Installation

DC Generator Sets

Models:

6VSG

24VDC 36VDC 48VDC

Controller:

VSC

▲ WARNING: This product can expose you to chemicals, including carbon monoxide and benzene, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65warnings.ca.gov

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 Identificati	Senerator Set Identification Numbers				
Record the product identific					
Model Designation					
Specification Number					
Serial Number					
Controller Identification					
Record the controller descr	iption from the generator set opera	tion manual, spec sheet, or sa	les invoice.		
Controller Description	Controller Description				
Engine Identification	Engine Identification Record the product identification information from the engine nameplate. Manufacturer Model Designation				
Record the product identified					
Manufacturer					
Model Designation					
Serial Number			_		
	1				
Accessory Number	Accessory Description	Accessory Number	Accessory Description		

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Safety Precautions and Instructions

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 a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

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 on/off button to shut down the generator set. All indicator lamps dim. (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.

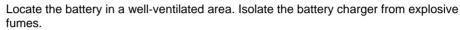


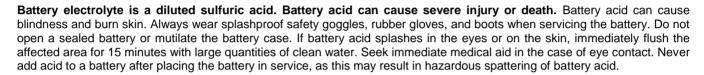


Explosion.

Can cause severe injury or death.

Relays in the battery charger cause arcs or sparks.





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.

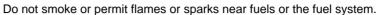
Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the 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

M WARNING

Risk of fire.

Can cause severe injury or death.



Servicing the fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the fuel mixer, fuel line, fuel filter, or other potential sources of fuel vapors. When removing the fuel line or fuel system be aware that liquid propane can cause frostbite on contact.

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

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 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.

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.

Fuel System







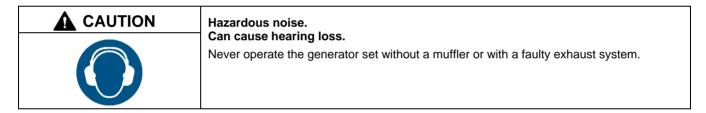
Explosive fuel vapors.
Can cause severe injury or death.

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 LPG vapor 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



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



Grounding electrical equipment. Hazardous voltage will 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 the generator set.

Can cause severe electrical equipment damage.

Welding on generator set will cause serious damage to engine electronic controls components. Disconnect all engine electronic control connections before welding.

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.

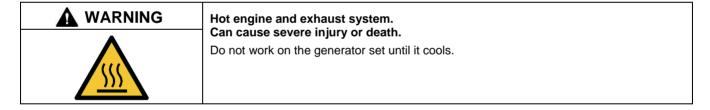
Connecting the battery and the battery charger. Hazardous voltage will cause severe injury or death. Reconnect the battery correctly, positive to positive and negative to negative, to avoid electrical shock and damage to the battery charger and battery(ies). Have a qualified electrician install the battery(ies).

Short circuits. Hazardous voltage/current will 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.

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



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.

This manual provides installation instructions for the DC (direct current) variable speed Model 6VSG generator set. Refer to TP-6843, Operation Manual, for generator set operation and maintenance instructions.

This generator set is approved for use in stationary applications in locations served by a public utility, photovoltaic cells, wind turbines, or any combination of power sources tied to a battery bank.

Have an authorized distributor/dealer install the generator set outdoors according to the instructions in this manual. The generator set installation must comply with the National Electrical Code (NEC) and local code requirements. Do not install this generator set indoors.

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.

List of Related Literature

Figure 1 identifies related literature available for the generator sets covered in this manual. Only trained and qualified personnel should install or service the generator set.

Literature Type	Literature Part No.
Operation Manual, 6VSG Generator Set	TP-6843
Service Manual, 6VSG Generator Set	TP-6844
Operation Manual, SiteTech™ Software	TP-6701
User Guide, OnCue® Plus	TP-7006
Technical Manual, OnCue® Plus	TP-7007
Installation Instructions, Programmable Interface Module (PIM)	TT-1584

Figure 1 Related Literature

Startup and Registration

When the generator set is installed, complete the startup and installation checklists supplied with the startup notification form. Complete and sign the startup notification form and register the unit using the Kohler online Warranty Processing System.

Service Assistance

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

- Visit the Kohler Co. website at KOHLERPower.com.
- Look at the labels and decals 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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East China Regional Office, Shanghai

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(91) 80 3366231

Fax: (91) 80 3315972

Japan, Korea

North Asia Regional Office

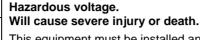
Tokyo, Japan

Phone: (813) 3440-4515 Fax: (813) 3440-2727

1.1 Introduction



DANGER



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

Have the generator set installed by an authorized Kohler distributor/dealer or authorized representative. Install the equipment in compliance with the National Electrical Code (NEC) and local codes. For Canadian installations, refer to the Canadian Electrical Code (CEC).

The generator set must be installed outdoors. The exhaust systems on enclosed units are designed for outdoor installation only.

Note:

DO NOT install these generator sets inside a building.

Note:

Install carbon monoxide (CO) detector(s) on each level of any building adjacent to a generator set. Locate the detectors to adequately warn the building's occupants of the presence of carbon monoxide.

Obtain a building permit and contact your local utility companies to mark the locations of underground pipes and cables.

Read and follow the safety precautions in this manual and observe the decals on the equipment. Refer to the diagrams and drawings in this manual for dimensions and electrical connections during the installation procedure. Read the entire installation procedure and obtain the accessories and tools needed before beginning installation. Perform the steps in the order shown.

To install optional accessories, follow the instructions provided with each kit.



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.

1.2 Lifting



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.

Model	Weight, kg (lb.)
6VSG	190 (420)

Figure 2 Approximate Weights

Approximate generator set weights are shown in Figure 2. Use lifting bars inserted through the holes in the skid to lift the unit. See the dimension drawings in the Installation Drawings section for lifting hole locations.

1.3 Generator Set Inspection

Complete a thorough inspection of the generator set. Check for the following:

- 1. Inspect the generator set for loose or damaged parts or wires. Repair or tighten any loose parts before installation.
- 2. Check the engine oil. Fill, if necessary, with the recommended viscosity and grade of oil. Use synthetic oil, API (American Petroleum Institute) Service Class SG or higher. See TP-6843, Operation Manual, for additional information.

1.4 Location and Mounting

Install the generator set outdoors. Choose a location that is away from any building or structure and near the incoming gas service. Allow clearance beyond the exhaust end of the generator set. Locate the generator set so that the hot exhaust does not blow on plants or other combustible materials. Do not install the generator set where exhaust gas could accumulate and seep inside or be drawn into a potentially occupied building.

Refer to your local codes and ordinances. See the figure titled: Dimension Drawing ADV-8060, Sheet 3 for the minimum clearance from structures and non-combustible materials.

Notice

DO NOT locate the generator set near patios, decks, play areas, or animal shelters. Keep items such as lawn furniture, toys, sports equipment, and all combustible materials away from the generator set exhaust outlet.

Remind family members, children, and visitors to use caution near the generator set. Generator sets will start automatically during exercise periods and power outages. Some generator set components become hot when the generator set is running and remain hot for a time after the generator set shuts down.

1.4.1 Mounting Area

Install the generator set on a single, level concrete mounting pad. This method provides maximum stability and ensures correct cooling air flow through the generator set. The recommended mounting pad dimensions are shown in the dimension drawings in the Installation Drawings section.

1.4.2 Vibration Isolation

The generator set is equipped with neoprene vibration isolators. Connections between the generator set or its mounting base and any conduits or fuel lines must include flexible sections to prevent breakage and to isolate vibration.

1.4.3 Exhaust Requirements

Figure 3 gives the exhaust temperature at rated load. The engine exhaust mixes with the generator set cooling air at the exhaust end of the enclosure. Mount the generator set so that the hot exhaust does not blow on plants or other combustible materials. Maintain the clearances shown in the figure titled: Dimension Drawing ADV-8060, Sheet 3.

Exhaust	Temperature, °C (°F)
Exhaust gas exiting the enclosure at rated kW, °C (°F)	110 (230)

Figure 3 Exhaust Flow and Temperature

The generator set requires correct air flow for cooling and combustion. The inlet and outlet openings in the sound enclosure provide the cooling and combustion air. Inspect the air inlet and outlet openings inside and outside the housing to ensure that the air flow is not blocked.

1.5 Dimension Drawings

See the dimension drawings in the Installation Drawings section for the generator set dimensions, fuel and electric inlet locations, and recommended clearance.

1.6 Fuel Requirements

The generator set operates using natural gas or LPG fuel. The generator set is EPA-certified for both natural gas and LPG fuels.

The fuel system installation must comply with the NEC and local codes.

1.6.1 Fuel Supply

Because of variable climates and geographical considerations, contact the local fuel supplier for fuel system planning and installation. Figure 4 lists the recommended fuel ratings and other fuel supply information for natural gas and LPG fuels.

Fuel type	Natural Gas	LPG
Fuel supply inlet ½ NP		PT
Fuel supply pressure, kPa (in. H ₂ O)	1.3-2.7 (5-11)	1.7-2.7 (7-11)
Fuel flow rate, maximum, Btu/hr.	115,000	106,000
Nominal Fuel Rating, Btu/ft. ³		
Natural gas 1000		00
LPG	250	00

Figure 4 Fuel Supply

Verify that the output pressure from the primary gas utility pressure regulator is as shown in Figure 4 and that the utility gas meter flow rate is sufficient to supply the generator set at rated load plus all other gas-consuming appliances. For LPG tanks, verify that the output pressure is as shown in Figure 4. See the figure titled: Fuel Consumption for fuel consumption. Contact the fuel supplier for flow rate information or a gas meter upgrade.

The dimension drawings in the Installation Drawings shows the location of the fuel inlet connection. Use flexible sections to prevent fuel line breakage caused by vibration. Protect all fuel lines from machinery or equipment contact, adverse weather conditions, and environmental damage.

1.6.2 Fuel Pipe Size

Ensure that the fuel pipe size and length meet the specifications in Figure 5. Measure the pipe length from the primary gas pressure regulator to the pipe connection on the generator set fuel inlet. Add 2.4 m (8 ft.) to the measured length for each 90 degree elbow. Compare the total pipe length with the chart in Figure 5 to find the required pipe size.

Contact local LPG or natural gas provider for LPG or natural gas installation information.

Minimum Gas Pipe Size Recommendation, in. NPT		
Pipe Length, m (ft.)	Natural Gas (115,000 Btu/hr.)	LPG (106,000 Btu/hr.)
8 (25)	3/4	1/2
15 (50)	1	3/4
30 (100)	1	3/4
46 (150)	1	3/4
61 (200)	1	1

Figure 5 Fuel Pipe Size Recommandations

Model	Fuel Type	% Load	Fuel Consumption, m ³ /hr. (cfh)
		100	3.3 (116)
	Natural Gas	75	2.7 (96)
	Natural Gas	50	2.1 (75)
6VSG		25	1.8 (62)
6726	LPG	100	1.2 (42)
		75	1.0 (35)
		50	0.9 (32)
		25	0.7 (27)
Nominal fuel rating:	Natural gas:	37 MJ/m ³ (1000 Btu/ft. ³)	
	LPG		
LPG conversion factors:		$8.58 \text{ ft.}^3 = 1 \text{ lb.}$	
		$0.535 \text{ m}^3 = 1 \text{ kg}$	
		$36.39 \text{ ft.}^3 = 1 \text{ gal.}$	

Figure 6 Fuel Consumption

1.7 Fuel Conversion



WARNING

Accidental starting. Can cause severe injury or death.



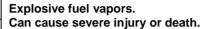




Disconnect the battery cables before working on the generator set. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery.

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) Turn the generator set master switch and switchgear engine control switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (–) lead first. Reconnect the negative (–) lead last when reconnecting the battery. Follow these precautions to prevent the starting of the generator set by an automatic transfer switch or a remote start/stop switch.









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 LPG vapor 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.

The multi-fuel system allows conversion from natural gas to LPG (or vice-versa) in the field while maintaining emissions-standard compliance. A trained technician or an authorized distributor/dealer can convert the fuel system.

Model 6VSG generator sets built in 2021 or later use the fuel system shown in this section. The fuel system uses a knob that controls a valve on the regulator to select the fuel type. See Figure 7.

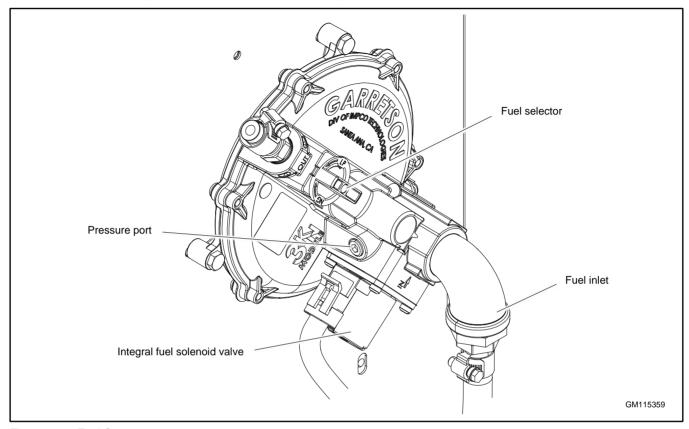
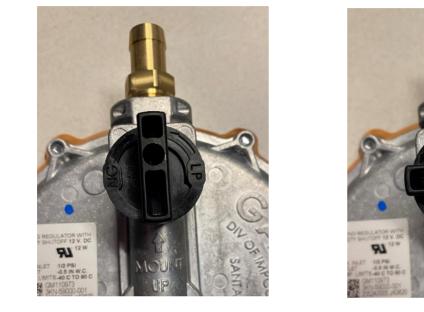


Figure 7 Fuel System

Fuel Selection, Fuel System

- 1. Press the OFF button on the generator set controller.
- 2. Disconnect the power to the battery charger.
- 3. Disconnect the generator set engine starting battery, negative (-) lead first.
- 4. Turn off the fuel supply.
- 5. To change the fuel selection:
 - a. For natural gas (NG), turn the selection knob all the way clockwise. The knob lines up with the UP arrow on the regulator body as shown in Figure 8.
 - b. For LPG, turn the selection knob counterclockwise as far as it will go, approximately ¼ turn. See Figure 8.



MIS MEDULATOR WITH STY SHUTOP 15 V. DO

PART 16 PM

CARLET 16 PM

CARLET

Img_0899 Img_0900

NG Knob Position

LPG Knob Position

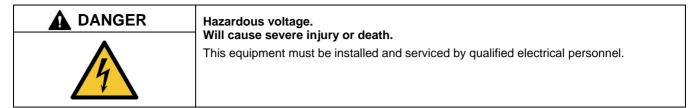
Figure 8 Knob Positions

- 6. Connect and turn on the fuel supply (Ensure that the fuel supply matches the fuel setting).
- 7. Reconnect the generator set engine starting battery leads, negative (-) lead last.
- 8. Reconnect power to the battery charger.
- 9. Change the fuel type setting on the RDC2 controller in the Genset System menu. See the Operation Manual for instructions to change settings on the controller.
- 10. Start the generator set by pressing the RUN button on the generator set controller.
- 11. Check for leaks using a gas leak detector.
- 12. Run the generator set and check the operation.
- 13. Press the OFF button to shut down the generator set.

A pressure port is provided on the fuel regulator. See Figure 7. Follow these steps to check the fuel pressure at the regulator, if necessary.

- 1. Remove the plug from the fuel pressure port.
- 2. Connect a manometer capable of measuring low pressure (3- 11 inches water column) to the pressure port.
- 3. When finished, replace the plug in the pressure port and check for leaks.

1.8 Electrical Connections



Grounding electrical equipment. Hazardous voltage will 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.

Have an authorized distributor/dealer or a licensed electrician make the following electrical connections. The electrical installation must comply with the National Electrical Code[®] (NEC) class 1 wire designation and all applicable local codes. Canadian installations must comply with the Canadian Electrical Code (CEC) and applicable local codes.

1.8.1 Grounding

The 6VSG has an isolated output, which should be referenced to ground. This can be accomplished by connecting either the positive or the negative DC output lead to ground. A floating voltage is not recommended in this application.

1.8.2 Electrical Lead Entry

Drill or punch holes in the enclosure for the electrical conduit in the locations shown in Figure 9.

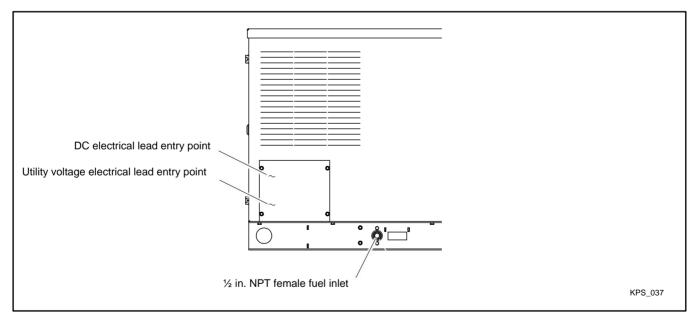


Figure 9 Electrical Lead Entry

1.8.3 Field-Connection Terminal Block

The generator set is equipped with a field-connection terminal block. Leads have been factory-installed from the junction box to the terminal block for easy field wiring.

See the dimension drawings in the Installation Drawings section for the customer field connection terminal block location. See Figure 10 for terminal block details. Refer to the terminal block decal for connections and wire sizes. Size the wire according to the length of run and 115% of the circuit current (amperage) based on 75°C wire rating or less as directed by the National Electrical Code (NEC) in ANSI/NFPA 70. Also see the section titled: Wiring Diagrams.

Route AC and DC leads through flexible conduit. Ensure that the leads and conduit do not interfere with the operation of the generator set or obstruct the service areas. Route AC and DC leads through separate conduit.

Procedure

- 1. Drill holes for the conduit fittings. See the figure titled: Electrical Lead Entry for the recommended electrical inlet locations. Feed the cables through the openings.
- 2. Connect the leads from the battery bank to the "+" and "-" connections on the generator set terminal block.
- 3. Connect the ground (GRD) lead to the corresponding connection points on the terminal block. See the section titled: Grounding.
- 4. Connect utility power leads to the terminal block connections labelled Utility. Connect to a circuit that is supplied by the utility source and backed up by the generator. The power source must be GFCI protected. See the section titled: Power Supply for more information about the utility power requirement.
- 5. For connection of the programmable interface module (PIM), see the section titled: PIM Input and Output Connections.
- 6. If the OnCue® Plus Generator Management System will be used with the generator set, run category 5E network cable from the generator set to the customer's router or modem. *

Note:

Installation of the network cable at the time of generator set installation is highly recommended. Installing the Ethernet cable now will make connection much easier if you choose to add OnCue® Plus later.

- a. Route the network cable with other low-voltage signal wiring (for example, the RBUS communication leads or engine start leads), in separate conduit from the AC load leads. If the network cable is longer than 100 m (328 ft.), use a repeater or switch.
- b. Use an RJ-45 inline coupler to connect the Ethernet cable to the cable in the customer connection box. See the figure titled: Network Connection for OnCue® Plus. The inline coupler is included with the OnCue® Plus kit.

^{*} If the OnCue® Plus Wireless Kit is being used, refer to the instructions provided with the wireless kit.

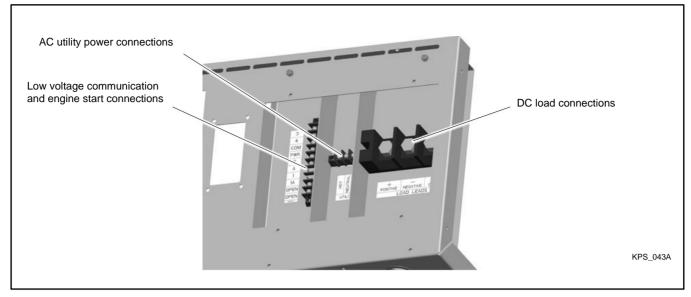


Figure 10 Electrical Connections

1.8.4 Power Supply

Provide AC power for the battery charger (integral to the VSC controller) and optional carburetor heater. The power requirements are shown in Figure 11. The power source must be GFCI protected.

Be sure to disconnect power at the distribution panel before making the connections. Connect power leads to the utility power connection points on the terminal block shown in the figure titled: Electrical Connections. See the section titled: Field-Connection Terminal Block and the wiring diagrams in the Installation Drawings section for connection details.

Equipment	Power Requirement, Max.		
Equipment	Watts	Amps	Volts
Battery charger (standard, integral to VSC controller)	120	1	100-250 VAC 50/60 Hz
Carburetor heater (optional)	37	0.33	120 VAC 50/60 Hz

Figure 11 Power Requirements

1.8.5 Programmable Interface Module (PIM) Connection

One programmable interface module can be connected to the generator set. Route low-voltage communication leads through separate conduit. All connections must comply with applicable state and local codes.

See Figure 13. Use Belden #9402 or equivalent 20 AWG shielded, twisted-pair cable to connect P10-1 through P10-4 on the programmable interface module (PIM) to the generator set terminal block TB1 connections A, B, PWR, and COM. Note the shield connections shown in Figure 13. The maximum cable length using Belden #9402 cable is 61 m (200 ft.).

For outdoor installations, including those with buried cables and/or conduit, use outdoor-rated Belden #1075A or equivalent 20 AWG shielded, twisted-pair communication cable.

For longer cable runs, use Belden #8762 or equivalent 20 AWG shielded, twisted-pair cable with 2 conductors for the A and B connections, and use 12-14 AWG wire for the COM and PWR connections. See Figure 12 for the maximum cable lengths.

Cable PWR and COM Connections	Maximum length meters (ft.)
Belden #9402 or equivalent 20AWG	46 (150)
14 AWG	137 (450)
12 AWG	137 (450)

Figure 12 Maximum Cable Lengths

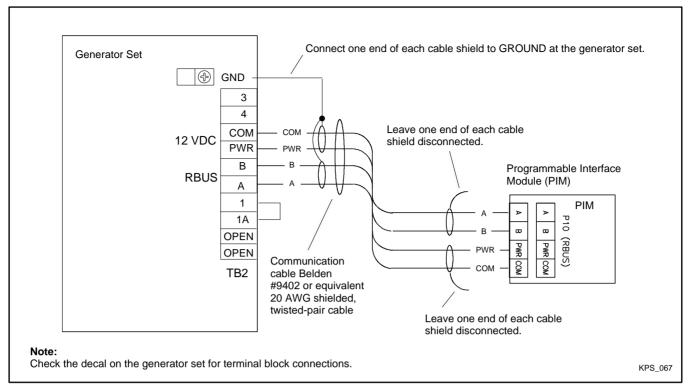


Figure 13 Programmable Interface Module (PIM) Communication Connection to Generator Set Terminal Block

1.8.6 PIM Input and Output Connections

The optional programmable interface module (PIM) provides two programmable inputs and six dry contact outputs, four of which are programmable. See TT-1584 for PIM installation and connection instructions.

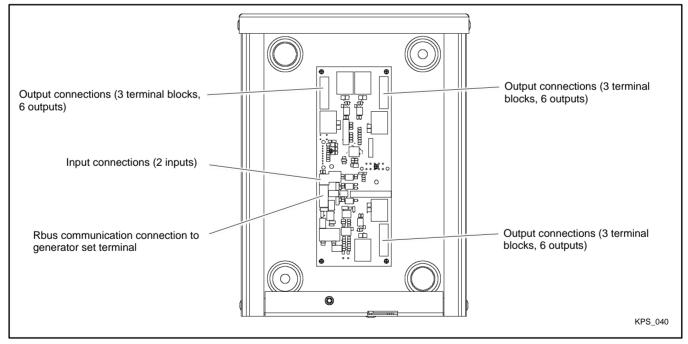


Figure 14 Optional PIM

The default settings for the inputs and outputs are shown in Figure 15. To change the input and output settings, use a personal computer running Kohler[®] SiteTech[™] software. See TP-6701, SiteTech Software Operation Manual, for instructions.

A personal computer running Kohler OnCue® Plus software can be used to actively control PIM outputs. See the OnCue® Plus Software Operation Manual for instructions.

Connection	PIM Settings
Input 1	None
Input 2	None
Output 1 (Relay 1)	Run
Output 2 (Relay 2)	Common Fault
Output 3 (Relay 3)	Low Battery Voltage (Programmable)
Output 4 (Relay 4)	Not in Auto (Programmable)
Output 5 (Relay 5)	Cooldown (Programmable)
Output 6 (Relay 6)	Normal Source Failure (Programmable)

Figure 15 PIM Factory Default Inputs and Outputs

1.8.7 Communications Kit Output Connections

The communications kit includes an interface board, which is factory-installed inside the generator set enclosure. The inputs and outputs are factory-set to the settings shown in Figure 16.

The outputs are factory-wired from the circuit board to terminal blocks in the customer connection area. Do not attempt to connect directly to the interface board. The output contacts are normally open (NO); outputs close on activation. Connect customer equipment to the outputs at the terminal blocks as shown in Figure 16.

Connection	Communications Kit
Input 1	Fuel Pressure
Input 2	Enclosure Intrusion Alarm
Output 1 (Relay 1)	Run
Output 2 (Relay 2)	Common Fault
Output 3 (Relay 3)	Battery Voltage
Output 4 (Relay 4)	Fuel Pressure Low Warning
Output 5 (Relay 5)	Enclosure Intrusion Alarm Warning
Output 6 (Relay 6)	Reserve Oil Empty (oil makeup kit required)

Figure 16 Communications Kit Factory Default Inputs and Outputs

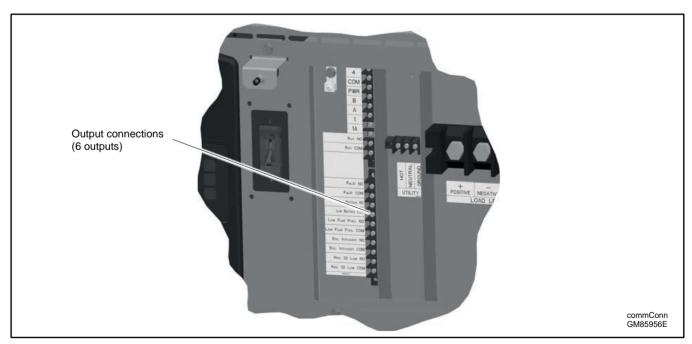


Figure 17 Communications Kit Output Connections

1.8.8 Optional Remote Engine Start Connection

A remote start switch can be connected to the generator set. Connect the engine start leads from a remote start switch to terminals 3 and 4 on the terminal block. See Figure 18. Route the engine start leads through separate conduit from the AC accessory power leads.

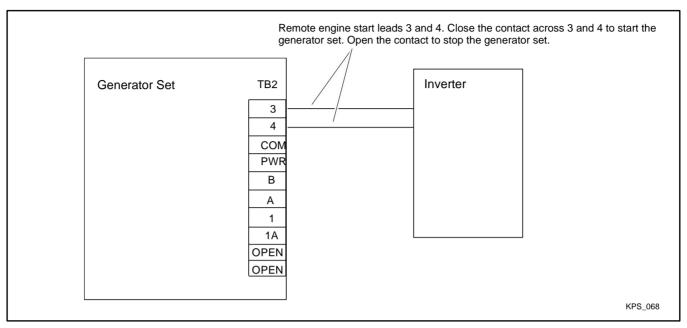


Figure 18 Optional Remote Engine Start Connections

1.9 Engine Starting Battery



WARNING

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

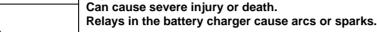


Wear protective goggles and clothing. Battery acid may cause blindness and burn skin.



WARNING

Explosion.



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.

Connecting the battery and the battery charger. Hazardous voltage will 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).

Use a 12-volt group 51 battery with a minimum rating of 500 cold cranking amps at 0°F. The generator set uses a negative ground with a 12-volt engine electrical system. See Figure 19 for battery connections. Make sure that the battery is correctly connected and the terminals are tight.

Note:

The generator set will not start and circuit board damage may occur if the battery is connected in reverse.

See the dimension drawings in the Installation Drawings section for the engine starting battery location behind the service door on the generator set. Standard battery cables provide easy connection to the battery.

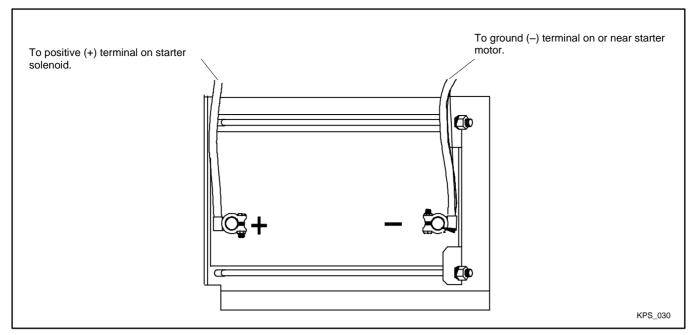


Figure 19 Typical Battery Connection

1.9.1 Engine Starting Battery Installation Procedure

Use the following procedure to install and connect the generator set engine starting battery.

- 1. Ensure that the starting battery is fully charged before placing the battery in service.
- 2. Clean the battery posts and/or adapters if necessary.
- 3. Install the battery post adapters, if needed.
- 4. Place the battery inside the housing.
- 5. Connect the positive (+) lead to the engine starting battery.
- 6. Connect the negative (–) lead to the engine starting battery.

Refer to the generator set operation manual and the battery manufacturer's instructions for battery maintenance instructions.

When power is applied to the VSC controller (that is, when the battery is connected), you will be prompted to set the date and time, and then to set the exerciser. See the generator set operation manual for instructions.

If the battery is disconnected for service or replacement, the exercise settings on the VSC controller are lost. Set the exerciser after installing and connecting the battery.

1.10 Generator Set Accessories

Have accessories installed by an authorized distributor/dealer or a licensed electrician. Follow the installation instructions provided with each kit. Use separate conduit for AC and DC leads to reduce the possibility of electrical interference. Verify that the leads and conduit do not interfere with the operation of the generator set or obstruct the service areas. Verify that the electrical installation complies with the National Electrical Code (NEC) and all applicable local codes. See the wiring diagrams in the Installation Drawings Section, for more information regarding generator set electrical connections.

1.10.1 Carburetor Heater

An optional carburetor heater is recommended for improved cold starting in locations where the ambient temperature drops below 0°C (32°F). The carburetor heater prevents condensation and carburetor icing. The heater turns on when the temperature at the thermostat falls below approximately 4°C (40°F) and turns off when the temperature rises above approximately 16°C (60°F). The carburetor heaters are shown in Figure 20.

To install the carburetor heater, follow the instructions provided with the kit. Figure 21 shows the installed carburetor heater kit installed for a 6 kW generator set.

The heater requires a continuous source of power. Plug the carburetor heater into the 120 VAC receptacle provided.

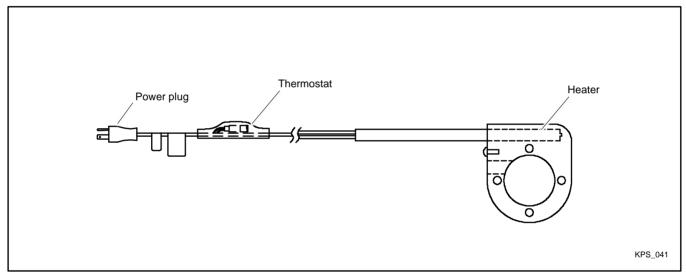


Figure 20 6VSG Carburetor Heater

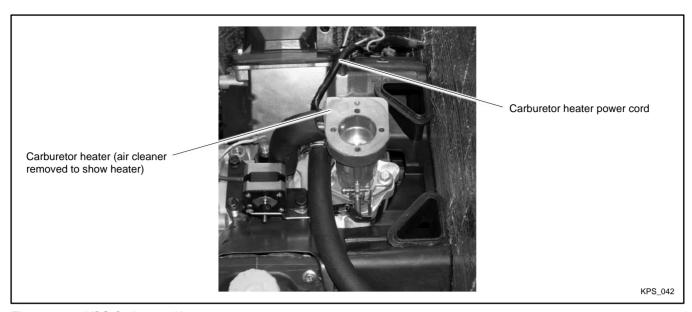


Figure 21 6VSG Carburetor Heater

1.10.2 OnCue® Plus Generator Management System

The OnCue® Plus Generator Management System allows monitoring and control of your generator set from a personal computer located in your home or at other remote locations. OnCue® Plus can also be configured to send email or text message notifications in the event of a generator set fault. See the OnCue® Plus Software Operation Manual, for software instructions.

The OnCue® Plus system is available separately as a loose kit. Use category 5E network cable to connect the VSC controller to the customer-supplied Ethernet router and cable or DSL modem. Route the cable with other low-voltage signal wiring (for example, the RBUS communication leads or engine start leads), in separate conduit from the AC accessory power. If the network cable is longer than 100 meters (328 ft.), use a repeater or switch. If the OnCue® Plus Wireless Kit is used, follow the installation instructions provided with the kit.

Recommended: Use a laptop computer to verify the network connection before connecting to the generator set.

Checking the network connection

- 1. Check for and turn off any wireless connections to the laptop.
- 2. Connect the network cable to the laptop. Connect the other end of the network cable to the customer's router or modem.
- 3. Verify the Internet connection by opening your web browser and going to www.kohlerpower.com or another website.
- 4. After verifying the connection through the network cable, disconnect the network cable from the laptop and turn the laptop wireless connections back on.

Connect to the Ethernet cable in the customer connection area of the generator set. See Figure 22. Use an RJ-45 inline coupler, provided with the OnCue® Plus kit, to connect the customer's Ethernet cable to the cable in the customer connection box.

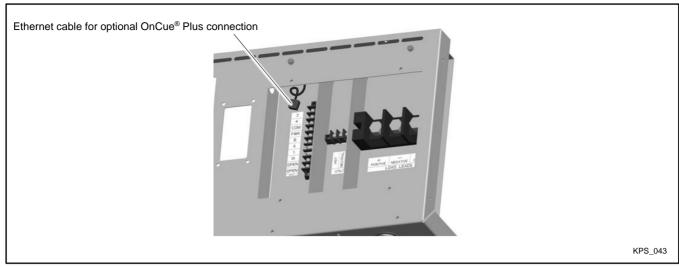


Figure 22 Network Connection for OnCue® Plus

1.10.3 Communications Kit

The optional communications kit is factory installed. The communications kit includes the following items:

- Interface board with factory set inputs and outputs
- Customer connection terminal blocks
- Enclosure intrusion alarm switch
- · Fuel pressure sensor

Connect the outputs to customer-supplied equipment as shown in the section titled: Communications Kit Output Connections, or on the wiring diagram.

1.11 Prestart Installation Check

Review the entire installation section. Inspect all wiring and connections to verify that the generator set is ready for operation. Check all items in the following Prestart Checklist.

Air Cleaner. Check that a clean air cleaner element is installed to prevent unfiltered air from entering the engine. See the generator set operation manual for instructions.

Air Inlets. Check for clean and unobstructed air inlets.

Battery. Check for tight battery connections. Consult the battery manufacturer's instructions regarding battery care and maintenance.

Enclosure. Check that all enclosure panels and internal baffling are in place.

Exhaust System. Check for exhaust leaks and blockages. Check the muffler condition.

- Inspect the exhaust system components for cracks, leaks, and corrosion. Check for tight exhaust system connections.
- Check for corroded or broken metal parts and replace them as needed.
- Check that the exhaust outlet is unobstructed.

Oil Level. Maintain the oil level at or near, not over, the full mark on the dipstick.

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

1.12 Set the Exerciser

Set the exerciser to automatically run the generator set on the desired day and time every week or every two weeks. See the generator set Operation Manual for detailed descriptions of the unloaded and loaded exercise operation.

When power is applied to the VSC controller (when the battery or the AC power for the battery charger is connected), you will be prompted to set the date and time, and then to set the exerciser.

The first setting will flash. Press the Up and Down arrow buttons to change the setting. Press Select to save the setting and move on to the next. Repeat until the date, time, and exercise are set and the controller display shows the main menu. See the generator set Operation Manual for more detailed instructions to set the date and time and set the exerciser.

Press AUTO to place the generator set controller into automatic mode.

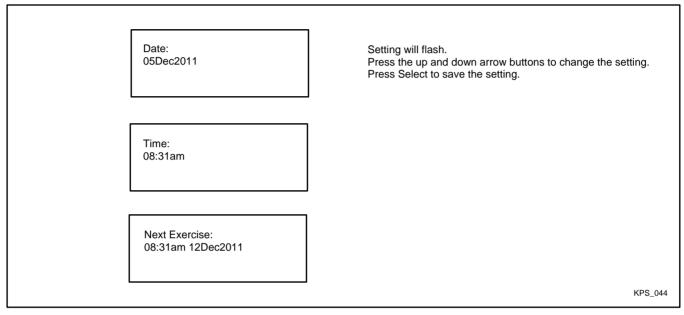


Figure 23 Set Time, Date, and Exercise (VSC)

1.13 Checking Generator Parameters

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. Contact an authorized Kohler distributor or dealer for assistance if the settings need to be changed.

1.13.1 System Voltage

This should be set for the required output voltage to properly support the load and charge the battery. Refer to battery manufacturer to correctly set the value. This value should not be confused with the voltage designation of the battery bank (four 12-volt batteries wired in series results in a 48V battery bank but the output voltage needed to charge the battery bank is 54V). Faults and warnings related to voltage are based off this value. For example, for a 6VSG-48V, setting this value to 54V will result in an output of the VSG to be 54V. This value relates to the recommended charging voltage specified by the battery manufacturer. The output of a 6VSG-48V set at 54V will have an output of 6 kW; however, as you increase the system voltage, the output drops below 6 kW due to the fixed rpm range.

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 default system voltage 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 24 illustrate the effect of changing the system voltage.

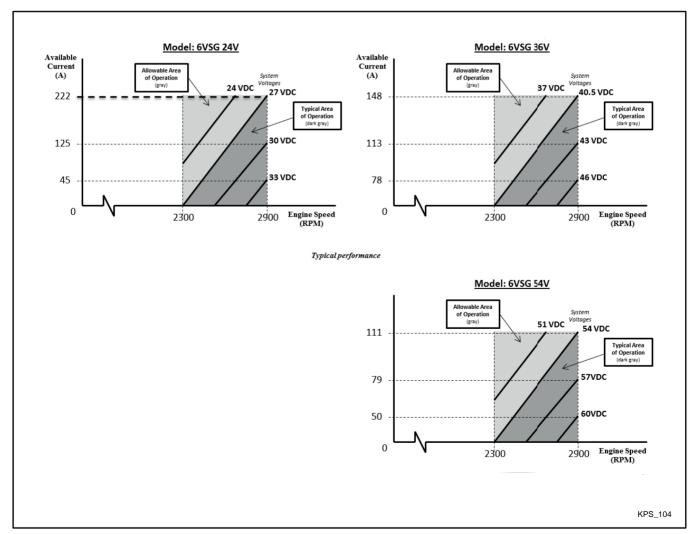


Figure 24 Effect of Changing the System Voltage Setting

1.13.2 Auto Start Volt

This value is the voltage at which the 6VSG will automatically start. The automatic start criteria are met when this voltage has reached or fallen below this value for the specified delay period (standard 3 minutes, only changed using SiteTech). This voltage is detected at the generator and may differ from the voltage measured at the load or the battery due to voltage drop in the lines.

	6VSG-24V	6VSG-36V	6VSG-48V
Default	25 VDC	37.5 VDC	50 VDC
Minimal value	15 VDC	15 VDC	15 VDC
Maximal value	60 VDC	60 VDC	60 VDC

Figure 25 Auto Start Voltage Settings

1.13.3 Auto Stop Load

This value is the load level at which the 6VSG will automatically stop. The automatic stop criteria are met when the load has reached or fallen below this value for the specified delay period (standard 3 minutes and only changed using SiteTech). This load is detected at the generator.

	6VSG-24V	6VSG-36V	6VSG-48V
Default	40%	40%	40%
Minimal value	0%	0%	0%
Maximal value	100%	100%	100%

Figure 26 Auto Stop Load Settings

1.13.4 Load Limit

This value is the limit to the generator capacity. This allows the 6VSG to limit current output to the maximum charge rate specified by the battery manufacturer or load in the application. Adjustments should be done by qualified individuals after referring to battery manufacturer's recommended maximum charge rate.

	6VSG-24V	6VSG-36V	6VSG-48V
Default	100%	100%	100%
Minimal value	0%	0%	0%
Maximal value	120%	120%	120%

Figure 27 Load Limit

Load Limit= $\frac{\text{(Charge voltage x Charge current)}}{60}$

1.13.5 Delay (seconds)

This delay is used to determine the amount of time a value (Auto Start Volt or Auto Stop Load) needs to be sustained before the respective action is taken pertaining to the value. The delay can only be changed using a personal computer (laptop) and Kohler SiteTech software. Contact an authorized Kohler distributor or dealer to adjust the setting, if necessary.

	6VSG-24V	6VSG-36V	6VSG-48V
Default	3 minutes	3 minutes	3 minutes
Minimal value	1 second	1 second	1 second
Maximal value	60 minutes	60 minutes	60 minutes

Figure 28 Auto Start/Auto Stop Delay Settings

This section contains dimension drawings, wiring diagrams, and schematics for the enclosed generator set. Figure 29 lists the drawing numbers and page numbers. See the generator set Operation Manual for service views, if necessary.

Installation Drawing Description	Figure Number	Figure Number	Page
Dimension Drawing	Figure 30		36
Dimension Drawing	Figure 31	ADV-8060	37
Dimension Drawing	Figure 32		38
Schematic Diagram	Figure 33	ADV-8707	39
Schematic Diagram	Figure 34	ADV-0707	40
Point-to-Point Wiring Diagram	Figure 35	GM93380	41
Point-to-Point Wiring Diagram	Figure 36	GIVI93360	42

Figure 29 Dimension Drawings, Wiring Diagrams, and Schematics

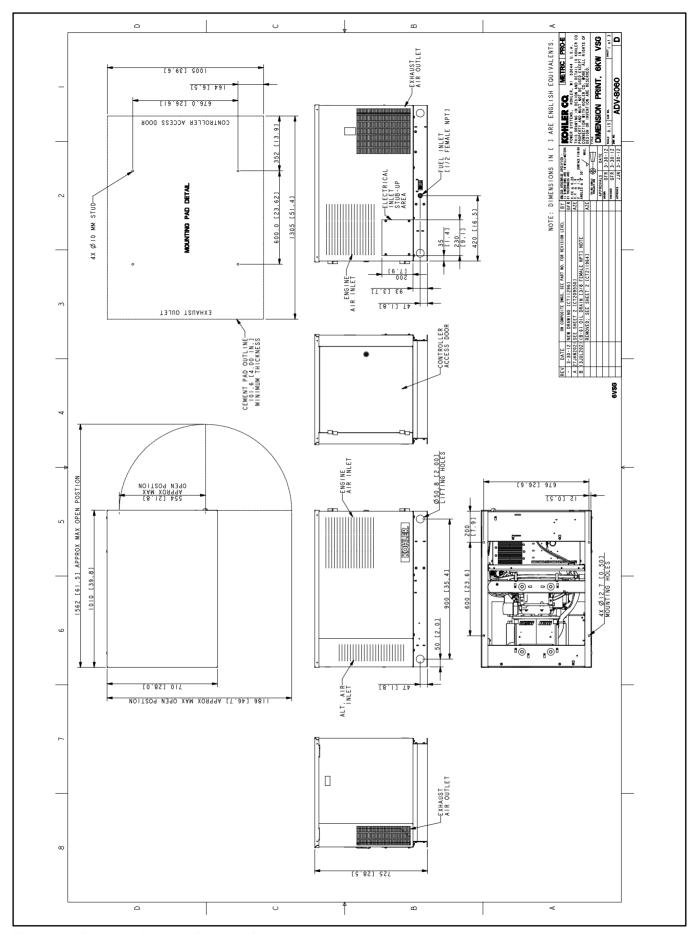


Figure 30 Dimension Drawing ADV-8060, Sheet 1

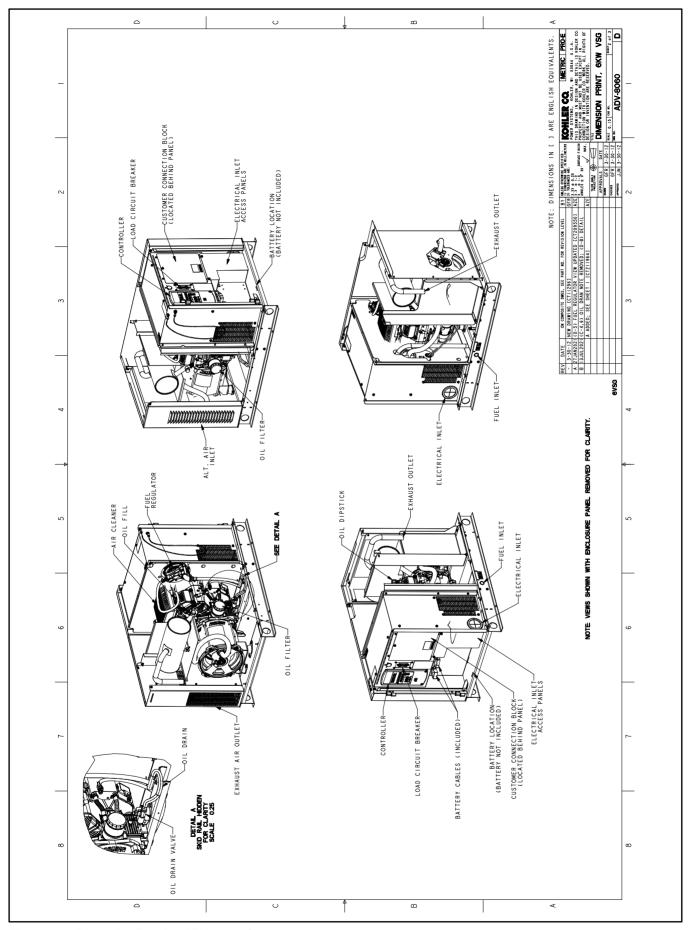


Figure 31 Dimension Drawing ADV-8060, Sheet 2

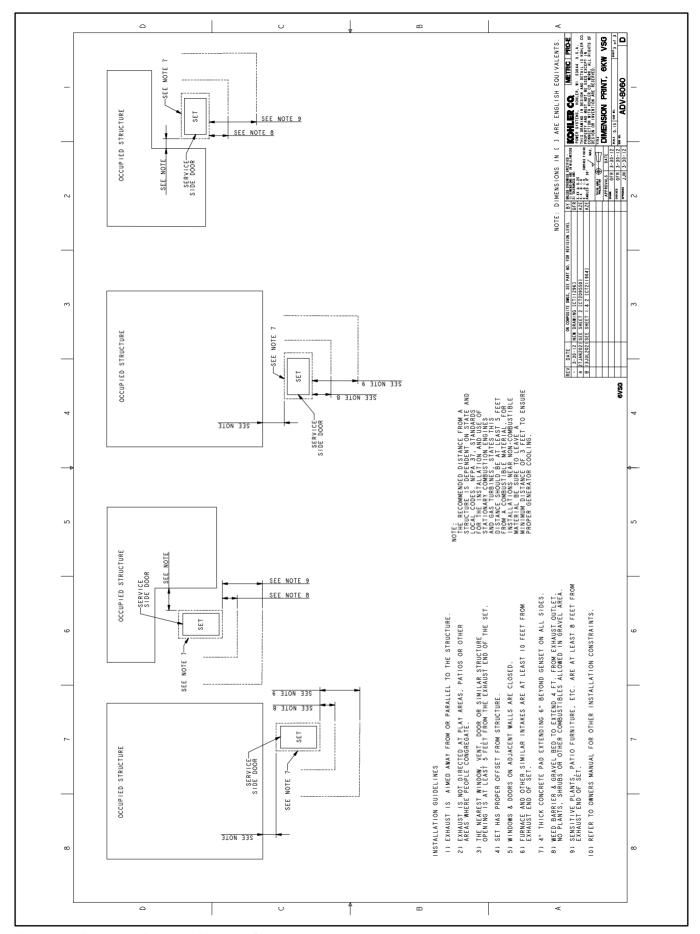


Figure 32 Dimension Drawing ADV-8060, Sheet 3

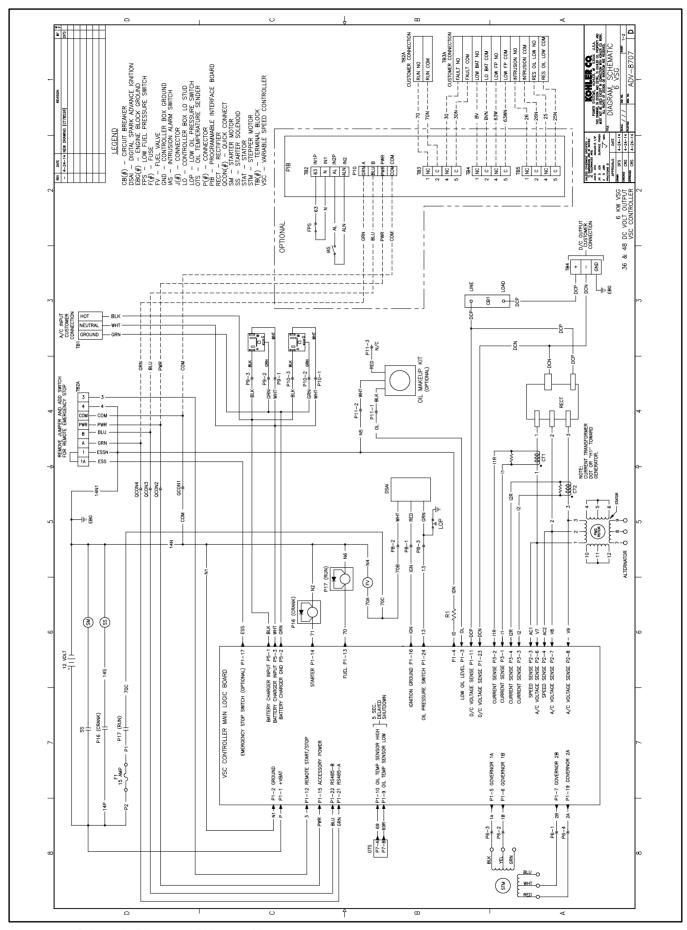


Figure 33 Schematic Diagram, ADV-8707, Sheet 1

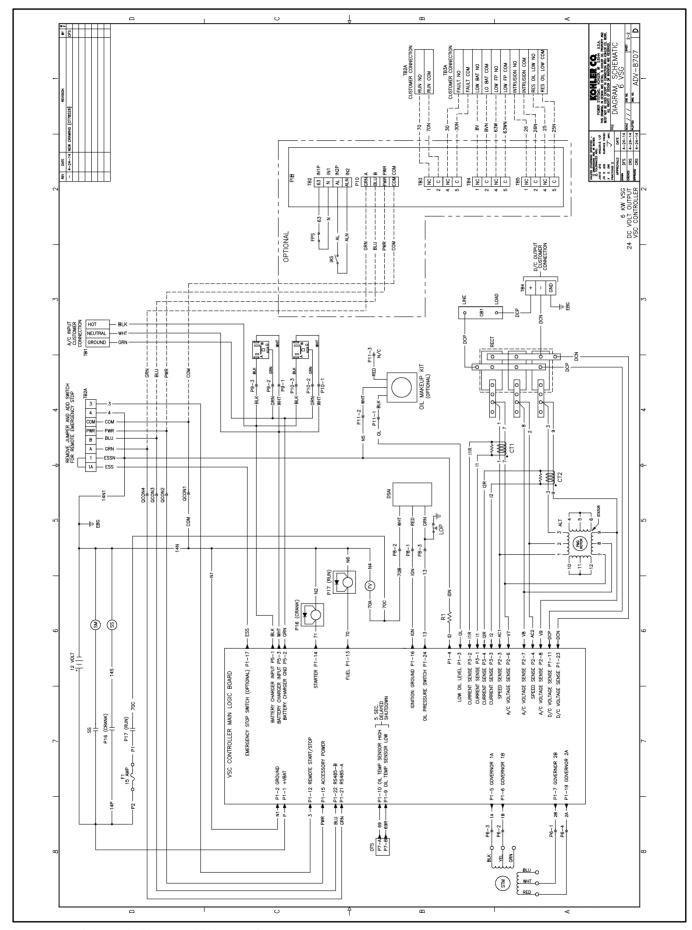


Figure 34 Schematic Diagram, ADV-8707, Sheet 2

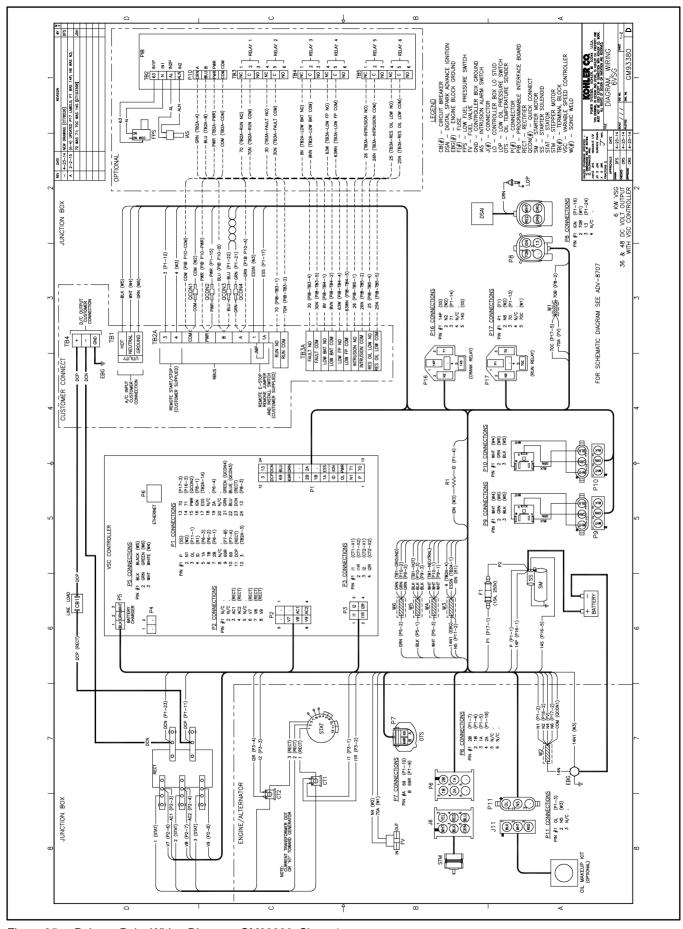


Figure 35 Point-to-Point Wiring Diagram, GM93380, Sheet 1

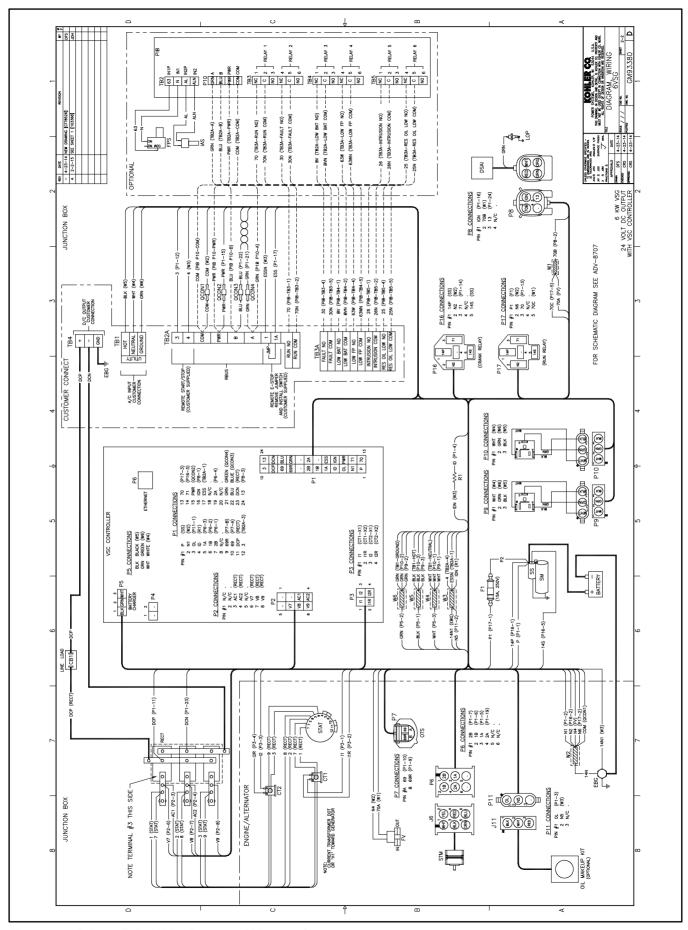


Figure 36 Point-to-Point Wiring Diagram, GM93380, Sheet 2

Appendix A. Abbreviations

A, amp	ampere	blk. htr.	block heater	DAC	digital to analog converter
ABDC	after bottom dead center	BMEP	brake mean effective pressure	dB	decibel
AC	alternating current	bps	bits per second	dB(A)	decibel (A weighted)
A/D	analog to digital	br.	Brass	DC	direct current
ADC	advanced digital control; analog to digital converter	BTDC	before top dead center	DCR	direct current resistance
adj.	adjust, adjustment	Btu	British thermal unit	DEF	diesel exhaust fluid
ADV	advertising dimensional drawing	Btu/min.	British thermal units per minute	deg., °	degree
AGM	absorbent glass mat	С	Celsius, centigrade	dept.	department
Ah	amp-hour	cal.	Calorie	dia.	Diameter
AHWT	anticipatory high water temperature	CAN	controller area network	DI/EO	dual inlet/end outlet
AISI	American Iron and Steel Institute	CARB	California Air Resources Board	DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
ALOP	anticipatory low oil pressure	CAT5	Category 5 (network cable)	DIP	dual inline package
alt.	alternator	СВ	circuit breaker	DPDT	double-pole, double-throw
Al	aluminum	CC	crank cycle	DPST	double-pole, single-throw
ANSI	American National Standards Institute (formerly American Standards Association, ASA)	СС	cubic centimeter	DS	disconnect switch
AO	anticipatory only	CCA	cold cranking amps	DVR	digital voltage regulator
APDC	Air Pollution Control District	ccw.	Counterclockwise	E ² PROM, EEPROM	electrically-erasable programmable read-only memory
API	American Petroleum Institute	CEC	Canadian Electrical Code	E, emer.	emergency (power source)
approx.	approximate, approximately	cert.	certificate, certification, certified	EATS	Exhaust Aftertreatment System
APU	Auxiliary Power Unit	cfh	cubic feet per hour	ECM	electronic control module, engine control module
AQMD	Air Quality Management District	cfm	cubic feet per minute	EDI	electronic data interchange
AR	as required, as requested	CG	center of gravity	EFR	emergency frequency relay
AS	as supplied, as stated, as suggested	CID	cubic inch displacement	e.g.	for example (exempli gratia)
ASE	American Society of Engineers	CL	centerline	EG	electronic governor
ASME	American Society of Mechanical Engineers	cm	centimeter	EGSA	Electrical Generating Systems Association
assy.	Assembly	CMOS	complementary metal oxide substrate (semiconductor)	EIA	Electronic Industries Association
ASTM	American Society for Testing Materials	com	communications (port)	EI/EO	end inlet/end outlet
ATDC	after top dead center	coml	commercial	EMI	electromagnetic interference
ATS	automatic transfer switch	Coml/Rec	Commercial/Recreational	emiss.	Emission
auto.	Automatic	conn.	Connection	eng.	Engine
aux.	auxiliary	cont.	continued	EPA	Environmental Protection Agency
avg.	average	CPVC	chlorinated polyvinyl chloride	EPS	emergency power system
AVR	automatic voltage regulator	crit.	Critical	ER	emergency relay
AWG	American Wire Gauge	CRM	Common Rail Manifold	ES	engineering special, engineered special
AWM	appliance wiring material	CSA	Canadian Standards Association		
bat.	Battery	CT	current transformer	ESD	electrostatic discharge
BBDC	before bottom dead center	Cu	copper	est.	estimated
ВС	battery charger, battery charging	cUL	Canadian Underwriter's Laboratories	E-Stop	emergency stop
BCA	battery charging alternator	cu. in.	cubic inch	etc.	et cetera (and so forth)
BCI	Battery Council International	CW.	Clockwise	exh.	exhaust
BDC	before dead center	CWC	city water-cooled	ext.	external
BHP	brake horsepower	cyl.	Cylinder	F	Fahrenheit, female
blk.	black (paint color), block (engine)	D/A	digital to analog	FDS	Fluid Dosing System

FHM	flat head machine (screw)	in.	inch	Lpm	liters per minute
fl. oz.	fluid ounce	in. H ₂ O	inches of water	LOP	low oil pressure
flex.	flexible	in. Hg	inches of mercury	LP	liquefied petroleum
freq.	frequency	in. Lb.	inch pounds	LPG	liquefied petroleum gas
FS	full scale	Inc.	incorporated	LS	left side
ft.	foot, feet	ind.	Industrial	L_{wa}	sound power level, A weighted
ft. lb.	foot pounds (torque)	int.	internal	LWL	low water level
ft./min.	feet per minute	int./ext.	internal/external	LWT	low water temperature
ftp	file transfer protocol	I/O	input/output	m	meter, milli (1/1000)
g	gram	IP	internet protocol	M	mega (10 ⁶ when used with SI units), male
ga.	gauge (meters, wire size)	ISO	International Organization for Standardization	m ³	cubic meter
gal.	gallon	J	joule	m³/hr.	cubic meters per hour
gen.	generator	JIS	Japanese Industry Standard	m³/min.	cubic meters per minute
genset	generator set	k	kilo (1000)	mA	milliampere
GFI	ground fault interrupter	K	kelvin	man.	manual
GND, ⊕	ground	kA	kiloampere	max.	maximum
gov.	governor	KB	kilobyte (2 ¹⁰ bytes)	MB	megabyte (2 ²⁰ bytes)
gph	gallons per hour	KBus	Kohler communication protocol	MCCB	molded-case circuit breaker
gpm	gallons per minute	kg	kilogram	MCM	one thousand circular mils
gr.	grade, gross	kg/cm ²	kilograms per square centimeter	meggar	megohmmeter
GRD	equipment ground	kgm	kilogram-meter	MHz	megahertz
gr. wt.	gross weight	kg/m³	kilograms per cubic meter	mi.	mile
H x W x D	height by width by depth	kHz	kilohertz	mil	one one-thousandth of an inch
HC	hex cap	kJ	kilojoule	min.	minimum, minute
HCHT	high cylinder head temperature	km	kilometer	misc.	miscellaneous
HD	heavy duty	$k\Omega hm,\\ k\Omega$	kilo-ohm	MJ	megajoule
HET	high exhaust temp., high engine temp.	kPa	kilopascal	mJ	millijoule
hex	hexagon	kph	kilometers per hour	mm	millimeter
Hg	mercury (element)	kV	kilovolt	mOhm, mΩ	milliohm
НН	hex head	kVA	kilovolt ampere	$\begin{array}{l} MOhm, \\ M\Omega \end{array}$	megohm
HHC	hex head cap	kVAR	kilovolt ampere reactive	MOV	metal oxide varistor
HP	horsepower	kW	kilowett	MPa	megapascal
hr.	Horsepower		kilowatt	IVIFA	• ,
	hour	kWh	kilowatt-hour	mpg	miles per gallon
HS	hour heat shrink	kWh kWm	kilowatt-hour kilowatt mechanical	mpg mph	miles per gallon miles per hour
hsg.	hour heat shrink Housing	kWh kWm kWth	kilowatt-hour kilowatt mechanical kilowatt-thermal	mpg mph MS	miles per gallon miles per hour military standard
hsg. HVAC	hour heat shrink	kWh kWm	kilowatt-hour kilowatt mechanical	mpg mph	miles per gallon miles per hour
hsg.	hour heat shrink Housing heating, ventilation, and air	kWh kWm kWth L	kilowatt-hour kilowatt mechanical kilowatt-thermal liter local area network	mpg mph MS	miles per gallon miles per hour military standard
hsg. HVAC	hour heat shrink Housing heating, ventilation, and air conditioning	kWh kWm kWth L	kilowatt-hour kilowatt mechanical kilowatt-thermal liter	mpg mph MS ms	miles per gallon miles per hour military standard millisecond
hsg. HVAC HWT Hz	hour heat shrink Housing heating, ventilation, and air conditioning high water temperature	kWh kWm kWth L LAN L x W x H	kilowatt-hour kilowatt mechanical kilowatt-thermal liter local area network	mpg mph MS ms m/sec.	miles per gallon miles per hour military standard millisecond meters per second
hsg. HVAC HWT Hz	hour heat shrink Housing heating, ventilation, and air conditioning high water temperature hertz (cycles per second)	kWh kWm kWth L LAN L x W x H	kilowatt-hour kilowatt mechanical kilowatt-thermal liter local area network length by width by height	mpg mph MS ms m/sec. mtg.	miles per gallon miles per hour military standard millisecond meters per second mounting
hsg. HVAC HWT Hz IBC IC	hour heat shrink Housing heating, ventilation, and air conditioning high water temperature hertz (cycles per second) International Building Code integrated circuit inside diameter, identification	kWh kWm kWth L LAN L x W x H Ib. Ibm/ft³ LCB	kilowatt-hour kilowatt mechanical kilowatt-thermal liter local area network length by width by height pound, pounds	mpg mph MS ms m/sec. mtg. MTU MW mW	miles per gallon miles per hour military standard millisecond meters per second mounting Motoren-und Turbinen-Union
hsg. HVAC HWT Hz IBC IC	hour heat shrink Housing heating, ventilation, and air conditioning high water temperature hertz (cycles per second) International Building Code integrated circuit	kWh kWm kWth L LAN L x W x H Ib.	kilowatt-hour kilowatt mechanical kilowatt-thermal liter local area network length by width by height pound, pounds pounds mass per cubic feet line circuit breaker liquid crystal display	mpg mph MS ms m/sec. mtg. MTU MW	miles per gallon miles per hour military standard millisecond meters per second mounting Motoren-und Turbinen-Union megawatt
hsg. HVAC HWT Hz IBC IC	hour heat shrink Housing heating, ventilation, and air conditioning high water temperature hertz (cycles per second) International Building Code integrated circuit inside diameter, identification International Electrotechnical	kWh kWm kWth L LAN L x W x H Ib. Ibm/ft³ LCB	kilowatt-hour kilowatt mechanical kilowatt-thermal liter local area network length by width by height pound, pounds pounds mass per cubic feet line circuit breaker	mpg mph MS ms m/sec. mtg. MTU MW mW	miles per gallon miles per hour military standard millisecond meters per second mounting Motoren-und Turbinen-Union megawatt milliwatt

N, norm.	normal (power source)	PMG	permanent magnet generator	SCR	silicon controlled rectifier (electrical), selective catalytic reduction (exhaust emissions)
NA	not available, not applicable	pot	potentiometer, potential	s, sec.	second
nat. gas	natural gas	ppm	parts per million	SI	Systeme international d'unites, International System of Units
NBS	National Bureau of Standards	PROM	programmable read-only memory	SI/EO	side in/end out
NC	normally closed	psi	pounds per square inch	sil.	Silencer
NEC	National Electrical Code	psig	pounds per square inch gauge	SMTP	simple mail transfer protocol
NEMA	National Electrical Manufacturers Association	pt.	pint	SN	serial number
NiCd	nickel cadmium	PTC	positive temperature coefficient	SNMP	simple network management protocol
NFPA	National Fire Protection Association	PTO	power takeoff	SPDT	single-pole, double-throw
Nm	newton meter	PVC	polyvinyl chloride	SPST	single-pole, single-throw
NO	normally open	PVC	polyvinyl chloride	spec	specification
no., nos.	number, numbers	PWM	pulse width modulated, pulse width modulation	specs	specification(s)
NPS	National Pipe, Straight	qt.	quart, quarts	sq.	square
NPSC	National Pipe, Straight-coupling	qty.	quantity	sq. cm	square centimeter
NPT	National Standard taper pipe thread per general use	R	replacement (emergency) power source	sq. in.	square inch
NPTF	National Pipe, Taper-Fine	rad.	radiator, radius	SMS	short message service
NR	not required, normal relay	RAM	random access memory	SS	stainless steel
Ns	nanosecond	RDO	relay driver output	std.	standard
OC	overcrank	ref.	reference	stl.	Steel
OD	outside diameter	rem.	Remote	tach.	Tachometer
OEM	original equipment manufacturer	Res/Co ml	Residential/Commercial	TB	terminal block
OF	overfrequency	RFI	radio frequency interference	TCP	transmission control protocol
opt.	option, optional	RH	round head	TD	time delay
os	oversize, overspeed	RHM	round head machine (screw)	TDC	top dead center
OSHA	Occupational Safety and Health Administration	rly.	Relay	TDEC	time delay engine cooldown
OSHPD	Office of Statewide Health Planning and Development (California)	rms	root mean square	TDEN	time delay emergency to normal
OV	overvoltage	rnd.	Round	TDES	time delay engine start
OZ.	ounce	RO	read only	TDNE	time delay normal to emergency
p., pp.	page, pages	ROM	read only memory	TDOE	time delay off to emergency
PC	personal computer	rot.	rotate, rotating	TDON	time delay off to normal
PCB	printed circuit board	rpm	revolutions per minute	temp.	temperature
pF	picofarad	RS	right side	term.	Terminal
PF	power factor	RTDs	resistance temperature detectors	THD	total harmonic distortion
ph., ø	phase	RTU	remote terminal unit	TIF	telephone influence factor
PHC	Phillips® head Crimptiter (screw)	RTV	room temperature vulcanization	tol.	Tolerance
PHH	Phillips® hex head (screw)	RW	read/write	turbo.	Turbocharger
PHM	pan head machine (screw)	SAE	Society of Automotive Engineers	typ.	typical (same in multiple locations)
PLC	programmable logic control	scfm	standard cubic feet per minute	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 wat

WCR withstand and closing rating

w/ with
WO write only
w/o without
wt. weight
xfmr transformer



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