Operation

Marine Generator Sets

Models:

14/16/21/24/32/40EKOZD
12/13.5/17/18/20.5/28/35EFKOZD

Controller:
Decision Maker® 3500

KOHLER®

TP-7044 9/24f

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

⚠ **WARNING:** Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65warnings.ca.gov/diesel

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: _____

Engine Identification

Record the product identification information from the engine nameplate.

Manufacturer_____

Model Designation_____

Serial Number_____

Accessory Number	Accessory Description

Accessory Number	Accessory Description

Table of Contents

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

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

Accidental Starting

⚠ WARNING	**Accidental starting.** **Can cause severe injury or death.** Disconnect the battery cables before working on the generator set. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery.
	

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

Engine Backfire/Flash Fire

WARNING	
	**Risk of 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

⚠ DANGER	**Hazardous voltage. Moving parts.** **Will 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 will 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 will cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, 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 will 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 will cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while making adjustments or repairs. Remove all jewelry before servicing the equipment.

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 will 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 engine and allow it to cool. Then loosen the pressure cap to relieve pressure.
	

WARNING	**Hot engine and exhaust system.** **Can cause severe injury or death.** Do not work on the generator set until it cools.
	

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

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.

Introduction

This manual provides operation instructions for the following marine model generator sets:

14/16/21/24/32/40EKOZD (60 Hz) and 12.5/13.5/17/18/20.5/28/35EFKOZD (50 Hz)

Refer to the engine operation manual for generator set engine scheduled maintenance information.

Information in this publication represents data available at the time of print. Discovery Energy, LLC 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 generator set specification sheets provide specific generator and engine information. Refer to the spec sheet for data not supplied in this manual. Consult the generator set service manual, engine operation manual, and engine service manual for additional specifications. Obtain copies of the latest spec sheets, manuals, diagrams, and drawings from your local distributor/dealer.

The equipment service requirements are very important to safe and efficient operation. Inspect the parts often and perform required service at the prescribed intervals. Obtain service from an authorized service distributor/dealer to keep equipment in top condition.

Before installing a marine generator set, obtain the most current installation manual from your local distributor/dealer. Only qualified persons should install the generator set.

Service Assistance

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

- Visit the company website at KOHLEREnergy.com.
- Look at the labels and decals on your 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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Bangalore, India
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(91) 80 3366231
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North Asia Regional Office
Tokyo, Japan
Phone: (813) 3440-4515
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Maintenance and Service Parts

Figure 1 identifies maintenance and service parts for your generator set. Obtain a complete list of maintenance and service parts from your authorized generator distributor/dealer.

Part Description	Models			
	14EKOZD and 12EFKOZD (1 and 3 Phase)	16EKOZD and 13.5EFKOZD (1 and 3 Phase)	21EKOZD, 18EFKOZD, and 17EFKOZD (1 and 3 Phase)	24EKOZD, and 20.5EFKOZD (1 and 3 Phase)
Fuel Filter Element	ED0021753200-S	ED0021753200-S	ED0021753200-S	ED0021753200-S
Oil Filter	ED0021752800-S	ED0021752800-S	ED0021752800-S	ED0021752800-S
Seawater Pump Impeller Kit	229826	229826	229826	229826
V-Belt (Seawater Pump)	GM90645	GM90645	GM90645	GM90645
Zinc Anode	ED0090802840-S	ED0090802840-S	ED0090802840-S	ED0090802840-S

Part Description	Models	
	32EKOZD and 28EFKOZD (1 and 3 Phase)	40EKOZD and 35EFKOZD (1 and 3 Phase)
Air Intake Filter	GM101994	GM101994
Fuel Filter Element (Primary)	GM41014	GM41014
Fuel Filter Element (Secondary)	ED0021753180-S	ED0021753180-S
Oil Filter Element	ED0021750010-S	ED0021750010-S
Seawater Pump Impeller Kit	ED0042002060-S	ED0042002060-S
V-Belt (Alternator)	GM102586	GM102586
Zinc Anode	ED0090802840-S	ED0090802840-S

Figure 1 Maintenance and Service Parts

Related Literature

Figure 2 identifies related literature available for the generator sets covered in this manual. Only trained and qualified personnel should install or service the generator set.

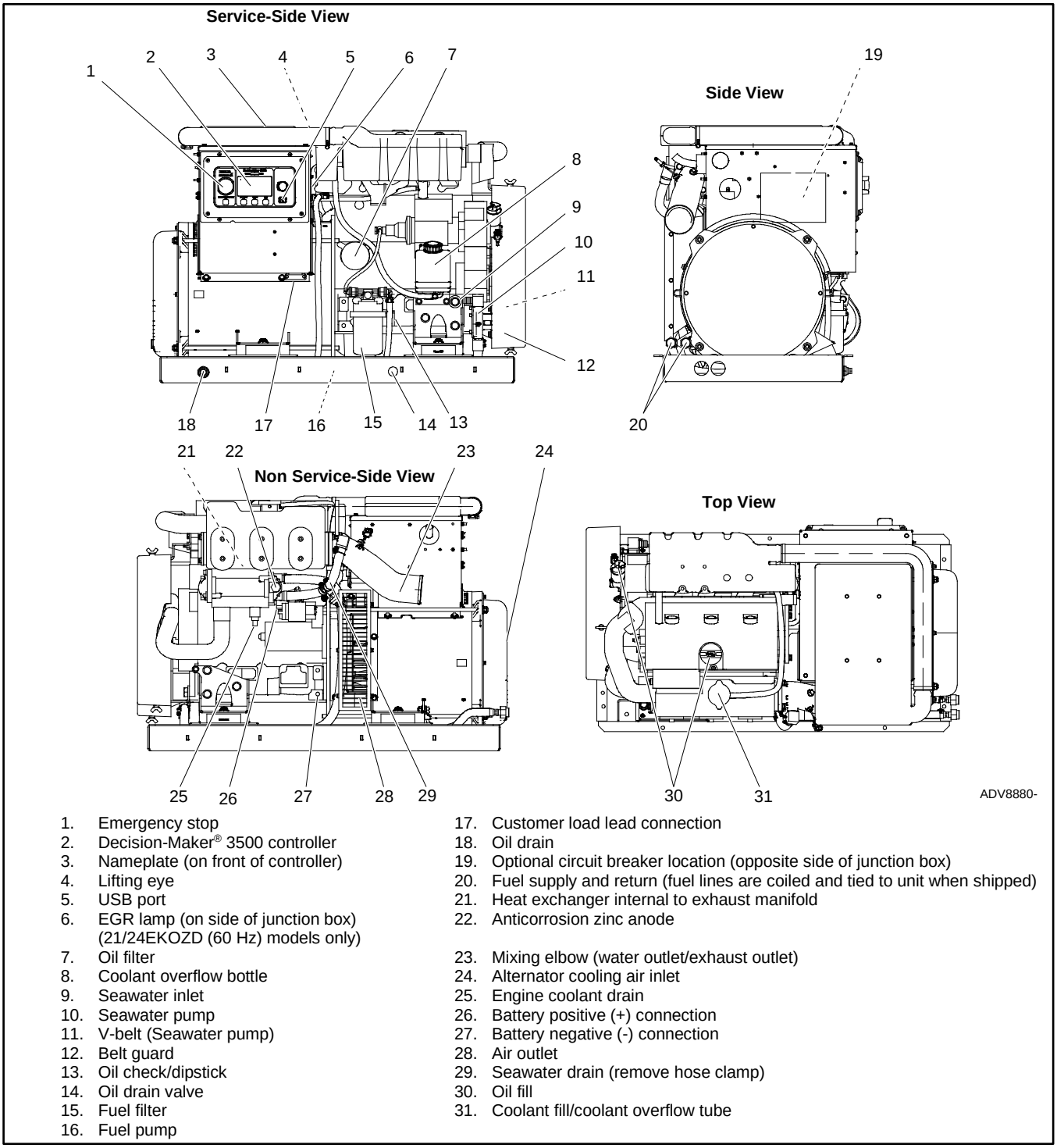
Literature Type	Models			
	14EKOZD and 12EFKOZD (1 Phase)	**14EKOZD and 12EFKOZD (3 Phase)**	**16EKOZD and 13.5EFKOZD (1 Phase)**	**16EKOZD and 13.5EFKOZD (3 Phase)**
Specification Sheet	G2-185	G2-186	G2-187	G2-188
Installation Manual	TP-7045			
Operation Manual	TP-7044			
Parts Catalog*	TP-6954			
Service Manual (Engine)	TP-6939			
Service Manual (Generator)	TP-6953			
Kohler KDI Special Tools Manual	TP-7105			
SiteTech™ Software Operation Manual	TP-6701			
Modbus® Communications Protocol Operation Manual	TP-6113			

Literature Type	**21EKOZD and 18EFKOZD (1 Phase)**	**21EKOZD and 17EFKOZD (3 Phase)**	**24EKOZD and 20.5EFKOZD (1 Phase)**	**24EKOZD and 20.5EFKOZD (3 Phase)**
Specification Sheet	G2-189	G2-190	G2-191	G2-192
Installation Manual	TP-7045			
Operation Manual	TP-7044			
Parts Catalog*	TP-6954			
Service Manual (Engine)	TP-6939			
Service Manual (Generator)	TP-6953			
Kohler KDI Special Tools Manual	TP-7105			
SiteTech™ Software Operation Manual	TP-6701			
Modbus® Communications Protocol Operation Manual	TP-6113			

Literature Type	**32EKOZD and 28EFKOZD (1 Phase)**	**32EKOZD and 28EFKOZD (3 Phase)**	**40EKOZD and 35EFKOZD (1 Phase)**	**40EKOZD and 35EFKOZD (3 Phase)**
Specification Sheet	G2-194	G2-195	G2-196	G2-197
Installation Manual	TP-7045			
Operation Manual	TP-7044			
Parts Catalog*	TP-6954			
Service Manual (Engine)	TP-6916			
Service Manual (Generator)	TP-6953			
Kohler KDI Special Tools Manuals	TP-7105, TP-7083, and TP-7084			
SiteTech™ Software Operation Manual	TP-6701			
Modbus® Communications Protocol Operation Manual	TP-6113			

* Includes generator and engine information.

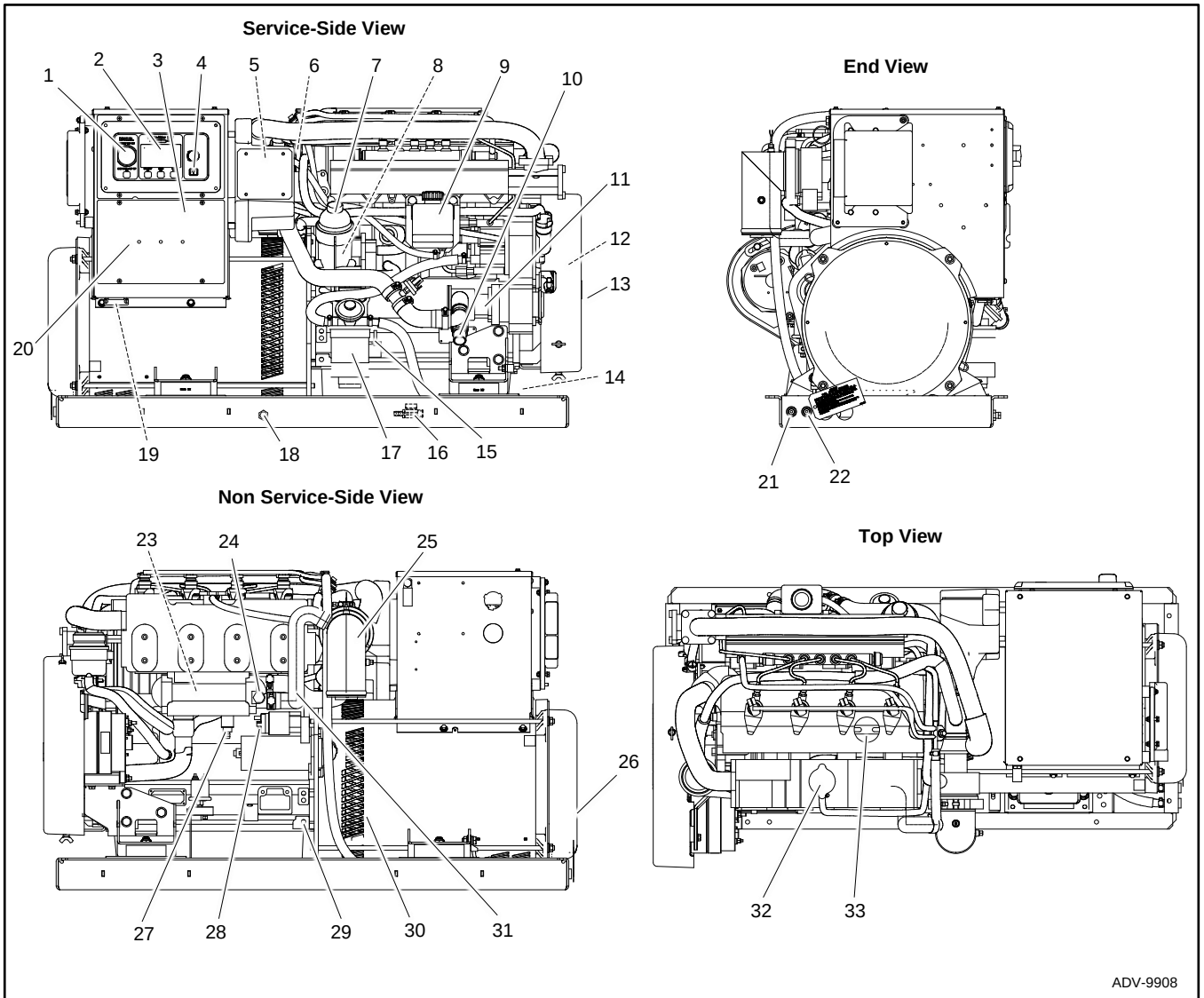
Figure 2 Generator Set Literature



1. Emergency stop
2. Decision-Maker® 3500 controller
3. Nameplate (on front of controller)
4. Lifting eye
5. USB port
6. EGR lamp (on side of junction box) (21/24EKOZD (60 Hz) models only)
7. Oil filter
8. Coolant overflow bottle
9. Seawater inlet
10. Seawater pump
11. V-belt (Seawater pump)
12. Belt guard
13. Oil check/dipstick
14. Oil drain valve
15. Fuel filter
16. Fuel pump
17. Customer load lead connection
18. Oil drain
19. Optional circuit breaker location (opposite side of junction box)
20. Fuel supply and return (fuel lines are coiled and tied to unit when shipped)
21. Heat exchanger internal to exhaust manifold
22. Anticorrosion zinc anode
23. Mixing elbow (water outlet/exhaust outlet)
24. Alternator cooling air inlet
25. Engine coolant drain
26. Battery positive (+) connection
27. Battery negative (-) connection
28. Air outlet
29. Seawater drain (remove hose clamp)
30. Oil fill
31. Coolant fill/coolant overflow tube

Figure 3 Service Views—Typical (14-24EKOZD and 12-20.5EFKOZD Models)

Note:
Consult installation drawings in the spec sheet or installation manual for more details. Consult an authorized distributor/dealer or the service manual for items not shown.



1. Emergency stop
2. Decision-Maker® 3500 controller
3. Nameplate (on front of controller)
4. USB port
5. Air filter element
6. Lifting eye
7. Oil filter cartridge cover
8. Oil filter cartridge
9. Coolant overflow bottle
10. Seawater inlet
11. Seawater pump
12. V-belt (battery charging alternator)
13. Belt guard
14. Fuel pump
15. Oil check/dipstick
16. Oil drain valve (on engine)
17. Fuel filter
18. Oil drain
19. Customer load lead connection
20. Optional circuit breaker location
21. Fuel return connection
22. Fuel supply connection
23. Heat exchanger internal to exhaust manifold
24. Anticorrosion zinc anode
25. Water cooled exhaust outlet
26. Alternator cooling air inlet
27. Engine coolant drain
28. Battery positive (+) connection
29. Battery negative (-) connection
30. Air outlet
31. Seawater drain (remove hose clamp)
32. Coolant fill/coolant overflow tube
33. Oil fill

Figure 4 Service Views,Typical (32-40EKOZD and 28-35EFKOZD Models)

Note:

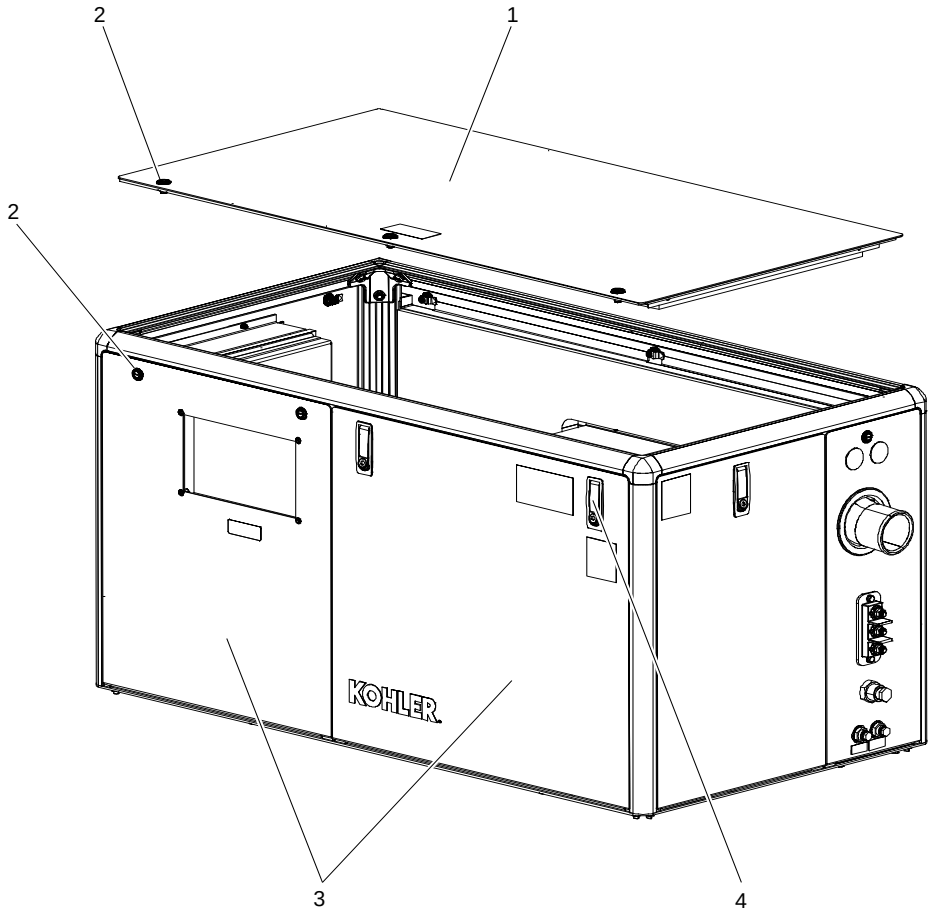
Consult installation drawings in the spec sheet or installation manual for more details. Consult an authorized distributor/dealer or the service manual for items not shown.

⚠ WARNING	**Accidental starting.** **Can cause severe injury or death.** Disconnect the battery cables before working on the generator set. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery.

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

Sound Shield Roof and Door Removal

1. Open the service doors by releasing the latches, if equipped, or by using a flat-head screwdriver to turn the 1/4-turn fasteners. See Figure 5.
2. Lift up the roof by using a flat-head screwdriver to turn the 1/4-turn fasteners. See Figure 5.
3. Slide the roof towards the service side of the unit for removal.
4. Open the front, rear, and non-service side doors as needed.



1. Sound shield roof
2. 1/4-turn fastener
3. Service door
4. Latch

Figure 5 Sound Shield Door and Roof Removal, Typical

Notes

2.1 Prestart Checklist

WARNING	
	**Carbon monoxide.** **Can cause severe nausea, fainting, or death.** The exhaust system must be leakproof and routinely inspected.

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.

DANGER	
	**Hazardous voltage. Moving parts.** **Will 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 will 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.

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 Inlets. Check for clean and unobstructed air inlets.

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

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

Drive Belts if equipped. Check the belt condition and tension of the water pump 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 *(blow by).* 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.

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

Discovery Energy, LLC 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.

Discovery Energy, LLC also recommends having the generator's exhaust system inspected at the start of each boating season by an authorized 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.
	

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.

2.3 Angular Operation

See Figure 6 for angular operation limits.

14-24EKOZD/12-20.5EFKOZD Models	
Instant Operation (up to 1 min.)	**Intermittent Operation (up to 30 min.)**
35°	25°
32-40EKOZD/28-35EFKOZD Models	
Intermittent Operation (up to 1 min.)	**Continuous Operation**
35°	25°

Figure 6 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, Discovery Energy, LLC recommends maintaining the minimum load profile indicated in Figure 7. 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 7 Load Profile

Unburned Fuel (Wet Stacking) occurs when water/fuel 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) for long periods of time, diesel exhaust stays hot enough to prevent water/fuel vapor from condensing. Conversely, if the generator set is subjected to light loads (30% or less) for long periods of time, water/fuel vapors accumulate and may result in the following conditions to develop:

- Cylinder wall glazing
- Fuel on water
- Crankcase oil dilution
- Wet stacking

Note:
Consult the engine manufacturer's guidelines for more details on unburned fuel and wet stacking.

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 Introduction

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

2.7 Controller Specifications

Decision-Maker® 3500	
Power source with circuit protection	12- or 24-volt DC
Power drain	400 milliamps at 12V 200 milliamps at 24V
Humidity range	5-95%
Operating temperature	-40° to 70°C (-40° to 158°F)
Storage temperature	-40° to 85°C (-40° to 185°F)

Note:
Have setup and adjustments of the Decision-Maker® 3500 controller performed only by an authorized distributor/dealer. The setup and adjustments are password protected.

2.8 Decision-Maker 3500® Controller Information

The following data must be resident for the controller to function.

- **Application program** contains the software that controls system operation. The application file was preprogrammed in the *original* controller at the factory.
- **Personality profile** is specific to the engine and alternator and was preprogrammed in the *original* controller at the factory.

  Typically, the authorized distributor/dealer creates a backup of the personality profile and passes this information onto the owner. Inform the owner to store this information for possible future use such as controller replacement or other circumstances requiring a backup.

  Note:
  If the personality profile is NOT available, request a replacement from Kohler Aftermarket Parts Department.

  Enter an aftermarket parts order for part number *PROFILE.* Include in the order notes the generator set model, specification number, serial number, generator set modifications, and email of recipient.
- **User parameters** unique to an installation include timer values, setpoints, generator set data such as voltage and input/output selections. These parameters are typically set up for or by the installer at the time of installation. User parameters are typically recorded on the personality profile disk, a separate backup disk/drive, or written on a paper form.

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

  Note:
  After the unit is set up on the vessel, authorized distributor/dealer saves any user parameter changes to an external medium. Authorized distributor/dealer passes this information onto the owner. The owner should store this information for possible future use such as controller replacement or other circumstances requiring a backup.

  Note:
  Controller service replacement kits do not include the three files. The service technician *must* install the three files into the replacement controller.

2.9 Controller Features

The controller features include the annunciator lamp, graphical display and pushbutton/rotary selector dial, switches and controls, and terminal blocks. See Figure 8 for an illustration of the controller front panel. The following paragraphs detail the features by general topics. The controller provides:

- The backlit LCD (liquid crystal display) for monitoring the generator set functions and output values
- Master control buttons with status lights
- Fault lamp
- Pushbutton/rotary selector dial to navigate the generator set displays
- Alarm horn and alarm silence switch/light
- Mini USB connector for PC setup using SiteTech™ software

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.

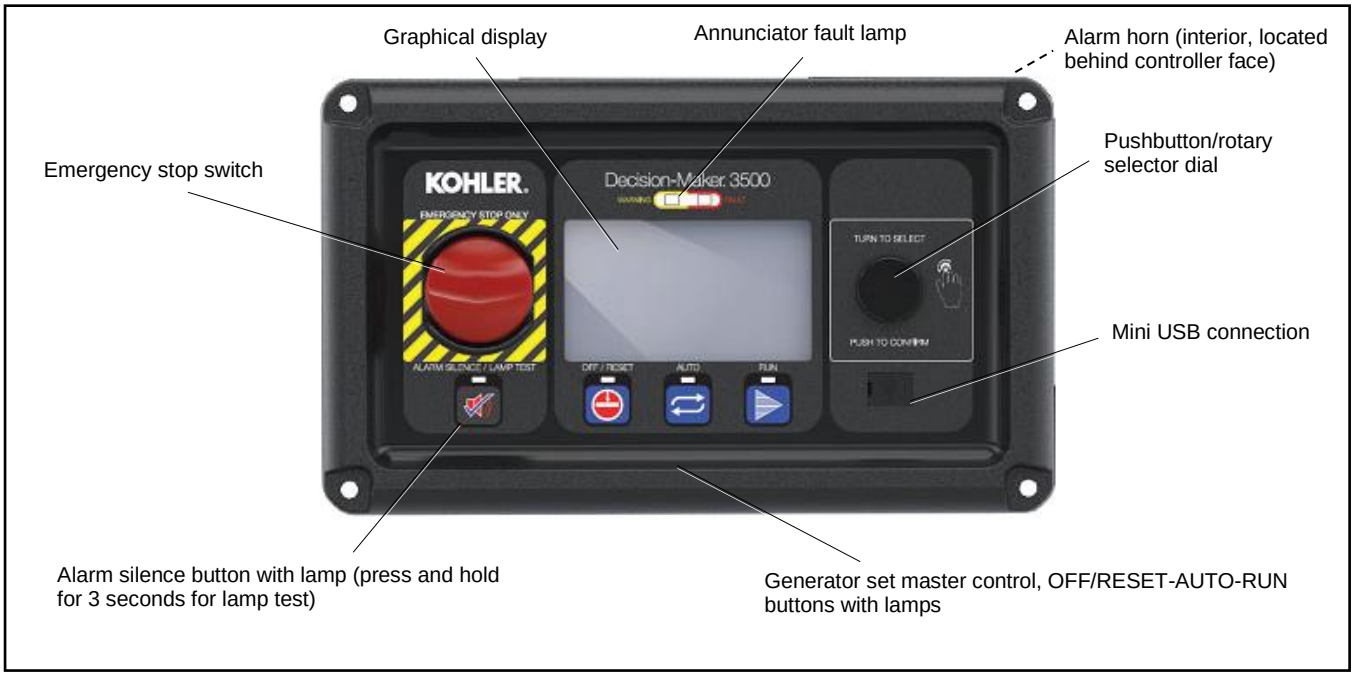


Figure 8 Decision-Maker® 3500 Controller with Digital Display and Pushbutton/Rotary Selector Dial

Note:
Press the pushbutton/rotary selector dial to turn on the controller lights and display. The backlight turns off 60 minutes after the last entry when in the AUTO mode.

Note:
After about 5 minutes of no user input (pushbutton/rotary selector dial or buttons), the menu is reset to the top of the main menus and auto-paging activates for the Overview submenus.

Note:
Measurements display in metric or English units. Use the Controller Configuration menu to change the measurement display.

2.9.1 Switches and Controls

Note:
US/Metric Display is selectable in the Controller Configuration Menu section.

Alarm Horn. The alarm horn alerts the operator or other attendants that a warning or shutdown condition exists.

Alarm (Horn) Silence. The alarm silence switch silences the alarm horn at the operator's discretion. Press the master control switch AUTO button *before* pressing the alarm silence button. The alarm horn cannot be silenced unless the master control switch AUTO button is pressed.

Note:
Additional alarm silencing options are shown in the Controller Configuration Menu section.

Restore alarm horn switches at all locations including those on remote annunciator kits after correcting the fault shutdown to avoid reactivating the alarm horn. See the Operation, Controller Resetting section for resetting the controller.

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 emergency stop switch outward. *Use the emergency stop switch for emergency shutdowns only*. Use the master control switch OFF/RESET button for normal shutdowns.

Generator Set Master Control (OFF/RESET-AUTO-RUN). These buttons reset the controller fault lamps and start/stop the generator set. Additional information is shown in the Operation section.

Lamp Test. Press and hold the Alarm Silence/Lamp Test button to test the controller indicator lamps, alarm horn, and digital display.

Pushbutton/Rotary Selector Dial. This control provides access to the menus for monitoring. Press the selector dial to activate the graphical display and to select choices shown on the display. Rotate the dial to navigate through the menus.

The pushbutton/rotary selector dial has several features and functions:

- Momentarily press the dial to activate the graphical display if dark.
- Rotate the dial to navigate through the main menus—turn counterclockwise to go forward (down) and clockwise to go back (up). The menus wrap to the beginning.
- Press the dial at a given main menu to access the submenus within the selected main menu.
- When in the submenu, rotate the dial to navigate through the submenu—counterclockwise to go forward (down) and clockwise to go back (up). The menus wrap to the beginning.
- Momentarily press the dial when in the submenu to make a user selection choice (if available) or to go back to the respective main menu.
- To return to the previous menu, rotate the dial (counterclockwise or clockwise) until the back arrow appears in the upper left corner and press the dial.

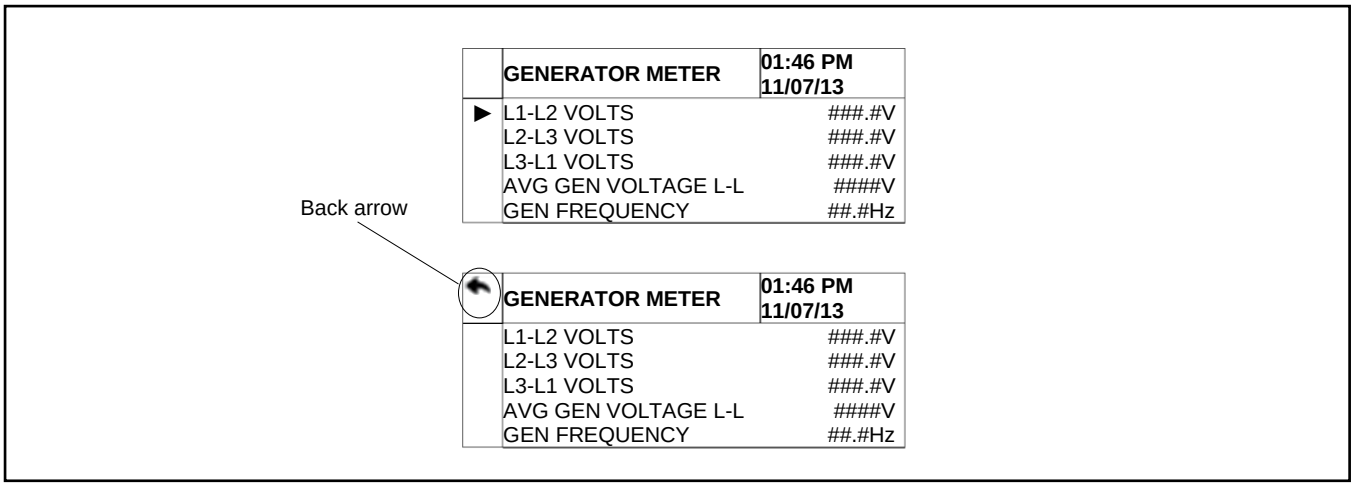


Figure 9 Back Arrow Location

- After about 5 minutes of no user input (pushbutton/rotary selector dial or buttons), the menu resets to the top of the main menus and auto-paging activates for the Overview submenus.

2.9.2 Exhaust Gas Recirculation (EGR) Lamp

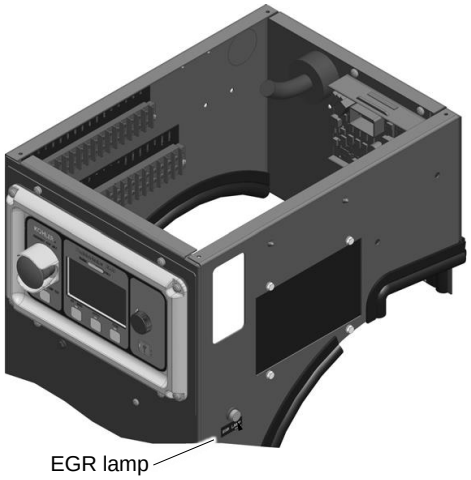


Figure 10 EGR Lamp (21/24EKOZD 60 Hz Models Only)

The EGR lamp is located on the side of the junction box for 21/24EKOZD 60 Hz models only. See Figure 10. Under normal operation, the light illuminates for approximately 1 second at startup to indicate that power is available to the EGR and then, the light goes out. If the light pulses more than one time, verify that the ECU module is properly connected and verify that the EGR valve is properly connected. If all connections are good and the light continues to pulse, contact an authorized distributor/dealer for service.

2.9.3 Annunciator Lamps

The controller has a single annunciator fault lamp providing visual generator set status. In addition, each button has a lamp. See Figure 11**.**

Lamp/Button	Lamp Color
Alarm (Fault) Lamp	Yellow (Warning) or Red (Shutdown)
Off/Reset Button	Blue
Auto Button	Blue (System Ready)
Run Button	Blue
Alarm Silence Button	Orange

Figure 11 Annunciator Lamps

System Status Lamps (Master Control Switches)

The lamp illuminates on the master control switch AUTO (automatic start) button indicating the system senses no faults and the unit is ready to start by remote command.

The lamp illuminates on the master control switch OFF/RESET button indicating the generator set is stopped.

The lamp illuminates on the master control switch RUN button indicating the generator set is cranking or running from a local command.

Only one of the three master control switch lamps will illuminate at any given time.

Alarm Silence Lamp. Orange lamp illuminates indicating the alarm horn was silenced.

Alarm Fault Lamp. Yellow lamp illuminates indicating a warning condition or red lamp illuminates indicating a shutdown condition. See System Warning Fault Lamp and System Shutdown Fault Lamp following for system fault conditions.

System Warning Fault Lamp. 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 the System Fault Warning Lamp with Digital Displays section, for definitions of the items listed.

System Shutdown Fault Lamp. 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 the Controller Resetting procedure section.

See the System Fault Shutdown Lamp with Digital Displays section, for definitions of the items listed.

Note:
Always identify and correct the cause of a fault shutdown before resetting the controller.

2.9.4 Graphical Display

Press the pushbutton/rotary selector dial to turn on the controller lamps and display. The backlight turns off 10 minutes after the last entry when in the AUTO mode.

The generator set must be running for some displays to indicate values. If the generator set is not running some values will display zero or N/A (not available).

The 5-line, 35 character per line backlit heated display provides generator set and engine data, system status, and fault information. See the Decision-Maker® 3500 Controller with Digital Display and Pushbutton/Rotary Selector Dial figure. The graphical display shows abbreviations in some instances.

Note:
US/Metric Unit Display is selectable in the Controller Configuration menu.

Note:
After about 5 minutes of no user input (pushbutton/rotary selector dial or buttons), the menu resets to the top of the main menus and auto-paging activates for the Overview submenus.

The main menus are listed below. Within each main menu are multiple submenus with descriptions following.

- Metering (See the Metering Menu section)
- Generator Information (See the Generator Information Menu section)
- Controller Configuration (See the Controller Configuration Menu section)
- I/O Setup (See the I/O Setup Menu section)
- Active Events (See the System Fault Warning Lamp with Digital Displays, System Fault Shutdown Lamp with Digital Displays, and Status and Notice Digital Display section)

2.10 Metering Menu

2.10.1 Generator Metering Submenu

- **Volts** displays the alternator output AC voltages. The display shows all line-to-line and line-to-neutral voltage combinations for three-phase or single-phase configurations. The display also shows the average line-to-line and line-to-neutral voltages.

  Note:
  The average line-to-neutral is not listed for the delta connection.
- **Current** displays the alternator output AC amps. The display shows each line (L1-L2-L3) of three-phase models or L1-L2 current for single-phase models. The display also shows the average current.
- **Frequency (Hz)** displays the frequency (Hz) of alternator output voltage.
- **Power kW** displays the total and the individual L1, L2, and L3 alternator output as actual output values.
- **Power Factor** displays the total and individual line power factor values.
- **% Rated kW** displays alternator output as a percentage of the entered rated value.
- **Reactive Power kVAR** displays the total and individual L1, L2, and L3 kVAR.
- **Apparent Power kVA** displays the total and individual L1, L2, and L3 kVA.
- **% Rated kVA** displays alternator kVA as a percentage of the entered rated value.
- **Phase Rotation** displays the actual generator rotation.

2.10.2 Engine Metering Submenu

Note:
Not all of these engine metering submenus may apply.

- **Engine Speed (Tachometer)** displays the engine speed (RPM) at which the engine is presently running.
- **Oil Pressure** displays the engine oil pressure.
- **Coolant Temperature** displays the engine coolant temperature.
- **Fuel Rate** displays the calculated fuel consumption rate based on fuel injector outputs (if available from ECM).
- **Gen Battery Voltage** displays the DC voltage of the generator starting battery(ies) as measured by the controller.
- **ECM Battery Voltage** displays the DC voltage of the engine starting battery(ies) as reported from the ECM.
- **Oil Temperature** displays the engine oil temperature.
- **Coolant Pressure** displays for the engine coolant pressure.
- **Fuel Pressure** displays the fuel line pressure at the generator set inlet for gas-powered models.
- **Fuel Temperature** displays the fuel supply temperature.
- **Fuel Used Last Run** displays the accumulated amount of fuel used since last reset (if available from ECM).
- **Crankcase Pressure** displays the engine crankcase pressure.
- **Intake Air Pressure** displays the engine intake manifold air pressure if available.
- **Intake Air Temperature** displays the engine intake manifold air temperature if available.

2.10.3 Overview Submenu

Generator Status:

- **Average Volts Line-to-Line.** For three-phase configurations the average line-to-line voltage of L1, L2, and L3 is displayed. Single-phase configurations show the L1-L2 voltage.
- **Average Current** value displays as the average for three-phase configurations or the current value for L1-L2 with single-phase configurations.
- **Frequency (Hz)** value displays for the output AC voltage.

Engine Status:

- **Coolant Temperature** displays the engine coolant temperature.
- **Oil Pressure** displays the engine oil pressure.
- **Battery Voltage** displays the DC voltage of the engine starting battery(ies).

System Status:

- **Fuel Pressure** displays fuel injection pressure.
- **Total Power** displays the generator operating power rating in kW.
- **Engine Run Time** displays the total run time hours.

2.10.4 Paralleling Metering Submenu

Note:
The paralleling metering is only valid if the Decision-Maker® 3500 controller is controlling a motor-operated circuit breaker.

- **Connected to Bus** displays if the generator is connected to the paralleling bus (the output breaker or contactor is closed).
- **Avg Bus Voltage L-L** displays the average of the three-phase line-to-line voltage measured by the paralleling bus sensing.
- **Avg Gen Voltage L-L** displays the average of the three-phase line-to-line voltage of the generator output.
- **Bus Frequency** displays the cycle frequency of the paralleling bus.
- **Gen Frequency** displays the cycle frequency of the generator.
- **Bus Total Power** displays the real power provided by all the generators in the paralleling system.
- **Bus % of Rated kW** displays the ratio between the Bus Total Power and the Bus Total Capacity (found in the Generator Management screen) expressed as a percentage.
- **Bus % of Rated kVAR** displays the ratio between the reactive load on all generators in the paralleling system and the bus reactive capacity (the sum of 3/4 of the rated kW of all connected generators) expressed as a percentage.

2.11 Generator Information Menu

2.11.1 Generator Information Submenu

- **Total Run Time** displays the total run time hours.
- **Hours Loaded** displays the total loaded hours.
- **Hours Unloaded** displays the total unloaded hours.
- **kW Hours** displays the total kW hours.
- **Operating Hours** displays the total operating hours.
- **Total Number of Starts** displays the total number of times that the engine was started via the generator set controller.
- **Last Maintenance** displays the date on the controller system clock when the last maintenance was performed.
- **Operating Hours Since Maintenance** displays the total number of hours of operation since the last maintenance date.
- **Starts Since Maintenance** displays the total number of generator set startup events since the last maintenance date.
- **Engine Hours Since Maintenance** displays the total engine hours since last maintenance.
- **Loaded Since Maintenance** displays the total loaded hour since last maintenance.
- **Unloaded Since Maintenance** displays the unloaded hours since last maintenance.
- **kW Hours Since Maintenance** displays the total kW hours since last maintenance.
- **Reset Maintenance Records:** displays a Yes/No choice for the user to select.
- **Last Start** displays the date when the generator set last operated.
- **Last Run Length** displays the length of time that the engine ran the last time it was started via the generator set controller.
- **Controller Serial No.** displays the controller serial number.
- **Software Version** displays the software version number. Use the version number to determine if an upgrade is needed and/or when troubleshooting the controller.
- **ECM Serial No.** displays the ECM serial number.
- **Genset Model No.** displays the generator set model number. Only adjustable from SiteTech™.

- **Genset Spec No.** displays the generator set specification number. Only adjustable from SiteTech™.
- **Genset Serial No.** displays the generator set serial number. Only adjustable from SiteTech™.
- **Alternator Part No.** displays the alternator part number. Only adjustable from SiteTech™.
- **Engine Part No.** displays the engine part number. Only adjustable from SiteTech™.
- **Engine Model No.** displays the engine model number. Only adjustable from SiteTech™.
- **Engine Serial No.** displays the engine serial number. Only adjustable from SiteTech™.

2.11.2 Event History Submenu

Generator Event History:

This menu allows the user to review up to 1000 entries of generator system events including shutdown faults, warning faults, notices, and status events with date and time stamp. See Controller Fault Diagnostics section for a list of the items that appear on the Generator Event History.

Engine Event Log:

A message is sent each time there is a change in a monitored engine condition (i.e. fault becomes active, fault is cleared). Upon broadcast of this message, the controller will request another message that contains the following information for each fault:

- **SPN (Suspect Parameter Number)** is a four-digit code that represents an engine component.
- **FMI (Failure Mode Indicator)** is a two-digit code that represents the type of fault that occurred (i.e. short circuit, out of range).
- **Occurrence Count** is a count of how many times a fault has occurred.

2.11.3 Configuration Submenu

Generator Configuration

The values in this menu are user-entered for the generator set configuration and are NOT measured values of the generator set.

Note:
Have setup and adjustments of the Decision-Maker® 3500 controller performed only by an authorized distributor/dealer. The setup and adjustments are password protected.

- **Operating Mode** displays the programmer entered generator set application configuration as Standby or Prime.
- **Application Type** displays the programmer entered generator set application type as None, Marine, Mobile, Standby or Prime.
- **System Voltage** displays the programmer-entered L1-L2-L3 output voltage for three-phase or the L1-L2 output voltage for single-phase.
- **System Frequency** displays the programmer-entered L1-L2-L3 output voltage frequency for three-phase or the L1-L2 output voltage frequency for single-phase.
- **System Phase** displays the programmer-entered configuration as Single Phase, Single Phase Dogleg, Three Phase Wye, or Three Phase Delta.
- **Rated Engine Speed** displays the programmer entered engine speed in RPM.
- **Adjusted Engine RPM** displays the target engine speed setting.
- **kW Rating** displays the programmer entered kW value for the generator set.
- **kVA Rating** displays the programmer entered kVA value for the generator set.
- **Rated Current** displays the programmer entered current value for the generator set.
- **Battery Voltage** displays the programmer entered battery voltage.

- **Engine Start Delay** displays the time delay before the generator set starts while the master switch is in AUTO or RUN positions.
- **Starting Aid Delay** displays the engine starting aid activation time.
- **Crank On Delay** displays the time allocated for generator set crank on in seconds.
- **Crank Pause Delay** displays the time allocated for generator set crank pause in seconds.
- **Engine Warmed Up** displays the temperature when the engine is warmed up enough to be loaded.
- **Engine Cooled Down** displays the temperature below which the engine cooldown can be overridden.
- **Cooldown Delay** displays the time delay for engine cooldown while the master switch is in the AUTO or RUN positions and not in the idle mode.
- **Cooldown Override** allows the user to select the Cooldown Temperature Override Mode. If set to ON, the engine will stop immediately if the coolant temperature is below the engine cooled threshold, but will run for the duration of the cooldown cycle otherwise. If set to OFF, the engine will always complete the cooldown cycle.
- **Fuel Type** displays the programmer entered fuel type as NG (Natural Gas), LP (Liquefied Petroleum), Gasoline, Diesel, or Unknown.
- **Crank Cycles Limit** displays the programmer entered crank cycle.
- **Enable NFPA Defaults:** Allows the user to Enable or Disable the NFPA defaults.
- **Enable Emergency Battlemode:** Allows the user to turn On/Off the emergency battlemode feature. **Note:**
  Conditional for certain units.

Protection Configuration

Note:
The time delays are user adjustable using SiteTech™. Have setup and adjustments of the Decision-Maker® 3500 controller performed only by an authorized distributor/dealer. The setup and adjustments are password protected.

- **Overvoltage** displays the percentage of the system voltage that the generator voltage must exceed for an overvoltage condition to be indicated.
- **Overvoltage Delay** displays the time that the generator voltage must be in an overvoltage condition before a fault is indicated.
- **Undervoltage** displays the percentage of the system voltage that the generator voltage must drop below for an undervoltage condition to be indicated.
- **Undervoltage Delay** displays the time that the generator voltage must be in an undervoltage condition before a fault is indicated.
- **Overfrequency** displays the percentage of the system frequency that the generator frequency must exceed for an overfrequency condition to be indicated.
- **Underfrequency** displays the percentage of the system frequency that the generator frequency must drop below for an under frequency condition to be indicated.
- **Overspeed** displays the engine speed that the engine must exceed for an overspeed condition to be indicated.
- **Low Battery Voltage** displays the system battery voltage that the battery voltage must drop below for a low battery voltage condition to be indicated.
- **High Battery Voltage** displays the system battery voltage that the battery voltage must exceed for a high battery voltage condition to be indicated.

2.11.4 Voltage Regulation Submenu

Note:
Have setup and adjustments of the Decision-Maker® 3500 controller performed only by an authorized distributor/dealer. The setup and adjustments are password protected.

The Decision-Maker® 3500 controller has a built-in voltage regulation function. 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.

The descriptions of the voltage regulator adjustments and features follow.

Voltage Adjust. The voltage adjust allows the user to enter the desired generator set output level. The voltage regulator controls the average of the three output phase voltages to this target in a three phase configuration, and L1L2 voltage to this target in a single phase configuration.

Submenus display the individual line-to-line voltages and the individual phase 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.

Target Voltage. The voltage that the Decision-Maker® 3500 controller is trying to achieve including droop and parallelling bias.

Volts/Hz. The excitation control system includes an under-frequency unloading feature. This is sometimes referred to as Volts-per-Hertz or V/Hz. When the frequency drops below a certain value, the output voltage is reduced to decrease engine load, allowing the engine speed to recover more quickly. The output voltage reduction is based on the frequency.

Volts per Hz Settings. The amount of voltage reduction can be adjusted to achieve the desired transient response of the engine and alternator system. The V/Hz function will use the following parameter settings:

- V/Hz Setpoint (Hz)
- V/Hz Slope (%/Hz)
- V/Hz reduction limit (fixed at 50% of rated voltage)

Volts per Hz Adjustment. The V/Hz settings can be changed using the PC-based setup program or at the front panel using the password. The setup program will read current settings to determine a similar function when making changes to alternator connections, system voltages or operating frequency.

Volts/Hz Setpoint. This adjustment affects the voltage droop (volts per Hz) when load is applied and underfrequency occurs. The volts/Hz setpoint setting defines the threshold below which the underfrequency unloading is active. Any frequency below the setpoint causes the voltage to drop thus reducing the load allowing the engine speed to recover according to the volts/Hz slope setting.

Engine speed recovery depends upon characteristics such as engine make, fuel type, load types, and operating conditions. The volts/Hz setpoint setting is set at the factory to match the engine speed recovery characteristics for the application.

Volts/Hz Slope. This setting determines how much the voltage drops during an underfrequency condition. The Volts/Hz Slope setting is set at the factory. 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 degree of unloading that occurs for each 1 Hz decrease in frequency.

Voltage Droop at 100% kVAR (Reactive Droop). Reactive droop compensation provides reactive current flow adjustment in the generator set when connected in paralleling applications. Reactive droop reduces excitation levels with increasing reactive power. A reduced excitation level reduces generator set reactive power or generated VARs, improving reactive load sharing.

Enter the parameter as a percentage of system voltage when 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.

Voltage Gain Adjust. Regulator gain refers to the gain of the control system. Generally, the higher the gain the faster the system responds to changes and 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.

The voltage regulator value is reviewable at all times and provides the ability to fine adjust voltage. Changing the system voltage or replacing the circuit board typically requires a voltage adjustment.

The user can change the individual value or can select *Reset Regulator Defaults*?-Yes to reset to the default value. The *Reset Regulator Defaults* display will only show if editing is enabled.

Start-Up Ramp Rate. Slowly ramps the voltage to its target to minimize voltage overshoot at startup.

2.11.5 Voltage Selector Switch

The voltage selector switch menu does not apply to the EKOZD and EFKOZD models.

2.11.6 Paralleling Operation

Note:
Have paralleling setup performed by appropriately skilled and suitably trained maintenance personnel familiar with generator set parallel commissioning, operation, service, and troubleshooting.

The Decision-Maker® 3500 controller is a paralleling controller and provides varying degrees of paralleling functionality.

While the Decision-Maker® 3500 controller can also be used with external switchgear controlling the speed, voltage and paralleling breaker/contactor, the Parallel Operation menu is used to configure settings for parallel operation where the controller is communicating on a network with other controllers and provides integral paralleling functionality.

Paralleling Setup

The Paralleling Setup menu is intended to configure the basic settings for the parallel operation of the controller. Most of the settings in this menu are configured during commissioning and do not require user adjustment. There are a few settings that may be viewed or adjusted after commissioning is complete.

Volts-Hz OK Delay. The time that the voltage and frequency must remain within the acceptable window before the controller considers them to be stable. The voltage window requires the output voltage of the generator to be within the **Voltage OK Pickup** of the system voltage, the frequency window requires the operating frequency of the generator to be within the **Frequency OK Pickup** of the system frequency. This delay may need to be increased if the first generator to close to the bus has not yet reached rated operating parameters or if the speed/voltage is in an overshoot condition when the generator comes online.

First On Delay. The time that the system will wait before closing the first generator to the bus. This delay should be set as low as possible, but can be extended to ensure that a different generator will be the first to close. One generator in the system should have the first on delay set to a low number to minimize the delay before the generator can supply power to the load.

kW Ramp Rate. The generator will load and unload against the other generators at this rate. The default rate (5%/sec) requires 20 sec to accept 100% load. Increasing the ramp rate will allow the generator to disconnect more quickly from the bus when signal to stop by generator management, but may result in variations in the output voltage or frequency of the generator system. The ramp rate can be decreased if there is noticeable fluctuation in the voltage or frequency when a generator is loading or unloading.

Trims Enable. The trims are the mechanism that the paralleling system uses to keep the output voltage and frequency near the rated values when the generator system is operating. The trims default is enabled on all generators, but they can be disabled on some generators in the system to improve load sharing. The trims should be enabled on at least one generator in the paralleling system or the voltage and frequency may drift significantly during the operation of the system.

Load Enable. The generator will unload and trip the circuit breaker/contactor when this setting is set to OFF. This can be used to force a generator to soft-unload and shut down for service. To keep the breaker/contactor from reclosing, the Sync Mode in Auto can be set to OFF (see Sync Mode In Auto below). A generator is not considered for generator management when Load Enable is set to OFF. This parameter should always be returned to ON after the generator has been stopped for service, as it will keep the generator from sharing load or starting for generator management if it is set to OFF.

Stand Alone Mode. This will tell the controller that it is a paralleling controller, even if it does not see another generator on the communication lines. This may be required if all other generator controllers are removed from service for a period of time in which the battery power to this controller will be cycled (the controller remembers that it is in a paralleling system until power is cycled). If the controller sees another controller on the PGEN communication network, this parameter will not change the operation of the system in any way.

Sync Mode In Auto. This should be set to Active before leaving the vessel when commissioning or testing is complete, but can be used to keep the controller from closing the paralleling breaker/contactor to complete a test or to take a generator out of service. Setting the Sync Mode to OFF will disable the synchronizer, the paralleling breaker/contactor will not close with the synchronizer disabled. To remove a generator from service manually, set the Sync Mode in Auto to OFF, wait for any additional generators to start, and set the Load Enable to OFF. When the breaker/contactor trips, stop the generator by pressing the OFF button, then set the Sync Mode back to Active and the Load Enable back to ON.

Note:
Pressing the OFF button will also disconnect the generator from the paralleling bus, but it will not give the other generators any opportunity to negotiate an arrangement to support the load. Even if there are enough generators online to support the load, the voltage and frequency may dip when the other running generators are required to pick up the load formerly supported by this generator.

Sync Mode In Run. The default setting for this parameter is Check. In Check mode, the controller will close the paralleling breaker/contactor to a dead bus (no other generators supplying the load) but will hold synchronism with the bus without closing the paralleling breaker/contactor if it is already supplied by another generator. This allows operational verification of the synchronizer, but does not allow the generator to supply the load. If the generator system is to be operated with the engine control switch in Run, the Sync Mode in Run may need to be set to Active.

Note:
System Start (AUTO-RUN) is the preferred method of operating a generator system. RUN is intended for testing or verification only.

Note:
Sync Mode in Auto and Sync Mode in Run can also be found on the Synchronizing Setup screen.

Synchronizing Setup

This screen is primarily used to configure the synchronizer. There is a lot of metering information that can be accessed on this screen, but the parameters should be adjusted only during commissioning.

Volts-Hz OK. The voltage and frequency have been within the acceptable window for the Volts-Hz OK Delay.

In Sync. The frequency, voltage and phase rotation of the generator have matched that of the bus and the generator and bus have been in phase for the duration of the dwell timer. This value is only updated when the controller is synchronizing (Synch Mode = Active, Passive or Check, breaker/contactor is open, generator is running).

Voltage Matched. The difference between the generator voltage and the bus voltage is within the acceptable window. This value is only updated when the controller is synchronizing (Synch Mode = Active, Passive or Check, breaker/contactor is open, generator is running).

AVG Bus Voltage L-L. The average voltage of the paralleling bus.

AVG Gen Voltage L-L. The average voltage of this generator.

Voltage Bias. The amount that the controller is attempting to adjust the output voltage

(100% bias = +10% on the output voltage, -100% = -10% on the output voltage).

The controller adjusts the Voltage Bias to match the generator voltage to the bus voltage

Frequency Matched. The difference between the generator frequency and the bus frequency is within the acceptable window. This value is only updated when the controller is synchronizing (Synch Mode = Active, Passive or Check, breaker/contactor is open, generator is running).

Bus Frequency. The operating frequency of the paralleling bus.

Gen Frequency. The operating frequency of this generator.

Speed Bias. The amount that the controller is attempting to adjust the output frequency of the generator (100% bias = +5% on the engine speed, -100% = -5% on the engine speed).

The controller adjusts the Speed Bias to match frequency and phase with the paralleling bus.

Phase Matched. The phase between the generator voltage and the bus voltage is within the acceptable window. This value is only updated when the controller is synchronizing (Synch Mode = Active, Passive or Check, breaker/contactor is open, generator is running).

Phase Difference. The phase angle between the generator and the bus.

Note:
This value is only accurate if the generator is running and the bus is energized. The phase angle must be established between two waveforms.

Dwell Time Remaining. The remaining time for the dwell timer in seconds. The generator is considered to be in Sync when the dwell timer expires. If this value is resetting to the Dwell Time (directly above it), the generator is not holding synchronism. This value is only updated when the controller is synchronizing (Synch Mode = Active, Passive or Check, breaker/contactor is open, generator is running).

Sync Time Remaining. The remaining time before the controller issues a Failure to Synchronize warning. The Failure to Synchronize warning will cause the generator management to consider this generator unreliable and to start another generator (if available). If the system commissioning has been performed properly, this warning should only occur if the system is overloaded or if there is a malfunction on this generator. This value is only populated when the generator is actively synchronizing (Sync Mode = Active, breaker/contactor is open, generator is running).

Note:
Dwell Time Remaining and Sync Time Remaining are not supported on all firmware versions. If the controller firmware does not support the time remaining parameters, they will be populated with N/A.

Sharing Setup

Bus % of Rated kW. The ratio of the total load on the bus (sum of the loads on all connected generators) to the total bus capacity (sum of all the connected generator capacities), expressed as a percentage. This value can be monitored to determine system loading (also found on Bus Metering screen, and Generator Management screen).

Gen % of Rated kW. The ratio of the total load on this generator to its rated capacity, expressed as a percentage. This value can be compared to the Bus % of Rated kW (directly above it) to determine if the system is sharing load properly. The acceptable difference between the generator and bus is site-dependent. The adjustment of the parameters on this screen (during commissioning) will determine how closely the generators share load.

Speed Bias. The amount that the controller is attempting to adjust the output frequency of the generator (100% bias = +5% on the engine speed, -100% = -5% on the engine speed).

The controller adjusts the speed bias to share load between the generators connected to the paralleling bus.

Bus % of Rated kVAR. The ratio of the total reactive load on the bus (sum of the reactive loads on all connected generators) to the total bus reactive capacity (sum of all the connected generator reactive capacities), expressed as a percentage. This value can be monitored to determine system loading (also found on Bus Metering screen). The Reactive Power rating of the generator is fixed at 3/4 of the rated kW capacity of the generator (even in single-phase applications).

Gen % of Rated kVAR. The ratio of the total reactive load on this generator to its rated reactive capacity, expressed as a percentage. This value can be compared to the Bus % of Rated kVAR (directly above it) to determine if the system is sharing reactive load properly. The acceptable difference between the generator and bus is site-dependent. The adjustment of the parameters on this screen (during commissioning) will determine how closely the generators share reactive load. The Reactive Power rating of the generator is fixed at 3/4 of the rated kW capacity of the generator (even in single-phase applications).

Voltage Bias. The amount that the controller is attempting to adjust the output voltage of the generator (100% bias = +10% on the output voltage, -100% = -10% on the output voltage). The controller adjusts the voltage bias to share reactive load between the generators connected to the paralleling bus.

Note:
The metering values in this screen are populated regardless of the state of the generator system, but the system must be in a sharing mode before it will attempt to match generator and bus loading.

Protective Relays

The protective relays serve two purposes:

1. To protect the generator from damage
2. To protect the loads supplied by the generator from damage

The protective relays are configured during commissioning and should not be adjusted except by a trained commissioning agent. These settings are often taken into consideration for breaker trip curves, load control settings, and generator management settings. The adjustment without careful consideration of the implications may mask a problem in the system and cause another. Properly-configured protective relays should only trip due to a failure.

Note:
All protective relay events will trip the breaker/contactor, but will not stop the generator until the Trip to Shutdown Delay has expired. During this time, the protective relay which tripped the breaker/contactor will be listed under the Active Events, the warning LED will be active, and the generator will remain running. The protective relay can be reset by pressing the AUTO button (note, if the generator is in Run, the protective relay will have to be cleared by stopping the generator). Pressing OFF/RESET or removing the remote start signal to the generator system also clears any active protective relays.

Gen Management

Generator Management is intended to minimize wear and tear, fuel consumption, pollutant/sound emissions, and generated heat. It acts by signaling each generator to stop when it is unneeded. If generator management for a generator is disabled, the generator will start—generator management failures will result in additional generators running any time the system receives a start signal (this unit or others).

Generator management sequences the generators off in a predetermined order. The highest order generators stop first (when load is low enough) and re-start last (when load is too high). The order can be viewed on the front panel of the controller, but can only be adjusted under certain conditions (see Gen Management Order later in this section).

The time to start a generator (if the load increases) varies with the degree of overload.

The time to stop a generator (if the load is low enough that the generator is no longer needed) varies with the degree of available capacity.

Note:
Receipt of a start signal will cause all generators to start, synchronize, and close to the bus. Generator management requires that the generators are available (not faulted) in order to be permitted to stop. If a generator is faulted or manually stopped and then placed back in Auto, Generator Management will require the generator to start and connect to the bus before it is considered available (and permitted to stop) again—even if generator management had previously signaled the generator to stop.

Start Capacity. The percent of generator rated kW of the running generators that the system allows before the accumulator to start this generator begins filling. ***The Start Capacity is set during commissioning and should not be changed*.**

Start Delay. The time to decide to start the generator at 10% over capacity. ***The Start Delay is set during commissioning and should not be changed.***

Stop Capacity. The percent of generator rated kW of the other running generators that the system allows before the accumulator to stop this generator begins filling. ***The Stop Capacity is set during commissioning and should not be changed.***

Stop Delay. The time to decide to stop the generator at 10% available capacity. ***The Stop Delay is set during commissioning and should not be changed.***

Gen Management Modes

The method that generator management uses to determine the starting and stopping order of the available generators. All the generators in the system must have the same setting for this parameter for the generator management to operate. If this parameter is changed, it will be updated on all the generators which are connected to the PGEN network. This parameter can be set to one of the following:

- **Manual/Fixed.** The order of the generators is manually set. In this mode, the order is set once by the user.

  Note:
  The controllers require that the order be valid. If two nodes share a common order or there is a gap in the order sequence, the controllers will attempt to re-sort the order until it is valid. If the order is not valid (automatic re-sorting failed) generator management will be disabled (all generators will run all the time).

- **Run Time.** The generator management start/stop order is determined by the runtime hours on the generators. In this mode, the order is determined to ensure that the generator with the fewest runtime hours is the last to stop. Each subsequent order is assigned to generators with increasing runtime hours.

  If a generator is not running, the system will add the Run Time Threshold to the runtime hours for that generator before it considers it in the order—this allows the generators to avoid starting and stopping continuously. The actual runtime will have to differ by more than the threshold to force the generator order to switch (the stopped generator will start, synchronize to the paralleling bus, and begin sharing load—the running generator will soft-unload, disconnect from the bus, cool down and stop).

  The generator management order is not user adjustable in runtime mode.

  Note:
  If the load on the system requires an additional generator to start, the generator with the most runtime hours will always be the first one to stop if the load decreases enough to permit it (the threshold is no longer taken into consideration as soon as the generator is connected to the paralleling bus).

- **Fuel Level.** The generator management start/stop order of the generators is determined by the level of the fuel in the tank which supplies each generator. In this mode, the order is determined to ensure that the generator with the most fuel is the last to stop. Each subsequent order is assigned to generators with decreasing fuel percentage.

  If a generator is running, the system will add the Fuel Level Threshold to the measured Fuel Level for that generator before it considers it in the order. This allows the generators to avoid starting and stopping continuously. The actual fuel level will have to differ by more than the threshold to force the generator order to switch (the stopped generator will start, synchronize to the paralleling bus, and begin sharing load and the running generator will soft-unload, disconnect from the bus, cool down and stop).

  The generator management order is not user adjustable in Fuel Level mode.

  Note:
  Fuel Level Order Selection mode requires separate fuel tanks for the generators and fuel level senders connected to the controller to operate. Operation of Fuel Level mode without sensors is not defined.

  Note:
  If the load on the system requires an additional generator to start, the generator with the lowest fuel level will always be the one to stop (the threshold is no longer taken into consideration as soon as the generator is connected to the paralleling bus).

Gen Management. Allows permanent disabling of the generator management on this generator. This parameter can be set individually for each generator and will inhibit the Generator Management Configuration Mismatch Warning for this generator if set to OFF.

Note:
Disabling the generator management on one generator in a paralleling system will not keep the other generators in the paralleling system from alarming if the generator management configuration of any of the other nodes differs from the disabled generator.

Note:
Generators with Generator Management disabled are not taking into consideration for generator management on the other generators. It is not recommended to disable any of the generators in a paralleling system where generator management is intended to be used, the generator management may operate too many generators in these cases.

Generator management defaults to OFF. It should be enabled on all generators in the system if it is desired.

Gen Management Order. Determines the Start/Stop Order of this generator. Generators with a lower order will start before generators with a higher order, higher order generators stop before lower order generators.

If the Generator Management Order for a generator changes, generator management will start any generators which were involved in the order changing process (including automatic re-sort). After the incoming generators connect to the paralleling bus, the generators with a high enough order to stop will start filling their accumulators to stop.

The generator order is adjustable in Manual/Fixed Order selection mode. It is only adjustable in Runtime or Fuel level mode if the generators have identical runtime or fuel level.

Total Bus Capacity. The total bus capacity is simply the sum of the kW rating of all generators that are connected to the paralleling bus (running with paralleling breaker/contactor closed). Generators in Baseload, System Control, or Unload mode are not taking into consideration for this capacity.

Bus Total Power. The sum of the power output of all generators which are connected to the bus and available for sharing load. Generators in Baseload, System Control, or Unload mode are not taking into consideration for this level. The Bus Total Power is compared to the Start kW and Stop kW of the generator to determine if the generator should be started, stopped, or remain as-is.

Start kW. The threshold of Bus Total Power above which the Start Accumulator for this generator will start filling.

Note:
The Accumulator fill rate is higher for larger differences between Bus Total Power and Start kW.

Stop kW. The threshold of Bus Total Power below which the Stop Accumulator for this generator will start filling.

Note:
The Accumulator fill rate is higher for larger differences between Stop kW and the Bus Total Power.

Preemptive Warnings. A preemptive warning tells the system that a generator may have a problem in the future. If Generator Management has stopped the generators, it will start one of the unused generators but keep the running generator with the preemptive fault online. The following conditions are considered preemptive warnings:

- Low Oil Pressure Warning
- Low Fuel Pressure Warning
- High Coolant Temperature Warning
- Failure to Synchronize Warning
- Water in Fuel Warning
- Fuel Tank Leak Warning
- Loss of Fuel Warning

A preemptive warning disables Generator Management on the unit which has the warning. It will run as long as the start signal is present.

Note:
Most of the preemptive warnings have a shutdown which follows shortly after the warning. The intent of starting another generator is that it will be able to supply the load when the generator shuts down on a fault.

Start Accumulator. The Start Accumulator fills from 0% to 100% while the Bus Total Load remains above the Start kW. This generator will be signaled to start when this accumulator reaches 100%.

Note:
The Start Accumulator will reset to 0% if the Bus Total Power drops below the Start kW for one second.

The Start Accumulator may be filling while the engine is running in cooldown. If it reaches 100% before the cooldown is complete, the generator will synchronize and close to the bus (it will not have to go through a start sequence).

Stop Accumulator. The Stop Accumulator fills from 0% to 100% while the Bus Total Load remains below the Stop kW. This generator will be signaled to stop when this accumulator reaches 100%.

Note:
The Stop Accumulator will reset to 0% if the Bus Total Power exceeds the Stop kW for one second.

The generator may remain running and connected to the paralleling bus for a few seconds after the Stop Accumulator reaches 0%. During this time, the generator is unloading so that it can trip the circuit breaker/contactor connecting it to the bus with minimal wear on the contacts in the breaker/contactor and minimal disturbance to the voltage and frequency of the system.

Run Time Threshold. The maximum difference in runtime hours that generator management will accept before it re-sorts the Start/Stop Order of the generators to equalize hours (see Gen Management Order earlier in this section). All the generators in the system must have the same setting for the Run Time Threshold for the generator management to operate. If this parameter is changed on any controller, it will be updated on all the generators which are connected to the PGEN network.

Total Run Time. The actual runtime hours of this generator (to the nearest tenth of an hour). This parameter is also available in the Generator Information screen, but is rounded to the nearest hour.

Fuel Level Threshold. The maximum difference in fuel level that generator management will accept before it re-sorts the Start/Stop Order of the generators to equalize fuel level. (See Gen Management Order earlier in this section). All the generators in the system must have the same setting for the Fuel Level Threshold for the generator management to operate. If this parameter is changed, it will be updated on all the generators which are connected to the PGEN network.

Fuel Level. The level of the fuel in the tank supplying this generator. This is available in the engine metering section in SiteTech™, but not elsewhere on the User Interface. If no fuel level sensor is connected, this parameter will display N/A. Do not use Fuel Level as the Generator Management Mode if there is no fuel level sensor connected—the operation of the system is not defined in this case.

Stable Delay. The time between the system entering a valid generator management state and the time that generator management becomes active.

A valid generator management state requires:

- A Start Signal is present (Local start, remote start, or communications start)
- A least one generator is closed to the paralleling bus
- Generator Management is enabled
- The configuration of vital parameters of the system are identical between all controllers
- No generators have recently failed
- Load control has added priorities through the Min Loads Added Threshold
- The generator management order is valid

Once active, generator management will only go inactive if:

- A generator fails (shuts down with either a fault or user input)
- All generators are disconnected from the bus
- The Start Signal is removed
- Generator Management is disabled
- The configuration on any controller on the network is changed by a user
- The order becomes invalid

All the generators in the system must have the same setting for the stable delay for the generator management to operate. If this parameter is changed, it will be updated on all the generators which are connected to the PGEN network.

Minimum Gens Online. Generator Management will always try to keep this many generators online (even if they are not needed). All the generators in the system must have the same setting for the Minimum Gens Online for the generator management to operate. If this parameter is changed, it will be updated on all the generators which are connected to the PGEN network.

The purpose of this setting is to allow configuration to support large transient loads or potential generator failure (N+1 redundancy).

Note:
Only 1 and 2 Minimum Gens Online is supported at this time.

Min Loads Added. The Load Shed priority that must be online before generator management will consider stopping a generator. This is implemented so that generators aren't stopped prematurely (before all the available load has been applied to the system). All the generators in the system must have the same setting for Min Loads Added for the generator management to operate. If this parameter is changed, it will be updated on all the generators which are connected to the PGEN network.

Note:
Min Loads Added should be set up to support the load control outputs which are connected to actual loads. There is no reason to wait for a load control output to add if no load will be added to the system when it does. At the same time, it is important that all load which the paralleling system will have to support be supplied by the system before generator management makes the determination to stop a generator.

The load control outputs should be capable of shedding enough load that a single generator can support what remains (this should be handled during commissioning, but is included for consideration as loads grow).

Load Control

Load Control drives 6 outputs (Load Priority 1 Shed through Load Priority 6 Shed) to remove loads from the paralleling bus when the attached generators are unable to support them. See the Load Control Description section following for more information.

The outputs must be tied to programmable outputs in the configuration before they can be used, but they are controlled internally regardless of output configuration or external connection status.

All generators on the PGEN network initiate load control at the same time and use the same measured values to determine the Add and Shed timing (Bus % kW and Bus Frequency). If the load control settings are set identically, each load control priority will add at the same time on all generators in the paralleling system. This allows Priorities 1 and 2 to be connected to one generator, while Priorities 3 and 4 can be connected to another generator.

Note:
Load Control in a paralleling system operates identically to the load control on a single generator, except that it takes different metered values into consideration.

Load Control Description

The purpose of Load Control is to permit a generator to support load which may occasionally exceed the rated capacity of the generator. In paralleling systems, load shed permits the bus to stay at rated voltage and frequency while an additional generator is synchronizing to it. In single-generator applications, load control may shed unimportant but highly demanding loads when the generator is overloaded, preventing a power outage caused by the generator going offline.

The Load Control in the Decision-Maker® 3500 controller supports 6 load control priorities. These priorities generate internal notices for the shed condition. The internal notices are generated any time a load is shed, but they will only operate a load control relay if they are configured to a digital output.

Only 4 load control priorities can be configured to the RDO outputs on the controller (2 in paralleling applications) but the optional 14 relay dry contact kit will permit all 6 load control priorities to be accessed and configured to disconnect 6 different loads (each load priority can interrupt several devices).

In paralleling applications, the load shed priorities can be divided between all the generators. For instance, Generator #1 can support Load Priorities 1 and 4, Generator #2 can support Priorities 2 and 5, and Generator #3 can support Priorities 3 and 6. This configuration does not require the 14 relay dry contact kit and permits partial load shed functionality even if one controller is powered down or fails (redundancy).

Load Priority 1 is shed last and added first, the priorities are added in increasing sequence and shed in decreasing sequence.

All Load Priorities are immediately shed when load control is initiated. Load control is initiated when the system receives a start signal (a system start, a remote start, or a start by communication). In a paralleling application, the controller can receive a start signal from any generator which is connected to the PGEN communication network. Pressing RUN on the controller will not cause the loads to shed.

All loads are added immediately when Load Control is de-activated—this occurs when the start signal is removed.

Load Control adds loads based on the capacity of the system—loads will add more quickly if the available capacity is higher.

Load Control sheds loads based on the degree of overload of the system—loads will shed more quickly as the degree of the system overload increases.

Note:
The generator management start % should be significantly lower than the Gen Overload Percent so that additional generators will come online before a load is shed.

An under frequency event will also shed load—the under frequency threshold is not adjustable from the User Interface.

The load control will shed subsequent loads more quickly if shedding a load did not remove the overload or underfrequency condition.

In a standard application (single generator or generator controlled by external switchgear) the load control logic uses the Gen % or Rated kW and the Gen Frequency.

In a paralleling application (where the Decision-Maker® 3500 controller is responsible for first-on, synchronizing, load sharing, and generator management) the load control logic uses the Bus % of Rated kW and Bus Frequency. All generators use the same start signal, load and frequency values to determine load control timing, hence each controller will shed and add a given load priority at the same time (provided that the load control settings are identical in each controller).

In a paralleling application where Generator Management is used, some generator sets may be shut down (turned Off) by Generator Management. Even if the generator set is Off, it may de-activate its Load Control outputs to energize those loads. This may seem counter-intuitive, but the generator sets are acting as a system. If voltage and frequency of the paralleling bus are adequate, and Load Add accumulators are met, the loads will be enabled, even if a particular generator set is shut down by the Generator Management.

Description of User Adjustable Load Control Settings

The Load Control settings are found under GENERATOR INFO -> PARALLEL OPERATION -> LOAD CONTROL. Load control is active, even if the generator is not operating in a paralleling application.

Gen % Max Cap. The load level on the generator (or paralleling bus, in a paralleling application) that the load control will not intentionally exceed. If the load is within 15% of this load level, the load control will not add the next priority until the load decreases (or another generator starts, synchronizes and closes its paralleling breaker/contactor, in a paralleling application).

Gen Overload Percent. The load level on the generator (or paralleling bus, in a paralleling application) above which the load Control will start to consider shedding loads. Loads will shed more quickly if the generator is heavily overloaded, more slowly if the generator is barely overloaded. If the load drops below the Gen Overload Percent before a load priority is shed, the accumulator for shedding load is reset.

Note:
Additional load control settings are provided in SiteTech™, but they are configured during commissioning and should not require adjustment after commissioning is complete. Have setup and adjustments of the Decision-Maker® 3500 controller performed only by an authorized distributor/dealer.

2.12 Controller Configuration Menu

2.12.1 Controller Configuration Submenu

- **Language** displays the user selected language. At this time, English is the only available option.
- **Units** displays the user selected unit of measure as Metric or English.
- **Time Format** displays the user selected time format as 12 hours or 24 hours.
- **Date Format** displays the user selected date format as mm/dd/yyyy or dd/mm/yyyy.
- **Contrast** displays user selected resolution values to improve digital display clarity.
- **Alarm Silence** displays the programmer selected alarm silence method Always or Auto Only using SiteTech™ software. The Always selection activates the alarm horn in any of the OFF/RESET-AUTO-RUN modes. The Auto Only selection activates the alarm horn only when in the Auto mode.

Note:
Press the Alarm Silence/Lamp Test button to silence the alarm horn.

2.12.2 Communication Setup Submenu

Modbus® Communications

The controller communicates using Modbus®* as a slave connection with the Modbus® master initiating the communication. The controller seeks the system and alternator parameters and diagnostic information then responds back to the Modbus® master. In addition, the controller accepts information to alter controller parameters including generator set starting and stopping. See Figure 12. Refer to the List of Related Materials for available Modbus® literature.

Note:
Only one Modbus® master can be connected to the controller. Examples include the remote serial annunciator, monitoring software, and switchgear applications.

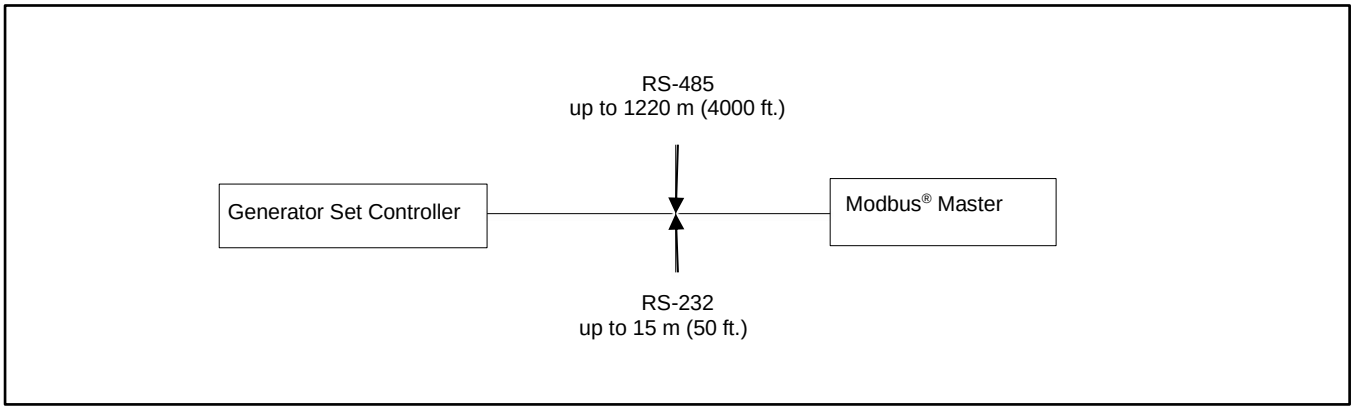


Figure 12 Modbus® Connections

A controller can communicate directly to a Modbus® master or participate in a network of devices. It can also be used to interface a local master to a network of devices.

The Modbus® master polls slave devices for data. Controller devices are slaves. Examples of master devices are a personal computer running monitoring software and the remote serial annunciator

SiteTech Group	Parameter	Setting
Modbus	Address	Use a unique network address between 1 and 247 for each unit. Use 1 for a single connection. Do not use 0 (zero).
	Baud rate	9600, 19200, 38400, or 57600. Must match the master PC and all devices in the system.

Figure 13 Decision-Modbus® 3500 Communication Parameters

Select the baud rate. Choose the same baud rate for the Modbus® master, modems, and connected devices. See Figure 13.

Each generator set controller must have a unique Modbus® address and PGEN node number (1-4).

Note:
The PGEN node number is automatically determined. The number of nodes online should match the number of installed generators.

Note:
The PGEN baud rate should not be adjusted except under direction from a factory service representative. Different baud rates between controllers on the network will result in a loss of communication on the network.

* Modbus® is a registered trademark of Schneider Electric.

2.12.3 Calibration Submenu

The calibration values are reviewable at all times and provide the calibration of the voltage and current sensing logic. Changing the system voltage or replacing the circuit board requires a calibration adjustment.

Note:
Have calibration adjustments performed by an authorized distributor/dealer.

To enable calibration, when the line is highlighted, push and hold the pushbutton/rotary selector dial to enable the calibration capability. The user is prompted with a Yes/No prompt for calibration. The display will show the following:

- Gen L1-L0 Volts
- Gen L2-L0 Volts
- Gen L3-L0 Volts
- Gen L1-L2 Volts
- Gen L2-L3 Volts
- Gen L3-L1 Volts
- Gen L1 Current
- Gen L2 Current
- Gen L3 Current
- Bus L1-L2 Volts
- Bus L2-L3 Volts
- Bus L3-L1 Volts
- Reset Gen Volt Meter: (Yes/No)
- Reset Gen Amp Meter: (Yes/No)
- Reset Bus Volt Meter: (Yes/No)
- Reset All Meters: (Yes/No)

The user can change individual values or can select the individual Reset to reset certain values. The Reset selections will only show if calibration is enabled. Refer to the requirements shown with Generator Set Calibration in Status and Notice Digital Displays section.

To disable calibration, Rotate the pushbutton/rotary selector dial until the <- *Return* popup appears. Momentarily press the pushbutton/rotary selector dial. Stop the generator set if not already done.

2.13 I/O Setup Menu

Note:
Have setup and adjustments of the Decision-Maker® 3500 controller performed only by an authorized distributor/dealer. There is a lot of setup information that can be accessed on this screen, but the parameters should be adjusted only during commissioning.

Analog and Digital Input Setup

There are three types of inputs setups:

1. Analog Resistive
2. Analog Differential (used in paralleling applications)
3. Digital

Note:
Analog = a sender, variable-resistant device.

Digital = a switch with contacts.

The I/O Setup Menu displays the setup of digital and analog warning and shutdown inputs. These inputs provide choices for configuring customized auxiliary inputs.

The user must enable the programming mode to edit the display. See the Menu Displays section for changeable settings in this menu.

Descriptions. Descriptions for user inputs (auxiliary analog or auxiliary digital) may be entered using the SiteTech™ software accessory where the user determines the descriptions.

Enabled. This menu indicates whether or not the input is enabled. If the input is not enabled, the controller will ignore this input signal.

Analog inputs have separate warning and shutdown enabled choices.

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 the fault or status event. The controller will ignore the input until the inhibit time expires. If the inhibit time is set to zero, the input is monitored at all times, even when the generator set is not running. The inhibit time delay range is 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 the fault or status event and the controller warning or shutdown lamp illuminates. The delay prevents any nuisance alarms. The time delay range is from 0 to 60 seconds.

Additional Analog Input Entries. The analog input selection typically requires entering four values—low warning, high warning, low shutdown, and high shutdown.

Digital Output and Relay Driver Output Setup

The I/O Setup Menu displays the setup of digital status and fault outputs and relay driver outputs (RDO). These RDO outputs provide choices for configuring customized auxiliary outputs. Additional individual outputs are available for monitoring, diagnostics, and control functions. See Optional Dry Contact Kit following.

The user must enable the programming mode to edit the display. See the Menu Displays section for changeable settings in this menu.

Note:
Changes to the Digital Outputs description requires the use of SiteTech™ software. The digital output can either open or close the circuit to activate.

Optional Dry Contact Kit

Dry contact kits provide an isolated interconnection between the generator set controller and optional devices. Up to fourteen conditions can be specifically identified with this kit.

A relay coil will be energized when the corresponding engine or generator sensing device or switch monitored by the microprocessor control board is activated.

Each relay provides one set of SPST contacts for field connection of customer supplied indicators or alarms. Contacts are rated for a maximum resistive load of 10A at 120VAC.

The fifteen-relay dry contact board has four digital inputs and two analog inputs. There are fourteen programmable relay outputs and one common fault relay output.

The relay contacts (K1 to K14) are rated:

- 10 amp @ 120 VAC
- 10 amp @ 28 VDC (max.)
- 0.01 amp @ 28 VDC (min.)

The common fault relay contact (K15) is rated:

- 500 mA @ 125 VAC
- 2 amp @ 30 VDC

2.13.1 Controller Fault Diagnostics

Figure 15 provides descriptions of possible system events and their types—warning, shutdown, status, and notice.

Warnings show a yellow warning lamp and sound an audible alarm to signal an abnormal condition. A warning does not shut down the unit but indicates attention is required. **Shutdowns** show a red fault lamp, sound an audible alarm, and stop the generator set. **Statuses** do not require user interaction but are part of the event history. **Notices** are used for controlling outputs and notifying the user of the operating status. Notices are NOT part of the event history.

The default selection time delays and digital outputs are factory set and adjustable. Some data entries require using a PC and SiteTech™ software.

Note:
Always identify and correct the cause of a fault shutdown before resetting the controller.

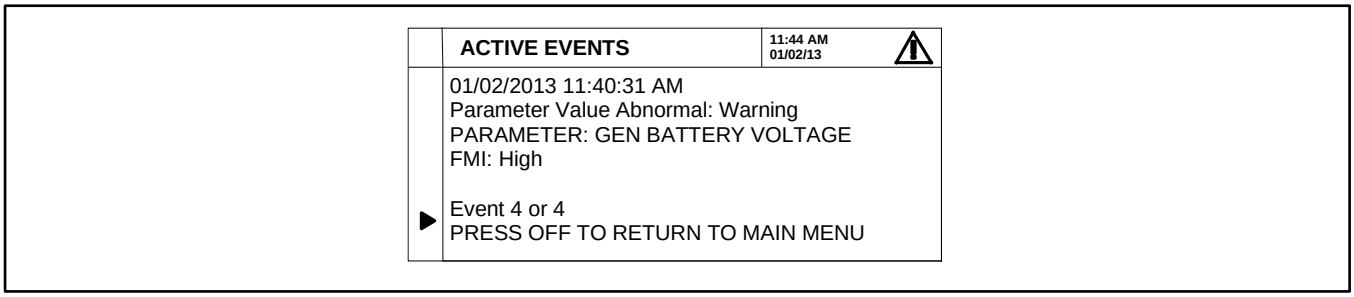


Figure 14 Event Screen Capture (Example)

FMI (Failure Mode Indicator)	Event ID/Parameter at Local Display	Level	Alarm Horn	Fault Lamp	Programmed Input	Programmed Output
	Protectives					
Low	Engine Speed	Shutdown	On	Red		D
High	Engine Speed	Shutdown	On	Red		D
Shorted High	Engine Oil Pressure *	Warning	On	Yellow	AD	D
Shorted High	Engine Oil Pressure *	Shutdown	On	Red	AD	D
Shorted Low	Engine Oil Pressure *	Shutdown	On	Red		D
Low	Engine Oil Pressure	Warning	On	Yellow	AD	D
Low	Engine Oil Pressure	Shutdown	On	Red	D	D
Open Circuit	Engine Oil Pressure *	Shutdown	On	Red		D
Open Circuit	Engine Oil Pressure *	Warning	On	Yellow		D
Low	Engine Coolant Temperature *	Warning	On	Yellow	AD	D
Low	Engine Coolant Temperature *	Shutdown	On	Red		D
High	Engine Coolant Temperature *	Warning	On	Yellow	AD	D
High	Engine Coolant Temperature *	Shutdown	On	Red	AD	D
Open Circuit	Engine Coolant Temperature *	Shutdown	On	Red		D
Open Circuit	Engine Coolant Temperature *	Warning	On	Yellow		D
Shorted High (3)	Engine Coolant Temperature *	Shutdown	On	Red		D
Shorted Low (4)	Engine Coolant Temperature *	Shutdown	On	Red		D
High	Lube Oil Temperature *	Warning	On	Yellow	AD	
High	Lube Oil Temperature *	Shutdown	On	Red	D	
Low	Engine Coolant Level	Shutdown	On	Red	D	D
Low	Engine Fuel Level	Warning	On	Yellow	AD	D
Low	Engine Fuel Level	Shutdown	On	Red	D	D
High	Engine Fuel Level	Warning	On	Yellow	D	D
Critically High	Engine Fuel Level	Warning	On	Yellow	D	D
Low	Fuel Pressure	Warning	On	Yellow	AD	D
Low	Fuel Pressure	Shutdown	On	Red	AD	D
Low	Gen Battery Voltage	Warning	On	Yellow		D
High	Gen Battery Voltage	Warning	On	Yellow		D
Low	Cranking Voltage	Warning	On	Yellow		D
Low	Engine Oil Level	Warning	On	Yellow	AD	D
Low	Engine Oil Level	Shutdown	On	Red	D	D
Low	Generator Voltage L1-L2	Shutdown	On	Red		D
High	Generator Voltage L1-L2	Shutdown	On	Red		D
Low	Generator Voltage L2-L3	Shutdown	On	Red		D
High	Generator Voltage L2-L3	Shutdown	On	Red		D
Low	Generator Voltage L3-L1	Shutdown	On	Red		D
High	Generator Voltage L3-L1	Shutdown	On	Red		D
Low	Avg Gen Voltage L-L	Warning	On	Yellow		D
High	Avg Gen Voltage L-L	Warning	On	Yellow		D
Low	Generator Frequency	Warning	On	Yellow		D
High	Generator Frequency	Warning	On	Yellow		D
Low	Generator Frequency	Shutdown	On	Red		D

FMI (Failure Mode Indicator)	Event ID/Parameter at Local Display	Level	Alarm Horn	Fault Lamp	Programmed Input	Programmed Output
High	Generator Frequency	Shutdown	On	Red		D
Low	Total Power (Generator Total Real Power)	Warning	On	Yellow		D
High	Total Power (Generator Total Real Power)	Warning	On	Yellow		D
High	Total Power (Generator Total Real Power)	Shutdown	On	Red		D
Low	Total Reactive Power	Warning	On	Yellow		D
High	Avg Current	Warning	On	Yellow		D
Low	Maximum Alternator Current	Shutdown	On	Red		D
High	Exhaust Temperature	Shutdown	On	Red	D	D
Low	Engine Seawater Pressure	Shutdown	On	Red	D	D
Open Circuit	Exhaust Temperature, if equipped	Warning	On	Yellow		D
Open Circuit	Exhaust Temperature, if equipped	Shutdown	On	Red		D
High	Intake Air Temperature	Warning	On	Yellow		D
High	Intake Air Temperature	Shutdown	On	Red		D
High	Fuel Temperature	Warning	On	Yellow		D
High	Fuel Temperature	Shutdown	On	Red		D
Low	Coolant Pressure	Warning	On	Yellow	AD	D
	AC Sensing Lost	Warning	On	Yellow		D
	AC Sensing Lost	Shutdown	On	Red		D
	Alternator Protection	Shutdown	On	Red		D
	Auxiliary Input	Warning	On	Yellow	AD	D
	Auxiliary Input	Shutdown	On	Red	D	D
	Battery Charger Fault	Warning	On	Yellow	AD	D
	Ecm Communication Loss	Shutdown	On	Red		D
	Ecm Model Mismatch	Shutdown	On	Red		
	Emergency Stop	Shutdown	On	Red		D
	Fuel Tank Leak	Warning	On	Yellow	AD	D
	Fuel Tank Leak	Shutdown	On	Red	D	D
	Ground Fault Input	Warning	On	Yellow	AD	D
	Locked Rotor	Shutdown	On	Red		D
	Electrical Metering Communication Loss	Shutdown	On	Red		
	Over Crank	Shutdown	On	Red		D
	Speed Sensor Fault	Warning	On	Yellow		D
	Other Alerts					
	Alarm Horn Silenced	Status				
	Engine Cool Down Active	Notice				D
	Engine Start Aid Active	Notice				D
	Engine Started	Status				
	Engine Stopped	Status				
	Emergency Power System Supplying Load	Notice				D
	Generator Running	Notice				D
	Not In Auto	Warning	On	Yellow		D
	Option Board 2A Communication Loss	Notice				

FMI (Failure Mode Indicator)	Event ID/Parameter at Local Display	Level	Alarm Horn	Fault Lamp	Programmed Input	Programmed Output
	Option Board 2B Communication Loss	Notice				
	Option Board 2C Communication Loss	Notice				
	Remote Start	Status				
	Load Priority 1 Shed	Notice				D
	Load Priority 2 Shed	Notice				D
	Load Priority 3 Shed	Notice				D
	Load Priority 4 Shed	Notice				D
	Load Priority 5 Shed	Notice				D
	Load Priority 6 Shed	Notice				D
	Cabinet Intrusion Alarm	Warning	On	Yellow	D	D
	Reserve Oil Empty	Warning	On	Yellow	D	D
	Stopped By Generator Management	Status				D
	Failure To Synchronize	Warning	On	Yellow		D
High	Fail To Open Delay	Warning	On	Yellow		
High	Fail To Close Delay	Warning	On	Yellow		
High	Max Close Attempts	Warning	On	Yellow		
Erroneous Data Received	Generator Management (Invalid Generator Management Enabled)	Warning	On	Yellow		
High	Trip To Shutdown Delay	Shutdown	On	Red		
	Run Relay Coil Overload	Shutdown	On	Red		
	Starter Relay Coil Overload	Shutdown	On	Red		
High	System Frequency	Warning	On	Yellow		
Low	System Frequency	Warning	On	Yellow		
High	System Voltage	Warning	On	Yellow		
Low	System Voltage	Warning	On	Yellow		
Erroneous Data Received	System Phase	Warning	On	Yellow		
	ECM Diagnostics					
	Engine Derate Active	Warning	On	Yellow		
	Injector Wiring Fault	Warning	On	Yellow		
	Run Relay Coil Overload	Warning	On	Yellow		
	Sensor Supply Voltage	Warning	On	Yellow		
	Speed Sensor Fault	Warning	On	Yellow		
	Starter Relay Coil Overload	Warning	On	Yellow		
	Water In Fuel	Warning	On	Yellow		
	Notices Excluded From Display					
	Common Fault	Notice				D
	Common Warning	Notice				D
	System Ready	Notice				D
	Remote Start Command Issued	Notice				

FMI (Failure Mode Indicator)	Event ID/Parameter at Local Display	Level	Alarm Horn	Fault Lamp	Programmed Input	Programmed Output
	Run Button Acknowledged	Notice				
	Contactor	Notice				D
	Close Breaker	Notice				D
	Remove Breaker Trip	Notice				D
	Standalone Operation	Status			D	
	Load Enable	Status			D	
	Baseload Mode	Status			D	
	System Control Mode	Status			D	
	System Sync Mode	Status			D	
	Enable Trims	Status			D	

∗ Sensor dependent

Note:
A = Analog, D = Digital

Figure 15 System Events Display Message List

2.13.2 Main Logic Circuit Board

The main logic circuit board provides the connection sockets to connect the controller to the engine/generator, input/output connections, optional I/O module kit, and circuit protection fuses. See the Accessories section for the circuit board connectors.

Circuit Board Connections

P1 (35-Pin) Connector for engine/generator wiring harness.

P2 (14-Pin) Connector for sensor input connections and relay driver output connections.

P3 (8-Pin) Connector for generator set output voltage connection and paralleling bus voltage sensing connections.

P4 (Ethernet) Connector connects to a network communication line.

2.14 Controller Operation

Note:
Opening seacock. Before starting the generator set, open the seacock to allow cooling water passage. Failure to do so could damage the seawater pump impeller and cause serious engine overheating damage.

Note:
Transfer switch. Check that the marine ship-to-shore transfer switch, if equipped, is in the ship position.

Note:
If the generator set does not start after 3 crank attempts (an overcrank fault occurs):

1) Close the seacock.

2) Completely drain the water from the exhaust system at the silencer's drain plug.

3) Do not attempt generator set restart.

4) Contact an authorized distributor/dealer. A water-filled exhaust piping and silencer may further hinder generator starting and cause seawater entry into the engine cylinders through the exhaust valves. Water ingested into the engine may cause major engine damage that the Discovery Energy, LLC warranty does not cover.

The controller operation includes several types of starting and stopping functions as detailed below. The controller buttons, lamps, and alarm horn functions are summarized in Figure 16.

There are three primary modes of operation, selected by pressing the respective buttons:

- **OFF**
- **RUN**
- **AUTO** (Standby Mode)

When the OFF button is pressed, the generator set is in OFF or goes to OFF and will not start. When the RUN button is pressed, the generator set starts and runs until the OFF or AUTO button is pressed or until a fault is received. When the AUTO button is pressed, the generator set enters the Standby Mode (STANDBY-RUNNING or STANDBY-OFF depending upon the start signal).

- **OFF.** If the generator set was previously running, pressing the OFF button immediately shuts off the generator set, with no engine cooldown. The generator set remains off and will not respond to a remote start signal.
- **RUN—Local Start.** A single generator set starts. No other generator sets in the system will start (or stop).
- **AUTO—Standby or System Ready.** The generator set is waiting for a start signal. The generator set will start and run when a start signal is received via a remote start, local auto-start, or communications-based start.

All generator sets in the system (connected by PGEN and in Standby Mode by pressing AUTO) will start when any one of the generator sets receives a start signal.

Any generator set in the system not in AUTO will not start.

If Generator Management is on, some generator sets may shutdown after a period of time.

With removal of the start signal, all generator sets will shutdown with the appropriate engine cooldown.

- **AUTO-RUN** (Press AUTO and RUN together for a system start signal). All generator sets in the system start and run, close to bus, synchronize, parallel, share load, etc. Some generator sets may shut down after a period of time (indicated by Generator Management) but they remain in Standby Mode ready to start and run if needed.
- **AUTO-OFF** (Press AUTO and OFF together to remove a system start signal, if AUTO-RUN is active). All generator sets in the system open their breakers, enter engine cooldown, shut down, and enter Standby Mode. Closing the remote start contacts has no affect. Generator sets in the system will enter Standby Mode.

Note:
Pressing AUTO and OFF together only stops the generator sets if there are no other system start signals present.

Start Signal

A start signal includes the following:

- Remote start signal via contacts 3 and 4. An ATS (used during a power outage, exercise period, etc.) or a remote panel used in the vessel take precedence over all other start signals.
- System Start (AUTO-START). Press AUTO and RUN simultaneously to send a start signal.
- Communications-based start message from SiteTech™ or a CAN-based remote panel.

Hardwired contacts (remote start contacts 3 and 4) have priority over all other start signals. If the remote start contacts are activated, the generator sets in the system that are in AUTO, will start and run. If the generator sets were already running, they will remain running but the original source of that start signal will be ignored. The contacts now have control.

Note:
The alarm horn sounds and the Not-In-Auto Warning display appears whenever the generator set is not in the AUTO mode.

Note:
The transient start/stop function of the controller prevents accidental cranking of the rotating engine. The generator set stops and recranks when the OFF/RESET button is momentarily pressed and then the RUN button is pressed.

Note:
The controller provides up to 30 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 SiteTech™ software.

Stop Signal

A stop signal includes the following:

- Removal of start signal via contacts 3 and 4. An ATS (used during a power outage, exercise period, etc.) or a remote panel used in the vessel take precedence over all other start signals.
- System Stop (AUTO-OFF). Press AUTO and OFF simultaneously to send a stop signal to cancel the system start.

  Note:
  This will not do anything if the system start is not active or if the system is receiving a start signal from another source. Press AUTO and OFF on any controller in the system.
- Communications-based stop message from SiteTech™ or a CAN-based remote panel.

Engine Cooldown

Cooldown is a state where the generator is running at no load to allow hot engine components time to cool slowly before the engine is stopped. In paralleling applications, this occurs with the circuit breaker open.

When the generator set is running in AUTO mode (AUTO-RUN), an engine cooldown cycle begins when the remote start input is deactivated. Also, if stopping due to a stop signal, a cooldown cycle begins.

If the Cooldown Override is disabled (OFF) in the Generator Configuration Menu, coolant temperature is ignored. The generator will enter cooldown when the start signal is removed, only if the engine control switch is in AUTO. The engine will run for a period of time equal to the Cooldown Delay parameter setting, regardless of the coolant temperature.

If the Cooldown Override is enabled (ON) in the Generator Configuration Menu, coolant temperature will be considered for cooldown. The generator will enter cooldown when the start signal is removed, only if the engine control switch is in AUTO. The engine will run until the coolant temperature is below the Engine Cooled Down parameter setting, or until the Cooldown Delay has expired.

The cooldown cycle lasts for some predetermined amount of time. The cooldown delay is an adjustable parameter. The Engine Cooled Down temperature is not adjustable.

Note:
No engine cooldown cycle occurs if the OFF button is pressed or if a fault occurs. The shutdown is immediate. If possible, run the generator set without load for 5 minutes to ensure adequate engine cooldown.

Button Mode	Generator Set Status	Fault Lamp	Alarm Horn	Alarm Silence Button	Alarm Horn Lamp	Controller Display
AUTO	Off	—	Off	—	—	Scrolling Overview Menu Only
	On (or Cranking)	—	Off	—	—	
	Running and then Off	Red	On	—	—	Shutdown Message
			Off	Pressed	Yellow	
OFF/RESET	Off	Yellow	On	—	—	Not In Auto Warning
			Off	Pressed	Yellow	
RUN (unit fails to start)	Off (or Cranking)	Yellow	On	—	—	Not in Auto Warning
			Off	Pressed	Yellow	
	Off	Red	On	—	—	Locked Rotor Shutdown (or other shutdown message)
			Off	Pressed	Yellow	
RUN (unit starts)	Off (or Cranking)	Yellow	On	—	—	Not in Auto Warming
	On		Off	Pressed	Yellow	
	Running and then Off	Red	On	—	—	Shutdown Message
			Off	Pressed	Yellow	

Figure 16 Button Function Summary

2.14.1 Emergency Stop

Use the controller emergency stop switch for immediate emergency 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 OFF/RESET button for normal shutdowns.

The controller fault lamp lights and the unit shuts down when the local emergency stop switch activates.

Use the following procedure to reset the generator set after shutdown by a local or remote emergency stop switch. Refer to the Controller Resetting (Following System Shutdown or Warning) section, Controller Resetting procedure, to restart the generator set following a fault shutdown.

1. Investigate and correct the cause of the emergency stop.
2. Reset the controller emergency stop switch by pulling the switch dial outward.
3. Press the generator set OFF/RESET button.
4. After resetting all faults using the controller reset procedure in the Controller Resetting (Following System Shutdown or Warning) section, press the generator set RUN and/or AUTO button to restart the generator set. The generator set will not crank until the reset procedure completes.

2.14.2 System Status Lamps

The (OFF/RESET-AUTO-RUN) buttons indicate the status condition with an integrated lamp at the button.

The lamp illuminates on the AUTO (automatic start) button indicating the system senses no faults and the unit is ready to start by remote command.

The lamp illuminates on the OFF/RESET button indicating the generator set is stopped.

The lamp illuminates on the RUN button indicating the generator set is cranking or running from a local command or is commanded to run from a local command.

Only one of the three button lamps will illuminate at any given time.

2.14.3 System Fault Warning Lamp with Digital Displays

The system FAULT lamp glows yellow and the alarm horn sounds indicating a warning fault but does not shut down the generator set. The fault lamp illuminates yellow and the alarm horn sounds when the fuel tank level on diesel-fueled models approaches empty. This fault requires an optional low fuel level switch for the lamp to function. See the Controller Resetting (Following System Shutdown or Warning) section, for instructions on resetting a system warning.

When the system warning lamp is on and no message displays, rotate the dial to the Active Events menu. Press the dial to view messages. Rotate the dial to view additional messages. Press the OFF button to return to the main menu. When the system warning continues, it may lead to a fault and cause a system shutdown.

Use the Silence Alarm button to silence the alarm horn at the operator's discretion.

If the controller is setup for an NFPA 110 application, press the AUTO button before silencing the alarm horn. The alarm horn cannot be silenced unless the button is in the AUTO mode. See Status and Notice Digital Displays section for more information.

AC Sensing Lost (controller in RUN or AUTO and voltage was never present). The fault lamp illuminates yellow and the alarm horn sounds when the controller does not detect the nominal generator set AC output voltage after crank disconnect.

Auxiliary Input. The fault lamp illuminates yellow and the alarm horn sounds when an auxiliary digital or analog input signals the controller. The digital inputs do not function during the first 30 seconds after startup. Use SiteTech™ software to define inputs as shutdowns or warnings.

Average Current High. The fault lamp illuminates yellow and the alarm horn sounds when the generator encounters excessive load or a downstream fault. The output breaker trips. The available sustained fault current of the generator can be obtained from the per-unit transient reactance of the generator and the system voltage and power.

Average Generator Voltage High. The fault lamp illuminates yellow and the alarm horn sounds when the generator encounters an over voltage condition. This condition can be caused by a loss of sensing wire, a winding failure, voltage regulator failure, etc. The output breaker trips. The generator may continue to produce excessive voltage until it is shut down.

Average Generator Voltage Low. The fault lamp illuminates yellow and the alarm horn sounds when the generator encounters an under voltage condition. This condition can be caused by a loss of a diode on the rectifier bridge, sensing problem, a winding failure, voltage regulator failure, etc. The output breaker trips. The generator may continue to produce insufficient voltage until it is shut down.

Battery Charger Fault. The fault lamp illuminates yellow and the alarm horn sounds when the battery charger malfunctions. This fault feature requires an optional battery charger with a malfunction output for the lamp to function.

Current Below Normal or Open Circuit Coolant Temperature. The fault lamp illuminates yellow and the alarm horn sounds when the engine coolant temperature sender circuit is not receiving enough current or is open for more than 5 seconds.

Current Below Normal or Open Circuit Exhaust Temperature. The fault lamp illuminates yellow and the alarm horn sounds when the exhaust temperature sender circuit is not receiving enough current or is open for more than 5 seconds.

Current Below Normal or Open Circuit Oil Pressure. The fault lamp illuminates yellow and the alarm horn sounds when the engine oil pressure sender circuit is not receiving enough current or is open for more than 5 seconds.

Cabinet Intrusion. The fault lamp illuminates yellow and the alarm horn sounds when the door to the unit was opened.

Common Warning. The fault lamp illuminates yellow and the alarm horn sounds when the controller is signaled by a common warning. Use SiteTech™ software to activate the common warning. The common warning comprises all of the warnings under a single alert.

Critically High Fuel Level (diesel-powered models only). The fault lamp illuminates yellow and the alarm horn sounds when the fuel tank level on diesel models approaches full. This fault requires an optional critical high fuel switch and fuel tank for the lamp to function.

ECM Diagnostics (Multiple Engine Inputs). The fault lamp illuminates yellow and the alarm horn sounds when ECM diagnostics signals the controller. The specific display (xxxxx) will be a brief message or fault code that is engine manufacturer dependant. The engine literature provides the fault code description and further information.

Failure to Synchronize. The fault lamp illuminates yellow and the alarm horn sounds when the generator set does not successfully synchronize to the live bus within the time delay as defined in the synchronizing setup menu. The controller will continue attempting to synchronize to the bus after the time delay expires and the warning occurs. Generator Management will start another generator set if this warning occurs.

Fuel Tank Leak. The fault lamp illuminates yellow and the alarm horn sounds when the fuel tank signals a leak of the inner tank. This fault requires an optional fuel tank leak switch for the lamp to function.

Generator Frequency High. The fault lamp illuminates yellow and the alarm horn sounds when the generator has an overfrequency condition. The output breaker trips. This condition can be caused by various mechanical failures (loss of speed signal to ECU, improperly controlled or inadvertent injection of gaseous fuel etc.).

Generator Frequency Low. The fault lamp illuminates yellow and the alarm horn sounds when the generator has an underfrequency condition. The output breaker trips.

Generator Total Real Power High. The fault lamp illuminates yellow and the alarm horn sounds when the generator encounters excessive load or a downstream fault. The output breaker trips.

Generator Total Real Power Low. The fault lamp illuminates yellow and the alarm horn sounds when the generator is no longer producing power (loss of fuel, bearing failure, fuel system failure, ECU problem, or speed bias connection failure on non-ECM engines). The output breaker trips.

Ground Fault Input. The fault lamp illuminates yellow and the alarm horn sounds when a user-supplied ground fault detector signals the controller.

High Battery Voltage. The fault lamp illuminates yellow and the alarm horn sounds when the battery voltage rises above the preset level for more than 10 seconds. Figure 17 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	13.2-16.2	15
24	26.4-32.4	30

Figure 17 High Battery Voltage Specs

High Coolant Temperature. The fault lamp illuminates yellow and the alarm horn sounds when the engine coolant temperature approaches the shutdown range. The high coolant temperature warning does not function during the preset inhibit time delay period after startup.

High Fail To Close Delay. The fault lamp illuminates yellow and the alarm horn sounds when the circuit breaker did not close within the allocated breaker closure time.

High Fail To Open Delay. The fault lamp illuminates yellow and the alarm horn sounds when the circuit breaker did not open as quickly as the controller expected.

High Fuel Level (diesel-powered models only). The fault lamp illuminates yellow and the alarm horn sounds when the fuel tank level on diesel models approaches near full. This fault requires an optional high fuel switch and fuel tank for the lamp to function.

High Genset System Frequency. The fault lamp illuminates yellow and the alarm horn sounds when another generator in the paralleling system has a lower system frequency than this generator. The local display shows System Frequency, FMI: High.

High Genset System Voltage. The fault lamp illuminates yellow and the alarm horn sounds when another generator in the paralleling system has a lower system voltage than this generator. The local display shows System Voltage, FMI: High.

High Intake Air Temperature. The fault lamp illuminates yellow and the alarm horn sounds when the engine intake air temperature approaches the shutdown range.

High Lube Oil Temperature. The fault lamp illuminates yellow and the alarm horn sounds when the engine high oil temperature approaches the shutdown range.

High Max. Close Attempts The fault lamp illuminates yellow and the alarm horn sounds when the circuit breaker did not close, even after the controller attempted to close it as many times as specified by the max. close attempts.

Invalid Generator Management Enabled. The fault lamp illuminates yellow and the alarm horn sounds when the generator management has been disabled because the generator management configuration of this generator does not match the generator management configuration of another generator that is connected to the same PGEN network. The local display shows Generator Management.

Invalid Genset Voltage Phase Connection. The fault lamp illuminates yellow and the alarm horn sounds when another generator in the paralleling system has a different phase connection than this generator. The local display shows System Phase.

Low Battery Voltage. The fault lamp illuminates yellow and the alarm horn sounds when the battery voltage drops below a preset level for more than 90 seconds.

Engine Electrical System Voltage	Low Battery Voltage Range	Low Battery Voltage Default Setting
12	9.6-12.6	12
24	19.2-25.2	24

Figure 18 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 Temperature. The fault lamp illuminates yellow and the alarm horn sounds when the engine coolant temperature is low. The low coolant temperature warning does not function during the preset inhibit time delay period after startup.

Low Cranking Voltage. The fault lamp illuminates yellow and the alarm horn sounds when the battery voltage drops below 60% of the nominal voltage (12 VDC or 24 VDC) for more than 6 seconds during the crank cycle.

Low Engine Oil Level. The fault lamp illuminates yellow and the alarm horn sounds because of low engine oil level. This fault feature requires an optional low engine oil level sensor for the lamp to function.

Low Fuel Level. The fault lamp illuminates yellow and the alarm horn sounds when the fuel tank level on diesel-fueled models approaches empty. This fault requires an optional low fuel level switch for the lamp to function.

Low Fuel Pressure. The fault lamp illuminates yellow and the alarm horn sounds when low fuel pressure occurs. This fault requires an optional low fuel pressure switch for the lamp to function.

Low Genset System Frequency. The fault lamp illuminates yellow and the alarm horn sounds when another generator in the paralleling system has a higher system frequency than this generator. The local display shows System Frequency, FMI: Low.

Low Genset System Voltage. The fault lamp illuminates yellow and the alarm horn sounds when another generator in the paralleling system has a higher system voltage than this generator. The local display shows System Voltage, FMI: Low.

Low Oil Pressure. The fault lamp illuminates yellow and the alarm horn sounds when the engine oil pressure approaches the shutdown range. The low oil pressure warning does not function during first the 30 seconds after startup.

Not in Auto (Generator Master Control Switches). The fault lamp illuminates yellow and the alarm horn sounds when the generator set button is in the RUN or OFF/RESET mode.

Option Board 2X Communication Loss. The fault lamp illuminates yellow and the alarm horn sounds when the communication with option board 2X (A, B, or C) has been lost.

Reserve Oil Empty. The fault lamp illuminates yellow and the alarm horn sounds when the oil makeup kit level has dropped below a threshold.

Speed Sensor Fault. The fault lamp illuminates yellow and the alarm horn sounds when the speed signal is absent for one second while the generator set runs.

Total Reactive Power Low. The fault lamp illuminates yellow and the alarm horn sounds when the generator has a loss of field condition due to insufficient reactive load production to support real load. The output breaker trips.

2.14.4 System Fault Shutdown Lamp with Digital Displays

The system FAULT lamp glows red, the alarm horn sounds, and the unit shuts down to indicate a fault shutdown under the following conditions. See the Controller Resetting (Following System Shutdown or Warning) section, Controller Resetting procedure, for information on resetting a system shutdown.

Note:
Always identify and correct the cause of a fault shutdown before resetting the controller.

When the system shutdown lamp is on and no message displays, rotate the dial to the Active Events menu. Press the dial to view messages. Rotate the dial to view additional messages. Press the OFF button to return to the main menu.

Use the Alarm Off button to silence the alarm horn at the operator's discretion. If the controller is setup for an NFPA 110 application, press the AUTO button before silencing the alarm horn. The alarm horn cannot be silenced unless the button is in the AUTO mode. See Status and Notice Digital Displays for more information.

AC Sensing Lost (controller in AUTO and voltage was previously present). The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the controller does not detect the nominal generator set AC output voltage for more than 3 seconds after crank disconnect.

Alternator Protection. The fault lamp illuminates red and the unit shuts down because of an alternator overload or short circuit.

Auxiliary Input (Shutdown). The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when an auxiliary digital or analog inputs signals the controller. The digital inputs do not function during the first 30 seconds after startup. Use SiteTech™ software to define inputs as shutdowns or warnings.

Common Fault. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the controller is signaled by a common fault. Use SiteTech™ software to activate the common fault shutdown. The common fault comprises of any combination of the fault shutdowns under a single alert.

Current Below Normal or Open Circuit Coolant Temperature. The fault lamp illuminates yellow and the alarm horn sounds when the engine coolant temperature sender circuit is not receiving enough current or is open for more than 5 seconds.

Current Below Normal or Open Circuit Exhaust Temperature. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the exhaust temperature sender circuit is not receiving enough current or is open for more than 5 seconds.

Current Below Normal or Open Circuit Oil Pressure. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the engine oil pressure sender circuit is not receiving enough current or is open for more than 5 seconds.

ECM Communications Loss. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the ECM communication link is disrupted.

ECM Diagnostics (Multiple Engine Inputs). The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when ECM diagnostics signals the controller. The specific display (xxxxx) will be a brief message or fault code that is engine manufacturer dependant. The engine literature provides the fault code description and further information.

ECM Model Mismatch. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the controller detects an error with the ECM model.

Electrical Metering Communication Loss. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the metering to the controller communication link is disrupted.

Emergency Stop. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the local or optional remote emergency stop switch activates.

Fuel Tank Leak. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the fuel tank signals a leak of the inner tank. This fault requires an optional fuel tank leak switch for the lamp to function.

Generator Total Real Power High. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the generator set supplies more than 102% of the rated standby output kW (or 112% of the rated prime power output kW) for more than 60 seconds.

High Coolant Temperature. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down because of high engine coolant temperature. The high coolant temperature shutdown does not function during the preset inhibit time delay period after startup.

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 Engine Speed. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down immediately when the governed frequency on 50 and 60 Hz models exceeds the over speed setting.

High Exhaust Temperature. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down immediately when the engine exhaust temperature exceeds the default setting.

High Intake Air Temperature. The fault lamp illuminates red, the alarm horn sounds, 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.

High Generator Frequency. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the frequency is above the overfrequency setting. See Figure 19.

Overfrequency Setting Range	Time Delay	Overfrequency Default Setting
102%-140% of nominal	10 sec.	110% of nominal

Figure 19 Overfrequency Specs

High Generator Voltage (Each Phase). The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the voltage exceeds the overvoltage setting for the preset time delay period. See Figure 20 for overvoltage specifications.

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
105%-135% of nominal	2-10 sec.	120% at 2 sec.

Figure 20 Overvoltage Specs

High Lube Oil Temperature. The fault lamp illuminates red, the alarm horn sounds, 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.

Locked Rotor (failed to crank). If none of the speed sensing inputs show engine rotation within the preset time delay of initiating engine cranking, the ignition and crank circuits turn off for the preset period and the cycle repeats. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down after the second cycle of the preset period of cranking.

Low Coolant Level. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down because of low coolant level. Shutdown occurs 5 seconds after low coolant level is detected.

Low Engine Oil Level. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down because of low engine oil level. This fault feature requires an optional low engine oil level sensor for the lamp to function.

Low Engine Speed. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down immediately when the governed frequency on 50 and 60 Hz models drops below the under speed setting.

Low Fuel Level (diesel-powered models only). The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the fuel tank level on diesel-fueled models approaches empty. This fault requires an optional low fuel level switch for the lamp to function.

Low Fuel Pressure. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when low fuel pressure occurs. This fault requires an optional low fuel pressure switch for the lamp to function.

Low Generator Frequency. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the frequency drops below the underfrequency setting. See Figure 21 for underfrequency specifications.

Underfreq. Setting Range	Time Delay	Underfrequency Default Setting
80%-95% of nominal	10 sec. (short term) 60 sec. (long term)	90% of nominal

Figure 21 Underfrequency Specs

Low Generator Voltage (Each Phase). The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the voltage drops below the undervoltage setting for the time delay period. See Figure 22 for undervoltage specifications.

Undervoltage Setting Range	Time Delay Range	Undervoltage Default Setting
70%-95% of nominal	5-30 sec.	80% of nominal at 10 sec.

Figure 22 Undervoltage Specs

Low Oil Pressure. The fault lamp illuminates red, the alarm horn sounds, and 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.

Low Seawater Pressure. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down after a loss of seawater pressure is detected.

Max. Alternator Current Low. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when Alternator Protection Configuration in the personality profile is not correct. If the settings are correct for the application, the controller may need a new or updated personality profile. Consult your local authorized distributor.

Overcrank. The fault lamp illuminates red, the alarm horn sounds, and cranking stops when the unit does not start within the defined cranking period. See the Controller Operation section for cyclic crank specifications.

Note:
The controller is equipped with an automatic restart function. When speed drops below 25 Hz (750 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.

Run Relay Coil Overload. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the current draw on the 70 wire from the controller has exceeded 40 amps or has exceeded 10 amps for at least 10 ms.

Starter Relay Coil Overload. The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the current draw on the 71 wire from the controller has exceeded 40 amps or has exceeded 10 amps for at least 10 ms.

Trip to Shutdown Delay The fault lamp illuminates red, the alarm horn sounds, and the unit shuts down when the generator is stopped if the circuit breaker has tripped for a Protective Relay function, and the trip to shutdown time delay has expired. This delay allows mitigation of problem conditions without engine shutdown. If the delay expires, it is presumed no successful action was taken in the allotted time.

2.14.5 Status and Notice Digital Displays

Warnings and shutdown faults appear on the digital display under the Active Events menu and become part of the event history. Beyond the warnings and shutdowns there are several events which also appear on the digital display under the Active Events menu. Status is an event that is not an alert but is part of the event history. Notice is an alert that is not part of the event history.

The controller allows a selected number of changes by the user for setting up the controller application which are covered in this section.

Alarm Horn Silence. This status message indicates whether the alarm horn can be silenced in any button mode (OFF/RESET-AUTO-RUN) or requires the AUTO button be pressed first compliant per NFPA 110. Use SiteTech™ software to change this setting. See the Controller Resetting (Following System Shutdown or Warning) section, Controller Resetting procedure, for information on resetting the system.

The local display shows *Alarm Silence*: *Always* when the alarm horn can be silenced with the master control buttons in any position (default setting).

The local display shows *Alarm Silence*: *Auto Only* when the alarm horn can be silenced only when in the AUTO mode. The correct reset sequence requires pressing the OFF/RESET button, then pressing the AUTO button, and then pressing the ALARM SILENCE button.

Close Breaker. This notice message indicates that the controller is attempting to close the circuit breaker (a close command is being sent to the circuit breaker). This notice only appears in paralleling applications (where the bus sensing is connected to the bus side of the paralleling breaker).

Contactor. This notice message indicates that the controller wants to be connected to the paralleling bus. If a contactor is used for paralleling, this output controls it. This notice only appears in paralleling applications (where the bus sensing is connected to the bus side of the paralleling breaker).

Emergency Power System (EPS) Supplying Load. This notice message indicates when the generator set supplies more than 1% of the rated standby output current.

Engine Cooldown (Delay) Active. This notice message indicates that the delay for engine cooldown is active where the generator set will continue to run after the OFF/RESET button is pressed. The unit will continue to run until the time delay times out.

Engine Start Aid Active. This notice message indicates that the start aid is active and will energize an engine equipped preheat or ether system during the crank cycle. Use SiteTech™ software to set up this feature.

Engine Started. This status indicates that the generator set start circuit is closed allowing the engine to crank and run.

Engine Stopped. This status indicates that the generator set start circuit is open causing the engine to shut down.

Generator Running. This notice indicates that the generator set has started and is running.

Load Priority # Shed. This status message indicates the digital output for load priority # (1, 2, 3, 4, 5, or 6) shed is active (contacts closed), indicating the 1st, 2nd, 3rd, 4th, 5th, or 6th priority load shed has been activated.

Remote Start. This notice indicates that the generator set start circuit was closed from a remote location allowing the engine to crank and run. The remote location is typically a set of contacts on a transfer switch or remote start switch.

Remove Breaker Trip. This notice message indicates that the controller considers the breaker to be safe to close. The breaker may be closed or preparing to close when this notice is displayed. This notice only appears in paralleling applications (where the bus sensing is connected to the bus side of the paralleling breaker).

Run Button Acknowledged. This notice message indicates that the RUN button on the controller has been pushed.

System Ready. This status indicates that the generator set is in the AUTO mode and available to start if the start circuit is closed.

2.14.6 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.

Refer to the Emergency Stop section, to reset the generator set after an emergency stop.

1. Disconnect the generator set load using the line circuit breaker or automatic transfer switch.
2. Correct the cause of the fault shutdown or warning. See the Safety Precautions and Instructions section of this manual before proceeding.

Note:
Always identify and correct the cause of a fault shutdown before resetting the controller.

3. Reset the fault by pressing the OFF/RESET button.
4. Start the generator set by pressing the generator set OFF/RESET button and then press the RUN button.

   When equipped, the remote annunciator alarm horn sounds. Press the ALARM SILENCE/LAMP TEST button to stop the alarm horn. The alarm silenced lamp turns on if the alarm is silenced.
5. Test operate the generator set to verify correction of the shutdown cause by pressing the RUN button.
6. Press the generator set OFF/RESET button to stop the generator set.
7. Press the generator set AUTO button.
8. Silence the controller alarm horn by pressing the ALARM SILENCE button.
9. Reconnect the generator set load via the line circuit breaker or automatic transfer switch.
10. When equipped, the remote annunciator alarm horn sounds. Press the ALARM SILENCE/LAMP TEST button to stop the alarm horn. The alarm silenced lamp turns on if the alarm is silenced.

2.15 Menu Displays

Use the Menu Summary List and Figure 23 after reading and understanding the features of the pushbutton/rotary selector dial. See the Graphical Display section.

The Menu Summary List and Figure 23 provide a quick reference to the digital display data. Some digital display data may not be identical to your display due to generator set application differences. The closed bullet items represent main level data and the open bullet items are sub-level data. The Menu Summary List indicates items that are user selectable. Use SiteTech™ software for changing programmable information.

Menu Summary List (Legend: ● First level submenu, ○ second level submenu, ◊ third level submenu)

Metering Menu

- **Generator Metering**
  - o L1-L2 VOLTS: ###V
  - o L2-L3 VOLTS: ###V
  - o L3-L1 VOLTS: ###V
  - o AVG GEN VOLTAGE L-L: ###V
  - o GEN FREQUENCY: ##.#Hz
  - o L1-L0 VOLTS: ###V
  - o L2-L0 VOLTS: ###V
  - o L3-L0 VOLTS: ###V
  - o AVG GEN VOLTAGE L-N: ###V
  - o GEN FREQUENCY: ##.#Hz
  - o L1 CURRENT: ###A
  - o L2 CURRENT: ###A
  - o L3 CURRENT: ###A
  - o AVG CURRENT: ###A
  - o GEN FREQUENCY: ##.#Hz
  - o L1 POWER: ####W
  - o L2 POWER: ####W
  - o L3 POWER: ####W
  - o TOTAL POWER: ####.#kW
  - o GEN % OF RATED kW: ###%
  - o L1 REACTIVE POWER: ####VAR
  - o L2 REACTIVE POWER: ####VAR
  - o L3 REACTIVE POWER: ####VAR
  - o TOTAL REACTIVE POWER: ####VAR
  - o L1 APPARENT POWER: ####VA
  - o L2 APPARENT POWER: ####VA
  - o L3 APPARENT POWER: ####VA
  - o TOTAL APPARENT PWR: ####VA
  - o GEN % OF RATED kVA: ###%
  - o L1 PF: #.##
  - o L2 PF: #.##
  - o L3 PF: #.##
  - o TOTAL PF: #.##
  - o GEN PHASE ROTATION: ###
- **Engine Metering**
  - o ENGINE SPEED: ####RPM
  - o ECM BATTERY VOLTAGE: ##.#VDC
  - o GEN BATTERY VOLTAGE: ##.#VDC
  - o GENSET CONTROLLER TEMP: ###°F
  - o OIL PRESSURE: ###PSI
  - o OIL TEMPERATURE: ###°F
  - o COOLANT TEMPERATURE: ###°F
  - o COOLANT PRESSURE: ###PSI
  - o FUEL LEVEL: ###%
  - o FUEL PRESSURE: ###PSI
  - o FUEL TEMPERATURE: ###°F

Metering Menu (Continued)

  - o FUEL RATE: ###GAL/h
  - o (shown if available from ECM)
  - o FUEL USED LAST RUN: ###GAL
  - o (shown if available from ECM)
  - o CRANKCASE PRESSURE: ###PSI
  - o INTAKE AIR PRESSURE: ###PSI
  - o INTAKE AIR TEMP: ###°F
- **Battery X Meter**

  Note:

  This menu option does not apply to marine generator sets.
  - o STATUS: (IDLING/STANDBY/
  - o CHARGING/ BATT FAIL/CHRGR FAIL/ NOT AVAILABLE)
  - o OUTPUT VOLTAGE: ##.#VDC
  - o OUTPUT CURRENT: ##.#A
  - o CHARGER STATE: IDLE/BULK/
  - o ABSORB/FLOAT/EQUAL/
  - o REFRESH/ RECOVER/NA
  - o CHARGER TEMP: ###°F
  - o REDUCED OUTPUT ACTIVE: YES/NO
  - o TEMP COMPENSATION ACTIVE: YES/NO
  - o SOFTWARE VER.: XXXXXXXXXXXX
- **Overview**
  - o GENERATOR STATUS
  - ◊ AVG GEN VOLTAGE L-L: ##V
  - ◊ AVG CURRENT: ###A
  - ◊ GEN FREQUENCY: ##.#Hz
  - o ENGINE STATUS
    - ◊ COOLANT TEMPERATURE: ###°F
    - ◊ OIL PRESSURE: ###PSI
    - ◊ GEN BATTERY VOLTAGE: ##.#V
  - o SYSTEM STATUS
    - ◊ FUEL PRESSURE: ###PSI
    - ◊ TOTAL POWER: ####kW
    - ◊ TOTAL RUN TIME: #####.#hrs
- **Paralleling Metering**
  - o CONNECTED TO BUS: TRUE/FALSE
  - o AVG BUS VOLTAGE L-L: ###.#V
  - o AVG GEN VOLTAGE L-L: ###.#V
  - o BUS FREQUENCY: ##.##Hz
  - o GEN FREQUENCY: ##.##Hz
  - o BUS TOTAL POWER: #####.#kW
  - o BUS % OF RATED kW: ###%
  - o BUS % OF RATED kVAR: ###%

Generator Information Menu

- **Generator Information**
  - o TOTAL RUN TIME: #####.#hrs
  - o HOURS LOADED: #####hrs
  - o HOURS UNLOADED: #####hrs
  - o kW HOURS: #####kWh
  - o OPERATING HOURS: ######hrs
  - o TOTAL # OF STARTS: ########

Generator Information Menu (Continued)

  - o LAST MAINTENANCE: ##/##/####
  - o OP HRS SINCE MAINT: ####hrs
  - o STARTS SINCE MAINT: ###
  - o ENG HRS SINCE MAINT: ####hrs
  - o LOADED SINCE MAINT: ####hrs
  - o UNLOADED SINCE MAINT: ####hrs
  - o kW HRS SINCE MAINT: ####kWh
  - o RESET MAINT RECORDS: YES/NO*
  - o LAST START: ##/##/####
  - o LAST RUN LENGTH: ####hrs
  - o CTRL SERIAL #: XXXXXXXXX
  - o SOFTWARE VER.: XXXXXXXXX
  - o ECM SERIAL #: XXXXXXXXX
  - o GENSET MODEL #: XXXXXXXXX
  - o GENSET SPEC. #: XXXXXXXXX
  - o GENSET SERIAL #: XXXXXXXXX
  - o ALT. PART #: XXXXXXXXX
  - o ENGINE PART #: XXXXXXXXX
  - o ENGINE MODEL #: XXXXXXXXX
  - o ENGINE SERIAL #: XXXXXXXXX
- **Event History**
  - o GENERATOR EVENT HISTORY ##/##/#### (Date) ##:##.##XX (Time) DEVICE EVENT: ### STATUS/FAULT/NOTICE/ WARNING EVENT X OF Y
  - o ENGINE EVENT LOG SPN: #### FMI: ## OCCURRENCE COUNT: ### EVENT X OF Y
- **Configuration**
  - o GENERATOR CONFIGURATION
    - ◊ OPERATING MODE: (STANDBY/PRIME)
    - ◊ APPLICATION TYPE: (NONE/MARINE/ MOBILE/STANDBY/PRIME)
    - ◊ SYSTEM VOLTAGE L-L: ###V*
    - ◊ SYSTEM FREQUENCY: ##.#Hz*
    - ◊ SYSTEM PHASE: (SINGLE/SINGLE DOG/THREE-WYE/THREE-DELTA)*
    - ◊ RATED ENGINE SPEED: ####RPM
    - ◊ ENGINE SPEED ADJUSTMENT: *
    - ◊ ADJUSTED ENGINE RUN SPEED: ####RPM

* User-Defined (changeable) Menu Displays. Use SiteTech™ software to change other settings including User-Defined Menu Displays.

Generator Information Menu (Continued)

- ◊ kW RATING: ####kW
- ◊ kVA RATING: #####kVA
- ◊ RATED CURRENT: ###A
- ◊ BATTERY VOLTAGE: ##VDC*
- ◊ POWER ECM: ON/OFF*
- ◊ ENGINE START DELAY: ##s*
- ◊ STARTING AID DELAY: ##s*
- ◊ CRANK ON DELAY: ##s*
- ◊ CRANK PAUSE DELAY: ##s*
- ◊ ENGINE WARMED UP: ###°F
- ◊ ENGINE COOLED DOWN: ###°F
- ◊ COOLDOWN DELAY: ##s*
- ◊ COOLDOWN OVERRIDE: ON/OFF*
- ◊ FUEL TYPE: (NATURAL GAS/LP/GASOLINE/ DIESEL/ UNKNOWN)*
- ◊ CRANK CYCLES LIMIT:##*
- ◊ NFPA DEFAULTS: ON/OFF*
- ◊ EMERGENCY BATTLEMODE: ON/OFF*
- ◊ POWER UP IN AUTO: ON/OFF*
- ◊ NOT IN AUTO WARN ENABLE: ON/OFF*
- ◊ AUX FAULT DELAY: ##s*
- ◊ AUX FAULT INHIBIT DELAY: ##s*

o PROTECTION CONFIGURATION

- ◊ OVERVOLTAGE: ###%*
- ◊ OVERVOLTAGE: ###.#V
- ◊ OVERVOLTAGE DELAY: ##s*
- ◊ UNDERVOLTAGE: ##%*
- ◊ UNDERVOLTAGE: ##.#V
- ◊ UNDERVOLTAGE DELAY: ##s*
- ◊ OVERFREQUENCY: ##%*
- ◊ OVERFREQUENCY: ##.#Hz
- ◊ UNDERFREQUENCY: ##%*
- ◊ UNDERFREQUENCY: ##.#Hz
- ◊ OVERSPEED: ##.#%*
- ◊ OVERSPEED: ##.#Hz
- ◊ OVERSPEED: ####RPM
- ◊ LOW BATTERY VOLTAGE: ###%*
- ◊ LOW BATTERY VOLTAGE: ##.#VDC
- ◊ HIGH BATTERY VOLTAGE: ###%*
- ◊ HIGH BATTERY VOLTAGE: ##.#VDC

o BATT X BASIC CONFIG

Note:
This menu option does not apply to marine generator sets.

- ◊ BATTERY TOPOLOGY: (DEFAULT/ VRLA/ AGM/GEL/NiCd*
- ◊ CHARGER SYSTEM VOLTAGE: 12VDC/24VDC
- ◊ AUTO EQUALIZE ENABLED: ON/OFF*
- ◊ TEMP COMPENSATION ENABLED: ON/OFF*
- ◊ ABSORPTION TERMINATION: #.##A (+/- 0.05)*
- ◊ BULK VOLTAGE: ##.##VDC (+/- 0.05)*
- ◊ ABSORPTION VOLTAGE: ##.##VDC (+/- 0.05) *
- ◊ FLOAT VOLTAGE: ##.##VDC (+/- 0.05)*
- ◊ MANUAL EQUALIZE ACTIVE: YES/NO*
- ◊ CUSTOM PROFILE ENABLED: ON/OFF*
- ◊ TEMP COMPENSATION SLOPE: ##mV/C*
- ◊ EQUALIZE VOLTAGE: ##.##VDC (+/- 0.05)*
- ◊ MAX ABSORPTION TIME: ###MIN*
- ◊ MAX BULK TIME: ###MIN*
- ◊ BULK STATE RETURN: ##.##V (+/- 0.05)*

• **Voltage Regulation**

- o AVG GEN VOLTAGE L-L: ###.#V
- o VOLTAGE ADJUST: ###.#V*
- o TARGET VOLTAGE: ###.#V
- o L1-L2 VOLTS: ###.#V
- o L2-L3 VOLTS: ###.#V
- o L3-L1 VOLTS: ###.#V
- o GEN FREQUENCY: ##.#Hz
- o V/Hz SETPOINT: ##.#Hz*
- o V/Hz SLOPE: ##%/Hz*
- o VOLT DROOP AT 100% kVAR: ##.#%*
- o VOLTAGE GAIN ADJUST: ###*
- o START UP RAMP RATE: ###.#%/s*
- o RESET REG. DEFAULTS:YES/NO*

• **Paralleling Operation**

- o PARALLELING SETUP
  - ◊ DEAD BUS LEVEL: ##.#%*
  - ◊ VOLTAGE OK PICKUP: ##.#%*
  - ◊ VOLTAGE OK DROPOUT: ##.#%*
  - ◊ FREQUENCY OK PICKUP: ##.#Hz*
  - ◊ FREQUENCY OK DROPOUT: ##.#Hz*
  - ◊ VOLTS-Hz OK DELAY: ##.#s*
  - ◊ FIRST ON DELAY: ##.#s*
  - ◊ FAIL TO OPEN DELAY: ##s*
  - ◊ FAIL TO CLOSE DELAY: ##s*
  - ◊ RECLOSE DELAY: ##.#s*
  - ◊ MAX CLOSE ATTEMPTS: ###*
  - ◊ CB CRNT FAULT LIMIT: ###.#%*
  - ◊ CB CRNT FAULT DELAY: ##.#s*
  - ◊ CB PHASE FAULT LIMIT: ##.#_*
  - ◊ CB PHASE FAULT DELAY: ##.#s*
  - ◊ kW RAMP RATE: ##.#%/s*
  - ◊ kW DISCONNECT LEVEL: ##.#%*
  - ◊ TRIMS ENABLE: ON/OFF*
  - ◊ LOAD ENABLE: ON/OFF*
  - ◊ SYSTEM LOAD CONTROL: ON/OFF*
  - ◊ SYSTEM SYNC CONTROL: ON/OFF*
  - ◊ STAND ALONE MODE: ON/OFF*
  - ◊ SYNC MODE IN AUTO: (INVALID/OFF/PASSIVE/ CHECK/ ACTIVE/DEAD FIELD)*
  - ◊ SYNC MODE IN RUN: (INVALID/OFF/PASSIVE/ CHECK/ ACTIVE/DEAD FIELD)*
- o SYNCHRONIZING SETUP
  - ◊ SYNC MODE IN RUN: (INVALID/OFF/PASSIVE/ CHECK/ ACTIVE/DEAD FIELD)*
  - ◊ SYNC MODE IN AUTO: (INVALID/OFF/PASSIVE/ CHECK/ ACTIVE/DEAD FIELD)*
  - ◊ CONNECTED TO BUS: TRUE/FALSE
  - ◊ VOLTS-Hz OK: TRUE/FALSE
  - ◊ IN SYNC: TRUE/FALSE
  - ◊ VOLTAGE MATCHED: TRUE/FALSE
  - ◊ VOLTAGE MATCH WINDOW: ##.#%*
  - ◊ AVG BUS VOLTAGE L-L: ###.#V
  - ◊ AVG GEN VOLTAGE L-L: ###.#V
  - ◊ VOLTAGE MATCH P GAIN: ##.##*
  - ◊ VOLTAGE MATCH I GAIN: ##.##*
  - ◊ VOLTAGE MATCH D GAIN: ##.##*
  - ◊ VOLTAGE BIAS: ###.##
  - ◊ FREQUENCY MATCHED: TRUE/FALSE
  - ◊ FREQUENCY WINDOW: #.#Hz*
  - ◊ BUS FREQUENCY: ##.##Hz
  - ◊ GEN FREQUENCY: ##.##Hz
  - ◊ FREQ MATCH P GAIN:##.##*
  - ◊ FREQ MATCH I GAIN: ##.##*
  - ◊ FREQ MATCH D GAIN:##.##*
  - ◊ SPEED BIAS: ###.##
  - ◊ PHASE MATCHED: TRUE/FALSE
  - ◊ PHASE MATCH WINDOW: ##.#°*
  - ◊ PHASE DIFFERENCE: ###.#°
  - ◊ PHASE MATCH P GAIN: ##.##*
  - ◊ PHASE MATCH I GAIN: ##.##*
  - ◊ PHASE MATCH D GAIN: ##.##*
  - ◊ SPEED BIAS: ###.##
  - ◊ DWELL TIME: ##.#s*
  - ◊ DWELL TIME REMAINING: ##.#s
  - ◊ FAIL TO SYNC TIME: ####s*
  - ◊ SYNC TIME REMAINING: ####s

* User-Defined (changeable) Menu Displays. Use SiteTech™ software to change other settings including User-Defined Menu Displays.

Generator Information Menu (Continued)

- ◊ BUS PHASE ROTATION: DISABLED/A-B-C/C-B-A
- ◊ GEN PHASE ROTATION: DISABLED/A-B-C/C-B-A
- ○ SHARING SETUP
  - ◊ BUS % OF RATED kW: ###.##%
  - ◊ GEN % OF RATED kW: ###.##%
  - ◊ kW SHARING P GAIN: ##.##*
  - ◊ kW SHARING I GAIN: ##.##*
  - ◊ kW SHARING D GAIN: ##.##*
  - ◊ SPEED BIAS: ###.##
  - ◊ SYSTEM FREQUENCY: ##.#Hz
  - ◊ GEN FREQUENCY: ##.#Hz
  - ◊ FREQ TRIM P GAIN: ##.##*
  - ◊ FREQ TRIM I GAIN: ##.##*
  - ◊ FREQ TRIM D GAIN: ##.##*
  - ◊ SPEED BIAS: ###.##
  - ◊ FREQ DROOP AT 100% kW: ##.#%*
  - ◊ BUS % OF RATED kVAR: ###.##%
  - ◊ GEN % OF RATED kVAR: ###.##%
  - ◊ kVAR SHARING P GAIN: ##.##*
  - ◊ kVAR SHARING I GAIN: ##.##*
  - ◊ kVAR SHARING D GAIN: ##.##*
  - ◊ VOLTAGE BIAS: ###.##
  - ◊ SYSTEM VOLTAGE L-L: ###.#V
  - ◊ AVG GEN VOLTAGE L-L: ###.#V
  - ◊ VOLT TRIM P GAIN: ##.##*
  - ◊ VOLT TRIM I GAIN: ##.##*
  - ◊ VOLT TRIM D GAIN: ##.##*
  - ◊ VOLTAGE BIAS: ###.##
  - ◊ VOLT DROOP AT 100% kVAR: ##.#%*
- ○ PROTECTIVE RELAY SETUP
  - ◊ OVER POWER TRIP: ###.#%*
  - ◊ OVER POWER DELAY: ##.#s*
  - ◊ REVERSE POWER TRIP: ###.#%*
  - ◊ REVERSE POWER DELAY: ##.#s*
  - ◊ OVER VOLTAGE TRIP: ###.#%*
  - ◊ OVER VOLTAGE DELAY: ##.#s*
  - ◊ UNDER VOLTAGE TRIP: ###.#%*
  - ◊ UNDER VOLTAGE DELAY: ##.#s*
  - ◊ OVER FREQ TRIP: ###.#%*
  - ◊ OVER FREQ DELAY: ##.#s*
  - ◊ UNDER FREQ TRIP: ###.#%*
  - ◊ UNDER FREQ DELAY: ##.#s*
  - ◊ REVERSE VAR TRIP: ###.#%*
  - ◊ REVERSE VAR DELAY: ##.#s*
- ◊ OVER CURRENT TRIP: ###.#%*
- ◊ OVER CURRENT DELAY: ##.#s*
- ◊ TRIP TO SHTDWN DELAY: #####s*
- ○ GENERATOR MANAGEMENT
  - ◊ GEN MANAGEMENT MODE:
  - ◊ (INVALID/MANUAL FIXED/RUN TIME/FUEL LEVEL)*
  - ◊ GEN MANAGEMENT: ON/OFF*
  - ◊ GEN MANAGEMENT ORDER: #*
    will revert to previous setting in run time or fuel level mode.
  - ◊ START CAPACITY: ###.#%*
  - ◊ START DELAY: ####s*
  - ◊ STOP CAPACITY: ###.#%*
  - ◊ STOP DELAY: ####s*
  - ◊ TOTAL BUS CAPACITY: #####kW
  - ◊ BUS TOTAL POWER: #####kW
  - ◊ START kW: #####kW
  - ◊ STOP kW: #####kW
  - ◊ START ACCUMULATOR: #####
  - ◊ STOP ACCUMULATOR: #####
  - ◊ RUN TIME THRESHOLD: ###.#hrs*
  - ◊ only if in Run Time Management
  - ◊ TOTAL RUN TIME: ########.#hrs
  - ◊ FUEL LEVEL THRESHOLD: ##.#%*
    only if in Fuel Level Management
  - ◊ FUEL LEVEL: ###.#%
  - ◊ STABLE DELAY: ####s*
  - ◊ MINIMUM GENS ONLINE: ##*
  - ◊ MIN LOADS ADDED: ##*
  - ◊ STOPPED BY GEN MGMT:
  - ◊ TRUE/FALSE
- ○ LOAD CONTROL
  - ◊ GEN MAX % CAP: ###.#%*
  - ◊ GEN OVERLOAD %: ###.#%*

Controller Configuration Menu

- **Controller Configuration**
  - o LANGUAGE: English*
  - o UNITS: Metric/English*
  - o TIME FORMAT: Hr 12/Hr 24*
  - o DATE FORMAT: Month Date Year/
  - o Date Month Year*
  - o DATE: ##/##/####*
  - o TIME: ##:## XM*
  - o CONTRAST: ###*
  - o ALARM SILENCE: ALWAYS/AUTO ONLY*
- **Communication Setup**
  - o MODBUS BAUD RATE: OFF/9600 b/s/
  - o 19200 b/s/38400 b/s/57600 b/s/
  - o 115200 b/s*
  - o MODBUS ADDRESS: ##*
  - o PGEN BAUD RATE: OFF/9600 b/s/
  - o 19200 b/s/38400 b/s/57600 b/s/
  - o 115200 b/s
  - o PGEN NODE ID: ##
  - o PGEN NODES ONLINE: ##
  - o PGEN NODES OFFLINE: ##
- **Calibration**
  When the line is highlighted, hold the knob down to enable the calibration capability.
  - o GEN L1-L0 VOLTS: ###.#V*
  - o GEN L2-L0 VOLTS: ###.#V*
  - o GEN L3-L0 VOLTS: ###.#V*
  - o GEN L1-L2 VOLTS: ###.#V*
  - o GEN L2-L3 VOLTS: ###.#V*
  - o GEN L3-L1 VOLTS: ###.#V*
  - o GEN L1 CURRENT: ###.#A*
  - o GEN L2 CURRENT: ###.#A*
  - o GEN L3 CURRENT: ###.#A*
  - o BUS L1-L2 VOLTS: ###.#V*
  - o BUS L2-L3 VOLTS: ###.#V*
  - o BUS L3-L1 VOLTS: ###.#V*
  - o RESET GEN VOLT METER: YES/NO*
  - o RESET GEN AMP METER: YES/NO*
  - o RESET BUS VOLT METER: YES/NO*
  - o RESET ALL METERS: YES/NO*

* User-Defined (changeable) Menu Displays. Use SiteTech™ software to change other settings including User-Defined Menu Displays.

I/O Menu	I/O Menu (Continued)	Active Events Menu
• **Resistive Input** Analog Input 0:1 Analog Input 0:2 Analog Input 0:3 Analog Input 0:4 Analog Input 0:5 Analog Input 0:6 o DESCRIPTION: (*function by default unless modified via SiteTech)* o MEASUREMENT: ###.#Ohms o EVENT: * o INPUT ENABLED: ON/OFF* o SENSOR TYPE: * o LOW PROTECTIVE INHIBIT: ##s* o LOW WARNING: ON/OFF* o LOW WARNING LIMIT: * o LOW WARNING DELAY: ##s* o LOW SHUTDOWN: ON/OFF* o LOW SHUTDOWN LIMIT: * o LOW SHUTDOWN DELAY: ##s* o HIGH PROTECTIVE INHIBIT: ##s* o HIGH WARNING: ON/OFF* o HIGH WARNING LIMIT: * o HIGH WARNING DELAY: ##s* o HIGH SHUTDOWN: ON/OFF* o HIGH SHUTDOWN LIMIT: * o HIGH SHUTDOWN DELAY: ##s*	• **Digital Input** Digital Input 0:1 Digital Input 0:2 Digital Input 0:3 Digital Input 0:4 Digital Input 0:5 Digital Input 0:6 o DESCRIPTION: (function by default unless modified via SiteTech) o STATUS: ACTIVE/INACTIVE o FUNCTION: * o EVENT: * o LOGIC: ACTIVE ON/ACTIVE OFF * o ENABLED: ON/OFF* o INHIBIT TIME: ##s* o DELAY TIME: ##s* • **Digital Output** Digital Output 0:1 Digital Output 0:2 Digital Output 0:3 Digital Output 0:4 Digital Output 1:1 (**Note**: *Only displayed if the 15-Relay Dry Contact Kit is installed.)* o DESCRIPTION: (function by default unless modified via SiteTech) o STATUS: ACTIVE/INACTIVE o FUNCTION: * o EVENT: * o LOGIC: ACTIVE ON/ACTIVE OFF*	Rotate the dial to view Active Events: Warnings Shutdowns Statuses Notices See the **System Fault Warning Lamp with Digital Displays**, **System Fault Shutdown Lamp With Digital Displays**, and **Status and Notice Digital Displays sections** for descriptions. Press the OFF button to return to the main menu.

* User-Defined (changeable) Menu Displays. Use SiteTech™ software to change other settings including User-Defined Menu Displays.

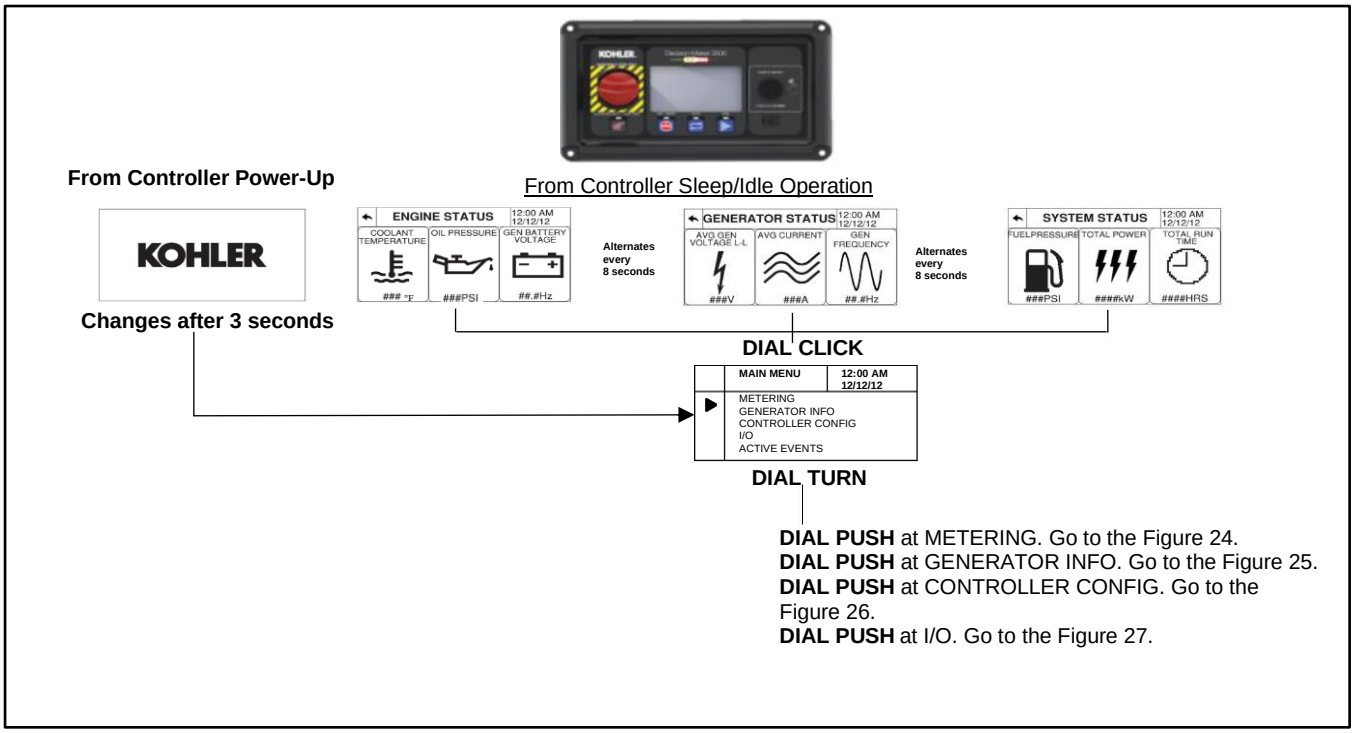


Figure 23 Decision-Maker 3500 Controller Information Menu Structure

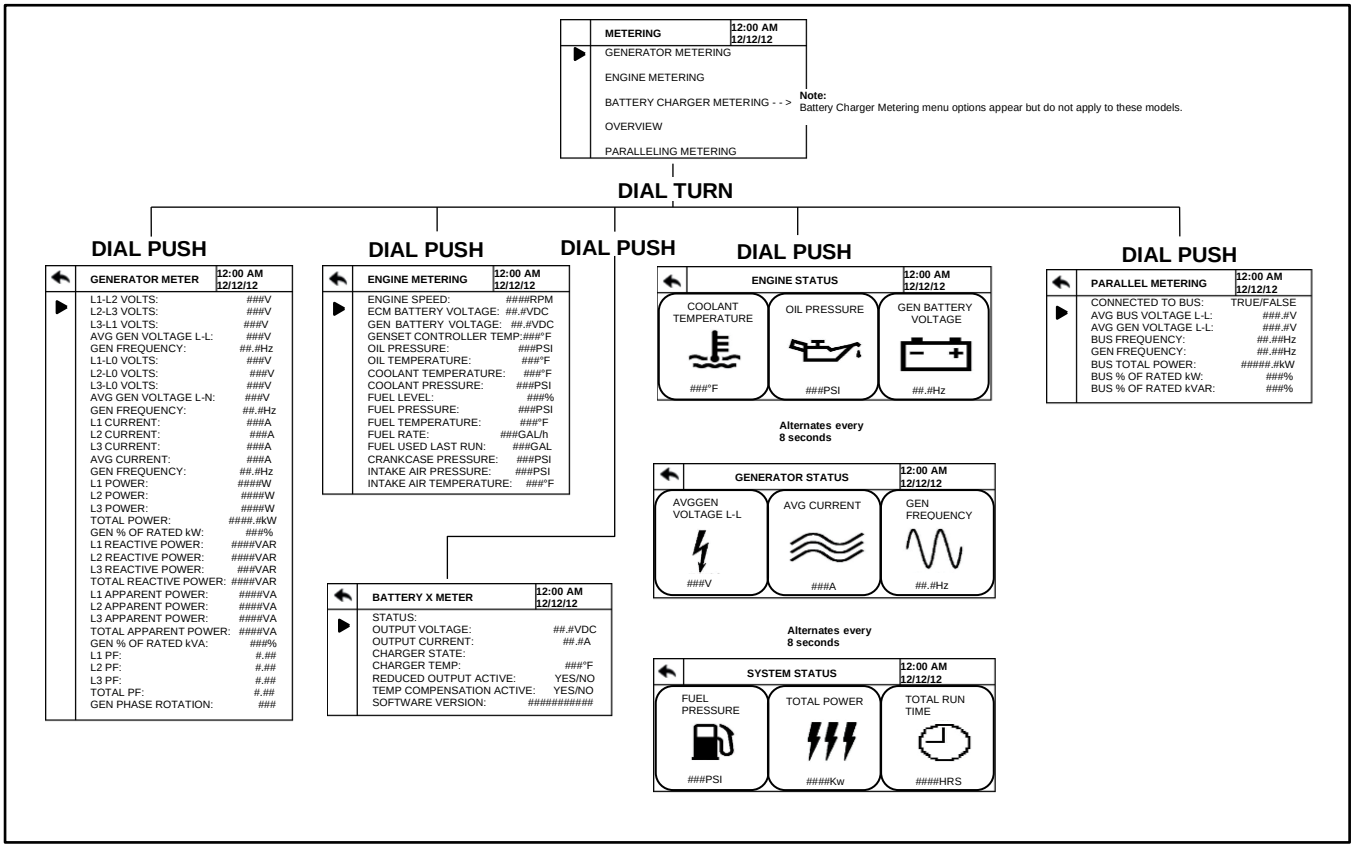


Figure 24 Metering Menu

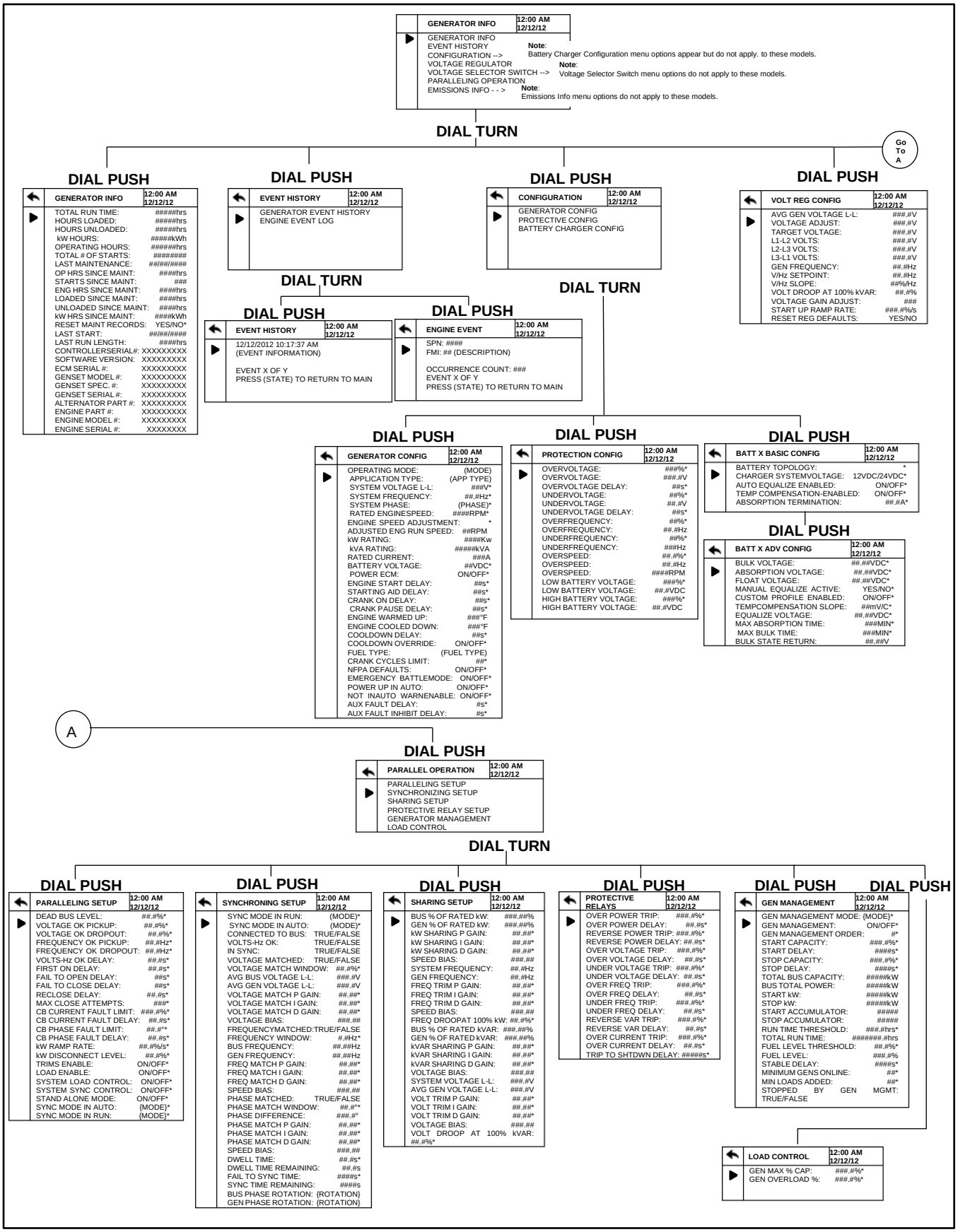


Figure 25 Generator Information Menu

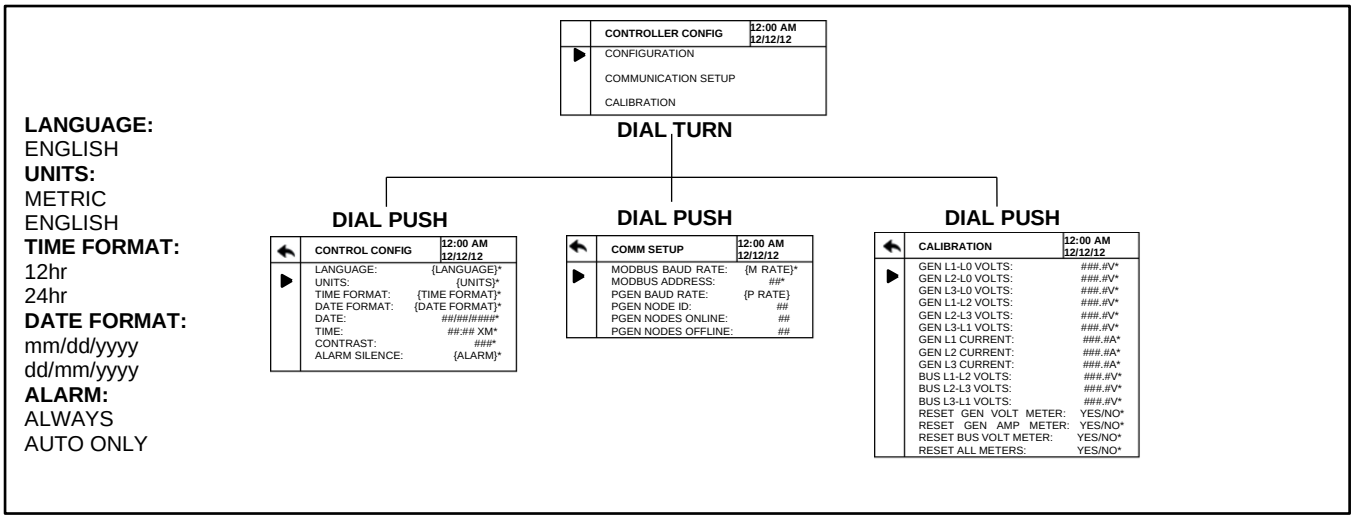


Figure 26 Controller Configuration Menu

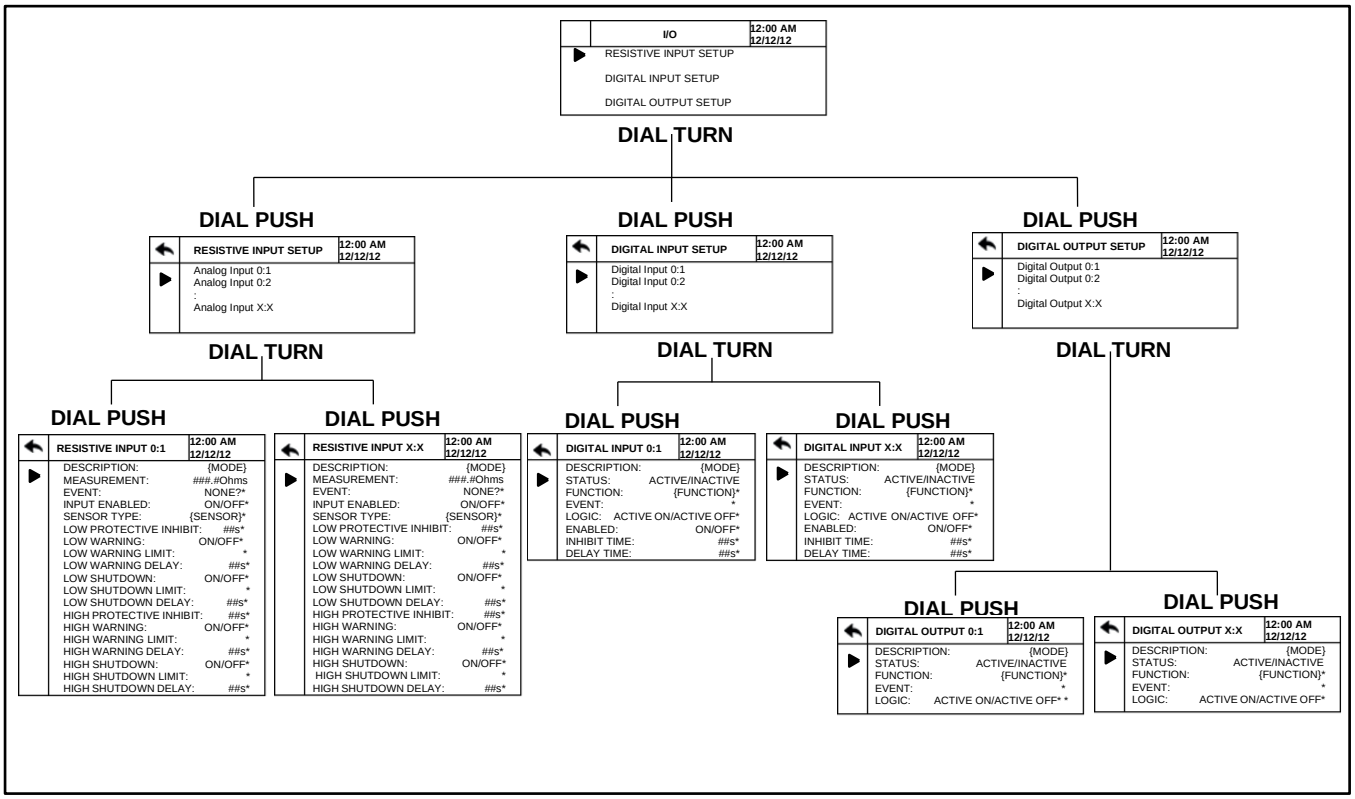


Figure 27 I/O Menu

2.16 Monitoring and Programming Setup

The user programmer can access the controller data with the controller digital display or a personal computer (PC) with optional SiteTech™ software to monitor and/or program. Access the controller system with a PC using a USB cable with a mini USB plug. Refer to the Introduction, List of Related Materials for related software literature.

While this manual focuses on data access through the controller pushbutton/rotary selector dial and display, most data entries require input using a PC for initial setup. The PC entries typically include alpha characters such as digital input descriptions.

2.16.1 PC Communications

Communicate between a PC and the generator set controller logic using USB communication protocol. The PC connections require optional SiteTech™ software. Contact your authorized distributor/dealer for assistance.

Local Single Connection

A PC connects to the USB port of the generator set controller using a mini USB connector. See Figure 28.

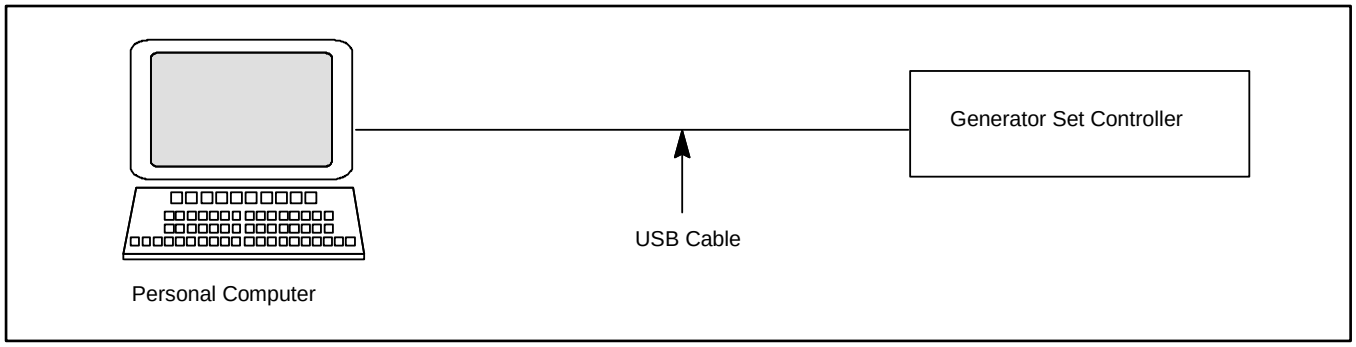


Figure 28 Local Single Connection

Remote Single Connection

A modem connects a PC to a single device. The PC communicates with the device via telephone line or an Ethernet network. See Figure 29.

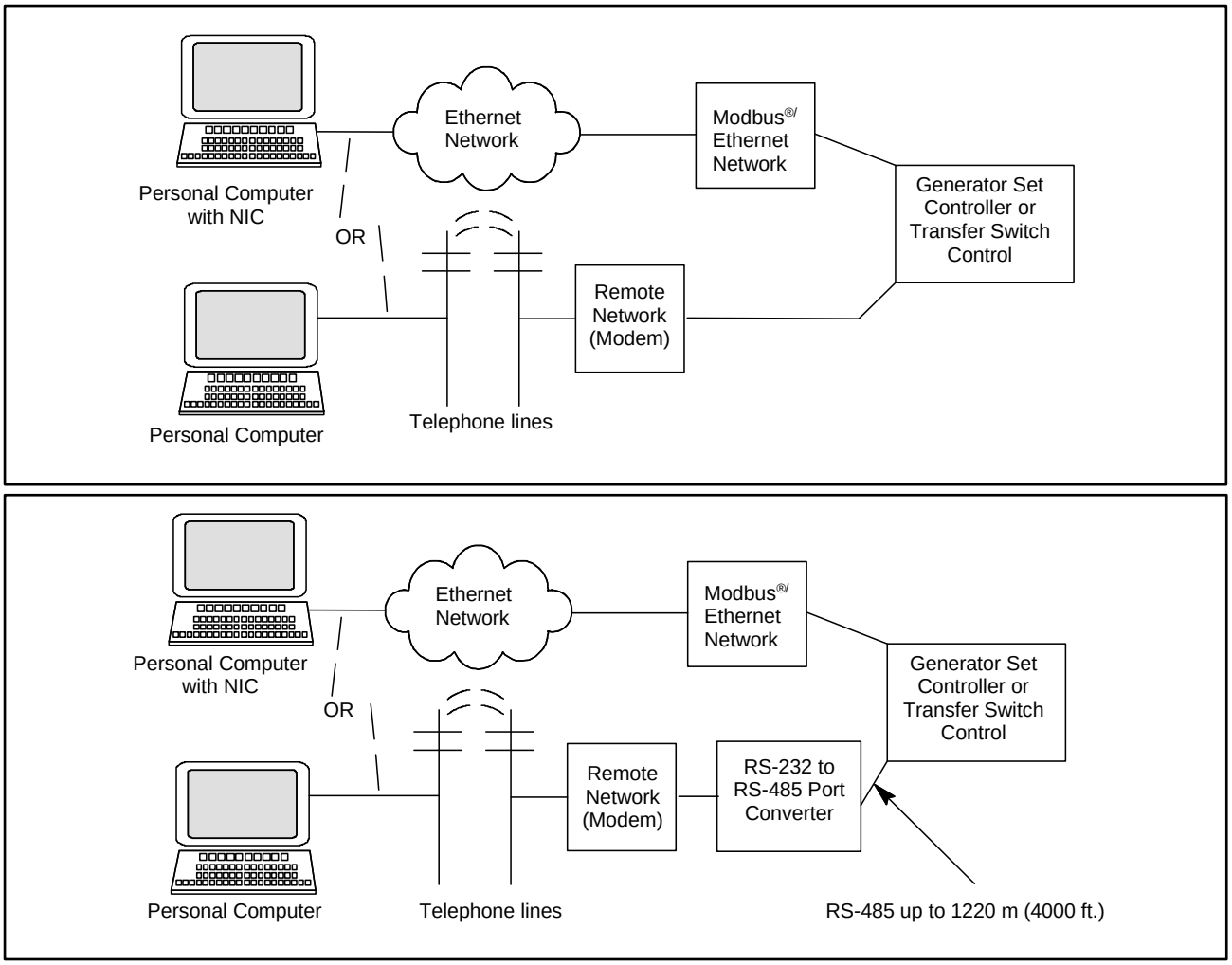


Figure 29 Remote Single Connection

2.16.2 Modbus® Communications

The controller communicates using Modbus® as a slave connection with the Modbus® master initiating the communication. The controller seeks the system and alternator parameters and diagnostic information then responds back to the Modbus® master. In addition, the controller accepts information to alter controller parameters including generator set starting and stopping. See Figure 30. Refer to the List of Related Materials for available Modbus® literature.

Note:
Only one Modbus® master can be connected to the controller. Examples include the remote serial annunciator and switchgear applications

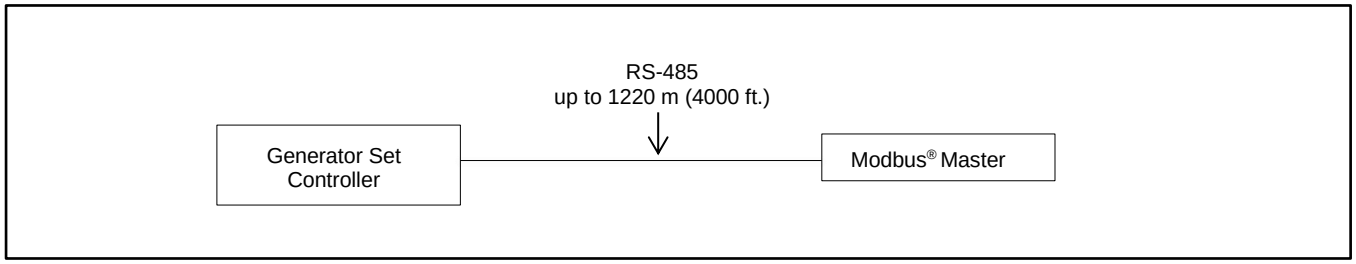


Figure 30 Modbus® Connections

Modbus® is a registered trademark of Schneider Electric.

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

DANGER	
	**Hazardous voltage. Moving parts.** **Will 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 will 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 will cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, 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 will 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.

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.

WARNING	
	**Risk of 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.

WARNING	
	**Hot coolant and steam.** **Can cause severe injury or death.** Before removing the pressure cap, stop the engine and allow it to cool. Then loosen the pressure cap to relieve pressure.

WARNING	
	**Hot engine and exhaust system.** **Can cause severe injury or death.** Do not work on the generator set until it cools.

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

NOTICE

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

Notice

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

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.

Routine Maintenance. Refer to the following generator set service schedule, the engine service schedule, and the runtime hours shown on the Decision-Maker® 3500 controller to determine when to schedule routine maintenance. Service more frequently generator sets that are subject to extreme weather or dusty or dirty conditions.

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 6months, 300 hours or 9 months, and so on.

3.2 Service Schedule for 14-24EKOZD/12-20.5EFKOZD Models

Perform Service at Intervals Indicated (X)	Reference Section	Daily	Every 50 Hrs. or 1 Month	Every 250 Hrs. or 3 Months	Every 500 Hrs. or 6 Months	Every 1000 Hrs. or Yearly
FUEL SYSTEM						
Check the fuel level and fill as necessary	Fuel System	X (Before operation)				
Check for any unusual noise †		X (During operation)				
Remove the sediment from the fuel tank and drain the fuel tank †§				X		
Bleed the fuel system (if encountering hard starting)	Fuel System Bleed		X			
Replace the fuel filter *	Fuel Filter			X		
Fuel/water separator draining, if equipped *†			X			
Fuel/water separator cleaning, if equipped *†					X	
LUBRICATION SYSTEM						
Check the crankcase oil level and add oil as necessary	Oil Check	X (Before operation)				
Replace the oil in the crankcase *	Oil Change		X (Break-in period)		X	
Replace the lube oil filter element *	Oil Change		X (Break-in period)		X	
COOLING SYSTEM						
Check the coolant level and fill as necessary *	Checking and Filling Coolant	X (Before operation)				
Check the seawater outlet and clean as necessary	Exhaust System	X				
Check/adjust the seawater pump belt tension *	Belt Tensioning Procedure		X (Break-in period)	X		
Check the function of the siphon break, if equipped	Siphon Break			X		
Check/replace the seawater pump impeller *†	Seawater Pump			X (Check)		X (Replace)
Replace the coolant *†	Flushing and Cleaning				X	
Check/replace the heat exchanger anticorrosion zinc anode *†	Anticorrosion Zinc Anode			X (Check)		X (Replace)
Clean the heat exchanger tube *†	Gen. S/M				X	
Check/replace the coolant hoses *†				X (Check)		X (Replace)

* Requires removal of the sound shield door, if installed

† Consult your local distributor/dealer for service

‡ Read the WARNING found at the beginning of the manual regarding moving parts

§ Consult the operating instructions supplied with the craft

Service Schedule for 14-24EKOZD/12-20.5EFKOZD Models, continued

Perform Service at Intervals Indicated (X)	Reference Section	Daily	Every 50 Hrs. or 1 Month	Every 250 Hrs. or 3 Months	Every 500 Hrs. or 6 Months	Every 1000 Hrs. or Yearly
INTAKE/EXHAUST SYSTEM						
Inspect the exhaust system components *†	Exhaust System	X (Before operation)				
Check the exhaust gas condition. If the exhaust is blue or black, contact your local distributor/dealer	Exhaust System	X (During operation)				
Clean the exhaust/water mixing elbow *†	Exhaust System					X
Inspect the crankcase breather system *†	Eng. S/M					X (1500 hrs.)
Check the breather pipe for obstructions *†					X	
Inspect the complete exhaust system *†	Marine Inspection					X
ELECTRICAL SYSTEM						
Keep the battery charged and in good condition §	Battery	X (Before operation)				
Check and tighten the electrical connections *			X			
Clean the battery cables †						X
Check the starter motor †						X (5000 hrs.)
ENGINE AND MOUNTING						
Check for water, fuel, coolant, and oil leakage *†‡		X (After operation)				
Retighten any loose nuts and bolts *		X (Before operation)				
Check the mounting bolts/vibromounts and tighten if necessary *					X	
Check the compartment condition (fuel, oil, or water leaks)		X (Before operation)				
Total engine overhaul *†	Eng. S/M					X (10000 hrs.)
REMOTE START PANEL						
Check the remote start panel operation, if equipped			X (Break-in period)			X
GENERATOR						
Test run the generator set			X (Weekly)			
Blow dust out of the generator *†	General Maintenance					X

* Requires removal of the sound shield door, if installed

† Consult your local distributor/dealer for service

‡ Read the WARNING found at the beginning of the manual regarding moving parts

§ Consult the battery manufacturer's instructions

3.3 Service Schedule for 32-40EKOZD/28-35EFKOZD Models

Perform Service at Intervals Indicated (X)	Reference Section	Daily	Every 50 Hrs. or 1 Month	Every 250 Hrs. or 3 Months	Every 500 Hrs. or 6 Months	Every 1000 Hrs. or Yearly
FUEL SYSTEM						
Check the fuel level and fill as necessary	Fuel System	X (Before operation)				
Check for any unusual noise †		X (During operation)				
Remove the sediment from the fuel tank and drain the fuel tank †§				X		
Bleed the fuel system (if encountering hard starting)	Fuel System Bleed		X			
Replace the fuel filter cartridge *	Fuel Filter				X	
Fuel/water separator draining, if equipped *†			X			
Fuel/water separator cleaning, if equipped *†					X	
Replace the fuel line hoses †‖	Eng. S/M					X (5000 hrs.)
LUBRICATION SYSTEM						
Check the crankcase oil level and add oil as necessary	Oil Check	X (Before operation)				
Replace the oil in the crankcase *	Oil Change		X (Break-in)	X		
Replace the lube oil filter element *	Oil Change		X (Break-in)	X		
COOLING SYSTEM						
Check the coolant level and fill as necessary *	Checking and Filling Coolant	X (Before operation)				
Check the seawater outlet and clean as necessary	Exhaust System	X				
Check the function of the siphon break, if equipped	Siphon Break			X		
Check/replace the seawater pump impeller and check for leaks *†	Seawater Pump			X (Check)	X (Replace)	
Overhaul the seawater pump *†	Gen. S/M					X
Replace the seawater pump *†	Gen. S/M					X (2000 hrs.)
Replace the coolant *†	Flushing and Cleaning					X
Check/replace the heat exchanger anticorrosion zinc anode *†	Anticorrosion Zinc Anode		X (1^{st} at 10 hrs.)		X (Check)	X (Replace)
Clean the heat exchanger tube *†	Gen. S/M				X	
Clean the charge air cooler (intercooler) 40EKOZD and 35EFKOZD Models Only *†	Gen. S/M				X	
Check/replace the coolant hoses *†					X (Check)	X (Replace 5000 hrs.)

* Requires removal of the sound shield door, if installed

† Consult your local distributor/dealer for service

‡ Read the WARNING found at the beginning of the manual regarding moving parts

§ Consult the operating instructions supplied with the craft

‖ The replacement interval is only an indication, it strongly depends on the environmental condition and hose status detected during regular visual inspection. The exterior of the fuel lines should be visually inspected for leaks and damage. Fuel lines should be removed ONLY when being replaced with new ones.

Service Schedule for 32-40EKOZD/28-35EFKOZD Models, continued

Perform Service at Intervals Indicated (X)	Reference Section	Daily	Every 50 Hrs. or 1 Month	Every 250 Hrs. or 3 Months	Every 500 Hrs. or 6 Months	Every 1000 Hrs. or Yearly
INTAKE/EXHAUST SYSTEM						
Inspect the exhaust system components *†	Exhaust System	X (Before operation)				
Check the exhaust gas condition. If the exhaust is blue or black, contact your local distributor/dealer	Exhaust System	X (During operation)				
Clean/replace the air filter element *	Air Cleaner Service/Replacement (32-40EKOZD/28-35EFKOZD Models)			X		
Clean the exhaust/water mixing elbow *†	Exhaust System					X
Inspect the crankcase breather system *†	Eng. S/M					X (1500 hrs.)
Check the breather pipe for obstructions *†					X	
Check and clean the rubber intake air hose *†					X	
Replace the intake manifold hose *†						X (5000 hrs.)
Inspect the complete exhaust system *†	Marine Inspection					X
ELECTRICAL SYSTEM						
Keep the battery charged and in good condition §	Battery	X (Before operation)				
Check and tighten the electrical connections *			X			
Check the battery charging alternator belt tension *	Belt Tension		X (1st at 10 hrs.)	X		
Clean the battery cables †						X
Check the starter motor †						X (5000 hrs.)
Check the battery charging alternator †			X (1st at 10 hrs.)			X (5000 hrs.)
ENGINE AND MOUNTING						
Check for water, fuel, coolant, and oil leakage *†‡		X (After operation)				
Retighten any loose nuts and bolts *		X (Before operation)				
Check the mounting bolts/vibromounts and tighten if necessary *					X	
Check the compartment condition (fuel, oil, or water leaks)		X (Before operation)				
Total engine overhaul *†	Eng. S/M					X (10000 hrs.)
REMOTE START PANEL						
Check the remote start panel operation, if equipped			X (Break-in)			X
GENERATOR						
Test run the generator set			X (Weekly)			
Blow dust out of the generator *†	General Maintenance					X

* Requires removal of the sound shield door, if installed

† Consult your local distributor/dealer for service

‡ Read the WARNING found at the beginning of the manual regarding moving parts

§ Consult the battery manufacturer's instructions

3.4 Engine Break-In Period

For the first 50 hours of engine operation, do not exceed 75% of the maximum power supply.

3.5 Lubrication System

See the Scheduled Maintenance section for oil change and oil filter replacement intervals. See the Service Views section for the oil drain, oil check, oil fill, and oil filter locations.

3.5.1 Oil Specifications

Use oil that meets the specifications listed in Figure 31. Using an unsuitable oil or neglecting an oil change may result in damage and a shorter engine life.

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

14-24EKOZD/12-20.5EFKOZD		
Viscosity	SAE	10W-30 (-25ºC ÷ +40ºC) 10W-40 (-25ºC ÷ +50ºC) 5W-30 (-30ºC ÷ +40ºC) 5W-40 (-30ºC ÷ +50ºC) 0W-40 (-40ºC ÷ +50ºC)
With Specifications	API	CI-4 Plus, CI-4, CH-4
	ACEA	E5, E7

32-40EKOZD/28-35EFKOZD		
Viscosity	SAE	10W-30 (-25ºC ÷ +40ºC) 10W-40 (-25ºC ÷ +50ºC) 5W-30 (-30ºC ÷ +40ºC) 5W-40 (-30ºC ÷ +50ºC) 0W-40 (-40ºC ÷ +50ºC)
With Specifications	API	CI-4 Plus, CI-4, CH-4
	ACEA	E4, E7

SAE Society of Automotive Engineers
API American Petroleum Institute
ACEA Association des Constructeurs Europeans d'Automobiles

Figure 31 Engine Oil Selection

3.5.2 Oil Check

Check the oil level in the crankcase daily or before each startup to ensure that the level is in the safe range. To check the oil level, remove the dipstick and wipe the end clean, reinsert as far as possible, and remove. Maintain the oil level between the Min and Max marks on the dipstick, as shown in Figure 32. See the Service Views section for dipstick location.

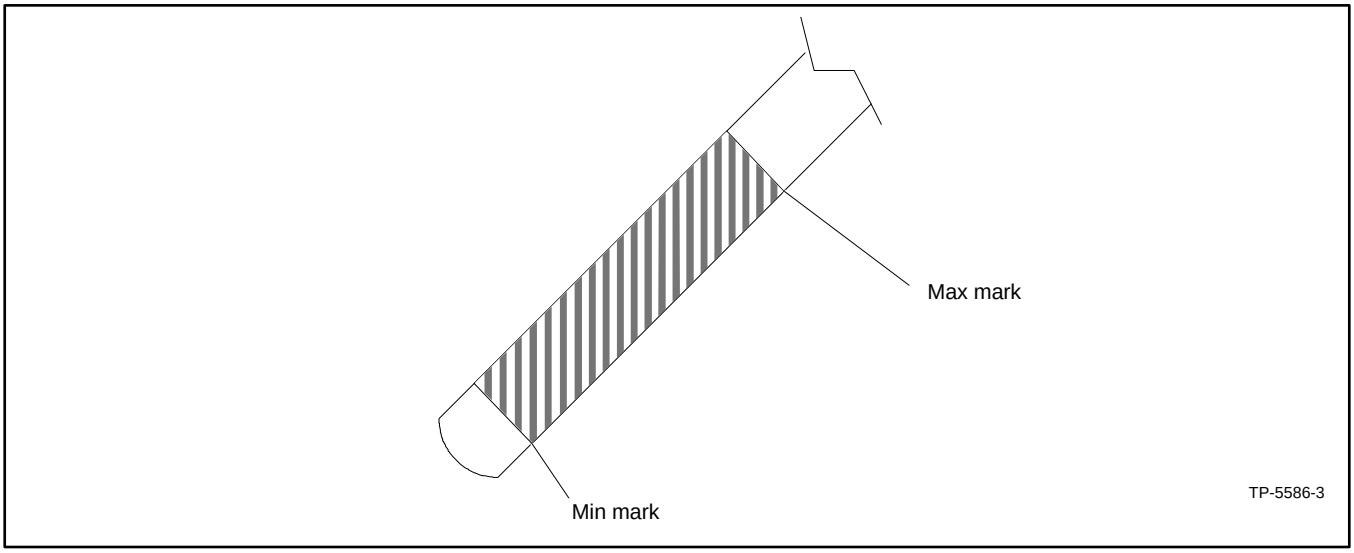


Figure 32 Oil Level Check Marks

Note:
Do not operate the set if the oil level is below the Min mark or above the Max mark.

3.5.3 Oil Change

Change the oil more frequently if the generator operates under dirty, dusty conditions. See Figure 33 for oil capacities.

Model	L (Qts.)
14EKOZD and 12EFKOZD (1 and 3 Phase)	8.7 (9.2)
16EKOZD and 13.5EFKOZD (1 and 3 Phase)	
21EKOZD and 18/17EFKOZD (1 and 3 Phase)	11.2 (11.6)
24EKOZD and 20.5EFKOZD (1 and 3 Phase)	
32EKOZD and 28EFKOZD (1 and 3 Phase)	10.5 (11.0)
40EKOZD and 35EFKOZD (1 and 3 Phase)	

Figure 33 Max. Oil Capacities with Filter

Oil Change Procedure

Whenever possible, drain the oil while it is still warm.

1. **Drain the oil.**
    a. Press the generator set OFF/RESET button to shut down the generator set.
    b. Disconnect the power to the battery charger, if equipped.
    c. Disconnect the generator set engine starting battery, negative (-) lead first.
    d. Remove the oil drain hose from its retaining clip. Remove the cap from the oil drain hose and lower the hose into an oil collection container.

        Electric Oil Drain/Oil Fill Pump Procedure:
        Connect the pump to the end of the oil drain hose. Place the outlet of the pump into an oil collection container. Remove the oil fill cap(s).

    e. Open the oil drain valve on the engine.
    f. Allow time for the engine oil to drain completely.

Electric Oil Drain/Oil Fill Pump Procedure:
Activate the pump until all of the oil is removed. Go to step 2.

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

g. Close the oil drain valve.

h. Replace the cap on the oil drain hose. Replace the oil drain hose in its retaining clip.

2. Replace the oil filter (14-24EKOZD/12-20.5EFKOZD Models).

a. Remove the oil filter by rotating it counterclockwise with an oil filter wrench.

b. Apply a light coat of clean oil to the rubber seal of the new oil filter.

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

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

3. Replace the oil filter (32-40EKOZD/28-35EFKOZD Models).

a. Loosen the cartridge holder cover three turns and wait 1 minute.

Note:
Waiting 1minute allows the oil contained in the oil filter support to return to the oil sump.

b. Unscrew the cartridge holder cover and check that the oil in the oil filter support has returned to the oil sump.

c. Remove the cartridge holder cover as well as the oil cartridge from the oil filter support.

d. Remove and replace the oil cartridge with a new oil cartridge.

e. Remove and replace the gaskets (qty. 3) with new gaskets.

f. Fit and tighten the cartridge holder cover on the oil filter support and torque to 25 Nm.

4. **Fill with oil.** Add new oil of the weight, grade, and quantity specified in Lubrication System section.

Electric Oil Drain/Oil Fill Pump Procedure:
Disconnect the pump. Close the oil drain valve. Replace the cap on the oil drain hose.

5. Check for leaks.

a. Check that the generator set is OFF.

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

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

d. Start the generator set and check for leaks around the oil filter.

e. Stop the generator set and tighten the oil filter to stop any leaks.

3.6 Fuel System

3.6.1 Fuel Specifications

Use a clean, good quality diesel fuel oil according to the specification listed below. Clean fuel prevents the diesel fuel injectors and pumps from clogging.

21/24EKOZD 60 Hz Models Only: Use fuel with a sulfur content less than 500 ppm.

32/40EKOZD 60 Hz Models and 28/35EFKOZD 50 Hz Models Only: Use fuel with a sulfur content less than 2000 ppm.

Diesel Fuel Specification
HVO 100% (EN 15940)
Military NATO Fuel F-54 (S=10 ppm)
JIS K 2204 No.1, No.2
Grade 1-D S15
Grade 2-D S15
Sulphur Fuel S< 500 ppm
High Sulphur Fuel S< 2000 ppm

Fuel Additives	Remarks
Fuel additives with biocide/algaecide functions only are allowed in case of storage of fuel in the tank for long periods (one year or more).	For suggested brands and types contact Kohler staff
These additives must be diluted in the fuel following the product prescribed percentages when filling the tank.	
Additives with functions other than biocide/algaecide are not al-lowed.	

Note:
Never store diesel fuel in galvanized containers; diesel fuel and the galvanized coating react chemically to produce flaking that quickly clogs filters or causes fuel pump or injector failure.

Note:
Avoid storing fuel for more than one month. Take special precautions to keep all dirt, water, and other contaminants out of fuel to prevent the growth of microbes. Microbes form slime that clogs the fuel filter and lines.

Note:
Do not run the generator set out of fuel because the fuel lines will draw in air and necessitate bleeding the fuel system before restarting the unit.

3.6.2 Fuel Filter

The quality and condition of the fuel largely determine the filter's useful life. Replace the fuel filter element as listed in the service schedule. Service Views section shows the typical location of a fuel filter. Use the applicable procedure below to replace the fuel filter.

Fuel Filter Cleaning/Replacement Procedure (14-24EKOZD/12-20.5EFKOZD Models and Primary Filter on 32-40EKOZD/28-35EFKOZD Models)

1. Press the generator set OFF/RESET button to shut down the generator set.
2. Disconnect the power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. Close the fuel supply valve.
5. Loosen the fuel filter by turning it counterclockwise. Remove the fuel filter and use rags to clean up spilled fuel oil.

   Note:
   Dispose of all waste materials (engine oil, fuel, filter, etc.) in an environmentally safe manner and in accordance with all applicable laws.
6. Clean the contact surface of the fuel oil filter adapter.
7. Lightly lubricate the gasket surface of the new fuel filter with fresh fuel oil. Thread the filter on the adapter until the gasket makes contact; hand-tighten the filter an additional one-half turn. Wash hands after any contact with fuel oil.
8. Open the fuel supply valve.
9. Bleed the system. See Step 12 in the following procedure (secondary filter on 32-40EKOZD/ 28-35EFKOZD models) or the Fuel System Bleed section.

Fuel Filter Cleaning/Replacement/Bleed Procedure (Secondary Filter on 32-40EKOZD/28-35EFKOZD Models)

1. Press the generator set OFF/RESET button to shut down the generator set.
2. Disconnect the power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. Close the fuel supply valve.

   Note:
   Place rags underneath the fuel filter during replacement procedure.
5. Disconnect the cable from the water sensor (located underneath the fuel filter cartridge).
6. Remove the water sensor from the fuel filter cartridge.
7. Loosen and remove the cartridge from the fuel filter support.
8. Lightly lubricate the gasket surface of a new fuel filter cartridge with fresh fuel oil.

   Note:
   Do not fill the new cartridge with fuel.
9. Tighten the new fuel filter cartridge onto the fuel filter support and torque to 17 Nm.
10. Tighten the water sensor onto the new fuel filter cartridge and torque to 5 Nm.
11. Reconnect the cable to the water sensor.
12. **Bleed Procedure.** Push repeatedly the button on the fuel filter support to fill and bleed the fuel system. See Figure 34.
13. Check that the generator set is OFF.
14. Reconnect the generator set engine starting battery, negative (-) lead last.
15. Reconnect the power to the battery charger, if equipped.

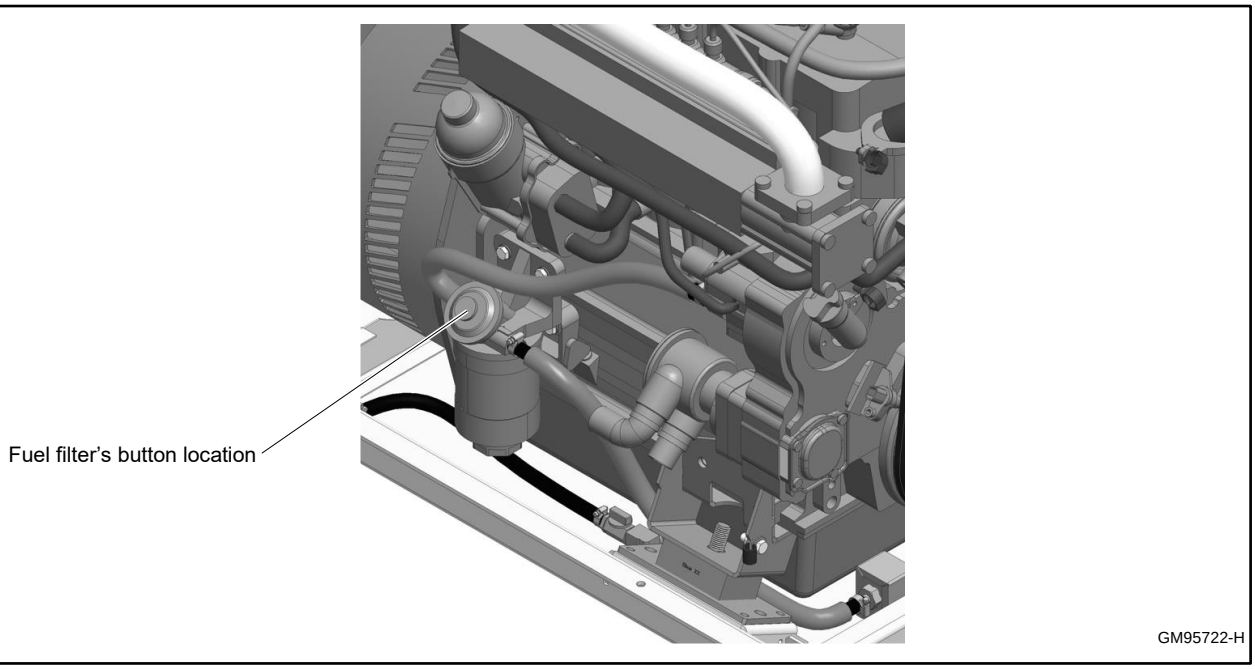


Figure 34 Fuel Filter's Button

3.6.3 Fuel System Bleed

Bleed air from the fuel system in order to reduce rough running or vapor lock. Trapped air in the fuel system can cause difficult starting and erratic engine operation.

Prime the fuel system under the following conditions:

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

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

Note:
Have a rag handy during this procedure. Wipe up any spilled diesel fuel. Wash hands after any contact with fuel.

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

Fuel System Bleed Procedure (14-24EKOZD/12-20.5EFKOZD Models)

1. Loosen the fuel filter's air vent screw. See Figure 35. Place a suitable container underneath to collect the fuel.
2. Initiate the auto/start sequence until fuel, free of air bubbles, flows from the vent screw at the fuel filter.
3. Tighten the fuel filter's air vent screw.

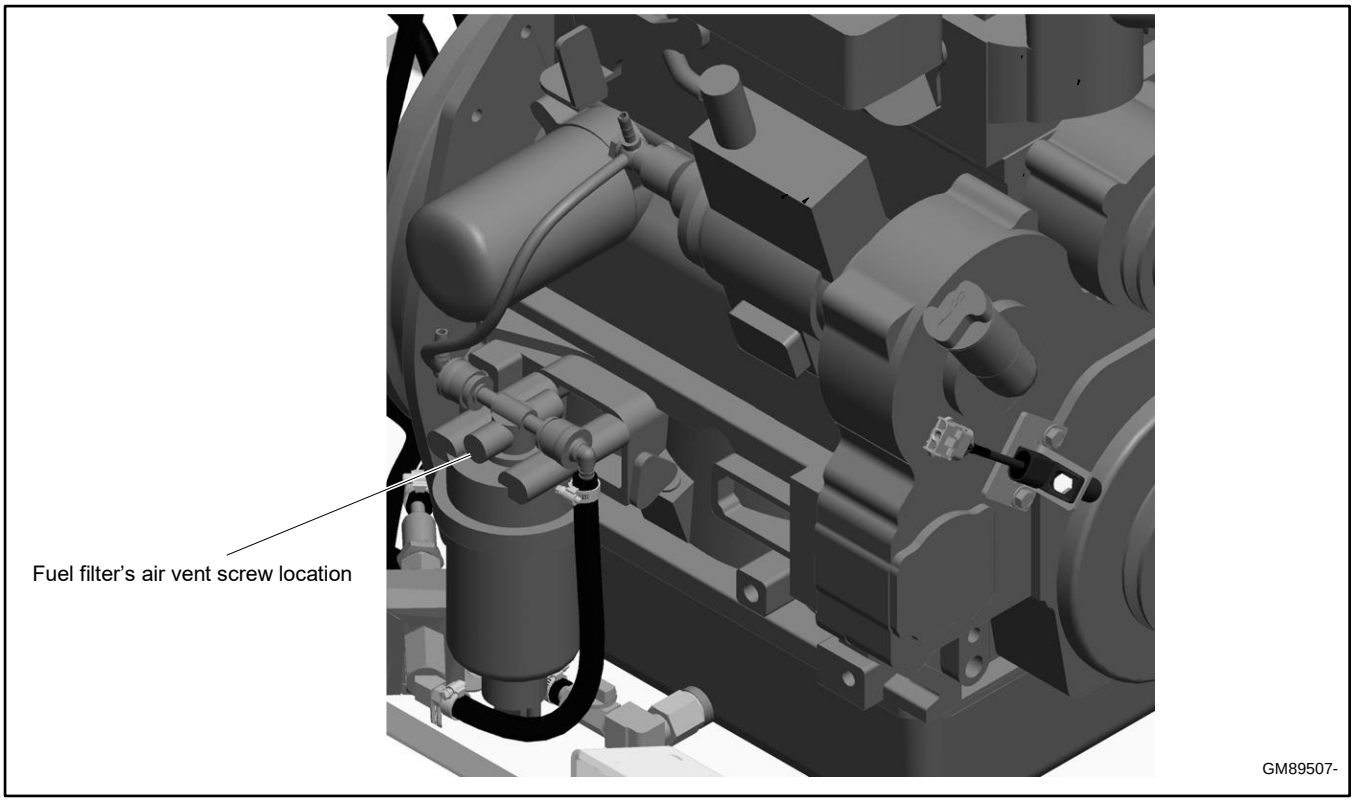


Figure 35 Fuel Filter's Air Vent Screw

4. Check that the generator set is OFF.
5. Reconnect the generator set engine starting battery, negative (-) lead last.
6. Reconnect the power to the battery charger, if equipped.

3.7 Air Cleaner Service/Replacement (32-40EKOZD/28-35EFKOZD Models)

A dry-type air cleaner silences and filters the intake air. The air cleaner is housed inside the resonator box. At the interval specified in the service schedule, clean or replace the air filter element. Clean the filter more frequently if the generator set operates in dirty, dusty conditions. See Figure 36 and follow the procedure below.

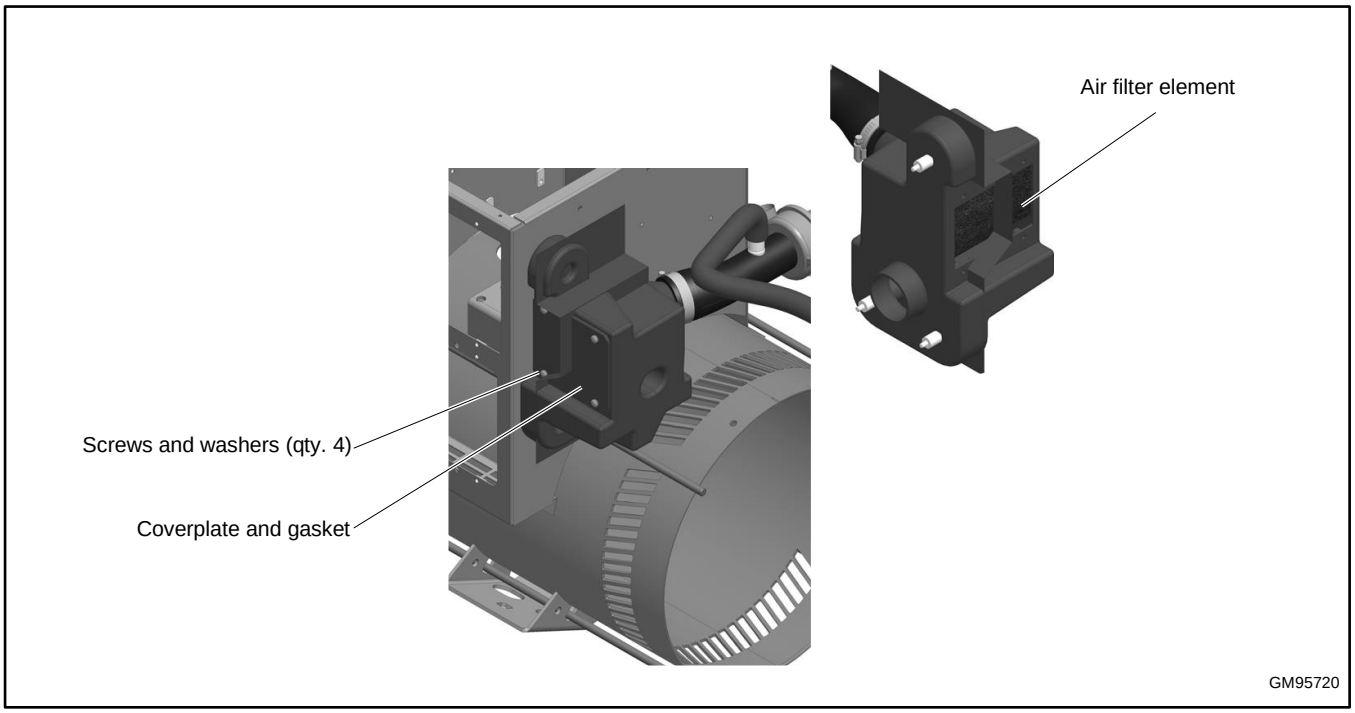


Figure 36 Air Filter Element

Air Filter Service/Replacement

1. Press the generator set OFF/RESET button to shut down the generator set.
2. Disconnect the power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. Remove the four screws to remove the air intake cover and gasket.
5. Remove the air filter element.
6. Tap the element lightly against a flat surface to dislodge loose surface dirt. Do not clean with any liquid or use compressed air as these will damage the filter element.
7. Examine the element, gasket, and housing for damage and wear. Replace the element or gasket, if necessary.
8. Wipe the cover and resonator box with a clean rag to remove any dirt. Make sure that the gasket seals correctly and reattach the cover and screws.
9. Check that the generator set is OFF.
10. Reconnect the generator set engine starting battery, negative (-) lead last.
11. Reconnect the power to the battery charger, if equipped.

3.8 Exhaust System

WARNING	**Carbon monoxide.** **Can cause severe nausea, fainting, or death.** The exhaust system must be leakproof and routinely inspected.
	

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

1. Press the generator set OFF/RESET button to shut down the generator set.
2. Disconnect the power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.

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

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

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

Exhaust System Inspection Points

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

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

4. Check that the generator set is OFF.
5. Reconnect the generator set engine starting battery, negative (-) lead last.
6. Reconnect the power to the battery charger, if equipped.

3.9 Cooling System

3.9.1 Closed Heat Exchanger

In a closed cooling system, the seawater circulates through separate chambers within the heat exchanger or manifold to cool the engine coolant. The seawater then mixes with the engine exhaust and ejects out of the exhaust outlet. See Figure 37 for coolant capacities (include coolant recovery tank capacity of 0.24 L (8 oz.).

Model	L (Qts.)
14EKOZD and 12EFKOZD (1 and 3 Phase)	5.2 (5.5)
16EKOZD and 13.5EFKOZD (1 and 3 Phase)	
21EKOZD and 18/17EFKOZD (1 and 3 Phase)	4.4 (4.6)
24EKOZD and 20.5EFKOZD (1 and 3 Phase)	
32EKOZD and 28EFKOZD (1 and 3 Phase)	7.0 (7.4)
40EKOZD and 35EFKOZD (1 and 3 Phase)	

Figure 37 Engine Block Coolant Capacities

NOTICE

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

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

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

Note:
Pay special attention to the coolant level. After the coolant drains, allow time when refilling the coolant for a complete refill of the engine water jacket. Check the coolant level as prescribed in the Prestart Checklist.

3.9.2 Checking and Filling Coolant

⚠ WARNING

Hot coolant and steam.
Can cause severe injury or death.
Before removing the pressure cap, stop the engine and allow it to cool. Then loosen the pressure cap to relieve pressure.

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

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

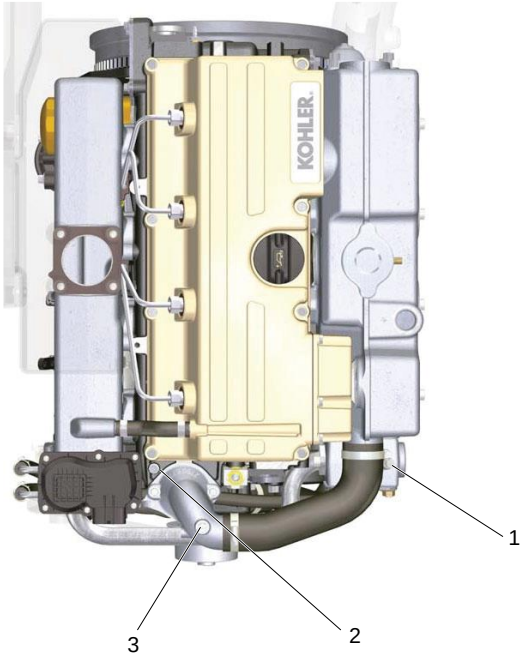
Bleed Procedure (14-24EKOZD & 12-20.5EFKOZD Models)

1. Remove the coolant fill cap. See the Typical (14-24EKOZD and 12-20.5EFKOZD Models) figure in the Service Views section for location.

   Note:
   For 21/24EKOZD 60 Hz models, proceed to Step 2. For all other models, proceed to Step 6.

2. Slowly fill the coolant system until observing coolant at the first bleed point (lowest port) with the plug removed. See Figure 38.
3. After seeing coolant, use a funnel to fill the coolant at this port until full. Cap this port.
4. Slowly fill the coolant system until observing coolant at the second bleed point with the plug removed. See Figure 38.
5. After seeing coolant, use a funnel to fill the coolant at this port until full. Cap this port.
6. Slowly fill the coolant system until observing coolant at the third bleed point (highest port) with the plug removed. See Figure 38.
7. After seeing coolant, use a funnel to fill the coolant at this port until full. Cap this port.
8. Fill the coolant system at the filler neck to just below the overflow tube opening.
9. Lightly squeeze the end coolant hose to ensure that any loose air pockets are bled from the system.
10. Replace the coolant fill cap.

Top View Engine



1. 1st bleed point (only available on 21/24EKOZD 60 Hz models)
2. 2nd bleed point (only available on 21/24EKOZD 60 Hz models)
3. 3rd bleed point

Figure 38 Bleed Point Locations

Bleed Procedure (32/40EKOZD & 28/35EFKOZD Models)

1. Remove the coolant fill cap. See the Typical (14-24EKOZD and 12-20.5EFKOZD Models) figure in the Service Views section for location.
2. Slowly fill the coolant system.

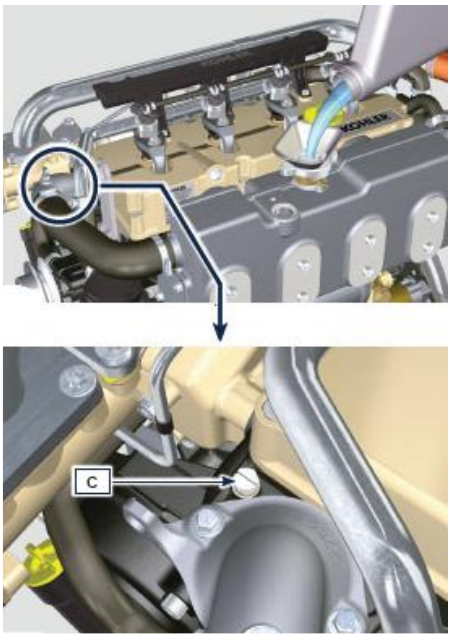


Figure 39 Bleed Point Location

3. Loosen the cap screw C (shown in Figure 39) to release any air and tighten the cap screw C. Torque cap screw to 8 Nm.

   Note:
   The max. filling level for the exhaust manifold is in correspondence of cap screw C. Complete the coolant refilling procedure as soon as the coolant starts leaking out of cap screw C.
4. Retighten cap screw C (if not already done) and the coolant fill cap.
5. After a few minutes of operation, stop the engine and allow the liquid to cool and recheck the coolant level.

3.9.3 Flushing and Cleaning

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

Flushing and Cleaning Procedure

1. Press the generator set OFF/RESET button to shut down the generator set.
2. Disconnect the power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. Open the pressure cap and open petcocks located at the heat exchanger, engine block, and cooling system, and let the system drain completely. Some models may have petcocks located behind the belt guard. Remove the pressure cap to simplify draining.
5. Drain, clean, and flush the coolant recovery tank.
6. Flush the system with clean water.
7. Fill the system with recommended coolant.
8. Check that the generator set is OFF.
9. Reconnect the generator set engine starting battery, negative (-) lead last.
10. Reconnect the power to the battery charger, if equipped.

3.9.4 Pressure Cap

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

3.9.5 Seawater Pump

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

Impeller Inspection and Replacement Procedure:

1. Press the generator set OFF/RESET button to shut down the generator set.
2. Disconnect the power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. Close the seacock.
5. Remove the seawater pump cover plate. See Figure 40.
6. Remove the impeller.
7. Inspect the impeller for damaged, cracked, broken, missing or flattened vanes. The impeller vanes should be straight and flexible. See Figure 41. Replace the impeller if it is damaged.
8. Lubricate the impeller with soapy water before installation.
9. Install the impeller.

   Note:
   During installation push and rotate the impeller in the same direction as the engine rotation until it is thoroughly seated in the impeller housing.

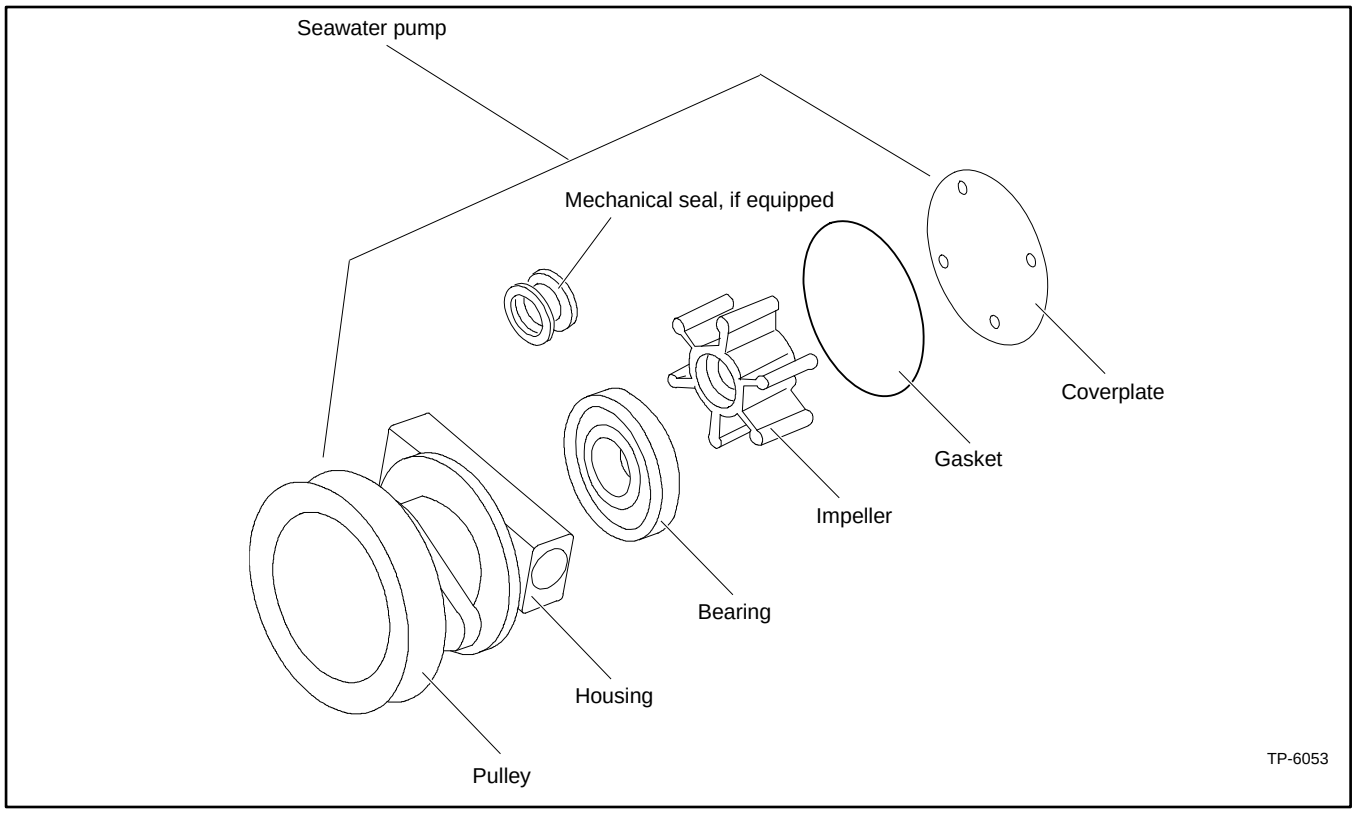


Figure 40 Seawater Pump, Typical

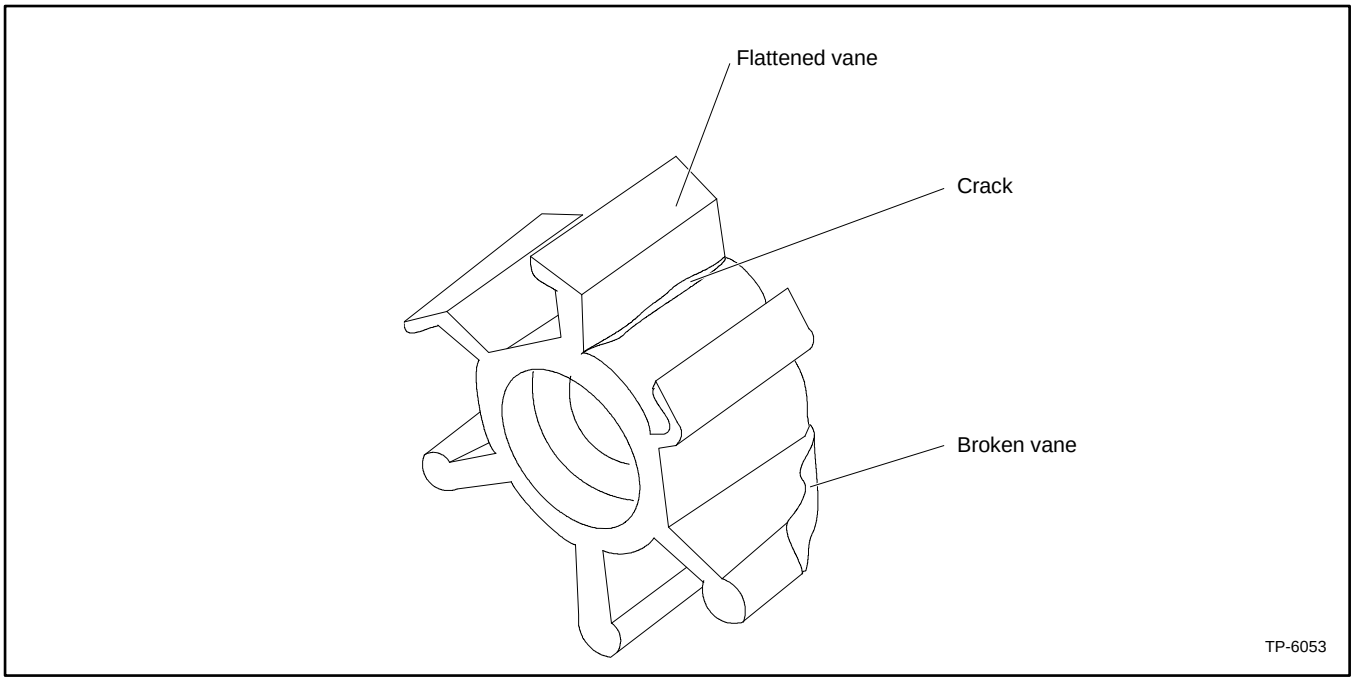


Figure 41 Worn Impeller

10. Inspect the coverplate and gasket for corrosion and/or damage. Replace components as necessary.
11. Lubricate the gasket with silicon grease and attach the gasket and coverplate to the seawater pump housing.
12. Open the sea cock.
13. Check that the generator set is OFF.
14. Reconnect the generator set engine starting battery, negative (-) lead last.
15. Reconnect the power to the battery charger, if equipped.
16. Start the generator set and check for leaks.
17. Stop the generator set and repair leaks or replace damaged or worn components.

3.9.6 Siphon Break

A siphon break prevents seawater entry into the generator set's engine when the engine exhaust manifold outlet is less than 230 mm (9 in.) above the waterline of a fully loaded, docked or stationary craft. See Figure 43. The siphon break may malfunction when the generator set operates while the craft is in contaminated waters or saltwater. Use the following procedure to inspect the siphon break at the intervals listed in the service schedule.

Siphon Break Inspection

1. Stop the generator set.
2. Remove the retaining cap and remove the reed valve for inspection. See Figure 42.
3. Use a mild detergent to remove residue and oxidation from the reed valve.
4. Clear blockage from the reed valve opening.
5. Replace the siphon break if the reed valve is cracked or if the reed valve material has hardened or deteriorated.
6. Install the reed valve into the mounting base with the valve downward. See Figure 42.
7. Install and only finger tighten the retaining cap. Do not overtighten it.

   Note:
   Ensure that the siphon break's cap is tight before operating the generator set.

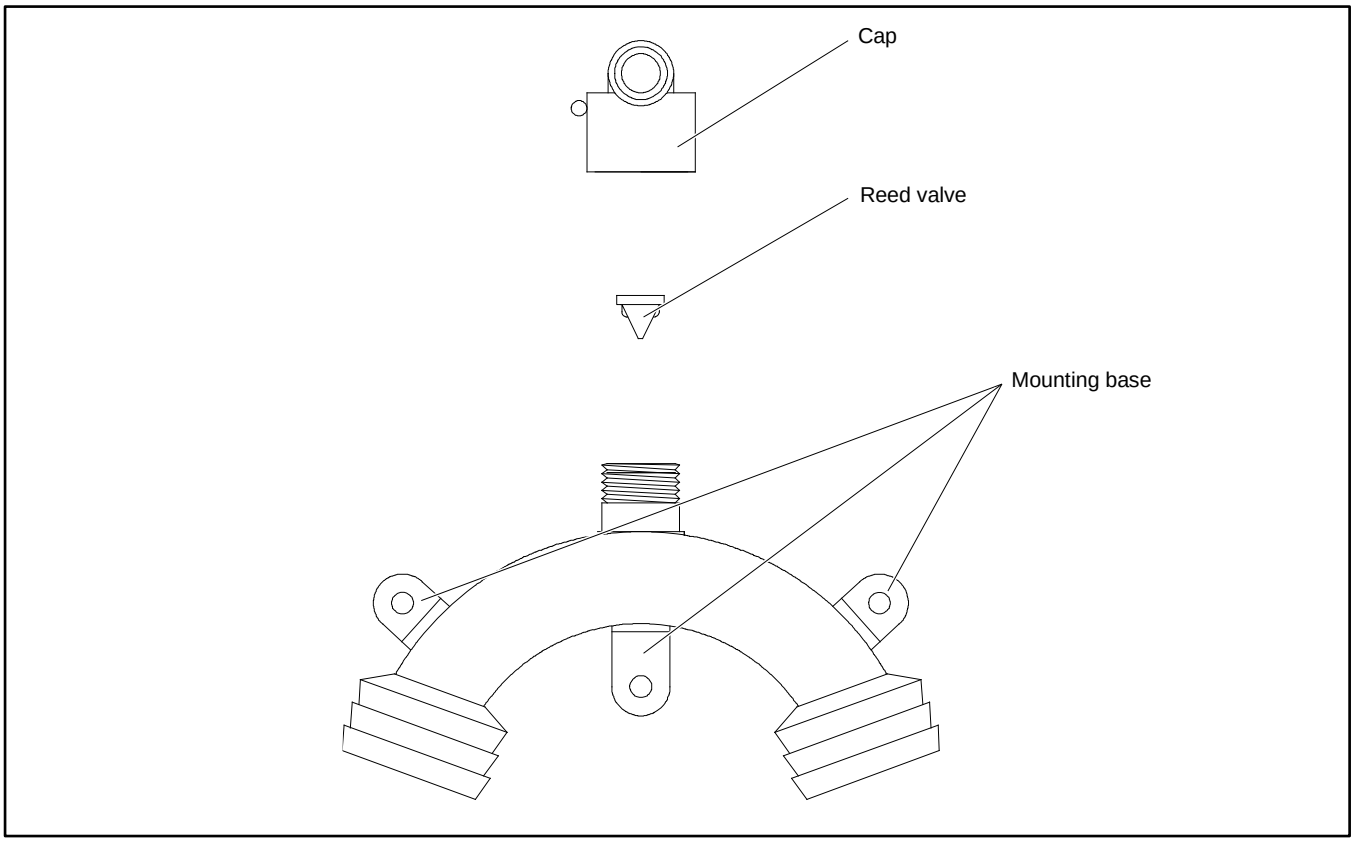
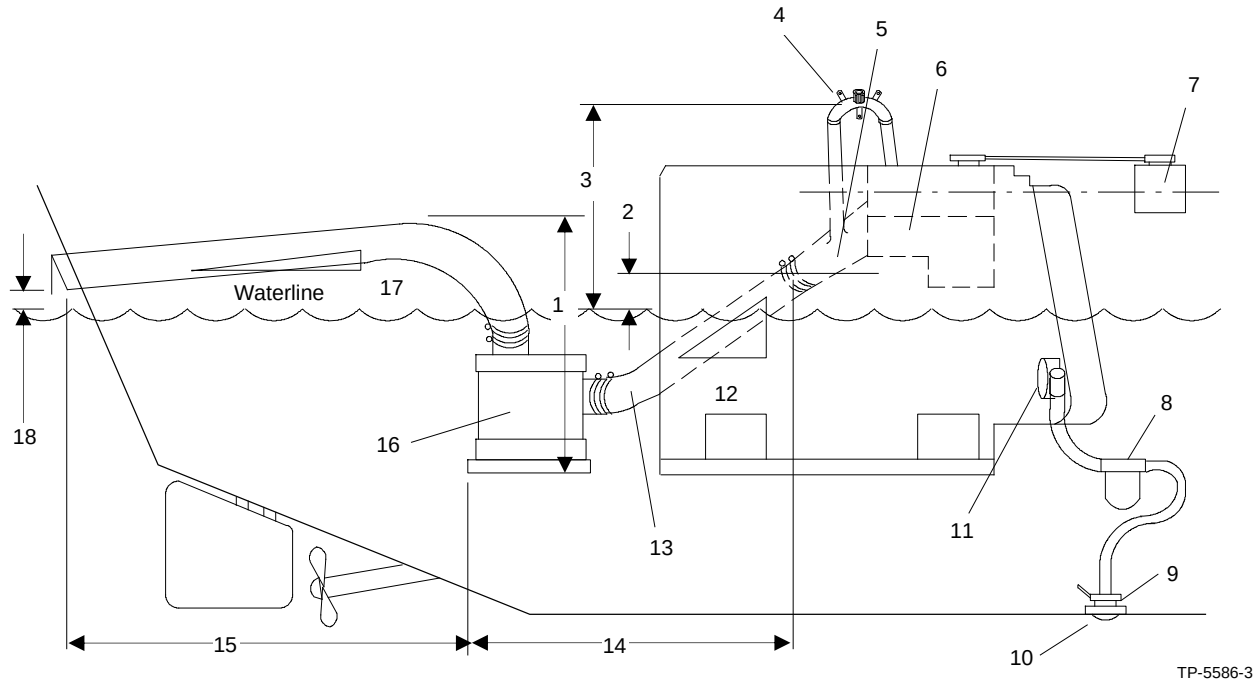


Figure 42 Siphon Break



1. Silencer vertical lift 1.2 m (4 ft.) max.
2. Exhaust mixer elbow distance above waterline. If less than 23 cm (9 in.), a siphon break is required.
3. Siphon break distance above waterline 30.5 cm (1 ft.) min.
4. Siphon break
5. Exhaust mixer elbow
6. Heat exchanger (locations vary by model)
7. Coolant recovery tank
8. Seawater strainer
9. Seacock
10. Intake strainer
11. Engine-driven seawater pump
12. Exhaust hose pitch 1.3 cm per 30.5 cm (0.5 in. per ft.) min.
13. Water lock (optional)
14. Silencer distance from exhaust mixer elbow 3 m (10 ft.) max.
15. Maximum distance between silencer and exhaust outlet of 1.5 m (5 ft.)
16. Silencer (customer supplied)
17. Exhaust hose pitch 1.3 cm per 30.5 cm (0.5 in. per ft.) min.
18. Exhaust outlet distance above the waterline 10 cm (4 in.) min.

Figure 43 Siphon Break (Plastic “U” Type) Installation

Note:

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

3.9.7 Anticorrosion Zinc Anode

The heat exchanger contains an anticorrosion zinc anode (plug) to prevent electrolytic corrosion by seawater. See Figure 44.

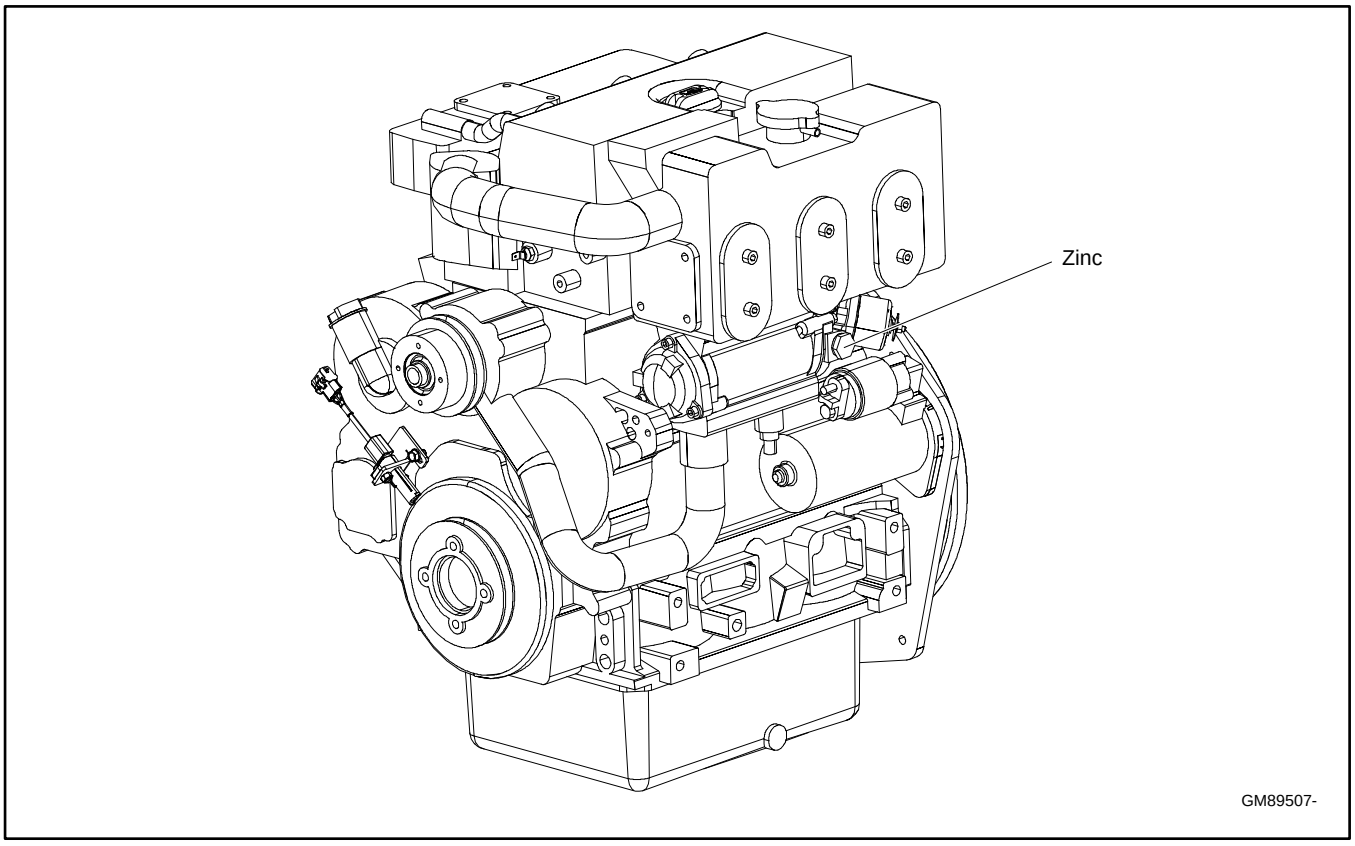


Figure 44 Anticorrosion Zinc Anode Location

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

Anticorrosion Zinc Anode Replacement

1. Press the generator set OFF/RESET button to shut down the generator set.
2. Disconnect the power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. With the generator set cooled, close the seacock, open the petcock on the engine, and drain the coolant into a suitable container.
5. Remove the anticorrosion zinc anode (plug) from the heat exchanger.
6. Use a wire brush to remove the loose corrosion on the anticorrosion zinc anode. Replace the anode according to Figure 45 and Figure 46.

Anticorrosion Zinc Anode Replacement		
Models	**New Anode Dimensions mm (in.)**	**Replace When Percent of Zinc Remaining Is:**
14EKOZD/12EFKOZD 16EKOZD/13.5EFKOZD 21EKOZD/18EFKOZD 17EFKOZD 24EKOZD/20.5EFKOZD 32EKOZD/28EFKOZD 40EKOZD/35EFKOZD	14.5 (0.57) x 40 (1.57)	<50% of length/diameter

Figure 45 Anticorrosion Zinc Anode (Plug) Measurements

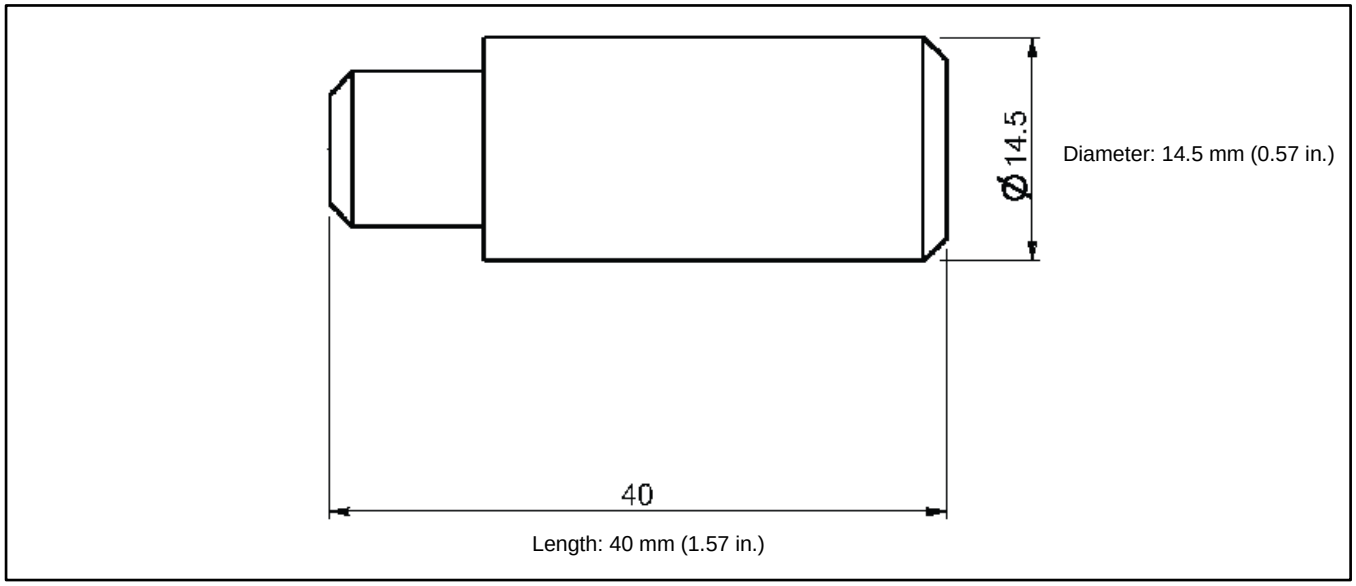


Figure 46 Anticorrosion Zinc Anode (Plug)

7. Clean the threaded hole of the heat exchanger and coat the threads of the anticorrosion zinc anode (plug) with pipe sealant suitable for marine applications. Cut the anticorrosion zinc to the correct length. Install the anticorrosion zinc anode into the heat exchanger.
8. Close the petcock on the engine and open the seacock. Refill the cooling system.
9. Check that the generator set is OFF.
10. Reconnect the generator set engine starting battery, negative (-) lead last.
11. Reconnect the power to the battery charger, if equipped.
12. Start the generator set and check for leaks at the anticorrosion zinc anode location. The pump is operating if the cooling water flows from the exhaust outlet. If water is not discharging at the exhaust outlet, see the Prestart Checklist section —Seawater Pump Priming.

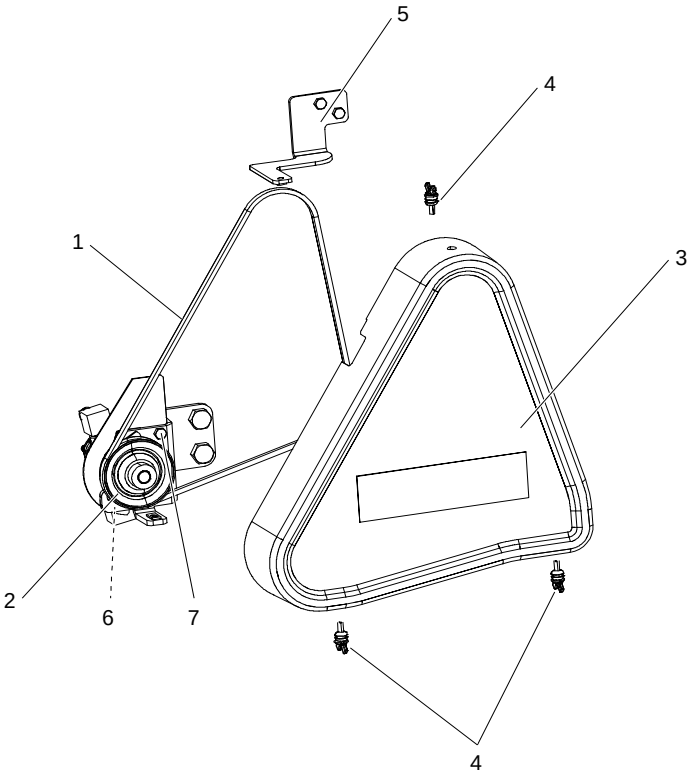
3.10 Belt Tension

DANGER	
	**Hazardous voltage. Moving parts.** **Will 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 will cause severe injury or death. Keep hands, feet, hair, clothing, and test leads away from the belts and pulleys when the generator set is running. Replace guards, screens, and covers before operating the generator set.

Check the belt tension at the interval specified in the service schedule. If tension is not within the specification, adjust as necessary using the following procedure.

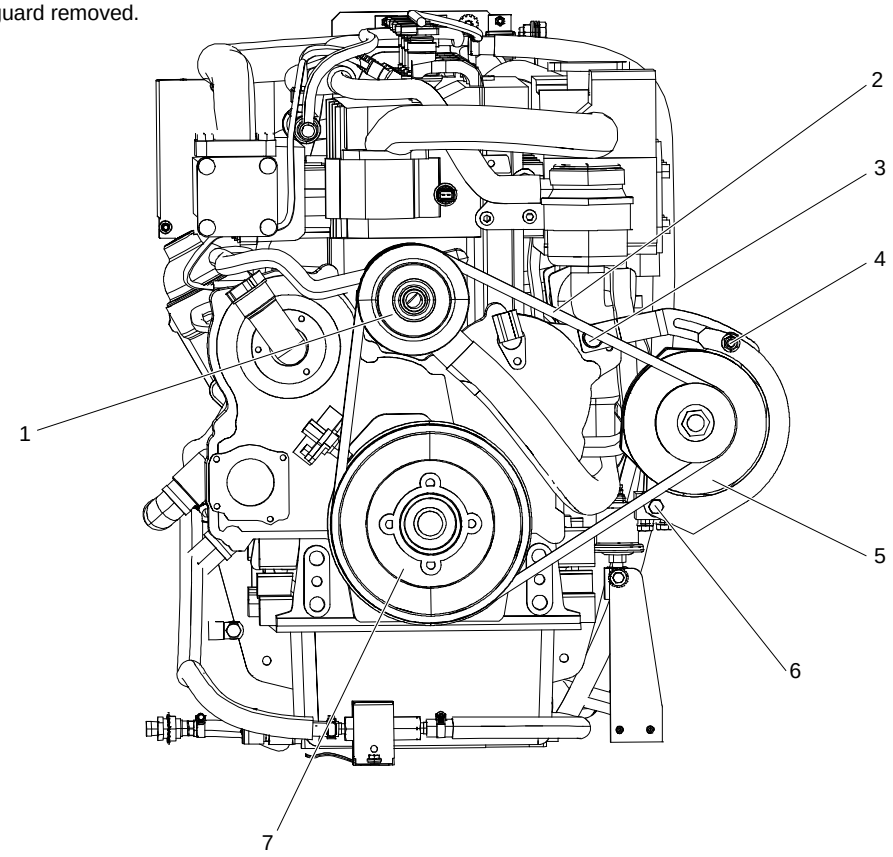
3.10.1 Belt Tensioning Procedure



1. Check the seawater pump belt deflection (tension) here
2. Seawater pump pulley
3. Belt guard
4. Wing screw and belt guard mounting hardware (qty. 3)
5. Engine mounting brackets (qty. 3)
6. Pivot screw (underneath pulley in slotted hole)
7. Seawater pump adjusting screw

Figure 47 Seawater Belt Tension (14-24EKOZD/12-20.5EFKOZD Model Shown)

Note:
Unit shown with belt guard removed.



1. Engine-driven water pump pulley
2. Check the alternator belt deflection (tension) here
3. Adjusting arm pivot screw
4. Alternator adjusting screw
5. Battery charging alternator pulley
6. Alternator pivot screw
7. Crankshaft pulley

Figure 48 Alternator Belt Tension (32-40EKOZD/28-35EFKOZD Model Shown)

1. Press the generator set OFF/RESET button to shut down the generator set.
2. Disconnect the power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. Remove the belt guard. See Figure 47.
5. Check the belt tension at the midpoint of the longest span of the belt by pressing with your finger approx. 10 kg (22 lbs.) of force. See Figure 49 for belt deflection. Recheck a new belt tension after 10 minutes of operation.

Deflection mm (in.)
10 (0.4)

Figure 49 Belt Specification

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

6. Loosen the pivot and adjusting screws.
7. While prying the seawater pump outward, tighten the adjusting screw.
8. Tighten the pivot screw.
9. Recheck and adjust as necessary.
10. Replace the belt guard.

11. Check that the generator set is OFF.
12. Reconnect the generator set engine starting battery, negative (-) lead last.
13. Reconnect the power to the battery charger, if equipped.

3.11 Battery

Consult the battery manufacturer's instructions regarding battery care and maintenance.

3.12 Generator Storage Procedure

Keep the craft afloat for generator operation during the storage procedure. Follow the procedure below when storing your generator set for 3 months or more.

Generator Set Storage Procedure

1. Start and run the generator set until it reaches operating temperature or about 15 minutes.
2. Stop the generator set.
3. Change the oil and oil filter. See the Oil Change section.
4. Close the seacock and remove the hose at the seacock. Place the hose in a container having approximately 3.7-7.5 L (1-2 U.S. gallons) of coolant/antifreeze. Discovery Energy, LLC recommends using an environmentally friendly potable antifreeze such as Peak® RV/marine propylene glycol/water mix or equivalent.
5. Disconnect the lead (#87) to the low seawater pressure (LWP) switch.
6. With a suitable container at the exhaust outlet, run the generator set until coolant discharges at the exhaust outlet or until the coolant mixture is depleted. Do not allow coolant mixture to flow into waterways.
7. Reconnect the lead (#87) to the low seawater pressure (LWP) switch.
8. Stop the generator set.
9. Connect a hose to the seacock. Leave the seacock closed.
10. Check the coolant level of the heat exchanger and add coolant if necessary.

    Note:
    Use antifreeze capable of withstanding the lowest possible temperatures.

11. Clean the exterior of the generator set and spread a light film of oil or silicon spray over any exposed surfaces that may be subject to rust or corrosion.
12. Disconnect and remove the battery. Place the battery in a warm, dry location for the storage period. Recharge the battery once a month to maintain a full charge.
13. Select a well-ventilated (not humid or dusty) location to store the generator.
14. Cover the entire unit with a dust cover.

    Note:
    Run the generator set once a month whenever possible.

Notes

Section 4. Troubleshooting

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

Use the following charts as a quick troubleshooting reference. The table groups generator set faults and suggests likely causes and remedies. The table also refers you to more detailed information including sections of this manual, the generator set service manual (S/M), the generator set installation manual (I/M), and the engine service manual (Engine S/M) to correct the indicated problem.

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	Displays error message/locks up	Exercise run time and/or event records inoperative			
Controller														
X	X											Controller circuit board(s) wiring fault.	Check the wiring.	W/D
				X								Controller fault.	Troubleshoot the controller.†	Gen S/M
X												Controller master control button in the OFF/RESET mode.	Press the controller master control RUN or AUTO button.	Operation Section
X												Engine start circuit open.	Press the controller master control RUN button to test the generator set. Troubleshoot the auto start circuit and the time delays.	Operation Section, W/D, Gen, S/M
X				X								Emergency stop switch activated, if equipped.	Reset the emergency stop switch.	Operation Section
				X								Remote stop command received from a remote switch or ATS.	Check the remote switch position.	
										X		Controller firmware error.	Review the controller display troubleshooting chart.	Controller Display and Voltage Regulation Troubleshooting Chart Section

* ATS - Automatic Transfer Switch; Eng. - Engine; Gen. - Generator Set; I/M - Installation Manual; O/M - Operation Manual; M/M – Maintenance 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	Displays error message/locks up	Exercise run time and/or event records inoperative			
Alternator														
			X									AC output circuit breaker open.	Reset the breaker and check for AC voltage at the generator set side of the circuit breaker.	—
X												Transfer switch test switch in the OFF position.	Move the transfer switch test switch to the AUTO position.	—
			X									Wiring, terminals, or pin in the exciter field open.	Check for continuity.	Gen. S/M or W/D
			X									Main field (rotor) inoperative (open or grounded).	Test and/or replace the rotor. †	Gen. S/M
			X									Stator inoperative (open or grounded).	Test and/or replace the stator.†	Gen. S/M
									X			Vibration excessive.	Tighten loose components.†	—
	X											Overcrank shutdown.	Reset the controller. If the overcrank fault occurs again, contact the distributor/dealer. †	—
Electrical System (DC Circuits)														
X	X											Battery connections loose, corroded, or incorrect.	Verify that the battery connections are correct, clean, and tight.	—
X	X											Battery weak or dead.	Recharge or replace the battery. The spec sheet provides recommended battery CCA rating.	Eng. O/M, S/S
X	X											Starter/starter solenoid inoperative.	Replace the starter or starter solenoid.	Eng. S/M
X				X								Engine harness connector(s) not locked tight.	Disconnect the engine harness connector(s) then reconnect it to the controller.	W/D
				X								Fault shutdown.	Reset the fault switches and troubleshoot the controller.	Operation Section

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† 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	Displays error message/locks up	Exercise run time and/or event records inoperative			
Electrical System (DC Circuits)														
				X								High exhaust temperature switch inoperative.	Replace the inoperative switch.	Gen. S/M or W/D
				X		X						High water temperature switch inoperative.	Replace the inoperative switch.	Gen. S/M or W/D
	X											Faulty ground connection.	Clean and retighten the connection.	—
Engine														
	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 installation manual for wattage specifications.	I/M
									X			Exhaust system leak.	Inspect the exhaust system. Replace the inoperative exhaust system components.†	Scheduled Maintenance Section, I/M
									X			Exhaust system not securely installed.	Inspect the exhaust system. Tighten the loose exhaust system components.†	Scheduled Maintenance Section, I/M
		X	X		X			X				Governor inoperative.	Adjust the governor.†	Gen. S/M
					X				X			Valve clearance incorrect.	Adjust the valves.†	Eng. O/M
									X			Vibration excessive.	Tighten all loose hardware.	—
X	X			X						X	X	Engine ECM and/or sensors.	Troubleshoot the engine ECM and/or sensors.	Eng. O/M & S/M
				X								Overspeed shutdown.	Reset the controller. If the overspeed fault occurs again, contact the distributor/dealer.	—

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† 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	Displays error message/locks up	Exercise run time and/or event records inoperative			
Cooling System														
						X		X				Air openings clogged.	Clean the air openings.	—
						X						Impeller inoperative.	Replace the impeller.	Scheduled Maintenance Section
						X		X				Seawater strainer clogged or restricted.	Clean the strainer, check the seawater pump impeller for damage.	Scheduled Maintenance Section
				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.	Eng. O/M
						X						Coolant level low.	Restore the coolant to normal operating level.	Eng. O/M
						X						Cooling water pump inoperative.	Tighten or replace the belt. Replace the water pump.	Eng. O/M or Eng. S/M
						X						Thermostat inoperative.	Replace the thermostat.	Eng. S/M

* ATS - Automatic Transfer Switch; Eng. - Engine; Gen. - Generator Set; I/M - Installation Manual; O/M - Operation Manual; M/M – Maintenance 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	Displays error message/locks up	Exercise run time and/or event records inoperative			
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							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. SM
	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
	X	X		X	X							Fuel filter restriction.	Clean or replace the fuel filter.†	Eng. O/M
Engine Lubrication 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
				X								Low oil pressure switch inoperative.	Replace the low oil pressure switch. Check the engine for damage.	W/D

* ATS - Automatic Transfer Switch; Eng. - Engine; Gen. - Generator Set; I/M - Installation Manual; O/M - Operation Manual; M/M – Maintenance 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*
Controller Display and Voltage Regulator			
Display is black.	No/low battery charge.	Recharge/replace battery.	—
Display shows single segment.	Low battery voltage.	Recharge battery.	—
Display shows an error message.	Controller firmware fault has occurred or pushbutton/ rotary selector dial entry error.	Review the Error Message section.	—
Display locks up.	No/low battery charge.	Recharge/replace battery.	—
Output voltage ramps.	Defective exciter winding. Voltage ramp on startup is normal, but ramping past the target without recovering may indicate additional failures in the alternator or excitation circuit.	Troubleshoot alternator components. †	Generator Service Manual
Output voltage unstable.	Voltage regulation calibration incorrect.	Readjust voltage regulation. †	SiteTech O/M
Unable to change voltage and current calibrations.	Calibration not enabled.	Enable calibration in Generator Metering section. .	Graphical Display Section

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

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

DANGER	**Hazardous voltage. Moving parts.** **Will cause severe injury or death.** Operate the generator set only when all guards and electrical enclosures are in place.
	

Grounding electrical equipment. Hazardous voltage will cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, 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 will 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.

5.1 Wiring Diagram Reference

Model	Point-to-Point	Figure	Schematic	Figure	Accessory	Figure	System Remote Display	Figure
14EKOZD/12EFKOZD 16EKOZD/13.5EFKOZD 18/17EFKOZD 20.5EFKOZD	**60 Hz Models:**		**60 Hz Models:**		GM88254-C	Figure 106 Figure 107	GM92060-A	Figure 108
	GM119901	Figure 50 Figure 51	ADV-9971	Figure 52 Figure 53				
	50 Hz Models:		**50 Hz Models:**					
	GM120034	Figure 54 Figure 55	ADV-9978	Figure 56 Figure 57				
21EKOZD (12 volt) 24EKOZD (12 volt)	GM119905	Figure 58 Figure 59	ADV-9972	Figure 60 Figure 61				
21EKOZD (24 volt) 24EKOZD (24 volt)	GM119906	Figure 62 Figure 63	ADV-9973	Figure 64 Figure 65				
32EKOZD/28EFKOZD (12 volt, standard ground)	GM120416	Figure 66 Figure 67 Figure 68	ADV-9992	Figure 69 Figure 70				
32EKOZD/28EFKOZD (24 volt, standard ground)	GM120418	Figure 71 Figure 72 Figure 73	ADV-9994	Figure 74 Figure 75				
32EKOZD/28EFKOZD (12 volt, isolated ground)	GM120417	Figure 76 Figure 77 Figure 78	ADV-9993	Figure 79 Figure 80				
32EKOZD/28EFKOZD (24 volt, isolated ground)	GM120419	Figure 81 Figure 82 Figure 83	ADV-9995	Figure 84 Figure 85				
40EKOZD/35EFKOZD (12 volt, standard ground)	GM120420	Figure 86 Figure 87 Figure 88	ADV-9996	Figure 89 Figure 90				
40EKOZD/35EFKOZD (24 volt, standard ground)	GM120422	Figure 91 Figure 92 Figure 93	ADV-9998	Figure 94 Figure 95				
40EKOZD/35EFKOZD (12 volt, isolated ground)	GM120421	Figure 96 Figure 97 Figure 98	ADV-9997	Figure 99 Figure 100				
40EKOZD/35EFKOZD (24 volt, isolated ground)	GM120423	Figure 101 Figure 102 Figure 103	ADV-9999	Figure 104 Figure 105				

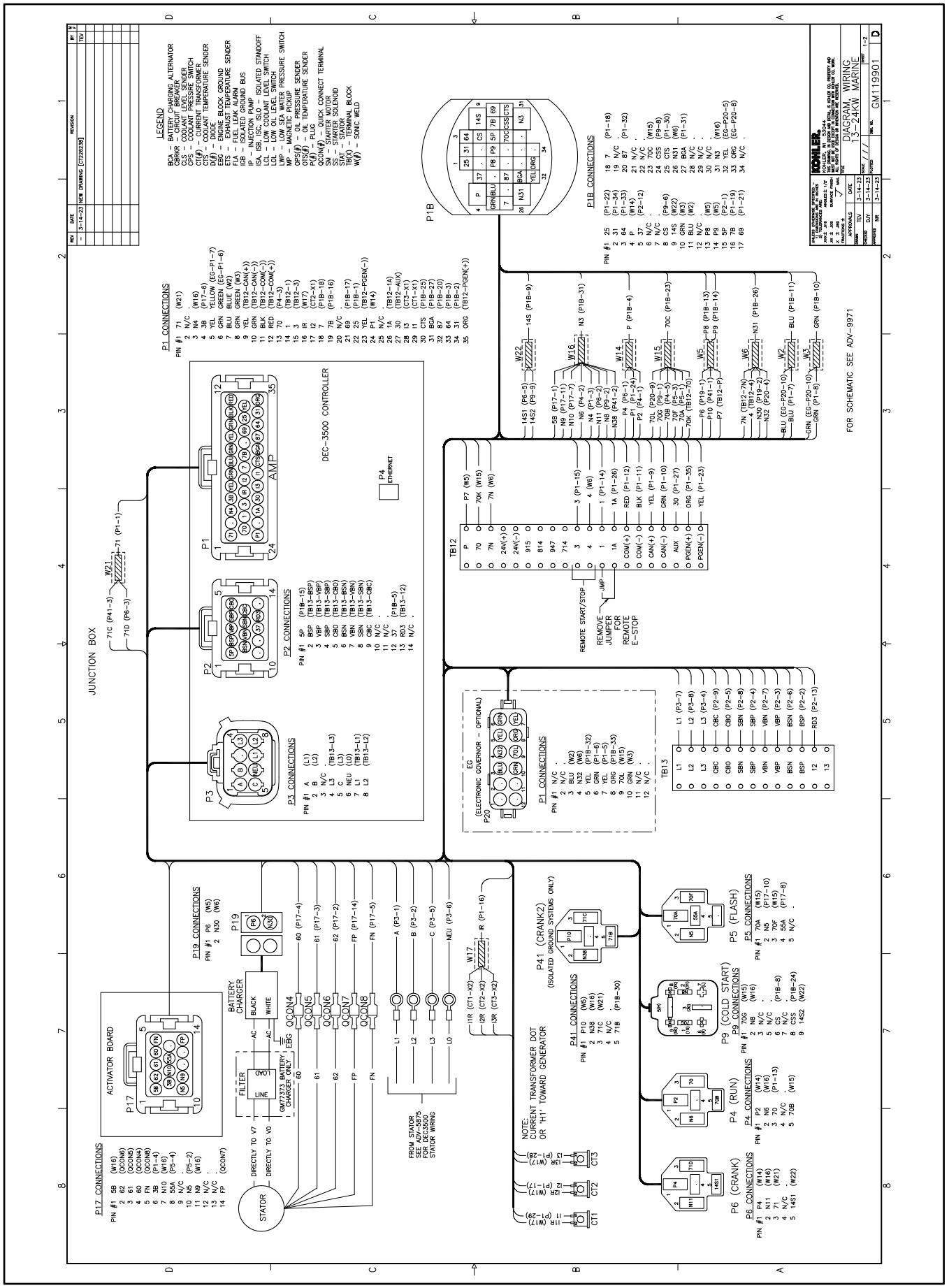

Figure 50 Wiring Diagram, Point-to-Point (Sheet 1 of 2) for 14/16EKOZD Models

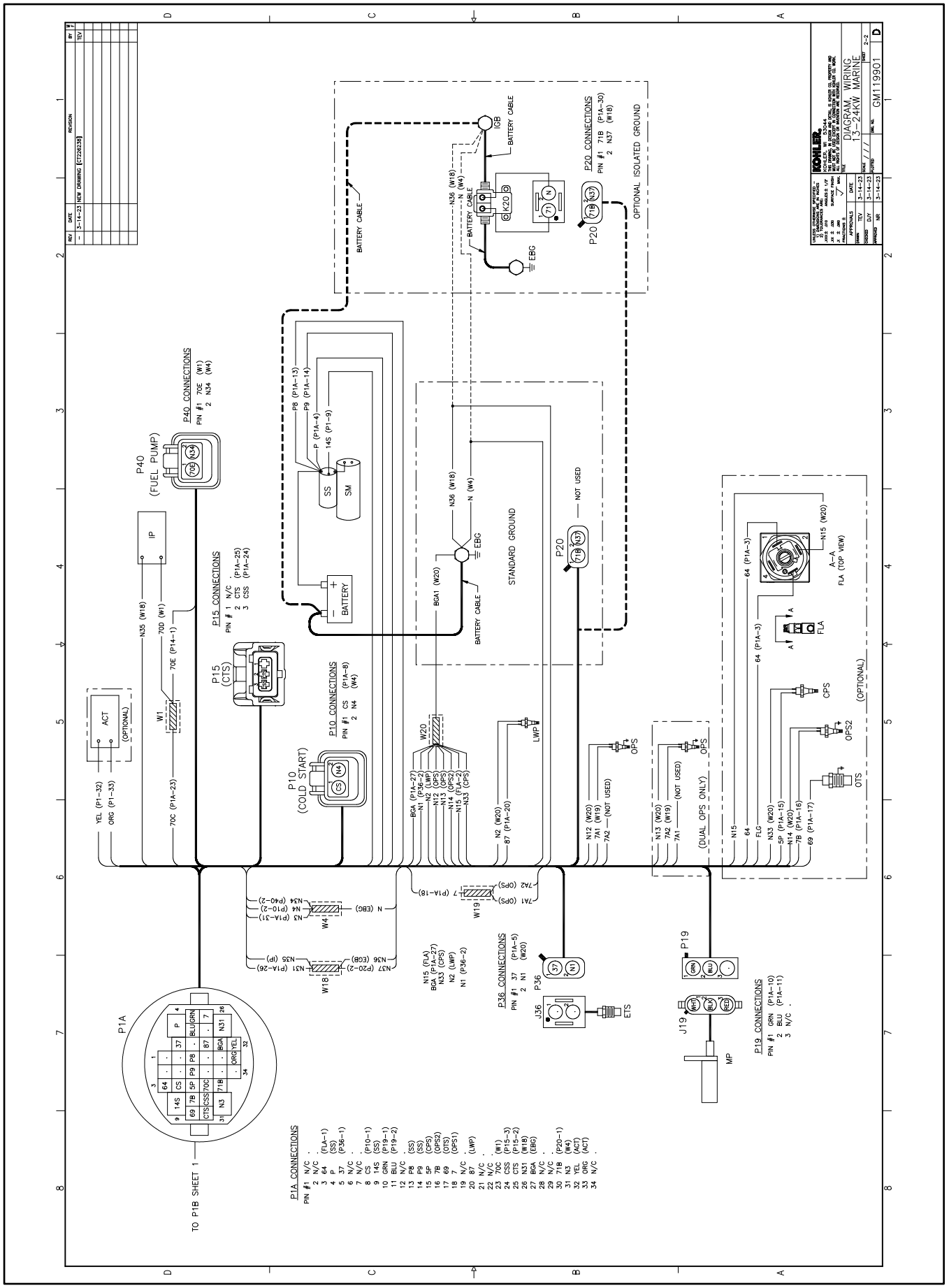

Figure 51 Wiring Diagram, Point-to-Point (Sheet 2 of 2) for 14/16EKOZD Models

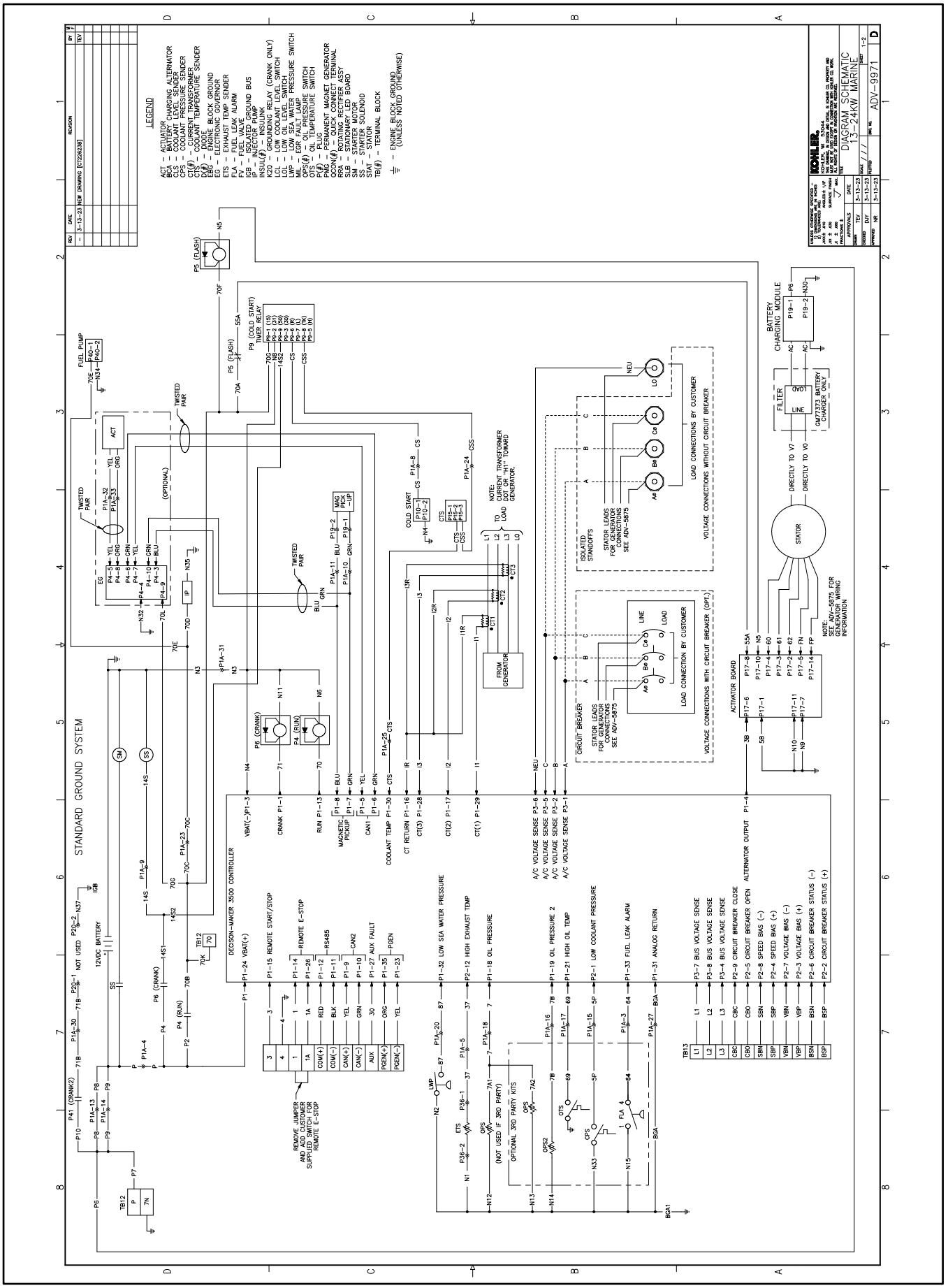

Figure 52 Wiring Diagram, Schematic (Sheet 1 of 2) for 14/16EKOZD Models

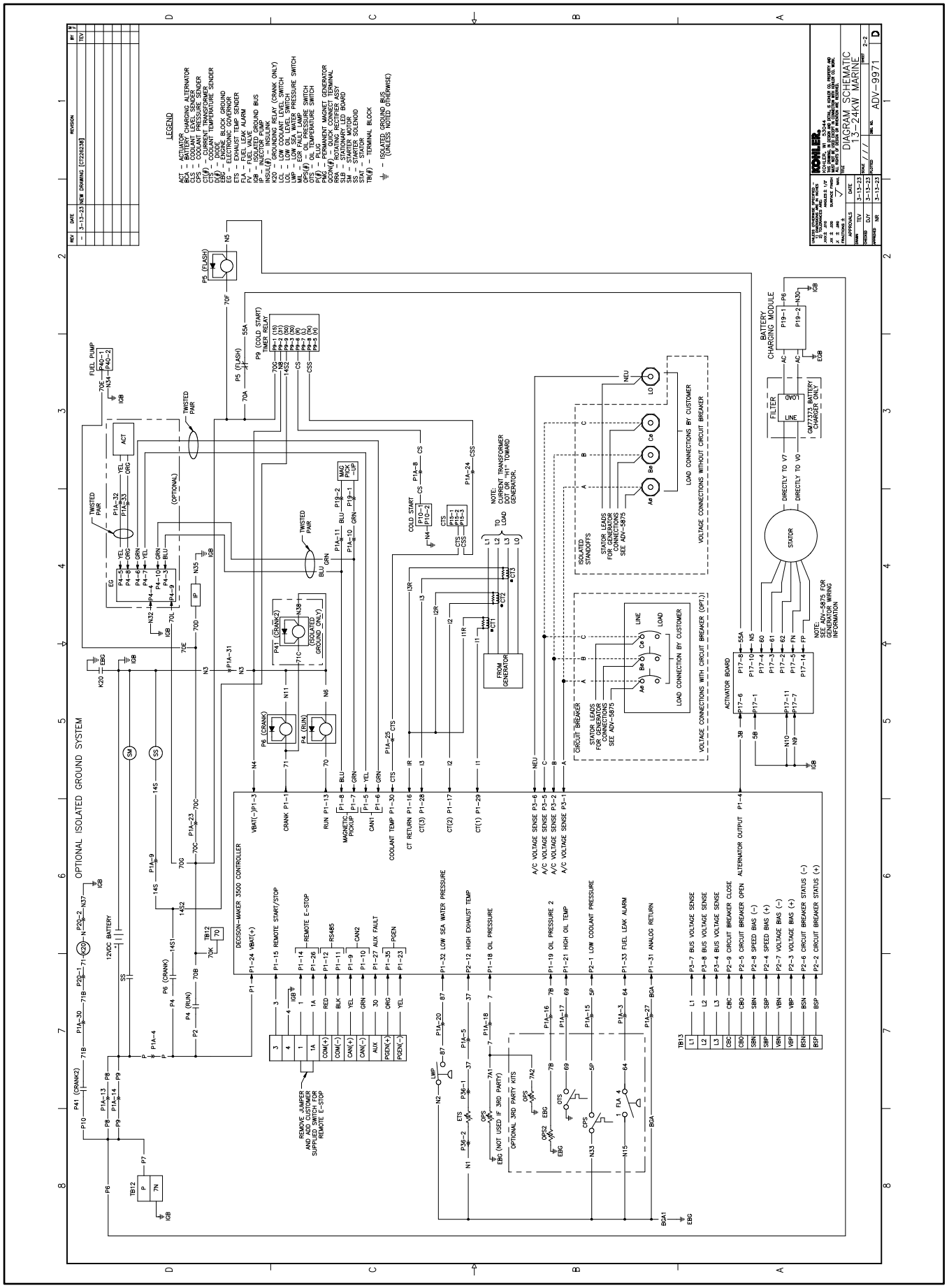

Figure 53 Wiring Diagram, Schematic (Sheet 2 of 2) for 14/16EKOZD Models

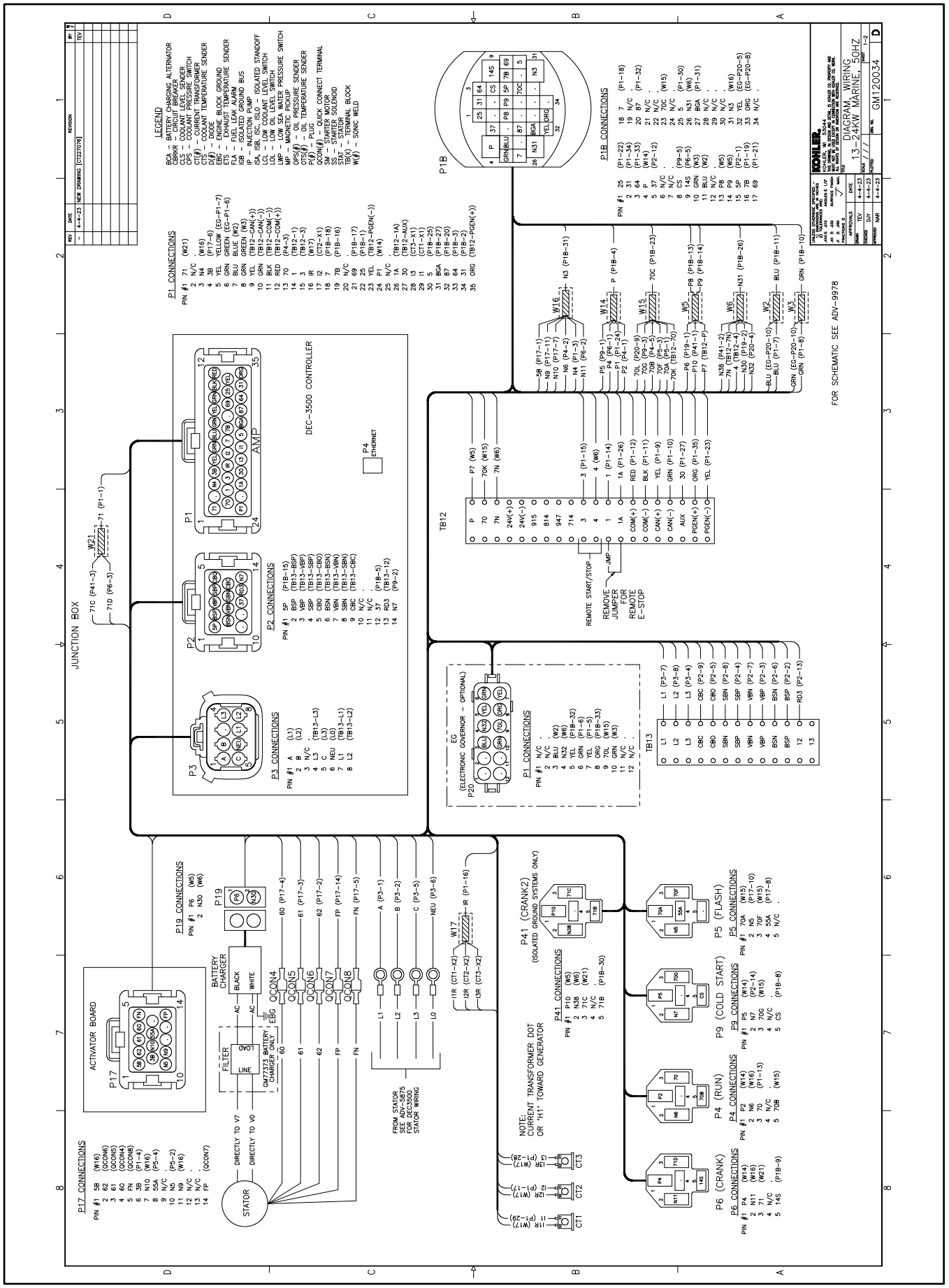

Figure 54 Wiring Diagram, Point-to-Point (Sheet 1 of 2) for 12/13.5/17/18/20.5EFKOZD Models

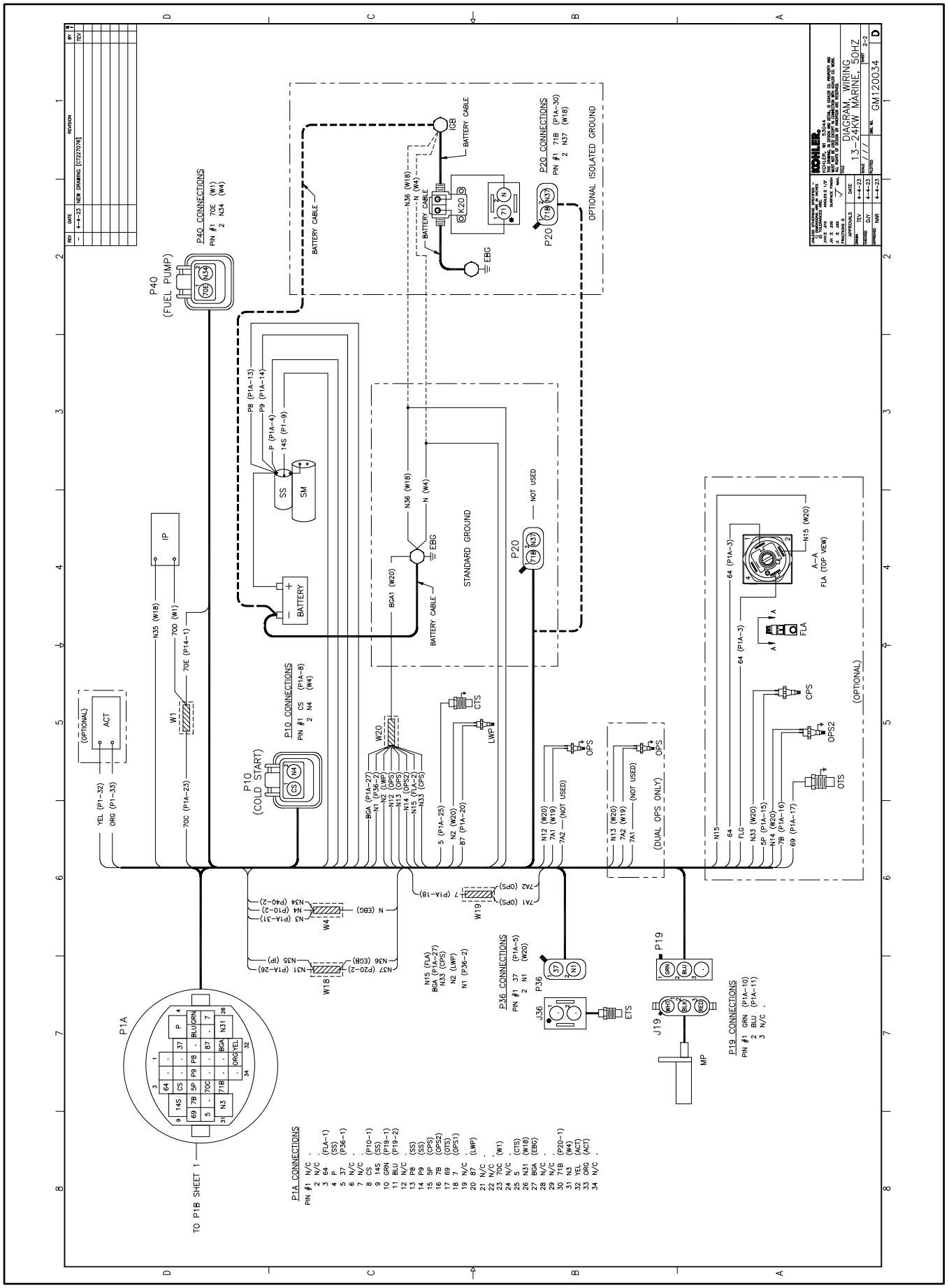

Figure 55 Wiring Diagram, Point-to-Point (Sheet 2 of 2) for 12/13.5/17/18/20.5EFKOZD Models

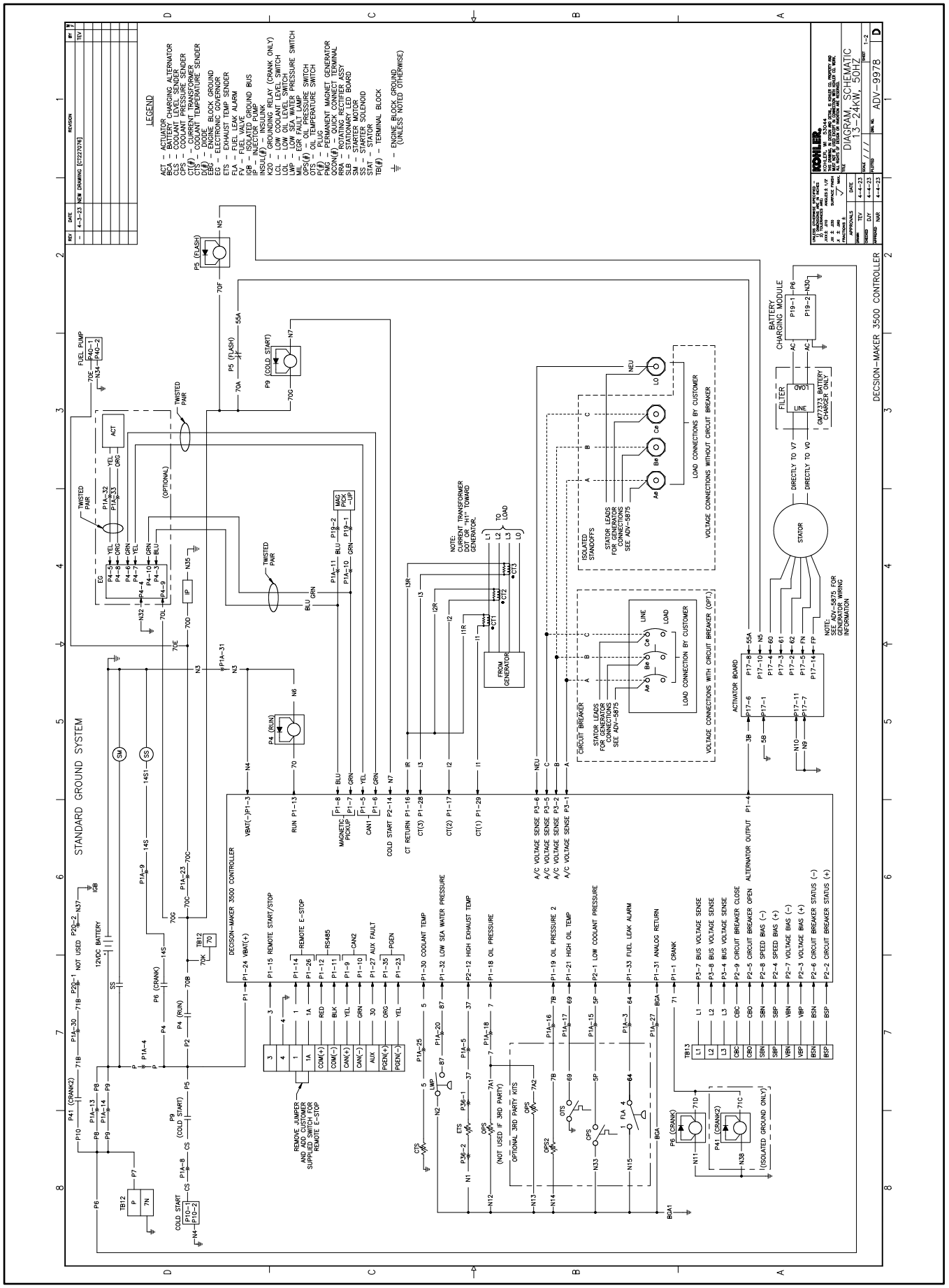

Figure 56 Wiring Diagram, Schematic (Sheet 1 of 2) for 12/13.5/17/18/20.5EFKOZD Models

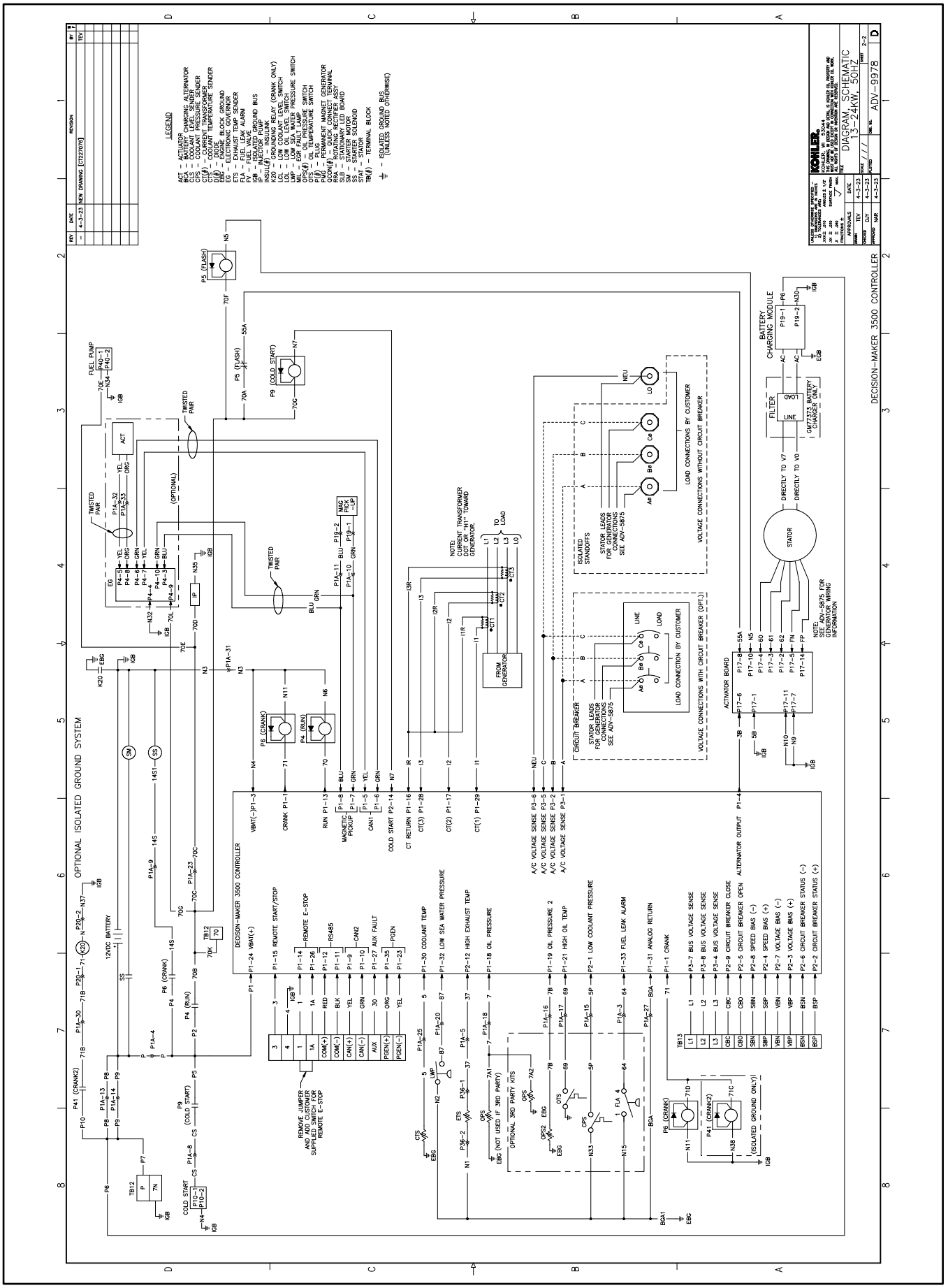

Figure 57 Wiring Diagram, Schematic (Sheet 2 of 2) for 12/13.5/17/18/20.5EFKOZD Models

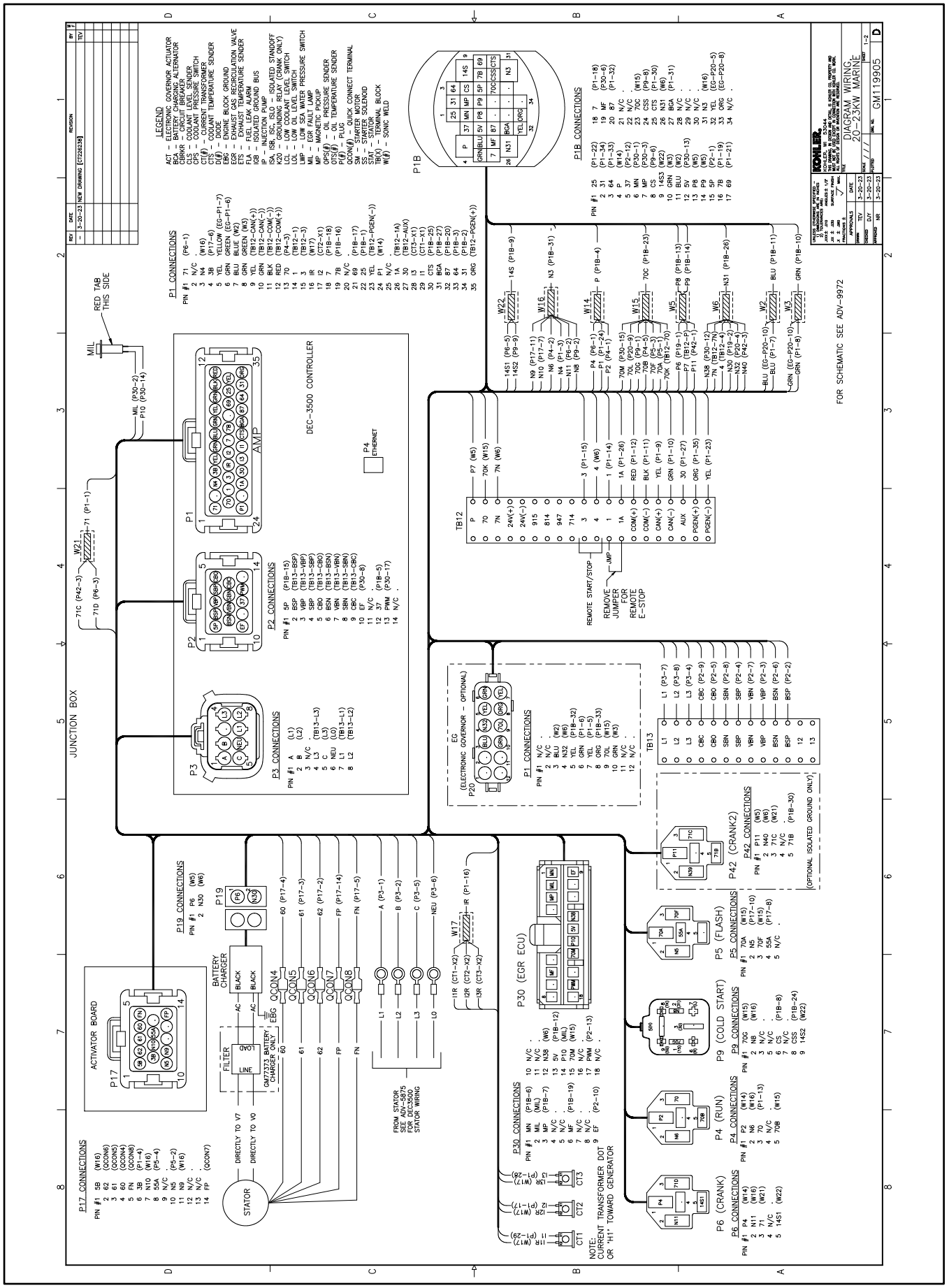

Figure 58 Wiring Diagram, Point-to-Point (Sheet 1 of 2) for 21/24EKOZD 12-Volt Models

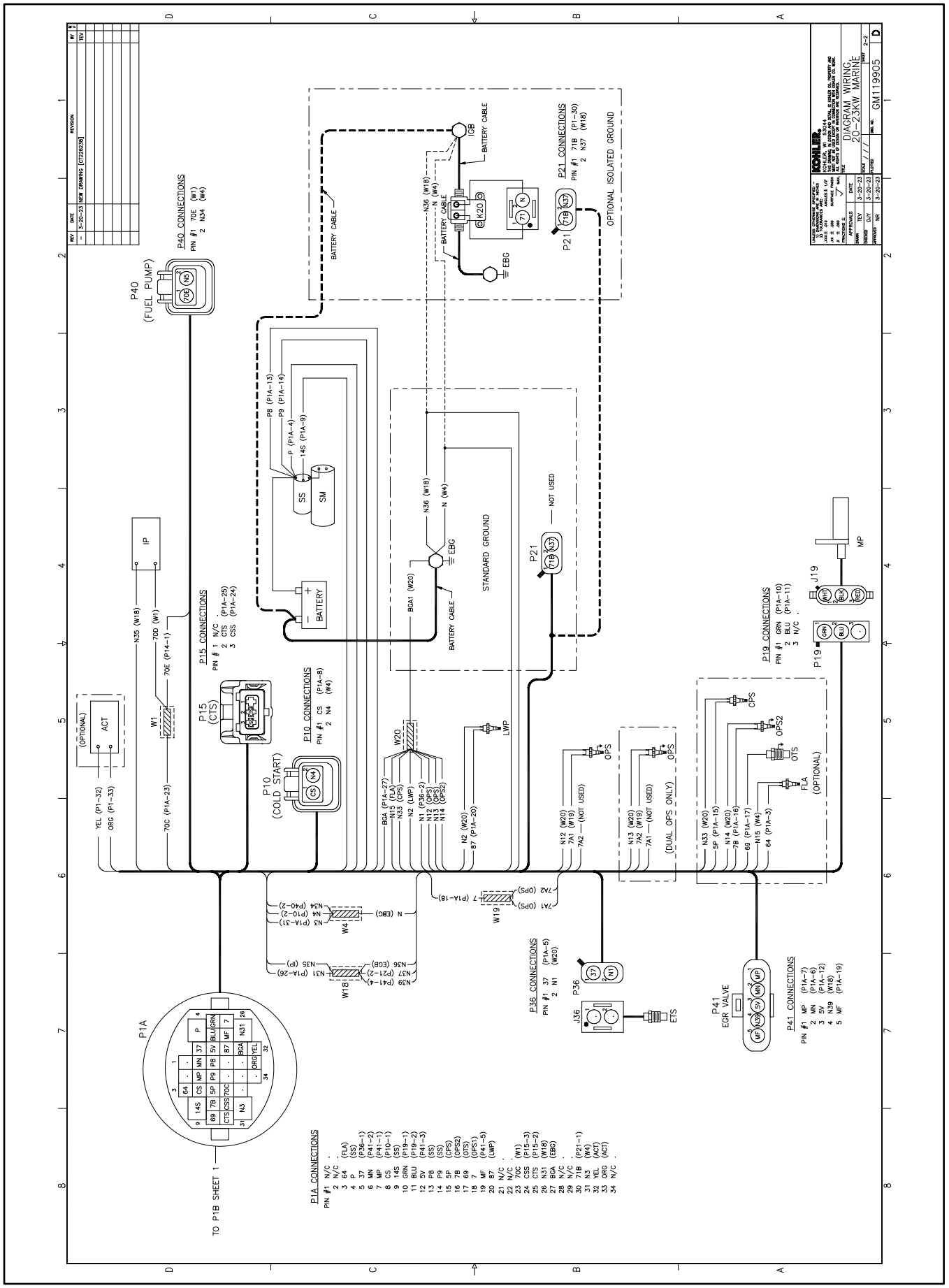

Figure 59 Wiring Diagram, Point-to-Point (Sheet 2 of 2) for 21/24EKOZD 12-Volt Models

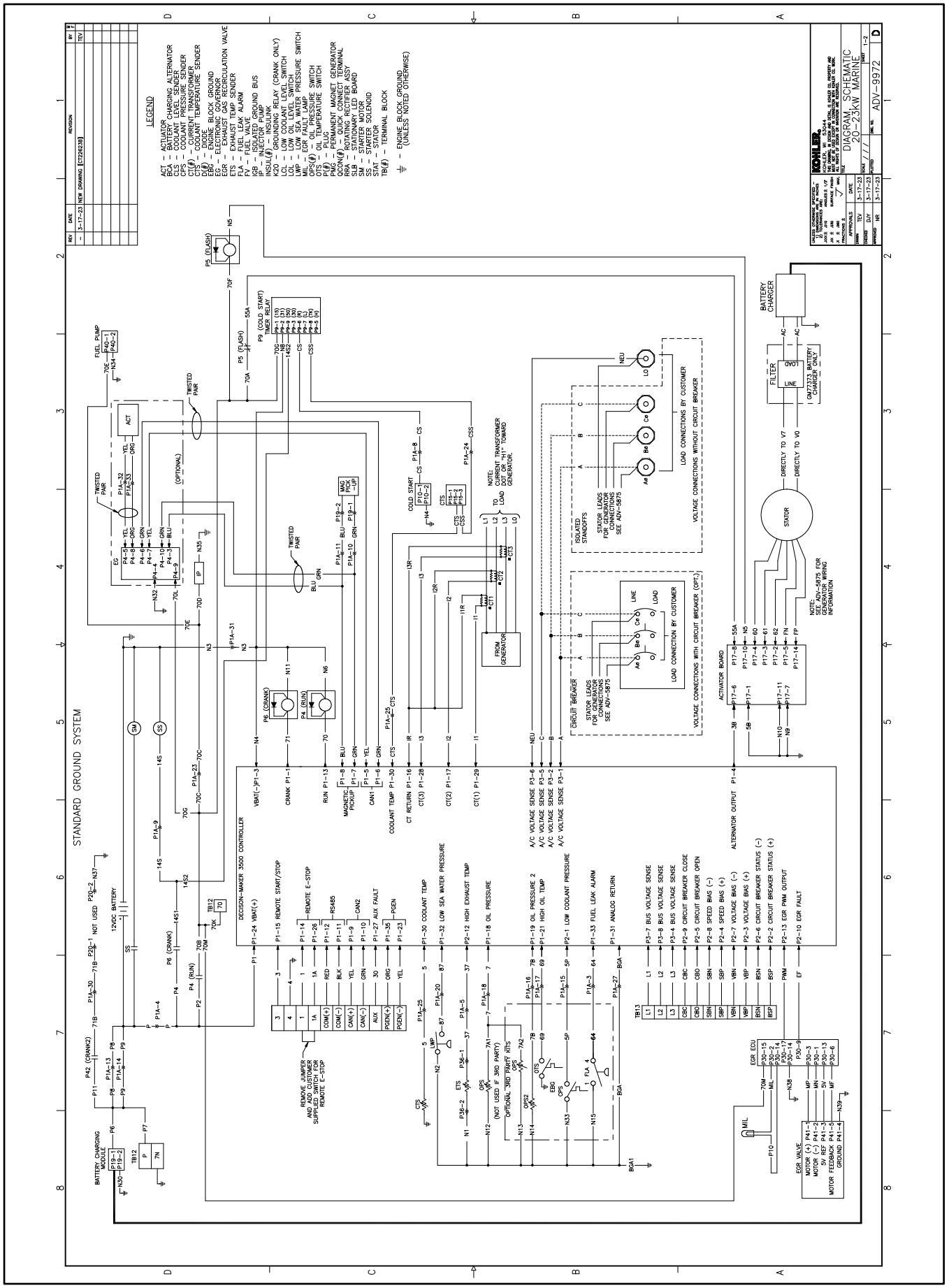

Figure 60 Wiring Diagram, Schematic (Sheet 1 of 2) for 21/24EKOZD 12-Volt Models

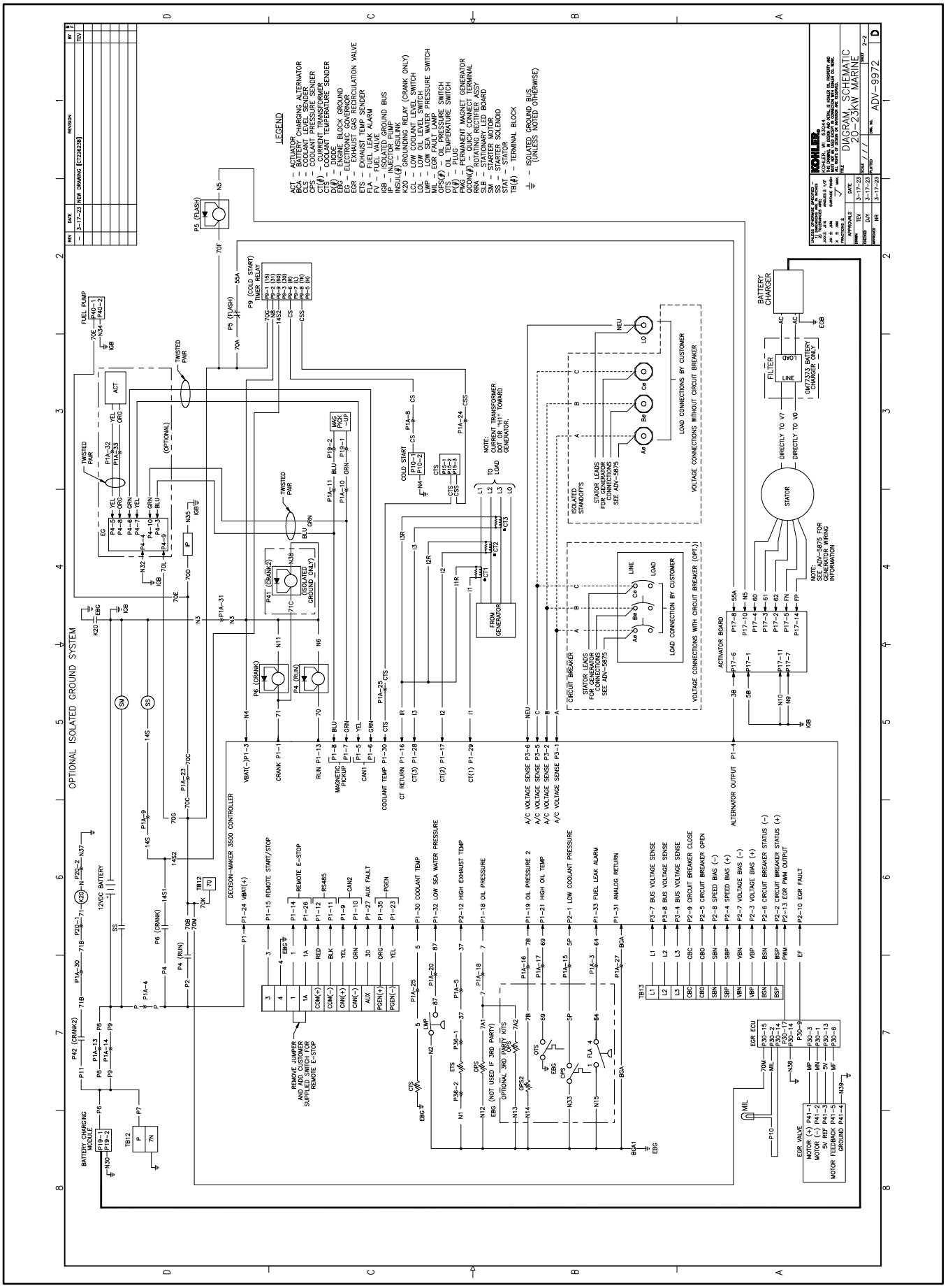

Figure 61 Wiring Diagram, Schematic (Sheet 2 of 2) for 21/24EKOZD 12-Volt Models

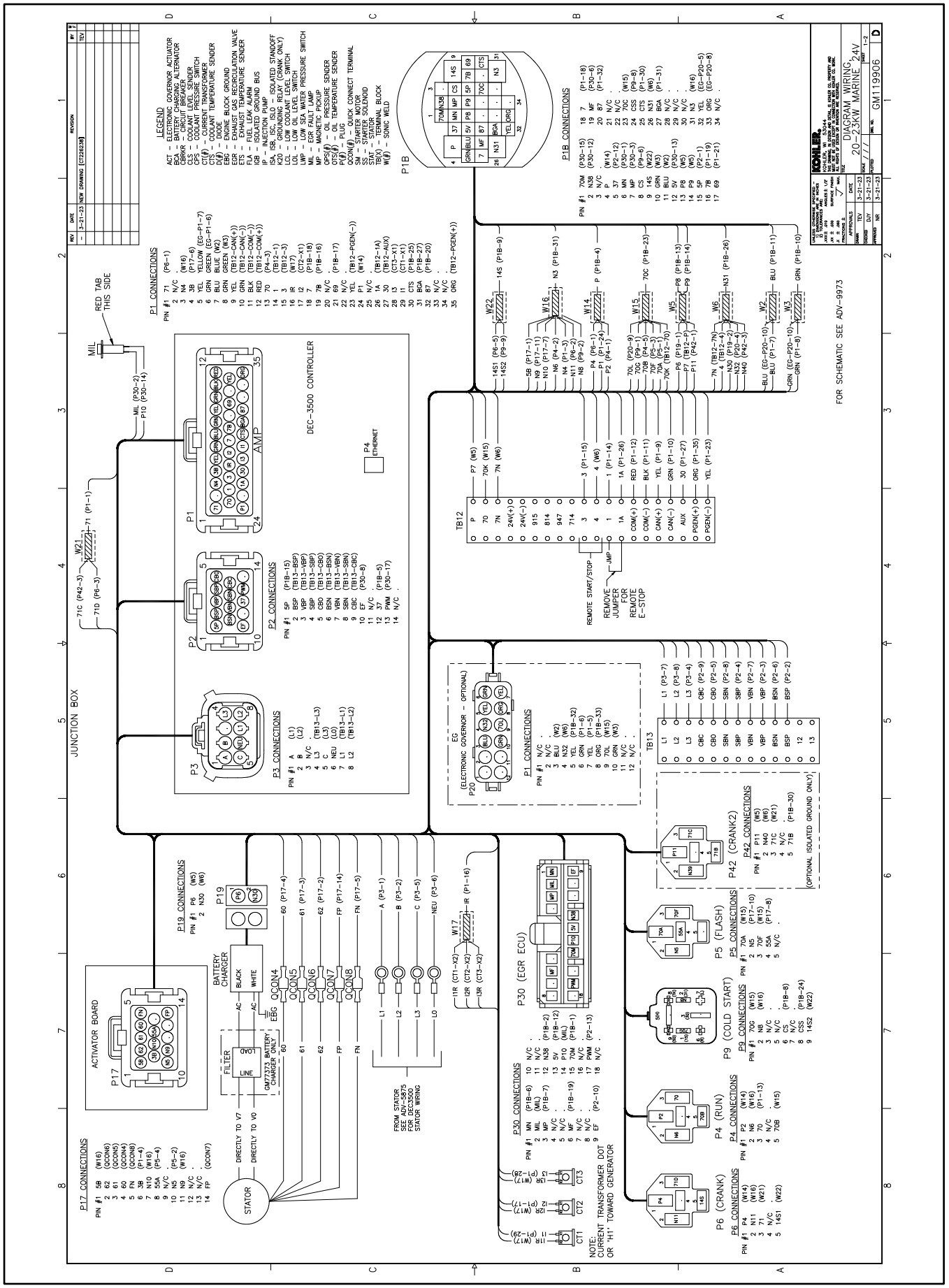

Figure 62 Wiring Diagram, Point-to-Point (Sheet 1 of 2) for 21/24EKOZD 24-Volt Models

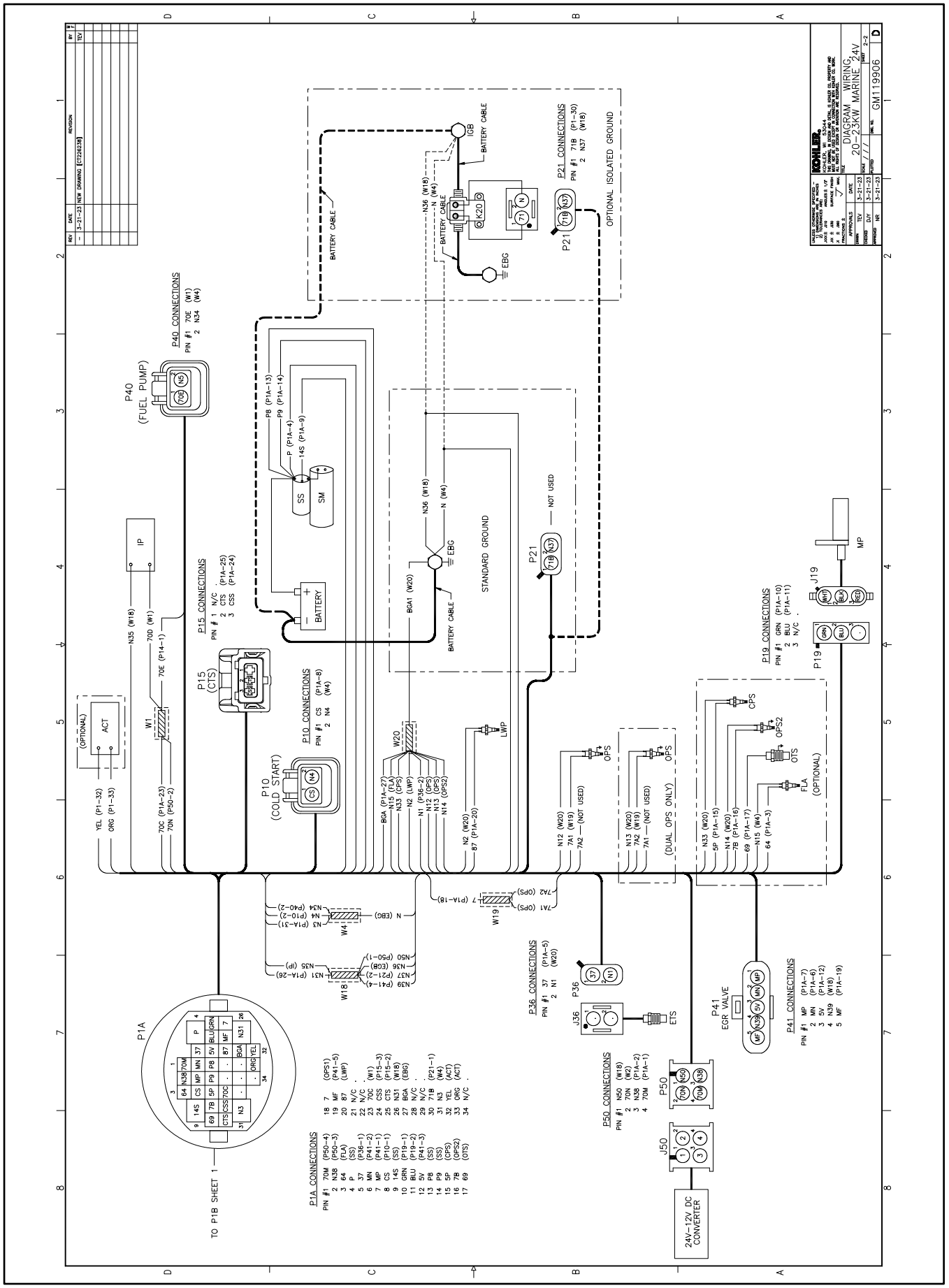

Figure 63 Wiring Diagram, Point-to-Point (Sheet 2 of 2) for 21/24EKOZD 24-Volt Models

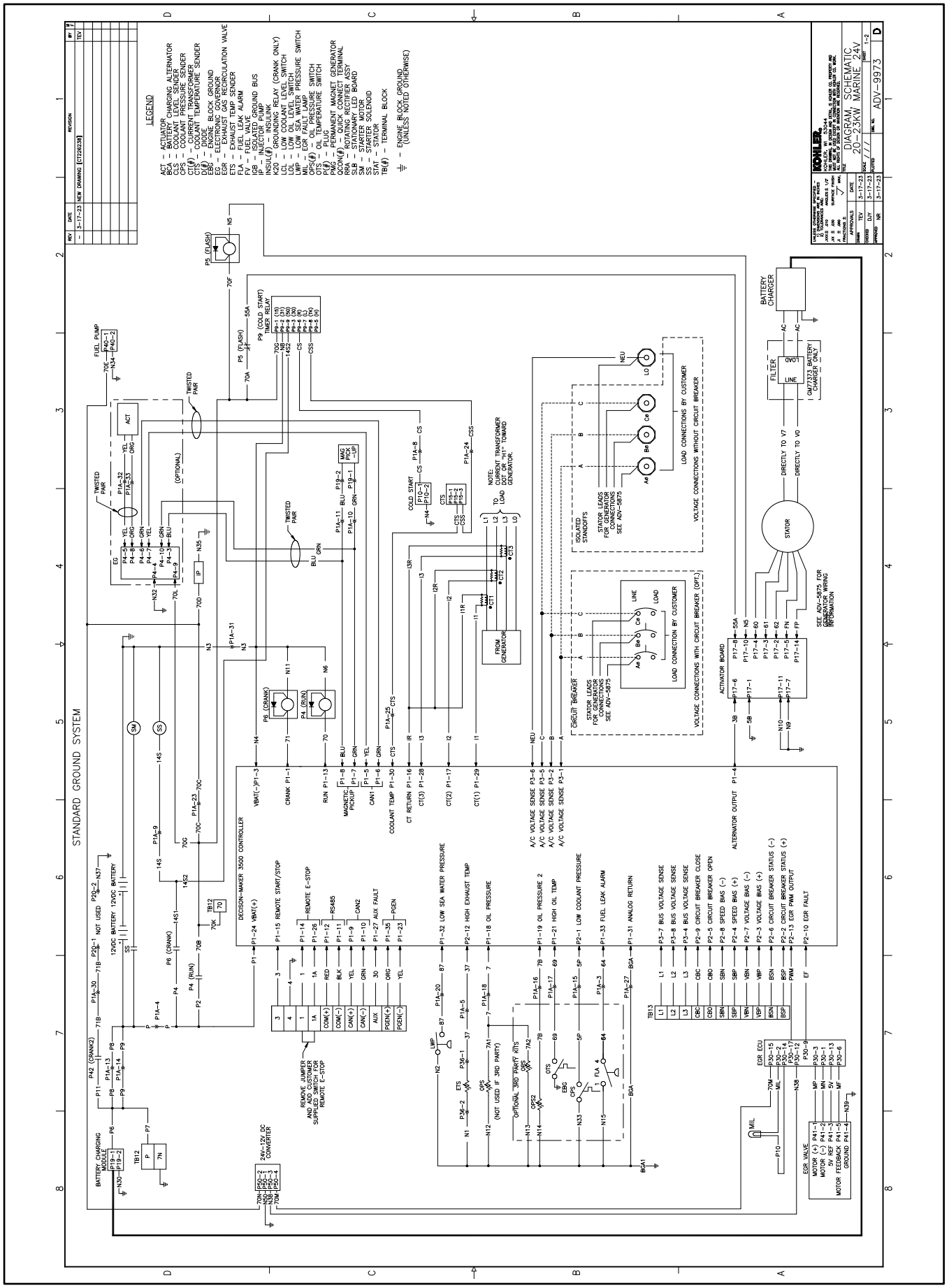

Figure 64 Wiring Diagram, Schematic (Sheet 1 of 2) for 21/24EKOZD 24-Volt Models

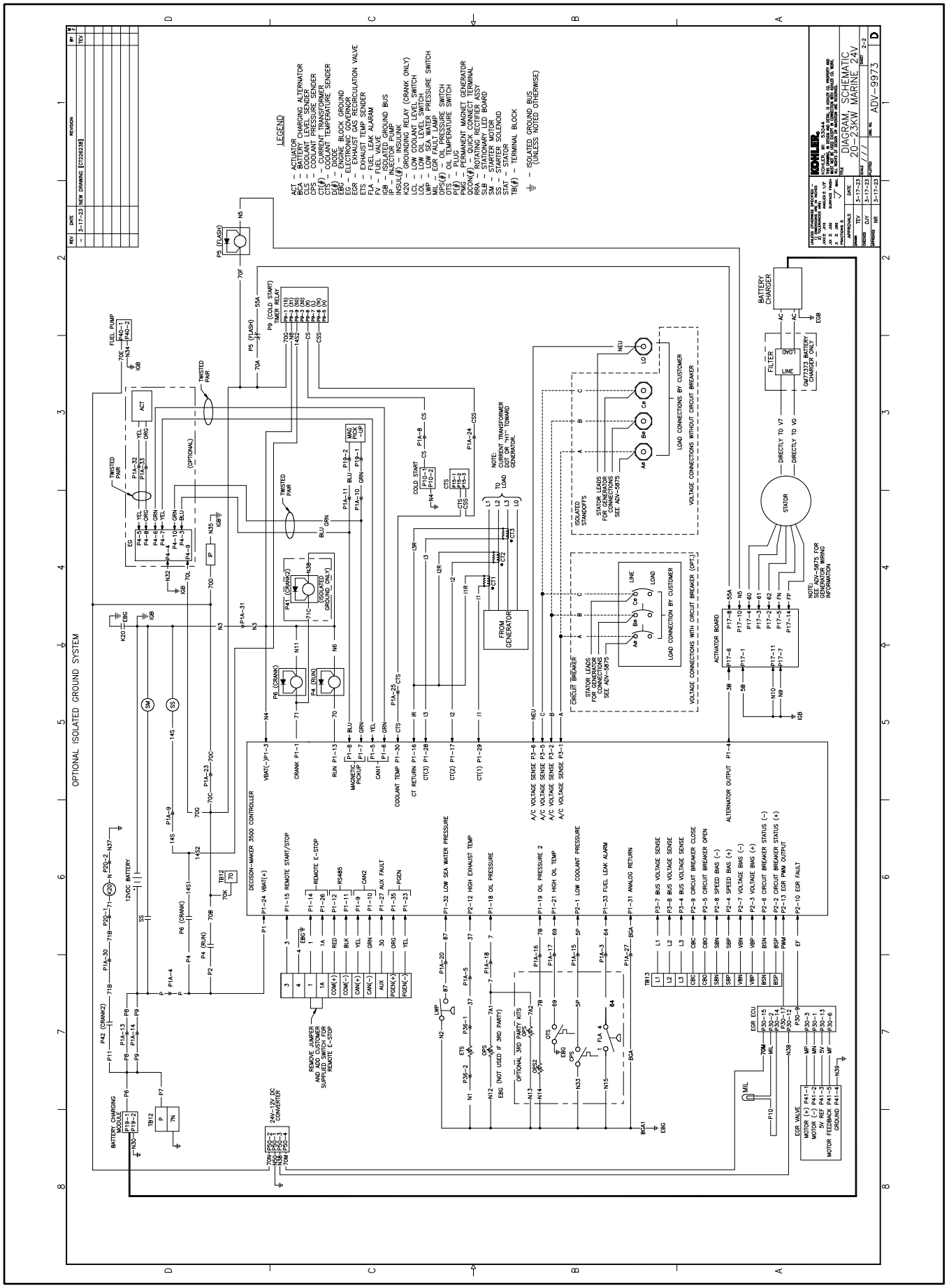

Figure 65 Wiring Diagram, Schematic (Sheet 2 of 2) for 21/24EKOZD 24-Volt Models

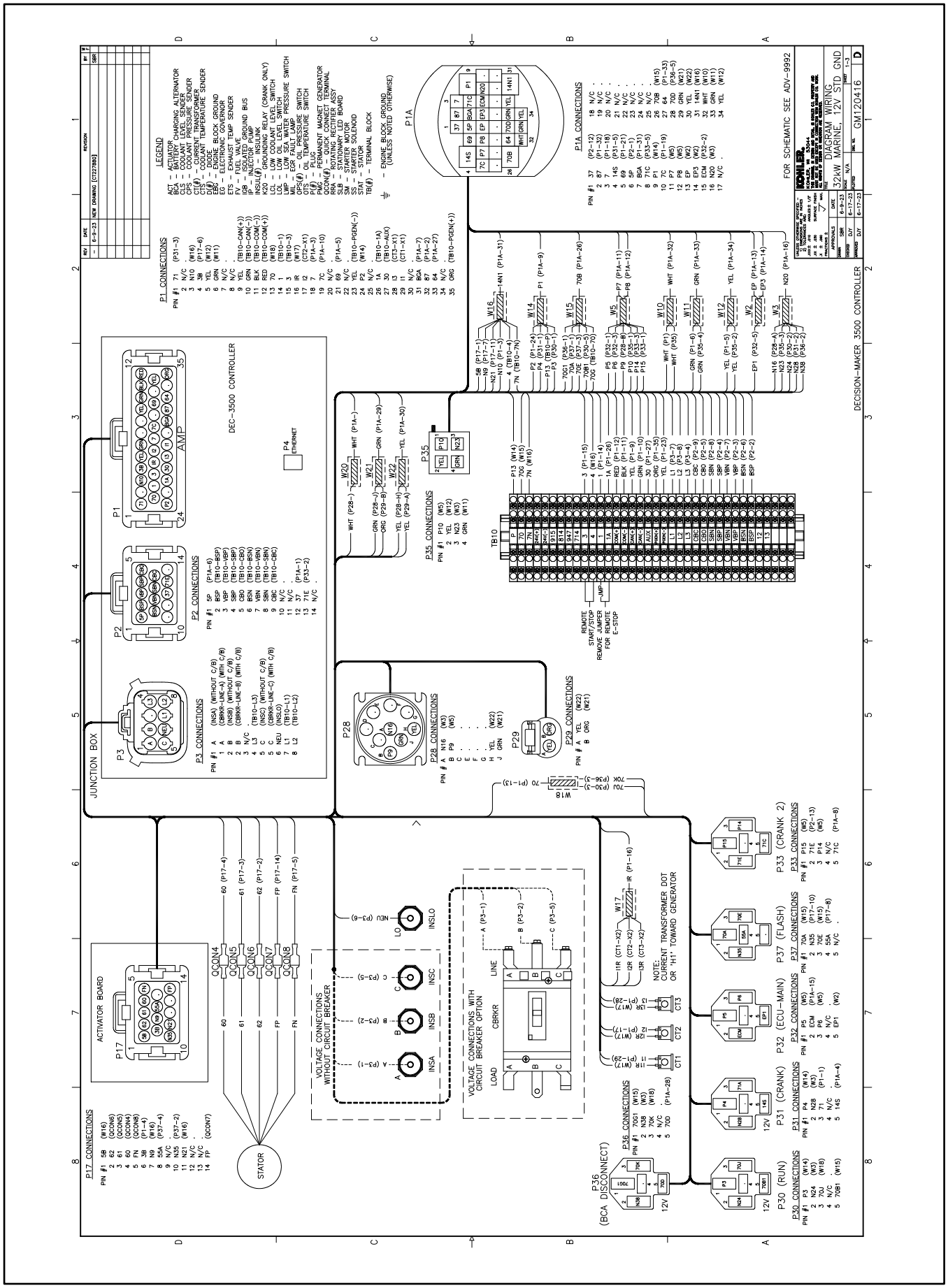

Figure 66 Wiring Diagram, Point-to-Point (Sheet 1 of 3) for 32EKOZD/28EFKOZD 12-Volt, Standard Ground Models

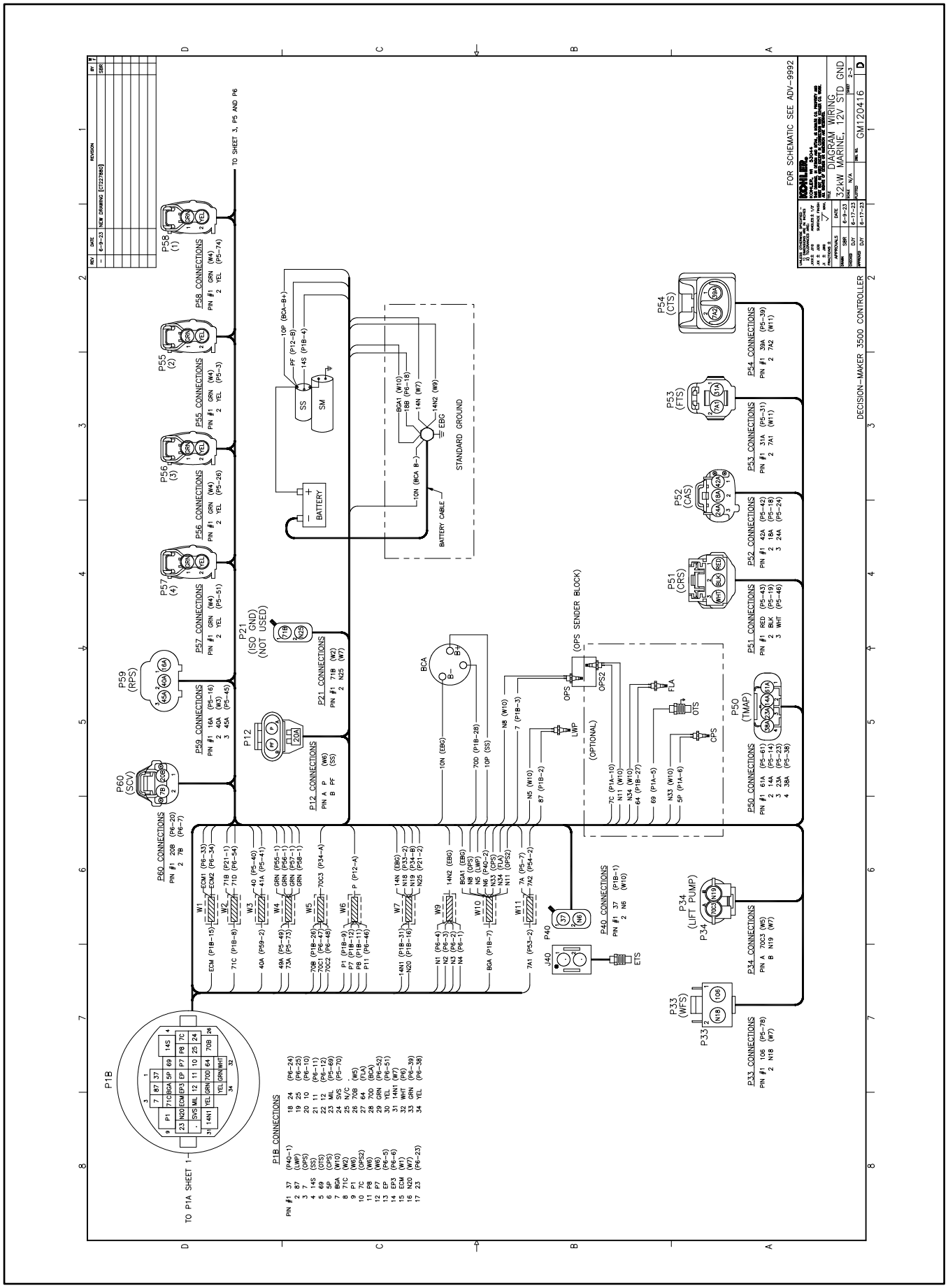

Figure 67 Wiring Diagram, Point-to-Point (Sheet 2 of 3) for 32EKOZD/28EFKOZD 12-Volt, Standard Ground Models

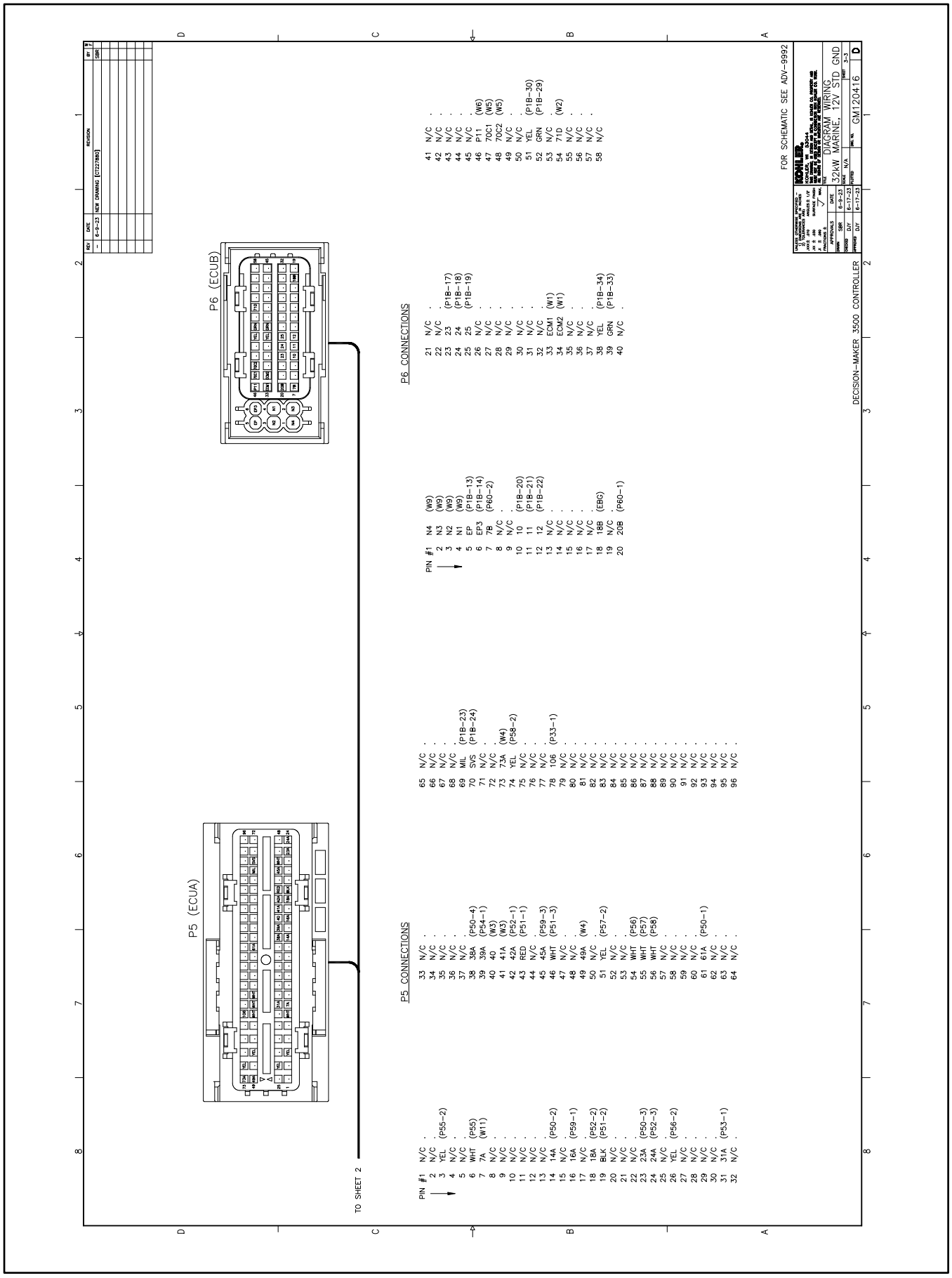

Figure 68 Wiring Diagram, Point-to-Point (Sheet 3 of 3) for 32EKOZD/28EFKOZD 12-Volt, Standard Ground Models

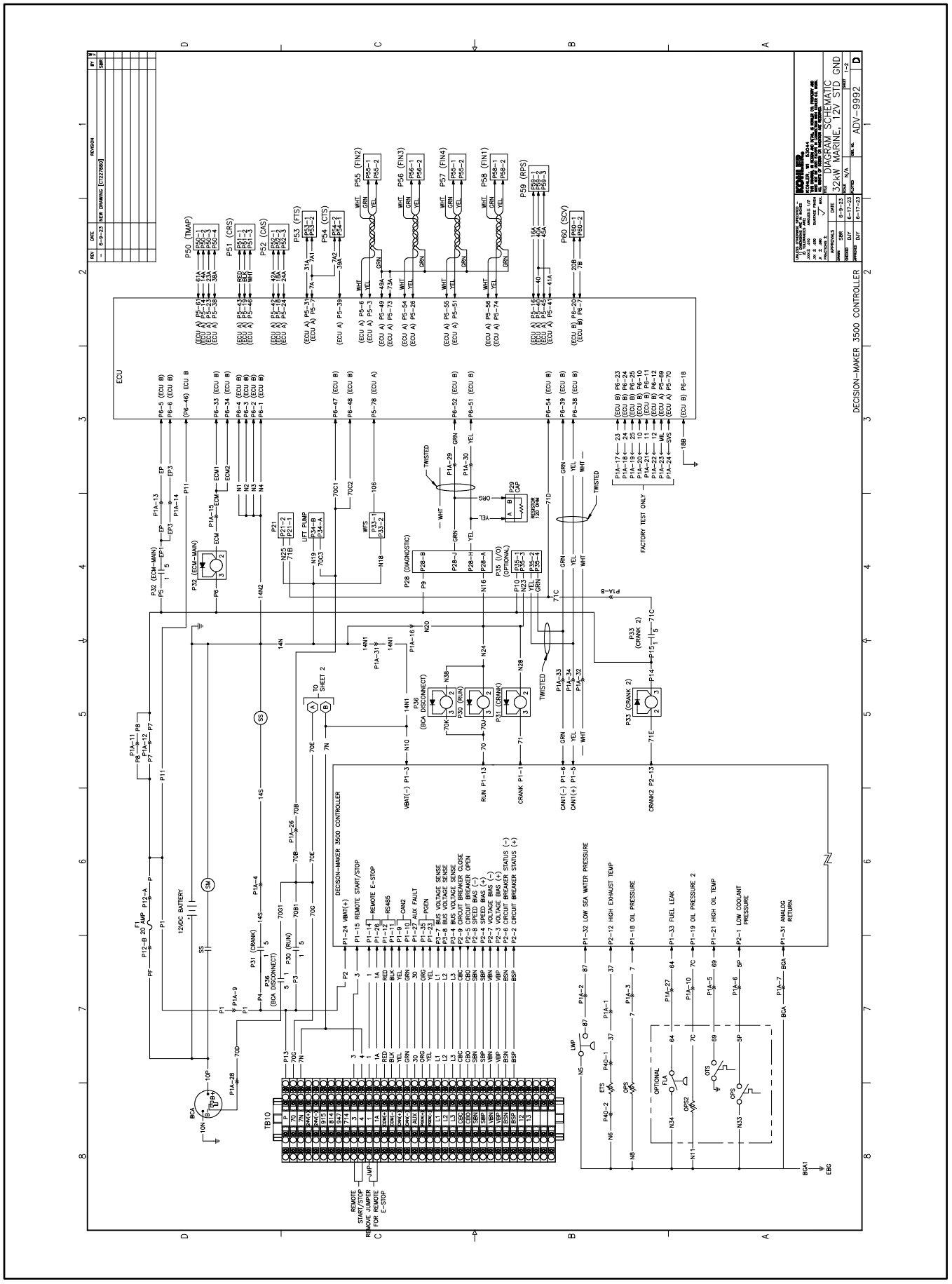

Figure 69 Wiring Diagram, Schematic (Sheet 1 of 2) for 32EKOZD/28EFKOZD 12-Volt, Standard Ground Models

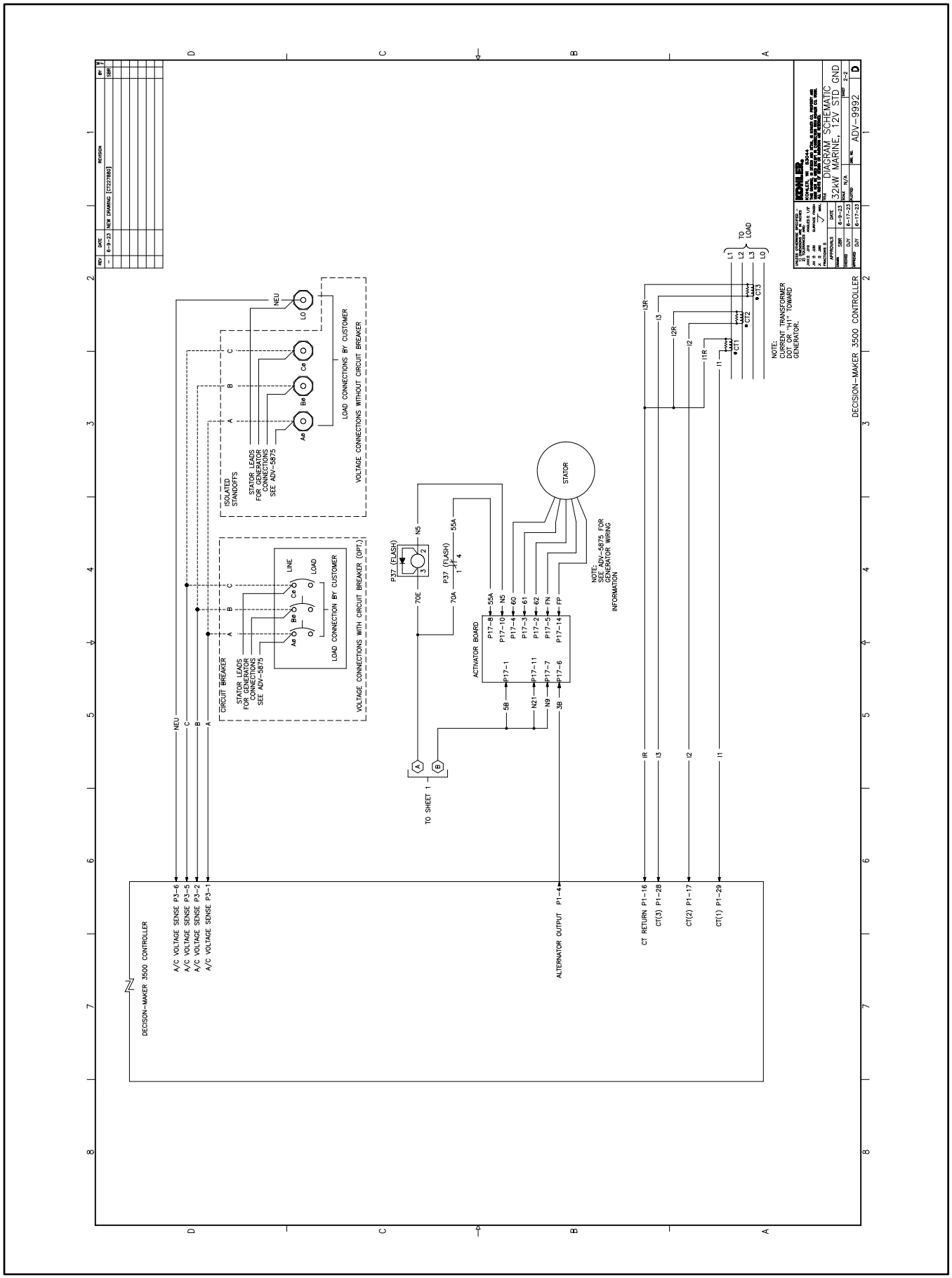

Figure 70 Wiring Diagram, Schematic (Sheet 2 of 2) for 32EKOZD/28EFKOZD 12-Volt, Standard Ground Models

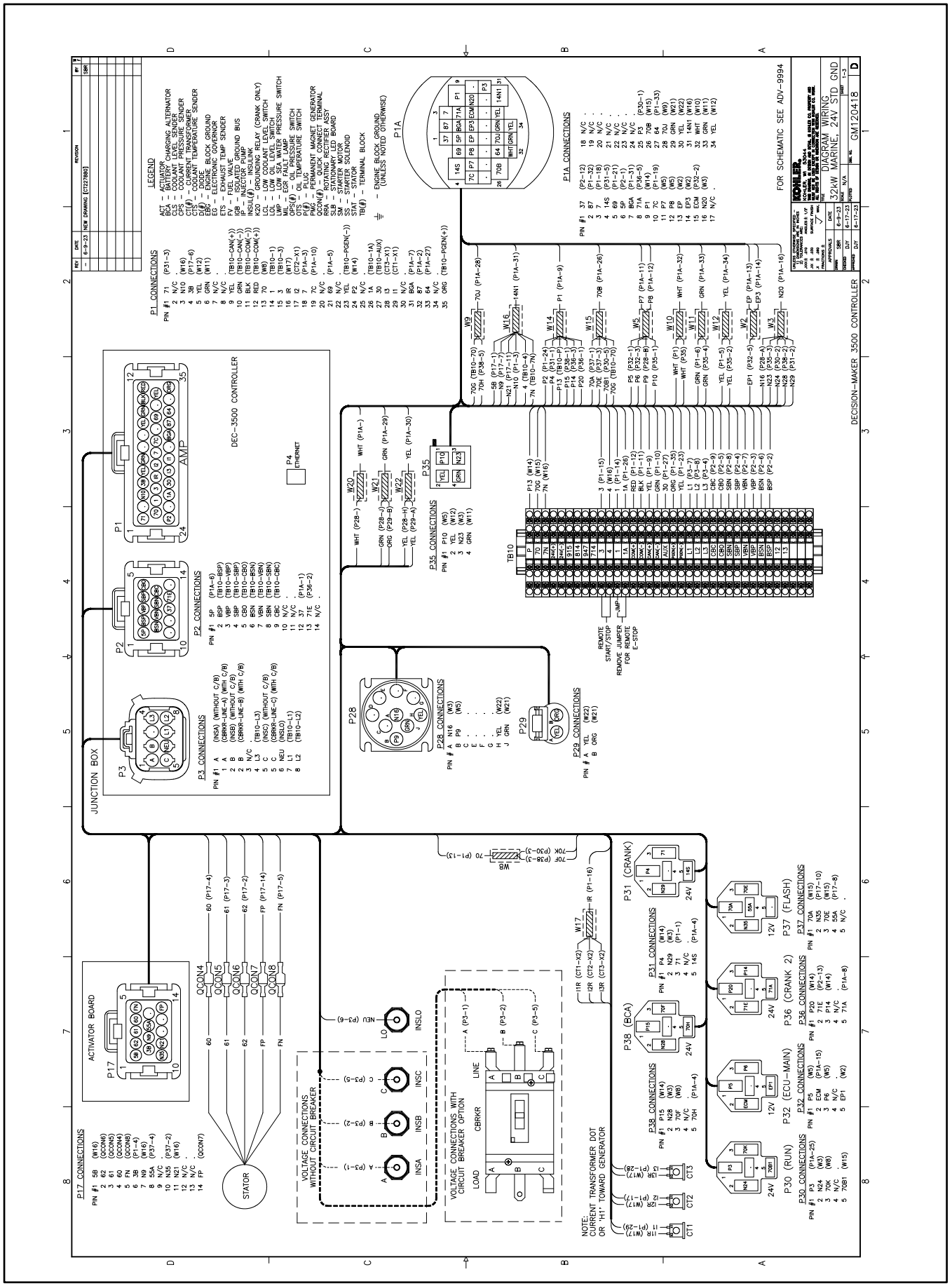

Figure 71 Wiring Diagram, Point-to-Point (Sheet 1 of 3) for 32EKOZD/28EFKOZD 24-Volt, Standard Ground Models

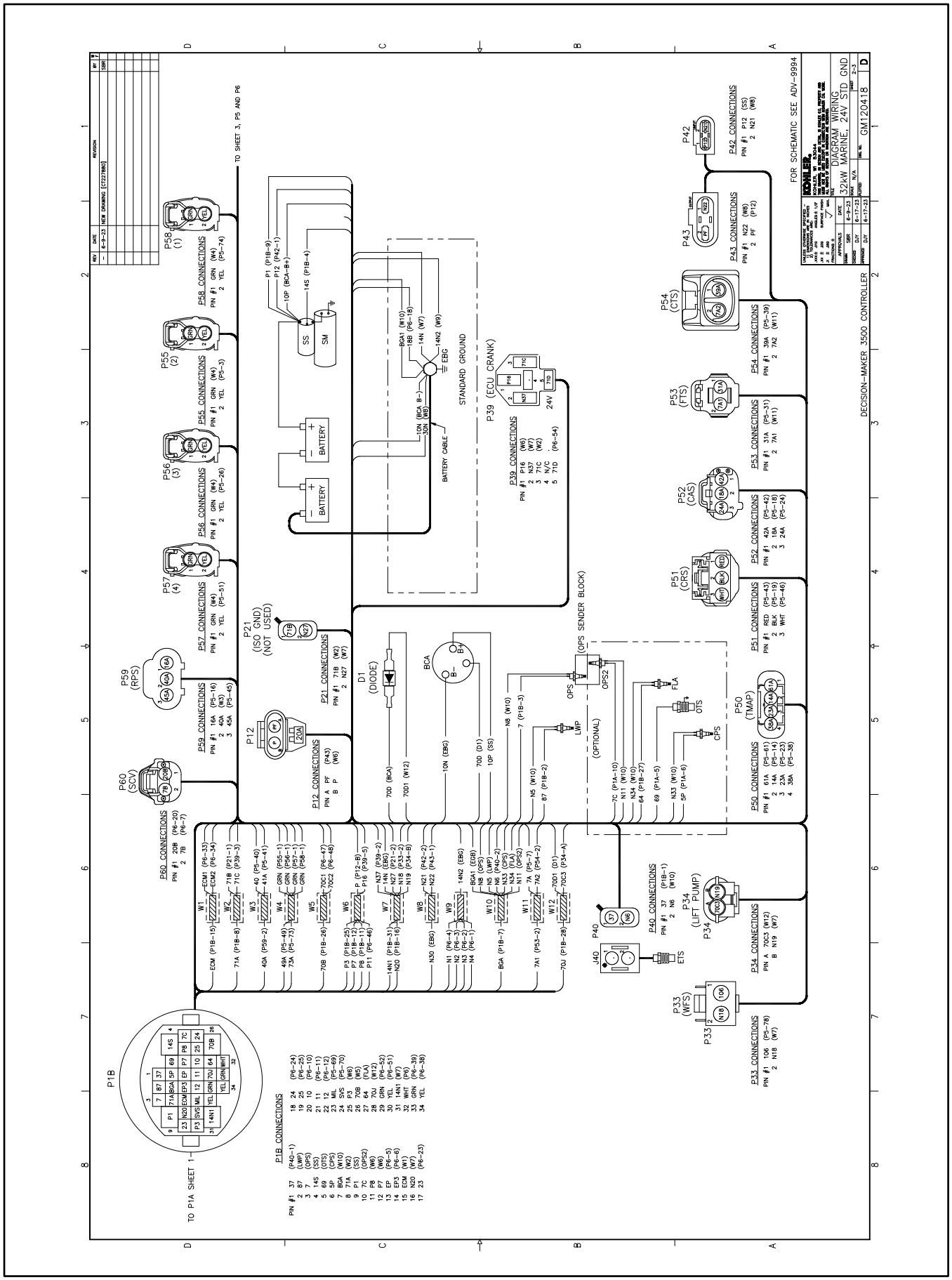

Figure 72 Wiring Diagram, Point-to-Point (Sheet 2 of 3) for 32EKOZD/28EFKOZD 24-Volt, Standard Ground Models

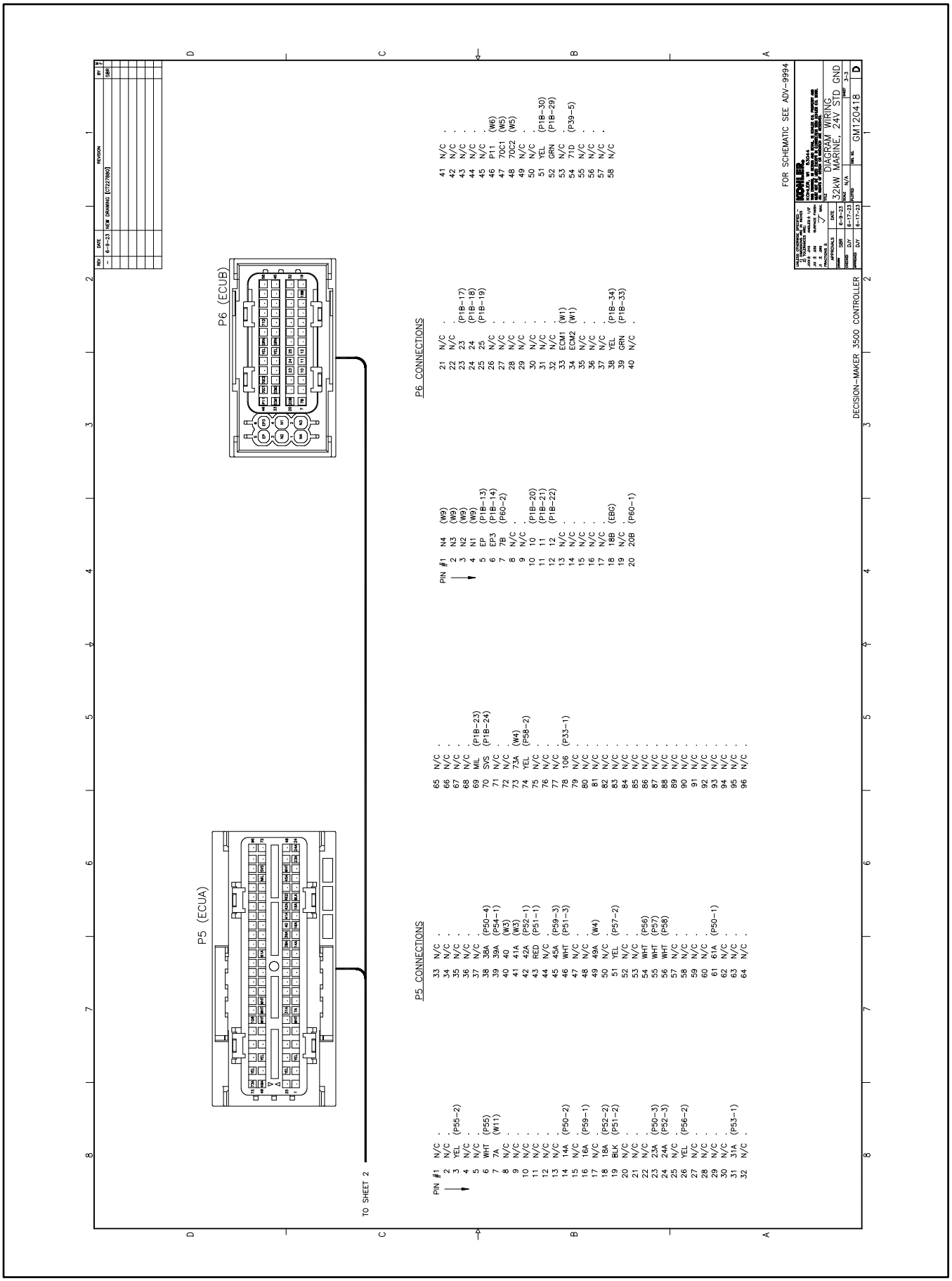

Figure 73 Wiring Diagram, Point-to-Point (Sheet 3 of 3) for 32EKOZD/28EFKOZD 24-Volt, Standard Ground Models

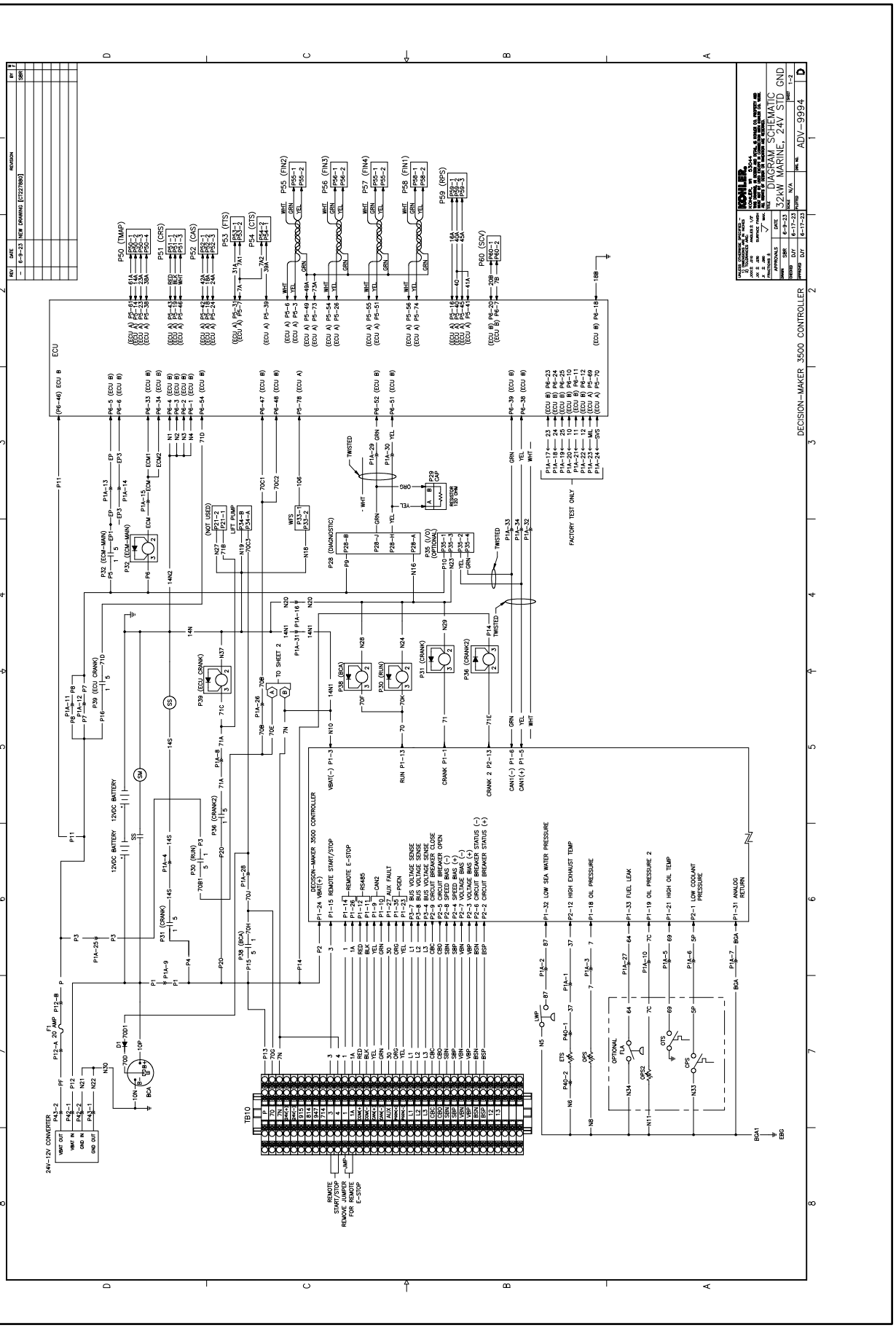

Figure 74 Wiring Diagram, Schematic (Sheet 1 of 2) for 32EKOZD/28EFKOZD 24-Volt, Standard Ground Models

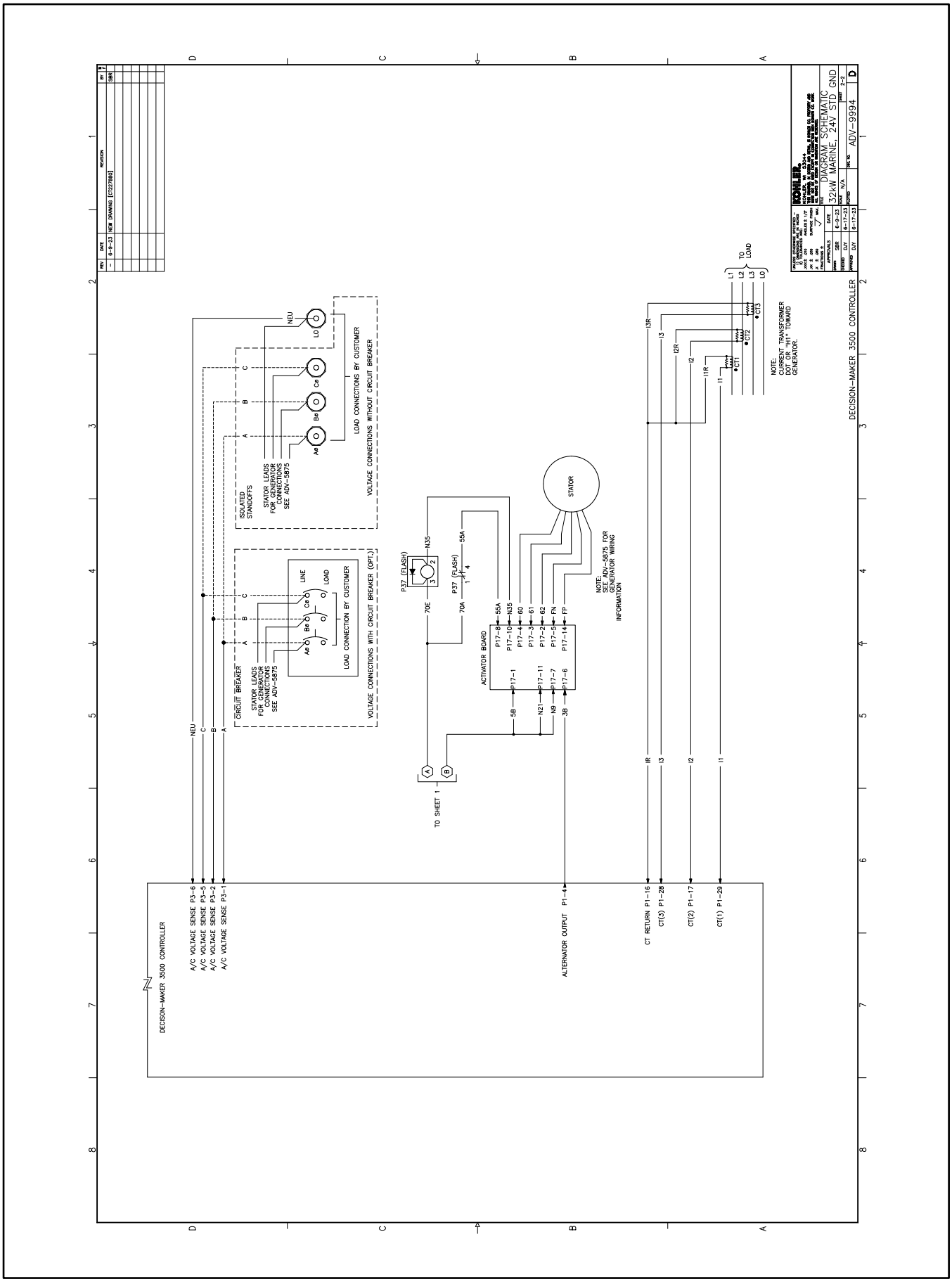

Figure 75 Wiring Diagram, Schematic (Sheet 2 of 2) for 32EKOZD/28EFKOZD 24-Volt, Standard Ground Models

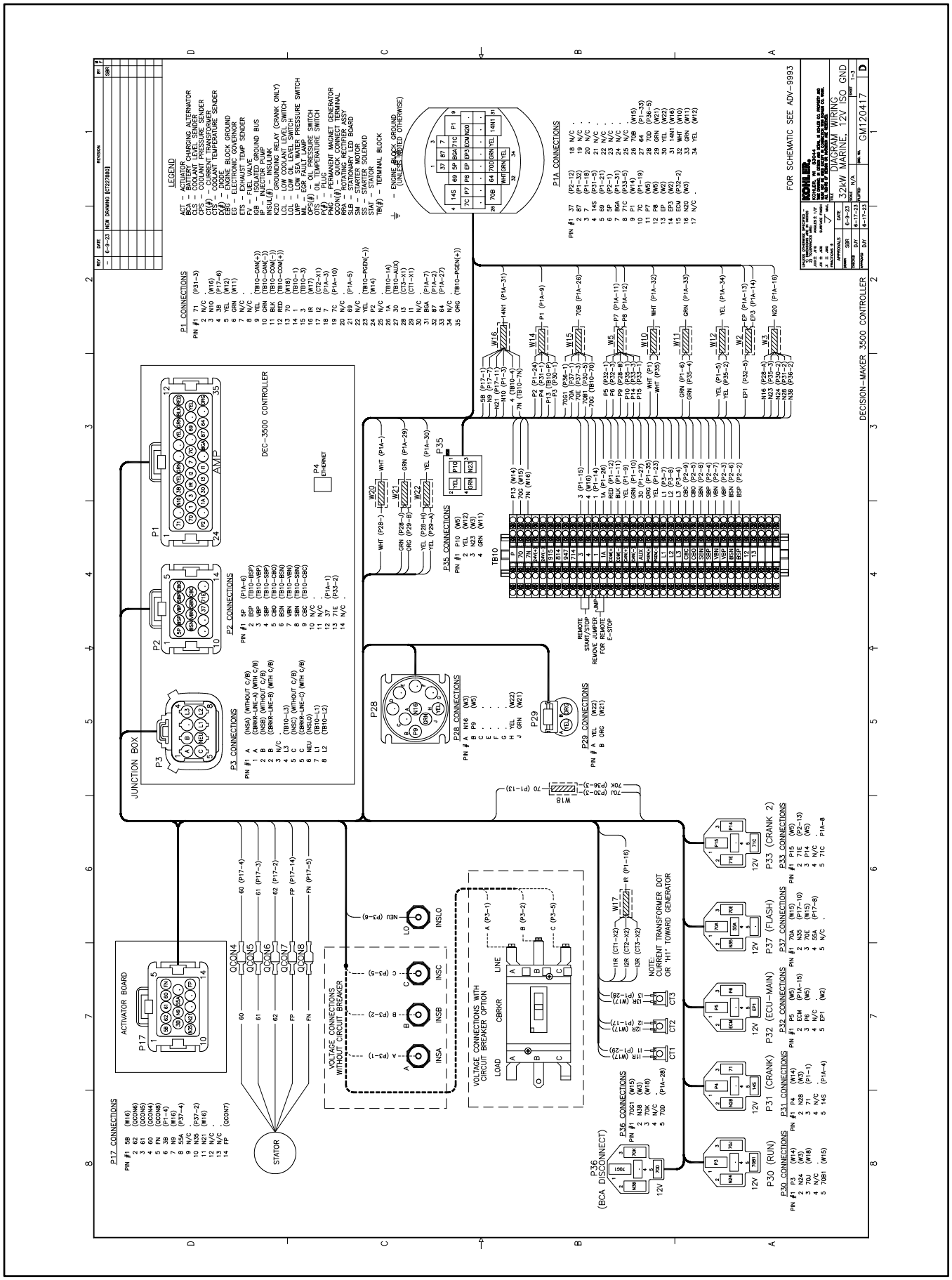

Figure 76 Wiring Diagram, Point-to-Point (Sheet 1 of 3) for 32EKOZD/28EFKOZD 12-Volt, Isolated Ground Models

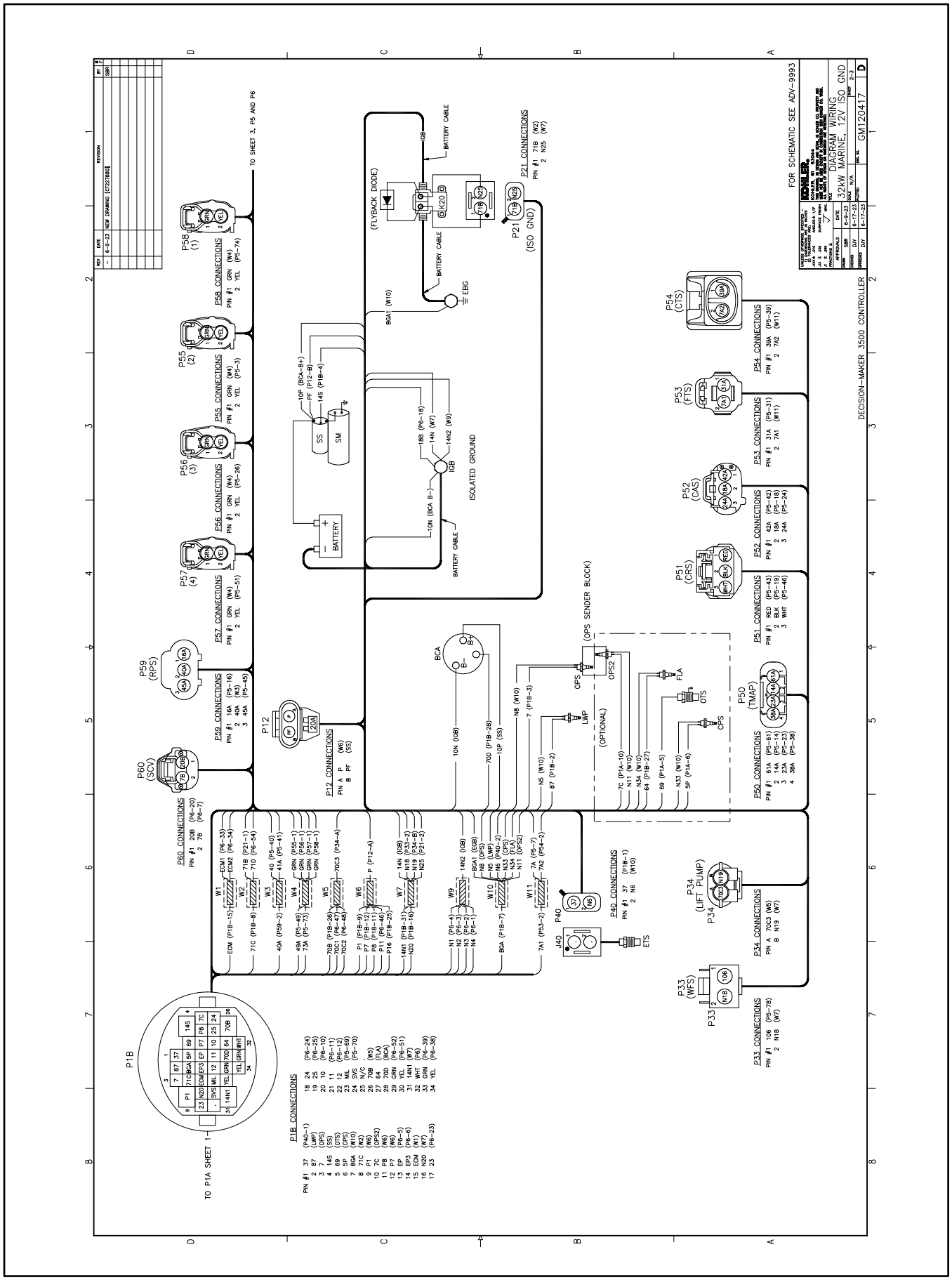

Figure 77 Wiring Diagram, Point-to-Point (Sheet 2 of 3) for 32EKOZD/28EFKOZD 12-Volt, Isolated Ground Models

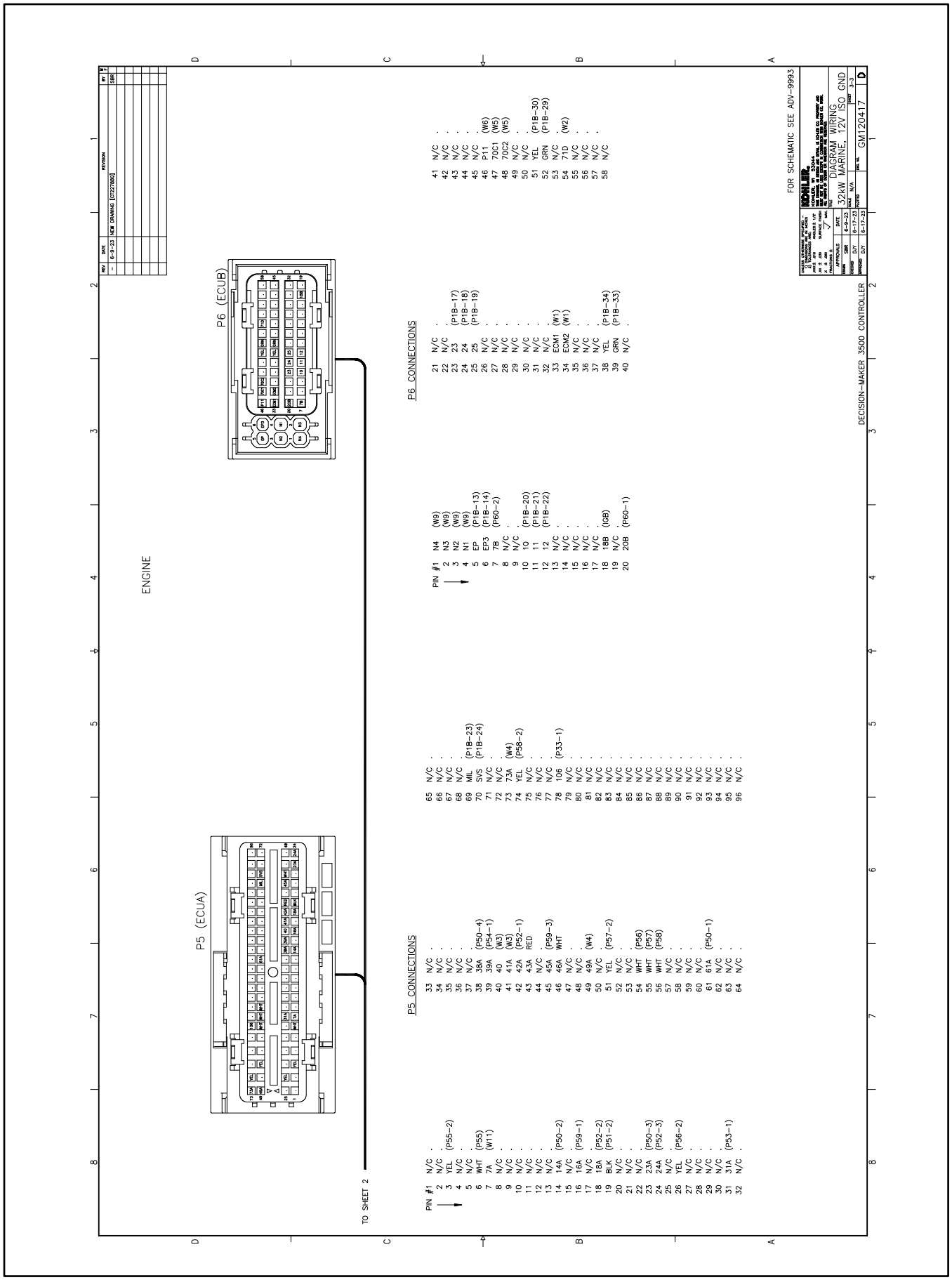

Figure 78 Wiring Diagram, Point-to-Point (Sheet 3 of 3) for 32EKOZD/28EFKOZD 12-Volt, Isolated Ground Models

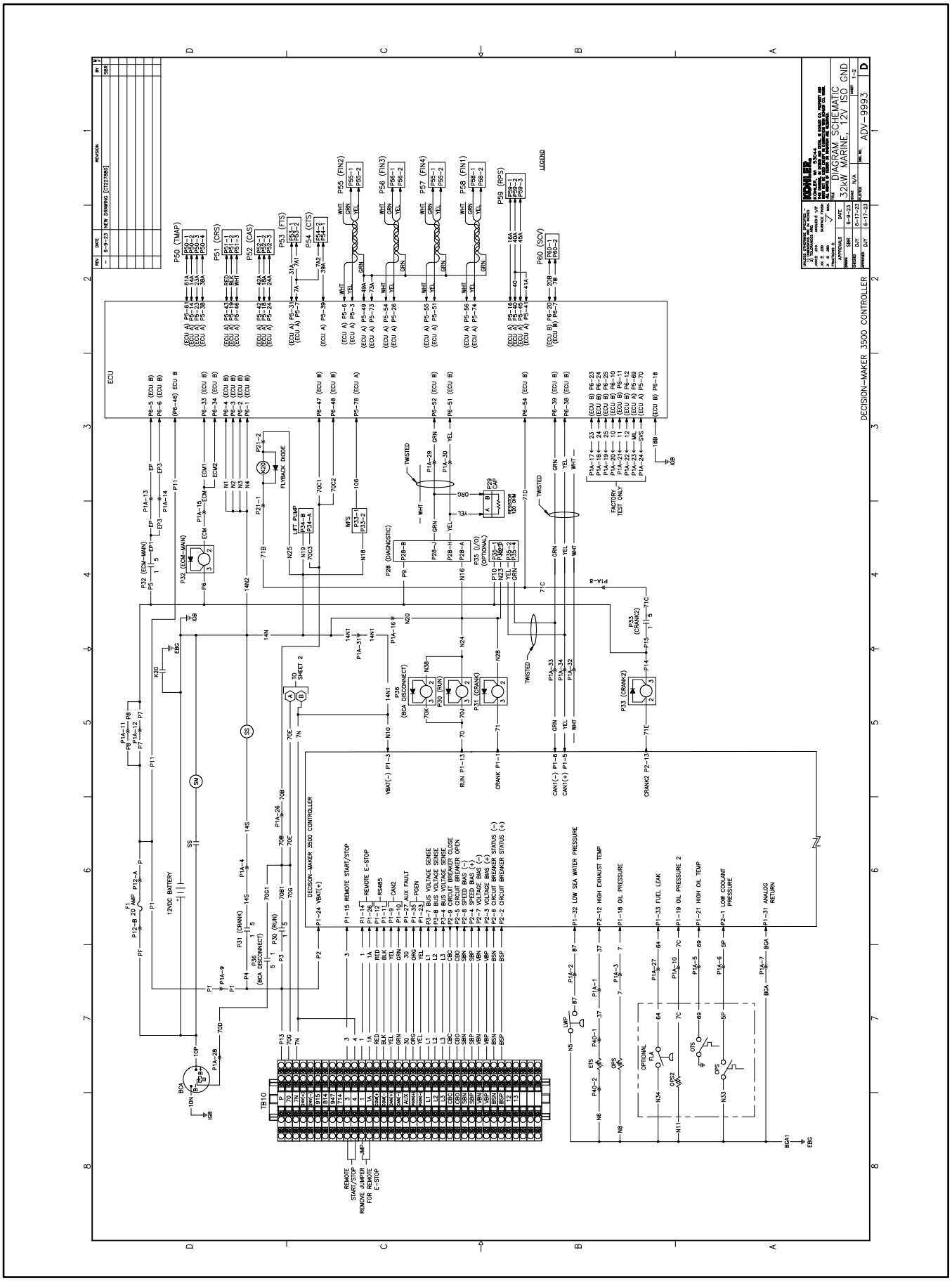

Figure 79 Wiring Diagram, Schematic (Sheet 1 of 2) for 32EKOZD/28EFKOZD 12-Volt, Isolated Ground Models

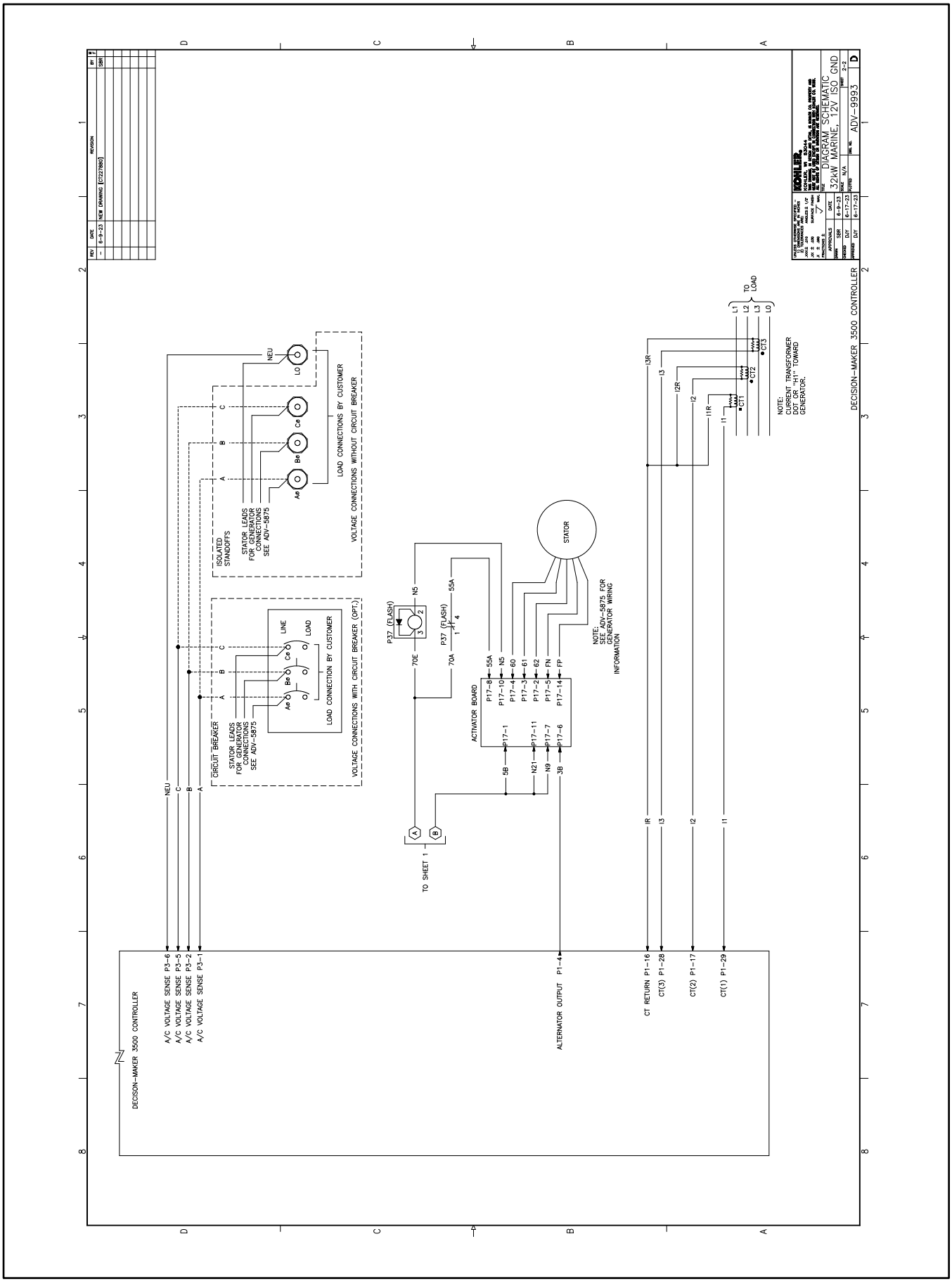

Figure 80 Wiring Diagram, Schematic (Sheet 2 of 2) for 32EKOZD/28EFKOZD 12-Volt, Isolated Ground Models

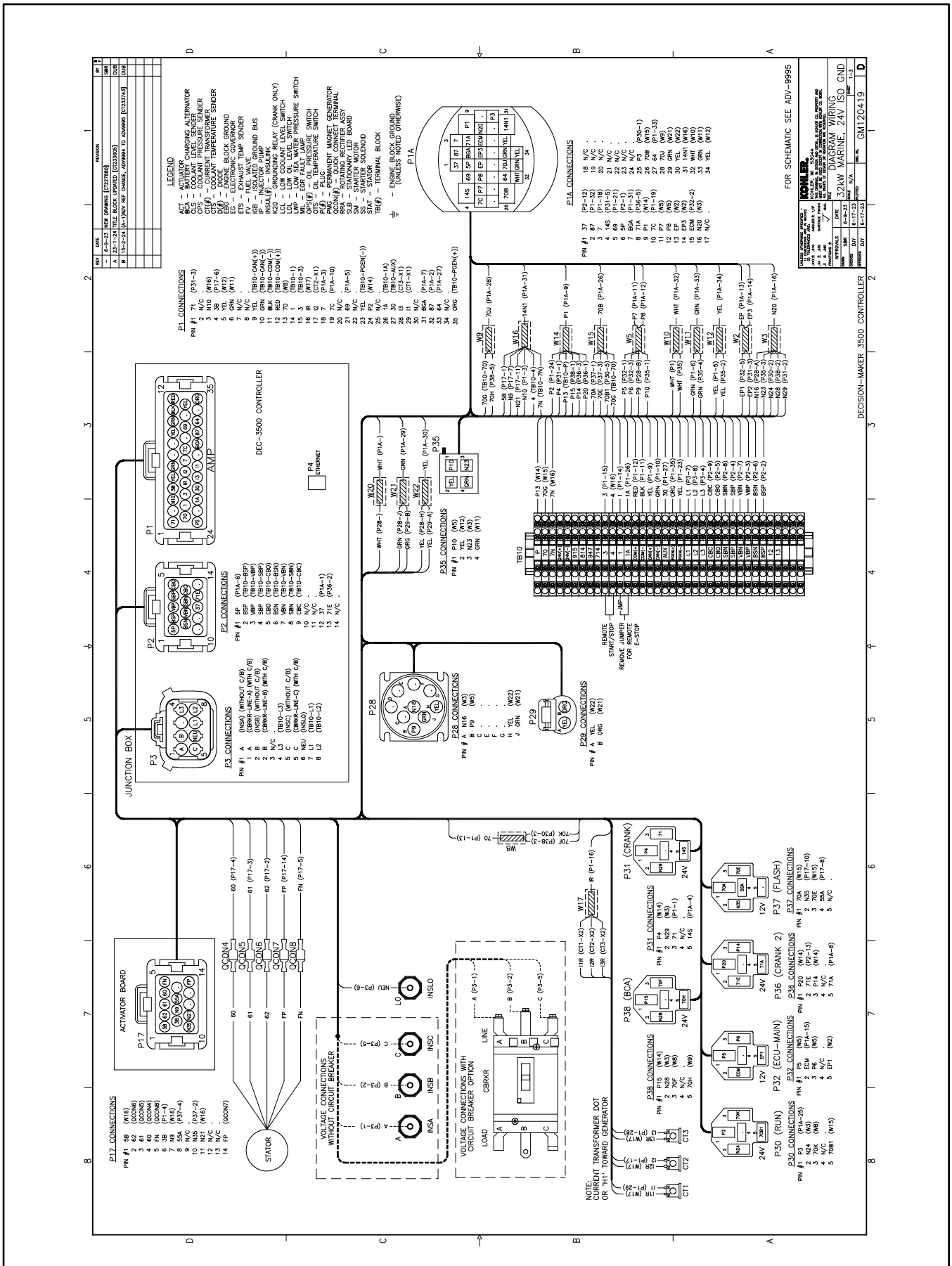

Figure 81 Wiring Diagram, Point-to-Point (Sheet 1 of 3) for 32EKOZD/28EFKOZD 24-Volt, Isolated Ground Models

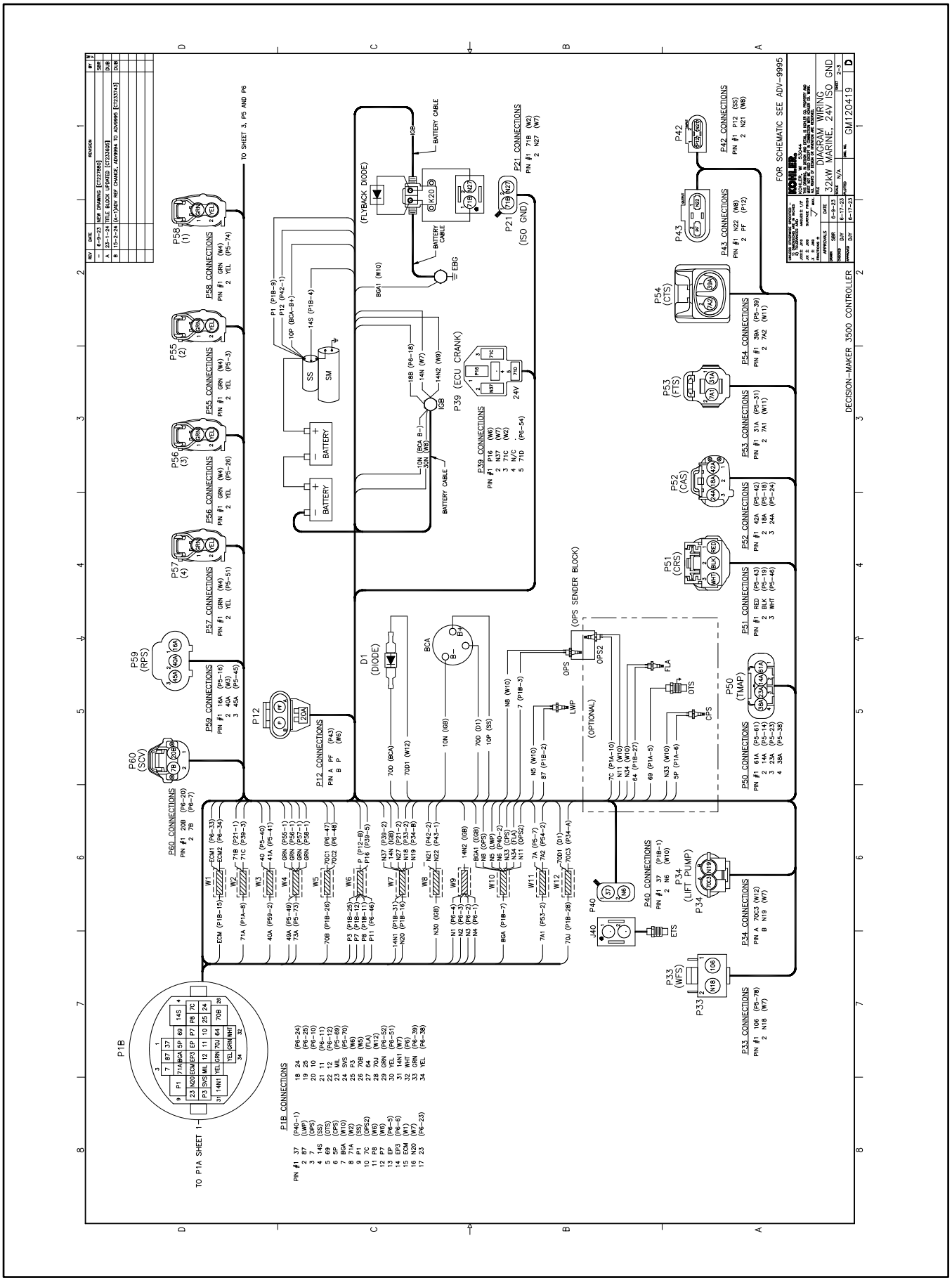

Figure 82 Wiring Diagram, Point-to-Point (Sheet 2 of 3) for 32EKOZD/28EFKOZD 24-Volt, Isolated Ground Models

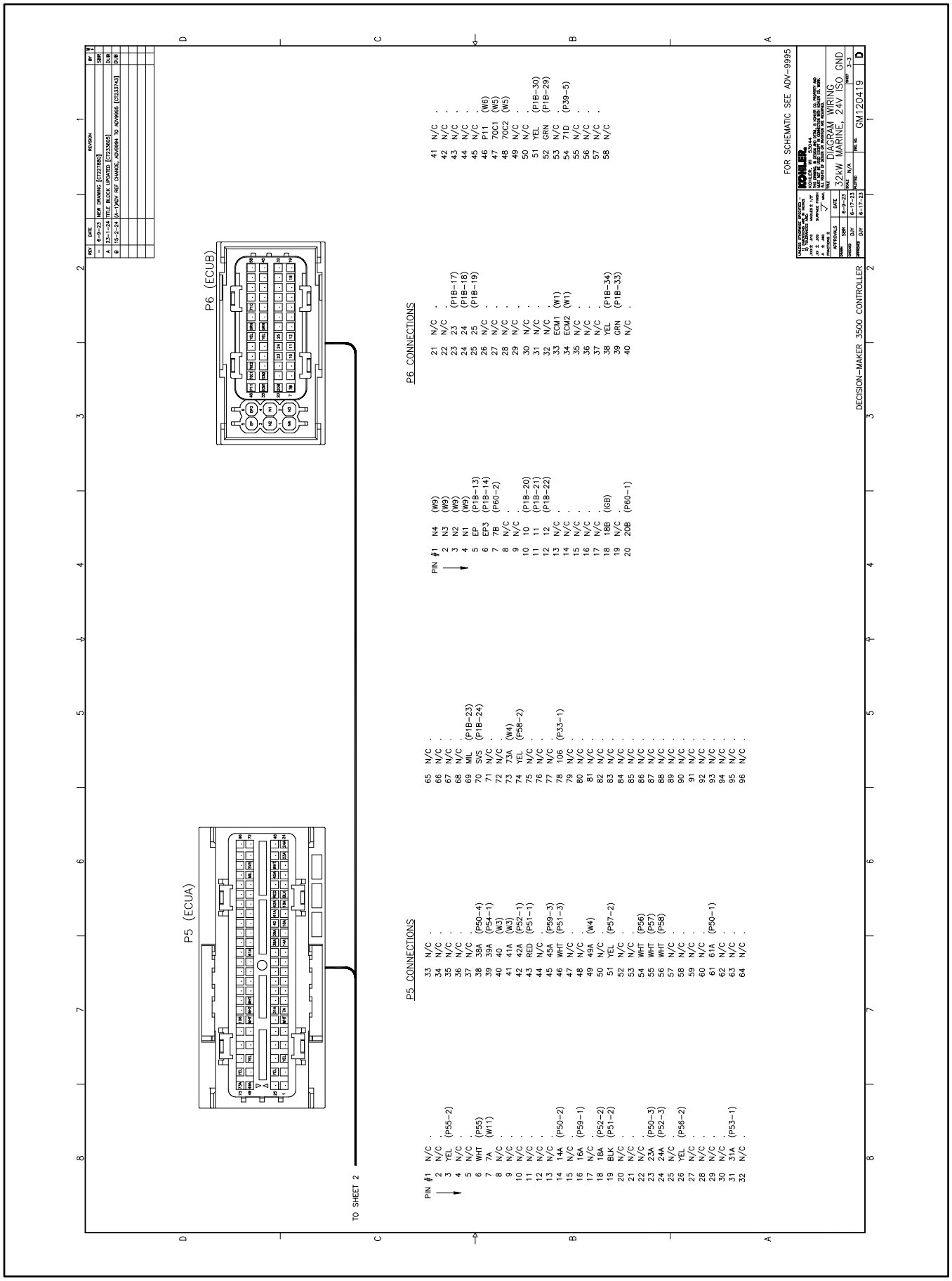

Figure 83 Wiring Diagram, Point-to-Point (Sheet 3 of 3) for 32EKOZD/28EFKOZD 24-Volt, Isolated Ground Models

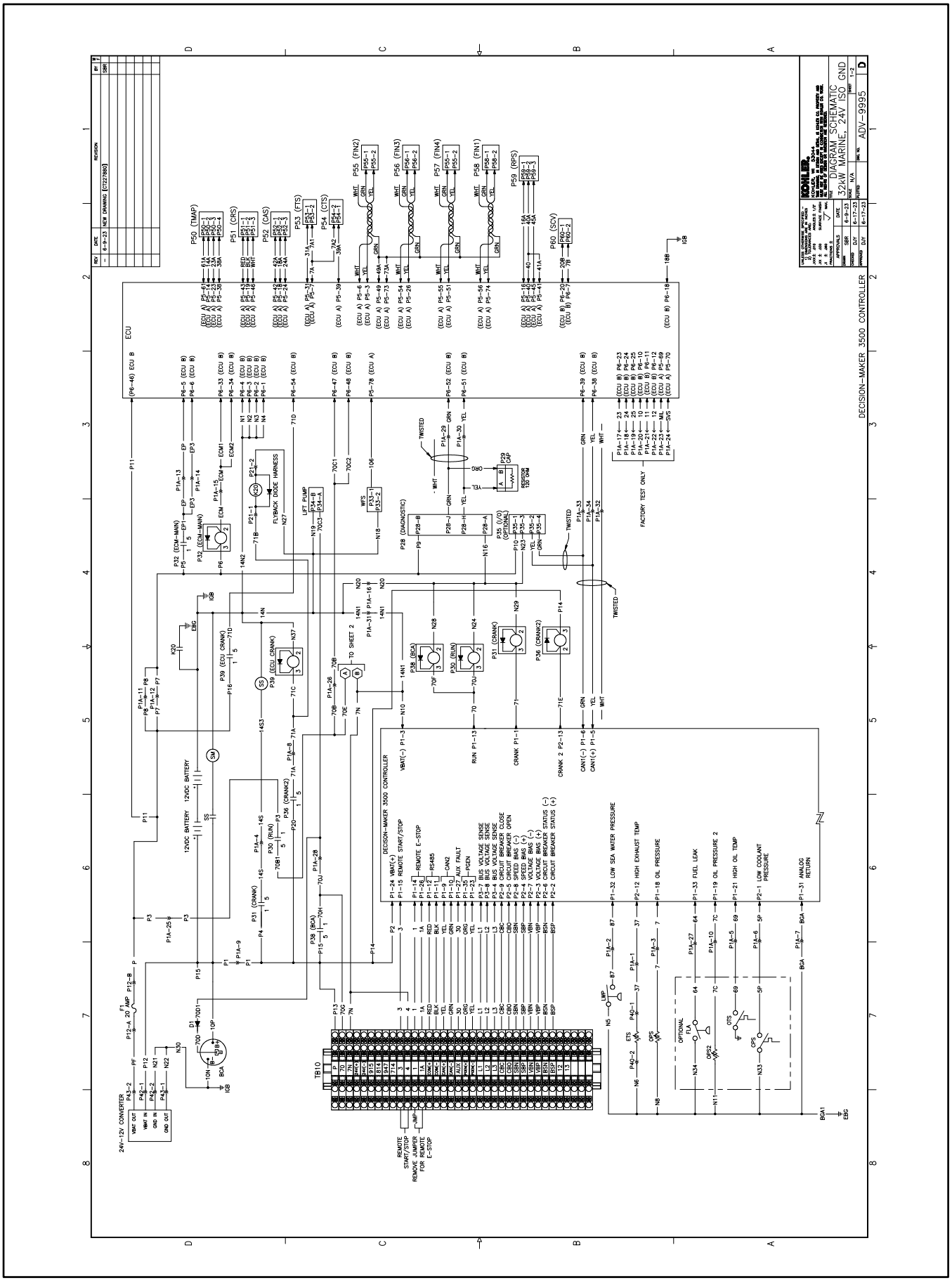

Figure 84 Wiring Diagram, Schematic (Sheet 1 of 2) for 32EKOZD/28EFKOZD 24-Volt, Isolated Ground Models

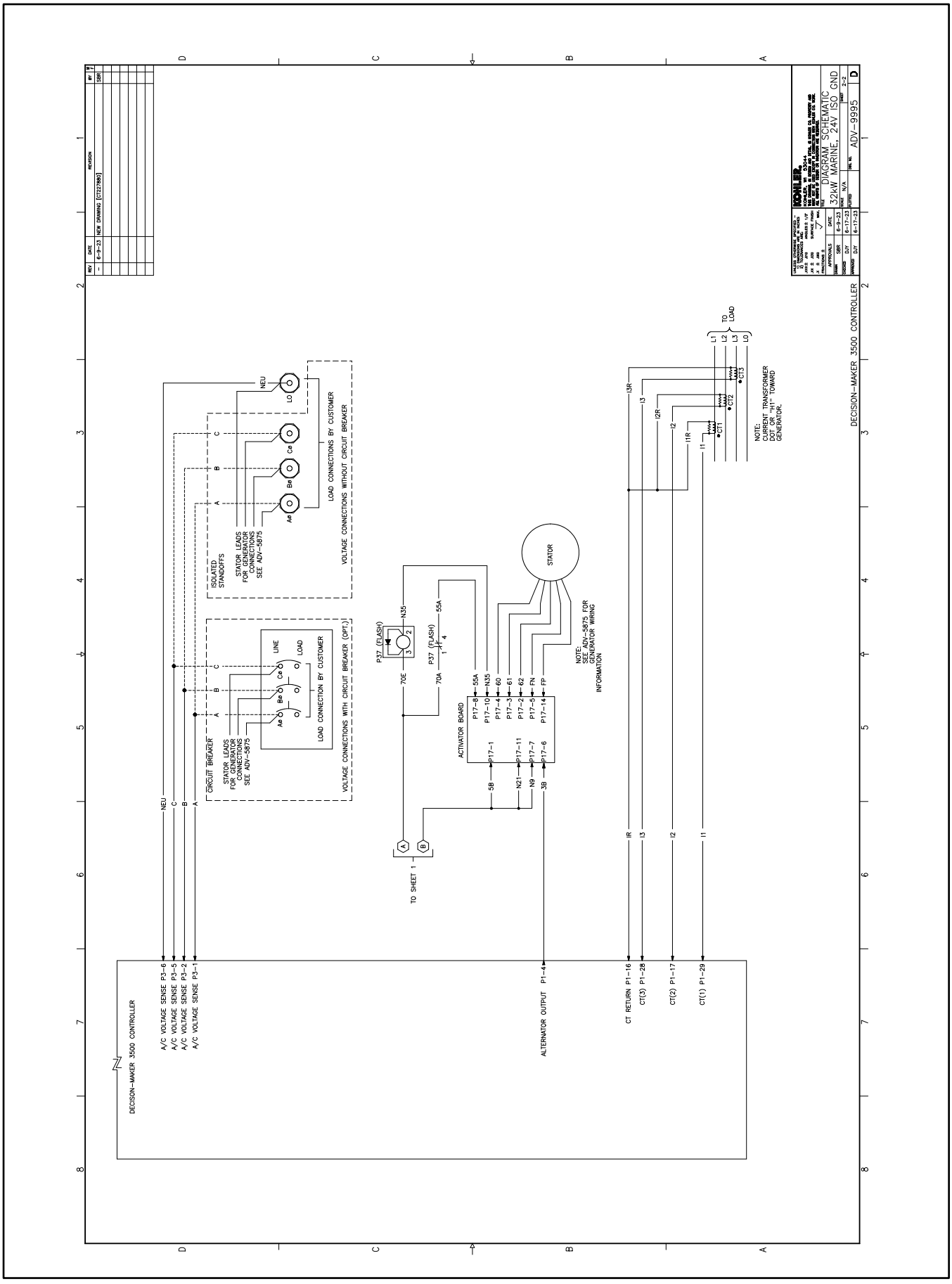

Figure 85 Wiring Diagram, Schematic (Sheet 2 of 2) for 32EKOZD/28EFKOZD 24-Volt, Isolated Ground Models

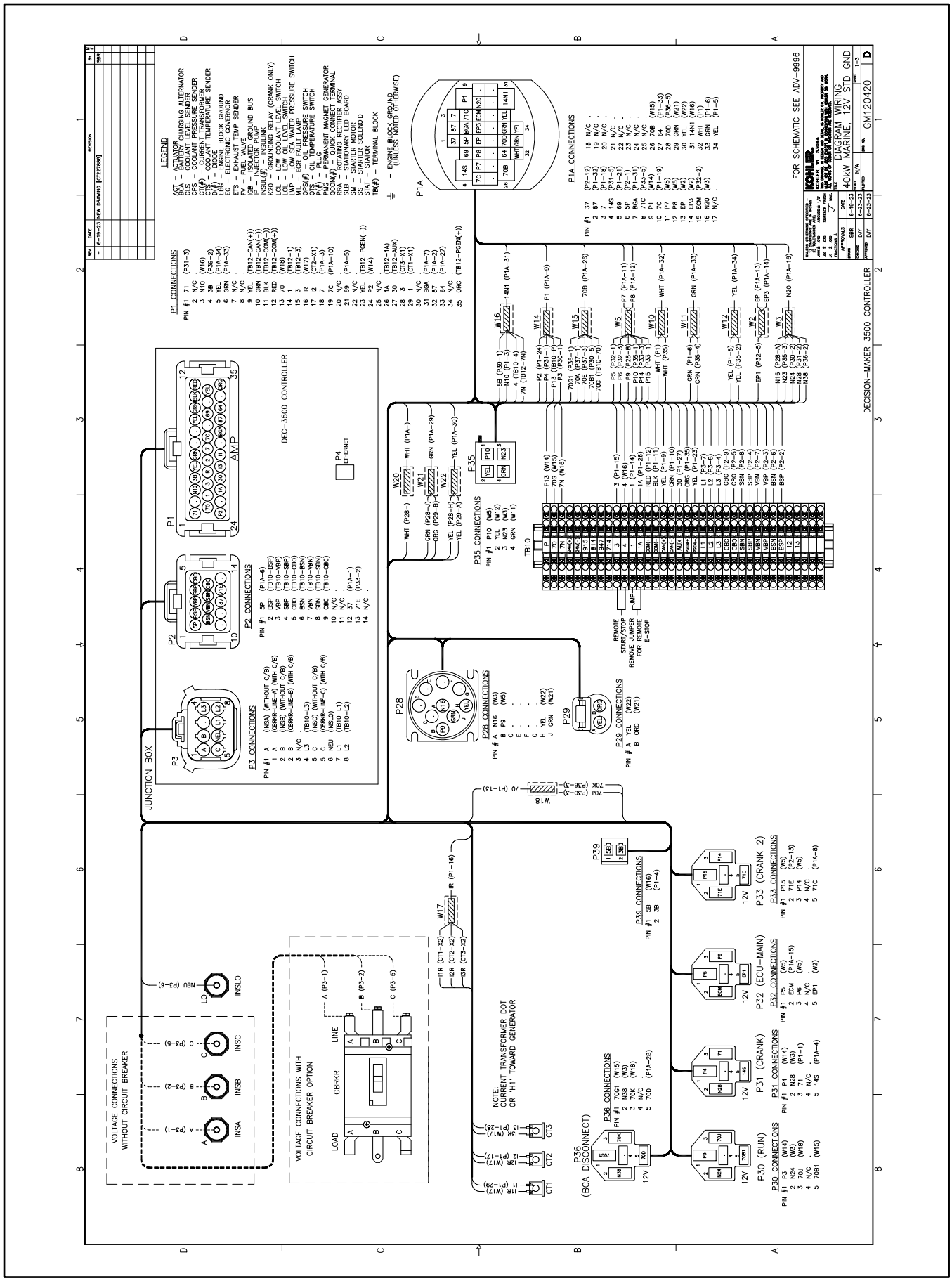

Figure 86 Wiring Diagram, Point-to-Point (Sheet 1 of 3) for 40EKOZD/35EFKOZD 12-Volt, Standard Ground Models

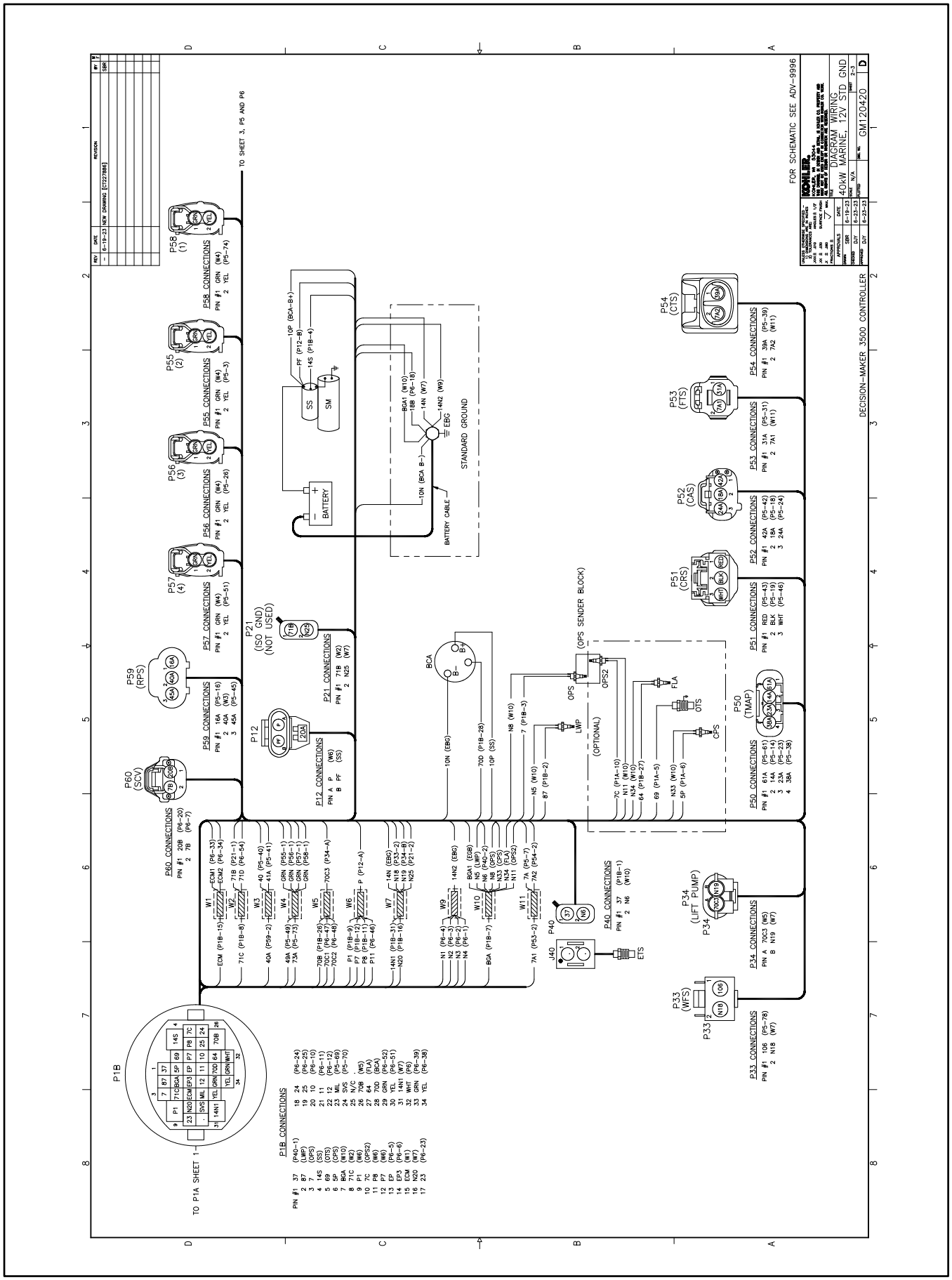

Figure 87 Wiring Diagram, Point-to-Point (Sheet 2 of 3) for 40EKOZD/35EFKOZD 12-Volt, Standard Ground Models

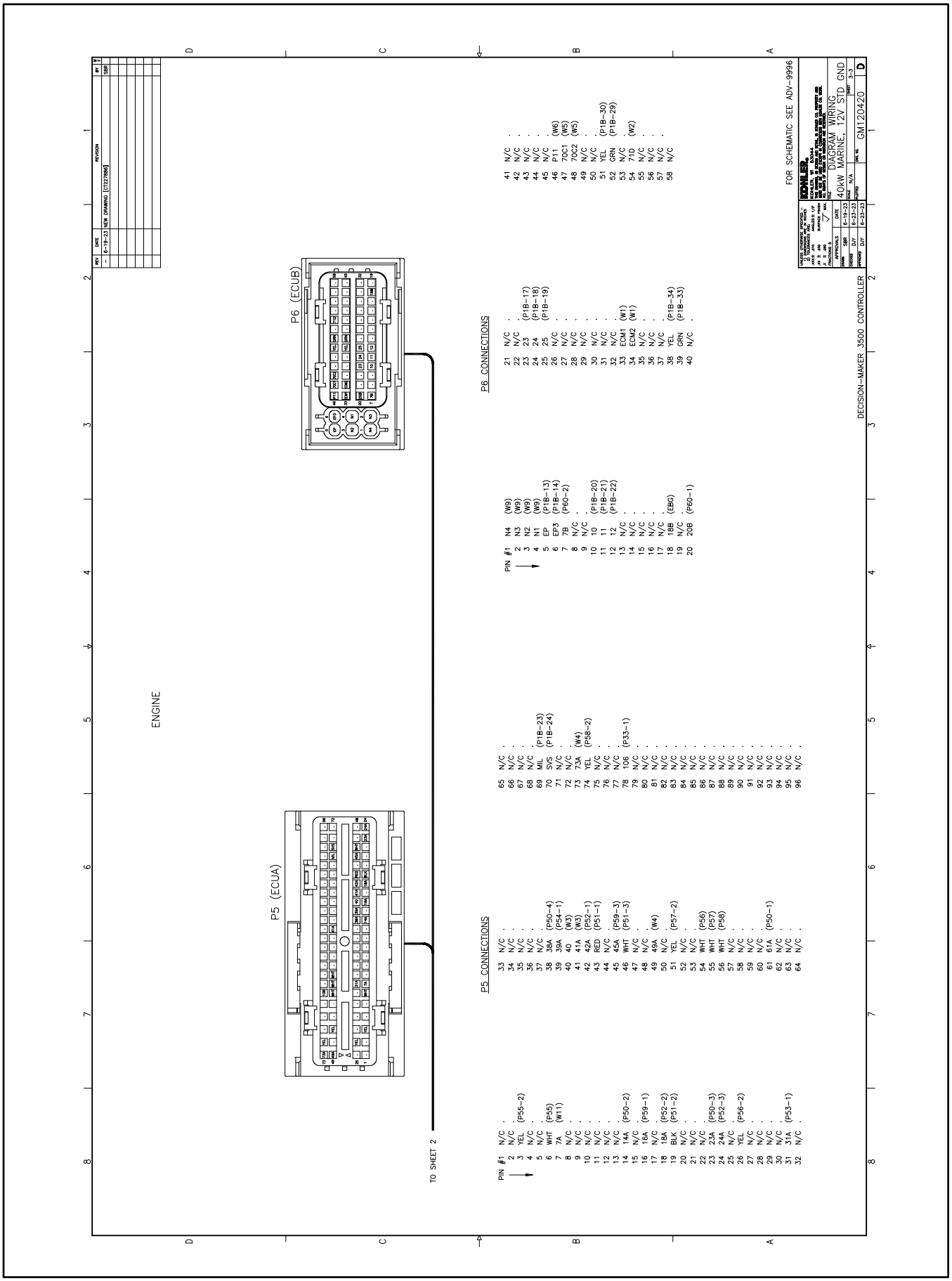

Figure 88 Wiring Diagram, Point-to-Point (Sheet 3 of 3) for 40EKOZD/35EFKOZD 12-Volt, Standard Ground Models

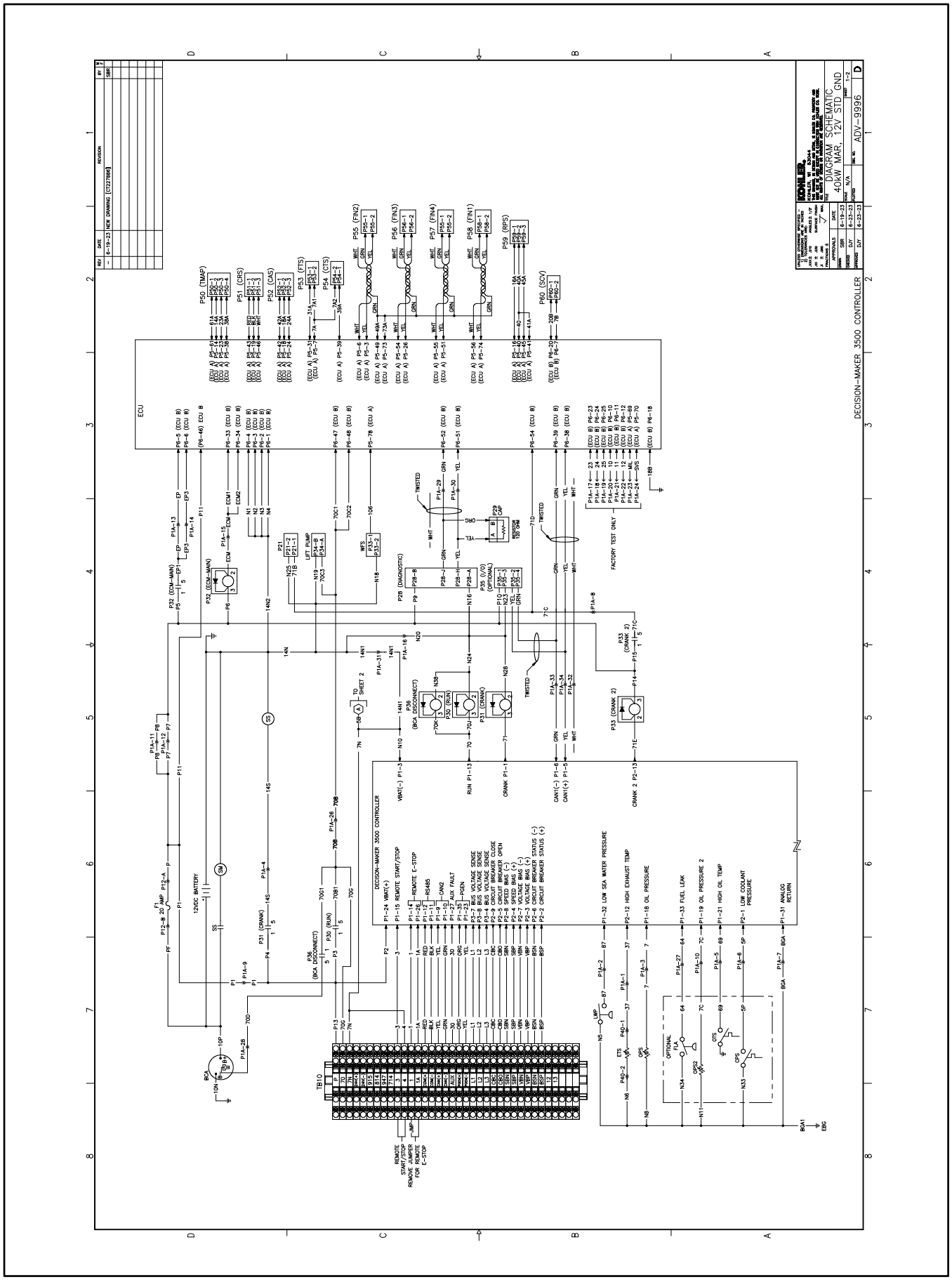

Figure 89 Wiring Diagram, Schematic (Sheet 1 of 2) for 40EKOZD/35EFKOZD 12-Volt, Standard Ground Models

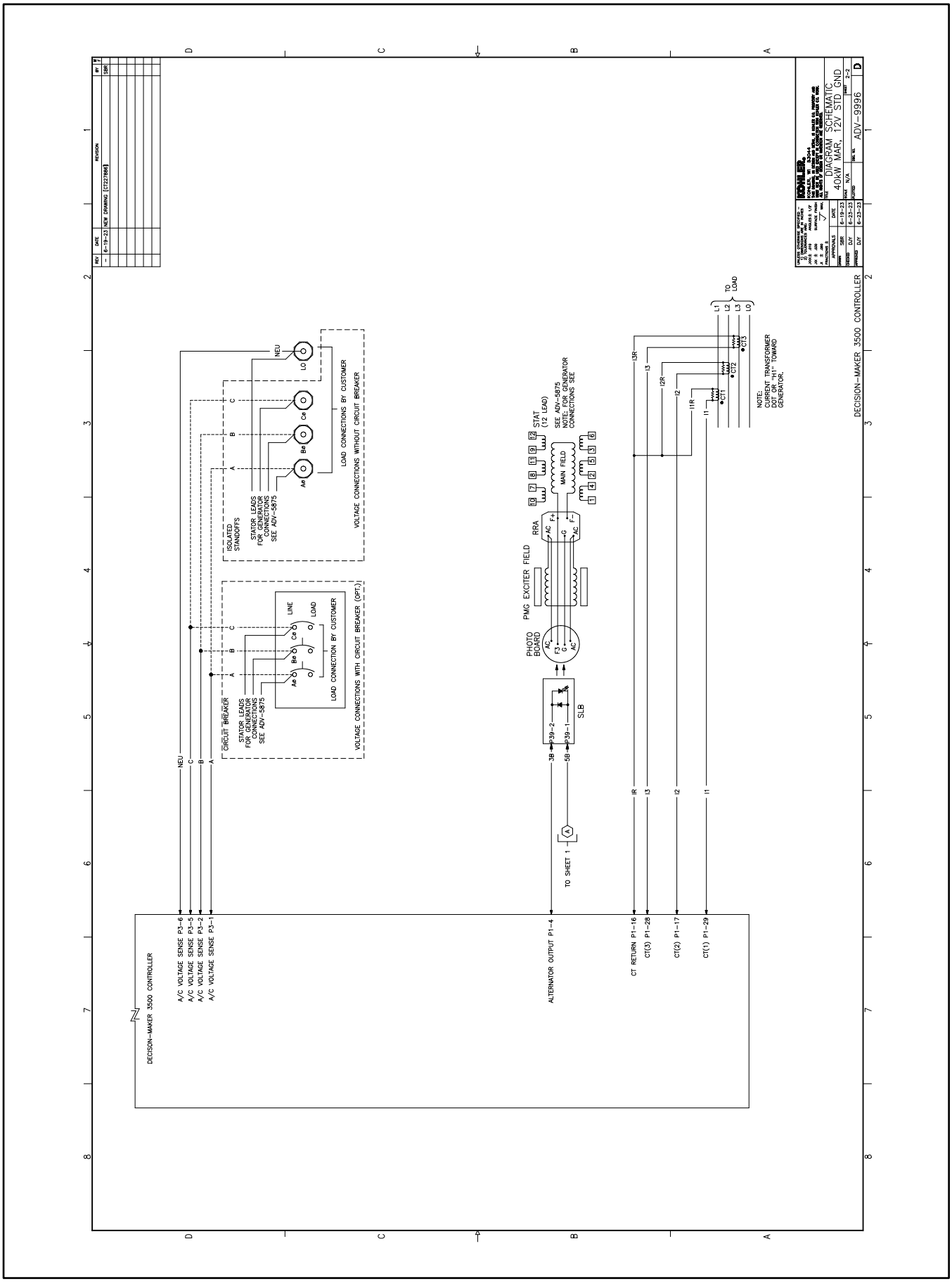

Figure 90 Wiring Diagram, Schematic (Sheet 2 of 2) for 40EKOZD/35EFKOZD 12-Volt, Standard Ground Models

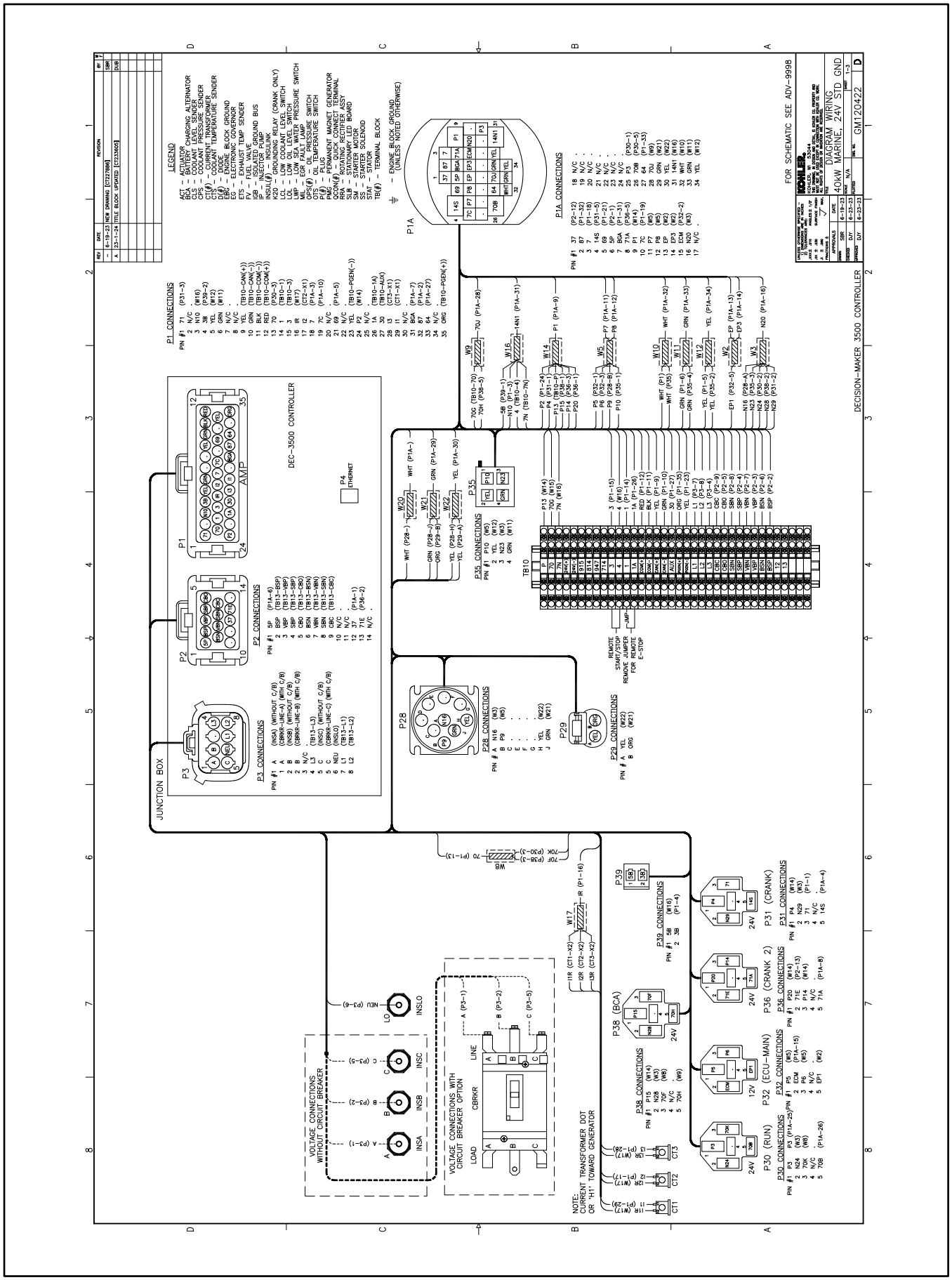

Figure 91 Wiring Diagram, Point-to-Point (Sheet 1 of 3) for 40EKOZD/35EFKOZD 24-Volt, Standard Ground Models

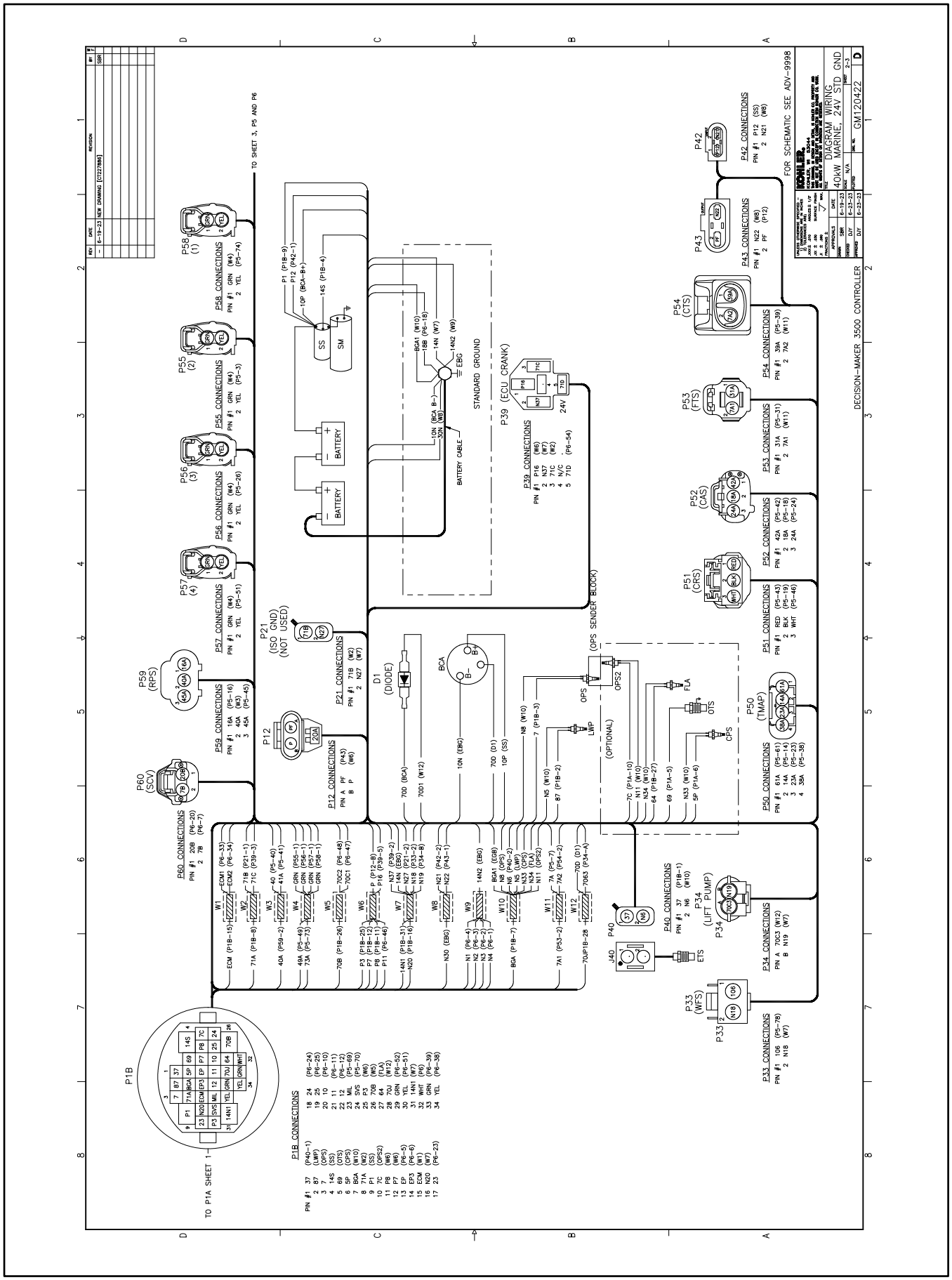

Figure 92 Wiring Diagram, Point-to-Point (Sheet 2 of 3) for 40EKOZD/35EFKOZD 24-Volt, Standard Ground Models

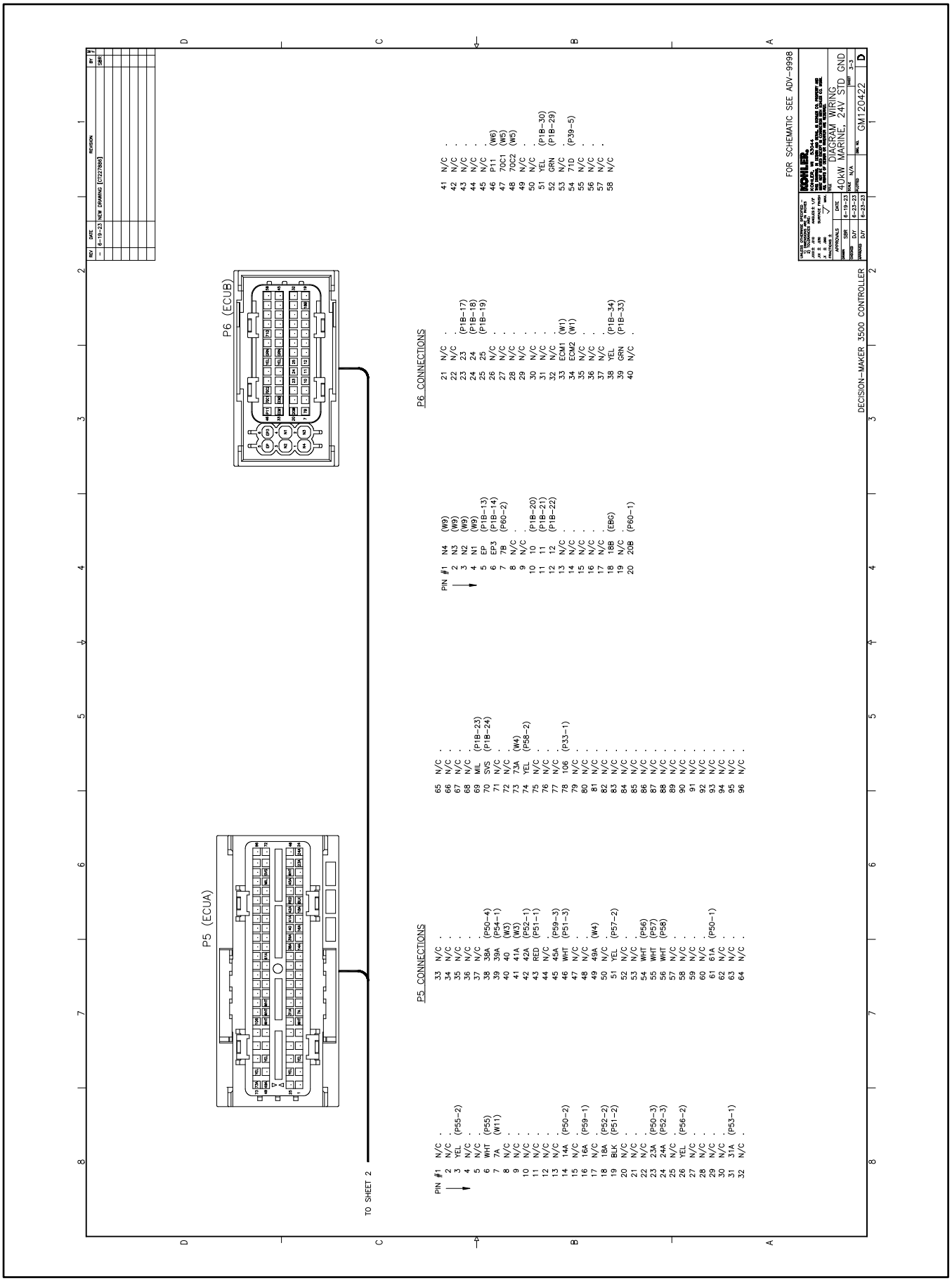

Figure 93 Wiring Diagram, Point-to-Point (Sheet 3 of 3) for 40EKOZD/35EFKOZD 24-Volt, Standard Ground Models

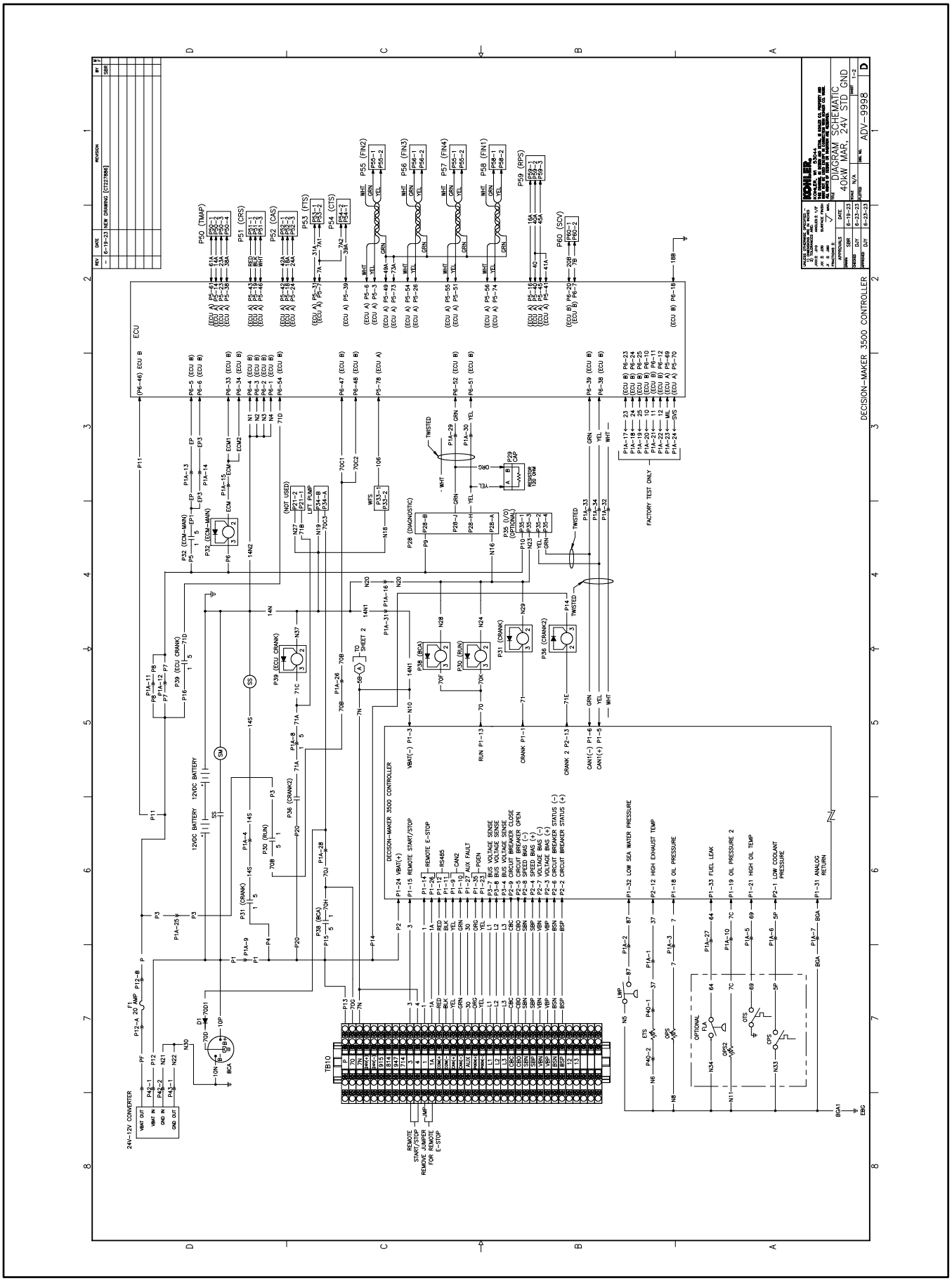

Figure 94 Wiring Diagram, Schematic (Sheet 1 of 2) for 40EKOZD/35EFKOZD 24-Volt, Standard Ground Models

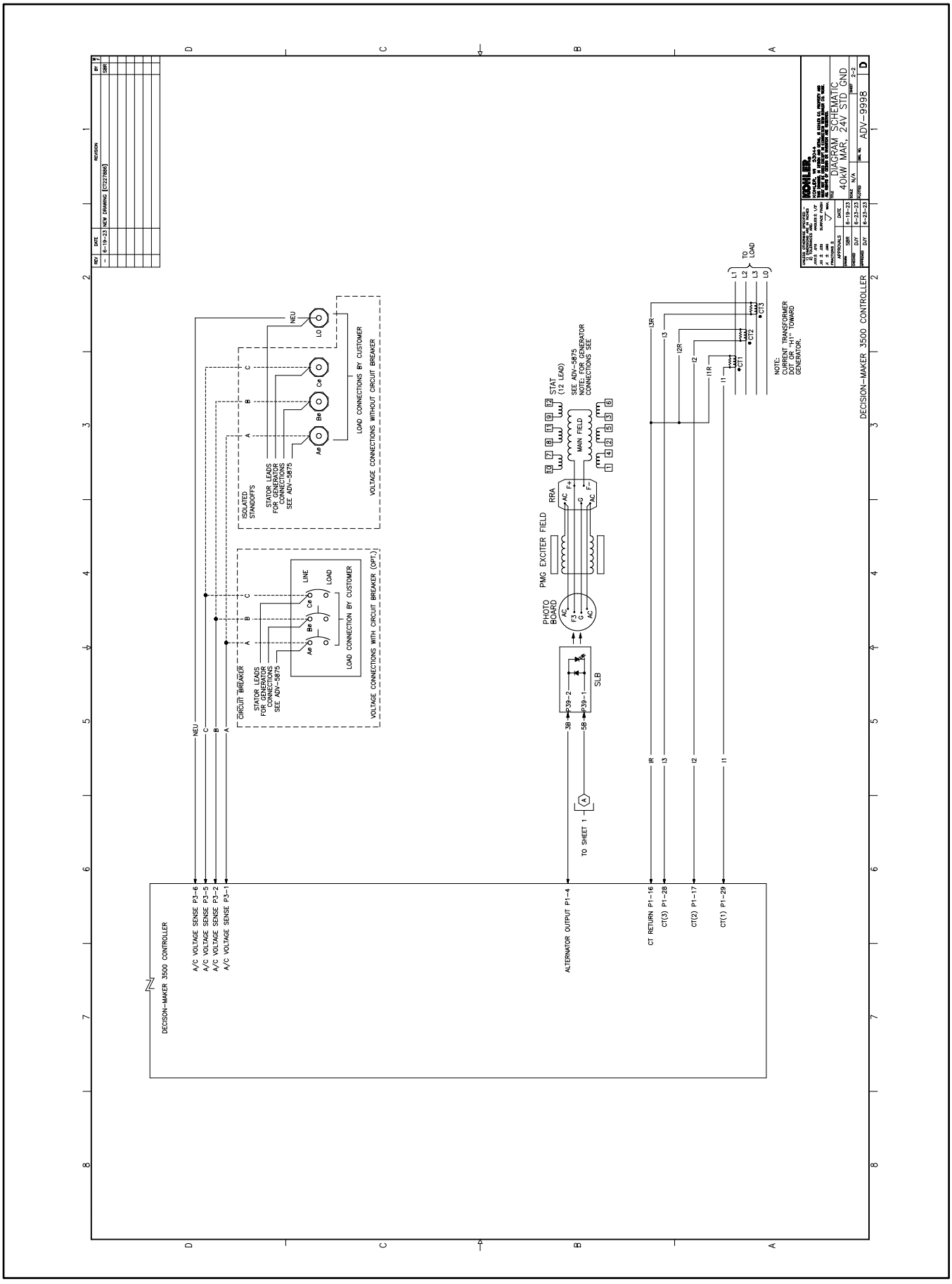

Figure 95 Wiring Diagram, Schematic (Sheet 2 of 2) for 40EKOZD/35EFKOZD 24-Volt, Standard Ground Models

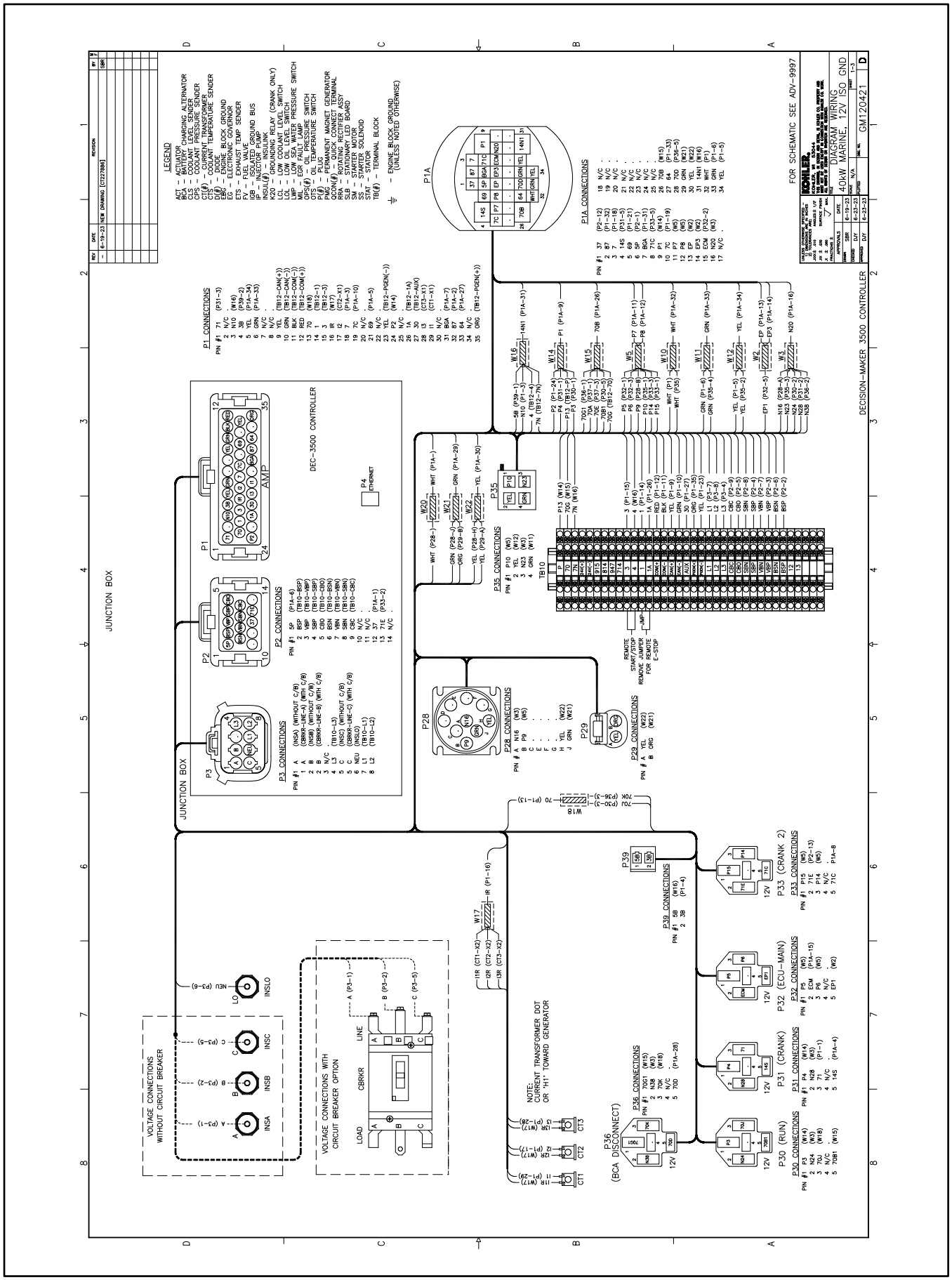

Figure 96 Wiring Diagram, Point-to-Point (Sheet 1 of 3) for 40EKOZD/35EFKOZD 12-Volt, Isolated Ground Models

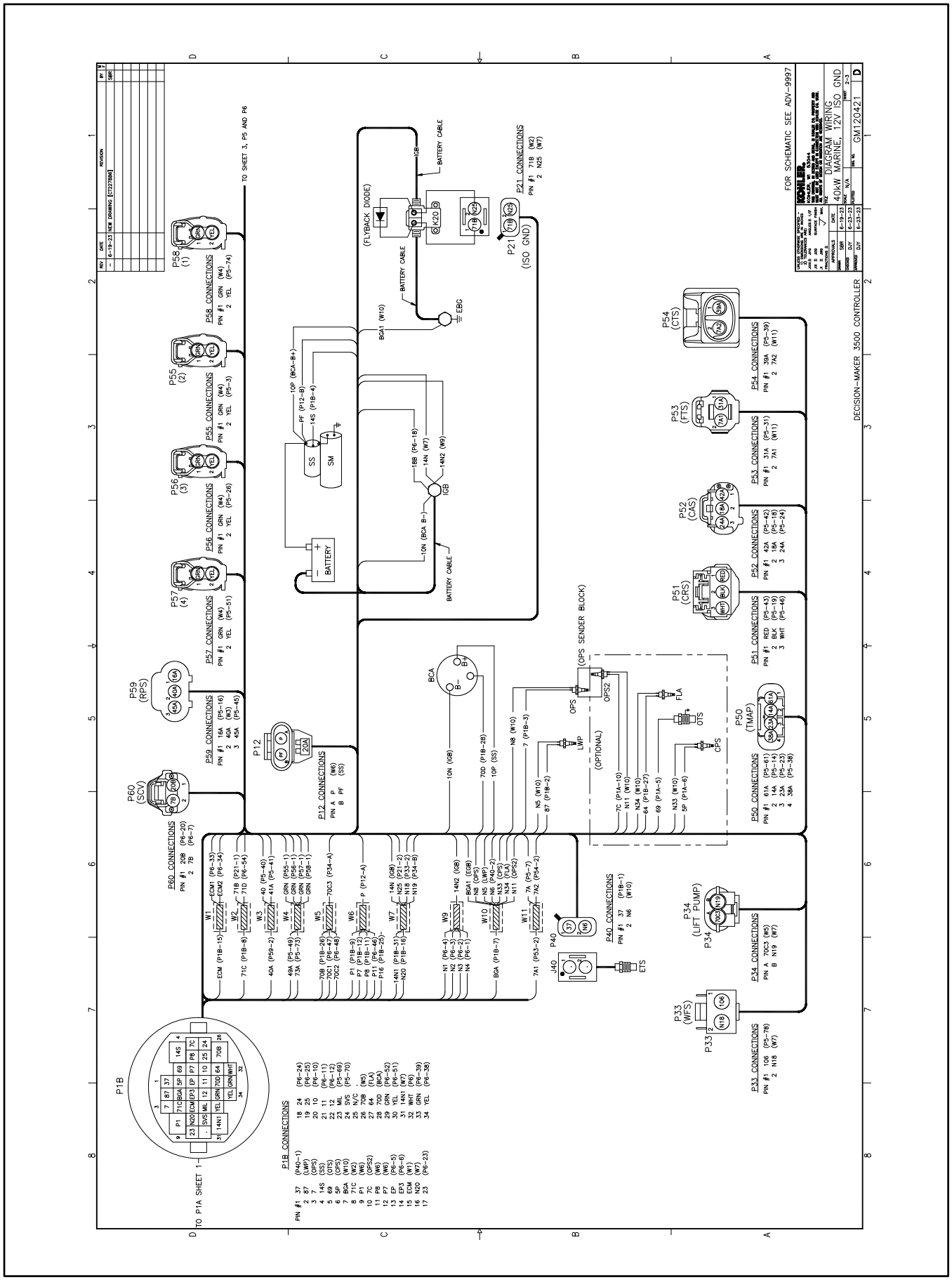

Figure 97 Wiring Diagram, Point-to-Point (Sheet 2 of 3) for 40EKOZD/35EFKOZD 12-Volt, Isolated Ground Models

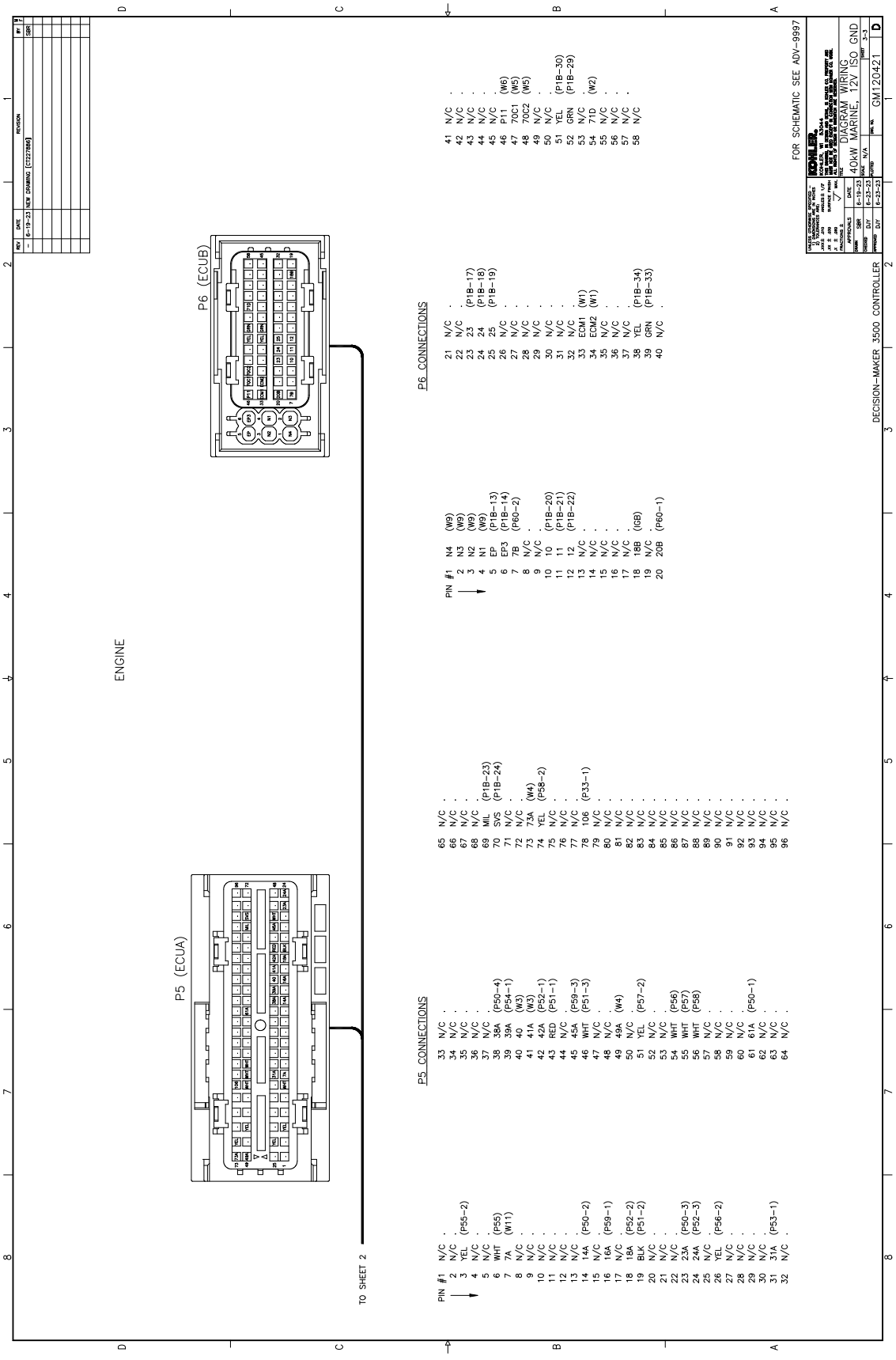

Figure 98 Wiring Diagram, Point-to-Point (Sheet 3 of 3) for 40EKOZD/35EFKOZD 12-Volt, Isolated Ground Models

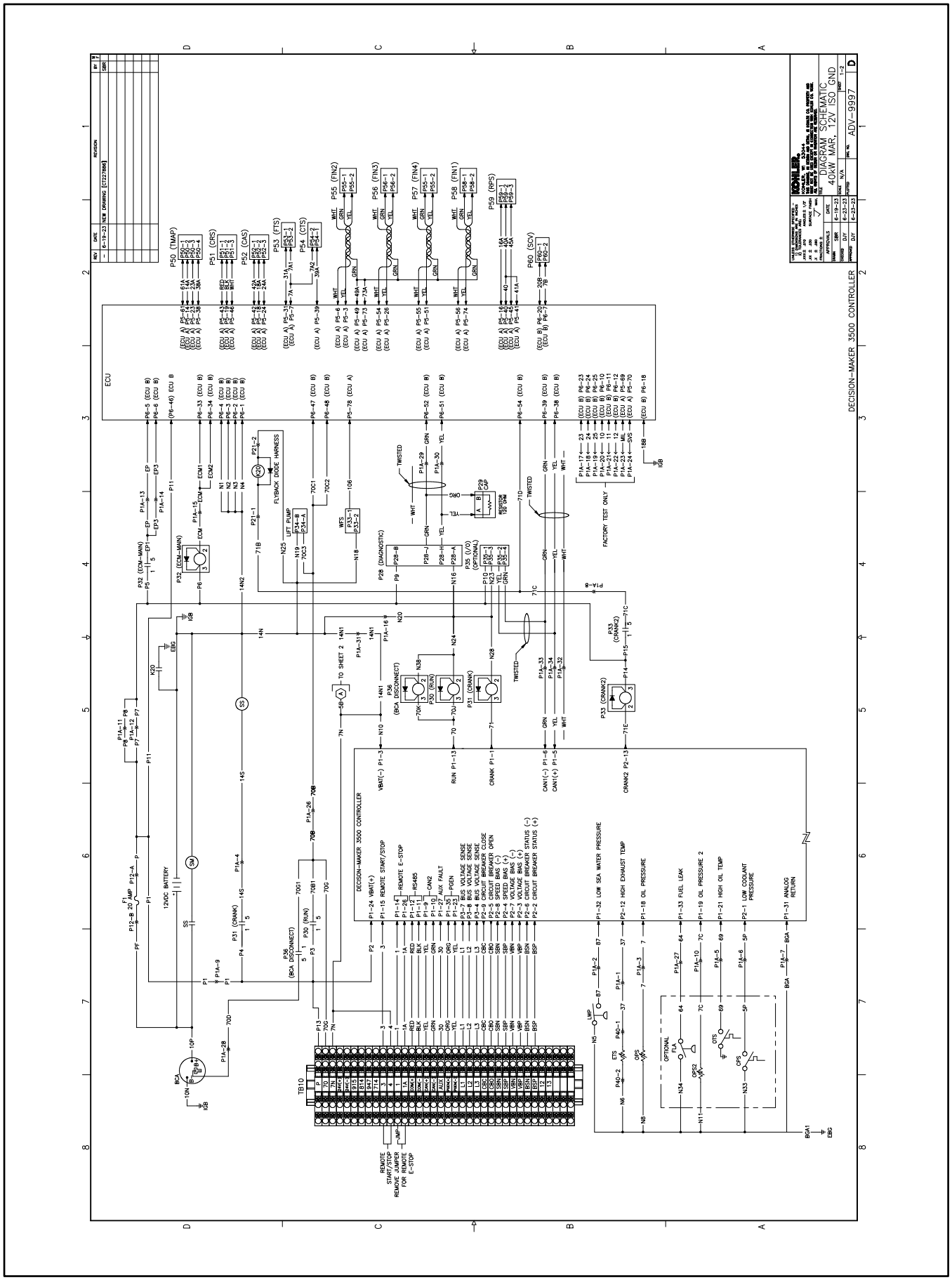

Figure 99 Wiring Diagram, Schematic (Sheet 1 of 2) for 40EKOZD/35EFKOZD 12-Volt, Isolated Ground Models

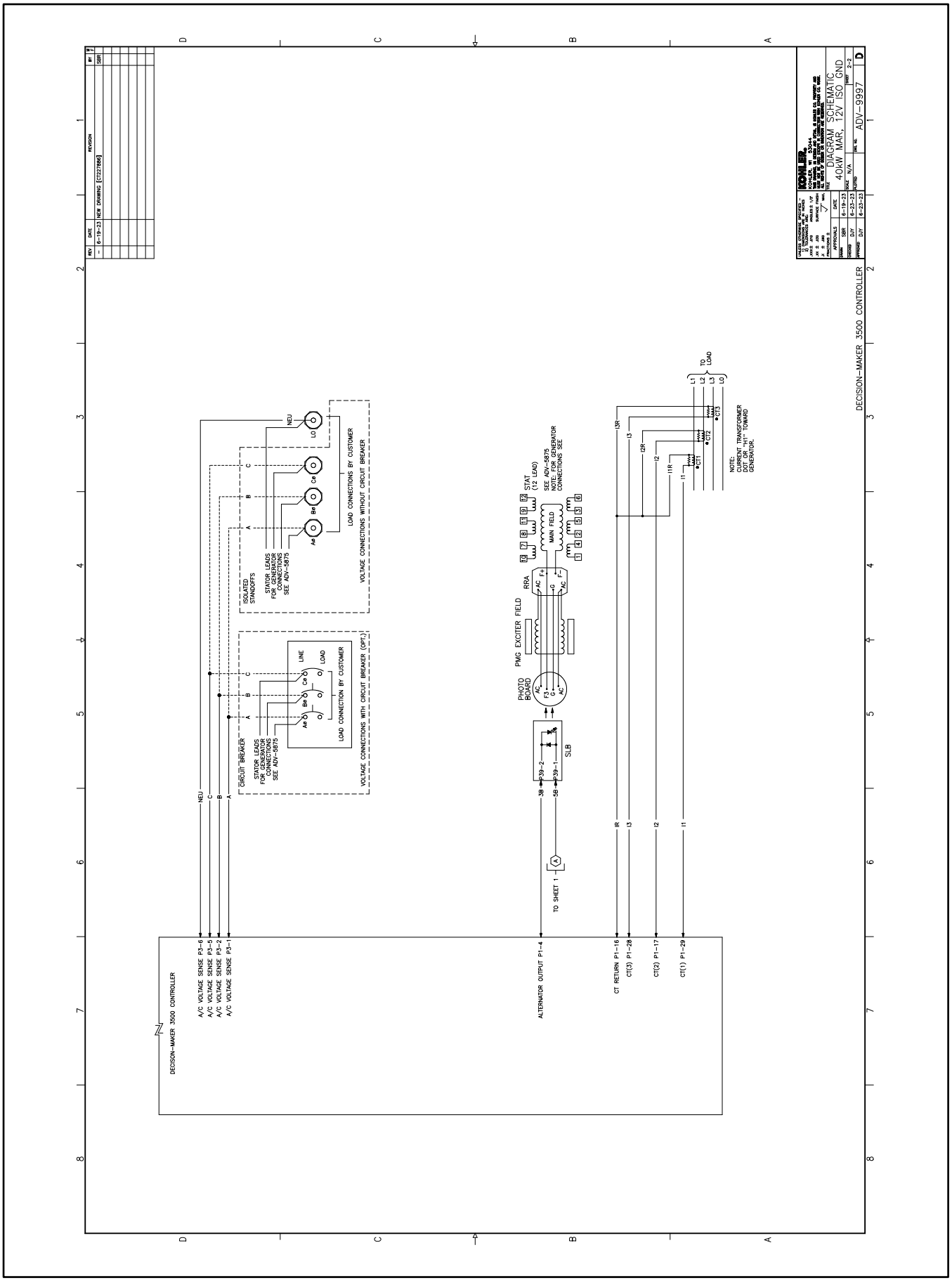

Figure 100 Wiring Diagram, Schematic (Sheet 2 of 2) for 40EKOZD/35EFKOZD 12-Volt, Isolated Ground Models

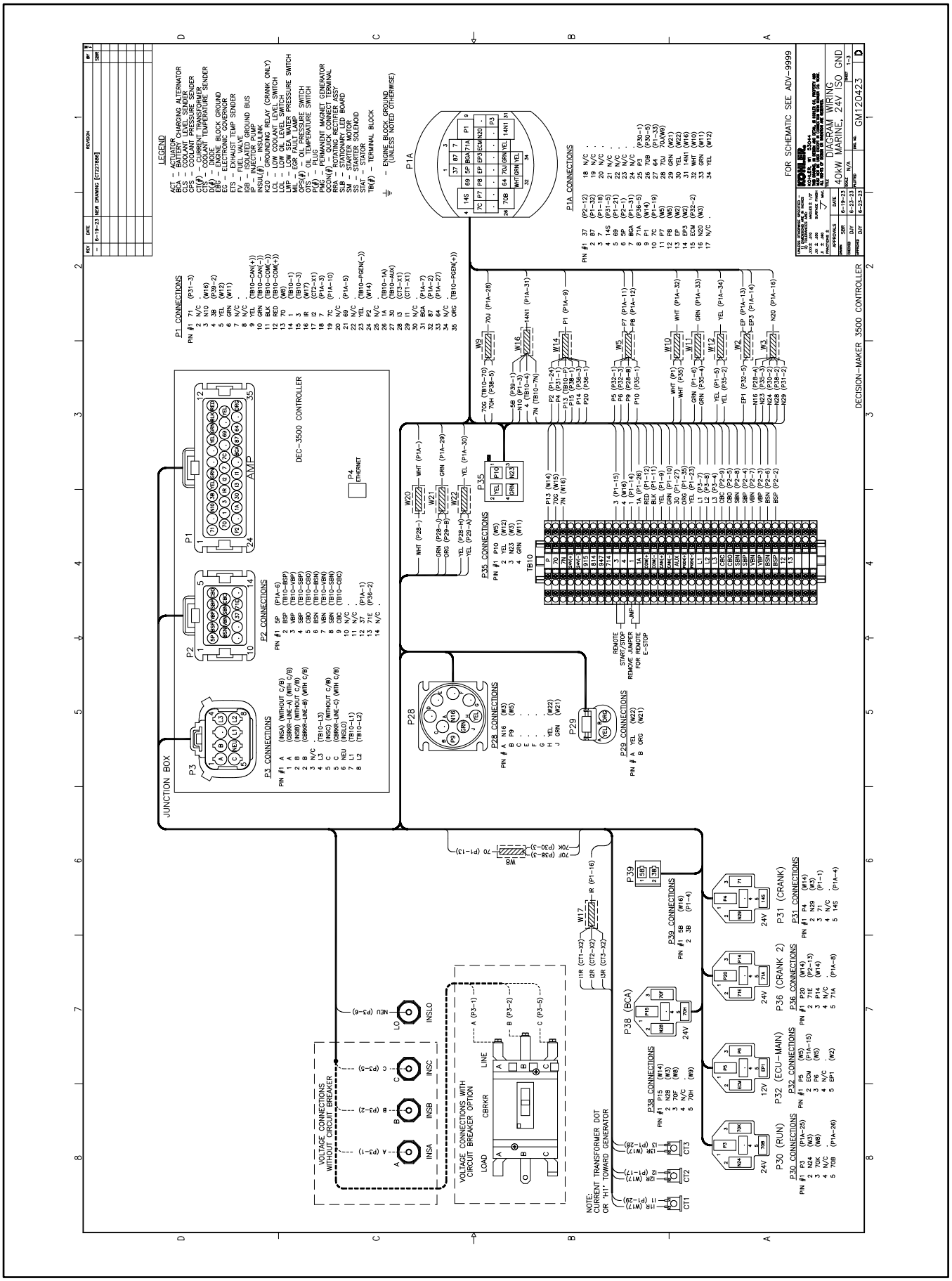

Figure 101 Wiring Diagram, Point-to-Point (Sheet 1 of 3) for 40EKOZD/35EFKOZD 24-Volt, Isolated Ground Models

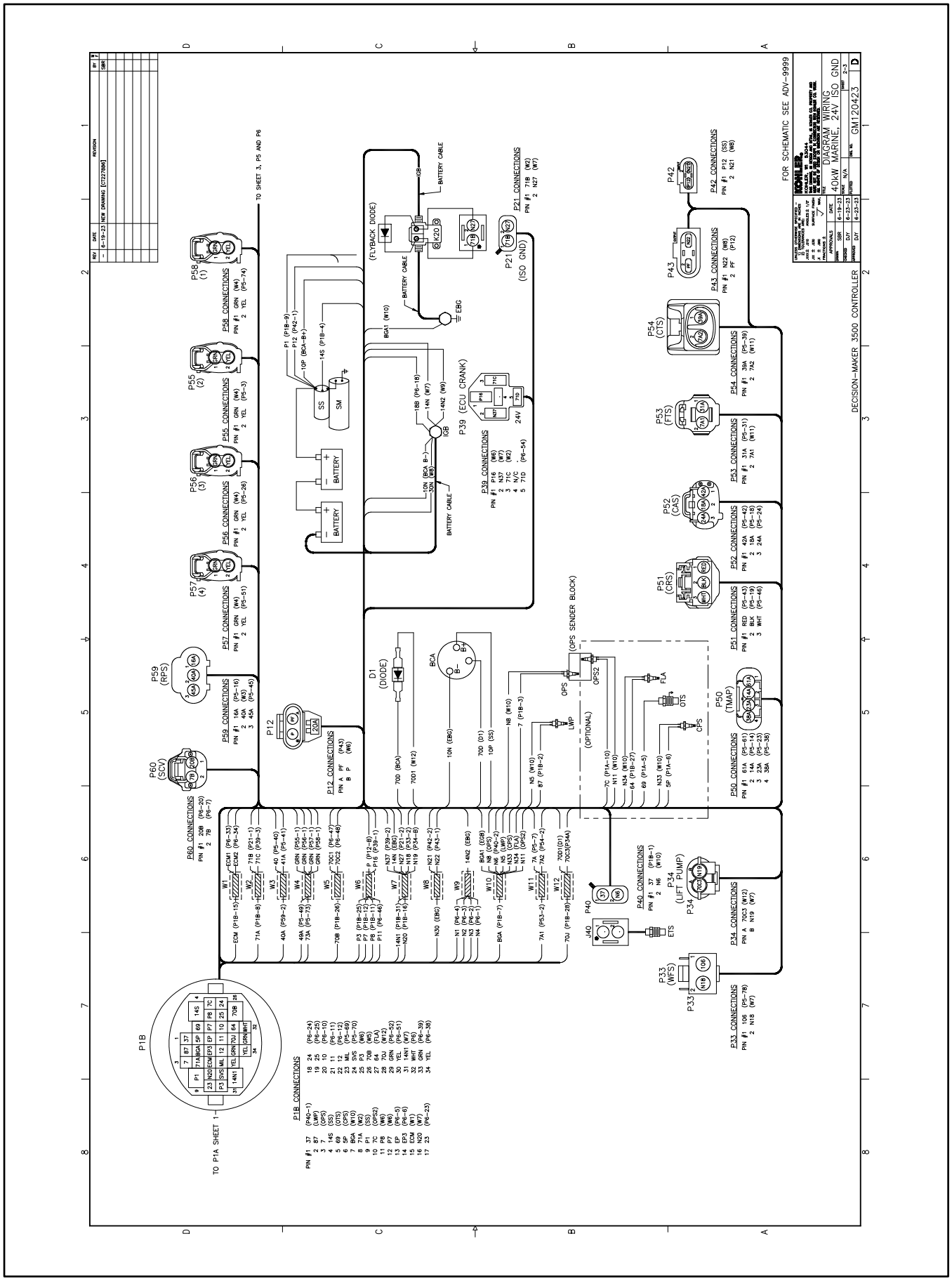

Figure 102 Wiring Diagram, Point-to-Point (Sheet 2 of 3) for 40EKOZD/35EFKOZD 24-Volt, Isolated Ground Models

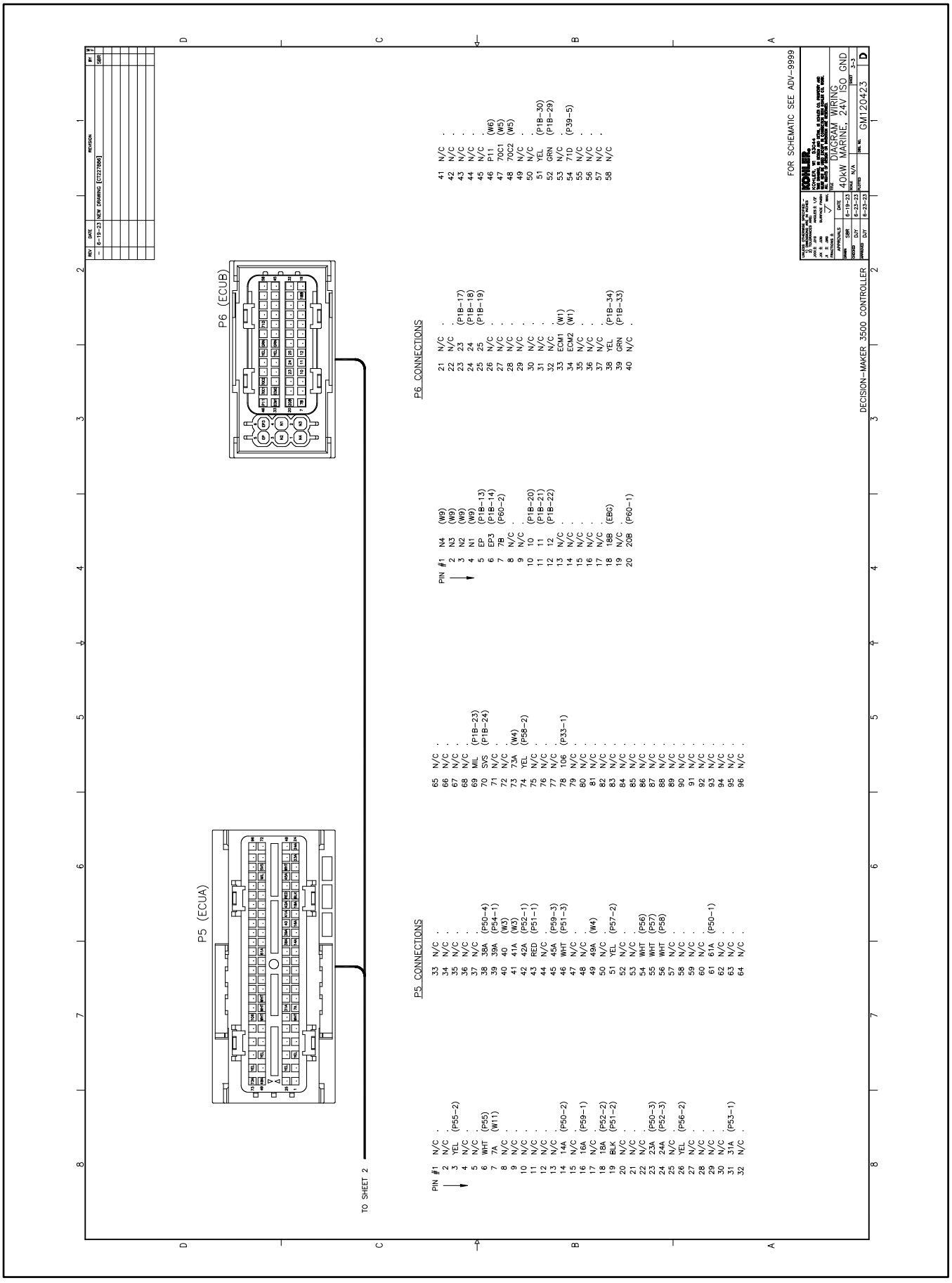

Figure 103 Wiring Diagram, Point-to-Point (Sheet 3 of 3) for 40EKOZD/35EFKOZD 24-Volt, Isolated Ground Models

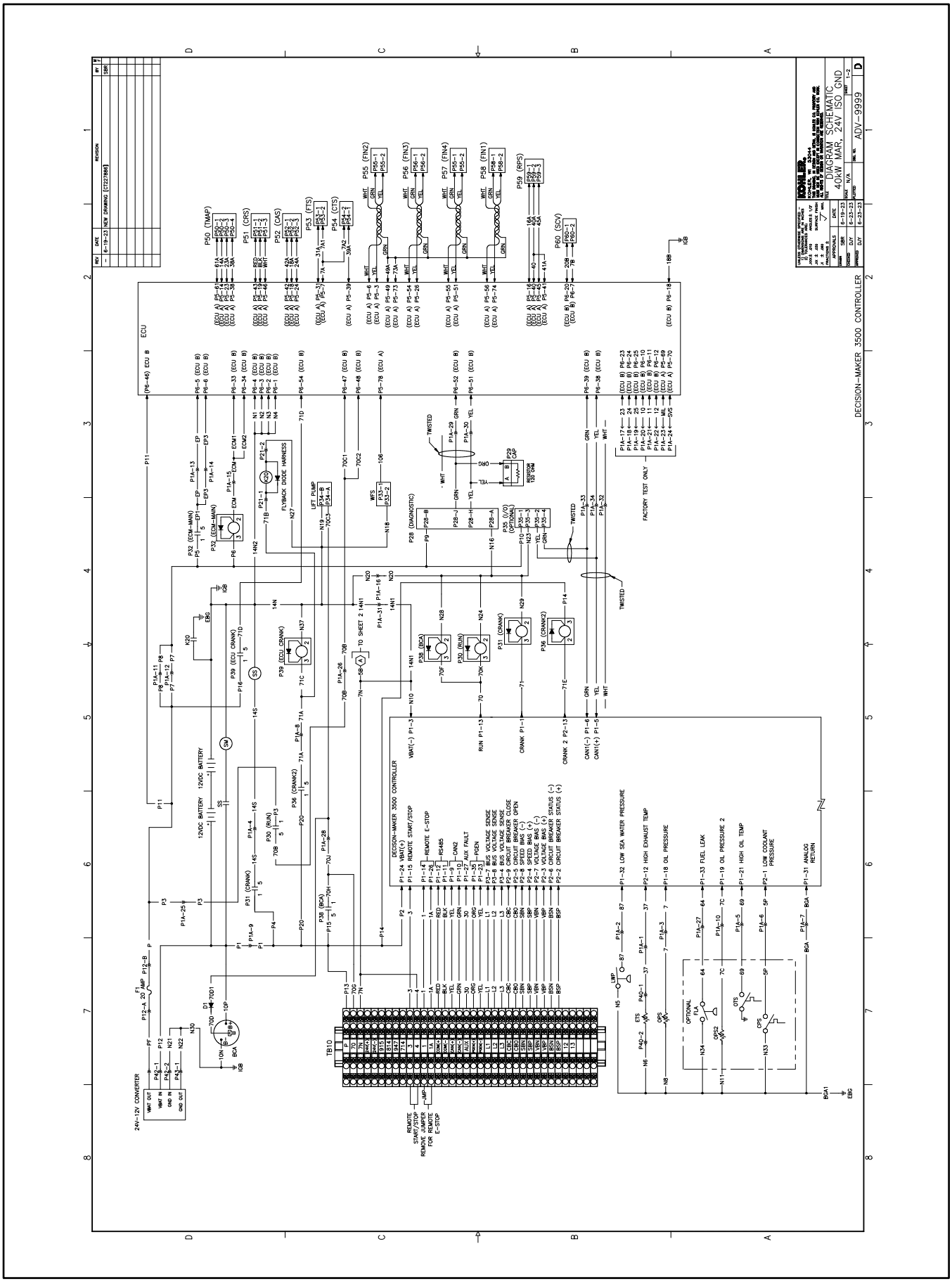

Figure 104 Wiring Diagram, Schematic (Sheet 1 of 2) for 40EKOZD/35EFKOZD 24-Volt, Isolated Ground Models

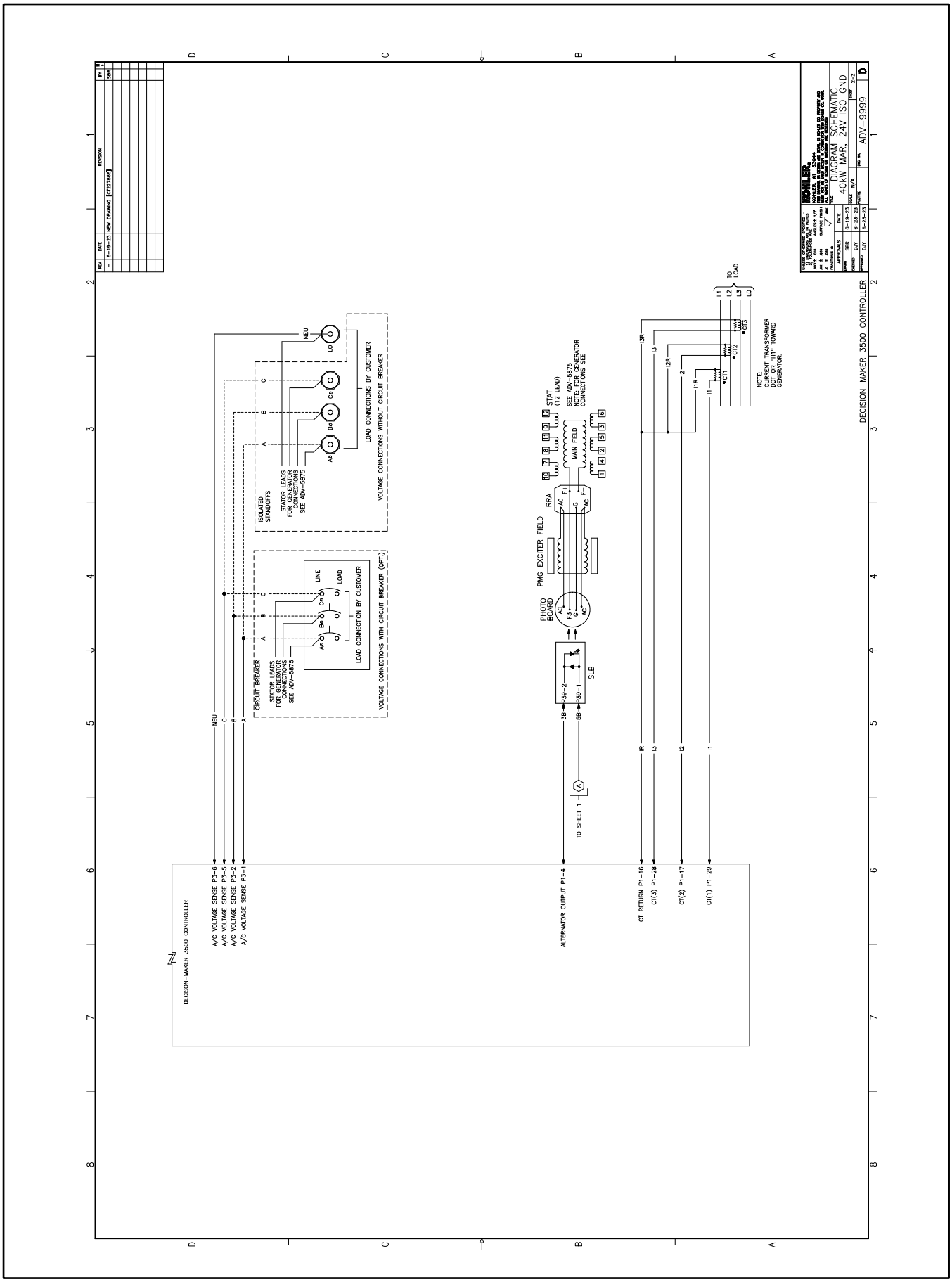

Figure 105 Wiring Diagram, Schematic (Sheet 2 of 2) for 40EKOZD/35EFKOZD 24-Volt, Isolated Ground Models

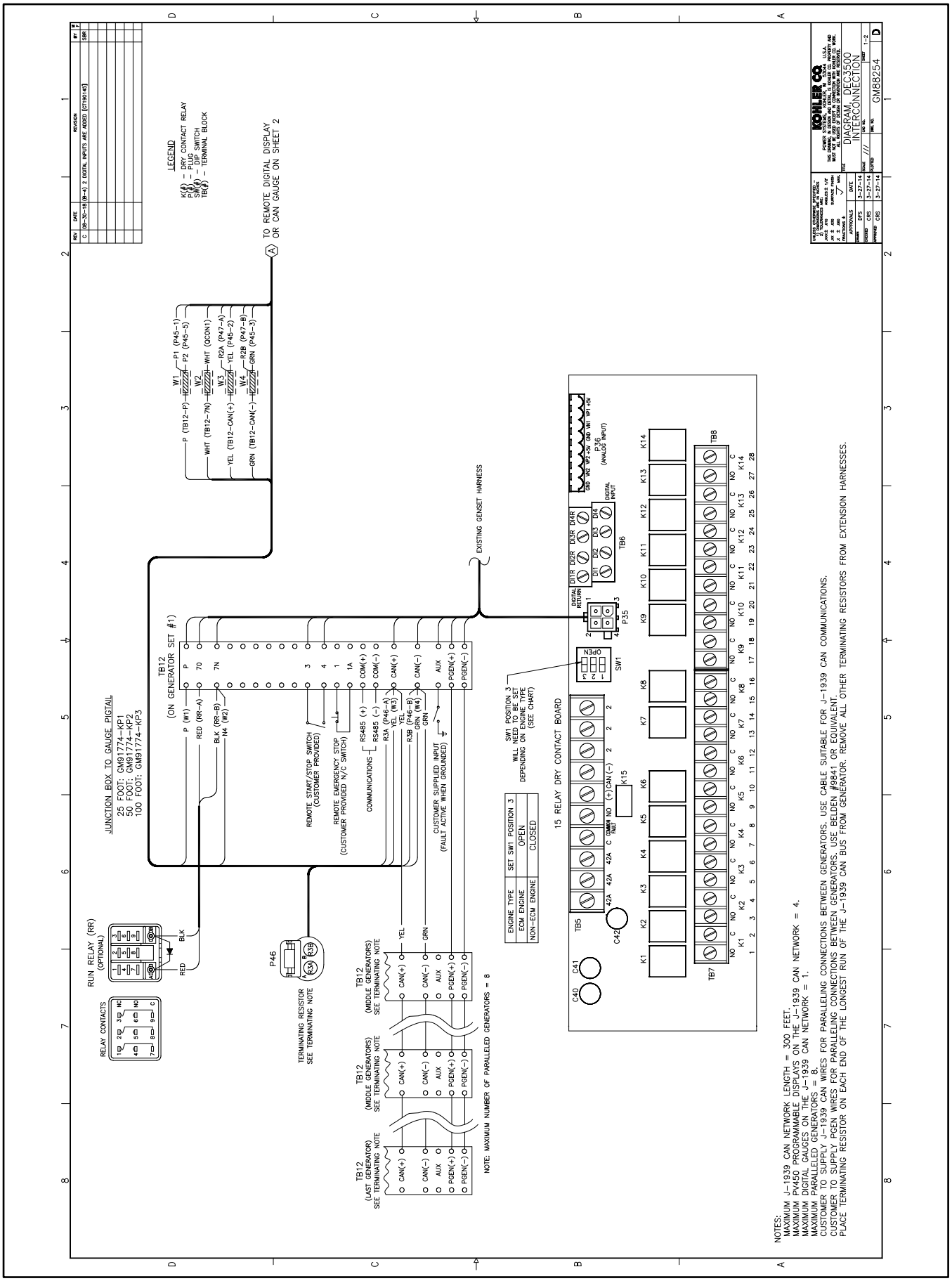

Figure 106 Accessory Interconnection Drawing (Sheet 1 of 2)

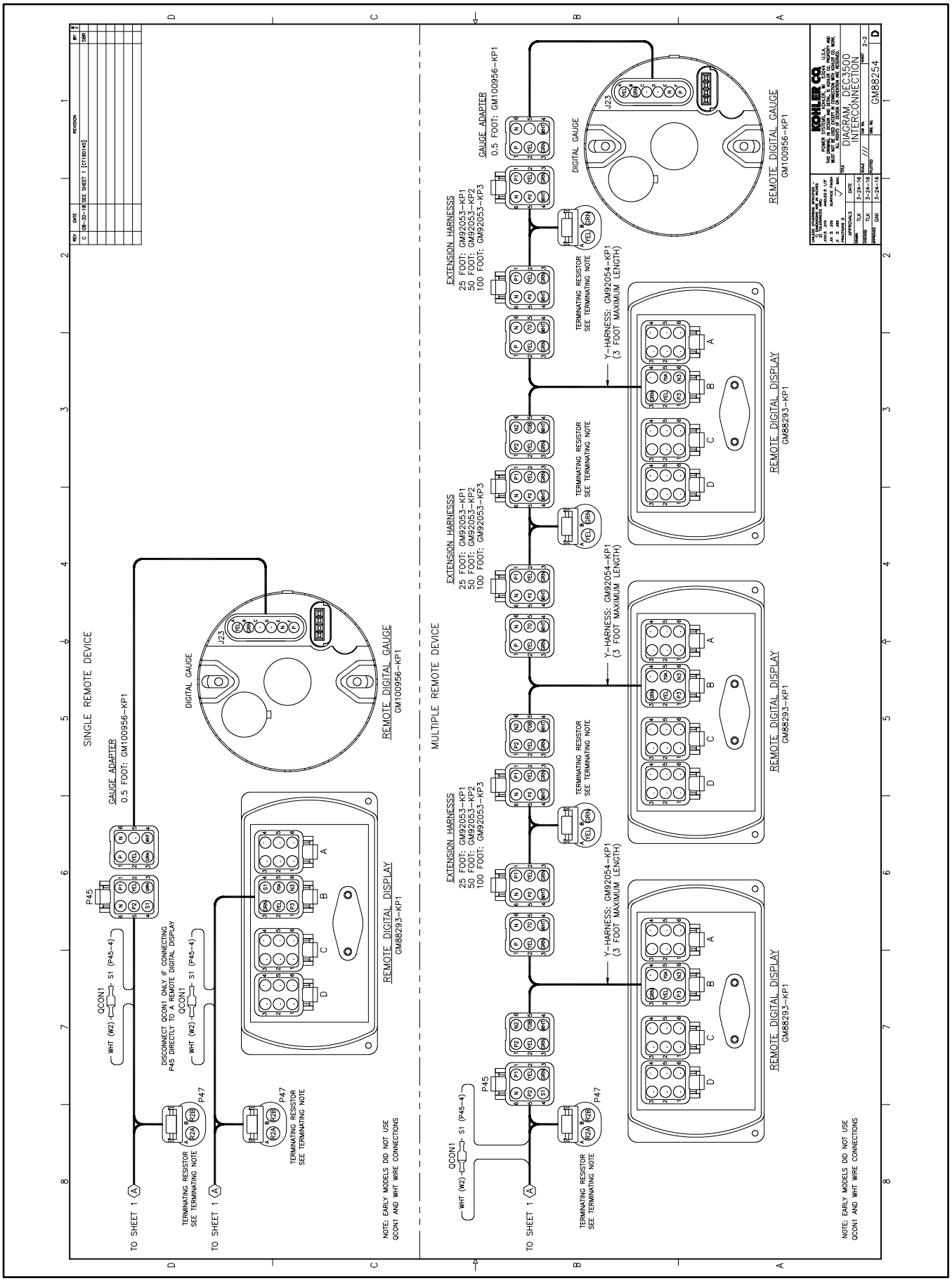

Figure 107 Accessory Interconnection Drawing (Sheet 2 of 2)

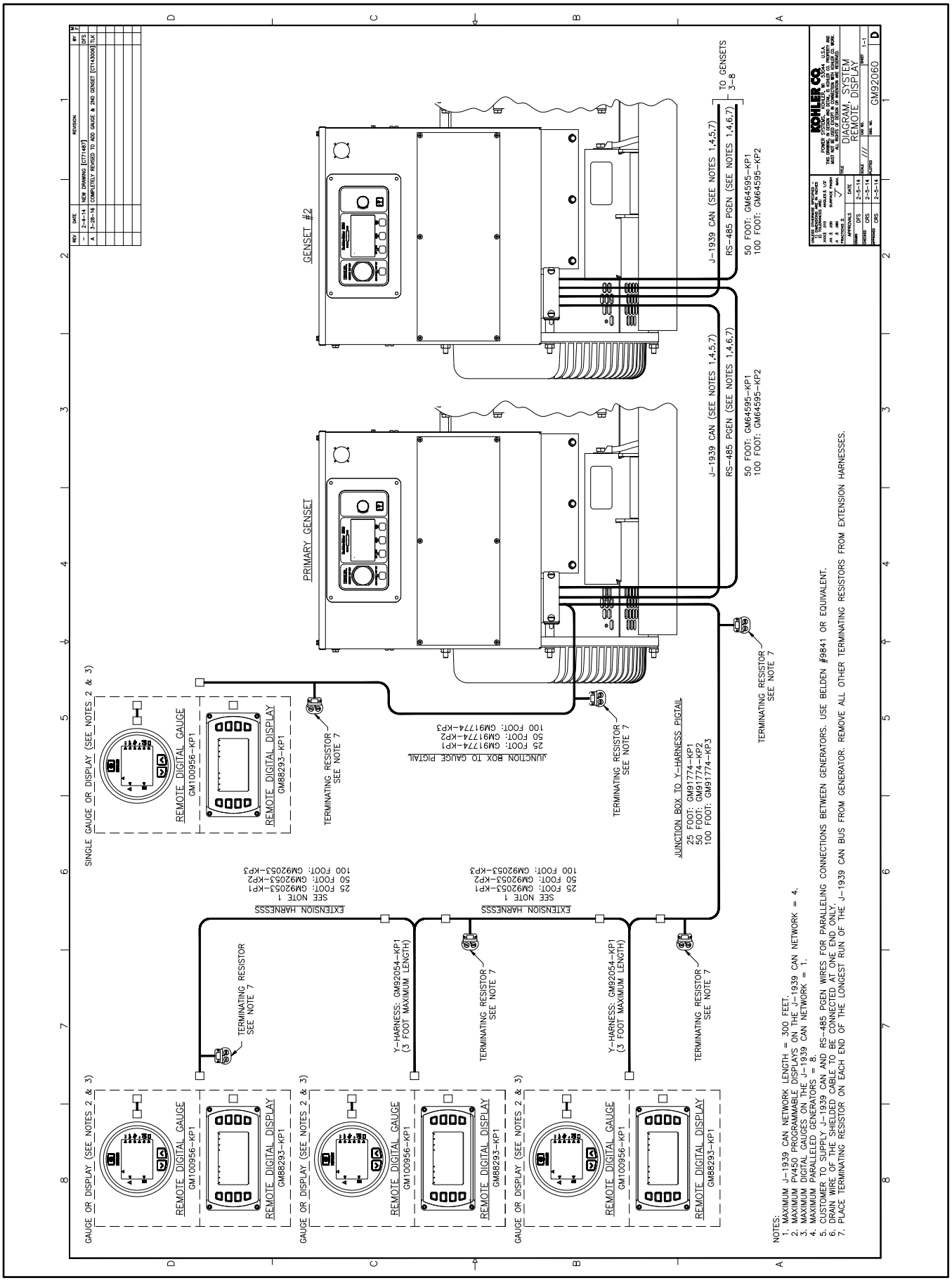

Figure 108 System Remote Display

Notes

Appendix A. Abbreviations

A, amp	ampere	blk. htr.	block heater	DAC	digital to analog converter
ABDC	after bottom dead center	BMEP	brake mean effective pressure	dB	decibel
AC	alternating current	bps	bits per second	dB(A)	decibel (A weighted)
A/D	analog to digital	br.	Brass	DC	direct current
ADC	advanced digital control; analog to digital converter	BTDC	before top dead center	DCR	direct current resistance
adj.	adjust, adjustment	Btu	British thermal unit	DEF	diesel exhaust fluid
ADV	advertising dimensional drawing	Btu/min.	British thermal units per minute	deg., °	degree
AGM	absorbent glass mat	C	Celsius, centigrade	dept.	department
Ah	amp-hour	cal.	Calorie	dia.	Diameter
AHWT	anticipatory high water temperature	CAN	controller area network	DI/EO	dual inlet/end outlet
AISI	American Iron and Steel Institute	CARB	California Air Resources Board	DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
ALOP	anticipatory low oil pressure	CAT5	Category 5 (network cable)	DIP	dual inline package
alt.	alternator	CB	circuit breaker	DPDT	double-pole, double-throw
Al	aluminum	CC	crank cycle	DPST	double-pole, single-throw
ANSI	American National Standards Institute (formerly American Standards Association, ASA)	cc	cubic centimeter	DS	disconnect switch
AO	anticipatory only	CCA	cold cranking amps	DVR	digital voltage regulator
APDC	Air Pollution Control District	ccw.	Counterclockwise	E2PROM, EEPROM	electrically-erasable programmable read-only memory
API	American Petroleum Institute	CEC	Canadian Electrical Code	E, emer.	emergency (power source)
approx.	approximate, approximately	cert.	certificate, certification, certified	EATS	Exhaust Aftertreatment System
APU	Auxiliary Power Unit	cfh	cubic feet per hour	ECM	electronic control module, engine control module
AQMD	Air Quality Management District	cfm	cubic feet per minute	EDI	electronic data interchange
AR	as required, as requested	CG	center of gravity	EFR	emergency frequency relay
AS	as supplied, as stated, as suggested	CID	cubic inch displacement	e.g.	for example (exempli gratia)
ASE	American Society of Engineers	CL	centerline	EG	electronic governor
ASME	American Society of Mechanical Engineers	cm	centimeter	EGSA	Electrical Generating Systems Association
assy.	Assembly	CMOS	complementary metal oxide substrate (semiconductor)	EIA	Electronic Industries Association
ASTM	American Society for Testing Materials	com	communications (port)	EI/EO	end inlet/end outlet
ATDC	after top dead center	coml	commercial	EMI	electromagnetic interference
ATS	automatic transfer switch	Coml/Rec	Commercial/Recreational	emiss.	Emission
auto.	Automatic	conn.	Connection	eng.	Engine
aux.	auxiliary	cont.	continued	EPA	Environmental Protection Agency
avg.	average	CPVC	chlorinated polyvinyl chloride	EPS	emergency power system
AVR	automatic voltage regulator	crit.	Critical	ER	emergency relay
AWG	American Wire Gauge	CRM	Common Rail Manifold	ES	engineering special, engineered special
AWM	appliance wiring material	CSA	Canadian Standards Association		
bat.	Battery	CT	current transformer	ESD	electrostatic discharge
BBDC	before bottom dead center	Cu	copper	est.	estimated
BC	battery charger, battery charging	cUL	Canadian Underwriter's Laboratories	E-Stop	emergency stop
BCA	battery charging alternator	cu. in.	cubic inch	etc.	et cetera (and so forth)
BCI	Battery Council International	cw.	Clockwise	exh.	exhaust
BDC	before dead center	CWC	city water-cooled	ext.	external
BHP	brake horsepower	cyl.	Cylinder	F	Fahrenheit, female
blk.	black (paint color), block (engine)	D/A	digital to analog	FDS	Fluid Dosing System

FHM	flat head machine (screw)	in.	inch	Lpm	liters per minute
fl. oz.	fluid ounce	in. H_2O	inches of water	LOP	low oil pressure
flex.	flexible	in. Hg	inches of mercury	LP	liquefied petroleum
freq.	frequency	in. Lb.	inch pounds	LPG	liquefied petroleum gas
FS	full scale	Inc.	incorporated	LS	left side
ft.	foot, feet	ind.	Industrial	L_{wa}	sound power level, A weighted
ft. lb.	foot pounds (torque)	int.	internal	LWL	low water level
ft./min.	feet per minute	int./ext.	internal/external	LWT	low water temperature
ftp	file transfer protocol	I/O	input/output	m	meter, milli (1/1000)
g	gram	IP	internet protocol	M	mega (10^6 when used with SI units), male
ga.	gauge (meters, wire size)	ISO	International Organization for Standardization	m^3	cubic meter
gal.	gallon	J	joule	m^3/hr.	cubic meters per hour
gen.	generator	JIS	Japanese Industry Standard	m^3/min.	cubic meters per minute
genset	generator set	k	kilo (1000)	mA	milliampere
GFI	ground fault interrupter	K	kelvin	man.	manual
GND, ⏚	ground	kA	kiloampere	max.	maximum
gov.	governor	KB	kilobyte (2^{10} bytes)	MB	megabyte (2^{20} bytes)
gph	gallons per hour	KBus	Kohler communication protocol	MCCB	molded-case circuit breaker
gpm	gallons per minute	kg	kilogram	MCM	one thousand circular mils
gr.	grade, gross	kg/cm^2	kilograms per square centimeter	meggar	megohmmeter
GRD	equipment ground	kgm	kilogram-meter	MHz	megahertz
gr. wt.	gross weight	kg/m^3	kilograms per cubic meter	mi.	mile
H x W x D	height by width by depth	kHz	kilohertz	mil	one one-thousandth of an inch
HC	hex cap	kJ	kilojoule	min.	minimum, minute
HCHT	high cylinder head temperature	km	kilometer	misc.	miscellaneous
HD	heavy duty	kOhm, kΩ	kilo-ohm	MJ	megajoule
HET	high exhaust temp., high engine temp.	kPa	kilopascal	mJ	millijoule
hex	hexagon	kph	kilometers per hour	mm	millimeter
Hg	mercury (element)	kV	kilovolt	mOhm, mΩ	milliohm
HH	hex head	kVA	kilovolt ampere	MOhm, MΩ	megohm
HHC	hex head cap	kVAR	kilovolt ampere reactive	MOV	metal oxide varistor
HP	horsepower	kW	kilowatt	MPa	megapascal
hr.	hour	kWh	kilowatt-hour	mpg	miles per gallon
HS	heat shrink	kWm	kilowatt mechanical	mph	miles per hour
hsg.	Housing	kWth	kilowatt-thermal	MS	military standard
HVAC	heating, ventilation, and air conditioning	L	liter	ms	millisecond
HWT	high water temperature	LAN	local area network	m/sec.	meters per second
Hz	hertz (cycles per second)	L x W x H	length by width by height	mtg.	mounting
IBC	International Building Code	lb.	pound, pounds	MTU	Motoren-und Turbinen-Union
IC	integrated circuit	lbm/ft^3	pounds mass per cubic feet	MW	megawatt
ID	inside diameter, identification	LCB	line circuit breaker	mW	milliwatt
IEC	International Electrotechnical Commission	LCD	liquid crystal display	µF	microfarad
IEEE	Institute of Electrical and Electronics Engineers	LED	light emitting diode	µF	microfarad
IMS	improved motor starting	Lph	liters per hour		

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

UHF	ultrahigh frequency
UIF	user interface
UL	Underwriter’s Laboratories, Inc.
UNC	unified coarse thread (was NC)
UNF	unified fine thread (was NF)
univ.	universal
URL	uniform resource locator (web address)
US	undersize, underspeed
UV	ultraviolet, undervoltage
V	volt
VAC	volts alternating current
VAR	voltampere reactive
VDC	volts direct current
VFD	vacuum fluorescent display
VGA	video graphics adapter
VHF	very high frequency
W	watt
WCR	withstand and closing rating
w/	with
WO	write only
w/o	without
wt.	weight
xfmr	transformer

Appendix B. Operating Hours and Service Log

Use the log below to keep a cumulative record of operating hours on your generator set and the dates required services were performed. Enter hours to the nearest quarter hour.

	Operating Hours		Service Record	
Date Run	Hours Run	Total Hours	Service Date	Service

TP-7044 9/24f

Original Instructions (English)

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