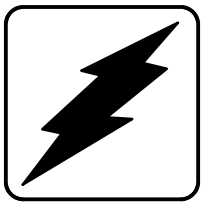
Service

Industrial Generator Sets



Models:

6.5RMY

Controllers:

Decision-Maker™ 3, 5-Light Relay

ISO 9001
KOHLER GENERATORS
INTERNATIONALLY REGISTERED
U.S.A. Plant ISO Registered

KOHLER®
POWER SYSTEMS

TP-5632 1/97a

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.

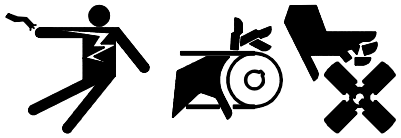
NOTICE

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.

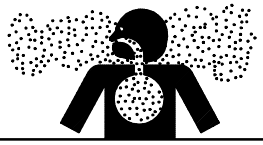
Do not smoke or permit flame or spark to occur near fuel or fuel system.

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.

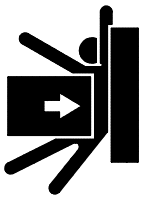
Testing voltage regulator. Hazardous voltage can cause severe injury or death. High voltage is present at the voltage regulator heat sink. Do not touch voltage regulator heat sink when testing or electrical shock will occur.
(PowerBoost™, PowerBoost™ III, and PowerBoost™ V voltage regulator models only.)

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

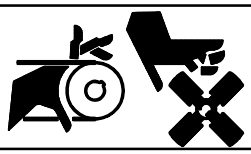
Hazardous voltage.

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.

Notes

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.

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. _____

Notes

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 operation manual, installation manual, engine operation manual, and engine service manual for additional specifications.

Generator Set Features

The generator is equipped with Kohler's PowerBoost™ voltage regulation system which provides instant response to load changes.

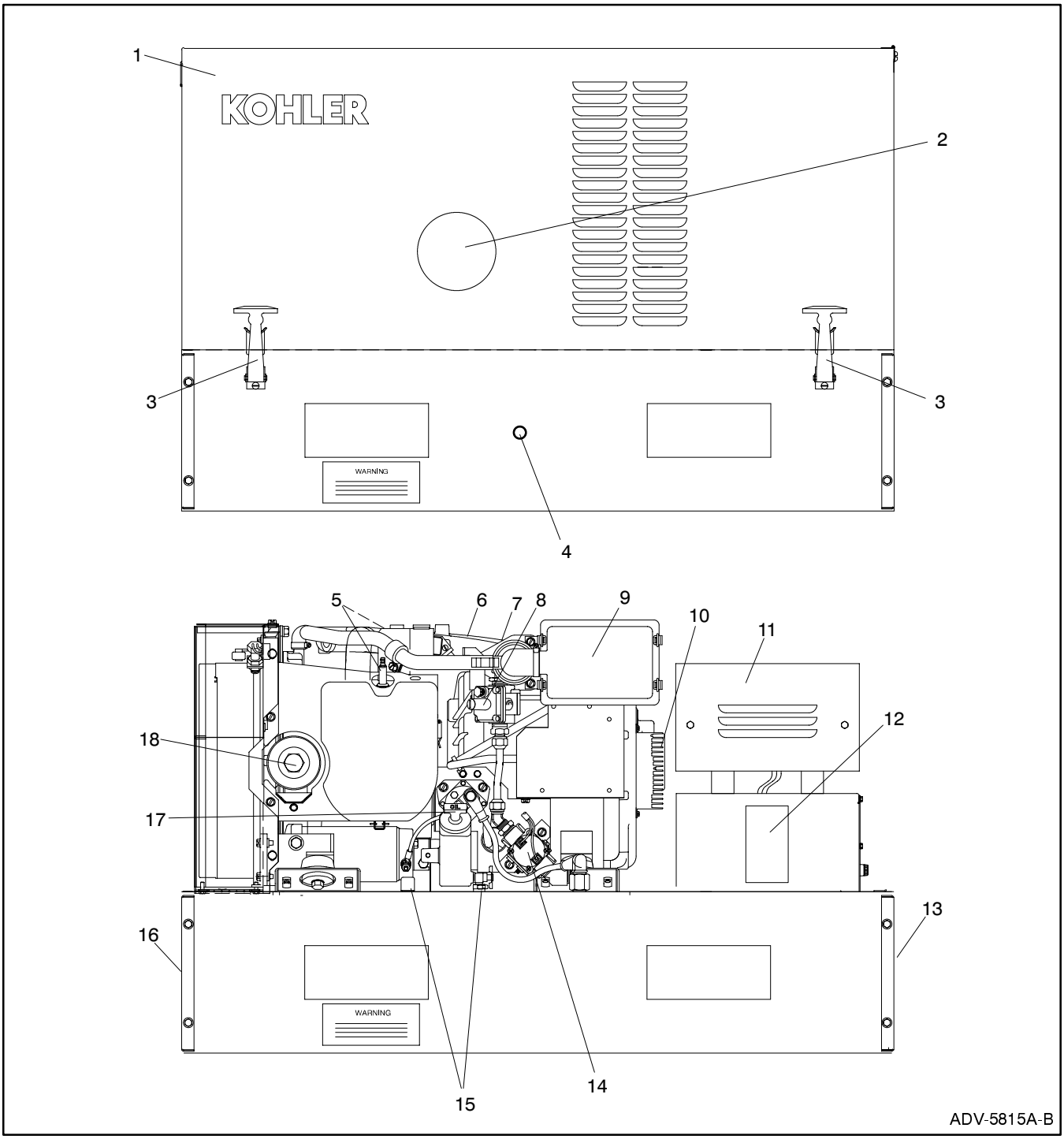
PowerBoost™ is a unique system that ensures reliable motor starting and consistent voltage levels.

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

- Static excited, rotating field design permits power to be obtained from stationary leads.
- Rotor and stator are vacuum impregnated with high bond epoxy varnish which helps prevent corrosion in high humidity areas.
- Dynamically balanced rotors minimize vibration.
- Copper windings ensure minimal heat buildup. Insulation meets NEMA standards for Class 155 insulation.
- Directly connected to the engine, the generator has sealed precision ball bearing with end bearing mounted in a cast metal sleeve to prevent shaft misalignment and extend bearing life.
- Voltage regulation (± 2% no load to full load transient) and frequency regulation (± 0.5% no load to full load transient) prevents prolonged operation at severe under- or over-voltage conditions which could damage appliances.
- Generator is self-ventilated and has drip-proof construction.
- Four-lead reconnectable stator (1-phase). Twelve-lead reconnectable (3-phase models).
- Air-Vac™ cooling system maintains exceptional generator and engine cooling even in high ambient temperatures. Compartment air enters over cylinder block, passes over engine cooling fins, and is discharged out bottom of compartment.

NOTE

DERATING: The kilowatts of the generator set will decrease 3% for each 1000 ft. (305 meters) above sea level and 2% for each 10°F (5.5°C) increase in ambient temperature above 60°F (16°C) and 11.1% when converted to LP fuel.



1. Weather housing
2. Oil check/fill access plug
3. Weather housing latches
4. Oil drain hose hole
5. Spark plugs
6. Ignition module
7. Carburetor
8. Gas fuel regulator
9. Air cleaner
10. Voltage regulator
11. Controller
12. Nameplate
13. Battery compartment
14. Gas fuel valve
15. Oil drain
16. Muffler
17. Oil check/fill
18. Oil filter

Figure 1-1. Generator Set Features

Specifications

Model Series	Voltage Code	Voltage	Gasoline Standby Amps	Phase	Hz	Standby Ratings, kW/kVA * Gasoline	LP	Nat. Gas
6.5RMY	01	120/240	20	3	60	6.5/8.1	6.3/7.8	5.3/6.6
6.5RMY	51	139/240	20	3	60	6.5/8.1	6.3/7.8	5.3/6.6
6.5RMY	51	127/220	21	3	60	6.5/8.1	6.3/7.8	5.3/6.6
6.5RMY	61	120/240	27	1	60	6.5/6.5	6.3/6.3	5.3/5.3
6.5RMY	71	277/480	10	3	60	6.5/8.1	6.3/7.8	5.3/6.6
6.5RMY	71	220/380	12	3	60	6.5/8.1	6.3/7.8	5.3/6.6
6.5RMY	81	120/208	23	3	60	6.5/8.1	6.3/7.8	5.3/6.6
6.5RFMY	01	110/220	18	3	50	5.5/6.9	5.3/6.6	4.7/5.9
6.5RFMY	51	110/190	21	3	50	5.5/6.9	5.3/6.6	4.7/5.9
6.5RFMY	61	110/220	25	1	50	5.5/5.5	5.3/5.3	4.7/4.7
6.5RFMY	71	220/380	10	3	50	5.5/6.9	5.3/6.6	4.7/5.9
6.5RFMY	81	120/208	19	3	50	5.5/6.9	5.3/6.6	4.7/5.9

* RATINGS: Standby ratings are continuous for the duration of any power outage. No overload capacity is specified at this rating. Prime ratings are continuous per BS 5514, DIN 6271, ISO-3046 and IEC 34-1 with 10% overload capacity one hour in 12 hours. All single-phase units are rated at 1.0 power factor. Larger generators may be used to meet special application requirements. Availability is subject to change without notice. Kohler Co. reserves the right to change the design or specifications without notice and without any obligation or liability whatsoever. Availability can be determined by contacting your local Kohler Co. dealer/distributor.

General

	6.5RMY (60 Hz)	6.5RMY (50 Hz)
Dimensions—L x W x H in. (mm)	39.76 x 23.18 x 25.32 (1010 x 589 x 643)	
Weight—lbs. (kg) (standard models)	350 (159)	
Air Requirements cfm (m^3/min.)		
—Cooling Air	540 (15.3)	450 (12.7)
—Combustion Air	25 (0.71)	21 (0.59)
Fuel Consumption Gasoline gph (Lph)		
—25% Load	0.57 (2.2)	0.49 (1.85)
—50% Load	0.72 (2.7)	0.61 (2.30)
—75% Load	0.97 (3.7)	0.83 (3.13)
—100% Load	1.27 (4.8)	1.18 (4.46)
Fuel Consumption Natural Gas cfh (m^3/hr.)		
—25% Load	54.3 (1.5)	46.1 (1.3)
—50% Load	69.8 (2.0)	57.5 (1.6)
—75% Load	86.7 (2.5)	68.3 (1.9)
—100% Load	109.7 (3.1)	85.5 (2.4)
Fuel Consumption LP Gas cfh (m^3/hr.)		
—25% Load	24.7 (0.70)	20.7 (0.59)
—50% Load	31.7 (0.90)	26.2 (0.74)
—75% Load	38.9 (1.10)	32.4 (0.92)
—100% Load	46.9 (1.33)	39.3 (1.11)

Generator

	6.5RMY (60 Hz)	6.5RMY (50 Hz)
Rated kW	See Specifications	
Rated voltage	See Specifications	
Rated amps	See Specifications	
Frequency Hz	60	50
Phase	Single-Phase or Three-Phase	
Number of leads	4 (Single-Phase) 12 (Three-Phase)	
Excitation method	Static Excited	
Voltage regulator type	PowerBoost™ IIIE (Single-Phase) PowerBoost™ V (Three-Phase)	
Coupling type	Direct	
Overbolt torque in. lbs. (Nm)	60 (7)	
Insulation (rotor and stator)	Class 155, Epoxy Varnish, Vacuum Impregnated	
Winding material	Copper	
Bearing, number and type	1, Replaceable Ball	
Circuit protection		
Controller	10-amp	
Voltage regulator	5-amp (Single-Phase only)	
Generator AC output	(Dependent on Voltage Configuration)	
Battery charging (available on specs above 140117)	15-amp Circuit Breaker, Auto-Resetting (located inside controller)	

Generator (continued)

	6.5RMY 1-Phase 60 Hz	6.5RMY 1-Phase 50 Hz
Rotor Resistance (ohms) (cold)	4.6-5.7	
Stator Resistance (ohms) * (cold)		
Leads: 1-2, 3-4	0.28	0.59
33-44	0.28	0.59
55-33	1.26	1.7
C1-CP, C2-CP	1.0	1.0
Stator Output Voltage with Separately Excited Rotor Using 12-Volt Battery (minimum)		
Leads: 1-2, 3-4	65	80
33-44	65	80
55-33	75	100
C1-CP, C2-CP	8	11
Rotor Field Voltage/Current Readings at Rated Output Voltage (Hot)		
No Load	26V/3.9A (63 Hz)	19V/2.7A (53 Hz)
Full Load	38V/5.6A (60 Hz)	33V/4.7A (50 Hz)

	6.5RMY 3-Phase 60 Hz	6.5RMY 3-Phase 50 Hz
Rotor Resistance (ohms) (cold)	4.6-5.7	
Stator Resistance (ohms) * (cold)		
Leads: 1-4, 2-5, 3-6, 7-10, 8-11, 9-12	1.0	
55-33	1.8	
C1-CP, C2-CP	0.9	
B1-B2	0.2	
Stator Output Voltage with Separately Excited Rotor Using 12-Volt Battery		
Leads: 1-4, 2-5, 3-6, 7-10, 8-11, 9-12	110	92
55-33	127	105
C1-CP, C2-CP	28	23
Rotor Field Voltage/Current Readings at Rated Output Voltage (Hot)		
No Load	16/3.0 (63 Hz)	19/3.4 (53 Hz)
Full Load	34/6.0 (60 Hz)	38/6.5 (50 Hz)

* Most ohmmeters will not give accurate readings when measuring less than 1 (one) ohm. The stator can be considered good if a low resistance reading (continuity) is obtained and there is no evidence of shorted windings (discoloration). Do not confuse a low resistance reading with a reading indicating a shorted winding.

Engine

	6.5RMY (60 Hz)	6.5RMY (50 Hz)
Manufacturer	Kohler	
Model	K-582	
Cycle	4	
Number of cylinders	2	
Compression ratio	7.1:1	
Displacement cu. in. (cc)	57.7 (945.7)	
Rated horsepower	12.7	10.6
RPM	1800	1500
Bore x stroke in. (mm)	3.50 x 3.0 (88.9 x 76.2)	
Valve material intake	Forged Steel	
Valve material exhaust	Stellite® (with Rotator)	
Valve clearance in. (mm) Intake Exhaust	 0.008-0.010 (0.20 -0.30) 0.017 -0.020 (0.43-0.51)	
Cylinder block material	Cast Iron	
Cylinder head tightening torque ft. lbs. (Nm)	35 (47.5)	
Cylinder head material	Aluminum Alloy	
Piston rings	2 Compression/1 Oil	
Crankshaft material	Ductile Iron	
Bearings	Replaceable Sleeve	
Governor	Electronic	
Lubrication system	Full Pressure	
Oil capacity (w/filter) U.S. qts. (L)	4 (3.8)	
Oil type (API)	SC, SC, SE, SF	
Oil pressure psi (kPa)	40-65 (276-448)	
Fuel system	Gasoline, LP Gas, or Natural Gas (Standard and optional Fuel Systems Are available)	
Fuel type (gasoline)	86 Octane Unleaded	
LP/Natural gas minimum supply pressure	7-11 Inches Water Column 4-6 oz. psi	
Battery voltage	12	
Battery ground	Negative	
Spark plug type	Champion RH10	
Spark plug gap in. (mm) Gasoline LP gas/natural gas	 0.025 (0.64) 0.018 (0.46)	
Spark plug tightening torque ft. lbs. (Nm)	18-22 (24-30)	
Ignition system	Electronic	
Starter motor cranking current at 70° F	Bendix Automotive Type 100 Amps	
Cooling system	Air-Cooled	

Engine Features

The 6.5RMY is powered by the Kohler K-582 twin-cylinder, air-cooled, four-cycle gasoline engine.

- One-side serviceability of air cleaner, carburetor, oil fill, dipstick, and oil drain.
- Internally vented crankcase breathers reduce emissions of unburned hydrocarbons.
- Operates on leaded or unleaded fuel with octane rating of 86 or higher.
- Engine shutdown control prevents dieseling on shutdown.
- Combination oil fill and dipstick eases maintenance.
- Low oil pressure cutout shuts engine down to prevent failure.
- Electronic ignition provides efficient operation with less maintenance than mechanical system.
- Electronic governor ensures Hz output is maintained at desired frequency.
- Anti-icing module prevents moisture freezing in fuel delivery system.
- Overspeed shutdown prevents governed frequency from exceeding 70 Hz.

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 in the Operation Manual. 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 Microprocessor 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 Distributor/Dealer 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 1-2.

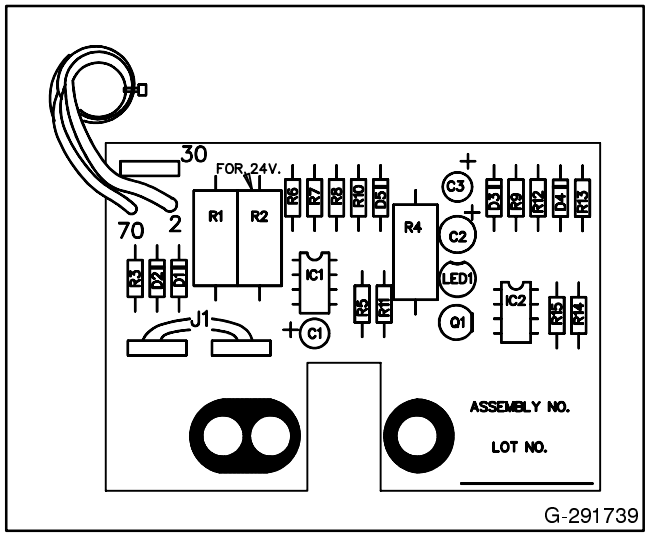


Figure 1-2. Overvoltage Kit

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 1-3.

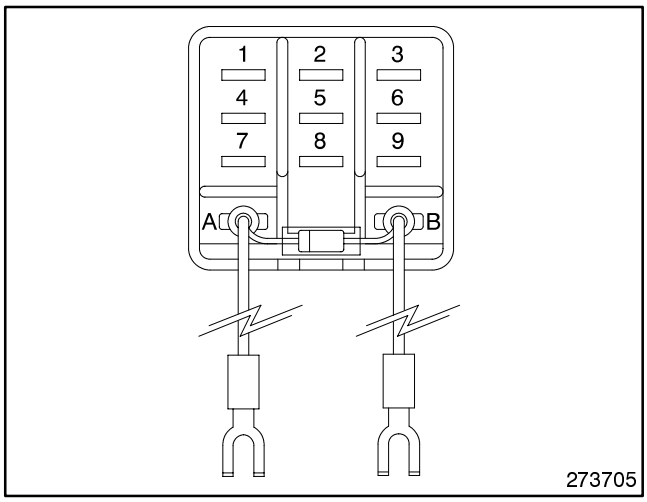


Figure 1-3. Run Relay Kit

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 1-4. 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.

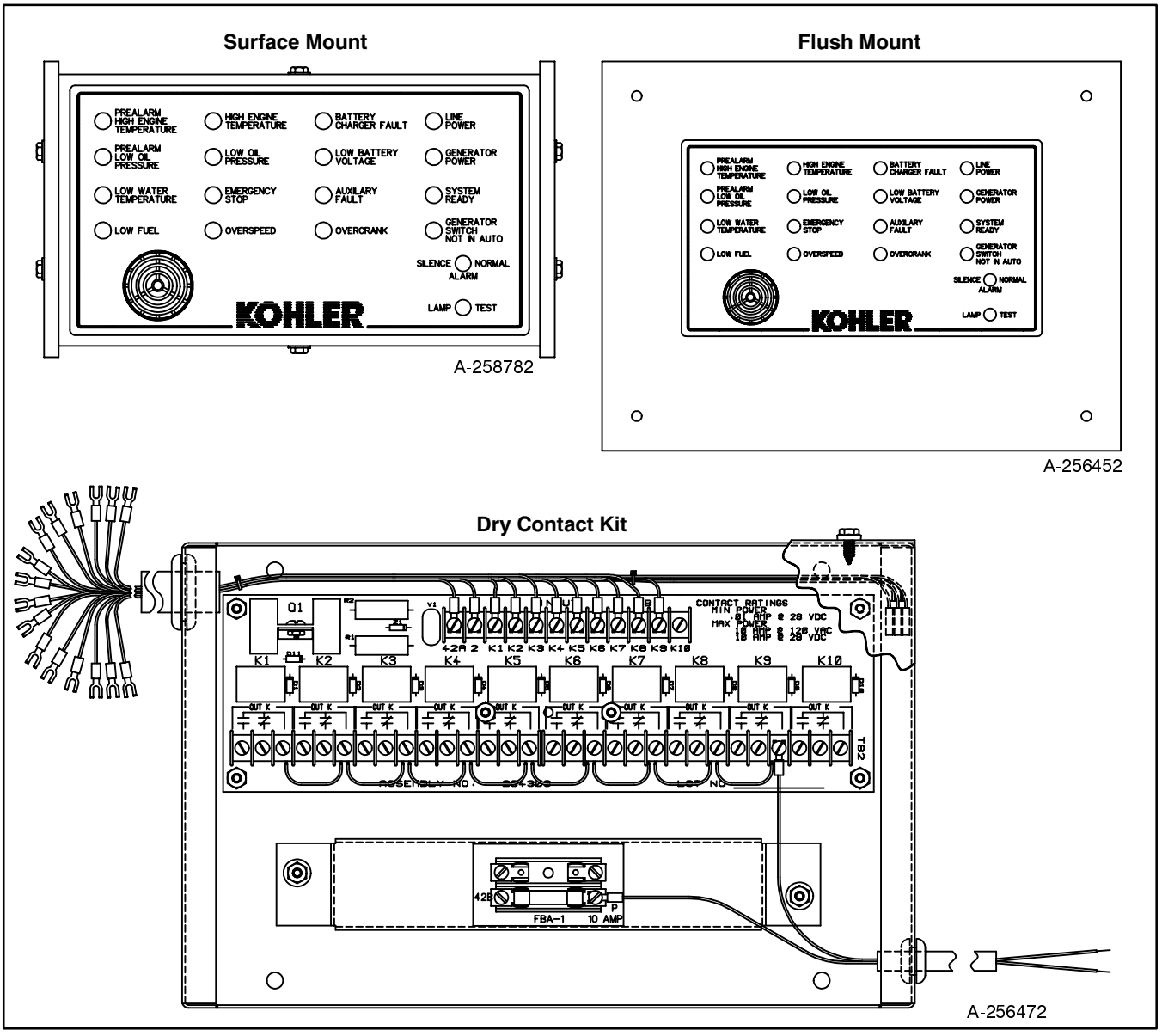


Figure 1-4. Remote Annunciator

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 1-5.

NOTE

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

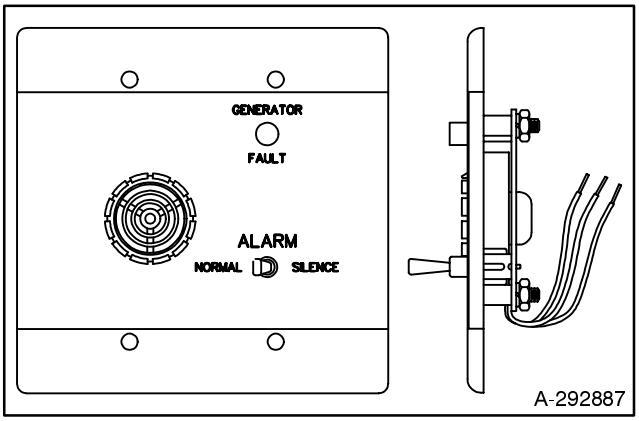


Figure 1-5. Audio-Visual Alarm

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 1-6.

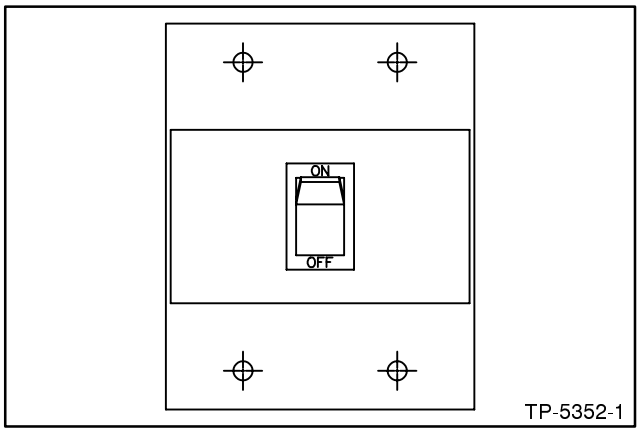


Figure 1-6. Line Circuit Breaker

Remote Emergency Stop Kit (microprocessor controller)

The emergency stop kit allows immediate shutdown of the generator set from a remote location. See Figure 1-7. 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.

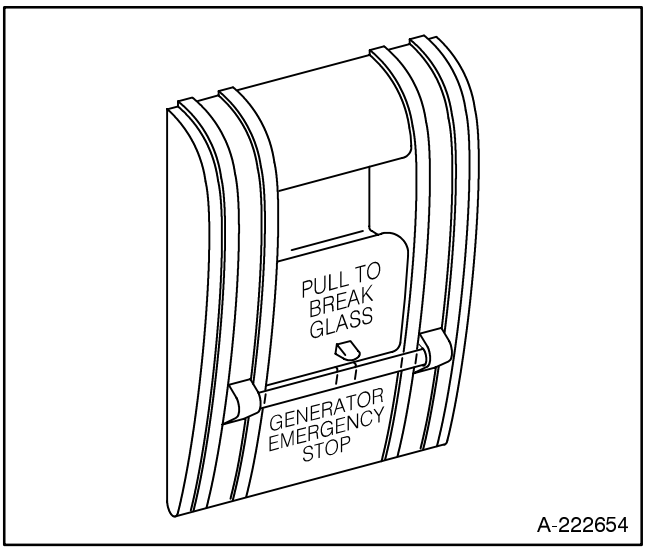


Figure 1-7. Emergency Stop Kit

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 1-8. 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

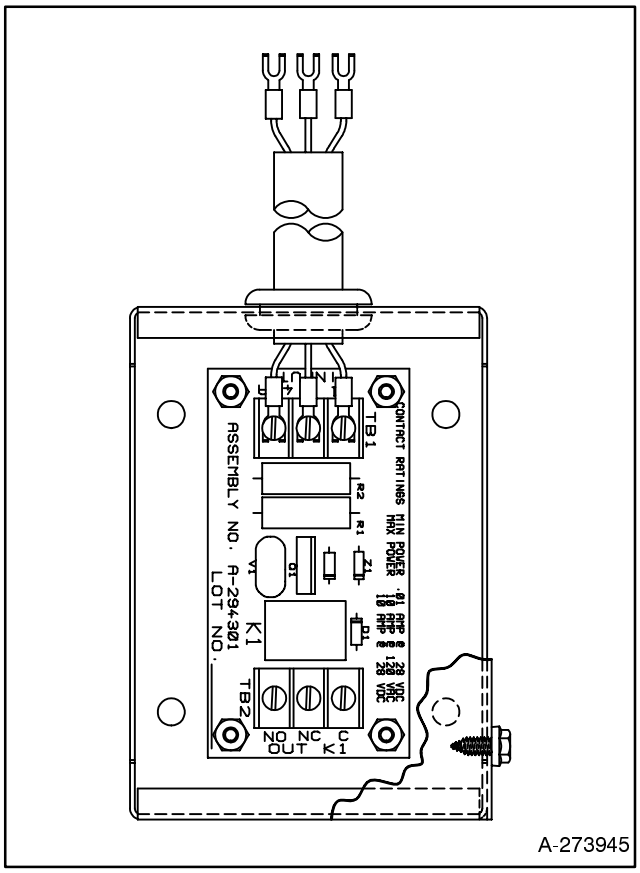


Figure 1-8. Single-Relay Dry Contact Kit

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 1-9.

Typical Contact Kit Output Connections:

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

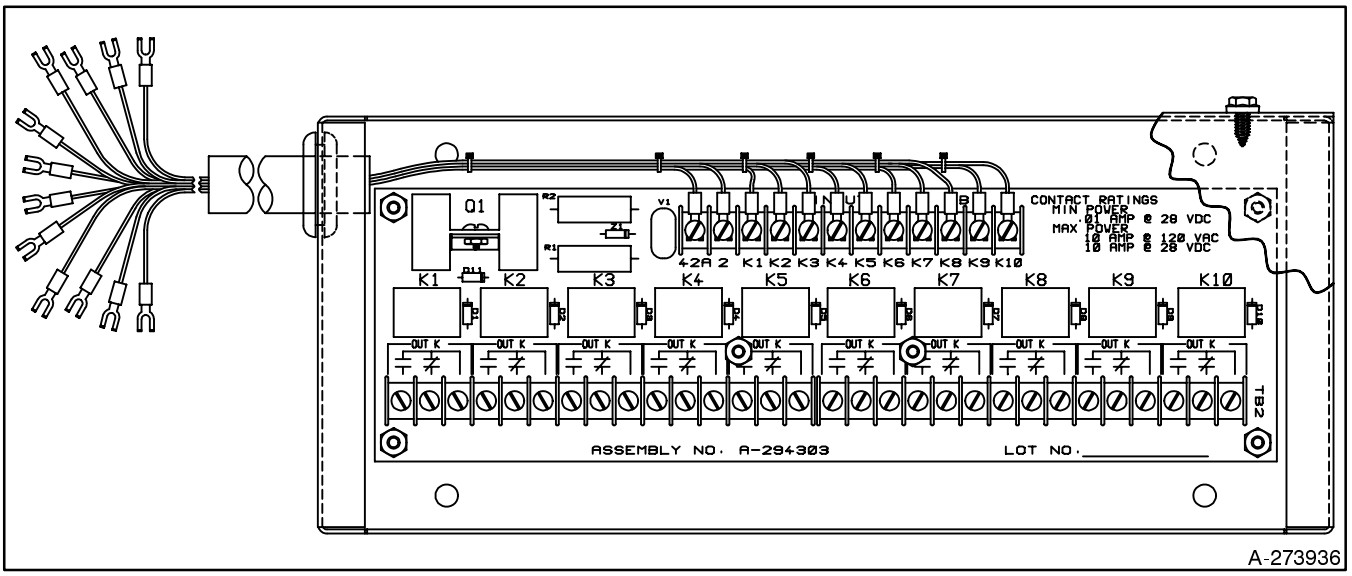
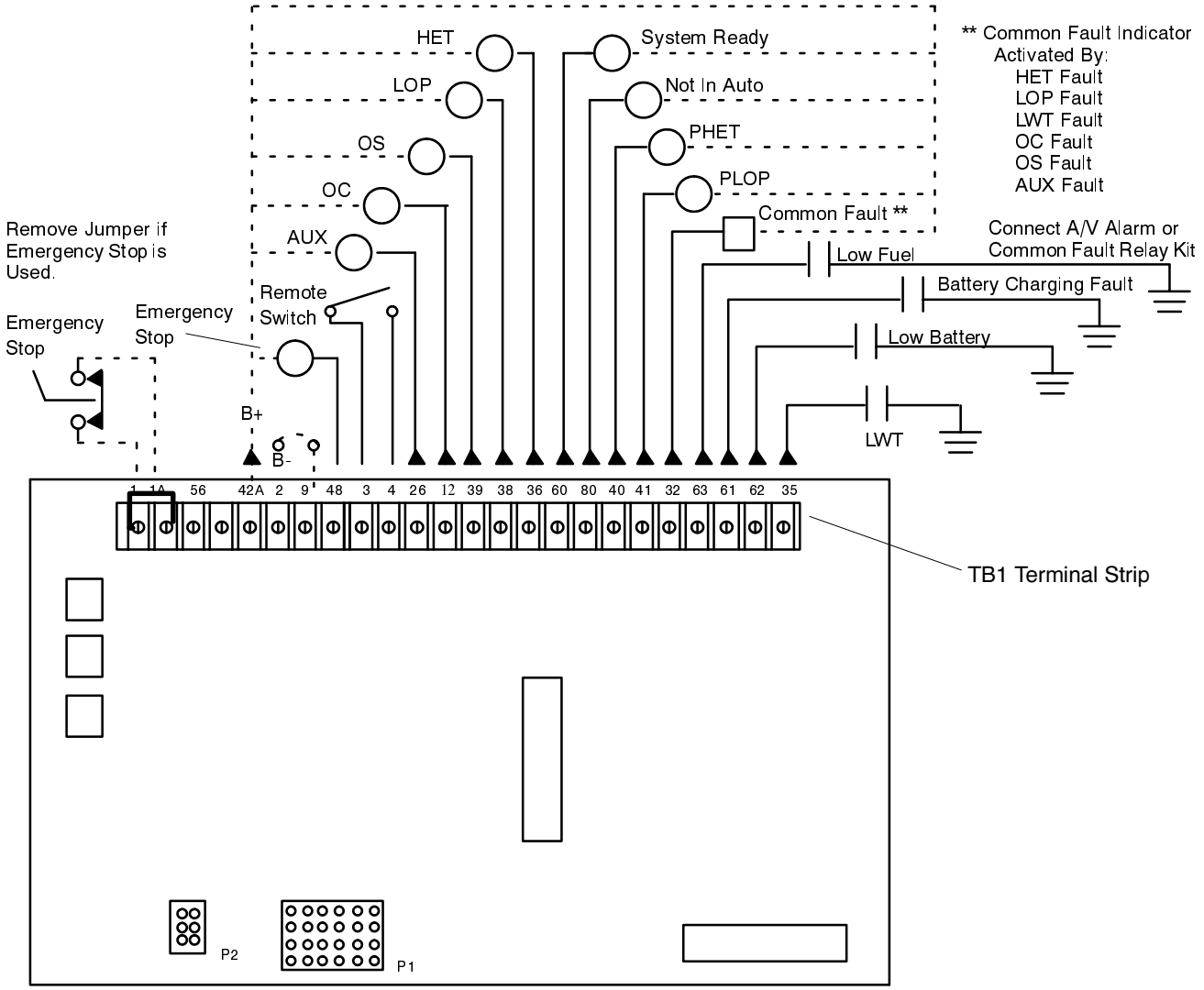


Figure 1-9. Ten-Relay Dry Contact Kit

Accessory Connection (microprocessor controller)

The Decision-Maker™ 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 1-10. Controller TB1 Terminal Strip Connections

Notes

Section 2. Operation

Refer to the Operation Manual for operating procedures.

Notes

Section 3. Scheduled Maintenance

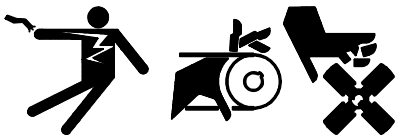
Introduction

Schedule routine maintenance using the Service Schedule following and the hourmeter located on the generator set controller. If the generator is subject to extreme operating conditions, service the unit more frequently. Instructions to perform most of the scheduled services are provided in the following pages.

Refer to the Generator Operation Manual for general maintenance procedures and the Engine Service Manual for engine overall procedures not provided in this manual. If the service schedule in this generator service manual differs from that of the generator operation manual, use the service schedule which provides the more stringent requirements.

Perform items in the maintenance schedule marked with an asterisk (*) more often if the generator set is operated in dirty, dusty conditions. Have items identified with asterisks (**) performed by an authorized Kohler service distributor/dealer.

⚠ 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.

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

⚠ WARNING

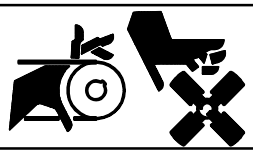
Hazardous voltage.

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.

NOTE

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.

NOTE

Perform the items listed in the service schedule at the designated intervals for the life of the generator set. For example, an item serviced every 100 hours or 3 months must also be serviced after 200 hours or 6 months, 300 hours or 9 months, etc. The generator eventually accumulates enough hours to warrant a complete overhaul. The exact time at which extensive service will be necessary cannot be predicted. However, rough operation, lack of power, and excessive oil use indicate serious generator set problems. As part of a preventative maintenance program, service the engine (clean cylinder head, inspect valves, check compression, etc.) and generator (replace bearing, inspect wiring, remove debris, etc.) at the earliest indication that a serious problem exists.

Service Schedule

Perform Service at Intervals Indicated (X)	Before Each Start-up	Every 50 Hours or 6 Months	Every 100 Hours or 12 Months	Every 500 Hours
Check exhaust outlet	X			
Check oil level	X			
Check fuel supply	X			
Keep cooling air inlets and outlets clean	X			
Remove loose dirt from compartment	X			
Check electrolyte level in battery	X			
Check air cleaner (replace if dirty)		X		
Change lube oil (change oil after first five hours of operation)			X	
Replace lube filter			X	
Regap or replace spark plugs			X	
Check battery specific gravity			X	
Check and tighten electrical connections			X	
Check and tighten mounting bolts and vibromounts			X	
Blow dust out of generator			X	
Check valve-tappet clearance				X*
Service cylinder heads**				X*
Check compression				X
Replace fuel filter (gasoline-fueled models only)				X

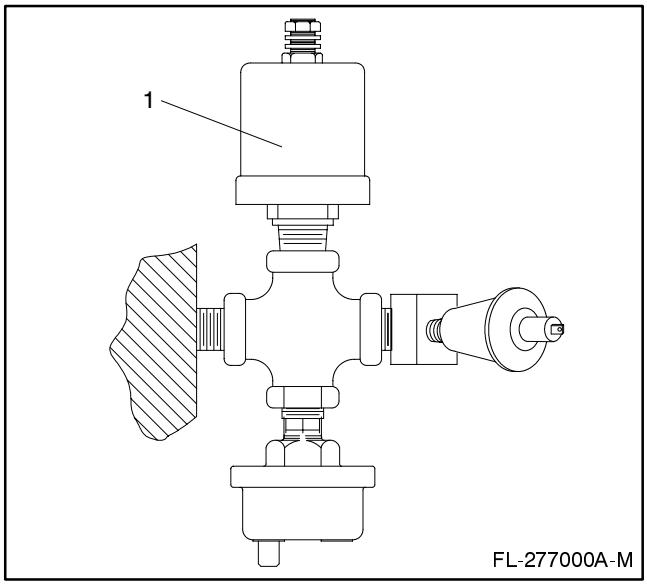
* It is recommended that service be performed by an authorized service distributor/dealer.
** Unleaded gasoline is recommended. If leaded gasoline is used, service cylinder heads every 250 hours.

Lubrication System

The engine used with the generator set has a positive pressure lubrication system and low oil pressure shutdown.

Low Oil Pressure Shutdown

The low oil pressure shutdown feature protects the engine against internal damage if the oil pressure drops below 14 psi ± 2 psi (96.5 kPa ± 13.8 kPa) because of oil pump fault or other malfunction. Low oil pressure shutdown does not protect against damage caused by operating with the oil level below the safe range—it is not a low oil level shutdown. The only protection against running out of oil is to check the level regularly and to add oil as needed. Location of the low oil pressure (LOP) switch is shown in Figure 3-1.



1. Switch

Figure 3-1. Low Oil Pressure Switch

Oil Check

Check crankcase oil level daily or before each start. To check oil level, remove oil cap/dipstick assembly and wipe dipstick clean. See Figure 3-2. Reposition dipstick in crankcase on top of hole (do not turn plug in) before removing for a reading. Oil level should read between L and F on dipstick. Do not operate set if oil level exceeds F or registers below L on dipstick. See Figure 3-3.

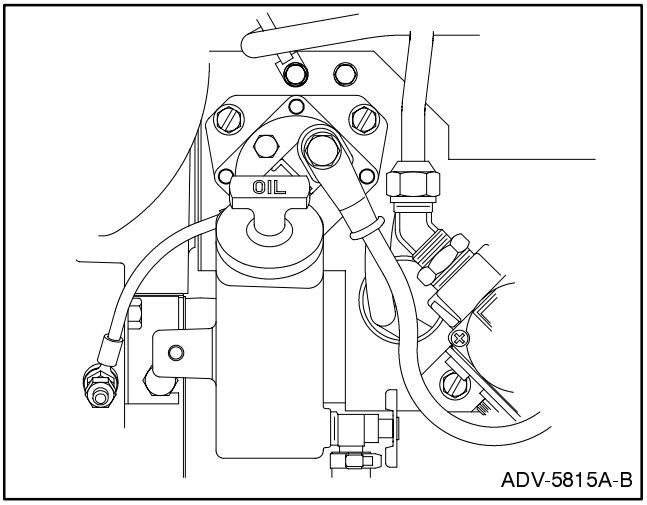


Figure 3-2. Oil Check

NOTE

Do not check oil level when the set is in operation. The engine must be stopped and on a level surface when checking oil. Shut down the generator set and wait several minutes before checking oil to obtain the most accurate oil reading.

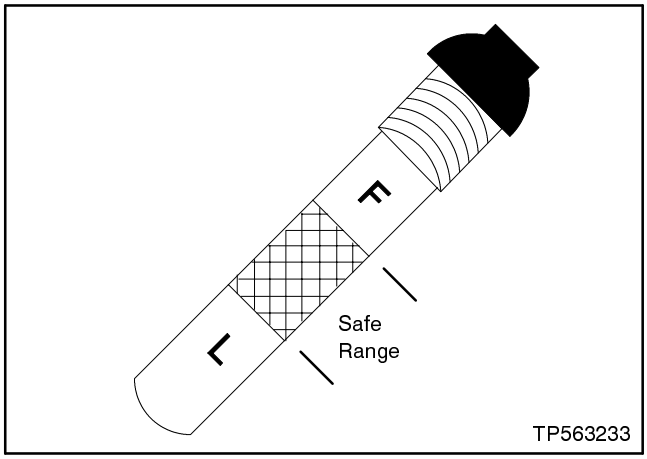


Figure 3-3. Lube Oil Level

Oil Change

Break-in Period Oil Recommendations

Generator set engines may be shipped dry, the oil used in factory testing having been drained. Before operating a new set, fill the engine crankcase to specified capacity with an oil having a viscosity appropriate for your climate. Do not use synthetic oils during the first five hours of operation or the rings may not seat correctly. Change the break-in oil immediately after the first five hours of operation. See Oil Type.

On a new engine, change the oil after the first five hours of operation and thereafter at 100 hour intervals or 12 months, whichever occurs first. Replace the oil filter at every oil change. Whenever possible, drain the oil while it is still warm.

Oil Capacity: 4 U.S. Quarts (3.8 L)*

*An additional 1/2 pint (0.23 L) is required when replacing oil filter. To avoid overfilling, check dipstick before adding the last quart of oil. Add oil gradually and check oil level several times. Recheck oil level after starting unit and add oil as necessary to bring level up to MAX mark.

Oil Type

High quality detergent oils meeting the requirements of SAE service class SC, SD, SE, and SF are recommended for use in the Kohler K-582 engine. Use straight weight oils as specified. If using multi-viscosity oil be aware of the resulting increase in oil consumption and combustion deposits when used in temperatures above 32°F (0°C). Base oil weight selection on anticipated air temperature before the next oil change. Consult the SAE Viscosity Grade chart, see Figure 3-4.

Recommended SAE Viscosity Grades

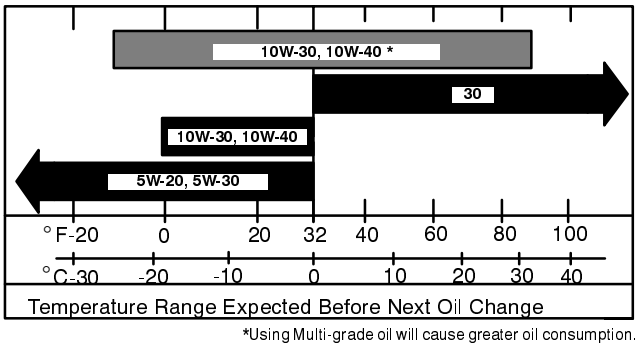


Figure 3-4. Oil Selection

Cooling System

To prevent damage to the generator set from overheating, keep the cooling air inlets to the compartment clean and unobstructed at all times. Cooling air is brought into the compartment from the cutouts in the skid and the weather housing louvers.

A fan on the rotor of the generator draws cooling air into the compartment through the generator end bracket cooling slots and expels it at the engine/generator adapter. The engine of the generator set features an Air-Vac™ reverse flow cooling system. Fins on the engine flywheel pull cooling air past the fins of the cylinder heads and discharge heated air downward and out of the compartment through the discharge chute. See Figure 3-5.

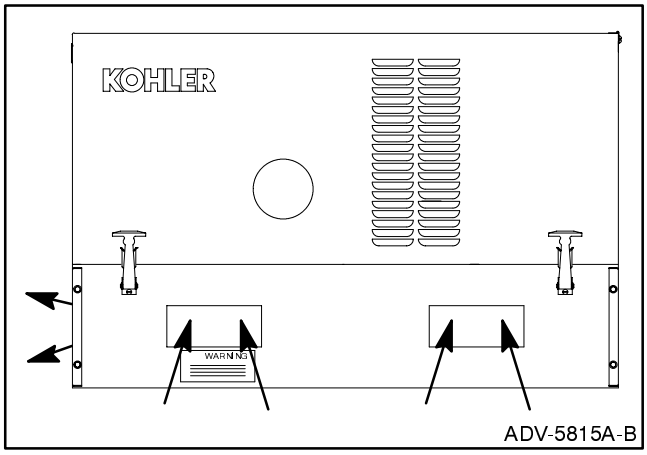


Figure 3-5. Cooling Air Circulation

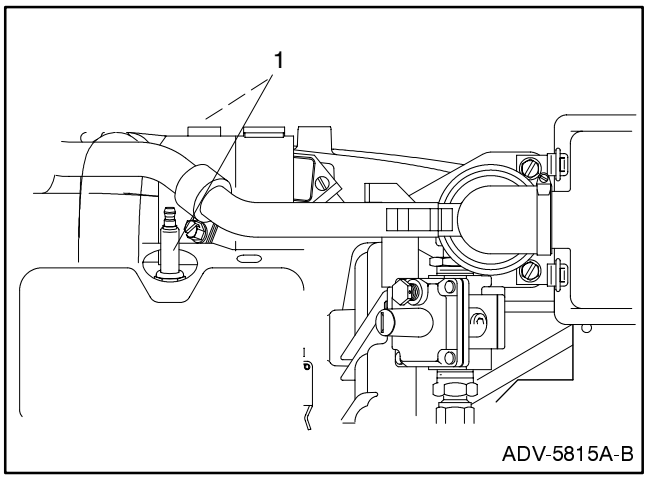
Ignition System

Spark Plugs

Every 100 hours remove both spark plugs and check condition, see Figure 3-6. Reset gap or replace spark plugs if needed. A light deposit of gray or tan material on the spark plug electrodes indicates correct generator set operation. A dead white, blistered coating indicates overheating. A black (carbon) coating indicates an overrich fuel mixture caused by a clogged air cleaner or incorrect carburetor adjustment.

NOTE

Do not sandblast, wire brush, scrape, or otherwise service a spark plug in poor condition—obtain best results with a new spark plug. Use only resistor type spark plugs. Set spark plug gap at 0.025 in. (0.64 mm) on gasoline fueled sets and 0.018 in (0.46 mm) on LP gas and natural gas fueled sets. Tighten spark plugs to 18-22 ft. lbs. (24-30 Nm) when installing.



1. Spark plugs

Figure 3-6. Spark Plug Locations

Gasoline Fuel System

Specification

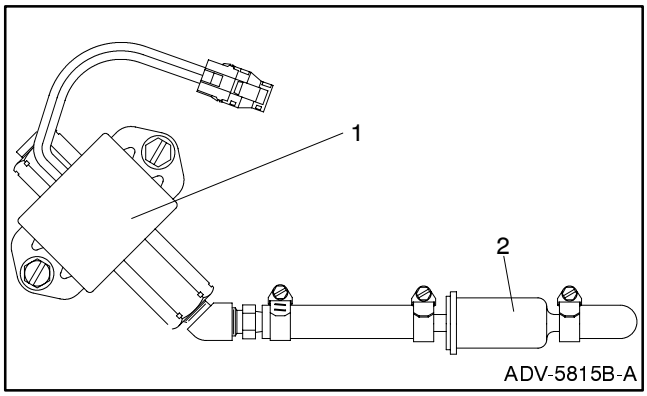
Use only clean, fresh regular grade unleaded gasoline with a pump sticker octane rating of 86 or higher in the U.S.A. In countries using the research rating method, fuel should be 90 octane minimum.

Use unleaded gasoline because it leaves fewer combustion chamber deposits. Regular grade leaded gasoline may also be used; however, be aware that the combustion chamber and cylinder head will require more frequent service. Gasohol containing no more than 10% ethanol can be used if unleaded gasoline is unavailable. Never use gasohol containing more than 10% ethanol or gasoline containing Methanol. Do not mix oil with the fuel.

Use fresh gasoline to ensure it is blended for the season and to reduce the possibility of gum deposits forming that could clog the fuel system. Do not use gasoline left over from the previous season.

Fuel Filter

The generator set utilizes an in-line type fuel filter located before the electric (solid-state) fuel pump. Replace the filter every 500 hours of running time or when rough operation indicates an engine tune-up may be necessary. Location of the fuel pump and fuel filter are shown in Figure 3-7.



1. Fuel pump
2. Fuel filter

Figure 3-7. Gasoline Fuel Pump and Fuel Filter

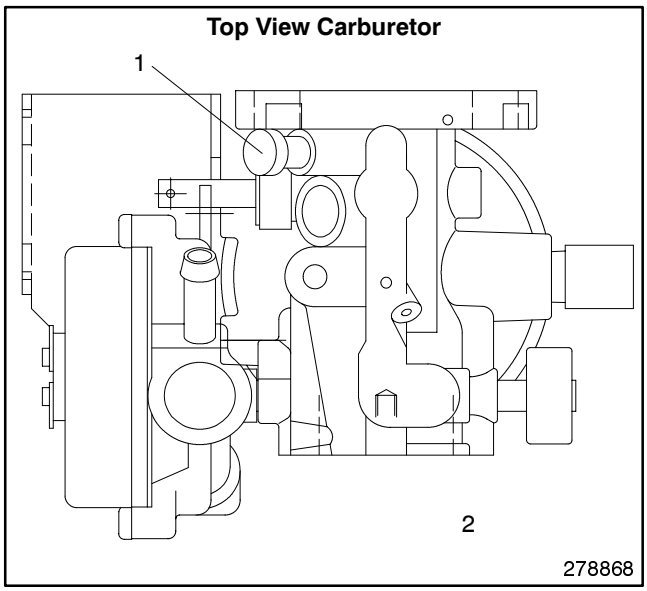
Carburetor Adjustments

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

Lack of power and black sooty exhaust smoke usually indicate that the fuel mixture is too rich. An overrich mixture may be caused by a clogged air cleaner or incorrectly adjusted choke. Always check the air cleaner before readjusting the choke or carburetor. If the engine skips (misses) or backfires, the fuel mixture may be too lean. Refer to Figure 3-8 for adjustment needles locations.

Turning the adjusting needles in (clockwise) decreases the supply of fuel to the carburetor providing a leaner fuel/air mixture.

Turning the adjusting needles out (counterclockwise) increases the supply of fuel to the carburetor providing a richer fuel/air mixture.



1. Idle fuel needle
2. Main fuel needle

Figure 3-8. Carburetor Adjustment Needles

Main and Idle Fuel Mixture

1. Stop the engine. Turn the main fuel and idle fuel adjusting needles in (clockwise) until they bottom lightly.

NOTE

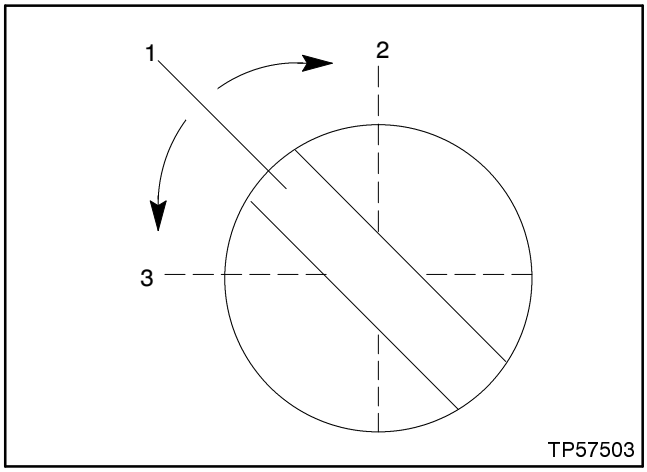
The ends of the main fuel and idle fuel adjusting needles are tapered to critical dimensions. Damage to needles and seats will result if the needles are forced.

2. **Preliminary Settings:** Turn the main fuel and idle fuel adjusting needles **out** (counterclockwise) as follows:
   Main Fuel Needle: 2 1/2 Turns
   Idle Fuel Needle: 1 1/2 Turns
3. Start the engine and run at 1/2 load for 5-10 minutes to warm up to operating temperature. The engine must be warm before making final settings.
4. **Final Setting—Main Fuel:** Place engine 3/4 to full load. Turn main fuel adjusting needle in (clockwise) from preliminary setting until the engine does not operate smoothly. Note the position of the needle.
5. Next turn the adjusting needle out (counterclockwise) 1/4 turn. See Figure 3-9.

NOTE

At higher elevations the main fuel adjustment needle will require leaning.

6. **Final Setting—Idle Fuel:** Set idle fuel adjusting needle using the same procedure as in step 4.
7. STOP generator set when adjustments are complete.

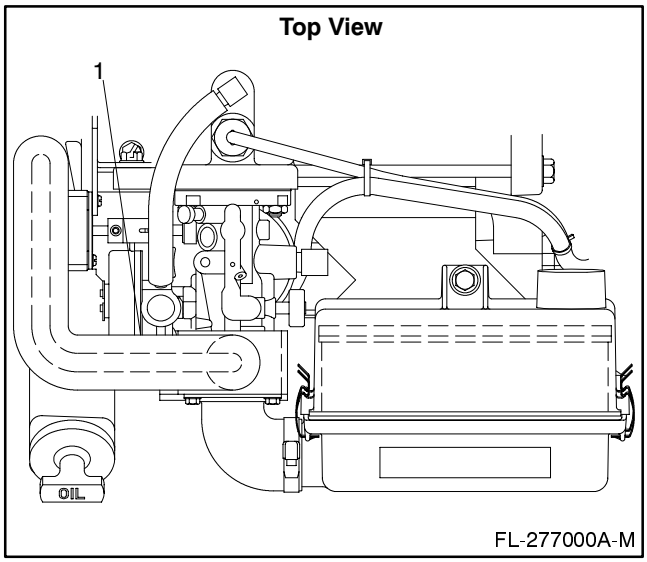


1. Fuel adjusting screw
2. Lean
3. Rich

Figure 3-9. Carburetor Adjustment

Choke Adjustments

A thermo-electric automatic choke is used to enrich the gasoline fuel mixture during starting. The choke automatically closes as the ambient temperature cools or as the engine temperature decreases. As the engine warms, the coils inside the choke allow the choke plate to open. If readjustment is needed, loosen the two screws securing the choke bracket to the carburetor and shift the position of the choke assembly, see Figure 3-10. When correctly set, the choke plate will be within 5 to 10 degrees of full open at approximately 70°F (21°C).



1. Casting mark

Figure 3-10. Automatic Choke Adjustment

Choke Adjustment Procedure for Operation Above 10°F (-12.2°C)

The choke is factory adjusted for operation at temperatures above 10°F (-12.2°C). No further adjustment should be necessary unless the setting has been tampered with or the adjustment setting is unknown.

1. Where the choke casting mark meets the black plastic cover of the choke, make a scribe mark on the choke black cover. See Figure 3-10.
2. Loosen the two choke adjusting screws and rotate choke cover counterclockwise towards leaner setting (follow direction of arrow on choke).
3. When the distance between the scribe mark on the black cover and the casting mark is 5/16 in. (8 mm), tighten the two choke adjusting screws.

Choke Adjustment Procedure for Operation Below 10°F (-12.2°C)

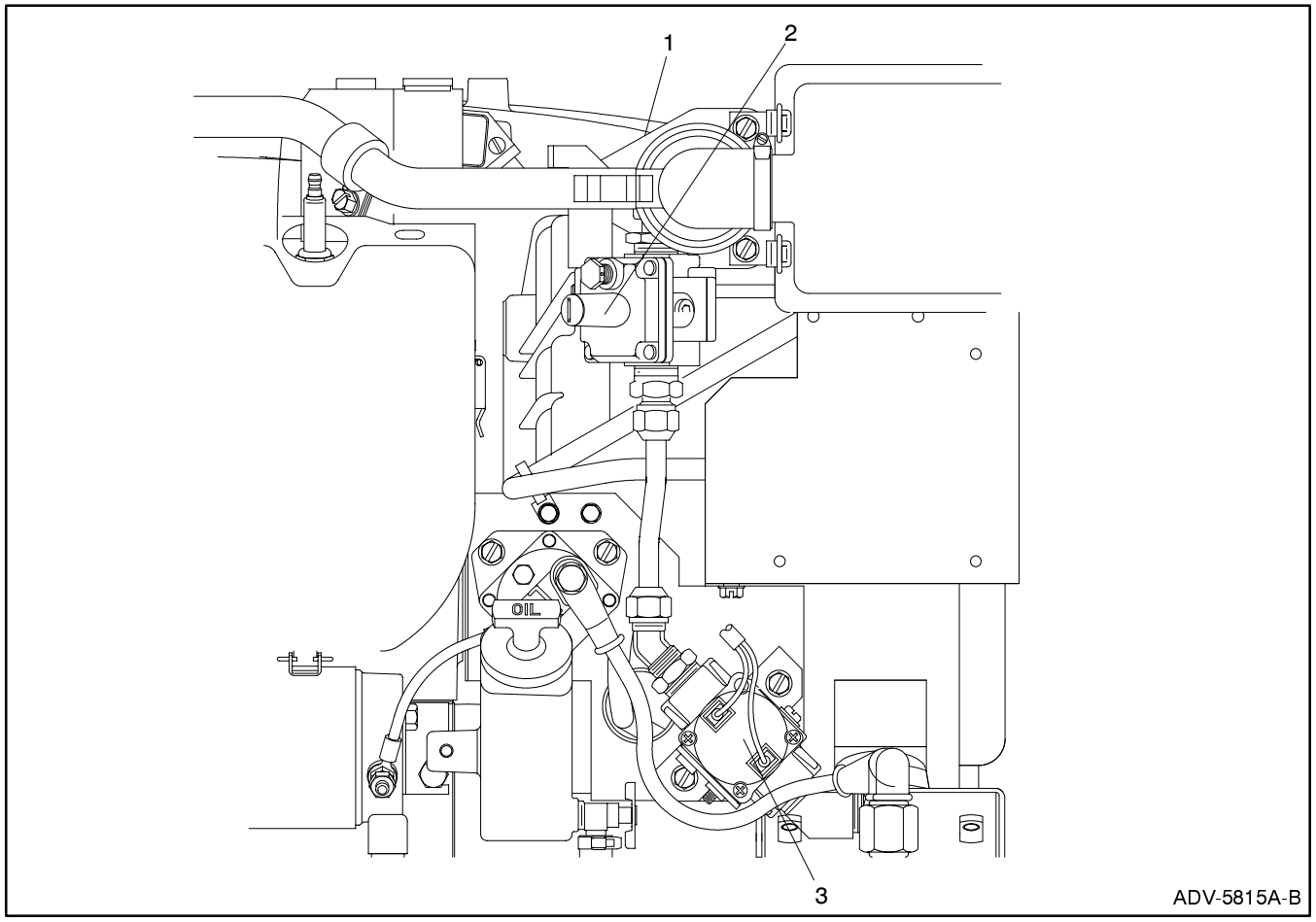
Perform the following procedure if the generator set is operated at temperatures below 10°F (-12.2°C).

1. If scribe mark has been made on the choke black cover, loosen the two choke adjusting screws and rotate choke cover clockwise (opposite direction of arrow on choke).
2. When the scribe mark on the black plastic cover of the choke and the choke casting mark line up, tighten the two adjusting screws.

Gaseous Fuel Systems

Specification

The gaseous fuel system uses propane LP vapor gas or natural gas. The gaseous fuel system consists of a fuel shutoff valve, a secondary fuel regulator, and a carburetor that adjusts the mixture of fuel and air for correct combustion. See Figure 3-11.



1. LP gas carburetor
2. Secondary fuel regulator
3. Fuel shutoff valve

Figure 3-11. Gas Fuel System

The gas supply pressure should not exceed six ounces. To check inlet pressure, remove plug on fuel inlet of gas regulator. Insert ounce pressure gauge or manometer. Adjust pressure to 4-6 ounces or 7-11 inches water column; adjust inlet pressure on primary regulator (pressure greater than 10 ounces will not allow electric fuel valve to open).

NOTE

If using a removable fuel container as a fuel source, prevent fuel leakage during a container change by using a quick-close coupling on the fuel line or a check valve installed in the fuel line.

NOTE

A hydrostatic relief valve is also required between the container shutoff valve and the automatic shutoff valve on the generator set.

⚠ WARNING

Explosive fuel vapors.
Can cause severe injury or death.

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

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 Gas/Natural Gas Conversion

Fuel regulators are compatible with both natural gas and LP gas. Install the spring and retainer when using 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.

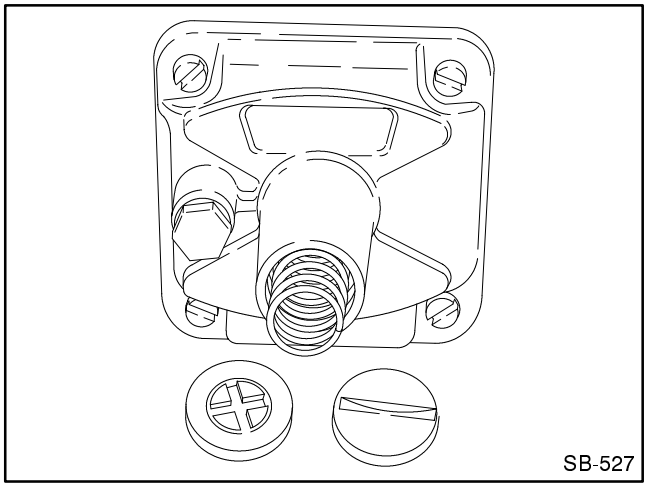


Figure 3-12. LP Vapor Gas Fuel Regulator

Carburetor Adjustments

Main Fuel Mixture

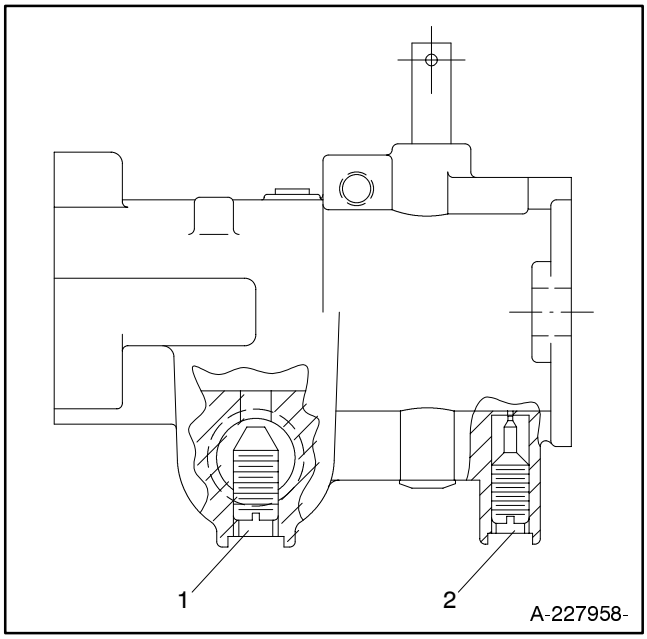
Some generator sets may be equipped with an emission certified engine. Emission certified engines may be fitted with carburetors that have no adjustments.

For preliminary setting turn the main fuel valve in a clockwise direction until it bottoms lightly (do not force), then back out 1 turn. See Figure 3-13. With the engine thoroughly warmed up and running at rated rpm under full load, turn main fuel valve in until the engine slows down (lean setting); then turn valve out until the engine regains full speed (about 1/8 turn). When correctly adjusted, the engine will operate with steady governor action. Incorrect adjustment (rich setting) causes incorrect operation of the vaporizer and excess fuel consumption.

Idle Fuel Mixture

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

The idle system functions only at part and no-load conditions. For this reason, the idle setting has only a momentary effect. To adjust, stop the engine and then turn the idle fuel screw all the way in (clockwise) then back out 1/4 turn. Adjust for correct no-load operation.



1. Main fuel adjustment
2. Idle fuel adjustment

Figure 3-13. Gas Carburetor Adjustments

Air Cleaner

The engine is equipped with a dry-type air cleaner. **Gasoline models only (if so equipped):** Place the lever on the side of the air cleaner housing in the correct temperature position for ease of starting. Place lever in up position for winter and down for summer. Gasoline models without the air cleaner lever incorporate an automatic anti-icing system.

Every 50 hours (more often if operating under extremely dusty or dirty conditions) remove element and service by tapping element lightly against flat surface to dislodge loose surface dirt. Do not clean in any liquid or blow out with compressed air as this will ruin filter material in element. Replace element if dirty, bent, or damaged. See Figure 3-14.

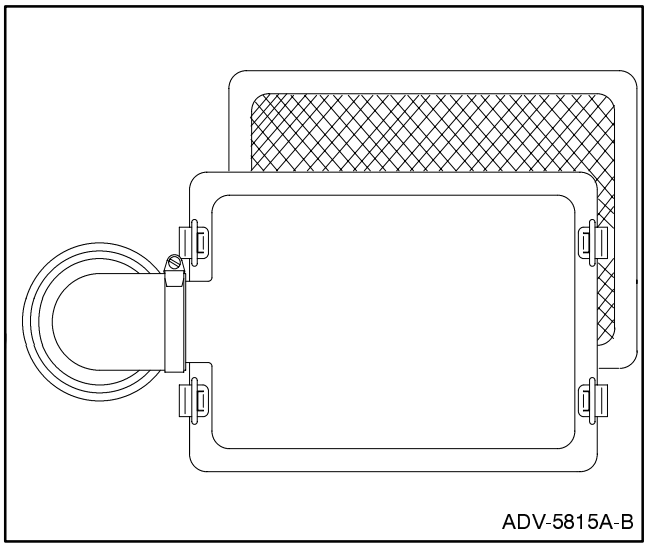
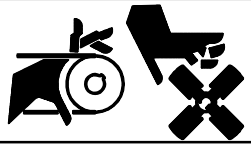


Figure 3-14. Air Cleaner

Valve Adjustment

At the specified interval (or sooner if noticing excessive valve train noise), adjust valve lash. Check clearance between the valve stems and tappets. Stop and cool engine to ambient temperature to accurately gauge and adjust valve clearances. Use the following procedure to adjust. Refer to the Engine Service Manual for more information.

⚠ 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.

NOTE

Stop and cool engine to ambient temperature to accurately gauge and adjust valve clearances.

NOTE

The piston must be at top dead center (TDC) of the compression stroke to measure valve-to-tappet clearance. Rotate the flywheel and observe the movement of the valves and tappets to determine if a cylinder is at TDC.

For example, if while rotating the flywheel movement is noticed in the No. 2 side valve box—the opposite cylinder (No. 1 side) will be at TDC and valve-to-tappet clearance can be measured.

Rotating the flywheel one complete revolution (360°) will then cause movement in the No. 1 side valve box—the No. 2 side cylinder will be at TDC, enabling measurement of valve-to-tappet clearance for that side.

Clearance Specifications

Intake

0.008-0.010 in. (0.20-0.25 mm)

Exhaust

0.017-0.020 in. (0.43-0.51 mm)

1. Turn engine over until piston in #1 cylinder (closest to flywheel) is at top dead center on compression—in this position, both valves will be closed and cam will have no affect on tappet.
2. Measure clearance between valve stem and tappet with a feeler gauge, see Figure 3-15. To adjust, turn adjusting screw on tappet in or out until correct clearance is attained.
3. After adjusting valve-tappet clearance on #1 cylinder, turn engine over until #2 cylinder is at TDC on compression and repeat adjustment on this cylinder.
4. After valves are in adjustment, position new head gasket and reinstall cylinder heads. Make sure head bolts are tightened in the specified sequence and to the torque value in Cylinder Head Tightening.

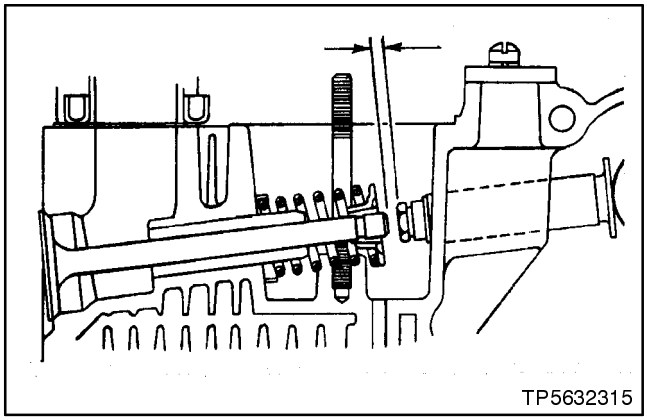


Figure 3-15. Valve-Tappet Clearance

Cylinder Head Tightening

At the specified interval, remove the cylinder heads from the engine and service. Remove carbon deposits from combustion chamber in head. Scrape and remove carbon with a sharp piece of wood or plastic. Use wood or similar material to avoid scratching aluminum surfaces of the cylinder head. Always use a new cylinder head gasket. Tighten head bolts in the sequence and to the torque value specified. See Figure 3-16 and Section 1, Specifications.

NOTE

If the engine operates on leaded fuel or under certain conditions, such as continued light load or relatively constant speed, carbon may build up more rapidly. If engine shows early indications of this, such as heavy deposits of carbon on spark plug electrodes, service the heads more frequently. See Service Schedule NOTE concerning leaded fuel.

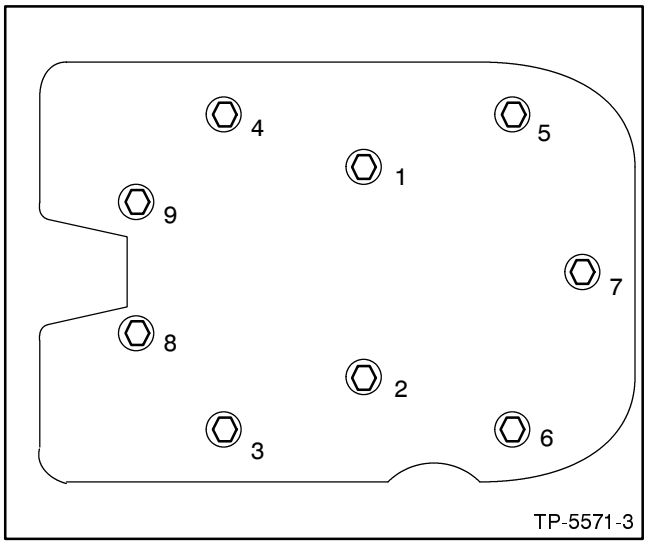


Figure 3-16. Cylinder Head Fastener Tightening Sequence

Generator Service

Under normal conditions, generator service will not be required on a regular basis. If operating under extremely dusty and dirty conditions, use dry compressed air to blow dust out of the generator at frequent intervals. 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. Have an authorized service distributor/dealer perform generator service.

Wattage Requirements

If the generator rated capacity is exceeded, the circuit breaker(s) located in the controller trip to protect the generator against damage. This could be caused by a short in the AC circuit in the electrical system or by having too many appliances on at the same time resulting in an overload condition. If the circuit breaker(s) trip, the set may continue running but there will be no AC output to the protected circuit. Before resetting the circuit breaker(s), turn off some of the appliances and lights to bring the load down within the rated limits of the set. If this is done and the circuit breaker(s) trips again after being reset, a short circuit is indicated. In this event, turn off the set and have a qualified electrician locate and correct the cause of the short circuit.

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.

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.

Notes

Section 4. General Troubleshooting

Use the following tables as a quick reference in troubleshooting individual problems. Generator set faults are listed by specific groups and include likely causes and remedies. Also listed is the source of more detailed information needed to correct a problem. These sources include various sections of this manual, the Operation and Installation Manual (TP-5631), the Wiring Diagrams Manual, and the Engine Service Manual. Corrective action and testing in many cases requires knowledge of electrical and electronic circuits. Service should be done only by an authorized service distributor/dealer. Incorrect repair by unqualified personnel can lead to additional failures.

Problem	Possible Cause	Corrective Action	Reference
Engine			
Will not crank (dead)	Controller voltage supply fuse blown	Replace fuse	Section 5. Controller Troubleshooting
	Battery disconnected or incorrectly connected	Check connections	Wiring Diagrams Manual
	Weak or dead battery	Check electrolyte level and specific gravity (batteries with filler caps only). Perform load test	Operation Manual
		Recharge or replace: check battery charger operation. Check battery charging circuit* (circuit breaker module, and wiring, if equipped).	Section 7. Component Testing and Adjustment
	Corroded or loose battery connections	Clean or replace	Operation Manual
	Defective starter/starter solenoid	Replace	Engine Service Manual
	Defective start/stop switch	Check continuity	Section 7. Component Testing and Adjustment, Wiring Diagrams Manual
	Open wiring, terminal pin, foil, etc.	Check continuity	Section 7. Component Testing and Adjustment, Wiring Diagrams Manual
	Remote start/stop switch not operating correctly	Check wiring and connection to controller. If controller start/stop switch functions, replace/repair remote switch and/or wiring.	Section 7. Component Testing and Adjustment, Wiring Diagrams Manual
	Generator set master switch in OFF position (attempting start-up from remote switch)	Move generator set master switch to AUTO position	
	K1 relay (NC) contact open (relay controller)	Check continuity	Section 7. Component Testing and Adjustment, Wiring Diagrams Manual
	Oil viscosity too heavy	Use correct viscosity oil	Section 3. Lubrication System, Engine Service Manual
	Defective controller circuit board	Check circuit board operation	Section 5. Controller Troubleshooting

Problem	Possible Cause	Corrective Action	Reference
Will not crank (dead) (continued)	Overcrank shutdown	Check engine fuel, ignition systems. Shutdown occurs after 30 seconds of cyclic cranking (relay controller) or 45 seconds of continuous cranking or 75 seconds of cyclic cranking (5-light controller)	
	K3 relay coil defective (if LED 2 is lit, relay is receiving power but may not be energized)	Check relay coil continuity	Section 7. Component Testing and Adjustment, Wiring Diagrams Manual
	Defective K4 relay contacts	Test circuit board	Section 5. Controller Troubleshooting
	Defective K1 relay (relay controller)	Test circuit board	Section 5. Controller Troubleshooting
Will not start (cranks okay)	No fuel in tank	Replenish	
	Defective carburetor anti-diesel solenoid (gasoline fuel system)	Check operation	Section 7. Component Testing and Adjustments
	Carburetor adjustment wrong	Adjust carburetor	Section 3. Carburetor Adjustment
	Defective/misadjusted spark plug(s)	Regap or replace	Section 3. Ignition System—Spark Plugs
	Loose spark plug wires	Reconnect wires	Section 3. Ignition System—Spark Plugs
	Defective ignition module	Test. Replace if defective	Engine Service Manual
	Air intake restriction	Check air intake	Section 3. Servicing Air Cleaner
	Engine malfunction	Troubleshoot engine	Engine Service Manual
	Defective electric fuel pump (gasoline fuel system)	Verify operation with 12 volts DC applied. Check fuel pressure of 2-3.5 psi (14-24 kPa)	Section 7. Component Testing and Adjustments
	Clogged fuel filter (gasoline fuel only)	Replace filter	Section 3. Fuel Filter Service
	Open wiring terminal, or pin (P2 connector)	Check continuity	Wiring Diagrams Manual
	Too low overspeed setting on electronic governor board	Readjust overspeed on governor board	Section 7. Component Testing and Adjustments
	Defective/misadjusted choke (gasoline fuel systems)	Replace/readjust choke	Section 3. Choke Adjustment Section 7 or 8.
	Faulty ground (–) connection	Clean and retighten	
	Bad fuel mixture	Replace fuel; clean carburetor	
	Weak or dead battery	Check electrolyte level and specific gravity (batteries with filler caps only). Perform load test	Section 3. Battery
		Recharge or replace: check battery charger operation. Check battery charging circuit* (circuit breaker module, and wiring), if equipped.	
	Defective fuel regulator/valve (LP/natural gas systems)	Test. If defective replace	Section 7. Component Testing and Adjustments

Problem	Possible Cause	Corrective Action	Reference
Engine starts, but stops after start switch is released	No generator output voltage	Check AC voltage. Separately excite unit. Check stator continuity.	Section 7. Component Testing and Adjustments Wiring Diagrams Manual
	Fuse blown on voltage regulator circuit	Replace fuse	Wiring Diagrams Manual
	No/low oil pressure (time delay of 5-10 seconds or 30 seconds [5-light controller])	Check oil pressure, oil pump, and low oil pressure shutdown switch	Engine Service Manual
	Low oil pressure (LOP) shutdown	Correct cause of shutdown. Check oil level, oil pump, etc.	Section 2. Fault shutdowns (operation manual) Section 7 or 8. Engine Service Manual
Hard starting	Contaminated fuel	Replace	
	Fuel vapor lock (hot engine only)	Check fuel line routing	Operation and Installation Manual—Fuel Systems
	Air intake restriction	Check air intake	Section 3. Servicing Air Cleaner
	Carburetor adjustment wrong	Adjust carburetor	Section 3. Carburetor Adjustment
	Choke out of adjustment (gasoline fuel system)	Repair/replace	Section 7. Carburetor Choke
	Defective ignition module	Test and/or replace	Engine Service Manual
	Defective spark plug(s)	Replace spark plugs	Section 3. Ignition System
	Worn piston rings, valves, etc.	Check compression	Engine Service Manual
	Incorrect cooling (hot engine only)	Inspect cooling system	Section 3. Cooling System
	Defective anti-icing plate (thermistor)	Test and/or repair	Section 7. Component testing and Adjustment
Generator set shuts down by itself	Out of fuel	Add fuel	
	Fuel line restriction	Inspect fuel lines and tank	
	Clogged fuel pump filter (gasoline fuel system)	Replace filter	Section 3. Fuel Filter Service
	Defective electric fuel pump (gasoline fuel system)	Verify operation with 12 volts DC applied. Check fuel pressure of 2-3.5 psi (14-24 kPa)	Section 7. Component Testing and Adjustment
	Defective fuel valve/fuel regulator (LP/natural gas fuel systems)	Check regulator/valve operation	Section 3 and Section 7 or 8.
	Engine overload (hot engine only)	Reduce electrical load	Section 3. Wattage Requirements
	Engine overheated (hot engine only)	Check air intake, carburetor adjustment, oil level, etc.	Section 3. Scheduled Maintenance, Engine Service Manual
	Loss of generator output voltage to K1 relay (LED1 not lit)	Check AC voltage at rectifier (BR1). Check continuity of B1/B2 stator leads	Section 7. Components Testing and Adjustment, Wiring Diagrams Manual
	Fuel vapor lock (hot engine only)	Reroute fuel lines away from heat source (exhaust system)	Operation Manual—Fuel Systems
	Faulty carburetor shutdown solenoid	Replace solenoid	Section 7. Fuel System—Carburetor Shutdown Solenoid
	Air intake clogged	Clean air intake	Section 3. Servicing Air Cleaner

Problem	Possible Cause	Corrective Action	Reference
Generator set shuts down by itself (continued)	Faulty spark plug(s)	Replace spark plugs	Section 3. Ignition System—Spark Plugs
	Defective ignition module	Test and/or replace	Engine Service Manual
	No/low oil pressure	Check oil pressure, oil pump, and low oil pressure shutdown switch	Engine Service Manual
	Controller fuse blown	Replace fuse	Section 7. Component Testing and Adjustment , Wiring Diagrams Manual
	Blown voltage regulator fuse	Replace fuse. If fuse blows again, test generator components	
	Defective low oil pressure (LOP) shutdown	Check engine oil level, oil pressure, and oil pump. Disconnect lead from LOP switch and isolate terminal. If engine continues to run, replace LOP switch. LOP switch contacts close at approximately 14 psi ± 2 psi (96.5 kPa ± 13.8 kPa). **Note:** Verify correct engine oil pressure of psi (kPa) before replacing LOP shutdown switch.	
	Overspeed shutdown	Check electronic governor and voltage regulator	Section 7 and Section 1.
	Defective K3 relay (field flashing) in relay controller circuit board	Test/replace relay controller circuit board	Section 7. Component Testing and Adjustment.
	Defective K5 relay (field flashing) (5-light controller only)	Test/replace K5 relay	Section 8.
Will not carry load or runs rough	Excessive load connected to generator	Reduce electrical load	Section 3. Wattage Requirements
	Incorrect cooling (hot engine only)	Inspect cooling system	Section 3. Cooling system
	Governor not correctly adjusted or defective (engine not operating at rated rpm)	Check speed using tachometer or frequency meter. **Note** Hz x 120/No. of rotor poles = rpm (**Example** 60 x 120/4 = 1800)	
	Carburetor not correctly adjusted or defective	Check and/or adjust	Section 3. Carburetor Adjustments
	Defective ignition module	Test and/or replace	Engine Service Manual
	Defective/misadjusted spark plug(s)	Regap or replace plug(s)	Section 3. Spark Plug Service
	Carburetor choke (gasoline fuel system)	Test and/or replace	Section 3. Carburetor Choke
		Fuel line restriction tank. Check fuel pump pressure of 2-3.5 psi (14-24 kPa)	
	Dirty fuel filter (gasoline fuel only)	Replace fuel filter	Section 3. Fuel Filter Service
	Defective electric fuel pump (gasoline fuel only)	Check fuel pressure of 2-3.5 psi (14-24 kPa)	
	Excessive carbon build-up	Clean cylinder head	Engine Service Manual
	Valves not seating	Inspect valves and valve seats	Section 3. Valve Service, Engine Service Manual
	Air intake restriction	Check air intake	Section 3. Servicing Air Cleaner
	Incorrect type of fuel	Use correct type of fuel	Section 3. Fuel System
	Fuel vapor lock (hot engine only)	Reroute fuel lines away from heat source (exhaust systems)	Operation Manual—Fuel Systems

Problem	Possible Cause	Corrective Action	Reference
Lacks Power	Governor not correctly adjusted or defective (engine not operating at rated rpm)	Check speed using tachometer or frequency meter. **Note** Hz x 120/No. of rotor poles=rpm (**Example** 60 x 120/4=1800)	Section 7. Electronic Governor
	Air intake restriction	Check air intake	Section 3. Servicing Air Cleaner
	Carbon build-up	Clean carbon from cylinder heads	Engine Service Manual
	Incorrect cooling	Inspect cooling system	Section 3. Cooling System
	Engine overload	Reduce electrical load	Section 3. Wattage Requirements
	Contaminated fuel	Replace	
	Carburetor adjustment wrong	Adjust carburetor	Section 3. Carburetor Adjustment
	Choke misadjusted or defective	Check and/or adjust	Section 3. Carburetor Choke Section 7. Component Testing and Adjustment
	Fuel line restriction	Check fuel lines and tank	
	Dirty fuel filter (gasoline fuel system)	Replace fuel filter	Section 3. Fuel Filter Service
	Faulty spark plug(s)	Replace spark plug(s)	Section 3. Spark Plug Service
	Defective ignition module	Test and/or replace coil	Engine Service Manual
	Defective fuel regulator (LP fuel only)	Check function of fuel regulator	Section 3. LP Fuel System
	Insufficient fuel pressure (LP fuel only)	Check fuel pressure	Section 3. LP Fuel System
	LP liquid fuel filter clogged	Replace	Section 3. LP Fuel System
	LP liquid shut-off solenoid clogged	Clean	Section 3. LP Fuel System
	Grease build-up in LP liquid primary regulator	Clean	Section 3. LP Fuel System
	Generator overload	Reduce load	Section 3. Scheduled Maintenance
Operates erratically	Air intake restriction	Check air intake	Section 3. Servicing Air Cleaner
	Contaminated fuel	Replace	
	Faulty spark plug(s)	Replace spark plugs(s)	Section 3. Ignition Systems, Spark Plugs
	Carburetor adjustment wrong	Adjust carburetor	Section 3. Carburetor Adjustment
	Governor not correctly adjusted or defective (engine not operating at rated rpm)	Check speed using tachometer or frequency meter. **Note** Hz x 120/No. of rotor poles=rpm (**Example** 60 x 120/4=1800)	Section 7. Electronic Governor
	Fuel line restriction	Inspect fuel lines and tanks. Check fuel pump pressure of 2-3.5 psi (14-24 kPa)	
	Dirty fuel filter (gasoline fuel system)	Replace filter	Section 3. Fuel Filter
	Carburetor choke incorrectly adjusted (gasoline fuel systems)	Readjust choke	Section 3. Choke Adjustments
	Defective fuel pump (gasoline fuel systems)	Verify operation with 12 volts DC applied. Check fuel pressure of 2-3.5 psi (14-24 kPa)	Section 7 for additional information
	Carbon build-up in engine	Clean cylinder head	Engine Service Manual

Problem	Possible Cause	Corrective Action	Reference
Operates erratically (continued)	Engine valves not seating correctly	Inspect valves and valve seats	Engine Service Manual
	Vapor lock (gasoline fuel systems)	Check fuel line routing	
	Clogged gasoline fuel filter	Replace filter	Section 3. Fuel Filter
	Defective gasoline antidiesel solenoid	Test and/or replace	Section 7. Antidiesel Solenoid
	Defective ignition system	Test and/or replace components	Engine Service Manual
Overheats	Incorrect cooling	Check cooling system	Section 3. Cooling System
	Air intake restriction	Check air intake	Section 3. Air Cleaner
	Carburetor adjustment too lean	Adjust carburetor mixture	Section 3. Carburetor Adjustments
Unit is noisy	Exhaust system leaks	Check and replace as necessary	Operation Manual—Exhaust System
	Broken or damaged vibromounts	Check and replace as necessary	Section 8. Disassembly/ Reassembly
	Loose or vibrating sheet metal/ housing	Retighten screws	
	Exhaust piping or air inlets/outlets not securely installed	Inspect for loose parts	Operation Manual—Exhaust System
	Excessive vibration—engine/ generator	Check rotor, crankshaft, bearing, etc. (disassembly of engine and/ or generator may be required.	Section 8. Disassembly/ Reassembly, Engine Service Manual
High fuel consumption	Air intake restriction	Check air intake	Section 3. Servicing Air Cleaner
	Carburetor adjustment wrong	Adjust carburetor	Section 3. Carburetor Adjustment
	Choke out of adjustment (gasoline fuel system)	Repair/replace	Section 3. Carburetor Adjustment
	Defective spark plug(s)	Replace spark plugs	Section 3. Ignition System
Emits black or gray smoke	Carburetor adjustment wrong	Adjust carburetor	Section 3. Carburetor Adjustment
	Choke out of adjustment (gasoline fuel system)	Repair/replace	Section 3. Carburetor Adjustment
	Air intake restriction	Check air intake	Section 3. Air Cleaner
	Worn piston rings, valves, etc.	Check compression	Engine Service Manual
	Oil level high	Check oil level	Section 3. Lubrication System, Engine Service Manual
High oil consumption	External leakage/defective gaskets	Replace gaskets	Engine Service Manual
	Worn piston rings, valves, etc.	Check compression	Engine Service Manual
Engine Knocks	Contaminated fuel	Replace fuel	
	Engine overheated	Inspect cooling system	Section 3. Cooling system

Problem	Possible Cause	Corrective Action	Reference
Electrical System			
Battery will not charge	Loose or corroded connections	Clean and tighten connections	Operation Manual
	Sulfated or worn-out battery	Check electrolyte level and specific gravity (batteries with filler caps only)	Operation Manual
	Defective battery charging circuit	Check battery charging system	Section 7. Component Testing and Adjustment
Starter does not work correctly	Loose or corroded connections	Clean and tighten loose connections	Operation Manual
	Low battery output	Check electrolyte level and specific gravity (batteries with filler caps only)	Operation Manual
	Defective starter solenoid	Check starter solenoid	Section 7. Component Testing and Adjustment
	Defective START/STOP switch	Replace switch	Section 7. Component Testing and Adjustment
	Defective wiring	Check wiring	Wiring Diagrams Manual
	Defective starter	Replace starter	Engine Service Manual
Starter cranks slowly	Low battery output	Check electrolyte level and specific gravity (batteries with filler caps only)	Operation Manual
	Too heavy viscosity lube oil	Use correct viscosity oil	Section 3. Lubrication System
	Loose or corroded wiring	Clean and tighten loose connections	Operation Manual
	High starter current draw	Replace starter	
	Battery cable undersize	Select correct size cable	Section 1. Specifications Chart—Installation, Operation Manual—Electrical Systems

Problem	Possible Cause	Corrective Action	Reference
Generator			
No generator output voltage	AC output circuit breaker open or defective	Check position of circuit breaker. Check AC voltage on generator side of circuit breakers.	Section 2. Circuit Protection, Wiring Diagrams Manual
	AC circuit breaker tripping because of overload on unit	Reduce load, reset and attempt start-up	
	Transfer switch in OFF position or other power source position	Turn handle to correct position	Wiring Diagrams Manual, Operation Manual
	No battery voltage to terminal (+) and (–) of voltage regulator during cranking	Check for 12 VDC at voltage regulator (+) and (–)	Wiring Diagrams Manual
	Fuse blown in voltage regulator circuit (lead 55)	Replace fuse. If fuse blows again, check voltage regulator and stator auxiliary windings	Section 7. Component Testing and Adjustment, Wiring Diagrams Manual
	Short circuit in wiring causing circuit breaker to trip open	Reset circuit breaker. If breaker trips again, check wiring	Wiring Diagrams Manual
	Open wiring, terminals or pin in auxiliary winding circuit (field flashing)	Check continuity	Wiring Diagrams Manual
	Defective rotor (open, grounded, or shorted windings)	Test and/or replace	Section 7. Component Testing and Adjustment
	Defective stator (open, grounded, or shorted windings)	Test and/or replace	Section 7. Component Testing and Adjustment
	Open D5 or D8 diode	Check for open or shorted diode (a good diode has a high resistance one way and a low resistance the other way, when tested with ohmmeter)	Section 7. Component Testing and Adjustment, Wiring Diagrams Manual
	K1 relay (NC) contacts open (relay controller)	Check continuity	Section 7. Circuit Board, Wiring Diagram Manual
	Brushes sticking in holder	Check alignment	Section 7. Brushes
	Rotor slip rings dirty or corroded	Check and/or service	Section 7. Brushes
	Broken, weak, or missing brush spring	Check condition	Section 7. Brushes
	Defective or misdajusted voltage regulator	Excite (rotor) separately	Section 7. Separate Excitation Section 7. Voltage Regulator Test
	Low engine rpm	Check engine speed using tachometer or frequency meter. **Note** Hz x 120/No. of rotor poles=rpm (**Example** 60 x 120/4=1800)	Section 7. Governor Adjustments
	Generator set overloaded	Make sure capacity is not being exceeded	
	Defective rotor	Test and/or replace	Section 7. Rotor
	Defective stator	Test and/or replace	Section 7. Stator
	Defective voltage	Test and/or replace	Section 7. Voltage
	Incorrectly adjusted voltage regulator	Readjust	Section 7. Voltage Regulator

Problem	Possible Cause	Corrective Action	Reference
High generator output voltage	Defective voltage regulator	Test and/or replace	Section 7. Voltage Regulator
	Voltage regulator misadjusted	Readjust	Section 7. Voltage Regulator
	Open or poor splice connection at terminals 33-3 or 44-4 on stator (regulator sensing) or poor pin connection at voltage regulator	Check continuity	Section 7. Stator
	Governor misadjusted	Readjust	Section 7. Component Testing and Adjustment

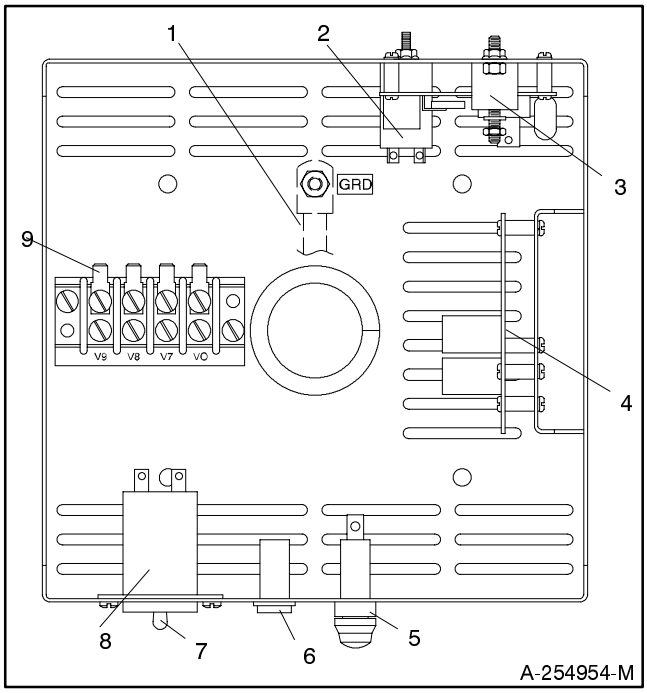
Notes

Section 5. Controller Troubleshooting

Relay Controller

Description

The following text covers the controller troubleshooting procedure for 6.5RMY generators equipped with relay controller and related engine components. Refer to Section 2, Relay Controller Operation in the Operation Manual to identify controller external components. Refer to Figure 5-1 to identify the relay controller internal components.



1. Ground strap
2. K21 relay
3. Cyclic cranking circuit board
4. Controller main circuit board
5. 10-amp fuse
6. Fault lamp
7. Generator master switch
8. Hourmeter
9. TB2 AC terminal block

Figure 5-1. Relay Controller Internal Components

Sequence of Operation

The following text covers the controller sequence of operation during generator start, run, stop, and fault shutdown modes. Use this as a starting point for controller fault identification. The LEDs on the controller circuit board will assist in the troubleshooting process. An illuminated LED indicates the respective relay is receiving power; the LED does not indicate whether that relay is energized. (Additional relay test procedures are covered later in this section.) Refer to the wiring diagrams in the Wiring Diagrams Manual to assist in the troubleshooting procedure.

Starting

- Close the start/stop switch between N and 47 (local starting) or with switch in AUTO position, close contacts 3 and 4 (remote starting).
- K2 relay is energized (LED2 lights). Normally open K2 contacts close to energize relay board (K4 relay is energized, LED4 lights) and K25 relay. Power is also supplied to hourmeter and optional oil pressure and voltmeter gauges.
- Normally open K4 contacts close to supply field flash current to rotor and energize K21 (cyclic crank) relay to provide on/off crank cycle. K21 normally open contacts close to energize K20 relay. K20 normally open contacts close to energize starter.
- K25 normally open contacts close to energize ignition module and coil, governor, de-icing plate, gas valve (gaseous-fueled), fuel pump, anti-diesel solenoid, and choke heater (gasoline-fueled).
- When engine comes up to speed, normally closed low oil pressure switch contacts open.

NOTE

Fault shutdowns are inhibited during start-up until K3 relay is energized.

Running

- When correct AC output is obtained from generator 1-2 winding (1PH) or 7-10 winding (3PH) or engine speed reaches 1100 rpm, K3 relay is energized (LED3 lights). K3 normally closed contacts open to disconnect field flash current. K4 relay is de-energized on crank disconnect. Normally open K4 contacts open to de-energize K20 relay. K20 normally open contacts open to de-energize starter. K3 normally open contacts close to energize fault shutdown circuit after a 5-second delay.

NOTE

AC output must be obtained within 30 seconds or generator will shut down on overcrank fault.

Stopping

- Move the start/stop switch to OFF/RESET position. K2 relay is de-energized (LED2 goes out) and K2 normally open contacts open to de-energize relay board and K25 relay. K25 relay normally open contacts open to de-energize engine components. Generator set stops.

Low Oil Pressure (LOP) Shutdown

- Five to eight seconds after engine lube oil pressure falls below a safe level and LOP switch closes, the K1 relay is energized (LED1 lights). K1 normally open contacts close and fault lamp lights. Normally closed K1 contacts open to de-energize K25 relay. K25 relay normally open contacts open to de-energize engine components. Generator shuts down. (Fault shutdown is latched and generator master switch must be moved to OFF/RESET before set can be restarted.)

Overspeed Shutdown

When engine speed exceeds 70 Hz (2100 rpm) on 50/60 Hz sets, K1 relay is energized (LED1 lights). K1 normally open contacts close and fault lamp lights. K1 normally closed contacts open to de-energize K25 relay. K25 relay normally open contacts open to de-energize engine components. Generator set shuts down. (Fault shutdown is latched and generator master switch must be moved to OFF/RESET before set can be restarted.)

Overcrank Shutdown

If the generator does not start after three crank cycles (crank/rest, crank/rest, crank), the K1 relay is energized (LED1 lights). K1 normally open contacts close and the fault lamp lights. K1 normally closed contacts open to de-energize K25 relay. K25 relay normally open contacts open to de-energize engine components. Generator shuts down. (Fault shutdown is latched and generator set master switch must be moved to OFF/RESET before set can be restarted.)

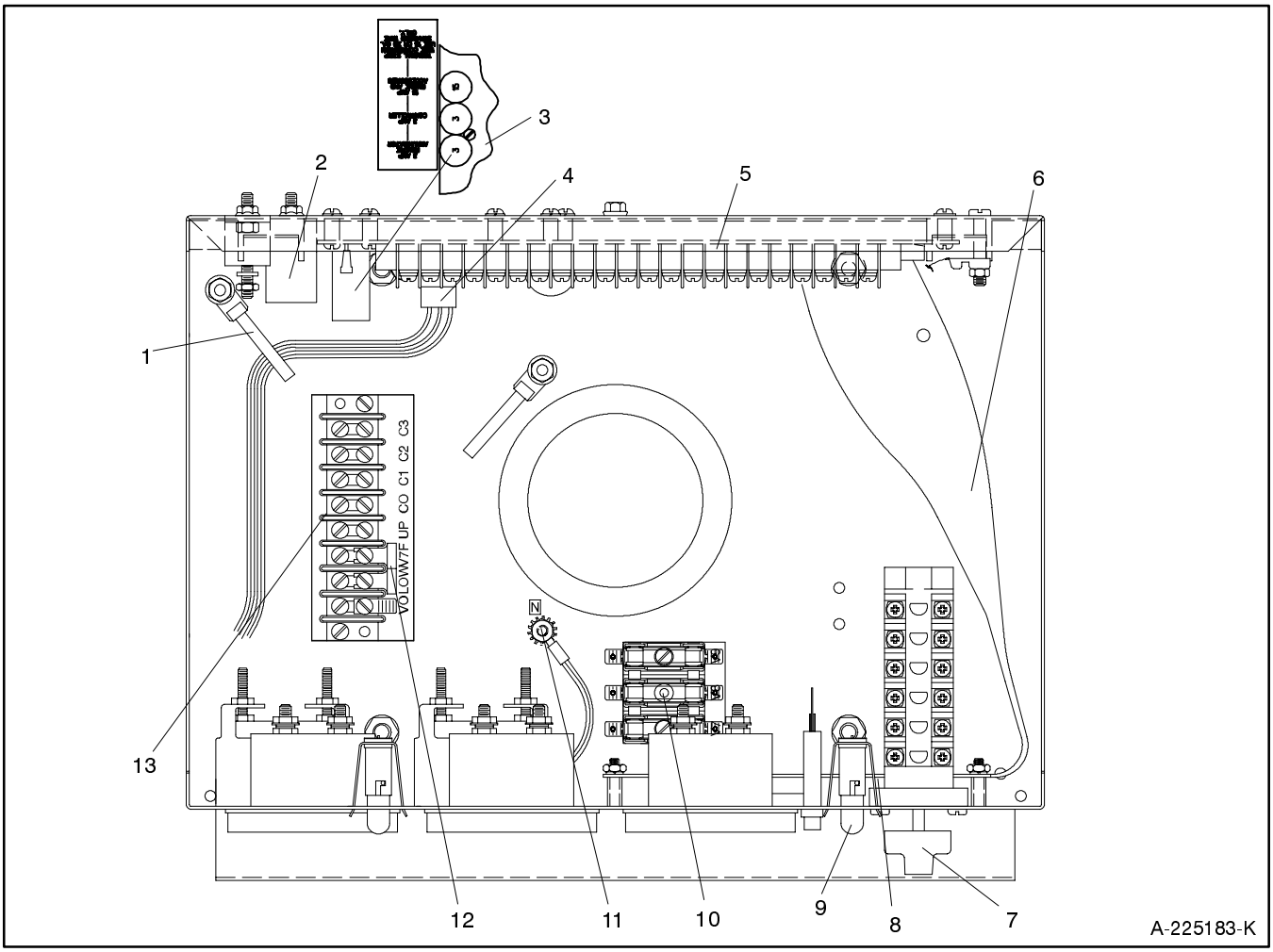
NOTE

If the generator set stops from lack of fuel, the generator set will cyclic crank for 30 seconds before shutting down on overcrank. (The unit attempts restart whenever speed sensor detects no rotor rotation or AC disconnect circuit detects no AC.)

5-Light Microprocessor Controller

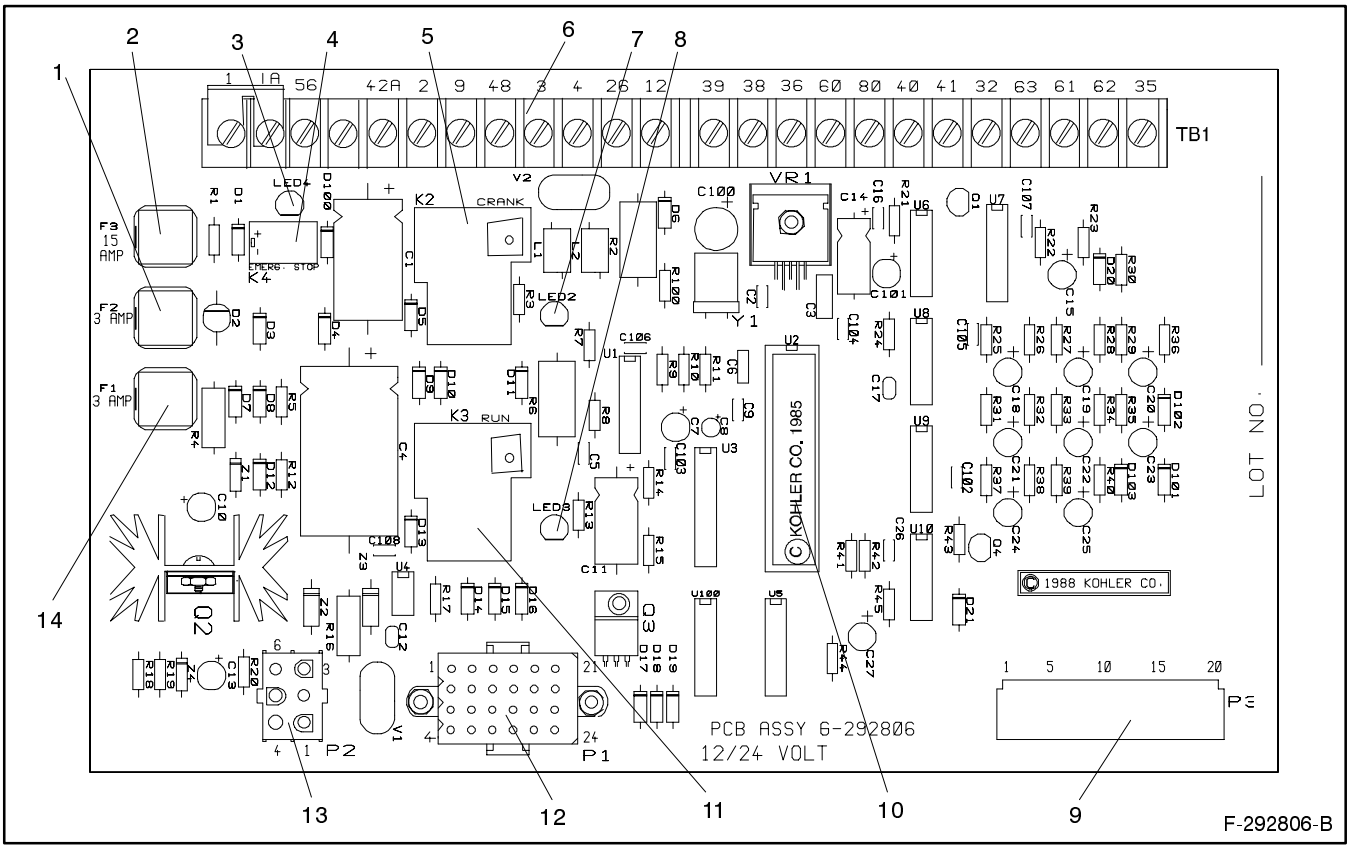
Introduction

Troubleshooting the microprocessor controller and related engine components is done through a combination of methods including fault detection flow charts and using the FASTCHECK® diagnostic tester. These methods are described in the following pages. To identify external features, see Section 2, 5-Light Microprocessor Controller Operation in the Operation Manual. Refer to Figure 5-2 to identify microprocessor controller internal components. Refer to Figure 5-3 to identify controller circuit board components. See the Wiring Diagrams Manual for a logic schematic showing input/output circuits for reference in troubleshooting the controller.



1. Accessory wire guide loops
2. K1 relay (field flash)
3. Controller fuses F1, F2, F3
4. P2 connector
5. Controller main circuit board
6. P3/P4 harness
7. Selection switch
8. Lamp circuit board
9. Panel lamps
10. AC fuse terminal block (TB3)
11. DC ground terminal (N)
12. Lamp selection jumper
13. CT/meter scale terminal block (TB2)

Figure 5-2. 5-Light Microprocessor Controller Components



1. Fuse—3-amp (F2) controller
2. Fuse—15-amp (F3) engine and accessories
3. LED4
4. K4 relay (emergency stop relay)
5. K2 relay (crank relay)
6. TB1 terminal strip (accessories)
7. LED2
8. LED3
9. P3 connector (control panel harness)
10. Microcomputer chip
11. K3 relay (run relay)
12. P1 connector (DC harness)
13. P2 connector (AC harness)
14. Fuse—3-amp (F1) remote annunciator

Figure 5-3. 5-Light Microprocessor Controller Circuit Board Components

NOTE

Jumper must connect TB1-1 and TB1-1A terminals if no emergency stop switch is used.

5-Light Microprocessor Controller Circuit Board Components

Circuit Board Terminal Identification (TB1)

1. Ground—Emergency Stop Relay (K4)
1A. Emergency Stop Relay (K4) Coil; Negative
56. Air Damper #
42A. Battery Voltage (Fuse #1 Protected)
2. Ground
9. Crank Mode (open—cyclic crank; ground—continuous crank)
48. Emergency Stop Indicator
3. Remote Start Ground
4. Remote Start (Active Low*)
26. Auxiliary Indicator
12. Overcrank Indicator
39. Overspeed Indicator
38. Low Oil Pressure Indicator
36. High Engine Temperature Indicator #
60. System Ready Indicator
80. Not In Auto Indicator
40. Prealarm High Engine Temperature Indicator #
41. Prealarm Low Oil Pressure Indicator
32. Common Fault/Prealarm Line
63. Low Fuel (Active Low*)
61. Battery Charger Fault (Active Low*)
62. Low Battery Volts (Active Low*)
35. Low Water Temperature #

P1 Connector Pins

1. Output to K1 Relay (Crank Relay), Wire 71
2. Ground for Speed Sensor, Wire 2
3. Output to Safeguard Breaker Terminal, Wire 70
4. Not Used
5. Ground (–), Wire N
6. Speed Sensor Shield Ground, Wire S2
7. Output to Governor System (GS), Wire 70
8. Battery Positive to Speed Sensor, Wire 24
9. Input from Speed Sensor, Wire 16
10. Not Used
11. Not Used
12. Input from Battery Positive (P)
13. Not Used
14. Input from Water Level Switch, Wire 31 #
15. Not Used
16. Not Used
17. Not Used
18. Not Used
19. Not Used
20. Not Used
21. Input from High Engine Temperature Switch, Wire 34 #
22. Input from Low Oil Pressure Switch, Wire 13
23. Not Used
24. Not Used

P2 Connector Pins

1. Output to Oil Pressure Sender, Wire 70
2. Input from Overvoltage Board, Wire 30
3. Input for AC Crank Disconnect and Instrumentation, Wire V7
4. Not Used
5. Input for AC Crank Disconnect and Instrumentation, Wire V0
6. Engine Ground, Wire 2

P3 Connectors Pins

1. Output to # Low Water Temperature/Aux Indicator (E.Stop), Wire 48
2. Output to # Low Water Temperature/Aux Indicator, Wire 26
3. Output to Overcrank Indicator, Wire 12
4. Output to Overspeed Indicator, Wire 39
5. Output to Low Oil Pressure Indicator, Wire 38
6. Output to High Engine Temperature Indicator, Wire 36 #
7. Not Used
8. Voltage (+) to Front Panel, Wire 24
9. Not Used
10. Not Used
11. Not Used
12. Output to # Low Water Temperature/Aux Indicator, Wire 35
13. Not Used
14. Not Used
15. Not Used
16. Not Used
17. Input from Generator Master Switch, RUN position, Wire 47
18. Input from Generator Master Switch, OFF/RESET position, Wire 43
19. Input from Generator Master Switch, AUTO position, Wire 46
20. Ground (–), Front Panel, Wire 2

P4 Connectors Pins

1. Input to # Low Water Temperature/Aux Indicator (E. Stop), Wire 48
2. Input to # Low Water Temperature/Aux Indicator, Wire 26
3. Input to Overcrank Indicator, Wire 12 **
4. Output to Overspeed Indicator, Wire 39 **
5. Input to Low Oil Pressure Indicator, Wire 38 **
6. Input to High Engine Temperature Indicator, Wire 36 ** #
7. Not Used
8. Voltage (+) to Front Panel, Wire 24
9. Not Used
10. Not Used
11. Not Used
12. Input to # Low Water Temperature/Aux Indicator, Wire 35 **
13. Not Used
14. Not Used
15. Not Used
16. Not Used
17. Output from Generator Master Switch, RUN position, Wire 47
18. Output from Generator Master Switch, OFF/RESET position, Wire 43
19. Output from Generator Master Switch, AUTO position, Wire 46
20. Ground (–), Front Panel

* Active low circuits may be checked for proper operation by placing ground on terminals so designated.

** Common alarm triggered by High Engine Temperature, Low Oil Pressure, Low Water Temperature, Overcrank, Overspeed , and Auxiliary Faults. High Engine Temperature and Low Water Temperature are not applicable to 6.5RMY.

\# Items do not apply to 6.5RMY.

Fault Shutdowns—5-Light Microprocessor Controller

If the generator set will not start or stops running because of a fault shutdown (fault lamp lit), refer to the following chart to identify fault conditions. Consult the Engine Service Manual for detailed information on correcting engine related faults. To reset the generator set after a fault shutdown, see Section 2, 5-Light Microprocessor Controller Operation—Resetting Fault Shutdowns in the Operation Manual.

Indicator	Fault Condition
Low oil pressure lamp lights	Engine oil pressure dropped to 7.1 psi (49 kPa)
Overspeed lamp lights	Governed frequency in excess of 70 Hz. (50 and 60 Hz models).
Overcrank lamp lights	Speed sensor signal absent longer than one second.
Auxiliary lamp lights	Overvoltage condition (if overvoltage equipped)— output voltage 15% above nominal voltage(for one second or longer). Activated by fault sensing devices connected to auxiliary immediate shutdown port (P1-17).
Emergency stop (if equipped)	Emergency stop switch activated. Emergency stop switch disconnected from controller terminals TB-1 or 1A.

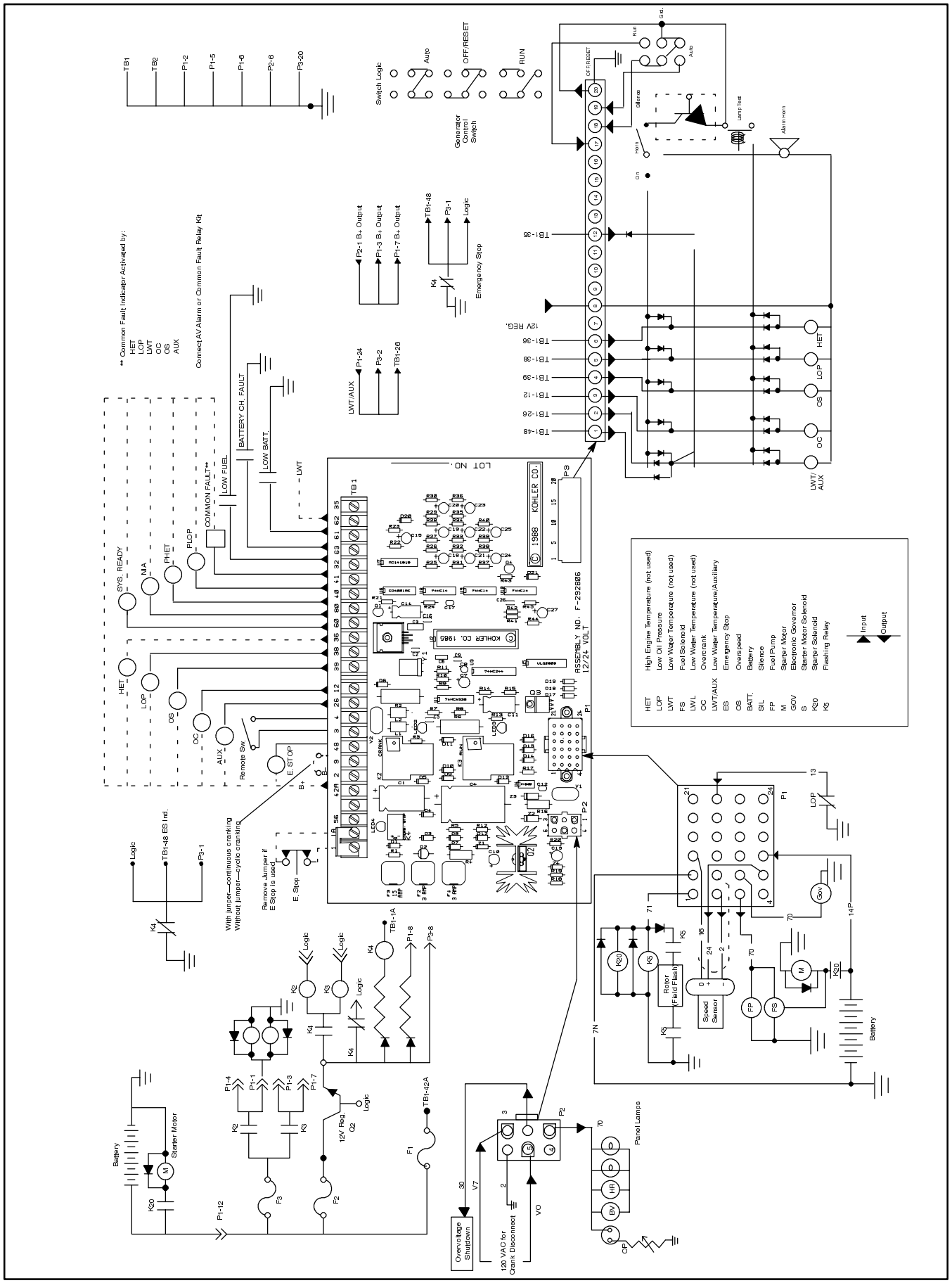
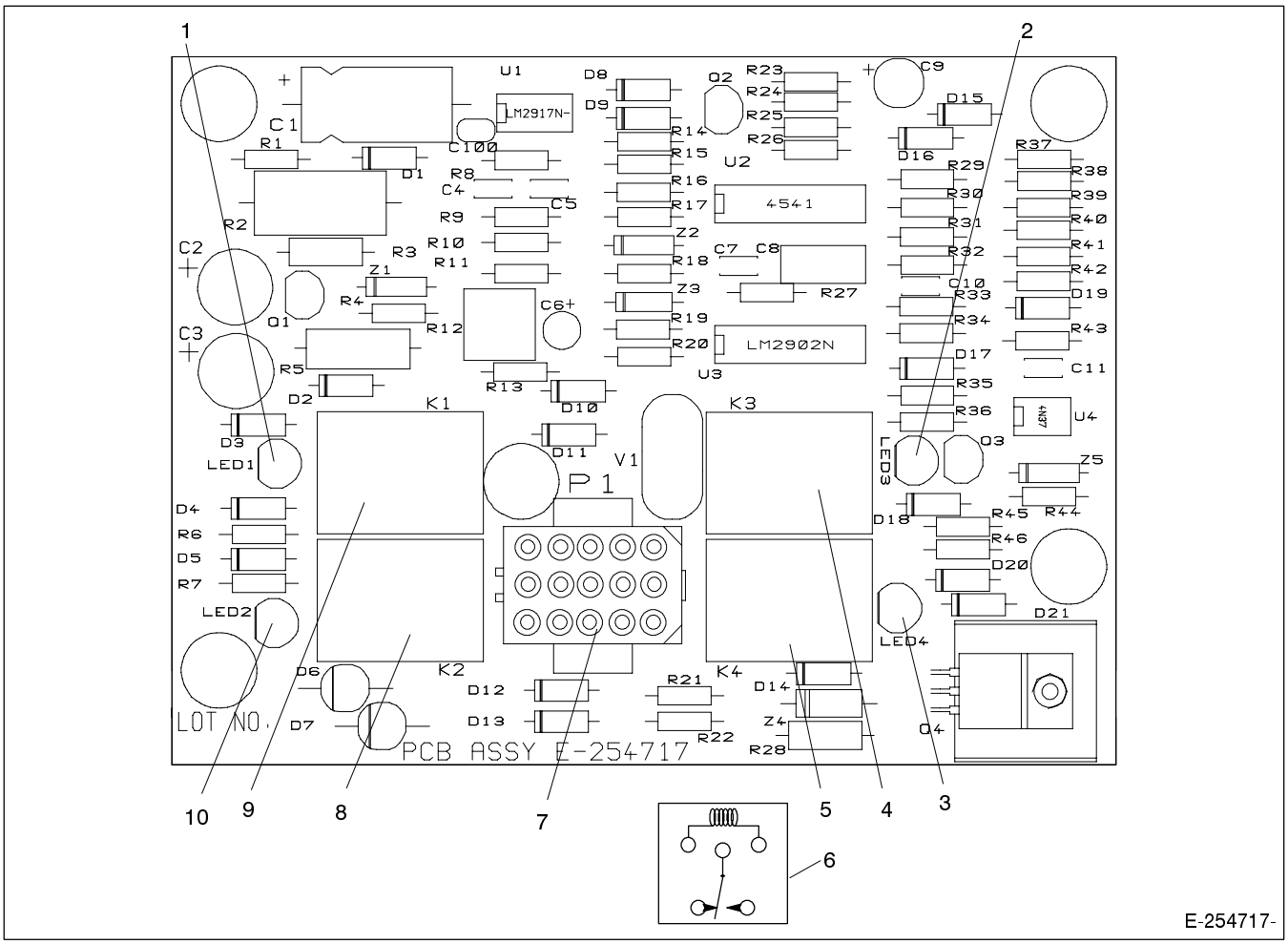


Figure 5-4. 5-Light Microprocessor Controller Connections

Section 6. Generator/Controller Troubleshooting

Relay Controller



1. LED1
2. LED3
3. LED4
4. K3 relay
5. K4 relay
6. K1, K2, K3, K4 relay schematic
7. P1 connector
8. K2 relay
9. K1 relay
10. LED2

Figure 6-1. Controller Circuit Board Testing

Use the following flow chart as an aid in troubleshooting the main circuit board and the entire generator set. If the prescribed remedy does not correct the problem, the circuit board may have to be replaced. The controller circuit board is equipped with LEDs (light emitting diodes) which indicate relay coil power and aid in circuit board and generator fault detection. When the K1, K2, K3, or K4 relays are receiving power, the corresponding LED will light. The LED does not indicate whether the relay coil is energized. This conclusion can only be reached through analysis of generator faults and by performing a continuity test on the relay coil (covered later in this section).

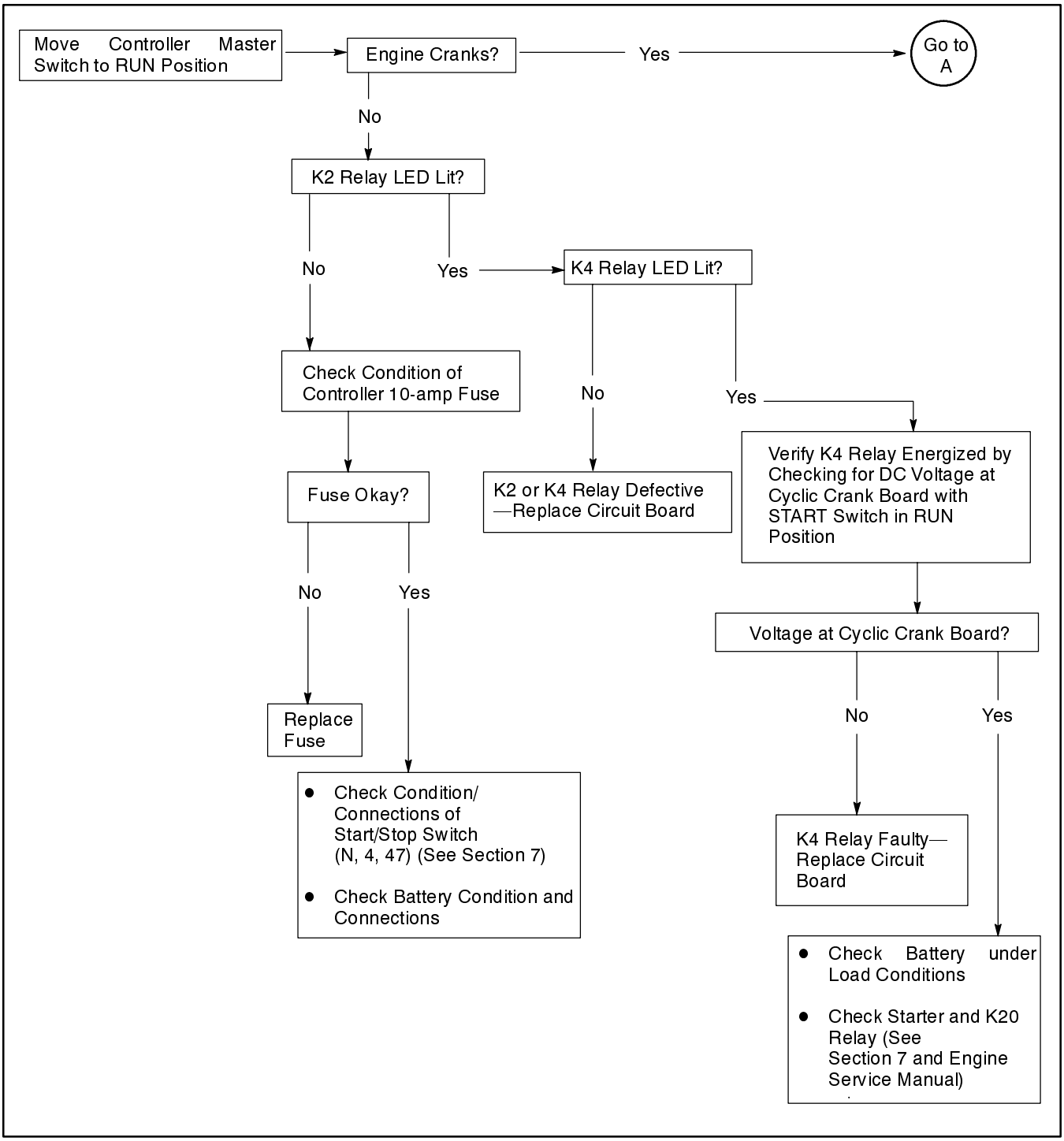


Figure 6-2. Troubleshooting Relay Controller Circuit Board (Sheet 1 of 3)

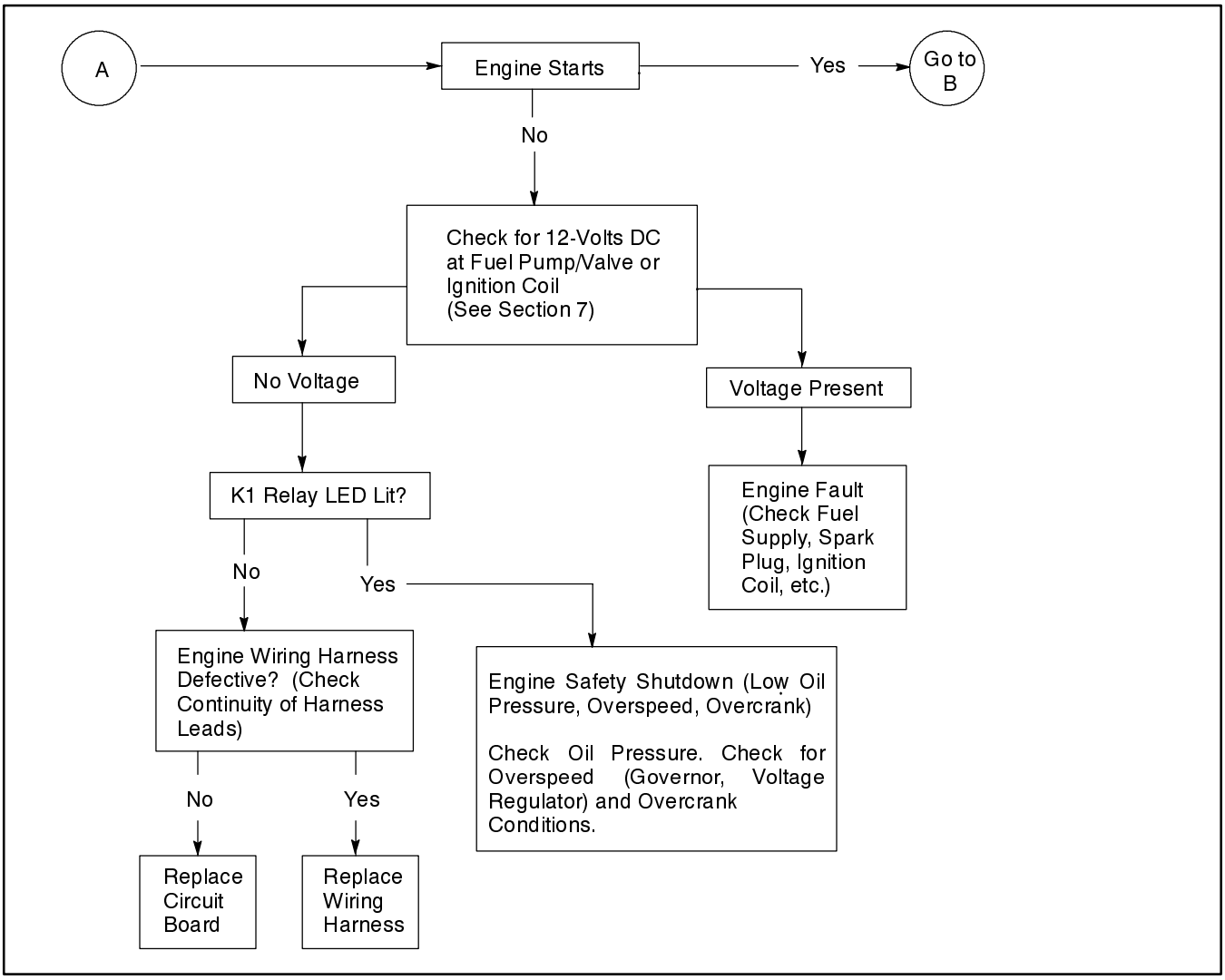


Figure 6-3. Troubleshooting Relay Controller Circuit Board (Sheet 2 of 3)

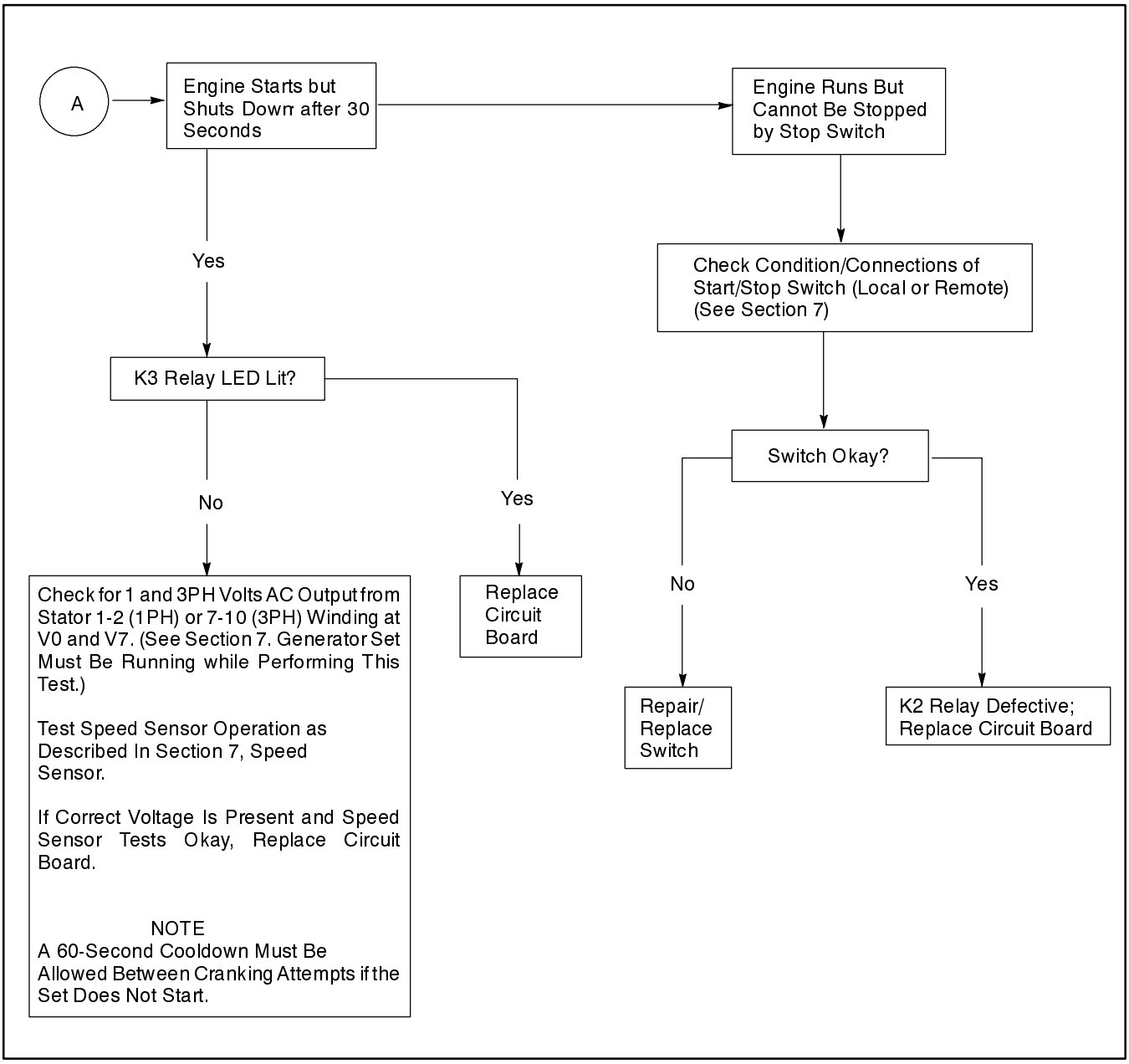


Figure 6-4. Troubleshooting Relay Controller Circuit Board (Sheet 3 of 3)

5-Light Microprocessor Controller

Relay Descriptions

A description of the relays used on sets with 5-light microprocessor controllers is given below. This information is useful in troubleshooting the generator and should be used in conjunction with the troubleshooting flow charts on the following pages.

K20 Relay (Starter Solenoid)

Energizes starter; K20 relay located on skid. See Figure 6-5.

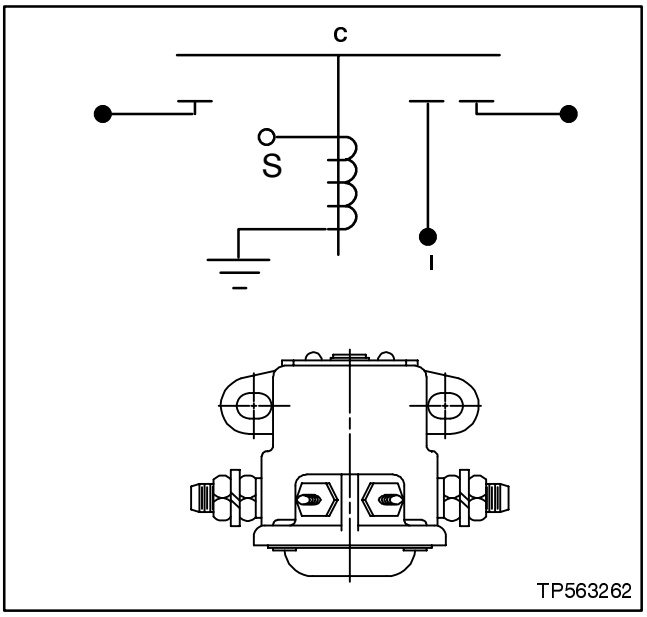


Figure 6-5. K20 Starter Solenoid

K2 Relay (Crank Relay)

Energizes K20 Relay. LED2 lights when energized during crank mode. K2 relay located on controller circuit board.

K3 Relay (Run Relay)

Energizes fuel pump, fuel solenoid, and meters/gauges.

Energizes engine safety shutdowns after time delay. LED3 lights when energized during crank and run modes. K3 relay located on controller circuit board.

K4 Relay (Emergency Stop Relay)

The K4 relay is energized continuously except during emergency stop conditions. LED4 is lit at all times except during emergency stop. K4 relay located on controller circuit board. If emergency stop kit is connected (local or remote), remove jumper from circuit board TB1-1 and 1A. If no emergency stop kit is connected, a jumper must connect terminals TB1-1 and 1A.

K5 Relay (Field Flashing Relay)

Relay provides field flashing current to main field (rotor) during start-up. The K-5 relay is located in the controller and is only energized during cranking. See Figure 6-6.

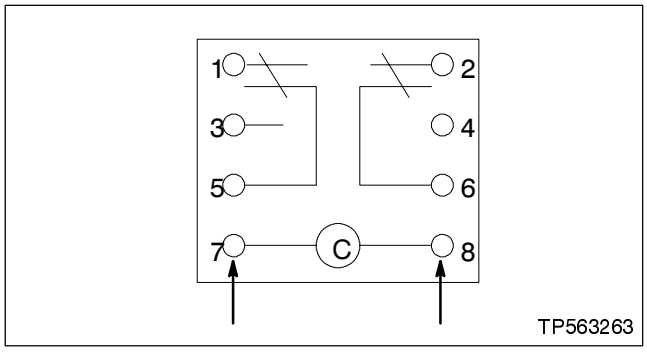
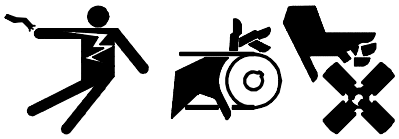


Figure 6-6. K-5 Flashing Relay

Generator

Use the following charts as a quick reference in troubleshooting specific generator set problems. Consult the first chart for aid in locating the cause of blown fuses. In the successive charts, generator faults are listed by specific groups and correlated with possible causes and corrective action. Troubleshooting using the FASTCHECK® follows. Before beginning any troubleshooting procedure, read all safety precautions at the beginning of this manual and those included in the text. Do not neglect these precautions.

⚠ 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.

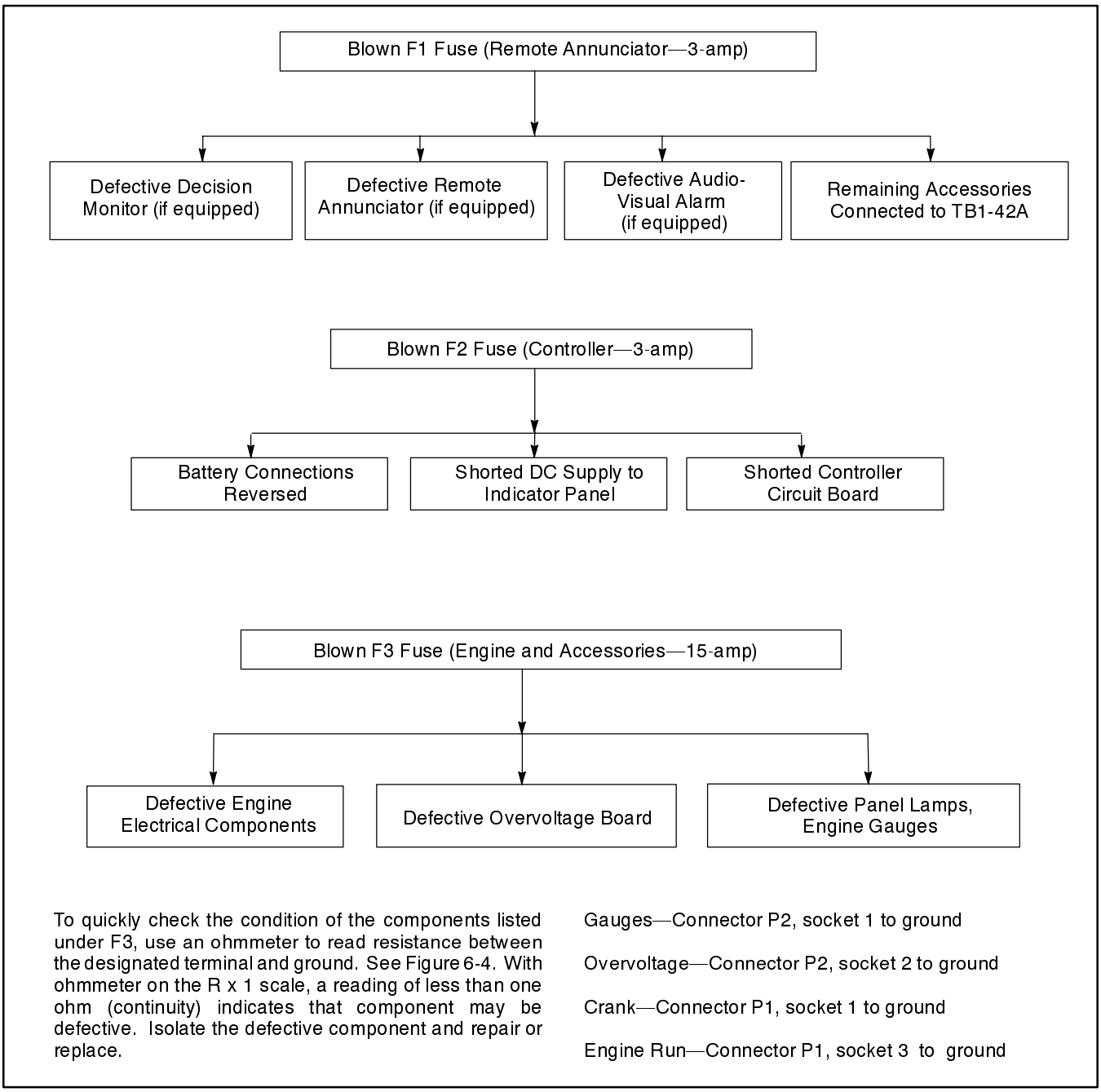
Grounding generator set. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the generator set and electrical circuits 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.

Disconnecting electrical load. Hazardous voltage can cause severe injury or death. Disconnect generator set from load by opening line circuit breaker or by disconnecting generator set output leads from transfer switch and heavily taping ends of leads. High voltage transferred to load during test may cause personal injury and equipment damage. Do not use the safeguard circuit breaker in place of the line circuit breaker.

NOTE

If starting unit by remote switch, verify correct operation of remote switch before troubleshooting controller. Test remote switch operation by placing generator master switch in the AUTO position and running a jumper between terminals 3 and 4 on controller circuit board. If the generator does not start, proceed with the controller troubleshooting procedure.

The chart below lists the possible causes of blown controller fuses F1, F2, and F3. If a fuse is blown, replace it and resume operation. If the fuse blows again, use the chart to identify the faulty component(s).



To quickly check the condition of the components listed under F3, use an ohmmeter to read resistance between the designated terminal and ground. See Figure 6-4. With ohmmeter on the R x 1 scale, a reading of less than one ohm (continuity) indicates that component may be defective. Isolate the defective component and repair or replace.

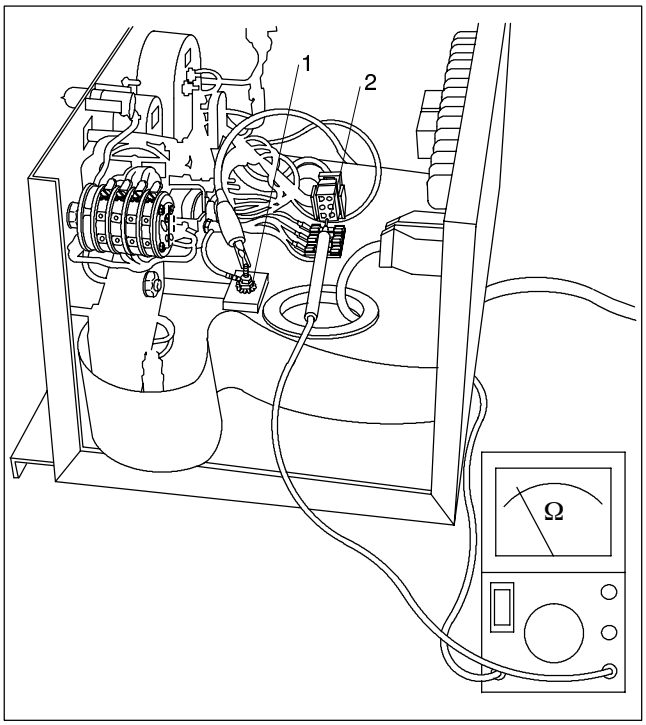
Gauges—Connector P2, socket 1 to ground

Overvoltage—Connector P2, socket 2 to ground

Crank—Connector P1, socket 1 to ground

Engine Run—Connector P1, socket 3 to ground

Figure 6-7. Troubleshooting Microprocessor Fuses



1. Ground connection
2. P2 connection

Figure 6-8. Controller P1/P2 Components

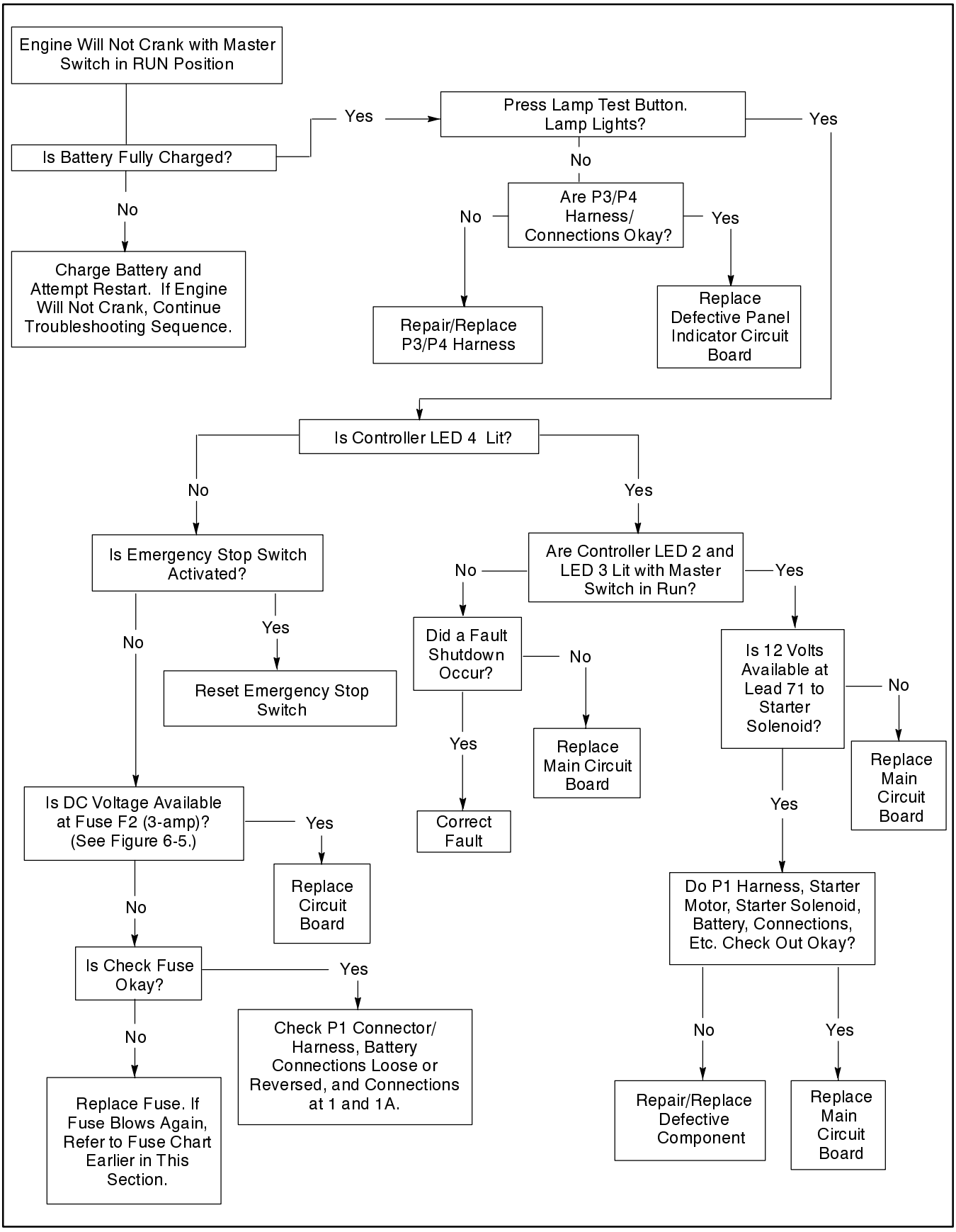
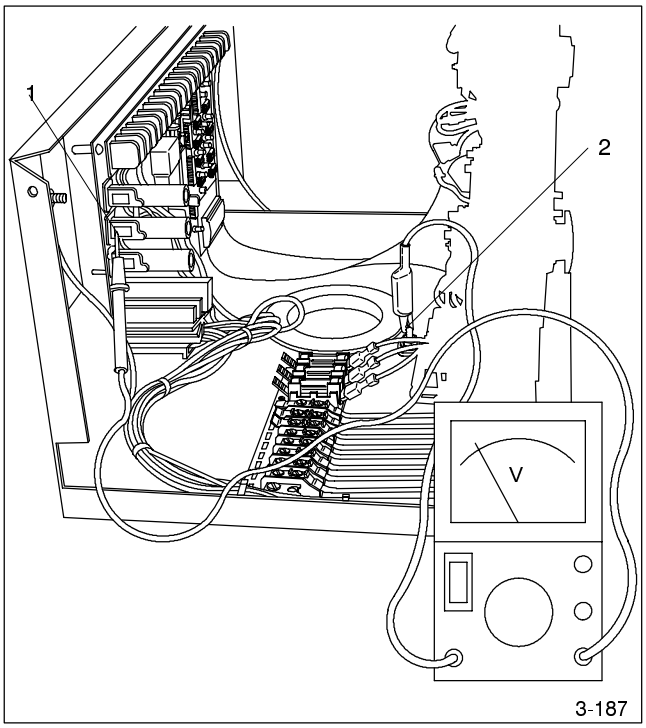


Figure 6-9. Troubleshooting Microprocessor Controller Circuit Board (Sheet 1 of 5)



1. Fuse terminal
2. Ground connection

Figure 6-10. Controller—Location of Fuses

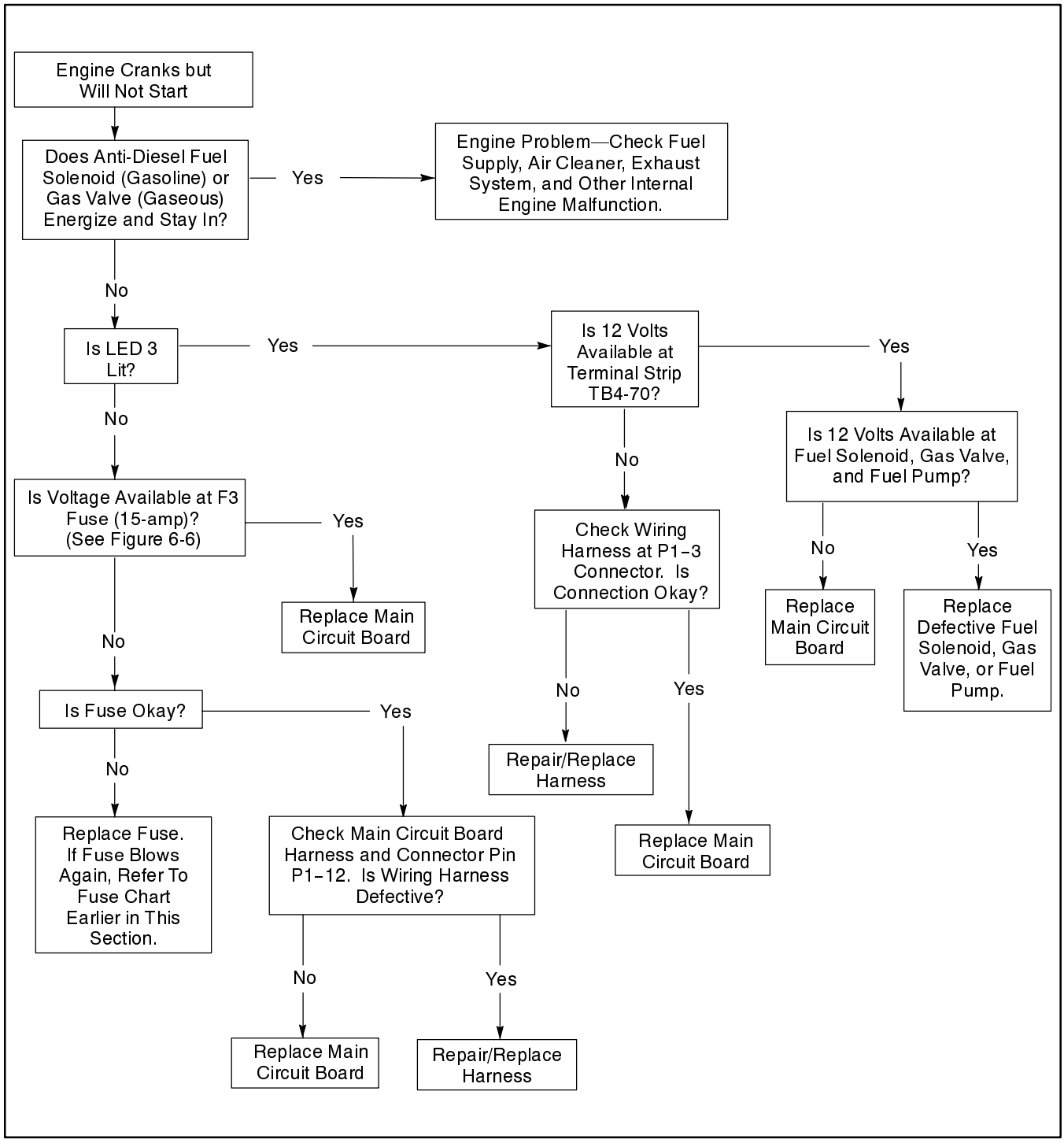


Figure 6-11. Troubleshooting Microprocessor Controller Circuit Board (Sheet 2 of 5)

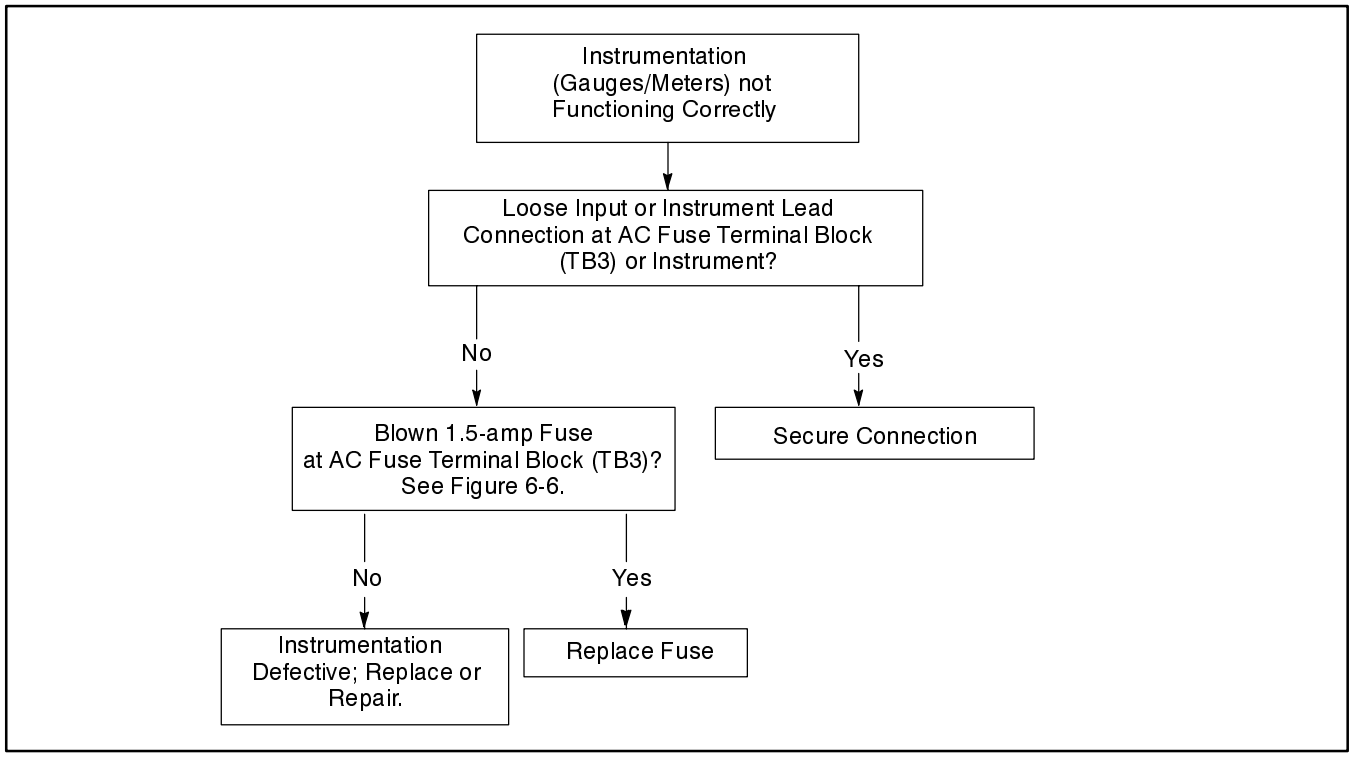
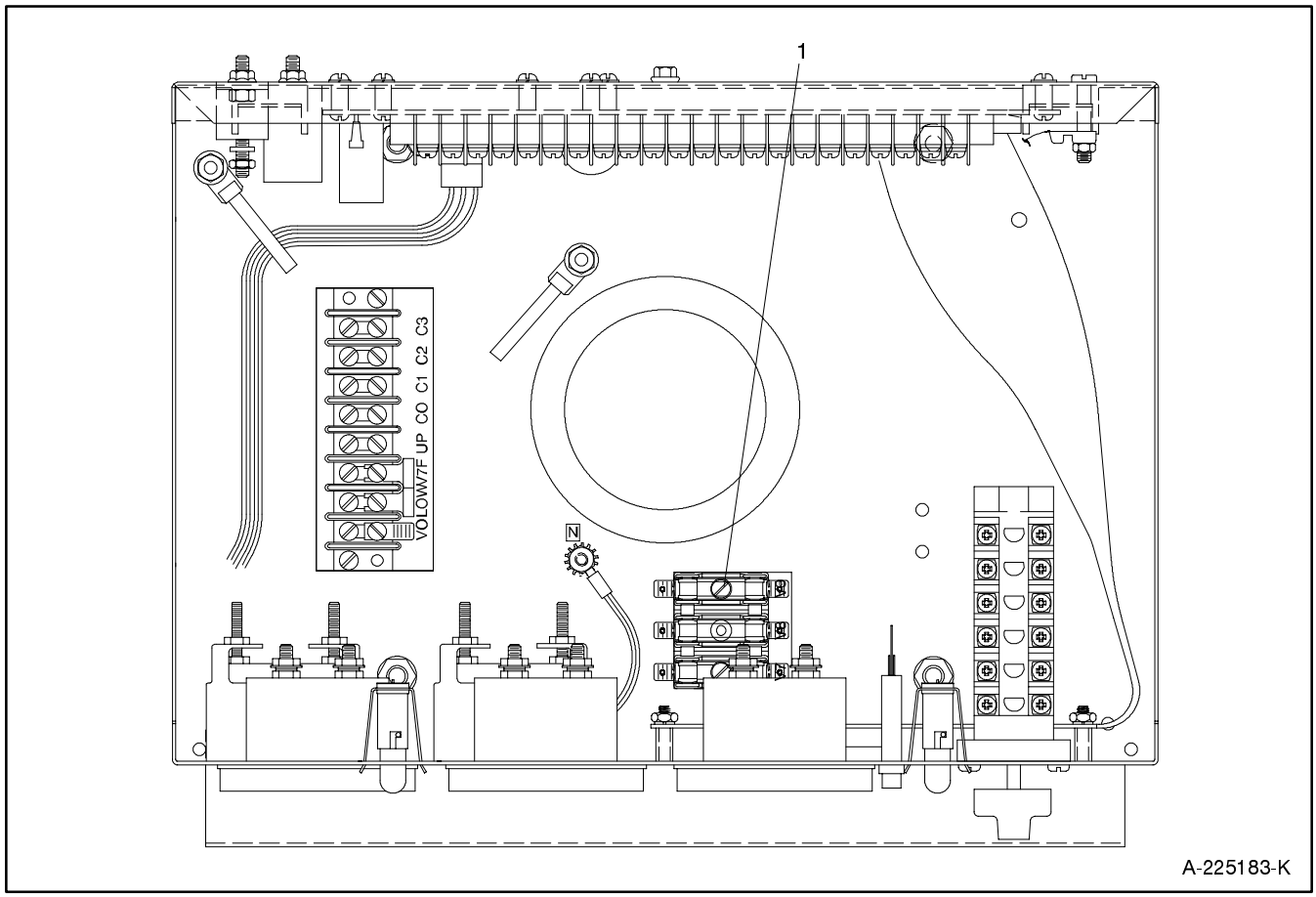


Figure 6-12. Troubleshooting Microprocessor Controller Circuit Board (Sheet 3 of 5)



1. AC fuse terminal block (TB3)

Figure 6-13. Microprocessor Controller AC Fuse Terminal Block (TB3)

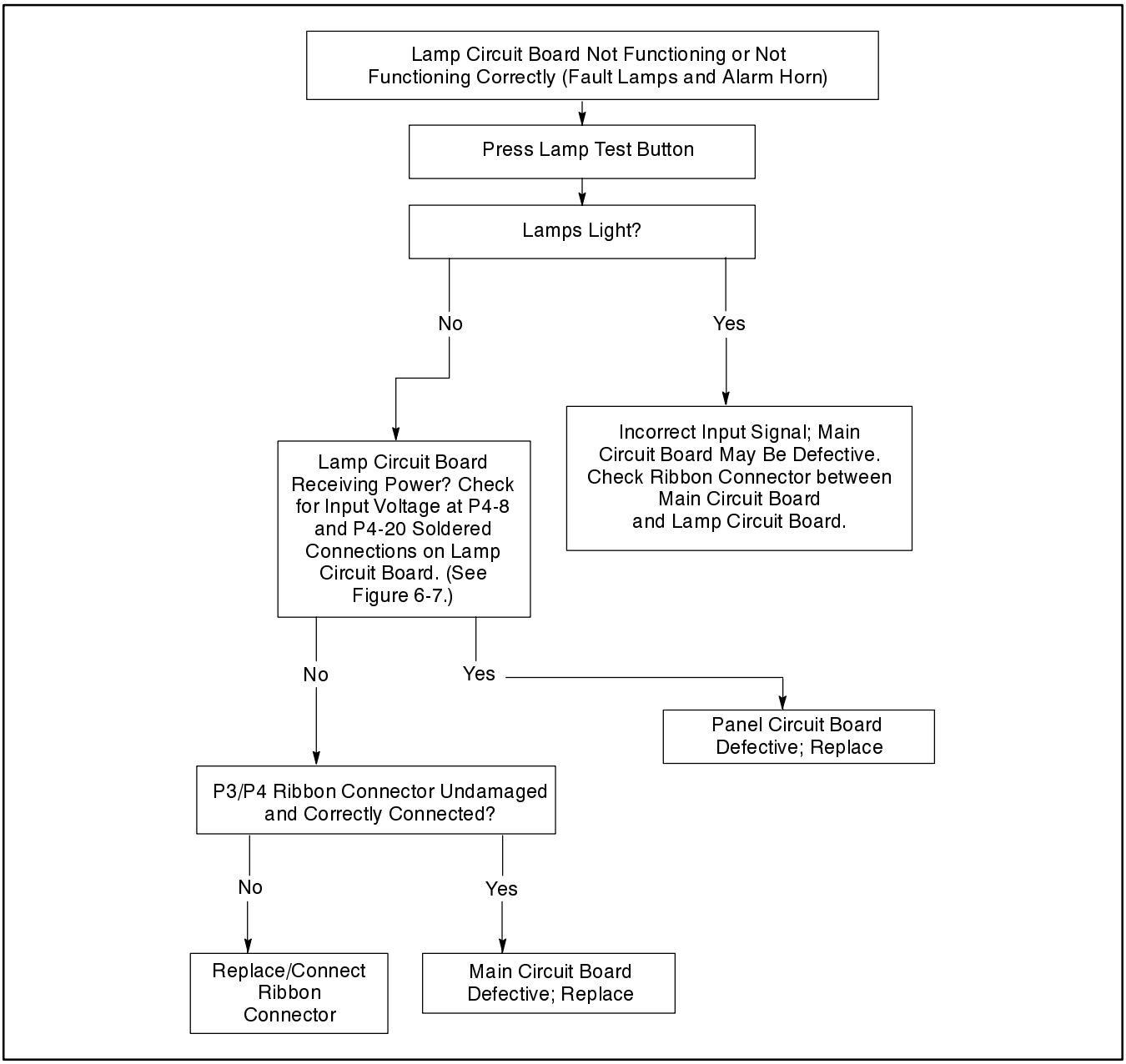
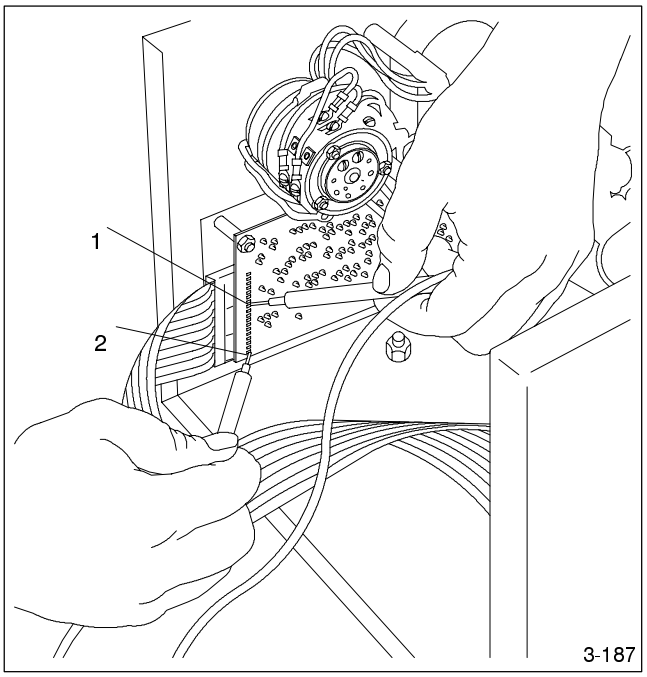


Figure 6-14. Troubleshooting Microprocessor Controller Circuit Board (Sheet 4 of 5)



1. P4-8 (+) connection
2. P4-20 (–) connection

Figure 6-15. Controller Input to Lamp Circuit Board

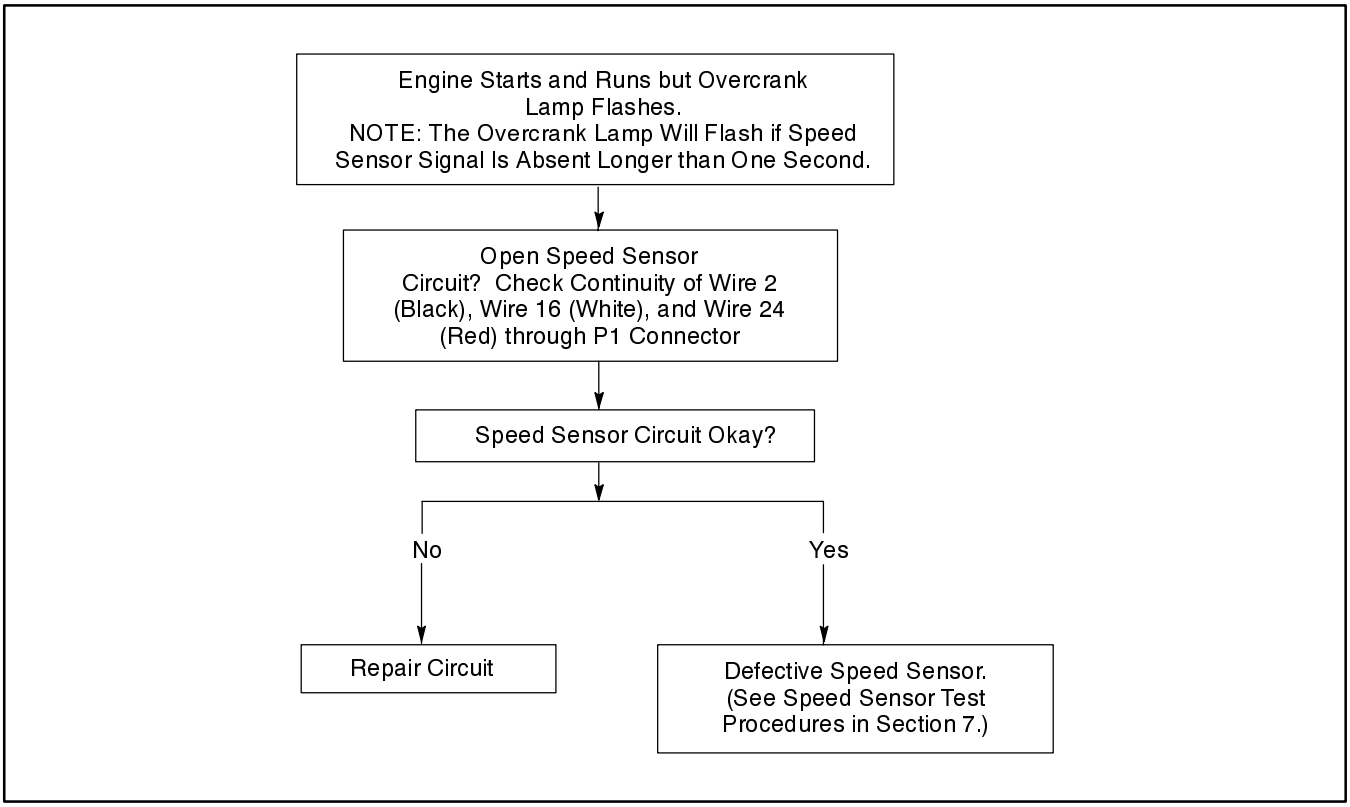


Figure 6-16. Troubleshooting Microprocessor Controller Circuit Board (Sheet 5 of 5)

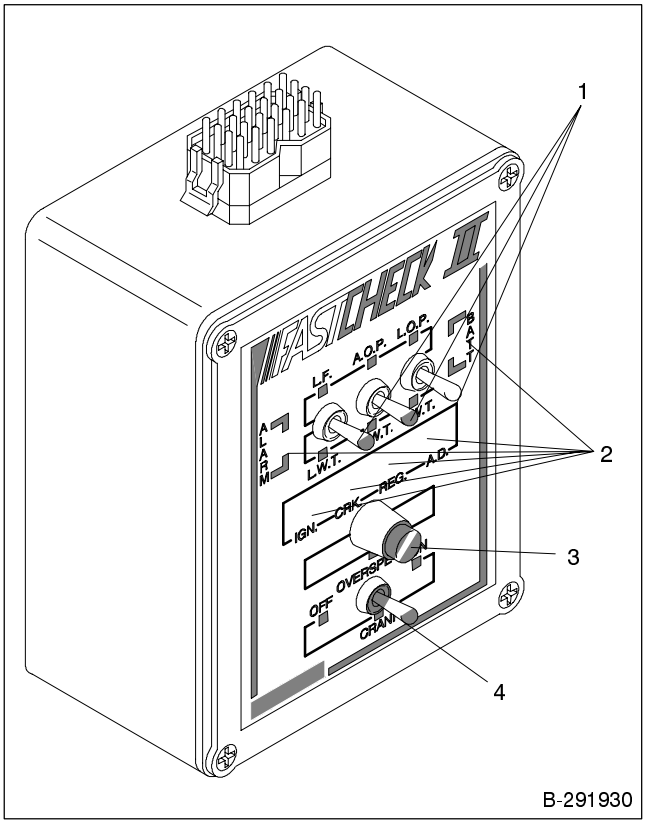
FASTCHECK® Features and Operation

The FASTCHECK® is an engine simulator for testing and troubleshooting the 5-light microprocessor controller.

Features

Engine conditions are simulated by the following engine switch positions:

- **OFF**—locked engine (starter energized but not turning).
- **CRANK**—engine cranking but not started.
- **RUN**—engine running



1. Toggle switches
2. Indicator lamps
3. Overspeed button
4. Engine switch

Figure 6-17. FASTCHECK® Simulator

Indicator Lamps

IGN. (ignition) lamp shows

- battery voltage supplied to fuel pump, fuel solenoid, and water valve (city-water cooled sets)
- lights during cranking and running

CRK. (crank) lamp shows

- battery voltage switched to starter (engine not necessarily turning)
- lights only during on-crank cycles

REG. (regulator) lamp shows

- battery voltage supplied to generator's AC voltage regulator
- lights only during cranking and running

BATT. (battery) lamp shows

- lights when test battery or DC power supply is live and correctly connected.

NOTE

LOP, and OVERSPEED simulate malfunctions causing engine shutdown. LOP circuits will start timing after engine has been running for 30 seconds. Engine shutdown should occur 5 seconds after pushing fault switch.

Switches

LOP—low oil pressure

HWT—high water (engine) temperature (not used)

OVERSPEED—simulates a 70 Hz overspeed condition

LF—low fuel (not used for testing)

LWT—low engine water temperature (not used)

ALOP—anticipatory (pre) low oil pressure

AWT—anticipatory (high) water temperature (not used)

Operation

Use the FASTCHECK® to test the 5-Light Microprocessor Controller on the generator set when troubleshooting start-up problems occur or to test and troubleshoot the controller when removed from the generator set.

To operate the FASTCHECK® the following equipment is required:

- FASTCHECK® simulator (A-291930) and harness (255915)
- Variable low-voltage DC power supply; 0 to 30 volt, 3-amp minimum current, 0.5% maximum output voltage ripple at 30 volts DC. A 12-volt battery can also be used to operate the FASTCHECK®.

To Connect/Operate The FASTCHECK® Tester

1. Unplug DC engine harness from DC harness connector (P1). See Figure 6-18.
2. Connect FASTCHECK® harness to DC harness connector (P1) and top of FASTCHECK®.
3. Move the generator set master switch to the OFF/RESET position.
4. Move FASTCHECK® engine switch to OFF.
5. Clip red (+) and black (–) harness leads to battery(ies) or DC power supply of correct voltage for generator set (12 volt). The generator set battery(ies) may be used if accessible and fully charged.

NOTE

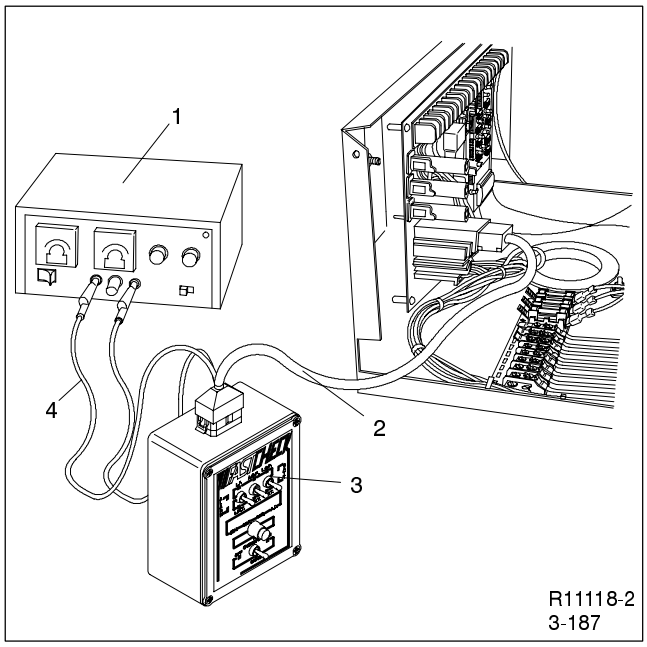
Because of the absence of AC output, the LOW WATER TEMP/AUXILIARY lamp flashes during controller testing.

6. Move FASTCHECK® engine switch to CRANK. FASTCHECK® IGN., CRK., and REG. lamps should light. FASTCHECK® simulates cyclic cranking (15 seconds on, 15 seconds off, 15 seconds on, etc.) until engine switch is moved to RUN or OVERCRANK shutdown appears on FASTCHECK®.
7. Move the FASTCHECK® engine switch to RUN. CRK. lamp should go out and REG. and IGN. lamps should stay on.
8. Simulate engine malfunctions by pressing FASTCHECK® fault switches. Corresponding fault lamp on controller should light during each simulated engine malfunction.

NOTE

Leave the FASTCHECK® engine switch in RUN position for at least 30 seconds before pushing toggle switches. Toggle generator set master switch to OFF/RESET and FASTCHECK® engine switch to OFF, then back to RUN after simulated fault shutdowns.

9. Procedures to test overcrank circuitry, speed sensor circuitry, and generator condition indicators are described later in this section.



1. DC power supply
2. FASTCHECK® wiring harness
3. FASTCHECK®
4. DC harness connector

Figure 6-18. FASTCHECK® Connections

Overcrank

To test the controller's ability to do the following:

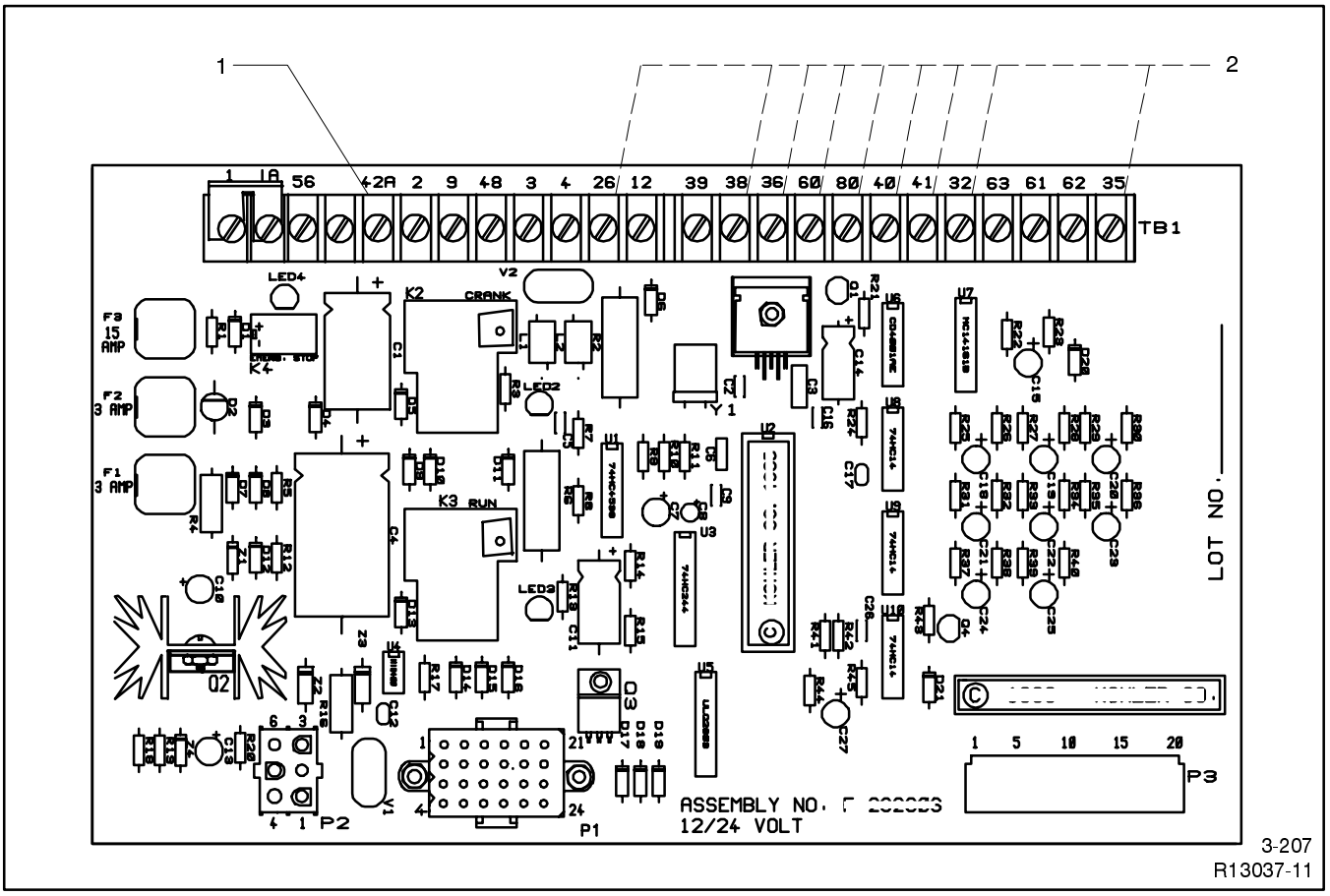
- Detect a locked engine.
- Stop a start-up attempt if the starter locks or will not engage.

1. Move FASTCHECK® engine switch to OFF.
2. Move the generator set master switch to OFF and then move switch to RUN.
3. IGN., CRK., and REG. lamps on FASTCHECK® should light for approximately 5 seconds and then go out. Five seconds later the IGN., CRK., and REG. lamps should relight for 5 seconds before going out again (15 seconds total elapsed time). Controller OVERCRANK lamp lights. Check for operating voltage between TB1-42A (+) and TB1-12 (–).
4. This test verifies the operation of the entire overcrank circuit. If the OVERCRANK shutdown fails to function, check the speed sensor and related circuitry.

Controller Speed Sensor Circuitry

To test speed sensor output, refer to Section 7, Speed Sensor. To check the controller's ability to respond to signals from the speed sensor perform the following test:

1. Move the generator set master switch to the OFF/RESET position.
2. Move FASTCHECK® engine switch to OFF position.
3. Move the generator set master switch to the RUN position. Observe IGN., CRK., and REG. lamps light.
4. Within 5 seconds, move FASTCHECK® engine switch to RUN.
5. If CRK. lamp goes out on FASTCHECK®, the controller speed sensor circuitry is functioning.



1. TB1-42A (+)
2. TB1- (see chart)

Figure 6-19. Indicator Lamp Test Connections

Generator Condition Indicator Terminals (TB1 Terminal Strip)

Connect remote accessories (A/V alarm, Decision Monitor™, Alarm Contact Kits, etc.) to the controller TB1 terminal strip to signal the condition of the generator set. (The generator set may not be equipped with the sending devices necessary to operate all generator condition indicators.) If remote accessories will not operate, test for output voltage at the TB1 terminal strip. To test the operation of each indicator, move the generator set master switch and FASTCHECK® engine switch to the position indicated (see chart). Check for voltage at the prescribed test points with the FASTCHECK® toggle in the position prescribed. Test point voltage should be slightly less than the voltage being supplied to the controller (12 volts). If correct voltage is not detected at the test point, remote accessories (A/V alarm, Decision Monitor™, dry contact kits, etc.) will not function. Test point connections are shown in Figure 6-19.

NOTE

When checking controller test point voltage, place negative (–) lead of voltmeter on terminal designated in the chart and voltmeter positive (+) lead on TB1-42A.

NOTE

Because of the absence of AC output, the Low Water Temperature/AUX. lamp will flash during controller testing.

NOTE

Leave FASTCHECK® engine switch in the RUN position for at least 30 seconds before pushing toggle switches. Toggle generator set master switch to OFF/RESET position. Move the FASTCHECK® engine switch to OFF position. Move generator set master switch to RUN position. Observe IGN., CRK., and REG. lamps light. Within 5 seconds, move the FASTCHECK® engine switch to RUN.

Indicator	Switch Position/Remarks	Check for Presence of 12 Volts DC Between:
System Ready	Master switch in AUTO position; engine switch in OFF position	TB1-42A (+) and TB1-60 (–)
Low Oil Pressure (LOP)	Master switch in RUN position; engine switch in RUN position; hold toggle switch to LOP for at least 5 seconds	TB1-42A (+) and TB1-38 (–)
Auxiliary (AUX.)	Master switch in RUN position; engine switch in RUN position; wait 10 seconds. Flashing AUX. lamp indicates operation of all auxiliary functions	TB1-42A (+) and TB1-26 (–)
Emergency Stop (local/remote)	Master switch in RUN position; engine switch in RUN position; remove switch lead connected to controller terminals TB1-1 or 1A.	Not Applicable
Not in Auto	Master switch in RUN or OFF/RESET; engine switch in any position	TB1-42A (+) and TB1-80 (–)
Anticipatory (Pre) Low Oil Pressure (ALOP)	Master switch in RUN position; engine switch in RUN; hold toggle to ALOP	TB1-42A (+) and TB1-401 (–)
Low Fuel	Ground master switch in OFF/RESET; engine switch in RUN position Ground controller terminal TB1-63 to test. If Low Fuel Lamp lights, circuit is functioning	Not Applicable
Battery Charger Fault (if battery charger equipped)	Generator master switch in OFF/REST; engine switch in RUN position Ground controller terminal TB1-61 to test. If Low Battery Volts lamp lights, circuit is functioning	Not Applicable
Common Fault Line	Master switch in RUN position; engine switch in RUN; hold toggle switch to LWT, HWT, or LOP	TB1-42A (+) and TB1-32 (–)
Overspeed	See Controller Speed Sensor Circuitry earlier in this section	Not Applicable
Overcrank	See Overcrank earlier in this section	Not Applicable

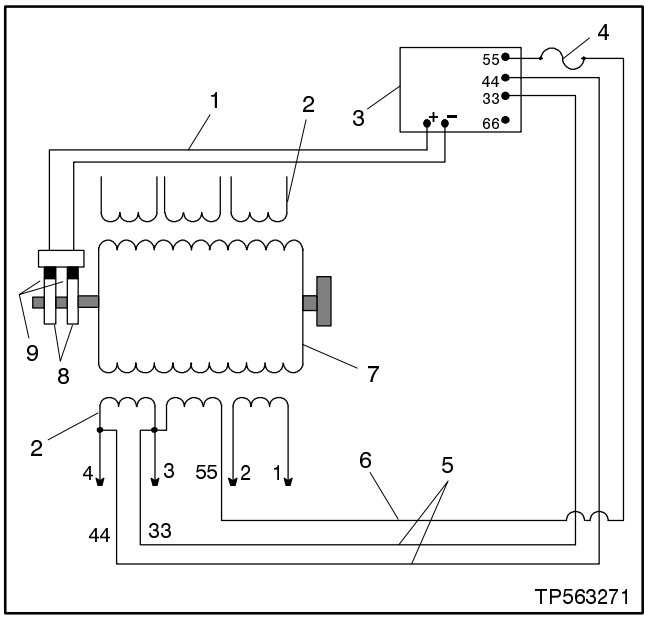
Figure 6-20. Terminal Strip Testing

Notes

Section 7. Component Testing and Adjustment

Theory of Operation, 1-Phase Generators with PowerBoost™ IIIE

The single-phase models utilize a rotating field generator to produce AC current. When the start switch is activated, the rotor (field) is magnetized by DC current from the battery. When the magnetized rotor is rotated within the stator windings, an electrical current develops within the stator. As engine speed and generator output increase, stator output current (rectified by the voltage regulator) is fed to the rotor through the brushes/slip rings to increase the strength of the rotor field. As the rotor field increases in strength, generator output also increases. The voltage regulator monitors the generator output voltage through leads 33 and 44 and allows the correct amount of DC current to flow to the rotor to meet load requirements. See Figure 7-1.

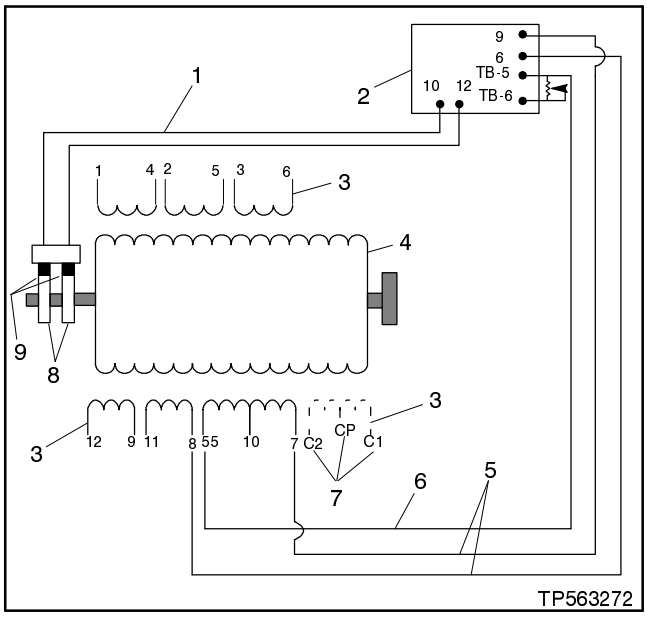


1. DC output excitation
2. Stator
3. Voltage regulator PowerBoost™ IIIE
4. 5-amp fuse
5. Sensing leads (33-44)
6. Power lead (55)
7. Main field (rotor)
8. Slip rings
9. Brushes

Figure 7-1. 6.5RMY, 1-Phase Generator Schematic

Theory of Operation, 3-Phase Generators with PowerBoost™ V

The three-phase models utilize a rotating field generator to produce AC current. When the start switch is activated, the rotor (field) is magnetized by DC current from the battery. When the magnetized rotor is rotated within the stator windings, an electrical current develops within the stator. As engine speed and generator output increase, stator output current (rectified by the voltage regulator) is fed to the rotor through the brushes/slip rings to increase the strength of the rotor field. As the rotor field increases in strength, generator output also increases. The voltage regulator monitors the generator output voltage through leads 7 and 8 and allows the correct amount of DC current to flow to the rotor to meet load requirements. See Figure 7-2.



1. DC Output excitation
2. Voltage regulator PowerBoost™ V
3. Stator
4. Main field (rotor)
5. Sensing leads (7-8)
6. Power lead (55)
7. Battery charging leads (C1, C2, CP) (available Spec. No. 140119 and above)
8. Slip rings
9. Brushes

Figure 7-2. 6.5RMY, 3-Phase Generator Schematic

Generator Troubleshooting

To determine the cause of no or low AC output, refer to the troubleshooting flow chart (Figure 7-3) and the separate excitation procedure following. Before beginning the troubleshooting procedures, read all safety precautions at the beginning of this manual. Additional safety precautions are included with the tests.

Begin the troubleshooting procedure by checking the condition of the voltage regulator 5-amp fuse (1-phase only). See Section 2 (for fuse location) and Section 7, Component Testing. If the fuse is not blown, separately excite the generator. The generator field (rotor) may be excited (magnetized) using an outside power source (12-volt automotive battery). The separate excitation test duplicates the role of the voltage regulator in providing excitation current to the rotor. By separately exciting the generator to determine the presence of a faulty voltage regulator, it is possible to determine if a running fault exists in the rotor and/or stator. A generator component that appears good while static (stationary) may exhibit a running open or short while dynamic (moving). This fault can be caused by centrifugal forces acting on the windings during rotation or insulation breakdown as temperatures increase. The flow chart in Figure 7-3 summarizes the troubleshooting procedure.

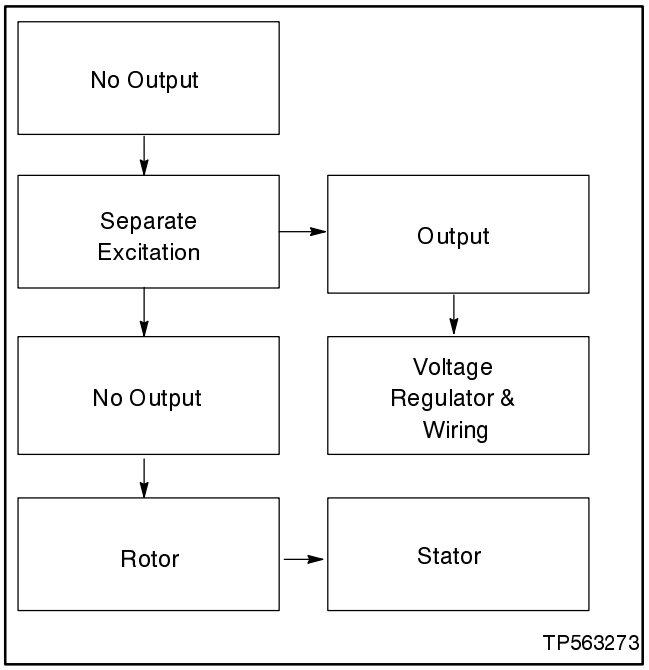


Figure 7-3. Generator Troubleshooting

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.

Separate Excitation

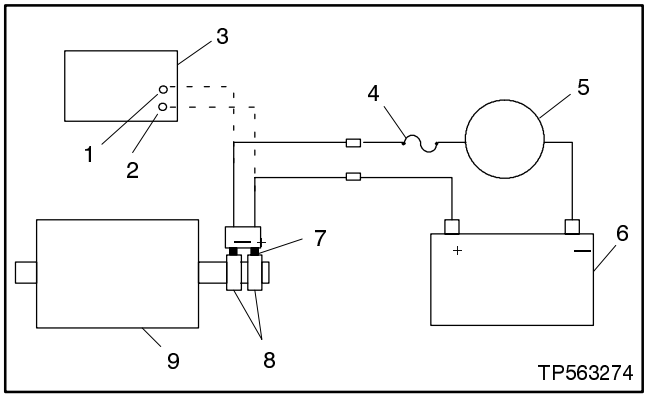
1. Disconnect all leads from voltage regulator.
2. Connect a DC ammeter, 10-amp fuse, and a 12-volt automotive battery to the positive (+) and negative (–) brush leads as shown in Figure 7-4. Note and record the ammeter reading.
3. The approximate ammeter reading should be battery voltage divided by specified rotor resistance.

   Example:

   $$\frac{\text{12 volts (battery voltage)}}{\text{5.1 ohms (rotor resistance)}} = \text{2.4 amps (rotor current)}$$

   Specified rotor resistance values are found in Section 1, Specifications.

4. Start engine and check that ammeter remains stable. An increasing meter reading indicates a shorted rotor. A decreasing meter reading to zero or an unstable reading suggests a running open. Refer to Rotor to test rotor. If ammeter is stable proceed to Step 5.
5. Check for AC output across stator leads (see Stator) and compare to readings in Section 1, Specifications. If readings vary considerably, a faulty stator is likely. Refer to Stator for further information.
6. If rotor and stator test good in prior steps, the voltage regulator is probably defective. See Voltage Regulator.



1. (–) Terminal—1-phase (12) Terminal—3-phase
2. (+) Terminal—1-phase (10) Terminal—3-phase
3. Voltage regulator
4. 10-amp fuse
5. DC ammeter
6. 12 V battery
7. Brushes
8. Slip rings
9. Main field (rotor)

Figure 7-4. Separate Excitation Connections

Voltage Regulator Test—PowerBoost™ IIIE

The voltage regulator used on the 1-phase models is PowerBoost™ IIIE. See Figure 7-5.

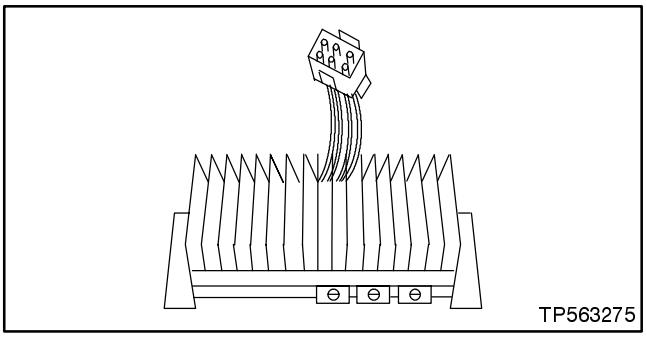


Figure 7-5. PowerBoost™ IIIE Voltage Regulator

The voltage regulator monitors output voltage magnitude and frequency to supply current to the generator exciter field. If the regulator 5-amp fuse is blown, the generator set shuts down. Verify regulator fuse is good before proceeding with test. To determine if the voltage regulator is functioning, reduce engine speed (Hz) and watch for a corresponding drop in AC voltage. AC voltage should remain constant until engine speed drops below 57.5 Hz (on 60 Hz models) or 47.5 Hz (on 50 Hz models). When frequency drops below 57.5/47.5 Hz, AC voltage should decline. If this test proves inconclusive, perform the following test to check regulator output. To test the voltage regulator the following components will be needed:

- Variable Transformer, 0-140 Volts (0.5-amp Minimum)
- 120 Volt AC Plug
- 120 Volt, 100-Watt Lamp
- AC Voltmeter
- #14 AWG Copper Wire (Minimum)

⚠ WARNING

Hazardous voltage. **Moving rotor.**

Can cause severe injury or death.

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

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.

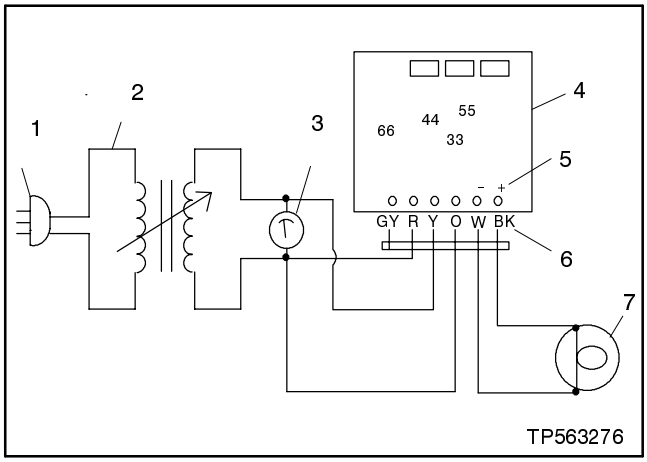
Grounding generator set. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the generator set and electrical circuits 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.

Test Procedure

1. Connect components as shown in Figure 7-6.
2. Turn variable transformer setting to zero. Plug in variable transformer.
3. Turn variable transformer on. Slowly increase variable transformer voltage to 100 volts. The lamp should go on. If the lamp does not light, turn the voltage adjustment potentiometer (pot) clockwise. If the light still does not go on, the voltage regulator is defective and should be replaced. A voltage regulator failing the test would cause a generator no/low output condition.
4. Slowly increase voltage to 120 volts. The lamp should go out and stay out as voltage is further increased. If the lamp does not go out, turn the voltage adjustment pot counterclockwise. If the light still does not go out, replace the voltage regulator. A voltage regulator failing the test would cause a generator high voltage output condition.
5. Turn variable transformer to zero and unplug AC cord.

NOTE

Terminal 66 on PowerBoost™ IIIE voltage regulator is intended for connection of a remote rheostat in applications where fine voltage adjustment is required.



1. 120 volts AC
2. Variable transformer
3. AC voltmeter
4. Voltage regulator PowerBoost™ IIIE
5. Stator/rotor connections (for reference only)
6. Lead color
7. 120 volt, 100-watt lamp

Figure 7-6. PowerBoost™ IIIE Voltage Regulator Test

Voltage Regulator Adjustment

The PowerBoost™IIIE voltage regulator monitors generator output to control current flow to the generator field. PowerBoost™IIIE maintains generator output at specified voltage under load until the generator engine speed drops to a pre-set level (factory setting 57.5 Hz on 60 Hz models and 47.5 Hz on 50 Hz models). At this point the regulator allows generator voltage and current to drop. The voltage/current drop enables the engine to pick up the load. When the generator speed returns to normal (60 Hz or 50 Hz) as load is accepted, generator output also returns to normal. The voltage regulator is factory set for proper generator operation under a variety of load conditions. Under normal circumstances, no further adjustment is necessary. However, if the regulator is replaced or has been tampered with, readjust according to the following procedure. Voltage regulator components are identified in Figure 7-7 and described in the following paragraphs.

NOTE

The voltage regulator is located on the generator end bracket and is serviceable by removing four screws.

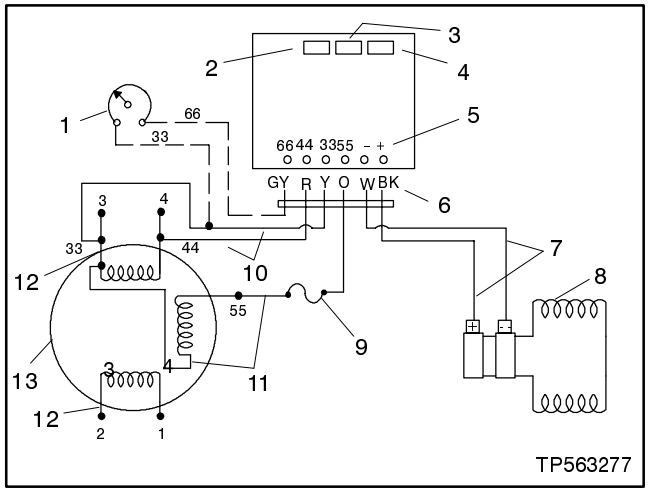
Voltage Adjustment Pot—Adjusts generator output within range of 100-130 volts.

NOTE

A customer-provided rheostat may be connected across regulator leads/terminals 33 and 66 to adjust generator output voltage from a location remote from the set. The rheostat (10K ohms, 1/2 watt minimum) provides a 5- volt adjustment range.

Stabilizer Pot—Fine-tunes regulator circuitry to reduce light flicker.

Volts/Hz Pot—Adjustment determines engine speed (Hz) at which generator output voltage will begin to drop.



1. Remote rheostat
2. Voltage adjustment potentiometer
3. Stabilizer potentiometer
4. Volts/Hz potentiometer
5. Stator/rotor connections (for reference only)
6. Lead color
7. DC output
8. Main field (rotor)
9. 5-amp fuse
10. Sensing leads (33-44)
11. AC power input (auxiliary) lead (55)
12. Main leads (1-2, 3-4)
13. Stator

Figure 7-7. PowerBoost™ IIIE Voltage Regulator

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

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

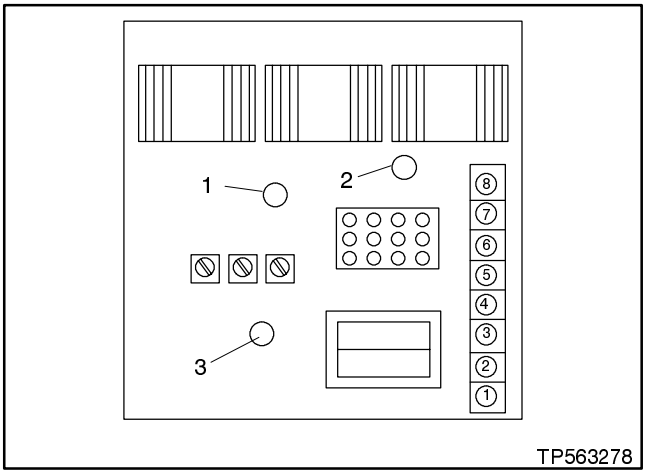
Short circuits. Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry before servicing equipment.

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.

PowerBoost™ V Voltage Regulator Adjustment Procedure

1. With generator set off, turn remote rheostat (if equipped) to mid-point. Turn voltage, volts/Hz, and stability pots fully counterclockwise. Connect voltmeter to AC circuit or an electrical outlet.
2. Start generator set. Rotate voltage adjustment pot clockwise (increase voltage) or counterclockwise (decrease voltage) until desired output voltage is achieved.
3. Rotate stability pot clockwise until minimum light flicker is obtained.
4. Readjust voltage adjustment pot (if necessary).
5. Adjust engine speed to desired cut-in frequency by installing a jumper on the electronic governor circuit board -2.5Hz/Freq terminals. See Electronic Governor (optional) later in this section. When a jumper is placed across these terminals, generator frequency will drop by 2.5 Hz. The recommended cut-in frequency is 57.5 Hz for 60 Hz operation and 47.5 Hz for 50 Hz operation (as measured on frequency meter).
6. Rotate volts/Hz adjustment pot clockwise until voltage level begins to drop (as measured on voltmeter). When set to these specifications, the generator attempts to maintain normal output until engine speed drops below the frequency set in step 5 (as load is applied).
7. Remove jumper from governor circuit board -2.5 Hz/Freq. terminals.
8. Readjust voltage adjustment pot (if necessary).
9. Readjust stability pot (if necessary).

10. Use remote rheostat (if equipped) to make final voltage adjustments.
11. Stop generator set.



1. LED1 (input) green
2. LED2 (output) red
3. LED3 (sensing) yellow

Figure 7-8. PowerBoost™ V Voltage Regulator

Voltage Regulator Test—PowerBoost™ V

The PowerBoost™ V voltage regulator monitors output voltage magnitude and frequency to supply current to the generator exciter field. LEDs offer a visual indication of sensing, input power, and field output availability. See Figure 7-8. To determine if the voltage regulator is functioning, reduce engine speed (Hz) and watch for a corresponding drop in AC voltage. AC voltage should remain constant until engine speed drops below 57.5 Hz (on 60 Hz models) or 47.5 Hz (on 50 Hz models). When frequency drops below 57.5/47.5 Hz, AC voltage should decline. If this test proves inconclusive, perform the following test to check regulator output. To test the voltage regulator the following components will be needed:

- 1:2 Step-Up Transformer (0.5-amp Minimum)
- 120 Volt AC Plug (240 Volt AC Optional)
- 250 Volt, 100-Watt Lamp
- AC Voltmeter (250 Volt Minimum)
- #14 AWG Copper Wire (Minimum)

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

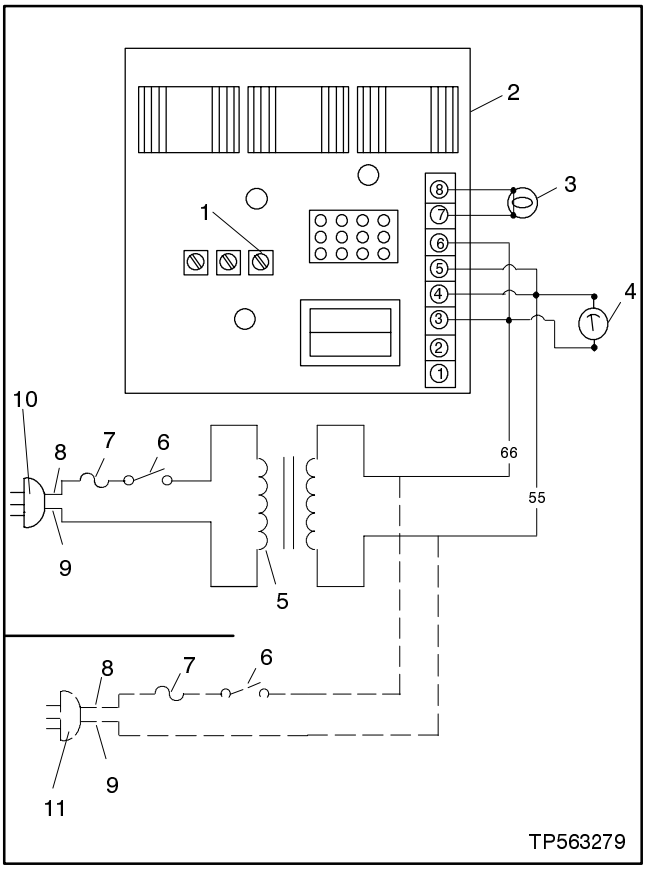
Operate generator set only with all guards and electrical enclosures in place.

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.

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.

Test Procedure

1. Connect components as shown in Figure 7-9. If a 200-240-volt power source is available, the step-up transformer is not required.
2. Turn volts pot fully counterclockwise.
3. Plug power cord into outlet. Turn power supply on. AC voltmeter should indicate power supply voltage of 200-240 volts. Lamp should be off. Slowly turn volts adjustment potentiometer (pot) clockwise. The lamp should go on. If the light does not go on, the voltage regulator is defective and should be replaced.
4. Turn power supply off and disconnect power cord.

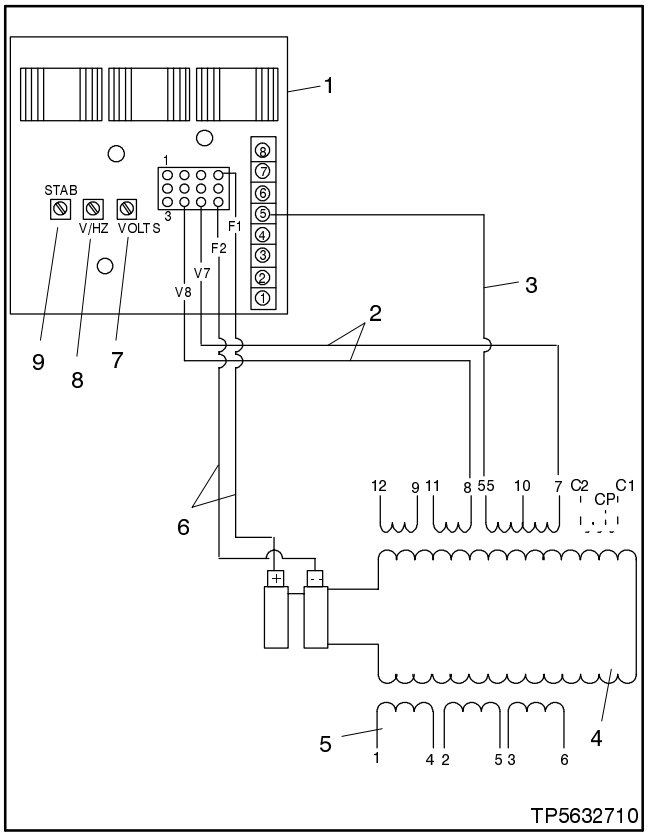


1. Volts potentiometer
2. Voltage regulator PowerBoost™ V
3. Lamp, 250 volt, 100-watt
4. AC voltmeter, 250 volt (minimum)
5. 1:2 step-up transformer
6. Single-pole single-throw switch
7. Fuse, 1-amp
8. Black wire
9. White wire
10. 100-120 vac
11. 200-240 vac (optional)

Figure 7-9. PowerBoost™ V Voltage Regulator Test

Voltage Regulator Adjustment

The PowerBoost™ V voltage regulator monitors generator output to control current flow to the generator field. However, unlike early PowerBoost™ regulators, PowerBoost™ V maintains generator output under load until the generator engine speed drops to a preset level (factory setting 57.5 Hz on 60 Hz models and 47.5 Hz on 50 Hz models). At this point (under factory settings) the regulator allows generator voltage and current to drop to a sufficient level to handle load. When the generator speed returns to normal (60 Hz or 50 Hz) as load is accepted, generator output also returns to normal. The voltage regulator is factory set for correct generator operation under a variety of load conditions. Under normal circumstances, no further adjustment is necessary. However, if the regulator is replaced or has been tampered with, readjust according to the following procedure. Voltage regulator components are identified in Figure 7-10 and described in the following paragraphs.



1. Voltage regulator PowerBoost™ V
2. Sensing leads (7, 8)
3. Power supply Lead (55)
4. Main field (rotor)
5. Stator
6. DC output
7. Voltage adjustment potentiometer
8. Volts/Hz potentiometer
9. Stabilizer potentiometer

Figure 7-10. PowerBoost™ V Voltage Regulator

Voltage Adjustment Pot adjusts generator output within range of 190-270 volts (line-to-line).

NOTE

A customer-provided rheostat may be connected across regulator terminals 1 and 2 to adjust generator output voltage from a location remote from the set. The rheostat (10K ohms, 1/2 watt minimum) provides a 5-volt adjustment range.

Stabilizer Pot fine-tunes regulator circuitry to reduce light flicker.

Volts/Hz Pot adjustment determines engine speed (Hz) at which generator output voltage will begin to drop.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

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

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.

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.

PowerBoost™ V Voltage Regulator Adjustment Procedure

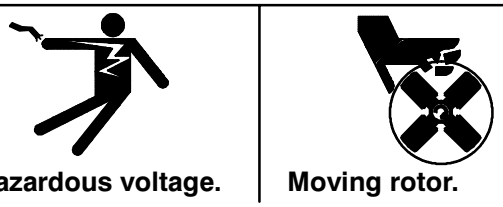
1. With generator set off, turn remote rheostat (if equipped) and stability pots to mid-point. Turn voltage and volts/Hz pots fully counterclockwise. Connect voltmeter to AC circuit or an electrical outlet.
2. Start generator set. Rotate voltage adjustment pot clockwise (increase voltage) or counterclockwise (decrease voltage) until desired output voltage is achieved.
3. Rotate stability pot clockwise until minimum light flicker is obtained.
4. Readjust voltage adjustment pot (if necessary).
5. Adjust engine speed to desired cut-in frequency by installing a jumper on the electronic governor circuit board -2.5 Hz/Freq terminals. See Section 6, Electronic Governor. When a jumper is placed across these terminals, generator frequency drops by 2.5 Hz. The recommended cut-in frequency is 57.5 Hz for 60 Hz operation and 47.5 Hz for 50 Hz operation (as measured on frequency meter).
6. Rotate volts/Hz adjustment pot clockwise until voltage level begins to drop (as measured on voltmeter). When set to these specifications, the generator attempts to maintain normal output until engine speed drops below the frequency set in step 5 (as load is applied).
7. Remove jumper from governor circuit board -2.5 Hz/Freq. terminals.
8. Readjust stability pot (if necessary).
9. Readjust voltage adjustment pot (if necessary).
10. Use remote rheostat (5-light microprocessor controller only) to make final voltage adjustments.
11. Stop generator set.

Main Field (Rotor)

The four-pole rotor creates the magnetic field needed to produce alternating current in the stator windings. Prior to testing, inspect the rotor for visible damage to pole shoes, insulation, exposed coil windings, and slip ring surfaces. Check bearing for wear, heat discoloration, or noise when rotated.

Slip rings acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright, newly-machined appearance. Ordinary cleaning with a dry, lint-free cloth is usually sufficient. Use very fine sandpaper (#00), and apply light pressure to remove roughness. Do not use emery or carborundum paper or cloth. Clean out all carbon dust from the generator. If the rings are black or pitted, remove the rotor and remove some of the surface material using a lathe.

⚠ WARNING



Hazardous voltage. **Moving rotor.**

Can cause severe injury or death.

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

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.

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.

1. Disconnect generator set engine starting battery, negative (–) lead first. Disconnect power to battery charger, if equipped.
2. Check the rotor for continuity and resistance. Measure the rotor resistance (ohms) between the two slip rings (Figure 7-11). Raise the brushes from the slip rings while performing ohmmeter tests. See Section 1, Specifications for rotor resistance readings. If the resistance test proves inconclusive, perform megohmmeter test on rotor as described in next step.

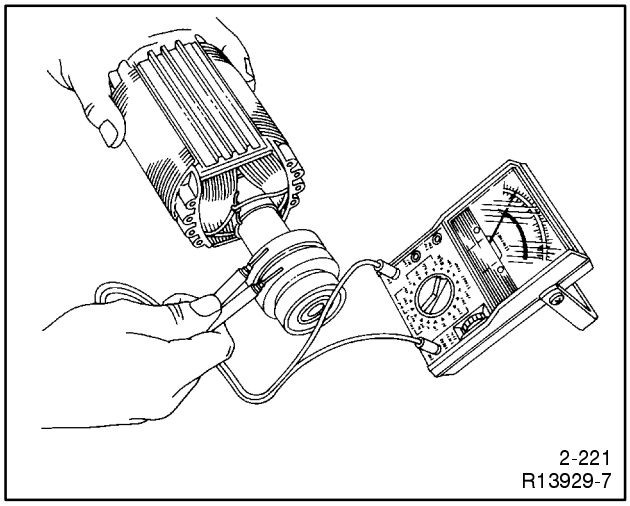


Figure 7-11. Rotor Resistance Check

NOTE

Because ohmmeters vary in their accuracy, use resistance readings as a reference for approximate readings. Readings must be at room temperature.

3. Determine whether the rotor is shorted to ground by performing a megohmmeter test. Raise brushes away from slip rings and secure in this position by inserting a retaining wire in the brush holder hole.

   Using a megohmmeter, apply 500 volts DC to either rotor slip ring and rotor poles or shaft. Follow the instructions of the megohmmeter manufacturer when performing this test.

   A reading of approximately 500K ohms (1/2 megohm) and higher indicates the rotor is good.

   A reading of less than 500K ohms (approximately) indicates deterioration of the winding insulation and possible current flow to ground. Repair or replacement of the rotor is necessary.

   Following test, remove retainer wire from brush holder and verify that brushes are correctly positioned on slip rings. (See Brushes, later in this section.)

Stator, 1-Phase

The stator consists of a series of coils of wire laid in a laminated steel frame. The stator leads supply voltage to the AC load and voltage regulator. Prior to testing, inspect the stator for heat discoloration and visible damage to housing lead wires, exposed coil windings, and exposed and varnished areas of frame laminations. Be sure the stator is securely fastened in the stator housing.

NOTE

Disconnect all stator leads prior to performing all stator tests.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

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

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.

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.

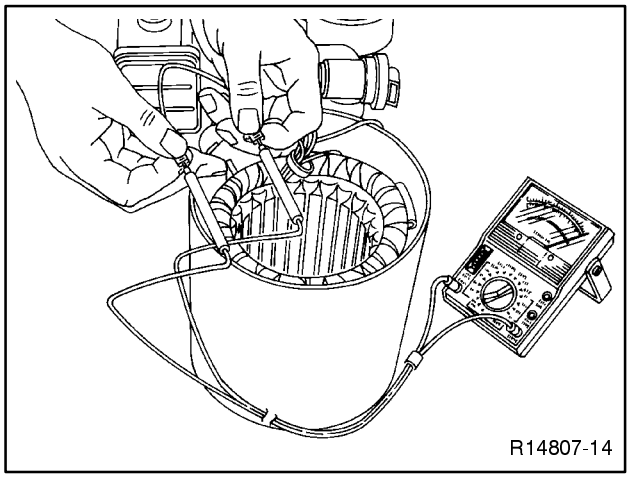


Figure 7-12. Testing Stator Windings

1. Disconnect generator set engine starting battery, negative (–) lead first. Disconnect power to battery charger, if equipped.
2. To check stator continuity, set ohmmeter on R x 1 scale. Contact the red and black meter leads while adjusting ohmmeter to zero ohms. Check stator continuity by connecting meter leads to stator leads as shown in Figure 7-12.

   Leads 1, 2, 3, and 4 are the generator output leads. Leads 33, 44, and 55 are the voltage regulator sensing and supply leads. Refer to the schematic in Figure 7-13 when performing the following tests.

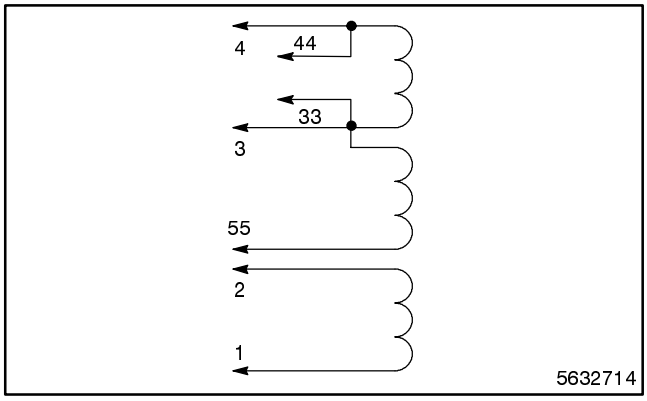


Figure 7-13. Generator Stator Leads

Leads	Continuity
1 and 2	Yes
3 and 4	Yes
33 and 44	Yes
3 and 44	Yes
55 and 3	Yes
55 and 33	Yes
1 and 3,4,33,44,55	No
Any stator lead and ground on stator housing or frame laminations	No

Figure 7-14. Continuity Test

3. Contact ohmmeter leads and readjust ohmmeter to zero ohms. Check cold resistance of stator windings by connecting meter leads to stator leads 1-2, 3-4, 33-44, and 55-33. Typical stator winding resistance readings are found in Section 1, Specifications. If the resistance test proves inconclusive, perform a megohmmeter test on stator as described in next step.

NOTE

Because ohmmeters vary in their accuracy, use resistance readings as a reference for approximate readings. Ohmmeter readings must be taken at room temperature.

NOTE

Most ohmmeters will not provide accurate readings below 1 ohm. Consider the stator good if the resistance reading (continuity) is low and there is no evidence of shorted windings (heat discoloration).

4. Perform a megohmmeter test to determine whether the stator is shorted to ground. Using a megohmmeter, apply 500 volts DC to any stator lead and stator frame. Perform the megohmmeter test following the instructions of the megohmmeter manufacturer. Repeat test on other stator leads until each coil is tested.

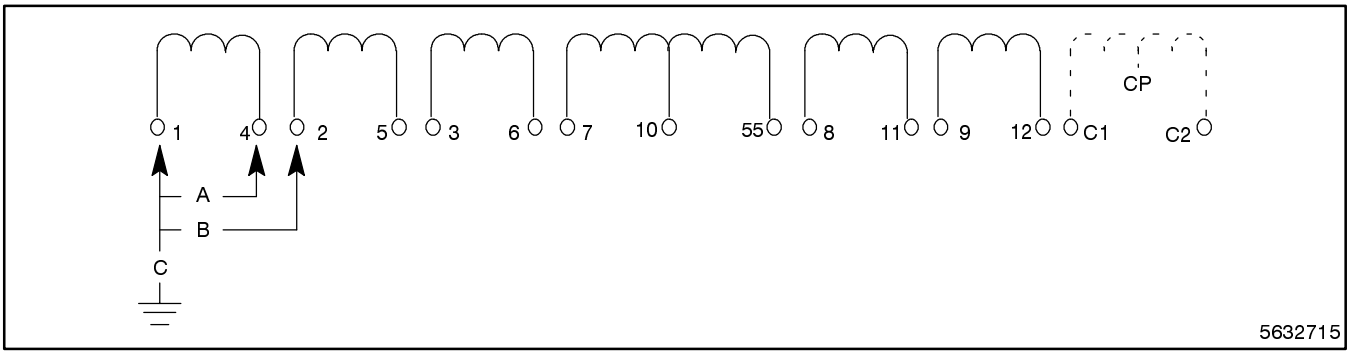
   A reading of approximately 500K ohms (1/2 megohm) and higher indicates the stator is good.

   A reading of less than 500K ohms (approximately) indicates deterioration of winding insulation and possible current flow to ground. Repair or replace stator.

Stator, 3-Phase

The stator produces electrical output (AC) as the magnetized main field rotates within the stator windings. Test the condition of the stator according to the following procedure.

1. Disconnect generator set engine starting battery, negative (–) lead first. Disconnect power to battery charger, if equipped.
2. Check the generator output leads for correct connections (see Wiring Diagrams Manual).
3. Check condition of V0, V7, V8, and V9 at stator, terminal strip TB2 (relay controller) or TB3 (5-light microprocessor controller), and at voltage regulator (V7 and V8).
4. Use an ohmmeter to check continuity of V7, V8, and 55 leads between stator and voltage regulator. No continuity (low resistance) indicates an open lead. Repair any open leads.
5. Inspect stator for evidence of shorted windings (heat discoloration). If the stator shows signs of heat discoloration, test stator windings as described in the following steps before replacing stator.



1. A—continuity/resistance between points
2. B—no continuity between points
3. C—no continuity between points

Figure 7-15. Generator Stator Leads

6. Disconnect all stator leads to isolate windings. To check stator continuity, set ohmmeter on R x 1 scale. Contact the red and black ohmmeter leads; adjust ohmmeter to zero ohms. Check stator continuity by connecting meter leads to stator leads as shown in Figure 7-15.

NOTE

Leads	Continuity
1 and 4, 2 and 5, 3 and 6, etc.	Yes
1-4 and any other winding. This also applies to windings 2-5, 3-6, 7-10-55, etc.	No
Any stator lead and ground on stator housing or frame laminations.	No

Perform stator tests on all stator windings.

7. Contact ohmmeter leads and readjust ohmmeter to zero ohms. Check cold resistance of stator windings by connecting meter leads to stator leads 1-4, 2-5, 3-6, etc. Typical stator winding resistances are found in Section 1, Specifications. If the stator resistance test proves inconclusive, perform a megohmmeter test on stator as described in the next step.

NOTE

Most ohmmeters will not provide accurate readings when measuring less than one ohm. The stator can be considered good if a low resistance reading (continuity) is obtained and there is no evidence of shorted windings (heat discoloration).

⚠ 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.

Moving rotor.

Can cause severe injury or death.

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

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.

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.

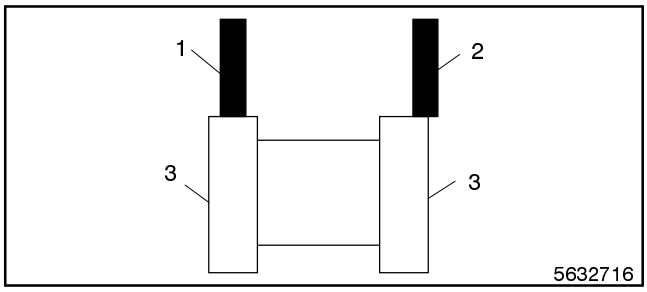
8. Check stator for a grounded condition. Using a megohmmeter, apply 500 volts DC to any stator lead from each winding and stator frame. (Follow the instructions of the megohmmeter manufacturer when performing this test.) Repeat test on other leads until all stator windings have been tested. A reading of approximately 500K ohms (1/2 megohm) and higher indicates the stator is good. A reading of less than 500K ohms (approximately) indicates deterioration of winding insulation and possible current flow to ground. Repair or replacement of the stator is necessary.

Brushes

The brushes transfer current from the voltage regulator to the slip rings. Because the brushes carry a very low current (approximately 2-amps), they should last the life of the generator. Abrasive dust on the slip rings could, however, shorten the life of the brushes. Excessive arcing at the brushes could damage the voltage regulator. Arcing could be caused by weak springs, damaged slip rings, sticking brushes, loose holder, or poor brush contact.

The brushes must be free to move within the holder and be held in contact by the springs. When correctly positioned, spring pressure on the brush surface will cause the brush to wear evenly. Brushes must ride 100% on the rings or arcing will occur and cause burned rings or failure of the voltage regulator. Figure 7-16 shows the correct positioning of the brushes. Add or remove shims as necessary to center brushes on slip rings.

Replace brushes if they show excessive or uneven wear.



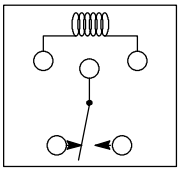
1. Correctly positioned brush
2. Incorrectly positioned brush
3. Slip ring

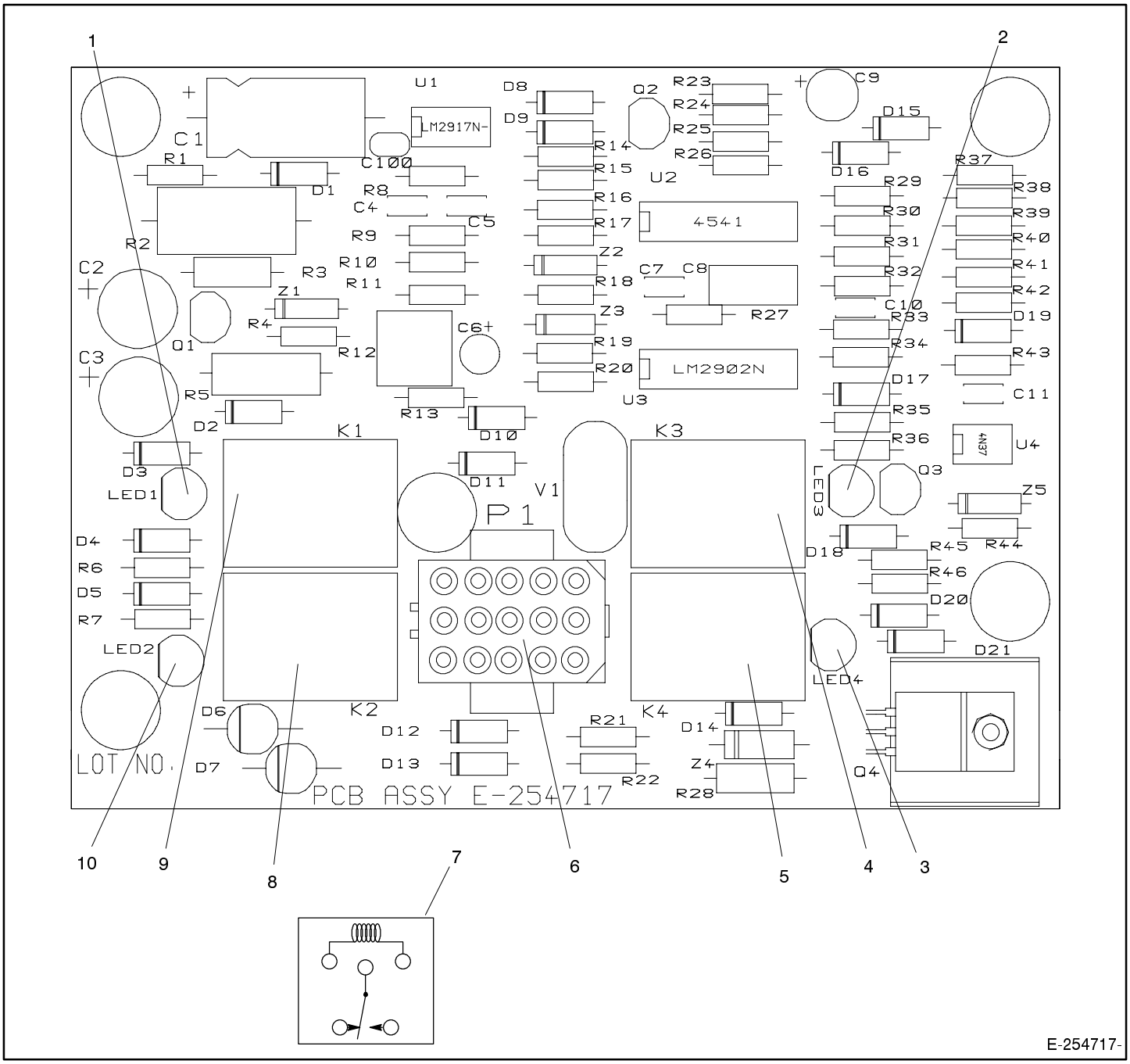
Figure 7-16. Brush Positioning

Controller Circuit Board

Some controller circuit board components can be checked without removing the component from the

board. These checks should be made prior to installing a new board and attempting start-up. Most of the tests are referenced in Section 4, General Troubleshooting. Use a high quality multimeter and follow the manufacturer's instructions. To obtain accurate readings when testing, remove all circuit board connectors and conformal coating (transparent insulation) from component terminals. Use the following chart and the controller circuit board illustration, see Figure 7-17.

Component	Ohmmeter Connection	Remarks	Results
K1, K2, K3, K4 Relay Coil	K1 Coil Terminals (see relay schematic)  Relay Schematic	Ohmmeter on R x 10 scale	If good, approx. 400 ohms. Low resistance (continuity)—shorted coil. High resistance— open coil.



1. LED1
2. LED3
3. LED4
4. K3 relay
5. K4 relay
6. P1 connector
7. K1, K2, K3, K4 relay schematic
8. K2 relay
9. K1 relay
10. LED2

Figure 7-17. Controller Circuit Board

Engine/Generator Components

With the generator set battery connected, the wiring harness and some engine/generator components can be checked. Place the controller master switch or remote start/stop switch in the prescribed position and check for voltage at each component using a voltmeter. This will verify that the switches function and voltage is present at each component.

Component	Voltmeter Connections	Procedure	Results
Hourmeter and Wiring	Red test clip to hourmeter (+) terminal. Black test clip to hourmeter (–) terminal.	Voltmeter setting 12 volts DC or greater. Start generator set.	12 volt DC reading indicates wiring harness is okay. Hourmeter will function if good.
Fault Lamp and Wiring	Red test clip to fault lamp (+) terminal. Black test clip to fault lamp (–) terminal.	Voltmeter setting 12 volts DC or greater. Start generator set. Connect a jumper from LOP (low oil pressure) switch to ground to cause LOP shutdown.	12 volt DC reading indicates wiring harness is okay. Fault lamp should light if good.
Stator 1-2, 1PH; 7-10, 3PH Winding (control winding)	V0 and V7 terminals in controller.	Voltmeter setting 150 volts AC or greater. Start generator set and allow to reach rated speed.	Reading of 120 volts AC (approx.) indicates stator winding is good.
Choke Heater, Carburetor Solenoid (gasoline), Fuel Pump, Fuel Valve (LP)	Red test clip to each component positive (+) terminal. Black test clip to engine block (ground).	Place controller or remote switch to START position. Voltmeter setting 12 volts DC or greater.	12 volt DC reading indicates wiring harness is okay. To determine if fuel pump, fuel valve (LP), or vaporizer solenoid (LP) is good, proceed to next step. Also see engine component ohmmeter checks following.
Fuel Pump (gasoline only)	None	Disconnect fuel pump battery positive (+) lead and apply 12 volts DC. **WARNING**: See Safety Precautions before proceeding.	If good, fuel pump will operate.
Gas Valve (gaseous fuel only)	None	Disconnect fuel valve battery positive (+) lead and apply 12 volts DC. **WARNING**: See Safety Precautions before proceeding.	If good, fuel valve will actuate; fuel valve will make audible click sound.
Governor Actuator	None	Disconnect actuator harness and apply 12 volts DC to actuator.	If good, actuator will thrust. Actuator should return to relaxed position when DC is removed.

Figure 7-18. Engine/Generator Component Testing (Sheet 1 of 4)

Component	Voltmeter Connections	Procedure	Results
Oil Pressure Gauge (if equipped)	Red test lead to positive side (wire 70) of gauge. Black test lead to generator ground connection.	Start generator set to test voltage. Battery voltage (approx. 12 volts DC) should be read. If no voltage, check controller circuit board and wiring. If voltage is present at gauge, stop set and check continuity of wiring between gauge and ground. (Resistance of sender will be read during continuity check. See Oil Pressure Sender in Section 1.)	If wiring tests okay, replace gauge.
Voltmeter (if equipped)	Red test lead to positive side (wire 70) of gauge. Black test lead to generator ground connection.	Start generator set. Battery voltage (approx. 12 volts DC) should be read. If no voltage, check controller circuit board and wiring. If voltage is present, stop set and check continuity of wiring between meter and ground.	If wiring tests okay, replace meter.

Figure 7-19. Engine/Genrator Component Testing (Sheet 2 of 4)

To further check generator set components, disconnect the battery and remove wiring harness plugs from the controller circuit board. Use an ohmmeter to check continuity and to isolate defective components. Use the following chart and the Wiring Diagrams Manual.

NOTE

Before performing ohmmeter checks, disconnect generator set battery to prevent damage to the ohmmeter.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

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

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.

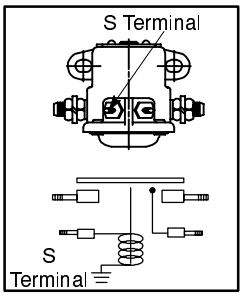
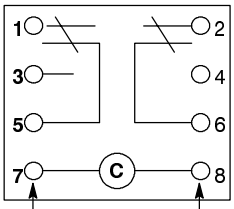
Component	Voltmeter Connections	Procedure	Results
Generator Set Master Switch	P1-2 (47) and P1-14 (N)	Ohmmeter on R x 1000 scale. Place master switch in RUN position.	If good, zero ohms (continuity). Any resistance other than zero indicates defective switch.
	P1-2 (47) and P1-14 (N)	Ohmmeter on R x 1000 scale. Place master switch in OFF/RESET position.	If good, no reading (infinity). Any other reading indicates defective switch.
Remote Switch Light (if equipped)	(+) and (–) terminals	Ohmmeter on R x 1 scale	If good, continuity. No continuity, replace light.
Hourmeter	(+) and (–) terminals	Ohmmeter on R x 1 scale	If good, continuity. No continuity, replace hourmeter.
Choke Heater	Choke terminals	Ohmmeter on R x 100 scale	If good, continuity.
P1 Wiring Harness	P1-14 and ground (relay controller) PI-5 and ground (5-light microprocessor controller)	Ohmmeter on R x 1 scale	If good, zero ohms. Any other reading indicates a poor ground connection.
	P1-12 and P1-15 (1 and 2 stator leads, 1PH) (7 and 10 stator leads, 3PH)	Ohmmeter on R x 1 scale	If good, continuity (zero ohms).
P2 wiring harness (5-light microprocessor controller)	P2-6 and ground	Ohmmeter on R x 1 scale	If good, zero ohms. Any other reading indicates a poor ground connection.
Relay Controller 10-amp Fuse and Wiring	P1-10 and battery positive (+) cable	Ohmmeter on R x 100 scale	If good, zero ohms. No continuity, open circuit and/or blown fuse.
Voltage Regulator Circuit 5-amp Fuse, (PowerBoost™ IIIE only)	P10-5 and stator lead 55 at fuse holder (relay controller). P10-5 and P8-2 (5-light microprocessor).	Ohmmeter on R x 100 scale	If good, zero ohms. No continuity, blown fuse or open wiring.
K20 Relay Coil (starter relay) NOTE: See illustration below. 	K20 S terminal and relay base (ground)	Ohmmeter on R x 1 scale	If good, 3, 5-4 ohms. Low resistance, shorted K20 relay coil and/or wiring. High resistance, open K20 relay coil and/or wiring.

Figure 7-20. Engine/Generator Component Testing (Sheet 3 of 4)

Component	Voltmeter Connections	Procedure	Results
K21 Relay Coil (cyclic crank relay and wiring) See Figure 5-1 for location. 	K21 relay terminals 7 and 8	Disconnect and remove relay from controller. Ohmmeter on R x 1 scale.	If good, 160 ohms (approx.). Low resistance, shorted relay coil. High resistance, open relay coil.
Low Oil Pressure (LOP) Switch *	P1-7 and ground (engine block)	Ohmmeter on R x 1000 scale	If good, zero ohms (continuity). No reading, defective switch and/or wiring.

* See Fault Shutdown Test Procedure following.

Figure 7-21. Engine/Generator Component Testing (Sheet 4 of 4)

Fault Shutdown Test Procedure

Verify the operation of the generator set overspeed, overcrank, low coolant level, low oil pressure, and high engine temperature shutdowns by performing the following tests with the generator set running. If these tests are inconclusive, test individual shutdown circuit components (circuit board, wiring harness, switch, etc.) as described earlier in this section.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

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

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

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.

Overspeed

Start generator set and manually adjust engine speed (by moving throttle linkage) to exceed rated engine rpm (1800 rpm). Generator set shuts down and fault lamp lights when engine speed is between 68 and 71 Hz.

Low Oil Pressure (LOP) Shutdown

Connect a jumper wire from the LOP switch (lead 13) to the generator set ground. See Section 5, Engine Safety Shutdown Switches. Start generator set. After approximately 25-35 seconds the generator set should shut down, alarm horn will sound, and the Low Water Temp/Aux lamp will light.

Overcrank Shutdown

Disconnect lead between starter solenoid K20 and starter motor at K20 terminal. Move controller master switch to the RUN position. Generator set simulates cranking for 15 seconds then rests for 15 seconds. After the third crank/rest cycle, the generator set alarm horn

sounds and the Overcrank lamp lights. If the controller is set for continuous cranking, overcrank shutdown occurs after 45 seconds of continuous simulated cranking.

Electronic Governor

The governor system consists of an electronic isochronous governor, an electro-mechanical stepper motor, 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 compares the frequency of these pulses to a preset reference and provides a signal to the stepper motor which controls the carburetor throttle position and the engine speed. The system is closed loop and typically provides steady state speed regulation of ±0.25%.

The electronic governor is factory set and under normal circumstances will not require further adjustment. If the engine operates erratically check the following items *before* adjustment.

- Check electrical connections, including the stepper motor, controller box, and governor connector (inside the controller) for clean and tight connections.
- Check magnetic pickup connections. Poor connections may cause an erratic signal. As long as this erratic signal is being sent, the unit will not shut down from loss of pickup.
- Check electrical ground connections. Provide a good DC ground to the controller assembly and governor circuit.
- Check for dirt build-up on magnetic pickup. Metal filings or caked-on dirt/grease decreases the output signal of magnetic pickup.
- Check for stepper motor/throttle shaft coupling wear. If the roll pin has caused wear to the slot of the stepper motor coupling, loosen coupling screw and move coupling so that roll pin is positioned at a point in stepper motor coupling without wear. Tighten coupling screw.
- Check the carburetor for dirt, grime, or misadjustment. Also, check the idle-adjustment screw. The screw should not prevent the throttle plate from completely closing. Also, check the throttle linkage for any binding, dirt, damage, etc.
- Check for a good positive 12-volt DC supply. Also check if the positive voltage supply is unstable or below 8-volts DC making the control unit function erratically.

Condition (Fault)	Result
Loss of pickup while running	Throttle moves to closed position and fuel shut-off solenoid de-energizes (genset shutdown)
Engine overspeed	Fuel shut-off solenoid de-energizes (genset shutdown)
Break of fuel shut-off solenoid lead	Fuel shut-off solenoid de-energizes
Loss of DC power to governor assembly	Fuel shut-off solenoid de-energizes (genset shutdown)
Break of stepper motor leads	Erratic performance, then fuel shut-off solenoid de-energizes (genset shutdown)
Actuator linkage failure	Erratic performance, then fuel shut-off solenoid de-energizes (genset shutdown)

Figure 7-22. Electronic Governor Fault Shutdown Conditions and Results

Governor Adjustment Procedure

If the governor is removed or tampered with, use the following adjustment procedure.

1. Check the adjustment of the governor actuator shaft to carburetor throttle shaft. For correct engagement, shafts must be concentric. Throttle plate position can be either open or closed during assembly. Carburetor throttle shaft pin must be in the slot of the stepper motor coupling with the pin in the middle of the depth of the slot. No other adjustment is necessary or possible with this arrangement.

   The governor stepper motor should function with steady and smooth movement during operation. If movement of stepper motor is erratic or large changes in movement occur, check shaft alignment, check for excessive coupling slot wear, and check for broken or loose wiring including plug connections.

   Only two actuator leads of each coil group are utilized. (BLK-YEL, and RED-WHT.) Resistance per phase 38.5 ohms. See Figure 7-23.

   To test for operation of the stepper motor, disconnect magnetic pickup leads. Manually move the throttle shaft/governor stepper motor fully counterclockwise (closed throttle). Start generator set. Stepper motor should initially move clockwise (wide open throttle) and then go completely counterclockwise. The stepper motor should remain in this position. STOP generator set. If stepper motor fails this test, replace stepper motor. Connect magnetic pickup leads.

   NOTE

   Before replacing the stepper motor, make sure that the controller circuit board is functioning correctly by verifying that 12 volts are entering the governor circuit board at pin 6.

2. The magnetic pickup air gap is 0.040 in. (1.02 mm) ± 0.005 in. (0.127 mm). See Figure 7-24.

   NOTE

   Measure the air gap at 3 or 4 places to get an accurate reading.

   a. Adjust the air gap by loosening the locknut and turning the pickup clockwise until it just bottoms on the ring gear, then back out 3/4 turn.

   b. Hold the pickup in this position while retightening locknut.

   To verify operation of the magnetic pickup, connect voltmeter to magnetic pickup leads. See Figure 7-25.

   During engine cranking, voltage should be 1.75 volts AC minimum. If the air gap has been checked and is correct, replace magnetic pickup if correct voltage is not measured.

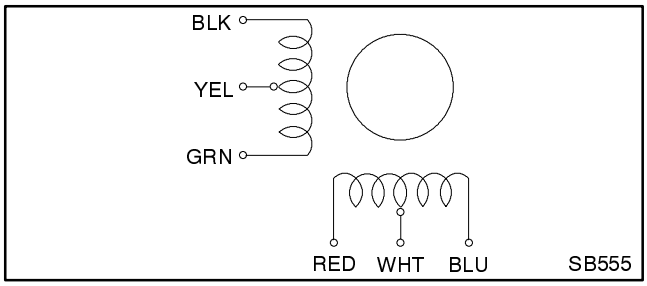
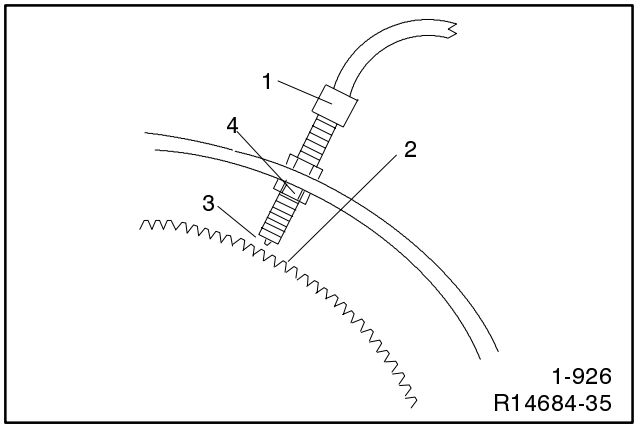


Figure 7-23. Actuator Coil Group



1. Magnetic pickup
2. Top of flywheel ring gear tooth
3. Air gap
4. Locknut

Figure 7-24. Magnetic Pickup Air Gap

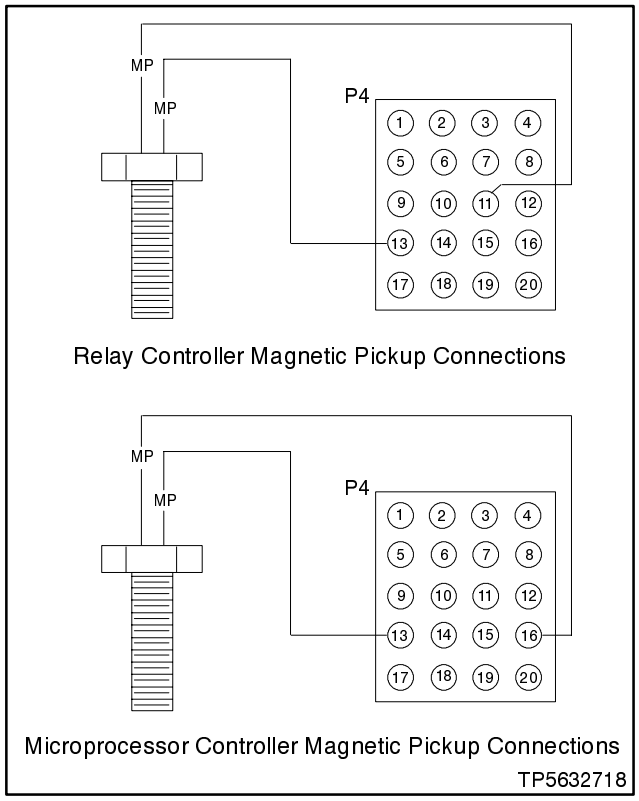


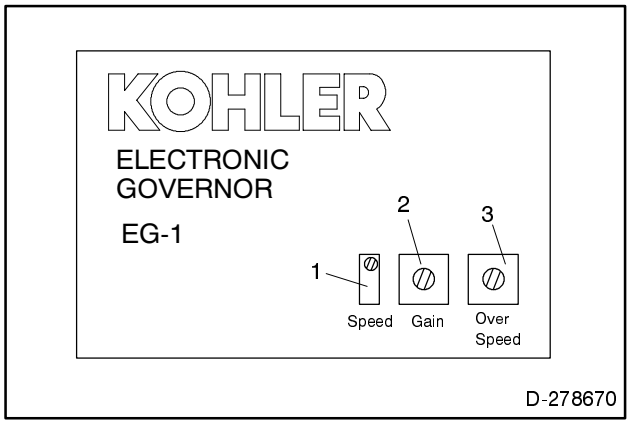
Figure 7-25. Magnetic Pickup Leads

3. Adjust carburetor fuel mixture as stated in Section 3, Carburetor Adjustments.

NOTE

Often hunting/surging problems thought to be caused by the governor are actually linked to carburetor adjustment. Carburetor MUST be correctly adjusted before continuing to next step. See Section 3, Carburetor Adjustment.

4. Attach a frequency meter to AC output leads. Start and run the generator set until normal operating temperature is obtained (about 5-10 minutes).
5. Adjust the electronic governor speed potentiometer (pot.) to obtain a full load engine speed of 60 Hz (1800 rpm) on 60 Hz models and 50 Hz (1500 rpm) on 50 Hz models. See Figure 7-26. Turn pot. clockwise to increase frequency and counterclockwise to decrease frequency.



1. Speed potentiometer
2. Gain potentiometer
3. Overspeed potentiometer

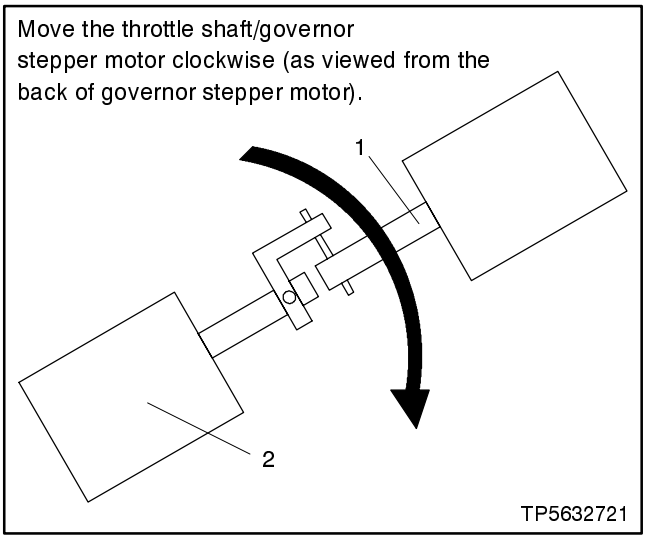
Figure 7-26. Governor Adjustments

6. Check stability with generator set running and with no load applied. If generator set speed is unstable or hunting/surging is observed, turn gain pot. approximately 1/8 turn counterclockwise or until the generator set becomes stable where there is no hunting/surging. Observe frequency reading. Repeat Step 5, as necessary.
7. Apply rated load to generator set and observe frequency reading. No load and full load frequency should be within 0.4 Hz (120 rpm). If not within specs, check that carburetor throttle plate is opening fully and that it is not sticking; and check that carburetor is correctly adjusted. If these procedures do not correct the problem, the circuit board is defective and should be replaced.

   Check for hunting/surging at full load. Turn gain pot. in 1/8 turn increments counterclockwise until stability is observed.
8. Remove load and observe frequency. Frequency should return to value as stated in speed adjustment (Step 5). Gain adjustment may affect generator set speed/frequency. If speed has been changed, repeat Step 5.

NOTE

If speed adjustments were repeated, it is not necessary to repeat gain adjustments (Steps 6 and 7) as speed adjustments have no effect on gain adjustments.



1. Carburetor throttle shaft
2. Electronic governor stepper motor

Figure 7-27. Manually Moving Stepper Motor

9. Check overspeed cutout point with unit running. Manually move the throttle shaft/governor stepper motor coupling clockwise (as viewed from the back of the governor stepper motor). See Figure 7-27. Do not use speed adjustment pot. to check the overspeed cutout point. Observe frequency meter and note frequency when generator set shuts down. Factory setting is 72 Hz for 60 Hz models and 60 Hz for 50 Hz models (or 120% of rated speed/frequency).

NOTE

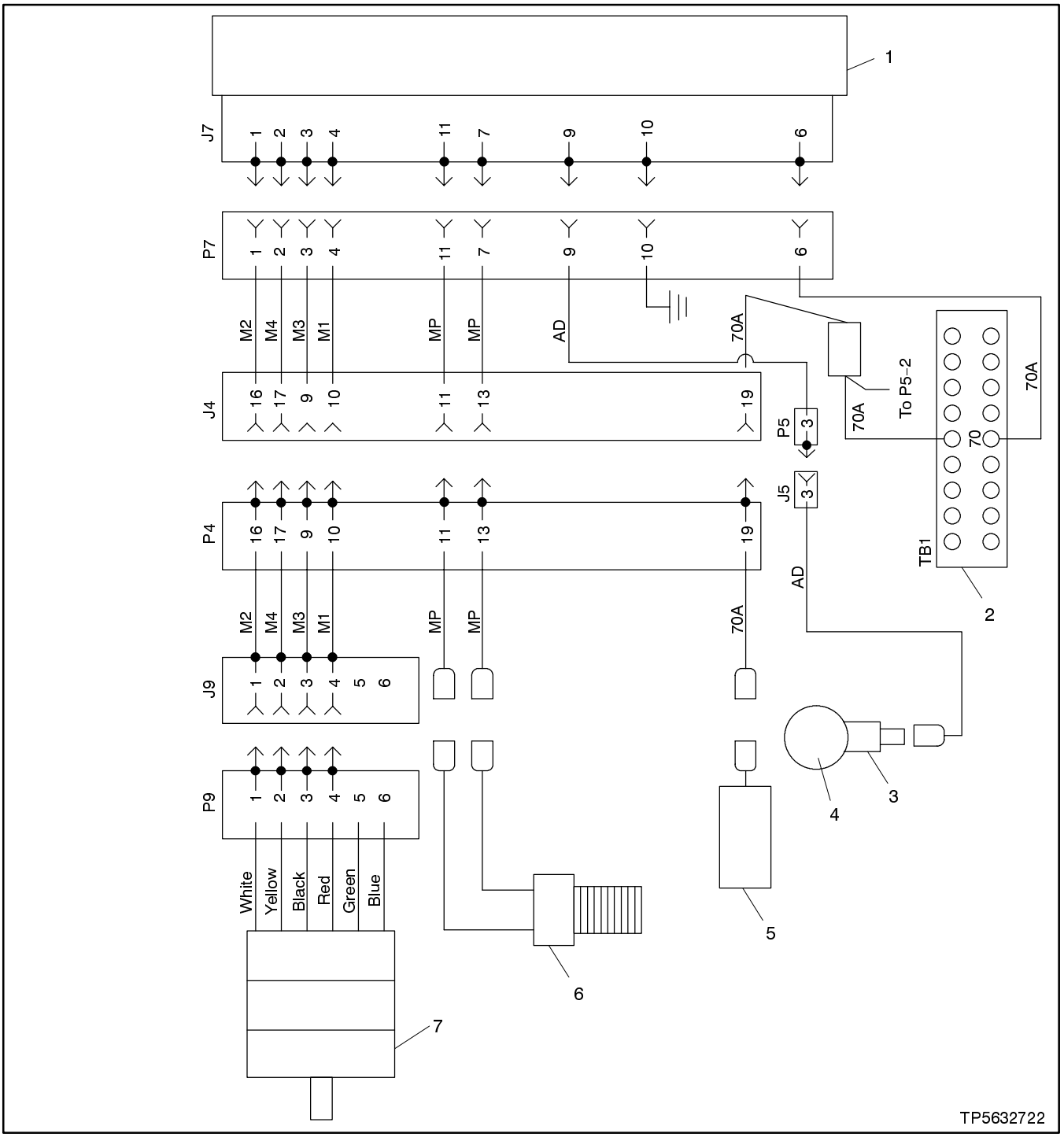
Overspeed must be reset after any speed adjustments are made.

Turn overspeed pot counterclockwise to increase overspeed cutout point and clockwise to decrease overspeed cutout point. Readjust overspeed pot and repeat procedure, as necessary, to obtain the desired overspeed cutout point.

STOP generator set.

If after performing governor adjustments the generator set is not within the stated specifications, repeat Steps 5-9. If this fails to bring generator set to correct electronic governor specifications, replace governor controller circuit board.

See Figure 7-28 for electronic governor wiring.



1. Governor controller circuit board
2. Terminal block TB1
3. Antidieseling solenoid
4. Carburetor
5. Ignition
6. Magnetic pickup
7. Stepper motor

Figure 7-28. Electronic Governor Wiring

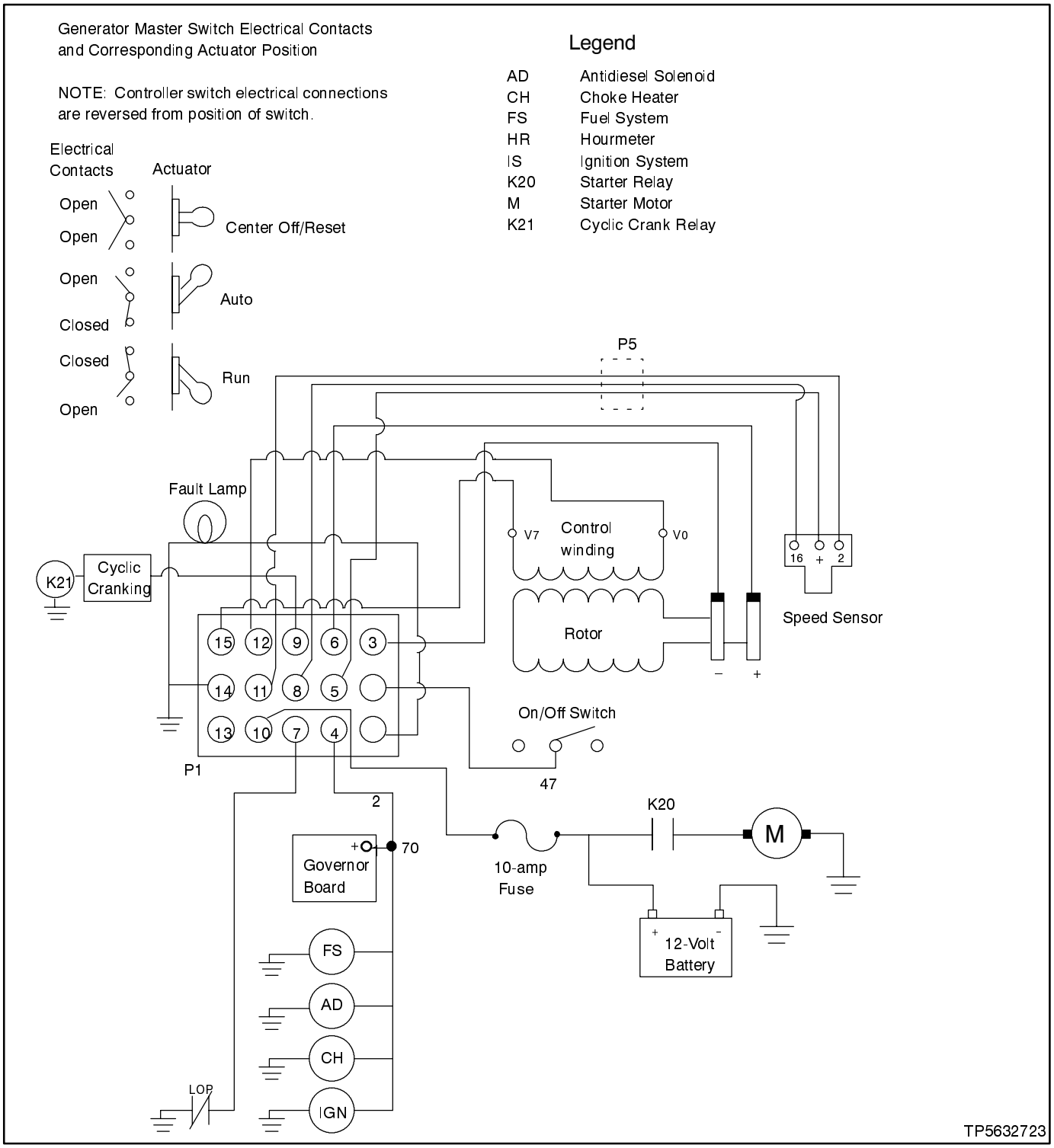


Figure 7-29. 6.5RMY Wiring Harness Schematic

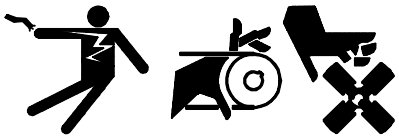
Cyclic Cranking Board Test Procedure

The cyclic cranking circuit board, located in the controller, allows adjustment of the cranking cycle for improved starter motor engagement. See Section 2, Relay Controller and Figure 7-30. The factory setting is eight seconds on time and three seconds off time. If the cranking cycle seems shorter than the factory setting, check the condition of the battery before readjusting the board. Timing decreases if the battery charge is too low. It is possible to vary the on/off cycles from 1-60 seconds. Increase the on or off time periods by rotating the potentiometer clockwise. If the generator engine does not perform the cyclic crank routine during starting, verify that the cyclic cranking board is correctly adjusted. The cyclic crank feature does not operate when both potentiometers (pots) are in the full counterclockwise position. If the cyclic crank circuit board is correctly adjusted but the engine does not go through the preferred crank cycle, test the board using the cyclic crank board test procedure following.

Equipment needed:

12-volt battery or DC power supply
DC voltmeter

⚠ 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).

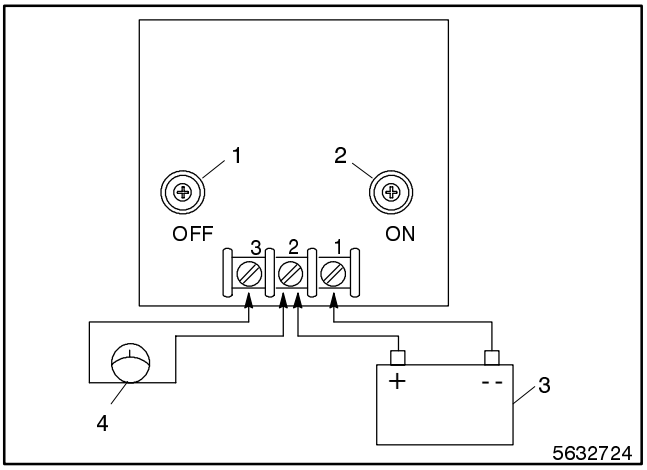
Disabling generator set. Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on the generator set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

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.

1. Place the generator set master switch in the OFF position.
2. Disconnect generator set engine starting battery, negative (–) lead first. Disconnect power to battery charger, if equipped.
3. Disconnect leads connected to terminals 1, 2, and 3 of the cyclic crank circuit board. Remove cyclic crank board from controller.
4. Connect a voltmeter across cyclic crank board terminals 2 and 3 with voltmeter on 12-15 volt DC scale. Connect battery positive (+) terminal to circuit board terminal 2. Connect battery negative (–) terminal to cyclic crank terminal 1. See Figure 7-30.
5. When 12 volts DC is applied to circuit board, voltmeter should show 12 volts DC for approximately eight seconds (factory crank setting) then no voltage for approximately three seconds (factory rest setting). This sequence should continue for 30 seconds (8 on, 3 off, 8 on, 3 off, 8 on). (The cyclic crank board may have been customer adjusted to provide longer or shorter crank/rest cycles). If no voltage is read at the cyclic

cranking board, verify the battery is fully charged and the cyclic cranking board is adjusted. The cyclic crank feature will not operate at low battery voltage or when both circuit board pots. are in the full counterclockwise position. If no voltage is read with the battery fully charged and the cyclic crank board correctly adjusted, the cyclic crank circuit board is defective and needs to be replaced.

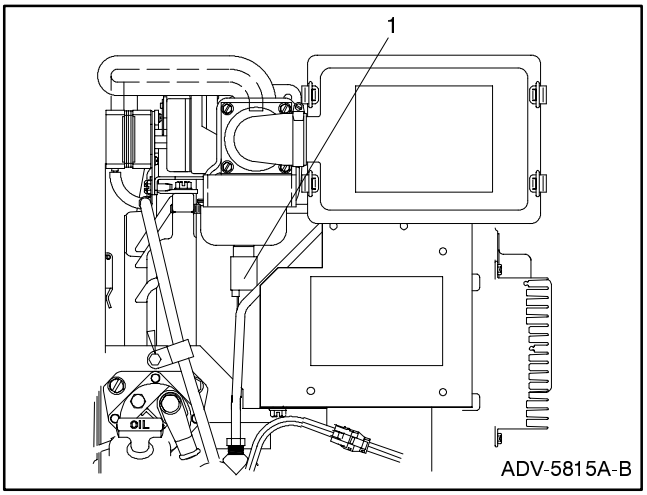


1. Off
2. On
3. Battery
4. Voltmeter

Figure 7-30. Cyclic Cranking Board Test Connections

Anti-Diesel Solenoid

1. Disconnect lead at thermistor. See Figure 7-31.
2. Set ohmmeter on R x 1 scale. Connect ohmmeter to thermistor terminal and engine block (ground). A reading of approximately 10 ohms indicates a good anti-diesel solenoid.

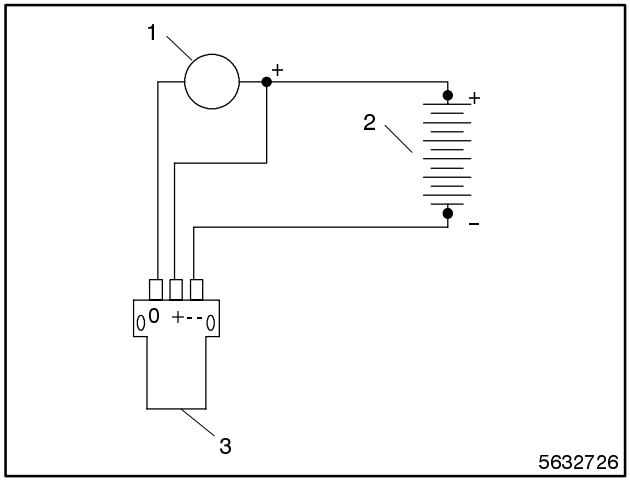


1. Anti-diesel solenoid terminal

Figure 7-31. Anti-Diesel Solenoid

Speed Sensor Test Procedure

1. Remove speed sensor from generator adapter. Connect speed sensor, voltmeter, and DC voltage source as shown in Figure 7-32.
2. Touch sensing surface with a flat piece of iron or steel—contact surface area of iron or steel piece should be at least 1/4 cubic inch (4.1 cm).
3. Voltmeter test reading should equal source voltage.
4. Remove iron or steel from sensing surface—voltmeter should indicate no voltage.
5. Reinstall speed sensor in generator adapter using all original hardware. When correctly installed, air gap between speed sensor and flywheel should be 0.020-0.050 in. (0.5-1.27 mm).



1. DC voltmeter
2. 12-volt DC power supply
3. Speed sensor sensing surface

Figure 7-32. Speed Sensor Test

Notes

Section 8. Disassembly/Reassembly

Disassembly

Before beginning generator disassembly procedure, carefully read all safety precautions at the beginning of this manual.

Use the disassembly procedure as a step-by-step means to help take apart the generator. The disassembly procedure provides important information to minimize disassembly time and indicates where special configurations exist which may require taking notes.

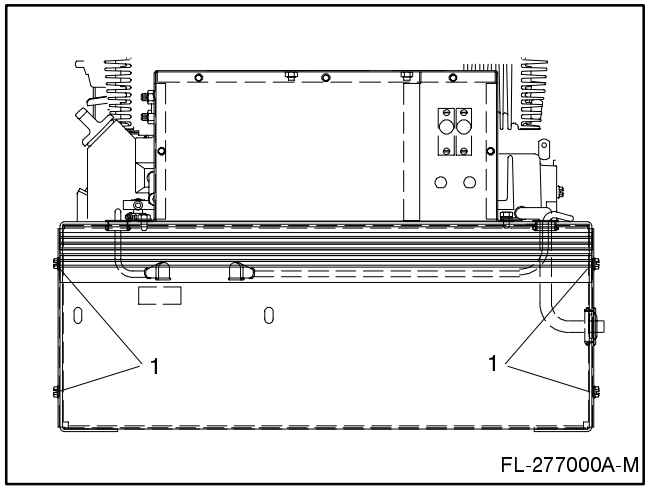
Prior to disassembly disconnect items in Figure 8-1.

Generator set housing	Exhaust system
All external connections	Battery cables at battery
AC output leads at the AC circuit breaker and neutral stud	Fuel supply line at fuel line connector
Remote start at the controller connector	

Figure 8-1. Disconnections

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.

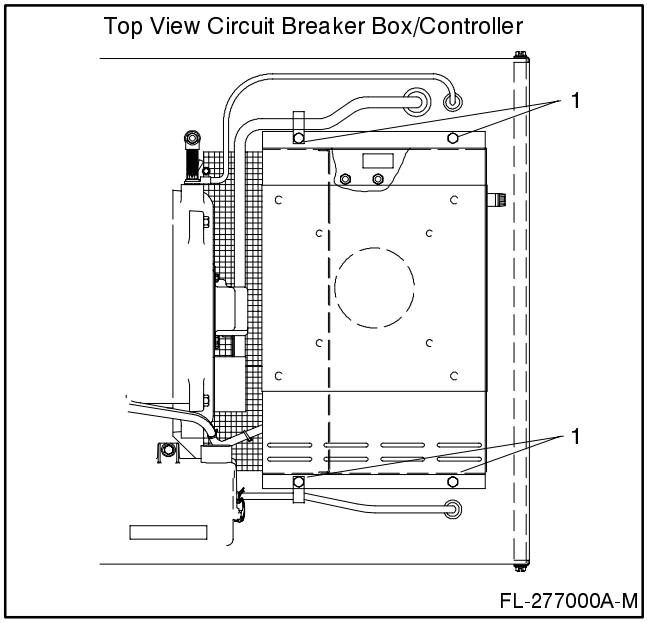
1. Remove four screws to remove battery compartment panel. See Figure 8-2.
2. Disconnect the generator set engine starting battery, negative (–) lead first.



1. Battery compartment cover screws

Figure 8-2. Battery Compartment Panel

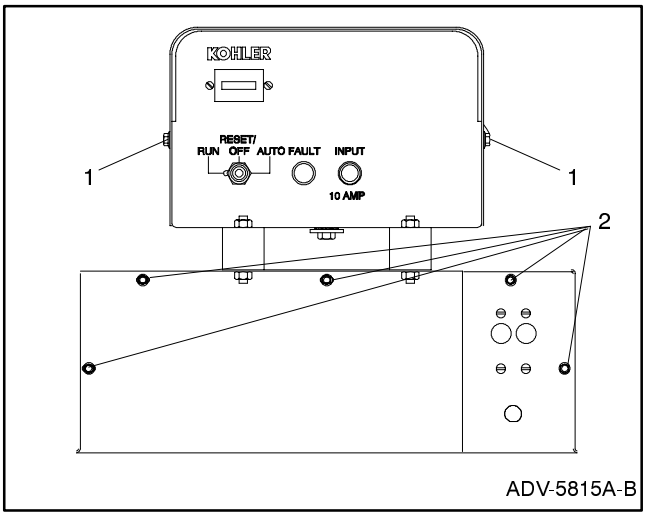
3. Remove the four AC circuit breaker box screws from the skid. One screw secures the battery positive (+) cable and one screw secures the fuel line. Remove the AC circuit breaker box. See Figure 8-3.



1. Circuit breaker box mounting screws

Figure 8-3. Circuit Breaker Box

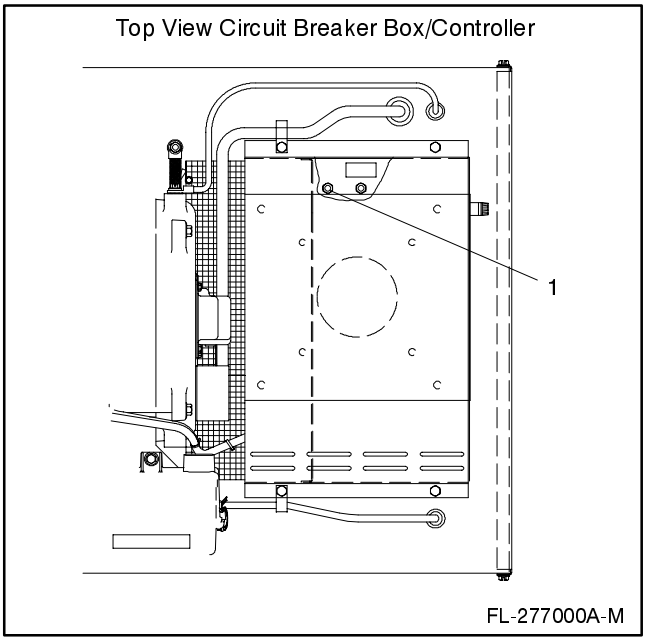
4. Remove the four controller cover screws and remove the controller cover. See Figure 8-4.
5. Remove the five AC circuit breaker panel and electronic governor panel screws. Remove the panel. See Figure 8-4.



1. Controller cover screws
2. Circuit breaker/governor panel

Figure 8-4. Controller Cover and Circuit Breaker/Governor Panel

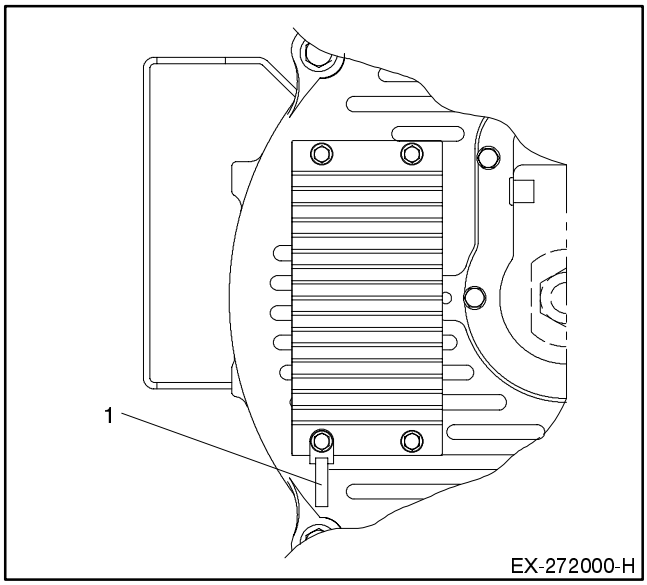
6. Remove the nut on equipment ground screw to release ground strap from the controller. See Figure 8-5. If replacing stator, remove the stator leads from the neutral and circuit breakers. Leave stator leads connected when reusing stator.



1. Ground stud

Figure 8-5. Ground Strap

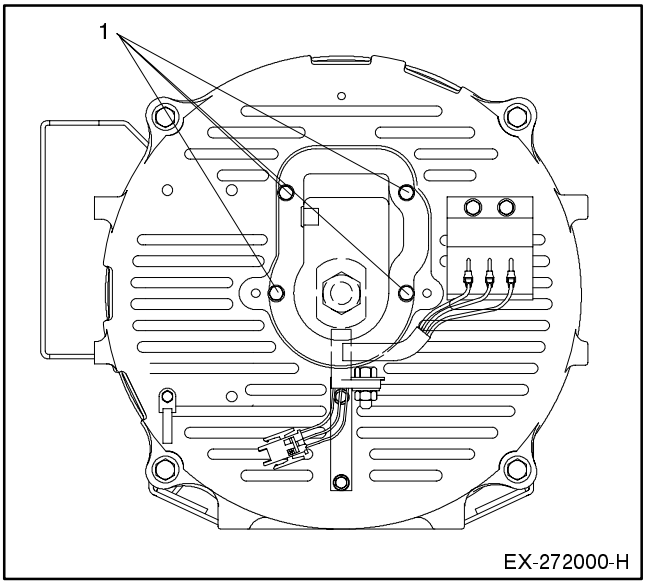
7. Disconnect the 15-pin, P3/J3 connector in the AC circuit breaker box and remove controller and AC circuit breaker box assembly.
8. Remove screw securing the wiring harness cable tie at the voltage regulator. Disconnect speed sensor (P2/J2) and voltage regulator (P10/J10) connectors. See Figure 8-6.



1. Wiring harness cable tie

Figure 8-6. P2/J2 and P10/J10 Connectors

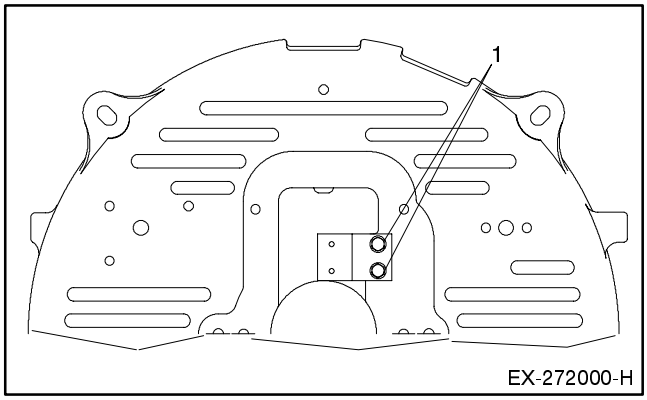
9. Disconnect stator sensing lead connector (P8/J8), gas valve connector (P5/J5) (gas-fueled models), or fuel pump and anti-diesel solenoid (gasoline-fueled models). Cut the cable tie at the air cleaner bracket to release the wiring harness. Disconnect engine wiring harness (P4/J4). Now all wiring harnesses (except brush holder) should be disconnected from the alternator assembly.
10. Remove the four screws that attach the brush cover. Slide the cover down on brush leads FP and FN. See Figure 8-7.



1. Brush cover screws

Figure 8-7. Brush Cover

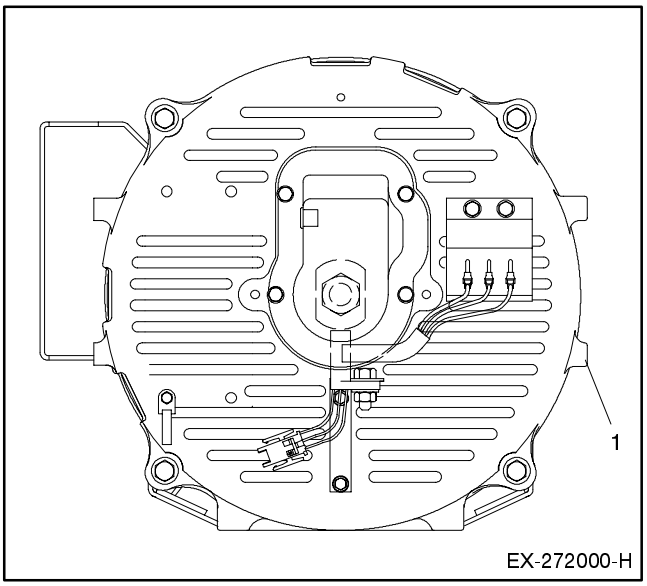
11. Remove the two screws that attach the brush holder. See Figure 8-8. Save these components.



1. Brush holder screws

Figure 8-8. Brush Holder

12. Remove the battery negative (–) cable and ground strap at the end bracket by removing one screw. See Figure 8-9.

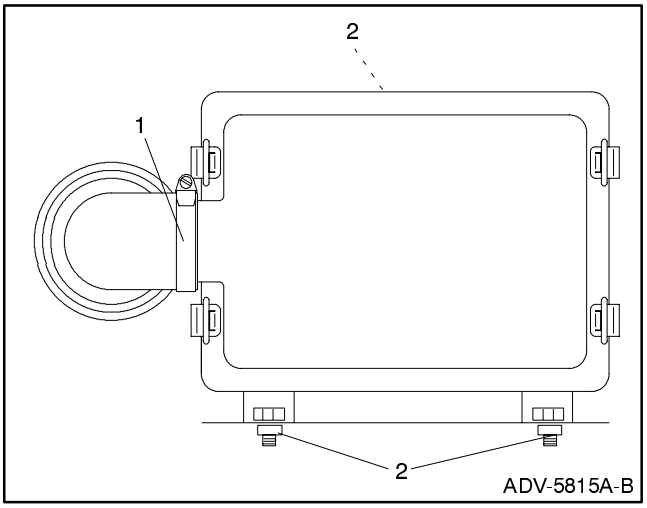


1. Battery cable and ground strap screw

Figure 8-9. Battery Cable and Ground Strap

13. Remove the hose clamp at the air cleaner outlet. See Figure 8-10.

14. Remove the air cleaner assembly. Remove one screw from the engine and two screws, flat washers, and whiz nuts from the air cleaner support bracket. See Figure 8-10.

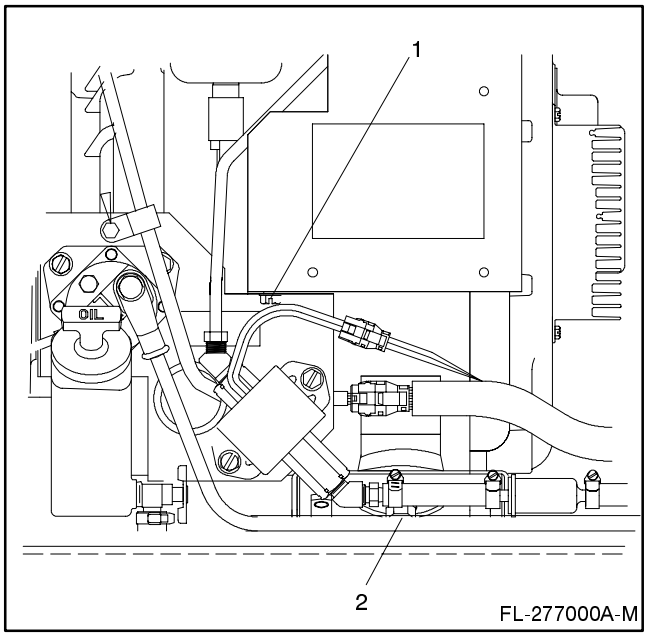


1. Air cleaner outlet hose clamp
2. Screws, flat washers, and whiz nuts

Figure 8-10. Air Cleaner Assembly

15. Remove the screw attaching gas valve (for gas fuel) or fuel pump (for gasoline) to stator assembly bracket. See Figure 8-11.

16. Remove two screws and internal tooth lockwashers from the inside of base/skid to release vibromounts from skid. See Figure 8-11.



1. Screw attaching the gas valve (gas-fueled models) or the fuel pump (gasoline-fueled models) to stator assembly bracket
2. Vibromount screws and washers

Figure 8-11. Gas Valve or Fuel Pump and Vibromount (Gasoline Model Shown)

17. Place a hoist strap under the stator/end bracket assembly and raise the unit enough to place a block of wood under to oil pan. See Figure 8-12. Lower the unit and remove the lift strap.

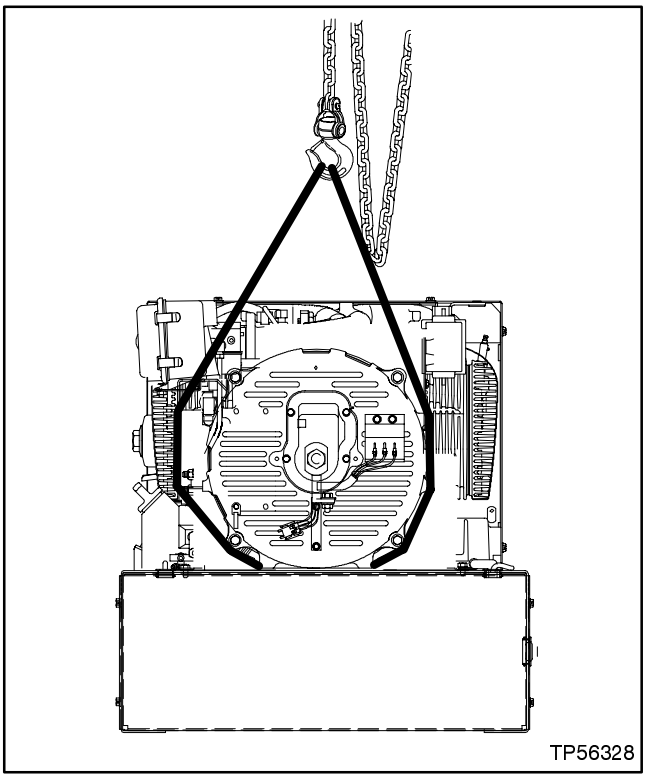
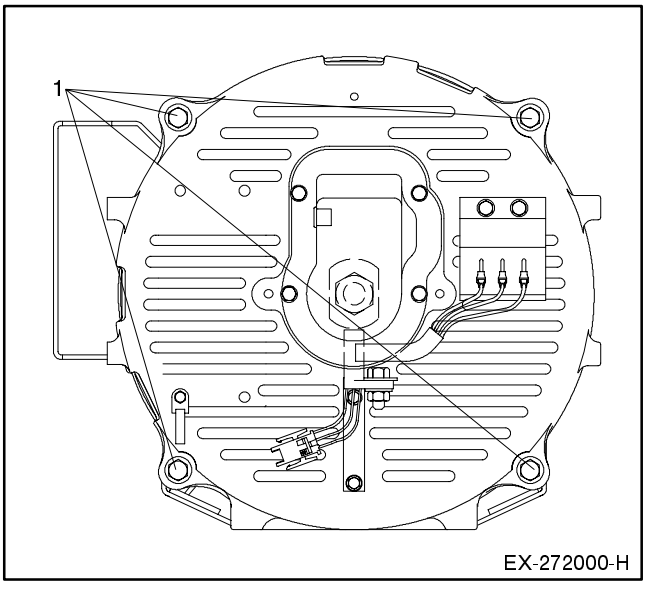


Figure 8-12. Stator/End Bracket

18. Remove four overbolts and centering washers. See Figure 8-13.



1. Overbolts

Figure 8-13. End Bracket Overbolts

19. Use a soft-faced hammer and strike end bracket with medium-force blows to remove end bracket from stator. See Figure 8-14.

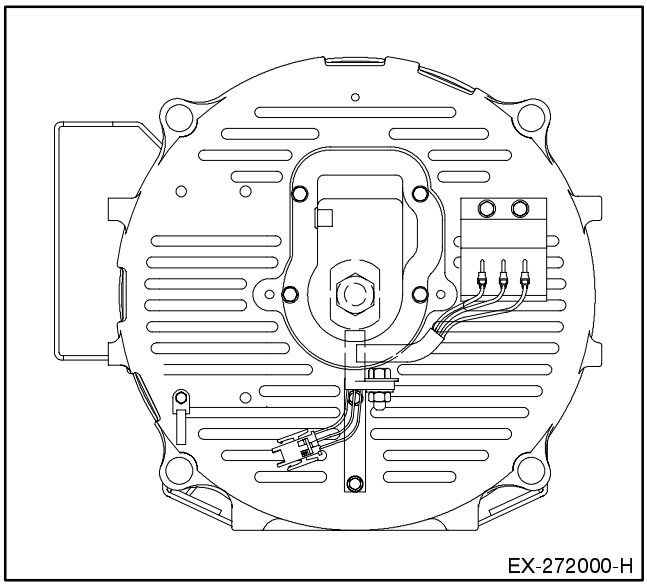
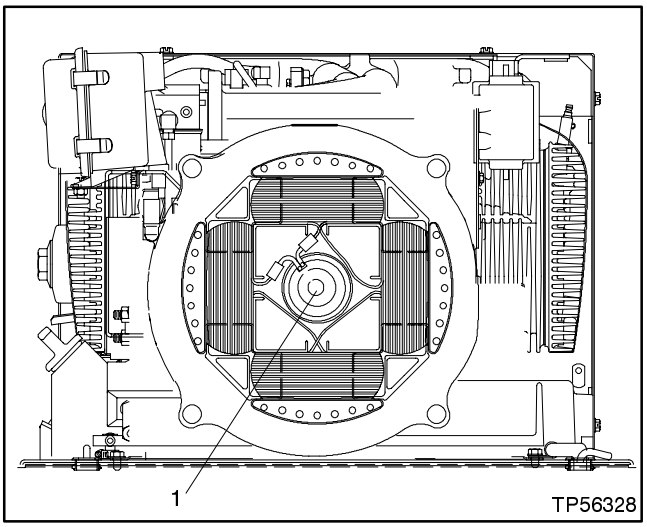


Figure 8-14. End Bracket from Stator

20. Remove stator from around rotor.

21. Loosen the thru-bolt 2-3 turns, leaving a 1/8 in. (3 mm) gap between the bolt head and rotor. Maintain rotor's position with a strap wrench. See Figure 8-15.



1. Thru-bolt

Figure 8-15. Loosening Rotor

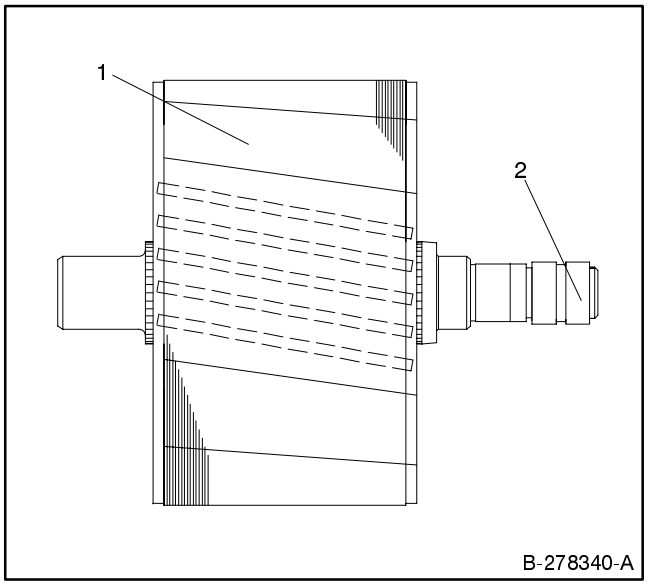
22. Strike the thru-bolt head with a lead hammer using medium-force blows to loosen the rotor. If necessary, use a prybar or large screwdriver to pry the rotor at the laminations. Position the prybar at one of the four slots on the generator adapter. DO NOT allow the prybar to contact the rotor windings. Place the rotor to one side of the generator set if the leads are still connected.

NOTE

Do not attempt to loosen the rotor thru-bolt by blocking the rotor cooling fan and turning the rotor with a wrench. Doing so could damage blades and rotor.

23. Remove the rotor thru-bolt to remove the rotor. Maintain rotor's position with a strap wrench.

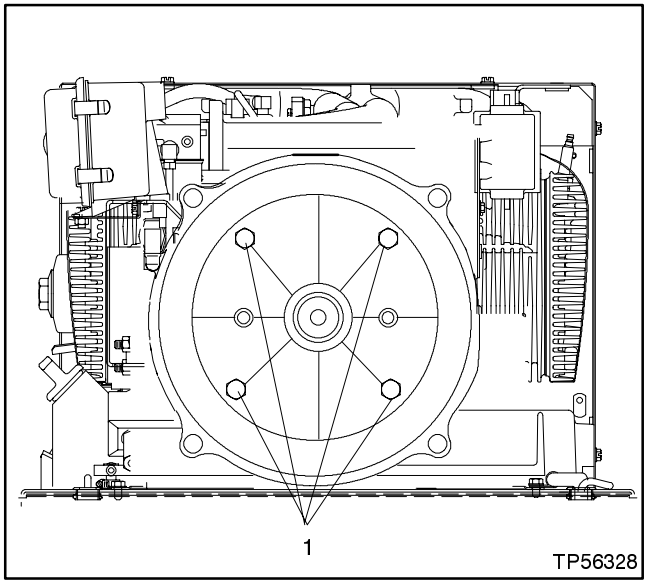
24. Pry the speed sensor magnetic actuator from the rotor. See Figure 8-16.



1. Rotor
2. Magnetic actuator

Figure 8-16. Speed Sensor Magnetic Actuator

25. Remove the four outer bolts to remove the generator adapter from the engine. See Figure 8-17.

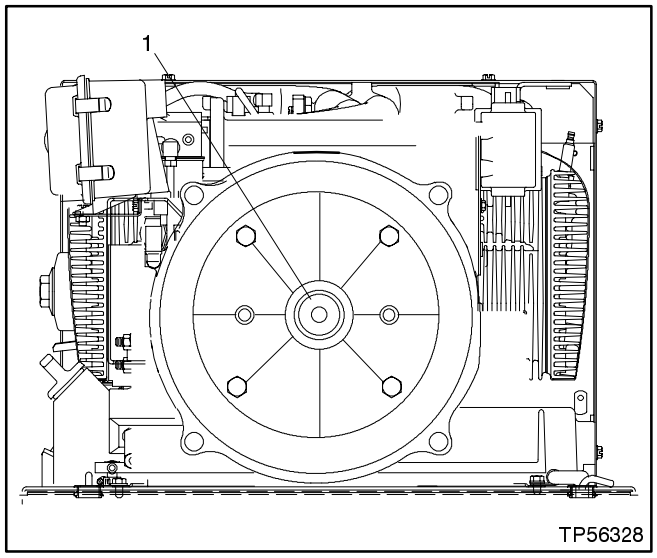


1. Generator adaptor bolts

Figure 8-17. Generator Adapter from Engine

Reassembly

1. Install the generator adapter to the engine using four screws.
2. Attach the speed sensor magnetic actuator to the rotor.
3. Apply anti-seize compound to the crankshaft tapered shaft. See Figure 8-18. Place rotor on the crankshaft tapered shaft and install the thru-bolt. Tighten the thru-bolt to 40-55 ft. lbs.(54-75 Nm) while holding the rotor with a strap wrench. Do not allow flywheel to rotate when assembling the rotor to the crankshaft.



1. Crankshaft

Figure 8-18. Crankshaft

4. Place the stator over the rotor and align it with the generator adapter lip.
5. Align the end bracket onto the stator assembly. Loosely attach the four overbolts and the centering washers. Place the centering tab of washer in the slot of the end bracket.

NOTE

DO NOT attempt to install the end bracket to the rotor by tightening the overbolts. Doing so may damage the end bracket and/or the generator adapter.

Using a hard rubber or dead blow hammer, strike the end bracket using medium-force blows in sequence shown in Figure 8-19 to install the end bracket.

When the end bracket is completely installed in the stator assembly, install and tighten the overbolts to 60 in. lbs.(7 Nm).

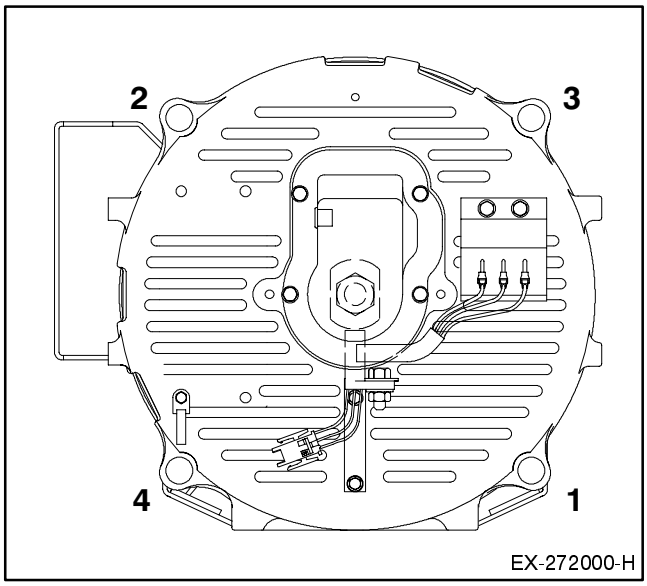


Figure 8-19. End Bracket

6. Remove the wood block from under the oil pan. Use a hoist to lift the unit if necessary.
7. Attach the vibromount using two screws and the internal tooth lockwashers from inside of base/skid.
8. Attach the gas valve for gas fuel or fuel pump for gasoline to the stator assembly bracket using one screw.

9. Assemble the air cleaner to the unit by installing one screw to the engine and two screws, flat washers, and whiz nuts to the support bracket. Tighten the hose clamp at the air cleaner outlet.
10. Use one screw to attach the ground strap and battery negative (–) cable at the end bracket.
11. Attach the brush holder using two screws. Remove the brush retainer.
12. Install the brush cover using four screws. Make sure brush leads are not pinched between cover and end bracket.
13. Reconnect the generator wiring to the alternator assembly. Connect engine wiring harness (P4/J4), gas valve (P5/J5) for gas fuel or fuel pump and anti-diesel solenoid for gasoline fuel, and stator sensing leads (P8/J8). See Wiring Diagram Manual if necessary.
14. Reconnect voltage regulator connector (P10/J10) and speed sensor connector (P2/J2). Attach new cable tie and secure it with screw.
15. Reposition the controller/AC circuit breaker box assembly. Reconnect the 15-pin (P3/J3) connector in the AC circuit breaker box.
16. Reconnect the stator leads if they are disconnected. See Wiring Diagram Manual. Reconnect the ground strap from the controller to the equipment ground.
17. Using five screws, attach the AC circuit breaker panel and electronic governor panel.
18. Attach the controller cover using four screws.
19. Use four screws to install the AC circuit breaker box to the skid. One screw secures the fuel line and one screw secures the battery positive (+) cable.
20. Reconnect the generator set engine starting battery, negative (–) lead last.
21. Attach the battery compartment panel using four screws.

Section 9. Generator Reconnection

Voltage Reconnection

The reconnection procedure explains voltage reconnections only. Adjust the governor and voltage regulator at time of frequency adjustment. See Section 7, Electronic Governor for information regarding frequency adjustment.

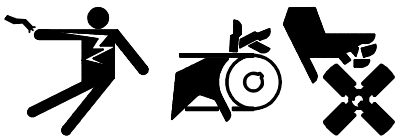
The following information illustrates the reconnection of 4-lead or 12-lead generator sets. In all cases, follow the National Electrical Code (NEC) guidelines.

Reconnect the stator leads of the generator set to change output phase (12-lead models only) or voltage. 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.

Voltage Reconnection Procedure

Four-Lead (Single-Phase) Generator Sets

NOTE

Only generator sets equipped with controllers with meters have current transformers (CTs).

NOTE

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

See Figure 9-1 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 9-1. 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

Do not connect the load-side terminals of the circuit breaker together when using a factory two-pole circuit breaker. See Figure 9-3. If the installation requires a 100-120 volt, 2 wire system, use a single pole circuit breaker. See Figure 9-4. When connecting stator phase leads together, size output lead (L1) according to output. 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 9-2. Voltage Range Between Load Leads

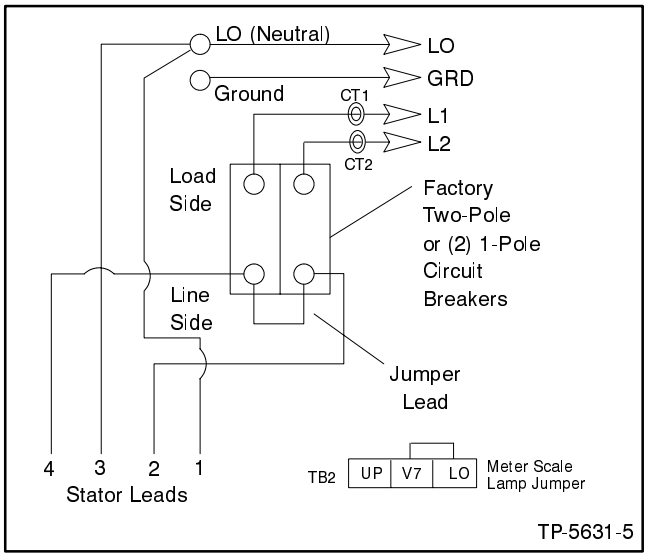


Figure 9-3. 100-120 Volt, 3 Wire Configurations

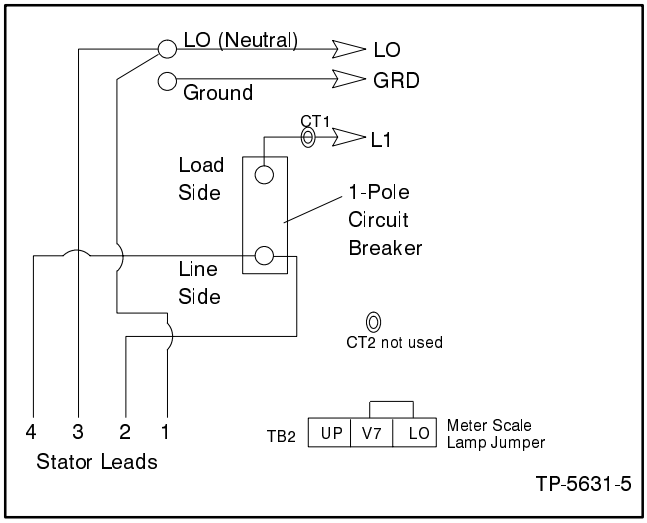


Figure 9-4. 100-120 Volt, 2 Wire Configurations

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 9-6 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, 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 9-5. Voltage Range Between Load Leads

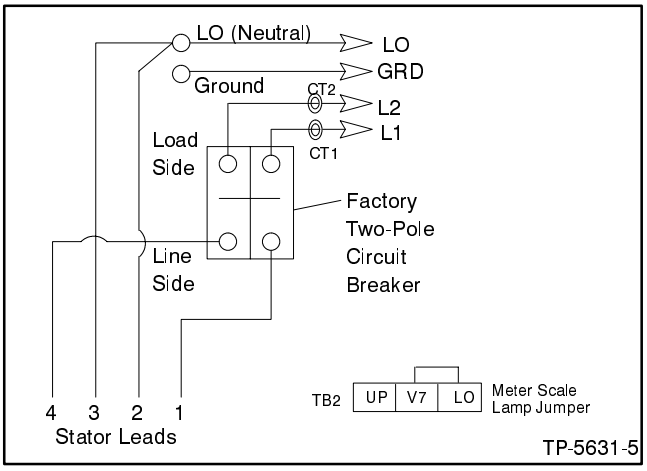


Figure 9-6. 100-120/200-240 Volt, 3 Wire Configurations

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 9-7 for location of jumper lead.

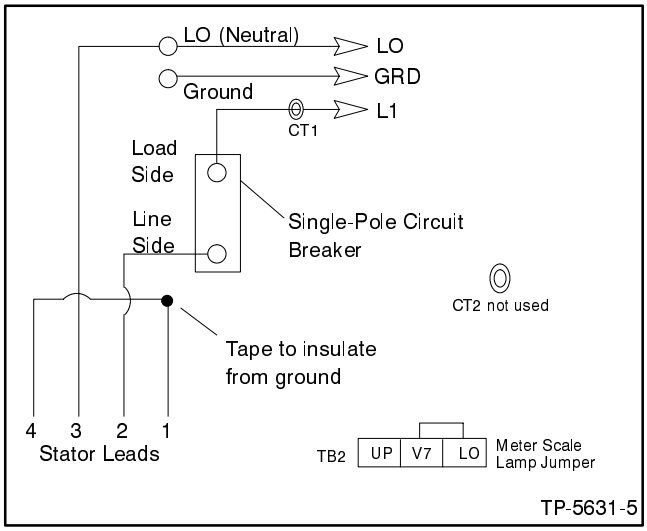


Figure 9-7. 200-240 Volt, 2 Wire Configurations

12-Lead (Three-Phase) Generator Sets

NOTE

Only generator sets equipped with controllers with meters have current transformers (CTs).

NOTE

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

Reconnect three-phase, 12-lead generator sets to the voltages and phases shown in Figure 9-8. If the generator set is reconnected to obtain a different output voltage, voltage regulator voltage adjustments may be necessary to obtain desired voltage.

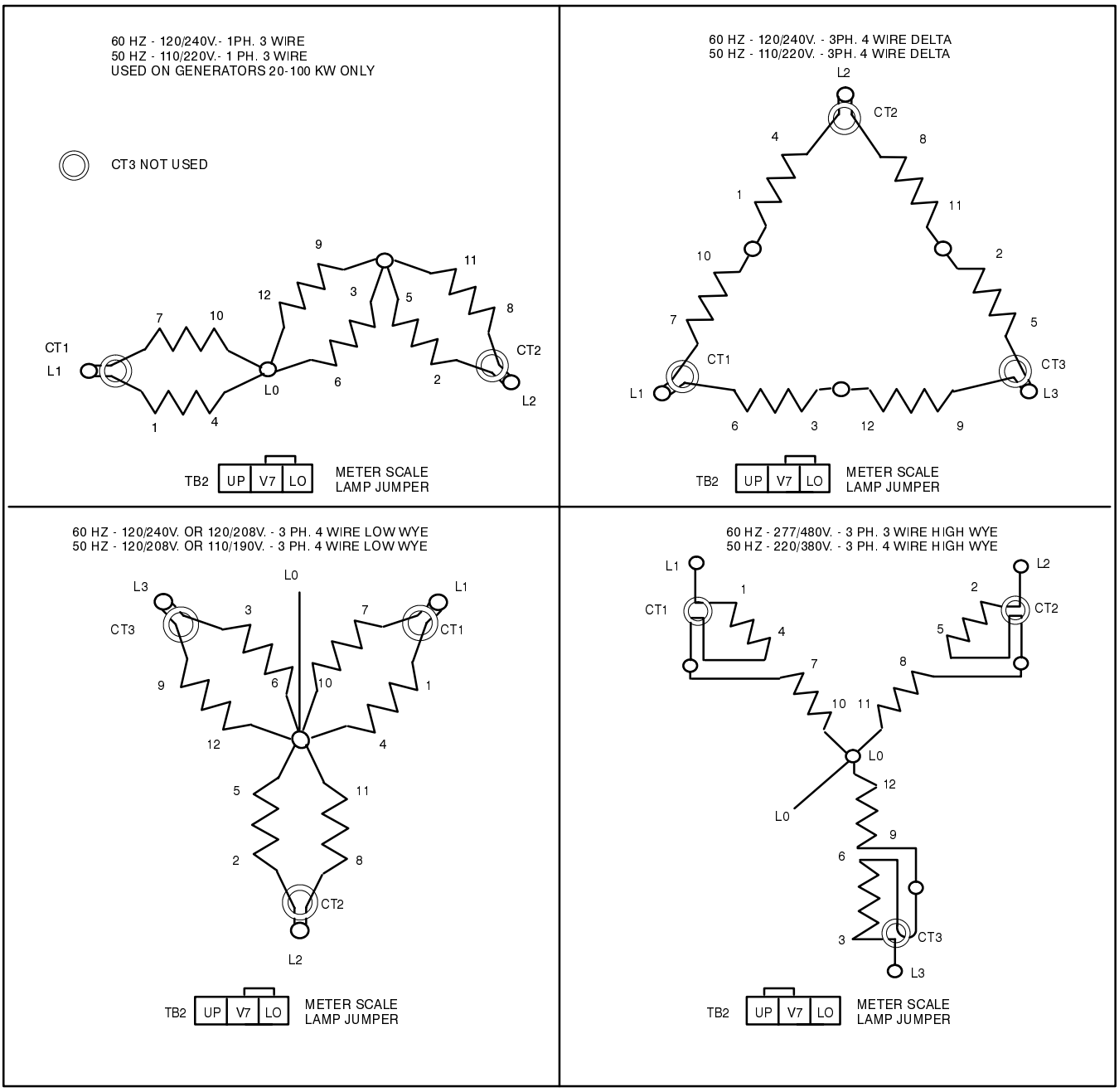


Figure 9-8. Generator Reconnection

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 9-8. 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. Only generator sets equipped with controllers with meters have current transformers (CTs).

NOTE

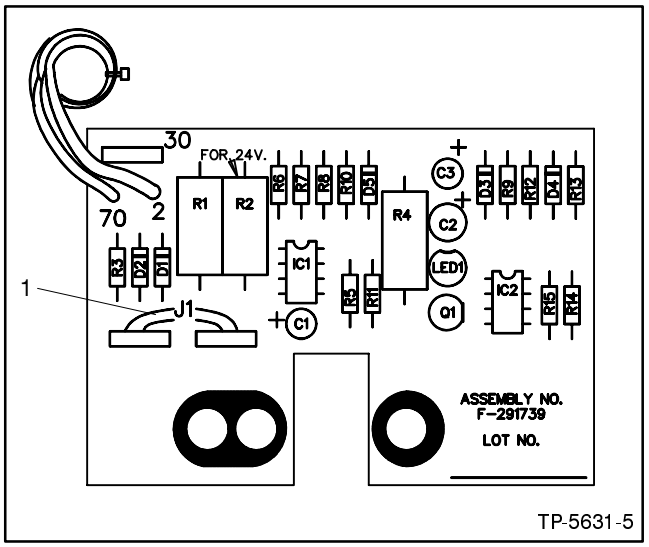
Equipment Damage! Verify that transfer switch, line circuit breakers, and any other accessories using line voltage are sized for the voltage selected.

NOTE

See Section 7, Electronic Governor for information regarding frequency adjustment.

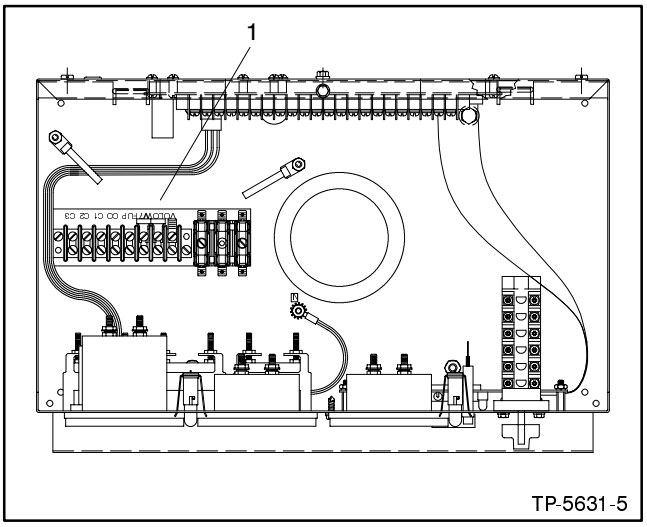
4. If controller is equipped with meters, remove controller cover and reposition meter scale lamp jumper, if necessary, to match meter scale lamps with desired voltage. See Figure 9-10.
5. The jumper J1 must be in place on the overvoltage circuit board if the generator set is connected for 139/240 or 277/480 volts (3-phase, 4-wire, 60 Hz) and if the generator set is equipped with the overvoltage kit. See Figure 9-9 for J1 jumper location on the overvoltage circuit board.

   For all other voltages, remove J1 jumper from 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 voltage at voltmeter. Adjust voltage using the voltage adjustment potentiometer on the controller front panel. See Figure 9-11.
10. Stop generator set after adjustment procedure.



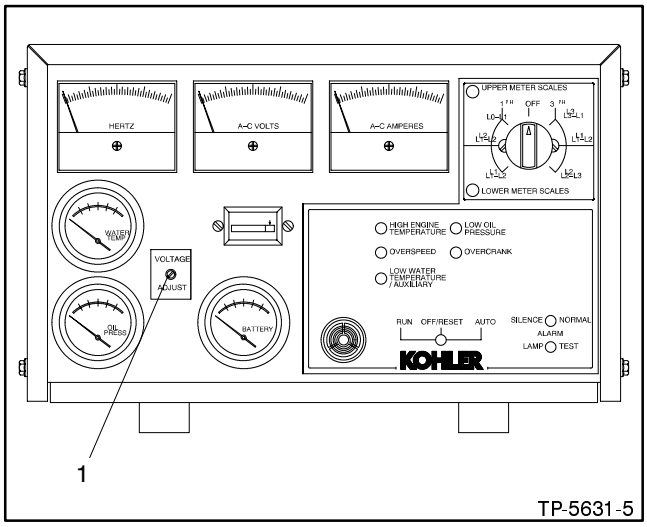
1. J1 jumper

Figure 9-9. Overvoltage Circuit Board



1. Lamp jumper

Figure 9-10. Meter Scale Lamp Jumper



1. Voltage adjustment potentiometer

Figure 9-11. Voltage Adjustment (typical)

Appendix A.

Glossary of Abbreviations

Abbreviations are used throughout this manual. Normally in the text they will appear in complete form with the abbreviation following in parenthesis the first time they are used. After that they will appear in the abbreviated form. The commonly used abbreviations are shown below.

AC	alternating current
AISI	American Iron and Steel Institute
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
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
aux.	auxiliary
AWG	American Wire Gauge
AWM	appliance wiring material
BBDC	before bottom dead center
BDC	before dead center
BHP	brake horsepower
bmep	brake mean effective pressure
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
CSA	Canadian Standards Association
CT	current transformer
cu. in.	cubic inch, cubic inches
cyl.	cylinder
dB	decibel
dBA	decibels (A weighted)
DC	direct current
DCR	direct current resistance
deg.	degree
dept.	department
dia.	diameter
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, fluid ounces
FM	frequency modulation
ft.	foot, feet
ft. lbs.	foot pound, foot pounds
ga.	gauge
gal./ gals.	gallon, gallons
gph	gallons per hour
gpm	gallons per minute
gr.	grade
grd.	ground
HCHT	high cylinder head temperature
HET	high exhaust (or engine) temperature
Hg	mercury (element)
H_2O	water
HP	horsepower
hr, hrs	hour
Hz	hertz (cycles per second)
ID	inside diameter
IEEE	Institute of Electrical and Electronic Engineers
in.	inch(es)
inc.	incorporated
in. lbs.	inch pounds
int.	internal
int.-ext.	internal-external
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
lb., lbs.	pound, pounds
L/hr.	liter per hour, liters per hour
L/min.	liter(s) per minutes,
LOP	low oil pressure

LP	liquefied petroleum
m	meter, meters
m^3	cubic meter, cubic meters
max.	maximum
MCM	one thousand circular mils.
megger	megohmmeter
MHz	megahertz
mi.	mile, miles
mil	one one-thousandth of an inch
min.	minimum
mJ	millijoule, millijoules
MJ	mega joule, mega joules
mm	millimeter, millimeters
m^3/min	cubic meters per minute
MPa	megaPascal
mW	milliwatt, milliwatts
MW	megawatt, megawatts
N/A	not available or not applicable
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, Newton meters
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, oversize
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 mean square
RPM	revolutions per inch
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, square inches
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's 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

Appendix B.

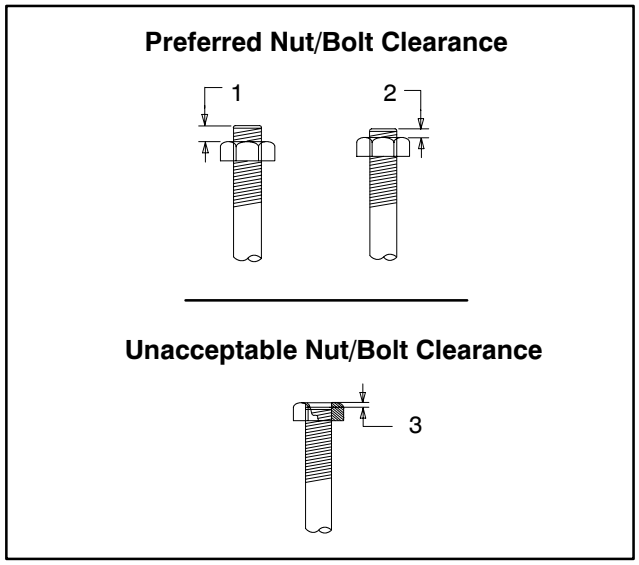
Common Hardware Application Guidelines

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

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

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

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



1. 1/2 of bolt diameter
2. Min. 1 full thread beyond top of nut
3. Below top of nut

Figure 1. Acceptable Bolt Lengths

Steps for common hardware application:

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

   For round and slotted exit holes, determine if hardware is greater than 1/2 inch in diameter, or 1/2 inch in diameter or less. Hardware that is *greater than 1/2 inch* in diameter takes a standard nut and SAE washer. Hardware *1/2 inch or less* in diameter can take a properly torqued whiz nut or spiralock nut. See the diagram below.

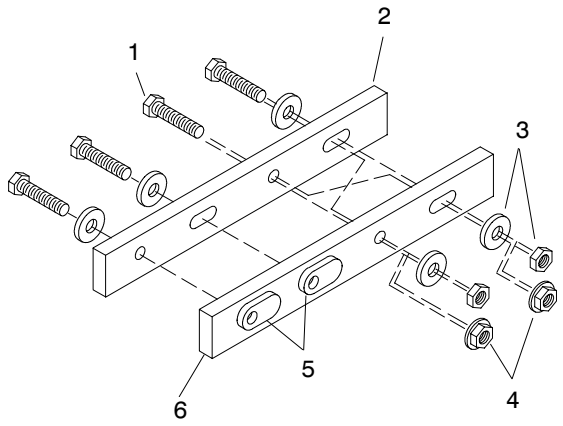
3. Follow these SAE washer rules after determining exit hole type:

   a. Always use a washer between hardware and a slot.

   b. Always use a washer under a nut (see 2 above for exception).

   c. Use a washer under a bolt when the female thread is fixed (weld nut).

4. Refer to the diagram below, which depicts the preceding hardware configuration possibilities.



1. Cap screw
2. Entry hole types
3. Standard nut and SAE washer
4. Whiz nut or spiralock: up to 1/2" dia. hardware
5. Weld nuts: above 1/2" dia. hardware
6. Exit hole types

Figure 2. Acceptable Hardware Combinations

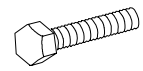
Notes

Appendix C.

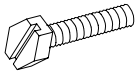
Common Hardware Identification

Screws/Bolts/Studs

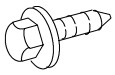
Head Styles



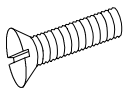
Hex. Head or Machine Head



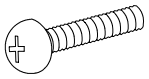
Hex. Head or Machine Head



Hex. Head or Machine Head with Washer

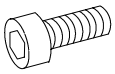


Flat Head (f.h.m.)

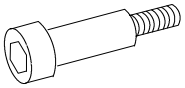


Round Head (r.h.m.)

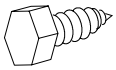
Pan Head



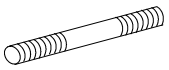
Socket Head Cap or Allen Head Cap



Socket Head or Allen Head Shoulder Bolt



Sheet Metal Screw



Stud

Drive Styles

Hex.

Hex. and Slotted

Phillips

Slotted

Hex. Socket

Grade (Hardness)

American Standard

Grade 2

Grade 5

Grade 8

Grade 8/9

Metric

5.8

8.8

10.9

12.9

Sample Dimensions

American Standard

Major Thread Diameter In Fractional Inches Or Screw Number Size — 1/4-20 x 1 — Length In Inches

Threads Per Inch

Metric

Major Thread Diameter In Millimeters — M8-1.25 x 20 — Length In Millimeters

Distance Between Threads In Millimeters

Figure 3. Screws/Bolts/Studs

Nuts

Styles

Hex. Head

Lock Nut or
Nylock Nut

Square Nut

Cap Nut or
Acorn Nut

Wing Nut

Grade (Hardness)

American Standard

Grade 2

Grade 5

Metric

5.8

8.8

10.9

12.9

Sample Dimensions

American Standard

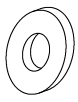
Major Thread Diameter In Fractional Inches Or Screw Number Size — 1/4-20 — Threads Per Inch

Metric

Major Thread Diameter In Millimeters — M8-1.25 — Distance Between Threads In Millimeters

Washers

Styles



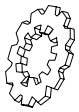
Plain
Washer

Split Lock Washer
or Spring Washer

Spring Washer
or Wave Washer

External
Tooth Lock
Washer

Internal Tooth
Lock Washer



Internal-External Tooth
Lock Washer

Grade (Hardness)

There is no marking to identify hardness. Usually hardened washers have a black oxide or black phosphate finish rather than a zinc (silver-colored) finish.

Sample (Hardness)

Plain Washers

Internal Dimension — 9/32 x 5/8 x 1/16 — Thickness

External Dimension

Lock Washers

5/8

Internal Dimension

Figure 4. Nuts/Washers

Appendix D.

General Torque Specifications

Use the following specifications for SAE fasteners when no torque values are given elsewhere in this or the service manual for a specified bolt. The values given are based on new plated threads. Increase values by 20% if nonplated threads are used.

Size	Measurement	Assembled in Cast Iron or Steel Grade 2	Grade 5	Grade 8	Assembled into Aluminum Grade 2 or 5
8-32	in. lbs. (Nm)	16 (1.8)	20 (2.3)	–	16 (1.8)
10-24	in. lbs. (Nm)	26 (2.9)	32 (3.6)	–	26 (2.9)
10-32	in. lbs. (Nm)	26 (2.9)	32 (3.6)	–	26 (2.9)
1/4-20	in. lbs. (Nm)	60 (6.8)	96 (10.8)	132 14.9)	60 (6.8)
1/4-28	in. lbs. (Nm)	72 (8.1)	108 (12.2)	144 (16.3)	72 (8.1)
5/16-18	in. lbs. (Nm)	120 (13.6)	192 (21.7)	264 (29.8)	120 (13.6)
5/16-24	in. lbs. (Nm)	132 (14.9)	204 (23.1)	288 (32.5)	132 (14.9)
3/8-16	in. lbs. (Nm)	18 (24)	28 (38)	39 (53)	18 (24)
3/8-24	ft. lbs. (Nm)	20 (27)	31 (42)	44 (60)	20 (27)
7/16-14	ft. lbs. (Nm)	29 (39)	44 (60)	63 (85)	
7/16-20	ft. lbs. (Nm)	32 (43)	50 (68)	70 (95)	
1/2-13	ft. lbs. (Nm)	44 (60)	68 (92)	96 (130)	
1/2-20	ft. lbs. (Nm)	49 (66)	76 (103)	108 (146)	
9/16-12	ft. lbs. (Nm)	60 (81)	98 (133)	138 (187)	
9/16-18	ft. lbs. (Nm)	67 (91)	109 (148)	154 (209)	
5/8-11	ft. lbs. (Nm)	83 (113)	135 (183)	191 (259)	
5/8-18	ft. lbs. (Nm)	94 (128)	153 (208)	216 (293)	
3/4-10	ft. lbs. (Nm)	147 (199)	240 (325)	338 (458)	
3/4-16	ft. lbs. (Nm)	164 (222)	268 (363)	378 (513)	
1-8	ft. lbs. (Nm)	191 (259)	532 (721)	818 (1109)	
1-12	ft. lbs. (Nm)	209 (283)	582 (789)	895 (1214)	

Use the following specifications for metric fasteners when no torque values are given elsewhere in this manual for a specified bolt. These values on based on new plated threads. Increase values by 20% if nonplated threads are used. Screws threaded into aluminum must have two diameters of threads engaged and may require 30% or more reduction in the torque.

	Torque ft-lb (Nm)			
Size (mm)	5.8	6.8	10.9	Fasteners Assembled Into Aluminum
6 x 1.00	5 (7)	6 (9)	9 (12)	5 (7)
8 x 1.25	14 (19)	14 (20)	20 (37)	14 (19)
8 x 1.00	16 (21)	17 (24)	23 (31)	16 (21)
10 x 1.50	25 (35)	27 (37)	38 (51)	25 (35)
10 x 1.25	29 (39)	34 (46)	45 (61)	29 (39)
12 x 1.75	42 (57)	45 (61)	65 (89)	
12 x 1.50	48 (65)	55 (75)	78 (106)	
14 x 2.00	64 (86)	69 (94)	101 (137)	
14 x 1.50	74 (100)	81 (110)	116 (157)	
16 x 2.00	98 (133)	104 (141)	150 (204)	
16 x 1.50	104 (141)	116 (157)	168 (228)	
18 x 2.50	133 (181)	145 (196)	208 (283)	
18 x 1.50	145 (196)	156 (212)	226 (306)	

Notes

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