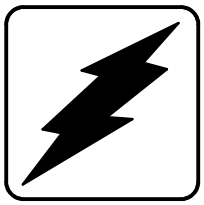
Operation Manual

Industrial Generator Sets



Models:
6.5RMY
10-18RY/RZ

Controllers:
Decision-Maker **t** 3, 5-Light
Relay

KOHLER®
POWER SYSTEMS

ISO 9001
KOHLER GENERATORS
INTERNATIONALLY REGISTERED

TP-5631 7/96

California Proposition 65

⚠ WARNING

Engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

Table of Contents

Safety Precautions and Instructions

A generator set, 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.

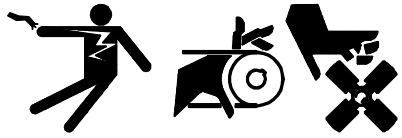
NOTICE

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

Safety decals affixed to the generator set in prominent places advise the operator or service technician of potential hazards and how to act safely. The decals are reproduced in this publication to improve operator recognition. Replace missing or damaged decals.

Accidental Starting

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (disconnect negative lead first and reconnect it last).

Disabling generator set. Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on the generator set or connected equipment. The generator set can be started by an automatic transfer switch or remote start/stop switch unless these precautions are followed.

Battery

⚠ WARNING

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

Use protective goggles and clothes. Battery acid can cause permanent damage to eyes, burn skin, and eat holes in clothing.

⚠ WARNING

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

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

Battery acid. Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in battery can cause permanent damage to eyes, burn skin, and eat holes in clothing. Always wear splash-proof safety goggles when working near the battery. If battery acid is splashed in the eyes or on 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.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is charging. Avoid touching terminals with tools, etc., to prevent burns and sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being charged. Always turn battery charger off before disconnecting battery connections. Remove negative lead first and reconnect it last when disconnecting battery.

Engine Backfire/Flash Fire

⚠ WARNING

Fire.
Can cause severe injury or death.

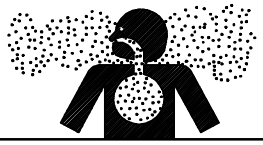
Do not smoke or permit flame or spark to occur near fuel or fuel system.

Servicing fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flame or spark to occur near carburetor, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuel or fuel vapors. Catch all fuel in a suitable container when removing fuel line or carburetor.

Servicing air cleaner. A sudden backfire can cause severe injury or death. Do not operate with air cleaner removed.

Exhaust System

⚠ WARNING



Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

Generator set operation. Carbon monoxide can cause severe nausea, fainting, or death. Never operate the generator set inside a building unless the exhaust gas is piped safely outside. Never operate in any area where exhaust gas could accumulate and seep back inside a potentially occupied building. Avoid breathing exhaust fumes when working on or near the generator set. Carbon monoxide is particularly dangerous because it is an odorless, colorless, tasteless, nonirritating gas. Be aware that it can cause death if inhaled for even a short time.

Carbon monoxide symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas which is present in exhaust gases. Carbon monoxide poisoning symptoms include but are not limited to the following:

- Light-headedness, dizziness
- Physical fatigue, weakness in joints and muscles
- Sleepiness, mental fatigue, inability to concentrate or speak clearly, blurred vision
- Stomachache, vomiting, nausea

If experiencing any of these symptoms and carbon monoxide poisoning is possible, affected persons should seek fresh air immediately. They should remain active. They should not sit, lie down, or fall asleep. Alert others to the possibility of carbon monoxide poisoning. If the condition of affected persons does not improve within minutes of breathing fresh air, they should seek medical attention.

Fuel System

⚠ WARNING

Explosive fuel vapors.
Can cause severe injury or death.

Use extreme care when handling, storing, and using fuels.

Fuel system. Explosive fuel vapors can cause severe injury or death. All fuels are highly explosive in a vapor state. Use extreme care when handling and storing fuels. Store fuel in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running since spilled fuel may ignite on contact with hot parts or from ignition spark. Do not smoke or permit flame or spark to occur near sources of spilled fuel or fuel vapors. Keep fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid breakage caused by vibration. Do not operate generator set in the presence of fuel leaks, fuel accumulation, or sparks. Repair systems before resuming generator set operation

Explosive fuel vapors can cause severe injury or death. Take additional precautions when using the following fuels:

Gasoline– Store gasoline only in approved red containers clearly marked GASOLINE.

Propane (LP)– Adequate ventilation is mandatory. Propane is heavier than air; install propane gas detectors low in room. Inspect detectors often.

Natural Gas– Adequate ventilation is mandatory. Natural gas rises; install natural gas detectors high in room. Inspect detectors often.

Fuel tanks. Explosive fuel vapors can cause severe injury or death. Gasoline and other volatile fuels stored in day tanks or subbase fuel tanks can cause an explosion. Store only diesel fuel in tanks.

Draining fuel system. Explosive fuel vapors can cause severe injury or death. Spilled fuel can cause an explosion. Use a container to catch fuel when draining fuel system. Wipe up all spilled fuel after draining system.

LP gas fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check LP vapor gas or natural gas fuel system for leakage using a soap-water solution with fuel system test pressurized to 6-8 ounces per square inch (10-14 inches water column). Do not use soap containing ammonia or chlorine in test solutions, since the soap will not bubble and will not allow an accurate leakage test.

LP liquid withdrawal fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check LP liquid withdrawal gas fuel system for leakage using a soap-water solution with fuel system test pressurized not less than 90 psi (621 kPa). Do not use soap containing ammonia or chlorine in test solutions, since the soap will not bubble and will not allow an accurate leakage test.

Hazardous Noise

⚠ CAUTION

Hazardous noise.
Can cause loss of hearing.

Never operate generator set without a muffler or with a faulty exhaust system.

Hazardous Voltage/ Electrical Shock

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Operate generator set only with all guards and electrical enclosures in place.

⚠ WARNING

Hazardous voltage.
Backfeed to utility system can cause property damage, severe injury, or death.

If generator set is used for standby power, install an automatic transfer switch to prevent inadvertent interconnection of standby and normal sources of supply.

Grounding generator set. 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 generator set and electrical circuits when in use. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution is increased under such conditions.

High voltage test. Hazardous voltage can cause severe injury or death. Follow instructions of test equipment manufacturer when performing high-voltage test on rotor or stator. An improper test procedure can damage equipment or lead to future generator set failures.

Installing battery charger. Hazardous voltage can cause severe injury or death. Electrical shock may occur if battery charger is not electrically grounded. Connect battery charger enclosure to ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect to equipment grounding terminal or lead on battery charger. Perform battery charger installation as prescribed in equipment manual. Install battery charger in compliance with local codes and ordinances.

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

Short circuits. Hazardous voltage 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 adjustments are made. Remove wristwatch, rings, and jewelry before servicing equipment.

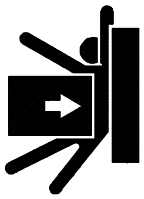
Testing voltage regulator. Hazardous voltage can cause severe injury or death. High voltage is present at the voltage regulator heat sink. Do not touch voltage regulator heat sink when testing or electrical shock will occur.
(PowerBoost **t** *, PowerBoost* **t** *III, and PowerBoost* **t** *V voltage regulator models only.)*

Engine block heater. Hazardous voltage can cause severe injury or death. Engine block heater can cause electrical shock. Remove engine block heater plug from electrical outlet before working on block heater electrical connections.

Electrical backfeed to utility. Hazardous backfeed voltage can cause severe injury or death. Install a transfer switch in standby power installations to prevent connection of standby and other sources of power. Electrical backfeed into a utility electrical system can cause serious injury or death to utility personnel working on transmission lines.

Heavy Equipment

⚠ WARNING



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

Do not use lifting eyes.
Lift generator set using lifting bars inserted through skid lifting holes.

Hot Parts

⚠ WARNING

Hot coolant and steam.
Can cause severe injury or death.

Before removing pressure cap, stop generator set and allow it to cool. Then loosen pressure cap to relieve pressure.

⚠ WARNING

Hot engine and exhaust system.
Can cause severe injury or death.

Do not work on generator set until it is allowed to cool.

Servicing generator. Hot parts can cause severe injury or death. Avoid touching generator set field or exciter armature. Generator set field and exciter armature when shorted become hot enough to cause severe burns.

Checking coolant level. Hot coolant can cause severe injury or death. Allow engine to cool. Release pressure from cooling system before opening pressure cap. To release pressure, cover the pressure cap with a thick cloth; then slowly turn it counterclockwise to the first stop. Remove cap after pressure has been completely released and the engine has cooled. Check coolant level at tank if generator set is equipped with a coolant recovery tank.

Servicing exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. An engine becomes hot while running and exhaust system components become extremely hot.

Moving Parts

⚠ WARNING

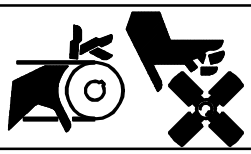
Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Operate generator set only with all guards and electrical enclosures in place.

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

Do not operate generator set without all guards, screens, and covers in place.

Tightening hardware. Flying projectiles can cause severe injury or death. Retorque all crankshaft and rotor hardware after servicing. Do not loosen crankshaft hardware or rotor thrubolt when making adjustments or servicing generator set. Rotate crankshaft manually in a clockwise direction only. Turning crankshaft bolt or rotor thrubolt counterclockwise can loosen hardware. Loose hardware can cause hardware or pulley to release from engine of generator set and can cause personal injury.

Servicing generator set when operating. Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, clothing, and test leads away from belts and pulleys when generator set is running. Replace guards, screens, and covers before operating generator set.

Notice

NOTICE

This generator set has been rewired from its nameplate voltage to:

246242

NOTICE

Voltage reconnection! Affix notice to generator set after reconnecting to a voltage different than the nameplate. Order voltage reconnection decal 246242 from authorized service distributors/dealers.

NOTICE

Hardware damage! Engine and generator set may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of bolt heads and nuts.

NOTICE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. American Standard hardware uses a series of markings and metric hardware uses a numeric system to indicate hardness. Check markings on bolt head and nuts for identification.

NOTICE

Canadian installations only:
For standby service connect output of generator set to a suitably rated transfer switch in accordance with Canadian Electrical Code, Part 1.

Introduction

All information in this publication represents data available at time of printing. Kohler Co. reserves the right to change this literature and the products represented without incurring obligation.

Read through 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 equipment for future reference.

Equipment service requirements are minimal but are very important to safe and efficient operation; therefore, inspect parts often and perform required service at the prescribed intervals. An authorized service distributor/dealer should perform required service to keep equipment in top condition.

California Emission Certification

If your engine/generator has this identification label, it is certified for operation in the state of California.

IMPORTANT ENGINE INFORMATION
THIS ENGINE MEETS 1995-1998
CALIFORNIA EMISSION CONTROL
REGULATIONS FOR ULGE* ENGINES

DISPLACEMENT: _____
FAMILY: _____
BUILD DATE: _____

REFER TO OWNERS MANUAL FOR
SAFETY, MAINTENANCE SPECS AND
ADJUSTMENTS. FOR SALES AND
SERVICE IN US/CANADA CALL:
1-800-544-2444

KOHLER
POWER SYSTEMS

* Utility Lawn and Garden Equipment

This engine/generator is certified to operate on natural gas or propane fuel.

This engine certified with engine modifications.

Service Assistance

For sales and service in the U.S.A. and Canada check the yellow pages of the telephone directory under the heading GENERATORS– ELECTRIC for an authorized service distributor/dealer or call 1-800-544-2444.

For sales and service outside the U.S.A. and Canada, contact your local distributor.

For further information or questions, contact the company directly at the following address or number:

KOHLER CO., Kohler, Wisconsin 53044 U.S.A.
Phone: 414-565-3381
Fax: 414-459-1646 (U.S.A. Sales)
414-459-1614 (International)

To ensure supply of correct parts or information, make note of the following identification numbers in the spaces provided:

GENERATOR SET

MODEL, SPEC, and SERIAL numbers are found on the nameplate attached to the generator set.

Model No. _____

Specification No. _____

Serial No. _____

GENERATOR SET ACCESSORIES

An alternate nameplate inside the junction box identifies factory-installed generator set accessories.

Accessory Nos. _____

_____

_____

_____

_____

_____

_____

_____

_____

ENGINE

The engine serial number is found on the engine nameplate.

Engine Serial No. _____

Section 1. Specifications

Introduction

The spec sheets for each generator set provide specific generator and engine information. Refer to the respective spec sheet for data not supplied in this manual. Consult the generator set service manual, installation manual, engine operation manual, and engine service manual for additional specifications.

Generator

The generator is equipped with Kohler's PowerBoost **t** voltage regulation system which provides instant response to load changes.

PowerBoost **t** is a unique system that ensures reliable motor starting and consistent voltage levels.

PowerBoost **t** utilizes a voltage monitoring system that employs a winding independent of the field to monitor and stabilize voltage.

Controller

Controller Features

The generator set is equipped with either a relay controller or a 5-light microprocessor controller. For a specific description of the controller, see Section 2, Operation. Controller features include the following:

Relay Controller

- Fault shutdowns with common indicator:
  - Level, low coolant (liquid-cooled models only)
  - Overcrank
  - Overspeed
  - Pressure, low oil
  - Temperature, high engine
- Running time meter
- Switches and standard features:
  - Cranking, cyclic
  - Start, remote two-wire
  - Switch, run/off-reset/auto (engine start)

5-Light Controller

- Analog gauges, 2 in. (51 mm), 2% full-accuracy:
  - Pressure gauge, oil
  - Temperature gauge, engine water (liquid-cooled models only)
  - Voltmeter, DC only
- Analog meters, 3.5 in. (89 mm):
  - AC ammeter, 2% full-scale accuracy
  - AC voltmeter, 2% full-scale accuracy
  - Frequency meter, 0.5% full-scale accuracy
- Fault shutdowns and status indicators:
  - Auxiliary (red)
  - Level, low coolant (uses auxiliary fault indicator)(liquid-cooled models only)
  - Overcrank (red)
  - Overspeed (red)
  - Pressure, low oil (red)
  - Temperature, high engine (red)
  - Temperature, low water (red)*(liquid-cooled models only)

    *Requires optional kit or user-provided device for lamp to function.
- Running time meter
- Switches and standard features:
  - Cranking, cyclic
  - Horn, alarm (with silence switch)
  - Rheostat, generator output voltage-adjusting (front panel mounted, ±5% of nominal voltage)
  - Start, remote two-wire
  - Switch, lamp test
  - Switch, meter range selector
  - Switch, run/off-reset/auto (engine start)
  - Timer, engine cool down (5-minute fixed)

Accessories

Several accessories are available to finalize the installation, to add convenience to operation and service, and to comply with state and local codes. Accessories vary with each generator set model and controller. Accessories are offered factory-installed and/or shipped loose. Some accessories are available only with the microprocessor controller. Contact your local Kohler Dealer/Distributor to obtain the most current information. Accessories available at the time of print of this publication are as follows:

Overvoltage Kit (microprocessor controller)

The overvoltage circuit immediately shuts down the engine when triggered by a DC signal from an overvoltage shutdown option. The generator set automatically shuts down if output voltage is 15% above nominal voltage longer than one second. The overvoltage option connects to wire 30 in the controller. See Figure 1-1.

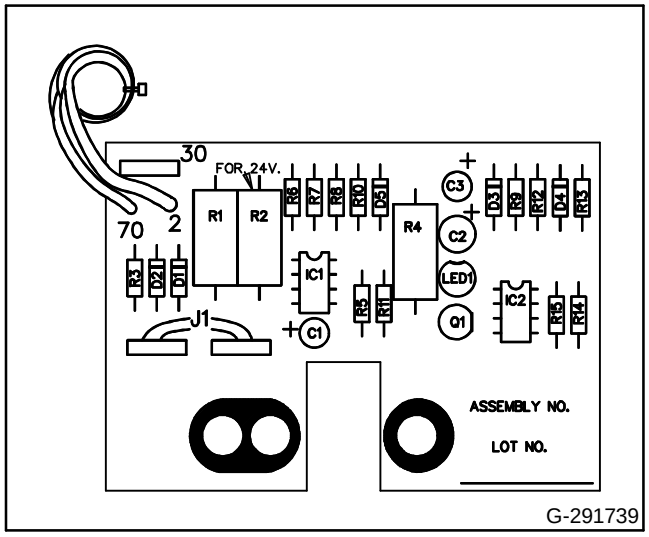


Figure 1-1. Overvoltage Kit

Run Relay Kit

The run relay kit is energized only when the generator set is running. The three sets of contacts in the kit are typically used to control air intake and/or radiator louvers. However, alarms and other signalling devices can also be connected to the contacts. Refer to the accessory wiring diagram for correct connection of the run relay kit. See Figure 1-2.

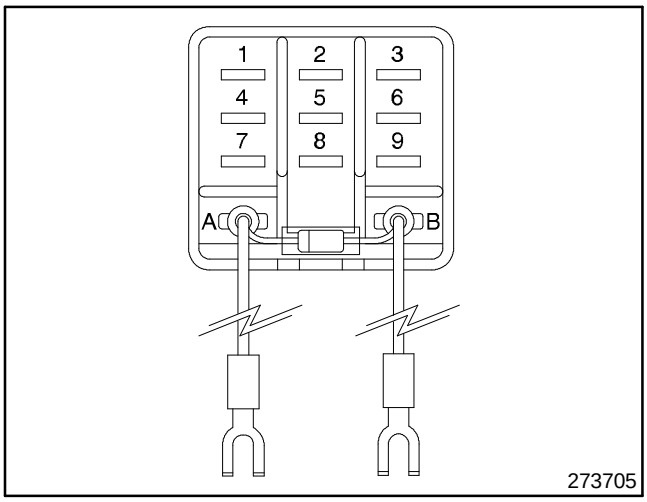


Figure 1-2. Run Relay Kit

Remote Annunciator Kit (microprocessor controller)

The remote annunciator allows convenient monitoring of the generator set's condition from a remote location. The remote annunciator kit is available in surface mount and flush mount. A ten-relay dry contact kit is included with this kit. See Figure 1-3. The remote annunciator includes alarm horn, alarm silence switch, lamp test, and the same lamp indicators as the 5-light microprocessor controller, plus the following:

Line Power Lamp. Lamp lights when commercial utility power is in use.

Generator Power Lamp. Lamp lights when generator set power is in use.

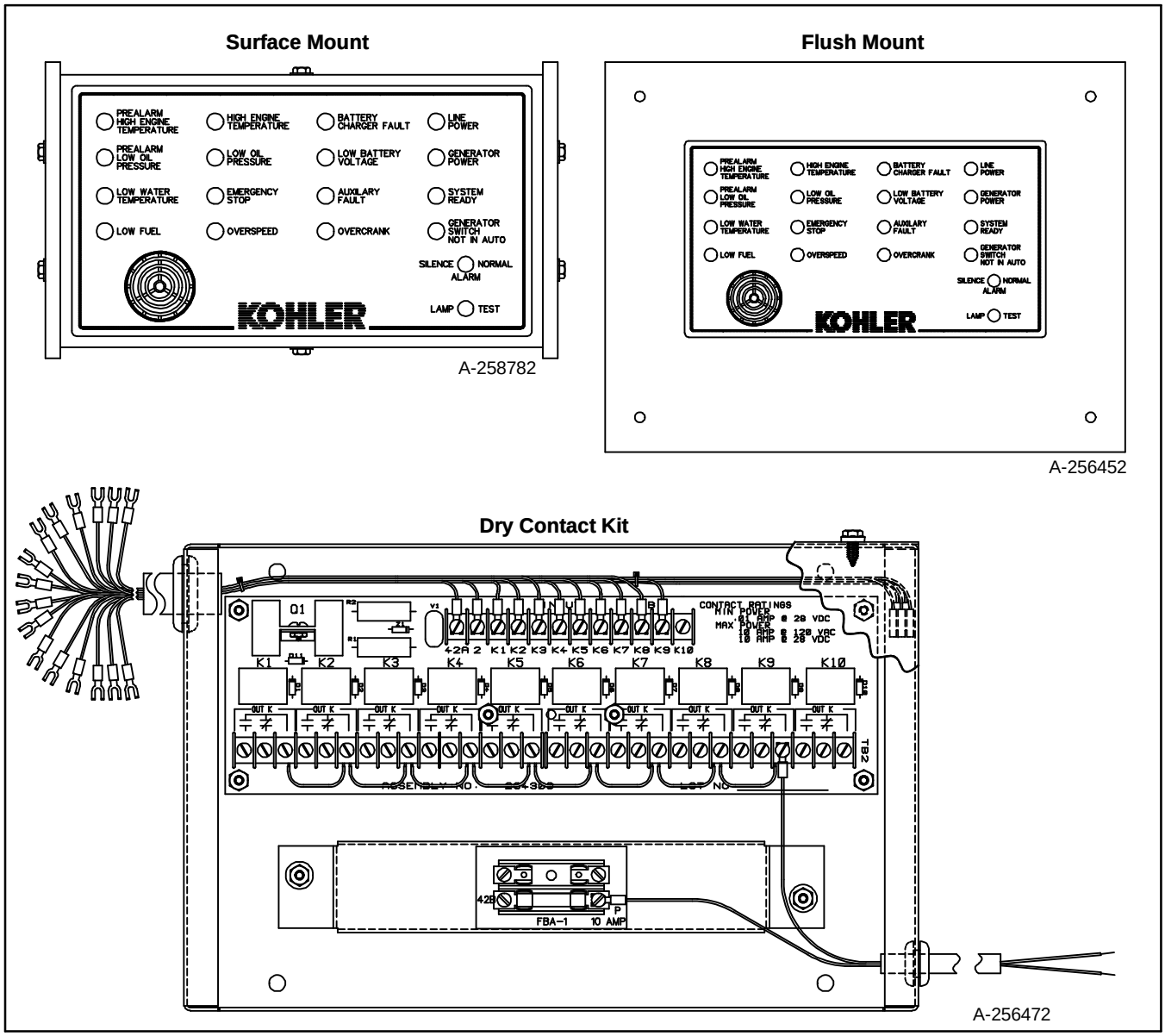


Figure 1-3. Remote Annunciator

Audio-Visual (A/V) Alarm (microprocessor controller)

An A/V alarm warns the operator of fault shutdowns and pre-alarm conditions (except battery charger fault and low battery voltage) from a remote location. A/V alarms include alarm horn, alarm silence switch, and common fault lamp. See Figure 1-4.

NOTE

Connect a maximum of three remote annunciators and/or A/V alarms in any combination to the generator set controller.

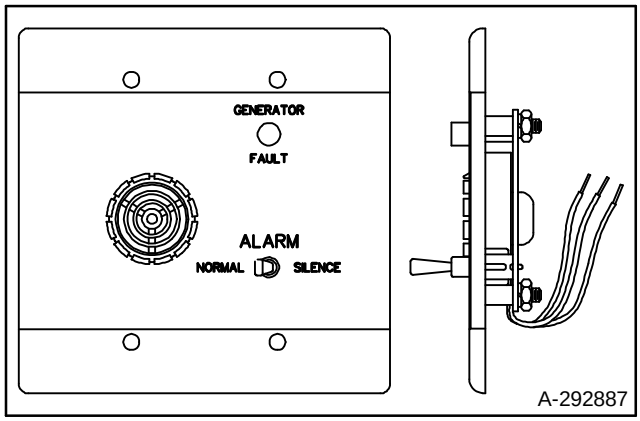


Figure 1-4. Audio-Visual Alarm

Line Circuit Breaker

The line circuit breaker interrupts generator output in the event of an overload or short circuit. Use the line circuit breaker to manually disconnect the generator set from the load when servicing the generator set. See Figure 1-5.

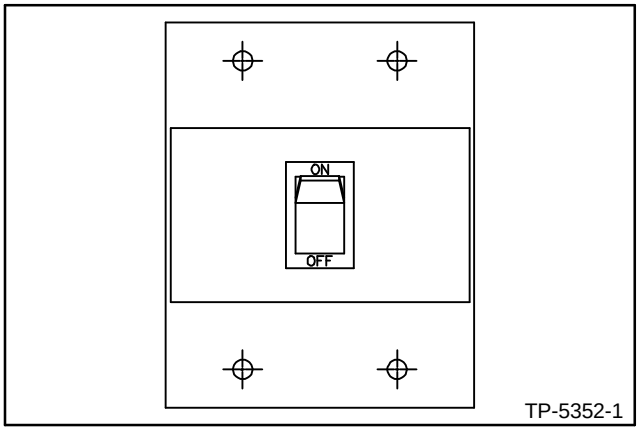


Figure 1-5. Line Circuit Breaker

Remote Emergency Stop Kit (microprocessor controller)

The emergency stop kit allows immediate shutdown of the generator set from a remote location. See Figure 1-6. The emergency stop lamp lights and the generator set shuts down if the emergency stop switch is activated. The generator set cannot be restarted until the emergency stop switch is reset (by replacing glass piece) and the controller is reset by placing generator set master switch in the OFF/RESET position.

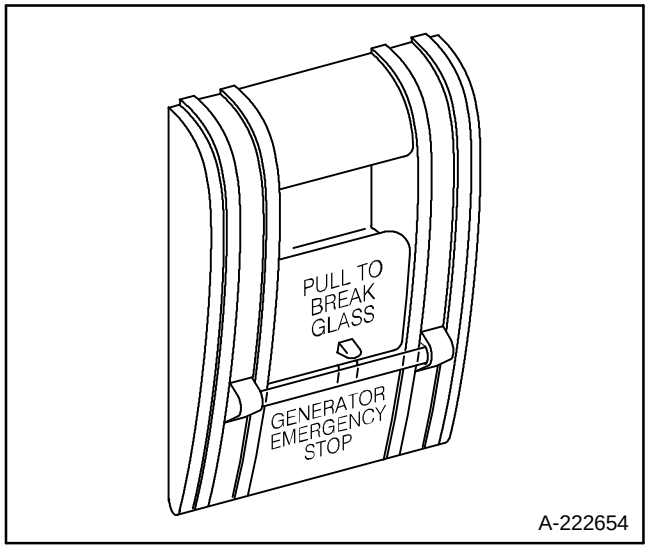


Figure 1-6. Emergency Stop Kit

Single-Relay Dry Contact Kit (microprocessor controller)

The single-relay dry contact kit uses one set of relay contacts to trigger customer-provided warning devices if a fault condition occurs. See Figure 1-7. A wiring harness included with the kit links the relay kit with the controller terminal strip or controller connection kit. Reference the accessory wiring diagram for correct connection of the single-relay dry contact kit wiring harness. Connect the single-relay dry contact kit to any controller fault output (on TB1 terminal strip). Typical connections include:

- Emergency Stop
- Auxiliary
- Overspeed
- Low Oil Pressure
- High Engine Temperature

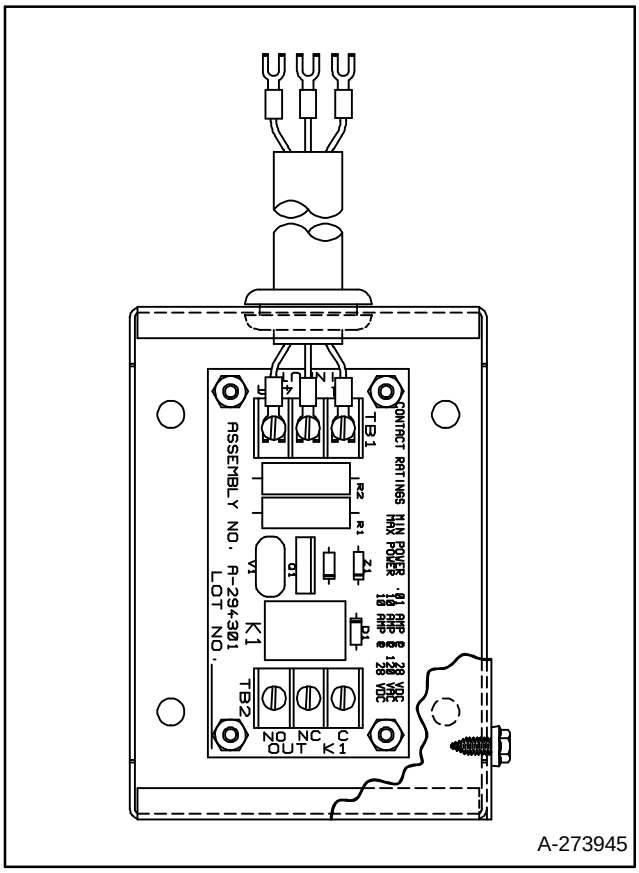


Figure 1-7. Single-Relay Dry Contact Kit

Ten-Relay Dry Contact Kit (microprocessor controller)

The ten-relay dry contact kit allows monitoring of the standby system and/or the ability to activate accessories such as derangement panels. The kit includes ten sets of relay contacts for connection of customer provided devices to generator set functions. Connect warning devices (lamps, audible alarms) and other accessories to the controller outputs listed. Connect a total of three dry contact kits to the controller. An internal view of the contact kit is shown in Figure 1-8.

Typical Contact Kit Output Connections:

- Overspeed
- Overcrank
- Low Oil Pressure
- Auxiliary Fault
- Emergency Stop

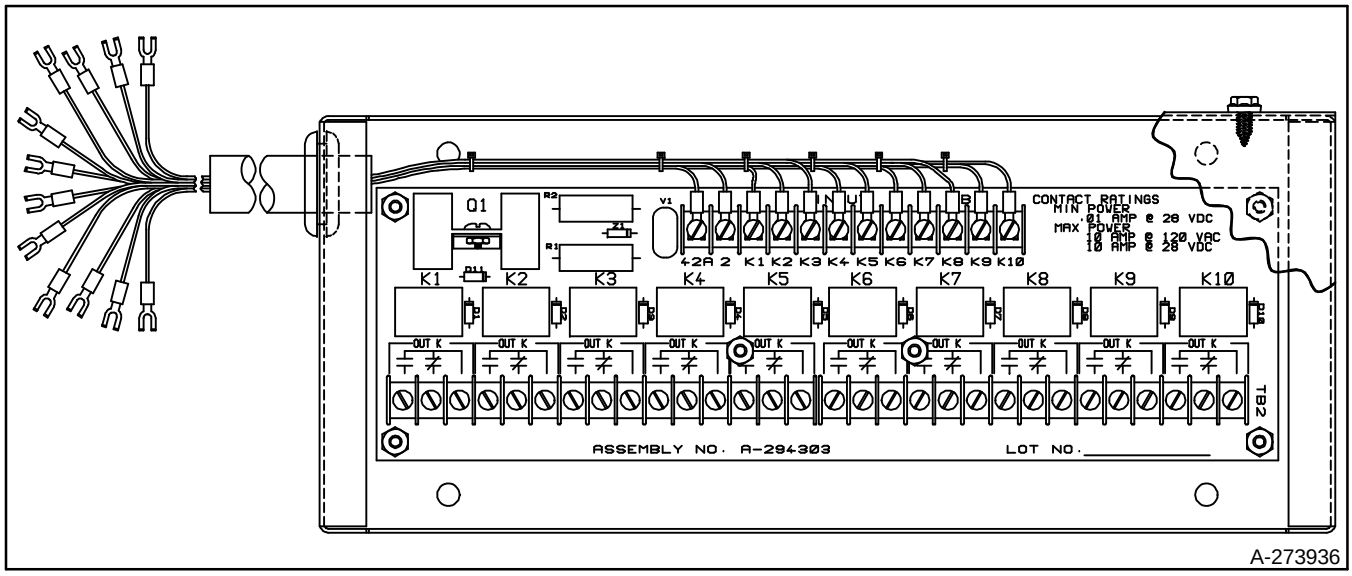
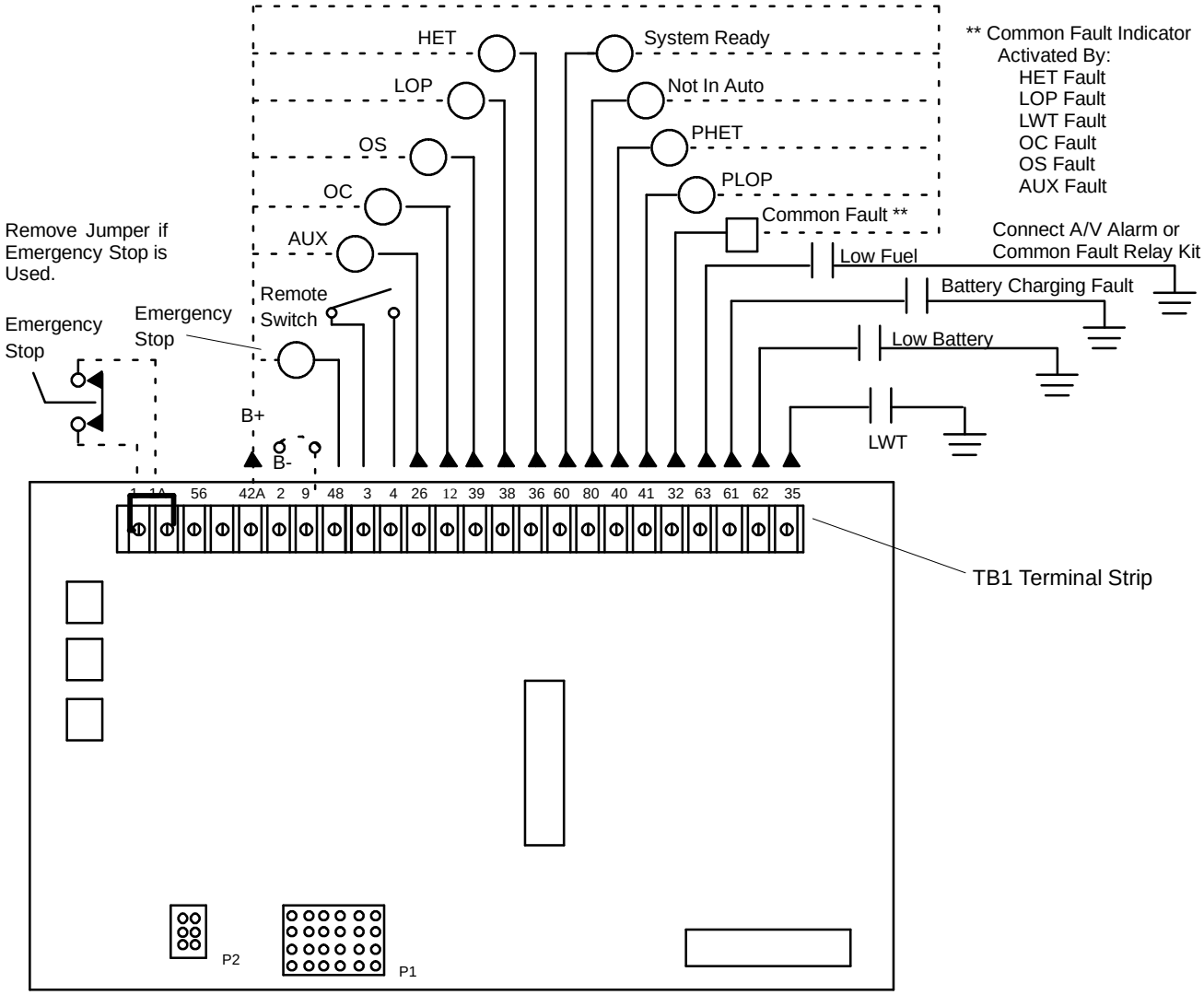


Figure 1-8. Ten-Relay Dry Contact Kit

Accessory Connection (microprocessor controller)

The Decision-Makerä 3 controller circuit board is equipped with a terminal strip (TB1) for easy connection of generator set accessories. Do not direct connect accessories to the controller terminal strip. Connect all accessories to either a single-relay dry contact kit or to a ten-relay dry contact kit. Connect the dry contact kit(s) to the controller terminal strip. Connect alarms, battery chargers, remote switches, and other accessories to the dry contact kit relay(s) using 18 or 20 gauge stranded wire.

To connect accessories to the controller TB1 terminal strip, lower the controller circuit board panel until it is lying flat. Route dry contact relay leads through the controller port and guide loops to the circuit board terminal strip. The controller circuit board panel must be lying flat to ensure adequate slack in dry contact relay leads and/or harnesses. For specific information on accessory connections, refer to Figure 1-10, the accessory wiring diagram and the instruction sheet accompanying each kit.



CIRCUIT BOARD TERMINAL IDENTIFICATION (TB1)

1 - Ground– Emergency Stop Relay (K4)– Connect Emergency Stop Across Terminals TB1-1 and 1A.
1A - Emergency Stop Relay (K4) Coil; Negative– Connect Emergency Stop Across Terminals TB1-1 and 1A.
56 - Not Used
\- Not Used
42A - Battery Voltage (Fuse #1 Protected)– Accessory Power Supply; Customer may also Provide Separate Accessory Power Source
2 - Ground Terminal
9 - Crank Mode Selection (open– cyclic crank; ground– continuous crank) Connect TB1-2 to TB1-9 for Continuous Cranking; Leave TB1-9 open for cyclic cranking. See Starting Procedure.
48 - Emergency Stop Indicator *
3 - Remote Start Ground– Connect Remote Start Switch to TB1-3 and TB1-4
4 - Remote Start– Connect Remote Start Switch to TB1-3 and TB1-4
26 - Auxiliary Indicator (Aux.) *
12 - Overcrank Indicator (OC) *
39 - Overspeed Indicator (OS) *
38 - Low Oil Pressure Indicator (LOP) *
36 - High Engine Temperature Indicator (HET) *
60 - System Ready Indicator *
80 - Not In Auto Indicator *
40 - Prealarm High Engine Temperature Indicator (PHET) *
41 - Prealarm Low Oil Pressure Indicator (PLOP) *
32 - Common Fault/Prealarm Line– A/V Alarm or Common Fault Relay Activated by HET, LOP, LWT, OC, OS, and AUX Faults
63 - Low Fuel– Connect Fuel Level Sensor to TB1-63 to Activate Fault Lamp (If Used)
61 - Battery Charger Fault– Connect Battery Charger to TB1-61 to Activate Fault Lamp (If Used)
62 - Low Battery Volts– Connect Battery Charger to TB1-62 to Activate Fault Lamp (If Used)
35 - Low Water Temperature– Connect LWT Sensor (Prealarm Kit) to TB1-35 to Activate LWT or LWT/AUX Lamp

NOTE: Not all terminal connections are used for all generator sets (see Wiring Diagrams).
* Indicators may be customer supplied lamps and/or alarms or A/V Alarms, Annunciators, Dry Contact Kits, etc.

Figure 1-9. Controller TB1 Terminal Strip Connections

Section 2. Operation

Prestart Checklist

To ensure continued satisfactory operation, check the following items before each startup and at regular intervals. Refer to the engine service manual for specific service procedures.

AIr Cleaner. Keep air cleaner element clean. Install element to keep unfiltered air from entering engine.

Battery. Ensure tight battery connections. Maintain full battery electrolyte level.

Coolant Level (liquid-cooled models only). Check level after the engine has cooled. Maintain coolant level at just below the overflow tube on the radiator filler neck. Open air-bleed petcocks, if equipped, when filling radiator. Close air-bleed petcock when coolant begins to flow from petcock. If equipped with a coolant recovery tank, maintain level in tank between 1/3 full (cold) and 2/3 full (hot). Use a coolant solution of 50% ethylene glycol and 50% clean, softened water to inhibit rust/corrosion.

A coolant solution of 50% ethylene glycol provides freezing protection of −34°F (−37°C) and overheating protection to 265°F (129°C). A coolant solution with less than 50% ethylene glycol may not provide adequate freezing and overheating protection. A coolant solution with more than 50% ethylene glycol can cause engine or component damage. Do not use alcohol or methanol antifreeze or mix them with the specified coolant. Consult the engine manufacturer's operation manual for engine coolant specifications.

Do not add coolant to a hot engine. Wait until engine has cooled. Adding coolant to a hot engine can cause the cylinder block or cylinder head to crack.

Do not energize block heater before filling cooling system. Before energizing block heater, run engine until it is warm and refill radiator to purge air from the system. Immerse heater element in coolant to prevent block heater failure.

Exhaust System. Keep exhaust outlet clear. Keep silencer and piping tight and in good condition.

Fuel Level. Keep tank(s) full to ensure adequate fuel supply.

Lamp Test. Press the lamp test button (if equipped) to verify operation of all controller LEDs.

Oil Level. Maintain oil level at or near full mark on dipstick but not over. Keep the oil level in the mechanical governor (if equipped) at or near the full level.

Operating Area. Check for obstructions that could block the flow of cooling air. Keep the air intake area clean. Do not leave rags, tools, or debris on or near the generator set.

Exercising the Generator

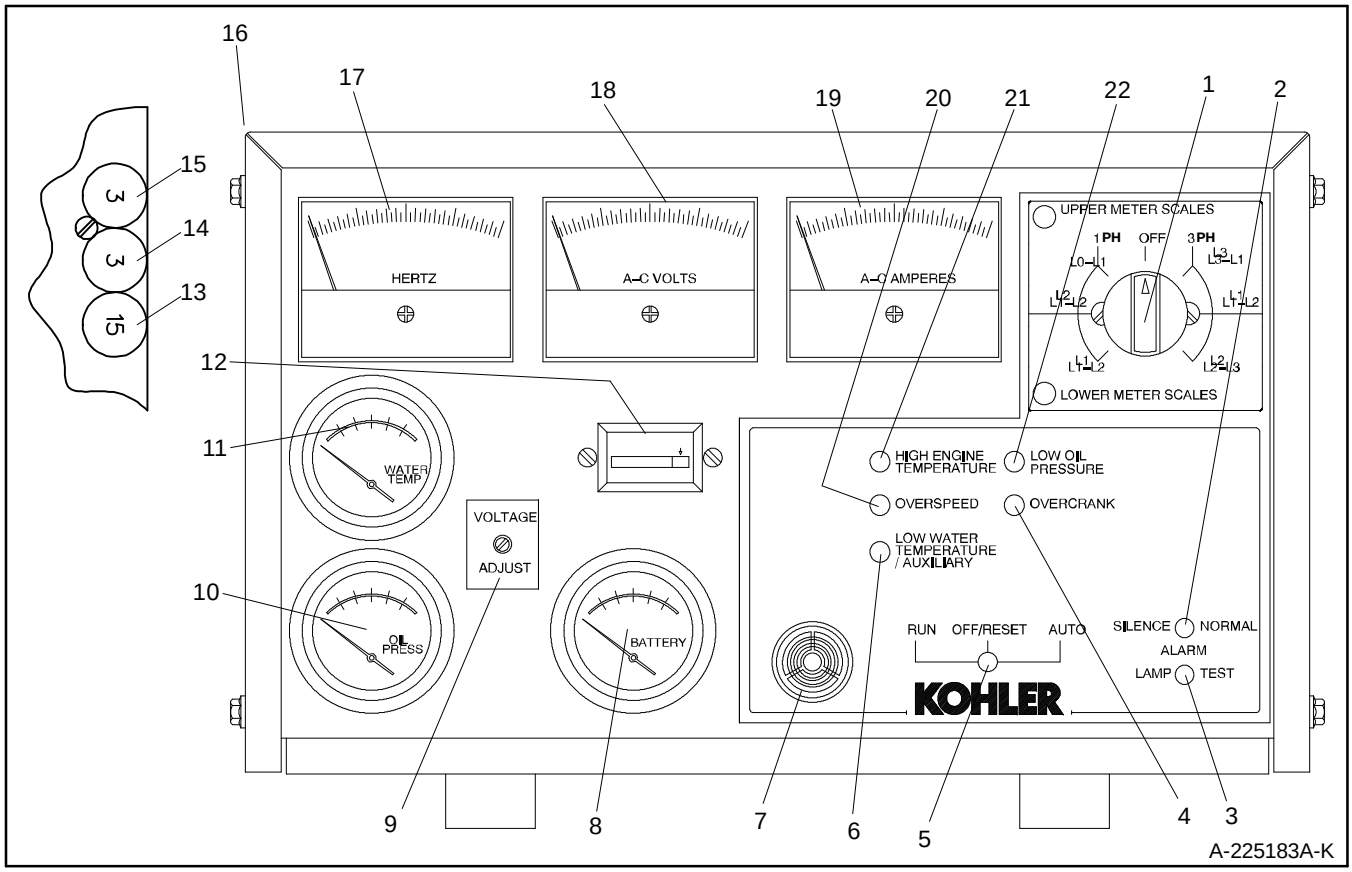
Run the generator set under load once each week for one hour. Perform this exercise in the presence of an operator if the generator set does not have an automatic transfer switch with an exercise option.

Operator should perform all prestart checks before starting the exercise procedure. While the generator set is running, listen for a smooth-running engine and visually inspect the generator set to ensure there are no fluid or exhaust leaks.

Start the generator set according to the starting procedure in the controller section of this manual.

Microprocessor Controller Operation

5-Light Microprocessor Controller



1. Selector switch
2. Alarm silence switch
3. Lamp test
4. Overcrank
5. Generator master switch
6. Auxiliary light
7. Alarm horn
8. DC voltmeter
9. Voltage adjustment potentiometer
10. Oil pressure gauge
11. Engine water temperature gauge (not used on 6.5 kW)
12. Hourmeter
13. 15-amp engine and accessories fuse
14. 3-amp controller fuse
15. 3-amp remote annunciator fuse
16. Fuse location
17. Frequency meter
18. AC voltmeter
19. AC ammeter
20. Overspeed light
21. High engine temperature (not used on 6.5 kW)
22. Low oil pressure lamp

Figure 2-1. 5-Light Microprocessor Controller Features

Microprocessor Controller Features

Microprocessor controller features include the annunciator panel lamps, analog meters, switches and controls, fuses, and terminal strip. The following paragraphs cover each of these topics.

Lamps

Auxiliary Fault. Lamp flashes or lights when fault is detected.

Flashing Lamp Conditions

- The auxiliary lamp flashes immediately if the controller senses no AC output while the generator set is running (except during the first 10 seconds after start-up). The flashing stops and the light is off when AC output is sensed. No manual reset is required.
- The auxiliary lamp flashes if the battery power was reconnected or was low and then came back up again while the generator set master switch was in the RUN or AUTO position. A temporarily low battery condition where the battery is weak or undersized for the application is a possible cause. To clear this condition, place the generator set master switch in the OFF/RESET position.

Continuous On Lamp Conditions

- The auxiliary lamp lights and generator set shuts down immediately if the emergency stop switch is activated (if generator set is equipped with optional emergency stop shutdown switch).
- The auxiliary lamp lights if the optional emergency stop switch is reset while the generator set master switch is in the AUTO or RUN position. Place the generator set master switch in OFF/RESET position to clear this condition.
- The auxiliary lamp lights and engine shuts down 5 seconds after high oil temperature (P1-13) or auxiliary delay shutdown (P1-15) faults occur (if so equipped). These conditions are inhibited during first 30 seconds after crank disconnect.
- The auxiliary lamp lights and engine shuts down immediately if an overvoltage condition occurs (if equipped with overvoltage shutdown kit).
- The auxiliary lamp lights and engine shuts down immediately if activated by any customer-supplied sensing devices connected to auxiliary immediate shutdown ports (P1-17 and P1-18).

Low Oil Pressure. Lamp illuminates if generator set shuts down because of low oil pressure. Shutdown occurs 5 seconds after engine reaches pressure shutdown range.

Overcrank. Lamp illuminates and cranking stops if engine does not start after 45 seconds of continuous cranking or 75 seconds of cyclic cranking. See Auto Starting.

- Cranking stops and overcrank lamp illuminates after 15 seconds if starter or engine does not turn (locked rotor).
- Overcrank lamp flashes if speed sensor signal is absent longer than one second.

NOTE

The controller is equipped with an automatic restart function. The generator set attempts to restart if the engine speed drops below 13 Hz (390 RPM). Continued decreased engine speed causes an overcrank fault condition.

Overspeed. Lamp illuminates if generator set shuts down because governed frequency on 50 and 60 Hz models exceeds 70 Hz (2100 RPM).

Analog Meters

AC Ammeter. Meter measures amperage from output leads. Use selector switch to choose output lead circuits.

AC Voltmeter. Meter measures voltage across output leads. Use selector switch to choose output lead circuits.

DC Voltmeter. Meter measures voltage of starting battery.

Frequency Meter. Meter measures frequency (Hz) of generator set output voltage.

Hourmeter. Hourmeter records generator set total operating hours for reference in scheduling maintenance.

Switches and Controls

Alarm Horn. Horn sounds if any fault or anticipatory condition exists. Place the generator set master switch in the AUTO position before silencing alarm horn. See Controller Resetting Procedure later in this section.

Alarm Silence. Switch disconnects alarm during service (place the generator set master switch in the AUTO position before silencing alarm horn). Restore alarm horn switches at all locations (controller, remote annunciator, and audio/visual alarm) to normal position after fault shutdown is corrected to avoid reactivating alarm horn. See Controller Resetting Procedure later in this section.

Generator Master Switch(RUN/OFF-RESET/AUTO). Switch functions as controller reset and generator set operation switch. Refer to Starting, Stopping, and Controller Resetting Procedure later in this section.

Lamp Test. Switch tests the controller indicator lamps.

Selector Switch. Switch selects generator output circuits to measure. When switched to a position with three circuit lead labels, amperage is measured on the upper lead and voltage is measured between the lower two leads. AC ammeter and voltmeter do no register with switch in the OFF position.

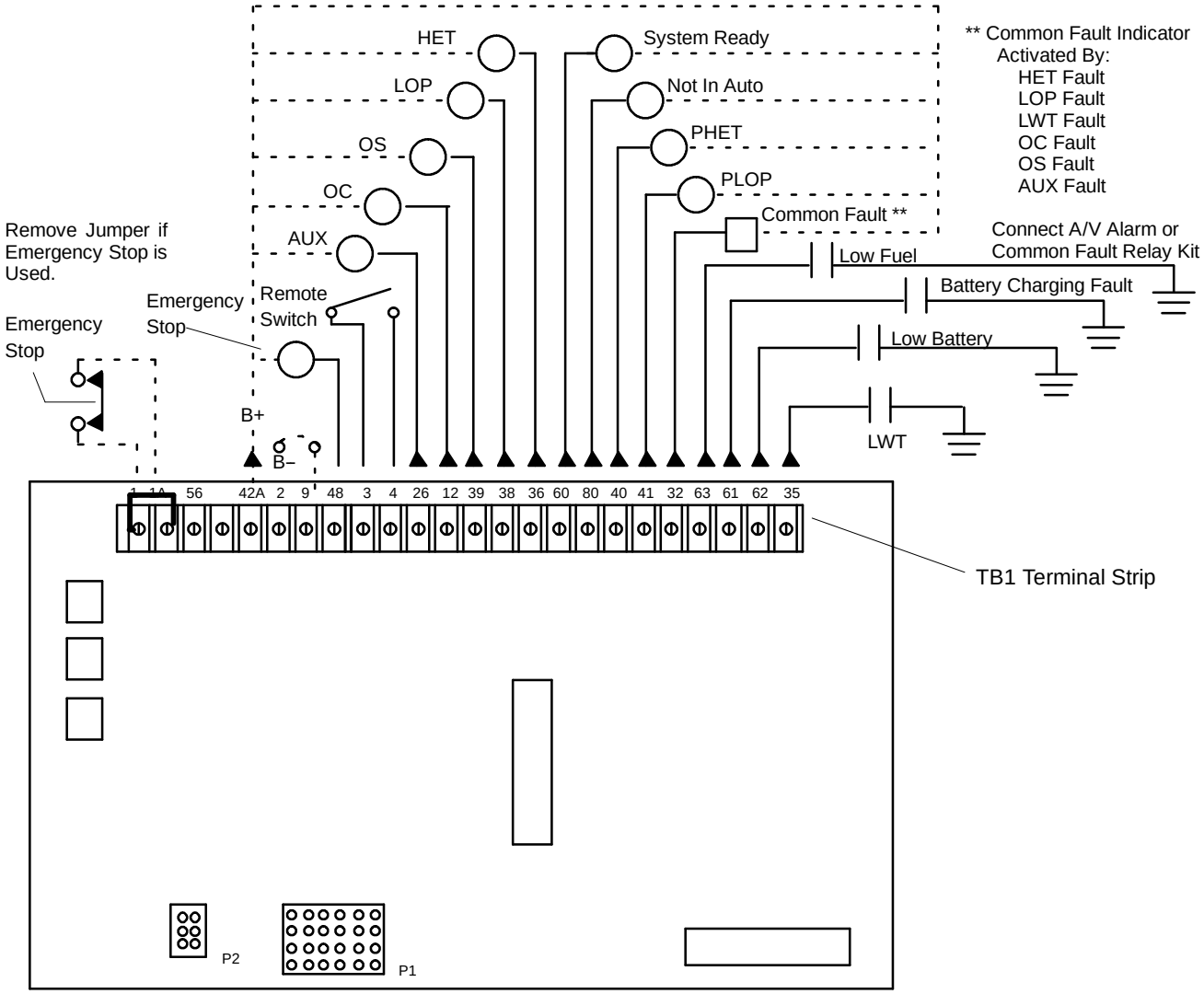
Voltage Adjustment Potentiometer. Fine adjustment (±5%) for generator output voltage. See Wiring Diagrams, Voltage Reconnection.

Fuses and Terminal Strip

Fuses. Fuses are located on controller circuit board.

- **3-amp Remote Annunciator (F1).** Fuse protects remote annunciator circuit, A/V alarm, and isolated alarm kit (if equipped).
- **3-amp Controller.** Fuse protects controller circuit board, speed sensor, and lamp circuit board.
- **15-amp Engine and Accessory.** Fuse protects engine/starting circuitry and accessories.

Controller TB1 Terminal Strip (on Circuit Board). Connect generator set accessories such as emergency stop switch, remote start stop/switch, audio/visual alarms, etc., to the TB1 terminal strip. Make crank mode selection (cyclic or continuous) on the TB1 terminal strip. Figure 2-2 shows the location of the TB1 terminal strip on the controller circuit board. Refer to appropriate wiring diagrams for additional information on connecting accessories to the TB1 terminal strip.



CIRCUIT BOARD TERMINAL IDENTIFICATION (TB1)

1 - Ground– Emergency Stop Relay (K4)– Connect Emergency Stop Across Terminals TB1-1 and 1A.
1A - Emergency Stop Relay (K4) Coil; Negative– Connect Emergency Stop Across Terminals TB1-1 and 1A.
56 - Not Used
\- Not Used
42A - Battery Voltage (Fuse #1 Protected)– Accessory Power Supply; Customer may also Provide Separate Accessory Power Source
2 - Ground Terminal
9 - Crank Mode Selection (open– cyclic crank; ground– continuous crank) Connect TB1-2 to TB1-9 for Continuous Cranking; Leave TB1-9 open for cyclic cranking. See Starting Procedure.
48 - Emergency Stop Indicator *
3 - Remote Start Ground– Connect Remote Start Switch to TB1-3 and TB1-4
4 - Remote Start– Connect Remote Start Switch to TB1-3 and TB1-4
26 - Auxiliary Indicator (Aux.) *
12 - Overcrank Indicator (OC) *
39 - Overspeed Indicator (OS) *
38 - Low Oil Pressure Indicator (LOP) *
36 - High Engine Temperature Indicator (HET) *
60 - System Ready Indicator *
80 - Not In Auto Indicator *
40 - Prealarm High Engine Temperature Indicator (PHET) *
41 - Prealarm Low Oil Pressure Indicator (PLOP) *
32 - Common Fault/Prealarm Line– A/V Alarm or Common Fault Relay Activated by HET, LOP, LWT, OC, OS, and AUX Faults
63 - Low Fuel– Connect Fuel Level Sensor to TB1-63 to Activate Fault Lamp (If Used)
61 - Battery Charger Fault– Connect Battery Charger to TB1-61 to Activate Fault Lamp (If Used)
62 - Low Battery Volts– Connect Battery Charger to TB1-62 to Activate Fault Lamp (If Used)
35 - Low Water Temperature– Connect LWT Sensor (Prealarm Kit) to TB1-35 to Activate LWT or LWT/AUX Lamp

NOTE: Not all terminal connections are used for all generator sets (see Wiring Diagrams).
* Indicators may be customer supplied lamps and/or alarms or A/V Alarms, Annunciators, Dry Contact Kits, etc.

Figure 2-2. Controller TB1 Terminal Strip Connection

Start/Stop Procedure

Local Starting

Place the generator set master switch in the RUN position to start the generator set at the controller.

NOTE

The alarm horn sounds whenever the generator set master switch is not in the AUTO position.

NOTE

The microprocessor controller is equipped with a transient start/stop function to avoid accidental cranking of the rotating engine. If the generator set master switch is momentarily placed in the OFF/RESET position then quickly returned to RUN, the genset slows to 249 rpm and recranks before returning to rated speed.

NOTE

The microprocessor controller is equipped with an automatic restart function. The generator set attempts to restart if the engine speed drops below 13 Hz (390 rpm). Failure to correct the cause of the decreased engine speed results in an overcrank condition.

Auto (Remote) Starting

Place the generator set master switch to the AUTO position for start-up by automatic transfer switch or remote start/stop switch (connected to controller terminals TB1-3 and TB1-4).

Crank Mode Selection

The microprocessor controller provides up to 45 seconds of continuous cranking or 75 seconds of cyclic cranking (crank 15 seconds, rest 15 seconds, crank 15 seconds, etc.) before overcrank shutdown. Make the cranking mode (cyclic or continuous) selection on the controller circuit board terminal strip. For cyclic cranking, leave circuit board terminal TB1-9 open. Run a jumper between circuit board terminal TB1-2 (ground) and terminal TB1-9 for continuous cranking.

Stopping

Normal Stopping

1. Disconnect load from generator set and allow it to run without load for 5 minutes.

   NOTE

   Run the generator set at no load for 5 minutes prior to stopping to ensure adequate cooling of the set.

2. Place the generator set master switch in the OFF/RESET position. The engine stops.

   NOTE

   The generator set runs for a 5-minute cooldown cycle if engine stop is signaled by a remote switch or automatic transfer switch.

Emergency Stopping

Place the generator set master switch in the OFF/RESET position or activate remote emergency stop (if equipped) for immediate shutdown. The controller AUXILIARY lamp lights and the generator set shuts down if the emergency stop switch is activated. The remote annunciator and/or audio-visual alarms, if equipped, signal an emergency stop.

NOTE

Use the emergency stop switch(s) for emergency shutdowns only. Use the generator set master switch to stop the generator set under normal operating conditions.

Circuit Protection (microprocessor controller)

An optional line circuit breaker (sized for generator output) is available to protect the generator from damage because of overload or short circuits. If the circuit breaker trips, reduce the load and switch the breaker back to the ON position. With the breaker in the OFF position, the generator set runs but there is no output voltage.

NOTE

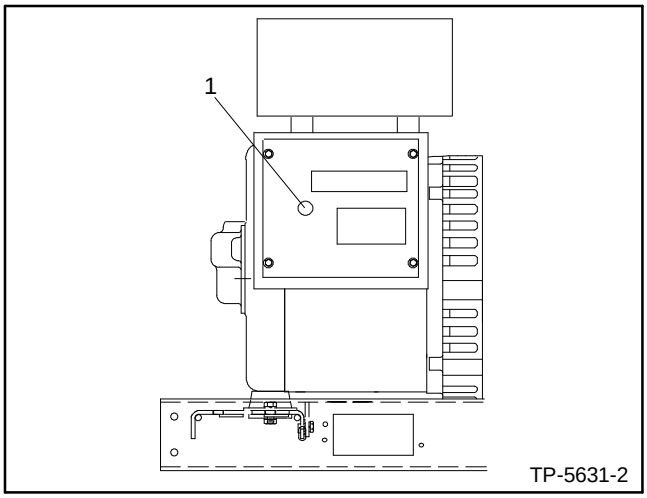
If the generator set circuit breaker trips repeatedly, see Section 4, Troubleshooting for possible causes.

Fuses F1 (3-amp), F2 (3-amp) and F3 (15-amp) on the controller circuit board protect the engine and controller circuitry. (See Fuses earlier in this section.) If the generator set will not crank or accessories will not work, and the battery/connections appear okay, one of these fuses may be blown.

Fuses V7, V8, and V9 on the AC terminal block (TB2) protect the controller meters and lights. If the controller lights and meters are not functioning, check the condition of the V7, V8, and V9 fuses. If a fuse is replaced and then blows again, see Section 4, Troubleshooting for possible causes.

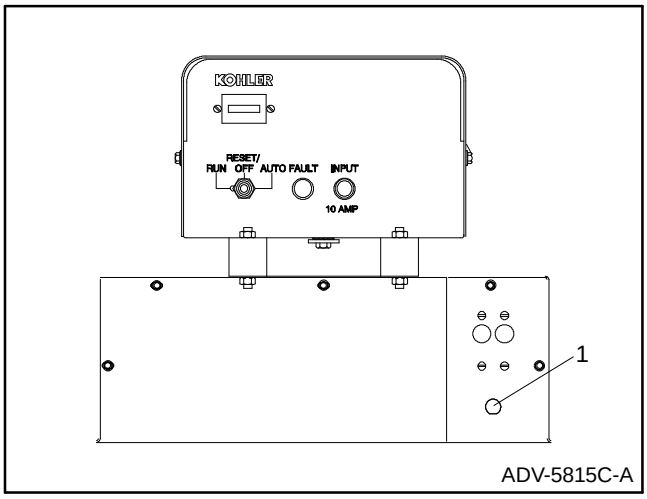
Voltage Regulator Fuse

A 10-amp fuse protects the voltage regulator circuitry from damage because of overload or short circuits. If this fuse blows, the generator set shuts down. If this fuse is replaced and then blows again, see Section 4, Troubleshooting for possible causes. Location of the voltage regulator fuse is shown in Figure 2-3 for 10-18 kW, and Figure 2-4 for 6.5 kW.



1. 10-amp fuse

Figure 2-3. 10-18 kW Voltage Regulator Fuse Location



1. 10-amp fuse

Figure 2-4. 6.5 kW Voltage Regulator Fuse Location

Fault Shutdowns

The generator set shuts down automatically under the following fault conditions. The generator set will not run until the fault condition has been corrected. The shutdown switches automatically reset when the problem is corrected or the generator set cools (if high engine temperature was the fault).

NOTE

Low oil pressure will not function during the first 30 seconds after start-up. If the cause of the shutdown is not corrected, the generator set can be restarted (after controller reset) and will run approximately 30 seconds before shutting down again. See Resetting Fault Shutdown procedure.

Overcrank. Shutdown occurs after 45 seconds of continuous cranking. Shutdown occurs after 75 seconds of cyclic cranking (crank 15 seconds, reset 15 seconds, crank 15 seconds, etc. for a total of 75 seconds). Shutdown occurs after 15 seconds if engine or starter will not turn (locked rotor).

Overspeed. Generator set shuts down immediately when governed frequency exceeds 70 Hz (2100 rpm) on 50 and 60 Hz models.

Low Oil Pressure. Shutdown occurs 5 seconds after fault. Low oil pressure shutdown will not function during the first 30 seconds after start-up.

Overvoltage. The generator set shuts down and auxiliary lamp lights when voltage is 15% or more over nominal voltage for 2 seconds or more. Overvoltage shutdown is standard on controllers.

NOTE

Overvoltage can damage sensitive equipment in less than one second. Install separate overvoltage protection on on-line equipment requiring faster shutdowns.

Controller Resetting Procedure (Following Fault Shutdown)

Use the following procedure to restart the generator set after a fault shutdown. Refer to Resetting Emergency Stop Switches in this section to reset the generator set after an emergency stop.

1. Place controller alarm horn switch in the SILENCE position. A/V annunciator alarm horn and lamp are activated, if equipped. Place A/V annunciator alarm switch in SILENCE position to stop alarm horn. A/V annunciator lamp stays lit. (The A/V alarm uses one lamp to indicate a fault shutdown; the appropriate fault lamp lights on the remote annunciator to indicate a fault condition.)
2. Disconnect generator set from load with line circuit breaker or automatic transfer switch.
3. Correct cause of fault shutdown. See Safety Precautions section of this manual before proceeding.
4. Place the generator set master switch in the OFF/RESET position and then in the RUN position to start generator set. A/V annunciator alarm horn sounds and lamp, if equipped goes out.
5. Verify that cause of shutdown has been corrected by test operating generator set.
6. Reconnect generator set to load via line circuit breaker or automatic transfer switch.
7. Place generator set master switch in AUTO position for start-up by remote transfer switch or remote start/stop switch. Place A/V annunciator alarm switch, if equipped in NORMAL position.

NOTE

Place generator set master switch in the AUTO position before silencing alarm horn.

8. Place controller alarm horn switch in the NORMAL position.

Resetting Emergency Stop Switches

Use the following procedure to restart the generator set after shutdown by the remote emergency stop switch. Refer to the Controller Resetting procedure in this section to restart the generator set following a fault shutdown.

1. Determine cause of emergency stop and correct problem(s).
2. Replace glass piece in remote emergency stop switch to reset switch, if equipped.

NOTE

The controller auxiliary lamp lights if the generator set master switch is in the RUN or AUTO position during the resetting procedure.

3. Toggle the generator set master switch to OFF/RESET and then to RUN or AUTO to restart generator set. The generator set does not crank until the resetting procedure is completed.

Relay Controller Operation

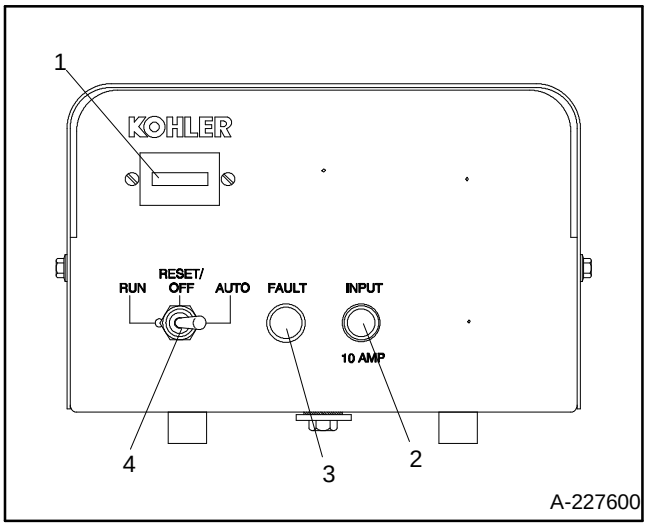
Generator sets equipped with a relay controller refer to Figure 2-5 and the following descriptions to identify controller components.

Fault Lamp. Lamp lights to indicate a fault condition. Generator set shuts down on Overcrank, Overspeed, and Low Oil Pressure faults. See Fault Shutdowns following. (Fault lamp will not stay lit after generator set shuts down. Fault lamp lights as fault occurs.)

Hourmeter. Hourmeter records generator set operating hours for reference in maintenance scheduling.

Generator Master Switch (Run/Off-Rest/Auto). Switch functions as controller reset and generator set operation switch. Refer to Starting, Stopping, and Controller Resetting procedure in this section.

Controller Fuse. Fuse (10-amp) protects controller circuitry.



1. Hourmeter
2. Controller fuse
3. Fault lamp
4. Generator master switch
5. AC circuit breaker (not shown)

Figure 2-5. Relay Controller Features

Starting/Stopping Procedure (relay controller)

Starting

Place the controller or remote Start/Stop switch in the RUN position until the engine starts. If the engine fails to start after three 8 second attempts, the generator set stops cranking because of overcrank fault shutdown. Wait for the engine to come to a complete stop before attempting restart. Place switch in RESET/OFF position and then to RUN position.

NOTE

Do not crank engine continuously for more than 30 seconds at a time. Allow a 60-second cooldown period between cranking attempts if the engine does not start.

If the generator set does not start after three attempts, see Section 4. Troubleshooting for possible causes.

Stopping

1. Disconnect load from generator set and allow generator set to run without load for 5 minutes.

   NOTE

   Run the generator set at no load for 5 minutes prior to stopping to ensure adequate cooling of the set.

2. Place controller or remote start/stop switch in the OFF/RESET position. The generator set shuts down.

Fault Shutdowns (relay controller)

The generator set shuts down automatically under the following fault conditions and cannot be restarted until the fault condition is corrected. The shutdown switches automatically reset when the problem is corrected or the generator set cools (if overheating was the fault).

Overcrank. Shutdown occurs after 30-60 seconds of continuous cranking.

Overspeed. Generator set shuts down immediately if governed frequency exceeds 70 Hz (2100 rpm) on 50 and 60 Hz models.

Low Oil Pressure. Shutdown occurs approximately 8 seconds after fault. Fault occurs when engine oil pressure drops below specified limit.

NOTE

Low oil pressure shutdown does not protect against low oil level. Check for oil level at engine.

NOTE

If the cause of a low oil pressure shutdown is not corrected, the generator set can be restarted (after controller reset) and will run approximately 8 seconds before shutting down again. See Resetting Fault Shutdown procedure following.

Circuit Protection (relay controller)

An optional line circuit breaker (sized for generator output) is available to protect the generator from damage because of overload or short circuits. If the circuit breaker trips, reduce the load and switch the breakers back to the ON position. With the breaker in the OFF position, the generator set runs but there is no output voltage.

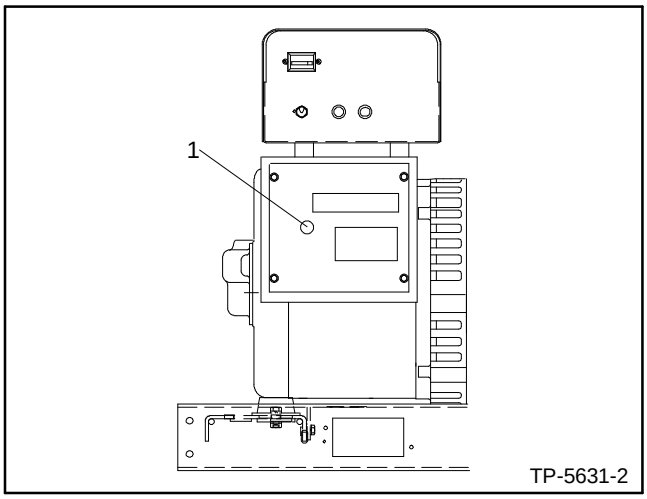
NOTE

If the generator set circuit breaker trips repeatedly, see Section 4. Troubleshooting for possible causes.

The controller circuitry is protected by a replaceable 10-amp fuse. Check the controller fuse if the generator set will not crank and the battery and/or connections appear correct. Replace fuse. If fuse blows again, see Section 4. Troubleshooting for possible causes.

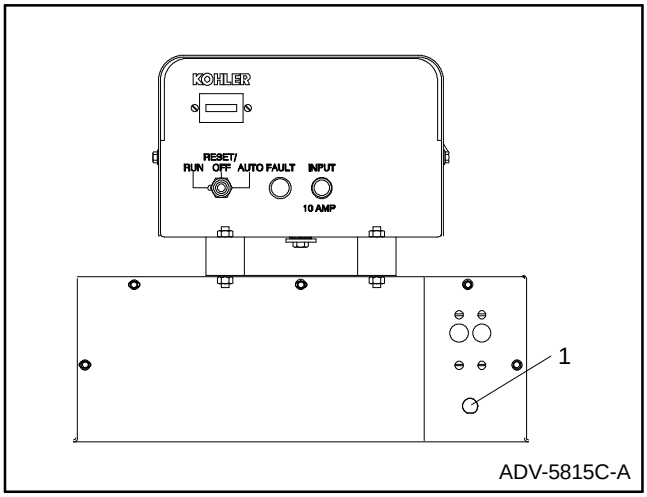
Voltage Regulator Fuse

A replaceable 10-amp fuse protects the voltage regulator circuitry. The generator set shuts down if this fuse is blown. Typically with this condition, the generator set starts and then shuts down in 8 seconds. If this fuse is replaced and then blows again, see Section 4, Troubleshooting for possible causes. Location of the voltage regulator fuse for 10-18 kW is shown in Figure 2-2. See Figure 2-7 for 6.5 kW.



1. 10-amp fuse

Figure 2-6. 10-18 kW Voltage Regulator Fuse Location



1. 10-amp fuse

Figure 2-7. 6.5 kW Voltage Regulator Fuse Location

Controller Resetting Procedure (following fault shutdown)

Use the following procedure to restart the generator set after a fault shutdown. Reset the controller and correct the fault before resetting the generator set.

NOTE

If the fault is not corrected, the generator set will start and then shut down in 8 seconds.

1. Place the generator set master switch in the OFF/RESET position until the fault lamp goes out. See Safety Precautions before proceeding.
2. Disconnect generator set from load with line circuit breaker or automatic transfer switch.
3. Place generator set master switch in the RUN position to restart the generator set. Refer to Section 4 Troubleshooting for possible causes of fault shutdown.
4. Place the generator set master switch in the OFF/RESET position.
5. Correct cause of fault shutdown.
6. Place the generator set master switch in NORMAL position (RUN or AUTO) for start-up.

Section 3. Scheduled Maintenance

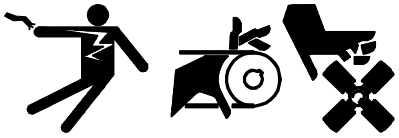
The generator set alternator does not require regular or scheduled service under normal operating conditions. The prestart checklist lists the main areas of the generator set that require attention.

If generator set operates under dusty or dirty conditions, use DRY compressed air to blow dust out of the generator. Do this with the generator set running and direct the stream of air through the openings in the generator end bracket.

Perform generator set engine service at the intervals specified by the engine manufacturer in the engine service literature. Contact an authorized service distributor/dealer to obtain service literature for specific models.

Some generator sets may be equipped with an emission certified engine. Emission certified engines are fitted with carburetors that have no possible adjustments.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (disconnect negative lead first and reconnect it last).

Disabling generator set. Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on the generator set or connected equipment. The generator set can be started by an automatic transfer switch or remote start/stop switch unless these precautions are followed.

⚠ WARNING

Hot coolant and steam.
Can cause severe injury or death.

Before removing pressure cap, stop generator set and allow it to cool. Then loosen pressure cap to relieve pressure.

Servicing exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. An engine becomes hot while running and exhaust system components become extremely hot.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Operate generator set only with all guards and electrical enclosures in place.

Servicing generator set when operating. Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, clothing, and test leads away from belts and pulleys when generator set is running. Replace guards, screens, and covers before operating generator set.

Fuel Regulators

Fuel regulators are compatible with both natural gas and LP gas. The spring and retainer are installed when used with natural gas.

Some models require removal of the spring and retainer, while other models maintain the spring and retainer, when using LP gas. Read and follow the instructions found on the hang tag attached to the generator set.

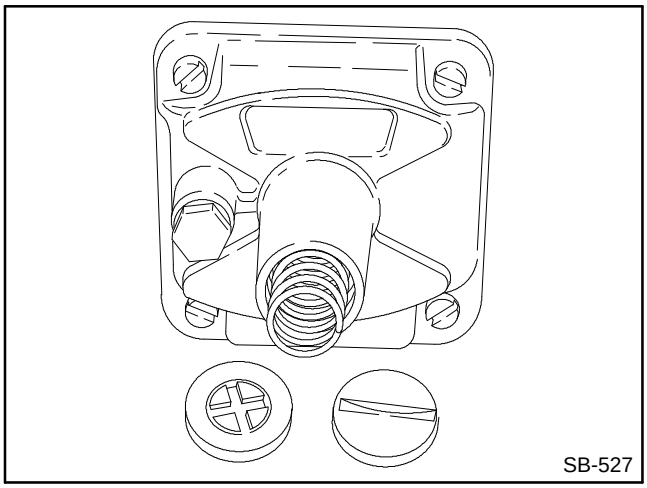
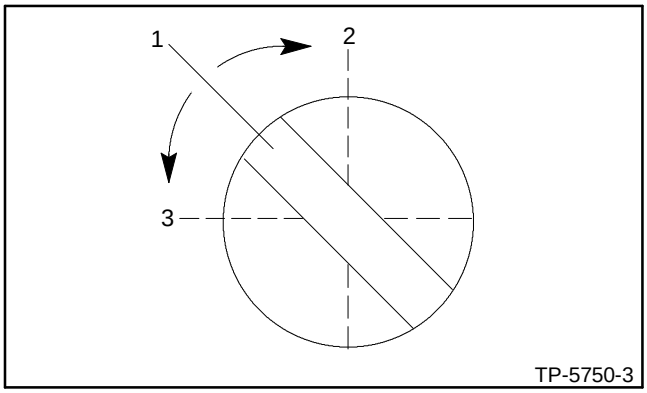


Figure 3-1. LP Vapor Gas Fuel Regulator

Carburetor Adjustments (LP/Natural Gas)

Some generator sets may be equipped with an emission certified engine. Emission certified engines may be fitted with carburetors that have no adjustments.

To adjust the carburetor, run the generator set at approximately half-load. Rotate engine fuel mixture screw clockwise or counterclockwise until the engine runs smoothly. See Figure 3-2. Apply varying loads and adjust carburetor again (if necessary) to achieve smooth engine performance at all loads.



1. Fuel adjusting screw
2. Lean
3. Rich

Figure 3-2. Fuel Mixture Adjustment (typical)

LP Liquid Withdrawal Fuel System

With the LP liquid withdrawal system, LP fuel in liquid form is directed under pressure from the tank to a vaporizer. The vaporizer converts the fuel from a liquid to a gaseous state and then the LP vapor is drawn off to the carburetor. The system also includes a fuel valve which shuts off the fuel flow when the engine is stopped. Contact an authorized service distributor/dealer for LP liquid withdrawal availability.

Electronic Governor

The governor control system consists of an electronic isochronous governor, an electro-mechanical actuator, and a magnetic pickup. Electrical pulses are supplied by the magnetic pickup to the isochronous governor (control unit) each time one of the ring gear teeth passes the pickup. The control unit then compares the frequency of these pulses to a preset reference and provides a signal to the actuator which, in turn, controls the carburetor and hence the engine speed. This is a closed loop system and typically provides ±0.25% steady state speed regulation.

Battery

Refer to the following section for general maintenance if the generator set is equipped with the battery charging feature. Use a 12-volt battery with a rating of at least 290 cold cranking amps with 6.5-12 kW models, and 630 cold cranking amps with 18 kW models. When using a maintenance-free battery, it is not necessary to check the specific gravity or electrolyte level. Perform these procedures at the intervals specified in the Service Schedule. A negative ground system is used. Battery connections are shown on the wiring diagrams. Make sure battery is correctly connected and terminals are tight.

Battery Charging Systems

6.5 kW

The battery charging circuit incorporates a winding in the generator set alternator and a rectifying module protected by a self resetting circuit breaker. This battery charging feature is intended to only replenish the necessary voltage used while the generator set is running. It is not intended to charge a severely discharged battery.

Generator sets used as a standby to utility power where the generator set is not used regularly require an external battery charger to keep the starting battery fully charged. Observe battery polarity when connecting battery to the generator set.

NOTE

Some early 6.5 kW generator sets do not have battery charging.

10-18 kW

The generator set is equipped with a belt-driven battery charging alternator to keep the engine starting battery fully charged. The alternator requires no maintenance other than maintaining belt tension. To adjust alternator belt tension see Drive Belts earlier in this section.

Generator sets used as a standby to utility power where the generator set is not used regularly require an external battery charger to keep the starting battery fully charged. Observe battery polarity when connecting battery to the generator set.

NOTE

The generator set will not start and possible circuit board damage may result if the battery connections are made in reverse.

⚠ WARNING

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

Locate in a well ventilated area. Keep explosive fumes away.

⚠ WARNING

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

Use protective goggles and clothes. Can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc. to prevent burns and to prevent sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together or sparks could ignite battery gases or fuel vapors. Any compartment containing batteries must be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being charged and always turn charger off before disconnecting battery connections. When disconnecting battery, remove negative lead first and reconnect it last.

Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in batteries can cause permanent damage to eyes, burn skin, and eat holes in clothing. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. In the case of eye contact, seek immediate medical aid. Never add acid to a battery once the battery has been placed in service. Doing so may result in hazardous spattering of electrolyte.

Cleaning

Keep battery clean by wiping it with a damp cloth. Keep all electrical connections dry and tight. If corrosion is present, disconnect cables from battery and remove corrosion with a wire brush. Clean battery and cables with a solution of baking soda and water. Be careful that cleaning solution does not enter battery cells. When cleaning is complete, flush battery and cables with clean water and wipe with a dry cloth. Coat terminals with petroleum jelly or other nonconductive grease after the battery cables are reconnected.

Checking Electrolyte Level

It is not possible to check the electrolyte level of a maintenance-free battery. Check the electrolyte level before each start-up. Remove filler caps and verify that electrolyte level is up to bottoms of filler holes. Refill as necessary with distilled water or clean tap water. DO NOT add fresh electrolyte! Tighten all filler caps.

Checking Specific Gravity

It is not possible to check the specific gravity of a maintenance free battery. Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell. While holding the hydrometer vertical, read the number on the glass bulb at the top of the electrolyte level. Use the correction table in Figure 3-3 if the hydrometer used does not have a correction table. Determine specific gravity and electrolyte temperature of battery cells. Locate temperature in Figure 3-3 and adjust specific gravity by amount shown. The battery is fully charged if the specific gravity is 1.260 at an electrolyte temperature of 80°F (26.7°C). The difference between specific gravities of each cell should not exceed ±0.01. The battery should be charged if the specific gravity is below 1.215 at an electrolyte temperature of 80°F (26.7°C).

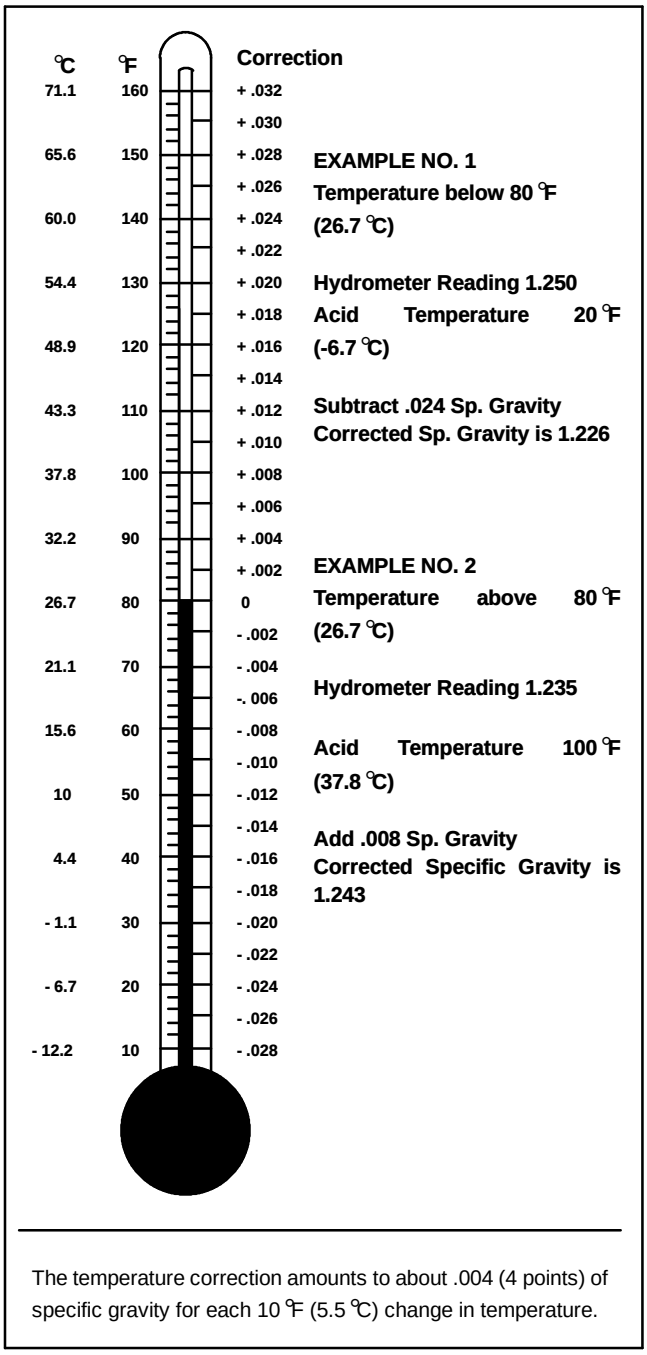


Figure 3-3. Specific Gravity Temperature Correction

Generator Service

Have an authorized service distributor/dealer perform all generator set service. Under normal conditions, regular generator service is not required. For operation under dusty and dirty conditions, use dry compressed air to blow dust out of the generator. Do this with the generator set operating and direct the stream of air in through the cooling slots at the end of the generator.

Replace the end bracket bearing every 10,000 hours of operation in standby and prime power applications. Service more frequently if bearing inspection indicates excessive rotor end play or bearing damage from corrosion or heat build-up. The end bracket bearing is sealed and requires no additional lubrication.

Storage Procedure

Perform the following steps if the generator set is out of service for three months or longer.

Engine oil

1. Operate generator set for 5 minutes.
2. Stop the generator set.
3. While the engine is still warm, drain the engine lubrication oil from the crankcase.
4. Refill the engine crankcase with an oil having a viscosity appropriate for the particular climate.
5. Run the generator set for a few minutes to distribute the clean oil.
6. Stop the generator set.

Fuel (gasoline-fueled engines)

1. To remove fuel.
   a. Drain the fuel from the fuel tank.
   b. Drain the carburetor bowl (or run generator set until empty). This prevents the gasoline from becoming stale.
2. To stabilize fuel.
   a. Use a gas stabilizer for gasoline-fueled generator sets in lieu of draining the carburetor bowl. Add fuel stabilizer to the fuel according to the manufacturer's instructions.

Fuel (gaseous-fueled engines)

1. With the generator set running, shut off the gas supply.
2. Run generator set until the engine stops from lack of fuel.

Coolant (liquid-cooled models only)

1. Check engine coolant protection.

Lubricate Cylinders

1. Remove the spark plugs.
2. Pour approximately one tablespoon of engine oil into each spark plug hole.
3. Crank the engine two or three revolutions to lubricate the cylinders.
4. Reinstall spark plugs.

Exterior Preparation

1. Clean exterior surface of generator set.
2. Seal all openings in the engine with non-absorbent adhesive tape.
3. Mask off all areas to be used for electrical contact.
4. Spread a light film of oil over unpainted metallic surfaces to prevent rust and corrosion.

Section 4. Troubleshooting

When troubles occur, do not overlook simple causes which might seem too obvious to be considered. A starting problem, for example, could be attributed to an empty fuel tank. As a general aid to diagnosing common problems, refer to the Troubleshooting Table below. If the trouble cannot be corrected through routine servicing, contact an authorized service distributor/dealer for assistance.

General Troubleshooting Chart (Sheet 1 of 2)

Problem	Possible Cause	Corrective Action
Generator set will not crank	Weak or dead battery	Recharge or replace; check battery charger operation. Check battery charging circuit (circuit breaker, module, and wiring), if equipped.
	Reversed or poor battery connections	Check connections
	Fuse blown in controller	Replace fuse
	Defective starter/starter solenoid	Test function
	Defective start/stop switch (master switch)	Test function
	Generator master switch in OFF position (attempting start-up from remote switch) *	Move master switch to AUTO position
Generator set cranks but will not start, starts hard, lacks power, or operates erratically	Incorrect fuel	Replace fuel
	No fuel	Add fuel; check fuel control circuit
	Clogged fuel filter (gasoline models only)	Replace fuel filter
	Air cleaner lever in the wrong temperature position (6.5 kW models only)	Place air cleaner lever in correct position for winter or summer starting (6.5 kW)
	Air cleaner clogged	Clean and/or replace
	Weak or dead battery	Recharge or replace
	Defective fuel pump (gasoline models only)	Check fuel pump for function
	Defective fuel valve or (gas models only)	Check fuel valve for function
	Defective antidiesel solenoid (gasoline models only)	Check antidiesel solenoid for function
	Defective carburetor choke (gasoline models only)	Check function of carburetor choke
	Defective fuel regulator (gas models only)	Check function of fuel regulator
	Faulty ground (–) connection	Clean and tighten ground connections
	Faulty spark plugs	Replace (and regap) spark plugs
	Defective ignition system	Check ignition coil, module, and wiring
	Loose spark plug wire connection	Check spark plugs wires
	Insufficient fuel pressure (gas models only)	Check fuel pressure
	Engine malfunction	Troubleshoot engine
	Defective cold weather starting aid	Check cold weather starting device
	Low oil pressure shutdown switch	Check oil level, oil pressure, and check switch for function
	Carburetor adjustment incorrect	Adjust carburetor
	Carbon build-up on cylinder heads	Service cylinder heads
	Incorrect engine timing (signal)	Check air gap of ignition pickup

* 5-light microprocessor controller only.

General Troubleshooting Chart (Sheet 2 of 2)

Problem	Possible Cause	Corrective Action
No AC output	AC circuit breaker in OFF position	Place circuit breaker in ON position
	AC circuit breaker tripping because of overload	Reduce load on generator set
	AC circuit breaker tripping because of short circuit	Correct cause of short circuit
	Voltage regulator fuse blown	Replace fuse
	Internal generator problem	Contact distributor
Low output or excessive drop in voltage	Generator set overloaded	Reduce load
	Engine speed too low	Check governor
	Faulty/misadjusted voltage regulator	Check voltage regulator adjustment and/or test voltage regulator
	Internal generator problem	Contact distributor
High output voltage (or high frequency)	Loose voltage regulator connections	Check connections
	Governor misadjusted (high frequency)	Check governor
	Faulty voltage regulator	Check voltage regulator adjustment and/or test voltage regulator
	Internal generator problem	Contact distributor
Generator set stops suddenly	Low oil pressure shutdown	Check oil level, oil pressure, and switch for function
	Out of fuel	Add fuel
	Overcrank shutdown *	Reset controller. If overcrank fault reoccurs, troubleshoot generator and/or controller
	Fuse blown in controller	Replace fuse. If fuse blows again, troubleshoot controller
	Engine malfunction	Troubleshoot engine
	Overspeed shutdown *	Reset controller. If generator set overspeeds again, troubleshoot generator and controller
	Overvoltage shutdown (if equipped) *	Troubleshoot generator and controller
	Generator master switch in OFF/RESET position *	Move switch to correct position (RUN or AUTO)
	Emergency stop switch activated (local or remote) *	Check reason for emergency shutdown; reset switch
* 5-light microprocessor controller only.		

Section 5. Generator Reconnection

Voltage Reconnection Procedure

The reconnection procedure explains voltage reconnections only. If frequency changes are required, the governor and voltage regulator need adjustment. See the generator set service manual for information regarding frequency adjustment.

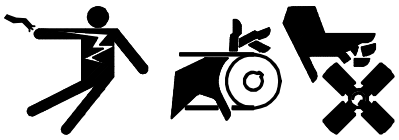
To illustrate the reconnection of 4-lead or 12-lead generator sets, the following information is provided. In all cases, follow the National Electrical Code (NEC) guidelines.

Reconnect the stator leads of the generator set if a different output phase (12-lead models only) or voltage is desired. Refer to the following procedure and the connection schematics. Follow all safety precautions at the front of this manual and in the text while performing this procedure.

NOTE

Order voltage reconnection decal 246242 from an authorized service distributor/dealer and affix decal to generator set after reconnecting to a voltage different than the nameplate.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (disconnect negative lead first and reconnect it last).

Disabling generator set. Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on the generator set or connected equipment. The generator set can be started by an automatic transfer switch or remote start/stop switch unless these precautions are followed.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Operate generator set only with all guards and electrical enclosures in place.

Grounding generator set. 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 generator set and electrical circuits when in use. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution is increased under such conditions.

Short circuits. Hazardous voltage 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 adjustments are made. Remove wristwatch, rings, and jewelry before servicing equipment.

Four-Lead (Single-Phase) Generator Sets

NOTE

Current transformers (CTs) are used only on generator sets equipped with controllers with meters.

NOTE

Position current transformers CT1, CT2, and CT3 with dot or HI side toward generator set.

See Figure 5-1 for four-lead reconnectable (single-phase) generator set options.

	60 Hz	50 Hz
100-120 volt	X	
100-120/200-240 volt	X	X
200-240 volt		X

Figure 5-1. Four-Lead, Single-Phase Generator Set Voltage Connection Options

NOTE

Microprocessor controller only: Make fine adjustment ±5% using voltage adjustment potentiometer on the controller front panel.

100-120 Volt Configurations

The load side terminals of the circuit breaker are not to be connected together when a factory two-pole circuit breaker is used, see Figure 5-2. If the installation requires a 100-120 volt, 2 wire system, use a single pole circuit breaker. See Figure 5-3. When connecting stator phase leads together, size output lead (L1) accordingly. Use a jumper lead on the line side of the circuit breaker to balance the load of the generator set.

	60 Hz	50 Hz
L0-L1	100-120 volt	100-120 volt
L0-L2	100-120 volt	100-120 volt

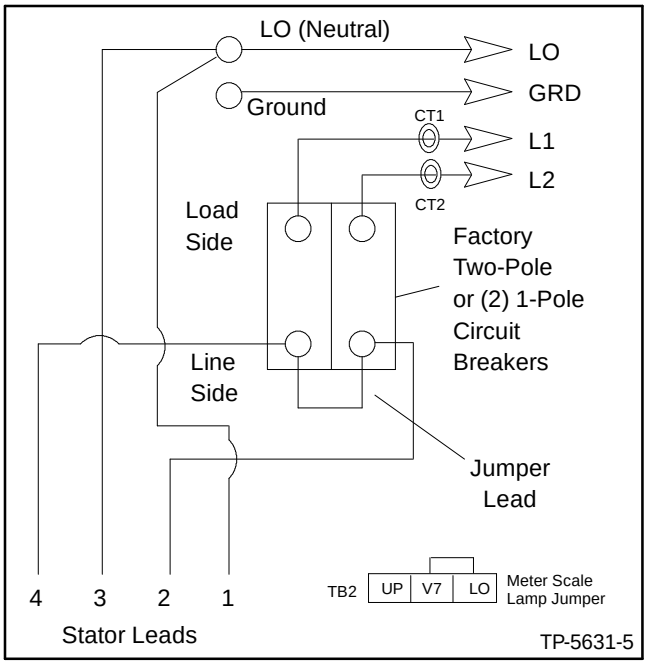


Figure 5-2. 100-120 volt, 3 wire

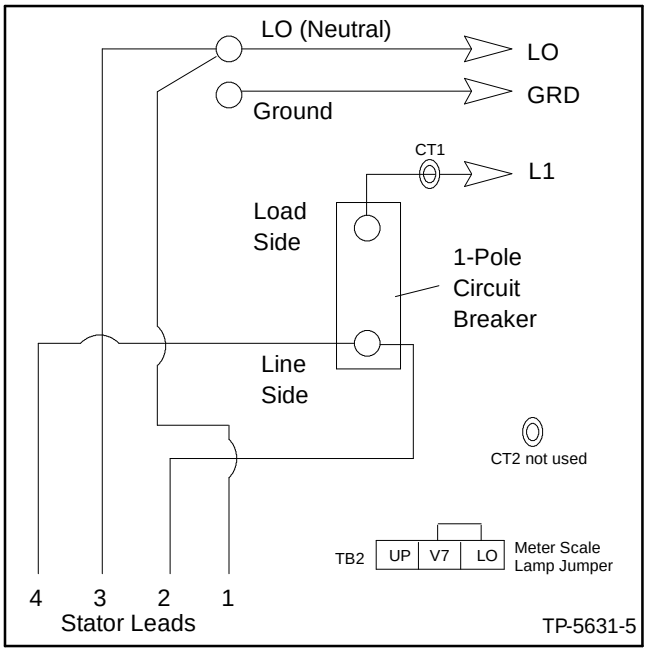


Figure 5-3. 100-120 volt, 2 wire

100-120/200-240 Volt

Jumper lead not used. If the generator set was originally wired for straight 100-120 volt 3 wire, be sure to remove jumper lead. See Figure 5-4 for location of jumper lead. Leads L1 and L2 are of different phases. Never connect Leads L1 and L2 together.

NOTE

Use a circuit breaker manufacturer's two-pole circuit breaker. Two single-pole circuit breakers do not conform to NEC requirements when supplying a 200-240 volt load. This is true even if they are mechanically attached together.

	60 Hz	50 Hz
L0-L1	100-120 volt	100-120 volt
L0-L2	100-120 volt	100-120 volt
L1-L2	200-240 volt	200-240 volt

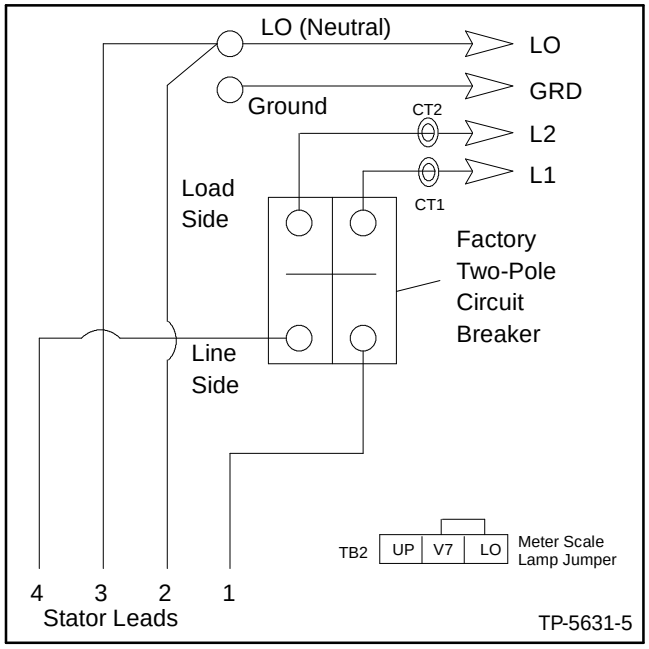


Figure 5-4. 100-120/200-240 volt, 3 wire configurations

200-240 Volt

Jumper lead not used. If the generator set was originally wired for straight 100-120 volt, 3 wire, be sure to remove jumper lead. See Figure 5-5 for location of jumper lead.

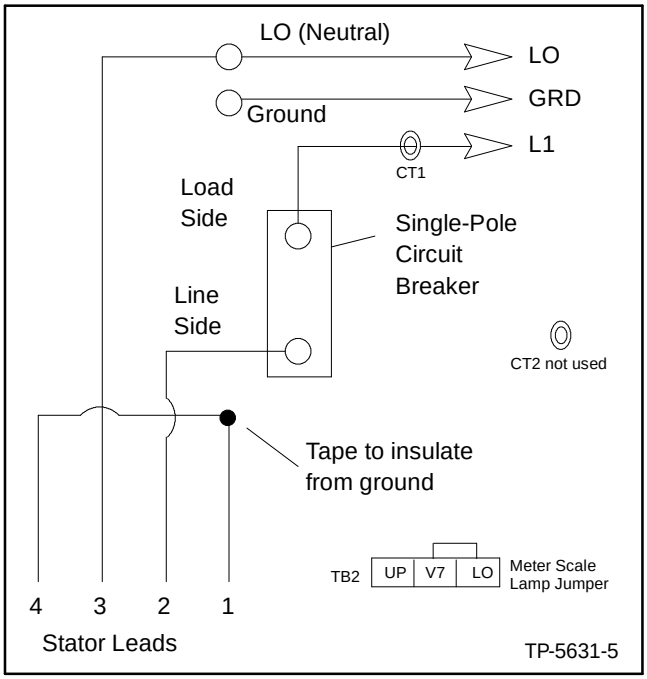


Figure 5-5. 200-240 volt, 2 wire configurations

12-Lead (Three-Phase) Generator Sets

NOTE

Current transformers (CTs) are used only on generator sets equipped with controllers with meters.

NOTE

Position current transformers CT1, CT2, and CT3 with dot or HI side toward generator set.

Three-phase, 12-lead generator sets are reconnectable to the voltages and phases shown in Figure 5-6. If the generator set is reconnected to obtain a different output voltage, voltage regulator voltage adjustments may be necessary to obtain desired voltage.

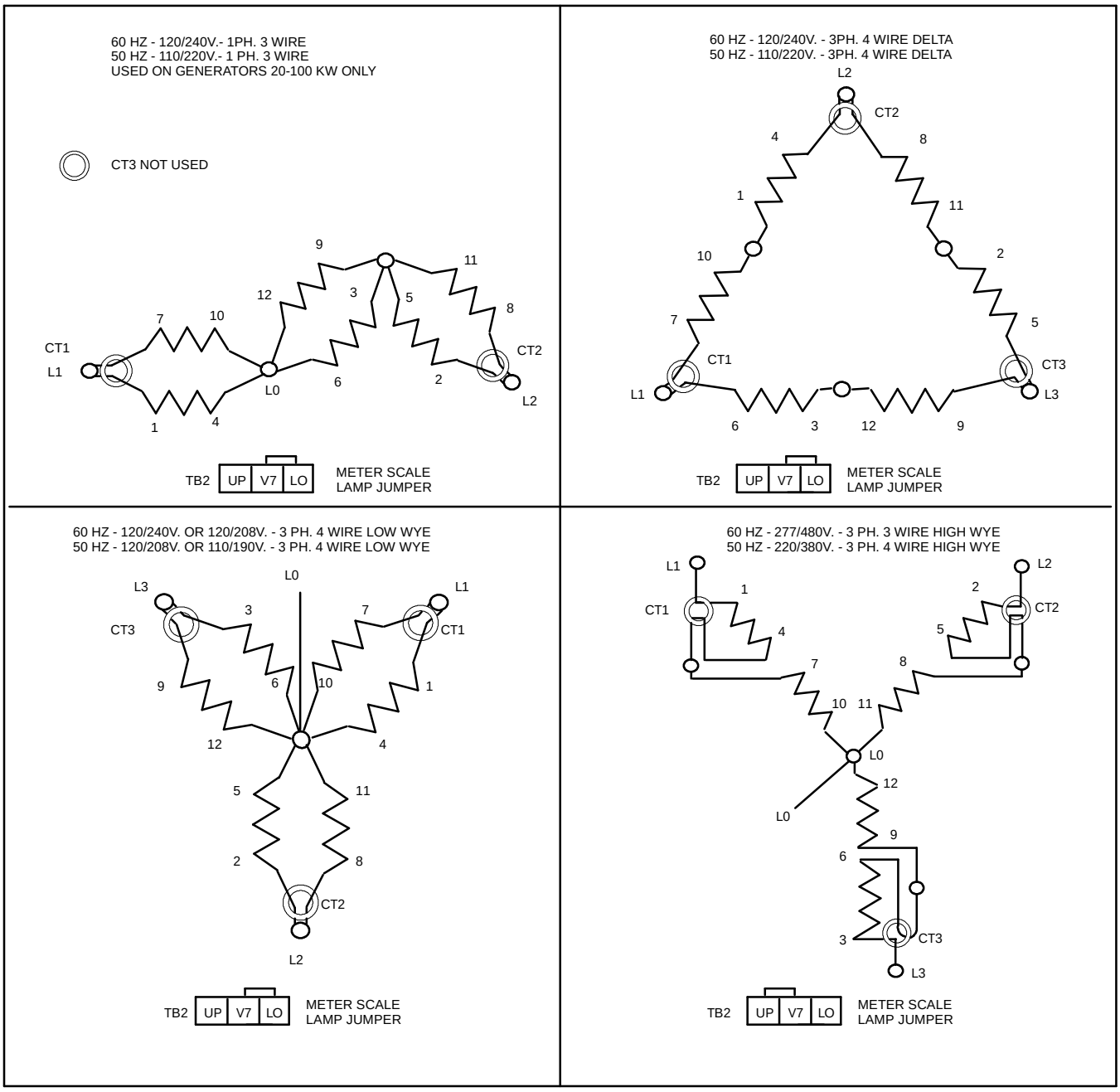


Figure 5-6. Generator Reconnection

Reconnection Procedure (Microprocessor Controller only)

1. Place the generator set master switch in the OFF/RESET position.
2. Disconnect engine starting battery, negative (–) lead first. Disconnect power to battery charger (if equipped).
3. Select desired voltage connection from Figure 5-6. Route leads through current transformers and connect according to the diagram for desired phase and voltage.

NOTE

Position current transformers CT1 and CT2 (single-phase) or CT1, CT2, and CT3 (three-phase) with dot or HI mark toward generator set. Current transformers are only used on generator sets equipped with metered controllers.

NOTE

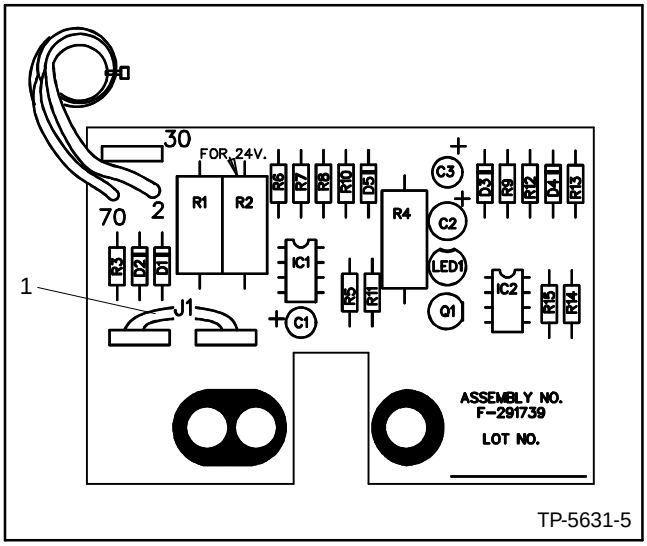
Equipment Damage! Verify that transfer switch, line circuit breakers, and any other accessories using line voltage are sized for the voltage selected.

NOTE

See generator service manual for information on changing generator frequency.

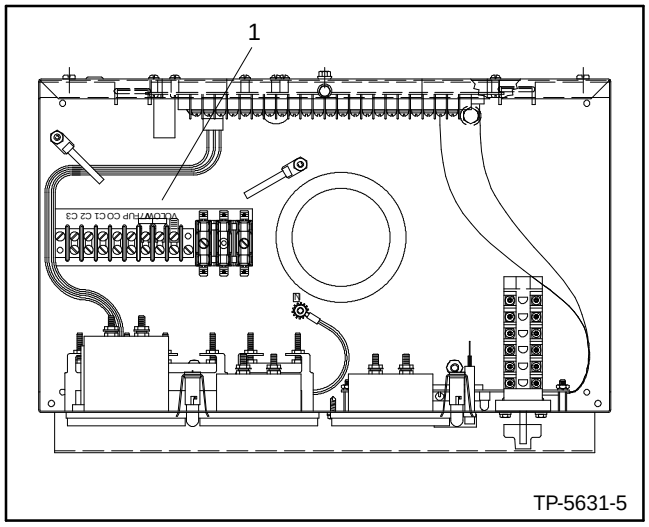
4. If controller is equipped with meters, remove controller cover and reposition meter scale lamp jumper, if necessary, to match meter scale lamps with desired voltage. See Figure 5-8.
5. The jumper J1 must be in place on the overvoltage circuit board if the generator set is connected for 139/240 or 277/480 volts (3-phase, 4-wire, 60 Hz) if the generator set is equipped with the overvoltage kit.

   For all other voltages, remove J1 jumper from the overvoltage circuit board. See Figure 5-7 for J1 jumper location on the overvoltage circuit board.
6. If the controller is equipped with meters, turn the phase selector switch to the L1-L2 position (1-phase or 3-phase depending on generator connection). If the controller is not equipped with meters, connect a voltmeter across leads L1 and L2.
7. Reconnect generator set engine starting battery, negative (–) lead last.
8. Place the generator master switch in the RUN position to start the generator set.
9. Check voltmeter for correct voltage. Adjust voltage if necessary with the voltage adjustment potentiometer on the controller front panel. See Figure 5-9.
10. Stop generator set after adjustment procedure.



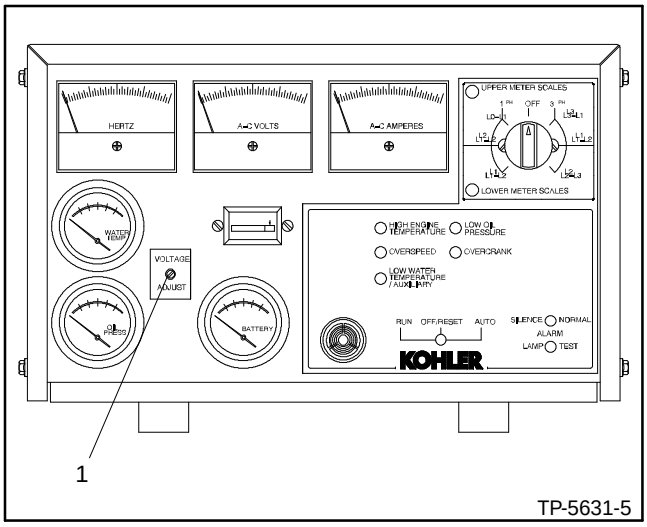
1. J1 jumper

Figure 5-7. Overvoltage Circuit Board



1. Lamp jumper

Figure 5-8. Meter Scale Lamp Jumper



1. Voltage adjustment potentiometer

Figure 5-9. Voltage Adjustment (typical)

Section 6. Installation

General

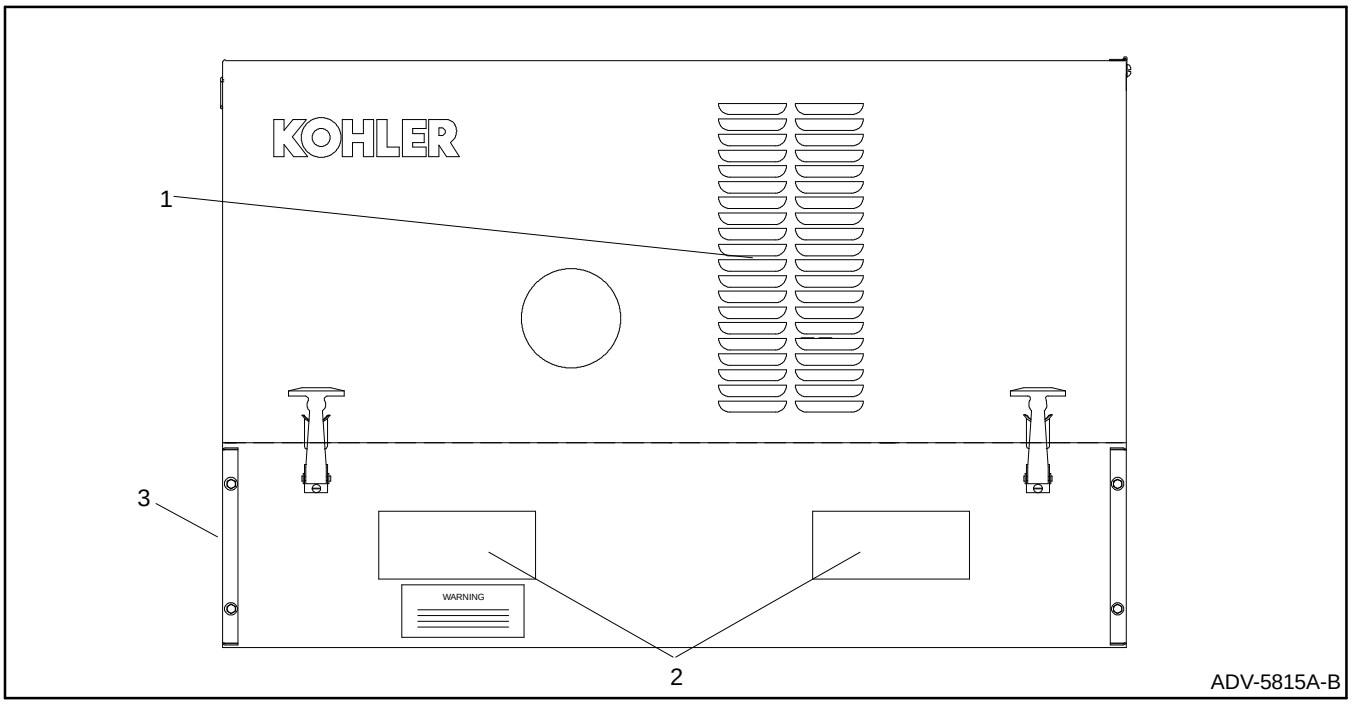
Refer to the Industrial Installation Manual TP-5700 for general information regarding generator set installation. TP-5700 is generic and provides the information required to complete the installation. The information contained in this section is specific for the 6.5RMY model.

Follow the guidelines presented here and in the Industrial Installation Manual to plan and install the 6.5RMY. Use specifications and drawings provided here only in initial planning. Use respective spec sheets, dimension drawings, and wiring diagrams for installation. Contact an authorized service distributor/dealer for current information.

Air Requirements

The generator set requires correct air flow for cooling and combustion. The louvers on the upper portion of the weather housing and the cutouts in the skid provide the cooling and combustion air. Do not block or otherwise interfere with the function of these openings. The heated air is expelled by an Air-Vacä reverse flow cooling system where it is discharged downward and out of the compartment through the discharge chute located near the muffler.

If the generator set is to be mounted indoors, maintain the air flow shown in the spec sheet. Install appropriately sized vents in the building. An air duct flange kit is available to provide the connection to duct the heated air to the outside of the building.



1. Weather housing louvers (air inlet)
2. Skid cutouts (air inlet)
3. Heated air exhaust

Figure 6-1. Cooling Air Intake and Air Exhaust

Exhaust Requirements

The exhaust muffler is located in a compartment in the skid under the engine end of the generator set. See Figure 6-2. The exhaust system is complete for generator sets installed outdoors. The screened piece covering the muffler compartment prevents contact with the hot exhaust system and keeps rodents and other animals out.

For generator sets installed inside a building pipe exhaust outside. Use available flexible exhaust kit and duct flange kit. Correctly size any extension added to the exhaust outlet so it does not affect the maximum allowable back pressure of the engine. Total length and number of bends in the exhaust system may have an effect on the back pressure. Locate the exhaust outlet to prevent entry by rodents and birds. Use a rain cap when the exhaust outlet is directed upward.

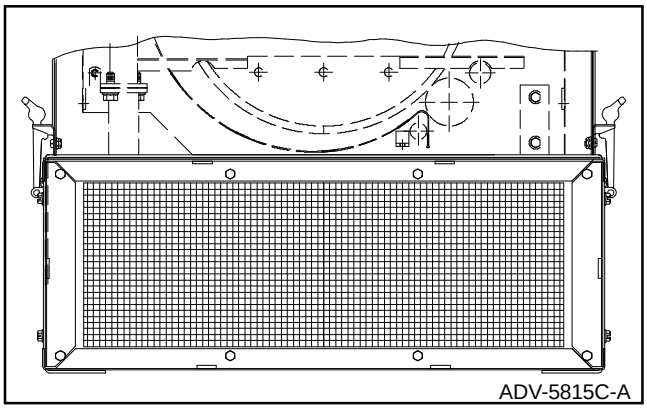


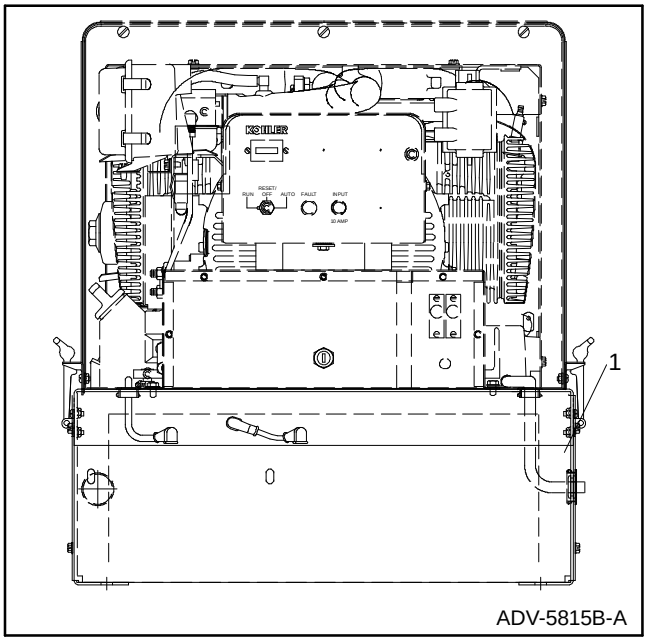
Figure 6-2. Exhaust Muffler Location

Fuel System

Some generator sets may be equipped with an emission certified engine. Emission certified engines may be fitted with carburetors that have no possible adjustments.

The generator set can be fueled by gasoline, LP gas, or natural gas. Gasoline requires a different fuel system than the gas fuels. The gas fuels use the same system but different fuel regulators. For information on gas fuel conversion, see Section 3, Gaseous Fuel Systems. The fuel inlet connection for gasoline models is a rubber hose with a 1/4 in. (6 mm) ID. The gas fuel models have a fuel line with a 5/8-18 SAE 45° flare female swivel connector. The rubber hose for all fuels is located near the battery compartment on the 6.5 kW. Route this hose as necessary to reach the fuel supply.

Comply with local and state codes regarding the correct storage of fuel. Because of the scope of the topic involving variable climate conditions and geographical considerations, contact Authorized Service Distributor/Dealer for fuel system planning and installation. Protect all fuel lines from machinery or equipment contact, adverse weather conditions, and environmental damage.



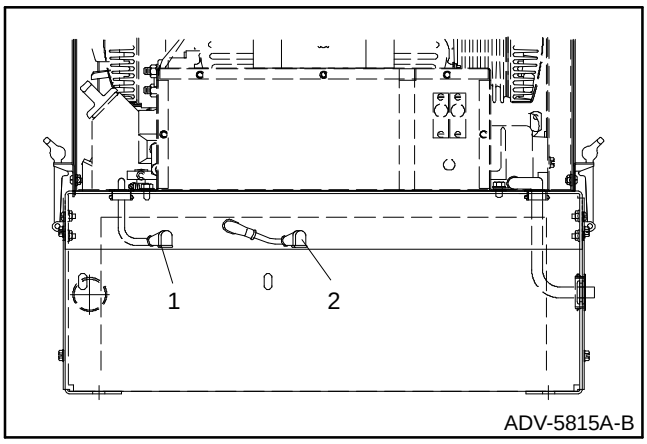
1. Fuel inlet

Figure 6-3. Fuel Supply Line (gas-fueled model shown)

Electrical Connections

Battery

The battery is mounted in a skid compartment located on the generator end of the skid. Standard battery cables provide easy connection to the battery. A battery rack is available to secure the battery if required. Remove the hole plug located on the right side of the skid to connect battery charger cables and any other battery connections.



1. Positive, red battery connection
2. Negative, black battery connection

Figure 1. Battery Connections

Accessory Electrical Connections

There are numerous accessories which can be connected to the generator set including remote annunciator, audio-visual alarm, dry contact relay kit, and remote emergency stop switch. See Section 1– Accessories and an authorized service distributor/dealer for a list of available accessories.

Most of the accessories operate on 12 volts DC and some may require AC line voltage. Do not direct-connect accessories to the controller terminal strip. Connect all accessories to either a single-relay dry contact kit or ten-relay dry contact kit. Connect the dry contact kit(s) to the controller terminal strip. Use separate conduit for AC and DC leads to reduce the possibility of electrical interference especially with the microprocessor controller. Verify that leads and conduit do not interfere with the operation of the generator set or obstruct the service areas. Verify that electrical installation complies with the National Electrical Code (NEC) and is done by a licensed electrician. Follow all applicable local and state codes. See Wiring Diagrams Manual for more information regarding generator set electrical connections.

AC Load Lead Connections

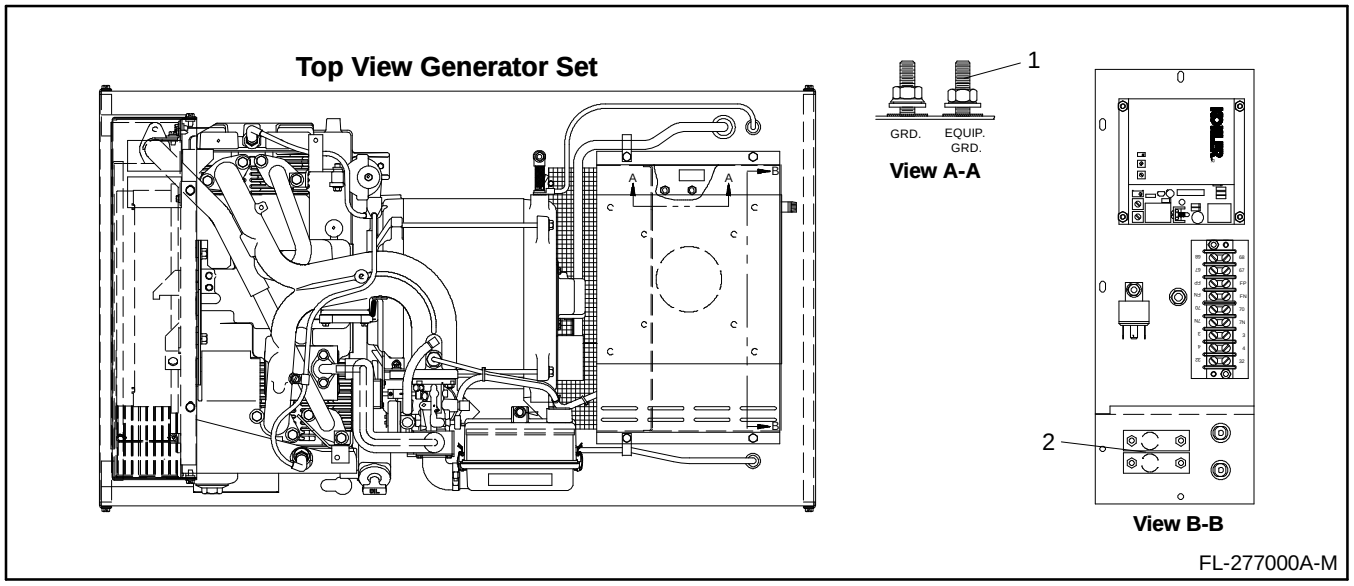
Make the AC output lead connections in the compartment where the AC circuit breakers are located. Route the building distribution panel or transfer switch leads through the bottom of generator set or flexible conduit directly attached to the AC circuit breaker box. Verify that leads and conduit do not interfere with the operation of the generator set or obstruct the service areas. Verify that the electrical installation complies with the National Electrical Code (NEC) and is done by a licensed electrician. All applicable local and state codes must be followed. See Wiring Diagram manual for more information regarding generator set electrical connections.

1. Connect L1/L2 black leads to AC circuit breaker load side.
2. Connect L0 white lead to neutral stud.
3. Connect green lead to equipment ground.

NOTE

Canadian installations only:

For standby service connect output of generator set to a suitably rated transfer switch in accordance with Canadian Electrical Code, Part 1.



1. Equipment ground
2. Circuit breaker

Figure 6-4. Load Lead Connections

Appendix A. Glossary of Abbreviations

Abbreviations are used throughout this manual. Normally they will appear in the text in complete form with the abbreviation following in parentheses the first time they are used. After that they will appear in the abbreviated form. The commonly used abbreviations are shown below. Some items may not apply to this application.

Abbreviation	Description
ABDC	after bottom dead center
AC	alternating current
AISI	American Iron and Steel Institute
AHWT	anticipatory high water temp.
ALOP	anticipatory low oil pressure
AM	amplitude modulation
amp	ampere
amps	amperes
ANSI	American National Standard Institute
API	American Petroleum Institute
approx.	approximate, approximately
A/R	as required, as requested
A/S	as supplied, as stated, as suggested
ASA	American Standards Association (former name of ANSI)
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after dead top center
aux.	auxiliary
A/V	audio−visual
AWG	American Wire Gage
AWM	appliance wiring material
BBDC	before bottom dead center
BDC	before dead center
BHP	brake horsepower
bmep	brake mean effective power
BTDC	before top dead center
Btu	British thermal unit
_C	Celsius degree
cc	cubic centimeter
CCA	cold cranking amps
CEC	Canadian Electrical Code
cfh	cubic feet per hour
cfm	cubic feet per minute
CID	cubic inch displacement
cm	centimeter, centimeters
cmm	cubic meters per minute
co.	company
cont'd.	continued
CPVC	chloropoly vinyl chloride
CRT	cathode ray tube
CSA	Canadian Standards Association
CT	current transformer
cu. in.	cubic inch (es)
CWC	city-water cooled
cyl.	cylinder
dB	decibel
dBA	decibels (A weighted)
DC	direct current
DCR	direct current resistance
deg.	degree
dept.	department
dia.	diameter
DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
e.g.	example given
EIA	Electronic Industries Association
EMI	electromagnetic interference
EPA	Environmental Protection Agency
etc.	etcetera, (and so forth)
ext.	external
_F	Fahrenheit degree
fl. oz.	fluid ounce(s)
FM	frequency modulation
ft.	foot, feet
ft. lbs.	foot pound(s)
fs	full scale
ga.	gauge (meters wire size)
gal./gals.	gallon, gallons
gph	gallons per hour
gpm	gallons per minute
gr.	grade
grd.	ground
HCHT	high cylinder head temperature
HET	high exhaust temperature
Hg.	mercury (element)
H_2O	water
HP	horsepower
hr, hrs	hour, hours
HWT	high water temperature
Hz	hertz (cycles per second)
ID	inside diameter
IEEE	Institute of Electrical and Electronic Engineers
in.	inch, inches
inc.	incorporated
in. lbs.	inch pounds
int.	internal
int.-ext.	internal−external

Abbreviation	Description
ISO	International Standards Organization
J	joule, joules
JIS	Japanese Industry Standard
kg	kilogram, kilograms
kg/cm^2	kilograms per square centimeter
kgm	kilogram meter(s)
kJ	kilojoules (btu cal)
km	kilometer, kilometers
kPa	kiloPascal, kiloPascals
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt amperes
kW	kilowatt, kilowatts
kWH	kilowatt hour
L	liter, liters
LxWxH	length x width x height
LED(s)	light emitting diode(s)
lb., lbs.	pound, pounds
L/hr.	liter per hour, liters per hour
L/min.	liter(s) per minute
LOP	low oil pressure
LP	liquified petroleum
LWT	low water temperature
m	meter, meters
m^3	cubic meter, cubic meters
max.	maximum
MCM	one thousand circular mils.
meggar	megohmmeter
MHz	megahertz
mi.	mile, miles
mil	one one−thousandth of an inch
min.	minimum
misc.	miscellaneous
mJ	milli joule(s)
MJ	mega joule(s)
mm	millimeter
m^3/min	cubic meters per minute
MPa	megaPascal
mpg	miles per gallon
mph	miles per hour
MS	military standard
mW	milliwatt(s)
MW	megawatt(s)
N/A	not available
NBS	National Bureau of Standards
N.C.	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	Newton meter(s)
N.O.	normally open
no., nos.	number, numbers
NPT	National Standard taper pipe thread per general use
N/R	not required
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OS	overspeed
O/S	oversize
OSHA	Occupational Safety and Health Act
OV	overvoltage
oz.	ounce, ounces
PF	power factor
PMG	permanent magnet generator
pot	potentiometer
ppm	parts per million
psi	pounds per square inch
pt., pts.	pint, pints
PVC	polyvinyl chloride
qt., qts.	quart, quarts
qty.	quantity
ref.	reference
RFI	radio frequency interference
r.h.m.	round−head machine (screw)
rms	root means square
RPM	revolutions per minute
RTV	room temperature vulcanization
SAE	Society of Automotive Engineers
SCR	silicon controlled rectifier
sec.	second, seconds
spec, specs	specification
sq.	square
sq. cm.	square centimeters
sq. in.	square inch(es)
tach	tachometer
TDC	top dead center
tech. pub.	technical publications
temp.	temperature
TIF	telephone influence factor
TP, TPs	technical publications
turbo	turbocharger
UHF	ultrahigh frequency
UNC	Unified coarse thread (was NC)
UNF	Unified fine thread (was NF)
UL	Underwriter ȿ Laboratories, Inc.
U/S	undersize
U.S.A.	United States of America
V	volt, volts
vac	volts alternating current
vdc	volts direct current
VHF	very high frequency
W	watt, watts

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