Service

Marine Generator Sets

Models:

6EOD
4.5EFOD
8–32EOZD
6.5–28EFOZD

ISO 9001
KOHLER POWER SYSTEMS
NATIONALLY REGISTERED

KOHLER®
POWER SYSTEMS

TP-6255 4/10c

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

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***.

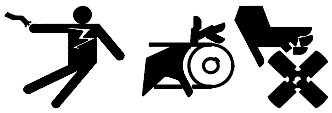
NOTICE

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 connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

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 fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the fuel injection system, 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 fuel system.

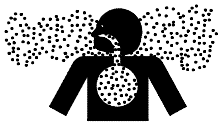
Servicing the air cleaner. A sudden backfire can cause severe injury or death. Do not operate the generator set with the air cleaner/silencer removed.

Combustible materials. A sudden flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the generator set. Keep the compartment and the generator set clean and free of debris to minimize the risk of fire. Catch fuels in an approved container. Wipe up spilled fuels and engine oil.

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.

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.

Inspecting the exhaust system. Carbon monoxide can cause severe nausea, fainting, or death. For the safety of the craft's occupants, install a carbon monoxide detector. Never operate the generator set without a functioning carbon monoxide detector. Inspect the detector before each generator set use.

Operating the generator set. Carbon monoxide can cause severe nausea, fainting, or death. Be especially careful if operating the generator set when moored or anchored under calm conditions because gases may accumulate. If operating the generator set dockside, moor the craft so that the exhaust discharges on the lee side (the side sheltered from the wind). Always be aware of others, making sure your exhaust is directed away from other boats and buildings.

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.

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

Hazardous Noise

⚠ CAUTION

Hazardous noise.
Can cause hearing loss.

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

Hazardous Voltage/ Moving Parts

⚠ 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.

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.

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, transfer switch, 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.

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

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.

Electrical backfeed to the utility. Hazardous backfeed voltage can cause severe injury or death. Connect the generator set to the building/marina electrical system only through an approved device and after the building/marina main switch is turned off. Backfeed connections can cause severe injury or death to utility personnel working on power lines and/or personnel near the work area. Some states and localities prohibit unauthorized connection to the utility electrical system. Install a ship-to-shore transfer switch to prevent interconnection of the generator set power and shore power.

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)

Hot Parts

⚠ WARNING

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

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

Notice

NOTICE

Fuse replacement. Replace fuses with fuses of the same ampere rating and type (for example: 3AB or 314, ceramic). Do not substitute clear glass-type fuses for ceramic fuses. Refer to the wiring diagram when the ampere rating is unknown or questionable.

NOTICE

Saltwater damage. Saltwater quickly deteriorates metals. Wipe up saltwater on and around the generator set and remove salt deposits from metal surfaces.

Notes

Introduction

This manual provides troubleshooting and repair instructions for 6EOD, 8-32EOZD, 4.5EFOD and 6.5-28EFOZD model generator sets (4-lead and 12-lead), Advanced Digital Control, and accessories.

Refer to the engine service manual for generator set engine service information.

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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.

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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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Latin America Regional Office
Lakeland, Florida, USA
Phone: (863) 619-7568
Fax: (863) 701-7131

Notes

1.1 General

This manual covers maintenance, troubleshooting, and repair of the alternating current marine generator sets listed in Figure 1-1. Consult the generator set nameplate for specific generator set ratings.

Models	Voltage	Hz	Ph
6EOD	120 120/240	60	1
8/9/10EOZD	120 120/240	60	1
10EOZD	220/380 240/416	60	3
13/15/15.5/20/23/28/32EOZD	120/240	60	1
14/20/24/28/32EOZD	120/240	60	1
14/20/24/28/32EOZD	120/208 120/240 127/220 139/240 277/480	60	3
4.5EFOD	115/230 230 240	50	1
6.5/7/9/11/13/17/20/23/25/27/28EFOZD	115/230 230 240	50	1
8.5EFOZD	230/400	50	3
11.5/17.5/20/23/25/27/28EFOZD	115/230	50	1
11.5/17.5/20/23/25/27/28EFOZD	110/190 115/230 120/208 220/380 230/400 240/416	50	3

Figure 1-1 Generator Model Coverage

The 6EOD/4.5EFOD models are powered by a three-cylinder, water-cooled, four-cycle diesel engine with a heat exchanger.

The 8EOZD/6.5EFOZD, 9EOZD/7EFOZD, 10EOZD/9EFOZD, 10EOZD/8.5EFOZD, and 13EOZD/11EFOZD models are powered by a three-cylinder, water-cooled, four-cycle diesel engine with a heat exchanger.

The 14EOZD/11.5EFOZD and 15/15.5EOZD/13EFOZD models are powered by a three-cylinder, water-cooled, turbocharged diesel engine with a heat exchanger.

The 20EOZD/17EFOZD and 20EOZD/17.5EFOZD models are powered by a four-cylinder, water-cooled, four-cycle diesel engine with a heat exchanger.

The 23EOZD/20EFOZD and 24EOZD/20EFOZD models are powered by a four-cylinder, water-cooled, four-cycle, turbocharged diesel engine with a heat exchanger.

The 28EOZD/23/25EFOZD and 32EOZD/27/28EFOZD models are powered by a four cylinder, water cooled, four cycle diesel engine with heat exchanger.

Heat exchanger cooling consists of a heat exchanger with a coolant recovery tank, thermostat, rubber impeller seawater pump, centrifugal type engine circulating pump, water-cooled exhaust manifold, and an exhaust mixer.

Kohler Co. develops all Kohler® marine generator set ratings using accepted reference conditions of 25°C (77°F) and pressure of 29.2 in. Hg dry barometer. ISO 3046 and ISO 8528-1 include reference conditions and output calculations. Obtain the technical information bulletin on ratings guidelines (TIB-101) for complete ratings definitions.

Read this manual, then carefully follow all service recommendations. See Figure 1-2 for identification and location of components.

1.2 Engine

Generator Model	8EOZD/ 6.5EFOZD	9EOZD/ 7EFOZD	10EOZD/ 8.5EFOZD/ 9EFOZD	13EOZD/ 11EFOZD	14EOZD/ 11.5EFOZD	15EOZD/ 15.5EOZD/ 13EFOZD
Number of cylinders	3					
Type	4 cycle				4 cycle, turbocharged	
Cylinder block material	Cast iron					
Cylinder head material	Cast iron					
Crankshaft material	Stamped forging	Forged steel				
Piston rings	2 compression/1 oil					
Connecting rod material	Forged carbon steel					
Governor	Centrifugal, mechanical					
Engine firing order (#1 cylinder on flywheel side)	1-3-2					
Direction of rotation (as viewed from flywheel)	Counterclockwise					
Combustion system	Special swirl pre-combustion chamber	Indirect injection	Direct injection			
Bore x stroke, mm (in.)	74 x 78 (2.91 x 3.07)	76 x 82 (3.0 x 3.2)	82 x 84 (3.23 x 3.30)	88 x 90 (3.46 x 3.54)	84 x 90 (3.31 x 3.54)	
Displacement L (CID)	1.01 (61.39)	1.115 (68)	1.33 (81.14)	1.642 (100.2)	1.5 (91.3)	
Compression ratio	23:1	23.5:1	19.2:1	19.1:1	19.0:1	
Max. power at rated RPM, 60/50 Hz	14.0/11.6	14.74/12.43	18.4/15.1	22.6/18.6	26.1/21.8	
RPM 60/50 Hz	1800/1500					
Lubrication system	Pressure, trochoid pump					
Lube oil capacity, w/filter L (U.S. qts.)	2.3 (2.4)	3.6 (3.8)		4.7 (5.0)		
Oil recommendation (API)	CD or CF class					
Fuel recommendation (API)	Diesel-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.)					
Fuel shutoff solenoid	Electric					
Fuel pump	Electric, rotary vane					
Fuel pump priming	Electric					
Max. recommended fuel pump lift, m (ft.)	1.2 (4)					
Battery voltage	12 volts		12 volts (standard) 24 volts (optional)			
Battery charging	40-amp alternator					
Battery recommendation (minimum)	500 CCA, 100 amp hr.					
Starter motor	0.8 kW Bendix automotive type		1.8 kW Bendix, gear-reduction automotive type			
Recommended coolant	50% ethylene glycol; 50% clean, softened water					
Coolant capacity, approx. L (U.S. qts.) add 0.24 L (8 oz.) for coolant recovery tank	3.9 (4.12)	2.46 (2.6)		4.4 (4.6)		
Thermostat, °C (°F)	82 (179)					
High exhaust temperature shutdown, °C (°F)	102 (215) ± 5					
Low oil pressure shutdown, kg/cm^2 ± 0.1 kg/cm^2 (psi)	0.5 (7.1)					
Seawater inlet water line hose ID, mm (in.)	1/2 NPT with sound shield 16 (5/8) without sound shield			3/4 NPT with sound shield 25 (1) without sound shield		

Generator Model	8EOZD/ 6.5EFOZD	9EOZD/ 7EFOZD	10EOZD/ 8.5EFOZD 9EFOZD	13EOZD/ 11EFOZD	14EOZD/ 11.5EFOZD	15EOZD 15.5EOZD/ 13EFOZD
Water cooled exhaust outlet hose ID, mm (in.)	51 (2) with sound shield 51 (2) without sound shield			76 (3) with sound shield 76 (3) without sound shield		
Fuel inlet size	3/8 NPT with sound shield 1/4 NPT without sound shield					
Fuel return size	3/8 NPT with sound shield 1/4 NPT without sound shield					
Fuel injection pressure, kgf/cm sq. (psi)	120 (1706)	120–130 (1706–1849)	200–210 (2844–2986)			
Intake/exhaust valve clearance (cold), mm (in.)	0.15–0.25 (0.006–0.0010)					
Fuel pump static pressure, psi	4–8 (12-volt pump) or 5.5–9 (24-volt pump)					
Pressure cap rating, kPa (psi)	97 (14)					

Generator Model	20EOZD/ 17EFOZD/ 17.5EFOZD (1 and 3 Ph.)	23EOZD/ 20EFOZD	24EOZD/ 20EFOZD	28EOZD/ 23EFOZD/ 25EFOZD (1 and 3 Ph.)	32EOZD/ 27EFOZD/ 28EFOZD (1 and 3 Ph.)
Number of cylinders	4				
Type	4 cycle	4 cycle, turbocharged		4 cycle, naturally aspirated	
Cylinder block material	Cast iron				
Cylinder head material	Cast iron				
Crankshaft material	Forged steel				
Piston rings	2 compression/1 oil				
Connecting rod material	Forged carbon steel				
Governor	Centrifugal, mechanical				
Engine firing order (#1 cylinder on flywheel side)	1-3-4-2				
Direction of rotation (as viewed from flywheel)	Counterclockwise				
Combustion system	Direct injection				
Bore x stroke, mm (in.)	88 x 90 (3.46 x 3.54)	84 x 90 (3.31 x 3.54)		98 x 110 (3.86 x 4.33)	
Displacement L (CID)	2.189 (133.58)	1.995 (121.74)		3.319 (202.5)	
Compression ratio	19.1:1	18.9:1		18.5:1	
Max. power at rated RPM, 60/50 Hz	30.1/24.8	37.1/29.3		55.8/46.7	
RPM 60/50 Hz	1800/1500				
Lubrication system	Pressure, trochoid pump				
Lube oil capacity, w/filter L (U.S. qts.)	5.8 (6.1)			10.2 (10.78)	
Oil recommendation (API)	CD or CF class				
Fuel recommendation (API)	Diesel-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.)				
Fuel shutoff solenoid	Electric				
Fuel pump	Electric, rotary vane				
Fuel pump priming	Electric				
Max. recommended fuel pump lift, m (ft.)	1.2 (4)				
Battery voltage	12 volts (standard) 24 volts (optional)				
Battery charging	40-amp alternator				
Battery recommendation (minimum)	650 CCA, 100 amp hr.			800 CCA, 100 amp hr.	
Starter motor	1.8 kW			2.3 kW	
Recommended coolant	50% ethylene glycol; 50% clean, softened water				
Coolant capacity, approx. L (U.S. qts.) add 0.24 L (8 oz.) for coolant recovery tank	6.0 (6.3)			7.57 (8)	
Thermostat, °C (°F)	82 (179)				
High exhaust temperature shutdown, °C (°F)	102 (215) ± 5				
Low oil pressure shutdown, kg/cm^2 ± 0.1 kg/cm^2 (psi)	0.5 (7.1)				
Seawater inlet water line hose ID, mm (in.)	3/4 NPT with sound shield 25 (1) without sound shield or 19 (0.75) without sound shield for specs GM55348-GA1 to -GA16			3/4 NPT with sound shield 19 (0.75) without sound shield	
Water cooled exhaust outlet hose ID, mm (in.)	76 (3) with sound shield 76 (3) without sound shield			76 (3) with sound shield 76 (3) without sound shield	

Generator Model	20EOZD/ 17EFOZD/ 17.5EFOZD (1 and 3 Ph.)	23EOZD/ 20EFOZD	24EOZD/ 20EFOZD	28EOZD/ 23EFOZD/ 25EFOZD (1 and 3 Ph.)	32EOZD/ 27EFOZD/ 28EFOZD (1 and 3 Ph.)
Fuel inlet size	3/8 NPT with sound shield 1/4 NPT without sound shield				
Fuel return size	3/8 NPT with sound shield 1/4 NPT without sound shield				
Fuel injection pressure, kgf/cm sq. (psi)	200–210 (2844–2986)			220–230 (3129–3271)	
Intake/exhaust valve clearance (cold), mm (in.)	0.15–0.25 (0.006–0.0010)				
Fuel pump static pressure, psi	4–8 (12-volt pump) or 5.5–9 (24-volt pump)				
Pressure cap rating, kPa (psi)	97 (14)				

Generator Model	6EOD/ 4.5EFOD
Number of cylinders	3
Type	4 cycle
Cylinder block material	Cast iron
Cylinder head material	Cast iron
Crankshaft material	Forged steel
Piston rings	2 compression/1 oil
Connecting rod material	Cast iron
Governor	All speed, mechanical
Engine firing order (#1 cylinder on flywheel side)	1–2–3
Direction of rotation (as viewed from flywheel)	Counterclockwise
Combustion system	Indirect injection
Bore x stroke, mm (in.)	67 x 72 (2.64 x 2.83)
Displacement L (CID)	0.762 (46.5)
Compression ratio	23.5:1
Max. power at rated RPM, 60/50 Hz, HP	10.19/8.18
RPM 60/50 Hz	1800/1500
Lubrication system	Pressure, trochoid pump
Lube oil capacity, w/filter L (U.S. qts.)	3.05 (3.2)
Oil recommendation (API)	CD or CF class
Fuel recommendation (API)	Diesel–ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.)
Fuel shutoff solenoid	Electric
Fuel pump	Mechanical
Fuel pump priming	N/A
Max. recommended fuel pump lift, m (ft.)	0.9 (3.0)
Battery voltage	12 volts
Battery charging	18-amp alternator
Battery recommendation (minimum)	500 CCA, 100 amp hr.
Starter motor	0.8 kW Bendix automotive type
Recommended coolant	50% ethylene glycol; 50% clean, softened water
Coolant capacity, approx. L (U.S. qts.) add 0.24 L (8 oz.) for coolant recovery tank	2.0 (2.1)
Thermostat, °C (°F)	82 (179)
High exhaust temperature shutdown, °C (°F)	N/A

Low oil pressure shutdown, kg/cm^2 ± 0.1 kg/cm^2 (psi)	0.5 (7.1)
Seawater inlet water line hose ID, mm (in.)	1/2 NPT with sound shield 19 (0.75) without sound shield
Water cooled exhaust outlet hose ID, mm (in.)	51 (2) with sound shield 51 (2) without sound shield
Fuel inlet size	3/8 NPT with sound shield 8 (0.31) without sound shield
Fuel return size	1/4 NPT with sound shield 5 (0.19) without sound shield
Fuel injection pressure, kg/cm^2 (psi)	120 (1707)
Intake/exhaust valve lash (cold), mm (in.)	0.2 (0.0078)
Fuel pump static pressure, kPa psi	34 (5)
Pressure cap rating, kPa (psi)	96 (14)

1.3 Generator, 4 Lead

Component Specification	6EOD 4.5EFOD
Main field (rotor) resistance (cold)—ohms @ 20°C (68°F)	4.4–5.0
Stator output voltages with separately excited generator, using 12-volt battery (60 Hz only)	
1–2, 3–4—volts	130
55–66—volts	155
Cold stator resistance	
1–2, 3–4—ohms	0.19
55–66—ohms	2.7

Component Specification	8EOZD/ 6.5EFOZD	9EOZD/ 7EFOZD	10EOZD/ 9EFOZD	13EOZD/ 11EFOZD	15EOZD/ 15.5EOZD/ 13EFOZD
Hot exciter field voltage/amperage readings at rated voltage					
No load (63 Hz)—volts/amps	4/0.9	4/0.9	4/0.8	4/0.7	4/0.7
Full load (60 Hz)—volts/amps	9/1.5	9/1.5	12/2.2	12/1.8	14/2.3
Exciter field resistance (cold)—ohms @ 20°C (68°F)	4.8	4.8	4.8	5.8	5.8
Exciter armature resistance (cold)—ohms (line-to-line)	1.18	1.18	1.18	0.51	0.51
Main field (rotor) resistance (cold)—ohms @ 20°C (68°F)	5.0	5.0	5.7	4.3	2.9
Stator output voltages with separately excited generator, using 12-volt battery (60 Hz only)					
1–2, 3–4—volts	135	135	135	135	135
55–66—volts	180	180	180	180	180
Cold stator resistance					
1–2, 3–4—ohms	0.26	0.26	0.19	0.12	0.12
55–66—ohms	2.11	2.11	1.89	1.46	1.46

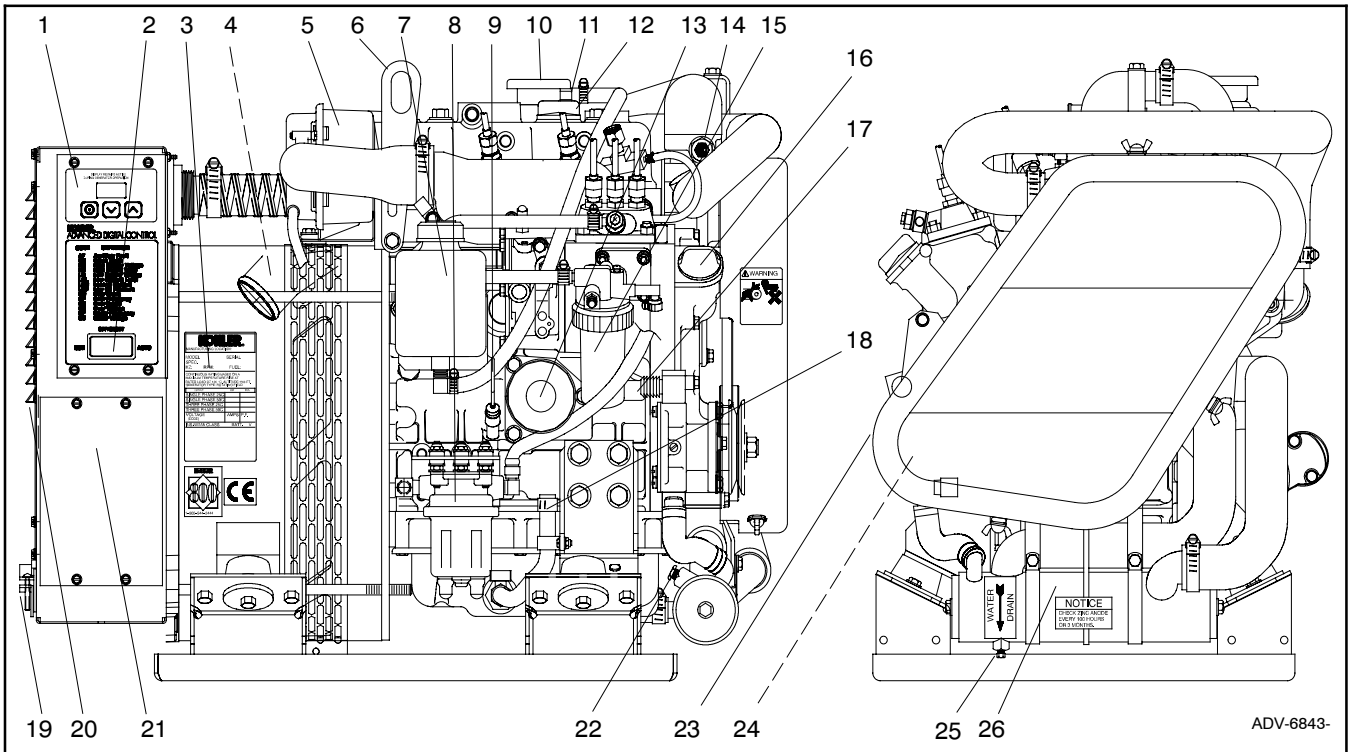
Component Specification	20EOZD/ 17EFOZD	23EOZD/ 20EFOZD	28EOZD/ 23EFOZD/ 25EFOZD	32EOZD/ 27EFOZD/ 28EFOZD
Hot exciter field voltage/amperage readings at rated voltage				
No load (63 Hz)—volts/amps	6/1.0	6/1.0	18/0.7	18/0.7
Full load (60 Hz)—volts/amps	14/2.1	16/2.4	42/1.6	45/1.7
Exciter field resistance (cold)—ohms @ 20°C (68°F)	5.8	5.8	22.7 ±2.3	22.7 ±2.3
Exciter armature resistance (cold)—ohms (line-to-line)	0.51	0.51	0.601 ±0.045	0.601 ±0.045
Main field (rotor) resistance (cold)—ohms @ 20°C (68°F)	3.0	3.0	2.24	2.24
Stator output voltages with separately excited generator, using 12-volt battery (60 Hz only)				
1–2, 3–4—volts	95	95	84	84
55–66—volts	125	125	148	148
Cold stator resistance				
1–2, 3–4—ohms	0.07	0.07	0.040	0.040
55–66—ohms	1.26	1.26	1.70	1.70

1.4 Generator, 12 Lead

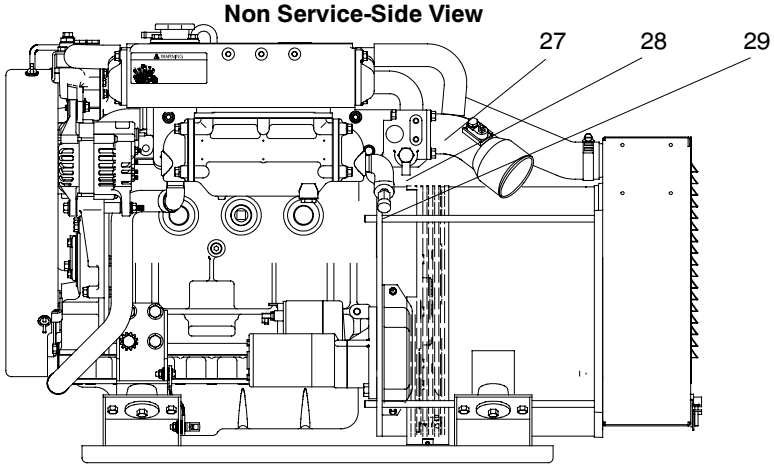
Component Specification	10EOZD/ 8.5EFOZD	14EOZD/ 11.5EFOZD	20EOZD/ 17.5EFOZD	24EOZD/ 20EFOZD
Hot exciter field voltage/amperage readings at rated voltage				
No load (63 Hz)—volts/amps	4/0.9	6/0.9	8/1.4	8/1.4
Full load (60 Hz)—volts/amps	12/2.2	17/2.6	14/2.1	16/2.4
Exciter field resistance (cold)—ohms @ 20°C (68°F)	4.8	5.8	5.8	5.8
Exciter armature resistance (cold)—ohms (line-to-line)	1.18	0.51	0.51	0.51
Main field (rotor) resistance (cold)—ohms @ 20°C (68°F)	5.7	2.9	3.0	3.0
Stator output voltages with separately excited generator, using 12-volt battery (60 Hz only)				
1-4, 2-5, 3-6, 7-10, 8-11, 9-12—volts	150	145	140	140
55-66—volts	170	165	158	158
Cold stator resistance				
1-4, 2-5, 3-6, 7-10, 8-11, 9-12—ohms	0.09	0.06	0.04	0.04
55-66—ohms	2.5	1.5	1.3	1.3

Component Specification	28EOZD/ 23EFOZD/ 25EFOZD	32EOZD/ 27EFOZD/ 28EFOZD
Hot exciter field voltage/amperage readings at rated voltage		
No load (63 Hz)—volts/amps	21/0.8	21/0.8
Full load (60 Hz)—volts/amps	64/2.3	70/2.5
Exciter field resistance (cold)—ohms @ 20°C (68°F)	22.7 ±2.3	22.7 ±2.3
Exciter armature resistance (cold)—ohms (F1-F2, F1-F3, F2-F3)	0.601 ±0.045	0.601 ±0.045
Main field (rotor) resistance (cold)—ohms @ 20°C (68°F)	2.24	2.24
Stator output voltages with separately excited generator, using 12-volt battery (60 Hz only)		
1-4, 2-5, 3-6, 7-10, 8-11, 9-12—volts	84	84
55-66—volts	150	150
Cold stator resistance		
1-4, 2-5, 3-6, 7-10, 8-11, 9-12—ohms	0.094	0.094
55-66—ohms	2.1	2.1

1.5 Service Views



13-24EOZD & 11-20EFOZD Models
Non Service-Side View



1. ADC 2100 Control
2. Run-Off/Reset-Auto switch
3. Nameplate
4. Mixing elbow (water outlet/exhaust outlet)
5. Air intake silencer
6. Lifting eye
7. Coolant overflow bottle (location varies by model)
8. Fuel feed pump
9. Oil check
10. Pressure cap
11. Overflow tube
12. Oil fill
13. Lube oil filter
14. High engine temperature sensor
15. Fuel filter
16. Oil fill
17. Seawater pump (water inlet)
18. Oil drain valve and hose
19. Strain relief for the load lead cable
20. Cooling air inlet
21. AC circuit breaker coverplate
22. Anticorrosion zinc anode (seawater drain) (all models except 13-24EOZD & 11-20EFOZD models)
23. Belt guard
24. V-belts
25. Coolant (freshwater) drain (all models except 13-24EOZD & 11-20EFOZD models)
26. Heat exchanger (all models except 13-24EOZD & 11-20EFOZD models)
27. Heat exchanger (13-24EOZD & 11-20EFOZD models)
28. Seawater drain (13-24EOZD & 11-20EFOZD models)
29. Coolant (freshwater) drain (13-24EOZD & 11-20EFOZD models)

Figure 1-2 Service Views—Typical (8EOZD Model Shown Unless Noted)

1.6 Torque Specifications

Follow the general torque specification found in Appendix C of this manual unless noted below.

Generator Model	6EOD/ 4.5EFOD
Overbolts	9.5 Nm (7.0 ft. lbs.)
Back plate mtg. bolts	15 Nm (11 ft. lbs.)
Flywheel bolts	73 Nm (54 ft. lbs.)
Drive disc	45 Nm (34 ft. lbs.)
Fan to flywheel stud	23 Nm (17 ft. lbs.)
Fan to flywheel nut	23 Nm (17 ft. lbs.)
SCR to junction box	4 Nm (35 in. lbs.)

Generator Model	8EOZD/ 6.5EFOZD	9EOZD/ 7EFOZD	10EOZD/ 8.5EFOZD 9EFOZD	13EOZD/ 11EFOZD	14EOZD/ 11.5EFOZD	15EOZD/ 15.5EOZD/ 13EFOZD
Overbolts	34 Nm (25 ft. lbs.)					
Rotating diode board	38 Nm (28 ft. lbs.)					
Crankshaft pulley	36.6 Nm (27 ft. lbs.)					
Thermostat housing	21.6 Nm (192 in. lbs.)	23 Nm (17 ft. lbs.)	21.6 Nm (192 in. lbs.)			
Exhaust manifold	19 Nm (14 ft. lbs.)					
Seawater pump pulley	38-41 Nm (28-30 ft. lbs.)	37 Nm (27 ft. lbs.)	38-41 Nm (28-30 ft. lbs.)			
Back plate to engine block	37 Nm (27 ft. lbs.)					
Rotor hub to flex. disc	38 Nm (28 ft. lbs.)					
Flex disc to flywheel	19 Nm (14 ft. lbs.)					
Flywheel bolts	78.5-88.3 Nm (58-65 ft. lbs.)	83.3-88.2 Nm (62-65 ft. lbs.)				
SCR to end bracket	4 Nm (35 in. lbs.)					

Generator Model	20EOZD/ 17EFOZD/ 17.5EFOZD (1 and 3 Ph.)	23EOZD/ 20EFOZD	24EOZD/ 20EFOZD	28EOZD/ 23EFOZD/ 25EFOZD (1 and 3 Ph.)	32EOZD/ 27EFOZD/ 28EFOZD (1 and 3 Ph.)
Overbolts	34 Nm (25 ft. lbs.)				
Rotating diode board	38 Nm (28 ft. lbs.)				
Back plate to engine block	36.6 Nm (27 ft. lbs.)				
Rotor hub to flex. disc	38 Nm (28 ft. lbs.)				
Flex disc to flywheel	19 Nm (14 ft. lbs.)				
Exhaust manifold	22.7 Nm (16.8 ft. lbs.)				
Thermostat housing	21.6 Nm (192 in. lbs.)				
Rotor fan to flywheel				45 Nm (34 ft. lbs.)	
Crankshaft pulley	36.6 Nm (27 ft. lbs.)				
Generator adapter (rear 1/2 to front 1/2)	N/A			53 Nm (39 ft. lbs.)	
Generator adapter to flywheel housing/backplate	37 Nm (27 ft. lbs.)			45 Nm (34 ft. lbs.)	
Seawater pump pulley	38-41 Nm (28-30 ft. lbs.)				
SCR to end bracket	4 Nm (35 in. lbs.)				

2.1 General

Schedule routine maintenance using the service schedule located in the generator set operation manual and the runtime hours shown on the ADC 2100. If the generator set will be subject to extreme operating conditions, service the unit accordingly.

Note: See the generator set operation manual for the service schedule and other service not included in this manual.

Note: High-mineral content seawater (salt water) can cause rapid destruction of metals. Wipe up all salt water spillage on and around the generator set and keep metal surfaces free from accumulated salt deposits.

⚠ WARNING

Accidental starting.
Can cause severe injury or death.

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

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (–) lead first. Reconnect the negative (–) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

⚠ 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.

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.

2.2 Lubrication System

Use oil that meets the American Petroleum Institute (API) classification of CD or CF. Using an unsuitable oil or neglecting an oil change may result in damage and a shorter engine life. Figure 2-1 and Figure 2-2 show the recommended Society of Automotive Engineers (SAE) viscosity designation for given operating temperature ranges.

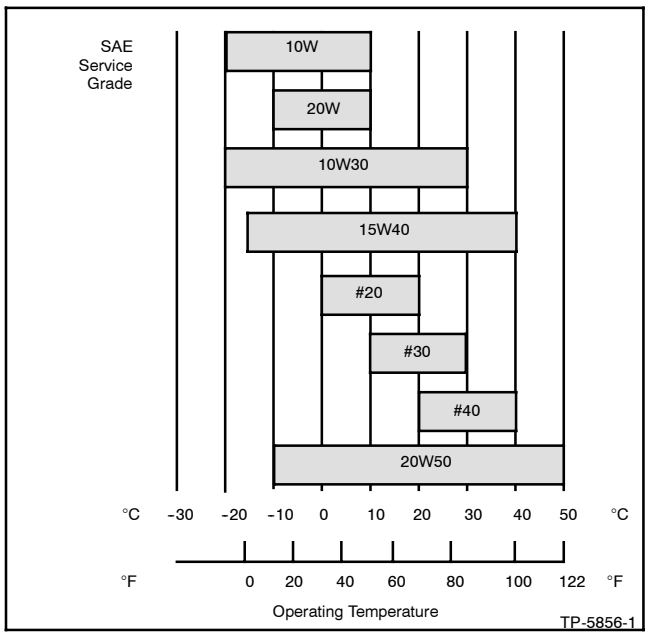


Figure 2-1 Engine Oil Selection for Models 8–32EOZD and 6.5–27EFOZD

Engine Oil Viscosity		
SAE Service Grade	**Ambient Temperature**	
	Minimum	**Maximum**
0W20	-40°C (-40°F)	10°C (50°F)
0W30	-40°C (-40°F)	30°C (86°F)
0W40	-40°C (-40°F)	40°C (104°F)
5W30	-30°C (-22°F)	30°C (86°F)
5W40	-30°C (-22°F)	40°C (104°F)
10W30	-20°C (-4°F)	40°C (104°F)
15W40	-10°C (14°F)	50°C (122°F)

Figure 2-2 Engine Oil Selection for Models 6EOD and 4.5EFOD

Note: Failure to observe the oil specifications may cause inadequate lubrication/oil pressure and cold-starting difficulties.

3.1 Air Intake Silencer/Cleaner

At the interval specified in the service schedule, clean *or replace* the air intake silencer element. Clean the silencer more frequently if the generator set operates in dirty, dusty conditions. Follow one of the procedures described below.

6EOD, 8/9/10EOZD, 4.5EFOD, and 6.5/7/9EFOZD Models:

A dry-type air cleaner silences and filters the intake air. The air intake silencer assembly connects to the intake manifold via a flexible hose.

Air Cleaner Service/Replacement Procedure:

1. Release the spring clips to open the housing and remove the air silencer element. See Figure 3-1.
2. Tap the element lightly against a flat surface to dislodge loose surface dirt. Do not clean in any liquid or use compressed air as these will damage the filter element.
3. Examine the element and housing for damage and wear. Replace the element or housing if necessary.
4. Wipe the cover and base with a clean rag to remove any dirt. Make sure that the sealing surfaces fit correctly, and reattach the spring clips.

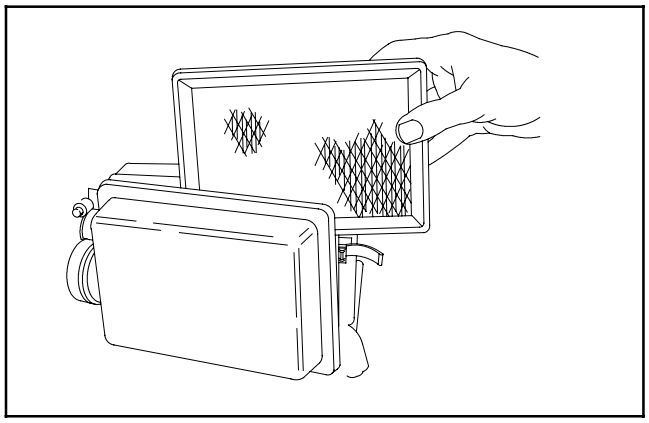
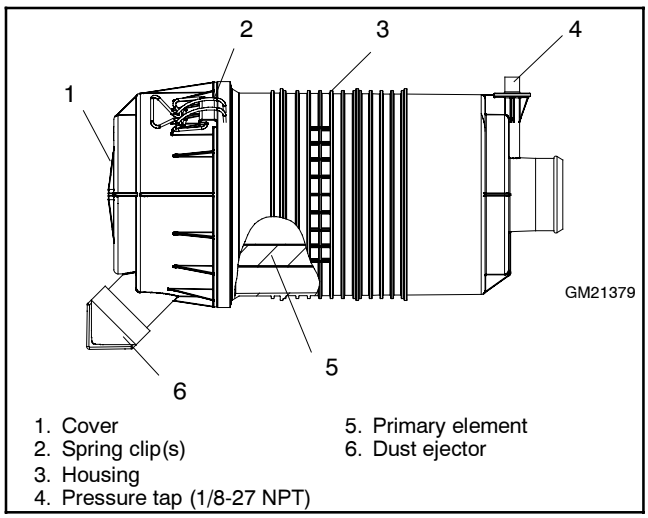


Figure 3-1 Air Cleaner Element Element

13/20/28/32EOZD and 11/17/17.5/23/25/27/28EFOZD Models:

A dry-type air cleaner silences and filters the intake air. The air intake silencer assembly connects to the intake manifold via a flexible hose. Refer to Figure 3-2 during this procedure.



1. Cover
2. Spring clip(s)
3. Housing
4. Pressure tap (1/8-27 NPT)
5. Primary element
6. Dust ejector

Figure 3-2 Air Cleaner

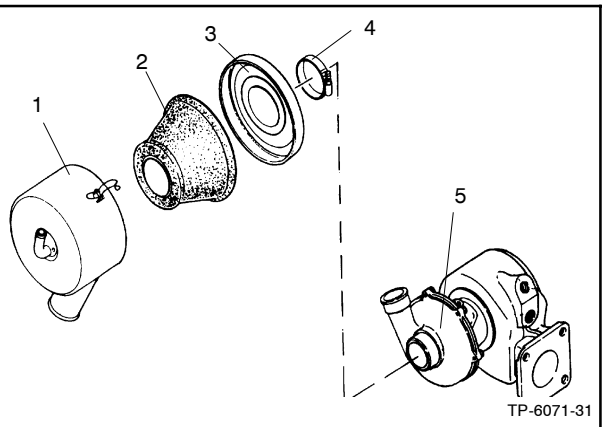
1. Release the spring clips to open the housing and remove the air silencer element.
2. Tap the element lightly against a flat surface to dislodge loose surface dirt. Do not clean the element in any liquid or use compressed air as these will damage the filter element.
3. Examine the element and housing for damage. Replace the element or housing if necessary.
4. Wipe the cover and housing with a clean rag to remove dirt. Make sure the sealing surfaces fit correctly and reattach the spring clips.

14/15/15.5/23/24EOZD and 11.5/13/20EFOZD Models:

These models use a round, polyurethane, sound-absorbing-type intake silencer to silence the intake air drawn into the cylinder head from the intake port. Besides providing a silencing effect, the silencer also acts as an air cleaner. Clean the silencer more frequently if operating in dirty, dusty conditions. See Figure 3-3 and refer to the following procedure.

Air Intake Silencer Cleaning Procedure:

1. Remove the intake silencer cover.
2. Remove the element from the cover and inspect it. To clean the element, continue to step 3. If the element is damaged or in poor condition, replace the element; skip step 3 and go to step 4. If the element is clean go to step 6.



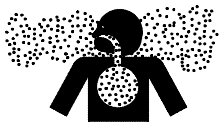
1. Air intake silencer cover
2. Air intake silencer element
3. Base
4. Clamp
5. Turbocharger

Figure 3-3 Air Intake Silencer

3. Wash the element in mild detergent and water solution. Rinse the element and allow it to air dry.
4. Lightly coat the foam element with oil.
5. Squeeze out any excess oil.
6. Wipe the cover and base with a clean rag to remove any dirt. Replace the base if it is damaged.
7. Reassemble the element and cover assembly to the intake silencer base. Make sure the sealing surfaces fit properly.
8. Direct the air intake silencer duct down and away from engine.

3.2 Exhaust System Inspection

⚠ WARNING



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

The exhaust system must be leakproof and routinely inspected.

Inspecting the exhaust system. Carbon monoxide can cause severe nausea, fainting, or death. For the safety of the craft's occupants, install a carbon monoxide detector. Never operate the generator set without a functioning carbon monoxide detector. Inspect the detector before each generator set use.

At the interval specified in the service schedule, inspect the exhaust system components (exhaust manifold, mixing elbow, exhaust hose, hose clamps, silencer, and outlet flapper) for cracks, leaks, and corrosion.

Ensure that the carbon monoxide detector(s) is (1) in the craft, (2) functional, and (3) energized whenever the generator set operates.

For your safety: Never operate the generator set without a functioning carbon monoxide detector(s) for your safety and the safety of others on your vessel.

Exhaust System Inspection Points

Check for exhaust leaks and blockages. Check the silencer and piping condition and check for tight exhaust system connections.

- Check the hoses for softness, cracks, leaks, or dents. Replace the hoses as needed.
- Check for corroded or broken metal parts and replace them as needed.
- Check for loose, corroded, or missing clamps. Tighten or replace the hose clamps and/or hangers as needed.
- Check that the exhaust outlet is unobstructed.
- Visually inspect the exhaust system for exhaust leaks *(blowby)*. Check for carbon or soot residue on exhaust components. Carbon and soot residue indicates an exhaust leak. Seal leaks as needed.

3.3 Servicing Mixing Elbow

The mixing elbow combines high-temperature exhaust with cooling seawater. See the operation manual for mixing elbow scheduled maintenance.

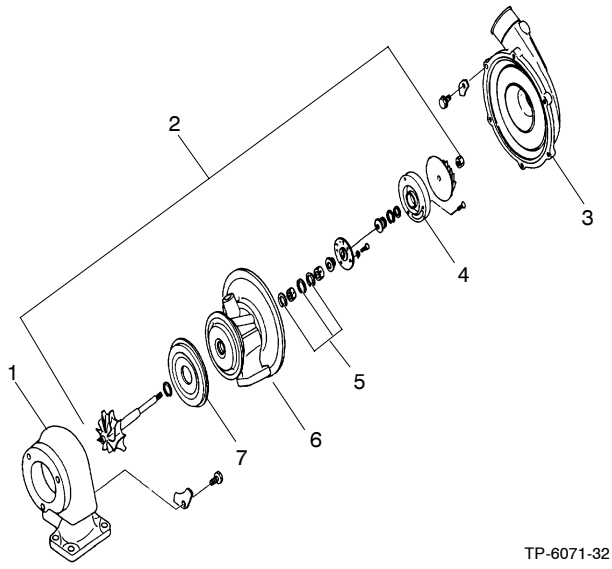
1. Check the mixing elbow for carbon buildup and corrosion inside the pipe.
2. Clean or replace the mixing elbow as necessary.
3. Inspect the exhaust manifold mounting threads for cracking and corrosion.

3.4 Turbocharger (Models: 14/15/15.5/23/24EOZD and 11.5/13/20EFOZD)

Inspect the compressor (blower) at the specified interval for build-up of carbon residue. Perform all other turbocharger inspection and service as described in the service schedule of the engine service manuals. See Figure 3-4 and Figure 3-5 to inspect the compressor.

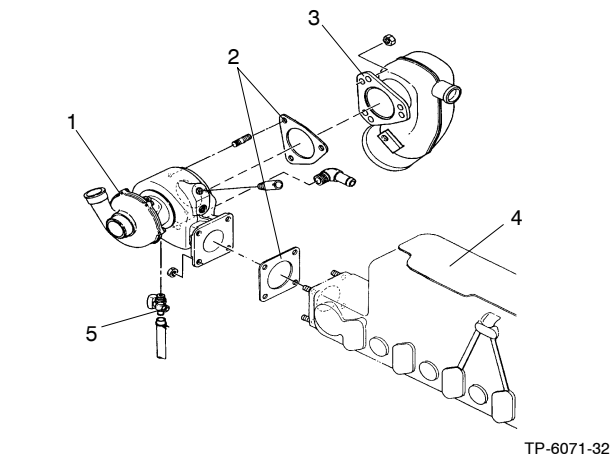
Compressor Inspection:

1. Remove the breather hose from the air intake silencer connector, if equipped.
2. Remove the air intake silencer.
3. Inspect the compressor (blower) housing and the impeller (blower wheel) for buildup of carbon residue. Use a Yanmar approved turbocharger cleaner, if cleaning is required.
4. Place the air intake silencer over the turbocharger compressor housing inlet and tighten the clamp.
5. Attach the breather hose to the air intake silencer connector, if equipped.



1. Compressor housing
2. Rotor assembly (turbo)
3. Housing assembly (blower)
4. Plate assembly (seal)
5. Circlips
6. Housing assembly (bearing)
7. Heat protector

Figure 3-4 Turbocharger Inspection



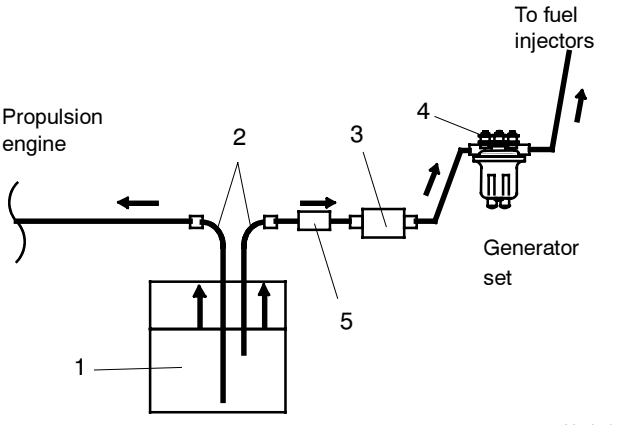
1. Turbocharger assembly
2. Gaskets
3. Exhaust elbow
4. Exhaust manifold
5. Petcock PT 1/8

Figure 3-5 Turbocharger Components, Typical

Notes

4.1 General

In most installations, both the generator set and the propulsion engine operate from a common fuel tank with a dual dip tube arrangement. The generator set's dip tube is shorter than the propulsion engine's dip tube. With this arrangement fuel may not be available to the generator set when the fuel supply is low. See Figure 4-1 for a fuel system schematic.



1. Fuel tank
2. Dual dip tubes
3. Fuel filter
4. Fuel feed pump
5. Water trap

Figure 4-1 Fuel System Schematic, Typical

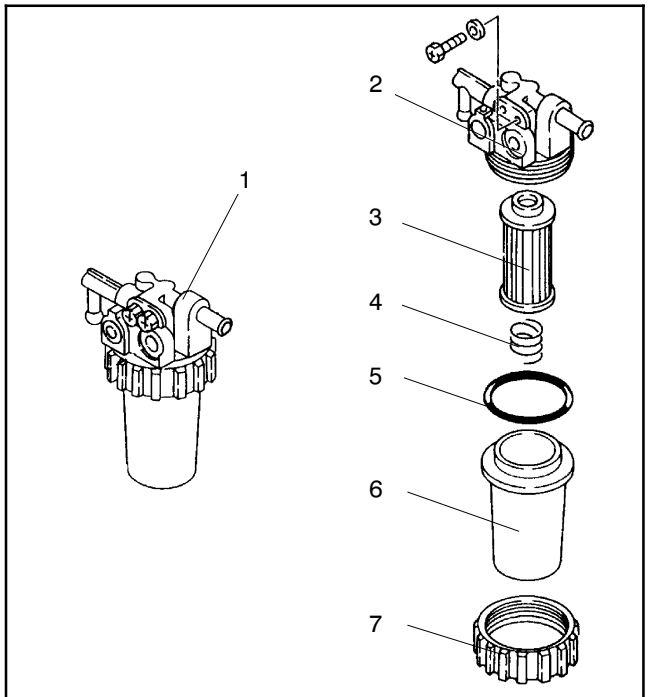
4.2 Fuel Filter

Clean the fuel filter with fresh fuel oil and compressed air. The filter's useful life will be determined largely by the quality and condition of the fuel used. Under normal conditions, replace the fuel filter element at the specified interval in the generator set's operation manual. Use the following procedure to replace the fuel filter.

Fuel Filter Replacement Procedure

8/9EOZD and 6.5/7EFOZD Models:

1. Place the generator set on/off switch in the OFF position.
2. Disconnect the generator set engine starting battery, negative (-) lead first.
3. Close the fuel supply valve.
4. Remove the retaining ring, filter cup, o-ring, fuel filter element and spring.
5. Wipe off all parts with a clean rag. Inspect all mating surfaces and threads for damage; replace as necessary.
6. Replace the fuel filter element and install as shown in Figure 4-2.
7. Open the fuel supply valve.
8. Reconnect the generator set engine starting battery, negative (-) lead last.
9. Bleed the system. See Section 4.2.1, Bleeding the Fuel System.

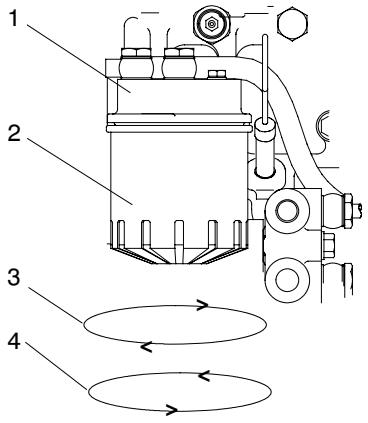


1. Fuel strainer assembly
2. Body
3. Fuel element
4. Spring
5. O-ring
6. Filter cup
7. Retaining ring

Figure 4-2 Fuel Oil Filter Element

6EOD, 10-32EOZD, 4.5EFOD, and 9-28EFOZD Models:

1. Place the generator set on/off switch in the OFF position.
2. Disconnect the generator set engine starting battery, negative (-) lead first.
3. Close the fuel supply valve.
4. Loosen the fuel filter by turning it counterclockwise. Remove the fuel filter and use rags to clean up spilled fuel oil. Dispose of the fuel filter and rags in an approved manner.
5. Clean the contact surface of the fuel oil filter adapter.
6. Lightly lubricate the gasket surface of the new fuel filter with fresh fuel oil. Thread the filter on the adapter until the gasket makes contact; hand-tighten the filter an additional one-half turn. Wash hands after any contact with fuel oil.
7. Open the fuel supply valve.
8. Reconnect the generator set engine starting battery, negative (-) lead last.
9. Bleed the system. See Section 4.2.1, Bleeding the Fuel System.



1. Fuel filter adapter
2. Fuel filter
3. Removal (counterclockwise)
4. Installation (clockwise)

Figure 4-3 Spin-On Fuel Oil Filter

4.2.1 Priming the Fuel System

Prime the fuel system to bleed the air from the system. Trapped air in the fuel system can cause difficult starting and erratic engine operation.

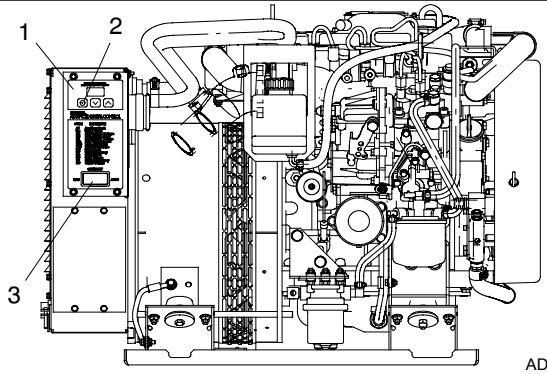
Prime the fuel system under the following conditions:

- Before starting the engine for the first time.
- After running out of fuel and adding fuel to the tank.
- After fuel system maintenance such as changing the fuel filter, draining the fuel/water separator, or replacing a fuel system component.

Fuel System Priming Procedure (Preferred)

Note: To prevent damage to the starter motor, do not crank the engine to prime the fuel system. Use the following procedure.

1. Press and hold the Select button located on the ADC. See Figure 4-4.
2. Move the generator set master switch to the RUN position to enter the programming mode.
3. Continue to hold the Select button for 10 seconds. The ADC will display “Fuel” and the fuel priming pump will start.
4. Continue to hold the Select button for as long as you want the fuel priming pump to function (typically 10 seconds).
5. Release the Select button and move the Master switch to the OFF position.
6. Place the Master switch to the RUN position to start the unit.



1. ADC control
2. Select button
3. Generator set master switch

Figure 4-4 ADC Control

Fuel System Priming Procedure

If the above priming procedure does not accomplish adequate fuel system priming, use the following procedure.

Note: Connect the battery during the priming procedure to allow engine cranking.

Note: If the ADC 2100 indicates an overcrank fault during this procedure, disconnect the negative wire from the fuel solenoid (allowing the fuel injection pump to fill with fuel) and repeat this procedure after allowing the starter motor to cool down.

Note: Have a rag handy during the bleeding procedure. Wipe up all spilled diesel fuel after bleeding the system. Wash hands after any contact with fuel oil.

Procedure to Bleed the Fuel System

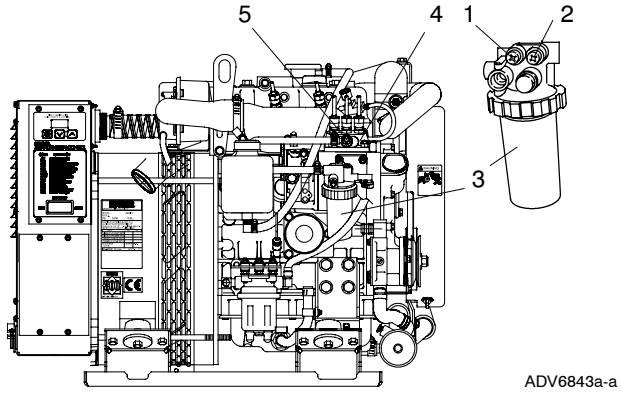
8/9EOZD and 6.5/7EFOZD Models and 13-32EOZD and 11-27EFOZD Models with Specs: GM33035-GA1/GA2, GM33036-GA1/GA2, and GM33037-GA1/GA2

1. Loosen the fuel filter screw at position 1. See Figure 4-5.
2. Initiate the auto/start sequence until fuel, free of air bubbles, flows from the vent screw at position 1. Tighten the screw.
3. Loosen the fuel filter screw at position 2.
4. Initiate the auto/start sequence until fuel, free of air bubbles, flows from the vent screw at position 2. Tighten the screw.
5. Loosen the fuel injection pump screw at position 5.
6. Initiate the auto/start sequence until fuel, free of air bubbles, flows from the vent screw at position 5. Tighten the screw.

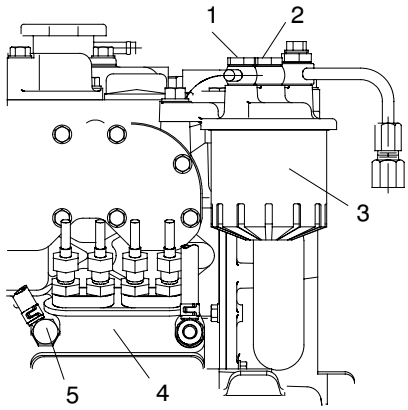
6EOD, 10-32EOZD, 4.5EFOD, and 9-28EFOZD Models

1. Loosen the fuel injection pump screw. See Figure 4-5.
2. Initiate the auto/start sequence until fuel, free of air bubbles, flows from the injection pump screw.
3. Tighten the fuel injection pump screw.

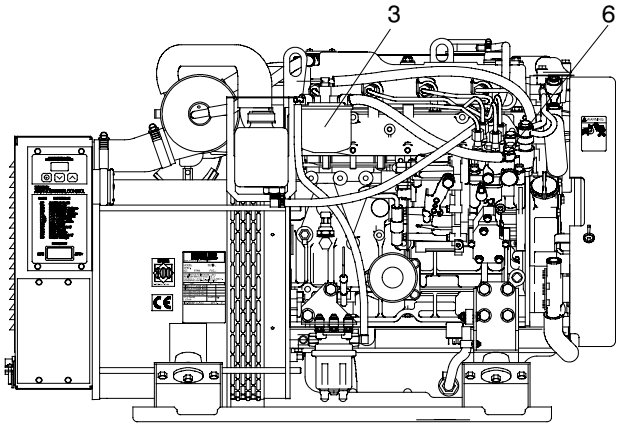
8/9EOZD and 6.5/7EFOZD Models



13-32EOZD & 11-27EFOZD Models with Specs: GM33035-GA1/GA2, GM33036-GA1/GA2, & GM33037-GA1/GA2



6EOD, 10-32EOZD, 4.5EFOD, and 9-28EFOZD Models



1. Vent screw, position 1
2. Vent screw, position 2
3. Fuel filter
4. Fuel injection pump
5. Vent screw, position 5
6. Fuel injection pump screw

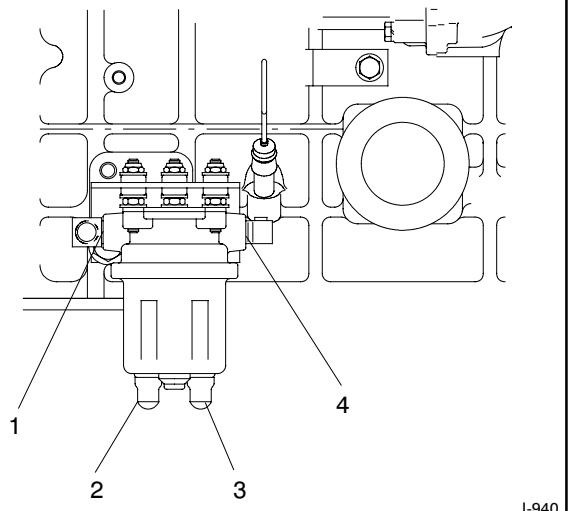
Figure 4-5 Fuel System (Typical)

4.3 Fuel Pump (8-32EOZD and 6.5-28EFOZD Models)

The fuel pump transfers fuel from a source to the injection pump.

Fuel Pump Test Procedure:

1. Remove the two leads at the bottom of the fuel pump. The pump terminals are labeled (-) and (+). See Figure 4-6.
2. Connect the inlet side of the pump to a fuel source. Disconnect the outlet hose from the fuel filter and place the hose end in a container to catch the fuel.
3. Connect the positive (+) terminal of a 12-volt battery to the positive terminal of the fuel pump. Connect the negative terminal of the fuel pump to the negative (-) terminal of the battery. You should hear the pump operate and see fuel discharge from the pump outlet. Replace the pump if it does not operate.
4. Connect a pressure gauge to the outlet side of the fuel pump. Repeat step 3. See Section 1 for the specified fuel pump pressure ratings.



1. Fuel inlet
2. Negative (-) terminal
3. Positive (+) terminal
4. Fuel outlet

Figure 4-6 Fuel Pump

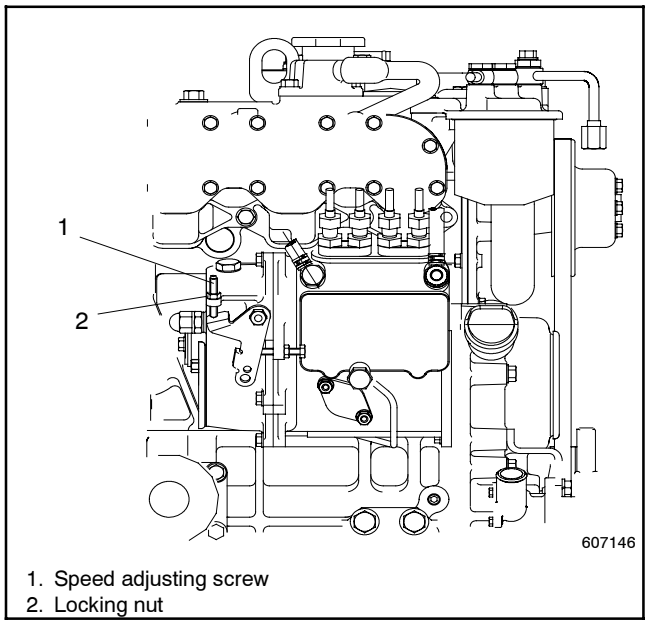
4.4 Governor

The centrifugal, mechanical governor keeps the engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. The governor requires no regular service. The factory adjusts the governor during run-in, and further adjustment should not be needed unless greatly varying load conditions are encountered or if poor governor control develops after extended usage.

60 Hz generator sets are designed to operate in the range of 57-63 Hz (1800 rpm under full load and 1890 rpm under no load).

50 Hz generator sets are designed to operate in the range of 47-53 Hz (1500 rpm under full load and 1590 rpm under no load).

To check the engine speed, use a frequency meter connected to the load leads or use a hand tachometer. If adjustment is needed, loosen the locking nut on the speed adjusting screw. Turn the screw clockwise to increase the speed (and frequency). To decrease the speed, turn the screw counterclockwise. Tighten the locking nut when the correct setting is reached. See Figure 4-7.



1. Speed adjusting screw
2. Locking nut

Figure 4-7 Governor Adjustment

The generators use a 3-lead fuel solenoid. This solenoid has a white lead (P) which energizes the pull-in coil only during cranking. During operation, the red lead energizes the hold coil and the black lead is the common ground.

5.1 General

Heat exchanger cooling consists of a heat exchanger with coolant recovery tank, thermostat, rubber impeller seawater pump, centrifugal-type engine circulating pump, water-cooled exhaust manifold, and an exhaust mixer. See Figure 5-1 for cooling system components.

⚠ WARNING

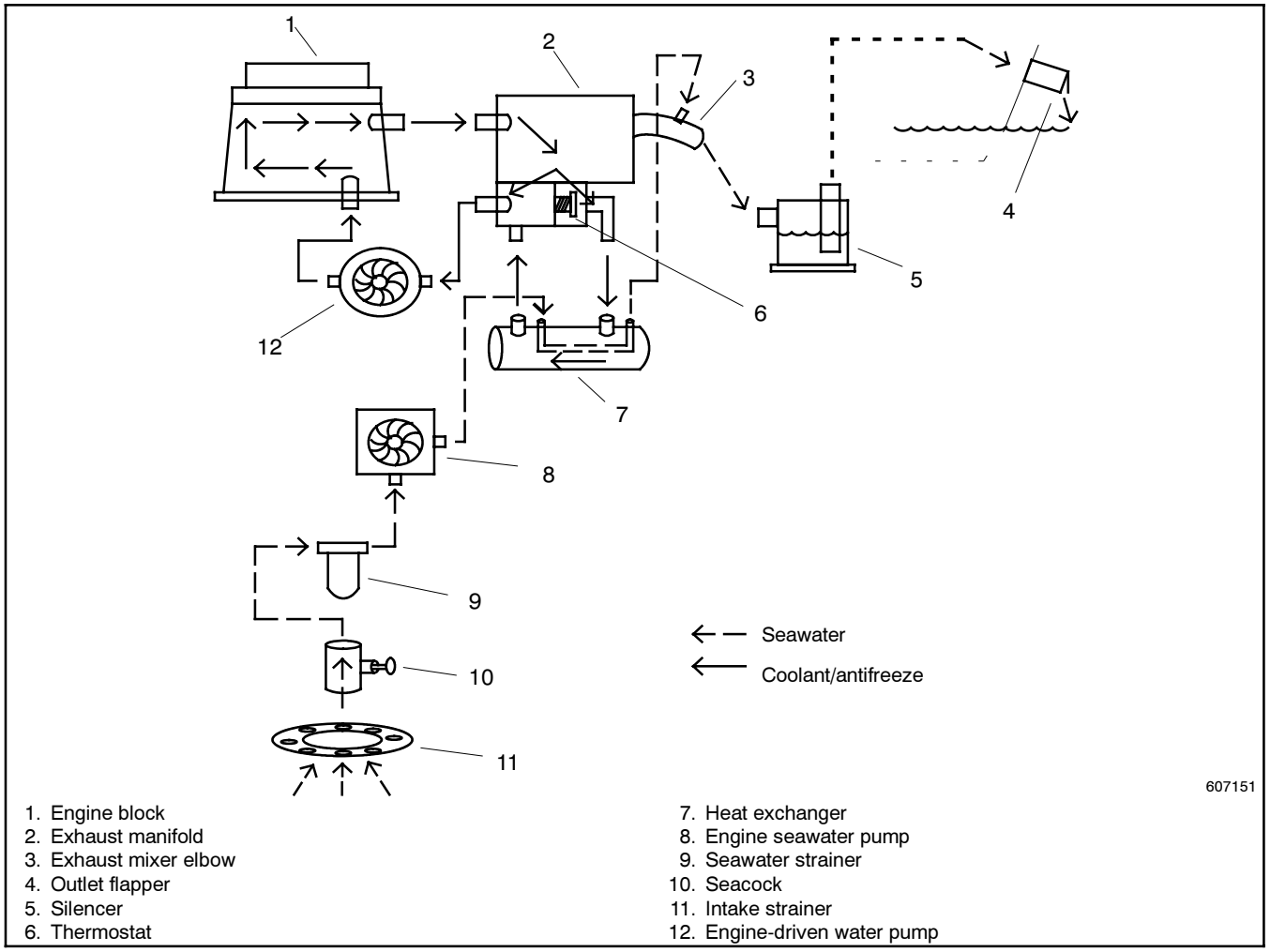
Hot coolant and steam.
Can cause severe injury or death.

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

Allow the engine to cool. Release pressure from the cooling system before removing the pressure cap. To release pressure, cover the pressure cap with a thick cloth and then slowly turn the cap counterclockwise to the first stop. Remove the cap after pressure has been completely released and the engine has cooled. Check the coolant level at the tank if the generator set has a coolant recovery tank.

NOTICE

Saltwater damage. Saltwater quickly deteriorates metals. Wipe up saltwater on and around the generator set and remove salt deposits from metal surfaces.



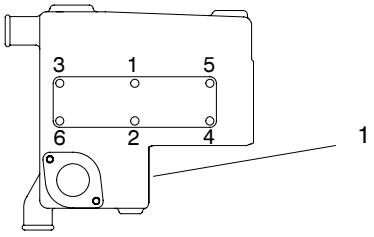
1. Engine block
2. Exhaust manifold
3. Exhaust mixer elbow
4. Outlet flapper
5. Silencer
6. Thermostat
7. Heat exchanger
8. Engine seawater pump
9. Seawater strainer
10. Seacock
11. Intake strainer
12. Engine-driven water pump

Figure 5-1 Cooling System Components

5.2 Water-Cooled Exhaust Manifold

Each marine generator set has a water-cooled exhaust manifold. The coolant solution circulates through the manifold, reducing the amount of heat radiated from the exhaust into the surrounding area.

The engine thermostat is located in the water-cooled exhaust manifold. See Figure 5-2. See Section 1 for the water-cooled exhaust manifold torque spec.



1. Thermostat housing

Figure 5-2 Thermostat Location (10EOZD model shown)

5.3 Closed Heat Exchanger

In a closed cooling system, seawater circulates through separate chambers within the heat exchanger to cool the engine coolant. The seawater then mixes with engine exhaust and ejects out of the exhaust outlet. See Section 1 for coolant capacity, thermostat and pressure cap ratings.

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

5.4 Check and Fill Coolant

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

Maintain the coolant level in the coolant recovery tank at approximately 1/4 full. Before filling the cooling system, close all petcocks and tighten all hose clamps. Use a solution of 50% ethylene glycol and 50% clean, softened water to inhibit rust/corrosion and prevent freezing. Add coolant, as necessary, to the coolant recovery tank. Periodically check the coolant level on closed systems by removing the pressure cap. Do not rely solely on the level in the coolant recovery tank. Add fresh coolant until level is just below the overflow tube opening.

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

5.5 Flush and Clean Cooling System

For optimum protection, drain, flush, and refill the cooling system at the interval listed in the service schedule.

Pay special attention to the coolant level. When refilling the cooling system, allow time for complete refill of the engine water jacket. Check the coolant level as described in Section 5.4.

Flush and Clean Procedure:

1. Remove the water drain pipe plug located at the heat exchanger and completely drain the system.
2. Remove the pressure cap to make draining easier.
3. Drain, clean, and flush the cooling system and the coolant recovery tank with clean water.
4. Replace the water drain pipe plug.
5. Fill the cooling system with recommended coolant.
6. Replace the pressure cap.

5.6 Pressure Cap

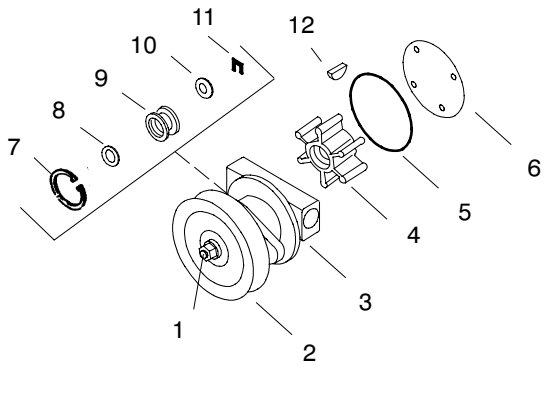
Closed heat exchanger systems utilize a pressure cap to raise the boiling point of the coolant, enabling proper operating temperatures. If the cap leaks, replace it with a cap of the same rating. See Section 1, Specifications. The pressure cap typically has the pressure rating stamped on the cap body.

5.7 Impeller Inspection and Replacement

The belt-driven seawater pump is located on the service side of the generator set. Check and change the seawater pump impeller at the interval specified in the service schedule. Follow the instructions included with the impeller kit. If the instructions are not included with the kit, use the following procedure.

Impeller Inspection and Replacement Procedure:

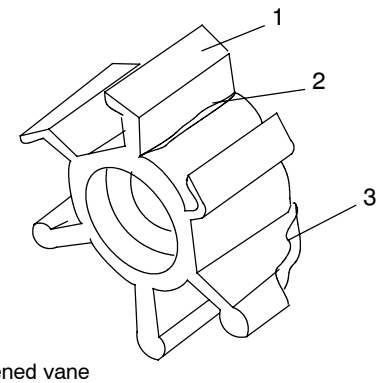
1. Close the seacock.
2. Remove the seawater pump coverplate. See Figure 5-3.



1. Drive shaft assembly
2. Pulley
3. Housing
4. Impeller
5. Gasket
6. Cover plate
7. Snap ring
8. Brass washer
9. Seal
10. Ceramic seat
11. Rubber seat
12. Key (impeller end)

Figure 5-3 Seawater Pump, Typical

3. Remove the impeller.
4. Inspect the impeller for damage, including cracks, broken or flattened vanes. The impeller vanes should be straight and flexible. See Figure 5-4.



1. Flattened vane
2. Crack
3. Broken vane

Figure 5-4 Worn Impeller

5. Lubricate the impeller with soapy water before installation.
6. While installing the impeller, always rotate the drive shaft and the impeller together in the same direction as the engine rotation.
7. Inspect the coverplate and gasket for corrosion and/or damage. Replace components as necessary.

8. Lubricate the gasket with silicon grease and attach the gasket and coverplate to the seawater pump housing.

9. Open the seacock.

10. Start the generator set and check for leaks.

11. Stop the generator set and repair leaks or replace components as necessary.

5.8 Belt Tension

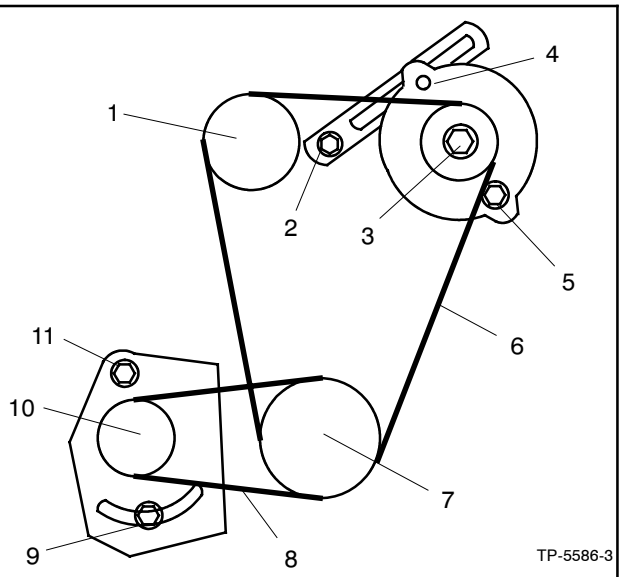
⚠ WARNING

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

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

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.

Check the belt tensions at the interval specified in the service schedule. If tensions are not within the specifications, adjust as necessary using the following procedures.



1. Engine-driven water pump pulley
2. Adjusting arm pivot screw
3. Battery charging alternator pulley
4. Alternator adjusting screw
5. Alternator pivot screw
6. Check the alternator belt tension here
7. Crankshaft pulley
8. Check the seawater pump belt tension here
9. Seawater pump adjusting screw
10. Seawater pump pulley
11. Pivot screw

Figure 5-5 Belt Tension (Typical)

5.8.1 Seawater Pump Belt Tensioning Procedure

1. Remove the belt guard.

2. Check the belt tension at the midpoint of the longest span of the belt using a belt-tensioning tool set to 55 ft. lbs. See Figure 5-5. Recheck a new belt tension after 10 minutes of operation.

   Note: If the belt tension is not within specifications, go to step 3. If the belt tension is within specifications, go to step 7.

3. Loosen the pivot and adjusting screws.

4. While prying the seawater pump outward, tighten the adjusting screw.

5. Tighten the pivot screw.

6. Recheck and adjust as necessary.

7. Replace the belt guard.

5.8.2 Battery Charging Alternator Belt Tensioning Procedure

1. Remove the belt guard.
2. Check the belt tension at the midpoint of the longest span of the belt by pressing with your finger. See Figure 5-5 and Figure 5-6. If the belt is not within the specifications, go to step 3. If the belt is within the specifications, go to step 7.

Belt Type	Deflection mm (in.)
New	8–12 (0.3–0.5)
Used	10–14 (0.4–0.6)

Figure 5-6 Belt Specifications

3. Loosen the adjusting arm pivot screw, alternator pivot screw, and alternator adjusting screw.
4. While prying the alternator outward, tighten the alternator adjusting screw.
5. Tighten the adjusting arm pivot screw and alternator pivot screw.
6. Recheck and adjust as necessary.
7. Replace the belt guard.

5.8.3 Anticorrosion Zinc Anode

The heat exchanger on models 8/9/10EOZD, 6.5/7/9EFOZD, 28/32EOZD, and 23/25/27/28EFOZD contains an anticorrosion zinc anode (plug) to prevent electrolytic corrosion by seawater.

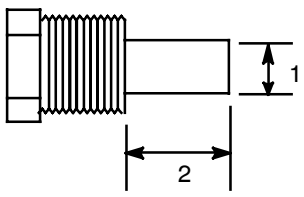
Check and replace the anticorrosion zinc anode at intervals recommended in the service schedule. Depending upon operating conditions and seawater properties, the anticorrosion zinc anode may require more frequent replacement. See Section 1 for the location and use the following procedure.

Anticorrosion Zinc Anode Replacement

1. With the generator set cooled, close the seacock, open the petcock on the engine, and drain the coolant into a suitable container.
2. Remove the anticorrosion zinc anode (plug) from the heat exchanger.
3. Use a wire brush to remove the loose corrosion on the anticorrosion zinc anode. Replace the anode according to Figure 5-7 and Figure 5-8.

Anticorrosion Zinc Anode Replacement		
Models	**New Anode Dimensions mm (in.)**	**Replace When Percent of Zinc Remaining Is:**
8/9/10EOZD 6.5/7/9EFOZD	9 (0.34) x 43 (1.7)	<50% of length/diameter
28/32EOZD 23/25/27/28EFOZD	9 (0.34) x 19 (0.75)	<50% of length/diameter

Figure 5-7 Anticorrosion Zinc Anode (Plug) Measurements



TP-5586-3

1. Diameter: 9 mm (0.34 in.)
2. Length:
   43 mm (1.7 in.) for 8/9/10EOZD, 6.5/7/9EFOZD models or 19 mm (0.75 in.) for 28/32EOZD, 23/25/27/28EFOZD models

Figure 5-8 Anticorrosion Zinc Anode (Plug)

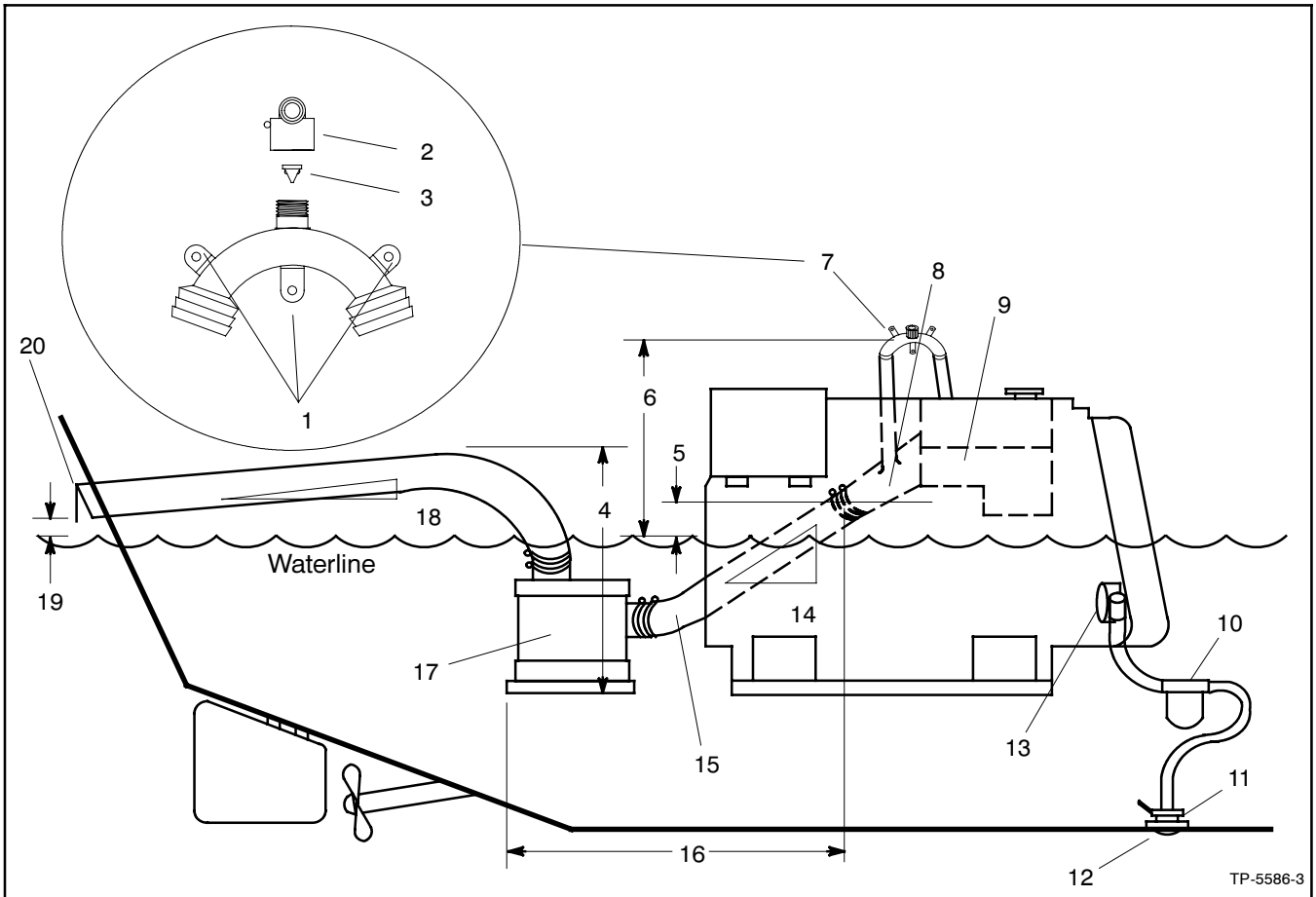
4. Clean the threaded hole of the heat exchanger and coat the threads of the anticorrosion zinc anode (plug) with pipe sealant suitable for marine applications. Cut the anticorrosion zinc to the correct length. Install the anticorrosion zinc anode into the heat exchanger.
5. Close the petcock on the engine and open the seacock. Refill the cooling system.
6. Start the generator set and check for leaks at the anticorrosion zinc anode location. The pump is operating if the cooling water flows from the exhaust outlet. If water is not discharging at the exhaust outlet, see the Operation Manual's Prestart Checklist—Seawater Pump Priming.

5.9 Siphon Break

A siphon break prevents seawater entry into the engine when the engine exhaust manifold outlet is less than 23 cm (9 in.) above the waterline of a fully-loaded, shut-down craft. Use the following procedure to inspect the siphon break.

Siphon Break Inspection Procedure:

1. Stop the generator set.
2. Remove the retaining cap and lift out the reed valve assembly for inspection. See Figure 5-9.
3. Use a light detergent to clean the reed valve to remove residue and oxidation.
4. Check that the reed valve opening is clear.
5. Replace the siphon break if it is cracked or if the reed valve material has hardened or deteriorated.
6. Install the reed valve into the mounting base with the valve downward.
7. Install the retaining cap and finger-tighten only. Do not overtighten.



1. Mounting base
2. Retaining cap
3. Reed valve assembly
4. Silencer vertical lift 1.2 m (4 ft.) max.
5. Exhaust mixer elbow distance above waterline; if less than 23 cm (9 in.), siphon break is required
6. Siphon break distance above waterline 30.5 cm (1 ft.) min.
7. Siphon break
8. Exhaust mixer elbow
9. Heat exchanger (locations vary by model)
10. Seawater strainer
11. Seacock
12. Intake strainer
13. Engine-driven seawater pump
14. Exhaust hose pitch 1.3 cm per 30.5 cm (0.5 in./ft.) min.
15. Water lock (optional)
16. Silencer distance from exhaust mixer elbow 3 m (10 ft.) max.
17. Silencer (customer-supplied)
18. Exhaust hose pitch 1.3 cm per 30.5 cm (0.5 in./ft.) min.
19. Exhaust outlet distance above waterline 10 cm (4 in.) min.
20. Seawater outlet

NOTE: Consult the installation manual for complete explanation of dimensions and other installation considerations.

Figure 5-9 Siphon Break (Plastic “U” Type)

6.1 Introduction

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

Refer to the engine service manual for engine service information.

If the troubleshooting procedures in this section identify a bad part, refer to the parts catalog for replacement part numbers.

6.2 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.**
- **Fault shutdown.** Check for a fault code on the controller display. Section 7.4 describes the warning and shutdown fault codes.
- **Blown fuses.** Fuses in the wiring harness protect the controller, SCR module, and relay interface board. Always check and replace the fuses before replacing other components.
- **Incorrect controller settings.** Always check the controller configuration settings before replacing the controller. Section 7.5 contains the instructions for checking and changing the controller configuration.

Some problems may be solved by updating the controller's application program. Check www.kohlernet.com, Tech Tools, Software, for information on ADC 2100 application program updates. Refer to Section 7.6 for instructions to check the version number of the controller's application program and for more information on updating the application program.

6.3 General

Before beginning the troubleshooting procedures, read all the safety precautions at the beginning of this manual.

⚠ 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.

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, transfer switch, 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.

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.

6.4 Troubleshooting Chart

Use the following tables 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.

Troubleshooting Chart			
Problem	**Possible Cause**	**Corrective Action**	**Reference**
Generator set does not crank	Weak or dead battery	Recharge or replace battery.	Generator Set O/M
	Battery connections	Check for reversed or poor battery connections.	—
	Open circuit in engine/controller connections	Check for loose connections. Check the wire harness continuity.	Section 8.15 Section 10
	Blown fuse F3, controller	Replace fuse; if fuse blows again, check circuit and components.	Section 8.14 Section 10
	Blown fuse F2, relay interface board (RIB)	Replace fuse.	Section 8.14
		If fuse blows again, disconnect the board leads one at a time to identify the cause of the blown fuse: Lead 70A at the fuel solenoid Lead 71A at the crank relay Lead FP and FN at the rotor Repair or replace the component causing the blown fuse.	Section 10
		If the fuse continues to blow and the previous step did not identify the cause, remove the leads from the P14 connector using a pin pusher, part #241918 (large) or 241919 (small). If replacing the leads does not solve the problem, replace the RIB.	Section 7.10 Section 10
	Crank relay on relay interface board (RIB)	Check connections to the RIB. Check for 12VDC to the RIB between PF2 and 71N. Check for a good ground connection (lead N) Check crank relay K2 operation (LED3). Replace the RIB if the relay does not operate.	Section 7.10 Section 10 Section 7.10
	Generator set master switch	Check connections to the master switch on the ADC 2100. Test function of the switch.	Section 7.9 Section 8.15
	Poor ground (-) connection	Clean and retighten.	—
	Starter	Check the starter connections.	Section 10
		Rebuild or replace the starter.	Engine Service Manual (S/M)
	Controller	Check the controller connections and operation. Check for power to the controller. Move the generator set master switch to the OFF/RESET position and then to the RUN position.	Section 7 Section 10

Troubleshooting Chart, continued			
Problem	**Possible Cause**	**Corrective Action**	**Reference**
Generator set cranks but does not start	No fuel	Check the fuel supply.	—
	Loose connection or open circuit	Check for loose or open connections at the fuel solenoid (lead 70A). Check the controller/engine wiring continuity.	Section 10
	Air cleaner clogged	Clean or replace.	Section 3
	Incorrect controller configuration	Check for correct controller configuration parameters: unit configuration (UC) and engine configuration (EC).	Section 7.5
	No engine rotation sensed (check for an overcrank fault shutdown)	Check for a locked rotor.	Section 8.8
Generator set starts hard	Low battery voltage	Check battery voltage, power supply, and operation.	Generator Set O/M
	Air cleaner clogged	Replace element.	Section 3
	Worn piston rings, valves	Check compression.	Engine S/M
Generator set starts but shuts down	Fault shutdown	Check for a fault shutdown code on the Advance Digital Control's LED display. Correct the fault and then move the generator set master switch to the OFF/RESET position to reset the ADC.	Section 7.4
Generator set stops suddenly	Fault shutdown	Check for a fault shutdown code on the Advanced Digital Control's LED display. Correct the fault and then move the generator set master switch to the OFF/RESET position to reset the ADC.	Section 7.4
	No fuel	Check the fuel supply.	—
	Fuel line restriction	Inspect fuel lines.	—
	Air cleaner clogged	Replace element.	Section 3
	Blown controller fuse (F3)	Replace fuse.	Section 8.14
	Blown auxiliary winding fuse (F1)	Replace fuse. If fuse blows again, test generator components.	Section 8.14
	Blown relay interface board (RIB) fuse (F2)	Replace fuse.	Section 8.14
	Engine overheated (hot engine only)	Check air intake, oil level, air inlet/outlet.	Sections 2 and 3
	Low oil pressure (LOP) shutdown	Attempt startup. If the unit shuts down, remove the lead from the LOP switch and reset the controller. A successful restart attempt indicates a faulty LOP shutdown switch. **Note:** Check the engine oil pressure before performing the test and/or replacing the LOP shutdown switch.	Section 8.13
	Engine overloaded	Reduce electrical load.	Generator Set I/M
	Loss of generator output voltage to controller	Check connections at P15 plug. Check continuity of AC sensing leads 11 and 44 (for 1-phase models) or leads 7, 8, and 9 (for 3-phase models).	Section 10
	Faulty K3 (flash) relay	Check for Flash LED illumination. Check RIB fuse. Replace relay board.	Section 7.10

Troubleshooting Chart, continued			
Problem	**Possible Cause**	**Corrective Action**	**Reference**
Generator set operates erratically	Air cleaner clogged	Replace element.	Section 3
	Governor adjustment incorrect	Adjust governor stability.	Section 4.4
	Inadequate cooling (hot engine only)	Inspect air inlet and outlet.	—
	Carbon buildup in engine	Clean cylinder head.	Engine S/M
	Engine valves not seating correctly	Inspect valves and valve seats.	Engine S/M
Generator set lacks power	Air intake restriction, inadequate cooling	Inspect air intakes and exhaust for obstructions. Check the air cleaner.	 Section 3
	Generator overloaded	Reduce load.	Generator Set I/M
	Engine not running at rated rpm	Check controller settings for unit configuration (UC) and engine type (EC). Adjust governor speed.	Section 7.5 Section 4.4
	Engine power loss	Refer to the Engine Service Manual for troubleshooting and repair instructions.	Engine S/M
	Governor malfunction or misadjustment	Test/readjust governor.	Section 4.4
Generator set overheats	Inadequate cooling	Inspect cooling system for obstructions.	—
	Air cleaner clogged	Replace element.	Section 3
Low output or excessive drop in voltage	Generator overloaded	Reduce load.	Generator Set I/M
	Incorrect controller configuration	Check and adjust the controller configuration parameters.	Section 7.5
	Incorrect controller voltage settings	Check and adjust the controller voltage settings.	Section 7.5.3
	Alternator or control system	Perform separate excitation procedure to isolate problem to the alternator or the control system.	Section 8.2
	SCR module	Check wiring and connections to the SCR module. Check the auxiliary winding fuse F1 (lead 55). Replace SCR module and test voltage.	Section 7.5 Section 7.7
	Controller	Check the controller settings. Check the controller fuse, wiring and connections. Before replacing the controller, replace the SCR module and test voltage.	Section 7.5 Section 7.7 Section 7.11
	Rotor (open, grounded, or shorted windings)	Test and/or replace.	Section 8.8
	Stator (open, grounded, or shorted windings)	Test and/or replace.	Section 8.9
	Low engine speed causing voltage roll-off	Check system voltage/frequency (UU) and engine type (EC) parameters. Adjust the engine governor speed. Troubleshoot the engine.	Section 7.5 Section 4.4 Engine S/M

Troubleshooting Chart, continued			
Problem	**Possible Cause**	**Corrective Action**	**Reference**
Light flicker	Voltage stability (gain) setting	Check and adjust the voltage stability (gain) setting using the ADC 2100.	Section 7.5.3
High generator output voltage	Incorrect controller configuration	Check and adjust the controller configuration parameters.	Section 7.5
	Incorrect controller voltage settings	Check and adjust the controller voltage settings.	Section 7.5.3
	Engine speed too high	Check the engine speed using tachometer or frequency meter. Adjust governor as necessary.	Section 4.4
	Loose voltage sensing connections	Check connections: stator leads 11 and 44 (for 1-phase models) or leads 7, 8, and 9 (for 3-phase models) and P15 controller connection.	Section 8.9
	SCR module	Check the wiring and connections to the SCR module. Check the auxiliary winding fuse F1 (lead 55). Replace SCR module and test voltage.	Section 7.7
	Controller	Check fuses, wiring, and connections. Before replacing the controller, replace the SCR module and test voltage.	Section 7.5 Section 7.7 Section 7.11
No output voltage	AC output circuit breaker open	Check for AC voltage on the generator side of the circuit breaker. If there is AC 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 or control system	Perform separate excitation procedure to isolate the problem to the alternator or the control system. Then troubleshoot the alternator or control system components as follows.	Section 8.2
	Aux. winding fuse blown (lead 55)	Replace blown fuse. If fuse blows again, check stator.	Section 8.14
	SCR module	Check auxiliary winding fuse F1 (lead 55). Replace SCR module and test voltage.	Section 8.14 Section 7.7
	Controller	Check controller settings. Check wiring and connections. Before replacing the controller, replace the SCR module and test voltage.	Section 7.5 Section 7.7 Section 7.11

Troubleshooting Chart, continued			
Problem	**Possible Cause**	**Corrective Action**	**Reference**
No output voltage (continued)	Open wiring, terminal, or pin in buildup circuit or SCR module circuit	Check continuity.	Section 7.7
	Rotor connections	Check for open circuit in the rotor connection circuit (leads FN and FP to the SCR and RIB).	Section 8.8
	Rotor (open, grounded, or shorted windings)	Check voltage and continuity.	Section 8.8
	Stator (open, grounded, or shorted windings)	Check voltage and continuity.	Section 8.9
	Flash relay (K3) on relay interface board (RIB)	Check flash LED on RIB. Check fuse F2 and troubleshoot RIB.	Section 7.10
Generator set is noisy	Exhaust system leaks	Check and replace as necessary.	—
	Engine not running smoothly	See “Generator set operates erratically,” this table.	See “Generator set operates erratically,” this table
	Broken or damaged vibromount(s)	Check and replace as necessary.	—
	Loose or vibrating sheet metal/housing	Retighten screws, replace rivets.	—
	Exhaust piping or air inlets/outlets not securely installed	Inspect for loose parts and secure if necessary.	—
	Excessive engine/generator vibration	Check, rotor, crankshaft, bearing, etc. (disassembly of engine and/or alternator may be required).	Section 9, Disassembly/ Reassembly and Engine S/M
Emits black or gray smoke	Air intake restriction	Check air cleaner and intake.	Section 3
Emits black or gray smoke	Oil level high	Check oil level.	Section 2 and Generator Set O/M
	Worn piston rings, valves, etc.	Check compression.	Engine S/M
High oil consumption	External leakage/defective gaskets	Replace gaskets.	Engine S/M
	Worn piston rings, valves, etc.	Check compression.	Engine S/M
Engine knocks	Excessive load	Reduce load	Generator Set I/M
	Low oil level	Check oil level and add oil if low	Section 2 and Generator Set O/M

7.1 Introduction

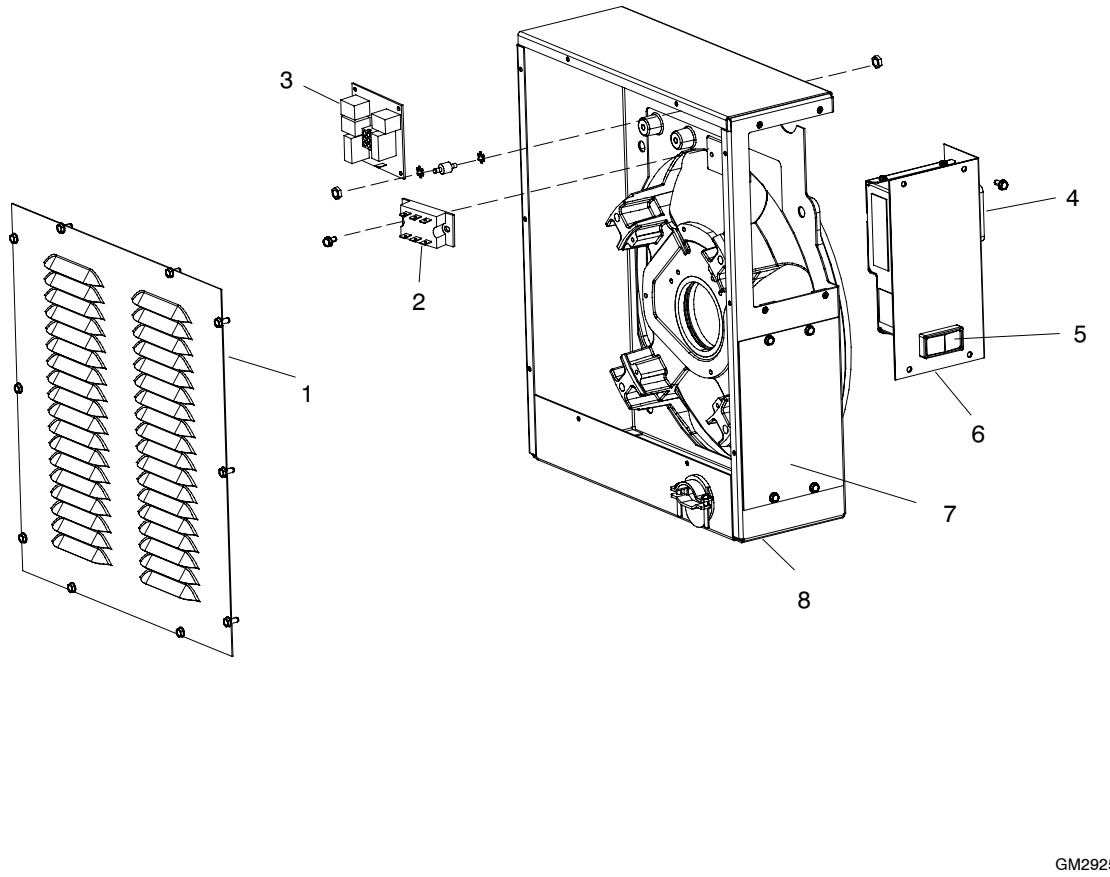
This section covers operation, configuration, adjustment, and replacement of the ADC 2100 controller. See Section 6 for troubleshooting procedures.

See Figure 7-1 for the locations of the controller and related components. Section 7.2 describes the controller keypad and display.

Section 7.3 describes the sequence of operation, and faults are described in Section 7.4. Controller configuration and adjustment are covered in Section 7.5.

A silicon controlled rectifier (SCR) module works with the controller to regulate the output voltage. See Section 7.7.

A relay interface board (RIB) is used with the ADC controller. Section 7.10 describes the standard and optional RIBs.



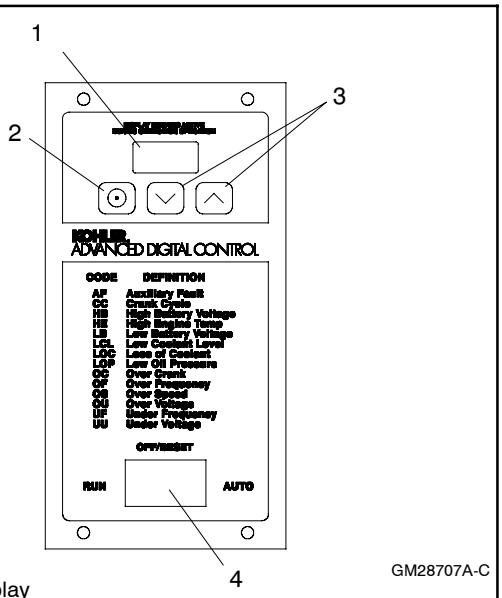
1. Junction box louvered panel
2. SCR module (mounted behind ADC 2100 on 6EOD and 4.5EFOD models)
3. Relay board
4. Engine harness-to-controller connection
5. Generator set master switch
6. ADC 2100
7. Line circuit breaker plate
8. Junction box

Figure 7-1 Advanced Digital Control (ADC 2100)

7.2 Advanced Digital Control Display and Keypad

The Advanced Digital Control has an LED display and a three-button keypad. See Figure 7-2. The LED display shows runtime hours, fault codes, application program version number, or controller parameters during configuration and adjustment. See Figure 7-3. The keypad is used to enter the controller's configuration and adjustment menus, and to change the controller settings.

A password key sequence is required to enter the configuration and adjustment menus. Section 7.5 contains the instructions to enter the configuration and adjustment menus and change the settings using the controller keypad.



1. LED display
2. Select button (use for setup and adjustment only)
3. Up and down arrow buttons (use for setup and adjustment only)
4. Generator set master switch

Figure 7-2 Advanced Digital Control

Controller Display	
Item	**Description**
Crank indication	Displays CC_1, CC_2, or CC_3 to indicate the 1st, 2nd or 3rd attempt to start the engine. The last digit flashes during the crank cycle rest periods.
Runtime hours	Displays total generator set runtime hours when no other code is displayed.
Fault codes	Flashes a 2- or 3-letter fault code to indicate various fault conditions. See Section 7.4.
System parameters	Displays 2-letter codes or 4-digit alphanumeric codes during system configuration or adjustment. See Section 7.5.
Application program version number	Displays the version number of the controller's application program before entering the configuration or adjustment mode. See Section 7.6.

Figure 7-3 Advanced Digital Control's LED Display

7.3 Sequence of Operation

The following sections describe the controller sequence of operation during generator start, run, stop, and fault shutdown modes. Use this as a starting point for controller and relay board fault identification. Refer to the wiring diagrams in Section 10 to assist in the troubleshooting procedure.

7.3.1 Starting Sequence, Master Switch Moved to RUN

When the master switch is moved to the RUN position, there is a delay of about 1 second before the ADC attempts to start the engine. The run relay energizes and the run LED (1) turns on. The crank and flash relays energize and the corresponding LEDs (2 and 3) turn on 0.5 seconds later. The ADC display indicates the crank cycle 1 code, CC 1.

The ADC attempts to start the generator set three times (three crank cycles, 15 seconds crank and 15 seconds off). If the generator set does not start in three attempts, the system shuts down on an overcrank fault.

When the engine comes up to speed, the low oil pressure switch contacts open.

Note: The controller circuit board prevents fault shutdowns during startup until the crank disconnect relay energizes.

The cyclic cranking cycle is programmed into the ADC's application code and is not adjustable in the field.

The factory sets the cranking cycle for three cycles of 15 seconds on time and 15 seconds off time. If the cranking cycle seems shorter than the factory setting, check the engine starting battery.

7.3.2 Starting Sequence, Remote Start

When the master switch is moved to the AUTO position, the controller may remain OFF until the remote start switch or transfer switch engine start contacts close the first time, if the power jumper is removed.

The start sequence proceeds as described in Section 7.3.1, Starting Sequence, Master Switch Moved to RUN.

7.3.3 Running Sequence

When the engine speed reaches 750 rpm, the crank relay deenergizes and the crank LED (3) turns off. When the output voltage on leads 11 and 44 (for 1-phase models) or leads 7, 8, and 9 (for 3-phase models) reaches about 30 VAC, the flash relay deenergizes and the flash LED (2) turns off.

7.3.4 Stopping Sequence, Master Switch Moved to OFF/RESET

Place the generator master switch in the OFF/RESET position. The run relay deenergizes and the run LED (1) turns off. The generator set stops.

7.3.5 Stopping Sequence, Remote Stop

If the generator set is running, momentarily closing the remote start/stop contacts deenergizes the run relay and the run LED (1) turns off, but the controller does not power down. The controller remains powered and displays the engine runtime hours.

Note: For units with serial numbers before 2051415:
Disconnecting the P7 jumper will allow the controller to power down 48 hours after generator set shutdown. See Section 7.8, Continuous Power Mode.

Note: For units with serial numbers 2051415 and later:
If the ADC 2100 is configured for a CAN gauge, the controller will not power down (if the master switch is in the AUTO position).

If the ADC 2100 is not configured for a CAN gauge, the controller will power down after 48 hours (if the master switch is in the AUTO position). If the generator has been started, the controller will power down 48 hours after the generator stops.

7.4 Faults

7.4.1 Fault Shutdowns

Under the fault conditions listed in Figure 7-4, the ADC displays a fault code and the generator set shuts down.

Always identify and correct the cause of a fault shutdown before restarting the generator set. Refer to Section 6, Troubleshooting, for instructions to identify and correct the cause of the fault.

To restart the generator set, first move the generator set master switch to the OFF/RESET position to reset the controller.

Note: For units with serial numbers before 2051415:
If the power jumper is removed and the controller powers down after a fault shutdown, move the master switch to the OFF/RESET position and then to the RUN position to display the fault code. Moving the master switch to the OFF position again will clear the fault. See Section 7.8 for more information on the continuous power mode jumper.

7.4.2 Warnings

The fault conditions listed in Figure 7-5 will cause the controller to display a fault code but will not shut down the generator set.

Code	Fault	Description	Check
AF	Auxiliary fault input shutdown	Input from a customer-supplied switch that closes when the fault is active. Shutdown occurs 0.3 seconds after the fault is detected and will not start when the fault is active (input is grounded). This protection becomes active 3-seconds after crank disconnect.	Check the cause of the auxiliary fault.
HE	High engine temperature shutdown	Shutdown occurs if the engine coolant temperature exceeds the maximum temperature for more than 5 seconds. This protection becomes active after the engine reaches the crank disconnect speed. **Note:** The high engine temperature shutdown functions only when the coolant level is in the operating range.	Check for a low engine coolant level.
LOC	Loss of coolant shutdown	Shutdown occurs 5 seconds after a loss of coolant condition is detected. This protection becomes active 10 seconds after the engine has reached its stated crank disconnect speed and remains active as long as the generator run command is active.	Check for a clogged seawater intake or sea strainer. Check for a damaged seawater pump impeller.
LOP	Low oil pressure shutdown	Shutdown occurs if a low oil pressure condition exists for more than 5 seconds. This protection becomes active 30 seconds after the engine has reached crank disconnect speed (30 second inhibit). **Note:** The low oil pressure shutdown does not protect against low oil level. Check the oil level at the engine.	Check for leaks in the lubrication system. Check the oil level and add oil if the level is low.
OC	Overcrank shutdown	Shutdown occurs after 3 unsuccessful starting attempts. The crank cycle is set for three starting attempts.	Check the fuel supply and battery. If there is no output voltage, check the line circuit breaker. Also check for loose connections. Contact an authorized distributor/dealer for service if problem continues.
OF	Overfrequency shutdown	Shutdown occurs when the governed frequency exceeds 110% of the system's frequency setpoint for more than 5 seconds. This protection becomes active 10 seconds after engine start (10 second inhibit).	Contact an authorized distributor/dealer for service if problem continues.
OS	Overspeed shutdown	Shutdown occurs if the engine speed exceeds 115% of the normal running speed for more than 0.3 seconds.	Contact an authorized distributor/dealer for service if problem continues.
OU	Overvoltage shutdown	Shutdown occurs if the voltage exceeds 120% of the voltage regulator setpoint for more than 2 seconds.	Contact an authorized distributor/dealer for service if problem continues.
UF	Underfrequency shutdown	Shutdown occurs when the governed frequency falls below 90% of the system's frequency setpoint for more than 5 seconds. This protection becomes active 10 seconds after engine start (10-second inhibit).	Reduce the load and restart the generator set. Contact an authorized distributor/dealer for service if problem continues.
UU	Undervoltage shutdown	Shutdown occurs if the voltage falls below 80% of the voltage regulator setpoint for more than 10 seconds.	Reduce the load and restart the generator set. Contact an authorized distributor/dealer for service if problem continues.
SCF0	Controller error	Indicates a software or communication problem within the ADC 2100.	Contact an authorized distributor/dealer for service if problem continues.

Figure 7-4 Fault Shutdowns

Code	Fault	Description	Check
HB	High battery voltage warning	Fault code is displayed if the engine starting battery voltage rises above 16 VDC for a 12 VDC system or above 30 VDC for a 24 VDC system for more than 2 seconds when the engine is not running. This fault condition does not inhibit engine starting. The fault condition clears when the battery voltage returns to a voltage within the limits for more than 2 seconds.	Check the battery rating and condition.
LB	Low battery voltage warning	Fault code is displayed if the engine starting battery voltage falls below 9.5 VDC for a 12 VDC system or below 16 VDC for a 24 VDC system for more than 2 seconds when the engine is not running. This fault condition does not inhibit engine starting. The fault condition clears when the battery voltage returns to a voltage within the limits for more than 2 seconds.	Check the battery rating and condition. Charge or replace the battery.

Figure 7-5 Fault Warnings

7.5 Controller Configuration and Adjustment

The first step in troubleshooting the controller is to verify that the controller is correctly configured for the generator set. The controller's configuration modes allow setting of the engine type, generator set configuration (marine, mobile, or standby), data input types, and other parameters.

The controller configuration for each generator model is set at the factory. Generator set reconnection, sender changes, controller replacement, or other changes may result in the need to change the controller configuration. Use the instructions in the following section to check the controller settings and change them, if necessary.

7.5.1 Controller Time Out

The controller will automatically exit the configuration mode without saving any changes after about 1 minute if no buttons are pressed. Start the configuration procedure over again from the beginning if the controller exits the configuration mode before the settings have been saved.

Changes in voltage and speed adjustments are also lost if they are not saved before the generator set shuts down. The generator set continues to run with the new settings until it shuts down but then reverts to the previous settings at the next startup. Be sure to save your changes immediately after making adjustments.

7.5.2 Controller Configuration

The controller configuration is factory-set and should not normally require changes in the field. However, the controller configuration may need to be changed after generator set reconnection or controller replacement.

The controller's configuration mode allows adjustment of the system parameters listed in this section. Change the system voltage and frequency after reconnection or controller replacement. The unit configuration and engine type are factory-set for each type of generator set and engine and should not require changes unless the controller is replaced.

The controller's advanced configuration mode allows the user to set the data input type for engine senders, toggle the battery voltage between 12 and 24 volts, and change the controller communications setting for optional meters. Check these settings after controller replacement and change them, if necessary, to match the settings shown in Figure 7-6.

Follow the instructions in Figure 7-9 to enter the configuration mode while the engine is not running and then step through the following parameters. Use the up (∧) and down (∨) arrow buttons to select the appropriate setting for the application.

Note: Be sure to save your settings before exiting the configuration mode. The controller reverts to the last saved settings when the master switch is moved to the OFF/RESET position.

Voltage/frequency setting (Uu). Select the system voltage and frequency from the table in Figure 7-6.

Note: This parameter sets the nominal system voltage and frequency. To adjust the output (measured) voltage and frequency, see Section 4.4, Section 7.5.3, and Figure 7-12.

Unit configuration (Uc). This parameter sets the generator set type: marine, standby, or mobile.

Engine configuration (Ec). The engine configuration must match the generator set engine type.

Advanced configuration mode (Adnc). The data input types, battery voltage, and communications setting can be changed in the advanced configuration mode. Press the up arrow button when *Adnc* is displayed to enter the advanced configuration mode.

Engine data input types (Ed). This setting defines the type of senders used on the generator set engine.

Battery voltage (Bt). This setting toggles between 12 and 24 VDC for the engine starting battery voltage.

Communications setting (Cn). This setting allows the user to set the controller for communication with optional gauges, which are available for marine and mobile units only.

7.5.3 Voltage Adjustment

The flowchart in Figure 7-12 outlines the procedures for using the ADC controller to adjust the output voltage. Voltage adjustment may be required after controller replacement, generator set reconnection, or other service procedures. The generator set must be running during this adjustment. Use a multimeter to measure the generator set output voltage during adjustment. Refer to Section 8.10.2, Voltage Adjustment for instructions to measure the output voltage.

Note: Be sure to save your settings before exiting the configuration mode. The controller reverts to the last saved settings when the master switch is moved to the OFF/RESET position.

Marine Diesel Model	Freq. Hz	Voltage, Phases	Volts, Hz	Market	Engine Type	Data Inputs	Battery Voltage	CANbus Comm.
			Uu*	Uc	Ec	Ed†	Bt	Cn‡
4.5EFOD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0	1	1 (std.) or 3 (opt. ops)	12	0 (No Can) 1 or 6 (J1939) 7 or 9 (Smartcraft) ‡
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
6EOD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
		120 V, 1 Ph, 3 W	0					
		120 V, 1 Ph, 2 W	0					
6.5EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				0 (No Can) 1 or 6 (J1939) ‡
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
7EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				0 (No Can) 1 or 6 (J1939) 7 or 9 (Smartcraft) ‡
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
8EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				0 (No Can) 1 or 6 (J1939) ‡
		120 V, 1 Ph, 3 W	0					
		120 V, 1 Ph, 2 W	0					
8.5EFOZD (3 Ph)	50	230/400 V, 3 Ph, 4 W, Wye	3	0	2		12 or 24	0 (No Can) 1 or 6 (J1939) 7 or 9 (Smartcraft) ‡
9EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
9EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0	1		12	
		120 V, 1 Ph, 3 W	0					
		120 V, 1 Ph, 2 W	0					
10EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0	2		12 or 24	
		120 V, 1 Ph, 3 W	0					
		120 V, 1 Ph, 2 W	0					
10EOZD (3 Ph)	60	120/240 V, 3 Ph, 4 W, Delta	10	0				
		127/220 V, 3 Ph, 4 W, Wye	16					
		220/380 V, 3 Ph, 4 W, Wye	19					
		240/416 V, 3 Ph, 4 W, Wye	20					
11EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
11.5EFOZD (3 Ph)	50	115/230 V, 1 Ph, 3 W	6	0				
		115/230 V, 3 Ph, 4 W, Delta	14					
		110/190 V, 3 Ph, 4 W, Wye	17					
		120/208 V, 3 Ph, 4 W, Wye	18					
		220/380 V, 3 Ph, 4 W, Wye	21					
		230/400 V, 3 Ph, 4 W, Wye	3					
		240/416 V, 3 Ph, 4 W, Wye	22					
13EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
13EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					

* Use voltage/frequency parameters Uu07–Uu23 only with ADC application program version 1.20 or higher.
† See Figure 7-7 for Ed settings with optional sender kits.
‡ See Figure 7-8 for Cn settings with optional digital gauges (gauges are available on selected models only).
Note: Setting the Ec parameter automatically selects the Ed parameter for the standard data inputs for that engine. If you change Ec, check the Ed setting.

Marine Diesel Model	Freq. Hz	Voltage, Phases	Volts, Hz	Market	Engine Type	Data Inputs	Battery Voltage	CANbus Comm.
			Uu*	Uc	Ec	Ed†	Bt	Cn‡
14EOZD (3 Ph)	60	120/240 V, 1 Ph, 3 W	1	0	2	1 (std.) or 3 (opt. ops)	12 or 24	0 (No Can) 1 or 6 (J1939) 7 or 9 (Smartcraft) ‡
		120/208 V, 3 Ph, 4 W, Wye	11					
		127/220 V, 3 Ph, 4 W, Wye	16					
		120/240 V, 3 Ph, 4 W, Delta	10					
		139/240 V, 3 Ph, 4 W, Wye	10					
		277/480 V, 3 Ph, 4 W, Wye	4					
15EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
15.5EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
17EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
17.5EFOZD (3 Ph)	50	115/230 V, 1 Ph, 3 W	6	0				
		115/230 V, 3 Ph, 4 W, Delta	14					
		110/190 V, 3 Ph, 4 W, Wye	17					
		120/208 V, 3 Ph, 4 W, Wye	18					
		220/380 V, 3 Ph, 4 W, Wye	21					
		230/400 V, 3 Ph, 4 W, Wye	3					
		240/416 V, 3 Ph, 4 W, Wye	22					
20EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
20EOZD (3 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
		120/208 V, 3 Ph, 4 W, Wye	11					
		127/220 V, 3 Ph, 4 W, Wye	16					
		120/240 V, 3 Ph, 4 W, Delta	10					
		139/240 V, 3 Ph, 4 W, Wye	10					
		277/480 V, 3 Ph, 4 W, Wye	4					
20EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0	2 (w.o. preheater) or 9 (w/ preheater)			
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
20EFOZD (3 Ph)	50	115/230 V, 1 Ph, 3 W	6	0				
		115/230 V, 3 Ph, 4 W, Delta	14					
		110/190 V, 3 Ph, 4 W, Wye	17					
		120/208 V, 3 Ph, 4 W, Wye	18					
		220/380 V, 3 Ph, 4 W, Wye	21					
		230/400 V, 3 Ph, 4 W, Wye	3					
		240/416 V, 3 Ph, 4 W, Wye	22					
23EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
24EOZD (3 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
		120/208 V, 3 Ph, 4 W, Wye	11					
		127/220 V, 3 Ph, 4 W, Wye	16					
		120/240 V, 3 Ph, 4 W, Delta	10					
		139/240 V, 3 Ph, 4 W, Wye	10					
		277/480 V, 3 Ph, 4 W, Wye	4					
23EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0	7			
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
25EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					

* Use voltage/frequency parameters Uu07–Uu23 only with ADC application program version 1.20 or higher.
† See Figure 7-7 for Ed settings with optional sender kits.
‡ See Figure 7-8 for Cn settings with optional digital gauges (gauges are available on selected models only).
Note: Setting the Ec parameter automatically selects the Ed parameter for the standard data inputs for that engine. If you change Ec, check the Ed setting.

Marine Diesel Model	Freq. Hz	Voltage, Phases	Volts, Hz	Market	Engine Type	Data Inputs	Battery Voltage	CANbus Comm.
			Uu*	Uc	Ec	Ed†	Bt	Cn‡
23EFOZD (3 Ph)	50	115/230 V, 1 Ph, 3 W	6	0	7	1 (std.) or 3 (opt. ops)	12 or 24	0 (No Can) 1 or 6 (J1939) 7 or 9 (Smartcraft) ‡
		115/230 V, 3 Ph, 4 W, Delta	14	0				
		110/190 V, 3 Ph, 4 W, Wye	17	0				
		120/208 V, 3 Ph, 4 W, Wye	18					
		220/380 V, 3 Ph, 4 W, Wye	21					
		230/400 V, 3 Ph, 4 W, Wye	3					
		240/416 V, 3 Ph, 4 W, Wye	22					
25EFOZD (3 Ph)	50	115/230 V, 1 Ph, 3 W	6	0				
		115/230 V, 3 Ph, 4 W, Delta	14					
		110/190 V, 3 Ph, 4 W, Wye	17					
		120/208 V, 3 Ph, 4 W, Wye	18					
		220/380 V, 3 Ph, 4 W, Wye	21					
		230/400 V, 3 Ph, 4 W, Wye	3					
		240/416 V, 3 Ph, 4 W, Wye	22					
27EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
28EFOZD (1 Ph)	50	230 V, 1 Ph, 2 W	2	0				
		115/230 V, 1 Ph, 3 W	6					
		240 V, 1 Ph, 2 W	13					
27EFOZD (3 Ph)	50	115/230 V, 1 Ph, 3 W	6	0				
		115/230 V, 3 Ph, 4 W, Delta	14					
		110/190 V, 3 Ph, 4 W, Wye	17					
		120/208 V, 3 Ph, 4 W, Wye	18					
		220/380 V, 3 Ph, 4 W, Wye	21					
		230/400 V, 3 Ph, 4 W, Wye	3					
		240/416 V, 3 Ph, 4 W, Wye	22					
28EFOZD (3 Ph)	50	115/230 V, 1 Ph, 3 W	6	0				
		115/230 V, 3 Ph, 4 W, Delta	14					
		110/190 V, 3 Ph, 4 W, Wye	17					
		120/208 V, 3 Ph, 4 W, Wye	18					
		220/380 V, 3 Ph, 4 W, Wye	21					
		230/400 V, 3 Ph, 4 W, Wye	3					
		240/416 V, 3 Ph, 4 W, Wye	22					
28EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
28EOZD (3 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
		120/208 V, 3 Ph, 4 W, Wye	11					
		127/220 V, 3 Ph, 4 W, Wye	16					
		120/240 V, 3 Ph, 4 W, Delta	10					
		139/240 V, 3 Ph, 4 W, Wye	10					
		277/480 V, 3 Ph, 4 W, Wye	4					
32EOZD (1 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
32EOZD (3 Ph)	60	120/240 V, 1 Ph, 3 W	1	0				
		120/208 V, 3 Ph, 4 W, Wye	11					
		127/220 V, 3 Ph, 4 W, Wye	16					
		120/240 V, 3 Ph, 4 W, Delta	10					
		139/240 V, 3 Ph, 4 W, Wye	10					
		277/480 V, 3 Ph, 4 W, Wye	4					

* Use voltage/frequency parameters Uu07–Uu23 only with ADC application program version 1.20 or higher.
† See Figure 7-7 for Ed settings with optional sender kits.
‡ See Figure 7-8 for Cn settings with optional digital gauges (gauges are available on selected models only).
Note: Setting the Ec parameter automatically selects the Ed parameter for the standard data inputs for that engine. If you change Ec, check the Ed setting.

Figure 7-6 Controller Parameters Settings, Marine Diesel Models

Optional Sender Kits and Ed Setting

The installation of optional sender kits may require a change to the Ed (engine data inputs) setting. See Figure 7-7 for the Ed settings with optional sender kits. “No Change” means the installation of the kit does not require a change to the Ed setting.

Note: The Ec setting can affect the Ed setting. If you change the Ec setting, check the Ed setting and change it if necessary to match the value shown in the tables for your unit.

Note: Installation of an optional electronic governor kit with a magnetic pickup does not require a change to the Ed setting.

Model	Sender Kit	Ed
6EOD 4.5EFOD	None	1
	GM32112-KA1 and -KP1 *	3
	GM50552-KA1 †	No Change
	GM47164-KP1 ‡	No Change
8-32EOZD 6.5-28EFOZD	None	1
	GM32112-KA1 and -KP1 *	3
	GM50552-KA1 †	No Change
* OP and WT sender kits † Oil pressure sender kits ‡ Electronic governor kit		

Figure 7-7 Ed Settings with Optional Sender Kits

Cn Communication Parameter

See Figure 7-8 for communication parameter settings. If your generator set is connected to a remote digital gauge, refer to Figure 7-8 or the instruction sheet provided with the gauge to determine the communication parameter Cn setting.

Gauge Kit	Gauge Description	Cn Setting	Power Down Time	CAN Description
None	—	Cn00	48 Hours	No CAN
GM32337-KP1	Remote Digital Gauge (3 inch)	Cn01	Never/ None	J1939
		Cn06	1 Hour	
GM46035-KP1	Remote Digital Gauge (3 inch)	Cn07	48 Hours	Smartcraft
GM50822-KP1	Remote Digital Gauge (2 inch)	Cn09	1 Hour	

Figure 7-8 Communication Parameter Cn Settings (optional gauges are available on selected models only)

Power Modes

Use Figure 7-8 to determine power down times.

With the generator set master switch in the AUTO position, there are three possible controller power modes:

- **48-hour power down.** If the ADC 2100 communication parameter setting is Cn00 or Cn07, the controller will power down after 48 hours of inactivity. If the generator set has been started, the controller will power down 48 hours after the generator set stops.
- **Continuous power mode.** If the ADC 2100 communication parameter setting is Cn01, the controller will not power down. The controller remains powered at all times to maintain CAN communications and allow remote start commands from the CAN gauge.
- **1-hour power down.** If the ADC 2100 communication parameter setting is Cn06 or Cn09, the controller will power down after 1 hour of inactivity. In this mode, a remote start/stop switch or the generator set master switch must be used to activate the controller after it has powered down. ADC 2100 application code version 1.21 or higher is required for the 1-hour power down option.

Note: After controller power down, a remote digital gauge will not have power and therefore will not be able to send a start signal to activate the controller.

Note: Kohler’s 2-inch digital gauge allows “wake-up” of the controller remotely.

Controller Configuration Mode: *(Use Figure 7-6 with Controller Parameters.)*

Hold the Select button:

Display:

Move the generator set master switch to the RUN position. (The generator set engine will not start.)

. 0

Wait about 5 seconds until the display shows the program version number. (The number may be different than the one shown here.)

u104

Press the down arrow key and then the up arrow key 3 times to enter the configuration mode. (This is the controller "password.")

Uu0*x*

Now release the Select button.

Press:

or — To set the voltage/frequency setting. **Uu0*x***

To step to the next parameter, unit configuration Uc.

or — To set the unit configuration setting to Uc00, if necessary. **Uc00**

To step to the next parameter, engine type Ec.

or — To set the engine type, if necessary. **Ec0*x***

To step to the next parameter, advanced configuration mode or save mode selection. **Adnc**

Now either save your settings or enter the Advanced Configuration Mode to set the engine data inputs, battery voltage, and communications.

Press:

To enter advanced configuration mode. **Go to Figure 7-10.** **Ed0*x***

or

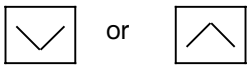
or — To proceed to the save mode without entering the advanced configuration mode. **Go to Figure 7-11.** **SAVE**

Note: Shaded boxes show which number in the controller display changes when the up or down arrow key is pressed. *"x"* denotes any number from 0 to 9.

Figure 7-9 Configuration Mode (system voltage/frequency, unit configuration, and engine type parameters)

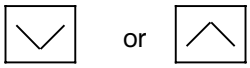
Pressing the up arrow key at the Adnc display (See Figure 7-9) puts you into the Advanced Configuration Mode.

Press:



To set the engine data input type. **E d 0 *x***

To enter battery voltage selection mode.

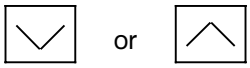


To toggle between 12 and 24 VDC.

12-volt models **B t 1 2**

24-volt models **B t 2 4**

To enter communications selection mode.



To set the communications parameter mode. **C n 0 0**

To enter SAVE mode. Go to Figure 7-11. **S A V E**

Note: Shaded boxes show which number in the controller display changes when the up or down arrow key is pressed. *"x"* denotes any number from 0 to 9.

Figure 7-10 Advanced Configuration Mode (engine data input types, battery voltage, and engine communications)

There are 3 options when the display says SAVE:
Press: **S A V E**

To return to the first parameter, system voltage/frequency Uu, to check or change settings before saving. See Figure 7-9. **U u 0 *x***

or

To save changes. **Y E S**

or

To discard changes without saving. **n o**

"Yes"or "no" flashes when the up or down arrow is pressed and then the controller exits the configuration mode. The display returns to the runtime hours. ***x x x x***

Note: Be sure to save your settings before exiting the configuration mode. The controller reverts to the last *saved* settings when the master switch is moved to the OFF/RESET position.

* *x* in the runtime hours display above denotes any number from 0 to 9.

Now move the master switch to OFF/RESET.

Figure 7-11 Save Mode (after configuring generator set parameters)

Output Voltage Adjustment Mode:

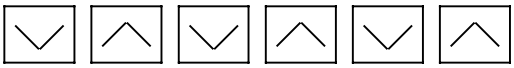
Display :*

Move the generator set master switch to the RUN position. The generator set engine starts and the controller display shows the engine runtime hours.

Hold:

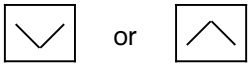
Wait about 5 seconds until the display changes from runtime hours to the program version number.

Press the down arrow key and then the up arrow key 3 times to enter the adjustment mode. (This is the controller "password.")



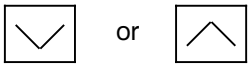
The controller is now in the voltage coarse adjustment mode.

Press:



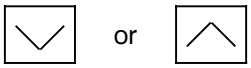
To raise or lower the voltage in large increments (approximately 5–7 volts per step).

To enter fine voltage adjustment mode.



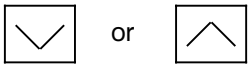
To raise or lower the voltage in smaller increments (approximately 0.5–0.7 volts per step).

To enter coarse voltage stability (gain) adjustment mode.



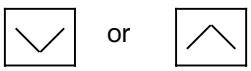
To raise or lower the voltage stability (gain) in large increments.

To enter fine voltage stability (gain) adjustment mode.



To raise or lower the voltage stability (gain) in smaller increments.

To enter volts/Hz adjustment mode.



To raise or lower the volts/Hz: 00=low; 09= high

To save, see Figure 7-11.

* Shaded boxes show which character in the controller display changes for each adjustment. *X* in the examples above denotes any number from 0 to 9. The actual values may vary from model-to-model.

TP6196

Figure 7-12 Output Voltage Adjustments

7.6 Controller Application Program

The controller's application program version number is displayed on the LED screen during the key sequence to enter the configuration mode. Hold the Select button and move the generator set master switch to the RUN position. After about 5 seconds, the application program version number will be displayed on the controller display. For example, u1.04 will be displayed for program version 1.04.

Use the Program Loader Software and a personal computer to update the controller's application program to the latest version, when necessary. Check www.kohlernet.com, Tech Tools, Software, for information on ADC 2100 application program updates and instructions to obtain the latest application code and Program Loader software. Refer to TT-1285, Program Loader, for instructions to load the application program onto the controller.

7.7 Silicon Controlled Rectifier (SCR) Module

The silicon controlled rectifier (SCR) module works with the ADC 2100 to regulate the output voltage. The ADC 2100 monitors generator output voltage and adjusts the excitation current to the rotor through the SCR module. The SCR module location is shown in Figure 7-1.

The SCR module is powered through stator leads 55 and 66 connected to SCR terminals AC1 and AC2. Leads G connected to terminals G1 and G2 provide the controller signal. Leads FP and FN connected to the positive (+) and negative (–) SCR terminals provide excitation current to the rotor. See Figure 7-13 and the wiring diagrams in Section 10.

The SCR module is protected by a 10-amp fuse (F1) in lead 55 in the wiring harness. Check the fuse and replace it, if blown.

In the case of output voltage problems, check the controller configuration and settings. Then test the SCR module using the following procedure.

SCR Module Test Procedure

Required equipment:

- Ohmmeter
- 12-volt test lamp (or voltmeter)
- 12-volt DC power source
- 100–500 ohm resistor
- Jumper

1. Set the ohmmeter to the R X 1 scale.
2. Connect the ohmmeter from (+) to (–) on the SCR module. You should read high resistance in one direction and low resistance in the other (reverse the leads).

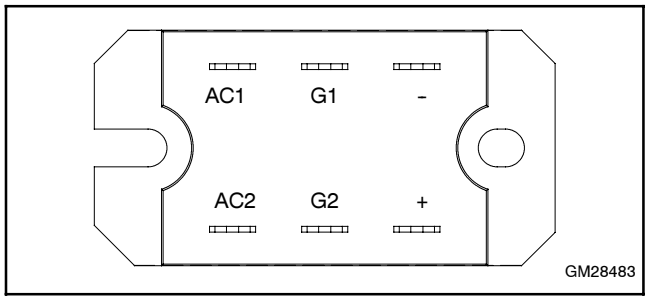
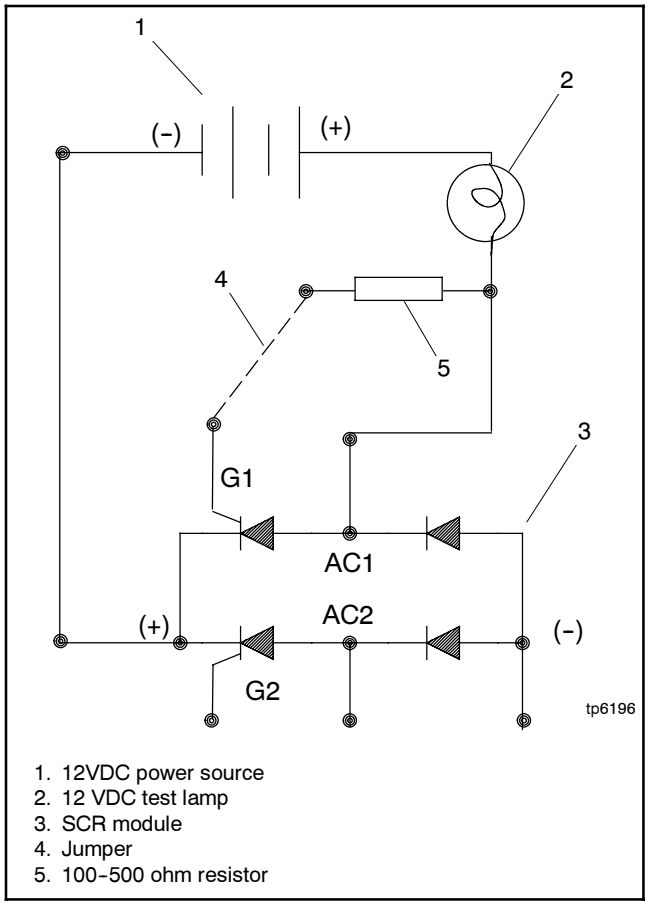


Figure 7-13 Silicon Controlled Rectifier (SCR) Module

3. Connect the ohmmeter from AC1 to (+) on the SCR module. You should read high resistance in both directions.
4. Connect the ohmmeter from AC1 to (–) on the SCR module. You should read high resistance in one direction and low resistance in the other.
5. Repeat steps 3 and 4 for AC2.
6. Connect the ohmmeter from G1 to (+) on the SCR module. You should read low resistance in both directions.
7. Repeat step 6 for G2. You should read low resistance in both directions.
8. See Figure 7-14. Connect the *negative* (–) lead from the DC power source to the *positive* (+) terminal on the SCR module.

   Note: The SCR module may be damaged if the power supply is connected incorrectly. Be sure to connect the *negative* lead from the battery to the *positive* terminal on the SCR module.



1. 12VDC power source
2. 12 VDC test lamp
3. SCR module
4. Jumper
5. 100–500 ohm resistor

Figure 7-14 SCR Test

9. Connect the positive (+) lead from the DC power source, with the lamp in series, to terminal AC1 on the SCR module. The lamp should not glow.

10. Connect the jumper, with the resistor in series, from the positive lead of the DC power source to terminal G1 on the SCR module. The lamp should glow.

11. Repeat steps 9 and 10, with the positive (+) lead and lamp connected to terminal AC2 on the SCR module, and connecting the jumper with resistor to terminal G2.

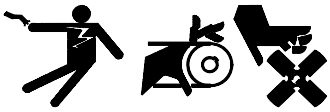
12. If any of the above checks indicates a bad SCR module, replace the module.

Note: When replacing the SCR module, be sure to apply thermal compound to the back of the module to prevent overheating. Thermal compound is provided with the SCR module replacement kit.

7.8 Continuous Power Mode Jumper, if equipped

Note: The P7 jumper was available on generator sets with serial numbers before 2051415.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

⚠ 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.

Note: The controller is powered by the generator set engine starting battery.

A jumper on connector P7 on the back of the controller causes the controller to remain powered at all times. With the jumper connected, the ADC's LED display is powered by the generator set's battery. Also, the remote start/stop command is supported via the ADC remote gauge. See the wiring diagram and schematic drawing in Section 10. Controllers are shipped from the factory with the jumper connected. Disconnecting the jumper allows the controller to power down 48 hours after the generator set shuts down and the remote start/stop command is no longer supported.

A jumper across controller pins P7-1 and P7-2 maintains power to the controller at all times. Controllers are shipped with the jumper connected for continuous power. See Figure 7-15.

If the generator set is not used for a long period of time, without exercising, the battery may drain. The P7 connector has either 2 or 3 pins. Disconnecting the jumper or moving the jumper to pins P7-2 and P7-3 allows the controller to power down automatically 48 hours after the generator set shuts down if the generator set master switch is in the AUTO position. A remote start signal (from a transfer switch or a remote start/stop switch connected to controller leads 3 and 4) or moving the generator set master switch to the RUN position turns the controller back on.

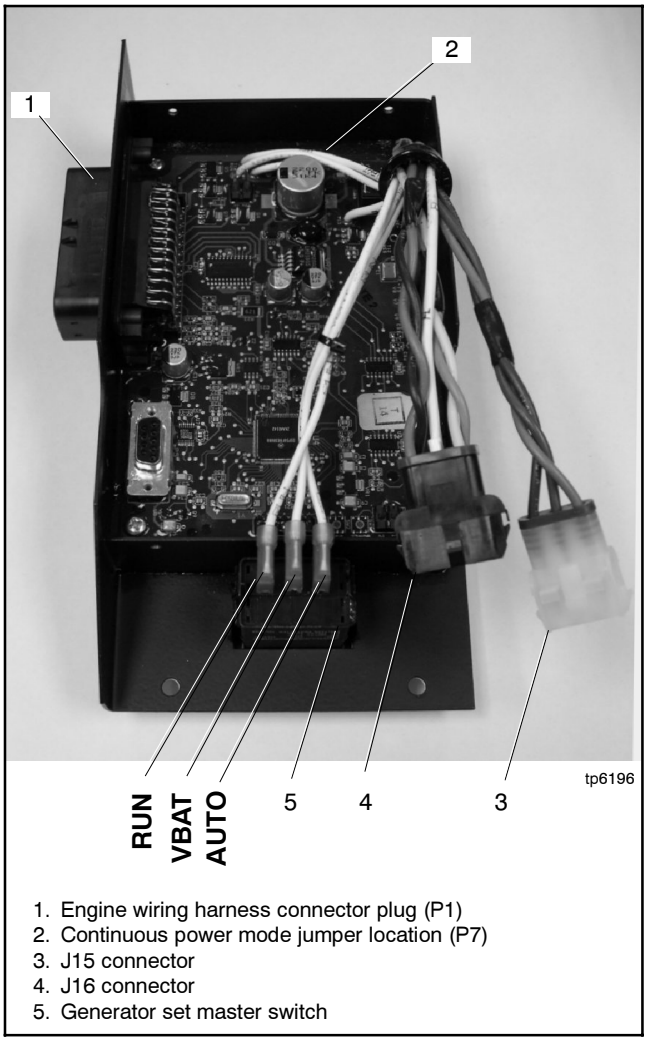
Note: For most applications, it is not necessary to disconnect the continuous power mode jumper. Use the following procedure to disconnect the jumper, if desired.

Procedure to disconnect the continuous power mode jumper (optional).

Note: The P7 jumper was available on generator sets with serial numbers before 2051415.

Note: For most applications, it is not necessary to disconnect the continuous power mode jumper.

1. Prevent the generator set from starting.
   a. Move the generator set master switch to the OFF/RESET position.
   b. Disconnect power to the battery charger, if equipped
   c. Disconnect the generator set engine starting battery, negative (–) lead first.
2. Remove the controller from the generator set housing.
   a. Disconnect the engine wiring harness connector P1 plug (35-pin) from the controller. Disconnect the J15 and J16 connectors. See Figure 7-15.
   b. Remove the controller from the generator set housing in order to access the back of the controller.
3. Remove the controller's back cover to access the jumper.
   a. Note the labels on the three leads connected to the generator set master switch for reconnection later. Disconnect the leads at the pink connectors. See Figure 7-15.
   b. Remove the cover screws and remove the controller's back cover. See Figure 7-15.
4. Locate the P7 connector near the top of the controller. See Figure 7-15. Remove the jumper from pins 1 and 2 of the P7 connector. If the P7 connector has three pins, connect the jumper across pins 2 and 3 for storage.
5. Replace the controller's back cover and secure the cover screws.
6. Reconnect the three pink connectors to the generator set master switch.
7. Reconnect the J15 and J16 connectors.
8. Reconnect the engine wiring harness connector P1 plug (35-pin) to the controller.
9. Reconnect the generator set engine starting battery, negative (–) lead last.
10. Reconnect power to the battery charger, if equipped.
11. Place the generator set master switch in the AUTO position.



1. Engine wiring harness connector plug (P1)
2. Continuous power mode jumper location (P7)
3. J15 connector
4. J16 connector
5. Generator set master switch

Figure 7-15 ADC Controller (back cover removed)

7.9 Master Switch

The generator set master switch is a three-position (RUN\OFF/RESET\AUTO) rocker switch. The leads connecting to the master switch are labeled RUN, VBAT, and AUTO. Check that the three pink connectors are connected to the terminals on the back of the switch as shown in Figure 7-15. Be careful not to reverse the RUN and AUTO leads.

7.10 Relay Interface Board (RIB)

The standard relay interface board (RIB) contains the K2 crank, K3 flash, and K5 run relays. Three LEDs indicate relay operation. See Figure 7-16.

Refer to the schematic diagram in Section 10 for the standard relay board connections.

The RIB is protected by a 10 amp fuse (F2) located in the wiring harness. If the fuse blows repeatedly, disconnect the board leads one at a time to identify the cause of the blown fuse:

- Lead 70A at the fuel solenoid
- Lead 71A at the starter relay
- Leads FP and FN at the rotor

Repair or replace the component causing the blown fuse.

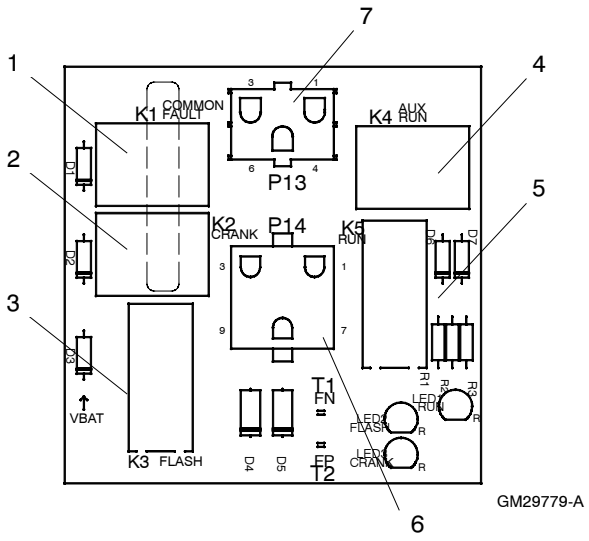
If fuse continues to blow and disconnecting components did not identify the cause, remove the leads from the P14 connector using a pin pusher, part #241918 (large) or 241919 (small). If replacing the leads does not solve the problem, replace the RIB.

The individual relays are not replaceable. If one or more relays are faulty, replace the entire RIB.

To replace the RIB:

1. Disconnect P14 and the exciter leads FP and FN.
2. Pull the board straight off the mounting stand-offs.
3. Snap the new board onto the stand-offs and reconnect P14 and the exciter leads.

The generator set may be equipped with an optional RIB, which contains the K4 auxiliary run relay and K1 common fault relay in addition to the standard relays. The optional relay board kit includes a wiring harness for connection of customer equipment to the K1 and K4 relays. See Figure 7-17 for optional relay connections.



1. K1 common fault relay (optional)
2. K2 crank relay (standard)
3. K3 flash relay (standard)
4. K4 auxiliary run relay (optional)
5. K5 run relay (standard)
6. P14, engine harness connection (standard)
7. P13, connection to optional relay harness (optional)

Figure 7-16 Relay Board

Harness Lead Number	Connector Pin Number	Connection
88	6	Common fault normally open
89	2	Common fault common
90	3	Common fault normally closed
91	4	Run relay normally open
92	1	Run relay common
93	5	Run relay normally closed

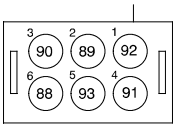


Figure 7-17 Optional Common Fault and Run Relay Board Harness Connections

7.11 Controller Replacement

If the troubleshooting procedures in Section 6 identify a faulty controller, use the procedure in this section for controller replacement. Always check the controller configuration, fuse, wiring, and connections before replacing the controller. For output voltage problems, replace the SCR module and check the operation again before replacing the controller.

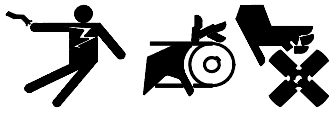
After replacing the controller, verify that the new controller's configuration settings match the generator set system voltage and frequency, unit configuration, engine type, engine data input types, battery voltage, and communications settings. Refer to Section 7.5 for instructions to check the controller configuration and to change the settings, if necessary.

After the controller configuration has been checked and set to match the generator set, use a voltmeter to check the generator set output voltage. If the output voltage or frequency needs adjustment, use the voltage adjustment procedure in Section 8.10.2 and the governor adjustment instructions in Section 4.4.

ADC 2100 Controller Replacement Procedure

1. Place the generator set master switch in the OFF position.
2. Disconnect power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.

⚠ WARNING

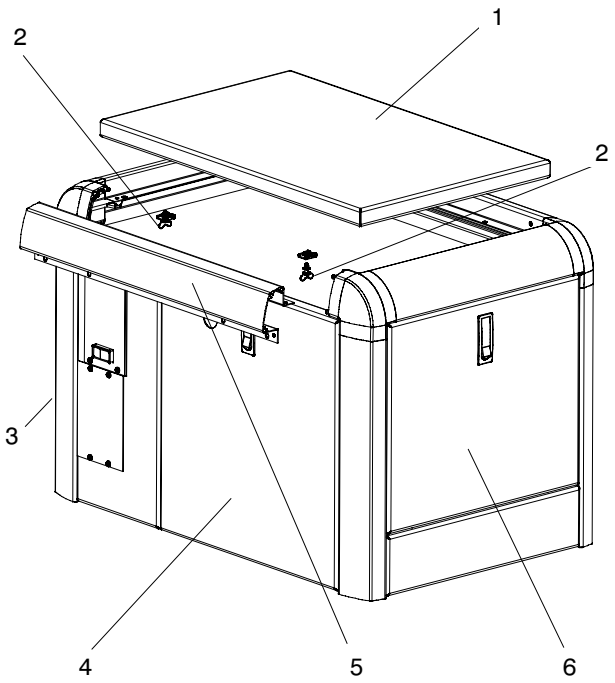


Accidental starting.
Can cause severe injury or death.

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.

Sound Shield Equipped Models: For access to the generator set to perform regular maintenance, remove the sound shield doors and roof.

4. **Sound-Shielded Models:** Open the service-side door.
5. **Sound-Shielded Models:** Release the two quarter-turn fasteners located underneath the roof. See Figure 7-18.
6. **Sound-Shielded Models:** Lift up the roof.
7. **Sound-Shielded Models:** Slide the roof towards the service side of the unit for removal.
8. **Sound-Shielded Models:** Open the front, rear, and non-service side doors as needed.



1. Sound shield roof
2. Quarter-turn fastener
3. Alternator-end door
4. Service-side door
5. Front rail
6. Engine-end door

Figure 7-18 Sound Shield Roof Removal

9. Disconnect wiring harness plugs P1, P15, and P16 from the ADC controller.

10. Loosen and remove the four controller mounting screws at the front of the controller. See Figure 7-19. Remove the controller.

1. Controller mounting screws (4 ea.)

Figure 7-19 Controller Mounting Screws

11. Place the new controller into position and install the four mounting screws.

12. Reattach connectors P1, P15, and P16 to the new controller.

13. Verify that the generator set master switch is in the OFF position.

14. Reconnect the engine starting battery, negative (-) lead last.

15. Reconnect power to the battery charger, if equipped.

16. Follow the instructions in Section 7.5.2 to change the new controller's configuration settings to match the generator set system voltage and frequency, unit configuration, engine type, engine data input types, battery voltage, and communications settings.

17. Use a voltmeter to check the output voltage. Follow the instructions in Sections 7.5.3, Voltage Adjustment and 8.10.2, Voltage Adjustment, to adjust the output voltage and stability.

18. Check the output frequency. Follow the instructions in Section 4.4, Governor, to adjust the output frequency.

19. Place the generator set master switch in the AUTO position if an ATS or remote start/stop switch is used.

20. Replace the sound shield roof and door(s), if equipped.

Notes

8.1 Theory of Operation

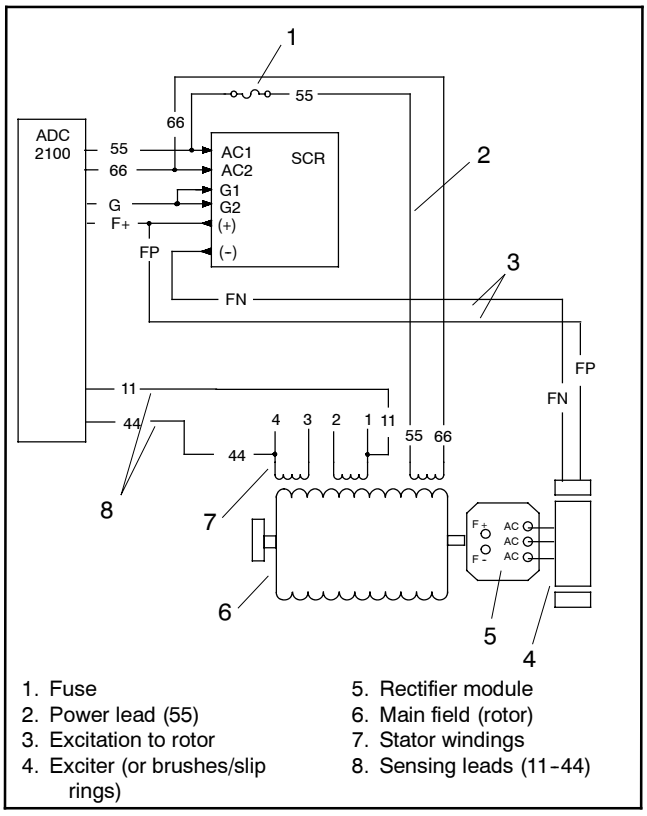
These generator sets utilize a rotating-field alternator to produce AC voltage. Upon activation of the generator master switch, DC current from the battery magnetizes the rotor (field). When the magnetized rotor rotates within the stator windings, an electrical voltage develops within the stator. As engine speed and generator output increase, the SCR module feeds rectified stator output current to the rotor through the exciter (or brushes/slip rings for model 6EOD/4.5EFOD) to increase the strength of the rotor field. As the rotor field increases in strength, generator output also increases. The ADC 2100 monitors the generator output voltage through leads 11 and 44 (for 1-phase models) or leads V7, V8, and V9 (for 3-phase models) and adjusts the DC current from the SCR module to the rotor to meet load requirements. See Figure 8-1.

8.2 Separate Excitation

To determine the cause of no- or low-AC output, refer to the troubleshooting flowchart in Figure 8-2. Before beginning the test procedures, read all of the safety precautions at the beginning of this manual. Many of the test procedures include additional safety precautions.

Check the condition of the alternator fuse before performing the separate excitation procedure. The inline fuse is located in lead 55 of the wiring harness. See Figure 8-1. If the fuse is not blown, use the following procedure to separately excite the generator using an external voltage source (a 12-volt automotive battery).

Separately exciting the generator can identify faulty voltage regulation by the ADC 2100 or reveal a running fault in the rotor and/or stator. An external power source duplicates the role of the voltage regulator and excites the generator field (rotor). A generator component that appears to be in good condition while stationary may exhibit a running open or short circuit while moving. Short circuits can be caused by centrifugal forces acting on the windings during rotation or insulation breakdown as temperatures increase.



1. Fuse
2. Power lead (55)
3. Excitation to rotor
4. Exciter (or brushes/slip rings)
5. Rectifier module
6. Main field (rotor)
7. Stator windings
8. Sensing leads (11–44)

Figure 8-1 Generator Schematic (Single-Phase Model Shown)

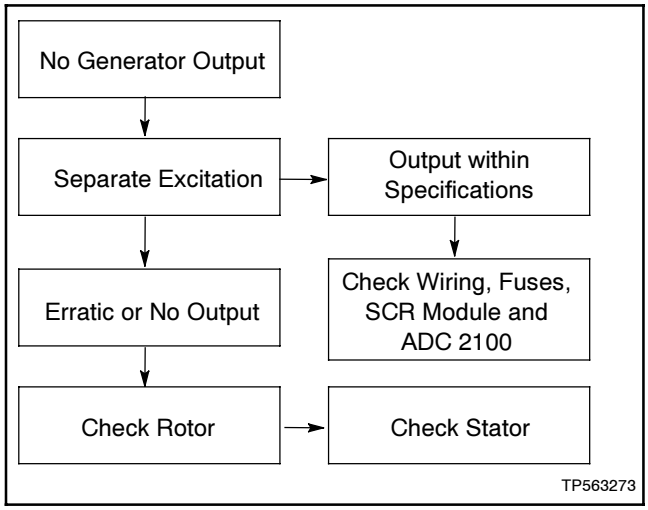


Figure 8-2 General Troubleshooting

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, transfer switch, 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.

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.

Separate Excitation Procedure:

Perform the following procedure to use an external voltage source to excite the main field (rotor).

1. Disconnect the black FN and FP leads from the alternator at the SCR module (+) and (–) terminals.

2. Connect a DC ammeter, 20-amp fuse, and a 12-volt automotive battery to the positive (FP) and negative (FN) exciter leads as shown in Figure 8-3. Note and record the ammeter reading.

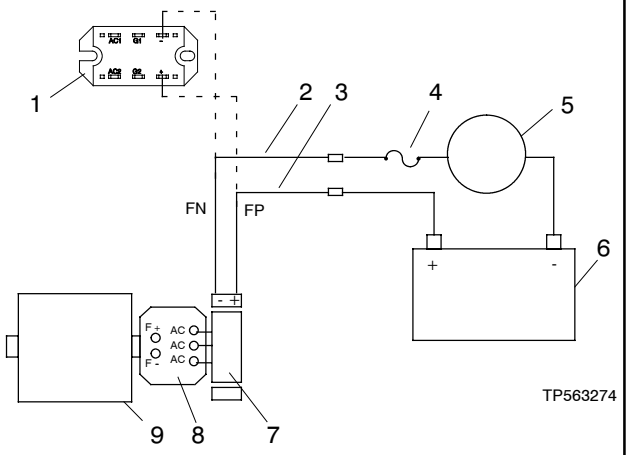
Note: The approximate ammeter reading should be the battery voltage divided by the specified rotor resistance. See Section 1, Specifications, for the specified rotor resistance values.

$$\text{Example}: \frac{\text{12 volts (battery voltage)}}{\text{3.5 ohms (rotor resistance)}} = \text{3.4 amps (rotor current)}$$

3. Start the engine and check that the ammeter reading remains stable. An increasing meter reading indicates a shorted rotor. A decreasing meter reading to zero or an unstable reading suggests a running open. Refer to Section 8.8, Rotor, to test the rotor. If the ammeter reading is stable, proceed to step 4.

4. Check for AC output across the stator leads; see Section 8.9, Stator. Compare the readings to the AC output values shown in Section 1, Specifications. If the readings vary considerably, a faulty stator is likely. Refer to Section 8.9, Stator, for further information.

5. If this test shows that the rotor and stator are in good condition, check the wiring and fuses. Check the SCR module. See Section 7.7, Silicon Controlled Rectifier (SCR) Module. Check the controller settings and connections. See Section 7, Controller.



1. SCR module
2. FN lead disconnected from SCR
3. FP lead disconnected from SCR
4. 10-amp fuse
5. DC ammeter
6. 12V battery
7. Exciter (or brushes/slip rings)
8. Rectifier module
9. Main field (rotor)

Figure 8-3 Separate Excitation Connections

8.3 Exciter Field (8-32EOZD/6.5-28EFOZD Models)

Direct current from the battery magnetizes the exciter field. When the exciter armature rotates within the magnetized exciter field windings, an electrical current develops within the exciter armature. Test the exciter field according to the following procedure.

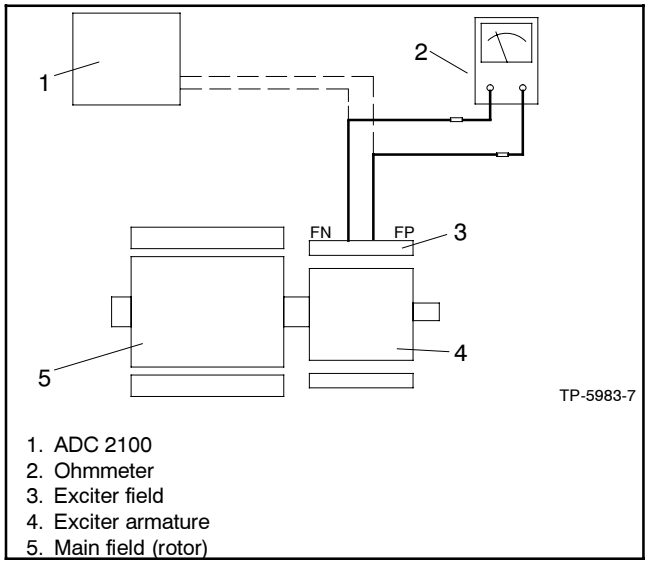
Exciter Field Test Procedure:

1. Place the generator set master switch in the OFF position.

2. Disconnect the generator set engine starting battery, negative (-) lead first.

3. Disconnect the FN/FP leads.

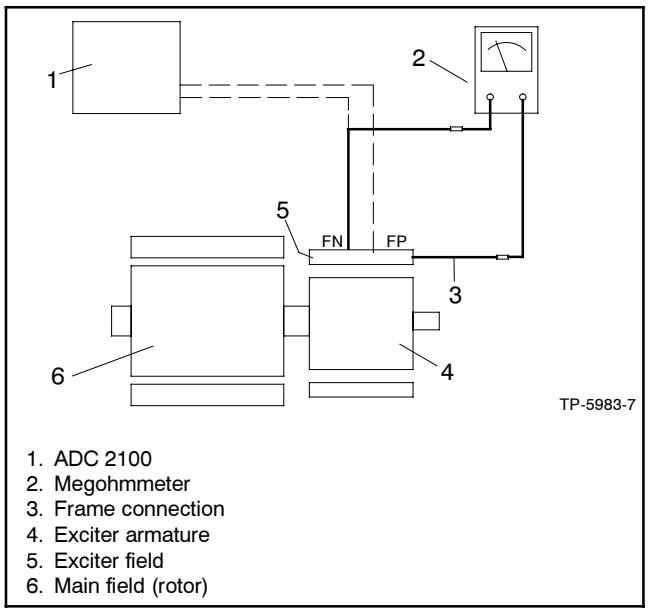
4. Check the exciter field resistance by connecting an ohmmeter across exciter field FN and FP leads. See Figure 8-4. See Section 1, Specifications for the resistance reading of a cold exciter field. A low reading indicates an internal short and a high reading indicates an open winding. Repair or replace the exciter field if the ohmmeter readings indicate an inoperative exciter field (refer to Section 9 for removal). If the resistance test is inconclusive, perform a megohmmeter test on the exciter field as described in the next step.



1. ADC 2100
2. Ohmmeter
3. Exciter field
4. Exciter armature
5. Main field (rotor)

Figure 8-4 Exciter Field Resistance Test

5. Check the exciter field for a short-to-ground condition. Use a megohmmeter to apply 500 volts DC to the FN or FP lead and the exciter field frame. See Figure 8-5. Follow the megohmmeter manufacturer's instructions for using the megohmmeter. A reading of approximately 1.5 MOhms and higher indicates the field winding is functional. A reading of less than approximately 1.5 MOhms indicates deterioration of the winding insulation and possible current flow to ground; if so, replace the exciter field.



1. ADC 2100
2. Megohmmeter
3. Frame connection
4. Exciter armature
5. Exciter field
6. Main field (rotor)

Figure 8-5 Megohmmeter Connections on the Exciter Field

8.4 Exciter Armature (8-32EOZD and 6.5-28EFOZD Models)

The exciter armature supplies excitation current to the generator main field through the rectifier module. Test the exciter armature as described in the following steps.

Exciter Armature Test Procedure:

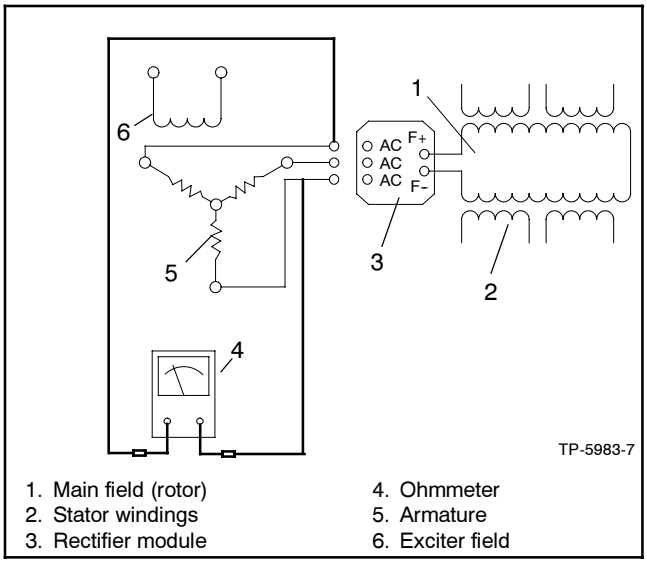
1. Disassemble the alternator. Refer to Section 9.

2. With the alternator disassembled, disconnect the armature leads from the rectifier module AC terminals. Refer to Section 10.

3. With an ohmmeter on the R x 1 scale, check the resistance across the exciter armature leads. See Figure 8-6. See Section 1, Specifications for the armature resistance. No continuity indicates an open armature winding. If the resistance test is inconclusive, perform a megohmmeter test on the exciter armature as described in the next step.

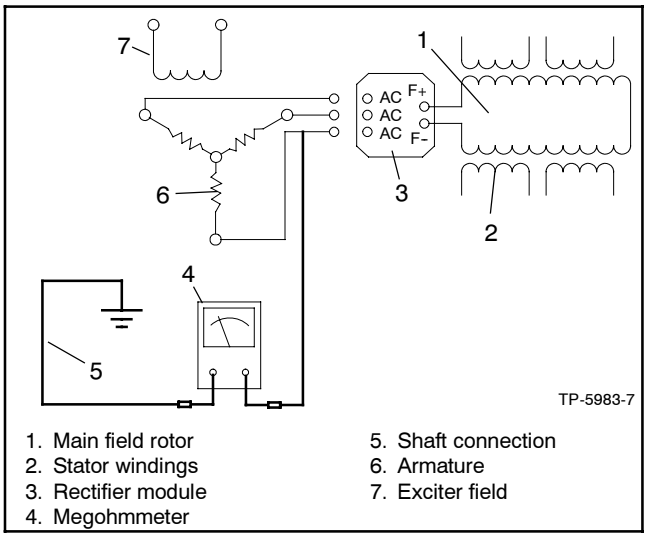
   Note: Most ohmmeters will not accurately measure less than one ohm. Consider the exciter armature functional if the resistance reading (continuity) is low and there is no evidence of a shorted winding (heat discoloration).

4. Check the exciter armature winding for a short-to-ground condition. Use a megohmmeter to apply 500 volts DC to either armature lead and the armature frame. Follow the megohmmeter manufacturer's instructions for using the megohmmeter. See Figure 8-7. A reading of approximately 1.5 MOhms and higher indicates the exciter armature is functional. A reading of less than approximately 1.5 MOhms indicates deterioration of the winding insulation and possible current flow to ground; if so, replace the exciter armature.



1. Main field (rotor)
2. Stator windings
3. Rectifier module
4. Ohmmeter
5. Armature
6. Exciter field

Figure 8-6 Exciter Armature Ohmmeter Test



1. Main field rotor
2. Stator windings
3. Rectifier module
4. Megohmmeter
5. Shaft connection
6. Armature
7. Exciter field

Figure 8-7 Megohmmeter Connections on Exciter Armature

8.5 Slip Rings (6EOD/4.5EFOD Models)

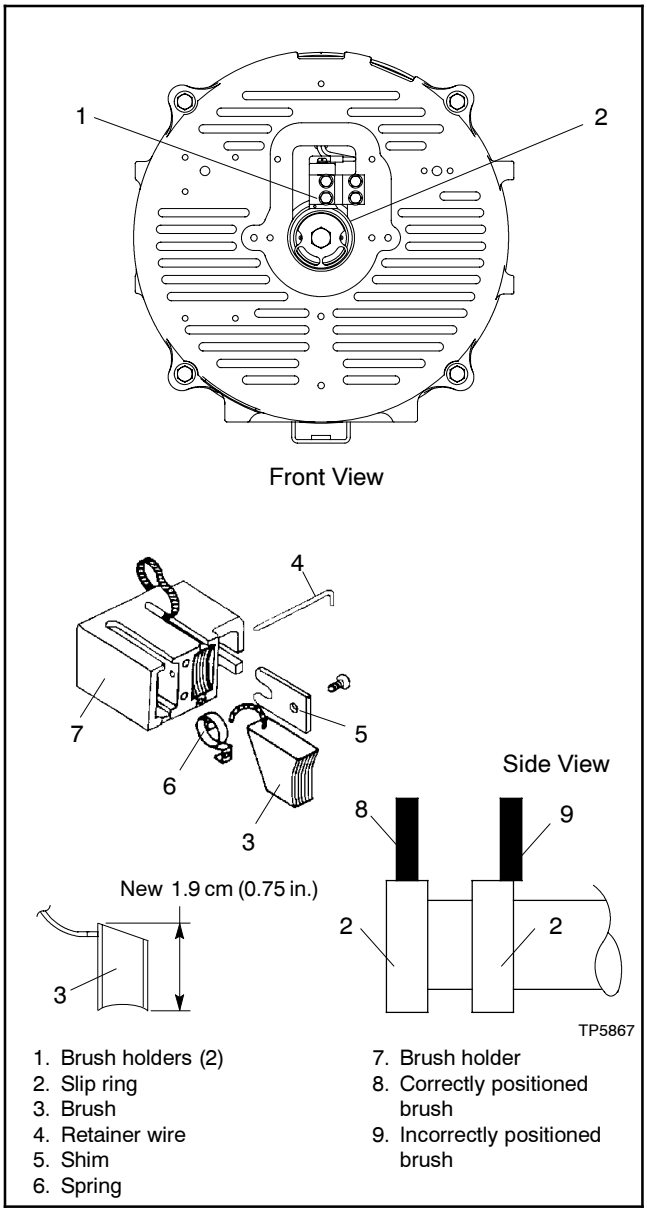
Slip rings acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright, newly-machined appearance on the slip rings. Cleaning with a dry, lint-free cloth is usually sufficient. Use very fine sandpaper (#00) and apply light pressure to remove roughness. Do not use emery or carborundum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

8.6 Brushes (6EOD/4.5EFOD Models)

The brushes transfer current from the SCR module to the slip rings. The brushes should last the life of the generator. Abrasive dust on the slip rings, however, shortens the life of the brushes. Excessive arcing at the brushes could damage the SCR module and the controller. Weak springs, damaged slip rings, sticking brushes, a loose brush holder, or poor brush contact causes arcing.

The brushes must be free to move within the holder and be held in contact with the slip rings by the springs. When correctly positioned, spring pressure on the brush surface causes the brush to wear evenly. The entire brush must ride on the ring or arcing occurs and causes burned rings or voltage regulator failure. Figure 8-8 shows the correct positioning of the brushes. Add or remove shims as necessary to center the brushes on the slip rings. Replace the brushes if they show uneven wear or are worn to one half their original length.

Check the resistance through the brushes. Resistance through the brushes should be low, 0.1–0.2 ohms without meter lead resistance.



1. Brush holders (2)
2. Slip ring
3. Brush
4. Retainer wire
5. Shim
6. Spring
7. Brush holder
8. Correctly positioned brush
9. Incorrectly positioned brush

Figure 8-8 Brush Assembly

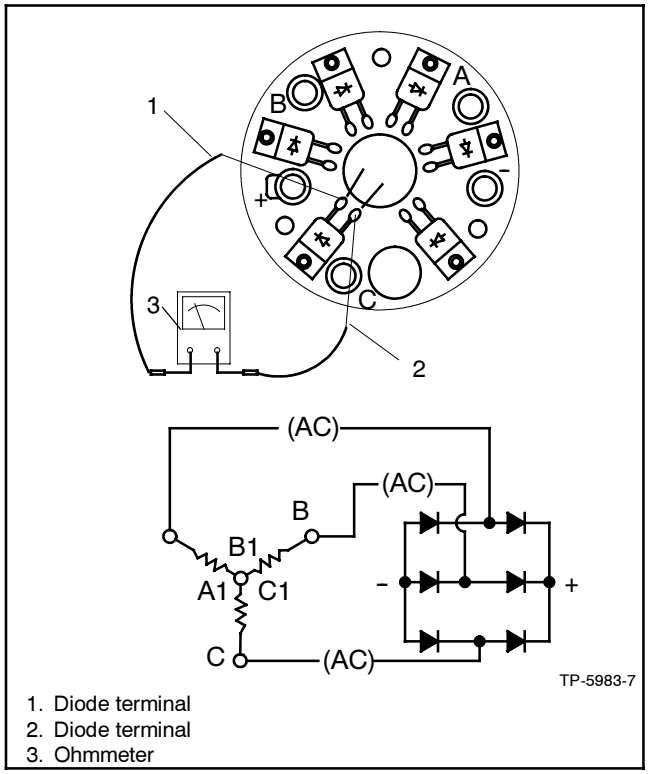
8.7 Rectifier Module (8-32EOZD and 6.5-28EFOZD Models)

The rectifier module located between the exciter armature and the main field converts AC from the exciter armature to DC, which magnetizes the generator main field. Test the rectifier module as described in the following steps.

Rectifier Module Test Procedure:

1. Disconnect the exciter armature and the main field leads from the rectifier module.

2. Use an ohmmeter on the R x 100 scale to check the resistance between all the rectifier diodes as shown in Figure 8-9. The ohmmeter should show a low resistance in one direction and, upon reversing the ohmmeter leads, a high resistance in the other direction. Replace the rectifier module if any of the diodes tests differently than described.



1. Diode terminal
2. Diode terminal
3. Ohmmeter

Figure 8-9 Rectifier Module Test

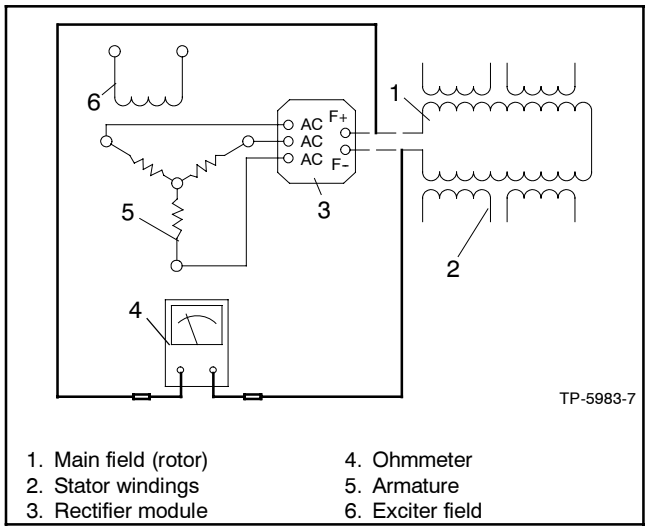
8.8 Rotor

The generator rotor (magnetized by DC from the rectifier module) rotating within the stator windings induces AC in the stator windings. Test the generator rotor (main field) as described in the following steps. Disassemble the generator prior to performing this test. See Section 9.

Generator Main Field (Rotor) Test Procedure:

1. With the generator disassembled, disconnect the generator main field windings at the rectifier module terminals F+ and F-.

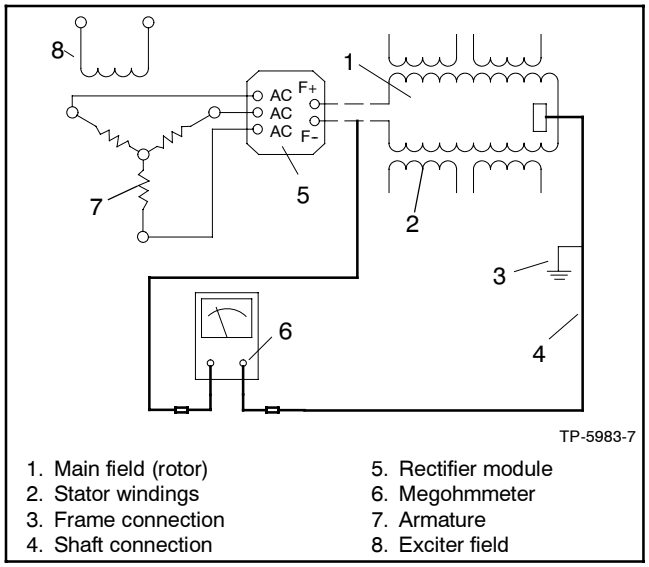
2. Check the main field resistance by connecting an ohmmeter across the main field F+ and F- leads. See Figure 8-10. See Section 1, Specifications for the resistance reading. A low reading indicates an internal short and a high reading indicates an open winding. Repair or replace the main field if the ohmmeter readings indicate the main field is inoperative. If the resistance test is inconclusive, perform a megohmmeter test on the main field as described in the next step.



1. Main field (rotor)
2. Stator windings
3. Rectifier module
4. Ohmmeter
5. Armature
6. Exciter field

Figure 8-10 Ohmmeter Connections on Main Field

3. Check the main field for a short-to-ground condition by using a megohmmeter. Apply 500 volts DC to either field lead and the main field frame. Follow the megohmmeter manufacturers instructions for using the megohmmeter. See Figure 8-11. A reading of 1.5 MOhms and higher indicates the main field is functional. A reading of less than 1.5 MOhms indicates deterioration of the winding insulation and possible current flow to ground; if so, replace the main field.



1. Main field (rotor)
2. Stator windings
3. Frame connection
4. Shaft connection
5. Rectifier module
6. Megohmmeter
7. Armature
8. Exciter field

Figure 8-11 Megohmmeter Connections on Main Field

8.9 Stator

The stator consists of a series of coils of wire laid in a laminated steel frame. The stator leads supply voltage to the AC load and exciter regulator.

Before testing the stator, inspect it for heat discoloration and visible damage to the housing lead wires and exposed and varnished areas of the frame laminations. Be sure the stator is securely fastened in the stator housing.

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

Leads 1, 2, 3, and 4 are the generator output leads. Leads 55 and 66 are the voltage regulator supply and sensing leads. Refer to the schematic in Figure 8-12 when performing the following tests.

Stator Test Procedure:

1. Place the generator master switch in the OFF position.

2. Disconnect the generator set engine starting battery, negative (-) lead first.

3. Check the generator output lead connections. See Section 10, Wiring Diagrams.

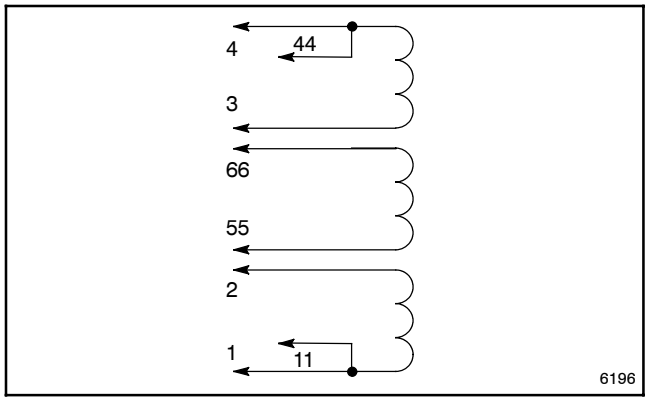


Figure 8-12 Alternator Stator Leads

4. Disconnect all the stator leads to isolate the windings. To check the stator continuity, set the ohmmeter on the R x 1 scale. Check the stator continuity by connecting the meter leads to the stator leads as shown in Figure 8-12. See Figure 8-13 for single-phase and Figure 8-14 for three-phase values. Perform the stator tests on all the stator windings.

Leads	Continuity
1 and 2	Yes
1 and 11	
2 and 11	
3 and 4	
3 and 44	
4 and 44	
55 and 66	
1 and 3, 4, 44, 55, or 66	No
2 and 3, 4, 44, 55, or 66	
3 and 1, 2, 11, 55, or 66	
4 and 1, 2, 11, 55, or 66	
Any stator lead and ground on stator housing or frame laminations	

Figure 8-13 Stator Continuity Test Results on a Good Stator (1-Phase)

Leads	Continuity
1 and 4	Yes
2 and 5	
3 and 6	
7 and 10	
8 and 11	
9 and 12	
55 and 66	
1 and 2, 3, 7, 8, or 9	No
1 and 55	
Any stator lead and ground	

Figure 8-14 Stator Continuity Test Results on a Good Stator (3-Phase)

5. Check the cold resistance of the stator windings by connecting the meter leads to the stator leads as shown in Figure 8-13 or Figure 8-14. See Section 1, Specifications for the stator resistance values. If the stator resistance test is inconclusive, perform a megohmmeter test on the stator as described in the next step.

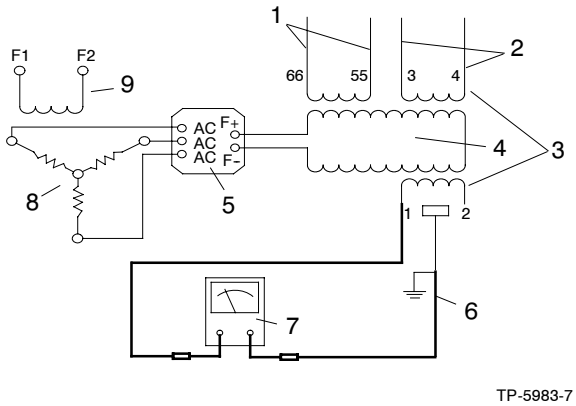
   Note: Consider the stator functional if the resistance reading (continuity) is low and there is no evidence of shorted windings (heat discoloration).

   Note: When taking an ohmmeter reading using lead 55, make the connection before the in-line fuse.

   Note: The stator resistance can vary directly with increased temperature.

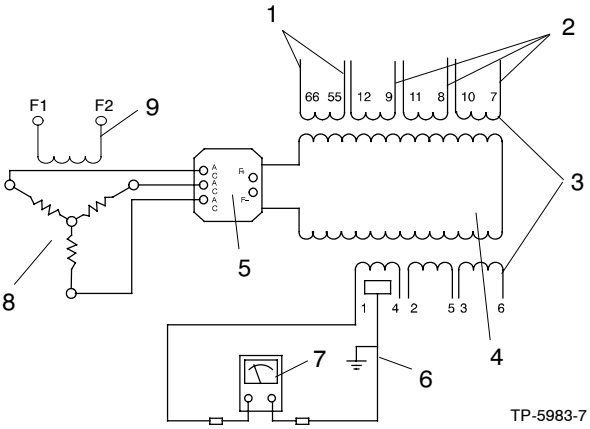
If any of the stator readings vary during the previous checks, replace the stator.

6. Check the stator for a short-to-ground condition using a megohmmeter. See Figure 8-15 for a single-phase megohmmeter connections and Figure 8-16 for three-phase megohmmeter connections. Apply 500 volts DC to any stator lead from each winding and the stator frame. Follow the megohmmeter manufacturer's instructions for using the megohmmeter. Repeat the test on the other leads until all of the stator windings have been tested. A reading of 1.5 MOhms and higher indicates the stator is functional. A reading of less than 1.5 MOhms indicates deterioration of the winding insulation and possible current flow to ground; if so, repair or replace the stator.



1. ADC's voltage regulator power supply leads
2. Sensing leads (208–240 volts nominal)
3. Stator windings
4. Main field (rotor)
5. Rectifier module
6. Frame connection
7. Megohmmeter
8. Armature
9. Exciter field

Figure 8-15 Megohmmeter Connections on 1-Phase Stator



1. ADC's voltage regulator power supply leads
2. Sensing leads (208–240 volts nominal)
3. Stator windings
4. Main field (rotor)
5. Rectifier module
6. Frame connection
7. Megohmmeter
8. Armature
9. Exciter field

Figure 8-16 Megohmmeter Connections on 3-Phase Stator

8.10 Voltage

8.10.1 Voltage Regulation

Voltage regulation is performed by the Advanced Digital Control (ADC) and the SCR module. The ADC monitors generator output voltage and adjusts the excitation current to the rotor through the SCR module.

8.10.2 Voltage Adjustment

The factory sets the voltage for correct generator operation under a variety of load conditions. Usually, the voltage needs no further adjustment. Adjust the voltage when necessary according to the following procedure.

The adjustment procedure requires a meter that can measure voltage and frequency.

Use the ADC to adjust the voltage, gain, and volts/Hz. Refer to Section 7 for instructions to adjust each parameter and save the changes using the controller keypad.

Note: The ADC controller will time out and exit the adjustment mode after approximately 1 minute if no buttons are pressed. Any unsaved changes are discarded if the controller times out before the settings are saved. Refer to Section 7.5 for instructions to save your settings.

Voltage Adjustment. Adjusts generator output between 100 and 130 volts.

Gain (Stability) Adjustment. Fine tunes regulator circuitry to reduce light flicker.

Volts/Hz Adjustment. Determines frequency (Hz) at which generator output voltage begins to drop.

The ADC maintains generator output at the specified voltage under load until the generator engine speed drops to a preset level (factory setting 57.5 Hz on 60 Hz models and 47.5 Hz on 50 Hz models). Then the ADC allows the generator voltage and current to drop. The voltage/current drop enables the engine to pick up the load. When the generator speed returns to normal (60 Hz or 50 Hz) as load is accepted, the generator output also returns to normal.

⚠ 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.

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, transfer switch, 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.

Voltage Adjustment Procedure

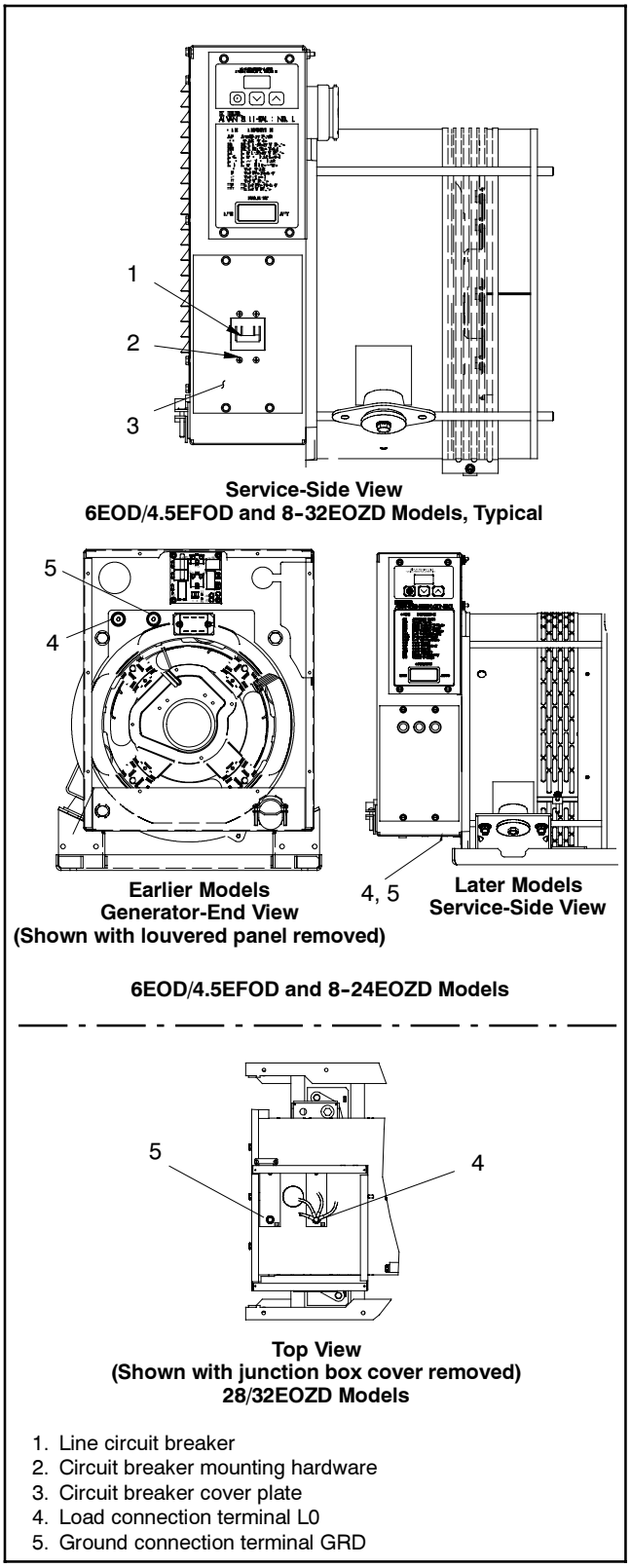
1. Connect a digital voltmeter from one side of the circuit breaker to the L0 terminal. See Figure 8-17 for the L0 terminal location. Set the meter to measure voltage.

   Note: For 120- or 240-volt systems the voltage measured from one side of the breaker to L0 should be approximately 120 VAC. For 240-volt systems, the voltage measured from one side of the circuit breaker to the other should be approximately 240 VAC.

2. Start the generator set.

3. Follow the ADC instructions in Section 7.5 to enter the adjustment mode and increase voltage or decrease voltage (parameter 1P) until the output reaches the desired voltage.

4. Follow the ADC instructions to step to the voltage gain adjustment menu. Adjust the voltage gain (parameter 2P) until the light flicker minimizes. Save the settings.



1. Line circuit breaker
2. Circuit breaker mounting hardware
3. Circuit breaker cover plate
4. Load connection terminal L0
5. Ground connection terminal GRD

Figure 8-17 Circuit Breaker and L0 Terminal Location

5. Check and readjust the voltage if necessary.

6. Set the voltmeter to measure frequency. Adjust the engine speed to the cut-in frequency shown in Figure 8-18 by adjusting the governor as described in Section 4.4.

7. Set the voltmeter to measure voltage. Adjust the volts/Hz (parameter 3P) until the voltage level measured by the voltmeter begins to drop. When set, the generator (as load is applied) attempts to maintain normal output until the engine speed drops below the cut-in frequency set in step 6.

8. Set the voltmeter to measure frequency. Adjust the engine speed to the operating frequency (50 or 60 Hz) by adjusting the engine governor.

9. Readjust the voltage gain (parameter 2P) until the light flicker minimizes, if necessary.

10. Check the voltage. Readjust the voltage (parameter 1P), if necessary.

11. Save the settings. Refer to Section 7.5 for instructions.

    Note: The ADC will revert to the previous settings at the next startup if the changes are not saved.

12. Stop the generator set.

Frequency	Cut-In Frequency
60 Hz	57.5 Hz
50 Hz	47.5 Hz

Figure 8-18 Cut-In Frequencies

8.11 Four-Lead Reconnection

The following information illustrates the reconnection of four-lead generator sets. In all cases, conform to the National Electrical Code (NEC).

NOTICE

Voltage reconnection. Affix a notice to the generator set after reconnecting the set to a voltage different from the voltage on the nameplate. Order voltage reconnection decal 246242 from an authorized service distributor/dealer.

8.11.1 100–120-Volt Configurations

If the installation requires a factory two-pole circuit breaker, do not connect the load-side terminals of the circuit breaker together; see Figure 8-19. If the installation requires a 100–120-volt, 2-wire system, use a single-pole circuit breaker. See Figure 8-20. When connecting stator phase leads together, size the output lead (L1) to handle the amperage. Use a jumper lead on the *line* side of the circuit breaker to balance the load of the generator set.

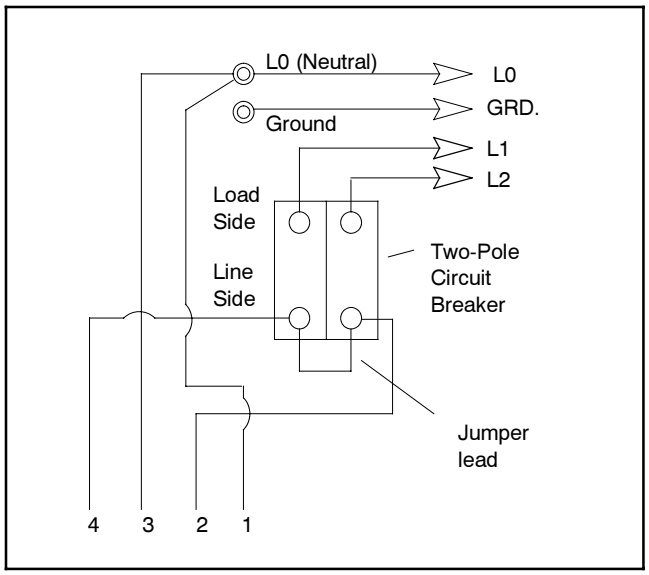
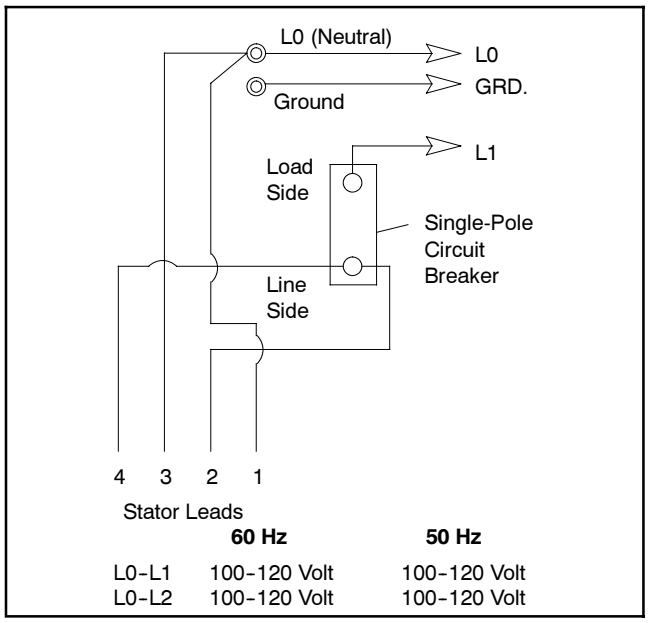


Figure 8-19 100–120-Volt, 3-Wire Configuration

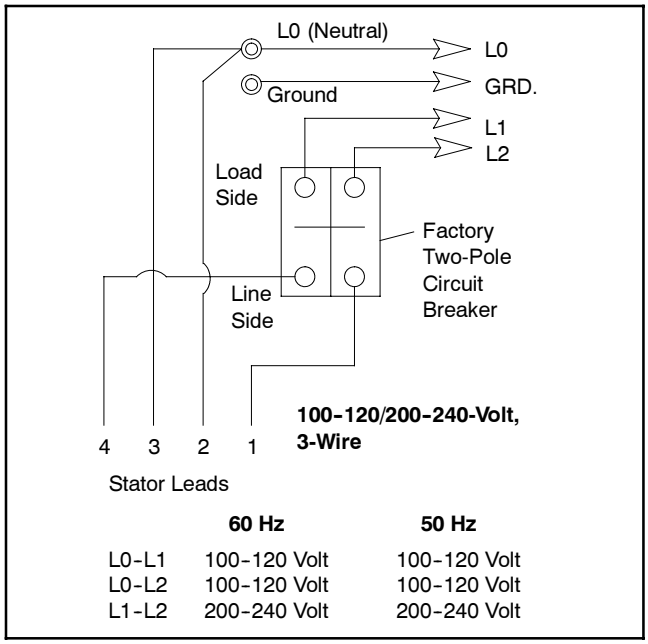
8.11.2 100–120/200–240-Volt Configurations

The 100–120/200–240-volt configuration does not use a jumper lead. If the unit was originally wired for straight 100–120 volt, 3-wire, remove the jumper lead (see Figure 8-19 for location). Select a two-pole circuit breaker. Application of two single-pole circuit breakers does not conform to NEC requirements for supplying a 200–240-volt load, even if the breakers are mechanically attached together. Leads L1 and L2 are for different phases; *never* connect them together.



	60 Hz	50 Hz
L0–L1	100–120 Volt	100–120 Volt
L0–L2	100–120 Volt	100–120 Volt

Figure 8-20 100–120-Volt, 2-Wire Configuration



	60 Hz	50 Hz
L0–L1	100–120 Volt	100–120 Volt
L0–L2	100–120 Volt	100–120 Volt
L1–L2	200–240 Volt	200–240 Volt

Figure 8-21 100–120/200–240-Volt, 3-Wire Configuration

8.11.3 200–240-Volt Configurations

The 200–240-volt configuration does not use a jumper lead. If the unit was originally wired for straight 100–120 volt, 3-wire, remove the jumper lead (see Figure 8-19 for location). See Figure 8-22.

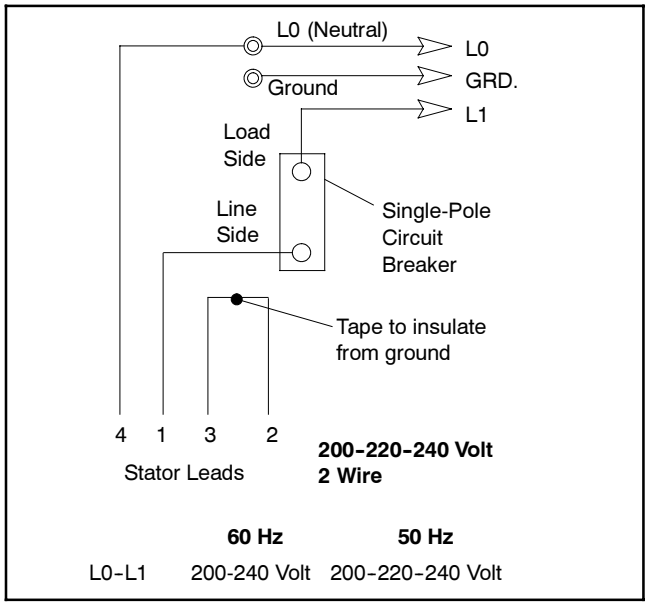


Figure 8-22 200–220–240-Volt, 2-Wire Configuration for ***Models with ADC 2100***

8.12 Twelve-Lead Reconnection

The reconnection procedure following details voltage reconnections only. If the generator set requires frequency changes, adjust the governor.

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

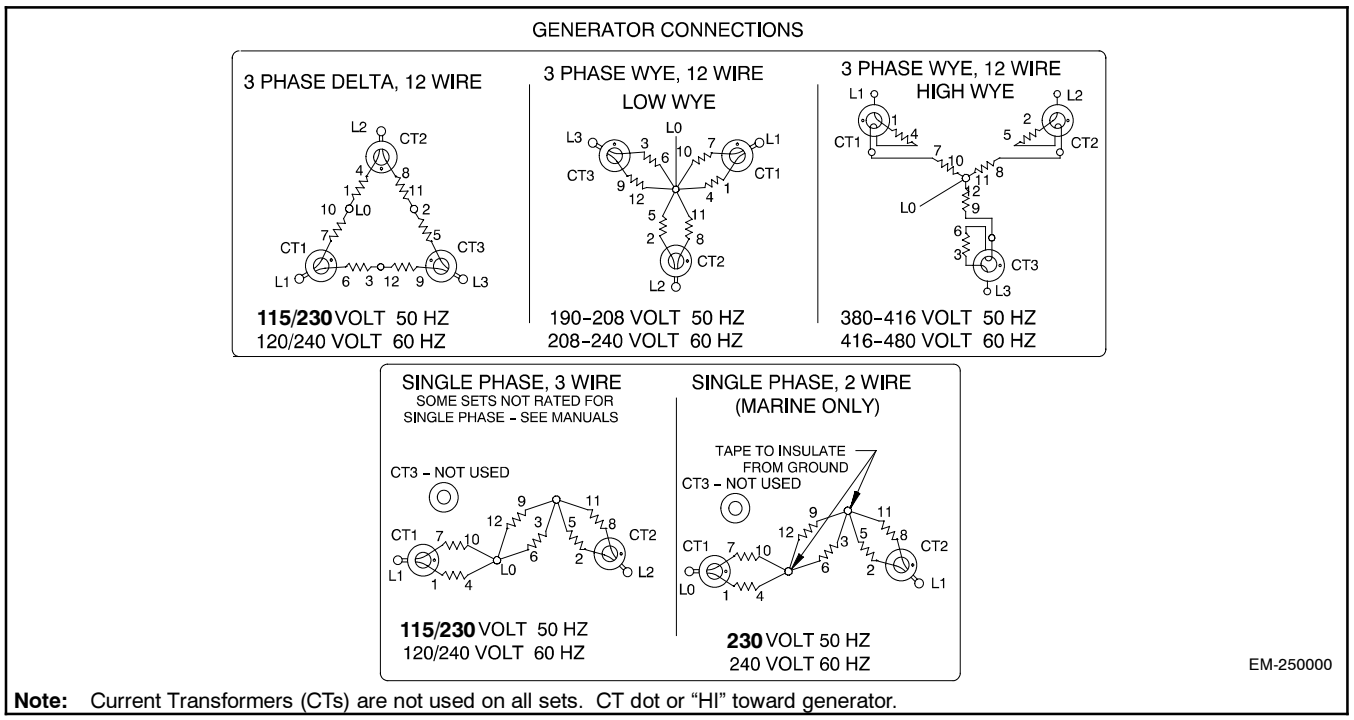
Reconnect the stator leads of the generator set to change output phase or voltage. Refer to the following procedure and connection schematics. Follow all safety precautions at the front of this manual and in the text during reconnection procedure.

NOTICE

Voltage reconnection. Affix a notice to the generator set after reconnecting the set to a voltage different from the voltage on the nameplate. Order voltage reconnection decal 246242 from an authorized service distributor/dealer.

Twelve-Lead Reconnection Procedure

1. Move generator set master switch to OFF/RESET position.
2. Disconnect engine starting battery, negative (-) lead first. Disconnect power to battery charger, if equipped.
3. Use Figure 8-23 to determine generator set voltage configuration. Note the original voltage and reconnect the generator set as needed.



Note: Current Transformers (CTs) are not used on all sets. CT dot or "HI" toward generator.

Figure 8-23 Generator Reconnection

8.13 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.

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.

8.13.1 Controller Fault Shutdown Functions

Check the operation of the fault functions programmed in the ADC 2100 by performing the following tests. If the ADC 2100 does not operate as described, check the ADC configuration settings; see Section 7.5.2. Also check the ADC 2100 wiring and connections; see Section 10.

Overspeed Shutdown

The overspeed setting is programmed into the ADC controller and is not adjustable. Verify that the following controller configuration parameters are set correctly for your unit. See Section 7.5.2 for the settings.

- System voltage/frequency parameter (UU)
- Unit configuration parameter (UC)
- Engine type parameter (EC)
- Engine data input type parameter (ED)

⚠ 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.

Open the generator set output circuit breaker before beginning the test. (See Figure 8-17 for the circuit breaker location.)

Connect a DVM to measure the output frequency. Start the generator set and manually adjust the engine speed. See Section 4.4.

Increase the engine speed to at least 115% of the rated engine speed, 69 Hz on 60 Hz models or 58 Hz on 50 Hz models. Verify that the generator set shuts down on an overspeed fault (OS). If the overspeed shutdown does not operate, the generator set should shut down on an overfrequency fault (OF) after approximately 5 seconds.

Low 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 starter motor lead at the starter solenoid (K20) terminal. Move the controller master switch to the RUN position. Observe that the generator set simulates cranking for 15 seconds and then rests for 15 seconds. Check that the generator set shuts down after the third crank/rest cycle.

High Engine Temperature Shutdown

Connect a jumper wire across coolant temperature sensor (CTS) connections P1-8 and P1-9. Start the generator set. Verify that the generator set shuts down approximately 5 seconds after the generator set comes up to speed. Remove the jumper wire. Start the generator set and run it for at least 30 seconds to verify that the generator set does not shut down.

8.13.2 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.

⚠ 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.

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.

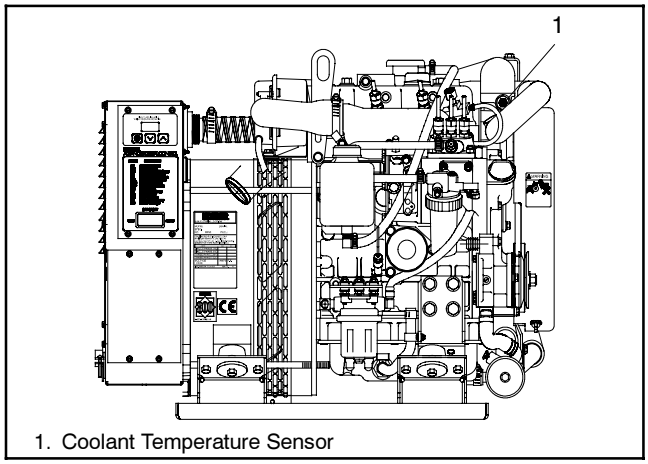
Temperature Sensor (CTS)

The coolant temperature sensor (CTS) is used to monitor engine temperature for the high engine temperature fault shutdown (HE). See Figure 8-24 for the coolant temperature sensor location. Set the generator set master switch to the OFF position and allow the generator set to cool. Disconnect the CTS 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 8-25. If the resistance is very low (indicated a short circuit) or very high (indicating an open circuit) replace the CTS.

Low Oil Pressure (LOP) Switch

See Figure 8-26 for the low oil pressure (LOP) switch location.

Remove the LOP switch and install an oil pressure gauge to verify that the engine oil pressure is within the range specified in Figure 8-27 before testing or replacing the LOP switch. To test the LOP switch, reinstall the switch and start the generator set. If the unit shuts down, disconnect lead 13 from the LOP switch and reset the controller. Restart the generator set and verify that it does not shut down. A successful restart indicates a bad LOP switch. Replace the switch.

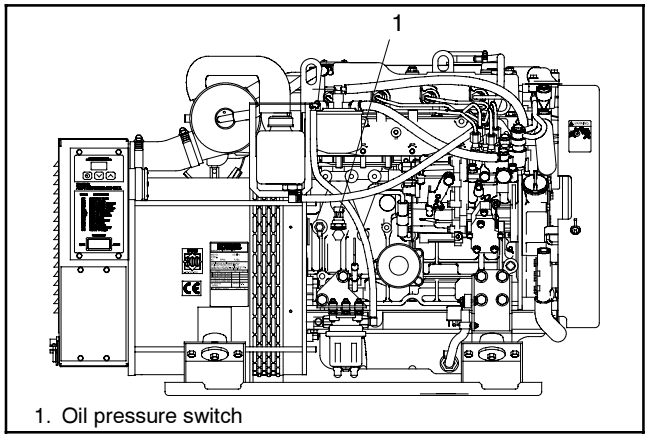


1. Coolant Temperature Sensor

Figure 8-24 Coolant Temperature Sensor Location (8EOZD Model Shown)

Temperature, °C (°F)	Resistance, Ohms
30 (86)	2106-2392
100 (212)	182-198

Figure 8-25 Coolant Temperature Sensor Resistance Readings (All Models)



1. Oil pressure switch

Figure 8-26 Oil Pressure Switch Location (24EOZD Model Shown)

Model	Oil Pressure Range MPa (kg/cm^2)
8-32EOZD and 6.5-28EFOZD	0.29-0.39 (3-4)
6EOD and 4.5EFOD	0.21-0.41 (2.1-4.2)

Figure 8-27 Oil Pressure Range

8.14 Fuses

The engine harness (or junction box for 6EOD/4.5EFOD and 9EOZD/7EFOZD models) contains three inline fuses. See Figure 8-28.

Always identify and correct the cause of a blown fuse before restarting the generator set. Refer to Section 6, Troubleshooting, for conditions that may indicate a blown fuse. Replace blown fuses with identical replacement parts.

Fuse	Label	Part Number	Location
Auxiliary Winding, 10 amps	F1	358337	Lead 55
Relay Interface Board, 10 amps	F2	223316	Lead PF2
Controller, 10 amps	F3	223316	Lead PF3

* See Figure 8-29 for 6EOD/4.5EFOD and 9EOZD/7EFOZD models fuse location.

Figure 8-28 Fuses

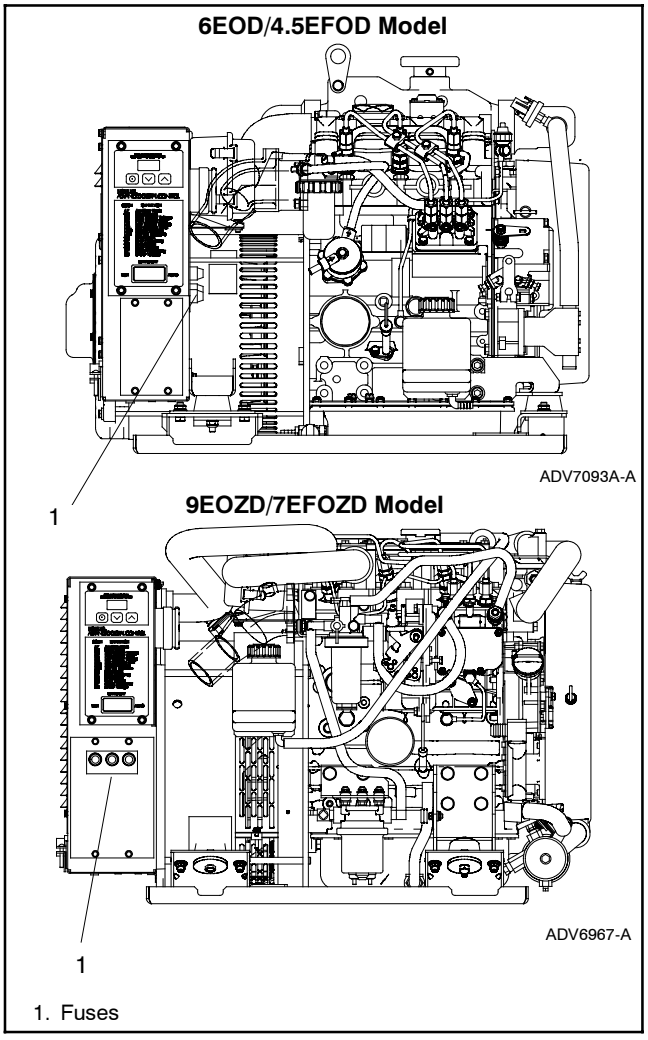


Figure 8-29 Fuse Location on 6EOD/4.5EFOD and 9EOZD/7EFOZD Models

8.15 Continuity Checks

⚠ 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.

To further check generator set components, disconnect the battery and remove wiring harness plugs from the ADC circuit board. Use an ohmmeter to check the continuity of the components listed in Figure 8-31. Also see Section 10, Wiring Diagrams.

Figure 8-31 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.

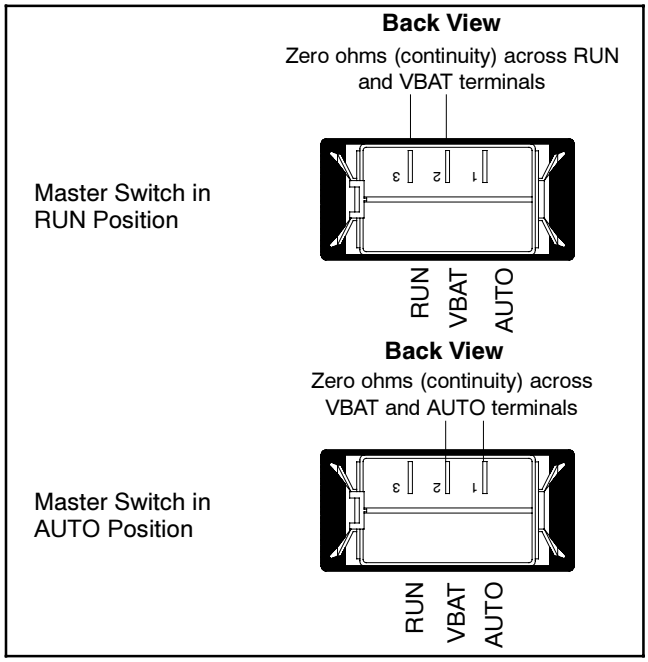


Figure 8-30 Generator Master Switch Continuity Check

Component	Ohmmeter Connections	Ohmmeter Scale	Generator Set Master Switch Position	Ohmmeter Readings for Operative Components*
Generator set master switch	RUN and VBAT (See Figure 8-30)	R x 100	RUN	Zero ohms (continuity). Any other reading indicates a bad switch.
			OFF/RESET	No reading (open circuit). Any other reading indicates a bad switch.
	AUTO and VBAT (See Figure 8-30)	R x 100	AUTO	Zero ohms (continuity). Any other reading indicates a bad switch.
			OFF/RESET	No reading (open circuit). Any other reading indicates a bad switch.
P1 wiring harness	P1-27 and ground	R x 1	OFF/RESET	Zero ohms (continuity) Any other reading indicates a poor ground connection.
	P15-1 and P15-3 (stator leads 11 and 44 for 1-phase models) or P15-1, P15-2, and P15-3 (stator leads 7, 8, and 9 for 3-phase models)	R x 1	OFF/RESET	Zero ohms (continuity). If no continuity, check wiring.
	P16-3 and P16-6 (stator leads 55 and 66)	R x 1	OFF/RESET	Zero ohms (continuity). If no continuity, check fuse F1 and wiring.
Controller fuse and wiring	P1-24 and battery positive (+)	R x 100	OFF/RESET	Zero ohms (continuity). If no continuity is found, check fuse F3 and wiring.
Auxiliary winding fuse 10 amp fuse	P16-3 and stator lead 55	R x 100	OFF/RESET	Zero ohms (continuity). If no continuity is found, check for an open circuit and/or a blown fuse.
Low oil pressure (LOP) switch *	Lead 13 and ground (engine block)	R x 100	OFF/RESET	Zero ohms (continuity). No continuity indicates a bad switch and/or wiring.
Temperature sensor (CTS) *	P1-8 and P1-9	R x 1000	OFF/RESET	180–2500 ohms, depending on engine temperature. Zero ohms or an open circuit indicates bad wiring or a bad switch.
Aux. run relay (K5)	Terminals 85 and 86	R x 1	OFF/RESET	12-volt relay: 85 ± 5 ohms coil resistance 24-volt relay: 305 ± 15 ohms coil resistance Lower resistance indicates a shorted relay coil and/or wiring. High resistance indicates an open relay coil and/or wiring.
* See Section 8.13.2, Fault Shutdown Switches				

Figure 8-31 Continuity Checks

9.1 Disassembly

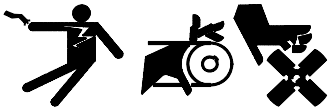
Disconnect all of the external connections—battery cables at the battery (negative (-) lead first), AC-output leads, remote interface connector, water line at the seawater pump, fuel line at the fuel pump filter inlet, and exhaust line at the mixing elbow. Observe all of the safety precautions listed at the beginning of this manual during the disassembly/reassembly procedures.

Note: Because this manual covers several models, the procedure for disassembly may vary because of product updates and the assembly variations.

Disassembly Procedure:

1. Place the generator set master switch in the OFF position.
2. Disconnect power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.

⚠ WARNING

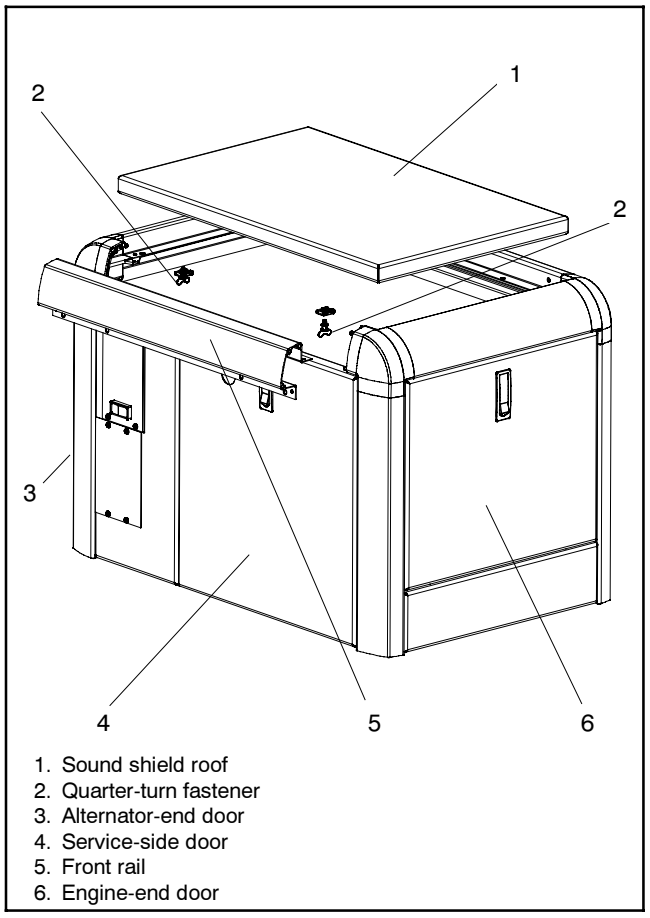


Accidental starting.
Can cause severe injury or death.

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.

Sound Shield Equipped Models: For access to the generator set to perform regular maintenance, remove the sound shield doors and roof.

4. **Sound-Shielded Models:** Open the service-side door.
5. **Sound-Shielded Models:** Release the two quarter-turn fasteners located underneath the roof. See Figure 9-1.
6. **Sound-Shielded Models:** Lift up the roof.
7. **Sound-Shielded Models:** Slide the roof towards the service side of the unit for removal.
8. **Sound-Shielded Models:** Open the front, rear, and non-service side doors as needed.



1. Sound shield roof
2. Quarter-turn fastener
3. Alternator-end door
4. Service-side door
5. Front rail
6. Engine-end door

Figure 9-1 Sound Shield Roof Removal

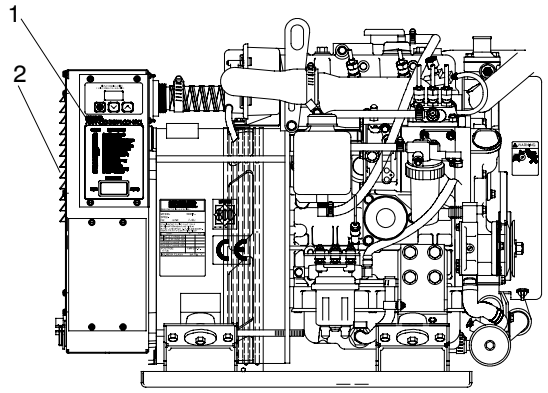
9. Disconnect wiring harness plugs P1, P15, and P16 from the ADC 2100.

10. Loosen and remove the four controller mounting screws at the front of the controller. See Figure 9-2. Remove the controller.

1. Controller mounting screws (4 ea.)

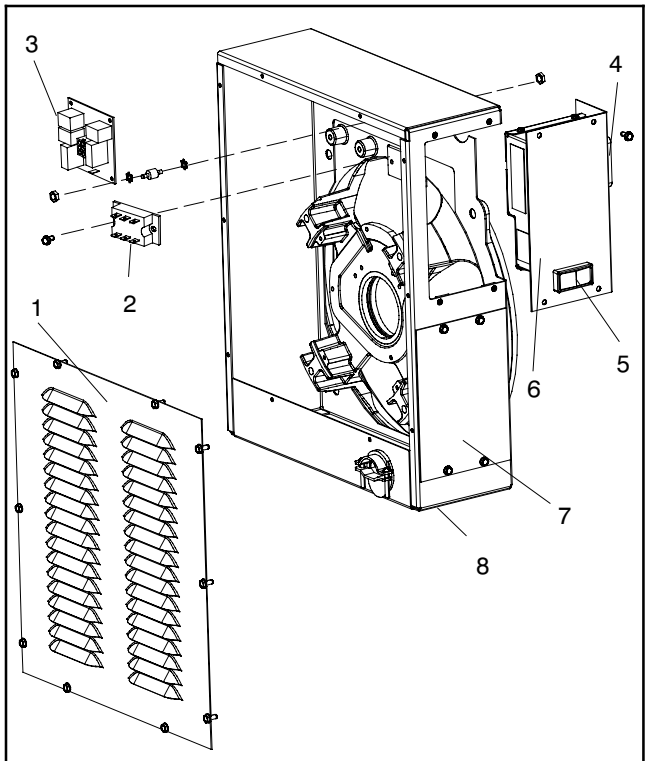
Figure 9-2 ADC 2100 Mounting Screws

11. Remove the junction box louvered panel. See Figure 9-3 and Figure 9-4.



1. ADC 2100
2. Junction box louvered panel

Figure 9-3 Covers



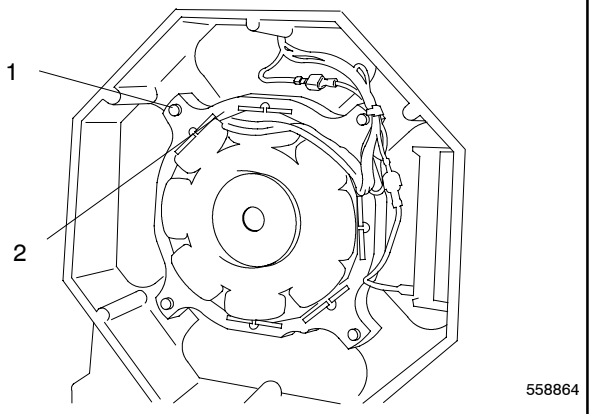
1. Junction box louvered panel
2. SCR module (mounted behind ADC 2100 on 6EOD/4.5EFOD models)
3. Relay board
4. Engine harness-to-controller connection
5. Generator set master switch
6. ADC 2100
7. Line circuit breaker plate
8. Junction box

Figure 9-4 Advanced Digital Control (ADC 2100)

12. Remove the junction box, SCR module, and relay board as necessary. See Figure 9-4.

13. Disconnect the FP and FN leads.

14. **8-32EOZD/6.5-28EFOZD Models:** Remove the four bolts to remove the exciter field. See Figure 9-5.



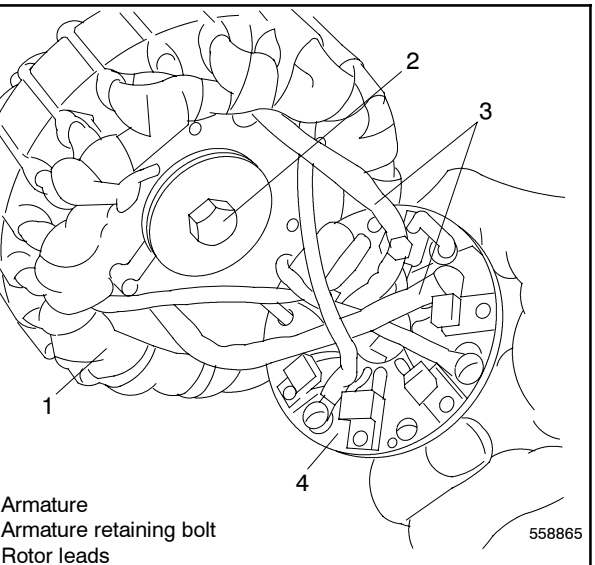
1. Bolts (4)
2. Exciter field

Figure 9-5 Exciter Field Removal

15. **8-32EOZD/6.5-28EFOZD Models:** Remove the three bolts and spacers from the rectifier board.

16. **8-32EOZD/6.5-28EFOZD Models:** Disconnect the main field rotor leads from the rectifier board positive/negative terminals. Remove the armature retaining bolt and washer. See Figure 9-6.

17. **8-32EOZD/6.5-28EFOZD Models:** Remove the armature from the shaft, guiding the rotor leads through the armature bores. See Figure 9-6.



1. Armature
2. Armature retaining bolt
3. Rotor leads
4. Rectifier board

Figure 9-6 Armature Removal

18. **6EOD/4.5EFOD Model:** Remove the four screws to remove the brush holder cover and brush cover gasket.

19. **6EOD/4.5EFOD Model:** Push the brushes into the holder. Secure the brushes into position by sliding a retainer into the brush keeping holder. See Section 8.6.

20. **6EOD/4.5EFOD Model:** Remove the brush holder and carefully pull the leads out of the stator housing.

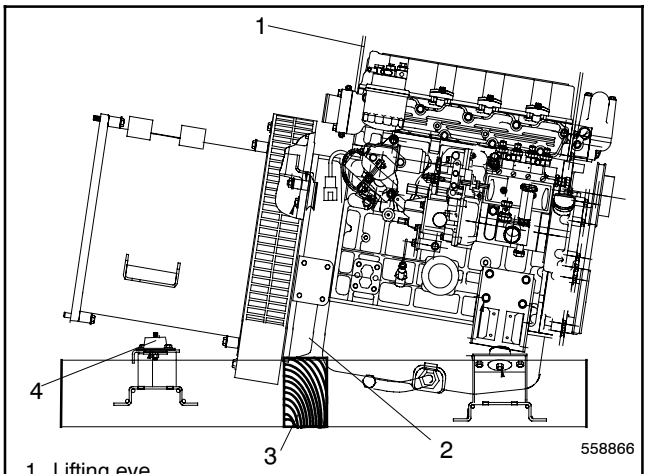
21. Attach a hoist hook to the generator lifting eye. See Figure 9-7.

    Note: The hoist capacity rating should be one-half ton or greater.

22. Remove the two vibromount bolts. See Figure 9-7.

23. Raise the alternator end and place a wood block under the locator plate. Lower the alternator until the wood block supports the backplate. See Figure 9-7.

24. Remove the four overbolts from the end bracket.



1. Lifting eye
2. Backplate
3. Wood block
4. Vibromounts

Figure 9-7 Supporting the Generator, Typical

25. Install a sling capable of handling the weight of the stator housing on the stator housing. See Figure 9-8.

26. Use a two-jaw puller to pull the end bracket/stator assembly from the bearing on the rotor shaft. See Figure 9-8.

27. Remove the stator assembly from the rotor. Remove or rotate the fan guard, if necessary, to clear the vibromounts.

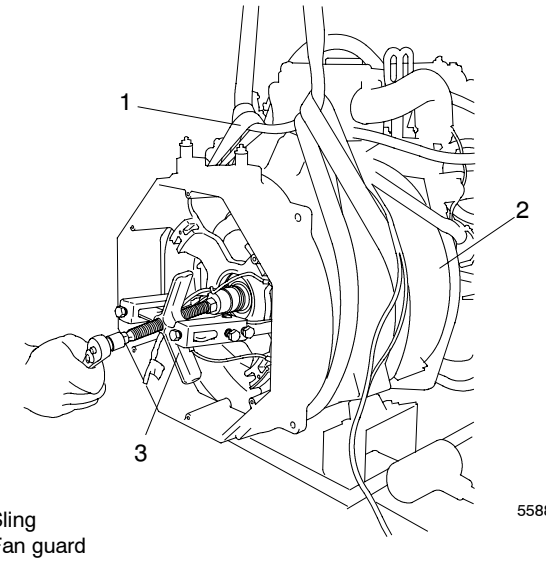
28. Mark the fan's position on the rotor/drive disc assembly with a permanent marker.

29. Remove the four screws with spacers and the four screws without spacers. See Figure 9-9.

30. Remove the fan and fan spacers. See Figure 9-9.

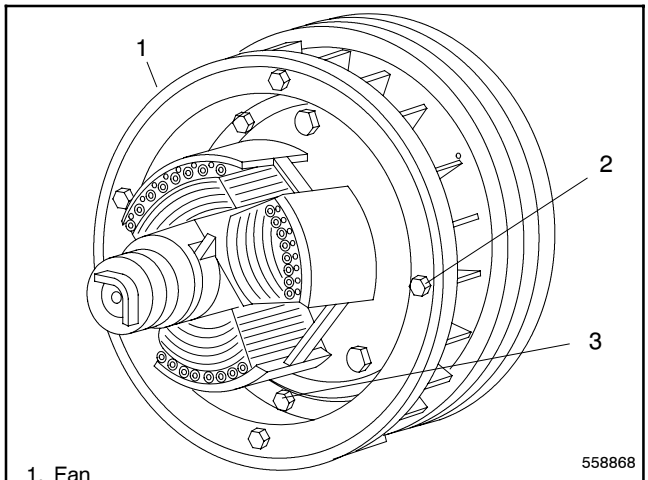
31. Remove the eight bolts and remove the drive disc/rotor assembly from the engine flywheel. See Figure 9-10.

32. Clamp the rotor in a soft-jaw vise. Remove the eight bolts and remove the drive disc assembly from the rotor. See Figure 9-11.



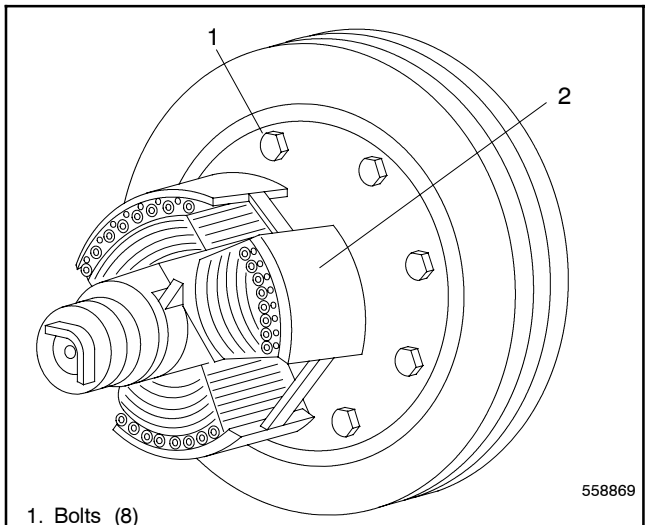
1. Sling
2. Fan guard
3. Two-jaw puller

Figure 9-8 Stator Assembly Removal



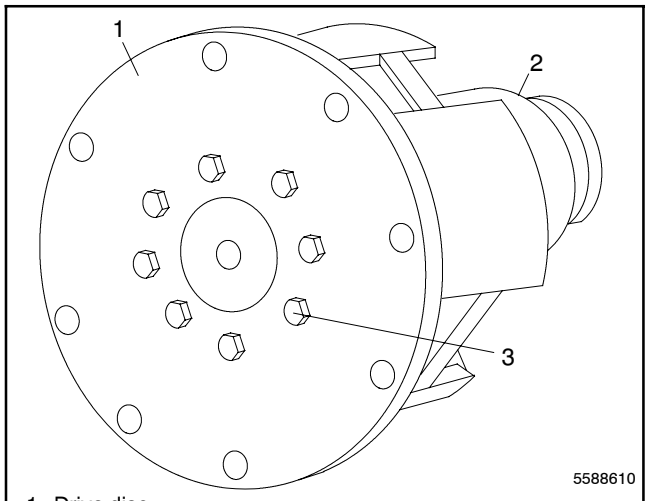
1. Fan
2. Screws with spacers (4)
3. Screws without spacers (4)

Figure 9-9 Fan Removal



1. Bolts (8)
2. Rotor assembly

Figure 9-10 Disc/Rotor Assembly



1. Drive disc
2. Rotor
3. Bolt

Figure 9-11 Drive Disc

9.2 Collector Ring and Bearing Replacement (6EOD/4.5EFOD Model)

1. Unsolder the collector ring leads from the collector ring terminals.
2. Remove the collector rings with a three-jaw puller.
3. Remove the bearing with a three-jaw puller.
4. Press the new bearing onto the rotor shaft.
5. Align the collector ring keyway with the keyway on the rotor shaft. See Figure 9-13.
6. Press the new collector rings onto the rotor shaft.

Note: The new collector rings must be turned down to a finish of 32 micro inches using a lathe and commutator stones. Turn down the collector rings on the rotor shaft.

7. Solder the leads onto the collector ring terminals. The connection is not to exceed 9.65 mm (0.38 in.) beyond the collector rings. See Figure 9-13.
8. Test to ensure continuity at the collector rings.

Min. diameter mm (in.)	57.15 (2.250)
Max. finish	32 micro inches
Max. eccentricity mm (in.)	0.08 (0.003)
Max. out-of-round mm (in.)	0.01 (0.0002)

Figure 9-12 Collector Ring Dimensions

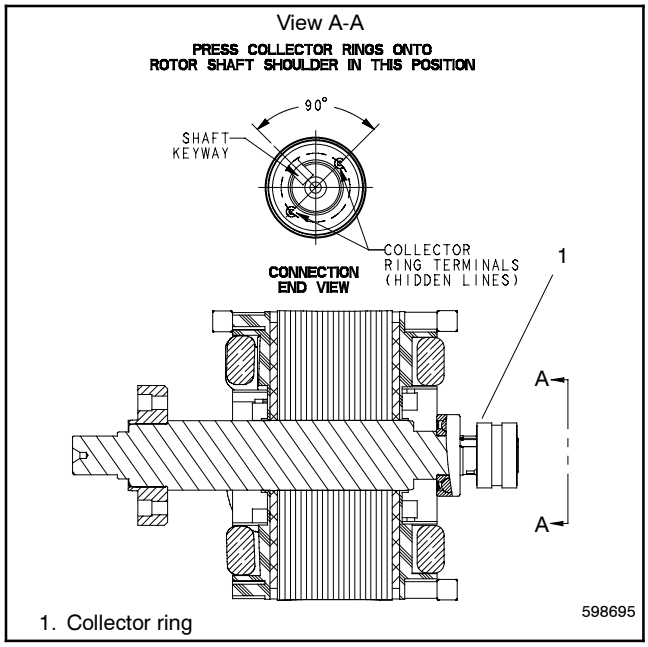


Figure 9-13 Rotor Assembly

9.3 Reassembly

1. Clamp the rotor in a soft-jaw vise. Install a new drive disc on the rotor. Tighten the eight bolts to 38 Nm (28 ft. lbs.) See Figure 9-14.

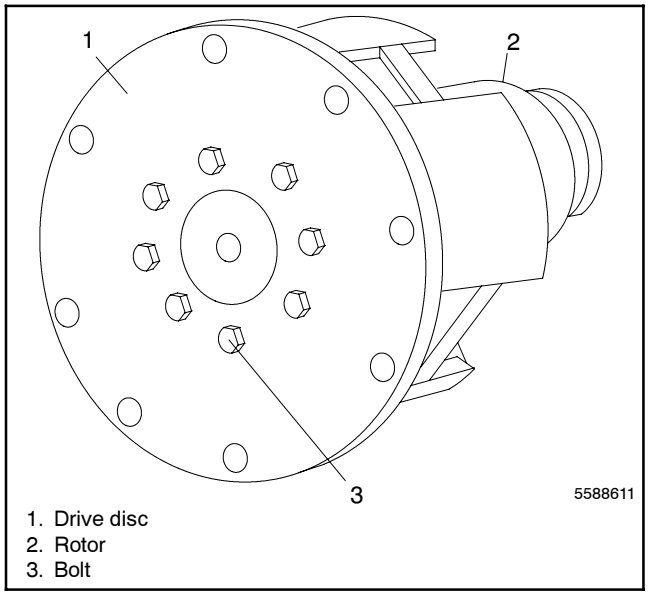


Figure 9-14 Drive Disc Installation

2. Install the rotor/drive disc assembly on the engine flywheel using eight washers and bolts. Tighten the bolts to 19 Nm (14 ft. lbs.)

3. Align the fan to the rotor/drive disc assembly using the mark created in the disassembly procedure. Install the fan to the drive disc using eight screws, four spacers, washers, and locknuts.

   Note: Install the fan with the flange side facing away from the flywheel.

4. Replace the O-ring in the end bracket bearing bore. Use a sling to support the stator assembly while installing the stator over the rotor. Do not damage the rotor. See Figure 9-15.

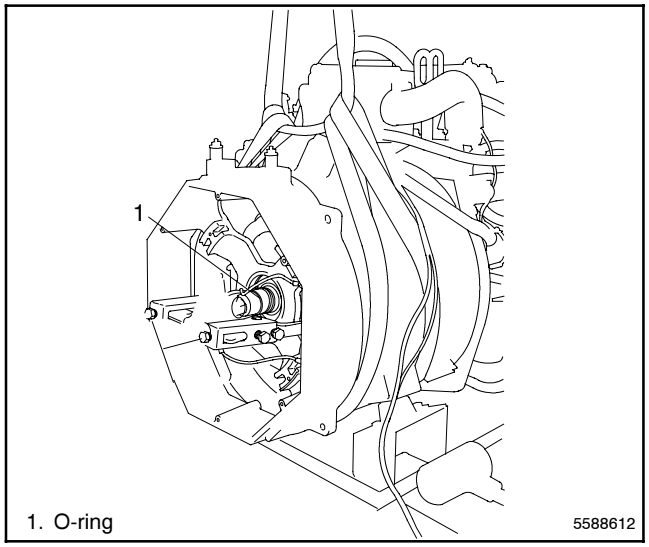


Figure 9-15 Stator Installation

5. Install the four overbolts (the two long bolts in the lower holes). Check that the alignment marks on the stator housing and locator plate match. See Figure 9-16. Tighten the overbolts to 34 Nm (25 ft. lbs.).

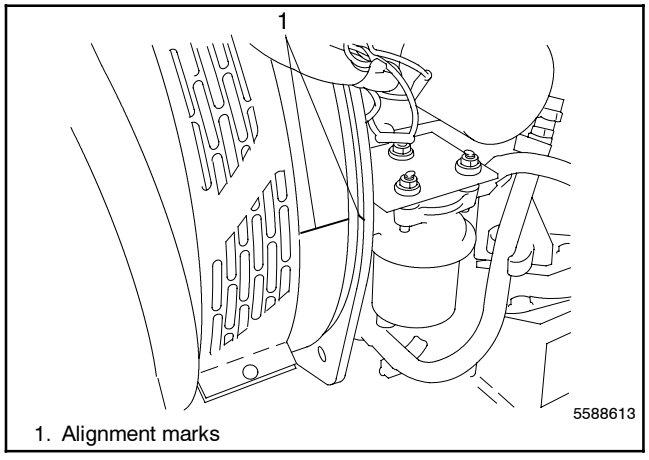


Figure 9-16 Alignment Marks

6. Use the hoist to raise the alternator end. Remove the wood block from under the locator plate. Lower the generator set and install a bolt, a large washer, two small washers, and a locknut on each vibromount. Tighten the mounting bolts to 28 Nm (20 ft. lbs.).

7. Apply antiseize compound to the keyed end of the rotor shaft. Bring the rotor leads through the bores in the armature while installing the armature on the shaft. Check the keyway of the shaft and key of the armature for damage. Install the armature retaining bolt and washer.

8. **6EOD/4.5EFOD Model:** Feed the brush leads inside the stator housing up through the opening. Secure the brush holder using the original screws.

9. **6EOD/4.5EFOD Model:** Remove the brush retainer and check alignment. See Section 8.6.

10. Use screws and lock washers to install the rotor leads to the rectifier board at the positive (+) and negative (-) terminals.

    Note: Position the lock washers against the rectifier board.

11. **6EOD/4.5EFOD Model:** Replace the brush cover gasket and install the brush holder cover.

12. Install the three spacers and bolts to mount the relay board.

13. Install the SCR module and junction box.

14. **8-23EOZD and 6.5-20EFOZD Models:** Position the field leads at the top. Install the exciter field using four bolts and washers. See Figure 9-17.

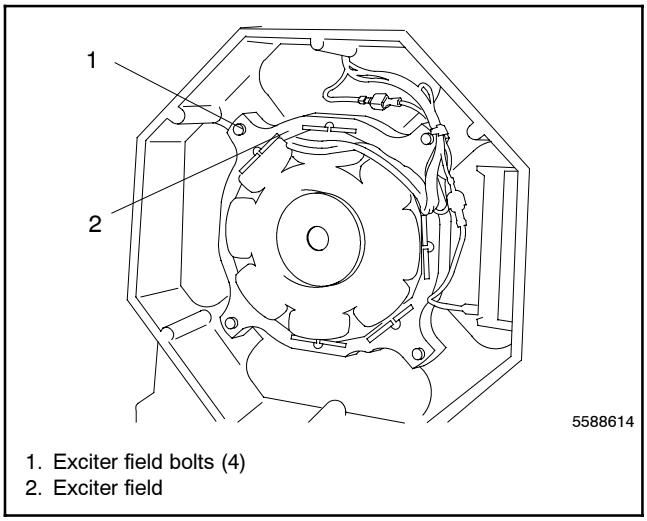


Figure 9-17 Installing Exciter Field (8-23EOZD and 6.5-20EFOZD Models0

15. Install tie wraps to secure the wires as necessary.

16. Reconnect the leads to the circuit breaker and neutral stud (LO) as marked during disassembly.

    Note: Check the generator set nameplate to verify the original voltage configuration.

17. Reconnect the P1, P15, and P16 connectors. Connect the ground strap using bolt, washer, and lock washer (install the lock washer against the ground strap).

18. Reinstall the ADC 2100.

19. Reinstall the junction box louvered panel.

20. Reconnect all of the external connections—the exhaust line to the mixing elbow, the fuel line to the fuel pump filter inlet, the water line to the seawater pump, the remote interface connector, the AC output leads, and the battery cables to the battery (negative (-) lead last).

21. Verify that the generator set master switch is in the OFF position.

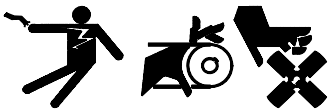
22. Reconnect the engine starting battery, negative (-) lead last.

23. Reconnect power to the battery charger, if equipped.

24. Replace the sound shield roof and door(s), if equipped.

Notes

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

⚠ 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.

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, transfer switch, 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.

10.1 Wiring Diagram Reference

Figure 10-1 and Figure 10-2 lists the wiring diagram numbers and locations.

Model	Wiring Diagram	Figure	Schematic	Figure	Accessory Diagram	Figure
6EOD 4.5EFOD	GM42202-F	Figure 10-3	ADV-7095A-D ADV-7095B-D	Figure 10-4 Figure 10-5	GM33846-C	Figure 10-10
9EOZD 7EFOZD	GM46351	Figure 10-6	ADV-6845A-F ADV-6845B-F	Figure 10-8 Figure 10-9		
8EOZD, 10-32EOZD, 6.5EFOZD, 8.5-27EFOZD	GM30264-H	Figure 10-7				

Figure 10-1 Wiring Diagrams For All Specs Except If Listed in Figure 10-2

Model	Specs	Wiring Diagram	Figure	Schematic	Figure	Accessory Diagram	Figure
9EOZD 7EFOZD	GM55351-GA1 to -GA2	GM50490-C	Figure 10-11	ADV-7283A-C ADV-7283B-C	Figure 10-13 Figure 10-14	GM33846-C	Figure 10-10
10-32EOZD, 8.5-28EFOZD	GM55350-GA1 to -GA8 GM55349-GA1 to -GA12 GM55348-GA1 to -GA16 GM55347-GA1 to -GA16	GM50488-C	Figure 10-12				

Figure 10-2 Wiring Diagrams

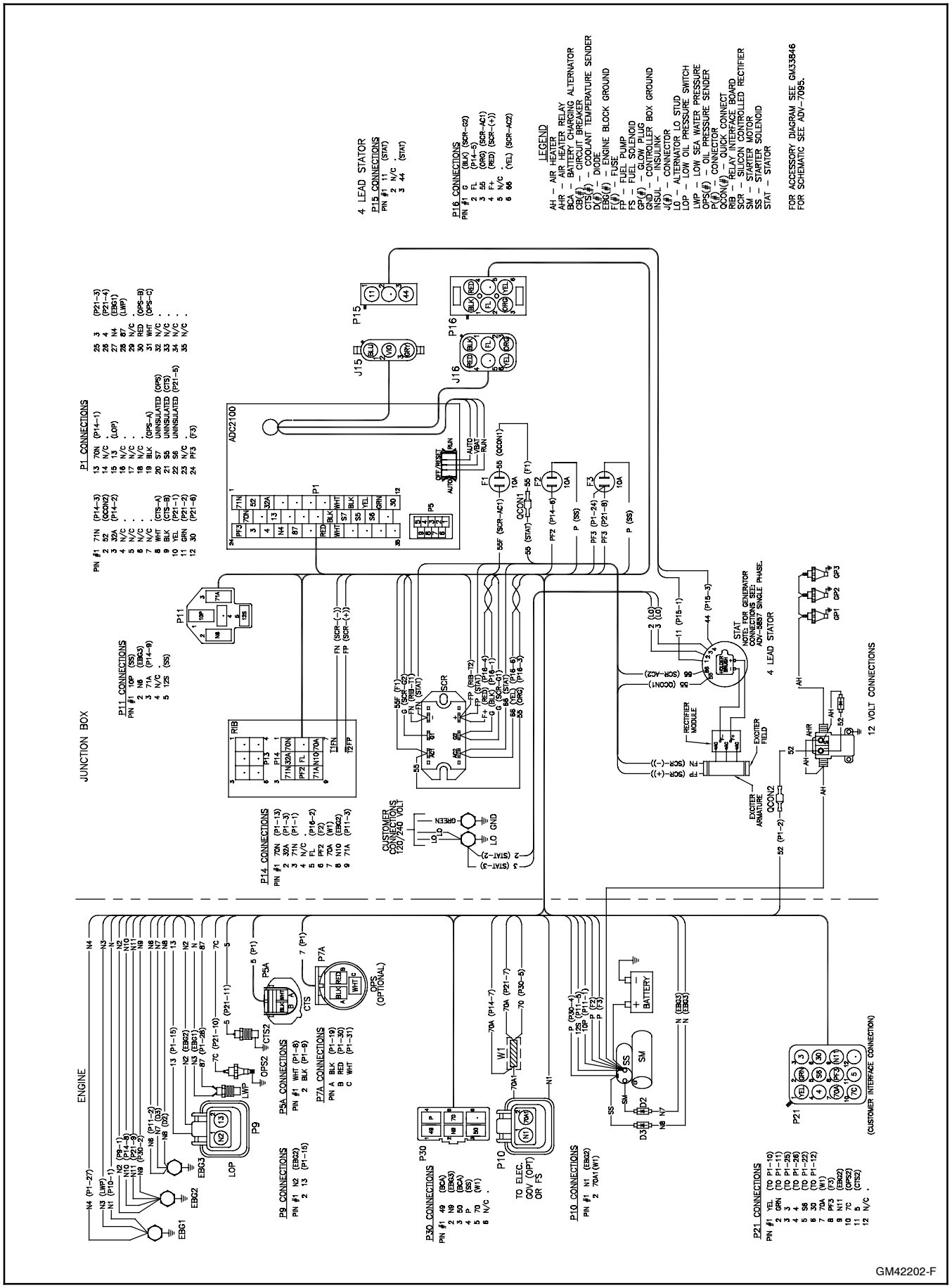


Figure 10-3 Wiring Diagram for Model 6EOD/4.5EFOD

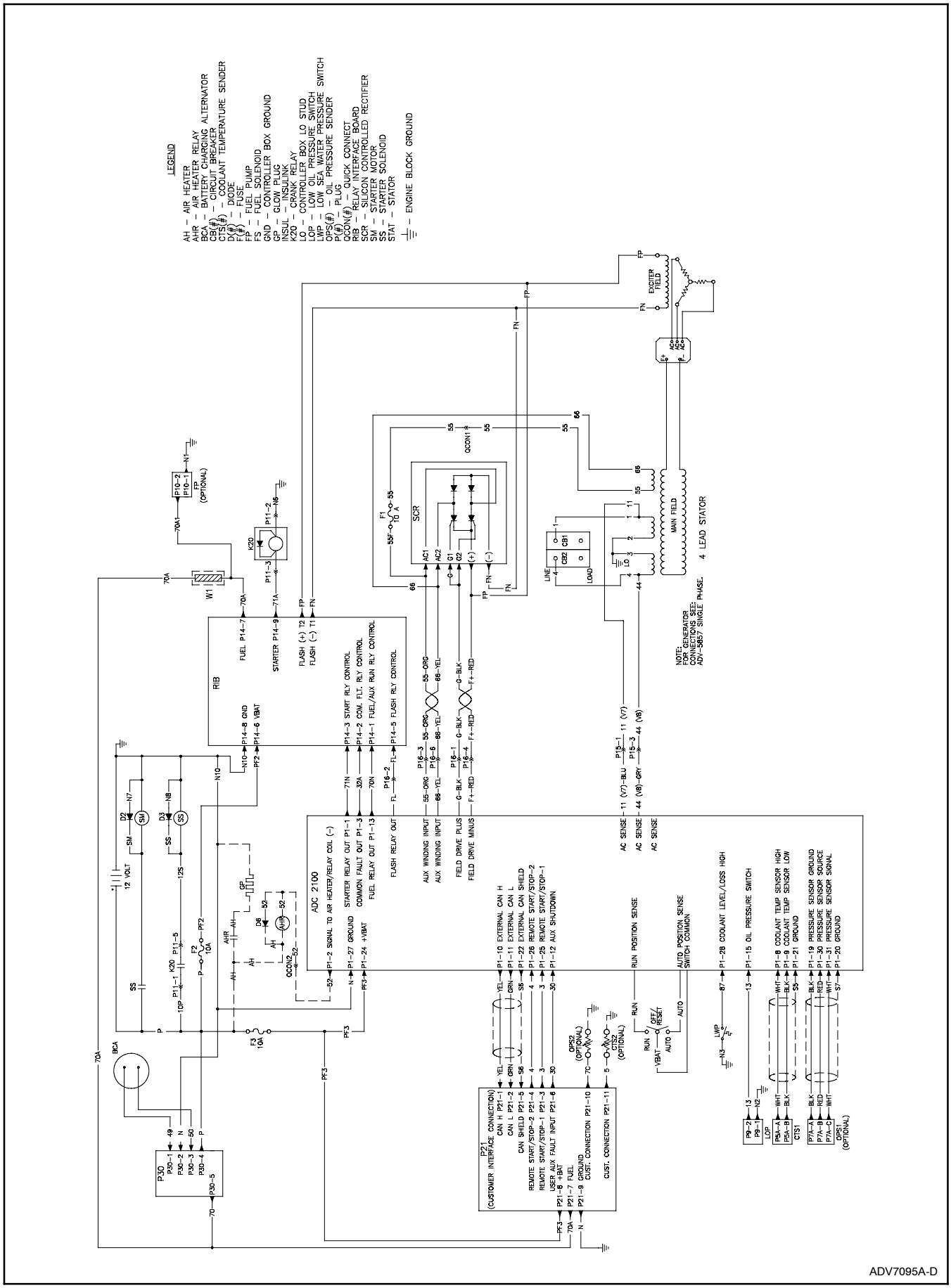


Figure 10-4 Schematic for Model 6EOD/4.5EFOD; Sheet 1 of 2

ADC 2100 CONTROLLER

P1 CONNECTIONS
P1-1 STARTER RELAY OUT
P1-2 SIGNAL TO AIR HEATER/RELAY COIL (-)
P1-3 COMMON FAULT
P1-4 GOVERNOR 1B
P1-5 GOVERNOR 1A
P1-6 GOVERNOR 2A
P1-7 GOVERNOR 2B
P1-8 COOLANT TEMP SENSOR HIGH
P1-9 COOLANT TEMP SENSOR LOW
P1-10 EXTERNAL CAN H
P1-11 EXTERNAL CAN L
P1-12 AUX SHUTDOWN
P1-13 FUEL RELAY OUT
P1-14 TACH OUT
P1-15 OIL PRESSURE SWITCH
P1-16 GROUND
P1-17 VR SENSOR LOW
P1-18 GROUND
P1-19 PRESSURE SENSOR GROUND
P1-20 GROUND
P1-21 GROUND
P1-22 GROUND
P1-23 GROUND
P1-24 VBAT +
P1-25 REMOTE START/STOP 1
P1-26 REMOTE START/STOP 2
P1-27 GROUND
P1-28 COOLANT LEVEL/LOSS HIGH
P1-29 VR SENSOR HIGH
P1-30 PRESSURE SENSOR SOURCE
P1-31 PRESSURE SENSOR SIGNAL
P1-32 GROUND
P1-33 VBAT ON
P1-34 GROUND
P1-35 RS232 TXD

P5 CONNECTIONS
P5-1 N/C
P5-2 RS232 RXD
P5-3 RS232 TXD
P5-4 N/C
P5-5 GROUND
P5-6 N/C
P5-7 N/C
P5-8 N/C
P5-9 N/C

J16 CONNECTIONS
P16-1 FIELD DRIVE PLUS (G)
P16-2 FLASH RELAY OUT
P16-3 AUX WINDING INPUT (55)
P16-4 FIELD DRIVE MINUS (F+)
P16-5 N/C
P16-6 AUX WINDING INPUT (66)

J15 CONNECTIONS
J15-1 AC INPUT (V7/11)
J15-2 AC INPUT (V9)
J15-3 AC INPUT (V8/44)

RELAY INTERFACE BOARD

P13 CONNECTIONS
P13-1 RUN RELAY COMMON
P13-2 COMMON FAULT COMMON
P13-3 COMMON FAULT NC
P13-4 RUN RELAY NO
P13-5 RUN RELAY NC
P13-6 COMMON FAULT NO

P14 CONNECTIONS
P14-1 FUEL/AUX RUN RELAY CONTROL
P14-2 COMMON FAULT RELAY CONTROL
P14-3 STARTER RELAY CONTROL
P14-4 IGNITION NEGATIVE
P14-5 FLASH RELAY CONTROL
P14-6 VBAT
P14-7 FUEL (70A)
P14-8 GROUND
P14-9 STARTER (71A)

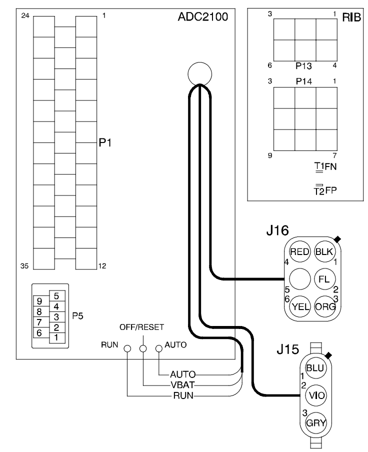


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Figure 10-5 Schematic for Model 6EOD/4.5EFOD; Sheet 2 of 2

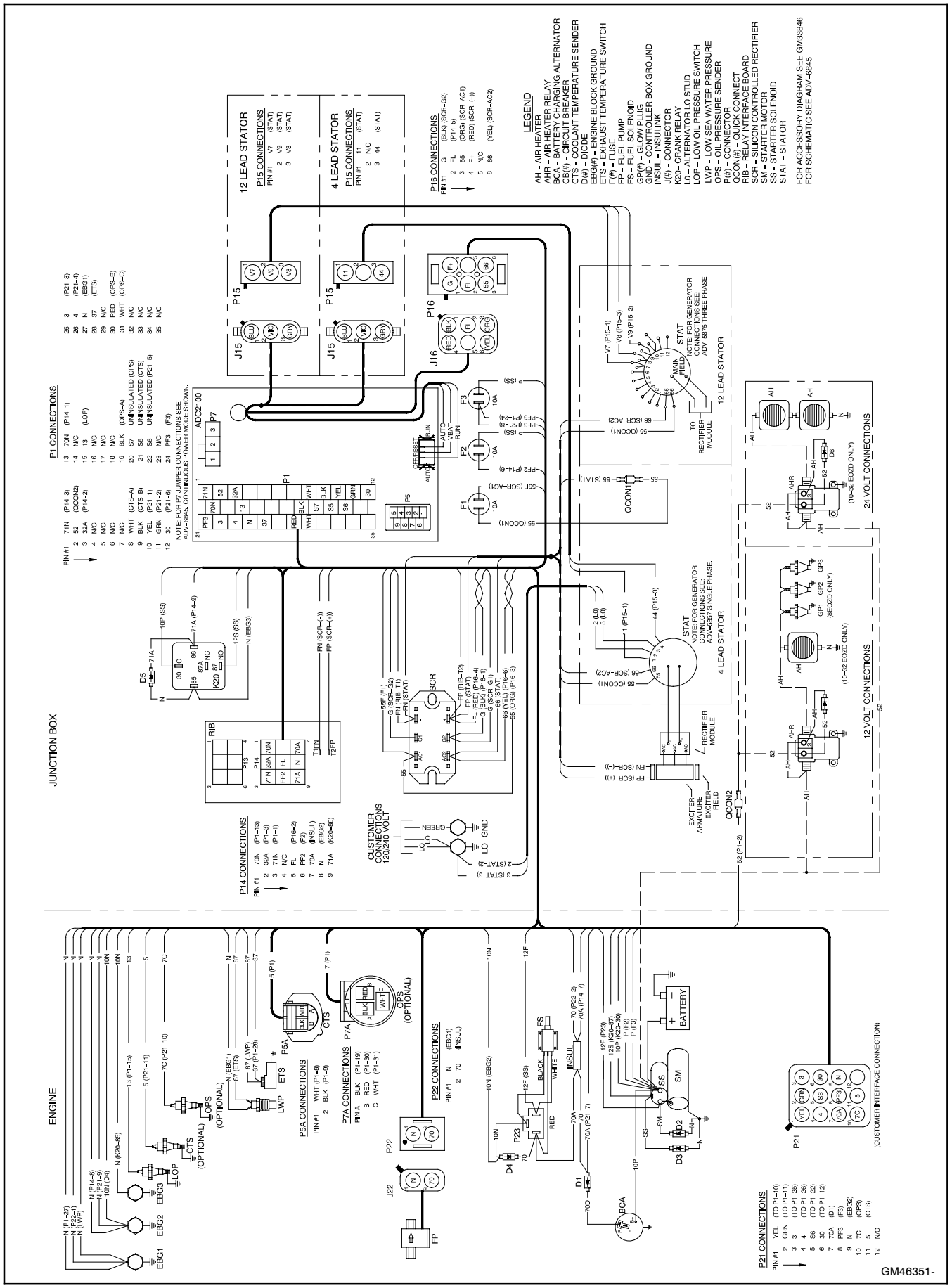


Figure 10-6 Wiring Diagram for Model 9EOZD/7EFOZD

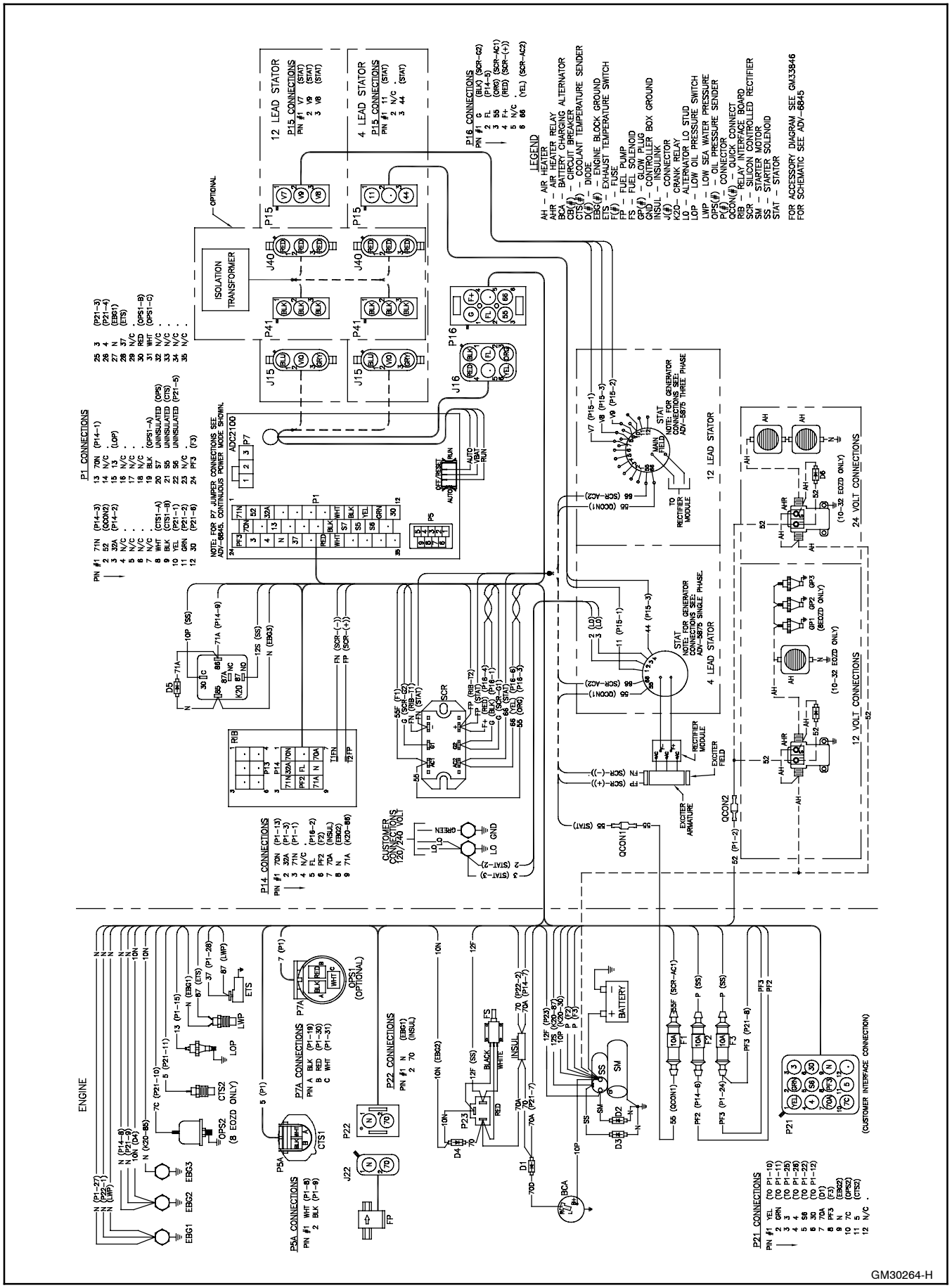


Figure 10-7 Wiring Diagram for Models 8EOZD, 10–32EOZD, 6.5EFOZD, and 8.5–27EFOZD

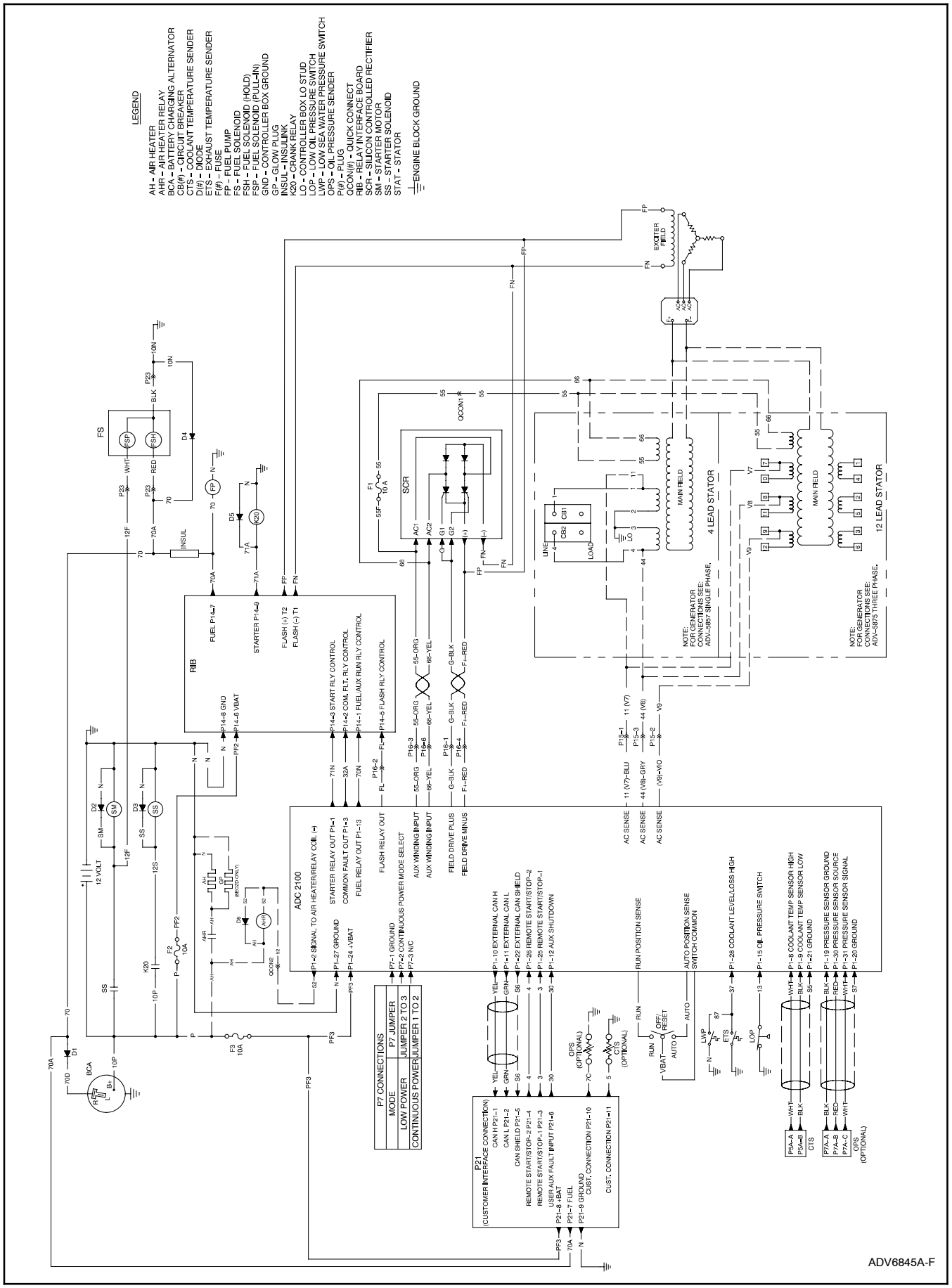
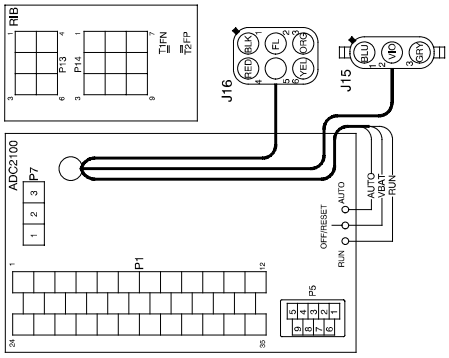


Figure 10-8 Schematic for Models 8–32EOZD and 6.5–27EFOZD; Sheet 1 of 2



RELAY INTERFACE BOARD

P13 CONNECTIONS
P13–1 RUN RELAY COMMON
P13–2 COMMON FAULT COMMON
P13–3 COMMON FAULT NC
P13–4 RUN RELAY NO
P13–5 RUN RELAY NC
P13–6 COMMON FAULT NO

P14 CONNECTIONS
P14–1 FUEL/AUX RUN RELAY CONTROL
P14–2 COMMON FAULT RELAY CONTROL
P14–3 STARTER RELAY CONTROL
P14–4 IGNITION NEGATIVE
P14–5 FLASH RELAY CONTROL
P14–6 VBAT
P14–7 FUEL (70A)
P14–8 GROUND
P14–9 STARTER (71A)

ADC 2100 CONTROLLER

P1 CONNECTIONS
P1–1 STARTER RELAY OUT
P1–2 SIGNAL TO AIR HEATER/RELAY COIL (–)
P1–3 COMMON FAULT
P1–4 GOVERNOR 1B
P1–5 GOVERNOR 1A
P1–6 GOVERNOR 2B
P1–8 COOLANT TEMP SENSOR HIGH
P1–9 COOLANT TEMP SENSOR LOW
P1–10 EXTERNAL CAN H
P1–11 EXTERNAL CAN L
P1–12 AUX SHUTDOWN
P1–13 FUEL RELAY OUT
P1–14 TACH OUT
P1–15 OIL PRESSURE SWITCH
P1–16 GROUND
P1–17 VR SENSOR LOW
P1–18 GROUND
P1–19 PRESSURE SENSOR GROUND
P1–20 GROUND
P1–21 GROUND
P1–22 GROUND
P1–23 GROUND
P1–24 VBAT +
P1–25 REMOTE START/STOP 1
P1–26 REMOTE START/STOP 2
P1–27 GROUND
P1–28 COOLANT LEVEL/LOSS HIGH
P1–29 VR SENSOR HIGH
P1–30 PRESSURE SENSOR SOURCE
P1–31 PRESSURE SENSOR SIGNAL
P1–32 GROUND
P1–33 VBAT ON
P1–34 GROUND
P1–35 RS232 TXD

P5 CONNECTIONS
P5–1 N/C
P5–2 RS232 RXD
P5–3 RS232 TXD
P5–4 N/C
P5–5 GROUND
P5–6 N/C
P5–7 N/C
P5–8 N/C
P5–9 N/C

P7 CONNECTIONS
P7–1 N/C
P7–2 CONTINUOUS POWER MODE SELECT
P7–3 GROUND

J16 CONNECTIONS
P16–1 FIELD DRIVE PLUS (G)
P16–2 FLASH RELAY OUT
P16–3 AUX WINDING INPUT (55)
P16–4 FIELD DRIVE MINUS (F+)
P16–5 N/C
P16–6 AUX WINDING INPUT (66)

J15 CONNECTIONS
J15–1 AC INPUT (V7/11)
J15–2 AC INPUT (V8)
J15–3 AC INPUT (V8/44)

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Figure 10-9 Schematic for Models 8–32EOZD and 6.5–27EFOZD; Sheet 2 of 2

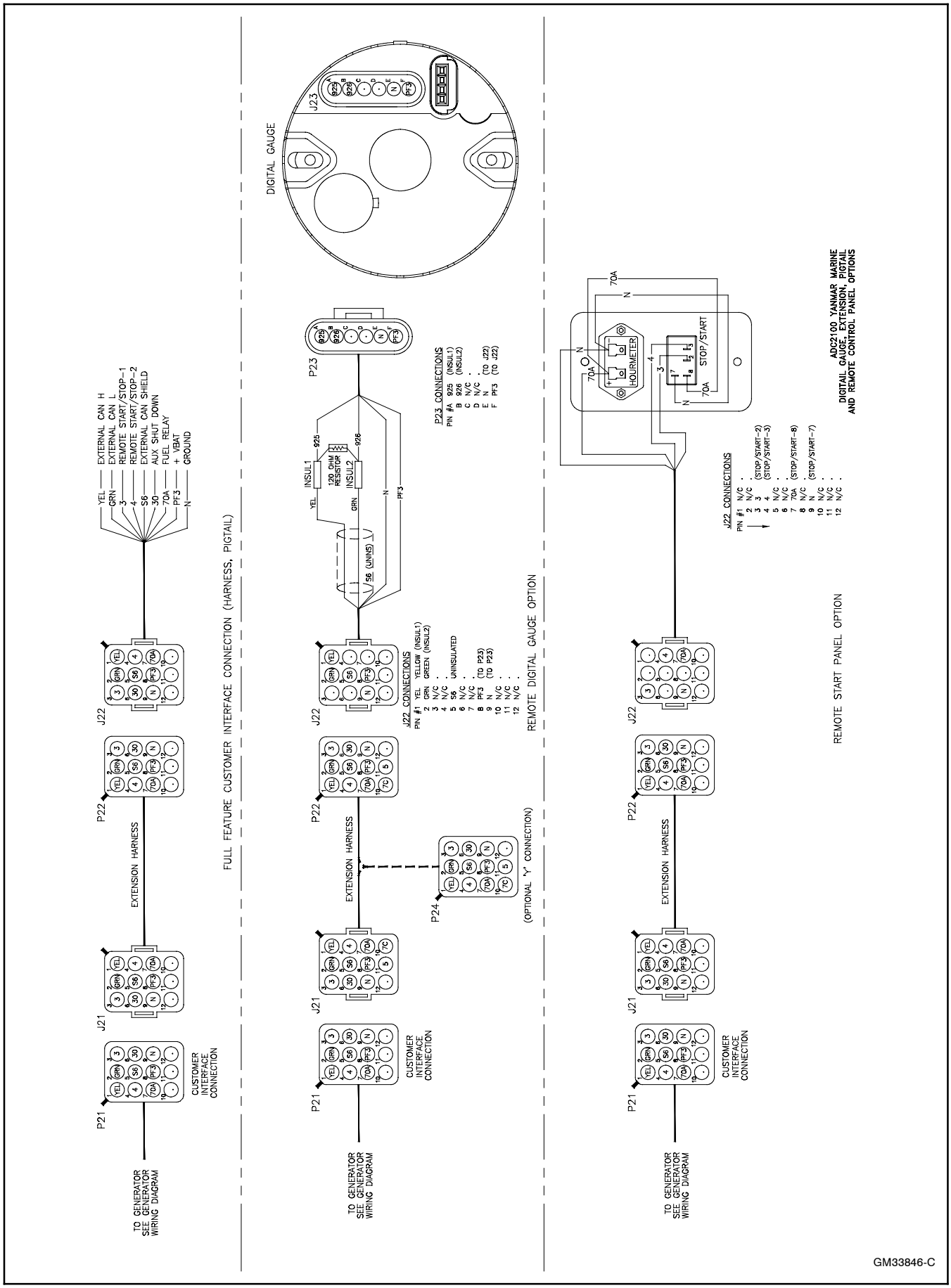


Figure 10-10 Accessory Diagram

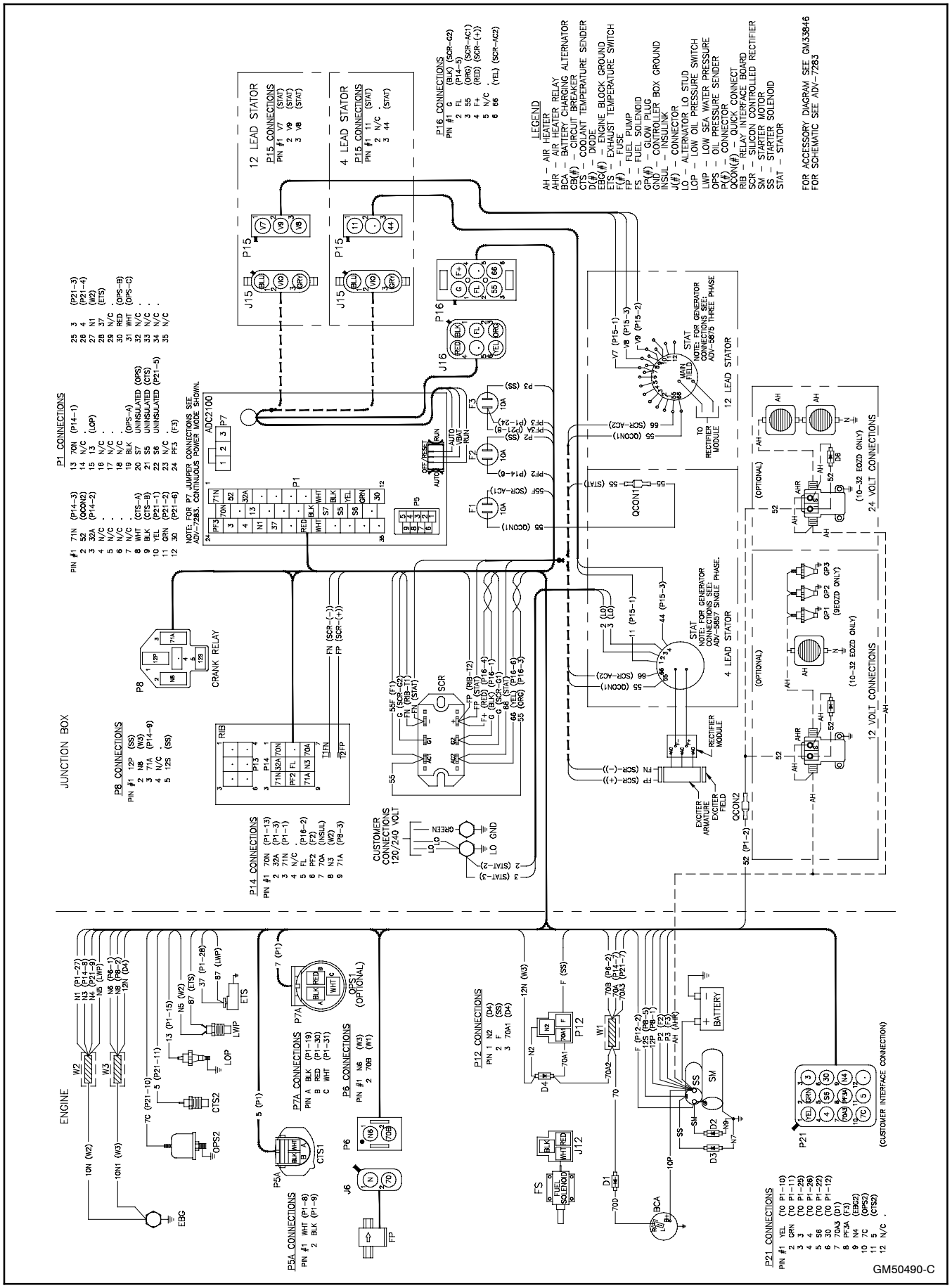


Figure 10-11 Wiring Diagram for Model 9EOZD/7EFOZD (see Figure 10-2 for applicable specs)

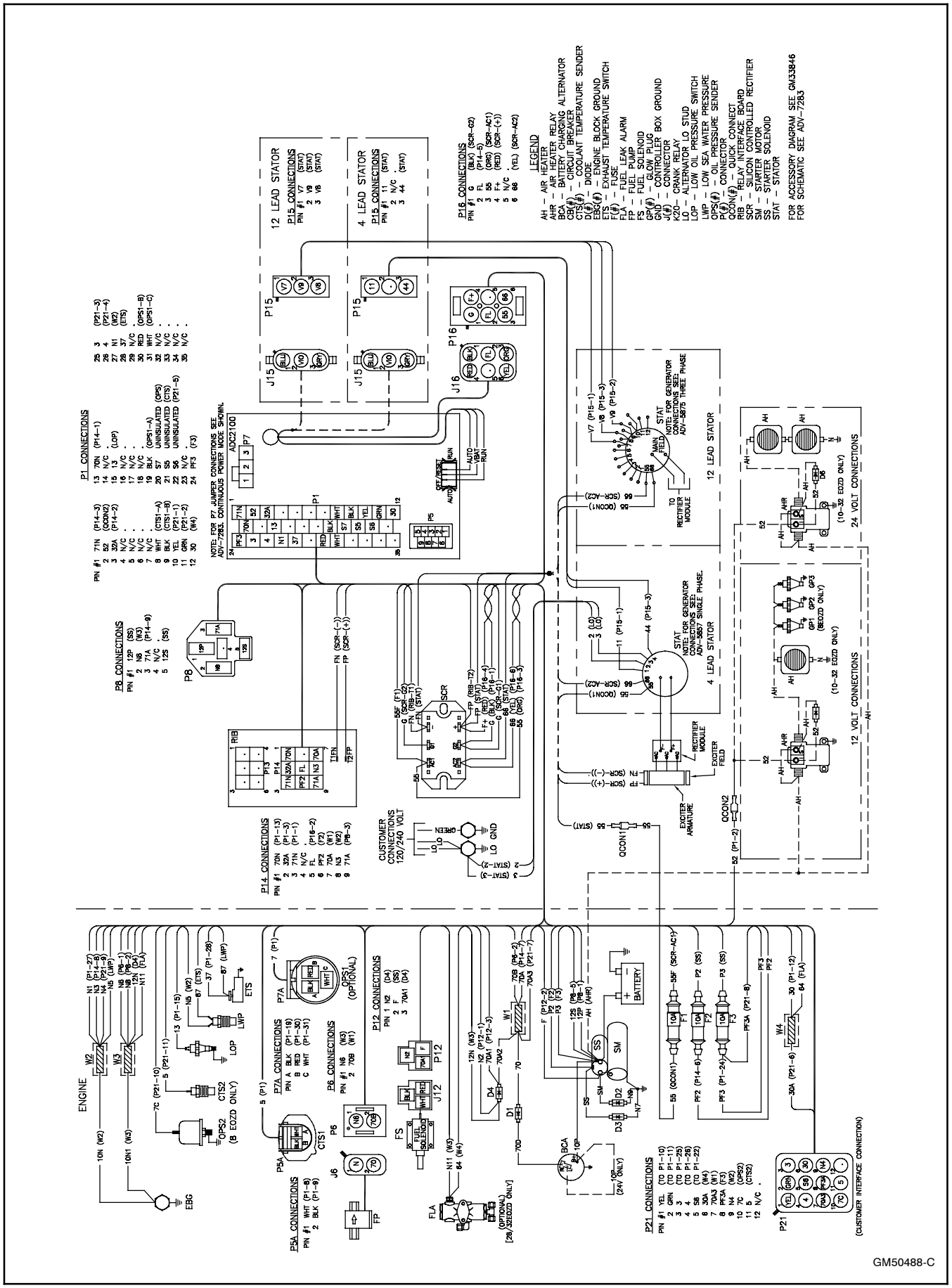


Figure 10-12 Wiring Diagram for Model 10–32EOZD/8.5–28EFOZD (see Figure 10-2 for applicable specs)

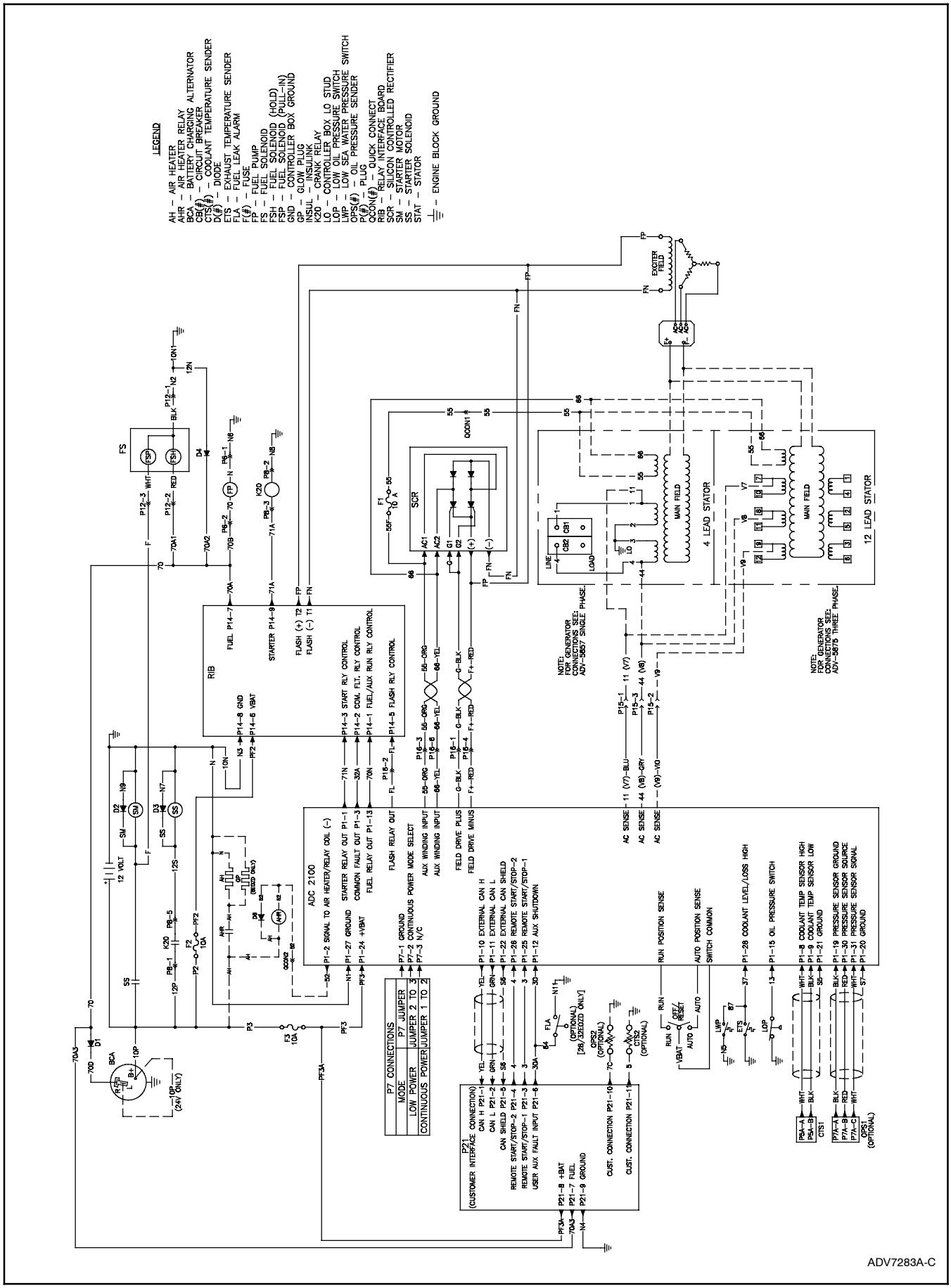
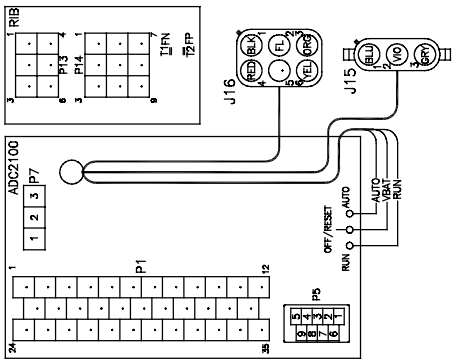


Figure 10-13 Schematic for Model 9-32EOZD/7-28EFOZD; Sheet 1 of 2 (see Figure 10-2 for applicable specs)



ADC 2100 CONTROLLER

RELAY INTERFACE BOARD

P1 CONNECTIONS
P1-1 STARTER RELAY OUT
P1-2 SIGNAL TO AIR HEATER/RELAY COIL (-)
P1-3 COMMON FAULT
P1-4 GOVERNOR 1B
P1-5 GOVERNOR 2A
P1-6 GOVERNOR 2B
P1-7 COOLANT TEMP SENSOR HIGH
P1-8 COOLANT TEMP SENSOR LOW
P1-9 EXTERNAL CAN H
P1-10 EXTERNAL CAN L
P1-11 AUX SHUTDOWN
P1-12 FUEL RELAY OUT
P1-13 TACH OUT
P1-14 OIL PRESSURE SWITCH
P1-15 GROUND
P1-16 VR SENSOR LOW
P1-17 GROUND
P1-18 PRESSURE SENSOR GROUND
P1-19 GROUND
P1-20 GROUND
P1-21 GROUND
P1-22 GROUND
P1-23 VBAT +
P1-24 REMOTE START/STOP 1
P1-25 REMOTE START/STOP 2
P1-26 GROUND
P1-27 COOLANT LEVEL/LOSS HIGH
P1-28 VR SENSOR HIGH
P1-29 PRESSURE SENSOR SOURCE
P1-30 PRESSURE SENSOR SIGNAL
P1-31 GROUND
P1-32 VBAT (D)
P1-33 GROUND
P1-34 RS232 TXD
P1-35

P5 CONNECTIONS
P5-1 N/C
P5-2 RS232 RXD
P5-3 RS232 TXD
P5-4 N/C
P5-5 GROUND
P5-6 N/C
P5-7 N/C
P5-8 N/C
P5-9 N/C

P7 CONNECTIONS
P7-1 N/C
P7-2 CONTINUOUS POWER MODE SELECT
P7-3 GROUND

J16 CONNECTIONS
P16-1 FIELD DRIVE PLUS (C)
P16-2 FLASH RELAY OUT
P16-3 AUX WINDING INPUT (55)
P16-4 FIELD DRIVE MINUS (F+)
P16-5 N/C
P16-6 AUX WINDING INPUT (66)

J15 CONNECTIONS
J15-1 AC INPUT (V7/11)
J15-2 AC INPUT (V9)
J15-3 AC INPUT (V8/44)

P13 CONNECTIONS
P13-1 RUN RELAY COMMON
P13-2 COMMON FAULT COMMON
P13-3 COMMON FAULT NC
P13-4 RUN RELAY NO
P13-5 RUN RELAY NC
P13-6 COMMON FAULT NO

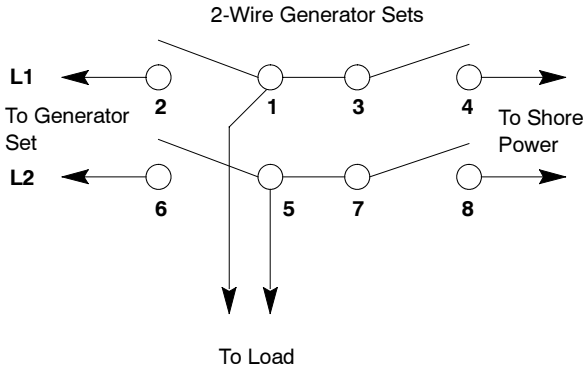
P14 CONNECTIONS
P14-1 FUEL/AUX RUN RELAY CONTROL
P14-2 COMMON FAULT RELAY CONTROL
P14-3 STARTER RELAY CONTROL
P14-4 IGNITION NEGATIVE
P14-5 FLASH RELAY CONTROL
P14-6 VBAT
P14-7 FUEL (70A)
P14-8 GROUND
P14-9 STARTER (71A)

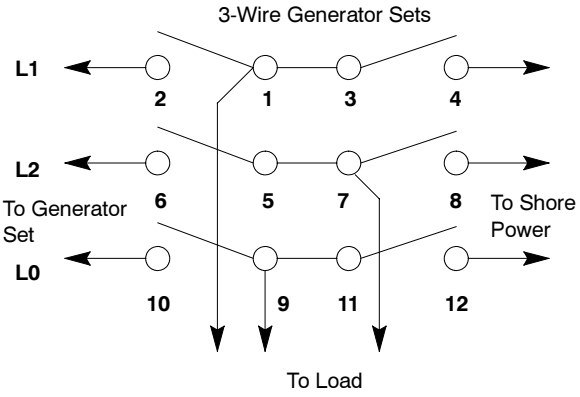
ADV7283A-C

Figure 10-14 Schematic for Model 9-32EOZD/7-28EFOZD; Sheet 2 of 2 (see Figure 10-2 for applicable specs)

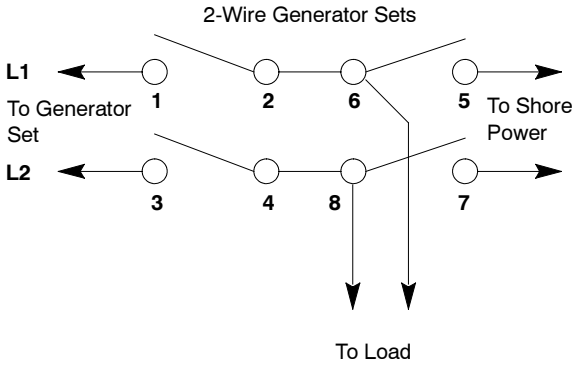
10.2 Manual Marine (Ship-to-Shore) 2 Wire and 3 Wire Transfer Switches

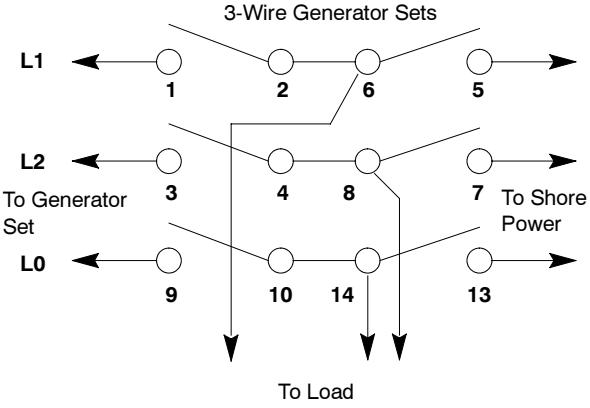
Electro Switch



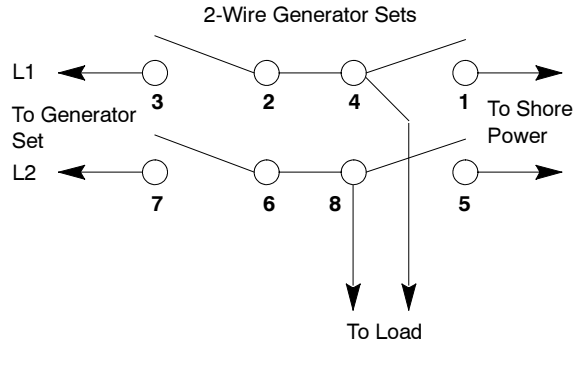


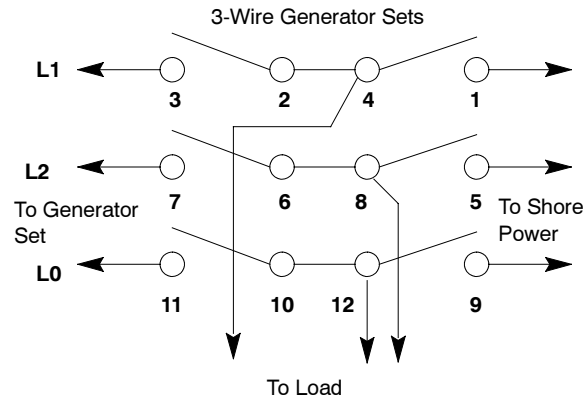
Kraus Naimler/American Solenoid (Early Rectangular Design)





Kraus Naimler/American Solenoid (Newer Round Design)

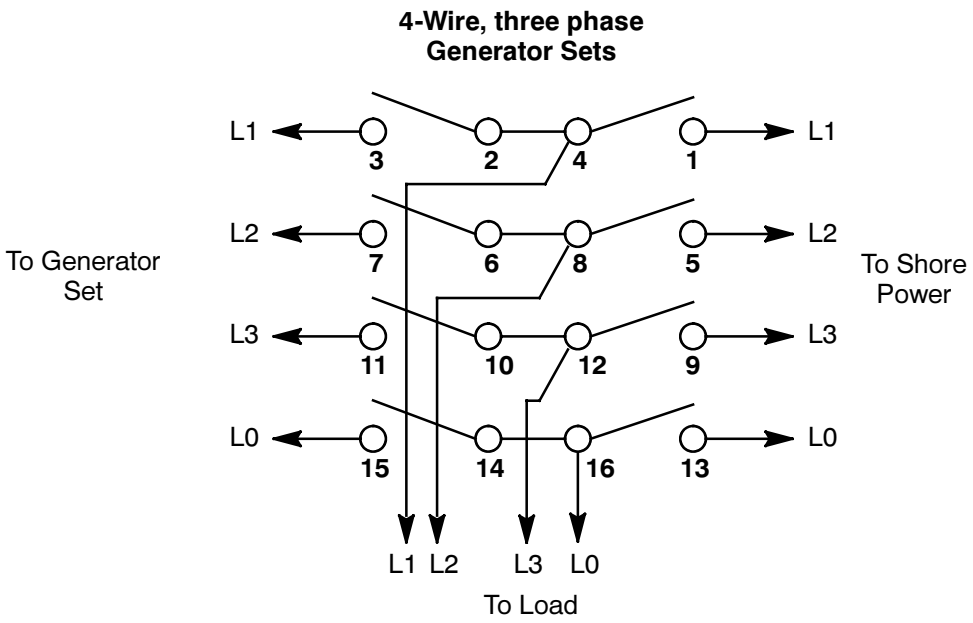




TP-5399-5

10.3 Manual Marine (Ship-to-Shore) 4 Wire Transfer Switch

Kraus Naimer/American Solenoid



Notes

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	analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
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
API	American Petroleum Institute
approx.	approximate, approximately
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
A/V	audiovisual
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
CARB	California Air Resources Board
CB	circuit breaker
cc	cubic centimeter
CCA	cold cranking amps
ccw.	counterclockwise
CEC	Canadian Electrical Code
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)
cogen.	cogeneration
Com	communications (port)
conn.	connection
cont.	continued
CPVC	chlorinated polyvinyl chloride
crit.	critical
CRT	cathode ray tube
CSA	Canadian Standards Association
CT	current transformer
Cu	copper
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dBA	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, emer.	emergency (power source)
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
fglass.	fiberglass
FHM	flat head machine (screw)
fl. oz.	fluid ounce
flex.	flexible
freq.	frequency
FS	full scale
ft.	foot, feet
ft. lbs.	foot pounds (torque)
ft./min.	feet per minute
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 temperature
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)
IC	integrated circuit
ID	inside diameter, identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	improved motor starting
in.	inch
in. H_2O	inches of water
in. Hg	inches of mercury
in. lbs.	inch pounds
Inc.	incorporated
ind.	industrial
int.	internal
int./ext.	internal/external
I/O	input/output
IP	iron pipe
ISO	International Organization for Standardization
J	joule
JIS	Japanese Industry Standard
k	kilo (1000)
K	kelvin
kA	kiloampere
KB	kilobyte (2^{10} bytes)

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
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
ld. shd.	load shed
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/min.	cubic meters per minute
mA	milliampere
man.	manual
max.	maximum
MB	megabyte (2^{20} bytes)
MCM	one thousand circular mils
MCCB	molded-case circuit breaker
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
m/sec.	meters per second
MTBF	mean time between failure
MTBO	mean time between overhauls
mtg.	mounting
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	picofarad
PF	power factor
ph., ∅	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
pt.	pint
PTC	positive temperature coefficient
PTO	power takeoff
PVC	polyvinyl chloride
qt.	quart
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
RDO	relay driver output
ref.	reference
rem.	remote
RFI	radio frequency interference
RH	round head
RHM	round head machine (screw)
rly.	relay
rms	root mean square
rnd.	round
ROM	read only memory
rot.	rotate, rotating
rpm	revolutions per minute
RS	right side
RTV	room temperature vulcanization
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
SN	serial number
SPDT	single-pole, double-throw
SPST	single-pole, single-throw
spec, specs	specification(s)
sq.	square
sq. cm	square centimeter
sq. in.	square inch
SS	stainless steel
std.	standard
stl.	steel
tach.	tachometer
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
TIF	telephone influence factor
TIR	total indicator reading
tol.	tolerance
turbo.	turbocharger
typ.	typical (same in multiple locations)
UF	underfrequency
UHF	ultrahigh frequency
UL	Underwriter's Laboratories, Inc.
UNC	unified coarse thread (was NC)
UNF	unified fine thread (was NF)
univ.	universal
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
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 General Torque Specifications and other torque specifications in the service literature.

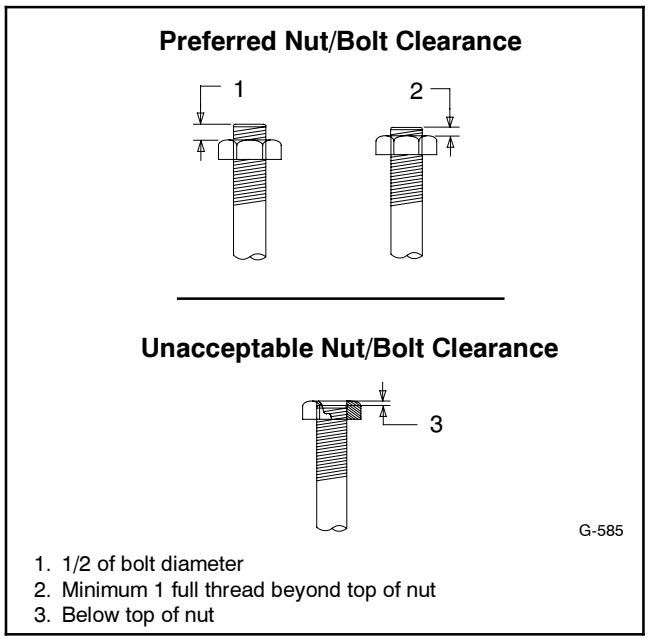


Figure 1 Acceptable Bolt Lengths

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 the diagram below.
3. Follow these SAE washer rules after determining exit hole type:
   a. Always use a washer between hardware and a slot.
   b. Always use a washer under a nut (see 2 above for exception).
   c. Use a washer under a bolt when the female thread is fixed (weld nut).
4. Refer to the diagram below, which depicts the preceding hardware configuration possibilities.

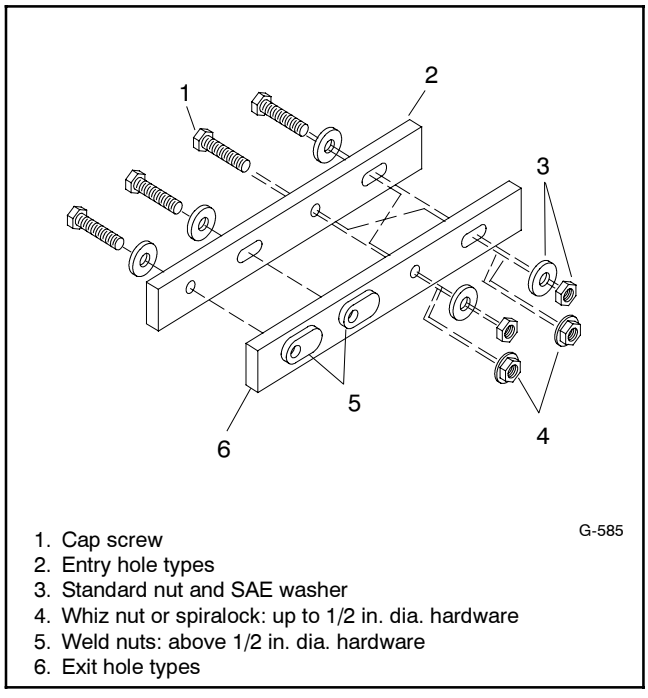


Figure 2 Acceptable Hardware Combinations

Appendix C General Torque Specifications

Use the following torque specifications when service literature instructions give no specific torque values. The charts list values for new plated, zinc phosphate, or oiled threads. Increase values by 15% for nonplated threads. All torque values are +0%/–10%.

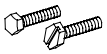
American Standard Fasteners Torque Specifications

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

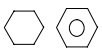
Metric Fasteners Torque Specifications, Measured in ft. lbs. (Nm)

Size (mm)	Assembled into Cast Iron or Steel			Assembled into Aluminum
	Grade 5.8	Grade 8.8	Grade 10.9	Grade 5.8 or 8.8
M6 x 1.00	4 (5.6)	7 (9.9)	10 (14)	4 (5.6)
M8 x 1.25	10 (13.6)	18 (25)	26 (35)	10 (13.6)
M8 x 1.00	16 (21)	18 (25)	26 (35)	16 (21)
M10 x 1.50	20 (27)	35 (49)	50 (68)	20 (27)
M10 x 1.25	29 (39)	35 (49)	50 (68)	29 (39)
M12 x 1.75	35 (47)	61 (83)	86 (117)	—
M12 x 1.50	48 (65)	65 (88)	92 (125)	—
M14 x 2.00	55 (74)	97 (132)	136 (185)	—
M14 x 1.50	74 (100)	103 (140)	142 (192)	—
M16 x 2.00	85 (115)	148 (200)	210 (285)	—
M16 x 1.50	104 (141)	155 (210)	218 (295)	—
M18 x 2.50	114 (155)	203 (275)	288 (390)	—
M18 x 1.50	145 (196)	225 (305)	315 (425)	—

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

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

Metric (Screws, Bolts, Studs, and Nuts)

M8-1.25 x 20

- Length In Millimeters (Screws and Bolts)
- Distance Between Threads In Millimeters
- Major Thread Diameter In Millimeters

Plain Washers

9/32 x 5/8 x 1/16

- Thickness
- External Dimension
- Internal Dimension

Lock Washers

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, 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		Spiralock
X-85-3	5/8-11	Standard
X-88-12	3/4-10	Standard
X-89-2	1/2-20	Standard

Washers

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)	
M931-06040-60	M6-1.00 x 40
M931-06055-60	M6-1.00 x 55
M931-06060-60	M6-1.00 x 60
M931-06070-60	M6-1.00 x 70
M931-06075-60	M6-1.00 x 75
M931-06090-60	M6-1.00 x 90
M931-08035-60	M8-1.25 x 35
M931-08040-60	M8-1.25 x 40
M931-08040-82	M8-1.25 x 40*
M931-08045-60	M8-1.25 x 45
M931-08050-60	M8-1.25 x 50
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
M931-10040-60	M10-1.50 x 40
M931-10045-60	M10-1.50 x 45
M931-10050-60	M10-1.50 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
M931-10090-60	M10-1.50 x 90
M931-10100-60	M10-1.50 x 100
M931-12045-60	M12-1.75 x 45
M931-12050-60	M12-1.75 x 50
M931-12055-60	M12-1.75 x 55
M931-12060-60	M12-1.75 x 60
M931-12065-60	M12-1.75 x 65
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
M931-16090-60	M16-2.00 x 90
M931-20065-60	M20-2.50 x 65
M931-20120-60	M20-2.50 x 120
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

Part No.	Dimensions
Hex Head Bolts (full thread)	
M933-04006-60	M4-0.70 x 6
M933-05050-60	M5-0.80 x 50
M933-06010-60	M6-1.00 x 10
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
M933-06040-60	M6-1.00 x 40
M933-06050-60	M6-1.00 x 50
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
M933-10012-60	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
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
M933-12016-60	M12-1.75 x 16
M933-12020-60	M12-1.75 x 20
M933-12025-60	M12-1.75 x 25
M933-12025-82	M12-1.75 x 25*
M933-12030-60	M12-1.75 x 30
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
M961-16025-60	M16-1.50 x 25
M933-16025-60	M16-2.00 x 25
M933-16030-82	M16-2.00 x 30*
M933-16035-60	M16-2.00 x 35
M933-16040-60	M16-2.00 x 40
M933-16050-60	M16-2.00 x 50
M933-16050-82	M16-2.00 x 50*
M933-16060-60	M16-2.00 x 60
M933-18050-60	M18-2.50 x 50
M933-18060-60	M18-2.50 x 60
Pan Head Machine Screws	
M7985A-03010-20	M3-0.50 x 10
M7985A-03012-20	M3-0.50 x 12
M7985A-04020-20	M4-0.70 x 20
M7985A-05010-20	M5-0.80 x 10
M7985A-05012-20	M5-0.80 x 12
Flat Head Machine Screws	
M965A-05016-20	M5-0.80 x 16

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

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

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

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