the new movable contact assembly with the pivot studs, locknuts, and lock washers. Torque the locknuts to 13.6 Nm (10 ft. lb.).

2. To replace an A-phase, C-phase, or neutral contact assembly secure the braid lugs to the bus bars with the bolts, nuts and compression washers. Torque the nuts to 19 Nm (14 ft. lb.). To replace a B-phase contact assembly, follow the procedure described in step 3b.

   OR

3. To replace a B-phase contact assembly:

   a. Use a bent wire to align the bus bar holes with the braid lug holes.

   b. Use the braid lug bolts that were removed from the C-phase assembly to push the B-phase braid lug studs back into position in the B-phase assembly. Tap the bolts lightly with a hammer, if necessary.

   c. Secure the B-phase studs and C-phase bolts with compression washers and nuts. Torque the nuts to 19 Nm (14 ft. lb.).

4. Install the anchor bars on the load bus assembly with twelve 1/4-20 socket head cap screws. The longer cap screws are used on the sides. Torque the cap screws to 10.2 Nm (90 in. lb.).

5. Connect the actuator arms to the contact posts and secure with two retaining rings.

6. Close the contacts slowly until the arcing contacts touch. The main contacts should have a 6.35 mm (1/4 in.) minimum gap. If they do not, adjust the arc finger adjustment nut as required. If the contacts cannot be brought within specifications, reject the contact assembly.

7. Measure and record the prespring gap.

8. Close the contacts fully.

9. Rock the arcing contact from toe to heel and verify that there is an 0.0762 mm (0.003 in.) minimum gap at the arcing contact. A feeler gauge must enter 1.59 mm (1/16 in.) past the edge of the silver.

10. The spring gap dimension must be 1.59 mm (1/16 in.) less than the prespring gap dimension measured in step 7. If the contacts are not within specifications, reject the contact assembly.

11. Check that the contact pressure of each of the three outside main contacts is between 1.7–2 kg (3.75–4.5 lb.). Check that the contact pressure of the arc finger, is between 4–6.4 kg (9–14 lb.).

12. Check that both main and arc contact fingers are not bottomed out when closed.

13. Secure the arc chute and arc chute pad with two machine screws.

14. Check the operation of the transfer switch by manually opening and closing the switch assemblies.

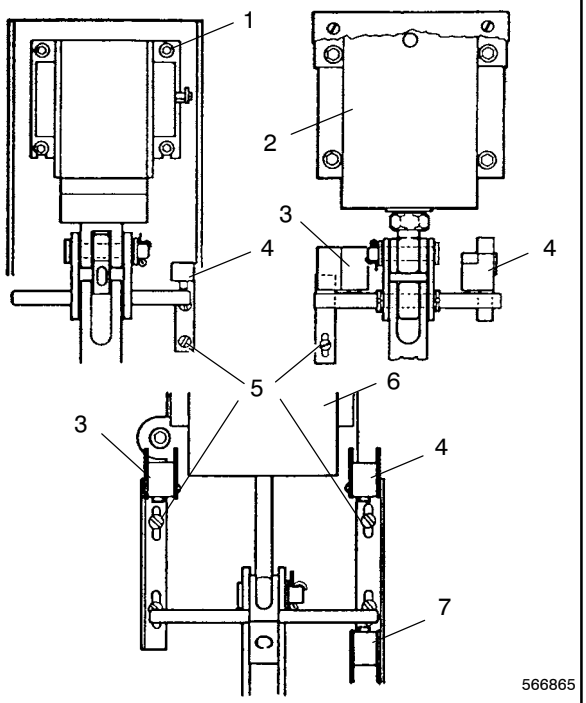
15. Reinstall and secure the blue plastic cover.

16. Close the cabinet door.

17. Reconnect the normal power source and the emergency power source. If a generator set is the emergency power source, connect the negative (–) battery cable to the starting battery and place the generator set master switch in the Auto (or Remote) position.

18. Test the switch for proper operation.

5.3 Auxiliary Switch Removal and Replacement



1. 1200 amp 2-position switches
2. 1600–3000 amp 2-position switches
3. SE switches
4. SN switches
5. Mounting screws
6. 1200–3000 amp 3-position switches
7. SNO switches

Figure 5-10 Auxiliary Switch

Disconnect both the normal and emergency power sources from the transfer switch before servicing. If a generator set provides standby emergency power, turn the generator set master switch to OFF/RESET and disconnect the negative (–) battery cable from the set starting battery.

Removing and Replacing Auxiliary Switch Assembly

1. Remove the four machine screws, if applicable, and lift off the metal solenoid cover.

2. Remove the two mounting screws that secure the bracket-mounted switch assembly to the panel.

3. Before disconnecting the control wiring leads from the auxiliary switch, observe and note the switch terminal markings, NO, NC, and C, and which wire connects to each.

4. Disconnect the wires and connect them to the corresponding terminals of the replacement switch assembly.

5. Install the new auxiliary switch assembly with the two mounting screws.

6. Manually operate the transfer switch to make sure that the new auxiliary switch trips. Listen for an audible click when the switch trips.

7. Check the following on the new auxiliary switch:

   a. SN/SNO and SE/SEO pairs are adjusted to have the same over travel.

   b. The auxiliary switch trips 1.59 mm (1/16 in.) before it reaches its fully seated position.

   c. After the auxiliary switch trips, there must be over travel to ensure good switch operation.

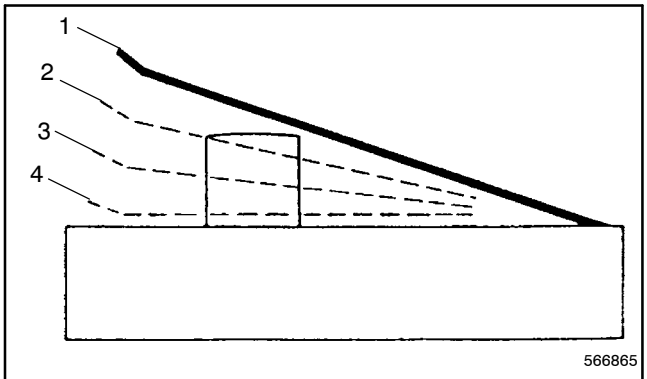
   d. Do not force the auxiliary switch into the fully operated position.

   e. The auxiliary switches that operate as the main contacts are closing should trip just as the contact mechanism reaches the over-center point.

8. Close the cabinet door.

9. Reconnect the normal power source and emergency power source. If a generator set is the emergency power source, connect the negative (–) battery cable to the starting battery and place the generator set master switch in the Auto or Remote position.

10. Test the switch for proper operation.



1. Full release position
2. Trip position
3. Over travel position
4. Fully operated position

Figure 5-11 Auxiliary Adjustment

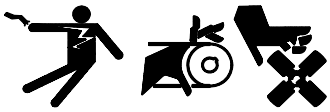
Notes

6.1 Introduction

This section contains instructions for component replacement on model KSS standard-transition transfer switches. See Section 7 for programmed-transition switches.

Observe the following safety precautions when performing any service procedures on the transfer switch.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

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

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

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

6.2 Microswitch Replacement

Required tools and equipment:
Basic electricians hand tools
Microswitch
Required protective equipment:
Rubber insulating gloves class 0
Safety glasses
Electrical hazard safety shoes

6.2.1 40–260 Amp

Microswitch Replacement Procedure

1. Prevent all connected generator sets from starting.
   a. Place the generator set master switch in the OFF position.
   b. Disconnect the power to the battery charger, if equipped.
   c. Disconnect the generator set engine starting battery(ies), negative (–) lead first.

      Note: On systems with multiple transfer switches connected to a single generator set, disconnect all power sources to the generator set before proceeding.
2. Disconnect power to the transfer switch.
3. Open the transfer switch enclosure.
4. Verify zero volts across each phase.
5. Note the location of the fast-on connectors to the microswitch terminals. See Figure 6-1.

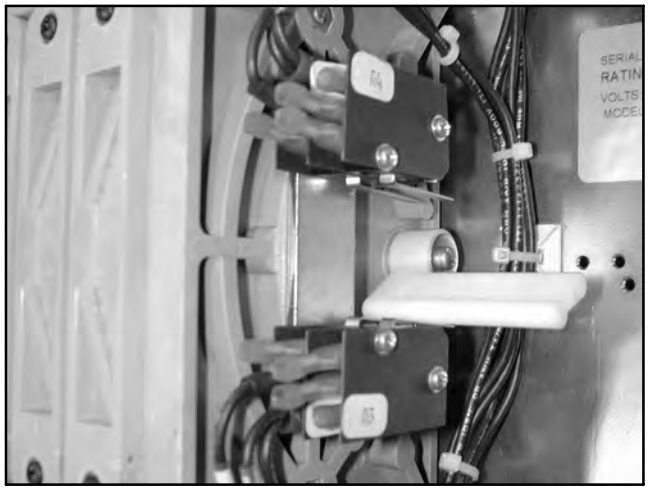


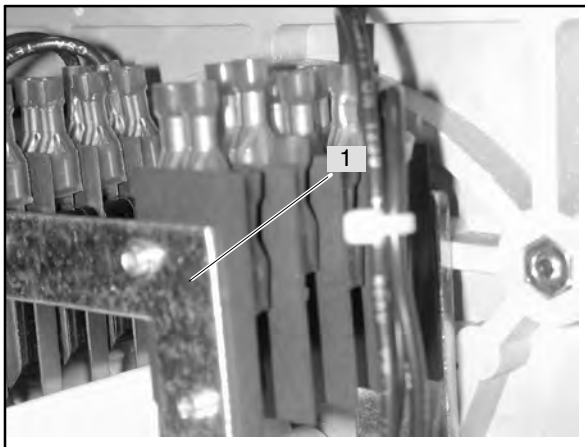
Figure 6-1 Microswitches

6. Disconnect the fast-on connectors.
7. Remove the holding screws.
8. Remove the suspect microswitch.

   Note: For SN/SE assemblies that have four microswitches, you must remove the end plate to access the microswitches. See Figure 6-2.
9. Install the new microswitch.

   Note: For SN/SE assemblies that have four microswitches, you must install an end plate for stability. See Figure 6-2.
10. Install the holding screws.
11. Tighten the holding screws to 0.3 Nm (3 in. lb.).
12. Connect the fast-on connections to the microswitch terminals. See Figure 6-1.

    Note: The terminals used were noted in step 5.
13. Close the ATS enclosure.
14. Connect power to the ATS.
15. Enable the generator set.
    a. Check that the generator set master switch is in the OFF position.
    b. Reconnect the generator set engine starting battery, negative (–) lead last.
    c. Reconnect power to the battery charger, if equipped.



1. End plate

Figure 6-2 End Plate (required for assemblies with four microswitches)

16. Move the generator set master switch to the AUTO position.

17. Test the transfer switch operation by performing the Automatic Operation Test described in Section 4.5.4.

    Note: Do not leave the transfer switch in the Test mode.

6.2.2 400–600 Amp

Microswitch Replacement Procedure

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

1. Prevent all connected generator sets from starting.

   a. Place the generator set master switch in the OFF position.

   b. Disconnect the power to the battery charger, if equipped.

   c. Disconnect the generator set engine starting battery(ies), negative (–) lead first.

      Note: On systems with multiple transfer switches connected to a single generator set, disconnect all power sources to the generator set before proceeding.

2. Disconnect power to the transfer switch.

3. Open the transfer switch enclosure.

4. Verify zero volts across each phase.

   Note: A3/A4 microswitches can still be energized with customer power. The microswitches may be used for primary alarm circuits or primary controlling devices. Verify that all power is disconnected before proceeding.

5. Note the location of the fast-on connectors to the microswitch terminals. See Figure 6-3.

6. Disconnect the fast-on connectors. See Figure 6-4.

7. Remove the microswitch holding screws. See Figure 6-5.

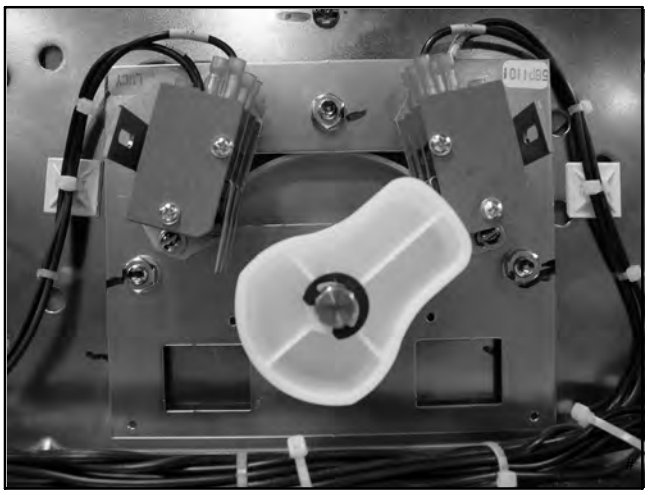


Figure 6-3 Microswitches

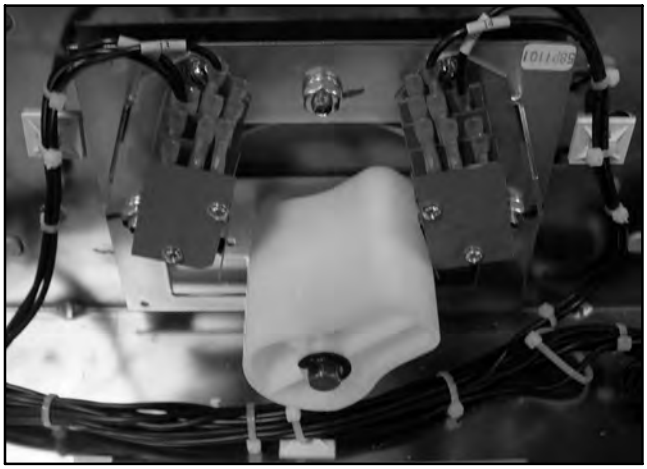


Figure 6-4 Microswitch Fast-On Connectors

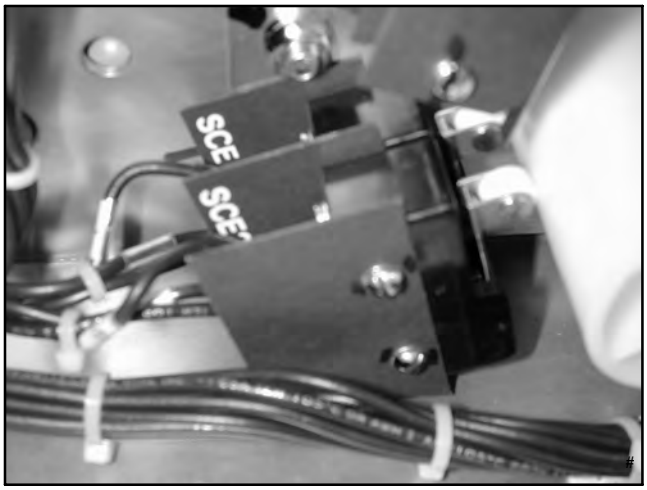


Figure 6-5 Microswitch Holding Screws

8. Remove the suspect microswitch.
9. Install the new microswitch.
10. Install the holding screws.
11. Tighten the holding screws to 0.3 Nm (3 in. lb.).
12. Connect the fast-on connections to the microswitch terminals as noted in step 5.
13. Close the transfer switch enclosure.
14. Connect power to the ATS.
15. Enable the generator set startup.
    a. Check that the generator set master switch is in the OFF position.
    b. Reconnect the generator set engine starting battery, negative (–) lead last.
    c. Reconnect power to the battery charger, if equipped.
16. Test the transfer switch operation by performing the Automatic Operation Test described in Section 4.5.4.

    Note: Do not leave the transfer switch in the Test mode.

6.3 Power Panel Replacement

Required tools and equipment:
Basic electricians hand tools
Multimeter digital or analog
Wiring harness
Tie wraps
Required protective equipment:
Rubber insulating gloves class 0
Safety glasses
Electrical hazard safety shoes

Power Panel Replacement Procedure

1. Disable all connected generator sets.
2. Disconnect primary and emergency power to the transfer switch.
3. Open the enclosure.
4. Check for zero volts on the normal and emergency power lugs.
5. Remove the tie wraps securing the harness.
6. Disconnect the power panel harness from the controller harness.

   Note: The replacement power panel is shipped with a factory-wired power panel harness.
7. Disconnect the engine start leads from the ATS engine start terminals.
8. Disconnect the emergency power supply cables from the switch.

   Note: Mark each cable as to its position as it is removed from the switch. Example: E1, E2 and E3 for the emergency side of the switch.
9. Disconnect the normal power supply cables from the switch, marking the cables as they are removed.
10. Disconnect the load cables from the switch, marking the cables as they are removed.
11. Remove the four nuts securing the power panel.
12. Remove the power panel.
13. Install the new power panel onto the studs in the back of the enclosure. See Figure 6-6.
14. Fasten the power panel with flat washers, lock washers and nuts.
15. Torque the nuts to 7.3 Nm (65 in. lb.).
16. Connect the power panel harness to the controller harness at the inline connector.
17. Connect the load cables to the T terminals.
18. Tighten the connecting bolts to 16.3 Nm (12 ft. lb.).
19. Connect the normal cables to the N terminals.

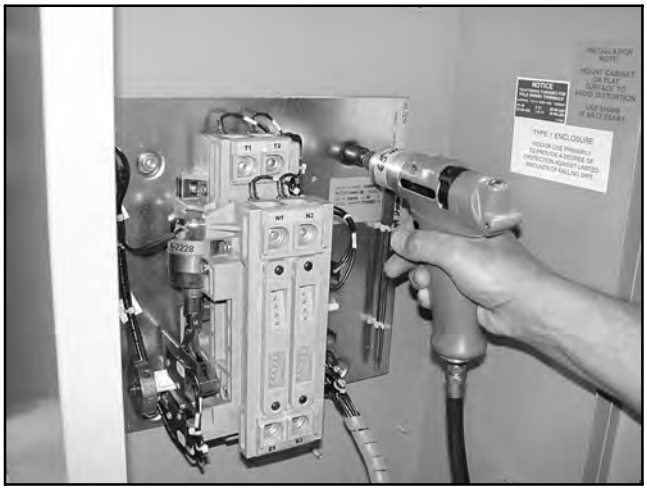


Figure 6-6 Installing the Power Panel

20. Tighten the connecting bolts to 16.3 Nm (12 ft. lb.).

21. Connect the emergency supply cables to the E terminals.

22. Tighten the connecting bolts to 16.3 Nm (12 ft. lb.).

23. Install tie wraps as needed to secure the harness.

24. Connect the generator set engine start leads.

25. Close the transfer switch enclosure.

26. Connect power to the ATS.

27. Enable the generator set.

    a. Check that the generator set master switch is in the OFF position.

    b. Reconnect the generator set engine starting battery, negative (-) lead last.

    c. Reconnect power to the battery charger, if equipped.

28. Move the generator set master switch to the AUTO position.

29. Test the transfer switch operation by performing the Automatic Operation Test described in Section 4.5.4.

    Note: Do not leave the transfer switch in the Test mode.

6.4 Arc Chute Replacement

Required tools and equipment:
Basic electricians hand tools
Arc chute
Required protective equipment:
Rubber insulating gloves class 0
Safety glasses
Electrical hazard safety shoes

Arc Chute Replacement Procedure

1. Prevent all connected generator sets from starting.

    a. Place the generator set master switch in the OFF position.

    b. Disconnect the battery charger, if equipped.

    c. Disconnect the generator set engine starting batter(ies), negative (-) lead first.

2. Disconnect power to the transfer switch.

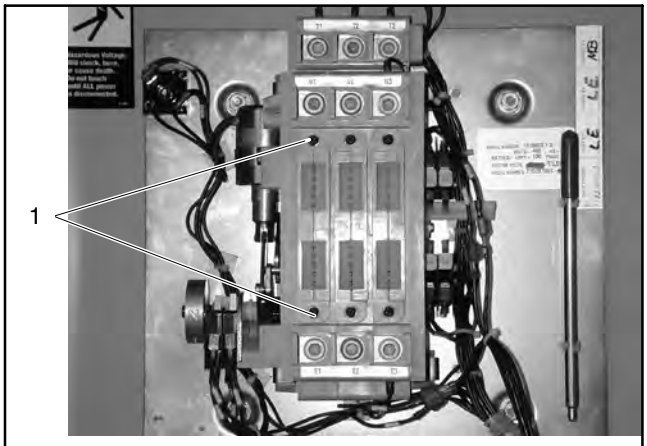
3. Open the transfer switch enclosure.

4. Verify zero volts across each phase.

5. Remove the arc chute hold down screws. See Figure 6-7.

6. Remove the arc chute.

7. Inspect the movable contact for damage. See Figure 6-8. If damage is found, order a replacement power panel and continue to Step 8.



1. Arc chute hold down screws

Figure 6-7 Arc Chute Screws

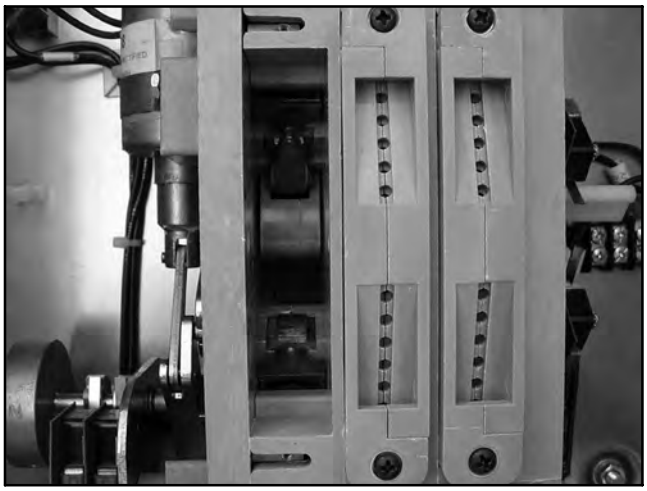


Figure 6-8 Movable Contacts (arc chute removed)

8. Install the new arc chute.
9. Install the holding screws and washers.
10. Torque screws to 2.8 Nm (25 in. lb.).
11. Manually operate the switch several times to ensure that it does not stick. See Figure 6-9.
12. Close the enclosure.
13. Reconnect power to the ATS.
14. Enable the generator set.
    a. Check that the generator set master switch is in the OFF position.
    b. Reconnect the generator set engine starting batter(ies), negative (–) lead last.
    c. Reconnect the battery charger, if equipped.
15. Move the generator set master switch to the AUTO position.
16. Test the transfer switch operation by performing the Automatic Operation Test Procedure described in Section 4.5.4.

    Note: Do not leave the transfer switch in the Test mode.

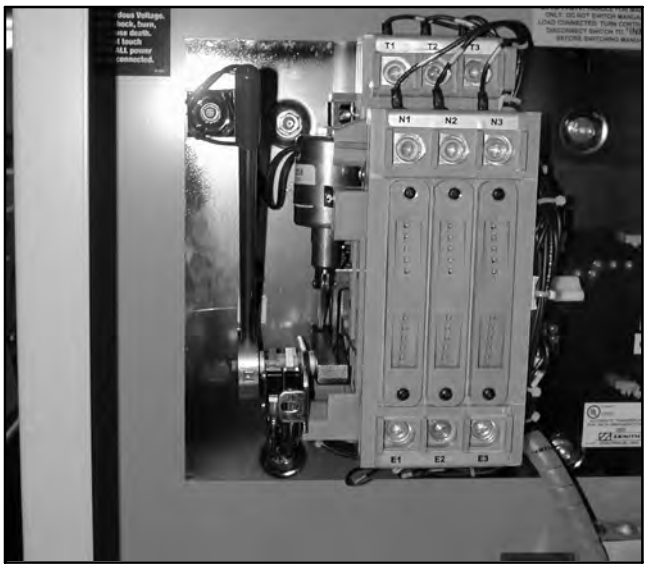


Figure 6-9 Manual Operation Handle Inserted

6.5 Limit Switch Assembly Replacement

Required tools and equipment:
Basic electricians hand tools
Multimeter digital or analog
Limit switch
Required protective equipment:
Rubber insulating gloves class 0
Safety glasses
Electrical hazard safety shoes

Procedure

1. Prevent all connected generator sets from starting.
    a. Place the generator set master switch in the OFF position.
    b. Disconnect the battery charger, if equipped.
    c. Disconnect the generator set engine starting batter(ies), negative (–) lead first.
2. Disconnect power to the transfer switch.
3. Open the transfer switch enclosure.
4. Verify zero volts across each phase.
5. Note the location of the fast-on connections to the SCN/SCE microswitch terminals.
6. Disconnect the fast-on connectors. See Figure 6-10.

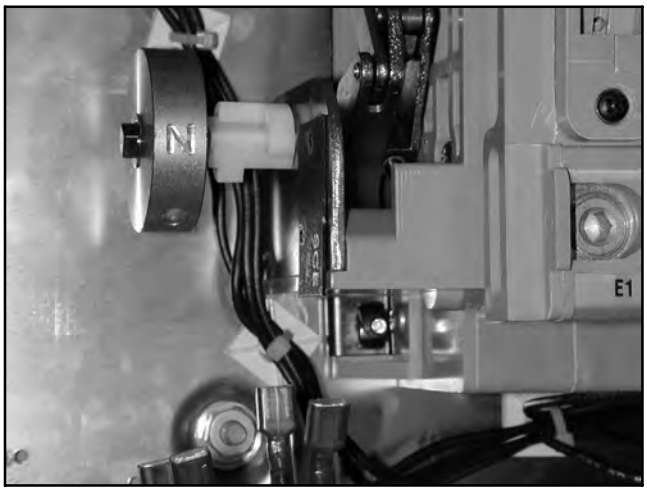


Figure 6-10 Microswitch Fast-On Connectors

7. Remove the holding screws. Note the microswitch labels on the insulators. See Figure 6-11.

8. Remove the microswitch assembly.

9. Remove the suspect microswitch. See Figure 6-12.

10. Install the new microswitch into the assembly.

    Note: Replace SCN/SCE insulators in the correct order. Normally, the SCE is closest to the base.

11. Reinstall the microswitch assembly. See Figure 6-13.

    a. Install the holding screws.

    b. Tighten the holding screws.

    c. Connect the fast-on connections to the microswitch terminals as noted in step 5.

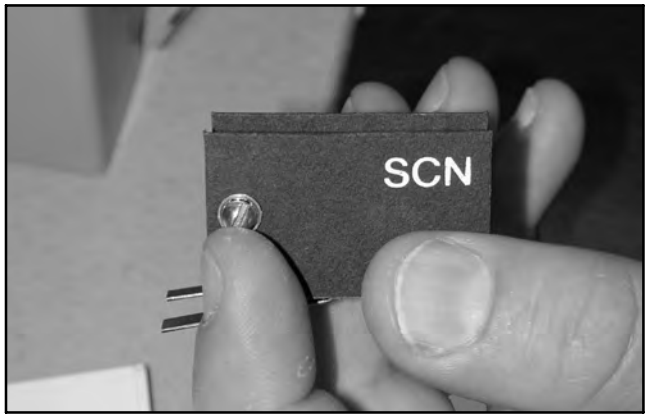


Figure 6-11 Microswitch Insulator with Label

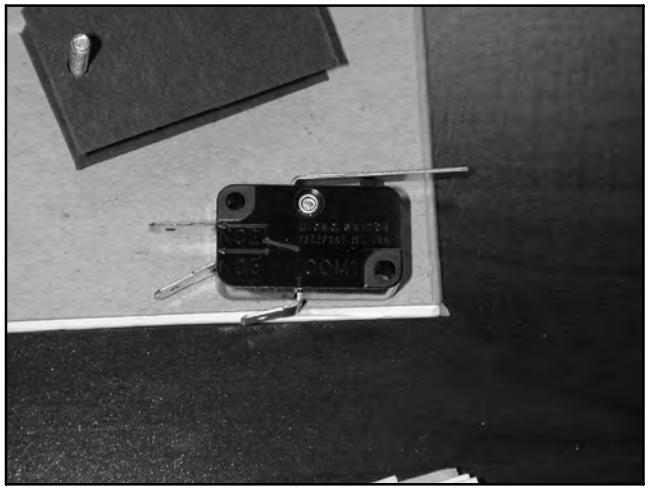


Figure 6-12 Microswitch

12. Clean the inside of the ATS.

13. Close and lock the enclosure.

14. Connect power to the ATS.

15. Enable the generator set startup.

    a. Check that the generator set master switch is in the OFF position.

    b. Reconnect the generator set engine starting batter(ies), negative (–) lead last.

    c. Reconnect the battery charger, if equipped.

16. Move the generator set master switch to the AUTO position.

17. Test the transfer switch operation by performing the Automatic Operation Test Procedure described in Section 4.5.4.

    Note: Do not leave the transfer switch in the Test mode.

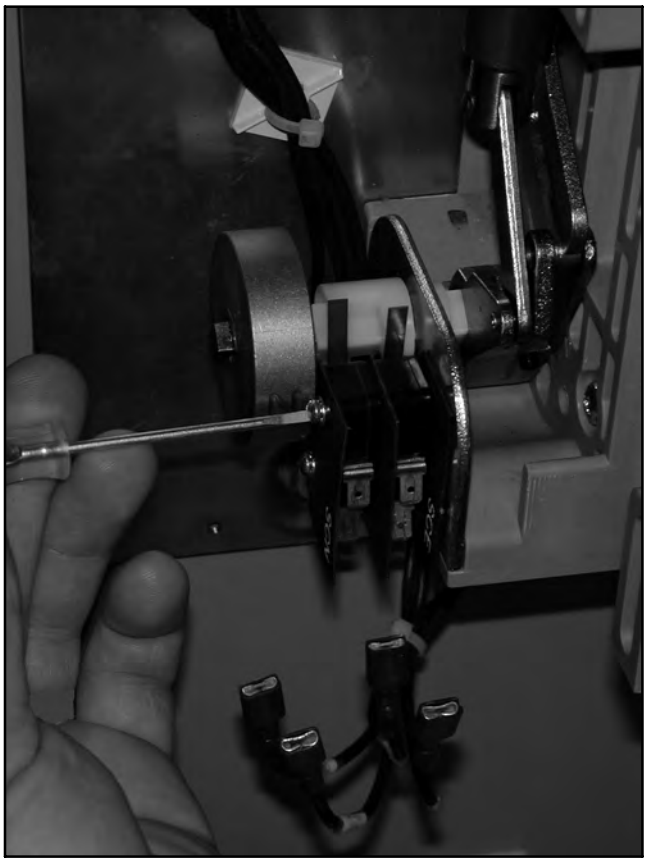


Figure 6-13 Microswitch Installation

6.6 Solenoid and Rectifier Replacement

6.6.1 Solenoid and Rectifier Replacement, 40–225 Amp Models

Required tools and equipment:
Basic electricians hand tools
Multimeter digital or analog
Solenoid
Tie wraps
Required protective equipment:
Rubber insulating gloves class 0
Safety glasses
Electrical hazard safety shoes

Procedure

1. Open the ATS enclosure.
2. Prevent all connected generator sets from starting.
   a. Place the generator set master switch in the OFF position.
   b. Disconnect the battery charger, if equipped.
   c. Disconnect the generator set engine starting batter(ies), negative (–) lead first.
3. Disconnect main power.
4. Verify zero volts across each phase.
5. Remove DC fast-on connections from the rectifier terminals. See Figure 6-14.

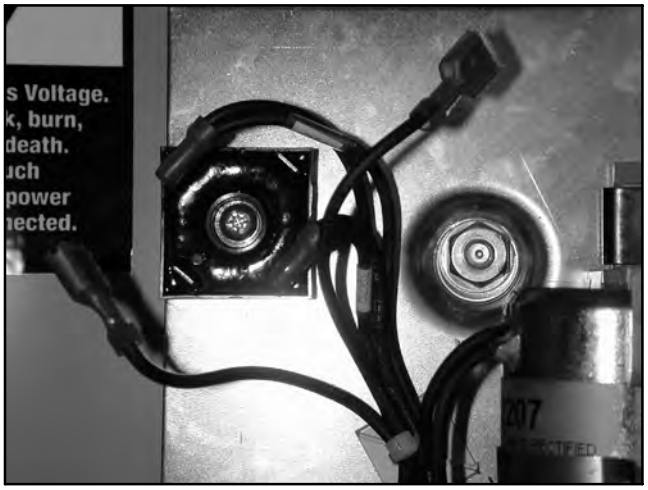


Figure 6-14 Rectifier Connections (DC solenoid leads shown disconnected)

6. Check the coil resistance. See Figure 6-15.

   Note: If the resistance reading is infinite or shorted, replace the coil.

Figure 6-15 Checking Coil Resistance

Rectifier Check and Replacement

7. Remove the AC fast-on connections from the AC terminals of the rectifier.
8. Check the diode operation of the rectifier. See Figure 6-16 and Section 3.5 for rectifier test instructions. If the rectifier is good, go to step 11. If the rectifier is bad, continue on.
9. Remove the faulty rectifier.
10. Install the new rectifier so that the red dot is in the upper right corner.
11. Connect the AC fast-on connections to the AC terminals.

    Note: The AC terminals are in the upper left and lower right hand corners.

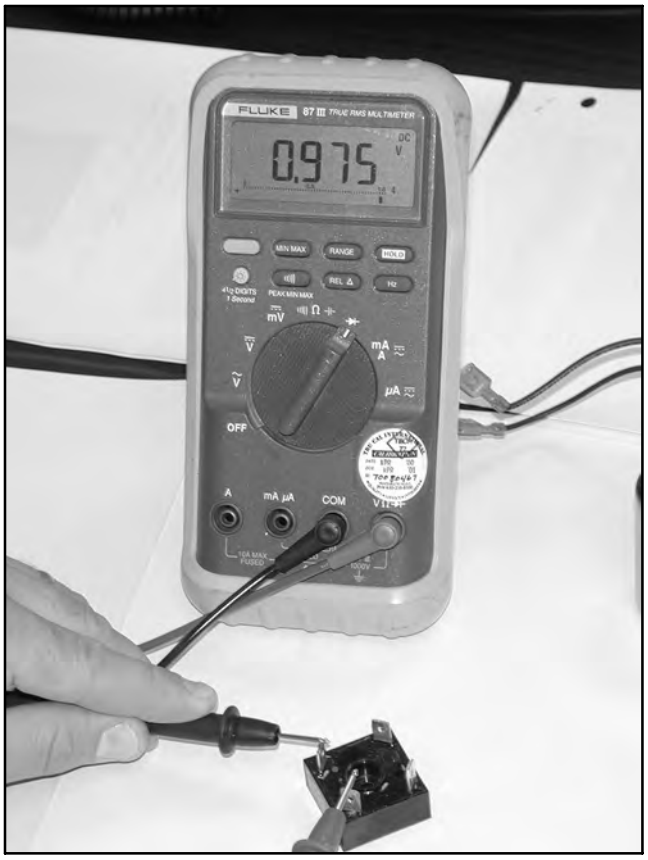


Figure 6-16 Checking Diode Operation of Rectifier

Solenoid Replacement

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Disassembling the solenoid. Spring-loaded parts can cause severe personal injury or property damage. The spring in the solenoid assembly exerts substantial force on the coil. Hold the coil assembly securely when removing the screws.

12. Remove tie wraps, as necessary.

    Note: Do not cut the insulation on the wiring.

13. Remove the front bolt of the coil securing the strap. See Figure 6-17.

14. Loosen the rear bolt of the coil securing the strap.

15. Remove the coil.

    Note: The plunger assembly is spring-loaded. See Figure 6-18.

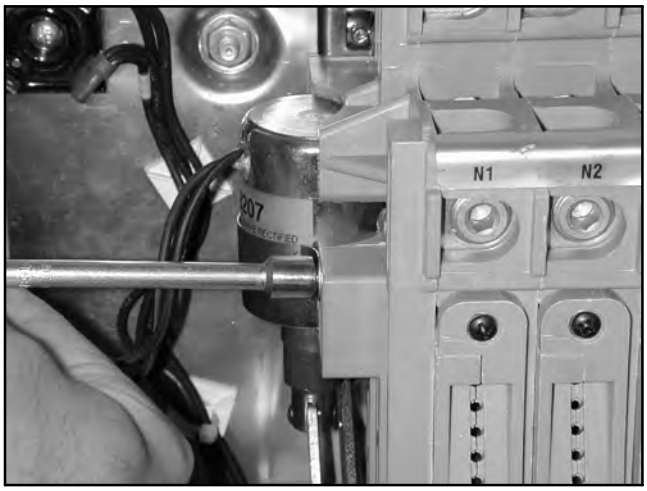


Figure 6-17 Coil Securing Strap

Figure 6-18 Spring and Plunger Assembly

16. Lubricate the spring and plunger assembly.

17. Insert the spring into the new coil.

    Note: Insert and seat the spring into the spring holder of the coil. The spring should be centered in the hole. See Figure 6-19.

Figure 6-19 Spring Holder in Coil

18. Install the plunger into the new coil.

    Note: The spring will slide into the plunger. See Figure 6-18.

19. Install the new coil into the coil slot.

20. Install the coil holding strap.

21. Tighten the bolts for the coil holding strap. See Figure 6-17.

22. Connect the DC fast-on connections to the DC terminals of the rectifier.

    Note: The DC terminals are in the lower left and upper right hand corners.

23. Install any required tie wraps.

24. Close the enclosure.

25. Reconnect power to the ATS.

26. Enable the generator set startup.

    a. Check that the generator set master switch is in the OFF position.

    b. Reconnect the generator set engine starting batter(ies), negative (-) lead last.

    c. Reconnect the battery charger, if equipped.

27. Move the generator set master switch to the AUTO position.

28. Test the transfer switch operation by performing the Automatic Operation Test Procedure described in Section 4.5.4.

    Note: Do not leave the transfer switch in the Test mode.

6.6.2 Solenoid and Rectifier Replacement, 400-600 Amp Models

Required tools and equipment:
Basic electricians hand tools
Multimeter digital or analog
Solenoid
Tie wraps
Required protective equipment:
Rubber insulating gloves class 0
Safety glasses
Electrical hazard safety shoes

Procedure

1. Prevent all connected generator sets from starting.

   a. Place the generator set master switch in the OFF position.

   b. Disconnect the battery charger, if equipped.

   c. Disconnect the generator set engine starting batter(ies), negative (-) lead first.

2. Disconnect main power and open the ATS enclosure.

3. Verify zero volts across each phase.

4. Remove the DC fast-on connections from the rectifier terminals. See Figure 6-20.

   Note: A red dot identifies one DC terminal. The other DC terminal is at the opposite corner of the rectifier.

5. Check the coil resistance.

   Note: If reading is infinite or shorted, replace coil.

Figure 6-20 Rectifier Fast-On Connectors (contactor shown on the bench)

Rectifier Check and Replacement

6. Remove the AC fast-on connections from the AC terminals of the rectifier.

7. Check the diode operation of the rectifier. See Figure 6-21 and Section 3.5 for rectifier test instructions. If the rectifier is bad, replace it. If the rectifier is good, proceed to step 9.

8. Replace the rectifier. Orient the new rectifier so that the red dot is in the upper right corner when the contactor is mounted in the enclosure.

9. Connect AC fast-on connections to AC terminals.

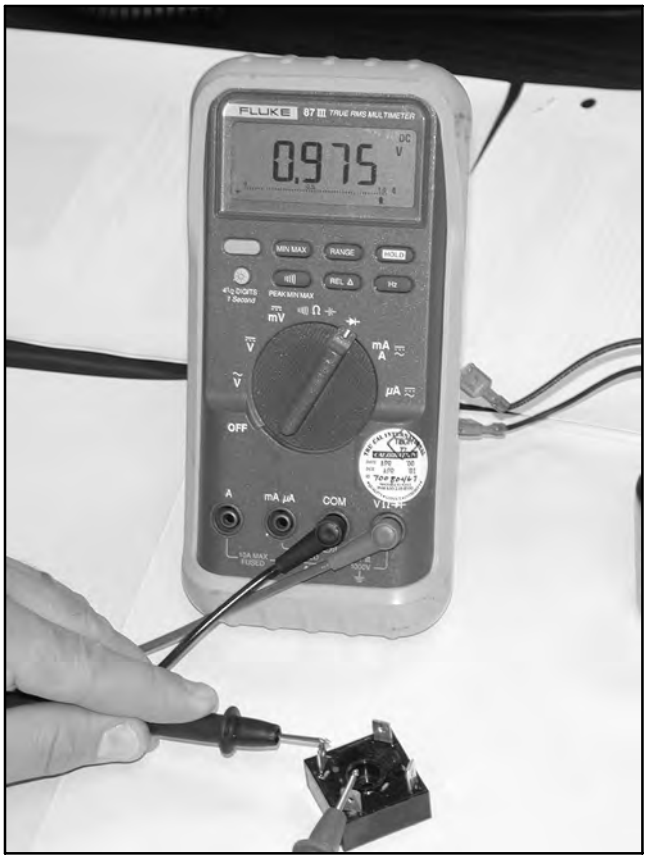


Figure 6-21 Checking Rectifier Diode Operation

Solenoid Replacement

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

Disassembling the solenoid. Spring-loaded parts can cause severe personal injury or property damage. The spring in the solenoid assembly exerts substantial force on the coil. Hold the coil assembly securely when removing the screws.

10. Note the rectifier connections and disconnect the AC leads. See Figure 6-22.

11. Remove tie wraps as necessary.

    Note: Be careful to avoid cutting the insulation on the leads.

12. Place the switch in the Normal position.

13. Mark the location of the solenoid assembly mounting bracket.

14. Hold the solenoid coil firmly and remove the four screws and washers. See Figure 6-22.

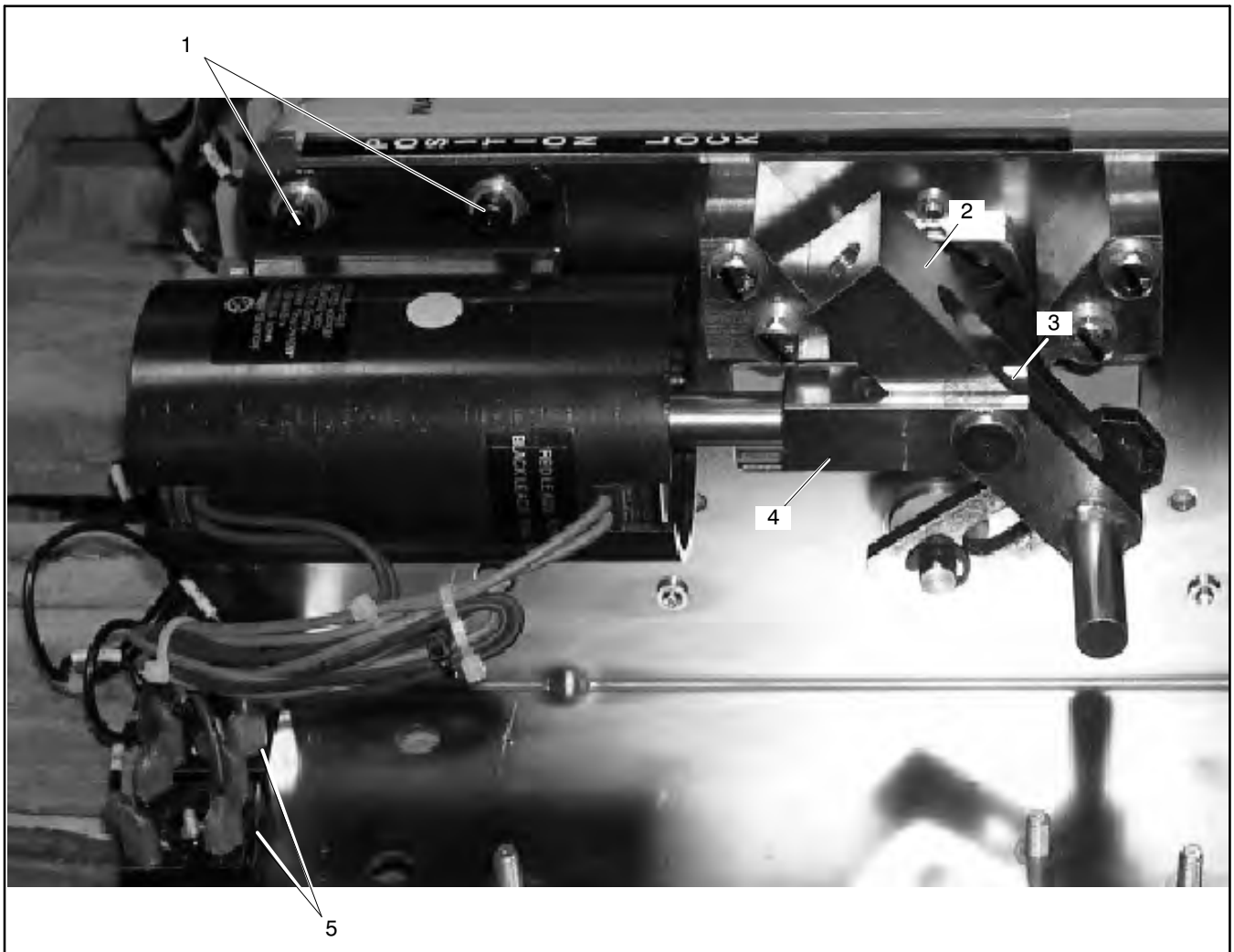
15. Pull the solenoid assembly with the attached linkage away from the contactor.

    Note: The sealed solenoid coil assembly contains the coil and the plunger. Do not attempt to remove the plunger from the coil assembly.

16. Remove the clip that secures the plunger to the linkage and remove the linkage from the coil assembly.

17. Use the clip to attach the linkage to the new coil assembly.

18. Place the new solenoid assembly into position, aligning the linkage pins with the mechanism slots. See Figure 6-22.



1. Mounting screws with washers (4 ea.)
2. Linkage
3. Clip location (not visible this view)
4. Plunger
5. Rectifier connections

Figure 6-22 Solenoid Assembly (shown on the bench)

19. Insert four mounting screws with washers and align the mounting bracket with marks made in step 13.

20. Tighten all four bolts to 10.8 Nm (96 in. lb).

21. Connect the DC fast-on connections to the DC terminals of the rectifier. See Figure 6-23.

    Note: A red dot identifies one DC terminal. The other DC terminal is at the opposite corner.

22. Install any required tie wraps. See Figure 6-23.

23. Close the ATS enclosure.

24. Reconnect power to the ATS.

25. Enable the generator set startup.

    a. Check that the generator set master switch is in the OFF position.

    b. Reconnect the generator set engine starting batter(ies), negative (-) lead last.

    c. Reconnect the battery charger, if equipped.

26. Move the generator set master switch to the AUTO position.

27. Test the transfer switch operation by performing the Automatic Operation Test Procedure described in Section 4.5.4.

    Note: Do not leave transfer switch in Test mode.

Figure 6-23 Rectifier Connections and Tie Wraps

Notes

7.1 Introduction

This section contains instructions for component replacement on Model KSP programmed-transition transfer switches.

Illustrations in this section show the transfer switch removed from the enclosure and placed on a bench. Remove the transfer switch from the enclosure if necessary to access components.

Read and follow all safety precautions before servicing the transfer switch.

⚠ 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.

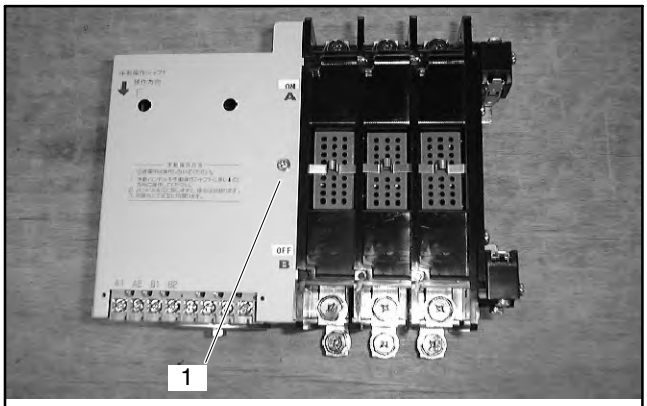
Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Turn off the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to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

7.2 Component Replacement, 100-400 Amp Models

7.2.1 Disassembly, 100-400 Amps

Disassemble the mechanical unit and the current-carrying unit.

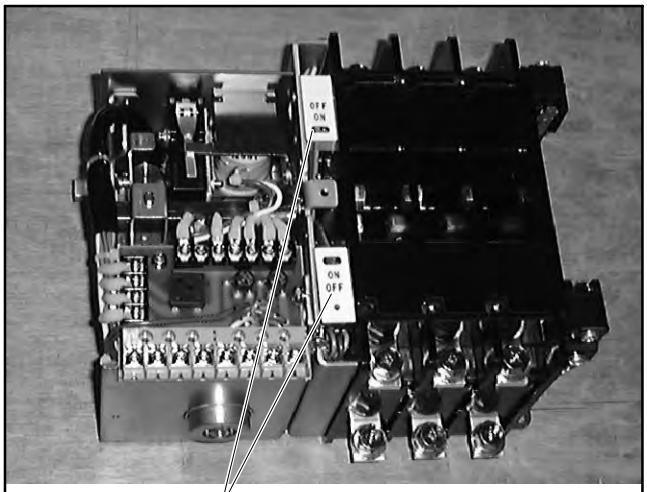
1. Loosen the M4 bolt and remove the cover from the mechanical unit. See Figure 7-1.



1. M4 bolt

Figure 7-1 Removing Cover

2. Remove the ON/OFF indicators. Save the indicators for installation during reassembly. See Figure 7-2.



1. ON/OFF indicators

Figure 7-2 ON/OFF Indicators

3. Remove the auxiliary switches. See Figure 7-3.

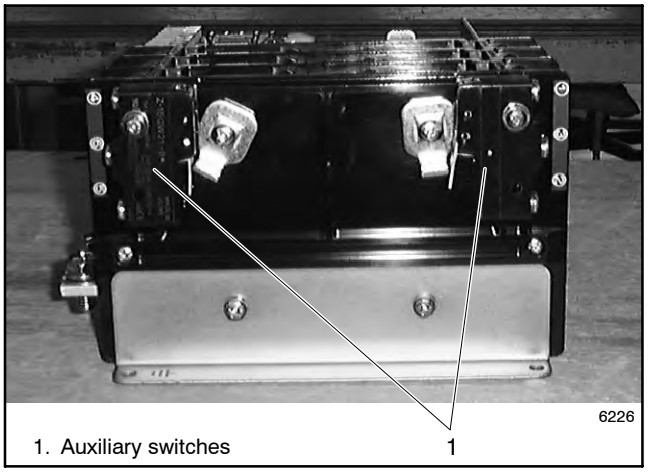


Figure 7-3 Auxiliary Switches

4. Loosen four bolts and separate the mechanical unit from the current-carrying unit. See Figure 7-4, Figure 7-5, and Figure 7-6.

   Note: The current-carrying unit on 400-models is made up of sections that will separate when disassembled.

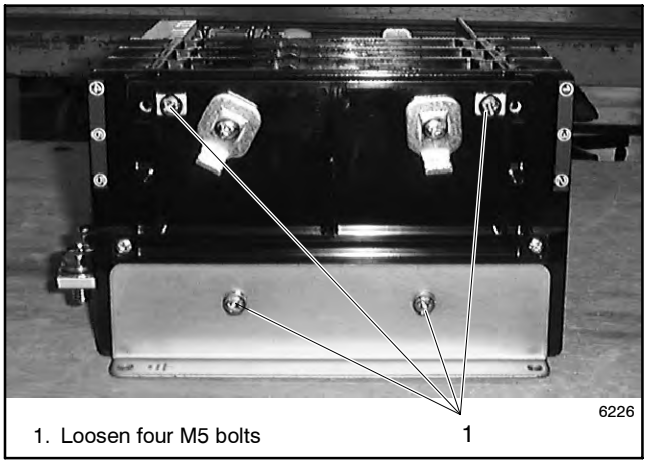


Figure 7-4 Separating Units, 100 and 200 Amp

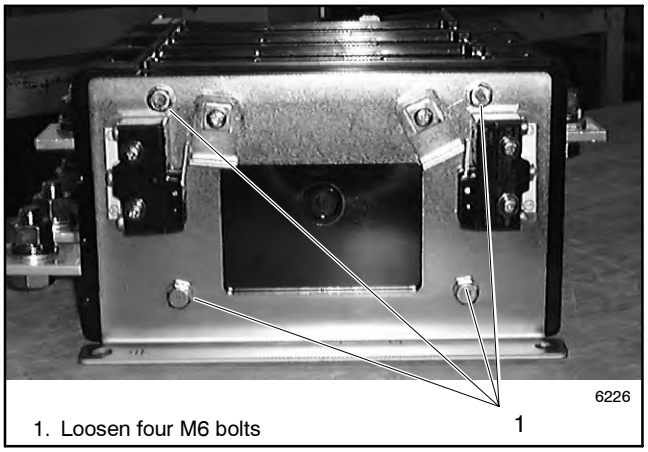


Figure 7-5 Separating Units, 400 Amp

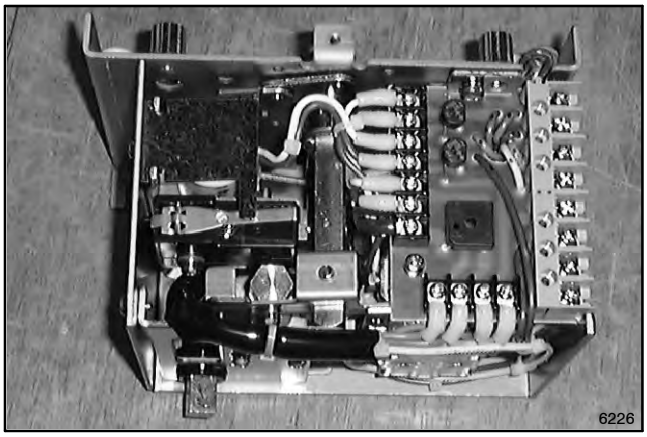


Figure 7-6 Mechanical Unit

7.2.2 Reassembly, 100–400 Amps

Reassemble the mechanical unit and the current-carrying unit.

1. Assemble the current-carrying unit and the mechanical unit. Make sure that the shaft from the mechanical unit goes through both main shaft levers. See Figure 7-7.

   On 400-amp units, the current-carrying unit is made up of separate sections. Make sure that the sections are flush across the front when reassembling.

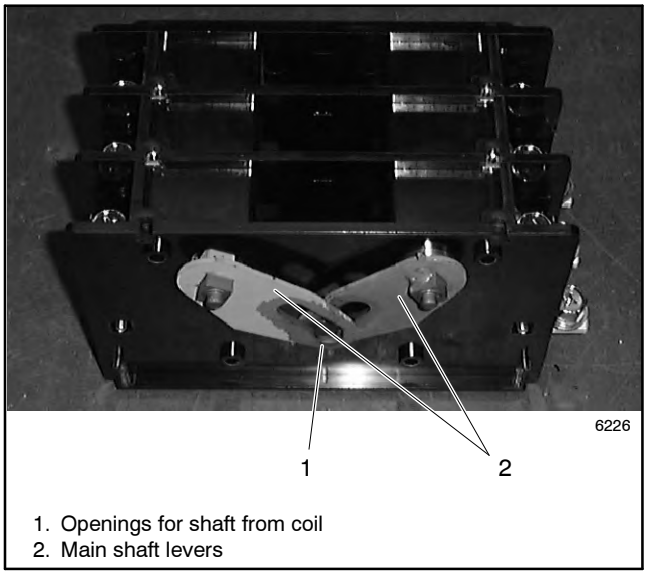
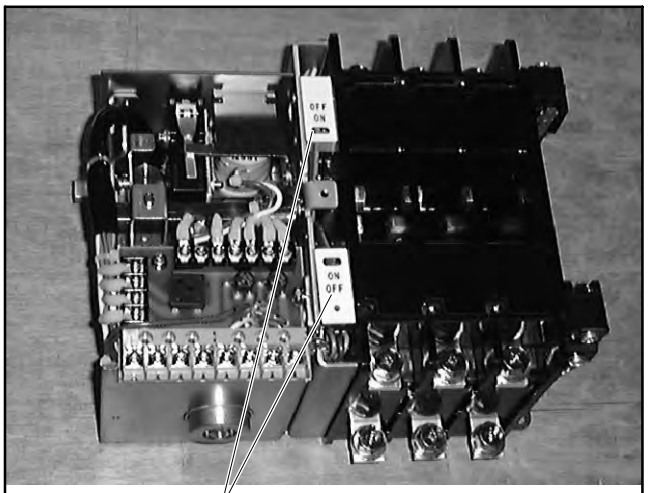


Figure 7-7 Current-Carrying Unit

2. Replace the ON/OFF indicators and the cover.

Note: The ON/OFF indicators are not identical. Locate them as shown in Figure 7-8.

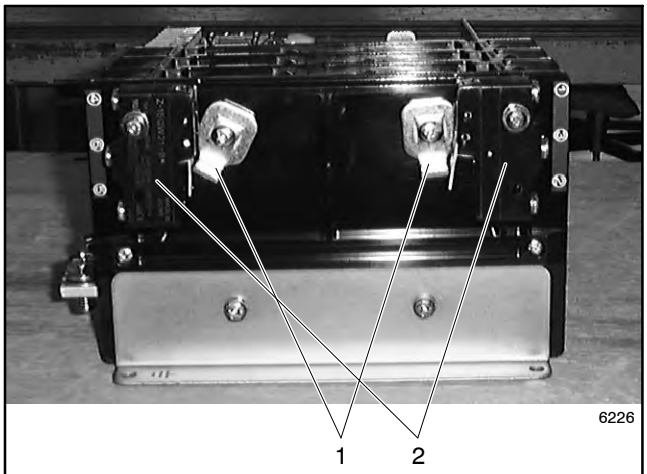


1. ON/OFF indicators

Figure 7-8 Assembled Units

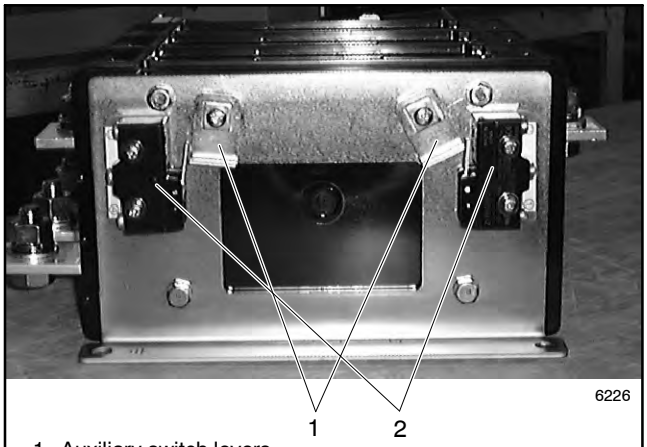
3. Reinstall the auxiliary switch levers, if removed, aligning the square indentation with the end of the square shaft. See Figure 7-9 and Figure 7-10.

4. Reinstall the auxiliary switches, if removed. The 100 and 200 amp models use one bolt and one alignment pin per switch. See Figure 7-9. Larger models use two bolts per switch. See Figure 7-10.



1. Auxiliary switch levers
2. Auxiliary switches

Figure 7-9 100 and 200 Amp Models



1. Auxiliary switch levers
2. Auxiliary switches

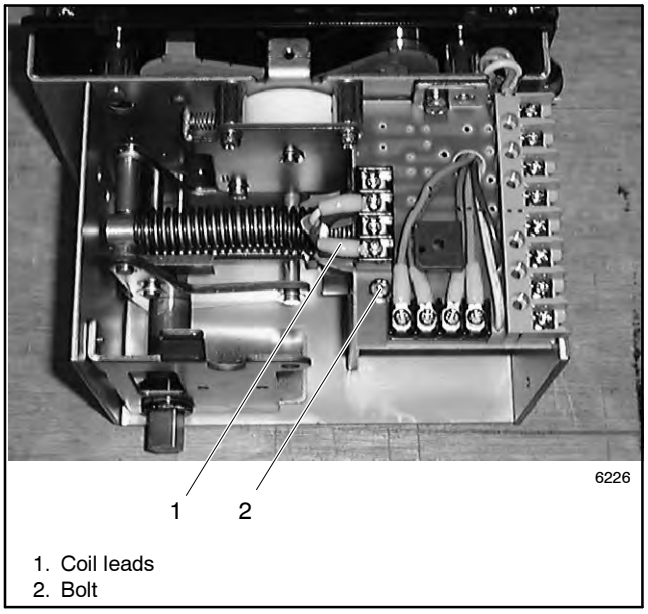
Figure 7-10 400 Amp Models

7.2.3 Printed Circuit Board Replacement, 100–400 Amps

Separate the current-carrying unit from the mechanical unit. See Section 7.2.1.

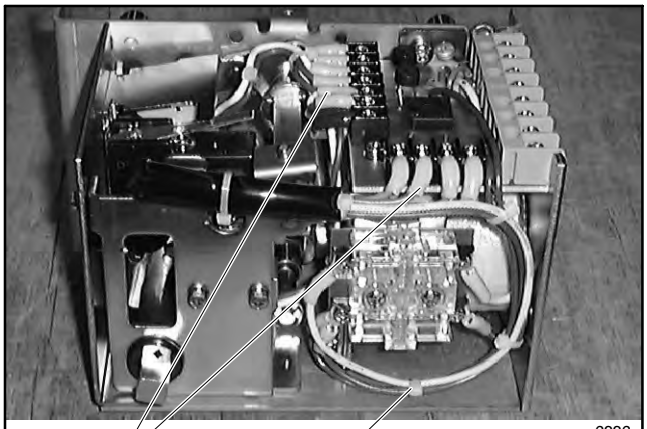
1. Note the connections (for reconnection later) and disconnect the printed circuit board leads. See Figure 7-11 or Figure 7-12.
2. Disconnect the control switch leads at three terminals. See Figure 7-12.

   Note: Hold the terminals while loosening the screws to avoid damage.
3. Note the connections (for reconnection later) and disconnect the control switch leads at eight locations. See Figure 7-13.
4. Remove the bolt and replace the printed circuit board. See Figure 7-11.
5. Reconnect all leads as noted during step 1.



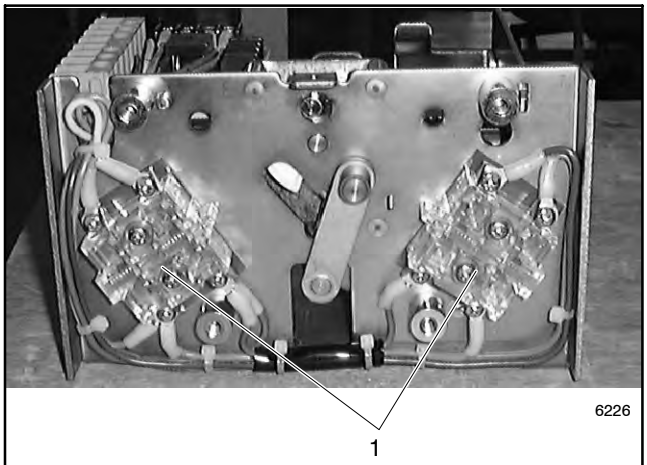
1. Coil leads
2. Bolt

Figure 7-11 Circuit Board Connections



1. Printed circuit board leads
2. Switch leads

Figure 7-12 Control Switch Wiring

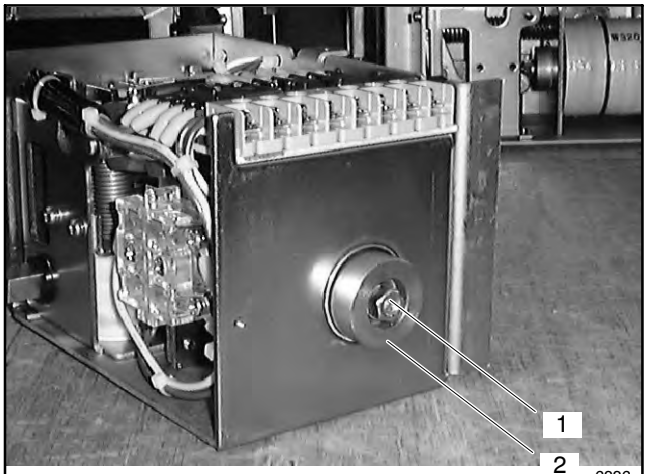


1. Control switches

Figure 7-13 Control Switches

7.2.4 Closing Coil Replacement, 100–400 Amps

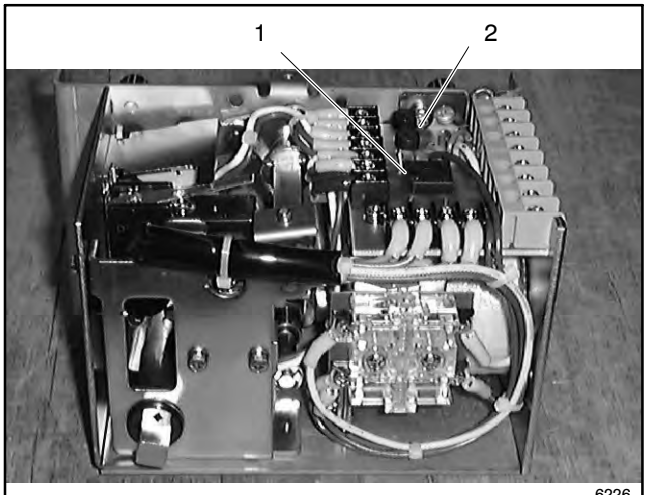
1. Push the trip button.
2. Remove the M6 nut and washer. Turn the movable steel shaft counterclockwise to remove it. See Figure 7-14.



1. M6 nut and washer
2. Movable steel shaft

Figure 7-14 Movable Steel Shaft, 100–400 Amp Models

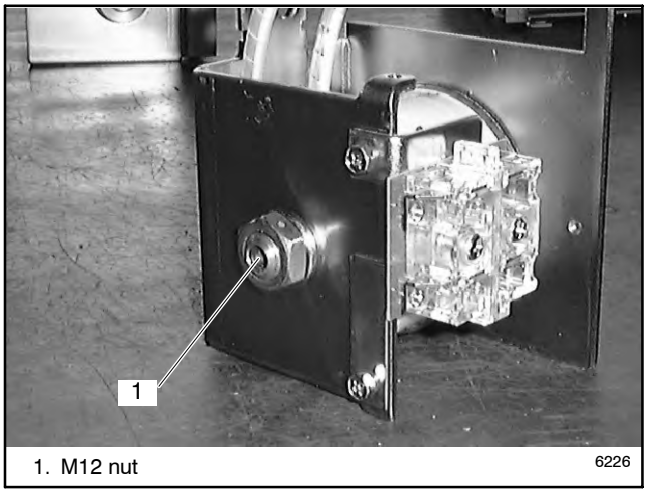
3. Remove the printed circuit board. See Figure 7-15 and Section 7.2.3.



1. Printed circuit board
2. M6 bolt location

Figure 7-15 Printed Circuit Board and M6 Bolt (for closing coil)

4. Loosen the M6 bolt and remove the frame with the coil. See Figure 7-15 and Figure 7-16.
5. Loosen the M12 nut and replace the closing coil. See Figure 7-16.



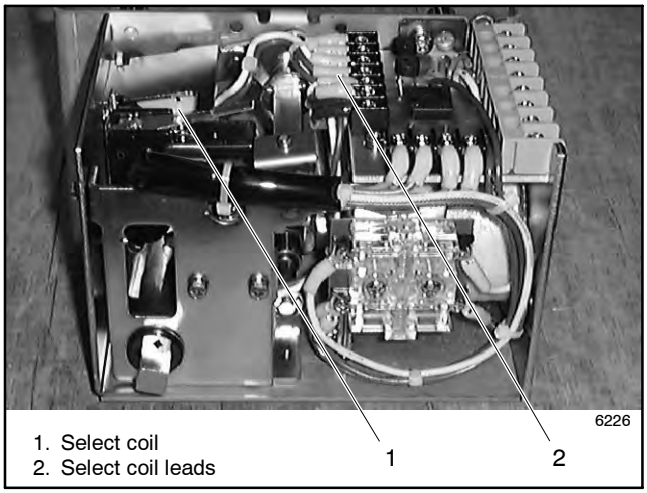
1. M12 nut

Figure 7-16 Closing Coil with Frame, 100–400 Amp Models

6. Reinstall movable steel shaft. To adjust the shaft:
   a. Turn the large round shaft in (clockwise) until mechanism just latches when operated with the manual handle. If turned too far, it won't latch.
   b. Back the shaft out (counterclockwise) one full rotation from the limit of the switching range.
   c. Install the washer and nut. Hold the shaft to prevent it from turning while tightening the nut.

7.2.5 Select Coil Replacement, 100–400 Amps

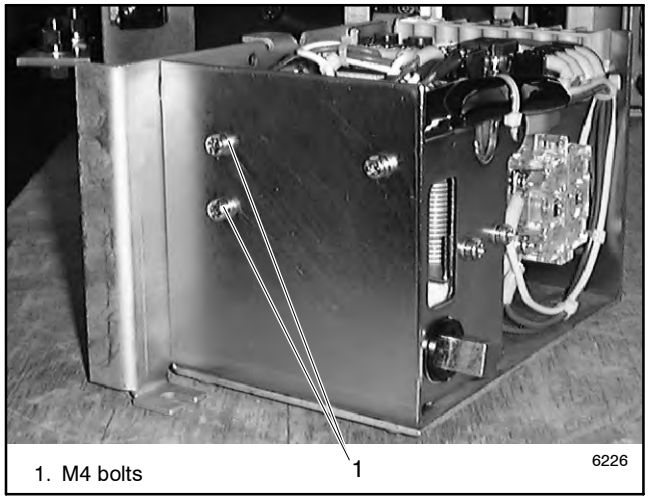
1. Note connections and disconnect select coil leads. See Figure 7-17. Cut the cable tie, if necessary.



1. Select coil
2. Select coil leads

Figure 7-17 Select Coil Connections

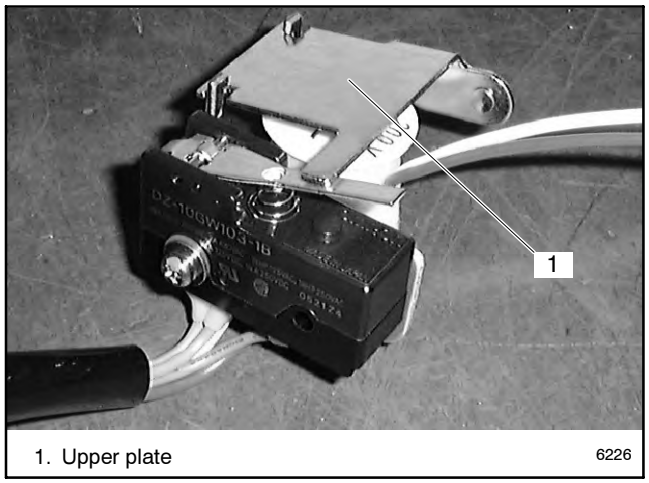
2. Remove two M4 bolts shown in Figure 7-18 and remove the select coil assembly.



1. M4 bolts

Figure 7-18 Select Coil Assembly Bolts

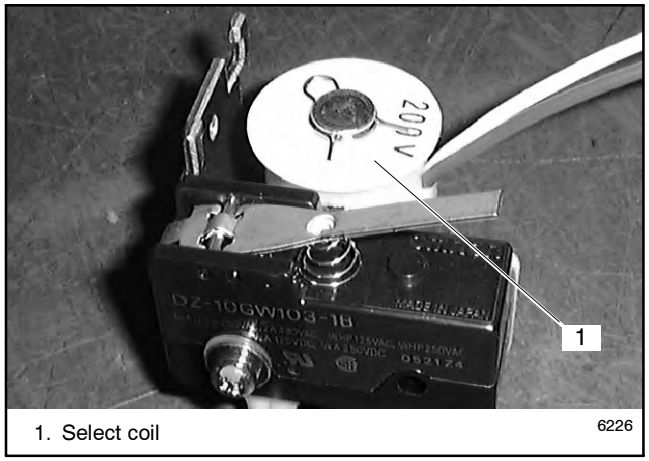
3. Remove the upper plate from the select coil assembly. See Figure 7-19.



1. Upper plate

Figure 7-19 Select Coil Assembly

4. Replace the select coil. See Figure 7-20.



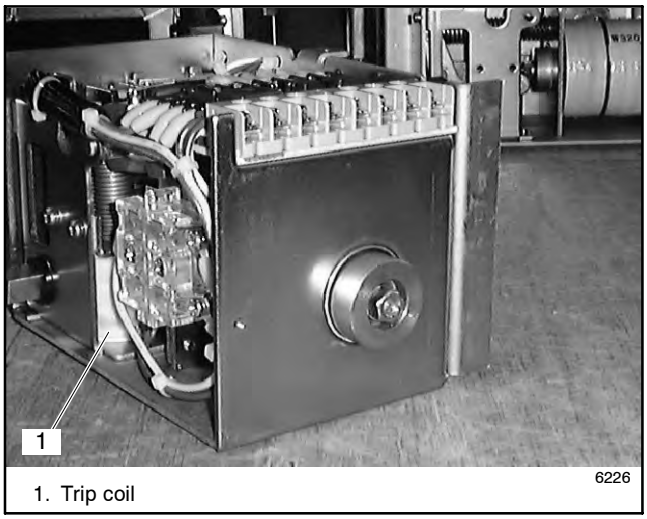
1. Select coil

Figure 7-20 Select Coil

7.2.6 Trip Coil Replacement, 100–400 Amps

Note: Remove the select coil first for easier access to the trip coil. See Section 7.2.5.

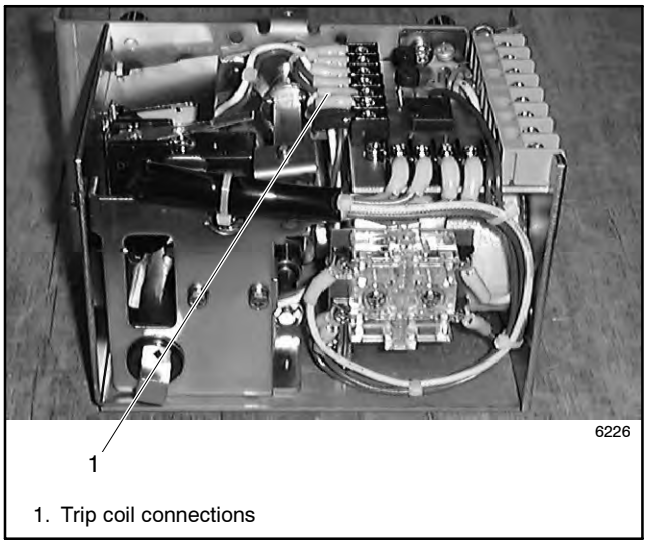
1. Locate the trip coil. See Figure 7-21.



1. Trip coil

Figure 7-21 Trip Coil Location

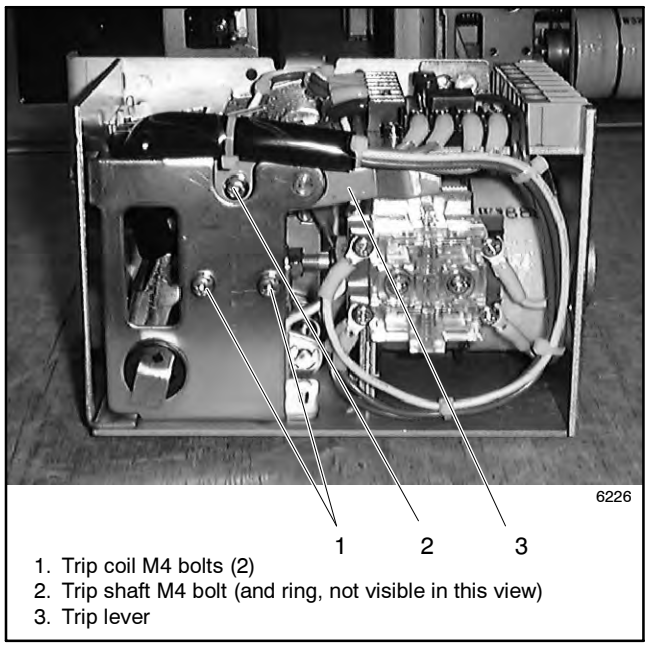
2. Note the connections and disconnect the trip coil leads from the printed circuit board. See Figure 7-22.



1. Trip coil connections

Figure 7-22 Trip Coil Connections

3. Remove two M4 bolts that secure the trip coil. See Figure 7-23.



1. Trip coil M4 bolts (2)
2. Trip shaft M4 bolt (and ring, not visible in this view)
3. Trip lever

Figure 7-23 Trip Coil and Trip Shaft Bolts

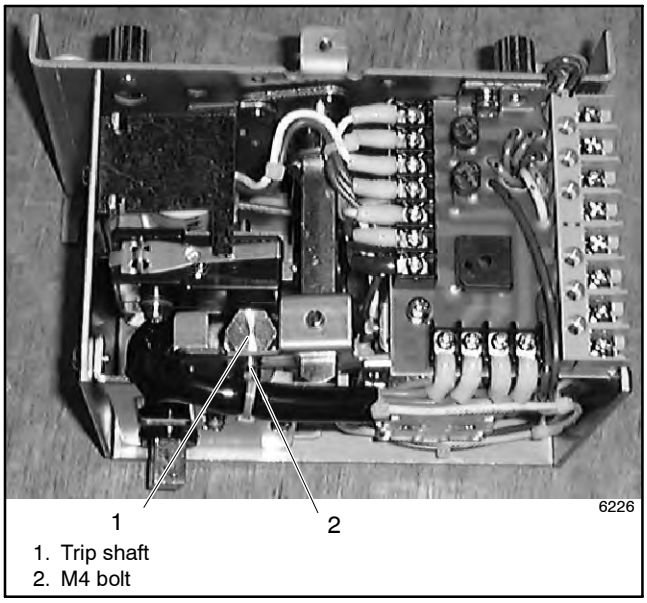
⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

4. The trip shaft is spring-loaded. Hold the shaft securely while removing the trip shaft bolt. See Figure 7-24. Remove the M4 bolt with ring, trip shaft, spring, and L-shaped bracket. See Figure 7-25. Keep the parts for reassembly later.

5. Loosen three bolts shown in Figure 7-26, remove the side plate, and replace the trip coil. See Figure 7-26.



1. Trip shaft
2. M4 bolt

Figure 7-24 Trip Shaft Location

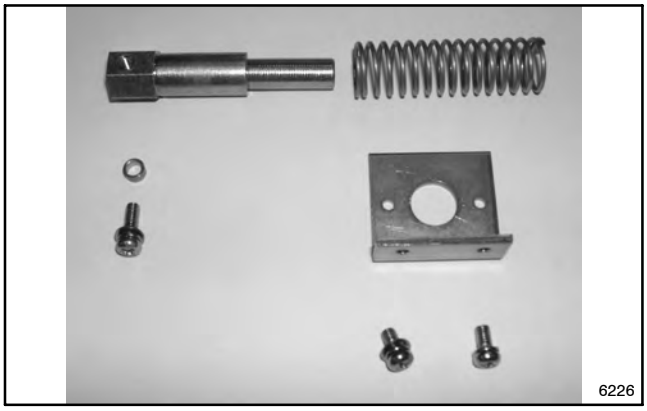
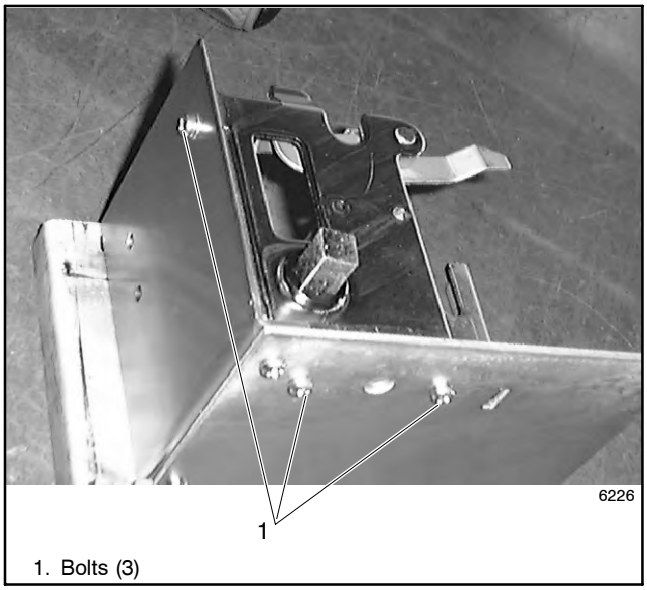


Figure 7-25 Trip Shaft Parts



1. Bolts (3)

Figure 7-26 Side Plate Bolts

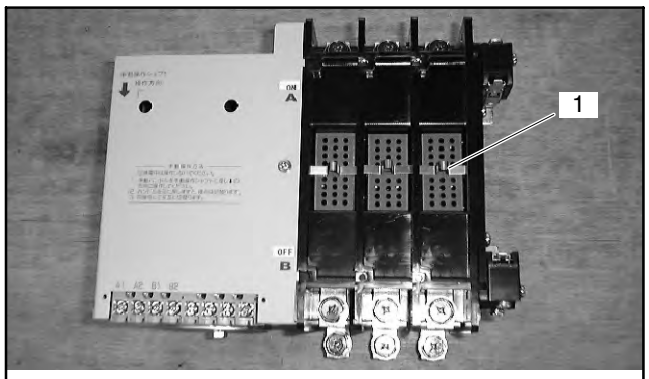
6. Reassemble in reverse order:

   Align the bosses on the coil with the holes in the L-shaped bracket.

   Be sure to reinstall the ring on the trip shaft bolt and align the parts so that the ring fits into the hole on the trip lever.

7.2.7 Arc Chute Replacement, 100–400 Amps

Remove the retainer clips shown in Figure 7-27 and replace the required arc chute. Reinstall the retainer clips.



1. Arc chute retainer clips

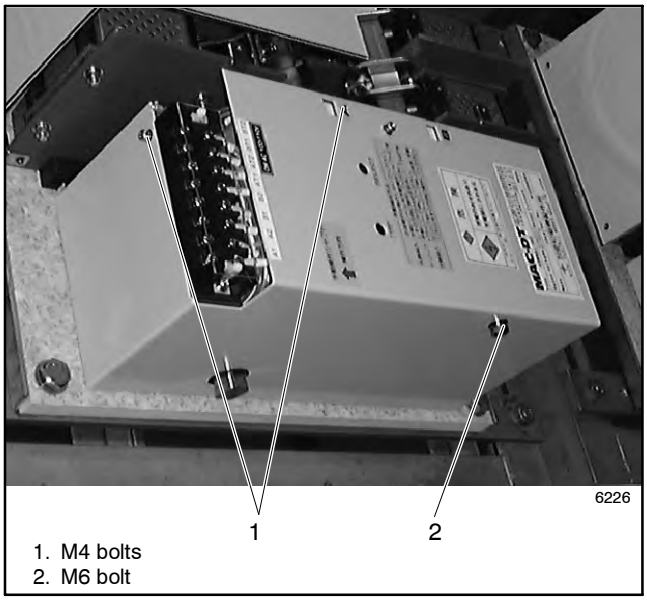
Figure 7-27 Arc Chutes

7.3 Component Replacement, 600 Amp Models

7.3.1 Closing Coil Replacement, 600 Amp Models

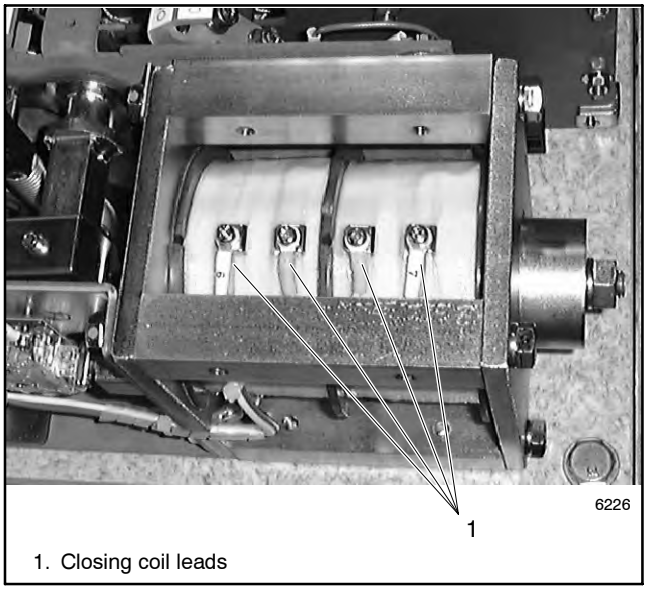
1. Remove the M4 bolts and the M6 bolt. Remove the cover from the mechanical unit. See Figure 7-28.

2. Note the connections shown in Figure 7-29 and disconnect the closing coil leads at four locations.



1. M4 bolts
2. M6 bolt

Figure 7-28 Removing the Cover



1. Closing coil leads

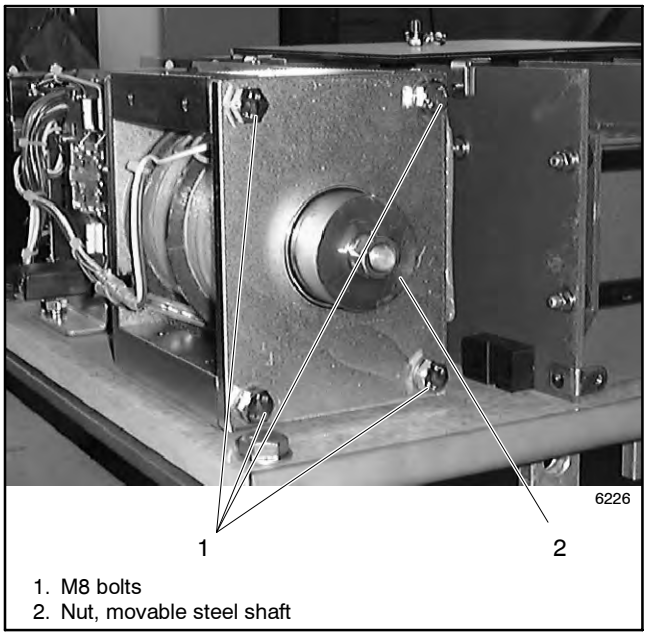
Figure 7-29 Closing Coil Connections

⚠ WARNING

Spring-loaded parts.
Can cause severe personal injury or property damage.

Wear protective goggles when servicing spring-loaded parts. Hold parts securely during disassembly.

3. The closing coil is spring-loaded. Hold the closing coil securely and remove four M8 bolts. Remove the closing coil. See Figure 7-30.



1. M8 bolts
2. Nut, movable steel shaft

Figure 7-30 Closing Coil Bolts and Nut

4. Replace the closing coil.
   a. Reuse the spring from the original coil.
   b. Align the boss on the coil into the recess in the frame.
   c. Replace the four M8 bolts. See Figure 7-30.
   d. Reconnect four leads shown in Figure 7-29.
5. Adjust the movable steel shaft as described in the following procedure.

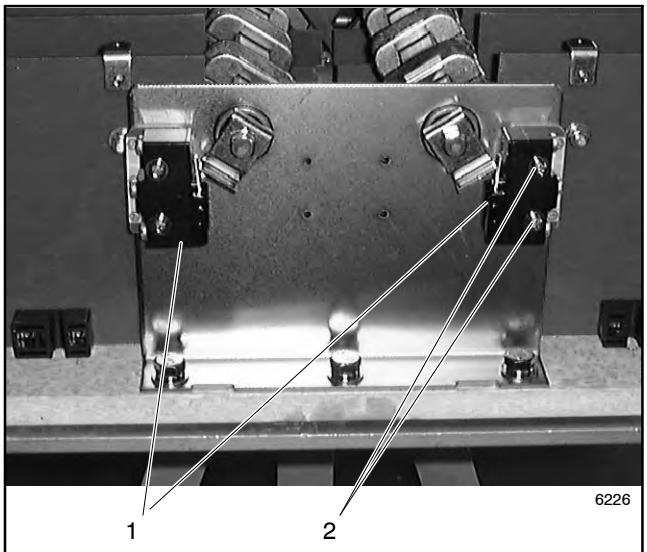
7.3.2 Shaft Adjustment, 600 Amp Models

Note: It is not necessary to remove the movable steel shaft when replacing the closing coil.

1. Turn the large round shaft in (clockwise) until the mechanism just latches when operated with the manual handle. If turned too far, it won't latch.
2. Turn the shaft back 1.5 rotations from the limit of the switching range.
3. Hold the shaft and tighten the nut.
4. Replace the cover on the mechanical unit.

7.3.3 Auxiliary Switch Replacement, 600 Amp Models

Loosen the M4 bolts and replace the auxiliary switches. Tighten the mounting screws to 0.14 Nm (1 in. lb.), maximum. See Figure 7-31.

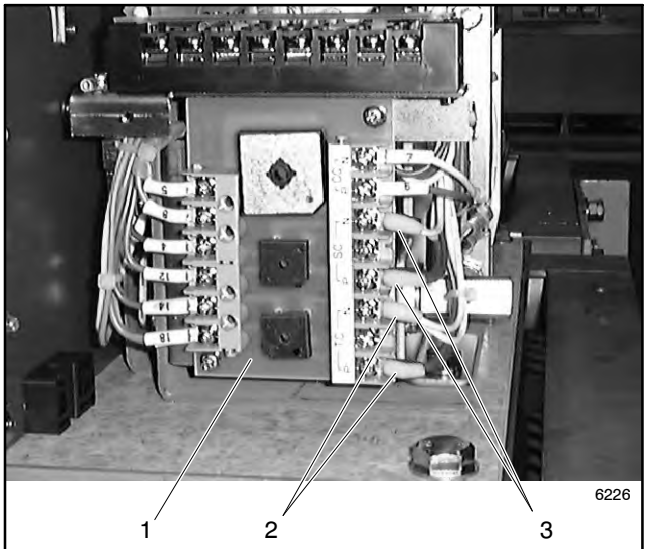


1. Auxiliary switches
2. M4 bolts

Figure 7-31 Auxiliary Switches, 600 Amp Models

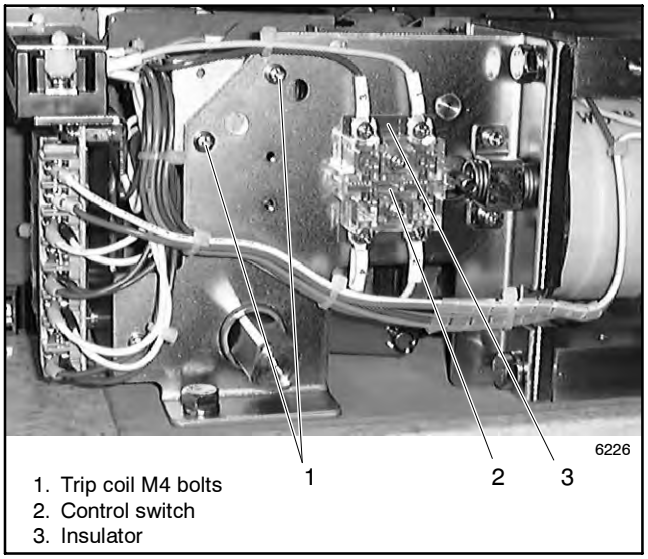
7.3.4 Trip Coil Replacement, 600 Amp Models

1. Note the connections and disconnect the trip coil leads from the printed circuit board and the control switch. See Figure 7-32 and Figure 7-33.



1. Printed circuit board
2. Trip coil (TC) leads
3. Select coil (SC) leads

Figure 7-32 Circuit Board Connections

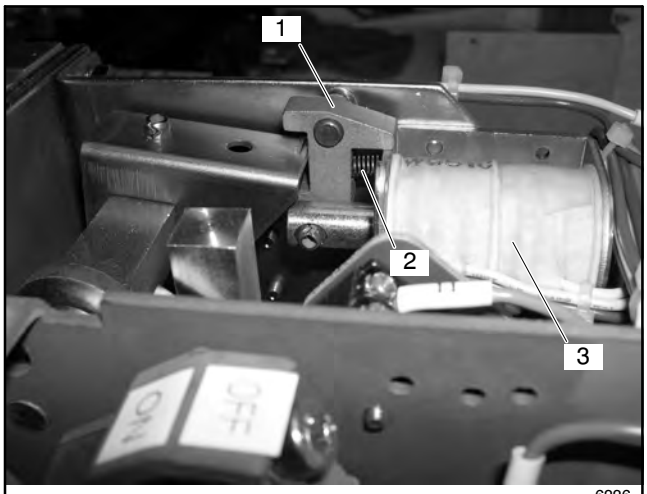


1. Trip coil M4 bolts
2. Control switch
3. Insulator

Figure 7-33 Trip Coil Replacement, 600 Amp Models

2. Remove two M4 bolts and replace the trip coil. Retain the small spring for the trip coil lever. See Figure 7-33 and Figure 7-34.

3. Connect the trip coil leads to the printed circuit board and control switch as noted during disassembly. Tighten control switch connections to 0.14 Nm (1 in. lb.), maximum.

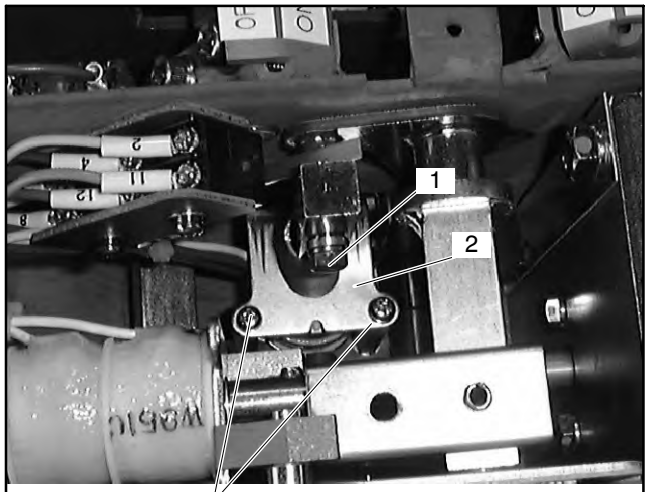


1. Trip lever
2. Spring
3. Trip coil

Figure 7-34 Trip Coil

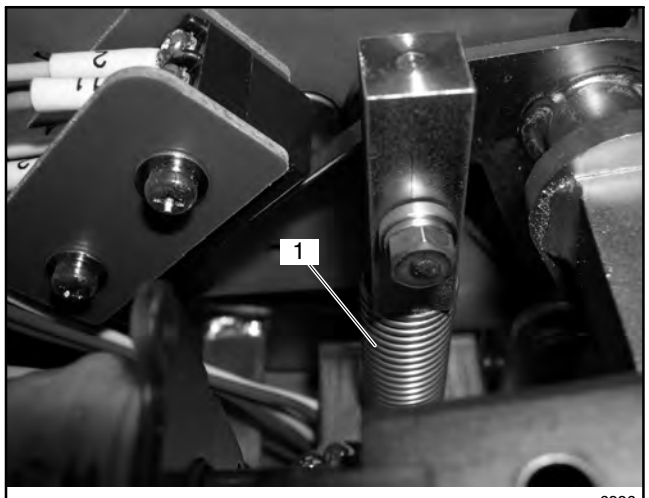
7.3.5 Select Coil Replacement, 600 Amp Models

1. Note the connections and disconnect the select coil leads from the printed circuit board and the control switch. See Figure 7-32 and Figure 7-33.
2. Loosen the M5 bolt and remove the select coil movable steel shaft and the spring. See Figure 7-35 and Figure 7-36.
3. Loosen the M4 bolts and replace the select coil. See Figure 7-35.
4. Connect the select coil leads to the control switch and circuit board.



1. Steel shaft (and spring, see Figure 7-36)
2. Select coil
3. Select coil M4 bolts

Figure 7-35 Select Coil Replacement, 600 Amp Models



1. Spring

Figure 7-36 Spring Location

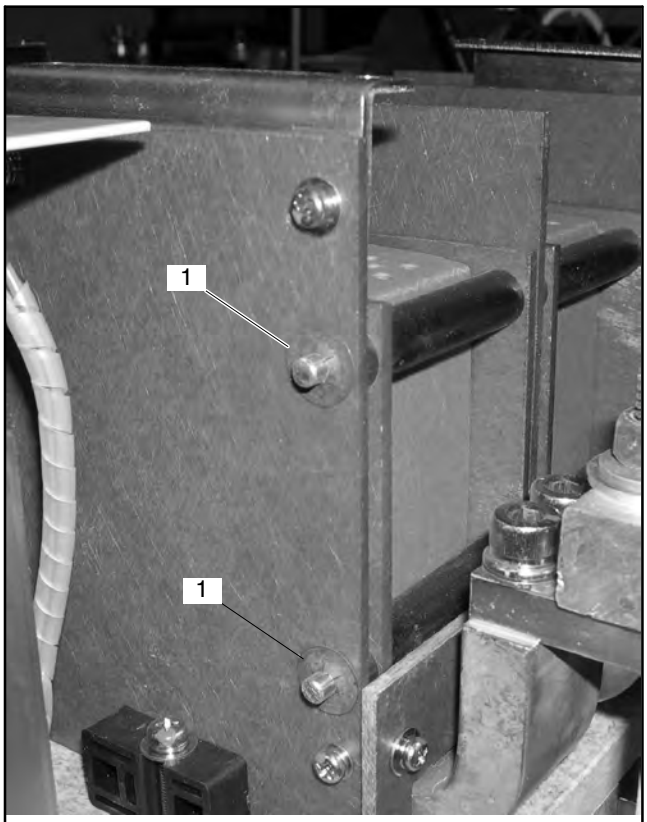
7.3.6 Printed Circuit Board Replacement, 600 Amp Models

Note: The individual rectifiers are not replaceable. Replace the entire printed circuit board in the case of rectifier failure.

1. Note the connections and disconnect all leads to the circuit board. See Figure 7-32.
2. Loosen the M4 bolts to replace the printed circuit board.
3. Reconnect all leads.

7.3.7 Arc Chute Replacement, 600 Amp Models

Note: Some units use retainers (part number 295010) instead of M6 nuts. See Figure 7-37. Obtain new retainers before disassembly.



1. Retainer

Figure 7-37 Retainer

1. Remove the insulation plate. See Figure 7-38.

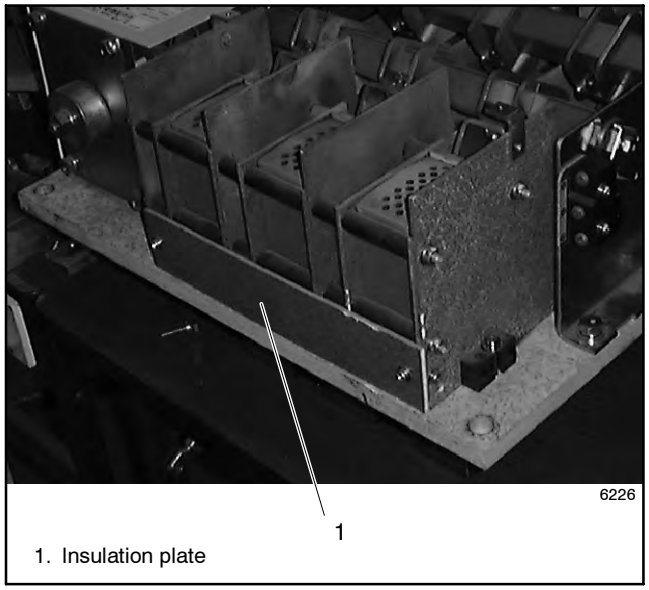


Figure 7-38 600 Amp Contactor

2. Attach a clamp or fixture similar to the one shown in Figure 7-39.

   Note: The transfer switch will come apart if the parts are not clamped as shown before the nuts or retainers are removed.

3. Loosen the M6 nuts or remove the retainers. See Figure 7-39.

4. Remove the upper rod shown in Figure 7-39.

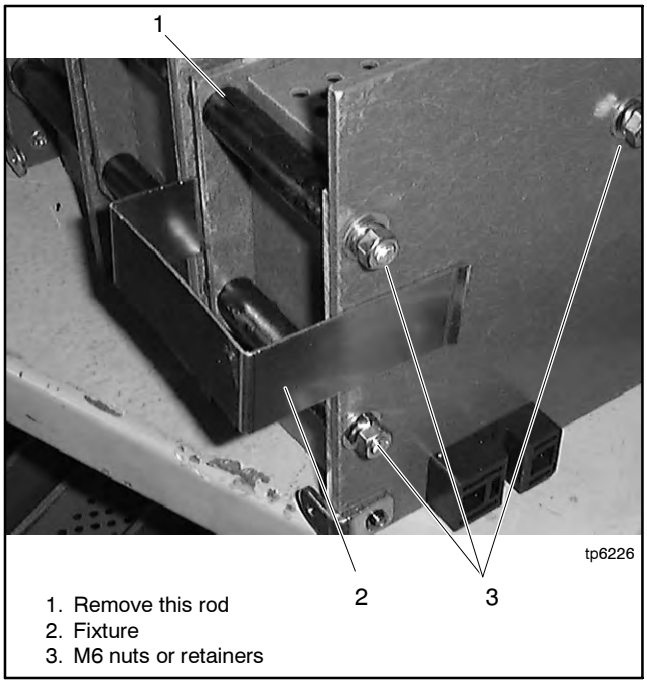


Figure 7-39 Fixture or Clamp, 600 Amp Models

5. Replace the arc chutes.

6. Replace the rod.

7. Reinstall and tighten the M6 nuts or install new retainers and then remove the clamp.

8. Reinstall the insulation plate.

Appendix A Abbreviations

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

A, amp	ampere
ABDC	after bottom dead center
AC	alternating current
A/D	analog to digital
ADC	advanced digital control; analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
Ah	amp-hour
AHWT	anticipatory high water temperature
AISI	American Iron and Steel Institute
ALOP	anticipatory low oil pressure
alt.	alternator
Al	aluminum
ANSI	American National Standards Institute (formerly American Standards Association, ASA)
AO	anticipatory only
APDC	Air Pollution Control District
API	American Petroleum Institute
approx.	approximate, approximately
AQMD	Air Quality Management District
AR	as required, as requested
AS	as supplied, as stated, as suggested
ASE	American Society of Engineers
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
ATS	automatic transfer switch
auto.	automatic
aux.	auxiliary
avg.	average
AVR	automatic voltage regulator
AWG	American Wire Gauge
AWM	appliance wiring material
bat.	battery
BBDC	before bottom dead center
BC	battery charger, battery charging
BCA	battery charging alternator
BCI	Battery Council International
BDC	before dead center
BHP	brake horsepower
blk.	black (paint color), block (engine)
blk. htr.	block heater
BMEP	brake mean effective pressure
bps	bits per second
br.	brass
BTDC	before top dead center
Btu	British thermal unit
Btu/min.	British thermal units per minute
C	Celsius, centigrade
cal.	calorie
CAN	controller area network
CARB	California Air Resources Board
CB	circuit breaker
cc	cubic centimeter
CCA	cold cranking amps
ccw.	counterclockwise
CEC	Canadian Electrical Code
cert.	certificate, certification, certified
cfh	cubic feet per hour
cfm	cubic feet per minute
CG	center of gravity
CID	cubic inch displacement
CL	centerline
cm	centimeter
CMOS	complementary metal oxide substrate (semiconductor)
cogen.	cogeneration
com	communications (port)
coml	commercial
Coml/Rec	Commercial/Recreational
conn.	connection
cont.	continued
CPVC	chlorinated polyvinyl chloride
crit.	critical
CRT	cathode ray tube
CSA	Canadian Standards Association
CT	current transformer
Cu	copper
cUL	Canadian Underwriter's Laboratories
CUL	Canadian Underwriter's Laboratories
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dB(A)	decibel (A weighted)
DC	direct current
DCR	direct current resistance
deg., °	degree
dept.	department
DFMEA	Design Failure Mode and Effects Analysis
dia.	diameter
DI/EO	dual inlet/end outlet
DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
DIP	dual inline package
DPDT	double-pole, double-throw
DPST	double-pole, single-throw
DS	disconnect switch
DVR	digital voltage regulator
E, emer.	emergency (power source)
ECM	electronic control module, engine control module
EDI	electronic data interchange
EFR	emergency frequency relay
e.g.	for example *(exempli gratia)*
EG	electronic governor
EGSA	Electrical Generating Systems Association
EIA	Electronic Industries Association
EI/EO	end inlet/end outlet
EMI	electromagnetic interference
emiss.	emission
eng.	engine
EPA	Environmental Protection Agency
EPS	emergency power system
ER	emergency relay
ES	engineering special, engineered special
ESD	electrostatic discharge
est.	estimated
E-Stop	emergency stop
etc.	et cetera (and so forth)
exh.	exhaust
ext.	external
F	Fahrenheit, female
fglass.	fiberglass
FHM	flat head machine (screw)
fl. oz.	fluid ounce
flex.	flexible
freq.	frequency
FS	full scale
ft.	foot, feet
ft. lb.	foot pounds (torque)
ft./min.	feet per minute
ftp	file transfer protocol
g	gram
ga.	gauge (meters, wire size)
gal.	gallon
gen.	generator
genset	generator set
GFI	ground fault interrupter
GND, ⏚	ground
gov.	governor
gph	gallons per hour
gpm	gallons per minute
gr.	grade, gross
GRD	equipment ground
gr. wt.	gross weight
H x W x D	height by width by depth
HC	hex cap
HCHT	high cylinder head temperature
HD	heavy duty
HET	high exhaust temp., high engine temp.
hex	hexagon
Hg	mercury (element)
HH	hex head
HHC	hex head cap
HP	horsepower
hr.	hour
HS	heat shrink
hsg.	housing
HVAC	heating, ventilation, and air conditioning
HWT	high water temperature
Hz	hertz (cycles per second)
IC	integrated circuit
ID	inside diameter, identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	improved motor starting
in.	inch
in. H_2O	inches of water
in. Hg	inches of mercury
in. lb.	inch pounds
Inc.	incorporated
ind.	industrial
int.	internal
int./ext.	internal/external
I/O	input/output
IP	iron pipe
ISO	International Organization for Standardization
J	joule
JIS	Japanese Industry Standard

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

Appendix B Screen Summaries

This section lists the items shown in the View and Setup screens for quick reference.

View Screens

Main Screen

- System Status
- Next Exercise Time and Date
- Normal and Emergency Voltage
- Frequency
- Normal Source Voltage
- Lamp Test
- Emergency Source Voltage
- Current, Amps
- Time/Date
- Daylight Saving Time Info
- Preferred Source
- Source-Source Type
- Commit/No Commit to Transfer
- Standard/Programmed Transition
- Phase Rotation (3-phase only)
- In-Phase Monitoring Enabled/Disabled

Test Sequence Screens

- Enter Password
- Type of Test
  - Loaded/Unloaded/Auto Load
  - Auto Load Test Run Time
- Test Sequence Status Screens
  - Active Time Delay with Time Remaining
  - Source Voltages
  - End Delay Button
  - End Test Button

View Exerciser Sequence (during exercise run)

- Exerciser Active
- Source Voltages
- Time Remaining (in exercise run)
- End Exercise Button

View Event History

- Event Description
- Date and Time of event

View Maintenance Records

- Total Min Not Preferred
- Reset Min Not Preferred
- Total Min in Standby
- Reset Min in Standby
- Total Min Operation
- Reset Min Operation
- Total Transfers
- Reset Transfers
- Total Fail Transfer
- Reset Fail Transfer
- Total Loss Pref Tran
- Reset Lodd Pref Tran
- Transfer Time N>E
- Transfer Time E>N
- System Start Date
- Last Maint Date
- Last Loss Duration
- Last Loss Date/Time

View Exerciser Setup

- Exercise Event Number
- Enabled/Disabled
- Exercise Run Time
- Start Date
- Start Time
- Weekly/Biweekly
- Loaded/Unloaded

View System Setup

- Open/Programmed Transition
- Source Type: Util/Gen, Gen/Gen, Util/Util or Util/Gen/Gen
- In-Phase Monitor Enabled/Disabled
- Commit/No Commit to Transfer
- # I/O Modules Installed
- Rated Current
- 3 Src Engine Start Mode Mode1/Mode2
- Remote Test Loading Loaded/Unloaded
- Peak Shave Delay Enabled/Disabled

View Source Setup

- ABC/BAC Rotation (3-phase only)
- System Voltage, Normal/Emergency
- Frequency (Hz), Source N and E
- Normal Under Voltage PU% and DO%
  - Normal Over Voltage PU% and DO%
  - Debounce Time, Seconds
- Normal Under Frequency PU% and DO%
  - Debounce Time
- Normal Voltage Unbalance Enable/Disable
  - Normal Voltage Unbalance PU% and DO%
- Emergency Under Voltage PU% and DO%
  - Emergency Over Voltage PU% and DO%
  - Debounce Time
- Emergency Under Frequency PU% and DO%
  - Emergency Over Frequency PU% and DO%
  - Debounce Time
- Emergency Voltage Unbalance Enable/Disable
  - Emergency Voltage Unbalance PU% and DO%

View Time Delays

- Source N and E
  - Engine Start (gen set only)
  - Engine Cooldown
- Load Disconnect N>E (E>N)
- Xfr Off > N (Off > E) (programmed-transition only)
- Xfr N>E (E>N)
- Loads to Control (1-9)
- Load Add N>E (E>N)
- Load Disc E>N (N>E)
- In Phase Xfr Fail Time Delay and Enabled/Disabled
- Fail to Acquire Standby (Preferred)

View Inputs/Outputs

- Main Board I/O
  - Input Function Descriptions (2)
  - Output Function Descriptions (2)
- Auxiliary Inputs/ Outputs
  - Aux I/O Module
    - Module Type and Address
    - Module Status
    - Input Function Descriptions
    - Output Function Descriptions

View Common Alarms

- Alarm Group (1 and 2)
- Alarm Description
- Audible (Yes or No)
- Common (Yes or No)

View Communications Setup

- Modbus Server TCP Enabled/Disabled
- Modbus Server Port 1 and 2 Enable/Disabled
- Modbus Address Port 1 and 2
- Baud Rate Port 1 and 2 9600/19200/57600
- Modbus TCP Unit ID
- IP Address
- Subnet Mask
- MAC Address

View Control Parameters

- Code Version
- ATS Serial Number
- Controller Serial Number
- Contactor Serial Number
- Site Designation
- Load Description
- Branch Description
- Location

Setup Screens

Set Time/Date

- Set Time
- Set Date
- Set Automatic Daylight Saving Time

Set Exerciser

- Exerciser Event Enable/Disable
- Exerciser Event Loaded/Unloaded
- Exerciser Event Interval
- Exerciser Event Repeat Rate
- Exerciser Event Duration
- Exerciser Event Start Date
- Exerciser Event Start time

Set Time Delay

- Source N(E)
- Engine Start
  - External Battery? Y or N
- Engine Cooldown
- In Phase Transfer Fail
- Load Disconnect N>E (E>N)
- Transfer N>E (E>N)
- Transfer Off>E (Off>N)(programmed-transition only)
- Load Add E>N (N>E)
- Loads to Add (1-9)
- Fail to Acquire Preferred Source
- Fail to Acquire Standby Source

Set Source

- Phase Rotation ABC/BAC/Disabled
- In-Phase Monitor Enable/Disable
- In-Phase Monitor Angle
- Set Preferred Source Normal/Emergency
- Set Normal (Emergency) Source:
  - Number of Phases
  - Voltage
  - Frequency
  - Under Voltage Pickup
  - Under Voltage Dropout
  - Over Voltage Pickup
  - Over Voltage dropout
  - Voltage Debounce Time
  - Voltage Unbalance Enable/Disable
  - Voltage Unbalance Pickup
  - Voltage Unbalance Dropout
  - Under Frequency Pickup
  - Under Frequency Dropout
  - Over Frequency Pickup
  - Over Frequency Dropout
  - Frequency Debounce time

Set Input/Output

- Set Main Board I/O
  - Set Input Functions *
  - Set Output Functions *
- Set Auxiliary I/O (Modules)
  - Set Input Functions *
  - Set Output Functions *

* See the ATS Operation and Installation Manual for more information about programmable inputs and outputs.

Set Common Alarms

- Alarm Group 1 or 2
- Modify Alarm
  - Alarm Description
  - Common (Yes/No)
  - Audible (Yes/No)
- Remove All Alarms Yes/No

Set System

- Source Type: Utility/Generator, Generator/Generator, Utility/Utility, Utility/Generator/Generator (3-source system)
- Transition Type: Standard/Programmed
- Rated Current, Amps
- 3 Source Engine Start Mode
  - Mode1/Mode2
  - Preferred Source Toggle Enable/Disable
- Transfer Commit Commit/No Commit
- Remote Test Loading Loaded/Unloaded
- Peak Shave TD Bypass Enable/Disable

Set Communications

- Modbus Server TCP Enable/Disable
- Modbus Server Port 1 or 2 Enable/Disable
- Modbus Address Port 1 or 2
- Baud Rate Port 1 or 2 9600/19200/57600
- Modbus TCP Unit ID
- IP Address
- Subnet Mask

Set Passwords

- Setup Password
- Test Password

Calibration

- Line-Neutral Voltages, Source N and E
- Line-Line Voltages, Source N and E
- Load Current, LA, LB, and LC

Reset Data

- Reset Maintenance Records, Yes or No
- Reset Event History, Yes or No
- Reset Default Parameters, Yes or No
- Reset Exercise Setup, Yes or No
- Reset Test Password, Yes or No
- Disable Test Password, Yes or No
- File Maintenance
  - Delete Files
  - Force History Save

USB Access Screen (appears only when a device is connected to the USB port)

- Download to Controller
- Upload to USB

Appendix C Noise and Wiring Practices

Electrical noise is an unwanted electrical signal that can cause errors in measurement, loss of control, malfunctions in microprocessor-based control systems, errors in data transfer between systems over communication links, or reductions in system performance.

Good system design and wiring practices can minimize noise levels and the effects of noise.

Noise, because of its random nature, is typically characterized by frequency distribution. Many noise sources are broad-spectrum, that is, they produce many frequencies distributed over a wide range. Broad-spectrum noise is particularly troublesome because it cannot be removed easily by filtering, and because it can affect a variety of systems in unpredictable ways. One common source of broad-spectrum noise is a switch, which can produce voltage and current changes when an electrical circuit is connected and disconnected.

Coupling is the transfer of signals between separate circuits. Signals from one circuit become noise in another. The amount of coupling is cumulative and is a function of the proximity of the circuits, their orientation, exposed area, and length of run. Minimize coupling by the following:

- Isolating circuits from each other by using separate raceways or conduit
- Separating circuits from each other by locating them as far apart as possible
- Enclosing circuits with a grounded metallic shield such as an enclosure, metallic conduit, or cable shield
- Running conductors perpendicular, rather than parallel, to each other
- Running wires loosely and randomly rather than bundling them tightly together
- Twisting a circuit's wires together in pairs

In an industrial environment, there are typically five types of circuits with different noise emission and rejection capabilities. The five types of circuits are as follows:

- **High-Power Distribution.** Circuits to high-power loads such as large electric motors and heaters can emit transient high levels of broad-spectrum noise. Loads on high-power distribution circuits are nearly immune to noise.
- **General Purpose Power Distribution.** Circuits to medium-power loads such as lighting, offices, light-duty equipment, and small motors such as fans and pumps can emit transient, medium levels of broad-spectrum noise. Some electronic equipment, such as computers, emits constant levels of broad-spectrum noise in addition to transient broad-spectrum noise. Loads on general-purpose circuits, except for sensitive electronic equipment, are nearly immune to noise.
- **Control.** Control circuits include DC circuits and 120 VAC maximum AC circuits that operate at a low power level (less than 1 W). Typical circuits include circuits to switches, actuators, and dry-contact relays, including the generator engine-start circuit. Control circuits emit transient low levels of broad-spectrum noise and are fairly immune to noise.
- **Analog.** Analog circuits are low-voltage DC circuits that convey measurement information as relatively small changes in current or voltage. Typical circuits include those connected to the controller's analog inputs. Analog circuits create the lowest noise levels and are the most sensitive to noise.
- **Communication and Signaling.** Communication and signaling circuits are low-voltage circuits that convey information. Typical circuits include RS-232 and RS-485 serial communication lines, telephone lines, and computer network lines. These circuits create noise with frequencies related to the communication signaling rate. These circuits have some level of built-in noise immunity. Typical systems will detect or correct errors caused by noise below certain levels, but with a corresponding reduction in the data transfer rate.

When planning an installation, separate all of these types of circuits as much as possible to minimize the hazards of insulation failure, accidental miswiring, and noise coupling. For best results, install control circuits, analog circuits, and communication and signaling circuits separately. Combining circuit types is unavoidable in the controller's enclosure and some other areas.

Note: It is very important to isolate high- and medium-power circuits in raceways or conduit separate from the other types of circuits.

Appendix D Common Hardware Application Guidelines

Use the information below and on the following pages to identify proper fastening techniques when no specific reference for reassembly is made.

Bolt/Screw Length: When bolt/screw length is not given, use Figure 1 as a guide. As a general rule, a minimum length of one thread beyond the nut and a maximum length of 1/2 the bolt/screw diameter beyond the nut is the preferred method.

Washers and Nuts: Use split lock washers as a bolt locking device where specified. Use SAE flat washers with whiz nuts, spiralock nuts, or standard nuts and preloading (torque) of the bolt in all other applications.

See Appendix E, General Torque Specifications, and other torque specifications in the service literature.

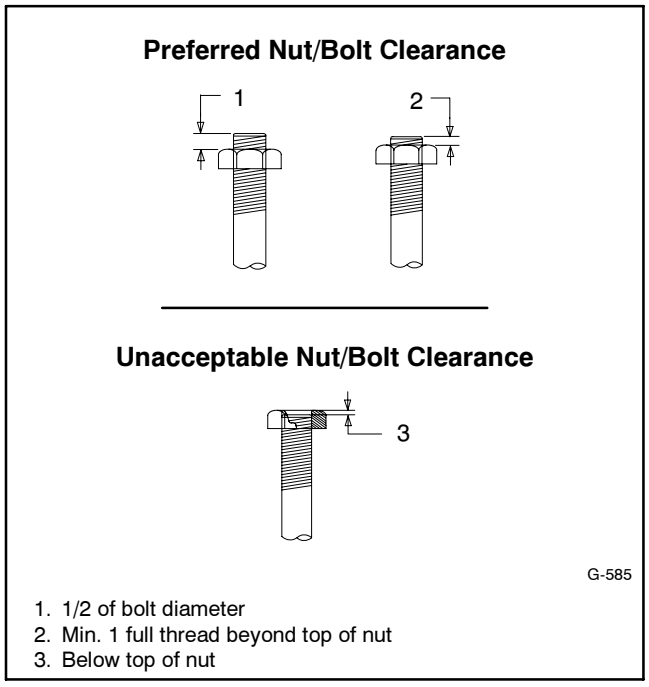


Figure 1 Acceptable Bolt Lengths

Steps for common hardware application:

1. Determine entry hole type: round or slotted.
2. Determine exit hole type: fixed female thread (weld nut), round, or slotted.

   For round and slotted exit holes, determine if hardware is greater than 1/2 inch in diameter, or 1/2 inch in diameter or less. Hardware that is *greater than 1/2 inch* in diameter takes a standard nut and SAE washer. Hardware *1/2 inch or less* in diameter can take a properly torqued whiz nut or spiralock nut. See Figure 2.
3. Follow these SAE washer rules after determining exit hole type:
   a. Always use a washer between hardware and a slot.
   b. Always use a washer under a nut (see 2 above for exception).
   c. Use a washer under a bolt when the female thread is fixed (weld nut).
4. Refer to Figure 2, which depicts the preceding hardware configuration possibilities.

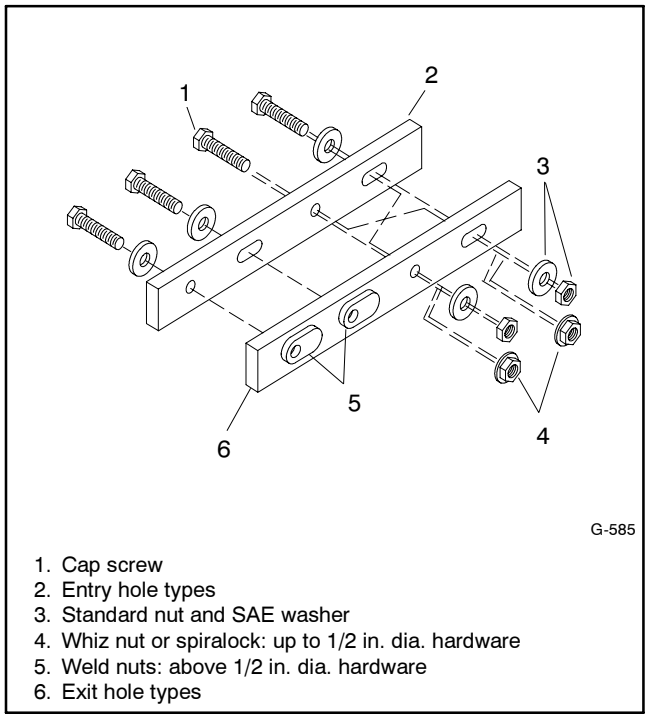


Figure 2 Acceptable Hardware Combinations

Appendix E General Torque Specifications

American Standard Fasteners Torque Specifications								
Size	Torque Measurement	Assembled into Cast Iron or Steel						Assembled into Aluminum Grade 2 or 5
		Grade 2		Grade 5		Grade 8		
8-32	Nm (in. lb.)	1.8	(16)	2.3	(20)	—		See Note 3
10-24	Nm (in. lb.)	2.9	(26)	3.6	(32)	—		
10-32	Nm (in. lb.)	2.9	(26)	3.6	(32)	—		
1/4-20	Nm (in. lb.)	6.8	(60)	10.8	(96)	14.9	(132)	
1/4-28	Nm (in. lb.)	8.1	(72)	12.2	(108)	16.3	(144)	
5/16-18	Nm (in. lb.)	13.6	(120)	21.7	(192)	29.8	(264)	
5/16-24	Nm (in. lb.)	14.9	(132)	23.1	(204)	32.5	(288)	
3/8-16	Nm (ft. lb.)	24.0	(18)	38.0	(28)	53.0	(39)	
3/8-24	Nm (ft. lb.)	27.0	(20)	42.0	(31)	60.0	(44)	
7/16-14	Nm (ft. lb.)	39.0	(29)	60.0	(44)	85.0	(63)	
7/16-20	Nm (ft. lb.)	43.0	(32)	68.0	(50)	95.0	(70)	
1/2-13	Nm (ft. lb.)	60.0	(44)	92.0	(68)	130.0	(96)	
1/2-20	Nm (ft. lb.)	66.0	(49)	103.0	(76)	146.0	(108)	
9/16-12	Nm (ft. lb.)	81.0	(60)	133.0	(98)	187.0	(138)	
9/16-18	Nm (ft. lb.)	91.0	(67)	148.0	(109)	209.0	(154)	
5/8-11	Nm (ft. lb.)	113.0	(83)	183.0	(135)	259.0	(191)	
5/8-18	Nm (ft. lb.)	128.0	(94)	208.0	(153)	293.0	(216)	
3/4-10	Nm (ft. lb.)	199.0	(147)	325.0	(240)	458.0	(338)	
3/4-16	Nm (ft. lb.)	222.0	(164)	363.0	(268)	513.0	(378)	
1-8	Nm (ft. lb.)	259.0	(191)	721.0	(532)	1109.0	(818)	
1-12	Nm (ft. lb.)	283.0	(209)	789.0	(582)	1214.0	(895)	

Metric Fasteners Torque Specifications, Measured in Nm (ft. lb.)								
Size (mm)	Assembled into Cast Iron or Steel						Assembled into Aluminum Grade 5.8 or 8.8
	Grade 5.8		Grade 8.8		Grade 10.9		
M6 x 1.00	6.2	(4.6)	9.5	(7)	13.6	(10)	See Note 3
M8 x 1.25	15.0	(11)	23.0	(17)	33.0	(24)	
M8 x 1.00	16.0	(11)	24.0	(18)	34.0	(25)	
M10 x 1.50	30.0	(22)	45.0	(34)	65.0	(48)	
M10 x 1.25	31.0	(23)	47.0	(35)	68.0	(50)	
M12 x 1.75	53.0	(39)	80.0	(59)	115.0	(85)	
M12 x 1.50	56.0	(41)	85.0	(63)	122.0	(90)	
M14 x 2.00	83.0	(61)	126.0	(93)	180.0	(133)	
M14 x 1.50	87.0	(64)	133.0	(98)	190.0	(140)	
M16 x 2.00	127.0	(94)	194.0	(143)	278.0	(205)	
M16 x 1.50	132.0	(97)	201.0	(148)	287.0	(212)	
M18 x 2.50	179.0	(132)	273.0	(201)	390.0	(288)	
M18 x 1.50	189.0	(140)	289.0	(213)	413.0	(305)	

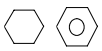
Notes:

1. The torque values above are general guidelines. Always use the torque values specified in the service manuals and/or assembly drawings when they differ from the above torque values.
2. The torque values above are based on new plated threads. Increase torque values by 15% if non-plated threads are used.
3. Hardware threaded into aluminum must have either two diameters of thread engagement or a 30% or more reduction in the torque to prevent stripped threads.
4. Torque values are calculated as equivalent stress loading on American hardware with an approximate preload of 90% of the yield strength and a friction coefficient of 0.125.

Appendix F Common Hardware Identification

Screw/Bolts/Studs	
Head Styles	
Hex Head or Machine Head	
Hex Head or Machine Head with Washer	
Flat Head (FHM)	
Round Head (RHM)	
Pan Head	
Hex Socket Head Cap or Allen™ Head Cap	
Hex Socket Head or Allen™ Head Shoulder Bolt	
Sheet Metal Screw	
Stud	
Drive Styles	
Hex	
Hex and Slotted	
Phillips®	
Slotted	
Hex Socket	

Nuts	
Nut Styles	
Hex Head	
Lock or Elastic	
Square	
Cap or Acorn	
Wing	
Washers	
Washer Styles	
Plain	
Split Lock or Spring	
Spring or Wave	
External Tooth Lock	
Internal Tooth Lock	
Internal-External Tooth Lock	

Hardness Grades	
American Standard	
Grade 2	
Grade 5	
Grade 8	
Grade 8/9 (Hex Socket Head)	
Metric	
Number stamped on hardware; 5.8 shown	

Allen™ head screw is a trademark of Holo-Krome Co.

Phillips® screw is a registered trademark of Phillips Screw Company.

Sample Dimensions

American Standard (Screws, Bolts, Studs, and Nuts)

1/4-20 x 1

- Length In Inches (Screws and Bolts)
- Threads Per Inch
- Major Thread Diameter In Fractional Inches Or Screw Number Size

Metric (Screws, Bolts, Studs, and Nuts)

M8-1.25 x 20

- Length In Millimeters (Screws and Bolts)
- Distance Between Threads In Millimeters
- Major Thread Diameter In Millimeters

Plain Washers

9/32 x 5/8 x 1/16

- Thickness
- External Dimension
- Internal Dimension

Lock Washers

5/8

- Internal Dimension

Appendix G Common Hardware List

The Common Hardware List lists part numbers and dimensions for common hardware items.

American Standard

Part No.	Dimensions
Hex Head Bolts (Grade 5)	
X-465-17	1/4-20 x .38
X-465-6	1/4-20 x .50
X-465-2	1/4-20 x .62
X-465-16	1/4-20 x .75
X-465-18	1/4-20 x .88
X-465-7	1/4-20 x 1.00
X-465-8	1/4-20 x 1.25
X-465-9	1/4-20 x 1.50
X-465-10	1/4-20 x 1.75
X-465-11	1/4-20 x 2.00
X-465-12	1/4-20 x 2.25
X-465-14	1/4-20 x 2.75
X-465-21	1/4-20 x 5.00
X-465-25	1/4-28 x .38
X-465-20	1/4-28 x 1.00
X-125-33	5/16-18 x .50
X-125-23	5/16-18 x .62
X-125-3	5/16-18 x .75
X-125-31	5/16-18 x .88
X-125-5	5/16-18 x 1.00
X-125-24	5/16-18 x 1.25
X-125-34	5/16-18 x 1.50
X-125-25	5/16-18 x 1.75
X-125-26	5/16-18 x 2.00
230578	5/16-18 x 2.25
X-125-29	5/16-18 x 2.50
X-125-27	5/16-18 x 2.75
X-125-28	5/16-18 x 3.00
X-125-22	5/16-18 x 4.50
X-125-32	5/16-18 x 5.00
X-125-35	5/16-18 x 5.50
X-125-36	5/16-18 x 6.00
X-125-40	5/16-18 x 6.50
X-125-43	5/16-24 x 1.75
X-125-44	5/16-24 x 2.50
X-125-30	5/16-24 x .75
X-125-39	5/16-24 x 2.00
X-125-38	5/16-24 x 2.75
X-6238-2	3/8-16 x .62
X-6238-10	3/8-16 x .75
X-6238-3	3/8-16 x .88
X-6238-11	3/8-16 x 1.00
X-6238-4	3/8-16 x 1.25
X-6238-5	3/8-16 x 1.50
X-6238-1	3/8-16 x 1.75
X-6238-6	3/8-16 x 2.00
X-6238-17	3/8-16 x 2.25
X-6238-7	3/8-16 x 2.50
X-6238-8	3/8-16 x 2.75
X-6238-9	3/8-16 x 3.00
X-6238-19	3/8-16 x 3.25
X-6238-12	3/8-16 x 3.50
X-6238-20	3/8-16 x 3.75
X-6238-13	3/8-16 x 4.50
X-6238-18	3/8-16 x 5.50
X-6238-25	3/8-16 x 6.50

Part No.	Dimensions
Hex Head Bolts, cont.	
X-6238-14	3/8-24 x .75
X-6238-16	3/8-24 x 1.25
X-6238-21	3/8-24 x 4.00
X-6238-22	3/8-24 x 4.50
X-6024-5	7/16-14 x .75
X-6024-2	7/16-14 x 1.00
X-6024-8	7/16-14 x 1.25
X-6024-3	7/16-14 x 1.50
X-6024-4	7/16-14 x 2.00
X-6024-11	7/16-14 x 2.75
X-6024-12	7/16-14 x 6.50
X-129-15	1/2-13 x .75
X-129-17	1/2-13 x 1.00
X-129-18	1/2-13 x 1.25
X-129-19	1/2-13 x 1.50
X-129-20	1/2-13 x 1.75
X-129-21	1/2-13 x 2.00
X-129-22	1/2-13 x 2.25
X-129-23	1/2-13 x 2.50
X-129-24	1/2-13 x 2.75
X-129-25	1/2-13 x 3.00
X-129-27	1/2-13 x 3.50
X-129-29	1/2-13 x 4.00
X-129-30	1/2-13 x 4.50
X-463-9	1/2-13 x 5.50
X-129-44	1/2-13 x 6.00
X-129-51	1/2-20 x .75
X-129-45	1/2-20 x 1.25
X-129-52	1/2-20 x 1.50
X-6021-3	5/8-11 x 1.00
X-6021-4	5/8-11 x 1.25
X-6021-2	5/8-11 x 1.50
X-6021-1	5/8-11 x 1.75
273049	5/8-11 x 2.00
X-6021-5	5/8-11 x 2.25
X-6021-6	5/8-11 x 2.50
X-6021-7	5/8-11 x 2.75
X-6021-12	5/8-11 x 3.75
X-6021-11	5/8-11 x 4.50
X-6021-10	5/8-11 x 6.00
X-6021-9	5/8-18 x 2.50
X-6239-1	3/4-10 x 1.00
X-6239-8	3/4-10 x 1.25
X-6239-2	3/4-10 x 1.50
X-6239-3	3/4-10 x 2.00
X-6239-4	3/4-10 x 2.50
X-6239-5	3/4-10 x 3.00
X-6239-6	3/4-10 x 3.50
X-792-1	1-8 x 2.25
X-792-5	1-8 x 3.00
X-792-8	1-8 x 5.00

Part No.	Dimensions	Type
Hex Nuts		
X-6009-1	1-8	Standard
X-6210-3	6-32	Whiz
X-6210-4	8-32	Whiz
X-6210-5	10-24	Whiz
X-6210-1	10-32	Whiz
X-6210-2	1/4-20	Spiralock
X-6210-6	1/4-28	Spiralock
X-6210-7	5/16-18	Spiralock
X-6210-8	5/16-24	Spiralock
X-6210-9	3/8-16	Spiralock
X-6210-10	3/8-24	Spiralock
X-6210-11	7/16-14	Spiralock
X-6210-12	1/2-13	Spiralock
X-6210-15	7/16-20	Spiralock
X-6210-14	1/2-20	Spiralock
X-85-3	5/8-11	Standard
X-88-12	3/4-10	Standard
X-89-2	1/2-20	Standard

Washers

Part No.	ID	OD	Thick.	Bolt/ Screw
X-25-46	.125	.250	.022	#4
X-25-9	.156	.375	.049	#6
X-25-48	.188	.438	.049	#8
X-25-36	.219	.500	.049	#10
X-25-40	.281	.625	.065	1/4
X-25-85	.344	.687	.065	5/16
X-25-37	.406	.812	.065	3/8
X-25-34	.469	.922	.065	7/16
X-25-26	.531	1.062	.095	1/2
X-25-15	.656	1.312	.095	5/8
X-25-29	.812	1.469	.134	3/4
X-25-127	1.062	2.000	.134	1

Metric

Hex head bolts are hardness grade 8.8 unless noted.

Hex Head Bolts (Partial Thread)

Part No.	Dimensions
M931-05055-60	M5-0.80 x 55
M931-06040-60	M6-1.00 x 40
M931-06055-60	M6-1.00 x 55
M931-06060-60	M6-1.00 x 60
M931-06060-SS	M6-1.00 x 60
M931-06070-60	M6-1.00 x 70
M931-06070-SS	M6-1.00 x 70
M931-06075-60	M6-1.00 x 75
M931-06090-60	M6-1.00 x 90
M931-06145-60	M6-1.00 x 145
M931-06150-60	M6-1.00 x 150
M931-08035-60	M8-1.25 x 35
M931-08040-60	M8-1.25 x 40
M931-08045-60	M8-1.25 x 45
M931-08050-60	M8-1.25 x 50
M931-08055-60	M8-1.25 x 55
M931-08055-82	M8-1.25 x 55*
M931-08060-60	M8-1.25 x 60
M931-08070-60	M8-1.25 x 70
M931-08070-82	M8-1.25 x 70*
M931-08075-60	M8-1.25 x 75
M931-08080-60	M8-1.25 x 80
M931-08090-60	M8-1.25 x 90
M931-08095-60	M8-1.25 x 95
M931-08100-60	M8-1.25 x 100
M931-08110-60	M8-1.25 x 110
M931-08120-60	M8-1.25 x 120
M931-08130-60	M8-1.25 x 130
M931-08140-60	M8-1.25 x 140
M931-08150-60	M8-1.25 x 150
M931-08200-60	M8-1.25 x 200
M931-10040-82	M10-1.25 x 40*
M931-10040-60	M10-1.50 x 40
M931-10045-60	M10-1.50 x 45
M931-10050-60	M10-1.50 x 50
M931-10050-82	M10-1.25 x 50*
M931-10055-60	M10-1.50 x 55
M931-10060-60	M10-1.50 x 60
M931-10065-60	M10-1.50 x 65
M931-10070-60	M10-1.50 x 70
M931-10080-60	M10-1.50 x 80
M931-10080-82	M10-1.25 x 80*
M931-10090-60	M10-1.50 x 90
M931-10090-82	M10-1.50 x 90*
M931-10100-60	M10-1.50 x 100
M931-10110-60	M10-1.50 x 110
M931-10120-60	M10-1.50 x 120
M931-10130-60	M10-1.50 x 130
M931-10140-60	M10-1.50 x 140
M931-10180-60	M10-1.50 x 180
M931-10235-60	M10-1.50 x 235
M931-10260-60	M10-1.50 x 260
M960-10330-60	M10-1.25 x 330
M931-12045-60	M12-1.75 x 45
M960-12050-60	M12-1.25 x 50
M960-12050-82	M12-1.25 x 50*
M931-12050-60	M12-1.75 x 50
M931-12050-82	M12-1.75 x 50*
M931-12055-60	M12-1.75 x 55
M931-12060-60	M12-1.75 x 60
M931-12060-82	M12-1.75 x 60*
M931-12065-60	M12-1.75 x 65
M931-12075-60	M12-1.75 x 75
M931-12080-60	M12-1.75 x 80
M931-12090-60	M12-1.75 x 90
M931-12100-60	M12-1.75 x 100
M931-12110-60	M12-1.75 x 110

Hex Head Bolts (Partial Thread), continued

Part No.	Dimensions
M960-16090-60	M16-1.50 x 90
M931-16090-60	M16-2.00 x 90
M931-16100-60	M16-2.00 x 100
M931-16100-82	M16-2.00 x 100*
M931-16120-60	M16-2.00 x 120
M931-16150-60	M16-2.00 x 150
M931-20065-60	M20-2.50 x 65
M931-20090-60	M20-2.50 x 90
M931-20100-60	M20-2.50 x 100
M931-20120-60	M20-2.50 x 120
M931-20140-60	M20-2.50 x 140
M931-20160-60	M20-2.50 x 160
M931-22090-60	M22-2.50 x 90
M931-22120-60	M22-2.50 x 120
M931-22160-60	M22-2.50 x 160
M931-24090-60	M24-3.00 x 90
M931-24120-60	M24-3.00 x 120
M931-24160-60	M24-3.00 x 160
M931-24200-60	M24-3.00 x 200

Hex Head Bolts (Full Thread)

Part No.	Dimensions
M933-04006-60	M4-0.70 x 6
M933-05030-60	M5-0.80 x 30
M933-05035-60	M5-0.80 x 35
M933-05050-60	M5-0.80 x 50
M933-06010-60	M6-1.00 x 10
M933-06012-60	M6-1.00 x 12
M933-06014-60	M6-1.00 x 14
M933-06016-60	M6-1.00 x 16
M933-06020-60	M6-1.00 x 20
M933-06025-60	M6-1.00 x 25
M933-06030-60	M6-1.00 x 30
M933-06040-60	M6-1.00 x 40
M933-06050-60	M6-1.00 x 50
M933-07025-60	M7-1.00 x 25
M933-08010-60	M8-1.25 x 10
M933-08012-60	M8-1.25 x 12
M933-08016-60	M8-1.25 x 16
M933-08020-60	M8-1.25 x 20
M933-08025-60	M8-1.25 x 25
M933-08030-60	M8-1.25 x 30
M933-08030-82	M8-1.25 x 30*
M933-10012-60	M10-1.50 x 12
M961-10020-60	M10-1.25 x 20
M933-10020-60	M10-1.50 x 20
M933-10025-60	M10-1.50 x 25
M961-10025-60	M10-1.25 x 25
M933-10025-82	M10-1.50 x 25*
M961-10030-60	M10-1.25 x 30
M933-10030-60	M10-1.50 x 30
M933-10030-82	M10-1.50 x 30*
M961-10035-60	M10-1.25 x 35
M933-10035-60	M10-1.50 x 35
M933-10035-82	M10-1.50 x 35*
M961-10040-60	M10-1.25 x 40

Hex Head Bolts (Full Thread), continued

Part No.	Dimensions
M933-12016-60	M12-1.75 x 16
M933-12020-60	M12-1.75 x 20
M961-12020-60F	M12-1.50 x 20
M933-12025-60	M12-1.75 x 25
M933-12025-82	M12-1.75 x 25*
M961-12030-60	M12-1.25 x 30
M933-12030-82	M12-1.75 x 30*
M961-12030-82F	M12-1.50 x 30*
M933-12030-60	M12-1.75 x 30
M933-12035-60	M12-1.75 x 35
M961-12040-82	M12-1.25 x 40*
M933-12040-60	M12-1.75 x 40
M933-12040-82	M12-1.75 x 40*
M961-14025-60	M14-1.50 x 25
M933-14025-60	M14-2.00 x 25
M961-14050-82	M14-1.50 x 50*
M961-16025-60	M16-1.50 x 25
M933-16025-60	M16-2.00 x 25
M961-16030-82	M16-1.50 x 30*
M933-16030-82	M16-2.00 x 30*
M933-16035-60	M16-2.00 x 35
M961-16040-60	M16-1.50 x 40
M933-16040-60	M16-2.00 x 40
M961-16045-82	M16-1.50 x 45*
M933-16045-82	M16-2.00 x 45*
M933-16050-60	M16-2.00 x 50
M933-16050-82	M16-2.00 x 50*
M933-16060-60	M16-2.00 x 60
M933-16070-60	M16-2.00 x 70
M933-18035-60	M18-2.50 x 35
M933-18050-60	M18-2.50 x 50
M933-18060-60	M18-2.50 x 60
M933-20050-60	M20-2.50 x 50
M933-20055-60	M20-2.50 x 55
M933-24060-60	M24-3.00 x 60
M933-24065-60	M24-3.00 x 65
M933-24070-60	M24-3.00 x 70

Pan Head Machine Screws

Part No.	Dimensions
M7985A-03010-20	M3-0.50 x 10
M7985A-03012-20	M3-0.50 x 12
M7985A-04010-20	M4-0.70 x 10
M7985A-04016-20	M4-0.70 x 16
M7985A-04020-20	M4-0.70 x 20
M7985A-04050-20	M4-0.70 x 50
M7985A-04100-20	M4-0.70 x 100
M7985A-05010-20	M5-0.80 x 10
M7985A-05012-20	M5-0.80 x 12
M7985A-05016-20	M5-0.80 x 16
M7985A-05020-20	M5-0.80 x 20
M7985A-05025-20	M5-0.80 x 25
M7985A-05030-20	M5-0.80 x 30
M7985A-05080-20	M5-0.80 x 80
M7985A-05100-20	M5-0.80 x 100
M7985A-06100-20	M6-1.00 x 100

Flat Head Machine Screws

Part No.	Dimensions
M965A-04012-SS	M4-0.70 x 12
M965A-05012-SS	M5-0.80 x 12
M965A-05016-20	M5-0.80 x 16
M965A-06012-20	M6-1.00 x 12

* This metric hex bolt's hardness is grade 10.9.

Metric, continued

Part No.	Dimensions	Type
Hex Nuts		
M934-03-50	M3-0.50	Standard
M934-04-50	M4-0.70	Standard
M934-04-B	M4-0.70	Brass
M934-05-50	M5-0.80	Standard
M934-06-60	M6-1.00	Standard
M934-06-64	M6-1.00	Std. (green)
M6923-06-80	M6-1.00	Spiralock
M982-06-80	M6-1.00	Elastic Stop
M934-08-60	M8-1.25	Standard
M6923-08-80	M8-1.25	Spiralock
M982-08-80	M8-1.25	Elastic Stop
M934-10-60	M10-1.50	Standard
M934-10-60F	M10-1.25	Standard
M6923-10-80	M10-1.50	Spiralock
M6923-10-62	M10-1.50	Spiralock†
M982-10-80	M10-1.50	Elastic Stop
M934-12-60	M12-1.75	Standard
M934-12-60F	M12-1.25	Standard
M6923-12-80	M12-1.75	Spiralock
M982-12-80	M12-1.75	Elastic Stop
M982-14-60	M14-2.00	Elastic Stop
M6923-16-80	M16-2.00	Spiralock
M982-16-80	M16-2.00	Elastic Stop
M934-18-80	M18-2.5	Standard
M982-18-60	M18-2.50	Elastic Stop
M934-20-80	M20-2.50	Standard
M982-20-80	M20-2.50	Elastic Stop
M934-22-60	M22-2.50	Standard
M934-24-80	M24-3.00	Standard
M982-24-60	M24-3.00	Elastic Stop
M934-30-80	M30-3.50	Standard

Washers

Part No.	ID	OD	Thick.	Bolt/ Screw
M125A-03-80	3.2	7.0	0.5	M3
M125A-04-80	4.3	9.0	0.8	M4
M125A-05-80	5.3	10.0	1.0	M5
M125A-06-80	6.4	12.0	1.6	M6
M125A-08-80	8.4	16.0	1.6	M8
M125A-10-80	10.5	20.0	2.0	M10
M125A-12-80	13.0	24.0	2.5	M12
M125A-14-80	15.0	28.0	2.5	M14
M125A-16-80	17.0	30.0	3.0	M16
M125A-18-80	19.0	34.0	3.0	M18
M125A-20-80	21.0	37.0	3.0	M20
M125A-24-80	25.0	44.0	4.0	M24

† This metric hex nut's hardness is grade 8.

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