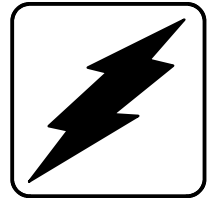


Operation and Installation

Automatic Transfer Switches



Models:

G220

Controls:

Solid-State

Power Switching Device:

100 and 200 Amperes

KOHLER®

POWER SYSTEMS

9001
KOHLER
POWER SYSTEMS
NATIONALLY REGISTERED

TP-6321 6/04

Product Identification Information

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

Transfer Switch Identification Numbers

Record the product identification numbers from the transfer switch nameplate.

Model Designation _____

Serial Number _____

[illegible]

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Safety Precautions and Instructions

A transfer switch, like any other electromechanical device, can pose potential dangers to life and limb if improperly maintained or operated. The best way to prevent accidents is to be aware of potential dangers and act safely. Please read and follow the safety precautions and instructions below to prevent harm to yourself and others. This manual contains several types of safety precautions and instructions which are explained below. SAVE THESE INSTRUCTIONS.

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.**

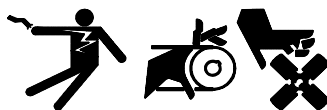
NOTICE

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

Safety decals affixed to the transfer switch in prominent places advise the operator or service technician of potential hazards and how to act safely. The decals are reproduced here 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.

Battery

WARNING



Sulfuric acid in batteries. Can cause severe injury or death.

Wear protective goggles and clothing. Battery acid may cause blindness and burn skin.

Battery electrolyte is a diluted sulfuric acid. Battery acid can cause severe injury or death. Battery acid can cause blindness and burn skin. Always wear splashproof safety goggles, rubber gloves, and boots when servicing the battery. Do not open a sealed battery or mutilate the battery case. If battery acid splashes in the eyes or on the skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

WARNING





Explosion. Can cause severe injury or death. Relays in the battery charger cause arcs or sparks.

Locate the battery in a well-ventilated area. Isolate the battery charger from explosive fumes.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flames or sparks to occur near a battery at any time, particularly when it is charging. Do not dispose of a battery in a fire. To prevent burns and sparks that could cause an explosion, avoid touching the battery terminals with tools or other metal objects. Remove all jewelry before servicing the equipment. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface away from the battery. To avoid sparks, do not disturb the battery charger connections while the battery is charging. Always turn the battery charger off before disconnecting the battery connections. Ventilate the compartments containing batteries to prevent accumulation of explosive gases.

Hazardous Voltage/ Electrical Shock


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


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


Grounding the transfer switch. **Hazardous voltage can cause severe injury or death.** Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the transfer switch and related equipment and electrical circuits to comply with applicable codes and standards. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution increases under such conditions.

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. Open 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.

Heavy Equipment


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


Airborne particles. Can cause severe injury or blindness. Wear protective goggles and clothing when using power tools, hand tools, or compressed air.

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

When replacing hardware, do not substitute with inferior grade hardware. 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

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

NOTICE

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

NOTICE

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

This manual provides operation and installation instructions for Kohler® Model G220 transfer switches with solid-state electrical controls.

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.

Service Assistance

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

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

Headquarters Europe, Middle East, Africa (EMEA)

Kohler Power Systems
ZI Senia 122
12, rue des Hauts Flouviars
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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

Notes

Section 1 Specifications

1.1 Purpose

An automatic transfer switch (ATS) transfers critical electrical loads from a normal (preferred) source of electrical power to an emergency (standby) source when the normal source fails to maintain a minimum voltage level.

When the normal source fails, the ATS signals the generator set(s) to start. When the emergency source reaches a minimum voltage level, the ATS transfers the load from the normal source to the emergency source. The ATS continuously senses the normal source and transfers the load back to the normal source when the normal source returns. After transfer of the load back to the normal source, the ATS removes the generator set start signal, allowing the generator set(s) to shut down.

1.2 Component Overview

The ATS components include the power switching device (contactor), the electrical controls, and the exerciser. See Figure 1-1.

The power switching device transfers power from the normal or emergency sources to the load. See Figure 1-2. The electrical controls electrically actuate the switch to select a power source, and the switch mechanically latches into the selected position. The switch also includes a provision for manual mechanical operation in emergency nonpowered conditions.

The electrical controls monitor power sources, control the contactor, and signal the generator to start when needed. The exerciser runs the generator set weekly if enabled.

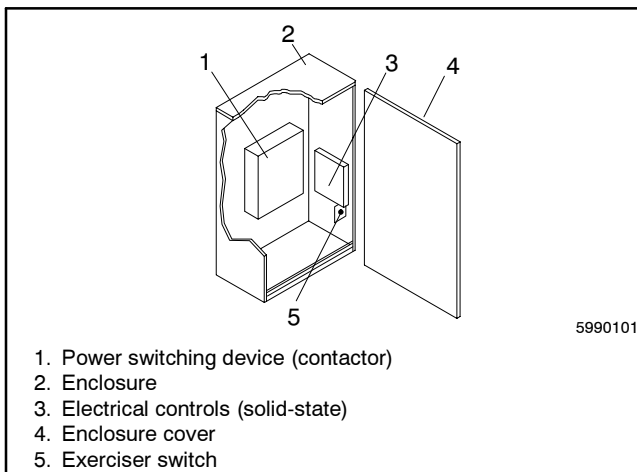


Figure 1-1 ATS Components

The power switch contains two sets of multipole contacts. One set of contacts selects power from the normal source and the other set selects power from the emergency source. Mechanical interlocks within the switch ensure that only one set of contacts is closed at a time ensuring load servicing without cross-coupling of power sources.

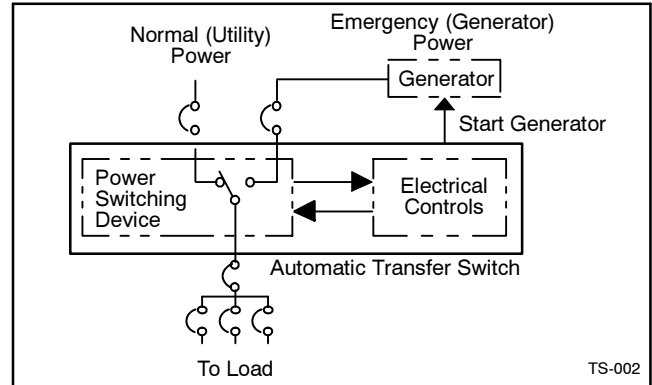


Figure 1-2 Typical ATS Block Diagram

1.3 Nameplate

A nameplate is attached to the inside of the ATS enclosure cover. See Figure 1-3. The nameplate label includes a model and serial number and provides rating information.

Copy the model and serial number from the nameplate into the spaces provided in the Service Assistance section of this manual for use when requesting service or parts.

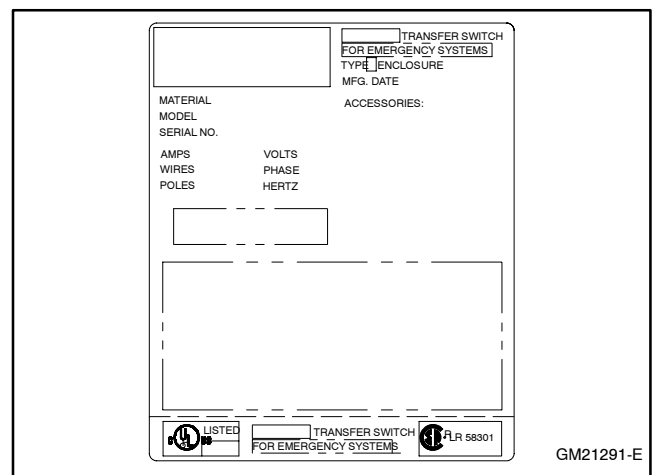


Figure 1-3 Typical Transfer Switch Nameplate

1.4 Model Number

Use Figure 1-4 to record and interpret the transfer switch model number.

Record the transfer switch part number in the boxes below. The transfer switch part number defines characteristics and ratings as explained in the accompanying chart.

Model	Controls	Voltage and Frequency	Poles	Wires	Enclosure	Current Rating
<div style="display: flex; justify-content: space-around; width: 100px;"> <div style="width: 20px; height: 20px; background-color: black;"></div> <div style="width: 20px; height: 20px; background-color: black;"></div> <div style="width: 20px; height: 20px; background-color: black;"></div> <div style="width: 20px; height: 20px; background-color: black;"></div> </div>	<div style="width: 20px; height: 20px; background-color: black;"></div>	<div style="display: flex; justify-content: space-around; width: 60px;"> <div style="width: 20px; height: 20px; background-color: black;"></div> <div style="width: 20px; height: 20px; background-color: black;"></div> </div>	<div style="width: 20px; height: 20px; background-color: black;"></div>	<div style="width: 20px; height: 20px; background-color: black;"></div>	<div style="width: 20px; height: 20px; background-color: black;"></div>	<div style="display: flex; justify-content: space-around; width: 100px;"> <div style="width: 20px; height: 20px; background-color: black;"></div> <div style="width: 20px; height: 20px; background-color: black;"></div> <div style="width: 20px; height: 20px; background-color: black;"></div> </div>

Kohler® Model Number Key

This chart explains the Kohler® transfer switch model number code. The sample model number shown is for a Model G220 automatic transfer switch that uses a 250-volt maximum contactor power switching device with solid-state electrical controls rated at 240 volts, 60 hertz, 1 phase, 2 pole, and 3 wires in a NEMA Type 3R enclosure with a current rating of 100 amperes. Not all possible combinations are available.

Model
G220: Model G220 transfer switch, 250-volt maximum contactor

Electrical Controls
1: Solid-state

Voltage and Frequency
63: 220 Volt, 50 Hz
64: 240 Volt, 60 Hz

Number of Poles and Phases
2: 2 Pole, 1 Phase

Number of Wires
3: 3 Wire

Enclosure
3 = NEMA type 3R

Current Rating
Numbers indicate the current rating of the switch in amperes.

SAMPLE PART NUMBER

G220-164233-0100

Figure 1-4 Transfer Switch Model Number Code

1.5 Standard Features

- G220 transfer switches are UL 1008 listed and UL listed to Canadian safety standards
- Contactors are rated 250 VAC maximum, 60 or 50 Hz
- The G220 ATS is a 2-pole, single-phase transfer switch
- NEMA type 3R enclosure
- Integrated solid-state logic controller with conformally coated printed circuit board for protection against harsh environments
- Single-phase switches: normal source dropout fixed at 160 VAC and pickup fixed at 190 VAC
- Emergency source voltage sensing one phase: dropout fixed at 160 VAC and pickup fixed at 190 VAC
- Time Delay Engine Start (TDES) fixed at 3 seconds
- Time Delay Normal to Emergency (TDNE) fixed at 2 seconds
- Time Delay Emergency to Normal (TDEN) fixed at 12 seconds
- Time Delay Engine Cooldown (TDEC) fixed at 2 minutes
- User-enabled generator exerciser: starts and runs the generator unloaded for a 20-minute period once a week
- Contactor electrically and mechanically interlocked
- Contactor manually operable for maintenance purposes
- Ambient operating temperature range
-20°C to 60°C (-4°F to 140°F)
- Ambient storage temperature range
-30°C to 70°C (-22°F to 158°F)
- Humidity range 5 to 85% noncondensing
- Provision for test switch

1.6 Application Data

See Figure 1-5 for application data including the range of wire sizes for transfer switch power terminals.

UL-Listed Solderless Screw-Type Terminals for External Power Connections		
Switch Rating, amps	Normal, Emergency, and Load Terminals	
	Cables per Pole	Range of Wire Sizes
100	1	#8 to 3/0 (copper or aluminum)
200	1	#8 to 3/0 (copper only)

Figure 1-5 Application Data

1.7 Ratings

Figure 1-6 lists contactor withstand and closing ratings (WCR) for 100 and 200 ampere switches with specific manufacturer's circuit breakers per UL 1008 standards. The ATS is suitable for control of motors, electric discharge lamps, tungsten filament lamps and electric heating equipment where the sum of motor full-load ampere ratings and the ampere ratings of other loads do not exceed the ampere rating of the switch and the tungsten load does not exceed 30 percent of switch rating at 240 VAC maximum.

Specific Manufacturer's Molded-Case Circuit Breakers*				
Switch Rating, amps	WCR, RMS Symmetrical Amperes	Manufacturer	Type or Class	Maximum Size, amps
100	22,000	Cutler-Hammer	FCL, FB	100
			QCHW	125
			FDC	150
		Square D	FI	100
		ITE/Siemens	ED4, CED6, ED6, HED4, HED6	125
200	22,000	Cutler-Hammer	BHW, FD, HFD, JDB, JD, HJD	225
			JD, JDB, HJD, JDC	250
			DK, KD, KDB, HKD, KDC, LCL, LA	400
		Square D	KI	250
			LE, LX, LXI	400
		ITE/Siemens	FD6-A, FXD6-A, HFD6, CFD6	250
		GE	TFL, THLC2	225
			SF, SFL, SFP	250

* UL 1008 listed at 240 VAC maximum.

Figure 1-6 Withstand and Closing Current Ratings With Coordinated Circuit Breakers, 240 V Maximum, UL and CSA Listings

Notes

2.1 Automatic Operation

The ATS controller monitors the normal and emergency power sources and determines when a power source has failed or is acceptable and controls the system accordingly. Built-in time delays ensure that the power source is stable before the load is transferred.

Failure of a power source occurs when its voltage on one or more phases falls below the dropout voltage level. A power source is acceptable when its voltage on one or more phases rises above the pickup voltage level and stays above the dropout voltage level. A power source is restored when it becomes acceptable again after failure. See Section 1.5, Specifications, for voltage sensing and pickup and dropout voltage specifications.

Typical ATS operation occurs in two separate automatic sequences.

- **Failure of normal power** and the resulting transfer to emergency power.
- **Restoration of normal power** and the resulting transfer back to normal power.

2.1.1 Failure of Normal Power

When the normal power source fails, the controller starts a time delay called Time Delay Engine Start (TDES). See Figure 2-1 for ATS time delays. TDES prevents unnecessary generator start-up during short normal power interruptions. If the normal power source is restored before TDES ends, the controller resets the time delay. If the normal power failure persists and TDES ends, the controller issues a signal to start the standby (emergency) generator to activate the emergency power source.

After signalling the generator to start, the controller monitors the emergency power source. When the controller determines that the emergency source is acceptable, the controller starts a time delay called Time Delay Normal to Emergency (TDNE). TDNE allows emergency power source stabilization before load connection. When TDNE ends, the controller signals the contactor to connect the load to the emergency source.

After load transfer the switch mechanically latches in the emergency position, supplying emergency source power to the load until normal power source restoration and stabilization.

2.1.2 Restoration of Normal Power

When the normal power source is restored, the controller starts a time delay called Time Delay Emergency to Normal (TDEN). If the normal source fails before TDEN ends, the time delay resets. TDEN ensures normal power source stabilization before load reconnection.

When the controller determines that the normal power source has maintained an acceptable level and TDEN ends, the controller signals the contactor to reconnect the load to the normal source.

After load transfer the switch mechanically latches in the normal position and the controller starts a 2-minute time delay called Time Delay Engine Cooledown (TDEC). TDEC allows the engine and generator to run unloaded and cool down before shutdown. When TDEC ends, the controller signals the generator set to shut down.

Time Delay	Duration
Engine Start (TDES)	3 seconds
Normal to Emergency (TDNE)	2 seconds
Emergency to Normal (TDEN)	12 seconds
Engine Cooledown (TDEC)	2 minutes

Figure 2-1 Time Delays

2.2 Exerciser Function

The exerciser function, when enabled, automatically starts and runs the generator set unloaded (the ATS does not transfer the load to the emergency source) for 20 minutes once a week. Exercising the generator set helps to ensure that the generator set starts when emergency power is needed. An exerciser switch selects exerciser functions. Automatic operation overrides the exerciser function. The loss of all power sources for an extended period can result in the loss of the exerciser set time. See Section 2.2.2, Exerciser Power Requirements.

2.2.1 Exerciser Switch

An exerciser switch is located inside the ATS enclosure. See Figure 1-1 and Figure 2-2.

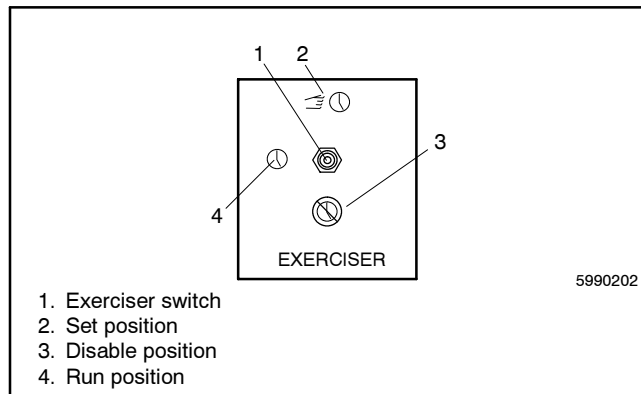
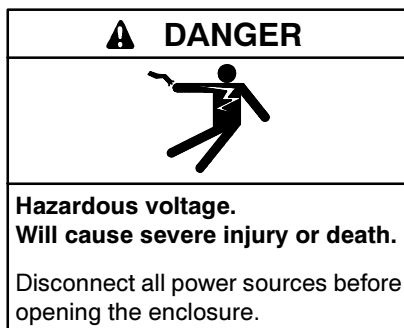


Figure 2-2 Exerciser Switch



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.

Note: The exerciser switch is set during installation and normally does not require adjustment. Line voltage is present on some components inside the ATS enclosure when power sources are applied. Only trained and qualified personnel should open the ATS enclosure when power is present. Read and follow all safety decals inside the enclosure and avoid contact with line voltage.

The exerciser switch selects the following exerciser functions when power is available. See Section 2.2.2, Exerciser Power Requirements.

- **Set (⚡⌚).** Placing the switch in the set position and releasing the switch sets the exerciser: the exerciser's internal one-week timer is reset and the exerciser starts and runs the generator set for a 20-minute period. Subsequent weekly 20-minute exercise periods start at the same day and time the exerciser was set.
- **Run (⌚).** Returning the switch to the run position enables the exerciser. The controller starts and runs the generator set unloaded for 20 minutes on the same day and time each week the exerciser was set.
- **Disable (⚡⊘).** Placing the switch in the disable position prevents the exerciser from starting and running the generator. The exerciser's internal one-week timer continues to run and the exerciser's set day and time are not lost. The ATS, however, starts the generator automatically when the normal power source fails.

Replace the enclosure cover on the ATS enclosure and tighten the screws that hold it in place after viewing or making changes to the exerciser switch setting.

2.2.2 Exerciser Power Requirements

An internal one-week timer for the exerciser function maintains its setting for up to 90 seconds after power loss on both the normal and emergency sources. When the normal power source fails, the generator must start and run to provide emergency power within approximately 90 seconds or the system loses the previously set day and time for the exerciser.

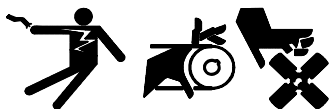
When power loss on both the normal and emergency power sources lasts longer than approximately 90 seconds, the exerciser is set to the day and time that either power source returns. Then, if the exerciser switch is in the Run (⌚) position, the controller starts and runs the generator set unloaded for 20 minutes one week from the day and time of power source return and on subsequent weeks at the same day and time.

2.3 Manual Operation

To test or troubleshoot the transfer switch, manually operate the contactor as described in the procedure below.

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

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. Open 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.

Manual Operation Procedures

1. Prevent the generator set that provides the emergency power source to the transfer switch from starting.
 - a. Move the generator set master switch to the OFF position.
 - b. Disconnect power to the generator engine start battery charger, if installed.
 - c. Disconnect all generator engine start batteries, negative (-) leads first.
2. Disconnect or turn off both the normal and emergency power sources by opening upstream circuit breakers or switches to the transfer switch.

Note: The manual operation handle is provided for maintenance purposes only. Do not attempt to use the manual operation handle to transfer the load.
3. Remove the cover on front of the transfer switch enclosure.

4. Slide the large end of the manual operation handle over the manual operation lever on the left side of the contactor. See Figure 2-3. Move the handle up to place the transfer switch in the Normal Source position, or down to place the contactor in the Emergency Source position.

Note: Do not attempt to move the manual operation lever without using the handle.

5. Move the handle up to place the transfer switch in the Normal Source position for normal operation.
6. Remove the handle and store it in a convenient location near the transfer switch.
7. Replace the cover on the transfer switch enclosure and tighten the screws that hold it in place.
8. Reconnect power supplies to the transfer switch.

Note: When power is applied to the transfer switch, the engine start contacts remain closed until Time Delay Engine Cooldown (TDEC) ends.

9. Return the generator set to automatic operation.

- a. Reconnect the generator engine start battery cables, negative (-) leads last.
- b. Reconnect power to the generator engine start battery charger, if installed.
- c. Move the generator set master switch to the AUTO (automatic) position. The generator set may start and run until the Time Delay Engine Cooldown (TDEC) ends (see **Note** above).

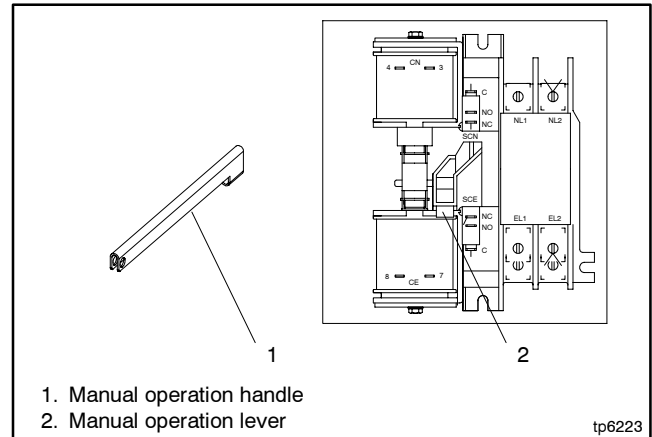


Figure 2-3 Contactor with Manual Operation Handle

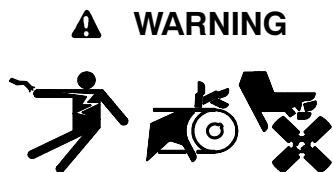
Section 3 Maintenance and Testing

3.1 Maintenance

Preventive maintenance ensures safe and reliable operation and extends the life of the transfer switch. Preventive maintenance includes periodic testing, cleaning, inspection, and replacement of worn or missing components.

Keep the outside of the transfer switch clean and dry. Have any other maintenance and service performed only by trained and qualified personnel following all applicable codes and standards. Keep a record of all maintenance and service.

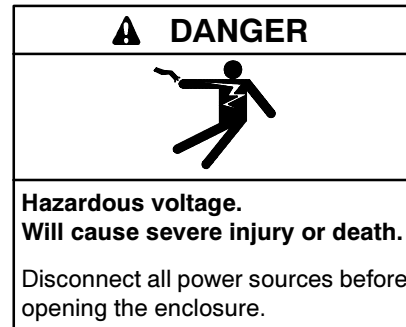
Your local authorized distributor/dealer can provide complete preventive maintenance and service to keep the transfer switch in top condition. Contact your local authorized distributor/dealer for additional information.



⚠ 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.



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.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open 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.

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.

Have an authorized service distributor/dealer perform periodic (at least annual) preventive maintenance of the transfer switch including the following.

Preventive Maintenance

- Clean and inspect the transfer switch.
- Tighten control and power terminals to torque specifications.
- Clean the contactor external operating mechanism when contaminated by debris and relubricate the mechanism using the lubricant recommended by the manufacturer.
- Perform any other maintenance, tests, or service that maintains the safe and reliable operation of the switch.

3.2 Testing

Start and run the generator set weekly. See Section 2.2, Exerciser Function, to set and enable the exerciser function to start and run the generator set once a week for 20 minutes.

Test the transfer switch operation monthly. To test, disconnect the normal power source by opening circuit breakers or switches to cause the transfer switch to automatically start the generator set and transfer the load to the emergency power source. When the switch has transferred the load to the emergency power source, reconnect the normal power source and verify that the transfer switch retransfers to the normal power source and shuts down the generator set after TDEC ends. See Section 2.1, Automatic Operation.

Section 4 Drawings and Diagrams

Diagram or Drawing	Drawing Number	Page
Enclosure Dimensions	ADV-6834	12
Wiring Diagram	GM25943-C	13
Schematic Diagram	GM25944-B	14

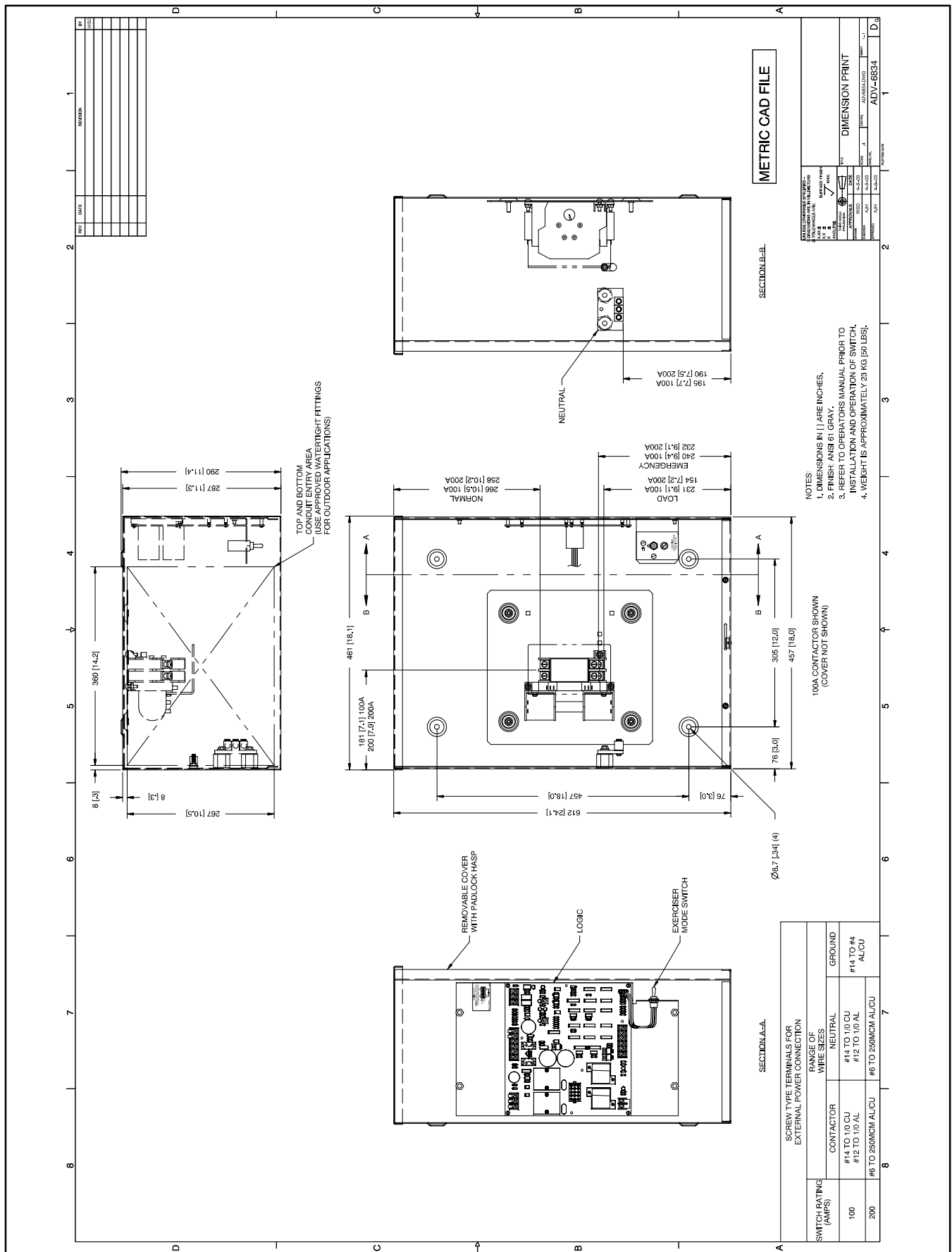


Figure 4-1 Enclosure Dimension Drawing, ADV-6834



Kohler® transfer switches are shipped factory-wired and tested, ready for installation. The installation process includes mechanical mounting; electrically wiring the unit to the normal and emergency power sources, to the load circuits, and to the generator; and initial setup and testing. Have installation performed only by trained and qualified personnel following all applicable codes and standards.


5.1 Upon Receipt of Unit

5.1.1 Inspection

At time of delivery, inspect the transfer switch for signs of shipping damage. If damage and/or rough handling is evident, file a damage claim immediately with the transportation company and promptly notify the distributor/dealer.

5.1.2 Lifting

⚠ WARNING



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

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

See Figure 5-1 for the approximate weight of each transfer switch covered in this manual. Carefully lift the enclosure to avoid damage to the transfer switch. Ensure that the front cover is in place and that the cover screws are tight when moving the unit.

Transfer Switch Rating, amps	Approximate Weight, kg (lb.)
100	21 (47)
200	

Figure 5-1 Approximate Transfer Switch Weight

5.1.3 Unpacking

Unpack the transfer switch immediately after receipt and inspect for shipping damage. Failure to perform an immediate inspection impedes recovery of losses caused by shipping damage. Use care when unpacking to avoid damaging any transfer switch components. Remove dirt and packing material that may have accumulated in the transfer switch or any of its components.

If the equipment has been stored at cold temperatures, allow equipment to warm to room temperature for 24 hours (minimum) before unpacking to prevent condensation on the electrical apparatus.

5.1.4 Storage

Do not remove the protective packing until ready for final installation. Protect the transfer switch at all times from excessive moisture, construction grit, and metal chips. Avoid storage in low temperature and high humidity areas where condensation could occur on the unit.

5.2 Mechanical Installation

⚠ WARNING



**Airborne particles.
Can cause severe injury or blindness.**

Wear protective goggles and clothing when using power tools, hand tools, or compressed air.

To plan the installation, use the dimensions given on the enclosure dimension drawings in Section 4. Select the mounting site to comply with electrical code restrictions for the enclosure type. Mount the transfer switch as close to the load and power sources as possible. Ensure adequate space for transfer switch servicing and opening of the enclosure.

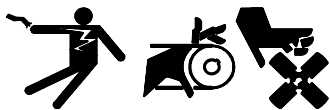
Vertically mount the 100- or 200-ampere automatic transfer switches covered in this manual to a rigid supporting structure, such as a wall, using 1/4-inch hardware. For mounting, use the four holes on the top and bottom of each unit. When mounting the unit, plumb the enclosure to avoid any distortion of the enclosure. Place washers behind the key holes to shim the enclosure to a plumb condition. Seal the mounting holes for installing the unit outdoors.

5.3 Contactor Manual Operation Test

Follow steps 1 through 6 in Section 2.3 to manually operate the contactor power switching device to verify that it operates smoothly without binding. If the contactor does not operate smoothly without binding, stop the test and call an authorized service distributor to service the contactor before proceeding.

5.4 Electrical Wiring

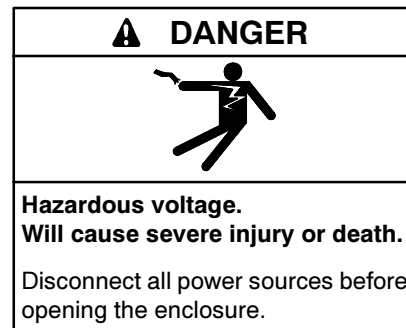
WARNING



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.



Grounding the transfer switch. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the transfer switch and related equipment and electrical circuits to comply with applicable codes and standards. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution increases under such conditions.

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.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open 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.

All internal electrical connections are prewired. The only wiring necessary for installing the transfer switch is to connect the transfer switch to external devices and power sources.

Observe all applicable national and local electrical codes during installation. See Section 4 for schematic diagrams and enclosure drawings.

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

5.4.1 Line Connections

All conductors should enter the enclosure at the locations shown on the drawings. When drilling entry holes for any conductors, cover the transfer switch components for protection from metal chips and construction grit. Remove any debris from enclosure with a vacuum cleaner—using compressed air for this purpose can lodge contaminants in components and cause damage.

Use watertight conduit hubs approved for outdoor use for installing the transfer switch outdoors.

Cable sizes are shown in Section 1.6, Application Data, and on the transfer switch specification sheet.

Before connecting wiring cables to terminal lugs, remove surface oxides from cables by cleaning with a wire brush. If using aluminum conductors, apply a joint compound to cables. After tightening terminal lugs, carefully wipe off excess joint compound.

Connection points for the normal power, emergency power, and load are clearly marked on the transfer switch and drawings. See Section 4. Be sure to heed the phase markings (A, B, C, and N).

Note: Connect source and load phases as indicated by the markings and drawings. Improper connections may cause short circuits or cause phase-sensitive load devices to malfunction or operate in reverse.

Note: When making power connections to the power switching device, leave sufficient slack in the power leads to reach all of the power connecting lugs.

Connect the normal, emergency, and load conductors to the clearly marked terminals on the contactor. Verify that all connections are consistent with drawings before tightening the contactor terminal lugs. Tighten the connections to the torque values shown in Figure 5-3.

Connect the neutral wires to the neutral terminals and tighten the lugs to the torque values shown in Figure 5-3.

Connect the ground wires to the ground terminal and tighten to the torque values shown in Figure 5-4.

5.4.2 Neutral Connections for 120VAC Coils

The solenoid coils operate at 120 VAC. Refer to Figure 5-2 and the wiring diagrams in Section 4 for required neutral connections.

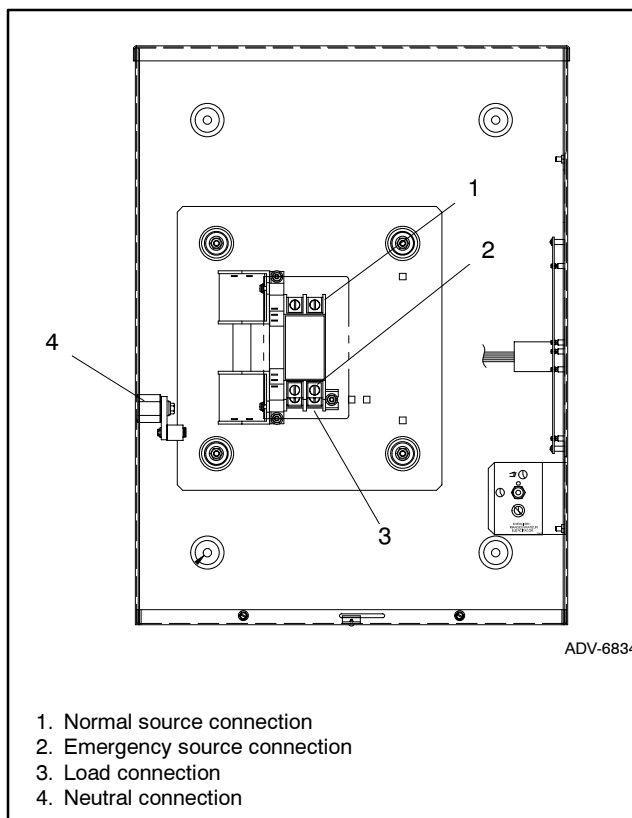


Figure 5-2 Model G220 Connections (also see wiring diagram in Section 4)

Wire Size (AWG or MCM)	Torque		
	Nm	In. Lb.	Ft. Lb.
8	8.5	75	6.2
6	12	110	9.2
4	12	110	9.2
2	17	150	13
1	17	150	13
1/0	20	180	15
2/0	20	180	15
3/0	28	250	21

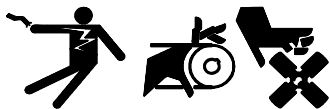
Figure 5-3 Tightening Torque for Terminal Lugs

Wire Size (AWG or MCM)	Torque		
	Nm	In. Lb.	Ft. Lb.
14	4.0	35	2.9
12	4.0	35	2.9
10	4.0	35	2.9
8	4.5	40	3.3
6	5.1	45	3.8
4	5.1	45	3.8

Figure 5-4 Tightening Torque for Ground Screw Terminal

5.4.3 Generator Engine Start Connection

⚠ WARNING



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

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

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

NOTICE

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

The transfer switch controller provides a contact closure across terminals ES3 and ES4 to signal the generator set to start. See Figure 5-5. The location of the terminal block is marked by an orange decal within the enclosure.

Procedure to Connect the Generator Engine Start Circuit

1. Prevent the emergency power source generator set from starting:
 - a. Move the generator set master switch to the OFF position.

- b. Disconnect power to the generator engine start battery charger, if installed.
 - c. Disconnect all generator engine start battery cables, negative (-) leads first.
2. Connect the generator set remote engine start signal inputs to the engine start terminals ES3 and ES4 on the transfer switch controller circuit board. See Figure 5-5.
 3. Tighten the terminal screws to 1.0 Nm (9 in. lb.) of torque.

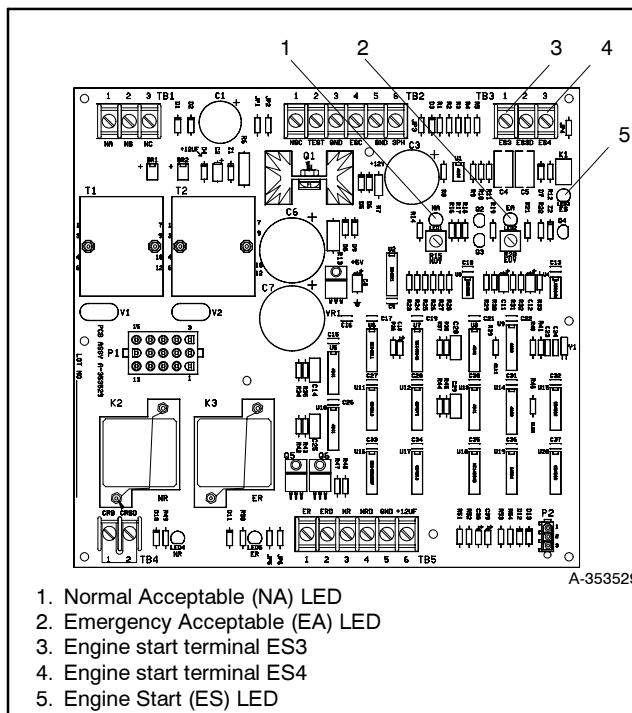


Figure 5-5 Controller Terminals and LEDs

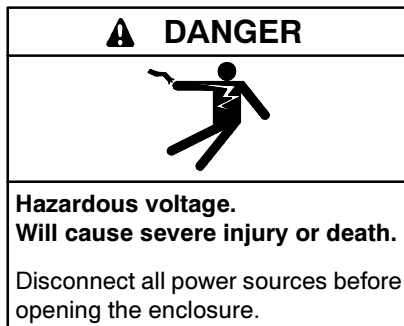
5.5 Initial Startup and Setup

Perform the following procedures before placing the transfer switch into normal service.

5.5.1 Manually Select the Normal Position

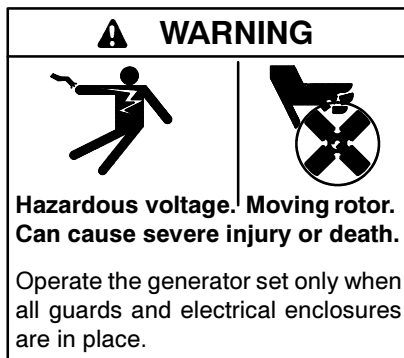
Manually operate the contactor to the normal position by following steps 1 through 6 in Section 2.3.

5.5.2 Select the Exerciser Function and Close the Enclosure



Move the exerciser switch to the Run (ⓘ) position to enable the weekly generator exerciser. Move the exerciser switch to the Disable (⓪) position to disable the weekly exerciser. See Section 2.2. Replace the transfer switch enclosure cover and tighten the screws that hold it in place.

5.5.3 Prepare the Generator Set for Operation



Prepare the emergency power source generator set for operation. Check the oil level, coolant level, fuel supply, batteries, and items specified by the generator set installation or operation checklist or manual.

Reconnect generator engine start battery cables, negative (-) leads last; reconnect power to the generator engine start battery chargers, if installed; and move the generator set master switch to the AUTO (automatic) position. The generator set should start.

5.5.4 Connect the Power Sources

Note: Close and secure the transfer switch enclosure cover before applying power.

Connect the normal and emergency power sources to the transfer switch by closing upstream circuit breakers or switches.

When power is applied to the transfer switch, the engine start contacts remain closed and the generator set continues to run at least until Time Delay Engine Cooldown (TDEC) ends.

If the transfer switch determines that the normal power source is acceptable, the transfer switch runs the generator set for TDEC and then signals the generator set to shut down by opening the engine start contacts. The Engine Start LED lights.

If the transfer switch determines that the normal power source is unacceptable at any time, the transfer switch begins an automatic sequence to transfer the load to the emergency source as if TDES had ended. The engine start contacts remain closed and the generator set continues to run. See Section 2.1.1.

The transfer switch sets the exerciser function when power is first applied. If the exerciser switch is in the Run (ⓘ) position, the first exercise period occurs one week after power is first applied and on subsequent weeks at the same day and time. See Section 2.2.

5.5.5 Perform a System Test

With normal power present, test the system by disconnecting the normal power source and verifying that the system responds as described in Section 2.1.1, starting the generator set automatically and transferring the load to the emergency power source. When the transfer switch has transferred the load to the emergency source, reconnect the normal power source and verify that the system operates as described in Section 2.1.2, retransferring the load to the normal source and shutting down the generator set after TDEC.

5.5.6 Complete the Installation

Ensure that the normal and emergency power sources are connected to the transfer switch. To set the exerciser to a different day and time, see Section 2.2. Replace the cover on the transfer switch enclosure and tighten the screws that hold it in place.


5.5.7 Ensure Warranty Registration

The transfer switch seller must complete a Startup Notification Form and submit it to the manufacturer within 60 days of the initial startup date. The Startup Notification Form covers all equipment in the standby system. Standby systems not registered within 60 days of the initial startup date are automatically registered using the manufacturer's ship date as the startup date.

Notes

Appendix A Abbreviations

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

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

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

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