Service

Marine Generator Sets

Models:

40–180EOZD
33–150EFOZD

Controllers:

Decision-Maker™ 1

Decision-Maker™ 3+

Decision-Maker™ 550
Software (Code) Version 2.10 or higher

ISO 9001
KOHLER POWER SYSTEMS
NATIONALLY REGISTERED

KOHLER®
POWER SYSTEMS

TP-6442 7/07

Product Identification Information

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

Generator Set Identification Numbers

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

Model Designation _____

Specification Number _____

Serial Number _____

Accessory Number	Accessory Description

Engine Identification

Record the product identification information from the engine nameplate.

Manufacturer _____

Model Designation _____

Serial Number _____

x:in:007:001

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

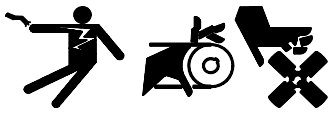
NOTICE

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

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

Accidental Starting

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

Engine Backfire/Flash Fire

⚠ WARNING

Fire.
Can cause severe injury or death.

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

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

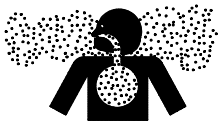
Servicing the air cleaner. A sudden backfire can cause severe injury or death. Do not operate the generator set with the air cleaner/silencer removed.

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

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

Exhaust System

⚠ WARNING



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

The exhaust system must be leakproof and routinely inspected.

Carbon monoxide symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas present in exhaust gases. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Carbon monoxide poisoning symptoms include but are not limited to the following:

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

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

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

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

Fuel System

⚠ WARNING

Explosive fuel vapors.
Can cause severe injury or death.

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

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

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

Hazardous Noise

⚠ CAUTION

Hazardous noise.
Can cause hearing loss.

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

Hazardous Voltage/ Moving Parts

⚠ WARNING

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

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

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

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

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

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

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

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

Hot Parts

⚠ WARNING

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

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

Notice

NOTICE

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

NOTICE

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

Notes

This manual provides troubleshooting and repair instructions for the following model generator sets:

40EOZD/33EFOZD,
55EOZD/40EFOZD,
65EOZD/50EFOZD,
80EOZD/70EFOZD,
99EOZD/80EFOZD,
125EOZD/100EFOZD,
150EOZD/125EFOZD, and
180EOZD/150EFOZD

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

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

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

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

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Tech Tools

Use your SecurID to access the KOHLERnet and click on the TechTools button to find the following topics:

- **Software** used by generator set controllers including updates and documentation references.
- **Network Communications** provides basics to terms, protocols, standards, wiring, configurations, and model.
- **Engine Electronic Control Module (ECM)** has information about electronic devices provided by the engine manufacturer to manage engine data.

Service Assistance

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

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

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(91) 80 3366231
Fax: (91) 80 3315972

Japan, Korea
North Asia Regional Office
Tokyo, Japan
Phone: (813) 3440-4515
Fax: (813) 3440-2727

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

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 permanent magnet alternator is identified with one of the following prefix designations: 4P, 4S, or 4UA. Example: Gen. Model 4S11. The letter W *does not* appear in permanent magnet alternator model designations.

The generator set is a rotating-field alternator with a smaller rotating-armature alternator turned by a common shaft. The main rotating-field alternator supplies current to load circuits while the rotating-armature (exciter) alternator supplies DC to excite the main alternator's field.

The generator set is a 4-pole, rotating-field with brushless, permanent magnet (PM) alternator excitation system. The PM system provides short-circuit excitation current up to 300% at 60 Hz (approximately 275% at 50 Hz) for a minimum of 10 seconds to allow selective circuit breaker tripping.

Solid state voltage regulator is PM powered, maintenance free, and encapsulated for moisture protection. The voltage regulator provides ±1/2%, no load to full load voltage regulation, adjustable volts/Hz, underspeed protection, 3-phase RMS sensing, and over excitation protection as standard.

1.2 Permanent Magnet Alternator Concept

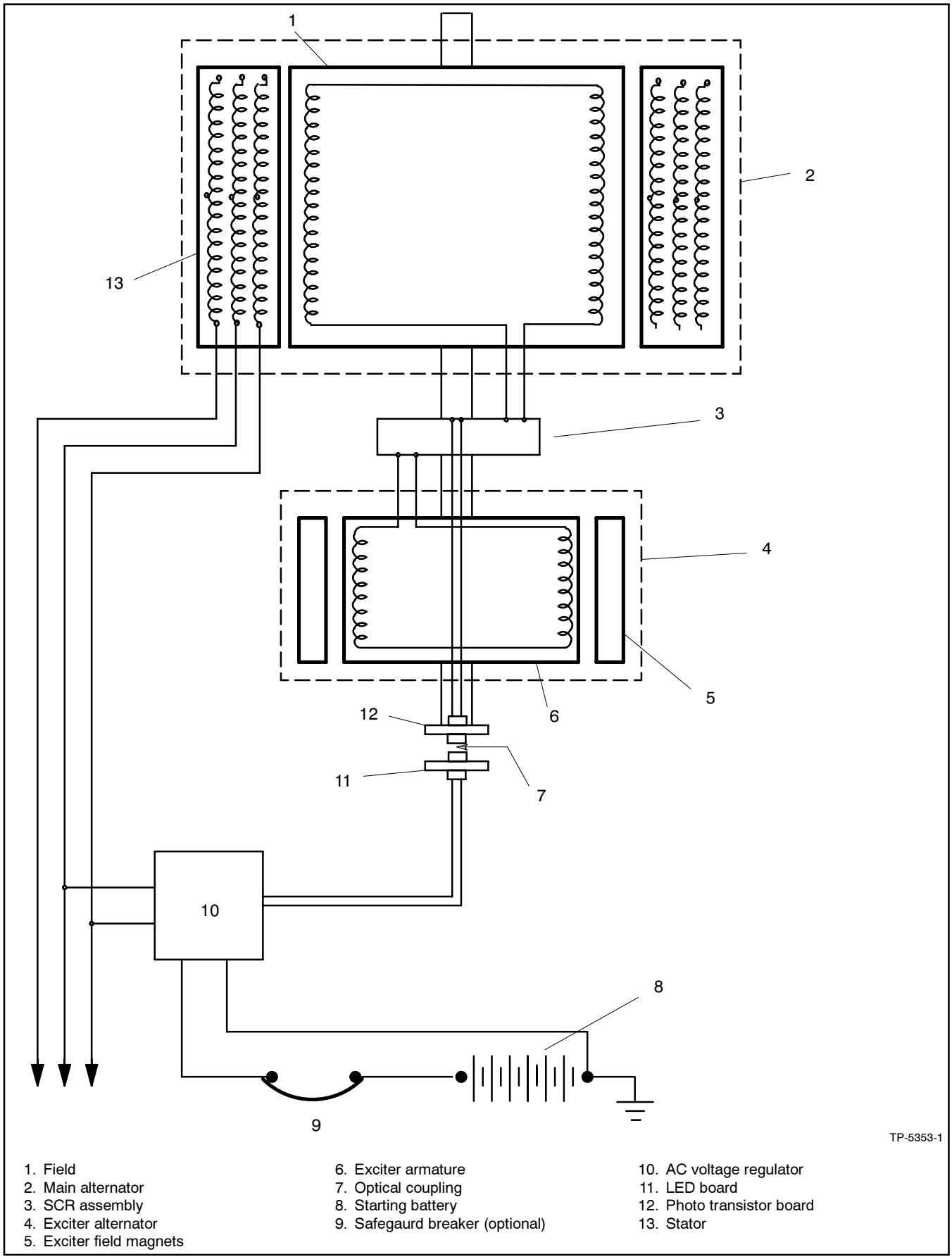
The alternator excitation system uses a permanent magnet exciter with a silicon controlled rectifier (SCR) assembly which controls the amount of DC current fed to the alternator field. This type of system uses a voltage regulator which signals the SCR assembly through an optical coupling. The voltage regulator monitors engine speed and alternator output voltage to turn a stationary light emitting diode (LED) on or off, according to engine speed and output voltage. The LED is mounted on the end bracket opposite a photo transistor board which rotates on the shaft. The photo transistor picks up the signal from the LED and tells the SCR assembly to turn on or off, depending upon the need, as dictated by the voltage regulator. See Figure 1-1.

The voltage recovery period of this type of alternator is several times faster than the conventionally wound field brushless alternator because it does not have to contend with the inductance of the exciter field. It also has better recovery characteristics than the static excited machine because it is not dependent upon the generator set output voltage for excitation power. Possibly the greatest advantage of this type machine is its inherent ability to support short-circuit current and allow system coordination for tripping downstream branch circuit breakers.

The generator set systems deliver exciter current to the main field within 0.05 seconds of a change in load demand.

1.3 Short Circuit Performance

When a short circuit occurs in the load circuit(s) being served, output voltage drops and amperage momentarily rises to 600%–1000% of the generator set's rated current until the short is removed. The SCR assembly sends full exciter power to the main field. The alternator then sustains up to 300% of its rated current. Sustained high current will cause correspondingly rated load circuit fuses/breakers to trip. The safeguard breaker kit serves to collapse the generator set's main field in the event of a sustained heavy overload or short circuit.



1. Field
2. Main alternator
3. SCR assembly
4. Exciter alternator
5. Exciter field magnets
6. Exciter armature
7. Optical coupling
8. Starting battery
9. Safegaurd breaker (optional)
10. AC voltage regulator
11. LED board
12. Photo transistor board
13. Stator

Figure 1-1 Alternator Schematic

1.4 Electrical Values

Component Specification	Value	Model
Alternator field resistance (F+/ F–)	2.7 ohms	40EOZD/33EFOZD
	1.9 ohms	55EOZD/40EFOZD 65EOZD/50EFOZD
	2.21 ohms	80EOZD/70EFOZD
	1.6 ohms	99EOZD/80EFOZD 125EOZD/100EFOZD
	1.79 ohms	150EOZD/125EFOZD
	1.44 ohms	180EOZD/150EFOZD
Exciter armature resistance	0.11 ohms	40EOZD/33EFOZD
	0.47 ohms	55EOZD/40EFOZD 65EOZD/50EFOZD
		80EOZD/70EFOZD
		99EOZD/80EFOZD 125EOZD/100EFOZD
		150EOZD/125EFOZD
	0.34 ohms	180EOZD/150EFOZD
End bracket to bearing outer race clearance	6.35 mm (0.25 in.)	40–180EOZD 33–150EFOZD *
Speed sensor air gap	0.36–0.71 mm (0.014–0.028 in.)	
Speed sensor voltage	2 (black) & 16 (white) 3–6 volts DC 2 (black) & 24 (red) 8–10 volts DC	

* The speed sensor on the Fast-Response™ alternator is only equipped on the 40EOZD/33EFOZD with a Decision-Maker™ 3+ Controller while being equipped on all units equipped with a Decision-Maker™ 1 controller. The ECU-equipped units get the speed signal from the engine (the speed sensor is not equipped on the alternator).

1.5 Torque Values

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

Component Specification	Torque Value	Model
Ground lug assembly nuts	45 Nm (34 ft. lb.)	40–180EOZD 33–150EFOZD
SCR assembly terminal nuts	0.9 Nm (8 in. lb.)	
SCR assembly mounting bolts	0.9 Nm (8 in. lb.)	
Fan to rotor flange bolts	29 Nm (260 in. lb.)	
End bracket to stator bolts	47 Nm (35 ft. lb.)	
Drive disks to rotor shaft bolts	68 Nm (50 ft. lb.)	
End bracket grease fitting	9.5 Nm (7 ft. lb.)	180EOZD 150EFOZD
End bracket grease vent screw	9.5 Nm (7 ft. lb.)	
Photo transistor circuit board, insulator, & magnetic actuator to rotor shaft screws	4.7 Nm (42 in. lb.)	40–180EOZD 33–150EFOZD
Alternator adapter to flywheel housing bolts	See chart following	
Drive discs to flywheel bolts	See chart following	

1.6 Alternator Adapter to Flywheel Housing Torque Values

Model	Engine	Alternator	Hardware Type,	Torque, Nm (ft. lb.)	Hardware Sequence
40 kW	John Deere	4P	3/8-16, grade 8 bolt	53 (39)	Bolt, hardened washer
			M10, grade 10.9 bolt		
55-150 kW		4S	3/8-16, grade 8 bolt	53 (39)	
			7/16-14, grade 8 bolt	60 (44)	
			M10, grade 10.9 bolt	65 (48)	
180 kW		4UA	3/8-16 grade 8 bolt	53 (39)	
			7/16-14, grade 8 bolt	85 (63)	
			M10, grade 10.9 bolt	65 (48)	

1.7 Drive Discs to Flywheel Torque Values

Model	Engine	Alt.	Hardware Type	Torque, Nm (ft. lb.)	Hardware Sequence
40 kW	John Deere	4P	3/8-16, grade 8 stud	53 (39)	Stud, spacer, hardened washer, grade 8 nut
55-150 kW		4S	3/8-16, grade 8 stud	53 (39)	Stud, spacer, hardened washer, nut
180 kW		4UA	1/2-13, grade 8 bolt	130 (96)	Bolt, hardened washer

1.8 Introduction

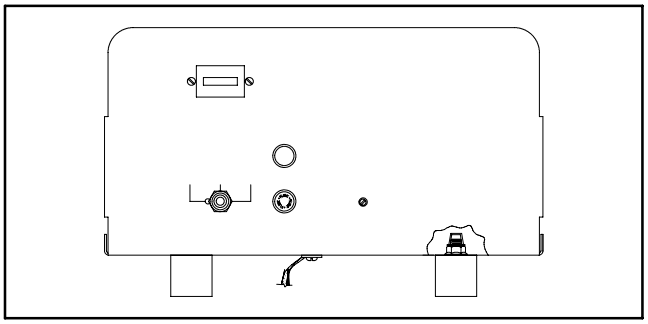
This service manual provides controller and accessory troubleshooting and repair information for the following controllers:

- Decision-Maker™ 1
- Decision-Maker™ 3+
- Decision-Maker™ 550

The following illustrations identify each of the controllers. The controller specification sheets provide features and specifications for each controller.

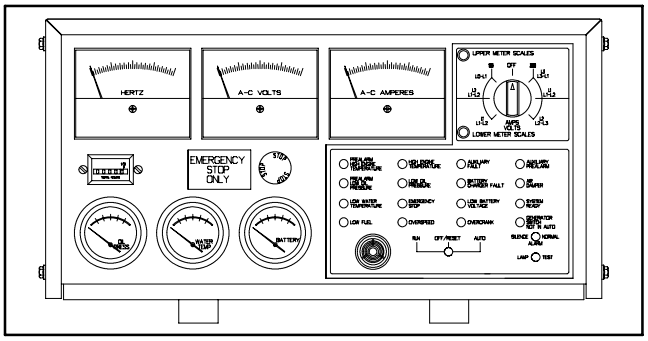
1.9 Controller Identification

1.9.1 Decision-Maker™ 1



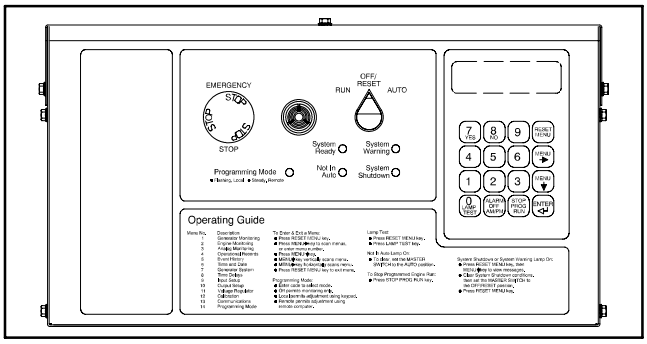
- Single-light annunciation and basic controls.
- Relay logic.
- 12- or 24-volt engine electrical system capability.
- Remote or automatic start options.

1.9.2 Decision-Maker™ 3+, 16-Light



- Audiovisual annunciation.
- Microprocessor logic, AC meters, and engine gauge features.
- 12- or 24-volt engine electrical system capability.
- Remote start, prime power, and remote annunciation options.

1.9.3 Decision-Maker™ 550



- Audiovisual annunciation.
- Programmable microprocessor logic and digital display features.
- Alternator safeguard circuit protection.
- 12- or 24-volt engine electrical system capability.
- Remote start, remote annunciation, and remote communication options.

1.10 Low Seawater Pressure Switch (All Models)

Switch P/N	Value
GM30263	0.5 ±0.3 psi

1.11 Exhaust Temperature Switch (All Models)

Switch P/N	Isolated Ground	Close	Open
249872	No	102°C ± 15°C (215°F ± 5°F)	88°C ± 15°C (190°F ± 10°F)
GM19189	Yes	102°C ± 15°C (215°F ± 5°F)	88°C ± 15°C (190°F ± 10°F)

1.12 Oil Pressure Sender

Decision-Maker™ 3+

Sender P/N	Isolated Ground	Value A	Value B	Value C
264390	No	240 +17 -15 ohms at 0 psi	153 +12 -15 ohms at 25 psi	33.5 ohms at 100 psi
GM29290	Yes	10-180 ohms		

Decision-Maker™ 550

Sender P/N	Input Pressure Range	Proof Pressure (Min.)	Burst Pressure (Min)
GM16788	0-1034 kPa (0-150 psi)	3103 kPa (450 psi)	5171 kPa (750 psi)

1.13 Coolant Temperature Sender

Decision-Maker™ 3+

Sender P/N	Value A	Value B
GM39458	123.8+7.2 -7.8 ohms at 195°F	35.6+3.4 -3.6 ohms at 280°F

Decision-Maker™ 550

Sender P/N	Output Range	Operating Supply Voltage
GM31045-1	10°C-140°C (50°F-284°F)	4-30 VDC

1.14 Water Temperature Sender

Decision-Maker™ 3+

Sender P/N	Isolated Ground	Value A	Value B
268298	No	180 ±22 ohms at 130°F	71 ± ≐ ohms at 180°F
GM47208	Yes	287.4 -22.7 ohms at 250°F	

1.15 Low Oil Pressure Switch

Decision-Maker™ 1 and Decision-Maker™ 3+

Switch P/N	Isolated Ground	Value
328309	No	15 ±2 psi
253323	Yes	15 ±3 psi

1.16 High Coolant Temperature Switch

Decision-Maker™ 1 and Decision-Maker™ 3+

Sensor P/N	Isolated Ground	Epoxy Color	Value A
241481	No	Olive	Normally open-to close on temp. rise of 103°C ±4°C (218°F ±7°F)
GM29288	Yes		Normally open-to close on temp. rise of 103°C ±4°C (218°F ±7°F)

1.17 550 Controller Voltage Regulator

1.17.1 Features

- A digital display and keypad provide access to data. A 2-line vacuum fluorescent display provides complete and concise information.
- The controller provides an interface between the generator set and switchgear for paralleling applications incorporating multiple generator set and/or utility feeds.
- The controller can communicate with a personal computer directly or on a network.
- Using optional menu-driven, Windows®-based PC software, an operator can monitor engine and alternator parameters and also provide control capability.
- The controller supports Modbus® RTU (Remote Terminal Unit), an industry standard open communication protocol.

Modbus® is a registered trademark of Schneider Electric.
Windows® is a registered trademark of Microsoft Corporation.

1.17.2 Specifications

Specification/Feature	Voltage Regulator Type Integral with 550 Controller
Generator Set Capability	40-180EOZD/33-150EFOZD
Type	Microprocessor based
Status and Shutdown Indicators	LEDs and Digital Display
Operating Temperature	-40°C to 70°C (-40°F to 158°F)
Storage Temperature	-40°C to 85°C (-40°F to 158°F)
Humidity	5-95% Non-Condensing
Circuit Protection	Solid-State, Redundant Software and Fuses
Sensing, Nominal	100-240 Volts (L-N), 50-60 Hz
Sensing Mode	RMS, Single- or 3-Phase
Input Requirements	8-36 VDC
Continuous Output	100 mA at 12 VDC
Maximum Output	100 mA at 12 VDC
Transition Frequency	50-70 Hz
Exciter Field Resistance	NA
No-Load to Full-Load Voltage Regulation	±0.25%
Thermal Drift	<0.5% (-40°C to 70°C range) [-40°F to 158°F]
Response Time	Less Than 5μS
Voltage Adjustment (of system voltage)	±10%
Voltage Adjustment	Controller Keypad
Remote Voltage Adjustment	Digital Input Standard/Analog 0-5 VDC Input Optional
Paralleling Capability	Reactive Droop Standard, VAR/PF Control
VAR/PF Control Input	Standard

DVR® is a registered trademark of Marathon Electric Mfg. Corp.
NA Data not available at time of print.

1.17.3 Calibrations

Calibration	Digital Display	Range Setting	Default Selection
Voltage Adjustment	Volt Adj.	±10% of System Voltage	System Voltage
Amplifier Gain	Regulator Gain Adj.	1–10000	100%
Underfrequency Unload or Frequency Setpoint	Frequency Setpoint	30 to 70 Hz	1 Hz Below System Frequency (ECM) 2 Hz Below System Frequency (non-ECM)
Underfrequency Unload Slope	Slope	0–10% of Rated Voltage (volts per cycle)	15 Volts per Cycle at 480 Volts (3.1%)
Reactive Droop	Voltage Droop	0–10% of System Voltage	4% of System Voltage
VAR Control	kVAR Adj.	0 to Rated kVAR Generating 0 to 35% of Rated kVAR Absorbing	0 kVAR
PF Adjust Control	PF Adj.	0.7 to 1.0 Leading, 0.6 To 1.0 Lagging	0.8 Lagging
VAR/PF Gain Adjustment	VAR/PF Gain Adj.	1–10000	100%

Notes

2.1 Prestart Checklist

To ensure continued satisfactory operation perform the following checks or inspections before or at each startup, as designated, and at the intervals specified in the service schedule. In addition, some checks require verification after the unit starts.

Air Cleaner. Check for a clean and installed air cleaner element to prevent unfiltered air from entering the engine.

Air Inlets. Check for clean and unobstructed air inlets.

Air Shrouding. Check for securely installed and positioned air shrouding.

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

Coolant Level. Check the coolant level according to the cooling system maintenance information.

Drive Belts. Check the belt condition and tension of the water pump and battery charging alternator belt.

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

Inspect the exhaust system components (exhaust manifold, mixing elbow, exhaust line, hose clamps, silencer, and exhaust outlet) for cracks, leaks, and corrosion.

- Check the hoses for softness, cracks, leaks, or dents. Replace the hoses as needed.
- Check for corroded or broken metal parts and replace them as needed.
- Check for loose, corroded, or missing clamps. Tighten or replace the hose clamps as needed.
- Check that the exhaust outlet is unobstructed.
- Visually inspect for exhaust leaks *(blowby)*. Check for carbon or soot residue on exhaust components. Carbon and soot residue indicates an exhaust leak. Seal leaks as needed.
- Ensure that the carbon monoxide detector(s) is (1) in the craft, (2) functional, and (3) energized whenever the generator set operates.

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

Fuel Level. Check the fuel level and keep the tank(s) full to ensure adequate fuel supply.

Lamp Test. Press the lamp test button, if equipped to verify that all controller LEDs illuminate.

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

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

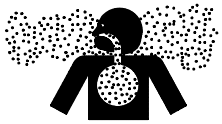
Seawater Pump Priming. Prime the seawater pump before initial startup. To prime the pump: (1) close the seacock, (2) remove the hose from the water-filter outlet, (3) fill the hose and seawater pump with clean water, (4) reconnect the hose to the water filter outlet, and (5) open the seacock. Confirm seawater pump operation on startup as indicated by water discharge from the exhaust outlet.

2.2 Marine Inspection

Kohler Co. recommends that all boat owners have their vessels inspected at the start of each boating season by the US Coast Guard, the local Coast Guard Auxiliary, or local state agency.

Kohler Co. also recommends having the generator's exhaust system inspected at the start of each boating season by an authorized Kohler® distributor/dealer. Repair any problems identified before operating the generator set.

⚠ WARNING



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

The exhaust system must be leakproof and routinely inspected.

2.3 Angular Operation

See Figure 2-1 for angular operation limits for units covered in this manual.

Model	Continuous	Intermittent— 3 minutes or less
40EOZD/33EFOZD	20°	30°
55EOZD/40EFOZD 65EOZD/50EFOZD	30°	45°
80EOZD/70EFOZD 99EOZD/80EFOZD	30°	35°
125EOZD/100EFOZD 150EOZD/125EFOZD 180EOZD/150EFOZD	20°	30°
Maximum value for all directions		

Figure 2-1 Angular Operation

2.4 Operation in European Union Member Countries

This generator set is specifically intended and approved for operation below the deck in the engine compartment. Operation above the deck and/or outdoors would constitute a violation of European Union Directive 2000/14/EC noise emission standard.

2.5 Load Profile

Whenever operating the generator set, Kohler Co. recommends maintaining the minimum load profile indicated in Figure 2-1. Maintaining the load profile prevents corrosion formation on internal engine components when they're exposed to the breakdown of exhaust gases. Extended light loading may result in engine "wet stacking."

Minimum Load Requirement	Ideal Load Requirement
30% load	70% load or more

Figure 2-2 Load Profile

Wet Stacking occurs when water vapor condenses in the exhaust system. At normal combustion temperatures, water stays vaporized but at low combustion temperatures, it condenses back to a liquid. When running the generator set under normal loads (30% load or more), diesel exhaust stays hot enough to prevent water vapor from condensing. At low load situations, wet stacking can occur.

The operator should perform all of the prestart checks. Start the generator set according to the starting procedure in the controller section of this manual. While the generator set is operating, listen for a smooth-running engine and visually inspect the generator set for fluid or exhaust leaks.

2.6 Decision-Maker™ 550 Controller Operation

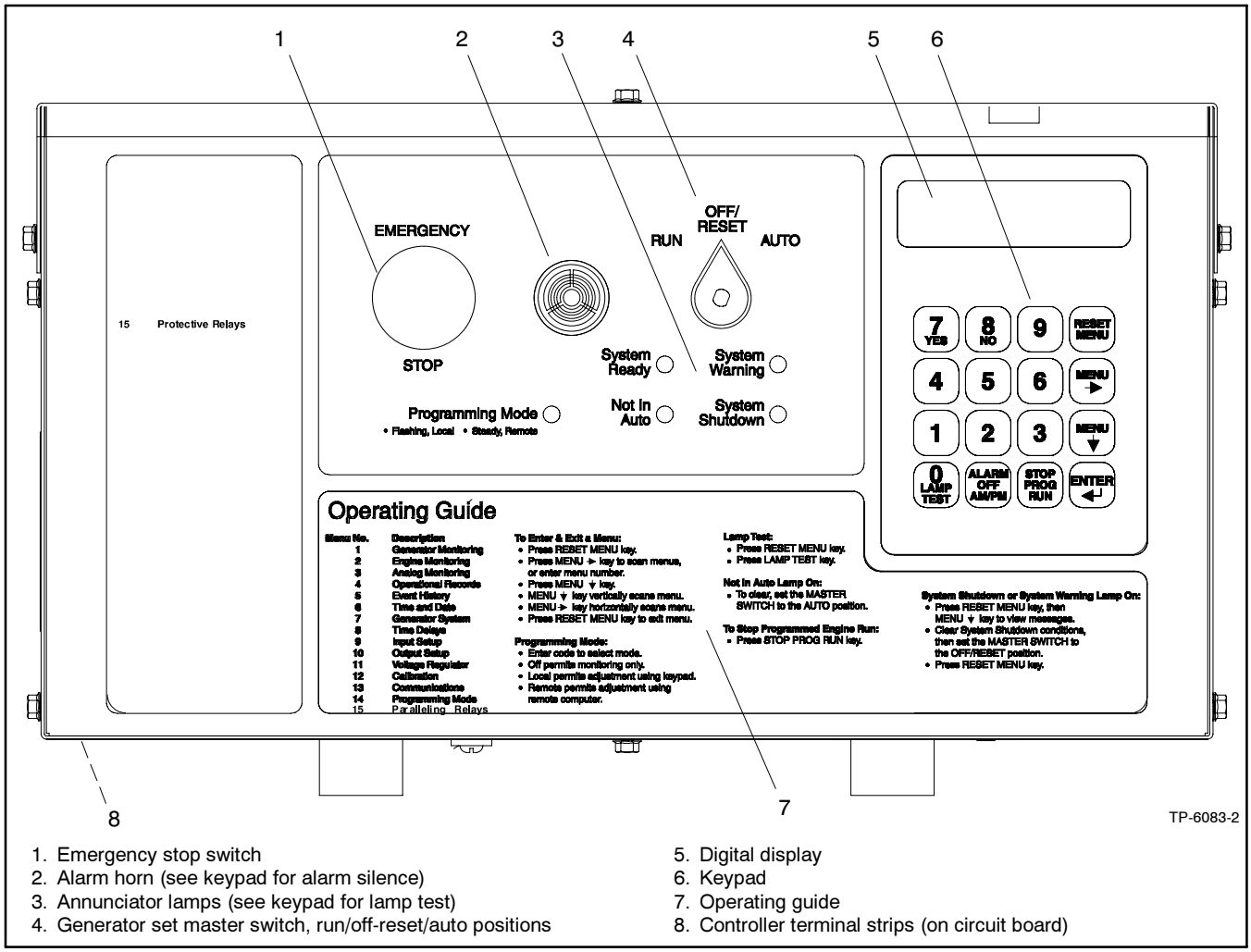
The controller features include the annunciator lamps, digital display and keypad, switches and controls, and fuses and terminal strip. The following paragraphs detail the features by general topics.

The controller features, accessories, and menu displays depend upon the engine electronic control module (ECM) setup and features. Controller features apply to generator set models with ECM and non-ECM engines unless otherwise noted.

Note: Press any key on the keypad to turn on the controller lights and display. The lights and display turn off 5 minutes after the last keypad entry.

Note: Measurements display in metric or English. Use Menu 7—Generator System to change the measurement display.

See Figure 2-3 for an illustration of the controller front panel.



1. Emergency stop switch
2. Alarm horn (see keypad for alarm silence)
3. Annunciator lamps (see keypad for lamp test)
4. Generator set master switch, run/off-reset/auto positions
5. Digital display
6. Keypad
7. Operating guide
8. Controller terminal strips (on circuit board)

Figure 2-3 550 Controller

2.6.1 Annunciator Lamps

Five annunciator lamps provide visual generator set status. See Figure 2-4.

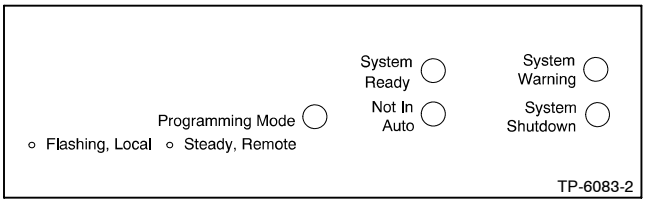


Figure 2-4 Annunciator Lamps

System Ready. Green lamp illuminates when the generator set master switch is in the AUTO (automatic start) position and the system senses no faults. The unit is ready to start.

Not in Auto (NIA). Yellow lamp illuminates when the generator set master switch is not in the AUTO (automatic start) position.

Programming Mode. Yellow programming lamp indicates the user selected programming mode. See Figure 2-5.

Programming Lamp	Programming Mode Selection
Lamp Flashing	Local Programming
Lamp Steady On	Remote Programming
Lamp Off	Programming Disabled

Figure 2-5 Programming Lamp Mode

System Warning. Yellow lamp identifies an existing fault condition that does not shut down the generator set. A continuing system warning fault condition may cause a system shutdown. Correct all system warnings as soon as practical.

See Section 2.7.8, System Warning Lamp, for definitions of the items listed.

The following conditions cause a system warning:

- Engine functions:
  - High battery voltage
  - High coolant temperature
  - Low battery voltage
  - Low coolant temperature
  - Low fuel (level or pressure)*
  - Low oil pressure
  - Speed sensor fault
  - Starting aid (system status)
  - Weak battery
- General functions:
  - Auxiliary—Analog up to 7 user selectable inputs each with a high and low programmable warning level
  - Auxiliary—Digital up to 21 user selectable warnings
  - Battery charger fault*
  - Emergency power system (EPS) supplying load
  - Engine cooldown delay
  - Engine start delay
  - Load shed kW overload
  - Load shed underfrequency
  - Master switch not in AUTO (automatic start) position
  - NFPA 110 fault (National Fire Protection Association)
  - System ready (system status)
- Alternator functions:
  - AC sensing loss
  - Ground fault*
  - Overcurrent

* Requires optional input sensors.

System Shutdown. Red lamp indicates that the generator set has shut down because of a fault condition. The unit will not start without resetting the controller, see Section 2.7.10, Controller Resetting.

See Section 2.7.9, System Shutdown Lamp, for definitions of the items listed.

The following conditions cause a system shutdown:

- Engine functions:
  - Air damper closed (status), if equipped
  - Coolant temperature signal loss
  - High coolant temperature
  - High oil temperature
  - Low coolant level
  - Low oil pressure
  - Oil pressure signal loss
  - Overcrank
  - Overspeed
- General functions:
  - Auxiliary—Analog up to 7 user selectable inputs each with a high and low programmable shutdown level
  - Auxiliary—Digital up to 21 user selectable shutdowns
  - ECM communications loss (ECM models only)
  - Emergency stop
  - Internal fault
  - Master switch in OFF/RESET position
  - Master switch error
  - Master switch open
  - NFPA 110 fault
- Alternator functions:
  - AC output overvoltage
  - AC output undervoltage
  - Alternator protection against overload and short circuits
  - Field overvoltage (M4, M5, or M7 alternator only)
  - Locked rotor (failed to crank)
  - Overfrequency
  - Underfrequency

2.6.2 Digital Display and Keypad

Figure 2-6 illustrates the digital display and keypad.

Note: Press any key on the keypad to turn on the controller lights and display. The lights and display turn off 5 minutes after the last keypad entry.

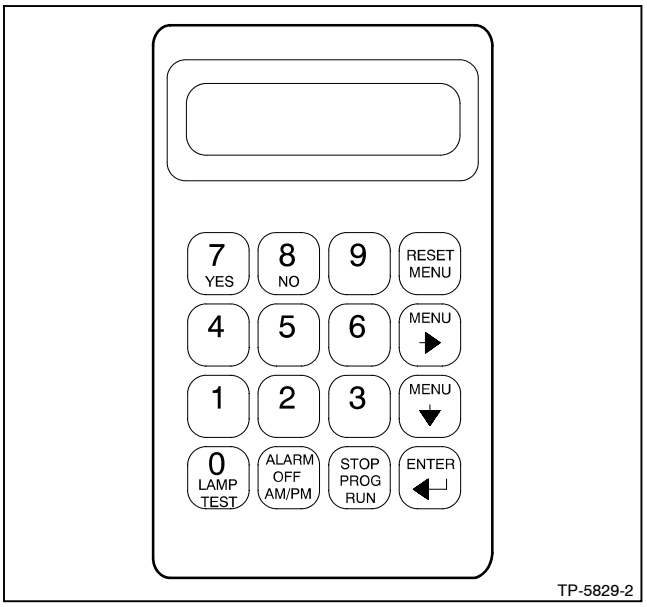


Figure 2-6 Digital Display and Keypad

The 2-line vacuum fluorescent display provides generator set and engine condition information.

The 16-button keypad gives the user information access and local programming capability.

Keypad Functions

Alarm (Horn) Off key silences the alarm horn at the operator's discretion. Place the generator set master switch in the AUTO position before silencing the alarm horn. See Section 2.7.10, Controller Resetting, and Section 2.6.3, Switches and Controls.

AM/PM key provides time of day data entries when programming.

Enter ↵ key provides confirmation entry when selecting menu or programming.

Lamp Test key tests the controller indicator lamps, horn, and digital display. See Section 2.6.3, Switches and Controls.

Menu down ↓ key provides navigation within menus when necessary.

Menu right → key provides navigation within menus when necessary.

Numeric 0–9 keys provide numeric data entries when selecting menus or programming.

Reset Menu key exits a menu, clears incorrect entries, and cancels the auto-scroll feature.

Stop Prog (Program) Run key allows the user to stop any previously programmed generator set run sequence. See Section 2.6.3, Switches and Controls.

Yes/No keys provides data answer entries when programming.

Alternator Output Displays

AC Amps displays the alternator output current. The display shows each line of 3-phase models.

AC Volts displays the alternator output voltages. The display shows all line-to-neutral and line-to-line voltage combinations.

Alternator Duty Level displays the actual load kW divided by the nameplate kW rating as a percentage.

Frequency displays the frequency (Hz) of alternator output voltage.

Hourmeter displays the generator set operating hours loaded and unloaded for reference in scheduling maintenance.

KVA displays the total and individual L1, L2, and L3 kVA.

KVAR displays the total and individual L1, L2, and L3 kVAR.

Power Factor displays the kW/kVA and the individual line power factor values.

Watts displays the total and individual L1, L2, and L3 kilowatts.

Engine Displays

Some engine displays are available with selected generator set engines using engine ECMs only. The controller display shows N/A (not available) for items that are unavailable. See the controller spec sheet for applicable generator set models.

Ambient Temperature displays the generator set area ambient temperature.

Coolant Level displays the engine coolant level.

Coolant Pressure displays the engine coolant pressure.

Coolant Temperature displays the engine coolant temperature.

Crankcase Pressure displays the engine crankcase pressure.

DC Volts displays the voltage of starting battery(ies).

Fuel Pressure displays the fuel supply pressure.

Fuel Rate displays the calculated fuel consumption rate based on fuel injector outputs.

Fuel Temperature displays the fuel supply temperature.

Oil Level displays the engine oil level as a percent of full capacity.

Oil Pressure displays the engine oil pressure.

Oil Temperature displays the engine oil temperature.

RPM (Tachometer) displays the engine speed.

Used Last Run displays the accumulated amount of fuel used since last reset by the DDC/MTU engine DDEC reader.

Operational Record Displays

The operational record displays events since last reset. See the operation manual for resetting procedure.

Engine Start Countdown displays the time remaining before the next generator set startup.

Event History displays up to 100 stored system events including status, warnings, and shutdowns.

Last Start Date displays the date when the generator set last operated.

Number of Starts displays the total number of generator set startup events.

Number of Starts (Since) Last Maintenance displays the total number of generator set startup events since the last maintenance date.

Operating Days (Since) Last Maintenance displays the total number of days of operation since the last maintenance date. A counted day of operation can be 1–24 hours.

Run Time displays the total loaded hours, total unloaded hours, and total kW hours.

Run Time Since Maintenance displays the total loaded hours, total unloaded hours, and total kW hours.

Time Delay Displays

The time delays are user adjustable. See the operation manual for time delay adjustments. See Section 2.7.1, Status Event and Fault Specifications, for range and default settings.

Crank On/**Crank Pause** displays the time allocated for generator set crank on and crank pause in minutes: seconds.

Engine Cooldown displays the time delay for engine cooldown while the master switch is in the AUTO or RUN positions and not in the idle mode.

Engine Start displays the time delay before the generator set starts while the master switch is in AUTO or RUN positions.

Overcrank Shutdown (Number of) Crank Cycles displays the number of unsuccessful crank cycles (crank on/crank pause) before the generator set shuts down on an overcrank fault.

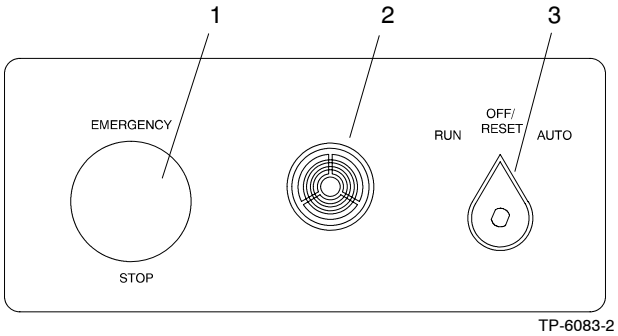
Overvoltage displays the time delay before the generator set shuts down because of an overvoltage condition.

Starting Aid displays the engine starting aid activation time.

Undervoltage displays the time delay before the generator set shuts down because of an undervoltage condition.

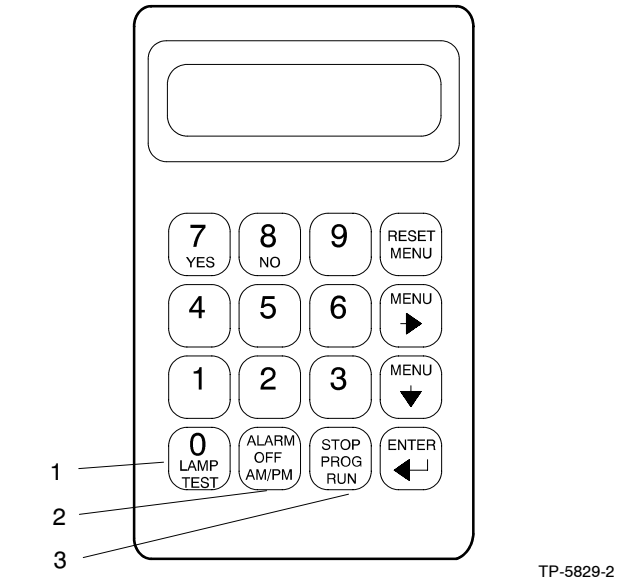
2.6.3 Switches and Controls

See Figure 2-7 and Figure 2-8 for switches and controls.



1. Emergency stop switch
2. Alarm horn
3. Generator set master switch

Figure 2-7 Switches and Alarm Horn



1. Lamp test
2. Alarm horn silence
3. Stop program run

Figure 2-8 Keypad Switches

Alarm Horn. The alarm horn alerts the operator or other attendants that a shutdown or warning condition exists. See Section 2.7, Decision-Maker™ 550 Controller Logic Specifications, for conditions. Place the generator set master switch in the AUTO position before silencing the alarm horn. The alarm horn cannot be silenced unless the generator set master switch is in the AUTO position. See Section 2.7.10, Controller Resetting.

Alarm (Horn) Off. The keypad switch silences the alarm horn at the operator's discretion. Place the generator set master switch in the AUTO position before silencing the alarm horn. Restore alarm horn switches at all locations including those on remote annunciator and audiovisual alarm kits to the normal position after correcting the fault shutdown to avoid reactivating the alarm horn. See Section 2.7.10, Controller Resetting.

AM/PM. This keypad switch provides time of day data entries when programming.

Emergency Stop. The operator-activated pushbutton immediately shuts down the generator set in emergency situations. Reset the emergency stop switch after shutdown by pulling the switch knob outward. *Use the emergency stop switch for emergency shutdowns only.* Use the generator set master switch for normal shutdowns.

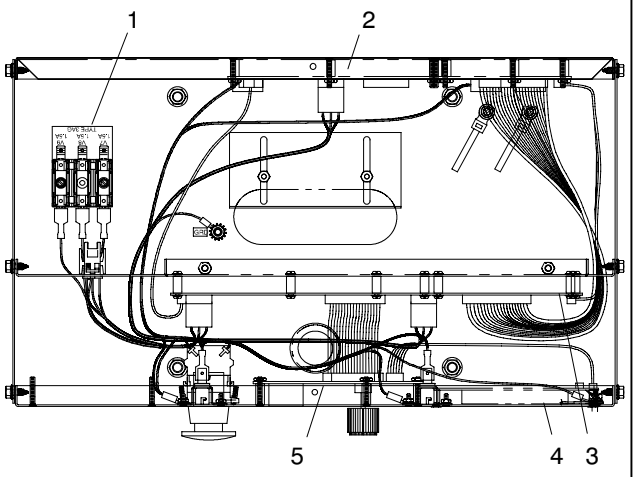
Generator Set Master Switch (Run/Off-Reset/Auto). This switch resets the controller fault lamps and start/stops the generator set. Refer to Section 2.7.4, Starting Generator Set, Section 2.7.5, Stopping, and Section 2.7.6, Emergency Stop Switch Resetting.

Lamp Test. The keypad switch tests the controller indicator lamps, horn, and digital display. Press the reset menu key before pressing the lamp test key.

Stop Prog (Program) Run. Keypad switch allows the user to stop any previously programmed generator set run sequence.

2.6.4 Controller Circuit Boards

The controller has five circuit boards—indicator, interconnection, keypad, digital display, and main logic/ communication. See Figure 2-9 for circuit board locations.



1. AC fuse block (TB5)
2. Interconnection circuit board TB1, TB2, TB3, and TB4 terminal strips and F1, F2, and F3 fuses
3. Main logic (microprocessor)/communication circuit board
4. Keypad and digital display circuit boards
5. Indicator circuit board (LED and alarm horn)

Figure 2-9 Controller Circuit Boards and Fuses (Controller Top View)

Indicator (Status) Circuit Board includes the LED status lamps, alarm horn, and generator set master switch.

Interconnection Circuit Board provides the terminal strips to connect the controller (customer) connection board and/or dry contact kits and three DC fuses (F1, F2, and F3). See the operation manual for more information.

Keypad (Switch Membrane) Circuit Board provides the keypad to navigate the generator set displays and enter data.

Digital Display Circuit Board provides the vacuum fluorescent display (VFD) for monitoring the generator set functions and output values.

Main Logic (Microprocessor)/Communication Circuit Board provides the controller operation logic and provides PC communication locally (direct) or remotely (via modem) using RS-232 or RS-485 connectors.

2.6.5 Fuses

AC Circuit Fuses (TB5). Fuses are located inside the controller. See Figure 2-9.

- **1.5-Amp (V7)** fuse protects L1 sensing input to interconnection circuit board.
- **1.5-Amp (V8)** fuse protects L2 sensing input to interconnection circuit board.
- **1.5-Amp (V9)** fuse protects L3 sensing input to interconnection circuit board.

DC Circuit Fuses fuses are located on the controller interconnection circuit board.

- **5-Amp Remote Annunciator (F1)** fuse protects the dry contact kit if equipped and the controller panel lamps.
- **5-Amp Controller (F2)** fuse protects the controller circuitry.
- **15-Amp Engine and Accessories (F3)** fuse protects the engine/starting circuitry and accessories.

2.6.6 Terminal Strips and Connectors

Terminal strips and connectors for inputs and outputs are located on the interconnection circuit board.

TB1 Input Connection Terminal Strip provides input connections for remote start and emergency stop (E-Stop).

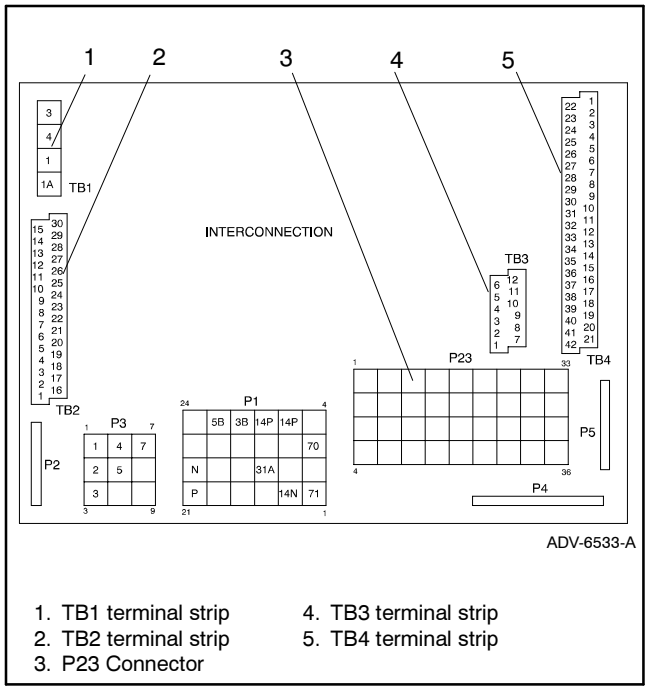
TB2 Analog Input Connection Terminal Strip provides analog input connections, including non-ECM sensor connections.

TB3 Accessory Power Output Connection Terminal Strips provides a generator set power supply for factory use.

TB4 Digital Input Connection Terminal Strips connect external devices (engine ECM and user supplied) to the generator set digital inputs.

P23 Connector connects the interconnection circuit board to the controller (customer) connection terminal strip (connector P25) inside the junction box. See the operation manual for more information.

Figure 2-10 shows locations of the terminal strips on the controller interconnection circuit board. Refer to the wiring diagrams for additional information on connecting accessories to the terminal strips.

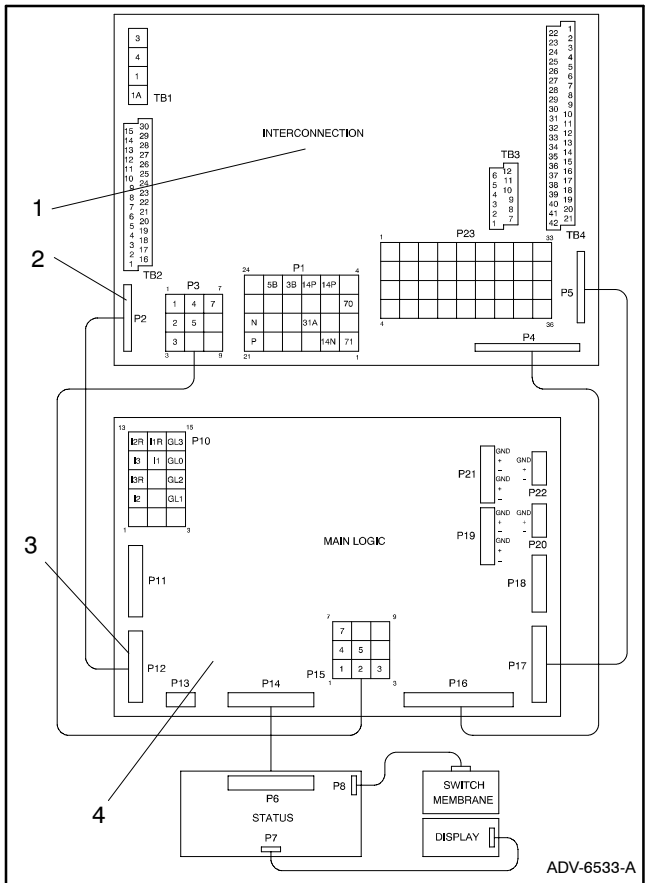


1. TB1 terminal strip
2. TB2 terminal strip
3. P23 Connector
4. TB3 terminal strip
5. TB4 terminal strip

Figure 2-10 Interconnection Circuit Board Terminal Strips and Connectors

2.6.7 Circuit Board Interconnections for Calibration Procedure

The interconnection circuit board shown in Figure 2-11 contains a ribbon connector that requires disconnection during the calibration procedure in Menu 12—Calibration. Disconnect ribbon connector P2 prior to zeroing out (resetting) the auxiliary analog inputs.

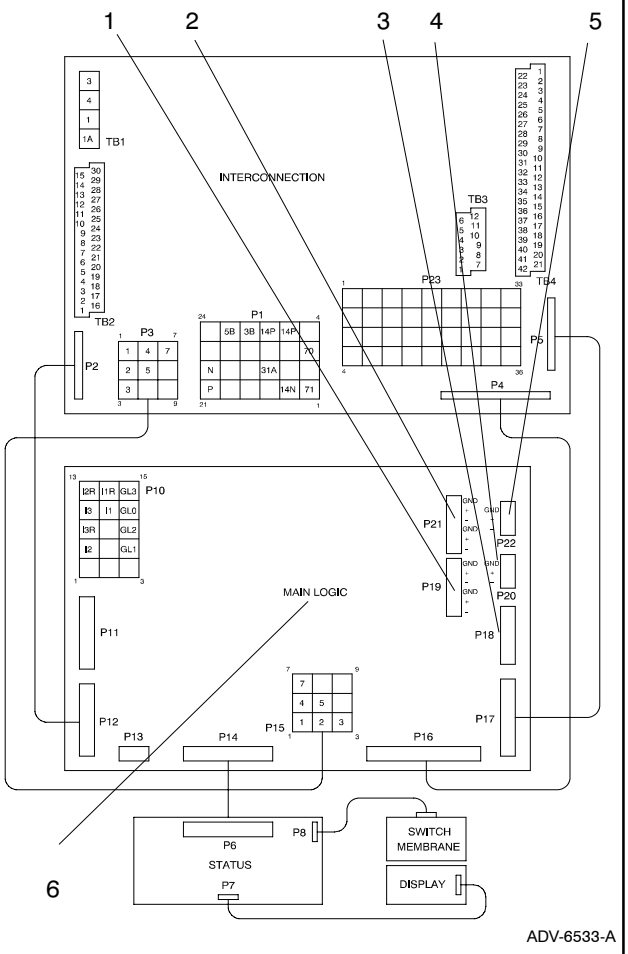


1. Interconnection circuit board
2. P2 ribbon connector
3. P12 ribbon connector
4. Main logic circuit board

Figure 2-11 Interconnection Circuit Board Ribbon Connector P2 (Top View of Circuit Board)

2.6.8 Communication Ports

The main logic circuit board contains several communication ports for Modbus® and KBUS connections. See Figure 2-12. Refer to the List of Related Materials in the Operation Manual for corresponding communication installation information.



1. P19—unused isolated connection (ISO2), RS-485 port
2. P21—KBUS isolated connection (ISO1), RS-485 port
3. P18—KBUS or Modbus®, RS-232 port
4. P20—Modbus, RS-485 port
5. P22—ECM connector
6. Main logic circuit board

Figure 2-12 Main Logic Circuit Board Communication Ports (Top View of Circuit Board)

2.7 Decision-Maker™ 550 Controller Logic Specifications

The controller logic specifications section is an overview of the various features and functions of the controller. Certain features function only when optional accessories are connected. See Section 2.6, Decision-Maker™ 550 Controller Operation, for details.

The default selection time delays and relay driver outputs (RDOs) are factory set and adjustable with the programming mode on (Menu 14). Some data entries require using a PC in the Remote Programming mode. See the Monitor Software operation manual for details.

Inhibit Time Delay. The inhibit time delay is the time period following crank disconnect during which the generator set stabilizes and the controller does not detect a fault or status event. Select the desired inhibit time delay from 0 to 60 seconds.

Time Delay (Shutdown or Warning). The time delay follows the inhibit time delay. The time delay is the time period between when the controller first detects a fault or status event and the controller warning or shutdown lamp illuminates. The delay prevents any nuisance alarms. Select the desired time delay from 0 to 60 seconds.

2.7.1 Status Event and Fault Specifications

The table starting on the next page contains all status events and faults with ranges and time delays including items that do not have adjustments.

Note: The engine ECM may limit the crank cycle even if the controller is set to a longer time period.

Modbus® is a registered trademark of Schneider Electric.

Factory-Defined Settings

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Alarm Horn	Lamp	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)
Access Code (password)	14					User Selectable	0 (zero)		
AC Sensing Loss	10	AC Sensing Loss	RDO-25*	On	Warning				
Air Damper Control (if used) **	10								
Air Damper Indicator (if used) Digital Aux. Input D20 **	9, 10	Air Damper D20	RDO-23* (lead 56)	On	Shutdown	Fixed	0 sec. inhibit, 0 sec. delay		
Air/Fuel Module (AFM) Engine Start Delay ‡	10	AFM Eng Start Delay				Fixed			
Air/Fuel Module (AFM) Remote Start ‡	10	AFM Remote Start	RDO-25‡	Off					
Air/Fuel Module (AFM) Shutdown ‡	9, 10	AFM Shutdown		On	Shutdown	Fixed			
Alternator Protection Shutdown	10	Alternator Protection		On	Shutdown				
Analog Aux. Inputs A01–A07	9	User-Defined A01–A07		On	Shutdown or Warning	Default Values with Warning Enabled: HI warning 90% LO warning 10% HI shutdown 100% LO shutdown 1%	30 sec. inhibit, 5 sec. delay	0–60	0–60
Analog Aux. Input A01 (non-ECM only)	9	A01 Coolant Temp		On	Shutdown or Warning	Default Values with Warning Enabled: HI/LO warning and HI/LO shutdown are all engine dependent	30 sec. inhibit, 0 sec. delay warning, 5 sec. delay shutdown		
Analog Aux. Input A02 (non-ECM only)	9	A02 Oil Pressure		On	Shutdown or Warning	Default Values with Warning Enabled: HI/LO warning and HI/LO shutdown are all engine dependent (255 psi max.)	30 sec. inhibit, 0 sec. delay warning, 5 sec. delay shutdown		
Analog Aux. Input A03‡	9	A03 Intake Air Temperature			Shutdown or Warning	Default Values with Warning Enabled: HI/LO warning and HI/LO shutdown are all engine dependent	30 sec. inhibit, 0 sec. delay warning		
Analog Aux. Input A04‡	9	A04 Oil Temperature		On	Warning	Default Values with Warning Enabled: HI/LO warning are engine dependent	30 sec. inhibit, 0 sec. delay warning		
Analog Aux. Input A07§	9	A07 Voltage Adjust				±10% of system voltage over the range of 0.5–4.5 VDC			
Battery Charger Fault, Digital Aux. Input D01 **	9, 10	Battery Charger Fault	RDO-11 (lead 61)	On	Warning	Fixed	0 sec. inhibit, 0 sec. delay		
Battle Switch (Fault Shutdown Override Switch)	9	Battle Switch		Off	Warning	Fixed			
Block Heater Control ††	10	Block Heater Control	RDO only						
Breaker Trip §	10	Breaker Trip	RDO-30	Off	Warning				
Common Protective Relay Output §	10	Common PR Output	RDO-31	Off	Warning				
Critical Overvoltage Shutdown	10	Critical Overvoltage		On	Shutdown	Fixed	275 volts (L1–L2)		

* All models, except Waukesha-powered models.
† Non-paralleling applications
** NFPA applications
‡ Waukesha-powered models
§ Paralleling applications
†† DDC/MTU engine with MDEC
‡‡ FAA only

Factory-Defined Settings

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Alarm Horn	Lamp	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)
Cyclic Cranking	8			Off		1–6 crank cycles 10–30 sec. crank on 1–60 sec. pause	3 15 sec. 15 sec.		
Defined Common Faults (each input value is set separately)	10	Defined Common Fault	RDO-18 (lead 32A)	On	Shutdown or Warning	Default shutdowns include: Emergency stop High coolant temp Low oil pressure Overcrank Overspeed	30 sec. inhibit, 5 sec. delay	0–60	0–60
Detonation Shutdown ‡	9, 10	Deton Shutdown		On	Shutdown	Fixed			
Detonation Warning ‡	9, 10	Deton Warning		On	Warning	Fixed			
Digital Aux. Input D01–D21	9, 10	User-Defined D01–D21		On	Shutdown or Warning		30 sec. inhibit, 5 sec. delay	0–60	0–60
Digital Aux. Input D05§	9, 10	D05 Breaker Closed							
Digital Aux. Input D06§	9, 10	D06 Enable Synch							
Digital Aux. Input D11‡	9, 10	D11 AFM Shutdown		On	Shutdown		0 sec. inhibit, 0 sec. delay		
Digital Aux. Input D12‡	9, 10	D12 Deton Warning		On	Warning		2 sec. inhibit, 0 sec. delay		
Digital Aux. Input D13 Detonation Sensing Module (DSM) ‡	9, 10	D13 Deton Shutdown		On	Shutdown		0 sec. inhibit, 0 sec. delay		
Digital Aux. Input D13 Knock Detection Module (KDM) ‡	9, 10	D13 Knock Shutdown		On	Shutdown		0 sec. inhibit, 0 sec. delay		
EEPROM Write Failure	10	EEPROM Write Failure		On	Shutdown				
Emergency Stop Shutdown	10	Emergency Stop	RDO-14 (lead 48)	On	Shutdown				
Engine Cooldown (see Time Delay-)									
Engine Start (see Time Delay-)									
EPS (Emergency Power System) Supplying Load	10	EPS Supplying Load	RDO-22	Off	Warning	Fixed	1% of rated line current		
Field Overvoltage Digital Aux. Input D04 (M4, M5, or M7 alternator only)	9, 10	Field Overvoltage		On	Shutdown	Fixed	1 sec. inhibit, 15 sec. delay		
Fuel Valve Relay ‡	10	Fuel Valve Relay	RDO-23‡						
Generator Set Running	10		RDO-15 (lead 70R)	Off					
Ground Fault Detected	10	Ground Fault		On	Warning				
High Battery Voltage	10	High Battery Voltage	RDO-13	Off	Warning	14.5–16.5 V (12 V) 29–33 V (24 V)	16 V (12 V) 32 V (24 V)		10

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** NFPA applications
‡ Waukesha-powered models
§ Paralleling applications
†† DDC/MTU engine with MDEC
‡‡ FAA only

Factory-Defined Settings

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Alarm Horn	Lamp	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)
High Coolant Temperature Shutdown	10	Hi Cool Temp Shutdown	RDO-03 (lead 36)	On	Shutdown			30	5
High Coolant Temperature Warning	10	Hi Cool Temp Warning	RDO-06 (lead 40)	On	Warning			30	
High Oil Temperature Shutdown	10	Hi Oil Temp Shutdown		On	Shutdown			30	5
High Oil Temperature Warning ‡ ††	10	Hi Oil Temp Warning		On	Warning			30	
Idle (speed) Mode Function Digital Aux. Input D21	9, 10	Idle Mode Active	RDO-21	Off	Warning	Fixed inhibit time	0 sec. inhibit, 60 sec. delay		0–600
Intake Air Temperature Shutdown ‡ ††	10	Intake Air Temp Sdwn		On	Shutdown			30	
Intake Air Temperature Warning ‡ ††	10	Intake Air Temp Warn		On	Warning			30	
Internal Fault Shutdown	10	Internal Fault		On	Shutdown				
Knock Shutdown ‡	10	Knock Shutdown		On	Shutdown	Fixed			
kW Overload (see Load Shed)									
Load Shed kW Overload	10	Load Shed KW Over	RDO-30‡‡	Off	Warning	80%–120%	100% of kW rating with 5 sec. delay		2–10
Load Shed Over Temperature ††	10	Load Shed Over Temperature	RDO only						
Load Shed Underfrequency	10	Load Shed Under Frequency	RDO-31†	Off	Warning		59 Hz with (60 Hz) 49 Hz with (50 Hz)		5
Locked Rotor Shutdown	10	Locked Rotor		On	Shutdown				
Loss of ECM Communication (ECM only)	10	Loss of ECM Comm	RDO-26*	On	Shutdown				4
Loss of Field Shutdown §	10	SD Loss of Field		On	Shutdown				
Low Battery Voltage	10	Low Battery Voltage	RDO-12 (lead 62)	Off	Warning	10–12.5 V (12 V) 20–25 V (24 V)	12 V (12 V) 24 V (24 V)		10
Low Coolant Level	10	Low Coolant Level	RDO-19	On	Shutdown			30	5
Low Coolant Level, Digital Aux. Input D14 (with LCL switch) **	9, 10	Low Coolant Level		On	Warning				
Low Coolant Temperature	10	Low Coolant Temp	RDO-05 (lead 35)	On	Warning		0 sec. inhibit, 0 sec. delay		
Low Coolant Temperature, Digital Aux. Input D03 **	9, 10	Low Coolant Temp		On	Warning				

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‡‡ FAA only

Factory-Defined Settings

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Alarm Horn	Lamp	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)
Low Coolant Temperature Shutdown ††	10	Low Coolant Temperature Shutdown		On	Shutdown				
Low Fuel Warning, Digital Aux. Input D02	9, 10	Low Fuel	RDO-08 (lead 63)	On	Warning		0 sec. inhibit, 0 sec. delay		
Low Fuel (Level or Pressure) Warning, Digital Aux. Input D02 **	9, 10	Low Fuel Warning		On	Warning				
Low Fuel Pressure Shutdown, Digital Aux. Input D09 (125RZG only)	9, 10	Low Fuel Shutdown		On	Shutdown	Fixed			
(Low) Oil Pressure Shutdown	10	Oil Pressure Shutdown	RDO-04 (lead 38)	On	Shutdown			30	5
(Low) Oil Pressure Warning	10	Oil Pressure Warning	RDO-07 (lead 41)	On	Warning			30	
Master Not In Auto (Generator Set Switch)	10	Not In Auto	RDO-09 (lead 80)	On	Not In Auto				
Master Switch Error	10	Master Switch Error		On	Shutdown				
Master Switch to Off	10	Master Switch to Off		On	Shutdown				
Master Switch Open	10	Master Switch Open		On	Shutdown				
MDEC Yellow Alarm ††	10	MDEC Yellow Alarm		On	Warning				
MDEC Red Alarm ††	10	MDEC Red Alarm		On	Shutdown				
NFPA 110 Fault	10	NFPA 110 Fault	RDO-10 (lead 32)	On	Shutdown or Warning				
No Air Temperature Signal Warning §	10	No Air Temp Signal		On	Warning				
No Coolant Temperature Signal	10	No Cool Temp Signal		On	Shutdown			30	4
No Oil Pressure Signal	10	No Oil Pressure Signal		On	Shutdown			30	4
No Oil Temperature Signal Warning §	10	No Oil Temp Signal		On	Warning			30	4
Overcrank Shutdown	8, 10	Over Crank	RDO-02 (lead 12)	On	Shutdown	0–6 Cycles	3 Cycles		
Overcurrent	10	Over Current		On	Warning		110%		10
Over Current Voltage Regulator Shutdown §	10	SD Over Current VR		On	Shutdown				
Overfrequency Shutdown	7, 10	Over Frequency	RDO-28	On	Shutdown	102%–140%	140% Std. 103% FAA		10
Over Power Shutdown §	10	SD Over Power		On	Shutdown		102% Stdby 112% Prime		
Overspeed Shutdown	7, 10	Over Speed	RDO-01 (lead 39)	On	Shutdown	65–70 Hz (60 Hz) 55–70 Hz (50 Hz)	70 (60 Hz) 70 (50 Hz)		0.25

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§ Paralleling applications
†† DDC/MTU engine with MDEC
‡‡ FAA only

Factory-Defined Settings

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Alarm Horn	Lamp	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)
Overvoltage Shutdown	7, 8, 10	Over Voltage	RDO-20 (lead 26)	On	Shutdown	105%–135% of nominal	115% 2-sec time delay† 135% 10-sec time delay§		2–10
Password (see Access Code)									
Pre Lube Relay ‡	10	Pre Lube Relay	RDO-26						4
Reverse Power Shutdown §	10	SD Reverse Power		On	Shutdown				
Speed Sensor Fault	10	Speed Sensor Fault	RDO-24	On	Warning				
Starting Aid (see Time Delay Starting Aid)									
Synchronized	10	In Synch	RDO-29§						
System Ready	10		RDO-17 (lead 60)	Off	System Ready				
Time Delay Engine Cooldown (TDEC)	8, 10	Delay Eng Cooldown	RDO-16 (lead 70C)	Off		00:00–10:00 min:sec	5:00		
Time Delay Engine Start (TDES)	8, 10	Delay Eng Start		Off		00:00–5:00 min:sec	00:01		
Time Delay Starting Aid	8, 10			Off		0–10 sec.			
Underfrequency	7, 10	Under Frequency	RDO-29‡	On	Shutdown	80%–97%	97% FAA 90%† 80%§		10
Undervoltage Shutdown	7, 8, 10	Under Voltage	RDO-27	On	Shutdown	70%–95%	85% 10-sec time delay† 70% 30-sec time delay§		5–30
Weak Battery	10	Weak Battery		Off	Warning		60% of nominal		2

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Calibration	Refer to Menu	Digital Display	Range Setting	Default Selection
Voltage Adjustment	11	Volt Adj	±10% of system voltage—Version 2.10 ±20% of system voltage—Version 2.11 or higher	System voltage
Underfrequency Unload Frequency Setpoint	11	Frequency Setpoint	40 to 70 Hz	1 Hz below system frequency (ECM) 2 Hz below system frequency (non-ECM)
Underfrequency Unload Slope	11	Slope	0–10% of rated voltage volts per cycle	3.1% of system voltage
Reactive Droop	11	Voltage Droop	0–10% of system voltage	4% of system voltage
VAR Control	11	kVAR Adj	0 to rated kVAR generating 0 to 35% of rated kVAR absorbing	0
Power FActor (PF) Adjust Control	11	PF Adj	0.7 to 1.0 leading 0.6 to 1.0 lagging	0.8 lagging
Regulator Gain or Stability	11	Regulator Gain	1–10000	100
VAR/PF Gain or Utility Stability	11	VAR/PF Gain	1–10000	100

Figure 2-13 Calibration Specifications for 550 Controller Internal Voltage Regulation

2.7.2 Voltage Regulator and Calibration Specifications

The 550 controller has a voltage regulation function that is internal to the processor. This means that no external voltage regulator is necessary. The voltage regulation of the controller uses root mean square (rms) sensing for fast response to changes in indicated and regulated voltages resulting in excellent regulation accuracy (±0.25% rms compared to 5% of AVR).

RMS voltage regulation is available for both paralleling and utility application to control changes in the reactive loads due to load changes, prime mover speed variation, thermal drift, and other variations. See Figure 2-13 for data on the 550 controller voltage regulation. Refer to the operation manual to customize adjustments for specific applications.

2.7.3 Voltage Regulator Adjustments

The descriptions of the voltage regulator adjustments and features follow. See the operation manual for additional information.

Voltage Adjustment. The voltage adjustment allows the user to *enter the desired generator set output level.* This regulated level setting is the average of the three line-to-line voltages in three-phase configurations or L1-to-L2 in single phase configurations.

Submenus display the individual line-to-line voltages. These voltages are for reference only and are relevant in unbalanced load conditions. The voltage adjust setpoint can be changed to accommodate an important phase in an unbalanced system.

Underfrequency Unload Frequency Setpoint. This adjustment affects the voltage droop (volts per Hz) when load is applied and underfrequency occurs. The underfrequency unload setting defines the *setpoint where underfrequency starts*. Any frequency below the setpoint causes the voltage to drop thus reducing the load allowing the engine speed to recover according to the underfrequency unload slope setting.

Engine speed recovery depends upon characteristics such as engine make, fuel type, load types, and operating conditions. The underfrequency unload setting should match the engine speed recovery characteristics for the application.

Underfrequency Unload Slope. This setting determines how much the voltage drops during an underfrequency condition. Typically, applying a large electrical load causes a dip in engine speed and frequency. The voltage regulator reduces voltage, allowing engine speed recovery. The volts-per-Hz setting determines the *amount of voltage drop*.

Reactive Droop. Reactive droop compensation provides reactive current flow adjustment in the generator set during generator set-to-generator set paralleling applications. Reactive droop reduces excitation levels with increasing reactive current. A reduced excitation level reduces generator set reactive current or generated VARs, improving reactive load sharing.

Enter the gain setting as a *percentage of system voltage w*hen full-rated load with 0.8 power factor is applied. Any loads less than full load force the voltage to drop by the ratio of reactive volt-amps (VARs) to rated VARs.

VAR Control. VAR control is used in some utility paralleling applications. The excitation is regulated to maintain the reactive load rather than output voltage. The VAR adjust setting determines what reactive load is maintained at the generator set output. The VAR adjust is the total reactive load (sum of three phases).

VAR control allows the user to define the direction of the reactive current out of the generator set (generating) or into the generator set (absorbing).

The utility supply, not the controller, determines terminal voltage. Engine fueling determines real power, measured in watts, using load sharing module control.

Power Factor (PF) Adjust Control. Power factor control is used in some utility paralleling applications. The excitation is regulated to maintain PF rather than output voltage. The PF adjustment setting determines what PF is maintained at the generator set output. PF adjustment is the average of three phases.

Power factor is defined as the ratio of real power (watts) over the volt-amps. Power factor can be calculated as the cosine of the electrical angle between current and voltage. The cosine function is positive for angles between –90 degrees and +90 degrees including zero; and is negative for angles between –90 and +90 including 180 degrees. This adjustment requires the user to determine whether the current leads or lags the voltage.

Regulator Gain. Regulator gain refers to the gain of the control system. Generally, the higher the gain the faster the system responds to changes. The lower the gain, the more stable the system.

If the voltage is slow to recover when loads are applied or removed, increase the regulator gain. If the voltage is unstable, decrease the regulator gain. Regulator gain is active only while not in the VAR/PF mode.

VAR/PF Gain. The VAR/PF gain also refers to the gain of the control system. Unlike the regulator gain, the response and stability of the system refers to the reactive current, or more specifically the VARs and/or power factor.

If the system is slow to recover to the desired VAR or PF setting, increase the VAR/PF gain. If the VARs or PF of the system is unstable, decrease the VAR/PF gain. Because VAR/PF stability can be effected by the prime mover (engine), VAR/PF gain adjustments should be coordinated with the load sharing adjustment.

2.7.4 Starting Generator Set

Local Starting

Move the generator set master switch to the RUN position to start the generator set at the controller.

Note: The alarm horn sounds and the Not-In-Auto lamp lights whenever the generator set master switch is not in the AUTO position.

Note: The transient start/stop function of the controller prevents accidental cranking of the rotating engine. The generator set stops and recranks when the generator set master switch is momentarily placed in OFF/RESET position and then returned to RUN.

Auto Starting

Move the generator set master switch to the AUTO position to allow startup by the automatic transfer switch or remote start/stop switch (connected to controller terminals 3 and 4).

Terminals 3 and 4 connect to a circuit that automatically starts the generator set crank cycle when an external source closes the circuit.

Note: The controller provides up to 60 seconds of programmable cyclic cranking and up to 60 seconds rest with up to 6 cycles. The default setting is 15 seconds cranking and 15 seconds rest for 3 cycles. Make cyclic cranking adjustments using the keypad.

Idle (Speed) Mode Warmup and Cooldown Function

The idle (speed) mode function provides the ability to start and run the engine at reduced speed for a selectable time period (0–10 minutes) during warmup.

The controller will override the idle speed mode when the engine reaches the preprogrammed engine warm-up temperature before the idle mode times out.

The idle function also provides engine cooldown at idle speed. The controller overrides the idle speed mode when the engine reaches the preprogrammed engine cooldown temperature before the idle mode times out.

During the idle (speed) mode the controller continues to monitor critical engine parameters such as oil pressure, coolant temperature, and engine speed. The voltage regulator, thermal protection feature, and AC metering are disabled in the idle speed mode.

The controller overrides the idle speed function when the generator set is signaled to start while in the AUTO position. This override provides emergency generator set power in the event of a utility power failure. When the utility power returns and the generator set is signalled to stop, the generator set continues to run for the duration of the idle mode period when the idle mode is active. When the idle mode is not active, the generator set will shut down in the normal stopping mode including time delays.

See Menu 9—Input Setup to activate the idle speed function as a user-defined digital input. The idle speed feature requires an ECM-equipped engine with the idle speed function.

Run Time Feature

The run time feature allows the user to set up the generator set to run unassisted and automatically return to the standby mode. The user does not need to wait for the exercise period (run time) to conclude in order to place the unit back in the standby mode. See Menu 4—Operational Records for setup of this feature.

With the run time enabled, the generator set will begin to crank and run based on the run time period and all previously established time delays from Menu 8—Time Delays.

Generator Set Connected to an Automatic Transfer Switch. Should a utility power failure occur while the unit is in the run time mode, the controller will bypass the run time mode and function in the standby (backup) mode. When the utility power returns, the generator set continues to run for the duration of the run time period when not timed out.

Note: Press the STOP PROG RUN key, when necessary, to stop the generator set when it is in the run time mode.

Prime Power Switch

The digital controller has an optional prime power mode of operation. The prime power mode requires installation of an optional prime power switch kit. See Section 6, Accessories, for instructions on how to install the optional prime power switch kit. The prime power switch kit prevents engine starting battery drain when the generator set is shut down and no external battery charging is available.

Move the prime power switch located on the back of the controller to the CONTROLLER ON position and set the controller time and date before attempting to start the generator set. When the prime power mode is off, all controller functions including the digital display, LEDs, and alarm horn are operative.

Note: After energizing the controller using the prime power switch, set the controller time and date

Stop the generator set using the stopping procedures in Section 2.7.5, Stopping, before placing the generator set in the prime power mode. Move the prime power switch located on the back of the controller to the CONTROLLER OFF position. When the generator set is is the prime power mode, all controller functions including the digital display, LEDs, alarm horn, and communications are inoperative.

2.7.5 Stopping (User Stopping and Fault Shutdown)

Normal Stopping

Run the generator set without load for 5 minutes to ensure adequate engine cooldown.

The controller has a programmable cooldown timer that functions only when the master switch is in the AUTO position. To stop the generator set, place the generator set master switch in the OFF/RESET position and wait until the generator set comes to a complete stop.

Note: The cooldown cycle times out before the generator set stops when a remote switch or automatic transfer switch initiates the generator set start/stop sequence.

Emergency Stopping

Use the controller emergency stop switch or optional remote emergency stop for immediate shutdown.

The emergency stop switch bypasses the time delay engine cooldown and immediately shuts down the generator set.

Note: Use the emergency stop switch(es) for emergency shutdowns only. Use the generator set master switch for normal shutdowns.

The controller system shutdown lamp lights and the unit shuts down when the local or remote emergency stop switch activates.

Battle Switch/Fault Shutdown Override Switch

The *battle* switch function forces the system to ignore normal fault shutdowns such as low oil pressure and high engine temperature. The battle switch does not override the emergency stop and overspeed shutdown. When the battle switch function is enabled the generator set continues to run regardless of shutdown signals where potential engine/alternator damage can occur.

When this input is enabled the yellow warning lamp illuminates and stored warning/shutdown events that are ignored continue to log in Menu 5— Event History.

See the operation manual for information on how to enable the battle switch feature.

Cooldown Temperature Override Function. This feature provides the ability to bypass (override) the generator set's smart cooldown temperature shutdown and force the generator set to run for the full engine cooldown time delay.

See the operation manual for information on how to enable the cooldown temperature override feature.

2.7.6 Emergency Stop Switch Resetting

Use the following procedure to reset the generator set after shutdown by a local or remote emergency stop switch. Refer to Section 2.7.10, Controller Resetting, to restart the generator set following a fault shutdown.

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

2. Investigate and correct the cause of the emergency stop.

3. Reset the optional remote emergency stop switch by replacing the glass piece, when equipped. Additional glass rods are available as a service part. Reset the controller emergency stop switch by pulling the switch knob outward.

4. After resetting all faults using the controller reset procedure in Section 2.7.10, toggle the generator set master switch to RUN or AUTO to restart the generator set. The generator set will not crank until the reset procedure completes.

2.7.7 Status Lamp

System Ready. The green lamp illuminates when the generator set master switch is in the AUTO position and the system has no fault conditions.

2.7.8 System Warning Lamp

The yellow warning lamp illuminates indicating a fault or status event but does not shut down the generator set under the following conditions. In some cases the alarm horn also sounds. See Section 2.7.10, Controller Resetting, for instructions on resetting a system warning.

When the system warning lamp is on and no message displays, press the Reset Menu and the menu down ↓ key to view messages. When the system warning continues, it may lead to a fault and cause a system shutdown.

Use the Alarm Off keypad switch to silence the alarm horn at the operator's discretion. Place the generator set master switch in the AUTO position before silencing the alarm horn. The alarm horn cannot be silenced unless the master switch is in the AUTO position.

Note: Text shown in *italics* in this manual represents digital display messages.

AC Sensing Loss. The lamp illuminates when the controller does not detect nominal generator set AC output voltage after crank disconnect. The local display shows *AC sensing loss*.

Battery Charger Fault. The lamp illuminates when the battery charger malfunctions. This fault feature requires an optional battery charger with a malfunction output for the lamp to function. Local display shows *bat chgr fault*.

Common Protective Relay Output. The lamp illuminates and the alarm horn sounds when any relay fault occurs. The local display shows *common pr output.* (Paralleling applications only.)

Customer Auxiliary (Warning). The lamp illuminates and the alarm horn sounds when an auxiliary digital or analog inputs signals the controller. The user can define inputs as shutdowns or warnings. The local display shows digital input *D01-D21* or analog input *A01-A07.*

Using the remote communications package, the user can label the auxiliary functions. The controller displays the selected name instead of digital input *D01-D21* or analog input *A01-A07.*

Detonation Warning. The lamp illuminates and the alarm horn sounds when the engine detects combustion system detonation. The local display shows *deton warning.* (Waukesha-powered models only.)

Emergency Power System (EPS) Supplying Load. The lamp illuminates when the generator set supplies more than 1% of the rated standby output current. The local display shows *EPS supplying load*.

Generator Switch Not in Auto. The lamp illuminates and the alarm horn sounds when the generator set master switch is in the RUN or OFF/RESET position. The local display shows *master not in auto*.

Ground Fault Detected. The lamp illuminates and the alarm horn sounds when a user-supplied ground fault detector signals the controller. The local display shows *ground fault*.

High Battery Voltage. The lamp illuminates when the battery voltage rises above the preset level for more than 10 seconds. The local display shows *high battery voltage*. Figure 2-14 shows high battery voltage specifications. The high battery voltage feature monitors the battery and battery charging system in the generator set operating and off modes.

Engine Electrical System Voltage	High Battery Voltage Range	High Battery Voltage Default Setting
12	14.5–16.5	16
24	29–33	32

Figure 2-14 High Battery Voltage Specs

High Coolant Temperature Warning. The lamp illuminates and the alarm horn sounds when the engine coolant temperature approaches the shutdown range. The local display shows *hi cool temp warning.*

High Oil Temperature Warning. The lamp illuminates and the alarm horn sounds when the engine high oil temperatuare approaches the shutdown range. The local display shows *hi oil temp warning* (DDC/MTU models with MDEC and Waukesha-powered models only).

Intake Air Temperature Warning. The lamp illuminates and the alarm horn sounds when the engine intake air temperature approaches the shutdown range. The local display shows *intake air temp warn* (DDC/MTU models with MDEC and Waukesha-powered models only).

Load Shed. The lamp illuminates when the generator set's total kW load exceeds the programmed level for more than the load shed time. When the load shed alarm sounds and resets more than twice in 1 minute, the load shed warning lamp circuit latches and remains on until the generator set shuts down. The local display shows *load shed kW over*.

When the generator set frequency drops to less than 59 Hz on a 60 Hz system or 49 Hz on a 50 Hz system for more than 5 seconds, the local display shows *load shed under freq*. When the load shed alarm sounds and resets more than twice in 1 minute, the load shed warning lamp latches and remains on until the generator set shuts down.

Low Battery Voltage. The lamp illuminates when the battery voltage drops below a preset level for more than 10 seconds. The local display shows *low battery voltage*. See Figure 2-15 for low battery voltage specifications.

Engine Electrical System Voltage	Low Battery Voltage Range	Low Battery Voltage Default Setting
12	10–12.5	12
24	20–25	24

Figure 2-15 Low Battery Voltage Specs

The low battery voltage feature monitors the battery and battery charging system in the generator set operating and off modes. The controller logic inhibits the low battery voltage warning during the crank cycle.

Low Coolant Level. The lamp illuminates and the alarm horn sounds when the engine coolant level is low. The local display shows *Low Coolant Level.* See NFPA 110 Fault following.

Low Coolant Temperature. The lamp illuminates and the alarm horn sounds when the engine coolant temperature is low. The local display shows *low coolant temp.*

Low Fuel (Level or Pressure) Warning. The lamp illuminates and the alarm horn sounds when the fuel tank level on gasoline or diesel models approaches empty or low fuel pressure on gaseous fueled models occurs. This fault requires an optional low fuel switch for the lamp to function. The local display shows *low fuel warning*.

(Low) Oil Pressure Warning. The lamp illuminates and the alarm horn sounds when the engine oil pressure approaches the shutdown range. The local display shows *oil press warning*.

Master Switch in OFF/RESET Position. The lamp illuminates and the alarm horn sounds when the master switch is placed in the OFF/RESET position. The local display shows *master not in auto.*

MDEC Yellow Alarm. The lamp illuminates and the alarm horn sounds when MDEC yellow alarm signals the controller. The local display shows *MDEC yellow alarm*. This fault only relates to the DDC/MTU engine with MDEC. The user can navigate the menus to access the fault code. The engine operation manual provides the fault code descriptions.

NFPA 110 Fault. The lamp illuminates and the alarm horn sounds when NFPA 110 faults signal the controller. The local display shows the respective fault message. The NFPA 110 faults include:

- Air damper indicator (Factory Reserved D20)
- Battery charger fault (Factory Reserved D01)
- EPS supplying load
- High battery voltage
- High coolant temperature warning
- High coolant temperature shutdown
- Low battery voltage
- Low coolant level (Factory Reserved D14)
- Low coolant temperature warning (Factory Reserved D03)
- Low fuel (level or pressure) (Factory Reserved D02)
- Low oil pressure warning
- Low oil pressure shutdown
- Master switch not in auto
- Overcrank
- Overspeed

Overcurrent. The lamp illuminates and the alarm horn sounds when the generator set supplies more than 110% of the rated standby output current for more than 10 seconds. The local display shows *overcurrent*.

Speed Sensor Fault. The lamp illuminates and the alarm horn sounds when the speed signal is absent for one second while the generator set runs. The local display shows *speed sensor fault*. This warning lamp remains on until the operator places the master switch in the OFF/RESET position.

Underfrequency. The lamp illuminates and the alarm horn sounds when the frequency falls below the underfrequency setting. The local display shows *underfrequency*. See Figure 2-16.

Underfrequency Setting Range	Time Delay Range	Underfrequency Default Setting
80%–95% of nominal	10 sec.	90% of nominal

Figure 2-16 Underfrequency Specs

Weak Battery. The lamp illuminates when the battery voltage falls below 60% of the nominal voltage (12 VDC or 24 VDC) for more than 2 seconds during the crank cycle. The local display shows *weak battery.*

2.7.9 System Shutdown Lamp

The red lamp illuminates, the alarm horn sounds, and the unit shuts down to indicate a fault shutdown under the following conditions. See Section 2.7.10, Controller Resetting, for information on resetting a system shutdown.

Use the Alarm Off keypad switch to silence the alarm horn at the operator's discretion. Place the generator set master switch in the AUTO position before silencing the alarm horn. The alarm horn will not stop sounding unless the master switch is in the AUTO position.

Note: The text shown in *italics* represents digital display messages.

Air Damper Indicator. The lamp illuminates and the unit shuts down when signaled by a closed air damper circuit. The local display shows *air damper indicator.*

Air/Fuel Module. The lamp illuminates and the unit shuts down when the controller detects a fault with the air/fuel module. The local display shows *afm shutdown*. (Waukesha-powered models only.)

Alternator Protection. The lamp illuminates and the unit shuts down because of an alternator overload or short circuit. The local display shows *altrntr protect sdwn.* See Appendix D, Alternator Protection for more information.

Critical Overvoltage. The lamp illuminates and the unit shuts down when the voltage exceeds 275 volts. The local display shows *critical overvoltage*.

For voltages configurations of **240 volts and less**, the critical voltage shutdown monitors nominal voltage line-to-line. For voltage configurations **greater than 240 volts and less than 600 volts**, the critical voltage shutdown monitors nominal voltage line-to-line with a center tap connection. For voltage configurations of **600 volts and above**, the critical voltage shutdown monitors nominal voltage with a stepdown transformer in the 208–240 voltage range.

Customer Auxiliary (Shutdown). The lamp illuminates and the unit shuts down when an auxiliary digital or analog input signals the controller. The user can define inputs as shutdowns or warnings. The local display shows digital input *D01-D21* or analog input *A01-A07* when activated.

Using the remote communications package, the user can label the auxiliary functions. The controller displays the selected name instead of digital input *D01-D21 or* analog input *A01-A07.*

Detonation Shutdown. The lamp illuminates and the unit shuts down when the controller detects combustion system detonation. The local display shows *deton shutdown*. (Waukesha-powered models only.)

EEPROM Write Failure. The lamp illuminates and the unit shuts down when the control logic detects a data save error. The local display shows *EEPROM write failure.*

Emergency Stop. The lamp illuminates and the unit shuts down when the local or optional remote emergency stop switch activates. The local display shows *emergency stop*.

Field Overvoltage. The lamp illuminates and the unit shuts down when the controller detects field overvoltage. The local display shows *field over volts.* (350–2000 kW generator sets only)

High Coolant Temperature Shutdown. The lamp illuminates and the unit shuts down because of high engine coolant temperature. The shutdown occurs 5 seconds after the engine reaches the temperature shutdown range. The high engine temperature shutdown does not function during the first 30 seconds after startup. The local display shows *hi cool temp shutdwn*.

Note: The high engine temperature shutdown function and the low coolant level shutdown function are independent. A low coolant level condition may not activate the high engine temperature switch.

High Oil Temperature. The lamp illuminates and the unit shuts down because of high engine oil temperature. The shutdown occurs 5 seconds after the engine oil reaches the temperature shutdown range. The high engine oil temperature shutdown does not function during the first 30 seconds after startup. The local display shows *high oil temp sdwn*.

Intake Air Temperature. The lamp illuminates and the unit shuts down because of high intake air temperature. The shutdown occurs 5 seconds after the engine intake air reaches the temperature shutdown range. The engine intake air temperature shutdown does not function during the first 30 seconds after startup. The local display shows *intake air temperature*. (DDC/MTU models with MDEC and Waukesha-powered models only.)

Internal Fault. The lamp illuminates and the unit shuts down when the internal diagnostics detect a controller malfunction. The local display shows *internal fault*.

Knock Shutdown. The lamp illuminates and the unit shuts down when the controller detects a detonation fault. The local display shows *knock shutdown.* (Waukesha-powered models only.)

Locked Rotor. If none of the speed sensing inputs show engine rotation within 5 seconds of initiating engine cranking, the ignition and crank circuits turn off for 5 seconds and the cycle repeats. The unit shuts down after the second cycle of 5 seconds of cranking. The local display shows *locked rotor*.

Loss of ECM Communications. The lamp illuminates and the unit shuts down when the ECM communication link is disrupted. The local display shows *loss of ECM comm.*

Loss of Field (Reverse VARs). The lamp illuminates and the unit shuts down when the reactive current into the alternator (absorbing) exceeds the shutdown level. This could be caused by a disruption of the field signal. The local display shows *sd loss of field.* (Paralleling applications only.)

Low Coolant Level. The lamp illuminates and the unit shuts down because of low low coolant level. Shutdown occurs 5 seconds after low coolant level is detected. Low coolant level shutdown is inhibited during the first 30 seconds after startup. Local display shows *low coolant level*.

Low Fuel (Pressure) Shutdown. The lamp illuminates and the unit shuts down when the controller detects a low fuel condition. The local display shows *low fuel shdown*. (125RZG only.)

(Low) Oil Pressure Shutdown. The lamp illuminates when the unit shuts down because of low oil pressure. The shutdown occurs 5 seconds after the low pressure condition is detected. The low oil pressure shutdown does not function during first the 30 seconds after startup. The local display shows *(low) oil press shutdown*.

Master Switch Error. The lamp illuminates and the unit shuts down when the controller detects a fault in the master switch position or circuit. The local display shows *master switch error.*

Master Switch Open. The lamp illuminates and the unit shuts down when the controller detects an open circuit in the master switch circuit. The local display shows *master switch open*.

MDEC Red Alarm. The lamp illuminates and the unit shuts down when the controller receives a signal from the engine. The local display shows *MDEC red alarm*. This fault only relates to the DDC/MTU engine with MDEC. The user can navigate the menus to access the fault code. The engine operation manual provides the fault code descriptions.

NFPA 110 Fault. The lamp illuminates and the unit shuts down when NFPA 110 faults signal the controller. The local display shows the respective fault message. See the Menu List Summary, Menu 10—Output Setup, for the NFPA 110 list.

No Air Temperature Signal. The lamp illuminates and the unit shuts down when the air temperature sender circuit is open. The local display shows *no air temp signal.* (Waukesha-powered models only.)

No Coolant Temperature Signal. The lamp illuminates and the unit shuts down when the engine coolant temperature sender circuit is open. The local display shows *no cool temp signal.*

No Oil Pressure Signal. The lamp illuminates and the unit shuts down when the engine oil pressure sender circuit is open. The local display shows *no oil press signal.*

No Oil Temperature Signal. The lamp illuminates and the unit shuts down when the oil temperature sender circuit is open. The local display shows *no oil temp signal.* (Waukesha-powered models only.)

Overcrank. The lamp illuminates and cranking stops when the unit does not start within the defined cranking period. The local display shows *overcrank*. See Section 2.7.4, Starting Generator Set, and Section 2.7, Decision-Maker™ 550 Controller Logic Specifications, for cyclic crank specifications.

Note: The controller is equipped with an automatic restart function. When speed drops below 13 Hz (390 rpm) while the engine is running, the unit attempts to recrank. The unit then follows the cyclic cranking cycle and, when the engine fails to start, will shut down on an overcrank fault condition.

Overcurrent Shutdown Paralleling Relay. The lamp illuminates and the unit shuts down when the controller detects an overcurrent fault with the paralleling relays. The local display shows *sd over current vr.* (Paralleling applications only.)

Overfrequency. The lamp illuminates and the unit shuts down when the frequency is above the overfrequency setting. The local display shows *overfrequency*. See Figure 2-17.

Overfrequency Setting Range	Time Delay	Overfrequency Default Setting
102%-140% of nominal	10 sec.	140% of nominal

Figure 2-17 Overfrequency Specs

Overpower. The lamp illuminates and the unit shuts down when the controller detects a fault in the paralleling system. The shutdown is set at 102% for standby and 112% for prime power applications. The local display shows *over power*. (Paralleling applications only.)

Overspeed. The lamp illuminates and the unit shuts down immediately when the governed frequency on 50 and 60 Hz models exceeds the overspeed setting for 0.25 seconds. The local display shows *overspeed*. See Figure 2-18 for overspeed specs.

Generator Set Frequency Hz	Time Delay	Overspeed Range Hz	Overspeed Default Setting Hz
60	0.25 sec.	65-70	70
50	0.25 sec.	55-70	70

Figure 2-18 Overspeed Specs

Overvoltage. The lamp illuminates and the unit shuts down when the voltage exceeds the overvoltage setting for the time delay period. The local display shows *overvoltage*. Overvoltage specifications follow. See Figure 2-19.

Note: Overvoltage can damage sensitive equipment in less than one second. Install separate overvoltage protection on online equipment requiring faster than 2-second shutdown.

Overvoltage Setting Range	Time Delay Range	Overvoltage Default Setting without Paralleling	Overvoltage Default Setting with Paralleling
105%-135% of nominal	2-10 sec.	115% at 2 sec.	135% at 10 sec.

Figure 2-19 Overvoltage Specs

Reverse Power. The lamp illuminates and the unit shuts down when the controller detects a reverse power condition. The reverse power relay senses AC power flow into the generator set. If the generator set is being feed power or being "motored" by another generator set or the utility, the reverse power relay senses this AC power flow and opens the generator set circuit breaker. The local display shows *sd reverse power.* (Paralleling applications only.)

Underfrequency. The lamp illuminates and the unit shuts down when the frequency falls below the underfrequency setting. The local display shows *underfrequency*. See Figure 2-20.

Underfreq. Setting Ranger	Time Delay	Underfrequency Default Setting without Paralleling	Underfrequency Default Setting with Paralleling
80%-95% of nominal	10 sec.	90% of nominal	80% of nominal

Figure 2-20 Underfrequency Specs

Undervoltage. The lamp illuminates and the unit shuts down when the voltage falls below the undervoltage setting for the time delay period. The local display shows *undervoltage*. Undervoltage specifications follow. See Figure 2-21.

Undervoltage Setting Range	Time Delay Range	Undervoltage Default Setting w-o/Paralleling	Undervoltage Default Setting w/Paralleling
70%-95% of nominal	5-30 sec.	85% of nominal at 10 sec.	70% of nominal at 30 sec.

Figure 2-21 Undervoltage Specs

2.7.10 Controller Resetting (Following System Shutdown or Warning)

Use the following procedure to restart the generator set after a system shutdown or to clear a warning lamp condition. This procedure includes the resetting of the optional remote annunciator and the audiovisual alarm.

Refer to Section 2.7.6, Emergency Stop Switch Resetting, to reset the generator set after an emergency stop.

1. Move the generator set master switch to the AUTO position, if not already done.
2. Silence the controller alarm horn by pressing the *alarm off* key.

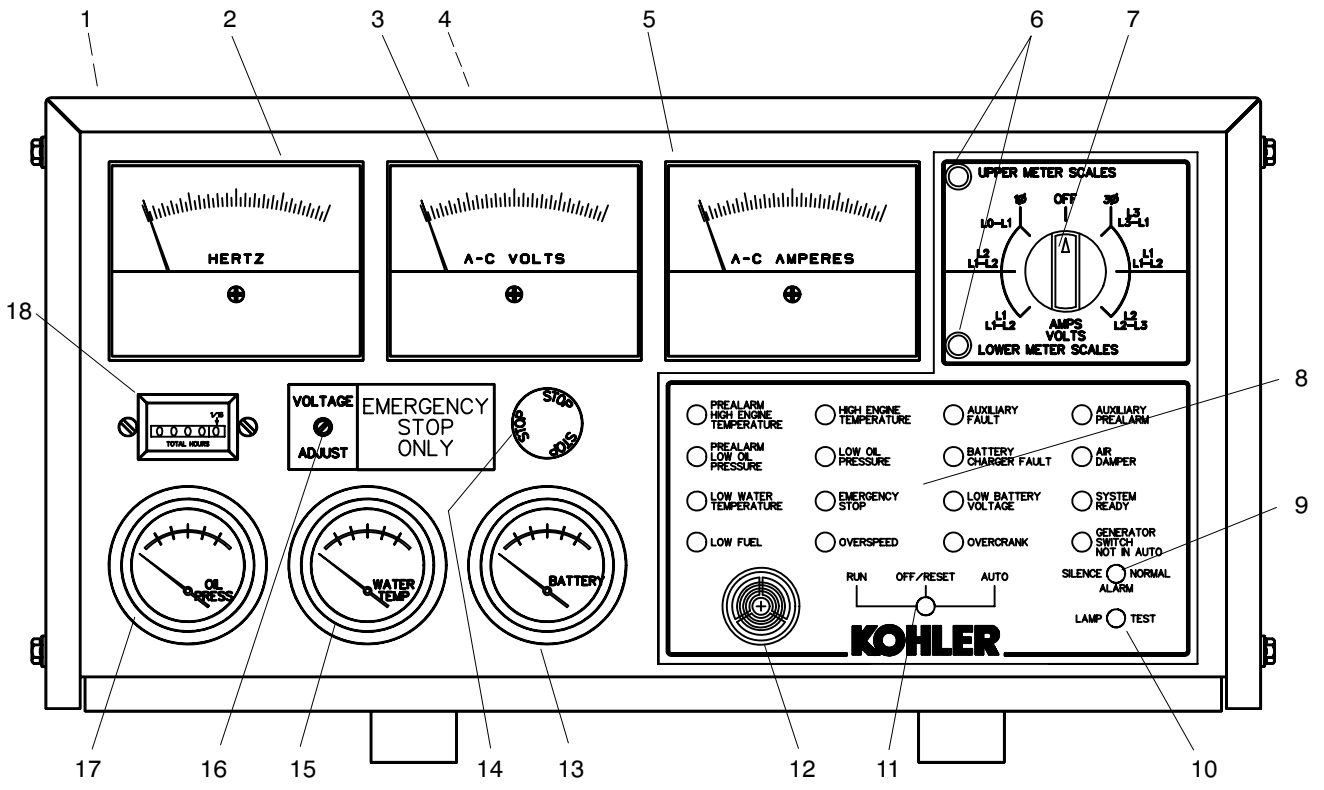
   When equipped, the optional remote annunciator and/or audiovisual alarm horn and lamp activate. Move the alarm switch to the SILENCE position to stop the alarm horn. The lamp stays lit.
3. Disconnect the generator set load using the line circuit breaker or automatic transfer switch.
4. Correct the cause of the fault shutdown or warning. See the Safety Precautions and Instructions section of this manual before proceeding.
5. Start the generator set by moving the generator set master switch to the OFF/RESET position and then to the RUN position.

   When equipped, the remote annunciator and/or audiovisual alarm horn sounds when the alarm switch is in the NORMAL position. When necessary, move the alarm switch to the SILENCE position to stop the alarm horn. The lamp turns off.
6. Test operate the generator set to verify correction of the shutdown cause.
7. Move the generator set master switch to the OFF/RESET position to stop the generator set.
8. Move the generator set master switch to the AUTO position.
9. Silence the controller alarm horn by pressing the *alarm off* key.
10. Reconnect the generator set load via the line circuit breaker or automatic transfer switch.
11. Move the generator set master switch to the AUTO position for startup by the remote transfer switch or the remote start/stop switch.

    When equipped, move the remote annunciator and/or audiovisual alarm switch to the NORMAL position.

2.8 Decision-Maker™ 3+, 16-Light Microprocessor Controller Operation

The Decision-Maker™ 3+, 16-light microprocessor controller has a prime power mode of operation. See Section 2.8.6 for prime power mode operation. Figure 2-22 identifies the controller's indicators, controls, and their functions.



1. Fuses (inside controller)
2. Frequency meter
3. AC voltmeter
4. Controller TB1 and TB2 terminal strips (on circuit board)
5. AC ammeter
6. Scale lamps (upper/lower)
7. Selector switch
8. Annunciator panel lamps
9. Alarm silence switch
10. Lamp test
11. Generator set master switch
12. Alarm horn
13. DC voltmeter
14. Emergency stop switch (if equipped)
15. Water temperature gauge
16. Voltage adjustment
17. Oil pressure gauge
18. Hourmeter

Figure 2-22 Decision-Maker™ 3+, 16-Light Microprocessor Controller

2.8.1 Controls and Indicators

The following table describes the controls and indicators located on the controller.

Name	Description
AC ammeter	Meter displays the AC output amperage. Use the selector switch to choose the phase current.
AC voltmeter	Meter displays the AC output voltage. Use the selector switch to choose the output lead circuits.
DC voltmeter	Meter displays the voltage of the starting battery(ies).
Alarm horn	Horn sounds if any fault or anticipatory condition exists. Place the generator set master switch in the AUTO position before silencing the horn. See the Controller Resetting Procedure later in this section.
Alarm silence switch	Switch disconnects the alarm during service (place the generator set master switch in the AUTO position before silencing the alarm horn). Restore the alarm horn switches at all locations (controller, remote annunciator, and audio/visual alarm) to normal positions after correcting the fault shutdown to avoid reactivating the alarm horn. See the Controller Resetting Procedure later in this section.
Auxiliary fault lamp	Lamp flashes or lights when the controller detects a fault. See the lamp conditions section following. NOTE: Low seawater pressure and high exhaust temperature will light the auxiliary fault indicator and are possible causes of the fault.
Frequency meter	Meter displays the frequency (Hz) of the generator set output voltage.
Generator set master switch	Switch functions as the controller reset and generator set operation switch.
High engine temperature lamp	Lamp illuminates if the generator set shuts down because of high engine temperature. Shutdown occurs 5 seconds after the engine reaches temperature shutdown range.
Hourmeter	Hourmeter records the generator set total operating hours for reference in maintenance scheduling.
Lamp test switch	Switch tests the controller indicator lamps.
Low oil pressure lamp	Lamp illuminates if the generator set shuts down because of low oil pressure. Shutdown occurs 5 seconds after the engine reaches oil pressure shutdown range.
Overcrank lamp	Lamp illuminates and cranking stops if the engine does not start after 45 seconds of continuous cranking or 75 seconds of cyclic cranking. Cranking stops and overcrank lamp lights after 15 seconds if the starter or engine does not turn (locked rotor). Overcrank lamp flashes if speed sensor signal is absent longer than one second. **Note:** The generator set controller's automatic restart function attempts to restart the generator set if the engine speed drops below 13 Hz (390 rpm). Continued decreased engine speed causes an overcrank condition.
Overspeed lamp	Lamp illuminates if the generator set shuts down because governed frequency on 50 and 60 Hz models exceeds 70 Hz.
Water temperature gauge	Gauge displays the engine coolant temperature.
Oil pressure gauge	Gauge displays the engine oil pressure.
Scale lamps (upper/lower)	Lamps indicate which AC voltmeter and/or ammeter scales to read.
Selector switch	Switch selects which generator set output circuits to measure. When switched to a position with two circuit labels, measures amperage on the lead shown in the upper label and measures voltage between the two leads shown in the lower label. The AC ammeter and voltmeter function only with the switch in the ON position.
Voltage adjustment potentiometer	Potentiometer fine-tunes (±5%) the generator set output voltage. Fine adjustment (5%) of generator output voltage level.
Auxiliary prealarm lamp	Lamp illuminates when customer-provided sensing devices activate the pump.
Emergency stop lamp	Lamp illuminates and the generator set shuts down when the operator energizes the optional emergency stop switch. The lamp needs the optional emergency stop switch to function.
Generator switch not in auto lamp	Lamp illuminates when the generator set master switch is in the RUN or OFF/RESET position.
Low fuel lamp	Lamp illuminates when the fuel level in the tank approaches empty. The lamp needs a low fuel sensor in the fuel tank to function.
High water temperature lamp	Lamp illuminates when the water temperature approaches shutdown range. The lamp needs an optional prealarm sender kit to function.
Prealarm high engine temperature lamp	Lamp illuminates when the engine coolant temperature approaches shutdown range. The lamp needs an optional prealarm sender kit to function.
Prealarm low oil pressure lamp	Lamp illuminates when the engine oil pressure approaches shutdown range. The lamp needs an optional prealarm sender kit to function.
System ready lamp	Lamp illuminates when the generator set master switch is in AUTO position and the system senses no faults.
Emergency stop switch	Switch, if activated, instantly shuts down the generator set in emergency situations. Use the emergency stop switch for emergency shutdowns only. Use the generator set master switch for normal shutdowns.

2.8.2 Fuses and Terminal Strips

The following table describes the controller circuit board fuses and controller terminal strips.

Name	Description
3-amp remote annunciator fuse	Fuse protects the remote annunciator circuit, A/V alarm, and isolated alarm kit, if equipped.
3-amp controller fuse	Fuse protects the controller circuit board, speed sensor, and lamp circuit board.
15-amp engine and accessories fuse	Fuse protects the engine/starting circuitry and accessories.
Controller TB1 terminal strip	Terminal strip provides connection points for customer-supplied sensing devices and generator set accessories such as the emergency stop switch, remote start stop/switch, audio/visual alarms, etc., to the controller. Figure 2-23 shows the location of the TB1 terminal strip on the controller circuit board. Refer to the wiring diagrams for information on connecting accessories to the TB1 terminal strip.
Controller TB2 terminal strip	Terminal strip provides connection points for crank mode selection (cyclic or continuous) and remote start/stop switch inputs of operation. Figure 2-23 shows the location of the TB2 terminal strip on the controller circuit board. Refer to the wiring diagrams for connection information.

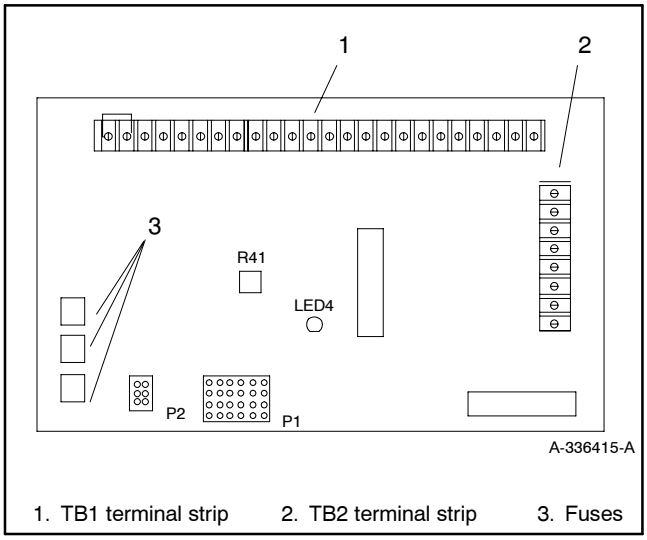


Figure 2-23 TB1 and TB2 Terminal Strips on Decision-Maker™ 3+ Controller Circuit Board

2.8.3 Auxiliary Fault Lamp Conditions

The following descriptions define the possible auxiliary fault lamp conditions.

Flashing Lamp Conditions

No AC Output. The auxiliary lamp flashes immediately if the controller senses no AC output while the generator set runs (except during the first 10 seconds after startup). The flashing stops and the light goes out when the controller senses AC output. The controller requires no manual reset.

Low Battery Voltage. The auxiliary lamp flashes if the battery power was reconnected or was low and then restored while the generator set master switch was in the RUN or AUTO position. A possible cause is a temporary low battery condition when the battery is weak or undersized for the application. To clear the low battery voltage condition, place the generator set master switch in the OFF/RESET position.

Continuous-On Lamp Conditions

Emergency Stop Switch Energized. Upon activation of the emergency stop switch, if equipped, the auxiliary lamp lights and the generator set shuts down immediately.

Emergency Stop Switch Reset. Resetting the optional emergency stop switch while the generator set master switch is in the AUTO or RUN position causes the auxiliary lamp to light. Place the generator set master switch in the OFF/RESET position to clear the auxiliary lamp ON condition.

Note: Auxiliary Delay Shutdown. The auxiliary lamp lights and the engine shuts down 5 seconds after the high oil temperature (P1-13) or auxiliary delay shutdown (P1-15) fault, if equipped, occurs. Auxiliary Delay Shutdown is inhibited during the first 30 seconds after crank disconnect.

Note: Overvoltage Shutdown. If a generator set is equipped with this kit, the auxiliary lamp lights and the engine shuts down immediately when an overvoltage condition occurs.

Note: Auxiliary Immediate Shutdown. The auxiliary lamp lights and the engine shuts down immediately when any customer-supplied sensing devices connected to auxiliary immediate shutdown ports (P1-17 and P1-18) activate them.

2.8.4 Starting Generator Set

The following procedures describe starting the generator set.

Local Starting (Nonautomatic). Move the generator set master switch to the RUN position to start the generator set at the controller.

Automatic (Auto) Starting. Move the generator set master switch to the AUTO position to allow startup by the automatic transfer switch or remote start/stop switch (connected to controller terminals TB1-3 and TB1-4).

Note: The alarm horn sounds whenever the generator set master switch is not in the AUTO position.

Note: The transient start/stop function of the Decision-Maker™ 3+ controller prevents accidental cranking of the rotating engine. When the generator set master switch is momentarily placed in the OFF/RESET position, then quickly returned to RUN, the generator set slows to 249 rpm and then recranks before returning to its rated speed.

Note: The Decision-Maker™ 3+ controller's automatic restart function attempts to restart the generator set if the engine speed drops below 390 rpm (generator output frequency of 13 Hz). Continued decreased engine speed causes an overcrank fault condition.

Crank Mode Selection

The Decision-Maker™ 3+ controller cranks continuously for up to 45 seconds or cyclically for up to 75 seconds (crank 15 seconds, rest 15 seconds, crank 15 seconds, etc.) before overcrank shutdown. Select the crank mode (cyclic or continuous) on the controller circuit board terminal strip. For cyclic cranking, leave circuit board terminal TB2-9 open. For continuous cranking, attach a jumper between circuit board terminal TB2-9A (ground) and terminal TB2-9.

2.8.5 Stopping Generator Set

The following procedures describe stopping the generator set.

Normal Stopping

1. **Cooldown.** Run the generator set at no load for 5 minutes to ensure adequate engine cooldown.
2. **Stopping.** Move the generator set master switch to the OFF/RESET position. The engine stops.

   Note: The generator set continues running during a 5-minute cooldown cycle if a remote switch or automatic transfer switch signals the engine to stop.

Emergency Stopping

Move the generator set master switch to the OFF/RESET position or activate the remote emergency stop, if equipped, for immediate shutdown. The controller AUXILIARY lamp lights and the generator set shuts down on activation of the emergency stop switch. The remote annunciator and/or A/V alarms, if equipped, signal an emergency stop.

2.8.6 Prime Power Mode Operation

The Decision-Maker™ 3+ controller operates in either the normal mode or the prime power mode. In prime power mode, the controller draws less current, minimizing the battery drain. Consider using the prime power mode for installations that do not have a battery charger.

Moving the generator set master switch to the OFF/RESET position disables all controller functions. Moving the generator set master switch to the AUTO position restores controller functions.

Enabling and Disabling the Prime Power Mode. Enable the prime power mode by connecting jumpers across the following terminals on terminal strip TB2 on the controller circuit board:

- TB2-1P and TB2-2P
- TB2-3P and TB2-4P
- TB2-3 and TB2-4

See Figure 2-23. Remove the jumpers listed above to disable the prime power mode.

Prime Power Starting. The prime power mode provides local starting only at the controller. When the generator set master switch is in the OFF/RESET position, the controller functions are inoperative. Move the generator set master switch to the AUTO position to start the generator set. Do not start the generator set with the master switch in the RUN position because the alarm horn will sound.

Note: Move the generator set master switch to the AUTO position to return controller functions to normal.

Prime Power Stopping. Move the generator set master switch to the OFF/RESET position to stop the generator set and power down the controller.

Note: The controller functions are inoperative when the generator set master switch is in the OFF/RESET position.

2.8.7 Fault Shutdowns

The generator set shuts down automatically under the following fault conditions and cannot be restarted until the fault condition is corrected. The system automatically resets when the problem is corrected or the generator set cools (if high engine temperature was the fault).

Name	Description
High engine temperature	Shutdown occurs 5 seconds after the fault. The high engine temperature shutdown does not function during the first 5 seconds after startup. **Note:** The high temperature shutdown functions only when the coolant level is in the operating range.
High exhaust temperature	Shutdown occurs 5 seconds after the fault. The high exhaust temperature shutdown does not function during the first 5 seconds after startup.
Low coolant level (water-cooled engines only)	Shutdown occurs 5 seconds after fault. The low coolant level shutdown does not function during the first 5 seconds after startup.
Low oil pressure	Shutdown occurs 5 seconds after the fault. The low oil pressure shutdown does not function during the first 5 seconds after startup. **Note:** The low oil pressure shutdown does not protect against low oil level. Check the engine oil level.
Overcrank	Shutdown occurs after 45 seconds of continuous cranking or 75 seconds of cyclic cranking (crank 15 seconds, rest 15 seconds, crank 15 seconds, etc.).
Overspeed	Shutdown occurs immediately when the governed frequency on 50 and 60 Hz models exceeds 70 Hz.
Overvoltage (optional)	The generator set shuts down and the auxiliary lamp lights when voltage is 15% or more over the nominal voltage for 2 seconds or longer. **Note:** Overvoltage can damage sensitive equipment in less than one second. Install separate overvoltage protection on on-line equipment requiring faster shutdown.

2.8.8 Controller Resetting Procedure (Following Fault Shutdown)

Use the following procedure to restart the generator set after a fault shutdown. Refer to Resetting the Emergency Stop Switch in this section to reset the generator set after an emergency stop.

1. Place the controller alarm horn silence switch in the SILENCE position to activate the A/V annunciator alarm horn and lamp, if equipped. Place the A/V annunciator alarm switch in the SILENCE position to stop the alarm horn. The A/V annunciator lamp stays lit. (The A/V alarm uses one lamp to indicate a fault shutdown; the respective fault lamp on the remote annunciator lights to indicate a fault condition.)
2. Disconnect the generator set from the load using the line circuit breaker or automatic transfer switch.
3. Correct the cause of the fault shutdown. See the Safety Precautions at the beginning of this section before proceeding.
4. Place the generator set master switch in the OFF/RESET position and then in the RUN position to start the generator set. The A/V annunciator alarm horn sounds and the lamp, if equipped, darkens.
5. Test operate the generator set to verify that the cause of the shutdown has been corrected.
6. Reconnect the generator set to the load via the line circuit breaker or automatic transfer switch.
7. Place the generator set master switch in the AUTO position for startup by a remote transfer switch or remote start/stop switch. Place the A/V annunciator alarm switch, if equipped, in the NORMAL position.
8. Place the generator set master switch in the AUTO position before silencing the alarm horn.

2.8.9 Resetting Emergency Stop Switch

Use the following procedure to restart the generator set after an emergency stop switch shutdown. Refer to the Controller Resetting Procedure in this section to restart the generator set following a fault shutdown. The generator set does not crank until the operator completes the resetting procedure.

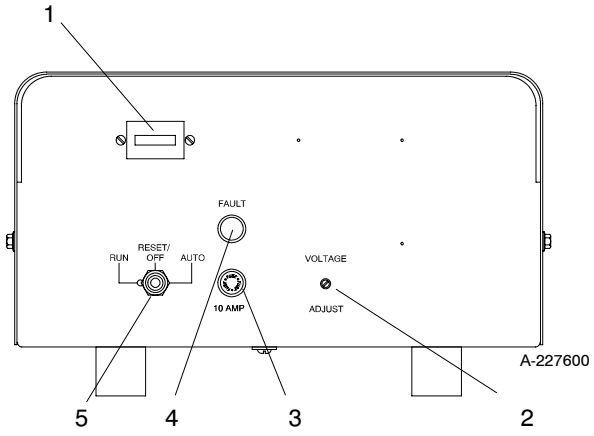
Note: The controller auxiliary lamp lights when the generator set master switch is in the RUN or AUTO position during the resetting procedure.

Procedure to Restart Generator Set After an Emergency Stop Shutdown:

1. Determine the cause of the emergency stop and correct the problem(s).
2. Reset the controller emergency stop switch by rotating the switch clockwise until the switch springs back to the original position.
3. Toggle the generator set master switch to OFF/RESET and then to RUN or AUTO to restart the generator set.

2.9 Decision-Maker™ 1 Controller Operation

For identification of the basic controller's indicators and controls and their functions, refer to Figure 2-24.



1. Hourmeter
2. Voltage adjustment
3. 10-amp controller fuse
4. Fault lamp
5. Generator set master switch

Figure 2-24 Decision-Maker™ 1 Controller

2.9.1 Controls and Indicators

The following table describes the controls and indicators located on the controller.

Name	Description
Fault lamp	Lamp illuminates during engine shutdown if the engine shuts down because of one of the following faults: high engine temperature, low water level, low oil pressure, overcrank, or overspeed. See Section 2.9.4, Fault Shutdowns, for additional shutdown information.
Generator set master switch	Switch functions as the controller reset and generator operation switch.
Hourmeter	Hourmeter records the generator set total operating hours for reference in maintenance scheduling.
Voltage adjust potentiometer	Potentiometer fine-tunes (±5%) generator output voltage.
10-amp controller fuse	Fuse protects the controller circuitry from short circuits and overloads.

2.9.2 Starting Generator Set

The following procedures describe starting the generator set.

Local Starting. Move generator set master switch to the RUN position to immediately start the generator set.

Automatic (Auto) Starting. Move the generator set master switch to the AUTO position to allow startup by the automatic transfer switch or the remote start/stop switch (connected to controller terminals TB1-3 and TB1-4).

Note: The controller provides up to 30 seconds of continuous cranking before the overcrank shutdown occurs.

2.9.3 Stopping Generator Set

The following procedure describe how to stop the generator set.

Normal Stopping

1. **Cooldown**. Run the generator set at no load for 5 minutes to ensure adequate engine cooldown.
2. **Stopping**. Move the generator set master switch to the OFF/RESET position. The engine stops.

2.9.4 Fault Shutdowns

The generator set shuts down automatically under the following fault conditions and cannot be restarted until the fault condition is corrected. The system automatically resets when the problem is corrected or the generator set cools (if high engine temperature was the fault).

Fault	Description
High engine temperature	Shutdown occurs 5 seconds after the fault. The high engine temperature shutdown does not function during the first 5 seconds after startup. **Note:** The high temperature shutdown functions only when the coolant level is in the operating range.
High exhaust temperature	Shutdown occurs 5 seconds after the fault. The high exhaust temperature shutdown does not function during the first 5 seconds after startup.
Low coolant level	Shutdown occurs 5 seconds after the fault. Low coolant level shutdown does not function during the first 5 seconds after startup.
Low oil pressure	Shutdown occurs 5 seconds after the fault. Low oil pressure shutdown does not function during the first 5 seconds after startup. **Note:** The low oil pressure shutdown does not protect against low oil level. Check the oil level at the engine.
Overcrank	Shutdown occurs after 30 seconds of continuous cranking. Shutdown occurs after 30 seconds if the engine or starter does not turn (locked rotor).
Overspeed	Shutdown occurs immediately when the governed frequency on 50 and 60 Hz models exceeds 70 Hz.

2.9.5 Controller Resetting Procedure (Following Fault Shutdown)

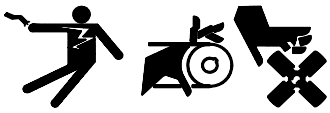
Use the following procedure to restart the generator set after a fault shutdown.

1. Disconnect the generator set from the load using the line circuit breaker or automatic transfer switch. See the Safety Precautions at the beginning of this section before proceeding.
2. Correct the cause of the fault shutdown. See the Safety Precautions at the beginning of this section before proceeding.
3. Start the generator set by moving the generator set master switch to RESET/OFF and then to RUN.
4. Verify that the cause of the shutdown has been corrected by test operating the generator set.
5. Reconnect the generator set to the load using the line circuit breaker or automatic transfer switch.
6. Move the generator set master switch to the AUTO position for startup by remote transfer switch or remote start/stop switch.

Notes

3.1 General Maintenance

⚠ 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 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

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

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

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

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

Engine Service. Perform generator set engine service at the intervals specified by the engine operation manual.

Generator Set Service. Perform generator set service at the intervals specified by the generator set operation manual.

If the generator set operates under dusty or dirty conditions, use *dry* compressed air to blow dust out of the alternator. With the generator set running, direct the stream of air in through the cooling slots at the alternator end.

Service Log. Use the Operating Hour Service Log located in the back of this manual to document performed services.

Service Schedule. Perform maintenance on each item in the service schedule at the designated intervals for the life of the generator set. For example, an item requiring service every 100 hours or 3 months also requires service after 200 hours or 6 months, 300 hours or 9 months, and so on.

x:sm:004:001

3.2 Generator Bearing

Replace the end bracket bearing every 10,000 hours of operation. Service more frequently if bearing inspection indicates excessive rotor end play or bearing damage from corrosion or heat buildup. Replace the tolerance ring, if equipped, if removing the end bracket. The end bracket bearing is sealed and requires no additional lubrication. Have all generator service performed by an authorized service distributor/dealer.

3.3 Storage Procedure

Perform the following storage procedure before taking a generator set out of service for three months or longer. Follow the engine manufacturer's recommendations, if available, for fuel system and internal engine component storage.

x:sm:002:001

3.3.1 Lubricating System

Prepare the engine lubricating system for storage as follows:

1. Run the generator set for a minimum of 30 minutes to bring it to normal operating temperature.
2. Stop the generator set.
3. With the engine still warm, drain the oil from the crankcase.
4. Remove and replace the oil filter.
5. Refill the crankcase with oil suited to the climate.
6. Run the generator set for two minutes to distribute the clean oil.
7. Stop the generator set.
8. Check the oil level and adjust, if needed.

x:sm:002:002

3.3.2 Cooling System

Prepare the cooling system for storage as follows:

1. Check the coolant freeze protection using a coolant tester.
2. Add or replace coolant as necessary to ensure adequate freezing protection. Use the guidelines included in the engine operation manual.
3. Run the generator set for 30 minutes to redistribute added coolant.

x:sm:002:003

3.3.3 Fuel System

Prepare the fuel system for storage as follows:

Diesel-Fueled Engines

1. Fill the fuel tank with #2 diesel fuel.
2. Condition the fuel system with compatible additives to control microbial growth.
3. Change the fuel filter/separator and bleed the fuel system. See the engine service manual.

3.3.4 Exterior

Prepare the exterior for storage as follows:

1. Clean the exterior surface of the generator set.
2. Seal all engine openings except for the air intake with nonabsorbent adhesive tape.
3. To prevent impurities from entering the air intake and to allow moisture to escape from the engine, secure a cloth over the air intake.
4. Mask electrical connections.
5. Spread a light film of oil over unpainted metallic surfaces to inhibit rust and corrosion.

x:sm:002:006a

3.3.5 Battery

Perform battery storage after all other storage procedures.

1. Place the generator set master switch in the OFF/RESET position.
2. Disconnect the battery(ies), negative (–) lead first.
3. Clean the battery. Refer to the battery manufacturer's instructions for the battery cleaning procedure.
4. Place the battery in a cool, dry location.
5. Connect the battery to a float/equalize battery charger or charge it monthly with a trickle battery charger. Refer to the battery charger manufacturer's recommendations.
6. Maintain a full charge to extend battery life.

Section 4 Troubleshooting

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

Use the chart on the following page 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.

Corrective action and testing often require knowledge of electrical and electronic circuits. To avoid additional problems caused by incorrect repairs, have an authorized service distributor/dealer perform service.

NOTICE

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

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										Controller master switch in the OFF/RESET position	Move the controller master switch to the RUN or AUTO position.	Section 2
x	x			x						Controller fuse blown	Replace the blown controller fuse. If the fuse blows again, troubleshoot the controller.†	Section 2, W/D
x				x						Controller circuit breaker tripped	Reset the controller circuit breaker.	Section 2
x										Controller master or start/stop switch inoperative	Replace the controller master or start/stop switch.	—
				x						Controller fault	Troubleshoot the controller.†	Section 5 or 6
x	x									Controller circuit board(s) inoperative	Replace the controller circuit board.	Section 5 or 6
Cooling System												
						x		x		Air openings clogged	Clean the air openings.	—
						x				Impeller inoperative	Replace the impeller	Gen. O/M
						x		x		Seawater strainer clogged or restricted	Clean the strainer.	Gen. O/M
				x						High temperature shutdown	Allow the engine to cool down. Then troubleshoot the cooling system.	Eng. O/M
				x						Low coolant level shutdown, if equipped	Restore the coolant to normal operating level.	Gen. O/M
						x				Coolant level low	Restore the coolant to normal operating level.	Gen. O/M
						x				Thermostat inoperative	Replace the thermostat.	Eng. S/M
						x				Cooling water pump inoperative	Tighten or replace the belt. Replace the water pump.	Eng. O/M or 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.

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.	Eng. O/M
x	x									Battery weak or dead	Recharge or replace the battery. The spec sheet provides recommended battery CCA rating.	S/S
x				x						Engine harness connector(s) not locked tight	Disconnect the engine harness connector(s) then reconnect it to the controller.	W/D
				x						Fault shutdown	Reset the fault switches and troubleshoot the controller.	Section 2
				x						High exhaust temperature switch inoperative	Replace the inoperative switch.	Gen. S/M or W/D
x	x									Starter/starter solenoid inoperative	Replace the starter or starter solenoid.	Eng. S/M
				x						High water temperature switch inoperative	Replace the inoperative switch.	Gen. S/M
Engine												
	x	x			x			x		Air cleaner clogged	Clean or replace the filter element.	Gen. 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.†	Section 7
					x				x	Valve clearance incorrect	Adjust the valves.†	Eng. S/M
									x	Vibration excessive	Tighten all loose hardware.	—

* 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.

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						Fuel tank empty or fuel valve shut off	Add fuel and move the fuel valve to the ON position.	—
	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			x					Air in fuel system (diesel only)	Bleed the diesel fuel system.	Eng. O/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 injection timing out of adjustment (diesel only)	Adjust the fuel injection timing.†	Eng. S/M
	x				x			x		Fuel feed or injection pump inoperative (diesel only)	Rebuild or replace the injection pump.†	Eng. S/M
Generator												
			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							Wiring, terminals, or pin in the exciter field open	Check for continuity.	Section 7, W/D
			x							Main field (rotor) inoperative (open or grounded)	Test and/or replace the rotor.†	Section 7
			x							Stator inoperative (open or grounded)	Test and/or replace the stator.†	Section 7
									x	Vibration excessive	Tighten loose components.†	—
			x	x						Voltage regulator out of adjustment	Adjust the voltage regulator.	Section 7
			x	x						Voltage regulator inoperative	Replace the voltage regulator fuse, If the fuse blows again, troubleshoot the voltage regulator.	Section 7
Lube System												
						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
	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

* 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

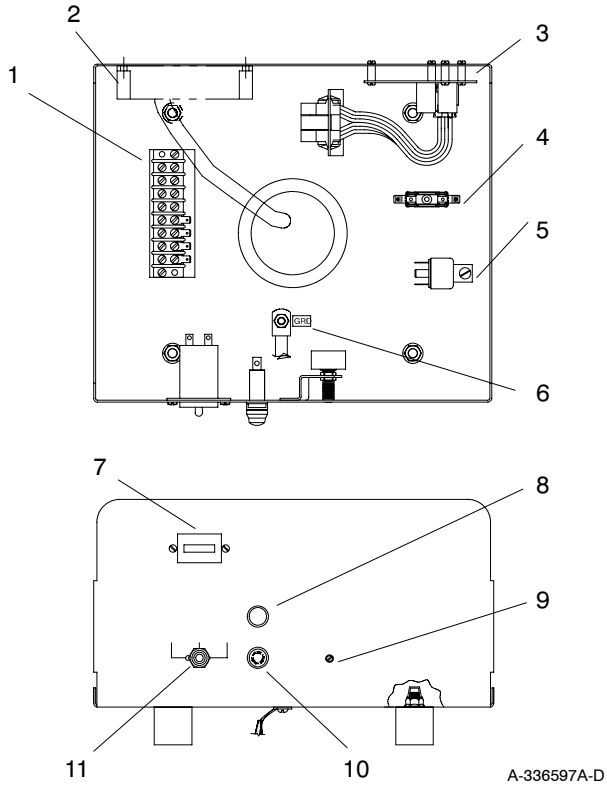
† Have an authorized service distributor/dealer perform this service.

bp #

5.1 Decision-Maker™ 1 Relay Controller

The following text covers the relay controller sequence of operation during generator start, run, stop, and fault shutdown modes. Use this information as a starting point for controller fault identification. See Section 2 to identify controller external components. See Figure 5-1 to identify internal components of the relay controller. Use the LEDs on the controller circuit board to assist in the troubleshooting process. An illuminated LED indicates the respective relay is receiving power; the LED does not indicate whether that relay is energized. See Figure 5-2 and Figure 5-3.

Circuit board F-254717 has five relays with an external K10 relay for engine run components. The fifth relay designated K5 latches the fault lamp during fault shutdown when in the auto/remote start mode.

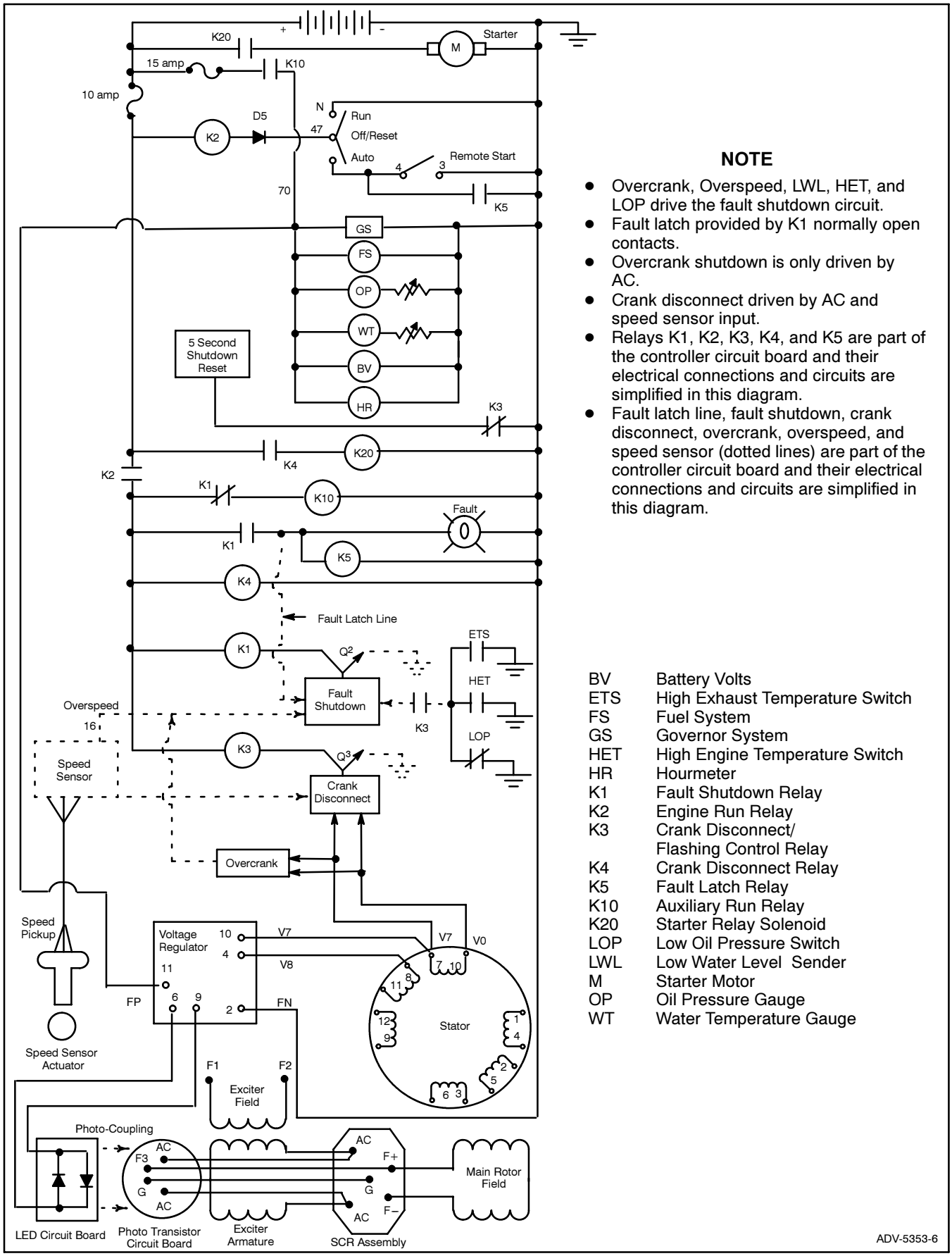


1. TB1 AC terminal block
2. Governor
3. Controller main circuit board
4. 15-amp fuse
5. K5 relay
6. Ground strap
7. Hourmeter (front panel)
8. Fault lamp (front panel)
9. Voltage adjust potentiometer (front panel)
10. 10-amp fuse (front panel)
11. Generator set master switch (front panel)

Figure 5-1 Decision-Maker™ 1 Relay Controller Internal Components

Function	Relay	Relay Contact Normal Position	Relay Contact Action	Energizes/Action:
Starting: Close the start/stop switch between N and 47. **Note**: Fault shutdowns are inhibited during startup until K3 energizes.				K2 relay and LED2 lights
	K2	Open	Close	K10 relay, engine components (fuel system, governor, ignition, etc.), K4 relay, and LED4 lights
	K10 or K5	Open	Close	Hourmeter on Decision-Maker™ 1
	K4	Open	Close	K20 relay
	K20	Open	Close	Starter motor
Running: Generator winding 7-10 produces AC output. **Note**: K3 relay must obtain AC output within 30 seconds or overcrank fault occurs.				K3 relay and LED3 lights
	K3	Closed	Open	Deenergizes K4 relay and LED4 deenergizes
	K4	Open	Open	Deenergizes starter motor
Stopping: Move the start/stop switch to open circuit between N and 47.				Deenergizes K2 relay and LED2 deenergizes
	K2	Open	Open	Deenergizes engine components; generator set shuts down
Fault shutdowns: Low oil pressure (LOP), high engine temperature (HET) after the engine operating temperature reaches 103°C (218°F), and high exhaust temperature (ETS) (wet exhaust only) after the exhaust temperature reaches 88-102°C (190-215°F). Contacts close 5-8 seconds after reaching shutdown level. **Note**: The fault shutdown latches to keep the fault lamp lit. Move the generator set master switch to OFF/RESET.				K1 relay, LED1 lights, and fault lamp
	K1	Closed	Open	Deenergizes engine components; generator set shuts down
Fault shutdown: Overspeed (OS). Contacts close when engine speed reaches shutdown level. Factory set at 70 Hz. **Note**: The fault shutdown latches to keep fault lamp lit. Move the generator set master switch to OFF/RESET.				K1 relay, LED1 lights, and fault lamp
	K1	Closed	Open	Deenergizes engine components; generator set shuts down
Fault shutdown: Overcrank (OC). Contacts close on overcrank (locked rotor) if the speed sensor signal is absent longer than 30 seconds. **Note**: The fault shutdown latches to keep the fault lamp lit. Move the generator set master switch to OFF/RESET.				K1 relay, LED1 lights, and fault lamp
	K1	Closed	Open	Deenergizes engine components; generator set shuts down

Figure 5-2 Relay Controller Sequence of Operation



NOTE

- Overcrank, Overspeed, LWL, HET, and LOP drive the fault shutdown circuit.
- Fault latch provided by K1 normally open contacts.
- Overcrank shutdown is only driven by AC.
- Crank disconnect driven by AC and speed sensor input.
- Relays K1, K2, K3, K4, and K5 are part of the controller circuit board and their electrical connections and circuits are simplified in this diagram.
- Fault latch line, fault shutdown, crank disconnect, overcrank, overspeed, and speed sensor (dotted lines) are part of the controller circuit board and their electrical connections and circuits are simplified in this diagram.

BV	Battery Volts
ETS	High Exhaust Temperature Switch
FS	Fuel System
GS	Governor System
HET	High Engine Temperature Switch
HR	Hourmeter
K1	Fault Shutdown Relay
K2	Engine Run Relay
K3	Crank Disconnect/ Flashing Control Relay
K4	Crank Disconnect Relay
K5	Fault Latch Relay
K10	Auxiliary Run Relay
K20	Starter Relay Solenoid
LOP	Low Oil Pressure Switch
LWL	Low Water Level Sender
M	Starter Motor
OP	Oil Pressure Gauge
WT	Water Temperature Gauge

Figure 5-3 Relay Controller Sequence of Operation with F-254717 and Later Circuit Boards

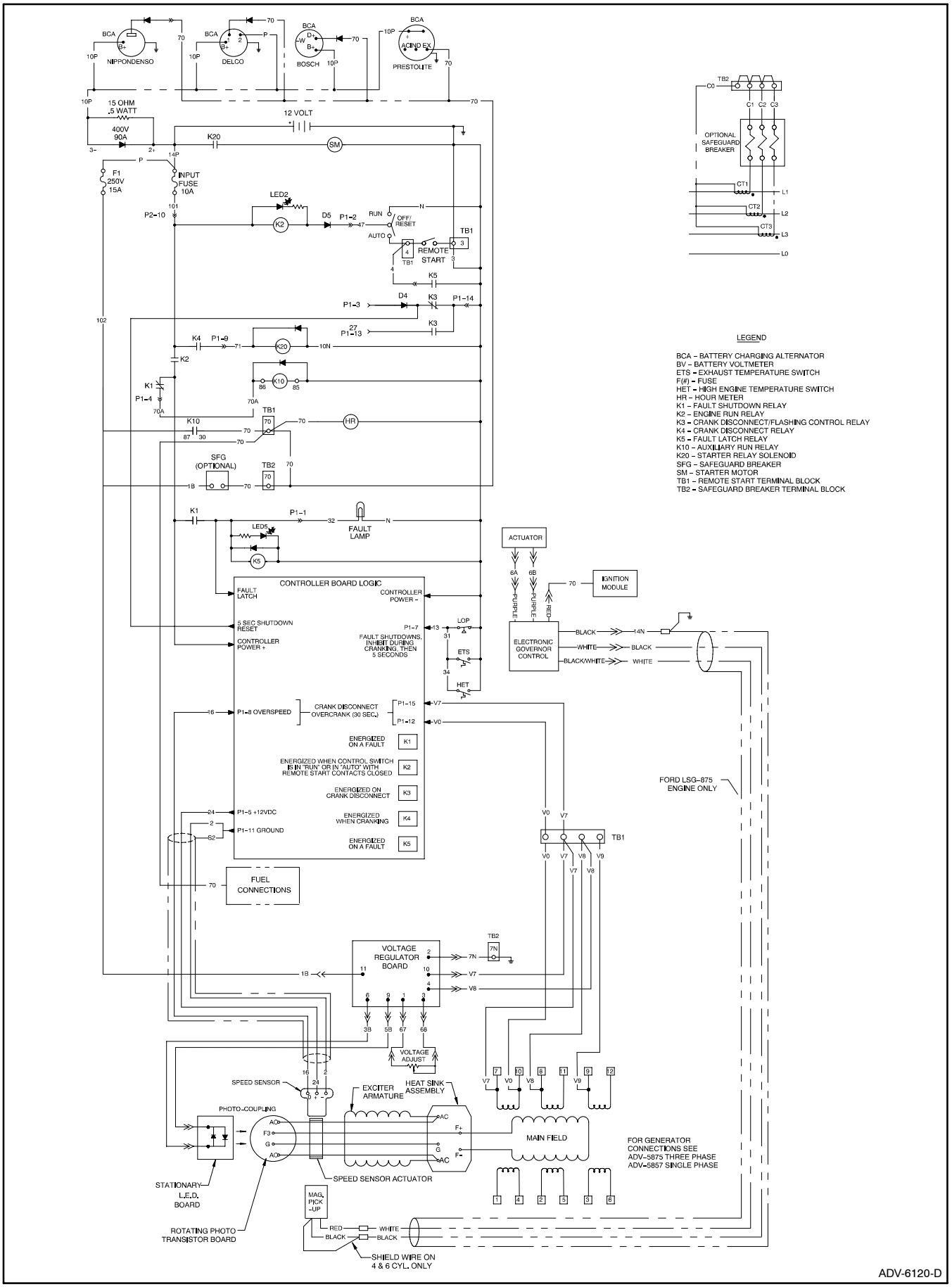
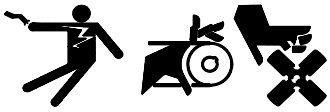


Figure 5-4 Decision-Maker™ 1 Relay Controller with F-254717 Circuit Board

5.2 Relay Controller

Use the following charts as a reference in troubleshooting individual problems. Before beginning any troubleshooting procedure, read all safety precautions at the beginning of this manual and those included in the text. Do not neglect these precautions.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

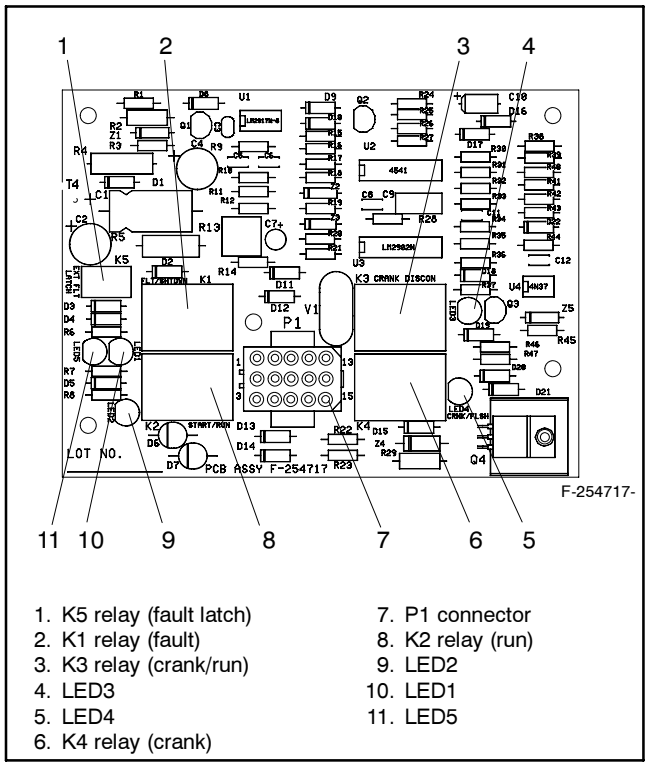
⚠ WARNING

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

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

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

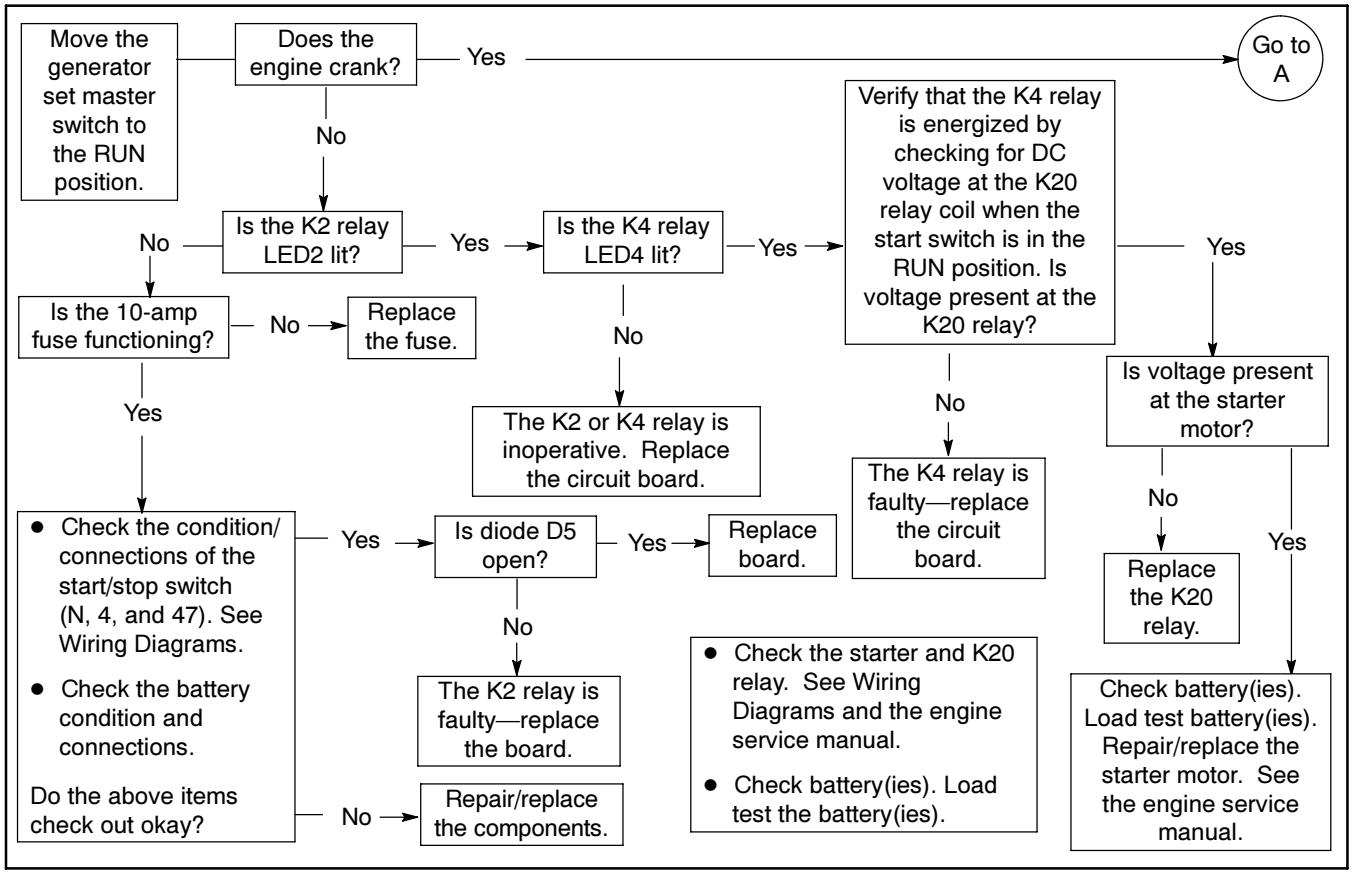
Use the following flowchart and Figure 5-5 as an aid in troubleshooting the main circuit board and the generator set. If the prescribed remedy does not correct the problem, replace the circuit board. The controller circuit board includes light emitting diodes (LEDs) indicating relay coil power and aids in circuit board and generator fault detection. When the K1, K2, K3, K4, or K5 relays receive power, the corresponding LED lights. The LED does not indicate whether the relay coil is energized. Determine if relay coil is energized, by analyzing the generator faults and performing a continuity test on the relay coil.

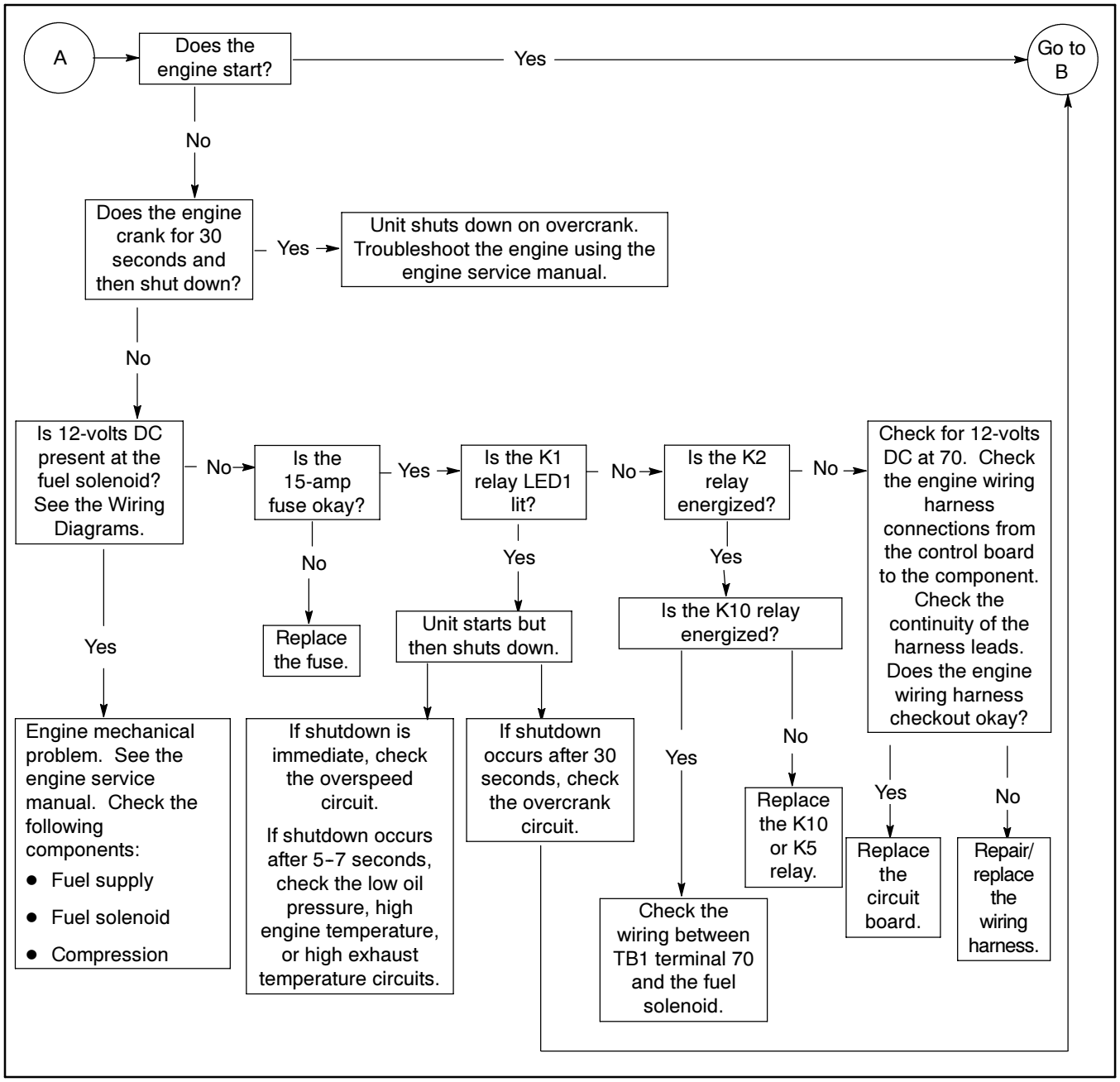


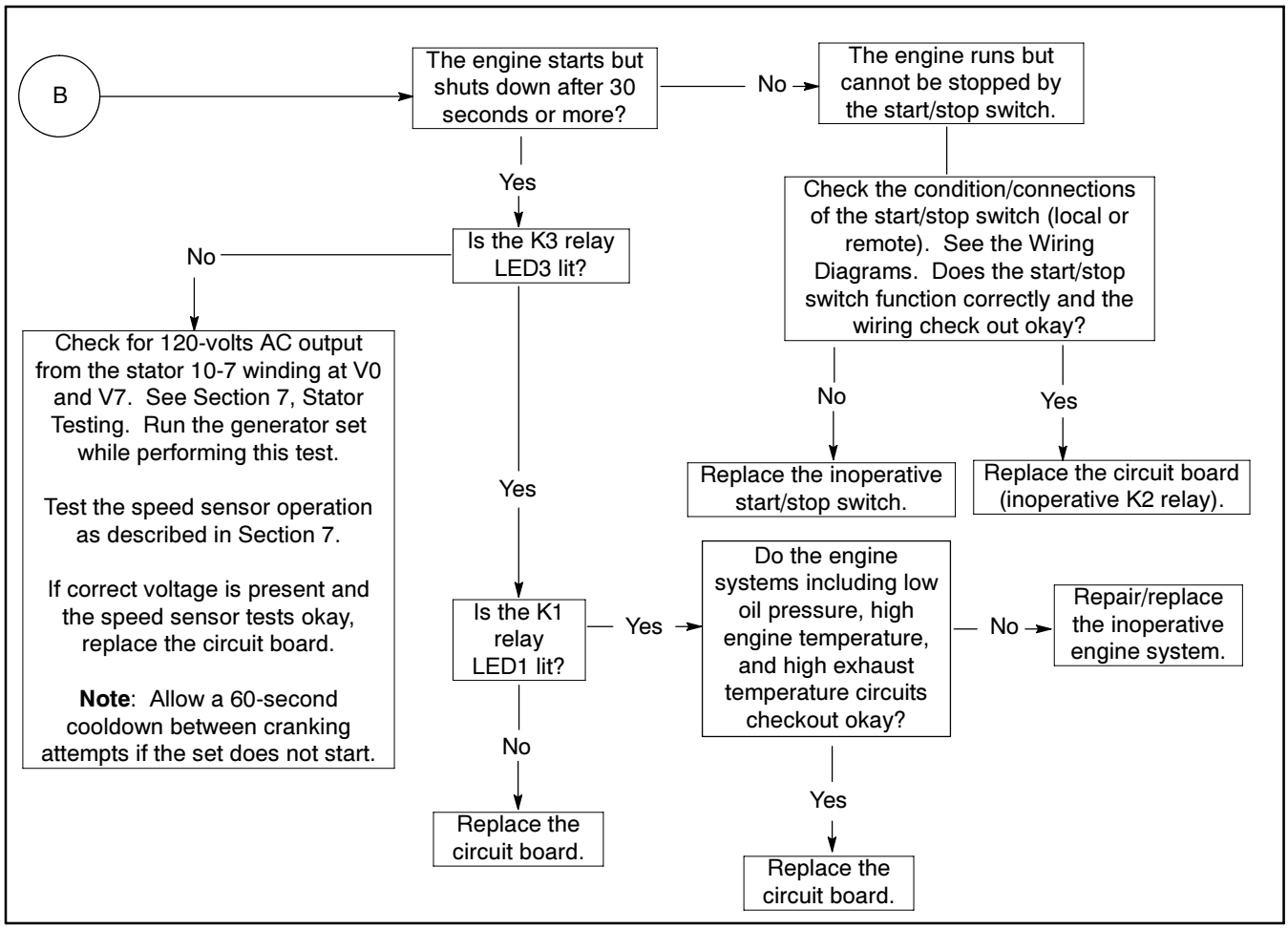
1. K5 relay (fault latch)
2. K1 relay (fault)
3. K3 relay (crank/run)
4. LED3
5. LED4
6. K4 relay (crank)
7. P1 connector
8. K2 relay (run)
9. LED2
10. LED1
11. LED5

Figure 5-5 Relay Controller Circuit Board F-254717

5.2.1 Relay Controller Flowchart



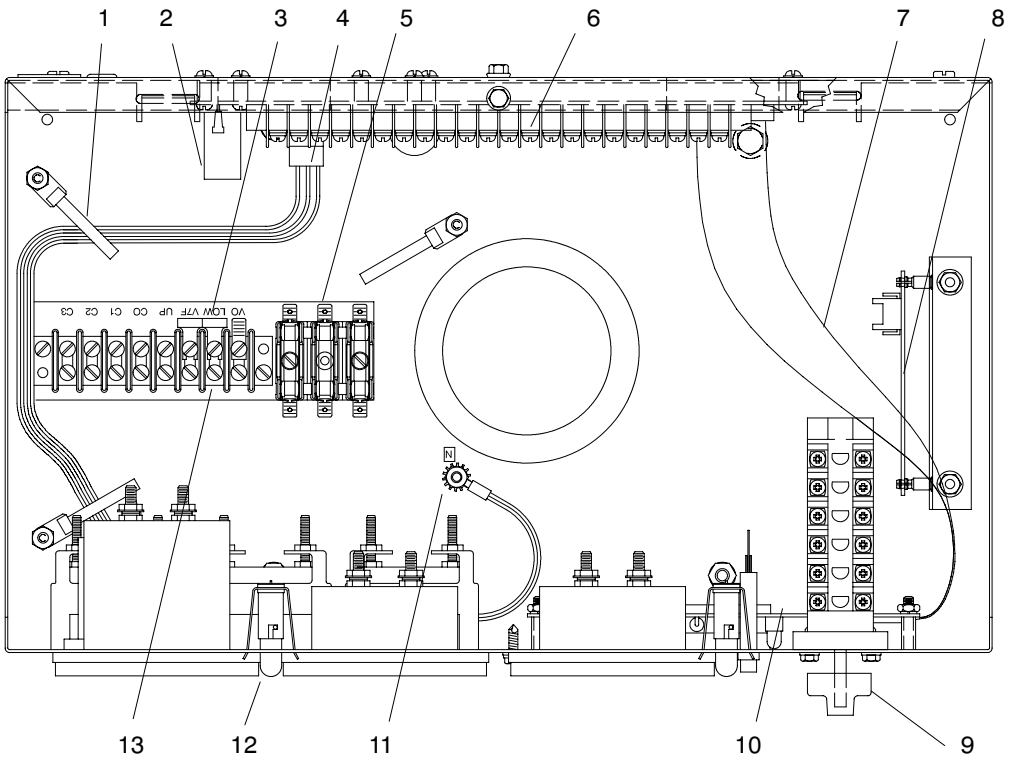

A
Does the engine start?
Yes
Go to B
No
Does the engine crank for 30 seconds and then shut down?
Yes
Unit shuts down on overcrank. Troubleshoot the engine using the engine service manual.
No
Is 12-volts DC present at the fuel solenoid? See the Wiring Diagrams.
No
Is the 15-amp fuse okay?
Yes
Is the K1 relay LED1 lit?
No
Is the K2 relay energized?
No
Check for 12-volts DC at 70. Check the engine wiring harness connections from the control board to the component. Check the continuity of the harness leads. Does the engine wiring harness checkout okay?
Yes
Engine mechanical problem. See the engine service manual. Check the following components:
Fuel supply
Fuel solenoid
Compression
No
Replace the fuse.
Yes
Unit starts but then shuts down.
Yes
Is the K10 relay energized?
Yes
If shutdown is immediate, check the overspeed circuit.
If shutdown occurs after 5–7 seconds, check the low oil pressure, high engine temperature, or high exhaust temperature circuits.
If shutdown occurs after 30 seconds, check the overcrank circuit.
Yes
Check the wiring between TB1 terminal 70 and the fuel solenoid.
No
Replace the K10 or K5 relay.
Yes
Replace the circuit board.
No
Repair/ replace the wiring harness.


B
The engine starts but shuts down after 30 seconds or more?
No
The engine runs but cannot be stopped by the start/stop switch.
Yes
Is the K3 relay LED3 lit?
No
Check the condition/connections of the start/stop switch (local or remote). See the Wiring Diagrams. Does the start/stop switch function correctly and the wiring check out okay?
No
Yes
Check for 120-volts AC output from the stator 10-7 winding at V0 and V7. See Section 7, Stator Testing. Run the generator set while performing this test.
Test the speed sensor operation as described in Section 7.
If correct voltage is present and the speed sensor tests okay, replace the circuit board.
Note: Allow a 60-second cooldown between cranking attempts if the set does not start.
Yes
Replace the inoperative start/stop switch.
Replace the circuit board (inoperative K2 relay).
Is the K1 relay LED1 lit?
Yes
Do the engine systems including low oil pressure, high engine temperature, and high exhaust temperature circuits checkout okay?
No
Repair/replace the inoperative engine system.
No
Yes
Replace the circuit board.
Replace the circuit board.

6.1 General Information

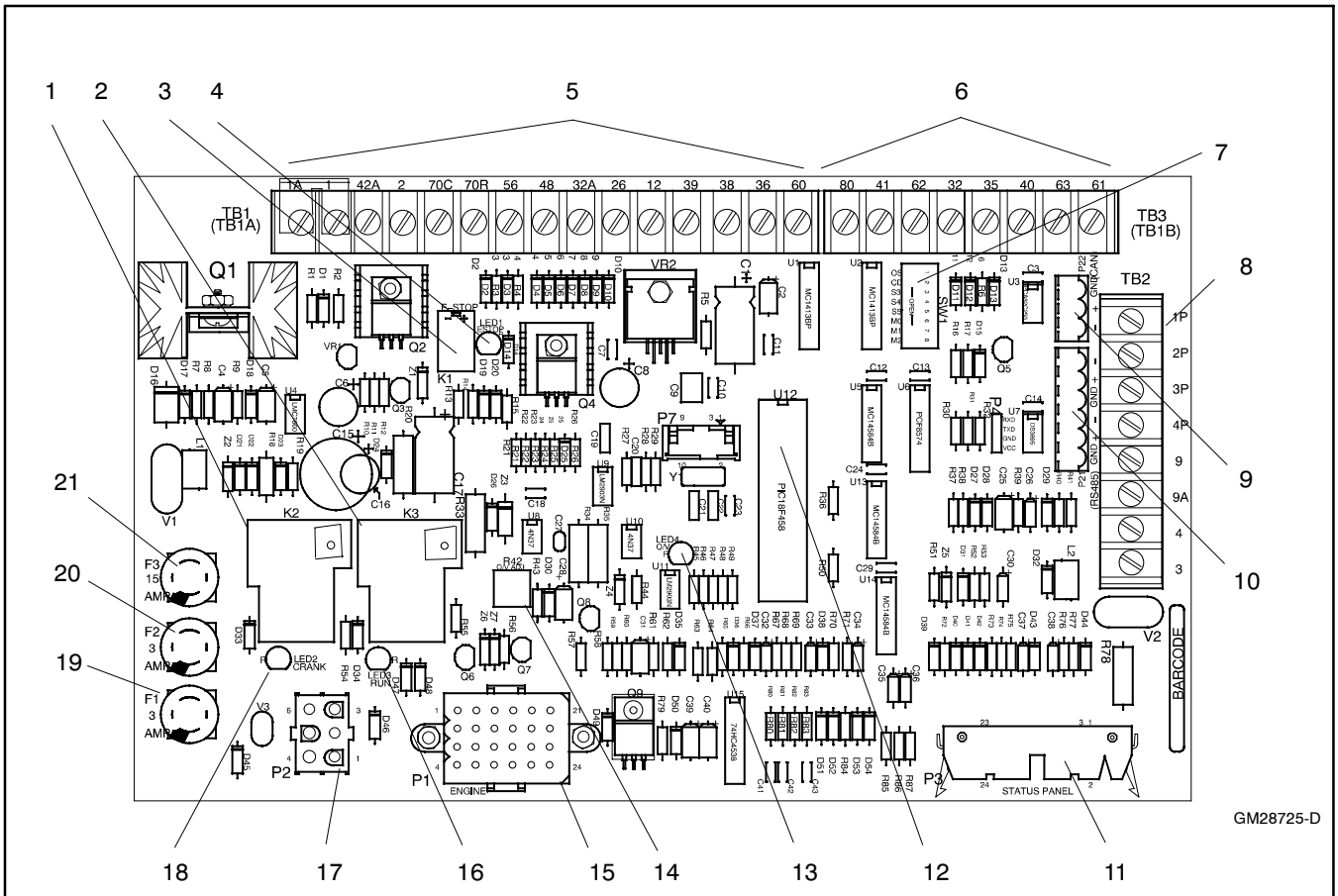
Use the following illustrations and text to troubleshoot the controller. Figure 6-1 through Figure 6-6 shows the locations of controller components and connections.

Troubleshooting procedures provided in this section and on the wiring diagrams may use active low and active high terminology. A battery ground connection energizes an *active low* circuit. A battery positive (+) connection energizes an *active high* circuit.



1. Accessory wire guide loops
2. Controller fuses
3. Lamp selection jumper
4. Control panel harness connector (P2)
5. AC fuse terminal block (TB3)
6. Controller main circuit board
7. P3/P4 harness
8. Engine speed pulse counter interface circuit board
9. Selector switch
10. Indicator panel circuit board
11. Controller DC ground terminal
12. Panel lamps
13. CT/meter scale terminal block (TB2)

Figure 6-1 16-Light Controller Components



1. K2 relay: control relay (crank)
2. K3 relay: control relay (run/fuel)
3. K1 relay: emergency stop
4. LED1 (emergency stop)
5. TB1 (TB1A) terminal strip
6. TB3 (TB1B) terminal strip
7. DIP switches
8. TB2 terminal strip
9. P22 for CAN (engine) communication connection
10. P21 for Modbus RS-485 communication connection
11. P3 connector (control panel harness) to P4 (LED indicator panel circuit board)
12. Microprocessor chip
13. LED4 (overvoltage)
14. R42 overvoltage adjustment
15. P1 connector (DC harness)
16. LED3 (K3 relay)
17. P2 connector (AC harness)
18. LED2 (K2 relay)
19. Fuse: 3 amp (F1) remote annunciator, battery positive (+) 42A connection
20. Fuse: 3 amp (F2) controller
21. Fuse: 15 amp (F3) engine and accessories

Figure 6-2 16-Light Controller Circuit Board GM28725 Components, Typical

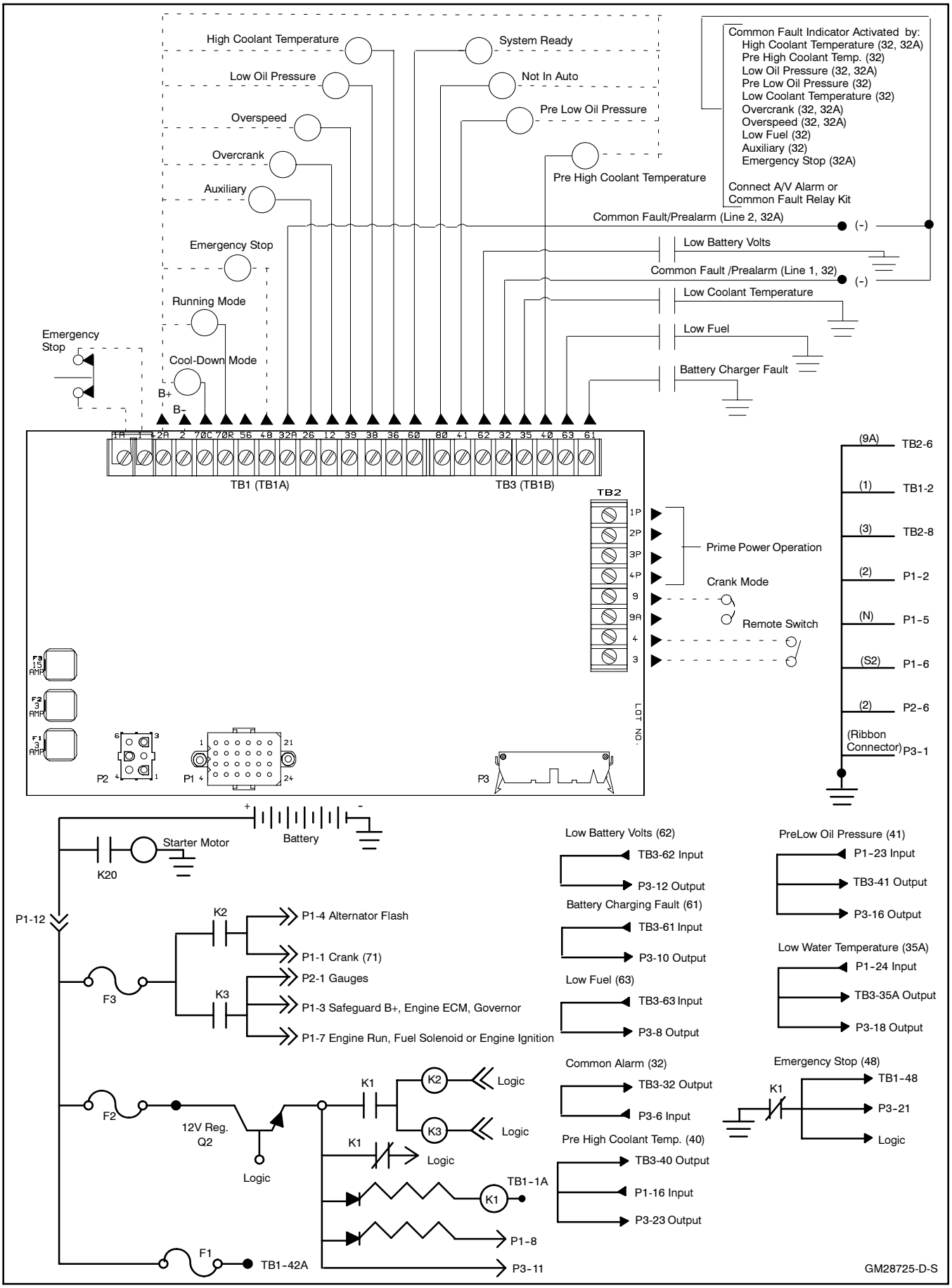


Figure 6-3 16-Light Controller Circuit Board GM28725 Connections TB1 (TB1A), TB3 (TB1B), and TB2

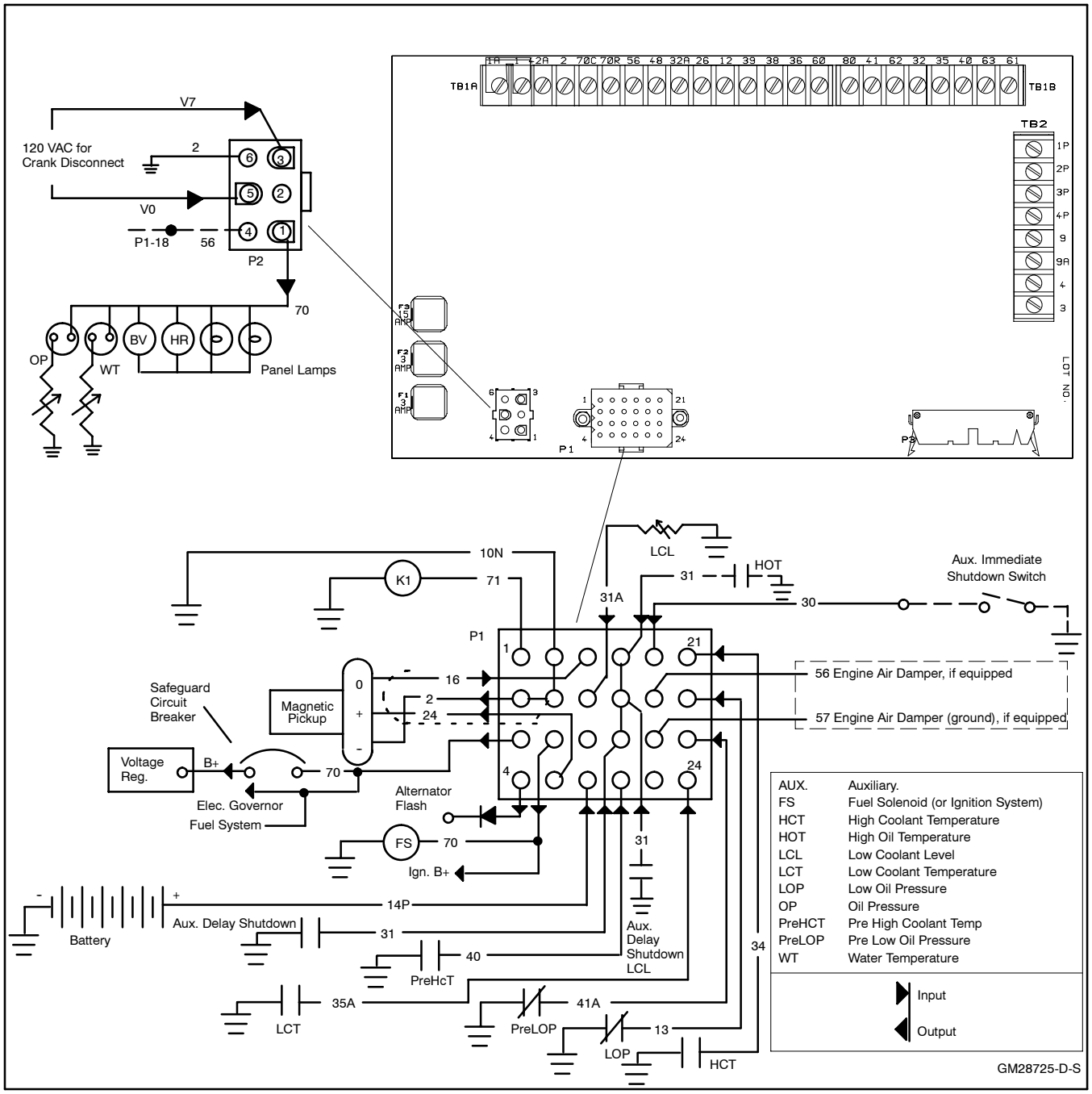


Figure 6-4 16-Light Controller Circuit Board GM28725 Connections P1 and P2

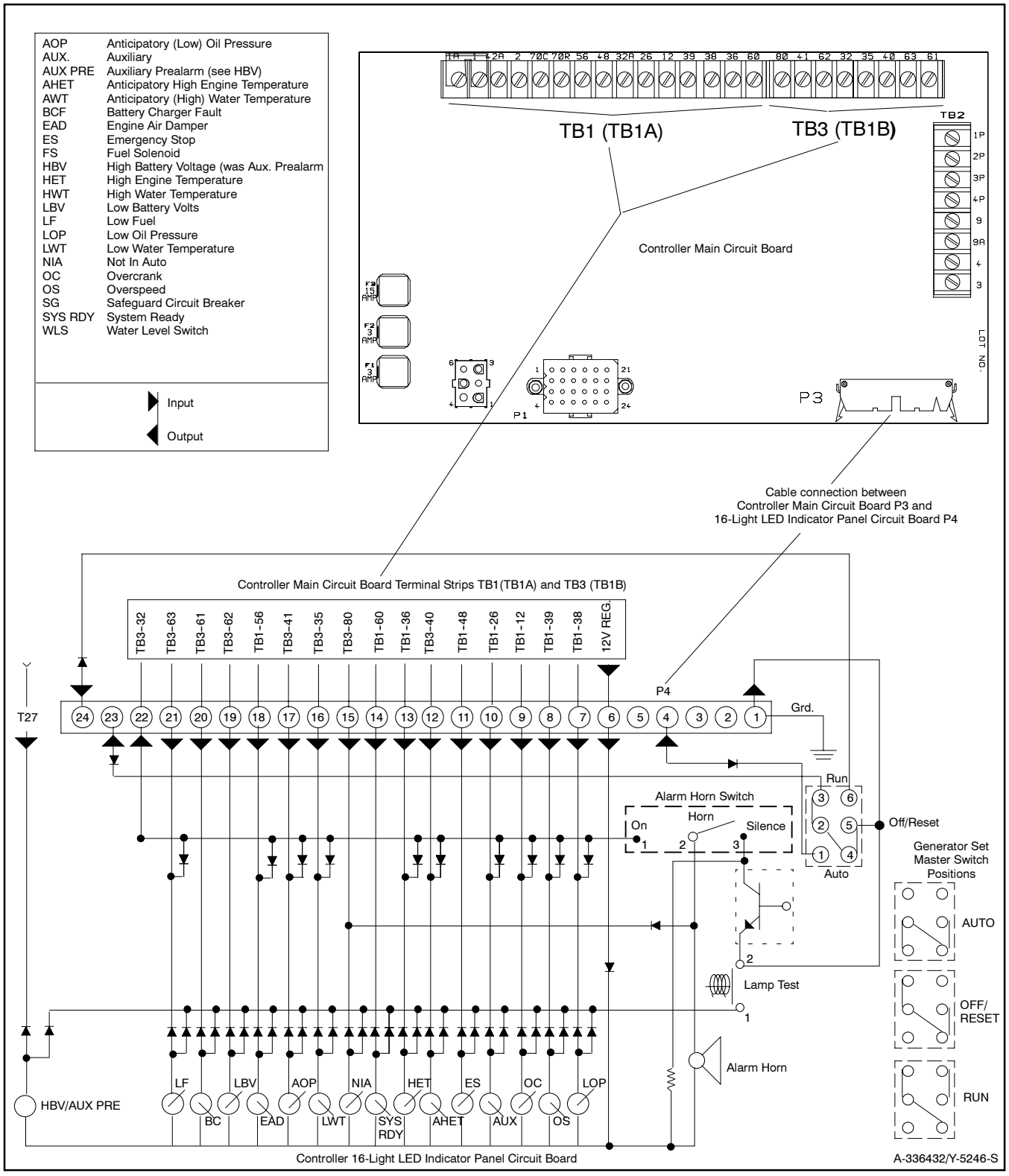


Figure 6-5 Controller to 16-Light LED Indicator Panel Circuit Board A-336432 Connections P3

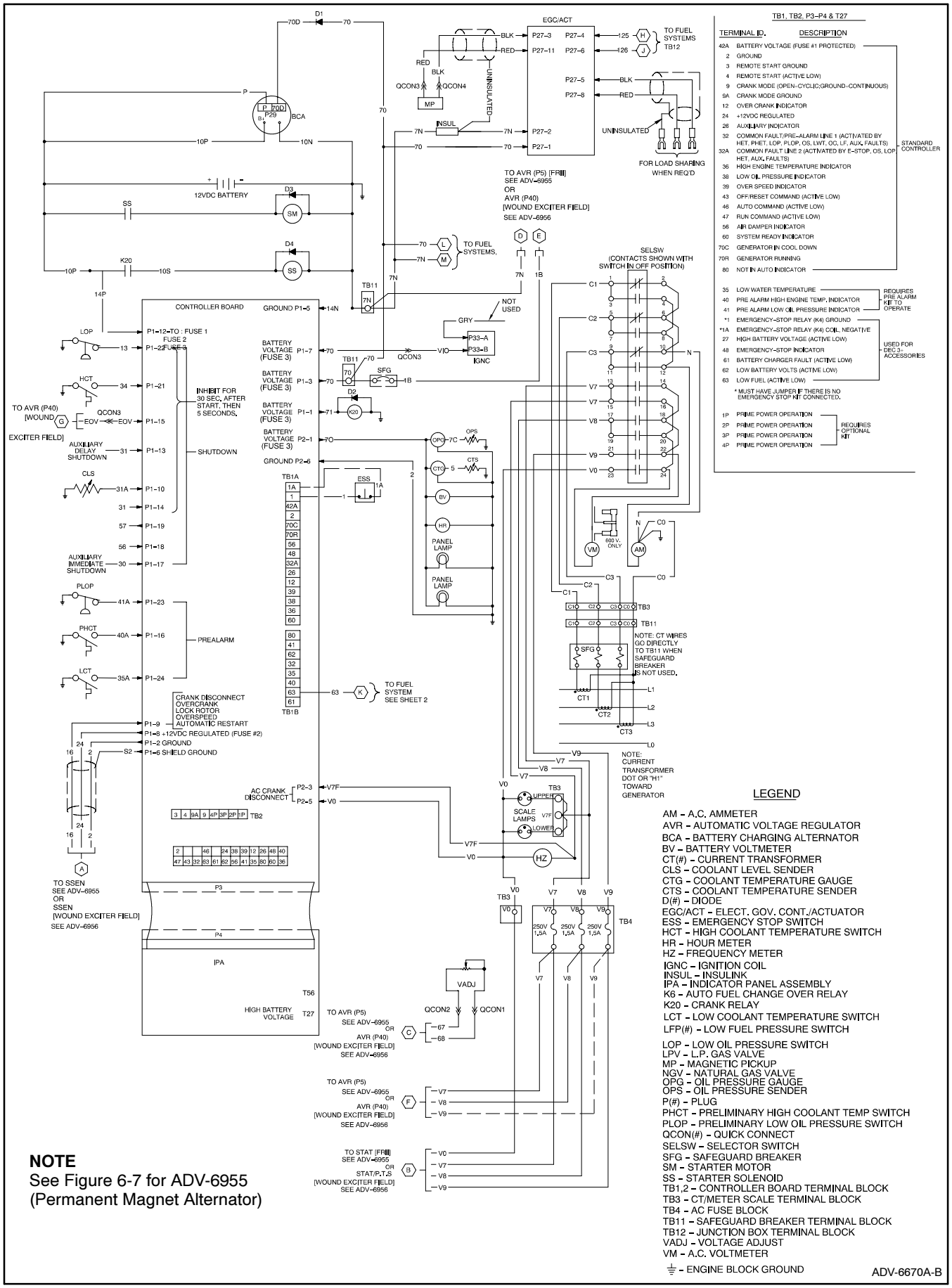


Figure 6-6 Logic Schematic, ADV-6670A-B Circuit Board, Typical

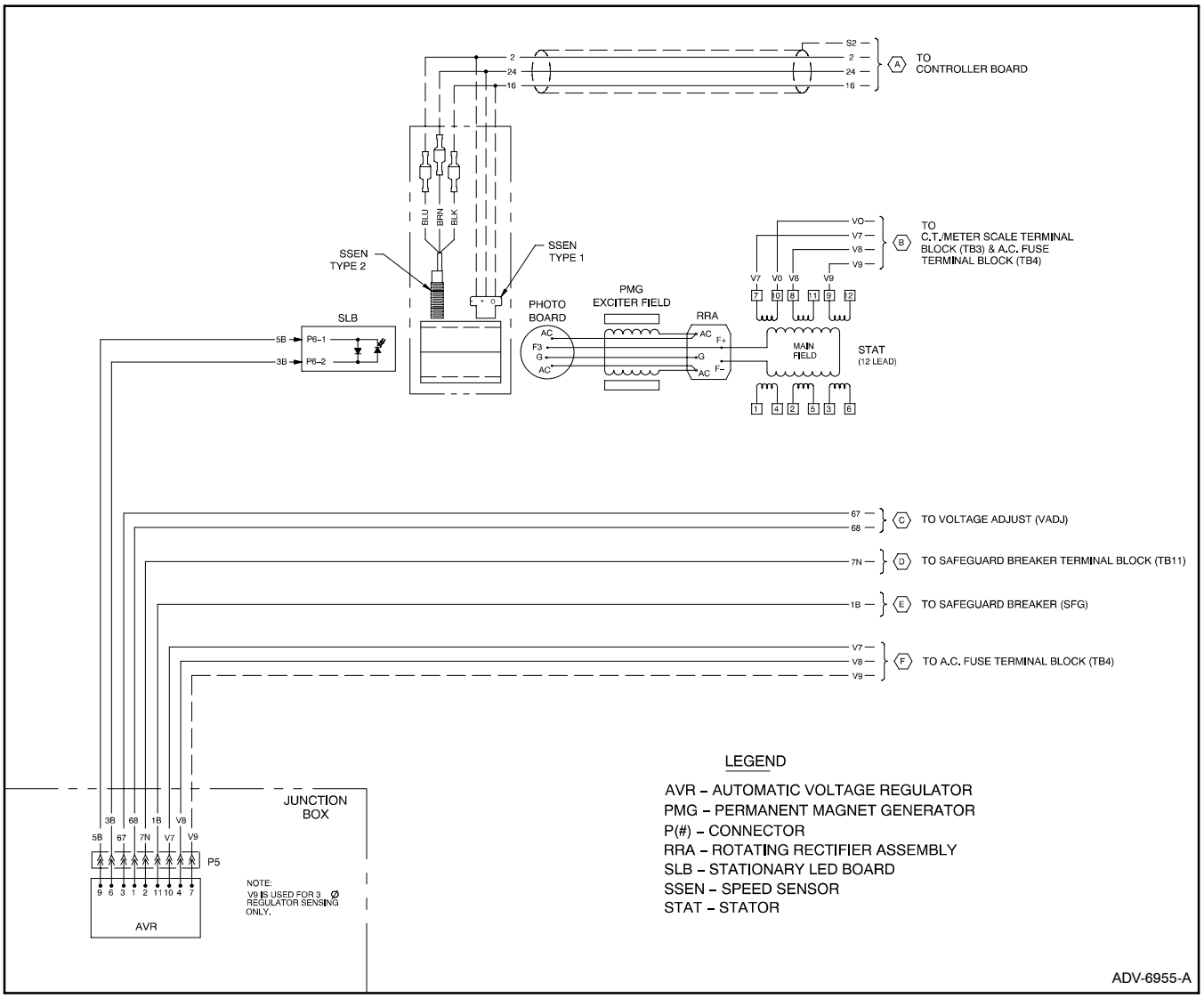


Figure 6-7 Logic Schematic, Permanent Magnet Alternator, ADV-6955-A, Typical

6.2 Circuit Board GM28725 Terminal/Connector Identification

Controller Main Circuit Board Terminal Strip TB1 (TB1A)		
Terminal	**Wire**	**Description**
1	1A	Emergency stop relay (K1) coil negative
2	1	Emergency stop relay (K1) ground
3	42A	Battery voltage (fuse #1 protected)
4	2	Ground
5	70C	Generator set in cooldown mode signal
6	70R	Generator set in running mode signal
7	56	Engine air damper indicator (if equipped)
8	48	Emergency stop indicator
9	32A	Common fault line 2
10	26	Auxiliary indicator
11	12	Overcrank indicator
12	39	Overspeed indicator
13	38	Low oil pressure indicator
14	36	High engine temperature indicator
Controller Main Circuit Board Terminal Strip TB3 (TB1B)		
Terminal	**Wire**	**Description**
15	60	System ready indicator
16	80	Not in auto indicator
17	41	Prealarm low oil pressure indicator
18	62	Low battery volts (active low*)
19	32	Common fault/prealarm line 1
20	35A	Low water temperature
21	40	Prealarm high coolant temperature indicator
22	63	Low fuel (active low*)
23	61	Battery charger fault (active low*)
* Check active low circuits for function by grounding designated terminals.		

Controller Main Circuit Board Terminal Strip TB2		
Terminal	**Wire**	**Description**
1	1P	Prime power operation (requires optional kit)
2	2P	Prime power operation (requires optional kit)
3	3P	Prime power operation (ground) (requires optional kit)
4	4P	Prime power operation (requires optional kit)
5	9	Crank mode (open-cyclic ground-continuous)
6	9A	Crank mode (ground)
7	4	Remote start (active low*)
8	3	Remote start (ground)
* Check active low circuits for function by grounding designated terminals.		

Controller Main Circuit Board P1 Connector Pins		
Pin	**Wire**	**Description**
1	71	Output to K2 relay (crank relay) (fuse #3 protected)
2	2	Ground for speed sensor
3	70	Output to safeguard breaker terminal and K5 relay (if equipped with electronic governor) (fuse #3 protected)
4	—	Alternator flash
5	10N	Starter motor ground (-)
6	S2	Speed sensor shield ground
7	70	Output to fuel solenoid (FS) on diesel models or ignition system (I.S.) on gas/gasoline models (fuse #3 protected)
8	24	Battery positive to speed sensor (fuse #2 protected)
9	16	Input from speed sensor
10	31A	Input from low coolant level (LCL), positive temperature coefficient (PTC) sensor
11	—	Not used
12	14P	Input from battery positive
13	31	Input from auxiliary delay shutdown, high oil temperature (HOT), if used
14	31	Input from auxiliary delay shutdown, low coolant level (LCL), if used
15	31	Input from auxiliary delay shutdown, if used
16	40	Input from pre-high coolant temperature (preHCT) switch
17	30	Input from auxiliary immediate shutdown, if used
18	56	Input from engine air damper switch, if equipped
19	57	Input from K6 air damper relay (ground), if equipped
20	—	Not used
21	34	Input from high coolant temperature (HCT) switch
22	13	Input from low oil pressure (LOP) switch
23	41	Input from pre low oil pressure (preLOP) switch
24	35A	Input from low coolant temperature (LCT) switch

Controller Main Circuit Board P2 Connector Pins		
Pin	**Wire**	**Description**
1	70	Output to engine gauges (fuse #3 protected)
2	30A	Overvoltage auxiliary
3	V7F	Input from AC crank disconnect & instrumentation
4	—	Not used
5	V0	Input from AC crank disconnect & instrumentation
6	2	Engine ground

Controller Main Circuit Board P3 Connector Pins		
Pin	**Wire**	**Description**
1	2	Ground (-), front indicator panel
2	47	Input from generator set master switch, run position
3	—	Not used
4	43	Input from generator set master switch, off/reset position
5	—	Not used
6	32	Input from common fault/prealarm line 1
7	46	Input from generator set master switch, auto position
8	63	Output to low fuel (LF) indicator, TB3-7 (TB1B-7)
9	—	Not used
10	61	Output to battery charger fault (BCF) indicator, TB3-8 (TB1B-8)
11	24	+12 VDC to front indicator panel
12	62	Output to low battery volts (LBV) indicator, TB3-3 (TB1B-3)
13	38	Output to low oil pressure (LOP) indicator, TB1-13 (TB1A-13)
14	56	Output to engine air damper (EAD) indicator, if equipped
15	39	Output to overspeed (OS) indicator, TB1-12 (TB1A-12)
16	41	Output to pre-low oil pressure (preLOP) indicator, TB3-2 (TB1B-2)
17	12	Output to overcrank (OC) indicator, TB1-11 (TB1A-11)
18	35A	Output to low coolant temperature (LCT) indicator
19	26	Output to auxiliary (AUX) indicator, TB1-10 (TB1A-10)
20	80	Output to not in auto (NIA) indicator, TB3-1 (TB1B-1)
21	48	Output to emergency stop (ES) indicator
22	60	Output to system ready (RS) indicator, TB1-15 (TB1A-15)
23	40	Output to pre-high coolant temperature (preHCT) indicator
24	36	Output to high coolant temperature (HCT) indicator, TB1-14 (TB1A-14)

16-Light LED Indicator Panel Circuit Board A-336432 P4 Connector Pins		
Pin	**Wire**	**Description**
1	2	Ground (-), front indicator panel
2	—	Not used
3	—	Not used
4	46	Output from generator set master switch, auto position
5	—	Not used
6	24	+12 VDC to front indicator panel
7	38	Input to low oil pressure (LOP) indicator †
8	39	Input to overspeed (OS) indicator †
9	12	Input to overcrank (OC) indicator †
10	26	Input to auxiliary (AUX) indicator
11	48	Input to emergency stop (ES) indicator
12	40	Input to pre-high coolant temperature (preHCT) indicator †
13	36	Input to high coolant temperature (HCT) indicator †
14	60	Input to system ready (SR) indicator
15	80	Input to not In auto (NIA) indicator
16	35A	Input to low coolant temperature (LCT) indicator †
17	41	Input to pre-low oil pressure (preLOP) indicator †
18	56	Input to engine air damper (EAD) indicator, if equipped
19	62	Input to low battery volts (LBV) indicator
20	61	Input to battery charger fault (BCF) indicator
21	63	Input to low fuel (LF) indicator †
22	32	Input to common fault/prealarm line 1 †
23	43	Output from generator set master switch, off/reset position
24	47	Output from generator set master switch, run position,

† Common fault/prealarm line 1 triggered by high engine temperature, high engine temperature prealarm, low oil pressure, low oil pressure prealarm, low water temperature, overcrank, overspeed, low fuel, and auxiliary faults.

16-Light LED Indicator Panel Circuit Board A-336432		
Terminal	**Wire**	**Description**
T27	—	Input to auxiliary prealarm or high battery volts indicator (if equipped)

6.3 Fault Shutdowns

If the generator set will not start or stops running because of a fault shutdown (fault lamp lit), see Figure 6-8 to identify fault conditions. Figure 6-8 contains the logic schematic showing input/output circuits for reference in troubleshooting. Consult the engine service manual for detailed information on correcting engine related faults. To reset the unit after a fault shutdown, see the generator set operation manual.

Indicator	Generator Set Mode	Fault Condition/Causes
High Engine Temperature Lamp Lights	While running	* Engine coolant temperature is above shutdown range. See Section 1, Specifications.
		Lead 34 grounded.
Low Oil Pressure Lamp Lights	While running	* Engine oil pressure is below shutdown range. See Section 1, Specifications
		Lead 13 grounded.
Overspeed Lamp Lights	While running	* Governed frequency is in excess of 70 Hz on 60 Hz models or 60 Hz on 50 Hz models. Some 50 Hz models have shutdown at 70 Hz.
Overcrank Lamp Lights	While cranking	Continuous cranking is more than 30 seconds and no starting.
		Cyclic cranking is more than 75 seconds and no starting. (15-second cycles alternating between crank and rest)
	While cranking or running	Speed sensor signal (locked rotor) is absent longer than 15 seconds.
		Engine fails to turn over within 15 seconds after signaled to start.
Overcrank Lamp Flashes	While running	Speed sensor signal (locked rotor) is absent longer than 1 second.
Auxiliary Lamp Flashes	While running	No AC output is present.
	While running or in auto position	Battery power was reconnected or was low and then came back up again while generator set master switch was in the RUN or AUTO position. Improper master switch signal to controller main circuit board.
Auxiliary Lamp Lights	While shutdown	Optional emergency stop switch is reset while the generator set master switch is in the RUN or AUTO position.
	While running	High oil temperature (P1-13), low coolant level (P1-14), or auxiliary delay shutdown (P1-15) faults occur, if sensor equipped.
		Overvoltage shuts down the unit when the voltage is at least 15% greater than nominal voltage for period longer than two seconds. Actual overvoltage shutdown is dependant upon R42 setting on main circuit board. Factory setting is 15% above nominal voltage.
		* Activated by customer-supplied sensing device connected to auxiliary immediate shutdown ports (P1-17 and P1-18).
		Activated by engine ECM fault detection.
Emergency Stop (if equipped)	While running or in auto position	* Emergency stop switch is activated (local or remote).
		* Emergency stop switch(es) are disconnected from controller terminals TB1-1 or 1A.
Multiple Lamps Light (where illumination may only appear dim)	While running or in auto or off/reset position	Main circuit board F1 (3 amp) fuse blown. F1 fuse supplies battery voltage to a remote annunciator and/or dry contact kit.
		Inoperative remote annunciator and/or dry contact kit.
		Inoperative indicator panel circuit board.
* Immediate shutdown (ISD)		

Figure 6-8 Fault Shutdown Troubleshooting Chart

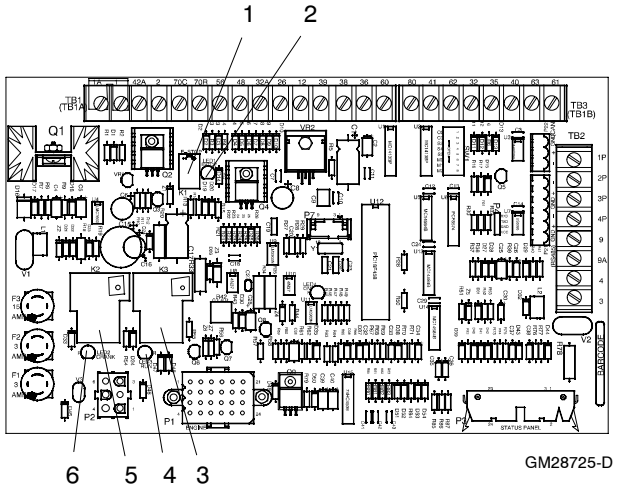
6.4 Relay Descriptions

See Figure 6-9 for controller and generator set relay descriptions and functions. Use this information to troubleshoot the generator set in conjunction with the controller flow charts in Section 6.5.2. Use Section 6.5 and the appropriate wiring diagram for additional information.

Note: Some generator set models may show relays K6, K11, and K20 with different designations. See the respective generator set wiring diagram manual.

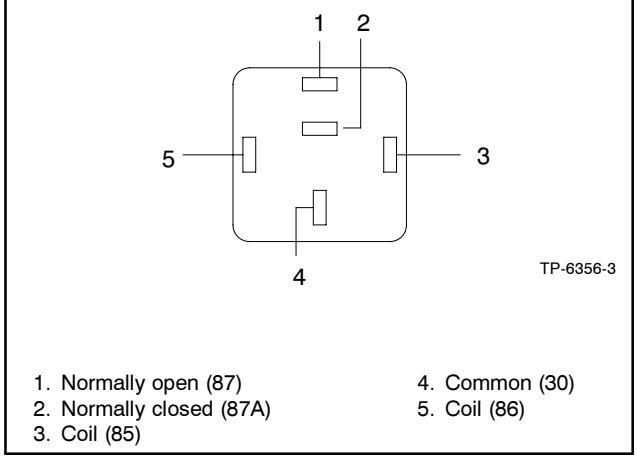
Relay	Description/Function	Location	Illustration	Energizes/Action:
K1	Emergency stop relay energizes continuously except during emergency stop conditions	Main circuit board	Figure 6-10	LED1 lights.
K2	Crank relay energizes during crank mode	Main circuit board	Figure 6-10	Energizes K20 relay LED2 lights.
K3	Run relay energizes during crank and run modes	Main circuit board	Figure 6-10	Energizes ignition, fuel solenoid, fuel pump, choke, instrumentation, voltage regulator, etc. LED3 lights.
K6	Engine ECM control relay energizes during crank and run modes	Junction box	Figure 6-11	ECM/Governor control circuit.
K11	Diagnostic box control relay energizes when control box switches are energized (ECM engines)	Junction box	Figure 6-11	Diagnostic box circuit.
K20	Starter solenoid energizes during crank mode	Engine	Figure 6-12	Starter motor.

Figure 6-9 Relay Descriptions and Functions



1. K1 relay: emergency stop
2. LED1 (K1 relay)
3. K3 relay: control relay (run)
4. LED3 (K3 relay
5. K2 relay: control relay (crank)
6. LED2 (K2 relay)

Figure 6-10 Main Circuit Board GM28725 Relays



1. Normally open (87)
2. Normally closed (87A)
3. Coil (85)
4. Common (30)
5. Coil (86)

Figure 6-11 K6/K11 Relay

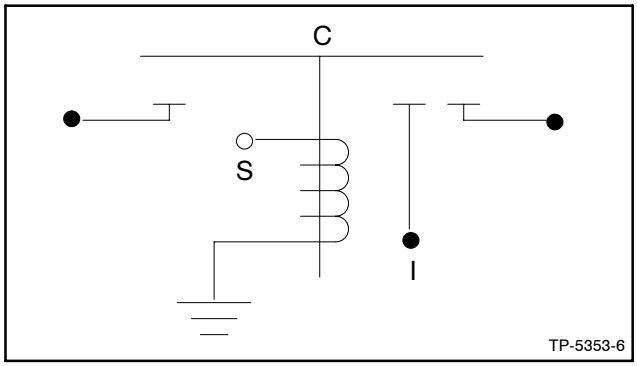


Figure 6-12 Starter Solenoid K20 Relay

6.5 Troubleshooting

Figure 6-13 lists some common problems relating to the 16-light controller. Use the following charts as a quick reference in troubleshooting individual problems. Refer to Figure 6-13 to assist in locating the cause of blown fuses. The successive charts list generator set faults by specific groups including possible causes and corrective action. Before beginning any troubleshooting procedure, read all safety precautions at the beginning of this manual and those included in the text. Do not neglect these precautions.

Note: If starting unit by remote switch, verify remote switch function before troubleshooting controller. Test remote switch operation using Figure 6-13 information. If the generator does not start, proceed with the controller troubleshooting procedure outlined in the following pages.

Problem	Possible Cause	Corrective Action	Reference
All lamps remain on	Ground fault from accessories connected to TB1 terminal strip	Disconnect and test each connection.	See wiring diagram
System ready lamp does not light	Inoperative generator set master switch	If engine/generator set checks out okay, replace generator set master switch (lamp circuit board). Check switch contacts with an ohmmeter. If switch is inoperative, replace generator set master switch (lamp circuit board).	
Aux. lamp goes on with generator set master switch in RUN or AUTO position	Inoperative generator set master switch	Check switch contacts with an ohmmeter. If switch is inoperative, replace generator set master switch (lamp circuit board).	
Unit will not crank when 3-4 contacts are closed (remote starting) and generator set master switch in AUTO position	Inoperative generator set master switch	Connect jumper wire between terminals 3-4. If unit cranks replace generator set master switch (lamp circuit board).	See wiring diagram
	Inoperative generator set master switch and/or inoperative ground to lamp circuit board	Connect jumper wire between terminal 4 and ground. If unit cranks and if lamp circuit board ground connection checks out okay, replace generator set master switch (lamp circuit board).	
Alarm horn will not silence using alarm horn silence switch	Improper operation sequence	Place generator set master switch in the AUTO position *before* placing the alarm horn silence switch in the SILENCE position.	See generator set operation manual

Figure 6-13 16-Light Controller Troubleshooting

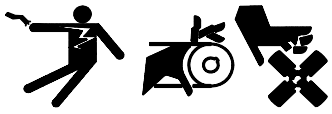
⚠ WARNING

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

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

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

⚠ 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.

6.5.1 Fuses

To quickly check the condition of the components mentioned in the following flowcharts, use an ohmmeter to measure resistance between designated terminal and ground. See Figure 6-14 and Figure 6-15. With ohmmeter on R x 1 scale, a reading of less than 1 ohm (continuity) indicates a potentially inoperative component. Isolate the inoperative component and repair or replace.

Component	Connect between ground and terminal:
Engine Gauges	Connector P2, pin 1
Crank (K2 Relay) Circuit	Connector P1, pin 1
Fuel/ignition Circuit	Connector P1, pin 7

Figure 6-14 P1 and P2 Connections

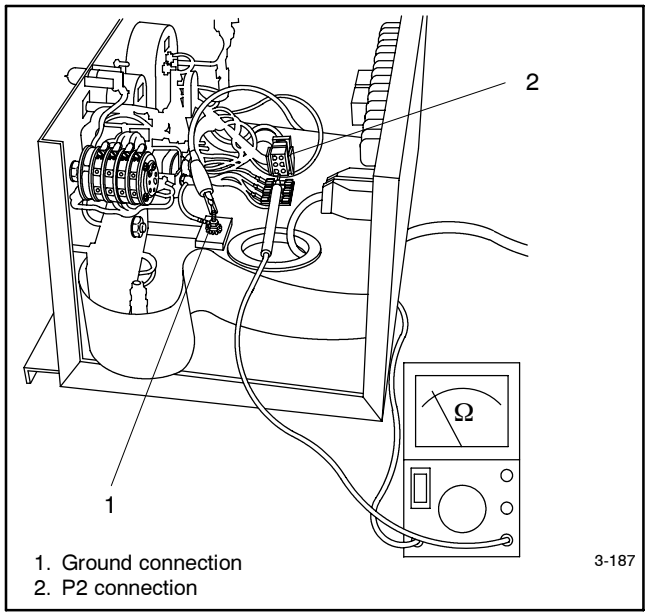


Figure 6-15 Checking P1 and P2 Connections

Figure 6-16 lists the possible causes of blown controller fuses F1, F2, and F3. Replace blown fuses and resume operation. If the fuse blows again, use the chart to identify the faulty component(s).

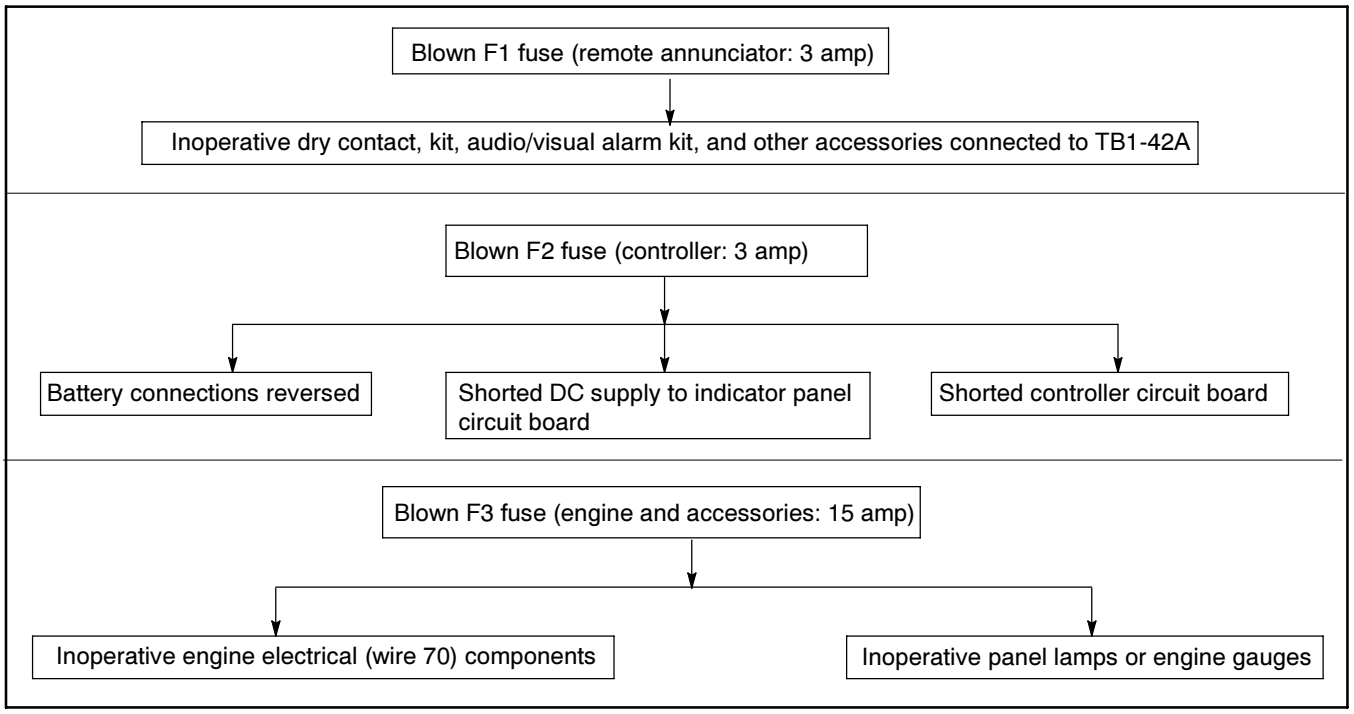
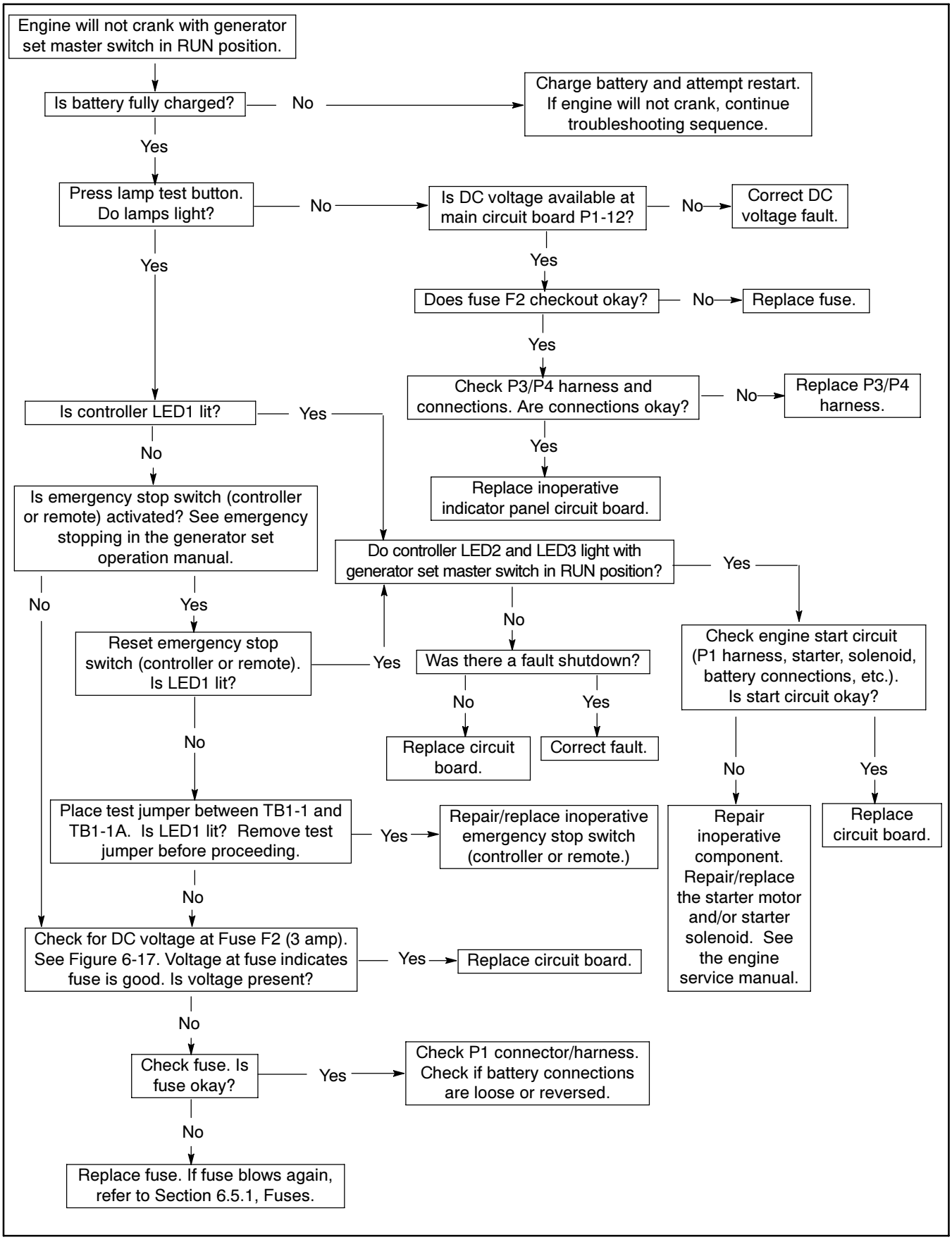


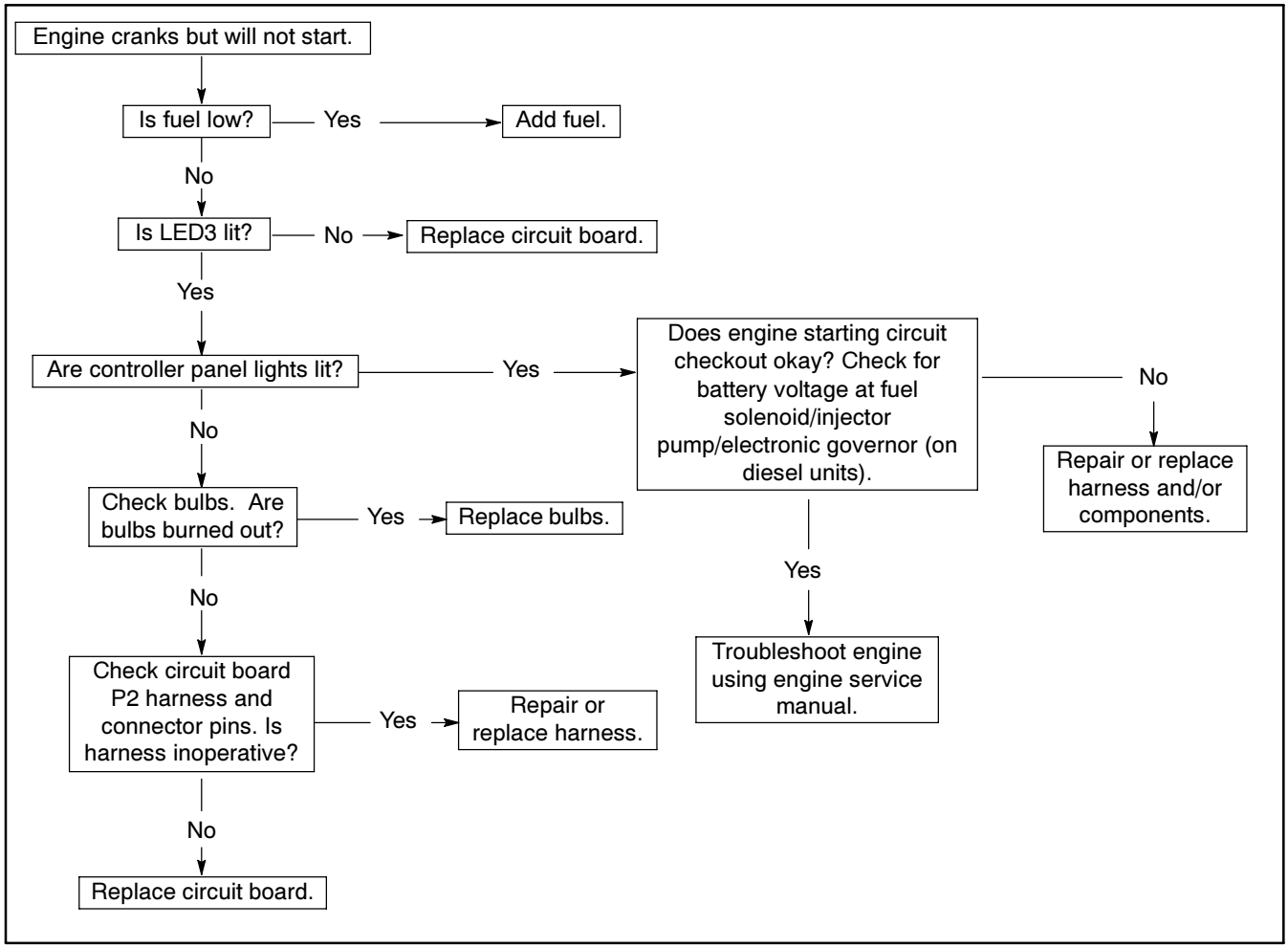
Figure 6-16 Checking Fuses F1, F2, and F3

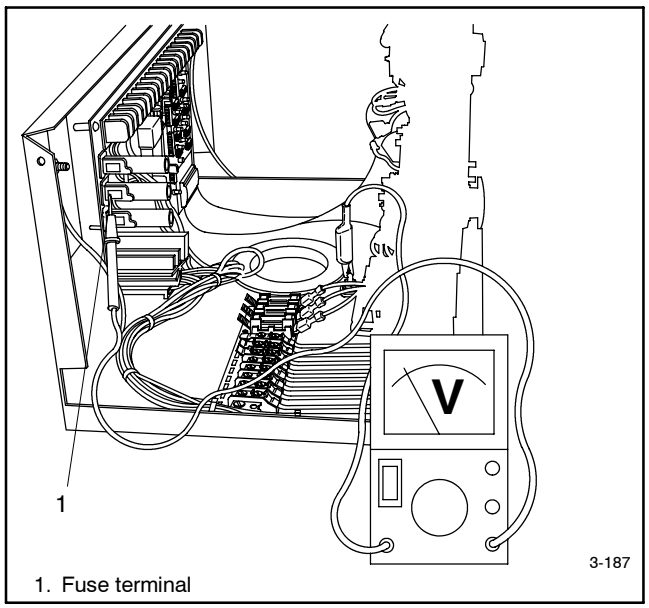
6.5.2 Controller Flowcharts

Engine Will Not Crank



Engine Cranks, But Will Not Start

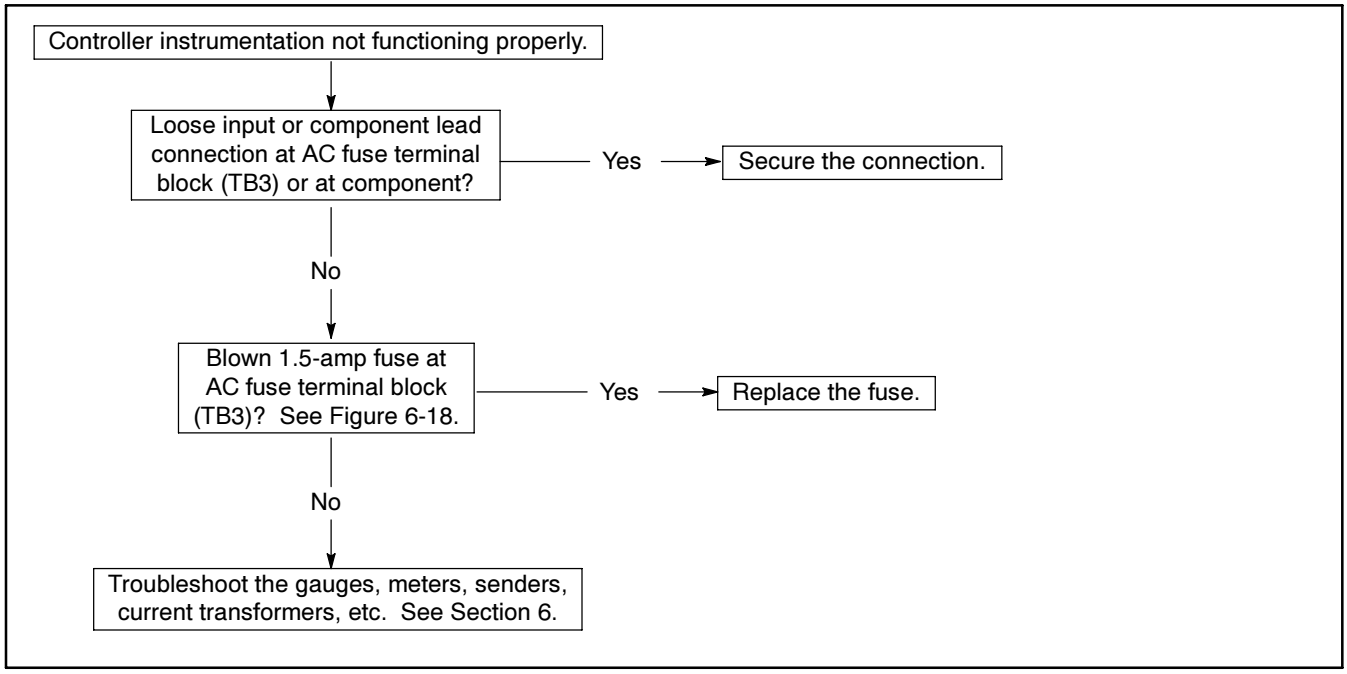




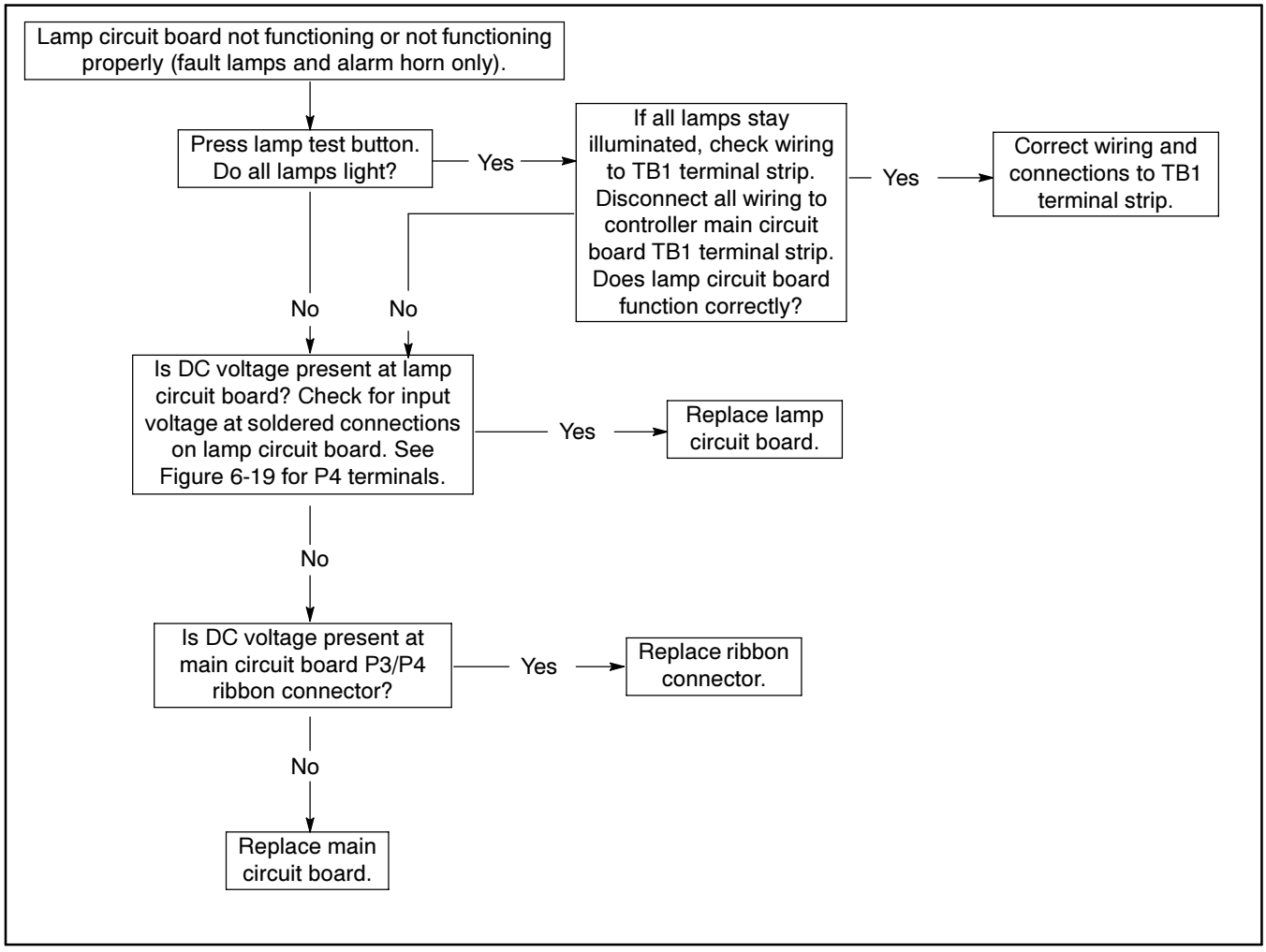
1. Fuse terminal

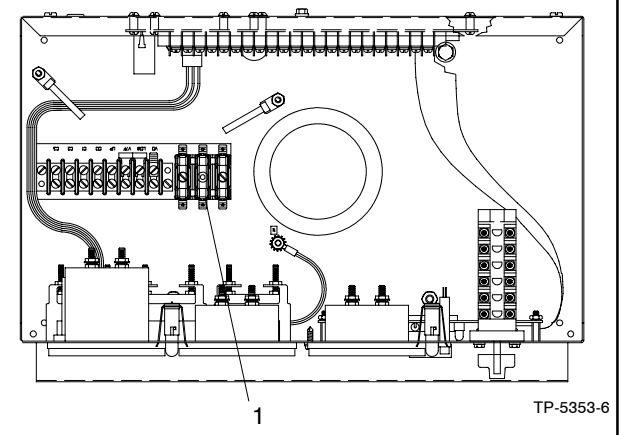
Figure 6-17 Checking Condition of Fuse F2

Controller Instrumentation



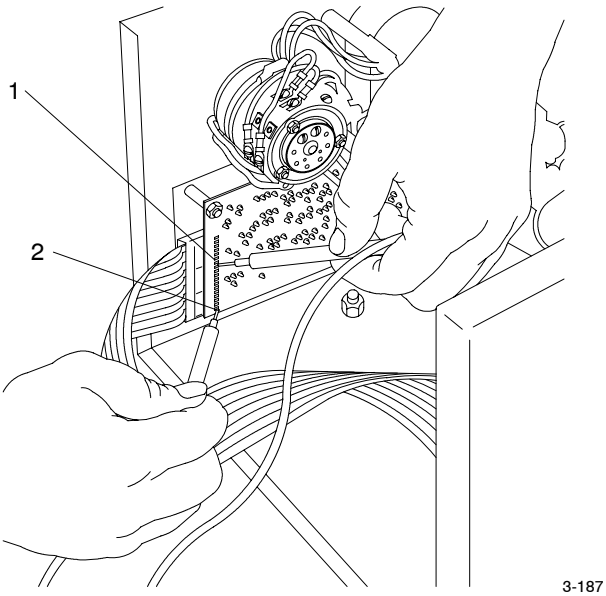
Indicator Panel Circuit Board





1. AC fuse terminal block

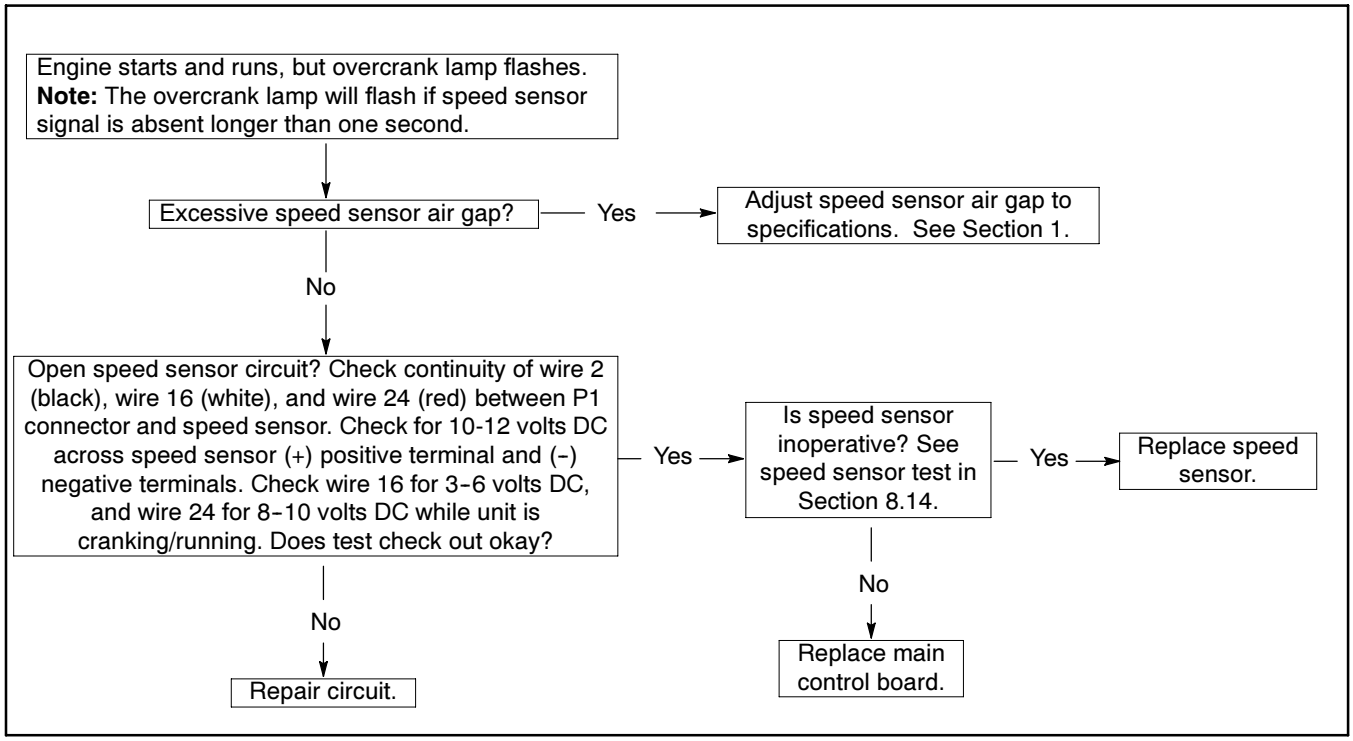
Figure 6-18 AC Fuse Terminal Block



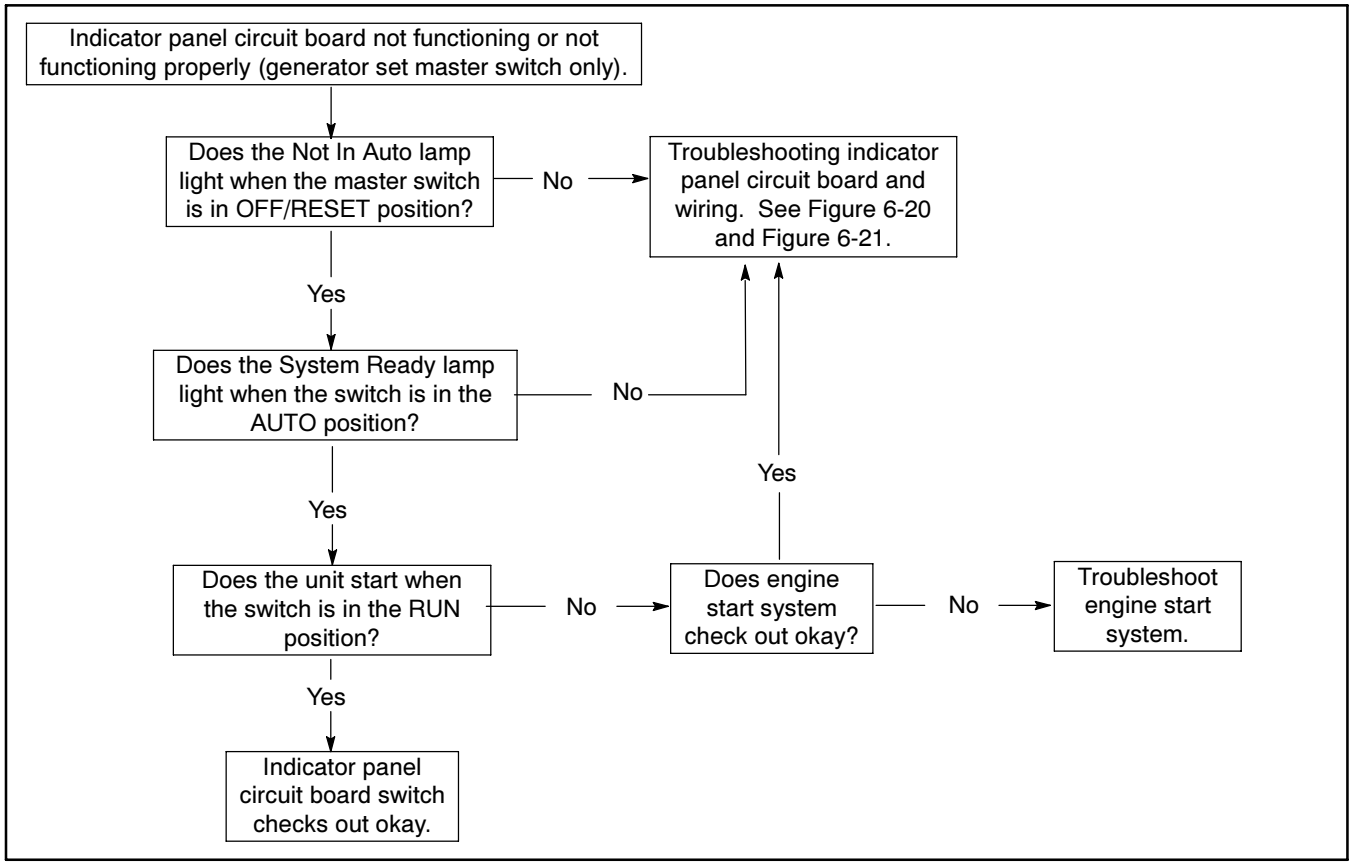
1. (+) Connection—P4-6
2. (-) Connection—P4-1

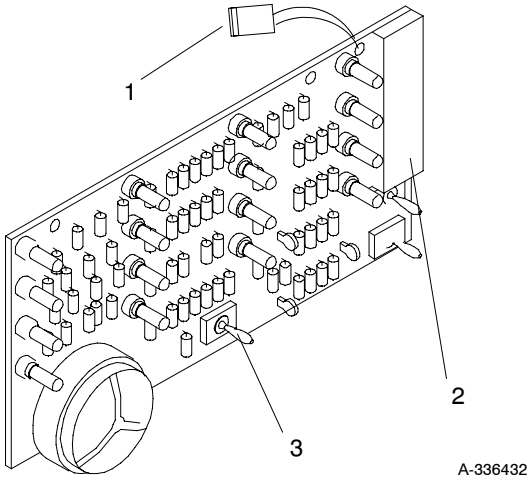
Figure 6-19 Checking Input Voltage to Lamp Circuit Board

Overcrank Lamp



Generator Set Master Switch on Indicator Panel Circuit Board





1. T27 Lead
2. P4 Connector. Check lamp (LEDs) using a 12-volt battery connected to P4-6 (12 VDC+) and P4-1 (ground). Individual LEDs should illuminate when each corresponding P4 pin is grounded.
3. Generator Set Master Switch SW3. Check switch continuity with an ohmmeter between P4-1/P4-23 (OFF/RESET), P4-1/P4-24 (RUN), and P4-1/P4-4 (AUTO).
   Note: Test for continuity in both directions by reversing test probes as the circuit contains diodes.

Figure 6-20 Indicator Panel Circuit Board

P4-	Wire	Description
1	2	Ground
2	—	—
3	—	—
4	46	Auto
5	—	—
6	24	12 VDC
7	38	Low Oil Pressure *
8	39	Overspeed *
9	12	Overcrank *
10	26	Auxiliary *
11	48	Emergency Stop *
12	40	Anticipatory High Engine Temperature *
13	36	High Engine Temperature *
14	60	System Ready *
15	80	Not in Auto *
16	35A	Low Water Temperature *
17	41	Anticipatory Low Oil Pressure *
18	56	Air Damper *
19	62	Low Battery Voltage *
20	61	Battery Charger Fault *
21	63	Low Fuel *
22	32	Common Fault
23	43	Off/Reset
24	47	Run
T27	—	High Battery Voltage
* Ground P4 pin to test		

Figure 6-21 Indicator Panel Circuit Board P4 Connections

6.6 FASTCHECK® Diagnostic Tool Features and Operation

The FASTCHECK® diagnostic tool serves as an engine simulator for testing and troubleshooting the 16-light controller.

6.6.1 Features

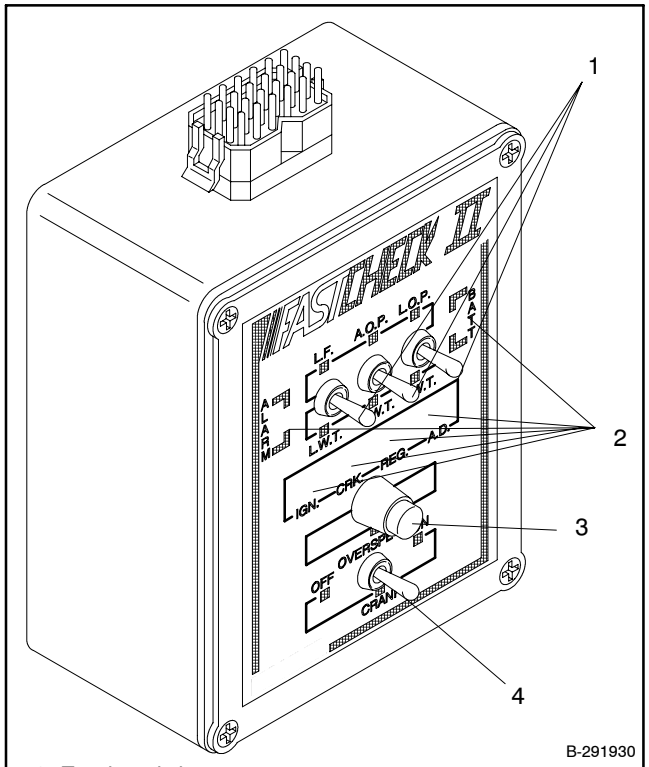
The following paragraphs detail the FASTCHECK®. See Figure 6-22 for an illustration. The following engine switches simulate engine conditions:

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

Indicator Lamps:

IGN—(ignition) lamp:

- Indicates battery voltage supply to ignition (gas/gasoline) or fuel solenoid (diesel), fuel valves, water valve (city-water cooled sets)
- Lights during cranking and running



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

Figure 6-22 FASTCHECK® Diagnostic Tool

CRK—(crank) lamp:

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

REG—(regulator) lamp:

- Indicates battery voltage supply to generator set's AC voltage regulator
- Lights only during cranking and running

BATT—(battery) lamp:

- Indicates test battery(ies) or DC power supply availability to circuit with correct polarity

Note: LOP, HWT, and OVERSPEED simulate malfunctions causing engine to shut down. LOP and HWT circuits start timing after engine runs for 30 seconds. Engine shutdown should occur 5 seconds after pushing the LOP or HWT fault switches. The OVERSPEED shut down is immediate.

Switches:

LOP—low oil pressure

HWT—high water (engine) temperature

OVERSPEED—simulates a 70 Hz overspeed condition

LF—low fuel (not used for testing)

LWT—low engine water temperature

AOP—anticipatory (low) oil pressure

AWT—anticipatory (high) water temperature

6.6.2 Application

Use the FASTCHECK® to test the controller on the generator set when troubleshooting startup problems, or to test and troubleshoot the controller when removed from the generator set.

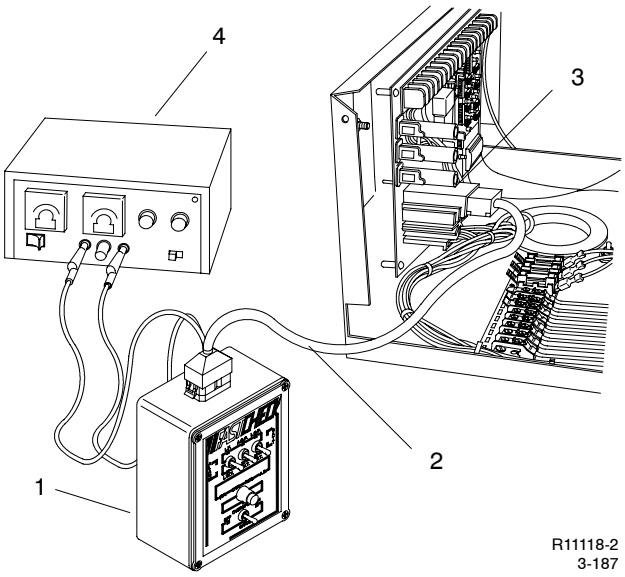
To operate the FASTCHECK®″ obtain the following equipment:

- FASTCHECK® simulator (B-291930) and harness (255915).
- Variable low-voltage DC power supply; 0-30 volt, 3 amp minimum current, 0.5% maximum output voltage ripple at 30 volts DC. A 12- or 24-volt battery (depending on system voltage) can also operate the FASTCHECK®.

Note: All 200 kW and above models use a 24-volt battery engine electrical systems. The 20-180 kW models use 12-volt or 24-volt engine electrical systems. Check generator set nameplate for engine electrical system voltage.

6.6.3 FASTCHECK Diagnostic Tool Use

1. Unplug the DC engine harness from the DC harness connector (P1). See Figure 6-23.



1. FASTCHECK® diagnostic tool
2. Wiring harness
3. DC harness connector
4. DC power supply

Figure 6-23 FASTCHECK® Connections

2. Connect the FASTCHECK® harness to the DC harness connector (P1) and to the top of the FASTCHECK®.

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

4. Move the FASTCHECK® engine switch to the OFF position.

5. Clip the red (+) and black (–) harness leads to a battery(ies) or DC power supply that corresponds to the generator set engine electrical system (12 or 24 volt). Adjust the output voltage to 1-2 volts above the battery voltage when using a DC power supply. Use generator set battery(ies) if accessible and fully charged.

   Note: Incorrect battery polarity may cause controller circuit board damage when connecting the FASTCHECK®.

   Note: Because of the absence of AC output, the auxiliary lamp flashes during controller testing. The NOT IN AUTO lamp illuminates whenever the generator set master switch is not in the AUTO position.

6. Move the generator set master switch to the RUN position. Move the FASTCHECK® engine switch to CRANK. The FASTCHECK® IGN., CRK., and REG. lamps should light. The generator set controller causes the engine to crank until the FASTCHECK® switch is moved to RUN (or OVERCRANK shutdown appears on generator set controller).

7. Move the FASTCHECK® engine switch to RUN. The CRK. lamp should go out and the REG. and IGN. lamps should stay on.

8. Simulate engine malfunctions by pressing the FASTCHECK® fault switches. The corresponding fault lamp on the controller should light during each simulated engine malfunction.

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

9. Use the following sections to test overcrank circuitry, speed sensor circuitry, and generator set condition indicators.

6.6.4 Overcrank

The following procedure tests the overcrank function on the generator set controller and the ability to:

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

If the OVERCRANK shutdown fails to function, check the speed sensor and related circuitry. See Section 6.6.5, Controller Speed Sensor Circuitry, and Section 8.14, Speed Sensor Test.

1. Move the FASTCHECK® engine switch to the OFF position.

2. Move the generator set master switch to the OFF position and then move the switch to the RUN position.

3. The IGN., CRK., and REG. lamps on the FASTCHECK® should light for approximately 5 seconds and then go out. Then 5 seconds later the IGN., CRK.,and REG. lamps should relight for 5 seconds before going out again (15 seconds total elapsed time). The controller OVERCRANK lamp lights.

4. Check for operating voltage between terminals TB1-42A (+) and TB1-12 (–).

6.6.5 Controller Speed Sensor Circuitry

To check the controller's ability to respond to signals from the speed sensor, perform the following test:

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

6.6.6 Generator Set Condition Indicator Terminal (TB1 Terminal Strip)

Connect the remote accessories (audiovisual alarm, remote annunciator, dry contact kits, etc.) to the controller's TB1 terminal strip to signal the condition of the generator set. Some generator sets may not have the optional sending devices necessary to operate all the generator set condition indicators.

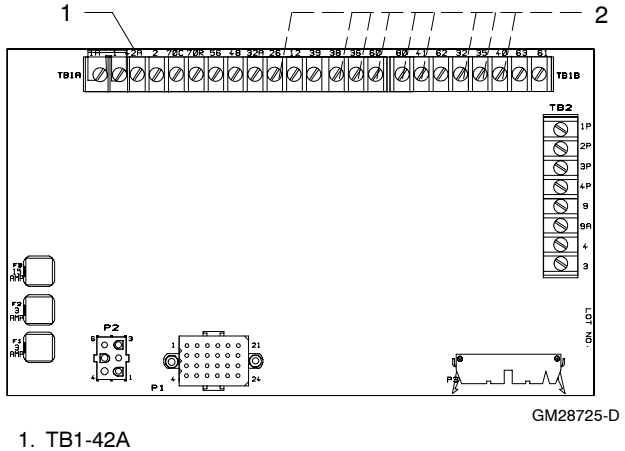
If the remote accessories will not operate, test for output voltage at the TB1 terminal strip. To test the operation of each indicator, move the generator set master switch and FASTCHECK® toggle switch to the position prescribed.

The test point voltage is slightly lower than the voltage supplied to the controller (12 or 24 volts). If the correct voltage is not detected at the test point, remote accessories (audiovisual alarm, remote annunciator, dry contact kits, etc.) will not function. Figure 6-24 and Figure 6-25 show test point connections.

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

Because of the absence of AC output, the auxiliary lamp flashes during controller testing. The NOT IN AUTO lamp illuminates whenever the generator set master switch is not in the AUTO position.

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



1. TB1-42A
2. TB1 (TB1A) and TB3 (TB1B) (see Section 6.6.6, Generator Set Condition Indicator Terminal)

Figure 6-24 Indicator Lamp Test Connections on the Main Circuit Board

Indicator	Switch Position/Remarks	Check for Voltage Between:
Anticipatory (High Engine) Water Temperature (AWT)	Place the generator set master switch in the RUN position. Place the engine switch in the RUN position. Press and hold the toggle switch to AWT.	TB1-42A (+) and TB3-40 (-)
Anticipatory (Low Engine) Oil Pressure (AOP)	Place the generator set master switch in the RUN position. Place the engine switch in the RUN position. Press and hold the toggle switch to AOP.	TB1-42A (+) and TB3-41 (-)
Auxiliary Fault	Place the generator set master switch in the RUN position. Place the engine switch in the RUN position and wait 10 seconds. A flashing AUX lamp indicates proper operation of all auxiliary functions.	TB1-42A (+) and TB1-26 (-)
Battery Charger Fault, if battery charger equipped and connected	Place the generator set master switch in the OFF/RESET position. Place the engine switch in the RUN position. Ground the controller terminal TB1-61 to test. If the Battery Charger lamp lights the circuit functions correctly.	Not Applicable
Common Fault/Auxiliary Prealarm	Place the generator set master switch in the RUN position. Place the engine switch in the RUN position. Press and hold the toggle switch to the LWT, HWT, or LOP position.	TB1-42 (+) and TB3-32 (-)
Emergency Stop (local/remote), if equipped	Place the generator set master switch in the RUN position. Place the engine switch in the RUN position. Remove the switch lead connected to controller terminal TB1-1 or 1A.	Not Applicable
Generator Switch Not in Auto	Place the generator set master switch in the RUN or OFF/RESET position. Place the engine switch in any position.	TB1-42A (+) and TB3-80 (-)
High Battery Volts (if battery charger equipped and connected)	Generator set master switch in OFF/RESET; engine switch in RUN position Ground controller terminal TB1-27 to test. If the High Battery Volts lamp lights the circuit functions correctly.	Not Applicable
High (Engine) Water Temperature (HWT)	Place the generator set master switch in the RUN position. Place the engine switch in the RUN position. Press and hold the toggle switch to HWT for at least 5 seconds.	TB1-42A (+) and TB1-36 (-)
Low Battery Volts, if battery charger equipped and connected	Place the generator set master switch in the OFF/RESET position. Place the engine switch in the RUN position. Ground controller terminal TB1-62 to test. If Low Battery Volts lamp lights the circuit functions correctly.	Not Applicable
Low Fuel	Place the generator set master switch in the OFF/RESET position. Place the engine switch in the RUN position. Ground controller terminal TB1-63 to test. If the Low Fuel lamp lights the circuit functions correctly.	Not Applicable
Low Oil Pressure (LOP)	Place the generator set master switch in the RUN position. Place the engine switch in the RUN position. Press and hold the toggle switch to LOP for at least 5 seconds.	TB1-42A (+) and TB1-38 (-)
Low Water Temperature (LWT)	Place the generator set master switch in the RUN position. Place the engine switch in the RUN position. Press and hold the toggle switch to LWT.	TB1-42A (+) and TB3-35A (-)
Overspeed	See Controller Speed Sensor Circuitry test in Section 6.6.5.	Not Applicable
Overcrank	See Overcrank test in Section 6.6.4.	Not Applicable
System Ready	Place the generator set master switch in the AUTO position. Place the engine switch in the OFF position.	TB1-42A (+) and TB3-60 (-)

Figure 6-25 Generator Set Condition Terminals TB1 (TB1A) and TB3 (TB1B)

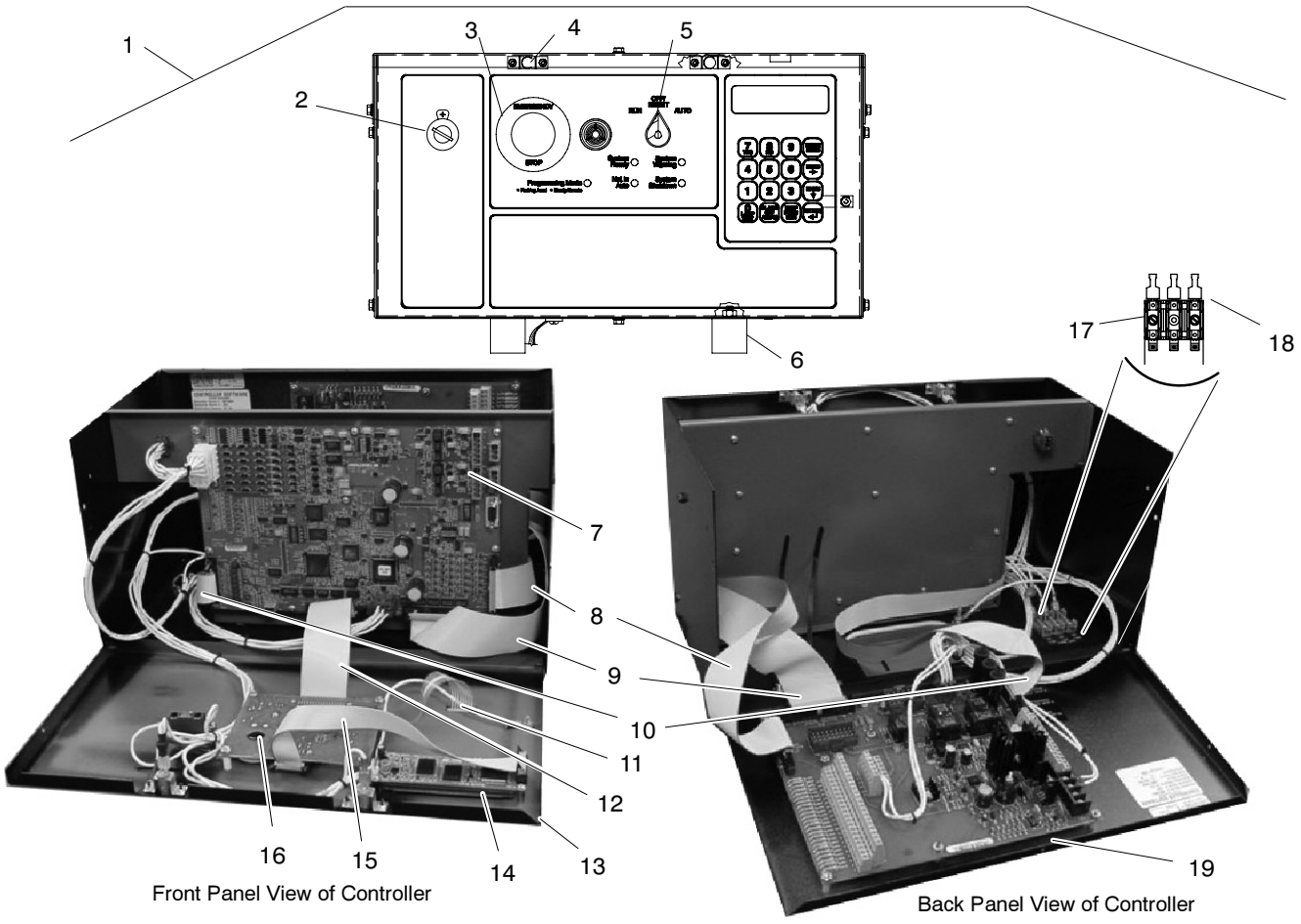
7.1 General Repair Information

This section contains 550 controller repair information. Service replacement of the 550 controller is limited to the items shown in Figure 7-1. Refer to the respective controller parts catalog for service part numbers. No other replacement service parts are available.

Before replacing the controller, remove all external accessories and other electrical connections to verify that these items are not the cause of the controller problems. Verify that the accessories and connections are functioning correctly before reconnecting them to the new controller.

Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage. Use the respective controller operation manual for details regarding Menu 20, Factory Setup.

550 Controller *prior to version 2.10*, use TP-6083.
550 Controller *version 2.10 or higher,* use TP-6200.



1. Service kit
   (Includes 12 V controller assembly, [2] lamps, and literature)
2. Switch, key (optional)
3. Switch, emergency stop pushbutton
4. Lamp, panel (2)
5. Rotary switch
6. Vibromount (4)
7. Circuit board, main logic
   (not available as a service part, order Item 1)
8. Cable, ribbon, 34-position
   (P17 on main logic board to P5 on interconnection board)
9. Cable, ribbon, 40-position
   (P16 on main logic board to P4 on interconnection board)
10. Cable, ribbon, 24-position
    (P12 on main logic board to P2 on interconnection board)
11. Cable, ribbon 8-position
    (P8 on status board to switch membrane keypad)
12. Cable, ribbon, 34-position
    (P6 on status board to P14 on main logic board)
13. Front panel assembly
    (replace entire front panel to replace switch membrane keypad)
14. Circuit board, display (kit-service only)
15. Cable, ribbon, 16-position
    (P7 on status board to display board)
16. Circuit board, status (board with alarm horn)
17. Fuse, 1.5 A, 250 V (3)
18. Holder, fuse
19. Circuit board, interconnection

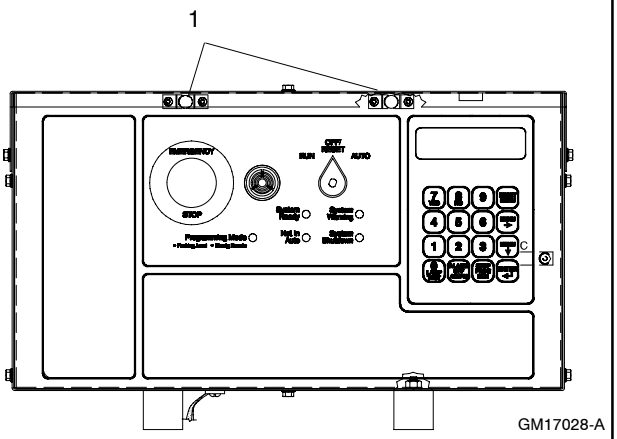
Figure 7-1 550 Controller Service Replacement Parts

7.2 Controller Service Replacement Kits

7.2.1 Introduction

The 550 controller service replacement kit is available to replace a non-functional 550 controller. Use the following procedure to install the replacement controller. See Figure 7-2 for typical controller identification. For features and operation of the 550 controller, see the operation manual in the literature kit.

Note: Do not use this controller replacement installation instruction for upgrading software.



1. Light bulbs

Figure 7-2 550 Controller Front Panel

When replacing the 550 controller, the personality profile must be installed in order for the 550 controller to function. Controller service replacement kits **do not** include the personality profile file installed on the generator set controller at the factory. The service technician *must* install the personality profile on the 550 controller service replacement kit.

- **Application program** contains the software that controls system operation. The application file is preprogrammed on the 550 controller service replacement kit at the factory.

  Note: The application program is not backwards compatible. Do not attempt to load an application program that is an older version than the application program version already installed.

- **Personality profile** is specific to the engine and alternator and is preprogrammed on the generator set controller at the factory.

  A backup disk of the personality profile and application program is supplied with the literature packet shipped with the generator set. Typically, the distributor stores this disk for possible future use such as controller replacement or other circumstances requiring a backup.

  Note: If the personality profile disk is NOT available, request a replacement from the manufacturer using the generator set serial number or order number.

- **User parameters** unique to an installation include timer values, setpoints, generator set data such as kW and voltage, and input/output selections. These parameters are typically set up for or by the installer at the time of installation. Created user parameters are typically documented and stored on the personality profile disk, a separate backup disk, or written in the User-Defined Settings appendix in the 550 controller operation manual. A copy of the User-Defined Settings form is included in Section 7.2.6.

Note: If the user parameters are included on the personality disk, the disk label should indicate Site Program—Yes.

Read the entire installation procedure and perform the steps in the order shown. Always observe applicable local and national electrical codes.

Note: The following service kit procedure changes only the controller. If the generator set requires voltage reconnection and/or frequency adjustment, see the 550 controller operation manual.

550 Controller *prior to version 2.10*, use TP-6083.

550 Controller *version 2.10 or higher,* use TP-6200.

7.2.2 Installation Requirements

The following items are necessary PC requirements for installing the controller service replacement kits.

- **Controller Application Program Software Version 2.10 or higher** from KOHLER*net* using the TechTools button to download on your PC hard drive or disk.
- **Program Loader Software Version 2.2.2 or higher** from KOHLER*net* using the TechTools button to download on your PC hard drive or disk if not already installed on your PC.
- **Monitor II Software PA-361725 or PA-365196, Version 4.0.0 or higher.** Add the user parameters from a backup disk and/or enter alphanumeric data. See the Monitor II software operation/installation manual for additional items.
- **Null Modem RS-232 Cable** with a 9-pin male plug on the controller end, part no. GM16657 or kit no. PA-294992.

7.2.3 Software Compatibility

Monitor II software version 4.0.0 requires Application Program version 2.10 to support the new controller features. Monitor II software version 4.0.0 also supports Application Programs prior to version 2.10. Monitor II software prior to 4.0.0 will not function with Application Program version 2.10 or higher. See Figure 7-3.

Software Description	New Software Versions	Old Software Versions
Application Program	2.10 or higher	1.34
Monitor II	4.0.0 or higher	2.2.5
Program Loader	2.2.2 or higher	2.2.2

Figure 7-3 Software Compatibility

7.2.4 Procedure

1. Acquire the User Parameters

   a. Choose one of the following methods to retrieve the user parameters:

      - Backup disk. If a backup disk was previously made, obtain the parameters from this disk. If a disk was not previously made, create a backup if possible using the Monitor II software, version 4.0.0 or higher. The existing controller must function in order to create the file.
      - Paper form. Parameters should have been recorded on the User-Defined Settings form located in the appendix of the 550 controller operation manual or other similar form.
      - Controller menu. Manually review the controller menu displays if possible and enter the parameter information in the 550 controller operation manual appendix, User-Defined Settings, form.

   b. Save the user parameter data for step a.

2. Acquire display data from the old controller for entry in the new controller.

   Certain data cannot be stored on electronic media for archival purposes and must be entered using a PC or the controller keypad.

   When possible, make note of the following data from the old controller for entry in the new controller. If the old controller is not functional, the installer must determine and document this information for entry later in this procedure. See Section 7.2.6. for the Controller User-Defined Settings form.

   a. From Menu 4, Operational Records
      - Total Run Time Hours
      - Total Run Time Loaded Hours
      - Total Run Time Unloaded Hours

   b. From Menu 7, Generator System
      - Metric Units, yes or no

   c. From Menu 12, Calibration
      - Scale Aux. Analog Inputs. Repeat for each input 01–07
      - Analog 01, scale value 1
      - Analog 01, scale value 2

d. From Menu 13, Communication

- Protocol KBUS
  - KBUS online, yes or no
  - Connection type
    - Local single, yes or no
    - Local LAN, yes or no
    - Local LAN conv, yes or no
    - Remote single, yes or no
    - Remote LAN, yes or no
    - Remote LAN conv, yes or no
  - Primary port
    - RS-232, yes or no
    - RS-485 ISO1, yes or no
  - Address (LAN connections)
  - System ID (remote connections)
  - BAUD rate
    - 1200
    - 2400
    - 9600
- Protocol Modbus
  - Modbus online, yes or no
  - Connection type
    - Single, yes or no
    - Convertor, yes or no
  - Primary port
    - RS-485
    - RS-232
  - Address
  - BAUD rate
    - 9600
    - 19200

e. From Menu 20, Factory Setup

- Final assembly date
- Final assembly clock number
- Model number
- Spec number
- Serial number

3. Acquire display data from the old controller for reference purposes.

   When possible, write down the old controller display data in Section 7.2.6 and Section 7.2.7, User-Defined Settings. This data is not required for the new controller but may be needed for future reference. If the old controller is not functional, the information is no longer retrievable.

4. Remove the generator set from service.

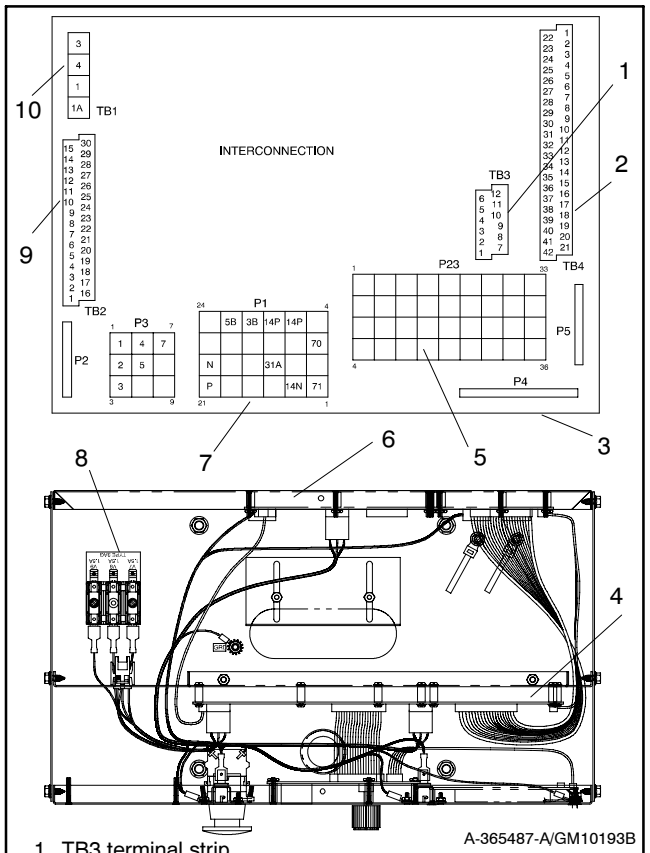
   a. Place the generator set master switch in the OFF position.

   b. Disconnect the power to the battery charger, if equipped.

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

5. Disconnect the existing 550 controller electrical connections.

   a. Remove the controller cover. If access to the interconnection circuit board on the rear panel and/or the main logic/communication circuit board on the front panel is difficult to access, partially disassemble the controller box. Remove the two controller panel top screws and center bottom screw and then loosen the bottom screw on each side to swing the controller panel down. See Figure 7-4.



1. TB3 terminal strip
2. TB4 terminal strip
3. Interconnection circuit board (front view)
4. P18 on main logic (microprocessor)/communication circuit board
5. P23 connector
6. Interconnection circuit board mounted on the controller rear panel
7. P1 plug
8. TB5 terminal block (fuses)
9. TB2 terminal strip
10. TB1 terminal strip

Figure 7-4 Disconnecting Controller Circuit Board External Wiring Connections

Note: Clearly mark all disconnected leads from the 550 controller with tape to simplify reconnection.

b. Disconnect the 550 controller harness leads. Listed below are some common leads and plugs that require removal or disconnection. Items below in **bold** are shown in Figure 7-4. These connections are typical and may not apply to all applications. See the corresponding wiring diagram found in the wiring diagrams manual.

- AC fuse terminal block **TB5** leads V7, V8, and V9
- All external connections to terminal strips **TB1, TB2, TB3, and TB4**
- CT/meter scale terminal block lead V0
- P24 connector to CT burden resistor board
- Plug **P1** on the burden resistor board and the Marathon excitation interface board
- Plug **P23** to the controller connection strip in the junction box
- Plug P22 to the engine wiring harness
- Plug **P18** remote communication connection (RS-232)
- Prime power kit
- Any other external leads to the controller

6. Remove the existing 550 controller.

a. Remove the junction box panel(s) to gain access to the controller vibromount screws.

b. Remove the four controller vibromount screws from underneath the junction box top panel.

c. Lift off the existing 550 controller.

7. Install the replacement 550 controller.

a. Place the replacement 550 controller on the junction box top panel holes.

b. Align the 550 controller vibromounts with the mounting holes and install four screws.

c. Change the controller's front display lamps, if required. See Figure 7-2 for location. See Figure 7-5 for lamp identification. The factory ships the 550 controller with 12-volt lamps. Replace bulbs in controller with lamps provided in the replacement kit if the generator set has a 24-volt engine electrical system. Determine the engine electrical system voltage using the generator set nameplate information.

8. Connect the replacement 550 controller.

a. Remove the controller cover. If access to the interconnection circuit board on the rear panel and/or the communication circuit board on the front panel is difficult, partially disassemble the controller box. Remove the two controller panel top screws and center bottom screw and then loosen the bottom screw on each side to swing controller panel down. See Figure 7-4.

b. Reconnect the controller wiring that was previously removed. See the corresponding wiring diagram found in the wiring diagrams manual. Listed below are some common leads and plugs that may require reconnection. These connections are typical and may not apply to all situations.

- AC fuse terminal block **TB5** leads V7, V8, and V9
- All external connections to terminal strips **TB1, TB2, TB3, and TB4**
- CT/meter scale terminal block lead V0
- P24 connector to the CT burden resistor board
- Plug **P1** on the burden resistor board and the Marathon excitation interface board
- Plug **P23** to the controller connection strip in the junction box
- Plug P22 to the engine wiring harness
- Prime power kit
- Any other external leads to the controller

c. Swing the rear controller panel up and replace and tighten the screws, as necessary.

d. Replace the junction box panel(s) and screws.

Lamp Part No.	Voltage	Bulb Part Number
255126	12	1892
283420	24	313

Figure 7-5 Lamp Identification

9. Restore power to the generator set.

   a. Check that the generator set master switch is in the OFF position.

   b. Reconnect the generator set engine starting battery, negative (-) lead last.

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

10. Install the program/data files.

    a. Connect the PC serial port to the controller RS-232 port using a null modem RS-232 cable with a 9-pin male plug on the controller end. See TT-1285 for details.

    b. Install the Program Loader program into the PC using the procedure outlined in TT-1285.

    c. Insert the personality profile backup disk and load the data. See TT-1285 for details.

11. Establish the controller identity in Menu 20.

    The controller displays the following error message: GENSET S/N WARNING.

    This procedure includes instructions on how to unlock and lock the factory setup after entering Menu 20. Use the down arrow key to go to the setup lock menu for determining the setup status.

    Note: After completing the factory setup, always return the controller to the setup lock position to prevent inadvertent program changes.

    a. Press the RESET MENU key on the controller keypad.

    b. Use the controller keypad to go to Menu 14, Programming Mode**,** and select programming mode—local. Use the information from the 550 controller operation manual as necessary.

       Note: The factory default access code is the number 0.

    c. Press the RESET MENU key on the controller keypad.

    d. Use the controller keypad to go to Menu 20, Factory Setup. See Figure 7-6 or Figure 7-7 for displays.

    e. Arrow down to the SETUP LOCK display.

       If the SETUP LOCK display indicates YES, go to step f.

       If the SETUP LOCK display indicates NO, go to step g.

       - Press the ENTER key. Changes to Menu 20, Factory Setup, are now possible.

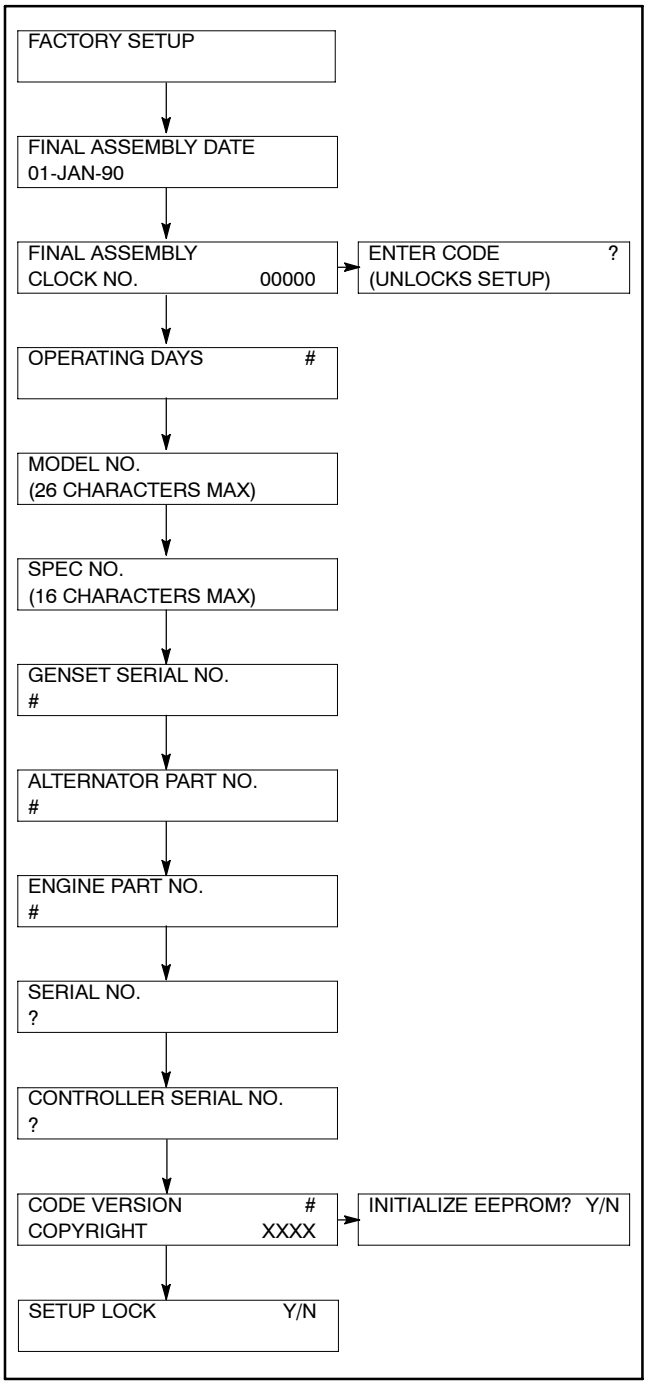


Figure 7-6 Menu 20, Factory Setup (prior to version 2.10)

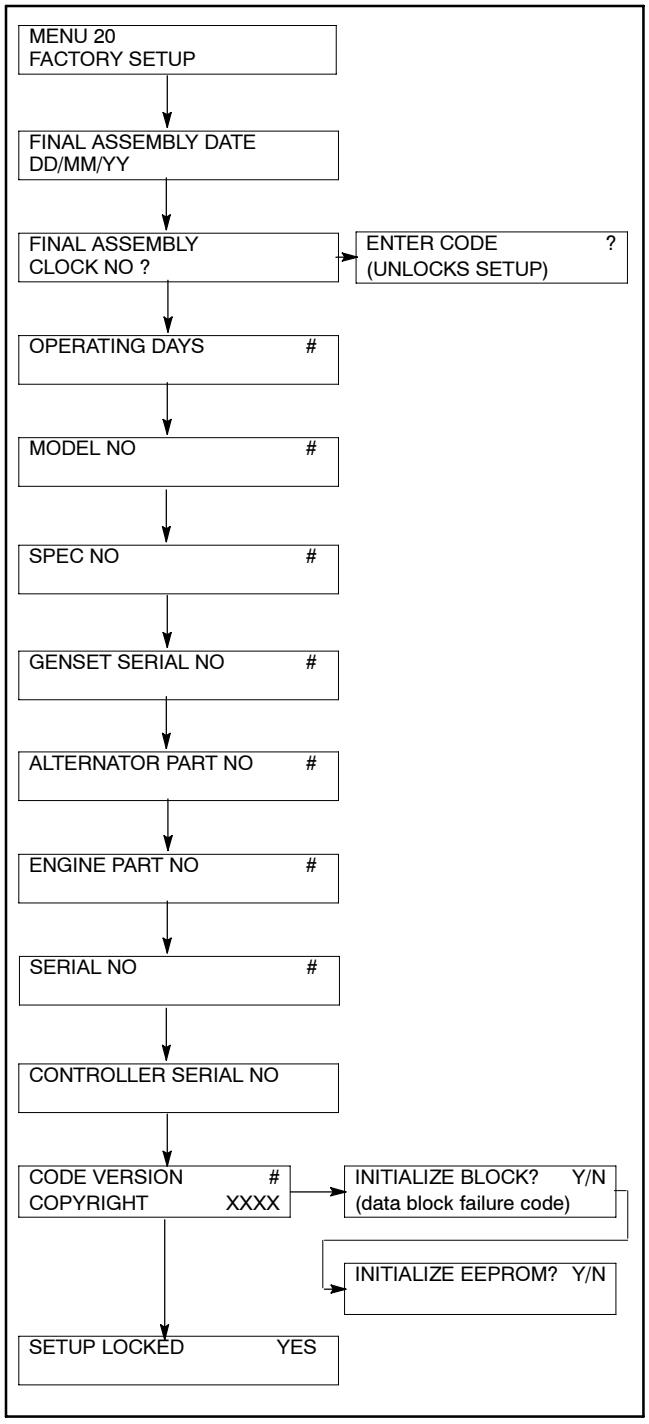


Figure 7-7 Menu 20, Factory Setup (version 2.10 or higher)

f. Unlock the setup.

- Arrow down to the FINAL ASSEMBLY, CLOCK NO. display. Record the clock number on the controller display.
- Arrow right to ENTER CODE display.
- Use the controller keypad to enter the clock number previously recorded.

g. Initialize the EEPROM.

- Arrow down to the CODE VERSION display.
- Arrow right to INITIALIZE EEPROM display.
- Press the YES key to initialize the EEPROM.
- Press the ENTER key.

h. Wait for completion of the system reset.

i. Go to Menu 20, Factory Setup. See Figure 7-6 or Figure 7-7 for displays.

j. Change the final assembly date.

- Arrow down to the FINAL ASSEMBLY DATE display.
- Enter the final assembly date using the data recorded from the old controller, reference step 2.e. If data from the old controller is not available, keep the default setting.
- Press the ENTER key if making a new entry.

k. Change the final assembly clock number.

- Arrow down to the FINAL ASSEMBLY CLOCK NO. display.
- Enter the final assembly clock number using the data recorded from the old controller. If data from the old controller is not available, keep the default setting.
- Press the ENTER key if making a new entry.

l. Change the serial number. The 550 controller service replacement kit will show the GENSET SERIAL NO. as 123456. After the personality profile is loaded, the GENSET SERIAL NO. shows the correct serial number for the respective generator set. Use the GENSET SERIAL NO. to update the SERIAL NO. display as follows:

- Arrow down to the SERIAL NO. display.
- Enter the serial number of the generator set using data recorded from the old controller or as shown on the generator set nameplate**.** If the serial number is six digits, enter a *leading zero* for a seven-digit serial number.
- Press the ENTER key. The GENSET S/N WARNING display no longer appears when the GENSET SERIAL NO. and SERIAL NO. match.

12. Perform the Menu 13, Communications entries.

    a. Press the RESET MENU key on controller keypad.

    b. Use the controller keypad to go to Menu 13, Communications.

    c. Complete the communication entries as necessary for remote programming. Use the information from the 550 controller operation manual as necessary.

13. Perform the Menu 14, Programming mode entries.

    a. Press the RESET MENU key on controller keypad.

    b. Use the controller keypad to go to Menu 14, Programming Mode**,** and select programming mode—remote. Use the information from the Monitor II software, version 4.0.0 or higher.

14. Perform the Menu 20, Factory Setup entries using the Generator Info window. Use the information from the Monitor II software, version 4.0.0 or higher.

    a. Change the model number.

    - Go to the MODEL NO. display.
    - Enter the model number using the data recorded from the old controller or as shown on the generator set nameplate.

    b. Change the spec (specification) number.

    - Go to the SPEC NO. display.
    - Enter the spec number using the data recorded from the old controller or as shown on the generator set nameplate.

15. Perform the Menu 14, Programming mode entries.

    a. Press the RESET MENU key on the controller keypad.

    b. Use the controller keypad to go to Menu 14, Programming Mode, and select programming mode—local. Use the information from the 550 controller operation manual as necessary.

16. Perform the Menu 4, Operational Records.

    a. Press the RESET MENU key on controller keypad.

    b. Use the controller keypad to go to Menu 4, Operational Records.

    c. Complete the operational records entries as necessary. Use the information from the 550 controller operation manual as necessary.

17. Lock the Menu 20, Factory Setup entries.

    a. Press the SETUP MENU key on the controller keypad.

    b. Use the controller keypad to go to Menu 20, Factory Setup.

    c. Arrow down to the SETUP LOCK display.

    d. Press the YES key to lock the setup and prevent alterations to Menu 20, Factory Setup.

18. Enter the Menu 6, Time and Date, settings.

    a. Press the RESET MENU key on the controller keypad.

    b. Use the controller keypad to go to Menu 6, Time and Date. Use the information from the 550 controller operation manual as necessary to set the time and date.

19. Perform the Menu 7, Generator System, entries for English or metric displays.

    a. Press the RESET MENU key on the controller keypad.

    b. Use the controller keypad to go to Menu 7, Generator System. Use the information from the 550 controller operation manual as necessary to change metric unit, yes or no.

20. Perform the Menu 12, Calibration, entries.

    a. See the 550 controller operation manual for disconnecting the ribbon connector. Disconnect ribbon connector P2 prior to zeroing out (resetting) the auxiliary analog inputs.

    b. Press the RESET MENU key on the controller keypad.

c. Use the controller keypad to go to Menu 12, Calibration. Use the information from the 550 controller operation manual as necessary to scale AC analog inputs.

d. With the information previously recorded from step 2, scale the auxiliary analog inputs. Use the information from the 550 controller operation manual as necessary.

21. Perform the Menu 14, Programming Mode entries.

a. Press the RESET MENU key on the controller keypad.

b. Use the controller keypad to go to Menu 14, Programming Mode.

- Select programming mode—remote when adding user parameter from a backup disk or PC.

- Select programming mode—local for keypad entries. Use the information from the 550 controller operation manual as necessary.

22. Add the user parameters.

a. Choose one of the following methods to load the user parameters.

- Backup disk. Use a PC to load the data from the user parameter backup disk. Enable Menu 14, Programming Mode—Remote. See the information from the Monitor II software manual.

- Paper form. Use a PC to enter the user parameter data from the filled-out 550 controller operation manual appendix, User-Defined Settings form, or other similar form. Enable Menu 14, Programming Mode—Remote. See the information supplied with the Monitor II software manual.

- Controller menu. Use the controller keypad to manually enter the user parameter data from the filled-out 550 controller operation manual appendix, User-Defined Settings form. Enable Menu 14, Programming Mode—Local. Use the information from the 550 controller operation manual as necessary.

b. Create a new user parameter data backup disk if any changes are made. See the Monitor II software manual.

c. Disconnect the PC null modem RS-232 cable.

d. Install the P18 (RS-232) remote communication connection, as necessary.

e. Swing the front controller panel up and replace and tighten the screws, as necessary.

f. Replace the controller cover and hardware. Tighten all controller screws.

23. Restore the generator set to service.

a. Perform the Menu 13, Communication, entries.

- Press the RESET MENU key on controller keypad.

- Use the controller keypad to go to Menu 13, Communications.

- With the information previously recorded from step d., complete the communication entries as necessary for the application. Use the information from the 550 controller operation manual as necessary.

b. Perform the Menu 14, Programming Mode entries.

- Press the RESET MENU key on controller keypad.

- Use the controller keypad to go to Menu 14, Programming Mode.

- Change the entries for the application as necessary.

c. The generator set system is now ready to function.

d. Move the generator set master switch to AUTO for startup by remote transfer switch or remote start/stop switch.

7.2.5 Display Items for Reference

Menu 4 Operational Records	Menu 5 Event History	Menu 20 Factory Setup	

• Factory Test Date
• Total Run Time
• Total Run Time Loaded Hours
• Total Run Time Unloaded Hours
• Total Run Time kW Hours
• No. of Starts
• Engine Start Countdown
  ○ Run Time
• Records-Maintenance
  ○ Reset Records
• Run Time Since Maintenance Total Hours
• Run Time Since Maintenance Loaded Hours
• Run Time Since Maintenance Unloaded Hours
• Run Time Since Maintenance kW Hours
• Operating Days Last Maintenance
• No. of Starts Last Maintenance
• Last Start Date
• Length of Run (Un)loaded Hours
	• (Message Text)
	• (Scroll through up to 100 stored events)
		• Final Assembly Date
		• Final Assembly Clock No.
		• Operating Days	

7.2.6 User-Defined Settings (550 Controller Prior to Version 2.10)

Use the table below to record user-defined settings during the generator set controller setup and calibration. The controller default settings and ranges provide guidelines. The table contains all faults with ranges and time delays including items that do not have adjustments.

Note: The engine ECM may limit the crank cycle even if the controller is set to a longer time period.

Status or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Range Setting	Default Selection	Inhibit Time Delay* (sec.)	Time Delay (sec.)	User-Defined Settings
AC Sensing Loss	10	AC Sensing Loss	RDO-25					Not adjustable
Access Code (password)	14				0 (zero)			
Analog Aux. Inputs 1-7	9	User-Defined A1-A7		Default values with Warning Enabled: HI warning 90%, LO warning 10%, HI shutdown 100%, LO shutdown 1%	30 sec. inhibit, 5 sec. delay	0-60	0-60	
Analog Aux. Input 1	9	Coolant Temperature		Default values with Warning Enabled: HI/LO warning and HI/LO shutdown are all engine dependant	30 sec. inhibit, 0 sec. delay	0-60	0-60	
Analog Aux. Input 2	9	Oil Pressure		Default values with Warning Enabled: HI/LO warning and HI/LO shutdown are all engine dependant (255 psi max.)	30 sec. inhibit, 0 sec. delay warning, 5 sec. delay shutdown	0-60	0-60	
Cyclic Cranking	8			1-6 crank cycles 10-60 sec. crank on 1-60 sec. pause	3 cycles 15 sec. 15 sec.			
Defined Common Faults	10	User-Defined	RDO-18	Default shutdowns include: Emergency stop High coolant temp Low oil pressure Overcrank Overspeed	30 sec. inhibit, 5 sec. delay	0-60	0-60	
Digital Aux. Inputs 1-21	9	User-Defined D1-D21			30 sec. inhibit, 5 sec. delay	0-60	0-60	
EPS (Emergency Power System) Supplying Load	10	EPS Supplying Load	RDO-15		5% of rated line current			
High Battery Voltage	10	High Battery Voltage	RDO-13	14.5-16.5 (12V) 29-33 (24V)	16 (12V) 32 (24V)		10	
High Coolant Temperature Shutdown	10	Hi Cool Temp Shutdown	RDO-03			30	5	Not adjustable
High Coolant Temperature Warning	10	Hi Cool Temp Warning	RDO-06			30		Not adjustable
High Oil Temperature Shutdown	10	Hi Oil Temp Shutdown	RDO-17			30	5	Not adjustable
Idle (speed) Mode Function Digital Aux. input D21	9, 10	Idle Speed Active	RDO-21	Fixed inhibit time	0 sec. inhibit, 60 sec. delay		0-600	

* Inhibited time delay is the time delay period after crank disconnect.

Status or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Range Setting	Default Selection	Inhibit Time Delay* (sec.)	Time Delay (sec.)	User-Defined Settings
Load Shed kW Overload	10	Load Shed KW Over	RDO-30	80%–120%	100% of kW rating		5	
Load Shed Underfrequency	10	Load Shed Under Frequency	RDO-31		59, (60 Hz) 49, (50 Hz)		5	
Low Battery Voltage	10	Low Battery Voltage	RDO-12	10–12.5 (12V) 20–25 (24V)	12 (12V) 24 (24V)		10	
Low Coolant Level	10	Low Coolant Level	RDO-14			30	5	Not adjustable
(Low) Oil Pressure Shutdown	10	Oil Pressure Shutdown	RDO-04			30	5	Not adjustable
(Low) Oil Pressure Warning	10	Oil Pressure Warning	RDO-07			30		Not adjustable
No Coolant Temperature Signal	10	No Cool Temp Signal				30		Not adjustable
No Oil Pressure Signal	10	No Oil Pressure Signal				30		Not adjustable
Overcrank Shutdown	8	Over Crank	RDO-02	0–6 cycles	3 cycles			
Overcurrent	10	Over Current			110%		10	
Overfrequency Shutdown	7, 10	Over Frequency	RDO-28	102%–140%	140% std. 103% FAA		10	
Overspeed Shutdown	7, 10	Over Speed	RDO-01	65–70 (60 Hz) 55–70 (50 Hz)	70 (60 Hz) 60 (50 Hz)		0.25	
Overvoltage Shutdown	7, 8, 10	Over Voltage	RDO-20	105%–135%	115% 2-sec. time delay		2–10	
Password (access code)	14				0 (zero)			See Access Code entry
Time Delay Engine Cooldown (TDEC)	8, 10		RDO-23	00:00–10:00 min:sec	5:00			
Time Delay Engine Start (TDES)	8, 10			00:00–5:00 min:sec	00:01			
Time Delay Starting Aid	8, 10			0–10 sec.				
Underfrequency Shutdown	7, 10	Under Frequency	RDO-29	80%–95%	90%		10	
Undervoltage Shutdown	7, 8, 10	Under Voltage	RDO-27	70%–95%	85% 10-sec. time delay		5–30	
Weak Battery	10	Weak Battery	RDO-26		60% of nominal		2	

* Inhibited time delay is the time delay period after crank disconnect.

7.2.7 User-Defined Settings (550 Controller Version 2.10 or Higher)

Use the table below to record user-defined settings during the generator set controller setup and calibration. The controller default settings and ranges provide guidelines. The table contains all faults with ranges and time delays including items that do not have adjustments.

Note: Inhibit time delay is the time delay period after crank disconnect.

Note: The engine ECM may limit the crank cycle even if the controller is set to a longer time period.

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)	User-Defined Settings
Access Code (password)	14			User selectable	0 (zero)			
AC Sensing Loss	10	AC Sensing Loss	RDO-25*					Not adjustable
Air Damper Indicator (if used) Digital Aux. Input D20 **	9, 10	Air Damper Indicator	RDO-23* (lead 56)	Fixed	0 sec. inhibit, 0 sec. delay			Not adjustable
Air/Fuel Mixture (AFM) Remote Start ‡	10	AFM Remote Start	RDO-25‡					Not adjustable
Air/Fuel Mixture (AFM) Shutdown ‡	10	AFM Shutdown		Fixed				Not adjustable
Alternator Protection	10	Alternator Protection						Not adjustable
Analog Aux. Inputs A01–A07	9	User-Defined A01–A07		Default Values with Warning Enabled: HI warning 90% LO warning 10% HI shutdown 100% LO shutdown 1%	30 sec. inhibit, 5 sec. delay	0–60	0–60	
Analog Aux. Input A01 (non-ECM only)	9	A01 Coolant Temp		Default Values with Warning Enabled: HI/LO warning and HI/LO shutdown are all engine dependent	30 sec. inhibit, 0 sec. delay warning, 5 sec. delay shutdown			
Analog Aux. Input A02 (non-ECM only)	9	A02 Oil Pressure		Default Values with Warning Enabled: HI/LO warning and HI/LO shutdown are all engine dependent (255 psi max.)	30 sec. inhibit, 0 sec. delay warning, 5 sec. delay shutdown			
Analog Aux. Input A03‡	9	A03 Intake Air Temperature		Default Values with Warning Enabled: HI/LO warning are engine dependent	30 sec. inhibit, 0 sec. delay warning			
Analog Aux. Input A04‡	9	A04 Oil Temperature		Default Values with Warning Enabled: HI/LO warning are engine dependent	30 sec. inhibit, 0 sec. delay warning			
Analog Aux. Input A07§	9	A07 Voltage Adjust		±10% of system voltage over the range of 0.5–4.5 VDC	2.5 VDC			
Battery Charger Fault, Digital Aux. Input D01 **	9, 10	Battery Charger Fault	RDO-11 (lead 61)	Fixed	0 sec. inhibit, 0 sec. delay			Not adjustable
Battle Switch (see Fault Shutdown Override Switch)	9	Battle Switch		Fixed				Not adjustable
Breaker Trip	10	Breaker Trip	RDO-30§					Not adjustable

* All models, except Waukesha-powered models
† Non-paralleling applications
** NFPA applications
‡ Waukesha-powered models
§ Paralleling applications

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)	User-Defined Settings
Common Protective Relay Output	10	Common PR Output	RDO-31§					Not adjustable
Critical Overvoltage Shutdown	10	Critical Overvoltage		Fixed	275 volts (L1-L2)			Not adjustable
Cyclic Cranking	8			1-6 crank cycles 1-30 sec. crank on 1-60 sec. pause	3 15 sec. 15 sec.			
Defined Common Faults (each input value is set separately)	10	Defined Common Fault	RDO-18 (lead 32A)	Default shutdowns include: Emergency stop High coolant temp Low oil pressure Overcrank Overspeed	30 sec. inhibit, 5 sec. delay	0-60	0-60	
Detonation Shutdown ‡	9, 10	Deton Shutdown		Fixed				Not adjustable
Detonation Warning ‡	9, 10	Deton Warning		Fixed				Not adjustable
Digital Aux. Input D01-D21	9, 10	User-Defined D01-D21			30 sec. inhibit, 5 sec. delay	0-60	0-60	
Digital Aux. Input D05§	9, 10	D05 Breaker Closed						Not adjustable
Digital Aux. Input D06§	9, 10	D06 Enable Synch						Not adjustable
Digital Aux. Input D11‡	9, 10	D11 AFM Shutdown			30 sec. inhibit, 5 sec. delay	0-60	0-60	
Digital Aux. Input D12‡	9, 10	D12 Deton Warning			30 sec. inhibit, 5 sec. delay	0-60	0-60	
Digital Aux. Input D13 Detonation Sensing Module (DSM) ‡	9, 10	D13 Deton Shutdown			30 sec. inhibit, 5 sec. delay	0-60	0-60	
Digital Aux. Input D13 Knock Detection Module (KDM) ‡	9, 10	D13 Knock Shutdown			30 sec. inhibit, 5 sec. delay	0-60	0-60	
EEPROM Write Failure	10	EEPROM Write Failure						Not adjustable
Emergency Stop Shutdown	10	Emergency Stop	RDO-14 (lead 48)					Not adjustable
Engine Cooldown (see Time Delay)								Not adjustable
Engine Start (see Time Delay)								Not adjustable
EPS (Emergency Power System) Supplying Load	10	EPS Supplying Load	RDO-22	Fixed	1% of rated line current			Not adjustable
Fault Shutdown Override Switch	9, 10	Battle Switch						Not adjustable
Field Overvoltage Digital Aux. Input D04 (M4, M5, or M7 alternator only)	9, 10	Field Overvoltage		Fixed	1 sec. inhibit, 15 sec. delay			Not adjustable

* All models, except Waukesha-powered models
† Non-paralleling applications
** NFPA applications
‡ Waukesha-powered models
§ Paralleling applications

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)	User-Defined Settings
Fuel Valve Relay ‡	10	Fuel Valve Relay	RDO-23‡					Not adjustable
Generator Running	10		RDO-15 (lead 70R)					Not adjustable
Ground Fault Detected	10	Ground Fault						Not adjustable
High Battery Voltage	10	High Battery Voltage	RDO-13	14.5–16.5 V (12 V) 29–33 V (24 V)	16 V (12 V) 32 V (24 V)		10	
High Coolant Temperature Shutdown	10	Hi Cool Temp Shutdown	RDO-03 (lead 36)			30	5	Not adjustable
High Coolant Temperature Warning	10	Hi Cool Temp Warning	RDO-06 (lead 40)			30		Not adjustable
High Oil Temperature Shutdown	10	Hi Oil Temp Shutdown				30	5	Not adjustable
Idle (speed) Mode Function Digital Aux. Input D21	9, 10	Idle Mode Active	RDO-21	Fixed inhibit time	0 sec. inhibit, 60 sec. delay		0–600	
Internal Fault Shutdown	10	Internal Fault						Not adjustable
Knock Shutdown	10	Knock Shutdown		Fixed				Not adjustable
Load Shed kW Overload	10	Load Shed KW Over	RDO-30†	80%–120%	100% of kW rating with 5 sec. delay		2–10	
Load Shed Underfrequency	10	Load Shed Under Frequency	RDO-31†		59 Hz with (60 Hz) 49 Hz with (50 Hz)		5	
Locked Rotor Shutdown	10	Locked Rotor						Not adjustable
Loss of ECM Communication	10	Loss of ECM Comm	RDO-26*				4	Not adjustable
Low Battery Voltage	10	Low Battery Voltage	RDO-12 (lead 62)	10–12.5 V (12 V) 20–25 V (24 V)	12 V (12 V) 24 V (24 V)		10	
Low Coolant Level	10	Low Coolant Level	RDO-19			30	5	Not adjustable
Low Coolant Level, Digital Aux. Input D14 (with LCL switch) **	9, 10	Low Coolant Level						Not adjustable
Low Coolant Temperature	10	Low Coolant Temp	RDO-05 (lead 35)		0 sec. inhibit, 0 sec. delay			Not adjustable
Low Coolant Temperature, Digital Aux. Input D03 **	9, 10	Low Coolant Temp						Not adjustable
Low Fuel, Digital Aux. Input D02	9, 10	Low Fuel	RDO-08 (lead 63)		0 sec. inhibit, 0 sec. delay			Not adjustable
Low Fuel (Level or Pressure) Warning, Digital Aux. Input D02 **	9, 10	Low Fuel Warning						Not adjustable
Low Fuel Pressure Shutdown, Digital Aux. Input D09 (125 kW, GM engine, and ‡	9, 10	Low Fuel Shutdown		Fixed				Not adjustable

* All models, except Waukesha-powered models
† Non-paralleling applications
** NFPA applications
‡ Waukesha-powered models
§ Paralleling applications

Status Event or Fault	Refer to Menu	Digital Display	Relay Driver Output (RDO)	Range Setting	Default Selection	Inhibit Time Delay (sec.)	Time Delay (sec.)	User-Defined Settings
(Low) Oil Pressure Shutdown	10	Oil Pressure Shutdown	RDO-04 (lead 38)			30	5	Not adjustable
(Low) Oil Pressure Warning	10	Oil Pressure Warning	RDO-07 (lead 41)			30		Not adjustable
Master Not In Auto (generator switch)	10	Not In Auto	RDO-09 (lead 80)					Not adjustable
Master Switch Error	10	Master Switch Error						Not adjustable
Master Switch Open	10	Master Switch Open						Not adjustable
NFPA 110 Fault	10	NFPA 110 Fault	RDO-10 (lead 32)					Not adjustable
No Coolant Temp. Signal	10	No Cool Temp Signal				30	4	Not adjustable
No Oil Pressure Signal	10	No Oil Pressure Signal				30	4	Not adjustable
Overcrank Shutdown	8, 10	Over Crank	RDO-02 (lead 12)	0–6 Cycles	3 Cycles			
Overcurrent	10	Over Current			110%		10	
Overfrequency Shutdown	7, 10	Over Frequency	RDO-28	102%–140%	140% Std. 103% FAA		10	
Overspeed Shutdown	7, 10	Over Speed	RDO-01 (lead 39)	65–70 Hz (60 Hz) 55–70 Hz (50 Hz)	70 (60 Hz) 70 (50 Hz)		0.25	
Overvoltage Shutdown	7, 8, 10	Over Voltage	RDO-20 (lead 26)	105%–135% of nominal	115% 2-sec. time delay† 135% 10-sec. time delay§		2–10	
Password (see Access Code)								
Pre Lube Relay	10	Pre Lube Relay	RDO-26‡				4	Not adjustable
Speed Sensor Fault	10	Speed Sensor Fault	RDO-24					Not adjustable
Starting Aid (see Time Delay Starting Aid)								Not adjustable
Synchronized	10	In Synch	RDO-29§					Not adjustable
System Ready	10		RDO-17 (lead 60)					Not adjustable
Time Delay Engine Cooldown (TDEC)	8, 10		RDO-16 (lead 70C)	00:00–10:00 min:sec	5:00			
Time Delay Engine Start (TDES)	8, 10			00:00–5:00 min:sec	00:01			
Time Delay Starting Aid	8, 10			0–10 sec.				
Underfrequency	7, 10	Under Frequency	RDO-29‡	80%–95%	90%† 80%§		10	
Undervoltage Shutdown	7, 8, 10	Under Voltage	RDO-27	70%–95%	85% 10-sec. time delay† 70% 30-sec. time delay§		5–30	
Weak Battery	10	Weak Battery			60% of nominal		2	

* All models, except Waukesha-powered models
† Non-paralleling applications
** NFPA applications
‡ Waukesha-powered models
§ Paralleling applications

7.3 Coolant Temperature Sensor Service Kits

(40EOZD/33EFOZD with 550 Controllers and Non-ECM Engines)

7.3.1 Introduction

Replacing the coolant temperature sensor on a generator set with a 550 controller and a non-ECM engine requires controller application software version 2.21 or higher.

The new sensor offers greater reliability with a different sensing range requiring the software upgrade. See Figure 7-8 for the coolant temperature sensor illustration and Figure 7-9 for coolant temperature sensor identification.

Note: Failure to upgrade to the new software, after changing the coolant temperature sensor, will cause the controller to sense a lower than actual coolant temperature. These lower temperature readings may prevent a fault shutdown during an actual high coolant temperature condition.

Note: If controller application software version 2.21 or higher is loaded for any reason and the coolant temperature sensor is NOT replaced, the user must change the temperature sensor selection in Menu 20, Factory Setup. Failure to change the temperature sensor selection will cause the controller to sense a higher than actual coolant temperature and may cause nuisance high coolant temperature shutdown faults.

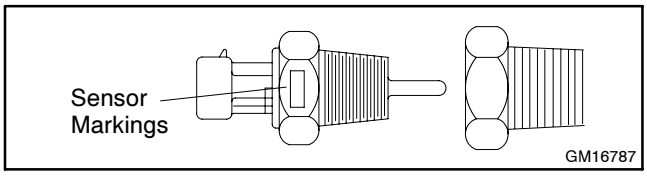


Figure 7-8 Coolant Temperature Sensor and Reducer Bushing (if equipped), Typical

Sensor Service Kit Part Number	Sensor P/N (shown in Menu 20)	Sensor Thread	Sensor Version	Sensor Manufacturer and Markings on Hex	Sensor Voltage Range
GM31990	GM31045-1	1/2-14 NPT	New	Airpax 5024-0443	0.2-1.5

Figure 7-9 Coolant Temperature Sensor Identification

7.3.2 Items Needed for Software Upgrade

The following items are needed to complete the software upgrade. In order to expedite the upgrade process, it is recommended to use the KOHLERnet to request the program loader and application program software and download them on your PC *before* installing the kit. Use your SecurID® to access the KOHLERnet and click on the TechTools button URL to request the files to download.

Note: Technicians without access to the KOHLERnet must contact their local authorized distributor for obtaining software.

- Generator Set Operation Manual and Engine Operation Manual
- Monitor II Software Operation/Installation Manual
- Personal Computer (see Program Loader for requirements)
- Null modem RS-232 cable with a 9-pin male plug on the controller end
- Program Loader Software (see KOHLERnet)
- Application Code Software (see KOHLERnet)

SecurID® is a registered trademark of RSA Security Inc.

7.3.3 Procedure

1. Remove the generator set from service.

   a. Place the generator set master switch in the OFF/RESET position.

   b. Disconnect the power to the battery charger, if equipped.

   c. Disconnect the power to the block heater, if equipped.

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

2. Locate and remove the coolant temperature sensor.

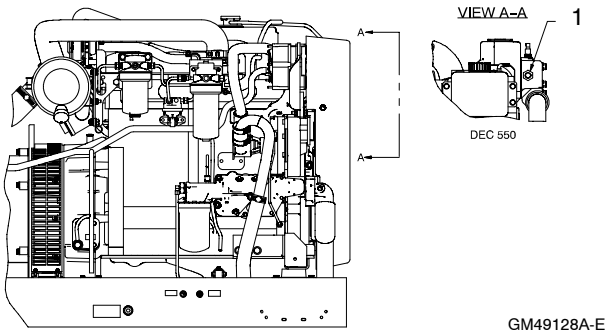
   The coolant temperature sensor is typically at the front of the engine block near the water pump and/or intake manifold. The coolant temperature sensor has a 3-lead connector with red-black-white leads and identified as lead 5. See Figure 7-10 for coolant temperature sensor location.

a. Allow the generator set to cool if the unit was recently operating.

b. Drain the coolant into a suitable container. Open the drain petcocks located at the bottom of the engine block and/or radiator. Drain the coolant to just below the coolant temperature sensor location.

c. Remove the electrical connector from the coolant temperature sensor.

d. Remove the coolant temperature sensor. Remove and discard the metric reducer bushing, if equipped.



1. Coolant temperature sensor

Figure 7-10 Coolant Temperature Sensor Location

3. Install the coolant temperature sensor and add coolant.

   a. Clean the threaded hole in the engine block.

   b. Install the new coolant temperature sensor in the engine block. The new sensor has Loctite® Vibra-Seal® 516 thread sealant already applied.

   c. Attach the electrical connector to the coolant temperature sensor.

4. Fill the radiator with coolant.

   a. Close all the drain petcocks located at the bottom of the engine block and/or radiator.

   b. Refill the cooling system using the procedure and coolant recommendation given in the engine operation manual and/or generator set operation manual. See the respective spec sheet for coolant capacity.

      Reuse the existing drained coolant if deemed acceptable. Otherwise, mix clean distilled water and coolant according to the engine manufacturer's recommendation in the engine operation manual.

      Dispose of all waste materials (engine oil, fuel, coolant, etc.) in an environmentally safe manner. Contact local authority for procedures.

   c. Use the procedure in the engine operation manual for dearating air in the cooling system. If dearation requires starting the generator set go to step 5.

5. Place the generator set into service.

   a. Place the generator set master switch in the OFF/RESET position.

   b. Reconnect the generator set engine starting battery(ies), negative (-) lead last.

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

   d. Complete the dearation procedure before energizing the block heater.

   e. Reconnect the power to the block heater, if equipped.

6. Install the application software (as needed).

   a. Determine the application code version. Use the procedure found in the generator set operation manual for Menu 20, Factory Setup information.

   b. If the application code version is 2.21 or higher, the software update is already done. The sensor installation is complete. Go to step 7.

      If the application code version is less than application code version 2.21, continue with the software update.

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c. Program loader and 550 controller application software files can be downloaded from the KOHLERnet. Use your SecurID to access the KOHLERnet and click on the TechTools button to request and download the files. Use the program loader instructions for completing the application code upgrade.

7. Determine the appropriate temperature sensor selection.

   Change the temperature sensor selection using the controller keypad.

   a. Go to Menu 20, Factory Setup. The menu can remain locked when changing the sensor selection. See Figure 7-11.

   b. Scroll down to the TEMP SENSOR display.

   c. Select temperature sensor part number that matches installed temperature sensor using the right arrow key. See Figure 7-9 for additional identification information. When correct display is shown, press YES and ENTER.

      Note: For coolant temperature sensors GM31045-1 or GM31045-2, choose the GM31045X display.

   d. Installation is complete. Place the controller master switch in the OFF/RESET position.

   e. Temporarily disconnect power to the controller by removing the F2 fuse located on the interconnection circuit board for 10 seconds and then replace the fuse.

      Note: The generator set controller must have the power supply disconnected and then reconnected before the microprocessor will accept the change.

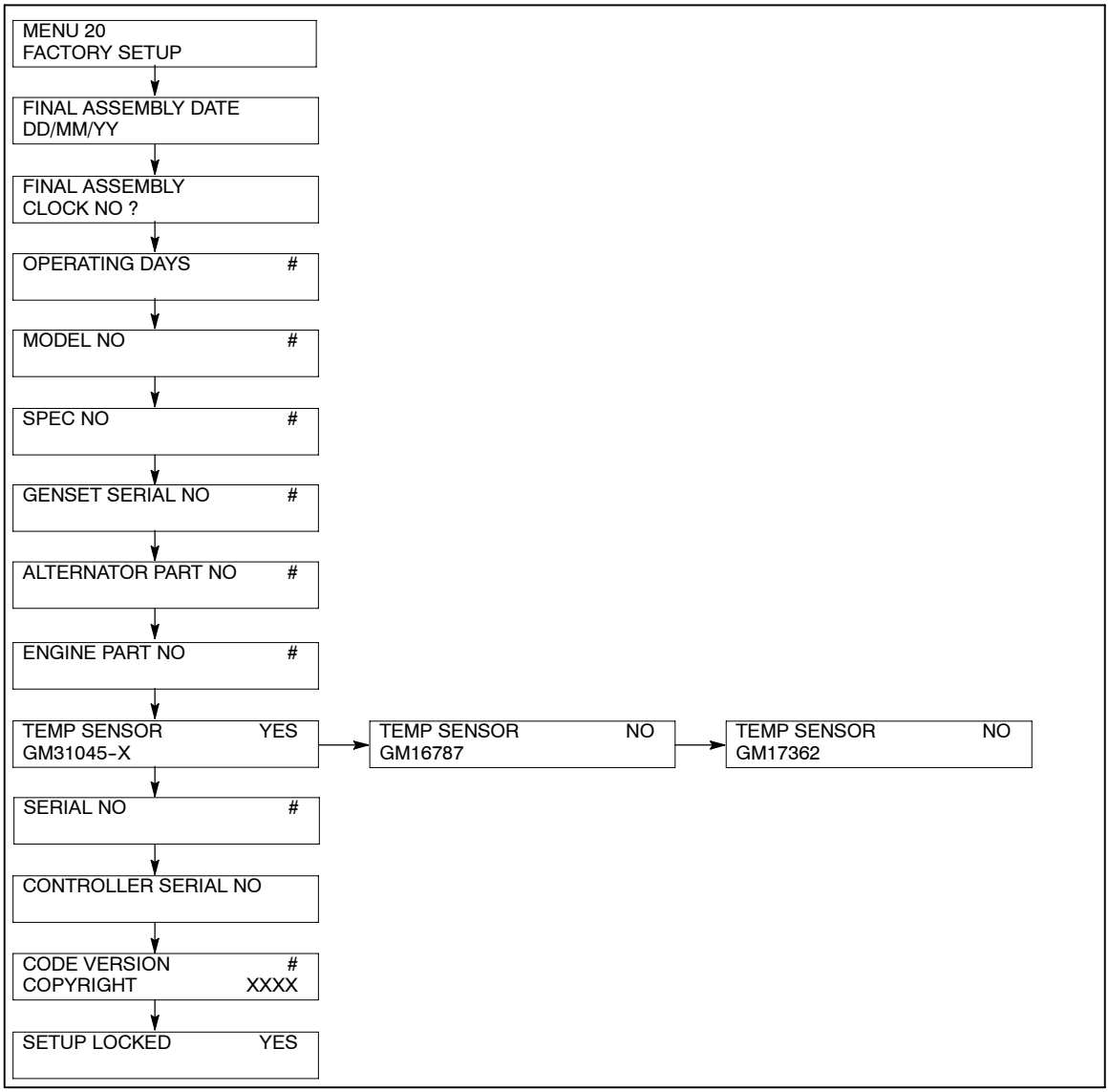


Figure 7-11 Menu 20, Factory Setup

f. At the next scheduled generator set exercise period or at this time, start the generator set by placing the generator set master switch in the RUN position.

   Verify that the engine water temperature reading is valid and no water temperature warning/shutdown faults occur. Refer to the generator set operation manual and engine operation manual for operation information and temperature values.

   When testing is complete, stop the generator set by placing the controller master switch in the OFF/RESET position.

7.4 Controller Circuit Board Failures

(Units Using RS-232 Communications)

The generator set manufacturer has received reports of 550 controller failures using the RS-232 communication port in some types of installations. The incidents reported occurred where the generator set is installed outdoors and the RS-232 connects to a remote communication device. The controller failure may be linked to areas experiencing frequent lightning strikes.

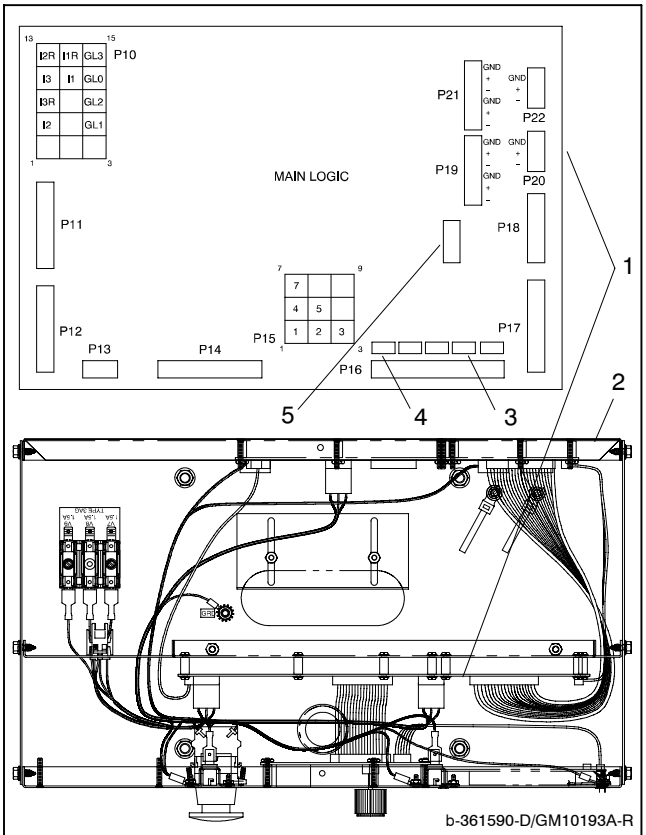
If controller circuit board replacement is needed, verify if the unit has some type of external communication using the RS-232 port. If RS-232 communication is used, verify physical damage to circuit board components, particularly integrated circuits U28, U55, and U58. See Figure 7-12.

If circuit board damage to the integrated circuit is present, the failure was likely caused by some type of electrical voltage surge such as a lightning strike.

The generator set manufacturer has developed an RS-232 Isolation Kit (part number GM32967-KP) to help reduce the likelihood of voltage surge damage. The kit contains optical isolator GM32968 and a 152 mm (6 in.) connection cable GM32969. Install the isolation kit if the RS-232 port is used in conjunction with a remote communication device.

Technicians encountering installations using RS-232 communications should consider using RS-232 isolation kit. This kit when installed will reduce the likelihood of controller circuit board failure caused by voltage surges.

Follow the recommendations in Section 7.5, Noise and Wiring Practices.



1. Main logic (microprocessor/communication) circuit board
2. Controller top view
3. U58 integrated circuit
4. U55 integrated circuit
5. U28 integrated circuit

Figure 7-12 Main Circuit Board

7.5 Noise and Wiring Practices

Adapted from Service Bulletin SB-640 4/04.

Electrical noise is an unwanted electrical signal that can cause errors in measurement, loss of control, malfunctions in microprocessor-based control systems, errors in data transfer between systems over communication links, or reductions in system performance.

Good system design and wiring practices can minimize noise levels and the effects of noise.

Noise, because of its random nature, is typically characterized by frequency distribution. Many noise sources are broad-spectrum, that is, they produce many frequencies distributed over a wide range. Broad-spectrum noise is particularly troublesome because it cannot be removed easily by filtering and because it can affect a variety of systems in unpredictable ways. One common source of broad-spectrum noise is a switch, which can produce voltage and current changes when an electrical circuit is connected and disconnected.

Coupling is the transfer of signals between separate circuits. Signals from one circuit become noise in another. The amount of coupling is cumulative and is a function of the proximity of the circuits, their orientation, exposed area, and length of run. Minimize coupling by the following:

- Isolating circuits from each other by using separate raceways or conduit for AC and DC circuits
- Separating circuits from each other by locating them as far apart as possible
- Enclosing circuits with a grounded metallic shield such as an enclosure, metallic conduit, or cable shield
- Running conductors perpendicular, rather than parallel, to each other
- Running wires loosely and randomly rather than bundling them tightly together
- Twisting a circuit's wires together in pairs

In an industrial environment, there are typically five types of circuits with different noise emission and rejection capabilities. The five types of circuits are as follows:

- **High-Power Distribution.** Circuits to high-power loads such as large electric motors and heaters can emit transient high levels of broad-spectrum noise. Loads on high-power distribution circuits are nearly immune to noise.
- **General Purpose Power Distribution.** Circuits to medium-power loads such as lighting, offices, light-duty equipment, and small motors such as fans and pumps can emit transient, medium levels of broad-spectrum noise. Some electronic equipment, such as computers, emits constant levels of broad-spectrum noise in addition to transient broad-spectrum noise. Loads on general-purpose circuits, except for sensitive electronic equipment, are nearly immune to noise.
- **Control.** Control circuits include DC circuits and 120 VAC maximum AC circuits that operate at a low power level (less than 1 W). Typical circuits include circuits to switches, actuators, and dry-contact relays, including the generator engine-start circuit. Control circuits emit transient low levels of broad-spectrum noise and are fairly immune to noise.
- **Analog.** Analog circuits are low-voltage DC circuits that convey measurement information as relatively small changes in current or voltage. Typical circuits include those connected to the controller's analog inputs. Analog circuits create the lowest noise levels and are the most sensitive to noise.
- **Communication and Signaling.** Communication and signaling circuits are low-voltage circuits that convey information. Typical circuits include RS-232 and RS-485 serial communication lines, telephone lines, and computer network lines. These circuits create noise with frequencies related to the communication signaling rate. These circuits have some level of built-in noise immunity. Typical systems will detect or correct errors caused by noise below certain levels, but with a corresponding reduction in the data transfer rate.

When planning an installation, separate all of these types of circuits as much as possible to minimize the hazards of insulation failure, accidental miswiring, and noise coupling. For best results, install control circuits, analog circuits, and communication and signaling circuits separately. Combining circuit types is unavoidable in the controller's enclosure and some other areas.

Note: It is very important to isolate high- and medium-power circuits in raceways or conduit separate from the other types of circuits.

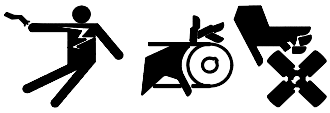
Notes

Section 8 Controller Component Testing and Adjustment

This section provides testing and troubleshooting information on select controller and generator set accessories.

The components and tests in this section apply to all controllers unless otherwise stated.

⚠ 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.

8.1 Controller Circuit Board Handling

Electronic printed circuit boards (PCBs) are sensitive to a variety of elements and can be damaged during removal, installation, transportation, or storage. Observe the following when working with circuit boards.

8.1.1 Circuit Board Handling

- Store circuit boards in the antistatic, cushioned packaging provided by the factory in a clean environment away from moisture, vibration, static electricity, corrosive chemicals, solvents, or fumes until installation.
- Wear an approved grounding, antistatic wrist strap when handling circuit boards or components.
- Carefully hold the circuit board only by its edges, not by any of its components.
- Don't bend or drop the circuit board or any of its components.
- Don't strike the circuit board or any of its components with a hard object.
- Clean dusty or dirty circuit boards only with a vacuum cleaner, dry brush, and/or aerosol spray cans specifically for electronic equipment and components. Aerosol spray cans are typically found with computer supplies.
- Never attempt component-level circuit repairs as this may void third party certification.
- Never remove or install a circuit board with the power connected.
- Label wiring when disconnecting it for reconnection later.

8.1.2 Circuit Board Removal

1. Remove all external connections from the circuit board.

   - Loosen screws on terminal strips and remove the individual leads. Label as needed.
   - Remove push-on terminals by firmly pulling on the terminal. Use a long-nose pliers as necessary.
   - Remove wiring harnesses with plug connectors by pressing the locking tab(s) and pulling on the plug straight out to remove the wiring harness plug from the circuit board socket.

2. Remove the mounting screws typically located at the corners of the circuit board.

3. Locate the PCB push-on standoffs found at various locations on the circuit board. Standoffs are typically made of white nylon but may be other colors or made of metal.

   Carefully pry the circuit board away from each standoff. Start at a location near the circuit board edge and work in succession either clockwise (CW), counterclockwise (CCW), or across the circuit board. DO NOT USE EXCESSIVE FORCE as circuit boards will break when sufficiently bent.

8.1.3 Circuit Board Replacement

1. Position the circuit board over the push-on standoffs on the controller mounting plate.

2. Gently push the circuit board onto the standoffs. Start at a location near the circuit board edge and work in succession either CW, CCW, or across the circuit board. DO NOT USE EXCESSIVE FORCE as circuit boards will break when sufficiently bent.

3. Replace the external connections on the circuit board.

8.2 Other Service Parts

The removal and installation of service parts other than circuit boards is covered by the following generic procedure. Service parts include plug-in relays, switches, lamps, meters, gauges, brackets, and other hardware.

8.2.1 Removal

1. Disconnect wiring from the part(s), noting the locations from which wiring was removed for later reconnection. Tape and label the wires as needed.

2. Note the position of the part(s) and loosen or remove hardware that holds the part(s) in place. If the removal is complex or will span several days, make sketches or use a video recorder or digital camera to help capture the detail.

   Note the location, type, and condition of the hardware removed and compare it with the parts list. Replace damaged or missing hardware.

3. Carefully remove the part(s) from the unit. Gently rock plug-in parts, such as relays, from side to side while pulling straight out to remove them without bending the circuit boards.

8.2.2 Installation

1. Position the part(s) in place in the same manner that the old part was installed. Support the back of circuit boards when installing plug-in parts, such as relays and wiring harness plugs, to avoid bending the circuit board.

2. Tighten or reinstall hardware that holds the part(s) in place to the general torque specifications in Appendix C, General Torque Specifications, unless otherwise noted.

   If the torque specifications do not cover the application or do not seem appropriate let common sense prevail. Avoid overtorquing hardware in sheet metal and non-metallic composites.

3. Reconnect wiring to the same location from which it was removed, torquing terminals to the specifications given in Section 1, Specifications.

8.3 General Information

Use the respective parts catalog to determine the appropriate replacement part. Sometimes service kits replace a given part where additional components in the kit are necessary to provide the functional component equivalent. The parts catalog illustrations may serve as a guide for replacement but be aware that multiple models are generally illustrated in a single view and details may not represent the specific application.

8.4 Leads/Wires/Wiring Harnesses

Repair/replace wiring when there is any doubt about its condition. Tape minor control circuit wire insulation cuts or abrasions less than 1 mm (0.04 in.) across by wrapping the section tightly with three layers of electrical tape.

Repair moderately damaged leads, where conductors are cut or insulation is damaged over sections shorter than about 100 mm (4 in.) or less than about 25% of the length of the wire by cutting out the damaged section and splicing in wire of the same type.

Replace extensively damaged or deteriorated leads completely. If the leads are part of a wiring harness, replace entire wiring harness. Fabricate replacement leads using the same type of wire as the old leads. Add terminals and lead markers at each end of the new load.

8.5 Controller Selector Switch

(Decision-Maker™ 1 and 16-Light Controllers)

The illustrations in Figure 8-1 and Figure 8-2 represent the electrical connections made to the controller selector switch. Use this information to troubleshoot the selector switch when the wiring and/or the selector switch contacts are in question.

See Figure 8-3 for typical controller selector switch external connections. See the respective wiring diagram for actual connections.

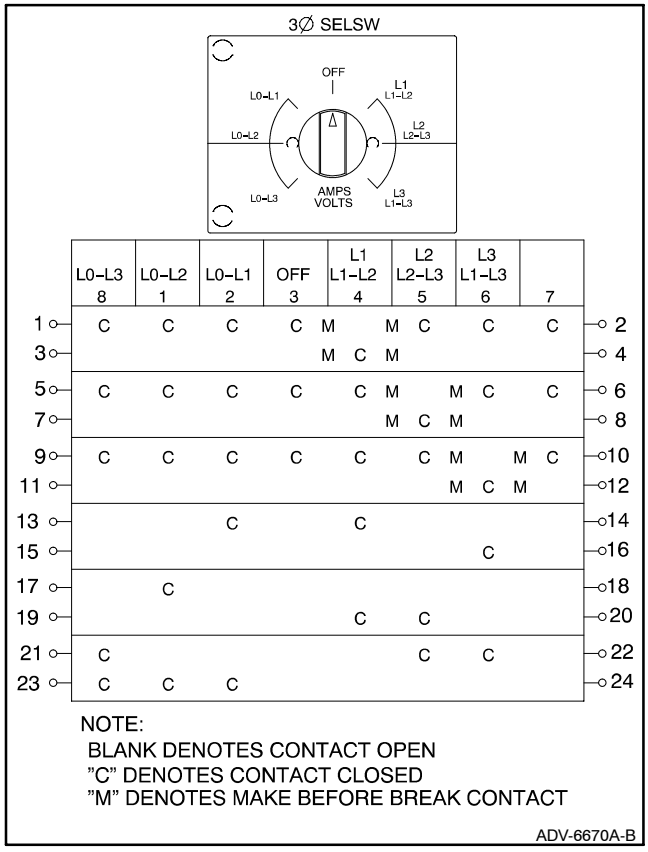


Figure 8-1 Controller Selector Switch, 3-Phase

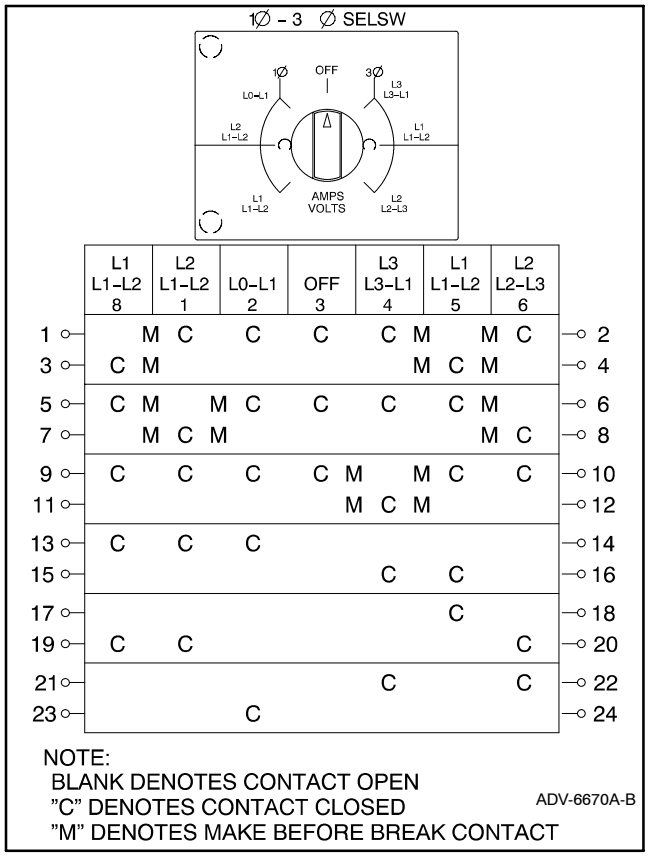


Figure 8-2 Controller Selector Switch, Single-Phase/3-Phase

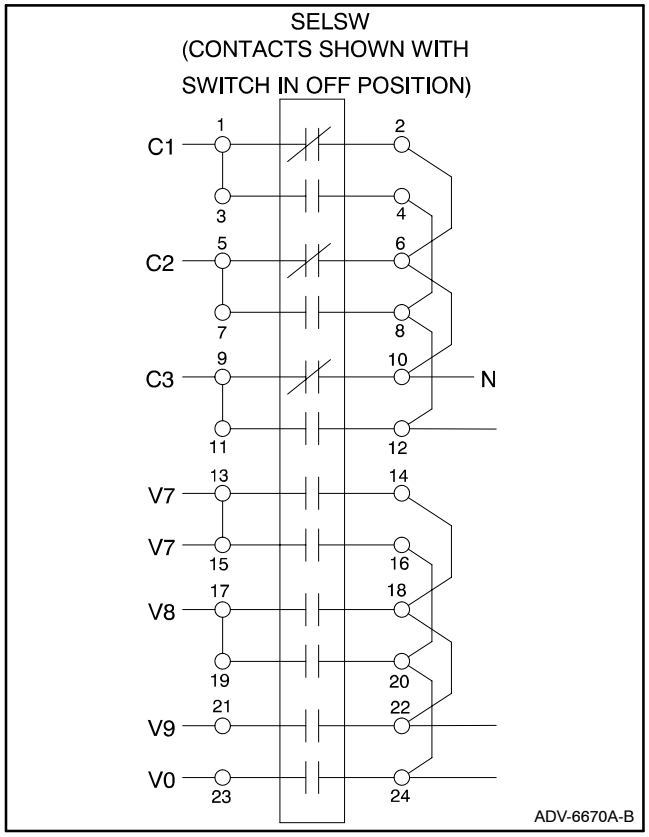


Figure 8-3 Controller Selector Switch External Connections, Typical

8.6 Crank Relay

The test procedure for the following crank relay applies to other applications of the same type relay. See Figure 8-4.

The relay is a single-pole, double-throw relay. Contacts 85 and 86 are the relay coil. See Figure 8-5 for specifications by relay part number. If replacement is necessary, do not substitute part numbers.

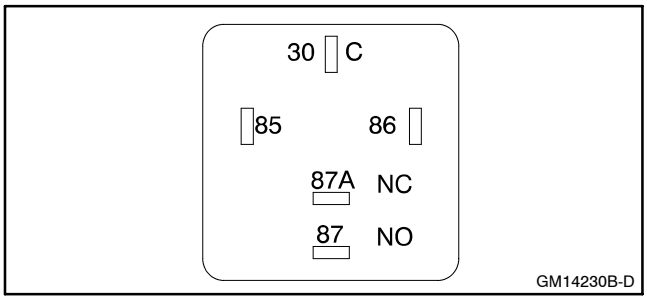


Figure 8-4 Crank Relay Contacts

Relay Part Number	Coil Voltage VDC	Coil Resistance, ohms	NO/NC Contacts Rating, Amp
259391	12	85 ±5	30/20
272684	24	305 ±15	20/16
GM28787	12	90 ±10	40/20
GM37390	12	90 ±10	40/30
GM49746	12	90 ±10	50/30
GM49747	24	360 ±10	50/30

Figure 8-5 Relay Specifications

8.7 Current Transformers

8.7.1 Function and Application

The current transformers provide several generator set functions including signal/drive for:

- Controller AC voltmeter/ammeter
- Safeguard circuit breaker
- Reactive droop compensator

The generator set models do not have current transformers when they do not include the above items. The meters and safeguard circuit breaker share the same current transformer while the reactive droop compensator uses a separate current transformer. See Figure 8-6. The generator set junction box contains the stator leads and the current transformers.

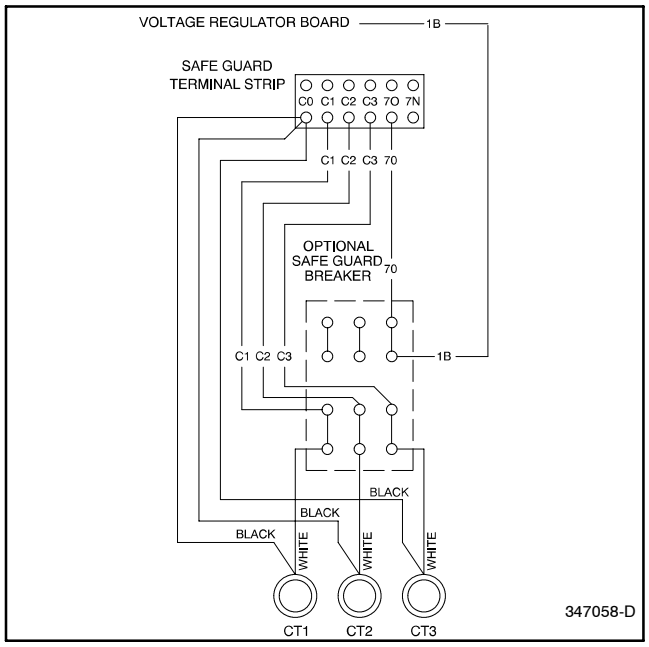


Figure 8-6 Current Transformers

When replacing the current transformer or stator assembly, install the current transformer according to the generator reconnection decal on the generator set, or see the wiring diagrams manual. Observe the correct current transformer position when installing the stator leads. The current transformer dot or HI mark position and the stator lead direction are essential for correct component function. The dot or HI mark should face toward the stator.

Two styles of current transformers are used. Round (doughnut) styles have black/white leads with no mounting provisions. The square styles have two #8-32 studs/nuts for connecting the leads and four notches in the base for mounting.

A current transformer contains a coil of wire that induces a secondary voltage/current from the primary or stator lead passing through the center. The number of coil turns inside the current transformer determines the ratio. Replacement current transformers must have the same ratio as the original.

Note: CTs can have hazardous voltage present at the secondary terminals. Ensure that these secondary terminals have a load or burden connected. If no load is connected, install a shorting bar or wire across these terminals.

⚠ WARNING

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

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

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

8.7.2 Testing

Use an ohmmeter to check the current transformer. Perform this test with the current transformer disconnected from the generator set. A resistance reading of infinity or 0 ohms suggests an open or shorted current transformer that needs replacement. Consider any other resistance reading acceptable.

8.8 Engine Pressure and Temperature Sensors

8.8.1 General

Use this section to test engine sensors (switches or senders) installed by the generator set manufacturer on the engine. Refer to the respective engine service manual for testing sensors installed by the engine manufacturer.

Use the following tests to determine if the sensor is functional. All sensors should have part numbers stamped on the metal housing. In cases where the number is illegible or missing, refer to the respective

generator set parts catalog for the corresponding part number. The user must determine the sensor part number in order to determine the sensor specifications which are found in Section 1, Specifications.

The sensors can be installed on the generator set provided the leads are disconnected and a temperature or pressure gauge is available to determine the engine values. Otherwise, remove the sensor after draining the respective engine fluid (oil or coolant) and test using a separate pressure or temperature source.

The resistance of the oil pressure and water temperature sender output signals varies as the respective pressure and temperature change. Use the resistance change for verification of sender function. Disconnect all leads from the sender before checking resistance. If the sender functions and the gauge does not function, check the engine wiring harness, leads, and connectors before replacing the gauge.

Some generator sets may have senders/switches incorporated with the engine ECM (electronic control module). Identify engine ECM senders/switches by lead designations listed in the following testing information. Refer to the wiring diagrams manual for additional lead identification information. Use the engine service manual for troubleshooting ECM senders/switches.

8.8.2 Sensor Types

The sensors referenced in this section typically provide the following controller inputs:

- High engine temperature shutdown switch
- High engine temperature warning (prealarm) switch
- Low oil pressure shutdown switch
- Low oil pressure warning (prealarm) switch
- Low water temperature warning switch
- Oil pressure gauge sender (see Section 8.8.5)
- Water temperature gauge sender (see Section 8.8.6)

8.8.3 Switch Testing

Before testing switch, disconnect the switch lead(s).

Pressure Switch

Some pressure switches make contact on falling pressure and some on rising pressure; refer to the respective drawing for contact style. Connect an ohmmeter to the switch terminals. Switches with one terminal require connection to ground on the switch metal body. Apply the pressure value shown in Section 1, Pressure Switches, and observe the ohmmeter before and after values to determine if the switch contacts open and close per specifications.

Temperature Switch

High water temperature switches make contact on rising temperature. Low water temperature switches make contact on falling temperature. Refer to the respective drawing for contact style. Connect an ohmmeter to the switch terminals. Switches with one terminal require connection to ground on the switch metal body. Apply the temperature value shown in Section 1, Temperature Switches, and observe the ohmmeter before and after values to determine if the switch contacts open and close per specifications.

8.8.4 Sender Testing

Before testing sender, disconnect the sender lead(s).

Pressure Sender

Pressure senders change resistance values as pressure changes. Connect an ohmmeter to the sender terminals. Senders with one terminal require connection to ground on the switch metal body. Apply pressure values shown in Section 1, Pressure Senders, and observe the ohmmeter values to determine if the sender changes resistance per specifications.

Temperature Sender

Temperature senders change resistance values as temperature changes. Connect an ohmmeter to the sender terminals. Senders with one terminal require connection to ground on the switch metal body. Apply temperature values shown in Section 1, Temperature Senders, and observe the ohmmeter values to determine if the sender changes resistance per specifications.

8.8.5 Oil Pressure Sender Testing

Disconnect the oil pressure sender lead 7C. See Figure 8-7. Check the sender resistance with an ohmmeter. Compare the resistance values when the generator set is shut down and when it is running at operating temperature to the values shown in Section 1, Specifications. Use a mechanical oil pressure gauge to further verify correct readings.

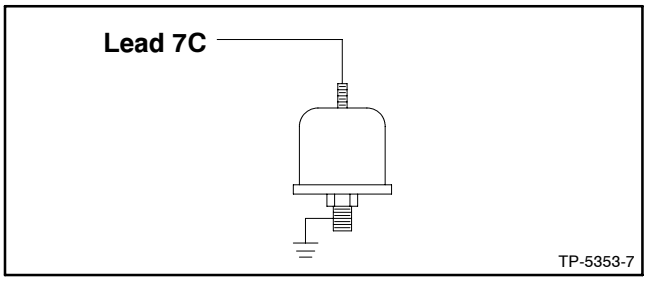


Figure 8-7 Oil Pressure Sender, Typical

8.8.6 Water Temperature Sender Testing

The water temperature sender has two configurations: (1) a single function, single-terminal type and (2) a single function, two-terminal type (used for isolated ground applications). See Figure 8-8.

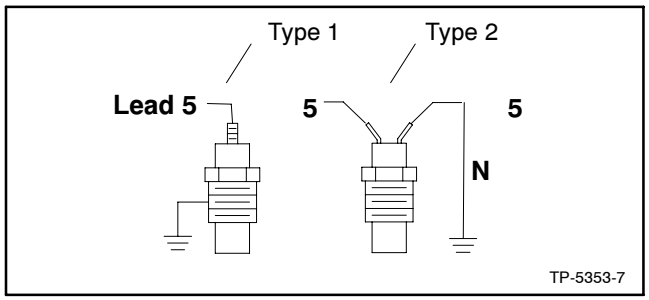


Figure 8-8 Water Temperature Sender, Typical

Disconnect the water temperature sender lead 5 (and lead N with type 2 configurations). Check the sender resistances with an ohmmeter. Compare the resistance values when the generator set is shut down and when it is running at operating temperature to the values listed in Section 1, Specifications.

8.9 Interface Circuit Board GM24832

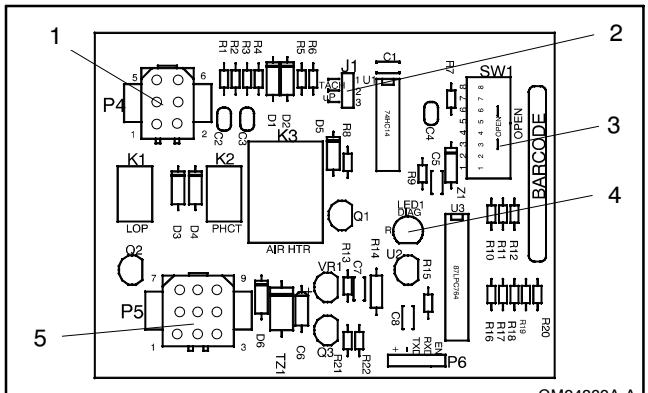
(16-Light and 550 Controllers)

Adapted from Service Bulletin SB-625 11/03.

8.9.1 Introduction

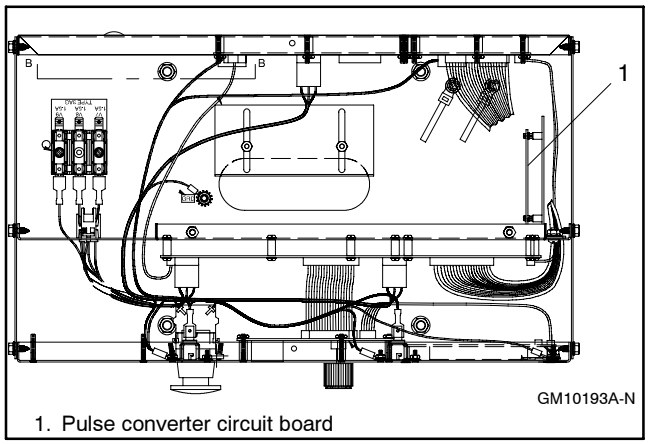
Use this section for controller troubleshooting and inteface circuit board replacement. The interface circuit board converts the engine speed sender signal to a 2-pulse output per engine revolution needed with some controllers.

The interface circuit board GM24832 uses an 8-position DIP switch to provide a 2-pulse output from flywheels with a tooth count between 15 and 255. See Figure 8-9 for the pulse converter circuit board. See Figure 8-10 for circuit board mounting location in the controller.



1. P4 connector
2. J1 jumper (programming shunt)
3. 8-Position DIP switch
4. Diagnostic LED1
5. P5 connector

Figure 8-9 Pulse Converter Circuit Board GM24832



1. Pulse converter circuit board

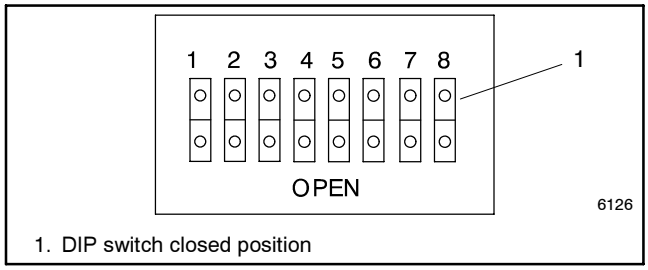
Figure 8-10 Pulse Converter Circuit Board Mounting in 550 Controller (top view)

DIP Switch

Service technicians should be aware that odd number tooth counts have an inherent percent error in engine speed calculations. An even number of flywheel teeth do not cause the percent error in speed. If the flywheel has an odd number of teeth, the circuit board logic uses a correction factor as follows:

(1 – [tooth count] / [tooth count + 1]) x 100 = correction value

Use the circuit board DIP switch, see Figure 8-11 to match the engine flywheel tooth number count.



1. DIP switch closed position

Figure 8-11 DIP Switch Positions

Programming Shunt

Use programming shunt J1 across pins 1 and 2 on the circuit board to get a 1:1 output. The shunt provides a 1:1 output regardless of the DIP switch selection. The shunt is typically used with the 550 controller and is also intended as a diagnostic test during troubleshooting.

Place J1 across pins 2 and 3 for a 2-pulse output signal.

Tach Output

The circuit board has a secondary output (P5-4) that matches the input signal 1:1. Some generator set models use this connection to eliminate an engine speed sensor. See Figure 8-9 for P5-4 location.

Air Heater Control

The circuit board provides a 6-minute (±30 seconds) signal pulsed on and off at 1 minute intervals to activate the air heater after the start switch is toggled. If the start switch signal is interrupted during the 6 minutes, the air heater control signal is deenergized.

8.9.2 Anticipatory High Coolant Temperature and Low Oil Pressure Relays

(40EOZD/33EFOZD Models with 16-Light Controllers)

The circuit board provides dry contacts for anticipatory high coolant temperature (AHCT) and low oil pressure (LOP) inputs for some generator set models.

LED Indicator

The red LED will flash at 1 Hz rate if the DIP switch setting matches the engine flywheel tooth count and the generator set is running at 60 Hz. The LED indicator provides some diagnostic help. See Section 8.9.3, Circuit Board Troubleshooting.

Circuit Board Connections

Figure 8-12 shows the connections made to the pulse converter circuit board. Some generator set models may not have all connections.

Plug-Pin	Connection
P4-1	Low oil pressure input signal
P4-2	Battery positive (+) lead 70
P4-3	Anticipatory high coolant temperature input signal
P4-4	Cable shield (ground)
P4-5	Magnetic pickup sensor low (ground)
P4-6	Magnetic pickup sensor high
P5-1	Magnetic pickup output signal shield (ground)
P5-2	Speed signal output signal
P5-3	Speed sensor ground
P5-4	Tach output signal
P5-5	Magnetic pickup output signal (ground)
P5-6	V+ Speed sensor
P5-7	Low oil pressure output signal
P5-8	Anticipatory high coolant temperature output signal
P5-9	Air heater output signal

Figure 8-12 Pulse Converter Circuit Board Connections

8.9.3 Circuit Board Troubleshooting

The pulse converter circuit board contains an LED indicator for diagnostic troubleshooting. See Figure 8-13.

LED Indicator	Probable Causes	Recommended Actions
Flashes very fast (greater than 1 Hz)	DIP switch set at less than 15 flywheel teeth DIP switch setting does not match flywheel number of teeth	Reset the DIP switch to match the engine flywheel number of teeth
Flashes at a 1 Hz rate	DIP switch set correctly. **NOTE:** The distinction between 1 Hz and 1.1 Hz, for example, is visually unrecognizable.	Circuit board functionally okay
Flashes very slowly (less than 1 Hz)	DIP switch setting does not match flywheel number of teeth	Reset the DIP switch to match the engine flywheel number of teeth
Off (red on, black off)	DIP switch setting does not match flywheel number of teeth No power to the circuit board Inoperative circuit board	Reset DIP switch Check power source Replace inoperative circuit board
On continuous (steady)	DIP switch setting does not match flywheel number of teeth Inoperative circuit board	Reset DIP switch Replace inoperative circuit board

Figure 8-13 Pulse Converter Circuit Board Troubleshooting Chart

8.10 Over/Underfrequency Relay with 16-Light Controller

8.10.1 Function and Connection

The over/underfrequency relay kit provides frequency protection when required. This kit mounts inside the controller with sensing connections to the CT terminal block and output to auxiliary shutdown at P1-15. Use the following procedure to set the shutdown points. See Figure 8-14.

Note: This over/underfrequency relay kit is not compatible with generator sets using electronic engine controls without a frequency adjustment provision.

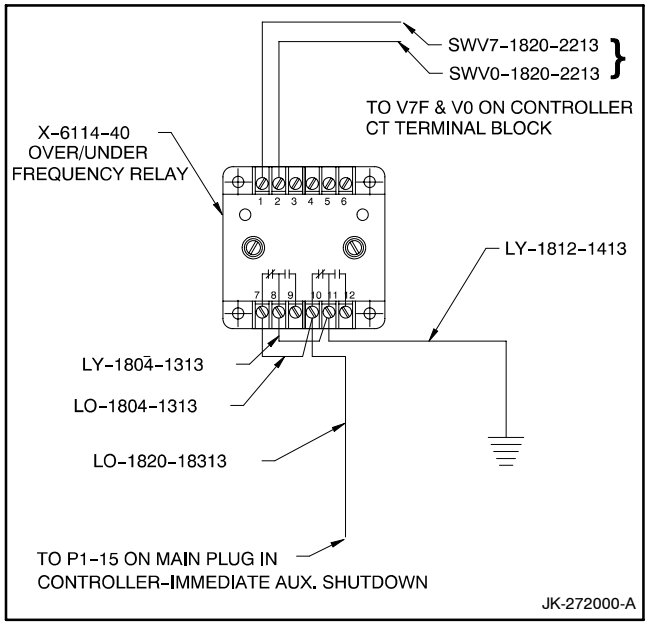


Figure 8-14 Over/Underfrequency Relay

8.10.2 Overfrequency Adjustment

1. Turn the overfrequency adjustment potentiometer fully clockwise (CW).
2. Place the generator set master switch to the RUN position to start the generator set.
3. Adjust governor. See engine operation manual, engine service manual, or the appropriate governor section of this manual for governor adjustment procedure. See Figure 8-15.

Specification Type	Overfrequency Hz	Underfrequency Hz
Standard	63	57

Figure 8-15 Over/Underfrequency Relay Specs

4. Slowly turn overfrequency potentiometer counterclockwise (CCW) until the LED starts flashing. After approximately 10 seconds, the generator set will shut down on auxiliary fault.
5. Place the generator set master switch to the OFF/RESET position to reset the controller.
6. Place the generator set master switch to the RUN position to start the generator set.
7. Readjust the governor to the desired frequency as required.
8. Place the generator set master switch to the OFF/RESET position to stop the generator set.

8.10.3 Underfrequency Adjustment

1. Turn underfrequency adjustment potentiometer fully clockwise (CW).
2. Place the generator set master switch to the RUN position to start the generator set.
3. Adjust governor See engine operation, engine service manual, or the appropriate governor section of this manual for governor adjustment procedure. See Figure 8-15.
4. Slowly turn underfrequency potentiometer counterclockwise (CCW) until LED starts flashing. After approximately 10 seconds, the generator set will shut down on auxiliary fault.
5. Place the generator set master switch to the OFF/RESET position to reset the controller.
6. Place the generator set master switch to the RUN position to start the generator set.
7. Readjust the governor to the desired frequency as required.
8. Place the generator set master switch to the OFF/RESET position to stop the generator set.

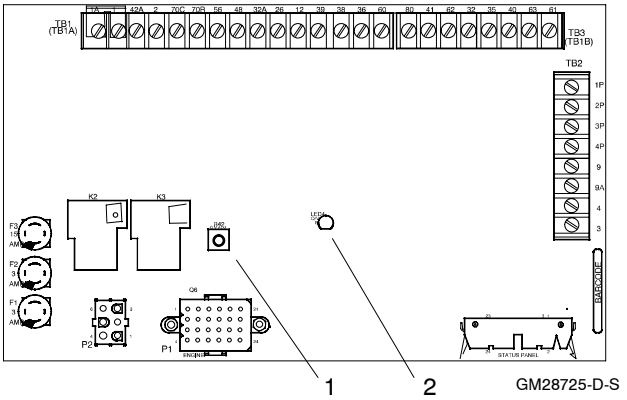
8.11 Overvoltage Feature with 16-Light Controller

8.11.1 Function and Application

The GM28725 main circuit board on 16-light controllers integrates an overvoltage protection feature. The overvoltage feature provides overvoltage protection when output voltage is 15% above nominal voltage for more than one second. The factory-setting of 15% above nominal voltage is field-adjustable.

8.11.2 Testing and Adjustment

If the function of the overvoltage feature is questionable or requires adjustment from the factory setting, perform the following adjustment. See Figure 8-16.



1. R42 overvoltage adjustment pot.
2. LED4 overvoltage shutdown

Figure 8-16 Overvoltage Adjustment Potentiometer R42

⚠ WARNING

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

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

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

1. Disconnect the generator set from the load by opening the line circuit breaker (if equipped) or disconnecting and heavily taping the output leads (if not already done).

2. Determine the overvoltage shutdown value based on the user requirement. The factory setting is 15% above nominal line-to-neutral voltage with a maximum value of about 200 volts.

3. Remove the controller cover.

4. Place the generator set master switch in the RUN position to start the generator set.

5. Observe the controller AC voltmeter during this step because the voltage reading just prior to shutdown is the present overvoltage shutdown point.

   Turn the voltage adjustment potentiometer on the controller front panel slowly CW until the generator set shuts down. See Figure 8-17. The circuit board LED4 lights and the controller auxiliary shutdown lamp lights.

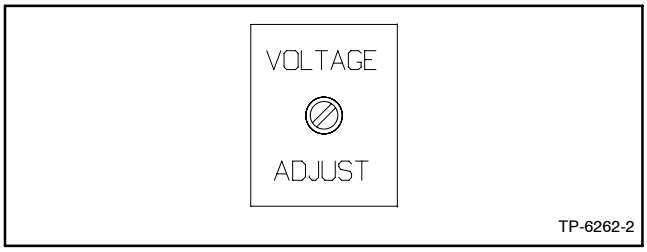


Figure 8-17 Controller Voltage Adjustment Potentiometer

6. If the present overvoltage shutdown point is correct for the application go to step 12.

   If the present overvoltage shutdown point requires adjustment go to the next step.

7. Turn the controller circuit board R42 adjustment potentiometer fully CW.

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

9. Place the generator set master switch to the RUN position to start generator set.

10. Observe the controller AC voltmeter while turning the controller voltage adjustment potentiometer to the desired overvoltage shutdown point as determined in step 2.

11. Turn the controller circuit board R42 adjustment potentiometer slowly CCW until the generator set shuts down.

    Note: Leaving the controller circuit board R42 adjustment potentiometer in the fully CW position effectively disables the overvoltage shutdown feature.

12. Turn the controller voltage adjustment potentiometer slightly CCW.

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

14. Place the generator set master switch to the RUN position to start generator set.

15. Turn the voltage adjustment potentiometer as necessary for the controller AC voltmeter to match the voltage and phase as indicated by the selector switch.

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

17. Disconnect the battery, negative lead first.

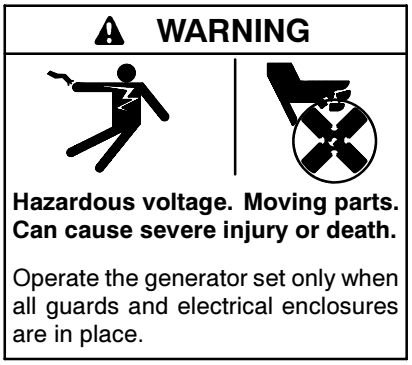
18. Reconnect the generator set to the load by closing the line circuit breaker (if equipped) or reconnecting and heavily taping the output leads. See the wiring diagram manual for correct voltage configuration.

19. Reconnect the battery, negative lead last.

8.12 Reactive Droop Compensator

8.12.1 Function and Application

The reactive droop compensator kit distributes the generator set load evenly between two generator sets in parallel. If the kit is not factory installed, use the installation instructions supplied with the kit for field installation. Use the following procedure for reactive droop compensator adjustment.



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

8.12.2 Reactive Droop Compensator Adjustment Procedure

Parallel the two generator sets using the following procedure. Read and understand the entire procedure before beginning.

1. Remove any load connected to the generator set. Start each generator set by placing the generator set master switch in the RUN position.

2. Set the reactive droop compensator rheostat on generator set no. 1 to the minimum CCW setting. Record the rpm or frequency and voltage at 1/4 load steps to full load on unit no. 1.

3. Repeat step 2 for generator set no. 2.

4. Compare the readings and make final adjustments so that the voltage is within 1 volt at each load step and the speed is within three rpm or the frequency is within 0.1 Hz for each unit. Adjust the voltage using the controller or remote voltage adjustment potentiometer. Adjust the speed at the electronic governor or at the remote adjusting potentiometer.

5. Check the droop compensation on each unit as follows:

   a. With unit no. 1 operating at the desired speed and voltage, apply an inductive load 1/2 to full load. Do not use a resistive load for this test.

   b. Observe the voltmeter on unit no. 1 with the reactive droop compensator rheostat set at minimum. As the rheostat is turned CW, the voltmeter should show a decrease in voltage. If observing a larger voltage, stop the generator sets and reverse the direction of the generator set load line through the current transformer or reverse the transformer leads on unit no. 1.

   c. Restart the generator sets and recheck the droop on unit no. 1.

   d. Set the reactive droop compensator rheostat to a value at approximately 4% below rated voltage at full load. As an example, the voltage droops (decreases) 19.2 volts on a 480-volt system at full load or 9.6 volts at 1/2 load. Use the following formula for loads other than full load:

      Rated Voltage x 0.04 x Actual Load (expressed as a % of full load) = Voltage Droop

      Note: With full load 0.8 power factor, a droop of 3%–5% should be adequate for paralleling.

6. Repeat step 5 for generator set no. 2. Adjust unit no. 2 where the voltage droop is equal and at the same point as on unit no. 1. The two units share reactive currents proportionately after correctly performing this procedure.

7. If reactive load is not available, go to Section 8.12.3, Reactive Droop Compensator Alternate Adjustment Procedure. If reactive load is available, go to Section 8.12.4, Testing.

8.12.3 Reactive Droop Compensator Alternate Adjustment Procedure

Initially calibrate each generator set using the following procedure.

1. Turn the reactive droop compensator rheostat on generator set no. 1 to the minimum setting.

2. Remove the controller cover. Move the voltage sensing lead from V7 to V9 at the AC fuse terminal block.

3. Remove any load connected to the generator set.

4. Start the generator set by placing the generator master switch in the RUN position.

5. Use the controller or remote voltage adjusting potentiometer on each generator set to fine adjust voltage as necessary.

6. Apply resistive load (1.0 power factor) until reaching rated current.

7. Adjust the reactive droop compensator rheostat to achieve a 4% droop (decrease) in voltage.

8. Remove the resistive load.

9. Stop the generator set by placing the generator master switch in the OFF position.

10. Return the voltage sensing lead from V9 to V7 at the AC fuse terminal block.

11. Replace the controller cover.

12. Repeat steps 1–11 for generator set no. 2.

8.12.4 Testing

Use the following procedure to check that the generator sets share the reactive load proportionately.

1. Parallel the units at 1/2 to full load. Verify that each unit carries equal kW load or a load proportional to its capacity using the wattmeter readings. If load unbalance exists, adjust and recheck the electronic governor throttle control to correctly balance loading. Engine speed determines load sharing ability.

2. With the load balanced, check the ammeters for equal current or proportional according to capacity. If the currents are incorrect, adjust the reactive droop compensator rheostat reducing the current of the unit with the highest reading. Reduce the current to an equal division or proportionately.

3. Stop each generator set by placing the generator master switch in the OFF position.

   Note: Step 1 balances the load using the electronic governor and step 2 balances the current using the reactive droop compensator. Consider these settings optimum for parallel operation.

   Note: Voltage must droop (decrease) on lagging power factor loads (inductive loads). A small change in voltage is acceptable on unity power factor loads (resistive loads).

8.13 Remote Serial Annunciator

The following information summarizes the setup items when troubleshooting the remote serial annunciator (RSA). Refer to the RSA installation instructions for operation and function. See Figure 8-18 for RSA front panel illustration.

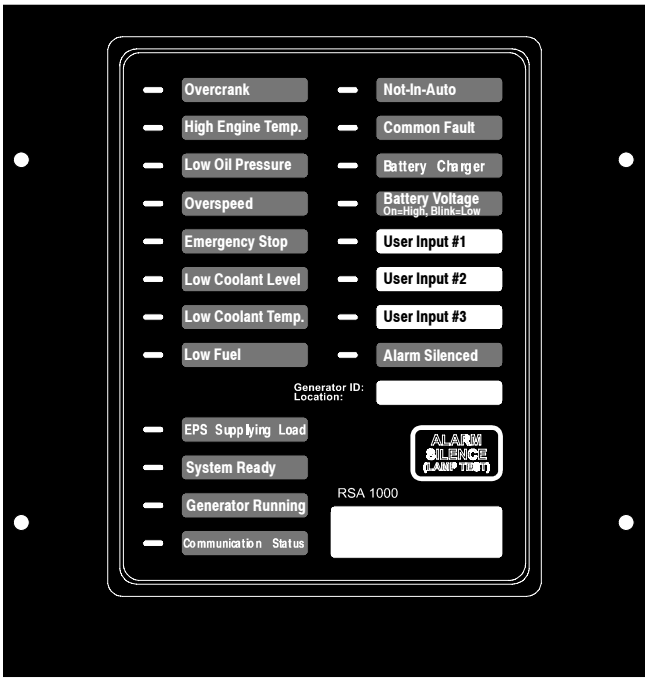
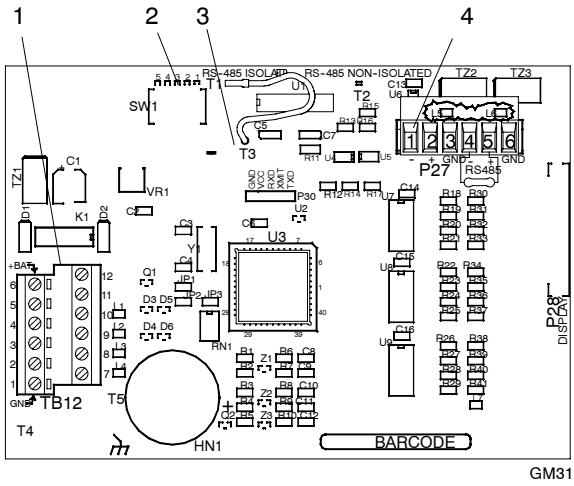


Figure 8-18 Remote Serial Annunciator (RSA)

8.13.1 DIP Switches

The RSA will function as master or slave by changing the DIP switch position on the RSA board. See Figure 8-19 for RSA circuit board features.



1. TB12 user input/outputs and DC power supply connections
2. SW1 DIP switches
3. T3 isolation jumper
4. P27 RS-485 communication connections

Figure 8-19 RSA Circuit Board

The RSA annunciates faults using LEDs and an alarm horn. Press the Alarm Silence/Lamp Test switch to test the RSA indicator LEDs and horn. If the horn is activated by a fault condition, press the Alarm Silence/Lamp Test switch to quiet the alarm during servicing. The horn will reactivate upon additional tests.

Set the SW1 DIP switches on the RSA master and subsequent RSA slave (if used). See Figure 8-20. RSA connected to controller MUST be assigned as the RSA master. See Figure 8-21 for a summary of the Emergency Power System (EPS) Supplying Load (ATS) annunciation sources depending upon DIP switch position.

SW1 DIP Switches (on = closed and off = open	
SW1-1	Local ATS (On is local)
SW1-2	User input 1 (On is local)
SW1-3	User input 2 (On is local)
SW1-4	Master/Slave (On is master)
SW1-5	Not used

Figure 8-20 RSA DIP Switch Selections

RSA SW1 Position	16-Light Controller	550 Controller
Local (hard wired)	RSA connection to the ATS	RSA connection to the ATS
Remote (RS-485)	Comm. module board connection to the ATS	550 controller connection to the ATS

Figure 8-21 EPS Supplying Load (ATS) Annunciation Sources

When SW1-1 is OFF, the generator set controller activates the EPS Supplying Load LED. When SW1-1 is ON (local), transfer switch activates LED.

Note: When SW1-4 is in the slave position, DIP switches SW1-1, SW1-2, and SW1-3 are not functional as the RSA master annunciates the RSA slaves.

8.13.2 Terminating Resistor

Each RSA is shipped with a terminating 121 ohm resistor connected to P27 terminals 4 and 5. Determine the need of the resistor based on the following three applications.

- **RSA master only.** Verify that the terminating 121 ohm resistor is connected to P27 terminals 4 and 5 on the RSA master.
- **RSA master with up to three RSA slaves.** Verify that the terminating 121 ohm resistor is connected to P27 terminals 4 and 5 on the last RSA slave in the daisy chain connection. Remove the 121 ohm resistor connected to P27 terminals 4 and 5 on the RSA master and all RSA slaves except the last RSA slave.
- **RSA master with more than three RSA slaves.** Connect the terminating 121 ohm resistor in *series* with a 0.1 MFD, 50-volt capacitor, part GM28875-1 (not supplied) to P27 terminals 4 and 5 on the *last* RSA slave in the daisy chain connection. Remove the 121 ohm resistor connected to P27 terminals 4 and 5 on the RSA master and all RSA slaves except the last RSA slave.

8.13.3 16-Light Controller Configuration

The RSA requires a controller with a MODBUS® address #1 and a baud rate of 19200. The 16-light controller baud rate is fixed at 19200.

Modbus® is a registered trademark of Schneider Electric.

Set controller MODBUS® address to #1 by placing DIP switches 6, 7, and 8 to open position. See Figure 8-22.

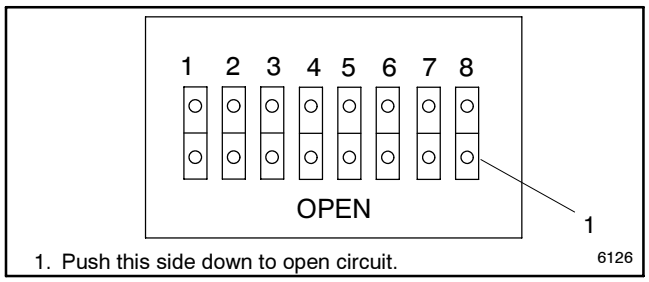


Figure 8-22 16-Light Controller DIP Switches

Note: After setting DIP switches to the generator set application, be sure to *power down* and then *power up* the controller. Either disconnect the battery and then reconnect the battery of the generator set, use the prime power switch (if equipped), or remove and then replace the F2 controller fuse. The controller will NOT acknowledge the DIP switch change until after generator set controller is *powered up*.

8.13.4 550 Controller Configuration

The RSA requires a controller with a MODBUS® address #1 and a baud rate of 19200.

Note: Refer to installation instructions furnished with RSA.

8.13.5 Service Disassembly

Should it be necessary to separate the RSA annunciator panel from the RSA circuit board for servicing and/or replacement, first unlock the P28 connector on the RSA circuit board *before* removing the ribbon connector to avoid circuit board damage. See Figure 8-23. Carefully slide the locking device (white plastic) outward approximately 1.5 mm (1/16 in.).

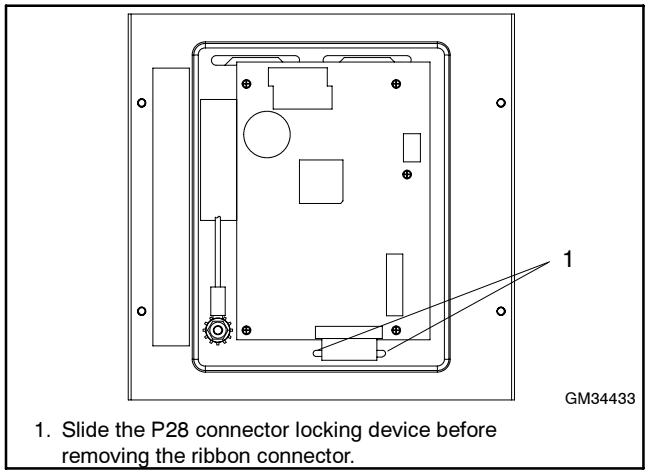


Figure 8-23 RSA Annunciator Panel and RSA Circuit Board (back view of front panel)

8.14 Speed Sensor

The speed sensor is found on permanent magnet (PM) alternators. The speed sensor is located on the alternator end bracket. Several styles are used, but they are all functionally the same.

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

8.14.1 Speed Sensor Test with Generator Set Running

1. With the generator set master switch in the OFF/RESET position, connect a DC voltmeter between the positive (+) lead (wire 24) at the speed sensor and the ground (wire 2). The voltmeter should read approximately 8–12 volts DC.

2. Place the generator set master switch in the RUN position to start the generator set.

3. With the generator set running, connect a DC voltmeter negative probe to the 0 terminal (wire 16—white) on the speed sensor. Place the voltmeter positive probe on the positive (+) terminal (wire 24—red). The voltmeter should indicate approximately 7–12 volts DC.

   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 test leads. Do not disconnect the leads.

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

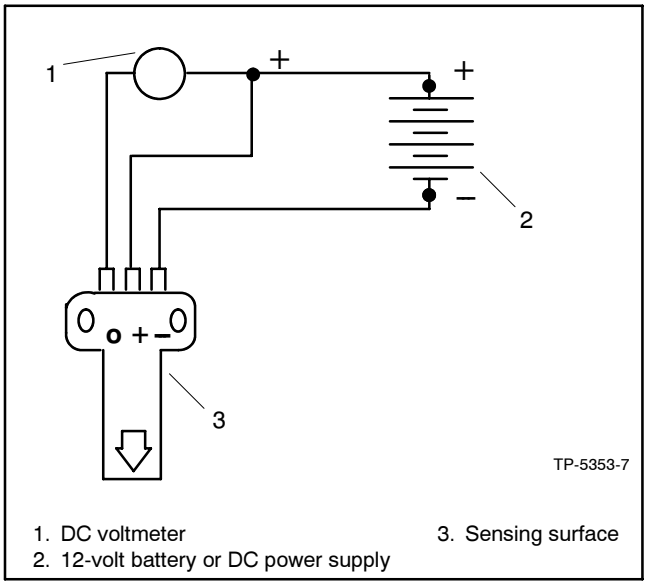
5. If the speed sensor is emitting a signal, check the continuity of the speed sensor leads (wires 2, 16, and 24) between the controller P1 connector and the lead terminals at the speed sensor.

   If the speed sensor is not emitting a signal, go to Section 8.14.2, Speed Sensor Test with Separate 12 VDC Source.

8.14.2 Speed Sensor Test with Separate 12 VDC Source

Test the speed sensor using the following procedure. It is NOT necessary to remove the speed sensor from the end bracket.

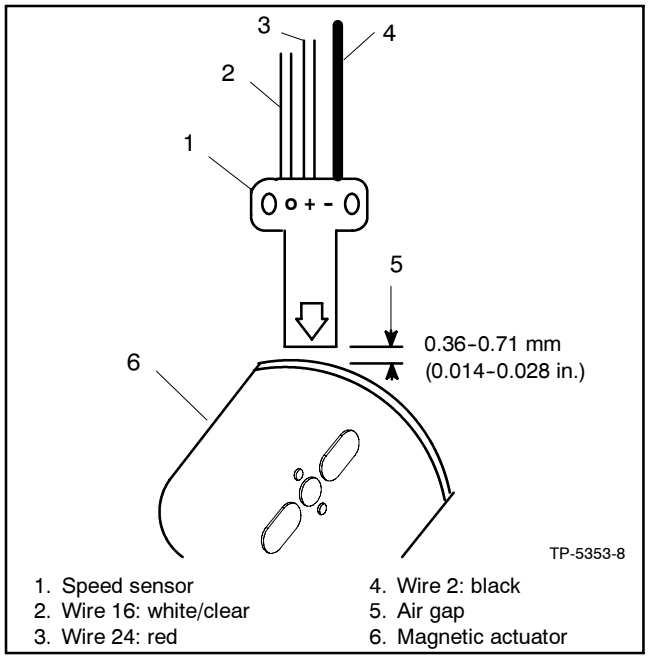
1. Place the generator set master switch in the OFF/RESET position.
2. Disconnect the speed sensor leads.
3. Connect speed sensor, DC voltmeter, and DC voltage source as shown in Figure 8-24.



1. DC voltmeter
2. 12-volt battery or DC power supply
3. Sensing surface

Figure 8-24 Speed Sensor Test

4. Touch sensing surface with a flat piece of iron or steel at least 4.1 cm (1/4 cu. in.) in size.
5. The DC voltmeter test reading should equal the source voltage, approximately 12 VDC.
6. Remove the iron or steel piece from the sensing surface and observe a voltmeter reading of 0 VDC.
7. If the speed sensor passes steps 5 and 6, the speed sensor is functional. Replace the speed sensor if it fails the test.
8. Connect the speed sensor leads and adjust the air gap. See Figure 8-25.



1. Speed sensor
2. Wire 16: white/clear
3. Wire 24: red
4. Wire 2: black
5. Air gap
6. Magnetic actuator

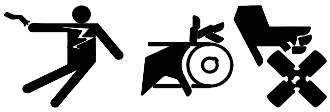
Figure 8-25 Speed Sensor Air Gap

9.1 Alternator Troubleshooting

This section provides information on testing components of the generator set. Contact an authorized service distributor/dealer for the appropriate technical manuals for the alternator and voltage regulator.

Use the following flowcharts to troubleshoot the generator set when no voltage or high voltage is detected. The remaining parts of this section give additional and more detailed information about the individual checks/tests mentioned in the flowchart. Use the flowchart to initially isolate the possible problem.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

⚠ WARNING

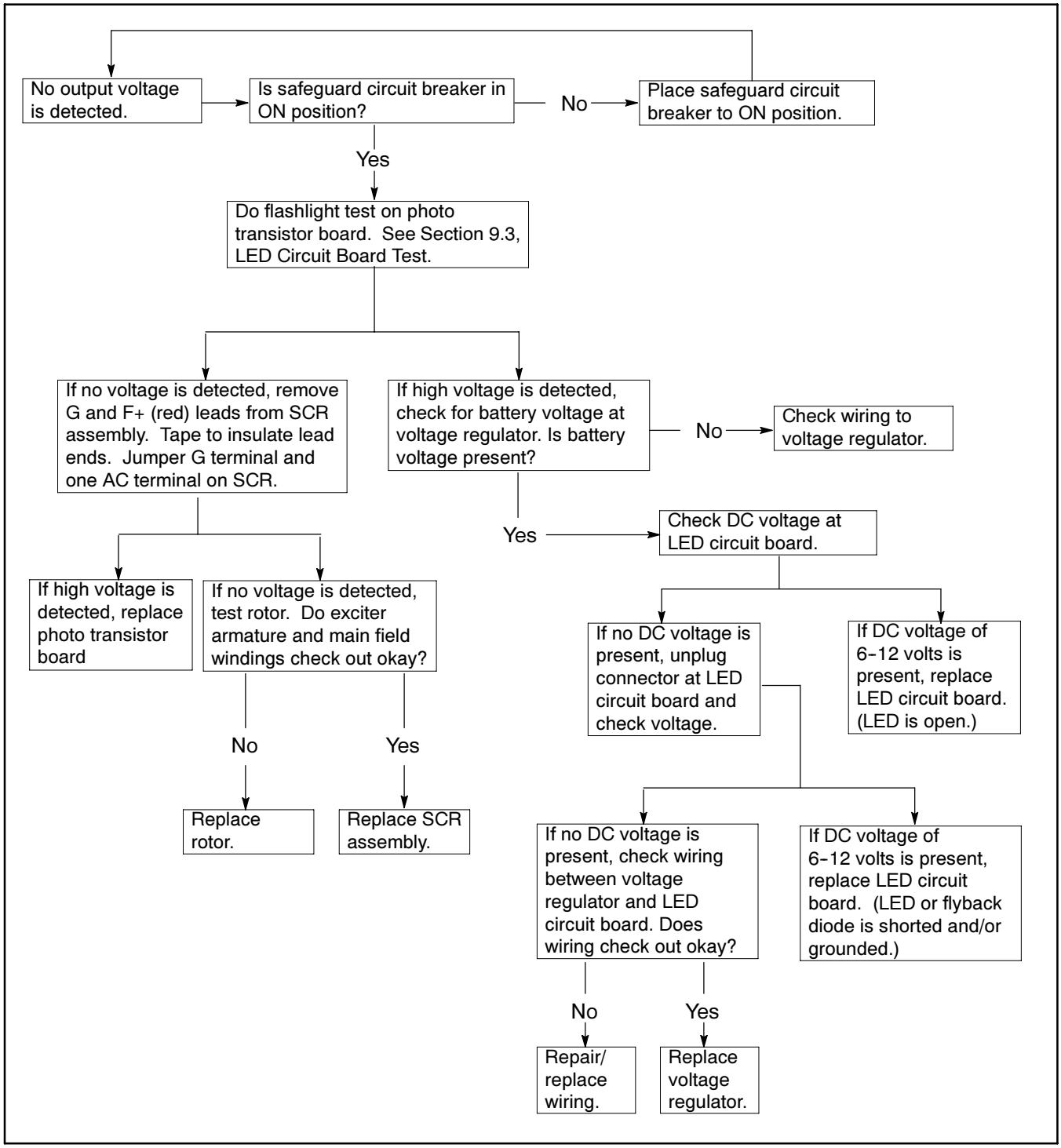
Hazardous voltage. Moving parts.
Can cause severe injury or death.

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

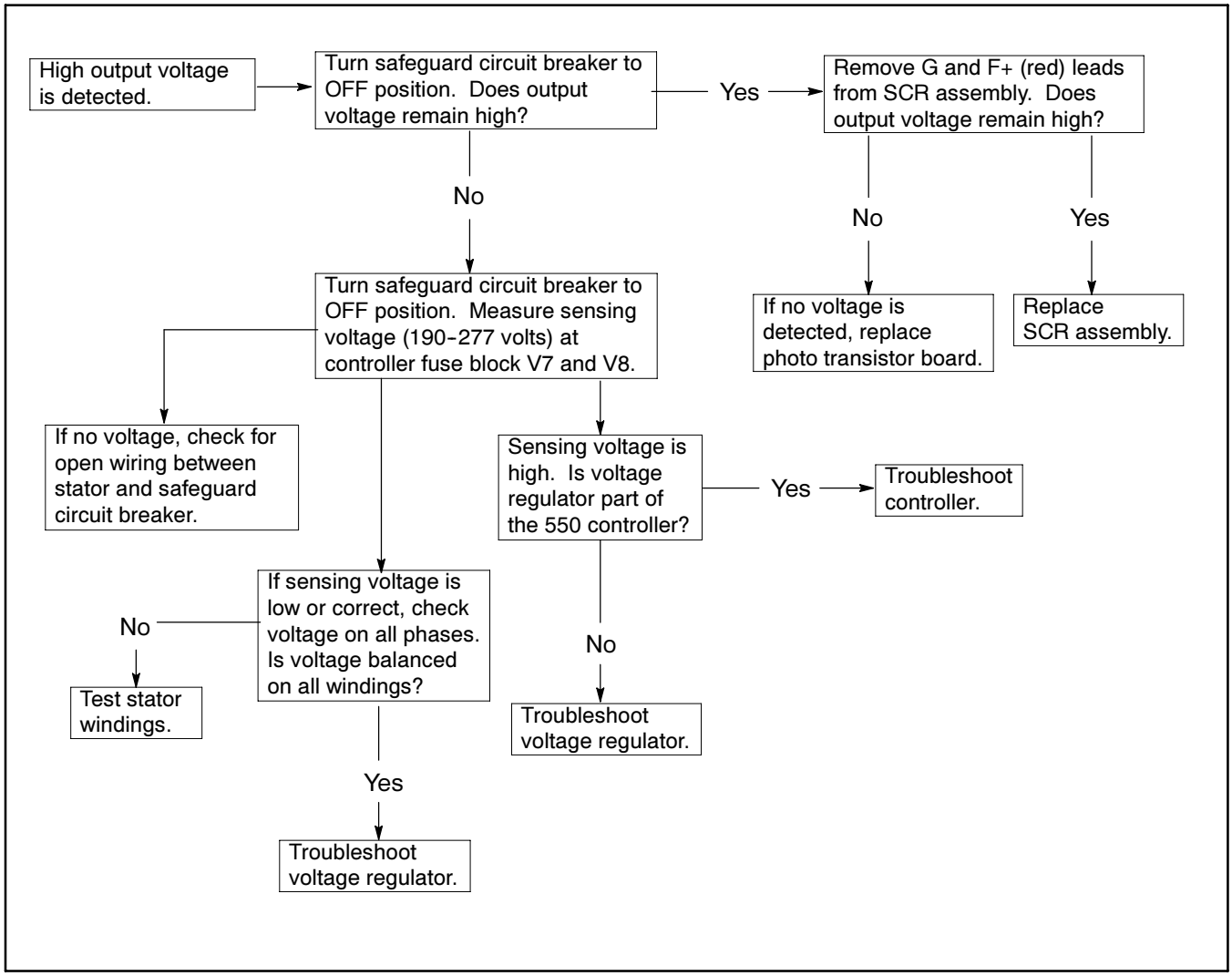
Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, transfer switch, and related equipment and electrical circuits.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

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

9.1.1 Troubleshooting Alternator, No Output Voltage



9.1.2 Troubleshooting Alternator, High Output Voltage

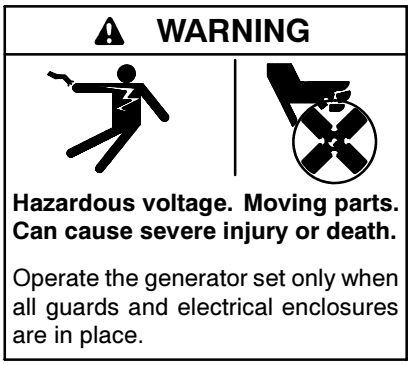


9.2 Alternator Testing

This section covers alternator testing for the following conditions:

- No output on any phase
- Overvoltage
- Fluctuating voltage

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.



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

Follow all safety precautions listed in the front of this manual and the additional precautions within the text. Figure 9-1 lists various alternator output conditions and component tests. Refer to Figure 9-2, AC Voltage Control, for assistance in troubleshooting.

9.2.1 No Output On Any Phase

1. Check the safeguard breaker (if equipped). If the safeguard breaker is open, close breaker and, with set running, check AC voltmeter for proper output voltage.

2. If proper output does not show, then:

   a. Check wire 1B from safeguard breaker and wire 7N (ground) to voltage regulator.

   b. Check for voltage to safeguard breaker (if equipped).

3. If all items in step 2 are okay, proceed to the LED circuit board flashlight test as described in Section 9.3, LED Circuit Board Test, and automatic voltage regulator (AVR) test described in Section 9.5, Automatic Voltage Regulator Operation and Adjustment.

4. If the tests indicate the LED circuit board and AVR are functioning correctly, visually inspect the photo transistor board for damage (open foil pattern or heat discoloration).

5. If the photo transistor board test appears good, proceed to the exciter armature test as described later in this section.

6. If the exciter armature test indicates the armature is functioning correctly, proceed to the alternator field test as described later in this section.

7. If the alternator field test indicates the field is functioning correctly, replace SCR assembly or the photo transistor board as described lin Section 9.4, SCR Assembly and Photo Transistor Board.

Components and Circuits to Test Under Certain Alternator Output Conditions

Alternator Output Condition	LED Board	Photo Transistor Board	Automatic Voltage Regulator ‡	SCR Assembly	Safeguard Breaker	Exciter Armature	Alternator Field	Alternator Stator	Voltage Adjustment Potentiometer
No Output	●	●	●	●	●	●	●	●	●*
Overvoltage		●†	●	●					
Fluctuating Voltage	●	●	●	●		●	●	●	

* No output voltage if voltage adjustment potentiometer circuit is open or shorted to ground.
† Overvoltage will occur if an outside light source is present when the LED board is removed.
‡ If the unit has a 550 controller, the voltage regulator is part of the controller, see the controller operation or service manual for operation, setup, and/or troubleshooting.

Figure 9-1 Troubleshooting Guide

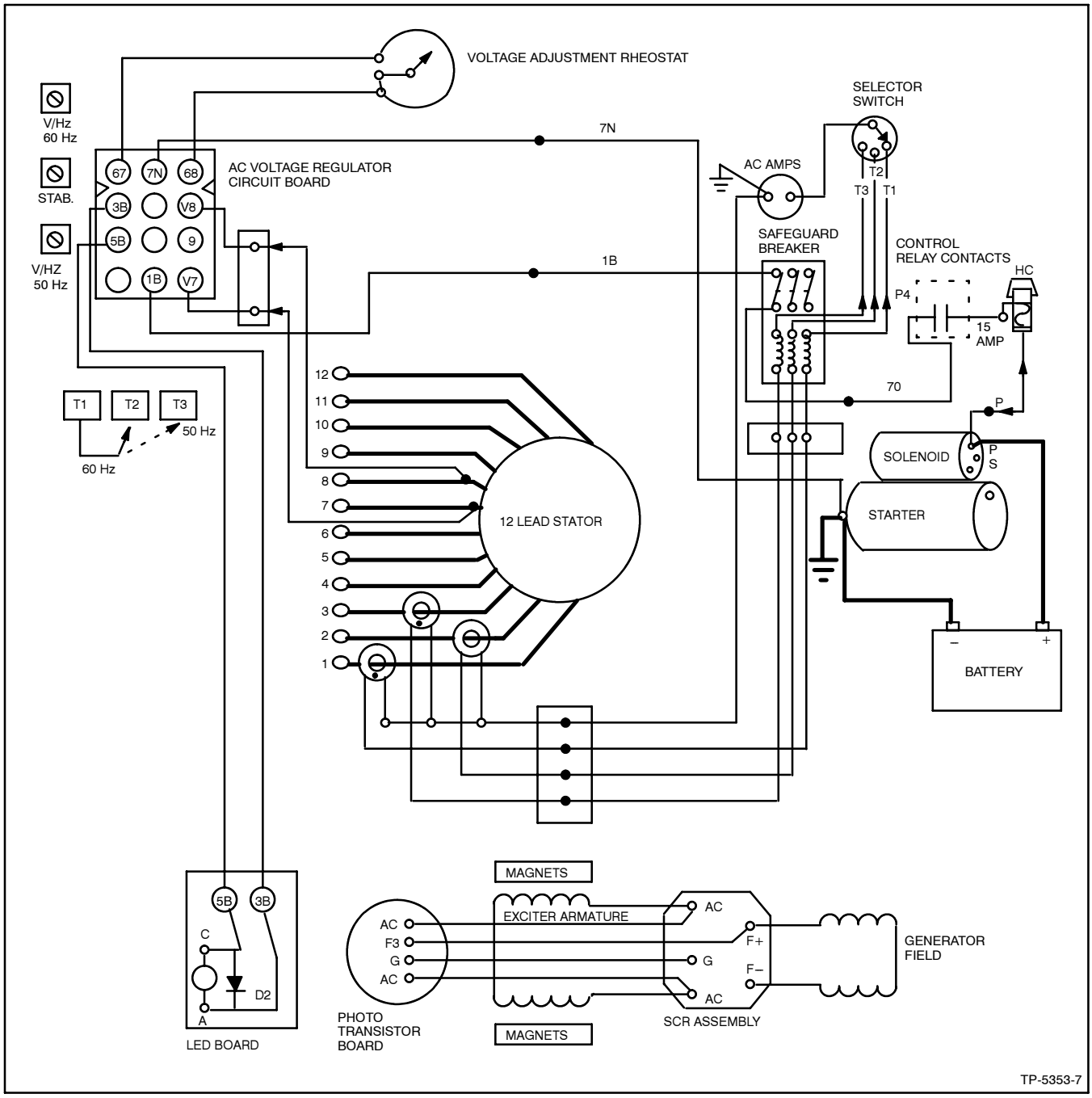


Figure 9-2 AC Voltage Control, Typical

9.2.2 Overvoltage

Note: If overvoltage occurs, disconnect harness plug at AVR. If overvoltage continues, the problem lies in the photo transistor circuit and/or SCR assembly; proceed through the following checks. If output voltage disappears, the problem is in the AVR, including connections and/or wiring.

1. Examine photo transistor board for visible signs of damage (open foil pattern or heat discoloration). Replace photo transistor board if visibly damaged. If overvoltage continues after replacement of photo transistor board, proceed to Step 2.

2. Remove green (center) lead from G terminal and red lead from F+ terminal of SCR assembly. Tape each terminal end of leads to prevent contact with adjacent metal components.

3. With safeguard breaker open, start generator set. The lack of AC output indicates the SCR assembly is functioning properly. If overvoltage continues, replace the SCR assembly.

   Note: When replacing SCR assembly, do not exceed torque value of 0.9 Nm (8 in. lb.) when tightening SCR mounting bolts.

4. If overvoltage is measured with the safeguard breaker closed, check for an open circuit in leads V7 and V8 to the AVR or controller fuse block. If these circuits are open or shorted, repair or replace. Check the voltage rheostat circuit at leads 67 and 68. Repair or replace as necessary.

5. If all the circuits described in step 4 are okay, check the AVR as described in Section 9.5.

9.2.3 Fluctuating Voltage

1. Check the alternator output leads for proper connections. Refer to the respective wiring diagrams manual.

2. Check for loose connections to the AVR, LED board, photo transistor board, or SCR assembly.

3. Check the stator for shorted or open windings; refer to stator testing later in this section.

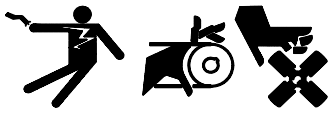
4. Verify the AVR adjustment. See Section 9.5, Automatic Voltage Regulator Operation and Adjustment.

5. Check the SCR and photo transistor circuit board by performing the flashlight test. See Section 9.3, LED Circuit Board Test.

9.3 LED Circuit Board Test

The following procedure provides information on testing the LED circuit board. Certain steps require that the generator set be running. When the generator set is not running, disable the generator set. See the safety precautions listed below. Disconnect all load from the generator set during this test.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

⚠ WARNING

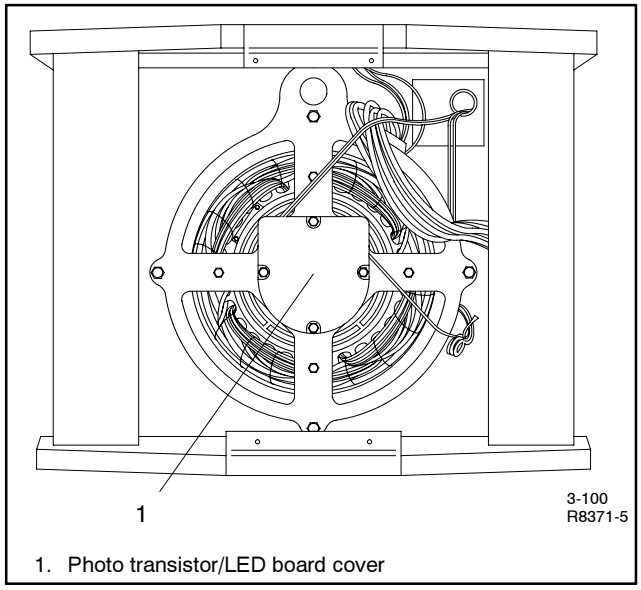
Hazardous voltage. Moving parts.
Can cause severe injury or death.

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

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

Testing the photo transistor circuit board. Hazardous voltage can cause severe injury or death. When the end cover is removed, do not expose the photo transistor circuit board mounted on the generator set end bracket to any external light source, as exposure to light causes high voltage. Keep foreign sources of light away from the photo transistor circuit board during testing. Place black electrical tape over the LED on the circuit board before starting the generator set.

1. Remove the junction box panels from the generator end of unit and remove the photo transistor board/LED board cover. See Figure 9-3.



1. Photo transistor/LED board cover

Figure 9-3 Photo Transistor Board Cover

2. With the generator set running at no load, shine a flashlight on the exposed photo transistor board. See Figure 9-4.

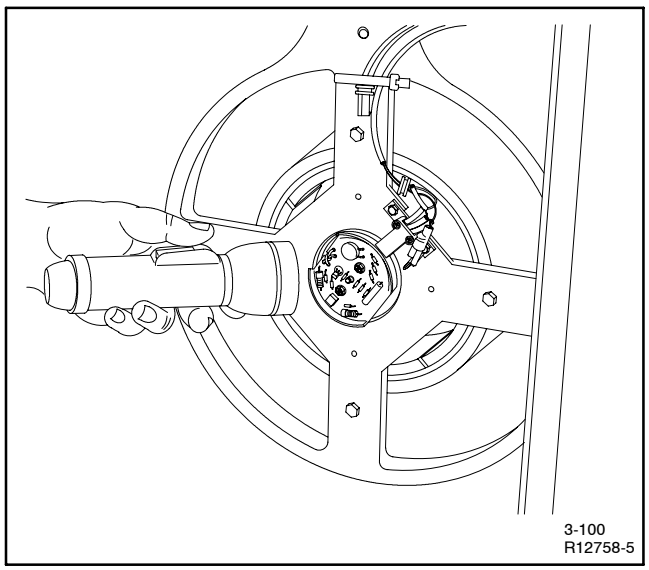


Figure 9-4 LED Flashlight Test

3. Observe the AC output voltmeter. High AC output voltage indicates the SCR assembly and photo transistor board are functioning properly. The fault is likely in the wiring, AVR, or LED circuit board as the output voltage should drop to low level when the flashlight is removed. If no output is observed, check the SCR assembly and photo transistor board.

4. If high output voltage exists with the flashlight off, stop the generator set and place a small piece of black electrical tape over the phototransistor. Restart the unit.

   If the output voltage is reduced, there is a source of external light contamination. STOP the generator set. Find the external light source and eliminate it or block it from reaching the phototransistor circuit board.

   If the output voltage remains high, there is a failure in the phototransistor circuit board or SCR assembly.

5. With the generator set running, approximately 1–2 volts DC should be observed at 3B (+) and 5B (–) at the LED board. See Figure 9-5. Shine the flashlight on the photo transistor. The DC voltage reading should drop, showing the AVR is functioning. If voltages are not observed, refer to the AVR test. Stop the generator set.

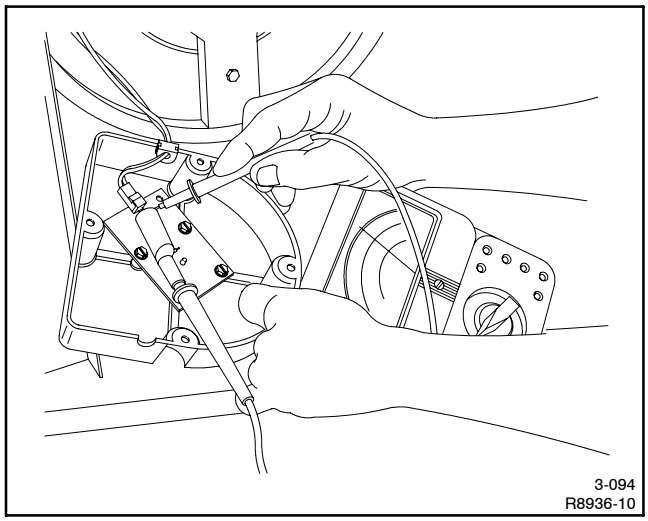


Figure 9-5 Checking LED Board

9.4 SCR Assembly and Photo Transistor Board

The SCR assembly is located behind the exciter armature and controls current flow to the alternator field. The command and sensing circuitry is located on the shaft-mounted photo transistor board. See Figure 9-6. The generator set will only function if both components are functional.

The following test determines which component is inoperative. Since it is necessary to remove the end bracket from the set to correctly test these components, do not begin this procedure unless there is reasonable certainty that these components are inoperative.

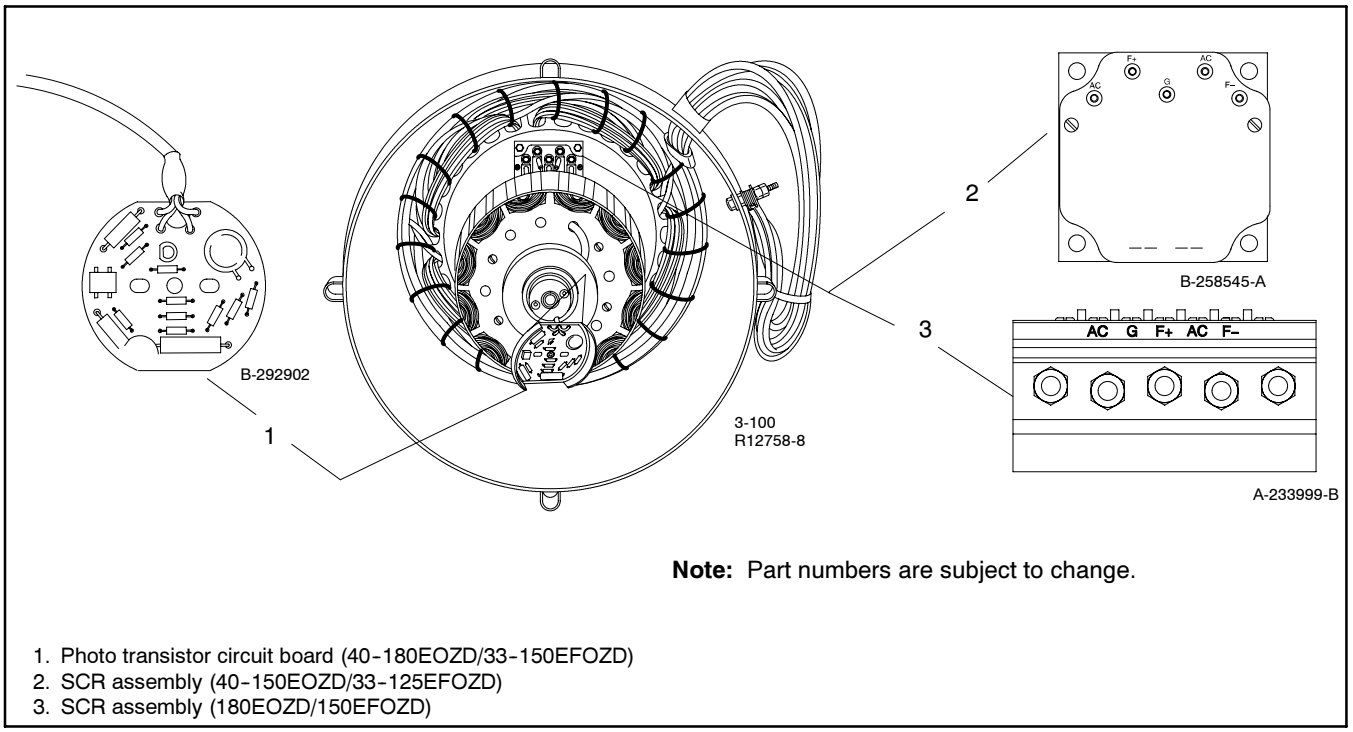
See Section 9.1, Alternator Troubleshooting. Examine the photo transistor board for visible signs of damage (open foil patterns and heat discoloration) before removing the entire SCR assembly for testing.

Refer to Section 9.10, End Bracket Removal and Replacement, if the end bracket only needs removal. Refer to Section 4, Alternator Disassembly/Reassembly, for complete alternator disassembly.

To test the SCR assembly and photo transistor board, the following components are needed:

- One 120-volt/110-watt light bulb with socket
- Switch, DPST (double-pole/single-throw) 120 volt 10 amp minimum)
- Fuse, 1 amp (in holder)
- 120 volt AC plug with cord
- One *known-functional* SCR assembly and photo transistor board

This test simulates the normal operation of the components when the alternator is running. In the test, a *known-functional* component (example: photo transistor board) is matched with a component of unknown quality (example: SCR assembly). If the components do not function normally during the test, it is reasonable to assume that the component of unknown quality is inoperative. Test either component in this manner.



Note: Part numbers are subject to change.

1. Photo transistor circuit board (40-180EOZD/33-150EFOZD)
2. SCR assembly (40-150EOZD/33-125EFOZD)
3. SCR assembly (180EOZD/150EFOZD)

Figure 9-6 Phototransistor Circuit Board and SCR Assembly Types and Locations

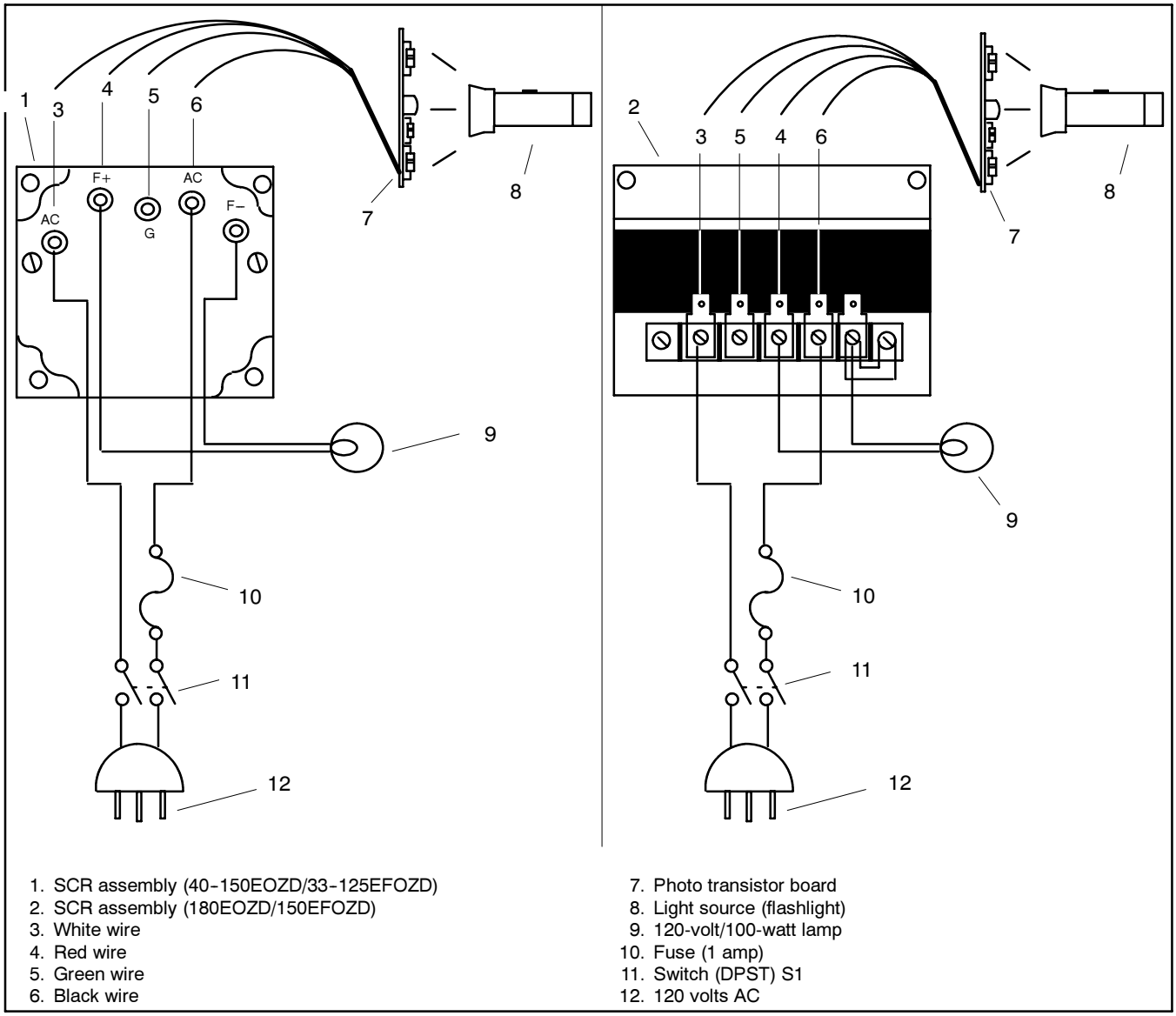
Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, transfer switch, and related equipment and electrical circuits.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

1. Connect components as illustrated in Figure 9-7. If testing the photo transistor board, SCR assembly must be *known-functional.* If testing the SCR assembly, the photo transistor board must be *known-functional.*

   Note: When testing the SCR assembly used on 40–150EOZD/33–125EFOZD models, connections must make good electrical contact with the SCR foil pattern. Secure all SCR connections with terminal nuts to ensure good electrical contact with foil pattern during testing. The SCR-threaded terminals are insulated from the SCR foil pattern and are not in contact except when *bridged* by the terminal nut, electrical lead, terminal, etc. Do not exceed 0.9 Nm (8 in. lb.) when tightening the SCR terminal nuts.

2. With the cord switch in the OFF position, plug in the electrical cord.

3. Turn the cord switch to the ON position.



1. SCR assembly (40–150EOZD/33–125EFOZD)
2. SCR assembly (180EOZD/150EFOZD)
3. White wire
4. Red wire
5. Green wire
6. Black wire
7. Photo transistor board
8. Light source (flashlight)
9. 120-volt/100-watt lamp
10. Fuse (1 amp)
11. Switch (DPST) S1
12. 120 volts AC

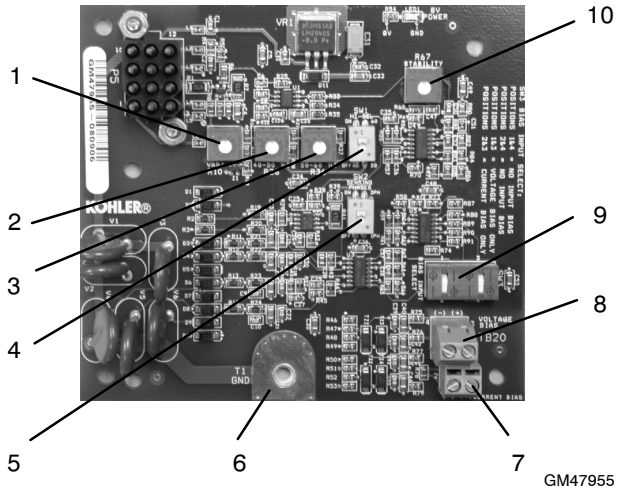
Figure 9-7 SCR Assembly and Photo Transistor Board

4. Apply light source directly to the photo transistor board. Shield the photo transistor board from all sources of light during this test. If both components are *functional,* the test fixture light bulb will light when the external light source is applied to the photo transistor board. Remove the light source; the fixture light bulb should go out. If the test fixture light bulb does not light or is lit prior to receiving external light source, the component being tested is inoperative (in this example the SCR). Replace the SCR assembly.

   Note: When replacing SCR assembly, do not exceed a torque value of 0.9 Nm (8 in. lb.) when tightening SCR mounting bolts.

9.5 Automatic Voltage Regulator Operation and Adjustment

The following procedure applies to the analog voltage regulator. If the unit has a 550 controller (with a digital voltage regulator), see the controller operation and/or service manuals for operation and adjustment.



1. Voltage adjustment potentiometer
2. 50 Hz V/Hz adjustment potentiometer
3. 60 Hz V/Hz adjustment potentiometer
4. Switch #1—Frequency select
   On = 60 Hz
   Off = 50 Hz
5. Switch #2—Phase sensing
   On = 3 Phase
   Off = 1 Phase
6. Grounding pad
7. 4-20mA current bias lead input
8. Voltage bias lead input
9. Dip switch for bias input select
   1 & 4 = No input bias
   2 & 4 = No input bias
   1 & 3 = 0-5 VDC voltage bias only
   2 & 3 = 4-20mA current bias only
10. Stability potentiometer

Figure 9-8 AVR Adjustment

The AVR monitors output voltage magnitude and frequency to supply current to the stationary LED board. The AVR circuit board includes volts/Hz and stability adjustment potentiometers. The volts/Hz adjustment is factory-set and normally requires no further adjustment. If replacement of the controller circuit board or operation of the generator under extreme loads results in voltage instability, adjust the potentiometers according to the following procedure. See Figure 9-8.

Stability Potentiometer. Fine tunes voltage regulator to reduce light flicker.

Volt/Hz Potentiometer. This adjustment determines engine speed (Hz) at which generator output voltage will begin to drop.

9.5.1 Volt/Hz Potentiometer Adjustment Procedure

This adjustment determines engine speed (Hz) at which alternator output voltage will begin to drop.

1. Turn generator set master switch to OFF/RESET.
2. Make selection for single- or three-phase sensing at switch #2.
3. Turn stability potentiometer fully counterclockwise.
4. Connect a 100-watt light bulb across terminals V0 and V7 on controller terminal strip or across terminals on controller frequency meter.
5. Start generator set. With generator running at no load, observe light bulb flicker. Excessive light bulb flicker indicates poor stability.
6. Adjust stability potentiometer until minimum flicker is obtained.
7. Use controller voltage adjustment potentiometer (or remote voltage adjustment potentiometer) to make adjustments to the generator set while running under normal load (if required).
8. Make the frequency selection, either 50 or 60 Hz, at switch #1.
9. Select the bias switch for “No Bias Input”.
10. Adjust the engine speed to the desired cut-in frequency (factory setting is 57.5-58.0 Hz for 60 Hz models or 47.5-48.0 Hz for 50 Hz models) as measured on frequency meter. See the governor manual for information on engine adjustment.

11. Rotate the volts/Hz adjustment potentiometer clockwise until voltage level begins to drop (as measured on voltmeter). When set to these specifications, the generator set will attempt to maintain normal output until engine speed drops below the frequency set in the previous step (as load is applied).

12. Adjust the engine speed to obtain a full load engine speed of 1800 rpm (60 Hz) or 1500 rpm (50 Hz). Confirm and adjust the output voltage as needed.

13. Use controller voltage adjustment potentiometer (or remote voltage adjustment potentiometer) to make final adjustments to the generator set while running under normal load.

14. Readjust stability potentiometer (if necessary).

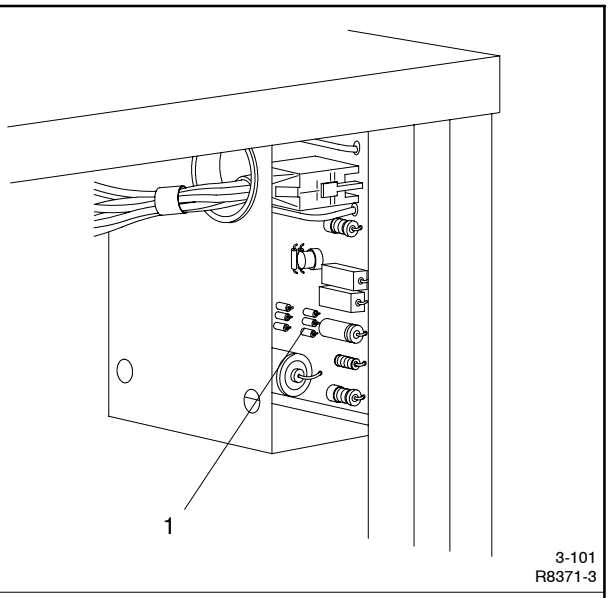
To determine whether the AVR is functioning properly, reduce the engine speed (Hz) and watch for a corresponding drop in AC voltage. At 60 Hz operation, the voltage will remain constant until the engine speed drops below 58 Hz (approximately). If AC frequency drops below 58 Hz, the AC voltage will decline. At 50 Hz operation, the AC voltage remains constant until the engine speed is reduced to 48 Hz (approximately). If the AVR is not functioning properly, refer to the following test to determine the cause of malfunction.

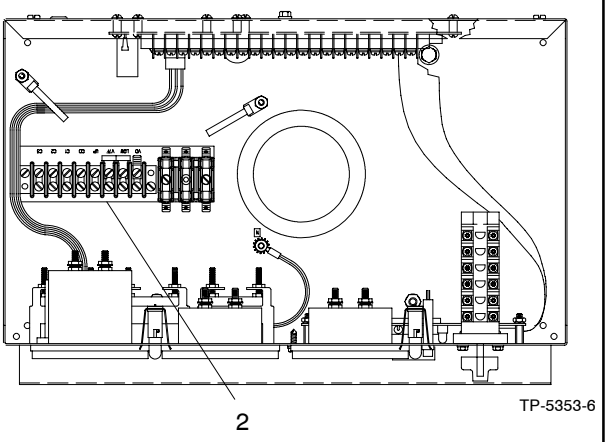
9.5.2 Testing Automatic Voltage Regulator

With the safeguard breaker closed (if equipped):

1. Disconnect the wiring harness connector from the voltage regulator and check for continuity between the voltage sensing leads V7 and V8 (pins 4 and 10). See Figure 9-9. If this circuit is open , repair or replace. An open circuit will normally result in a high voltage or overvoltage condition. Check the 15-amp fuse.

2. If there is continuity between V7 and V8, check for continuity in the voltage adjustment circuit (leads 67 and 68). With the harness disconnected, check the resistance between pins 1 and 3. This resistance should change as the voltage adjust rheostat is turned. Repair or replace inoperative components as necessary. A inoperative voltage adjust rheostat usually results in a nonadjustable voltage.





1. AVR board in junction box
2. Controller terminal strip

Figure 9-9 AVR and Connections

3. Check for battery voltage at the voltage regulator harness plug (pins 2 and 11) with the generator set running. If there is not a voltage reading, check the safeguard circuit breaker. If battery voltage is not present, there should be a very low voltage at the main output leads.

4. While the generator set is running, check for approximately 1–2 volts DC output at terminals 3B (+) and 5B (–) on the LED board. Disconnect the separate 3B/5B connector and check for 8 volts (approximately) at the connector. If voltage is not measured at connector, check for open or short circuit in wiring back to voltage regulator. If a fault exists in the voltage regulator wiring, repair or replace as necessary. If the voltage regulator wiring tests good, replace the voltage regulator. Low voltage at the LED circuit board may cause a low output voltage fault.

9.6 Stator

Note: Generator sets use a skewed (slanted) rotor with a straight stator. When replacing either rotor or stator, be sure replacement is same as original.

1. Check the alternator output leads for proper connections. Refer to the wiring diagrams manual.

2. Check the stator windings for:

   - Shorted windings: Inspect for burnt or hot windings. Replace the stator if these conditions exist. See Figure 9-10.

     Note: Disconnect V7, V8, V9, V0 at AC from controller terminal blocks before doing test.

   - Open windings: With ohmmeter, check **each pair** of leads for low resistance readings (continuity). High resistance across A or low resistance (continuity) across B and ground indicates a faulty stator; replace stator. See Figure 9-11.

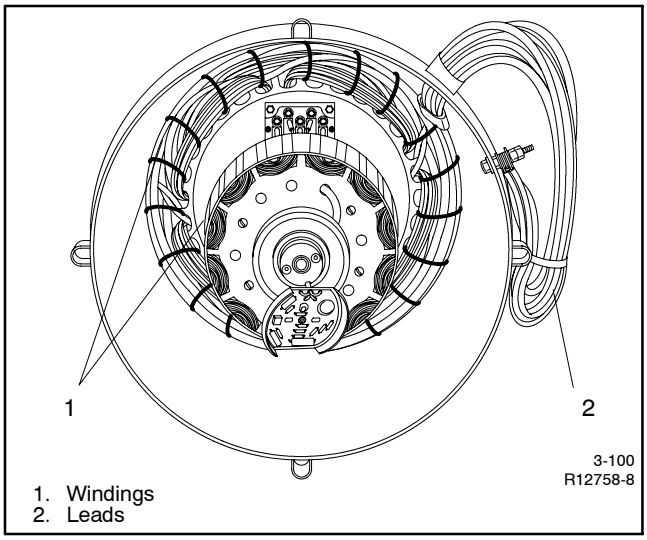


Figure 9-10 Stator

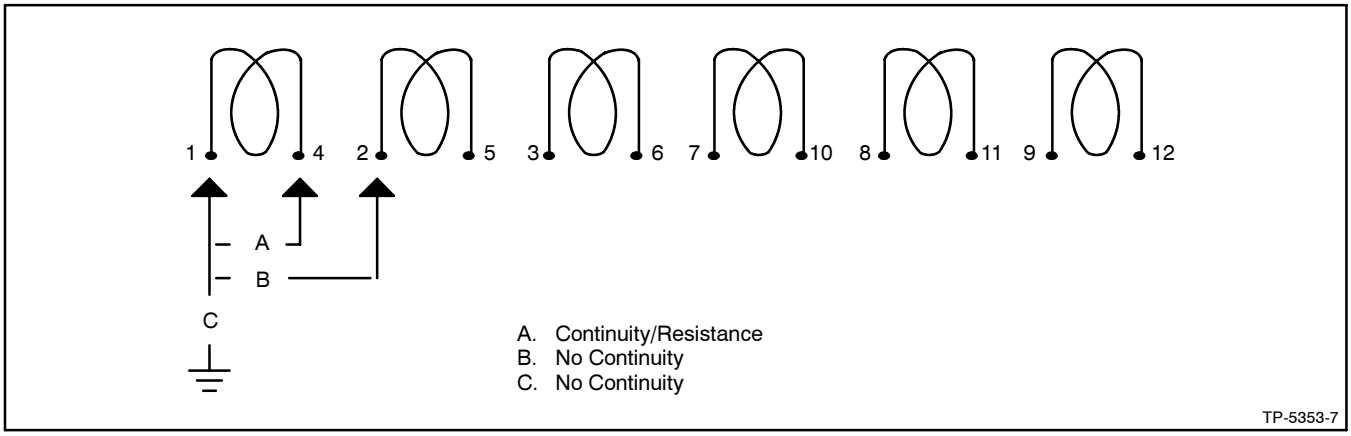


Figure 9-11 Stator Winding Test

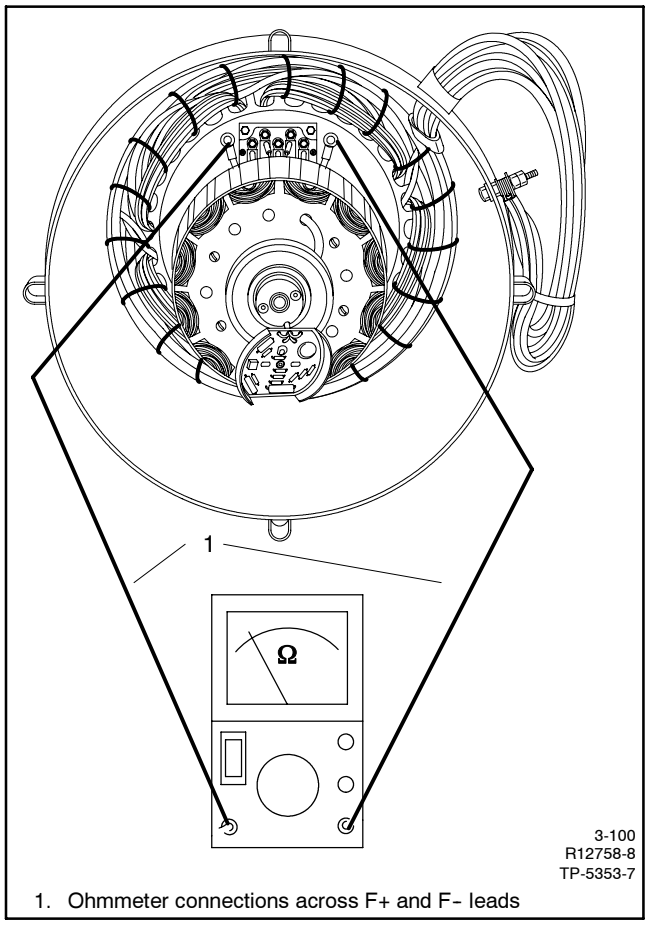
9.7 Alternator Field

1. Disconnect the battery (negative lead first).

   Remove the end bracket. Refer to Section 9.10, End Bracket Removal and Replacement, if only the end bracket needs removal. Refer to Section 4, Alternator Disassembly/Reassembly, for complete alternator disassembly.

   Disconnect the F+ and F– leads from the SCR assembly.

2. With an ohmmeter, check for continuity across the F+ and F– leads. See Figure 9-12. Resistance readings are shown in Section 1.4, Specifications, Electrical Values.



1. Ohmmeter connections across F+ and F– leads

Figure 9-12 Field Continuity Check

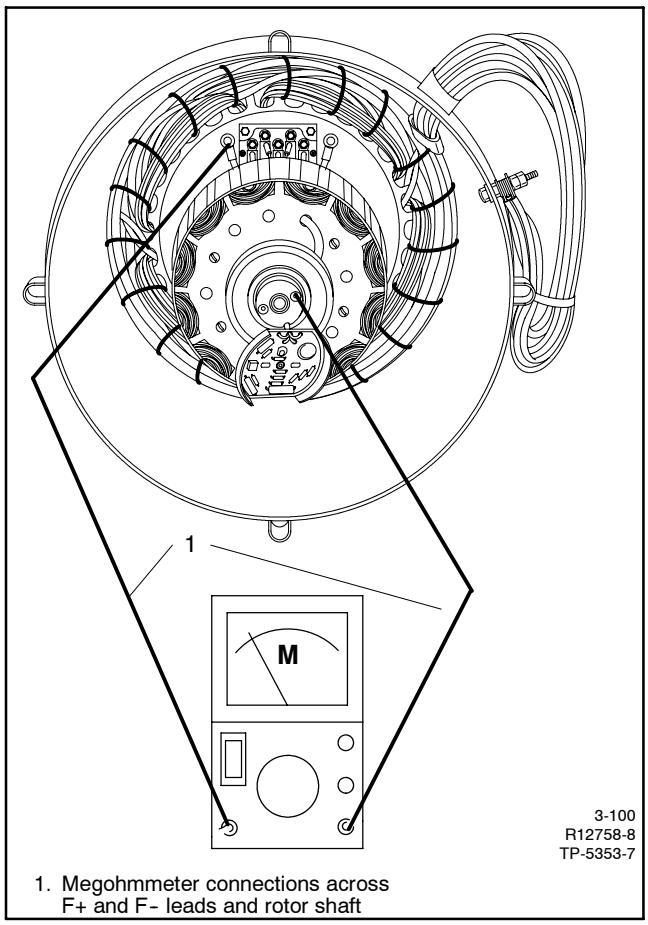
3. Check for a grounded alternator field. No continuity should exist between the field leads and the rotor assembly.

4. Using a megohmmeter, apply 500 volts DC to the F+ or F– lead and the rotor shaft. See Figure 9-13. Follow the instructions of the megohmmeter manufacturer when performing this test. A reading of approximately 500 kOhms (1/2 megohm) and higher indicates the field winding is good. A reading of less than 500 kOhms (approximately) indicates deterioration of winding insulation and possible current flow to ground. Repair or replacement of the rotor assembly is necessary.

   Repair the F+ and F– leads if test should show leads shorted to ground. Solder and insulate the splices. Use new sleeving when tying leads to shaft or heat sink. Replace the alternator rotor assembly if test shows a shorted or grounded winding.

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.

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.



1. Megohmmeter connections across F+ and F– leads and rotor shaft

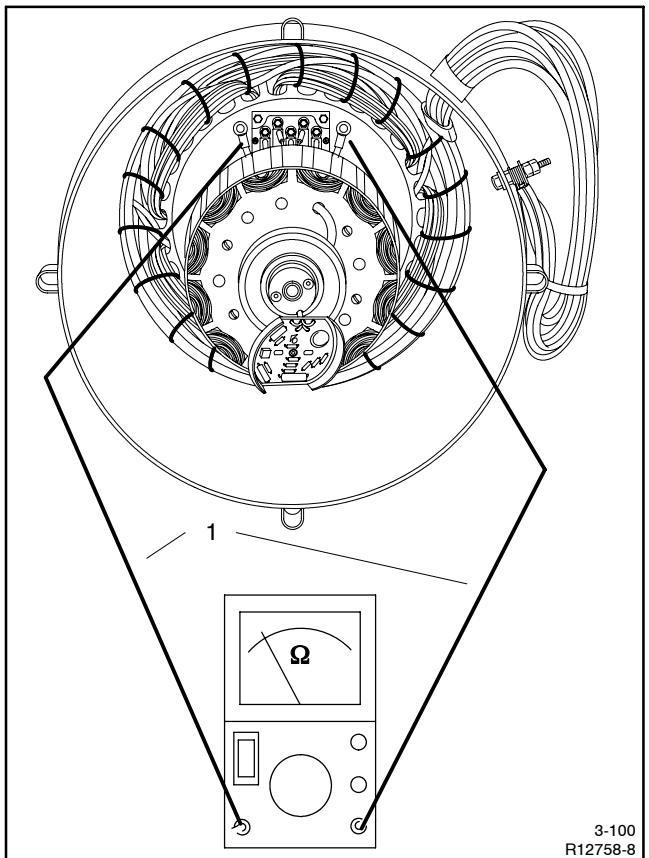
Figure 9-13 High Voltage Test

9.8 Exciter Armature

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.

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.

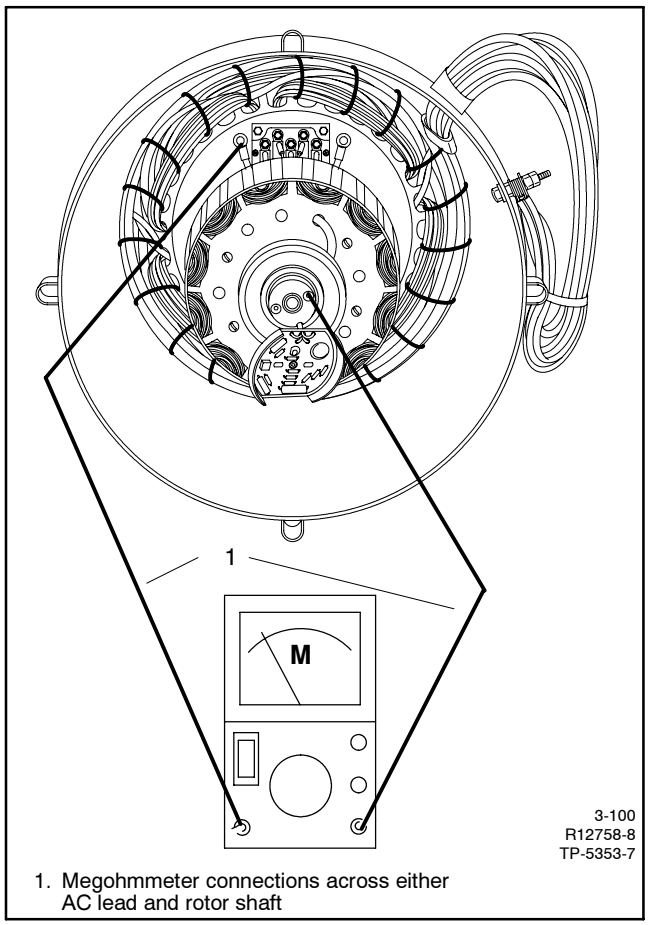
1. Disconnect the battery (negative lead first).
2. Remove the end bracket. Refer to Section 9.10, End Bracket Removal and Replacement, if only the end bracket needs removal. Refer to Section 4, Alternator Disassembly/Reassembly, for complete alternator disassembly.
3. Disconnect AC leads from SCR assembly.
4. With an ohmmeter, check for continuity across the AC leads. See Figure 9-14.



1. Ohmmeter connections across AC leads

Figure 9-14 Exciter Armature Continuity Check

5. Repair the AC leads if damaged or open. Solder and insulate the splices. Use new sleeving when tying leads to the shaft or heat sink.
6. Visually check the exciter armature for shorted winding(s) and with an ohmmeter, check for low resistance readings. See Section 1.4, Specifications, Electrical Values. See Figure 9-14. Low resistance readings indicate a faulty exciter armature requiring replacement of the rotor assembly.
7. Using a megohmmeter, apply 500 volts DC to the rotor shaft and either AC lead. See Figure 9-15. Follow the instructions of the megohmmeter manufacturer when performing this test. A reading of approximately 500 kOhms (1/2 megohm) and higher indicates the field winding is good. A reading of less than 500 kOhms (approximately) indicates deterioration of winding insulation and possible current flow to ground. Repair or replace the rotor.



1. Megohmmeter connections across either AC lead and rotor shaft

Figure 9-15 High Voltage Test

8. Repair the AC leads if the test indicates the lead is shorted to ground. Solder and insulate the splices. Use new sleeving when tying the leads to the shaft or heat sink.
9. Repair or replace the rotor assembly if the test shows the armature is shorted to ground.

9.9 Speed Sensor Test

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

1. With generator set master switch in OFF/RESET position, connect a DC voltmeter between the positive (+) lead (wire 24) at speed sensor and the ground (wire 2). The voltmeter should read approximately 8–10 volts DC.

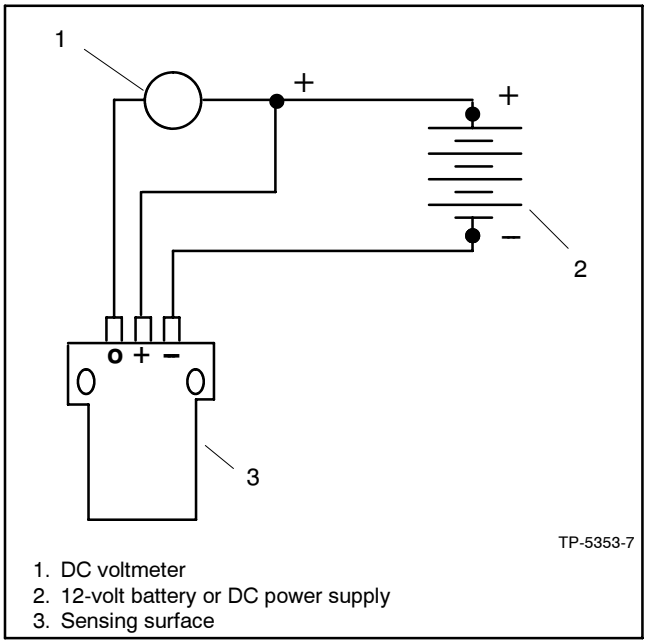
2. With the generator set running, connect a DC voltmeter negative probe to 0 terminal (wire 16—white) on speed sensor. Place voltmeter positive probe on the positive (+) terminal (wire 24—red). Voltmeter should indicate approximately 12 volts DC.

   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 test leads. Do not disconnect leads.

If the speed sensor is emitting a signal, check continuity of the speed sensor leads (wires 2, 16, and 24) between controller P1 connector and lead terminals at speed sensor.

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

1. Connect speed sensor, voltmeter, and DC voltage source as shown in Figure 9-16.



1. DC voltmeter
2. 12-volt battery or DC power supply
3. Sensing surface

Figure 9-16 Speed Sensor Test

2. Touch sensing surface with a flat piece of iron or steel, at least 4.1 cm (1/4 cu. in.) in size.

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

4. Remove the iron or steel piece from the sensing surface and observe the voltmeter reading.

9.10 End Bracket Removal and Replacement

Use this procedure to access the SCR and photo transistor board for testing and replacement purposes when it is deemed unnecessary to remove and disassemble the entire alternator assembly.

Note: On some models, it is necessary to loosen the generator set junction box to remove the end bracket. Remove the six junction box mounting screws and pull the junction box away from the engine to remove end bracket.

1. Remove the LED board and cover. Disconnect the leads from the speed sensor.
2. Remove the screws holding the magnetic actuator and photo transistor board.
3. Reach in and remove the leads; photo transistor board leads from the SCR assembly. This will allow slack when removing the end bracket.
4. Remove the four bolts holding the end bracket to the stator.
5. Use a puller tool to remove the end bracket. See Figure 9-17.

   Note: To avoid loosening the exciter field magnets, do not attempt to remove the end bracket by pounding with a hammer.

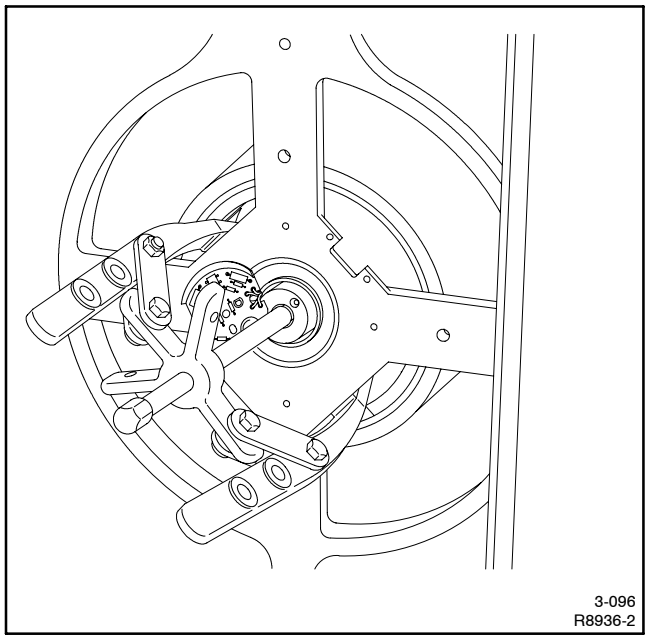


Figure 9-17 Removing End Bracket

6. Pull the end bracket and exciter field assembly over the exciter armature. Be extremely careful to avoid damaging the exciter field magnets or photo transistor board.
7. Reverse order of disassembly to reinstall end bracket/exciter field assembly.

10.1 Governor Identification

This section contains governor identification by model and engine including optional governors when available. The reference column provides the source for governor adjustment. This section provides governor adjustment Information when it is not available in the engine service literature. Refer to the respective wiring diagram for electrical connections. Refer to the respective parts catalog for engine literature part numbers.

10.1.1 Diesel Models

Model	Engine	Governor Type	Part Number	Reference
40EOZD 33EFOZD	John Deere 4045	Mechanical, Stanadyne DB2		See Section 10.2
		Electronic, Non-Load Sharing	GM17644-4	See Section 10.3.1
		Electronic, Load Sharing	GM17644-5	See Section 10.3.1
55-99EOZD 40-80EFOZD	John Deere 4045/6068	Electronic, JDEC/Stanadyne DE10		Engine S/M
125-180EOZD 100-150EFOZD	John Deere 6081	Electronic, JDEC		Engine S/M

10.2 Mechanical Governor

10.2.1 Stanadyne DB2

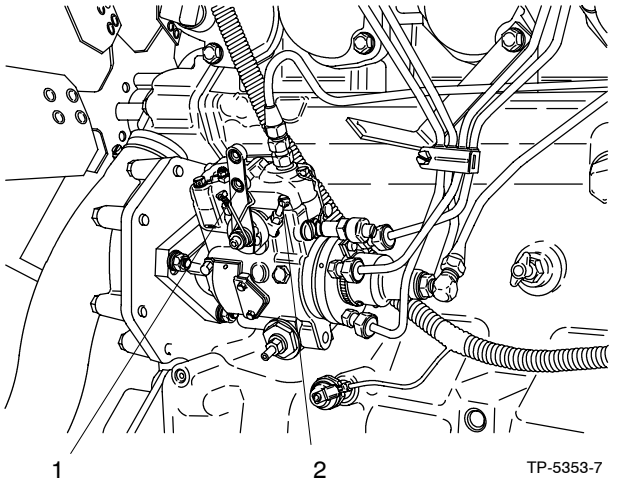
Note: Before checking and adjusting engine speed, make sure engine has reached its normal operating temperature.

All speeds indicated apply to a hot engine under load. The maximum permissible speed variation is 50 rpm for fast idle speed.

1. Disconnect speed control from fuel injection pump lever.

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

3. Verify that injector pump lever is held in fast idle position against fast idle adjusting screw. See Figure 10-1.



1. Injection Pump Lever
2. Fast Idle Adjusting Screw

Figure 10-1 Governor Adjustments, Typical

4. Using a tachometer, check engine speed. Adjust engine speed to obtain a full load engine speed of 1800 rpm (60 Hz) or 1500 rpm (50 Hz).

   To increase engine speed, rotate fast idle adjusting screw CCW; rotate fast idle adjusting screw CW to decrease engine speed.

5. Reconnect speed control to fuel injection pump lever.

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

10.3 Electronic Governor

10.3.1 GM17644-4 (Non-Load Sharing) and GM17644-5 (Load Sharing)

This section covers the non-load sharing governor (Figure 10-2) and the load sharing governor (Figure 10-3).

See Section 10.4 for the magnetic pickup adjustment.

Actuator Installation (John Deere)

Use the following procedure to install the actuator.

1. Install the new cover seal into the groove of the integrated actuator cover assembly.
2. Position the integrated actuator cover assembly into the top of the pump while holding the metering valve drive coupling parallel to the pump body. Slightly lift the front portion of the integrated actuator cover.
3. Carefully slide the integrated actuator cover toward the rear of the pump body until the mounting holes between the integrated actuator cover and pump body align.
4. Use two long cover screws and one short cover screw to assemble the integrated actuator cover to the pump body. Tighten the screws to 4–5 Nm (35–45 in. lb.).
5. Install a new O-ring on the return line connector assembly. Apply a light coating of all-purpose grease to the O-ring and install the connector. Tighten to 5–6 Nm (43–55 in. lb.).
6. Install the fuel return line to the return line connector.

Preliminary Adjustments

Refer to Section 10.5, Digital Isochronous Governor Programming Kit GM39344.

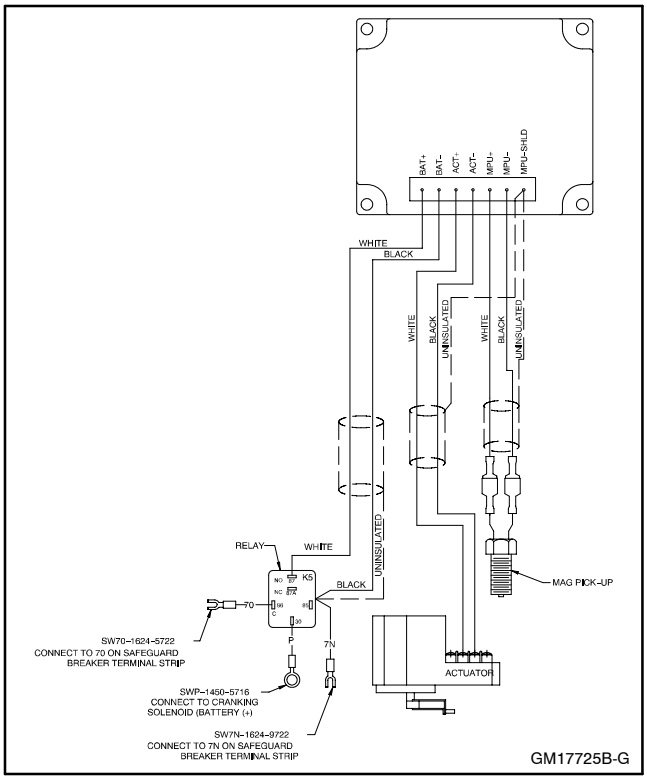


Figure 10-2 Governor Non-Load Sharing

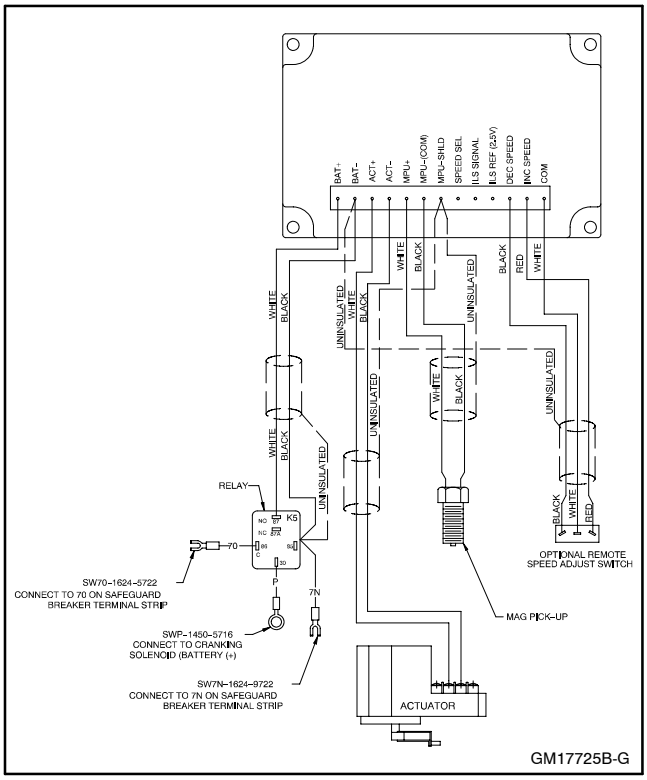


Figure 10-3 Governor Load Sharing

Final Adjustments

Warm engines are normally more stable than cold engines. If the governor is adjusted on a warm engine, decrease the overall gain, derivative gain, and integral gain by 5% to ensure a stable engine when started cold.

1. Move the generator set master switch to the RUN position.
2. Adjust the frequency with the INC/DEC buttons on governor controller to bring the frequency to 67 Hz for 60 Hz models and 56 Hz for 50 Hz models.

   If the desired frequency cannot be attained, go to step 3.

   If the desired frequency is attained, go to step 7.
3. Slowly back out the high idle screw while holding the engine speed lever in the high idle position until you obtain the desired frequency.
4. Tighten high idle locknut to 4–5 Nm (35–45 in. lb.).
5. Turn in the low idle screw to lock lever in place and tighten low idle locknut to 4–5 Nm (35–45 in. lb.).
6. Readjust the frequency with the INC/DEC buttons on governor controller to bring the frequency to 67 Hz for 60 Hz models and 56 Hz for 50 Hz models.
7. With no load applied, increase the overall gain until the engine begins to hunt.

   If the engine does not begin to hunt, momentarily disrupt the governor power supply. Then decrease the overall gain until stable.

   For optimum performance, the engine should oscillate 3–5 diminishing cycles after being disrupted.

Troubleshooting

If the governor system fails to operate and the actuator is suspected to be the problem, perform the following tests.

Measure the actuator coil resistance. The values shown in Figure 10-4 are for readings at ambient temperature.

Actuator	Resistance, ohms
12 VDC	2.05 ±0.25
24 VDC	7.20 ±0.50

Figure 10-4 Actuator Coil Resistance Values

Measure the coil isolation. The coil to case resistance should be >3 megohms.

Remove the actuator from the generator set. Manually move the actuator through its range of motion. No binding or sticking should occur.

Before testing the actuator, place a diode (Motorola P/N MUR810 or equivalent) across the actuator terminals. Energize the actuator to full fuel position. The actuator should operate smoothly throughout its entire stroke without any interruptions in motion.

If the actuator passes these tests, the problem is likely in the governor controller and/or fuel system.

10.4 Magnetic Pickup Adjustment

The magnetic pickup adjustment applies to all models so equipped. Use the following procedure.

1. Place the generator set master switch to the OFF/ RESET position.
2. The flywheel must not be rotating. Loosen the jam nut.
3. Turn in the magnetic pickup until the pole face of the magnetic pickup bottoms on the ring gear tooth.
4. Back out the magnetic pickup 1/4 to 1/2 turn providing a 0.35–0.71 mm (0.014–0.028 in.) air gap.
5. Tighten the jam nut without moving the magnetic pickup.

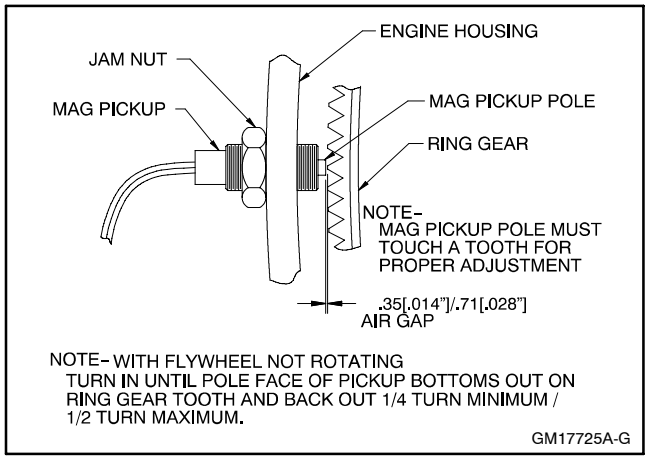


Figure 10-5 Magnetic Pickup Adjustment

10.5 Digital Isochronous Governor Programming Kit GM39344

10.5.1 Introduction

The digital isochronous governor programming kit includes the programming CD-ROM and cable for connecting the governor controller to the user's PC. This instruction is used in conjunction with the digital isochronous governor kits.

The programming kit or Parameter Setup Tool (PST) tells the governor controller how to operate the generator set governing system for that application.

Replacement governors are shipped unprogrammed. After installation and wiring, the governor kit requires downloading the PST and changing the default settings.

The PST overwrites any original programs in the governor controller's nonvolatile memory. Make a backup copy of the files onto a disk and store the disk in a safe place.

The CD-ROM file contents can also be requested through KOHLERnet. Use your SecurID to access the KOHLERnet, click on the TechTools button, and follow the instructions to request files.

Read the entire procedure before beginning. Install the software onto a PC. Carefully follow these instructions and any additional instructions that appear on the screen during the download procedure. The instructions provided assume you know how to operate a PC.

Loading incorrect or incomplete files may cause permanent damage to the governor controller's logic circuit board. Verify that the CD-ROM file contains settings for your specific generator set and engine. Do not attempt to modify the data files.

10.5.2 Kit Components

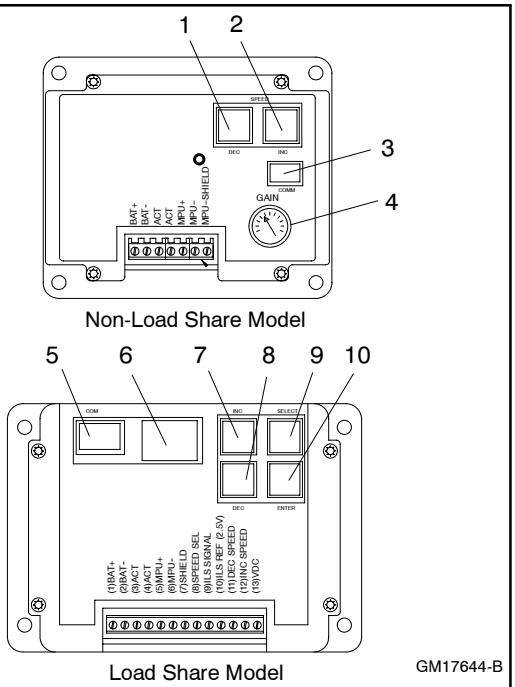
- COMM port cable (9-pin RS-232 DB9F serial port connector to a RJ11M plug)
- CD-ROM including:
  - Parameter Setup Tool Software
  - Parameter Text Files
  - Governor Parameter Detail Form
  - Governor Parameter Summary Form
  - TT-1399 Governor Programming Instructions

10.5.3 Features and Specifications

The microprocessor-based, digital isochronous governor allows adjustment of set speed and gain. Other adjustments include acceleration, deceleration, ramp rates, idle speed set, and hold time. The COMM port provides simple programming when connected to the user's PC. See Figure 10-6 for specifications and Figure 10-7 for governor controller illustrations.

Specifications	Value
Maximum Controlled Output Current	7 Amps
Maximum Current Surge	14 Amps for 10 seconds
Input Signal from Magnetic Pickup	2.0 VAC RMS min. during cranking
Ambient Operating Temperature	-40°C to +85°C (-40°F to +185°F)
Environmental Protection	Oil, water, dust resistant via conformal coating and die cast enclosure
Electrical Connections	Euro-style terminal strip

Figure 10-6 Specifications



1. Speed decrease
2. Speed increase
3. RJ11 connector
4. Gain potentiometer
5. RJ11 connector
6. LED display
7. Increase
8. Decrease
9. Select
10. Enter

Figure 10-7 Governor Controller Functions

Other features include:

- 0.25% frequency control.
- Reverse battery protection.
- 9-30 VDC input.
- Smoke control on startup.
- Serial communication port.
- Droop operation with 0%-10% set speed with 0.10% resolution (load share model).
- Parallel input (load share model).
- Speed adjustment and voltage measurement ranges (load share model).

10.5.4 Keypad Functions

The governor controller keypad provides functions as described below. Refer to Figure 10-7 illustrations.

The Set Speed A and Gain (OVG @ Set Speed A) values can be changed using the governor controller keypad and potentiometer adjustment on non-load share models.

All values can be changed using the governor controller keypad on load share models.

Non-Load Share Model

These models provide speed adjustment for increase/decrease speed and a gain potentiometer. No other functions are available on the governor controller.

Load Share Model

The user interface operates in two modes—Parameter Select Mode and Parameter Edit Mode.

The Parameter Select Mode provides the user selection of viewing and editing parameters. This mode is active when the 2-digit value display is flashing (blinks). The value is the parameter identification (ID) number. The governor controller label lists each user-adjustable parameter and the corresponding ID number.

The Parameter Edit Mode provides the user with the selected parameter's value and allows the changing of a value. This mode is active when the 2-digit value display is steady on. The value displayed is the selected parameter's current value. The decimal point display has several meanings:

- Decimal point flashing indicates the value can be edited.
- Decimal point not flashing indicates the value cannot be edited. The selected parameter is locked and values are viewable only. This situation occurs when the password protection is active and the unlocking code has not been entered.
- The right digit's decimal point is ON—the lower two digits of a parameter's 4-digit value are displayed.
- The left decimal point is ON—the greater two digits of a parameter's value are displayed. The upper two digits of a parameter are always view only and cannot be modified directly. The upper two digits will change when the lower digits transition from 99 upward or 00 downward.

The keypad consists of four pushbuttons—Enter, Select, INC, and DEC. See Figure 10-8 for a summary of functions by mode selection.

Parameter Select Mode	
LED Display	The ID number of a parameter listed on the label is flashing.
INC key	Increase the parameter ID number by 1.
DEC key	Decrease the parameter ID number by 1.
Select key	Activate the Parameter Edit Mode on the parameter number flashing.
Enter	Display the version number of the governor's programming.
INC and DEC simultaneously	Turn on all LED segments as a test.
Parameter Edit Mode	
LED Display	The value of the selected parameter is displayed. A flashing decimal point indicates the value can be changed.
INC key	Increase the selected parameter's value.
DEC key	Decrease the selected parameter's value.
Select key	Return to Parameter Select Mode and ignore the changes made to the parameter value.
Enter	Save the parameter's new value and return to the Parameter Select Mode.
INC and DEC simultaneously	Use to display the upper digits of values greater than 99.

Figure 10-8 Keypad Function Summary

Enter key. Use the Enter key to exit the Parameter Edit Mode and return to the Parameter Select Mode while the new value gets saved to nonvolatile memory. In the Parameter Select Mode, pressing the Enter key displays the version number of the governor's programming.

Select key. Use the Select key to enter the Parameter Edit Mode from the Parameter Select Mode after a particular parameter has been selected for editing.

Also use the Select key to escape the Parameter Edit Mode and return to the Parameter Select Mode without saving a change in the parameter's value. The parameter value reverts back to the value present when the Parameter Edit Mode was entered.

INC (Increase) key. Use the INC key to increase the displayed parameter ID or value depending upon mode selection.

In the Parameter Select Mode, each press of the INC key causes the display of the next higher parameter ID. After the maximum parameter ID is reached, the display loops back to the first display.

In the Parameter Edit Mode, each press of the INC key increases the current value. Holding the INC key down automatically causes the values to rise at an increasing rate until the INC key is released or the parameter's maximum value is reached.

DEC (Decrease) key. Use the DEC key to decrease the displayed parameter ID or value depending upon mode selection.

In the Parameter Select Mode, each press of the DEC key causes the display of the next lower parameter ID. After the minimum parameter ID is reached, the display loops back to the last display.

In the Parameter Edit Mode, each press of the DEC key decreases the current value. Holding the DEC key down automatically causes the values to fall at an increasing rate until the DEC key is released or the parameter's minimum value is reached.

INC and DEC keys together. In the Parameter Select Mode, pressing and holding the two keys at the same time causes the LED segments to go ON. This serves as a test for the LED segments. Release the keys to resume displaying the parameter ID number.

In the Parameter Edit Mode, pressing and holding the two keys at the same time permits viewing the upper two digits of a 4-digit number. The left digit's decimal point is turned on indicating that the thousands and hundreds digits are displayed.

Note: Not all parameters have four digit values, in which case the upper digits will display 0.0 (zero decimal point zero).

Release the keys and the tens and ones digits are again displayed. The right digit's decimal point is flashing when editing is allowed or steady on indicating that editing is not allowed.

10.5.5 LED Display Functions (Load Share Model only)

The governor controller LED display provides two 7-segment LEDs with digit's corresponding decimal point to display values and indicate mode of operation. Refer to Figure 10-7 illustration for the load share model.

When the LED display value flashes, the Parameter Select Mode is active.

When the LED display value is steady on, the selected parameter's value is displayed and the user interface is in the Parameter Edit Mode. The decimal points also indicate which half of a 4-digit value is displayed and whether editing is allowed.

The right digit's decimal point indicates that the lower 2 digits of a value (tens and ones) are displayed. When the right decimal point flashes, the values can be changed using the INC and DEC keys. When the right

digit is steady on, no editing is allowed or is password protected.

The left digit's decimal point indicates that the upper 2 digits of a value (the thousands and hundreds) are displayed. The greater 2 digits are always view only so the right decimal point does not flash.

When values exceed four digits, the LED display uses the hexadecimal numbering system to represent the value of the thousands position. See Figure 10-9 and the following examples.

Note: For generator set applications, the values will not exceed 9999. This text is for informational purposes only in the event that a value is inadvertently entered above 9999.

Decimal Value	Hexadecimal Equivalent
10	A
11	B
12	C
13	D
14	E
15	F

Figure 10-9 Decimal to Hexadecimal Conversion Chart

Example A

The desired set value is 10069 Hz. The upper two digits should display A.0 and the lower two digits should display 69.

Example B

The desired set value is 10972 Hz. The upper two digits should display A.9 and the lower two digits should display 72.

10.5.6 PST Software

The PST software enables the user to adjust parameter settings and monitor governor operation when a user-supplied PC is connected to the governor controller via the COMM port.

Features

- Automatic configuration to each generator set when communication is established.
- Read/write access to all of a generator set's programmable parameters and features.
- Display of each parameter's default, minimum, and maximum values.
- Diagnostics utilizing automatic refresh of the generator set's status.
- Saving and reloading generator set setup information to and from a file for reuse.
- Single button read for acquiring current parameter values.
- Single button write to program a generator set with previously saved setup values.
- Engine speed monitoring via a chart recorder to aid in governor tuning.
- Saving chart recorder data to a Microsoft® Excel compatible file.
- Help information on each of the governor's parameters.
- Help information on using the PST.

10.5.7 PC System Requirements

- 100% IBM® PC compatible with a 133 MHz or higher Pentium® compatible CPU.
- Microsoft Windows® 98SE (second edition), Windows NT® Workstation Version 4.0, Windows® 2000, or Windows XP® operating system.
- Display resolution with SVGA (800 x 600) or higher.
- CD-ROM drive and minimum of 4 MB hard drive space for installation.
- One 9-pin RS-232 DB9M serial port.
- PCs using USB ports will require a serial adapter.
- Stable power supply. A laptop system with a fully charged battery or desktop system running with a battery backup system is recommended.

Pentium® is a registered trademark of Intel Corporation.
IBM® is a registered trademark of International Business Machines Corporation.
Microsoft®, Windows®, and Windows NT® are registered trademarks of Microsoft Corporation.

10.5.8 PST User Interface Overview

The PST for generator set applications has two main display modes—Table View and Chart View. Table view is the PST default setting.

Table View

In the table view, the user can perform the following items:

- View the current values for all user-programmable parameters in the Parameter Setup panel's table.
- Edit a parameter's value by double clicking on a cell in the *Value* column of the table.
- Left click Read All to refresh the values in the table shown on the Parameter Setup panel.
- Left click Write All to transmit setup values to the governor controller.
- Left click View Status to display read only parameters in the View Status panel.
- Left click View Chart to set the display mode to Chart View.

Chart View

In the chart view, the user can perform the following items:

- View the current values for all user-programmable parameters in the Parameter Setup panel's table.
- Edit a parameter value related to governor tuning. These same parameters are also on the main parameter setup table.
- Left click Data File to open a file for saving chart recorder data.
- Left click Data Reset to start data collection to the open file at the beginning.
- Left click Pause Chart to stop the chart recorder, which also stops writing data to the file. Left click Continue to start the chart recorder function.
- Adjust the horizontal and vertical settings for the chart recorder.
- Left click View Table to set the display mode back to Table View.

10.5.9 PST Menu Items

Use the following menus as needed:

File Menu

- Open a previously saved setup data file.
- Save the setup data to a file.
- Exit the program.

View Menu

- Select the Parameter Table view (Table View).
- Select the Chart Recorder view (Chart View).

Port Menu

- Select the PC's serial port connected to the governor controller.

Help Menu

- Help on the PST for generator sets.
- Help on the governor controller that is currently in communication with the PC.
- Information about the PST for generator set application.

10.5.10 Parameter Setup

The Parameter Setup panel displays a table where each row shows the name of a user-programmable parameter, the current value, and the parameter's (default, minimum, and maximum) values.

To modify a parameter's current value, select the value by double clicking the left mouse button on a cell in the table. The selected cell will be highlighted and the value can be modified. After entering the new value, press the PC Enter key to change the governor controller value.

To get help on a particular parameter, left click the parameter's value, then press <Control> F on the PC.

To see the current values for all of the generator set's parameters, left click Read All.

Left click Write All to transmit all parameter values to the governor controller automatically. The Write All button is very useful when reusing saved setup data to configure a new system the same as a previously created one. Load an existing set of previously saved parameter values into the Parameter Setup table using Open a Setup Data File from the File menu and then left click Write All.

10.5.11 Status View

The Status View panel is displayed only after left clicking View Status. The Status View panel is part of the Table View display mode.

The Status View panel displays a table where each row shows the Name of a read only parameter and its current Value when Auto Read is ON.

Left click Start Monitoring to have the PST program automatically refresh the values. Left click Stop Monitoring to disable automatic refresh.

10.5.12 Tuning View

The Tuning View panel is displayed only after left clicking View Chart. The Tuning View panel is part of the Chart View display mode.

To modify a tuning parameter's current value, select the value by double clicking the left mouse button on a cell in the table. The selected cell will be highlighted and the value can be modified. After entering the new value, press the PC Enter key to change the governor controller value.

10.5.13 Chart Recorder

The Chart Recorder is part of the Chart View display mode. Each time Chart View is entered, the last Data File is reset, the vertical scale defaults to a preset value, and the horizontal scale defaults to 20 seconds.

The vertical and horizontal scale options control the chart recorder's display characteristics. Use the horizontal scale to provide a chart recorder display at 60, 30, 20, 10, or 5 second intervals. Larger values compress the display while smaller numbers expand the display.

The Data File button opens a dialog box to name the file and path where chart recorder data is saved.

Use the Data Reset button to start data collection over using the current data file. The progress bar to the right of this button indicates the capacity of the data file. Each data file can hold approximately 10 minutes of data and the data is sampled 100 times per second. The progress bar displays the message The Data File is Full when it can no longer accept chart recorder data.

The Pause Chart button stops the chart recorder and data file updates. Left click this button, which is now named Continue, to activate the chart recorder.

Use the View Table button to return to the Table View display mode. Be sure to open a new Data File before returning to Table View if the data already collected needs saving. The active Data File is automatically reset each time the Chart View display mode becomes active.

10.5.14 Installation Procedure

1. Determine the governor assembly part number and engine model number. Before beginning the programming procedure, the user must determine the governor assembly part number and engine model number. The selection of the correct Parameter Text File later in this procedure depends on knowing these numbers.

   a. The governor assembly part number is stamped on the replacement governor included in the service kit.

   b. The engine model number may be shown on the engine nameplate attached to the generator set engine block. Other sources for finding the engine model number include the respective generator set spec sheet and documentation included with the generator set sales invoice and/or warranty registration.

2. Connect the governor controller to the user-supplied PC.

   a. Place the generator set master switch in the OFF/ RESET position.

   b. Connect the supplied cable included in the kit from the user-supplied PC 9-pin RS-232 serial port to the governor controller RJ11 connector (phone jack). See Figure 10-7.

3. Open the CD-ROM files.

   The instructions provided assume you know how to operate a PC.

   a. Login to the user-supplied PC.

   b. Load the CD-ROM in the PC.

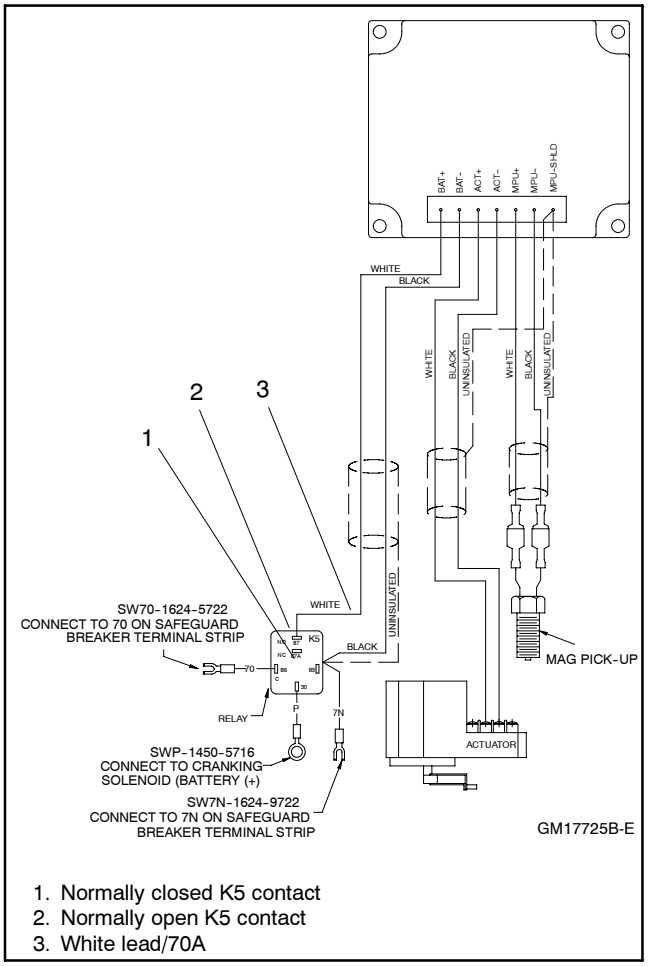
   c. Open the Readme.doc file and follow the instructions described. Use the *pst.help* file as needed.

   d. Copy the PST, Setup, and Parameter Text files to your PC hard drive.

   e. Run the Setup file on your PC hard drive by clicking *File-Open-Setup Data* and clicking *Run*.

   f. Copy the *PST_CONFIG.mdb* (MS Accessdatabase) file and paste it in the same folder as the PST file. The default folder is *ProgramFiles\Kohler\PST*.

g. Energize the governor controller by moving the white lead/70A from the normally open K5 contact to the normally closed K5 contact. See Figure 10-10. Connecting to the normally closed contact will energize the governor controller without starting/running the generator set.



1. Normally closed K5 contact
2. Normally open K5 contact
3. White lead/70A

Figure 10-10 Energizing the Governor Controller (non-load share model shown)

h. The supplied CD-ROM contains a Governor Parameter Summary for each generator set/engine combination. Print a copy of this summary as it provides the data necessary for programming the parameters for each specific generator set. See Section 10.6, Parameter Definitions, for detailed explanations of each parameter and Section 10.7, Parameter Defaults Reference.

- If Governor Parameter Summary includes your generator set/engine combination, go to step 4.
- If the Governor Parameter Summary DOES NOT include your generator set/engine combination, go to Section 10.9, Calibration Instructions.

Note: It is recommended to connect a load bank to the generator set in an effort to provide varying loads.

4. Program the governor controller and save the files.

   a. Use the part number data determined in step 1 and select the Parameter Text file by clicking *File-Open-"?.Txt"*

   The Read All values on the PC screen are the values shown on the printed Parameter Summary form.

   b. Click *Write All*. The selected parameter text file is then sent to the governor controller.

   c. Save and store this parameter text file on your PC hard drive, floppy disk, and/or CD-ROM for future reference.

5. Disconnect the governor controller from the user-supplied PC.

   a. Check that the generator set master switch is in the OFF position.

   b. Move the white lead/70A from the normally closed K5 contact back to the normally open K5 contact. See Figure 10-10.

   c. Disconnect the supplied cable included in the kit from the user-supplied PC 9-pin RS-232 serial port and the governor controller RJ11 connector (phone jack).

   d. Store the cable and CD-ROM together for later use as needed.

10.5.15 Troubleshooting

See Section 10.10, Diagnostics and Troubleshooting, for help in diagnosing generator set/engine problems relating to the governor controller.

10.6 Parameter Definitions

(Digital Isochronous Governor Programming Kit GM39344)

Use this section for definitions of each of the calibration values. Section 10.7, Parameter Defaults Reference, lists the default settings.

When changing values using the keypad, the PST display on the user's PC will not automatically update. To refresh the PST display, the user must select a different parameter with the PC mouse and then go back to the desired value. The PST provides *Read All* button which will refresh all of the parameter values.

1. **Number of flywheel teeth.** Enter the value from the Governor Parameter Summary. This display is not required. Displayed speeds can be changed between Hz and rpm.

2. **Set Speed A.** Enter the value from the Governor Parameter Summary.

3. **Set Speed B (load share model only).** Use the default value.

4. **Idle Speed.** Enter the value from the Governor Parameter Summary.

5. **Proportional.** Enter the value from the Governor Parameter Summary.

   A speed change creates a speed error (the difference between the target speed and the actual speed.) The Proportional gain controls the size of the governor output response to a step change in the speed error. See Figure 10-11.

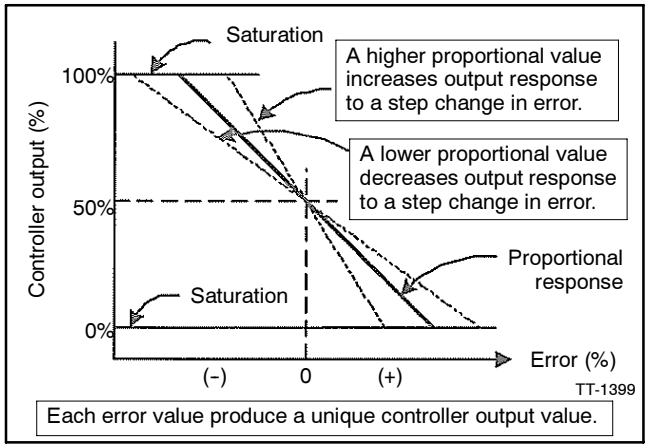


Figure 10-11 Proportional Value

6. **Integral.** Enter the value from the Governor Parameter Summary.

   The Integral value acts to drive the speed error to zero. In a Proportional only control with constant load, there will be a constant speed error that inversely relates to the Proportional gain of the system.

   The Integral value is key to isochronous speed control. This value eliminates the difference between the programmed set speed and the actual speed. The Integral gain changes the time it takes to drive the error to zero. The Integral value eliminates the speed offsets due to Proportional gain and should not be set to zero. See Figure 10-12.

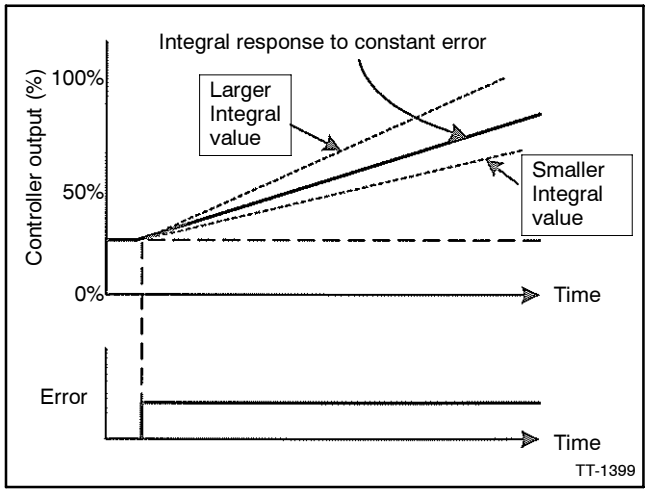


Figure 10-12 Integral Value

7. **Derivative.** Enter the value from the Governor Parameter Summary. See Figure 10-13.

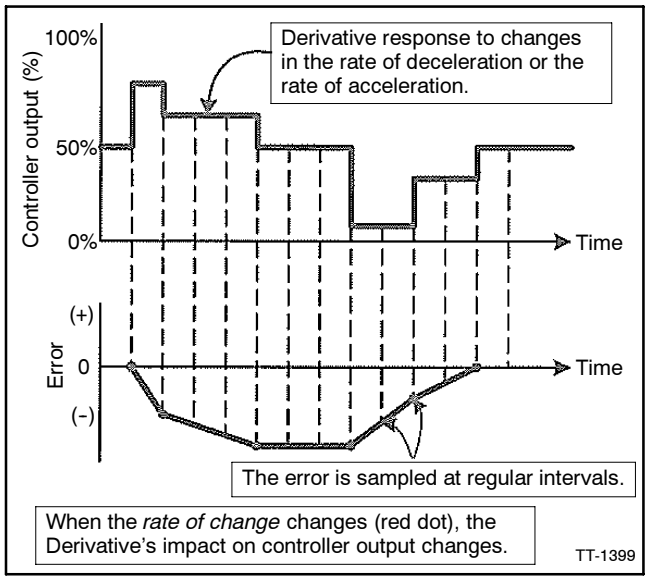


Figure 10-13 Derivative Value

The Derivative responds to the rate of change in the speed error. This parameter is primarily used to dampen very rapid oscillations resulting from large speed changes. The Derivative responds to engine acceleration or deceleration. When the engine speed approaches the target speed at a fast rate, the Derivative acts to minimize or eliminate overshoot. A zero value is allowed but systems typically require some Derivative gain to improve overall engine speed control.

8. **Overall Gain (OVG) @ Set Speed A.** Set the default setting from the Governor Parameter Summary.

   This gain value acts as a multiplier on the three Proportional, Integral, and Derivative (PID) values of Speed A.

9. **Overall Gain (OVG) @ Set Speed B (load share model only).** Use the default value.

   This gain value acts as a multiplier on the three PID values of Speed B.

10. **Overall Gain (OVG) @ Idle.** Enter the value from the Governor Parameter Summary.

    This gain value acts as a multiplier on the three PID values when the Idle Speed is the active target speed. The Idle Speed set point is active only during startup when the Idle Hold Timer is running.

11. **Gain Factor.** Enter the value from the Governor Parameter Summary.

    The Gain Factor permits more range of adjustment from the PID values. When any of the PID reaches their adjustment limit, the Gain Factor can be modified for more range of the PID and OVG values.

12. **Speed Filter.** Enter the value from the Governor Parameter Summary.

    This value indicates the number of speed signal pulses to use when calculating an average engine speed and is used to dampen out speed measurement variations that can make PID tuning difficult.

    Too much filtering slows down the governor's response to speed change and too little filtering can make the governor overly sensitive and tuning difficult. As a general rule, less filtering is needed when the number of engine cylinders increases because there is less time for the engine speed to slow down before the next engine cylinder firing.

    Note: Use 24 for three- or four-cylinder engines and 16 for six- or eight-cylinder engines.

13. **Idle Hold Time.** Use the default value.

    The Idle Hold Time specifies how long after starting the engine stays at Idle Speed before finishing the ramp to the target speed. The time value has a resolution of one-tenth of a second.

    During the startup sequence, the governor increases the engine speed from the engine's crank speed to the active target speed at the Startup Rate specified. When the Idle Hold Time is nonzero, the initial target speed will be the Idle Speed. After the Idle Hold Time times out, the governor uses the Startup Rate to ramp the engine to the selected Set Speed (A or B). The startup sequence is complete after the engine speed reaches the specified set speed.

14. **Accel Rate.** Use the default value.

    This value specifies how fast the governor should increase the engine's speed when a new higher speed is made active.

15. **Decel Rate.** Use the default value.

    This value specifies how fast the governor should decrease the engine's speed when a new higher speed is made active.

16. **Startup Rate.** Enter the value from the Governor Parameter Summary.

    This value achieves a smooth controlled engine start. On diesel engines, this value minimizes exhaust smoke at startup. When used in conjunction with the Idle Speed and Idle Hold Time, a brief warmup cycle can be programmed.

    The Startup Rate specifies how fast the governor should increase the engine speed when the engine is started. The governor increases the engine speed from the engine's crank speed to the active target speed at the rate specified. The governor brings the engine to the Idle Speed for the Idle Hold Time, then continues increasing the engine speed at this same ramp rate until the engine reaches the selected target speed (Set Speed A or B).

    Note: In cases where the target speed is less than the Idle Speed and the Idle Hold Time is nonzero, the startup ramp sequence ends when Idle Speed is reached. Decel Rate is then used to ramp engine speed down to target speed from Idle Speed.

The ramp up pauses at the Startup Speed until the governor senses an magnetic pickup (MPU) signal greater than the Startup Speed. This prevents the startup ramp from reaching completion before the engine has started.

The governor treats MPU frequencies below the Startup Speed as an indication that the engine is cranking but has not yet started. The governor treats MPU frequencies above the Startup Speed as an indication that the engine has started and the governor increases the engine speed until the selected set speed is reached.

Note: In cases where target speed is less than Startup Speed, the startup ramp sequence ends when the target speed is reached.

During the startup sequence, the governor increases the engine speed from the engine's crank speed to the active target speed at the Startup Rate specified. When the Idle Hold Time is nonzero, the initial target speed is the Idle Speed. After the Idle Hold Time times out, the governor uses the Startup Rate to ramp the engine to the selected set speed (Set Speed A or B). The startup sequence is complete after the engine speed reaches the selected set speed.

17. **Startup Limit (load share model only).** Use the default value.

    The Startup Limit parameter limits the fuel supplied to the engine during startup. This value is useful in reducing smoke when starting diesel engines.

    Note: The engine may not start if the value is set too low.

18. **Torque Limit (load share model only).** Use the default value.

    The Torque Limit parameter limits the fuel supplied to the engine during heavy generator set loads or generator set overloads.

    Note: The engine may not be able to carry its rated load if the value is set too low.

19. **Integral Low Limit.** Use the default value.

    The Integral Low Limit value reduces underspeed duration after a long or sustained overspeed condition was present. The low limit helps reduce the duration and amount of engine underspeed by maintaining a minimum actuator position.

    Note: Setting an improper value can prevent the governor from reaching target speed.

20. **Integral High Limit.** Enter the value from the Governor Parameter Summary.

    The Integral High Limit value reduces overspeed duration after a long or sustained underspeed condition was present. The high limit helps reduce the duration and amount of engine overspeed by maintaining a maximum actuator position.

    Note: Setting an improper value can prevent the governor from reaching target speed.

21. **Percent (%) Droop (load share model only).** Use the default value.

    The percent droop value selects droop mode operation and specifies the percentage of droop required. When the percent droop parameter is set to zero (default setting), droop is not active.

    Note: This value can only be changed during the Droop Calibration Procedure detailed in Appendix 10.9.

22. **No Load Calibration (load share model only).** Use the default value.

    The No Load Calibration value is determined during the Droop Calibration Procedure and should not be set manually.

    Note: This value can only be changed during the Droop Calibration Procedure.

23. **Full Load Calibration (load share model only).** Use the default value.

    The Full Load Calibration value is determined during the Droop Calibration Procedure and should not be set manually.

    Note: This value can only be changed during the Droop Calibration Procedure.

24. **Password.** Use the default value.

    The password feature provides protection against inadvertent parameter changes that can occur when keys are pressed and a parameter modification is not intended. The password parameter has three possible settings: Disabled, Locked, and Unlocked.

    Disabled. This setting turns off any password protection. Use this setting if password protect is not desired. This is the default setting from the factory. Enter a value of 99 to set the password protection parameter to the Disabled mode.

Load share model only. When the password protect parameter is selected, the governor controller LED display shows *Pd* for 2 seconds, indicating the password-disabled mode; then the value *00.* is displayed. The user can then edit the value.

Locked. This setting means that password protection is active and only parameter viewing is allowed (parameter editing is disabled). Enter a value of 22 to set password protection to the Locked mode.

Load share model only. For 2 seconds after selection of the password protection parameter, the LED display shows *PE* for this mode and the rightmost decimal point will be steady ON (not flashing), then the value *00.* is displayed. The user can edit the value.

Unlocked. This setting means that password protection is active but parameter editing is allowed.

Load share model only. Entering a value of *30* in the Locked mode will unlock parameter editing. The user is free to edit parameters. If there is no governor controller keypad activity for 5 minutes, the governor controller returns to the Locked mode. If not already in the Unlocked mode, the user must get into the Unlocked mode in order to enter *99* to disable password protection.

25. **Overspeed limit.** Use the default value.

    This value determines the engine speed that triggers the governor output minimum fuel. The parameter's value is in terms of a percentage over the highest set speed.

    Note: The governor controller must be turned off to clear the overspeed detection before the engine can be restarted.

26. **Set Speed A Min.** Enter the value from the Governor Parameter Summary.

    Use Set Speed A minimum to set the lowest value allowed for adjustments of Set Speed A.

27. **Set Speed A Max.** Enter the value from the Governor Parameter Summary.

    Use Set Speed A maximum to set the highest value allowed for adjustments of Set Speed A.

28. **Set Speed B Min. (load share model only).** Enter the value from the Governor Parameter Summary.

    Use Set Speed B minimum to set the lowest value allowed for adjustments of Set Speed A.

29. **Set Speed B Max. (load share model only).** Enter the value from the Governor Parameter Summary.

    Use Set Speed B maximum to set the highest value allowed for adjustments of Set Speed A.

30. **Idle Speed Min.** Enter the value from the Governor Parameter Summary.

    The Idle Speed minimum value is the lowest value allowed for adjustments of Idle Speed.

31. **Idle Speed Max.** Enter the value from the Governor Parameter Summary.

    The Idle Speed maximum value is the lowest value allowed for adjustments of Idle Speed.

32. **Duty Cycle Limit.** Enter the value from the Governor Parameter Summary.

    The duty cycle maximum value sets the absolute maximum amount of drive signal to the actuator and serves as a mechanism for fuel limiting. Fuel limiting is achieved by setting the maximum duty-cycle or ontime allowed during one cycle of the pulse width modulation (PWM) signal controlling the actuator drive circuit.

33. **Startup Speed.** Use the default value.

    The Startup Speed value allows the governor to determine whether the engine is cranking or running whenever an engine speed signal is present.

    The Startup Speed value should be at least 10% higher that the fastest engine cranking speed but lower than the engine's Idle Speed.

    If the Startup Speed is too low (less than crank speed) the governor's target speed is ramped to the active Set Speed (Idle, Set Speed A or B) before the engine has started. When the engine does not start, it may overspeed or output excessive smoke because the startup ramp, having already completed, no longer controls the rate of engine speed increase.

    If the Startup Speed is too high (above the active set speed) then the Startup Speed becomes the target speed that the governor must reach before the governor considers the startup sequence complete. Typically, the startup sequence ends when the engine speed reaches the active set

speed. The active set speed is the Idle Speed if the Idle Hold Time parameter is a nonzero value or the selected set speed (either Set Speed A or B).

34. **Startup Duty Cycle.** Enter the value from the Governor Parameter Summary.

    The Startup Duty Cycle value is used to preload the PID values with a PWM duty cycle value that provides an actuator output signal sufficient to allow enough fuel to idle the engine.

    If the Startup Duty Cycle value is too low, the engine crank time may be longer than desired because the governor's actuator output starts from a value much smaller than needed to begin opening the fuel valve.

    If the Startup Duty Cycle value is too high, the engine may overspeed because the actuator opens more that needed to start the engine.

10.7 Parameter Defaults Reference

(Digital Isochronous Governor Programming Kit GM39344)

No.	Parameter Name	Load Share Only	Minimum	Maximum
1	No. of flywheel teeth		0	572
2	Set Speed A (Hz)		Set Speed A Min.	Set Speed A Max.
3	Set Speed B (Hz)	Yes	Set Speed B Min.	Set Speed B Max.
4a	Idle Speed (Hz)		Idle Speed Min.	Idle Speed Max.
4b	Idle Speed (Hz)	Yes	Idle Speed Min.	Idle Speed Max.
5	Proportional		1	99
6	Integral		0	99
7	Derivative		0	99
8	OVG @ Set Speed A (gain potentiometer)	Yes	1	99
9	OVG @ Set Speed B	Yes	1	99
10	OVG @ Idle		1	99
11	Gain Factor		1	99
12	Speed Filter		1	24
13	Idle Hold Time (sec.)		0	9999
14	Accel Rate (Hz/sec.)		1	11000
15	Decel Rate (Hz/sec.)		1	11000
16	Startup Rate (Hz/sec.)		1	11000
17	Startup Limit	Yes	0	1000
18	Torque Limit	Yes	0	1000
19	Integral Low Limit		0	Integral High Limit
20	Integral High Limit		Integral Low Limit	99
21	% Droop	Yes	0	100
22	No Load Calibration	Yes	0	1000
23	Full Load Calibration	Yes	0	1000
24	Password		0	99
25	Overspeed limit (Hz)		0	6000
26	Set Speed A Min. (Hz)		10	Set Speed A
27	Set Speed A Max. (Hz)		Set Speed A	11000
28	Set Speed B Min. (Hz)	Yes	10	Set Speed A
29	Set Speed B Max. (Hz)	Yes	Set Speed B	11000
30	Idle Speed Min. (Hz)		10	Idle Speed
31	Idle Speed Max. (Hz)		Idle Speed	11000
32	Duty Cycle Limit		10	95
33	Startup Speed (Hz)		10	11000
34	Startup Duty Cycle		5	95

10.8 Parameter Default Settings

No.	Parameter Name	Load Share Only	Default Settings		
			GM17644-4	GM17644-5	GM17644-6
1	No. of flywheel teeth		0	0	0
2	Set Speed A (Hz)		1000	1000	25
3	Set Speed B (Hz)	Yes	–	1000	–
4a	Idle Speed (Hz)		500	–	20
4b	Idle Speed (Hz)	Yes	–	500	–
5	Proportional		1	1	1
6	Integral		0	0	0
7	Derivative		0	0	0
8	OVG @ Set Speed A (gain potentiometer)	Yes	–	20	–
9	OVG @ Set Speed B	Yes	–	20	–
10	OVG @ Idle		20	20	20
11	Gain Factor		1	1	1
12	Speed Filter		16	16	4
13	Idle Hold Time (sec.)		0	0	0
14	Accel Rate (Hz/sec.)		1000	1000	3000
15	Decel Rate (Hz/sec.)		1000	1000	3000
16	Startup Rate (Hz/sec.)		1000	1000	3000
17	Startup Limit	Yes	–	1000	–
18	Torque Limit	Yes	–	1000	–
19	Integral Low Limit		0	0	0
20	Integral High Limit		99	99	99
21	% Droop	Yes	–	0	–
22	No Load Calibration	Yes	–	0	–
23	Full Load Calibration	Yes	–	1000	–
24	Password		0	0	0
25	Overspeed limit (Hz)		6000	6000	450
26	Set Speed A Min. (Hz)		1000	1000	25
27	Set Speed A Max. (Hz)		5000	5000	300
28	Set Speed B Min. (Hz)	Yes	–	1000	–
29	Set Speed B Max. (Hz)	Yes	–	5000	–
30	Idle Speed Min. (Hz)		500	500	20
31	Idle Speed Max. (Hz)		5000	5000	300
32	Duty Cycle Limit		10	10	10
33	Startup Speed (Hz)		1000	1000	25
34	Startup Duty Cycle		5	5	5

10.9 Calibration Instructions

(Digital Isochronous Governor Programming Kit GM39344)

10.9.1 Basic Adjustments

The governor controller is programmed at the factory with default setting parameter settings. These settings allow the controller to operate but usually require some further adjustments to obtain the best system performance. In order to bring the engine up to a single speed for the first time, the user needs to adjust the parameters shown in Figure 10-14. Use the Calibration Instructions only when the Governor Parameter Summary does **not** include a specific generator set/ engine combination.

The parameters listed in Figure 10-14 are the primary items to get the governor controller tuned and the engine running smoothly. It is recommended that the default settings in Figure 10-14 be initially used and then adjusted to satisfy the generator set/engine application. Leave all other parameters at their default settings until the primary parameter settings are determined.

Parameter No.	Parameter Name	Default Value
2	Set Speed A	1000
5	Proportional	25
6	Integral	50
7	Derivative	25
8	OVG @ Set Speed A	20
11	Gain Factor *	20
12	Speed Filter †	18

* Modify the Gain Factor only when the PID or OVG values reach their min./max. parameters.
† The Speed Filter value should be set to 24 for 3- or 4-cylinder engines. Use a value of 16 for 6- or 8-cylinder engines.

Figure 10-14 Primary Parameter Setup

10.9.2 Calibration Techniques

After the engine is running, use the following procedure to determine optimum values for the Proportional, Integral, and Derivative (PID) values and the Overall Gain Parameters (OVG). The goal is to find PID values that allow the governor controller to govern the engine optimally at all loads while only requiring gain adjustment. Use the following steps:

1. Calibration Procedure.

   The governor controller default programming provides the values shown in Figure 10-14. It is recommended to connect a load bank to the generator set in an effort to provide varying loads.

   Note: Steps 1.f. through 1.j. require varying the generator set load to cause engine speed changes. Start with small load variations and continue with greater load changes to provide a better overall performance test.

   With Integral, a speed error may persist after a load-on load-off transition. During steps 1.c. through 1.i., temporarily increase the Integral to get the engine speed back to the set speed, and then reset the Integral to a lower value again while working to find good Proportional and Derivative values.

   Repeat steps 1.f. through 1.k. as needed to find Proportional, Integral, and Derivative values that work well with a variety of overall gain values and different load transients. See Figure 10-15.

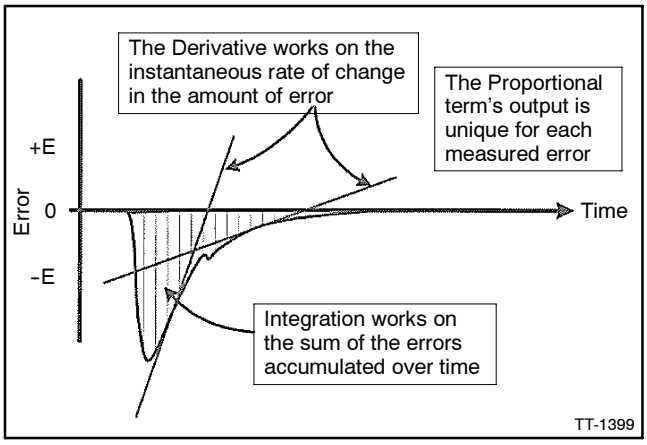


Figure 10-15 Relationships of DIP

a. Open the line circuit breaker to disconnect the load from the generator set.

b. Place the generator set master switch in the RUN position to start the generator set.

c. Set the Set Speed A to 1800 rpm for 60 Hz models and 1500 rpm for 50 Hz models.

d. Set the Integral and Derivative values to 0.

e. Set the Overall Gain low (less than 20).

f. Increase the Proportional value until the engine shows continuous oscillations greater than 2 Hz.

g. Reduce the Proportional value by 25%–50%.

h. Close line circuit breakers to connect load to the generator set.

i. Make small Derivative value changes to dampen out *ringing* in response to load transients.

j. Increase the Integral to eliminate any steady-state error in the engine's speed and help decrease error recovery time.

k. Increase the Overall Gain to improve response time while keeping the ratios of the PID values relative to each other constant.

2. Droop Calibration Procedure (load share model only).

   If droop calibration is required, go to step 2.a.

   If droop calibration is not required, go to step 3.

   Use this calibration procedure when droop is required.

   After droop calibration, the difference between the No Load Cal and the Full Load Cal parameter values should be greater than 100 for best operation of droop. The droop function may still work for smaller differences but with less accuracy.

   a. Open the line circuit breaker to disconnect the load from the generator set.

   b. Place the generator set master switch in the RUN position to start the generator set.

   c. Set the Set Speed A to 1800 rpm for 60 Hz models and 1500 rpm for 50 Hz models if not already completed.

   d. Enter a value of 41 in the Password parameter allowing editing of the droop related parameters.

   e. Select the % Droop parameter and adjust the value to:

      Selected Set Speed / [(1000 - Value of % Droop) / 1000]

   f. Allow the engine to stabilize at the No Load droop speed and then press the governor controller's Enter key to set the percent droop. No Load Calibration is now complete.

   g. Select the Full Load Calibration procedure. The engine speed will return to the selected set speed.

   h. Apply full load to the engine and allow the speed to stabilize.

   i. Wait 5 seconds and then press the governor controller's Enter key to record the calibration value. Full Load Calibration is now complete.

   j. Remove the load from the generator set. The engine speed will increase to the no load droop speed. Droop calibration is now complete.

   k. Place the generator set master switch in the OFF position to stop the generator set.

3. Update the governor controller and save the files.

   a. Select WRITE ALL. The updated program is then sent to the governor controller.

   b. Save and store this modified PST file on your PC hard drive, floppy disk, and/or CD-ROM for future reference.

   c. In an effort to help us build a more complete data base, we request you share your calibration values by filling out the Governor Parameter Detail form. E–mail or fax the completed form to us and after our review, we will include the data in the Governor Parameter Summary.

      E-mail: generatorfieldservice@Kohler.com

      Fax number: 920-803-4977.

4. Disconnect the governor controller from the user-supplied PC.

   a. Check that the generator set master switch is in the OFF position.

   b. Move the white lead/70A from the normally closed K5 contact back to the normally open K5 contact. See Figure 10-10.

   c. Disconnect the supplied cable included in the kit from the user-supplied PC 9-pin RS-232 serial port and the governor controller RJ11 connector (phone jack).

   d. Store the cable and CD-ROM together for later use as needed.

10.10 Diagnostics and Troubleshooting

(Digital Isochronous Governor Programming Kit GM39344)

10.10.1 Introduction

Use the troubleshooting chart to help diagnose generator set/engine problems relating to the governor controller.

10.10.2 Display Codes (Load Share Model)

Code	Fault
E0	Controller memory failure. Replace governor controller.
E1	Loss of remote speed potentiometer signal.
E2	Overspeed detected. Governor controller must be turned off and reset to allow an engine restart.
E3	Actuator drive overcurrent detected. Check wiring. Check actuator loading and linkage.

10.10.3 LED Indications (Non-Load Share Model)

LED State	Fault
Off	Governor controller is either not currently powered or is being reverse powered. (Check polarity of supplied power.) If correctly powered, governor controller is malfunctioning.
Blinking Slow (1/2 Hz)	Governor controller is powered, but not sensing a speed signal. OK if engine is not running. If the engine is running, this indicates a fault with the speed signal.
Blinking Fast (1 1/2 Hz)	Governor controller is powered and an engine speed signal is being detected. If the engine is not running, this indicates electrical noise on the speed signal wires.
ON and Not Blinking	Governor controller is powered and is malfunctioning. Replace governor controller.

10.10.4 Troubleshooting Chart

Symptom	Possible Cause	Remedy
LED display does not light up when the governor controller is powered	BAT+ and BAT- leads are reversed.	Check and correct wiring.
	Battery voltage is too low. Governor controller supply voltage should be 9-30 VDC.	Charge or replace the battery.
	Governor controller is inoperative.	Replace governor controller.
Unable to modify parameters	The parameter's value is the maximum value allowed.	Enter acceptable value.
	The parameter's value is the minimum value allowed.	Enter acceptable value.
	A display code is active (load share model).	Refer to Section 10.10.2, Display Codes.
	Password protection is enabled (load share model).	Enter Password.
	PST not communicating with the controller (non-load share model).	Check cable connection.
	Keypad is inoperative.	Replace governor controller.
Engine does not start	Actuator leads not connected or shorted.	Check and correct actuator wiring.
	No fuel source.	Check fuel supply, fuel line, and shutoff valves.
	Battery voltage is low.	Charge or replace the battery.
	Set speed is lower than crank speed.	Increase the set speed value.
	Startup rate setting is too low. The target speed ramps up too slow.	Increase the startup rate value.
	Startup limit is too low, limiting the actuator drive signal too much.	Increase the startup limit value.
	No magnetic pickup (MPU) speed signal present. Magnetic pickup should be 2.0 VRMS minimum.	Adjust the MPU gap. Try reversing the MPU leads; otherwise, replace the MPU.
	If a speed signal is present, measure the actuator output duty cycle.	If not greater than 5%, restore all parameter values to factory default settings and crank the engine again.
	Final target speed must be greater than crank speed before the governor will attempt to drive the actuator open (non-load share model).	Increase the final target speed value and/or decrease the crank speed value.
Engine overspeeds at startup	The proportional value is too low.	Increase the proportional value.
	The appropriate overall gain (OVG) value is too low.	Increase the appropriate OVG value.
	The startup limit is incorrect (load share model).	Adjust the startup limit value.
	The startup ramp rate is too high.	Decrease the startup ramp rate value.

Symptom	Possible Cause	Remedy
Engine does not reach set speed	Improper Proportional, Integral, and Derivative (PID) tuning values.	Check and adjust the PID values.
	Integral value is too low or zero.	Increase the integral value.
	Derivative value is too low or zero (load share model).	Increase the derivative value.
	PID values are too low. A tuning that is too soft can prevent the governor from delivering the needed actuator drive signal to reach the set speed.	Check and adjust the PID values.
	PID values are too high. Tuning is too hot or oversensitive to small speed errors causing the governor to make large, rapid changes in actuator drive signal, creating an average signal that is inadequate.	Decrease PID tuning values.
	The integral low limit setting is too high.	Return the integral low limit value to the default setting of zero.
	The integral high limit setting is too low.	Return the integral high limit value to the default setting of 99.
Engine takes too long to reach the set speed	Improper PID tuning values.	Check and adjust the PID values.
	Integral setting is too low.	Increase the integral value.
	Startup rate setting is too low.	Increase the startup rate value.
	Accel rate setting is too low.	Increase the Accel rate value.
	Speed filter setting is too high.	Decrease the speed filter value.
Engine does not track speed setting changes	Is the LED decimal point flashing (load share model)?	If yes, enter password.
	Is the LED flashing fast (3 Hz) (non-load share model)?	If no, check speed sensing circuit.
	Is the selected set speed parameter being modified?	If yes, speed setting display is unavailable during changes.
	A PID value or an OVG value is too high.	Decrease the PID values or OVG value.
	A PID value is too low or zero.	Increase the PID value.
	Accel rate is set too low.	Increase the Accel rate value.
	Decel rate is set too low.	Increase the Decel rate value.
Excessive smoke at startup	Improper PID tuning values.	Check and adjust the PID values.
	The startup rate is too high.	Use a lower startup rate value.
	The startup limit is too high.	Use a lower startup limit value.
	No/low MPU speed signal present. MPU should be 2.0 VRMS minimum.	Adjust the MPU gap. Try reversing the MPU leads; otherwise, replace the MPU.
Slow response to load changes	Gain value set too low.	Decrease the gain value.
	Improper PID tuning values.	Check and adjust the PID values.
	Speed filter setting is too high.	Decrease the speed filter value.
Engine instability with no load	Improper PID tuning values.	Check and adjust the PID values.
	Speed filter setting is too low.	Increase the speed filter value.
	Fuel flow is restricted.	Check actuator linkage.
	Battery voltage is too low.	Charge or replace the battery.
Engine instability with load	Improper PID tuning values.	Check and adjust the PID values.
	Fuel flow is restricted.	Check actuator linkage.
	Battery voltage is too low.	Charge or replace the battery.
Engine unable to carry rated load	PID values may be too high, causing the governor to overreact and make large, rapid changes in PWM duty cycle output to the actuator.	Check and decrease the PID values.
	Improper PID tuning values.	Check and adjust the PID values.
	Torque limit is set too low (load share model).	Increase the torque limit.
	Fuel flow is restricted.	Check actuator linkage.
Load share does not work (load share model)	No/low ILS input signal present. ILS should be 2.375–2.625 VDC.	Check ILS wiring; otherwise, replace the ILS.
	ILS signal wiring having electrical interference problems.	Use shielded wiring.
Droop does not work (load share model)	The no load and full load values are not calibrated.	Perform the droop calibration procedure.
	Difference between no load and full load calibration values is too small. Should be >100 for best performance.	Adjust the no load and/or full load calibration values.
	Actuator linkage range too small.	Modify or adjust actuator linkage to increase range of actuator loading.

Notes

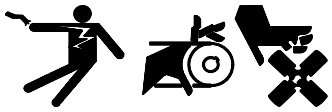
Section 11 Alternator Disassembly/Reassembly

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

The following procedures cover many models and some steps may not apply to a particular engine. Use Figure 11-1 and Figure 11-2 to help understand component descriptions and general configuration of the alternator.

Use disassembly procedure as a step-by-step means to help disassemble the alternator. The disassembly procedure provides important information to minimize disassembly time and indicates where special configurations exist that may require taking notes. The reassembly procedure includes important alignment steps and provides critical torque specs.

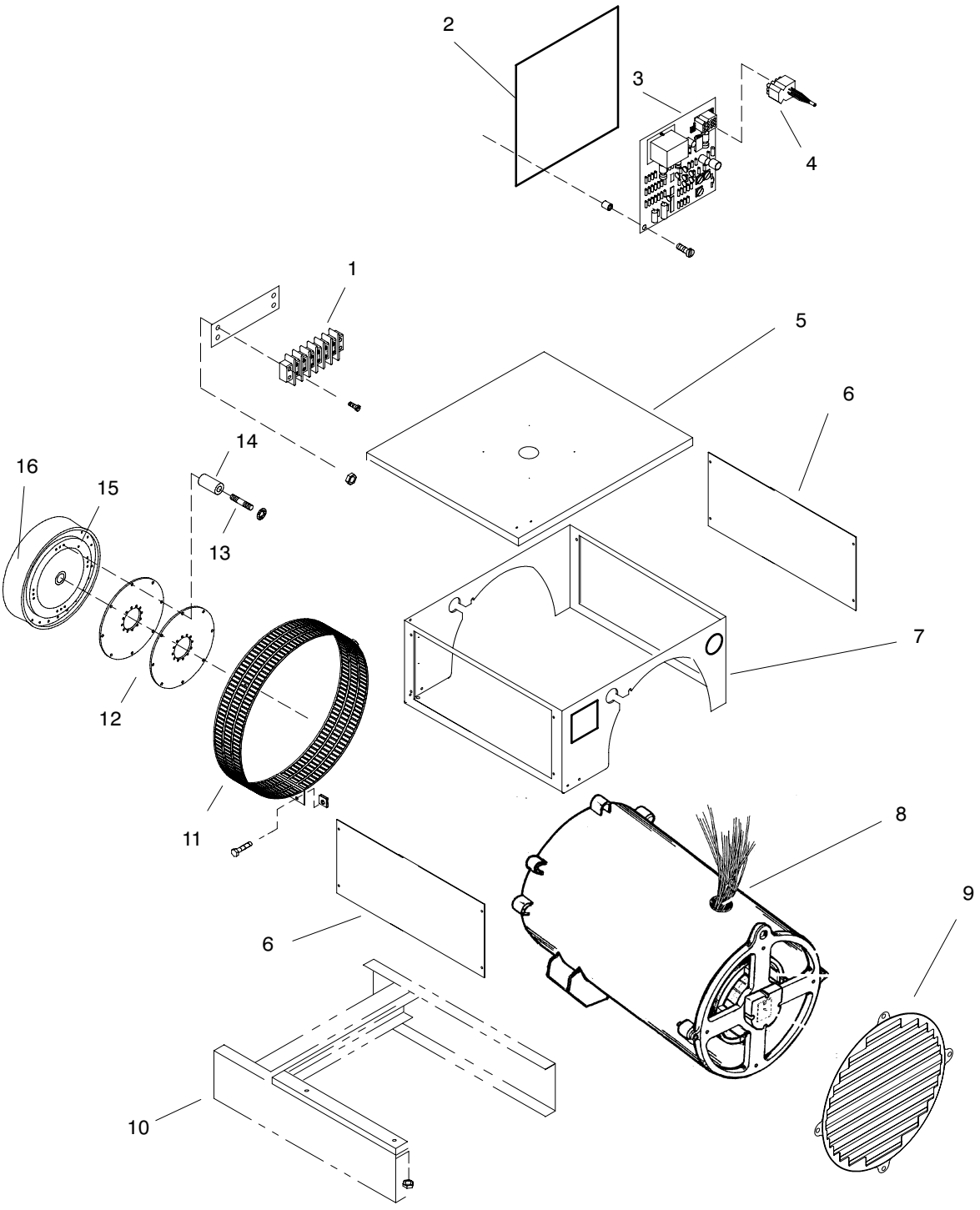
⚠ WARNING



Accidental starting.
Can cause severe injury or death.

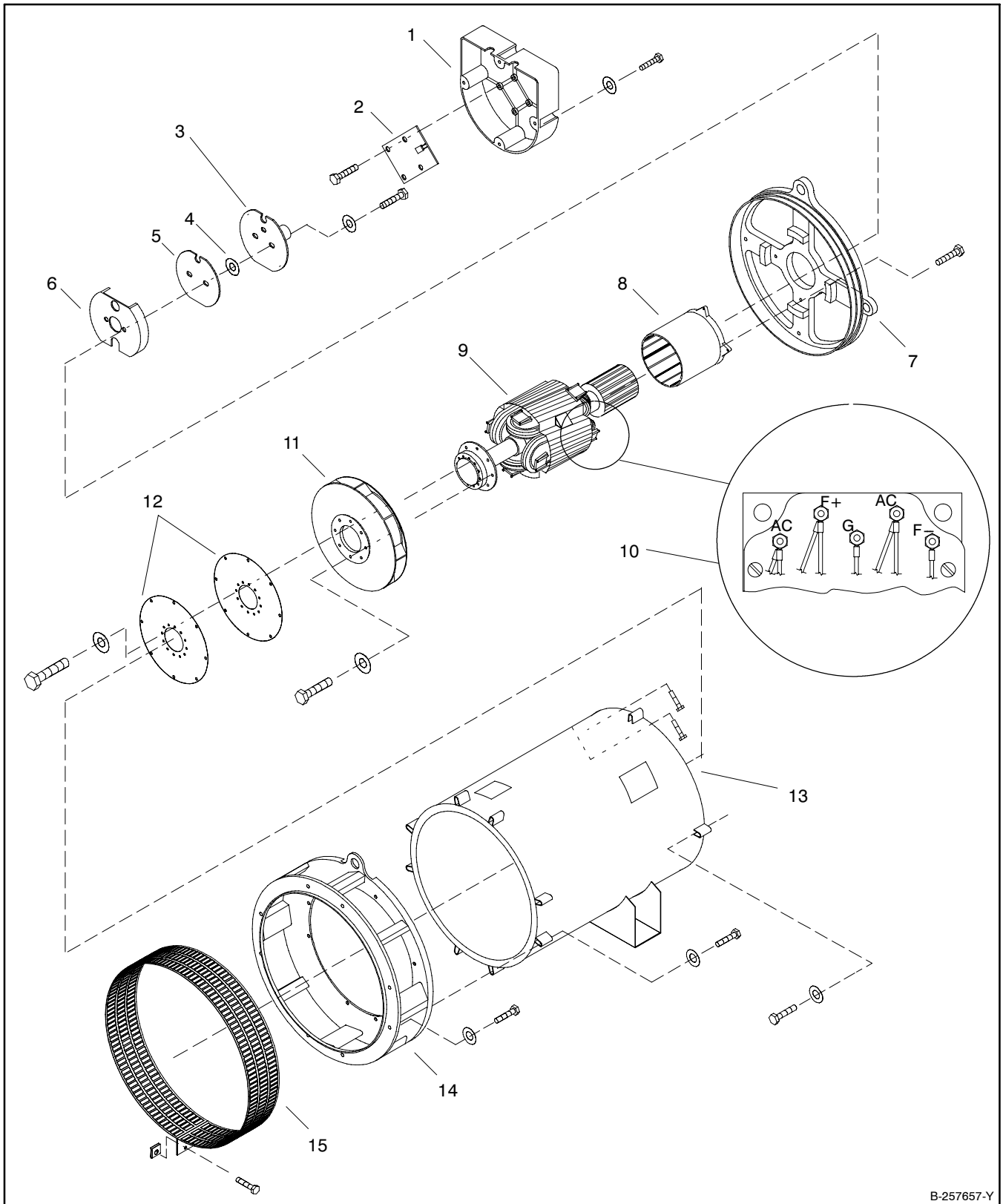
Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

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.



1. Voltage regulator terminal strip
2. Voltage regulator panel
3. Voltage regulator
4. Voltage regulator wiring harness
5. Junction box cover
6. Junction box panel
7. Junction box
8. Alternator assembly
9. End bracket cover
10. Skid
11. Generator fan guard
12. Drive discs
13. Stud
14. Spacer
15. Flywheel
16. Engine side of flywheel

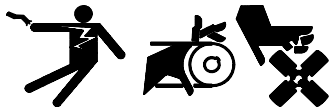
Figure 11-1 Generator Set Components, Typical



1. LED circuit board cover
2. LED circuit board
3. Photo transistor circuit board
4. Insulating washer
5. Insulator
6. Magnetic actuator
7. End bracket
8. Exciter field assembly
9. Rotor assembly
10. SCR assembly
11. Alternator fan
12. Drive discs
13. Stator assembly
14. Alternator adapter
15. Alternator fan guard

Figure 11-2 Alternator Components, Typical

⚠ 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

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.

Perform the following steps prior to disassembling the generator set.

Remove the Generator Set from Service

1. Disconnect the generator set engine starting battery, negative (-) lead first and remove the starting batteries from the work area to prevent fire hazard.

2. Disconnect the AC-powered accessories, such as the battery charger, block heater, and fuel transfer pump.

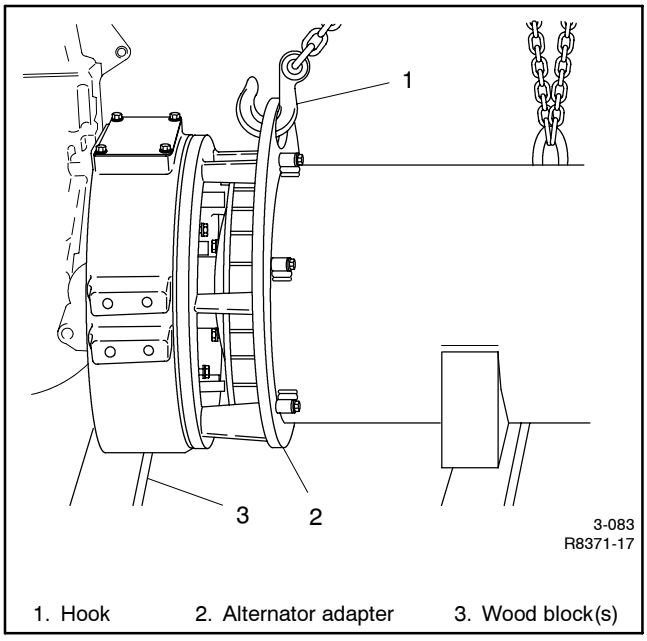
3. Shut off fuel supply. Drain fuel system as necessary by emptying fuel into proper containers. Remove fuel containers from work area to prevent fire hazard. Ventilate the work area to clear fumes.

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

5. 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 generator set nameplate or spec sheet for weight.

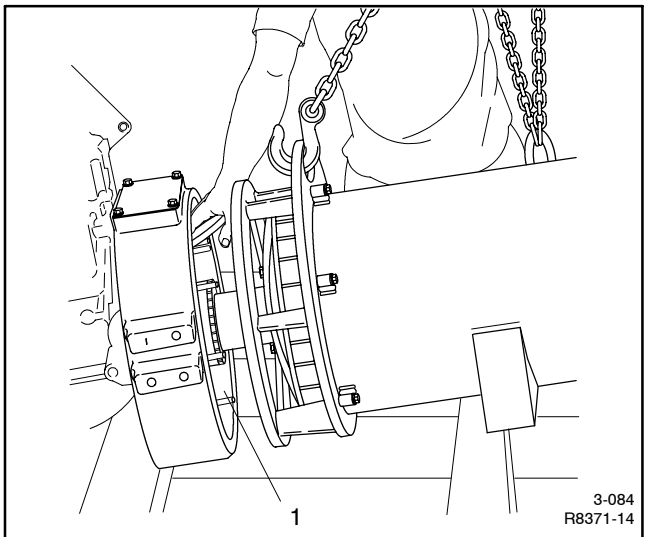
11.1 Disassembly

1. Disconnect all controller-to-engine and engine-to-alternator harnesses and wiring. Disconnect alarm horn circuit board connector (if equipped), LED board and housing, and speed sensor. Remove the junction box and controller as a unit.
2. Remove the fan guard.
3. Remove the LED circuit board cover.
4. Remove the speed sensor from the end bracket.
5. Remove bolts from the alternator vibromounts.
6. Suspend the alternator at both ends with hooks in lifting eyes. Use a hoist to raise the alternator end off the vibromounts. See Figure 11-3.
7. Support the engine by placing wood blocks under the flywheel housing. Lower the alternator end until the alternator flywheel housing rests on the blocks. See Figure 11-3.
8. Remove bolts holding the adapter to the flywheel housing.
9. Remove hardware holding the drive discs to the flywheel.
10. Work the drive discs over the studs (if equipped) to separate the alternator from the engine. See Figure 11-4.
11. Use a stud remover and remove the studs from the flywheel, if damaged.
12. Set alternator assembly on the floor in a horizontal position. Remove the support slings or chains.



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

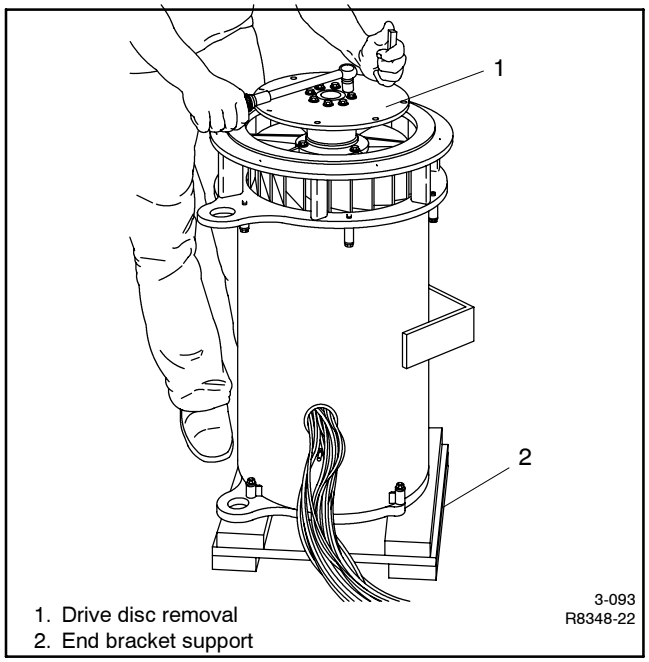
Figure 11-3 Hoisting Alternator



1. Drive discs

Figure 11-4 Separating Alternator and Engine

13. To remove the rotor assembly, hook hoist to adapter and place the alternator assembly on the floor in a vertical position. See Figure 11-5. Before lowering assembly, place boards along edge of end bracket to prevent damage to the photo transistor circuit board.



1. Drive disc removal
2. End bracket support

Figure 11-5 Alternator Support, Drive Disc, and Fan Removal

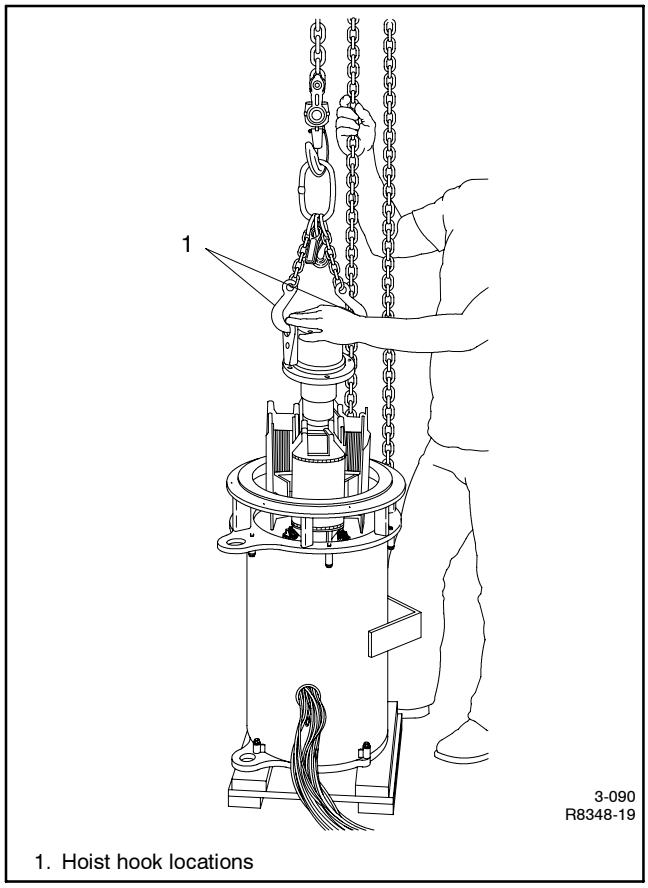
14. Remove the drive discs and fan from the alternator assembly. See Figure 11-5.

15. Fasten the lifting eye and hoist hook to the rotor flange. Hoist the rotor assembly carefully to avoid damaging the photo transistor circuit board, exciter armature, or exciter field magnets. See Figure 11-6.

16. While the rotor assembly is suspended, remove the photo transistor circuit board, insulator, and magnetic actuator. Remove F3, G, and AC leads from SCR assembly. Cut off photo transistor circuit board terminals to remove the circuit board. If the photo transistor circuit board is reused, leave the leads as long as possible.

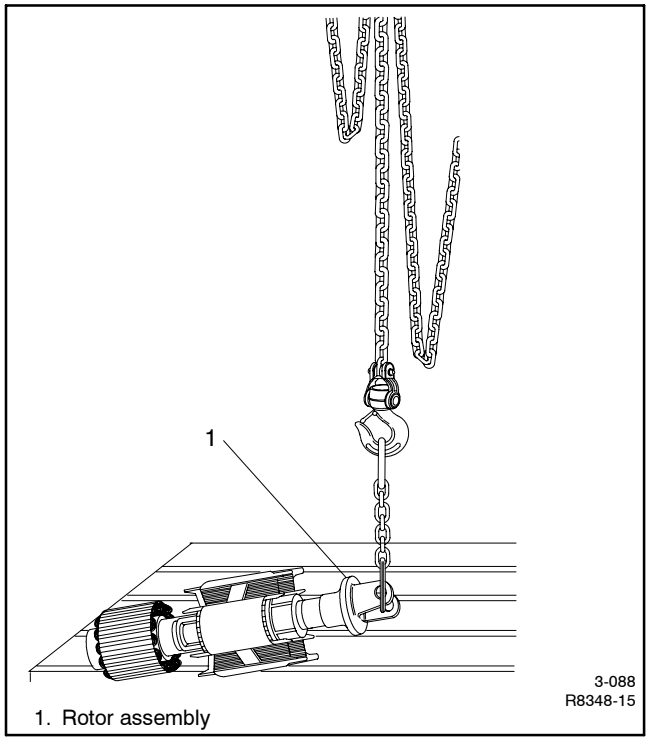
17. Slowly lower the rotor to the horizontal position. Set the rotor on a wooden surface. Take care not to damage the windings, laminations, or bearing. See Figure 11-7.

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



1. Hoist hook locations

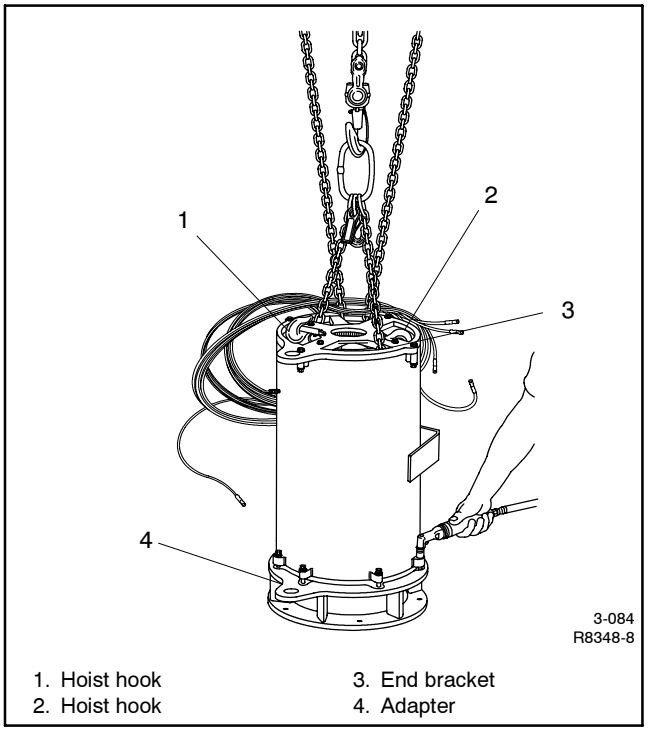
Figure 11-6 Rotor Removal



1. Rotor assembly

Figure 11-7 Lowering Rotor

19. Place the alternator assembly on the alternator adapter end in order to remove the alternator adapter and end bracket from the stator. Fasten chains to the alternator adapter and lower to a horizontal position. Fasten hook to the end bracket eye and hoist to a vertical position. See Figure 11-8.



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

Figure 11-8 Removing Generator Adapter

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

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

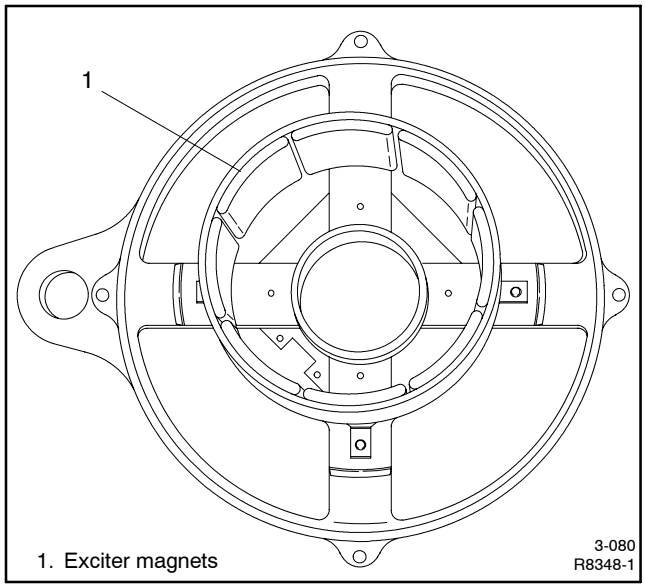
22. Remove the exciter magnets from the end bracket. See Figure 11-9.

11.2 Reassembly

1. Attach the exciter field to the end bracket with four mounting screws. See Figure 11-9. Torque to specifications.

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

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

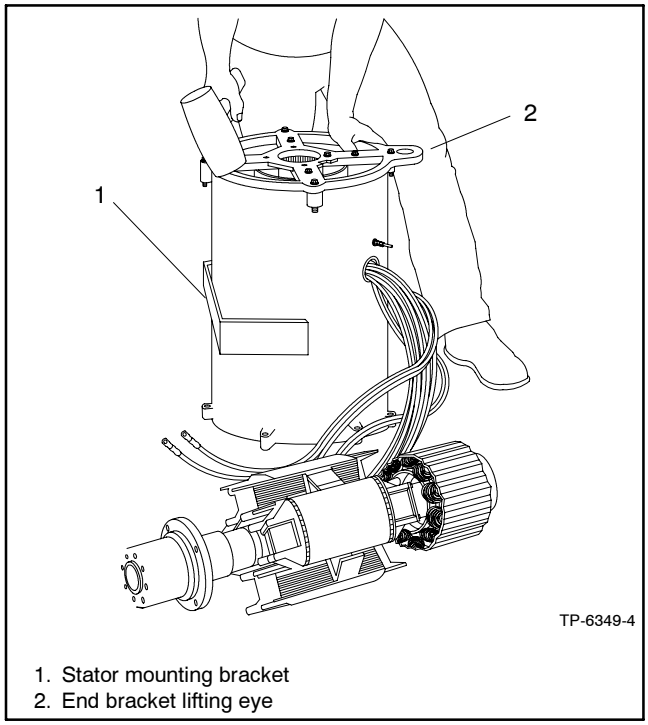


1. Exciter magnets

Figure 11-9 End Bracket View

3. Position the end bracket on the stator assembly and use bolts to align the holes. Use a rubber mallet to mount the end bracket flush with the stator assembly. See Figure 11-10.

   Place the end bracket housing eye opposite the stator mounting bracket during reassembly.

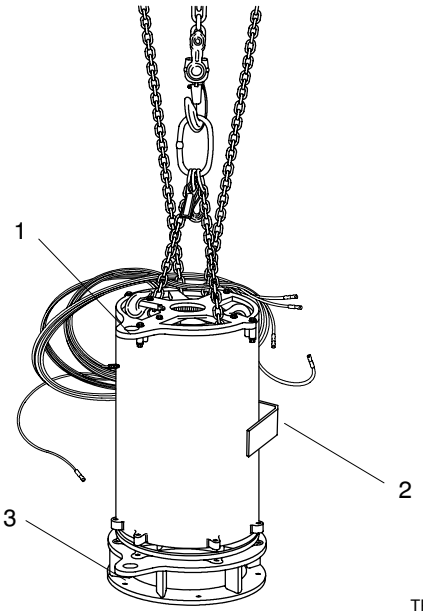


1. Stator mounting bracket
2. End bracket lifting eye

Figure 11-10 Mounting End Bracket on Stator

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

5. Attach hoist hooks to the end bracket and suspend the stator. Place the alternator adapter on the floor and lower the stator to within 6–12 mm (1/4–1/2 in.) of the adapter lip. See Figure 11-11.



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

Figure 11-11 Aligning Adapter and Stator

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 tighten the bolts. Torque to specifications.

7. Attach hoisting hooks to the adapter as shown in Figure 11-12. Suspend the alternator assembly. Before lowering the alternator, place boards along the edge of end bracket. Maintain sufficient clearance underneath the center of the end bracket to prevent damage to the photo transistor board and magnetic actuator when installing the rotor.

8. 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.

9. Place the alternator assembly on the end bracket end when installing the rotor. Fasten the hoisting hook to the end bracket eye and lower the alternator assembly to a horizontal position.

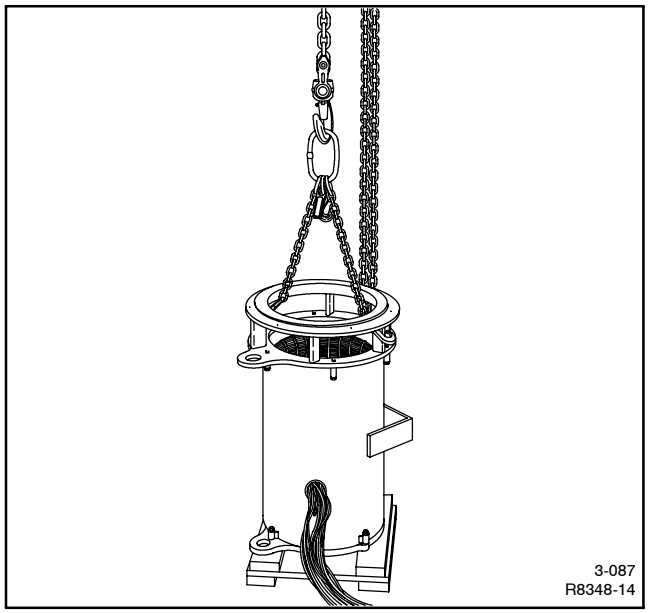
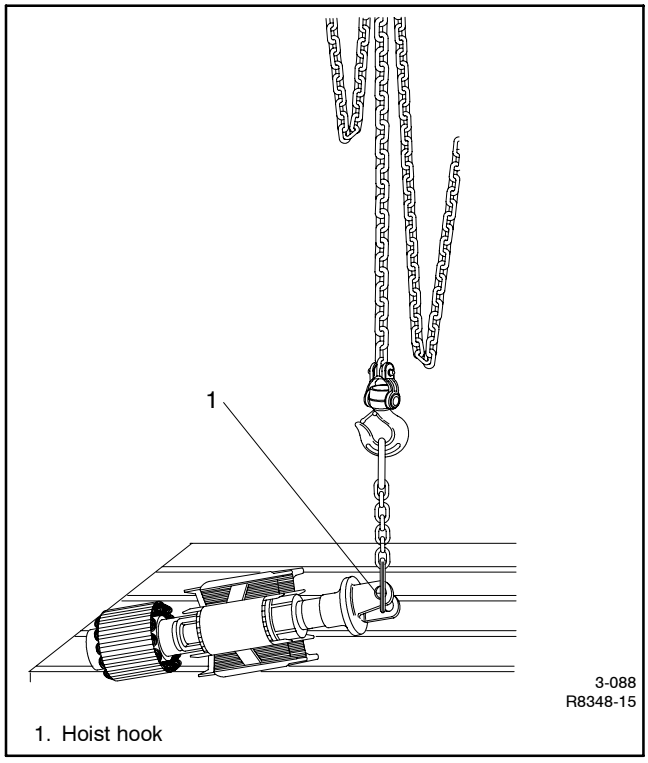


Figure 11-12 Supporting Generator Assembly

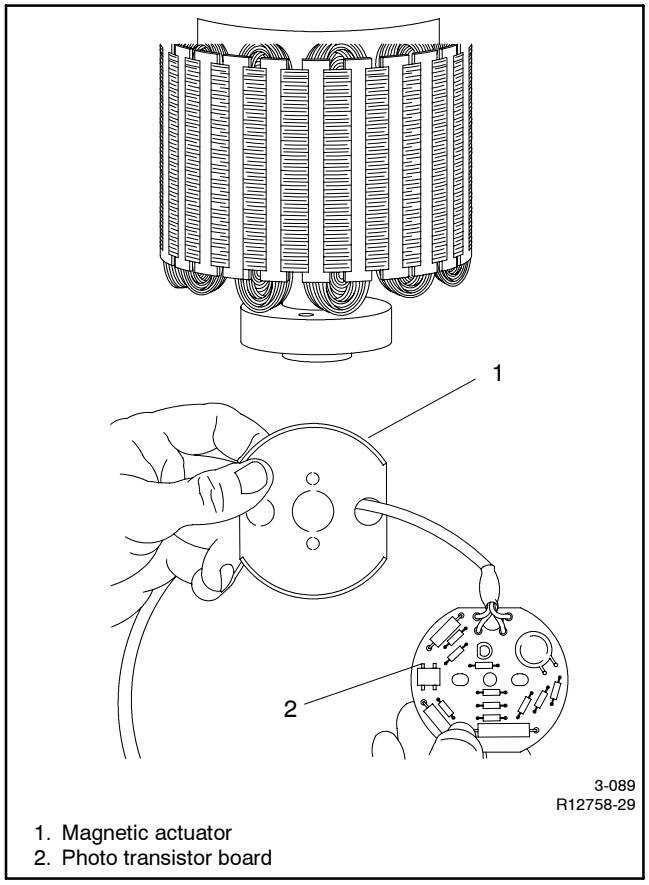
10. Fasten the lifting eye and hoist hook to the rotor flange. See Figure 11-13. Hoist the rotor to a vertical position taking care not to damage windings, laminations, or bearing.



1. Hoist hook

Figure 11-13 Hoisting Rotor

11. While the rotor is suspended, install the photo transistor board, insulator board, and magnetic actuator. Place the photo transistor board lead through the magnetic actuator as shown in Figure 11-14. Push the lead through the hole in the rotor shaft and then through the exciter laminations ending near the SCR assembly.



1. Magnetic actuator
2. Photo transistor board

Figure 11-14 Installing Photo Transistor Board

⚠ WARNING

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

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

Installing the photo transistor circuit board. Hazardous voltage can cause severe injury or death. Ensure that the foil side of the photo transistor circuit board, the end of the shaft, and the threaded holes are clean and free of metal particles and chips. Metal debris may short-circuit the photo transistor circuit board and cause hazardous voltage in the generator set. Do not reconnect the generator set to the load until the AC voltmeter shows the correct output.

12. Attach the photo transistor circuit board and magnetic actuator to the end of rotor shaft with two mounting screws. See Figure 11-15. Cut off excess lead wire, leaving enough wire to reach the SCR assembly. Strip 50–75 mm (2–3 in.) of gray insulator jacket from the lead. Cut off all exposed uninsulated wire. Strip about 0.6 mm (1/4 in.) of insulation on red and black leads and crimp on #8 electrical terminals (part no. X-283-7).

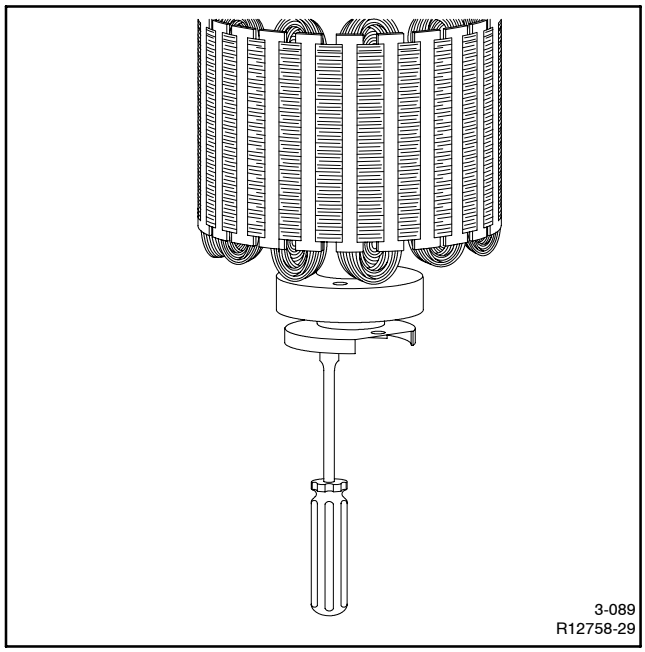


Figure 11-15 Mounting Photo Transistor Board and Magnetic Actuator

Before connecting to the SCR studs, secure the leads with tie wraps. Reconnect the photo transistor circuit board white lead to SCR AC stud, red lead to F+ stud, green lead to G stud, and black lead to the remaining AC stud. Secure the leads with stop nuts. See Figure 11-16 for SCR connections and respective wiring diagram as needed. Torque connections to specifications.

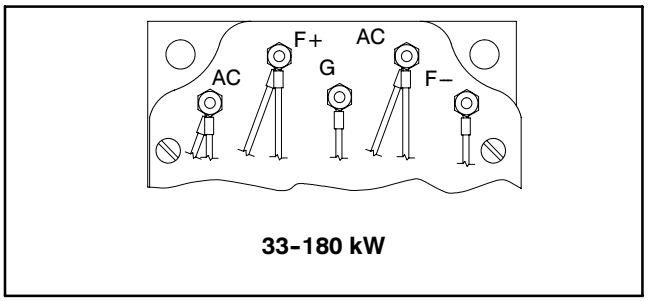


Figure 11-16 SCR Connections

13. Suspend the rotor over the alternator assembly. Lower the rotor field into the stator. Be extremely careful while lowering the rotor to avoid damaging the photo transistor circuit board, exciter armature, field magnets, stator windings, or rotor laminations. See Figure 11-17. Carefully align rotor bearing into end bracket. Check for an outer race measurement of 6.35 mm (1/4 in.) from bracket to bearing. Make sure the photo transistor board and magnetic actuator have clearance below the end bracket.

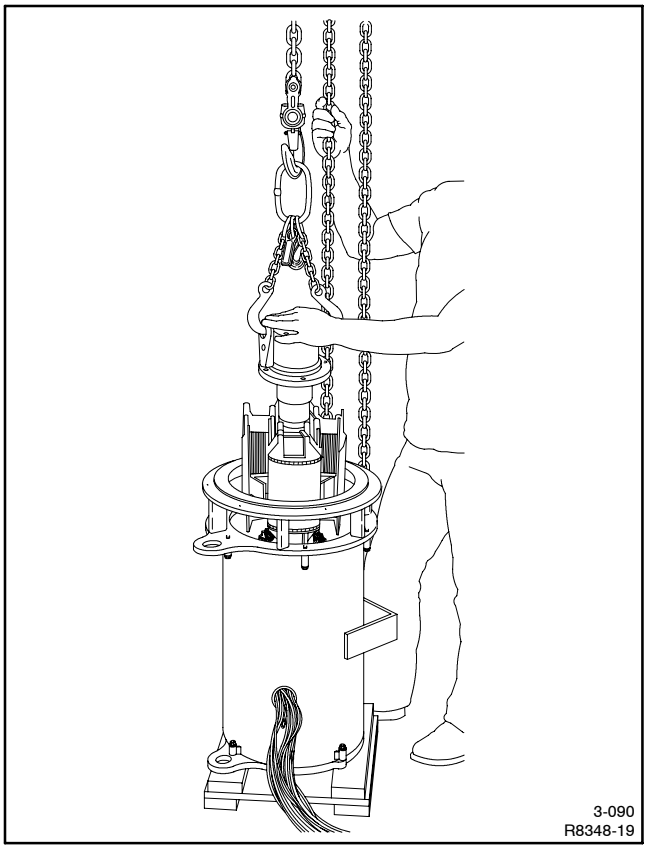
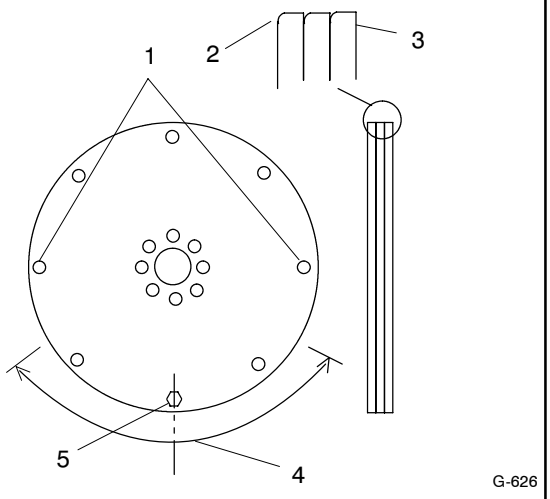


Figure 11-17 Installing Rotor

14. Place the fan over the rotor flange and torque bolts to specifications.

15. 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 11-18.

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



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

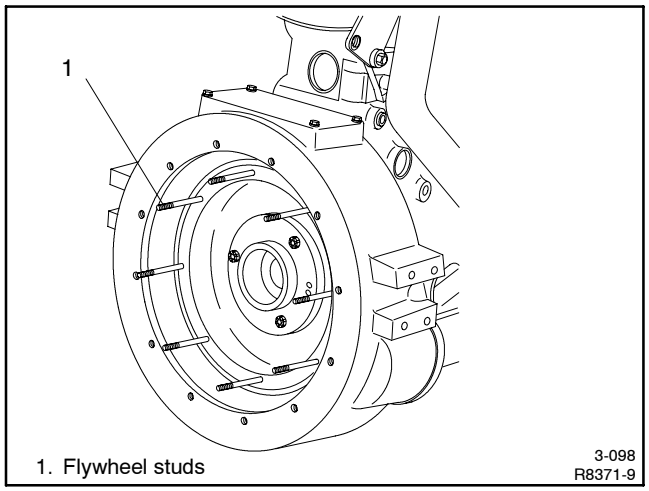
Figure 11-18 Aligning and Mounting Drive Disks

16. Attach the drive disc(s) to the end of the 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.

17. Attach the hoist to 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 alternator to the top.

18. **180EOZD/150EFOZD Model (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 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.

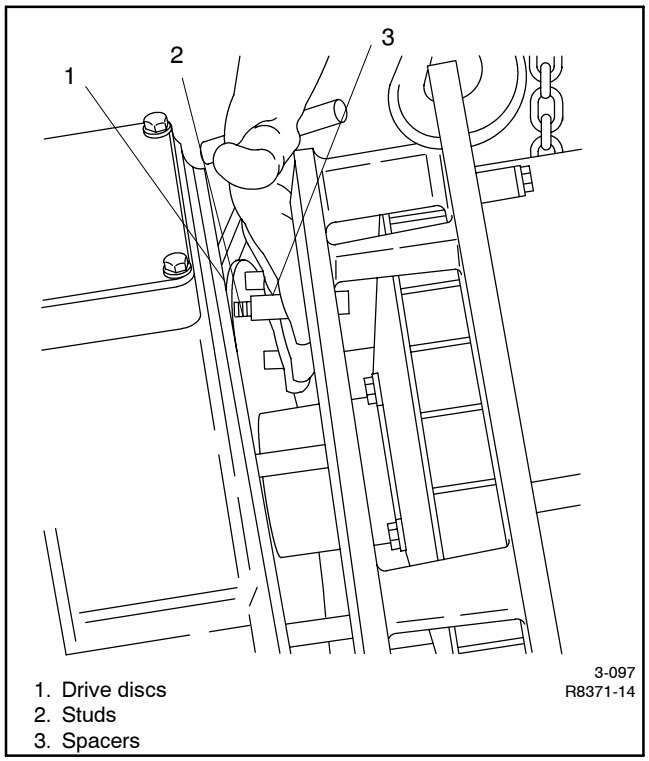
19. If studs are used, apply Loctite® No. 271 red to stud threads and install into flywheel as shown in Figure 11-19. Install studs completely into flywheel. Apply Loctite® No. 242 blue to stud threads on nut side.



1. Flywheel studs

Figure 11-19 Flywheel Studs

20. 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 studs. When the drive discs are about 25 mm (1 in.) over the studs, install spacers if so equipped. See Figure 11-20.



1. Drive discs
2. Studs
3. Spacers

Figure 11-20 Installing Spacers

21. Move the alternator as necessary to align the alternator adapter and the flywheel housing. Fasten and final tighten the adapter to the flywheel housing using bolts and hardened lock washers. See Figure 11-21. Torque bolts to specifications.

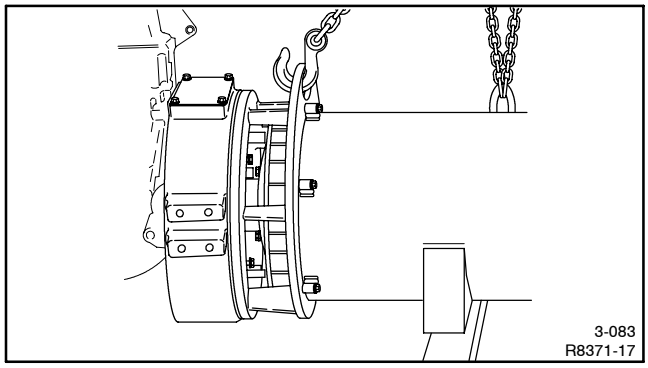


Figure 11-21 Aligning Adapter and Flywheel Housing

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

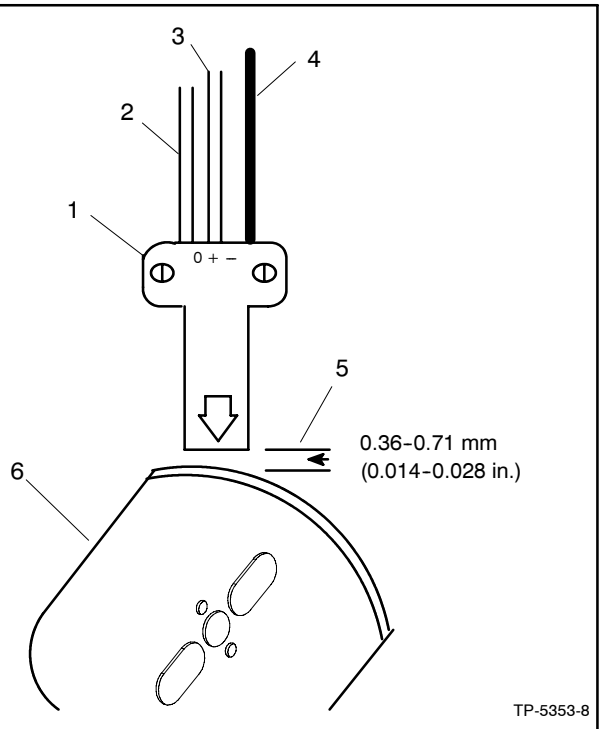
    Note: Some models mount drive discs to flywheel using bolts. Some applications use hardened washers.

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

24. Remove the chains or slings used for suspending the alternator. Final tighten the drive discs to the flywheel. Torque hardware to specifications.

Loctite® is a registered trademark of Loctite Corporation.

25. Install the speed sensor to the end bracket. Adjust the air gap. See Figure 11-22.



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 11-22 Speed Sensor Air Gap

26. Replace the LED circuit board cover to the end bracket.

27. Install the fan guard.

28. Reinstall the junction box and controller.

29. Reconnect all controller-to-engine and engine-to-alternator harnesses and wiring. Refer to the wiring diagrams as required.

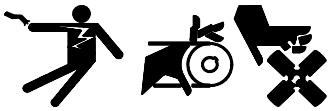
30. Replace the junction box panels.

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

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

Notes

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

⚠ WARNING

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

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

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

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.

Wiring Diagram/Schematic Reference Table

Model	Controller	Wiring Diagram	Figure	Schematic	Figure
40EOZD 33EFOZD	**Decision-Maker™ 1 Controller Modules:** GM40397-MA1 and GM40397-MA2	GM47822A-B GM47822B-B GM47822C-B	Figure 12-1 Figure 12-2 Figure 12-3	ADV-7148-A	Figure 12-4
	GM40397-MA27 and GM40397-MA28	GM51638A- GM51638B- GM51638C-	Figure 12-5 Figure 12-6 Figure 12-7	ADV-7332-	Figure 12-8
	Decision-Maker™ 3+ Controller Modules: GM40397-MA5 and GM40397-MA6	GM47808A-B GM47808B-B GM47808C-B GM47808D-B GM47808E-B GM47808F-B GM47808G-B	Figure 12-9 Figure 12-10 Figure 12-11 Figure 12-12 Figure 12-13 Figure 12-14 Figure 12-15	ADV-7145-A	Figure 12-16
	GM40397-MA29 and GM40397-MA30	GM51639A- GM51639B- GM51639C- GM51639D- GM51639E- GM51639F- GM51639G-	Figure 12-17 Figure 12-18 Figure 12-19 Figure 12-20 Figure 12-21 Figure 12-22 Figure 12-23	ADV-7333-	Figure 12-24
	Decision-Maker™ 550 Controller Modules: GM40720-MA3 and GM40720-MA4	GM49654A- GM49654B-	Figure 12-25 Figure 12-26	ADV-7271A- ADV-7271B-	Figure 12-27 Figure 12-28
	GM40720-MA13 and GM40720-MA14	GM51640A- GM51640B-	Figure 12-29 Figure 12-30	ADV-7334A- ADV-7334B-	Figure 12-31 Figure 12-32
55-180EOZD 40-150EFOZD	**Decision-Maker™ 1 Controller Modules:** GM40397-MA25 and GM40397-MA26	GM49661A- GM49661B- GM49661C- GM49661D-	Figure 12-33 Figure 12-34 Figure 12-35 Figure 12-36	ADV-7272-	Figure 12-37
	55-99EOZD/40-80EFOZD Models GM40397-MA31 and GM40397-MA32	GM51643A- GM51643B- GM51643C- GM51643D-	Figure 12-38 Figure 12-39 Figure 12-40 Figure 12-41	ADV-7337-	Figure 12-42
	Decision-Maker™ 3+ Controller Modules: GM40397-MA9, GM40397-MA10, GM40397-MA13, GM40397-MA14, GM40397-MA17, GM40397-MA18, GM40397-MA21, GM40397-MA22, GM40397-MA23, and GM40397-MA24	GM47820A-F GM47820B-F	Figure 12-43 Figure 12-44	ADV-7147-F	Figure 12-45
	55-99EOZD/40-80EFOZD Models GM40397-MA33, GM40397-MA34, GM40397-MA35, and GM40397-MA36	GM51644A- GM51644B-	Figure 12-46 Figure 12-47	ADV-7338-	Figure 12-48
	Decision-Maker™ 550 Controller Modules: GM40720-MA1, GM40720-MA2, GM40720-MA5, GM40720-MA6, GM40720-MA7, GM40720-MA8, GM40720-MA9, GM40720-MA10, GM40720-MA11, and GM40720-MA12	GM40559A-C GM40559B-C	Figure 12-49 Figure 12-50	ADV-7231A-C ADV-7231B-C	Figure 12-51 Figure 12-52
	55-99EOZD/40-80EFOZD Models GM40720-MA15, GM40720-MA16, GM40720-MA17, and GM40720-MA18	GM51645A- GM51645B-	Figure 12-53 Figure 12-54	ADV-7339A- ADV-7339B-	Figure 12-55 Figure 12-56

Isolated Ground Wiring Diagram/Schematic Reference Table

Model	Controller	Wiring Diagram	Figure	Schematic	Figure
40EOZD 33EFOZD	Decision-Maker™ 3+ with Isolated Ground	GM49697A-A GM49697B-A GM49697C-A GM49697D-A GM49697E-A GM49697F-A GM49697G-A	Figure 12-57 Figure 12-58 Figure 12-59 Figure 12-60 Figure 12-61 Figure 12-62 Figure 12-63	ADV-7274-A	Figure 12-64
	Decision-Maker™ 550 with Isolated Ground	GM49696A-A GM49696B-A	Figure 12-65 Figure 12-66	ADV-7273A-A ADV-7273B-A	Figure 12-67 Figure 12-68
55-99EOZD 40-80EFOZD	Decision-Maker™ 3+ with Isolated Ground	GM40886A-A GM40886B-A	Figure 12-69 Figure 12-70	ADV-7250-A	Figure 12-71
	Decision-Maker™ 550 with Isolated Ground	GM40750A-B GM40750B-B	Figure 12-72 Figure 12-73	ADV-7244A-B ADV-7244B-B	Figure 12-74 Figure 12-75
125-180EOZD 100-150EFOZD	Decision-Maker™ 3+ with Isolated Ground	GM49700A-A GM49700B-A	Figure 12-76 Figure 12-77	ADV-7281-A	Figure 12-78
	Decision-Maker™ 550 with Isolated Ground	GM49698A-A GM49698B-A	Figure 12-79 Figure 12-80	ADV-7280A-A ADV-7280B-A	Figure 12-81 Figure 12-82

Voltage Reconnection Reference Table

Model	Voltage Reconnection	Figure
40-180EOZD 33-150EFOZD	ADV-5875A-G	Figure 12-83

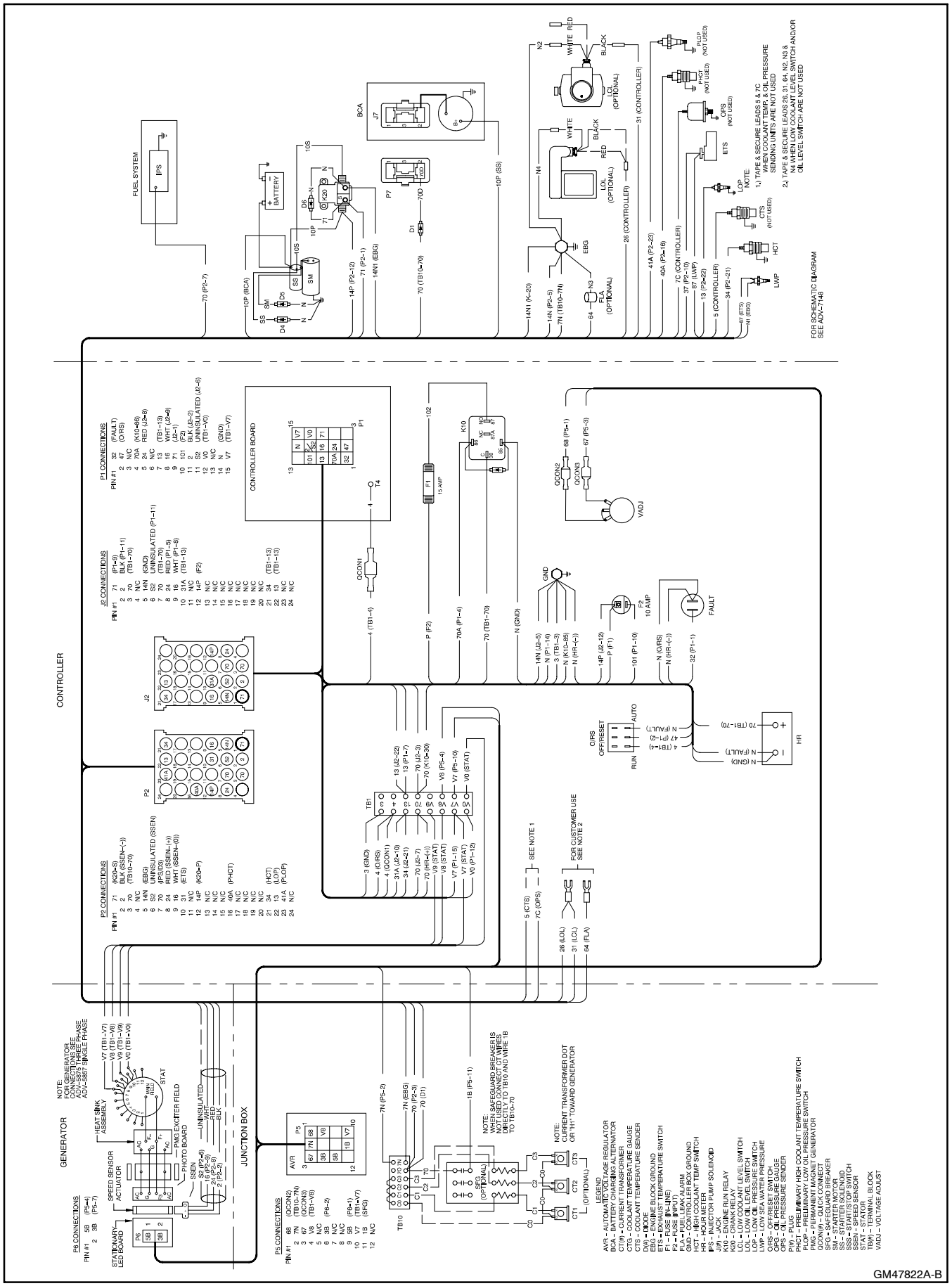


Figure 12-1 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 1 Controller, Sheet 1 of 3, GM47822A-B

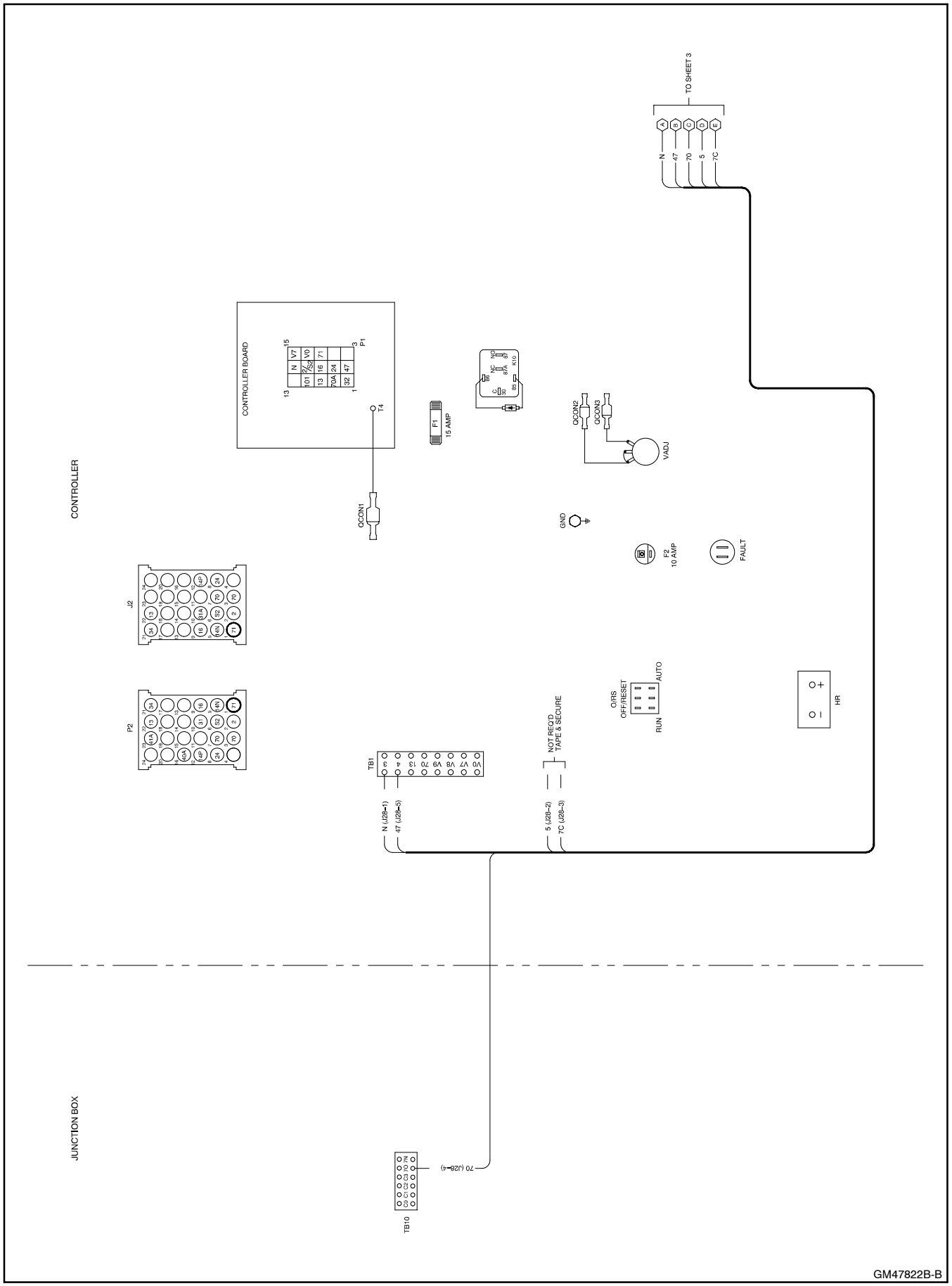


Figure 12-2 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 1 Controller, Sheet 2 of 3, GM47822B-B

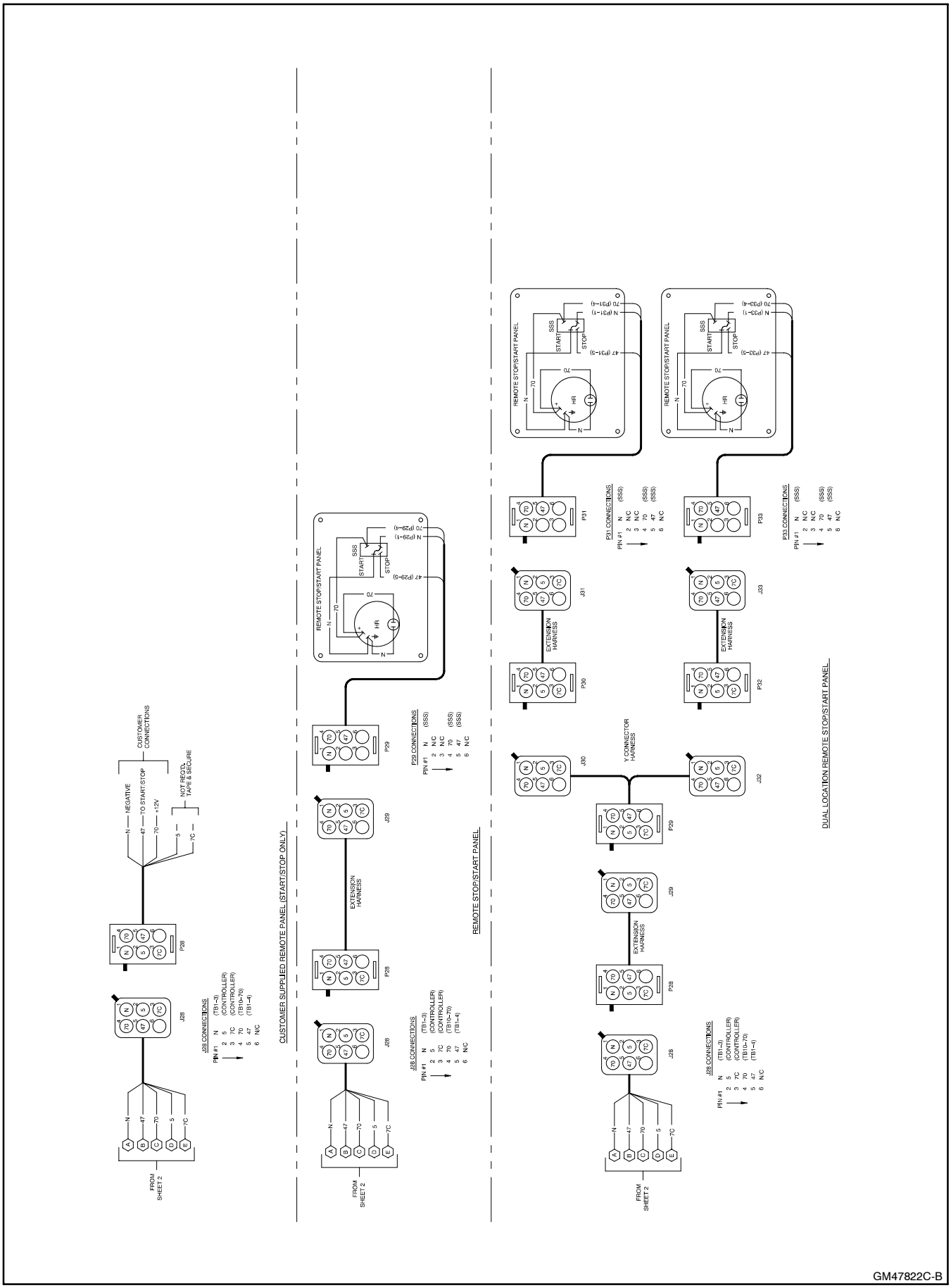


Figure 12-3 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 1 Controller, Sheet 3 of 3, GM47822C-B

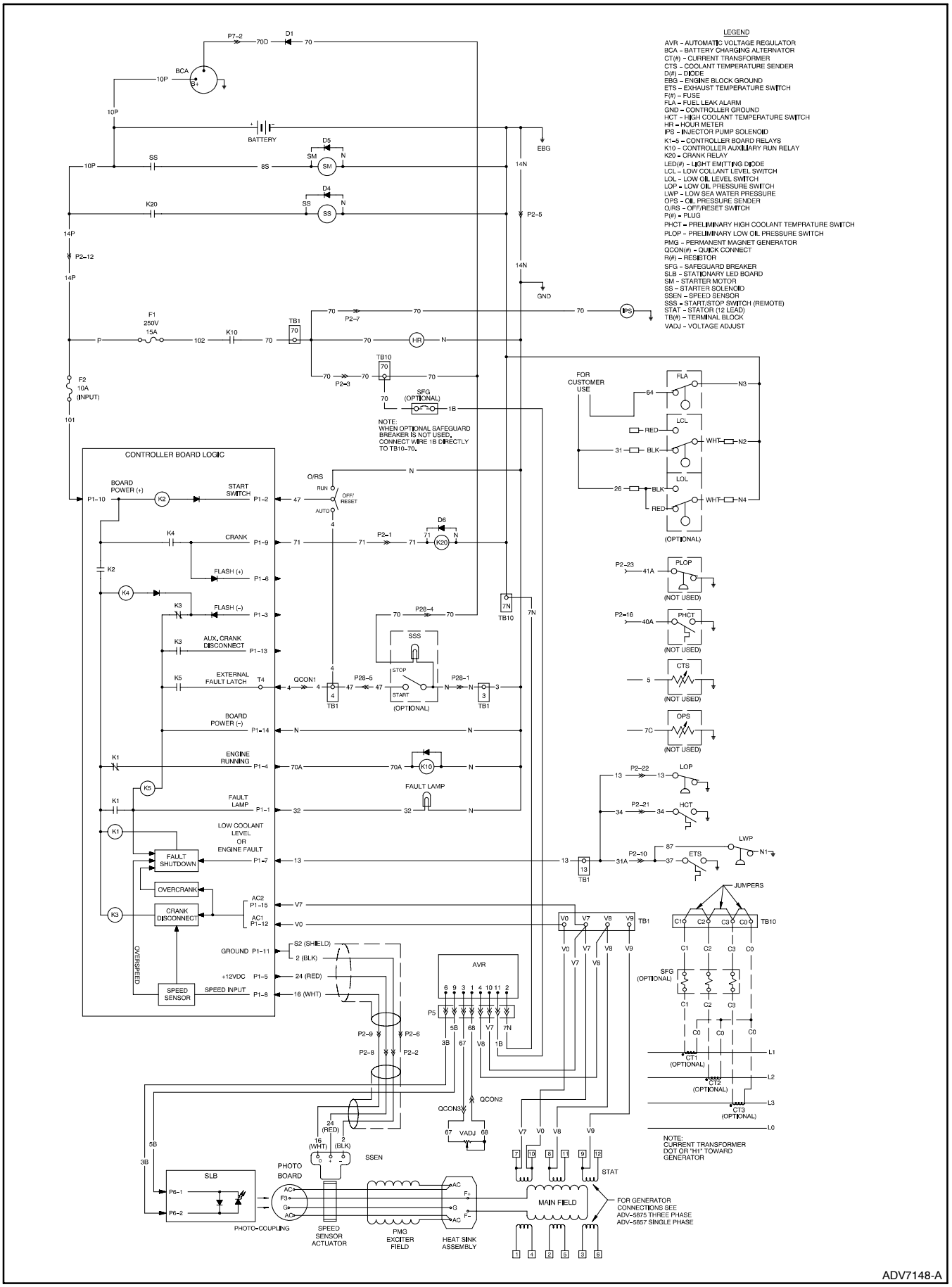


Figure 12-4 40EOZD/33EFOZD Schematic, Decision-Maker™ 1 Controller, Sheet 1 of 1, ADV-7148-A

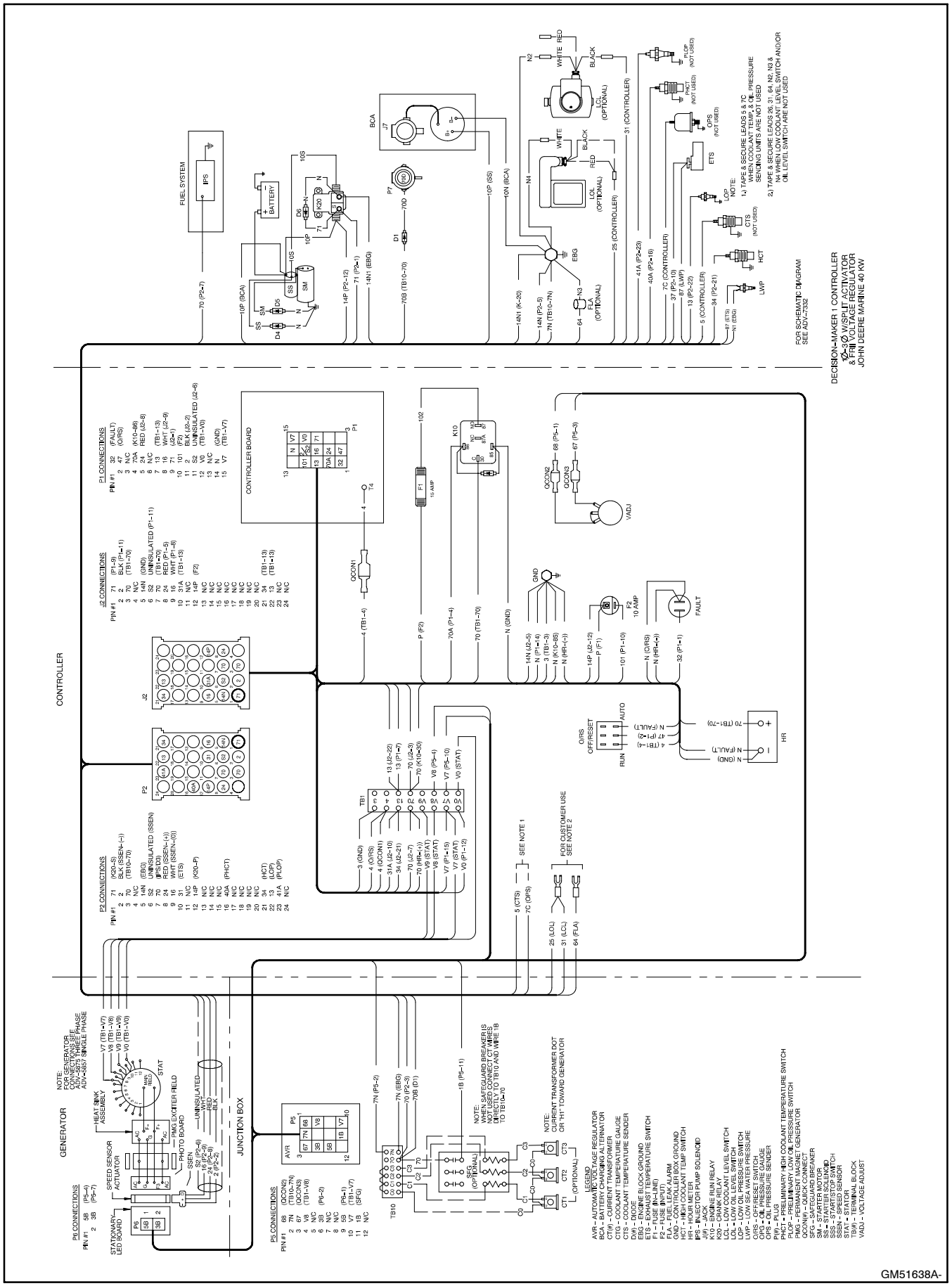


Figure 12-5 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 1 Controller, Sheet 1 of 3, GM51638A

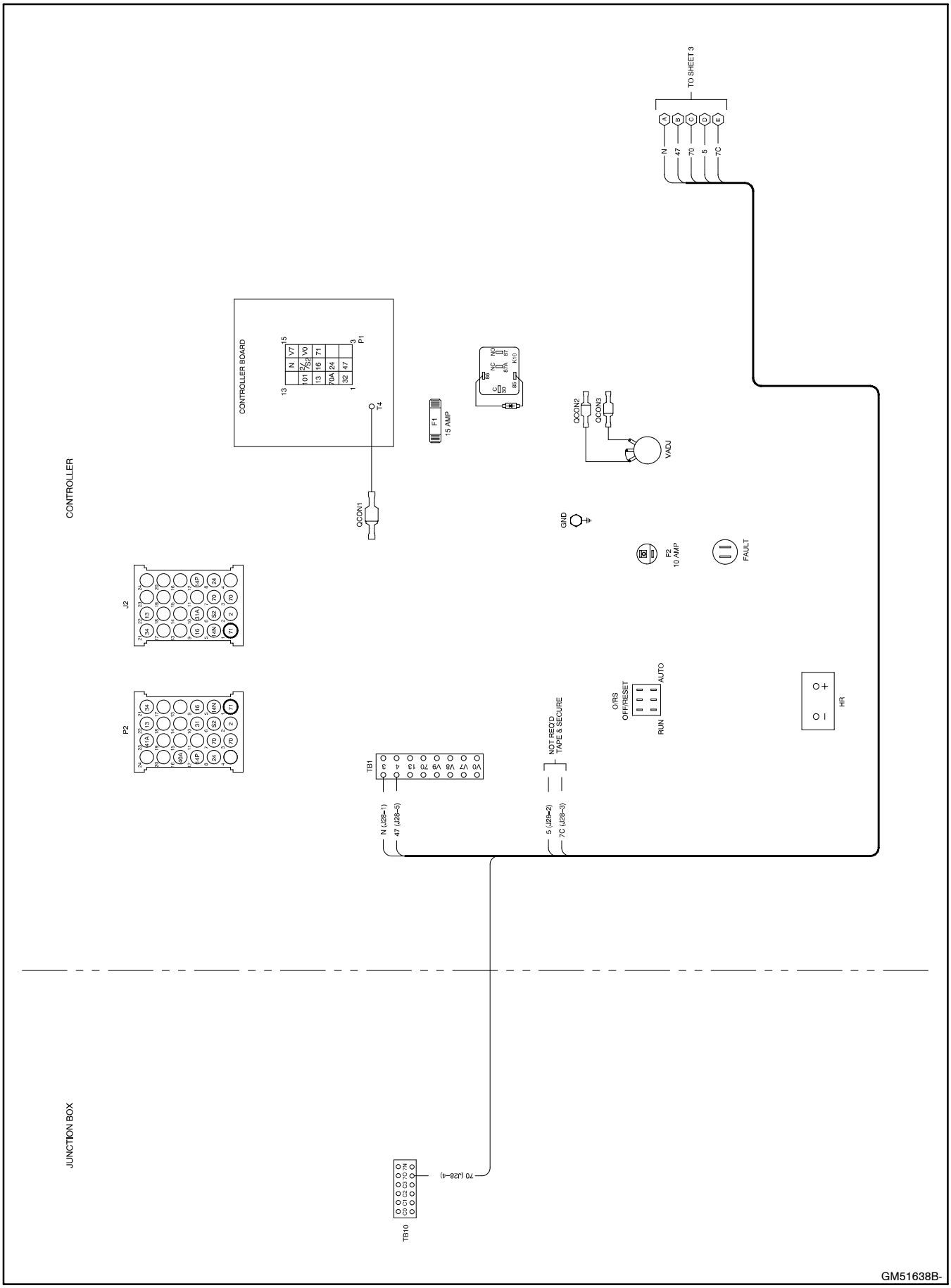


Figure 12-6 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 1 Controller, Sheet 2 of 3, GM51638B

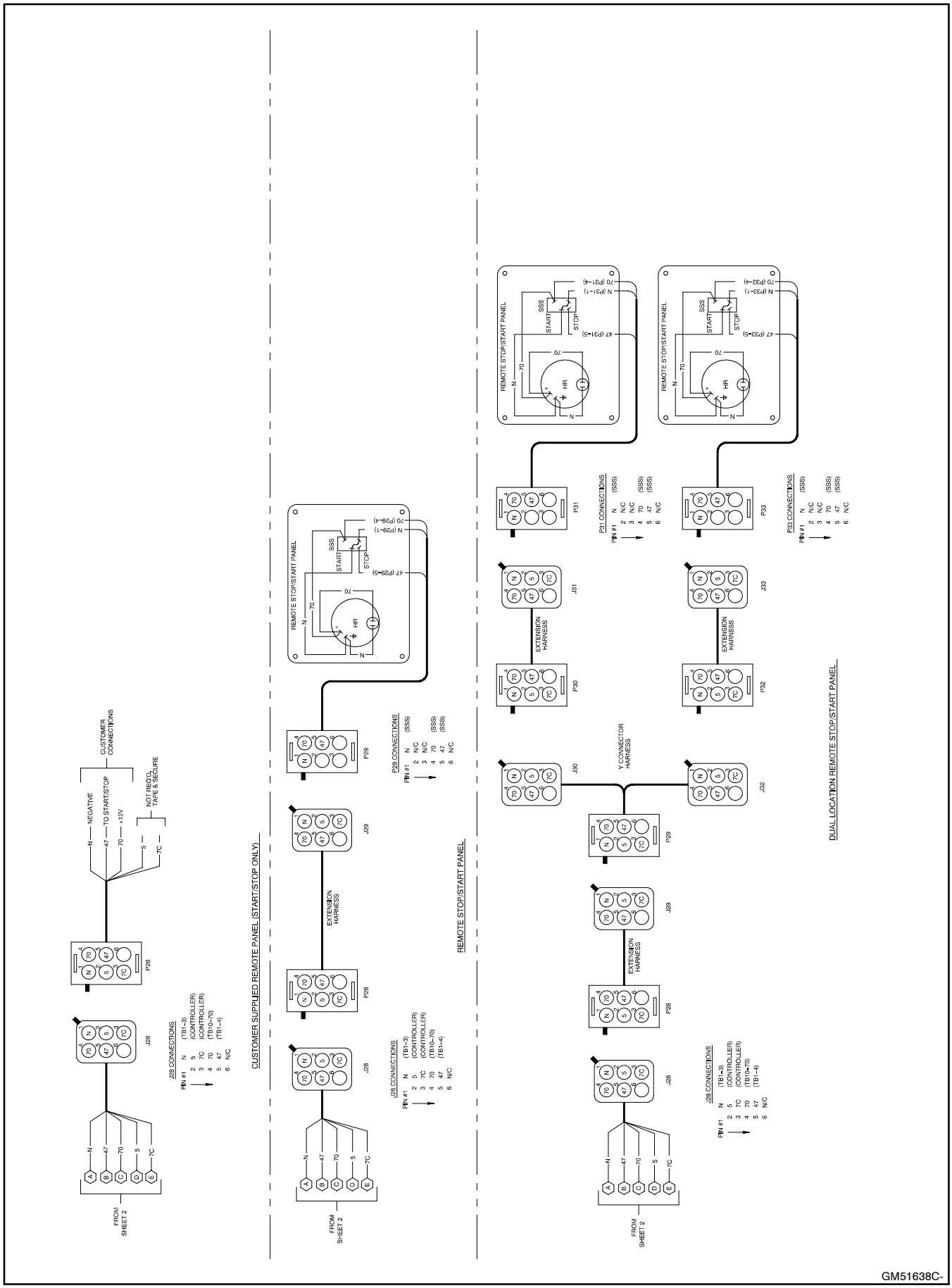


Figure 12-7 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 1 Controller, Sheet 3 of 3, GM51638C

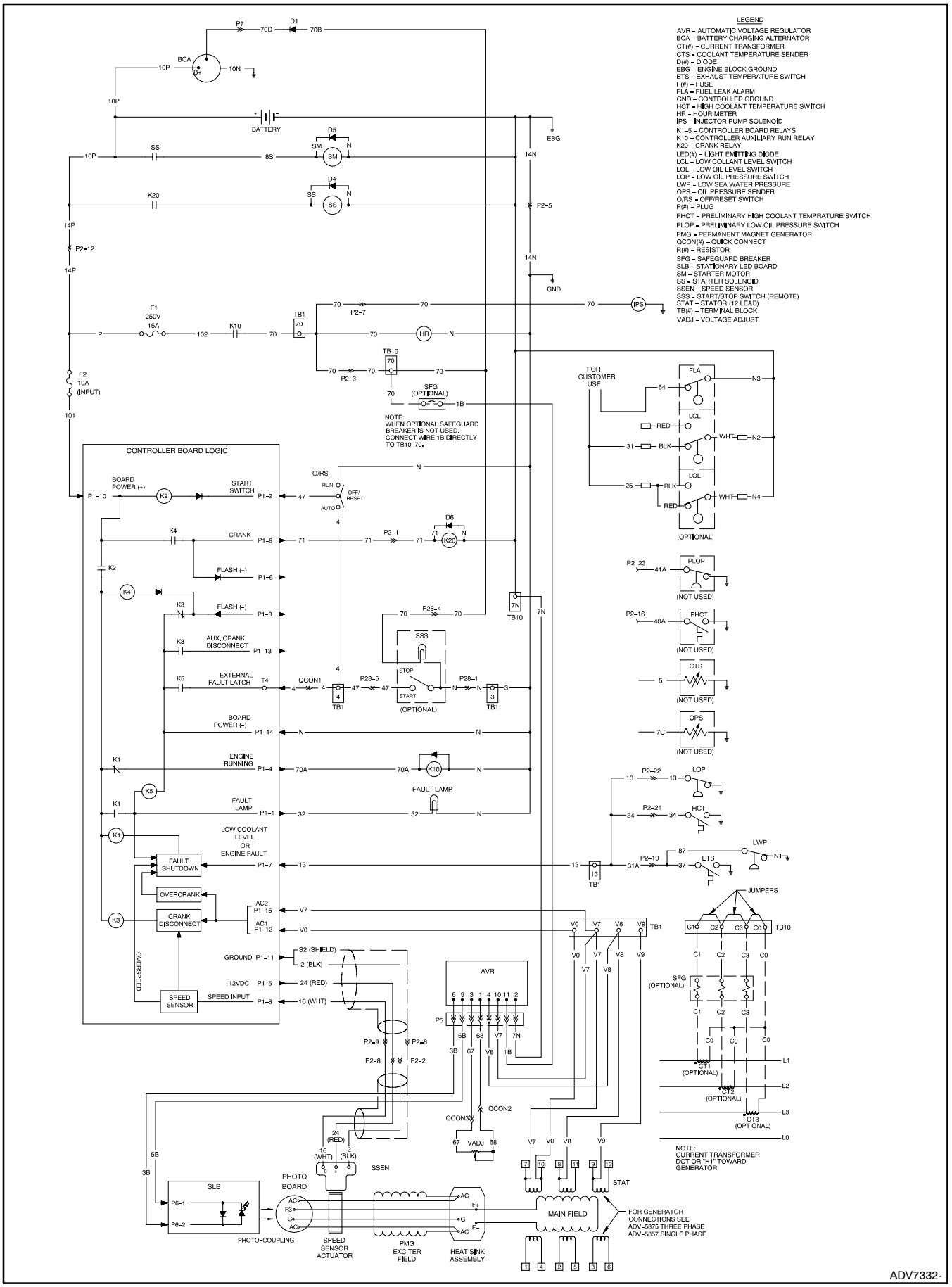


Figure 12-8 40EOZD/33EFOZD Schematic, Decision-Maker™ 1 Controller, Sheet 1 of 1, ADV-7332

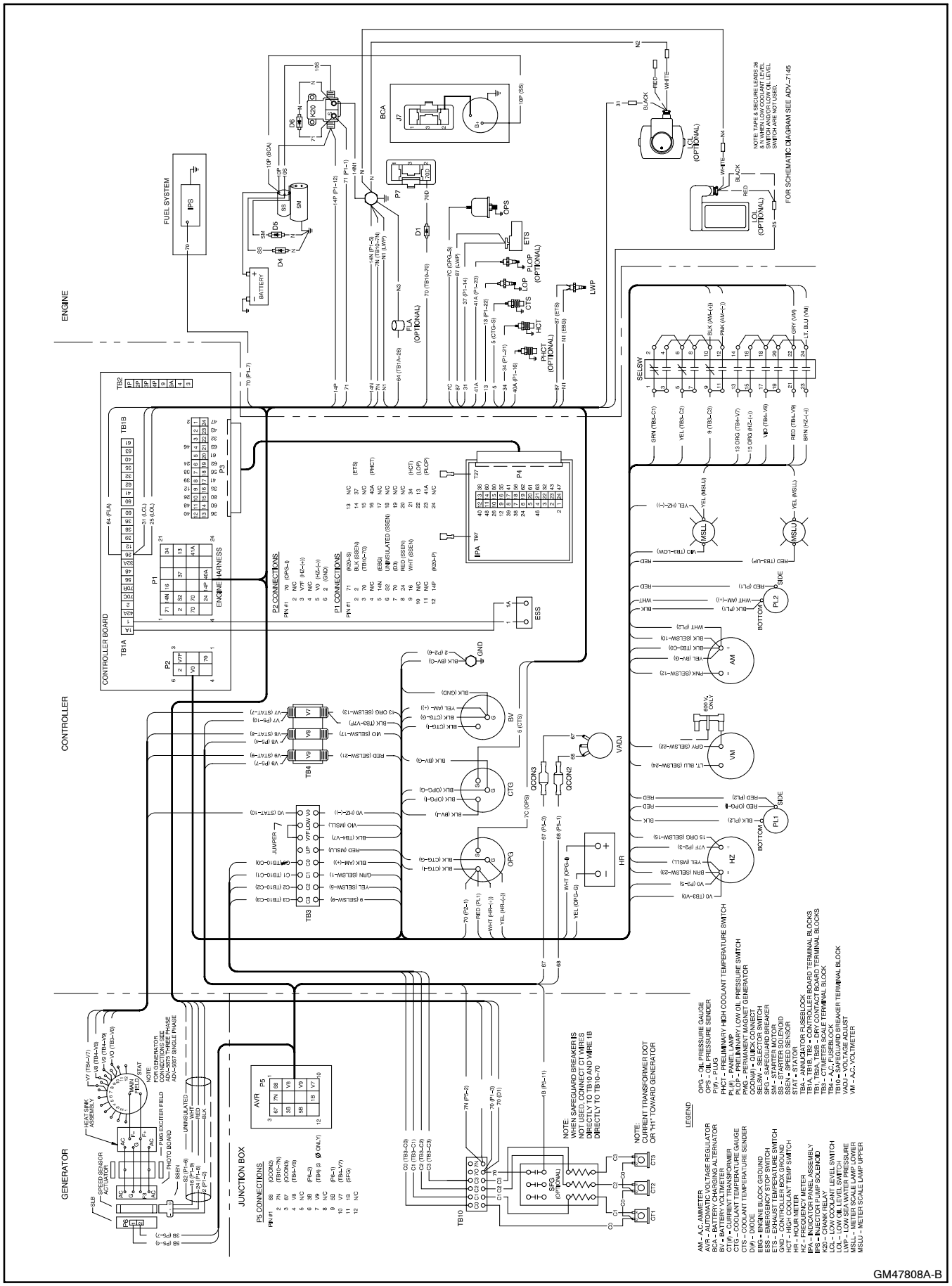


Figure 12-9 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 1 of 7, GM47808A-B

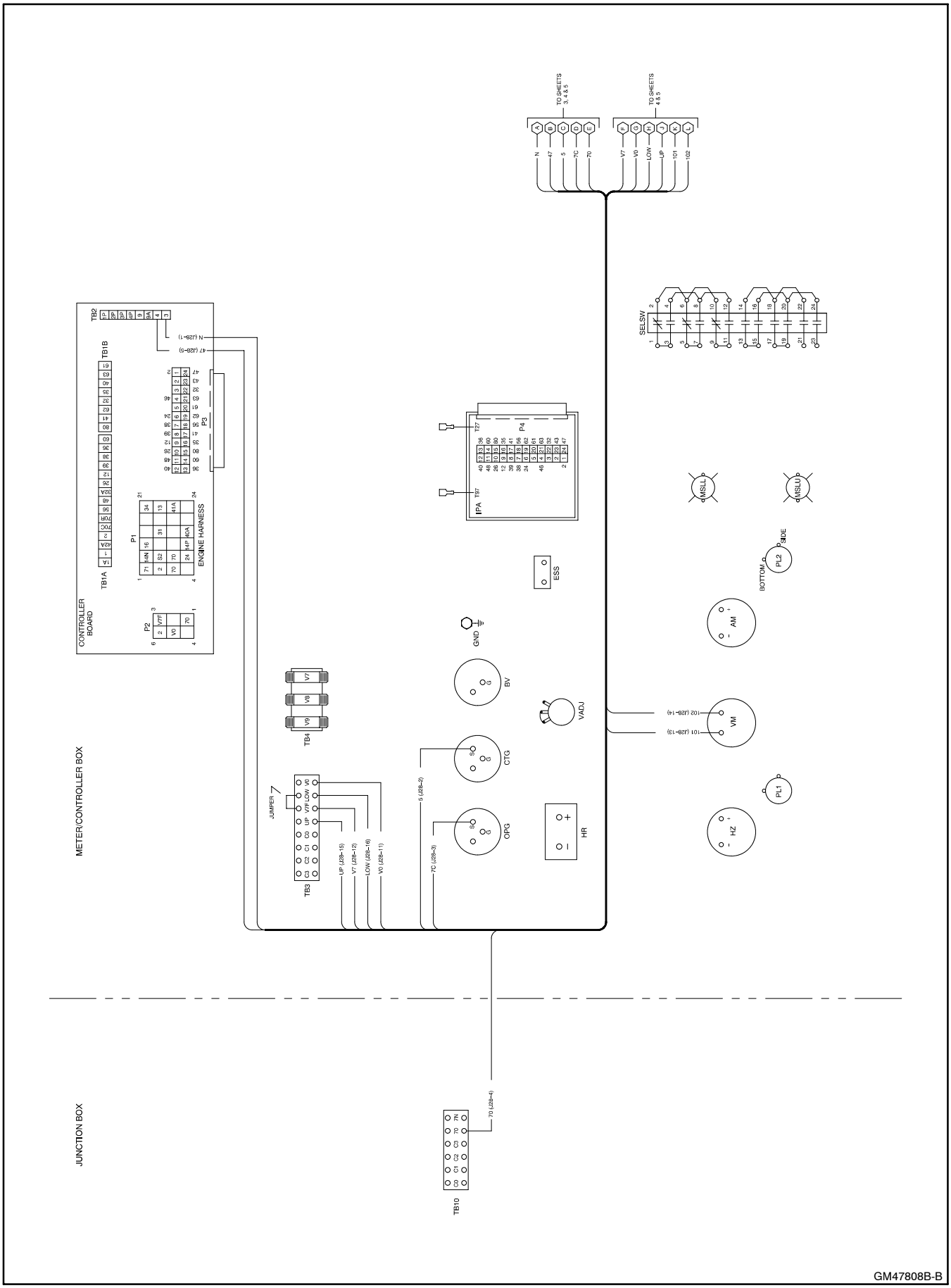


Figure 12-10 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 2 of 7, GM47808B-B

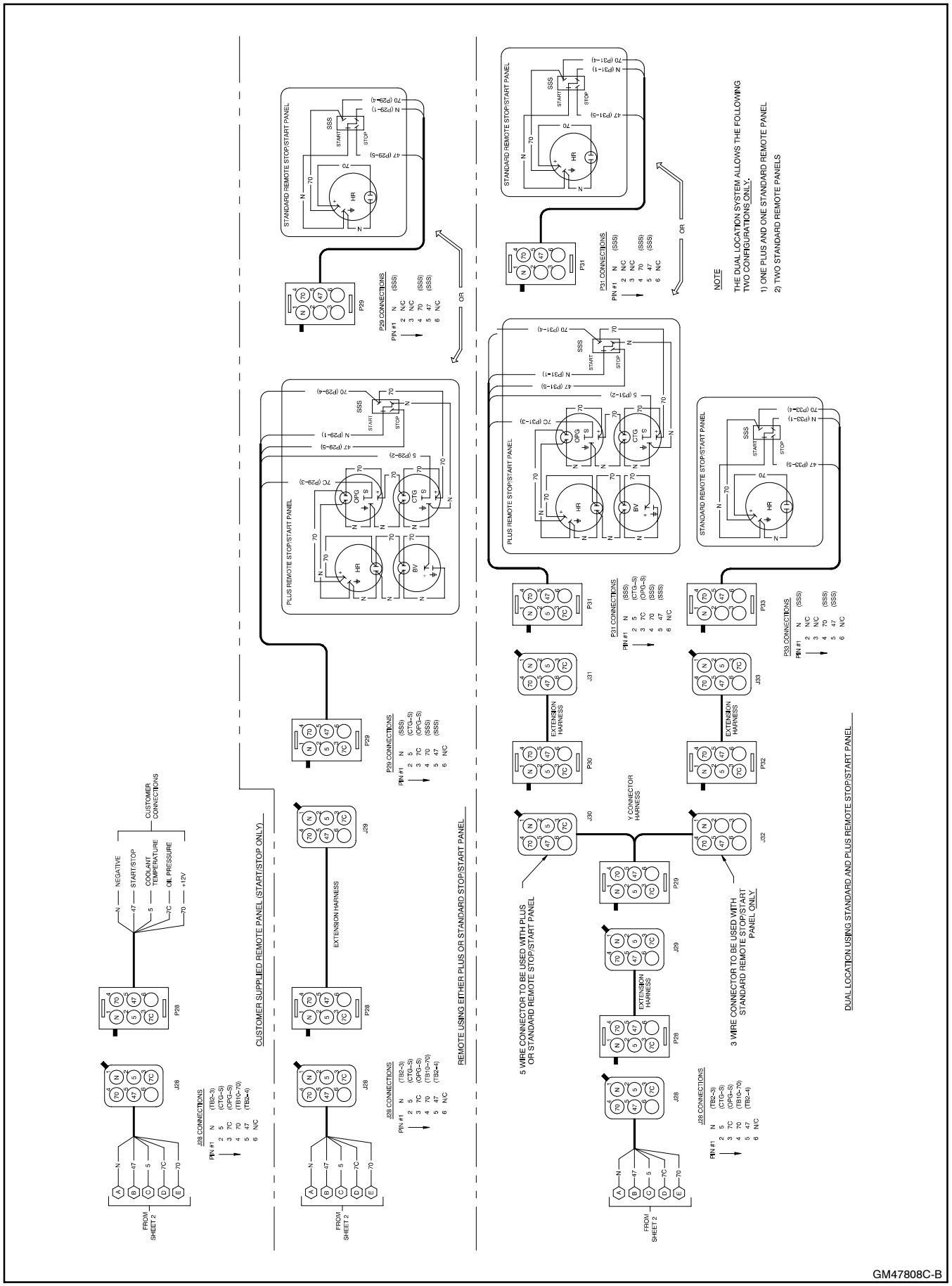


Figure 12-11 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 3 of 7, GM47808C-B

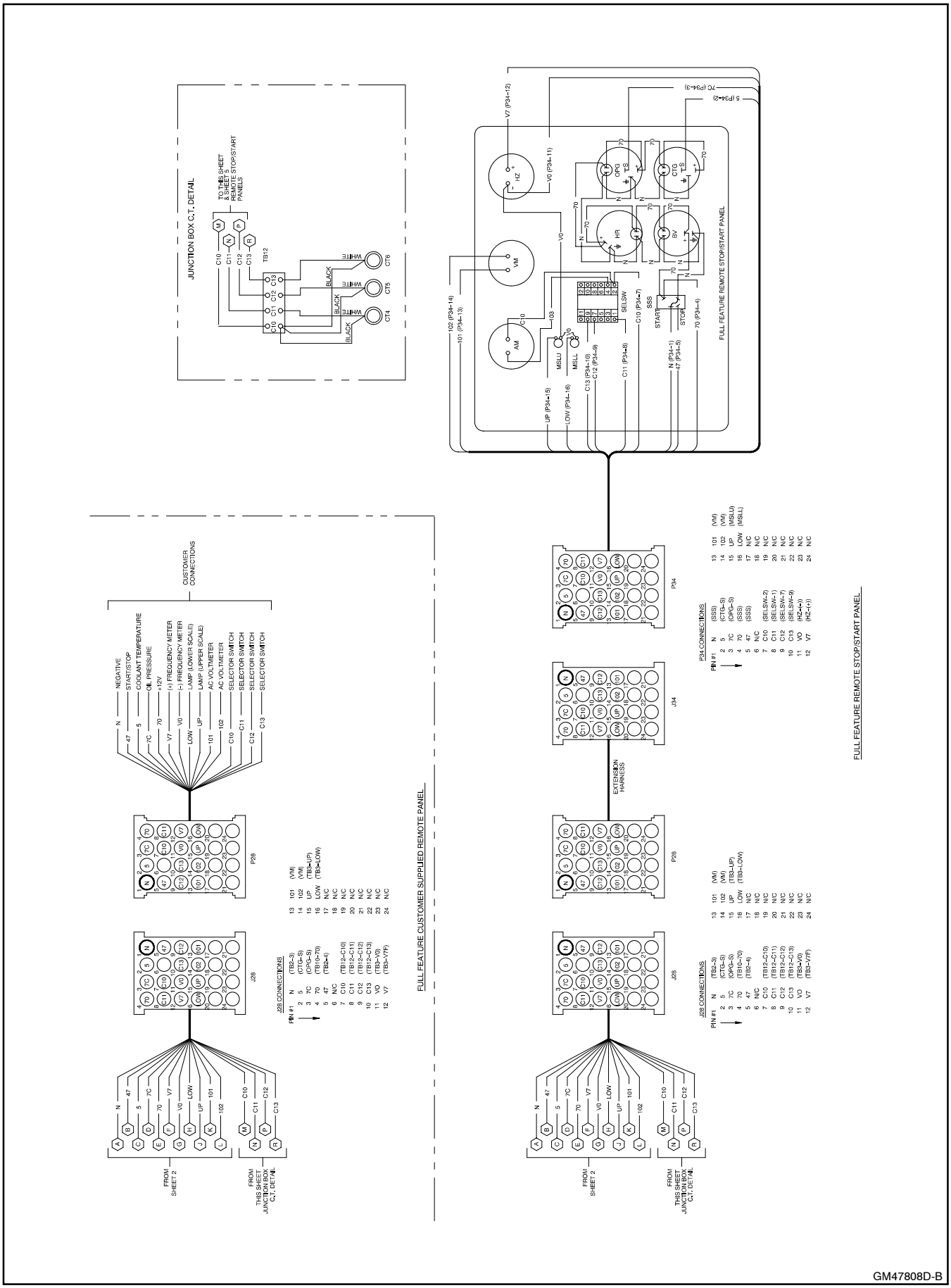


Figure 12-12 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 4 of 7, GM47808D-B

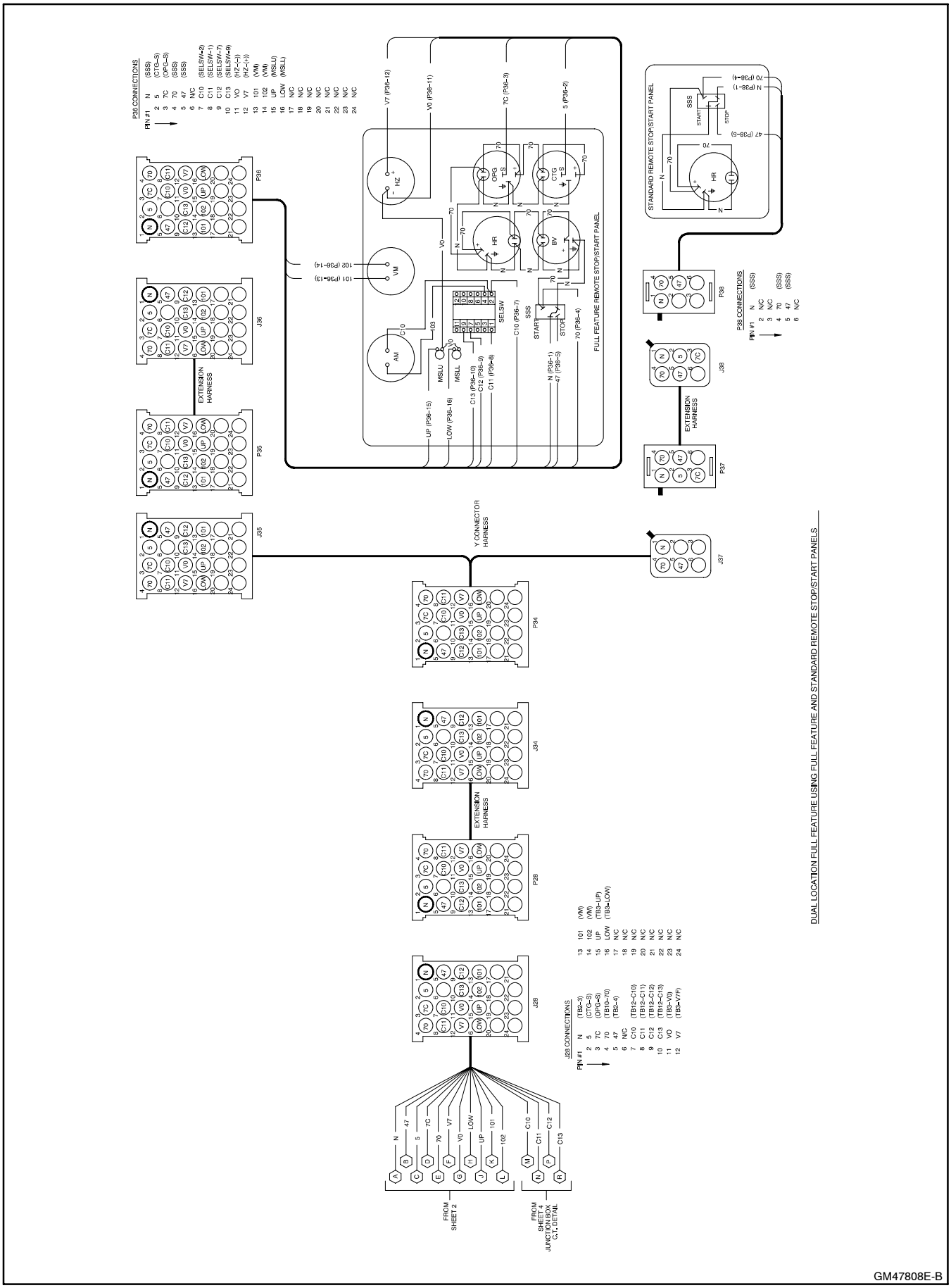


Figure 12-13 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 5 of 7, GM47808E-B

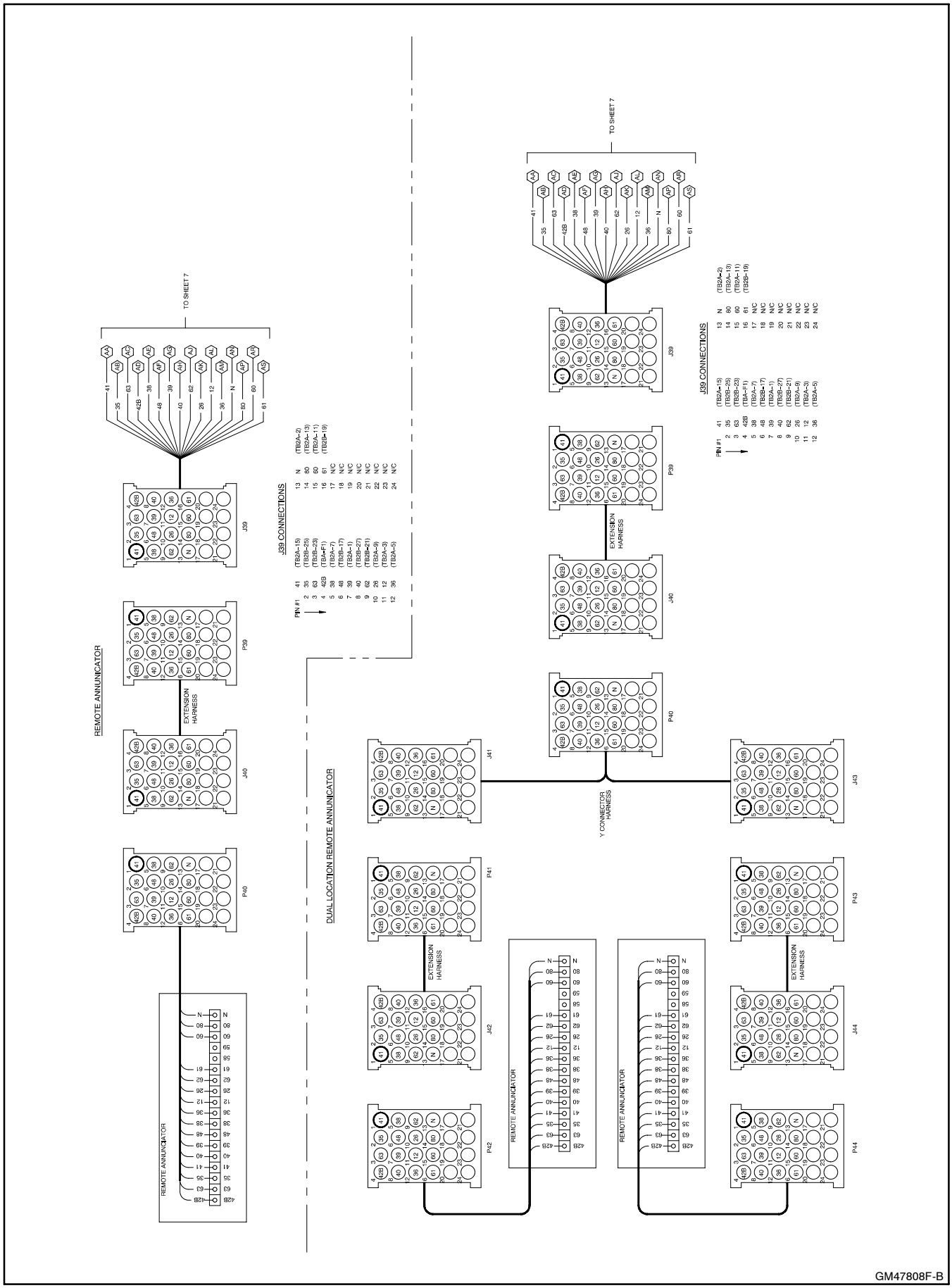


Figure 12-14 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 6 of 7, GM47808F-B

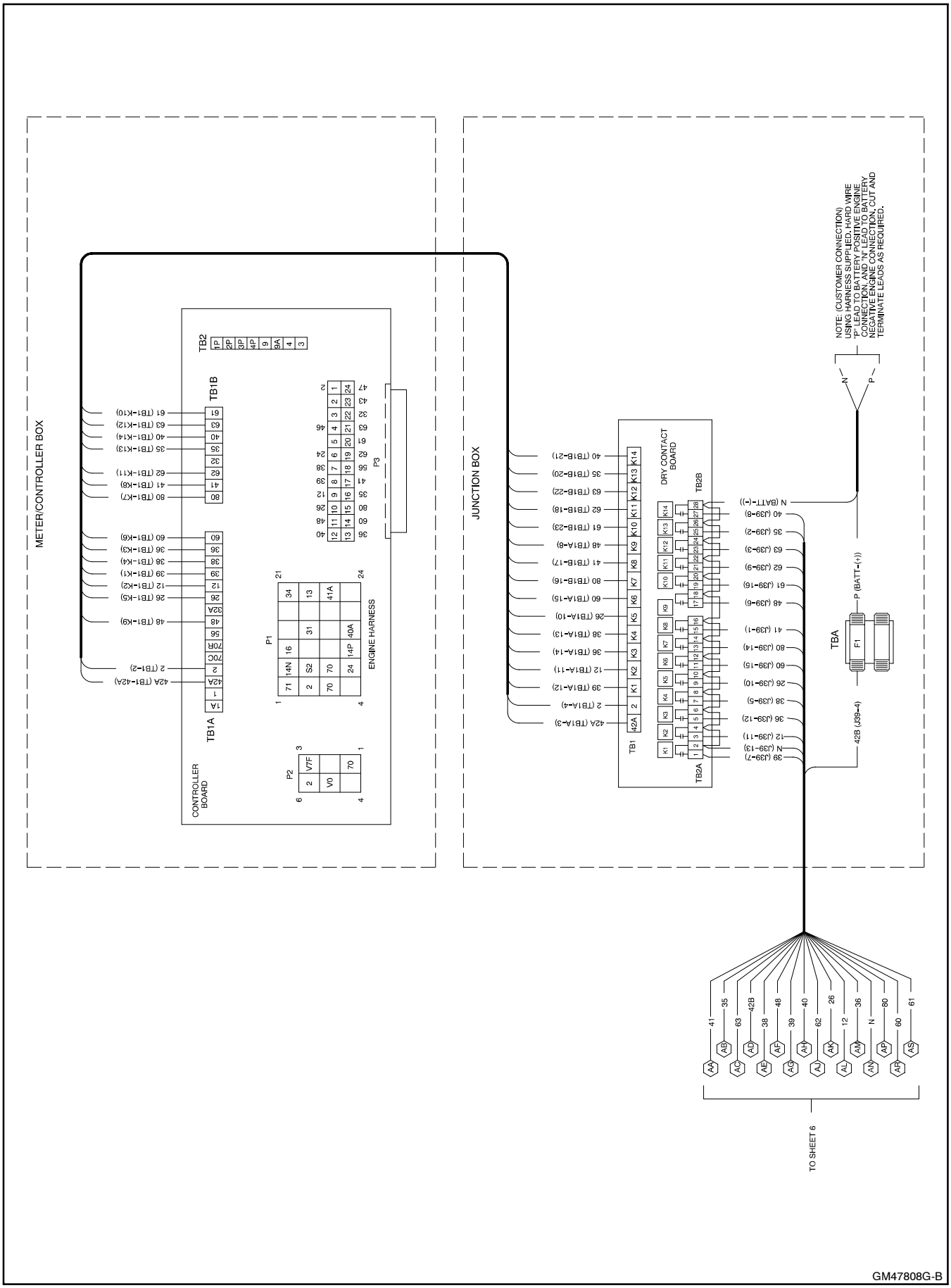


Figure 12-15 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 7 of 7, GM47808G-B

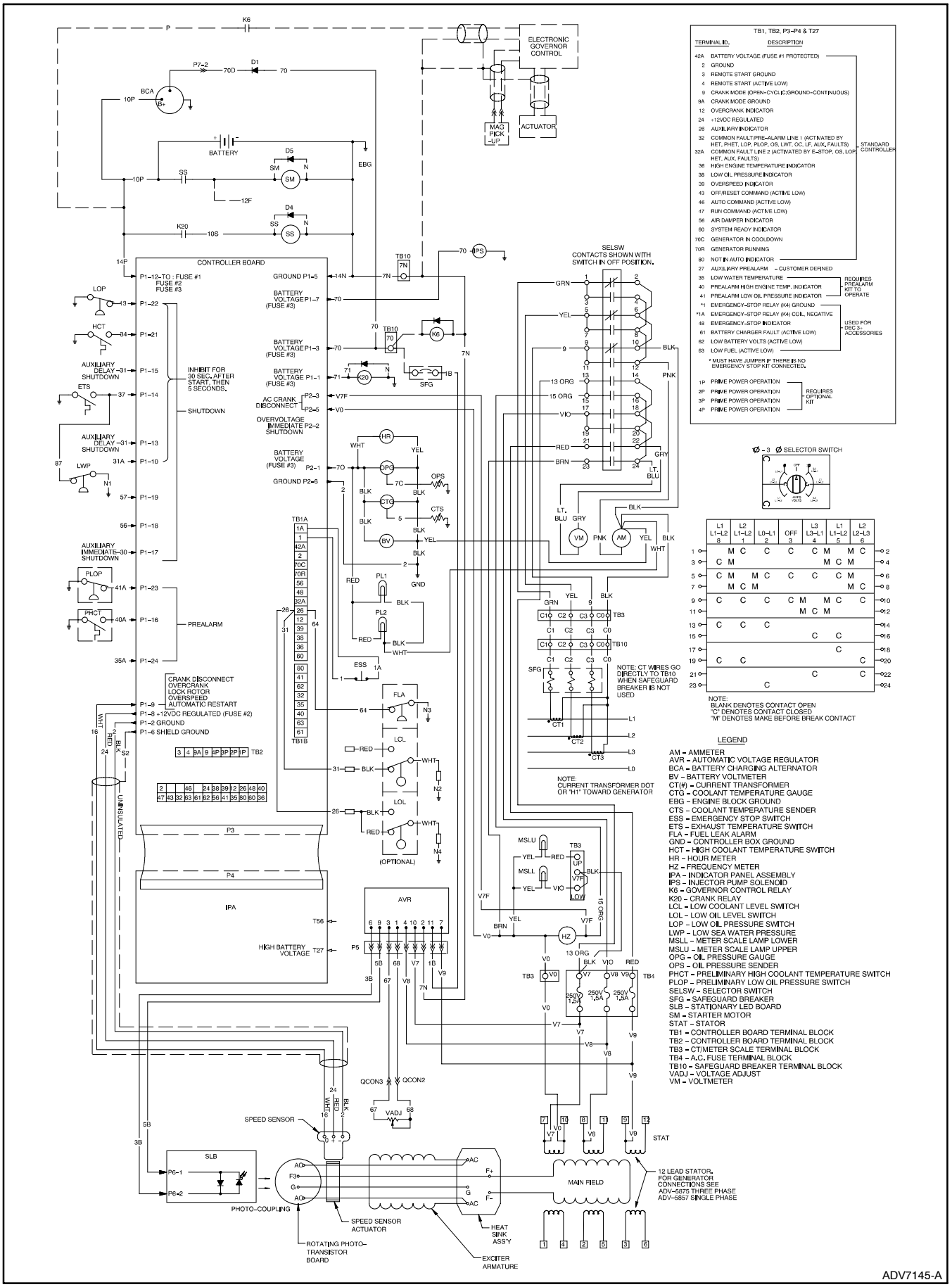


Figure 12-16 40EOZD/33EFOZD Schematic, Decision-Maker™ 3+ Controller, Sheet 1 of 1, ADV7145-A

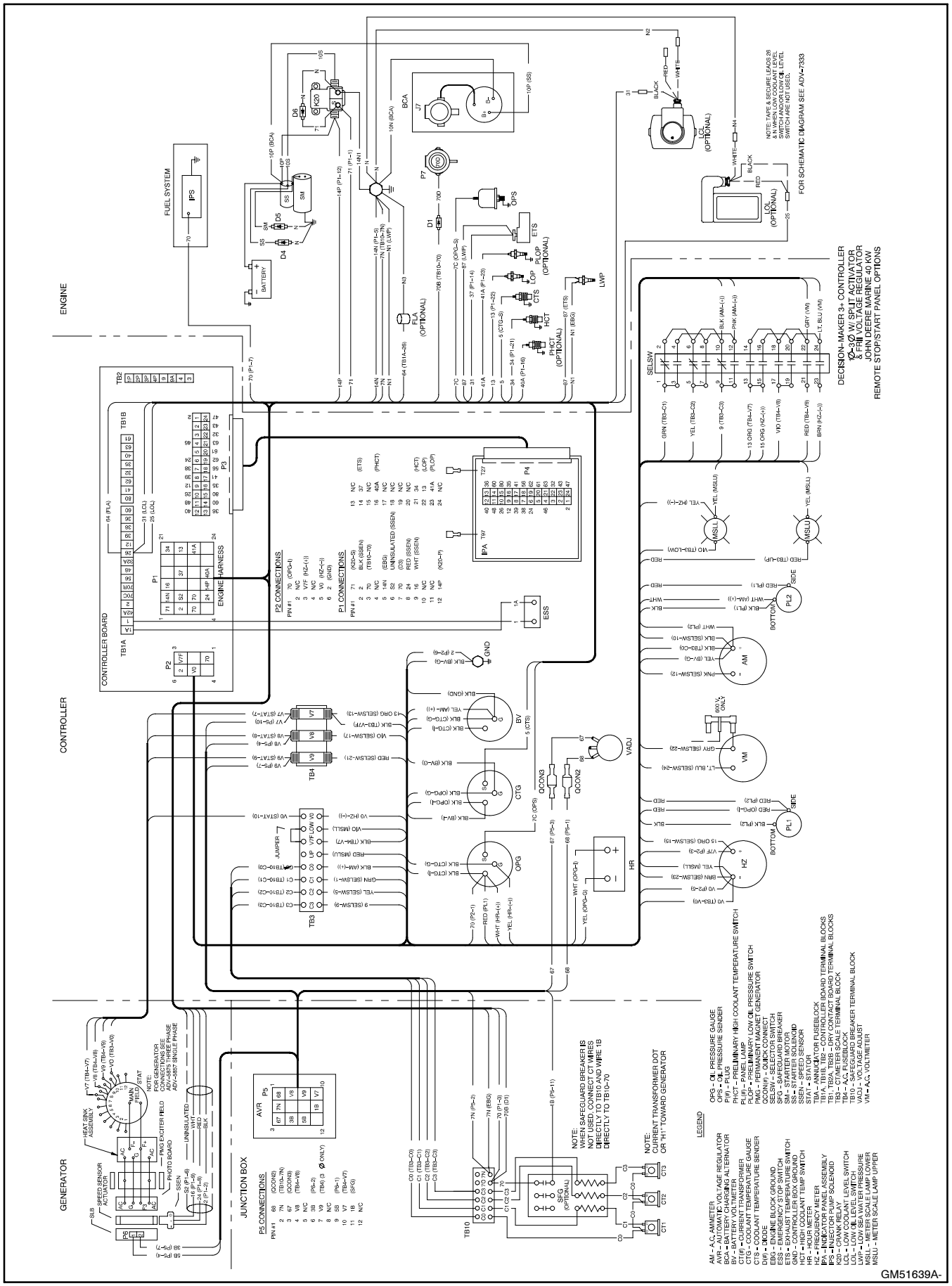


Figure 12-17 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 1 of 7, GM51639A

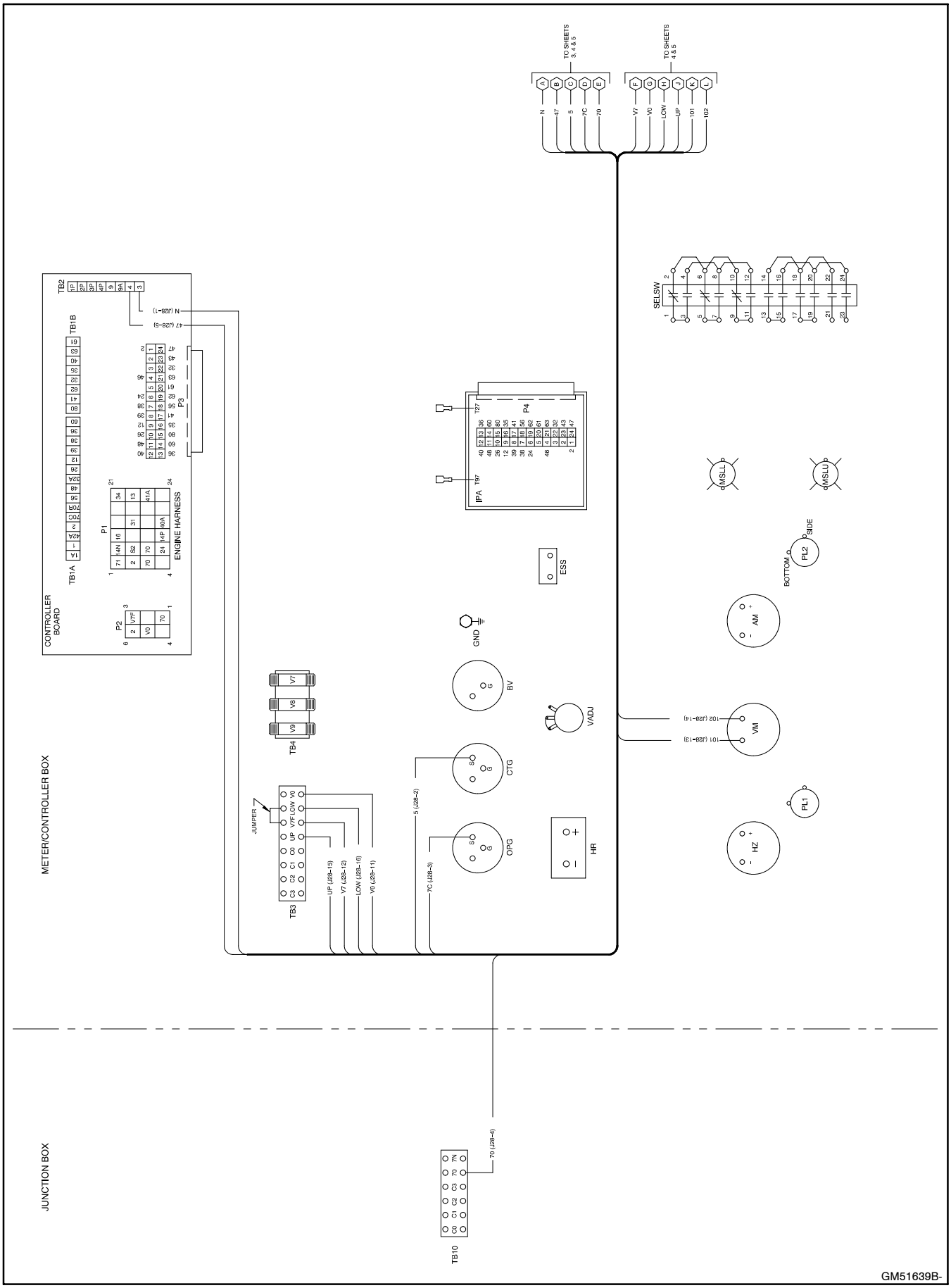


Figure 12-18 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 2 of 7, GM51639B

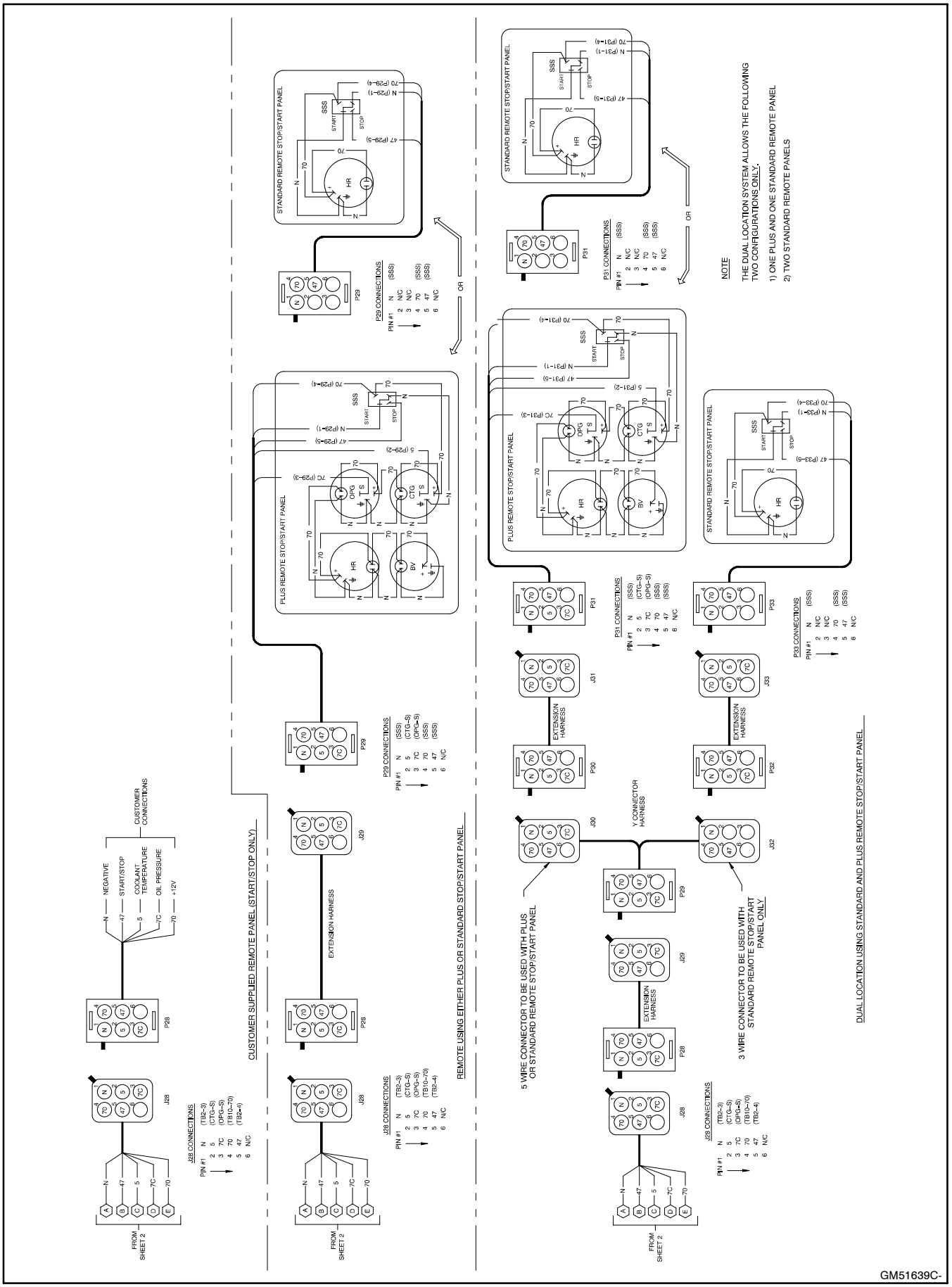


Figure 12-19 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 3 of 7, GM51639C

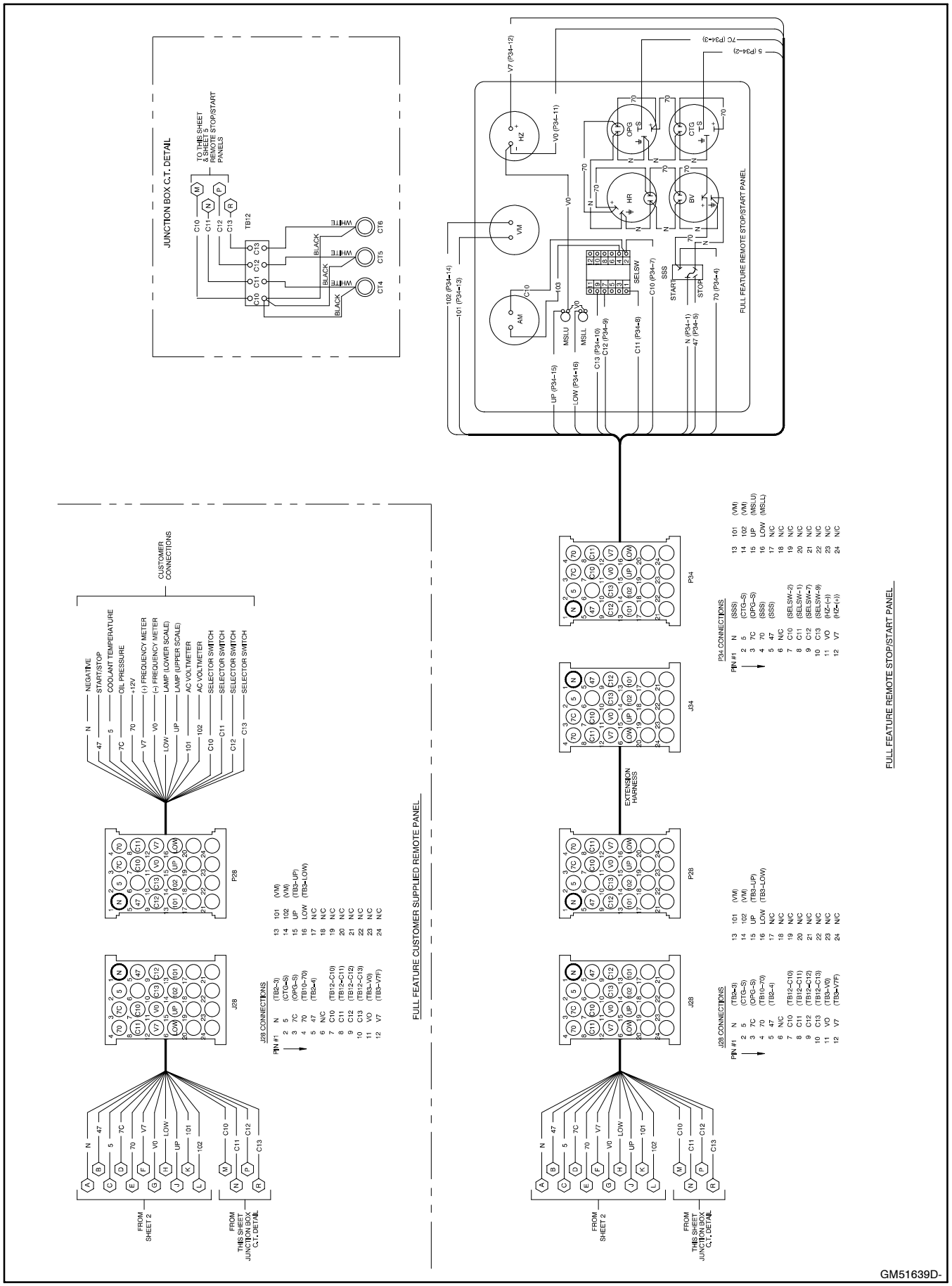


Figure 12-20 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 4 of 7, GM51639D

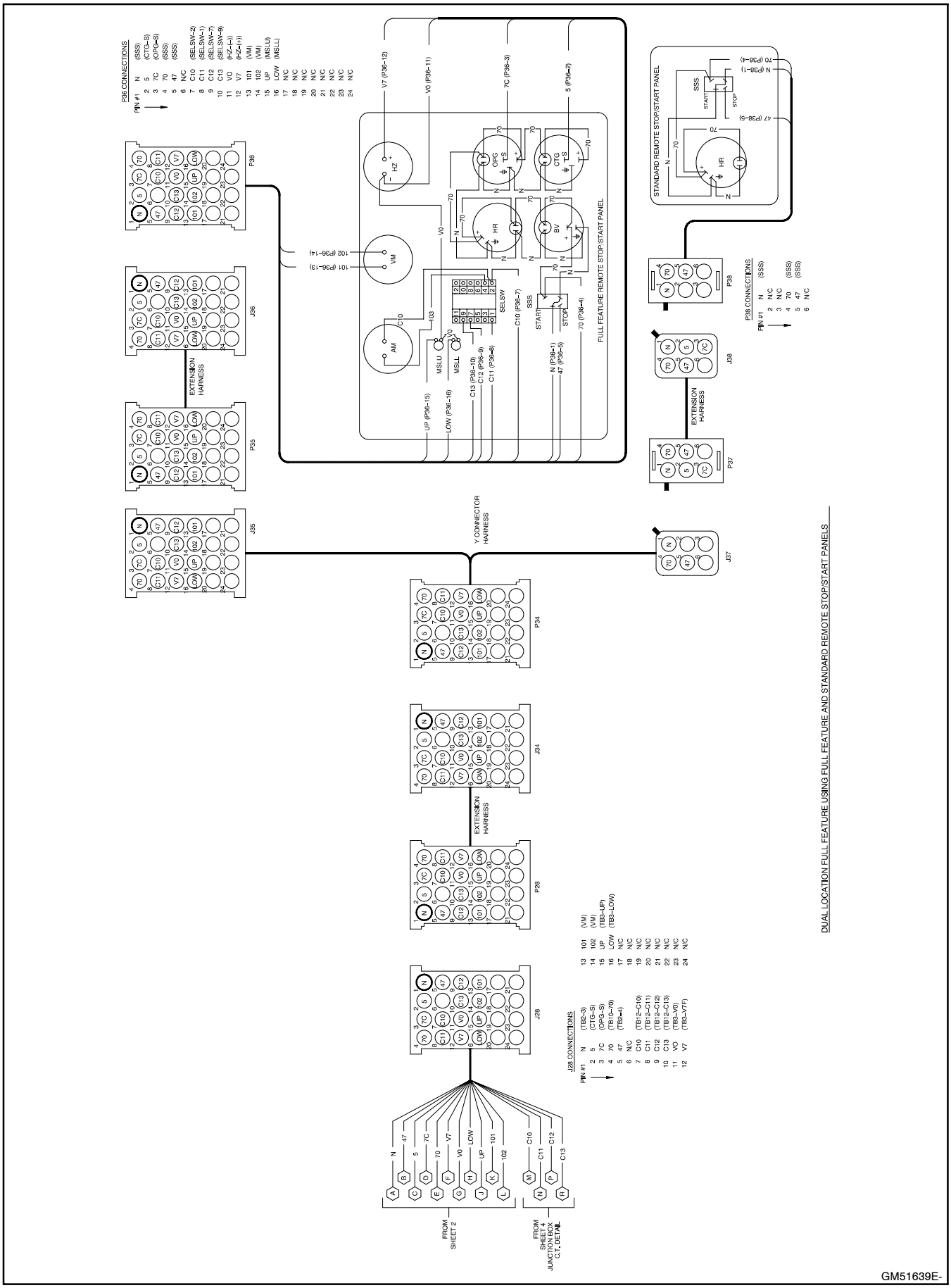


Figure 12-21 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 5 of 7, GM51639E

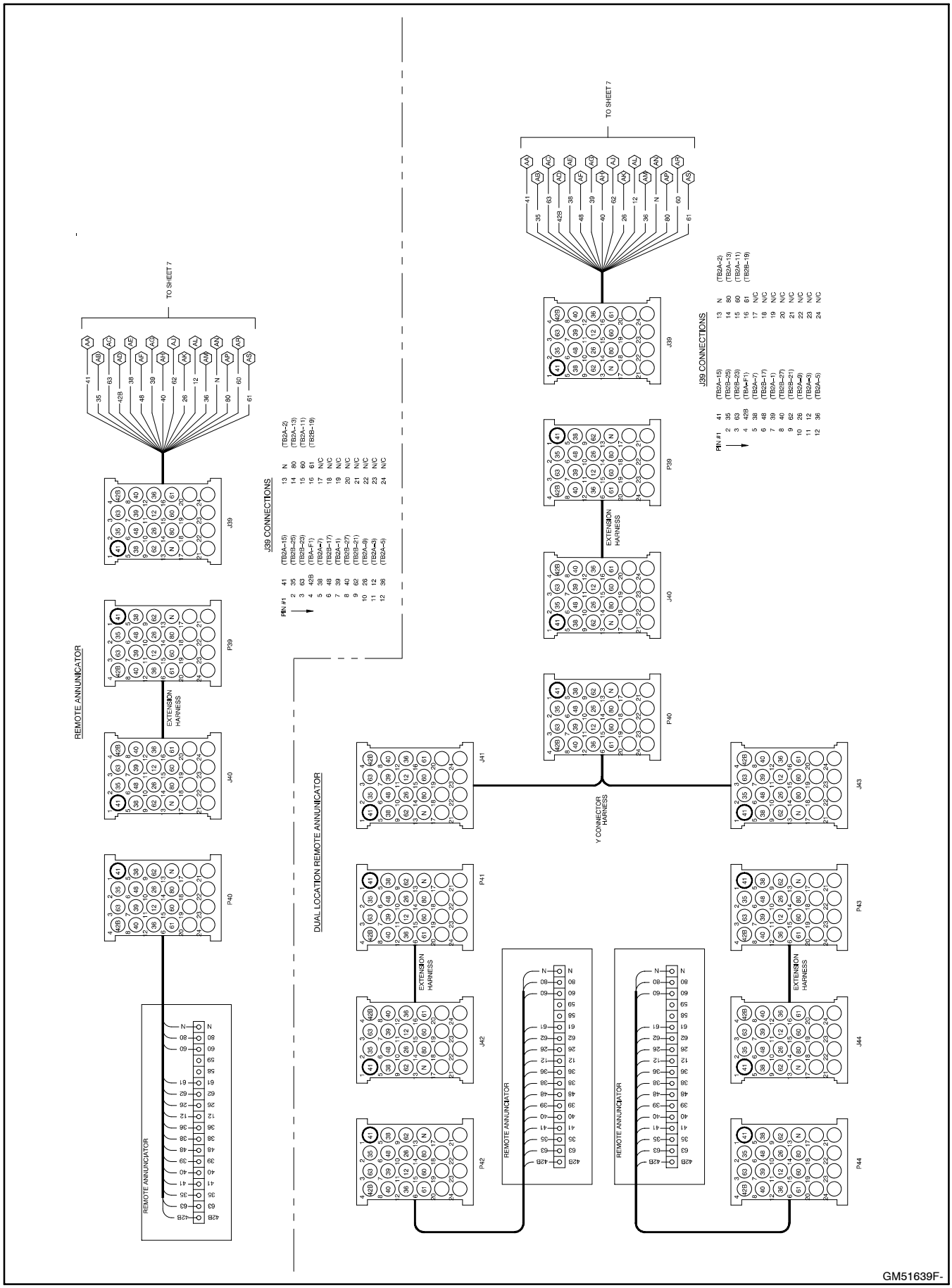


Figure 12-22 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 6 of 7, GM51639F

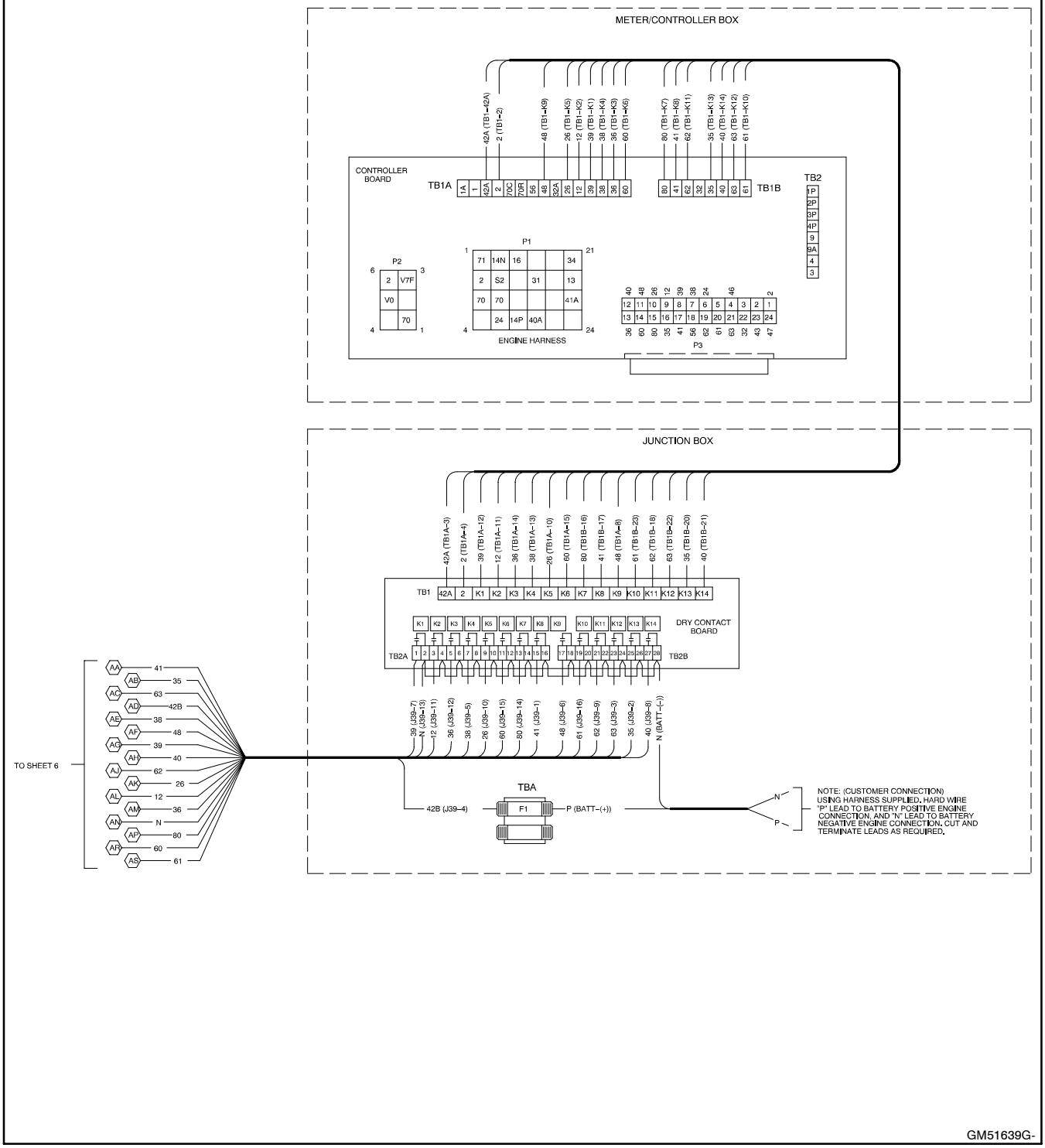


Figure 12-23 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 3+ Controller, Sheet 7 of 7, GM51639G

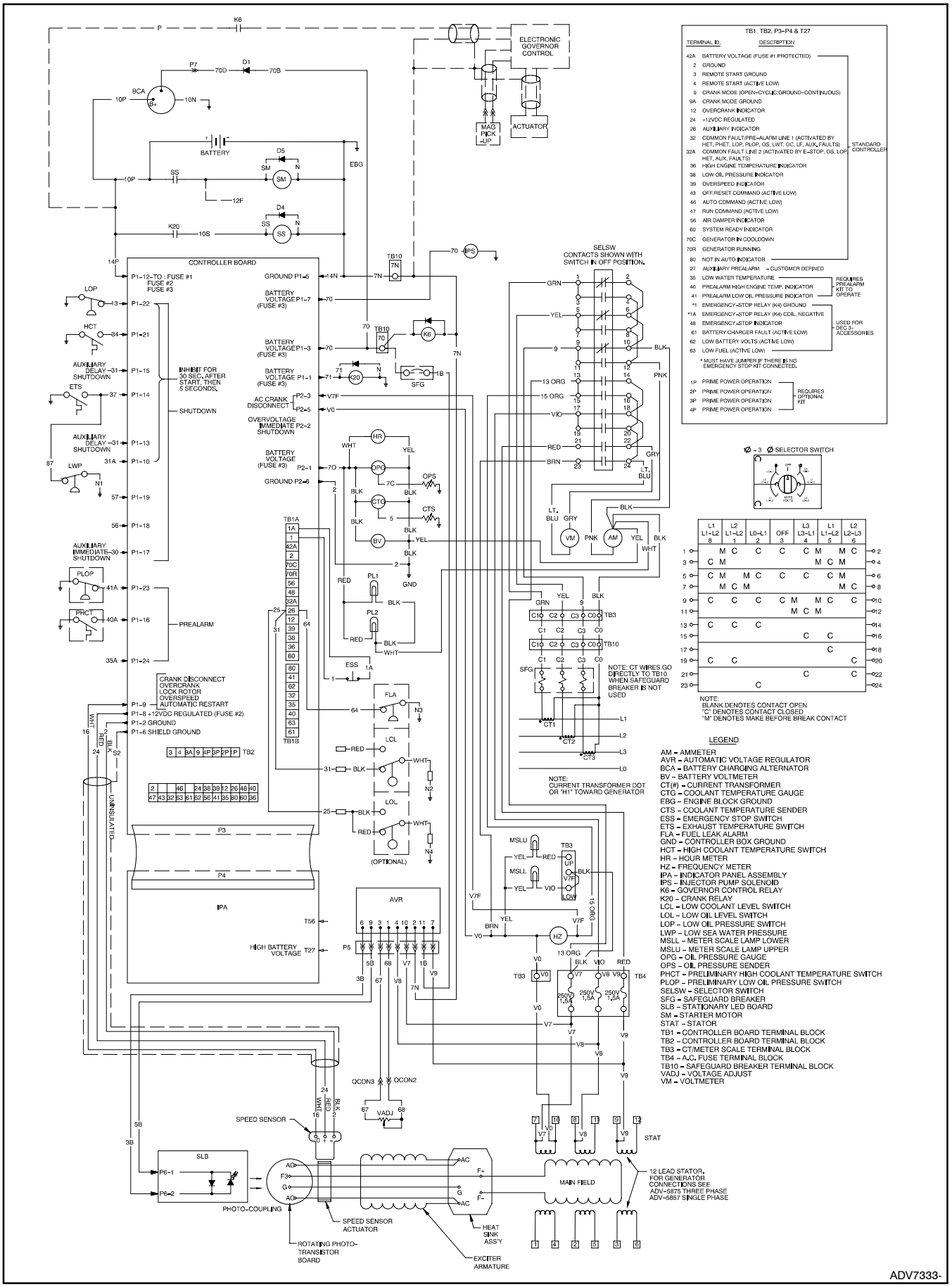


Figure 12-24 40EOZD/33EFOZD Schematic, Decision-Maker™ 3+ Controller, Sheet 1 of 1, ADV7333

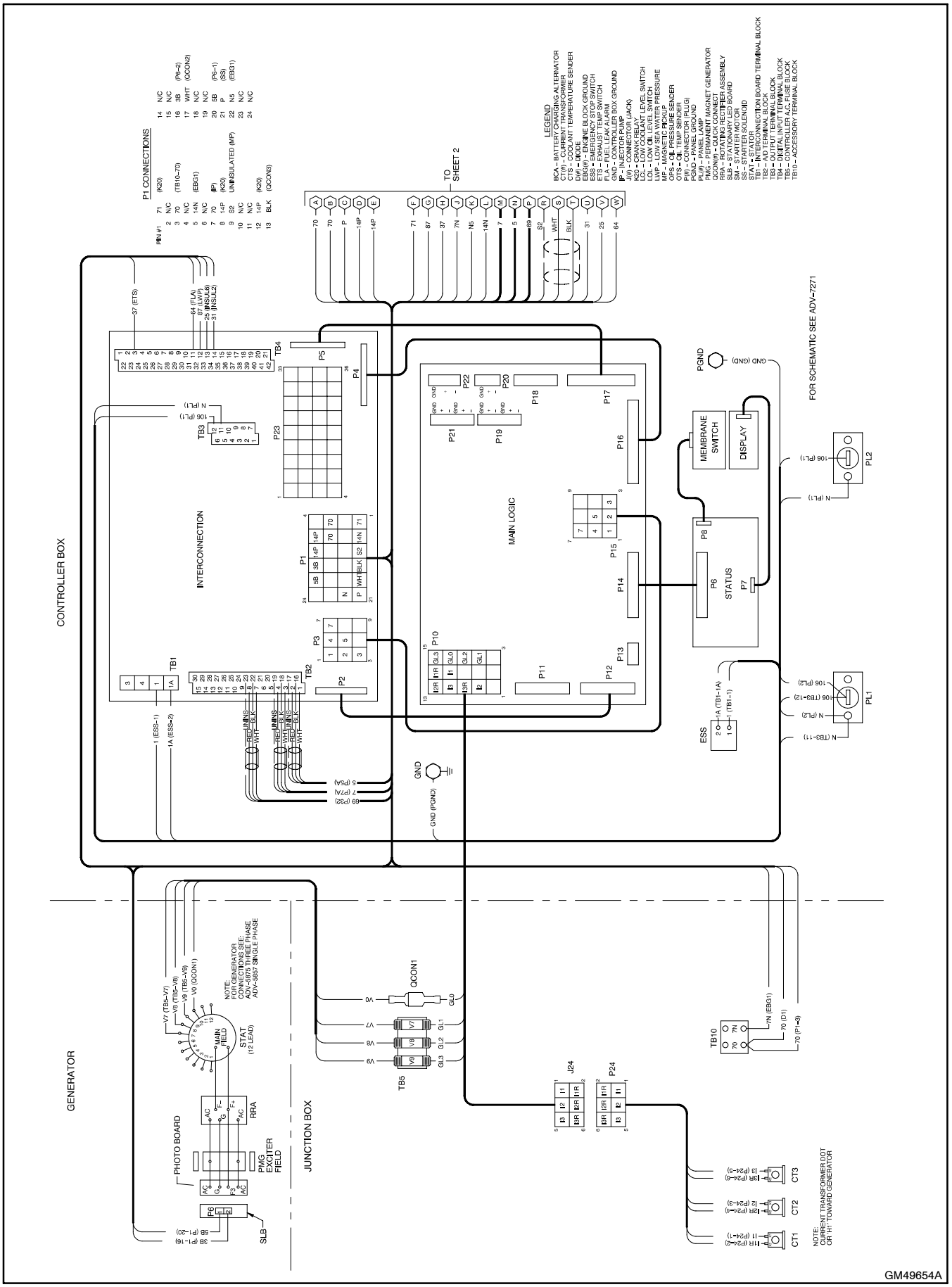


Figure 12-25 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 550 Controller, Sheet 1 of 2, GM49654A

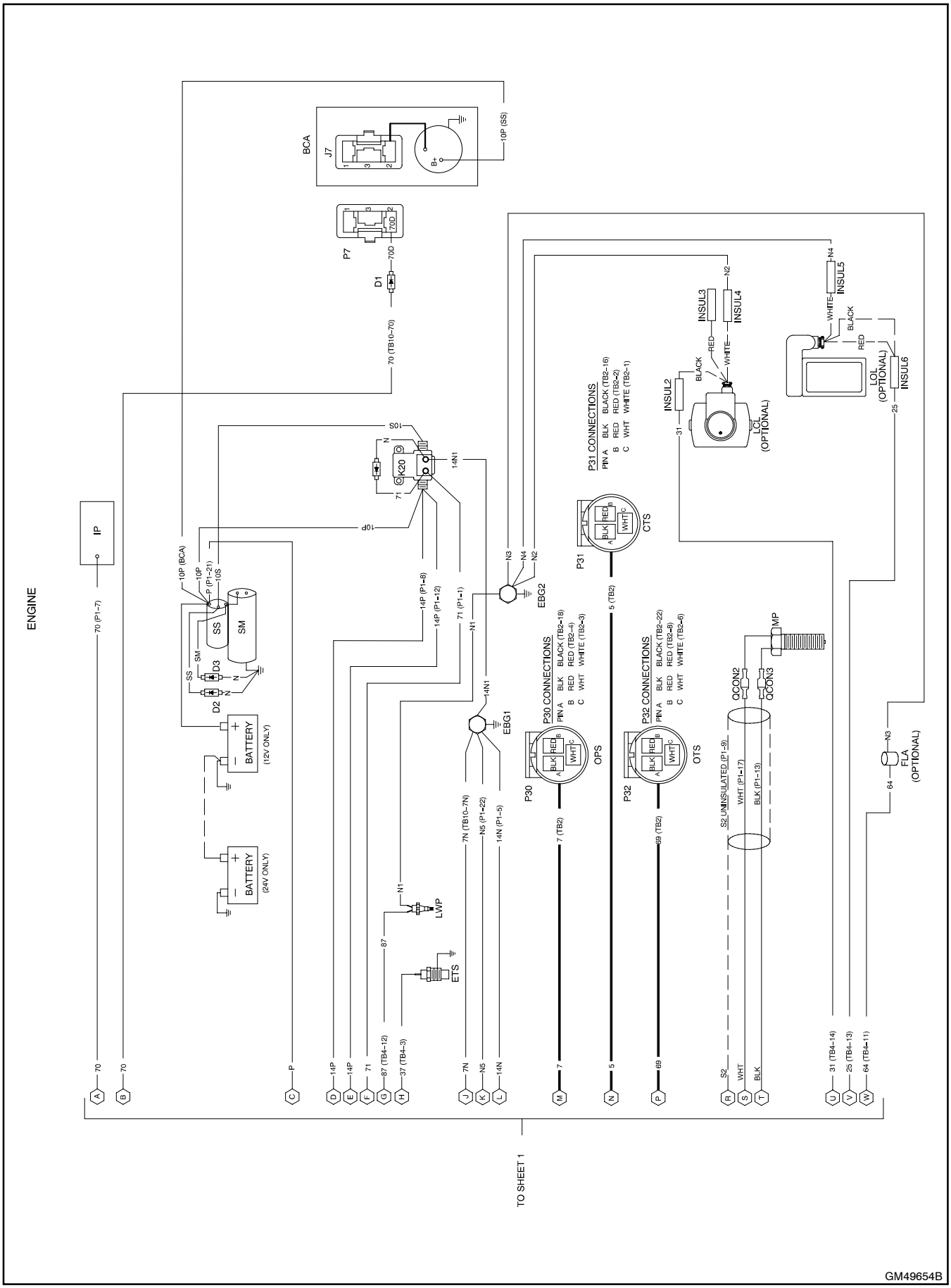


Figure 12-26 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 550 Controller, Sheet 2 of 2, GM49654B

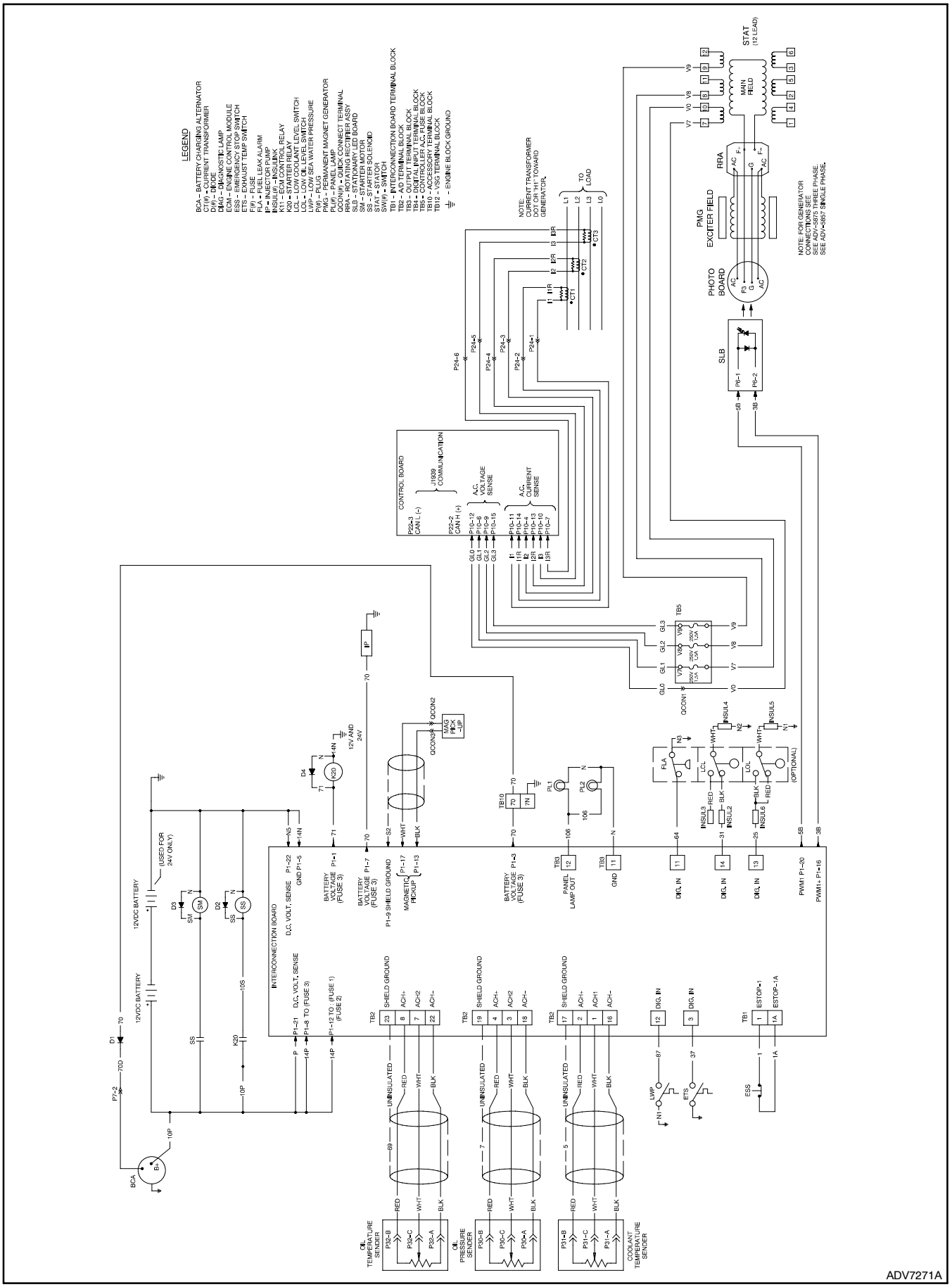


Figure 12-27 40EOZD/33EFOZD Schematic, Decision-Maker™ 550 Controller, Sheet 1 of 2, ADV7271A

Figure 12-28 40EOZD/33EFOZD Schematic, Decision-Maker™ 550 Controller, Sheet 2 of 2, ADV7271B

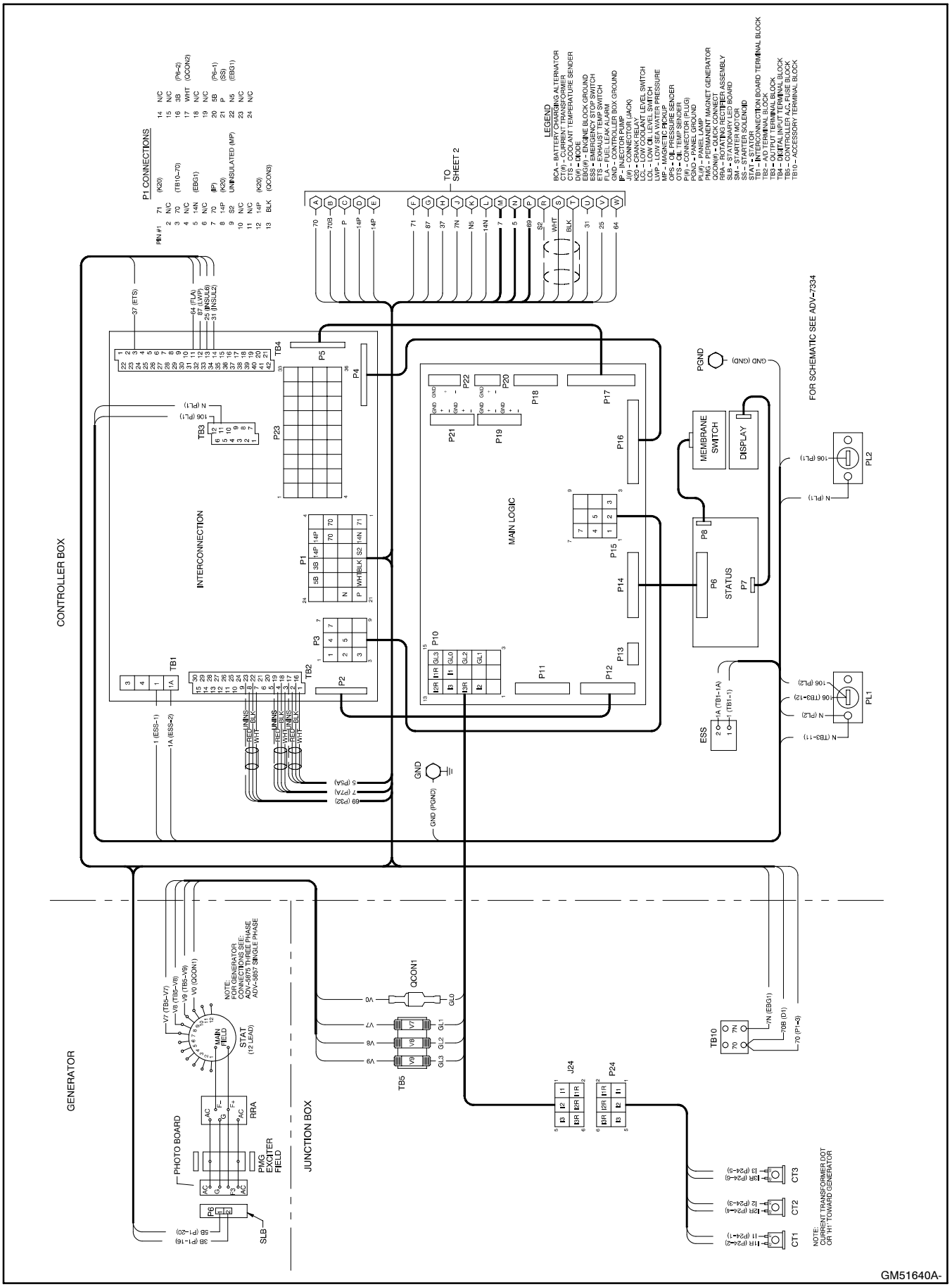


Figure 12-29 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 550 Controller, Sheet 1 of 2, GM51640A

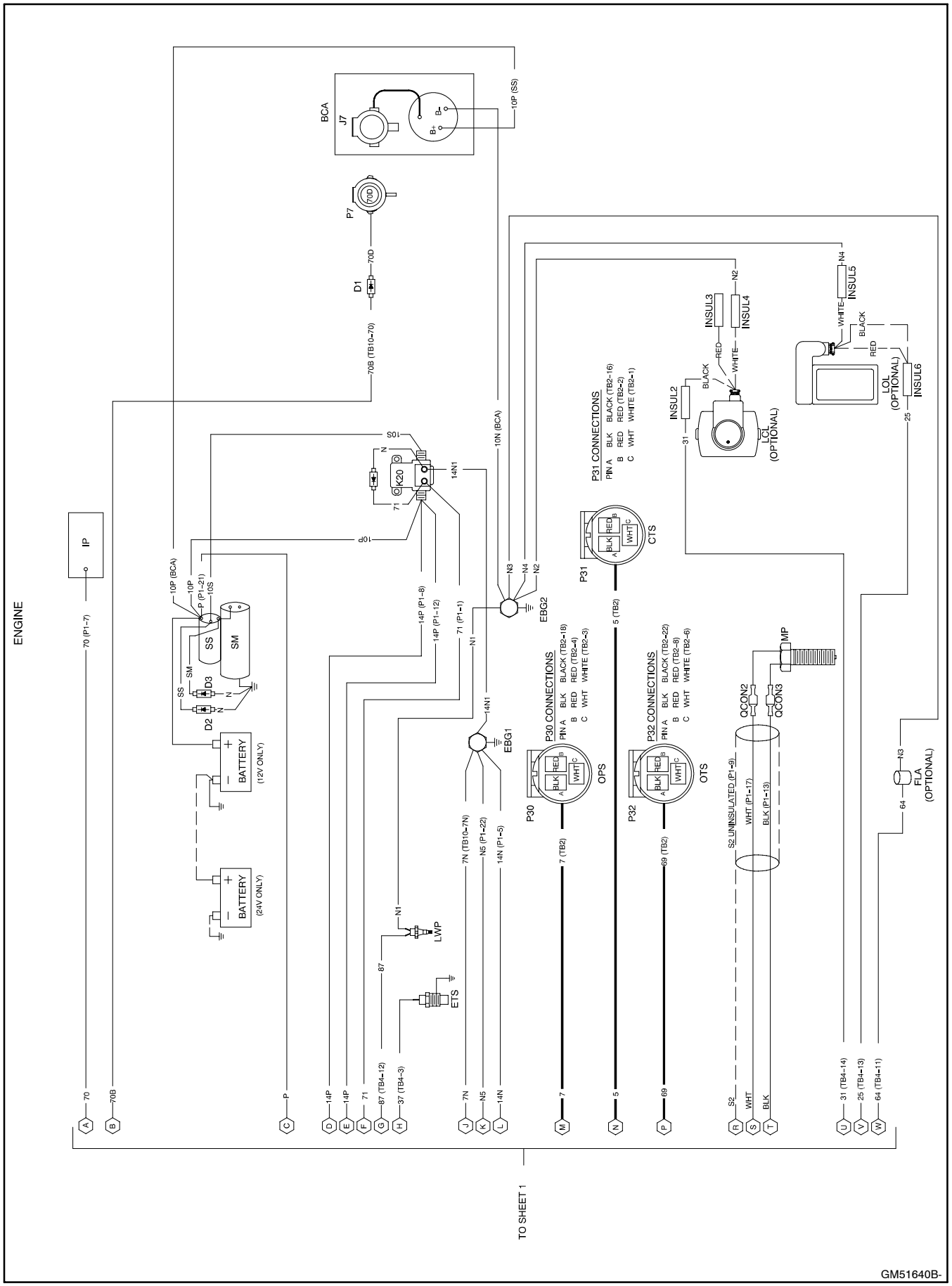


Figure 12-30 40EOZD/33EFOZD Wiring Diagram, Decision-Maker™ 550 Controller, Sheet 2 of 2, GM51640B

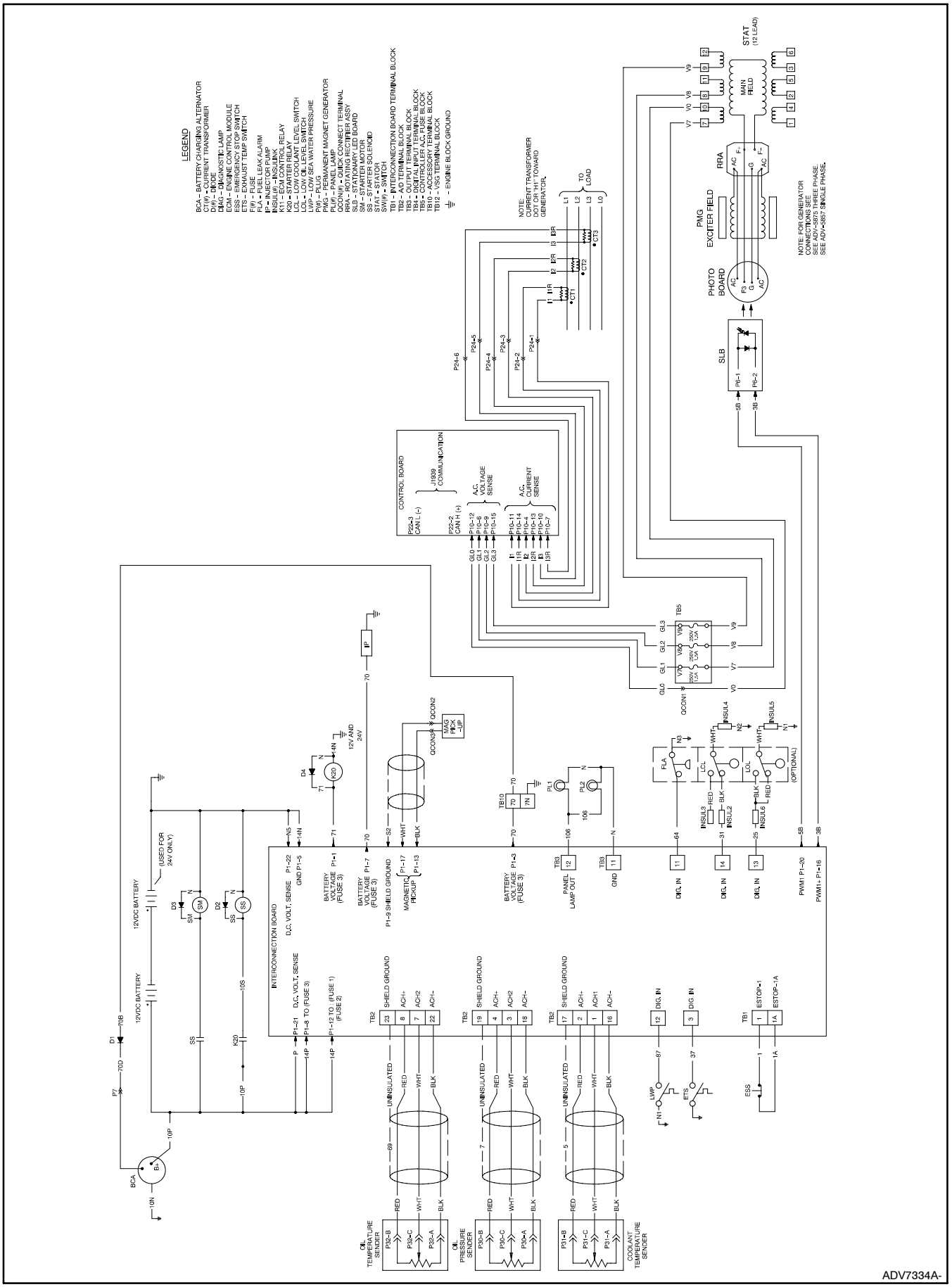


Figure 12-31 40EOZD/33EFOZD Schematic, Decision-Maker™ 550 Controller, Sheet 1 of 2, ADV7334A

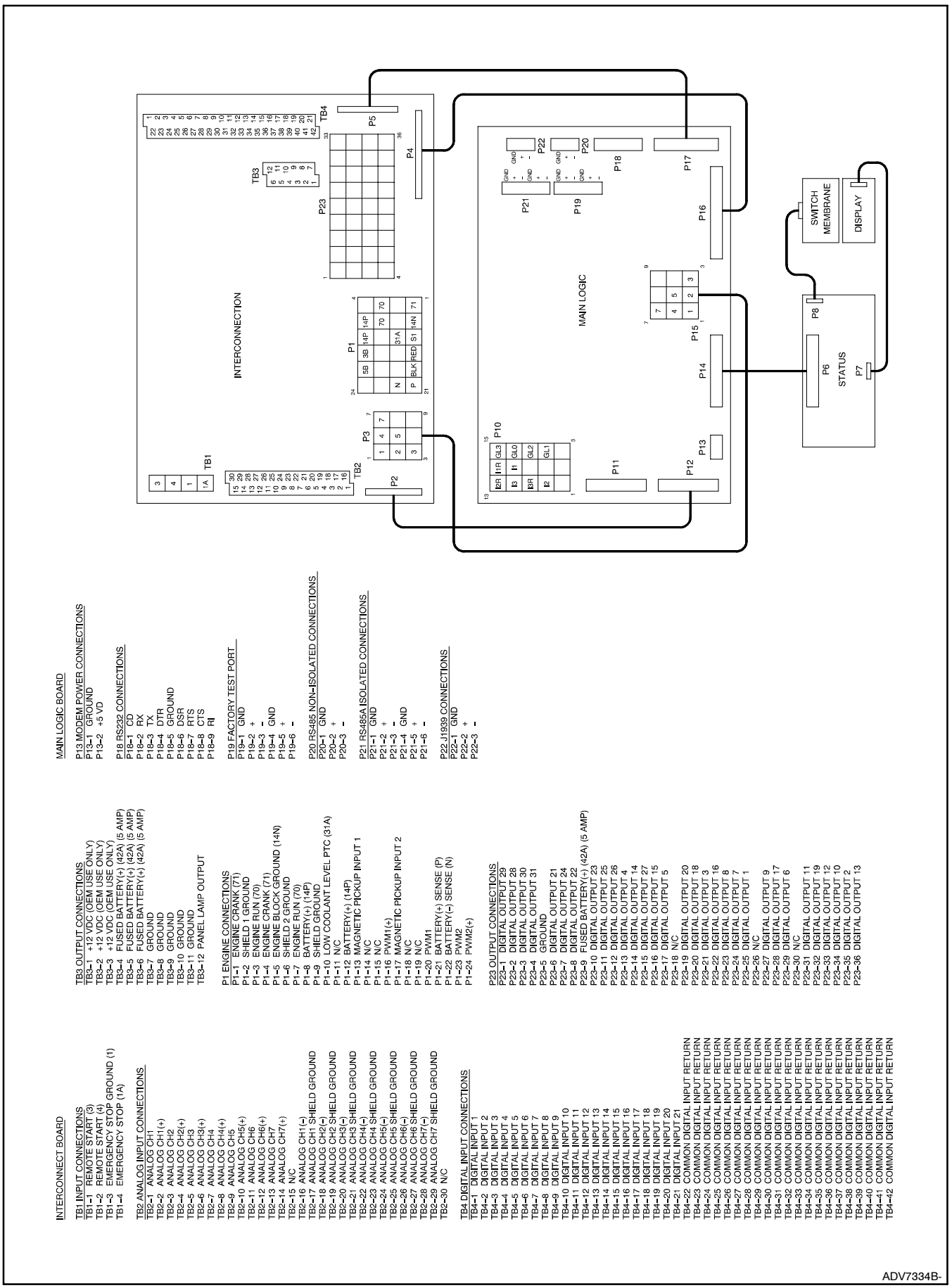


Figure 12-32 40EOZD/33EFOZD Schematic, Decision-Maker™ 550 Controller, Sheet 2 of 2, ADV7334B

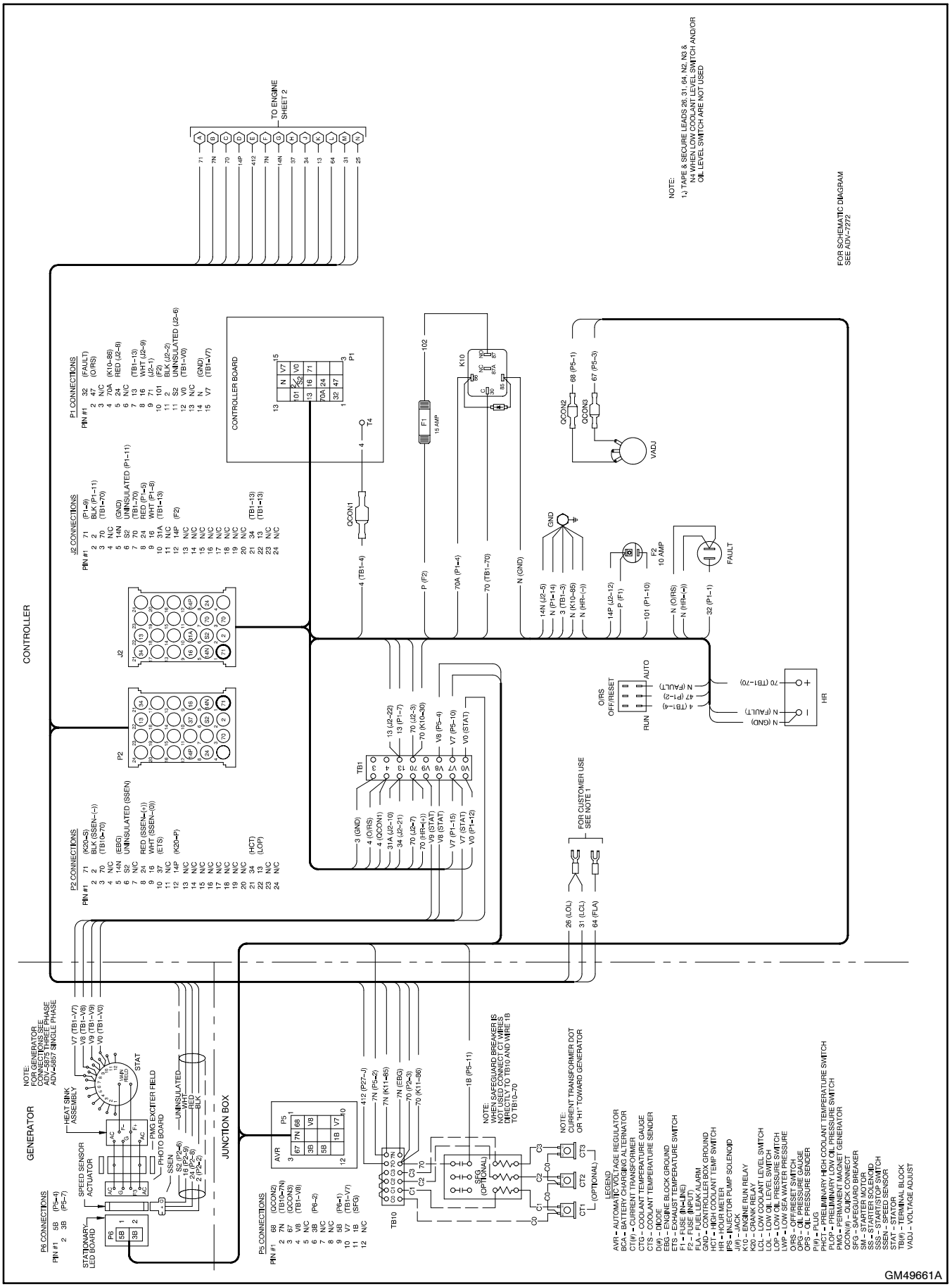


Figure 12-33 55–180EOZD/40–150EFOZD Wiring Diagram, Dec 1 Controller, Sheet 1 of 4, GM49661A

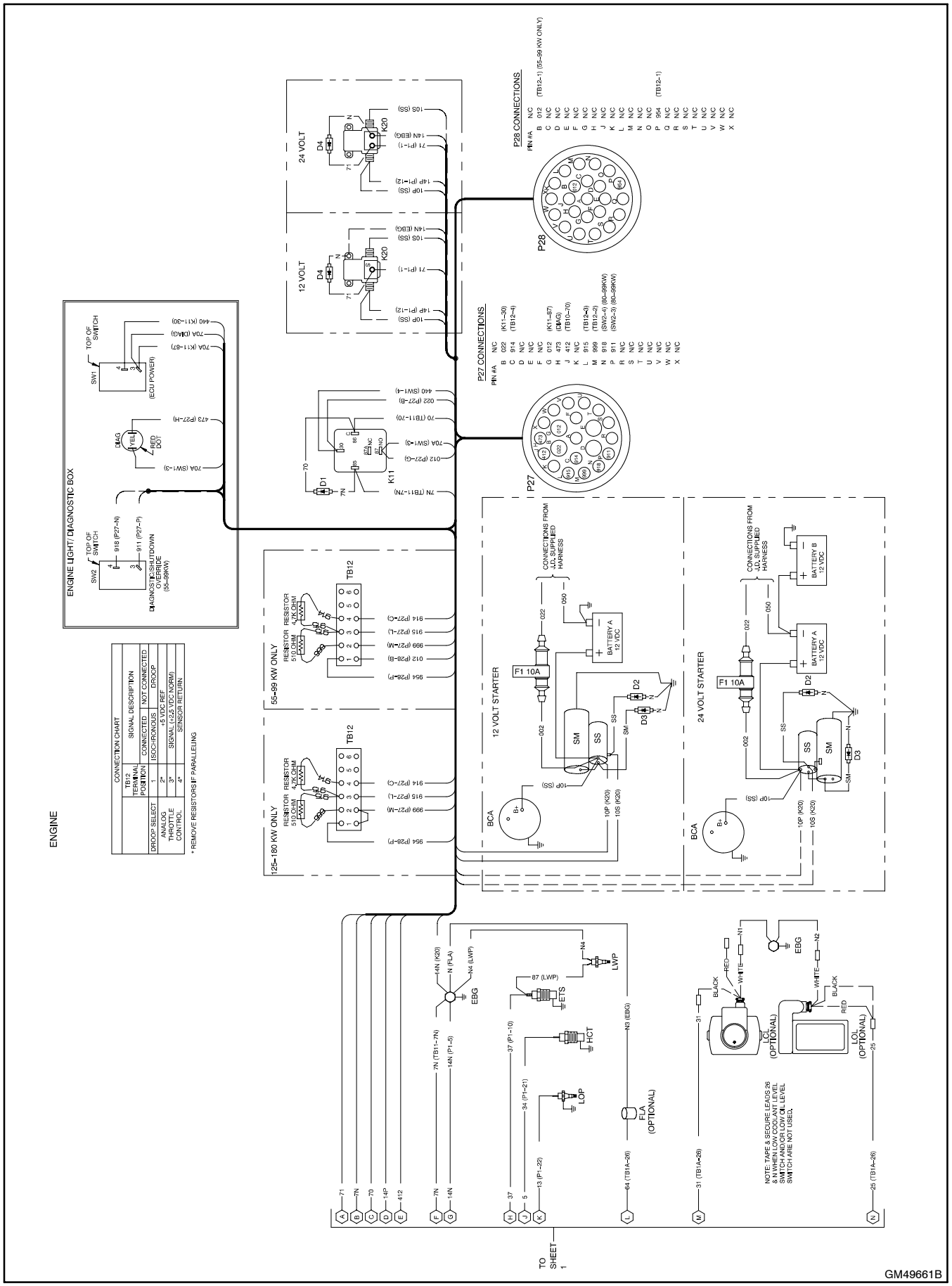


Figure 12-34 55–180EOZD/40–150EFOZD Wiring Diagram, Dec 1 Controller, Sheet 2 of 4, GM49661B

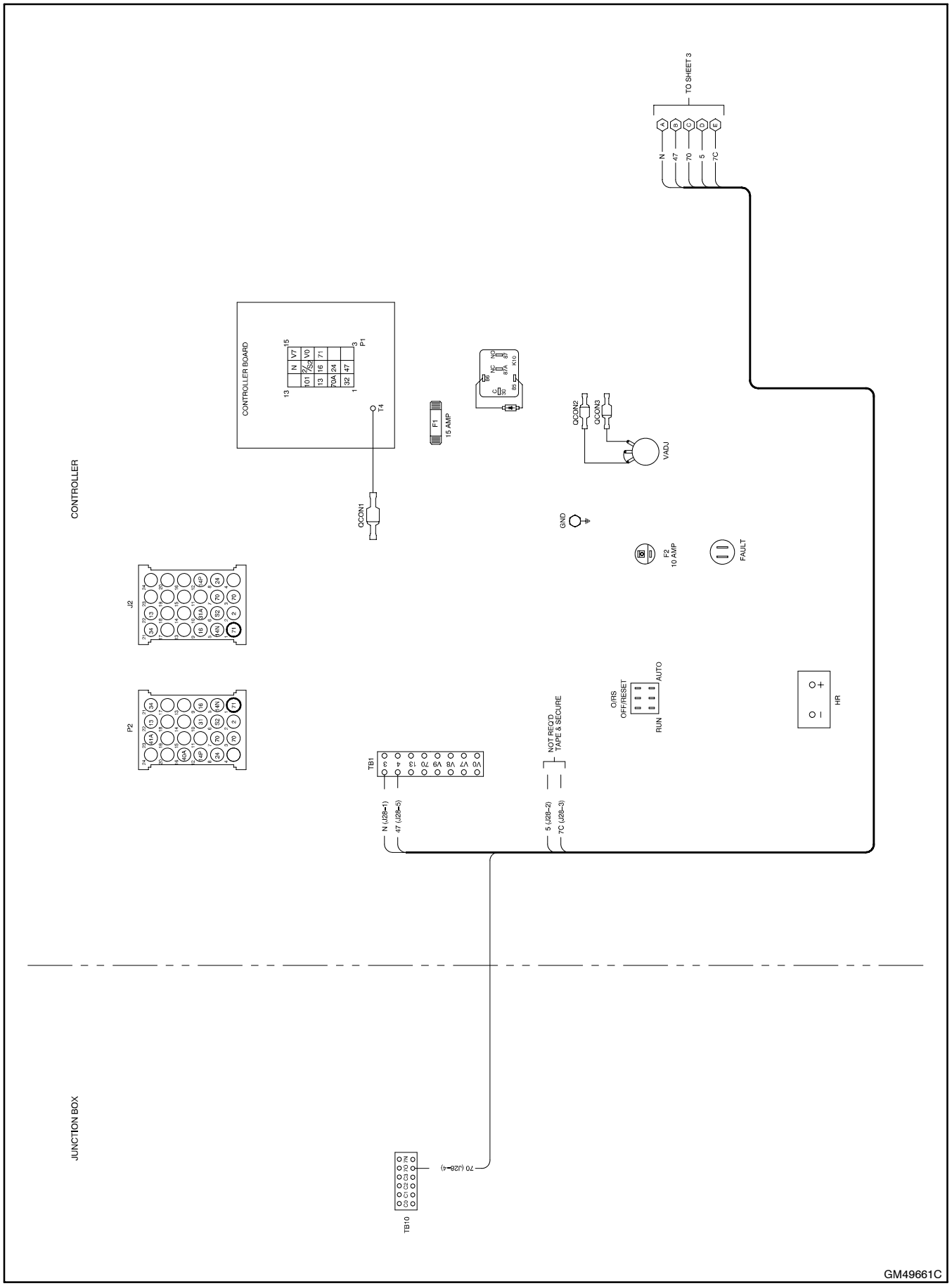


Figure 12-35 55–180EOZD/40–150EFOZD Wiring Diagram, Dec 1 Controller, Sheet 3 of 4, GM49661C

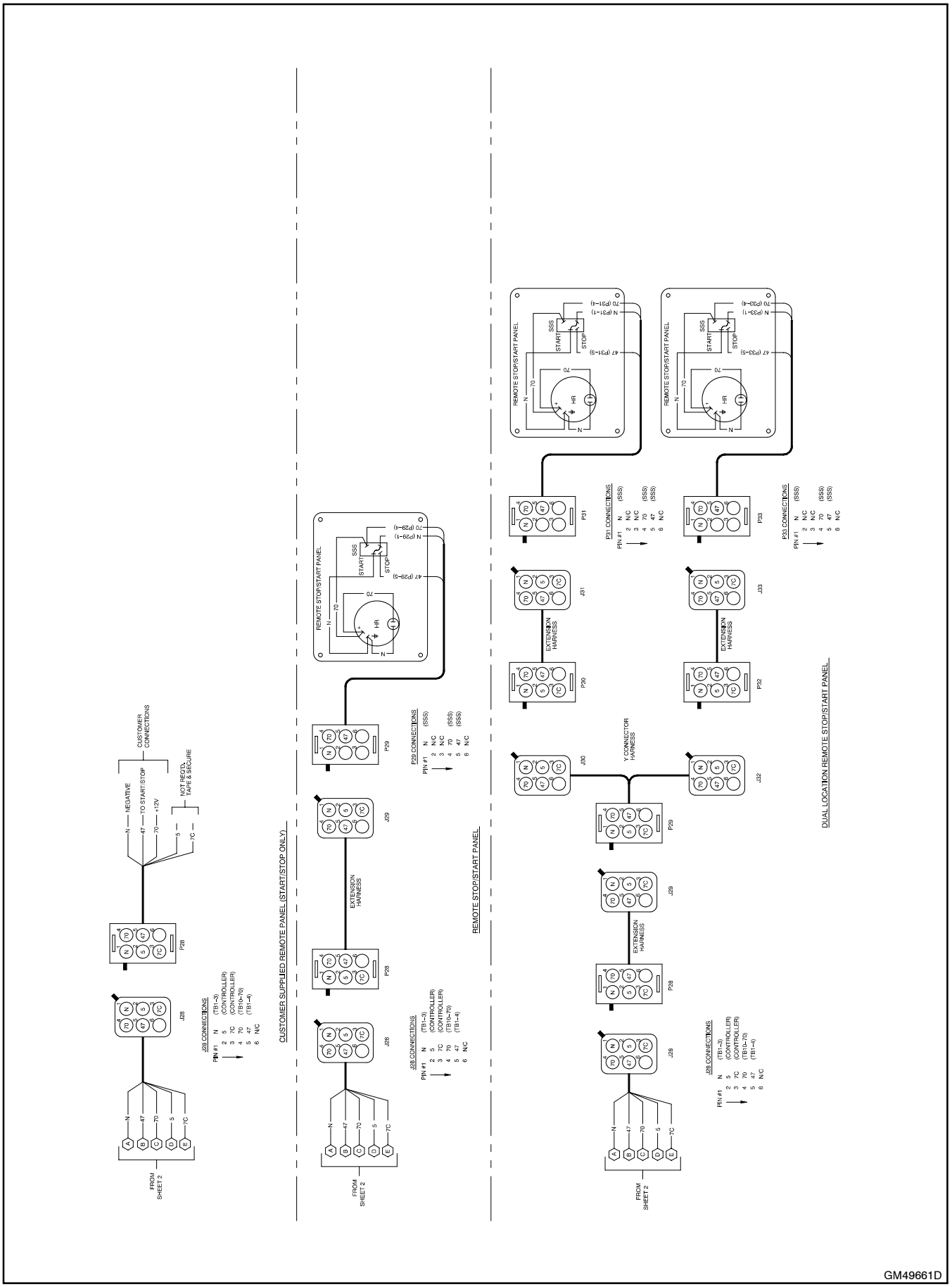


Figure 12-36 55–180EOZD/40–150EFOZD Wiring Diagram, Dec 1 Controller, Sheet 4 of 4, GM49661D

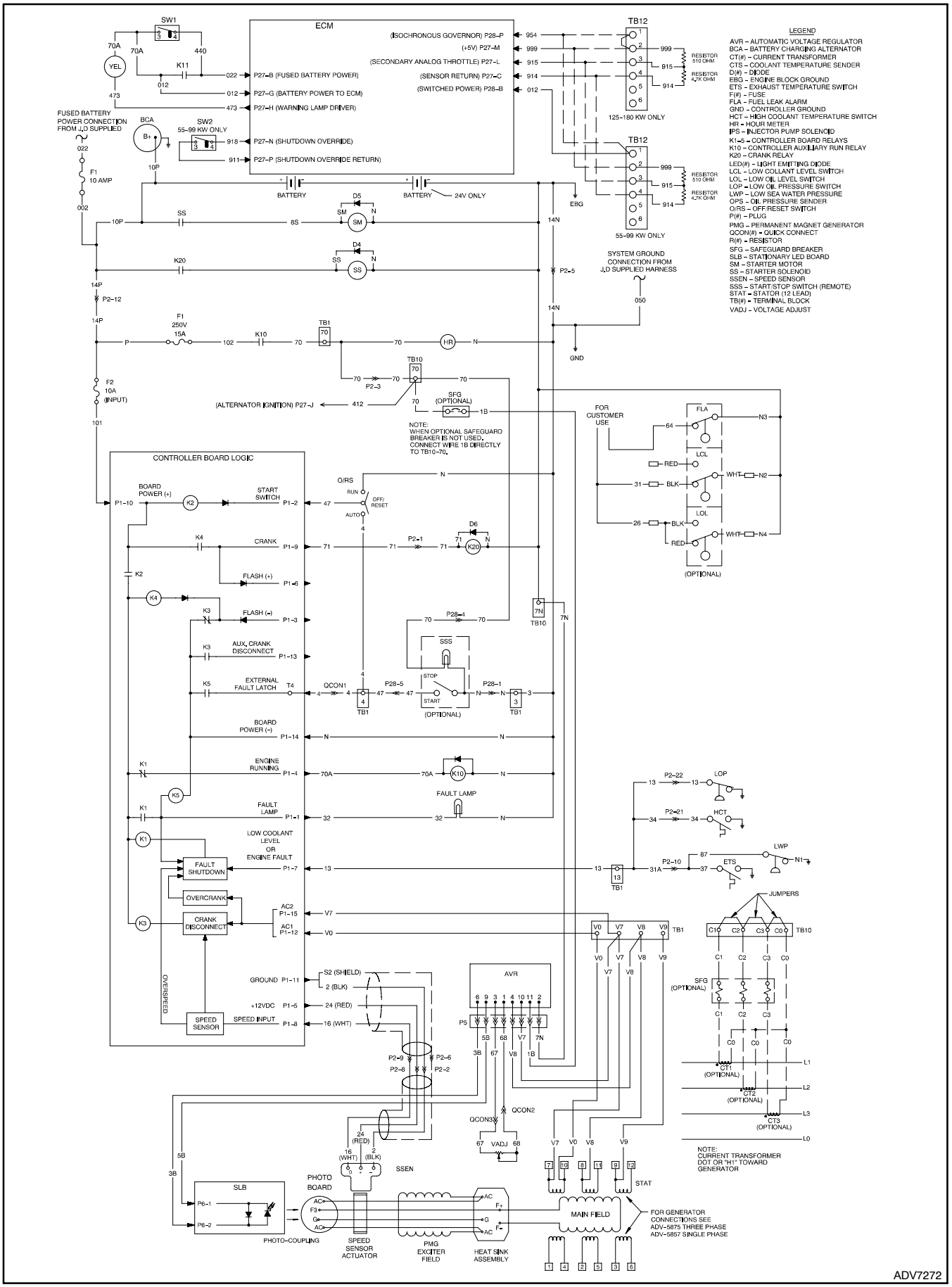


Figure 12-37 55–180EOZD/40–150EFOZD Schematic, Dec 1 Controller, Sheet 1 of 1, ADV7272

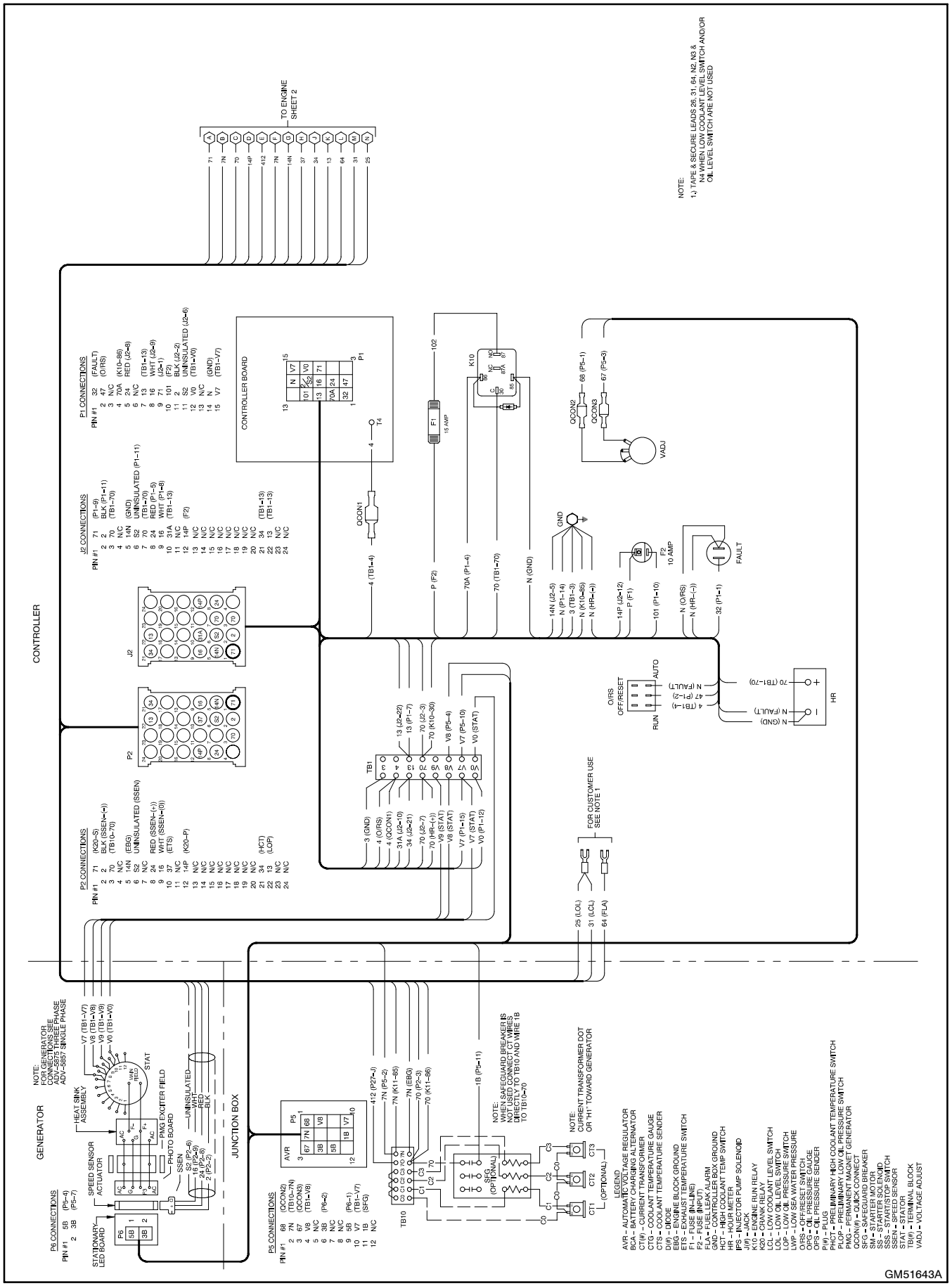


Figure 12-38 55–99EOZD/40–80EFOZD Wiring Diagram, Dec 1 Controller, Sheet 1 of 4, GM51643A

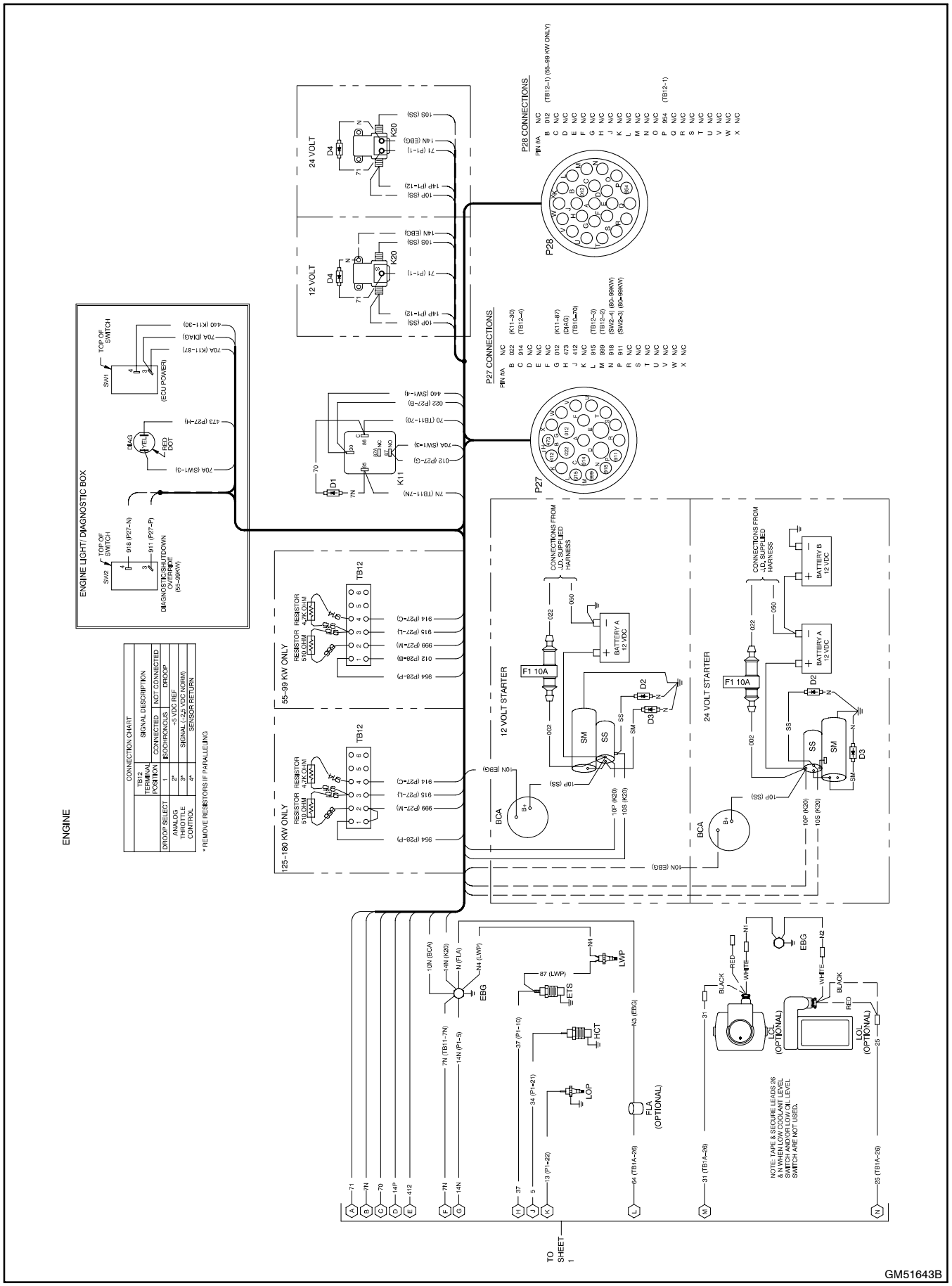


Figure 12-39 55-99EOZD/40-80EFOZD Wiring Diagram, Dec 1 Controller, Sheet 2 of 4, GM51643B

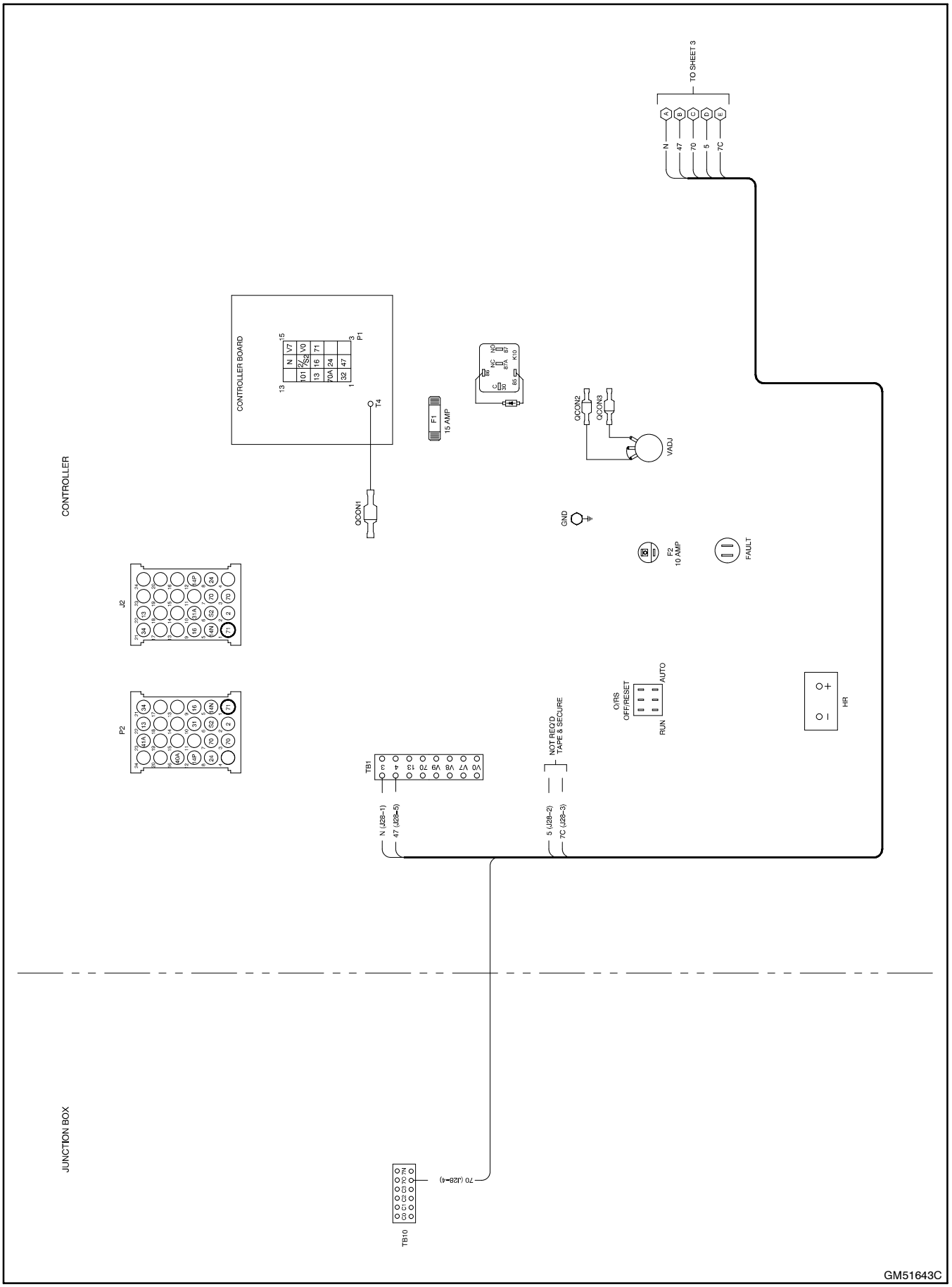


Figure 12-40 55-99EOZD/40-80EFOZD Wiring Diagram, Dec 1 Controller, Sheet 3 of 4, GM51643C

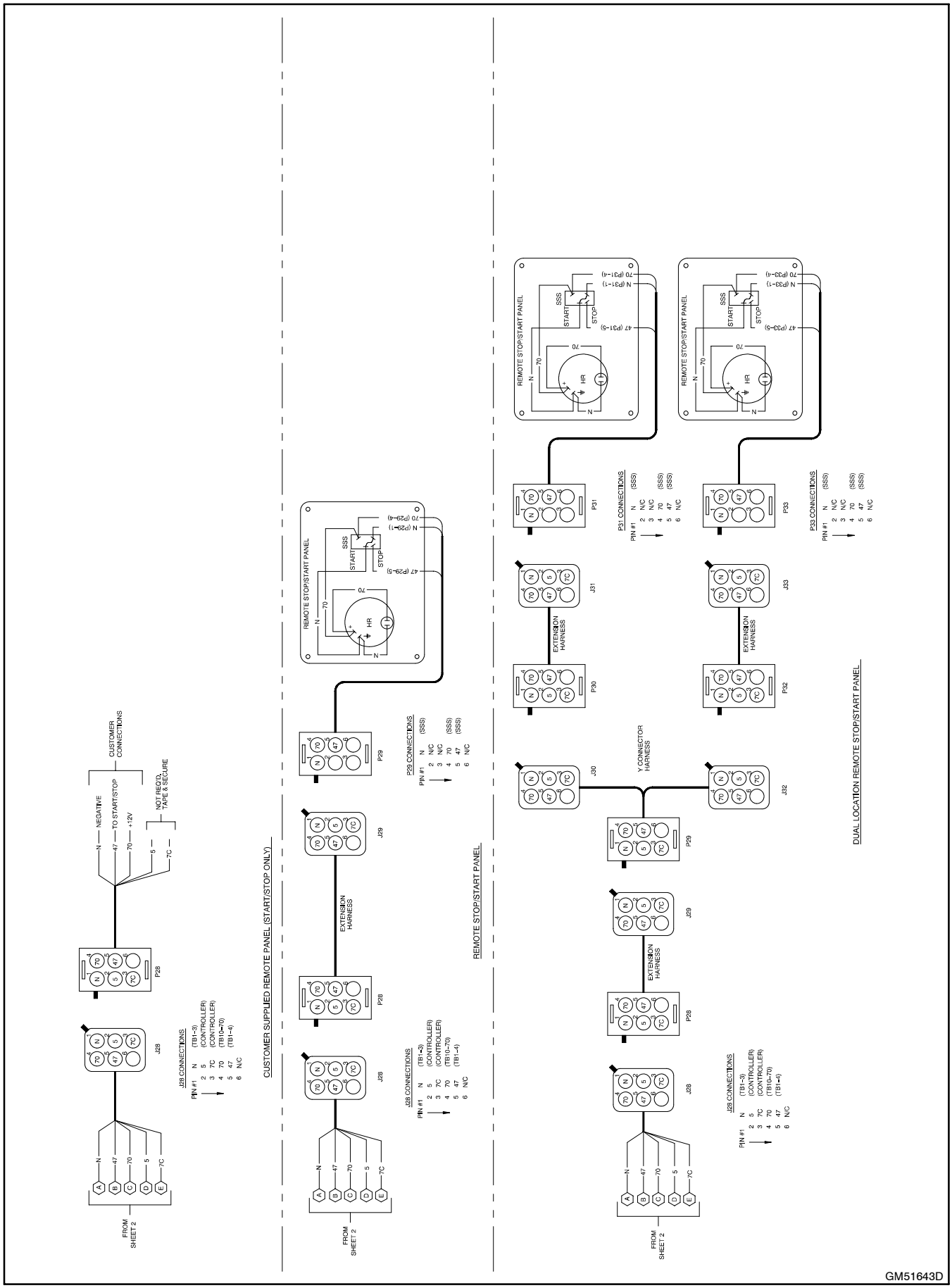


Figure 12-41 55-99EOZD/40-80EFOZD Wiring Diagram, Dec 1 Controller, Sheet 4 of 4, GM51643D

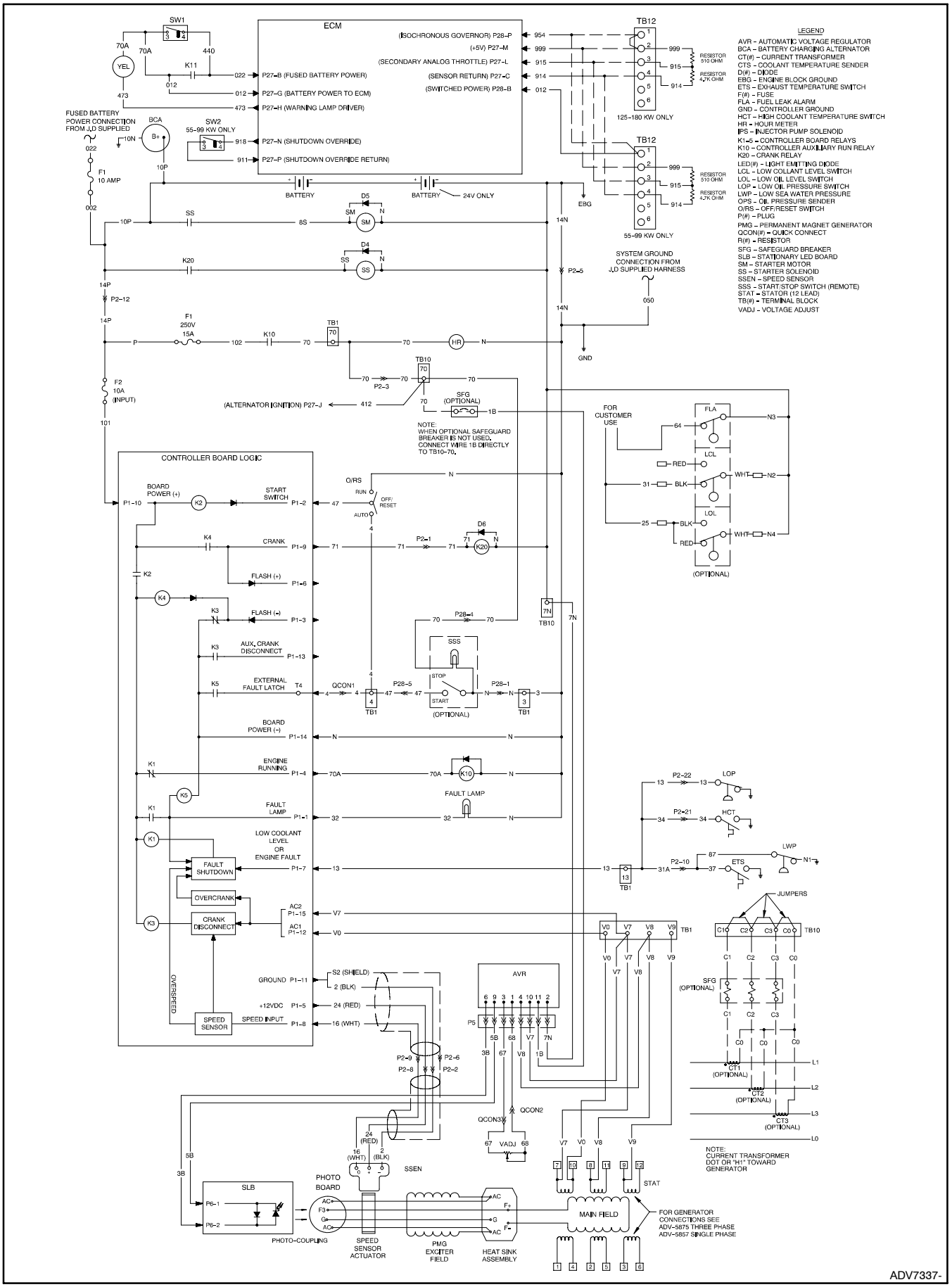


Figure 12-42 55-99EOZD/40-80EFOZD Schematic, Dec 1 Controller, Sheet 1 of 1, ADV7337

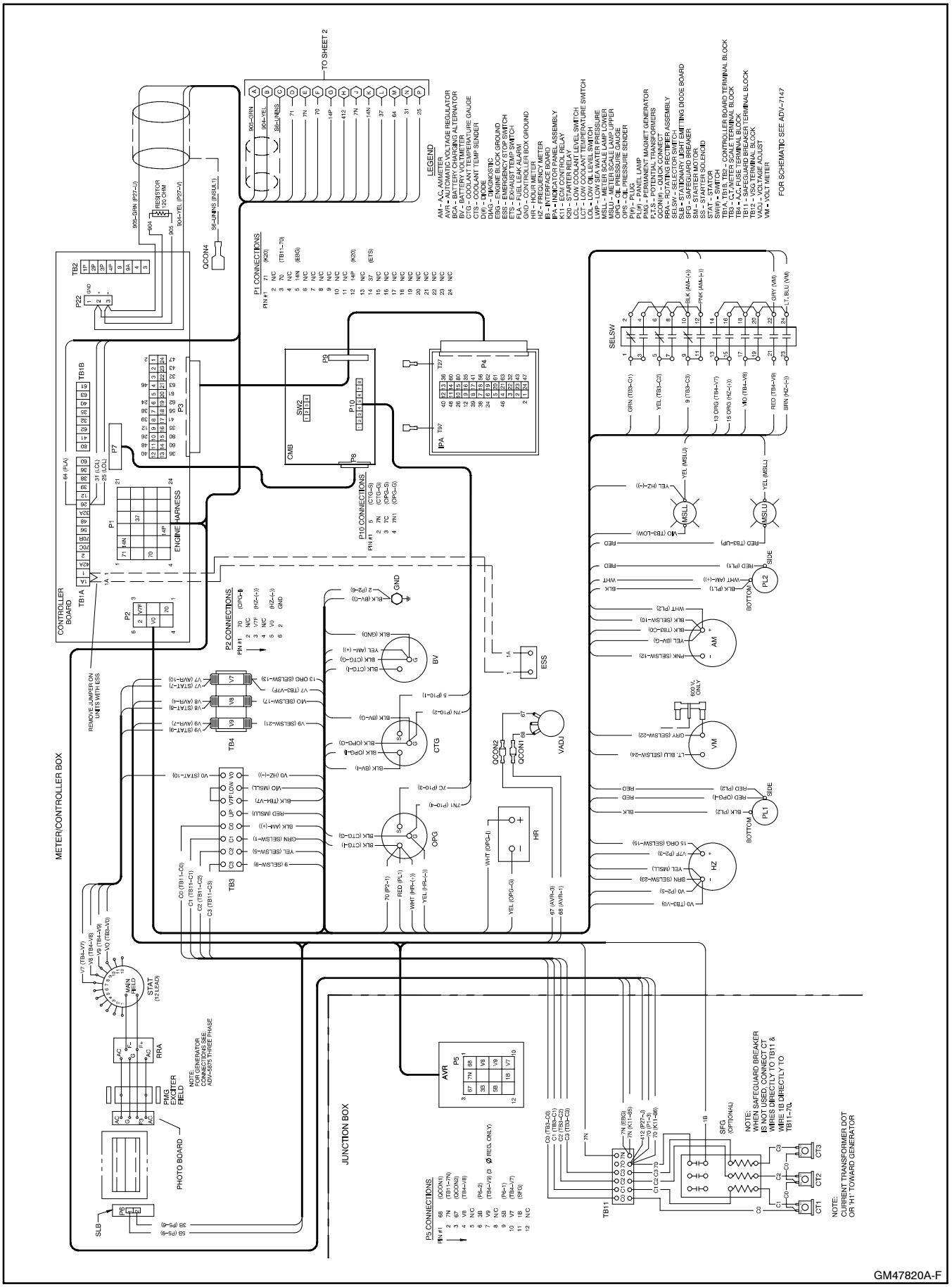


Figure 12-43 55–180EOZD/40–150EFOZD Wiring Diagram, Dec 3+ Controller, Sheet 1 of 2, GM47820A-F

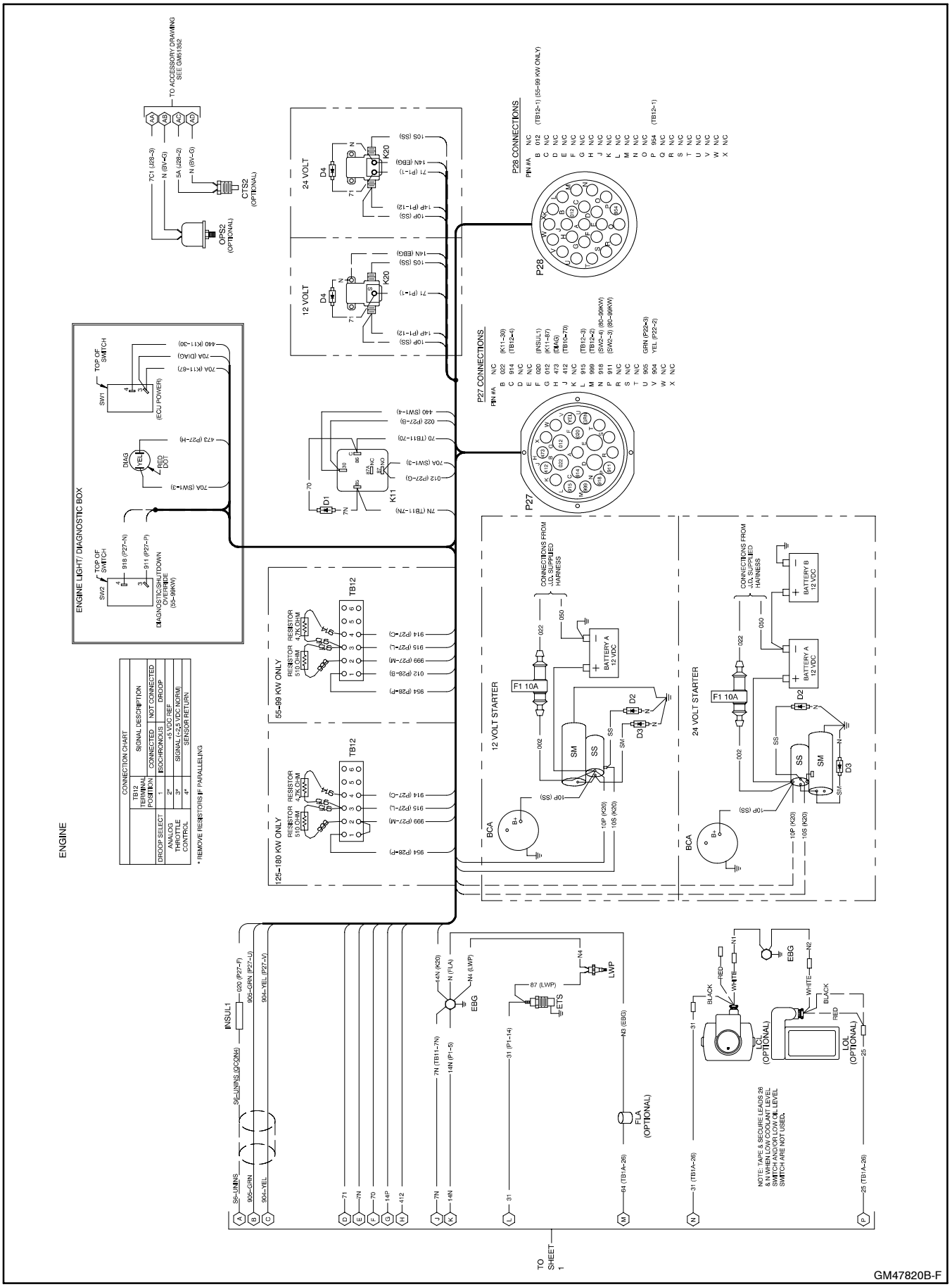
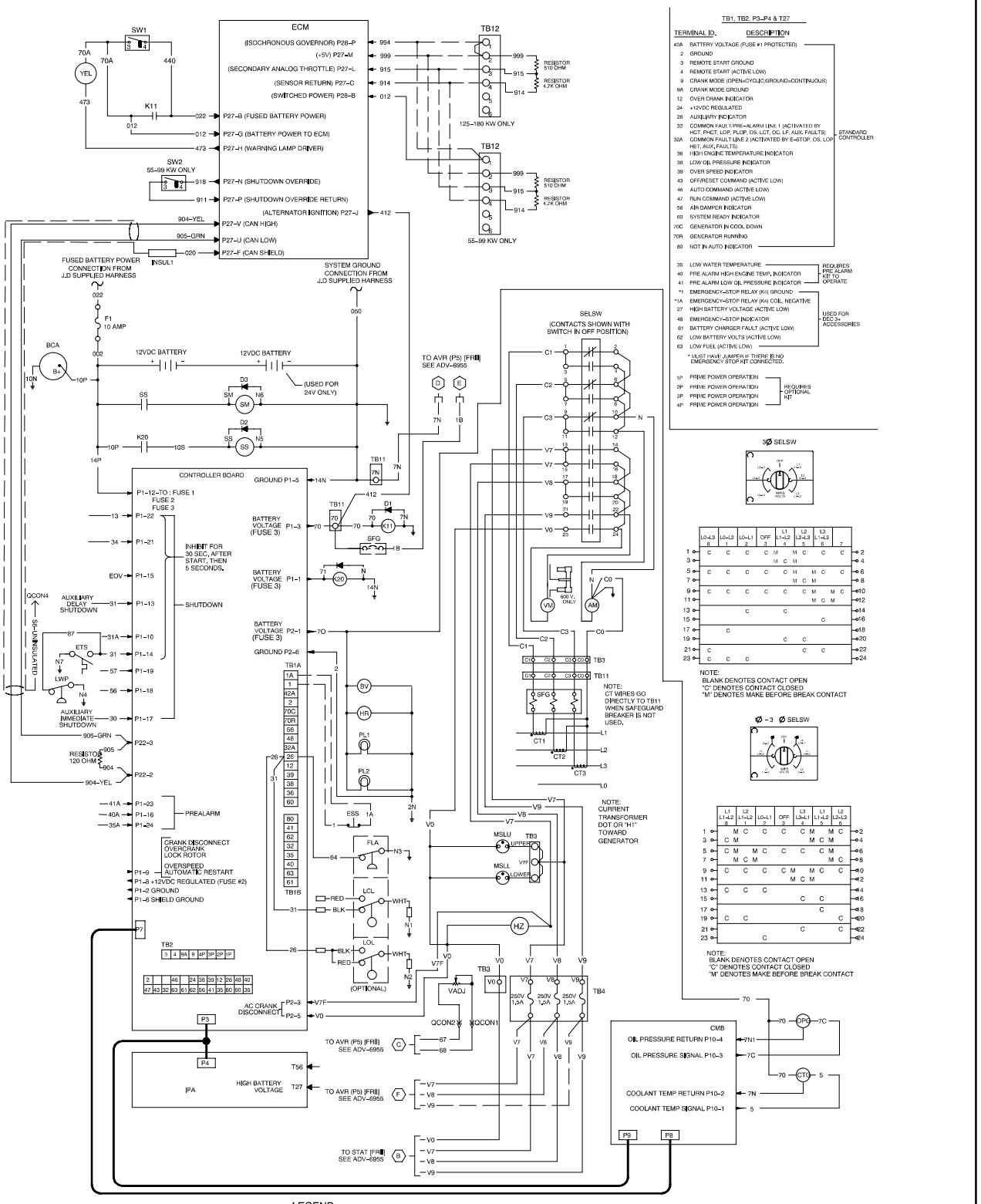


Figure 12-44 55–180EOZD/40–150EFOZD Wiring Diagram, Dec 3+ Controller, Sheet 2 of 2, GM47820B-F



LEGEND

AM – A.C. AMMETER
AVR – AUTOMATIC VOLTAGE REGULATOR
BCA – BATTERY CHARGING ALTERNATOR
BV – BATTERY VOLTMETER
CMB – COMMUNICATION MODULE BOARD
CT(#) – CURRENT TRANSFORMER
CTG – COOLANT TEMPERATURE GAUGE
CTS – COOLANT TEMPERATURE SENDER
D(#) – DIODE
ECM – ENGINE CONTROL MODULE
ESS – EMERGENCY STOP SWITCH
ETS – EXHAUST TEMPERATURE SWITCH
FLA – FUEL LEAK ALARM
HR – HOUR METER
HR – HOUR METER
HZ – FREQUENCY METER
IPA – INDICATOR PANEL ASSEMBLY
K11 – ECM CONTROL RELAY
K20 – STARTER RELAY
LCL – LOW COOLANT LEVEL SENSOR
LCT – LOW COOLANT TEMPERATURE SENSOR
LOL – LOW OIL LEVEL SWITCH
LWP – LOW SEA WATER PRESSURE
MSLL – METER SCALE LAMP LOWER
MSLU – METER SCALE LAMP UPPER
OPG – OIL PRESSURE GAUGE
OPS – OIL PRESSURE SENDER
P(#) – PLUG
PL(#) – PANEL LAMP
SELSW – SELECTOR SWITCH
SFG – SAFEGUARD BREAKER
SM – STARTER MOTOR
SS – STARTER SOLENOID
TB1,2 – CONTROLLER BOARD TERMINAL BLOCK
TB3 – CT/METER SCALE TERMINAL BLOCK
TB4 – AC FUSE BLOCK
TB11 – SAFEGUARD BREAKER TERMINAL BLOCK
TB12 – VSG TERMINAL BLOCK
VADJ – VOLTAGE ADJUST
VM – A.C. VOLTMETER
⏚ – ENGINE BLOCK GROUND

ADV7147-F

Figure 12-45 55–180EOZD/40–150EFOZD Schematic, Dec 3+ Controller, Sheet 1 of 1, ADV7147-F

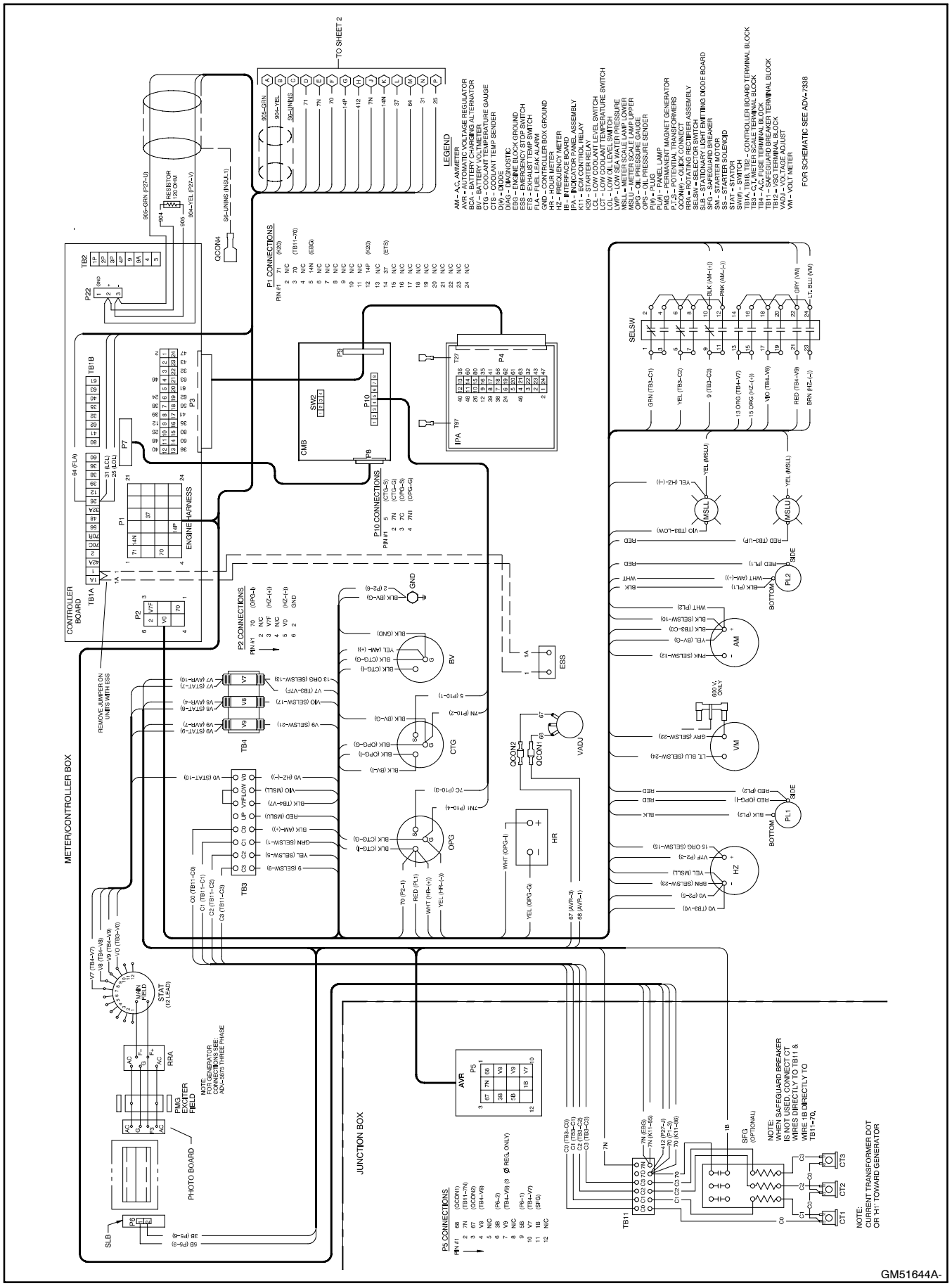


Figure 12-46 55-99EOZD/40-80EFOZD Wiring Diagram, Dec 3+ Controller, Sheet 1 of 2, GM51644A

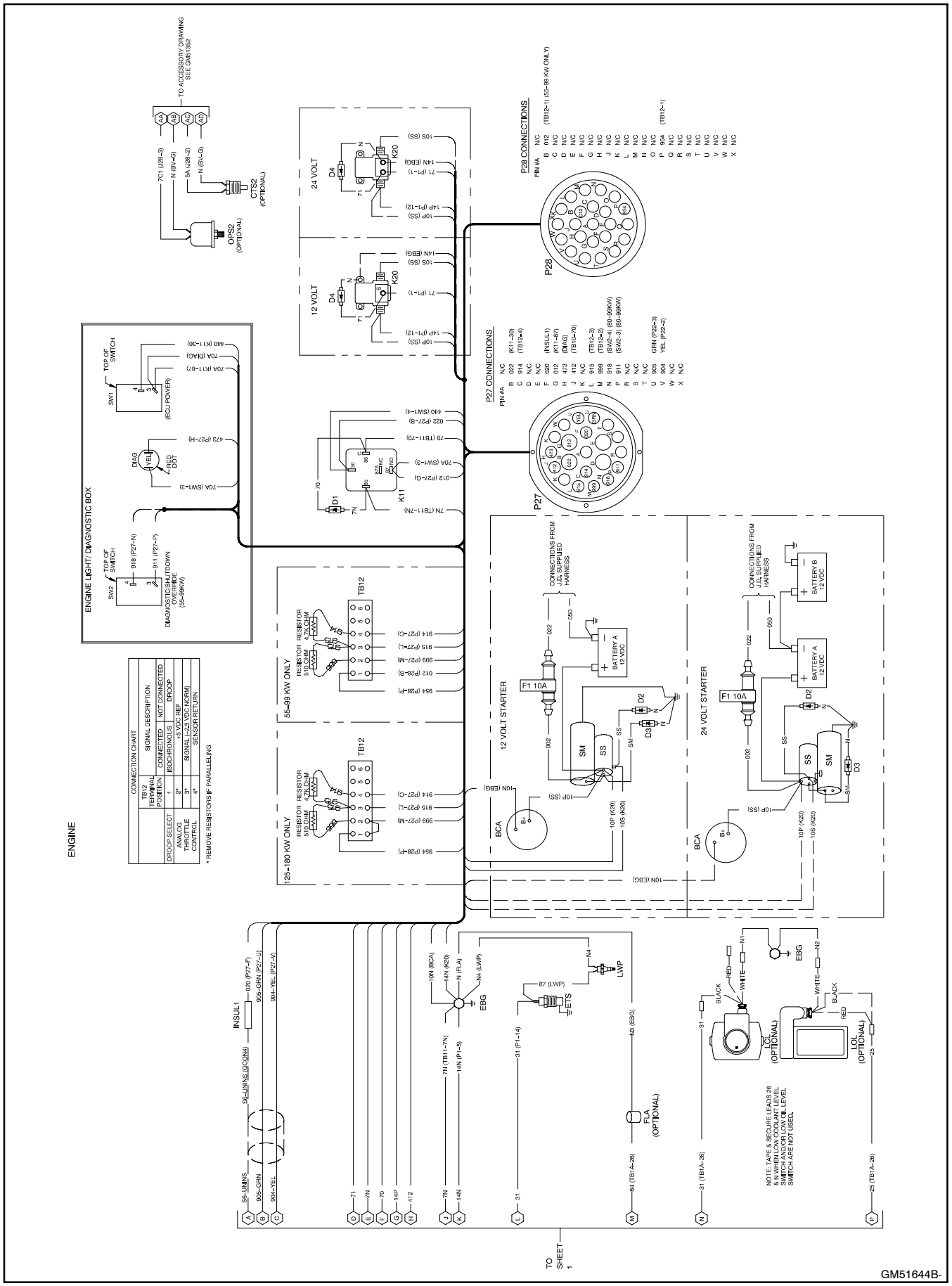
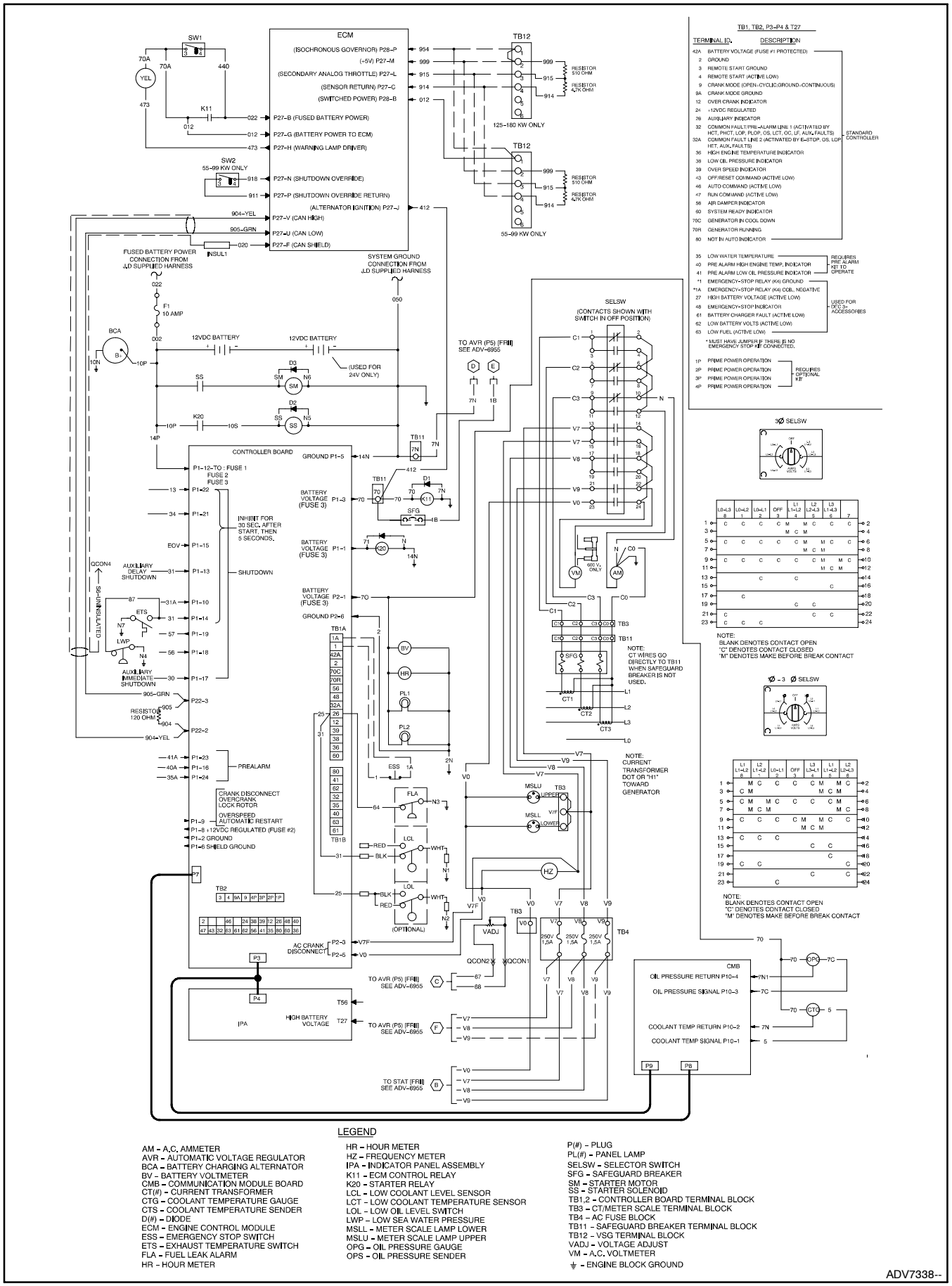


Figure 12-47 55-99EOZD/40-80EFOZD Wiring Diagram, Dec 3+ Controller, Sheet 2 of 2, GM51644B



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CTS – COOLANT TEMPERATURE SENDER
D(#) – DIODE
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TB3 – CT/METER SCALE TERMINAL BLOCK
TB4 – AC FUSE BLOCK
TB11 – SAFEGUARD BREAKER TERMINAL BLOCK
TB12 – VSG TERMINAL BLOCK
VADJ – VOLTAGE ADJUST
VM – A.C. VOLTMETER
⏚ – ENGINE BLOCK GROUND

ADV7338--

Figure 12-48 55–99EOZD/40–80EFOZD Schematic, Dec 3+ Controller, Sheet 1 of 1, ADV7338

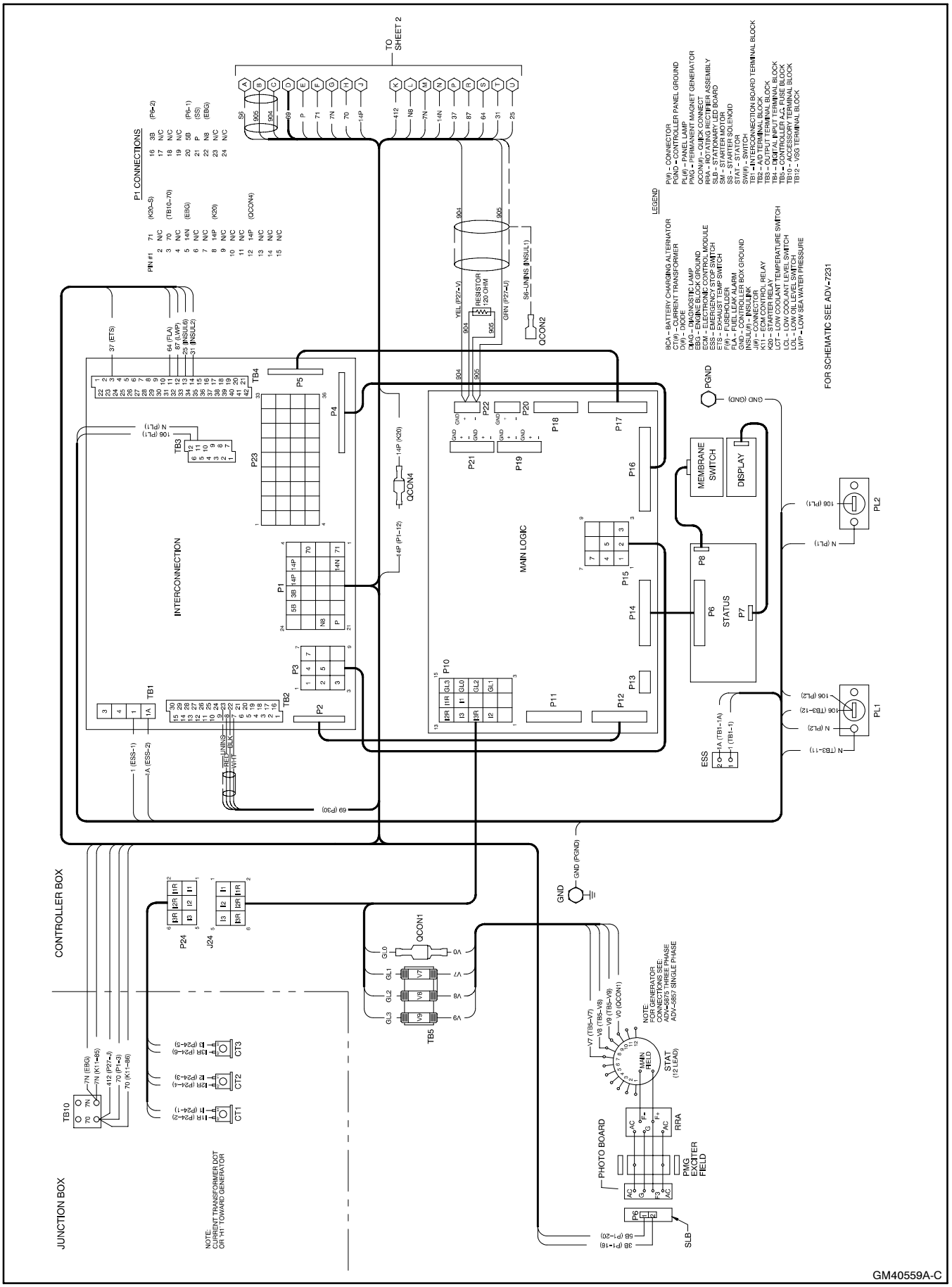


Figure 12-49 55–180EOZD/40–150EFOZD Wiring Diagram, Dec 550 Controller, Sheet 1 of 2, GM40559A-C

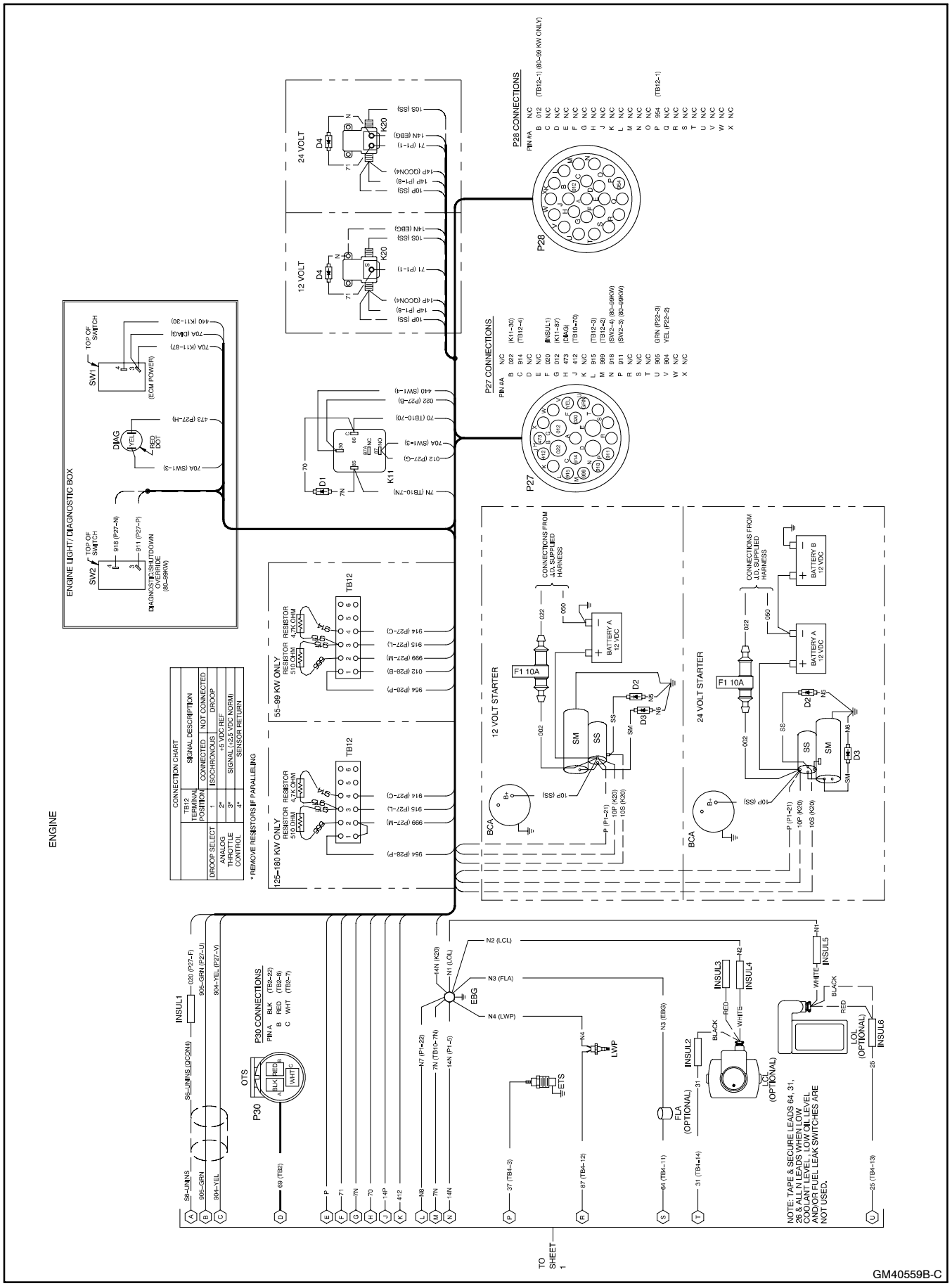


Figure 12-50 55–180EOZD/40–150EFOZD Wiring Diagram, Dec 550 Controller, Sheet 2 of 2, GM40559B-C

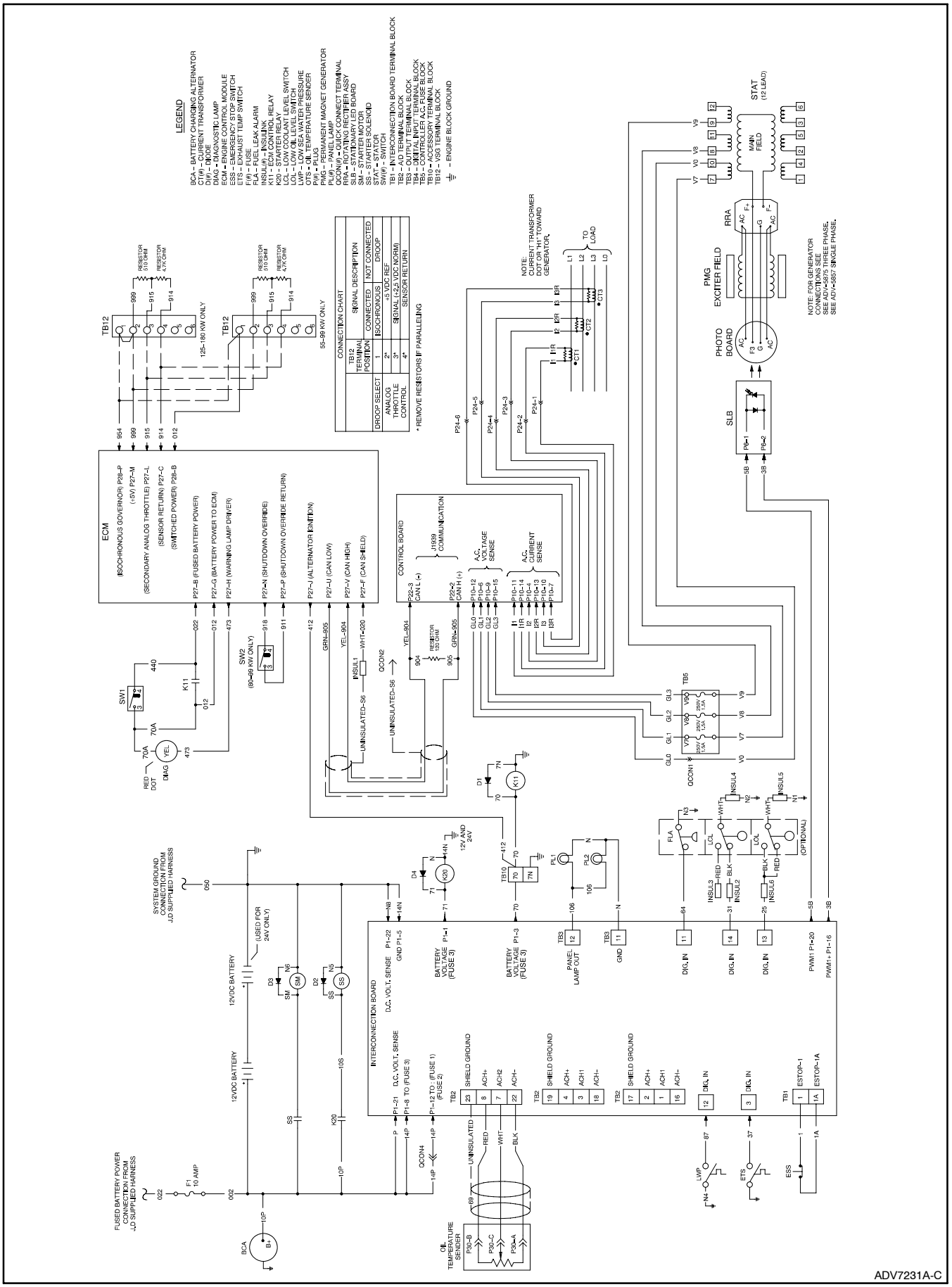


Figure 12-51 55–180EOZD/40–150EFOZD Schematic, Dec 550 Controller, Sheet 1 of 2, ADV7231A-C

Figure 12-52 55–180EOZD/40–150EFOZD Schematic, Dec 550 Controller, Sheet 2 of 2, ADV7231B-C

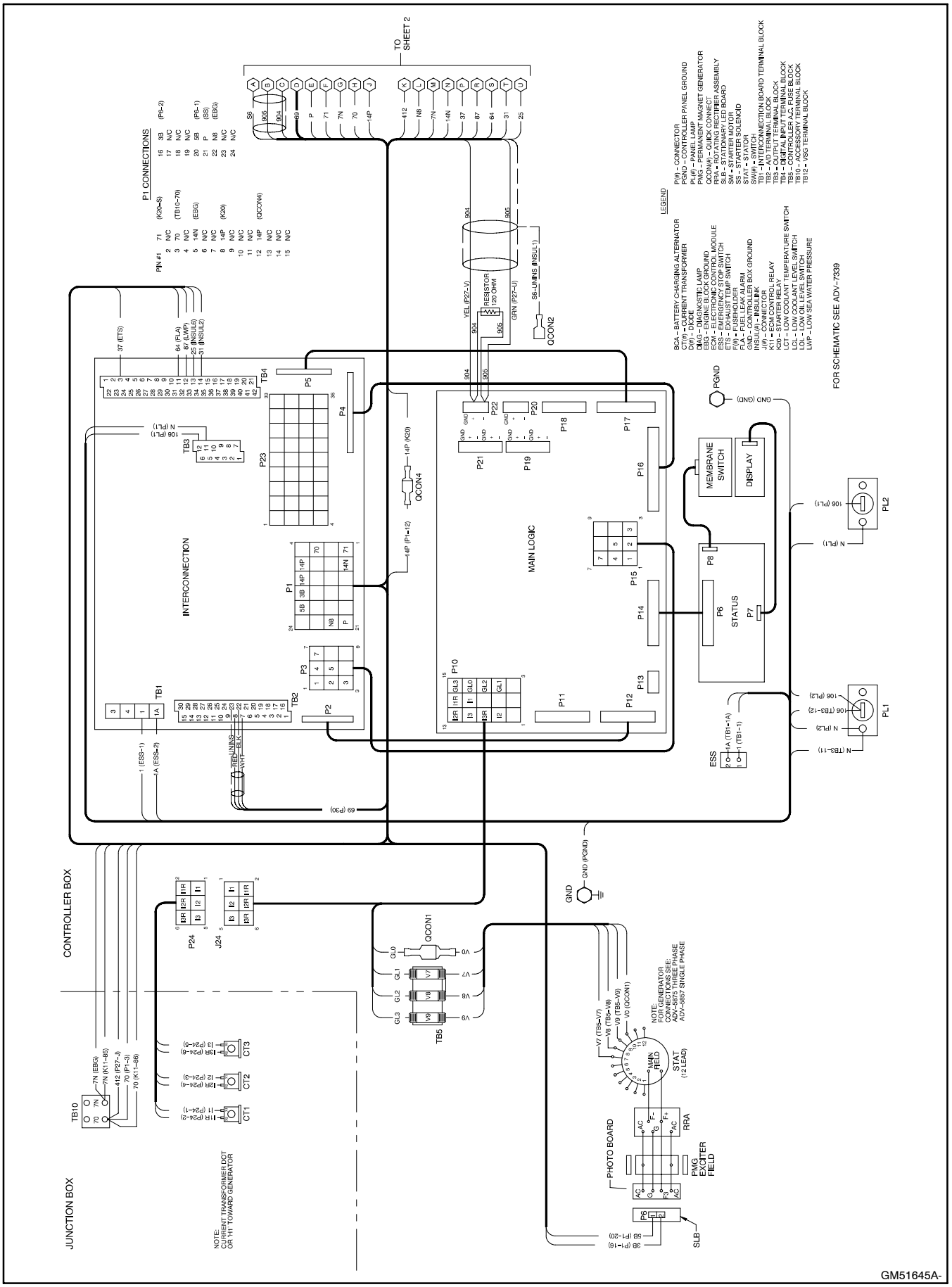


Figure 12-53 55-99EOZD/40-80EFOZD Wiring Diagram, Dec 550 Controller, Sheet 1 of 2, GM51645A

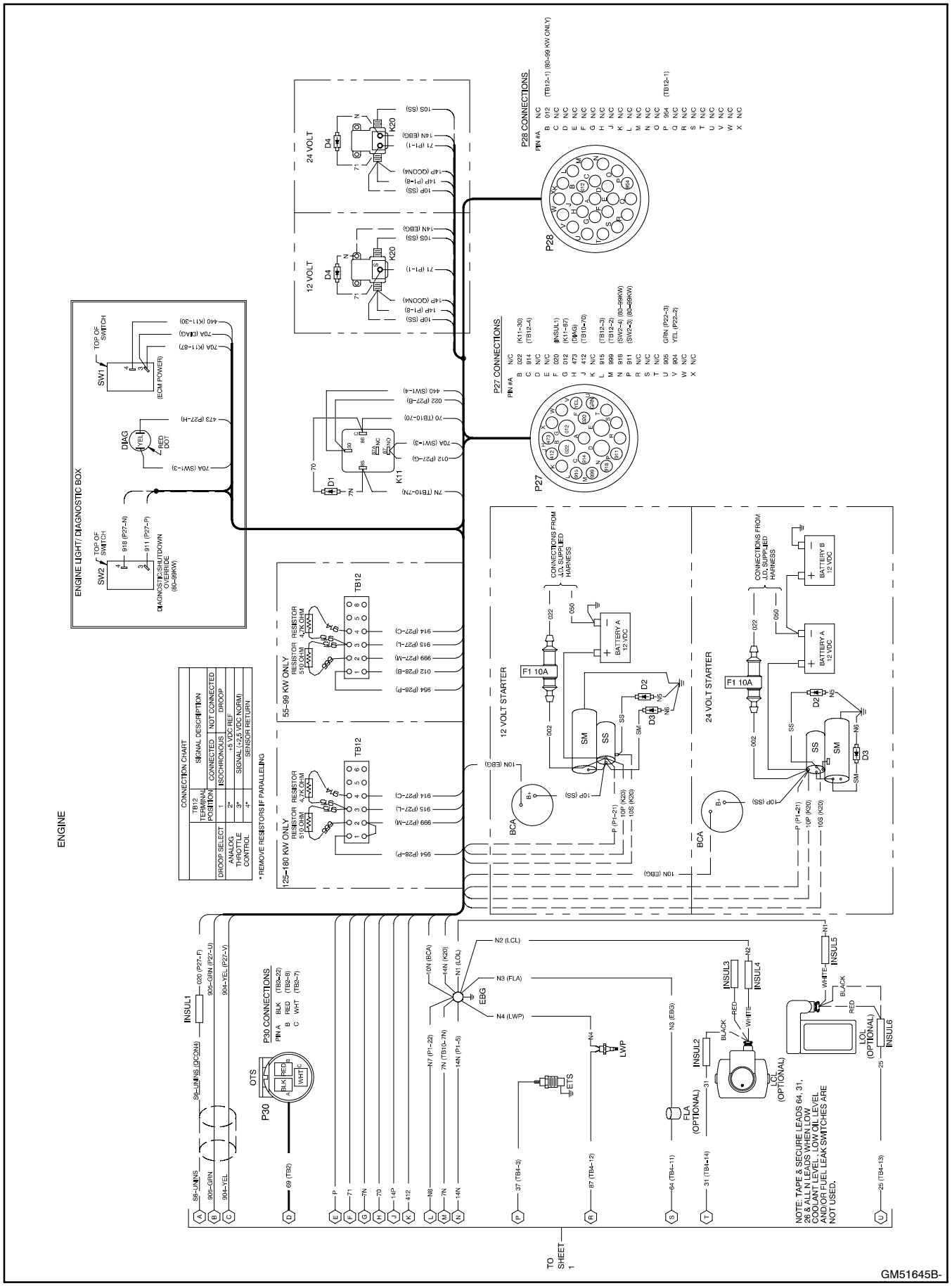


Figure 12-54 55–99EOZD/40–80EFOZD Wiring Diagram, Dec 550 Controller, Sheet 2 of 2, GM51645B

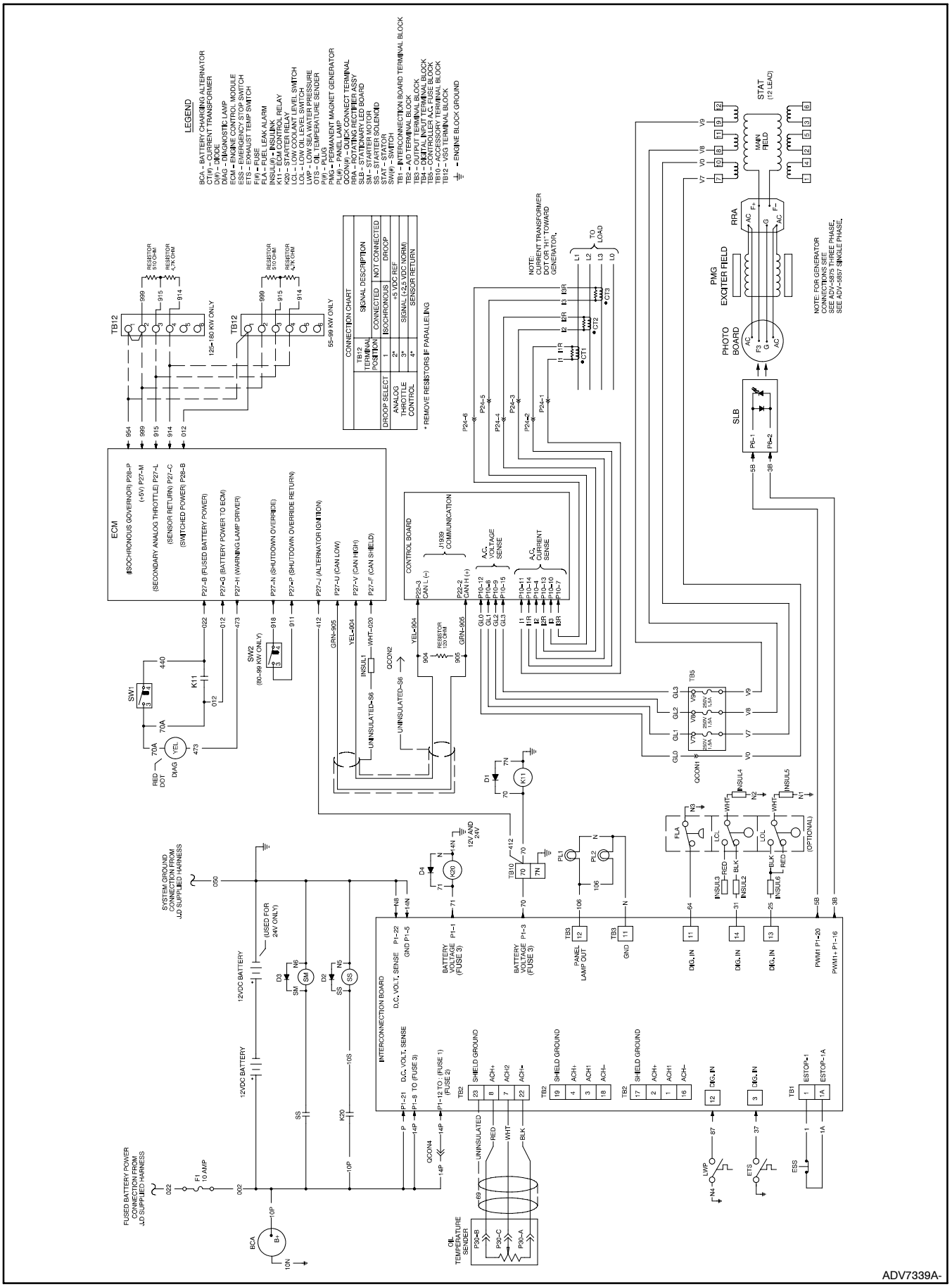


Figure 12-55 55–99EOZD/40–80EFOZD Schematic, Dec 550 Controller, Sheet 1 of 2, ADV7339A

Figure 12-56 55–99EOZD/40–80EFOZD Schematic, Dec 550 Controller, Sheet 2 of 2, ADV7339B

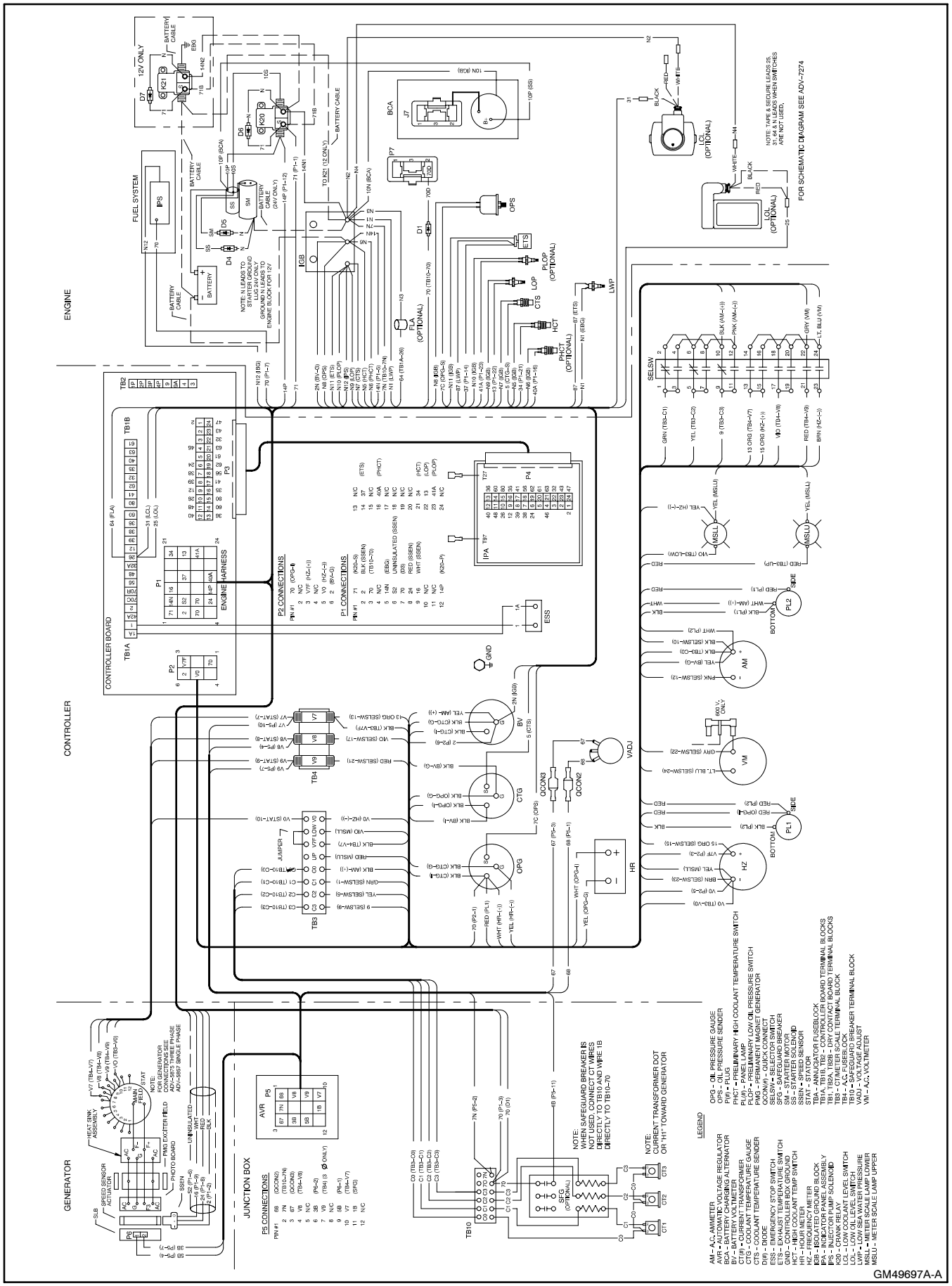


Figure 12-57 40EOZD/33EFOZD Wiring Diagram, Dec 3+ Controller—Isolated Ground, Sheet 1 of 7, GM49697A-A

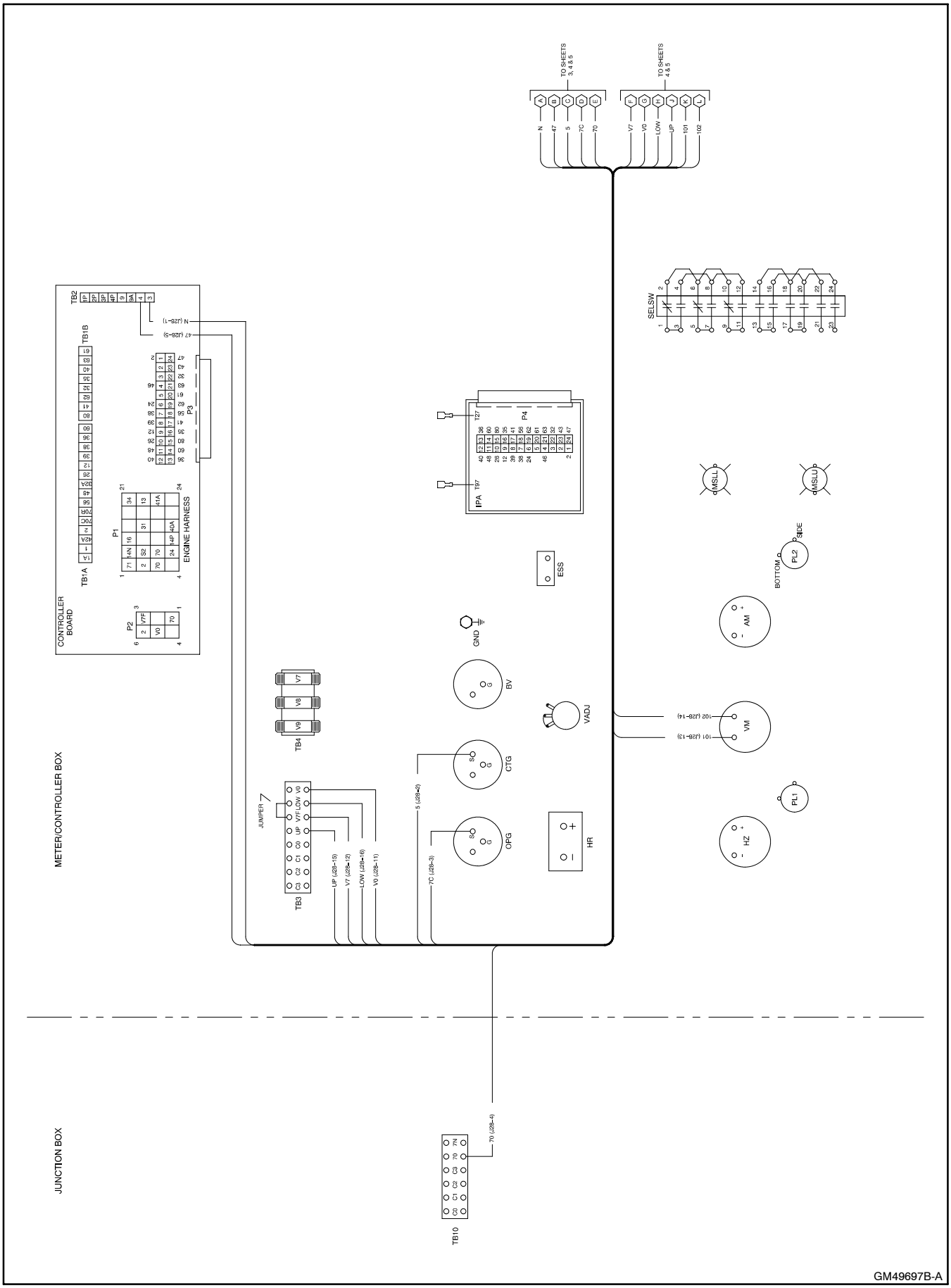


Figure 12-58 40EOZD/33EFOZD Wiring Diagram, Dec 3+ Controller—Isolated Ground, Sheet 2 of 7, GM49697B-A

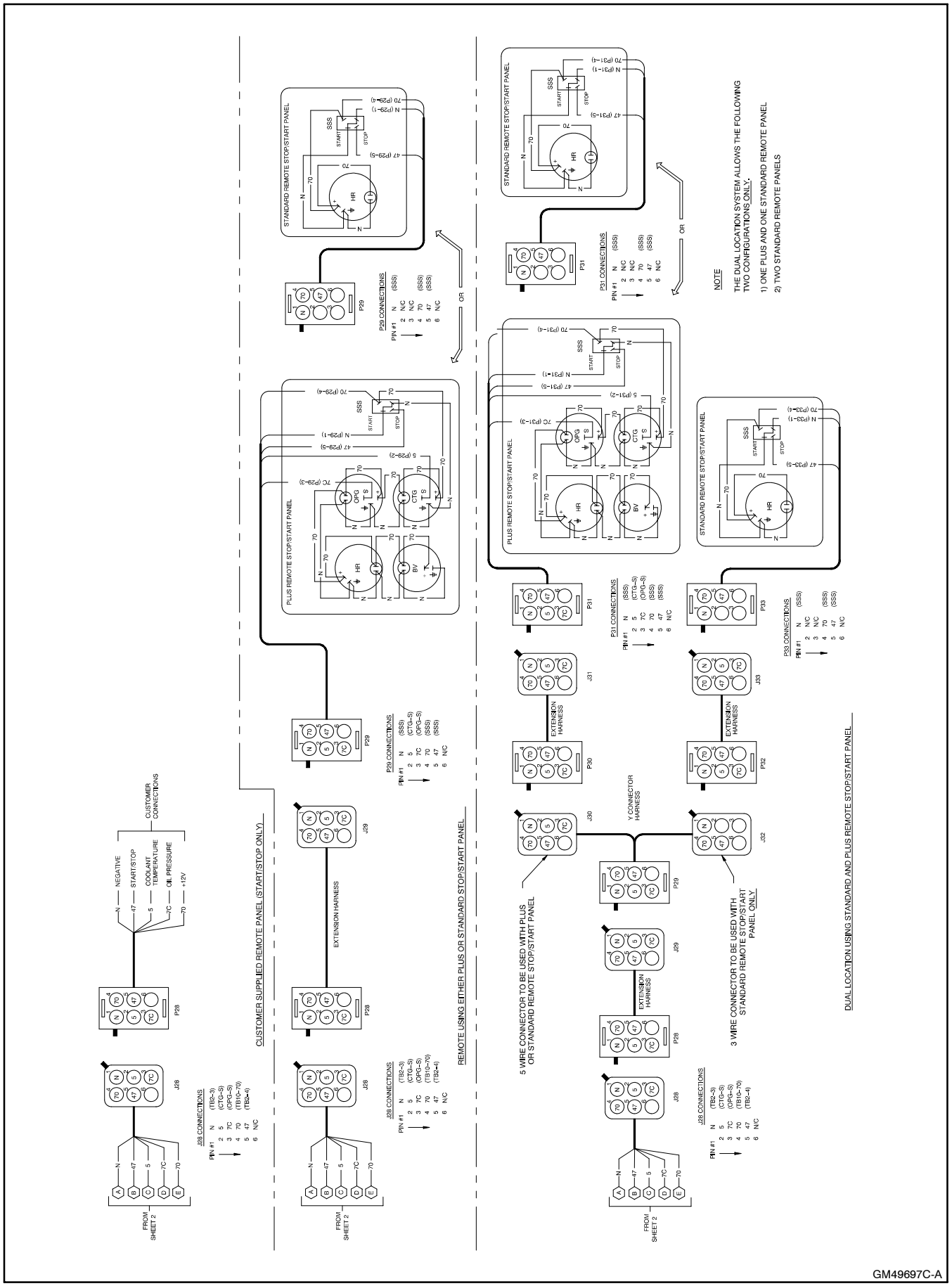


Figure 12-59 40EOZD/33EFOZD Wiring Diagram, Dec 3+ Controller—Isolated Ground, Sheet 3 of 7, GM49697C-A

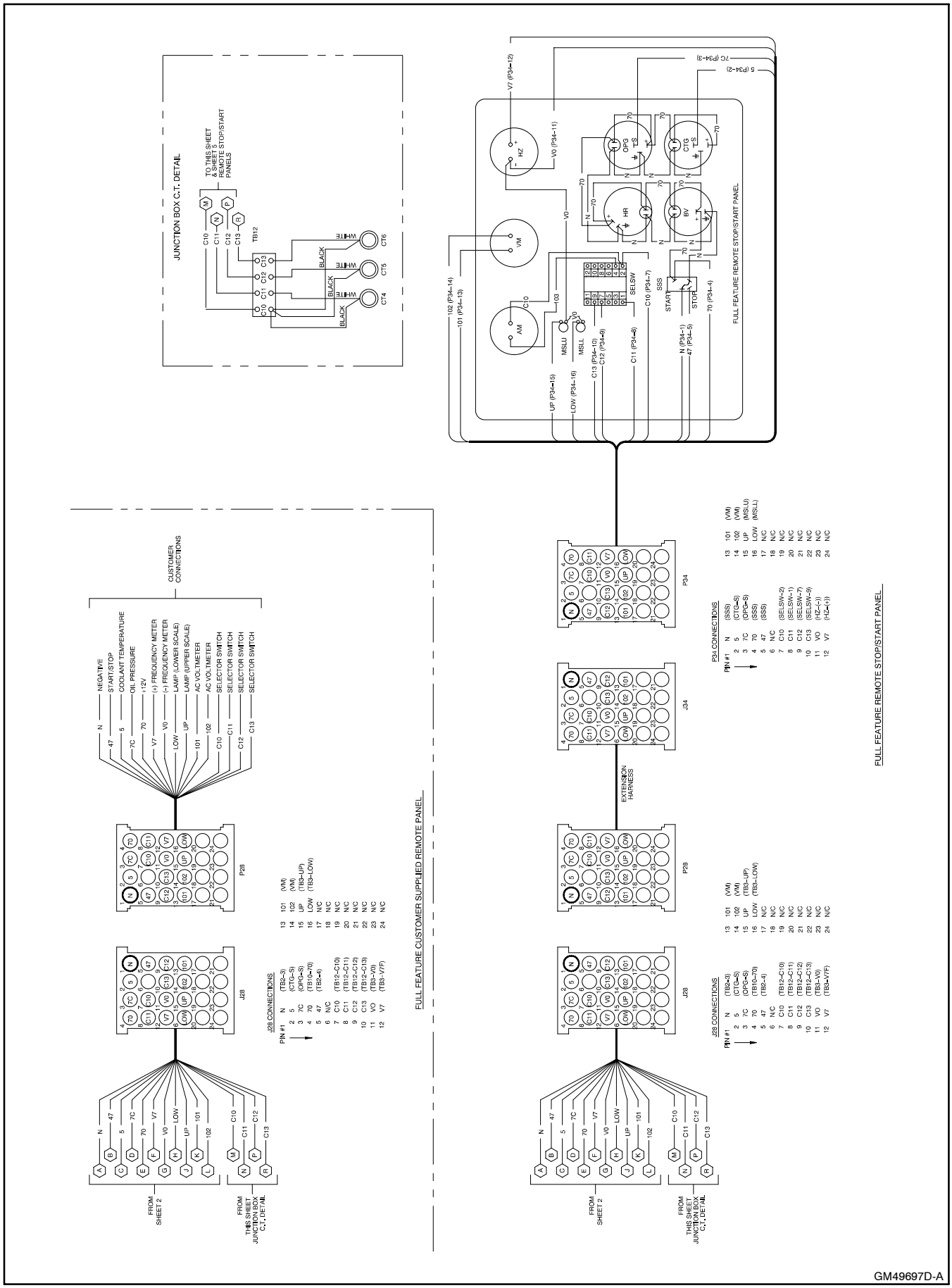


Figure 12-60 40EOZD/33EFOZD Wiring Diagram, Dec 3+ Controller—Isolated Ground, Sheet 4 of 7, GM49697D-A

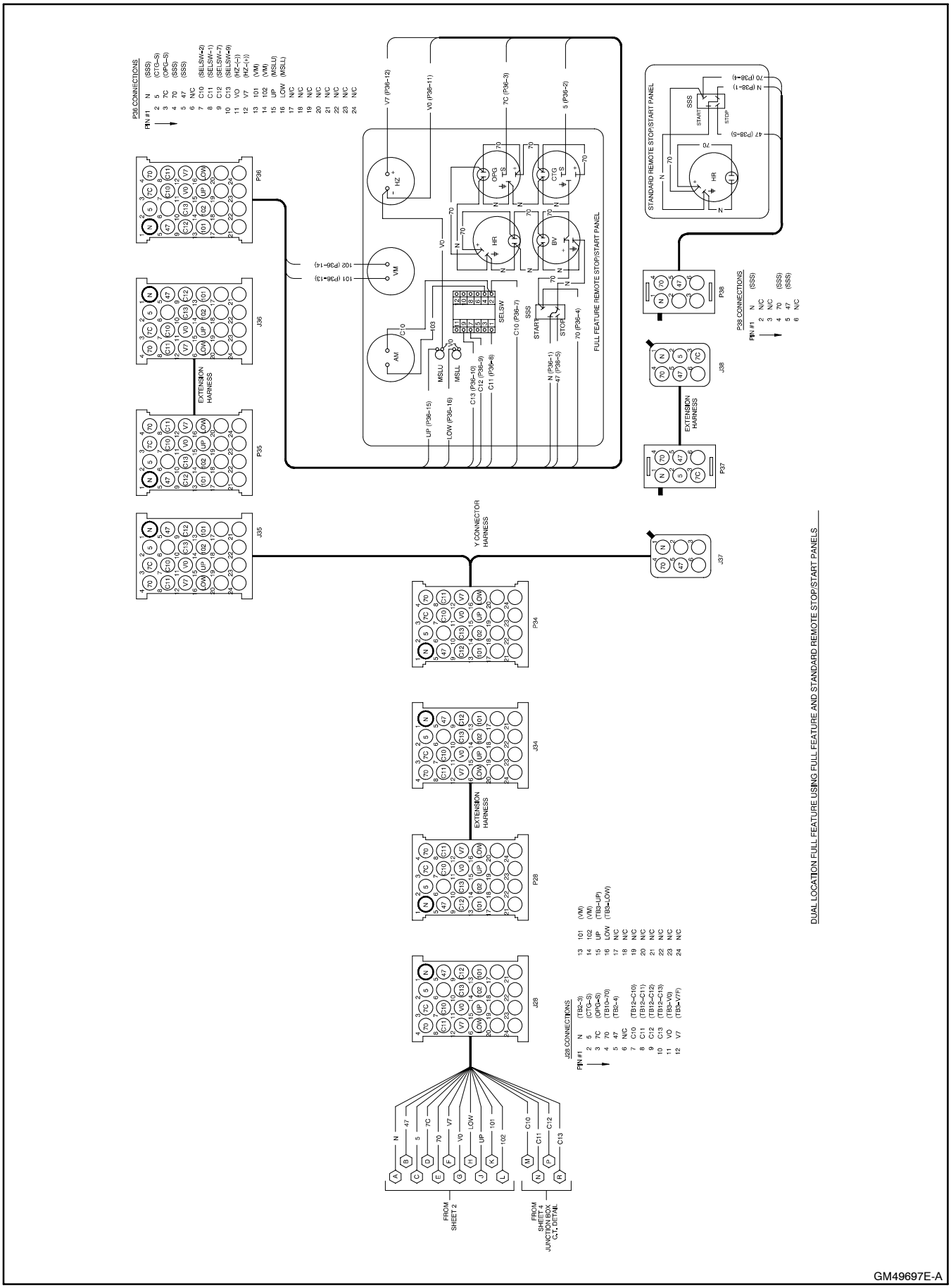


Figure 12-61 40EOZD/33EFOZD Wiring Diagram, Dec 3+ Controller—Isolated Ground, Sheet 5 of 7, GM49697E-A

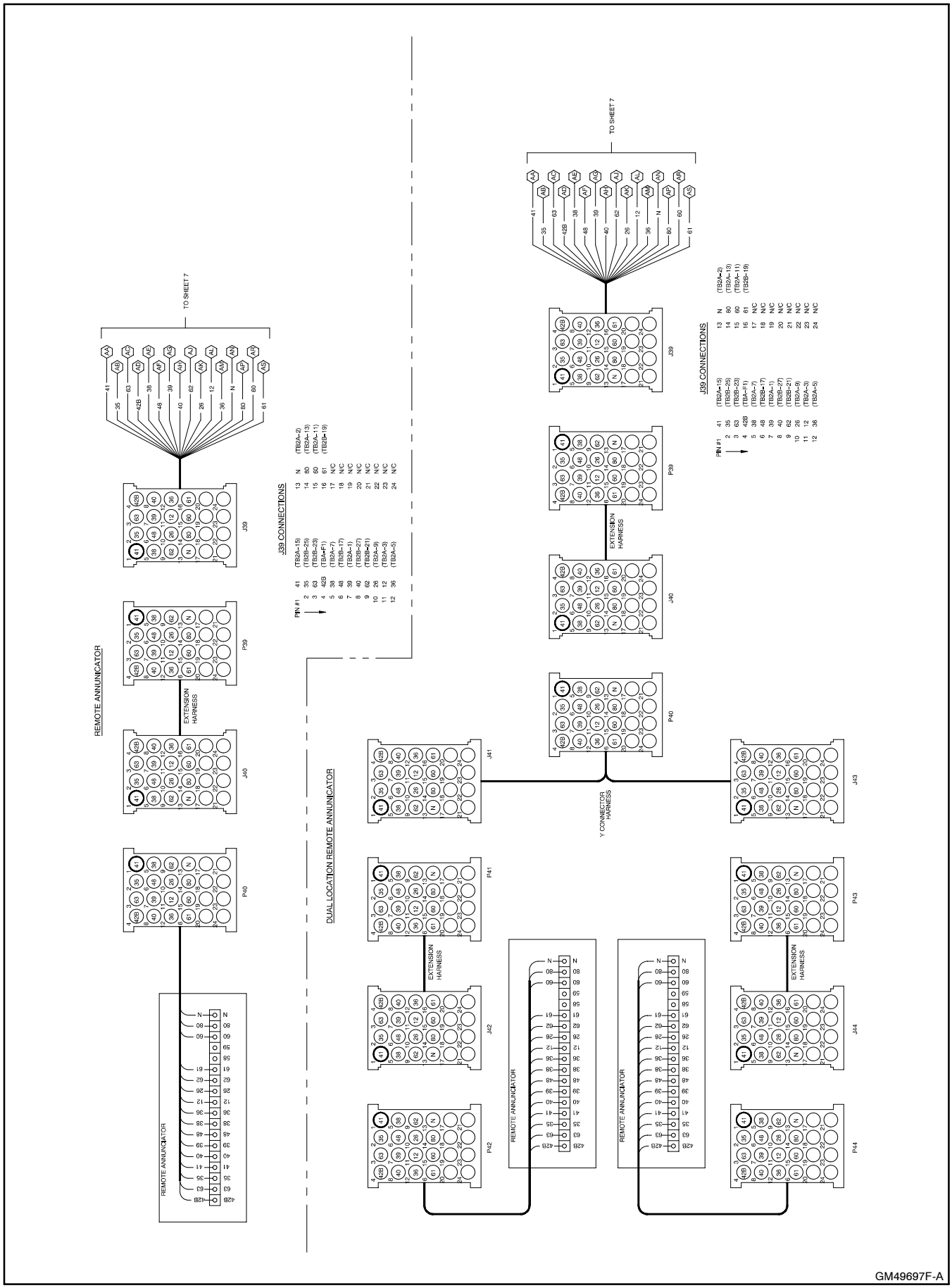


Figure 12-62 40EOZD/33EFOZD Wiring Diagram, Dec 3+ Controller—Isolated Ground, Sheet 6 of 7, GM49697F-A

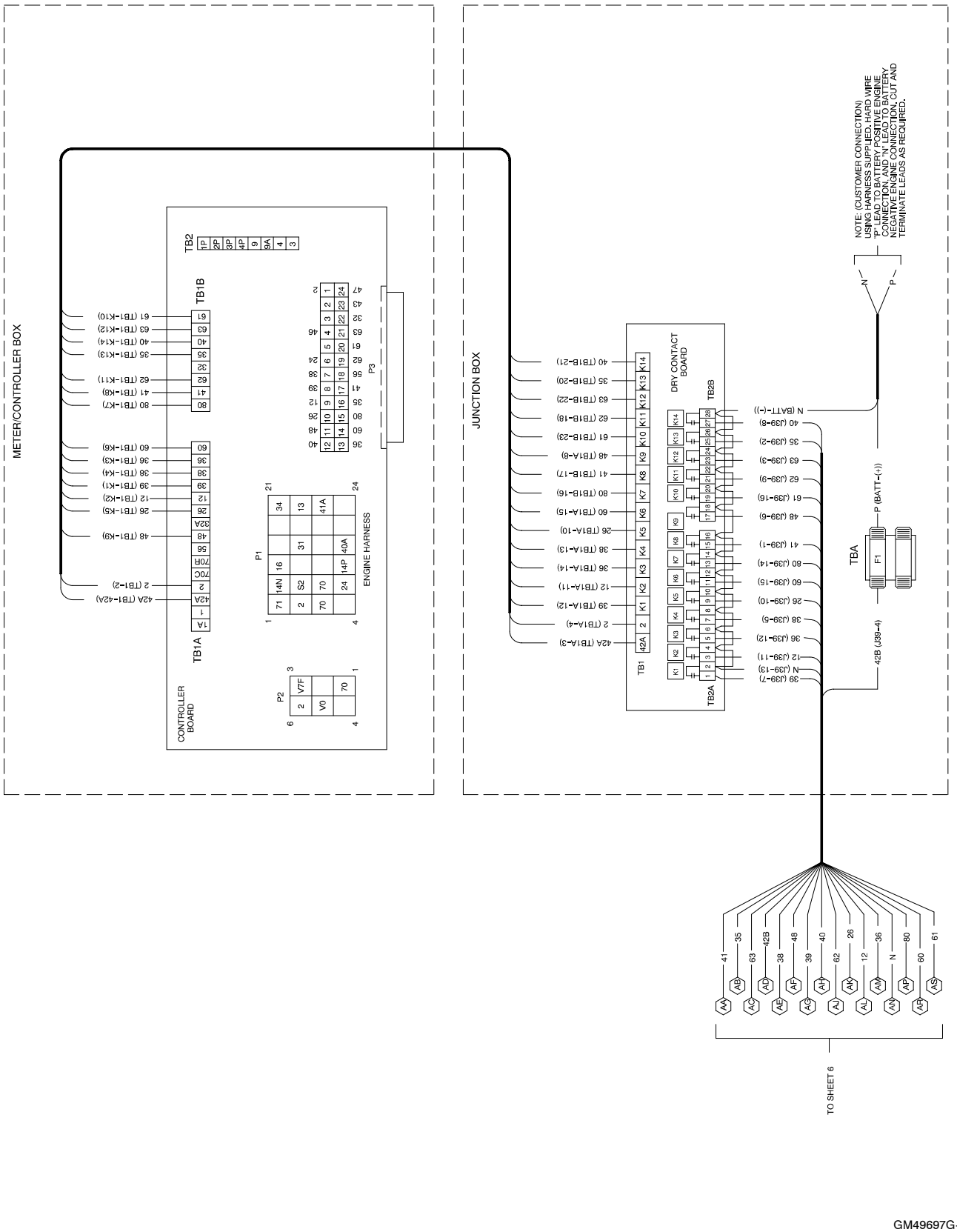


Figure 12-63 40EOZD/33EFOZD Wiring Diagram, Dec 3+ Controller—Isolated Ground, Sheet 7 of 7, GM49697G-A

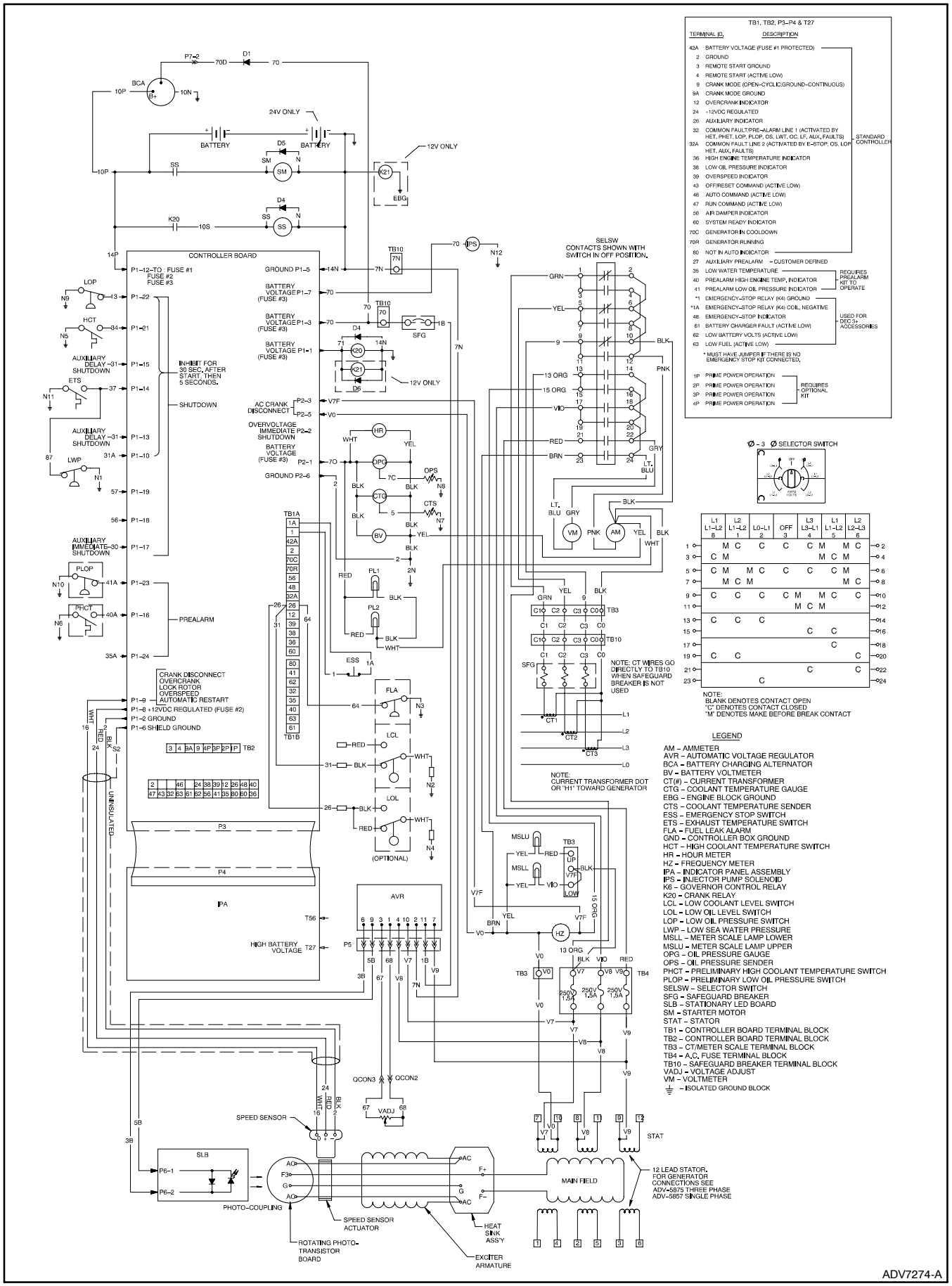


Figure 12-64 40EOZD/33EFOZD Schematic, Dec 3+ Controller—Isolated Ground, Sheet 1 of 1, ADV7274-A

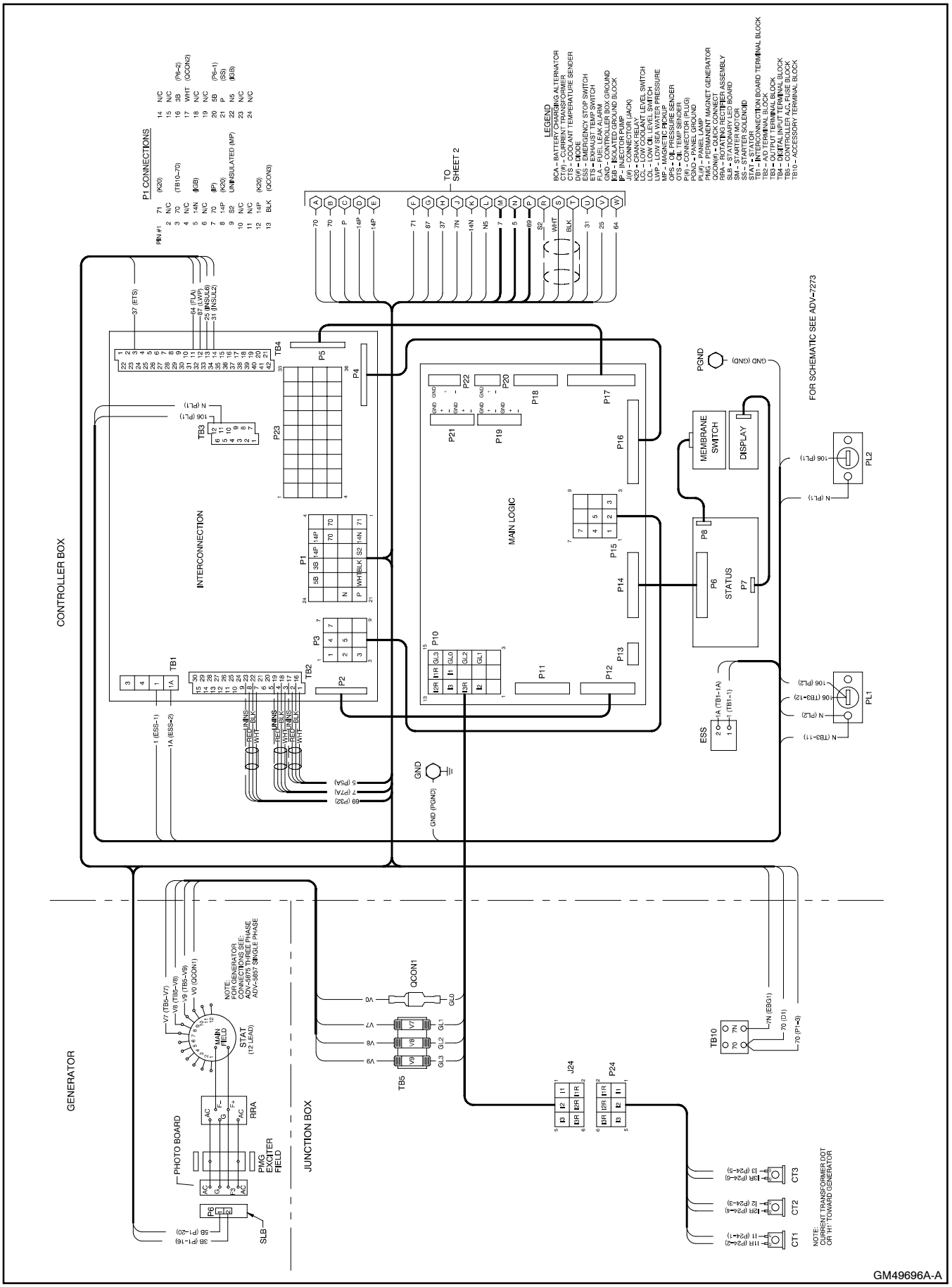


Figure 12-65 40EOZD/33EFOZD Wiring Diagram, Dec 550 Controller—Isolated Ground, Sheet 1 of 2, GM49696A-A

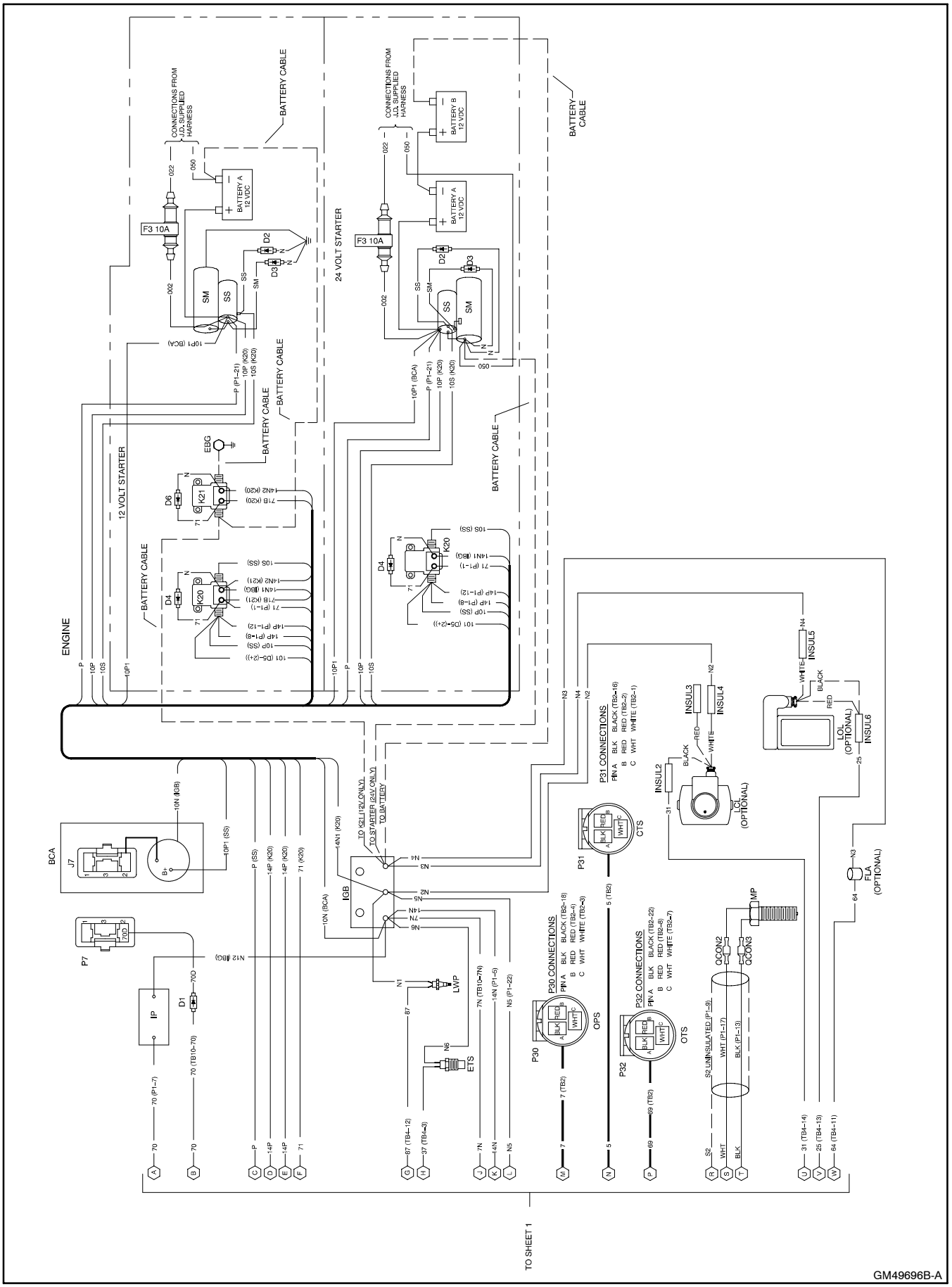


Figure 12-66 40EOZD/33EFOZD Wiring Diagram, Dec 550 Controller—Isolated Ground, Sheet 2 of 2, GM49696B-A

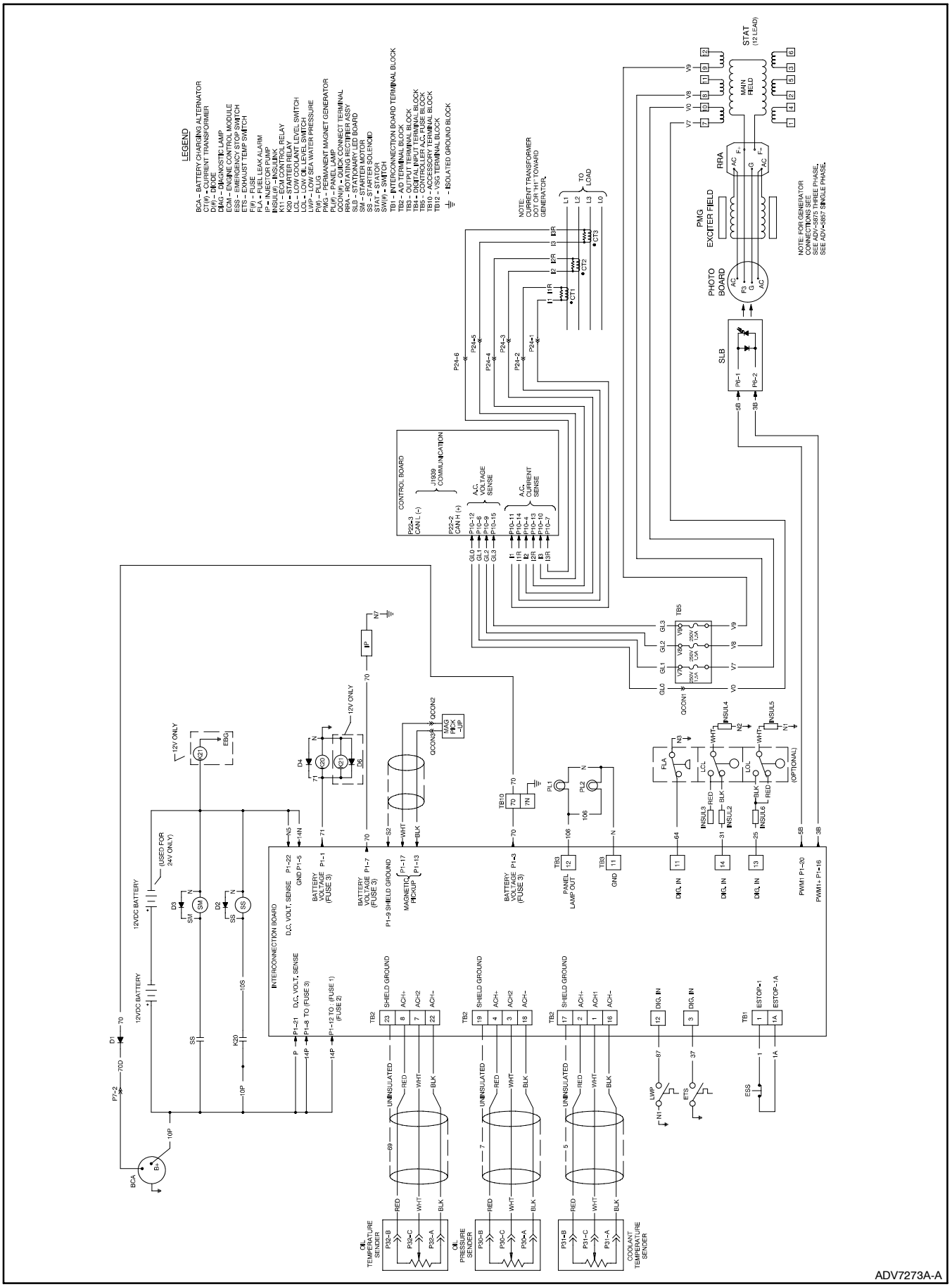


Figure 12-67 40EOZD/33EFOZD Schematic, Dec 550 Controller—Isolated Ground, Sheet 1 of 2, ADV7273A-A

Figure 12-68 40EOZD/33EFOZD Schematic, Dec 550 Controller—Isolated Ground, Sheet 2 of 2, ADV7273B-A

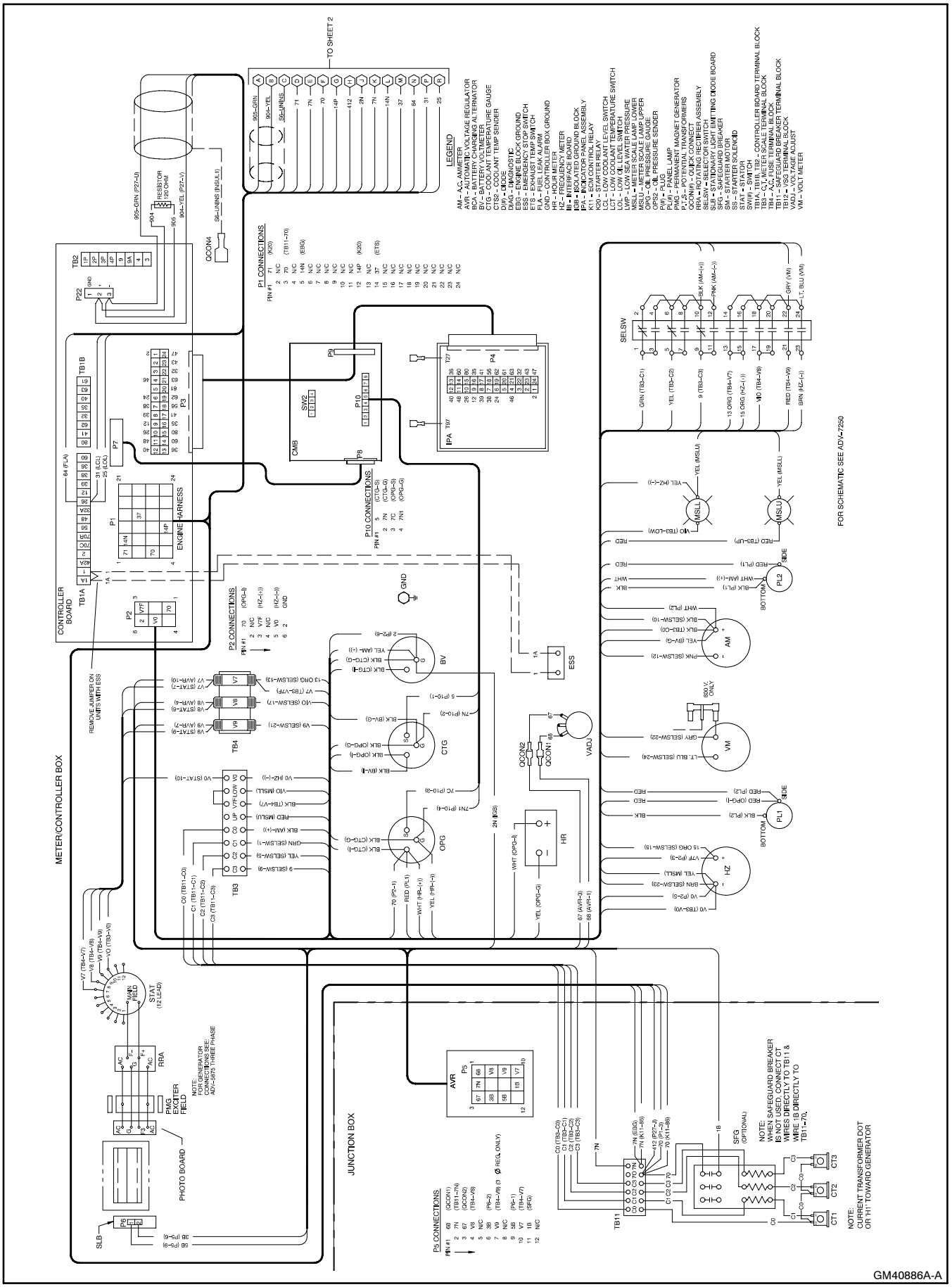


Figure 12-69 55–99EOZD/40–80EFOZD Wiring Diag, Dec 3+ Contr.—Isolated Ground, Sheet 1 of 2, GM40886A-A

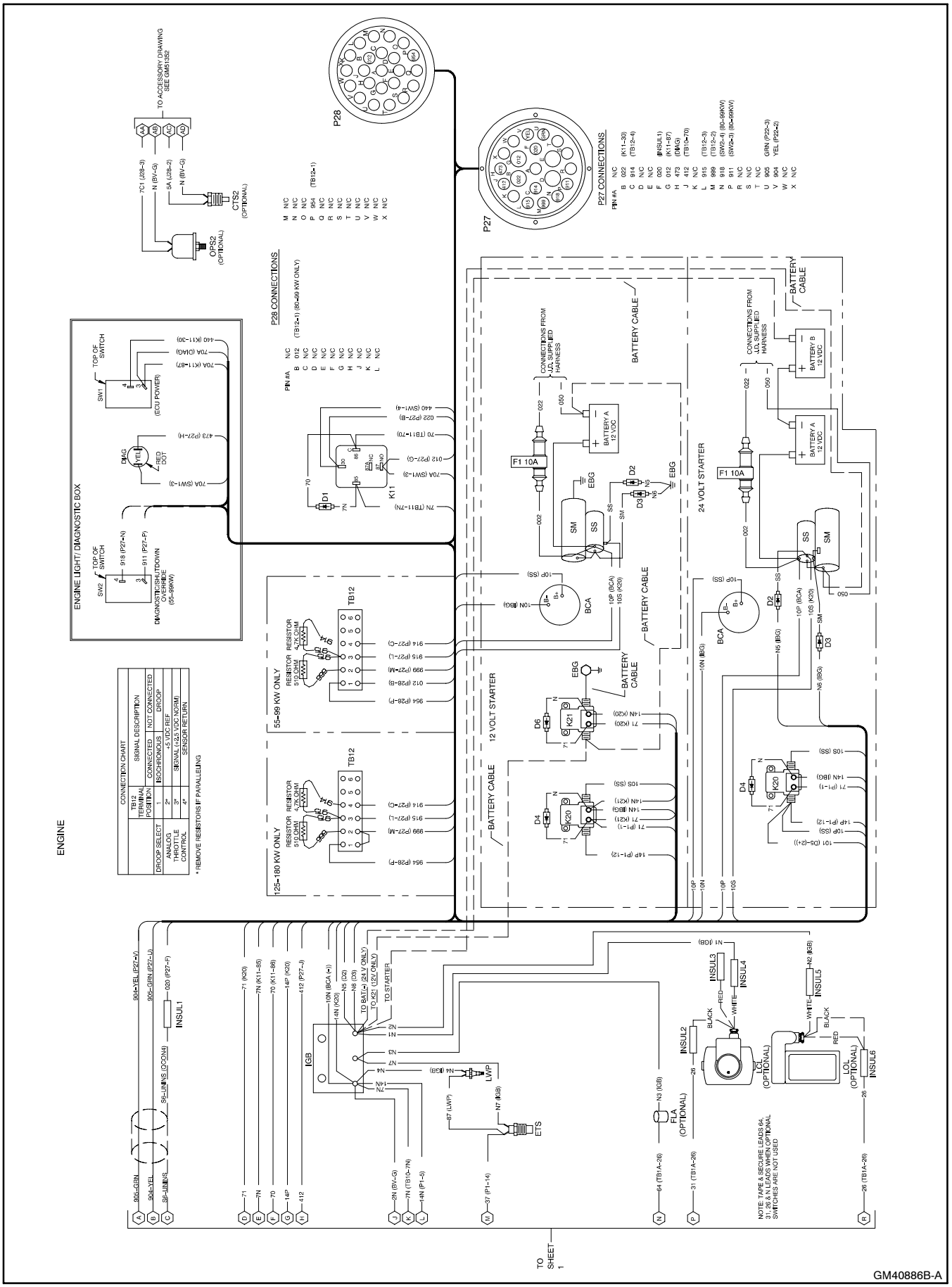


Figure 12-70 55–99EOZD/40–80EFOZD Wiring Diag, Dec 3+ Contr.—Isolated Ground, Sheet 2 of 2, GM40886B-A

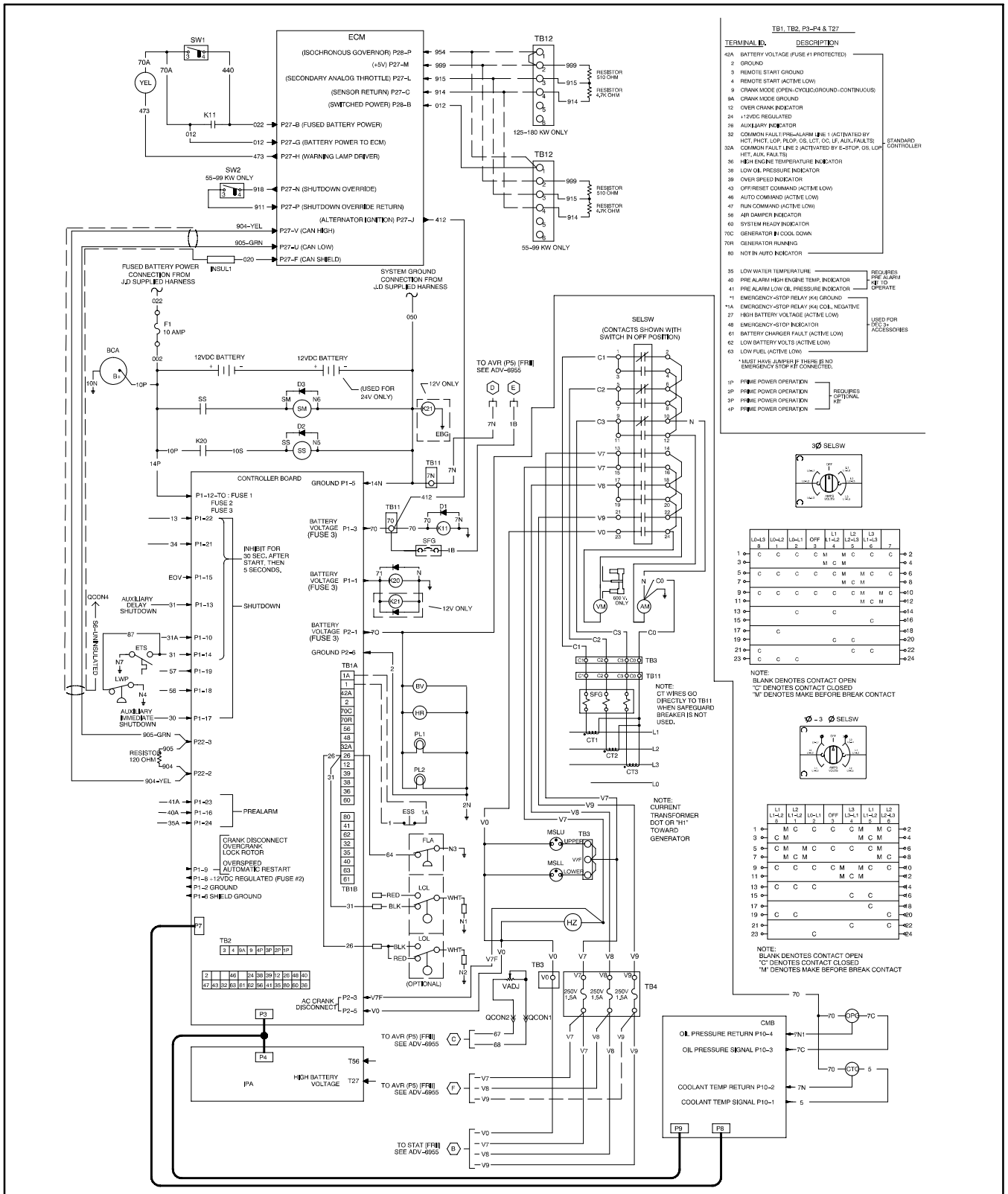


Figure 12-71 55–99EOZD/40–80EFOZD Schematic, Dec 3+ Controller—Isolated Ground, Sheet 1 of 1, ADV7250-A

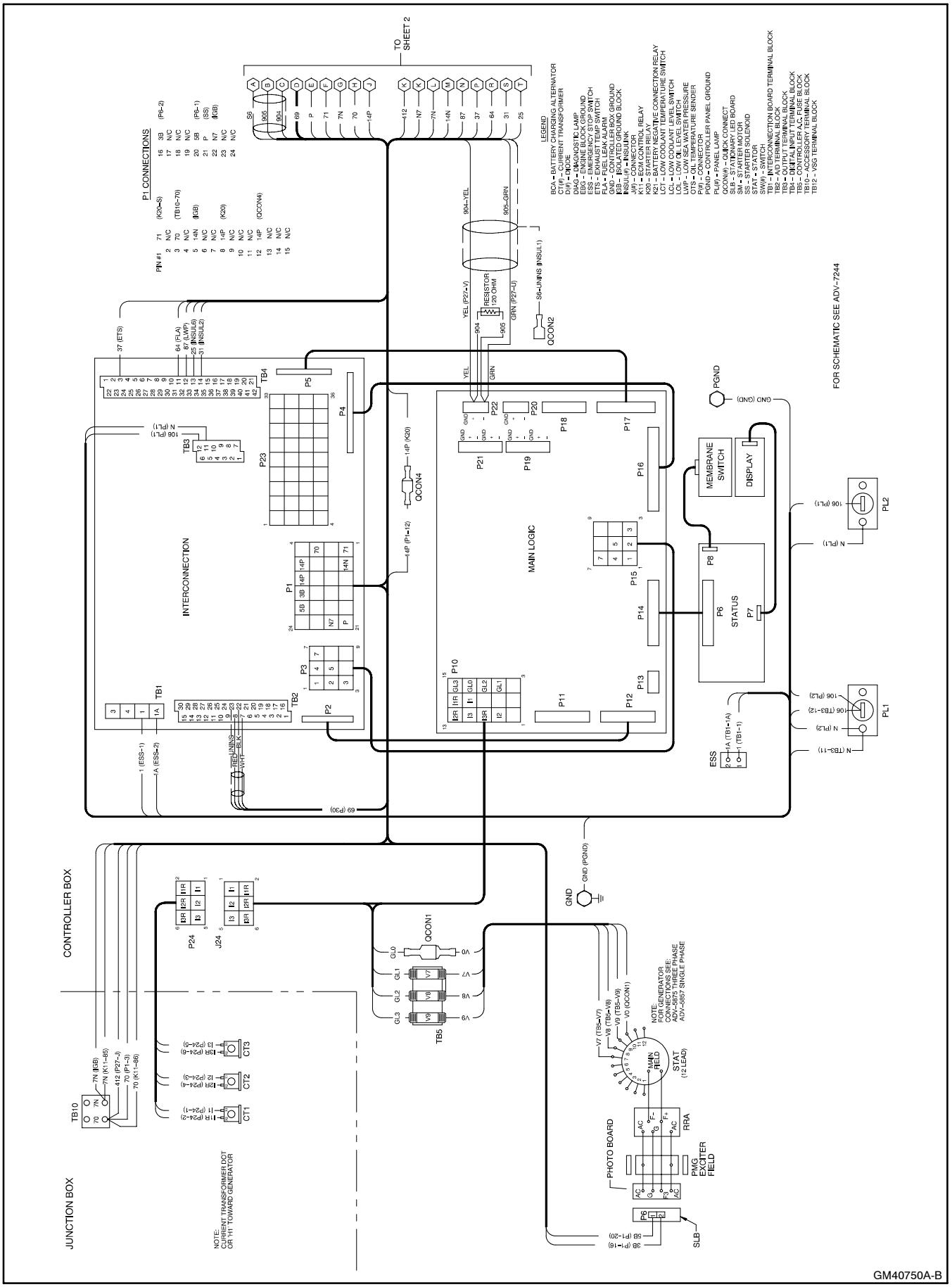


Figure 12-72 55-99EOZD/40-80EFOZD Wiring Diag., Dec 550 Contr.—Isolated Ground, Sheet 1 of 2, GM40750A-B

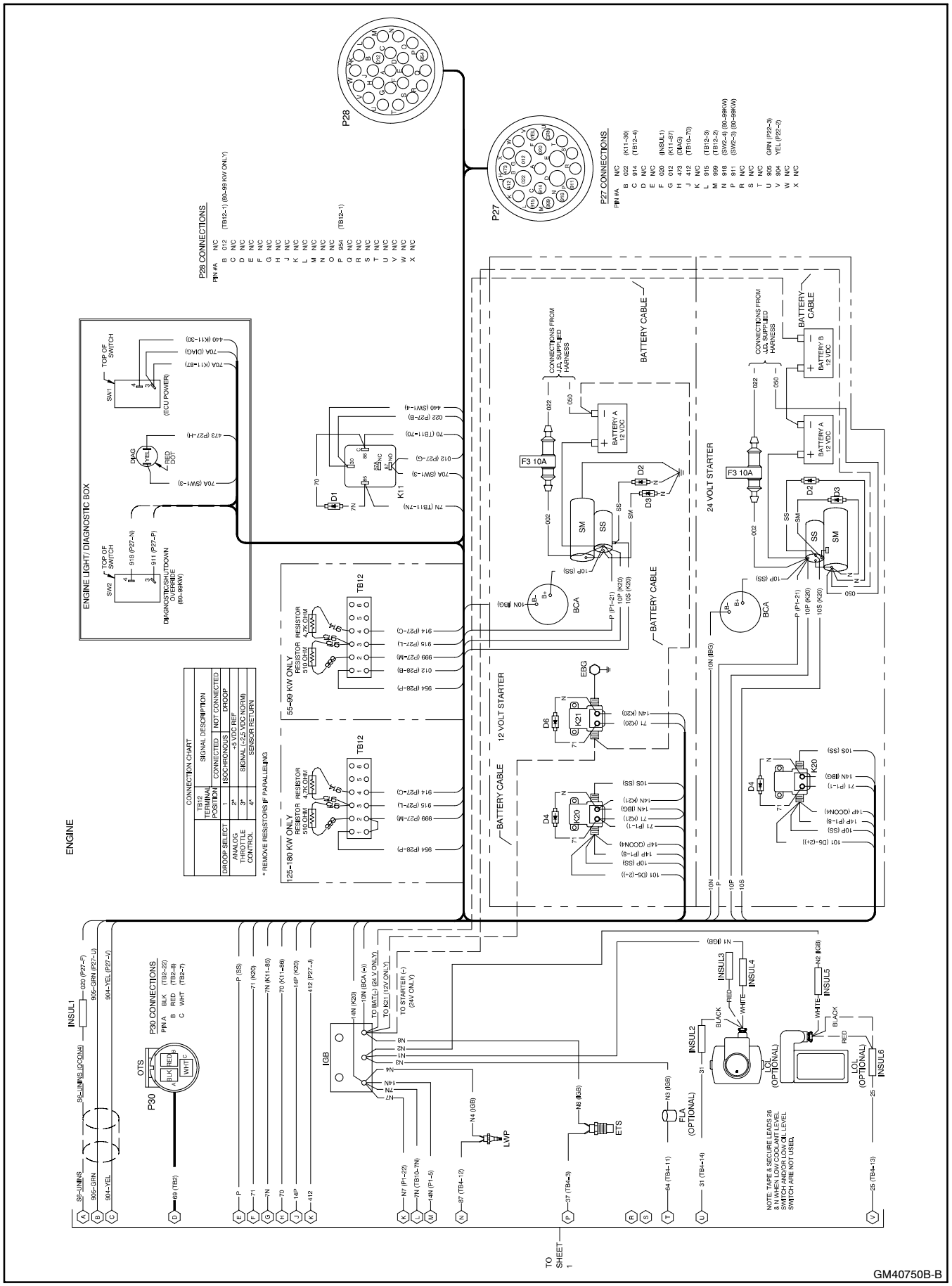


Figure 12-73 55–99EOZD/40–80EFOZD Wiring Dia., Dec 550 Contr.—Isolated Ground, Sheet 2 of 2, GM40750B-B

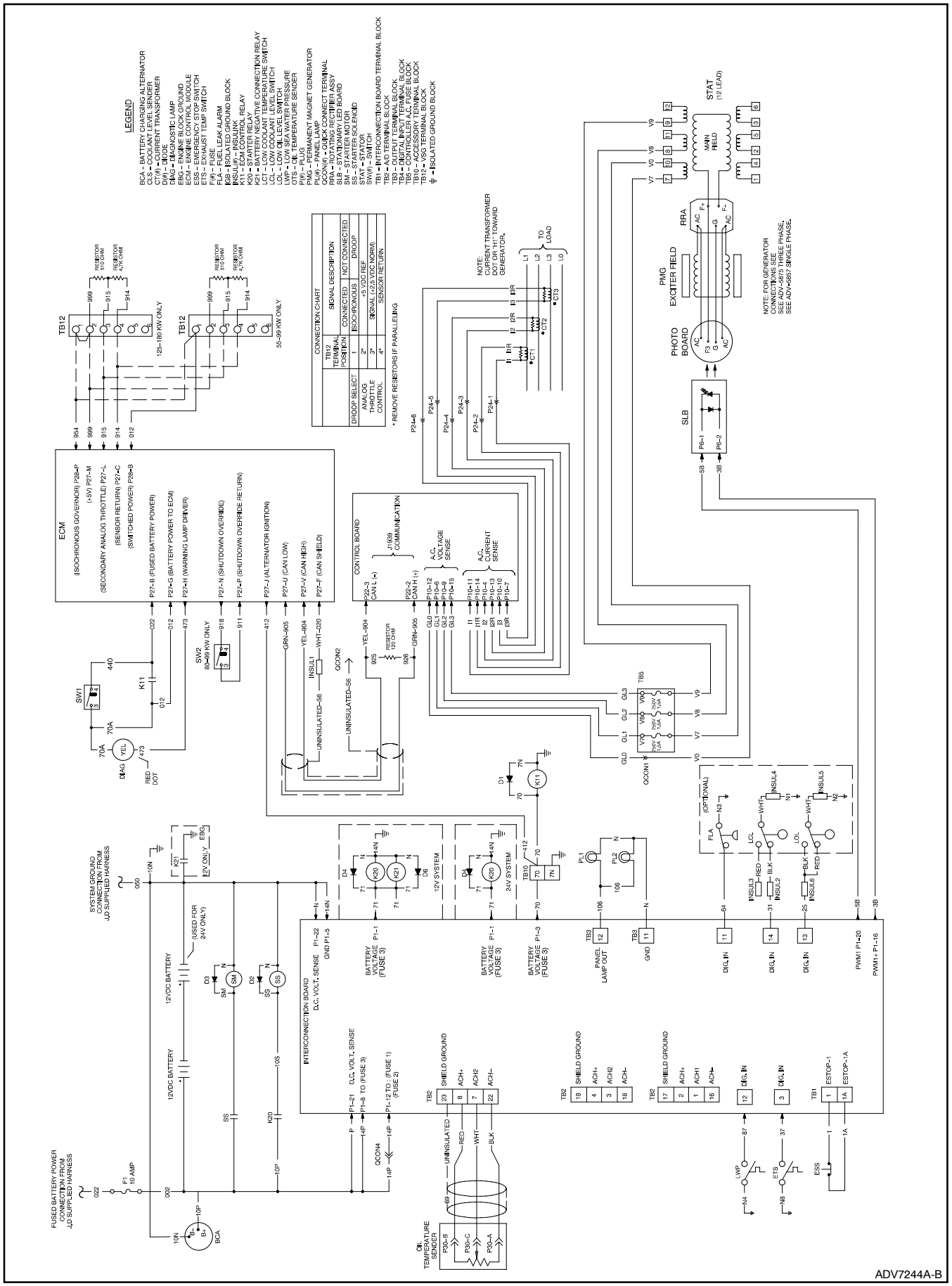


Figure 12-74 55–99EOZD/40–80EFOZD Schematic, Dec 550 Contr.—Isolated Ground, Sheet 1 of 2, ADV7244A-B

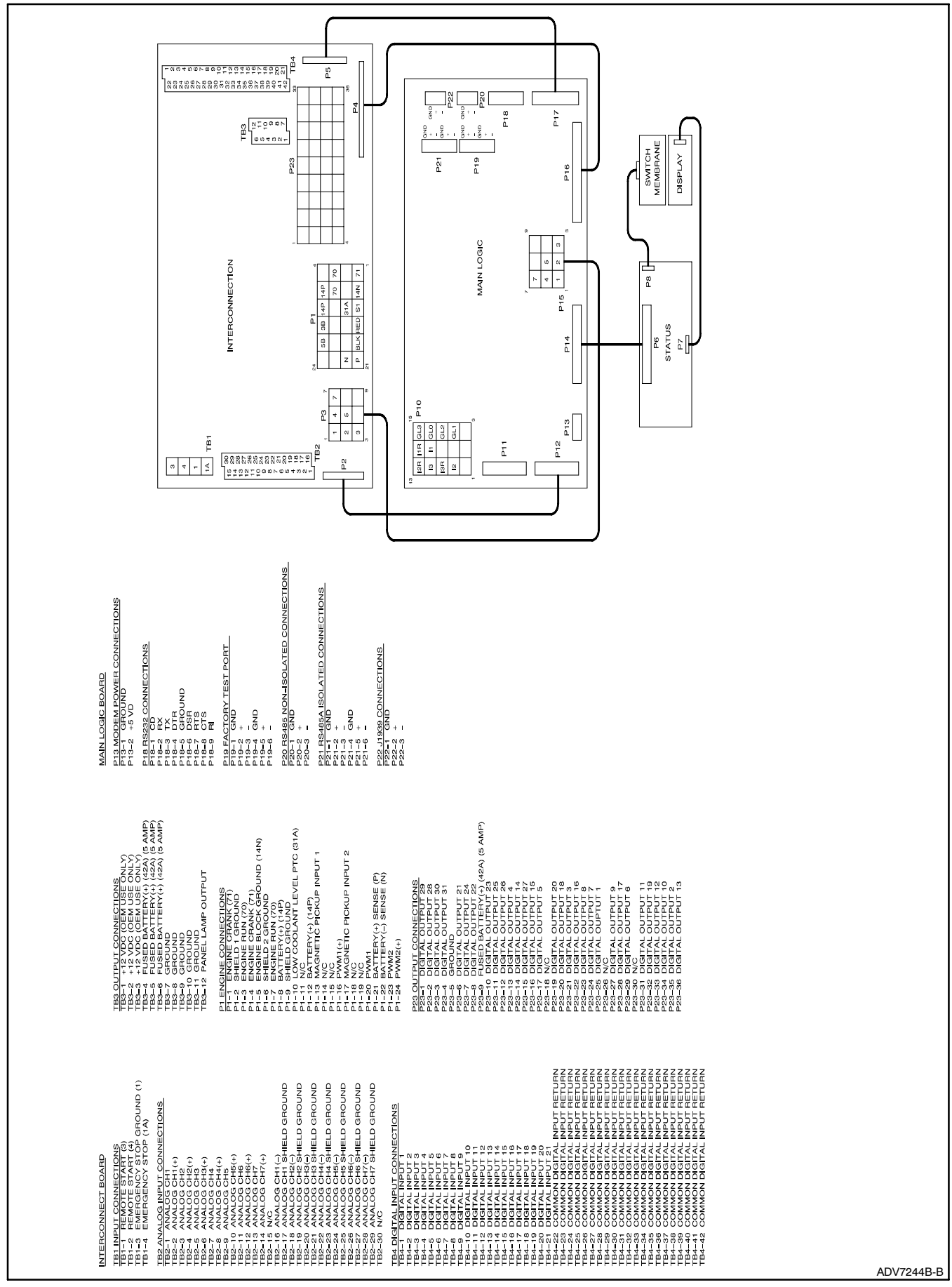


Figure 12-75 55-99EOZD/40-80EFOZD Schematic, Dec 550 Contr.—Isolated Ground, Sheet 2 of 2, ADV7244B-B

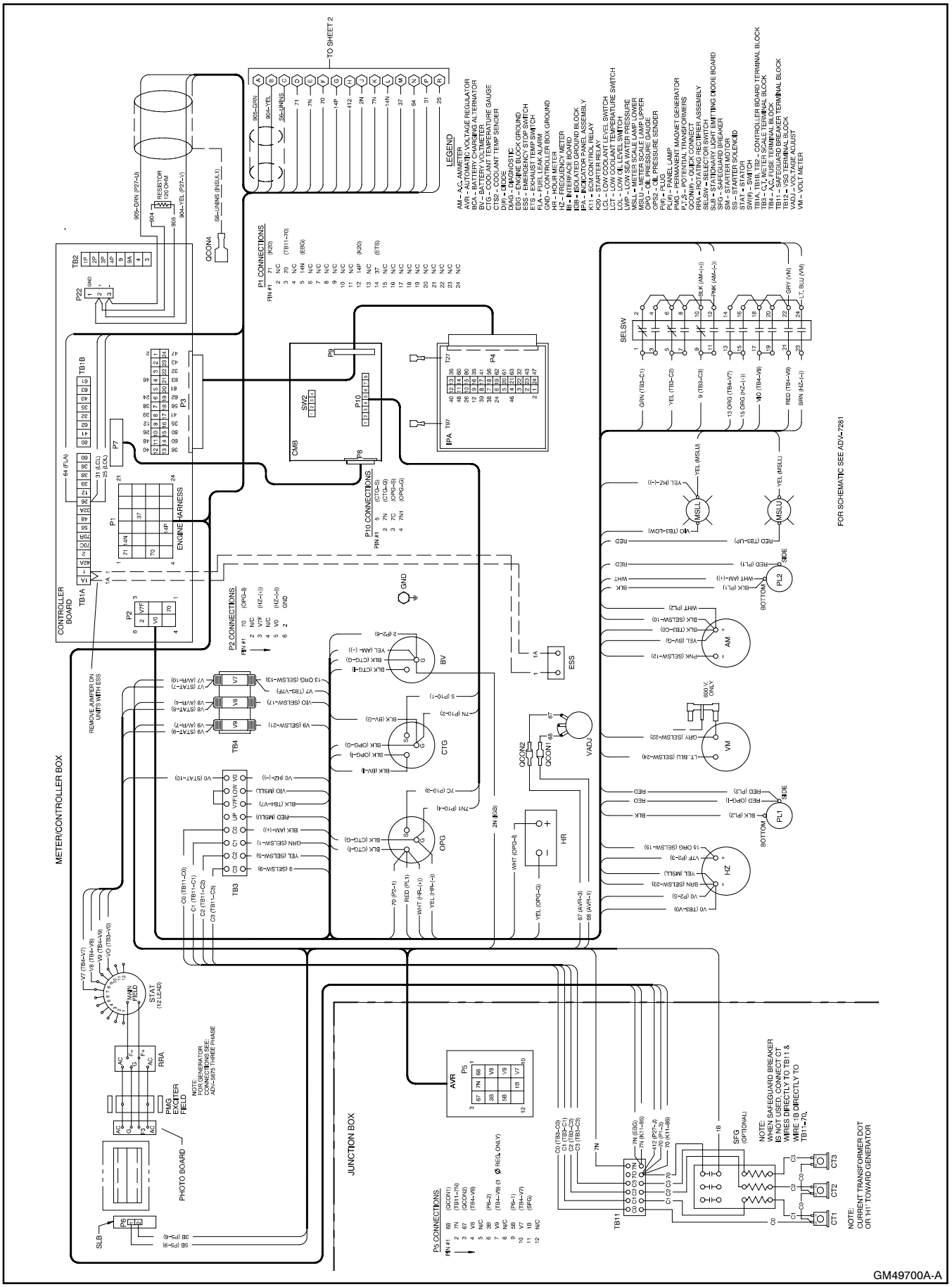


Figure 12-76 125–180EOZD/100–150EFOZD Wiring Dia., Dec 3+ Contr.–Isolated Ground, Sheet 1 of 2, GM49700A-A

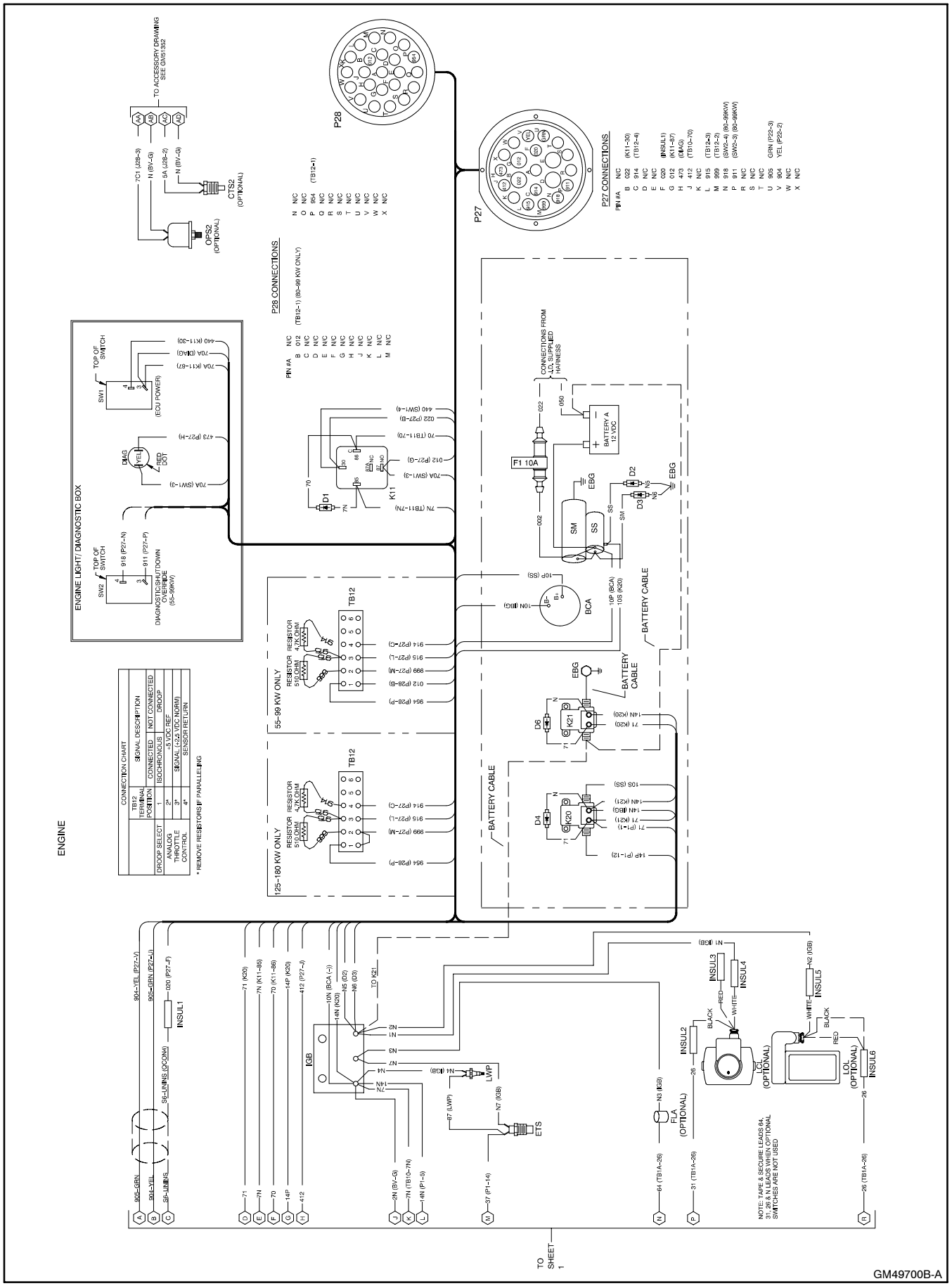


Figure 12-77 125–180EOZD/100–150EFOZD Wiring Dia., Dec 3+ Contr.–Isolated Ground, Sheet 2 of 2, GM49700B-A

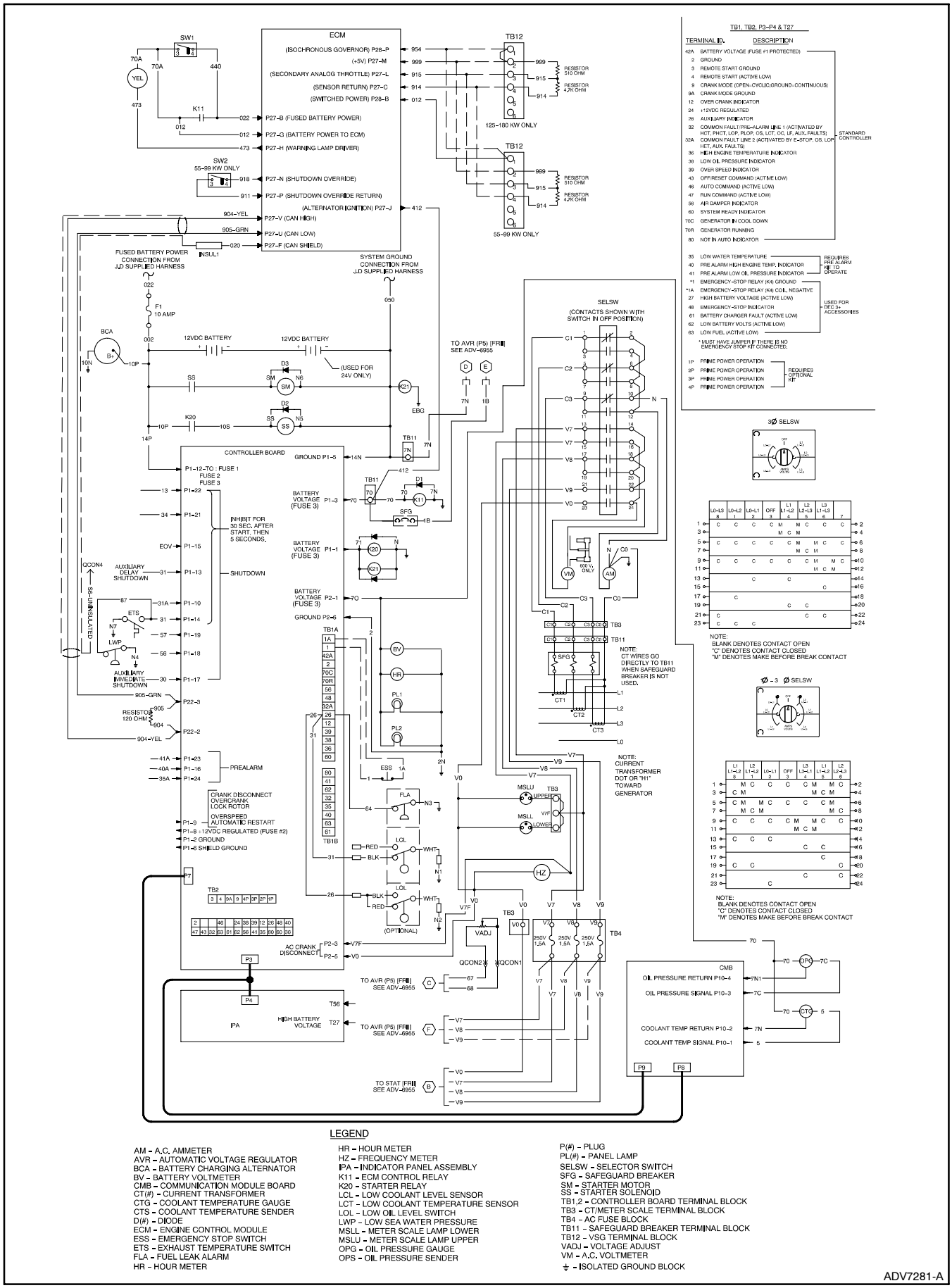


Figure 12-78 125–180EOZD/100–150EFOZD Schematic, Dec 3+ Contr.—Isolated Ground, Sheet 1 of 1, ADV7281-A

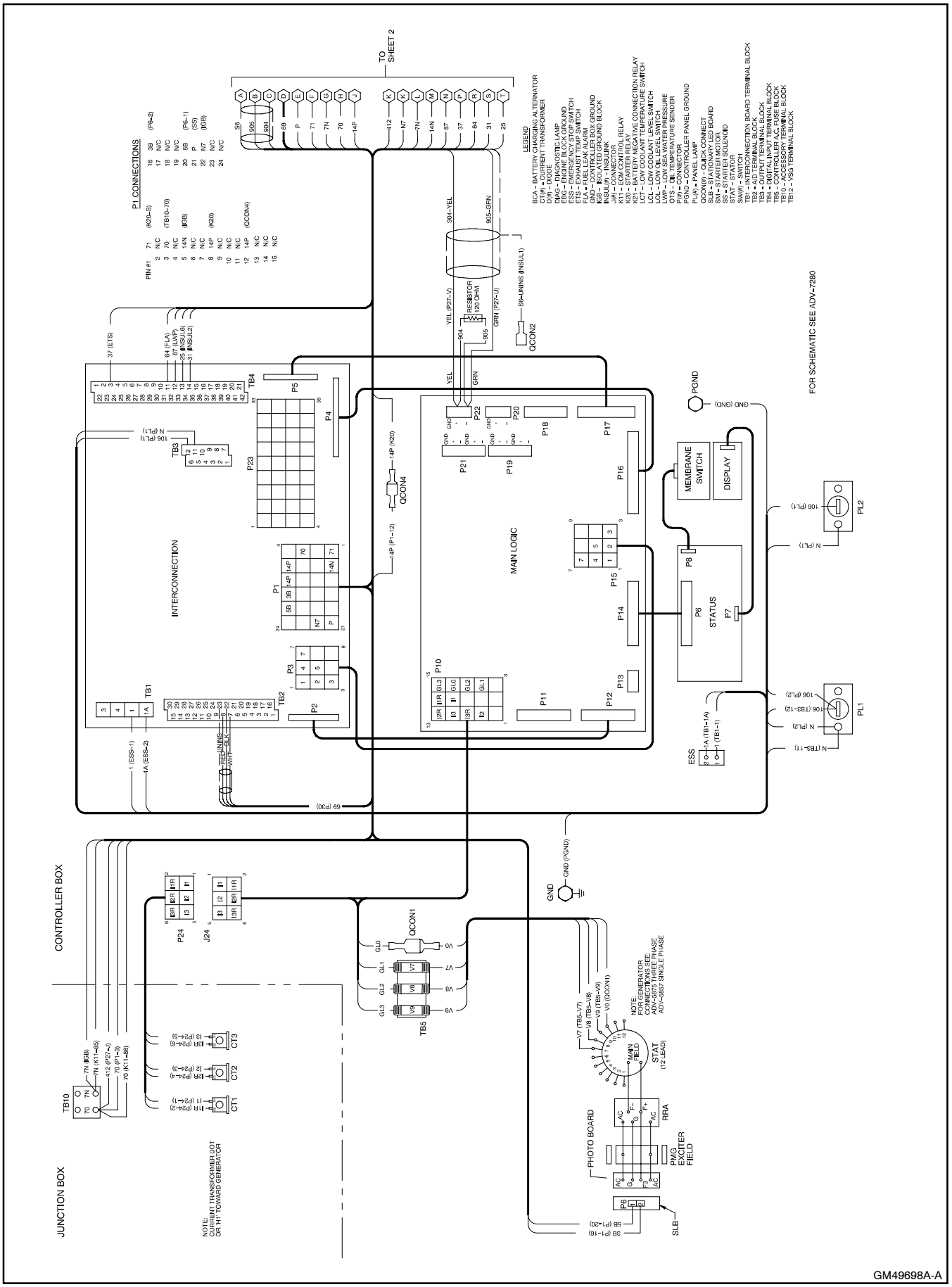


Figure 12-79 125–180EOZD/100–150EFOZD Wiring Dia. Dec 550 Contr.–Isolated Ground, Sheet 1 of 2, GM49698A-A

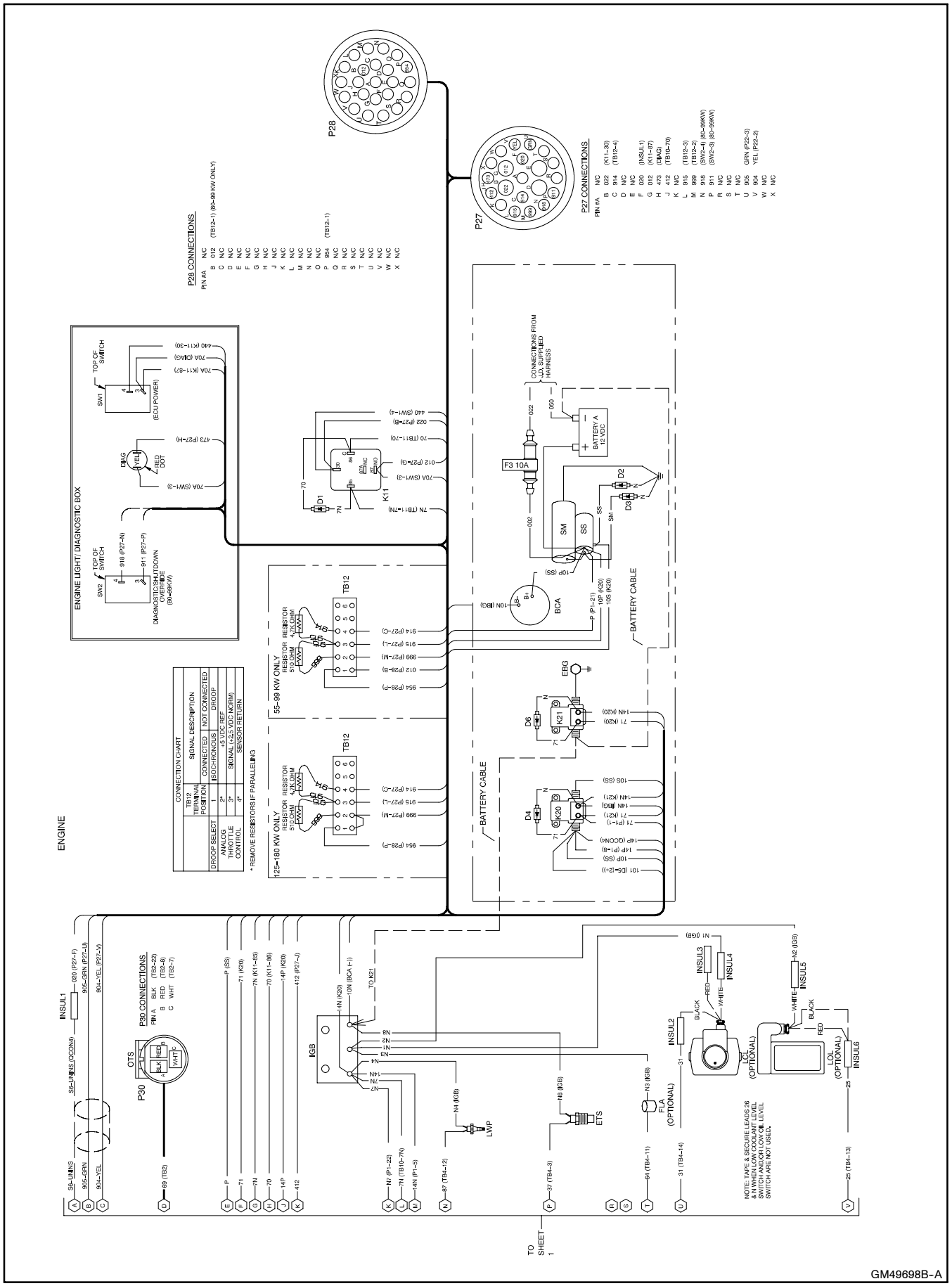


Figure 12-80 125–180EOZD/100–150EFOZD Wiring Dia. Dec 550 Contr.–Isolated Ground, Sheet 2 of 2, GM49698B-A

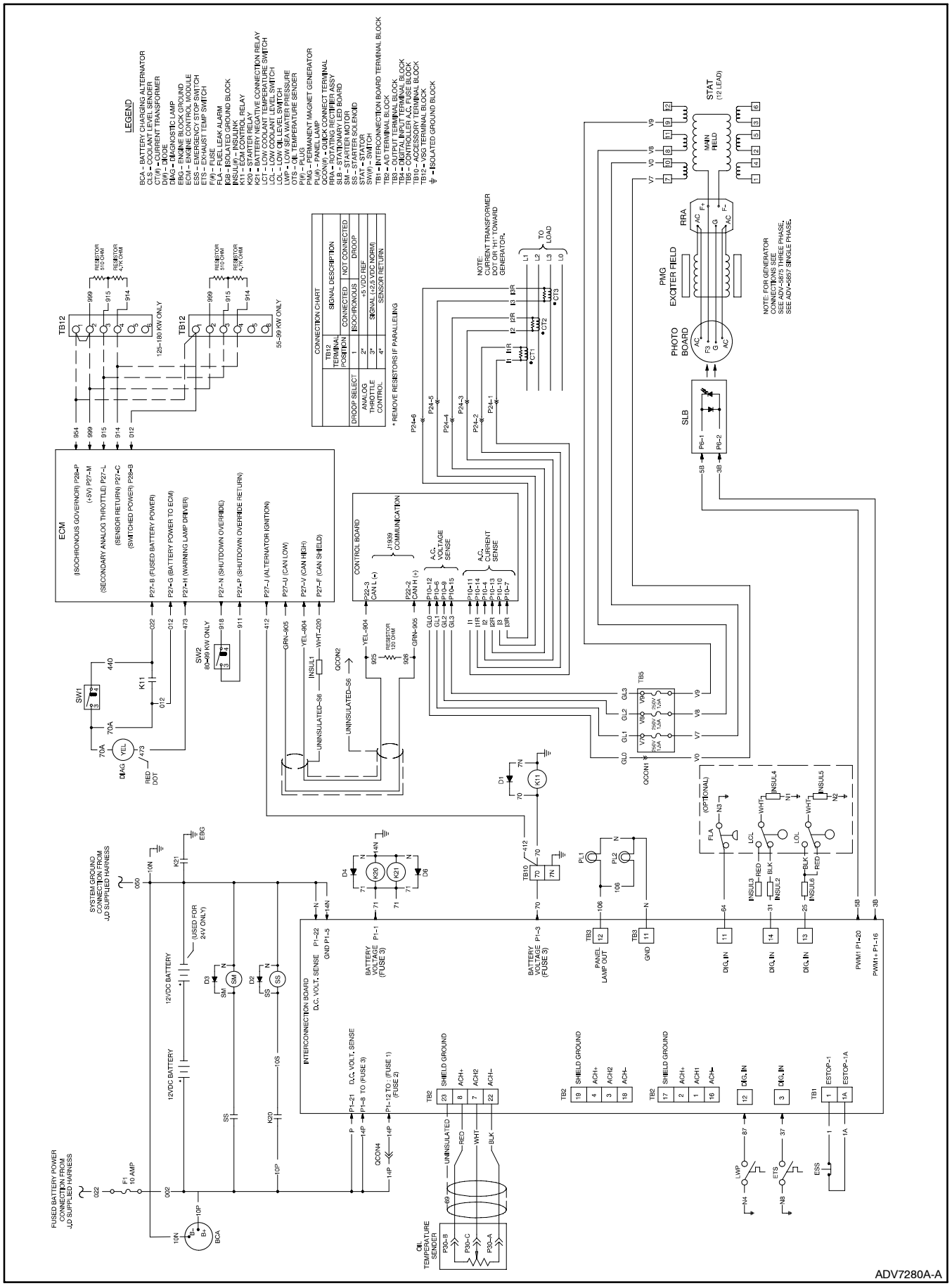


Figure 12-81 125–180EOZD/100–150EFOZD Schematic, Dec 550 Contr.–Isolated Ground, Sheet 1 of 2, ADV7280A-A

Figure 12-82 125–180EOZD/100–150EFOZD Schematic, Dec 550 Contr.–Isolated Ground, Sheet 2 of 2, ADV7280B-A

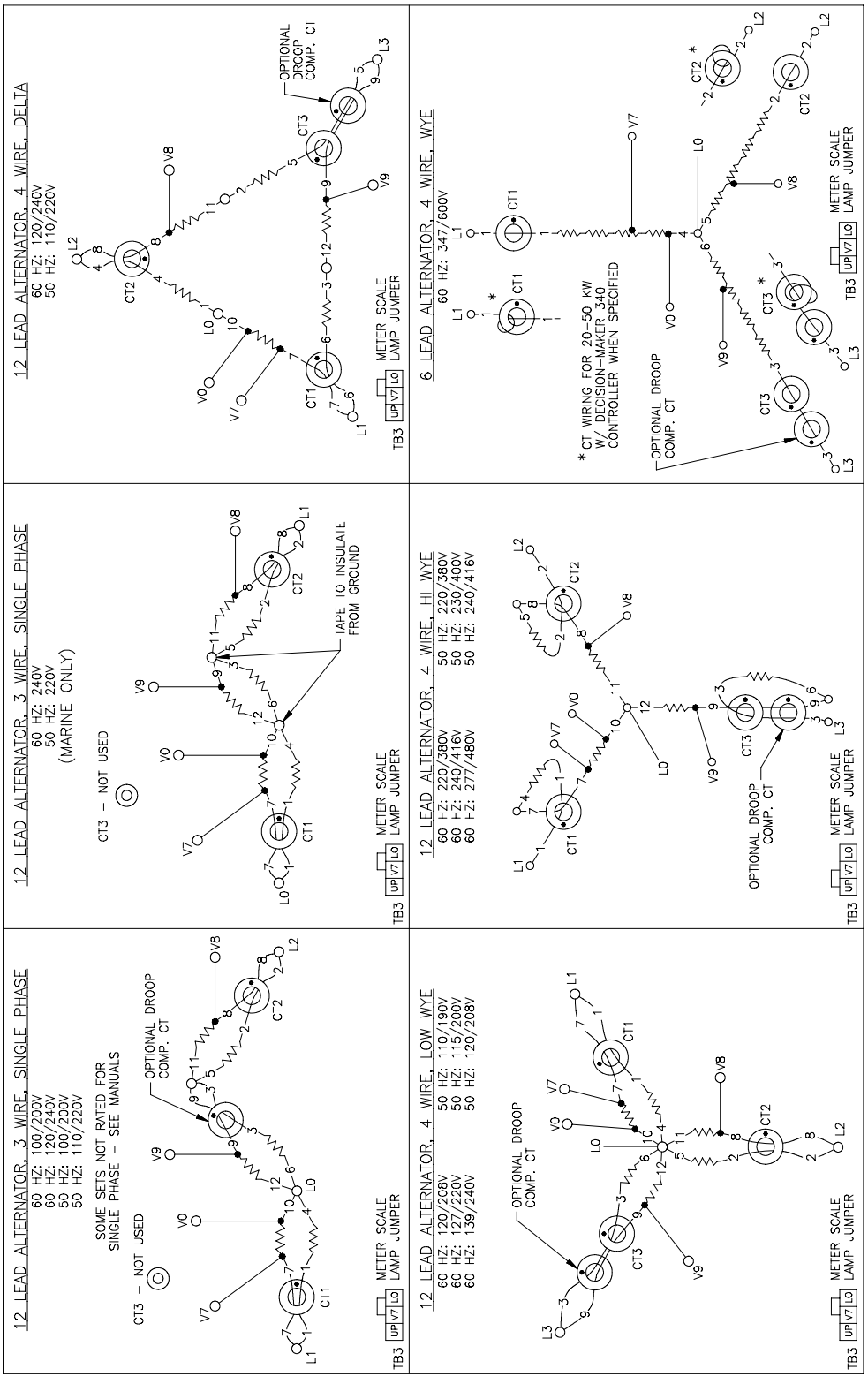


Figure 12-83 Wiring Diagram, Alternator Reconnections, 12 Lead, Sheet 1 of 1

Terminal	Purpose
1	Ground—emergency stop relay (K4)—connect emergency stop across terminals TB1-1 and 1A *
1A	Emergency stop relay (K4) coil; negative side—connect emergency stop across terminals TB1-1 and 1A *
2	Ground terminal
12	Overcrank (OC) signal †
26	Auxiliary (AUX) signal †
32	Common fault/prealarm line 1—A/V alarm or common fault relay activated by OC, 12; AUX, 26; LWT, 35; HET, 36; LOP, 38; OS, 39; AHET, 40; ALOP, 41; and LF, 63 faults
32A	Common fault/prealarm line 2—A/V alarm or common fault relay activated by AUX, 26; HET, 36; LOP, 38; OS, 39; and ES, 48 faults
35	Low water temperature (LWT) signal
36	High engine temperature (HET) signal †
38	Low oil pressure (LOP) signal †
39	Overspeed (OS) signal †
40	Anticipatory high engine temperature (AHET) signal †
41	Anticipatory low oil pressure (ALOP) signal †
42A	Battery voltage (fuse #1 protected)—accessory power supply; customer may also provide separate accessory power source
48	Emergency stop (ES) signal †
56	Air damper (AD) switch, if equipped
60	System ready signal †
61	Battery charger fault—connect battery charger alarm contact to TB1-61 to activate fault lamp (active low), if used
62	Low battery volts—connect battery charger alarm contact to TB1-62 to activate fault lamp (active low), if used
63	Low fuel (LF) fault—connect fuel level sensor to TB1-63 to activate fault lamp (active low), if used
70C	Generator in cool down mode signal
70R	Generator in running mode signal
80	Not in auto signal †

* Connect jumper across terminals 1 and 1A if emergency stop switch is not used.

† Use a remote annunciator and/or A/V alarm kit as an indicator with a dry contact kit connected to controller terminal strip TB1.

Note: Not all terminals are used for all generator sets (see appropriate wiring diagrams for specific generator set model).

Figure 12-84 Controller TB1 Terminal Strip (Decision-Maker™ 3+ Controller)

Terminal	Purpose
1P	Prime power operation
2P	Prime power operation
3	Remote start ground—connect transfer switch or remote start switch to TB2-3 and TB2-4
3P	Prime power operation
4	Remote start—connect transfer switch or remote start switch to TB2-3 and TB2-4
4P	Prime power operation
9	Crank mode selection (open: cyclic crank, ground: continuous crank); connect TB2-9 to TB2-9A for continuous cranking; leave TB2-9 open cyclic cranking; see starting instructions in Section 2 Operation.
9A	Crank mode ground

Note: To use prime power mode—place jumpers across TB2-1P to TB2-2P, TB2-3P to TB2-4P, and TB2-3 to TB2-4. To deactivate prime power mode—remove jumpers across TB2-1P to TB2-2P, TB2-3P to TB2-4P, and TB2-3 to TB2-4.

Figure 12-85 Controller TB2 Terminal Strip (Decision-Maker™ 3+ Controller)

12.1 Voltage Reconnection

12.1.1 Introduction

Use the following voltage reconnection procedure to change the voltage of 12-lead generator sets. See Generator Set Frequency Change and Adjustment later in this section for frequency adjustment information.

Refer to 12.1.2, Voltage Reconnection Procedure and the connection schematics. Follow the safety precautions at the front of this manual and in the procedure text and observe National Electrical Code (NEC) guidelines.

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.

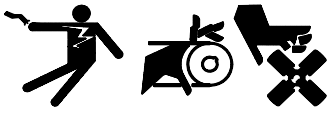
NOTICE

This generator set has been rewired from its nameplate voltage to

246242

Note: Equipment damage. Verify that the voltage ratings of the transfer switch, line circuit breakers, and other accessories match the desired line voltage.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

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

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

⚠ WARNING

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

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

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

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.

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12.1.2 Voltage Reconnection Procedure

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

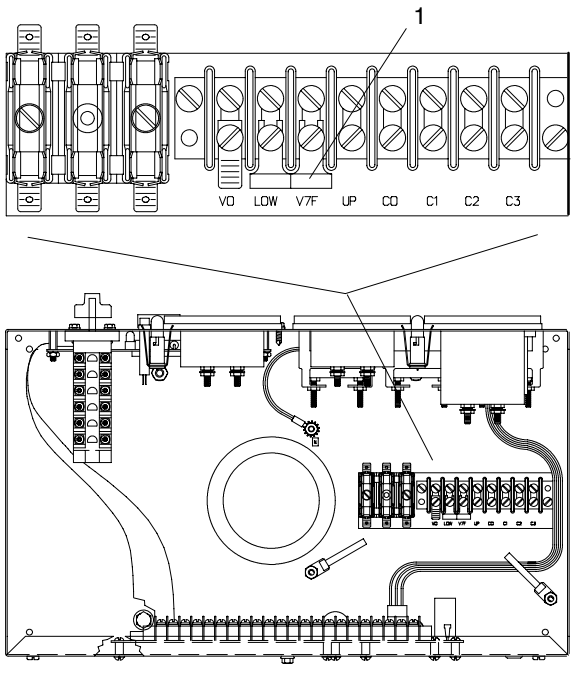
2. Disconnect the generator set engine starting battery, negative (-) lead first. Disconnect power to the battery charger (if equipped).

3. Use Figure 12-83 determine the generator set voltage configuration. Note the original voltage and reconnect as needed. Route leads through current transformers (CTs) and connect them according to the diagram for desired phase and voltage.

Note: Position the current transformers with the dot or HI side CT marking toward the generator set.

Note: Only generator sets equipped with AC meter controllers and/or safeguard circuit breakers require CTs.

4. If the controller has meters, remove the controller cover and reposition the meter scale lamp jumper (see Figure 12-86) matching the position of the desired voltage (shown in Figure 12-83).



1. Lamp jumper

Figure 12-86 Meter Scale Lamp Jumper

5. The overvoltage shutdown is standard on Decision-Maker™ 3+ controllers. The **139/240 volt (low wye)** and **277/480 volt (high wye)**, 3-phase, 4-wire, 60 Hz configurations use different overvoltage shutdown settings than all other configurations. Recalibrate the overvoltage shutdown if the reconnection changes the voltage to or from one of these configurations. See Section 12.2, Overvoltage Shutdown Adjustment. Do not recalibrate the overvoltage adjustment for other voltage changes.

6. If the controller has meters, set the phase selector switch to the L1-L2 position (1-phase or 3-phase configuration depending on generator set connection). Connect a voltmeter across leads L1 and L2 if the controller has no meters.

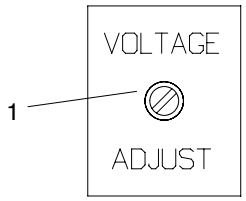
Note: Equipment damage. Verify that the voltage ratings of the transfer switch, line circuit breakers, and other accessories match the desired line voltage.

7. Reconnect the starting battery, negative (–) lead last. Place the generator set master switch in the RUN position to start the generator set. Observe the voltmeter and verify that the unit has the desired line voltage.

   Adjust the voltage using the voltage adjustment potentiometer on the generator controller front panel. See Figure 12-87.

8. Stop the generator set after completing the voltage adjustment.

9. Disconnect the external voltmeter if used. Replace the controller cover.



1. Voltage adjustment potentiometer

Figure 12-87 Voltage Adjustment Potentiometer on Controller

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12.2 Overvoltage Shutdown Adjustment

The 139/240 volt (low wye) and 277/480 volt (high wye), 3-phase, 4-wire, 60 Hz configurations use different overvoltage shutdown settings than all other configurations. Recalibrate the overvoltage shutdown if the reconnection changes the voltage to or from one of these configurations. **Do not recalibrate the overvoltage adjustment for other voltage changes.**

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

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

Overvoltage Shutdown Adjustment Procedure

1. Disconnect the generator set engine starting battery, negative (–) lead first. Disconnect power to the battery charger (if equipped).

2. With the generator set shut down, open the output line circuit breaker to disconnect the load from the generator set.

3. Remove the controller cover.

4. Wrap the shaft of an insulated-handle screwdriver with electrical tape to insulate the metal shaft. Turn the overvoltage potentiometer (R41) on the main circuit board fully clockwise. See Figure 12-88.

5. Connect a digital AC voltmeter (or other 1% minimum accuracy voltmeter) to terminals V0 and V7F (or V7) on the controller terminal block. See Figure 12-86.

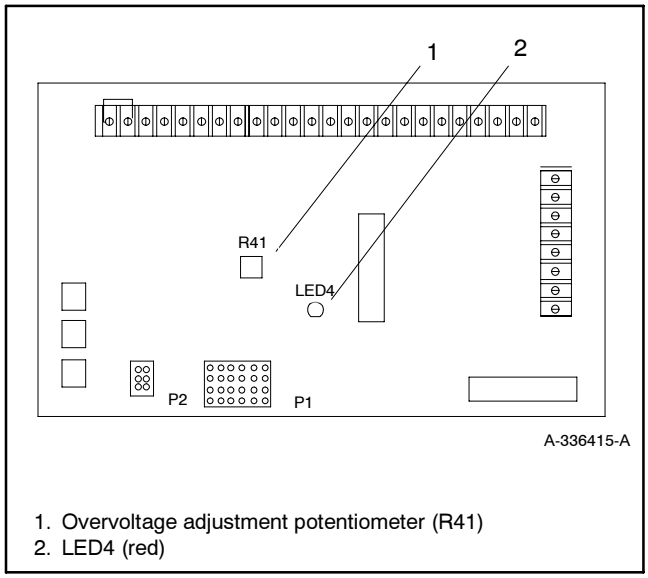
6. Reconnect the battery, negative (–) lead last.

7. Start the generator set by placing the generator set master switch in the RUN position.

8. Adjust the output voltage to 115% of the nominal output voltage using the voltage adjustment potentiometer. If the voltage configuration is 139/240 volts (low wye) or 277/480 volts (high wye), 3-phase, 4-wire, 60 Hz, adjust the output voltage to 160 volts across terminals V0 and V7F (or V7). For all other voltages, adjust the output voltage to 115% of the nominal output voltage measured across terminals V0 and V7F (or V7).

   Adjust the voltage using the voltage adjustment potentiometer on the generator controller front panel. See Figure 12-87.

9. Use the insulated screwdriver to slowly rotate the overvoltage adjustment potentiometer (R41) counterclockwise until red LED4 lights. See Figure 12-88. The generator set should shut down on an overvoltage fault in approximately 2 seconds.



1. Overvoltage adjustment potentiometer (R41)
2. LED4 (red)

Figure 12-88 Overvoltage Shutdown Adjustment on Main Circuit Board

10. Turn the voltage adjustment potentiometer counterclockwise to prevent overvoltage shutdown upon restart. Restart the generator set. Slowly increase the voltage by turning the voltage adjustment potentiometer clockwise. Verify the shutdown voltage point (115% of the nominal output voltage) by observing the voltmeter and noting when LED4 lights. The generator set should shut down on overvoltage fault in approximately 2 seconds. If the shutdown voltage point is not 115% of nominal voltage, repeat the calibration procedure; otherwise, continue to step 11.

11. Turn the voltage adjustment potentiometer counterclockwise to prevent overvoltage shutdown upon restart. Restart the generator set. Readjust the generator set output to the nominal voltage using the voltage adjustment potentiometer.

12. Stop the generator set by placing the generator set master switch in the OFF/RESET position. Seal the overvoltage adjustment potentiometer (R41) with RTV sealant or equivalent. Replace the controller cover.

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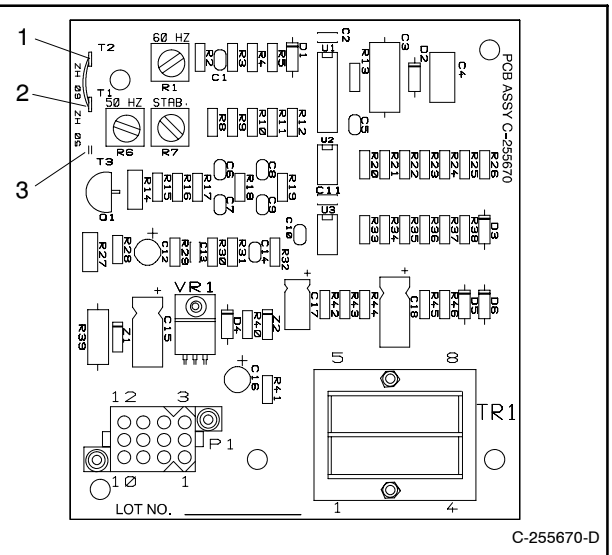
12.3 Fast-Response™ II Voltage Regulator Setup (Decision-Maker™ 1 and Decision-Maker™ 3+)

12.3.1 Frequency Change

Set the voltage regulator circuit board for either 50 or 60 Hz application. See Figure 12-89. Connect a jumper between terminals T1 and T2 for 60 Hz operation. Connect a jumper between terminals T1 and T3 to convert voltage regulator circuit board to 50 Hz application.

This procedure changes the voltage regulator circuit board for the desired frequency. See Frequency Adjustment for changing generator set frequency and speed.



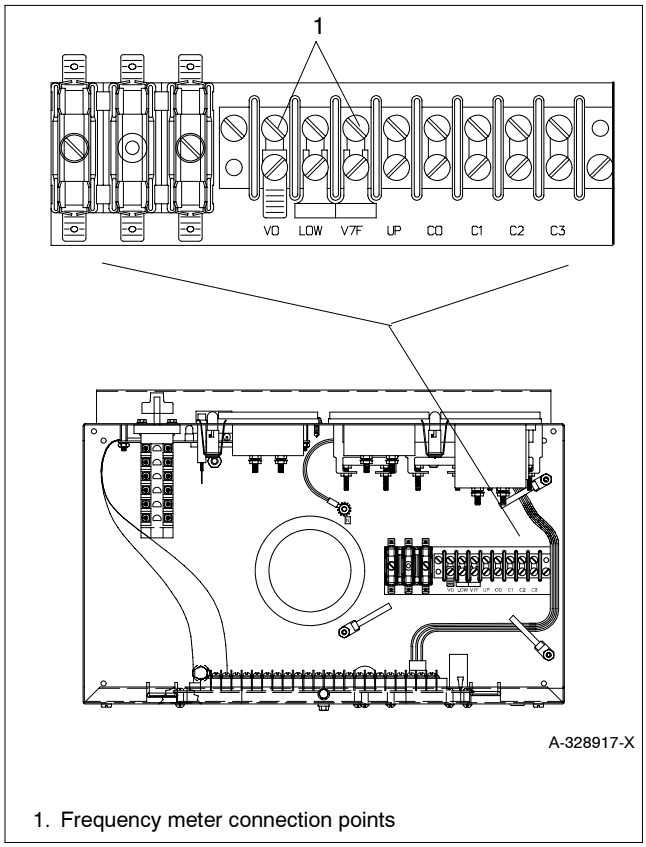
1. T2 terminal
2. T1 terminal
3. T3 terminal

Figure 12-89 Jumper Location for 50 or 60 Hz Operation

12.3.2 Frequency Adjustment

Check the frequency meter for a no-load reading of 63 Hz for 60 Hz operation and 53 Hz for 50 Hz operation to determine correct frequency operation. Check for 50 and 60 Hz operation at no load if the generator set is equipped with an isochronous governor. Connect a frequency meter across V0 and V7 on the control board terminal strip (generator set must not be running while making connections) if the controller is not equipped with a frequency meter. Refer to Figure 12-90.

To adjust governor speed, refer to Section 10, Governor Adjustments.



1. Frequency meter connection points

Figure 12-90 Frequency Meter Connections

Notes

Appendix A Abbreviations

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

A, amp	ampere
ABDC	after bottom dead center
AC	alternating current
A/D	analog to digital
ADC	advanced digital control; analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
Ah	amp-hour
AHWT	anticipatory high water temperature
AISI	American Iron and Steel Institute
ALOP	anticipatory low oil pressure
alt.	alternator
Al	aluminum
ANSI	American National Standards Institute (formerly American Standards Association, ASA)
AO	anticipatory only
APDC	Air Pollution Control District
API	American Petroleum Institute
approx.	approximate, approximately
AQMD	Air Quality Management District
AR	as required, as requested
AS	as supplied, as stated, as suggested
ASE	American Society of Engineers
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
ATS	automatic transfer switch
auto.	automatic
aux.	auxiliary
avg.	average
AVR	automatic voltage regulator
AWG	American Wire Gauge
AWM	appliance wiring material
bat.	battery
BBDC	before bottom dead center
BC	battery charger, battery charging
BCA	battery charging alternator
BCI	Battery Council International
BDC	before dead center
BHP	brake horsepower
blk.	black (paint color), block (engine)
blk. htr.	block heater
BMEP	brake mean effective pressure
bps	bits per second
br.	brass
BTDC	before top dead center
Btu	British thermal unit
Btu/min.	British thermal units per minute
C	Celsius, centigrade
cal.	calorie
CAN	controller area network
CARB	California Air Resources Board
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
cUL	Canadian Underwriter's Laboratories
CUL	Canadian Underwriter's Laboratories
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dB(A)	decibel (A weighted)
DC	direct current
DCR	direct current resistance
deg., °	degree
dept.	department
DFMEA	Design Failure Mode and Effects Analysis
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)
ECM	electronic control module, engine control module
EDI	electronic data interchange
EFR	emergency frequency relay
e.g.	for example (*exempli gratia)*
EG	electronic governor
EGSA	Electrical Generating Systems Association
EIA	Electronic Industries Association
EI/EO	end inlet/end outlet
EMI	electromagnetic interference
emiss.	emission
eng.	engine
EPA	Environmental Protection Agency
EPS	emergency power system
ER	emergency relay
ES	engineering special, engineered special
ESD	electrostatic discharge
est.	estimated
E-Stop	emergency stop
etc.	et cetera (and so forth)
exh.	exhaust
ext.	external
F	Fahrenheit, female
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
ftp	file transfer protocol
g	gram
ga.	gauge (meters, wire size)
gal.	gallon
gen.	generator
genset	generator set
GFI	ground fault interrupter
GND, ⏚	ground
gov.	governor
gph	gallons per hour
gpm	gallons per minute
gr.	grade, gross
GRD	equipment ground
gr. wt.	gross weight
H x W x D	height by width by depth
HC	hex cap
HCHT	high cylinder head temperature
HD	heavy duty
HET	high exhaust temp., high engine temp.
hex	hexagon
Hg	mercury (element)
HH	hex head
HHC	hex head cap
HP	horsepower
hr.	hour
HS	heat shrink
hsg.	housing
HVAC	heating, ventilation, and air conditioning
HWT	high water temperature
Hz	hertz (cycles per second)
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)
KBus	Kohler communication protocol
kg	kilogram
kg/cm^2	kilograms per square centimeter
kgm	kilogram-meter
kg/m^3	kilograms per cubic meter
kHz	kilohertz
kJ	kilojoule
km	kilometer
kOhm, kΩ	kilo-ohm
kPa	kilopascal
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt ampere
kVAR	kilovolt ampere reactive
kW	kilowatt
kWh	kilowatt-hour
kWm	kilowatt mechanical
kWth	kilowatt-thermal
L	liter
LAN	local area network
L x W x H	length by width by height
lb.	pound, pounds
lbm/ft^3	pounds mass per cubic feet
LCB	line circuit breaker
LCD	liquid crystal display
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/hr.	cubic meters per hour
m^3/min.	cubic meters per minute
mA	milliampere
man.	manual
max.	maximum
MB	megabyte (2^{20} bytes)
MCCB	molded-case circuit breaker
MCM	one thousand circular mils
meggar	megohmmeter
MHz	megahertz
mi.	mile
mil	one one-thousandth of an inch
min.	minimum, minute
misc.	miscellaneous
MJ	megajoule
mJ	millijoule
mm	millimeter
mOhm, mΩ	milliohm
MOhm, MΩ	megohm
MOV	metal oxide varistor
MPa	megapascal
mpg	miles per gallon
mph	miles per hour
MS	military standard
ms	millisecond
m/sec.	meters per second
MTBF	mean time between failure
MTBO	mean time between overhauls
mtg.	mounting
MTU	Motoren-und Turbinen-Union
MW	megawatt
mW	milliwatt
µF	microfarad
N, norm.	normal (power source)
NA	not available, not applicable
nat. gas	natural gas
NBS	National Bureau of Standards
NC	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	newton meter
NO	normally open
no., nos.	number, numbers
NPS	National Pipe, Straight
NPSC	National Pipe, Straight-coupling
NPT	National Standard taper pipe thread per general use
NPTF	National Pipe, Taper-Fine
NR	not required, normal relay
ns	nanosecond
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OF	overfrequency
opt.	option, optional
OS	oversize, overspeed
OSHA	Occupational Safety and Health Administration
OV	overvoltage
oz.	ounce
p., pp.	page, pages
PC	personal computer
PCB	printed circuit board
pF	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
psig	pounds per square inch gauge
pt.	pint
PTC	positive temperature coefficient
PTO	power takeoff
PVC	polyvinyl chloride
qt.	quart, quarts
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
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
RTU	remote terminal unit
RTV	room temperature vulcanization
RW	read/write
SAE	Society of Automotive Engineers
scfm	standard cubic feet per minute
SCR	silicon controlled rectifier
s, sec.	second
SI	*Systeme international d'unites,* International System of Units
SI/EO	side in/end out
sil.	silencer
SN	serial number
SNMP	simple network management protocol
SPDT	single-pole, double-throw
SPST	single-pole, single-throw
spec	specification
specs	specification(s)
sq.	square
sq. cm	square centimeter
sq. in.	square inch
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
THD	total harmonic distortion
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.

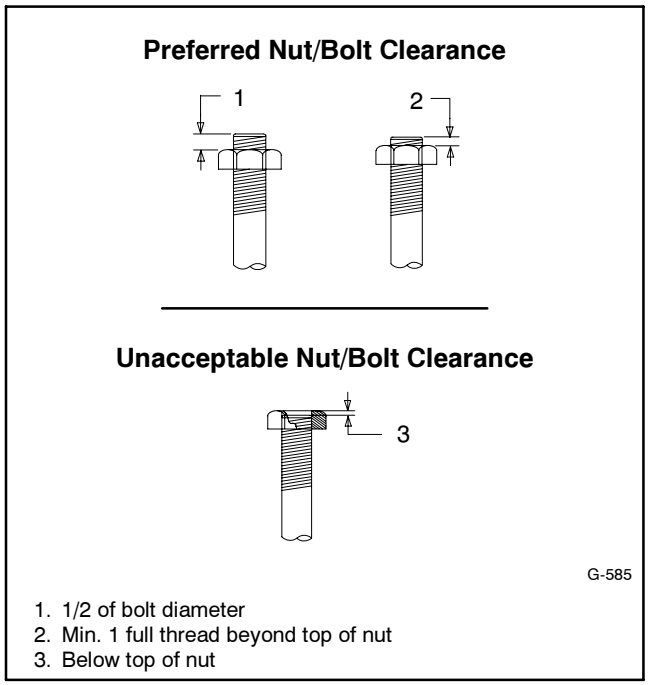


Figure 1 Acceptable Bolt Lengths

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.

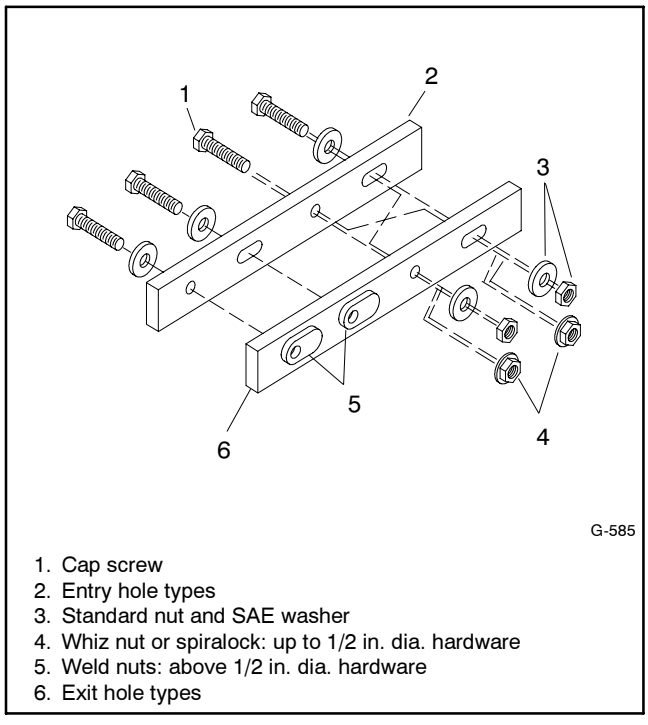


Figure 2 Acceptable Hardware Combinations

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)	

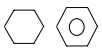
Notes:

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

Appendix D Common Hardware Identification

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

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

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

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

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

Sample Dimensions

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

1/4-20 x 1

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

Metric (Screws, Bolts, Studs, and Nuts)

M8-1.25 x 20

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

Plain Washers

9/32 x 5/8 x 1/16

- Thickness
- External Dimension
- Internal Dimension

Lock Washers

5/8

- Internal Dimension

Appendix E Common Hardware List

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

American Standard

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

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

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

Washers

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

Metric

Hex head bolts are hardness grade 8.8 unless noted.

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

Part No.	Dimensions
Hex Head Bolts (Partial Thread), continued	
M960-16090-60	M16-1.50 x 90
M931-16090-60	M16-2.00 x 90
M931-16100-60	M16-2.00 x 100
M931-16100-82	M16-2.00 x 100*
M931-16120-60	M16-2.00 x 120
M931-16150-60	M16-2.00 x 150
M931-20065-60	M20-2.50 x 65
M931-20090-60	M20-2.50 x 90
M931-20100-60	M20-2.50 x 100
M931-20120-60	M20-2.50 x 120
M931-20140-60	M20-2.50 x 140
M931-20160-60	M20-2.50 x 160
M931-22090-60	M22-2.50 x 90
M931-22120-60	M22-2.50 x 120
M931-22160-60	M22-2.50 x 160
M931-24090-60	M24-3.00 x 90
M931-24120-60	M24-3.00 x 120
M931-24160-60	M24-3.00 x 160
M931-24200-60	M24-3.00 x 200
Hex Head Bolts (Full Thread)	
M933-04006-60	M4-0.70 x 6
M933-05030-60	M5-0.80 x 30
M933-05035-60	M5-0.80 x 35
M933-05050-60	M5-0.80 x 50
M933-06010-60	M6-1.00 x 10
M933-06012-60	M6-1.00 x 12
M933-06014-60	M6-1.00 x 14
M933-06016-60	M6-1.00 x 16
M933-06020-60	M6-1.00 x 20
M933-06025-60	M6-1.00 x 25
M933-06030-60	M6-1.00 x 30
M933-06040-60	M6-1.00 x 40
M933-06050-60	M6-1.00 x 50
M933-07025-60	M7-1.00 x 25
M933-08010-60	M8-1.25 x 10
M933-08012-60	M8-1.25 x 12
M933-08016-60	M8-1.25 x 16
M933-08020-60	M8-1.25 x 20
M933-08025-60	M8-1.25 x 25
M933-08030-60	M8-1.25 x 30
M933-08030-82	M8-1.25 x 30*
M933-10012-60	M10-1.50 x 12
M961-10020-60	M10-1.25 x 20
M933-10020-60	M10-1.50 x 20
M933-10025-60	M10-1.50 x 25
M961-10025-60	M10-1.25 x 25
M933-10025-82	M10-1.50 x 25*
M961-10030-60	M10-1.25 x 30
M933-10030-60	M10-1.50 x 30
M933-10030-82	M10-1.50 x 30*
M961-10035-60	M10-1.25 x 35
M933-10035-60	M10-1.50 x 35
M933-10035-82	M10-1.50 x 35*
M961-10040-60	M10-1.25 x 40

Part No.	Dimensions
Hex Head Bolts (Full Thread), continued	
M933-12016-60	M12-1.75 x 16
M933-12020-60	M12-1.75 x 20
M961-12020-60F	M12-1.50 x 20
M933-12025-60	M12-1.75 x 25
M933-12025-82	M12-1.75 x 25*
M961-12030-60	M12-1.25 x 30
M933-12030-82	M12-1.75 x 30*
M961-12030-82F	M12-1.50 x 30*
M933-12030-60	M12-1.75 x 30
M933-12035-60	M12-1.75 x 35
M961-12040-82	M12-1.25 x 40*
M933-12040-60	M12-1.75 x 40
M933-12040-82	M12-1.75 x 40*
M961-14025-60	M14-1.50 x 25
M933-14025-60	M14-2.00 x 25
M961-14050-82	M14-1.50 x 50*
M961-16025-60	M16-1.50 x 25
M933-16025-60	M16-2.00 x 25
M961-16030-82	M16-1.50 x 30*
M933-16030-82	M16-2.00 x 30*
M933-16035-60	M16-2.00 x 35
M961-16040-60	M16-1.50 x 40
M933-16040-60	M16-2.00 x 40
M961-16045-82	M16-1.50 x 45*
M933-16045-82	M16-2.00 x 45*
M933-16050-60	M16-2.00 x 50
M933-16050-82	M16-2.00 x 50*
M933-16060-60	M16-2.00 x 60
M933-16070-60	M16-2.00 x 70
M933-18035-60	M18-2.50 x 35
M933-18050-60	M18-2.50 x 50
M933-18060-60	M18-2.50 x 60
M933-20050-60	M20-2.50 x 50
M933-20055-60	M20-2.50 x 55
M933-24060-60	M24-3.00 x 60
M933-24065-60	M24-3.00 x 65
M933-24070-60	M24-3.00 x 70
Pan Head Machine Screws	
M7985A-03010-20	M3-0.50 x 10
M7985A-03012-20	M3-0.50 x 12
M7985A-04010-20	M4-0.70 x 10
M7985A-04016-20	M4-0.70 x 16
M7985A-04020-20	M4-0.70 x 20
M7985A-04050-20	M4-0.70 x 50
M7985A-04100-20	M4-0.70 x 100
M7985A-05010-20	M5-0.80 x 10
M7985A-05012-20	M5-0.80 x 12
M7985A-05016-20	M5-0.80 x 16
M7985A-05020-20	M5-0.80 x 20
M7985A-05025-20	M5-0.80 x 25
M7985A-05030-20	M5-0.80 x 30
M7985A-05080-20	M5-0.80 x 80
M7985A-05100-20	M5-0.80 x 100
M7985A-06100-20	M6-1.00 x 100
Flat Head Machine Screws	
M965A-04012-SS	M4-0.70 x 12
M965A-05012-SS	M5-0.80 x 12
M965A-05016-20	M5-0.80 x 16
M965A-06012-20	M6-1.00 x 12

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

Metric, continued

Hex Nuts

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

Washers

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

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

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TP-6442 7/07

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