Service

DETROIT DIESEL®

mtu

Industrial Generator Sets

Models:

20–300 kW

Alternators:

Wound Field

DETROIT DIESEL ISO CERTIFIED ORGANIZATION 9001 CORPORATION

MP-6349 9/05a

California Proposition 65

⚠ WARNING

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

Product Identification Information

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

Generator Set Identification Numbers

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

Model Designation _____

Specification Number _____

Serial Number _____

Accessory Number	Accessory Description

Controller Identification

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

Controller Description _____

Engine Identification

Record the product identification information from the engine nameplate.

Manufacturer _____

Model Designation _____

Serial Number _____

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Notes

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***.

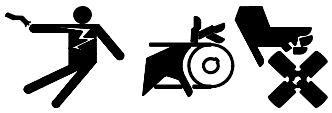
NOTICE

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.

Battery

WARNING

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

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

WARNING

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

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

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

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

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

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

Engine Backfire/Flash Fire

⚠ WARNING

Fire.
Can cause severe injury or death.

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

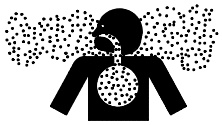
Servicing the fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the carburetor, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuels or fuel vapors. Catch fuels in an approved container when removing the fuel line or carburetor.

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

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

Exhaust System

⚠ WARNING



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

The exhaust system must be leakproof and routinely inspected.

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

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

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

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

Fuel System

⚠ WARNING

Explosive fuel vapors.
Can cause severe injury or death.

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

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

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

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

Propane (LP)—Adequate ventilation is mandatory. Because propane is heavier than air, install propane gas detectors low in a room. Inspect the detectors per the manufacturer's instructions.

Natural Gas—Adequate ventilation is mandatory. Because natural gas rises, install natural gas detectors high in a room. Inspect the detectors per the manufacturer's instructions.

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

Draining 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.

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

LP liquid withdrawal fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check the LP liquid withdrawal gas fuel system for leakage by using a soap and water solution with the fuel system test pressurized to at least 90 psi (621 kPa). Do not use a soap solution containing either ammonia or chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

Hazardous Noise

⚠ CAUTION

Hazardous noise.
Can cause hearing loss.

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

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

Hazardous Voltage/ Electrical Shock

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ WARNING

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

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

⚠ WARNING

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

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

⚠ CAUTION

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

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

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

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

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

Installing the battery charger. Hazardous voltage can cause severe injury or death. An ungrounded battery charger may cause electrical shock. Connect the battery charger enclosure to the ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect it to the equipment grounding terminal or the lead on the battery charger. Install the battery charger as prescribed in the equipment manual. Install the battery charger in compliance with local codes and ordinances.

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

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

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

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

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

Heavy Equipment

⚠ WARNING

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

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

Hot Parts

⚠ WARNING

Hot 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.

⚠ WARNING

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

Do not work on the generator set until it cools.

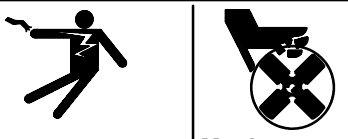
Servicing the alternator. Hot parts can cause severe injury or death. Avoid touching the alternator field or exciter armature. When shorted, the alternator field and exciter armature become hot enough to cause severe burns.

Checking the coolant level. Hot coolant can cause severe injury or death. 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.

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.

Moving Parts

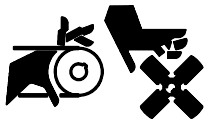
⚠ WARNING



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

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

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

Operate the generator set only when all guards, screens, and covers are in place.

⚠ WARNING

Airborne particles.
Can cause severe injury or blindness.

Wear protective goggles and clothing when using power tools, hand tools, or compressed air.

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

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.

Notice

NOTICE

This generator set has been rewired from its nameplate voltage to

246242

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.

NOTICE

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

NOTICE

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

NOTICE

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

Notes

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

Wiring diagram manuals are available separately.

Refer to the generator set controller operation manual for operating instructions. Refer to the engine operation manual for generator set engine scheduled maintenance information. Refer to the engine service manual for generator set engine repair and overhaul information.

Information in this publication represents data available at the time of print. The manufacturer of DDC/MTU Power Generation products 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.

List of Related Materials

Separate literature contains voltage regulator setup information not provided in this manual when the generator set has a 550 controller. Figure 1 lists the available literature part numbers.

Manual Description	Literature Part No.
Voltage Reguator Spec Sheet	M6-58
550 Controller Operation Manual	MP-6200

Figure 1 Related Literature

Service Assistance

For professional advice on generator power requirements and conscientious service, please contact your nearest DDC/MTU Power Generation distributor.

- Consult the Yellow Pages under the heading Generators—Electric
- Visit the DDC/MTU Power Generation website at ddcmtupowergeneration.com
- Look at the labels and stickers on your DDC/MTU Power Generation product or review the appropriate literature or documents included with the product

1.1 Introduction

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

A wound field alternator is identified with a W as the last digit. Example: Gen. Model 4S11W.

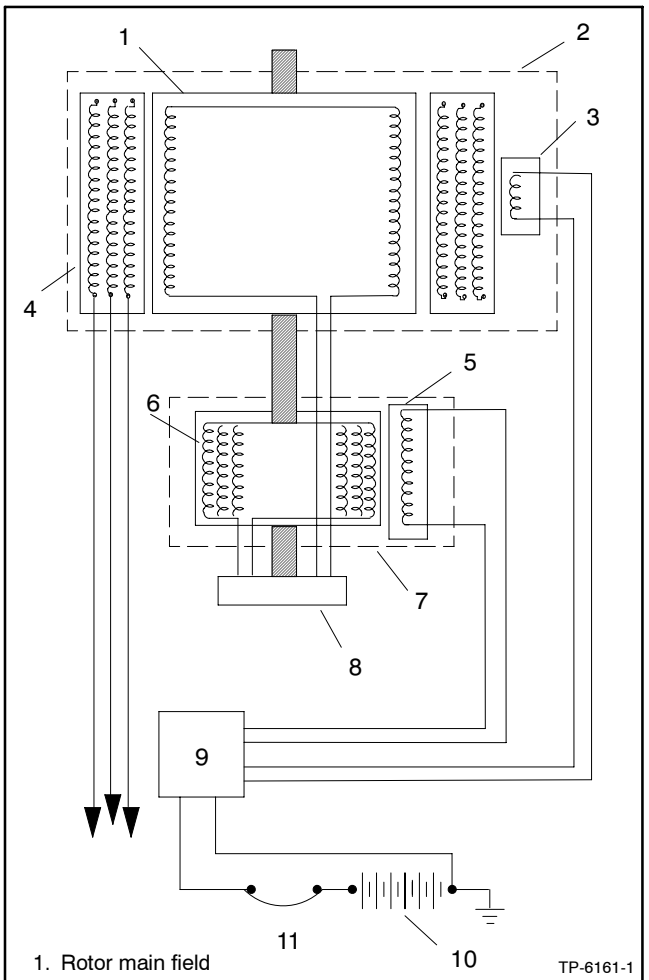
1.2 Wound Field Alternator Concept

The alternator is a 4-pole, rotating-field unit with a brushless, wound field (WF) excitation system. The generator set excitation system uses a wound exciter field and a three-phase exciter armature. The rotating rectifier assembly (RRA) is rated for over five times full load voltage and three times full load current with added surge protection. See Figure 1-1.

The ±0.25% average voltage regulator is powered by a stator auxiliary winding providing an independent power source for the exciter field. In addition, a rare earth permanent magnet is embedded in the exciter field for positive voltage buildup during startup. The voltage regulator has volt/Hz, stability, and voltage adjustments.

WF alternator sets offer the following advantages:

- Very good recovery characteristics because the auxiliary power for the voltage regulator comes from an independent stator winding that actually boosts the alternator's output during heavy loads.
- The inherent ability to support short-circuit current allowing system coordination for tripping downstream branch circuit breakers.
- For the duration of a short circuit in the load circuit(s), the output voltage drops and the amperage momentarily rises to 600%–1000% of the generator set's rated current.
- The voltage regulator requires low power and has tight average voltage regulation.
- The safeguard circuit breaker kit collapses the generator set's main field during a sustained heavy overload or short circuit.



1. Rotor main field
2. Main alternator
3. Stator auxiliary winding
4. Stator main windings
5. Exciter field winding
6. Exciter armature
7. Exciter alternator
8. Rotating rectifier assembly (RRA) and surge suppressor (varistor)
9. Voltage regulator
10. Engine starting battery
11. Safeguard circuit breaker (optional)

Figure 1-1 WF Alternator

1.3 Specifications, Resistance Values

Alternator Model	Alternator Leads	Nominal kW	Stator Main Winding, milliohm	Stator Aux. Winding, ohms	Rotor Main Field, ohms	Exciter Field Winding, ohms	Exciter Armature, ohms
4P4W	12 (Three Phase)	25	134	2.3	1.99	12.1	0.8
4P5W		30	101	2.1	2.25		
4P5BW		35	97	2.3	2.28		
4P7W		40	68	1.8	2.61		
4P7BW		45	69	1.9	2.67	17.3	0.4
4P8W		50	47.2	1.5	2.88		
4P10W		60	35.1	1.5	2.01		
4S7W		80	39.3	2.5	1.79		
4S9W		100	24.4	1.9	2.08		
4S11W		125	19.1	1.4	1.49		
4S13W		150	14.4	1.2	1.76		
4S15W		170	10.5	1.0	2.14		
4UA7W		180	15.5	1.9	1.56	10.8 *	0.3
4UA9W		230	9.7	1.2	1.83		
4UA10W		275	8.1	1.5	1.94		
4UA13W		300	5.5	1.0	2.54		
4P4W	6 (600 V)	25	218	2.3	1.99	12.1	0.8
4P5W		30	149	2.1	2.25		
4P5BW		35	152	2.3	2.28		
4P7W		40	116	1.8	2.61		
4P7BW		45	118	1.9	2.67	17.3	0.4
4P8W		50	88	1.5	2.88		
4P10W		60	55	1.5	2.01		
4S7W		80	61.5	2.5	1.79		
4S9W		100	45.4	1.9	2.08		
4S11W		125	36.6	1.4	1.49		
4S13W		150	30.8	1.2	1.76		
4S15W		170	15.9	1.0	2.14		
4UA7W		180	28.3	1.9	1.56	10.8 *	0.3
4UA9W		230	17.6	1.2	1.83		
4UA10W		275	18.8	1.5	1.94		
4UA13W		300	12.1	1.0	2.28		
4Q4W	4 (Single Phase)	30	50.5	2.4	1.99	12.1	0.8
4Q5W		35	34.7	1.9	2.25		
4Q7W		40	25.8	1.7	2.61		
4Q8W		45	23.6	1.6	2.88	17.3	0.4
4Q10W		55	17.5	1.3	2.01		
4V7W		75	16.3	1.4	1.79		
4V9W		95	10.6	1.1	2.08		
4V11W		110	6.7	1.1	1.49		
All resistance values are at 25°C (77°F) with ±12% tolerance.							
* Early alternators with part numbers GM33000-xx have resistance values of 17.2 ohms.							

1.4 Specifications, Electrical Values

Use the values shown in Figure 1-2 and Figure 1-3 during alternator testing.

Alternator Model	Hot Exciter Field No Load Readings at Rated Voltage	
	Volts	Amps
4P4W	7.4	0.6
4P5W	8.0	0.7
4P5BW	7.6	0.6
4P7W	9.4	0.8
4P7BW	9.0	0.7
4P8W	10.7	0.9
4P10W	9.6	0.8
4S7W	7.8	0.5
4S9W	9.3	0.5
4S11W	8.6	0.5
4S13W	9.7	0.6
4S15W	15.0	0.9
4UA7W	7.8	0.7
4UA9W	7.8	0.7
4UA10W	8.5	0.8
4UA13W	10.2	0.8
All values are at 25°C (77°F)		

Figure 1-2 Exciter Field Voltage/Current Values

Component	Value
Stator output voltages with separately excited alternator using a 12-volt battery	
Stator main windings, volts	>150 Volts
Stator auxiliary winding, volts	>300 Volts
All values are at 25°C (77°F)	

Figure 1-3 Stator Output Voltages

1.5 Specifications, Torque Values

Use the torque values shown in Figure 1-4 during alternator assembly. For assembly torque values not shown use the guidelines in Appendix C, General Torque Specifications.

Component	Model, kW	Torque Value
Ground lug assembly nuts	20-60	10.8 Nm (8 ft. lb.)
	80-300	45 Nm (34 ft. lb.)
Drive discs to rotor shaft bolts	20-170	61 Nm (45 ft. lb.)
	180-300	115 Nm (85 ft. lb.)
Fan to rotor flange bolts	20-170	26.4 Nm (19.5 ft. lb.)
	180-300	35 Nm (28 ft. lb.)
End bracket to stator bolts	180-300	95 Nm (70 ft. lb.)
Stator to generator adapter bolts	180-300	95 Nm (70 ft. lb.)
Terminal block to stator bolts	180-300	9.5 Nm (7 ft. lb.)
Terminal block link nuts	180-300	45 Nm (34 ft. lb.)
End bracket grease fitting	180-300	9.5 Nm (7 ft. lb.)
End bracket grease vent screw	180-300	9.5 Nm (7 ft. lb.)
Rotating rectifier assembly		
Mounting bolts	20-300	6.6 Nm (58 in. lb.)
AC exciter armature nuts	20-300	1.8 Nm (16 in. lb.)
F1/F2 main field nuts	20-300	2.9 Nm (26 in. lb.)
Alternator adapter to flywheel housing bolt torque	20-300	See chart following
Drive discs to flywheel bolt torque	20-300	See chart following

Figure 1-4 Torque Values

1.6 Alternator Adapter to Flywheel Housing Torque Values

Model	Engine	Alternator	Hardware Type,	Torque, Nm (ft. lb.)	Hardware Sequence
20-40 kW	John Deere	4P, 4Q	3/8-16, grade 8 bolt	53 (39)	Bolt, hardened washer
30-60 kW	GM		3/8-16, grade 8 bolt	53 (39)	
50/60 kW	John Deere		3/8-16, grade 8 bolt	53 (39)	
			M10, grade 10.9 bolt		
60-125 kW	GM	4S, 4V	3/8-16 grade 8 bolt	53 (39)	
60-180 kW	John Deere		3/8-16 grade 8 bolt	53 (39)	
			7/16-14, grade 8 bolt	60 (44)	
			M10, grade 10.9 bolt	65 (48)	
135/150 kW	DDC Series 50/60 Gas		7/16-14, grade 8 bolt	60 (44)	
150-275 kW	DDC Series 50/60 Gas	4UA	7/16-14, grade 8 bolt	85 (63)	
200 kW	DDC Series 40		3/8-16, grade 8 bolt	53 (39)	
200/230 kW	John Deere		3/8-16, grade 8 bolt	53 (39)	
			7/16-14, grade 8 bolt	85 (63)	
			M10, grade 10.9 bolt	65 (48)	
230-300 kW	DDC Series 60 Diesel		7/16-14, grade 8 bolt	85 (63)	

1.7 Drive Discs to Flywheel Torque Values

Model	Engine	Alt.	Hardware Type,	Torque, Nm (ft. lb.)	Hardware Sequence
20-40 kW	John Deere	4P, 4Q	3/8-16, grade 8 stud	53 (39)	Stud, spacer, hardened washer, grade 8 nut
30-60 kW 50/60 kW	GM John Deere		3/8-16, grade 8 stud	53 (39)	Stud, spacer, hardened washer, nut
60-125 kW 80-180 kW	GM John Deere	4S, 4V	3/8-16, grade 8 stud	53 (39)	
135/150 kW	DDC Series 50/60 Gas		1/2-13, grade 8 bolt	60 (44)	Bolt, hardened washer
150-275 kW	DDC Series 50/60 Gas	4UA	1/2-13, grade 8 bolt	130 (96)	
200 kW	DDC Series 40		3/8-16, grade 8 stud	53 (39)	Stud, spacer, hardened washer, grade 8 nut
200/230 kW	John Deere		1/2-13, grade 8 bolt	130 (96)	Bolt, hardened washer
230-300 kW	DDC Series 60 Diesel		1/2-13, grade 8 bolt	130 (96)	

1.8 Terminal Block Reconnection Decal, 80–300 kW

The terminal block decal shown in Figure 1-5 and Figure 1-6 provide the voltage reconnection combinations and terminal block hardware torque values.

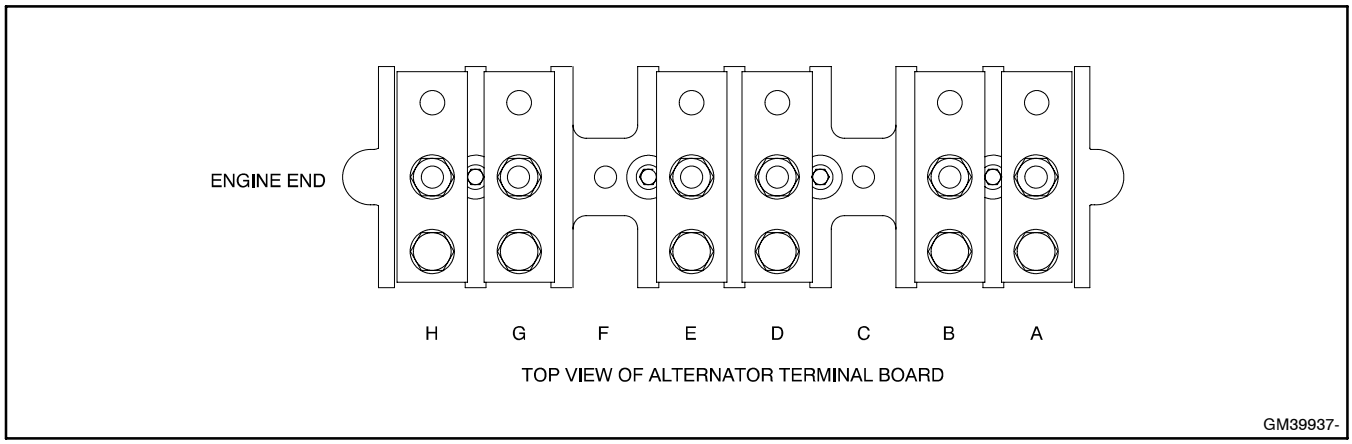
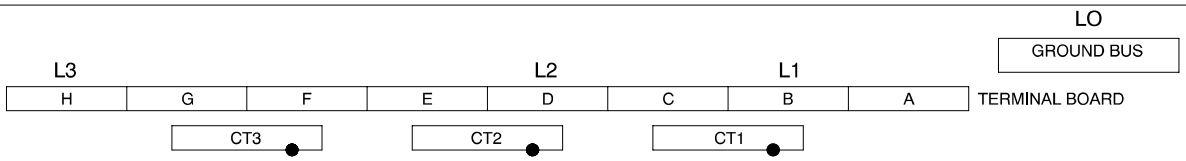


Figure 1-5 Load Connections

TERMINAL BOARD RECONNECTION DIAGRAM



TERMINAL BOARD LOCATION	12/24 LEAD STATOR CONNECTIONS								6 LEAD STATOR		4 LEAD STATOR	
	HIGH WYE 380V 416V 480V		LOW WYE 208V 240V		DELTA 120V/240V		DOGLEG 120V/240V		WYE 600V		SINGLE PHASE ONLY 120V/240V	
	CONN	BUS QTY	CONN	BUS QTY	CONN	BUS QTY	CONN	BUS QTY	CONN	BUS QTY	CONN	BUS QTY
A	4,7	1	OPEN	0	3,12	1	OPEN	0	OPEN	0	OPEN	0
B (L1)	1 (L1)	NOTE 1	1,7 (L1)	NOTE 2	6,7 (L1)	NOTE 1	1,7 (L1)	NOTE 1	1 (L1)	NOTE 1	1 (L1)	NOTE 1
C	OPEN	0	OPEN	0	OPEN	0	OPEN	0	OPEN	0	OPEN	0
D (L2)	2 (L2)	NOTE 1	2,8 (L2)	0	4,8 (L2)	NOTE 1	2,8 (L2)	NOTE 1	2 (L2)	NOTE 1	4 (L2)	NOTE 1
E	5,8	1	OPEN	NOTE 2	OPEN	0	OPEN	0	OPEN	0	OPEN	0
F	OPEN	0	OPEN	0	OPEN	0	OPEN	0	OPEN	0	OPEN	0
G	6,9	1	OPEN	0	2,11	1	OPEN	0	OPEN	0	OPEN	0
H (L3)	3 (L3)	NOTE 1	3,9 (L3)	NOTE 2	5,9 (L3)	NOTE 1	3,5,9,11	1	3 (L3)	NOTE 1	OPEN	0
NOTES: 1) USE 1 BUS FOR 4S7, 4V7, 4S9, 4V9, 4S11, 4V11, 4S13, 4S15, 4UA7, 4UA9, 4AU10. USE 2 BUS FOR 4UA13 AND 4UA16. 2) USE 2 BUS FOR 4S7, 4V7, 4S9, 4V9, 4S11, 4V11, 4S13, 4S15, 4UA7, 4UA9, 4AU10. USE 3 BUS FOR 4UA13 AND 4UA16.												
GROUND BUS	10,11,12		4,5,6,10,11,12		1,10		4,6,10,12		4,5,6		2,3	
CURRENT TRANSFORMERS												
CT1	1,7		1,7		6,7		1,7		1		1	
CT2	2,8		2,8		4,8		2,8		2		4	
CT3	3,9		3,9		5,9		OPEN		3		OPEN	
LINE CONNECTIONS												
L1	B		B		B		B		B		B	
L2	D		D		D		D		D		D	
L3	H		H		H				H			
L0	GROUND BUS		GROUND BUS		GROUND BUS		GROUND BUS		GROUND BUS		GROUND BUS	
NOTE: CURRENT TRANSFORMER DOT OR "HI" TOWARD GENERATOR TORQUE TERMINAL BOARD HARDWARE TO 45 Nm [34 FT–LBS]												

GM39792-B

Figure 1-6 Reconnection Decal

Notes

Section 2 Troubleshooting

This section contains generator set troubleshooting, diagnostic, and repair information.

Use the chart on the following pages to diagnose and correct common problems. First check for simple causes such as a dead engine starting battery or an open circuit breaker. The chart includes a list of common problems, possible causes of the problem, recommended corrective actions, and references to detailed information or repair procedures.

Maintain a record of repairs and adjustments performed on the equipment. If the procedures in this manual do not explain how to correct the problem, contact an authorized distributor/dealer. Use the record to help describe the problem and repairs or adjustments made to the equipment.

Trouble Symptoms										Probable Causes	Recommended Actions	Section or Publication Reference*
Does not crank	Cranks but does not start	Starts hard	No or low output voltage	Stops suddenly	Lacks power	Overheats	Low oil pressure	High fuel consumption	Excessive or abnormal noise			
Controller												
x	x									Controller circuit board(s) inoperative	Replace the controller circuit board.	—
				x						Controller fault	Troubleshoot the controller.†	Generator set O/M
x	x			x						Controller fuse blown	Replace the blown controller fuse. If the fuse blows again, troubleshoot the controller.†	W/D
x										Controller master switch inoperative	Replace the controller master switch.	—
x										Controller master switch in the OFF/RESET position	Move the controller master switch to the RUN or AUTO position.	Generator set O/M
x										Engine start circuit open	Move the controller master switch to the RUN position to test the generator set. Troubleshoot the auto start circuit and time delays.	Generator set O/M, W/D, ATS O/M, S/M
Cooling System												
						x		x		Air openings clogged	Clean the air openings.	—
						x				Coolant level low	Restore the coolant to normal operating level.	Generator set O/M
						x				Cooling water pump inoperative	Tighten or replace the belt. Replace the water pump.	Eng. O/M or S/M
				x						High temperature shutdown	Allow the engine to cool down. Then troubleshoot the cooling system.	Generator set O/M, Eng. O/M
				x						Low coolant level shutdown, if equipped	Restore the coolant to normal operating level.	Generator set O/M
						x				Thermostat inoperative	Replace the thermostat.	Eng. S/M

* Sec./Section—numbered section of this manual; ATS—Automatic Transfer Switch; Eng.—Engine; Gen.—Generator Set; I/M—Installation Manual; O/M—Operation Manual; S/M—Service Manual; S/S—Spec Sheet; W/D—Wiring Diagram Manual

† Have an authorized service distributor/dealer perform this service.

‡ If the unit has a 550 controller, refer to the 550 controller operation manual for voltage regulator settings. Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage.

Trouble Symptoms										Probable Causes	Recommended Actions	Section or Publication Reference*
Does not crank	Cranks but does not start	Starts hard	No or low output voltage	Stops suddenly	Lacks power	Overheats	Low oil pressure	High fuel consumption	Excessive or abnormal noise			
Electrical System (DC circuits)												
x	x									Battery connections loose, corroded, or incorrect	Verify that the battery connections are correct, clean, and tight.	Generator set O/M
x	x									Battery weak or dead	Recharge or replace the battery. The spec sheet provides recommended battery CCA rating.	Generator set O/M, S/S
x	x									Starter/starter solenoid inoperative	Replace the starter or starter solenoid.	Eng. S/M
x				x						Engine harness connector(s) not locked tight	Disconnect the engine harness connector(s) then reconnect it to the controller.	W/D
				x						High water temperature switch inoperative	Replace the inoperative switch.	Engine S/M or W/D
				x						Fault shutdown	Reset the fault switches and troubleshoot the controller.	Generator set O/M
				x						High exhaust temperature switch inoperative	Replace the inoperative switch.	Engine S/M or W/D
Engine												
	x	x			x			x		Air cleaner clogged	Clean or replace the filter element.	Eng. O/M
	x	x				x		x	x	Compression weak	Check the compression.†	Eng. S/M
			x		x	x		x	x	Engine overload	Reduce the electrical load. See the generator set spec sheet for wattage specifications.	S/S
									x	Exhaust system leak	Inspect the exhaust system. Replace the inoperative exhaust system components.†	I/M
									x	Exhaust system not securely installed	Inspect the exhaust system. Tighten the loose exhaust system components.†	I/M
		x	x		x			x		Governor inoperative	Adjust the governor.†	Governor literature
					x				x	Valve clearance incorrect	Adjust the valves.†	Eng. S/M
									x	Vibration excessive	Tighten all loose hardware.	—
	x	x			x					Ignition system inoperative (gas/gasoline only)	Check the ignition system (spark plugs, spark plug wires, etc.).	Eng. O/M

* Sec./Section—numbered section of this manual; ATS—Automatic Transfer Switch; Eng.—Engine; Gen.—Generator Set; I/M—Installation Manual; O/M—Operation Manual; S/M—Service Manual; S/S—Spec Sheet; W/D—Wiring Diagram Manual

† Have an authorized service distributor/dealer perform this service.

‡ If the unit has a 550 controller, refer to the 550 controller operation manual for voltage regulator settings. Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage.

Trouble Symptoms										Probable Causes	Recommended Actions	Section or Publication Reference*
Does not crank	Cranks but does not start	Starts hard	No or low output voltage	Stops suddenly	Lacks power	Overheats	Low oil pressure	High fuel consumption	Excessive or abnormal noise			
Fuel System												
	x	x			x					Air in fuel system (diesel only)	Bleed the diesel fuel system.	Eng. O/M
	x	x								Ether canister empty or system inoperative, if equipped (diesel only)	Replace or repair the ether starting system.	Eng. O/M
	x			x						Fuel tank empty or fuel valve shut off	Add fuel and move the fuel valve to the ON position.	—
	x				x			x		Fuel feed or injection pump inoperative (diesel only)	Rebuild or replace the injection pump.†	Eng. S/M
	x	x			x					Fuel or fuel injectors dirty or faulty (diesel only)	Clean, test, and/or replace the inoperative fuel injector.†	Eng. S/M
	x	x		x	x					Fuel filter restriction	Clean or replace the fuel filter.	Eng. O/M
	x									Fuel solenoid inoperative	Troubleshoot the fuel solenoid.†	Eng. S/M
	x				x					Fuel pressure insufficient (gas only)	Check the fuel supply and valves.†	S/S, Gen. O/M
	x	x			x			x		Fuel injection timing out of adjustment (diesel only)	Adjust the fuel injection timing.†	Eng. S/M
Alternator												
			x							AC output circuit breaker open	Reset the breaker and check for AC voltage at the generator side of the circuit breaker.	—
x										Transfer switch test switch in the OFF position	Move the transfer switch test switch to the AUTO position.	ATS O/M
			x							Transfer switch fails to transfer load	Move the ATS test switch to the AUTO position. Troubleshoot the transfer circuit and time delays.	ATS O/M, S/M
			x							Wiring, terminals, or pin in the exciter field open	Check for continuity.	Section 3, W/D
			x							Main field (rotor) inoperative (open or grounded)	Test and/or replace the rotor.†	Section 3
			x							Stator inoperative (open or grounded)	Test and/or replace the stator.†	Section 3
									x	Vibration excessive	Tighten loose components.†	—
			x	x						Voltage regulator digital settings incorrect (digital controller only)	Adjust the voltage regulator.	Section 3 ‡
			x	x						Voltage regulator inoperative	Replace the voltage regulator fuse, If the fuse blows again, troubleshoot the voltage regulator.	Section 3 ‡
			x	x						Voltage regulator out of adjustment	Adjust the voltage regulator.	Section 3 ‡

* Sec./Section—numbered section of this manual; ATS—Automatic Transfer Switch; Eng.—Engine; Gen.—Generator Set; I/M—Installation Manual; O/M—Operation Manual; S/M—Service Manual; S/S—Spec Sheet; W/D—Wiring Diagram Manual

† Have an authorized service distributor/dealer perform this service.

‡ If the unit has a 550 controller, refer to the 550 controller operation manual for voltage regulator settings. Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage.

Trouble Symptoms										Probable Causes	Recommended Actions	Section or Publication Reference*
Does not crank	Cranks but does not start	Starts hard	No or low output voltage	Stops suddenly	Lacks power	Overheats	Low oil pressure	High fuel consumption	Excessive or abnormal noise			
Lube System												
	x	x					x		x	Crankcase oil type incorrect for ambient temperature	Change the oil. Use oil with a viscosity suitable for the operating climate.	Eng. O/M
						x	x		x	Oil level low	Restore the oil level. Inspect the generator set for oil leaks.	Eng. O/M
				x						Low oil pressure shutdown	Check the oil level.	Eng. O/M

* Sec./Section—numbered section of this manual; ATS—Automatic Transfer Switch; Eng.—Engine; Gen.—Generator Set; I/M—Installation Manual; O/M—Operation Manual; S/M—Service Manual; S/S—Spec Sheet; W/D—Wiring Diagram Manual

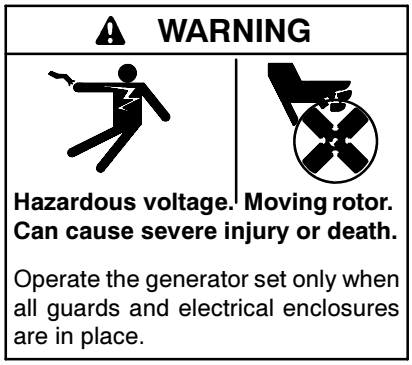
† Have an authorized service distributor/dealer perform this service.

‡ If the unit has a 550 controller, refer to the 550 controller operation manual for voltage regulator settings. Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage.

Notes

3.1 General

Before beginning the troubleshooting procedures, read all the safety precautions at the beginning of this manual. The following tests include additional safety precautions; OBSERVE THESE PRECAUTIONS!



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

3.2 General Troubleshooting

To determine the cause of no- or low-AC output , refer to the following steps and the troubleshooting flow chart (Figure 3-1).

1. Check the condition of the voltage regulator 10-amp fuse located in the junction box.

2. If the fuse is good, separately excite the alternator (see Section 3.3). The separate excitation test duplicates the role of the voltage regulator in providing the excitation current to the rotor.

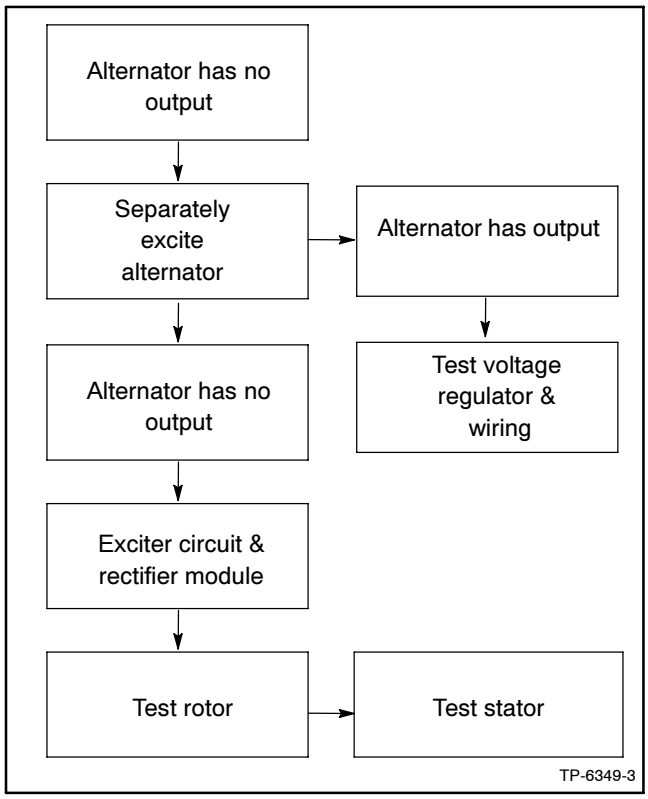


Figure 3-1 General Troubleshooting

3.3 Separate Excitation

By separately exciting the alternator to determine the presence of a faulty voltage regulator, it is possible to determine if a running fault exists in the rotor and/or stator. A alternator component that appears good while static (stationary) may exhibit a running open or short circuit while dynamic (moving). Short circuits can be caused by centrifugal forces acting on the windings during rotation or insulation breakdown as temperatures increase.

1. Disconnect all of the leads from the voltage regulator.

2. Disconnect the FP/FN connector.

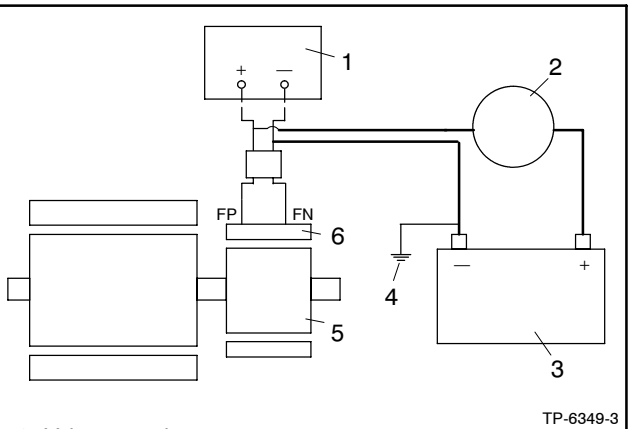
3. Disconnect the exciter field winding leads. Connect an ohmmeter to the exciter field winding and measure the resistance.

4. Connect separate excitation circuit as shown in Figure 3-2. Connect a DC ammeter in series with FP. Note and record the ammeter reading.

   The approximate ammeter reading should be battery voltage divided by the specified exciter field winding resistances (cold). See Section 1, Specifications, for the values.

   Example:

   $$\frac{\text{12 Volts (Battery Voltage)}}{\text{12.1 Ohms Exciter Field Winding Resistance}} = \text{0.99 amps Exciter Field Winding Current}$$



1. Voltage regulator
2. DC ammeter
3. Battery
4. Ground to alternator frame
5. Exciter armature
6. Exciter field winding

Figure 3-2 Separate Excitation Connections

5. Move the generator set master switch to the RUN position to start the generator set.

6. Check the ammeter values.

   Unstable ammeter reading. An increasing meter reading indicates a shorted exciter field. A decreasing meter reading to zero, or unstable reading, suggests a running open in the exciter.

   Stable ammeter reading. If the ammeter is stable, continue with the next step.

7. Use a voltmeter and check for AC output across the stator main windings and compare it to the values in Section 1, Specifications. If the stator main windings output varies considerably from those listed, a faulty stator, rotor, rotating rectifier assembly, or exciter armature is likely.

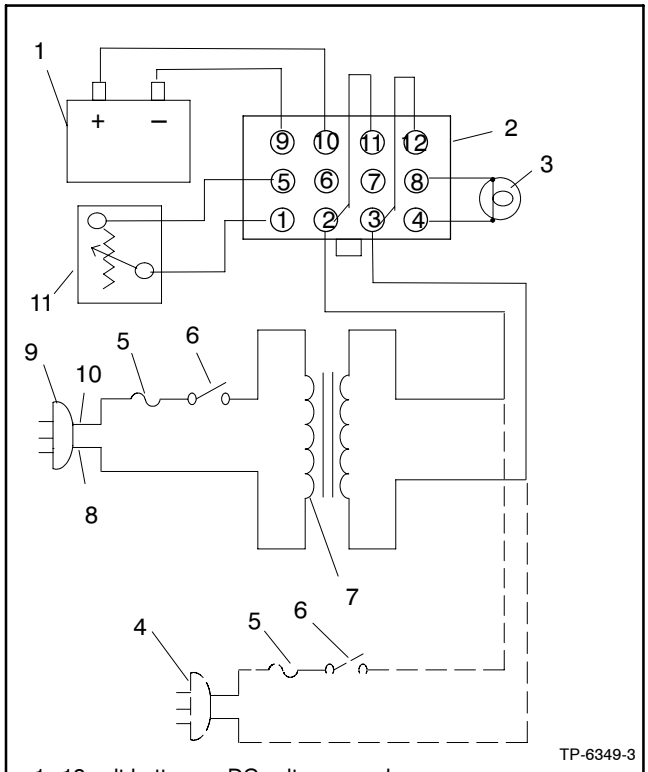
8. Place the generator set master switch to the OFF/RESET position to stop the generator set.

If the AC output is not within specifications, the voltage regulator is probably defective. If there is no alternator output during normal operation, but output is available when the generator set is separately excited, the voltage regulator is probably defective.

Note: See Section 1, Specifications, for the stator output voltages (with separately excited alternator). These specifications are based on a battery voltage of 12. Should the battery voltage vary (11–14 volts), the resulting stator output values will also vary.

3.4 Wound Field Voltage Regulators

The generator set is equipped with a wound field voltage regulator. See Figure 3-3.



1. 12 volt battery or DC voltage supply
2. Voltage regulator 12-pin plug (pin insertion end shown)
3. 250-volt, 100-watt lamp
4. 200–240 VAC (optional)
5. 1-amp fuse
6. Single-pole single-throw switch
7. 1:2 step-up transformer
8. White wire
9. 100–120 VAC
10. Black wire
11. Potentiometer (1 kOhm)

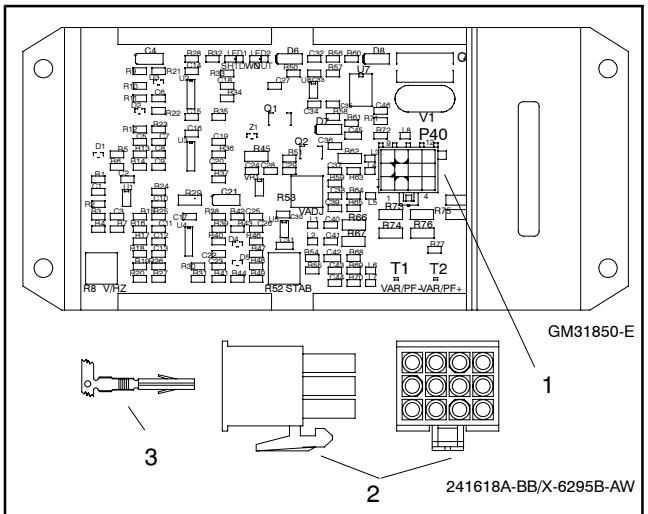
Figure 3-3 Voltage Regulator Test with User-Fabricated Adapter Harness

The voltage regulator monitors output voltage magnitude to control the current to the exciter field windings. The voltage regulator has an underfrequency unloading feature that is referred to as volts-per-Hz (V/Hz). To determine if the voltage regulator is functioning, reduce the engine speed (Hz), if possible, and watch for a corresponding drop in the AC voltage. The AC voltage should remain constant until the engine speed drops below 57.5 Hz on 60 Hz models or 47.5 Hz on 50 Hz models.

When the frequency drops below either 57.5 or 47.5 Hz, the AC voltage should decline. Perform the following test to check the voltage regulator output.

The following components will be needed to test the voltage regulator:

- 12 volt battery or DC power supply, isolated
- Step-up transformer, 1:2, 120 volts to 240 volts (1.0 amp min.)
- 1 kOhm 1/2 watt potentiometer
- Variable transformer, 0–140 volts (1.0 amp min.)
- Voltage regulator adapter harness (see Figure 3-4) make from:
  - (1) plug, part no. GM11858
  - (10) terminals, part no. 337137
  - (10) leads, 18 ga., 610 mm (24 in.) long



1. Voltage regulator 12-pin socket
2. GM11858 12-pin plug
3. 337173 terminal (10) female 0.99 mm (0.39 in.) diameter

Figure 3-4 Voltage Regulator Adapter Harness

- Lamp, 250-volt, 100-watt
- Fuse, 1-amp
- Switch, 1 single-pole single-throw (SPST) 1 amp (minimum)
- Plug, 120-volt AC (200–240 volt AC plug optional)
- Stranded copper wire, #18 AWG

⚠ WARNING

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

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

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

Voltage Regulator Test Procedure

1. Connect the components as shown in Figure 3-3. If a 200–240 volt power source is available, the step-up transformer is not required.

2. Turn 1 kOhm potentiometer fully counterclockwise. See Figure 3-3, item 11.

3. Plug the power cord into the outlet.

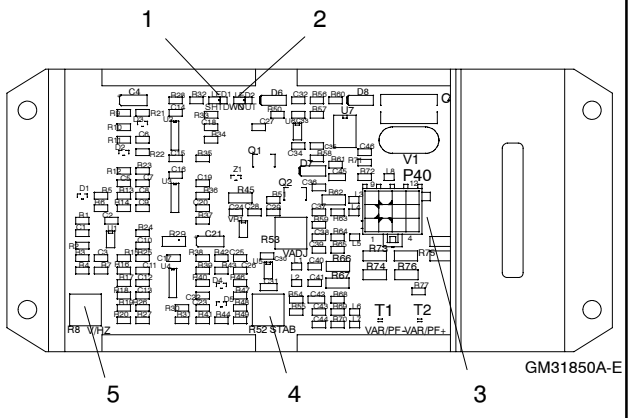
4. Turn the power supply on. The 100-watt lamp should be off. If 100-watt lamp is lit, replace the voltage regulator. It is acceptable for the lamp to briefly illuminate at powerup.

5. Slowly turn the 1 kOhm potentiometer clockwise. The 100-watt lamp should light. Replace the voltage regulator if the 100-watt lamp does not light.

3.5 Voltage Regulator Adjustment

The voltage regulator is factory-set and, under normal circumstances, requires no further adjustment. However, if the voltage regulator has been replaced, or tampered with, or if voltage/frequency reconnection has been done, readjust the voltage regulator according to the following procedure. The voltage regulator components are identified and described in the following paragraphs. Figure 3-5 illustrates the voltage regulator features. Figure 3-6 identifies the voltage regulator connections to the P40 socket.

Note: Frequency reconnection. Refer to the respective generator set spec sheet to determine if engine frequency (speed) is fixed or field-convertible.



1. LED1 (red shutdown)
2. LED2 (green output)
3. 12-pin socket P40
4. Stability potentiometer
5. Volts/Hz potentiometer

Figure 3-5 Voltage Regulator Features

Socket P40-	Lead	Description/Function
1	68	Remote voltage adjustment
2	V7	TB4-V7 sensing input
3	V8	TB4-V8 sensing input
4	FP	Exciter field output
5	67	Remote voltage adjustment
6	EOV	Overvoltage controller output signal
7	—	Not used
8	FN	Exciter field output
9	7N	TB11-7N (battery negative)
10	1B	Safeguard circuit breaker (battery positive)
11	55	Voltage regulator power supply
12	66	Voltage regulator power supply

Figure 3-6 Voltage Regulator P40 Connections

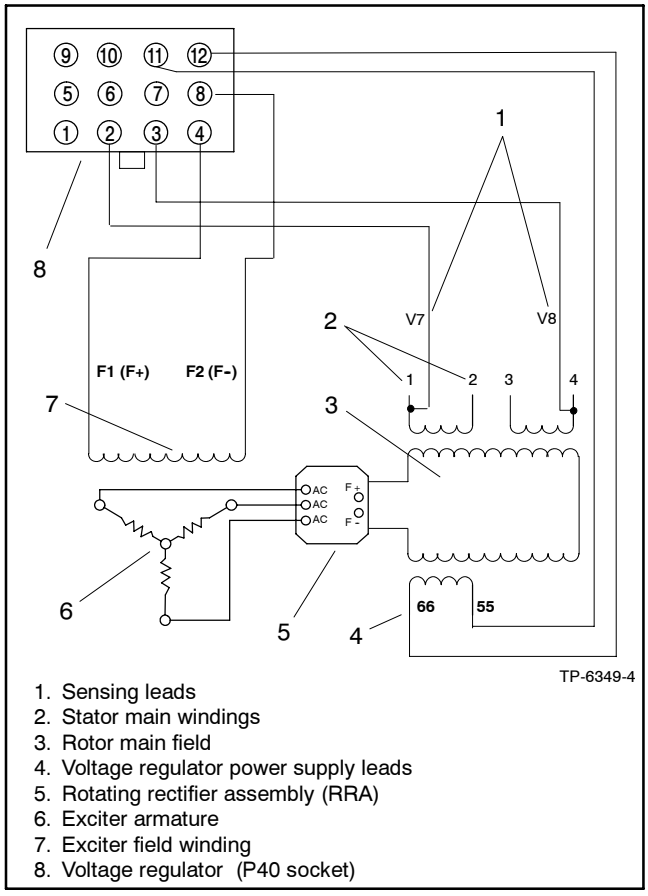
Stability Potentiometer. Potentiometer fine tunes the regulator circuitry to reduce light flicker.

Volts/Hz Potentiometer. Potentiometer adjustment determines the engine speed (Hz) at which the alternator output begins to drop.

Voltage Adjustment (remote only). Use the generator set controller voltage adjustment control to adjust the alternator output. See the respective generator set operation manual for further information.

Voltage Regulator Adjustment Procedure

Figure 3-7 illustrates the wiring connections necessary for the voltage regulator adjustment procedure.



1. Sensing leads
2. Stator main windings
3. Rotor main field
4. Voltage regulator power supply leads
5. Rotating rectifier assembly (RRA)
6. Exciter armature
7. Exciter field winding
8. Voltage regulator (P40 socket)

Figure 3-7 Voltage Regulator Connection

1. Verify that the generator set master switch is in the OFF/RESET position.

2. Turn the Volts/Hz and the stability potentiometers fully counterclockwise. Connect the voltmeter to the AC circuit or an electrical outlet.

3. Move the generator set master switch to the RUN position.

4. Change the voltage adjustment control (located at the generator set controller) until the desired output voltage is achieved.

5. Rotate the stability potentiometer clockwise until light flicker minimizes.

6. Readjust the voltage adjustment control (located at the generator set controller) until the desired output voltage is achieved.

7. If the engine has a speed adjustment governor, adjust the engine speed to the specified cut-in frequency as measured on the frequency meter. The factory setting is 57.5–58 Hz for 60 Hz models and 47.5–48 Hz for 50 Hz models.

   Note: Some engines do not permit engine speed adjustment.

8. Rotate the volts/Hz potentiometer clockwise until the voltage level as measured on the voltmeter begins to drop. When the regulator is set to these specifications, the alternator will attempt to maintain normal output until the engine speed drops below the frequency set in step 7 as load is applied.

9. Readjust the engine speed to 1800 rpm for 60 Hz models or1500 rpm for 50 Hz models.

10. Readjust the voltage adjustment control (located at the generator set controller) until the desired output is achieved.

11. Readjust the stability potentiometer until light flicker minimizes.

12. Move the generator set master switch to the OFF/ RESET position.

3.6 Exciter Field

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

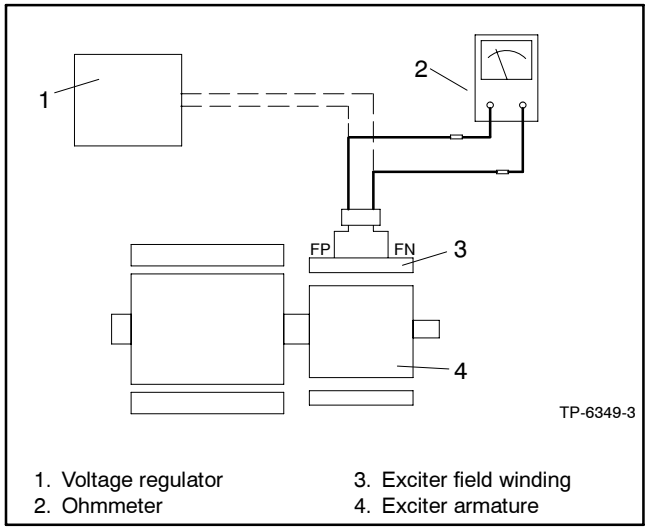
Exciter Field Test Procedure

1. Place the generator set master switch to the OFF/RESET position.

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

3. Disconnect the FP/FN leads.

4. Check the exciter field resistance by connecting an ohmmeter across exciter field FP and FN leads. See Figure 3-8. See Section 1, Specifications, for resistance reading for a cold exciter field winding.

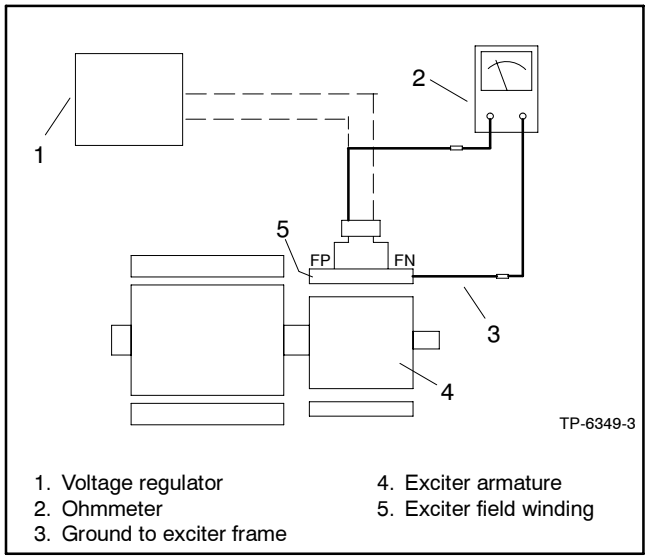


1. Voltage regulator
2. Ohmmeter
3. Exciter field winding
4. Exciter armature

Figure 3-8 Exciter Field Winding Resistance Test

A low reading indicates an internal short and a high reading indicates an open winding. Repair or replace the exciter field winding if the ohmmeter readings indicate an inoperative exciter field winding. If the resistance test is inconclusive, perform a megohmmeter test on the exciter field winding as described in the next step.

5. Check the exciter field winding for a short to ground condition. See Figure 3-9. Use a megohmmeter to apply 500 volts DC to the FP or FN lead and the exciter field winding frame. Follow the megohmmeter manufacturer's instructions for using the megohmmeter.



1. Voltage regulator
2. Ohmmeter
3. Ground to exciter frame
4. Exciter armature
5. Exciter field winding

Figure 3-9 Megohmmeter Connections on Exciter Field Winding

A reading of approximately 500 kOhms (1/2 megohm) and higher indicates the exciter field winding is good. A reading of less than approximately 500 kOhms indicates deterioration of the exciter field winding insulation and possible current flow to ground. Replace the exciter field winding.

3.7 Exciter Armature

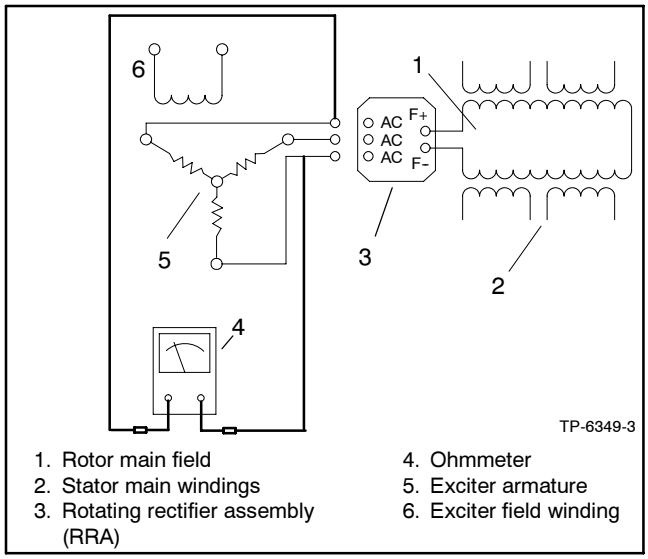
The exciter armature supplies excitation current to the main field windings through the rotating rectifier assembly (RRA). Test the exciter armature as described in the following steps.

Exciter Armature Test Procedure

1. Disassemble the alternator. See Section 4, Alternator Disassembly/Reassembly for the procedure.

2. With the alternator disassembled, disconnect the armature leads from the RRA AC terminals.

3. With an ohmmeter on the R x 1 scale, check the resistance across the exciter armature leads. See Figure 3-10. 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.

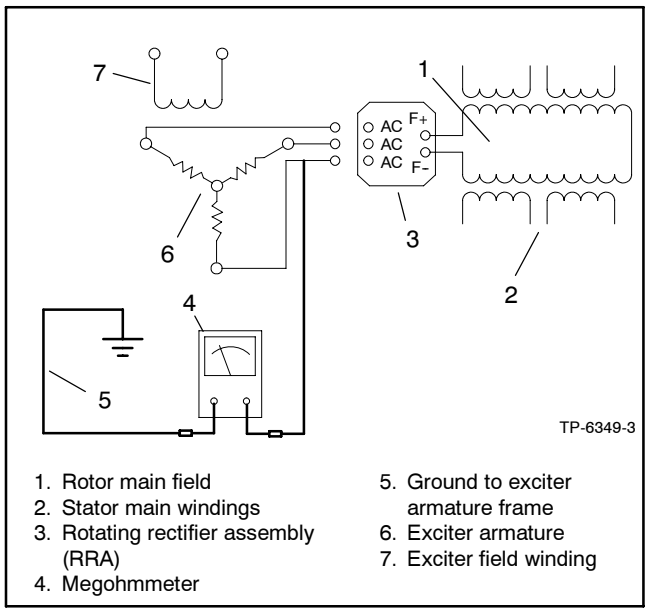


1. Rotor main field
2. Stator main windings
3. Rotating rectifier assembly (RRA)
4. Ohmmeter
5. Exciter armature
6. Exciter field winding

Figure 3-10 Exciter Armature Resistance Test

Note: Consider the exciter armature good if the resistance reading (continuity) is low and there is no evidence of a shorted winding (heat discoloration).

4. Check the exciter armature 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 3-11. A reading of approximately 500 kOhms (1/2 megohm) and higher indicates the exciter armature is good. A reading of less than approximately 500 kOhms indicates deterioration of the winding insulation and possible current flow to ground. Replace the exciter armature.



1. Rotor main field
2. Stator main windings
3. Rotating rectifier assembly (RRA)
4. Megohmmeter
5. Ground to exciter armature frame
6. Exciter armature
7. Exciter field winding

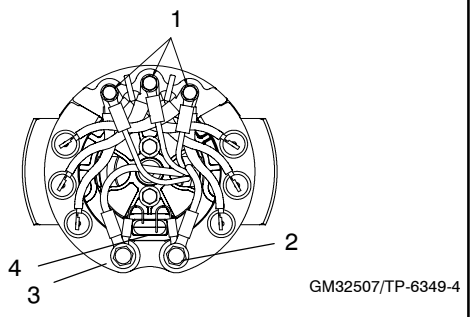
Figure 3-11 Megohmmeter Connections on Exciter Armature

3.8 Rotating Rectifier Assembly (RRA)/Varistor

The RRA converts the AC from the exciter armature to DC, which magnetizes the main field windings. Test the RRA as described in the following steps. The RRA consists of two diode assembly plates and varistor attached to the diode assembly hub. The diode assembly plates are available only as a set when ordering service parts.

Rotating Rectifier Assembly (RRA) Test Procedure

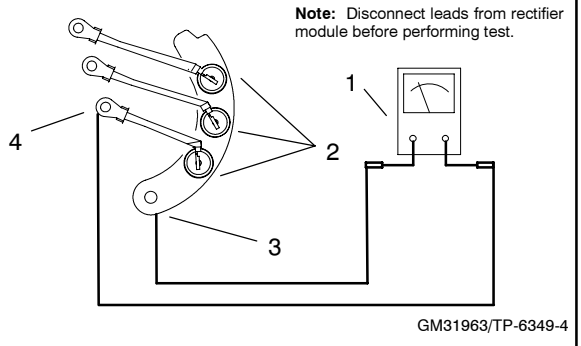
1. Disconnect the exciter armature and the rotor main field winding leads from the RRA. See Figure 3-12. Keep each lead electrically separated from the other leads and any metal components.



1. AC terminals
2. Diode terminal (F–)
3. Diode terminal (F+)
4. Varistor

Figure 3-12 RRA Connections

2. Use an ohmmeter on the R x 100 scale to check the resistance between the RRA diodes as shown in Figure 3-13. 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 diode assembly plates (service part set) if any of the six diodes test differently than described.



1. Ohmmeter
2. Diodes (3 diodes per plate)
3. Diode ground connection
4. Diode terminal

Figure 3-13 Diode Assembly Plate (part of RRA) Test

3. Replace the varistor if there is evidence of heat damage. Replace the diode assembly hub if any damage is evident.

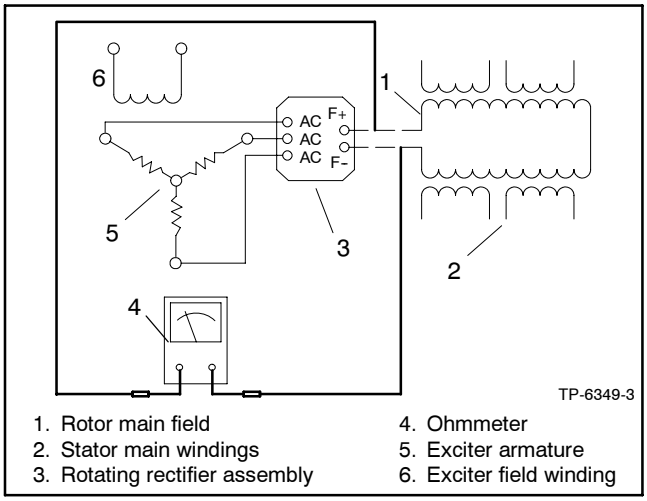
3.9 Rotor

The rotor (magnetized by DC from the rotating rectifier assembly) rotating within the stator induces AC in the stator windings. Test the rotor main field as described in the following steps. Disassemble the alternator prior to performing this test. See Section 4, Alternator Disassembly/Reassembly for the procedure.

Generator Rotor Test Procedure

1. With the alternator disassembled, disconnect the rotor main field from the rotating rectifier assembly (RRA) terminals F+ and F–.

2. Check the rotor main field resistance by connecting an ohmmeter across leads field F+ and F–. See Figure 3-14. See Section 1, Specifications for the resistance values.

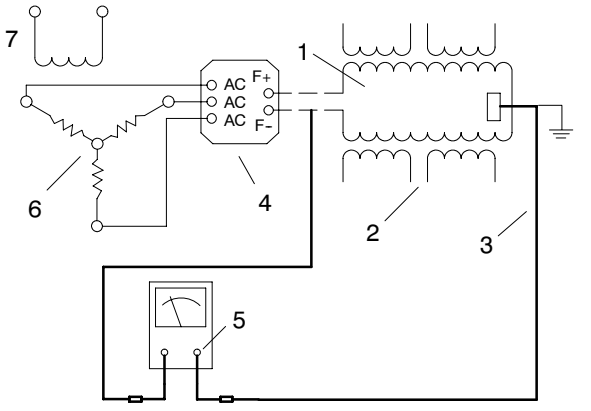


1. Rotor main field
2. Stator main windings
3. Rotating rectifier assembly
4. Ohmmeter
5. Exciter armature
6. Exciter field winding

Figure 3-14 Rotor Resistance Test

A low reading indicates an internal short and a high reading indicates an open winding. Repair or replace the rotor main field if the ohmmeter readings indicate the rotor main field is inoperative. If the resistance test is inconclusive, perform a megohmmeter test on the rotor main field as described in the next step.

3. Check the rotor main field for a short to ground condition by using a megohmmeter. Apply 500 volts DC to either rotor main field lead and the main field frame. Follow the megohmmeter manufacturer's instructions for using the megohmmeter. See Figure 3-15.



1. Rotor main field
2. Stator main windings
3. Ground to stator frame
4. Rotating rectifier assembly
5. Megohmmeter
6. Exciter armature
7. Exciter field windings

Figure 3-15 Megohmmeter Connections on Rotor Main Field

A reading of 500 kOhms (1/2 megohm) and higher indicates the rotor main field is good. A reading of less than 500 kOhms indicates deterioration of the rotor main field winding insulation and possible current flow to ground. Replace the rotor.

3.10 Stator

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

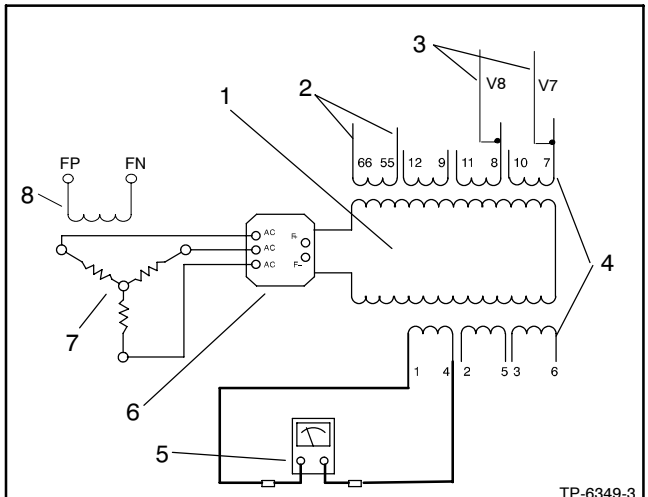
Before testing the stator, inspect it for heat discoloration and visible damage to the housing lead wires and exposed and varnished areas of the frame laminations. Be sure the stator is securely fastened in the stator housing.

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 1–4 (single phase) or leads 1–12 (three phase) are the alternator AC output leads. Leads 55 and 66 are the voltage regulator supply and sensing leads. Refer to Figure 3-16 and Figure 3-17 (three phase) or Figure 3-18 and Figure 3-19 (single phase) when performing the following tests.

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

Figure 3-16 Stator Continuity, Three Phase

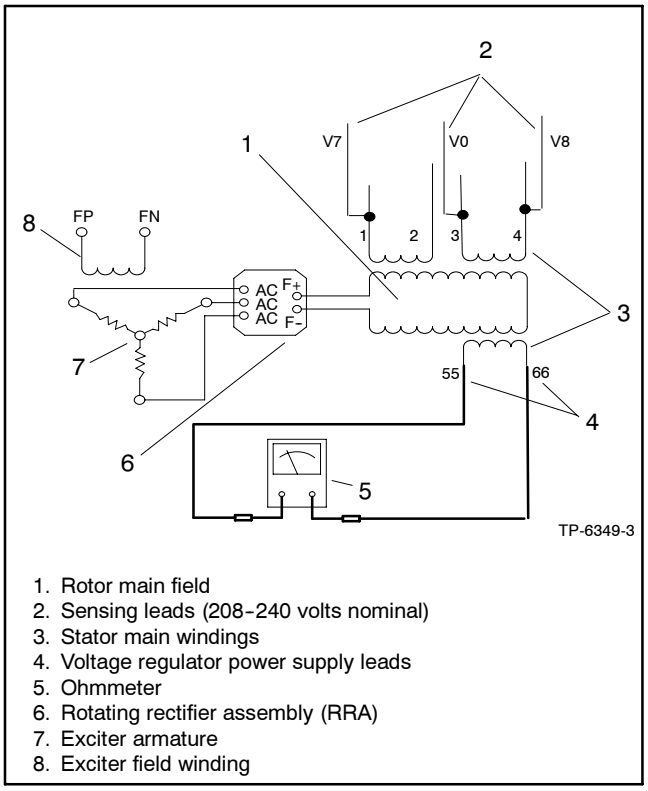


1. Rotor main field
2. Sensing leads (208–240 volts nominal)
3. Voltage regulator power supply leads
4. Stator main windings
5. Ohmmeter
6. Rotating rectifier assembly (RRA)
7. Exciter armature
8. Exciter field winding

Figure 3-17 Stator Ohmmeter Connections, 3-Phase

Between Leads	Continuity
1 and 2	Yes
3 and 4	Yes
55 and 66	Yes
1 and 3, 4, 33, 44	No
1 and 55	No
Any stator lead and ground	No

Figure 3-18 Stator Continuity, Single Phase



1. Rotor main field
2. Sensing leads (208–240 volts nominal)
3. Stator main windings
4. Voltage regulator power supply leads
5. Ohmmeter
6. Rotating rectifier assembly (RRA)
7. Exciter armature
8. Exciter field winding

Figure 3-19 Stator Ohmmeter Connections, Single Phase

Stator Test Procedure

1. Move the generator set master switch to the OFF/RESET position.

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

3. Check the alternator output lead connections. Refer to wiring diagram manual and/or generator set operation manual.

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 3-19. Perform the stator tests on all of the stator windings. For single-phase alternators use Figure 3-18. For three-phase alternators use Figure 3-16.

5. Contact the ohmmeter leads and readjust the ohmmeter to zero ohms. Check the cold resistance of the stator windings by connecting the meter leads to the stator leads 1-2, 3-4, etc. 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.

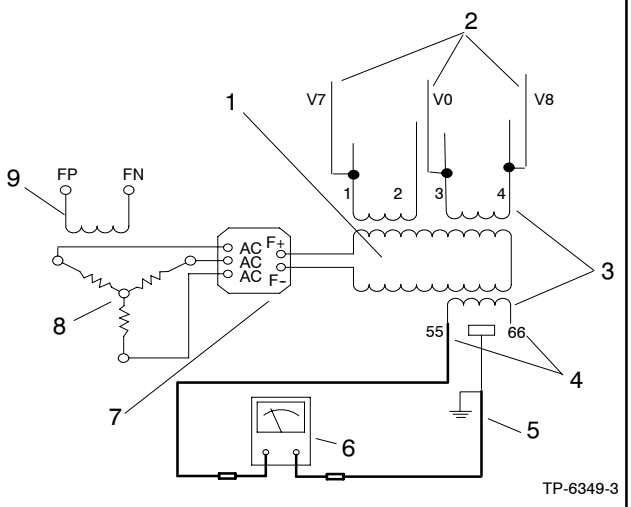
   Note: Consider the stator good if the resistance reading (continuity) is low and there is no evidence of shorted windings (heat discoloration).

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

   Note: The stator resistance varies directly with increased temperature.

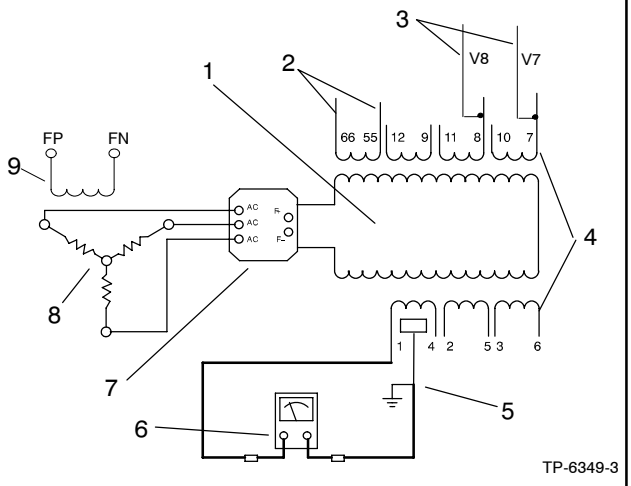
6. If any of the stator readings vary during the previous checks, replace the stator.

7. Check the stator for a short to ground condition using a megohmmeter. See Figure 3-20 and Figure 3-21.



1. Rotor main field
2. Sensing leads (208-240 volts nominal)
3. Stator main windings
4. Voltage regulator power supply leads
5. Ground to stator frame
6. Megohmmeter
7. Rotating rectifier assembly (RRA)
8. Exciter armature
9. Exciter field winding

Figure 3-20 Megohmmeter Connections on Stator, Single Phase



1. Rotor main field
2. Sensing leads (208-240 volts nominal)
3. Voltage regulator power supply leads
4. Stator main windings
5. Ground to stator frame
6. Megohmmeter
7. Rotating rectifier assembly (RRA)
8. Exciter armature
9. Exciter field winding

Figure 3-21 Megohmmeter Connections on Stator, Three Phase

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 the stator windings have been tested.

A reading of 500 kOhms (1/2 megohm) and higher indicates the stator is good. A reading of less than 500 kOhms indicates deterioration of the stator winding insulation and possible current flow to ground. Repair or replace the stator.

3.11 Speed Sensor Test

Follow the procedure outlined below to determine if the speed sensor (overspeed fault) is emitting a signal.

Note: During the test the controller leads must remain connected to the speed sensor terminals. Slide leads from speed sensor terminals only enough to expose connection for the test leads. **Do not disconnect** the speed sensor leads.

1. Move the generator set master switch to the OFF/RESET position.

2. Connect a DC voltmeter between positive (+) lead (wire 24) at speed sensor and ground (wire 2). The voltmeter should indicate approximately 8-10 volts DC.

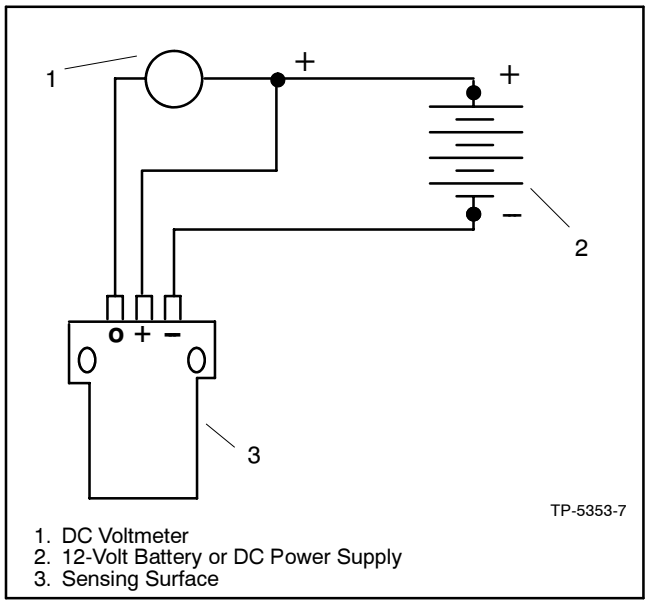
3. Move the generator set master switch to the RUN position to start the generator set.

4. With generator set running, connect the DC voltmeter negative probe to the 0 terminal (wire 16—white) on the speed sensor. Place the voltmeter positive probe on positive (+) terminal (wire 24—red). The voltmeter should indicate approximately 12 volts DC.

If the speed sensor is emitting a signal, check the continuity of the speed sensor leads (wires 2, 16, and 24) between the controller connector and lead terminals at speed sensor.

If the speed sensor is not emitting a signal, test the speed sensor using the following procedure:

1. Connect the speed sensor, voltmeter, and DC voltage source as shown in Figure 3-22.



1. DC Voltmeter
2. 12-Volt Battery or DC Power Supply
3. Sensing Surface

Figure 3-22 Speed Sensor Test

2. Touch the sensing surface with a flat piece of iron or steel—at least 4 cm (1/4 cu. in.) in size.

3. The voltmeter test reading should equal the source voltage.

4. Remove the iron or steel from the sensing surface and observe a no voltage reading on the voltmeter.

3.12 Interface Circuit Board GM11718

The 550 controller has an integral voltage regulator. Circuit board GM11718 interfaces between the wound field alternator and 550 controller voltage regulator. See Figure 3-23 for an illustration of the circuit board. The circuit board is typically located in the junction box.

There is no field test for this circuit board. Use the following information to help troubleshoot the circuit board.

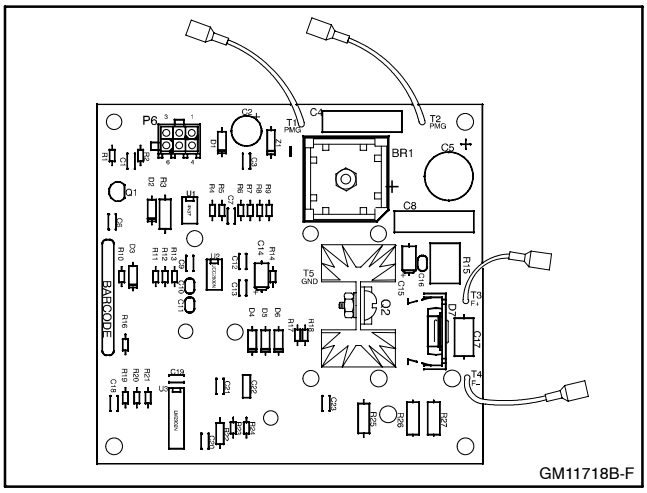


Figure 3-23 Interface Circuit Board GM11718

Verify connection and continuity of the wires shown in Figure 3-24 and Figure 3-25. Check the wires for broken strands and damaged insulation including cuts and chafing. Check the terminals for corrosion and loose electrical connections. Repair and/or replace any defective wiring.

If the circuit board is still suspected of questionable function after the circuit board wiring checks out okay, replace with a known good circuit board and test the generator set for functionality.

Wire	Circuit Board Connection	Component Connection
E12	P6-1	TB3-1
N	P6-2	TB3-7
EOV	P6-3	TB4-4
3B	P6-4	P1-16
5B	P6-5	P1-20
Not used	P6-6	none
55	T1	Stator main field 55
66	T2	Stator main field 66
F1	T3	Exciter field IB-F (+)
F2	T4	Exciter field IB-F (-)

Figure 3-24 Interface Circuit Board Connections

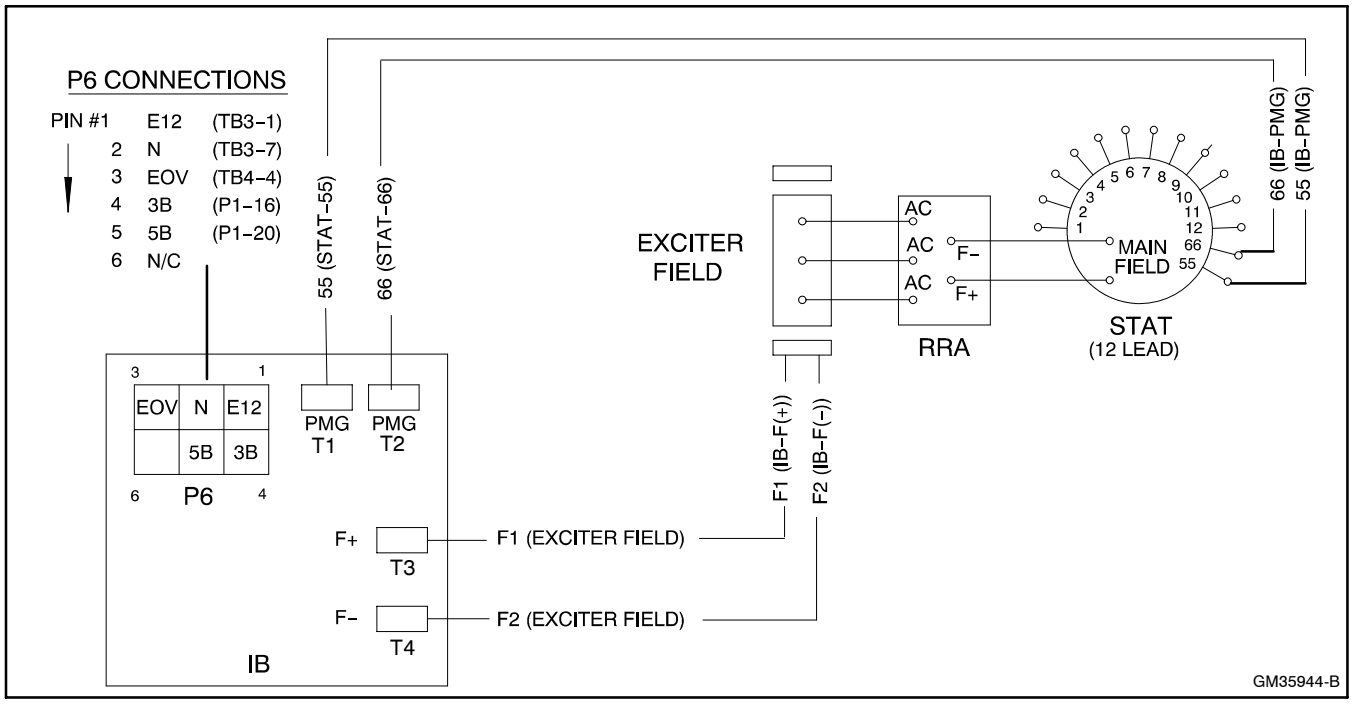


Figure 3-25 Interface Circuit Board Diagram

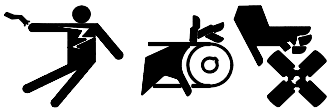
4.1 General

Before beginning alternator disassembly procedure, carefully read all safety precautions at the beginning of this manual. Please observe these precautions and those included in text during the disassembly/ reassembly procedure.

The following procedures cover many models and some steps may not apply to a particular engine. Use Figure 4-1 or Figure 4-2 to help understand component descriptions and general configuration of the alternator.

Use the disassembly procedure as a guideline to help take apart the alternator. The disassembly procedure provides important information to minimize disassembly time and indicates where special configurations exist which may require taking notes. The reassembly procedure includes important alignment steps and provides special torque specs.

⚠ 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.

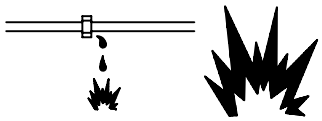
⚠ WARNING

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

Do not work on the generator set until it cools.

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

⚠ WARNING



Explosive fuel vapors.
Can cause severe injury or death.

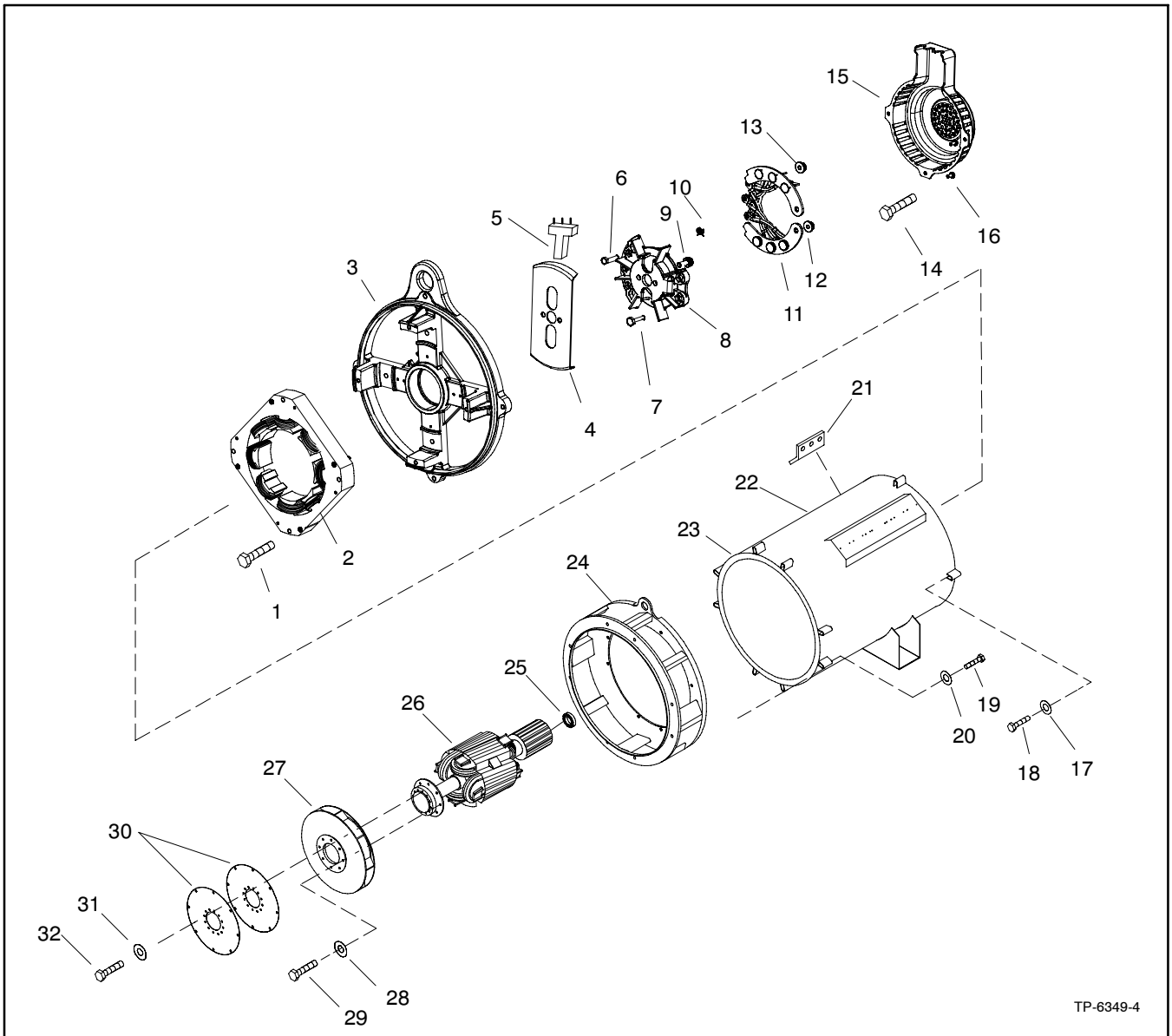
Use extreme care when handling, storing, and using fuels.

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.

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

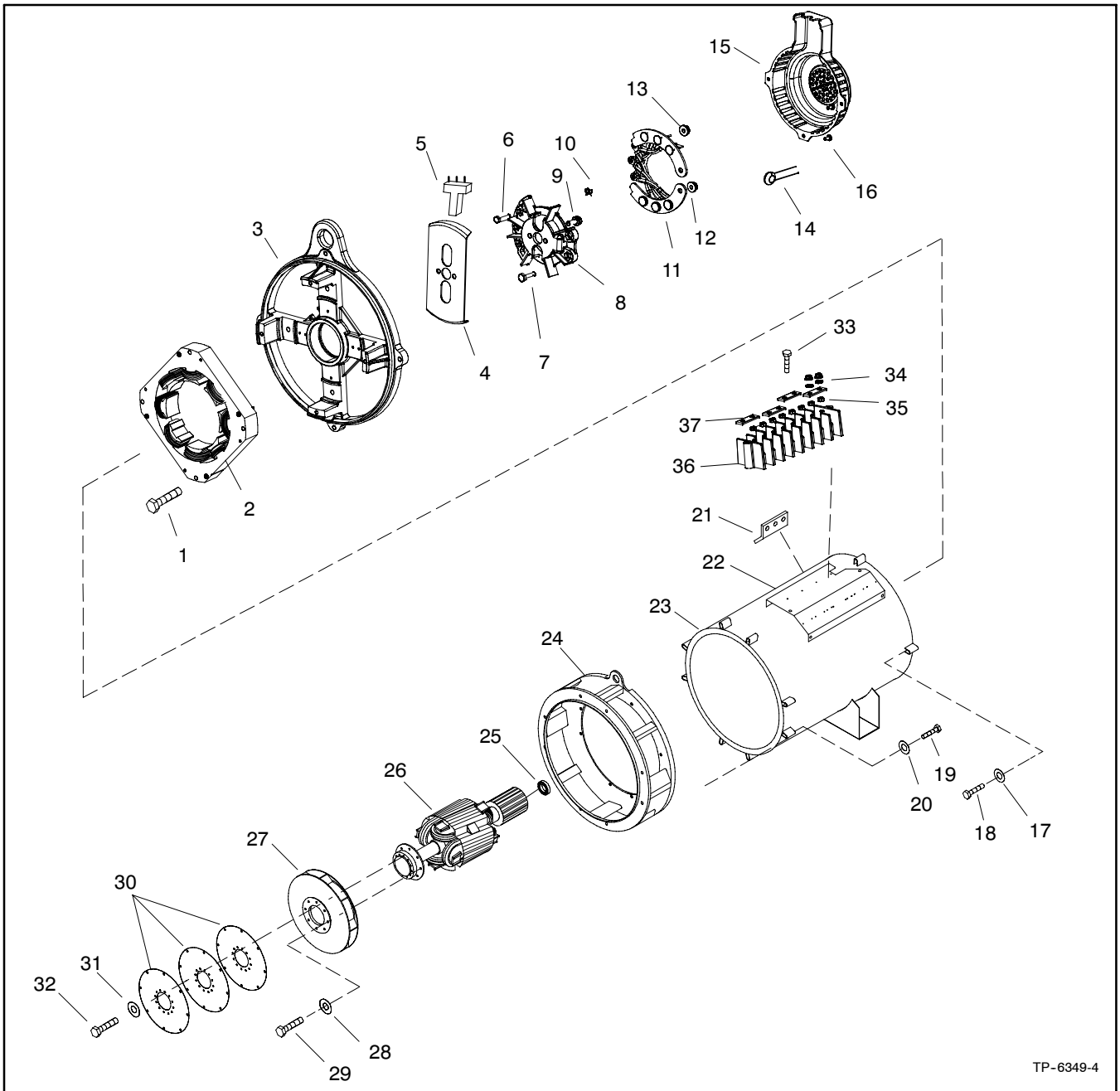
Gasoline—Store gasoline only in approved red containers clearly marked GASOLINE.

Propane (LP)—Adequate ventilation is mandatory. Because propane is heavier than air, install propane gas detectors low in a room. Inspect the detectors per the manufacturer's instructions.



1. Screw
2. Exciter field winding
3. End bracket
4. Magnetic actuator
5. Speed sensor
6. Screw
7. Screw
8. Rotating rectifier assembly hub
9. Screw
10. Nut
11. Diode assembly plates (2 pieces—red and blue)
12. Elastic stop nut
13. Elastic stop nut
14. Varistor
15. Rotating rectifier assembly cover
16. Screw
17. Plain washer
18. Screw
19. Screw
20. Plain washer
21. Terminal
22. Equipment ground decal
23. Stator
24. Adapter
25. Ball bearing
26. Rotor
27. Alternator fan
28. Plain washer
29. Screw
30. Drive discs (2)
31. Hardened washer
32. Screw

Figure 4-1 4PW and 4QW Alternator Components, 20–60 kW



1. Screw
2. Exciter field assembly
3. End bracket
4. Magnetic actuator
5. Speed sensor
6. Screw
7. Screw
8. Rotating rectifier assembly hub
9. Screw
10. Nut
11. Diode assembly plates (2 pieces—red and blue)
12. Elastic stop nut
13. Elastic stop nut
14. Varistor
15. Rotating rectifier assembly cover
16. Screw
17. Plain washer
18. Screw
19. Screw
20. Plain washer
21. Terminal
22. Equipment ground decal
23. Stator
24. Adapter
25. Ball bearing
26. Rotor
27. Alternator fan
28. Plain washer
29. Screw
30. Drive discs, 3 with 4SW/4VW and 4 with 4UAW
31. Hardened washer
32. Screw
33. Screw
34. Plain washer
35. Nut
36. Terminal block
37. Terminal block link

Figure 4-2 4SW, 4VW, and 4UAW Alternator Components, 60 kW IMS–300 kW

Perform the following steps prior to disassembling the generator set.

1. Disconnect (negative lead first) and remove the starting batteries from the work area to prevent a fire hazard. Disconnect AC-powered accessories, such as the battery charger, block heater, and fuel transfer pump.

2. Shut off the fuel supply. Drain the fuel system as necessary by emptying the fuel into proper containers. Remove any fuel containers from the work area to prevent a fire hazard. Ventilate the work area to clear fumes.

3. Disconnect the fuel, cooling, and exhaust systems as necessary to tilt the generator set. Disconnect the output leads or load circuit cables at the generator set.

4. Any cranes, hoists, or other lifting devices used in the disassembly or reassembly procedure must be rated for the weight of the generator set. Check the generator set nameplate or spec sheet for weight.

5. Remove the junction box panels.

4.2 Disassembly

1. Disconnect all controller-to-engine and engine-to-alternator harnesses and wiring. Disconnect the speed sensor wiring. Remove the junction box and the controller as a unit.

2. Remove the fan guard.

3. Remove the rotating rectifier assembly housing.

4. Remove the alternator (rodent) guard on the end bracket (if equipped).

5. Remove the speed sensor from the end bracket.

6. Remove all leads from the three AC terminals on the rotating rectifier assembly hub. See Figure 4-3. Make notes as needed for reconnection later.

7. Remove the leads from the F+/F– terminals on the rotating rectifier assembly hub. Make notes as needed for reconnection later. Remove the diode assembly plates. The varistor is accessible after the F+/F– screws are removed.

8. Remove the two mounting screws. Lift off the rotating rectifier assembly hub and magnetic actuator.

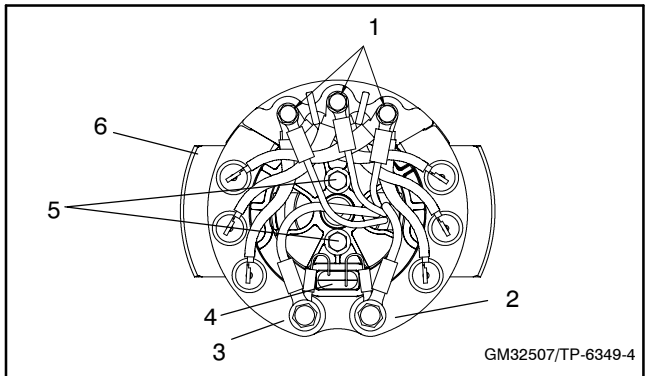
9. Remove bolts from the alternator vibromounts.

10. Suspend the alternator at both ends with hooks in lifting eyes. Use a hoist to raise alternator end off vibromounts. See Figure 4-4.

11. Support the engine by placing wood blocks under the flywheel housing. Lower the alternator end until the flywheel housing rests on the blocks. See Figure 4-4.

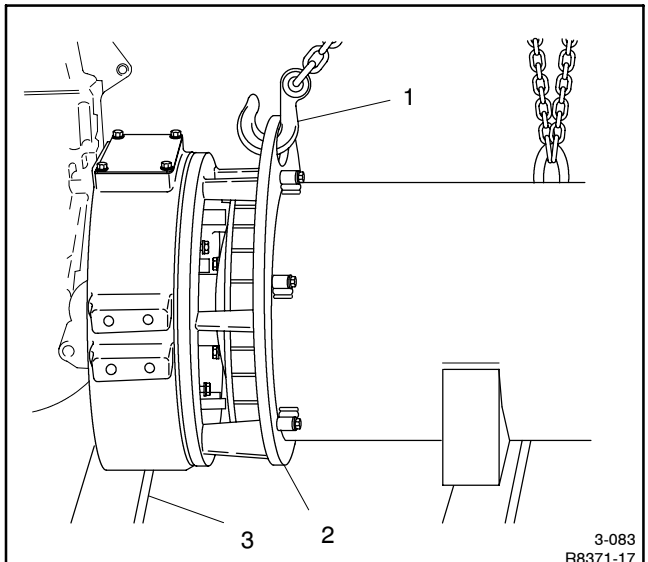
12. Remove the bolts holding the adapter to the flywheel housing.

13. Remove the hardware attaching the drive discs to the flywheel.



1. AC terminals
2. Diode terminal (F–) (red)
3. Diode terminal (F+) (blue)
4. Varistor
5. Mounting screws
6. Magnetic actuator

Figure 4-3 Rotating Rectifier Assembly Hub and Components



1. Hook
2. Alternator adapter
3. Wood block(s)

Figure 4-4 Hoisting Generator

14. Work the drive discs over the studs (if equipped) to separate the alternator from the engine. See Figure 4-5.

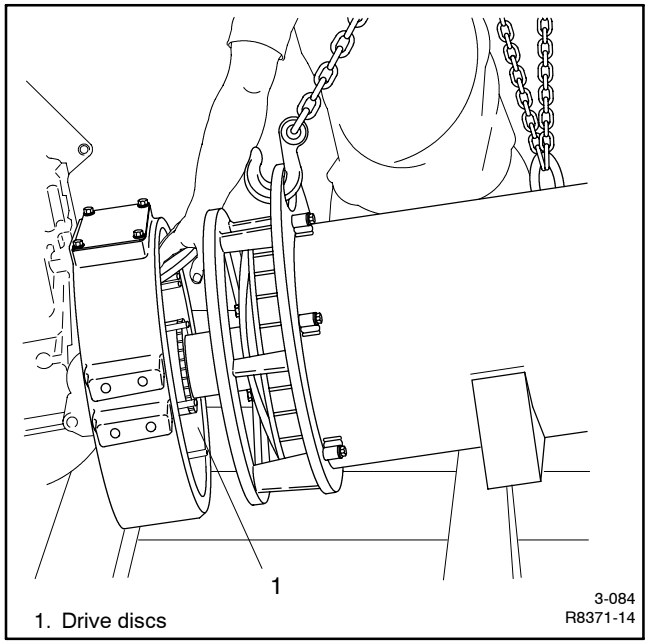


Figure 4-5 Separating Generator and Engine

15. Use a stud remover and remove the studs from the flywheel, if damaged.

16. Set the alternator assembly on the floor in a horizontal position. Remove the support slings or chains.

17. To remove the rotor assembly, attach the hoist hook to the adapter and lift the alternator assembly to a vertical position. See Figure 4-6. Place boards along the edge of the end bracket to prevent damage to the rotating rectifier assembly hub and magnetic actuator. Lower the rotor assembly.

18. Remove the drive discs and fan from the alternator assembly. See Figure 4-6.

19. Fasten the lifting eye and hoist hook to the rotor flange. Hoist the rotor carefully to avoid damaging the exciter armature or exciter field winding. See Figure 4-7.

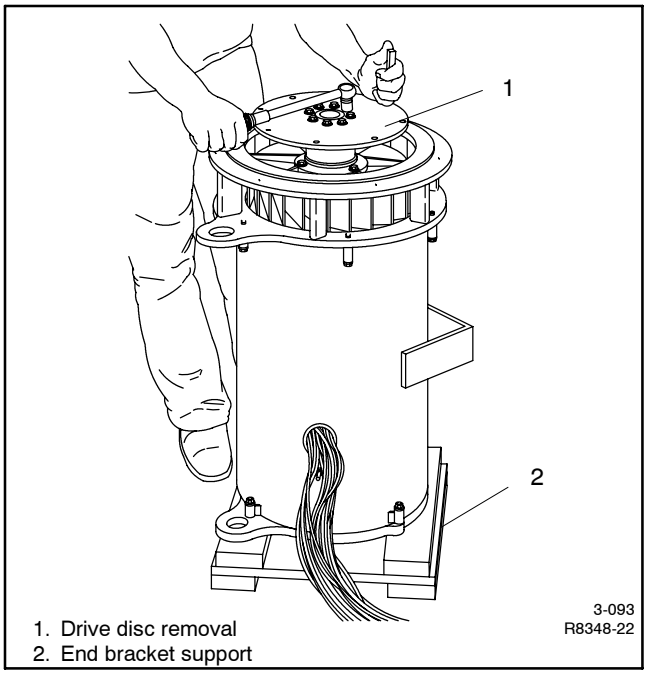


Figure 4-6 Alternator Support, Drive Discs, and Fan Removal

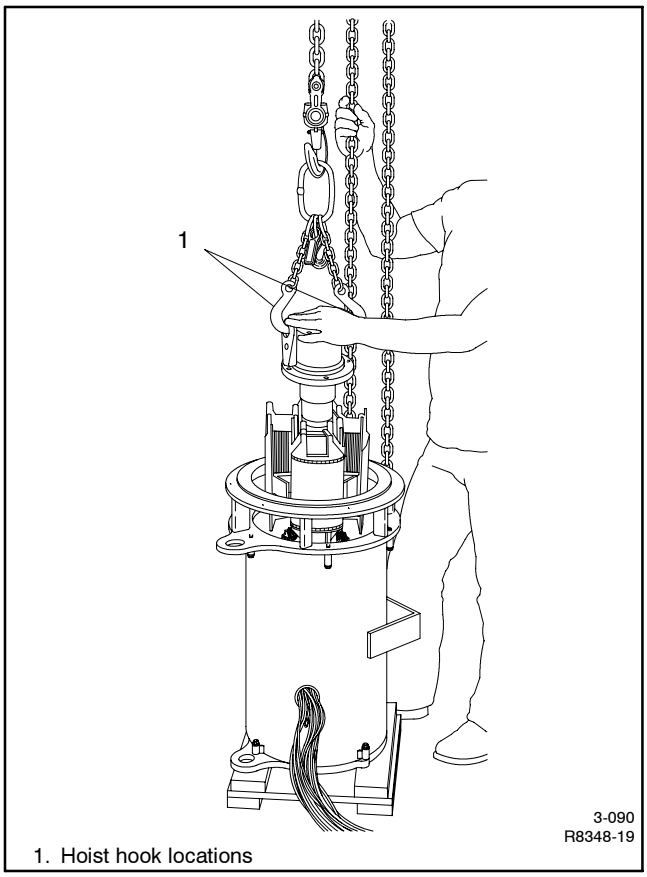


Figure 4-7 Rotor Removal

20. Place a pallet or other wooden surface under the rotor and slowly lower the rotor to a horizontal position. Take care not to damage the windings, laminations, or bearing. See Figure 4-8.

21. Make note of the bearing location dimensions from the rotor shaft end for reference during installation if the bearing will be removed. Use a hydraulic press to remove the bearing, if needed.

22. Place the alternator assembly on the adapter end in order to remove the adapter and end bracket from the stator. Fasten chains to the adapter and lower to a horizontal position. Fasten the hoist hook to the end bracket eye and lift to a vertical position. See Figure 4-9.

23. Remove the adapter mounting bolts. Fasten the hoist hooks to the end bracket and raise the stator assembly slightly. Tap adapter loose by using a rubber mallet.

24. Lower the stator assembly. Remove the end bracket mounting bolts. Separate the end bracket from the stator by tapping loose with a rubber mallet.

25. Remove the exciter field winding from the end bracket.

4.3 Reassembly

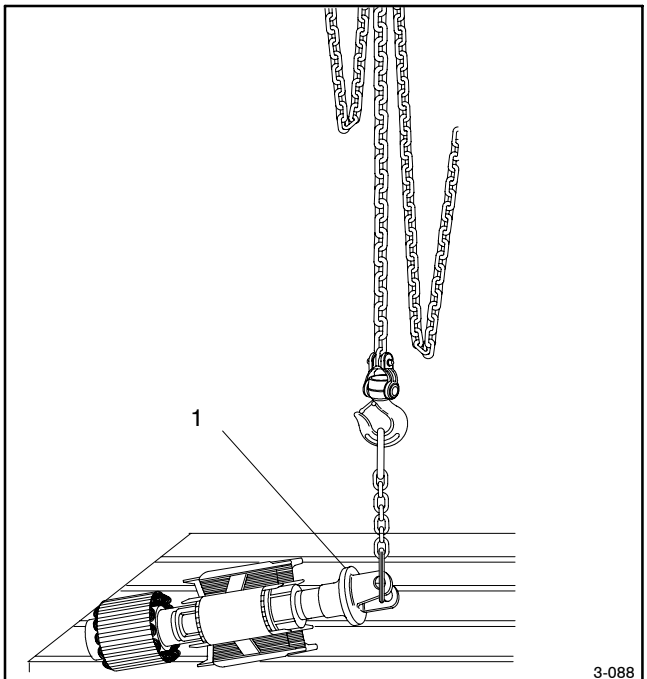
Follow the general guidelines in the following procedure. In addition, Figure 4-23, Figure 4-24, and Figure 4-25 at the end of this section may provide some detailed help during the reassembly procedure.

When torque specifications are not shown in Section 1, Specifications, use the guidelines shown in Appendix C, General Torque Specifications.

1. Attach the exciter field to the end bracket with four mounting bolts. Torque to specifications.

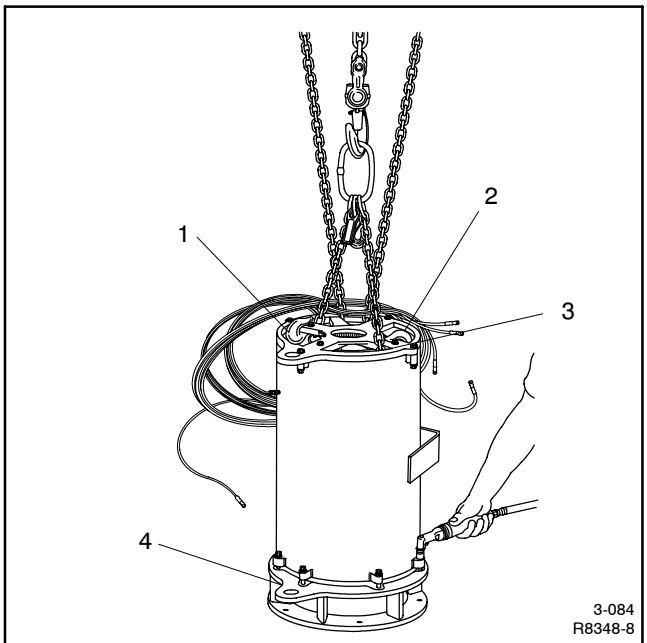
2. Place the stator in a vertical position with the end bracket side up.

   Note: The end bracket side of the stator has four mounting bosses.



1. Rotor assembly

Figure 4-8 Lowering Rotor

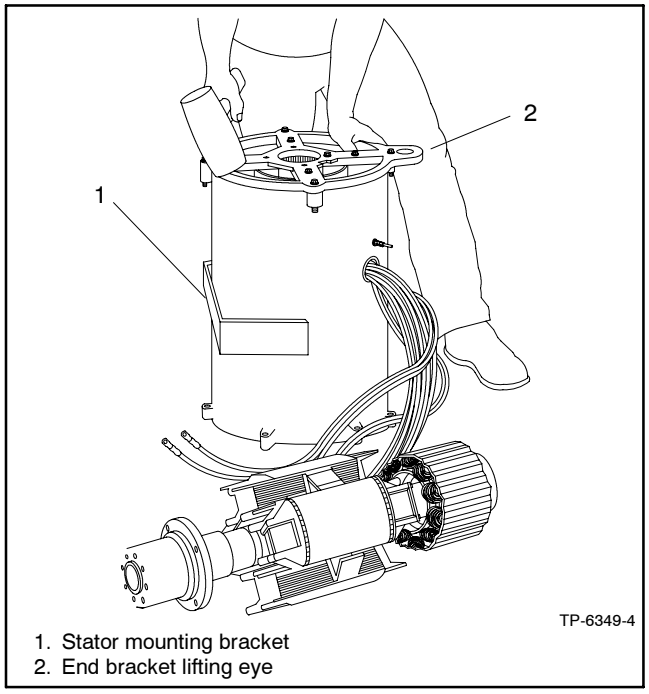


1. Hoist hook
2. Hoist hook
3. End bracket
4. Adapter

Figure 4-9 Removing Alternator Adapter

3. Position the end bracket housing eye opposite the stator mounting bracket during reassembly. See Figure 4-10.

   Place the end bracket on the stator and use bolts to align the holes. Use a rubber mallet to mount the end bracket flush with the stator.



1. Stator mounting bracket
2. End bracket lifting eye

Figure 4-10 Attaching End Bracket on Stator

4. Attach the end bracket to the stator using the original hardware. Torque to specifications.

5. Attach the hoist hooks to the end bracket and suspend the stator. Place the adaptor on the floor and lower the stator to within 12.7–6.4 mm (1/2–1/4 in.) of the adapter lip. See Figure 4-11.

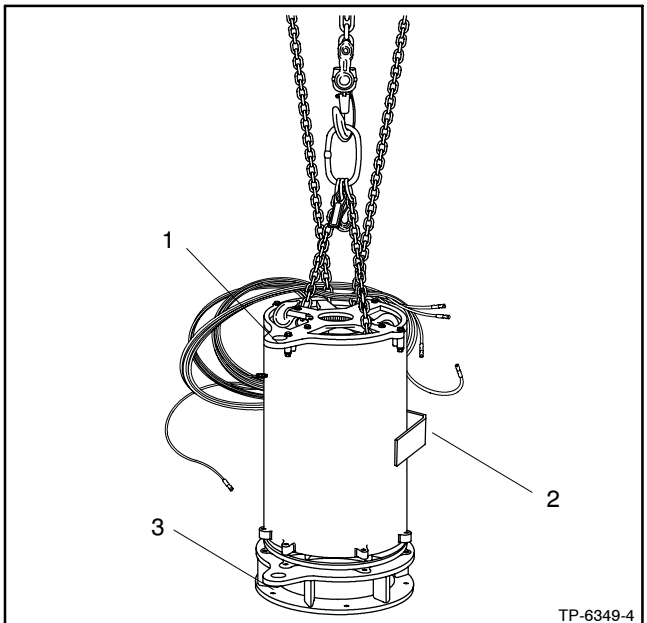
6. Position the adapter hoisting eye opposite of the stator mounting bracket and directly below the end bracket hoisting eye.

   Align the adapter with the stator and start the bolts with washers. Lower the stator onto the adapter and finish tightening the bolts. Torque to specifications.

7. Lower the alternator assembly to a horizontal position.

8. Attach the hoisting hooks to the adapter as shown in Figure 4-12. Suspend the alternator assembly. Before lowering the alternator assembly, place boards along the edge of the end bracket. Maintain a 25 mm (1 in.) clearance underneath the center of the end bracket to allow for rotor shaft clearance.

9. Rotor shaft bearing installation. Use a hydraulic press, bearing heater, or heavy rubber mallet and a piece of round steel stock with an outside diameter less than the bearing inner race to install the new bearing using measurements taken during the disassembly procedure.



1. End bracket lifting eye
2. Stator mounting bracket
3. Adapter lifting eye

Figure 4-11 Aligning Adapter and Stator

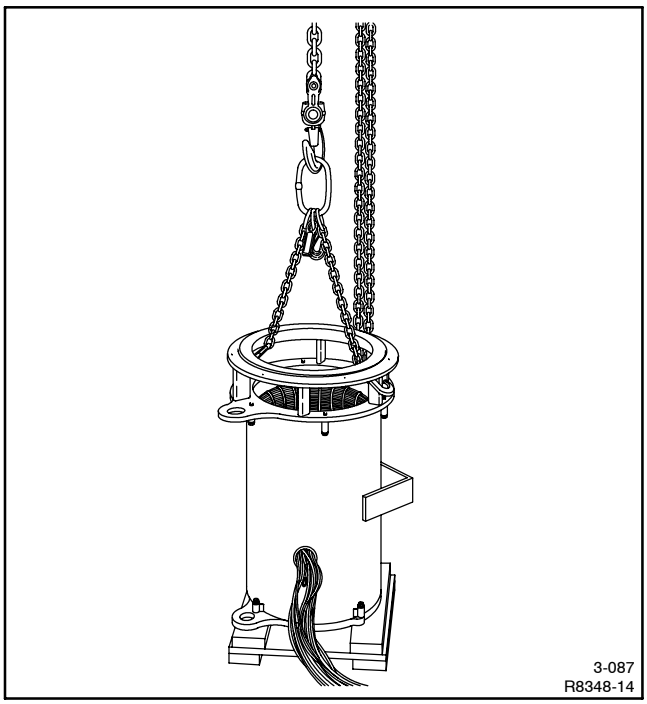
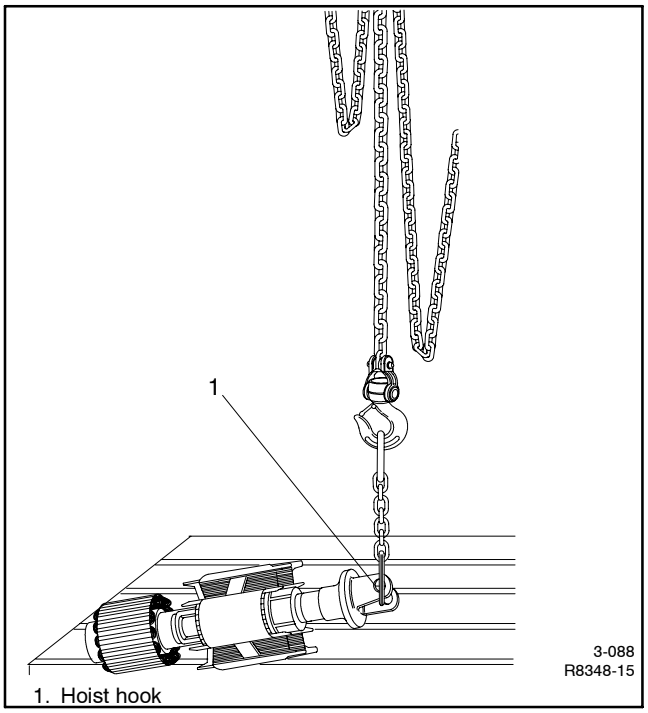


Figure 4-12 Supporting Alternator Assembly

10. Fasten the lifting eye and hoist hook to the rotor flange. See Figure 4-13. Hoist the rotor to a vertical position taking care not to damage windings, laminations, or bearing.



1. Hoist hook

Figure 4-13 Hoisting Rotor

11. Suspend the rotor over the alternator assembly. Lower the rotor into the stator. Be extremely careful while lowering the rotor to avoid damaging the exciter field assembly, stator windings, or rotor laminations. See Figure 4-14. Carefully align rotor bearing into end bracket.
12. Place the fan over the rotor flange and the torque bolts to specifications.
13. Align the individual drive disks with the hex holes together and with the hole burr sides facing the same direction. Temporarily place two alignment pins (not supplied) or bolts in the outer holes at opposite ends and 90° from the hex hole before installing the drive disk to the rotor shaft. The pins help maintain concentric alignment of the individual drive disks during installation. See Figure 4-15.

    Note: The user-supplied pins should be no smaller than 0.025 mm (0.001 in.) of the disc hole diameter.

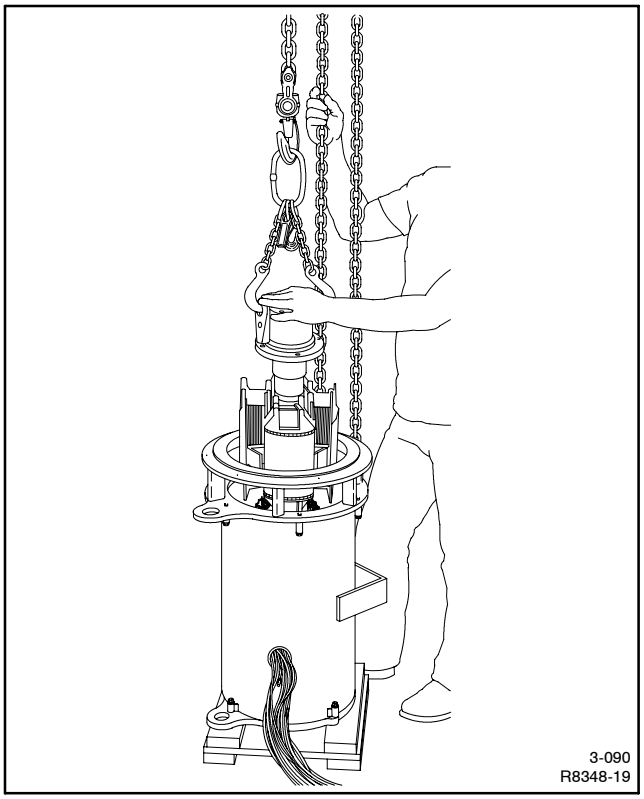
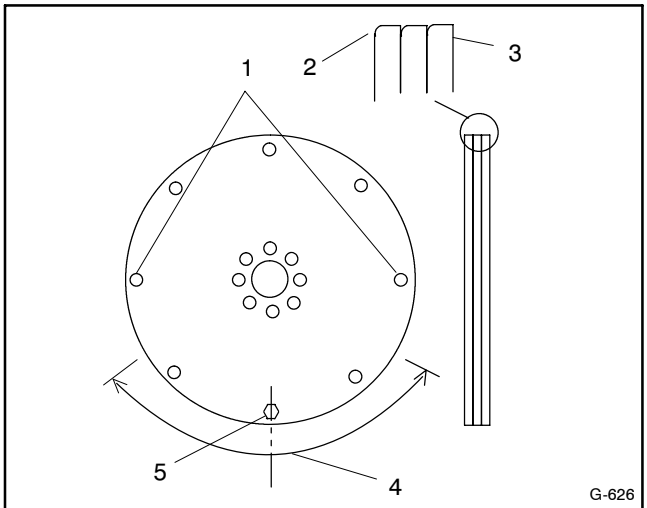


Figure 4-14 Installing Rotor



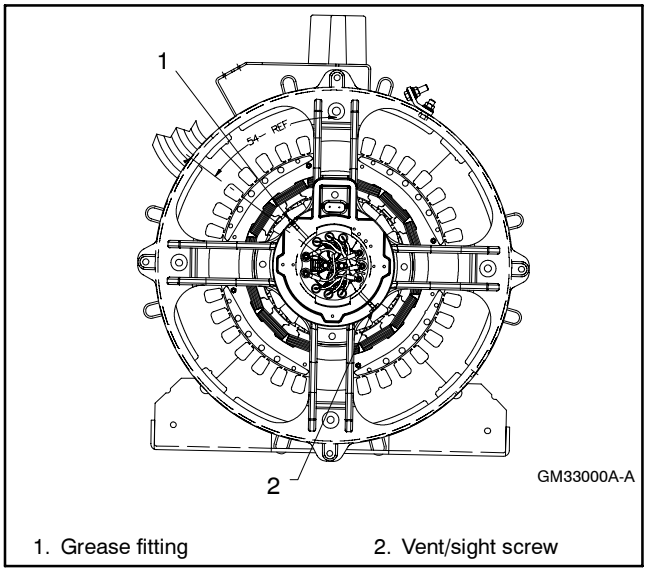
1. Install alignment pins or bolts here
2. Rolled corner
3. Burr side
4. 120° total; position drive disk hex hole at the stator bottom position or within 60° CW or CCW from the stator bottom position
5. Hex hole

Figure 4-15 Aligning and Mounting Drive Disks

14. Attach the drive disc(s) to end of rotor shaft with the hole burr side toward the alternator fan and with the hex hole at the stator bottom position or within 60° clockwise (CW) or counterclockwise (CCW) of the bottom position as viewed when the stator is installed on the skid. Torque the drive disc(s) mounting bolts to specifications. Remove the two alignment pins or bolts.

15. Attach a hoist to the adapter eye and place the alternator assembly in a horizontal position. Take care not to damage the rotor or stator. Place the hoisting eyes of the alternator to the top.

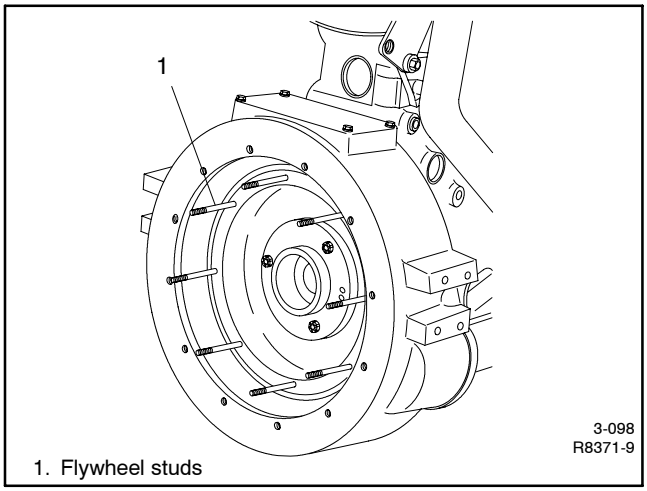
16. **UA alternator only.** Remove the vent/sight hole screw from the end bracket located 180° from the grease fitting. Use a grease gun and fill with Chevron SRI2 or equivalent lithium-based grease until the grease is visible at the vent/sight hole. Wipe excess grease from the end bracket. Replace the vent/sight hole screw and torque to specifications. See Figure 4-16.



1. Grease fitting
2. Vent/sight screw

Figure 4-16 Applying Grease to UA Alternator

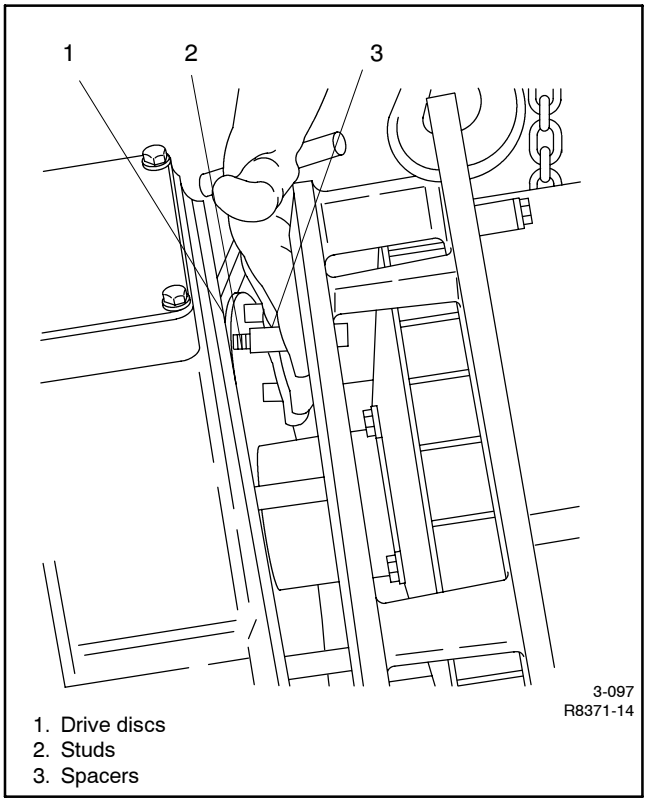
17. Apply Loctite® No. 271 red to stud threads and install into flywheel as shown in Figure 4-17. Install studs completely into flywheel. Apply Loctite® No. 242 blue to stud threads on nut side.



1. Flywheel studs

Figure 4-17 Flywheel Studs

18. Place hoist hooks into the end bracket and adapter eye. Raise the alternator assembly and align the studs with the drive discs by turning the flywheel. Move the alternator as necessary to work the drive discs over the studs. When the drive discs are about 25 mm (1 in.) over studs, install spacers if so equipped. See Figure 4-18.



1. Drive discs
2. Studs
3. Spacers

Figure 4-18 Installing Spacers

Loctite® is a registered trademark of Loctite Corporation.

19. Move the alternator as necessary to align the adapter and the flywheel housing. Fasten and final tighten the adapter to the flywheel housing using bolts and hardened lock washers. See Figure 4-19. Torque the bolts to specifications.

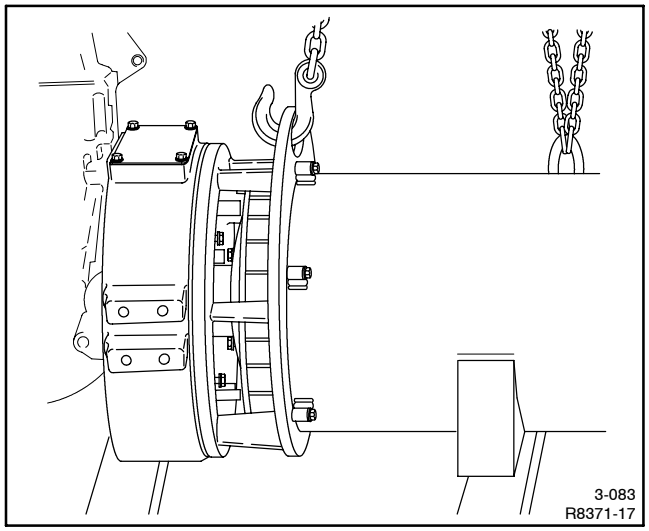


Figure 4-19 Aligning Adapter to Flywheel Housing

20. Install the hardware attaching the drive discs to the flywheel. Do not final tighten at this time.

    Note: Some applications use hardened washers. Do not substitute with non-hardened washers.

21. Hoist the alternator and engine slightly to remove the wood block(s) from under the flywheel housing. Align the alternator assembly and the skid. Lower the alternator and tighten the vibromount mounting bolts.

22. Remove the chains or slings from the alternator. Final tighten the drive discs to the flywheel. Torque the hardware to specifications.

23. Mount the rotating rectifier assembly hub and magnetic actuator to the rotor shaft using two screws. Torque to specifications.

24. Replace the diode assembly plates and varistor if removed. The diode assembly plates are color coded. The positive diode assembly is blue and the negative diode assembly is red. See Figure 4-20.

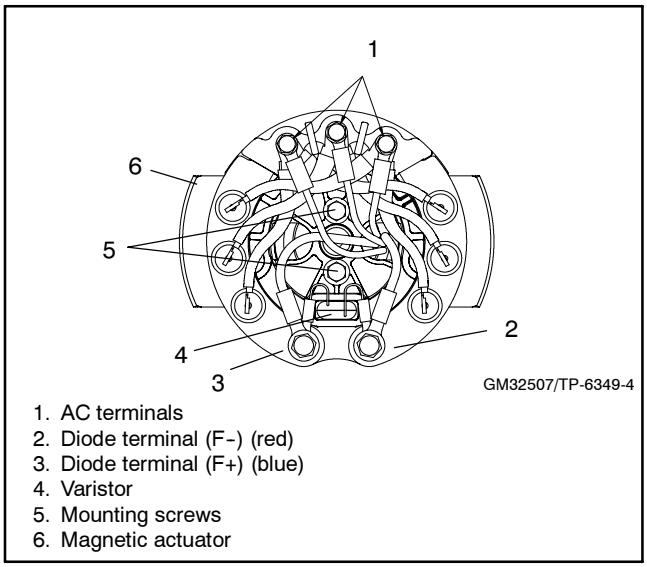


Figure 4-20 Rotating Rectifier Assembly Hub and Components

25. Reconnect the wiring to the three AC terminals and F+/F- terminals of the rotating rectifier assembly hub. See Figure 4-21. Torque to specifications.

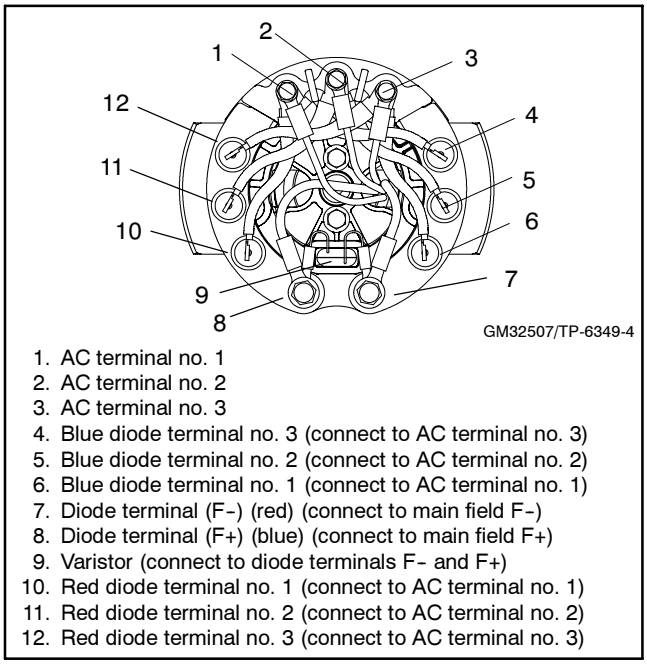
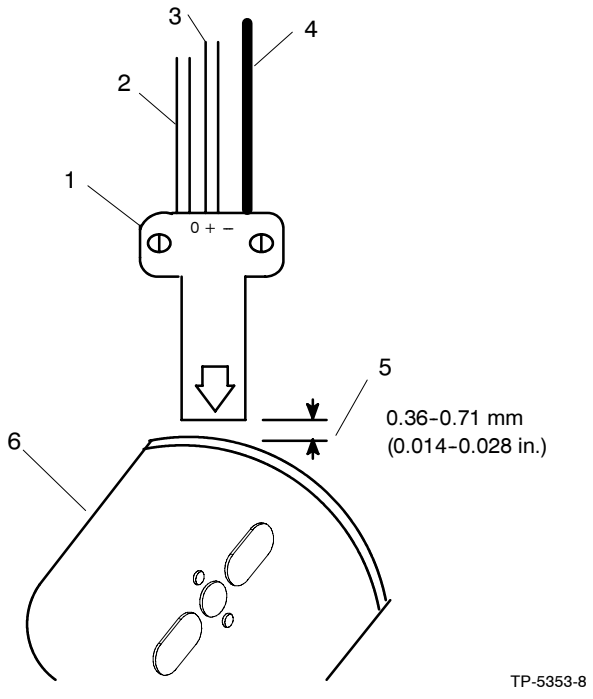


Figure 4-21 Rotating Rectifier Assembly Hub Electrical Connections

26. Attach the speed sensor to the end bracket using two screws. Adjust the air gap. See Figure 4-22.



1. Speed sensor
2. Wire 16: white/clear
3. Wire 24: red
4. Wire 2: black
5. Air Gap: 0.36–0.71 mm (0.014–0.028 in.)
6. Magnetic actuator

Figure 4-22 Speed Sensor Air Gap

27. Replace the alternator (rodent) guard on the end bracket (if equipped).

28. Replace the rotating rectifier assembly housing.

29. Install the fan guard.

30. Reinstall the junction box and controller.

31. Reconnect all controller-to-engine and engine-to-alternator harnesses and wiring. Reconnect the speed sensor wiring. Refer to the respective wiring diagram manual as required.

32. Replace the junction box panels.

33. Reconnect the fuel, cooling, and exhaust systems that were disconnected during disassembly. Reconnect the output leads or load circuit cables at the alternator. Open the fuel supply valve.

34. Reconnect the starting batteries, negative lead last. Connect any AC-powered accessories such as the battery charger, block heater, fuel transfer pump, etc.

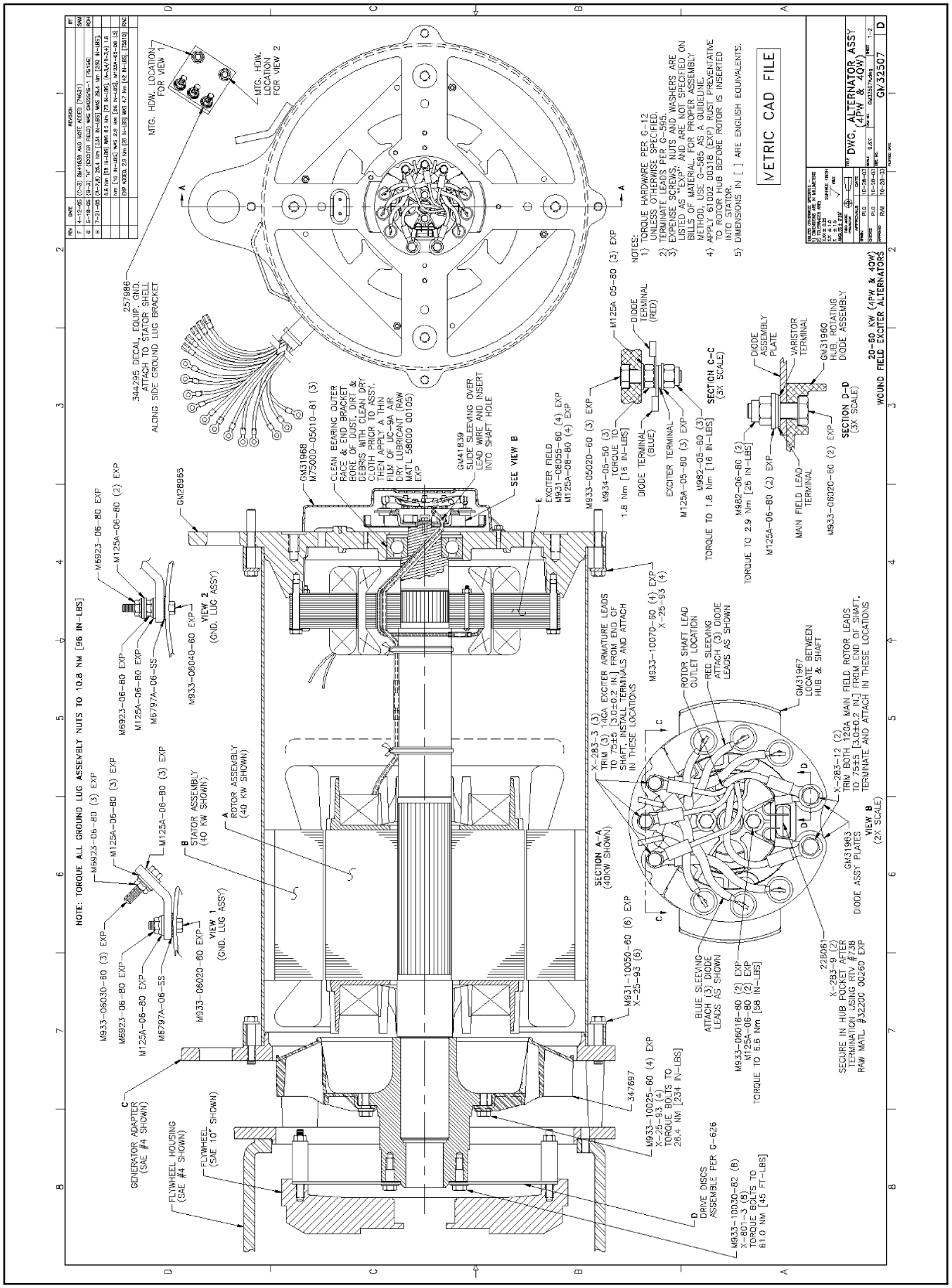


Figure 4-23 4PW and 4QW Alternator Components, 20–60 kW

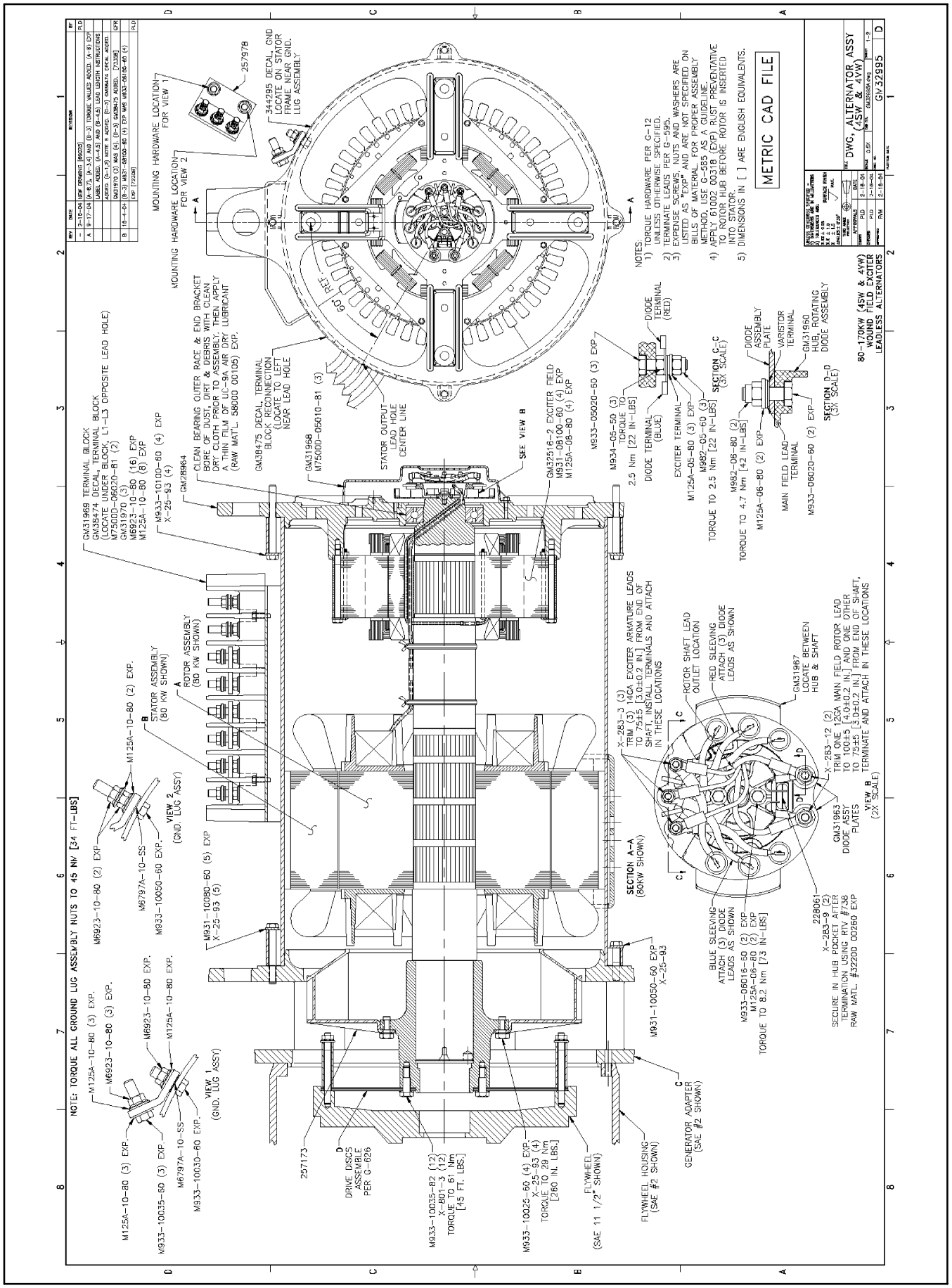


Figure 4-24 4SW and 4VW Alternator Components, 60 kW IMS–170 kW

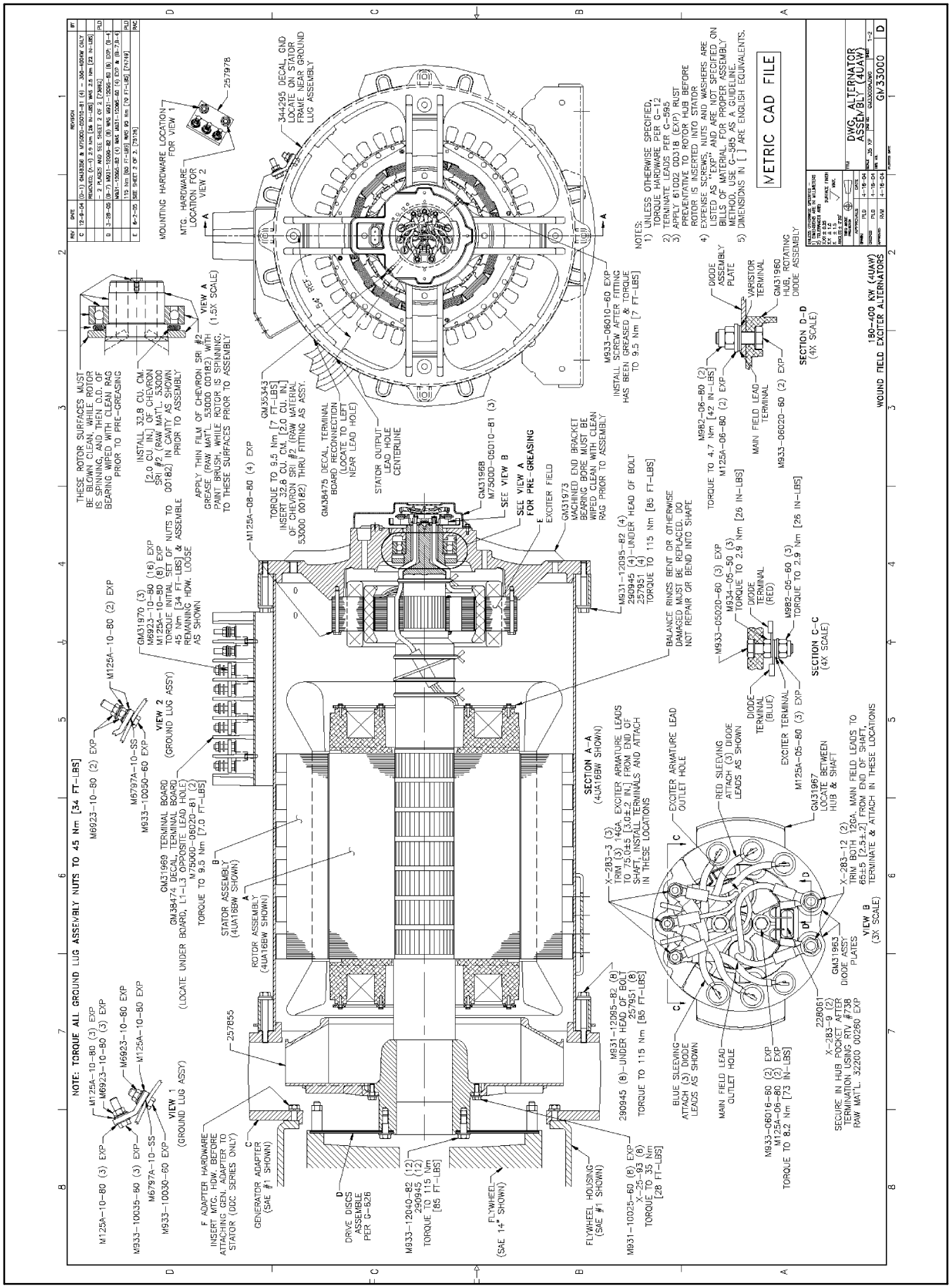


Figure 4-25 4UAW Alternator Components, 180–300 kW

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
cert.	certificate, certification, certified
cfh	cubic feet per hour
cfm	cubic feet per minute
CG	center of gravity
CID	cubic inch displacement
CL	centerline
cm	centimeter
CMOS	complementary metal oxide substrate (semiconductor)
cogen.	cogeneration
com	communications (port)
coml	commercial
Coml/Rec	Commercial/Recreational
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. lb.	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, high engine 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. lb.	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, quarts
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
RDO	relay driver output
ref.	reference
rem.	remote
Res/Coml	Residential/Commercial
RFI	radio frequency interference
RH	round head
RHM	round head machine (screw)
rly.	relay
rms	root mean square
rnd.	round
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 Appendix C, General Torque Specifications, and other torque specifications in the service literature.

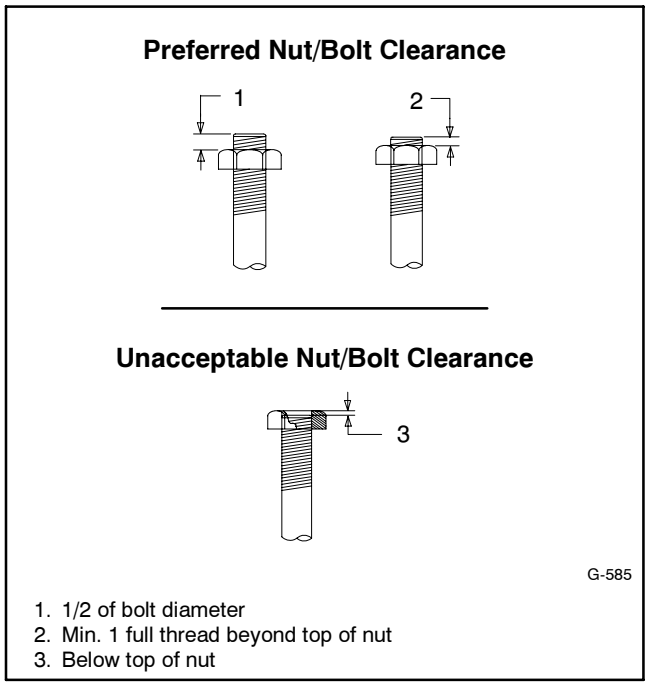


Figure 1 Acceptable Bolt Lengths

Steps for common hardware application:

1. Determine entry hole type: round or slotted.

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

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

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

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

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

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

4. Refer to Figure 2, which depicts the preceding hardware configuration possibilities.

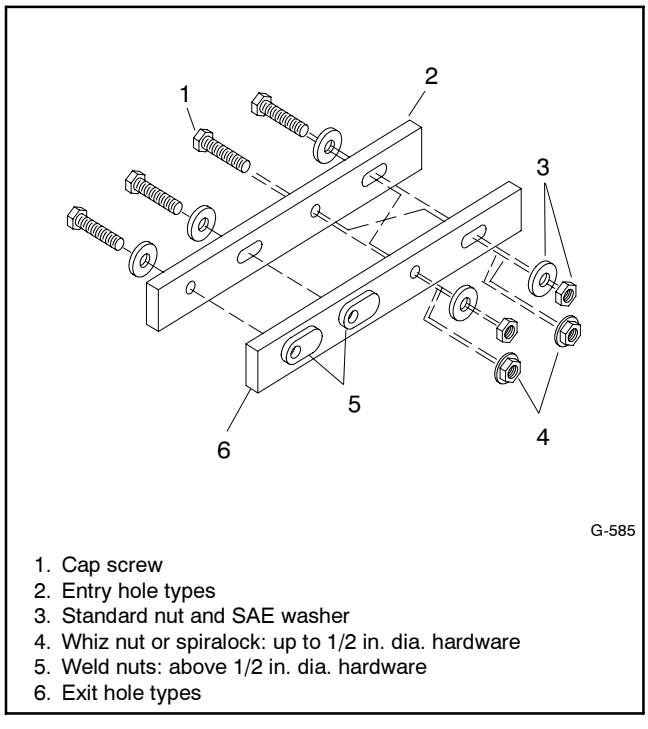


Figure 2 Acceptable Hardware Combinations

Appendix C General Torque Specifications

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

Metric Fasteners Torque Specifications, Measured in Nm (ft. lb.)								
Size (mm)	Assembled into Cast Iron or Steel						Assembled into Aluminum Grade 5.8 or 8.8
	Grade 5.8		Grade 8.8		Grade 10.9		
M6 x 1.00	6.2	(4.6)	9.5	(7)	13.6	(10)	See Note 3
M8 x 1.25	15.0	(11)	23.0	(17)	33.0	(24)	
M8 x 1.00	16.0	(11)	24.0	(18)	34.0	(25)	
M10 x 1.50	30.0	(22)	45.0	(34)	65.0	(48)	
M10 x 1.25	31.0	(23)	47.0	(35)	68.0	(50)	
M12 x 1.75	53.0	(39)	80.0	(59)	115.0	(85)	
M12 x 1.50	56.0	(41)	85.0	(63)	122.0	(90)	
M14 x 2.00	83.0	(61)	126.0	(93)	180.0	(133)	
M14 x 1.50	87.0	(64)	133.0	(98)	190.0	(140)	
M16 x 2.00	127.0	(94)	194.0	(143)	278.0	(205)	
M16 x 1.50	132.0	(97)	201.0	(148)	287.0	(212)	
M18 x 2.50	179.0	(132)	273.0	(201)	390.0	(288)	
M18 x 1.50	189.0	(140)	289.0	(213)	413.0	(305)	
M20 x 2.50	245.0	(181)	374.0	(276)	535.0	(395)	
M20 x 1.50	264.0	(195)	402.0	(297)	576.0	(425)	
M22 x 2.50	332.0	(245)	507.0	(374)	725.0	(535)	
M22 x 1.50	351.0	(259)	535.0	(395)	766.0	(565)	
M24 x 3.00	425.0	(314)	649.0	(479)	928.0	(685)	
M24 x 2.00	447.0	(330)	682.0	(503)	976.0	(720)	

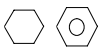
Notes:

1. Do not use these values when the torque values are specified on the assembly drawing.
2. These values are based on new plates threads. Increase values by 15% if non-plated threads are used.
3. Hardware threaded into aluminum must have two diameters of thread engagement or may require 30% or more reduction in the torque.
4. Torques are calculated as equivalent stress loading to American hardware and approximately a preload of 90% of yield strength and friction coefficient of 0.125.

Appendix D Common Hardware Identification

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

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

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

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

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

Sample Dimensions

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

1/4-20 x 1

- 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

Notes

Notes

Notes

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605 North 8th Street, Suite 501
Sheboygan, Wisconsin 53081 USA
Phone 920-451-0846, Fax 920-451-0843
ddcmtupowergeneration.com

MP-6349 9/05a