Service

DC Generator Sets

Models:

6VSG

24VDC
36VDC
48VDC

Controller:

VSC

ISO 9001
KOHLER POWER SYSTEMS
NATIONALLY REGISTERED

KOHLER®
Power Systems

TP-6844 1/13a

California Proposition 65

⚠ WARNING

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

Product Identification Information

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

Generator Set Identification Numbers

Record the product identification numbers from the generator set nameplate(s).

Model Designation _____

Specification Number _____

Serial Number _____

Accessory Number	Accessory Description
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Controller Identification

Record the controller description from the generator set operation manual, spec sheet, or sales invoice.

Controller Description _____

Engine Identification

Record the product identification information from the engine nameplate.

Manufacturer _____

Model Designation _____

Serial Number _____

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

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

Accidental Starting

⚠ WARNING

Accidental starting.
Can cause severe injury or death.

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

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

Battery

⚠ WARNING

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

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

⚠ WARNING

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

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

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

Battery acid cleanup. Battery acid can cause severe injury or death. Battery acid is electrically conductive and corrosive. Add 500 g (1 lb.) of bicarbonate of soda (baking soda) to a container with 4 L (1 gal.) of water and mix the neutralizing solution. Pour the neutralizing solution on the spilled battery acid and continue to add the neutralizing solution to the spilled battery acid until all evidence of a chemical reaction (foaming) has ceased. Flush the resulting liquid with water and dry the area.

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

Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery. Never connect the negative (–) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together.

Engine Backfire/Flash Fire

⚠ WARNING

Fire.
Can cause severe injury or death.

Do not smoke or permit flames or sparks near fuels or the fuel system.

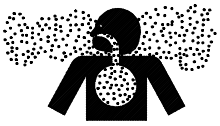
Servicing the air cleaner. A sudden backfire can cause severe injury or death. Do not operate the generator set with the air cleaner removed.

Servicing the fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the carburetor, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuels or fuel vapors. Catch fuels in an approved container when removing the fuel line or carburetor.

Combustible materials. A fire can cause severe injury or death. Generator set engine fuels and fuel vapors are flammable and explosive. Handle these materials carefully to minimize the risk of fire or explosion. Equip the compartment or nearby area with a fully charged fire extinguisher. Select a fire extinguisher rated ABC or BC for electrical fires or as recommended by the local fire code or an authorized agency. Train all personnel on fire extinguisher operation and fire prevention procedures.

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. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Avoid breathing exhaust fumes when working on or near the generator set. Never operate the generator set inside a building. Never operate the generator set where exhaust gas could seep inside or be drawn into a potentially occupied building through windows, air intake vents, or other openings.

Carbon monoxide detectors. Carbon monoxide can cause severe nausea, fainting, or death. Install carbon monoxide detectors on each level of any building adjacent to the generator set. Locate the detectors to adequately warn the building's occupants of the presence of carbon monoxide. Keep the detectors operational at all times. Periodically test and replace the carbon monoxide detectors according to the manufacturer's instructions.

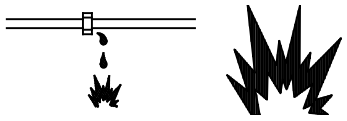
Carbon monoxide symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas present in exhaust gases. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Carbon monoxide poisoning 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, seek fresh air immediately and remain active. Do not sit, lie down, or fall asleep. Alert others to the possibility of carbon monoxide poisoning. Seek medical attention if the condition of affected persons does not improve within minutes of breathing fresh air.

Fuel System

⚠ WARNING



Explosive fuel vapors.
Can cause severe injury or death.

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

The fuel system. Explosive fuel vapors can cause severe injury or death. Vaporized fuels are highly explosive. Use extreme care when handling and storing fuels. Store fuels 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 because spilled fuel may ignite on contact with hot parts or from sparks. Do not smoke or permit flames or sparks to occur near sources of spilled fuel or fuel vapors. Keep the fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid fuel line breakage caused by vibration. Do not operate the generator set in the presence of fuel leaks, fuel accumulation, or sparks. Repair fuel systems before resuming generator set operation.

Gas fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check the LP vapor gas or natural gas fuel system for leakage by using a soap and water solution with the fuel system test pressurized to 6–8 ounces per square inch (10–14 inches water column). Do not use a soap solution containing either ammonia or chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

Hazardous Noise

⚠ CAUTION

Hazardous noise.
Can cause hearing loss.

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

Engine noise. Hazardous noise can cause hearing loss. Generator sets not equipped with sound enclosures can produce noise levels greater than 105 dBA. Prolonged exposure to noise levels greater than 85 dBA can cause permanent hearing loss. Wear hearing protection when near an operating generator set.

Hazardous Voltage/ Moving Parts

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

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

⚠ WARNING

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

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

⚠ CAUTION

Welding the generator set.
Can cause severe electrical equipment damage.

Never weld components of the generator set without first disconnecting the battery, controller wiring harness, and engine electronic control module (ECM).

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set and related equipment and electrical circuits. Turn off the main circuit breakers of all power sources before servicing the equipment. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

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

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

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

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

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

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

Heavy Equipment

⚠ WARNING

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

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

Hot Parts

⚠ WARNING

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

Do not work on the generator set until it cools.

Servicing the alternator. Hot parts can cause severe injury or death. Avoid touching the alternator field or exciter armature. When shorted, the alternator field and exciter armature become hot enough to cause severe burns.

Servicing the exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. The engine and exhaust system components become extremely hot during operation.

Servicing the engine heater. Hot parts can cause minor personal injury or property damage. Install the heater before connecting it to power. Operating the heater before installation can cause burns and component damage. Disconnect power to the heater and allow it to cool before servicing the heater or nearby parts.

Notice

Notice

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

This manual provides troubleshooting and repair instructions for the generator set models listed on the front cover.

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

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

The equipment service requirements are very important to safe and efficient operation. Inspect the parts often and perform required service at the prescribed intervals. Maintenance work must be performed by appropriately skilled and suitably trained maintenance personnel familiar with generator set operation and service.

For engine service procedures not covered in this manual, refer to the Engine Service Manual.

Figure 1 Model 6VSG

List of Related Literature

Separate manuals contain operation, installation, and parts information not provided in this manual. Separate engine operation and service manuals are also available. Figure 2 lists the available manual part numbers.

Literature Type	Part Number
Specification Sheet, 6VSG	G4-213
Installation Manual, 6VSG	TP-6842
Operation Manual, 6VSG Generator Set	TP-6843
Parts Catalog	TP-6845
Engine Service Manual, CH740	24 690 06
SiteTech™ Software Operation Manual	TP-6701
Operation Manual, OnCue® Software	TP-6796
Installation Instructions, Programmable Interface Module (PIM)	TT-1584

Figure 2 Related Literature

Nameplate

The following illustration shows a typical generator set nameplate. Copy the model, serial, and specification numbers from the nameplate into the spaces provided in the product information section on the inside front cover of this manual. See the service views in Section 1.8 for the nameplate location.

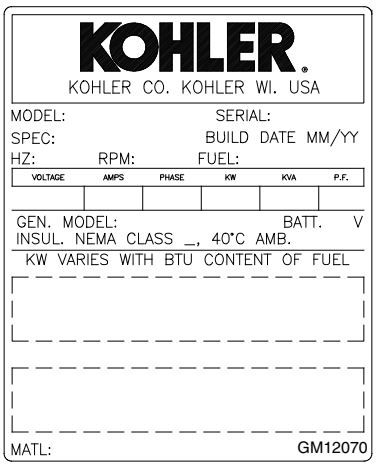


Figure 3 Nameplate, Typical

Emission Information

The Kohler Model CH740 engine used on the 6VSG generator set is certified to operate using natural gas or LPG fuel.

The Emission Compliance Period referred to on the Emission Control or Air Index label indicates the number of operating hours for which the engine has been shown to meet CARB or EPA emission requirements. Figure 4 provides the engine compliance period (in hours) associated with the category descriptor, which may be found on the certification label.

Emission Compliance Period			
EPA	Category C 250 hours	Category B 500 hours	Category A 1000 hours
CARB	Moderate 125 hours	Intermediate 250 hours	Extended 500 hours

Figure 4 Emission Compliance Period

Refer to the certification label for engine displacement. The exhaust emission control system for the CH740 engines (6VSG) is EM for U.S. EPA, California, and Europe. See Figure 1-6 for engine certification label location.

Service Assistance

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

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

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North China Regional Office, Beijing

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

Fax: (86) 10 6518 7955

East China Regional Office, Shanghai

Phone: (86) 21 6288 0500

Fax: (86) 21 6288 0550

India, Bangladesh, Sri Lanka

India Regional Office
Bangalore, India

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

Fax: (91) 80 3315972

Japan, Korea

North Asia Regional Office
Tokyo, Japan

Phone: (813) 3440-4515

Fax: (813) 3440-2727

Latin America

Latin America Regional Office
Lakeland, Florida, USA

Phone: (863) 619-7568

Fax: (863) 701-7131

Notes

1.1 Introduction

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

Consult the generator set nameplate for specific generator set ratings.

1.2 Controller Specifications

Model 6VSG generator sets are equipped with the VSC controller. For a specific description of the controller, see the generator set operation manual.

Environmental Specification	All Models
Operating temperature	-30 to 70°C
Storage temperature	-40 to 85°C
Humidity	0–95% condensing
Power requirements:	
Voltage	12 VDC
Current (standby state)	250 mA @ 12 VDC

Figure 1-1 Controller Specifications

1.3 Engine Service

Generator sets covered in this manual are equipped with four-cycle, twin cylinder, air-cooled Kohler engines.

For engine service information and specifications not covered in this manual, see the engine service manual. See the List of Related Literature in the Introduction section.

1.4 Engine Specifications

Engine Specification	6VSG
Manufacturer	Kohler
Model	CH740
Cycle	4
Number of cylinders	2
Compression ratio	9:1
Displacement, cc (cu. in.)	725 (44)
Rated power, propane fuel, kW (HP)	The engine max horsepower at 2900 rpm is ~21.2LPG and 18.5NG. This unit is underrated by limiting current to 6 kW.
Rated power, natural gas, kW (HP)	
Rpm, No load	2300
Rpm, Full load	2900
Bore x stroke, mm (in.)	83 x 67 (3.27 x 2.64)
Valve material	Steel/Stellite®
Cylinder block material	Aluminum w/cast iron liners
Cylinder head material	Aluminum
Piston rings	2 compression/ 1 oil
Crankshaft material	Heat-treated ductile iron
Main bearings: number, type	2, parent material
Lubrication system	Full pressure
Oil capacity (w/filter), L (qt.)	1.9 (2.0)
Oil pressure, kPa (psi)	172–241 (25–35)
Fuel system	LPG or natural gas
Minimum fuel supply pressure, kPa (in. H_2O)	LPG and NG: 1.2–2.7 (5–11)
Battery voltage	12 VDC
Battery ground	Negative
Spark plug gap, mm (in.)	0.76 (0.030)
Ignition system	Capacitor discharge
Starter motor	Electric, solenoid shift
Cooling system	Air-cooled

Figure 1-2 Engine Specifications

1.5 Alternator Specifications

Alternator Specification	24V	36V	48V
Number of poles	24		
Phase	Three-phase		
Number of leads	3		
Excitation method	Permanent magnet		
Voltage regulator type	Hybrid		
Coupling type	Direct		
Insulation (stator)	Epoxy varnish, vacuum impregnated Class 180 (H)		
Winding material	Copper		
Bearing, number, and type	1, sealed ball		
Circuit protection	125 amps	175 amps	250 amps
Stator resistance, ohms,* cold 48V - 1-2, 2-3, 3-1 36V - 1-2, 2-3, 3-1 24V - between any 2 leads	0.002	0.005	0.009
Stator output voltage with engine running at 2300 rpm No Load, Minimum 48V - 1-2, 2-3, 3-1 36V - 1-2, 2-3, 3-1 24V - between any 2 leads	18V	27V	36V

* Most ohmmeters do not give accurate readings when measuring less than 1 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.

Figure 1-3 Alternator Specifications

1.6 Torque Specifications

Torque Specifications, 6VSG	Nm (ft. lb.)
Alternator overbolts	15 (11)
Alternator thrubolt	85 (63)
Generator adapter screws	40 (28)
Muffler flange bolts	24 (17.7)
Oil filter	3/4 to 1 turn after gasket contact
Spark plug	24.4–29.8 (18–22)
Rectifier terminal connections	1.5–2.5 (1.1–1.8)

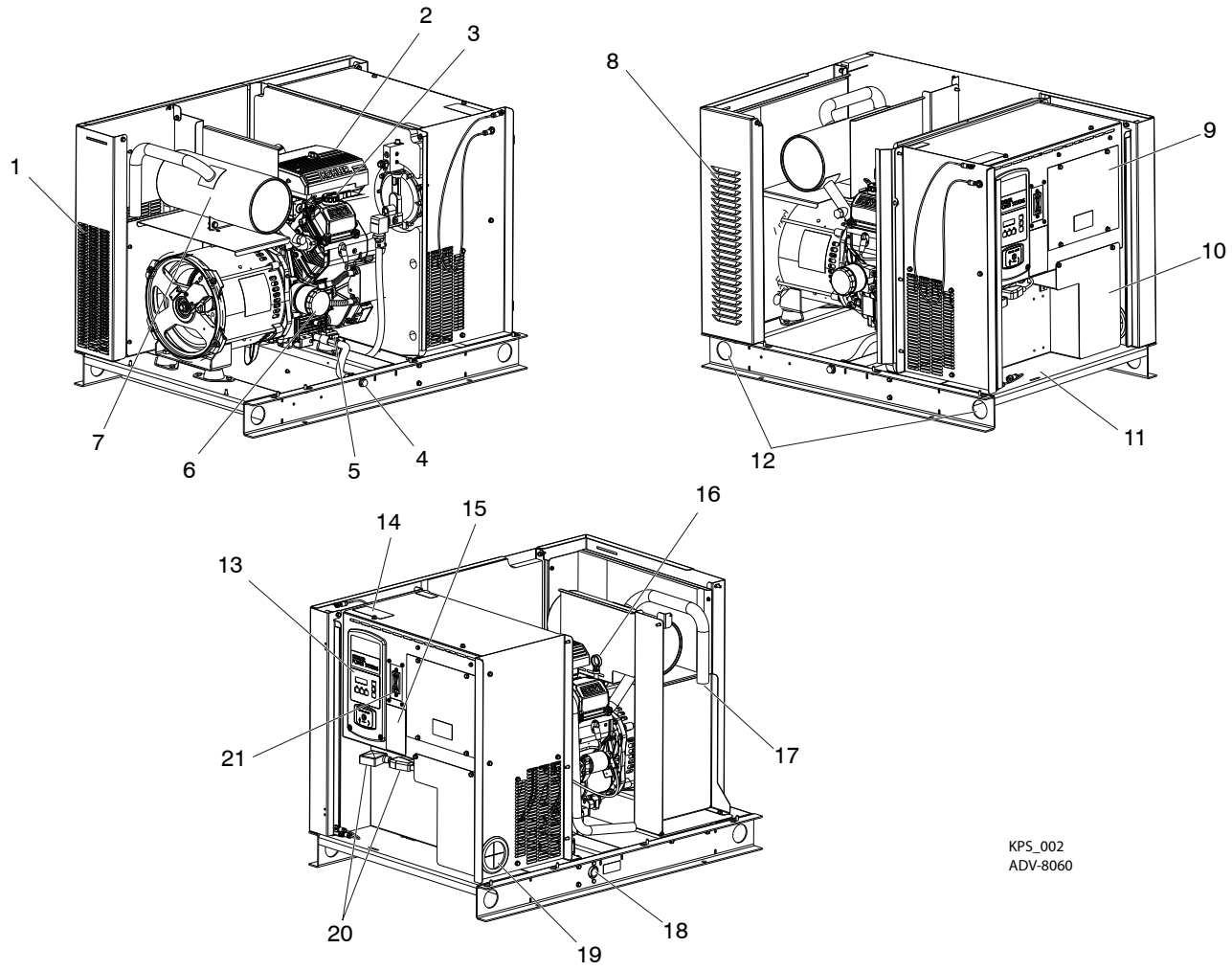
Figure 1-4 Torque Specifications

1.7 Rectifier Specifications

Specification	24V	36V and 48V
Rated Voltage, V	800	
Rated Current, A	100	200
Surge Current, A	2000	
Insulation Voltage VAC, 1 minute	2500	
Forward Voltage Drop	1.35	1.20
Thermal Resistance, °C/W	0.35	0.10

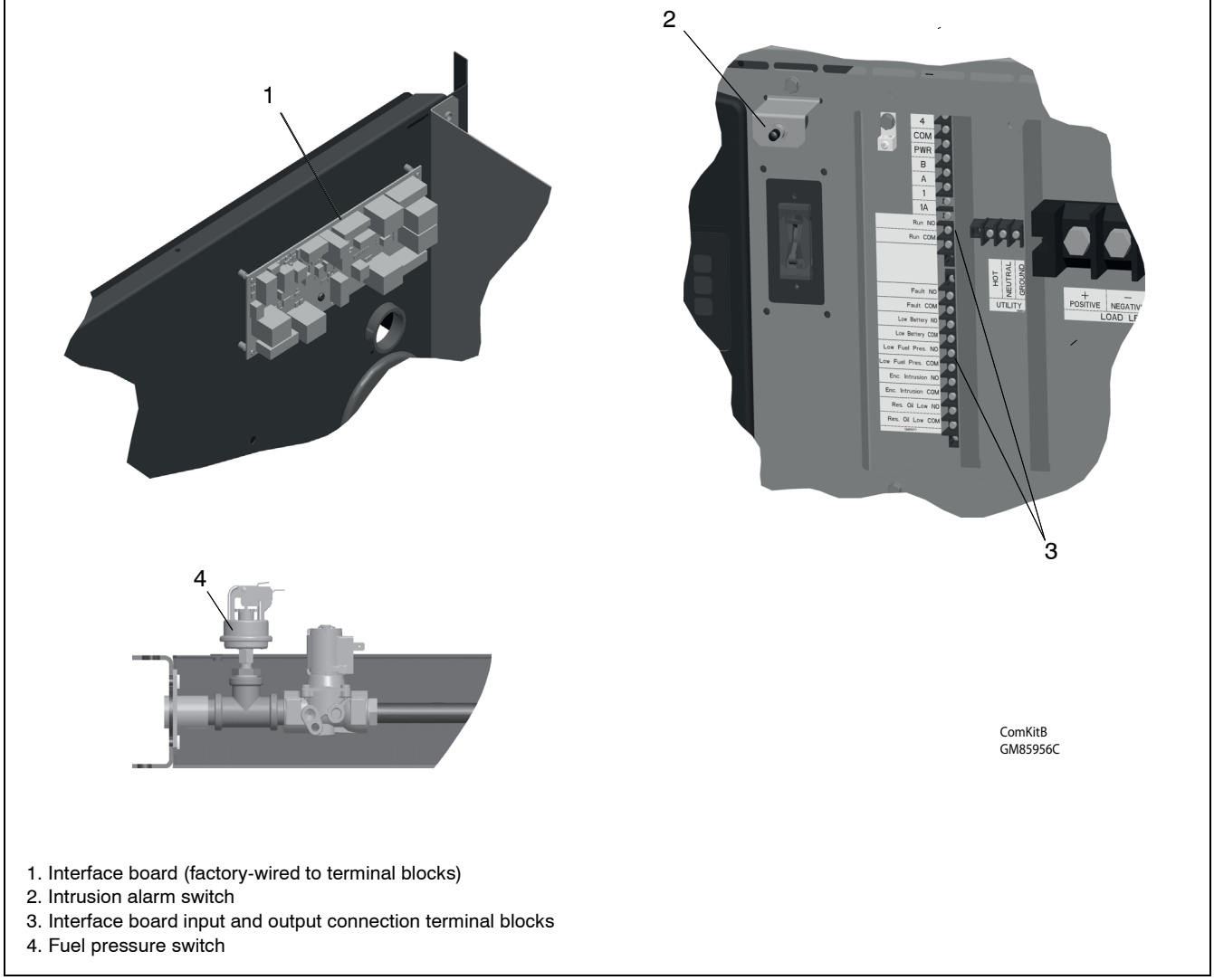
Figure 1-5 Rectifier Specifications

1.8 Service View



1. Exhaust air outlet
2. Air cleaner
3. Oil fill
4. Oil drain
5. Oil drain valve
6. Oil filter
7. Muffler
8. Alternator air inlet
9. Customer connection blocks (located behind panel)
10. Electrical inlet access panel
11. Engine starting battery location (battery not included)
12. Lifting holes
13. Controller
14. Engine certification label
15. Line circuit breaker
16. Oil dipstick
17. Exhaust outlet
18. Fuel inlet
19. Electrical inlet
20. Battery cables (included)
21. Nameplate

Figure 1-6 Service View (See Figure 1-7 for optional communications kit components)



1. Interface board (factory-wired to terminal blocks)
2. Intrusion alarm switch
3. Interface board input and output connection terminal blocks
4. Fuel pressure switch

Figure 1-7 Communications Kit Components

WARNING

Accidental starting.
Can cause severe injury or death.

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

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

WARNING

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

Do not work on the generator set until it cools.

Servicing the exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. The engine and exhaust system components become extremely hot during operation.

WARNING

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

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

See the Safety Precautions and Instructions at the beginning of this manual before attempting to service, repair, or operate the generator set. Have an authorized distributor/dealer perform generator set service.

Alternator Service. Under normal operating conditions the generator set alternator does not require scheduled service. Refer to the service schedule for items that require maintenance.

Engine Service. Perform generator set engine service at the intervals specified by the engine service literature. Contact an authorized Kohler® service distributor/dealer to obtain engine service literature.

All generator sets have emission-certified engines. The carburetors on emission-certified engines are not adjustable.

Routine Maintenance. Refer to the following generator set service schedule, the engine service schedule, and the runtime hours displayed on the generator set controller to determine when to schedule routine maintenance. Service the generator set more frequently if it is subject to extreme weather, long operating hours, or dusty or dirty conditions.

Maintenance Reminders. The 6VSG controller displays a reminder message every 100 hours of engine run time. Change the oil and perform other maintenance tasks listed on the service schedule. Then reset the reminder. See Section 2.3 for instructions to reset the maintenance reminder.

Service Schedule. Perform maintenance on each item in the service schedule at the designated interval for the life of the generator set.

Tools. Tools and instruments used to perform some maintenance items are not generally available to the generator set owner. Therefore, have service performed by an authorized distributor/dealer.

2.1 Service Schedule

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.

System Component or Procedure	See Section	Procedure					Frequency
		Visually Inspect	Check	Change	Clean	Test	
Fuel							
Flexible lines and connections		X		R			Quarterly
Main tank supply level (if LPG fueled)			X				Weekly
Fuel piping		X					Yearly
Lubrication	2.2						
Oil level		X	X				8 hours or before use**
Crankcase breather hose		X					Yearly or 500 hours
Change oil				X			Yearly or 100 hours ‡
Replace filter				X			Yearly or 200 hours
Cooling	2.6						
Air ducts, louvers			X		X		Yearly
Exhaust Line	2.7						
Leakage		X	X				Weekly
Insulation, fire hazards		X					Yearly
Obstructions or combustible materials near exhaust outlet		X					Weekly
DC Electrical System	2.9						
Battery charger operation, charge rate (if equipped)		X					Monthly
Remove corrosion, clean and dry battery and rack		X			X		Yearly
Clean and tighten battery terminals and inspect boots		X	X				Yearly
Battery electrolyte level and specific gravity *			X				Yearly
AC Electrical System							
Tighten control and power wiring connections			X				Yearly
Remote control system (if equipped)						X	Monthly
Visible wear or damage		X					Quarterly
Wire abrasions where subject to motion		X	X				6 months
Wire-cable insulation condition		X					3 years or 500 hours
Engine and Mounting							
Visible wear or damage		X					Weekly
Air cleaner and precleaner service †	2.5			R			Yearly or 100 hours
Spark plugs	2.4			X			Yearly or 300 hours
Replace stepper motor coupling and bushing				D			500 hours
Generator							
Visible wear or damage		X					Quarterly
Exercise generator set						X	Weekly
Brushes and collector ring		D			D		Yearly
Measure and record resistance readings of windings with insulation tester (Megger®, with SCR assembly or rectifier and load leads disconnected) *						D	3 years
General Condition of Equipment							
Evidence of vibration, leakage, excessive noise, temperature, or deterioration		X	X		X		Weekly
Interior of sound enclosure		X			X		Quarterly

* Not necessary for maintenance-free batteries.

† Service more frequently under extremely dusty/dirty conditions.

‡ Yearly or 250 hours if equipped with optional oil makeup kit.

** Every 24 hours of operation if equipped with optional oil makeup kit.

Megger® is a registered trademark of Biddle Instruments.

X Action

D Authorized distributor/dealer only

R Replace as necessary

Figure 2-1 Service Schedule

2.2 Lubrication System

See Section 2.1, Service Schedule, for oil change and oil filter replacement intervals. See Section 1.8, Service View, for the oil drain, oil check, oil fill, and oil filter locations.

2.2.1 Low Oil Pressure Shutdown

The low oil pressure (LOP) shutdown feature protects the engine against internal damage if the oil pressure drops below a minimum pressure because of oil pump failure or other malfunction.

Note: The LOP shutdown feature does not protect against damage caused by operating when the oil level is low; it is not a low oil level shutdown. Check the oil level regularly, and add oil as needed.

2.2.2 Oil Check

The generator set is shipped with oil. Before operating the generator set, check the engine oil in the crankcase. See Figure 2-2.

Maintain the oil level at or near, not over, the full mark on the dipstick. Add 5W-30 synthetic oil when the oil level is low.

Check the oil level before each use. For extended operation, check the oil level every 8 hours. Do not check the oil level when the generator set is running. Shut down the generator set and wait several minutes before checking the oil.

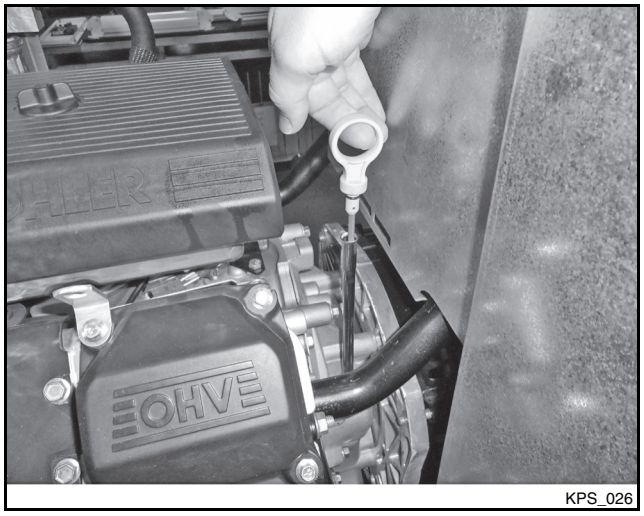


Figure 2-2 Oil Check (typical)

2.2.3 Engine Oil Recommendation

Use 5W-30 API (American Petroleum Institute) Service Class SG, SH, or SJ synthetic oil. Synthetic oil oxidizes and thickens less than other oils and leaves the engine intake valves and pistons cleaner.

Model	Oil Capacity, L (qt.)
Without Makeup Kit	1.9 (2.0)
Makeup Kit Reservoir	Additional 1.9 (2.0)

Figure 2-3 Oil Capacity (approximate)

2.2.4 Oil Change Procedure

Note: Dispose of all waste materials (engine oil, fuel, filter, etc.) in an environmentally safe manner.

Drain the oil while it is still warm.

1. **Drain the oil.**
   a. Press the OFF button on the generator set controller.
   b. Disconnect the power to the generator set, if applicable.
   c. Disconnect the generator set engine starting battery, negative (–) lead first.
   d. Open the housing service door and remove roof panel.
   e. If the unit is equipped with the optional oil makeup kit, close the valve between the bottom of the engine block and the oil makeup kit.
   f. Clean the area around the dipstick and oil fill cap.
   g. Remove the screw in plug on drain fitting in skid rail.
   h. Open the oil drain valve on the engine.
   i. Remove the dipstick and oil fill cap. Allow time for the engine oil to drain completely.
   j. Close the oil drain valve. Replace the cap in skid rail.
   k. Replace the dipstick.
2. **Replace the oil filter.**
   a. Clean the area around the oil filter. Remove the oil filter by rotating it counterclockwise with an oil filter wrench.
   b. Clean the gasket sealing surface of the oil filter adapter.
   c. Apply a light coat of clean oil to the rubber seal of the new oil filter.

d. Install the new oil filter following the instructions provided with the filter.

3. **Fill with oil.**

   a. Fill the engine to the F mark on the dipstick. The engine oil capacity is shown in Figure 2-4. See Operator Manual for oil selection.

Generator Set Model	Oil Capacity, L (qt.)
6VSG	1.9 (2.0)

Figure 2-4 Engine Oil Capacity

   b. Reinstall the dipstick and the oil fill cap.

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

   d. Reconnect the power to the generator set, if applicable.

   e. Press the RUN button on the generator set controller. The generator set will start.

   f. Run the generator set for a minute to allow the oil pressure to reach operating range.

   g. Stop the generator set, wait 1 minute, and then recheck the oil level. Add oil to bring the level up to the F mark on the dipstick.

   h. Open the valve to the oil makeup kit, if equipped.

4. **Check for leaks.**

   a. Check for oil leaks.

   b. Fix leaks and recheck the oil level.

   c. Reinstall the roof panel and close service door.

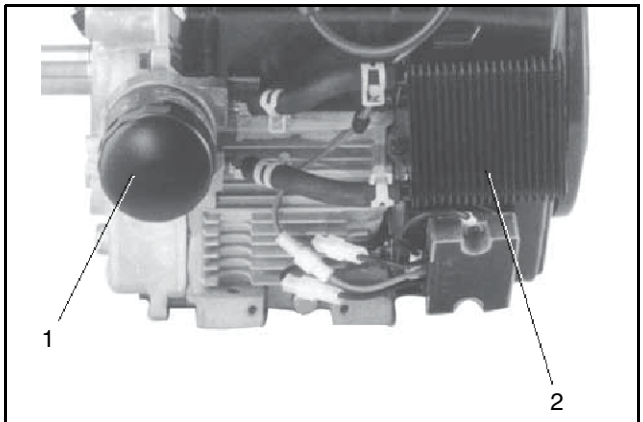
5. **Reset the maintenance timer on the controller. See Section 2.3 for instructions.**

2.2.5 Oil Cooler, 6VSG

Inspect and clean the oil cooler at the intervals shown in the Service Schedule. The oil cooler must be kept free of debris.

Remove the front enclosure panel to access the oil cooler. See Section 6.2 for instructions to remove the front panel.

See Figure 2-5 for the oil cooler location. Clean the outside of the oil cooler with a brush or compressed air. If it is necessary to clean the back of the oil cooler, remove the two screws holding the oil cooler unit to the blower housing. Tilt the cooler and clean with a brush or compressed air as shown in Figure 2-6. After cleaning, reinstall the oil cooler and secure with the mounting screws.



1. Oil filter
2. Oil cooler

Figure 2-5 Oil Cooler Location, 6VSG

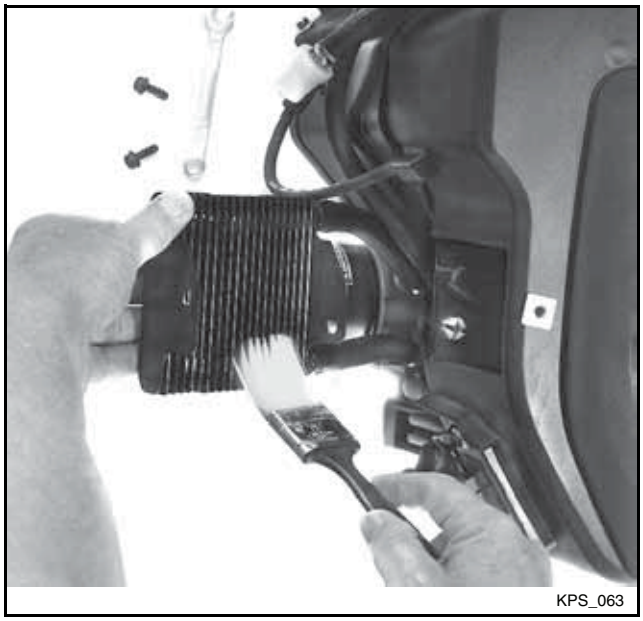


Figure 2-6 Cleaning the Oil Cooler

2.3 Resetting the Maintenance Timer

6VSG (VSC):

1. In the Overview menu, step down to the Next Maintenance screen.
2. Press the Select button.
3. Press the Up arrow button so that Reset Maint Timer? Yes is displayed.
4. Press the Select button. The next maintenance interval and date will be displayed after about 2 minutes.

2.4 Spark Plugs

Reset the spark plug gap or replace the plugs with new plugs as necessary.

1. Clean the area around the base of the spark plug to keep dirt and debris out of the engine.
2. Remove the spark plug and check its condition. Replace the spark plug if it is worn or if its reuse is questionable.
3. Check the spark plug gap using a wire feeler gauge. Adjust the gap to 0.76 mm (0.030 in.) by carefully bending the ground electrode. See Figure 2-7 and Figure 2-8.
4. Reinstall the spark plug into the cylinder head. Torque the spark plug to 24.4–29.8 Nm (18–22 ft. lb.).

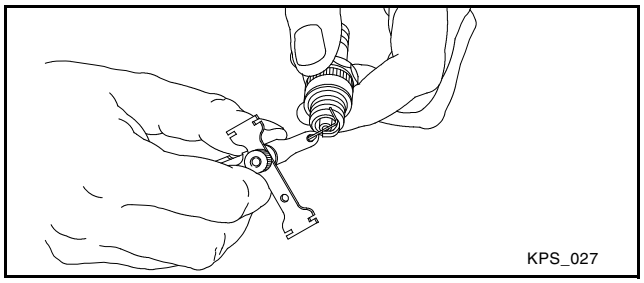


Figure 2-7 Checking the Spark Plug Gap

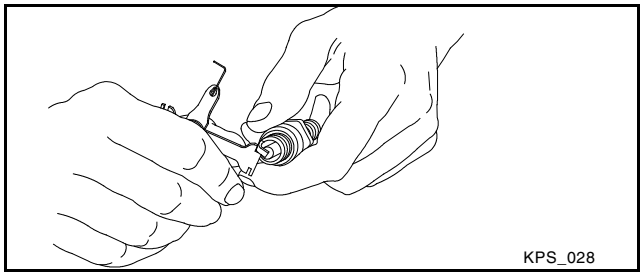
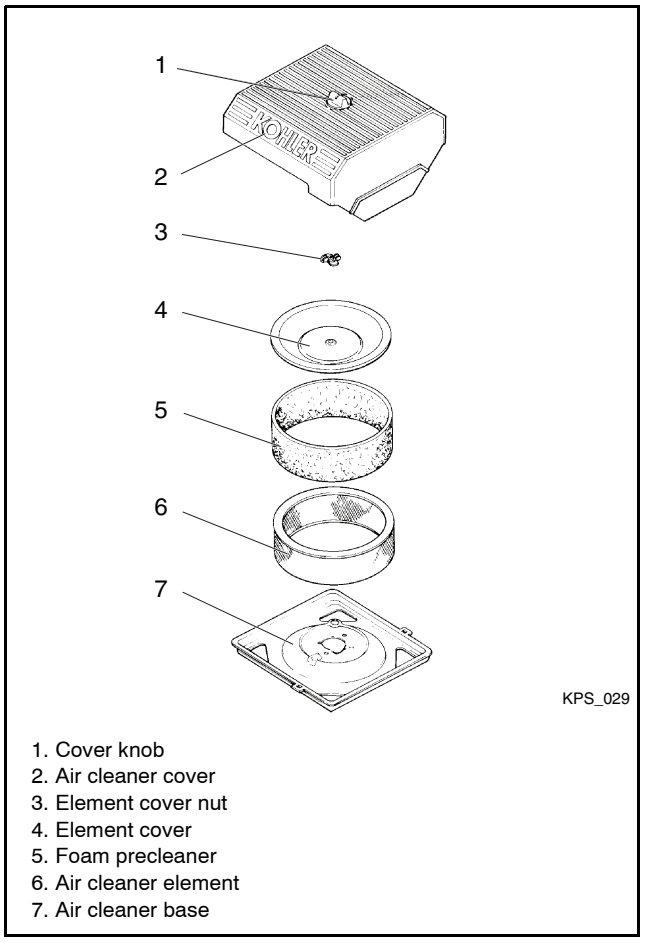


Figure 2-8 Adjusting the Spark Plug Gap

2.5 Air Cleaner Service

The engine has a replaceable high-density paper air cleaner element with an oiled foam precleaner. See Figure 2-9.



1. Cover knob
2. Air cleaner cover
3. Element cover nut
4. Element cover
5. Foam precleaner
6. Air cleaner element
7. Air cleaner base

Figure 2-9 Air Cleaner Components

Check for a buildup of dirt and debris around the air cleaner system. Keep this area clean. Also check for loose or damaged components. Replace all bent or damaged air cleaner components.

Note: Operating the engine with loose or damaged air cleaner components could allow unfiltered air into the engine causing premature wear and failure.

Precleaner Service

Use the following procedure to wash and oil the precleaner as indicated in the service schedule. Wash and oil the precleaner more often under extremely dusty or dirty conditions.

1. Press the OFF button on the generator set controller.
2. Disconnect the power to the generator set.
3. Disconnect the engine starting battery, negative (–) lead first.
4. Loosen the cover knob and remove the air cleaner cover. Remove the precleaner from the paper element. Wash the precleaner in warm water with detergent. Rinse the precleaner thoroughly until all traces of detergent are eliminated. Squeeze out excess water (do not wring). Allow the precleaner to air dry.
5. Saturate the precleaner with new engine oil. Squeeze out all of the excess oil.
6. Reinstall the precleaner over the paper element.
7. Reinstall the air cleaner cover. Secure the cover with the cover knob.
8. Reconnect the power to the battery charger.
9. Reconnect the generator set engine starting battery, negative (–) lead last.

Paper Element Service

Use the following procedure to replace the paper element at the intervals specified in the service schedule. Replace the paper element more often under extremely dusty or dirty conditions.

1. Press the OFF button on the generator set controller.
2. Disconnect the power to the generator set.
3. Disconnect the generator set engine starting battery, negative (–) lead first.
4. Loosen the cover knob and remove the cover.
5. Remove the element cover nut, element cover, and the paper element with precleaner.
6. Remove the precleaner from the paper element.

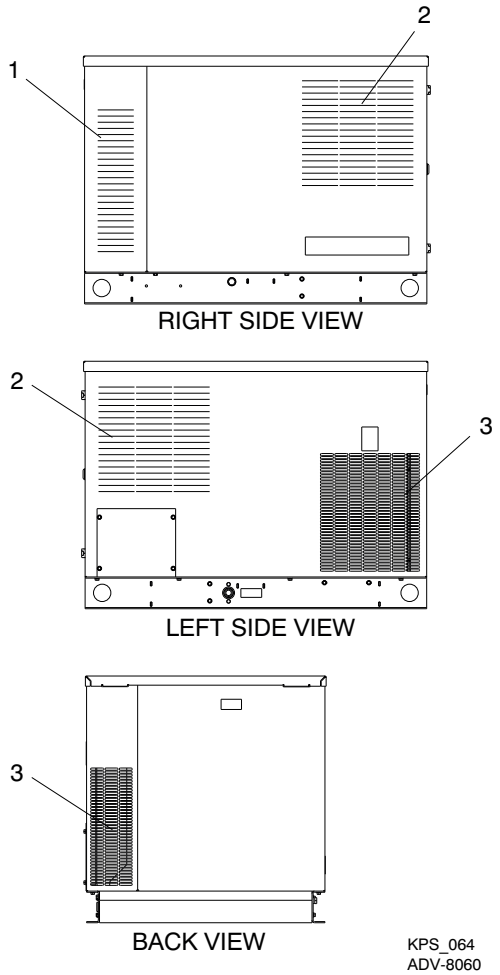
Note: Do not wash the paper element or clean it with pressurized air, as this will damage the element.

7. Replace the element if it is dirty, bent, or damaged.
8. Check the air cleaner base. Make sure it is secure and not bent or damaged. Also check the element cover for damage and fit. Replace all damaged air cleaner components. Remove any loose dirt or debris from the air cleaner base. Wipe the base carefully so that no dirt drops into the intake throat. Check the condition of the rubber seal on the air cleaner stud and replace the seal if necessary.
9. Reinstall the paper element, precleaner, element cover, element cover nut, and the air cleaner cover. Secure the cover with the cover knob.
10. Reconnect the power to the generator set.
11. Reconnect the generator set engine starting battery, negative (–) lead last.

2.6 Cooling System

The engine fan draws cooling air through the openings in the sides and end near the battery. The alternator fan draws cooling air through openings on the side walls of the enclosure. The cooling air mixes with the engine exhaust and is discharged at the exhaust outlet. See Figure 2-10. To prevent generator set damage caused by overheating, keep the housing cooling inlets and outlets clean and unobstructed at all times.

Note: Do not block the generator set cooling air inlets or mount other equipment near or above them. Overheating and severe generator damage may occur.



1. Alternator air inlet
2. Engine air inlet
3. Exhaust air outlet

Figure 2-10 Cooling Air Intake and Exhaust

2.7 Exhaust System

Remove all combustible materials from the exhaust location. Combustible materials include building materials as well as natural surroundings. Keep dry field grass, foliage, and combustible landscaping material a minimum of 1.5 m (5 ft.) from the exhaust outlet.

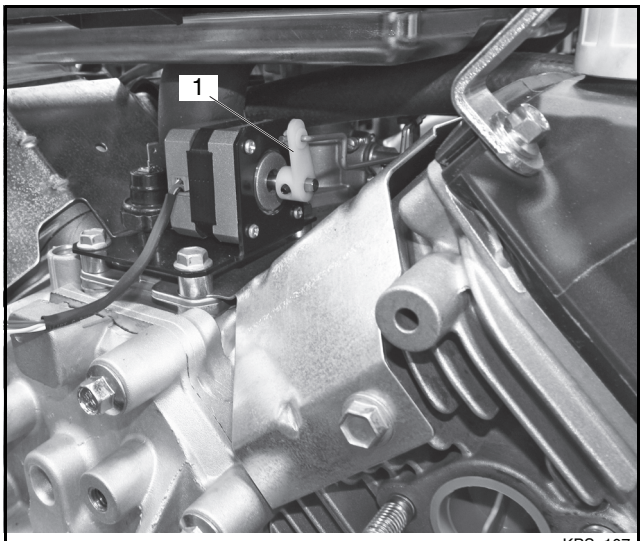
Periodically inspect the exhaust system components for cracks, leaks, and corrosion.

- Check for corroded or broken metal parts and replace them as needed.
- Check that the exhaust outlet is clear.

2.8 Stepper Motor Coupling

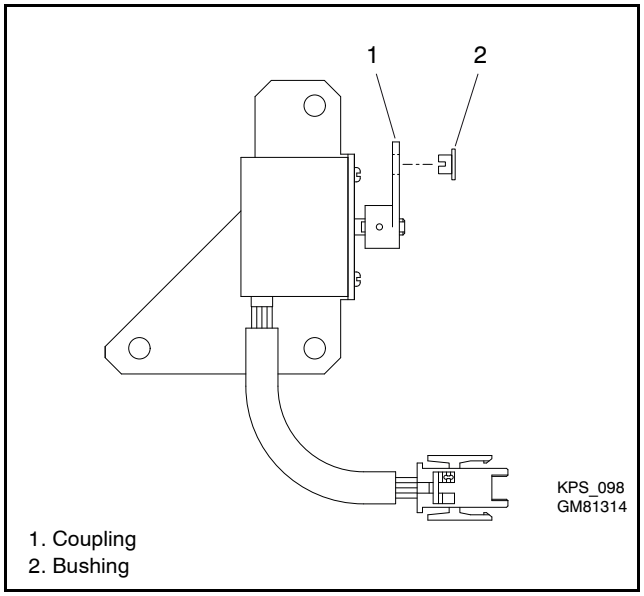
Replace the stepper motor coupling and bushings at the intervals shown in the service schedule. See the Parts Catalog for replacement part numbers.

Figure 2-11 shows the location of the coupling assembly under the air cleaner. Loosen the set screw to remove the coupling from the motor shaft.



1. Coupling and bushing

Figure 2-11 Stepper Motor Coupling



1. Coupling
2. Bushing

Figure 2-12 Stepper Motor Coupling and Bushing

2.9 Engine Starting Battery

⚠ WARNING

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

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

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

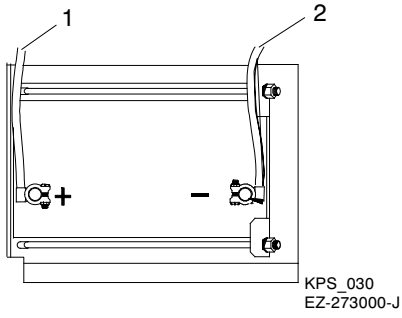
Battery acid cleanup. Battery acid can cause severe injury or death. Battery acid is electrically conductive and corrosive. Add 500 g (1 lb.) of bicarbonate of soda (baking soda) to a container with 4 L (1 gal.) of water and mix the neutralizing solution. Pour the neutralizing solution on the spilled battery acid and continue to add the neutralizing solution to the spilled battery acid until all evidence of a chemical reaction (foaming) has ceased. Flush the resulting liquid with water and dry the area.

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

Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery. Never connect the negative (–) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together.

Refer to this section for general battery information and maintenance. Also consult the battery manufacturer's instructions for battery maintenance.

All generator set models use a negative ground with a 12-volt engine electrical system. Consult the generator set nameplate for the engine electrical system voltage. Consult the generator spec sheet for battery capacity recommendations for replacement purposes. Wiring diagrams provide battery connection information. See Figure 2-13 for typical battery connections.



1. To positive (+) terminal on starter solenoid
2. To ground (–) terminal on or near starter motor

Figure 2-13 12-Volt Engine Electrical System Single Starter Motor, Typical Battery Connection

Clean the battery and cables and tighten battery terminals using the service schedule recommendations. To prevent corrosion, maintain tight, dry electrical connections at the battery terminals. To remove corrosion from battery terminals, disconnect the cables from the battery and scrub the terminals with a wire brush. Clean the battery and cables with a solution of baking soda and water. After cleaning, flush the battery and cables with clean water and wipe them with a dry, lint-free cloth.

After reconnecting the battery cables, coat the battery terminals with petroleum jelly, silicone grease, or other nonconductive grease.

2.10 Fuel System Maintenance

Routine service items include draining water/sediment from piping at petcock or pipe end cap, checking for fuel leakage at pipe connections, checking flexible sections for cracking or chafing, and keeping components clean including fuel regulator vent holes.

A grease or wax residue tends to accumulate in the piping and fuel regulators over time. If fuel system problems persist, disassemble the fuel system components and check for residue buildup. Remove any residue with a brush and mild detergent.

2.11 Storage Procedure

Perform the following storage procedure before removing the generator set from service for three months or longer. Follow the engine manufacturer's recommendations for storage, if available.

Note: Run the generator set monthly whenever possible.

2.11.1 Lubricating System

1. Operate the generator set until it reaches operating temperature, or about 15 minutes.
2. Stop the generator set.
3. While the engine is still warm, drain the engine lubrication oil from the engine crankcase.
4. Refill engine crankcase with oil. See Operation Manual for oil recommendations.
5. Run the generator set for a few minutes to distribute the clean oil.
6. Stop the generator set.

2.11.2 Fuel System

1. Start the generator set.
2. With the generator set running, shut off the gas supply.
3. Run the generator set until the engine stops.
4. Press the OFF button on the generator set controller.

2.11.3 Cylinder Lubrication

1. Remove the spark plugs.
2. Pour one tablespoon of engine oil into each spark plug hole. Install the spark plugs and ground the spark plug leads. Do not connect the leads to the plugs.
3. Crank the engine two or three revolutions to lubricate the cylinders.

2.11.4 Exterior Preparation

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

2.11.5 Battery

Perform battery storage last.

1. Press the OFF button on the generator set controller.
2. Disconnect the battery, negative (–) lead first.
3. Clean the battery.
4. Place the battery in a warm, dry location.
5. Connect the battery to a float/equalize battery charger, or charge the battery monthly using a trickle charger. Follow the battery charger manufacturer's recommendations.

Notes

3.1 Introduction

The VSC controller manages the operation of the generator set and the optional Programmable Interface Module (PIM). See the generator set Operation Manual for controller operation instructions.

This section covers adjustment and replacement of the VSC controller. See Section 4.10 for troubleshooting information.

The VSC controller is shown in Figure 3-1. See the service view, Figure 1-6, for the controller location.

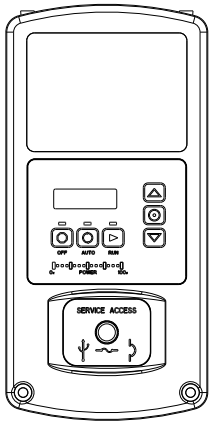


Figure 3-1 VSC Controller

3.2 SiteTech and OnCue Software

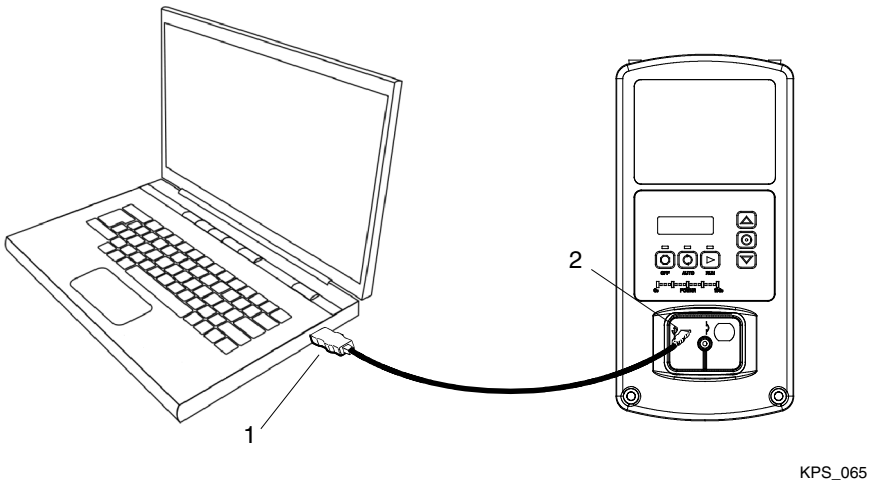
Many procedures in this manual require the use of a personal computer (or laptop) with Kohler® SiteTech™ software to change controller settings or update firmware. SiteTech software is available to Kohler-authorized distributors and dealers. See the SiteTech Operation Manual, TP-6701, for general software operation instructions.

Some procedures can be also performed using Kohler® OnCue® software if the controller is connected to the computer with a USB cable. See Figure 3-3.

Use a USB cable to connect the personal computer directly to the device. See Figure 3-3. The USB cable must have a male USB A connector on one end and a male mini-B connector on the other and must be less than 5 m (16.4 ft.) long. See Figure 3-2.

1. Detail, mini-B connector

Figure 3-2 USB Cable



1. USB cable connection to PC
2. USB cable connection to controller

Figure 3-3 USB Connection

3.3 Controller Parameters

Adjustable parameter settings can be changed using a personal computer (or laptop) with Kohler SiteTech software. See Section 3.2, SiteTech and OnCue Software for USB connection information. See the SiteTech Operation Manual, TP-6701, for general software operation instructions.

Some parameter settings can also be changed at the VSC controller. See the generator set operation manual for instructions to navigate through the controller menus and change settings.

3.3.1 Genset System Menu

The genset system menu displays the system information shown in Figure 3-4. Generator sets are factory-set and should not require changes to the system settings in the field.

A Kohler-authorized distributor or dealer can adjust these settings, if necessary. If the system settings require adjustment, see Installation Manual for instructions.

Note: Use caution when navigating the controller menus. In some menus, pressing the Select button can enable editing of the controller settings. Changing the settings to incorrect values can adversely affect generator set operation or render the unit inoperable.

System Parameters for Battery Bank Charging

The following system parameters can be viewed in the Genset System menu on the user interface on the generator set's VSC controller.

- System Voltage
- Auto Start Voltage
- Auto Stop Load (%)
- Load Limit

Note: Changing these settings can damage your generator set and batteries. Always refer to the information provided by the battery bank manufacturer for the correct voltage and charge current limits for your batteries. See the Operation Manual for instructions to change settings, if necessary.

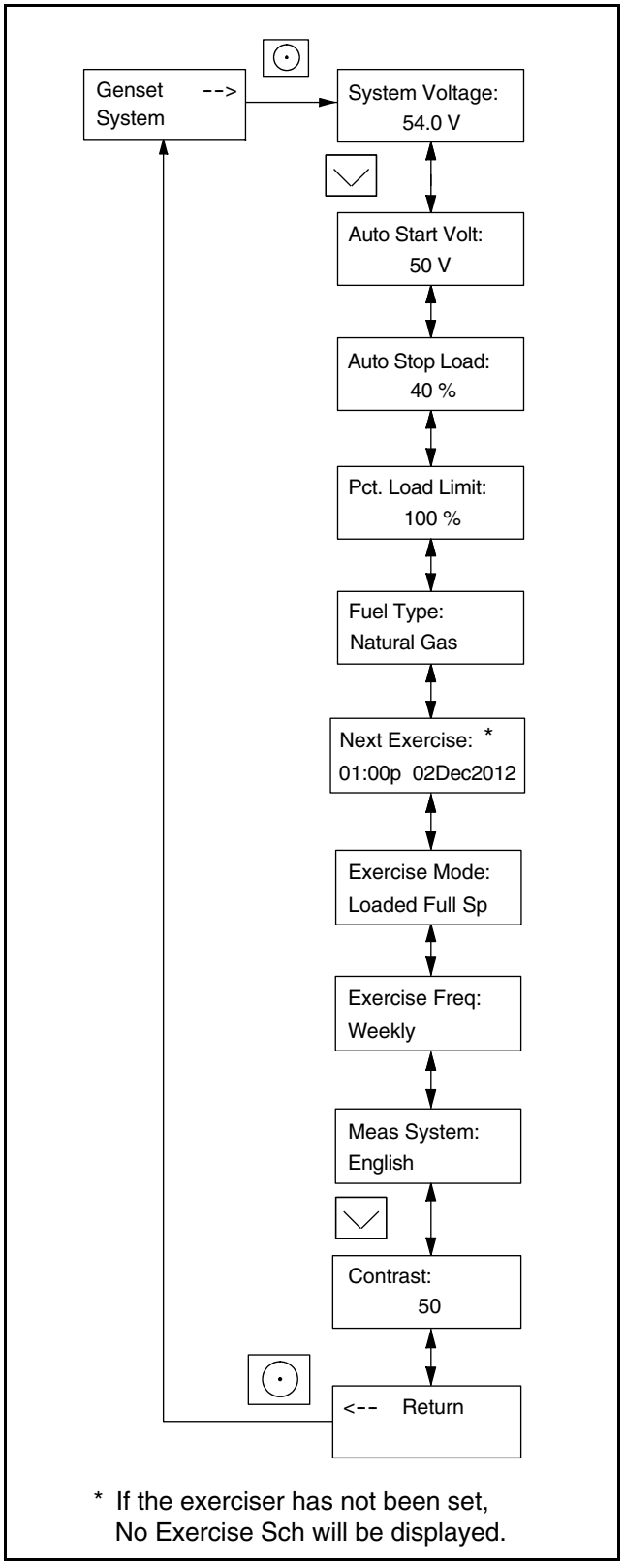


Figure 3-4 Genset System Menu

System Voltage: The system voltage is the output voltage of the generator set. Default values are shown in Figure 3-5. The system voltage is set to the required output voltage to properly support the load and charge the battery. Do not confuse this value with the voltage designation of the battery stack. For example, four 12V batteries in series results in a 48V battery stack, but the output voltage needed to charge the battery stack is 54V.

Nominal Voltage	24V	36V	48V
Default System Voltage, VDC	27	40.5	54

Figure 3-5 System Voltage Default Settings

Refer to the battery manufacturer's documentation for the recommended charging voltage. If the system voltage needs to be changed, see the Operation Manual for instructions to change settings.

Note: Setting the system voltage to a higher value than the factory default setting will decrease the power output of the generator set.

A 6VSG set at the system voltage shown in Figure 3-5 will have an output of 6 kW. If the system voltage is set to a higher value, the output current decreases. The available power output also decreases below 6 kW due to the limits on the engine speed. The graphs in Figure 3-7 illustrate the effect of changing the system voltage.

Auto Start Volt: The 6VSG will automatically start when the battery bank voltage has reached or fallen below this value for 180 seconds (3 minutes). Default settings are shown in Figure 3-6.

Nominal Voltage	24V	36V	48V
Default Auto Start Voltage, VDC	25	37.5	50

Figure 3-6 Auto Start Voltage

Note: The 3-minute (180-second) time delay can be changed using a personal computer (laptop) and Kohler® SiteTech™ software. See Figure 3-9 for SiteTech parameters.

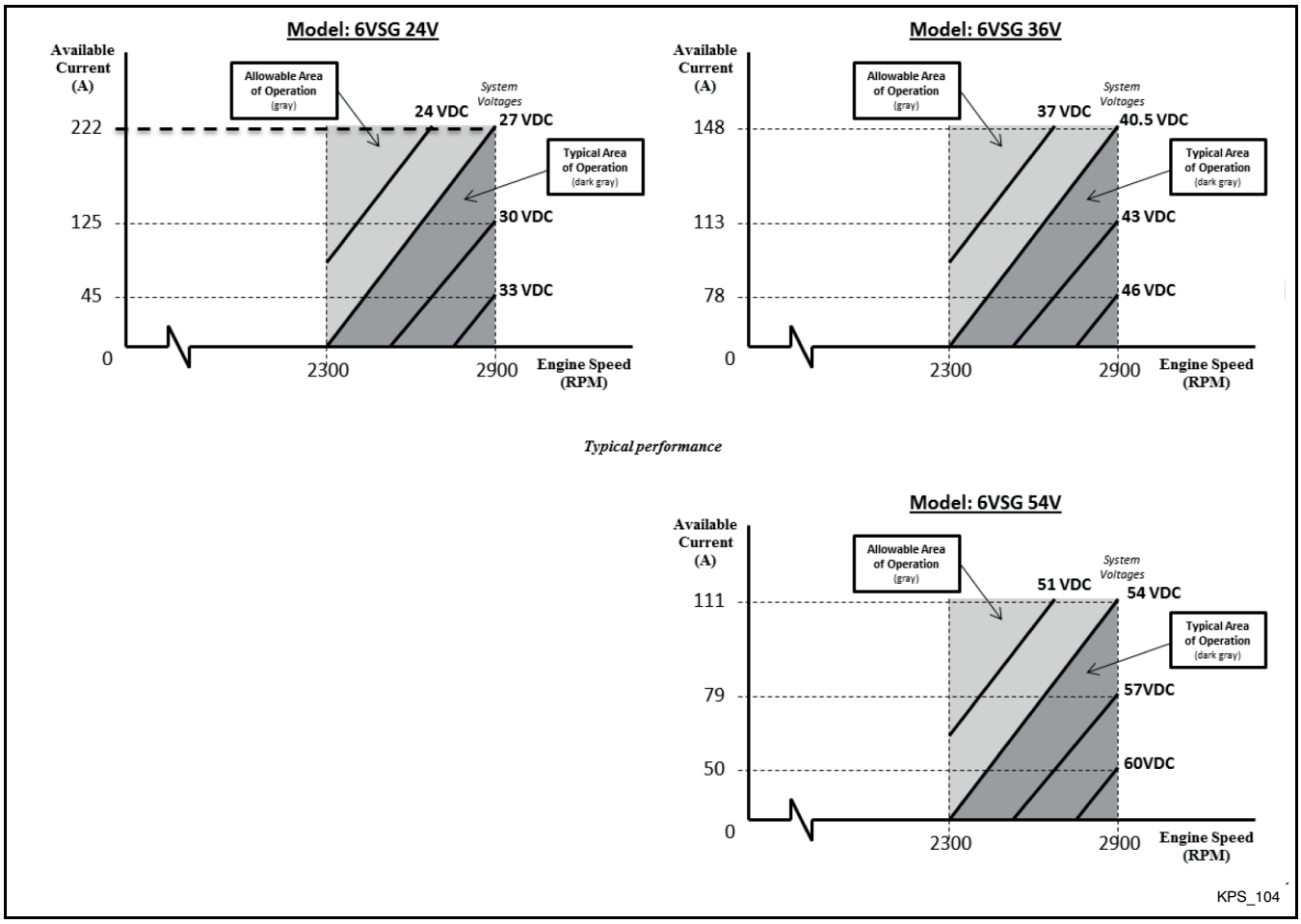


Figure 3-7 Effect of Changing the System Voltage Setting

Auto Stop Load: The auto stop load is set as a percentage of full load. As the battery bank approaches the fully charged state, the charge rate slows, and the load on the generator set decreases. The 6VSG will automatically stop when the load has reached or fallen below the Auto Stop Load setting for 180 seconds (3 minutes). The default setting is 40% load.

Load Limit (%): This setting limits the current output to the maximum charge rate specified by the battery manufacturer or load in the application. The default setting is 100%, which gives the maximum current values shown in Figure 3-8. Refer to the battery manufacturer's recommended maximum charge rate and see the Operation Manual for instructions if the setting needs to be changed.

Nominal Voltage	24V	36V	48V
System Voltage, VDC	27	40.5	54
Maximum Current at 100% Load Limit, Amps	222	148	111

Figure 3-8 Maximum Charge Current at Default Load Limit Setting of 100%

$$\text{Load Limit} = \frac{\text{(Recommended charging voltage (VDC) x Maximum charging current (amps)) x 100}}{\text{6000 watts}}$$

Setting the Exerciser

Use the Genset System menus to set the generator set exerciser. See Figure 3-4 and the Operation Manual for instructions to set the exerciser and for more information about exercising the generator set.

After a scheduled exercise run, the Next Exercise time and date will be updated automatically based on the Exercise Frequency setting.

Adjusting the Display Contrast

To adjust the display contrast, use the down arrow button to step to the Contrast menu. See Figure 3-4. Press the Select button, and then use the up and down arrow buttons to adjust the contrast. Press the Select button to save the contrast setting.

3.3.2 Notes on Selected Parameters

Temperature Settings

In SiteTech, all temperature settings are shown in degrees F but stored as degrees C. When you highlight a parameter value (click it), the °F value changes to the equivalent °C value. Enter temperature settings in °F. The new setting is calculated from a conversion equation, so the final value may include some rounding that makes the setting higher or lower by 1 degree.

Engine Speed Governor Settings

Engine Speed Gain Adjustment. The recommended setting for the engine speed gain adjustment is 50, which is the default setting. See Section 5.6.5 for instructions to adjust the Engine Speed Gain, if necessary.

Genset Info

Model numbers and serial numbers are factory-set for each unit. If the controller is replaced, the genset model number and serial number will need to be entered by the installer. For the genset model number, select 6VSG and the appropriate voltage from the dropdown list. Find the generator set serial number on the nameplate and enter it using SiteTech. See Section 3.5, Controller Replacement, for information about other setup required on a replacement controller.

Changing the genset voltage number will update the appropriate parameters automatically. Enter the System Voltage setting and then click Apply Changes in SiteTech to see the updated settings.

Genset Fuel Type

The Genset Fuel Type setting is located in the Genset System Configuration group in SiteTech. Generator set power and current ratings are the same for different fuel types (natural gas or LPG).

RBUS Devices

One programmable interface module (PIM) or one communications kit with interface board can be connected to the generator set.

3.3.3 Digital Inputs and Outputs

An optional Programmable Interface Module (PIM) or optional communications kit provides two digital inputs and 6 digital outputs. They are Digital Inputs B1–B2 and Digital Outputs B1–B6 in SiteTech. Other digital inputs and outputs that may appear in SiteTech do not apply to the 6VSG.

Programmable Interface Module (PIM)

Dropdown menus allow selection of the digital input and output events. Refer to Installation Instruction Sheet TT-1584, provided with the PIM, for information about the input and output events.

Communications Kit

The inputs and outputs on the communications kit interface board are factory-set and locked. The input and output settings correspond to factory-connected sensors on the generator set.

On generator sets equipped with the communications kit, the Personality Installed Options parameter is factory-set to 6VSG Telecom. This parameter is located in the Genset Personality profile group in SiteTech. Setting this parameter to 6VSG Telecom assigns the inputs and outputs to the values shown in the parameter table and locks the settings. See Section 3.3.4 for the parameter table.

When replacing the VSC controller on a generator set equipped with the factory-installed communications kit, use SiteTech to set the Personality Installed Options parameter to 6VSG Telecom. This will set the digital inputs and outputs to the correct settings.

3.3.4 Controller Parameter Table

Figure 3-9 on the following pages lists controller parameters that are visible in SiteTech. Parameters marked Read Only are not user-adjustable.

Some parameters that are visible in SiteTech do not apply to the Model 6VSG generator sets. Those parameters are not listed in the table.

The table indicates the following:

- The group in SiteTech that contains the parameter
- Factory default settings
- Units for the setting (e.g., rpm)
- Adjustment range for user-adjustable settings

SiteTech Group	Parameter	Units	Adjustment Range *	Default Setting
Identity	Vendor		Read Only	Kohler Company
Identity	Product		Read Only	VSG
Identity	Firmware Version		Read Only	N/A
Engine Metering	Engine Speed	R/min	Read Only	N/A
Engine Metering	Engine Target Speed	R/min	Read Only	N/A
Engine Metering	Battery Voltage	V	Read Only	N/A
Engine Metering	Lube Oil Temperature	° C	Read Only	N/A
Engine Metering	Genset Controller Temperature	°C	Read Only	N/A
Engine Metering	Engine Low Oil Pressure Switch		Read Only	N/A
Engine Speed Governor	Engine Speed Gain Adjustment		35–65	50
Generator Metering	Generator True Percent Of Rated Power	%	Read Only	N/A
Generator Metering	Generator Voltage L1-L2	V	Read Only	N/A
Generator Metering	Generator Voltage L2-L3	V	Read Only	N/A
Generator Metering	Generator Voltage Average Line To Line	V	Read Only	
Generator Metering	Generator Current L1	A	Read Only	N/A
Generator Metering	Generator Current L3	A	Read Only	N/A
Generator Metering	Generator Current Average	A	Read Only	N/A
Genset Info	Genset Model Number Select		Dropdown list: 6VSG-24V 6VSG-36V 6VSG-48V	Factory-set per unit. See Section 3.3.2
Genset Info	Genset Serial Number		0–20 characters	
Genset Info	Alternator Part Number		0–20 characters	
Genset Info	Genset Controller Serial Number		1–10 characters	
Genset Info	Engine Part Number		0–20 characters	
Genset Info	Engine Model Number		CH-74	
Genset Info	Engine Serial Number		0–10 characters	
Genset Info	Genset State	N/A	Read Only	N/A
Genset Run Time	Genset Controller Clock Time		Read Only	
Genset Run Time	Genset Controller Total Operation Time	h	Read Only	N/A
Genset Run Time	Engine Total Run Time	h	Read Only	N/A
Genset Run Time	Engine Total Run Time Loaded	h	Read Only	N/A
Genset Run Time	Engine Total Number Of Starts		Read Only	N/A
Genset Run Time	Genset Date Time Of Last Maintenance		Read Only (See Section 2.3, Resetting the Maintenance Timer)	1/1/01 12:00:00 AM
Genset Run Time	Engine Run Time Until Maintenance	h	Read Only	100, 250

SiteTech Group	Parameter	Units	Adjustment Range *	Default Setting
Genset Run Time	Genset Controller Date Format		MM/DD/YYYY or DD/MM/YYYY	MM/DD/ YYYY
Genset Run Time	Genset Controller Time Format		12 or 24 hr	12 Hr
Genset Run Time	Genset Date Time of Next Maintenance		Read Only	N/A
Genset Run Time	Maintenance Period In Days	days	Read Only	365
Genset Run Time	Maintenance Period Remaining	s	Read Only	31536000
Genset Run Time	Genset Controller Clock Time Zone Offset		Read Only	1/1/01 12:00:00 AM
Genset Personality Profile	ECM Model		**DO NOT CHANGE**	No ECM
Genset Personality Profile	Engine Number Of Flywheel Teeth		Locked	12
Genset Personality Profile	Engine Warmed Up Temperature	°C/F	77–140°C	90°C
Genset Personality Profile	Engine Cooled Down Temperature	°C/F	Locked	102°C
Genset Personality Profile	Engine Crank Disconnect Speed	rpm	300–1000	750
Genset Personality Profile	Engine Idle Speed	rpm	600–3000	2200
Genset Personality Profile	Engine Run Speed	rpm	1000–3900	2900
Genset Personality Profile	Personality Installed Options		None or 6VSG Telecom for comm. kit	6VSG:None; Comm Kit: 6VSG Telecom
Genset System Configuration	Genset System Voltage	V	24–60	24V = 27 36V = 40.5 48V - 54V
Genset System Configuration	Genset Power Rating	kW	DO NOT CHANGE	Auto select based on genset model and fuel type
Genset System Configuration	Genset Rated Current	A	Read Only	
Genset System Configuration	Genset System Battery Voltage	V	12/24	12
Genset System Configuration	Current Transformer Ratio		Locked	400
Genset System Configuration	Measurement System		English or metric	English
Genset System Configuration	Display Contrast		0–100	50
Genset System Configuration	Genset System Language	%	English	English
Genset System Configuration	Generator Maximum Percent Capacity	%	0–120	85.0
Genset System Configuration	Genset Fuel Type		Natural Gas or LPG (pulldown)	Natural Gas
Genset System Configuration	Automatic Start Minimum Voltage	V	Read Only	37.5
Genset System Configuration	Automatic Stop Minimum Percent Load	%	Read Only	40
Genset System Configuration	Automatic Start Minimum Voltage Delay	s	Read Only	180
Genset System Configuration	Automatic Stop Minimum Load Delay	s	Read Only	180
Genset Calibration	Genset Calibration Factor Voltage L1-L2		0.9–1.1	1.0063
Genset Calibration	Genset Calibration Factor Voltage L2-L3		0.9–1.1	0.9909
Genset Calibration	Genset Calibration Factor Voltage L1-N		0.9–1.1	0.9427
Genset Calibration	Genset Calibration Factor Current L1		0.9–1.1	1.000000
Genset Calibration	Genset Calibration Factor Current L3		0.9–1.1	1.000000
Genset Calibration	Current Transformer Calibration At No Load		Read Only	3.7
Genset Calibration	Current Transformer Calibration At Full Load		Read Only	170.3
Advanced Speed Control	Proportional Gain		DO NOT ADJUST unless instructed by the Kohler Generator Service Department.	Factory set per unit.
Advanced Speed Control	Transient Integral Gain			
Advanced Speed Control	Derivative Gain			
Advanced Speed Control	Slow Correction Integral Gain			

SiteTech Group	Parameter	Units	Adjustment Range *	Default Setting
Voltage Regulator	Voltage Regulator Average Voltage Adjustment	V	24–64 (Auto select with system voltage)	27, 40.5, or 54 (System Voltage)
Voltage Regulator	Voltage Regulator Volts Per Hertz Slope	%	1–10	5
Voltage Regulator	Voltage Regulator Gain		1–255	128
Engine Timing	Engine Start Delay	s	0–300	0
Engine Timing	Engine Cool Down Delay	s	300–600	300
Engine Timing	Engine Crank On Delay	s	10–30	15
Engine Timing	Engine Crank Pause Delay	s	1–60	15
Engine Timing	Engine Number Of Crank Cycles		1–6	3
Genset Protection	Genset Low Battery Voltage Warning Delay	s	Read Only	90
Genset Protection	Genset High Battery Voltage Warning Delay	s	Read Only	10
Genset Protection	Genset Low Battery Voltage Warning Limit	%	80–100	100
Genset Protection	Genset High Battery Voltage Warning Limit	%	110–135	125
Genset Protection	Genset Battery Low Cranking Voltage Warning Delay	s	Read Only	6
Genset Protection	Genset Battery Low Cranking Voltage Warning Limit	%	Read Only	60
Engine Protection	Engine Locked Rotor Shutdown Delay	s	3	3
Engine Protection	Genset Low Engine Speed Shutdown Limit	%	75–95	85
Engine Protection	Genset High Engine Speed Shutdown Limit	%	105–120	115
Generator Protection	Genset High Voltage Shutdown Delay	s	Read Only	2
Generator Protection	Genset High Voltage Shutdown Limit	%	Read Only	120
Digital Input B1 †	Digital Input B1 Value		Read Only	False
Digital Input B1 †	Digital Input B1 Enabled		True or False	False
Digital Input B1 †	Digital Input B1 Event		See dropdown list in SiteTech	PIM: None; (0) Comm Kit: Fuel Pressure Switch
Digital Input B2 †	Digital Input B2 Value		Read Only	False
Digital Input B2 †	Digital Input B2 Enabled		True or False	False
Digital Input B2 †	Digital Input B2 Event		See dropdown list in SiteTech	PIM: None; (0) Comm. Kit: Intrusion Alarm Switch
Digital Output B1 †	Digital Output B1 Value		Read Only	False
Digital Output B1 †	Digital Output B1 Event		See dropdown list in SiteTech	Generator Running
Digital Output B2 †	Digital Output B2 Value		Read Only	False
Digital Output B2 †	Digital Output B2 Event		See dropdown list in SiteTech	Common Fault
Digital Output B3 †	Digital Output B3 Value		Read Only	False
Digital Output B3 †	Digital Output B3 Event		See dropdown list in SiteTech	Low Battery Voltage Warning
Digital Output B4 †	Digital Output B4 Value		Read Only	False
Digital Output B4 †	Digital Output B4 Event		See dropdown list in SiteTech	PIM: Not in Auto Warning; Comm Kit: Low Fuel Pressure Warning
Digital Output B5 †	Digital Output B5 Value		Read Only	False

SiteTech Group	Parameter	Units	Adjustment Range *	Default Setting
Digital Output B5 †	Digital Output B5 Event		See dropdown list in SiteTech	PIM: Engine Cool Down Active; Comm Kit: Intrusion Alarm Warning
Digital Output B6 †	Digital Output B6 Value		Read Only	False
Digital Output B6 †	Digital Output B6 Event		See dropdown list in SiteTech	PIM: Normal Source Failure; Comm Kit: Reserve Oil Empty Warning
ATS Exercise	Exercise Interval		Weekly or Every Other Week	Weekly
ATS Exercise	Exercise Run Duration	min	10–30	20
ATS Exercise	Exercise Mode		Pulldown See List	Unloaded Cycle (2)
ATS Exercise	Exercise Warning Enabled		True or False	True
Network Configuration	DHCP Enabled		True or False	True
Network Configuration	Static IP Address		0.0.0.0 – 255.255.255.255	0.0.0.0
Network Configuration	Static Subnet Mask		0.0.0.0 – 255.255.255.255	0.0.0.0
Network Configuration	Static Default Gateway		0.0.0.0 – 255.255.255.255	0.0.0.0
Network Configuration	Static DNS Server 1		0.0.0.0 – 255.255.255.255	0.0.0.0
Network Configuration	Static DNS Server 2		0.0.0.0 – 255.255.255.255	0.0.0.0
Network Configuration	Server Host Name		oncue.kohler.com	oncue. kohler.com
Network Status	IP Address		Read Only	0.0.0.0
Network Status	Subnet Mask		Read Only	0.0.0.0
Network Status	Default Gateway		Read Only	0.0.0.0
Network Status	DNS Server 1		Read Only	0.0.0.0
Network Status	DNS Server 2		Read Only	0.0.0.0
Network Status	MAC Address		Read Only	N/A
Network Status	Connected Server IP Address		Read Only	0.0.0.0
Network Status	Network Connection Established		Read Only	False
Network Status	Media Connected		Read Only	False
Rbus Network	Rbus Active		Read Only	False
Rbus Network	Rbus Connection Count		Read Only	0
Rbus Network	Rbus Net Cycle Time	ms	Read Only	100
Rbus Network	Rbus Timeouts		Read Only	0
Rbus Network	Rbus Errors		Read Only	0
Rbus Devices B1	Rbus Devices B1 Serial Number		Read Only	N/A
Rbus Devices B1	Rbus Devices B1 Type		Read Only	N/A
Rbus Devices B1	Rbus Devices B1 Communication Errors		Read Only	N/A
Rbus Devices B1	Rbus Devices B1 Communication Timeouts		Read Only	N/A
Rbus Devices B1	Rbus Devices B1 Modbus Id		Read Only	N/A

SiteTech Group	Parameter	Units	Adjustment Range *	Default Setting
Rbus Devices B1	Rbus Devices B1 Last Connection Date		Read Only	N/A
Rbus Devices B1	Rbus Devices B1 Firmware Version		Read Only	N/A
Rbus Devices B1	Rbus Devices B1 Connected		Read Only	N/A
Rbus Devices B2	Rbus Devices B2 Serial Number		Read Only	N/A
Rbus Devices B2	Rbus Devices B2 Type		Read Only	N/A
Rbus Devices B2	Rbus Devices B2 Communication Errors		Read Only	N/A
Rbus Devices B2	Rbus Devices B2 Communication Timeouts		Read Only	N/A
Rbus Devices B2	Rbus Devices B2 Modbus Id		Read Only	N/A
Rbus Devices B2	Rbus Devices B2 Last Connection Date		Read Only	N/A
Rbus Devices B2	Rbus Devices B2 Firmware Version		Read Only	N/A
Rbus Devices B2	Rbus Devices B2 Connected		Read Only	N/A
Rbus Devices B3	Rbus Devices B3 Serial Number		Read Only	N/A
Rbus Devices B3	Rbus Devices B3 Type		Read Only	N/A
Rbus Devices B3	Rbus Devices B3 Communication Errors		Read Only	N/A
Rbus Devices B3	Rbus Devices B3 Communication Timeouts		Read Only	N/A
Rbus Devices B3	Rbus Devices B3 Modbus ID		Read Only	N/A
Rbus Devices B3	Rbus Devices B3 Last Connection Date		Read Only	N/A
Rbus Devices B3	Rbus Devices B3 Firmware Version		Read Only	N/A
Rbus Devices B3	Rbus Devices B3 Connected		Read Only	N/A

* Read Only = Not adjustable

† PIM or communications kit is required for digital inputs and outputs

Figure 3-9 VSG Parameters Accessible with SiteTech

3.4 Controller Firmware

The manufacturer may release new versions of controller firmware. Kohler® distributors can download the latest software from the TechTools area of the Kohler Power Resource Center website. Controller firmware is also available for download on the Kohler dealer portal and at www.kohlerpower.com/oncue.

The firmware version number is shown in the VSC controller's Overview menu. See SW Version in Figure 3-10. The firmware version number is also displayed in SiteTech and OnCue.

A personal computer (laptop), a USB cable, and Kohler® SiteTech™ or OnCue® software are required for firmware updates. Use a USB cable to connect the computer to the controller's USB port. See Section 3.2. To check the firmware version number, select the parameters view in SiteTech or OnCue. The firmware version number is shown in the Identity Group, which is the first group displayed.

Refer to the SiteTech Software Operation Manual or the OnCue Software Operation Manual for instructions to load new firmware onto the controller.

Firmware version numbers: Preceding zeros may be dropped from firmware version numbers. For example, version number 4.03 is the same as version 4.3. The version number displayed in SiteTech may show a third number. For example, SiteTech may display version 4.3.5 for software version 4.3.

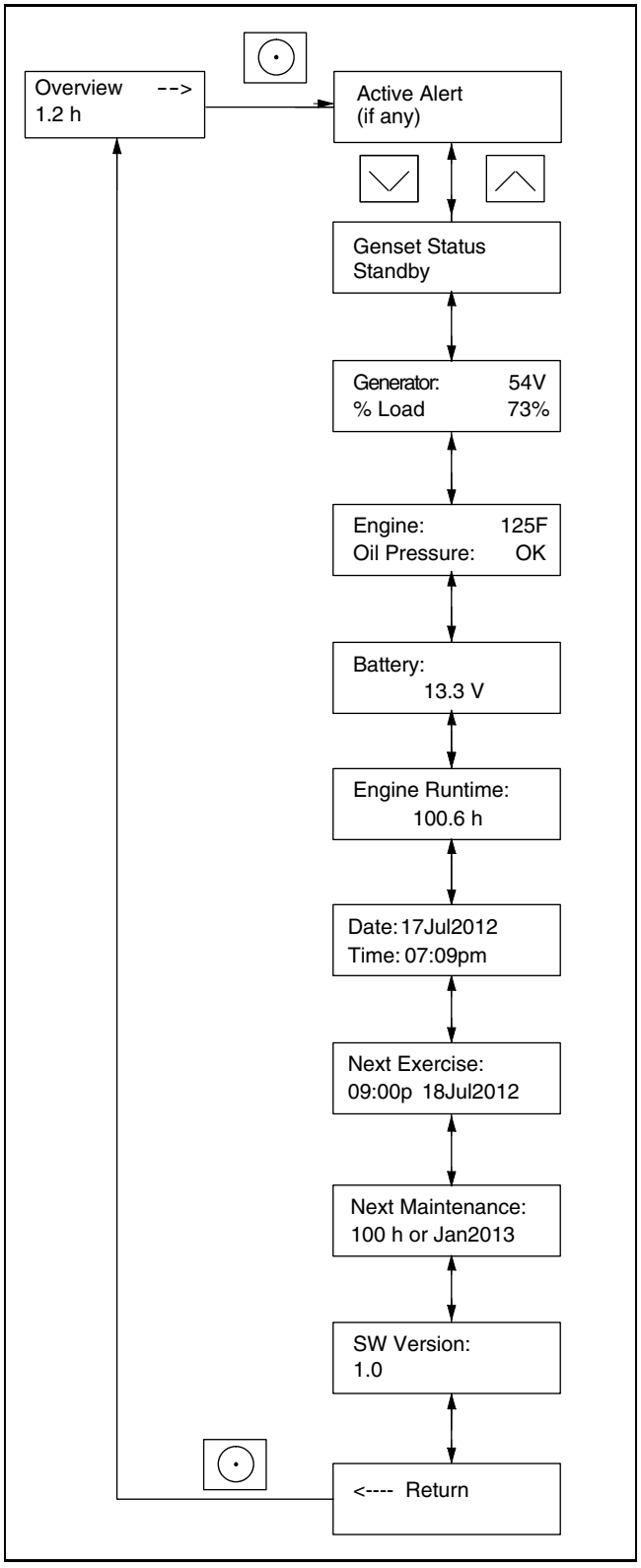


Figure 3-10 Firmware (SW) Version Number in Overview Menu

3.5 Controller Replacement

Always check the controller settings, wiring, and connections before replacing the controller. Use the procedure in this section for controller replacement, when necessary.

If a controller settings file was created at installation or at some other time when the controller was known to be operating correctly, a personal computer (laptop) with Kohler® SiteTech™ software can be used to load the settings onto the new controller. In some cases, the Kohler Generator Service Department may provide a settings file to load onto the controller for testing or troubleshooting. See TP-6701, SiteTech Software Operation Manual, for instructions to export and import settings after controller replacement.

Note: Export the old controller settings to the new controller only if you are certain that the settings are correct. Many controller operation problems can be caused by incorrect settings.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

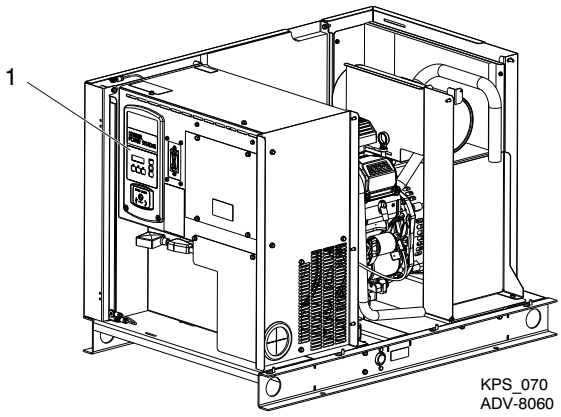
Disconnect all power sources before opening the enclosure.

Some setup is required once the new controller is installed. The VSC controller can be set up using the buttons on the controller or using a personal computer and Kohler® SiteTech™ software.

3.5.1 Controller Replacement Procedure

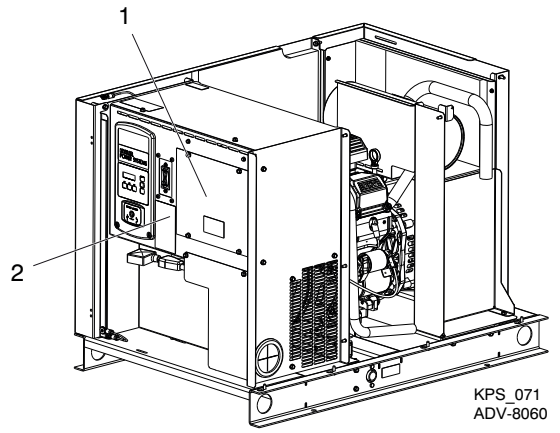
1. Using the enclosure locking tool provided with the generator set, open the enclosure roof. See Figure 3-11.
2. Press the OFF button on the controller.
3. Disconnect power to the generator set by opening the circuit breaker in the distribution panel (if equipped). Use a voltmeter to verify that power has been disconnected. See Figure 3-12 for the power connection location.
4. Disconnect the generator set engine starting battery, negative (–) lead first.
5. Remove the two screws securing the controller to the junction box and carefully lift the bottom edge of the controller. See Figure 3-13.

Note: Be careful of the leads and harness connected to the controller panel.



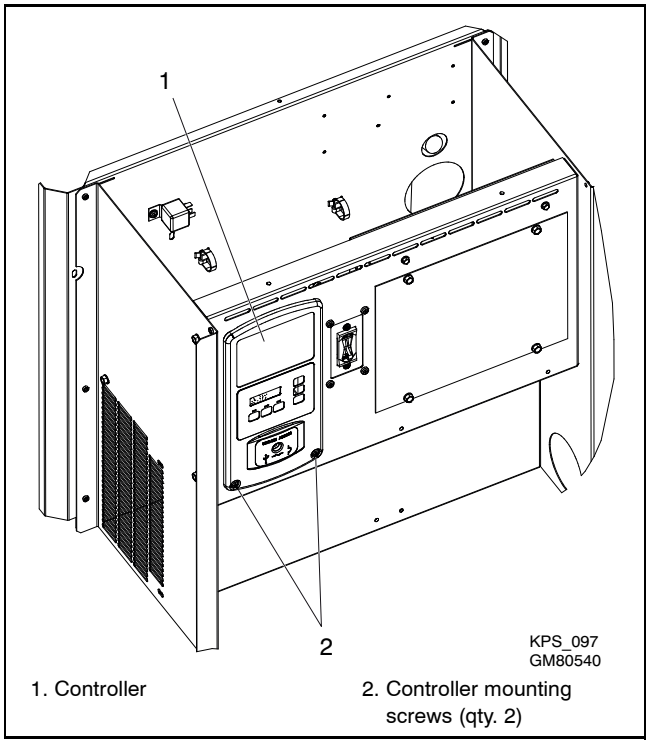
1. VSC controller

Figure 3-11 Controller Location



1. Power connection location (terminal block behind panel)
2. Nameplate location

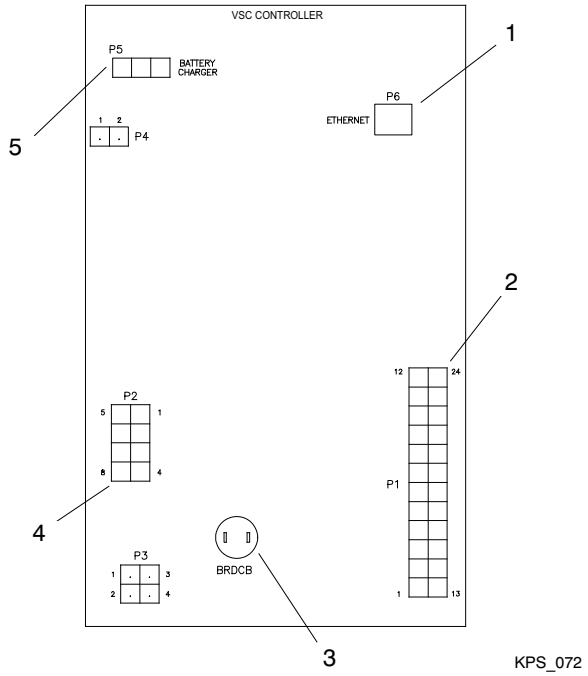
Figure 3-12 Power Connection and Nameplate Locations



1. Controller
2. Controller mounting screws (qty. 2)

Figure 3-13 Controller Mounting

6. Note the connections on the back of the controller, and then disconnect all harnesses and leads from the controller. See Figure 3-14 or the wiring diagram.
7. Remove the old controller.
8. Reconnect all harnesses to the new controller assembly.
9. Install the controller onto the junction box using the two screws removed in step 5.
10. Reconnect the engine starting battery, negative (–) lead last.
11. Reconnect the power to the generator set by closing the circuit breaker in the distribution panel.
12. The controller will prompt you to set the date and time, and then to set the exerciser. See the generator set Operation Manual for instructions, if necessary.
13. Check the firmware version on the controller. See Section 3.4. Use SiteTech or OnCue with the computer connected to the controller's USB port to update the firmware to the latest released version. See the OnCue Operation Manual or the SiteTech Software Operation Manual for instructions.
14. Set up the controller as instructed in Section 3.6, Controller Setup.
15. Calibrate the voltage. See Section 3.7, Voltage Calibration.
16. If OnCue® is used to monitor this generator set, reset the OnCue password on the controller and note the new password. See Section 3.9, Setting the OnCue Password. Then connect with OnCue and enter the new password.
17. Verify that OnCue® can communicate with the generator set over the Internet before leaving the job site.



1. P6 Ethernet connection for OnCue
2. P1
3. Not used
4. P2
5. P5

Figure 3-14 Controller Connections

3.6 Controller Setup

Controller setup is required after installation. Follow the instructions in this section to set the necessary parameters.

If a personal computer (laptop) and Kohler® SiteTech® software were used to create a controller settings file at the time of generator set installation (when the controller was known to be operating correctly), then SiteTech software can be used to load the saved settings onto the new controller. See TP-6701, SiteTech Software Operation Manual, for instructions to export and import controller settings.

Note: Load the old controller settings to the new controller only if you are certain that the settings are correct. Many generator set operation problems can be caused by incorrect settings.

If a controller setting file is not available, follow the instructions in this section to set the parameters using the controller menus and/or SiteTech software.

Controller Setup Notes:

- Some of the required information can be found on the generator set nameplate. See Figure 3-12 for the nameplate location.
- For the Genset Model Number, select 6VSG-24V for the 24V VSG, 6VSG-36V for the 36V VSG, or 6VSG-48V for the 48V VSG.
- Setting the model number will automatically set the system parameters to the default settings. Check the system parameters listed in Figure 3-15 and adjust if necessary. See Section 3.3.1 for more information.

Controller Setup Procedure

1. Use one of the following methods to set the parameters shown in Figure 3-15.
   a. Use the buttons on the controller to navigate through the controller menus and change the settings. See the required controller menus in Figure 3-16 and Figure 3-17. See the generator set operation manual for additional instructions, if necessary.
   b. Use a personal computer and Kohler® SiteTech® software.
   c. Use Kohler® OnCue® software (version 3.1 or higher) and a personal computer connected directly to the controller with a USB cable to set the genset serial number and model. See Section 3.2 for the USB connection.
2. Check the voltage calibration and adjust, if necessary. See Section 3.7, Voltage Calibration.
3. Verify that the voltage regulator gain is set to 128. Use SiteTech to adjust, if necessary.
4. If the generator set is connected to a programmable Interface Module (PIM), use SiteTech to set the digital inputs and outputs.
5. If the generator set is equipped with the factory-installed communications kit, use SiteTech to set the Personality Installed Options parameter to 6VSG Telecom.
6. If OnCue® is used to monitor this generator set, reset the OnCue password on the controller and note the new password. See Section 3.9, Setting the OnCue Password. Then connect with OnCue and enter the new password. Verify that OnCue can communicate with the generator set over the Internet before leaving the job site.

Controller Parameter	SiteTech Parameter	Settings		
		24V	36V	48V
Genset M/N	Genset Model Number	6VSG-24V	6VSG-36V	6VSG-48V
Genset S/N	Genset Serial Number	From nameplate		
System Voltage	Genset System Voltage	27 *	47.5 *	54 *
Auto Start Volt	Auto Start Minimum Voltage	25 *	37.5 *	50 *
Auto Stop Load (%)	Auto Stop Minimum Percent Load	40 *		
Pct. Load Limit (%)	Genset Maximum Percent Capacity	100 *		
Fuel Type	Genset Fuel Type	Natural Gas or LPG		
—	Voltage Regulator Gain †	128		
—	Personality Installed Options † (in Genset Personality Profile Group)	None for standard 6VSG; 6VSG Telecom if communications kit is installed.		

* Setting the Model Number automatically sets these parameters to the default settings shown. See Section 3.3.1 for information about these parameters.

† SiteTech is required to adjust these parameters.

Figure 3-15 Controller Setup

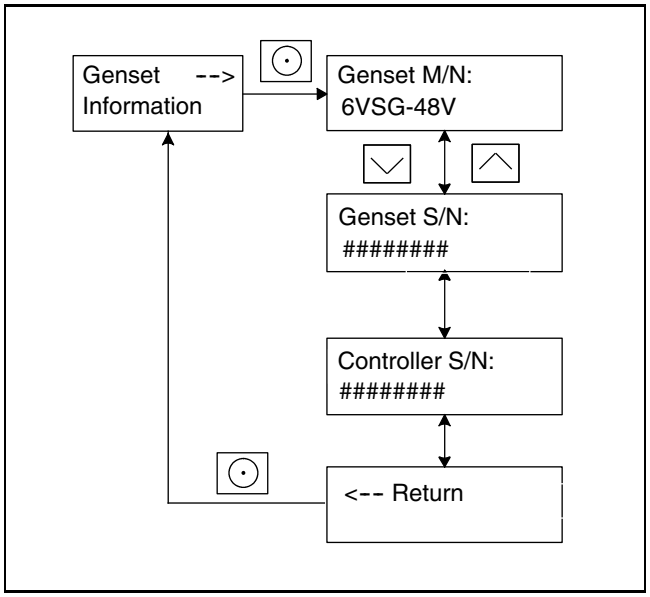


Figure 3-16 Generator Set Information Menu, VSC

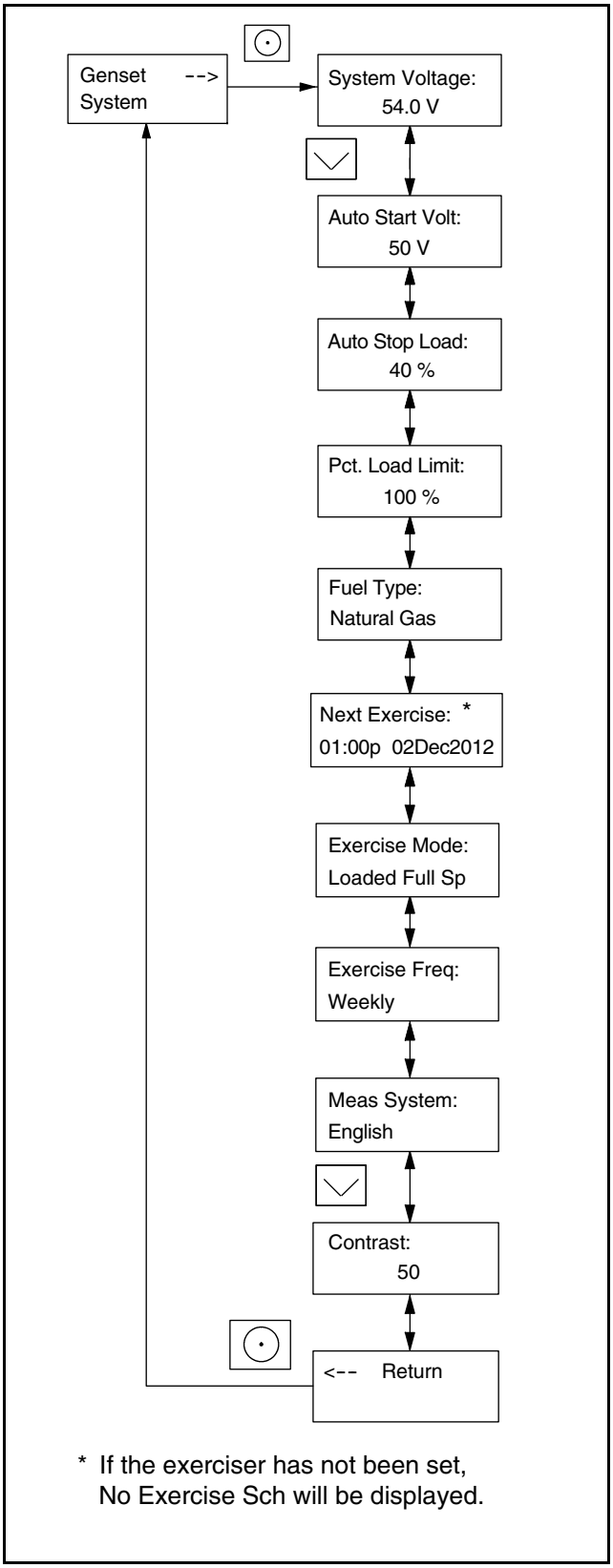
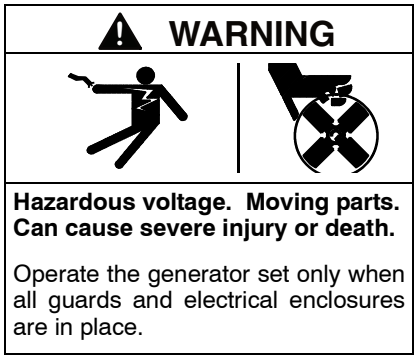


Figure 3-17 Genset System Menu, VSC

3.7 Voltage Calibration



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

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

The voltage can be calibrated using the controller keypad and menus, or using a personal computer with Kohler® SiteTech™ software.

3.7.1 Voltage Calibration using the Controller Keypad

See Figure 3-18 and follow the procedure below to calibrate the voltage using the controller keypad.

Note: A digital voltmeter is required for this procedure.

1. With the generator set off, connect a digital multimeter to measure output voltage across TB3 + and – terminals. Set the meter to measure DC volts.
2. Start the generator set by pressing the RUN button on the VSC controller.
3. Navigate to the Generator Metering menu and press the Select button. Volts will be displayed.
4. Press the Select button. The voltage number will flash.
5. Press the up or down arrow buttons to change the voltage reading to match the reading on the voltmeter.
6. When the correct voltage is displayed, press the Select button.
7. Use the arrow buttons to step down to the Return screen.
8. Pressing select when Reset Calibration is displayed will discard the changes and reset the calibration to the default settings.
9. Press OFF to stop the generator set.

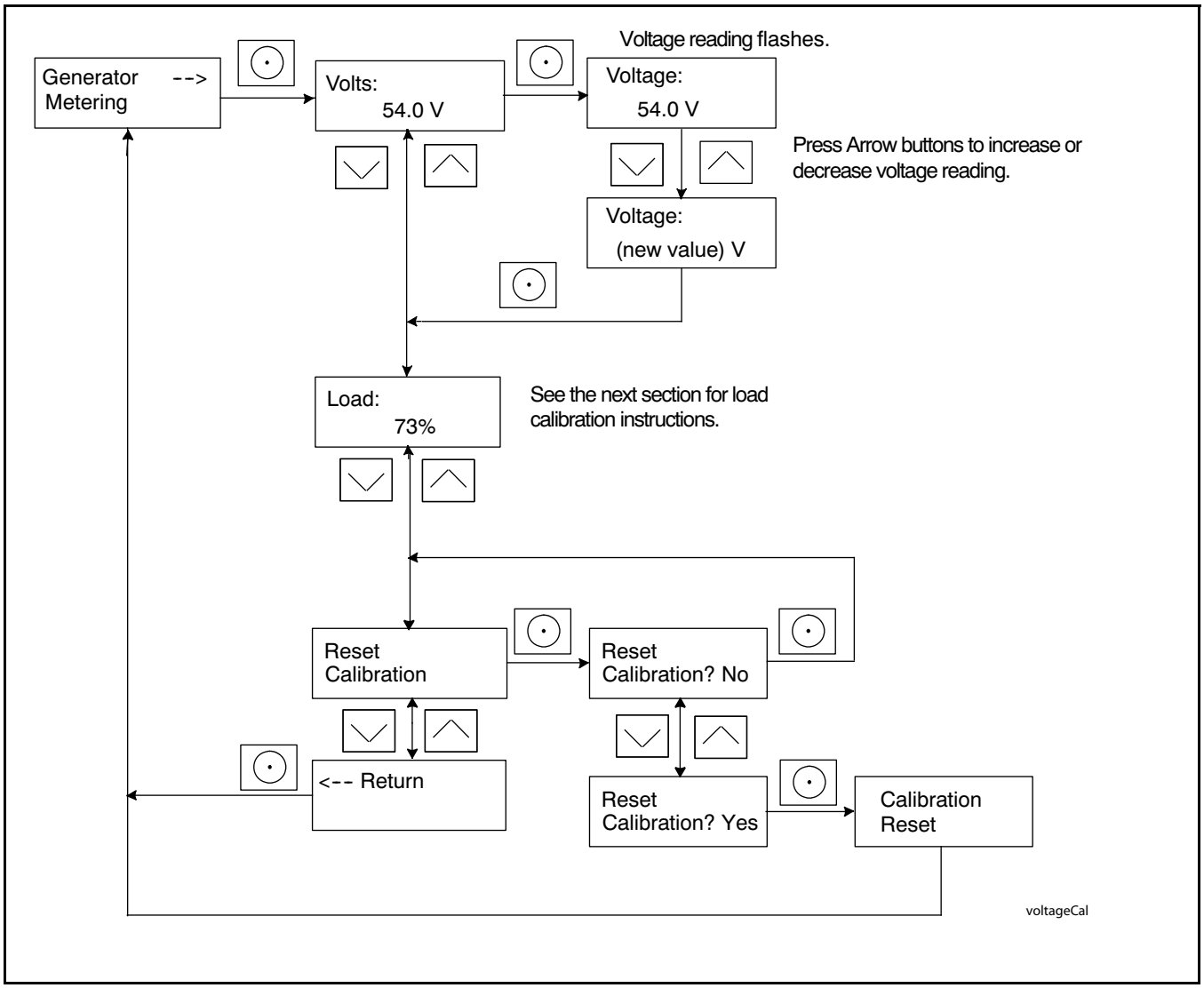


Figure 3-18 Voltage Calibration from the Controller Keypad

3.7.2 Voltage Calibration using SiteTech

Connect a personal computer (laptop) to the controller using a USB cable and follow this procedure to use Kohler® SiteTech™ software to calibrate the controller.

The voltage calibration factors are located in the Genset Calibration group in SiteTech™. Find the parameter labeled Genset Calibration Factor Voltage, L1-N. See Figure 3-20.

Note: A digital voltmeter is required for these adjustments.

1. With the generator set off, connect a digital multimeter to measure output voltage across + and -. Set the meter to measure DC volts.
2. Start the generator set by pressing the RUN button on the VSC controller.
3. Compare the voltage reading on the digital voltmeter to the voltage displayed by the controller.
4. If the voltage displayed on the controller does not match the measured voltage, use the equation in Figure 3-19 to calculate a new value for Genset Calibration Factor Voltage, L1-N.
5. Type the new value for Genset Calibration Factor Voltage, L1-N into SiteTech and click on Apply Changes. See Figure 3-20.
6. Allow a few seconds for the controller to adjust to the new factor and then compare the voltmeter reading with the voltage displayed on the controller.
7. If the voltage readings do not match, check your calculations. Check the calibration factor and both voltage readings again. Repeat the procedure using the new values, if necessary.

Note: To simplify the calculation, set the calibration factor to 1.0000 and then repeat the calibration procedure from step 3.

8. Press OFF to stop the generator set.

$$(V_{meter} \div V_{control}) \times F_{old} = F_{new}$$

V_{meter} = Voltmeter reading

$V_{control}$ = Voltage displayed on controller

F_{old} = Genset Calibration Factor Voltage, L1–N, from SiteTech before calibration

F_{new}= New value to enter for Genset Calibration Factor Voltage, L1–N, in SiteTech

Example:

Voltmeter reading: 53.4

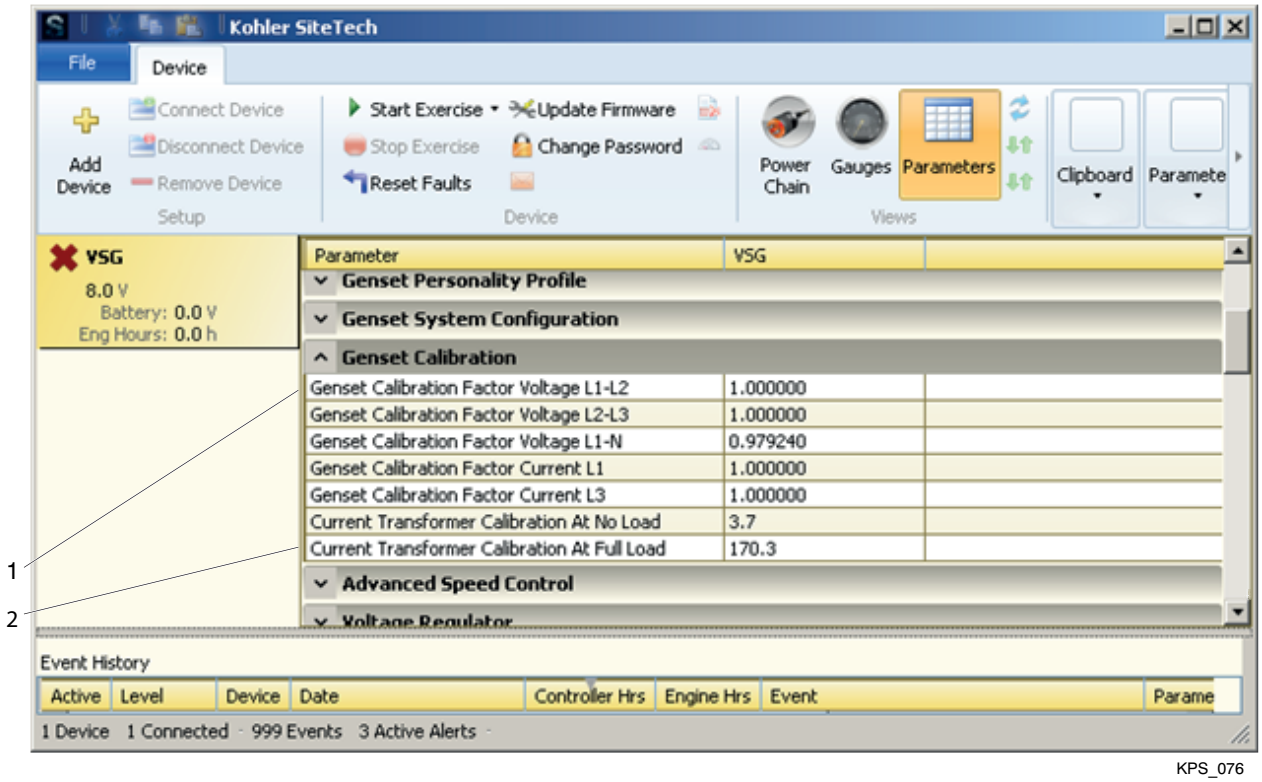
Controller display: 54.0

Old calibration factor (from SiteTech): 1.0063

New calibration factor:

$$(53.4 \div 54.0) \times 1.0063 = 0.995118$$

Figure 3-19 Voltage Calibration Factor



1. Voltage calibration factor
2. Current transformer calibration factor

Figure 3-20 Voltage and Current Transformer Calibration Factors in SiteTech™

3.8 Load (Current) Calibration

The VSC controller can be calibrated using the controller keypad and menus, or using a personal computer with Kohler® SiteTech™ software.

3.8.1 Calibration Using the VSC Controller Keypad and Menus

The controller's load calibration can be adjusted using the controller keypad. See Figure 3-21 and follow the procedure below.

Note: A digital ammeter is required for these adjustments.

1. With the generator set off, connect a digital multimeter to a DC current probe and configure it to measure current supplied by the generator (DC Amps).

Note: The 6VSG supplies current far in excess of what a digital multimeter can handle using the internal current measurement channel. A clamp-on DC current probe or DC current meter is required.

2. Start the generator set by pressing the RUN button on the VSC controller.
3. Adjust the system voltage to obtain rated current output if battery bank is attached. If no battery bank is attached, a load bank will be necessary to calibrate the generator load metering.

Note: If the generator current and voltage will not increase when the setpoint is raised, it is possible that the generator is in current-limit mode. The maximum percent load may need to be increased to reach rated output current on the generator for calibration. The maximum percent load may not be set above 105%. It is possible that several calibration attempts may be required to reach rated output current if the controller has been replaced.

Note: If the current does not reach rated current when the output voltage has reached a maximum safe voltage, the battery bank may require discharging before the calibration can be completed. This may require the use of a load bank.

Note: If the Percent Load of the generator is correct, there is no need to complete calibration. Percent Load is computed by the following:

% Load = (Measured Current * Output Voltage) / 60

4. Trip the output breaker on the generator.
5. Navigate to the Generator Metering menu and press the Select button. Gen Voltage will be displayed.
6. Press the Down button. The Generator Load will be displayed.
7. Press and hold the Select button. No-Load Calibration will be displayed.
8. Verify that the generator output breaker is open. Press Select, select Yes, and press Select again.
9. Close the circuit breaker for the generator output.
10. Verify that the generator is supplying rated output current. Press Select, select Yes, and press Select again.
11. Verify that the load on the generator is displayed correctly. Recalibrate if necessary.
12. Press OFF to stop the generator set.

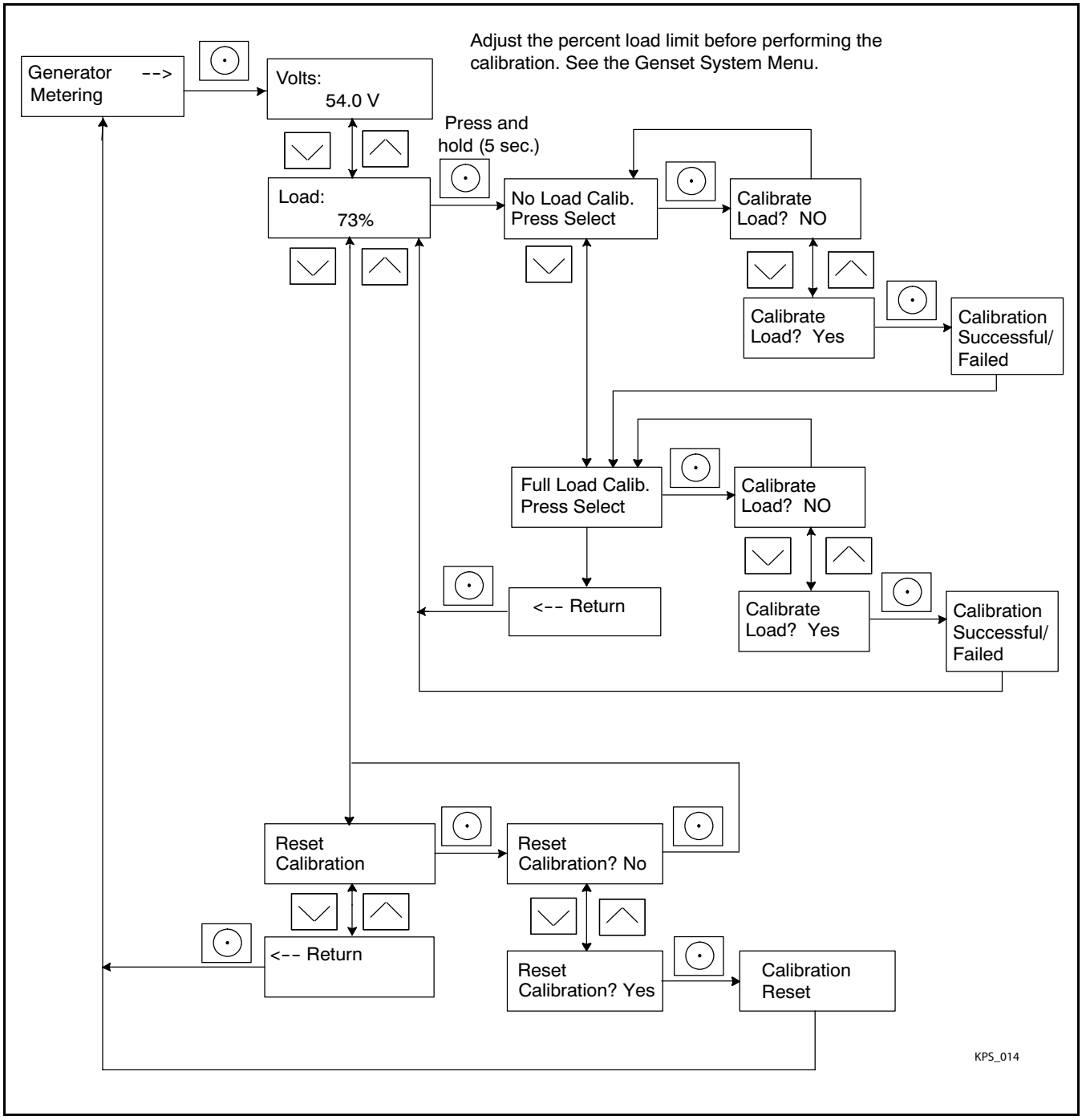


Figure 3-21 Load Calibration

3.8.2 Calibration Using SiteTech

Current calibration factors can be adjusted using SiteTech™ software to calibrate the VSC controller. Connect a personal computer (laptop) to the controller using a USB cable and follow this procedure to use Kohler® SiteTech™ software to calibrate the controller.

The current calibration factors are located in the Genset Calibration group in SiteTech. Find the parameters labeled Current Transformer Calibration At No Load and Current Transformer Calibration At Full Load. See Figure 3-20.

Note: A digital ammeter is required for these adjustments.

1. With the generator set off, connect a digital multimeter to a DC current probe and configure it to measure current supplied by the generator (DC Amps).

Note: The 6VSG supplies current far in excess of what a digital multimeter can handle using the internal current measurement channel. A clamp-on DC current probe or DC current meter is required.

2. Start the generator set by pressing the RUN button on the VSC controller.
3. Adjust the Voltage Regulator Average Voltage Adjustment to obtain rated current output if battery bank is attached. If no battery bank is attached, a load bank will be necessary to calibrate the generator load metering.

Note: If the generator current and voltage will not increase when the setpoint is raised, it is possible that the generator is in current-limit mode. Increasing the Current Transformer Calibration At Full Load setting will permit additional load to be placed on the generator set.

Note: If the current does not reach rated current when the output voltage has reached a maximum safe voltage, the battery bank may require discharging before the calibration can be completed. This may require the use of a load bank.

Note: If the Percent Load of the generator is correct, there is no need to complete calibration. Percent Load is computed by the following:

% Load = (Measured Current * Output Voltage) / 60

4. Set the Current Transformer Calibration At Full Load to the value displayed under the Generator Current Average while the generator is at 100% load.
5. Open the generator output breaker.
6. Set the Current Transformer Calibration At No Load to the value displayed under the Generator Current Average while the generator is at no load (breaker tripped).
7. Close the circuit breaker for the generator output.
8. Verify that the load on the generator is displayed correctly. Recalibrate if necessary.
9. Press OFF to stop the generator set.

3.9 Setting the OnCue Password

If the Kohler OnCue Generator Management System is used to monitor the generator set, reset the OnCue password as described below for the VSC.

See Figure 3-22 during this procedure.

1. Press Select and then press the down arrow button to navigate to the networking Information menu.
2. Press Select. Networking Status is displayed.
3. Press the Down arrow button. Networking Configuration is displayed.
4. Press Select. Reset OnCue Password is displayed.
5. Press and HOLD the Select button until Reset OnCue Password? No appears. The word No will flash.
6. Press the Up arrow button to change the word No to Yes.
7. Press Select to reset the password. The generator set serial number and new password are displayed for 10 seconds. Be sure to write down the new password for entry into the OnCue program.

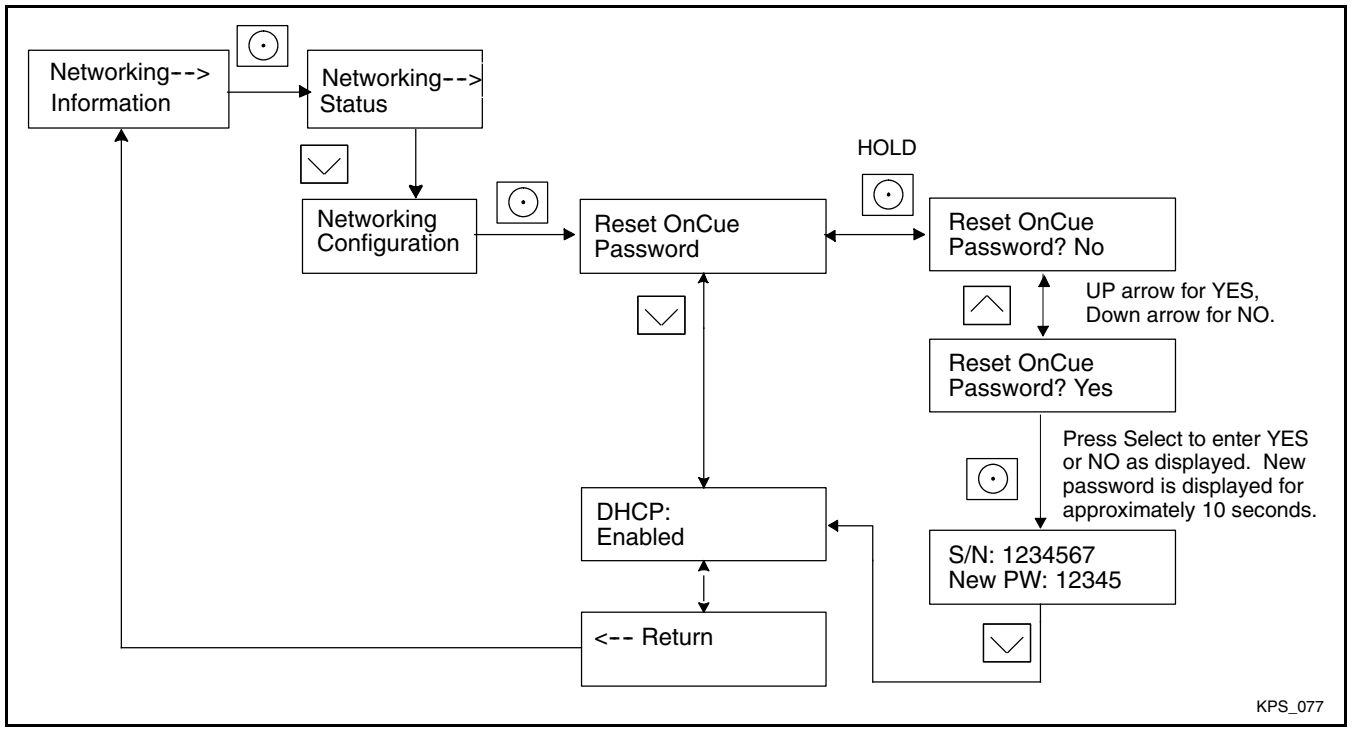


Figure 3-22 Setting the OnCue Password, VSC

Notes

4.1 Introduction

Corrective action and testing in many cases requires knowledge of electrical systems and electronic circuits. Have an authorized distributor/dealer or trained service technician perform testing and service.

Refer to the engine service manual for engine service information. See the List of Related Literature for the document part number.

If the troubleshooting procedures in this section identify a failed part, refer to the parts catalog for replacement part numbers. See the List of Related Literature in the Introduction for the parts catalog number.

4.2 Initial Checks

When troubleshooting, always check for simple problems first. Check for the following common problems before replacing parts:

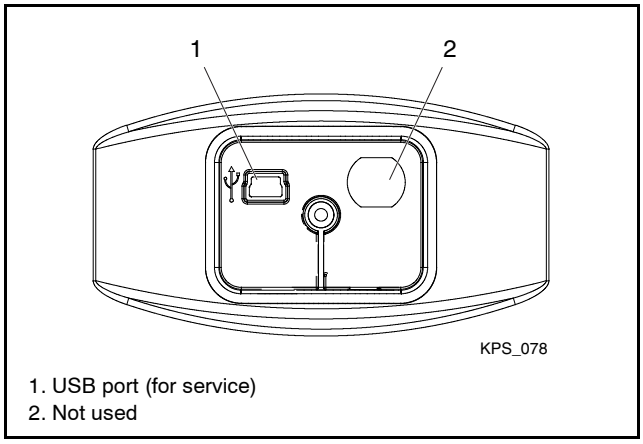
- **Loose connections or damaged wiring.**
- **Dead battery.**
- **Inadequate fuel supply.** Check for damaged primary or secondary fuel regulators, loose connections to the fuel solenoid valve, a damaged or closed fuel shutoff valve, an empty LPG fuel tank, or other problems with the fuel supply. Check the fuel supply pressure to the generator set. See Section 5.8, Fuel Systems.
- **Fault shutdown.** Check for a fault message on the controller display. Section 4.7 describes the warning and shutdown fault messages. If a fault message is displayed, identify and correct the cause of the fault condition. Then press the OFF button on the controller to clear the fault.
- **Incorrect controller settings.** Always check the controller settings before replacing the controller. Section 3.3.1 for controller settings. Refer to the operation manual for instructions to check and change the controller settings from the controller keypad, or use a personal computer and Kohler® SiteTech™ software.

4.3 Controller Service Access

The USB port is accessible from the front of the controller. Remove the service access door to access the USB port. See Figure 4-1.

Section 3.3 lists controller settings. Some settings can be changed from the controller keypad. All other adjustable settings require a personal computer (laptop) with Kohler® SiteTech™ software for changes. Use a USB cable with a mini-B connector to connect the controller's USB port to your PC.

See TP-6701, SiteTech™ Software Operation Manual, for software operation instructions.



1. USB port (for service)
2. Not used

Figure 4-1 Controller Service Access (cover removed)

4.4 Circuit Protection

Line Circuit Breaker

The line circuit breaker interrupts the generator output in the event of an overload condition or a fault in the wiring between the generator and the load. If the circuit breaker trips, check the wiring and if necessary, decrease the Maximum Percent Capacity.

Controller Internal Circuit Protection

The controller is equipped with internal circuit protection for accessory and main power overload conditions. Press OFF to reset.

4.5 OnCue Troubleshooting

See TP-6796, OnCue Software Operation Manual, for troubleshooting instructions for the OnCue Generator Management System.

4.6 Fuel System Troubleshooting

Most problems with gas fuels involve either fuel pressure or fuel regulator function. Basic troubleshooting consists of verifying fuel pressures and checking each fuel system component.

Check the following items:

- Check primary fuel regulator outlet pressure. This is the line pressure.
- Check the primary regulator vent for obstructions and clean, if necessary.
- Check fuel shutoff inlet pressure.
- Check secondary fuel regulator inlet pressure.
- Check fuel inlet pressure at the gas mixer.
- Perform fuel system maintenance if necessary. See Section 2.10, Fuel System Maintenance.

4.7 Fault Messages

The VSC controller displays fault messages to aid in troubleshooting. Fault messages, descriptions, and recommended checks are listed in Figure 4-2.

Fault messages will also appear in the Event History in SiteTech. The wording of the message in the Event History may vary slightly from the message shown on the controller display.

Identify and correct the cause of the fault condition. Refer to the troubleshooting charts in Section 4.9 for additional recommendations. Then press the OFF button to reset the controller after a fault shutdown.

Fault Message	Action	Description/Comments	Check
AC Sens Loss Shutdwn (Loss of AC sensing shutdown)	Shutdown	The controller shut down the generator because there was less than 5% of rated voltage measured on Phase A for 3 seconds, only in AUTO, only after acceptable voltage (> 5% of UV setting) has been detected.	Check for loose wiring and connections. Check all AC leads. Troubleshoot alternator.
AC Sens Loss Warning (Loss of AC sensing warning)	Warning	The controller has measured less than 5% of rated voltage on Phase A for 1 second, 10 seconds after crank disconnect.	Check for loose wiring and connections. Check all AC leads. Troubleshoot alternator.
AccyPwrOver Warning	Warning	Accessory Power Overload. An overcurrent fault (short circuit) on the accessory power output.	Check wiring to accessories. Check PWR and COM connections. Troubleshoot the accessories. Refer to the documentation provided with the accessories.
Aux Input Shutdwn * (Auxiliary input shutdown)	Shutdown	The controller shut down the generator because the digital input for a custom shutdown (AuxiliaryInputShutdown - PIM) was activated (low).	Check customer equipment connected to the PIM module
Aux Input Warning * (Auxiliary input warning)	Warning	The digital input for a custom warning (AuxiliaryInputWarning - PIM) is active (low).	Check customer equipment connected to the PIM module
Batt Chg Flt Warning * (Battery charger fault warning)	Warning	The digital input for Battery Charger Fault Warning (PIM) is active (low). For an external battery charger only, not applicable to the VSC built-in battery charging.	Check customer equipment connected to the PIM module.
Battery High Warning	Warning	The controller has measured battery voltage that is above the high warning setting for 10 seconds or more. Operates during exercise and normal operation.	Check engine starting battery.
Battery CRLow Warning †	Warning	Battery voltage dropped to 11 VDC or less for 30 seconds or more.	Check engine starting battery. Check battery charger DC output voltage from VSC on lead CHO to the battery.

Fault Message	Action	Description/Comments	Check
Battery Low Warning †	Warning	The controller has measured battery voltage that is below the low warning setting for 90 seconds or more. The battery voltage is checked before allowing an exercise to start.	Check engine starting battery. Check battery charger DC output voltage from VSC on lead CHO to the battery.
Chk DateTime Warning (Check date and time warning)	Warning	DC power to the controller has been interrupted and the date and time may not be correct. Event history may not have accurate time/date stamps.	Verify the time and date settings to ensure proper operation of scheduled operations and for event history logging.
Default Pars Warning (Default Parameters)	Warning	The controller has been loaded with default parameters.	Configure settings as required for desired operation.
Enclosure Intrusion Alarm	Warning	Enclosure door is open. (Optional communications kit required.)	Close and secure the enclosure door. Check for signs of unauthorized entry.
Engine M/N Invalid Shutdwn	Shutdown	Generator model number has not been entered. (Engine model number is selected automatically based on generator set model.)	Enter the generator set model number from the VSC keypad, or use SiteTech to select the genset model number.
Engine Speed High Shutdwn	Shutdown	The controller shut down the generator because engine speed, as calculated from AC frequency, was above the high speed setting for 0.3 seconds or more.	Troubleshoot engine operation per the engine service manual.
Engine Speed Low Shutdwn	Shutdown	The controller shut down the generator, after crank disconnect, because engine speed, as calculated from AC frequency, was below the low speed setting for 3 seconds or more.	Troubleshoot engine operation per the engine service manual.
Exer Not Sch Warning	Warning	There is no exercise scheduled.	Set the exercise schedule.
Fuel Leak Shutdwn *	Shutdown	The controller shut down the generator because the digital input for Fuel Tank Leak Shutdown (PIM) was activated (low).	Check customer equipment connected to the PIM module.
Fuel Leak Warning *	Warning	The digital input for Fuel Tank Leak Warning (PIM) is active (low).	Check customer equipment connected to the PIM module.
Fuel Level CrHi Warning *	Warning	The digital input for Critically High Fuel Level Warning (PIM) is active (low).	Check customer equipment connected to the PIM module.
Fuel Level High Warning *	Warning	The digital input for High Engine Fuel Level Warning (PIM) is active (low).	
Fuel Level Low Shutdwn *	Shutdown	The controller shut down the generator because the digital input for Low Fuel Level Shutdown (PIM) was activated (low).	Check customer equipment connected to the PIM module.
Fuel Level Low Warning *	Warning	The digital input for Low Fuel Level Warning (PIM) is active (low).	
Fuel Pressure Low	Warning	Fuel pressure sensor has measured fuel pressure below 4.5 inches of water column. (Optional communications kit required.)	Check fuel supply and fuel lines. Check the fuel pressure at the regulator. See Section 5.8.2.
GenBrkerOpen Warning (Generator Circuit Breaker Open)	Warning	There is voltage at the generator set but no voltage measured on the emergency side of the ATS (Model RXT transfer switch required).	Check line circuit breaker. Check for and correct short circuits or overloading on the load side before resetting the circuit breaker.
Ground Fault Warning *	Warning	The digital input for Ground Fault Warning (PIM) is active (low).	Check customer equipment connected to the PIM module.

Fault Message	Action	Description/Comments	Check
High Lube Oil Temperature	Warning	Oil temperature higher than 300°F (149°C).	See Overheats in the troubleshooting charts in Section 4.9.
High Lube Oil Temperature	Shutdown	Oil temperature higher than 325°F (163°C).	
Lo Crank Vlt Warning	Warning	During cranking, the controller measured battery voltage less than 60% (7.2V or 14.4V) for 6 seconds or more during cranking.	Check cranking battery.
Locked Rotor Shutdwn	Shutdown	The controller shut down the generator because no rotation of the engine or alternator was detected, for 3 seconds or more, during cranking.	Check cranking circuit. Troubleshoot the engine. See Engine Service Manuals. Check alternator connections to controller and auxiliary winding circuit breaker. Troubleshoot the alternator.
MainPwrOverL Shutdwn	Shutdown	The internal current limit circuit has tripped, indicating an overcurrent condition on the DC power supply circuit.	Check crank, run, and flash relay circuits for short circuits.
Maint Req'd Warning	Warning	Engine run time, or calendar days, has exceeded the maintenance reminder setting.	Change the oil and perform other maintenance according to the service schedule in Section 2.1. Reset the maintenance timer after service. See Section 2.3.
Not In Auto Warning	Warning	The VSC controller is not in AUTO. The generator will not start from a remote device. The digital output for Not In Auto (PIM) is active (contacts closed).	Press the Auto button to ensure automatic system operation.
OB1 CommLoss (PIM)	Warning	Communications with option board #1 has been lost.	Check RBUS wiring to inoperative option board.
Oil Level Low Shutdwn *	Shutdown	The controller shut down the generator because the digital input for Low Oil Level Shutdown (PIM) was activated (low).	Check customer equipment connected to the PIM module.
Oil Level Low Warning *	Warning	The digital input for Low Oil Level Warning (PIM) is active (low).	Check customer equipment connected to the PIM module.
Oil Pressure Low Shutdwn	Shutdown	The low oil pressure switch was closed for 5 seconds or more, indicating low oil pressure. Function is inhibited until 30 seconds after crank disconnect.	Check for oil leaks. Check the oil level and add oil if low. Check the oil pressure sensor; see Engine Service Manuals.
Oil Pressure OpenCR Warning	Warning	When the generator set is not running and controller is in OFF or AUTO, the low oil pressure switch is not working properly.	Check the oil pressure switch connection. Replace the LOP switch if necessary. See Section 5.7.2.
Over Crank Shutdwn	Shutdown	The controller shut down the generator, and ceased cranking, because the engine was not successfully started after the completion of the last of the crank cycles setting delay 15 seconds.	Check fuel supply. Check cranking circuit. Check cranking battery. Troubleshoot engine; see Engine Service Manuals.
RBUS ComError Warning	Warning	The controller has lost communications with a PIM that had previously been communicating properly.	Check connection to the PIM.
Reserve Oil Empty	Warning	The oil makeup kit reservoir bottle is empty. (Optional communications kit and oil makeup kit required.)	Add oil to the oil makeup kit reservoir. See TT- 1591, provided with the oil makeup kit, if necessary.

Fault Message	Action	Description/Comments	Check
Spd Sens Flt Shutdwn (Speed sensor fault)	Shutdown	The controller shut down the generator because the speed signal was lost.	Check leads AC1 and AC2 between the alternator and the controller. This fault also occurs if the engine stalls; check the engine and see the troubleshooting chart in Section 4.9.
Volts L1-L2 DC High Shutdwn †	Shutdown	The controller shut down the generator because the voltage measured from Phase A to Phase B exceeded the high limit for a time greater than the delay setting 2 seconds.	Troubleshoot alternator. See Section 4.9, Troubleshooting Charts, and Section 5, Component Testing and Adjustment.

* Programmable Interface Module (PIM) required.
† Applies during exercise runs and normal operation.

Figure 4-2 Fault Messages Displayed on the 6VSG VSC Controller

4.8 Status Messages

The following messages are displayed to show system status. Notices are displayed in the Event History in SiteTech when active but do not appear on the controller display. Some status messages are displayed when a digital input is activated; the optional Programmable Interface Module (PIM) is required for display of those messages as noted in the table.

Fault Message	Action	Description/Comments	Check
Always Off *	Notice	OnCue's Power Chain view has been used to control this digital output. The digital output is no longer controlled by the generator set. Applies to digital outputs B3 through B6 on the PIM only.	Click on the output in OnCue's Power Chain view to turn the output on or off. See the OnCue Operation Manual. To reset the digital output to a function controlled by the generator set, use SiteTech software to re-assign the output event.
Always On *	Notice		
Auto Locked * (Chicago Code Active)	Notice	The digital output for Chicago Code Active (PIM) is active (contacts closed), indicating the digital input for Chicago Code Active (PIM) is active (low) and thus master switch is locked in the AUTO position.	Check customer equipment connected to the PIM module.
Common Fault	Notice	The digital output for Common Fault (PIM) is active (contacts closed), indicating the generator is shutdown for any (all) fault.	Check for faults and troubleshoot any/all fault conditions individually.
Common Warng	Notice	The digital output for Common Warning (PIM) is active (contacts closed), indicating that any (all) warning is active.	Check for warnings and troubleshoot any/all warning conditions individually.
Emerg Pwr On (Emergency Power System Supplying Load)	Notice	The digital output for EPS Supplying Load (PIM) is active (contacts closed), indicating there is current output (>5%) from the alternator, only if CTs are installed.	—
Eng Cooldown	Notice	The digital output for Engine Cooldown Active (PIM) is active (contacts closed), indicating the generator is running in cooldown. (Delay 5 min.)	Check remote start circuit if it was expected that the generator should be running.

Fault Message	Action	Description/Comments	Check
Fuel Spill *	Notice	The digital output for Fuel Spill (PIM) is active (contacts closed), indicating any of the digital inputs for Fuel Tank Leak Warning, Fuel Tank Leak Shutdown, Engine Fuel Level Warning or Engine Fuel Level Critically High (PIM) is active (low).	Check customer equipment connected to the PIM module.
Gen Running	Notice	The digital output for Generator Running (PIM) is active (contacts closed), indicating the generator is running.	Check controller front panel buttons for potential RUN command. If in AUTO, check remote start lines.
Low Fuel *	Notice	The digital output for Low Fuel (PIM) is active (contacts closed), indicating any of the digital inputs for Low Fuel Pressure Warning, Low Fuel Level Warning or Low Fuel Level Shutdown (PIM) is active (low).	Check customer equipment connected to the PIM module.
Minor Fault	Notice	The digital output for Minor Fault (PIM) is active (contacts closed), indicating either the digital input for Ground Fault Indicator Warning (PIM) is active (low) or the controller detected Low Cranking Voltage.	Check customer equipment connected to the PIM module. Check cranking battery condition.
Rmt StartCmd (Remote Start Command Issued)	Notice	The controller has received a remote start signal while the master switch is in AUTO, and will go to normal running.	Verify remote start signal.
Run Btn Ack (Run Button Acknowledged)	Notice	The RUN button on the controller has been pushed.	NA
Start Delay (Engine Start Delay Active)	Notice	The digital output for Engine Start Delay (PIM) is active (contacts closed), indicating the engine is in between active cranking cycles.	NA
System Ready	Notice	The digital output for System Ready (PIM) is active (contacts closed), indicating the generator has no active faults or warnings.	NA
VSpdStartCmd (Variable Speed Start Command)	Notice	A diagnostic exercise request has been received by the controller.	Check for a remote exercise command from OnCue.

* Programmable Interface Module (PIM) required.

Figure 4-3 Status Messages Displayed on the VSC Controller

4.9 Troubleshooting Chart

Use Figure 4-4 as a reference in troubleshooting individual problems. Generator set faults are listed in groups and include likely causes and remedies. The simplest and most likely causes of the problem are listed first; follow the recommendations in the order shown. The reference column provides additional sources of information in this and related manuals regarding the problem and solution.

Problem	Possible Cause	Test	Corrective Action	Reference
Generator set engine does not crank	Battery connections	Check for reversed or poor battery connections.	Correct and tighten battery connections.	—
	Weak or dead battery	Check the battery voltage. Test battery according to battery manufacturer's recommendations.	Recharge or replace battery.	O/M
		Check battery charger connections and power connection to the generator set.	Tighten connections. Connect 120VAC power to the genset terminal block.	I/M
	Open circuit in engine/controller connections	Check for loose connections.	Tighten connections.	Section 5.8
		Check the wire harness continuity.	Replace harness or harness leads if damaged.	Section 5.10 Section 7
	Poor ground (–) connection	Test ground connection.	Clean and retighten.	—
	Starter relay	Check connections to the starter relay.	Tighten connections. Replace wiring if damaged.	Section 5.9 W/D Section 7
		Check continuity of circuit.	Replace harness or harness leads if damaged.	Section 5.10 W/D Section 7
		Check that the starter relay picks up when 12 VDC is applied at lead 71 connection.	Replace starter relay.	W/D Section 7
	Starter	Check starter connections.	Tighten connections. Replace wiring if damaged.	W/D Section 7
		Troubleshoot the starter. See the engine service manual for instructions.	Rebuild or replace starter.	Engine S/M
	Controller	Check for 12 VDC to the controller.	Check battery and connections.	W/D
		Check the genset model, engine model, and other controller settings.	Adjust controller settings, if necessary.	Section 3.3
		Troubleshoot the controller as described in Section 4.10.	See Section 4.10.	Section 4.10

W/D = Wiring Diagram(s) (Section 7)
I/M = Generator Set Installation Manual
S/S = Generator Set Specification Sheet
Engine S/M = Engine Service Manual
O/M = Generator Set Operation Manual

Problem	Possible Cause	Test	Corrective Action	Reference
Cranks but does not start	No fuel	Verify that manual fuel valve is open. Check fuel supply tank (LPG).	Open (turn on) manual fuel valve. Contact fuel supplier to add fuel to fuel supply tank (LPG).	—
	Insufficient fuel pressure	Check fuel pressure to the generator set. Verify adequate fuel pressure and pipe size for the generator set plus all other gas appliances.	Contact fuel supplier to replace fuel supply lines with larger pipe and replace gas meter if fuel pressure is insufficient.	Section 5.8.2
	Fuel regulator/valve	Check regulator/valve operation.	Check regulator/valve operation.	Section 5.8 Section 4
	Weak battery	Check the battery voltage.	Recharge or replace battery.	O/M
		Check battery charger connections and power connection to the generator set.	Tighten loose connections.	W/D Section 7
	Spark plugs or spark plug connections	Check spark plug wires and connections. Check spark plugs.	Tighten connections. Replace spark plug wires if damaged. Replace or clean and re-gap spark plugs.	O/M
	Loose connection or open circuit	Check for loose or open connection at the fuel valve (lead 70A) and at the engine spark control module (leads IGN and 70B). Check controller/engine wiring continuity.	Tighten connections. Replace wiring if damaged.	Section 7
	Air cleaner clogged	Check for a dirty air cleaner element.	Replace air cleaner element. Check and replace air cleaner element at the intervals shown in the Service Schedule.	O/M
	Incorrect controller settings	Check the genset model setting.	Enter the correct genset model number setting. Engine model is selected automatically based on genset model.	Section 3.3
	Ignition system spark control or ignition coil	Test according to instructions in the engine service manual.	Adjust or replace components as indicated in engine service manual.	Engine S/M
	No engine rotation sensed (check for an overcrank or locked rotor fault shutdown)	Check the cranking circuit.	Troubleshoot engine and alternator.	Engine S/M

W/D = Wiring Diagram(s) (Section 7)
I/M = Generator Set Installation Manual
S/S = Generator Set Specification Sheet
Engine S/M = Engine Service Manual
O/M = Generator Set Operation Manual

Problem	Possible Cause	Test	Corrective Action	Reference
Starts hard	Low battery voltage	Check battery voltage during cranking.	Charge battery. Replace battery if necessary.	O/M
		Check battery charger connections and power connection to the generator set.	Tighten loose connections.	W/D Section 7
	Air cleaner clogged	Check for a dirty air cleaner element.	Replace element.	O/M
	Fuel mixture adjustment incorrect	Use oxygen sensor to check fuel mixture.	Adjust fuel mixture.	Section 5.8
	Spark plug(s)	Check spark plug condition and gap.	Replace or regap spark plug(s).	O/M
	Spark plug wire(s)	Check spark plug wires and connections.	Tighten connections. Replace spark plug wires if damaged.	Engine S/M
	Ignition components (spark control or ignition module)	Test ignition components according to instructions in the engine service manual.	Replace ignition components if necessary.	Engine S/M
	Insufficient fuel pressure	Check fuel pressure to the generator set. Verify adequate fuel pressure and pipe size for the generator set plus all other gas.	Contact fuel supplier to replace fuel supply lines with larger pipe and replace gas meter if fuel pressure is insufficient.	Section 5.8.2
	Output Shorted	Check wiring and load.	Remove short circuit.	
	Engine problem	Troubleshoot the engine.	See engine service manual.	Engine S/M
Noisy operation	Exhaust system leaks	Check silencer and connections for leaks.	Replace gaskets and exhaust system components as necessary.	—
	Engine not running smoothly	See “Erratic operation,” this table.	See “Erratic operation,” this table.	—
	Broken or damaged vibromount(s)	Inspect vibromounts.	Replace as necessary.	Section 6
	Loose or vibrating sheet metal/ housing	Check for loose screws and rivets.	Retighten screws; replace rivets.	—
	Exhaust piping or air inlets/outlets not securely installed	Inspect for loose parts.	Secure loose parts as necessary.	—
	Excessive engine/generator vibration	Check rotor, crankshaft, bearing, etc. (disassembly of engine and/or alternator may be required).	Check, rotor, crankshaft, bearing, etc. (disassembly of engine and/or alternator may be required).	Section 6 Engine S/M
	High engine speed	Check settings.	Return to factory settings.	
Overheats	Inadequate cooling	Inspect engine and enclosure for air intake obstructions.	Clear any air intake obstructions.	O/M
	Air cleaner clogged	Check for a dirty air cleaner element.	Replace air cleaner element.	O/M

W/D = Wiring Diagram(s) (Section 7)
I/M = Generator Set Installation Manual
S/S = Generator Set Specification Sheet
Engine S/M = Engine Service Manual
O/M = Generator Set Operation Manual

Problem	Possible Cause	Test	Corrective Action	Reference
Stops suddenly	Fault shutdown	Check for a fault shutdown message on the controller display. Identify the cause of the fault.	Correct the fault and then press the controller's OFF button to reset the controller.	Section 4.7
	No fuel	Check fuel valves and fuel supply.	Open manual fuel valve. Contact fuel supplier to replenish fuel supply.	—
	Fuel line restriction	Inspect fuel lines.	Clear restriction.	—
	Fuel lines too long	Check fuel line length and pipe size.	Contact fuel supplier to replace fuel lines with larger pipe.	Generator set S/S, I/M
	Air cleaner clogged	Check for a dirty air cleaner element.	Replace air cleaner element.	O/M
	Spark plug(s)	Check spark plug(s).	Replace or regap plug(s).	O/M
	Engine overheated (hot engine only)	Check air intake and generator set enclosure air inlets and outlet.	Clear air intake and enclosure air inlets and outlets.	O/M
		Use oxygen sensor to check fuel mixture.	Adjust fuel mixture.	Section 5.8 O/M
		Check oil level.	Add oil. Check and replace oil at the intervals shown in the Service Schedule.	
	Low oil pressure (LOP) switch	Check oil pressure.	See engine S/M.	Engine S/M
		Attempt startup. If unit shuts down, remove lead from LOP switch and reset controller. A successful restart attempt indicates a faulty LOP shutdown switch. **Note:** Check engine oil pressure before performing test and/or replacing LOP shutdown switch.	Replace faulty LOP shutdown switch. **Note:** Check engine oil pressure before performing test and/or replacing LOP shutdown switch.	Section 5.7.2
	Fuel valve/fuel regulator	Check fuel valve connections. Check regulator/valve operation. Check fuel pressure.	Tighten fuel valve connections. Replace damaged wires. Replace regulator or valve.	Section 5.8.2
	Engine overloaded	Reduce electrical load and check operation.	Unplug some lights or appliances connected to the generator set.	—
	Engine speed sensing connections	Check for loose connections: V7, V8, V9, and connections to the line circuit breaker.	Tighten connections. Replace damaged wiring.	W/D Section 7
	Ignition module	Test the ignition system according to the instructions in the engine service manual.	Service the ignition system according to the instructions in the engine service manual.	Engine S/M
	Loss of generator output voltage to controller	Check connections at P2 plug.	Tighten connections at P2 plug.	Section 7
		Check continuity of AC sensing leads 11 and 44. See Section 5 for alternator test procedures.	Replace wiring if damaged.	Section 5.3
			Repair or replace components if necessary, as indicated by tests in Section 5.	Section 5

W/D = Wiring Diagram(s) (Section 7) Engine S/M = Engine Service Manual
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S/S = Generator Set Specification Sheet

Problem	Possible Cause	Test	Corrective Action	Reference
Erratic operation	Air cleaner clogged	Check air filter element.	Replace element.	O/M
	Spark plug(s)	Check spark plug condition and gap.	Replace or regap plugs. O/M	Engine S/M
	Spark plug wire(s)	Check spark plug connections and wires.	Tighten connections. Replace damaged spark plug wires.	—
	Fuel line restriction	Check fuel lines. Check fuel pipe size.	Clear restricted fuel lines. Contact fuel supplier to install larger diameter pipe.	Section 5.8.2
	Fuel mixture adjustment incorrect	Use oxygen sensor to check fuel mixture.	Adjust fuel mixture.	Section 5.8
	Governor adjustment incorrect	Check governor operation.	Adjust governor.	Section 5.6 Section 3.3
	Ignition system	Test ignition system according to instructions in engine service manual.	Service ignition system according to instructions in engine service manual.	Engine S/M
	Inadequate cooling (hot engine only)	Check air inlet and outlet.	Clear air inlet and outlet.	—
	Other engine service required	See engine service manual.	Service according to instructions in engine service manual.	Engine S/M
High output voltage	Incorrect controller settings	Check genset model, engine model, system voltage, and other controller settings. *	Adjust the controller settings. *	Section 3.3
	Incorrect voltage calibration	Check the voltage calibration. *	Adjust the voltage calibration. *	Section 3.7
	Loose voltage sensing connections	Check connections: stator leads V7, V8, V9, and P2 controller connection.	Tighten connections.	W/D Section 7

W/D = Wiring Diagram(s) (Section 7) Engine S/M = Engine Service Manual
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S/S = Generator Set Specification Sheet

Problem	Possible Cause	Test	Corrective Action	Reference
Lacks power	Air intake restriction, inadequate cooling	Inspect air intakes and exhaust for obstructions.	Clear air intakes and exhaust area. Maintain clearances shown on the genset dimension drawing.	I/M
		Check air cleaner.	Replace air cleaner element.	O/M
	Generator overloaded	Reduce electrical load and check operation.	Unplug some lights or appliances connected to the generator set.	—
	Spark plug(s)	Check spark plugs.	Regap or replace plug(s).	O/M
	Spark plug connections	Check tightness and condition of spark plug wires.	Tighten or replace spark plug wires.	Engine S/M
	Low fuel pressure	Check fuel pressure at carburetor outlet. Check for adequate fuel pipe size and meter capacity for generator set and all gas-fired appliances.	Contact fuel supplier to replace pipe and/or meter as required to provide sufficient fuel supply pressure for the generator set and all gas-fired appliances.	Section 5.8
	Fuel line restriction	Check fuel pipe size.	Contact fuel supplier to provide larger pipe.	Section 5.8
	Fuel regulator	Check function of fuel regulator.	Repair or replace fuel regulator.	Section 5.8.2
	Engine not running at rated rpm	Check controller setting for engine model. *	Select the correct engine model. *	Section 3.3
		Check engine speed.	Adjust engine speed.	
	Engine power loss	Refer to the engine service manual for troubleshooting and repair instructions.	Refer to the engine service manual for troubleshooting and repair instructions.	Engine S/M
	Governor malfunction or misadjustment	Test governor.	Adjust governor.	Section 5.6
	Ignition system	See the engine service manual for service procedures.	See the engine service manual for service procedures.	Engine S/M
Low output or excessive drop in voltage	Generator overloaded	Reduce electrical load and check operation.	Unplug some lights or appliances connected to the generator set.	—
	Incorrect controller settings	Check the controller settings. *	Adjust the controller settings. *	Section 3.3
	Incorrect controller voltage settings	Check the controller voltage settings. *	Adjust the controller voltage settings. *	Section 3.3
	Alternator	Perform alternator troubleshooting, Section 5.2.	Make repairs based on results from alternator troubleshooting, Section 5.2	Section 5.2
	Controller	Check the controller settings.	Adjust controller settings.	Section 3.3
		Test the controller as described in Section 4.10.	See Section 4.10.	Section 4.10
	Stator	Test stator for open, grounded, or shorted windings.	Replace stator if faulty windings are found.	Section 5.3
	Rectifier	Perform Rectifier Troubleshooting, Section 5.3.	Make repairs based on Rectifier Troubleshooting, Section 5.3	Section 5.3
	Low engine speed causing voltage roll-off	Check system voltage, system frequency, and engine model settings.	Change the controller settings if not correct. *	Section 3.3
		Check engine speed setting.	Adjust engine speed setting.	Section 3.3
		Engine problem.	Troubleshoot the engine.	Engine S/M

W/D = Wiring Diagram(s) (Section 7)
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O/M = Generator Set Operation Manual

Problem	Possible Cause	Test	Corrective Action	Reference
No output voltage	DC output circuit breaker open	Check for DC voltage on the generator side of circuit breaker. If there is DC voltage on the generator side of the breaker, then a problem in the load circuits is causing the line circuit breaker to trip.	Check for and correct short circuits or overloading on the load side before resetting the circuit breaker.	—
	Alternator	Perform alternator troubleshooting, Section 5.2.	Make repairs based on results from alternator troubleshooting, Section 5.2.	Section 5.2
	Controller	Check the controller settings.	Adjust controller settings.	Section 3.3
		Troubleshoot the controller as described in Section 4.10.	See Section 4.10.	Section 4.10
	Open wiring, terminal, or pin in buildup circuit	Check wiring.	Replace wiring as necessary.	W/D Section 7
	Rectifier	Perform rectifier troubleshooting, Section 5.3.	Make repairs based on rectifier troubleshooting, Section 5.3.	Section 5.3
	Stator (open, grounded, or shorted windings)	Check voltage and continuity as described in Section 5.3.	Repair or replace the stator if indicated by the test results.	Section 5.3

W/D = Wiring Diagram(s) (Section 7) Engine S/M = Engine Service Manual
I/M = Generator Set Installation Manual O/M = Generator Set Operation Manual
S/S = Generator Set Specification Sheet

* VSC controller settings can be checked and adjusted using the controller user interface or using a personal computer running SiteTech software.

Figure 4-4 Troubleshooting Chart

4.10 Controller Troubleshooting

Refer to the controller troubleshooting table in Figure 4-5 when troubleshooting procedures in Section 4.9 indicate a possible controller problem. Also check the controller display for fault messages and see Section 4.7, Fault Messages.

Always check the controller settings before replacing the controller. VSC controller settings can be checked and adjusted through the controller's user interface or using a personal computer and Kohler SiteTech software. The generator set operation manual contains the instructions for checking and changing the controller settings. See TP-6701, SiteTech Software Operation Manual. Kohler SiteTech software is available to authorized distributors and dealers.

Problem	Possible Cause	Corrective Action	Reference
Controller LCD display is off.	Low or no battery voltage	Check controller connections. Check DC power to the VSC controller. Check generator set battery connections and condition. Check power connection to the generator set terminal block (power for battery charging). (if equipped)	W/D Section 7
Controller display backlight is off.	Backlight turns off after about 1 minute with no activity	Backlight will turn on when a button is pressed or the generator set starts.	—
Loss of communication to accessory modules.	Bad connections	Check wiring and connections. Verify that cable size and length of run comply with the instructions in the Installation Manual.	Generator set Installation Manual or accessory module documentation
	Communication cable does not meet required specifications	Use shielded, twisted-pair cable as specified in the Installation Manual. Do not exceed the maximum cable lengths given in the Installation Manual.	Installation Manual
	Low or no battery voltage	Check generator set battery connections and condition. See "Low or no battery voltage" above.	—
Date is flashing.	Controller power was disconnected and then reconnected	Check battery connections. Check controller connections. Check power connection to the generator set terminal block. Reset the time, date, and exercise schedule.	 W/D Section 7 Generator set O/M
Cannot change input and output settings.	Controller is set up for the optional communications kit, which locks the input and output settings.	For a generator set with a communications kit, no action is needed. Inputs and outputs are not adjustable. If the generator set is connected to a PIM, use SiteTech to change the Personality Installed Option parameter setting.	Section 3.3.3, Digital Inputs and Outputs, and Section 3.3.4, Controller Parameter Table

Figure 4-5 VSC Controller Troubleshooting

5.1 Theory of Operation

The generator set uses a permanent-magnet alternator to produce 3-phase AC voltage. This voltage is rectified using a full-wave 3-phase rectifier (single block rectifier for 36V and 48V, three individual rectifier blocks for 24V) to produce low-ripple DC output. See Figure 5-1 and Figure 5-2.

The VSC measures the average DC voltage on the output and lists this on the auto-scrolling display, in the Overview menu and in the Generator metering menu.

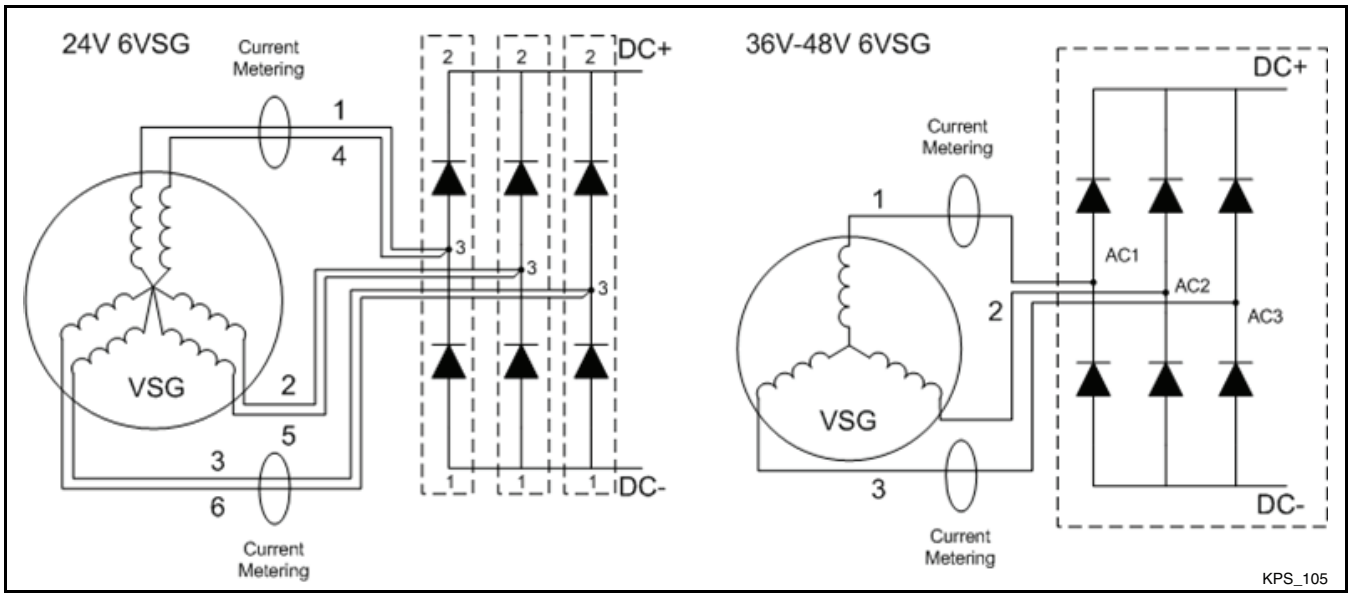


Figure 5-1 Basic VSG Power Connections

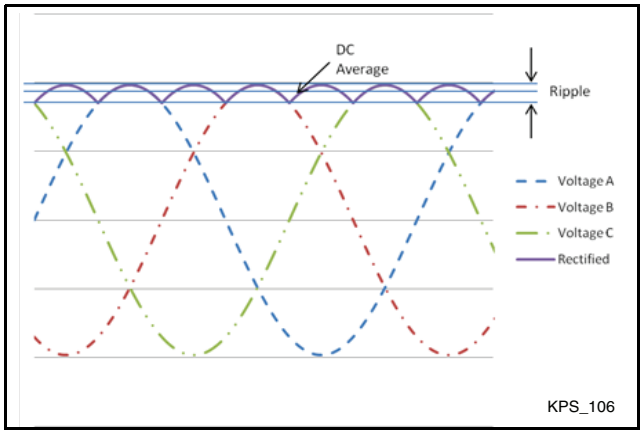


Figure 5-2 Output Waveform, with Rectified Signal

The voltage is regulated to maintain a constant output voltage, which is equal to the System Voltage setting. When the load on the 6VSG generator increases, the generator controller increases the engine speed. The 6VSG series is designed to produce rated voltage at 2300 rpm with no load and at 2900 rpm when supplying full load. The output current and power increase with the engine speed. The engine speed is limited to a maximum of 2900 rpm. See Section 3.3.1 for more information.

5.2 Electrical Output Troubleshooting

5.2.1 No to Low Voltage Operation

This section covers the operation of the electrical output and troubleshooting information for low or no voltage output. Before beginning the test procedures, read all safety precautions at the beginning of this manual. Many of the test procedures include additional safety precautions.

If the output voltage is below 85% of the rated voltage at no load, check the following with the engine running (press RUN to start the generator set):

- The output breaker is closed (check voltage at the rectifier).
- The Voltage Regulator Average Voltage Adjustment parameter is correct.
- Engine Speed (should be within 300 rpm of the idle speed) – if the engine speed is low, check the voltage and % load reading on the VSC controller. High current means a short circuit; rated voltage indicates that the VSC controller sees the correct voltage.

- Double-check connections to the output blocks. High indicated voltage may indicate incorrect calibration; recalibrate the voltage metering for the controller.
- The AC output of the generator (measure across leads 1-2, 2-3, and 3-1 before the rectifier).

If the AC output of the generator is good (>50% of nameplate voltage) and the DC output is low, check the rectifier to verify that it is working correctly (see Section 5.3).

- Open the generator output breaker and measure the DC voltage at the rectifier; this will remove the possibility of an external short circuit or excessive load.
- If the voltage recovers when the output breaker is opened, it is possible that the rectifier is not operating correctly. Follow rectifier troubleshooting in Section 5.3.
- Stop the generator and remove the stator leads from the rectifier. Make sure that the controller sensing leads are still connected to the stator leads before restarting the generator.
- Restart the generator and check the voltage between each disconnected stator lead. If there is voltage (>50% of nameplate) on the leads when they are disconnected, there may be an internal short in the rectifier.

Note: There should not be voltage between leads 1 and 4, 2 and 5, and 3 and 6 on the 24V 6VSG unit. If there is more than 2V between each pair, there may be an internal alternator short.

If the output voltage is low, but not below 85% of the generator rating, check the following with the engine running in run:

- The load on the generator (may be in current limit mode)
- The controller calibration
- The Voltage Regulator gain (try increasing gain to see if the voltage will increase)
- The engine speed (has the engine reached the maximum operating speed)
- Open the output breaker and see if the generator voltage (as displayed on the controller) recovers.

5.2.2 Erratic Voltage Regulation

If the voltage is unstable, check the following:

The output voltage of the 6VSG is determined by the speed that the engine is running. Unstable engine speed will cause unstable voltage. Unstable loading may drive unstable engine speed.

Engine Speed Stability – If the engine speed is stable, try tripping the output breaker and watching the rectifier voltage to see if it stabilizes. If the engine speed is unstable, try changing the voltage regulator gain and the engine speed governor gain. Increasing the gain may help to remove a slower instability; decreasing the gain may remove a faster-cycling instability.

Note: Often engine speed instability is caused by mechanical obstructions of the throttle plate, ignition issues such as worn spark plugs, or fuel supply inadequacies. Pressure biasing on the pressure regulator may also affect engine stability.

If the engine speed stabilizes with the removal of load, check whether the load is changing quickly due to a nonlinear load connected to the same DC bus.

If the engine speed is stable, but the voltage is varying significantly, check for load stability and for loose connections on the rectifier. Verify rectifier operation (see Section 5.3).

5.2.3 High Voltage

The following guide can help to identify the cause of abnormally high output voltage:

Check the controller calibration – if the controller reads accurately, check the Voltage Regulator Gain (increase gain to see if voltage will correct).

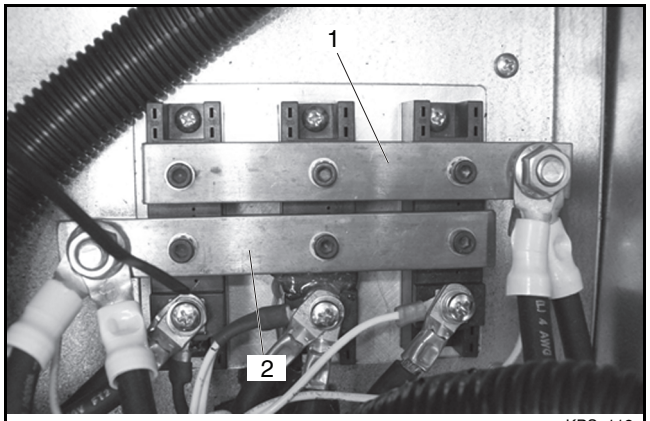
1. Check the Voltage Regulator Average Voltage Adjustment.
2. Check whether the engine speed is matching the target speed (using Kohler SiteTech).
3. Check for speed stability (fuel supply, throttle linkage, gains, etc.).

5.3 Rectifier Testing

The 6VSG supplies AC voltage from the alternator to a 3-phase, full-wave rectifier to produce a low-ripple DC voltage to supply to the load. Figure 5-1 illustrates the rectifier connections on the 6VSG. The 24V 6VSG uses three individual rectifier blocks to handle the high current output of the 24V 6VSG, while the 36V and 48V 6VSG generators use a single block 3-phase rectifier because they produce less current.

If the rectifier is believed to be malfunctioning, follow the following instructions to help determine if the rectifier is working correctly.

With the generator running at no load and with the output circuit breaker open, check the DC output of the rectifier (between the + and – terminals, most easily found by the connection of the DCP and DCN wires going to the controller).



1. DC –
2. DC +

Figure 5-3 DC Output

If the DC voltage is close to the generator rating, measure the AC voltage on the DC output. This value should be less than 10% of the measured DC value if the rectifier is working correctly.

Alternatively, it is possible to test the rectifier with the generator stopped, the output breaker open and the stator leads to the alternator disconnected. To test the rectifier in this manner, a multimeter capable of measuring forward-bias voltage of a diode is necessary. Measure the diodes as shown in Figure 5-4 or Figure 5-5. Repeat the measurements for all three diodes.

Negative Lead Test Point	Positive Lead Test Point	Diode Forward Voltage Drop
Pin 2	Pin 3	0.1V to 0.6V
Pin 2	Pin 1	0.2V to 1.2V
Pin 3	Pin 1	0.1V to 0.6V
Pin 3	Pin 2	No diode conduction
Pin 1	Pin 2	No diode conduction
Pin 1	Pin 3	No diode conduction

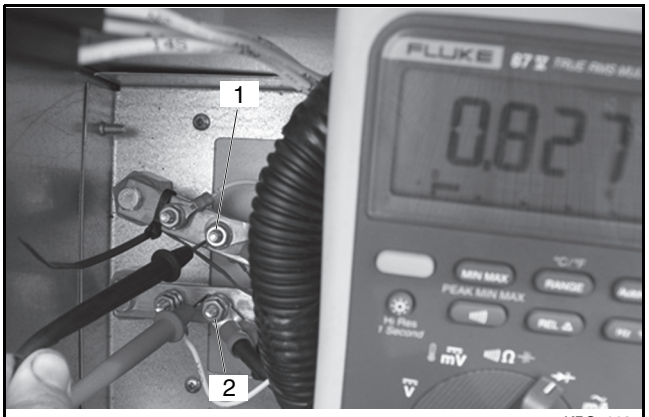
Figure 5-4 24V 6VSG Units

If conduction is found when measuring the diode forward drop with + lead on pin 2 and – lead on pin 1 of the diode assembly, one of the diodes may be damaged. Disconnect the bus bar tying the three diode blocks together and retest each block. If a block has conduction when connecting a multimeter with + lead on pin 2 and – lead on pin 1 of the diode assembly, it may be damaged. If all three have conduction, it is possible that the multimeter in use is not intended for measuring high power diodes.

Negative Lead Test Point	Positive Lead Test Point	Diode Forward Voltage Drop
AC1	DC –	0.1V to 0.6V
AC2	DC –	0.1V to 0.6V
AC2	DC –	0.1V to 0.6V
DC +	AC1	0.1V to 0.6V
DC +	AC2	0.1V to 0.6V
DC +	AC2	0.1V to 0.6V
DC –	AC1	No diode conduction
DC –	AC2	No diode conduction
DC –	AC2	No diode conduction
AC1	DC +	No diode conduction
AC2	DC +	No diode conduction
AC2	DC +	No diode conduction
DC +	DC –	0.2V to 1.2V
DC –	DC +	No diode connection

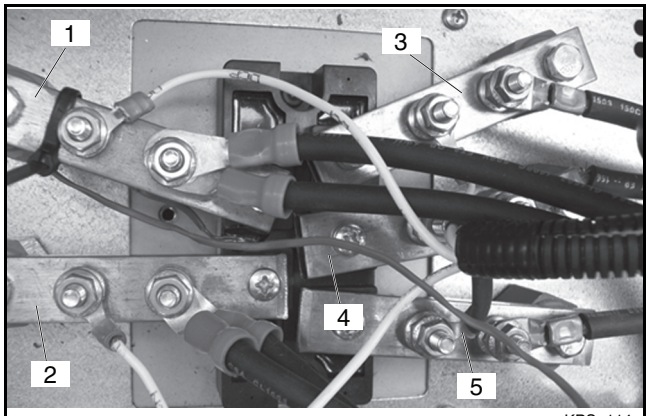
Figure 5-5 36V and 48V 6VSG Units

If all tests appear to have diode conduction, it is possible that the multimeter in use is not intended for measuring high power diodes.



1. DC +
2. DC –

Figure 5-6 DC Voltage Test



1. DC +
2. DC –
3. AC 1
4. AC 2
5. AC 3

Figure 5-7 DC Voltage Test

5.4 Stator

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

Note: Disconnect all stator leads before performing all stator tests.

⚠ WARNING

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

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

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

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

Stator Continuity and Resistance Tests

1. Press the OFF button on the controller to turn off the generator set.
2. Disconnect power to the generator set (if equipped).
3. Disconnect the generator set engine starting battery, negative (–) lead first.
4. Disconnect all stator leads before performing all stator tests.
5. To check for stator continuity, set the ohmmeter on R x 1 scale. First set the ohmmeter zero by holding the red and black meter leads together and setting the ohmmeter reading to zero. Then check the stator continuity by connecting the meter leads to the stator leads as shown in Figure 5-8.

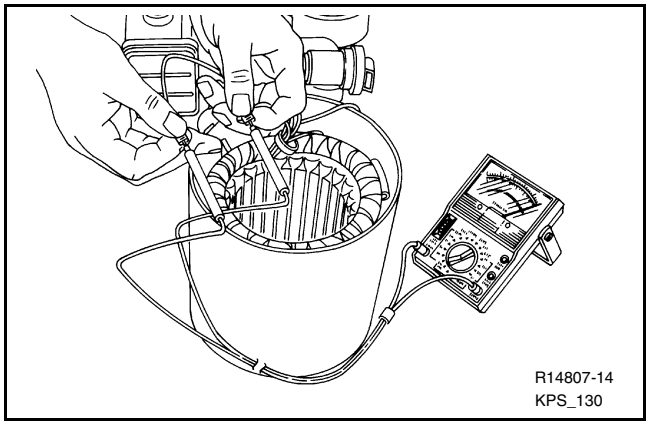


Figure 5-8 Testing Stator Windings

Note: For 24V units, 1, 2, 3, 4, 5, and 6 are the generator output leads. For 36 and 48V units, leads 1, 2, 3 are the generator output leads. Refer to the schematic in Figure 5-9 when performing the following steps.

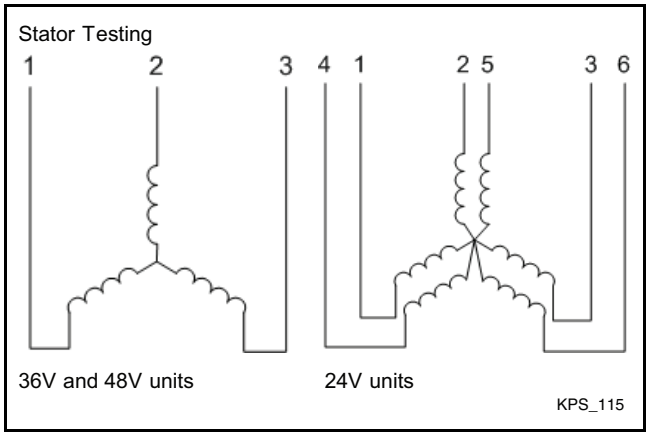


Figure 5-9 Single-Phase Alternator Stator Leads

6. Contact the ohmmeter leads and readjust the ohmmeter to read zero ohms.

7. Check the cold resistance of the stator windings by connecting the meter leads to stator leads 1-2, 2-3, and 3-1. See Section 1.5, Alternator Specifications, for stator winding resistances. Most ohmmeters do not provide accurate readings below 1 ohm. Low resistance readings (continuity) and no evidence of shorted windings (heat discoloration) indicate a stator in good condition. See Figure 5-10.

Leads	Continuity
1 and 2, 2 and 3, 3 and 1	Yes
4 and 5, 5 and 6, 6 and 4	
1 and 4, 2 and 5, 3 and 6	
1 and 5, 2 and 6, 3 and 4	
1 and 6, 2 and 4, 3 and 5	
1, 2, 3, 4, 5, or 6 to ground	No

Figure 5-10 Continuity Test Results on a Good Stator

8. If the resistance test proves inconclusive, use a megohmmeter to test the stator as described in the next step.

Note: Because ohmmeter accuracy varies, resistance readings are approximate readings. Take readings of the rotor and stator at room temperature.

Note: Make sure that all stator leads are disconnected before running the megohmmeter test.

9. Use a megohmmeter to determine whether the stator is shorted to ground.

   a. Apply 500 volts DC to any stator lead and the stator frame. Perform the megohmmeter test following the instructions of the megohmmeter manufacturer.

   b. Repeat the test on the other stator leads until each coil is tested.

Note: A reading of approximately 500 kOhms (1/2 megohm) and higher indicates a good stator.

   c. Repair or replace the stator if any reading is less than approximately 500 kOhms. A reading of less than 500 kOhms indicates deterioration of the winding insulation and possible current flow to ground.

5.5 Voltage Adjustments

⚠ WARNING

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

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

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

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

Note: See Section 3.7 for voltage calibration instructions.

Voltage Adjustments Using SiteTech

The SiteTech parameters used to adjust the voltage are shown in Figure 5-11.

SiteTech Group	Parameter
Genset System Configuration	Genset System Voltage
Voltage Regulator	Average Voltage Adjustment
	Volts per Hertz Slope
	Volts per Hertz Cut-in Frequency
	Voltage Regulator Gain

Figure 5-11 SiteTech Parameters for Voltage

5.5.1 Voltage Regulator Average Voltage Adjustment

Voltage regulation is performed by the controller. The controller monitors generator output voltage and adjusts the Voltage Correction Factor to change the operating speed range of the generator. The 6VSG requires no adjustment to maintain rated output voltage, as the DC output voltage is corrected to the Voltage Regulator Average Voltage Adjustment as the generator runs.

The Voltage Regulator Average Voltage Adjustment can be adjusted if the DC output voltage of the 6VSG generator is desired to track to a value other than the nameplate rating. If the output voltage is changed, the output current limiting should be recalibrated to the new output current rating. The output current rating is computed as: 6000 / Voltage Regulator Average Voltage Adjustment. This current rating is also listed in SiteTech.

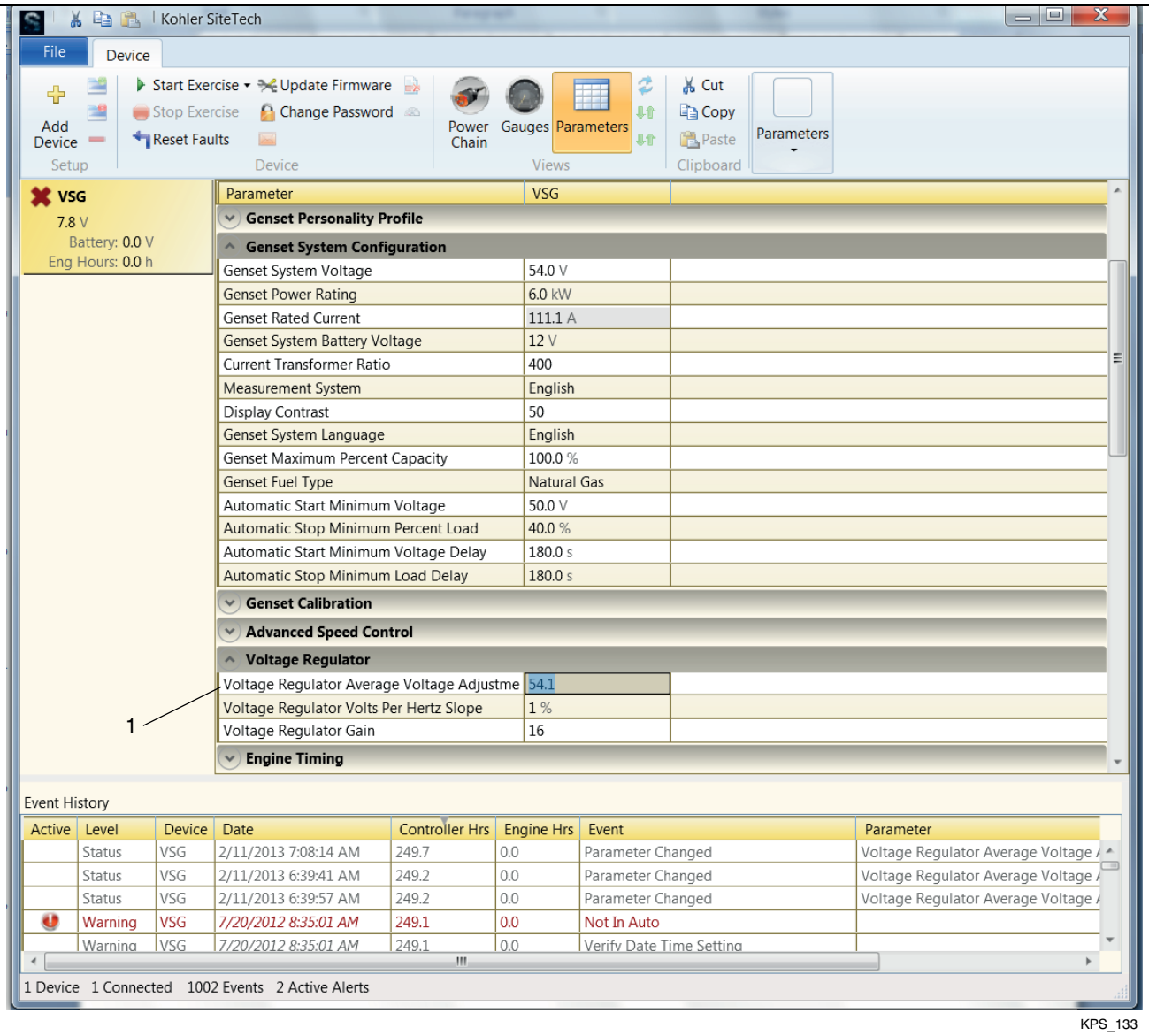
The Voltage Regulator Average Adjustment (VRAA) allows for the generator to operate at an output voltage that is different than the default setting. For example, to set the 6VSG-54V to run at 58V, change this VRAA setting to 58.0. See Figure 3-7.

Note: The protective trip points are based on the system voltage; therefore, changing the VRAA will not shift the protective trip points. Adjusting system voltage value to 58V will shift the protective trip points up, but will result in a slow ramp up from default output of 54V to desired 58V each time the VSG starts.

Note: Depending on the system and the application, adjustments may need to be made to both the VRAA and the system voltage settings.

Note: The current limit does not change. The current limit is based on the circuit breaker on the VSG for each system.

The Voltage Regulator Average Voltage Adjustment requires Kohler SiteTech to change.



1. Voltage Regulator Average Voltage Adjustment

Figure 5-12 Voltage Regulator Average Voltage Adjustment Using SiteTech

5.5.2 Volts/Hz Slope

The Volts/Hz setting for the voltage regulator performs the following functions on the generator:

- Improve stability in transient loading conditions
- Minimize hunting that may be caused by switching loads

Higher values of a Volts/Hz Slope will cause the Voltage Correction Factor to shift more on a sudden change in the output voltage. Lower values will cause a lower shift. High values in the Volts/Hz Slope may cause the 6VSG to become unstable.

5.5.3 Voltage Regulator Gain

The 6VSG uses a closed loop voltage correction controller to correct for long-term temperature drift. The voltage controller acts by changing the correction factor that the desired speed is multiplied by to accommodate changes in the alternator over time and with temperature. If the voltage is constant (within 4% of a 1.6 second average) and stable (<2% change in 0.1 seconds), the voltage correction controller will decrease the correction factor if the voltage is high and increase the correction factor if the voltage is low.

The Voltage Regulator Gain determines the rate at which the factor is updated. At a gain of 1, the voltage correction will change the correction factor by 0.1% every 102.5 seconds. At a gain of 255, the voltage correction will change the correction factor by 0.4% every 0.5 seconds. The default setting for the Voltage Regulator Gain is 128. If the transient response is slow, use SiteTech to increase the Voltage Regulator Gain setting.

Note: Increasing the gain too much may cause the output to oscillate. If adjustment does not improve the transient response, return the gain parameter back to the factory setting and continue with troubleshooting procedures.

Note: This closed loop voltage compensation is not active when the controller is in current limiting mode; the last known voltage correction factor is used.

5.6 Governor System

The governor system consists of an electromechanical stepper motor (actuator) and an engine speed detection/feedback circuit. The VSC controller controls the governor system operation.

See Section 7, Wiring Diagrams, for the governor connections.

5.6.1 Operation

The engine speed is maintained by an electronic governor system that consists of an embedded controller and electric actuator (stepper motor).

The governor system is controlled by the generator set controller. The controller provides regulated power to the bidirectional stepper motor actuator, which is linked to the carburetor throttle arm.

If the engine is hunting or surging, test the governor operation as described in Sections 5.6.3 and 5.6.4. Then adjust the governor gain to stabilize the engine operation if necessary. See Section 5.6.5.

5.6.2 Initial Checks

The factory sets the electronic governor. Under normal circumstances the electronic governor requires no further adjustment. Verify that the governor stepper motor moves smoothly and steadily during operation. If the engine operates erratically, check the following connections and conditions before adjusting the governor.

- Verify that the electrical connections are clean and tight.
- Verify that the battery connections are clean and tight.
- Check for a loose or worn stepper motor/throttle shaft coupling. Replace the shaft and bushing every 500 hours of engine operation.
- Check the carburetor for dirt, grime, or misadjustment. Check for a loose mixer assembly.
- Check the idle-adjustment screw. The screw should not prevent the throttle plate from closing completely.
- Check the throttle linkage for any binding, dirt, damage, or other visible problems.
- Observe the stepper motor operation. The stepper motor should open the throttle while cranking, and pull back as the engine approaches the target speed.

- Check for electronic governor faults. The fuel shutoff solenoid deenergizes and the generator set shuts down under the following conditions:
  - Closed throttle
  - Engine overspeed
  - Broken fuel shutoff solenoid lead
  - Broken stepper motor leads (erratic performance)
  - Failed actuator linkage (erratic performance)
- Check the fuel supply pressure and the fuel supply system for leaks, blockages, and/or failed system components (regulators, valves, etc.). See Section 5.8, Fuel Systems.

5.6.3 Hunting/Surging

Hunting/surging problems thought to be caused by the governor system are more likely to be caused by fuel supply, engine, or carburetor problems. Check engine speed stability using the following procedure before testing the governor.

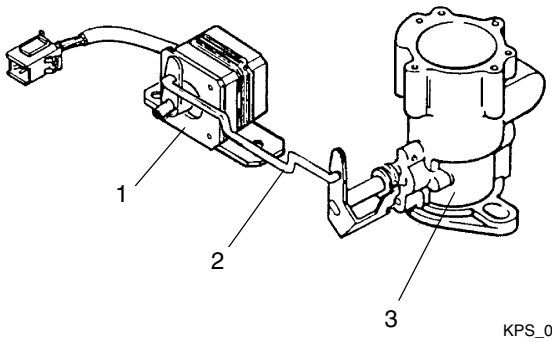
⚠ WARNING

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

Do not work on the generator set until it cools.

Servicing the exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. The engine and exhaust system components become extremely hot during operation.

1. Open the generator set line circuit breaker.
2. Start the generator set.
3. Hold the throttle linkage steady while the engine is running. See Figure 5-13. If the engine runs at a steady speed with no hunting or surging when the throttle is held steady, then the hunting/surging problems during operation may be caused by the governor. Proceed to Section 5.6.4.
4. Check the linkage between the stepper motor and the carburetor. Replace any worn or damaged components.
5. Verify that the speed control parameters have not been modified. Reset the Engine Speed Governor setting to the default setting. See Figure 5-16.
6. If the engine speed hunts or surges while the throttle is held steady, check the carburetor and engine operation. Refer to the engine service manual for engine diagnostic and service information.



1. Electronic governor stepper motor
2. Carburetor throttle linkage
3. Carburetor

Figure 5-13 Stepper Motor and Carburetor

5.6.4 Governor System Operation Test

If the engine continues to operate erratically after the previous checks, test the governor system operation using the following procedure. The procedure is summarized in the flowchart in Figure 5-14.

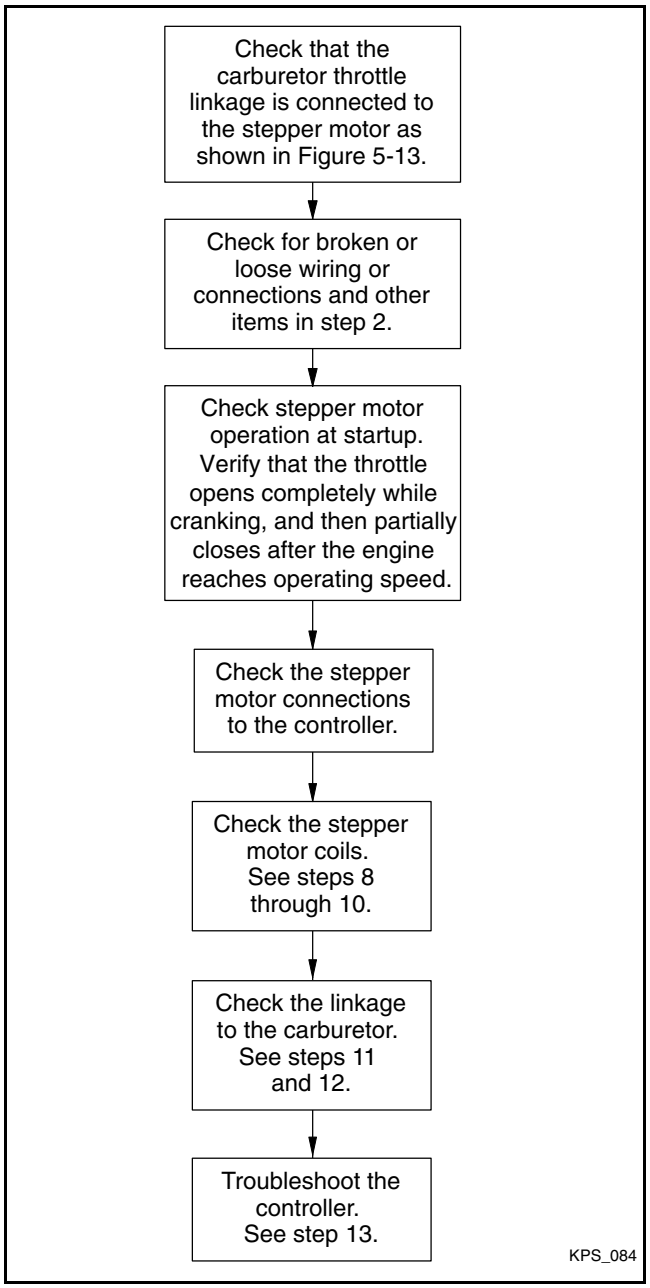


Figure 5-14 Governor System Operation Test Procedure Summary

Governor System Operation Test Procedure

1. Verify that the carburetor throttle linkage is connected to the stepper motor as shown in Figure 5-13.
2. Look for broken or loose wiring or plug connections if the stepper motor moves erratically. Check the condition of the throttle linkage, and verify that the throttle plate closes completely.

Check the operation of the stepper motor at startup.

3. Before starting the generator, move the throttle to the fully closed position. Press the RUN button to initiate the start sequence.
4. If the throttle stays in the fully closed position, and the controller shows a Locked Rotor fault, verify that the generator set model is set to 6VSG. Then check and verify the alternator connections, functionality, and operation. See the wiring diagrams and Sections 5.2 through 5.5 of this document.
5. If the throttle moves to the fully open position and remains fully open, and the controller shuts down the generator for an overspeed or overfrequency fault, verify that the generator set model is set to 6VSG. Then check the throttle linkage and stepper motor connections and operation. Go to step 8 of this procedure.
6. If the throttle moves to the fully open position and remains fully open, the engine goes to a high speed condition, and the controller does not shut down the generator, verify that the generator set model is set to 6VSG. Then check and verify the alternator connections, functionality, and operation. See the wiring diagrams and Sections 5.2 through 5.7 of this document.
7. If the throttle moves to the fully open position and then moves toward the closed position, but the engine speed is erratic or behaves poorly, check the throttle linkage and stepper motor connections and operation. See stepper motor troubleshooting starting with step 8 of this procedure. Also check that the engine speed control parameters are set to the default settings (Engine Speed Governor and Advanced Speed Control parameters in SiteTech).

Check the stepper motor, carburetor, and linkage.

8. To test controller's governing function, open the generator set circuit breaker, disconnect the engine starting battery, and shut off the fuel supply.
9. Disconnect the stepper motor plug P6 to access the stepper motor terminals.
10. Check the stepper motor coil resistance across pins 2 and 3 and across pins 1 and 4. Only two stepper motor leads of each coil group are used (BLK-YEL and RED-WHT). See Figure 5-15. The resistance per half coil is 38.5 ohms. If one of the coils has a significantly higher resistance or is shorted, replace the stepper motor.

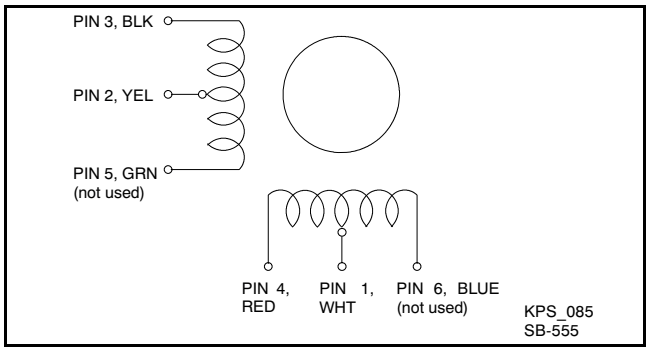


Figure 5-15 Actuator Coil Group

11. Inspect the linkage and the bushings between the stepper motor and the carburetor for damage. Replace as necessary.
12. Disconnect the linkage between the stepper motor and the carburetor. Verify free, full range of motion for the stepper motor and the carburetor throttle plate. Replace as necessary.
13. If there is power and a good ground connection to the controller and the stepper motor, and the carburetor and linkage pass the checks of steps 10 through 12, the problem may be with the controller. Check controller connections, wiring, and settings. Refer to the troubleshooting procedures in Section 4.

5.6.5 Engine Speed Gain Adjustment for the Governor

Note: Adjusting the governor gain may cause the generator to operate incorrectly.

Note: Typical governor gain settings are between 35 and 65. Settings outside this range are not recommended for extended use (troubleshooting only).

The governor gain controls how much throttle movement is tied to a given change in the generator speed or target speed. Higher gains make the throttle move more aggressively on a speed change; lower gains make the throttle move more slowly.

Using Kohler SiteTech, adjust the Engine Speed Gain Adjustment setting in the Engine Speed Governor group. See Figure 5-16. Change the governor gain setting in small steps (5 or less).

- If the engine is hunting slowly (changes from maximum to minimum speed in more than a second), increase the governor gain.
- If the generator is hunting quickly (maximum to minimum speed several times per second), decrease the gain.
- If changing the gain makes the hunting worse, try changing the gain in the other direction.

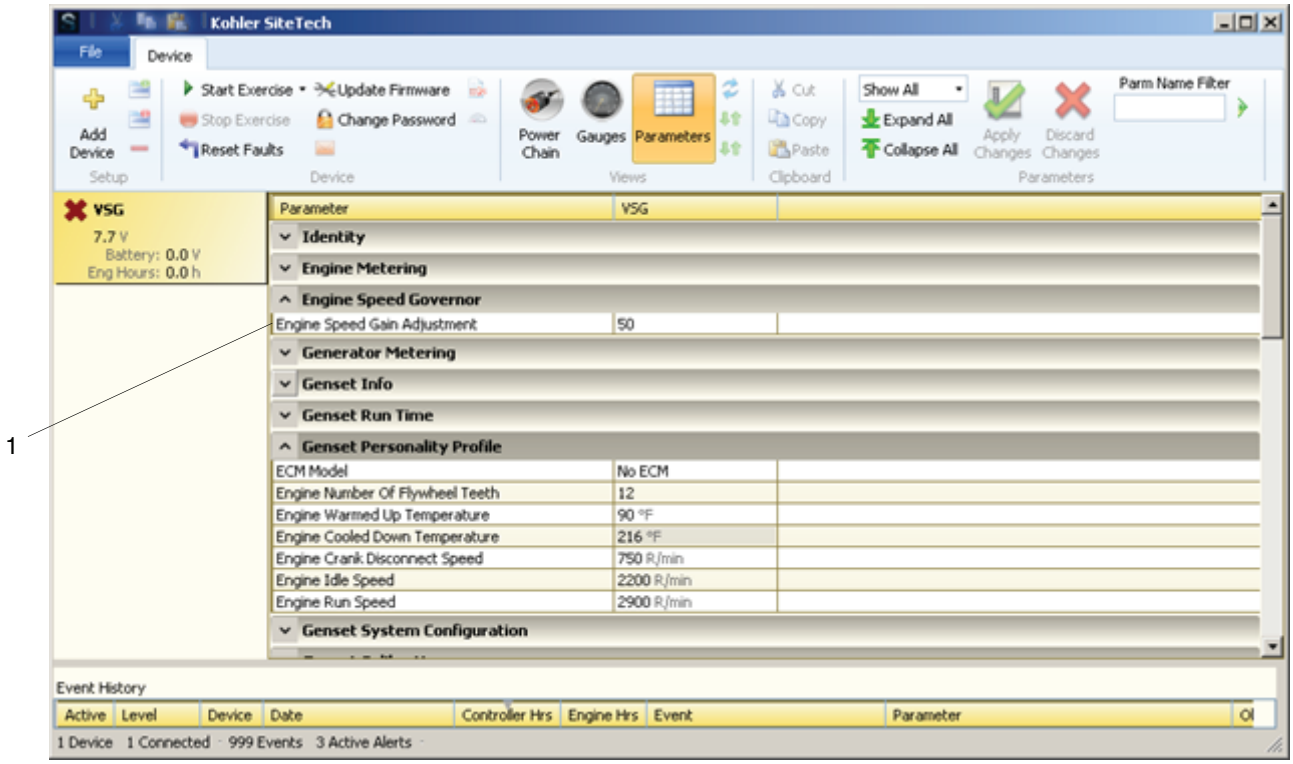
5.6.6 Advanced Speed Control

Note: Do not adjust the Advanced Speed Control settings unless instructed to do so by the Kohler Generator Service Department.

The four parameters under Advanced Speed Control also permit adjustment of the governor function, but have the potential of dramatically affecting the load transient performance of the generator. They are set in the factory and are tested to comply with factory performance standards. They should never be changed from the factory settings except under the direction of factory personnel.

SiteTech Group	Parameter	Units	Adjustment Range	Default Setting
Engine Speed Governor	Engine Speed Gain Adjustment		35 – 65	50

Figure 5-16 Engine Speed Governor Parameter in SiteTech



1. Engine Speed Governor settings

Figure 5-17 Engine Speed Parameters in SiteTech

5.7 Fault Shutdown Tests

Verify the operation of the generator set overspeed, overcrank, and low oil pressure shutdowns by performing the following tests. If these tests are inconclusive, test individual shutdown circuit components (wiring harness, switch, etc.) as described elsewhere in this section.

⚠ WARNING

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

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

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

⚠ WARNING

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

Do not work on the generator set until it cools.

Servicing the exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. The engine and exhaust system components become extremely hot during operation.

5.7.1 Controller Fault Shutdown Functions

Check the operation of the fault functions programmed in the controller by performing the following tests. If the controller does not operate as described, check the controller settings. Also check the controller wiring and connections.

Verify that the controller parameters shown in Figure 5-18 are set correctly for your unit.

Open the generator set output circuit breaker before beginning the test. (See Figure 1-1 for the circuit breaker location.)

Parameter	Setting
Genset Model Number*	6VSG
Genset Serial Number*	From nameplate
Fuel Type†	Natural Gas or Liquid Propane Gas (LPG)
Genset System Voltage†	From nameplate; see Figure 3-5

* In the Generator Set Information menu.
† In the Genset System menu.

Figure 5-18 Controller Settings

Overspeed Shutdown

Connect a digital voltmeter (DVM) to measure the AC output frequency. Start the generator set and manually adjust the engine speed by moving the throttle linkage.

Note: Be careful not to touch the hot silencer when reaching in to adjust the throttle linkage.

Increase the engine speed to at least 115% of the engine run speed, typically 3350 rpm. Verify that the generator set shuts down on an overspeed fault. If the overspeed shutdown limit is not reached quickly enough the generator set should shut down on an overvoltage fault after approximately 2 seconds.

Lower Oil Pressure (LOP) Shutdown

Connect a jumper wire from the LOP switch (lead 13) to the generator set ground. Start the generator set. Verify that the generator set shuts down after approximately 25–35 seconds of operation. Remove the jumper wire from the LOP switch and ground. Start the generator set and run it for at least 25–35 seconds to verify that the generator set does not shut down.

Overcrank Shutdown

Disconnect the fuel solenoid valve. Press the RUN button on the controller. Observe that the generator set cranks for 15 seconds and then rests for 15 seconds. Check that the generator set shuts down after the third crank/rest cycle.

Underspeed Shutdowns

Close the throttle while the generator is running. The engine speed should decrease until the generator set shuts down and the controller indicates an Engine Speed Low Shutdown.

Locked Rotor Shutdown

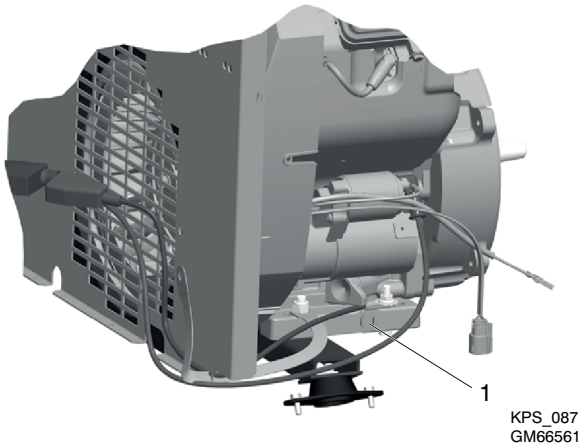
Remove the connector from the starter relay (see Figure 5-29). Press RUN. Verify that the engine does not turn and the controller indicates a Locked Rotor fault.

High Engine Temperature Shutdown

Note: Testing the high engine temperature shutdown requires connecting a jumper wire across the temperature sensor connections. Because the temperature sensor can be difficult to reach, the jumper can be placed across pins 9 and 10 on connector P1 at the generator set controller, if desired.

Disconnect the harness (connector P7) at the engine temperature sensor (CTS). See Figure 5-19 for the temperature sensor location, or see the note above. Connect a jumper wire across the temperature sensor connections in connector P7 or connections P1-9 and P1-10 on the controller. See Figure 5-20. Press RUN to start the generator set. After 5 seconds, verify that the controller displays a high lube oil temperature fault. If the oil temperature remains high (jumper connected) without increasing, the generator set will run for 5 minutes in engine cooldown mode.

Press the OFF button on the controller and remove the jumper wire. Start the generator set and verify that the generator set does not enter the engine cooldown cycle or shut down on a high temperature fault. Reconnect P7 to the temperature sensor.



1. Temperature sensor

Figure 5-19 Temperature Sensor (CTS) Location

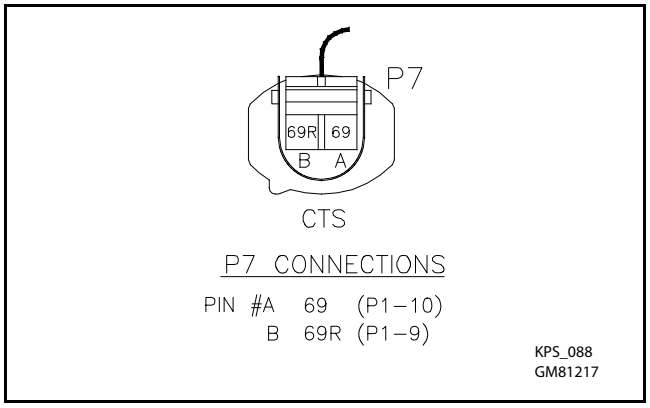
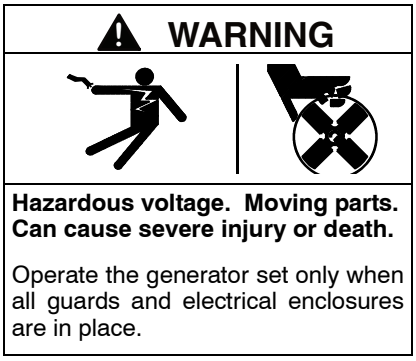


Figure 5-20 Temperature Sensor Connector P7

5.7.2 Fault Shutdown Switches

Check the low oil pressure and high engine temperature shutdown switches on the engine by performing the following tests. If the sensor does not function as described, replace it.



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

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

Temperature Sensor (CTS)

The temperature sensor (labeled CTS on the wiring diagram and schematic drawing) is used to monitor engine temperature for the high engine temperature fault shutdown. See Figure 5-19 for the temperature sensor location. Press the OFF button on the controller to stop the generator set and allow the generator set to cool. Disconnect the temperature sensor (or see the following note) and use an ohmmeter to measure the resistance across the sensor. The sensor resistance varies with temperature and should be within the values shown in Figure 5-21.

If the resistance is very low (indicating a short circuit) or very high (indicating an open circuit), replace the CTS.

Note: Because the temperature sensor can be difficult to reach, the resistance can be measured across pins 9 and 10 on connector P1 at the generator set controller, if desired. Disconnect P1 from the controller before checking the resistance across P1-9 and P1-10.

Note: The temperature sensor is located in the engine oil pan. Drain the engine oil before removing the switch.

Temperature, °C (°F)	Resistance, Ohms
30 (86)	2100–2400
100 (212)	180–200

Figure 5-21 Temperature Sensor CTS Resistance Readings

Low Oil Pressure (LOP) Switch

The low oil pressure (LOP) switch is located under the engine air cleaner. See Figure 5-22. The oil pressure switch should be closed when the engine is stopped (no oil pressure) and open when the engine is running.

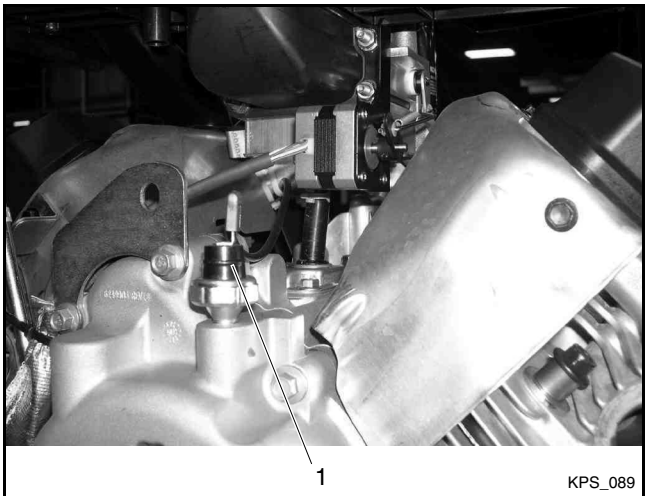
Before testing the LOP switch, check the oil level and add oil if necessary. Inspect the generator set engine for evidence of oil leaks.

To test the LOP switch:

1. Press the OFF button to stop the engine.
2. Disconnect lead 13 from the switch.
3. Use an ohmmeter or continuity tester to verify that the switch is closed (connected to the engine block).
4. Start the engine and verify that the switch opens after a few seconds.

If the LOP switch does not operate as described above, use a gauge to check the oil pressure:

1. Press the OFF button to stop the engine.
2. Remove the LOP switch and install an oil pressure gauge.
3. Start and run the generator set.
4. Verify that the engine oil pressure is within the range specified in Section 1, Specifications, before replacing the LOP switch.

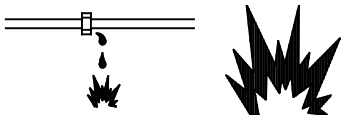


1. Oil pressure switch

Figure 5-22 Oil Pressure Switch Location (under the air cleaner)

5.8 Fuel Systems

⚠ WARNING



Explosive fuel vapors.
Can cause severe injury or death.

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

The fuel supplier provides and maintains manual shutoff valves and the primary regulator. See the generator set installation manual for fuel pipe size recommendations. Verify that the fuel system capacity is adequate to supply the generator set plus all other gas appliances.

A factory-installed secondary regulator and 12 VDC solenoid valve are located in the front air intake compartment. The controller energizes the fuel solenoid valve to open at startup and deenergizes the valve to close at shutdown. The secondary fuel regulator reduces fuel pressure for delivery to the fuel block. The fuel flows from the fuel block to the carburetor in a gaseous state. The carburetor mixes the fuel with intake air for consumption by the engine.

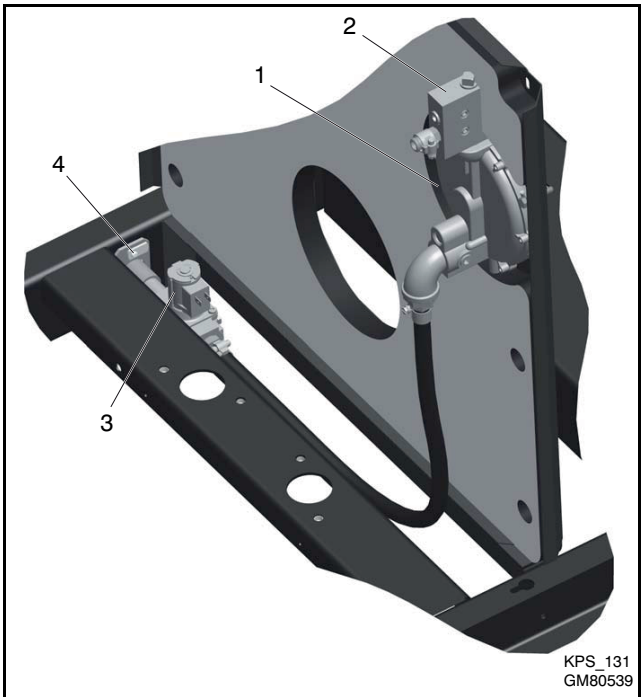
Refer to the troubleshooting instructions in Section 4, Troubleshooting, to identify generator set operation problems that may be caused by an inadequate fuel supply, incorrect adjustments, or damaged fuel system components. Then use the instructions in this section to check fuel system components.

5.8.1 Fuel Solenoid Valve

A solenoid valve upstream of the regulator and the flexible fuel connector provides automatic fuel on/off control. See Figure 5-23. The engine starting battery powers the solenoid valve and the engine starting controls open the valve when the engine cranks or runs.

Fuel Valve Operation Test Procedure

1. Disconnect the positive (+) battery lead from the gas valve terminal.
2. Apply 12 VDC to the gas valve terminal and listen for an audible click, indicating that the valve actuates.
3. Replace the gas valve if it does not actuate in step 2.



1. Regulator
2. Fuel block
3. Fuel solenoid valve
4. Fuel inlet, 1/2 in. NPT female

Figure 5-23 Fuel System

5.8.2 Fuel Regulators

The typical gaseous fuel system uses two regulators. The primary regulator reduces the line pressure to an allowable inlet pressure for the secondary regulator. The fuel supplier provides and maintains the primary regulator. The secondary regulator is factory-installed on the generator set and is designed for a maximum inlet pressure of 2.7 kPa (6 oz./in.^{2}) or 280 mm (11 in.) water column.

Note: Do not attempt to adjust the fuel mixture or engine speed by adjusting the regulators.

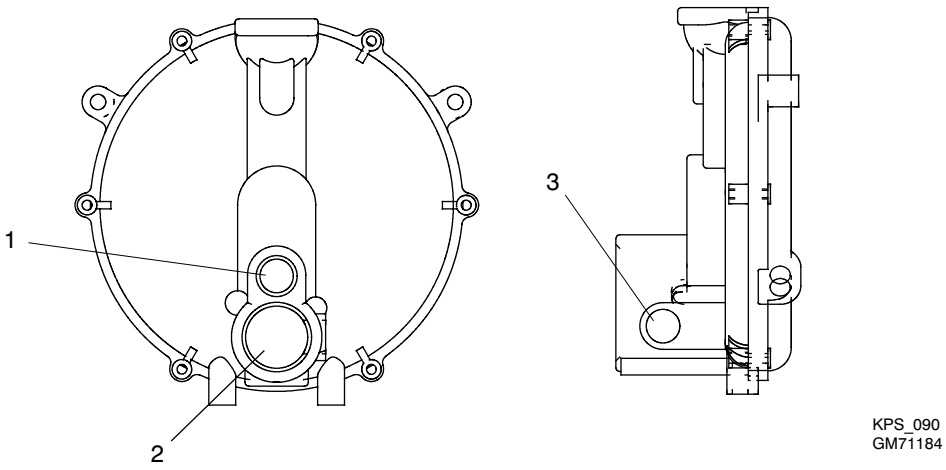
The fuel lockoff prevents fuel flow when the engine is not operating. See Figure 5-25. Do not try to adjust the fuel pressure, fuel mixture, or engine speed using the fuel lockoff.

Checking the Fuel Pressure

Use a gauge or manometer to check the fuel pressure at the secondary regulator inlet. See Figure 5-25. Measure the fuel pressure with the generator set running at rated load. Contact the fuel supplier if the inlet pressure is not within the range shown in Figure 5-24.

Fuel	Fuel Pressure Required
Natural Gas	1.2–2.7 kPa (5–11 inches H_2O)
LPG	1.7–2.7 kPa (7–11 inches H_2O)

Figure 5-24 Fuel Pressure Requirements



1. Fuel lockoff (do not adjust)
2. Fuel inlet, 1/2 in. NPT
3. Inlet pressure check location

Figure 5-25 Fuel Regulator

5.8.3 Fuel Conversion, 6VSG

Two fuel connections on the fuel block allow field conversion between natural gas and LPG. The fuel metering valves are factory-set and sealed to comply with applicable emission standards and to provide the best possible hot and cold starting.

Note: Do not adjust the factory-sealed fuel-metering adjustments on the fuel block. Changing the fuel metering adjustments may violate federal or state laws.

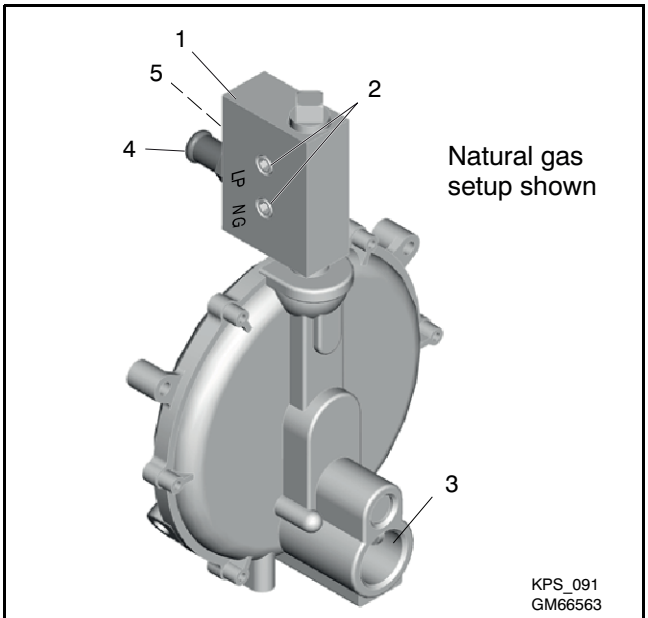
Use the following procedure to convert from natural gas (NG) to LPG. See Figure 5-26 for the fuel system component locations.

Procedure to Convert from NG to LPG

1. Press the OFF button on the generator set controller.
2. Disconnect the power to the generator set.
3. Disconnect the generator set engine starting battery, negative (–) lead first.
4. Turn off the fuel supply.
5. Remove the hose clamp and fuel hose from the hose fitting in the fuel block. See Figure 5-26.
6. Remove the hose fitting from the natural gas outlet port in the fuel block. See Figure 5-26.
7. Remove the plug from the LPG port in the fuel block. See Figure 5-26.
8. Clean the plug with a dry cloth or brush, apply fresh pipe sealant, and install the plug into the natural gas outlet port.
9. Clean the hose fitting with a dry cloth or brush, apply fresh pipe sealant to the threads, and install the fitting into the LPG port.

Note: Do not adjust the fuel metering valves.

10. Slide the hose onto the hose fitting and secure it with the clamp.



1. Fuel block
2. Fuel metering valves—*factory-sealed, do not adjust*
3. Fuel inlet, 1/2 in. NPT
4. Hose fitting
5. Plug

Figure 5-26 Fuel Block

11. Connect and turn on the new fuel supply.

12. Reconnect the generator set engine starting battery leads, negative (–) lead last.
13. Reconnect power to the generator set.
14. Start the generator set by pressing the RUN button on the generator set controller.
15. Check for leaks using a gas leak detector.
16. Press the OFF button to shut down the generator set.
17. The Fuel Type parameter can be set at the controller in the Genset System menu. SiteTech is not required. Setting this parameter is optional; it does not affect the operation of the generator set.

To convert from LPG to natural gas, follow the same fuel conversion procedure, moving the hose fitting to the natural gas port and plugging the LPG port.

5.8.4 Fuel Metering Valve Adjustment

The fuel system is factory-adjusted to comply with applicable emission standards and to provide the best possible hot and cold starting. The fuel metering valves are sealed to prevent field adjustments. If the fuel metering valve requires adjustment, do not break the seals on the factory-installed fuel metering valve. Obtain a new fuel metering valve to replace the factory-installed valve, and adjust the fuel mixture according to the instructions in this section. See Figure 5-26 for the fuel metering valve location. Refer to the generator set Parts Catalog for the fuel metering valve part number.

Note: Adjusting the factory-installed fuel metering valves on emissions-certified generator sets will void the emission certification.

Use an exhaust gas oxygen sensor to check the fuel mixture after replacing the fuel regulator, carburetor, or silencer. Use the following procedure to check the fuel mixture after the engine has reached normal operating temperature.

Only trained, authorized service technicians may adjust the new fuel metering valve. The adjustment procedure requires a digital voltmeter (DVM), oxygen sensor service kit GM58035, and a load bank capable of the rated kW for the fuel being used. Always use an oxygen sensor when adjusting the fuel metering valves.

Observe the following safety precautions while performing the procedure.

⚠ WARNING

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

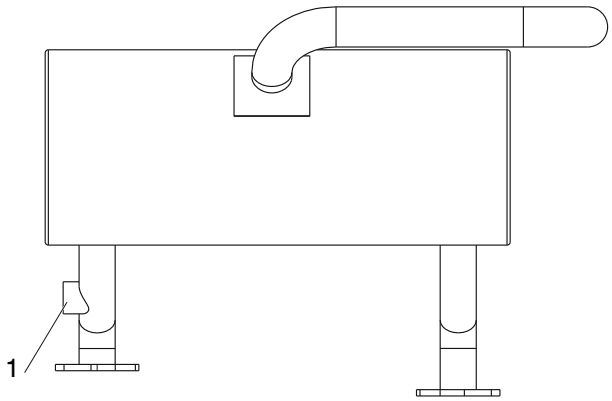
Do not work on the generator set until it cools.

Servicing the exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. The engine and exhaust system components become extremely hot during operation.

Note: The oxygen sensor gets very hot during operation. DO NOT touch the oxygen sensor, during or after operation, until cool.

Fuel Mixture Check/Fuel Metering Valve Adjustment Procedure

1. Follow the instructions provided with the oxygen sensor kit to perform the initial programming and setup of the air/fuel (A/F) reader. See SB-675, provided with the oxygen sensor kit.
2. Press the OFF button on the controller.
3. Disconnect power to the generator set.
4. Remove the oxygen sensor plug from the silencer and install the oxygen sensor. See Figure 5-27 for location.



1. Oxygen sensor mounting location

Figure 5-27 Oxygen Sensor Mounting Location

5. Follow the instructions provided with the oxygen sensor kit to connect the oxygen sensor to the power supply and A/F reader.
6. Reconnect power to the generator set.
7. Press the RUN button on the controller to start the generator set.
8. Allow the generator set to run until the engine reaches normal operating temperature.
9. With the generator set at normal operating temperature, apply full load (6 kW).
10. After several minutes, note the air/fuel ratio meter measurements and compare to the λ (lambda) values in Figure 5-28.

Fuel	Lambda (λ)	UEGO, VDC*
LPG	0.944–0.966	2.60 ± 0.05
Natural Gas	1.063–1.091	2.10 ± 0.05

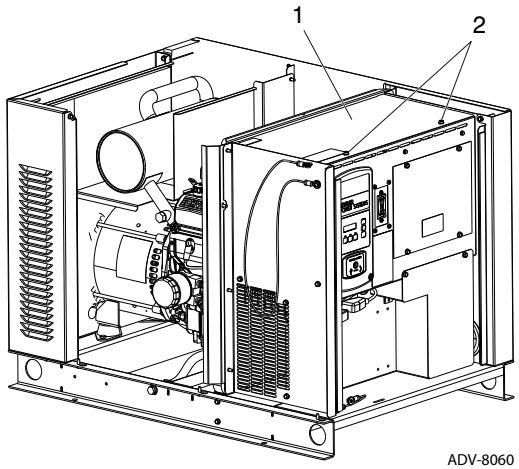
***** UEGO sensor readings shown for reference.

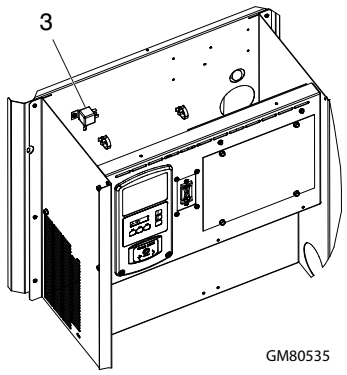
Figure 5-28 Acceptable Oxygen Sensor Readings

11. Adjust the fuel metering valve as required to obtain the output from the oxygen sensor specified in Figure 5-28.
12. When the fuel mixture is correct, use thread sealant to seal the metering valve adjustment screws.
13. Remove the load and allow the generator set to run unloaded to cool for at least 5–10 minutes.
14. Stop the generator set by pressing the OFF button on the controller.
15. Disconnect the generator set engine starting battery, negative (–) lead first.
16. Disconnect power to the generator set.
17. Allow the generator set exhaust system to cool.
18. Disconnect the DVM leads from the oxygen sensor.
19. After the sensor has cooled, remove the oxygen sensor from exhaust manifold.
20. Apply a small amount of antiseize compound to exhaust plug and reinstall the plug into the exhaust manifold.
21. Reconnect the generator set engine starting battery, negative (–) lead last.
22. Reconnect power to the generator set.

5.9 Starter Relay

The starter relay is located behind the controller. See Figure 5-29.





KPS_093

1. Cover
2. Screws
3. Starter relay

Figure 5-29 Starter Relay Location

The starter relay contains an internal diode across the relay coil. See Figure 5-30. Continuity checks across the coil terminals will show continuity (low resistance) in one direction and an open circuit in the other.

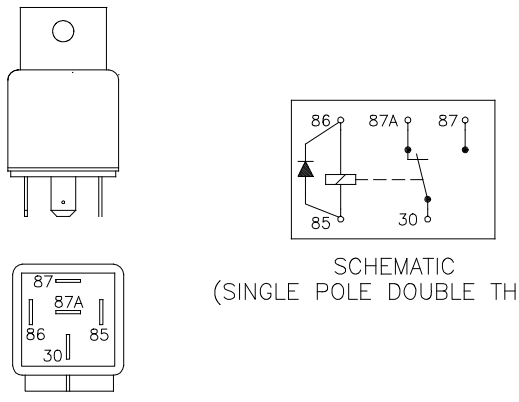
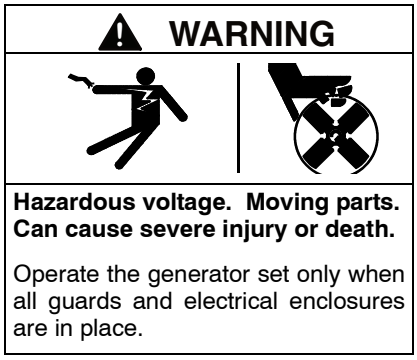


Figure 5-30 Starter Relay

See the wiring diagram in Section 7 for the starter relay connections.

5.10 Continuity Checks



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

To further check generator set components, disconnect the battery and remove wiring harness plugs from the controller circuit board. Use an ohmmeter to check the continuity of the components listed

Figure 5-31 gives resistance readings for functional components. A zero reading on the ohmmeter indicates continuity. No ohmmeter reading indicates very high resistance or an open circuit. A measurement that varies significantly from the value shown in the table indicates a faulty component; replace faulty components.

Note: Disconnect the generator set battery before performing continuity checks to prevent damage to the ohmmeter.

For rectifier and stator resistance and continuity checks, see Section 5.3, Rectifier Testing and Section 5.4, Stator.

Component	Ohmmeter Connections	Ohmmeter Scale	Generator Set State	Ohmmeter Readings for Operative Components
P1 wiring harness	P1-2 and ground	R x 1	OFF	Less than 1 ohm (continuity). Any other reading indicates a poor ground connection
	P2-6, P2-7, and P2-8 (stator leads 1, 2, and 3)	R x 1	OFF	Less than 1 ohm (continuity). If no continuity, check wiring.
	P2-3 and P2-4 (stator leads 1 and 2)	R x 1	OFF	Less than 1 ohm (continuity). If no continuity, check wiring.
Controller wiring	P1-1 and battery positive (+)	R x 100	OFF	Less than 1 ohm (continuity). If no continuity is found, check wiring.
Low oil pressure (LOP) switch *	Lead 13 and ground (engine block)	R x 100	OFF	Less than 1 ohm (continuity). No continuity indicates a faulty switch and/or wiring.
Temperature sensor (CTS) *	P1-9 and P1-10	R x 100	OFF	180–2500 ohms, depending on engine temperature. See Section 5.7.2. Less than 1 ohm or an open circuit indicates faulty wiring or a faulty sensor.

* Section 5.7, Fault Shutdown Tests

Figure 5-31 Continuity Checks

Notes

This section provides instructions for the disassembly and reassembly of the generator set alternator. Before beginning the generator disassembly or reassembly procedure, carefully read all safety precautions at the beginning of this manual.

The engine and generator set may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

⚠ WARNING

Accidental starting.
Can cause severe injury or death.

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

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

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ WARNING

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

Do not work on the generator set until it cools.

6.1 Initial Steps

Perform the following steps before disassembling the generator set.

1. Disconnect power to the generator set.
2. Shut off the fuel supply. Disconnect the fuel system if necessary to tilt the generator set. Ventilate the area to clear fumes.
3. Allow the generator set and engine to cool.
4. Verify that any hoists or lifting devices used in the disassembly or reassembly procedure are rated for the weight of the generator set, which is approximately 190 kg (420 lb.).

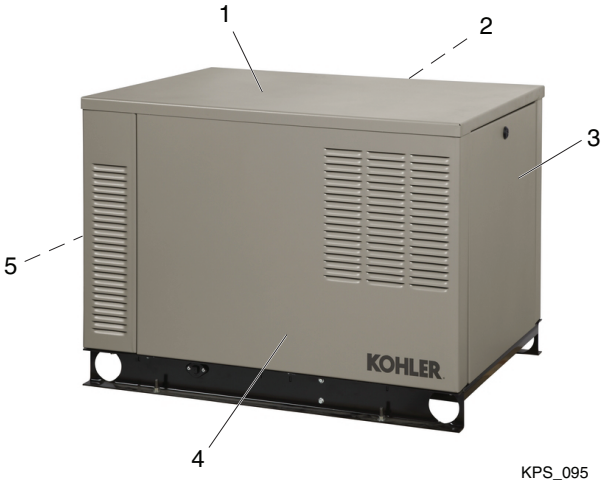
6.2 Disassembly

The disassembly procedure explains how to disassemble the generator set enclosure and other parts in order to access the alternator for service. The procedure provides important information to minimize disassembly time and indicates where special configurations exist which may require taking notes.

Remove Enclosure

Remove the generator set enclosure as described in the following steps. See Figure 6-1.

1. Open the front service door.
2. Press the OFF button on the controller.
3. Lift off roof and slide toward exhaust end to disengage tabs from slots. Remove ground strap if necessary.



1. Roof
2. Left-side panel
3. Front service door
4. Right-side panel
5. Rear panel (exhaust end)

Figure 6-1 Enclosure

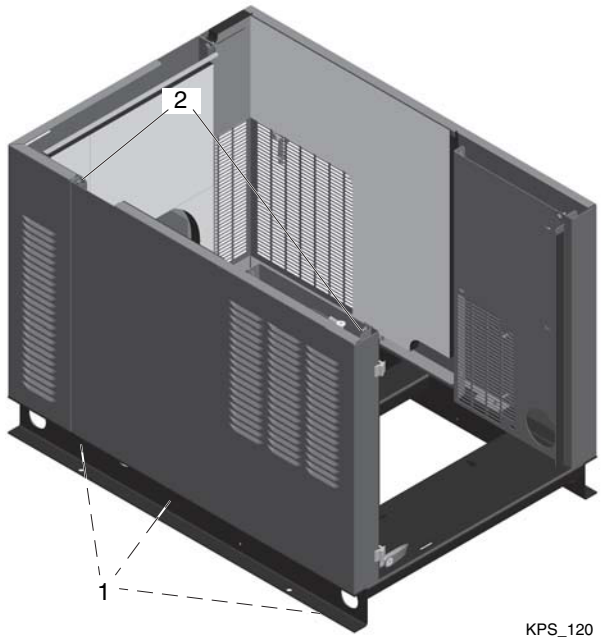
4. Remove the right-side panel:

Note: The three bottom screw holes are slotted and only need to be loosened.

a. Loosen the bottom screws. See Figure 6-2.

b. Remove the top two screws.

c. Slide the right-side panel to the front and lift up and off.



1. Three bottom screws
2. Two top screws

Figure 6-2 Right-Side Panel

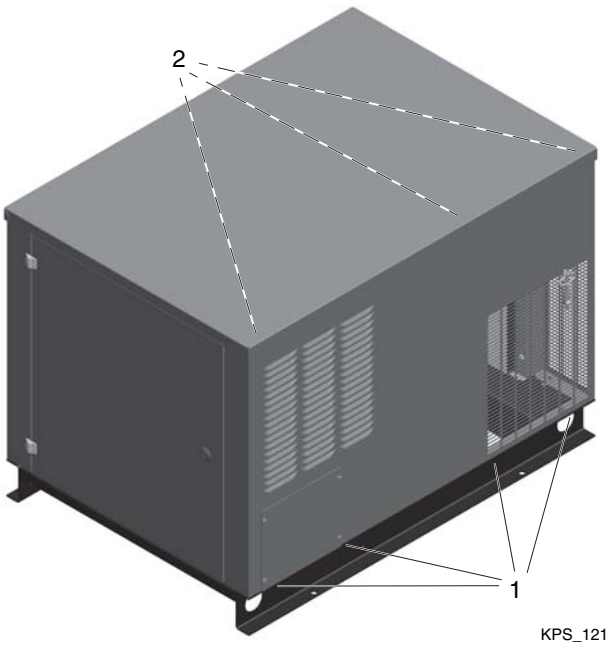
5. Remove the left-side panel:

Note: The four bottom screw holes are slotted and only need to be loosened.

a. Loosen the four bottom screws.

b. Remove the top three screws.

c. Slide the left-side panel to the front and lift it up and off.



1. Four bottom screws
2. Three top screws

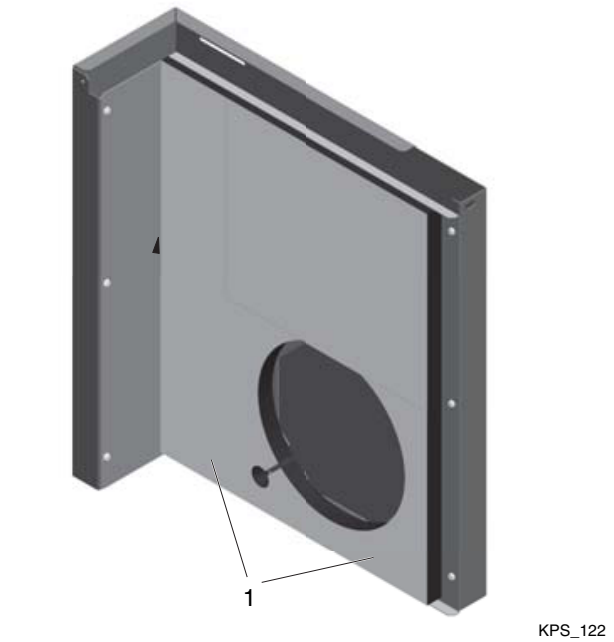
Figure 6-3 Left-Side Panel

6. Remove rear panel:

Note: The two bottom screw holes are slotted and only need to be loosened.

a. Loosen the two bottom screws.

b. From the rear, slide the panel to the left side and lift up and off.

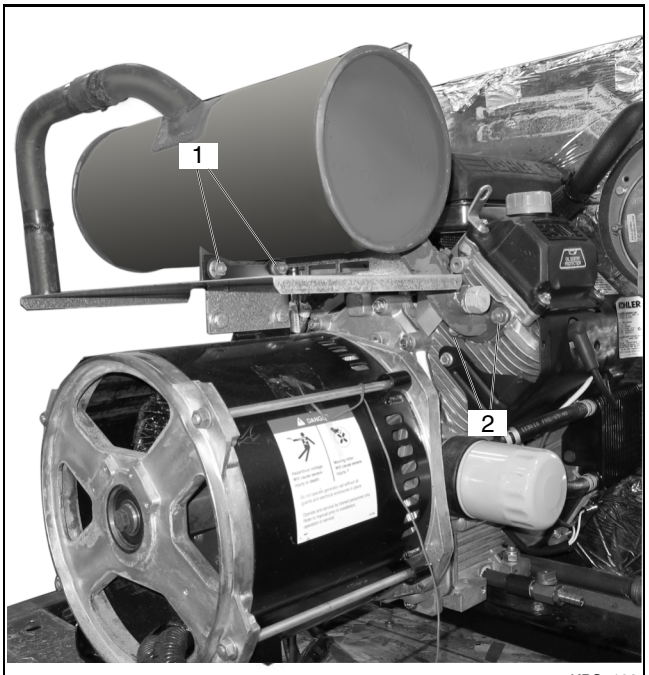


1. Two bottom screws

Figure 6-4 Remove Rear Panel

Remove the Muffler

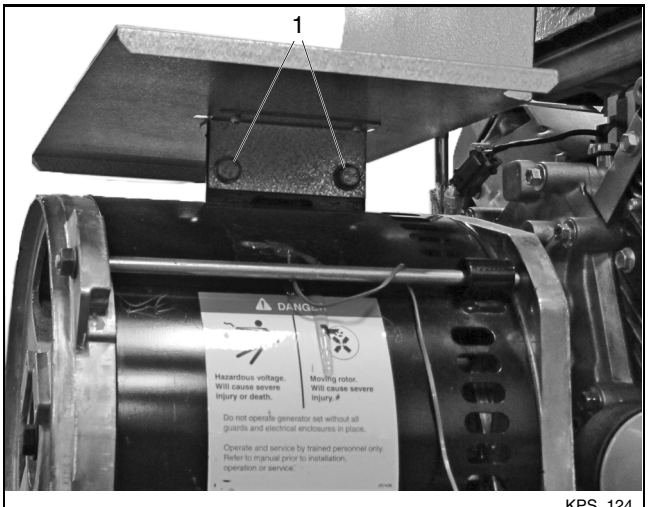
1. Remove the two bolts and nuts from the muffler bracket.
2. Remove the four nuts from the exhaust flanges.



1. Two muffler bracket bolts and nuts
2. Four exhaust flange nuts

Figure 6-5 Removing Muffler

3. Remove the two bolts and nuts holding the heat shield to the alternator.

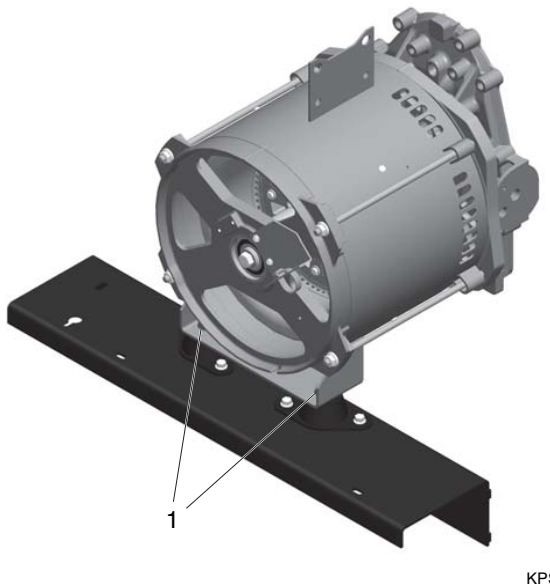


1. Two heat shield bolts and nuts

Figure 6-6 Removing Heat Shield

Generator Disassembly

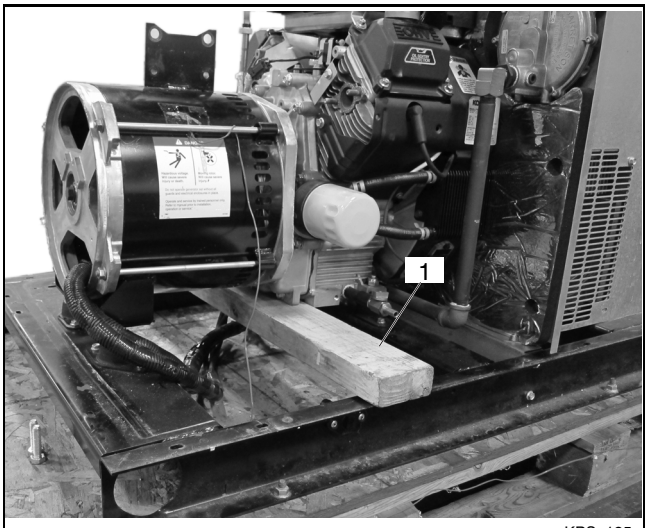
1. Remove the two bolts from the center of the rubber isolators.



1. Mounting bolts

Figure 6-7 Removing Mounting Bolts

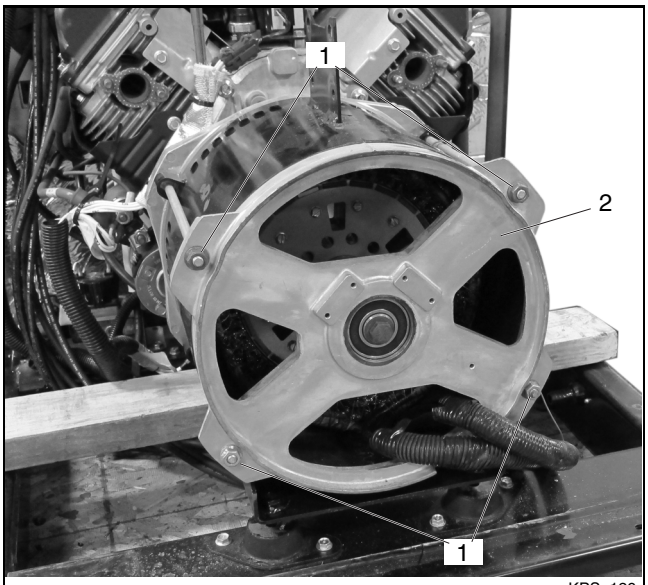
2. Lift up on the back of the alternator and place a wood support under the engine.



1. Engine support

Figure 6-8 Wood Support for Engine

3. Remove the four nuts holding the end cap on the stator and remove the end cap.

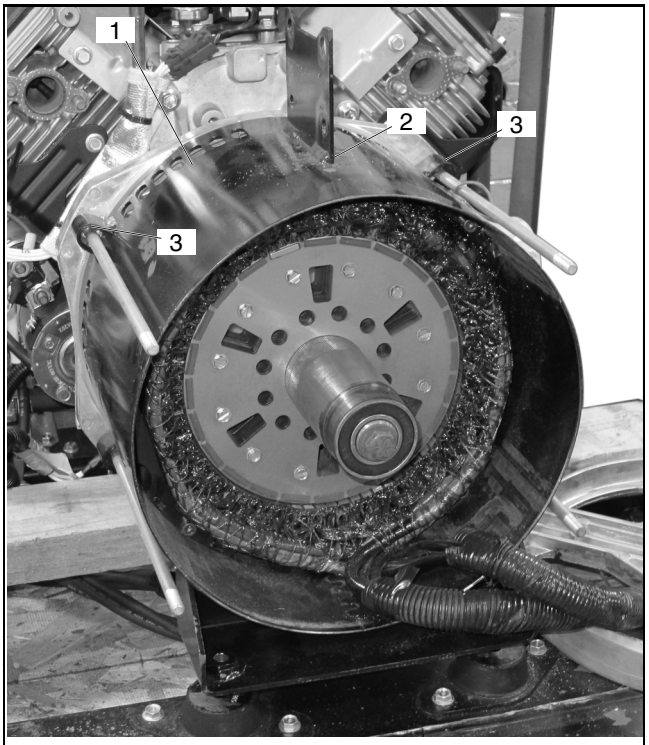


1. End cap nuts
2. End cap

Figure 6-9 Removing End Cap

4. Pry lightly between the adapter and the stator to separate them slightly and tap on the top bracket on stator.

5. Slide the stator away from the rotor using the guides on the stator.



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1. Prying area
2. Top bracket
3. Stator guides

Figure 6-10 Removing Stator

6. The rotor can be removed two different ways:

   Method 1:

   a. Loosen but do not remove the rotor thrubolt. Hold the rotor with a strap wrench if needed.

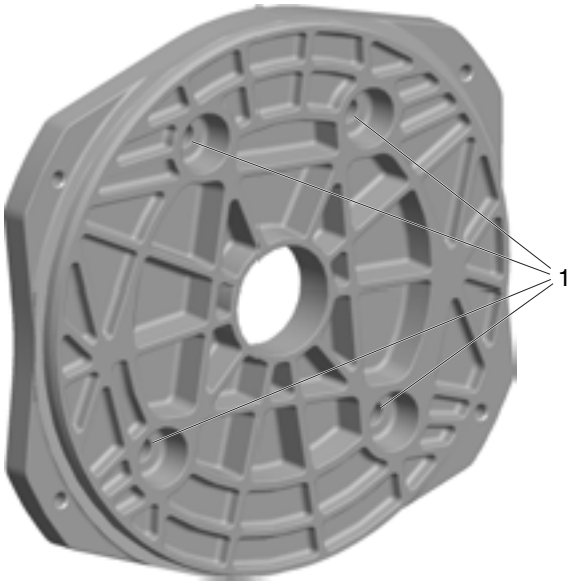
   b. Using a soft faced hammer strike the rotor shaft. Rotate the rotor and strike it on alternate sides until it can be rocked back and forth. Do not strike the rotor anywhere but on the shaft area.

   Method 2:

   a. Remove the rotor thrubolt. Hold the rotor with a strap wrench if needed.

   b. Thread a slide hammer into the threads of the rotor shaft and use the slide hammer to remove the rotor.

7. Remove the four adapter mounting bolts to remove the adapter if required.



KPS_135

1. Adapter mounting bolts

Figure 6-11 Adapter Plate

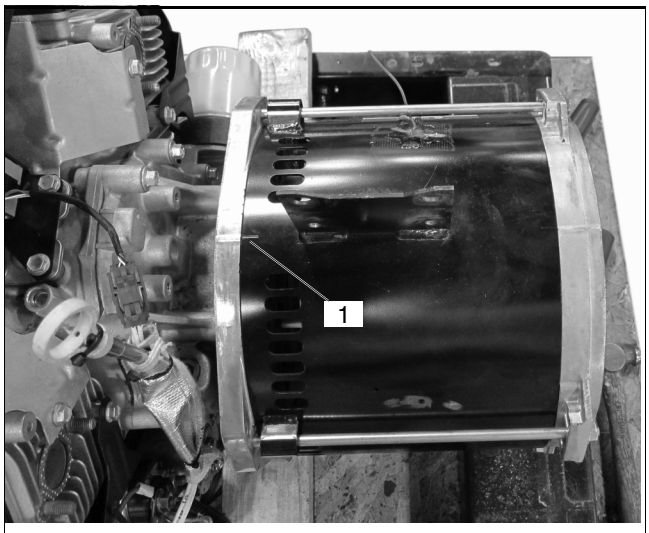
6.3 Assembly

Assembly is done in reverse order of disassembly, except as noted.

1. Install the adapter plate to the engine and tighten bolts to 40 Nm (28 ft. lb.).

2. Install the rotor and tighten the rotor thrubolt to 85 Nm (63 ft. lb.).

3. Install the stator, making sure the alignment marks on the stator and the adapter plate line up.



KPS_129

1. Alignment marks

Figure 6-12 Installing Stator

4. Install end cap and tighten end cap bolts to 14.9 Nm (11 ft. lb.).

Notes

Figure 7-1 lists the installation drawing numbers and page numbers.

Installation Drawing Description	Drawing Number	Page
Dimension Drawing	ADV-8060, Sheet 1	92
Dimension Drawing	ADV-8060, Sheet 2	93
Dimension Drawing	ADV-8060, Sheet 3	94
Schematic Diagram, 36V and 48V	ADV-8460, Sheet 1	95
Schematic Diagram, 24V	ADV-8460, Sheet 2	96
Point-to-Point Wiring Diagram, 36V and 48V	GM81321, Sheet 1	97
Point-to-Point Wiring Diagram, 24V	GM81321, Sheet 2	98

Figure 7-1 Dimension Drawings, Wiring Diagrams, and Schematics

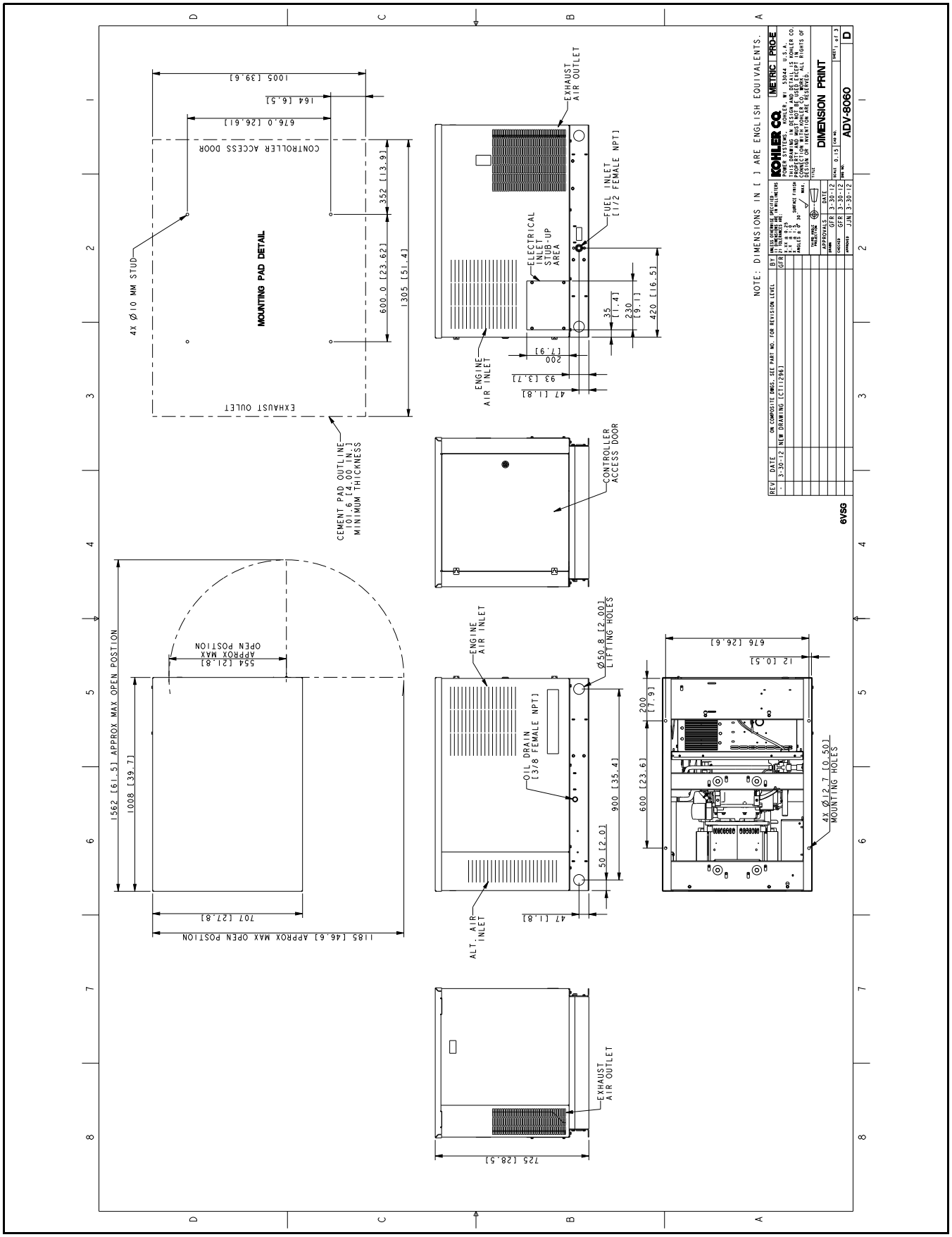


Figure 7-2 Dimension Drawing ADV-8060, Sheet 1

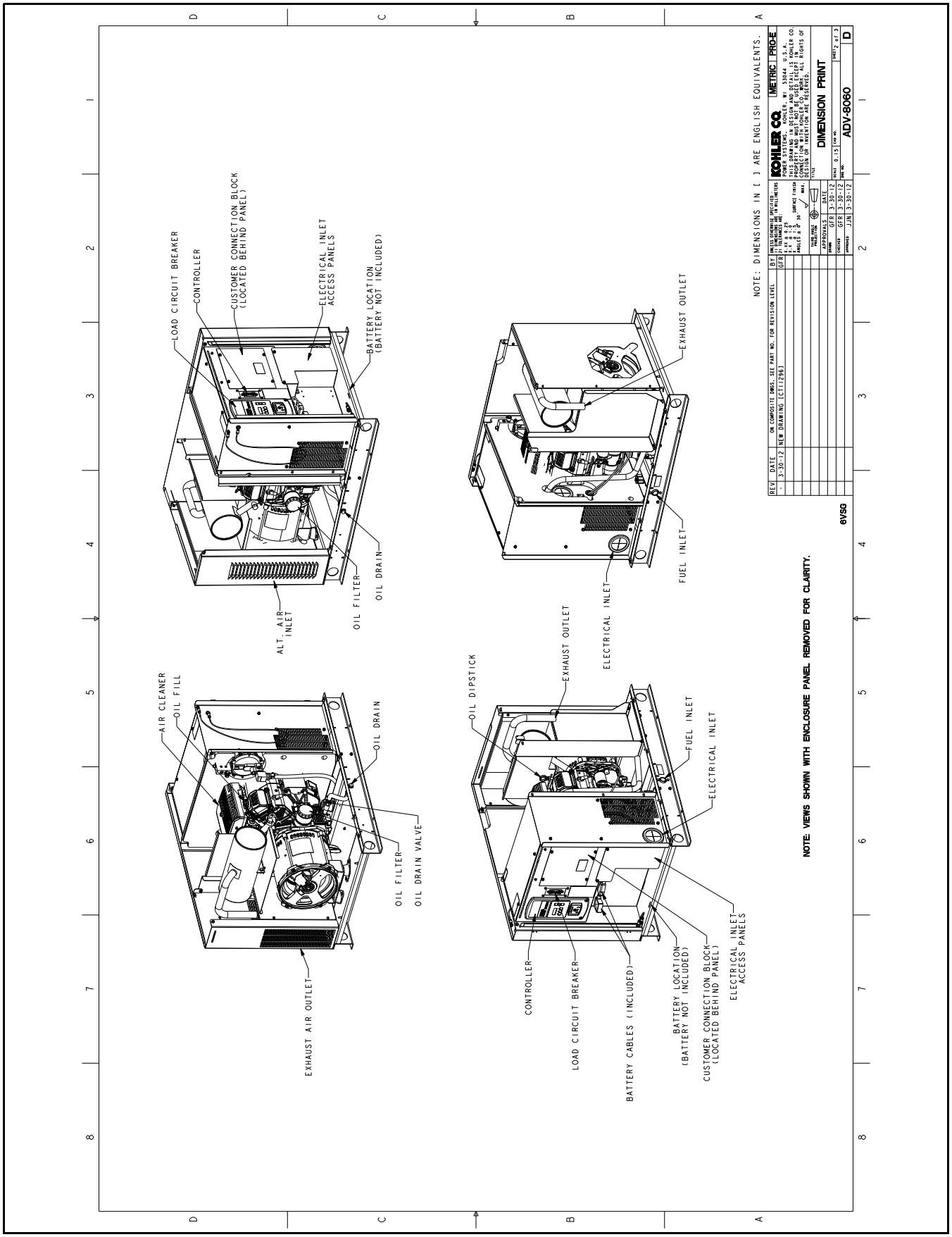


Figure 7-3 Dimension Drawing ADV-8060, Sheet 2

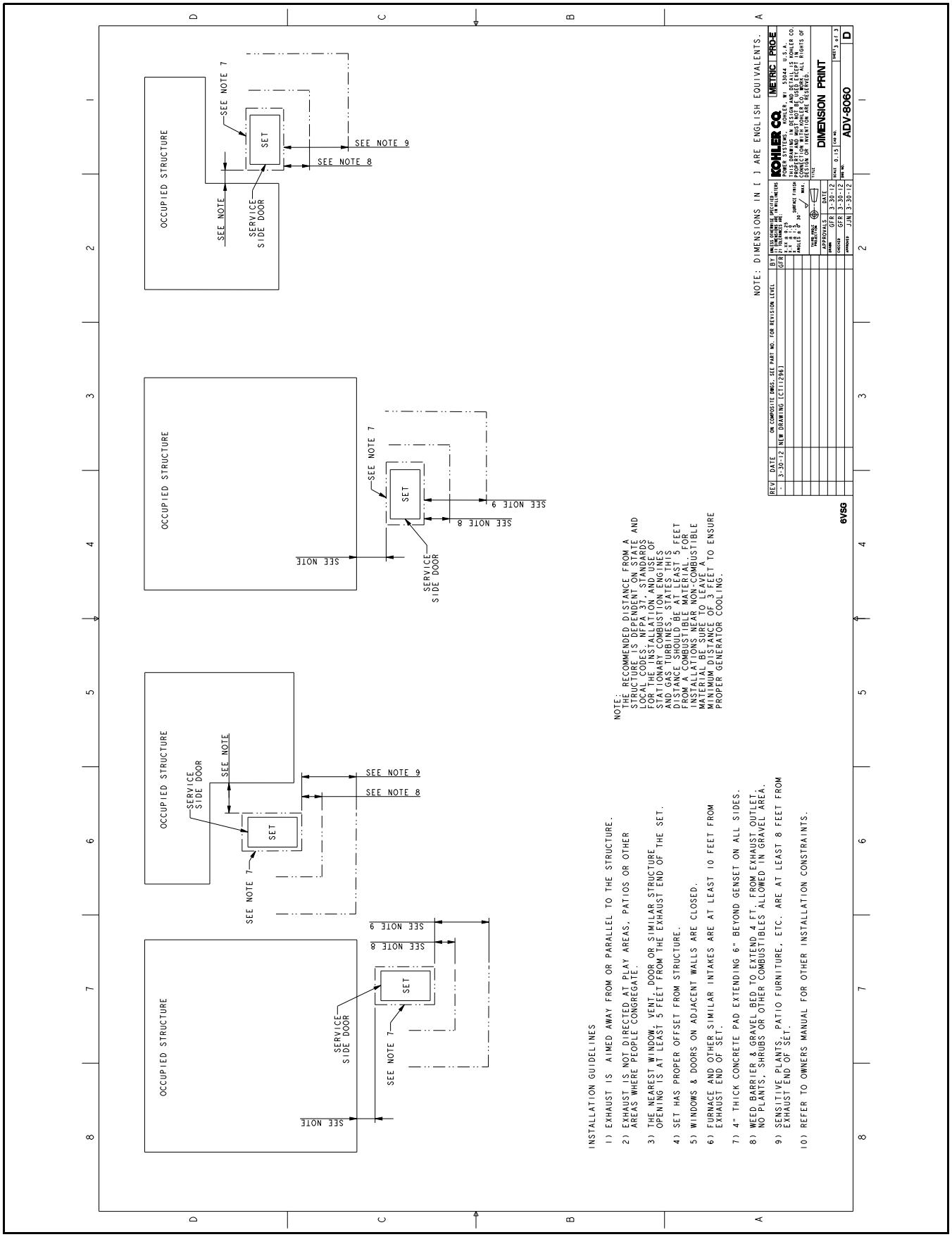


Figure 7-4 Dimension Drawing ADV-8060, Sheet 3

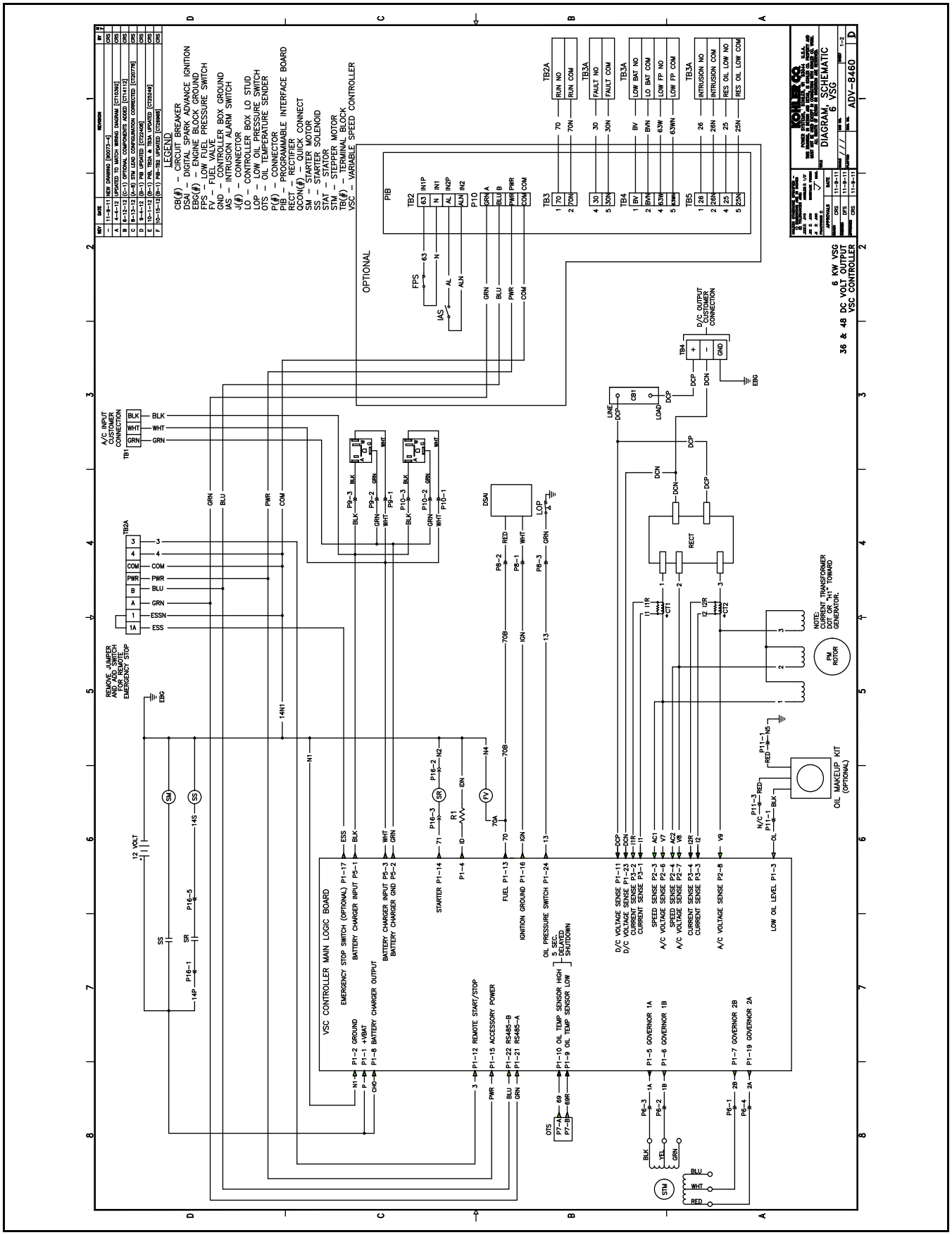


Figure 7-5 Schematic Diagram, 36V and 48V, ADV-8460, Sheet 1

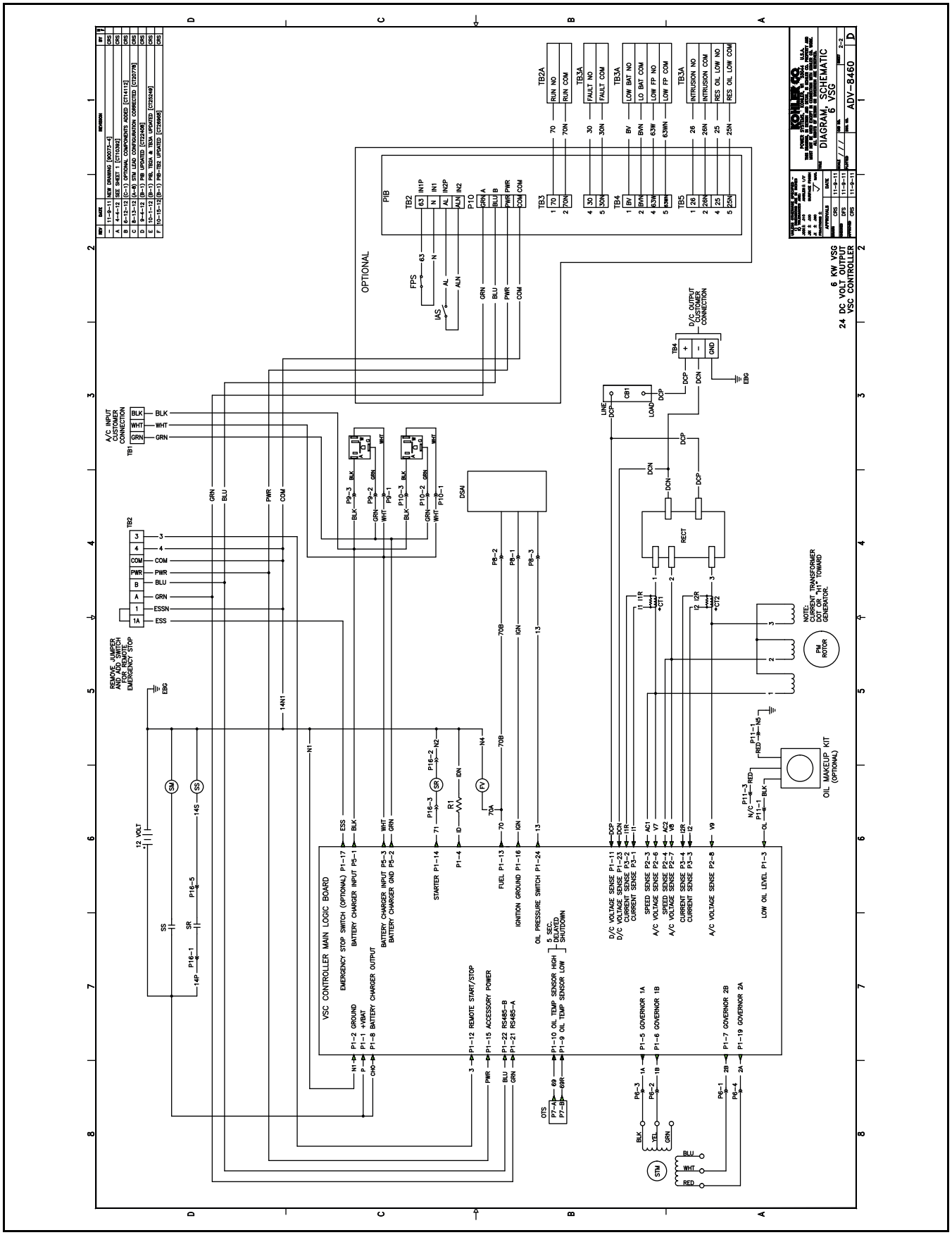


Figure 7-6 Schematic Diagram, 24V, ADV-8460, Sheet 2

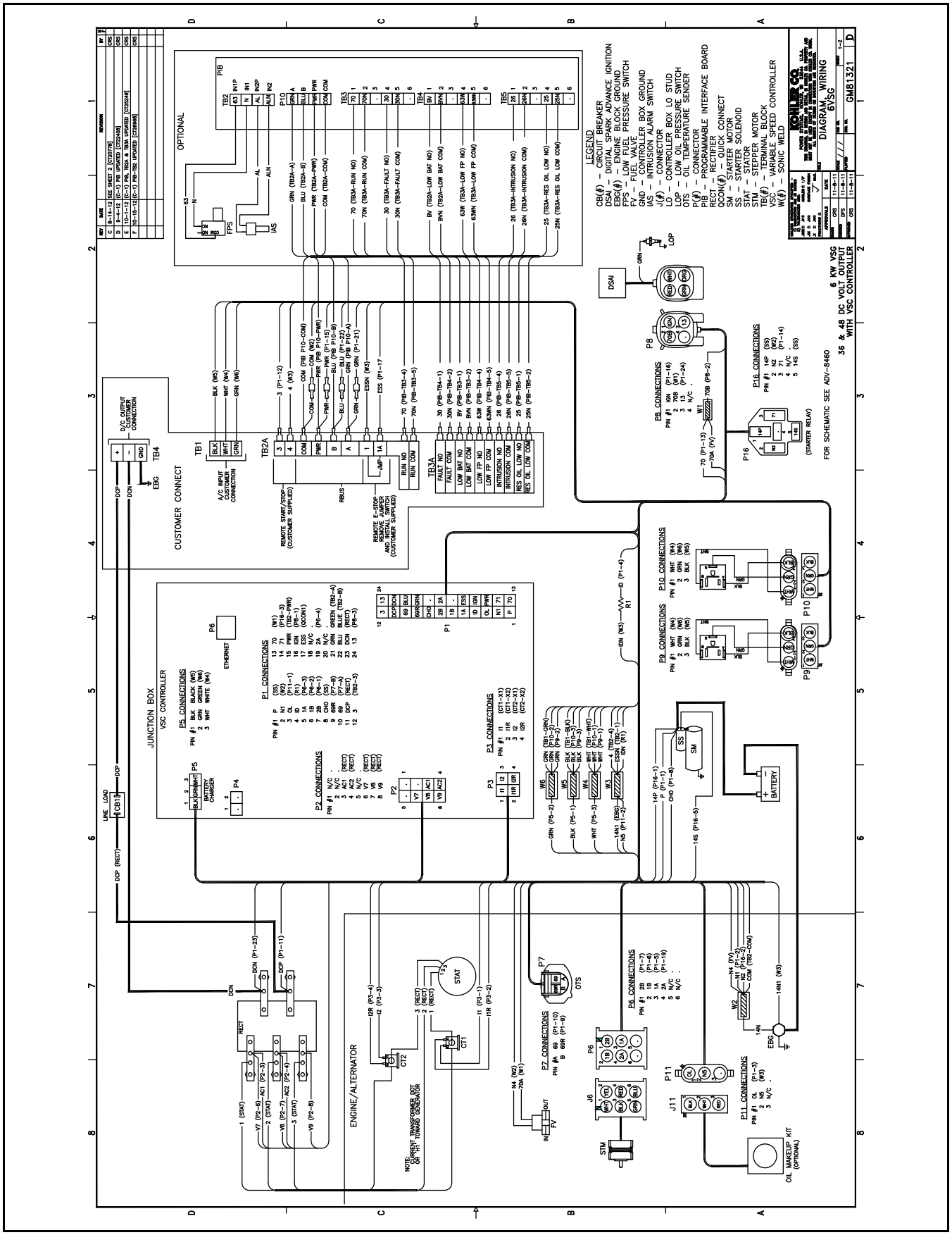


Figure 7-7 Point-to-Point Wiring Diagram, 36V and 48V, GM81321, Sheet 1

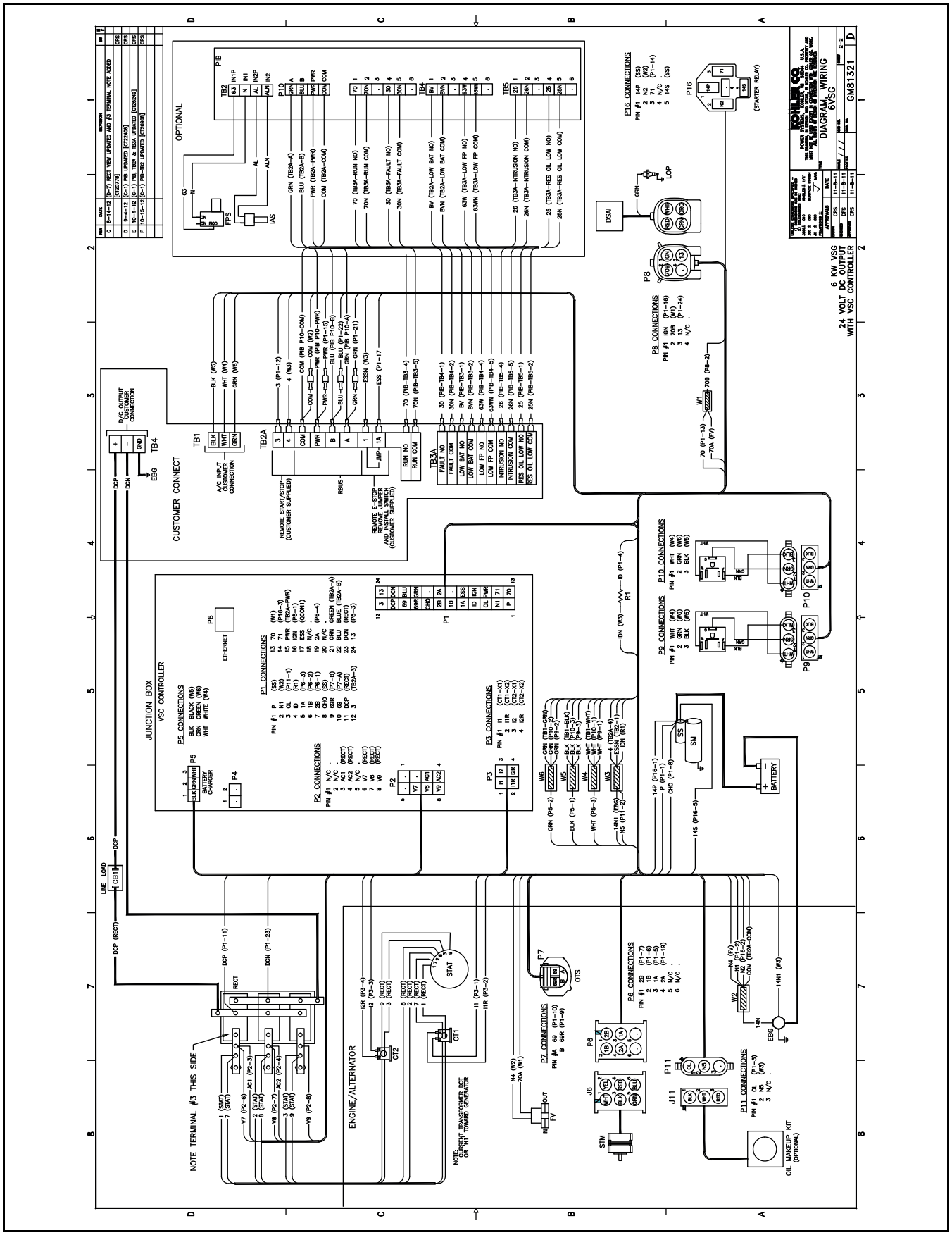


Figure 7-8 Point-to-Point Wiring Diagram, 24V, GM81321, Sheet 2

Appendix A Abbreviations

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

A, amp	ampere
ABDC	after bottom dead center
AC	alternating current
A/D	analog to digital
ADC	advanced digital control; analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
Ah	amp-hour
AHWT	anticipatory high water temperature
AISI	American Iron and Steel Institute
ALOP	anticipatory low oil pressure
alt.	alternator
Al	aluminum
ANSI	American National Standards Institute (formerly American Standards Association, ASA)
AO	anticipatory only
APDC	Air Pollution Control District
API	American Petroleum Institute
approx.	approximate, approximately
APU	Auxiliary Power Unit
AQMD	Air Quality Management District
AR	as required, as requested
AS	as supplied, as stated, as suggested
ASE	American Society of Engineers
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
ATS	automatic transfer switch
auto.	automatic
aux.	auxiliary
avg.	average
AVR	automatic voltage regulator
AWG	American Wire Gauge
AWM	appliance wiring material
bat.	battery
BBDC	before bottom dead center
BC	battery charger, battery charging
BCA	battery charging alternator
BCI	Battery Council International
BDC	before dead center
BHP	brake horsepower
blk.	black (paint color), block (engine)
blk. htr.	block heater
BMEP	brake mean effective pressure
bps	bits per second
br.	brass
BTDC	before top dead center
Btu	British thermal unit
Btu/min.	British thermal units per minute
C	Celsius, centigrade
cal.	calorie
CAN	controller area network
CARB	California Air Resources Board
CAT5	Category 5 (network cable)
CB	circuit breaker
CC	crank cycle
cc	cubic centimeter
CCA	cold cranking amps
ccw.	counterclockwise
CEC	Canadian Electrical Code
cert.	certificate, certification, certified
cfh	cubic feet per hour
cfm	cubic feet per minute
CG	center of gravity
CID	cubic inch displacement
CL	centerline
cm	centimeter
CMOS	complementary metal oxide substrate (semiconductor)
com	communications (port)
coml	commercial
Coml/Rec	Commercial/Recreational
conn.	connection
cont.	continued
CPVC	chlorinated polyvinyl chloride
crit.	critical
CSA	Canadian Standards Association
CT	current transformer
Cu	copper
cUL	Canadian Underwriter's Laboratories
CUL	Canadian Underwriter's Laboratories
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dB(A)	decibel (A weighted)
DC	direct current
DCR	direct current resistance
deg., °	degree
dept.	department
dia.	diameter
DI/EO	dual inlet/end outlet
DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
DIP	dual inline package
DPDT	double-pole, double-throw
DPST	double-pole, single-throw
DS	disconnect switch
DVR	digital voltage regulator
E_2PROM, EEPROM	electrically-erasable programmable read-only memory
E, emer.	emergency (power source)
ECM	electronic control module, engine control module
EDI	electronic data interchange
EFR	emergency frequency relay
e.g.	for example (exempli gratia)
EG	electronic governor
EGSA	Electrical Generating Systems Association
EIA	Electronic Industries Association
EI/EO	end inlet/end outlet
EMI	electromagnetic interference
emiss.	emission
eng.	engine
EPA	Environmental Protection Agency
EPS	emergency power system
ER	emergency relay
ES	engineering special, engineered special
ESD	electrostatic discharge
est.	estimated
E-Stop	emergency stop
etc.	et cetera (and so forth)
exh.	exhaust
ext.	external
F	Fahrenheit, female
FHM	flat head machine (screw)
fl. oz.	fluid ounce
flex.	flexible
freq.	frequency
FS	full scale
ft.	foot, feet
ft. lb.	foot pounds (torque)
ft./min.	feet per minute
ftp	file transfer protocol
g	gram
ga.	gauge (meters, wire size)
gal.	gallon
gen.	generator
genset	generator set
GFI	ground fault interrupter
GND, ⏚	ground
gov.	governor
gph	gallons per hour
gpm	gallons per minute
gr.	grade, gross
GRD	equipment ground
gr. wt.	gross weight
H x W x D	height by width by depth
HC	hex cap
HCHT	high cylinder head temperature
HD	heavy duty
HET	high exhaust temp., high engine temp.
hex	hexagon
Hg	mercury (element)
HH	hex head
HHC	hex head cap
HP	horsepower
hr.	hour
HS	heat shrink
hsg.	housing
HVAC	heating, ventilation, and air conditioning
HWT	high water temperature
Hz	hertz (cycles per second)
IBC	International Building Code
IC	integrated circuit
ID	inside diameter, identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	mproved motor starting
in.	inch
in. H_2O	inches of water
in. Hg	inches of mercury
in. lb.	inch pounds
Inc.	incorporated
ind.	industrial
int.	internal
int./ext.	internal/external
I/O	input/output
IP	internet protocol
ISO	International Organization for Standardization
J	joule
JIS	Japanese Industry Standard
k	kilo (1000)
K	kelvin
kA	kiloampere
KB	kilobyte (2^{10} bytes)
KBus	Kohler communication protocol
kg	kilogram
kg/cm^2	kilograms per square centimeter
kgm	kilogram-meter
kg/m^3	kilograms per cubic meter
kHz	kilohertz

kJ	kilojoule
km	kilometer
kOhm, kΩ	kilo-ohm
kPa	kilopascal
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt ampere
kVAR	kilovolt ampere reactive
kW	kilowatt
kWh	kilowatt-hour
kWm	kilowatt mechanical
kWth	kilowatt-thermal
L	liter
LAN	local area network
L x W x H	length by width by height
lb.	pound, pounds
lbm/ft^3	pounds mass per cubic feet
LCB	line circuit breaker
LCD	liquid crystal display
LED	light emitting diode
Lph	liters per hour
Lpm	liters per minute
LOP	low oil pressure
LP	liquefied petroleum
LPG	liquefied petroleum gas
LS	left side
L_{wa}	sound power level, A weighted
LWL	low water level
LWT	low water temperature
m	meter, milli (1/1000)
M	mega (10^6 when used with SI units), male
m^3	cubic meter
m^3/hr.	cubic meters per hour
m^3/min.	cubic meters per minute
mA	milliampere
man.	manual
max.	maximum
MB	megabyte (2^{20} bytes)
MCCB	molded-case circuit breaker
MCM	one thousand circular mils
meggar	megohmmeter
MHz	megahertz
mi.	mile
mil	one one-thousandth of an inch
min.	minimum, minute
misc.	miscellaneous
MJ	megajoule
mJ	millijoule
mm	millimeter
mOhm, mΩ	milliohm
MOhm, MΩ	megohm
MOV	metal oxide varistor
MPa	megapascal
mpg	miles per gallon
mph	miles per hour
MS	military standard
ms	millisecond
m/sec.	meters per second
mtg.	mounting
MTU	Motoren-und Turbinen-Union
MW	megawatt
mW	milliwatt
μF	microfarad
N, norm.	normal (power source)
NA	not available, not applicable
nat. gas	natural gas
NBS	National Bureau of Standards
NC	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	newton meter
NO	normally open
no., nos.	number, numbers
NPS	National Pipe, Straight
NPSC	National Pipe, Straight-coupling
NPT	National Standard taper pipe thread per general use
NPTF	National Pipe, Taper-Fine
NR	not required, normal relay
ns	nanosecond
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OF	overfrequency
opt.	option, optional
OS	oversize, overspeed
OSHA	Occupational Safety and Health Administration
OV	overvoltage
oz.	ounce
p., pp.	page, pages
PC	personal computer
PCB	printed circuit board
pF pic	picofarad
PF	power factor
ph., Ø	phase
PHC	Phillips® head Crimptite® (screw)
PHH	Phillips® hex head (screw)
PHM	pan head machine (screw)
PLC	programmable logic control
PMG	permanent magnet generator
pot	potentiometer, potential
ppm	parts per million
PROM	programmable read-only memory
psi	pounds per square inch
psig	pounds per square inch gauge
pt.	pint
PTC	positive temperature coefficient
PTO	power takeoff
PVC	polyvinyl chloride
qt.	quart, quarts
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
RBUS	RS-485 proprietary communications
RDO	relay driver output
ref.	reference
rem.	remote
Res/Coml	Residential/Commercial
RFI	radio frequency interference
RH	round head
RHM	round head machine (screw)
rly.	relay
rms	root mean square
rnd.	round
RO	read only
ROM	read only memory
rot.	rotate, rotating
rpm	revolutions per minute
RS	right side
RTDs	Resistance Temperature Detectors
RTU	remote terminal unit
RTV	room temperature vulcanization
RW	read/write
SAE	Society of Automotive Engineers
scfm	standard cubic feet per minute
SCR	silicon controlled rectifier
s, sec.	second
SI	*Systeme international d'unites,* International System of Units
SI/EO	side in/end out
sil.	silencer
SMTP	simple mail transfer protocol
SN	serial number
SNMP	simple network management protocol
SPDT	single-pole, double-throw
SPST	single-pole, single-throw
spec	specification
specs	specification(s)
sq.	square
sq. cm	square centimeter
sq. in.	square inch
SMS	short message service
SS	stainless steel
std.	standard
stl.	steel
tach.	tachometer
TB	terminal block
TCP	transmission control protocol
TD	time delay
TDC	top dead center
TDEC	time delay engine cooldown
TDEN	time delay emergency to normal
TDES	time delay engine start
TDNE	time delay normal to emergency
TDOE	time delay off to emergency
TDON	time delay off to normal
temp.	temperature
term.	terminal
THD	total harmonic distortion
TIF	telephone influence factor
tol.	tolerance
turbo.	turbocharger
typ.	typical (same in multiple locations)
UF	underfrequency
UHF	ultrahigh frequency
UIF	user interface
UL	Underwriter's Laboratories, Inc.
UNC	unified coarse thread (was NC)
UNF	unified fine thread (was NF)
univ.	universal
URL	uniform resource locator (web address)
US	undersize, underspeed
UV	ultraviolet, undervoltage
V	volt
VAC	volts alternating current
VAR	voltampere reactive
VDC	volts direct current
VFD	vacuum fluorescent display
VGA	video graphics adapter
VHF	very high frequency
W	watt
WCR	withstand and closing rating
w/	with
WO	write only
w/o	without
wt.	weight
xfmr	transformer

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

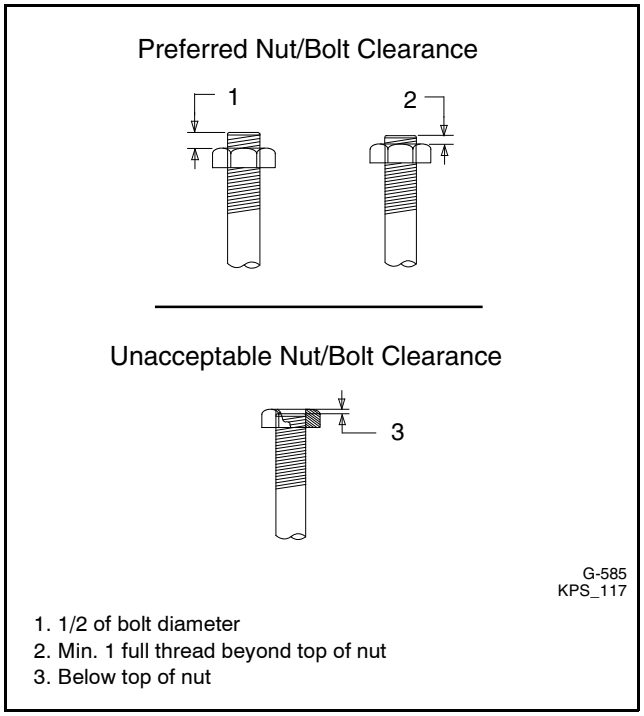


Figure 1 Acceptable Bolt Lengths

Steps for common hardware application:

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

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

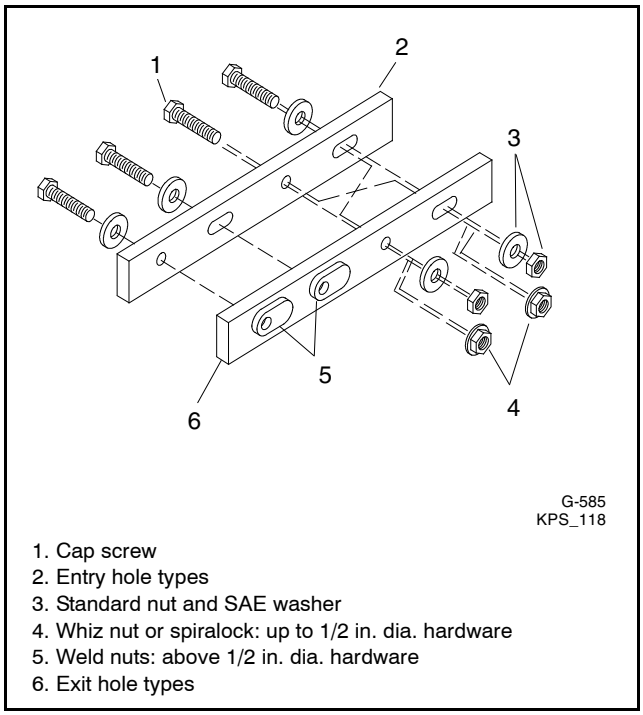


Figure 2 Acceptable Hardware Combinations

Appendix C General Torque Specifications

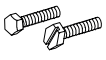
American Standard Fasteners Torque Specifications								
Size	Torque Measurement	Assembled into Cast Iron or Steel						Assembled into Aluminum Grade 2 or 5
		Grade 2		Grade 5		Grade 8		
8-32	Nm (in. lb.)	1.8	(16)	2.3	(20)	—		See Note 3
10-24	Nm (in. lb.)	2.9	(26)	3.6	(32)	—		
10-32	Nm (in. lb.)	2.9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

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

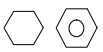
Notes:

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

Appendix D Common Hardware Identification

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

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

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

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

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

Sample Dimensions

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

1/4-20 x 1

- 1 — Length In Inches (Screws and Bolts)
- 20 — Threads Per Inch
- 1/4 — Major Thread Diameter In Fractional Inches Or Screw Number Size

Metric (Screws, Bolts, Studs, and Nuts)

M8-1.25 x 20

- 20 — Length In Millimeters (Screws and Bolts)
- 1.25 — Distance Between Threads In Millimeters
- M8 — Major Thread Diameter In Millimeters

Plain Washers

9/32 x 5/8 x 1/16

- 1/16 — Thickness
- 5/8 — External Dimension
- 9/32 — Internal Dimension

Lock Washers

5/8

- 5/8 — Internal Dimension

Appendix E Common Hardware List

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

American Standard

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

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

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

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

Metric

Hex head bolts are hardness grade 8.8 unless noted.

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

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

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

Hex Head Bolts (Full Thread)	
M933-04006-60	M4-0.70 x 6
M933-05030-60	M5-0.80 x 30
M933-05035-60	M5-0.80 x 35
M933-05050-60	M5-0.80 x 50
M933-06010-60	M6-1.00 x 10
M933-06012-60	M6-1.00 x 12
M933-06014-60	M6-1.00 x 14
M933-06016-60	M6-1.00 x 16
M933-06020-60	M6-1.00 x 20
M933-06025-60	M6-1.00 x 25
M933-06030-60	M6-1.00 x 30
M933-06040-60	M6-1.00 x 40
M933-06050-60	M6-1.00 x 50
M933-07025-60	M7-1.00 x 25
M933-08010-60	M8-1.25 x 10
M933-08012-60	M8-1.25 x 12
M933-08016-60	M8-1.25 x 16
M933-08020-60	M8-1.25 x 20
M933-08025-60	M8-1.25 x 25
M933-08030-60	M8-1.25 x 30
M933-08030-82	M8-1.25 x 30*
M933-10012-60	M10-1.50 x 12
M961-10020-60	M10-1.25 x 20
M933-10020-60	M10-1.50 x 20
M933-10025-60	M10-1.50 x 25
M961-10025-60	M10-1.25 x 25
M933-10025-82	M10-1.50 x 25*
M961-10030-60	M10-1.25 x 30
M933-10030-60	M10-1.50 x 30
M933-10030-82	M10-1.50 x 30*
M961-10035-60	M10-1.25 x 35
M933-10035-60	M10-1.50 x 35
M933-10035-82	M10-1.50 x 35*
M961-10040-60	M10-1.25 x 40

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

Pan Head Machine Screws	
M7985A-03010-20	M3-0.50 x 10
M7985A-03012-20	M3-0.50 x 12
M7985A-04010-20	M4-0.70 x 10
M7985A-04016-20	M4-0.70 x 16
M7985A-04020-20	M4-0.70 x 20
M7985A-04050-20	M4-0.70 x 50
M7985A-04100-20	M4-0.70 x 100
M7985A-05010-20	M5-0.80 x 10
M7985A-05012-20	M5-0.80 x 12
M7985A-05016-20	M5-0.80 x 16
M7985A-05020-20	M5-0.80 x 20
M7985A-05025-20	M5-0.80 x 25
M7985A-05030-20	M5-0.80 x 30
M7985A-05080-20	M5-0.80 x 80
M7985A-05100-20	M5-0.80 x 100
M7985A-06100-20	M6-1.00 x 100

Flat Head Machine Screws	
M965A-04012-SS	M4-0.70 x 12
M965A-05012-SS	M5-0.80 x 12
M965A-05016-20	M5-0.80 x 16
M965A-06012-20	M6-1.00 x 12

Metric, cont.

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

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

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

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