Service Manual

CENTUM™ Series Generator Sets

QSK78 Engine with PowerCommand® 3.3 or PowerCommand® 3.3MLD Control and S9 Alternator

C2750D6E (Spec A)
C3000D6EB (Spec A)

English
Original Instructions
9-2025
A075L576 (Issue 2)

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1 IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS. This manual contains important instructions that should be followed during installation and maintenance of the generator set and batteries.

Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

1.1 Warning, Caution, and Note Styles Used in This Manual

The following safety styles and symbols found throughout this manual indicate potentially hazardous conditions to the operator, service personnel, or equipment.

⚠ DANGER
Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

⚠ WARNING
Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

⚠ CAUTION
Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTICE
Indicates information considered important, but not hazard-related (e.g., messages relating to property damage).

1.2 General Information

This manual should form part of the documentation package supplied by Cummins with specific generator sets. In the event that this manual has been supplied in isolation, contact your authorized distributor.

NOTICE
It is in the operator’s interest to read and understand all warnings and cautions contained within the documentation relevant to the generator set, its operation and daily maintenance.

1.2.1 Safety Precautions

1.2.1.1 General Safety Precautions

⚠ WARNING

Hot Pressurized Liquid

Contact with hot liquid can cause severe burns.

Do not open the pressure cap while the engine is running. Let the engine cool down before removing the cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury.

Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

⚠ WARNING

Toxic Hazard

Used engine oils have been identified by some state and federal agencies to cause cancer or reproductive toxicity.

Do not ingest, breathe the fumes, or contact used oil when checking or changing engine oil. Wear protective gloves and face guard.

⚠ WARNING

Electrical Generating Equipment

Incorrect operation can cause severe personal injury or death.

Do not operate equipment when fatigued, or after consuming any alcohol or drug.

⚠ WARNING

Toxic Gases

Substances in exhaust gases have been identified by some state and federal agencies to cause cancer or reproductive toxicity.

Do not breathe in or come into contact with exhaust gases.

⚠ WARNING

Combustible Liquid

Ignition of combustible liquids is a fire or explosion hazard which can cause severe burns or death.

Do not store fuel, cleaners, oil, etc., near the generator set.

⚠ WARNING

High Noise Level

Generator sets in operation emit noise, which can cause hearing damage.

Wear appropriate ear protection at all times.

⚠ WARNING

Hot Surfaces

Contact with hot surfaces can cause severe burns.

The unit is to be installed so that the risk of hot surface contact by people is minimized. Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.

⚠ WARNING

Electrical Generating Equipment

Incorrect operation and maintenance can result in severe personal injury or death.

Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

⚠ WARNING

Toxic Hazard

Ethylene glycol, used as an engine coolant, is toxic to humans and animals.

Wear appropriate PPE. Clean up coolant spills and dispose of used coolant in accordance with local environmental regulations.

⚠ WARNING

Combustible Liquid

Ignition of combustible liquids is a fire or explosion hazard which can cause severe burns or death.

Do not use combustible liquids like ether.

⚠ WARNING

Automated Machinery

Accidental or remote starting of the generator set can cause severe personal injury or death.

Isolate all auxiliary supplies and use an insulated wrench to disconnect the starting battery cables (negative [–] first).

⚠ WARNING

Fire Hazard

Materials drawn into the generator set are a fire hazard. Fire can cause severe burns or death.

Make sure the generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.

⚠ WARNING

Fire Hazard

Accumulated grease and oil are a fire hazard. Fire can cause severe burns or death.

Keep the generator set and the surrounding area clean and free from obstructions. Repair oil leaks promptly.

⚠ WARNING
Fall Hazard
Falls can result in severe personal injury or death.
Make sure that suitable equipment for performing tasks at height are used in accordance with local guidelines and legislation.

⚠ WARNING
Fire Hazard
Materials drawn into the generator set are a fire hazard. Fire can cause severe burns or death.
Keep the generator set and the surrounding area clean and free from obstructions.

⚠ WARNING
Pressurized System
Pressurized systems can rupture/leak which can result in severe personal injury or death.
Use appropriate lock out/tag out safety procedures to isolate from all energy sources before performing any service tasks. Use PPE.

⚠ WARNING
Confined Areas
Confined spaces or areas with restricted access or potential to entrap can cause severe personal injury or death.
Use appropriate lock out/tag out safety procedures to isolate from all energy sources. Use PPE. Follow site specific lone worker protocols/permits to work.

⚠ CAUTION
Manual Handling Heavy Objects
Handling heavy objects can cause severe personal injury.
Use appropriate lifting equipment and perform tasks with two people where doing so would make completion of the task safe.

⚠ CAUTION
Power Tools and Hand Tools
Tools can cause cuts, abrasions, bruising, puncture injuries.
Only trained and experienced personnel should use power tools and hand tools. Use PPE.

⚠ CAUTION
Sharp Edges and Sharp Points
Projecting corners/parts may cause cuts, abrasions and other personal injury.
Use PPE. Be aware of sharp edges and corners/sharp points. Cover/protect them.

NOTICE
Keep multi-type ABC fire extinguishers close by. Class A fires involve ordinary combustible materials such as wood and cloth. Class B fires involve combustible and flammable liquid fuels and gaseous fuels. Class C fires involve live electrical equipment. (Refer to NFPA No. 10 in the applicable region.)

NOTICE

Before performing maintenance and service procedures on enclosed generator sets, make sure the service access doors are secured open.

NOTICE

Stepping on the generator set can cause parts to bend or break, leading to electrical shorts, or to fuel leaks, coolant leaks, or exhaust leaks. Do not step on the generator set when entering or leaving the generator set room.

1.3 Generator Set Safety Code

Before operating the generator set, read the manuals and become familiar with them and the equipment. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

⚠ WARNING

Electrical Generating Equipment

Incorrect operation and maintenance can result in severe personal injury or death.

Read and follow all Safety Precautions, Warnings, and Cautions throughout this manual and the documentation supplied with the generator set.

1.3.1 Moving Parts Can Cause Severe Personal Injury or Death

- Keep hands, clothing, and jewelry away from moving parts. Do not wear loose clothing or jewelry in the vicinity of moving parts or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts.
- Before starting work on the generator set, disconnect the battery charger from its AC source, then disconnect the starting batteries using an insulated wrench, negative (**–**) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps; keep guards in position over fans, drive belts, etc.
- If any adjustments must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

1.3.2 Positioning of Generator Set - Open Sets

The area for positioning the set should be adequate and level, and the area immediately around the set must be free of any flammable material.

1.4 Electrical Shocks and Arc Flashes Can Cause Severe Personal Injury or Death

⚠ WARNING

Electric Shock Hazard

Voltages and currents present an electrical shock hazard that can cause severe burns or death.

Contact with exposed energized circuits with potentials of 50 Volts AC or 75 Volts DC or higher can cause electrical shock and electrical arc flash. Refer to standard NFPA 70E or equivalent safety standards in corresponding regions for details of the dangers involved and for the safety requirements.

Guidelines to follow when working on de-energized electrical systems:

- Use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- De-energize and lockout/tagout electrical systems prior to working on them. Lockout/Tagout is intended to prevent injury due to unexpected start-up of equipment or the release of stored energy. Please refer to *Locking the Generator Set Out of Service* section for more information.
- De-energize and lockout/tagout all circuits and devices before removing any protective shields or making any measurements on electrical equipment.
- Follow all applicable regional electrical and safety codes.

Guidelines to follow when working on energized electrical systems:

NOTICE

It is the policy of Cummins Inc. to perform all electrical work in a de-energized state. However, employees or suppliers may be permitted to occasionally perform work on energized electrical equipment only when qualified and authorized to do so and when troubleshooting, or if de-energizing the equipment would create a greater risk or make the task impossible and all other alternatives have been exhausted.

NOTICE

Exposed energized electrical work is only allowed as per the relevant procedures and must be undertaken by a Cummins authorized person with any appropriate energized work permit for the work to be performed while using proper PPE, tools and equipment.

In summary:

- Do not tamper with or bypass interlocks unless you are authorized to do so.
- Understand and assess the risks - use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- Make sure that an accompanying person who can undertake a rescue is nearby.

1.4.1 AC Supply and Isolation

NOTICE

Local electrical codes and regulations (for example, *BS EN 12601:2010 Reciprocating internal combustion engine driven generating sets)* may require the installation of a disconnect means for the generator set, either on the generator set or where the generator set conductors enter a facility.

NOTICE

The AC supply must have the correct over current and earth fault protection according to local electrical codes and regulations. This equipment must be earthed (grounded).

It is the sole responsibility of the customer to provide AC power conductors for connection to load devices and the means to isolate the AC input to the terminal box; these must comply with local electrical codes and regulations. Refer to the wiring diagram supplied with the generator set.

The disconnecting device is not provided as part of the generator set, and Cummins accepts no responsibility for providing the means of isolation.

1.4.2 AC Disconnect Sources

⚠ WARNING

Hazardous Voltage

Contact with high voltages can cause severe electrical shock, burns, or death.

The equipment may have more than one source of electrical energy. Disconnecting one source without disconnecting the others presents a shock hazard. Before starting work, disconnect the equipment, and verify that all sources of electrical energy have been removed.

1.4.3 Medium Voltage Equipment (601 V to 15 kV - U.S. and Canada)

- Medium voltage acts differently than low voltage. Special equipment and training is required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and experienced to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Due to the nature of medium voltage electrical equipment, induced voltage remains even after the equipment is disconnected from the power source. Plan the time for maintenance with authorized personnel so that the equipment can be de-energized and safely grounded.

1.5 Fuel and Fumes Are Flammable

Fire, explosion, and personal injury or death can result from improper practices.

- Do not fill fuel tanks while the engine is running unless the tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- Do not permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.

- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Make sure all fuel supplies have a positive (+) shutoff valve.
- Make sure the battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

1.5.1 Spillage

Any spillage that occurs during fueling, oil top-off, or oil change must be cleaned up before starting the generator set.

1.5.2 Fluid Containment

NOTICE
Where spillage containment is not part of a Cummins supply, it is the responsibility of the installer to provide the necessary containment to prevent contamination of the environment, especially water courses and sources.

Fluid containment is incorporated into the base of the generator set, it must be inspected at regular intervals. Any liquid present should be drained out and disposed of in accordance with local health and safety regulations. Failure to perform this action may result in spillage of liquids which could contaminate the surrounding area.

Any other fluid containment area must also be checked and emptied, as described above.

1.5.3 Do Not Operate in Flammable and Explosive Environments

Flammable vapor can cause an engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury, and death. Do not operate a generator set where a flammable vapor environment can be created, unless the generator set is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the generator set are solely responsible for operating the generator set safely. Contact your authorized Cummins distributor for more information.

1.6 Exhaust Gases Are Deadly

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas, and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust system daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Make sure the unit is well ventilated.

1.6.1 Exhaust Precautions

⚠ WARNING
Hot Exhaust Gases ***Contact with hot exhaust gases can cause severe burns.*** ***Wear personal protective equipment when working on equipment.***

⚠ WARNING

Hot Surfaces

Contact with hot surfaces can cause severe burns.

The unit is to be installed so that the risk of hot surface contact by people is minimized. Wear appropriate PPE when working on hot equipment and avoid contact with hot surfaces.

⚠ WARNING

Toxic Gases

Inhalation of exhaust gases can cause asphyxiation and death.

Pipe exhaust gas outside and away from windows, doors, or other inlets to buildings. Do not allow exhaust gas to accumulate in habitable areas.

⚠ WARNING

Fire Hazard

Contaminated insulation is a fire hazard. Fire can cause severe burns or death.

Remove any contaminated insulation and dispose of it in accordance with local regulations.

The exhaust outlet may be sited at the top or bottom of the generator set. Make sure that the exhaust outlet is not obstructed. Personnel using this equipment must be made aware of the exhaust position. Position the exhaust away from flammable materials - in the case of exhaust outlets at the bottom, make sure that vegetation is removed from the vicinity of the exhaust.

The exhaust pipes may have some insulating covers fitted. If these covers become contaminated they must be replaced before the generator set is run.

To minimize the risk of fire, make sure the following steps are observed:

- Make sure that the engine is allowed to cool thoroughly before performing maintenance or operation tasks.
- Clean the exhaust pipe thoroughly.

1.7 Earth Ground Connection

The neutral of the generator set may be required to be bonded to earth ground at the generator set location, or at a remote location, depending on system design requirements. Consult the engineering drawings for the facility or a qualified electrical design engineer for proper installation.

NOTICE

The end user is responsible to make sure that the ground connection point surface area is clean and free of rust before making a connection.

NOTICE

The end user is responsible for making sure that an earthing arrangement that is compliant with local conditions is established and tested before the equipment is used.

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2 Introduction

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only a trained and experienced electrician makes generator set electrical output connections, in accordance with the installation instructions and all applicable codes.

⚠ WARNING
Electrical Generating Equipment
Faulty electrical generating equipment can cause severe personal injury or death.
Generator sets must be installed, certified, and operated by trained and experienced persons in accordance with the installation instructions and all applicable codes.

2.1 About This Manual

This manual provides troubleshooting and repair information for the Generator Sets listed on the front cover. Additional Engine and alternator service and maintenance instructions are contained within the applicable engine and alternator service manuals. Operating and basic maintenance instructions are in the applicable Generator Set Operator Manual.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins Inc. policy of continuous development and improvement, information may change at any time without notice. The users should therefore make sure that before commencing any work, they have the latest information available. The latest version of this manual is available on QuickServe Online (**https://quickserve.cummins.com**).

This manual contains basic (generic) wiring diagrams and schematics that are included to help in troubleshooting. The wiring diagrams and schematics that are maintained with the unit should be updated when modifications are made to the unit.

Read **Chapter 1 on page 1** and carefully observe all instructions and precautions in this manual.

2.2 Test Equipment

To perform the test procedures in this manual, the following test equipment must be available

- True RMS meter for accurate measurement of small AC and DC voltages.
- Grounding wrist strap to prevent circuit board damage due to electrostatic discharge (ESD).
- Battery Hydrometer
- INSITE service tool
- Jumper Leads
- Tachometer or Frequency Meter
- Wheatstone Bridge or Digital Ohmmeter
- Variac
- Load Test Panel
- Megger or Insulation Resistance Meter

- PCC Service Tool Kit (Harness Tool and Sensor Tool)
- InPower Service Tool (PC based Generator Set Service Tool)

2.3 Schedule of Abbreviations

This list is not exhaustive. For example, it does not identify units of measure or acronyms that appear only in parameters, event/fault names, or part/accessory names.

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
AC	Alternating Current	LTS	Long Term Storage
AMF	Automatic Mains Failure	LVRT	Low Voltage Ride Through
AMP	AMP, Inc., part of Tyco Electronics	MCB	Main Generator set Circuit Breaker
ANSI	American National Standards Institute	MFM	Multifunction Monitor
ASOV	Automatic Shut Off Valve	Mil Std	Military Standard
ASTM	American Society for Testing and Materials (ASTM International)	MLD	Masterless Load Demand
ATS	Automatic Transfer Switch	MRS	Manual Remote Start
AVR	Automatic Voltage Regulator	NC	Normally Closed
AWG	American Wire Gauge	NC	Not Connected
CAN	Controlled Area Network	NFPA	National Fire Protection Agency
CB	Circuit Breaker	NO	Normally Open
CE	Conformité Européenne	NWF	Network Failure
CFM	Cubic Feet per Minute	OEM	Original Equipment Manufacturer
CGT	Cummins Generator Technologies	OOR	Out of Range
CMM	Cubic Meters per Minute	OORH / ORH	Out of Range High
CT	Current Transformer	OORL / ORL	Out of Range Low
D-AVR	Digital Automatic Voltage Regulator	PB	Push Button
DC	Direct Current	PCC	PowerCommand® Control
DEF	Diesel Exhaust Fluid	PGI	Power Generation Interface
DPF	Diesel Particulate Filter	PGN	Parameter Group Number
ECM	Engine Control Module	PI	Proportional/Integral
ECS	Engine Control System	PID	Proportional / Integral / Derivative
EMI	Electromagnetic interference	PLC	Programmable Logic Controller
EN	European Standard	PMG	Permanent Magnet Generator
EPS	Engine Protection System	PPE	Personal Protective Equipment
E-Stop	Emergency Stop	PT	Potential Transformer

ABBR.	DESCRIPTION	ABBR.	DESCRIPTION
FAE	Full Authority Electronic	PTC	Power Transfer Control
FMI	Failure Mode Identifier	PWM	Pulse-width Modulation
FRT	Fault Ride Through	RFI	Radio Frequency Interference
FSO	Fuel Shutoff	RH	Relative Humidity
Genset	Generator Set	RMS	Root Mean Square
GCB	Generator set Circuit Breaker	RTU	Remote Terminal Unit
GCP	Generator Control Panel	SAE	Society of Automotive Engineers
GND	Ground	SCR	Selective Catalytic Reduction
LCT	Low Coolant Temperature	SPN	Suspect Parameter Number
HMI	Human-machine Interface	SWL	Safe Working Load
IC	Integrated Circuit	SW_B+	Switched B+
ISO	International Organization for Standardization	UL	Underwriters Laboratories
LBNG	Lean-burn Natural Gas	UPS	Uninterruptible Power Supply
LCD	Liquid Crystal Display	VPS	Valve Proving System
LED	Light-emitting Diode		

2.4 Related Literature

Before any attempt is made to operate the generator set, the operator should take time to read all of the manuals supplied with the generator set and familiarize themselves with the warnings and operating procedures.

⚠ CAUTION

A generator set must be operated and maintained properly if you are to expect safe and reliable operation. The Operator Manual includes a maintenance schedule and a troubleshooting guide.

The Health and Safety Manual must be read in conjunction with this manual for the safe operation of the generator set:

- Health and Safety Manual (0908-0110)

The relevant manuals appropriate to your generator set are also available, the documents below are in English.

- Installation Manual for C2750D6E and C3000D6EB with QSK78 Engine and PowerCommand® 3.3 or 3.3 MLD and S9 Alternator (A075L574)
- Operator Manual for C2750D6E and C3000D6EB with QSK78 Engine and PowerCommand® 3.3 or 3.3 MLD and S9 Alternator (A075L575)
- Service Manual for C2750D6E and C3000D6EB with QSK78 Engine and PowerCommand® 3.3 or 3.3 MLD and S9 Alternator (A075L576)
- Control Service Manual for PowerCommand® 3.3 (900-0670)
- Engine Operation and Maintenance Manual for QSK78 (5677186)

- Alternator Service Manual for S9 (A062L877)
- S-6763 *Specification* and *Data Sheet* (for engineering data specific to the generator set)
- T-030, *Liquid Cooled Generator Set Application Manual* (for application information)
- Parts Manual for C2750D6E and C3000D6EB (A076F900)
- Standard Repair Times - BK Family (0900-0904)
- Recommended Spares List (RSL) for C2750D6E (A075N340)
- Recommended Spares List (RSL) for C3000D6EB (A075N341)
- Warranty Administration Manual (4021290)
- Global Commercial Warranty Statement (A072R157)

2.5 After Sales Services

Cummins offers a full range of maintenance and warranty services.

2.5.1 Maintenance

⚠ WARNING
Electrical Generating Equipment
Incorrect operation and maintenance can result in severe personal injury or death.
Make sure that only suitably trained and experienced service personnel perform electrical and/or mechanical service.

For expert generator set service at regular intervals, contact your local distributor. Each local distributor offers a complete maintenance contract package covering all items subject to routine maintenance, including a detailed report on the condition of the generator set. In addition, this can be linked to a 24-hour call-out arrangement, providing year-round assistance if necessary. Specialist engineers are available to maintain optimum performance levels from generator sets. Maintenance tasks should only be undertaken by trained and experienced technicians provided by your authorized distributor.

2.5.2 Warranty

For details of the warranty coverage for your generator set, refer to the Global Commercial Warranty Statement listed in the Related Literature section.

In the event of a breakdown, prompt assistance can normally be given by factory trained service technicians with resources to undertake all minor and many major repairs to equipment on site.

Extended warranty coverage is also available.

For further warranty details, contact your authorized service provider.

NOTICE
Damage caused by failure to follow the manufacturer's recommendations will not be covered by warranty. Contact your authorized service provider.

2.5.2.1 Warranty Limitations

For details of the warranty limitations for your generator set, refer to the warranty statement applicable to the generator set.

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3 Specifications

3.1 Generator Set Specifications

TABLE 1. SPECIFICATIONS

MODELS	**C2750D6E**	**C3000D6EB**	**C3000D6EB**
Engine Cummins Diesel Series	QSK78-G36	QSK78-G36	QSK78-G37
Generator kW Rating	See generator set nameplate for rating information.		
Engine Fuel Connection Inlet/Outlet Thread Size	Refer to generator set outline drawing supplied. • A073W614		
Maximum Weight (with Enhanced High Ambient Radiator)	Dry - 25059 kg (55246 lb) Wet - 25361 kg (55911 lb)		
Fuel Max. Fuel Inlet Restriction Fuel Pump Flow Rate Fuel Pump Return Flow Rate at 1800 RPM Dead Head Pressure	47 kpa (13.8 in-hg) with clean fuel filter at maximum flow; 44 kpa (12.9 in-hg) with dirty fuel filter at maximum flow Maximum Flow: 18 L/min (4.75 gal/min) Maximum Flow: 7 L/min (1.8 gal/min) 34 kpa (10 in-hg)		
Exhaust Outlet Size Max. Allowable Back Pressure Exhaust Flow at Rated Load Exhaust Temperature	1800 RPM 12 inch (ASME B16.1 Class 125 NPS 12) 51 mm (2 inch) Hg 642 m^3/min (22676 cfm) at Standby Standby: 460 °C (860 °F), Continuous 439 °C (822 °F)	1800 RPM 12 inch (ASME B16.1 Class 125 NPS 12) 51 mm (2 inch) Hg 704 m^3/min (24878 cfm) at Standby Standby: 490 °C (914 °F), Continuous 460 °C (860 °F)	1800 RPM 12 inch (ASME B16.1 Class 125 NPS 12) 51 mm (2 inch) Hg 615 m^3/min (21721 cfm) at Standby Standby: 462 °C (863 °F), Continuous 444 °C (831 °F)
Electrical System Starting Voltage: Battery Group Number: Battery CCA: Generator Set minimum CCA: Cold Soak @ 0 °F (-18 °C) Required Battery Quantity:	24 Volts DC 8D 1400 A 2200 A at –18 °C to 0 °C (0 °F to 32 °F) 6 (Two 12 Volt batteries per starter)		
Cooling System Capacity with Standard Radiator	For 50 °C (122 °F) radiator, 455 liters (120.2 US gallons) For 40 °C (109 °F) radiator, 455 liters (120.2 US gallons)		
Lubricating System Oil Capacity with Filters	466 Liters (123 gallons)		

3.2 Generator Set Fuel Consumption

TABLE 2. FUEL CONSUMPTION L/HR (GAL/HR) AT 1800 RPM (60 HZ)

Model	Engine	Fuel Consumption Data at 60 Hz[1]
C2750D6E	QSK78-G36	738.7 L/hr (195.1 gal/hr)
C3000D6EB	Low NOx QSK78-G36	823.4 L/hr (217.5 US gal/hr)
C3000D6EB	QSK78-G37	773.2 L/hr (204.3 US gal/hr)

1. Standby/Full Load

Refer to data sheets for other applications. In line with the Cummins Inc. policy of continuous improvement, these figures are subject to change.

4 Periodic Maintenance

The periodic maintenance procedures should be performed at whichever interval occurs first. At each scheduled maintenance interval, perform all previous maintenance checks that are due for scheduled maintenance.

The tabular data that follows gives the recommended service intervals for a generator set on Standby service. If the generator set will be subjected to Prime usage or extreme operating conditions, the service intervals should be reduced accordingly.

Some of the factors that can affect the maintenance schedule are:

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand
- Poor quality of fuel

Consult with an authorized distributor if the generator set will be subjected to any extreme operating conditions and determine if extra protection or a reduction in service intervals is needed. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated, or after the number of operating hours indicated, whichever comes first.

4.1 Periodic Maintenance Schedule

4.1.1 Air Intake Maintenance Schedule

TABLE 3. AIR INTAKE MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 500 Hours**	**12 Months 1000 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**					
Check air cleaner restriction indicator (where fitted): If the service indicator shows red, replace air cleaner elements and reset the air cleaner service indicator.	■							
Check air intake system for leaks: Visually inspect the air intake system for signs of wear or damage. Check audibly when the generator set is running. To replace, contact your authorized distributor.	■							
Replace Air Filter Elements - Normal Duty					■[1]			

[1] Use this replacement interval or as shown by the air restriction indicator.

4.1.2 Control Maintenance Schedule

TABLE 4. CONTROL MAINTENANCE

MAINTENANCE ITEMS Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first	Daily 8 Hours	Weekly 50 Hours	6 Months 250 Hours	12 Months 500 Hours	1500 Hours 12 Months	2000 Hours	2 Years 6000 Hours
Task	**Operator Task**		**Service Technician Task**				
Check operation of Control Panel: Check display (the system will perform a control panel test on initial activation). To replace, contact your authorized distributor.	■						
Check operation of Emergency Stop Button: With the generator set running, press the Emergency Stop button. Check all systems, before resetting the fault.		■					

4.1.3 Cooling Maintenance Schedule

TABLE 5. COOLING MAINTENANCE

MAINTENANCE ITEMS Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first	Daily 8 Hours	Weekly 50 Hours	6 Months 250 Hours	12 Months 500 Hours	1500 Hours 12 Months	2000 Hours	2 Years 6000 Hours	3 Years
Task	**Operator Task**		**Service Technician Task**					
Check coolant level of radiator(s): If low, top up to coolant system specifications level, with Cummins recommended coolant mix.	■		■					
Check cooling fan blades: Visually inspect the fan blades through the guarding for signs of wear or damage. To replace, contact your authorized distributor.	■		■					
Check drive belt, condition and tension: Visually check belt for evidence of wear or slippage. To replace, contact your authorized distributor.	■		■					
Check coolant lines and radiator hoses for leaks, wear, and cracks: Visually check for leaks, worn or damages hoses. To replace, contact your authorized distributor.	■		■					

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	Daily 8 Hours	Weekly 50 Hours	6 Months 250 Hours	12 Months 500 Hours	1500 Hours 12 Months	2000 Hours	2 Years 6000 Hours	3 Years
Task	**Operator Task**		**Service Technician Task**					
Check radiator air flow: Visually inspect the radiator through the guarding for blockage, build up of debris, signs of wear or damage. To clean or replace, contact your authorized distributor.	■							
Check anti-freeze and DCA concentration			■					
Clean radiator core.			■[1]					
Re-grease bearings			■					
Check water pump.						■		
Change coolant filter.			■					
Check coolant heater.			■					
Fan drive idler arm and fan belt tensioner check.					■			
Replace cooling system coolant.							■	
Pressure test Radiator Pressure Cap.				■				
Replace Radiator Pressure Cap								■
■[1] – Cleaning schedule may be reduced depending on operating conditions/environment. Contact your authorized distributor.								

4.1.4 Engine Maintenance Schedule

TABLE 6. ENGINE MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	Daily 8 Hours	Weekly 50 Hours	6 Months 250 Hours	6 Months 500 Hours	12 Months 500 Hours	12 Months 1500 Hours	3 Years 500 Hours	2 Years 6000 Hours
Task	**Operator Task**		**Service Technician Task**					
Check fuel lines and hoses: Visually check for leaks, worn or damages hoses. To replace, contact your authorized distributor.	■[1]							
Check engine oil level: If low, top up to engine specifications level, with recommended oil.	■							
Drain water from fuel system primary filter/water separator: Drain one cup, or more, of fuel to remove water and sediment. See procedure in this chapter.	■							

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**6 Months 500 Hours**	**12 Months 500 Hours**	**12 Months 1500 Hours**	**3 Years 500 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**					
Crankcase breather tube/collector. Check for condensed oil. Drain and dispose of in accordance with local legislation.	■							
Check closed crankcase vent (CCV) check the filter service indicator (if equipped).	■			■				
Check charge alternator: Check visually and audibly when the generator set is running. To replace, contact your authorized distributor.	■							
Check engine oil make-up system: If low, top up to indicated level, with Cummins recommended oil.	■							
Check engine coolant heater: Check coolant heater has power and is running. To replace, contact your authorized distributor.	■							
Check all hardware (fittings, clamps, fasteners, etc.)			■					
Replace lubricating oil and filters.					■ 2			
Check engine ground. Clean as necessary.					■			
Replace water separator element.							■	
Replace fuel system secondary filter.							■	
Check engine mounts.					■			
Check starting motor.						■		
Check turbocharger.						■		
Engine oil heater check.						■		
Engine steam clean.						■		

1 – Check before starting and again with the generator set running.

2 – Oil change interval may differ and be up to three years depending on oil grade and fuel sulfur content. Refer to Cummins Bulletin 5677186.

4.1.5 Exhaust Maintenance Schedule

TABLE 7. EXHAUST MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 500 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**				
Check all exhaust components, and hardware (fittings, clamps, fasteners, etc.): Visually inspect the exhaust system for signs of wear or damage. Check audibly when the generator set is running. To replace, contact your authorized distributor.	■						
Check exhaust condensation trap: Drain condensation into a suitable container. Dispose of fluids in accordance with local legislation.	■						

4.1.6 Generator Set Maintenance Schedule

TABLE 8. GENERATOR SET MAINTENANCE

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 500 Hours**	**12 Months 1000 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**					
Check fuel level in tank: If low, add fuel (A full tank reduces condensation.)	■							
Check bedframe/enclosure fluid containment (where fitted): Drain as necessary. Clean all contaminated areas. Dispose of fluids in accordance with local legislation.	■							
Inspect Engine/Alternator Flexible Rubber Coupling					■			
Check generator set enclosure: Visually check enclosure, walk around inspection of generator set. Make sure no inlets/outlets are covered/restricted, service access doors are operational and safety systems are in place and operational. To replace damaged parts, contact your authorized distributor.	■							

MAINTENANCE ITEMS **Perform maintenance tasks as specified using Daily or Hourly periods – whichever occurs first**	**Daily 8 Hours**	**Weekly 50 Hours**	**6 Months 250 Hours**	**12 Months 500 Hours**	**12 Months 1000 Hours**	**1500 Hours 12 Months**	**2000 Hours**	**2 Years 6000 Hours**
Task	**Operator Task**		**Service Technician Task**					
Check batteries: Check connections are secure and battery area is free from tools and other items.		■				■		
Check battery electrolyte level.				■				
Check electrical connections (battery, starter motor and alternator connections).				■		■		
Check power cable connections going in and out of main circuit breaker. Make sure the connections are all tight and torque to specifications if required.				■				

4.1.7 Alternator Service Schedule

TABLE 9. ALTERNATOR SERVICE SCHEDULE

System	SERVICE ACTIVITY X = required * = if necessary	Alternator running	TYPE: Inspect	TYPE: Test	TYPE: Clean	TYPE: Refill/Replace	SERVICE LEVEL: Commission	Post Commission / 250 hrs / 0.5 year	Level 1 / 1000 hrs / 1 year	Level 2 / 10,000 hrs / 2 years	Level 3 / 30,000 hrs / 5 years
Alternator	Alternator rating		X				X				
Alternator	Bedplate arrangement		X				X				
Alternator	Coupling arrangement		X				X			*	X
Alternator	Environmental conditions and cleanliness		X				X	X	X	X	X
Alternator	Ambient temperature (inside & outside)			X			X	X	X	X	X
Alternator	Complete machine - damage, loose parts & earth bonds		X				X	X	X	X	X
Alternator	Guards, screens, warning and safety labels		X				X	X	X	X	X
Alternator	Maintenance access		X				X				
Alternator	Electrical nominal operating conditions & excitation	X		X			X	X	X	X	X
Alternator	Vibration	X		X			X	X	X	X	X
Windings	Condition of windings		X				X	X	X	X	X
Windings	Insulation resistance of all windings (PI test for MV/HV)			X			X	*	*	X	X
Windings	Insulation resistance of rotor, exciter and PMG			X				X	X		
Windings	Temperature sensors	X		X			X	X	X	X	X
Windings	Customer settings for temperature sensors		X				X				

System	SERVICE ACTIVITY X = required * = if necessary	Alternator running	TYPE: Inspect	Test	Clean	Refill/Replace	SERVICE LEVEL: Commission	Post Commission	250 hrs / 0.5 year	Level 1	1000 hrs / 1 year	Level 2	10,000 hrs / 2 years	Level 3	30,000 hrs / 5 years
Bearings	Condition of bearings		X				X							X	
	Grease exhaust & trap				X			**every 3000 to 3500 hours / 6 months**							
	Re-grease bearing(s) (A to H core length)	X				X		**every 3000 to 3500 hours / 6 months**							
	Replace re-greasable bearing(s)					X						*		X	
	Temperature sensors	X		X			X	X		X		X		X	
	Customer settings for temperature sensors		X				X								
Terminal Box	All alternator/customer connections and cabling		X				X	X		X		X		X	
Controls & Auxiliaries	Initial AVR & PFC set up	X		X			X								
	AVR & PFC settings	X		X				X		X		X		X	
	Customer connection of auxiliaries			X			X			X		X		X	
	Function of auxiliaries			X			X	X		X		X		X	
	Synchronization settings		X				X								
	Synchronization	X		X			X	X		X		X		X	
	Anti condensation heater					X						*		X	
Rectifier	Diodes and varistors		X				X	X		X		X			
	Diodes and varistors					X								X	
Cooling	Air inlet temperature	X		X			X	X		X		X		X	
	Air flow (rate & direction)	X	X				X								
	Condition of fan		X				X	X		X		X		X	
	Condition of air filter (where fitted)			X			X	X		X		X		X	
	Air filters (where fitted)				X	X				*		*		*	

4.2 Generator Set Long Term Storage

4.2.1 Required Materials

- Tectyl™ 915W40 or equivalent engine preservative oil that meets military specification MIL-PRF-21260, type P-10, Grade 2, SAE 30
- Tectyl™ 511-M, or equivalent rust preventative compound that meets military specification MIL-C-16173C, type P-2, Grade 1 or 2
- Daubert Chemical NoxRust No. 518 or equivalent preservative oil that meets military specification MIL-L-644, type P-9
- Moisture indicating silica desiccant gel packs
- Heavy paper or plastic and tape
- Corrosion inhibiting plastic such as Zerust

NOTICE
Do not leave Bio-Free diesel fuel in the fuel system longer than 6 months.

NOTICE
Do not leave diesel fuel containing bio components in the fuel system during storage. Fuel properties degradation may cause damages and lead to premature failure of fuel system components.

4.2.2 Procedure

⚠ WARNING
Hot Pressurized Liquid
Contact with hot liquid can cause severe burns.
Do not open the pressure cap while the engine is running. Let the engine cool down before removing the cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.

⚠ WARNING
Moving Parts
Moving parts can cause severe personal injury.
Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

⚠ WARNING
Persons working close to the generator during lightning risk receiving an electric shock.

⚠ WARNING
High Noise Level
Generator sets in operation emit noise, which can cause hearing damage.
Wear appropriate ear protection at all times.

⚠ WARNING

Hot Surfaces

Contact with hot surfaces can cause severe burns.

Wear appropriate PPE when working on hot equipment and avoid physical contact with hot surfaces.

NOTICE

Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth. Class B fires involve combustible and flammable liquid fuels and gaseous fuels. Class C fires involve live electrical equipment. (Refer to NFPA No. 10 in applicable region.)

NOTICE

Failure to follow these instructions may invalidate the warranty and may result in reduced reliability. Please contact your local factory representative for more details.

1. Follow the proper starting procedure to start the generator set.
2. Bring the generator set to rated speed with no load.
3. Operate the generator set until the coolant temperature reaches 160° F (70° C).
4. Follow the proper procedure to turn off the generator set.
5. Follow the necessary lock-out-tag-out procedures to ensure the generator does not start.
6. Drain the engine oil from the oil sump.
7. Install the drain plug and fill the engine to the high mark with the Tectyl™ 915W40, or equivalent engine preservative oil.
8. Disconnect the inlet fuel line to the engine fuel filter.
9. Disconnect the injector fuel return line.

   NOTICE

   Refer to the fuel consumption specifications to determine the amount of fuel required to run the engine for 25 minutes.

10. Put both fuel lines in the container of bio-free diesel fuel.
11. Follow the proper starting procedure to start the generator set.
12. Once the engine is operating smoothly, transfer the fuel supply line to the container of the Daubert Chemical NoxRust No. 518 or equivalent preservative oil outlined in the ***Required Materials Section.***
13. Operate the generator at idle for 25 minutes to ensure the engine preservative oil and the fuel system preservative is fully distributed.

    NOTICE

    Dispose of the mixed fuel in accordance with local regulations.

14. Follow the proper procedure to turn off the generator set.
15. Follow the necessary lock-out-tag-out procedures to ensure the generator set does not start.

16. Re-connect both fuel lines.
17. Drain the preservative oil from the engine oil pan sump, oil filter and fuel filters.
18. Install the drain plug in the oil sump. The sump can remain empty until the engine is ready to put in a service application.
19. Remove the intake and exhaust manifolds.
20. Spray Tectyl™ 511-M or equivalent into the intake and exhaust ports in the cylinder heads and in the manifolds.

NOTICE
Do NOT spray Tectyl™ 511-M or equivalent preservative oil on the intake manifold or any fuel system components as this may permanently damage sensors or valves.

21. Brush or spray Tectyl™ 511-M or equivalent on all the exposed surfaces that are not painted. Preservative oil should not be applied to any plastic, rubber or similar surfaces. Make sure to coat the flywheel, flywheel housing and all other unpainted machined surfaces with this preservative oil.
22. Remove the rocker lever covers.
23. Spray Tectyl™ 511-M or equivalent onto the rocker levers, valve stems, springs, valve guides, crossheads and push rods.
24. Install the covers.
25. Remove camshaft inspection covers.
26. Spray Tectyl™ 511-M or equivalent onto the camshaft.
27. Install the covers.
28. For components containing exposed bearings that are not easily accessible (e.g. fan hubs), remove the component to aid access. Brush or spray Tectyl™ 511-M or equivalent on all surfaces that are not painted and refit the component.
29. Remove any external drive belts to prevent localized stretching and deformation.
30. If the generator set will remain in storage for 24 months or more, the cooling system must be drained.

NOTICE
If the storage period will be less than 24 months, and if it meets Cummins coolant specifications for anti-freeze with anti-corrosion inhibitor, then it is not necessary to drain the coolant.

NOTICE
The engine cooling system must be drained and flushed with a suitable solvent or a hot, lightweight mineral oil after each 24-month period.

31. Place a warning tag on the generator stating "**Engine Does NOT Contain Oil**" and "**Do NOT Operate**."
32. Store the generator set in a clean, dry, vibration free and climate controlled area.
33. Place silicon gel packs in the following areas.
    - Generator control panel
    - Intake manifold

- Exhaust manifold

4.2.3 Additional Steps

NOTICE
For two bearing alternators, decouple the alternator from the engine. For single bearing machines, do not decouple.

NOTICE
Do not rotate the engine during long term storage.

NOTICE
If the two bearing alternator is decoupled, rotate only the alternator 6 complete revolutions every 4 weeks. For single bearing machines, do not rotate

- Leave the alternator anti-condensation heaters in operation. If power to the heaters is unavailable, then place multiple silica desiccant gel packs in the core of the alternator at both ends of the rotor and in the terminal box.
- Place multiple silica desiccant gel packs on the outside of the generator at, or near the following areas:
    - Intake/exhaust manifolds
    - Generator set control panel
    - ECM's
    - Alternator entrance box

NOTICE
The amount of silica desiccant gel packs required and the replacement interval for the silica gel packs will vary based on manufacturer and the environment the generator is exposed to. Follow manufacturer guidelines for replacement intervals and to determine the amount needed. Moisture indicating gel packs will better determine when the replacements need to occur. Inspect the silica gel packs once a month.

- If necessary, disconnect the generator set batteries. Follow the manufacturer's storage procedures to store the batteries.
- Cover all openings with heavy paper or plastic and tape to prevent dirt and moisture from entering the engine/alternator.
- Place a warning tag on the generator set stating there are silica desiccant gel packs at the locations placed.
- Wrap the generator set in a corrosion inhibiting plastic such as Zerust.

4.2.4 Returning the Generator Set to Service

1. Remove the protective paper and plastic coverings.
2. Remove all silica desiccant gel packs.

3. For alternators with re-greasable bearings:
   - If the alternator has been rotated during the storage period and has been in storage between 6 and 24 months, re-grease the bearings during the first run. Follow the recommended re-greasing procedure found in the specific alternator service manual.
   - If the alternator has not been rotated during the storage period and has been in storage for a period longer than 12 months, replace the bearings. Follow the recommended re-replacement procedure found in the specific alternator service manual.
4. For alternators with sealed for life bearings:
   - If the alternator has been rotated during the storage period and has been in storage for a period longer than 24 months, replace the bearings. Follow the recommended replacement procedure found in the specific alternator service manual.
   - If the alternator has not been rotated during the storage period and has been in storage for a period longer than 12 months, replace the bearings. Follow the recommended replacement procedure found in the specific alternator service manual.
5. For two bearing machines, recouple the alternator to the engine if necessary.
6. For the alternator, carry out the "pre-running" checks as detailed in the specific alternator model service manual to determine the condition of the windings.
7. Flush the engine preservative oil out of the engine by removing the plug from the main engine oil rifle and pumping a hot, lightweight mineral oil through it. Make sure that the engine crankshaft is barred at least 3 to 4 revolutions during this flushing procedure.
8. Drain all the mineral oil that was used to flush the engine clean and the engine preservative oil.
9. Install the drain plugs.
10. If necessary fill or flush/fill the cooling system:
    - If the generator set has been in storage for less than 24 months and if the cooling system was drained, fill the cooling system with new coolant.
    - If the generator set has been in storage for 24 months or more, the cooling system must be drained and flushed with a suitable solvent or a hot, lightweight mineral oil.
    - If the generator set has been in storage for less than 24 months and the cooling system has an extended life coolant with a rust inhibitor, then drain and fill the cooling system with new coolant.
11. Fill and install new oil, fuel and coolant filters.
12. Fill the oil pan sump.
13. If necessary, re-connect the generator set batteries.
14. Prime the lubricating system using the main oil rifles of the engine.
15. Reinstall any belts that were removed.

NOTICE
The engine may run unstable until the fuel system is completely primed, or until the preservative fluid is completely flushed out of the fuel system.

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5 Troubleshooting

5.1 Locking the Generator Set Out of Service

Before any work is carried out for maintenance, etc., the generator set must be immobilized. Even if the generator set is put out of service by pressing the **Off** switch on the operator panel, the generator set cannot be considered safe to work on until the engine is properly immobilized, as detailed in the following procedures.

NOTICE
Refer also to the engine specific Operator Manual. This manual contains specific equipment instructions that may differ from the standard generator set.

5.1.1 Immobilizing for Safe Working

To immobilize the generator set:

1. Press the **Off** mode switch on the operator panel to shut down the generator set.
2. Press the **Emergency Stop** button. This prevents the generator set starting, regardless of the Start signal source and provides an additional safety step for immobilizing the generator set.

NOTICE
When the Emergency Stop button is pressed, the operator panel indicates a Shutdown condition. The red Shutdown status LED illuminates and a message is displayed.

NOTICE
Do not cover Emergency stop button in any situation for easy accessibility

NOTICE
This condition is stored in the Fault History.

3. Isolate and lock off the starting battery/batteries.
4. As an additional precaution, thoroughly ventilate the plant room before disconnecting any leads.
5. Isolate and lock off the supply to the heater, where fitted.
6. Isolate and lock off the supply to the battery charger, where fitted.
7. Isolate the fuel supply to the engine.
8. Using an insulated wrench, disconnect the negative (–) cable first on the starting batteries and control system batteries (if separate).
9. Fit warning notices at each of the above points to indicate Maintenance in Progress — Plant Immobilized for Safe Working.

5.2 Troubleshooting - General

5.2.1 Control System

The generator set control system continuously monitors engine sensors for abnormal conditions, such as low oil pressure and high coolant temperature. If any of these conditions occur, the control will light a yellow Warning lamp or a red Shutdown lamp and will display a message on the graphical display panel. In the event of an engine shutdown fault (red Shutdown LED), the control will stop the engine immediately.

5.2.2 Safety Considerations

⚠ WARNING
Hazardous Voltage ***Contact with high voltages can cause severe electrical shock, burns, or death.*** ***Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.***

⚠ WARNING
Combustible Gases ***Ignition of battery gases is a fire and explosion hazard which can cause severe personal injury or death.*** ***Do not smoke, or switch the trouble light ON or OFF near a battery. Touch a grounded metal surface first before touching batteries to discharge static electricity. Stop the generator set and disconnect the battery charger before disconnecting battery cables. Using an insulated wrench, disconnect the negative (–) cable first and reconnect it last.***

⚠ WARNING
Automated Machinery ***Accidental or remote starting of the generator set can cause severe personal injury or death.*** ***Isolate all auxiliary supplies and use an insulated wrench to disconnect the starting battery cables (negative [–] first).***

Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review the safety precautions in the Important Safety Instructions section.

High voltages are present when the generator set is running. Do not open the generator set output box while the generator set is running.

NOTICE
Disconnect the battery charger from the AC source before disconnecting the battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the generator set.

When troubleshooting a generator set that is shut down, make certain the generator set cannot be accidentally restarted as follows:

1. Make sure the generator set is in the Off mode.
2. Turn off or remove AC power from the battery charger.

3. Turn the battery isolator to the Off position.
4. Using an insulated wrench, remove the negative (**–**) battery cable from the generator set starting battery.

5.2.3 InPower Service Tool

The InPower™ service tool can be used in troubleshooting to perform tests, verify control inputs and outputs, and test protective functions. Refer to the InPower User's Guide, provided with the InPower software for test procedures.

InPower, when used improperly, can cause symptoms like warnings and shutdowns that appear to be a defective base board. When these problems occur, always verify that a self-test or fault simulation (override) have not been left enabled with InPower. If you do not have InPower, or the enabled fault simulation(s) cannot be found using InPower, disconnect battery power to disable the test or override condition.

Make sure that parameter adjustments and time delays, related to the fault condition, have been appropriately set for the application. It may be necessary to write the initial capture file to the device or update the calibration file.

Updating a calibration file requires the InPower Pro version. Confirm that the installed calibration part number matches the serial plate information.

NOTICE
Using the wrong calibration file can result in equipment damage. Do not swap base boards from another generator set model.

Some features are not available until the hardware for that feature is installed and InPower Pro is used to update (enable) that feature. Confirm that the feature is installed and enabled prior to troubleshooting the base board for symptoms related to a feature.

5.2.4 Network Applications and Customer Inputs

In applications with networks and remote customer inputs, the generator set may start unexpectedly or fail to crank as a result of these inputs. These symptoms may appear to be caused by the base board or control module. Verify that the remote input is not causing the symptom or isolate the control from these inputs before troubleshooting the control.

5.2.5 Test Equipment

To perform the test procedures in this manual, the following test equipment must be available:

- True RMS digital multi-meter for accurate measurement of resistance, AC voltage (0-1000 VAC), and DC voltage.
- Current probe(s).
- Battery hydrometer.
- Jumper leads.
- Tachometer.
- Megger or insulation resistance meter.
- InPower service tool (PC-based service tool)
- InSite Tool

- Newest InPower InCal files (calibration for control) from the InCal web site (**power.cummins.com** under “Services", “Software Updates", “InCal Quick Links").
- PC-based service tool connector (Cummins Part number 0541-1199).
- Inline 6 / Inline 7 adapter or newer (Cummins Part numbers 2892092/5299899).
- Inline 6 / Inline 7 drivers (available via kit or online at **cummins.com/parts-and-service/electronic-service-tools/inline**).
- Basic electrical test lead set, with very small probe tips. Fluke test leads “TL80A" (part number 0541-1627) are recommended.
- 316289800 - Pressure/Temperature sensor breakout cable
- 382477400 - Pressure sensor breakout cable
- 382477600 - Pressure sensor breakout cable
- 316475200 - DanfossTM pressure sensor breakout cable TM pressure sensor breakout cable
- 382275800 - Male Deutsch/AMP/Metri-Pack test lead
- 382291700 - Female Deutsch/AMP/Metri-Pack test lead
- 382481200 - Deutsch socket pin test lead
- 382481100 - Deutsch pin test lead

5.2.6 Voltage/Continuity Testing

For voltage and continuity tests described in the troubleshooting section, it may be necessary to remove a plug to complete the test.

The following corrective actions will mention when it is necessary to remove a plug for testing. In other cases, the plug must not be removed for testing. When plug removal is not mentioned, testing must be performed by inserting a narrow meter probe into the back of the plug.

5.2.7 CT Ratio Calculator

InPower has a built-in CT ratio calculator which allow you to determine the required CT size and CT ratio.

The following generator set information is required to calculate the CT ratio:

- Generator set power ratings
- Frequency range
- Nominal frequency
- Nominal voltage Limits
- Secondary CT ratio value

Follow these steps to use the CT ratio calculator in InPower.

1. Connect to the PCC and highlight any of the folders under the PCC connection (such as Advanced Status). Right click on the folder, and click on Genset OEM Setup...

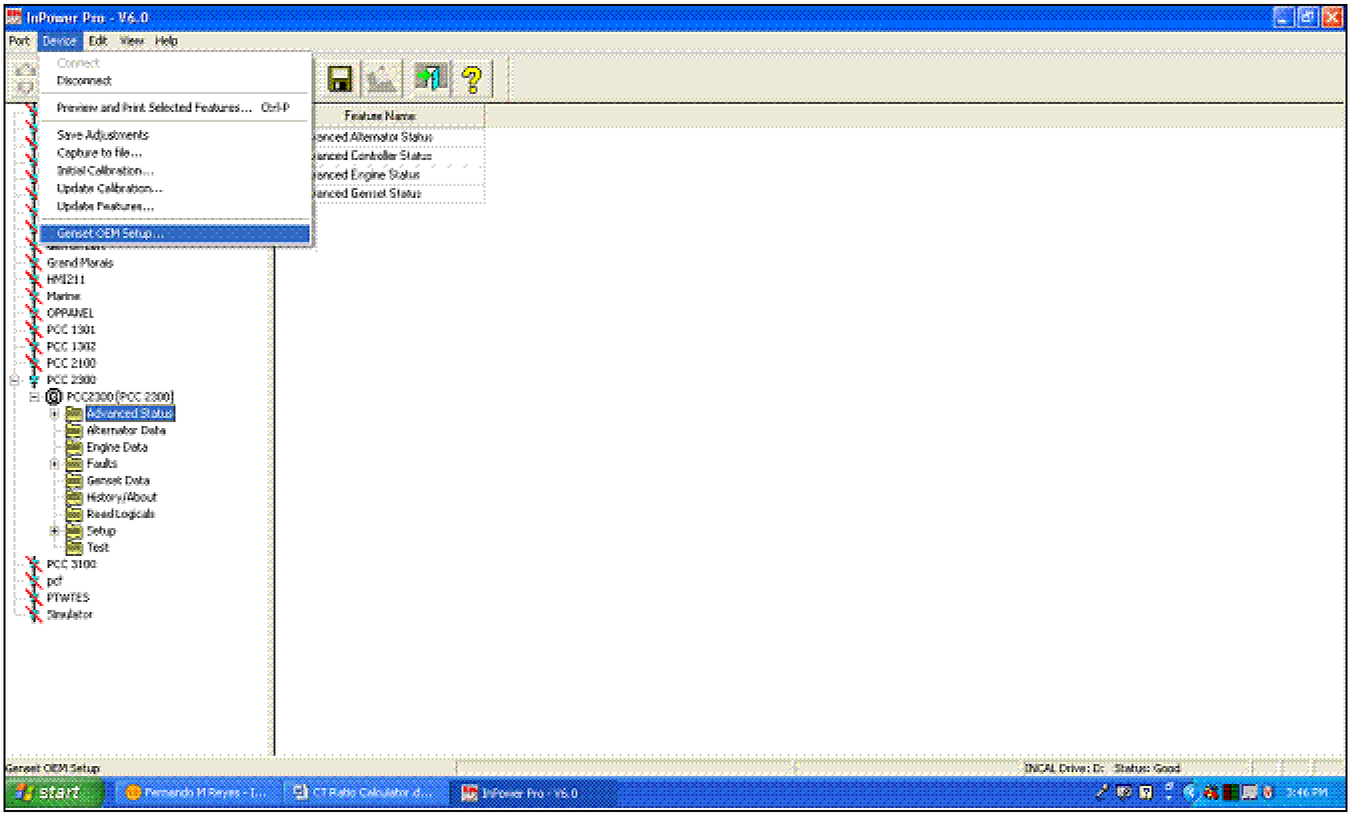


FIGURE 1. INPOWER - GENSET OEM SETUP SELECTION

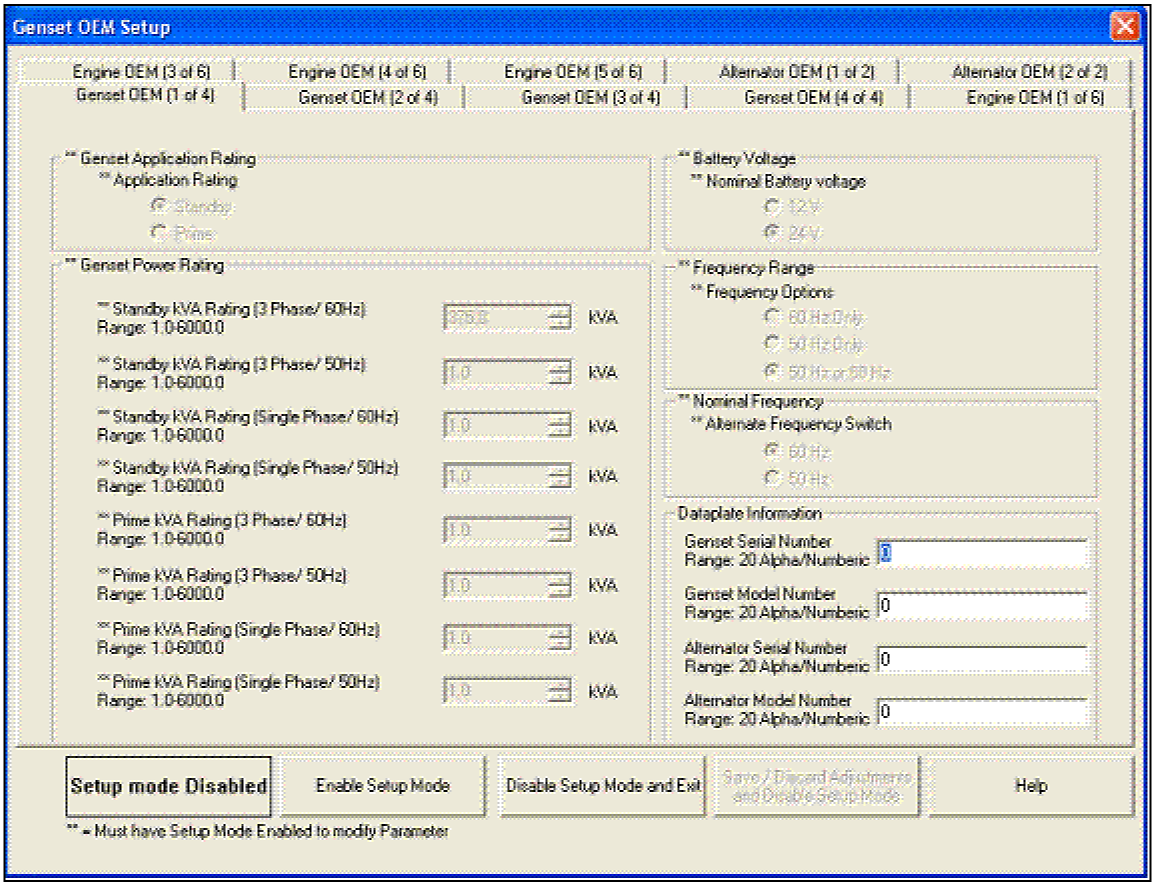


FIGURE 2. GENSET OEM SETUP WINDOW

2. Click on Enable Setup Mode in order to enable the menu.
3. Enter the generator set information under Genset Power Ratings, Frequency Range, and Nominal Frequency.
4. Click on Save/Discard Adjustments and Disable Setup Mode in order to save the generator set settings. This step is required.

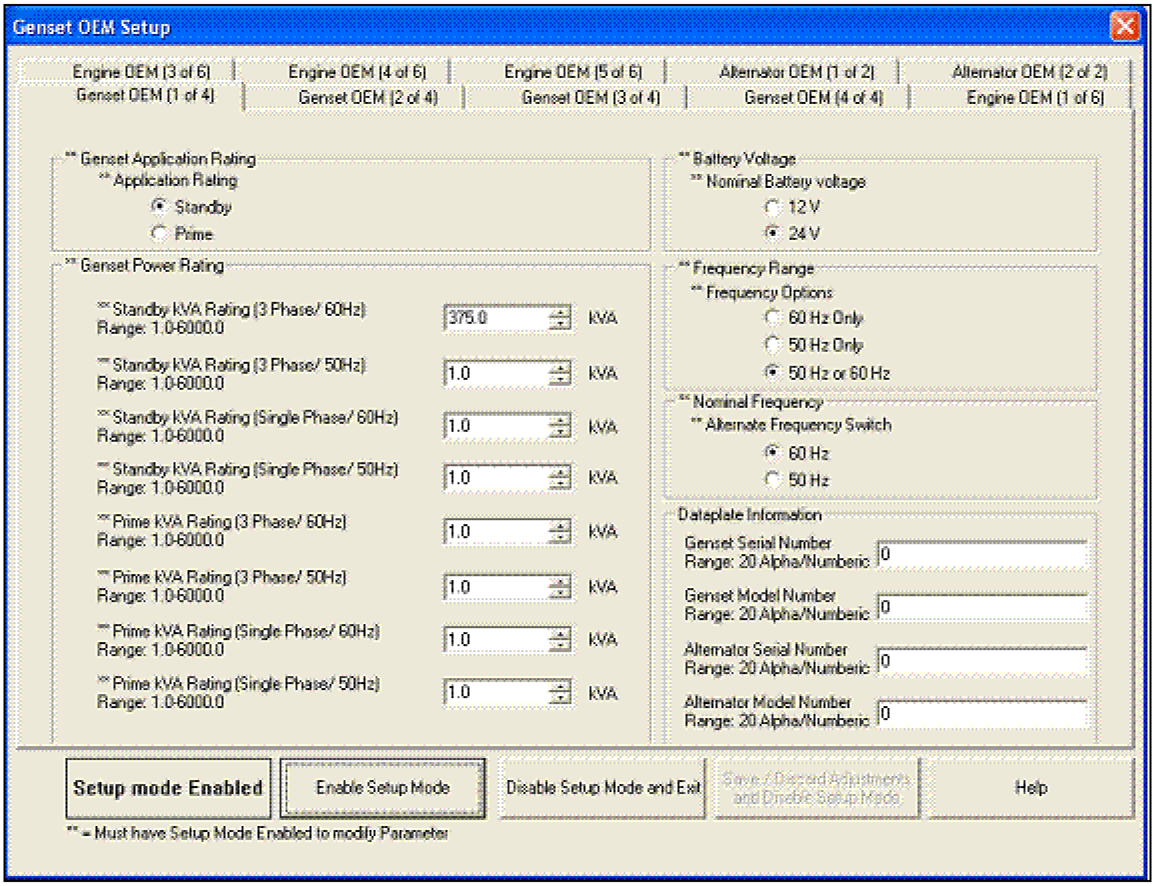


FIGURE 3. GENSET OEM SETUP WINDOW - ENABLE SETUP MODE

5. Open the Genset OEM Setup again.
6. Click on the Alternator OEM (1 of 2) tab to display the settings below.

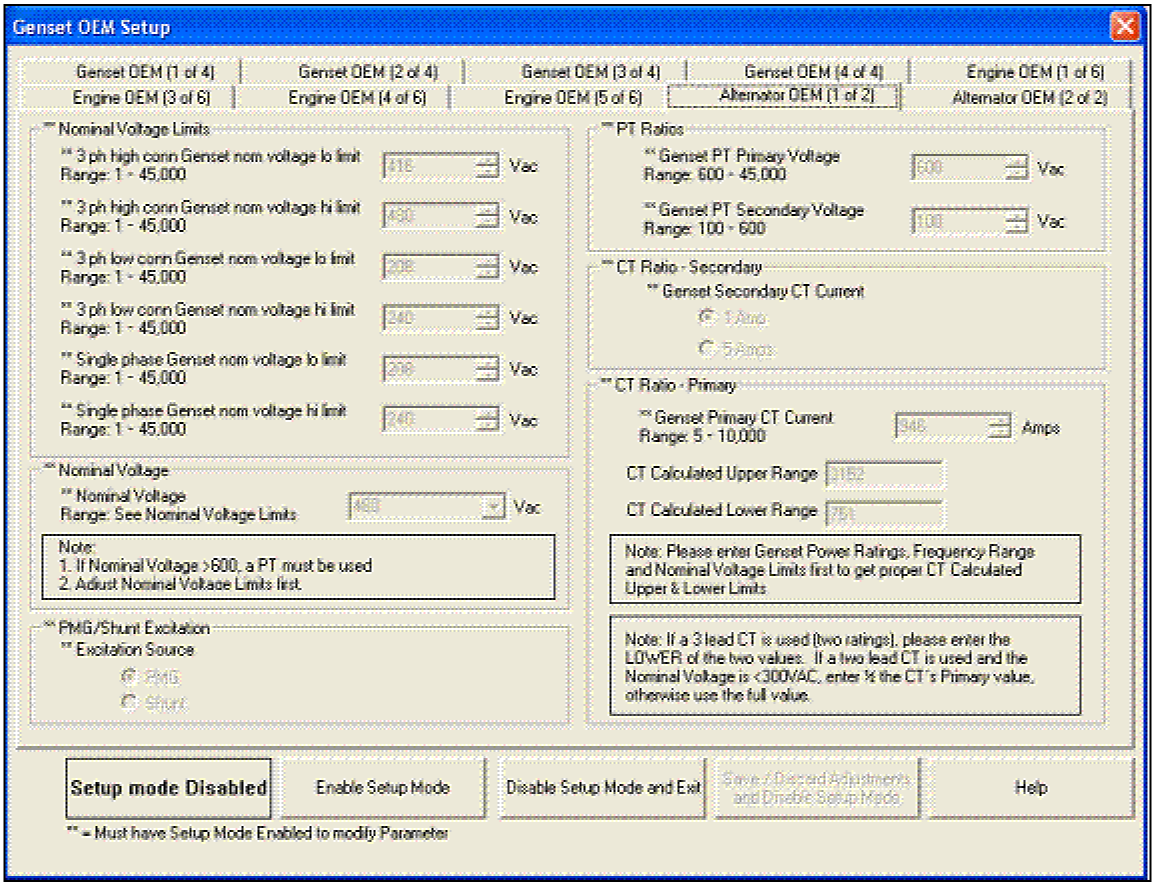


FIGURE 4. GENSET OEM SETUP WINDOW - OEM (1 OF 2)

7. Click on Enable Setup Mode in order to enable the menu.
8. Enter the generator set information under Nominal Voltage Limits and CT Ratio –Secondary. After all the information is entered, InPower will calculate the required Genset Primary CT Ratio limits. The primary CT Ratio needs to be between the CT Calculated Upper Range and the CT Calculated Lower Range.

   The CTs and the CT ratio setting in the PCC require a primary CT ratio between the CT Calculated Upper Range and the CT Calculated Lower Range.

   The alternator CT ratio is required to have a secondary CT Ratio equal to the setting under the CT Ratio – Secondary.

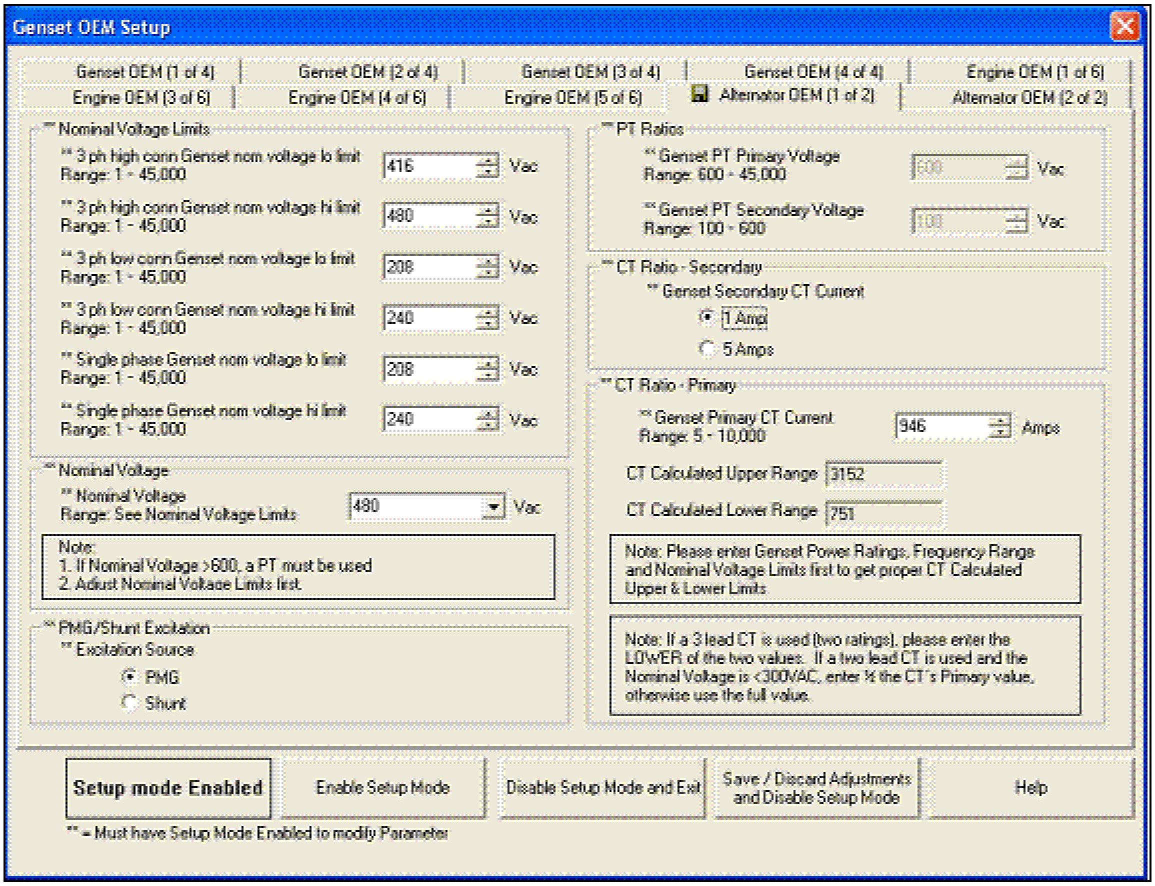


FIGURE 5. OEM (1 OF 2) NOMINAL VOLTAGES

9. To exit the setup mode and save changes, click on Save / Discard Adjustments and Disable Setup Mode.

   To exit the setup mode without saving changes, click on Disable Setup Mode and Exit. Then, click on Discard when the Save Adjustments Screen pops up.

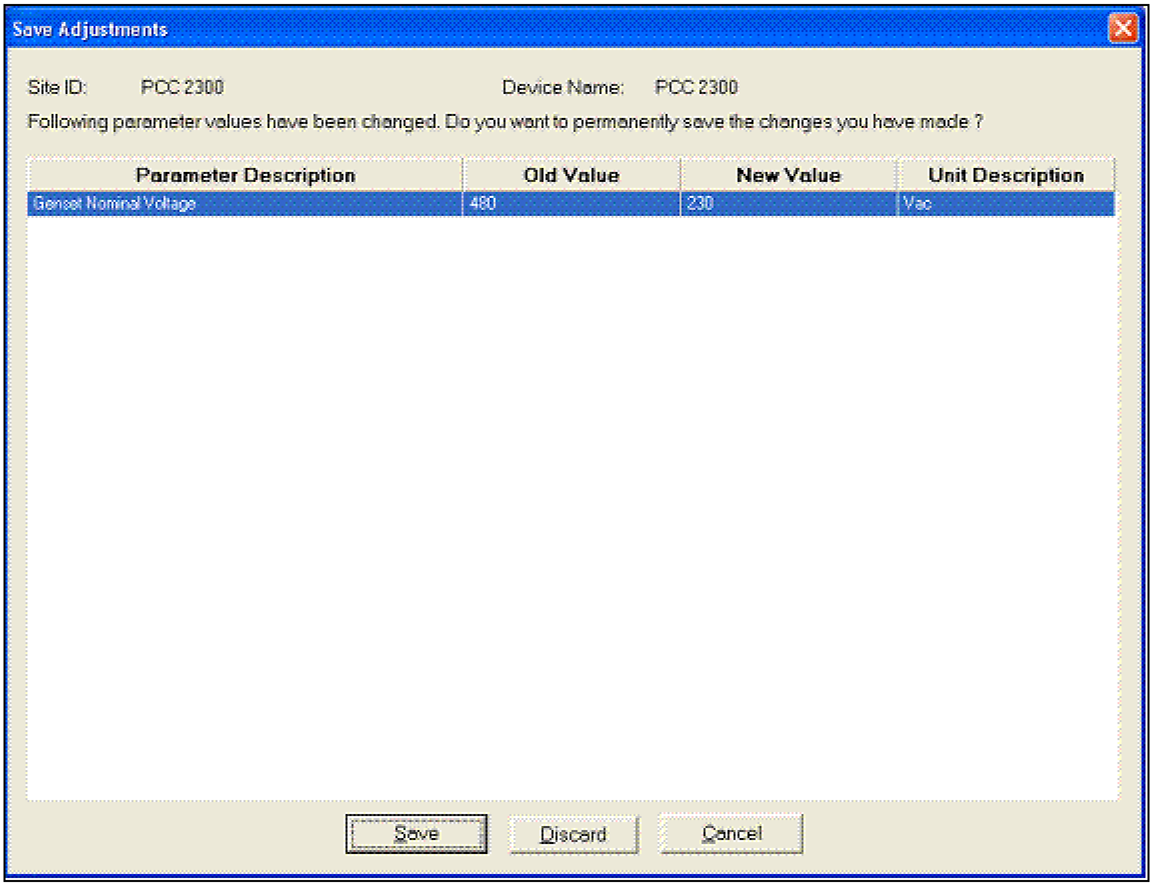


FIGURE 6. SAVE ADJUSTMENTS WINDOW

5.2.8 Reading Fault Codes

When a fault occurs, the graphical display on the HMI will display the fault code/message.

After the fault is acknowledged and corrected, the recorded fault will be deleted from the control panel memory, but will remain in a data log to maintain a fault code history. The InPower service tool is required to view this data log.

5.2.9 Troubleshooting Procedures

The following list of troubleshooting procedures are a guide to help you evaluate problems with the generator set. You can save time if you read through the manual ahead of time and understand the system.

NOTICE

Always set the generator set to off mode before disconnecting or connecting harness connectors. Otherwise, disconnecting the harness connectors can result in voltage spikes high enough to damage the DC control circuits of the set.

NOTICE

Electrostatic discharge will damage circuit boards. Always wear a wrist strap when handling circuit boards or when disconnecting or connecting harness connectors. See the *Circuit Board Removal/Replacement* procedure in the controller Service Manual.

NOTICE

The troubleshooting procedures for ECM-related faults and engine-related faults are in the engine service manual.

NOTICE

Each fault code “warning" can be changed to a “shutdown" using InPower. Default settings are used in this manual. It is recommended that all changes to settings be recorded at each site to aid in the troubleshooting of the generator set.

If you are troubleshooting a fault that does not appear in the graphical display, look at the SA field in the Faults screens to identify the source of the fault. If this field is blank, the PCC is the source of this fault.

Try to think through the problem. Go over what was done during the last service call. The problem could be as simple as a loose wire, an opened fuse, or a tripped circuit breaker.

This section contains the following information:

- How to troubleshoot a local/remote failure to crank problem when the control panel does not indicate any fault condition.
- How to troubleshoot engine problems that are not within the detectable range of the PC control.
- How to troubleshoot a Check Engine lamp fault for generator sets that contain the low emissions option.
- Descriptions of each status, warning, and shutdown code; warning and shutdown limits where applicable; and basic corrective actions, such as checking fluid levels, control reset functions, battery connections, etc.
- Detailed troubleshooting procedures. In the following list of troubleshooting procedures, the fault codes are arranged in numeric order.

5.2.10 Fault Reset Signal

This signal may come from any of these sources:

- PCC Fault Reset connection (typically, the Reset button on the Operator Panel)
- Reset button on the Operator Panel
- Modbus networks
- PC-based service tool, such as InPower

This signal becomes active for one second when any of these sources changes from inactive to active. Then, the signal remains inactive until any of these sources changes from inactive to active again.

5.2.11 Delayed Shutdown

The PCC provides advance warning of an impending shutdown if all of these conditions are met:

- *Delayed Shutdown Enable* is set to Enable.
- The ECM is set to enable Battle Short mode (Core 2 ECMs only).
- A non-critical shutdown fault occurs, and there are no critical shutdown faults.

When these conditions are met, the PCC generates warning fault 1124 (Delayed Shutdown) and waits *Delayed Shutdown Time Delay* before it initiates the stop sequence.

5.3 Troubleshooting Fault Codes

5.3.1 Types of Events/Faults

The PCC generates these types of events/faults.

5.3.2 Event/Fault List Definition

Faults and events that appear in the table that do not have a troubleshooting procedure in this manual are engine driven faults/events. To troubleshoot these faults, consult the engine Service manual, engine Troubleshooting and Repair manual, and/or QuickServe OnLine.

5.3.3 Events

The PCC generates events to notify external devices when certain conditions are met. The PCC may send notifications any of these ways:

- Configurable outputs.
- PCCNet devices (For example, events might control a LED or a configurable output on a PCCNet device.)

It is up to the external devices to respond to an event when they are notified about one. Events do not appear in any screen in the Operator Panel.

5.3.4 Warning Faults

The PCC generates warning faults to warn the operator when unsafe conditions are occurring.

When the PCC generates a warning fault, the warning fault becomes active. However, active warning faults have no effect on generator set operation. The generator set can start, continue running, and stop as usual.

Active warning faults appear in the Warning Faults screen. In addition, the PCC provides these indications as long as there is an active warning fault:

- The Warning LED on the Operator Panel is on.
- Event 1540 (Common Warning) is active.
- Event 1483 (Common Alarm) is active.

Follow these steps to clear a warning fault.

1. Correct the condition(s) that caused the fault.
2. Activate the fault reset signal.

Faults that have been cleared appear in the Fault History screen.

5.3.5 Derate Events

Derate events are warning faults in which the PCC also requests a reduction in the kW output level of the generator set.

If a derate event is active, *Derate Request* (This Parameter is not available in the Operator Panel, refer to parameters table) is the percentage of the current kW output level the PCC would like to have removed. Each derate event has this percentage associated with it. If two or more derate events are active at the same time, the PCC considers only the maximum percentage requested by each derate event. The PCC does not add the percentages together. For example, if one derate event requests a 10% reduction and a second derate event requests a 20% reduction, *Derate Request (This Parameter is not available in the Operator Panel, refer to parameters table)* is 20%, not 30%.

The PCC is running in Load Govern paralleling state, the PCC requests that *Genset % Standby Total kW* be no more than 100% - *Derate Request (This Parameter is not available in the Operator Panel, refer to parameters table)*. This becomes a limitation for *Load Govern kW Target*.

If the PCC is not running in Load Govern paralleling state, the PCC generates warning fault 1464 (Load Dump Fault). If *Load Dump/Configurable Output #11 Output Function Pointer* is set to Default, the Load Dump connection is active. The PCC does not do anything else to reduce the kW output level. It is up to external devices to reduce the load.

If *LBNG Genset Enable* is set to Enable, the PCC recognizes derate requests from the engine control module (ECM) only if all of these conditions are met.

- *LBNG Derate Enable* is set to Enable.
- The AUX101's Derate Authorization connection is active.

5.3.6 Shutdown Faults

The PCC generates shutdown faults to prevent damage to the generator set. The PCC shuts down the generator set immediately.

When the PCC generates a shutdown fault, the shutdown fault becomes active. The PCC initiates a Shutdown Without Cooldown sequence.

Active shutdown faults appear in the Shutdown Faults screen. In addition, the PCC provides these indications as long as there is an active shutdown fault:

- The Shutdown LED on the Operator Panel is on.
- Event 1541 (Common Shutdown) is active.
- Event 1483 (Common Alarm) is active.

You cannot start the generator set until you clear the shutdown fault. Follow these steps to clear a shutdown fault.

1. Correct the condition(s) that caused the fault.
2. Make sure the emergency stop buttons are inactive, and change the PCC to Off mode.

NOTICE
If Remote Fault Reset Enabled is set to Enable, you can also clear shutdown faults in Auto mode. In this case, change the PCC to Auto mode , and make sure the exercise signal and the remote start signal are inactive. The PCC generates event 2941 (Remote Shutdown Fault Reset Occurrence) when shutdown faults are reset in Auto mode.

3. Activate the fault reset signal.

Faults that have been cleared appear in the Fault History screen.

5.3.6.1 Shutdown with Cooldown Faults

Shutdown with cooldown faults are shutdown faults in which the PCC has time to cool down the generator set.

When the PCC generates a shutdown with cooldown fault, the shutdown with cooldown fault becomes active. If the PCC is running in Load Govern paralleling state, it initiates a Manual Stop sequence and starts running the load govern kW ramp unload process. If the PCC is not running in Load Govern paralleling state, it initiates a Controlled Shutdown sequence. When the stop sequence has finished, the PCC generates shutdown fault 1336 (Cooldown Complete).

If a shutdown with cooldown fault is active and the engine speed is greater than zero, warning fault 1132 (Controlled Shutdown) is active. You can assign this event/fault to a configurable output, so that the PCC notifies an external device that is going to shut down the generator set.

In other ways, shutdown with cooldown faults are the same as shutdown faults.

5.3.6.2 Critical Shutdown Faults vs. Non-critical Shutdown Faults

The PCC always shuts down the generator set when a critical shutdown fault is generated. Non-critical shutdown faults do not prevent the PCC from starting or running the generator set when Battle Short mode is active. The PCC also responds to critical shutdown faults and non-critical shutdown faults differently if Delayed Shutdown is set up.

NOTICE
This discussion applies to shutdown with cooldown faults as well as shutdown faults.

The table below identifies the critical shutdown faults.

TABLE 10. CRITICAL SHUTDOWN FAULTS

Event/Fault Code	Description
115	Eng Crank Sensor Error
234	Crankshaft Speed High
236	Both Engine Speed Signals Lost
359	Fail To Start
781	CAN Data Link Failure
1245	Engine Shutdown Fault
1247	Unannounced Engine Shutdown
1336	Cooldown Complete
1433	Local Emergency Stop
1434	Remote Emergency Stop
1438	Fail To Crank
1992	Crankshaft Sensor High
2335	AC Voltage Sensing Lost (Excitation Fault)
2914	Genset AC Meter Failed

All other shutdown faults are non-critical shutdown faults. The PCC still provides the usual indications that a shutdown fault has occurred, even if it overrides a non-critical shutdown fault.

5.3.7 Fault Codes

This table identifies the faults codes and events that the PCC can generate depending on its configuration.

NOTICE

InPower can be used to raise the response/severity of an event or fault. For example, an event can be changed to a warning fault or a warning fault to a shutdown fault. The response/severity of an event or fault (except event/fault 1452 (Genset Breaker Fail to Close)) cannot be set lower than its default value, and the severity cannot be changed of any fault or event with an asterisk (**).

Codes marked with * are generator related fault codes. For all other codes for the possible cause, failure and diagnosis refer to the relevant engine service manual.

TABLE 11. FAULT CODES

Code	Event/Lamp	Displayed Message
111	Shutdown	Internal ECM Failure
115	Shutdown	Eng Crank Sensor Error
118	Warning	Fuel Pressure OOR High
119	Warning	Fuel Pressure Sensor OOR Low
121	Shutdown	Loss of Speed Sense
122	Warning	Manifold 1 Press High
123	Warning	Manifold 1 Press Low
124	Warning	Manifold 1 Press High
135	Warning	High Oil Rifle 1 Pressure
141	Warning	Low Oil Rifle 1 Pressure
143	Warning	Low Oil Rifle Pressure
144	Warning	High Coolant 1 Temp
145	Warning	Low Coolant 1 Temp
146	Warning	Pre-High Engine Coolant Temperature
151	Shutdown	High Coolant Temp
153	Warning	High Intake Manf 1 Temp
154	Warning	low Intake Manf 1 Temp
155	Shutdown	High Intake Manf 1 Temp
187	Warning	Sensor Supply 2 Low
195	Warning	High Coolant 1 Level
196	Warning	Low Coolant 1 Level
197*	Warning	Low Coolant Level
212	Warning	High Oil 1 Temperature
213	Warning	Low Oil 1 Temperature
214	Shutdown	High Oil 1 Temp
219	Warning	Eng Oil Level Remote Reservoir: Least Severe Level

Code	Event/Lamp	Displayed Message
221	Warning	Air Pressure Sensor High
222	Warning	Air Pressure Sensor Low
223	Warning	Oil Burn Valve Sol Low
224	Warning	Oil Burn Valve Sol High
227	Warning	Sensor Supply 2 Low
228	Shutdown	Low Coolant Pressure
231	Warning	High Coolant Pressure
232	Warning	Low Coolant Pressure
233	Warning	HT Coolant Pressure Moderate Low
234*	Shutdown	Crankshaft Speed High
236*	Shutdown	Both Engine Speed Signals Lost
238	Warning	Sensor Supply 3 Low
239	Warning	Main Supply High
245	Warning	Fan Control Low
254	Shutdown	FSO PWM High Control Error
255	Warning	FSO PWM Low Control Error
259	Warning	Engine Fuel Shutoff Valve Stuck Open
261	Warning	High Fuel Temperature
263	Warning	High Fuel 1 Temperature
265	Warning	Low Fuel 1 Temperature
266	Shutdown	High Fuel Temperature
271	Warning	Low Fuel Pump Press
272	Warning	High Fuel Pump Press
277	Warning	Fuel Control Valve Out of Adj
281	Warning	Cylinder Press Imbalance
284	Warning	Eng Speed/Position Sensor: Voltage Below Normal
285	Warning	CAN Mux PGN Rate Error
286	Warning	CAN Mux Calibration Error
287	Warning	CAN Mux Accel Data Error
295	Warning	Key On Air Pressure Error
311	Warning	ACT1 FF Shorted HS TO LS Error
312	Warning	ACT5 Shorted HS TO LS Error
313	Warning	ACT3 RF Shorted HS TO LS Error
314	Warning	ACT6 Shorted HS TO LS Error

Code	Event/Lamp	Displayed Message
315	Warning	ACT2 FT Shorted HS TO LS_Error
319	Warning	RTC PWR Intr: Data Erratic Intermittent or Wrong
321	Warning	ACT4 RT Shorted HS TO LS Error
322	Warning	Inj 1 Solenoid Low Curr
323	Warning	Inj 5 Solenoid Low Curr
324	Warning	Inj 3 Solenoid Low Curr
325	Warning	Inj 6 Solenoid Low Curr
331	Warning	Inj 2 Solenoid Low Curr
332	Warning	Inj 4 Solenoid Low Curr
341	Warning	Engine Control Module Data Lost
342	Shutdown	Calibration Code Fail
343	Warning	ECM Hardware Failure
351	Warning	Injector Supply Failure
352	Warning	Sensor Supply 1 Low
359*	Shutdown	Fail to Start
378	Warning	Elect Fuel Inj Cntrl Valve Ckt: Curr Below Normal
379	Warning	Elect Fuel Inj Cntrl Valve Ckt: Curr Above Normal
386	Warning	Sensor Supply 1 High
394	Warning	Eng Timing Actuator Driver: Curr Below Normal
395	Warning	Eng Timing Actuator Driver: Curr Above Normal
396	Warning	Fuel Cntl Valve Solenoid Driver 2 Sensor Ckt: OC
397	Warning	Fuel Cntl Valve Solenoid Driver 2 -
398	Warning	Eng Timing Actuator Driver 2 Circuit: OC
399	Warning	Eng Timing Actuator Driver 2: Grounded Ckt
415	Shutdown	Low Oil Rifle Press
418	Warning	High H2O in Fuel
419	Warning	Intake Manifold Pres Bank Imbalance: Data Erratic
421*	Warning	High Oil Temperature
422	Warning	Coolant Level Data Error
425	Warning	Oil Temperature Error
426*	Event	J1939 Datalink: Data Erratic/Intermittent/Wrong
427*	Warning	CAN Data Link Degraded
428	Warning	Water In Fuel Indicator Sensor: Volt Above Normal
429	Warning	Water In Fuel Indicator Sensor: Volt Below Normal

Code	Event/Lamp	Displayed Message
433	Warning	Intake Manifold Press Sensor Ckt: Data Erratic
435	Warning	Oil Pressure Switch Error
441*	Warning	Low Battery 1 Voltage
442*	Warning	High Battery 1 Voltage
449	Shutdown	Inj Metering 1 Press High
451	Warning	Inj Metering 1 Press High
452	Warning	Inj Metering 1 Press Low
479	Warning	Exhaust Gas Temperature Data Incorrect
482	Warning	Fuel Press Low: Valid But Below Normal: Mod Severe
483	Warning	IMR 2 Pressure Sensor Circuit Shorted to High
484	Warning	IMR 2 Pressure Sensor Circuit Shorted to Low
488*	Warning	High Intake Manf 1 Temp
496	Warning	Eng Speed Sensor 2 Supply Volt: Root Cause Unknown
515	Warning	Sensor Supply 6 Circuit OORH
516	Warning	Sensor Supply 6 Circuit OORL
546	Warning	Fuel Delivery Press High
547	Warning	Fuel Delivery Press Low
553	Warning	APC Pressure High
554	Warning	APC Pressure Error
555	Warning	Crankcase Pressure High: Above Normal
556	Shutdown	Crankcase Pressure High
559	Warning	Inj Metering 1 Press Low
581	Warning	Fuel Pump Intake Pressure Sensor OOR Hi
582	Warning	Fuel Pump Intake Pressure Sensor OOR Lo
583	Warning	Low Fuel Pump Intake Pressure
611*	Warning	Engine Hot Shut Down
621	None	Exh Gas Temp Cyl 1 Deviation Low: Below Normal
622	None	Exh Gas Temp Cyl 3 Deviation Low: Below Normal
623	None	Exh Gas Temp Cyl 5 Deviation Low: Below Normal
624	None	Exh Gas Temp Cyl 7 Deviation Low: Below Normal
625	None	Exh Gas Temp Cyl 9 Deviation Low: Below Normal
626	None	Exh Gas Temp Cyl 11 Deviation Low: Below Normal
627	None	Exh Gas Temp Cyl 13 Deviation Low: Below Normal
628	None	Exh Gas Temp Cyl 15 Deviation Low: Below Normal

Code	Event/Lamp	Displayed Message
631	None	Exh Gas Temp Cyl 2 Deviation Low: Below Normal
632	None	Exh Gas Temp Cyl 4 Deviation Low: Below Normal
633	None	Exh Gas Temp Cyl 6 Deviation Low: Below Normal
634	None	Exh Gas Temp Cyl 8 Deviation Low: Below Normal
635	None	Exh Gas Temp Cyl 10 Deviation Low: Below Normal
636	None	Exh Gas Temp Cyl 12 Deviation Low: Below Normal
637	None	Exh Gas Temp Cyl 14 Deviation Low: Below Normal
638	None	Exh Gas Temp Cyl 16 Deviation Low: Below Normal
649	None	Engine Oil Change Needed
686	Warning	Turbo 1 Speed Incorrect
689	Warning	Crankshaft Speed Error
691	Warning	Turbocharger 1 Comp Intake Temp:Volt Above Normal
692	Warning	Turbocharger 1 Comp Intake Temp:Volt Below Normal
697	Warning	ECM Temperature High
698	Warning	ECM Temperature Low
731	Warning	Crankshaft Mech Misalign
743	Warning	Turbocharger 1 Compressor Intake Pressure Error
755	Warning	Injector Metering Rail 1 Pressure System Error
757	Warning	All Persistent Data Lost Error
778	Warning	EPS Backup Lost Sync Error
781*	Shutdown	CAN Data Link Failure
782	Warning	SAE J1939 Data Link 2 Engine Network No Data Received – Condition Exists
783	Shutdown	Intake Manf 1 Rate Error
1117	Warning	Power Lost With Ignition On
1121*	Warning	Fail To Disconnect
1122*	Event	Rated To Idle Delay
1123*	Shutdown	Shutdown After Battle Short (Shutdown)
1124*	Warning	Delayed Shutdown
1128	Warning	Mixer Inlet Humidity Sensor:Volt Above Normal
1129	Warning	Mixer Inlet Humidity Sensor:Volt Below Normal
1131*	Warning	Battle Short Active
1132*	Warning	Controlled Shutdown
1139	Warning	UFD Injector 1 Error

Code	Event/Lamp	Displayed Message
1141	Warning	UFD Injector 2 Error
1142	Warning	UFD Injector 3 Error
1143	Warning	UFD Injector 4 Error
1144	Warning	UFD Injector 5 Error
1145	Warning	UFD Injector 6 Error
1219*	Warning	Utility Breaker Tripped
1223*	Warning	Utility Frequency
1224*	Warning	Genset Overvoltage
1225*	Warning	Genset Undervoltage
1226*	Warning	Genset Frequency
1243*	Warning	Engine Derated
1244*	Shutdown	Engine Normal Shutdown
1245*	Shutdown	Engine Shutdown Fault
1246*	Warning	Unknown Engine Fault
1247*	Shutdown	Unannounced Engine Shutdown
1248*	Warning	Engine Warning
1256	Warning	Ctrl Mod ID In State Error
1257	Shutdown	Ctrl Mod ID In State Fail
1312*	Event	Configurable Input # 2
1317*	Event	Configurable Input # 13
1318*	Event	Configurable Input # 14
1322*	Warning	kW Load Setpoint OOR High
1323*	Warning	kW Load Setpoint OOR Low
1324*	Warning	kVAR Load Setpoint OOR High
1325*	Warning	kVAR Load Setpoint OOR Low
1328*	Warning	Genset Breaker Tripped
1336*	Shutdown	Cooldown Complete
1357	Warning	Oil Remote Level Low
1363	Warning	Intake Manf 1 Press Low
1367	Warning	High Prefilter Oil Press
1368	Warning	Low Prefilter Oil Press
1369	None	Aux Temp 1 Sensor OORH
1373	None	Start Enable Device 1: Cause Unknown
1376	Warning	Camshaft Speed Error

Code	Event/Lamp	Displayed Message
1377	None	Post Oil Filter Pressure OORH
1378	None	Post Oil Filter Pressure OORL
1379	None	Low Fuel Pump Intake Pressure - None severity
1383	None	Intake Manifold 1 Pressure OORH
1384	None	Intake Manifold 1 Pressure OORL
1385	None	Intake Manifold 2 Pressure OORH
1386	None	Intake Manifold 2 Pressure OORL
1389	None	High Fuel Pump Intake Pressure
1411	Warning	High Out Freq Adjust Pot
1412	Warning	High Droop Adjust Pot
1416*	Warning	Fail To Shutdown
1417*	Warning	Power Down Failure
1418	Warning	High Gain Adjust Pot
1427	Warning	Overspeed Relay Error
1428	Warning	LOP Relay Error
1429	Warning	HET Relay Error
1431	Warning	Pre-LOP Relay Error
1432	Warning	Pre-HET Relay Error
1433*	Shutdown	Local Emergency Stop
1434*	Shutdown	Remote Emergency Stop
1435*	Warning	Low Coolant Temperature
1438*	Shutdown	Fail To Crank
1439*	Warning	Low Day Tank Fuel Switch
1441*	Warning	Low Fuel Level
1442*	Warning	Weak Battery
1443*	Shutdown	Dead Battery
1444*	Warning	Overload
1445*	Shutdown	Short Circuit
1446*	Shutdown	High AC Voltage
1447*	Shutdown	Low AC Voltage
1448*	Shutdown	Under Frequency
1449*	Warning	Over Frequency
1451*	Warning	Gen/Bus Voltages Out of Calibration
1452*	Warning	Genset Breaker Fail To Close

Code	Event/Lamp	Displayed Message
1453*	Warning	Genset Breaker Fail To Open
1454*	Warning	Genset Breaker Position Contact
1455*	Warning	Utility Breaker Position Contact
1456*	Warning	Bus Out Of Synchronizer Range
1457*	Warning	Fail To Synchronize
1458*	Warning	Sync Phase Rotation Mismatch Overfrequency
1459*	Shutdown	Reverse Power
1461*	Shutdown	Loss of Field (Reverse kVAR)
1463**	Event	Not In Auto
1464**	Warning	Load Dump Fault
1465**	Event	Ready To Load
1469*	Warning	Speed/Hz Mismatch
1471*	Warning	Over Current
1472*	Shutdown	Over Current
1475*	Warning	First Start Backup
1483*	Event	Common Alarm
1517	Shutdown	Failed Module Shutdown
1518	Warning	Failed Module Warning
1519	Warning	At Least One Module Has: Least Severe Fault
1540*	Event	Common Warning
1541*	Event	Common Shutdown
1548	Warning	Inj 7 Solenoid Low Curr
1549	Warning	Inj 8 Solenoid Low Curr
1551	Warning	Inj 7 Solenoid Low Curr
1552	Warning	Inj 7 Solenoid Low Curr
1553	Warning	Inj 7 Solenoid Low Curr
1554	Warning	Inj 7 Solenoid Low Curr
1555	Warning	Inj 7 Solenoid Low Curr
1556	Warning	Inj 7 Solenoid Low Curr
1557	Warning	Inj 7 Solenoid Low Curr
1573*	Event	Configurable Input #1
1596	None	Aux Temp 1 Sensor OORL
1597	Warning	ECM Device/Component
1622	Warning	Inj 9 Solenoid Low Curr

Code	Event/Lamp	Displayed Message
1664	Warning	Exh Aft Oxidation Catalyst Missing
1665	Warning	Aftertreatment Exhaust Gas Temp1:Volt Below Normal
1666	Warning	Aftertreatment Ext Gas Temp 1:Volt Above Normal
1668	Warning	AT1 DEF Tank Level Sensor OOR Low
1669	Warning	AT1 DEF Tank Level Sensor OOR High
1673	Warning	AT1 Diesel Exhaust Fluid Tank Level Low
1674	Warning	Aftertreatment Exhaust Gas Temp2:Volt Below Normal
1675	Warning	Aftertreatment Exhaust Gas Temp2:Volt Above Normal
1677	Warning	AT1 DEF Tank Temperature Sensor OOR Low
1678	Warning	AT1 DEF Tank Temperature Sensor OOR High
1679	Warning	AT1 Diesel Exhaust Fluid Tank Temperature Error
1682	Warning	AT1 DEF Dosing Unit Input Lines condition
1683	Warning	AT1 Diesel Exhaust Fluid Tank Heater OOR High
1684	Warning	AT1 Diesel Exhaust Fluid Tank Heater OOR Low
1685	Warning	AT Diesel Exhaust Fluid Quality Sensor OOR Low
1686	Warning	AT Diesel Exhaust Fluid Quality Sensor OOR High
1689*	Warning	Real Time Clock Power
1691	Warning	Aft Oxidation Catalyst Efficiency: Below Normal
1695	Warning	Sensor Supply 5 High
1696	Warning	Sensor Supply 5 Low
1712	Warning	AT1 Diesel Exhaust Fluid Tank Heater Low
1713	Warning	AT1 Diesel Exhaust Fluid Tank Heater High
1714	Warning	Aftertreatment Diesel Exhaust Fluid Quality Error
1715	Warning	AT Diesel Exhaust Fluid Quality Root unknown
1794*	Shutdown with Cooldown	Fire Detected
1843	Warning	Crankcase Press High
1844	Warning	Crankcase Press Low
1845	Warning	H2O In Fuel Sens High
1846	Warning	H2O In Fuel Sens Low
1847*	Shutdown w/Cooldown	Eng Coolant Temp - Shutdown w/Cool
1852*	Warning	Pre-High H2O In Fuel
1853*	Warning	Annunciator Input 1 Fault
1854*	Warning	Annunciator Input 2 Fault

Code	Event/Lamp	Displayed Message
1855*	Warning	Annunciator Input 3 Fault
1866	Warning	EGR DP Autozero Error
1867	Warning	Exhaust Gas Recirculation Temperature Error
1879	Warning	Aft Particulate Filter Pressure OORH
1881	Warning	Aft Particulate Filter Pressure OORL
1883	Warning	Aft Particulate Filter Pressure: Incorrect
1885	Warning	Aftertreatment 1Intake NoxSensor:Volt Below Normal
1887	Warning	AT1 Outlet NOx Sensor Circuit OOR Low
1891	Warning	Change Oil
1893	Warning	CAN EGR Valve Comm
1894	Warning	CAN VGT Comm Error
1895	Warning	EGA DL Mismatch Error
1896	Warning	EGR DL Valve Stuck
1898	Warning	VGT Actuator Controller Out of Calibration
1899	Warning	Low EGR Dif Pressure
1911	Warning	Inj Metering 1 Press High
1912*	Warning	Utility Loss Of Phase
1913*	Warning	Genset Loss Of Phase
1914*	Warning	Utility Phase Rotation
1915*	Warning	Genset Phase Rotation
1916*	Event	Sync Check OK
1917*	Warning	Fuel Level High
1918*	Shutdown	Fuel Level Low
1921	Warning	Aftertreatment DPF Differential Pressure
1922	Shutdown	Aftertreatment DPF Differential Pressure Severe
1933	Warning	High EGR Data Link Volt
1934	Warning	Low EGR Data Link Volt
1935	Warning	EGR DL Cmd Source Err
1938	Warning	ECU Power Output Volt: Below Normal
1942	Warning	THD AZ Error
1944*	Warning	HMI 113 Out Config Error
1961	Warning	High EGR DL EDU Temp
1962	Warning	VGT Actuator Driver Temperature: Above Normal
1965	Warning	Aftertreatment Ext Gas Temp1:Data Above Normal

Code	Event/Lamp	Displayed Message
1966	Shutdown	Aftertmt Ext Gas Temp1:Above Normal-Most Severe
1968	Warning	Aftertmt Ext Gas Temp2:Above Normal-Severe
1969	Shutdown	Aftertmt Ext Gas Temp2:Above Normal-Most Severe
1974	Warning	Crankcase Press High
1978*	Warning	Speed Bias OOR Hi
1979*	Warning	Speed Bias OOR Lo
1982	Shutdown	Catalyst Over Temp:Data Above Normal - Most Severe
1984	Warning	Int Man 2 Tmp Moderate High
1992*	Shutdown	Crankcase Sensor High
1993	Warning	Aft Particulate Filter Missing
1999*	Warning	Maximum Parallel Time
2118	Warning	Low Fuel Pressure
2184	Warning	Fuel Injection Control Valve Root Cause Unknown
2185	Warning	Sensor Supply 4 High
2186	Warning	Sensor Supply 4 Low
2198	Warning	VGT Actuator Driver Circuit: Unknown Cause
2215	Warning	Fuel Pump Press Low
2249	Warning	APC 2 Pressure Low
2261	Warning	Fuel Pump Press High
2262	Warning	Fuel Pump Press Low
2265	Warning	High Fuel Lift Pump Volt
2266	Warning	Low Fuel Lift Pump Volt
2272	Warning	EGR DL POS Sensor Error
2273	Warning	EGR Delta P OOR High Error
2274	Warning	EGR Delta P OOR Low Error
2288	None	Turbo Charger 1 Speed: Above Normal
2292	Warning	APC Flow high
2293	Warning	APC Flow Low
2311	Warning	EFI Control Valve Fail
2328*	Event	Utility Available
2331*	Warning	Utility Undervoltage
2332*	Event	Utility Connected
2333*	Event	Genset Connected
2335*	Shutdown	AC Voltage Sensing Lost (Excitation Fault)

Code	Event/Lamp	Displayed Message
2336	Shutdown	Checksum Fault
2336*	Shutdown	Bad Checksum
2342*	Warning	Too Long In Idle
2343	None	Fuel Filter Press Hi Above Normal
2349	Warning	EGR DL Motor Open Error
2351	Warning	EGR DL Motor Short Error
2353	Warning	EGR Valve Control Circuit: Current OORH
2357	Warning	EGR DL Motor Lock Error
2358*	Warning	Utility Overvoltage
2359	Warning	EGR Delta P IR High Error
2372	Warning	Fuel Filter Pressure: Above Normal
2373	Warning	Exhaust Pressure: OORH
2374	Warning	Exhaust Pressure: OORL
2375	Warning	EGR Orifice TMPTR OOR High Error
2376	Warning	EGR Orifice TMPTR OOR Low Error
2377	Warning	High Fan Control Voltage
2387	Warning	VGT Actuator: Mechanical Sys Not Responding
2396*	Warning	Utility Breaker Fail To Close
2397*	Warning	Utility Breaker Fail To Open
2412	Shutdown w/Cooldown	Fan Speed Error
2442	Warning	Inj Solenoid Driver 1 Calib Error
2443	Warning	Inj Solenoid Driver 2 Calib Error
2444	Warning	Inj Solenoid Driver 3 Calib Error
2445	Warning	Inj Solenoid Driver 4 Calib Error
2446	Warning	Inj Solenoid Driver 5 Calib Error
2447	Warning	Inj Solenoid Driver 6 Calib Error
2448	Warning	Coolant Level Moderately Low
2449	Shutdown	VGT Actuator Controller: Out of Calibration
2539*	Warning	High Voltage Bias
2541*	Warning	Low Voltage Bias
2544	Shutdown w/Cooldown	Over Temperature (ECM Internal temperature Data valid but above normal operational range Most severe level)
2545*	Warning	Keysw Reset Required
2554	Warning	Exhaust Gar Pressure: Incorrect

Code	Event/Lamp	Displayed Message
2555	Warning	Low GHC 1 Voltage
2556	Warning	High GHC 1 Voltage
2557	Warning	Auxiliary PWM Driver 1 Circuit OOR High
2558	Warning	Auxiliary PWM Driver 1 Circuit OOR Low
2619*	Warning	Aux101 0 Input 1 Fault
2621*	Warning	Aux101 0 Input 2 Fault
2622*	Warning	Aux101 0 Input 3 Fault
2623*	Warning	Aux101 0 Input 4 Fault
2624*	Warning	Aux101 0 Input 5 Fault
2625*	Warning	Aux101 0 Input 6 Fault
2626*	Warning	Aux101 0 Input 7 Fault
2627*	Warning	Aux101 0 Input 8 Fault
2628	Warning	Aux102 0 Expansion Input 9 Fault
2629	Warning	Aux102 0 Expansion Input 10 Fault
2631	Warning	Aux102 0 Expansion Input 11 Fault
2632	Warning	Aux102 0 Expansion Input 12 Fault
2634	Shutdown	VGT Actuator Controller: Bad Device/Component
2635	Shutdown	VGT Actuator Driver Condition Exists
2636	Shutdown	VGT Actuator Circuit: Abnormal Update Rate
2637	None	Aft Catalyst Face Plugged: Reason Unknown
2639	None	Aftertreatment DPF Differential Press Least Severe
2651	None	Exhaust Gas Temperature Right Manifold: OORH
2652	None	Exhaust Gas Temperature Right Manifold: OORL
2653*	Warning	Exhaust St 2 Temp High
2654	Shutdown	Exhaust Stack Temp Right Bank Above Sh Threshold
2655	None	Exhaust Gas Temperature Left Manifold: OORH
2656	None	Exhaust Gas Temperature Left Manifold: OORL
2657*	Warning	Exhaust St 1 Temp High
2658	Shutdown	Exhaust Stack Temp Left Bank Above Sh Threshold
2661	Shutdown	At Least One Unacknowledged Most Severe Fault 0 Condition Exists
2662	Warning	At Least One acknowledged: Most Severe Fault
2677	Shutdown	Fail To Stop
2677*	Shutdown	Fail to Stop (Shutdown)
2678*	Warning	Charging Alternator Fail

Code	Event/Lamp	Displayed Message
2693*	Warning	Speed Bias OOR
2694*	Warning	Alternator RTD OOR
2727	Warning	Critical CEN Not Accessible Error
2729*	Warning	IO Module Lost
2731*	Shutdown	IO Module Lost
2738	Warning	Ether INJ Low CTRL Error
2739	Warning	Ether INJ High CTRL Error
2753	Shutdown	Exhaust Gas Recirculation Temp: Above Normal
2754	Warning	Diesel Particulate Filter Int Press: Above Normal
2765	None	Engine Inj Bank 1 Barcode: Out Of Calibration
2771	Warning	Aftertreatment 1 Outlet NOx Sensor Abnormal
2774	Warning	EGR DP Clogged Tubes Error
2777	None	Particulate Trap Regen Inhibit: Condition Exists
2779*	Event	Utility Unloaded Event
2814*	Shutdown	Genset CT Ratio Low
2815*	Warning	Genset CT Ratio High
2816*	Shutdown	Genset PT Ratio Low
2817*	Warning	Genset PT Ratio High
2818*	Warning	Bus PT Ratio Low
2819*	Warning	Bus PT Ratio High
2821*	Warning	Utility PT Ratio Low
2822*	Warning	Utility PT Ratio High
2882*	Warning	Aux101 1 Input 1 Fault
2883*	Warning	Aux101 1 Input 2 Fault
2884*	Warning	Aux101 1 Input 3 Fault
2885*	Warning	Aux101 1 Input 4 Fault
2886*	Warning	Aux101 1 Input 5 Fault
2887*	Warning	Aux101 1 Input 6 Fault
2888*	Warning	Aux101 1 Input 7 Fault
2889*	Warning	Aux101 1 Input 8 Fault
2891*	Warning	Aux102 1 Expansion Input 9 Fault
2892*	Warning	Aux102 1 Expansion Input 10 Fault
2893*	Warning	Aux102 1 Expansion Input 11 Fault
2894*	Warning	Aux102 1 Expansion Input 12 Fault

Code	Event/Lamp	Displayed Message
2895*	Warning	PCCNet Device Failed
2896*	Shutdown	Critical PCCNet Dev Fail
2897*	Warning	Factory Memory Block Corrupt
2898*	Warning	Periodic or Fault Memory Block Corrupt
2899*	Warning	User Memory Block Corrupt
2911*	Warning	Trim Memory Block Corrupt
2914*	Shutdown	Genset AC Meter Failed
2915*	Warning	Gen Bus AC Meter Failed
2916*	Warning	Utility AC Meter Failed
2917*	Warning	Gen Bus Voltage OOR Hi
2918*	Warning	Utility Voltage OOR Hi
2919*	Warning	Utility Current OOR Hi
2921*	Warning	Gen Bus Current OOR Hi
2922*	Warning	High Genset Neutral Curr
2923*	Warning	Gen Bus kW OOR Hi
2924*	Warning	Gen Bus kVAR OOR Hi
2925*	Warning	Gen Bus kVA OOR Hi
2926*	Warning	Utility kW OOR Hi
2927*	Warning	Utility kVAR OOR Hi
2928*	Warning	Utility kVA OOR Hi
2931*	Shutdown	Aux101 Device ID Fault
2934*	Warning	High Ambient Temp
2935*	Warning	Low Ambient Temp
2936*	Warning	Fuel Level High
2937*	Warning	Fuel Level Low
2938*	Warning	Earth/Ground Fault
2939*	Warning	Modbus Failure
2941*	Event	Remote Shutdown Fault Reset Occurrence
2942*	Warning	Shutdown Override Fail
2943*	Warning	Manual Sw Config Fail
2944*	Warning	Auto Switch Config Fail
2945*	Warning	Rupture Basin Switch
2946*	Warning	Exhaust St 2 Temp Low
2947*	Warning	Exhaust St 1 Temp Low

Code	Event/Lamp	Displayed Message
2948*	Warning	Exhaust St 2 Temp High
2949*	Warning	Exhaust St 1 Temp High
2951*	Warning	Alternator 1 Temp High
2952*	Warning	Alternator 1 Temp Low
2953*	Warning	Alternator 1 Temp High
2954*	Warning	Alternator 2 Temp High
2955*	Warning	Alternator 2 Temp Low
2956*	Warning	Alternator 2 Temp High
2957*	Warning	Alternator 3 Temp High
2958*	Warning	Alternator 3 Temp Low
2959*	Warning	Alternator 3 Temp High
2962	Warning	EGR RPM Derate Error
2965*	Event	Genset Available
2967*		Governor Fault
2968*		AVR Fault Failure and Diagnosis
2969*		LON Fault Failure and Diagnosis
2971*	Warning	Test/Exercise Fault
2972*	Shutdown	Field Overload
2973	Warning	Charge Press IR Error
2976	Warning	AT1 Diesel Exhaust Fluid Dosing Unit Temp. Error
2977*	Warning	Low Coolant Level 2 Sw
2978*	Warning	Low Intake Manf 1 Temp
2979*	Warning	High Alternator Temp Sw
2981*	Warning	High Drive Bearing Temp
2982*	Warning	Low Drive Bearing Temp
2983*	Warning	High Drive Bearing Temp
2984*	Warning	High Free Bearing Temp
2985*	Warning	Low Free Bearing Temp
2986*	Warning	High Free Bearing Temp
2992*	Warning	High Intake Manf 1 Temp
2993*	Warning	Battery Charger Sw Fail
2998	Warning	Engine Torque Limit Feature Special Instructions
3131*	Shutdown	Secondary Engine Overspeed
3134	Warning	Aft Particulate Filter Outlet Pressure: OORL

Code	Event/Lamp	Displayed Message
3135	Warning	Aft Particulate Filter Pressure: Data Eratic
3139	Warning	ASO Solenoid out of range high
3142	Warning	AT1 SCR Intake Temp. Sensor Circuit OOR High
3143	Warning	AT1 SCR Intake Temp. Sensor Circuit OOR Low
3144	Warning	AT1 SCR Intake Temperature Sensor Error
3146	Warning	AT1 SCR Outlet Temp. Sensor Circuit OOR High
3147	Warning	AT1 SCR Outlet Temp. Sensor Circuit OOR Low
3148	Warning	AT1 SCR Outlet Temperature Sensor Error
3151	Warning	AT1 SCR Catalyst System Missing Condition
3165	Shutdown	Aftertreatment 1 SCR Outlet Temperature High
3173	Warning	AT1 Warm Up DOCE Low
3226*	Event	Genset is paralleled to utility in base load operation
3228	Warning	Aftertreatment Intake Nox Sensor: Data Incorrect
3229	Shutdown	AT1 SCR Intake Temp. High - Most Severe Level
3231	Shutdown w/Cooldown	AT1 SCR Intake Temp. High - Moderate Severe Level
3232	Warning	Aftertreatment Intake Nox Sensor:Abrnormal Update
3235	Shutdown w/Cooldown	AT1 SCR Outlet Temperature High
3237	Warning	AT1 DEF Line Heater 1 Circuit OOR High
3238	Warning	AT1 DEF Line Heater 1 Circuit OOR Low
3239	Warning	AT1 DEF Line Heater 2 Circuit OOR High
3241	Warning	AT1 DEF Line Heater 2 Circuit OOR Low
3242	Warning	AT1 DEF Tank Heater Mechanical System Error
3245	Warning	Aft Particulate Filter System: Not Responding
3251	Shutdown	Aft Catalyst Intake Temp:Data Valid:Above Normal
3253	Shutdown	Particulate Filter Int Temp: Above Normal Mod Sev
3254	Warning	Particulate Filter Int Temp: Above Normal
3255	Shutdown	Particulate Filter Out Temp: Above Normal Mod Sev
3256	Warning	Particulate Filter Outlet Temp: Above Normal
3258	Warning	AT1 DEF Line Heater 1 Open Circuit
3261	Warning	AT1 DEF Line Heater 2 Open Circuit
3311	Shutdown	Particulate Filter Int Temp: Above Normal Severe
3312	Shutdown	Particulate Filter Out Temp: Above Normal Severe
3313	Warning	Aft Catalyst Intake Temperature: Below Normal

Code	Event/Lamp	Displayed Message
3314	Warning	Aft Catalyst Intake Temperature: Above Normal
3315	Warning	Aft Catalyst Intake Temperature: Incorrect
3316	Warning	Aft Particulate Filter Intake Temperature: OORL
3317	Warning	Aft Particulate Filter Intake Temperature: OORH
3318	Warning	Af Particulate Filter Intake Temp: Data Incorrect
3319	Warning	Aft Particulate Filter Outlet Temp Circuit: OORH
3321	Warning	Aft Particulate Filter Outlet Temp Circuit: OORL
3322	Warning	Aft Particulate Filter Outlet Temp: Data Incorrect
3325	Warning	Aft Catalyst Intake Temp Swapped: Out Of Cal
3329	None	J1939 Network 2 Data Incorrect
3331	None	J1939 Network 3 Data Incorrect
3341	Warning	Engine Air Filter Differential Pressure High
3396	Warning	DPF 1 Conditions Not Met for Active Regeneration
3397*	Shutdown	Low Gearbox Oil Pressure – Condition Exists
3398*	Shutdown	High Gearbox Oil Pressure – Condition Exists
3399*	Shutdown	Differential Fault – Condition Exists
3411*	Warning	DC Power Supply Fault – Condition Exists
3412*	Warning	GIB Isolator Open Fault – Condition Exists
3413*	Warning	Radiator Fan Trip Fault – Condition Exists
3414*	Warning	Ventilator Fan Trip Fault – Condition Exists
3415*	Warning	Louvres Closed Fault – Condition Exists
3416*	Warning	Start System Fault – Condition Exists
3417*	Warning	Alternator Heater Trip Fault – Condition Exists
3422	Warning	AT DEF Line Heater 3 Circuit OOR High
3423	Warning	AT DEF Line Heater 3 Circuit OOR Low
3425	Warning	AT DEF Line Heater 3 Open Circuit
3457*	Warning	Loss of Bus Voltage Sensing
3477	Warning	Fuel Actuator 2 Control Valve: Out of Adjustment
3478	Warning	Engine Charge Air Cooler Outlet Temperature Error
3479*	Warning	Start-Inhibit Warning Fault Event
3481*	Warning	Start-Inhibit Warning Fault Event
3482*	Shutdown	Start-Inhibit Shutdown Fault
3483*	Shutdown	High Alternator Temperature 1 Shutdown Fault
3484*	Shutdown	High Alternator Temperature 2 Shutdown Fault

Code	Event/Lamp	Displayed Message
3485*	Shutdown	High Alternator Temperature 3 Shutdown Fault
3486*	Shutdown	High Drive End Bearing Temperature Shutdown Fault
3487*	Shutdown	High Non-Drive End Bearing Temp Shutdown Fault
3497	Warning	Low AT1 Diesel Exhaust Fluid Tank Level
3498	Warning	AT1 DEF Tank Level Low
3513*	Warning	Negative Sequence Overcurrent
3539	Warning	Intake Throttle Sensor Circuit shorted to High
3541	Warning	Intake Throttle Sensor Circuit shorted to Low
3543	Warning	NOx limits exceeded - Cond Exists
3545	Warning	Aftertreatment 1 Outlet NOx Sensor - Abnormal
3547	Warning	Aftertreatment Diesel Exhaust Fluid Tank Empty
3555	Warning	Engine Wait to Start Lamp - Abnormal
3558	Warning	AT1 Diesel Exhaust Fluid Dosing Unit OOR High
3559	Warning	AT1 Diesel Exhaust Fluid Dosing Unit OOR Low
3562	Warning	AT DEF Line Heater Relay OOR High
3563	Warning	AT DEF Line Heater Relay OOR Low
3565	Warning	AT1 DEF Dosing Valve 1 OOR High
3567	Warning	AT DEF Dosing Valve Open Circuit
3568	Warning	AT DEF Dosing Valve Mechanical system Error
3571	Warning	AT1 Diesel Exhaust Fluid Pressure Sensor OOR High
3572	Warning	AT1 Diesel Exhaust Fluid Pressure Sensor OOR Low
3574	Warning	AT1 Diesel Exhaust Fluid Pressure Sensor Low
3575	Warning	AT1 Diesel Exhaust Fluid Pressure Sensor High
3577	Warning	AT Diesel Exhaust Fluid Return Valve OOR High
3578	Warning	AT Diesel Exhaust Fluid Return Valve OOR Low
3582	Warning	AT SCR Catalyst Conversion Efficiency Low
3583	Warning	AT1 Outlet NOx Sensor Heater - Abnormal
3584	Shutdown	Engine Derate: Special
3585	Warning	Generator Total Real Power: Root Cause Unkwn
3586	Warning	Generator Total Real Power: Data Incorrect
3587	Warning	Methane Percent Signal:Below Normal-Least Severe
3588	Shutdown	Methane Percent Signal:Below Normal-Most Severe
3589	Warning	Methane Percent Signal: Data Incorrect
3591	Shutdown	Methane Percent Signal: Special

Code	Event/Lamp	Displayed Message
3592	Warning	Methane Percent Signal: Current Above Normal
3593	Warning	Methane Percent Signal: Current Below Normal
3594	Warning	Eng Emissions Closed Loop Fueling Adj:Cond Exists
3595	Shutdown	Eng Emission Closed Loop Fuel Adj:Root Cause Unkwn
3596	Warning	AT1 Diesel Exhaust Fluid Pressure Sensor Error
3599*	Warning	Ground Current OOR Warning
3611*	Warning	Custom Overcurrent Fault
3614	Warning	Coolant Level Sensor Received N/W Data in Error
3629*	Warning	Device Calibration Update Recommended
3631*	Shutdown	Device Calibration Update Required
3633	Warning	Engine Fan Clutch 2 Control Circuit OOR High
3634	Warning	Engine Fan Clutch 2 Control Circuit OOR Low
3641	Shutdown	Start Enable Line 1 Disabled
3641*	Shutdown	Start Enable1 Shutdown Fault
3642	Shutdown	Start Enable Line 2 Disabled
3642*	Shutdown	Start Enable2 Shutdown Fault
3643	Shutdown	Start Enable Line 3 is Disabled
3643*	Warning	Start Enable3 Shutdown Fault
3644	Shutdown	Intake Manifold Temperature: Special
3645	Shutdown	Intake Manifold 2 Temperature: Special
3646	Shutdown	Intake Manifold 3 Temperature: Special
3647	Shutdown	Intake Manifold 4 Temperature: Special
3649	Warning	AT1 Intake NOx Sensor Heater - Abnormal
3664	Shutdown	Genset Config Mismatch
3681	Warning	AT1 Outlet NOx Sensor Power Supply Error
3682	Warning	Aftertmt Intake Nox:Power Supply Data Incorrect
3694	Warning	Gain Adjust Potentiometer Circuit: OORL
3695	Warning	Frequency Adjust Potentiometer Circuit: OORL
3696	Warning	Droop Adjust Potentiometer Circuit: OORL
3697	Shutdown	RAM Refresh Error
3717	Warning	AT1 Outlet NOx Sensor - Out of Calibration
3718	Warning	Aftertreatment Intake Nox Sensor:Out of Cal
3724	Warning	Battery 1 Voltage: Below Normal
3725	Warning	Aftertreatment 1 Intake NOx Sensor - Abnormal

Code	Event/Lamp	Displayed Message
3727	None	Common Rail Fuel Press Relief Valve: Not Resp
3728	Shutdown	Engine Throttle Control Actuator: Network Error
3741	Warning	Common Rail Fuel Pressure: Above Normal
3748	Warning	AT1 Intake NOx Sensor - Data not Rational
3749	Warning	AT1 Outlet NOx Sensor - Data not Rational
3753	None	Diesel Particulate Filter Active Regen Inhibited
3846	Warning	Fuel Actuator Ctrl:Data Above Normal-least severe
3847	Warning	Fuel Actuator Ctrl:Data Below Normal-Least Severe
3848	Shutdown	Fuel Actuator Control: Special
3849	Shutdown	Fuel Actuator Control: Bad Device
3851	Shutdown	Fuel Actuator Control: Network Error
3852	Warning	Fuel Act2Ctrl Valve:Data Above Normal-Least Severe
3853	Warning	Fuel Act2Ctrl Valve:Data Below Normal-Least Severe
3854	Shutdown	Fuel Actuator 2 Control Valve: Special
3855	Shutdown	Fuel Actuator 2 Control Valve: Bad Device
3856	Shutdown	Fuel Actuator 2 Control Valve: Network Error
3857	Warning	Fuel Actuator 2 Control Valve: Root Cause Unkwn
3858	Warning	Eng Turbochrg Compressor:Above Normal-Least Severe
3859	Warning	Eng Turbochrg Compressor:Below Normal-Least Severe
3861	Warning	Engine Turbocharger Compressor:Root Cause Unkwn
3862	Warning	Eng Turbocharg Compressor Bypass Actuator:Special
3863	Shutdown	Eng Turbochrg Compressor Bypass Actuator:Bad Comp
3864	Warning	Engine TurboChgr Comp Bypass Actuator: N/W error
3866	Warning	AT DEF Quality low Warning
3867	Warning	AT DEF Quality Low - Moderately Severe level
3868	Warning	AT Diesel Exhaust Fluid Quality Error
3876	Warning	AT DEF Quality Sensor Mech system Error
3878	Warning	AT Diesel Exhaust Fluid Quality Sensor Data error
3917	Warning	Engine Turbocharger Lube Oil Pressure low Warning
3918	Warning	Engine Turbocharger Wastegate Actuator Cal Error
3931	Shutdown	Engine Protection System Approaching Shutdown
4135	Warning	Inducement Approaching: Performance is Active
4152	Warning	AT SCR Temperature Sensor Module - Abnormal
4155	Warning	AT1 DEF Dosing Unit Heater Relay OOR High

Code	Event/Lamp	Displayed Message
4156	Warning	AT1 DEF Dosing Unit Heater Relay OOR Low
4157	Warning	AT DEF Return Valve Mechanical system Error
4159	Warning	AT SCR Temperature Sensor Module - Bad Device
4164	Warning	AT SCR Temperature Sensor Module OOR High
4165	Warning	AT SCR Temperature Sensor Module OOR Low
4166	Warning	AT SCR Temperature Sensor Module High
4168	Warning	AT1 DEF Dosing Unit Heater OOR High
4169	Warning	AT1 DEF Dosing Unit Heater OOR Low
4171	Warning	Selective Catalytic Reduction Temperature Low
4241	Warning	AT DEF Quality - Received Network Data Error
4243	Warning	AT1 Diesel Exhaust Fluid Temperature 2 - Abnormal
4249	Warning	AT1 DEF Dosing Temperature - Abnormal
4252	None	Engine Wait to Start Lamp - Condition Exists
4261	Warning	AT SCR Temp Sensor Module - Root Cause Unknown
4262	Warning	HPCR Fuel Pressure Relief Valve OOR High
4263	Warning	HPCR Fuel Pressure Relief Valve OOR Low
4265	Warning	High Press Common Rail Fuel Press Relief Valve Err
4277	Warning	AT Diesel Exhaust Fluid Quality - Abnormal
4285	Shutdown	LVRT Shutdown Fault
4293	Warning	Engine Brake Active Lamp OOR High
4294	Warning	Engine Brake Active Lamp OOR Low
4358	Shutdown	Setup Mode Shutdown
4358*	Warning	SetUp Mode Run Fault
4437	None	J1939 Network 4 Data Incorrect
4517	Warning	Vehicle Identification Number - Out of Calibration
4572	Warning	AT1 DEF Tank Temperature - Abnormal
4585	Shutdown	AT1 SCR Catalyst System - Special Instructions
4636	Warning	Throttle Delta Pressure Incorrect
4642	Shutdown	Water In Fuel Above Normal
4643	Warning	Inj Solenoid Driver 7 Calib Error
4644	Warning	Injector Solenoid Driver 8 Calib Error
4645	Warning	Injector Solenoid Driver 9 Calib Error
4646	Warning	Injector Solenoid Driver 10 Calib Error
4647	Warning	Injector Solenoid Driver 11 Calib Error

Code	Event/Lamp	Displayed Message
4648	Warning	Injector Solenoid Driver 12 Calib Error
4649	Warning	Injector Solenoid Driver 13 Calib Error
4651	Warning	Injector Solenoid Driver 14 Calib Error
4652	Warning	Injector Solenoid Driver 15 Calib Error
4653	Warning	Injector Solenoid Driver 16 Calib Error
4658	Warning	AT SCR Actual Dosing Reagent Quantity Low
4677	Warning	AT1 DEF Tank Level Abnormal Update Rate
4686	Warning	Connector Cap Not Present
4688	Warning	Water in Fuel Indicator 2 Sensor OOR Hi
4689	Warning	Water in Fuel Indicator 2 Sensor OOR Lo
4697	Warning	Crankcase Pressure 2 OORL
4698	None	Crankcase Pressure 2 Above Normal
4699	Warning	Crankcase Pressure 2 Moderate Hi
4711	None	Crankcase Pressure 2 Below Normal
4731	Warning	AT1 DEF Tank Temp Sensor Out of Calibration
4732	Warning	AT1 DEF Tank Level Sensor Out of Calibration
4739	Warning	AT1 DEF Tank Level Sensor - Root Cause Unknown
4741	Warning	AT DEF Quality Sensor Open Circuit
4742	Warning	AT DEF Quality Sensor Short Circuit
4743	Warning	AT1 DEF Temperature 2 Sensor Open Circuit
4744	Warning	AT1 DEF Temperature 2 Sensor Short Circuit
4745	Warning	AT1 DEF Temperature 2 - Root Cause Unknown
4747	Warning	AT Intake Oxygen Sensor Data not Rational - High
4748	Warning	AT Intake Oxygen Sensor Data not Rational - Low
4749	Warning	AT Outlet Oxygen Sensor Data not Rational - High
4751	Warning	AT Outlet Oxygen Sensor Data not Rational - Low
4761*	Warning	Genset Voltage Sensing MCB Protection
4766	Warning	Customer Gas Valve Close Warning
4766*	Warning	Customer Gas Valve Close
4767	Shutdown	Customer Gas Valve Close Shutdown
4767*	Warning	Customer Gas Valve Close
4768	Warning	AT1 DEF Property - Root Cause Unknown
4769	Warning	AT1 DEF Tank Level Sensor Abnormal Rate Change
4789	Warning	Fan Speed High - Most Severe Level

Code	Event/Lamp	Displayed Message
4791	Warning	Fan Speed Low - Most Severe Level
4842	None	Aftertreatment Diesel Exhaust Fluid Quality High
4867	Warning	HPCR Fuel Pressure Relief Valve - Condition Exists
4872*	Warning	System Network Failure
4873*	Warning	Genset Failed to Come Online
4874*	Warning	Load Demand SW Version Incompatibility
4875*	Warning	Genset Ineligible for Load Demand
4876*	Warning	Genset Lost on System Network
4877*	Warning	System Settings not Synchronized
4878*	Warning	Check System Network Installation
4879*	Warning	Load Demand Setup Error
4881*	Warning	System Genset ID Conflict
4882*	Warning	Genset Bus Overload
5135*	Warning	Overload Shutdown Fault
5145*	Warning	Load Demand Genset Bus Failure
5176	Warning	AT1 DEF Tank Level2 Abnormal Update Rate
5247	Warning	AT1 SCR Intake Temp. High Warning
5655	Warning	AT1 SCR Conversion Efficiency
5689	Warning	AT1 Outlet NOx Sensor Error
5838	Warning	AT1 Outlet NOx Sensor Abnormal Rate of Change
5864	Warning	AT1 DEF Pump Command OOR High
5865	Warning	AT1 DEF Pump Command OOR Low
5866	Warning	AT DEF Dosing Unit Relay Feedback OOR High
5867	Warning	AT DEF Dosing Unit Relay Feedback OOR Low
5887	None	AT1 SCR System Hydrocarbon High
5888	Warning	AT1 SCR System Hydrocarbon High Warning
5889	Shutdown	AT1 SCR System Hydrocarbon High Shutdown
5935	Warning	AT1 DEF Pressure Mechanical System Error
5936	Warning	AT1 DEF Pressure High Warning
6256	None	Battery 1 Voltage High
6257	None	Battery 1 Voltage Low
6258	None	Electric Lift Pump for Eng Fuel Supply OOR High
6259	None	Electric Lift Pump for Eng Fuel Supply OOR Low
6263	None	Fan Control Circuit OOR High

Code	Event/Lamp	Displayed Message
6264	None	Fan Control Circuit OOR Low
6336	None	Crankcase Breather Filter Heater OOR High
6337	None	Crankcase Breather Filter Heater OOR Low
6464	None	AT1 Out Nox Sens Error
6467	None	Fan Speed High
6468	None	Fan Speed Low
6475	None	AT1 DEF Tank Heater Mechanical Error
6476	None	AT1 DEF Tank Heater Low
6477	None	AT1 DEF Line Heater Relay OOR High
6478	None	AT1 DEF Line Heater Relay OOR Low
6479	None	AT1 DEF Tank Heater OOR High
6481	None	AT1 DEF Tank Heater OOR Low
6522	None	Coolant Level Sensor 1 OOR Low
6523	None	Coolant Level Sensor 1 OOR High
6524	None	Engine Oil Temperature Sensor 1 OOR High
6525	None	Engine Oil Temperature Sensor 1 OOR Low
6526	None	AT1 DEF Tank Level Out of Calibration Error
6531	None	AT1 DEF Line Heater1 OOR High
6532	None	AT1 DEF Line Heater1 OOR Low
6533	None	AT1 DEF Line Heater2 OOR High
6534	None	AT1 DEF Line Heater2 OOR Low
6535	None	AT1 DEF Line Heater3 OOR High
6536	None	AT1 DEF Line Heater3 OOR Low
6595	None	Engine Speed Root Cause Unknown
6619	None	AT1 DEF Temperature 2 Abnormal Update Rate
6692	None	AT1 SCR System Soot High
6693	Warning	AT1 SCR System Soot High Warning
6694	Shutdown	AT1 SCR System Soot High Shutdown
6752	None	AT DEF Quality Low
7135	Warning	Engine Turbocharger Speed High Warning
7243	Warning	Failed Normal Start Attempt
7268	None	AT1 SCR System Cleaning Incomplete Error
7269	Warning	AT1 SCR System Cleaning Incomplete Error Warning
7697	Shutdown	Bank Cut-Off FSO Failure

Code	Event/Lamp	Displayed Message
7823	Warning	Cylinder Cut-Off System failure
7824	Warning	Cylinder Cut-Off System State and Feedback Mismatch
7825	Shutdown	Generator Total Real Power Sensing Failure
8632	Warning	Charging Alternator Fuse Failure
9945	Warning	Injector 6 Circuit 2 Error
9946	Warning	Injector 5 Circuit 2 Error
9947	Warning	Injector 4 Circuit 2 Error
9948	Warning	Injector 3 Circuit 2 Error
9949	Warning	Injector 2 Circuit 2 Error
9951	Warning	Injector 1 Circuit 2 Error
9954*	Warning	Differential Fault
9955*	Warning	DC Power Supply Fault
9956*	Warning	GIB Isolator Fault
9957*	Warning	Radiator Dan Trip Fault
9958*	Warning	Vent Fan Trip Fault
9959*	Warning	Louvres Closed Fault
9960*	Warning	Start System Fault
9961*	Warning	Alt Heater Trip Fault
9971*	Warning	ECM Derate Fault
9973*	Warning	Watchdog Reset Fault

5.4 Alternator Performance Troubleshooting

5.4.1 No Voltage (No Load)

5.4.1.1 No Voltage (No Load) - Diagnosis and Repair

1. Faulty permanent magnet generator, stator or rotor
    - Disconnect the permanent magnet generator leads from automatic voltage regulator terminals P18-1, P18-2, and P18-3.
        - Check voltage across leads with a multimeter, with the set running at correct speed.
        - For 50 Hz, voltage should be approximately 160 to 180 VAC.
        - For 60 Hz, voltage should be approximately 190 to 210 VAC.
2. Use a multimeter to test the phase-to-phase resistance of the PMG stator windings . Resistance to be within 10% of expected value balanced across phases.
3. Insulation failure to earth (ground) on permanent magnet stator
    - Disconnect leads P18-1, P18-2, and P18-3 and, use insulation test meter to measure the resistance value of the insulation to earth (ground).

4. Voltmeter faulty
   - Check and verify voltage at generator output terminals with a multimeter.
5. Loose, broken, or corroded connections
   - Check all connections, repair and replace where necessary.
6. Automatic voltage regulator high excitation protection circuit activated, collapsing output voltage
   - Automatic voltage regulator protection circuit is factory set to trip at +70 VDC across automatic voltage regulator output, X+ (F1) and XX- (F2), after pre-set time delay.
     - Shut down the alternator, start and run alternator up again. If the voltage builds up normally but collapses again, the protection circuit has operated.
     - Run alternator again and check the excitation voltage across automatic voltage regulator output. If greater than 70 VDC, the protection circuit is operating correctly.
7. Varistor short circuit
   - Use a multimeter to test varistors on the main rotating rectifier assembly.
8. Main rectifier diodes short circuit
   - Check diodes.
     - Test diodes on the main rotating rectifier assembly with a multimeter.
9. Open circuit in exciter stator windings
   - Remove external leads from generator. Check the resistance value of the exciter stator across these two leads (approximately 18 to 30 ohms) with a multimeter. Refer to the procedure(s) in the troubleshooting and repair manual for the specific alternator for correct values.
10. Faulty automatic voltage regulator
    - Replace control board and re-test.
11. Winding fault, open circuit, or short circuit
    - Remove external leads from the alternator.
      - Use appropriate metering equipment (Wheatstone bridge or Kelvin bridge). Measure the low resistance winding of the main rotor and stator.

5.4.2 Low Voltage (No Load)

5.4.2.1 Low Voltage (No Load) - Diagnosis and Repair

1. Low engine speed, under frequency roll-off
   - Under frequency roll-off protection is activated, indicating low engine speed.
     - Troubleshoot and repair the engine performance issue.
2. Faulty voltage sensing
   - Use a multimeter to check and verify voltage at the generator set's output terminals.
   - Check voltage at the control board.
3. Automatic voltage regulator voltage adjustment trim configured incorrectly
   - Use the InPower service tool to adjust the nominal voltage parameter to the appropriate value for the application level.
4. Faulty automatic voltage regulator
   - Replace the control board and re-test.

5.4.3 High Voltage (No Load)

5.4.3.1 High Voltage (No Load) - Diagnosis and Repair

1. Automatic voltage regulator voltage adjustment trim is configured incorrectly
   - With the InPower service tool adjust nominal voltage parameter to the appropriate value for the application level.
2. Low sensing supply from main stator
   - Check sensing supply at all of leads of the alternator.
     - Open circuit or low sensing signal will cause the automatic voltage regulator to produce high excitation, this will produce a high output voltage.
3. Faulty automatic voltage regulator
   - Replace control board and re-test.

5.4.4 Unstable Voltage (No Load)

5.4.4.1 Unstable Voltage (No Load) - Diagnosis and Repair

1. Engine speed hunting (unstable)
   - Check with a frequency meter or InPower for speed variations due to hunting, or cyclic irregularities in the engine.
     - This may improve as load is applied.
2. Automatic voltage regulator parameters configured incorrectly
   - Adjust automatic voltage regulator gain and/or damping trims to the appropriate value(s).
     - Check again when loaded.
3. Loose or corroded connections
   - Repair or replace as necessary.
4. Intermittent earth (ground) on machine
   - Use insulation test meter to test all the windings including the exciter stator.
     - Low insulation resistance can affect the automatic voltage regulator.

5.4.5 Unbalanced Voltage (No Load)

5.4.5.1 Unbalanced Voltage (No Load) - Diagnosis and Repair

1. Fault in the main stator winding
   - Disconnect all external leads to the alternator and re-test.
     - Separately excite alternator by connecting DC battery supply to the exciter stator leads X+ (F1) and XX- (F2).
     - A winding short will get hot, and engine will sound slightly loaded.
     - Shut down the set and check by hand for hot spots.

5.4.6 Unbalanced Voltage (with Load)

5.4.6.1 Unbalanced Voltage (with Load) - Diagnosis and Repair

1. Single-phased load current unevenly distributed over the three phases
    - Check the current in each phase with clip-on ammeter.
        - The full load rated current must not be exceeded on any one (single) phase.
        - Re-distribute load if necessary.

5.4.7 Unstable Voltage (with Load)

5.4.7.1 Unstable Voltage (with Load) - Diagnosis and Repair

1. Engine governing hunting (unstable)
    - Use InPower to check for engine hunting, or cyclic irregularities in the engine.
2. Leading power factor load created by power factor correction capacitors
    - Isolate the power factor correction capacitors until sufficient motor load has been applied to counteract the leading power factor.
3. Non-linear loads causing interaction between dynamic closed loop control systems
    - The interaction of the alternator and the engine closed loop systems controls the load.
        - Instability is caused by oversensitive control settings.
        - Reduce automatic voltage regulator gain (stability).
4. Fluctuations in load current (motor starting or reciprocating loads)
    - Check the load current on a stable supply (i.e., mains) or separately excite the machine.
        - A variable DC supply is required for on load separate excitation tests.
5. Automatic voltage regulator parameters configured incorrectly
    - With the InPower service tool, adjust AVR control parameters until the voltage is stable.

5.4.8 Poor Voltage Regulation (with Load)

5.4.8.1 Poor Voltage Regulation (with Load) - Diagnosis and Repair

1. Unbalanced load
    - Check voltage and load current on all phases.
        - If unbalanced, redistribute the load more evenly across the phases.
2. Automatic voltage regulator parameters configured incorrectly
    - With the InPower service tool, adjust automatic voltage regulator control parameters until voltage is stable.
3. Voltage drop between alternator and load, caused by losses in supply cable (power losses)
    - Check the voltage at both ends of the cable run at full load.
        - Large differences in voltages indicate a large volts drop along the cable.
        - A larger diameter cable is required in severe cases.

4. Fault on main rectifier or excitation winding
   - Check the no load excitation voltage across automatic voltage regulator X+ (F1) and XX- (F2).
     - Voltage should be no higher than 12 VDC.
5. Under frequency roll-off protection activated
   - Under frequency roll-off protection is activated, indicating low engine speed.
     - Adjust or correct engine speed to an acceptable nominal.

5.4.9 Poor Response to Load Surges or Motor Starting (with Load)

5.4.9.1 Poor Response to Load Surges or Motor Starting (with Load) - Diagnosis and Repair

1. Engine performance
   - Check performance of the engine during application of load.
2. Load current surges significantly exceed the full load of the generator set
   - Use a clip-on ammeter to check surges.
     - Check with the factory for advice on voltage dips for motor starting.
3. Under frequency roll-off protection on automatic voltage regulator operational
   - Use InPower to monitor the load.
     - Low engine speed will activate the under frequency roll-off protection circuit.
4. Voltage drop between alternator and load caused by power losses in supply cable. This will be worse during current surges (motor starting, etc.).
   - Check the voltage at both ends of the cable run at full load.
     - Differences in voltages indicate a voltage drop along the cable.
     - A larger diameter cable may be required in severe cases.
5. Automatic voltage regulator gains set incorrectly
   - Automatic voltage regulator gain and/or damping trims to the appropriate value(s).
     - Check again when loaded.
6. Fault on windings or rotating rectifier
   - Check the no load excitation voltage across the automatic voltage regulator X+ (F1) and XX- (F2).
     - The voltage should be no higher than 12 VDC.
7. Fault in automatic voltage regulator
   - Replace the control board and re-test when loaded.

5.4.10 Voltage Collapses (with Load)

5.4.10.1 Voltage Collapses (with Load) - Diagnosis and Repair

1. Severe overload or short circuit on across phases
   - Use InPower or a clip-on ammeter to check load current.

2. AVR fault
    - Replace the control board and re-test it with load.

5.4.11 High Voltage (with Load)

5.4.11.1 High Voltage (with Load) - Diagnosis and Repair

1. Unbalanced load
    - Check voltage on all three phases. If it is unbalanced, re-distribute loading over the three phases.
2. Leading power factor
    - Check for capacitive (leading) PF load (i.e., kVA correction fluorescent lights).
        - Apply motor (lagging) PF load, or switch off capacitors.
        - A leading power factor load will give abnormally low DC excitation volts across X+ (F1) and XX-(F2).
3. Faulty automatic voltage regulator
    - Replace the automatic voltage regulator and re-test.

5.4.12 Low Voltage (with Load)

5.4.12.1 Low Voltage (With Load) - Diagnosis and Repair

1. Under frequency roll-off protection circuit operational
    - Under frequency roll-off protection is activated, indicating low engine speed.
        - Correct engine performance problems.
2. Faulty permanent magnet generator stator or rotor
    - Disconnect the permanent magnet generator leads from automatic voltage regulator terminals P18-1, P18-2, and P18-3.
        - Check voltage across leads with a multimeter, with the set running at correct speed.
        - For 50 Hz, voltage should be approximately 160 to 180 VAC.
        - For 60 Hz, voltage should be approximately 190 to 210 VAC.
3. Automatic voltage regulator faulty
    - Replace automatic voltage regulator and re-test.
4. Fault on winding or rotating diodes
    - Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2).
        - Remove external leads from the alternator.
        - Use appropriate metering equipment (Wheatstone bridge or Kelvin bridge). Measure the low resistance winding of the main rotor and stator.
        - Check diodes.
        - Test diodes on the main rotating rectifier assembly with a multimeter.
5. Voltage drop between alternator and load, due to power losses in the cable
    - Check the voltage at both ends of the cable run at full load.
        - Differences in voltage levels indicate a voltage drop along the cable.

- In severe cases, a larger diameter cable is required.
- This will be worse during current surges (motor starting etc).

5.4.13 Alternator Troubleshooting - P80

5.4.13.1 Fault Finding

Before starting any fault finding procedure, examine all wiring for broken or loose connections. If in doubt, refer to the wiring diagram supplied with the alternator.

The following list is to aid in troubleshooting and is not exhaustive. If after completing the appropriate action the problem still persists refer to the Fault Finding manual or STAMFORD | AvK™ customer services **www.stamford-avk.com**.

5.4.13.1.1 Without AVR in Alternator

NOTICE
Do tests in order, unless stated otherwise. Do method steps in order. Achieve result before doing the next step, unless action (in bold) states otherwise.

TABLE 12. FAULTFINDING: WITHOUT AVR

TEST	METHOD		RESULT and ACTION
1 External Excitation	1	Disconnect the exciter stator positive X+ (F1) lead from the control board.	-
	2	Disconnect the exciter stator negative XX- (F2) lead from the control board.	-
	3	Test the resistance across the exciter stator winding between positive and negative leads, with a multimeter.	Resistance of exciter stator winding greater than minimum values (see **Section 6.2.1.12.11**)
	4	Connect an external 24 V variable DC source to the exciter stator leads, positive to positive, negative to negative. Test the voltage.	Measured excitation is 15 VDC ±10% error.
	5	Test the phase-to-phase and phase-to-neutral voltage at output terminals. Adjust variable DC source.	Measured output equal to rated voltage (with same error as excitation), balanced across phases within 1%. Main & exciter stators, main & exciter rotors, and rectifier diodes are functioning correctly. **Go to test 7 AVR Sensing and Power Supply** If unbalanced by more than 1%, **Go to test 2 Main Stator** If balanced within 1%, but output voltage is more than 10% below rated voltage, and test 3 **not** yet done, **Go to test 3 Rectifier** If balanced within 1%, but output voltage is more than 10% below rated voltage, and test 3 already done, **Go to test 4 Exciter Rotor**

TEST		METHOD	RESULT and ACTION
2 Main Stator		A fault in the main stator will produce short circuit currents between turns in the windings. Test for symptoms to confirm diagnosis.	
	1	Disconnect main stator leads to exclude external components from the test.	-
	2	Test phase to neutral resistances of main stator windings with a micro ohmmeter.	Resistances of main stator windings dissimilar, and/or less than minimum values (see **Section 6.2.1.12.11**)
	3	Run up the alternator within 4% of nominal speed, no load or excitation. Connect battery to exciter stator (see test 1).	When battery connected to excite alternator, short circuit fault creates heat and burning smell. Engine sound changes with extra slight loading.
	4	-	**Repair or replace faulty main stator winding**
	5	Re-connect main stator leads	**Go to test 1 External Excitation**
3 Rectifier	1	Test the rectifier varistors (see **Section 6.2.1.12.8 on page 325**)	Both varistors functioning correctly.
	2	Test the rectifier diodes (see **Section 6.2.1.12.8 on page 325**)	All diodes functioning correctly. **Go to test 1 External Excitation**
4 Exciter Rotor	1	Inspect windings and insulation	Windings are not burnt or damaged.
	2	Disconnect the 6 exciter rotor leads from the a.c. connection studs on the rectifier.	-
	3	Taking 3 leads that were connected to the same rectifier plate, Test the phase-to-phase resistance, with a milliohm meter or micro ohmmeter.	Resistance of each phase pair greater than minimum values (see **Section 6.2.1.12.8**)
	4	Re-connect the exciter rotor leads.	**Go to test 5 Main Rotor**
5 Main Rotor	1	Disconnect a main rotor lead from the connection stud on one of the rectifier plates.	**-**
	2	Test the resistance across the main rotor winding between positive and negative leads, with a multimeter or milliohm meter.	Resistance of main rotor greater than minimum value (see **Section 6.2.1.12.8**)
	3	Re-connect the main rotor lead.	**Go to test 6 Exciter Stator Insulation**
6 Exciter Stator Insulation		Poor insulation of the exciter stator winding can affect AVR performance.	
	1	Test the electrical insulation of the exciter stator winding (see **Section 6.2.1.12.11 on page 340**)	Resistance of exciter stator winding to earth is greater than minimum value. **Go to test 7 AVR Sensing and Power Supply**

<table>
<tr><th>TEST</th><th colspan="2">METHOD</th><th>RESULT and ACTION</th></tr>
<tr><td rowspan="5">7
AVR
Sensing
And Power
Supply</td><td colspan="3">Output voltage is sensed at the AVR for closed loop control of the excitation voltage. The alternator wiring diagram shows how sensing leads at the output terminals are connected to the AVR, via transformers (as required). AVR power is also taken from the sensing leads or from a permanent magnet generator (PMG).</td></tr>
<tr><td>1</td><td>Disconnect the sensing and power supply(ies) from the AVR</td><td>-</td></tr>
<tr><td>2</td><td>Follow the method of Test 1 to run the alternator with excitation from a battery.</td><td>Alternator runs within 4% of rated speed, 10% of rated output voltage, balanced within 1% across phases.</td></tr>
<tr><td>3</td><td>Test the sensing voltage feedback at the AVR terminals. Check circuit between output terminals and AVR.</td><td>Measured voltage within range (see AVR instructions), balanced across phases. No wiring or transformer faults.</td></tr>
<tr><td>4</td><td>Disconnect battery, re-connect AVR and run alternator.</td><td>See Faultfinding: self-excited AVR or Faultfinding: separately-excited AVR.</td></tr>
</table>

5.4.13.1.2 Parallel Operation

TABLE 13. FAULTFINDING: PARALLEL OPERATION

<table>
<tr><th>SYMPTOM</th><th>CAUSE</th><th>ACTION</th></tr>
<tr><td rowspan="3">CIRCUIT BREAKER WILL NOT CLOSE WHEN ATTEMPTING PARALLEL OPERATION</td><td>Circuit breaker fitted with ‘Check Synchronizing’ protection, which prevents out of phase synchronizing.</td><td>Ensure that the synchroscope is indicating that machines are IN PHASE, or close to the eleven o'clock position, (when rotating in a clockwise direction). Ensure that the speed difference between the incoming set and the busbar is small enough to prevent rapid rotation of the synchroscope, (or rapid fluctuations of the lights), before closing circuit breaker.</td></tr>
<tr><td>Phase rotation of alternators differs.</td><td>DO NOT ATTEMPT TO PARALLEL until the phase rotation of all alternators are identical. Check the phase rotation of each alternator. Exchange the connections of two of the phases to reverse the phase rotation of an alternator.</td></tr>
<tr><td>Voltage difference too high between the incoming alternator and the busbar.</td><td>The voltage on the incoming set can be up to 4% higher than the bus bar voltage. THIS IS NORMAL. Do not adjust original no-load Voltage settings. If difference is greater than 4%, check for excessive droop on the loaded alternator(s).</td></tr>
</table>

SYMPTOM	CAUSE	ACTION
UNSTABLE IN-PHASE CONDITION, BEFORE SYNCHRONIZING	Governor drift on one or more of the engines.	Let engines warm up and stabilize before paralleling. If speed is still drifting check governors and engine condition.
	Load variation on the busbar causing speed/ frequency changes on the loaded alternator when synchronizing.	Disconnect any rapidly varying load. Check that there is no likelihood of a motor or automatic load starting when attempting to synchronize. DO NOT attempt to parallel if the load current is unstable.
UNSTABLE FREQUENCY IN PARALLEL WHEN ON LOAD	Engine speed droop too ‘tight’ or cyclic irregularities (instability) between the engines. (Check kW meters for rapid shifting of kW power between sets).	Increase the engine governor speed droop to 4% (no load to full load). Check for "sticky" governors on a new engine. Check engines for cyclic problems, (firing, out of balance, etc.).
STABLE VOLTAGE BEFORE AND AFTER BUT UNSTABLE WHILE SYNCHRONIZING	Usually results from ‘pick- up’ through the synchronizing panel and/or earth leakage protection circuits that can form a temporary ‘closed loop’ link between the alternators during synchronization.	The fluctuation will decay when the alternators approach synchronism, (almost identical speeds), and will disappear completely when the circuit breaker is closed. The synchronizing equipment, earth leakage protection, and/or wiring circuits in the switchboard can produce temporary pickup problems.
CURRENT UNCONTROLLED, RISES FAST WHEN CIRCUIT BREAKER CLOSED	Parallel droop equipment reversed on one of the alternators.	Check the droop CTs for reversal. Reverse lead S1-S2 on the droop CT. Test excitation volts - the alternator with reversed droop will have highest excitation volts.
STABLE CIRCULATING CURRENT ON ALL ALTERNATORS, NOT REDUCED BY VOLTAGE ADJUSTMENT	Parallel droop reversed on ALL alternators.	Check droops for reversal. Reverse leads S1–S2 to correct. This repeated wiring error will result in a stable circulating current which cannot be adjusted out by normal means.
STABLE CIRCULATING CURRENT ON BOTH ALTERNATORS AT NO LOAD	Voltage difference (excitation level) between the alternators.	Check Voltages at no load, (identical frequencies), and ensure all alternators have identical voltages. Do not adjust when load sharing.
	Parallel droop equipment reversed on BOTH alternators. (Unlike ONE droop reversal, which is a highly UNSTABLE condition).	Check ALL droop CTs for reversal.
	Incorrect setting of parallel droop equipment.	Check settings of droop trimmers. Check droop CTs are in correct phase. Check CT output to AVR S1-S2 is correct.

SYMPTOM	CAUSE	ACTION
UNBALANCED POWER ON KILOWATT METERS	Engines not sharing the power (kW) equally.	Adjust the governor droop of the engines to equalize the kilowatt sharing.
UNBALANCED CURRENT ON AMMETERS AFTER EQUILIZING KILOWATTS	Voltage difference (excitation levels) between the machines.	Test the machines individually for exact voltage at no load.
	Parallel droop equipment incorrectly adjusted.	Adjust as stated in previous text.
UNBALANCED POWER AS LOAD INCREASED OR DECREASED	Engine governors are incompatible, or new governors ‘sticking’, causing unequal kW sharing overload range variations.	The engine governors must be adjusted to give similar no load to full load characteristics. Check for ‘sticky’ governors on new or repainted engines. Electronic governors should be set with a minimum 2% speed droop to ensure satisfactory kilowatt load sharing. If tighter speed regulation is required, an Isochronous Load Sharing system should be installed.
INCREASING UNBALANCED CURRENT AS LOAD INCREASED	Difference in parallel droop level settings. Difference in no load to full load voltage regulation of AVRs. These settings are the major contributing factors to the load/voltage characteristics of the machine, and therefore must be set to give equal characteristics to the machines with which it is paralleled.	Run each alternator individually, and apply load at approximately 25%, 50% & 100% of full load. Test voltage at each load and compare values with the other alternators. Adjust control systems to remove regulation differences. Repeat method with as much inductive load as possible i.e. motors, transformers etc. Adjust the parallel droop trimmers, to achieve equal inductive load sharing.
POOR VOLTAGE REGULATION WHEN MACHINE RUNNING ALONE	Excess amount of parallel droop in circuit.	For normal voltage regulation as a single running machine, a shorting switch should be fitted across the parallel droop transformer. (S1-S2). This should be clearly marked ‘Single’ and ‘Parallel’ operation on the panel.
UNBALANCED POWER, ENGINES 'ROCK' ON MOUNTS	Electronic engine governor speed ‘droop’ characteristics are set too tight.	At least 2% engine droop is essential for kW (Active current) sharing. If 1% or less speed regulation is required, an electronic governing and Isochronous Load Sharing system should be installed.

5.5 Annunciator Fault Codes

5.5.1 Fault Code 1853 - Annunciator Input 1 Fault

Customer fault 1 (input 1, LED 1) on the Universal Annunciator is active.

A. Condition For Which Annunciator Input #1 Is Configured For Is Active

1. Check the condition for which "Annunciator Input #1" has been configured; ex. if "Annunciator Input #1" was configured to become active when the fuel level is low, check the fuel level and add fuel if needed. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Incorrectly Configured or Wiring Issue

1. Customer input 1 on the Universal Annunciator can be configured to conform to different applications. Below are two configurations that have an impact on how input 1 becomes active.

Configurable Parameter	Option 1 (Default)	Option 2
Negative or Positive Input 1 Activation	Negative Input (ground input)	Positive Input (B+ input)
Inverting Active Hardware Signals	Don't Invert	Invert

   Negative or positive Input 1 activation: Allows the user to activate with a negative (ground) or positive (B+) input; the default setting is a negative (ground) input.

   Inverting active hardware signals: Input 1 has the capability to be inverted. If annunciator input 1 is set to inverted, then an active hardware signal will be considered inactive and an inactive signal will be considered active, default is set to non-inverted.

   When set to default, event/fault code 1853 (customer input 1) becomes active when there is a ground input at TB1-1 on the back of the Universal Annunciator.

   Ensure that the Universal Annunciator is correctly configured; for setup and configuration instructions, refer to the Universal Annunciator operator's manual (P/N 0900-0301).

2. Check the wiring at TB1-1 and ensure that customer input 1 is not wired incorrectly. Depending on the configuration of the annunciator in step 1A, ensure that there is not a short or open circuit at the TB1-1 connection.
3. Check the sender, relay, or device that is activating Input 1 on the Universal Annunciator, replace if faulty.

C. Faulty Annunciator

1. If the wiring and configuration is satisfactory, replace the Universal Annunciator.

5.5.2 Fault Code 1854 - Annunciator Input 2 Fault

Customer fault 2 (input 2, LED 2) on the Universal Annunciator is active.

A. Condition For Which Annunciator Input #2 Is Configured For Is Active

1. Check the condition for which "Annunciator Input #2" has been configured; ex. if "Annunciator Input #2" was configured to become active when the fuel level is low, check the fuel level and add fuel if needed. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Incorrectly Configured or Wiring Issue

1. Customer input 2 on the Universal Annunciator can be configured to conform to different applications. Below are two configurations that have an impact on how input 2 becomes active.

Configurable Parameter	Option 1 (Default)	Option 2
Negative or Positive Input 2 Activation	Negative Input (ground input)	Positive Input (B+ input)
Inverting Active Hardware Signals	Don't Invert	Invert

Negative or positive Input 2 activation: Allows the user to activate with a negative (ground) or positive (B+) input; the default setting is a negative (ground) input.

Inverting active hardware signals: Input 2 has the capability to be inverted. If annunciator input 2 is set to inverted, then an active hardware signal will be considered inactive and an inactive signal will be considered active, default is set to non-inverted.

When set to default, event/fault code 1854 (customer input 2) becomes active when there is a ground input at TB1-2 on the back of the Universal Annunciator.

Ensure that the Universal Annunciator is correctly configured; for setup and configuration instructions, refer to the Universal Annunciator operator's manual (P/N 0900-0301).

2. Check the wiring at TB1-2 and ensure that customer input 2 is not wired incorrectly. Depending on the configuration of the annunciator in step 1A, ensure that there is not a short or open circuit at the TB1-2 connection.
3. Check the sender, relay, or device that is activating Input 2 on the Universal Annunciator, replace if faulty.

C. Faulty Annunciator

1. If the wiring and configuration is satisfactory, replace the Universal Annunciator.

5.5.3 Fault Code 1855 - Annunciator Input 3 Fault

Customer fault 3 (input 3, LED 3) on the Universal Annunciator is active.

A. Condition For Which Annunciator Input #3 Is Configured For Is Active

1. Check the condition for which "Annunciator Input #3" has been configured; ex. if "Annunciator Input #3" was configured to become active when the fuel level is low, check the fuel level and add fuel if needed. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Incorrectly Configured Or Wiring Issue

1. Customer input 3 on the Universal Annunciator can be configured to conform to different applications. Below are two configurations that have an impact on how input 3 becomes active.

Configurable Parameter	Option 1 (Default)	Option 2
Negative or Positive Input 3 Activation	Negative Input (ground input)	Positive Input (B+ input)

Configurable Parameter	Option 1 (Default)	Option 2
Inverting Active Hardware Signals	Don't Invert	Invert

Negative or positive Input 3 activation: Allows the user to activate with a negative (ground) or positive (B+) input; the default setting is a negative (ground) input.

Inverting active hardware signals: Input 3 has the capability to be inverted. If annunciator input 3 is set to inverted, then an active hardware signal will be considered inactive and an inactive signal will be considered active, default is set to non-inverted.

When set to default, event/fault code 1855 (customer input 3) becomes active when there is a ground input at TB1-3 on the back of the Universal Annunciator.

Ensure that the Universal Annunciator is correctly configured; for setup and configuration instructions, refer to the Universal Annunciator operator's manual (P/N 0900-0301).

2. Check the wiring at TB1-3 and ensure that customer input 3 is not wired incorrectly. Depending on the configuration of the annunciator in step 1A, ensure that there is not a short or open circuit at the TB1-3 connection.
3. Check the sender, relay, or device that is activating Input 3 on the Universal Annunciator, replace if faulty.

C. Faulty Annunciator

1. If the wiring and configuration is satisfactory, replace the Universal Annunciator.

5.5.4 Fault Code 1994 - Annunciator Output Configuration Error (Warning)

Annunciator output relay(s) are being activated by more than one source.

A. Annunciator output relay(s) activated by more than one source at the same time

1. Ensure that the annunciator(s) are only connected to one generator set control.

B. Faulty Annunciator

1. If the wiring and configuration is satisfactory, replace the Universal Annunciator.

5.6 Auxiliary Codes-101

5.6.1 Fault Code 1667 - AUX 101 Exhaust Temperature OOR (Warning)

Exhaust gas temperature sensor signal is out of range – shorted high.

A. Faulty Exhaust Gas Temperature Sensor Connections

1. Inspect the exhaust gas temperature sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the exhaust gas temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

c. Inspect for evidence of moisture in or on the connector.

d. Inspect for missing or damaged connector seals.

e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Exhaust Gas Temperature Sensor

1. Active Sensor.

   a. Check the exhaust gas temperature sensor supply voltage.

      i. Disconnect the engine harness connector from the exhaust gas temperature sensor.

      ii. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.

      iii. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.

   b. Check exhaust gas temperature sensor signal (sense) voltage.

      i. Disconnect the engine harness connector from the exhaust gas temperature sensor.

      ii. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.

      iii. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 V, then the signal voltage is correct. If not, sensor is faulty.

C. Faulty Engine Harness

1. Inspect the engine harness and the connector pins.

   a. Disconnect the engine harness connector from the extension harness.

   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

   c. Inspect for evidence of moisture in or on the connector.

   d. Inspect for missing or damaged connector seals.

   e. Inspect for dirt or debris in or on the connector pin.

2. Check for a short circuit from pin to pin.

   a. Disconnect the engine harness from the extension harness.

   b. Disconnect the engine harness connector from the exhaust gas temperature sensor.

   c. Disconnect the engine harness from all sensors that have a shared supply or return with the fuel pressure sensor.

   d. Measure the resistance from the exhaust gas temperature 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.

   e. Measure the resistance from the exhaust gas temperature sensor pin on the engine harness inline connector to all other pins in the engine harness inline connector.

   f. Measure the resistance from the exhaust gas temperature signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

   g. If all measurements are greater than 100k ohms, then the resistance is correct.

3. Check for an open circuit.

   a. Disconnect the engine harness from the extension harness.

b. Disconnect the engine harness connector from the exhaust gas temperature sensor.

c. Measure the resistance from the exhaust gas temperature return pin on the engine harness inline connector to the exhaust gas temperature return pin on the engine harness sensor connector.

d. If the measurement is less than 10 ohms, then the resistance is correct.

D. Faulty Extension Harness

1. Inspect the extension harness and the control connector pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to the exhaust gas temperature return pin on the extension harness inline connection.
   d. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the exhaust gas temperature 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the exhaust gas temperature signal pin on the extension harness connector to all other pins in the extension harness connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.

E. Verify Controller Calibrations

1. Using the display or the InPower Service tool, verify the calibration in the PCC control.
   a. If the calibration in the PCC control matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.

5.6.2 Fault Code 2619 - AUX 101 Input #1 Fault

Analog input #1 fault is active.

A. Condition For Which Analog Input #1 Is Configured Is Active

1. Check the condition for which "Analog Input #1" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #1 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #1. Ensure that the switch input setting is correctly set. If “Analog Input #1 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-1 (reference input 1) and J11-2 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.3 Fault Code 2621 - AUX 101 Input #2 Fault

Analog input #2 fault is active.

A. Condition For Which Analog Input #2 Is Configured Is Active

1. Check the condition for which "Analog Input #2" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #2 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #2. Ensure that the switch input setting is correctly set. If “Analog Input #2 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-3 (reference input 1) and J11-4 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.4 Fault Code 2622 - AUX 101 Input #3 Fault

Analog input #3 fault is active.

A. Condition For Which Analog Input #3 is Configured is Active

1. Condition for which "Analog Input #3" is configured is active
   a. Check the condition for which "Analog Input #3" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #3 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #3. Ensure that the switch input setting is correctly set. If “Analog Input #3 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-5 (reference input 1) and J11-6 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.5 Fault Code 2624 - AUX 101 Input #5 Fault

Analog input #5 fault is active.

A. Condition For Which Analog Input #5 Is Configured Is Active

1. Check the condition for which "Analog Input #5" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #5 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #5. Ensure that the switch input setting is correctly set. If “Analog Input #5 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-9 (reference input 1) and J11-10 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.6 Fault Code 2625 - AUX 101 Input #6 Fault

Analog input #6 fault is active.

A. Condition For Which Analog Input #6 Is Configured Is Active

1. Check the condition for which "Analog Input #6" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #6 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #6. Ensure that the switch input setting is correctly set. If “Analog Input #6 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-11 (reference input 1) and J11-12 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.7 Fault Code 2626 - AUX 101 Input #7 Fault

Analog input #7 fault is active.

A. Condition For Which Analog Input #7 Is Configured Is Active

1. Check the condition for which "Analog Input #7" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #7 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #7. Ensure that the switch input setting is correctly set. If “Analog Input #7 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-13 (reference input 1) and J11-14 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.8 Fault Code 2627 - AUX 101 Input #8 Fault

Analog input #8 fault is active.

A. Condition For Which Analog Input #8 Is Configured Is Active

1. Check the condition for which "Analog Input #8" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #8 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #8. Ensure that the switch input setting is correctly set. If “Analog Input #8 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-15 (reference input 1) and J11-16 (switch input) for an open circuit, short circuit, or a miswired condition.

5.6.9 Fault Code 2729 - IO Module Lost (Warning)

Indicates an intermittent data link between the I/O module and the PCC control (Aux 101 I/O Module option) and no input fault levels were set to Shutdown.

A. Incorrect Wiring

1. Connection between AUX 101 and PCC board is incorrect. Ensure proper wiring.
    a. PCC board TB1-1 – PCC Net A (+) to AUX 101 J1-3
    b. PCC board TB1-2 – PCC Net B (-) to AUX 101 J1-4
    c. PCC board TB1-3 – B+ Return to AUX 101 J14-2
    d. PCC board TB1-5 – Customer Fused B+ to AUX 101 J14-1
    e. PCC board TB15-5 – System Wake-up to AUX 101 J1-5

B. I/O Settings Misconfigured

1. If no AUX 101 is connected to PCC board, connect to InPower. Under Adjustments > System I/O Adjustment > Output Relays ensure System IO Board Enable is disabled.
2. If no AUX 101 is connected to PCC board, connect to InPower. Under Adjustments > System I/O Adjustment > ensure no inputs or outputs are configured as enabled.

5.6.10 Fault Code 2731 - IO Module Lost (Shutdown)

Indicates an intermittent data link between the I/O module and the PC Control (Aux 101 I/O Module option) and at least one input fault level was set to Shutdown.

A. Incorrect Wiring

1. Connection between AUX 101 and PCC board is incorrect. Ensure proper wiring.
    a. PCC board TB1-1 – PCC Net A (+) to AUX 101 J1-3
    b. PCC board TB1-2 – PCC Net B (-) to AUX 101 J1-4
    c. PCC board TB1-3 – B+ Return to AUX 101 J14-2
    d. PCC board TB1-5 – Customer Fused B+ to AUX 101 J14-1
    e. PCC board TB15-5 – System Wake-up to AUX 101 J1-5

B. I/O Settings Misconfigured

1. If no AUX 101 is connected to PCC board, connect to InPower. Under Adjustments > System I/O Adjustment > Output Relays ensure System IO Board Enable is disabled.
2. If no AUX 101 is connected to PCC board, connect to InPower. Under Adjustments > System I/O Adjustment > ensure no inputs or outputs are configured as enabled.

5.6.11 Fault Code 2882 - AUX 101 (1) Input #1 Fault

AUX 101 1 Analog/Switch input #1 fault is active.

A. Condition For Which Analog/Switch Input #1 Is Configured For Is Active

1. Verify the condition for which Analog/Switch Input #1 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
    a. If the fault does not clear go to the Aux 101 1 Analog Input #1 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #1 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #1. Go to: **Setup > Aux 101 Setup.**
    a. Verify that the switch input setting is set correctly.
    b. If Aux 101 1 Analog/Switch Input #1 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
    a. Bent or broken pins, pushed back, or expanded pins.
    b. Evidence of moisture or corrosion in or on the connector.
    c. Missing or damaged connector seals.
    d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, or Short Circuit to the AUX 101 Board

1. Check the wiring at J11-1 (reference input) and J11-2 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-2 (switch input) side for an active closed parameter fault setting activation.
    a. With the switch disconnected measure the resistance from the J11-2 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
    a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
    b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.12 Fault Code 2883 - AUX 101 (1) Input #2 Fault

AUX 101 1 Analog/Switch input #2 fault is active.

A. Condition For Which Analog Input #2 Is Configured Is Active

1. Check the condition for which "Analog Input #2" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Aux 101 1 Analog Input #2 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #2. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #2 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit’s connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-1 (reference input) and J11-2 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11- 2 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11- 2 input pin to the engine block ground; value should be more than 100k ohms.

5.6.13 Fault Code 2884 - AUX 101 (1) Input #3 Fault

AUX 101 1 Analog/Switch input #3 fault is active.

Possible Causes:

1. Condition for which Analog/Switch Input #3 is configured for is active
2. Aux 101 1 Analog Input #3 active state selection parameter is configured incorrectly
3. Faulty switch unit
4. Faulty switch connector(s)
5. Wiring harness incorrectly wired, open circuit, or short circuit to the AUX 101 board

A. Condition for which Analog/Switch Input #3 is configured for is active

1. Verify the condition for which Analog/Switch Input #3 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the next step; **Aux 101 1 Analog Input #3 Active State Selection Parameter is Configured Incorrectly**.

B. Aux 101 1 Analog Input #3 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #3. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #3 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit’s connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-5 (reference input) and J11-6 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.

2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-6 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-6 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.14 Fault Code 2885 - AUX 101 (1) Input #4 Fault

AUX 101 1 Analog/Switch input #4 fault is active.

A. Condition For Which Analog/Switch Input #4 Is Configured For Is Active

1. Condition for which Analog/Switch Input #4 is configured for is active
   a. Verify the condition for which Analog/Switch Input #4 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
      i. If the fault does not clear go to the Aux 101 1 Analog Input #4 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #4 Active State Selection Parameter is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #4. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #4 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-7 (reference input) and J11-8 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-8 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-8 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.15 Fault Code 2886 - AUX 101 (1) Input #5 Fault

AUX 101 1 Analog/Switch input #5 fault is active.

A. Condition For Which Analog/Switch Input #5 Is Configured For Is Active

1. Verify the condition for which Analog/Switch Input #5 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the Aux 101 1 Analog Input #5 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #5 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #5. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #5 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.

c. Missing or damaged connector seals.

d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-9 (reference input) and J11-10 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-10 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-10 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch’s output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch’s output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.16 Fault Code 2887 - AUX 101 (1) Input #6 Fault

AUX 101 1 Analog/Switch input #6 fault is active.

A. Condition For Which Analog/Switch Input #6 Is Configured For Is Active

1. Verify the condition for which Analog/Switch Input #6 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the Aux 101 1 Analog Input #6 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #6 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #6. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #6 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.
2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit’s connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.

2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Wiring harness incorrectly wired, open circuit, or short circuit to the AUX 101 board
   a. Check the wiring at J11-11 (reference input) and J11-12 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
   b. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-12 (switch input) side for an active closed parameter fault setting activation.
      i. With the switch disconnected measure the resistance from the J11-12 input pin to the engine block ground; value should be more than 100k ohms.
   c. Disconnect the wiring harness.
      i. Test the resistance of the wiring between the switch’s output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
      ii. Test the resistance from the switch’s output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.17 Fault Code 2888 - AUX 101 (1) Input #7 Fault

AUX 101 1 Analog/Switch input #7 fault is active.

A. Condition For Which Analog/Switch Input #7 Is Configured For Is Active

1. Verify the condition for which Analog/Switch Input #7 has been configured. After the issue is resolved press the Reset button on the operator panel in order to clear the fault.
   a. If the fault does not clear go to the Aux 101 1 Analog Input #7 active state selection parameter is configured incorrectly step below.

B. Aux 101 1 Analog Input #7 Active State Selection Parameter Is Configured Incorrectly

1. With the InPower service tool or through the operator panel verify the switch input setting (active closed or active open) for Analog/Switch Input #7. Go to: **Setup > Aux 101 Setup.**
   a. Verify that the switch input setting is set correctly.
   b. If Aux 101 1 Analog/Switch Input #7 Sensor Type parameter is set to active close, an active open will invert the logic, causing this fault code to go active.

C. Faulty Switch Unit

1. Visually inspect the switch for proper operation, intended range of movement, and functionality. If any defects or a physical damage are detected the switch unit should be replaced.

2. Measure the resistance of the switch, if the switch is reading incorrectly (shorted or open circuit), replace the switch (< 10 ohms for closed; > 100 Kohms for open).

D. Faulty Switch Connector(s)

1. Check the switch unit's connection at the plug for an adequate connection, short circuit, open circuit, or a wiring mismatch at the switch connector end.
2. Inspect the switch and the harness connector pins for:
   a. Bent or broken pins, pushed back, or expanded pins.
   b. Evidence of moisture or corrosion in or on the connector.
   c. Missing or damaged connector seals.
   d. Dirt or debris in or on the connector pins.

E. Wiring Harness Incorrectly Wired, Open Circuit, Or Short Circuit To The AUX 101 Board

1. Check the wiring at J11-13 (reference input) and J11-14 (switch input) for an open circuit, short circuit, or a miss wired condition at the AUX 101 input side.
2. Verify the wiring harness running from the switch plug to the AUX 101 board for shorted low condition at the J11-14 (switch input) side for an active closed parameter fault setting activation.
   a. With the switch disconnected measure the resistance from the J11-14 input pin to the engine block ground; value should be more than 100k ohms.
3. Disconnect the wiring harness.
   a. Test the resistance of the wiring between the switch's output leads (input and return) and input leads at the base board; value should be less than 10 ohms.
   b. Test the resistance from the switch's output leads (input and return) to all other pins in the harness connector; value should be greater than 100k ohms.

5.6.18 Fault Code 2623 - AUX 101 Input #4 Fault

Analog input #4 fault is active.

A. Condition For Which Analog Input #4 Is Configured Is Active

1. Check the condition for which "Analog Input #4" has been configured. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to next step.

B. Analog Input #4 Active State Selection Parameter Is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Analog Input #4. Ensure that the switch input setting is correctly set. If "Analog Input #4 Sensor Type" parameter is set to active low, an active high will invert the logic, causing this fault code to go active.

C. Incorrectly Wired; Or Open Circuit Or Short Circuit In The Wiring

1. Check the wiring at J11-7 (reference input 1) and J11-8 (switch input) for an open circuit, short circuit, or a miswired condition.

5.7 Battle Short Procedures

5.7.1 Battle Short Mode Procedures

All of the following procedures are required to activate Battle Short mode.

These procedures require the equipment identified in the table below.

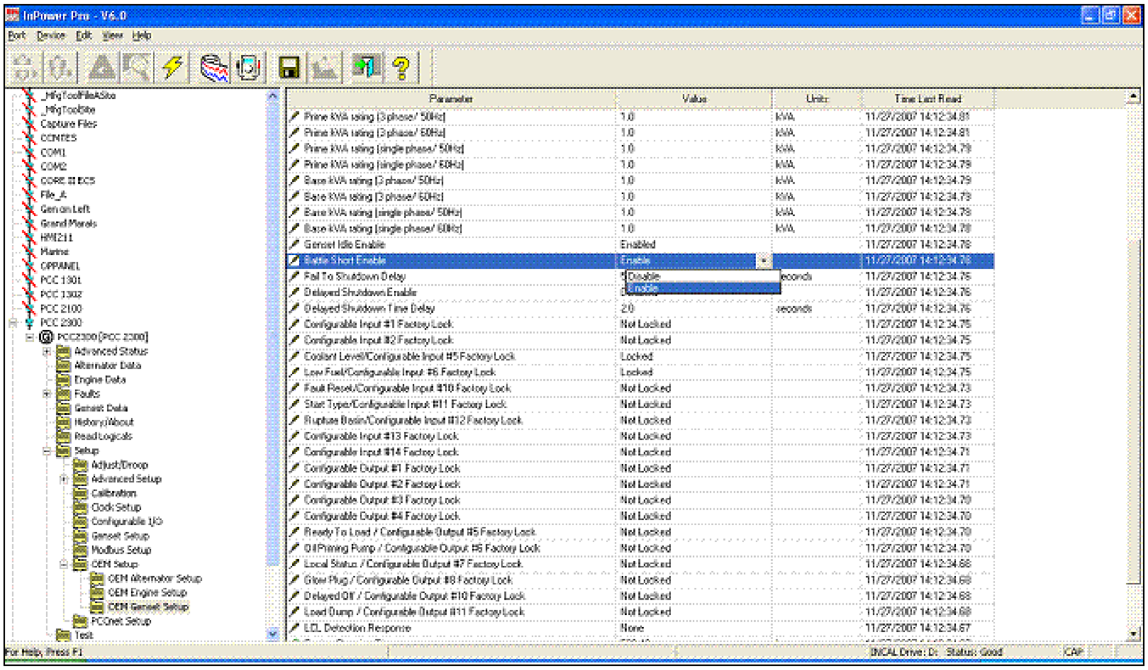
TABLE 14. REQUIRED EQUIPMENT FOR BATTLE SHORT MODE PROCEDURES

Part Description	Part Number
InPower Pro service tool	0998-0077-02 (existing user) 0988-0077-04 (new user)
INLINE 6 product kit	2892092
INLINE 7 product kit	5299899
PC-based service tool harness	0541-1199

NOTICE
Battle Short mode needs to be enabled in INSITE by enabling Shutdown Manual Override.

5.7.2 Enable Battle Short Mode in the PCC

1. Put the PCC in Off mode.
2. Use the PC-based service tool harness to connect the computer to TB15 on the PCC base board.
3. Open InPower (make sure that the security dongle is attached to the computer), and select the control in the left side of the window (Example: PCC 2300 shown).
4. Click on the Setup >OEM Setup > OEM Genset Setup folders.
5. Set the Battle Short Enable parameter to Enable, as shown below.

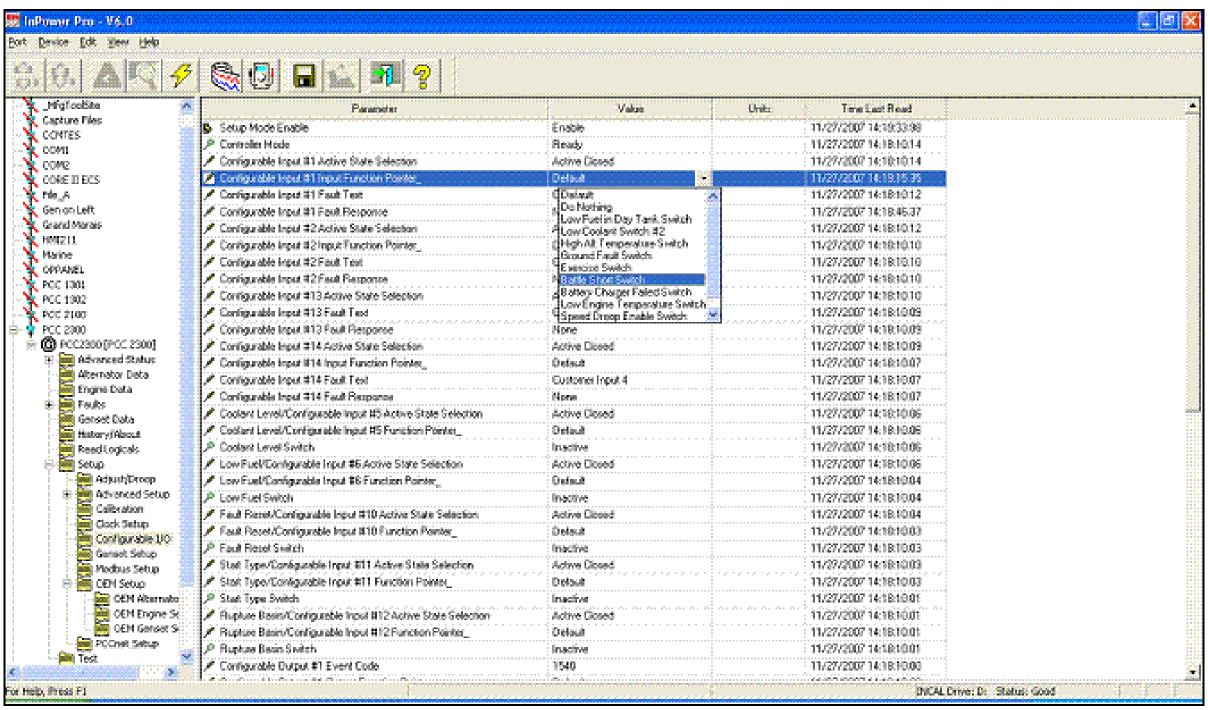


6. Click on Save in order to save the changes.

5.7.3 Activate Battle Short Mode

Each configurable input can be Active Open or Active Closed. Check the value of the configurable input that was configured to Battle Short Switch, and activate the configurable input accordingly.

For example, Configurable Input #1 Active State Selection is set to Active Closed below. In order to activate Battle Short mode, Configurable Input #1 (TB-12 and TB13) has to be closed (connected together).



If Configurable Input #1 Active State Selection were set to Active Open, Configurable Input #1 (TB-12 and TB13) has to be an open contact (disconnected) to activate Battle Short mode.

5.7.4 Battle Short Mode

⚠ WARNING

Automated Machinery

Battle Short mode overrides some parameters of generator set control. Unmonitored generator sets can cause a fire or electrical hazard, resulting in severe personal injury or death.

Make sure that the operation of the set is supervised during Battle Short operation.

Battle Short mode is used to satisfy local code requirements. While Battle Short mode is active, the PCC ignores non-critical shutdown faults and non-critical shutdown with cooldown faults. It does not initiate a stop sequence and continues to run the generator set until Battle Short Mode is inactive. Otherwise, generator set operation remains the same.

Battle Short mode must be set up at the factory or by an authorized service representative. Contact your local distributor for assistance.

Battle Short mode is active only when all of these conditions are met:

- *Battle Short Enable* is set to Enable.
- The Battle Short Switch or *Battle Short Switch (Modbus)* is active. (*Battle Short Switch (Modbus*) is not available in the Operator Panel.)

The PCC generates warning fault 2942 (Shutdown Override Fail) if the Battle Short Switch is active but any of the other conditions are not met.

Battle Short mode is not a distinct mode of operation . The PCC is still in Off mode, Manual mode, or Auto mode while Battle Short mode is active. The PCC still follows the appropriate sequence of operation to start the generator set and to stop the generator set.

The PCC generates warning fault 1131 (Battle Short Active) as long as Battle Short mode is active.

While Battle Short mode is active, the PCC ignores most shutdown faults and only initiates a Shutdown Without Cooldown sequence if a critical shutdown fault occurs.

When the PCC overrides a shutdown fault, it generates warning fault 1416 (Fail To Shutdown) after *Fail To Shutdown Delay* as long as Battle Short mode remains active. It also turns on the Shutdown LED.

NOTICE

The faults that are overridden in Battle Short mode can affect generator set performance and might cause permanent engine, alternator, or connected equipment damage. All shutdown faults, including those overridden in Battle Short mode, must be acted upon immediately to ensure the safety and well-being of the operator and the generator set.

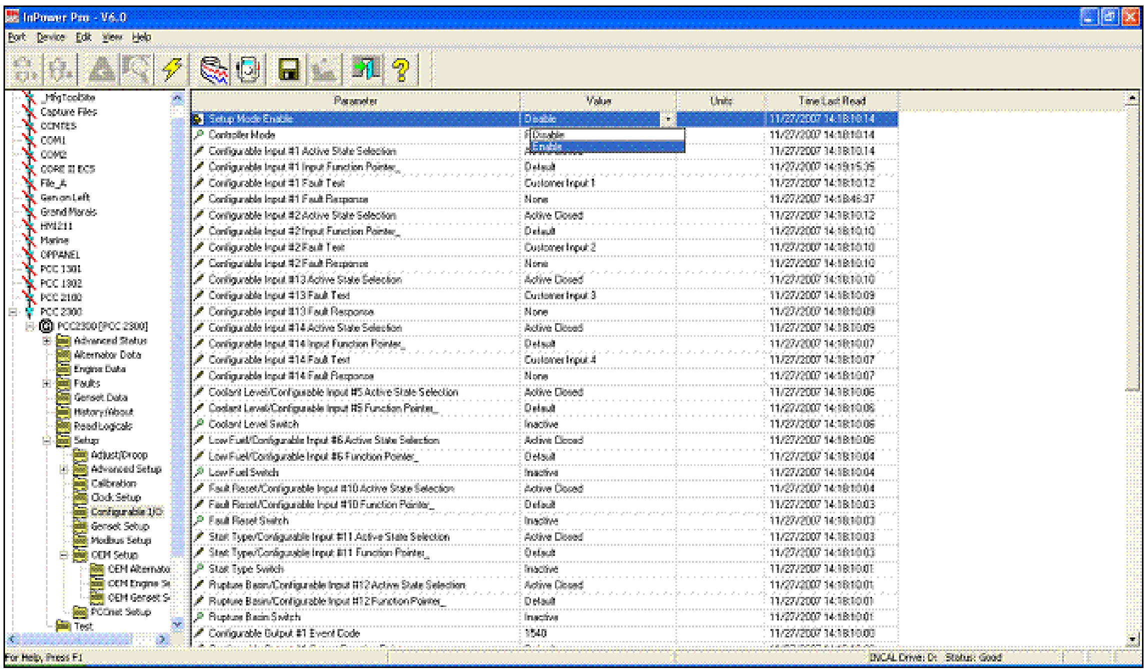
NOTICE

Any damage caused to the generator set as a direct result of running in Battle Short mode is not covered by the warranty.

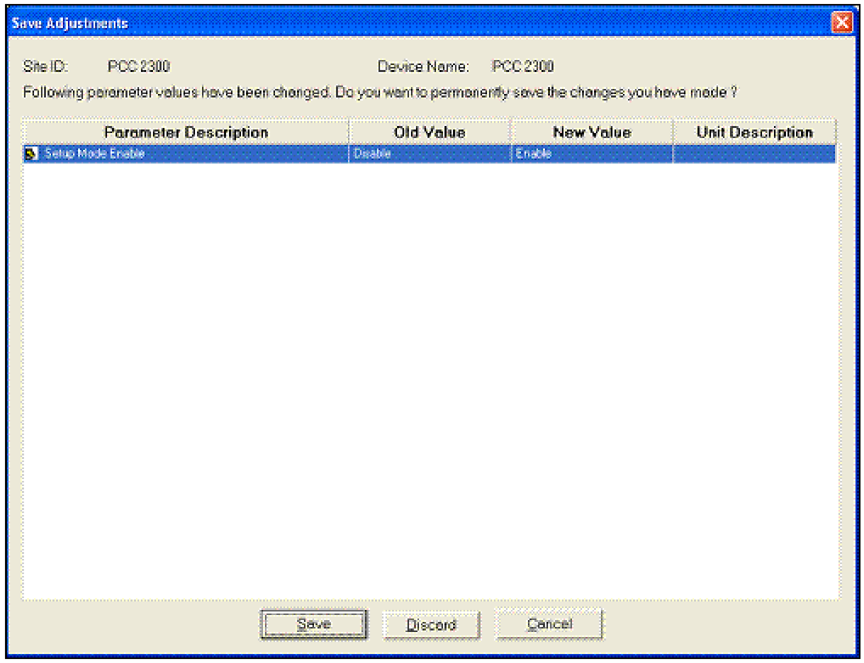
5.7.5 Map a Configurable Input to Battle Short Switch

After Battle Short mode is enabled in the baseboard, you have to map a configurable input to the Battle Short Switch.

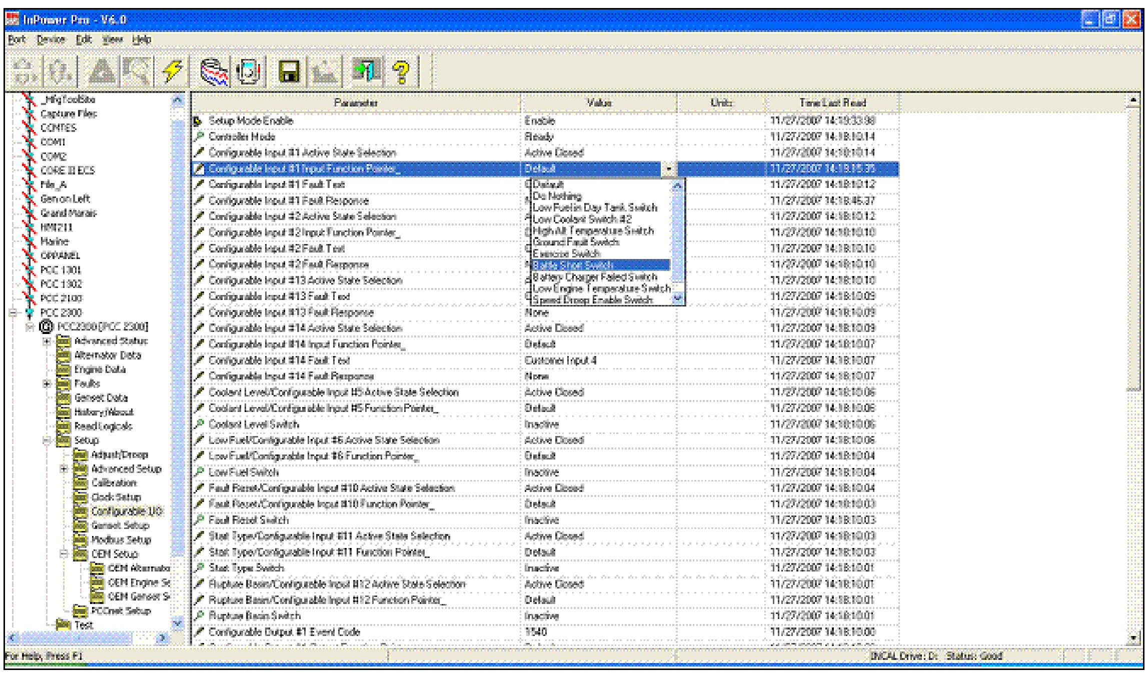
1. Put the PCC in Off mode.
2. Use the PC-based service tool harness to connect the computer to TB15 on the PCC base board.
3. Open InPower (make sure that the security dongle is attached to the computer) and click on the control (PCC 2300 in this example) in the left side of the window.
4. Click on the Setup >Configurable I/O folders.
5. Set the Setup Mode Enable parameter to Enable in order to enter Setup mode, as shown below.



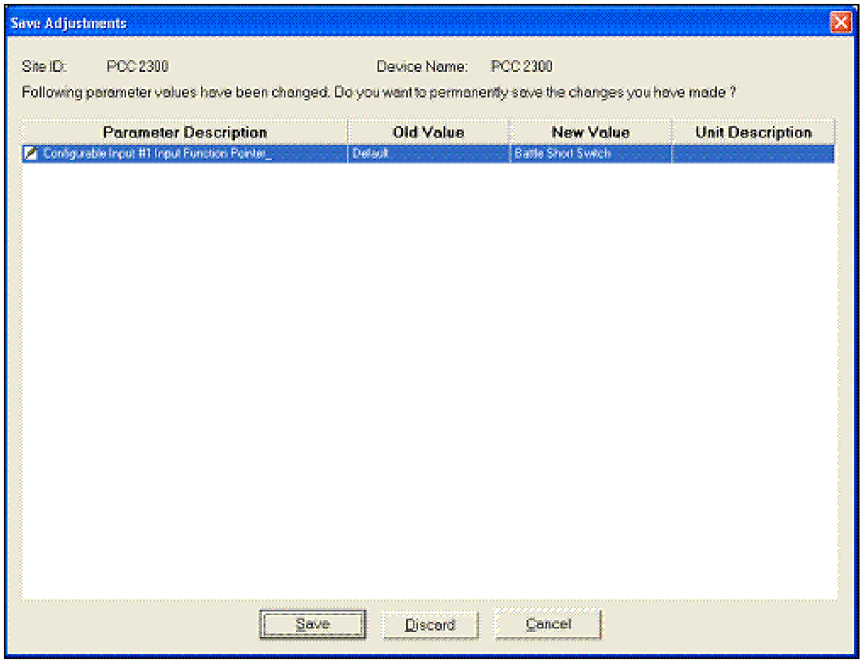
6. Click on Save, as shown below.



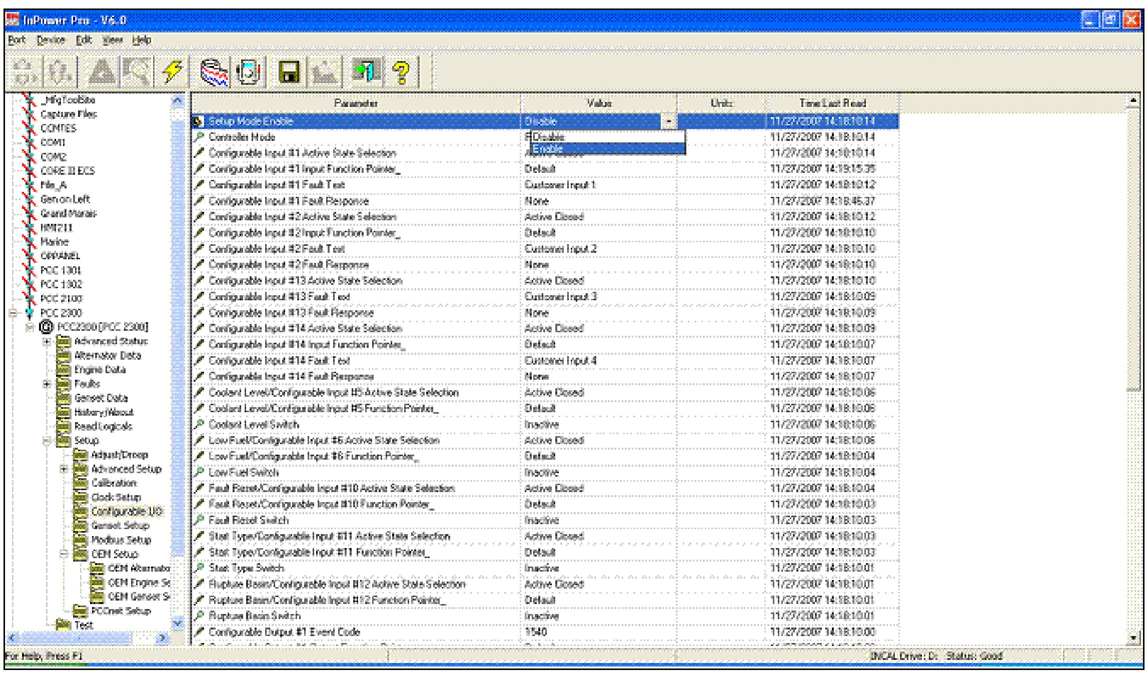
7. Any configurable input can be mapped to Battle Short Switch. Choose one of them. For example, set Configurable Input #1 Input Function Pointer parameter to Battle Short Switch, as shown below.



8. Click on Save, as shown below.



9. Set the Setup Mode Enable parameter to Disable, and click on Save in order to exit Setup mode.



5.8 Battery Troubleshooting

5.8.1 No DC Output (No Fault Message)

Charger cannot sense any DC output.

A. Tripped DC Circuit Breaker

1. Correct the possible overload and reset the circuit breaker.

B. Blown AC Fuse(s) (on 277, 380, 416 and 600 VAC Battery Chargers)

1. Correct the possible overload and replace the fuse(s).

C. Tripped AC circuit breaker(s) (on 120, 208 and 240 VAC battery chargers)

1. Correct the possible overload and reset the circuit breaker.

5.8.2 Low DC Output (No Fault Message)

Charger senses low DC output.

A. Battery Failure

1. Replace the battery and cycle through the Setup menus to clear the fault.

B. Charger Failure

1. Replace the battery charger.

5.8.3 High DC Output (No Fault Message)

Charger senses high DC Output.

A. Charger Failure

1. Replace the battery charger.

5.8.4 Fault Code 379 - Over Current

Charger output current is too high

A. Cycle Through The Setup Menus To Try And Clear The Fault

- If the fault returns, the charger control may have failed.

B. Clearing the Fault Code

NOTICE
Fault code can only be cleared by: • **Disconnect the charger harness plug,** • **Cycle completely through the setup menus,** **Or** • **Recycling the power.**

5.8.5 Fault Code 441 - Low Battery Voltage

Battery voltage is low.

A. No Battery Connected

1. Connect the battery.

B. Output Breaker Is In The Off (Down) Position.

1. Verify the output breaker is in “On” (up) position.

C. A 12V Battery Is Connected But The Charger Is Set For 24V Charging

1. Attach a 24V battery or set the charger for 12V charging

D. Battery Can No Longer Maintain Charge

1. Replace the battery.

E. The Wire Between The Charger And The Battery Is Loose Or Broken

1. Check the wire.

5.8.6 Fault Code 442 - High Battery Voltage

Battery voltage is high.

A. A 12V Battery Is Connected But The Charger Is Set For 24V Charging

1. Attach a 24V battery or set the charger for 12V charging

B. Large Load Dump May Have Caused Momentary Voltage Rise

Cycle through the Setup menus to clear the fault and restart charging.

C. Cycle Through The Setup Menus To Try And Clear The Fault

- If the fault returns, the charger control may have failed.

D. Clearing the Fault Code

NOTICE
Fault code can only be cleared by: • **Disconnect the charger harness plug,** • **Cycle completely through the setup menus,** **Or** • **Recycling the power.**

5.8.7 Fault Code 1442 - Weak Battery

This fault occurs when the engine is starting (cranking) and the voltage of the battery drops below the “Weak Battery Voltage threshold" for the time set in the “Weak Battery Voltage Set Time".

A. Weak Or Discharged Battery

1. Measure the voltage of the battery with a voltmeter. Battery voltage should be 12 VDC or greater in a 12 V system or 24 VDC or greater in a 24 VDC system. If the battery voltage is low, check the electrolyte level in the battery. Replenish the electrolyte level if low and recharge the battery; the specific gravity for a fully charged lead acid battery is approximately 1.260 at 80 °F (27 °C).
2. If the battery cannot hold adequate voltage, replace the battery.

B. Battery Connections Are Loose Or Dirty

1. Clean and tighten battery terminals and battery cable connectors. If the battery cable connectors are cracked or worn out, then replace.

C. Weak battery voltage threshold parameter is set too high

1. Ensure that the Weak Battery Voltage parameter is set to an appropriate voltage value that takes into account voltage drop during cranking (refer to the parameter list to see the default value). To access the battery voltage setup menu from the operator panel, go to **Adjustments > Features > Battery Voltage Setup (Genset) > Weak Battery Threshold 24V** and change the weak battery voltage parameter of the control accordingly.

D. Insufficient Battery Charging Voltage

1. Ensure that the battery charger is charging the battery at an acceptable rate. Adjust the charge rate if the rate is below the recommendation of the manufacturer.
2. If the battery located far from the battery charger, ensure that a proper wire size is used to compensate for voltage drop.

E. Faulty Engine DC Alternator

1. Check the engine DC alternator. If normal charging voltage is not 12 to 14 VDC in a 12 V system or 24 to 26 VDC in a 24 V system then replace the DC alternator.

F. Faulty Harness

1. Measure the battery voltage at the battery terminals, then measure the battery voltage at the base board input. Measure the voltage at B+ (J20–9, J20–10, J20-20, J20–21) and B- (negative) input (J20–2, J20–4, J20–7, J20–12).
   - If the voltage at the battery terminals and the control is not the same then check the harness and replace if necessary.

5.8.8 Fault Code 1443 - Dead Battery

During cranking, the battery voltage drops below the operating voltage of the control, which resets the control. After the control has reset three consecutive times, event/fault code 1443 will become active.

A. Weak Or Discharged Battery

1. Measure the voltage of the battery with a voltmeter. Battery voltage should be 12 VDC or greater in a 12 V system or 24 VDC or greater in a 24 VDC system. If the battery voltage is low, check the electrolyte level in the battery. Replenish the electrolyte level if low and recharge the battery; the specific gravity for a fully charged lead acid battery is approximately 1.260 at 80 °F (27 °C).
2. If the battery cannot hold adequate voltage, replace the battery.

B. Battery Connections Are Loose Or Dirty

1. Clean and tighten battery terminals and battery cable connectors. If the battery cable connectors are cracked or worn out, then replace.

C. Insufficient Battery Charging Voltage

1. Ensure that the battery charger is charging the battery at an acceptable rate. Adjust the charge rate if the rate is below the recommendation of the manufacturer.
2. If the battery located far from the battery charger, ensure that a proper wire size is used to compensate for voltage drop.

D. Faulty Engine DC Alternator

1. Check the engine DC alternator. If normal charging voltage is not 12 to 14 VDC in a 12 V system or 24 to 26 VDC in a 24 V system then replace the DC alternator.

E. Faulty Harness

1. Measure the battery voltage at the battery terminals, then measure the battery voltage at the base board input. Measure the voltage at B+ (J20–9, J20–10, J20-20, J20–21) and B- (negative) input (J20–2, J20–4, J20–7, J20–12).
   - If the voltage at the battery terminals and the control is not the same then check the harness and replace if necessary.

5.8.9 Fault Code 2263 - High Battery Temperature

Battery temperature is above 55 °C (FOR INSTALLATIONS THAT INCLUDE THE OPTIONAL BATTERY TEMP SENSOR)

A. Battery's Ambient Temperature Is Too High

1. Move the battery into a cooler location.
   a. Charger will automatically begin charging again after the battery temp lowers.

B. Possible Shorted Cells Within The Battery Is Causing An Excessive Battery Temperature Increase

1. Replace the battery.

5.8.10 Fault Code 2331 - Low AC Voltage

AC input voltage is more than 10% below nominal rated voltage.

A. AC Input Voltage Is More Than 10% Below Nominal Rated Voltage

1. Check level of input voltage.
   - Charger will not operate with voltage 10% or more below nominal.

5.8.11 Fault Code 2358 - High AC Voltage

AC input voltage is more than 10% above nominal rated voltage.

A. AC Input Voltage Is More Than 10% Above Nominal Rated Voltage

1. Check level of input voltage.
   - Charger will not operate with voltage 10% or more above nominal.

5.8.12 Fault Code 2544 - Over Temperature

Charger is overheating

A. Charger’s Ambient Temperature Is Too High

1. Move the charger to a cooler location.
   - The charger will automatically begin charging again after the internal temp lowers.

B. Charger’s Internal Cooling Fan Is Blocked, Failed, Or Air Inlets Are Covered

1. Verify that the charger’s air inlets on the side of the charger are not blocked and nothing is interfering with fan rotation.

5.8.13 Fault Code 2993 - Battery Charger Failed

A. Charger Failure

1. Replace the battery charger.

5.8.14 Fault Code 9115 - Battery Fail

Battery has failed.

A. Battery Failure

1. Replace the battery and cycle through the Setup menus to clear the fault.

5.9 Engine Performance Troubleshooting

5.9.1 Engine Does Not Crank in Manual Mode (No Fault Message)

Control has not received or recognized a manual start signal.

5.9.1.1 Engine Does Not Crank in Manual Mode - Diagnosis and Repair

1. No power is supplied to the control. (The Control Alive indicator on the base board is not flashing).
   - Poor battery cable connections. Clean the battery cable terminals and tighten all connections using an insulated wrench.
   - Remove the B+ inline fuse and check of continuity (see schematic diagram). If open, replace with fuse of the same type and amperage rating.
     - If fuse is good, remove connector P20 and check for B+ at P20-9, P20-10, P20-20 , and P20-21, and GND at P20-1, P20-2, P20-4, P20-7, and P20-12.

    - If B+ or ground missing, isolate to the harness and the TB BAT terminal mounted on the engine block.
    - If B+ and ground check good, the base board may be defective. Cycle power to the base board by reconnecting P20.

2. The base board is not properly calibrated or the calibration is corrupt. (The Control Alive indicator flashes every ½ second.)
    - Confirm that the installed calibration part number matches the serial plate information. Re-enter a calibration file if necessary. (When properly installed, the Control Alive indicator flashes once every second.)
3. The Emergency Stop switch or wiring is defective.
    - With the Emergency Stop push button not activated, remove connector P25 and check for continuity between P25-2 (ESTOP-NC1) and P25-6 (ESTOP-NC2). (If the circuit is open, the control will detect a local E-Stop condition but will not display the E-Stop condition.) If the circuit is open, isolate to the Emergency Stop switch and wiring.
    - If there is continuity, go to the next step.
4. The Manual start input is not getting from the HMI to the base board. The HMI or harness is defective
    - Disconnect P25 from the HMI. Measure voltage at P25-10. Press the Manual button, then press the start button. A ground signal should be at P25-10.
    - If there is not a ground signal, check wiring continuity from P25-10 to P29-6. If there is no continuity, replace the wiring harness. If there is continuity, replace the HMI.
    - If a ground signal is present proceed to the next step.
5. The base board is defective. Replace the baseboard.

5.9.2 Engine Does Not Crank in Remote Mode (No Fault Message)

Control has not received or recognized a remote start signal.

5.9.2.1 Engine Does Not Crank in Remote Mode - Diagnosis and Repair

1. The remote start switch or customer wiring is faulty.
    - Reset the control. Attempt to start and check for ground at TB1-11.
        - If ground is not present, isolate to the remote switch or customer wiring. Repair as necessary.
        - If ground is present, go to next step.
2. The Auto mode input is not getting from the HMI to the base board, indicating that the HMI or the harness is defective.
    - Check the harness for continuity from P29-4 to P25-11. If continuity does not exist, repair or replace the harness.
    - Press the Auto button on the HMI. Make sure the button illuminates. Check for ground signal at P25-11. If ground is not present, replace the HMI.

5.9.3 Engine Lacks Power or Is Unstable (No Fault Message)

Control has not received or recognized a generator set fault.

5.9.3.1 Engine Lacks Power or Is Unstable - Diagnosis and Repair

1. Determine proper derates for ambient conditions. Refer to the Specification Sheet for site derating factors.
2. Replace the air filter element.
3. See the Installation Manual.
4. Check for low coolant and fill if necessary.
5. Check for air in the cooling system and, if necessary, bleed the cooling system.
6. Governor Gain is misadjusted. Refer to *Governor/Regulator Setup Menu* in the controller Service Manual.
7. Service the engine according to the engine service manual.

5.9.4 Engine is Difficult to Start or Does Not Start (Exhaust Smoke)

5.9.4.1 Engine is Difficult to Start or Does Not Start (Exhaust Smoke) - Diagnosis and Repair

1. Battery voltage
    - Battery voltage is low, interrupted, or open.
        - Check the batteries connections, unswitched battery supply circuit, and fuses.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Starting procedure/aid
    - Starting procedure is not correct.
        - Verify the correct starting procedure.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Starting aid is necessary for cold weather or starting aid is malfunctioning.
        - Check for the correct operation of the starting aid.
        - Refer to the manufacturer's instructions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
    - Inspect fuel lines, fuel connections and fuel filters for leaks.
        - Repair if leaks found.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
        - Add fuel to the fuel tank if the fuel level is found to be low.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Manual fuel shutoff valve is closed.
        - Check the OEM fuel shutoff valves.
        - Verify that the fuel tanks are open.

- Fuel shutoff valve solenoid or circuit is malfunctioning.
    - Check the fuel shutoff valve solenoid and circuit.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for air in the fuel system.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for the fuel inlet restriction.
    - Check the fuel inlet lines for restriction.
    - Check for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for fuel drain line restriction.
    - Check the fuel drain lines for restriction.
    - Clear or replace the fuel lines, check valves, or tank vents as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel system restriction is above specification.
    - Check all fuel system lines for restrictions or debris.
    - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Air intake or exhaust issue(s)
    - Air intake system restriction is above specification.
        - Check the air intake system for restriction.
        - Clean or replace the air filter and inlet piping as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Sensor issue(s)
    - Fuel system pressure sensors (fueling/timing) are malfunctioning.
        - Check the fuel system pressure sensors (fueling/timing).
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Ambient air pressure sensor is malfunctioning.
  - Check the ambient air pressure sensor.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

6. Other issue(s)
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.
     - Refer to the OEM specifications.
   - Overhead adjustments are not correct.
     - Adjust the overhead settings.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Injector O-rings are damaged or missing.
     - Remove and check the injectors.
     - Replace the injector O-rings.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.5 Engine is Difficult to Start or Does Not Start (No Exhaust Smoke)

5.9.5.1 Engine is Difficult to Start or Does Not Start (No Exhaust Smoke) - Diagnosis and Repair

1. Emergency stop/remote emergency stop
   - Emergency Stop/Remote Emergency Stop circuit energized.
     - Verify that either the Emergency Stop or the Remote Emergency Stop circuit is not energized.
2. Battery voltage
   - Battery voltage is low, interrupted, or open.
     - Check the battery connections, un-switched battery supply circuit, and fuses.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Run/Stop circuit issue
   - Run/Stop circuit is malfunctioning.
     - Check the generator Run/Stop circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Fuel system issue(s)
   - Inspect fuel lines, fuel connections, and fuel filters for leaks.
     - Repair if leaks found.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
     - Add fuel to the fuel tank if the fuel level is found to be low.
   - Manual fuel shutoff valve is closed.
     - Check the OEM fuel shutoff valves.
     - Verify that the fuel tanks are open.
   - Fuel shutoff valve solenoid or circuit is malfunctioning.
     - Check the fuel shutoff valve solenoid and circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - In-line check valve(s) are installed backwards or have incorrect part number.
     - Inspect the check valve(s) for correct installation and part number.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel inlet restriction.
     - Check the fuel inlet lines for restriction.
     - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel drain line restriction.
     - Check the fuel drain lines for restriction.
     - Clear or replace the fuel lines, check valves, or tank vents as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system restriction is above specification.
     - Check all fuel system lines for restrictions or debris.
     - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Gear pump is malfunctioning.
     - Check the gear pump output pressure.
     - Replace the gear pump if necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Air intake or exhaust issues
   - Air intake system restriction is above specification.
     - Check the air intake system for restriction.
     - Clean or replace the air filter and inlet piping as necessary.

    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Exhaust system restriction is above specification.
    - Check the exhaust system for restrictions.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
6. Sensor issue(s)
  - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Intake manifold pressure sensor is malfunctioning.
    - Check the intake manifold pressure sensor.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Ambient air pressure sensor is malfunctioning.
    - Check the ambient air pressure sensor.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
7. Other issue(s)
  - Overhead adjustments are not correct.
    - Adjust the overhead settings.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Internal engine damage.
    - Analyze the oil and inspect the filters, pistons, camshaft, and other parts to locate an area of probable damage.

5.9.6 Engine Experiences Low Power, Poor Acceleration, or Poor Response

5.9.6.1 Engine Experiences Low Power, Poor Acceleration, or Poor Response - Diagnosis and Repair

1. Excessive load(s)
  - Ensure that the load on the generator set does not exceed the generator set KW rating.
    - Revisit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
    - Refer to the T−030 manual for proper generator set sizing and application.
2. Fuel system issue(s)
  - Inspect fuel lines, fuel connections, and fuel filters for leaks.
    - Repair if leaks found.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
    - Add fuel to the fuel tank if the fuel level is found to be low.
  - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
    - Operate the engine from a tank of high-quality fuel.

    - Refer to Fuel for Cummins Engines, Bulletin 3379001.
- Check for air in the fuel system.
    - Refer to procedure in the troubleshooting and repair manual for the specific engine.
- Check for fuel inlet restriction.
    - Check the fuel inlet lines for restriction.
    - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for fuel drain line restriction.
    - Check the fuel drain lines for restriction.
    - Clear or replace the fuel lines, check valves, or tank vents as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel system restriction is above specification.
    - Check all fuel system lines for restrictions or debris.
    - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel pump overflow valve is malfunctioning.
    - Check the overflow valve.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
    - Check the fuel lift pump for correct operation.
    - Check the pump output pressure.
    - Replace the fuel lift pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel injection pump is malfunctioning.
    - Remove and test the fuel injection pump.
    - Replace the pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for injector malfunction.
    - Perform the cylinder performance test.
    - Replace injectors as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Air intake or exhaust issue(s)
    - Air intake system restriction is above specification.
        - Check the air intake system for restriction.
        - Clean or replace the air filter and inlet piping as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Air intake or exhaust leaks.
        - Inspect the air intake and exhaust systems for air leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Turbocharger is malfunctioning.
        - Monitor the turbocharger boost pressure with an INSITE electronic service tool.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Sensor issue(s)
    - Coolant temperature sensor is malfunctioning.
        - Use InPower or INSITE service tool(s) to check the coolant temperature sensor.
        - Refer to the procedure in the troubleshooting and repair manual for the specific engine.
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Ambient air pressure sensor is malfunctioning.
        - Check the ambient air pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
    - Engine is operating above recommended altitude.
        - Engine power decreases above recommended altitude.
        - Refer to the Engine Data Sheet for the specific engine for specifications.
    - Engine parasitics are excessive.
        - Check engine-driven units for correct operation.
        - Check the cooling fan for correct operation and cycle time.
        - Refer to the OEM specifications.
    - Overhead adjustments are not correct.
        - Adjust the overhead settings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Base engine problem.
        - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.

- Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.7 Engine Runs Rough or Misfires

5.9.7.1 Engine Runs Rough or Misfires - Diagnosis and Repair

1. Air intake or exhaust issue(s)
    - Air intake system restriction is above specification.
        - Check the air intake system for restriction.
        - Clean or replace the air filter and inlet piping as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Fuel system issue(s)
    - Inspect fuel lines, fuel connections, and fuel filters for leaks.
        - Repair if leaks found.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
        - Operate the engine from a tank of high-quality fuel.
        - Refer to Fuel for Cummins Engines, Bulletin 3379001.
    - Check for air in the fuel system.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel inlet restriction.
        - Check the fuel inlet lines for restriction.
        - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel drain line restriction.
        - Check the fuel drain lines for restriction.
        - Clear or replace the fuel lines, check valves, or tank vents as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system restriction is above specification.
        - Check all fuel system lines for restrictions or debris.
        - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Gear pump is malfunctioning.
        - Check the gear pump output pressure.
        - Replace the gear pump if necessary.

- Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel pump overflow valve is malfunctioning.
  - Check the overflow valve.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for injector malfunction.
  - Perform the cylinder performance test.
  - Replace injectors as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
  - Check the fuel lift pump for correct operation.
  - Check the pump output pressure.
  - Replace the fuel lift pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel injection pump is malfunctioning.
  - Remove and test the fuel injection pump.
  - Replace the pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Sensor issue(s)
   - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system pressure sensors (fueling/timing) are malfunctioning.
     - Check the fuel system pressure sensors (fueling/timing).
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Coolant temperature sensor is malfunctioning.
     - Use InPower service tool to check the coolant temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Intake manifold pressure sensor is malfunctioning.
     - Check the intake manifold pressure sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Ambient air temperature sensor is malfunctioning.
     - Check the ambient air temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Other issue(s)
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.
     - Refer to the OEM specifications.

- Engine mounts are worn, damaged, loose, or not correct.
  - Verify the condition of the mounts.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Overhead adjustments are not correct.
  - Adjust the overhead settings.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Base engine problem.
  - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.8 Engine Shuts Off Unexpectedly or Dies During Deceleration

5.9.8.1 Engine Shuts Off Unexpectedly or Dies During Deceleration - Diagnosis and Repair

1. Emergency Stop/Remote Emergency Stop
   - Emergency Stop/Remote Emergency Stop circuit energized.
     - Verify that either the Emergency Stop or the Remote Emergency Stop circuit is not energized.
2. Fuel system issue(s)
   - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
     - Add fuel to the fuel tank if the fuel level is found to be low.
   - Manual fuel shutoff valve is closed.
     - Check the OEM fuel shutoff valves.
     - Verify that the fuel tank isolation valves are open.
   - Fuel shutoff valve solenoid or circuit is malfunctioning.
     - Check the fuel shutoff valve solenoid and circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel inlet restriction.
     - Check the fuel inlet lines for restriction.
     - Check for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel drain line restriction.
     - Check the fuel drain lines for restriction.
     - Clear or replace the fuel lines, check valves, or tank vents as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Fuel system restriction is above specification.
  - Check all fuel system lines for restrictions or debris.
  - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Gear pump is malfunctioning.
  - Check the gear pump output pressure.
  - Replace the gear pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
  - Check the fuel lift pump for correct operation.
  - Check the pump output pressure.
  - Replace the fuel lift pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Electronic control module related issue(s)
   - Battery voltage supply to the electronic control module has been lost.
     - Check the battery connections.
     - Check the un-switched battery supply circuit.
     - Refer to the operation and maintenance manual, for the specific engine.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Electronic control module is not grounded correctly.
     - Check the electronic control module for correct placement of star washers.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Electronic control module is malfunctioning.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Other issue(s)
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.9 Engine Speed Surges at High or Low Idle

5.9.9.1 Engine Speed Surges at High or Low Idle - Diagnosis and Repair

1. Fuel system issue(s)
   - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
     - Add fuel to the fuel tank if the fuel level is found to be low.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Check for fuel inlet restriction.
  - Check the fuel inlet lines for restriction.
  - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for fuel drain line restriction.
  - Check the fuel drain lines for restriction.
  - Clear or replace the fuel lines, check valves, or tank vents as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
  - Check the fuel lift pump for correct operation.
  - Check the pump output pressure.
  - Replace the fuel lift pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel system restriction is above specification.
  - Check all fuel system lines for restrictions or debris.
  - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Gear pump is malfunctioning.
  - Check the gear pump output pressure.
  - Replace the gear pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for injector malfunction.
  - Perform the cylinder performance test.
  - Replace injectors as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel pump overflow valve is malfunctioning.
  - Check the overflow valve.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel injection pump is malfunctioning.
  - Remove and test the fuel injection pump.
  - Replace the pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

2. Sensor issue(s)
   - Crankshaft or camshaft speed or position sensor(s) reading incorrectly.
     - Refer to the troubleshooting procedure(s) in the troubleshooting and repair manual for the specific engine.

- Fuel system pressure sensors (fueling/timing) are malfunctioning.
  - Check the fuel system pressure sensors (fueling/timing).
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Other issue(s)
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.
     - Refer to the OEM specifications.
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Alternator is malfunctioning.
     - Temporarily disconnect the alternator and test-run the engine.
     - Replace the alternator if necessary.
     - Refer to the OEM service manuals.

5.9.10 Engine Speed Surges Under Load or in Operating Range

5.9.10.1 Engine Speed Surges Under Load or in Operating Range - Diagnosis and Repair

1. Parameter(s) configured incorrectly
   - With the InPower service tool verify that all of the configurable parameters that can affect the engine operation are set correctly.
     - Adjust parameter(s) accordingly only when found to be configured incorrectly.
2. Alternator paralleling control
   - Alternator paralleling controls are sending inconsistent or incorrect commands to the engine electronic control system.
     - Verify that the alternator paralleling controls are functioning correctly.
     - Refer to the paralleling controls user manual for specifications.
3. Fuel system issue(s)
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel inlet restriction.
     - Check the fuel inlet lines for restriction.
     - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.

    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Check for fuel drain line restriction.
    - Check the fuel drain lines for restriction.
    - Clear or replace the fuel lines, check valves, or tank vents as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Fuel system restriction is above specification.
    - Check all fuel system lines for restrictions or debris.
    - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Check for injector malfunction.
    - Perform the cylinder performance test.
    - Replace injectors as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Sensor issue(s)
  - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
    - Refer to the troubleshooting procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Fuel system pressure sensors (fueling/timing) are malfunctioning.
    - Check the fuel system pressure sensors (fueling/timing).
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
  - Moisture in the wiring harness connectors.
    - Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
  - Base engine problem.
    - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
  - Alternator is malfunctioning.
    - Temporarily disconnect the alternator and test-run the engine.
    - Replace the alternator if necessary.
    - Refer to the OEM service manuals.

5.9.11 Engine Starts But Will Not Keep Running

5.9.11.1 Engine Starts But Will Not Keep Running - Diagnosis and Repair

1. Parameter(s) configured incorrectly
   - With the InPower or INSITE service tool(s) verify that engine idle speed is not set too low.
     - Verify the correct idle speed setting.
     - Increase the idle speed if necessary.
2. Battery voltage
   - Battery voltage is low, interrupted, or open.
     - Check the battery connections, un-switched battery supply circuit, and fuses.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Run/Stop circuit issue(s)
   - Run/Stop circuit is malfunctioning.
     - Check the alternator Run/Stop circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Fuel system issue(s)
   - Open the fuel tank cap and verify the fuel level is not below the pickup tube in the tank.
     - Add fuel to the fuel tank if the fuel level is found to be low.
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Fuel system restriction is above specification.
     - Check all fuel system lines for restrictions or debris.
     - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.
     - Refer to the OEM specifications.
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.12 Poor Engine Transient Response

5.9.12.1 Poor Engine Transient Response - Diagnosis and Repair

1. Excessive load(s)
   - Ensure that the load on the generator set does not exceed the generator set KW rating.
     - Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
     - Refer to the T−030 manual for proper generator set sizing and application.
2. Fuel system issue(s)
   - Inspect fuel lines, fuel connections, and fuel filters for leaks.
     - Repair if leaks found.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Low or no fuel pressure at the fuel filters (primary pressure).
     - Use an electronic service tool to measure the fuel pressure at the fuel filter.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel inlet restriction.
     - Check the fuel inlet lines for restriction.
     - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system restriction is above specification.
     - Check all fuel system lines for restrictions or debris.
     - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel drain line restriction.
     - Check the fuel drain lines for restriction.
     - Clear or replace the fuel lines, check valves, or tank vents as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Gear pump is malfunctioning.
     - Check the gear pump output pressure.
     - Replace the gear pump if necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Check for injector malfunction.
    - Perform the cylinder performance test.
    - Replace injectors as necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Air intake or exhaust issues
    - Air intake or exhaust leaks.
        - Inspect the air intake and exhaust systems for air leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Air intake system restriction is above specification.
        - Check the air intake system for restriction.
        - Clean or replace the air filter and inlet piping as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Turbocharger is malfunctioning.
        - Monitor the turbocharger boost pressure.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Sensor issue(s)
    - Intake manifold air temperature is below specification.
        - Refer to the coolant temperature below normal symptom tree in the troubleshooting and repair manual for the specific engine.
    - Fuel system pressure sensors (fueling/timing) are malfunctioning.
        - Check the fuel system pressure sensors (fueling/timing).
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Coolant temperature sensor is malfunctioning.
        - Use InPower service tool(s) to check the coolant temperature sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Ambient air temperature sensor is malfunctioning.
        - Check the ambient air temperature sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
    - Engine is operating above recommended altitude.
        - Engine power decreases above recommended altitude.
        - Refer to the specific Engine Data Sheet for specifications.

- Engine parasitics are excessive.
  - Check engine-driven units for correct operation.
  - Check the cooling fan for correct operation and cycle time.
  - Refer to the OEM specifications.
- Overhead adjustments are not correct.
  - Adjust the overhead settings.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Base engine problem.
  - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.13 Engine Will Not Reach Rated Speed (RPM)

5.9.13.1 Engine Will Not Reach Rated Speed (RPM) - Diagnosis and Repair

1. Excessive load(s)
   - Ensure that the load on the generator set does not exceed the generator set KW rating.
     - Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
     - Refer to the T−030 manual for proper generator set sizing and application.
2. Air intake or exhaust issue(s)
   - Air intake system restriction is above specification.
     - Check the air intake system for restriction.
     - Clean or replace the air filter and inlet piping as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Exhaust system restriction is above specification.
     - Check the exhaust system for restrictions.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system restriction is above specification.
     - Check all fuel system lines for restrictions or debris.
     - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Gear pump is malfunctioning.
    - Check the gear pump output pressure.
    - Replace the gear pump if necessary.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Sensor issue(s)
    - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system pressure sensors (fueling/timing) are malfunctioning.
        - Check the fuel system pressure sensors (fueling/timing).
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Ambient air temperature sensor is malfunctioning.
        - Check the ambient air temperature sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
    - Engine parasitics are excessive.
        - Check engine-driven units for correct operation.
        - Check the cooling fan for correct operation and cycle time.
        - Refer to the OEM specifications.
    - Engine is operating above recommended altitude.
        - Engine power decreases above recommended altitude.
        - Refer to the specific Engine Data Sheet for specifications.
    - Overhead adjustments are not correct.
        - Adjust the overhead settings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Injector O-rings are damaged or missing.
        - Remove and check the injectors.
        - Replace the injector O-rings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Base engine problem.
        - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.14 Engine Will Not Shut Off

5.9.14.1 Engine Will Not Shut Off - Diagnosis and Repair

1. Run/Stop circuit issue
   - Run/Stop circuit is malfunctioning.
     - Check the alternator Run/Stop circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Fumes in the intake air
   - Engine is running on fumes drawn into the air intake.
     - Check the air intake ducts.
     - Locate and isolate the source of the fumes.
     - Repair as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
   - Fuel shutoff valve solenoid or circuit is malfunctioning.
     - Check the fuel shutoff valve solenoid and circuit.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for injector malfunction.
     - Perform the cylinder performance test.
     - Replace injectors as necessary.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Turbocharger seal leak
   - Turbocharger oil seal is leaking.
     - Check the turbocharger for oil seals and for leaks.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Other issue(s)
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.15 Fuel Consumption is Excessive

5.9.15.1 Fuel Consumption is Excessive - Diagnosis and Repair

1. Excessive load(s)
   - Ensure that the load on the generator set does not exceed the generator set KW rating.
     - Re-visit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system.
     - Refer to the T−030 manual for proper generator set sizing and application.

2. Maintenance, repair, or environment effect(s)
    - Fuel consumption has increased after an engine repair.
        - Evaluate the engine repair to determine its effect on fuel consumption.
        - Check part numbers to make sure the correct parts were used.
    - Lubricating oil level is above specification.
        - Check the oil level.
        - Verify the dipstick calibration and oil pan capacity.
        - Fill the system to the specified level.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Environmental factors are affecting fuel consumption.
        - Consider altitude and ambient air temperature when evaluating fuel consumption.
        - Refer to the specific Engine Data Sheets for altitude derate information.
3. Air intake or exhaust issue(s)
    - Air intake or exhaust leaks.
        - Inspect the air intake and exhaust systems for air leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Air intake system restriction is above specification.
        - Check the air intake system for restriction.
        - Clean or replace the air filter and inlet piping as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Turbocharger is not correct.
        - Check the turbocharger part number and compare it to the control parts list.
        - Replace the turbocharger if necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Fuel system issue(s)
    - Inspect fuel lines, fuel connections and fuel filters for leaks.
        - Repair if leaks found.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
        - Operate the engine from a tank of high-quality fuel.
        - Refer to Fuel for Cummins Engines, Bulletin 3379001.
    - Gear pump is malfunctioning.
        - Check the gear pump output pressure.
        - Replace the gear pump if necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Check for injector malfunction.
  - Perform the cylinder performance test.
  - Replace injectors as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel pump overflow valve is malfunctioning.
  - Check the overflow valve.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
  - Check the fuel lift pump for correct operation.
  - Check the pump output pressure.
  - Replace the fuel lift pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel injection pump is malfunctioning.
  - Remove and test the fuel injection pump.
  - Replace the pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5. Sensor issue(s)
   - Crankshaft and/or camshaft speed/position sensor(s) reading incorrectly.
     - Refer to the troubleshooting procedure in the troubleshooting and repair manual for specific engine.
   - Fuel system pressure sensors (fueling/timing) are malfunctioning.
     - Check the fuel system pressure sensors (fueling/timing).
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
6. Other issue(s)
   - Engine parasitics are excessive.
     - Check engine-driven units for correct operation.
     - Check the cooling fan for correct operation and cycle time.
     - Refer to the OEM specifications.
   - Overhead adjustments are not correct.
     - Adjust the overhead settings.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Base engine problem.
     - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.16 Fuel in the Coolant

5.9.16.1 Fuel in the Coolant - Diagnosis and Repair

1. Coolant is contaminated
   - Bulk coolant supply is contaminated.
     - Check the bulk coolant supply.
     - Drain the coolant and replace with non-contaminated coolant.
     - Replace the coolant filters.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Cracked cylinder head
   - Cylinder head is cracked or porous.
     - Remove intake and exhaust manifolds.
     - Check for evidence of coolant leak.
     - If necessary, operate engine at low idle.
     - Pressure-test the cylinder head.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.17 Fuel in the Lubricating Oil

5.9.17.1 Fuel in the Lubricating Oil - Diagnosis and Repair

1. Oil is contaminated
   - Bulk oil supply is contaminated.
     - Check the bulk oil supply.
     - Drain the oil and replace with non-contaminated oil.
     - Replace the oil filters.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Excessive idle time
   - Engine idle time is excessive.
     - Low oil and coolant temperatures can be caused by long idle time (greater than 10 minutes).
     - Shut off the engine rather than idle for long periods.
     - If idle time is necessary, raise the idle speed.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system leaks
   - Fuel pump or injector is leaking fuel.
     - Perform the fluorescent dye tracer test.
     - Check the fuel pump.
     - Check the overhead for an injector leak.
     - Replace the fuel pump or injector(s) if necessary.

        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for injector malfunction.
        - Perform the cylinder performance test.
        - Replace injectors as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Cracked cylinder head
    - Cylinder head is cracked or porous.
        - Remove intake and exhaust manifolds.
        - Check for evidence of oil leak.
        - If necessary, operate engine at low idle.
        - Pressure-test the cylinder head.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Engine problem
    - Base engine problem.
        - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.18 Excessive Smoke - Black

5.9.18.1 Excessive Smoke - Black - Diagnosis and Repair

1. Air intake or exhaust issue(s)
    - Air intake system restriction is above specification.
        - Check the air intake system for restriction.
        - Clean or replace the air filter and inlet piping as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust system restriction is above specification.
        - Check the exhaust system for restrictions.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Air intake or exhaust leaks.
        - Inspect the air intake and exhaust systems for air leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Turbocharger is malfunctioning.
        - Monitor the turbocharger boost pressure with an INSITE electronic service tool.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Sensor issue(s)
    - Intake manifold pressure sensor is malfunctioning.
        - Check the intake manifold pressure sensor.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Intake manifold temperature sensor is malfunctioning.
    - Check the intake manifold temperature sensor.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel system pressure sensors (fueling/timing) are malfunctioning.
    - Check the fuel system pressure sensors (fueling/timing).
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Ambient air temperature sensor is malfunctioning.
    - Check the ambient air temperature sensor.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

3. Fuel system issue(s)
    - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
        - Operate the engine from a tank of high-quality fuel.
        - Refer to Fuel for Cummins Engines, Bulletin 3379001.
    - Check for fuel inlet restriction.
        - Check the fuel inlet lines for restriction.
        - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for fuel drain line restriction.
        - Check the fuel drain lines for restriction.
        - Clear or replace the fuel lines, check valves, or tank vents as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fuel system restriction is above specification.
        - Check all fuel system lines for restrictions or debris.
        - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Check for injector malfunction.
        - Perform the cylinder performance test.
        - Replace injectors as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Other issue(s)
    - Turbocharger oil seal is leaking.
        - Check the turbocharger oil seals for leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Overhead adjustments are not correct.
        - Adjust the overhead settings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Base engine problem.
  - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.19 Excessive Smoke - White

5.9.19.1 Excessive Smoke - White - Diagnosis and Repair

1. Cold ambient conditions
   - Engine is cold.
     - Starting aid is necessary for cold weather or starting aid is malfunctioning.
     - Check for the correct operation of the starting aid.
     - Refer to the OEM manufacturer's instructions.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
2. Sensor issue(s)
   - Coolant temperature sensor is malfunctioning.
     - Use InPower service tool(s) to check the coolant temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Intake manifold temperature sensor is malfunctioning.
     - Check the intake manifold temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Fuel system pressure sensors (fueling/timing) are malfunctioning.
     - Check the fuel system pressure sensors (fueling/timing).
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Ambient air temperature sensor is malfunctioning.
     - Check the ambient air temperature sensor.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Fuel system issue(s)
   - Fuel grade is not correct for the application; fuel quality is poor or presence of water in the fuel.
     - Operate the engine from a tank of high-quality fuel.
     - Refer to Fuel for Cummins Engines, Bulletin 3379001.
   - Check for air in the fuel system.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Check for fuel inlet restriction.
     - Check the fuel inlet lines for restriction.
     - Look for plugged fuel filters, a restricted lift pump bypass check valve, pinched fuel lines, or a restricted stand pipe in the fuel tank.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Check for fuel drain line restriction.
  - Check the fuel drain lines for restriction.
  - Clear or replace the fuel lines, check valves, or tank vents as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel system restriction is above specification.
  - Check all fuel system lines for restrictions or debris.
  - Clear or replace the fuel lines, fuel tubes, fuel manifold, check valves, tank vents, actuator screens, and cylinder head drillings as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Check for injector malfunction.
  - Perform the cylinder performance test.
  - Replace injectors as necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel pump overflow valve is malfunctioning.
  - Check the overflow valve.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Fuel lift pump is malfunctioning.
  - Check the fuel lift pump for correct operation.
  - Check the pump output pressure.
  - Replace the fuel lift pump if necessary.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
- Injector protrusion is not correct.
  - Check the injector protrusion.
  - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

4. Other issue(s)
   - Coolant level is below specification.
     - Check the coolant level and for air in the coolant system.
     - Completely bleed air from the coolant system.
     - Refer to the operation and maintenance manual for the specific engine.
   - Overhead adjustments are not correct.
     - Adjust the overhead settings.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Raw fuel in the intake manifold.
     - Check the intake manifold for fuel.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
   - Intake manifold is contaminated with lubricating oil.
     - Check the intake manifold for oil.
     - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

- Base engine problem.
    - Check the engine for high crankcase pressure, low compression, damaged pistons, camshaft, and other parts.
    - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.20 Engine Noise Is Excessive

5.9.20.1 Engine Noise is Excessive - Diagnosis and Repair

1. Lubricating issue(s)
    - Lubricating oil level is below specification.
        - Check the oil level.
        - Verify the dipstick calibration and the oil pan capacity.
        - Fill the system to the specified level.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Lubricating oil pressure is below specification.
        - Check the oil pressure.
        - If the pressure is low, refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Lubricating oil is thin or diluted.
        - Analyze the oil.
        - Refer to Cummins Engine Oil Recommendations, Bulletin 3810340.
2. Cooling issue(s)
    - Coolant temperature is above specification.
        - Check the coolant level.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Fan drive belt is loose, tight, or not in alignment.
        - Check the fan drive belt.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
3. Air intake or exhaust leaks
    - Inspect the air intake and exhaust systems for air leaks.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
4. Worn mounts
    - Engine mounts are worn, damaged, or incorrect.
        - Check the engine mounts.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
5. Turbocharger noise
    - Inspect the turbocharger(s) for excessive mechanical noise.
        - Replace if necessary.
        - Refer to the Engine Noise Excessive - Turbocharger symptom tree.

6. Mechanical or internal component wear or damage
    - Overhead adjustments are not correct.
        - Measure and adjust the overhead settings.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Overhead components are damaged.
        - Inspect the rocker levers, rocker shafts, cam followers or tappets, push rods, and valves for damage or excessive wear.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Exhaust valve to piston contact.
        - Inspect the rocker levers, rocker shafts, crossheads, valves, and pistons for damage.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Injector is malfunctioning.
        - Perform the cylinder performance test.
        - Replace injectors as necessary.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Vibration damper is damaged.
        - Inspect the vibration damper.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Gear train backlash is excessive or the gear teeth are damaged.
        - Check the gear backlash and the gear teeth.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Main bearing or connecting rod bearing noise.
        - Refer to the Engine Noise Excessive - Main Bearing symptom tree (engine specific manual).
    - Flywheel or flexplate cap screws are loose or broken.
        - Check the flywheel or flexplate and the mounting cap screws.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.
    - Piston, piston rings, or cylinder liner is worn or damaged.
        - Refer to the Engine Noise Excessive – Piston symptom tree (engine specific manual).
    - Internal engine damage.
        - Analyze the oil and inspect the filters to locate an area of probable damage.
        - Refer to the procedure(s) in the troubleshooting and repair manual for the specific engine.

5.9.21 Engine Does Not Crank in Manual Mode

Logic:

This indicates that the control has not received or recognized a manual start signal.

Possible Causes:

- No power supplied to the control.
- Control not properly calibrated or corrupt calibration.

- The Emergency Stop switch or wiring is defective.
- Oil pressure switch or wiring is defective.
- Oil pressure sender, setup on wiring is defective.

Diagnosis and Repair:

1. No power supplied to the control.
   a. Check if the control is in Manual mode and when the Start button is pressed, and that there are no shutdown faults present.
   b. Poor battery cable connections. Clean the battery cable terminals and tighten all connections.
   c. Check for blown fuses.
   d. Remove connector P16 and check for B+ at P16-2 and GND at P16-5. If B+ or ground missing, check the harness. If B+ and ground check OK, cycle power to control by reconnecting P16. Press Reset button to wake the control up. And retry operation.
2. Control not properly calibrated or corrupt calibration.
   a. Confirm that the installed calibration part number matches the serial plate information. Re-enter calibration file if necessary.
3. The Emergency Stop switch or wiring is defective.
   a. With Emergency Stop push button not activated (switch closed), remove leads from TB2-5 and B- and check for continuity between these two leads. If circuit is open, isolate to Emergency Stop switch and wiring. If there is continuity, go to next step.
4. Oil pressure switch or wiring is defective.
   a. Remove P16 connection and check wiring between P16-9 and P16-11 to the switch.
   b. Verify control is configured for the type of sensor installed.
   c. Verify proper operation of the switch.
5. Oil pressure sender, setup on wiring is defective.
   a. Remove P16 connection and check wiring between P16-9, P16-11 to the sender. Verify control is configured for the type of sender. Verify operation of the sender.

5.10 Troubleshooting - PowerCommand 3.3

5.10.1 No Code - The Operator Panel Is Unavailable After Changing the PCCNet Network

The Operator Panel was working until a PCCNet device was added or removed from the PCCNet network.

A. Bad Installation of PCCNet Device

1. Check the installation of the PCCNet device, in particular the connection at TB1. J25 and TB1 share the same electrical connection. If the PCCNet device is installed incorrectly, the Operator Panel on J25 stops working. Make sure the PCCNet device is connected correctly and is functioning properly.

5.10.2 Fault Code 118 - Fuel Pressure OOR High (Warning)

Fuel pressure sensor signal is out of range – shorted high.

A. Faulty Fuel Pressure Sensor Connections

1. Inspect the fuel pressure sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the fuel pressure sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Fuel Pressure Sensor (Active Sensor)

1. Check the fuel pressure sensor supply voltage.
   a. Disconnect the engine harness connector from the fuel pressure sensor.
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
2. Check the fuel pressure sensor signal (sense) voltage.
   a. Disconnect the engine harness connector from the fuel pressure sensor
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 V, then the signal voltage is correct. If not, sensor is faulty.

C. Faulty Engine Harness

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seal.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin on the crankshaft speed sensor conductors.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the crankshaft speed sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the crankshaft speed sensor.
   d. Measure the resistance from the crankshaft speed 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the crank shaft speed signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

   g. If all measurements are greater than 100k ohms, then the resistance is correct.

3. Check for a short circuit to engine block ground on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the crankshaft speed 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit on the crankshaft speed sensor conductors.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the crankshaft speed sensor.
   c. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to the crankshaft speed return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.
5. Check for a short circuit from pin to pin on the camshaft position sensor conductors.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the camshaft position sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the camshaft position sensor.
   d. Measure the resistance from the camshaft position 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the camshaft position return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the camshaft position signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   g. If all measurements are greater than 100k ohms, then the resistance is correct.
6. Check for a short circuit to engine block ground on the camshaft position sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the camshaft position signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the camshaft position 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
7. Check for an open circuit on the camshaft position sensor conductors.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the camshaft position sensor.
   c. Measure the resistance from the camshaft position return pin on the engine harness inline connector to the camshaft position return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

D. Faulty Extension Harness

1. Inspect the extension harness and control pins.
    a. Disconnect the extension harness connector from the control.
    b. Inspect for corroded, bent broken, pushed back, expanded, or loose pins.
    c. Inspect for evidence of moisture in or on the connector.
    d. Inspect for missing or damaged connector seals.
    e. Inspect for dirt or debris in or on the connector pins.
2. Check for a short circuit from pin to pin on the crankshaft speed sensor conductors.
    a. Disconnect the extension harness connector from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the crankshaft speed sensor 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
    d. Measure the resistance from the crankshaft speed return pin on the extension harness connector to all other pins in the extension harness connector.
    e. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to all other pins in the extension harness connector.
    f. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for a short circuit to engine block ground on the crankshaft speed sensor conductors.
    a. Disconnect the extension harness from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to the engine block ground.
    d. Measure the resistance from the crankshaft speed 5 VDC pin on the extension harness connector to the engine block ground.
    e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit on the crankshaft speed sensor conductors.
    a. Disconnect the extension harness from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to the crankshaft speed return pin on the engine harness sensor connector.
    d. If the measurement is less than 10 ohms, then the resistance is correct.
5. Check for a short circuit from pin to pin on the camshaft position sensor conductors.
    a. Disconnect the extension harness connector from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the camshaft position sensor 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
    d. Measure the resistance from the camshaft position return pin on the extension harness connector to all other pins in the extension harness connector.
    e. Measure the resistance from the camshaft position signal pin on the extension harness connector to all other pins in the extension harness connector.

   f. If all measurements are greater than 100k ohms, then the resistance is correct.

6. Check for a short circuit to engine block ground on the camshaft position sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the camshaft position signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the camshaft position 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
7. Check for an open circuit on the camshaft position sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the camshaft position return pin on the engine harness inline connector to the camshaft position return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

E. Verify the calibrations in the PowerCommand controls

1. Using the display or the InPower Service tool, verify the calibration in the PCC.
   a. If the calibration in the PCC matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.
2. Using the InSite Service tool, verify the calibration in the base board.
   a. If the calibration in the base board matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the base board to the latest calibration.

5.10.3 Fault Code 119 - Fuel Pressure Sensor OOR Low (Warning)

Fuel pressure sensor signal is out of range – shorted high.

A. Faulty Fuel Pressure Sensor Connections

1. Inspect the fuel pressure sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the fuel pressure sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Fuel Pressure Sensor (Active Sensor)

1. Check the fuel pressure sensor supply voltage.
   a. Disconnect the engine harness connector from the fuel pressure sensor.
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.

   c. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.

2. Check the fuel pressure sensor signal (sense) voltage.
   a. Disconnect the engine harness connector from the fuel pressure sensor
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 V, then the signal voltage is correct. If not, sensor is faulty.

C. Faulty Engine Harness

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seal.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin on the crankshaft speed sensor conductors.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the crankshaft speed sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the crankshaft speed sensor.
   d. Measure the resistance from the crankshaft speed 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the crank shaft speed signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   g. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for a short circuit to engine block ground on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the crankshaft speed 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit on the crankshaft speed sensor conductors.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the crankshaft speed sensor.

c. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to the crankshaft speed return pin on the engine harness sensor connector.

d. If the measurement is less than 10 ohms, then the resistance is correct.

5. Check for a short circuit from pin to pin on the camshaft position sensor conductors.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the camshaft position sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the camshaft position sensor.
   d. Measure the resistance from the camshaft position 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the camshaft position return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the camshaft position signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   g. If all measurements are greater than 100k ohms, then the resistance is correct.
6. Check for a short circuit to engine block ground on the camshaft position sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the camshaft position signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the camshaft position 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
7. Check for an open circuit on the camshaft position sensor conductors.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the camshaft position sensor.
   c. Measure the resistance from the camshaft position return pin on the engine harness inline connector to the camshaft position return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

D. Faulty Extension Harness

1. Inspect the extension harness and control pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded, bent broken, pushed back, expanded, or loose pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for a short circuit from pin to pin on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.

   c. Measure the resistance from the crankshaft speed sensor 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the crankshaft speed return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to all other pins in the extension harness connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for a short circuit to engine block ground on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the crankshaft speed 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to the crankshaft speed return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.
5. Check for a short circuit from pin to pin on the camshaft position sensor conductors.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the camshaft position sensor 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the camshaft position return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the camshaft position signal pin on the extension harness connector to all other pins in the extension harness connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.
6. Check for a short circuit to engine block ground on the camshaft position sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the camshaft position signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the camshaft position 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
7. Check for an open circuit on the camshaft position sensor conductors.
   a. Disconnect the extension harness from the control.

b. Disconnect the extension harness from the engine harness.

c. Measure the resistance from the camshaft position return pin on the engine harness inline connector to the camshaft position return pin on the engine harness sensor connector.

d. If the measurement is less than 10 ohms, then the resistance is correct.

E. Verify the calibrations in the PowerCommand controls

1. Using the display or the InPower Service tool, verify the calibration in the PCC.
   a. If the calibration in the PCC matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.
2. Using the InSite Service tool, verify the calibration in the base board.
   a. If the calibration in the base board matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the base board to the latest calibration.

5.10.4 Fault Code 121 - Loss of Speed Sense (Shutdown)

No engine speed signal detected from one of two signals: engine crankshaft speed or engine camshaft position.

A. Faulty Crankshaft Speed Sensor Connections

1. Inspect the crankshaft speed sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the crankshaft speed sensor.
   b. Inspect for corroded, bent broken, pushed back, expanded, or loose pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Crankshaft Speed Sensor

1. Check the crankshaft speed sensor supply voltage.
   a. Disconnect the engine harness connector from the crankshaft speed sensor.
   b. Install the speed sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
2. Check the crankshaft speed sensor signal (sense) voltage.
   a. Disconnect the engine harness connector from the camshaft position sensor.
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 VDC, then the signal voltage is correct. If not, sensor is faulty.

C. Faulty Camshaft Position Sensor Connections

1. Inspect the camshaft position sensor and the engine harness connector pins
   a. Disconnect the engine harness connector from the camshaft position sensor.
   b. Inspect for corroded, bent broken, pushed back, expanded, or loose pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

D. Faulty Camshaft Position Sensor

1. Check the camshaft position sensor supply voltage.
   a. Disconnect the engine harness connector from the camshaft position sensor.
   b. Install the speed sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
2. Check the camshaft position sensor signal (sense) voltage.
   a. Disconnect the engine harness connector from the camshaft position sensor.
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 VDC, then the signal voltage is correct. If not, sensor is faulty.

E. Faulty Engine Harness

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seal.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin on the crankshaft speed sensor conductors.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the crankshaft speed sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the crankshaft speed sensor.
   d. Measure the resistance from the crankshaft speed 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the crank shaft speed signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

   g. If all measurements are greater than 100k ohms, then the resistance is correct.

3. Check for a short circuit to engine block ground on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the crankshaft speed 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit on the crankshaft speed sensor conductors.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the crankshaft speed sensor.
   c. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to the crankshaft speed return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.
5. Check for a short circuit from pin to pin on the camshaft position sensor conductors.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the camshaft position sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the camshaft position sensor.
   d. Measure the resistance from the camshaft position 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the camshaft position return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the camshaft position signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   g. If all measurements are greater than 100k ohms, then the resistance is correct.
6. Check for a short circuit to engine block ground on the camshaft position sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the camshaft position signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the camshaft position 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
7. Check for an open circuit on the camshaft position sensor conductors.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the camshaft position sensor.
   c. Measure the resistance from the camshaft position return pin on the engine harness inline connector to the camshaft position return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

F. Faulty Extension Harness

1. Inspect the extension harness and control pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded, bent broken, pushed back, expanded, or loose pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for a short circuit from pin to pin on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed sensor 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the crankshaft speed return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to all other pins in the extension harness connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for a short circuit to engine block ground on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the crankshaft speed 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit on the crankshaft speed sensor conductors.
   a. Disconnect the extension harness from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the crankshaft speed return pin on the engine harness inline connector to the crankshaft speed return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.
5. Check for a short circuit from pin to pin on the camshaft position sensor conductors.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the camshaft position sensor 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the camshaft position return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the camshaft position signal pin on the extension harness connector to all other pins in the extension harness connector.

f. If all measurements are greater than 100k ohms, then the resistance is correct.

6. Check for a short circuit to engine block ground on the camshaft position sensor conductors.

    a. Disconnect the extension harness from the control.

    b. Disconnect the extension harness from the engine harness.

    c. Measure the resistance from the camshaft position signal pin on the extension harness connector to the engine block ground.

    d. Measure the resistance from the camshaft position 5 VDC pin on the extension harness connector to the engine block ground.

    e. If the measurement is more than 100k ohms, then the resistance is correct.

7. Check for an open circuit on the camshaft position sensor conductors.

    a. Disconnect the extension harness from the control.

    b. Disconnect the extension harness from the engine harness.

    c. Measure the resistance from the camshaft position return pin on the engine harness inline connector to the camshaft position return pin on the engine harness sensor connector.

    d. If the measurement is less than 10 ohms, then the resistance is correct.

G. Damaged Crankshaft Target Wheel

1. Visually inspect the crankshaft target wheel.

    a. Inspect for damaged, malformed, missing or broken target wheel teeth.

    b. Inspect for evidence of corrosion or other materials on or around the target wheel teeth.

    c. Inspect for dirt or debris on the target wheel teeth.

H. Verify the calibrations in the PowerCommand controls

1. Using the display or the InPower Service tool, verify the calibration in the PCC.

    a. If the calibration in the PCC matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.

2. Using the InSite Service tool, verify the calibration in the base board.

    a. If the calibration in the base board matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the base board to the latest calibration.

5.10.5 Fault Code 135 - Oil Pressure Sensor OOR High

Engine oil pressure sensor signal is out of range – shorted high.

NOTICE
This warning will only occur if the generator set is equipped with an oil pressure sensor.

A. Test Leads

Part Number 316289800 - Pressure/Temperature sensor breakout cable

Part Number 382477400 - Pressure sensor breakout cable

Part Number 382477600 - Pressure sensor breakout cable

Part Number 316475200 - Danfoss™ pressure sensor breakout cable

Part Number 382275800 - Male Deutsch/AMP/Metri-Pack test lead

Part Number 382291700 - Female Deutsch/AMP/Metri-Pack test lead

Part Number 382481200 - Deutsch socket pin test lead

Part Number 382481100 - Deutsch pin test lead

B. Oil Pressure Sensor Connections

1. Inspect the oil pressure sensor and the engine harness connector pins.
    a. Disconnect the engine harness connector from the oil pressure sensor.
    b. Inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
    c. Inspect for evidence of moisture in or on the connector.
    d. Inspect for missing or damaged connector seals.
    e. Inspect for dirt or debris in or on the connector pins.

C. Faulty Sensor/Switch

Active Sensor

1. Check the oil pressure sensor supply voltage.
    a. Disconnect the engine harness connector from the oil pressure sensor.
    b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
    c. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
2. Check the oil pressure sensor signal (sense) voltage.
    a. Disconnect the engine harness connector from the oil pressure sensor.
    b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
    c. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 V, then the signal voltage is correct. If not, the sensor is faulty.

Passive Sensor

Check the resistance of the sensor.

1. Disconnect the engine harness connector from the oil pressure sensor.
2. Measure the resistance between the oil pressure signal pin and the oil pressure return pin.
3. Refer to the troubleshooting and repair manual for the specific engine platform for oil pressure ranges.

Switch

1. Check generator set manual to determine if switch should be normally open or normally closed.
2. Ensure physical switch is of same type.

D. Faulty Engine Harness

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the oil pressure sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the oil pressure sensor.
   d. Measure the resistance from the oil pressure 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the oil pressure return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the oil pressure signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   g. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for a short circuit to engine block ground.
   a. Disconnect the extension harness from the base board.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the oil pressure signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the oil pressure 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the oil pressure sensor.
   c. Measure the resistance from the oil pressure return pin on the engine harness inline connector to the oil pressure return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

5.10.6 Fault Code 141 - Oil Pressure Sensor OOR Low

Engine oil pressure sensor signal is out of range – shorted low.

NOTICE
This warning will only occur if the generator set is equipped with an oil pressure sensor.

A. Test Leads

Part Number 316289800 - Pressure/Temperature sensor breakout cable

Part Number 382477400 - Pressure sensor breakout cable

Part Number 382477600 - Pressure sensor breakout cable

Part Number 316475200 - Danfoss™ pressure sensor breakout cable

Part Number 382275800 - Male Deutsch/AMP/Metri-Pack test lead

Part Number 382291700 - Female Deutsch/AMP/Metri-Pack test lead

Part Number 382481200 - Deutsch socket pin test lead

Part Number 382481100 - Deutsch pin test lead

B. Verify That The Fault Simulation Feature For The Sensor Is Not Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the intake manifold temperature sensor by connecting to the PCC via InPower. If the fault simulation is disabled, there is no problem.

C. Oil Pressure Sensor Connections

1. Inspect the oil pressure sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the oil pressure sensor.
   b. Inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

D. Faulty Sensor/Switch

Active Sensor

1. Check the oil pressure sensor supply voltage.
   a. Disconnect the engine harness connector from the oil pressure sensor.
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
2. Check the oil pressure sensor signal (sense) voltage.
   a. Disconnect the engine harness connector from the oil pressure sensor.
   b. Install the pressure sensor breakout cable between the sensor and the sensor harness connector.
   c. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 V, then the signal voltage is correct. If not, the sensor is faulty.

Passive Sensor

Check the resistance of the sensor.

1. Disconnect the engine harness connector from the oil pressure sensor.
2. Measure the resistance between the oil pressure signal pin and the oil pressure return pin.
3. Refer to the troubleshooting and repair manual for the specific engine platform for oil pressure ranges.

Switch

1. Check generator set manual to determine if switch should be normally open or normally closed.
2. Ensure physical switch is of same type.

E. Faulty Engine Harness

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the oil pressure sensor.
   c. Disconnect the engine harness from all sensors that have a shared supply or return with the oil pressure sensor.
   d. Measure the resistance from the oil pressure 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the oil pressure return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. Measure the resistance from the oil pressure signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   g. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for a short circuit to engine block ground.
   a. Disconnect the extension harness from the base board.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the oil pressure signal pin on the extension harness connector to the engine block ground.
   d. Measure the resistance from the oil pressure 5 VDC pin on the extension harness connector to the engine block ground.
   e. If the measurement is more than 100k ohms, then the resistance is correct.
4. Check for an open circuit.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the oil pressure sensor.
   c. Measure the resistance from the oil pressure return pin on the engine harness inline connector to the oil pressure return pin on the engine harness sensor connector.

d. If the measurement is less than 10 ohms, then the resistance is correct.

5.10.7 Fault Code 143 - Engine Oil Pressure Low (Warning)

Engine oil pressure is below the low oil pressure warning threshold.

A. Lubricating Oil Level Is Low

1. Check the oil level. Add or drain oil, if necessary.

B. External Leak

1. Inspect the engine and surrounding area for external oil leaks.
2. Tighten the capscrews, pipe plugs, and fittings.
3. Replace gaskets, if necessary.

C. Lubricating Oil Does Not Meet Specifications

1. Verify that the lubricating oil meets the specifications in the engine manual.
2. Verify that alternative oil and additives were not added during the oil's life.
3. Verify the age of the lubricating oil.
4. If necessary, take an oil sample. Refer to oil analysis technique bulletins for instructions on how to take an oil sample.

D. Lubricating Oil Is Contaminated With Coolant Or Fuel

1. Refer to Lubricating Oil Contaminated symptom tree for proper troubleshooting.

E. Engine Angularity During Operation Exceeds Specification

1. Verify generator set is level or near level.
2. See engine specification to determine suitable amount of angularity.

F. Coolant Temperature Is Above Specification

1. Using the display or the InPower service tool, note the engine coolant temperature.
2. Compare that coolant temperature against the coolant temperature specification in the engine manual.
3. If the coolant temperature is above the specification, refer to FC146 for above-normal coolant temperature troubleshooting.

G. Lubricating Oil Filter Plumbing Is Not Routed Correctly

1. Inspect the lubricating oil filter plumbing.
2. If the routing is an issue, refer to the lubricating filter plumbing procedure in the engine manual.

H. Main Oil Pressure Regulator Is Faulty

For further information refer to the Engine Service Manual.

I. Lubricating Oil Suction Or Transfer Tube Is Loose Or Broken

For further information refer to the Engine Service Manual.

J. Lubricating Oil Pump Is Faulty

For further information refer to the Engine Service Manual.

K. Incorrect Lubricating Oil Cooler Is Installed

1. Check if the correct lubricating oil cooler part number is installed. Verify against the appropriate parts manual.

L. Lubricating Oil Cooler Is Plugged

1. Visually inspect the oil cooler for cleanliness.
2. Refer to the engine manual for instructions on how to clean the oil cooler housing.

M. Lubricating Oil Temperature Is Above Specification

1. Using the display or the InPower service tool, note the engine oil temperature.
2. Compare that oil temperature against the oil temperature specification in the engine manual for operating oil temperatures. Refer to the coolant or block heater specification for a non-running engine.
3. If the oil temperature is above specification, refer to FC421 for above-normal coolant temperature troubleshooting.

N. Piston Cooling Nozzles Are Damaged Or Are Not Installed Correctly

For further information refer to the Engine Service Manual.

O. Oil Pressure Sensor Is Inaccurate Or Blocked

1. Connect a mechanical oil pressure gauge of known quality and calibration to the engine at one of the plugs on top of the oil filter head.
2. Connect InPower.
3. While the engine is stopped, compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
4. Proceed only if engine troubleshooting has been completed. Do not attempt to start the engine if there is any doubt about the oil pressure.
5. Start the generator set.
6. Compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
7. Refer to the troubleshooting and repair manual for the specific engine platform for oil pressure ranges.

P. Fault Simulation Is Enabled Or The Threshold Is Set To High

1. Connect to the control with InPower and ensure that the fault simulation for LOP is not enabled.
2. Using the electronic service tool, verify that the fault threshold is **not** within the normal operating range for the oil pressure sensor. Refer to the appropriate base engine manual for the normal operating range specification.

5.10.8 Fault Code 144 - Engine Coolant Temperature OOR High

Engine coolant temperature signal voltage is out of range - shorted high

NOTICE
Part number 382275800 - Male Deutsch/AMP/Metri-Pack test lead
Part number 382291700 - Female Deutsch/AMP/Metri-Pack test lead

A. Fault Simulation Feature is Enabled

1. Verify that the fault simulation feature is not enabled.
    a. Connect InPower.
    b. Verify that the fault simulation is NOT enabled for the intake manifold temperature sensor by connecting to the PCC via InPower. If fault simulation is disabled, there is no problem.

B. Faulty Coolant Temperature Sensor Connections

1. Inspect the coolant temperature sensor and the harness connector pins.
    a. Disconnect the engine harness connector from the coolant temperature sensor.
    b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins or expanded pins.
    c. Inspect for evidence of moisture in or on the connector.
    d. Inspect for missing or damaged connector seals.
    e. Inspect for dirt or debris in or on the connector pins.

C. Faulty Coolant Temperature Sensor

1. Check the resistance of the sensor.
    a. Disconnect the engine harness connector from the coolant temperature sensor.
    b. Measure the resistance between the coolant temperature signal pin and the coolant temperature return pin.
    c. Refer to the troubleshooting and repair manual for the specific engine platform for coolant temperature ranges.

D. Faulty Engine Harness Coolant Temperature Sensor

1. Inspect the engine harness and the extension harness connector pins.
    a. Disconnect the engine harness connector from the extension harness.
    b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins or expanded pins.
    c. Inspect for evidence of moisture in or on the connector.
    d. Inspect for missing or damaged connector seals.
    e. Inspect for dirt or debris in or on the connector pins.

   Check for a short circuit from pin-to-pin.
    a. Disconnect the engine harness connector from the extension harness.
    b. Disconnect the engine harness from the coolant temperature sensor.

c. Disconnect the engine harness from all sensors that have a shared return with the coolant temperature sensor.

d. Measure the resistance from the coolant temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.

e. Measure the resistance from the coolant temperature signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

f. If all measurements are greater than 100K ohms, then the resistance is correct.

Check for an open circuit.

a. Disconnect the engine harness connector from the extension harness.

b. Disconnect the engine harness from the coolant temperature sensor.

c. Measure the resistance from the coolant temperature return pin on the engine harness inline connector to the coolant temperature return pin on the engine harness sensor connector.

d. Measure the resistance from the coolant temperature signal pin on the engine harness inline connector to the coolant temperature signal pin on the engine harness sensor connector.

e. If the measurements are less than 10 ohms, then the resistance is correct.

5.10.9 Fault Code 145 - Engine Coolant Temperature OOR High (Warning)

Engine coolant temperature signal voltage is out of range – shorted high.

A. Fault Simulation Is Enabled Or The Threshold Is Set To High

1. Connect to the control with InPower and ensure that the fault simulation for LOP is not enabled.
2. Using the electronic service tool, verify that the fault threshold is **not** within the normal operating range for the oil pressure sensor. Refer to the appropriate base engine manual for the normal operating range specification.

B. Faulty Coolant Temperature Sensor Connections

1. Inspect the coolant temperature sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the coolant temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

C. Faulty Coolant Temperature Sensor

1. Check the resistance of the sensor
2. Disconnect the engine harness connector from the coolant temperature sensor.
3. Measure the resistance between the coolant temperature sensor signal pin and the coolant temperature sensor return pin.

D. Faulty Engine Harness - General

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
   f. Disconnect harness from base board and sensor.
   g. Measure the resistance in each pin from base board to sensor. Resistance should be 5 ohms or less.
   h. Repair or replace harness as necessary.

E. Faulty Extension Harness

1. Inspect the extension harness and the control connector pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to the exhaust gas temperature return pin on the extension harness inline connection.
   d. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the exhaust gas temperature 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.
   d. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to all other pins in the extension harness connector.
   e. Measure the resistance from the exhaust gas temperature signal pin on the extension harness connector to all other pins in the extension harness connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.

F. Verify Controller Calibrations

1. Using the display or the InPower Service tool, verify the calibration in the PCC control.
   a. If the calibration in the PCC control matches the latest calibration on the InCal website, then the calibration is correct. If it does not, update the calibration to the latest.

2. Using the InSite Service tool, verify the calibration in the base board.
   a. If the calibration in the base board matches the latest calibration on QSOL, then the calibration is correct. If it does not, update the base board to the latest calibration.

5.10.10 Fault Code 146 - Engine Coolant Temperature Above Normal (Warning)

Engine coolant temperature has exceeded the warning level and duration parameters set in the ECM or control.

A. High Ambient Temperature

1. Using a thermocouple, verify the air temperature entering the intake louver of the generator set.
2. Reduce loads or recirculation of discharge air to the generator set with an elevated ambient temperature.

B. Radiator Blocked

1. Inspect for dirt, debris or obstructions.
2. Remove blockage or winterfront as applicable.

C. Louvers Are Closed Or Damaged

1. Inspect the louvers for proper operation.
2. Repair or replace the louvers if damaged.
3. Check the louver motor for proper operation.
4. If the louver motor is operational, verify the louver shutterstat is operational.

D. Charge Air Cooler Fins or Radiator Fins are Damaged or Obstructed

1. Inspect for dirt, debris or obstructions.
2. Clean if necessary.

E. Coolant Level Is Below Specification

1. Inspect the engine, cooling system, and surrounding area for external coolant leaks.
2. Repair as required.
3. Verify that the coolant level is correct via the sight glass.
4. Add coolant as necessary.

F. Antifreeze And Water Mixture Is Not Correct

1. Verify the concentration of antifreeze in the coolant. Add coolant as necessary.

G. Fan Shroud Is Damaged Or Air Recirculation Baffles Are Damaged

1. Inspect shroud and baffles for damage and clearance.
2. Repair or replace if damaged.

H. Fan Belt Is Broken Or Loose

1. Inspect belt(s) for damage, wear, and proper tension.
2. Inspect pulleys and belt tensioner for damage or wear.
3. Repair or replace if damaged or worn.

I. Fan Drive Or Fan Controls Are Malfunctioning

1. Inspect pulleys and belt tensioner for damage or wear.
2. Repair or replace if damaged or worn.

J. Radiator Cap Is Faulty

1. Inspect radiator cap and gasket for damage and proper pressure operation.
2. Replace if damaged or worn.

K. Thermostat Is Faulty

1. Remove thermostat and inspect/test for proper operation.
2. Replace if damaged or malfunctioning.

L. Cooling System Hose Is Collapsed, Restricted Or Leaking

1. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks.
2. Replace if damaged or worn.

M. Intake Manifold Air Temperature Is Above Specification

1. Use a thermocouple to verify manifold air temperature.
2. Repair or replace faulty after cooler components.

N. Cooling System Is Contaminated With Dirt, Scale, Or Sludge

1. Inspect cooling system components for external contaminates and clean as required.
2. Open the radiator cap and inspect for contaminated coolant and scale.
3. Flush the cooling system per the engine service manual.

O. Water Pump Is Malfunctioning

1. Inspect water pump for proper operation.
2. Replace if damaged or worn.

P. Air Or Combustion Gases Are Entering The Cooling System

1. Inspect engine for head gasket leak.
2. Repair or replace faulty components.

Q. Inaccurate Coolant Temperature Sensor

1. Using a thermocouple or similar device, measure coolant temperature near sender and compare to coolant temperature displayed.

2. Verify the temperature sender resistance and compare to specifications called out in the engine manual.
3. Verify continuity from temperature sender wire pin to base board pin. Harness resistance should be less than 5 Ohms.
4. Repair or replace faulty components or wiring

R. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

S. Incorrect Threshold Setting

1. Use the service tool to connect to verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.

5.10.11 Fault Code 151 - Engine Coolant Temperature High (Shutdown)

Engine coolant temperature has exceeded the alarm (shutdown) threshold for high coolant temperature.

A. High Ambient Temperature

1. Using a thermocouple, verify the air temperature entering the intake louver of the generator set.
2. Reduce loads or recirculation of discharge air to the generator set with an elevated ambient temperature.

B. Radiator Blocked

1. Inspect for dirt, debris or obstructions.
2. Remove blockage or winterfront as applicable.

C. Louvers Are Closed Or Damaged

1. Inspect the louvers for proper operation.
2. Repair or replace the louvers if damaged.
3. Check the louver motor for proper operation.
4. If the louver motor is operational, verify the louver shutterstat is operational.

D. Charge Air Cooler Fins or Radiator Fins are Damaged or Obstructed

1. Inspect for dirt, debris or obstructions.
2. Clean if necessary.

E. Coolant Level Is Below Specification

1. Inspect the engine, cooling system, and surrounding area for external coolant leaks.

2. Repair as required.
3. Verify that the coolant level is correct via the sight glass.
4. Add coolant as necessary.

F. Antifreeze And Water Mixture Is Not Correct

1. Verify the concentration of antifreeze in the coolant. Add coolant as necessary.

G. Fan Shroud Is Damaged Or Air Recirculation Baffles Are Damaged

1. Inspect shroud and baffles for damage and clearance.
2. Repair or replace if damaged.

H. Fan Belt Is Broken Or Loose

1. Inspect belt(s) for damage, wear, and proper tension.
2. Inspect pulleys and belt tensioner for damage or wear.
3. Repair or replace if damaged or worn.

I. Fan Drive Or Fan Controls Are Malfunctioning

1. Inspect pulleys and belt tensioner for damage or wear.
2. Repair or replace if damaged or worn.

J. Radiator Cap Is Faulty

1. Inspect radiator cap and gasket for damage and proper pressure operation.
2. Replace if damaged or worn.

K. Thermostat Is Faulty

1. Remove thermostat and inspect/test for proper operation.
2. Replace if damaged or malfunctioning.

L. Cooling System Hose Is Collapsed, Restricted Or Leaking

1. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks.
2. Replace if damaged or worn.

M. Intake Manifold Air Temperature Is Above Specification

1. Use a thermocouple to verify manifold air temperature.
2. Repair or replace faulty after cooler components.

N. Cooling System Is Contaminated With Dirt, Scale, Or Sludge

1. Inspect cooling system components for external contaminates and clean as required.
2. Open the radiator cap and inspect for contaminated coolant and scale.
3. Flush the cooling system per the engine service manual.

O. Water Pump Is Malfunctioning

1. Inspect water pump for proper operation.
2. Replace if damaged or worn.

P. Air Or Combustion Gases Are Entering The Cooling System

1. Inspect engine for head gasket leak.
2. Repair or replace faulty components.

Q. Inaccurate Coolant Temperature Sensor

1. Using a thermocouple or similar device, measure coolant temperature near sender and compare to coolant temperature displayed.
2. Verify the temperature sender resistance and compare to specifications called out in the engine manual.
3. Verify continuity from temperature sender wire pin to base board pin. Harness resistance should be less than 5 Ohms.
4. Repair or replace faulty components or wiring

R. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

S. Incorrect Threshold Setting

1. Use the service tool to connect to verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.

5.10.12 Fault Code 153 - Intake Manifold Temperature OOR High (Warning)

Engine intake manifold temperature sensor signal is out of range – shorted high.

NOTICE
Part Number 3822758 - Male Deutsch/AMP/Metri-Pack test lead
Part Number 3822917 - Female Deutsch/AMP/Metri-Pack test lead

A. Faulty Intake Manifold Temperature Sensor Connections

1. Inspect the intake manifold temperature sensor and the harness connector pins.
   a. Disconnect the engine harness connector from the intake manifold temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.

d. Inspect for missing or damaged connector seals.

e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Intake Manifold Temperature Sensor

1. Check the resistance of the sensor.
   a. Disconnect the engine harness connector from the intake manifold temperature sensor.
   b. Measure the resistance between the intake manifold temperature signal pin and the intake manifold temperature return pin.
   c. Refer to the troubleshooting and repair manual for the specific engine platform for intake manifold temperature ranges.
2. Check for a short circuit to engine block ground.
   a. Disconnect the engine harness connector from the intake manifold temperature sensor.
   b. Measure the resistance from one of the pins of the intake manifold temperature sensor connector to engine block ground. If the resistance is more than 100k Ohms, the sensor is operating correctly.

C. Faulty Engine Harness

1. Inspect the engine harness and the extension harness connector pins.
   a. Disconnect the engine harness from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the intake manifold temperature sensor.
   c. Disconnect the engine harness from all sensors that have a shared return with the intake manifold temperature sensor.
   d. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the intake manifold temperature signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. If all measurements are greater than 100k Ohms, then the resistance is correct.
3. Check for an open circuit.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the intake manifold
   c. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to the intake manifold temperature return pin at the engine harness sensor connector.
   d. Measure the resistance from the intake manifold temperature signal pin on the engine harness inline connector to the intake manifold temperature signal pin at then engine harness sensor connector.

e. If the measurement is less than 10 Ohms, then the resistance is correct.

5.10.13 Fault Code 154 - Intake Manifold Temperature OOR Low (Warning)

Engine intake manifold temperature sensor signal is out of range – shorted low.

NOTICE
Part Number 3822758 - Male Deutsch/AMP/Metri-Pack test lead
Part Number 3822917 - Female Deutsch/AMP/Metri-Pack test lead

A. Faulty Intake Manifold Temperature Sensor Connections

1. Inspect the intake manifold temperature sensor and the harness connector pins.
   a. Disconnect the engine harness connector from the intake manifold temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Intake Manifold Temperature Sensor

1. Check the resistance of the sensor.
   a. Disconnect the engine harness connector from the intake manifold temperature sensor.
   b. Measure the resistance between the intake manifold temperature signal pin and the intake manifold temperature return pin.
   c. Refer to the troubleshooting and repair manual for the specific engine platform for intake manifold temperature ranges.
2. Check for a short circuit to engine block ground.
   a. Disconnect the engine harness connector from the intake manifold temperature sensor.
   b. Measure the resistance from one of the pins of the intake manifold temperature sensor connector to engine block ground. If the resistance is more than 100k Ohms, the sensor is operating correctly.

C. Faulty Engine Harness

1. Inspect the engine harness and the extension harness connector pins.
   a. Disconnect the engine harness from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness connector from the extension harness.

   b. Disconnect the engine harness from the intake manifold temperature sensor.
   c. Disconnect the engine harness from all sensors that have a shared return with the intake manifold temperature sensor.
   d. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the intake manifold temperature signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. If all measurements are greater than 100k Ohms, then the resistance is correct.
3. Check for an open circuit.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the intake manifold
   c. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to the intake manifold temperature return pin at the engine harness sensor connector.
   d. Measure the resistance from the intake manifold temperature signal pin on the engine harness inline connector to the intake manifold temperature signal pin at then engine harness sensor connector.
   e. If the measurement is less than 10 Ohms, then the resistance is correct.

5.10.14 Fault Code 155 - Intake Manifold Temperature High (Shutdown)

Engine intake manifold temperature has the shutdown level and duration parameters set in the ECM or control.

A. High Ambient Temperature

1. Using a thermocouple, verify the air temperature entering the intake louver of the generator set.
2. Reduce loads or recirculation of discharge air to the generator set with an elevated ambient temperature.

B. Radiator Blocked

1. Inspect for dirt, debris or obstructions.
2. Remove blockage or winterfront as applicable.

C. Louvers Are Closed Or Damaged

1. Inspect the louvers for proper operation.
2. Repair or replace the louvers if damaged.
3. Check the louver motor for proper operation.
4. If the louver motor is operational, verify the louver shutterstat is operational.

D. Charge Air Cooler Fins or Radiator Fins are Damaged or Obstructed

1. Inspect for dirt, debris or obstructions.
2. Clean if necessary.

E. Fan Belt Is Broken Or Loose

1. Inspect belt(s) for damage, wear, and proper tension.
2. Inspect pulleys and belt tensioner for damage or wear.
3. Repair or replace if damaged or worn.

F. Fan Drive Or Fan Controls Are Malfunctioning

1. Inspect pulleys and belt tensioner for damage or wear.
2. Repair or replace if damaged or worn.

G. Inaccurate Coolant Temperature Sensor

1. Using a thermocouple or similar device, measure coolant temperature near sender and compare to coolant temperature displayed.
2. Verify the temperature sender resistance and compare to specifications called out in the engine manual.
3. Verify continuity from temperature sender wire pin to base board pin. Harness resistance should be less than 5 Ohms.
4. Repair or replace faulty components or wiring

H. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

I. Incorrect Threshold Setting

1. Use the service tool to connect to verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.

5.10.15 Fault Code 195 - Coolant Level Sensor OOR High (Warning)

Coolant level sensor signal is out of range – shorted high.

NOTICE
Part Number 3822758 - Male Deutsch/AMP/Metri-Pack test lead
Part Number 3822917 - Female Deutsch/AMP/Metri-Pack test lead

A. Faulty Coolant Temperature Sensor Connections

1. Inspect the coolant temperature sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the coolant temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

c. Inspect for evidence of moisture in or on the connector.

d. Inspect for missing or damaged connector seals.

e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Coolant Level Sensor

Perform the checks in Generator Set Sensors.

C. Faulty Engine Harness-Coolant Level Sensor

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the coolant level sensor.
   c. Measure the resistance from the coolant level sensor supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   d. Measure the resistance from the coolant level sensor pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for an open circuit.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the coolant level sensor.
   c. Measure the resistance from the coolant level sensor return pin on the engine harness inline connector to the coolant level sensor return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

D. Faulty Extension Harness-Coolant Level Sensor

1. Inspect the extension harness and the extension harness connector pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
   a. Disconnect the extension harness connector from the control.

   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the coolant level sensor return pin on the engine harness inline connector to the coolant level sensor return pin at the engine harness sensor connector.
   d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to coolant level sensor signal pin at then engine harness sensor connector.
   e. If the measurement is less than 10 ohms, then the resistance is correct.

3. Check for a short circuit from pin to pin.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Disconnect the engine harness from all sensors that have a shared return with the coolant level sensor. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. If all measurements are greater than 100k Ohms, then the resistance is correct.

5.10.16 Fault Code 196 - Coolant Level Sensor OOR Low (Warning)

Coolant level sensor signal is out of range – shorted high.

NOTICE
Part Number 3822758 - Male Deutsch/AMP/Metri-Pack test lead
Part Number 3822917 - Female Deutsch/AMP/Metri-Pack test lead

A. Faulty Coolant Temperature Sensor Connections

1. Inspect the coolant temperature sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the coolant temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Coolant Level Sensor

Perform the checks in Generator Set Sensors.

C. Faulty Engine Harness-Coolant Level Sensor

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the coolant level sensor.
   c. Measure the resistance from the coolant level sensor supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   d. Measure the resistance from the coolant level sensor pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. If all measurements are greater than 100k ohms, then the resistance is correct.
3. Check for an open circuit.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the coolant level sensor.
   c. Measure the resistance from the coolant level sensor return pin on the engine harness inline connector to the coolant level sensor return pin on the engine harness sensor connector.
   d. If the measurement is less than 10 ohms, then the resistance is correct.

D. Faulty Extension Harness-Coolant Level Sensor

1. Inspect the extension harness and the extension harness connector pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the coolant level sensor return pin on the engine harness inline connector to the coolant level sensor return pin at the engine harness sensor connector.
   d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to coolant level sensor signal pin at then engine harness sensor connector.
   e. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.

c. Disconnect the engine harness from all sensors that have a shared return with the coolant level sensor. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.

d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

e. If all measurements are greater than 100k Ohms, then the resistance is correct.

5.10.17 Fault Code 197 - Coolant Level Low (Warning)

Coolant level sensor signal is showing a low coolant level for greater 10 seconds.

A. Low Coolant

1. Stop the engine and allow the engine to cool down.
2. Visually inspect that engine coolant is at the appropriate level through the sight glass or expansion tank.
3. Remove radiator cap and check that coolant is up to the required level.
4. If coolant is below 1 in. (2.54 cm) from the top of the radiator add manufacturer's prescribed coolant.

B. Faulty Coolant Temperature Sensor Connections

1. Inspect the coolant temperature sensor and the engine harness connector pins.
   a. Disconnect the engine harness connector from the coolant temperature sensor.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

C. Faulty Coolant Level Sensor

Perform the checks in Generator Set Sensors.

D. Faulty Engine Harness-Coolant Level Sensor

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin.
   a. Disconnect the engine harness from the extension harness.
   b. Disconnect the engine harness connector from the coolant level sensor.
   c. Measure the resistance from the coolant level sensor supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.

d. Measure the resistance from the coolant level sensor pin on the engine harness inline connector to all other pins in the engine harness inline connector.

e. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

f. If all measurements are greater than 100k ohms, then the resistance is correct.

3. Check for an open circuit.

a. Disconnect the engine harness from the extension harness.

b. Disconnect the engine harness connector from the coolant level sensor.

c. Measure the resistance from the coolant level sensor return pin on the engine harness inline connector to the coolant level sensor return pin on the engine harness sensor connector.

d. If the measurement is less than 10 ohms, then the resistance is correct.

E. Faulty Extension Harness-Coolant Level Sensor

1. Inspect the extension harness and the extension harness connector pins.

a. Disconnect the extension harness connector from the control.

b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

c. Inspect for evidence of moisture in or on the connector.

d. Inspect for missing or damaged connector seals.

e. Inspect for dirt or debris in or on the connector pins.

2. Check for an open circuit.

a. Disconnect the extension harness connector from the control.

b. Disconnect the extension harness from the engine harness.

c. Measure the resistance from the coolant level sensor return pin on the engine harness inline connector to the coolant level sensor return pin at the engine harness sensor connector.

d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to coolant level sensor signal pin at then engine harness sensor connector.

e. If the measurement is less than 10 ohms, then the resistance is correct.

3. Check for a short circuit from pin to pin.

a. Disconnect the extension harness connector from the control.

b. Disconnect the extension harness from the engine harness.

c. Disconnect the engine harness from all sensors that have a shared return with the coolant level sensor. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.

d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

e. If all measurements are greater than 100k Ohms, then the resistance is correct.

5.10.18 Fault Code 212 - Engine Oil Temperature OOR High

Engine oil temperature is out of range - shorted high.

NOTICE
Part number 382275800 - Male Deutsch/AMP/Metri-Pack test lead
Part number 382291700 - Female Deutsch/AMP/Metri-Pack test lead

A. Engine Oil Temperature Sensor Connections

1. Inspect the engine oil temperature sensor and the harness connector pins.
   a. Disconnect the engine harness connector from the engine oil temperature sensor.
   b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins, or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Engine Oil Temperature Sensor

1. Check the resistance of the sensor.
   a. Disconnect the engine harness connector from the engine oil temperature sensor.
   b. Measure the resistance between the engine oil temperature signal pin and the engine oil temperature return pin.
   c. Refer to the troubleshooting and repair manual for the specific engine platform for engine oil temperature ranges.

C. Faulty Engine Harness Oil Temperature Sensor

1. Inspect the engine harness and the extension harness connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins, or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

   Check for a short circuit from pin-to-pin.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the engine oil temperature sensor.
   c. Disconnect the engine harness from all sensors that have a shared return with the engine oil temperature sensor.
   d. Measure the resistance from the engine oil temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the engine oil temperature signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   f. If all measurements are greater than 100K ohms, then the resistance is correct.

Check for an open circuit.

a. Disconnect the engine harness connector from the extension harness.

b. Disconnect the engine harness from the engine oil temperature sensor.

c. Measure the resistance from the engine oil temperature return pin on the engine harness inline connector to the engine oil temperature return pin at the engine harness sensor connector.

d. Measure the resistance from the engine oil temperature signal pin on the engine harness inline connector to the engine oil temperature signal pin at the engine harness sensor connector.

e. If all measurements are less than 10 ohms, then the resistance is correct.

5.10.19 Fault Code 213 - Engine Oil Temperature OOR Low

Logic:

Engine oil temperature is out of range - shorted low.

NOTICE
Part number 382275800 - Male Deutsch/AMP/Metri-Pack test lead
Part number 382291700 - Female Deutsch/AMP/Metri-Pack test lead

A. Engine Oil Temperature Sensor Connections

1. Inspect the engine oil temperature sensor and the harness connector pins.

   a. Disconnect the engine harness connector from the engine oil temperature sensor.

   b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins, or expanded pins.

   c. Inspect for evidence of moisture in or on the connector.

   d. Inspect for missing or damaged connector seals.

   e. Inspect for dirt or debris in or on the connector pins.

B. Faulty Engine Oil Temperature Sensor

1. Check the resistance of the sensor.

   a. Disconnect the engine harness connector from the engine oil temperature sensor.

   b. Measure the resistance between the engine oil temperature signal pin and the engine oil temperature return pin.

   c. Refer to the troubleshooting and repair manual for the specific engine platform for engine oil temperature ranges.

C. Faulty Engine Harness Oil Temperature Sensor

1. Inspect the engine harness and the extension harness connector pins.

   a. Disconnect the engine harness connector from the extension harness.

   b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins, or expanded pins.

   c. Inspect for evidence of moisture in or on the connector.

   d. Inspect for missing or damaged connector seals.

e. Inspect for dirt or debris in or on the connector pins.

Check for a short circuit from pin-to-pin.

a. Disconnect the engine harness connector from the extension harness.
b. Disconnect the engine harness from the engine oil temperature sensor.
c. Disconnect the engine harness from all sensors that have a shared return with the engine oil temperature sensor.
d. Measure the resistance from the engine oil temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
e. Measure the resistance from the engine oil temperature signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.
f. If all measurements are greater than 100K ohms, then the resistance is correct.

Check for an open circuit.

a. Disconnect the engine harness connector from the extension harness.
b. Disconnect the engine harness from the engine oil temperature sensor.
c. Measure the resistance from the engine oil temperature return pin on the engine harness inline connector to the engine oil temperature return pin at the engine harness sensor connector.
d. Measure the resistance from the engine oil temperature signal pin on the engine harness inline connector to the engine oil temperature signal pin at the engine harness sensor connector.
e. If all measurements are less than 10 ohms, then the resistance is correct.

D. Faulty Extension Harness Oil Temperature Sensor

1. Inspect the extension harness and the AUX 105 connector pins.
   a. Disconnect the extension harness connector from the AUX 105.
   b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins, or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

Check for an open circuit.

a. Disconnect the extension harness connector from the AUX 105.
b. Disconnect the extension harness from the engine harness.
c. Measure the resistance from the engine oil temperature return pin on the extension harness connector to the engine oil temperature return pin at the extension harness inline connector.
d. Measure the resistance from the engine oil temperature signal pin on the extension harness connector to the engine oil temperature signal pin at the extension harness inline connector.
e. If all measurements are less than 10 ohms, then the resistance is correct.

Check for a short circuit from pin-to-pin.

a. Disconnect the extension harness from the AUX 105.
b. Disconnect the extension harness from the engine harness.

c. Measure the resistance from the engine oil temperature return pin on the extension harness connector to all other pins in the extension harness connector.

d. Measure the resistance from the engine oil temperature signal pin on the extension harness connector to all other pins in the extension harness connector.

e. If all measurements are greater than 100K ohms, then the resistance is correct.

5.10.20 Fault Code 214 - Engine Oil Temperature High - Critical

Engine oil temperature has exceeded the alarm (shutdown) threshold for high engine oil temperature.

A. Inaccurate Engine Temperature Sensor

1. Verify the sensor accuracy with a thermocouple or similar temperature probe.
    a. Connect the temperature probe to the engine near the engine oil temperature sensor.
    b. Connect InPower.
    c. Compare the engine oil temperature reading from the service tool to the reading from the temperature sensor. If the two readings are reasonably close, then the sensor is reading correctly.

B. Fault Simulation Feature Is Enabled

1. Verify that the fault simulation feature is not enabled.
    a. Connect InPower.
    b. Verify that the fault simulation is NOT enabled for the engine oil temperature sensor by connecting to the PCC via InPower. If fault simulation is disabled, there is no problem.

C. Incorrect Threshold Setting

1. Check threshold settings.
    a. Connect InPower.
    b. Verify that the fault threshold is set correctly for the normal operating range for the engine oil temperature sensor. Refer to the engine manual for correct threshold values, and make the appropriate changes using InPower.

5.10.21 Fault Code 234 - Engine Speed High (Shutdown)

Engine speed signals indicate an engine speed greater than shutdown threshold.

A. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

B. Incorrect Threshold Setting

1. Use the service tool to connect to verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.

C. Incorrect Fuel Type Setting

1. Connect InPower
2. Verify the fuel source set with InPower is the same fuel used by the generator.

D. Faulty Engine Speed Sensor Connections

1. Inspect the engine speed sensor and the harness connector pins.
2. Disconnect the engine harness connector from the engine speed sensor.
3. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
4. Inspect for evidence of moisture in or on the connector.
5. Inspect for missing or damaged connector seals.
6. Inspect for dirt or debris in or on the connector pins.

E. Faulty Engine Harness - General

1. Inspect the engine harness and the connector pins.
    a. Disconnect the engine harness connector from the extension harness.
    b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
    c. Inspect for evidence of moisture in or on the connector.
    d. Inspect for missing or damaged connector seals.
    e. Inspect for dirt or debris in or on the connector pin.
    f. Disconnect harness from base board and sensor.
    g. Measure the resistance in each pin from base board to sensor. Resistance should be 5 ohms or less.
    h. Repair or replace harness as necessary.

F. Faulty Extension Harness

1. Inspect the extension harness and the control connector pins.
    a. Disconnect the extension harness connector from the control.
    b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
    c. Inspect for evidence of moisture in or on the connector.
    d. Inspect for missing or damaged connector seals.
    e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
    a. Disconnect the extension harness connector from the control.
    b. Disconnect the extension harness from the engine harness.
    c. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to the exhaust gas temperature return pin on the extension harness inline connection.
    d. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
    a. Disconnect the extension harness connector from the control.

b. Disconnect the extension harness from the engine harness.

c. Measure the resistance from the exhaust gas temperature 5 VDC supply pin on the extension harness connector to all other pins in the extension harness connector.

d. Measure the resistance from the exhaust gas temperature return pin on the extension harness connector to all other pins in the extension harness connector.

e. Measure the resistance from the exhaust gas temperature signal pin on the extension harness connector to all other pins in the extension harness connector.

f. If all measurements are greater than 100k ohms, then the resistance is correct.

G. Faulty Engine Speed Position Sensor

1. Inspect the engine speed sensor.
2. Disconnect the engine speed/position sensor from the engine and engine harness.
3. Inspect sensor for bent, corroded or loose pins.
4. Inspect the sensor for structural deficiencies.
5. Check the crankshaft speed sensor supply voltage.
6. Disconnect the engine harness connector from the crankshaft speed sensor.
7. Install the speed sensor breakout cable between the sensor and the sensor harness connector.
8. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
9. Check the crankshaft speed sensor signal (sense) voltage.
10. Disconnect the engine harness connector from the camshaft position sensor.
11. Install the speed/position sensor breakout cable between the sensor and the sensor harness connector.
12. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 VDC, then the signal voltage is correct. If not, sensor is faulty.

5.10.22 Fault Code 235 - Low Coolant Level

Low Coolant Level input is active and the threshold response is set to “Shutdown".

A. Low Coolant

1. Stop the engine and allow the engine to cool down.
2. Visually inspect that engine coolant is at the appropriate level through the sight glass or expansion tank.
3. Remove radiator cap and check that coolant is up to the required level.
4. If coolant is below 1 in. (2.54 cm) from the top of the radiator add manufacturer's prescribed coolant.

B. Faulty Sensor Or Wiring.

1. Disconnect the signal leads at the sensor, so the sensor is no longer connected to the control; then reset the control by pressing the Reset button. If event/fault code 197 clears and does not reappear, then replace the low coolant level sensor.

2. If event/fault code 197 reappears, check for a short in the wiring between the low coolant level sensor and the input to the control (at J20-17: Input and J20-5: Ground). A ground input into J20-17 will activate the alarm at the control.

5.10.23 Fault Code 236 - Engine Speed/Position Sensor Circuit

Engine speed/position sensor signal is not detected.

If the generator set stalls after starting, this is not a control issue.

NOTICE
Part number 382275800 - Male Deutsch/AMP/Metri-Pack test lead
Part number 382291700 - Female Deutsch/AMP/Metri-Pack test lead

A. Inaccurate Engine Speed/Position Sensor

1. Check the sensor gap.
   a. Measure the sensor gap.
   b. Refer to the engine manual for appropriate gap size, and adjust as necessary.

B. Faulty Engine Speed Sensor Connections

1. Inspect the engine speed sensor and the harness connector pins.
   a. Disconnect the engine harness connector from the engine speed sensor.
   b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins, or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.

C. Faulty Engine Harness Engine Speed Position Sensor

1. Inspect the engine harness and the extension harness connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent pins, broken pins, pushed-back pins, or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for a short circuit from pin-to-pin.
   a. Disconnect the engine harness connector from the extension harness.
   b. Disconnect the engine harness from the engine speed sensor.
   c. Disconnect the engine harness from all sensors that have a shared return with the engine speed sensor.
   d. Measure the resistance from the engine speed return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   e. Measure the resistance from the engine speed signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

f. If all measurements are greater than 100K ohms, then the resistance is correct.

3. Check for an open circuit.
    a. Disconnect the engine harness connector from the extension harness.
    b. Disconnect the engine harness from the engine speed sensor.
    c. Measure the resistance from the engine speed return pin on the engine harness inline connector to the engine speed return pin at the engine harness sensor connector.
    d. Measure the resistance from the engine speed signal pin on the engine harness inline connector to the engine speed signal pin at the engine harness sensor connector.
    e. If all measurements are less than 10 ohms, then the resistance is correct.

D. Faulty Engine Speed Sensor

1. Inspect the engine speed sensor.
    a. Disconnect the engine speed/position sensor from the engine and engine harness.
    b. Inspect the sensor for bent, corroded, or loose pins.
    c. Inspect the sensor for structural deficiencies.

5.10.24 Fault Code 359 - Fail To Start

Engine has failed to start after the last crank cycle.

A. Faulty Ignition Relay

1. Remove the keyswitch relay. Measure resistance across terminals A1 and A2. If the resistance is infinite or zero, the coil is broken or shorted. Replace relay.
2. Check keyswitch relay signals at J26-13 and J26-15. When normal operation, J26-13 should have B+ and J26-15 should be ground.

B. Incorrect Flywheel Teeth Setting

1. Connect to the control via InPower. Make sure *Teeth Pulses Per Revolution* matches the actual number of flywheel teeth.

C. Incorrect Starter Disconnect Speed

1. Connect to the control via InPower. Make sure Starter Disconnect Speed is set to a reasonable value. Check the engine manual.

D. Faulty Engine Harness Oil Pressure Sensor

1. Inspect the engine harness and the connector pins.
    a. Disconnect the engine harness connector from the extension harness.
    b. Inspect for corroded pins, bent or broken pins, and pushed back or expanded pins.
    c. Inspect for evidence of moisture in or on the connector.
    d. Inspect for missing or damaged connector seals.
    e. Inspect for dirt or debris in or on the connector pin.
2. Check for a short circuit from pin to pin.
    a. Disconnect the engine harness from the extension harness.

b. Disconnect the engine harness connector from the oil pressure sensor.

c. Disconnect the engine harness from all sensors that have a shared supply or return with the oil pressure sensor.

d. Measure the resistance from the oil pressure 5 VDC supply pin on the engine harness inline connector to all other pins in the engine harness inline connector.

e. Measure the resistance from the oil pressure return pin on the engine harness inline connector to all other pins in the engine harness inline connector.

f. Measure the resistance from the oil pressure signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

g. If all measurements are greater than 100k ohms, then the resistance is correct.

3. Check for an open circuit.

   a. Disconnect the engine harness from the extension harness.

   b. Disconnect the engine harness connector from the oil pressure sensor.

   c. Measure the resistance from the oil pressure return pin on the engine harness inline connector to the oil pressure return pin on the engine harness sensor connector.

   d. If the measurement is less than 10 ohms, then the resistance is correct.

5.10.25 Fault Code 415 - Engine Oil Pressure Low (Shutdown)

Engine oil pressure is below the shutdown level and duration parameters set in the ECM or control.

A. Lubricating Oil Level Is Low

1. Check the oil level. Add or drain oil, if necessary.

B. External Leak

1. Inspect the engine and surrounding area for external oil leaks.
2. Tighten the capscrews, pipe plugs, and fittings.
3. Replace gaskets, if necessary.

C. Lubricating Oil Does Not Meet Specifications

1. Verify that the lubricating oil meets the specifications in the engine manual.
2. Verify that alternative oil and additives were not added during the oil's life.
3. Verify the age of the lubricating oil.
4. If necessary, take an oil sample. Refer to oil analysis technique bulletins for instructions on how to take an oil sample.

D. Engine Angularity During Operation Exceeds Specification

1. Verify generator set is level or near level.
2. See engine specification to determine suitable amount of angularity.

E. Coolant Temperature Is Above Specification

1. Using the display or the InPower service tool, note the engine coolant temperature.

2. Compare that coolant temperature against the coolant temperature specification in the engine manual.
3. If the coolant temperature is above the specification, refer to FC146 for above-normal coolant temperature troubleshooting.

F. Lubricating Oil Filter Plumbing Is Not Routed Correctly

1. Inspect the lubricating oil filter plumbing.
2. If the routing is an issue, refer to the lubricating filter plumbing procedure in the engine manual.

G. Main Oil Pressure Regulator Is Faulty

For further information refer to the Engine Service Manual.

H. Lubricating Oil Is Contaminated With Coolant Or Fuel

1. Refer to Lubricating Oil Contaminated symptom tree for proper troubleshooting.

I. Lubricating Oil Suction Or Transfer Tube Is Loose Or Broken

For further information refer to the Engine Service Manual.

J. Incorrect Lubricating Oil Cooler Is Installed

1. Check if the correct lubricating oil cooler part number is installed. Verify against the appropriate parts manual.

K. Lubricating Oil Pump Is Faulty

For further information refer to the Engine Service Manual.

L. Lubricating Oil Cooler Is Plugged

1. Visually inspect the oil cooler for cleanliness.
2. Refer to the engine manual for instructions on how to clean the oil cooler housing.

M. Lubricating Oil Temperature Is Above Specification

1. Using the display or the InPower service tool, note the engine oil temperature.
2. Compare that oil temperature against the oil temperature specification in the engine manual for operating oil temperatures. Refer to the coolant or block heater specification for a non-running engine.
3. If the oil temperature is above specification, refer to FC421 for above-normal coolant temperature troubleshooting.

N. Piston Cooling Nozzles Are Damaged Or Are Not Installed Correctly

For further information refer to the Engine Service Manual.

O. Oil Pressure Sensor Is Inaccurate Or Blocked

1. Connect a mechanical oil pressure gauge of known quality and calibration to the engine at one of the plugs on top of the oil filter head.

2. Connect InPower.
3. While the engine is stopped, compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
4. Proceed only if engine troubleshooting has been completed. Do not attempt to start the engine if there is any doubt about the oil pressure.
5. Start the generator set.
6. Compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
7. Refer to the troubleshooting and repair manual for the specific engine platform for oil pressure ranges.

P. Fault Simulation Is Enabled Or The Threshold Is Set To High

1. Connect to the control with InPower and ensure that the fault simulation for LOP is not enabled.
2. Using the electronic service tool, verify that the fault threshold is **not** within the normal operating range for the oil pressure sensor. Refer to the appropriate base engine manual for the normal operating range specification.

Q. Incorrect Threshold Setting

1. Use the service tool to connect to verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.

5.10.26 Fault Code 421 - Engine Oil Temperature High (Warning)

The control has detected the engine oil temperature has exceeded the warning threshold.

A. High Ambient Temperature

1. Using a thermocouple, verify the air temperature entering the intake louver of the generator set.
2. Reduce loads or recirculation of discharge air to the generator set with an elevated ambient temperature.

B. Radiator Blocked

1. Inspect for dirt, debris or obstructions.
2. Remove blockage or winterfront as applicable.

C. Louvers Are Closed Or Damaged

1. Inspect the louvers for proper operation.
2. Repair or replace the louvers if damaged.
3. Check the louver motor for proper operation.
4. If the louver motor is operational, verify the louver shutterstat is operational.

D. Charge Air Cooler Fins or Radiator Fins are Damaged or Obstructed

1. Inspect for dirt, debris or obstructions.

2. Clean if necessary.

E. Coolant Level Is Below Specification

1. Inspect the engine, cooling system, and surrounding area for external coolant leaks.
2. Repair as required.
3. Verify that the coolant level is correct via the sight glass.
4. Add coolant as necessary.

F. Fan Shroud Is Damaged Or Air Recirculation Baffles Are Damaged

1. Inspect shroud and baffles for damage and clearance.
2. Repair or replace if damaged.

G. Fan Belt Is Broken Or Loose

1. Inspect belt(s) for damage, wear, and proper tension.
2. Inspect pulleys and belt tensioner for damage or wear.
3. Repair or replace if damaged or worn.

H. Fan Drive Or Fan Controls Are Malfunctioning

1. Inspect pulleys and belt tensioner for damage or wear.
2. Repair or replace if damaged or worn.

I. Thermostat Is Faulty

1. Remove thermostat and inspect/test for proper operation.
2. Replace if damaged or malfunctioning.

J. Cooling System Hose Is Collapsed, Restricted Or Leaking

1. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks.
2. Replace if damaged or worn.

K. Intake Manifold Air Temperature Is Above Specification

1. Use a thermocouple to verify manifold air temperature.
2. Repair or replace faulty after cooler components.

L. Water Pump Is Malfunctioning

1. Inspect water pump for proper operation.
2. Replace if damaged or worn.

M. Oil Pressure Sensor Is Inaccurate Or Blocked

1. Connect a mechanical oil pressure gauge of known quality and calibration to the engine at one of the plugs on top of the oil filter head.
2. Connect InPower.

3. While the engine is stopped, compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
4. Proceed only if engine troubleshooting has been completed. Do not attempt to start the engine if there is any doubt about the oil pressure.
5. Start the generator set.
6. Compare the oil pressure reading on the service tool to the reading on the mechanical oil pressure gauge.
7. Refer to the troubleshooting and repair manual for the specific engine platform for oil pressure ranges.

N. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

5.10.27 Fault Code 488 - Intake Manifold Temperature High (Warning)

Engine intake manifold temperature has exceeded the warning level and duration parameters set in the ECM or control.

A. High Ambient Temperature

1. Using a thermocouple, verify the air temperature entering the intake louver of the generator set.
2. Reduce loads or recirculation of discharge air to the generator set with an elevated ambient temperature.

B. Radiator Blocked

1. Inspect for dirt, debris or obstructions.
2. Remove blockage or winterfront as applicable.

C. Louvers Are Closed Or Damaged

1. Inspect the louvers for proper operation.
2. Repair or replace the louvers if damaged.
3. Check the louver motor for proper operation.
4. If the louver motor is operational, verify the louver shutterstat is operational.

D. Charge Air Cooler Fins or Radiator Fins are Damaged or Obstructed

1. Inspect for dirt, debris or obstructions.
2. Clean if necessary.

E. Fan Belt Is Broken Or Loose

1. Inspect belt(s) for damage, wear, and proper tension.

2. Inspect pulleys and belt tensioner for damage or wear.
3. Repair or replace if damaged or worn.

F. Fan Drive Or Fan Controls Are Malfunctioning

1. Inspect pulleys and belt tensioner for damage or wear.
2. Repair or replace if damaged or worn.

G. Inaccurate Coolant Temperature Sensor

1. Using a thermocouple or similar device, measure coolant temperature near sender and compare to coolant temperature displayed.
2. Verify the temperature sender resistance and compare to specifications called out in the engine manual.
3. Verify continuity from temperature sender wire pin to base board pin. Harness resistance should be less than 5 Ohms.
4. Repair or replace faulty components or wiring

H. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

I. Incorrect Threshold Setting

1. Use the service tool to connect to verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.

5.10.28 Fault Code 611 - Engine Hot Shut Down

Engine shutdown hot without a proper cooldown run period.

A. Critical Shutdown Fault

1. A critical shutdown fault (e.g., overspeed) has caused the engine to shut down immediately without allowing the engine to complete the proper cooldown process. Troubleshoot the other shutdown fault(s) that are causing the generator set to shut down.

B. Emergency Shutdown

1. An Emergency Stop command has immediately shutdown the engine, which has bypassed the proper cooldown process for the engine.

C. Incorrect Shutdown of Generator Set

1. The generator set has been shut down without allowing the proper cooldown process for the engine (control switched to OFF manually by user/operator).

5.10.29 Fault Code 1121 - Fail To Disconnect

If the “Fail To Disconnect Enable" parameter is set to enable, and the Genset CB and Utility CB Fail to Open Faults are both active, the generator set control will display event/fault code 1121.

In case of recurrent warnings during start, verify battery voltage and state of health. Replace battery if necessary.

A. Event/Fault Code 1221 is Mapped to a Configurable Output and Event/Fault Code 1453 and Event/Fault Code 2397 are Active

1. Event/fault code 1221 can be mapped to send an external notification through a configurable customer output relay on the base board to an external device that the Genset CB and Utility CB have failed to open. This fault will become active if the “Fail To Disconnect Enable" parameter is set to enable, event/fault code 1221 is mapped to a configurable output, and if event/fault code 1453 and event/fault code 2397 are active. Troubleshoot event/fault code 1453 and event/fault code 2397 to resolve this issue.

   To disable event/fault code 1221 go to **Setup > Paralleling Setup > Power Transfer Control > Fail to Disc En** on the display and set the “Fail To Disconnect Enable" parameter to Disable, then determine which configurable output is set to activate when event/fault code 1221 is active and go to: **Setup > Configurable I/O** on the display and remove the mapping of event/fault code 1221 to that output.

5.10.30 Fault Code 1122 - Delayed Rated To Idle Transition

If the "Rated to Idle Transition Delay" is greater than zero, event/fault code 1122 will become active when the generator set transitions from rated to idle.

A. Event/Fault Code 1122 is Set to Warning or Shutdown and the Generator Set is Transitioning From Rated to Idle Mode.

1. This event/fault code can be mapped to a configurable customer output relay in order to send external notification via the relay on the base board to users so that proper action can be taken in the time given before the generator set transitions to idle. This fault can be disabled by setting the "Rated to Idle Transition Delay" to 0 seconds. To access the setup menu through the Operator Panel, go to **Setup > Genset Setup > Rated to Idle Delay** and set appropriately.

5.10.31 Fault Code 1123 - Shutdown After Battle Short (Shutdown)

A shutdown fault occurred while the Battle Short mode was enabled. Check fault history for faults that may have been bypassed.

5.10.32 Fault Code 1124 - Delayed Shutdown

Provides advance warning of an impending generator set shutdown to loads which cannot handle sudden losses of power.

A. A Shutdown Fault

1. Event/fault code 1124 is activated as a result of another non-critical shutdown fault. Troubleshoot the other non-critical shutdown fault(s) that is(are) causing the generator set to shutdown. This event/fault code was designed to send an external notification through a configurable customer output relay on the base board to loads which cannot handle a sudden loss of power. The generator set base board will send a signal to critical loads and will wait for the amount of time in the “Delayed Shutdown Time" parameter before shutting down the generator set. Go to **Setup > Genset Setup > Delayed shutdown delay** from the operator panel and set appropriately.

5.10.33 Fault Code 1131 - Battle Short Active

Battle Short has been enabled.

A. Battle Short Enabled

1. Disable Battle Short.
    a. The purpose of this fault is to provide a record in the fault history and fault occurrence list that the Battle Short feature is activate. The Battle Short fault becomes active when all of the following are true:
        - The Battle Short parameter is Enabled.
        - One of the configurable inputs on the base board is configured for Battle Short.
        - The configurable input configured for Battle Short becomes Active.

5.10.34 Fault Code 1132 - Controlled Shutdown

A fault set to Shutdown with Cooldown is active and has put the generator set in a controlled shutdown.

A. A Fault Set to Shutdown With Cooldown is Active

1. Event/fault code 1132 is activated by another active event/fault that is set to "Shutdown with Cooldown". Troubleshoot the other shutdown fault(s) that are causing the generator set to shutdown. A controlled shutdown of the system allows first for loads to be transferred or ramped off, and then for a proper cooldown of the generator set to take place before shutting down. Go to **Setup > Genset Setup > Ctrld Shutdown Advance** from the Operator Panel in order to appropriately set the Controlled Shutdown Advanced Notice Delay.

5.10.35 Fault Code 1219 - Utility CB Tripped

The Utility CB has tripped.

A. Overload, Short Circuit, or Ground Fault

1. Check the load of the application, load cables, and the ground fault relay if available. Repair if necessary.

B. Incorrectly Wired or Short Circuit

1. Verify the wiring from the Utility CB to the Utility CB Tripped status input on the base board. The Utility CB Tripped status input is a Normally Open contact at TB10-5 and TB10-1 (B+ Return). Ensure that the connection from the Utility CB to TB10-5 on the base board is not shorted to ground.

C. CB Trip Solenoid is Incorrectly Configured or Faulty

1. Utility CB Trip settings are configured to trip at a low over-current threshold. Check other settings on the Utility CB that might cause it to trip since circuit breakers can have multiple trip settings. Configure the Utility CB Trip Solenoid to trip at adequate trip settings for the application; refer to the CB Service Manual.
2. Faulty Trip solenoid, refer to the CB Service Manual for troubleshooting instructions.

D. Faulty Utility CB

1. Refer to the Utility CB Service Manual.

5.10.36 Fault Code 1223 - Utility Frequency Error

In Power Transfer Control (PTC) Operation, if the “Utility Frequency Sensor Enable" parameter is enabled and the utility frequency exceeds the “Utility Frequency Upper Drop-Out Threshold", or is below the “Utility Frequency Lower Drop-Out Threshold", or is Out of Range Low, for the “Utility Frequency Drop-Out Delay", fault code 1223 will become active.

A. Utility Frequency Drop-out Thresholds are Incorrectly Set

1. This fault will become active when the Utility Frequency goes above or below the drop-out thresholds. Drop-out threshold are dependent of the following parameters:
   - Utility Center Frequency.
   - Utility Frequency Pick-Up Bandwidth.
   - Utility Frequency Drop-Out Bandwidth.

   To Modify the preceding parameters, on the display go to: **Setup > Paralleling Setup > Power Transfer Control > Center Frequency** or **Pick-Up BW** or **Drop-out BW** or **Drop-Out Delay** and set appropriately. Refer to the PTC section for setup information and instructions.
2. To disable this function, set the “Utility Frequency Sensor Enable" parameter to disable. On the display go to: **Setup > Paralleling Setup > Power Transfer Control > Enable** and set appropriately. Refer to the PTC section for more information.

B. The Frequency of the Utility is Not Stable

1. The frequency of the utility is unstable, check with your utility company.

5.10.37 Fault Code 1224 - High Genset Voltage

In Power Transfer Control (PTC) Operation, if the “Genset Overvoltage Sensor Enable" parameter is set to enable, and the generator set voltage goes above the “Genset Overvoltage Drop-Out Threshold", for the “Genset Overvoltage Drop-Out Delay" time, fault code 1224 will become active.

A. Generator Set High AC Voltage Fault

1. If the High AC Voltage fault is active on the display, refer to the troubleshooting procedures for High AC Voltage, fault code 1446.

B. Genset Overvoltage Drop-out Thresholds are Incorrectly Set

1. This fault will become active when the generator set voltage goes above the “Genset Overvoltage Drop-Out Threshold" for the “Genset Overvoltage Drop-Out Delay" time. The genset overvoltage drop-out threshold is dependent of the following parameters:

   - Genset Overvoltage Drop-out percentage.
   - Genset Overvoltage Drop-out Delay.

     To modify the preceding parameters, on the display go to: **Setup > Paralleling Setup > Power Transfer Control > Drop out** or **Drop-Out Delay** and set appropriately. Refer to the PTC section for setup information and instructions.

2. To disable this function, set the “Genset Overvoltage Sensor Enable" parameter to disable. On the display, go to: **Setup > Paralleling Setup > Power Transfer Control > Enable** and set appropriately. Refer to the PTC section for more information.

5.10.38 Fault Code 1225 - Low Genset Voltage

In Power Transfer Control (PTC) Operation, if the generator set voltage drops below the “Genset Undervoltage Drop-Out Threshold", for the “Genset Undervoltage Drop-Out Delay" time, fault code 1225 will become active.

A. Genset Low AC Voltage Fault

1. If the Low AC Voltage fault is active on the display, refer to the troubleshooting procedures for Low AC Voltage, fault code 1447.

B. Genset Undervoltage Drop-out Thresholds are Incorrectly Set

1. This fault will become active when the generator set voltage drops below the “Genset Undervoltage Drop-Out Threshold" for the “Genset Undervoltage Drop-Out Delay" time. The genset Undervoltage drop-out threshold is dependent of the following parameters:

   - Genset Undervoltage Drop-out percentage.
   - Genset Undervoltage Drop-out Delay.

     To modify the preceding parameters, on the display go to: **Setup > Paralleling Setup > Power Transfer Control > Drop out** or **Drop-Out Delay** and set appropriately. Refer to the PTC section for setup information and instructions.

5.10.39 Fault Code 1226 - Genset Frequency Error

In Power Transfer Control (PTC) Operation, if the “Genset Frequency Sensor Enable" parameter is enabled and the generator set frequency exceeds the “Genset Frequency Upper Drop-Out Threshold", or is below the “Genset Frequency Lower Drop-Out Threshold", or is Out of Range Low, for the “Genset Frequency Drop-Out Delay", fault code 1226 will become active.

A. Genset Frequency Drop-out Thresholds are Incorrectly Set

1. This fault will become active when the generator set frequency goes above or below the drop-out thresholds. Drop-out threshold are dependent on the following parameters:

   - Genset Center Frequency.
   - Genset Frequency Pick-Up Bandwidth.
   - Genset Frequency Drop-Out Bandwidth.

To modify the preceding parameters, on the display go to: **Setup > Paralleling Setup > Power Transfer Control > Center Frequency** or **Pick-Up BW** or **Drop-out BW** or **Drop-Out Delay** and set appropriately. Refer to the PTC section for setup information and instructions.

B. The Frequency of the Generator Set is Not Stable

1. If the generator set frequency is not stable or the generator set is hunting/oscillating while it is running, refer to the troubleshooting procedures for fault codes 1448 and 1449.

5.10.40 Fault Code 1244 - Engine Normal Shutdown

A normal shutdown request has been received by the engine and no active shutdown with cooldown fault exists on the PCC (LBNG).

Corrective Actions:

- Check if updates for the ECM calibration are available.
- Connect the ECM to INSITE and check for fault codes.
- Refer to the *Engine Service Manual* to troubleshoot further.

A. The Generator Set Is Going Through A Normal Shutdown

1. The generator set is going through a normal shutdown and there are no active shutdown fault(s) for at least 2 seconds.

5.10.41 Fault Code 1245 - Engine Shutdown Fault

Engine shutdown fault has occurred in the base board, and no other active shutdown faults exist on the PCC.

A. Engine Shutdown Fault

1. Event/fault code 1245 is activated by another active shutdown fault in the base board. Connect to the Ebase board with InPower to determine the actual shutdown fault that is generating event/ fault code 1245; then troubleshoot the shutdown fault(s) (Reference the Engine Service Manual).

5.10.42 Fault Code 1246 - Unknown Engine Fault

An unrecognized engine fault has been received over the datalink.

A. The genset control has received an unknown event/fault code from the Base Board

1. Connect directly to the base board with InPower or the ECM with InSite to determine the actual warning or shutdown fault that is generating event/fault code 1246. Troubleshoot the fault(s) that are causing the genset to display event/fault code 1246 (Reference the Engine Service Manual).

5.10.43 Fault Code 1248 - Engine Warning

An engine warning fault has occurred in the base board, and there are no active warning faults on the PCC.

A. An Engine Warning Fault Is Active

1. Event/fault code 1248 is activated by another active warning fault in the base board. Connect to the base board with InPower or the ECM with Insite to determine the actual warning fault that is generating event/fault code 1248; then troubleshoot the warning fault(s) (Reference the Engine Service Manual).

5.10.44 Fault Code 1311 and 1312 - Customer Input #1 and #2 (Warning or Shutdown)

The nature of the fault is an optional customer selection. Example inputs: Low Fuel Day Tank, Water In Fuel, Ground Fault, Low Starting Hydraulic Pressure, Low Starting Air Pressure, etc.

Each of the fault functions can be programmed (using the InPower service tool), as follows:

- Enable/disable input (Default: enable)
- Status, Warning, or Shutdown (Default: #1-None, #2 and #3-Warning)
- Active closed or open (Default: closed [ground])
- Change the display name using up to 19 characters (Default: #1- Customer Fault 1, #2-Ground Fault, #3-Low Fuel)

A. Disconnect The Signal Lead From TB1 And Reset The Control.

1. CONFIG INPUT 1 - TB1-12
2. CONFIG INPUT 2 - TB1-14
3. If the message goes away, the external wiring has a short circuit. Grounding of either input activates fault.

5.10.45 Fault Code 1312 - Config Input #2 Fault

Configurable input #2 fault is active.

A. Condition for Which Configurable Input #2 is Configured for is Active

1. Check the condition for which "Configurable Input #2" has been configured; ex. if "Configurable Input #2" was configured to become active when the fuel level is low, check the fuel level and add fuel if needed. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to step 2.

B. Configurable Input #2 Active State Selection Parameter is Configured Incorrectly

1. With InPower or through the Operator Panel check the switch input setting (active closed or active open) for Configurable Input #2. Ensure that the switch input setting is correctly set. If “Configurable Input #2 Input Function Pointer" parameter is set to default and if “Configurable Input #2 Active State Selection" parameter is set to “active closed", input 2 (event/fault code 1312) will become active when TB1-14 (input 2) and TB1-15 (ground) are connected (shorted) together.
2. If “Configurable Input #2 Input Function Pointer" parameter is set to default and if “Configurable Input #2 Active State Selection" parameter is set to “active open", input 2 (event/fault code 1312) will become active when there is an open circuit between TB1-14 (input 2) and TB1-15 (ground).

3. To access the input configuration on the operator panel go to **Setup > Configurable I/O > Config Input #2 Menu > Active** and set this parameter appropriately for the application.

C. Incorrectly Wired; or Open Circuit or Short Circuit in the Wiring

1. Check the wiring at TB1-14 (input 2) and TB1-15 (ground) for an open circuit, short circuit, or a miswired condition.

5.10.46 Fault Code 1318 - Low Fuel (Warning or Shutdown)

Logic:

This fault is used when an optional low fuel level sensor is installed. The nature of the fault is an optional customer selection.

The fault function can be programmed (using the InPower service tool), as follows:

- Enable/disable input (Default: enable)
- Status, Warning, or Shutdown (Default: #1-None, #2 and #3-Warning)
- Active closed or open (Default: closed [ground])
- Change the display name using up to 19 characters (Default: #1- Customer Fault 1, #2-Ground Fault, #3-Low Fuel)

A. Low Fuel level

1. Add fuel

B. No Actual Fault, External Wiring Problem

1. Disconnect the signal lead from TB1 and reset the control.
   a. CONFIG INPUT 1 - TB1-14
2. If the message goes away, the external wiring has a short circuit. Grounding of either input activates fault.

5.10.47 Fault Code 1322 - kW Setpoint OOR Hi

If the “KW Load Setpoint OOR Check Enable" is enabled and the “KW Load Setpoint OOR High Limit" has been exceeded for the time that is registered in the “KW Load Setpoint OOR Time" the generator set control will display event/fault code 1322.

A. Wiring Issue kW Setpoint

1. Ensure that the KW Load Setpoint analog input (configurable analog Input #1) is not shorted high or disconnected. On the control, the KW Load Setpoint analog input is located at:

   TB9 – 1 Sense

   TB9 – 2 Return

B. Load Govern KW Setpoint RC Enable is Incorrectly Set

1. The "Load Govern KW Setpoint RC Enable" limits the KW Load Govern voltage input from 0 - 5 volts, when set to "Enable" (at TB9-1 and TB9-2); if the voltage input into the KW Load Govern input exceeds 5 VDC, the generator set control locks the KW output to zero since the control logic states that the voltage input is out of range, and displays event/fault code 1322. When the "Load Govern KW Setpoint RC Enable" parameter is set to "Disable" a greater input voltage than 5 VDC is recognized; a 24 VDC input is treated as a 5 VDC input. To change the "Load Govern KW Setpoint RC Enable" parameter appropriately for the application, on the display go to: **Setup > Paralleling Setup > Basic > Load Govern KW Setpoint RC Enable** and set appropriately.

5.10.48 Fault Code 1323 - kW Setpoint OOR Lo

If the “KW Load Setpoint OOR Check Enable" is enabled and the KW Load Setpoint analog input is below the “KW Load Setpoint OOR Low Limit" for the time that is registered in the “KW Load Setpoint OOR Time" the generator set control will display event/fault code 1323.

A. Wiring Issue kW Setpoint

1. Ensure that the KW Load Setpoint analog input (configurable analog Input #1) is not shorted high or disconnected. On the control, the KW Load Setpoint analog input is located at:

   TB9 – 1 Sense

   TB9 – 2 Return

B. KW Load Setpoint Input Voltage is too Low

1. If the voltage input at TB9-1 and TB9-2 is below the “KW Load Setpoint OOR Low Limit", the control will register that input as shorted low. Ensure that the voltage input at TB9-1 and TB9-2 is greater than “KW Load Setpoint OOR Low Limit". To verify the voltage value of the “KW Load Setpoint OOR Low Limit" check the parameter section.

5.10.49 Fault Code 1324 - kVAR Setpoint OOR Hi

If the “KVAR Load Setpoint OOR Check Enable" is enabled and the KVAR Load Setpoint analog input exceeds the “KVAR Load Setpoint OOR High Limit" parameter for the time that is registered in the “KVAR Load Setpoint OOR Time"; the generator set control will display event/fault code 1324.

A. Wiring Issue KVAR

1. Ensure that the KVAR Load Setpoint analog input (configurable analog Input #2) is not shorted high or disconnected. On the control, the voltage bias analog input is located at:

   TB9 – 3 Sense

   TB9 – 2 Return

B. Load Govern KVAR Setpoint RC Enable is Incorrectly Set

1. The "Load Govern KVAR Setpoint RC Enable" limits the KVAR Load Govern voltage input from 0 - 5 volts, when set to "Enable" (at TB9-3 and TB9-2); if the voltage input into the KVAR Load Govern input exceeds 5 VDC, the generator set control locks the KVAR output to zero since the control logic states that the voltage input is out of range, and displays event/fault code 1324. When the "Load Govern KVAR Setpoint RC Enable" parameter is set to "Disable" a greater input voltage than 5 VDC is recognized; a 24 VDC input is treated as a 5 VDC input. To change the "Load Govern KVAR Setpoint RC Enable" parameter appropriately for the application, on the display go to: **Setup > Paralleling Setup > Basic > Load Govern KVAR Setpoint RC Enable** and set appropriately.

5.10.50 Fault Code 1325 - kVAR Setpoint OOR Lo

If the “KVAR Load Setpoint OOR Check Enable" is enabled and the KVAR Load Setpoint analog input is below the “KVAR Load Setpoint OOR Low Limit" for the time that is registered in the “KVAR Load Setpoint OOR Time", the generator set control will display event/fault code 1325.

A. Wiring Issue KVAR

1. Ensure that the KVAR Load Setpoint analog input (configurable analog Input #2) is not shorted high or disconnected. On the control, the voltage bias analog input is located at:

   TB9 – 3 Sense

   TB9 – 2 Return

B. KVAR Load Setpoint Input Voltage Is Too Low

1. If the voltage input at TB9-3 and TB9-2 is below the “KVAR Load Setpoint OOR Low Limit", the control will register that input as shorted low. Ensure that the voltage input at TB9-3 and TB9-2 is greater than “KVAR Load Setpoint OOR Low Limit". To verify the voltage value of the “KVAR Load Setpoint OOR Low Limit" check the parameter section.

5.10.51 Fault Code 1328 - Genset CB Tripped

The Genset CB has tripped.

A. Correct Any Active Genset Faults

1. Check for active generator set faults on the display (especially Overload, Short Circuit, or Ground Faults); then correct these faults.

B. Incorrectly Wired or Short Circuit

1. Verify the wiring from the Genset CB to the Genset CB Tripped status input on the base board. The Genset CB Tripped status input is a Normally Open contact at TB10-10 and TB10-2 (B+ Return). Ensure that the connection from the Genset CB to TB10-10 on the base board is not shorted to ground.

C. CB Trip Solenoid is Incorrectly Configured or Faulty

1. Genset CB Trip settings are configured to trip at a low over-current threshold. Check other settings on the Genset CB that might cause it to trip since circuit breakers can have multiple trip settings. Configure the Genset CB Trip Solenoid to trip at adequate trip settings for the application; refer to the CB Service Manual.
2. Faulty Trip solenoid, refer to the CB Service Manual for troubleshooting instructions.

D. Faulty Genset CB

1. Refer to the appropriate circuit breaker service manual.

5.10.52 Fault Code 1416 - Fail To Shutdown

To provide a record in the fault history that generator set shutdown faults were bypassed while the control was in Battle Short mode.

A. A Shutdown Fault was Bypassed While the Battle Short Feature was Enabled on the Control

1. Event/fault code 1416 is activated because of an active “Shutdown fault" while the control is operating in battle-short mode. Troubleshoot the other shutdown fault(s) that are causing the generator set to display event/fault code 1416.

5.10.53 Fault Code 1417 - Power Down Failure

The PCC has failed to go to sleep.

A. Faulty Base Board

1. Remove power (B+) from the PCC for 5−10 seconds and reconnect B+ to the PCC. If the PCC fails to go to sleep after power is cycled from the PCC and the PCC shows event/fault code 1417 again, replace the base board.

5.10.54 Fault Code 1433 - Local E-Stop

The Local Emergency Stop has been activated.

A. The Local Emergency Stop Button Has Been Activated

1. Pull the Local Emergency stop button out.
2. Press the Off button.
3. Press the Reset button.
4. Select Manual or Auto as required.

B. Faulty Connection Or Faulty Emergency Stop Switch

1. Check the Emergency Stop button, and verify that it is working properly. The Emergency Stop button is a closed relay when it is pulled out (not active), and open relay when depressed (active).
2. Verify that the connection/wiring from the Local Emergency Stop switch to the control for an open circuit condition. A ground connection to the Local E−Stop control input (J25 – 2 Input; J25 – 6 Ground) disables the emergency stop alarm. An open circuit should activate the Emergency stop alarm.

   J25 – 2 Input

   J25 – 6 Ground

5.10.55 Fault Code 1434 - Remote E-Stop

The Remote Emergency Stop has been activated.

A. The Remote Emergency Stop Button Has Been Activated

1. Reset the Remote Emergency Stop:
   a. Pull the Remote Emergency stop button out.
   b. Press the Off button.
   c. Press the Reset button.
   d. Select Manual or Auto as required.
2. If the Remote Emergency Stop is not used:
   a. Install a jumper between the following:

      TB1 – 16 Input

      TB1 – 15 Ground
   b. Reset the Remote Emergency Stop:
      i. Pull the Remote Emergency stop button out.
      ii. Press the Off button.
      iii. Press the Reset button.
      iv. Select Manual or Auto as required.

B. Faulty Connection Or Faulty Emergency Stop Switch

1. Check the Emergency Stop button, and verify that it is working properly. The Emergency Stop button is a closed relay when it is pulled out (not active), and open relay when depressed (active).
2. Verify that the connection/wiring from the Remote Emergency Stop switch to the PCC for an open circuit condition. A ground connection to the Remote E−Stop control input (TB1 – 16 Input; TB1 – 15 Ground) disables the emergency stop alarm. An open circuit should activate the Emergency stop alarm.

   TB1 – 16 Input

   TB1 – 15 Ground

5.10.56 Fault Code 1435 - Low Coolant Temperature

Engine coolant temperature is below the low coolant temperature warning threshold.

A. Threshold Is Set Too High

1. On the operator panel, access the LCT Warning Threshold parameter by navigating to **Adjustments > Engine Protection > LCT Warning Threshold.** Verify that the LCT Warning Threshold parameter is set to an appropriate threshold.

B. Coolant Heater(s) Are Not Operating Properly

1. Ensure that the coolant heater(s) are connected properly to a working power supply:
   - Check for open circuits in the wiring.
   - Ensure that the power supply of the coolant heater is working properly.

2. Measure the temperature of the coolant heater(s) using a proper temperature measuring device. If the ambient temperature is above 4.5 °C (40 °F), the measured temperature of the coolant heater(s) should be above 32 °C (90 °F).
   - If the temperature of the coolant heater(s) is close to the ambient temperature, replace the coolant heater(s).
   - If the ambient temperature is very low, do not replace the coolant heaters, go to "Thermostat Not Operating Properly".

C. Low Ambient Temperature

1. If the coolant heaters are working properly and the radiator has enough coolant, but the ambient temperature around the generator set is less than 3.5 °C (40 °F), the coolant heaters might not have the capability to keep the coolant temperature above 21 °C (70 °F). This could be an application issue and will need to be further investigated.

D. Thermostat Not Operating Properly

1. Check the operation of the thermostat.

5.10.57 Fault Code 1438 - Fail to Crank (Shutdown)

The engine failed to crank after the generator control received a start signal.

A. Dead or Weak Battery

1. Verify battery voltage is at least 12 VDC (24 VDC where applicable).
2. Charge or replace the battery as necessary.

B. Blown 20Amp Supply Fuse

1. Verify the switched B+ supply fuse is in place and functional.
2. Replace fuse as necessary.

C. Failed Starter

1. Press the Reset/Fault Acknowledge button on the display.
2. Attempt to start the generator and test for B+ at the starter supply lug.
3. If B+ is present at the starter supply lug, the starter could be defective. Test the starter according to the appropriate engine service manual and replace if faulty.
4. If B+ is not present at the starter, check the emergency stop switch and switch connections.

D. Failed Starter Solenoid

1. Press the Reset/Fault Acknowledge button on the display.
2. Check wiring for continuity between terminal 87 on the starter relay and start solenoid SW terminal. Resistance should be less than 5 Ohms.
3. Attempt to start the generator and test for B+ at SW terminal of the starter solenoid.
4. Check wiring for continuity between the solenoid COM terminal and B+ lug of the battery. Resistance should be less than 5 Ohms.
5. Attempt to start the generator and test for B+ at the solenoid output lug.
6. If B+ is not present, the starter solenoid is defective.

E. Failed Starter Relay

1. Check wiring for continuity between terminal 86 on the starter relay and J20-13 control board terminal. Resistance should be less than 5 Ohms.
2. Check wiring for continuity between terminal 85 on the starter relay and J20-15 control board terminal. Resistance should be less than 5 Ohms.
3. Check for B+ at terminal 30 on the starter relay. If voltage is not present, verify 20 Amp fuse is in place and functional.
4. Attempt to start the generator and test for B+ at terminal 86 of the starter relay.
5. Check wiring for continuity between terminal 85 of the starter relay and ground. Resistance should be less than 5 Ohms.
6. Attempt to start the generator and test for B+ at terminal 87 of starter relay.
7. If B+ is not present, the starter relay is defective.

F. Engine Or Rotor Is Locked Or Binding

1. Verify that the generator can rotate freely by barring the engine over by hand. If generator cannot be turned over, identify the source of bind and repair as necessary.

G. Failed Emergency Stop Switch Or Wiring

1. Push emergency stop button in, remove the configurable leads from TB1–15 and TB1–16 and check for continuity between these two leads.
2. If the circuit is open, isolate to the emergency stop switch and wiring.
3. Push emergency stop button in and remove P25 from the base board. Check for continuity between J25–2 and J25–6.
4. Repair or replace the emergency stop switch or the wiring as necessary.

5.10.58 Fault Code 1439 - Low Day Tank Fuel

Indicates day tank fuel supply is running low.

A. Fuel Sender Incorrectly Wired

1. Check the wiring for improper wiring, a short or open circuit from the fuel sensor to the discrete configurable input on the base board that was configured for the “Low Day Tank Fuel Level". If a short or open circuit or improper wiring is found, correct the wiring.

B. Faulty Fuel Sender

1. Measure the resistance of the fuel sender at the day tank. If the sender is reading incorrectly (Shorted or Open Circuit), replace the fuel sender.

C. The Configurable Input Active State Selection Parameter is Configured Incorrectly

1. With InPower or through the operator panel, check the switch input setting (active closed or active open) for the configurable input that was configured to “Low Fuel in Day Tank Switch". Ensure that the switch input setting is correctly set. If the “Configurable Input Function Pointer" parameter is set to “Low Fuel in Day Tank Switch" and the “Configurable Input Active State Selection" parameter is set to “active closed", event/fault code 1439 will become active when the configurable input that was configured to “Low Fuel in Day Tank Switch" is connected to ground.

   If the “Configurable Input Function Pointer" parameter is set to “Low Fuel in Day Tank Switch" and the “Configurable Input Active State Selection" parameter is set to “active open", event/fault code 1439 will become active when the configurable input that was configured to “Low Fuel in Day Tank Switch" is an open circuit.

   To access the input configuration on the operator panel go to **Setup > Configurable I/O >** and set the “Configurable Input Active State Selection" parameter appropriately for the configurable input that was configured to “Low Fuel in Day Tank Switch".

5.10.59 Fault Code 1441 - Low Fuel Level

The "Fuel level % (AUX 101)" input has gone below the "Low Fuel Level Threshold (AUX 101)" setting for the time in the "Low Fuel Level Time (AUX 101)" setting.

A. Fuel Sender Incorrectly Wired

1. Check the wiring of the fuel sensor.
   a. Ensure that the sender is correctly wired to the base board. Check the wiring for a short circuit from the fuel sensor to the input on the base board that is configured for the “Fuel Level". If a short circuit is found, correct the wiring.

B. Faulty Fuel Sender

1. Measure the resistance between the fuel level signal pin and the fuel level return pin. The resistance should be between 600 Ohms to 2500 Ohms when the tank is full. Replace the sender if the resistance value is below the recommended threshold when the fuel tank is full.

C. The Low Fuel Set/Clear Time Parameter is Configured Incorrectly

1. Check the low fuel level setup parameter. To access the input configuration on the operator panel go to **Setup > Genset Setup** and set the "Low Fuel Set/Clear Time" parameter appropriately for the application.

5.10.60 Fault Code 1444 - kW Overload

The "Overload Threshold" has been exceeded for the time that is registered in the "Overload Set Time" parameter.

A. The Overload Threshold Parameter is Set Too Low

1. To access the input configuration on the operator panel go to **Setup > Genset Setup** and set the "Overload Threshold" parameter appropriately for the application. Refer to the parameter section to see the default value for Overload (Setting the overload threshold too high can cause damage to the alternator).

B. Short In the Load or Load Cables

1. Check the load and load cables. Repair if necessary.

C. Incorrect CT Ratio, CTs, or CT Connections

1. Check the CT Ratio, CTs, and CT connections, reference event/fault code 2814.

D. Incorrect PT Ratio, PTs, or PT Connections

1. Check the PT Ratio, PTs, and PT connections, reference event/fault code 2816

5.10.61 Fault Code 1445 - Short Circuit

The generator output current has exceeded 175% of rated current.

NOTICE
This fault remains active and cannot be reset until the Alternator Overheat Integral time has expired (which takes up to five minutes). The Alternator Overheat Integral time allows the alternator to cool down before allowing a restart.

A. Short In the Load or Load Cables

1. Check the load and load cables. Repair if necessary.

B. Faulty CTs, Incorrect CT Ratio, CTs, CT Connections

1. Verify the CT connections are correct from the CTs to the input of the base board.
2. Ensure the control is set up for the correct CT ratio. Reference event/fault code 2814 for CT ratio troubleshooting information.
3. Check the current going into the CT input on the control board (use a current probe to check the secondary output of the CT). This should be the value that the control secondary is calibrated with. (e.g. If the control is calibrated with a CT Ratio of 1000:5, the current input into the base board should not be more than 5 A.)
4. If previous steps check out ok, replace the base board.

5.10.62 Fault Code 1446 - High AC Voltage

One or more of the phase voltages has exceeded the high AC voltage threshold.

A. Fault Simulation is Enabled

Connect with InPower and ensure that the fault simulation for High AC Voltage is not enabled. If InPower is not available, cycle power to the control:

1. Depress the Emergency Stop button and wait 30 seconds.
2. Disconnect/disable the battery charger.
3. Disconnect the battery (disconnect negative first).
4. Leave the controller without power for 1 minute.
5. Reconnect the battery, enable the battery charger, pullout the E-Stop button, and reset the control (in this order).

B. The High AC Voltage Trip Parameter is Incorrectly Set For the Application

1. Ensure that the High AC voltage parameter is set correctly for the application.

   If the control is set up as “Inverse time", it will be more sensitive to voltage spikes and will trip more rapidly; “Inverse time" follows the “Instantaneous High AC Voltage Threshold".

   If the control is set to “Fixed Time", it will allow a greater time delay until shutdown when voltage overshoots; when trying to start a large motor, the “Fixed time" setting is recommended. This parameter works with the “High AC Voltage Delay" parameter.

   To access the configuration menu on the operator panel go to **Adjustment > Alternator protection > Voltage > High AC Voltage Threshold** and set the “High AC Voltage Trip" parameter appropriately for the application.

C. The High AC Voltage Threshold is Set Too Low for the Application

1. To access the High AC Voltage configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > High AC Voltage Threshold** and set the “High AC Voltage Threshold" parameter appropriately for the application. Refer to the parameter list to see the default value for High AC Voltage.

D. Faulty PTs, Incorrect PT Ratio, PT Connections

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

1. Ensure that the control is set up with the correct PT ratio (primary vs. secondary). Reference event/fault code 2816 for troubleshooting information on the PT ratio. To access the PT Ratio configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > PT Primary or PT Sec** and set the PT ratio appropriately for the application.
2. With a calibrated voltage meter, measure the voltage output of the PT. The output of the PT should match the ratio of the PT; ex. Outputs: L1=120, L2=120, L3=120. If the outputs of the PT are incorrect, replace the PT once the generator set has been properly grounded by a qualified electrician.

E. Faulty AVR

1. For alternators that do not include an AVR, go to step 3.
2. Measure the output of the AVR at J17-1 and J17-2. The output should be at 9-12 VDC when the generator set is operating at “No Load". If the voltage output of J17-1 and J17-2 is constantly high, then the AVR portion of the base board is faulty. Replace the base board.
3. Using a True RMS meter, measure the PWM at J19-2 (AVR PWM +) and J19-9 (AVR PWM -) while turning the generator set “ON". This is a 2.5 VDC max output from the base board to the AUX 103 AVR; if the voltage at J19-2 and J19-9 is continuously 2.0-2.5 VDC, without any change, then replace the base board.
4. Measure the output of the AUX 103 AVR at J17-1 and J17-2, the output should be at 9-12 VDC when the generator set is operating at “No Load", if the voltage output of J17-1 & J17-2 is constantly high, then the AUX 103 AVR is faulty replace the AUX 103 AVR.

F. Faulty PMG

1. Start the generator set and run at rated speed. Measure the voltages at the AVR terminals P2 (J18-1), P3 (J18-2), and P4 (J18-3). These should be balanced and within the following ranges:

   50Hz generators - 170-180 Volts

   60Hz generators - 200-216 Volts

2. Should the voltages be unbalanced, stop the generator set, remove the PMG sheet metal cover from the non drive end bracket and disconnect the multi-pin plug in the PMG output leads. Check leads P2, P3, and P4 for continuity. Check the PMG stator resistances between output leads. These should be balanced and within +/-10% of 2.3 Ohms. If resistances are unbalanced and/or incorrect the PMG stator must be replaced. If the voltages are balanced but low and the PMG stator winding resistances are correct the PMG rotor must be replaced.

G. Governor Preload Offset Percentage Too High

If this fault code occurs during startup,

1. Connect with InPower.
2. Check the governor preload offset percentage. The higher the percentage, the larger the overshoot. Lower the governor preload offset.

5.10.63 Fault Code 1447 - Low AC Voltage (Shutdown)

One or more of the phase voltages has dropped to 85% of nominal for more than 10 seconds.

A. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

B. Incorrect Threshold Setting Or AVR Settings

1. Check threshold settings.
2. Connect InPower.
3. Verify that fault threshold is within the normal operating range for low AC voltage.
4. Verify AVR settings. Compare gains, settings, and calibration factors against default calibrations.
5. Adjust or recalibrate as necessary

C. Overload

1. Check for overload.
2. Check that load is within proper operating range.
3. Check inrush current.
4. Check for current spikes.
5. Check for motor starts.
6. Check operation by disconnecting the load and restarting the unit.
7. Correct any overload.

D. Improper Connections At Generator Output Terminals

1. Check connections.
2. Compare connections in generator to wiring schematic.
3. Correct according to the appropriate schematic as needed.

E. The Voltage Sense Or Setup Wiring Connection Could Be Incorrect

1. Verify that the voltage sensing inputs J22-1, J22-2, J22-3, and J22-4 are connected to L1, L2, L3, and L4 respectively.
2. Verify that excitation inputs J18–1 and J18–2 are connected to the correct generator PMG terminals.

F. Damaged Voltage Regulator

1. Bring the generator to idle.
2. Connect InPower.
3. Using InPower, verify that the AC voltage output is greater than residual.
4. If the AC voltage output is residual, then the regulator is operating correctly.
5. Inspect the voltage regulator and the generator control harness connector pins.
6. Turn off the generator.
7. Disconnect the generator control harness from the voltage regulator.
8. Visually inspect for corroded pins, bent or broken pins, pushed back or expanded pins.

G. Rotating Rectifier Assembly (Diodes CR1 through CR6) is Faulty

Check each diode. See the alternator service manual.

5.10.64 Fault Code 1448 - Underfrequency

The frequency has dropped below the “Underfrequency Threshold" for the time set in the “Underfrequency Delay" parameter.

A. Fault Simulation is Enabled

1. Connect with InPower and ensure that the Fault simulation for Low Frequency is not enabled. If InPower is not available, cycle power to the control:
   a. Depress the Emergency Stop button and wait 30 seconds.
   b. Disconnect/disable the battery charger.
   c. Disconnect the battery (disconnect negative first).
   d. Leave the controller without power for 1 minute.
   e. Reconnect the battery, enable the battery charger, pullout the E-Stop button, and reset the control (in this order).

B. Underfrequency Threshold is Set Too High

1. To access the Underfrequency configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > Underfrequency Threshold** and set the “Underfrequency Threshold" Parameter appropriately for the application. Refer to the parameter list to see the default value for Underfrequency.

C. Overload

1. Ensure that the load on the generator set does not exceed the Genset KW Rating. If the generator set is producing correct frequency with no load, but shutting down on underfrequency when the generator set picks up certain loads, the underfrequency shutdowns are being cause by the load. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imagining Equipment, Fire Pumps and certain types of lighting have a considerable and different influence on a generator and might require starting these loads when there is a minimum load on the generator set. Revisit the generator set sizing process to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system (reference the T-030 manual).

5.10.65 Fault Code 1449 - Overfrequency

Frequency has gone above the "Overfrequency Threshold" for the time that is registered in the "Overfrequency Delay" parameter.

A. Fault Simulation is Enabled

1. Connect with InPower and ensure that the Fault simulation for Overfrequency Enable is not enabled. If InPower is not available, cycle power to the control:
   a. Depress the Emergency Stop button and wait 30 seconds.
   b. Disconnect/disable the battery charger.
   c. Disconnect the battery (disconnect negative first).
   d. Leave the controller without power for 1 minute.
   e. Reconnect the battery, enable the battery charger, pullout the E-Stop button, and reset the control (in this order).

B. Overfrequency Threshold is Set Too Low

1. To access the Overfrequency configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > Overfrequency Threshold** and set the "Overfrequency Threshold" Parameter appropriately for the application. Refer to the parameter list to see the default value for Overfrequency.

5.10.66 Fault Code 1451 - Genset/Bus V Mismatch

Five seconds after the Genset circuit breaker (CB) closes, the base board continuously verifies whether the generator set and bus voltages are within 5% of each other; if the difference between the generator set and bus voltage is greater than 5%, event/fault code 1451 becomes active.

A. The Generator Set and Bus Voltages Are Not Properly Set Up or Calibrated

1. Calibrate the generator set and bus voltage (all phases) in order to improve the voltage match performance, as well as the metering accuracy. Refer to the calibration section.

2. If the voltage is greater than 600 VAC, ensure that the PT ratio is correctly set. To change the Utility PT ratio parameter appropriately for the application, go to: **Setup > Paralleling Setup > Power Transfer Control > PT Primary or PT Secondary** and set appropriately. To change the Genset PT ratio parameter appropriately for the application, go to: **Setup > OEM Setup > OEM Alt Setup > PT Primary or PT Secondary** and set appropriately.

5.10.67 Fault Code 1452 - Genset CB Fail To Close

Genset circuit breaker (CB) has failed to close for the time that is registered in the “Gen CB Fail to Close Time Delay" parameter.

A. Incorrectly Wired

1. The base board is sending the Genset CB a close command, but the Genset CB Position Status remains open. Correct the wiring from the CB Close Control output on the base board at TB5-1 and TB5-2 to the Genset breaker; check for an open circuit at the circuit breaker. The Genset CB Close control output is a NO Relay at TB5-1 and TB5-2 (Relay Common) on the base board. When the relay on the base board is closed, the Genset Breaker should be closed. The output of TB5-1 and TB5-2 should match the status of the Genset CB Close command; go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Genset Breaker Position Contacts** and ensure that the status of the CB close position command at the display matches the output.
2. Verify the wiring of the CB position status from the Genset breaker to the base board. The CB position sensing can be set up as single or dual sensing in the base board; check the display if the base board is setup as single or dual sensing. To access the CB position sensing, go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Genset Breaker Position Contacts**
   - If the CB position sensing is set up as single, verify the connection at CB A (NO) status at TB10-7 and the Return at TB10-2.
   - If the CB position sensing is set up as dual, verify the connection at CB A (NO) status at TB10-7 and the Return at TB10-2 and also verify the connection at CB B (NC) status at TB10-8 and TB10-2 (Return). The input status at CB A (NO) and CB B (NC) should be opposite; one input will be open while the other is closed, if they are the same check the wiring between the Genset breaker and the CB status input on the base board.

     Ensure that the connections on the base board are correctly connected and that a short and/or open circuit does not exist. The physical connection to the base board should match the status of the CB position; go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Genset Breaker Position Contacts** and ensure that the status of the CB position matches the connection.

B. Faulty Genset CB

1. Refer to the appropriate circuit breaker service manual.

5.10.68 Fault Code 1453 - Genset CB Fail To Open

Genset circuit breaker (CB) has failed to open for the time that is registered in the “Gen CB Fail to Open Time Delay" parameter.

A. Incorrectly Wired

1. The base board is sending the Genset CB an open command, but the Genset CB Position Status remains closed. Correct the wiring from the CB Open Control output on the base board at TB5-5 and TB5-4 to the Genset breaker; check for a short circuit. The Genset CB Open control output is a NC Relay at TB5-5 and TB5-4 (Relay Common) on the base board. When the relay is closed the Genset Breaker is closed. The output of TB5-4 and TB5-5 should match the status of the Genset CB Open position command; go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Genset Breaker Position Contacts**, and ensure that the status of the CB Open position command at the display matches the output.
2. Verify the wiring of the CB position status from the Genset breaker to the base board. The CB position sensing can be set up as single or dual sensing in the base board; check the display if the base board is setup as single or dual sensing. To access the CB position sensing, go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Genset Breaker Position Contacts**
   - If the CB position sensing is set up as single, verify the connection at CB A (NO) status at TB10-7 and the Return at TB10-2.
   - If the CB position sensing is set up as dual, verify the connection at CB A (NO) status at TB10-7 and the Return at TB10-2 and also verify the connection at CB B (NC) status at TB10-8 and TB10-2 (Return). The input status at CB A (NO) and CB B (NC) should be opposite; one input will be open while the other is closed, if they are the same check the wiring between the Genset breaker and the CB status input on the base board.

     Ensure that the connections on the base board are correctly connected and that a short and/or open circuit does not exist. The physical connection to the base board should match the status of the CB position; go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Genset Breaker Position Contacts**, and ensure that the status of the CB position matches the connection

B. Faulty Genset CB

1. Refer to the appropriate circuit breaker service manual.

5.10.69 Fault Code 1454 - Genset CB Pos Error

A mismatch in the generator set position status exists.

A. Mismatch In The Genset Position Sensing

1. Verify the wiring of the CB position status from the generator set breaker to the base board. The CB position sensing can be set up as single or dual sensing in the base board; check the display if the base board is setup as single or dual sensing. To access the CB position sensing, go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Genset Breaker Position Contacts**
2. When the Genset Breaker Position contact is set to Single, the base board monitors current going through the Genset CB (Amps going through the CB means it is closed) and CB A position status to determine the position of the Genset CB. If there is a mismatch between the current-based breaker position and CB A position sensing, fault code 1454 will occur. Verify the connection at CB A (NO) status at TB10-7 and the Return at TB10-2, and ensure that an open/short circuit does not exist.

3. If the CB position sensing is set up as dual, verify the connection at CB A (NO) status at TB10-7 and the Return at TB10-2 and also verify the connection at CB B (NC) status at TB10-8 and TB10-2 (Return). The input status at CB A (NO) and CB B (NC) should be opposite; one input will be open while the other is closed, if they are the same, check the wiring between the Genset breaker and the CB status input on the base board. Ensure that the connections on the base board are correctly connected and that a short and/or open circuit does not exist. The physical connection to the base board should match the status of the CB position; go to: **Paralleling Status > Paralleling Status-Iso Bus Sc 1 > Genset CB Pos > Genset CB Position Status**, and ensure that the status of the CB position matches the connection.

B. Faulty Genset CB

1. Refer to the appropriate circuit breaker service manual.

5.10.70 Fault Code 1455 - Utility CB Pos Error

A mismatch in the Utility position status exists.

A. Utility Single Mode Verify Switch is Inactive

1. Event/fault code 1455 will become active, if the generator set is set up to operate in the following generator set application types; Utility Single, Utility Multiple, or PTC, and the Utility Single Mode Verify Switch is not active, The base board will not close the Utility breaker until the Utility Single Mode Verify Switch input is activated. This procedure is to ensure that the whole system has been rechecked before allowing the base board to close the Utility Breaker. To activate the Utility Single Mode Verify Switch, make a connection between TB10-12 (Single Mode Verify Input) and TB10-16 (Return); then press the fault reset button on the display to clear the fault.

B. Mismatch In The Utility Position Sensing

1. Verify the wiring of the CB position status from the Utility breaker to the base board. The CB position sensing can be set up as single or dual sensing in the base board; check the display if the base board is setup as single or dual sensing. To access the CB position sensing, go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Utility Breaker Position Contacts**.
2. When the Utility Breaker Position contact is set to Single, the base board monitors current going through the Utility CB (Amps going through the CB means it is closed) and CB A position status to determine the position of the Utility CB. If there is a mismatch between the current-based breaker position and CB A position sensing, fault code 1455 will occur. Verify the connection at CB A (NO) status at TB10-3 and the Return at TB10-1, and ensure that an open/short circuit does not exist.
3. If the CB position sensing is set up as dual, verify the connection at CB A (NO) status at TB10-3 and the Return at TB10-1 and also verify the connection at CB B (NC) status at TB10-4 and TB10-1 (Return). The input status at CB A (NO) and CB B (NC) should be opposite; one input will be open while the other is closed, if they are the same check the wiring between the Utility breaker and the CB status input on the base board. Ensure that the connections on the base board are correctly connected and that a short and/or open circuit does not exist. The physical connection to the base board should match the status of the CB position; go to: **Paralleling Status > Paralleling Status-PTC Sc 1 > Util CB Pos > Utility CB Position Status**, and ensure that the status of the CB position matches the connection.

C. Faulty Utility CB

1. Refer to the Utility CB Service Manual.

5.10.71 Fault Code 1456 - Bus Out Of Sync Range

The Synchronizer cannot be enabled because the Bus Voltage and/or Frequency are not within 60 – 110% of nominal.

A. System Bus Voltage Cables Are Incorrectly Wired or Open Circuit To The Paralleling Breaker

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

1. The system bus has lost a phase, using a phase rotation meter or a synchronizing light; verify that the phase rotation of the system bus at the paralleling breaker is correct; in synchronization with the generator set phase rotation. For proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation check shows that a phase is missing, check for blown fuses, and an open circuit at the system bus voltage cables connected to the paralleling breaker.

B. System Bus Voltage Sensing Connections Are Incorrectly Wired At The Base Board

1. If the nominal voltage is 600 VAC or lower, ensure that the voltage sensing connections are correct.
   - Measure the phase rotation and voltage input into the base board from the System bus at: L1, TB7-1; L2, TB7-2; and L3, TB7-3. The voltage should match nominal voltage, and the phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring.
2. If the nominal voltage is over 600 VAC, check the voltage sensing connections from the base board to the PT and the PT to the System bus.
   - Measure the phase rotation and voltage input into the base board from the PT (Potential Transformer) at: L1, TB7-1; L2, TB7-2; and L3, TB7-3. The voltage should match nominal voltage, and the phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring from the base board to the PT.
   - Measure the phase rotation and voltage input into the TB8 - 5 and TB8 – 1

C. Faulty PT

⚠ **WARNING**

Hazardous Voltage

Contact with high voltages can cause severe electrical shock, burns, or death.

Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

1. Ensure that the control is set up with the correct PT ratio (primary vs. secondary). Reference event/fault code 2816 for troubleshooting information on the PT ratio. To access the PT Ratio configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > PT Primary or PT Sec** and set the PT ratio appropriately for the application.
2. With a calibrated voltage meter, measure the voltage output of the PT. The output of the PT should match the ratio of the PT; ex. Outputs: L1=120, L2=120, L3=120. If the outputs of the PT are incorrect, replace the PT once the generator set has been properly grounded by a qualified electrician.

5.10.72 Fault Code 1457 - Fail To Synchronize

Synchronizer has not met the synch check conditions within the “Fail To Synchronize Time" parameter

A. Improper Adjustment of Bus or Generator Set Voltage

1. Ensure that that the base board is calibrated correctly by checking that the generator set is operating at proper voltage and frequency. With a calibrated Frequency and Voltage meter, measure the frequency and voltage output of the genset at the alternator; while thru the display, ensuring that the base board is displaying the same voltage and frequency that is shown on the meter. (Go to the Servicing the Generator section in the manual)
2. Ensure that that the base board is calibrated correctly by checking the System bus voltage and frequency. With a calibrated Frequency and Voltage meter, measure the frequency and voltage of the System bus; while thru the display, ensuring that the base board is displaying the same voltage and frequency that is shown on the meter. To view and adjust the Bus Voltage, go to: **Setup > Calibration > L12 (L23, L31) Adjust > Genset Bus L1L2 (L2L3, L3L1) Voltage Calibration** and if appropriate, change the Bus Voltage to reflect the voltage that is shown on the meter. To view and adjust the Bus Frequency go to: **Setup > Adjust > Frequency Calibration > Frequency Calibration** and if appropriate, change the Bus Frequency to reflect the frequency that is shown on the meter.

B. Faulty PT

⚠ **WARNING**

Hazardous Voltage

Contact with high voltages can cause severe electrical shock, burns, or death.

Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

1. Ensure that the control is set up with the correct PT ratio (primary vs. secondary). Reference event/fault code 2816 for troubleshooting information on the PT ratio. To access the PT Ratio configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > PT Primary or PT Sec** and set the PT ratio appropriately for the application.

2. With a calibrated voltage meter, measure the voltage output of the PT. The output of the PT should match the ratio of the PT; ex. Outputs: L1=120, L2=120, L3=120. If the outputs of the PT are incorrect, replace the PT once the generator set has been properly grounded by a qualified electrician.

C. Permissive Window Parameters are Set Too Tight

1. The synch check function monitors the generator set and bus voltage, frequency, and phase rotation, to determine whether the two sources can be paralleled. The difference in voltage, frequency, and phase rotation between the generator set and system bus must be smaller than the Permissive parameter windows. Set the following parameters appropriately for the application:
   - Permissive Frequency Window
   - Permissive Voltage Window
   - Permissive Window Time
   - Permissive Phase Window

   To access the Permissive Parameters Window setup menu from the display, refer to the parameter section for the default value, and limits.
2. Synchronizer has failed to synchronize the Generator set to the System bus within the “Fail To Synchronize Time" parameter. To increase the “Fail To Synchronize Time" parameter from the display, go to: Setup > Paralleling Setup > Basic > Sync Time and change the “Fail To Synchronize Time" parameter of the control appropriately. Refer to the parameter section for the default value, and limits.

5.10.73 Fault Code 1458 - Sync Ph Rot Mismatch

Mismatch in phase rotation between the generator set output and the system bus.

A. Generator Set Or System Bus Voltage Cables Are Incorrectly Wired To The Paralleling Breaker

1. If the nominal voltage is over 600 VAC, check the voltage sensing connections from the base board to the PT and the PT to the System bus.

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

   - Measure the phase rotation at the input of the PT (Potential Transformer) from the system bus. The phase rotation at the input of the PT should match the phase rotation at the input of the base board. The phase rotation (“L1 – L2 –L3") at the input of the PT should be the same as the phase rotation at the input of the base board at L1, TB7-1; L2, TB7-2; L3, TB7-3; if the phase rotation does not match, correct the wiring from the System bus to the PT and/or from the PT the base board.

- Measure the phase rotation at the input of the PT (Potential Transformer) from the generator set. The phase rotation at the input of the PT should match the phase rotation at the input of the base board. The phase rotation (“L1 – L2 –L3") at the input of the PT should be the same as the phase rotation at the input of the base board at J22-1; L2, J22-2; L3, J22-3; if the phase rotation does not match, correct the wiring from the Generator set to the PT and/or from the PT the base board.

B. Generator Set or System Bus Voltage Sensing Connections Are Incorrectly Wired at The Control Board

Mismatch in phase rotation between the generator set output and the system bus.

1. If the nominal voltage is 600 VAC or lower, ensure that the voltage sensing connections are correct.
   - Measure the phase rotation at base board from the system bus at: L1, TB7-1; L2, TB7-2; L3, TB7-3. The phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation is not correct, re-check the wiring.
   - Measure the phase rotation at base board from the Generator set at: L1, J22-1; L2, J22-2; L3, J22-3. The phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation is not correct, re-check the wiring.
2. If the nominal voltage is over 600 VAC, check the voltage sensing connections from the control board to the PT and the PT to the System bus.

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

   - Measure the phase rotation at the input of the PT (Potential Transformer) from the system bus. The phase rotation at the input of the PT should match the phase rotation at the input of the control board. The phase rotation (“L1 - L2 - L3") at the input of the PT should be the same as the phase rotation at the input of the control board at L1, TB7-1; L2, TB7-2; L3, TB7-3. If the phase rotation does not match, correct the writing from the System bus to the PT and/or from the PT to the control board.
   - Measure the phase rotation at the input of the PT (Potential Transformer) from the generator set. The phase rotation at the input of the PT should match the phase rotation at the input of the control board. The phase rotation (“L1 – L2 –L3") at the input of the PT should be the same as the phase rotation at the input of the control board at J22-1; L2, J22-2; L3, J22-3; if the phase rotation does not match, correct the wiring from the Generator set to the PT and/or from the PT the control board.

5.10.74 Fault Code 1459 - Reverse Power

The “Reverse KW threshold" has been exceeded for the time that is registered in the “Reverse KW time delay" setting.

A. CTs are Incorrectly Connected or Installed

1. If event/fault code 1459 becomes active as soon as the generator set picks up load, check the generator set operator panel under the **Alternator Data** menu and view the **L1 KW, L2 KW, and L3 KW** parameters when the generator set picks up load (right before the generator set shuts down). If L1 KW, L2 KW, or L3 KW is a negative value, it is likely that the CT connected to the negative KW value has an incorrect orientation or is connected backwards. Verify the CT orientation and CT wiring at L1: J12-1 and J12-4, L2: J12-2 and J12-5, L3: J12-3 and J12-6, correct if miswired.

B. Reverse KW Threshold Is Set Too Low

1. To access the Reverse KW threshold configuration menu on the operator panel go to **Setup > Genset Setup > Reverse KW Threshold** and set the “Reverse KW Threshold" Parameter appropriately for the application. Refer to the parameter list to see the default value for Reverse KW.

C. Loading Issue

1. Ensure that the load on the genset does not exceed the Genset KW Rating. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imaging Equipment, and Fire Pumps have a considerable and different influence on a generator. Revisit the genset sizing process to ensure that the genset is correctly sized for the application, especially if new loads have been introduced into the system (reference the T-030 manual).

NOTICE
Increasing the KW threshold or time delay may have adverse effects on the alternator. Always check the capability of the alternator

D. kW load Share Lines

1. Make sure the kW load share lines are wired correctly.

   Negative: TB9-7 to TB9-7

   Positive: TB9-8 to TB9-8

   Shield: TB9-9 to TB9-9

2. Disconnect the kW load share lines wires, including the shield. Check the continuity of each kW load share line. The resistance should be less than 10 ohms.

5.10.75 Fault Code 1461 - Loss of Field

The “Reverse KVAR threshold" has been exceeded for the time that is registered in the “Reverse KVAR time delay" setting.

A. Improper Voltage Calibration Of The Genset

1. If the genset is not operating in droop paralleling mode, go to the Load Sharing Lines Incorrectly Connected step.

2. Using a volt-meter measure the AC voltage of the Electric Bus that the genset is paralleled to (voltage of the Genset Bus or the Utility). Then measure the output voltage of the genset and ensure that the genset output voltage is +3 VAC/-0 VAC that of the source which the genset is paralleled to. Event/fault code 1461 is a result of the generator set not matching or exceeding the voltage of the electric bus, which causes the genset to import current from the electric bus (Reverse KVAR). To access the voltage calibration configuration menu on the display go to: **Setup > Adjust > Voltage Calibration** and increase the genset output voltage.

B. Load Sharing Lines Incorrectly Connected

1. Ensure that the orientation of the load sharing connections is correct, and that the shield is only grounded at one point. Check for damaged or disconnected wires at TB9-8, KW+ ; TB9-7, KW- ; TB9-10, KVAR+ ; TB9-11, KVAR- ; TB9-9, Shield (shield should be grounded at only one generator set). Correct connections if faulty.

C. Improperly Set Leading Power Factor

1. If loss of excitation occurs when the generator set is lightly loaded, a leading power factor may be the cause. Leading Power factor can be caused by operation of filters and power factor correction capacitors when the KW load level on the generator set is low. Motors, Uninterruptible Power Supply (UPS), Variable Frequency Drive (VFD), Medical Diagnostic Imagining Equipment, Fire Pumps and certain types of lighting have a considerable and different influence on a generator and can also cause a leading power factor. Leading power factor loads can cause the generator set to lose control of the output voltage of the generator set. To access the Power Factor menu on the operator panel, go to **Alternator Data** and view the value of L1 PF, L2 PF, L3 PF, and Total PF, right before the generator set shuts down on event/fault code 1461. Revisit the generator set sizing process if the power factor is leading to ensure that the generator set is correctly sized for the application, especially if new loads have been introduced into the system (reference the T-030 manual).

NOTICE
Increasing the KVAR threshold or time delay may have adverse effects on the alternator. Always check the capability of the alternator.

D. kVAR Load Share Lines

1. Make sure the kVAR load share lines are wired correctly.

   Negative: TB9-11 to TB9-11

   Shield: TB9-9 to TB9-9

   Positive: TB9-10 to TB9-10

2. Disconnect the kVAR load share lines wires, including the shield. Check the continuity of the each kVAR load share line. The resistance should be less than 10 ohms.

5.10.76 Fault Code 1464 - Load Dump

If the "Load Dump" parameter is enabled and the generator set KW output exceeds the "Overload Threshold" for the "Overload Set Time" or the output frequency of the generator set drops below the "Under-frequency Offset" for the "Under-frequency Set Time"; the generator set will dump its electrical load.

A. Active Fault Code Is Set To Derate

1. Event/fault code 1464 can be activated as a result of another active fault that is set to "Derate". Troubleshoot the other active fault(s) that are set to Derate.

B. The Under-frequency Offset Is Set To Low

1. To access the Under-frequency Offset configuration menu on the operator panel go to **Setup > Genset Setup** and set the "Under-frequency Offset" parameter appropriately for the application. Refer to the parameter list to see the default value for "Under-frequency Offset".

C. The Overload Set Time or Under-frequency Set Time Is Set Too Low

1. To access the "Overload Set Time" and "Under-frequency Set Time" configuration menu on the operator panel go to **Setup > Genset Setup** and set the "Overload Set Time" and "Under-frequency Set Time" Parameters appropriately for the application. Refer to the parameter list to see the default values for "Overload Set Time" and "Under-frequency Set Time".

D. Incorrect CTs or CT Connections

1. Check the CTs, CT Connections, and CT ratio. For installation instructions, refer to the section on Current Transformer Installation or reference event/fault code 2814 and event/fault code 2815.

5.10.77 Fault Code 1469 - Speed/Hz Mismatch

Engine speed and genset output frequency do not match.

A. Fly Wheel Teeth Number Is Incorrectly Set

1. Access the Flywheel Teeth setup screen through the Operator Panel and ensure that the PCC is set up with the correct number of engine flywheel teeth.

B. Faulty Engine Speed Sensor Connections

1. Inspect the engine speed sensor and the harness connector pins.
2. Disconnect the engine harness connector from the engine speed sensor.
3. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
4. Inspect for evidence of moisture in or on the connector.
5. Inspect for missing or damaged connector seals.
6. Inspect for dirt or debris in or on the connector pins.

C. Faulty Engine Harness - General

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
   f. Disconnect harness from base board and sensor.

g. Measure the resistance in each pin from base board to sensor. Resistance should be 5 ohms or less.

h. Repair or replace harness as necessary.

D. Faulty Engine Speed Position Sensor

1. Inspect the engine speed sensor.
2. Disconnect the engine speed/position sensor from the engine and engine harness.
3. Inspect sensor for bent, corroded or loose pins.
4. Inspect the sensor for structural deficiencies.
5. Check the crankshaft speed sensor supply voltage.
6. Disconnect the engine harness connector from the crankshaft speed sensor.
7. Install the speed sensor breakout cable between the sensor and the sensor harness connector.
8. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
9. Check the crankshaft speed sensor signal (sense) voltage.
10. Disconnect the engine harness connector from the camshaft position sensor.
11. Install the speed/position sensor breakout cable between the sensor and the sensor harness connector.
12. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 VDC, then the signal voltage is correct. If not, sensor is faulty.

E. Incorrect Engine Speed Data

1. Through the operator panel verify the engine speed by going to **Engine Data > Engine Speed.** Refer to the engine service manual to correct.

   Correct Speeds

   1800 RPM at 60 Hz

   1500 RPM at 50 Hz

F. A New Alternator Was Installed With A Different Number Of Poles

1. If a new alternator with a different number of poles replaced an original alternator, then the speed and frequency ratio is inaccurate. Go to **Setup > OEM Setup >OEM Engine Setup > Freq/Speed** and adjust the “Frequency to Speed Gain Select" parameter accordingly to the alternator. To calculate the Frequency to Speed value use the following equation:

   Frequency to Speed = 120 / Number of poles of the Alternator

G. Load Induced

1. Non-linear loads like Uninterruptible Power Supply (UPS) and certain types of lighting have a considerable and different influence on a generator which can cause significant frequency fluctuations that do not match measured engine speed; ex: a UPS causes 62 Hz at 1800 RPM. This is an application issue; correct the application issue and refer to the T030 manual.

H. Speed/Frequency Mismatch Threshold Set Too Low

1. Connect with InPower
2. Make sure the speed/frequency mismatch threshold is set within 0.1-20 Hz.

I. Speed/Frequency Mismatch Fault Time

1. Connect with InPower.
2. Make sure the speed/frequency mismatch threshold time is set within 0.2-10 sec.

J. Frequency-to-speed Gain Select

1. Connect with InPower.
2. Make sure the frequency-to-speed gain select is set properly.

5.10.78 Fault Code 1471 - High AC Current (Warning)

The generator output current has exceeded at least 110% of rated current for greater than 60 seconds.

A. Short or overload

1. Inspect the load cables and the AC harness connections.
2. Disconnect the AC harness from the load cables.
3. Inspect the AC harness and board connector pins.
4. Visually inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
5. Check for a short circuit to engine block ground.

B. Incorrect CTs, CT Connections, Or CT Setup

1. Check CTs.
   a. Check that correct CT’s have been installed.
   b. Check that CT connections are secure by zip ties to corresponding wires.
   c. Check that CTs are installed in the correct order.
   d. Connect InPower.
   e. Verify the correct CT ratio has been entered in the generator setup.
   f. Adjust the setting(s) as necessary.

C. CT Harness Connections

1. Measure the resistance of the CT harness on each pin.
2. Disconnect connector P12 from the control board and CTs.
3. Verify the resistance from board connector to CT connections. Resistance should be 5 ohms or less.
4. Measure the resistance of each pin on the CT harness connector to engine block ground. Resistance should be open or infinite.
5. Verify the CT connections are correct from P12 to the CT terminals.

   P12–1 (CT1) to P12–4 (CT1–COM)

   P12–2 (CT2) to P12–5 (CT2–COM)

P12–3 (CT3) to P12–6 (CT3–COM)

6. Re-terminate connections as necessary.

D. Incorrect Rating Setup

1. Connect InPower.
2. Verify the generator rating in the control is set correctly.
3. Verify CT ratings in the control are set correctly.
4. Adjust settings as necessary.

5.10.79 Fault Code 1472 - High AC Current (Shutdown)

The generator output current has exceeded at least 150% of rated current.

A. Short or overload

1. Inspect the load cables and the AC harness connections.
2. Disconnect the AC harness from the load cables.
3. Inspect the AC harness and board connector pins.
4. Visually inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
5. Check for a short circuit to engine block ground.

B. Incorrect CTs, CT Connections, Or CT Setup

1. Check CTs.
   a. Check that correct CT’s have been installed.
   b. Check that CT connections are secure by zip ties to corresponding wires.
   c. Check that CTs are installed in the correct order.
   d. Connect InPower.
   e. Verify the correct CT ratio has been entered in the generator setup.
   f. Adjust the setting(s) as necessary.

C. CT Harness Connections

1. Measure the resistance of the CT harness on each pin.
2. Disconnect connector P12 from the control board and CTs.
3. Verify the resistance from board connector to CT connections. Resistance should be 5 ohms or less.
4. Measure the resistance of each pin on the CT harness connector to engine block ground. Resistance should be open or infinite.
5. Verify the CT connections are correct from P12 to the CT terminals.

   P12–1 (CT1) to P12–4 (CT1–COM)

   P12–2 (CT2) to P12–5 (CT2–COM)

   P12–3 (CT3) to P12–6 (CT3–COM)
6. Re-terminate connections as necessary.

D. Incorrect Rating Setup

1. Connect InPower.
2. Verify the generator rating in the control is set correctly.
3. Verify CT ratings in the control are set correctly.
4. Adjust settings as necessary.

5.10.80 Fault Code 1475 - First Start Backup Fail

Generator set has not received permission to close the Genset CB to a dead bus from the First Start Input within the “First Start Back up time" parameter.

A. Wiring Issue At the First Start Arbitration Input

1. The First Start Arbitration input is incorrectly wired between generator sets or an open circuit exists at the First Start Arbitration input. Check the wiring at TB3-11 (First Start Arbitration) and TB3-12 (Return) between this and all generator sets that are interconnected, and ensure that the wiring is correct.

5.10.81 Fault Code 1483 - Common Alarm

The control has detected a warning fault and/or shutdown fault.

A. A Warning Fault and/or Shutdown Fault is Active

1. This fault is activated as a result of another warning or shutdown fault. Troubleshoot the other fault(s) that are causing the generator set to generate this event/fault code.

5.10.82 Fault Code 1540 - Common Warning

The control has detected a warning fault.

A. Active Warning Fault

1. This fault is activated as a result of another warning fault. Troubleshoot the other warning fault(s) that are causing the generator set to generate a warning fault.

5.10.83 Fault Code 1541 - Common Shutdown

The control has detected a shutdown fault.

A. Active Shutdown Fault

1. This fault is activated as a result of another shutdown fault. Troubleshoot the other shutdown fault(s) that are causing the generator set to shut down.

5.10.84 Fault Code 1573 - Config Input #1 Fault

Configurable input #1 fault is active.

A. Condition for Which Configurable Input #1 is Configured for Service

1. Check the condition for which "Configurable Input #1" has been configured; ex. if "Configurable Input #1" was configured to become active when the fuel level is low, check the fuel level and add fuel if needed. After the issue is resolved, press the Reset button on the Operator Panel in order to clear the fault, if the fault does not clear go to the next step.

B. Configurable Input #1 Active State Selection Parameter is Configured Incorrectly.

1. With InPower or through the operator panel check the switch input setting (active closed or active open) for Configurable Input #1. Ensure that the switch input setting is correctly set. If "Configurable Input #1 Input Function Pointer" parameter is set to default and if "Configurable Input #1 Active State Selection" parameter is set to "active closed", input 1 (event/fault code 1573) will become active when TB1-12 (input 1) and TB1-13 (ground) are connected (shorted) together.

   If "Configurable Input #1 Input Function Pointer" parameter is set to default and if "Configurable Input #1 Active State Selection" parameter is set to "active open", input 1 (event/fault code 1573) will become active when there is an open circuit between TB1-12 (input 1) and TB1-13 (ground).

   To access the input configuration on the operator panel go to **Setup > Configurable I/O > Config Input #1 Menu > Active** and set this parameter appropriately for the application.

C. Incorrectly Wired; or Open Circuit or Short Circuit in the Wiring

1. Check the wiring at TB1-12 (input 1) and TB1-13 (ground) for an open circuit, short circuit, or a miswired condition.

5.10.85 Fault Code 1689 - Reset Real Time Clock

Power to the Real Time Clock (RTC) chip on the base board has been lost and the clock is no longer accurate.

A. Battery Power Has Been Lost

1. The RTC chip requires little, but constant, power to keep the control's internal clock accurate. It has an internal capacitor that keeps the RTC operating for up to 1 hour when the battery is disconnected or dead. If battery power is lost for over 1 hour, the RTC will stop functioning. When battery power is supplied to the control again, the control will display event/fault code 1689, because the RTC is no longer accurate. If the fault clears after being acknowledged, then the control is OK. To set the real time clock, on the operator panel go to **Setup > Clock Setup** and set the RTC clock appropriately.

5.10.86 Fault Code 1847 - Engine Coolant Temperature High (Shutdown with Cooldown)

Exhaust gas temperature sensor signal is out of range – shorted high.

Possible Causes:

1. Inaccurate engine temperature sensor
2. Fault simulation feature is enabled
3. Threshold setting too low

A. Inaccurate Coolant Temperature Sensor

1. Using a thermocouple or similar device, measure coolant temperature near sender and compare to coolant temperature displayed.
2. Verify the temperature sender resistance and compare to specifications called out in the engine manual.
3. Verify continuity from temperature sender wire pin to base board pin. Harness resistance should be less than 5 Ohms.
4. Repair or replace faulty components or wiring

B. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

C. Threshold Setting Too Low

1. Use the service tool to connect to the base board and verify fault threshold settings for the sensor and compare to the specifications called out in the engine manual.
2. Verify base board and PCC calibration number and revision is correct.
3. Recalibrate the engine base board to reset the threshold settings.

5.10.87 Fault Code 1912 - Utility Loss Of Phase

In Power Transfer Control (PTC) Operation, if the phase angle between phases drops below 90 degrees or exceeds 150 degrees, for the “Utility Loss of Phase Drop-Out Delay" time parameter, fault code 1912 will become active.

A. Open Circuit At The Utility Voltage Sensing Inputs

1. The phase angle between phases L1-L2, L2-L3, and L3-L1 should be 120 degrees. At least one connection point that is used to calculate phase angle has been lost. Check the voltage sensing connections at L1: TB7-1; L2: TB7-2, L3: TB7-3 for an open circuit, and ensure that voltage and phase angle is correct. If using a PT also check the inputs and outputs of the PT.

B. Utility Voltage or Frequency is Unstable

1. Check with your utility company.

5.10.88 Fault Code 1913 - Genset Loss Of Phase

In Power Transfer Control (PTC) Operation, if the phase angle between phases drops below 90 degrees or exceeds 150 degrees, for the “Genset Loss of Phase Drop-Out Delay" time parameter, fault code 1913 will become active.

A. Correct Any Active Generator Set Faults

1. Correct any active generator set faults on the display, especially faults that might cause the engine to hunt/oscillate.

B. Open circuit at the generator set voltage sensing inputs

1. The phase angle between phases L1-L2, L2-L3, and L3-L1 should be 120 degrees. At least one connection point that is used to calculate phase angle has been lost. Check the voltage sensing connections at L1, J22-1; L2, J22-2; L3, J22-3 for an open circuit, and ensure that voltage and phase angle is correct. If using a PT, also check the inputs and outputs of the PT.

5.10.89 Fault Code 1914 - Utility Ph Rotation Error

Utility Phase rotation is incorrect.

A. Utility Voltage Sensing Connections are Incorrectly Wired at the Base Board

1. If the nominal voltage is 600 VAC or lower, ensure that the voltage sensing connections are correct.
   - Measure the phase rotation and voltage input into the base board from the Utility bus at: L1, TB7-1; L2, TB7-2; L3, TB7-3. The voltage should match nominal voltage, and the phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring.
2. If the nominal voltage is over 600 VAC, measure the voltage sensing connections from the base board to the PT and the PT to the Utility bus.

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

- Measure the phase rotation and voltage input into the base board from the PT (Potential Transformer) at: L1, TB7-1; L2, TB7-2; L3, TB7-3, L4, TB7-4. The voltage should match nominal voltage, and the phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring from the base board to the PT and correct if necessary.
- Measure the phase rotation and voltage input into the PT (Potential Transformer) from the Utility bus. The voltage into the PT should match the Utility bus voltage, and the phase rotation should be “L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring from the PT to the Utility bus and correct if necessary.

5.10.90 Fault Code 1915 - Genset Phase Rotation

Generator set phase rotation is incorrect.

A. Genset Voltage Sensing Connections are Incorrectly Wired at the Base Board

1. If the nominal voltage is 600 VAC or lower, ensure that the voltage sensing connections are correct.
   - Measure the phase rotation and voltage input into the base board from the Generator set at: L1, J22-1; L2, J22-2; L3, J22-3. The voltage should match nominal voltage, and the phase rotation should be "L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring.
2. If the nominal voltage is over 600 VAC, measure the voltage sensing connections from the base board to the PT and the PT to the Generator set.

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

- Measure the phase rotation and voltage input into the base board from the PT (Potential Transformer) at: L1, J22-1; L2, J22-2; L3, J22-3. The voltage should match nominal voltage, and the phase rotation should be "L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring from the base board to the PT and correct if necessary.
- Measure the phase rotation and voltage input into the PT (Potential Transformer) from the Generator set. The voltage into the PT should match the Generator set voltage, and the phase rotation should be "L1 – L2 –L3", for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation and/or voltage are not correct, re-check the wiring from the PT to the Generator set and correct if necessary.

5.10.91 Fault Code 1992 - Engine Crankshaft Speed Above Rated Speed (Warning)

Engine speed signals indicate an engine speed 15% greater than rated.

A. Fault Simulation Feature Is Enabled

1. Connect InPower.
2. Verify that the fault simulation is not enabled for the engine speed sensor by connecting to the PCC via InPower.
3. If the fault simulation is disabled, there is no problem.

B. Incorrect Threshold Setting

1. Use the service tool to connect to verify fault threshold settings and compare to the specifications called out in the engine manual.
2. Verify PCC calibration number and revision is correct.

C. Incorrect Fuel Type Setting

1. Connect InPower

2. Verify the fuel source set with InPower is the same fuel used by the generator.

D. Faulty Engine Speed Sensor Connections

1. Inspect the engine speed sensor and the harness connector pins.
2. Disconnect the engine harness connector from the engine speed sensor.
3. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
4. Inspect for evidence of moisture in or on the connector.
5. Inspect for missing or damaged connector seals.
6. Inspect for dirt or debris in or on the connector pins.

E. Faulty Engine Harness - General

1. Inspect the engine harness and the connector pins.
   a. Disconnect the engine harness connector from the extension harness.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pin.
   f. Disconnect harness from base board and sensor.
   g. Measure the resistance in each pin from base board to sensor. Resistance should be 5 ohms or less.
   h. Repair or replace harness as necessary.

F. Faulty Engine Speed Position Sensor

1. Inspect the engine speed sensor.
2. Disconnect the engine speed/position sensor from the engine and engine harness.
3. Inspect sensor for bent, corroded or loose pins.
4. Inspect the sensor for structural deficiencies.
5. Check the crankshaft speed sensor supply voltage.
6. Disconnect the engine harness connector from the crankshaft speed sensor.
7. Install the speed sensor breakout cable between the sensor and the sensor harness connector.
8. Measure the supply voltage by connecting the breakout cable's supply and return connectors to the multimeter. If the reading is between 4.75 and 5.25 VDC, then the supply voltage is correct.
9. Check the crankshaft speed sensor signal (sense) voltage.
10. Disconnect the engine harness connector from the camshaft position sensor.
11. Install the speed/position sensor breakout cable between the sensor and the sensor harness connector.
12. Measure the signal voltage by connecting the breakout cable's signal and return connectors to the multimeter. If the reading is between 0.46 and 4.56 VDC, then the signal voltage is correct. If not, sensor is faulty.

5.10.92 Fault Code 2331 - Low Utility Voltage

In Power Transfer Control (PTC) Operation, if the utility voltage is below the “Utility Undervoltage Drop-Out Threshold", for the “Utility Undervoltage Drop-Out Delay", fault code 2331 will become active.

A. Utility Undervoltage Drop-out Thresholds are Incorrectly Set

1. This fault will become active when the Utility voltage goes below the “Utility undervoltage drop-out threshold" for the “Utility Undervoltage Drop-Out Delay". Utility undervoltage drop-out threshold is dependent of the following parameters:
   - Utility Undervoltage Drop-out percentage.
   - Utility Undervoltage Drop-out Delay.

     To Modify the preceding parameters, on the display go to: **Setup > Paralleling Setup > Power Transfer Control > Drop out or Drop-Out Delay** and set appropriately. Refer the PTC section for setup information and instructions.

B. The Voltage of the Utility is Low and/or Unstable

1. The voltage of the utility is low and/or unstable, check with your utility company.

5.10.93 Fault Code 2335 - Excitation Fault

The control has detected the simultaneous loss of all phases of sensing.

A. Incorrectly Configured or Wiring Issue

1. Ensure that the configuration of the “Lost AC Voltage Threshold" parameter is set appropriately for the application. To access the Lost AC Voltage Threshold configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > Lost AC Voltage Threshold** and set the “Lost AC Voltage Threshold" parameter appropriately for the application. Refer to the parameter list to see the default value for “Lost AC Voltage Threshold".
2. All the connections that are used to calculate voltage and current by the control have been lost (either by disconnection or no voltage, current, frequency input into the control, etc.) Check the voltage sensing (L1: J22 -1; L2: J22 -2, L3: J22-3, L4: J22-4) and current sensing (L1: J12-1, J12-4; L2: J12-2, J12-5; L3: J12-3, J12-6;) connections into the control and ensure that voltage and current are available at these connections when the genset is running. If using a PT also check the inputs and outputs of the PT.

5.10.94 Fault Code 2336 - Checksum Fault

Integrity check has found corrupted memory block(s) in the PCC.

A. PCC Has Corrupted Memory Block(s)

1. The PCC has corrupted memory block(s), this is indicated by all of the LEDs on the base board flashing. Perform an initial calibration on the base board with the newest Incal files. If the Incal update does not resolve the issue, then replace the base board.

5.10.95 Fault Code 2342 - Too Long In Idle

The engine has been running at Low Speed Idle for a time longer than the "Max Idle Time" parameter.

A. Idle Time Parameters are Configured Incorrectly

1. If the genset has been running in Idle and displays event/fault code 2342, ensure that the genset is not configured to run in idle for more than 10 min. Long periods of engine idling (more than 10 min) can eventually affect engine performance and may not be covered by the engine warranty. Set the **"Idle Warmup Time"** and **"Idle Cooldown Time"** to an appropriate value. To access these parameters, on the operator panel go to **Setup > Genset Setup > Idle Warmup Time** or **Idle Cooldown Time** and set these parameter appropriately for the application. Refer to the parameter list to see the default value for "Idle Warmup Time" and "Idle Cooldown Time".
2. The "Max Idle Time" parameter might be set too low. To access the Max Idle Time configuration menu on the operator panel go to **Setup > Genset Setup > Max Idle Time** and set the "Max Idle Time" parameter appropriately for the application. Refer to the parameter list to see the default value for "Max Idle Time" parameter.
3. If the "Idle Warmup Coolant Temp" is set too high, the genset will idle for a longer period of time until the temperature of the engine reaches this set point. To access the Idle Warmup Coolant Temp configuration menu on the operator panel go to **Setup > Genset Setup > Idle Warmup Coolant Temp** and set the "Idle Warmup Coolant Temp" parameter appropriately for the application. Refer to the parameter list to see the default value for "Idle Warmup Coolant Temp" parameter.

5.10.96 Fault Code 2358 - High Utility Voltage

In Power Transfer Control (PTC) Operation, if the “Utility Overvoltage Sensor Enable" parameter is set to enable, and the utility voltage goes above the “Utility Overvoltage Drop-Out Threshold", for the “Utility Overvoltage Drop-Out Delay" time, fault code 2358 will become active.

A. Utility Overvoltage Drop-out Thresholds are Incorrectly Set

1. Utility Overvoltage drop-out thresholds are incorrectly set.
   a. This fault will become active when the Utility voltage goes above the “Utility Overvoltage Drop-Out Threshold" for the “Utility Overvoltage Drop-Out Delay" time. The utility overvoltage drop-out threshold is dependent of the following parameters:
      - Utility Overvoltage Drop-out percentage.
      - Utility Overvoltage Drop-out Delay.

        To Modify the preceding parameters, on the display go to: **Setup > Paralleling Setup > Power Transfer Control > Drop out or Drop-Out Delay** and set appropriately. Refer the PTC section for setup information and instructions.

        i. To disable this function, set the “Utility Overvoltage Sensor Enable" parameter to disable. On the display go to: **Setup > Paralleling Setup > Power Transfer Control > Enable** and set appropriately. Refer the PTC section for more information.

B. The Voltage of the Utility is Not Stable

1. The voltage of the utility is very high and/or unstable, check with your utility company.

5.10.97 Fault Code 2396 - Utility CB Fail To Close

Utility circuit breaker (CB) has failed to close for the time that is registered in the “Util CB Fail to Close Time Delay" parameter.

A. Incorrectly Wired Utility CB

1. The base board is sending the Utility CB a close command, but the Utility CB Position Status remains open. Correct the wiring from the CB Close Control output on the base board at TB5-6 and TB5-7 to the Utility breaker; check for an open circuit at the Utility breaker. The Utility CB Close control output is a NO Relay at TB5-6 and TB5-7 (Relay Common) on the base board. When the relay on the base board is closed, the Utility Breaker should be closed. The output of TB5-6 and TB5-7 should match the status of the Utility CB Close command; go to: **Advanced Status > Advanced Controller Status**, and ensure that the status of the CB close position command at the display matches the output.
2. Verify the wiring of the CB position status from the Utility breaker to the base board. The CB position sensing can be set up as single or dual sensing in the base board; check the display if the base board is setup as single or dual sensing. To access the CB position sensing, go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Utility Breaker Position Contacts**
   - If the CB position sensing is set up as single, verify the connection at CB A (NO) status at TB10-3 and the Return at TB10-1.
   - If the CB position sensing is set up as dual, verify the connection at CB A (NO) status at TB10-3 and the Return at TB10-1 and also verify the connection at CB B (NC) status at TB10-4 and TB10-1 (Return). The input status at CB A (NO) and CB B (NC) should be opposite, one input will be open while the other is closed, if they are the same check the wiring between the Utility breaker and the CB status input on the base board.
   - Ensure that the connections on the base board are correctly connected and that a short and/or open circuit does not exist. The physical connection to the base board should match the status of the CB position; go to: **Paralleling Status > Paralleling Status-PTC Sc 1 > Util CB Pos > Utility CB Position Status**, and ensure that the status of the CB position matches the connection.

B. Faulty Utility CB

1. Refer to the Utility CB Service Manual.

5.10.98 Fault Code 2397 - Utility CB Fail To Open

Utility circuit breaker (CB) has failed to open for the time that is registered in the “Utility CB Fail to Open Time Delay" parameter.

A. Incorrectly Wired Utility CB (Open)

1. The base board is sending the Utility CB an open command, but the Utility CB Position Status remains closed. Correct the wiring from the CB Open Control output on the base board at TB5-8 and TB5-9 to the Utility breaker; check for a short circuit. The Utility CB Open control output is a NO Relay at TB5-8 and TB5-9 (Relay Common) on the base board. When the relay is closed the Utility Breaker is closed. The output of TB5-8 and TB5-9 should match the status of the **Utility CB Open position command**; go to: **Advanced Status > Advanced Controller Status**, and ensure that the status of the Utility CB Open position command at the display matches the output.
2. Verify the wiring of the CB position status from the Utility breaker to the base board. The CB position sensing can be set up as single or dual sensing in the base board; check the display if the base board is setup as single or dual sensing. To access the CB position sensing, go to: **Setup > Paralleling Setup > Basic > Pos Contacts > Utility Breaker Position Contacts.**
   - If the CB position sensing is set up as single, verify the connection at CB A (NO) status at TB10-3 and the Return at TB10-1.

- If the CB position sensing is set up as dual, verify the connection at CB A (NO) status at TB10-3 and the Return at TB10-1 and also verify the connection at CB B (NC) status at TB10-4 and TB10-1 (Return). The input status at CB A (NO) and CB B (NC) should be opposite, one input will be open while the other is closed, if they are the same check the wiring between the Utility breaker and the CB status input on the base board.
- Ensure that the connections on the base board are correctly connected and that a short and/or open circuit does not exist. The physical connection to the base board should match the status of the Utility CB position; go to: **Paralleling Status > Paralleling Status-PTC Sc 1 > Util CB Pos > Utility CB Position Status**, and ensure that the status of the Utility CB position matches the connection.

B. Faulty Utility CB

1. Refer to the Utility CB Service Manual.

5.10.99 Fault Code 2545 - Keyswitch Reset Required (Warning)

CAN datalink communication has been lost between the generator set control and base board, therefore event/fault code 2545 becomes active if event/fault code 781 “CAN Data Link Failure" is also active at the base board.

A. CAN Datalink Failure

1. Reset the Keyswitch manually.
   a. Put the generator set control in the OFF position and press the Reset button on the operator panel. This action will clear any shutdown faults and resets the Keyswitch.
   b. Enable the Keyswitch through the operator panel. Go to **Test > Output > Engine > Keyswitch Driver Override Enable**, set to Enable.
2. Reset the ECM and PCC controls
   a. Push the Emergency Stop button in.
   b. Wait 30 seconds.
   c. Disconnect the battery terminals from the battery.
   d. Wait 10-15 seconds.
   e. Reconnect the battery cables to the battery terminals correctly.
   f. Pull the Emergency Stop button out.
   g. Press the Fault Reset button.
3. Check the relay that is proving power to the Keyswitch. This relay is normally open, and if faulty, replace.
4. Check the terminating resistors. With connectors J32 and J26 removed, measure resistance between pins P26-10 and P26-11 (60 ohms, is satisfactory). If the resistance is not correct, check terminating resistors at both ends of the CAN network.
5. Reference the troubleshooting procedure for event/fault code 781 in the engine service manual.

B. Faulty Base Board

1. After ensuring that the base board has an adequate B+ supply, connect to the base board with InPower or Insite in order to determine if it is functioning correctly and can communicate with the PCC controller. Replace the controller if communication to it with InPower is not possible.

5.10.100 Fault Code 2661 - One or More Unacknowledged Engine Fault Codes

Logic:

Fault code 2661 (unacknowledged engine fault): One or more unacknowledged Engine Shutdown Faults are active.

Diagnoses and Repair: Troubleshoot Engine Fault Codes.

5.10.101 Fault Code 2662 - At Least One ACK:Mod Severe Fault

Logic:

Fault code 2662: One or more acknowledged Engine Shutdown Faults are active.

Diagnoses and Repair: Troubleshoot Engine Fault Codes.

NOTICE
For PCC software version 3.280 and later, FC 2662 is no longer active. FC 2662 has been replaced with FC 6598 which has similar logic. Please see the troubleshooting for FC 6598 for additional information.

5.10.102 Fault Code 2677 - Fail to Stop (Shutdown)

Generator set continues to run after receiving shutdown command from the controller.

A. Stuck Fuel Shut-off Actuator

1. Check the wiring harness for damage, shorts, or abrasions. Repair as necessary.
2. Check for corroded, bent, broken, pushed back, expanded, or loose pins.
3. Check that the fuel shut-off valve is not mechanically stuck. Use a light tapping with a plastic or rubber mallet to dislodge a stuck actuator.
4. Refer to the engine service manual.

B. Generator Set is operating in a Fuel Rich Environment

1. Check ventilation. Ventilate area to disperse combustible gasses.

C. Keyswitch Short

1. Check wiring harness for damage, shorts, or abrasions. Repair as necessary.
2. Check for corroded, bent, broken, pushed back, expanded, or loose pins.

D. Governor Failure

1. Check wiring harness for damage, shorts, or abrasions. Repair as necessary.
2. Check for corroded, bent, broken, pushed back, expanded, or loose pins.
3. Refer to engine service manual.

5.10.103 Fault Code 2678 - Charging Alternator Fail

Battery charging alternator is not functioning correctly or is sensing too high of external battery voltage.

A. Faulty Engine DC Alternator Or Open Circuit

1. Check the wiring of the alternator for open circuits. If the wiring is satisfactory, measure the output voltage of the alternator to the battery while the engine is running. Normal charging voltage is 12-14 VDC in a 12 V system or 24-26 VDC in a 24 V system. If the appropriate output is not observed, replace the DC alternator.

5.10.104 Fault Code 2693 - Speed Bias OOR (Warning)

Indicates The Speed Bias Circuit Output Is Out Of Range (OOR), High Or Low.

A. Sensor/wiring is defective

1. Check wiring. Ensure speed bias OOR wiring is connected to the correct Aux 101 input.
2. Check wires for breaks or abrasions.
3. Check wires for moisture and debris at connection points.

5.10.105 Fault Code 2694 - Alternator RTD OOR (Warning)

Indicates the RTD circuit output is out of range (OOR), high or low.

A. Sensor/Wiring is Defective

1. Sensor/wiring is defective
    a. Check wiring. Ensure alternator RDT OOR wiring is connected to the correct Aux 101 input.
    b. Check wires for breaks or abrasions.
    c. Check wires for moisture and debris at connection points.

5.10.106 Fault Code 2696 - Alternator RTD Temperature High (Warning)

Indicates that the alternator temperature is above normal and has reached the shutdown trip point.

A. RTD Sensor Wiring Is Defective

1. Check wiring. Ensure alternator RDT temperature wiring is connected to the correct Aux 101 input.
2. Check wires for breaks or abrasions.
3. Check wires for moisture and debris at connection points.

5.10.107 Fault Code 2729 - IO Module Lost (Warning)

Indicates an intermittent data link between the I/O module and the PCC control (Aux 101 I/O Module option) and no input fault levels were set to Shutdown.

A. Incorrect Wiring

1. Connection between AUX 101 and PCC board is incorrect. Ensure proper wiring.
    a. PCC board TB1-1 – PCC Net A (+) to AUX 101 J1-3
    b. PCC board TB1-2 – PCC Net B (-) to AUX 101 J1-4

c. PCC board TB1-3 – B+ Return to AUX 101 J14-2

d. PCC board TB1-5 – Customer Fused B+ to AUX 101 J14-1

e. PCC board TB15-5 – System Wake-up to AUX 101 J1-5

B. I/O Settings Misconfigured

1. If no AUX 101 is connected to PCC board, connect to InPower. Under Adjustments > System I/O Adjustment > Output Relays ensure System IO Board Enable is disabled.
2. If no AUX 101 is connected to PCC board, connect to InPower. Under Adjustments > System I/O Adjustment > ensure no inputs or outputs are configured as enabled.

5.10.108 Fault Code 2731 - IO Module Lost (Shutdown)

Indicates an intermittent data link between the I/O module and the PC Control (Aux 101 I/O Module option) and at least one input fault level was set to Shutdown.

A. Incorrect Wiring

1. Connection between AUX 101 and PCC board is incorrect. Ensure proper wiring.
   a. PCC board TB1-1 – PCC Net A (+) to AUX 101 J1-3
   b. PCC board TB1-2 – PCC Net B (-) to AUX 101 J1-4
   c. PCC board TB1-3 – B+ Return to AUX 101 J14-2
   d. PCC board TB1-5 – Customer Fused B+ to AUX 101 J14-1
   e. PCC board TB15-5 – System Wake-up to AUX 101 J1-5

B. I/O Settings Misconfigured

1. If no AUX 101 is connected to PCC board, connect to InPower. Under Adjustments > System I/O Adjustment > Output Relays ensure System IO Board Enable is disabled.
2. If no AUX 101 is connected to PCC board, connect to InPower. Under Adjustments > System I/O Adjustment > ensure no inputs or outputs are configured as enabled.

5.10.109 Fault Code 2814 - Genset CT Ratio Low

The genset CT ratio (primary vs. secondary) is too small for the control to function properly for the voltage and KW rating of this generator set.

A. Incorrect CT Ratio Setup Or Feature Code

1. The control uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. Use the CT ratio calculator in InPower to determine the correct CT ratio for this generator set. Then enter the correct CT ratio via InPower or through the operator panel. To access the Genset CT ratio configuration menu on the operator panel, go to **Setup > OEM Setup > OEM Alt Setup > Genset CT Ratio** and set the “Genset CT Ratio primary" and “Genset CT Ratio secondary" parameters appropriately for the application.

B. The CTs Are Incorrectly Sized

1. Change the CTs to the correct size.

C. Incorrect Voltage Or kW Rating Setup

1. The PCC uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. If the voltage or kW setup is incorrect, event/fault code 2814 can become active. Use the CT calculator in InPower to determine the correct voltage and kW rating for this generator set. To access the generator set voltage and kW rating setup on the Operator Panel, go to **Setup > OEM Setup > OEM Alt Setup > Genset Nominal Voltage** and **Setup > OEM Setup > OEM Genset Setup** and set the parameters appropriately for the application.

5.10.110 Fault Code 2815 - Genset CT Ratio High

The ratio of the genset CT is too large for this generator set. The genset CT ratio (primary vs. secondary) is too large for the control to calculate current accurately at the voltage and KW ratings for this generator set.

A. The Control Is Set Up With The Incorrect CT Ratio or Feature Code

1. The control uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. Use the CT ratio calculator in InPower to determine the correct CT ratio for this generator set. Then enter the correct CT ratio via InPower or through the operator panel. To access the Genset CT ratio configuration menu on the operator panel go to Setup > OEM Setup > OEM Alt Setup > and set the “Genset CT Ratio primary" and “Genset CT Ratio secondary" parameters appropriately for the application.

B. The CTs Are Incorrectly Sized

1. Change the CTs to the correct size.

C. Incorrect Voltage Or kW Rating Setup

1. The PCC uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. If the voltage or kW setup is incorrect, event/fault code 2815 can become active. Use the CT calculator in InPower to determine the correct voltage and kW rating for this generator set. To access the generator set voltage and kW rating setup on the Operator Panel, go to **Setup > OEM Setup > OEM Alt Setup > Genset Nominal Voltage** and Setup > OEM Setup > OEM Genset Setup and set the parameters appropriately for the application.

5.10.111 Fault Code 2816 - Genset PT Ratio Low

The genset PT ratio is too small for the generator set rating. The genset PT ratio (primary vs. secondary) is too small and will cause high voltage readings.

A. The Control Is Set Up With The Incorrect CT Ratio or Feature Code

1. The control uses voltage, kW, and the CT ratio in order to determine if the CT ratio is correct for the operation of the generator set. Use the CT ratio calculator in InPower to determine the correct CT ratio for this generator set. Then enter the correct CT ratio via InPower or through the operator panel. To access the Genset CT ratio configuration menu on the operator panel go to Setup > OEM Setup > OEM Alt Setup > and set the “Genset CT Ratio primary" and “Genset CT Ratio secondary" parameters appropriately for the application.

B. The PTs Are Incorrectly Sized Ratio Low

1. Use the following equation to determine if the correct PT for the application is installed: (Genset Nominal Voltage / Genset PT Primary voltage) * Genset PT Secondary voltage > 600 VAC, your PT ratio is too small.
2. Check the voltage input into the control board. When the generator set is running, the voltage input between L1 and L2 (J22-1 and J22-2) or L2 and L3 (J22-2 and J22-3) should not be more than 600 VAC.

5.10.112 Fault Code 2817 - Genset PT Ratio High

The genset PT ratio is too large, which causes an inaccurate reading of nominal voltage during normal operation; when the genset PT is used (above 600 VAC).

A. The Control Is Set Up With The Incorrect PT Ratio

1. The control uses nominal voltage and the PT ratio in order to determine if the PT ratio is correct for the operation of the generator set. Voltage input into the control board should exceed 50% of the nominal voltage to allow the control to obtain an accurate voltage reading, whether an external PT is used or not. Use the following equation to determine if you have the correct PT ratio: If (Genset Nominal Voltage / Genset PT Primary voltage) * Genset PT Secondary voltage < (Nominal voltage *.5), the PT ratio is too large.

   Then configure the control with the correct PT ratio. To access the genset PT ratio configuration menu on the operator panel, go to **Setup > OEM Setup > OEM Alt Setup >** and set the “Genset PT Ratio primary" and “Genset PT Ratio secondary" parameters appropriately for the application.

B. The PTs Are Incorrectly Sized Ratio High

1. Use the following equation to determine if you have the correct PT for the application: (Genset Nominal Voltage / Genset PT Primary voltage) * Genset PT Secondary voltage < (Nominal voltage *.5), your PT ratio is too large.

   B. Check the voltage input into the control board. When the generator set is running, the voltage input between L1 and L2 (J22-1 and J22-2) or L2 and L3 (J22-2 and J22-3) should be greater than (Genset Bus Nominal Voltage *.5) VAC.

5.10.113 Fault Code 2818 - Bus PT Ratio Low

The Genset Bus PT ratio is too small for the Genset Bus rating. The Bus PT ratio (primary vs. secondary) is too small and will cause high voltage readings

A. The Control Is SetUp With The Incorrect PT Ratio

1. The control uses nominal voltage and the PT ratio in order to determine if the PT ratio is correct for proper operation of the bus. Voltage input into the control board should not exceed 600 VAC, whether an external PT is used or not. Use the following equation to determine if you have the correct PT Ratio: If (Genset Bus Nominal Voltage / Genset Bus PT Primary voltage) * Genset Bus PT Secondary voltage > 600 VAC, your PT Ratio is too small.
2. Then configure the control with the correct PT Ratio. To access the Bus PT ratio configuration menu on the display go to: **Setup > Paralleling Setup > Basic > PT Primary and PT Secondary** and set the “Genset Bus PT Primary Voltage" and “Genset Bus PT Secondary Voltage" parameters appropriately for the application.

B. The PTs Are Incorrectly Sized Bus PT Ratio Low

1. Use the following equation to determine if the correct PT for the application is installed: If (Genset Bus Nominal Voltage / Genset Bus PT Primary voltage) * Genset Bus PT Secondary voltage > 600 VAC, your PT Ratio is too small.
2. Check the voltage input into the control board between L1 & L2 or L2 & L3 the voltage reading should not be more that 600 VAC.

5.10.114 Fault Code 2819 - Bus PT Ratio High

The Genset Bus PT ratio is too large, which causes an inaccurate reading of Genset Bus Nominal voltage during normal operation; when the Genset PT is used (above 600 VAC)

A. The Control Is Set Up With The Incorrect Genset Bus PT Ratio

1. The control uses Genset Bus Nominal voltage and the PT ratio in order to determine if the PT ratio is correct for the operation of the generator set. Voltage input into the control board should exceed 50% of the Genset Bus Nominal voltage (up to 600 VAC), to allow the control to obtain an accurate voltage reading, whether an external PT is used or not. Use the following equation to determine if you have the correct PT Ratio: If (Genset Bus Nominal Voltage / Genset Bus PT Primary voltage) * Genset Bus PT Secondary voltage < (Genset Bus Nominal voltage *.5), the PT Ratio is too large.
2. Then configure the control with the correct PT Ratio. To access the Genset Bus PT ratio configuration menu on the display go to: **Setup > Paralleling Setup > Basic > PT Primary and PT Secondary** and set the "Genset Bus PT Primary Voltage" and "Genset Bus PT Secondary Voltage" parameters appropriately for the application.

B. The PT's Are Incorrectly Sized Bus PT Ratio High

1. Use the following equation to determine if you have the correct PT for the application: If (Genset Bus Nominal Voltage / Genset Bus PT Primary voltage) * Genset Bus PT Secondary voltage < (Genset Bus Nominal voltage *.5), the PT Ratio is too large.
2. Check the voltage input into the control board between L1 & L2 or L2 & L3 the voltage should be greater than (Genset Bus Nominal Voltage *.5) VAC.

5.10.115 Fault Code 2821 - Utility PT Ratio Low

The Utility PT ratio is too small for the Utility rating. The Utility PT ratio (primary vs. secondary) is too small and will cause high voltage readings.

A. The Control Is SetUp With The Incorrect PT Ratio

1. The control uses nominal utility voltage and the PT ratio in order to determine if the PT ratio is correct for proper operation of the utility. Voltage input into the control board should not exceed 600 VAC, whether an external PT is used or not. Use the following equation to determine if you have the correct PT Ratio: If (Utility Nominal Voltage / Utility PT Primary voltage) * Utility PT Secondary voltage > 600 VAC, your PT Ratio is too small.
2. Then configure the control with the correct PT Ratio. To access the utility PT ratio configuration menu on the display go to: **Setup > Paralleling Setup > Basic > PT Primary and PT Secondary** and set the “Utility PT Primary Voltage" and “Utility PT Secondary Voltage" parameters appropriately for the application.

B. The PTs are Incorrectly Sized Utility PT Ratio Low

1. Use the following equation to determine if the correct PT for the application is installed: If (Utility Nominal Voltage / Utility PT Primary voltage) * Utility PT Secondary voltage > 600 VAC, your PT Ratio is too small.
2. Check the voltage input into the control board between L1 & L2 (J22-1 & J22-2) or L2 & L3 (J22-2 & J22-3) the voltage reading should not be more that 600 VAC.

5.10.116 Fault Code 2822 - Utility PT Ratio High

The Utility PT ratio is too large, which causes an inaccurate reading of Utility Nominal voltage during normal operation; when the Genset PT is used (above 600 VAC)

A. The control is set up with the incorrect Utility PT Ratio

1. The control uses Utility Nominal voltage and the PT ratio in order to determine if the PT ratio is correct for the operation of the generator set. Voltage input into the control board should exceed 50% of the Utility Nominal voltage (up to 600 VAC), to allow the control to obtain an accurate voltage reading, whether an external PT is used or not. Use the following equation to determine if you have the correct PT Ratio: If (Utility Nominal Voltage / Utility PT Primary voltage) * Utility PT Secondary voltage < (Utility Nominal voltage *.5), the PT Ratio is too large.

   Then configure the control with the correct PT Ratio. To access the Utility PT ratio configuration menu on the display go to: **Setup > Paralleling Setup > Basic > PT Primary and PT Secondary** and set the “Utility PT Primary Voltage" and “Utility PT Secondary Voltage" parameters appropriately for the application.

B. The PTs are Incorrectly Sized Utility PT Ratio High

1. Use the following equation to determine if you have the correct PT for the application: If (Utility Nominal Voltage / Utility PT Primary voltage) * Utility PT Secondary voltage < (Utility Nominal voltage *.5), the PT Ratio is too large.
2. Check the voltage input into the control board between L1 & L2 (J22-1 & J22-2) or L2 & L3 (J22-2 & J22-3) the voltage should be greater than (Utility Nominal Voltage *.5) VAC.

5.10.117 Fault Code 2895 - PCCnet Device Failed

A non-critical PCCNet device has failed.

A. PCCNet Communication Has Been Lost Or PCCNet Device Is Faulty

1. If a PCCNet device has lost network communication, the network status light for that device will turn RED. Locate the device with the red network status LED to identify the affected device.
2. Ensure that the network device has sufficient voltage (12-24 V), as measured at the input of the device, not at the source or battery. Also verify that the device is awake and has a heartbeat. A heartbeat is a LED on the PCCNet device that blinks every 1 second to inform the operator that the device is functioning.
3. Check the network cable connections of the device(s) and ensure that there are no open or short circuits. The PCCNet network devices are polarity sensitive. For example: Control (RS485+) to Annunciator (RS485+) and Control (RS485-) to Annunciator (RS485-). If the connections are incorrect, the devices will not properly communicate over the network. Ensure that the shield is grounded at one point ONLY. Refer to the respective PCCNet device manual for line limitations and cable requirements.
4. If previous steps are satisfactory, replace the network device.

5. If replaced device is still exhibiting network issues, this can be due to a grounding loop or ground referencing for remotely mounted and powered network, incorrect network wire, or a noise (EMI) issue. As a test, connect the PCCNet device close (2-5 FT) to the base board, using the power supply from the base board (TB1-5, B+ and TB1-3 ground) and use the required network wire. If the network device functions appropriately, correct the grounding issue, EMI issue, or replace the network wire with the required network wire.

5.10.118 Fault Code 2896 - Critical PCCnet Device Fail

A critical PCCNet device has failed and has caused the generator set to shut down.

A. PCCNet Communication Has Been Lost Or PCCNet Device Is Faulty

1. If a PCCNet device has lost network communication, the network status light for that device will turn RED. Locate the device with the red network status LED to identify the affected device.
2. Ensure that the network device has sufficient voltage (12-24 V), as measured at the input of the device, not at the source or battery. Also verify that the device is awake and has a heartbeat. A heartbeat is a LED on the PCCNet device that blinks every 1 second to inform the operator that the device is functioning.
3. Check the network cable connections of the device(s) and ensure that there are no open or short circuits. The PCCNet network devices are polarity sensitive. For example: Control (RS485+) to Annunciator (RS485+) and Control (RS485-) to Annunciator (RS485-). If the connections are incorrect, the devices will not properly communicate over the network. Ensure that the shield is grounded at one point ONLY. Refer to the respective PCCNet device manual for line limitations and cable requirements.
4. If previous steps are satisfactory, replace the network device.
5. If replaced device is still exhibiting network issues, this can be due to a grounding loop or ground referencing for remotely mounted and powered network, incorrect network wire, or a noise (EMI) issue. As a test, connect the PCCNet device close (2-5 FT) to the base board, using the power supply from the base board (TB1-5, B+ and TB1-3 ground) and use the required network wire. If the network device functions appropriately, correct the grounding issue, EMI issue, or replace the network wire with the required network wire.

5.10.119 Fault Code 2897 - Factory Memory Block Corrupt

Control has detected a corrupted memory block.

A. Control Has Detected A Corrupted Memory Block

1. Contact factory for support.

5.10.120 Fault Code 2898 - Periodic or Fault Memory Block Corrupt

Control has detected a corrupted memory block.

A. Control Has Detected A Corrupted Memory Block

1. Contact factory for support.

5.10.121 Fault Code 2899 - User Memory Block Corrupt

Control has detected a corrupted memory block.

A. Control Has Detected A Corrupted Memory Block

1. Contact factory for support.

5.10.122 Fault Code 2911 - Trim Memory Block Corrupt

Control has detected a corrupted memory block.

A. Control Has Detected A Corrupted Memory Block

1. Contact factory for support.

5.10.123 Fault Code 2914 - Genset AC Meter Failed

Metering chip has failed and can no longer accurately monitor generator set current and voltage.

A. An Over-Voltage/-Current Condition Has Damaged The Metering Chip

1. Measure the voltage (L1: J22 -1; L2: J22 -2, L3: J22-3, L4: J22-4) and current (L1: J12-1, J12-4; L2: J12-2, J12-5; L3: J12-3, J12-6;) input into the control. Voltage input into the board should not exceed 600 VAC, (damage to board occurs at 750 VAC). Current input into the board should not exceed 5 Amps. If a short circuit or an over-voltage/-current issue exists, correct the problem(s).

5.10.124 Fault Code 2915 - Gen Bus AC Meter Failed

Metering chip has failed and can no longer accurately monitor generator set bus current and voltage.

A. An Over-Voltage/-Current Condition Has Damaged The Metering Chip

1. Measure the voltage using a volt-meter at L1: TB7-1; L2: TB7-2, L3: TB7-3, L4: TB7-4; and the current using a current probe at CT1, CT2, and CT3. Voltage input into the board should not exceed 600 VAC, (damage to board occurs at 750 VAC). Current input into the board should not exceed 5 Amps. If a short circuit or over-voltage/-current condition exists, correct the problem.

5.10.125 Fault Code 2916 - Utility AC Meter Failed

Metering chip has failed and can no longer accurately monitor utility current and voltage.

A. An Over-Voltage/-Current Condition Has Damaged The Metering Chip

1. Measure the voltage using a volt-meter at L1: TB7-1; L2: TB7-2, L3: TB7-3, L4: TB7-4; and the current using a current probe at CT1, CT2, and CT3. Voltage input into the board should not exceed 600 VAC, (damage to board occurs at 750 VAC). Current input into the board should not exceed 5 Amps. If a short circuit or over-voltage/-current condition exists, correct the problem.

5.10.126 Fault Code 2917 - Gen Bus Voltage OOR Hi

If the Paralleling Application parameter is set to “Genset Bus", and the Genset Bus Voltage sensing input into the base board exceeds 1020 VAC for the time that is registered in the “Genset Bus Voltage OOR Delay"; the generator set control will display event/fault code 2917.

A. The Control Is Set Up With The Incorrect Genset Bus PT Ratio or The PT's Are Incorrectly Sized.

1. Refer to event/fault code 2819.

B. The voltage of the Genset Bus is too high and/or unstable.

1. Ensure that the voltage of the Genset Bus is at nominal or stable; high generator set bus voltage can also damage the base board.

5.10.127 Fault Code 2918 - Utility Voltage OOR Hi

If the Paralleling Application parameter is set to “Utility", and the Utility Voltage sensing input into the base board exceeds 1020 VAC for the time that is registered in the “Utility Voltage OOR Delay; the generator set control will display event/fault code 2918.

A. The Control Is Set Up With The Incorrect Genset Bus PT Ratio 0r The PT's Are Incorrectly Sized.

1. Refer to event/fault code 2819.

B. The Voltage Of The Genset Bus Is Too High And Or Unstable

1. Check with your utility company.

5.10.128 Fault Code 2919 - Utility Current OOR Hi

If the Paralleling Application parameter is set to “Utility", and the Utility Current sensing input into the base board exceeds 140% for the time that is registered in the “Utility Current OOR Delay; the generator set control will display event/fault code 2919.

A. The Control Is Set Up With The Incorrect Utility CT Ratio Or The CT's Are Incorrectly Sized

1. If this fault becomes active during the commissioning processes, verify the sizing of the CT's and the setup of the Utility CT Ratio. The Utility secondary CT ratio can be set to 1 or 5 Amps; Fault code 2919 will become active when the Utility secondary CT current going into the base board is 1.4 amps or 7 amps. Ensure that the Maximum Utility primary CT current, Full Load Amps (FLA) of the building/application is correct.
   a. Use the following equation to determine the FLA.
      - FLA (one phase) = Maximum KW / Voltage
      - FLA (three phases) = Maximum KW / Voltage * (1.732)
      - Primary CT : Secondary CT = (FLA * 1.1) : (1 or 5 Amps).

        Ex. The maximum building load is 100KW, at 480 VAC, three phase.

        FLA = 100000 / 480*1.73 = 120.42

        The Utility primary CT size and CT Ratio should be at least 121 * (1.1) = 133 (1.1 is used as a buffer)

        Primary CT: Secondary CT = 133 : (1 or 5 Amps).
2. To change the Utility CT Primary Current and Utility CT Secondary Current ratio parameter appropriately for the application, go to: **Setup > Paralleling Setup > Basic > CT Primary or CT Secondary** and set appropriately.

B. Check For A Short Circuit

1. Check for a short circuit.

C. The Voltage Of The Genset Bus Is Too High And Or Unstable

1. Check with your utility company.

5.10.129 Fault Code 2921 - Gen Bus Current OOR Hi

If the Paralleling Application parameter is set to “Genset bus", and the Genset bus Current sensing input into the base board exceeds 140% for the time that is registered in the “Genset bus Current OOR Delay; the generator set control will display event/fault code 2921.

A. The Control Is Set Up With The Incorrect Utility CT Ratio Or The CT's Are Incorrectly Sized

1. If this fault becomes active during the commissioning processes, verify the sizing of the CT's and the setup of the Utility CT Ratio. The Utility secondary CT ratio can be set to 1 or 5 Amps; Fault code 2919 will become active when the Utility secondary CT current going into the base board is 1.4 amps or 7 amps. Ensure that the Maximum Utility primary CT current, Full Load Amps (FLA) of the building/application is correct.
   a. Use the following equation to determine the FLA.
      - FLA (one phase) = Maximum KW / Voltage
      - FLA (three phases) = Maximum KW / Voltage * (1.732)
      - Primary CT : Secondary CT = (FLA * 1.1) : (1 or 5 Amps).

        Ex. The maximum building load is 100KW, at 480 VAC, three phase.

        FLA = 100000 / 480*1.73 = 120.42

        The Utility primary CT size and CT Ratio should be at least 121 * (1.1) = 133 (1.1 is used as a buffer)

        Primary CT: Secondary CT = 133 : (1 or 5 Amps).
2. To change the Utility CT Primary Current and Utility CT Secondary Current ratio parameter appropriately for the application, go to: **Setup > Paralleling Setup > Basic > CT Primary or CT Secondary** and set appropriately.

B. The Current Of The Utility Is Too High And Or Unstable

1. Ensure that the current of the Genset Bus is at nominal or stable; high generator set bus current can also damage the base board.

5.10.130 Fault Code 2922 - Genset Neutral Curr OOR Hi

The Genset Neutral current is above the “Genset Neutral Current Calibration" parameter for the time in the “Genset Neutral Current OOR Delay" time parameter.

A. CT Ratio Is Too Small Or The CTs Are Not Sized Correctly For The Genset Voltage And kW Rating

1. Please see event/fault code 2814.

B. Genset Neutral Current Is Above The Genset Neutral Current Calibration Parameter

1. Measure the Genset Neutral current input into the control board with a current probe at J22-4. The maximum value of current going into the control CTs should not be more than the value of the “Genset CT Secondary Current" value that the control is calibrated for. For example, if secondary setting in the control is 1 Amp, current going into the control should not be more than 1 Amp. To access the Genset CT Secondary Current configuration menu on the operator panel go to **Setup > OEM Setup > OEM Alt Setup > CT Sec** and set the “Genset CT Secondary Current" parameter appropriately for the application.

C. Faulty CT

1. If the above is satisfactory, check the CT and replace if faulty.

5.10.131 Fault Code 2923 - Gen Bus kW OOR Hi

If the Paralleling Application parameter is set to “Genset Bus", and the Genset Bus KW exceeds 32,767 KW or is below -32768 KW for the time that is registered in the “Genset Bus KW OOR Delay; the generator set control will display event/fault code 2923.

A. Incorrect Application Or Setup GenBus kWOORHi

1. Generator set is being used in an incorrect application in which the power monitoring is out of range. Ex. If there are 25 paralleled generator sets operating at 2 MW and 13.8 KV, the generator set will not be able to monitor power above 32.767 MW and will display event/fault code 2923. This application will require external switchgear to monitor power.
2. Genset Bus CT Ratio is incorrectly set, refer to event/fault code 2921.
3. Genset Bus PT Ratio is incorrectly set, refer to event/fault code 2917.

5.10.132 Fault Code 2924 - Gen Bus kVAR OOR Hi

If the Paralleling Application parameter is set to “Genset Bus", and the Genset Bus KVAR exceeds 32,767 KVAR or is below -32768 KVAR for the time that is registered in the “Genset Bus KVAR OOR Delay; the generator set control will display event/fault code 2924.

A. Incorrect Application Or Setup GenBus kVAR OORHi

1. Generator set is being used in an incorrect application in which the power monitoring is out of range. Ex. If there are 25 paralleled generator sets operating at 2 MVAR and 13.8 KV, the generator set will not be able to monitor power above 32.767 MVAR and will display event/fault code 2924. This application will require external switchgear to monitor power.
2. Genset Bus CT Ratio is incorrectly set, refer to event/fault code 2921.
3. Genset Bus PT Ratio is incorrectly set, refer to event/fault code 2917.

5.10.133 Fault Code 2925 - Gen Bus kVA OOR Hi

If the Paralleling Application parameter is set to “Genset Bus", and the Genset Bus KVA exceeds 65,535 KVA for the time that is registered in the “Genset Bus KVA OOR Delay; the generator set control will display event/fault code 2925.

A. Incorrect Application Or Setup - Gen Bus kVA OOR Hi

1. Generator set is being used in an incorrect application in which the power monitoring is out of range. Ex. If there are 35 paralleled generator sets operating at 2 MVA and 25 KV, the generator set will not be able to monitor power above 65.535 MVA and will display event/fault code 2925. This application will require external switchgear to monitor power.
2. Genset Bus CT Ratio is incorrectly set, refer to event/fault code 2921.
3. Genset Bus PT Ratio is incorrectly set, refer to event/fault code 2917.

5.10.134 Fault Code 2926 - Utility kW OOR Hi

If the Paralleling Application parameter is set to “Utility", and the Utility KW exceeds 32,767 KW or is below -32768 KW for the time that is registered in the “Utility KW OOR Delay; the generator set control will display event/fault code 2926.

A. Incorrect Application Or Setup Utility kWOORHi

1. Generator set is being used in an incorrect application in which the power monitoring is out of range. Ex. If the Utility power is 40 MW, the generator set will not be able to monitor power above 32.767 MW and will display event/fault code 2926. This application will require external switchgear to monitor power.
2. Utility CT Ratio is incorrectly set, refer to event/fault code 2919.
3. Utility PT Ratio is incorrectly set, refer to event/fault code 2918.

5.10.135 Fault Code 2927 - Utility kVAR OOR Hi

If the Paralleling Application parameter is set to “Utility", and the Utility KVAR exceeds 32,767 KVAR or is below -32768 KVAR for the time that is registered in the “Utility KVAR OOR Delay; the generator set control will display event/fault code 2927.

A. Incorrect Application Or Set up kVAR

1. Generator set is being used in an incorrect application in which the power monitoring is out of range. Ex. If the Utility power is 40 MVAR, the generator set will not be able to monitor power above 32.767 MVAR and will display event/fault code 2927. This application will require external switchgear to monitor power.
2. Utility CT Ratio is incorrectly set, refer to event/fault code 2919.
3. Utility PT Ratio is incorrectly set, refer to event/fault code 2918.

5.10.136 Fault Code 2928 - Utility kVA OOR Hi

If the Paralleling Application parameter is set to “Utility", and the Utility KVA exceeds 65,535 KVA for the time that is registered in the “Utility KVA OOR Delay; the generator set control will display event/fault code 2928.

A. Code 2928 - Utility kVA OOR Hi

1. Generator set is being used in an incorrect application in which the power monitoring is out of range. Ex. If the Utility power is 70 MVAR, the generator set will not be able to monitor power above 65.535 MVA and will display event/fault code 2928. This application will require external switchgear to monitor power.
2. Utility CT Ratio is incorrectly set, refer to event/fault code 2919.
3. Utility PT Ratio is incorrectly set, refer to event/fault code 2918.

5.10.137 Fault Code 2938 - Earth/Ground Fault

Short to ground in the external wiring.

A. Configurable Input Active State Selection Parameter Is Incorrectly Configured For Ground Fault

1. Through the operator panel, check the switch input setting (active closed or open) for the Configurable Input setup for Ground Fault. Ensure that the switch input setting is correctly set. If "Configurable Input Function Pointer" parameter is set to Ground Fault and if "Configurable Input Active State Selection" parameter is set to "active closed", event/fault code 2938 will become active when the input is a ground input.
2. If "Configurable Input Function Pointer" parameter is set to Ground Fault and if "Configurable Input Active State Selection" parameter is set to "active open", event/fault code 2938 will become active when the input is an open circuit.
3. To access the input configuration on the operator panel go to **Setup > Configurable I/O > Config Input Menu > Active** and set the "Configurable Input Active State Selection" parameter appropriately for the application.

B. Incorrectly Wired Open Or Short Circuit In The Wiring

1. Depending on the "Configurable Input Active State Selection" parameter setting, check the wiring for an open/short circuit, or mis-wired condition from the generator set (L1, J22-1; L2, J22-2; L3, J2-3; LN, J22-4) to the Ground Fault Alarm Relay (Input 6 and 8), correct if faulty.

C. Faulty Ground Fault Alarm Relay

1. Ensure that the input voltage to the Ground Fault Alarm Relay is 24 VDC, at input 1 and 2.
2. Verify that the Trip Current and Time Delay settings on the Ground Fault Alarm Relay are set appropriately for the application.
3. If the previous steps are satisfactory, replace the Ground Fault Alarm Relay.

(refer to instruction sheet C648a).

5.10.138 Fault Code 2939 - MODBUS Failure

If any of the Modbus parameters are Active, and the Modbus device stops communicating with the base board for a time period longer than in the “Modbus Failure Time Delay", event/fault code 2939 becomes active.

A. Active Modbus Fault Or Wiring Issue

1. Check the following parameters for an “Active" Modbus state. If any of the below listed Modbus parameters are Active and have stopped communicating with the base board for a time period longer than in the “Modbus Failure Time Delay", event/fault code 2939 becomes active. Communication with these items will need to be restored.
    - Exercise Switch
    - Remote Start Switch
    - Load Demand Stop
    - Start Type
    - Fault Reset
    - Battle Short Switch

- Genset CB Inhibit Switch
- Utility CB Inhibit Switch
- Synch Enable Switch
- Ramp Load Unload Switch
- Speed Droop Enable Switch
- Voltage Droop Enable Switch
- Genset CB Tripped Switch
- Utility CB Tripped Switch
- Extended Parallel Switch
- PTC Mode Switch

2. Check the Modbus connection from the parameters listed above to that base board connection at TB15-3 (RS485+) and TB15-4 (RS485-) for open/short circuits or miswiring. There should be a 120 Ohm terminating resistor at each end of the Modbus network (a resistor at the control TB15-3 (RS485+) and TB15-4 (RS485-) and at the last device of the Modbus network). Also ensure that the shield is grounded at TB15-1. the shield should be grounded at ONLY this point.

B. Faulty Modbus Device

1. Check the Modbus device that is transmitting information to the base board. If this device is faulty and/or has stopped communicating with the base board, event/fault code 2939 becomes Active. If the external Modbus device is faulty then repair or replace.

5.10.139 Fault Code 2942 - Shutdown Override Fail

The genset has failed to transition to Battle Short mode or Delayed Shutdown mode.

A. Battle Short Or Delayed Shutdown Is Not Enabled In The Genset Control

1. Through the operator panel, verify that the “Battle Short" parameter is set to enable. To access the “Battle Short" configuration menu on the operator panel go to **Setup > OEM Setup > OEM Genset Setup > Battle Short** and set the parameter to enable, if the battle short mode is required by the customer.
2. Ensure that one of the configurable inputs is set up to activate Battle Short mode (e.g., Configurable Input #1 = Battle Short). Battle Short may now be enabled by activating the configurable input that was set up for Battle Short (e.g., Enable Configurable Input #1 with a ground input).
3. Through the operator panel, verify that the “Delayed Shutdown" parameter is set to enable. To access the “Delayed Shutdown" configuration menu on the operator panel go to **Setup > OEM Setup > OEM Genset Setup > Delayed Shutdown** and set the parameter to enable, if the Delayed Shutdown mode is required by the customer.

B. Battle Short Is Not Enabled In The Baseboard

1. Connect to the baseboard with InPower and enable the Battle Short parameter in the baseboard. Under “Engine Protection", set “Shutdown Manual Override" to “Enable".

5.10.140 Fault Code 2943 - Manual Sw Config Fail

Event/fault code 2943 is activated when the control receives an active Manual input from both the operator panel and the PCCNet network at the same time for two seconds or more.

A. Two Manual Command Inputs That Are Active At The Same Time_Manual

1. Ensure there is only one Manual switch input to the control that is active, either through the operator panel or PCCNet Network (PCCNet DIM) but not both at the same time.

5.10.141 Fault Code 2944 - Auto Switch Config Fail

Event/fault code 2944 is activated when the control receives an active Auto input from both the operator panel and the PCCNet network at the same time for two seconds or more.

A. Two Auto Command Inputs That Are Active At The Same Time

1. Ensure there is only one Auto switch input to the control that is active, either through the operator panel or through PCCNet Network (PCCNet DIM) but not both at the same time

5.10.142 Fault Code 2945 - Rupture Basin

Main fuel tank is leaking into the rupture basin.

A. Rupture Basin/Configurable Input #12 Active State Selection Parameter Is Incorrectly Configured

1. Through the operator panel check the switch input setting (active closed or open) for the Rupture Basin/Configurable Input #12 Active State Selection. Ensure that the switch input setting is correctly set. If "Rupture Basin/Configurable Input #12 Function Pointer" parameter is set to Default and if "Rupture Basin/Configurable Input #12 Active State Selection" parameter is set to "active closed", event/fault code 2945 will become active when the input is a ground input.
2. If ""Rupture Basin/Configurable Input #12 Function Pointer" parameter is set to Default and if "Rupture Basin/Configurable Input #12 Active State Selection" parameter is set to "active open", event/fault code 2945 will become active when the input is an open circuit.
3. To access the input configuration on the operator panel go to **Setup > Configurable I/O > Rupture Basin/Configurable Input #12 Active State Selection** and set the "Rupture Basin/Configurable Input #12 Active State Selection" parameter appropriately for the application.

B. Incorrectly Wired; Open Or Short Circuit In The Wiring

1. Depending on the "Rupture Basin/Configurable Input #12 Active State Selection" parameter setting, check the wiring at for an open/short circuit, or miswired condition, from the rupture basin sender to the base board at J20-19 and J20-8; correct if wiring is faulty.

C. Faulty Sender

1. Measure the rupture basin sender for an open or short circuit reading, replace if faulty.

5.10.143 Fault Code 2958 - Alternator 3 Temperature Sender Low

If "AUX101 Alternator Temperature OOR Check Enabled" is enabled and if the Alternator 3 temperature input into the AUX101 exceeds the "AUX101 Alternator Temperature OOR Low Limit" setting for the time in the "AUX101 Alternator Temperature OOR Time" setting, event/fault code 2958 becomes active.

5.10.143.1 Sender is Incorrectly Connected or the Wiring is Shorted Low

1. Check the wiring from the alternator 3 temperature sender to the AUX101 and make sure that the sender is correctly wired to the AUX101.
2. Also make sure that the wiring is not a short circuit.
3. For AUX101 installation and connection information, refer to Instruction Sheet C693.

5.10.143.2 Faulty Alternator 3 Temperature Sender

1. Measure the resistance between the alternator 3 temperature signal pin and the alternator 3 temperature return pin.
2. The resistance should be between 530 Ohms to 2214 Ohms.
3. Replace the sender if the resistance value is out of specification.

5.10.143.3 Faulty Base Board

1. If the previous steps do not reveal any problems, replace the base board.

5.10.144 Fault Code 2972 - Field Overload

If the time that the Field AVR Duty Cycle is operating at maximum output is longer than the time in the “Max Field Time" parameter, event/fault code 2972 will become active.

NOTICE
Excessive voltage is possible during testing. Make sure your meter can handle alternator full voltage.

A. Max Field Time Delay Is Set Too Low

1. Through the operator panel, check the “Max Field Time" parameter setting. Verify that the “Max Field Time" is not set to zero. The “Max Field Time" parameter may require adjustment to a value more appropriate for the application. To access the Max Field Time configuration menu on the operator panel go to Setup > OEM Setup > OEM Alt Setup > Max Field Time and set the “Max Field Time" parameter appropriately for the application. Refer to the parameter list to see the default value for “Max Field Time".

B. Voltage Sensing Into The Base Board Is Too Low, Or There Is An Open/Short Circuit

1. Measure the voltage going into the base board at L1 = J22-1, L2 = J22-2, L3 = J22-3, and LN = J22-4 (for single phase applications use L1, L2 and LN). If the generator set control is not sensing voltage, it will try to overcompensate by maxing out the AVR output. If the voltage going into the control board is zero, or less than the voltage that the control was calibrated for (Nominal Voltage), then check the wiring from the alternator to the base board for an open circuit or short circuit.

2. If the generator set is over 600 VAC, check connections from the alternator to the PT, and from the PT to the base board. If there is voltage going into the PT, but not coming out of the PT, replace the PT.
3. Measure the output of the AVR at J17 -1 and J17-2 while turning the generator set on. The output should be at least 30 VDC when the generator set is starting, but the voltage should decrease significantly when the generator set builds up voltage. If the output of J17-1 and J17-2 is constantly high or is locked in, then the AVR portion of the PCC is faulty. Replace the base board if the AVR is faulty.

C. Application Issue

1. If the generator set runs adequately with no load or some load but as soon as additional load is applied, the generator set shuts down on “Field Overload"; then this might be an application issue (load issue, generator set undersized, etc.).

5.10.145 Fault Code 2977 - Low Coolant Level 2

Low Coolant Level switch #2 indicates that the coolant level is low in the second radiator.

Possible Causes:

1. Low Coolant.
2. Coolant sender incorrectly wired.
3. Faulty coolant level sender.
4. The "Configurable Input Active State Selection" parameter is configured incorrectly.
5. Faulty Extension Harness Coolant Level Sensor.

A. Low Coolant

1. Stop the engine and allow the engine to cool down.
2. Visually inspect that engine coolant is at the appropriate level through the sight glass or expansion tank.
3. Remove radiator cap and check that coolant is up to the required level.
4. If coolant is below 1 in. (2.54 cm) from the top of the radiator add manufacturer's prescribed coolant.

B. Cooling System Hose Is Collapsed, Restricted Or Leaking

1. Inspect upper and lower radiator hoses for collapse, distortion, or fluid leaks.
2. Replace if damaged or worn.

C. Coolant Sender Incorrectly Wired

1. Check for improper wiring, such as a short or open circuit from the coolant sensor to the discrete configurable input on the base board that was configured for the "Low Coolant Level 2 Switch". If a short/open circuit or improper wiring is found, correct the wiring.

D. Configurable Input Active State Selection parameter is configured incorrectly

1. Through the operator panel, check the switch input setting (active closed or active open) for the Configurable Input that was configured to "Low Coolant Level 2 Switch". Ensure the setting is correct. If the "Configurable Input Function Pointer" parameter is set to "Low Coolant Level 2 Switch" and the "Configurable Input Active State Selection" parameter is set to "active closed", event/fault code 2977 will become active when the Configurable Input that was configured to "Low Coolant Level 2 Switch" is connected to ground.

   If the "Configurable Input Function Pointer" parameter is set to "Low Coolant Level 2 Switch" and the "Configurable Input Active State Selection" parameter is set to "active open", event/fault code 2977 will become active when the Configurable Input that was configured to "Low Coolant Level 2 Switch" is an open circuit.

   To access the input configuration on the operator panel go to **Setup > Configurable I/O >** and set the "Configurable Input Active State Selection" parameter appropriately for the Configurable Input that was configured to "Low Coolant Level 2 Switch".

E. Faulty Coolant Level Sensor

Perform the checks in Generator Set Sensors.

F. Faulty Extension Harness-Coolant Level Sensor

1. Inspect the extension harness and the extension harness connector pins.
   a. Disconnect the extension harness connector from the control.
   b. Inspect for corroded pins, bent or broken pins, pushed back or expanded pins.
   c. Inspect for evidence of moisture in or on the connector.
   d. Inspect for missing or damaged connector seals.
   e. Inspect for dirt or debris in or on the connector pins.
2. Check for an open circuit.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Measure the resistance from the coolant level sensor return pin on the engine harness inline connector to the coolant level sensor return pin at the engine harness sensor connector.
   d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to coolant level sensor signal pin at then engine harness sensor connector.
   e. If the measurement is less than 10 ohms, then the resistance is correct.
3. Check for a short circuit from pin to pin.
   a. Disconnect the extension harness connector from the control.
   b. Disconnect the extension harness from the engine harness.
   c. Disconnect the engine harness from all sensors that have a shared return with the coolant level sensor. Measure the resistance from the intake manifold temperature return pin on the engine harness inline connector to all other pins in the engine harness inline connector.
   d. Measure the resistance from the coolant level sensor signal pin on the engine harness inline connector to all other pins in the engine harness inline connector.

e. If all measurements are greater than 100k Ohms, then the resistance is correct.

5.10.146 Fault Code 2979 - High Alternator Temp

Indicates that the alternator temperature is high.

A. Alternator Temperature Sender Incorrectly Wired

1. Check for improper wiring or a short/open circuit from the alternator temperature sender to the discrete configurable input on the base board that was configured for the "High Alternator Temp Switch". If a short/open circuit or improper wiring is found, correct the wiring.

B. Faulty Alternator Temperature Sender

1. Measure the resistance between the alternator temperature signal pin and return pin. The resistance should be between 530 Ohms to 2214 Ohms. Replace the sender if the resistance value is out of specification.

C. Configurable Input Active State Selection parameter is configured incorrectly

1. Through the operator panel, check the switch input setting (active closed or open) for the Configurable Input that was configured to "High Alternator Temp Switch". Ensure the setting is correct. If the "Configurable Input Function Pointer" parameter is set to "High Alternator Temp Switch" and the "Configurable Input Active State Selection" parameter is set to "active closed", event/fault code 2979 will become active when the Configurable Input that was configured to "High Alternator Temp Switch" is connected to ground.

   If the "Configurable Input Function Pointer" parameter is set to "High Alternator Temp Switch" and the "Configurable Input Active State Selection" parameter is set to "active open", event/fault code 2979 will become active when the Configurable Input that was configured to "High Alternator Temp Switch" is an open circuit.

   To access the input configuration on the operator panel go to **Setup > Configurable I/O >** and set the "Configurable Input Active State Selection" parameter appropriately for the Configurable Input that was configured to "High Alternator Temp Switch".

5.10.147 Fault Code 3399 - Differential Fault

⚠ WARNING
Electrical Explosion
CTs powered without load are susceptible to explosion, which can cause personal injury.
Do not power the current transformers (CTs) without load.

A. Faulty, Improperly Wired or Improperly Sized Current Differential CT or Protection Relay

1. Secure all CT and relay connections to mitigate any intermittent current imbalances resulting from poor connection that may trip the protection relay.
2. Verify clearance between CT phases, ground and secondary conductors (one inch/kV + one inch). Ensure the secondary conductors are not parallel or in close proximity to primary conductors to prevent secondary circuit current induction and corresponding protection relay trip. Reroute as needed.

3. Verify the CT primary and secondary circuits are properly sized for the genset and protection relay, replace as needed. Note, all CTs must perform identically with respect to the differential protection relay sensitivity unless percent differential relays are employed.

B. Line Load Imbalance

1. Verify and adjust so all loads are properly applied and balanced to below the differential current relay active threshold.

C. Faulty Current Differential CT

1. Differential CT primary or secondary internal failure has delivered an inaccurate current to the protection relay rendering it active. Employ a DVOM and test leads to measure the following with the genset not producing voltage:
   a. Measure winding, winding-to-winding and winding-to-ground or CT case electrical resistance to establish any shorting.
2. Differential CT primary or secondary internal failure has delivered an inaccurate current to the protection relay rendering it active. Employ a CT tester or A/C current clamp (not in-line) to validate CT performance. Replace CT if damaged or suspect.

D. Faulty Current Differential Protection Relay

1. Differential protection relay internal failure rendering it active when all CT input is balanced.
   a. Disconnect all connections to protection relay.
   b. Measure the resistance between the CT secondary line relay inputs. All groups of line inputs should be similar, else: replace relay.
2. For further assessment, conduct the following if active with relay closed.
   a. Disconnect all connections to protection relay.
   b. Measure the resistance between the relay active output terminals. If resistance is relatively low, replace relay.
3. For further assessment, conduct the following if active with relay open.
   a. Disconnect all connections to protection relay.
   b. Measure the resistance between the relay active output terminals. If resistance is relatively low, relay is OK. Verify by applying a test current to any set of CT secondary line relay inputs, simulating a common input voltage, and measure relay resistance which should be OL or relatively high.

E. Faulty Alternator Winding Insulation or Short.

1. A faulty alternator winding insulation or short has resulted in higher current on a winding, rendering the protection relay active.
   a. A faulty alternator winding insulation or short has resulted in higher current on a winding, rendering the protection relay active.
   b. Visually investigate load lines for wear and shorting, replace and support as necessary.
   c. Conduct an insulation resistance test for all alternator lines, repair as necessary.

F. Faulty AUX101- Differential

1. AUX101 isn't communicating differential current protection relay state properly and/or is falsely presenting protection relay state as active to PCC. Check wiring and connections to AUX101 or refer to AUX101 troubleshooting with respect to the protection relay times.

5.10.148 Fault Code 3411 - DC Power Supply Fault

NOTICE
Due to AUX101 sensed DC power supply unit (PSU) state is below inactive threshold lower limit for the duration of DC PSU Dwell Time.

A. Inadequate DC PSU Dwell Time

1. Via InPower, verify and adjust DC PSU Dwell Time (default = 5 seconds) to permit surge power recovery or battery charger engagement to attain voltage within inactive threshold limits. Note that a high DC PSU Dwell Time may mask DC power supply issues.

B. Faulty or Poor DC Power Supply

1. Check source state of charge and physical condition as faulty or poor component state has resulted in voltage below AUX101 inactive threshold lower limit. Clean and replace as necessary.

C. Faulty DC Power Supply to AUX101 Wiring

1. Check for continuity in powered mode, between DC PSU and AUX101 (including but not limited to fuses and key switches) as failed component resulted in voltage below AUX101 inactive threshold lower limit. Repair as necessary.

D. Faulty AUX 101 - DCPCU

1. AUX101 isn't communicating DC PSU properly and/or is falsely presenting DC PSU state as below inactive threshold lower limit to PCC. Check wiring and connections to AUX101 or refer to AUX101 troubleshooting with respect to DC PSU.

5.10.149 Fault Code 3412 - GIB Isolator Open Fault

NOTICE
Due to AUX101 sensed generator interface box (GIB) isolator switch state is active (open).

A. GIB Isolator Switch is Open

1. Close the GIB doors to engage the switch body with switch mechanism and rotate the switch until aligned with the closed symbol to change the switch state to inactive (closed).

B. Faulty GIB Isolator Switch or Wiring

1. Check all wiring and measure switch state resistances to ensure proper contact as failed component or wiring to AUX101 is mimicking an active isolator switch. Repair as necessary.

C. Faulty AUX 101- GIB

1. AUX101 isn't communicating GIB isolator switch state properly and/or is falsely presenting switch state as active to PCC. Check wiring and connections to AUX101 or refer to AUX101 troubleshooting with respect to GIB isolator switch state.

5.10.150 Fault Code 3414 - Ventilator Fan Trip

⚠ WARNING

Moving Parts

Moving parts can cause severe personal injury.

To prevent personal injury, turn off and remove power while troubleshooting.

NOTICE

Due to AUX101 sensed active ventilator fan circuit protection state during fan run command active from PCC.

NOTICE

Ventilator fans are site-specific, not genset-specific; be sure to refer to plant wiring diagrams when available.

A. Inadequate Circuit Protection

1. Check fan wiring and circuit protection device(s) are sized to suit circuit's current capability as faulty component resulted in active circuit protection. Replace as necessary.

B. Faulty Ventilator Motor or Wiring

1. Check the wiring for loose connections, short circuits, or stuck motors resulting in active circuit protection. Replace and repair as necessary.

C. Faulty Aux 101 - Ventilator Fan Trip

1. AUX101 isn't communicating ventilator fan circuit protection state properly and/or is falsely representing circuit protection state as active to the control module. Check wiring and connections to AUX101 or refer to AUX101 troubleshooting with respect to ventilator circuit protection.

5.10.151 Fault Code 3415 - Louvre Closed

NOTICE

Due to AUX101 sensed active ventilation louvre closed switch state for the duration of the Louvre Closed Dwell Time.

A. Louvre Didn't Open

1. Clear obstruction and/or fix damaged louvre and movement driving mechanisms to ensure unrestricted movement beyond the louvre position switch inactive threshold.
2. Verify wiring and connections between louvre motor control relay and louvre motor are proper to enable movement beyond the louvre position switch inactive threshold; Repair as needed.

B. Faulty Louvre Position Switch Or Wiring

1. Check wiring between AUX101 and louvre position switch for short circuits that may mimic position below switch inactive threshold. Replace and/or repair as needed.
2. Correspond switch active/inactive states with louvre position via resistance measurement across switch terminals.
   a. Disconnect all connections to louvre position switch.
   b. Attach DVOM test leads to louvre position switch terminals to measure electrical resistance.
   c. Prepare DVOM to measure electrical resistance.
   d. Measure and note switch resting resistance (louvre closed) = active resistance.
   e. Open louvre beyond louvre position switch inactive threshold.
   f. Measure and note switch resistance (louvre open) = inactive resistance.
   g. Replace switch if active resistance = inactive resistance.

C. Inadequate Louvre Closed Dwell Time

1. Via InPower, verify/adjust Louvre Closed Dwell Time (default - 100 seconds) so-as to permit position switch to attain inactive and stable state. Mind time required for complete louvre opening. Note that a high Louvre Closed Dwell Time may mask louvre mechanism issues.

D. Faulty AUX 101

1. AUX101 isn't communicating Louvre position switch state properly and/or is falsely representing state to the control module. Check wiring and connections to AUX101 or refer to AUX101 troubleshooting with respect to louvre closed protection.

5.10.152 Fault Code 3416 - Start System

See the troubleshooting procedures for fault code 359 or 1438.

5.10.153 Fault Code 3417 - Alternator Heater Trip

NOTICE
Due to AUX101 sensed active alternator heater circuit protection state during alternator heater control active from PCC.

A. Inadequate Circuit Protection

1. Check heater wiring, heater relays and circuit protection device(s) are sized to suit circuit's current capability as faulty component resulted in current greater than heater circuit protection active threshold. Replace as necessary.

B. Faulty Alternator Heater or Wiring

1. Check the following circuits, repair as needed:
   a. AUX101 to alternator heater relay input for loose connections and short circuit between wires as fault will result in failure to deliver the electrical current required to close the alternator heater relay switch and mimic alternator heater current greater than circuit protection active threshold.

b. AUX101 to alternator heater relay sense for loose connections and short circuit between wires as fault will result in failure to report alternator heater circuit current and mimic alternator heater current greater than circuit protection active threshold.

c. Alternator heather circuit protection to alternator heater relay for short to ground as fault will result in alternator heater current greater than circuit protection active threshold.

C. Faulty Alternator heater Relay

1. Check that the alternator heater relay for closure when AUX 101 input is applied by measuring resistance of relay's high current circuit; replace if open as fault will mimic circuit protection active.

D. Faulty AUX101

1. AUX101 isn't communicating alternator heater circuit current properly and/or is falsely representing state to the control module. Check wiring and connections to AUX101 or refer to AUX101 troubleshooting with respect to alternator heater circuit protection.

5.10.154 Fault Code 3457 - Loss of Bus Voltage Sensing

An open circuit condition exists in all 3 phases of the bus voltage sensing in Isolated Bus or Utility Multiple applications.

A. Genset Bus Voltage Sensing Connections Are Open Circuit Or Incorrectly Wired At The Base Board

1. The purpose of this event/fault code is to prevent the generator set circuit breaker from closing to a live bus, but it appears to the controller to be dead. Check and ensure that the following are OK: TB7 is securely connected to the base board, bus fuses have been closed after troubleshooting/maintenance procedures, blown bus fuses have been checked and replaced as needed, and if applicable, disconnected medium voltage set of PTs have been reconnected.

2. If the nominal voltage is 600 VAC or lower, ensure that the voltage sensing connections are correct.

   a. Measure the phase rotation, frequency, and voltage input into the base board from the Genset bus at: L1, TB7-1; L2, TB7-2; and L3, TB7-3. The voltage and frequency should match the Genset bus nominal voltage and frequency. The phase rotation should be "L1-L2-L3" at TB7-1, TB7-2, and TB7-3 on the base board; for proper phase rotation measurement procedures, refer to the phase rotation meter instructions. If the phase rotation, voltage and/or frequency are not correct, re-check the wiring.

3. If the nominal voltage is over 600 VAC, check the voltage sensing connections from the base board to the PT and the PT to the Genset bus.

   a. Measure the phase rotation, frequency, and voltage input into the base board from the PT (Potential Transformer) at: L1, TB7-1; L2, TB7-2; and L3, TB7-3. The voltage input into the base board should match the secondary voltage of the PT (for example, if the PT ratio is 13,800:240, the voltage measured at the base board should be 240 VAC). The phase rotation at TB7-1, TB7-2, and TB7-3 should be "L1-L2-L3" for proper phase rotation measurement procedures; refer to the phase rotation meter instructions. The frequency should match the Genset bus nominal frequency. If the phase rotation, frequency, and/or voltage are not correct at the base board, correct the wiring from the base board to the PT.

B. kW Load Share And kVAR Lines Are Switched

1. Ensure kW load share line on genset 1 is connected to kW load share line on genset 2 and kVAR load share is connected to kVAR it will cause this fault code.

C. Faulty PT

⚠ WARNING
Hazardous Voltage
Contact with high voltages can cause severe electrical shock, burns, or death.
Make sure that only personnel who are trained and qualified to work on this equipment are allowed to operate the generator set and perform maintenance on it.

1. Ensure that the control is set up with the correct PT ratio (primary vs. secondary). Reference event/fault code 2816 for troubleshooting information on the PT ratio. To access the PT Ratio configuration menu on the operator panel go to **Setup > OEM Setup > OEM ALT Setup > PT Primary or PT Sec** and set the PT ratio appropriately for the application.
2. With a calibrated voltage meter, measure the voltage output of the PT. The output of the PT should match the ratio of the PT; ex. Outputs: L1=120, L2=120, L3=120. If the outputs of the PT are incorrect, replace the PT once the generator set has been properly grounded by a qualified electrician.

5.10.155 Fault Code 4872 - System Network Failure

The generator set has lost network communications with all generator sets on the s-CAN network.

MLD Response:

When this fault is present all generator sets will start and connect to the bus, but will not operate load demand. The Load Demand State will change to Halted. If three or more generator sets exist on the network, the other generator sets in the system rather than the generator set with this warning will have Generator Set Lost on System Network (4876). If only two generator sets exist on the network, both will show this warning.

A. Incorrectly wired connections on the s-CAN network

Make sure that s-CAN network wires are securely landed in TB3 and have no external damage.

Verify that:

1. s-CAN shield ground is landed securely in TB3-1.
2. s-CAN isolated ground is landed securely in TB3-2.
3. s-CAN L is landed securely in TB3-3.
4. s-CAN H is landed securely in TB3-4.

B. Improper Installation Of The S-CAN Network

1. If using local termination resistors in the board, verify that only the termination resistors of the generator sets that are at both ends of the system are on, the termination resistors of the rest of the boards should be off.
2. Verify the interconnection harness (s-CAN cable) of the s-CAN bus to make sure there is no interruption of the s-CAN signal to the generator set that is affected.

3. If using external terminator resistors, disconnect power from the PCC 3300 board and measure ohms between TB3-3 and TB3-4, should get 55 to 65 ohms indicating that a 120 ohm resistor is on each end of the system.
4. If using local termination resistors in the board, isolate the board from the network and measure the resistance between TB3-3 and TB3-4. The resistance should be between 110 and 130 ohms.
5. Verify that the cable used for s-CAN network meets the J1939-11 standards (type Belden 3106A) or equivalent.
6. Verify that the total length of the s-CAN bus is no longer than 200 meter.
7. Refer to (CAN Network Troubleshooting Recommendations) for additional details on how troubleshoot CAN network.

NOTICE
If an external termination resistor is being used, the switch activated termination resistor on the PCC3300MLD control should be turned Off. The combination of active switch-activated and external termination resistors must be 2

5.10.156 Fault Code 4873 - Generator Set Failed to Come Online

A generator set running on MLD mode failed to come online within the load demand generator set failed delay period.

MLD Response:

If available, another generator set will start up to replace the generator set that failed to come online.

A. The generator set that failed to come online has an active shutdown that prevented the generator set from starting, or the generator set is having trouble starting (low battery, out of fuel, and etc.)

1. Locate the generator set that Failed to come online (Indicated as Failed on the Load Demand System Status Screen) and troubleshoot any active fault on the generator set by referring to the specific troubleshooting procedure for the active fault. Check for any problems that might prevent the generator set for starting (low battery, out of fuel, etc.).

NOTICE
If the generator set is eventually able to come online, it will no longer appear as failed on the Paralleling Status (8/9) screen.

B. The Generator Sets On The S-CAN Network Have Different Settings

1. Verify system settings are In sync by using Inpower service tool or by setting (Sync System Settings) to Yes in HMI paralleling setup screen 7 of 9. (See Masterless Load Demand Status Screen).

C. The Time Delay (LD Time Delay) Is Set Too Short

1. Verify that the load demand generator set fail Delay (LD Gen Fail Delay) is not set lower than the time the generator set takes to normally come online, depending on what type of generator set on the system; the time required for a generator set to come online will vary. Increase this time delay as required.

D. The Expected-To-Come-Online Generator Set Has Trouble Synchronizing To The Bus

1. If the generator set that fails to synchronize to the system has an active fault code 1457 Fail To Synchronize, reference fault code 1457 to troubleshoot the fault

E. The Generator Set CB Inhibit Signal To The Generator Set Is Active Which Prevents The Breaker From Closing

1. If any of the configurable inputs on the PCC are set to a Generator Set CB inhibit, verify that those configurable inputs are not active

NOTICE
The default input for generator set CB inhibit is TB10-11.

5.10.157 Fault Code 4874 - Load Demand Software Version Incompatibility

There is an incompatibility in MLD versions, between two or more generator sets on the s-CAN network.

NOTICE
MLD does not require all generator sets to have the same software version to operate. This fault is independent of software version; however the two may be linked.

MLD Response:

All generator sets will start up but Load Demand State (LD State) will indicate the generator set as halted, MLD no longer operates.

NOTICE
MLD does not require all generator sets to have the same software version to operate.

A. Generator Sets In The MLD System Have Different MLD Versions That Are Incompatible

1. Perform an update calibration on each generator set in the network to the latest released calibration, starting at the generator set with the oldest software version until the issue is resolved.

5.10.158 Fault Code 4875 - Generator Set Ineligible for Load Demand

A networked generator set on the s-CAN Network has transitioned to Ineligible.

NOTICE

By default the response of this fault is set to None. The fault response for this fault must be set to warning for this fault to be declared.

MLD Response:

If a generator set becomes ineligible for load demand the MLD system bus will bring the next priority generator set online. When the ineligible generator set is again eligible, the MLD system will again utilize that generator set based on its assigned priority and start and stop generator set as required.

A. Generator Set Not In Auto

Find the generator set with LD State status set to Ineligible, HMI320 Paralleling Status menu and verify that all conditions for a generator set to be eligible for use in load demand are met.

1. Make sure that the generator set is running in Auto mode by setting the control switch position to Auto.

B. Load Demand Generator Set Enable (trim) Set To Disable

Find the generator set with LD State status set to Ineligible, HMI320 Paralleling Status menu and verify that all conditions for a generator set to be eligible for use in load demand are met.

1. Verify with InPower or through the HMI paralleling/Basic setup 9/9 menu that the LD Gen Enable trim is set to Enable.

C. The Generator Set Does Not Have A Remote Start Command

Find the generator set with LD State status set to Ineligible, HMI320 Paralleling Status menu and verify that all conditions for a generator set to be eligible for use in load demand are met.

1. Verify if the generator set is getting a remote start command via wired input, system remote start, or through a Modbus command. The Remote Start LED on the HMI320 will be on or blinking when a valid Remote Start command exists.

D. Inadequate Generator Set Application

1. Make sure that the Generator Set Application type is set to Isolated Bus.

E. Active Shutdown Fault

1. This fault is activated as a result of another shutdown fault. Troubleshoot the other shutdown fault(s) that are causing the generator set to shut down.

F. Load Demand Stop Input Is Active

Find the generator set with LD State status set to Ineligible, HMI320 Paralleling Status menu and verify that all conditions for a generator set to be eligible for use in load demand are met.

NOTICE

The default input for Load Demand Stop is Configurable Input 31.

1. Verify that the Load Demand Stop Input/Modbus command is Inactive.

G. Generator Set Circuit Breaker Inhibit Command Is Active

Find the generator set with LD State status set to Ineligible, HMI320 Paralleling Status menu and verify that all conditions for a generator set to be eligible for use in load demand are met.

NOTICE
The default input for generator set CB inhibit is TB10-11.

1. If any of the configurable inputs on the PCC are set to a Generator Set CB inhibit, verify that those configurable inputs are not active.

5.10.159 Fault Code 4876 - Generator Set Lost on System Network

Network communications have been lost to one or more generator sets, but the network is still active (two or more generator sets are still communicating). This fault can only occur if three or more generator sets exist on the s-CAN network.

NOTICE
If only one generator set lost communications with all generator sets on the network, that generator set will indicate a System Network Failure (4872) warning, while the rest of the generator sets indicate a Generator Set Lost on System Network (4876) fault.

NOTICE
If a break occurs between two groups of communication generator sets, each group may continue to communicate within their group. In this scenario the disconnected groups of networked generator sets will indicate all generator sets of the disconnected group as Lost.

MLD Response:

All generator sets will start. The Load Demand state will change to halted. The generator set(s) that is/are no longer communicating on the network will be indicated as Lost.

A. Incorrectly Wired Connections On The s-CAN Network

1. Make sure that s-CAN network wires are securely landed in TB3 and have no external damage.

   Verify that:

1. s-CAN shield ground is landed securely in TB3-1.
2. s-CAN isolated ground is landed securely in TB3-2.
3. s-CAN L is landed securely in TB3-3.
4. s-CAN H is landed securely in TB3-4.

B. Improper Installation Of The s-CAN Network

NOTICE

If an external termination resistor is being used, the switch activated termination resistor on the PCC3300MLD control should be turned Off. The combination of active switch-activated and external termination resistors must be 2.

1. Verify a proper installation of the s-CAN communication cable.
   a. If using local termination resistors in the board, verify that only the termination resistors of the generator sets that are at both ends of the system are on, the termination resistors of the rest of the boards should be off.
   b. Verify the interconnection harness (s-CAN cable) of the s-CAN bus to make sure there is no interruption of the s-CAN signal to the generator set that is affected.
   c. If using external terminator resistors, disconnect power from the PCC 3300 board and measure ohms between TB3-3 and TB3-4, should get 55 to 65 ohms indicating that a 120 ohm resistor is on each end of the system.
   d. If using local termination resistors in the board, isolate the board from the network and measure the resistance between TB3-3 and TB3-4. The resistance should be between 110 and 130 ohms.
   e. Verify that the cable used for s-CAN network meets the J1939-11 standards (type Belden 3106A) or equivalent.
   f. Verify that the total length of the s-CAN bus is no longer than 200 meter.
   g. Refer to *[CAN Network Troubleshooting Recommendation]* for additional details on how troubleshoot CAN network.

C. Power Is Lost To One Or More Generator Sets On The s-CAN Network

1. Verify that all generator sets on the network have adequate battery voltage, HMI320s are communicating and displaying information, and LEDs on the PCC3300 are active.

D. An Improper Update Calibration Was Performed On The Generator Set And It Is No Longer Functioning

NOTICE

See *[MLD Service Procedures]* for information on how to remove and return a generator set to the network.

1. Verify that the generator set control functions (generator set starts and stops, and HMI320 is showing valid information). Perform an update or initial calibration if required.

5.10.160 Fault Code 4877 - System Settings Not Synchronized

There is a discrepancy between system settings on the system network (s-CAN). A Synchronize System Settings (Sync System Settings) operation from a generator set controller with the desired settings is needed to clear the fault.

MLD Response:

The MLD system will decide which generator set to turn on and off based on the system settings in the 'acting master'. This will be the generator set with the lowest priority communicating to network. Operation of the system may not be consistent when viewed from all HMI screens.

A. An Updated Calibration

1. Go to a generator set with the desired settings and Synchronize (broadcast) system setting from that generator set. The synchronization can be done through the HMI Paralleling/Basic Setup menu (7/9) or by using the service tool.

B. System Settings Status (System Settings Status) is set to Out of Sync

1. Go to a generator set with the desired settings and Synchronize (broadcast) system setting from that generator set. The synchronization can be done through the HMI Paralleling/Basic Setup menu (7/9) or by using the service tool.

C. A New Generator Set Was Added To The s-CAN Network

1. Go to a generator set with the desired settings and Synchronize (broadcast) system setting from that generator set. The synchronization can be done through the HMI Paralleling/Basic Setup menu (7/9) or by using the service tool.

D. System Settings Were Modified While The Generator Set Was Running And, The Control Has Lost Power Or Battery Was Disconnected While Running.

1. Go to a generator set with the desired settings and Synchronize (broadcast) system setting from that generator set. The synchronization can be done through the HMI Paralleling/Basic Setup menu (7/9) or by using the service tool.

5.10.161 Fault Code 4878 - Check System Network Installation

Switch S1 is switched On in more than two controls in the s-CAN Network, or the s-CAN Network Datalink status has been active for at least 20 seconds and a degraded system network connection has been detected by the controller due to errors in communication detected on the s-CAN network.

MLD Response:

The MLD system will continue to run with this warning active. MLD data updates may be delayed.

This warning provides early detection of potential issues on the s-CAN bus. If uncorrected, this fault may progress into more serious network failure (i.e. code 4872 or code 4876).

A. Incorrectly Wired Connections On The s-CAN Network

1. Make sure that s-CAN network wires are securely landed in TB3 and have no external damage.

   Verify that:

1. s-CAN shield ground is landed securely in TB3-1.
2. s-CAN isolated ground is landed securely in TB3-2.
3. s-CAN L is landed securely in TB3-3.
4. s-CAN H is landed securely in TB3-4.

B. Improper Installation Of The s-CAN Network

NOTICE
If an external termination resistor is being used, the switch activated termination resistor on the PCC3300MLD control should be turned Off. The combination of active switch-activated and external termination resistors must be 2.

1. Verify a proper installation of the s-CAN communication cable.
   a. If using local termination resistors in the board, verify that only the termination resistors of the generator sets that are at both ends of the system are on, the termination resistors of the rest of the boards should be off.
   b. Verify the interconnection harness (s-CAN cable) of the s-CAN bus to make sure there is no interruption of the s-CAN signal to the generator set that is affected.
   c. If using external terminator resistors, disconnect power from the PCC 3300 board and measure ohms between TB3-3 and TB3-4, should get 55 to 65 ohms indicating that a 120 ohm resistor is on each end of the system.
   d. If using local termination resistors in the board, isolate the board from the network and measure the resistance between TB3-3 and TB3-4. The resistance should be between 110 and 130 ohms.
   e. Verify that the cable used for s-CAN network meets the J1939-11 standards (type Belden 3106A) or equivalent.
   f. Verify that the total length of the s-CAN bus is no longer than 200 meter.
   g. Refer to *[CAN Network Troubleshooting Recommendation]* for additional details on how troubleshoot CAN network.

5.10.162 Fault Code 4879 - Load Demand Setup Error

An improper %kW or kW setup condition exists with regard to Load Demand Settings.

MLD Response:

All generator sets will turn on.

A. Improper Setup of Load Demand Settings

1. Verify that Load demand settings are set correctly:
   a. Verify system settings are In sync through the HMI Paralleling/Basic Setup Menu (7/9) or using the service tool.
   b. From the HMI Paralleling/Basic Setup Menu (7/9) or from the service tool, determine the setting of the Load Demand Threshold Method (Threshold Method):
      - If the Load Demand Threshold Method (Threshold Method) is %kW, make sure the Load Demand Start Threshold (%kW) (Start Thresh %kW) is greater than the Load Demand Stop Threshold (%kW) (Stop Thresh %kW) by at least 5%.
      - If the Load Demand Threshold Method (Threshold Method) is kW, make sure Load Demand Stop Threshold (kW) (Stop Thresh kW) is greater than Load Demand Start Threshold (kW) (Start Thresh kW).
   c. After the changes are made, set Synchronize System Settings (Sync System Settings) to Yes, to propagate settings to all generator sets in the network.

5.10.163 Fault Code 5145 - Load Demand Generator Set Bus Failure

The generator set AC bus fails while Load Demand is running (AC Bus < 20% of Nominal).

MLD Response:

All generator sets will restart.

MLD operation will resume once all generator sets are online and the initial Load Demand Start Delay Timer (Start Dly Tmr) has expired.

A. System Load Exceeded System Capacity

1. If fault code 4882 - Generator Set Bus Overload is active, refer to *[Fault Code 4882 - Diagnosis and Repair]* for troubleshooting the fault.

B. One Or More Online Generator Sets Had A Shut Down Failure

1. Locate the generator set that failed to come online (Indicated as Failed on the Load Demand System Status Screen) and troubleshoot any active fault on the generator set by referring to the specific troubleshooting procedure for the active fault.

C. System Remote Start Is Set To Enable, And The Generator Set With The Single Remote Start Input Is Removed Or Lost On The s-CAN Network

1. Determine if System remote start is being used. If this is set to enable and there is a network failure on the s-CAN network, all generator sets in the network will shutdown as they will lose their remote start command. Refer to *[System Remote Start]* and *[Load Demand System Settings]* for additional details on the system remote start feature, see *[Fault Code 4872 - System Network Failure]*, *[Fault Code 4876 - Generator Set Lost on System Network]*, or *[Fault Code 4878 - Check System Network Installation]* for information on how to diagnose and repair s-CAN network failures.

D. Load Demand Settings Are Not Properly Configured To Respond To Changes In Load On The System Leading To A Generator Set Bus Overload

1. Load Demand start delay timers are set incorrectly (too long).
2. Load Demand Stop delay timers are set incorrectly (too short).
3. Load Demand Stop threshold is set incorrectly (too low).

Verify each Load Demand parameter is correctly set to meet the needs of the system.

E. Low load And MLD Settings Result In The System Having Only One Generator Set Online Followed By A Generator Set Shutdown. (Loss of remote start, generator set fault, etc.)

1. Set the Load Demand Stop Threshold (kW) (Stop Thresh kW) to a value greater than the rating of a single generator set to ensure system redundancy.

5.10.164 Fault Code 6598 - At Least One ACK:Mod Severe Fault

Fault code 6598 (acknowledged engine fault): One or more acknowledged Engine Shutdown Faults are active.

6 Generator Set Subsystems

6.1 Engine Control Module (ECM)

The Engine Control Module (ECM) monitors signal inputs from engine sensors to control the fuel metering and speed of the engine (see figure below). The ECM also provides diagnostic control over the engine and fuel system. The Generator Set Control Module controls the starting and stopping sequence of the engine through the ECM.

In the event of an engine fault, the ECM provides a signal output, via the CAN datalink, to the Generator Set Control Module. If the ECM triggers an engine shutdown, the Generator Set Control Module displays an engine shutdown or service fault. The Generator Set Control Module will display an additional fault to determine the root cause of the engine shutdown. If no additional fault is displayed in the Generator Set Control Module, the engine fault code can be determined by connecting to the ECM with the INSITE service tool.

The wiring harness and INSITE software required to perform engine diagnostics are available from your authorized distributor.

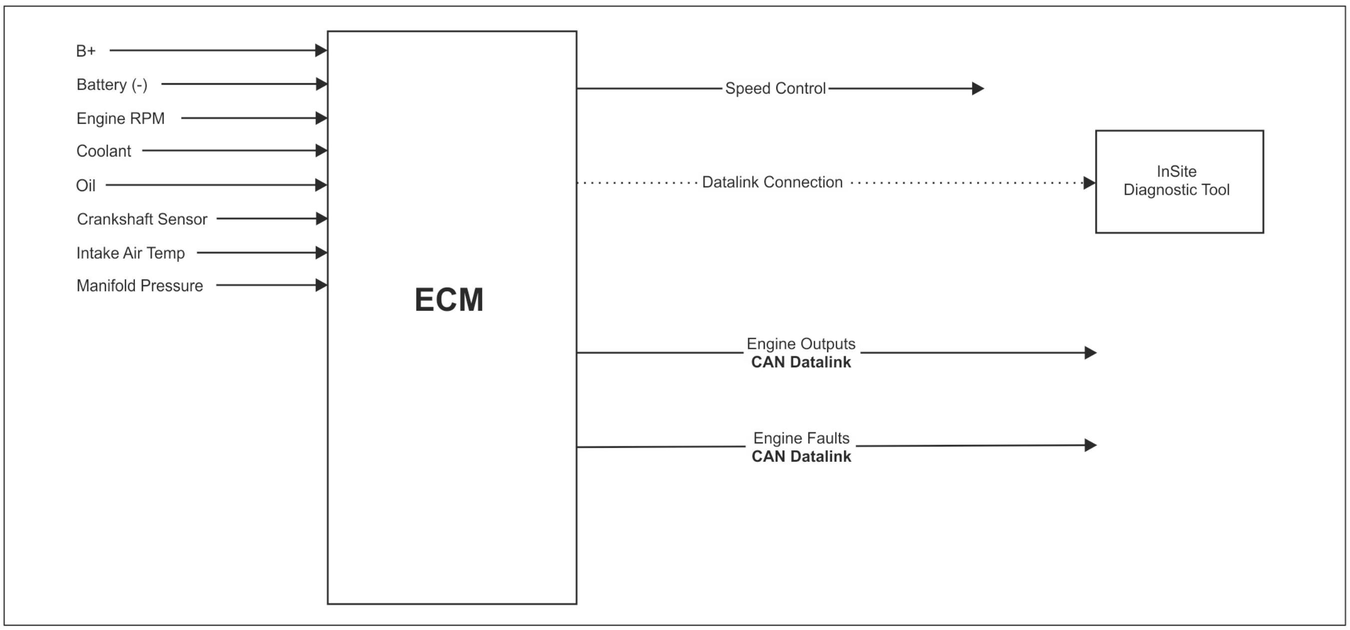


FIGURE 7. ECM INPUT AND OUTPUT

6.1.1 Keyswitch Control

The Keyswitch input to the ECM remains active during all controller modes other than when the Sleep Mode is active or the Emergency Stop is engaged. The PCC sends a start signal to the ECM via the Keyswitch Relay and the Start Relay. When the PCC detects a start command, both relays become charged, sending the start signal to the ECM, causing the engine to crank.

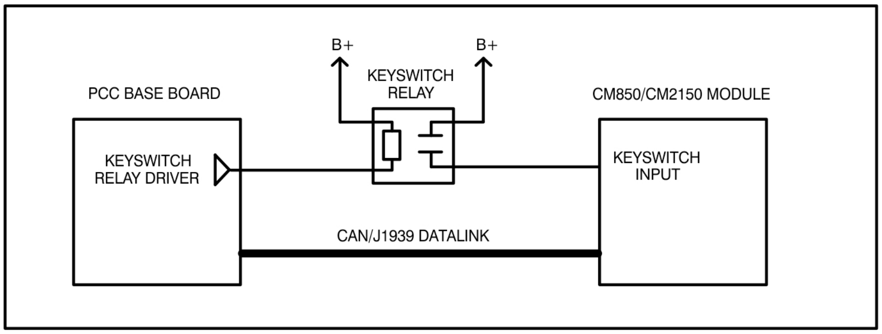


FIGURE 8. CONTROL SYSTEM BLOCK DIAGRAM

6.2 Alternator

6.2.1 S9 Alternators

6.2.1.1 General Description

S9 alternators are of brushless rotating field design, available in the following ranges:

- Low Voltage (LV) up to 1000 V, 50 Hz (1500 RPM, 4 pole) and 1000 V, 60 Hz (1800 RPM, 4 pole).
- Medium Voltage (MV) up to 3.3 kV, 50 Hz (1500 RPM, 4 pole) and 4.16 kV, 60 Hz (1800 RPM, 4 pole).
- High Voltage (HV) up to 13.8 kV, 50 Hz (1500 RPM, 4 pole) and 13.8 kV, 60 Hz (1800 RPM, 4 pole).

S9 alternators have an excitation system which uses various AVR's, powered by a Permanent Magnet Generator (PMG).

6.2.1.2 Environment

The alternators are protected to IP23 as standard. IP23 is not adequate protection for use outdoors without additional measures.

TABLE 15. ENVIRONMENTAL SPECIFICATION

Ambient Temperature	-15 °C to 50 °C (5 °F to 122 °F)
Relative Humidity	< 70%
Altitude	< 1000 m (3280 ft)

The alternator has been designed for the environment shown in the table. The alternator can operate outside these conditions if it is rated accordingly; the nameplate gives details. If the operating environment is changed after purchase, refer to the factory for a revised alternator rating.

6.2.1.3 Air Flow

TABLE 16. S9 LV, MV, HV MINIMUM AIR FLOW AND MAXIMUM PRESSURE DIFFERENCE

Alternator model and frequency	Minimum Air flow, m^3/s (ft^3/min)		Maximum intake to outlet pressure difference, mm (in) water gauge
	50 Hz	60 Hz	
S9 (All Variants)	2.78 (5890)	3.33 (7056)	13 (0.5)

Make sure that the air inlets and outlets are not obstructed when the alternator is running.

6.2.1.4 Airborne Contaminants

⚠ **CAUTION**

Dust & Airborne Particles/Fumes

Dust and other airborne particles and fumes can cause minor or moderate injury by irritating the lungs and eyes. Prolonged or repetitive exposure can cause serious medical conditions. To prevent injury:

- ***Use mechanical vacuum extraction to remove dust and airborne particles or fumes.***
- ***Ventilate the area fully.***
- ***Always wear the appropriate personal protective equipment. Refer to Safety Precautions Chapter.***

NOTICE

Contaminants such as salt, oil, exhaust fumes, chemicals, dust, and sand will reduce the effectiveness of the insulation and the life of the windings. Consider using air filters and an enclosure to protect the alternator.

6.2.1.5 Air Filters

Air filters trap airborne particulates above 5 microns. The filters must be cleaned or replaced regularly, depending on site conditions. Check the filters frequently to establish an appropriate service interval.

Alternators with factory-fitted filters are rated to account for the reduced flow rate of cooling air. If filters are retrofitted, the alternator rating must be reduced by 5%.

Air filters do not remove water. Keep the filters dry with additional protection. Wet filters further restrict airflow, causing the alternator to overheat and leading to premature failure of the insulation.

6.2.1.6 Humid Conditions

The water carrying capacity of air depends on temperature. If the air temperature falls below its saturation point, dew may form on the windings, reducing the electrical resistance of the insulation. In humid conditions, additional protection may be required even if the alternator is fitted inside an enclosure. Anti-condensation heaters are supplied on request.

6.2.1.7 Anti-Condensation Heaters

⚠ **DANGER**

Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:

- ***Shut down and isolate the alternator from all energy sources.***
- ***Remove or isolate stored energy.***
- ***Test isolated parts for electrical isolation using a suitable voltage tester.***
- ***Use lock out/tag out safety procedures.***

⚠ WARNING

Condensed Water

Operating an alternator with condensed water in the windings can cause serious injury by electric shock, burns or exposure to flying debris and particles. To prevent injury and before operating the alternator:

- ***Use anti-condensation heaters (if fitted) to prevent condensation accumulating.***
- ***Check for condensed water.***
- ***If condensed water is present, drain/remove the water, dry and inspect the alternator, refer to: Maintenance and Servicing Chapter.***

⚠ WARNING

Hot Surfaces and Fire

Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:

- ***Avoid contact with hot surfaces.***
- ***Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.***
- ***Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).***
- ***Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.***

Power to the anti-condensation heater is supplied from a separate source. Anti-condensation heaters raise the air temperature around the windings to deter condensation forming in humid conditions when the alternator is not operating. Best practice is to energize the heaters automatically when the alternator is off.

6.2.1.8 Enclosures

⚠ WARNING

Enclosures

Alternators may be installed within an enclosure for environmental protection, noise reduction or transportation reasons. Before entering the enclosure to prevent injury or death, personnel must:

- ***Know the related hazards / risks.***
- ***Have a safe access route in to and out of the enclosure, have sufficient ventilation and obey the alternator hazard zones.***
- ***Wear the appropriate protective equipment.***

Additionally when working with Medium or High Voltage alternators:

- ***Enter the enclosure when the alternator is operating, only if absolutely necessary.***
- ***To minimize risks to personnel use remote diagnostic, monitoring and measuring systems.***

⚠ WARNING

Water ingress during rainy season could lead to electrical shock near alternator, and other electrical components.

- Fit an enclosure to protect the alternator from adverse environmental conditions.
- Make sure that air entering the alternator is of adequate flow rate, free from moisture and contaminants and below the maximum ambient temperature on the rating plate.
- The airflow should be modeled to identify and prevent hot air from re-circulating within the enclosure.
- Make sure there is sufficient access around the alternator for safe maintenance.

6.2.1.9 Vibration

The alternators are designed to withstand the vibration levels encountered on generator sets built to meet the requirements of ISO 8528-9 and BS 5000-3. (Where ISO 8528 is taken to be broad band measurements and BS5000 refers to the predominant frequency of any vibrations on the generator set).

NOTICE

Exceeding either of the above specifications will have a detrimental effect on the life of the bearings and other components and may invalidate the alternator warranty.

NOTICE

The terminal box is designed to support the fitted busbars or terminals, transformers, load cables and auxiliary terminal box. Additional mass could cause excessive vibration and lead to failure of the terminal box enclosure and mounting. Refer to the Installation Manual to connect the load cables to the terminal box. Speak to STAMFORD | AvK™ customer services before fixing any additional mass to the terminal box.

6.2.1.9.1 Definition of BS5000–3

Alternators shall be capable of continuously withstanding linear vibration levels with amplitudes of 0.25 mm between 5 Hz and 8 Hz, and velocities of 9.0 mm/s RMS between 8 Hz and 200 Hz, when measured at any point directly on the carcass or main frame of the machine. These limits refer only to the predominant frequency of vibration of any complex waveform.

6.2.1.9.2 Definition of ISO 8528-9

ISO 8528-9 refers to a broad band of frequencies, the broad band is taken to be between 10 Hz and 1000 Hz. The table below is an extract from ISO 8528-9 (Table C.1, value 1). This simplified table lists the vibration limits by kVA and speed for acceptable operation of standard generator set designs.

6.2.1.9.3 Vibration Frequencies

The main vibration frequencies produced by the alternator are as follows:

- 4-pole 1500 RPM 25 Hz
- 4-pole 1800 RPM 30 Hz

Vibrations induced in the alternator by the engine are complex. It is the responsibility of the generator set designer to ensure that the alignment and stiffness of the bedplate and mountings do not allow vibration to exceed BS5000 part 3 and ISO 8528 part 9 limits.

6.2.1.9.4 Linear Vibration Limits

TABLE 17. S9 VIBRATION LEVEL MEASUREMENTS

Linear Vibration Levels As Measured On The Alternator - S9			
Engine Speed RPM (min^{-1})	**Power Output S (kVA)**	**Vibration Displacement RMS (mm)**	**Vibration Velocity RMS (mm/s)**
1 300 $\leq n_r$ $\leq$2 000	>250	0.32	20
The broad band is taken as 10 Hz - 1000 Hz			

6.2.1.9.5 Linear Vibration Monitoring

We recommend using vibration analyzing equipment to measure vibration at the positions shown below. Check that vibration of the generator set is below the limits stated in the standards. If vibration is above the limits, the generator set builder should investigate the root causes and eliminate them. Best practice is for the generator set builder to take initial readings as a reference and for the user to periodically monitor vibration, according to the recommended service schedule, to detect a deteriorating trend.

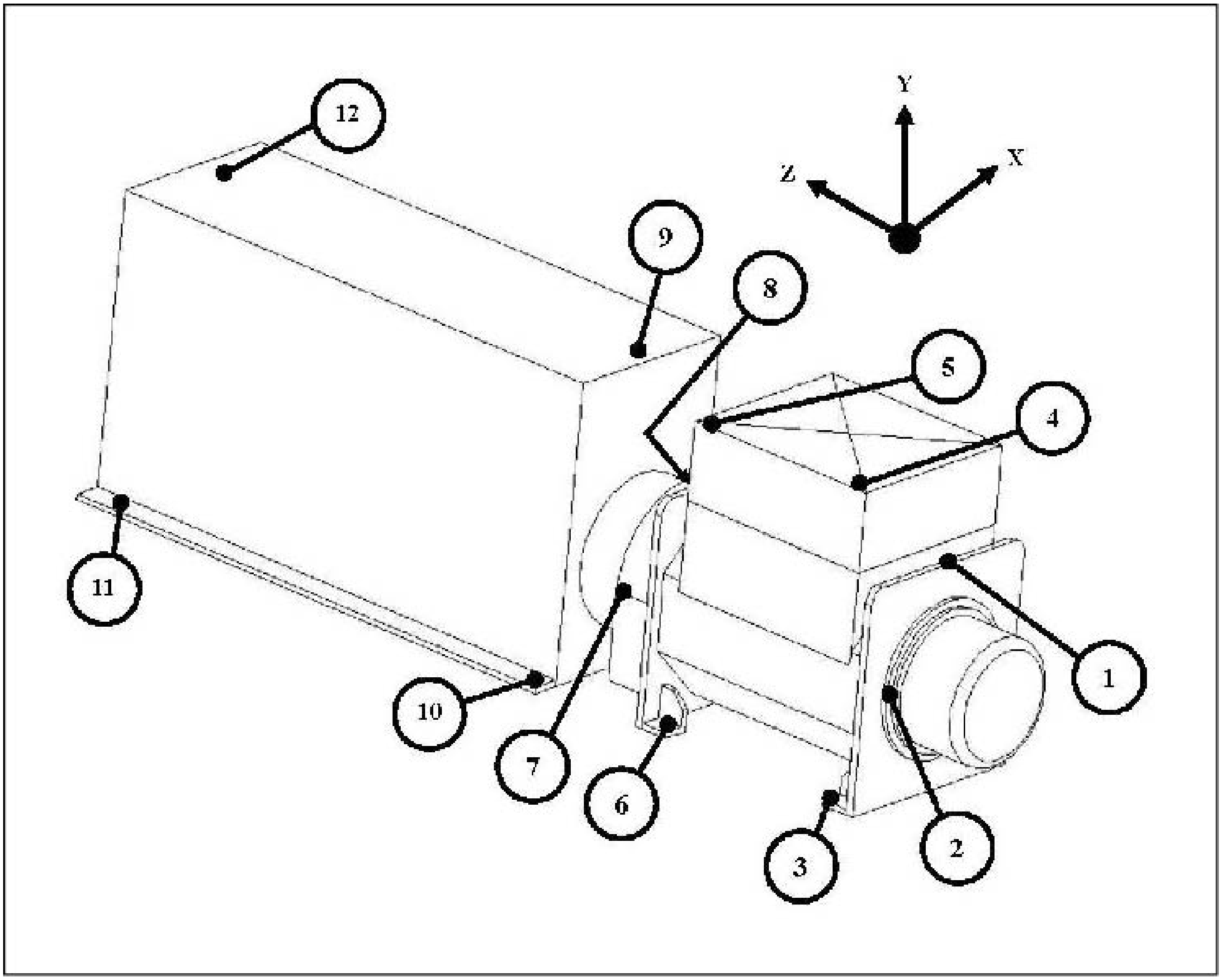


FIGURE 9. VIBRATION MEASUREMENT POSITIONS

6.2.1.9.6 Excessive Vibration

⚠ WARNING
Exposure to Ejected Debris and Particles
Ejected debris and particles can cause serious injury or death by impact, severing or puncturing. Exposure to mechanically driven release of debris and particles exists in all directions (horizontally and vertically) in the areas surrounding the alternator air outlet(s), air inlets(s) and the open shaft end (also commonly known as the Drive End (DE)). To prevent injury or death:
• ***Keep away from the air inlet(s) and air outlet(s) when the alternator is operating.***
• ***Do not position operator controls near the air inlet(s) or air outlet(s).***
• ***Do not cause overheating by running the alternator outside rating plate parameters.***
• ***Do not overload the alternator.***
• ***Do not operate an alternator displaying excessive vibration.***
• ***Do not synchronize parallel alternators outside the specified parameters.***

If the measured vibration of the generator set is not within the limits:

1. Consult with the generator set manufacturer to reduce vibration to an acceptable level.
2. Speak to STAMFORD | AvK™ customer services **www.stamford-avk.com** to assess the impact on bearing and alternator life expectancy.

6.2.1.10 Bearings

6.2.1.10.1 Re-greasable Bearings

Each bearing housing is connected by a grease pipe to an external grease nipple. A label gives the grease type and quantity, and frequency for re-greasing. The recommended grease is a high specification synthetic compound that must not be mixed with grease of a different specification. Refer to the Service and Maintenance chapter for detailed instructions.

6.2.1.10.2 Bearing Life

Factors that reduce bearing life or lead to bearing failure include:

- Adverse operating conditions and environment.
- Stress caused by misalignment of the generator set.
- Vibration from the engine that exceeds the limits in BS 5000-3 and ISO 8528-9.
- Long periods (including transportation) when the alternator is stationary and subjected to vibration can cause false brinelling wear (flats on the balls and grooves on the races).
- Humid or wet conditions that cause corrosion and deterioration of the grease by emulsification.

6.2.1.10.3 Health Monitoring of the Bearings

We recommend that the user checks the bearing condition using vibration monitoring equipment. Best practice is to take initial readings as a reference and periodically monitor the bearings to detect a deteriorating trend. It will then be possible to plan a bearing change at an appropriate generator set or engine service interval.

6.2.1.10.4 Bearing 'Service Life' Expectancy

Bearing manufacturers recognize that the service life of bearings depends on factors that are outside their control. Rather than quote a service life, practicable replacement intervals are based on the L10 life of the bearing, the type of grease, and the recommendations of the bearing and grease manufacturers.

For general purpose applications, if the correct maintenance is carried out, vibration levels do not exceed the levels stated in ISO 8528-9 and BS5000-3, and the ambient temperature does not exceed 50 °C, plan to replace the bearings within 30,000 hours of operation.

If in doubt regarding any aspect of bearing life of a STAMFORD | AvK™ alternator, contact the nearest authorized supplier of the alternator or STAMFORD | AvK™ customer services **www.stamford-avk.com**.

6.2.1.10.5 Replace Bearings

To replace the bearings, do the following procedure:

1. Refer to: **Remove Non-Drive End** section to access NDE bearing.
2. If the DE bearing is to be replaced, refer to: **Remove Drive End** section to access DE bearing.
3. Assemble and fit the new NDE bearing (and DE bearing, as required) onto the rotor shaft, referring to: **Assemble Bearing** section.
4. If the DE bearing has been replaced, refer to: **Assemble Drive End** section to refit DE components.
5. Refer to: **Assemble Non-Drive End** section to refit NDE components.

6.2.1.10.5.1 Requirements

TABLE 18. RE-GREASABLE BEARING REPLACEMENT REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	• Wear appropriate protective equipment as directed by site rules and risk assessment requirements. • Wear heat-resistant gloves for handling heated parts.
Consumables	• Lint-free cleaning cloths • Thin disposable gloves • Washing fluid • Large plastic bags for storing parts • White anti-static assembly surface • Wooden bearers
Parts	• NDE bearing • DE bearing (if fitted) • CGT-recommended grease • CGT-recommended anti-fretting paste • O-rings (if fitted) • Wavy washer • Grease flinger
Tools	• Grease gun (calibrated for volume or mass) • Washing bowl and brush • Induction heater (with protective sleeve on bar) • Torque wrench • Bearing removal tooling • Rotor support packing (nylon strips 4 mm x 60 mm x core length) • Hydraulic cylinder jack and pump • NDE bracket lifting tool • M10 x 120 guide studs x 2 • M12 x 100 bolt x 2 (G-H cores only) • M16 x 100 bolt x 2

6.2.1.10.5.2 Remove Non-Drive End

NOTICE
Delicate exciter leads and temperature sensor leads may be fixed to the inside of the NDE bracket. Note the routing of leads and locations of all fasteners. Detach the leads carefully and keep all fasteners for re-use during assembly. Take care not to damage the leads when removing and storing the NDE bracket.

1. Turn off the anti-condensation heaters and isolate from supply.
2. Clean thoroughly with lint free cloths all tools to be used on greased parts.
3. Remove the air inlet cover or air filter components (if fitted).
4. Remove the grease trap assembly.
5. Remove the fixing bracket for the permanent magnet generator (PMG) control cable.
6. Unplug the PMG control cable.
7. Remove the air inlet mesh.
8. Disconnect the grease pipe.
9. Disconnect the heaters.
10. Disconnect the RTD sensor for bearing temperature.
11. Remove the PMG stator and PMG rotor together as an assembly.
12. Remove the NDE bearing cap assembly.
13. Put the PMG assembly and NDE bearing cap parts into separate plastic bags. Seal the bags to protect the parts from debris.
14. Turn the main rotor so that the NDE keyway is at the top of the rotor shaft. In this position, the lowest rotor pole is vertical and will support the rotor weight when the bearing is removed. If the rotor cannot be turned and no rotor pole is vertical, fit two rotor support packing pieces (see next step) to support the lower two poles.
15. For alternators with a DE bearing, insert a rotor support packing piece into the air gap between the lowest rotor pole and the stator, along the full length of the rotor pole. When the NDE bearing is removed, the packing will keep the rotor near-horizontal to reduce non-radial loading on the other bearing.
16. Withdraw the NDE bearing cartridge fasteners by 10 mm.
17. Support the NDE bracket with a crane and sling, also supporting the NDE bearing assembly and rotor.
18. Remove the NDE bracket fasteners.
19. Use the NDE bracket removal tool to release the NDE bracket from the landing bars – approximately 10 mm movement.
20. Remove the NDE bearing cartridge fasteners.
21. Supported by the crane sling, carefully slide the NDE bracket along the rotor shaft and away from the alternator, without damaging the exciter stator windings on the exciter rotor.
22. Set aside the NDE bracket flat on the floor on wooden bearers, with the exciter stator face up, and remove the crane sling.

6.2.1.10.5.3 Remove Drive End

1. Remove NDE components first and fit rotor support packing piece(s), see **Remove Non-Drive End** section.
2. Remove the upper and lower air outlet screen covers.
3. Disconnect the alternator from the prime mover.
4. Disconnect the grease tube.
5. Disconnect the RTD sensor for bearing temperature.
6. Remove fasteners from DE bearing cartridge.
7. Remove fasteners from DE bearing bracket.
8. Fit M12 x 100 mm bolts to the bearing cartridge jacking holes (G & H cores only)
9. Use a crane sling to lift the rotor at the drive end a small amount, to support its weight.
10. Fit M16 x 100 mm bolts to the jacking holes of the DE bracket (all cores).
11. Gently lower the rotor onto the the support packing and remove the crane sling.
12. Remove the DE bearing bracket along the rotor shaft and away from the alternator.

6.2.1.10.5.4 Assemble Bearing

TABLE 19. S9 HV INITIAL GREASING: GREASE QUANTITY

Quantity of recommended grease										
Bearing Type	Cartridge		Bearing		Bearing Cap Inner		Bearing Cap Outer		TOTAL	
	Vol (cm^3)	Mass (g)	Vol (cm^3)	Mass (g)	Vol (cm^3)	Mass (g)	Vol (cm^3)	Mass (g)	Vol (cm^3)	Mass (g)
Drive End (S9 Core length A, B, C, D)	126	121	252	242	N/A	N/A	126	121	504	484
Drive End (S9 Core length E, F)	180	173	360	346	N/A	N/A	180	173	720	692
Drive End (S9 Core length G, H)	N/A	N/A	188	180	94	90	94	90	376	360
Non-drive End (S9 Core length A, B, C, D, E, F)	157	151	314	302	N/A	N/A	157	151	628	604
Non-drive End (S9 Core length G, H)	182	175	364	350	N/A	N/A	182	175	728	700

1. Remove the wavy washer (NDE only)
2. Expand the grease flinger by local heating with a blowtorch flame.

3. Remove the grease flinger.
4. Remove the circlip (NDE only, if fitted) from the main rotor shaft groove.
5. Remove the bearing cartridge from the main rotor shaft.
6. Use the bearing extraction puller tool to remove the old bearing from the cartridge.
7. Prepare for assembly, by cleaning:
    a. Wipe clean the anti-static assembly surface, using solvent on lint free cloth.
    b. Wash the bearing cartridge, wavy washer and the bearing cap and inspect for contamination.
    c. Wipe off excess washing fluid with a lint free cloth and place all components on the clean anti-static assembly surface.
    d. Thoroughly clean the external surface of the grease gun nozzle using a lint free cloth.
8. Prepare the bearing:
    a. Remove the bearing from its packaging.
    b. Wipe off the preservative oil with a lint free cloth from the surface of the inner and outer rings.
    c. Place the bearing on the clean anti-static assembly surface, with the bearing type identification markings face down.
9. Grease and assemble the bearing components:
    a. Fit a new O ring in the groove in the bearing housing (NDE only), if fitted.
    b. Apply the specified quantity of grease to the back face of the bearing cartridge.
    c. Apply a small amount of grease to the grooved sealing surface in the cartridge.
    d. Without rubbing in, use a lint free cloth to smear anti-fretting paste in a thin coherent layer to the bearing housing circumference.
    e. Apply half the specified quantity of grease to the upper face of the bearing (without the bearing designation markings).
    f. Press the grease into the bearing, ensuring good penetration into the raceways and between the balls.
    g. Assemble the bearing into the bearing cartridge, greased side first, by pressing **ONLY** on the bearing outer race. Ensure the bearing outer race contacts the location shoulder.
    h. Apply the remaining half of the specified quantity of grease to the exposed side of the bearing.
    i. Press the grease into the bearing, ensuring good penetration into the raceways and between the balls.
    j. Apply the specified quantity of grease to the inside face of the bearing cap.
    k. Fill the grease exhaust slot, with grease.
    l. Apply a small amount of grease to the grooved sealing surface in the bearing cap.
    m. Fill the grease pipe and grease nipple with grease.
10. Fit the bearing components:
    a. Expand the bearing and cartridge assembly by heating to between 100 and 110 ºC in the induction heater.
    b. Slide the bearing and cartridge assembly over the rotor shaft, pushing it firmly against the seating shoulder.
    c. Oscillate the assembly (including inner race) 45 degrees in both directions, to ensure bearing is seated. Hold the bearing in place until it cools and contracts onto the rotor shaft.

d. Refit the circlip (NDE only, if fitted) into the main rotor shaft groove.

e. Expand the grease flinger by heating to 100 °C in the induction heater.

f. Slide the grease flinger over the rotor shaft and push it firmly against the bearing assembly. Hold the flinger in place while it cools and contracts onto the rotor shaft.

g. Fit the wavy washer (NDE only).

h. Wait for the bearing and cartridge assembly and flinger to cool to ambient temperature.

6.2.1.10.5.5 Assemble Drive End

1. Insert two guide studs into the DE bearing cartridge. Slide the DE bearing bracket onto the rotor shaft and locate over the DE bearing assembly.
2. Use a crane sling to lift the rotor and DE bearing bracket at the drive end a small amount, to support the weight.
3. Fit the DE bearing bracket onto the frame using the correct hardware and ensure the machined faces are flush. Remove the two guide studs and replace with the remaining two bolts and washers. Apply the correct torque to all fasteners.
4. Reconnect the grease pipe.
5. Reconnect the RTD sensor (if fitted).
6. Recouple the alternator to the prime mover.

6.2.1.10.5.6 Assemble Non-Drive End

NOTICE
Route the delicate exciter leads and temperature sensor leads carefully, and fix securely to the inside of the NDE bracket. Take care not to damage the leads when fitting the NDE bracket.

1. Lift the NDE bracket with a crane and sling.
2. Fit the NDE bearing cap to the NDE bracket.
3. Insert two guide studs into the NDE bearing cartridge.
4. Rotate the NDE cartridge to orientate the grease port and RTD leads for connection.
5. Slide the NDE bracket up to the landing bars, using the studs to align the threaded fastener holes of the NDE bearing cap and cartridge.
6. Fix the NDE bearing cap to the NDE bearing cartridge, removing the alignment studs. Do not fully tighten the fasteners.
7. Gently lift the NDE bracket with a crane and sling, also supporting the NDE bearing assembly and rotor, to align the fasteners with the landing bars.
8. Remove the rotor support packing piece(s).
9. Refit the shims in their original positions. Fix the NDE bracket and fully tighten the NDE bearing cap fasteners. Make sure the bearing and bracket are secure.
10. Gently lower the crane sling to add the full rotor weight onto the bearing and remove the sling.
11. Remove the alternator frame supports.
12. Turn the rotor by hand to check bearing alignment and free rotation.
13. Fix the PMG rotor and the PMG stator.
14. Reconnect the control cable plug.

15. Reconnect the grease pipe.
16. Reconnect the RTD sensor.
17. Fix the PMG control cable fixing bracket.
18. Fix the NDE bearing cap assembly.
19. Fix the air inlet mesh and screen and air inlet cover or air filter components (if fitted).
20. Refit the grease trap assembly.
21. Reconnect the supply to the anti-condensation heaters.

6.2.1.10.6 Standby Applications

Run alternators in standby applications at no load for a minimum of 10 minutes every week. For alternators fitted with re-greasable bearings, re-grease the bearings every 6 months, regardless of the number of accumulated running hours.

6.2.1.11 Installation into the Generator Set

6.2.1.11.1 Alternator Dimensions

Dimensions are included in the data sheet specific to the alternator model. Refer to the rating plate to identify the alternator model.

NOTICE
Data sheets are available from www.stamford-avk.com

6.2.1.11.2 Lifting the Alternator

⚠ DANGER
Falling Mechanical Parts
Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping. To prevent injury or death and before lifting:
• ***Check the capacity, condition and attachment of lifting equipment.***
• ***Check the capacity, condition and attachment of accessories for lifting.***
• ***Check the capacity, condition and attachment of lifting point(s) on the load.***
• ***Check the mass, integrity and stability of the load.***
• ***If available: Install drive end and non-drive end transit fittings to prevent movement and damage to bearings.***
• ***Keep the alternator horizontal when lifting.***
• ***Do not use alternator lifting points for lifting a complete generator set.***
• ***Do not use cooler lifting points for lifting the alternator or a complete generator set.***
• ***Do not remove the lifting label attached to one of the lifting points.***

Lift the alternator by shackles attached to the lifting points (lugs or eyes) provided. A label attached to a lifting point shows the correct lifting arrangement. Use chains of sufficient length, and a spreader bar if necessary, to make sure that the chains are vertical when lifting. Make sure that the capacity of the lifting equipment is sufficient for the alternator mass shown on the label attached to the alternator.

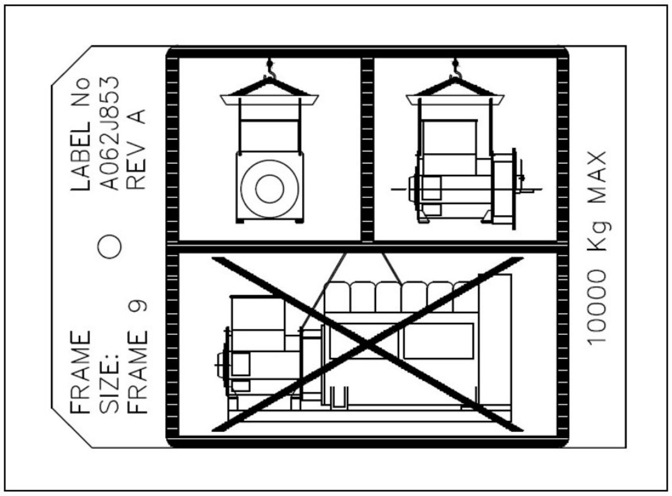


FIGURE 10. EXAMPLE LIFTING LABEL

6.2.1.11.3 Storage

⚠ WARNING

Condensed Water

Operating an alternator with condensed water in the windings can cause serious injury by electric shock, burns or exposure to flying debris and particles. To prevent injury and before operating the alternator:

- ***Use anti-condensation heaters (if fitted) to prevent condensation accumulating.***
- ***Check for condensed water.***
- ***If condensed water is present, drain/remove the water, dry and inspect the alternator, refer to: Maintenance and Servicing Chapter.***

⚠ WARNING

Hot Surfaces and Fire

Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:

- ***Avoid contact with hot surfaces.***
- ***Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.***
- ***Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).***
- ***Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.***

If the alternator will not be used immediately, it must be stored in a clean, dry, vibration-free environment. We recommend the use of anti-condensation heaters, when available.

If the alternator can be rotated, turn the rotor a minimum of 6 revolutions every month during storage.

6.2.1.11.3.1 After Storage

After a period of storage, do the pre-running checks to determine the condition of the windings. If the windings are damp or the insulation resistance is low, refer to alternator insulation drying procedure: Section 6.2.1.12.11.7 on page 345.

Before putting the alternator into service, refer to the following table.

TABLE 20. BEARING STORAGE

Bearing Type	Not Rotated during Storage	Rotated during Storage
Sealed Bearing(s)	If stored less than 12 months, put the alternator into service. If stored more than 12 months, replace the bearing(s), then put the alternator into service.	If stored less than 24 months, put the alternator into service. If stored more than 24 months, replace the bearing(s), then put the alternator into service.
Re-greasable Bearing(s)	If stored less than 6 months, put the alternator into service. If stored between 6 and 12 months, re-grease the bearings(s) during the first run, then put the alternator into service. If stored more than 12 months, replace the bearing(s), then put the alternator into service.	If stored less than 6 months, put the alternator into service. If stored between 6 and 24 months, re-grease the bearing(s) during the first run, then put the alternator into service. If stored more than 24 months, replace the bearing(s), then put the alternator into service.

6.2.1.11.3.2 Long-term Storage

When an alternator is stationary, in storage or otherwise, it may be subjected to environmental factors, such as vibration, humidity, temperature and airborne contaminant particles, that could degrade the bearing arrangements.

Contact STAMFORD | AvK™ customer services **www.stamford-avk.com** for advice in advance if the alternator will be stationary for long periods.

6.2.1.11.4 Generator Set Coupling

⚠ WARNING

Coupling an Alternator

Moving mechanical parts during coupling can cause serious injury by crushing, severing or trapping. When coupling the alternator to a prime-mover or when installing large components, to prevent injury:

- ***Personnel must keep limbs and body parts away from coupling surfaces during coupling and/or installing operations.***

NOTICE

Do not attempt to rotate the alternator rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.

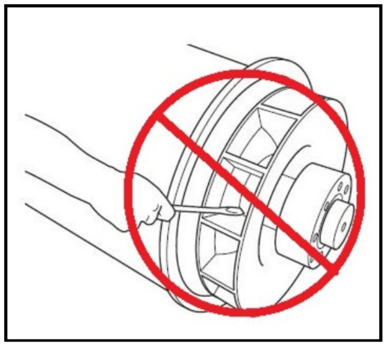


FIGURE 11. DO NOT ROTATE WITH A LEVER

Efficient operation and long component life depend on minimizing mechanical stresses on the alternator. When coupled in a generator set, misalignment and vibration interactions with the prime mover engine can cause mechanical stress.

A coupling mass greater than 150 kg will reduce bearing life significantly. Refer to the factory for further information.

Generator sets need a substantial flat continuous bedplate to suit the installation site floor loading, with engine and alternator mounting pads to make a firm base for accurate alignment. The height of all mounting pads must be within 0.25 mm for skid mounting, 3 mm for non-adjustable anti-vibration mounts (AVM) or 10 mm for adjustable height AVMs. Use shims or adjust alignment elements to achieve level. The rotational axes of alternator rotor and engine output shaft must be coaxial (radial alignment) and perpendicular to the same plane (angular alignment). The axial alignment of the alternator and engine coupling must be within 0.5 mm, to allow for thermal expansion without unwanted axial force on the bearings at operating temperature.

Vibration can occur by flexing of the coupling. The alternator is designed for a maximum bending moment not exceeding 275 kgm (2000 lbs ft). Check the maximum bending moment of the engine flange with the engine manufacturer.

Torsional vibrations occur in all engine-driven shaft systems and may be large enough to cause damage at critical speeds. The generator set builder must consider the effect of torsional vibration on the alternator shaft and couplings, referring to the torsional drawings supplied for shaft dimensions and rotor inertia.

Close-coupling of alternator and engine can increase the rigidity of the generator set. Both one and two bearing alternators can be close-coupled. The generator set builder must supply guarding for open-coupled applications.

To prevent rust during transit and storage, the alternator frame spigot, rotor coupling plates and shaft extension have been treated with a rust preventative coating. Remove this before coupling the generator set.

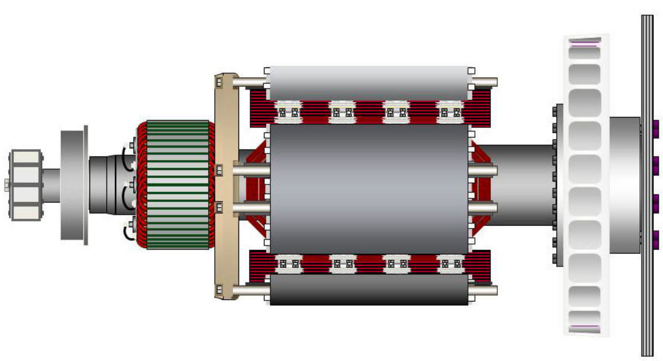


FIGURE 12. ONE BEARING ALTERNATOR ROTOR SHOWING COUPLING DISCS BOLTED TO DRIVE END COUPLING HUB (AT RIGHT)

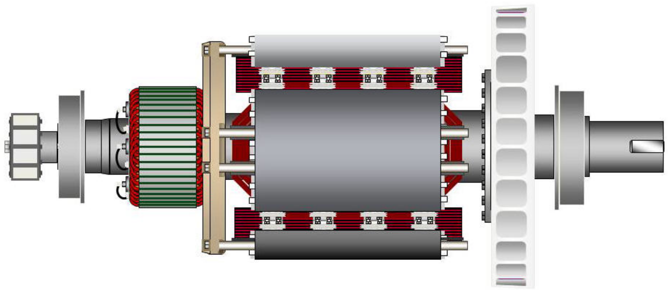


FIGURE 13. TWO BEARING ALTERNATOR ROTOR SHOWING SHAFT WITH KEYWAY FOR FLEXIBLE COUPLING (AT RIGHT)

6.2.1.11.5 Two Bearing Alternators

A flexible coupling, designed to suit the specific engine/alternator combination, is recommended to minimize torsional vibration effects.

If a close coupling adaptor is used the alignment of machined faces must be checked by offering the alternator up to the engine. Shim the alternator feet if necessary.

6.2.1.11.6 Pre-Running Checks

Before starting the generator set, test the insulation resistance of windings and check that all connections are tight and in the correct location. Make sure the alternator air path is clear of obstructions. Replace all covers.

6.2.1.11.7 Direction of Rotation

As standard, alternator rotation is clockwise, as viewed from the drive end (unless counter-clockwise rotation is specified when ordering). The fan must be changed if the direction of rotation is changed, speak to STAMFORD® or AvK® customer services **www.stamford-avk.com**.

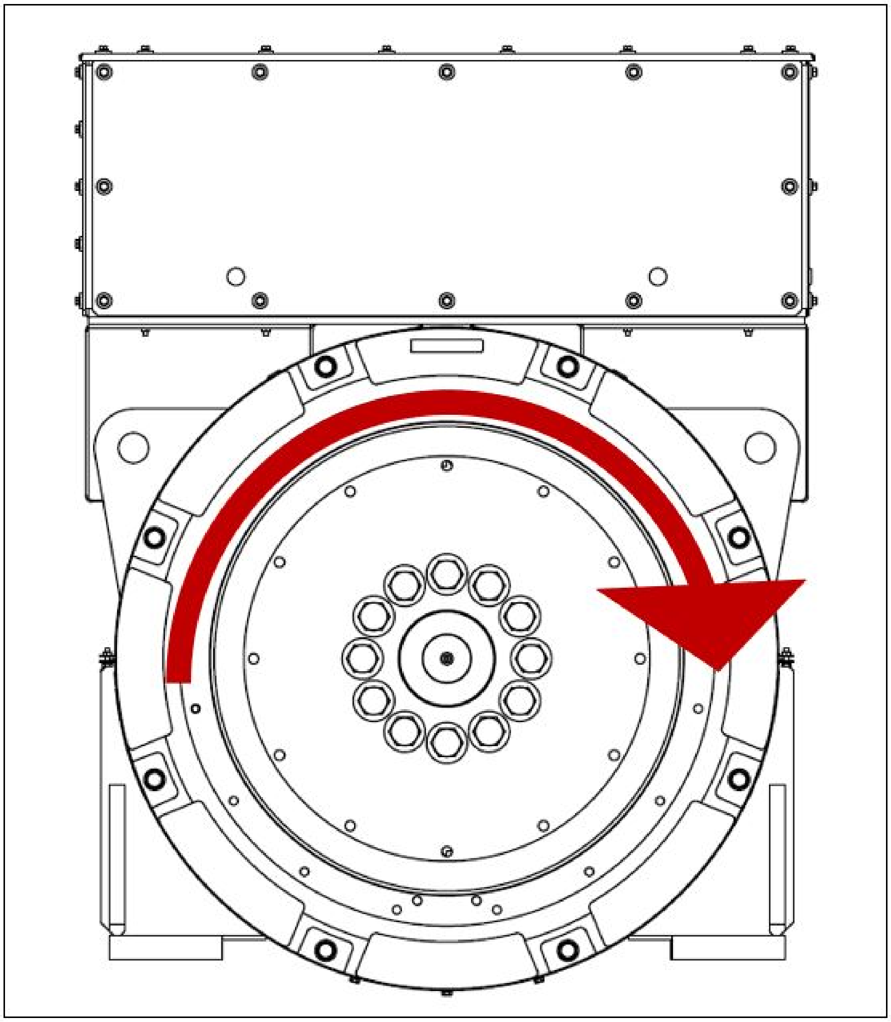


FIGURE 14. DIRECTION OF ROTATION

6.2.1.11.8 Phase Rotation

Main stator output is connected for a phase sequence of U V W when the alternator runs clockwise, as viewed from the drive end. If the phase rotation must be reversed, the customer must re-connect the output cables in the terminal box. STAMFORD | AvK™ customer services **www.stamford-avk.com** for a circuit diagram of 'reverse phase connections'.

6.2.1.11.9 Voltage and Frequency

Check that the voltage and frequency shown on the alternator rating plate meet the requirements of the generator set application. Refer to detailed instructions in the AVR manual for adjustments.

6.2.1.11.10 AVR Settings

The AVR is factory set for initial running tests. Check that the AVR settings are compatible with your required output. Refer to detailed instructions in the AVR manual for on- and off-load adjustments.

6.2.1.11.11 Electrical Connections

⚠ WARNING

Incorrect Electrical Installation and System Protection

Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:

- ***Have completed related, applicable and approved training.***
- ***Know the equipment, understand the task(s) and procedure(s).***
- ***Know related hazards / risks.***
- ***Know and obey site / location specific emergency procedures and applicable laws and regulations.***

The terminal box is designed to support the fitted busbars or terminals, transformers, load cables and auxiliary terminal box. Additional mass could cause excessive vibration and lead to failure of the terminal box enclosure and mounting. Speak to STAMFORD | AvK™ customer services **www.stamford-avk.com** before fixing any additional mass to the terminal box. Panels must be removed to be drilled or cut, to prevent swarf entering the terminal box or alternator.

Fault current curves and alternator reactance values are available on request from the factory so that the system designer can calculate the necessary fault protection and/or discrimination.

The installer must check that the alternator frame is bonded to the generator set bedplate, and must bond to site earth. If anti-vibration mounts are fitted between the alternator frame and its bedplate, a suitably-rated earth conductor must bridge across the anti-vibration mount.

Refer to wiring diagrams for electrical connection of the load cables. Electrical connections are made in the terminal box, constructed with removable panels to suit site-specific cable entry and glanding. Route single core cables through the insulated or non-magnetic gland plates supplied. Panels must be removed to be drilled or cut to prevent swarf entering the terminal box or alternator. After wiring, inspect the terminal box, remove all debris using a vacuum cleaner if necessary and check that no internal components are damaged or disturbed.

As standard, the alternator neutral is not bonded to the alternator frame. If required, neutral may be connected to the earth terminal in the terminal box, by a conductor of at least one half of the sectional area of a phase lead.

Load cables must be supported appropriately to avoid a tight radius at the point of entry into the terminal box, clamped at the terminal box gland, and allow at least ±25 mm movement by the alternator set on its anti-vibration mountings, without causing excessive stress to the cables and alternator load terminals.

The palm (flattened part) of load cable lugs must be clamped in direct contact with the main stator load output terminals so that the whole palm area conducts the output current. Using a torque wrench on the uppermost nut and a spanner positioned on the nut below, apply equal reverse leverage to avoid damaging the insulation post. The tightening torque of M12 fasteners is 70 Nm (51.6 ft-lb) (main nut) and 45 Nm (33.2 ft-lb) (lock nut) on insulated terminals.

FIGURE 15. CORRECT CABLE CLAMPING (MULTIPLE CABLES)

6.2.1.11.12 Grid Connection: Voltage Surges and Micro-Interruptions

Consideration should be given to any transient voltages loads generated by connected loads and/or distribution system which could damage the alternator components.

According to the specifics of the application and installation the points below must be considered:

- Loads with characteristics that result in large load step changes.
- Load control by switchgear and power control by any method likely to generate transient voltage spikes.
- Distribution systems susceptible to external influences, such as lightning strikes.
- Applications involving parallel operation to a mains supply, where the risk of a mains disturbance in the form of a micro-interruption could occur.

If the alternator is at risk from voltage surges or micro-interruptions, it is recommended that the installation includes adequate protection of the generation system to meet regulations and installation requirements. It is recommended to seek guidance from specialist protection system designers and associated professional bodies.

6.2.1.11.13 Varying Load

Under certain conditions, load variations can reduce alternator life.

Identify any possible risk, especially the following:

- Large capacitive loads (for example Power Factor Correction equipment) can affect alternator stability and cause pole slip.
- Stepped grid voltage variation (for example Tap Changing).

If the alternator is at risk from varying load, include adequate protection into the generator set system by under-excitation protection.

6.2.1.12 Service and Maintenance

6.2.1.12.1 Alternator Removal and Installation

6.2.1.12.1.1 Parts Identification

Refer to **Section 6.2.1.13** for an exploded view of components and for fastener information.

6.2.1.12.1.2 Lifting the Alternator

⚠ DANGER

Falling Mechanical Parts

Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping. To prevent injury or death and before lifting:

- ***Check the capacity, condition and attachment of lifting equipment.***
- ***Check the capacity, condition and attachment of accessories for lifting.***
- ***Check the capacity, condition and attachment of lifting point(s) on the load.***
- ***Check the mass, integrity and stability of the load.***
- ***If available: Install drive end and non-drive end transit fittings to prevent movement and damage to bearings.***
- ***Keep the alternator horizontal when lifting.***
- ***Do not use alternator lifting points for lifting a complete generator set.***
- ***Do not use cooler lifting points for lifting the alternator or a complete generator set.***
- ***Do not remove the lifting label attached to one of the lifting points.***

NOTICE

A shock load detector fitted on the DE bracket activates if the alternator is subjected to a 15 g acceleration. If the detector has been activated, the alternator must be inspected for damage by CGT. As a minimum, the bearings must be replaced.

Lift the alternator by shackles attached to the lifting points (lugs or eyes) provided. A label attached to a lifting point shows the correct lifting arrangement. Use chains of sufficient length, and a spreader bar if necessary, to make sure that the chains are vertical when lifting. Make sure that the capacity of the lifting equipment is sufficient for the alternator mass shown on the label.

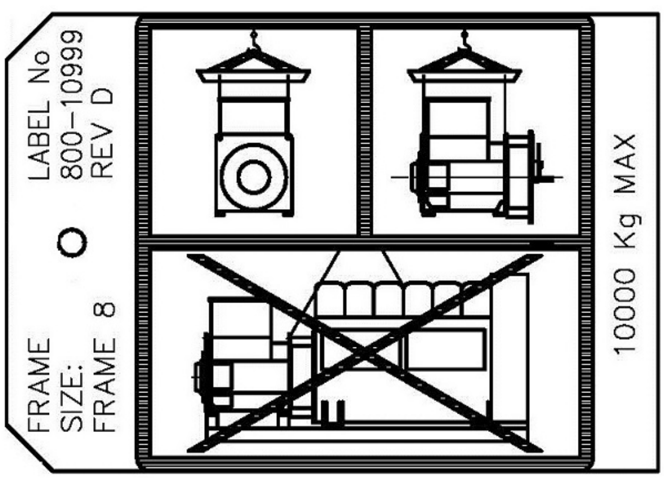


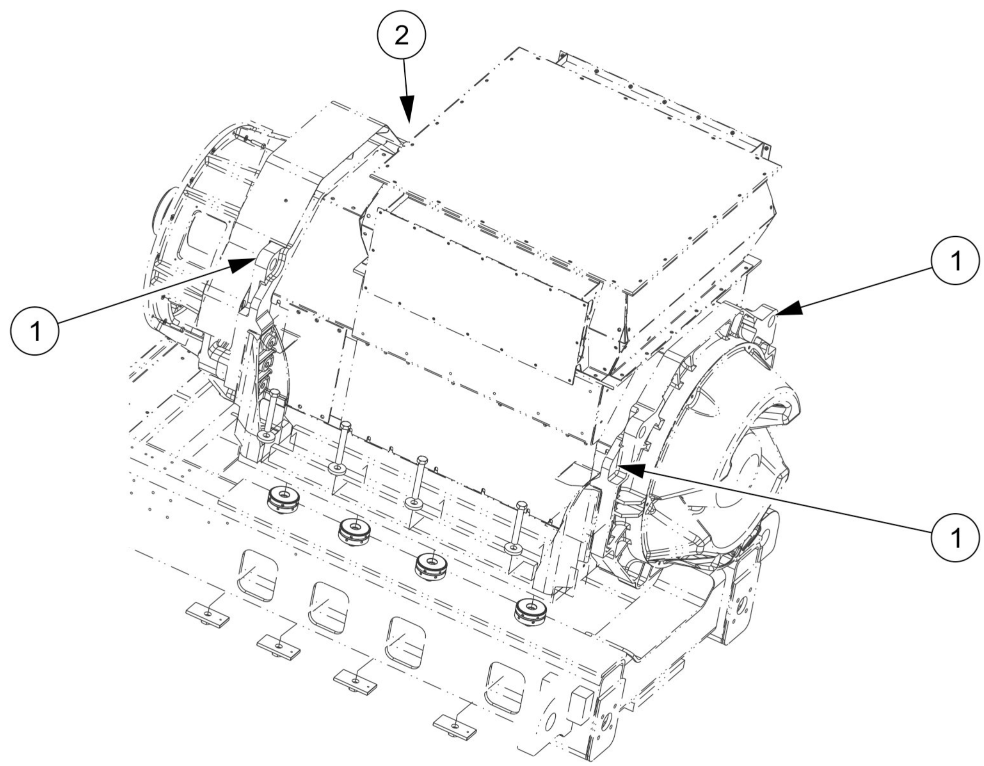
FIGURE 16. LIFTING LABEL

6.2.1.12.1.3 Personal Protective Equipment (PPE)

Wear hearing protection, face shield, steal toed shoes and leather gloves. Wear all site mandatory PPE.

6.2.1.12.1.4 Remove Alternator

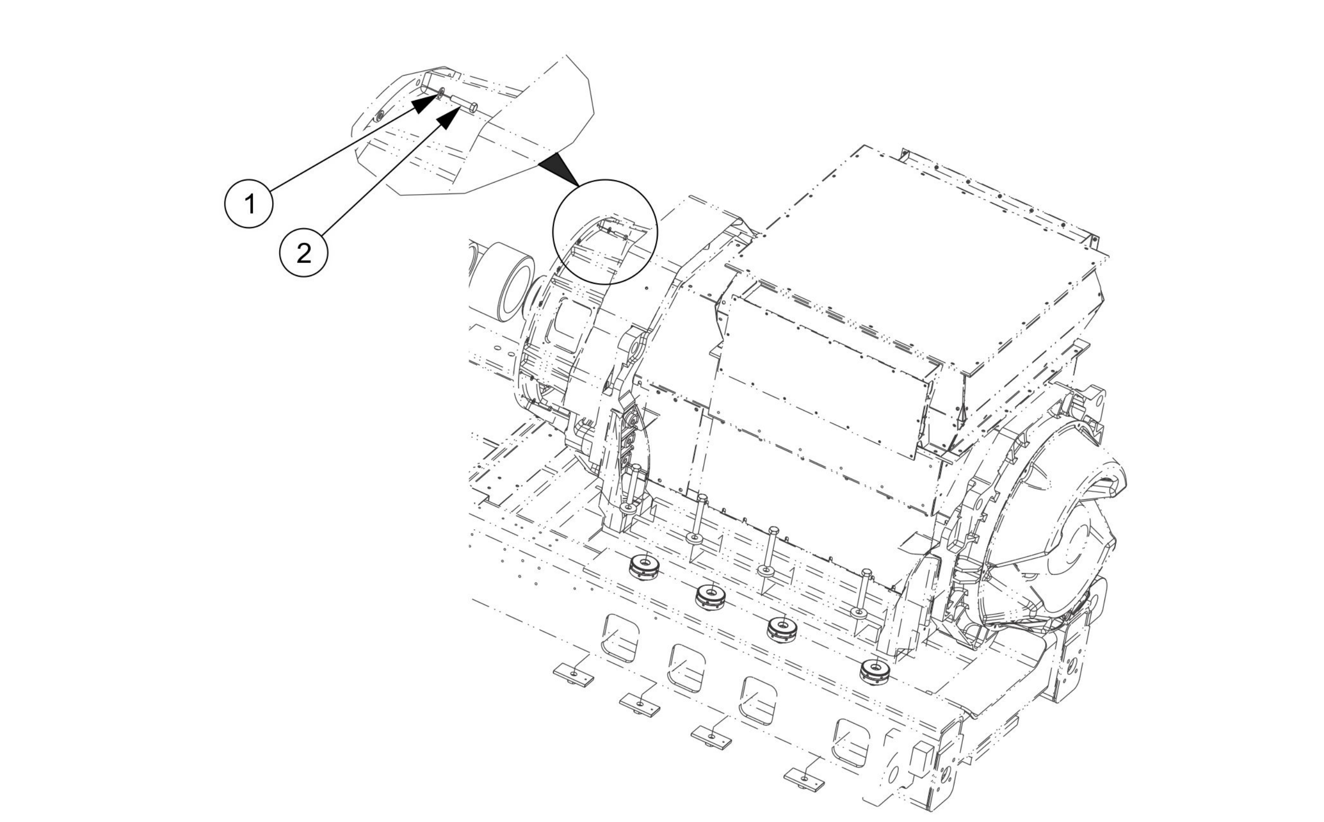
1. Make sure all sources of potential energy are isolated. Lock the generator set out of service. See **Section 5.1**.
2. Block chassis to prevent chassis from sagging when the generator set center of gravity shifts during the alternator pullback. Snug two jack stands under the skid and under the lifting eyes on the non drive end side. Be careful not to load the isolators.
3. Disconnect all harnesses between the engine and the alternator.
4. Disconnect the customer load cables and remove from the entrance box.
5. Disconnect and remove any additional hardware and piping that could interfere with the alternator movement during pullback.
6. Connect to the alternator appropriately sized shackles, spreader bars, slings, and a crane rated to at least twice the alternator weight. Remove the slack from the slings without lifting the alternator.



No.	Description	No.	Description
1	Lifting point	2	Lifting point (not shown)

FIGURE 17. ALTERNATOR LIFTING POINTS

7. Remove the 16 mounting bolts for the alternator bell housing and the flywheel housing.



No.	Description	No.	Description
1	Bolt	2	Washer

FIGURE 18. ALTERNATOR HOUSING BOLTS

8. Remove the alternator to chassis mounting bolts.
9. Use the crane to gently remove the alternator weight off the alternator shims.
10. Use a paint pen to draw a line over the two halves of the alternator shims, this serves as reference for realignment. Label the alternator shims 1 to 8 or (left, right, front back etc.) to identify the location on the alternator foot.
11. Remove the alternator shims. Do not twist and change the alternator shim height.

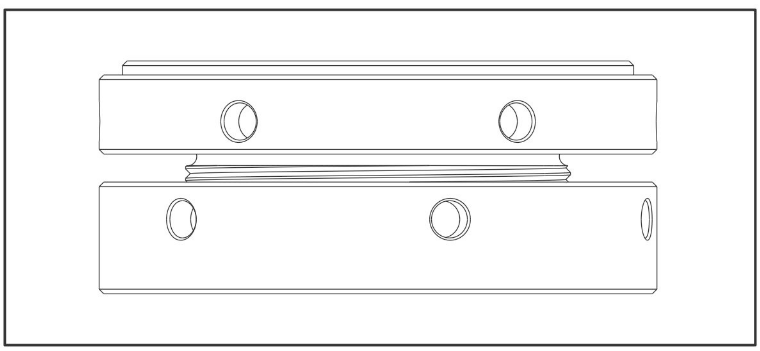


FIGURE 19. ALTERNATOR SHIM

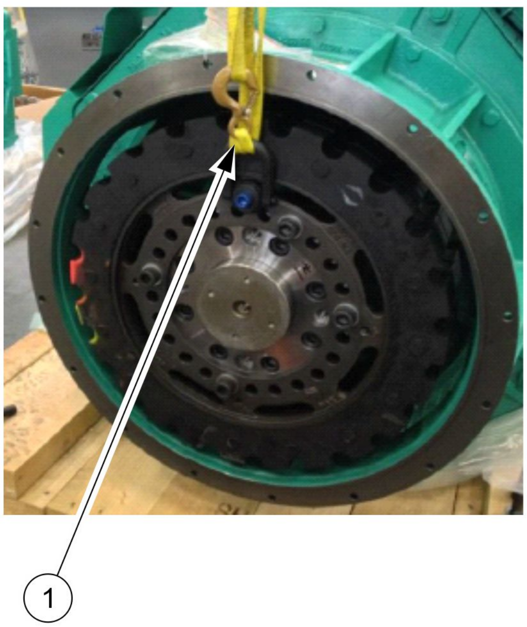
12. Three people are required for this step.

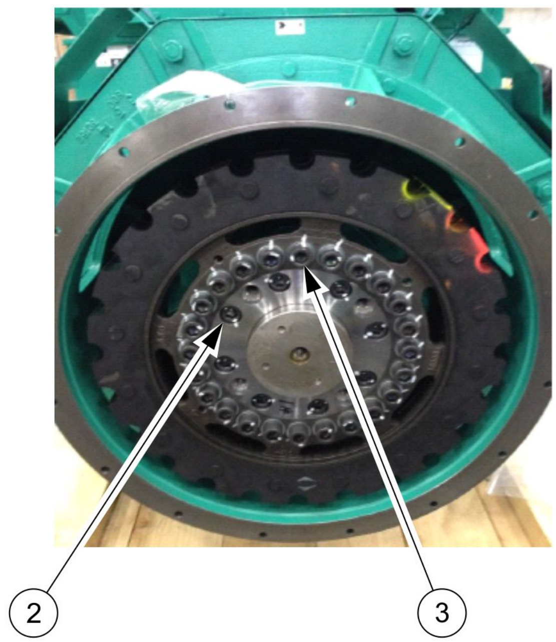
Use two pry bars on each side of the alternator, separate the alternator and flywheel housing while gently operating the crane to pull the alternator toward the non drive end.

13. When the alternator coupling is free from the bell housing, lift the alternator off and away from the generator set. Place the alternator on blocks so that it does not rest on the ground.

6.2.1.12.1.5 Remove Drive Coupling from Alternator

1. Support the weight of the rubber element with suitable rigging equipment Rubber element weight is 68 kg (150 lb).
2. Remove the 24 bolts on the rubber element with a 19 mm hex key.
3. Support the weight of the coupler with suitable rigging equipment Coupling hub weight is 136 kg (300 lb). Drive ring weight is 27 kg (60 lb).
4. Remove the eight hub bolts with a 19 mm hex key.

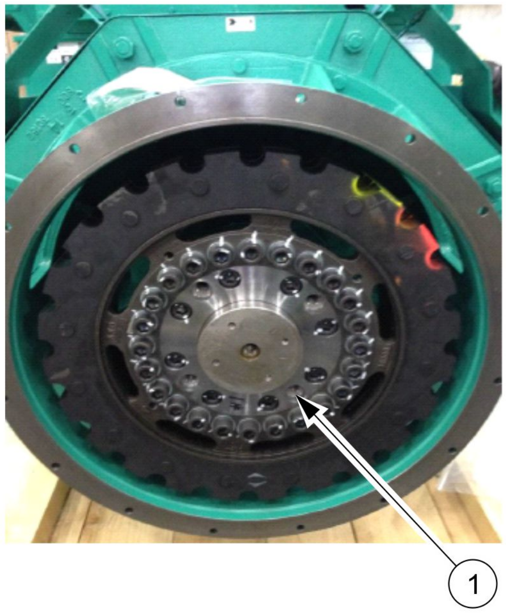




No.	Description	No.	Description
1	Rigging equipment	2	Eight M24 bolts
3	24 M24 bolts		

FIGURE 20. RIGGING EQUIPMENT AND BOLTS

5. Separate the hub inner and outer rings. Insert two M24 coupling bolts into two adjacent jacking holes and alternately torque until the outer ring is released.



No.	Description	No.	Description
1	Jacking hole		

FIGURE 21. JACKING HOLE

6.2.1.12.1.6 Install Drive Coupling on Alternator

Required tools and disposables:

- Hoist
- Coupling Install Tool (A050N812)
- Clamp assembly (A051D415)
- Torque wrench
- Degreaser
- Molykote/lithium based graphite

1. Degrease the spacer. Put the spacer on alternator shaft.
2. Slide the spacer on the rotor shaft until it meets the step on the shaft.
3. Degrease and debur the alternator shaft.
4. Degrease and debur inner diameter of the hub.

FIGURE 22. DEGREASE AND DEBUR

5. Use level spirit (as shown) to make sure that alternator shaft (axis) is horizontal.

FIGURE 23. CHECK HORIZONTAL

6. Make sure that there is no lubricant or oil between the hub and the shaft.

7. Apply a thin film of molykote/lithium based graphite on the inner diameter of the hub outer ring and on the tapered side of the hub.

NOTICE
There should not be lubricant or oil between the hub and the rotor shaft.

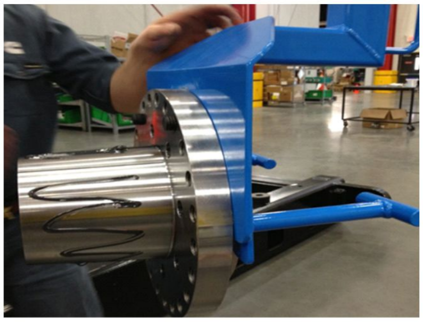
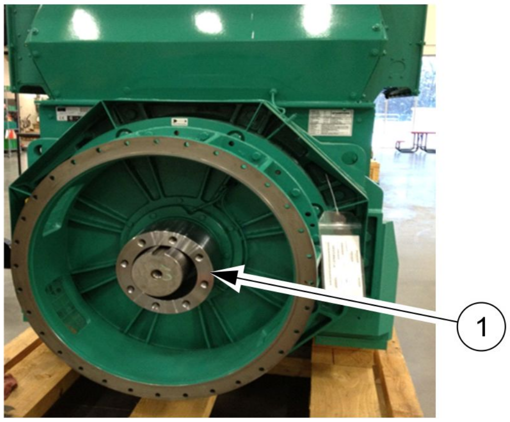


FIGURE 24. LUBRICATE INNER DIAMETER OF THE HUB OUTER RING

8. Install the hub outer ring on the shaft.

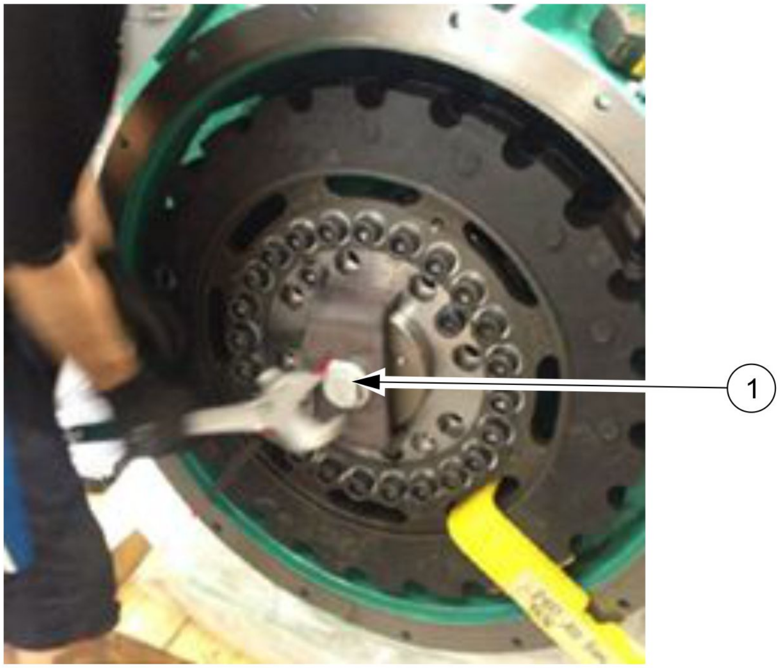
NOTICE
For a new installation the outer ring comes attached to the hub. Do not disassemble, install as one part.



No.	Description	No.	Description
1	Outer ring		

FIGURE 25. HUB OUTER RING

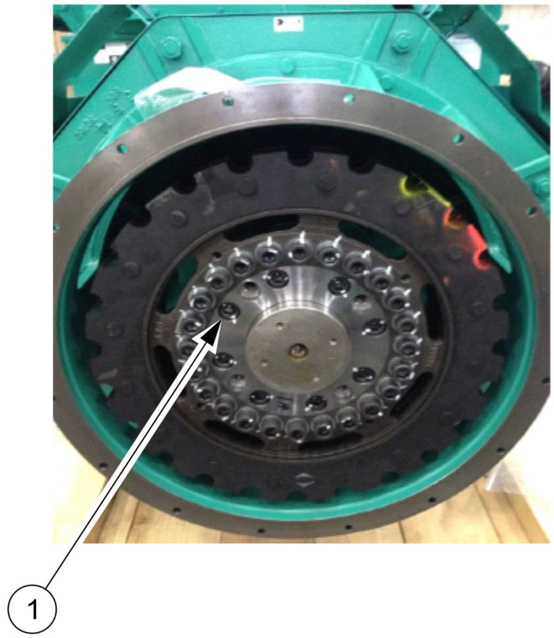
9. Use a hoist and the coupling install tool to install the hub. Slide the hub on the alternator shaft. Make sure that there is roughly the same amount around the alternator shaft and the inner hub.
10. Loosely install two bolts in the outer and inner ring to be sure that the bolt holes align.
11. Install the clamp assembly at the end of the rotor shaft. Torque M24 bolt to 340 Nm (250.8 ft-lb). This ensures the spacer does not become loose.



No.	Description	No.	Description
1	Clamp assembly		

FIGURE 26. CLAMP ASSEMBLY

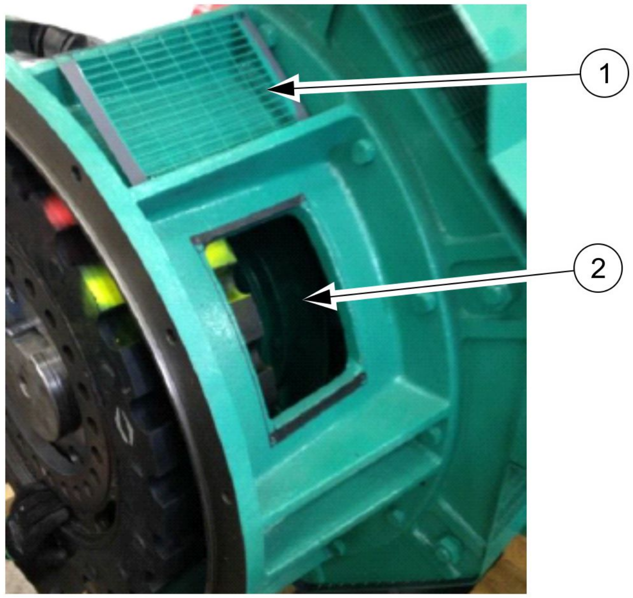
12. Remove the two bolts from the outer and inner ring.
13. Apply anti seize and torque the M24 bolts coupling bolts in a crosswise pattern as follows:
    a. Snug the bolts.
    b. Torque to 340 Nm (250.8 ft-lb) (40%).
    c. Torque to 510 Nm (376.1 ft-lb) (60%).
    d. Torque to 850 Nm (626.9 ft-lb) (100%).



No.	Description	No.	Description
1	Bolt		

FIGURE 27. HUB BOLTS

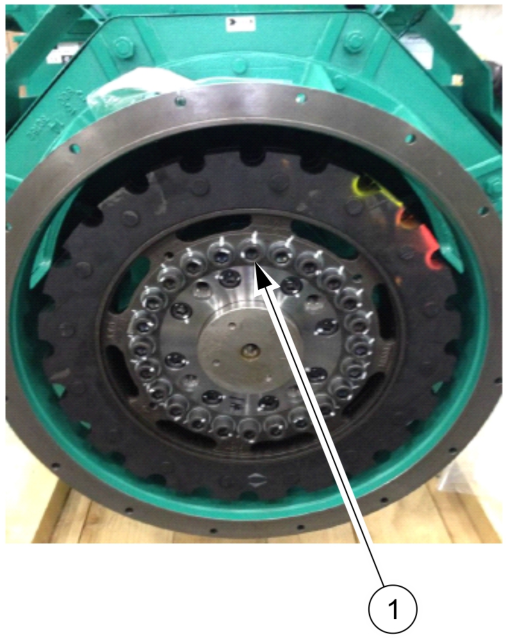
14. Remove one alternator bell housing mesh to check that the spacer does not move. If it moves remove the bolts and repeat the torque sequence in the previous step.



No.	Description	No.	Description
1	Mesh	2	Spacer

FIGURE 28. MESH AND SPACER

15. Install the rubber element. Apply anti seize and torque the M24 bolts coupling bolts in a crosswise pattern as follows:
    a. Snug the bolts.
    b. Torque to 340 Nm (250.8 ft-lb) (40%).
    c. Torque to 510 Nm (376.1 ft-lb) (60%).
    d. Torque to 850 Nm (626.9 ft-lb) (100%).



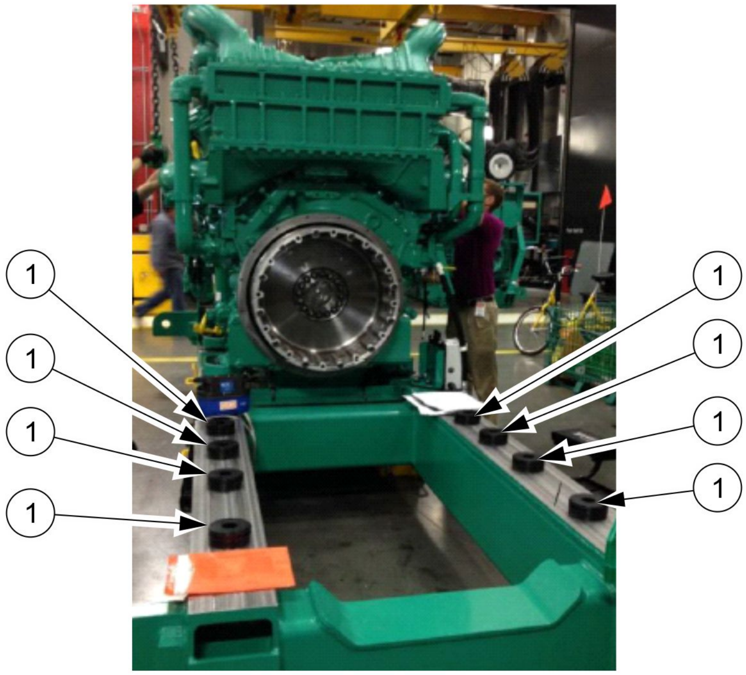
No.	Description	No.	Description
1	Bolt		

FIGURE 29. RUBBER ELEMENT BOLTS

16. Repeat torque step until all bolts remain at 850 Nm (626.9 ft-lb) torque.
17. Remove one alternator bell housing mesh to check that the spacer again **Figure 29** to make sure it does not move.
18. Re-install the bell housing mesh.
19. Remove the clamp assembly from the rotor shaft.

6.2.1.12.1.7 Install Alternator

1. Use an alternating pattern to torque the drive ring onto engine on the flywheel end to torque 245 ± 25 Nm (180.7 ± 18.4 ft-lb).
2. Prepare the skid. Clean the skid surface. Stage the alternator shims as shown below. Make sure the holes in the alternator foot railing and the alternator shim pads are aligned.



No.	Description	No.	Description
1	Alternator shim		

FIGURE 30. ALTERNATOR SHIM PLACEMENT

3. Lift the alternator (**Figure 17**).
4. Spray anti rust solution onto the rubber element and outer ring on the alternator.
5. Align the holes on the alternator bell housing with corresponding holes on engine flywheel housing.
6. Hand tighten the 16 mounting bolts for the alternator bell housing and the flywheel housing (**Figure 18**).
7. Check that the holes in the foot railing of the alternator and the alternator shim machined pads are aligned. The holes in the foot railing of the alternator and the alternator shim machined pads must be aligned. If realignment is necessary, repeat steps 5 and 6.
8. Snug up all the alternator shims to bottom of the alternator feet.
9. Install the alternator bell housing and the flywheel housing 16 mounting bolts. Torque to 126 ± 25 Nm (92.9 ± 18.4 ft-lb) in alternate pattern.
10. Remove load from the hoist.
11. Remove the 16 mounting bolts from the flywheel housing and the alternator.
12. Use a feeler gauge and document the gap between the flywheel housing and the alternator at 3, 6, 9 and 12 o’clock positions. If the gap is greater than 0.1 mm, adjust alternator shims with spherical washer facing up to reduce the gap between the alternator and flywheel housing to less than or equal to 0.1 mm.

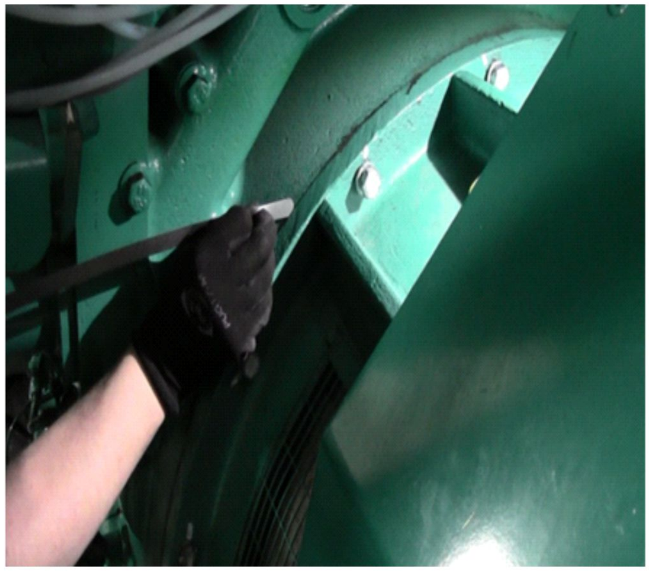
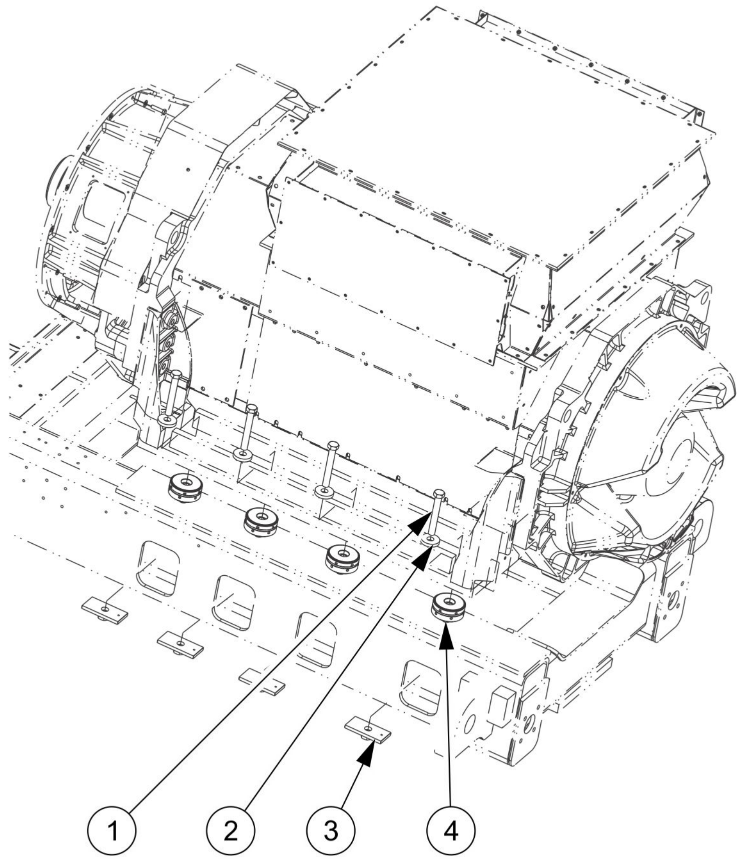


FIGURE 31. MEASURE GAP

13. If the gap is less than 0.1 mm, torque the 16 mounting bolts of the bell housing and flywheel housing to 126 ± 25 Nm (92.9 ± 18.4 ft-lb) in alternating pattern. After torqueing, mark each bolt with a paint pen.

14. Put new hex bolts and flat washers through the foot railing holes and run it through nut plate. Torque the bolts to 1050 ± 50 Nm (774.4 ± 36.9 ft-lb). Mark each bolt with a paint pen after torqueing. Do not re-use the old bolt or washer.



No.	Description	No.	Description
1	Bolt	3	Nut plate
2	Washer	4	alternator shim

FIGURE 32. HEX BOLT AND NUT PLATE

6.2.1.12.2 Alternator Decouple and Recouple

6.2.1.12.2.1 Personal Protective Equipment

Wear the following personal protective equipment (PPE):

- Hearing protection
- Steel toe shoes
- Face shield
- Leather gloves
- All site mandatory PPE

6.2.1.12.2.2 Consumables

- Lint-free cloths
- Thin disposable gloves
- Anti seize compound

6.2.1.12.2.3 Parts

- Alternator feet mounting bolts

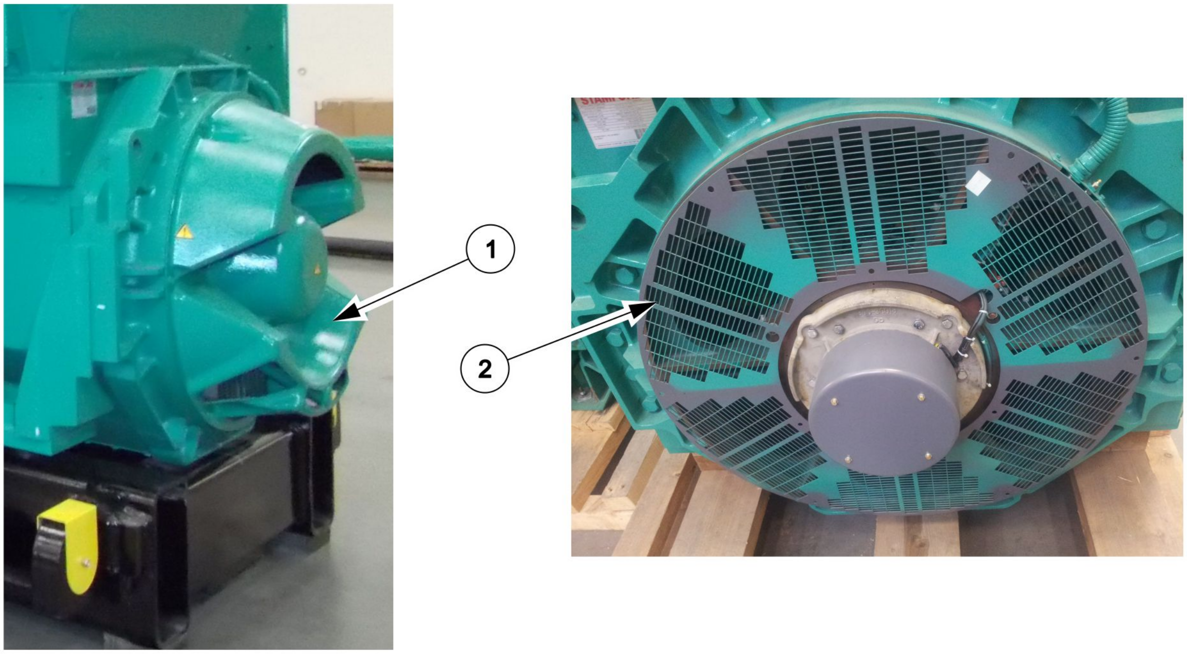
6.2.1.12.2.4 Tools

- 1/2" socket set (SAE/Metric)
- Torque wrench
- Jacks
- Alternator pullback service kits
  - A050R999

6.2.1.12.2.5 Decouple the Alternator from the Engine

6.2.1.12.2.5.1 Procedure

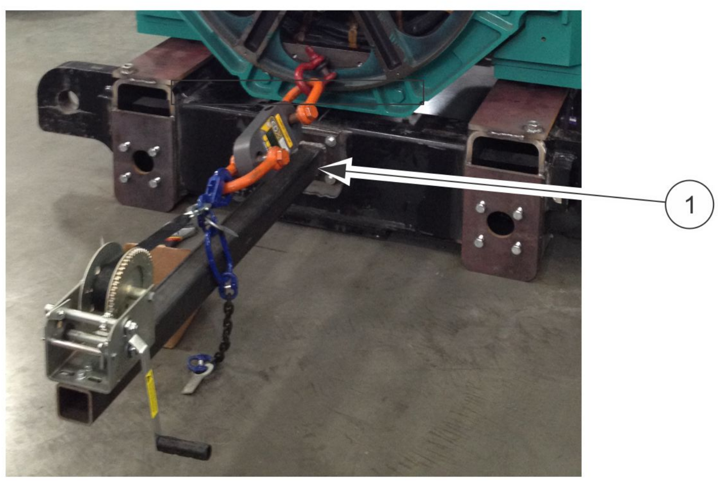
1. Make sure all sources of potential energy are isolated. Lock the generator set out of service. See **Section 5.1**.
2. Block the chassis to prevent chassis from sagging when the generator set center of gravity shifts during the alternator pullback. Snug two jack stands under the skid non drive end lifting eyes. Be careful not to load the isolators.
3. Disconnect all harnesses between the engine and the alternator.
4. Disconnect the customer load cables and remove from the entrance box.
5. Disconnect and remove any additional hardware and piping that could interfere with the alternator movement during pullback.
6. Remove the alternator NDE cover (9 bolts) and mesh.



No.	Description	No.	Description
1	Cover	2	Mesh

FIGURE 33. ALTERNATOR NDE COVER AND MESH

7. Install the winch support tube on the chassis NDE cross member with 4 bolts. Torque the bolts to 91 ± 9 Nm (67 ± 7 ft-lb).

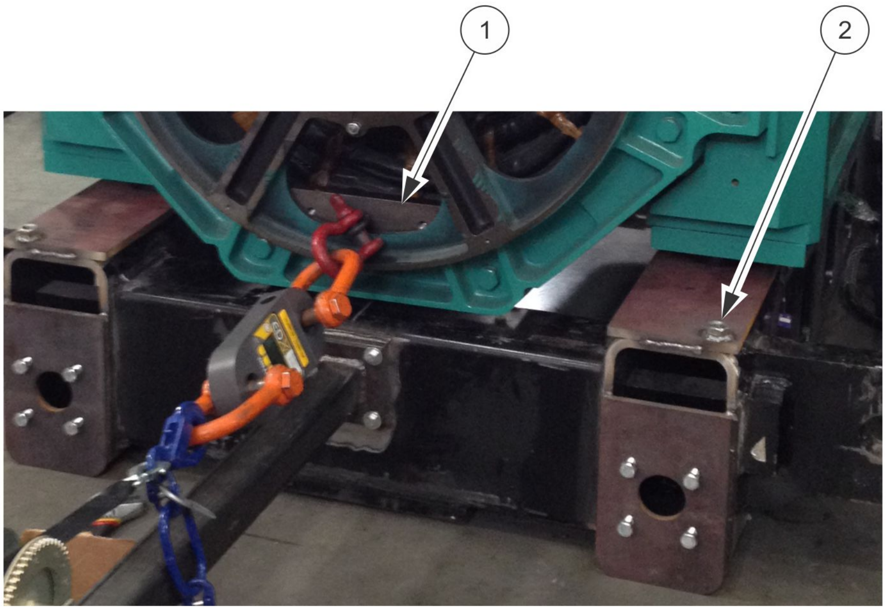


No.	Description	No.	Description
1	Winch support tube		

FIGURE 34. WINCH SUPPORT TUBE

8. Install the Stop bolts at the end of chassis

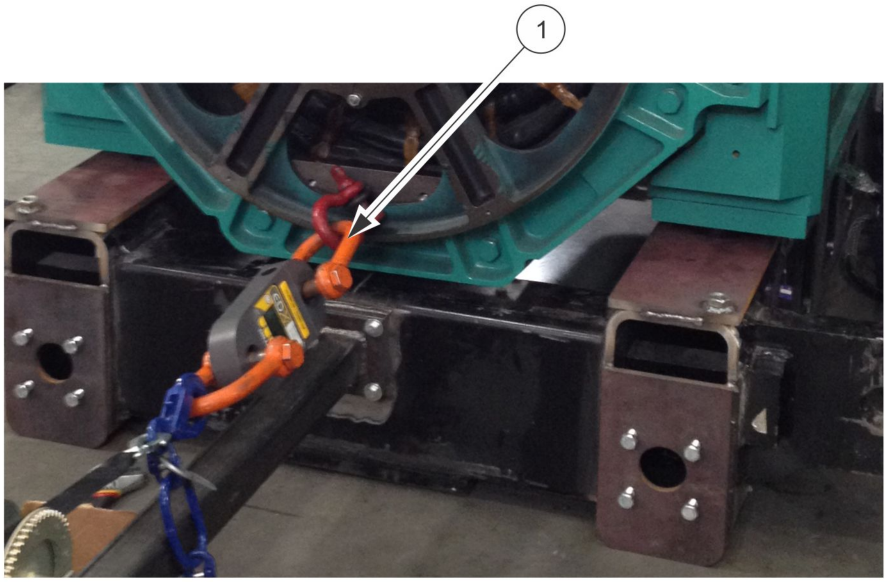
9. Install the pulling bracket at 6 o-clock behind the NDE bracket with the eyelid pointing toward you.



No.	Description	No.	Description
1	Pull back brace	2	Stop bolt

FIGURE 35. PULL BACK BRACE AND STOP BOLT

10. Hook the winch strap to the pulling bracket eyelid.



No.	Description	No.	Description
1	Winch strap connection		

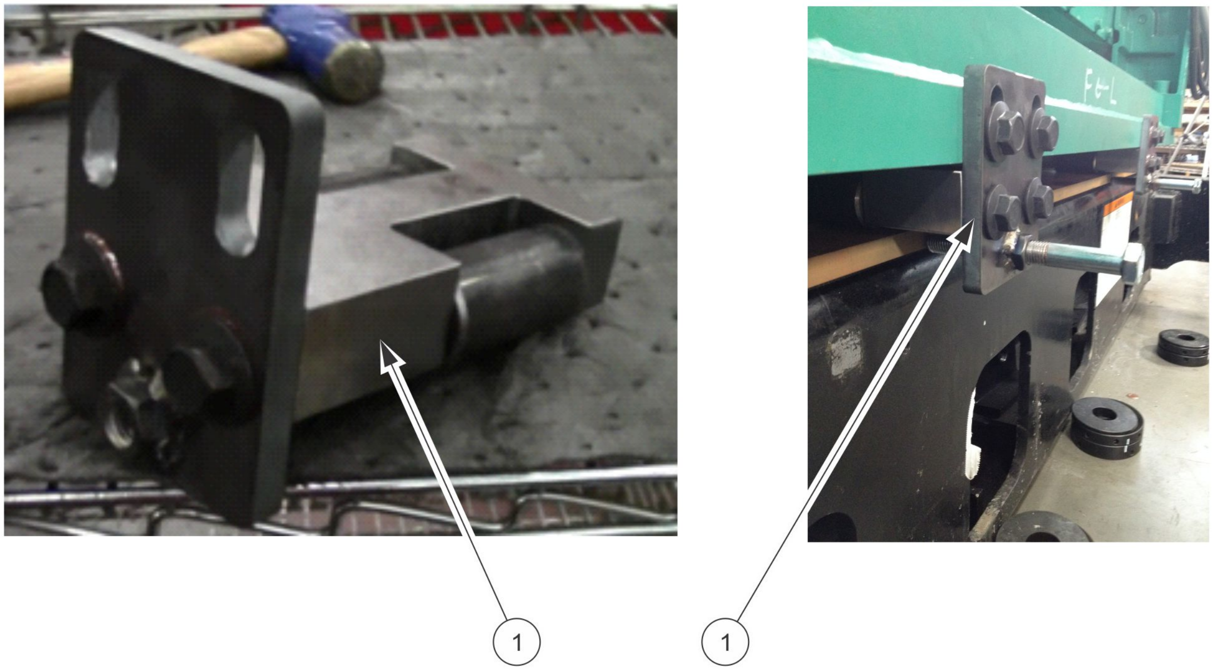
FIGURE 36. WINCH STRAP CONNECTION

11. Remove the 16 mounting bolts for the alternator bell housing and flywheel housing. The bottom two bolts are hard to reach. Stand on the right to remove left side bolt and on the left to remove the right side using a 19 mm socket with a ½ inch driver. Stand on the right to remove left side bolt and on the left to remove the right side using a 19 mm socket with a ½ inch driver

    The bottom two bolts are hard to reach. Stand on the right to remove left side bolt and on the left side to remove the right side. Using a 19 mm socket with a ½ inch driver.

12. Remove the alternator jacking bolts.

13. Apply anti seize compound to the roller assembly mounting bolts. Install the four roller assemblies, two on each side of the alternator. Torque bolts to 198 ± 20 Nm (146 ± 15 ft-lb).



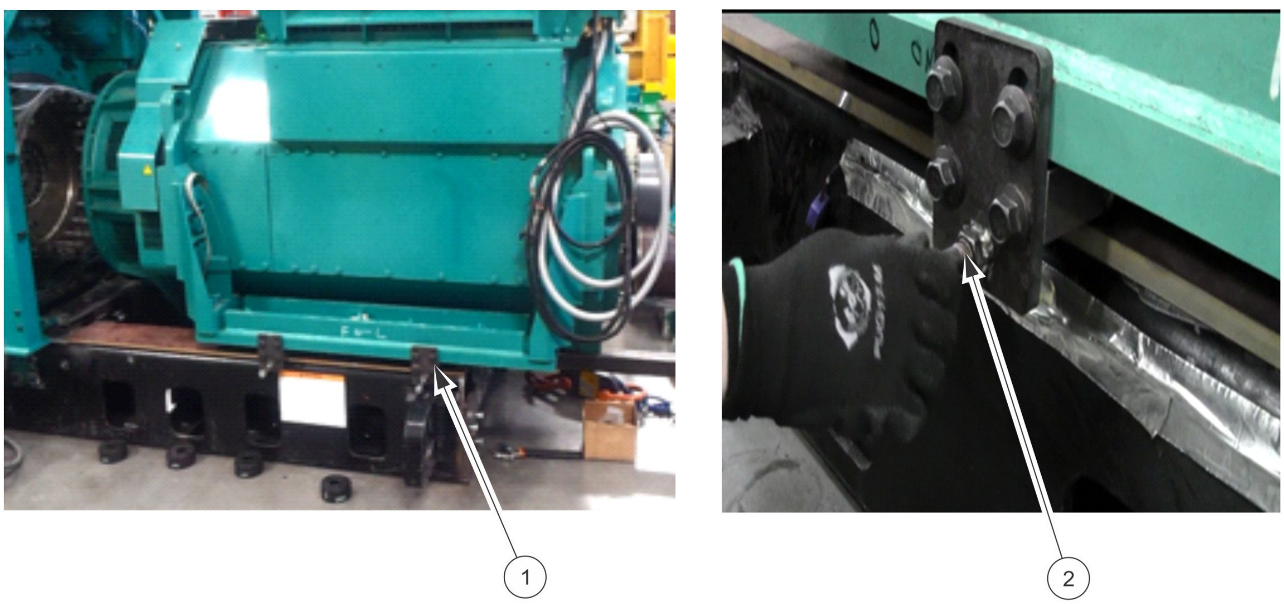
No.	Description	No.	Description
1	Roller assembly		

FIGURE 37. ROLLER ASSEMBLY

14. Remove the alternator to chassis mounting bolts.
15. Apply anti seize compound to the Jacking bolts and install the jacking bolts. Torque each jacking bolt just enough (approximately 90 Nm (66.3 ft-lb)) to relieve pressure from the alternator shims so they can be removed.
16. Use a paint pen to draw a line over the two halves of the alternator shims. This provides a reference for realignment. Label the alternator shims 1 to 8 or (left, right, front back etc.) to identify their location on the alternator foot.

FIGURE 38. MARKED ALTERNATOR SHIM

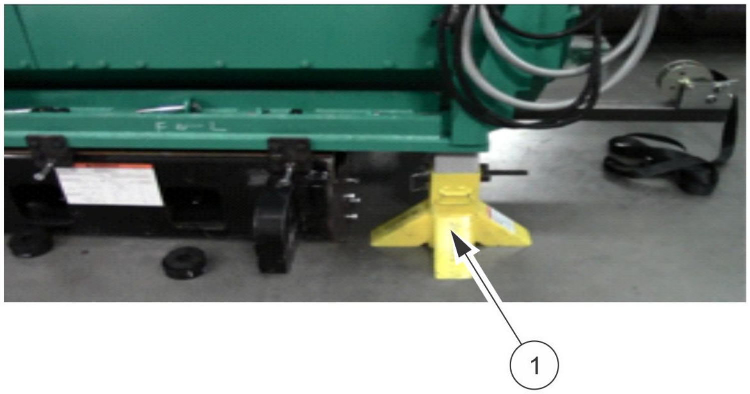
17. Remove the alternator shims. Do Not Twist and Change the height of the alternator shims.
18. Review the winch latch mechanism for proper engagement.
19. Operate the winch lever clockwise to begin pulling the alternator toward you.
20. When the alternator has reached the maximum pullback distance, the roller assembly touches the stop bolt, lock the alternator in place. Insert the locking bolts into the alternator foot rail and skid and tighten the nuts.



No.	Description	No.	Description
1	Roller assembly	2	Locking bolt

FIGURE 39. ROLLER ASSEMBLY AND LOCKING BOLT

21. Insert two jack stands under the alternator foot as an additional precaution.



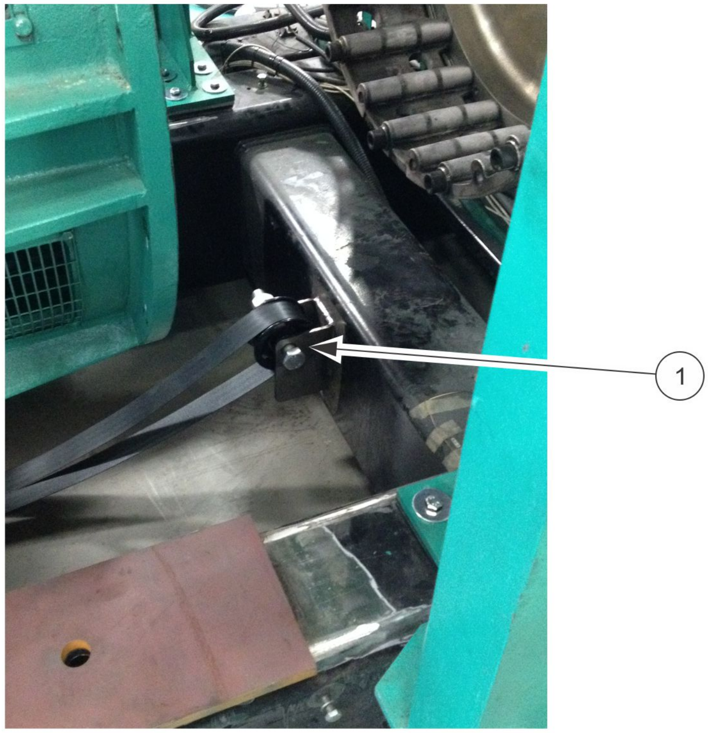
No.	Description	No.	Description
1	Jack stand		

FIGURE 40. JACK STAND

6.2.1.12.2.6 Couple the Alternator to the Engine

6.2.1.12.2.6.1 Procedure

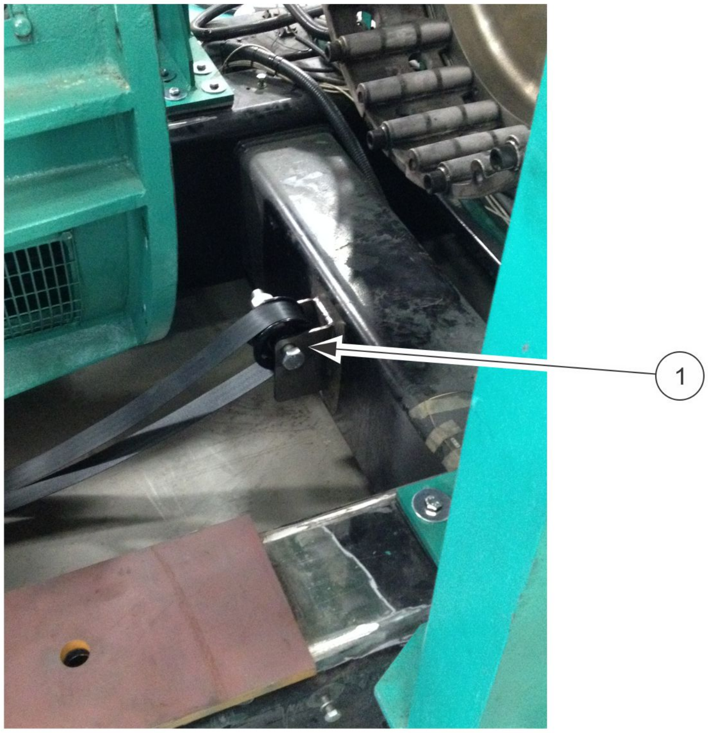
1. Make sure all sources of potential energy are isolated. Lock the generator set out of service. See **Section 5.1**.
2. Install the pulley assembly on the skid cross-member on the DE side. Torque 4 mounting bolt to 91 ± 9 Nm (67 ± 7 ft-lb).



No.	Description	No.	Description
1	Pully assembly		

FIGURE 41. DE PULLY ASSEMBLY

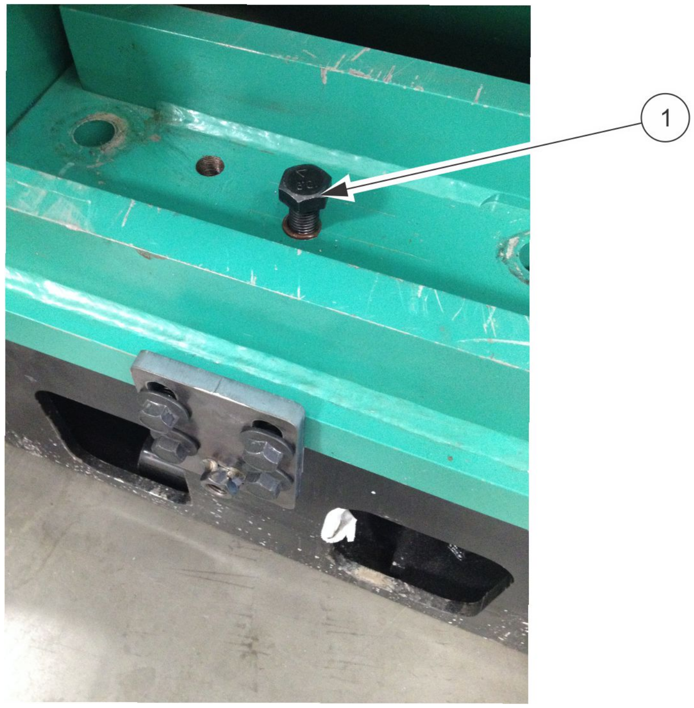
3. Unhook the winch strap from the pulling bracket. Run the strap under the alternator, through the bottom of the pulley, and back to the strap to hock on the NDE pulling bracket.



No.	Description	No.	Description
1	Wench strap	2	Connection to pulling bracket

FIGURE 42. WINCH STRAP ROUTING

4. Unlock the alternator. Remove the locking bolts from the alternator foot.
5. Wear a face shield and leather gloves.
6. Operate the winch lever clockwise to begin pulling the alternator until the bell housing comes in contact with the engine flywheel housing.
7. Install the alternator bell housing and the flywheel housing with 16 mounting bolts. Torque the bolts to 126 ± 25 Nm (92.9 ± 18.4 ft-lb) in alternating pattern.
8. Carefully inspect the alternator shims to ensure the marks on the two halves are aligned. Install the alternator shims to the correct location as previously marked. Do not twist or change the height of the alternator shims.
9. Ensure the holes in the alternator foot railing and the alternator shim machined pads are aligned.
10. Loosen the jacking bolts to lower the alternator until the alternator shims are snug to the bottom of the alternator feet.



No.	Description	No.	Description
1	Jacking bolt		

FIGURE 43. JACKING BOLTS

11. Torque the 16 mounting bolts on the alternator bell housing and flywheel housing to 126 ± 25 Nm (92.9 ± 18.4 ft-lb) in alternating pattern.
12. Loosen the four jacking bolts so that the entire alternator weight is supported by the alternator shims.
13. Remove the 16 mounting bolts from the flywheel housing and the alternator.
14. Use a feeler gage and document the gap between the flywheel and bell housing at 3, 6, 9, and 12 o'clock positions.

FIGURE 44. GAP MEASUREMENT

15. If the gap is greater than 0.1 mm, adjust the alternator shims with washer facing up to reduce the gap between the flywheel and bell housing to less than 0.1 mm.
16. When the gap is less than 0.1 mm, torque the 16 mounting bolts of the bell housing and flywheel housing to 126 ± 25 Nm (92.9 ± 18.4 ft-lb) in alternating pattern.
17. Install new alternator feet mounting bolts and torque to 1050 ± 50 Nm (774.4 ± 36.9 ft-lb).
18. Remove the winch strap from the pulling bracket eyelid.
19. Remove the pulling bracket from the alternator NDE.
20. Remove the winch strap from the DE pulley and completely remove it from the bottom of the alternator.
21. Disconnect the pulley assembly.
22. Remove the winch support assembly from the skid.

6.2.1.12.3 Recommended Service Schedule

Refer to: Safety Precautions in **Section 1.2.1 on page 2** before starting any service and maintenance activity.

Refer to: Parts Identification in **Section 6.2.1.13 on page 347** for an exploded view of components and fastener information.

The recommended service schedule shows the recommended service activities in table rows, grouped by alternator subsystem. Columns of the table show the types of service activity, whether the alternator must be running, and the service levels. Service frequency is given in running hours or time interval, whichever is sooner. A cross (X) in the cells where a row intersects the columns shows a service activity type and when it is required. An asterisk (*) shows a service activity done only when necessary.

All service levels in the recommended service schedule can be purchased directly from STAMFORD | AvK™ customer services **www.stamford-avk.com**.

1. Proper service and repair are vital to the reliable operation of your alternator and the safety of anyone coming into contact with the alternator.
2. These service activities are intended to maximize the life of the alternator but shall not vary, extend or change the terms of the manufacturer's standard warranty or your obligations in that warranty.
3. Each service interval is a guide only, and developed on the basis that the alternator was installed and is operated in accordance with the manufacturer's guidelines. If the alternator is located and/or operated in adverse or unusual environmental conditions, the service intervals may need to be more frequent. The alternator should be continually monitored between services to identify any potential failure modes, signs of misuse, or excessive wear and tear.

6.2.1.12.3.1 Alternator Service Schedule

TABLE 21. ALTERNATOR SERVICE SCHEDULE

System	SERVICE ACTIVITY	Alternator running	TYPE				SERVICE LEVEL								
	X = required * = if necessary		Inspect	Test	Clean	Refill/Replace	Commission	Post Commission	250 hrs / 0.5 year	Level 1	1000 hrs / 1 year	Level 2	10,000 hrs / 2 years	Level 3	30,000 hrs / 5 years
Alternator	Alternator rating		X				X								
	Bedplate arrangement		X				X								
	Coupling arrangement		X				X					*		X	
	Environmental conditions and cleanliness		X				X	X		X		X		X	
	Ambient temperature (inside & outside)			X			X	X		X		X		X	
	Complete machine - damage, loose parts & earth bonds		X				X	X		X		X		X	
	Guards, screens, warning and safety labels		X				X	X		X		X		X	
	Maintenance access		X				X								
	Electrical nominal operating conditions & excitation	X		X			X	X		X		X		X	
	Vibration	X		X			X	X		X		X		X	

System	SERVICE ACTIVITY X = required * = if necessary	Alternator running	TYPE: Inspect	TYPE: Test	TYPE: Clean	TYPE: Refill/Replace	SERVICE LEVEL: Commission	Post Commission	250 hrs / 0.5 year	Level 1	1000 hrs / 1 year	Level 2	10,000 hrs / 2 years	Level 3	30,000 hrs / 5 years
Windings	Condition of windings		X				X	X		X		X		X	
	Insulation resistance of all windings (PI test for MV/HV)			X			X	*		*		X		X	
	Insulation resistance of rotor, exciter and PMG			X				X		X					
	Temperature sensors	X		X			X	X		X		X		X	
	Customer settings for temperature sensors		X				X								
Bearings	Condition of bearings		X				X							X	
	Grease exhaust & trap				X			**every 3000 to 3500 hours / 6 months**							
	Re-grease bearing(s) (A to H core length)	X				X		**every 3000 to 3500 hours / 6 months**							
	Replace re-greasable bearing(s)					X						*		X	
	Temperature sensors	X		X			X	X		X		X		X	
	Customer settings for temperature sensors		X				X								
Terminal Box	All alternator/customer connections and cabling		X				X	X		X		X		X	
Controls & Auxiliaries	Initial AVR & PFC set up	X		X			X								
	AVR & PFC settings	X		X				X		X		X		X	
	Customer connection of auxiliaries			X			X			X		X		X	
	Function of auxiliaries			X			X	X		X		X		X	
	Synchronization settings		X				X								
	Synchronization	X		X			X	X		X		X		X	
	Anti condensation heater					X						*		X	
Rectifier	Diodes and varistors		X				X	X		X		X			
	Diodes and varistors					X								X	

System	SERVICE ACTIVITY	Alternator running	TYPE				SERVICE LEVEL								
	X = required * = if necessary		Inspect	Test	Clean	Refill/Replace	Commission	Post Commission	250 hrs / 0.5 year	Level 1	1000 hrs / 1 year	Level 2	10,000 hrs / 2 years	Level 3	30,000 hrs / 5 years
Cooling	Air inlet temperature	X		X			X	X		X		X		X	
	Air flow (rate & direction)	X	X				X								
	Condition of fan		X				X	X		X		X		X	
	Condition of air filter (where fitted)			X			X	X		X		X		X	
	Air filters (where fitted)				X	X				*		*		*	

6.2.1.12.4 Bearings

6.2.1.12.4.1 Introduction

NOTICE
Do not overfill a bearing with grease, the bearing can be damaged.
Do not mix lubricant types.
Change gloves to handle different lubricant
Assemble bearings in static and dust-free conditions, wearing lint free gloves.
To prevent damage or contamination, store removed parts and tools in static and dust-free conditions.
Do not reuse bearings. Bearings are damaged by the axial force needed to remove it from the rotor shaft.
Do not press fit bearing. Bearings are damaged if the insertion force is applied through the bearing balls.
Do not try to turn the rotor by levering against the cooling fan vanes. The fan will be damaged.

The alternator rotor is supported by a bearing at the non-drive end (NDE) and by either a bearing or a coupling to the prime mover at the drive end (DE).

- Lubricate each re-greasable bearing according to the recommended service schedule with the correct quantity and type of grease, also shown on a label fitted at the grease nipple.

6.2.1.12.4.2 Safety

⚠ DANGER

Rotating Mechanical Parts

Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping. To prevent injury:

- ***Before operating the alternator: The rotating coupling between the alternator and prime mover must be covered by a guard or cover.***
- ***Before attempting service or maintenance tasks or removing covers from rotating parts: Shut down and isolate the generator set from all energy sources, isolate stored energy and use lock out/tag out safety procedures.***

⚠ WARNING

Hot Surfaces and Fire

Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:

- ***Avoid contact with hot surfaces.***
- ***Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.***
- ***Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).***
- ***Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.***

⚠ WARNING

Exposure to Ejected Debris and Particles

Ejected debris and particles can cause serious injury or death by impact, severing or puncturing. Exposure to mechanically driven release of debris and particles exists in all directions (horizontally and vertically) in the areas surrounding the alternator air outlet(s), air inlets(s) and the open shaft end (also commonly known as the Drive End (DE)). To prevent injury or death:

- ***Keep away from the air inlet(s) and air outlet(s) when the alternator is operating.***
- ***Do not position operator controls near the air inlet(s) or air outlet(s).***
- ***Do not cause overheating by running the alternator outside rating plate parameters.***
- ***Do not overload the alternator.***
- ***Do not operate an alternator displaying excessive vibration.***
- ***Do not synchronize parallel alternators outside the specified parameters.***

⚠ CAUTION

Hazardous Substances

Hazardous substances can cause minor or moderate injury. Prolonged or repetitive exposure to hazardous substances can cause serious medical conditions. To prevent injury:

- ***Always read and obey the instructions provided by the product manufacturer.***
- ***Use, handle and store substances as specified by the product manufacturer.***
- ***Always wear appropriate personal protective equipment, refer to Safety Precautions Chapter.***

6.2.1.12.4.3 Re-Grease Bearings

6.2.1.12.4.3.1 Requirements

TABLE 22. RE-GREASING: EQUIPMENT REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.
Consumables	• Lint-free cleaning cloths • Thin disposable gloves
Parts	• CGT recommended grease
Tools	• Grease gun (calibrated for volume or mass)

6.2.1.12.4.3.2 Re-grease Method

TABLE 23. REGREASING: GREASE QUANTITY

Bearing Type	Quantity of recommended grease	
	Volume (cm^3)	Mass (g)
Drive End (S9 Core length A, B, C, D)	126	121
Drive End (S9 Core length E, F)	180	173
Drive End (S9 Core length G, H)	94	90
Non-Drive End (S9 A, B, C, D, E, F)	157	151
Non-Drive End (S9 G, H)	182	175

1. For each bearing, identify grease nipple, re-greasing label and bearing type.
2. Make sure the new grease is not contaminated. It must be a uniform whitish-beige colour of stiff consistency throughout.
3. Clean the grease gun nozzle and grease nipple.
4. Clean the grease exhaust.

5. Where an air filter is fitted, with the alternator stopped, remove the NDE cover and air filter and clean the exhausted grease trap. Afterwards, replace the air filter and reinstall the NDE cover.
6. With the alternator running, fit the grease gun to the grease nipple and add the correct quantity of grease.
7. Run the alternator for at least 60 minutes, off-load.
8. Remove the grease trap, clean the grease exhaust and re-fit.
9. Inspect the colour and consistency of grease expelled from the exhaust and compare with new grease - whitish-beige of stiff consistency.
10. Replace the bearing if the expelled grease is severely discoloured or absent.

NOTICE
If the exhaust grease trap overflows, the stator and rotor windings would be contaminated. Make sure trap is emptied when re-greasing.

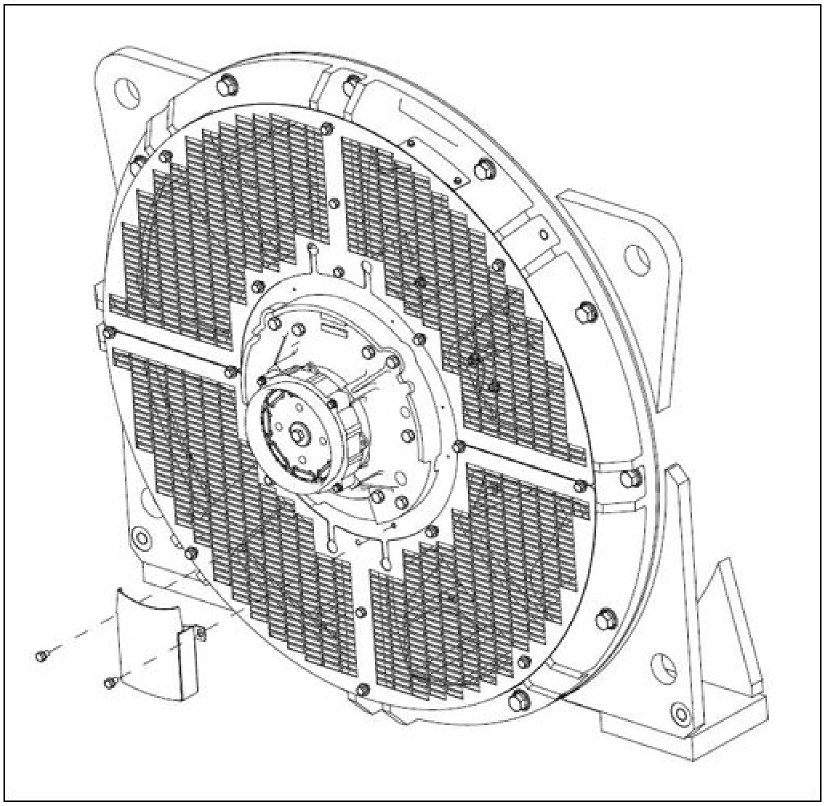


FIGURE 45. GREASE TRAP S9

6.2.1.12.5 Controls

6.2.1.12.5.1 Introduction

An operating alternator is a harsh environment for control components. Heat and vibration can cause electrical connections to loosen and cables to fail. Routine inspection and test can identify an issue before it becomes a failure that incurs unplanned downtime.

6.2.1.12.5.2 Safety

⚠ DANGER
Live Electrical Conductors   ***Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:***   • ***Shut down and isolate the alternator from all energy sources.***   • ***Remove or isolate stored energy.***   • ***Test isolated parts for electrical isolation using a suitable voltage tester.***   • ***Use lock out/tag out safety procedures.***

⚠ WARNING
Hot Surfaces and Fire   ***Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:***   • ***Avoid contact with hot surfaces.***   • ***Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.***   • ***Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).***   • ***Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.***

⚠ WARNING
Incorrect Electrical Installation and System Protection   ***Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:***   • ***Have completed related, applicable and approved training.***   • ***Know the equipment, understand the task(s) and procedure(s).***   • ***Know related hazards / risks.***   • ***Know and obey site / location specific emergency procedures and applicable laws and regulations.***

6.2.1.12.5.3 Connection Test Requirements

TABLE 24. CONNECTION TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.
Consumables	• None

Requirements	Description
Parts	• None
Tools	• Insulation test meter • Multimeter • Torque wrench

6.2.1.12.5.4 Inspect and Test

1. Remove the terminal box lid
2. Check the tightness of fasteners securing the load cables.
3. Check that cables are firmly clamped at the terminal box gland, and allow ±25 mm movement by an alternator on anti-vibration mounts.
4. Check that all cables are anchored and unstressed within the terminal box.
5. Check all cables for signs of damage caused by vibration, including insulation wear and wire strand breaks.
6. Check that all AVR accessories and current transformers are correctly fitted, and cables pass centrally through current transformers.
7. If an anti-condensation heater is fitted:
    a. Isolate the supply and measure electrical resistance of the heater element(s). Replace heater element if open circuit.
    b. Connect together both ends of the heater leads.
    c. Apply the test voltage between the winding and earth.
    d. Measure the insulation resistance after 1 minute (IR 1min).
    e. Discharge the voltage.
    f. If the measured insulation resistance is less than the minimum acceptable value, replace the heater element(s), refer to: **Table 25 on page 320** for values.
8. Test the supply voltage to the anti-condensation heaters (if fitted). 100 VAC to 277 VAC should be present across each heater element when the alternator is stopped. Refer to the wiring diagram for heater connections.
9. Check that AVR and AVR accessories within the terminal box are clean, securely fitted on anti-vibration mounts, and the cable connectors are firmly attached to the terminals. AVR and AVR accessories do not need further routine servicing.
10. For parallel operation, check that alternator frequency signal cables to the synchronization equipment are securely connected.
11. Refit the terminal box lid.

TABLE 25. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ANTI-CONDENSATION HEATERS

	Test Voltage (V)	Minimum Insulation Resistance at 1 minute (MΩ)	
		New	In-service

Anti-condensation heater	500	10	1

6.2.1.12.6 Cooling System

6.2.1.12.6.1 Introduction

The alternators are designed to meet standards supporting EU Directives and UK Statutory Instruments, and are rated for the effect of operating temperature on winding insulation.

BS EN 60085 (≡ IEC 60085) Electrical insulation – Thermal Evaluation and Designation classifies insulation capability by the maximum operating temperature for a reasonable design and service life. When considering thermal design life, thermal conditioning of insulation system components and their combination are predominantly influenced by the level of thermal stress applied to the system. Additional, single or a combination of factors such as mechanical, electrical and environmental stress, may cause degradation over time, but these are considered secondary when considering thermal degradation of an insulation system.

If the operating environment differs from the values shown on the rating plate, rated output must be reduced by

- 3% for class H utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C
- 3.5% for class F utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C
- 4.5% for class B utilization for every 5 °C that the temperature of the ambient air entering the cooling fan exceeds 40 °C, up to a maximum of 60 °C
- 3% for every 500 m increase in altitude above 1000 m, up to 4000 m*****, due to the reduced thermal capacity of lower density air, and
- 5% if air filters are fitted due to restricted air flow.

NOTICE
The values above are cumulative dependent on environmental conditions.

Efficient cooling depends on maintaining the condition of the cooling fan, air filters and gaskets.

***** The following changes to the insulation system of medium and high voltage alternators, must be applied to minimize the adverse effects of operating at higher altitudes, to ensure normal operational life expectancy. The changes are calculated according to the specific alternator design and Pashen's Curve.

- Up to 1500 m elevation: No change to insulation system required
- 1500 - 3000 m elevation: Requires a change to the insulation system design to meet altitude operational requirements. Maximum system voltage (Un) designs up to 11 kV. This design upgrade is factory manufactured only.
- 3000 - 4000 m elevation: Requires a change to the insulation system design to meet altitude operational requirements. Maximum system voltage (Un) designs up to 6.6 kV. This design upgrade is factory manufactured only.

NOTICE
For alternators with nominal design voltage above 1.1 kV, thermal derate due to the change in insulation system design to meet higher altitude operational conditions above 1000 MASL cannot be assumed based on standard derate factors. Advice must be obtained from Cummins Generator Technologies, as special considerations are required to allow for increased insulation systems thermal transfer capabilities.

6.2.1.12.6.2 Safety

⚠ DANGER

Rotating Mechanical Parts

Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping. To prevent injury:

- ***Before operating the alternator: The rotating coupling between the alternator and prime mover must be covered by a guard or cover.***
- ***Before attempting service or maintenance tasks or removing covers from rotating parts: Shut down and isolate the generator set from all energy sources, isolate stored energy and use lock out/tag out safety procedures.***

⚠ WARNING

Hot Surfaces and Fire

Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:

- ***Avoid contact with hot surfaces.***
- ***Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.***
- ***Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).***
- ***Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.***

⚠ CAUTION

Dust & Airborne Particles/Fumes

Dust and other airborne particles and fumes can cause minor or moderate injury by irritating the lungs and eyes. Prolonged or repetitive exposure can cause serious medical conditions. To prevent injury:

- ***Use mechanical vacuum extraction to remove dust and airborne particles or fumes.***
- ***Ventilate the area fully.***
- ***Always wear the appropriate personal protective equipment. Refer to Safety Precautions Chapter.***

NOTICE

Do not attempt to rotate the alternator rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.

NOTICE

Filters are designed to remove dust, not moisture. Wet filter elements can cause reduced air flow and overheating. Do not allow filter elements to get wet.

6.2.1.12.6.3 Cooling System Test Requirements

TABLE 26. COOLING SYSTEM TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.
Consumables	• Lint-free cleaning cloths • Thin disposable gloves
Parts	• Air filters (if fitted) • Air filter sealing gaskets (if fitted)
Tools	• None

6.2.1.12.6.4 Inspect and Clean

1. Inspect the fan for damaged vanes and cracks.
2. Remove air filters (at the fan and terminal box, if fitted) from their frames.
3. Wash and dry the air filters and gaskets to remove contaminant particles.
4. Inspect the filters and gaskets for damage and replace, as necessary.
5. Install the filters and gaskets.
6. Reinstate the generator set for running.
7. Make sure the air inlets and outlets are not blocked.

6.2.1.12.7 Coupling

6.2.1.12.7.1 Introduction

Efficient operation and long component life rely on minimizing mechanical stresses on the alternator. When coupled in a generator set, misalignment and vibration interactions with the prime mover engine can cause mechanical stress.

The rotational axes of alternator rotor and engine output shaft must be coaxial (radial and angular alignment).

Torsional vibration can cause damage to internal combustion engine shaft-driven systems, if not controlled. The generator set manufacturer is responsible for assessing the effect of torsional vibration on the alternator: Rotor dimensions and inertia, and coupling details are available on request.

6.2.1.12.7.2 Safety

NOTICE
Do not attempt to rotate the alternator rotor by levering against the vanes of the cooling fan. The fan is not designed to withstand such forces and will be damaged.

⚠ WARNING

Coupling an Alternator

Moving mechanical parts during coupling can cause serious injury by crushing, severing or trapping. When coupling the alternator to a prime-mover or when installing large components, to prevent injury:

- ***Personnel must keep limbs and body parts away from coupling surfaces during coupling and/or installing operations.***

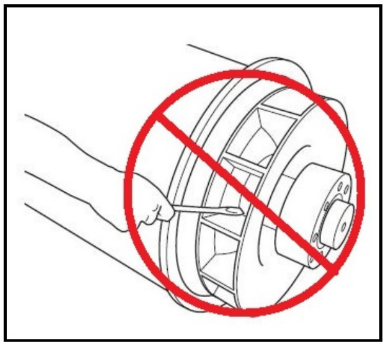


FIGURE 46. DO NOT ROTATE THE ALTERNATOR ROTOR WITH A LEVER

6.2.1.12.7.3 Coupling Test Requirements

TABLE 27. COUPLING TEST REQUIREMENTS

Requirements	Description
Personal Protective Equipment (PPE)	• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.
Consumables	• None
Parts	• None
Tools	• Dial gauge • Torque wrench

6.2.1.12.7.4 Inspect Mounting Points

1. Check the generator set bedplate and mounting pads are in good condition, not cracked.
2. Check that rubber in anti-vibration mounts has not perished.
3. Check vibration monitoring historical records for a trend of increasing vibration.

6.2.1.12.7.4.1 One Bearing Coupling

1. Remove the DE adaptor screen and cover to access the coupling.
2. Check that the coupling discs are not damaged, cracked or distorted, and the coupling disc holes are not elongated. If any are damaged, replace the complete set of discs.
3. Check tightness of bolts fixing the coupling discs to the engine flywheel. Tighten in the sequence shown for alternator coupling in the Installation chapter, to the torque recommended by the engine manufacturer.

4. Replace the DE adaptor screen and drip proof cover.

6.2.1.12.8 Rectifier System

6.2.1.12.8.1 Introduction

The rectifier converts alternating current (AC) induced in the exciter rotor windings into direct current (DC) to magnetize the main rotor poles. The rectifier comprises two semicircular annular positive and negative plates, each with three diodes. In addition to connecting to the main rotor, the DC output of the rectifier also connects to a matched pair of varistors (one at each end of the plates) and two pairs of resistors, if fitted (mounted into holes in the exciter rotor). These additional components protect the rectifier from voltage spikes and surge voltages that may be present on the rotor under various loading conditions of the alternator.

Diodes provide a low resistance to current in one direction only: Positive current will flow from anode to cathode, or another way of viewing it is that negative current will flow from cathode to anode.

The exciter rotor windings are connected to 3 diode anodes to form the positive plate and to 3 diode cathodes to form the negative plate to give full wave rectification from AC to DC. The rectifier is mounted on, and rotates with, the exciter rotor at the non-drive end (NDE).

6.2.1.12.8.2 Safety

⚠ DANGER

Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:

- ***Shut down and isolate the alternator from all energy sources.***
- ***Remove or isolate stored energy.***
- ***Test isolated parts for electrical isolation using a suitable voltage tester.***
- ***Use lock out/tag out safety procedures.***

⚠ DANGER

Rotating Mechanical Parts

Rotating mechanical parts can cause serious injury or death by crushing, severing or trapping. To prevent injury:

- ***Before operating the alternator: The rotating coupling between the alternator and prime mover must be covered by a guard or cover.***
- ***Before attempting service or maintenance tasks or removing covers from rotating parts: Shut down and isolate the generator set from all energy sources, isolate stored energy and use lock out/tag out safety procedures.***

⚠ WARNING
Incorrect Electrical Installation and System Protection   ***Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:***   • ***Have completed related, applicable and approved training.***   • ***Know the equipment, understand the task(s) and procedure(s).***   • ***Know related hazards / risks.***   • ***Know and obey site / location specific emergency procedures and applicable laws and regulations.***

6.2.1.12.8.3 Requirements

TABLE 28. RECTIFIER SYSTEM: TEST AND REPLACE COMPONENT REQUIREMENTS

Personal Protective Equipment (PPE)	• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.
Consumables	• Dow Corning Silicone heat sink compound type 340 or similar. • Duralco 4461N Amber Electrically Resistant Epoxy [Part: 030-02668]. If Resistors are fitted. • Vidaflex 942 Acrylic 3mm sleeving [Part: 030-01548]. If Resistors are fitted. • Vidaflex 942 Acrylic 5mm sleeving [Part: 030-01550]. If Resistors are fitted. • Sumitube B2 Polyolefin heat shrink 9.5mm tubing [Part: 030-04179]. If Resistors are fitted.
Parts	• Kit of three Anode lead Diodes and three Cathode lead Diodes (all from the same manufacturer). • Kit of two metal-oxide Varistors (same type, same manufacturer, same voltage grading: A, B, C, D, E, F). • Kit of four Snubber Resistors (same type, same manufacturer). If fitted.
Tools	• Multimeter. • Insulation tester. • Torque wrench. • Resistor removal tool. If Resistors are fitted. • Hammer. If Resistors are fitted. • Round file. If Resistors are fitted.

6.2.1.12.8.4 Test and Replace Varistors

1. Inspect both varistors.
2. Record varistor as faulty if there are signs of overheating (discoloration, blisters, melting) or disintegration. Check for loose connectors vs. varistor body.

3. Disconnect the varistor leads.
4. A serviceable varistor will read open circuit in both directions using a multimeter (set in the Ohms (Ω) range). A faulty varistor can read short circuit in both directions and/or it may be physically damaged.
5. If either varistor is faulty, replace both varistors with a matched pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F) and replace all diodes.
6. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

6.2.1.12.8.5 Test and Replace Diodes

NOTICE
Do not tighten a diode above the stated torque. The diode will be damaged.

1. Disconnect the lead of one diode where it joins the windings at the insulated terminal post. Store fastener and washers.
2. Measure the voltage drop across the diode in the forward direction, using the diode test function of a multimeter.
3. Measure the resistance across the diode in the reverse direction, using the 1000 VDC test voltage of an insulation tester.
4. Diode is faulty if the voltage drop in the forward direction is outside the range 0.3–0.9 VDC, or the resistance is below 20 MΩ in the reverse direction.
5. Repeat the tests for the five remaining diodes.
6. If any diode is faulty, replace the full set of six diodes (same type, same manufacturer):
   a. Remove diode(s).
   b. Apply a small amount of heat sink compound **only** to the base of the replacement diode(s), not the threads.
   c. Check polarity of diode(s).
   d. Screw each replacement diode into a threaded hole in the rectifier plate.
   e. Apply 2.6–3.1 Nm (23–27.4 in-lb) torque to give good mechanical, electrical and thermal contact.
   f. Replace both varistors with a matched pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F)
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

6.2.1.12.8.6 Test and Replace Resistors - If Fitted

1. Inspect the visible ends of all four resistors.
2. Resistor is faulty if there are any signs of discoloration or overheating.
3. Break the electrical circuit by removing fasteners from one resistor of each pair. Store fasteners and washers.
4. Measure the total resistance of both resistor pairs, using the ohms range of a digital multimeter.
5. Resistors are faulty if the total resistance of a resistor pair is outside the range 160 Ω ± 10 %.
6. If resistors are faulty, replace all four resistors:
   a. Remove the fasteners from the existing resistors.
   b. Label and disconnect the six exciter rotor winding leads at the insulated terminal posts.

c. Label and disconnect the two main rotor winding leads at the terminals on the rectifier plate.

d. Disconnect a lead from both varistors to allow the rectifier plates to be removed separately.

e. Note the rotational position of the rectifier plates. Use a 5 mm Allen key to remove four M6 x 120 fasteners and both plates (complete with diodes) from the exciter rotor.

f. Cut the leads and connecting the bases of both resistor pairs.

g. Remove each resistor:

   i. Resistors may disintegrate during removal. Position covers and vacuum extraction to collect any ceramic fragments.

   ii. At the NDE, align the cylindrical removal tool squarely over the threaded terminal and onto the ceramic body of the resistor.

   iii. Strike the free end of the tool sharply with a hammer to break the glue seal and then drive the resistor out of the hole towards the drive end.

h. Use a round file to remove resin from the rotor core holes. Clean with a lint-free cloth.

i. Loose fit a replacement resistor into each cleaned hole to check that all resin has been removed.

j. Apply 2 gm of epoxy and insert a replacement resistor into a rotor core hole, threaded post towards the rectifier plate position. Rotate the resistor to coat its surface evenly. Position the resistor so its base protrudes 3 mm from the core.

k. Repeat with the remaining three replacement resistors.

l. Leave the epoxy to cure.

m. Fit a nut and a spring and flat washer on the M6 threaded post of each resistor.

n. Refit the complete rectifier assembly onto the exciter rotor.

o. Apply thread lock and fit a flat washer and stover nut on the M6 threaded post of each resistor. Ensure good electrical contact with the rectifier plate.

p. Refer to the images and the steps below to finish and secure the resistor leads.

TABLE 29. RESISTOR LEAD CONNECTIONS

q. Sleeve each resistor lead with 3 x 130 mm Vidaflex 942.

r. Sleeve two of the resistor leads (which are electrically connected through the rectifier plate) with 5 x 70 mm Vidaflex 942 and 9.5 x 100 mm heat shrink tubing (030-04179).

s. Connect by a crimped ferrule (003-09103) with the remaining resistor leads (electrically connected on the other rectifier plate) as shown.

t. Slide the 5 x 70 mm Vidaflex 942 and 9.5 x 100 mm heat shrink tubing over the ferrule and shrink the tube by heating.

u. Secure both lead assemblies to the inside of the exciter rotor windings with seven heat-stabilized cable ties (052-45017). Position the cable tie heads to the inside.

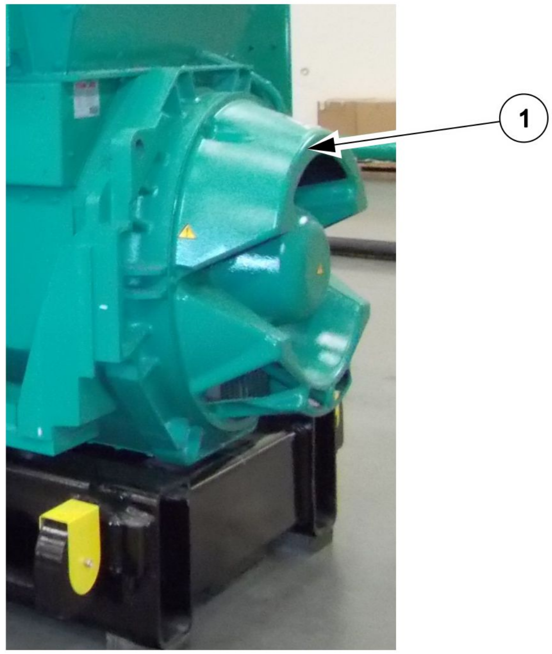
7. Replace both varistors with a matching pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F) (see below).
8. Replace all diodes (see below).
9. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

6.2.1.12.9 Permanent Magnet Generator (PMG)

⚠ WARNING
Strong Magnetic Field
The PMG has a strong magnetic field that could interfere with an implanted medical device, such as an implated heart pace maker.
Do not go near the PMG if you have an implanted medical device.

6.2.1.12.9.1 PMG Removal

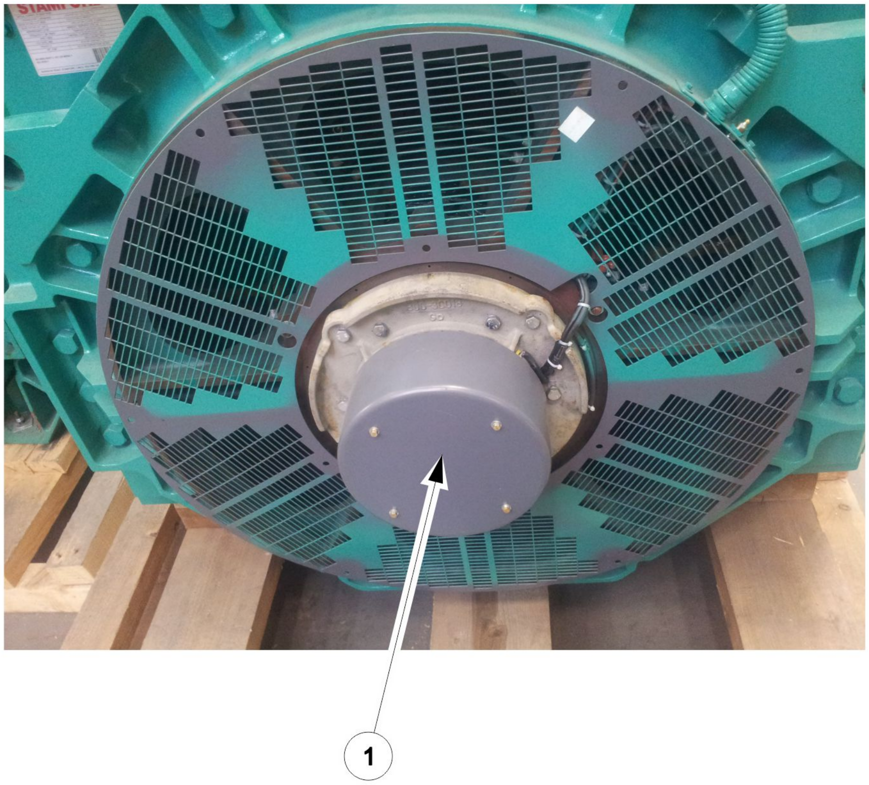
1. Make sure all sources of energy are isolated. Lock the generator set out of service. See **Section 5.1**.
2. Remove the air inlet cover (1, **Figure 47**) and air filter components (if fitted).



No.	Description	No.	Description
1	Air inlet cover		

FIGURE 47. AIR INLET COVER

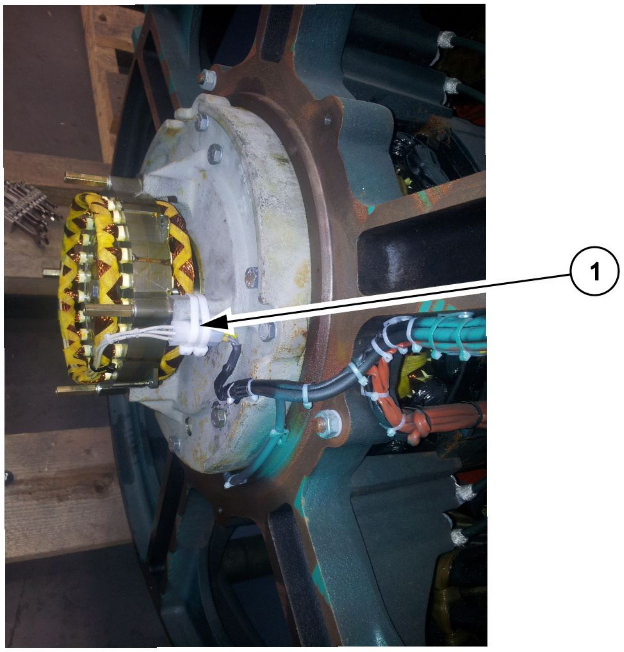
3. Remove the PMG access cover (1, **Figure 48**).



No.	Description	No.	Description
1	PMG access cover		

FIGURE 48. ACCESS COVER AND AIR INLET COVER

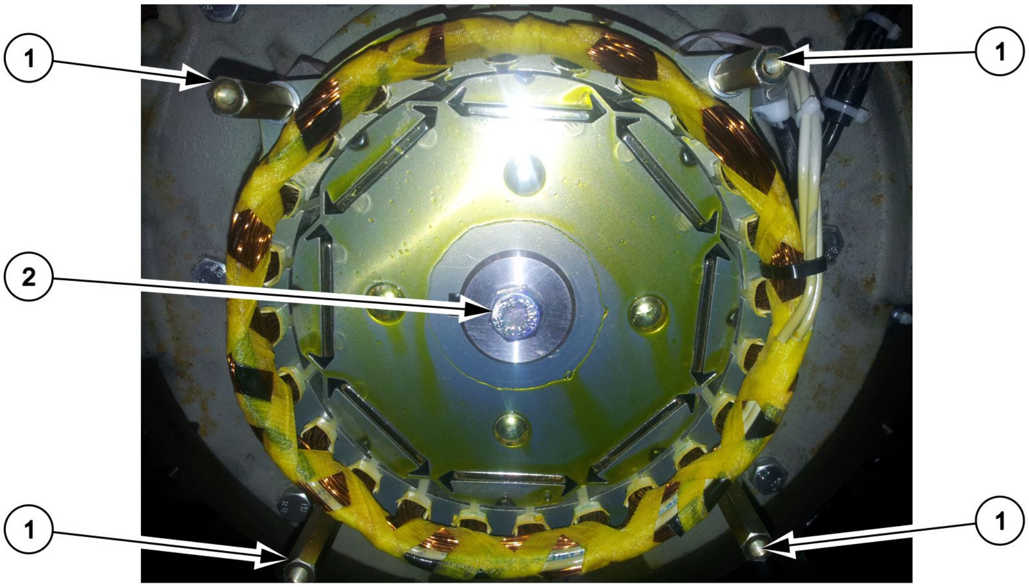
4. Disconnect the control cable plug (1, **Figure 49**) from the PMG.



No.	Description	No.	Description
1	Control cable		

FIGURE 49. PMG CONTROL CABLE

5. Remove four bolts (1, **Figure 50**) from the PMG stator.
6. Remove one bolt (2, **Figure 50**) from the PMG rotor.



No.	Description	No.	Description
1	PMG stator bolt	2	PMG rotor bolt

FIGURE 50. STATOR AND ROTOR BOLTS

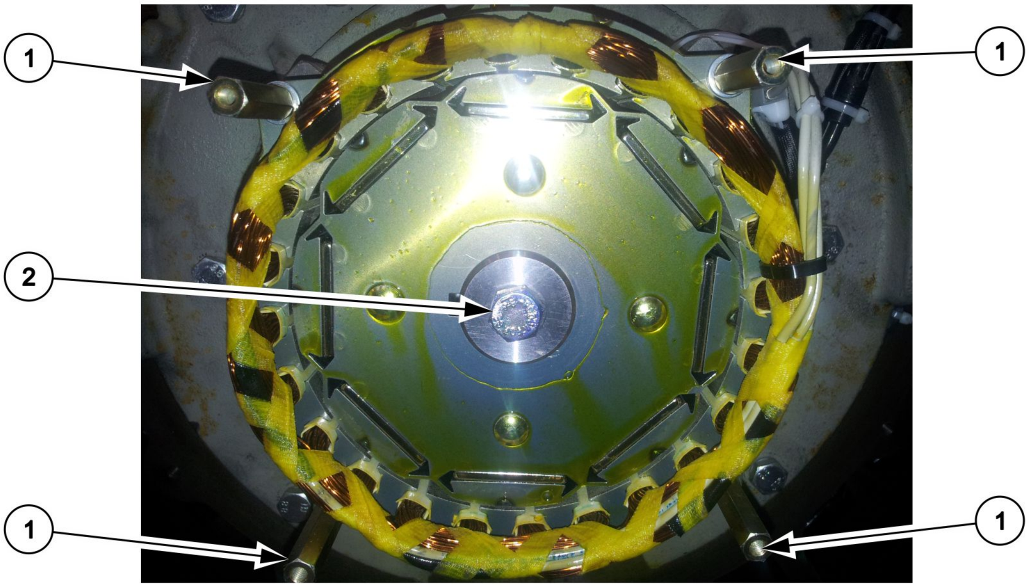
7. Pull the PMG rotor and stator assembly from the alternator shaft. A quick, strong pull is required to overcome the magnetic attraction between the PMG and the alternator shaft.

6.2.1.12.9.2 PMG Installation

1. Make sure all sources of energy are isolated. Lock the generator set out of service. See **Section 5.1**.

⚠ CAUTION
Strong Magnetic Force
Fingers can be damaged when the magnetic force pulls the PMG onto the alternator shaft.
Keep fingers clear of the area between the alternator shaft and the PMG.

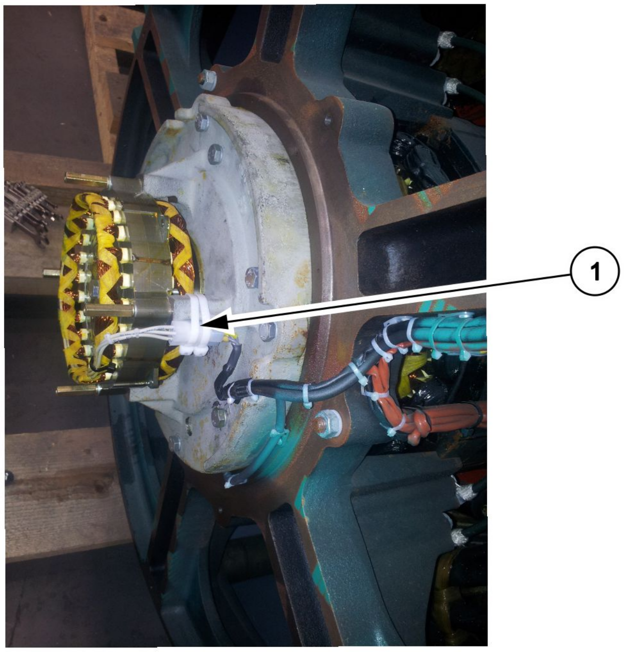
2. Guide the PMG rotor and stator assembly onto the alternator shaft. Keep fingers clear of the area between the alternator shaft and the PMG.
3. Attach one bolt (2, **Figure 51**) to secure the PMG rotor. Torque the bolt to 45 Nm (33.2 ft-lb).



No.	Description	No.	Description
1	PMG stator bolt	2	PMG rotor bolt

FIGURE 51. STATOR AND ROTOR BOLTS

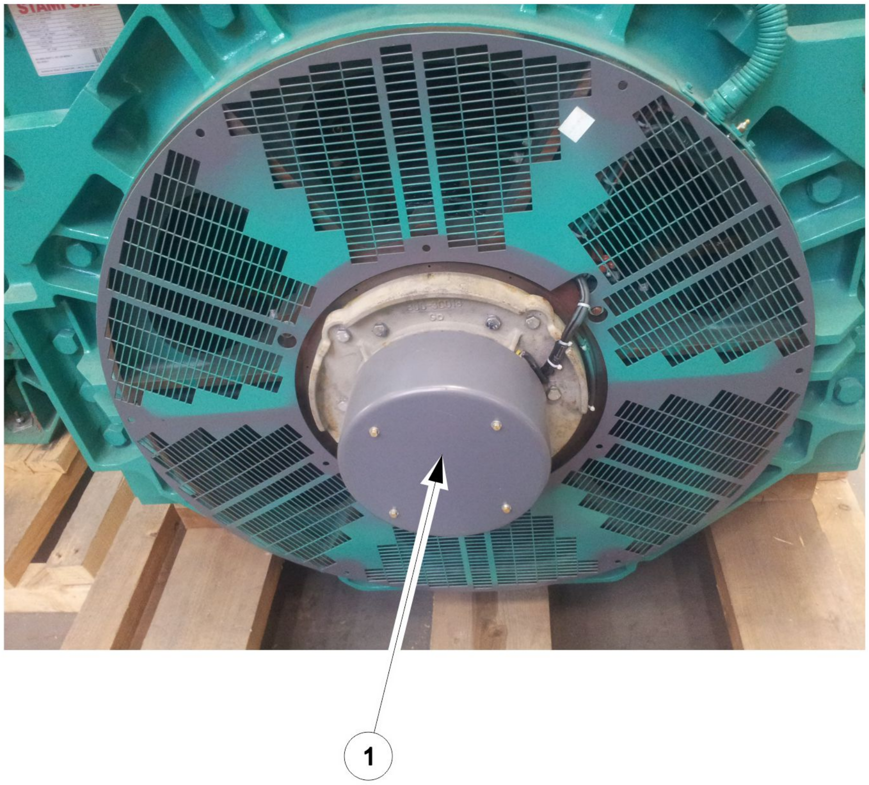
4. Attach four bolts (1, **Figure 51**) to secure the PMG stator. Torque the bolts to 9.4 Nm (6.9 ft-lb).
5. Connect the control cable plug (1, **Figure 52**) to the PMG.



No.	Description	No.	Description
1	Control cable		

FIGURE 52. PMG CONTROL CABLE

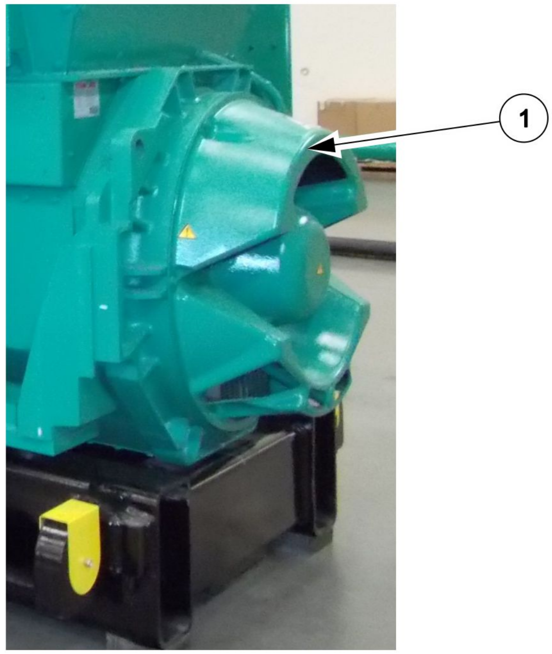
6. Attach the PMG access cover (1, **Figure 53**).



No.	Description	No.	Description
1	PMG access cover		

FIGURE 53. ACCESS COVER AND AIR INLET COVER

7. Attach the air inlet cover (2, **Figure 54**) and air filter components (if fitted).



No.	Description	No.	Description
1	Air inlet cover		

FIGURE 54. ACCESS COVER AND AIR INLET COVER

6.2.1.12.10 Temperature Sensors

6.2.1.12.10.1 Introduction

The alternators are designed to meet standards supporting EU Safety Directives, and recommended operating temperatures. Temperature sensors (where fitted) detect abnormal overheating of the main stator windings and bearing(s). Sensors are of Resistance Temperature Detector (RTD) type, with three wires terminated at a terminal block in the auxiliary terminal box. The resistance of Platinum (PT100) RTD sensors increases linearly with temperature.

TABLE 30. RESISTANCE (Ω) OF PT100 SENSOR BETWEEN 40 TO 180 °C

Temperature (°C)		+1 °C	+ 2 °C	+3 °C	+ 4 °C	+ 5 °C	+ 6 °C	+ 7 °C	+ 8 °C	+ 9 °C
40.00	115.54	115.93	116.31	116.70	117.08	117.47	117.86	118.24	118.63	119.01
50.00	119.40	119.78	120.17	120.55	120.94	121.32	121.71	122.09	122.47	122.86
60.00	123.24	123.63	124.01	124.39	124.78	125.16	125.54	125.93	126.31	126.69
70.00	127.08	127.46	127.84	128.22	128.61	128.99	129.37	129.75	130.13	130.52
80.00	130.90	131.28	131.66	132.04	132.42	132.80	133.18	133.57	133.95	134.33
90.00	134.71	135.09	135.47	135.85	136.23	136.61	136.99	137.37	137.75	138.13

Temperature (°C)		+1 °C	+ 2 °C	+3 °C	+ 4 °C	+ 5 °C	+ 6 °C	+ 7 °C	+ 8 °C	+ 9 °C
100.00	138.51	138.88	139.26	139.64	140.02	140.40	140.78	141.16	141.54	141.91
110.00	142.29	142.67	143.05	143.43	143.80	144.18	144.56	144.94	145.31	145.69
120.00	146.07	146.44	146.82	147.20	147.57	147.95	148.33	148.70	149.08	149.46
130.00	149.83	150.21	150.58	150.96	151.33	151.71	152.08	152.46	152.83	153.21
140.00	153.58	153.96	154.33	154.71	155.08	155.46	155.83	156.20	156.58	156.95
150.00	157.33	157.70	158.07	158.45	158.82	159.19	159.56	159.94	160.31	160.68
160.00	161.05	161.43	161.80	162.17	162.54	162.91	163.29	163.66	164.03	164.40
170.00	164.77	165.14	165.51	165.89	166.26	166.63	167.00	167.37	167.74	168.11
180.00	168.48	-	-	-	-	-	-	-	-	-

Customer-supplied external equipment may be connected to monitor the sensors and generate signals to raise an alarm and to shut down the generator set.

BS EN 60085 (≡ IEC 60085) Electrical insulation – Thermal Evaluation and Designation classifies insulation of windings by the maximum operating temperature for a reasonable service life. To avoid damage to windings, signals should be set, appropriate to the insulation class shown on the alternator rating plate.

TABLE 31. ALARM AND SHUTDOWN TEMPERATURE SETTINGS FOR WINDINGS

Windings insulation	Max. Continuous temperature (°C)	Alarm temperature (°C)	Shutdown temperature (°C)
Class B	130	120	140
Class F	155	145	165
Class H	180	170	190

To detect overheating of bearings, control signals should be set according to the following table.

TABLE 32. ALARM AND SHUTDOWN TEMPERATURE SETTINGS FOR BEARINGS

Bearings	Alarm temperature (°C)	Shutdown temperature (°C)
Drive end bearing	45 + maximum ambient	50 + maximum ambient
Non-drive end bearing	40 + maximum ambient	45 + maximum ambient

6.2.1.12.10.2 Safety

⚠ DANGER

Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:

- ***Shut down and isolate the alternator from all energy sources.***
- ***Remove or isolate stored energy.***
- ***Test isolated parts for electrical isolation using a suitable voltage tester.***
- ***Use lock out/tag out safety procedures.***

⚠ WARNING

Hot Surfaces and Fire

Contact with hot surfaces can cause serious injury and death by burns. A risk of fire exists where hot surfaces are contacted by combustible items. To prevent injury, death or risk of fire:

- ***Avoid contact with hot surfaces.***
- ***Always wear the appropriate personal protection equipment, refer to: Safety Precaution Chapter.***
- ***Make sure combustible materials or flammable substances are not stored close to or contact the anti-condensation heater (if fitted).***
- ***Make sure combustible materials or flammable substances are not stored close to the alternator or prime mover, including the ventilation and exhaust system(s) where applicable.***

6.2.1.12.10.3 Test RTD Temperature Sensors

1. Remove the auxiliary terminal box lid.
2. Identify the sensor leads at the terminal block and where each sensor is fitted.
3. Measure the resistance between the white and each red wire of one sensor.
4. Calculate the sensor temperature from the measured resistance.
5. Compare calculated temperature with temperature indicated by external monitoring equipment (if available).
6. Compare alarm and shutdown signal settings (if available) with recommended settings.
7. Repeat steps 3 to 7 for each sensor.
8. Refit the auxiliary terminal box lid.
9. Replace any faulty sensors.
10. Note: Main stator RTD are not replaceable. Bearing RTD are replaceable.

6.2.1.12.11 Windings

6.2.1.12.11.1 High Voltage Test

NOTICE
Windings have been tested at high voltage during manufacture. Repeated high voltage tests may degrade the insulation and reduce operating life. If a further test is required at installation for customer acceptance, it must be done at a reduced voltage, V = 0.8 x (2 x Rated Voltage + 1000). Once in service, any further tests for maintenance purposes must be done after passing visual checks and insulation resistance tests, and at a reduced voltage, V = (1.5 x Rated Voltage).

Damage to alternator insulation may occur if repeated high voltage resistance tests are carried out. Prior to carrying out any high voltage tests speak to STAMFORD® | AvK® customer services **www.stamford-avk.com**.

6.2.1.12.11.2 Introduction

NOTICE
Disconnect all control wiring and customer load leads from alternator winding connections before conducting these tests.

NOTICE
The Automatic Voltage Regulator (AVR) contains electronic components which would be damaged by high voltage applied during insulation resistance tests. The AVR must be disconnected before doing any insulation resistance test. Temperature sensors must be grounded to earth before doing any insulation resistance test. **Damp or dirty windings have a lower electrical resistance and could be damaged by insulation resistance tests at high voltage. If in doubt, test the resistance at low voltage (500 V) first.**

Alternator performance depends on good electrical insulation of the windings. Electrical, mechanical and thermal stresses, and chemical and environmental contamination, cause the insulation to degrade. Various diagnostic tests indicate the condition of insulation by charging or discharging a test voltage on isolated windings, measuring current flow, and calculating the electrical resistance by Ohm’s law.

When a DC test voltage is first applied, three currents can flow:

- **Capacitive Current:** To charge the winding to the test voltage (decays to zero in seconds),
- **Polarizing Current:** To align the insulation molecules to the applied electric field (decays to near-zero in ten minutes), and
- **Leakage Current:** Discharge to earth where the insulation resistance is lowered by moisture and contamination (increases to a constant in seconds).

For an insulation resistance test, a single measurement is made one minute after a DC test voltage is applied, when capacitive current has ended. For the polarization index test, a second measurement is made after ten minutes. An acceptable result is where the second insulation resistance measurement is at least double the first, because the polarization current has decayed. In poor insulation, where leakage current dominates, the two values are similar. A dedicated Insulation Tester takes accurate, reliable measurements and may automate some tests.

6.2.1.12.11.3 Safety

⚠ DANGER

Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before working on live conductors:

- ***Shut down and isolate the alternator from all energy sources.***
- ***Remove or isolate stored energy.***
- ***Test isolated parts for electrical isolation using a suitable voltage tester.***
- ***Use lock out/tag out safety procedures.***

⚠ DANGER

Testing Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns. To prevent injury and before testing on or near live electrical conductors:

- ***Take applicable precautions to prevent contact with live conductors, refer to: Safety Precautions Chapter.***
- ***Test on or near live conductors, only if absolutely necessary.***
- ***Only trained personnel may test on or near live electrical conductors.***
- ***Do not test on or near live electrical conductors alone: Another competent person must be present, trained to isolate energy sources and take action in an emergency.***

⚠ WARNING

Condensed Water

Operating an alternator with condensed water in the windings can cause serious injury by electric shock, burns or exposure to flying debris and particles. To prevent injury and before operating the alternator:

- ***Use anti-condensation heaters (if fitted) to prevent condensation accumulating.***
- ***Check for condensed water.***
- ***If condensed water is present, drain/remove the water, dry and inspect the alternator, refer to: Maintenance and Servicing Chapter.***

⚠ WARNING

Exposure to Particles and Fumes from an Alternator.

Particles and fumes can be released in all directions (horizontally and vertically) from where alternator ventilation is installed. To avoid or injury:

- ***Avoid the areas around ventilation openings, air intake(s) and air outlet(s) when the alternator is operating.***
- ***Use the correct personal protective equipment when working around an alternator.***

⚠ WARNING

Live Electrical Conductors

Live electrical conductors at the winding terminals can cause serious injury or death by electric shock or burns. After an insulation resistance test, to prevent injury or death:

- ***Discharge the windings immediately after the test has concluded by shorting to a suitable earth. The windings must discharge for the greater of:***
  1. ***A length of time equal to the duration of the test.***
     or
  2. ***5 minutes.***

⚠ WARNING

Incorrect Electrical Installation and System Protection

Incorrect electrical installation and / or system protection can cause serious injury or death by electric shock and burns. To prevent injury or death and before starting work, personnel:

- ***Have completed related, applicable and approved training.***
- ***Know the equipment, understand the task(s) and procedure(s).***
- ***Know related hazards / risks.***
- ***Know and obey site / location specific emergency procedures and applicable laws and regulations.***

6.2.1.12.11.4 Requirements

TABLE 33. WINDING TEST REQUIREMENTS

Requirement	Description
Personal Protective Equipment (PPE)	• Wear appropriate protective equipment as directed by site rules and risk assessment requirements.
Consumables	• None
Parts	• None
Tools	• Insulation test meter • Multimeter • Milliohm meter or micro ohmmeter • Clamp ammeter • Infrared thermometer • Earth rod

6.2.1.12.11.5 Test the Electrical Resistance of Windings

1. Stop the alternator.
2. Verify the electrical resistance of the exciter field (stator) winding:
   a. Disconnect the exciter field leads F1 and F2 from the AVR.

   b. Measure and record the electrical resistance between F1 and F2 leads with a multimeter.
   c. Reconnect the exciter field leads F1 and F2.
   d. Make sure the fasteners are secure.
3. Verify the electrical resistance of the exciter armature (rotor) winding:
   a. Mark the leads attached to diodes on one of the two rectifier plates.
   b. Disconnect all exciter rotor leads from all diodes at the rectifier.
   c. Measure and record the electrical resistance between pairs of marked leads (between phase windings). A specialist micro ohmmeter must be used.
   d. Reconnect all exciter rotor leads to the diodes.
   e. Make sure the fasteners are secure.
4. Verify the electrical resistance of the main field (rotor) winding:
   a. Disconnect the two main rotor DC leads from the rectifier plates.
   b. Measure and record the electrical resistance between the main rotor leads. A specialist micro ohmmeter must be used.
   c. Reconnect the two main rotor DC leads to the rectifier plates.
   d. Make sure the fasteners are secure.
5. Verify the electrical resistance of the main armature (stator) winding:
   a. Disconnect the leads of the main stator from the output terminals.
   b. Measure and record the electrical resistance between U1 and U2 leads and between U5 and U6 (if present). A specialist micro ohmmeter must be used.
   c. Measure and record the electrical resistance between V1 and V2 leads and between V5 and V6 (if present). A specialist micro ohmmeter must be used.
   d. Measure and record the electrical resistance between W1 and W2 leads and between W5 and W6 (if present). A specialist micro ohmmeter must be used.
   e. Reconnect the leads to the output terminals, as before.
   f. Make sure the fasteners are secure.
6. Verify the electrical resistance of the PMG armature (stator) winding:
   a. Disconnect the three PMG output leads P2, P3 and P4 from the AVR.
   b. Measure and record the electrical resistance between pairs of the PMG output leads, with a multimeter.
   c. Reconnect the three PMG output leads P2, P3 and P4 to the AVR.
   d. Make sure the fasteners are secure.
7. Refer to the winding resistance table in: **Section 6.2.1.14 on page 351** to verify the measured resistances of all windings agree with the reference values.

6.2.1.12.11.6 Test the Insulation Resistance of Windings

NOTICE
The alternator must not be put into service until the minimum insulation resistance is achieved.

TABLE 34. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

	Test Voltage (V)	Minimum Insulation Resistance at 1 minute (IR_{1min}) (MΩ)		Minimum Polarisation Index (PI = (IR_{10min}) / (IR_{1min}))
		New	In-service	
Medium voltage (MV) stator, 1 to 4.16 kV (each phase)	2500	100	50	2
High Voltage (HV) stator, 4.16 to 13.8 kV (each phase)	5000	300	150	2
PMG stator	500	5	3	N/A
Exciter stator	500	10	5	N/A
Exciter rotor, rectifier & main rotor combined	1000	200	100	N/A

1. Inspect the windings for mechanical damage or discoloration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. For Medium Voltage (MV) and High Voltage (HV) main stators:
    a. Separate the three neutral leads.
    b. Connect together both ends of each phase winding (if possible).
    c. Ground two phases to earth.
    d. Apply the test voltage from the table between the non-grounded phase and earth.
    e. Measure the insulation resistance after 1 minute (IR_{1min}).
    f. Measure the insulation resistance after 10 minutes (IR_{10min}).
    g. Discharge the test voltage with an earth rod for five minutes.
    h. Calculate the polarization index (PI = (IR_{10min}) / (IR_{1min}))
    i. Test the other two phases in turn.
    j. If the equivalent insulation resistance or polarization index is less than the minimum acceptable values, dry the insulation, then repeat the method.
    k. Remove the connections made for testing and reconnect the neutral leads.
3. For PMG and exciter stators, and combined exciter and main rotors:
    a. Connect together both ends of the winding (if possible).
    b. Apply the test voltage from the table between the winding and earth.
    c. Measure the insulation resistance after 1 minute (IR_{1min}).
    d. Discharge the test voltage with an earth rod for five minutes.
    e. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
    f. Repeat the method for each winding.
    g. Remove the connections made for testing.

6.2.1.12.11.7 Dry the Insulation

Use the methods below to dry the insulation of the main stator windings. To prevent damage as water vapor is expelled from the insulation, make sure the winding temperature does not increase faster than 5 ºC per hour or exceed 90 ºC.

Plot the insulation resistance graph to show when drying is complete.

6.2.1.12.11.7.1 Dry with Ambient Air

In many cases, the alternator can be dried sufficiently using its own cooling system. Disconnect the cables from the X+ (F1) and XX- (F2) terminals of the AVR so there is no excitation voltage supply to the exciter stator. Run the generator set in this de-excited state. Air must flow freely through the alternator to remove the moisture. Operate the anti-condensation heater (if fitted) to assist the drying effect of the air flow.

After drying is complete, re-connect the cables between the exciter stator and AVR. If the generator set is not put into service immediately, turn on the anti-condensation heater (if fitted) and retest the insulation resistance before use.

6.2.1.12.11.7.2 Dry with Hot Air

Direct the hot air from one or two 1 to 3 kW electrical fan heaters into the alternator air inlet. Make sure each heat source at least 300 mm away from the windings to avoid scorching or over-heating damage to the insulation. Air must flow freely through the alternator to remove the moisture.

After drying, remove the fan heaters and re-commission as appropriate.

If the generator set is not put into service immediately, turn on the anti-condensation heaters (where fitted) and retest the insulation resistance before use.

6.2.1.12.11.7.3 Plot Insulation Resistance (IR) Graph

Whichever method is used to dry out the alternator, measure the insulation resistance and temperature (if sensors fitted) of the main stator windings every 15 to 30 minutes. Plot a graph of insulation resistance, IR (y axis) against time, t (x axis).

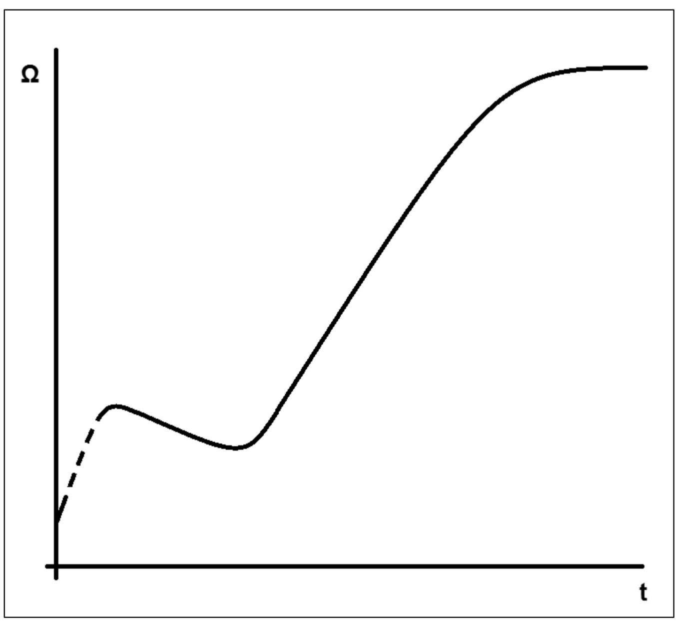


FIGURE 55. INSULATION RESISTANCE GRAPH

A typical curve shows an initial increase in resistance, a fall and then a gradual rise to a steady state. If the windings are only slightly damp the dotted portion of the curve may not appear. Continue drying for another hour after steady state is reached.

NOTICE
The alternator must not be put into service until the minimum insulation resistance is achieved.

6.2.1.13 Parts Identification

6.2.1.13.1 S9 Two Bearing Alternator

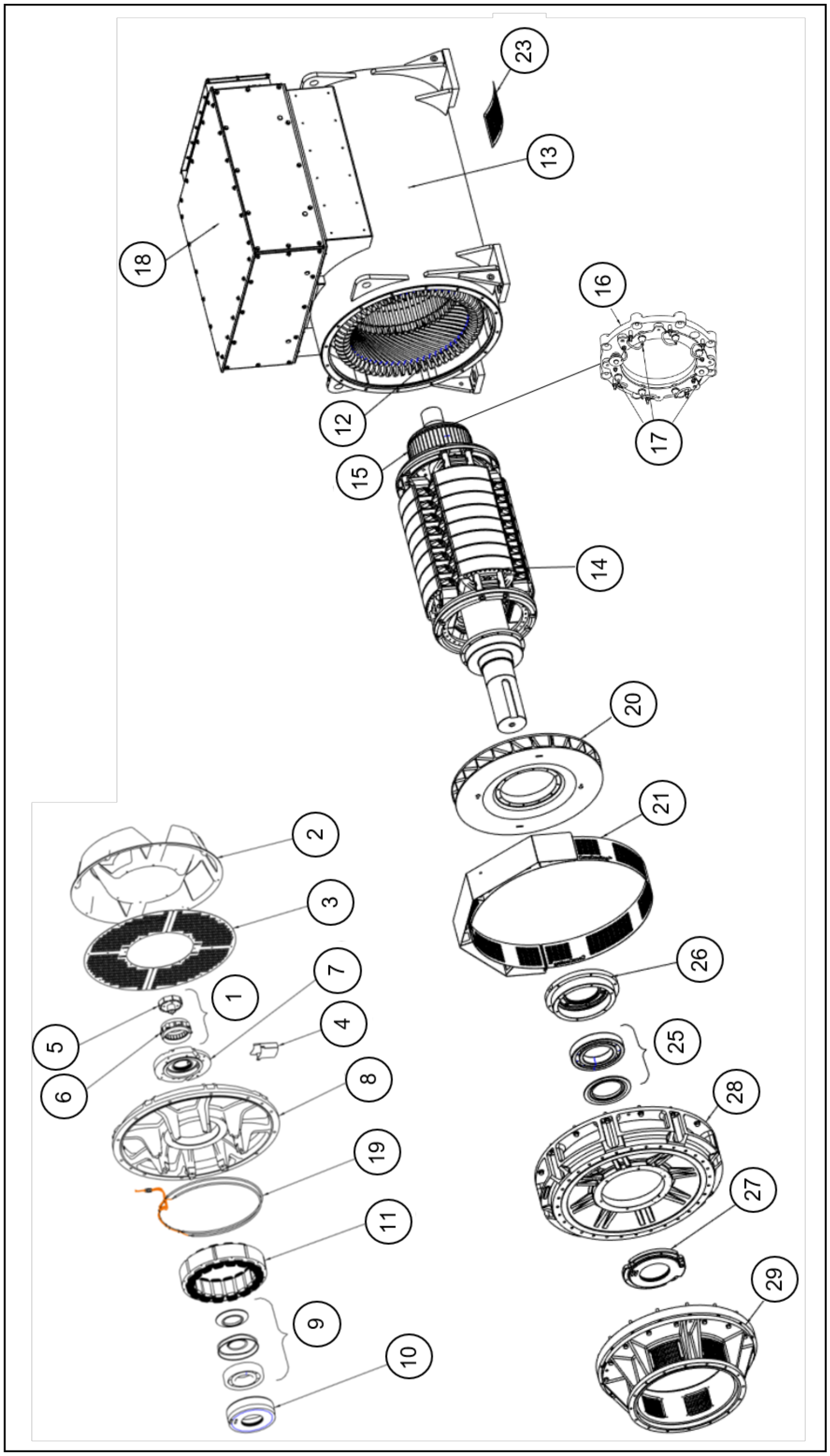


FIGURE 56. S9 TWO BEARING ALTERNATOR

6.2.1.13.2 S9 Medium and High Voltage Parts and Fasteners

TABLE 35. S9 PARTS AND FASTENERS

Reference	Component	Fastener	Quantity	Torque (Nm)
1	Complete PMG parts	-	-	-
2	Air Inlet Cover	M8 x 20	14	10
3	Air Inlet Screen (axial)	M8 x 14	3	25
4	Grease Trap	M8 x 14	2	25
5	PMG Rotor	M10 x 100	1	48
6	PMG Stator	M6 x 45	4	10
7	NDE Bearing Cap (A-F cores) NDE Bearing Cap (G-H cores)	M10 x 55 M12 x 55	4 7	48 84
8	NDE Bracket (mass 177 kg)	M16 x 60	12	206
9	NDE Bearing	-	-	-
10	NDE Bearing Cartridge (A-F cores) NDE Bearing Cartridge (G-H cores)	M10 x 55 M10 x 50	4 6	48 48
11	Exciter Stator (A-F cores) Exciter Stator (G-H cores)	M8 x 120 M8 x 150	8 8	25 25
12	Main Stator	-	-	-
13	Main Frame	-	-	-
14	Main Rotor	-	-	-
15	Exciter Rotor	-	-	-
16	Rectifier Assembly	M8 Stover Nut	8	20
17	Diode/Varistor	-	-	2.6 - 3.1
18	Terminal Box	-	-	-
19	Anti-condensation Heaters	M6 x 20	8	10
20	Fan	M10 x 110	12	45
21/21a	DE Air Outlet Screen	M8 x 25	4	25
22	DE Adapter (One Bearing)	M16x 55	16	206
23	NDE Air Inlet Screen (Radial)	M8 x 14	6	25
24	DE Coupling Discs (One Bearing) SAE18 DE Coupling Discs (One Bearing) SAE21	M30 x 90 M30 x 70	12 12	1350 1350
25	DE Bearing (Two Bearing)	-	-	-

Reference	Component	Fastener	Quantity	Torque (Nm)
26	DE Bearing Cartridge (Two Bearing A-D cores) DE Bearing Cartridge (Two Bearing E-F cores) DE Bearing Cartridge (Two Bearing G-H cores)	M10 x 75 M12 x 90 M12 x 75	6 6 6	48 84 84
27	DE Bearing Cap (Two Bearing A-D cores) DE Bearing Cap (Two Bearing E-F cores) DE Bearing Cap (Two Bearing G-H cores)	M10 x 45 M10 x 45 M12 x 120	6 6 4	48 48 48
28	DE Bracket (Two Bearing)	M16 x 55	16	206
29	DE Adapter (Two Bearing)	M16 x 60	16	206

6.2.1.13.3 S9 Medium and High Voltage Terminal Box Parts and Fasteners

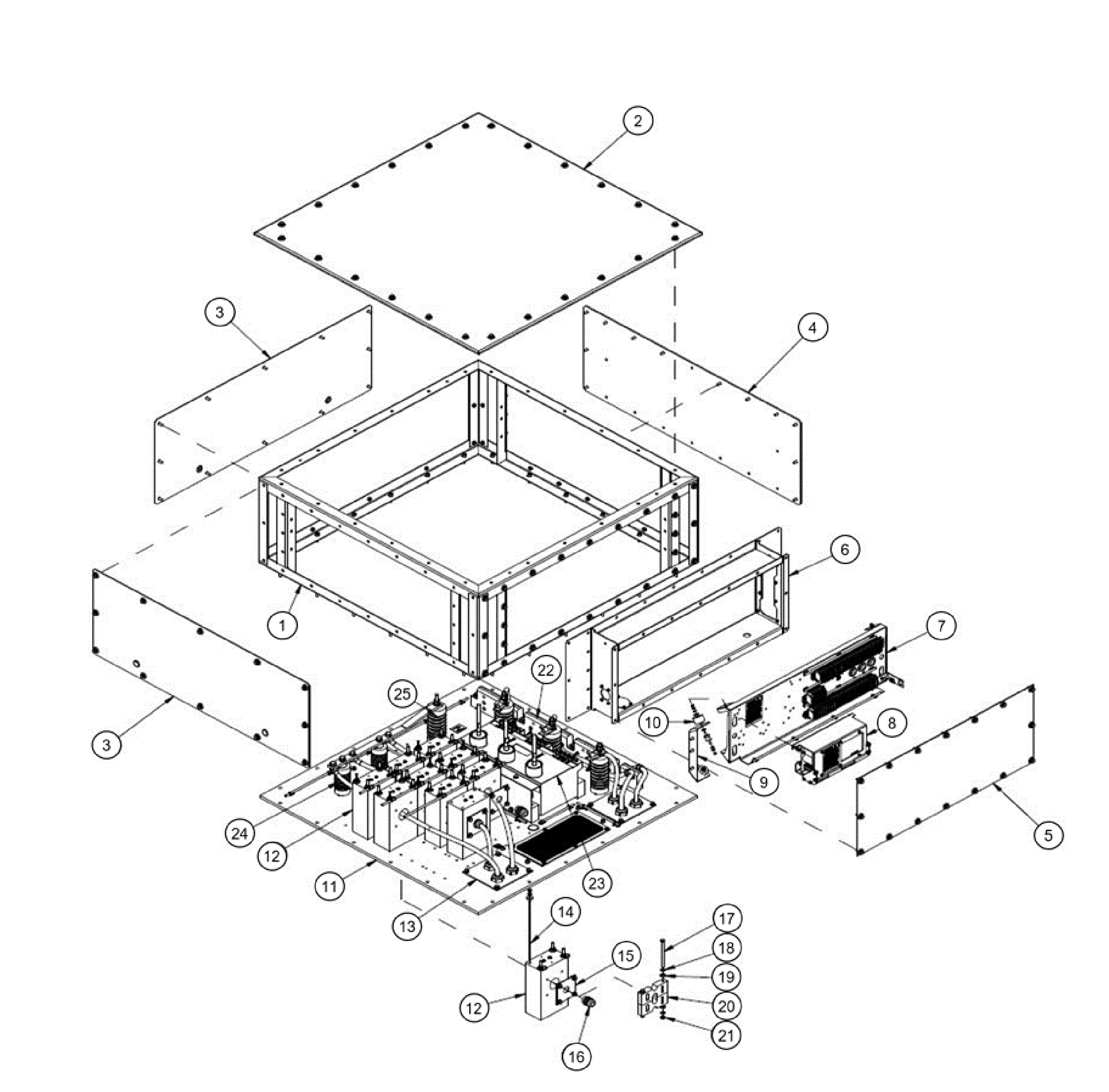


FIGURE 57. MEDIUM AND HIGH VOLTAGE TERMINAL BOX PARTS AND FASTENERS

TABLE 36. PARTS AND FASTENERS: S9 MV/HV TERMINAL BOX

Reference	Component	Fastener	Torque (Nm)
1	Terminal Box Frame	M8 x 35	25
2	Terminal Box Lid	M8 x 25	25
3	Terminal Box Panel	M8 x 25	25

Reference	Component	Fastener	Torque (Nm)
4	Gland Plate	M8 x 25	25
5	Auxiliary Terminal Box Cover	M8 x 25	25
6	Auxiliary Terminal Box	M8 x 25	25
7	Auxiliary Terminal Box Panel	M6	10
8	Automatic Voltage Regulator (AVR)	M6 x 16	10
9	Anti-Vibration Mount (AVM) Fixing Bracket	M8 x 25	25
10	AVM	M6	10
11	Terminal Box Base Plate	M8 x 35	25
12	Current Transformer (CT)	-	-
13	Gland Plate	M6 x 16	10
14	CT Stud	-	-
15	Gland Plate	M8 x 16	15
16	Cable Gland	-	-
17	Cable Clamp Bolt	M8 x 030	15
18	Washer, Belleville		-
19	Washer, Flat		-
20	Cable Clamp	-	-
21	Nut	M8	15
22	Cable Support	M8 x 70	15
23	Voltage Transformer (VT)	M8	15
24	Post Insulator to Base Plate	M12	90
25	Post Insulator to Base Plate	M12	90

6.2.1.14 Technical Data

NOTICE

Compare measurements with the technical data sheet and the test certificate supplied with the alternator.

6.2.1.14.1 S9 Medium and High Voltage Winding Resistances

TABLE 37. S9 WINDING RESISTANCES (5/6 PITCH)

Alternator	Resistance of windings at 22 °C (measured values should be within 10%)								
	Main Stator (lead-lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	51 (U1-U2) (V1-V2) (W1-W2)	61 (U1-U2) (V1-V2) (W1-W2)	63 (U1-U2) (V1-V2) (W1-W2)	83 (U1-U2) (V1-V2) (W1-W2)	91 (U1-U2) (V1-V2) (W1-W2)				
S9-A4	0.052	0.272	0.168	0.828	0.8940	9.8	0.028	0.48	3.8
S9-B4	0.0378	0.191	0.14	0.618	0.711	9.8	0.028	0.5	3.8
S9-C4	0.038	0.144	0.108	0.504	0.596	9.8	0.028	0.53	3.8
S9-D4	0.03	0.129	0.0905	0.409	0.497	9.8	0.028	0.57	3.8
S9-E4	0.0247	0.121	0.078	0.342	0.408	11.2	0.032	0.63	3.8
S9-F4	0.02	0.082	0.061	0.284	0.336	11.2	0.032	0.69	3.8
S9-G4	0.0172	0.0624	0.048	0.206	0.253	11.2	0.032	0.76	3.8
S9-H4	0.0132	0.058	0.042	0.188	0.218	11.2	0.032	0.81	3.8

TABLE 38. S9 WINDING RESISTANCES (2/3 PITCH)

Alternator	Resistance of windings at 22 °C (measured values should be within 10%)								
	Main Stator (lead-lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	851 (U1-U2) (V1-V2) (W1-W2)	961 (U1-U2) (V1-V2) (W1-W2)	963 (U1-U2) (V1-V2) (W1-W2)	983 (U1-U2) (V1-V2) (W1-W2)	991 (U1-U2) (V1-V2) (W1-W2)				
S9-A4	0.0618	0.329	0.191	1.139	1.318	9.8	0.028	0.48	3.8
S9-B4	0.048	0.251	0.154	0.761	0.822	9.8	0.028	0.5	3.8
S9-C4	0.0366	0.196	0.132	0.598	0.687	9.8	0.028	0.53	3.8
S9-D4	0.037	0.143	0.111	0.505	0.577	9.8	0.028	0.57	3.8
S9-E4	0.0304	0.147	0.094	0.418	0.498	11.2	0.032	0.63	3.8
S9-F4	0.024	0.1	0.078	0.348	0.408	11.2	0.032	0.69	3.8
S9-G4	0.0205	0.0827	0.062	0.289	0.336	11.2	0.032	0.76	3.8

Alternator	Resistance of windings at 22 °C (measured values should be within 10%)								
	Main Stator (lead-lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	851 (U1-U2) (V1-V2) (W1-W2)	961 (U1-U2) (V1-V2) (W1-W2)	963 (U1-U2) (V1-V2) (W1-W2)	983 (U1-U2) (V1-V2) (W1-W2)	991 (U1-U2) (V1-V2) (W1-W2)				
S9-H4	0.0172	0.066	0.047	0.208	0.252	11.2	0.032	0.81	3.8

6.3 Cooling System

6.3.1 Cooling System Components

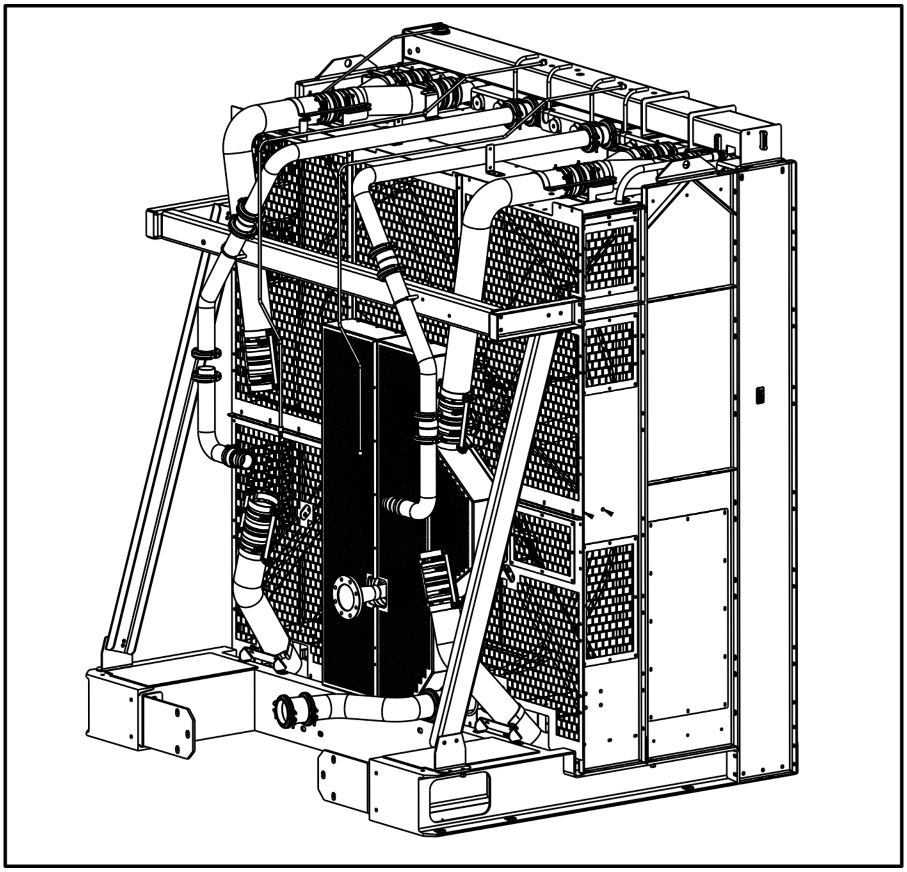
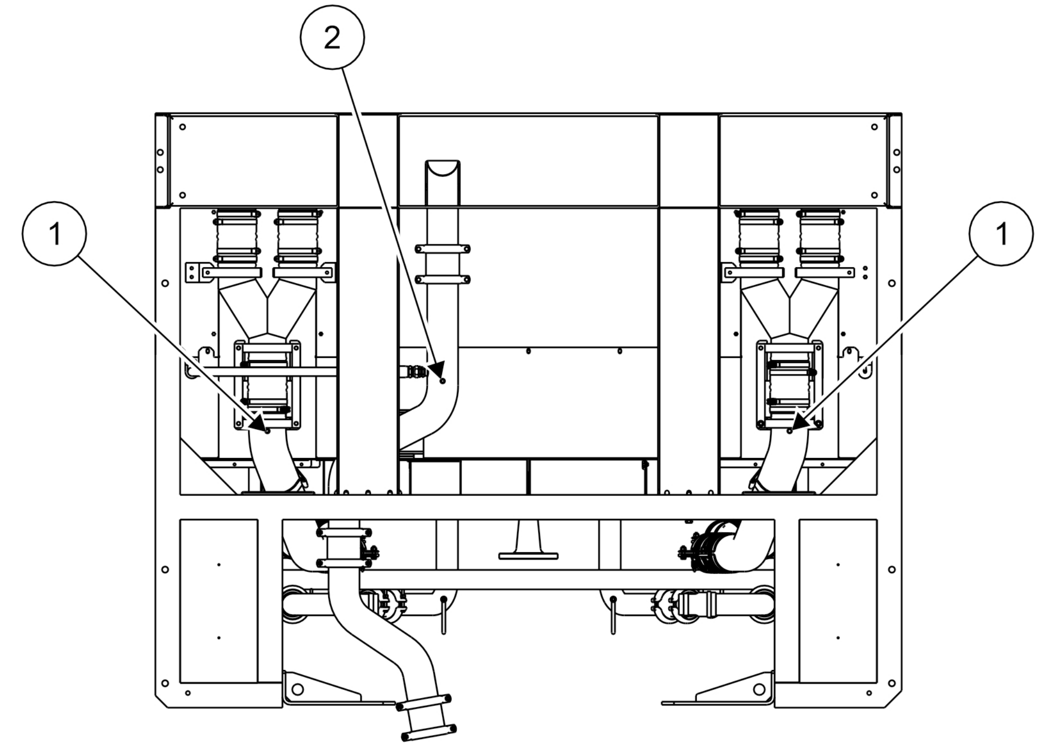


FIGURE 58. COOLING SYSTEM



No.	Description	No.	Description
1	Charge Air Cooler Drain	2	Radiator Drain

FIGURE 59. COOLING SYSTEM DRAINS, BOTTOM OF RADIATOR

6.3.2 Cooling System Maintenance

This section provides information on cleaning the radiator and updated information regarding bearings that has been provided by our supplier to enable efficient and prolonged life of the equipment.

NOTICE
The following information regarding the correct choice and fitting of hose clamps has also been provided by our supplier to assist and guide the user.

6.3.2.1 Hose Clamp Installation

This section provides general installation guidelines for the correct positioning, orientation and torque figures required when fitting hose clamps. Recommended hose and clamp combinations are also included.

6.3.2.1.1 Choosing the Right Hose Size

The recommended fit for hose to pipe is a 0.8 mm interference fit, i.e. the inner diameter of the hose should be 0.5 mm smaller than the overall diameter of the pipe.

6.3.2.1.2 Types of Hose Clamps

There are three main types of hose clamps:

- Constant Torque Clamps

- T-Clamps
- Worm Drive Clamps

6.3.2.1.2.1 Constant Torque Clamps

T Type	Worm Gear Type
	

FIGURE 60. CONSTANT TORQUE CLAMPS

TABLE 39. CONSTANT TORQUE CLAMP SPECIFICATIONS

DIA. RANGE (mm)	BOLT SIZE	PIPE DIA. (mm)	HOSE TYPE	INSTALLATION TORQUE
25.4 – 44.4	3/8”	25.4	EPDM RUBBER	8 Nm
31.7 – 54.1	3/8”	38.1	APT THICK WALL	14 Nm
31.7 – 54.1	3/8”	38.1	EPDM RUBBER	14 Nm
31.7 – 54.1	3/8”	38.1	SILICONE NOMEX	14 Nm
57.1 – 79.5	3/8”	57.1	EPDM RUBBER	14 Nm
57.1 – 79.5	3/8”	57.1	APT THICK WALL	14 Nm
69.8 – 92.2	3/8”	76.2	APT THICK WALL	14 Nm
69.8 – 92.2	3/8”	76.2	SILICONE NOMEX	14 Nm
69.8 – 92.2	3/8”	76.2	EPDM RUBBER	14 Nm
82.5 – 104.9	3/8”	88.9	APT THICK WALL	14 Nm
95.2 – 117.65	3/8”	101.6	APT THICK WALL	14 Nm
95.2 – 117.65	3/8”	101.6	SILICONE NOMEX	14 Nm
95.2 – 117.65	3/8”	101.6	EPDM RUBBER	14 Nm
133.3 – 155.7	3/8”	127	APT THICK WALL	14 Nm

6.3.2.1.2.2 T-Clamps

FIGURE 61. T-CLAMP

DIA. RANGE (mm)	BOLT SIZE	PIPE DIA. (mm)	HOSE TYPE	INSTALLATION TORQUE
43 – 47	M6 X 50	38.1	SILICONE NOMEX	4 Nm
63 – 68	M7 X 60	57.1	EPDM RUBBER	4 Nm
68 – 73	M8 X 80	63.5	EPDM RUBBER	12 Nm
97 -104	M8 X 80	88.9	SILICONE NOMEX	12 Nm
121 – 130	M8 X 80	114.3	EPDM RUBBER	12 Nm
121 – 130	M8 X 80	114.3	SILICONE NOMEX	12 Nm
130 – 140	M8 X 80	127	EPDM RUBBER	12 Nm
130 – 140	M8 X 80	127	SILICONE NOMEX	12 Nm
162 - 174	M10 X 110	152.4	SILICONE NOMEX	30 Nm

6.3.2.1.2.3 Worm Drive Clamps

FIGURE 62. WORM DRIVE CLAMP

DIA. RANGE (mm)	INSTALLATION TORQUE	SOCKET REQUIRED	HOSE TYPE
8 - 16	3 Nm	7 mm	EPDM Rubber
12 - 20	3 Nm	7 mm	EPDM Rubber
16 - 25	4.5 Nm	7 mm	EPDM Rubber

DIA. RANGE (mm)	INSTALLATION TORQUE	SOCKET REQUIRED	HOSE TYPE
25 - 40	4.5 Nm	7 mm	EPDM Rubber
20 - 32	4.5 Nm	7 mm	EPDM Rubber
32 - 50	4.5 Nm	7 mm	EPDM Rubber
40 - 60	4.5 Nm	7 mm	EPDM Rubber
50 - 70	4.5 Nm	7 mm	EPDM Rubber
60 - 80	4.5 Nm	7 mm	EPDM Rubber
70 - 90	4.5 Nm	7 mm	EPDM Rubber
80 - 100	4.5 Nm	7 mm	EPDM Rubber
90 - 110	4.5 Nm	7 mm	EPDM Rubber
100 - 120	4.5 Nm	7 mm	EPDM Rubber
120 - 140	4.5 Nm	7 mm	EPDM Rubber

6.3.2.2 Cleaning

6.3.2.2.1 General Cleaning

The Cleaning Of Radiator Cores Using Pressurized Water Equipment:

NOTICE
In specific dust laden environments, this procedure should not be used as the initial cleaning operation; it should follow Cleaning - Dust Laden Environments.

On enclosed generator sets with removable end panel(s), remove the end panel(s) to assist in the cleaning of the radiator.

Inspect the exterior of the radiator for obstructions. During the service life of a radiator, a build up of foreign matter can obstruct the flow of air through the radiator cores, reducing the cooling capability. To ensure the continued efficiency of the radiator, the core will require cleaning.

For thorough cleaning, pressure wash in the opposite direction to the airflow. A suitable proprietary degreasing additive (as recommended by the manufacturer of the pressure washer) should be applied via the pressure washer but this must not contain ammonia as it will corrode the core.

The recommended equipment for cleaning a radiator core is an industrial pressure washer, but it must be used in the correct manner as misuse can reduce the performance of the core. Protect the generator set from any over spray during this procedure.

To be effective, it is recommended that a hot water washer be used.

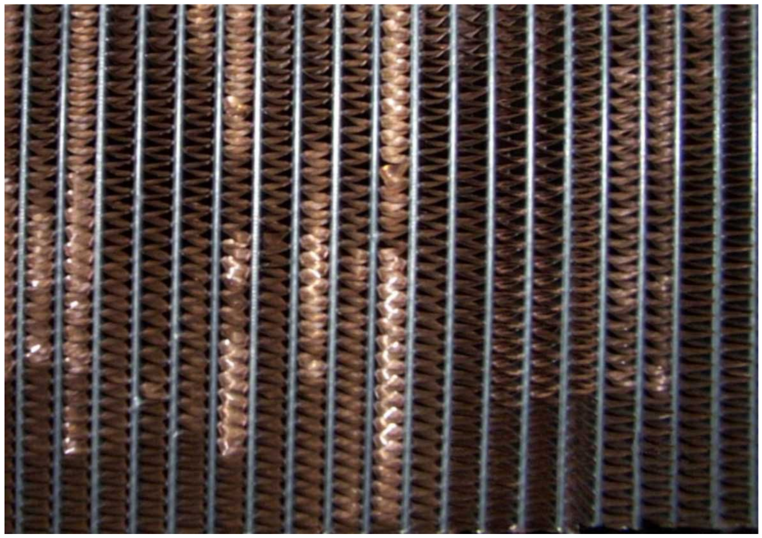


FIGURE 63. FINS DAMAGED BY PRESSURE WASHING AT ACUTE ANGLES TO CORE FACE

NOTICE
With the pressures involved it is important that the distance between the core face and the nozzle is a minimum of 100 mm (3.93 inches); any closer and damage may occur.

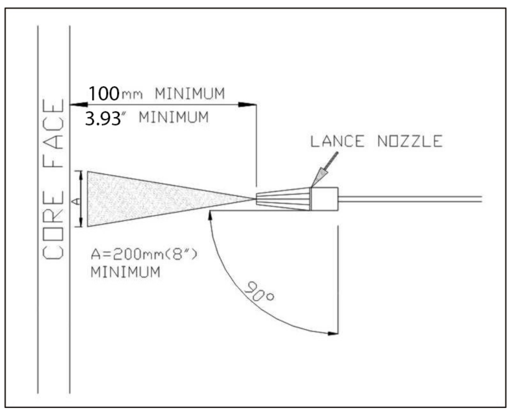


FIGURE 64. PRESSURE WASHER NOZZLE POSITIONING

NOTICE
Most Industrial pressure washers work at pressures of around 1500 psi to 2000 psi (103 bar to137.89 bar). It is very important that, when washing a core in this way, the lance must be kept at a right angle to the core

NOTICE
If your pressure washer works above 2000 psi, then the gap between the nozzle and the core face must be increased or fin damage will occur.

NOTICE
Always follow pressure washer Manufacturer's Health and Safety Guidelines.

Replace the end panel(s) where necessary.

6.3.2.2.2 Dust Laden Environments

Specific Instructions for the Cleaning of Radiator Cores Used in an Environment Subjected to Crushed Aggregate or Ceramic Dust Contamination

On enclosed generator sets with removable end panel(s), remove the end panel(s) to assist in the cleaning of the radiator.

Inspect the exterior of the radiator for obstructions. During the service life of a radiator, a buildup of foreign matter can obstruct the flow of air through the radiator cores, reducing cooling capability. To maintain the efficiency of the radiator, the core will require cleaning.

Unless the radiator can be dismantled and the core treated in a professional caustic immersion cleaning system, the radiator should not be "wet" cleaned. This is because of the tendency of this type of contamination to coalesce and become extremely difficult to remove.

The correct procedure is to regularly blow through the entire core area with low pressure compressed air (against the direction of cooling airflow). It is very important to ensure that resultant debris blown from the core is subsequently removed and disposed of before engine start-up. An industrial vacuum cleaner will achieve this requirement. In most installations, it will be necessary to remove cowls and guarding.

To prevent damage to fins and resultant loss of cooling, it is important to ensure that the air gun used is maintained at right angles to the core face.

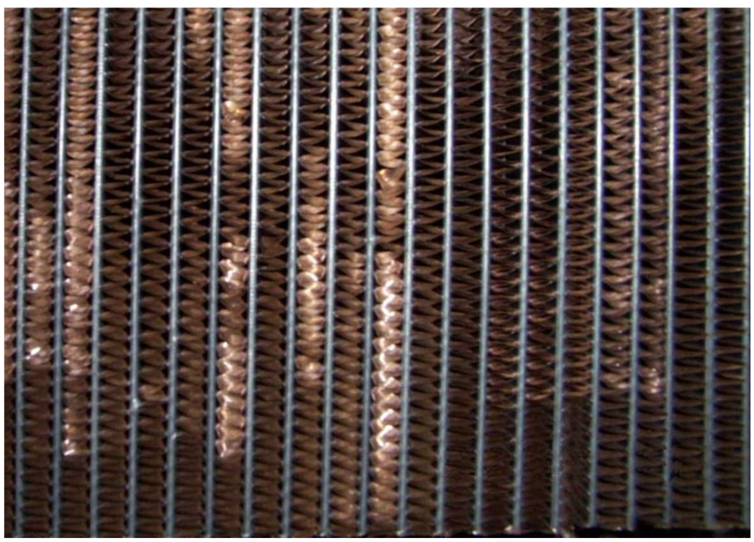


FIGURE 65. FINS DAMAGED BY COMPRESSED AIR AT ACUTE ANGLES TO CORE FACE

After this procedure has been effectively carried out with only the lightest of dust remaining, follow it immediately (if necessary) by cleaning the radiator cores using pressurized water equipment.

Replace the end panel(s) where necessary.

NOTICE
It is vitally important that the core is thoroughly dried before start-up.

6.3.2.3 Bearing Health Check

The following information is relevant to both Interference Fit and Non-Interference Fit bearings.

Determine if there are any sounds emanating from the shaft/bearing assembly which may be indicative of failure, or imminent failure.

6.3.2.4 Bearing and Grease Change

The fan drive and design has been changed to improve serviceability of the bearing set-up, both in terms of greasing and fitting.

6.3.2.5 Greasing Schedule

Lubrication

Radiators using bearings require greasing at an interval dependent upon their usage. The table below shows a lubrication maintenance schedule according to service hours. All motor bearings should be greased with Mobil Polyrex EM polyurea base grease or equivalent. All fan bearings should be greased with Certified Labs Premalube Red aluminum complex base grease or equivalent. DO NOT MIX GREASE TYPES. Radiators requiring different lubricant or lubrication methods will be specified on the radiator drawing.

Service Hours	Lubrication Frequency
40 Hours per Year	Every Six Months
18 Hours per Day	Twice per Month
18 Hours per Day (dirty environment)	Once Each Week
24 Hours per Day	Once Each Week
24 Hours per Day (dirty environment)	Daily

When lubricating pillow black bearings, add greases slowly until it shows slightly at the seals. This indicates proper bearing lubrication. The use of excessive pressure when greasing the bearing can pop the bearing seals. Electric motor bearings should always be kept between 1/2 and 3/4 full. This will make sure proper lubrication to the motor. Both pillow block and electric motor bearings should be serviced using the maintenance schedule listed above.

⚠ WARNING
Lithium and polyurea greases are not compatible and must NOT be mixed.

6.4 Fuel System

6.4.1 Fuel System Adjustments

NOTICE
Read the warranty statement provided with the generator set for US Environmental Protection Agency (EPA) restrictions on servicing specific components.

6.4.1.1 Fuel Filter Maintenance

6.4.1.1.1 Fuel Filters - Drain

Refer to the engine specific manual for a more detailed procedure for draining the fuel filters.

Drain the water and sediment daily. The fuel filters can be inspected for collected water by checking the clear bowl at the bottom of each filter.

To drain the water:

1. Shut off the engine.
2. Place a suitable container under the fuel filter.
3. With the fuel supply valve closed, open the vent cap to break the airlock in the filter.
4. Open the drain valve. Accumulated water will drain first.
5. When fuel begins to flow out of the drain, close the drain valve.

The drained liquids must be disposed of in accordance with local environmental regulations.

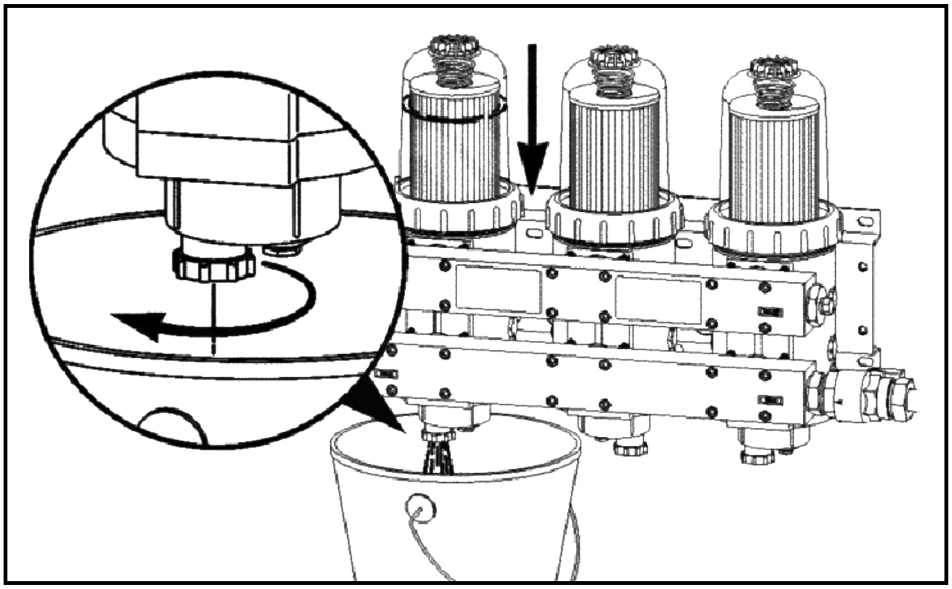
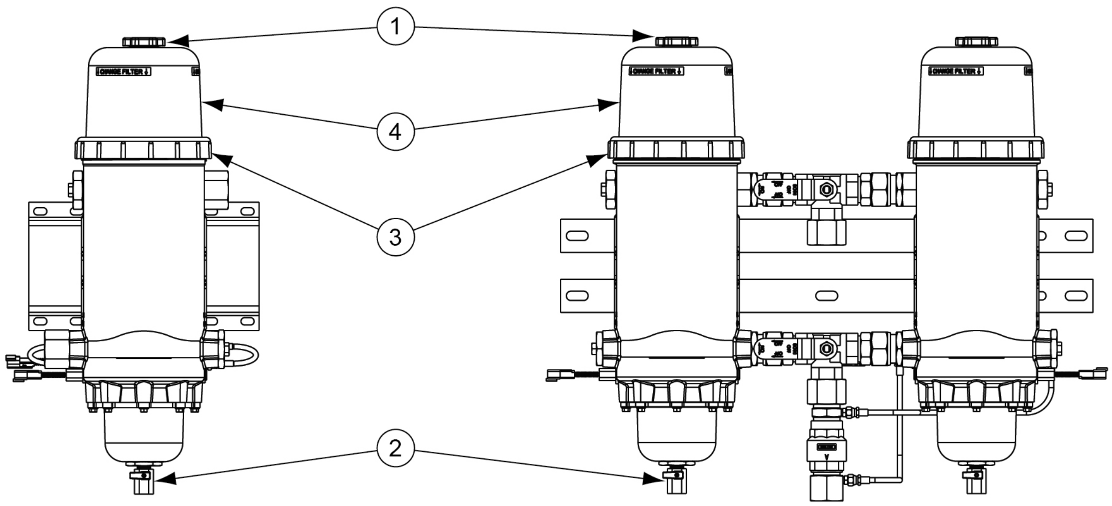


FIGURE 66. DRAINING THE FILTER/SEPARATORS

6.4.1.1.2 Fuel Filters - Element Removal

⚠ WARNING
Combustible Liquid   ***Diesel fuel is a fire and explosion hazard which can cause severe personal injury or death.***   ***Do not permit any open flame, or other igniter near the fuel system, or in areas sharing ventilation.***



No.	Description	No.	Description
1	Vent Cap	3	Collar
2	Drain Valve	4	Clear Cover

FIGURE 67. FUEL FILTER REMOVAL - SINGLE TALL AND DUPLEX FUEL FILTERS

NOTICE

The fuel must be drained from the filter head prior to removing the element. Do not allow fuel to drain onto the ground. Drained fuel must be collected and disposed of in accordance with local environmental regulations.

1. Shut down the engine.
2. Close the fuel supply shutoff valve.
3. Place a suitable container under the filter to be replaced.
4. Use the collar/vent cap wrench to open the vent cap to break the air lock in the filter.
5. Open the drain valve, and allow the fuel level to drain to a point below the collar.
6. Close the drain valve.
7. Loosen the collar with the collar/vent cap wrench.
8. Remove the clear cover, filter spring, fuel filter element, and o-ring.
9. Remove the sealing grommet.
10. Discard the o-ring and grommet.

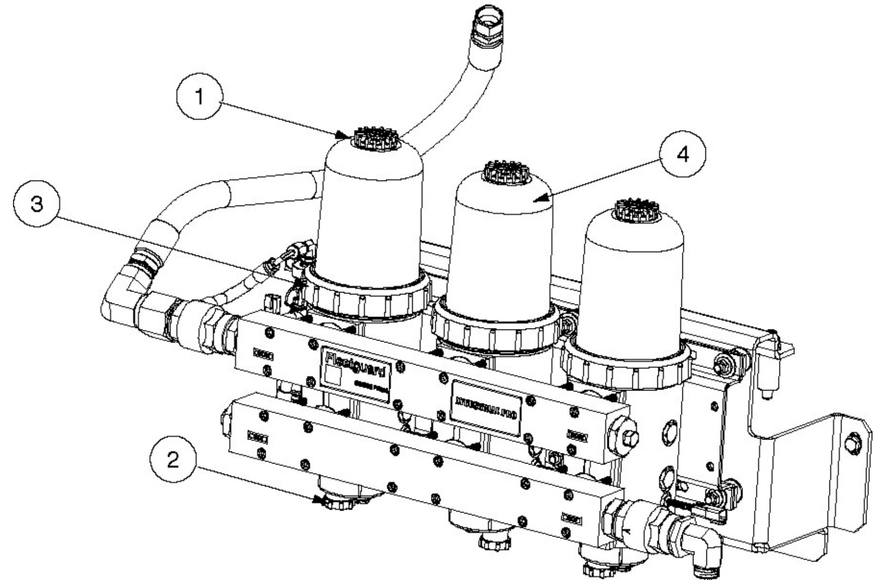
6.4.1.1.3 Fuel Filters - Element Removal

⚠ WARNING

Combustible Liquid

Diesel fuel is a fire and explosion hazard which can cause severe personal injury or death.

Do not permit any open flame, or other igniter near the fuel system, or in areas sharing ventilation.



No.	Description	No.	Description
1	Vent Cap	3	Collar
2	Drain Valve	4	Clear Cover

FIGURE 68. FUEL FILTER REMOVAL

NOTICE

The fuel must be drained from the filter head prior to removing the element. Do not allow fuel to drain onto the ground. Drained fuel must be collected and disposed of in accordance with local environmental regulations.

1. Shut down the engine.
2. Close the fuel supply shutoff valve.
3. Place a suitable container under the filter to be replaced.
4. Use the collar/vent cap wrench to open the vent cap to break the air lock in the filter.
5. Open the drain valve, and allow the fuel level to drain to a point below the collar.
6. Close the drain valve.
7. Loosen the collar with the collar/vent cap wrench.
8. Remove the clear cover, filter spring, fuel filter element, and o-ring.
9. Remove the sealing grommet.
10. Discard the o-ring and grommet.

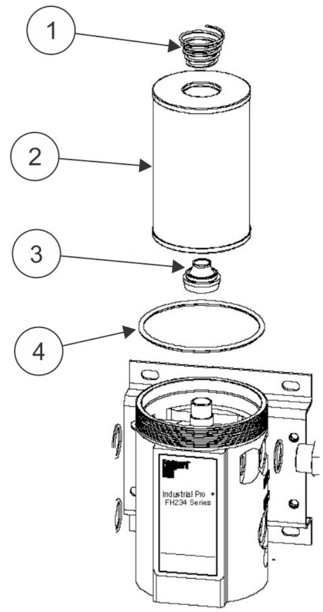
6.4.1.1.4 Fuel Filter - Element Replacement

⚠ WARNING

Combustible Liquid

Diesel fuel is a fire and explosion hazard which can cause severe personal injury or death.

Do not permit any open flame, or other igniter near the fuel system, or in areas sharing ventilation.



No.	Description	No.	Description
1	Filter Spring	3	Sealing Grommet
2	Filter Element	4	O-Ring

FIGURE 69. FUEL FILTER ELEMENT

NOTICE
Fuel filter replacement includes the appropriate o-ring and sealing grommet. The o-ring and grommet must be replaced with the filter element to make sure of proper operation.

1. Install a new o-ring, filter element (supplied with a sealing grommet inserted into the filter element), filter spring, and clear cover.
2. Install the vent cap and the collar onto the clear cover.
3. Hand tighten. Do not use tools to tighten the collar.

6.4.1.1.5 Fuel Filter Canister Removal and Replacement

⚠ CAUTION
Hazardous Liquid   ***Benzine and lead, found in some diesel oils, have been identified as causing cancer or reproductive toxicity.***   ***When checking, draining, or adding diesel, do not to ingest, breathe the fumes, or come into physical contact with the diesel. Use appropriate PPE.***

NOTICE
Only authorized and competent personnel who are familiar with the equipment and its operation should carry out maintenance.

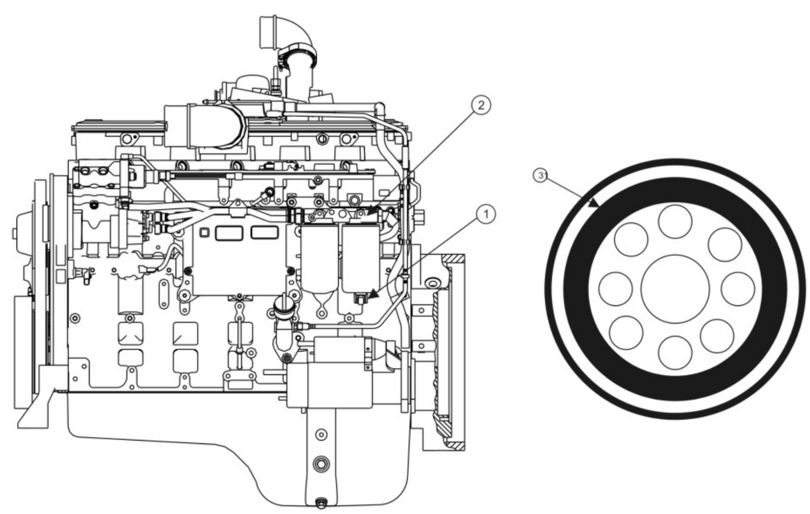
NOTICE
Before carrying out any maintenance, isolate all supplies to the generator set and any control panels. Render the set inoperative by disconnecting the battery.

NOTICE
Shut down the generator set as described in the Operation and Maintenance Manual supplied with the generator set.

This procedure is to be used with canister-type fuel filters that do not include a separate, removable, washable filter element. These canisters are disposable and are to be removed and replaced with a new canister, instead of cleaning the internal element.

The following equipment is required to remove the fuel filter canister.

- Strap wrench
- Container to drain the remaining fuel from the filter into
- Lint free cloth
- Clean fuel
- Disposable gloves



1	Water drain tap and water sensor connector (If fitted)
2	Filter housing
3	O-ring seal

FIGURE 70. FUEL FILTER CANNISTER (EXAMPLE)

1. If the canister is fitted with one, disconnect the fuel/water sensor connector.
2. Place the lint free cloth below the fuel canister(s).
3. Using a suitable strap wrench, release the fuel filter canister from the fuel filter housing.
4. Unscrew the fuel filter canister and empty the fuel into a suitable container.

NOTICE
Dispose of the fuel filter canister in accordance with local regulations.

5. Using the lint free cloth, clean the filter housing.
6. Lubricate the O-ring seal on the new fuel filter canister with clean fuel.
7. Fill the new fuel filter canister with clean fuel.

NOTICE
Over-tightening of the fuel filter canister may distort the threads or damage the seal.

8. Screw the fuel filter canister to the filter housing and tighten by hand.
9. If the canister is fitted with one, connect the water sensor connector.
10. Wipe the fuel filter canister, cleaning off any spilled fuel.
11. Remove the lint free cloth from below the fuel filter(s).
12. Start the generator set and check for leaks.

6.5 Air Intake System

The direct flow air cleaner consists of a primary filter and a secondary filter within the air cleaner housing. The air cleaner has been designed for a maximum restriction, at which point the filter elements should be changed. Refer to the Model Specifications section.

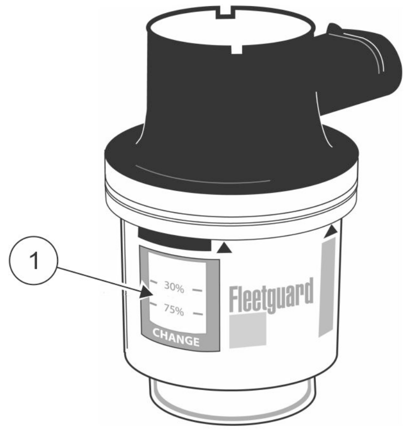
6.5.1 Air Cleaner Service Indicator

⚠ **WARNING**
Moving Parts
Moving parts can cause severe personal injury.
Use extreme caution around moving parts. All guards must be properly fastened to prevent unintended contact.

⚠ **WARNING**
Hot Surfaces
Contact with the hot surfaces can cause severe burns.
Avoid contact with hot parts. Allow hot parts to completely cool.

The air cleaner service indicator is located either on the air cleaner assembly or between the assembly and the inlet side of the turbocharger.

Check the air cleaner service indicator. If the gauge has crossed the red mark (1), replace the filter.



No.	Description
1	Red Mark

FIGURE 71. AIR CLEANER SERVICE INDICATOR

6.5.2 Normal Duty Air Cleaner

6.5.2.1 Air Filter Element Removal

NOTICE
Holes, loose-end seals, dented sealing surfaces, corrosion of pipes, and other forms of damage render the air cleaner inoperative and require immediate element replacement or engine damage can occur.

NOTICE
Cummins Inc. does not recommend cleaning paper-type air cleaner elements. Elements that have been cleaned will clog, and airflow to the engine will be restricted.

Use care when servicing components for the engine combustion air intake system.

1. Loosen air filter straps (1) and band clamp (2).
2. Slide the air filter element (3) straight toward the front of the engine to remove.
3. Repeat steps 1-3 to remove the remaining three filter elements.

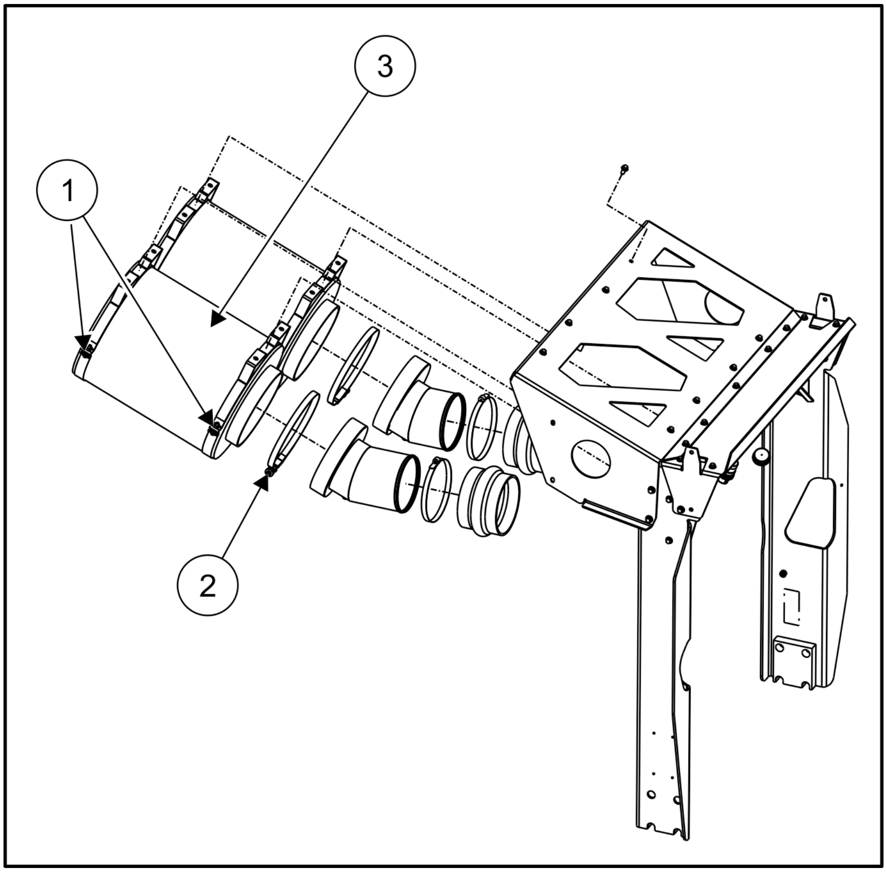


FIGURE 72. NORMAL DUTY AIR CLEANER

6.5.2.2 Air Filter Element Installation

1. Install the new air filter element (3) by sliding toward the rear of the engine within the air filter straps (1).

NOTICE
Air filter straps must be aligned with the black rubber air filter element ends. Failure to properly align the air filter element could result in damage to the air filter element.

2. Tighten the band clamp to secure the air filter element to the air induction pipe (2). Torque to 11 nm (97 in-lb).
3. Tighten the two air filter straps to secure the air filter element (1). Torque to 4.5 nm (40 in-lb).
4. Repeat steps 1-3 to remove the remaining three air filter elements.

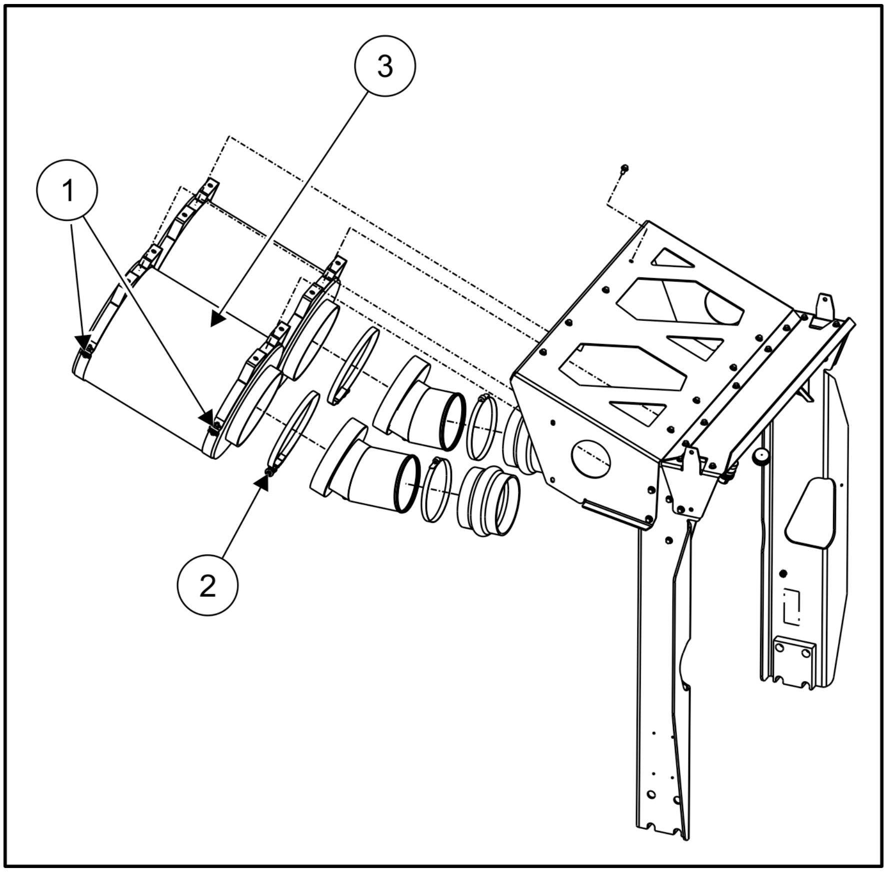


FIGURE 73. NORMAL DUTY AIR CLEANER

6.6 Exhaust System

6.6.1 Overview

NOTICE
Read the warranty statement provided with the generator set for US Environmental Protection Agency (EPA) restrictions on servicing specific components.

The exhaust system is comprised of up to three active components - the turbocharger (if equipped), the oxygen sensor, and the muffler/catalytic converter (if equipped) - in addition to manifold(s) and piping connecting the components.

6.7 SAE J1939 CAN (Controlled Area Network)

The following section describes the function and operation of the J1939 Controlled Area Network (CAN) datalink, as it applies to this generator set. The engine control module (ECM) communicates to the generator set controller (I.e., PCC) over this network.

CAN communications follow the SAE J1939 communication protocol standard. The CAN datalink is based on a main trunk no more than 131 feet (40 meters) long and with 30 devices that is terminated by a 120 Ohm resistor at each end. Stubs no longer than 3.3 feet (1 meter) extend from the main trunk to each module in the bus.

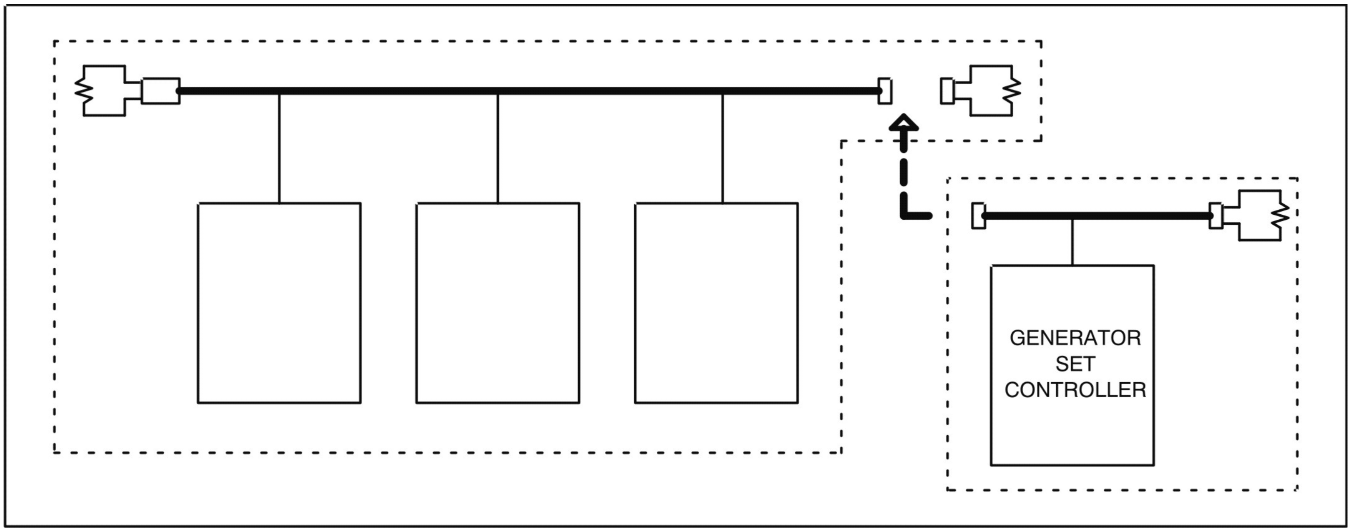


FIGURE 74. CAN DATALINK

6.7.1 CAN Datalink Signals

The CAN datalink carries the binary signal between the ECM (Engine Control Module) and the generator set controller. The binary signal is expressed by a change in voltage. The table below shows how the generator set controller distinguishes between the voltage signals.

TABLE 40. CAN DATALINK VOLTAGE DIFFERENTIALS

Signal	0	1
J1939 High (+)	2.5 V	3.5 V
J1939 Low (–)	2.5 V	1.5 V
Voltage Differential	0 V	2 V

The CAN datalink transmits the signal at 250 KBaud, or 250 kilobits per second. Hence, it is possible for the voltages on J1939 High (+) and J1939 Low (–) to change 250,000 times per second.

The figures below show examples of good and bad datalink signals, on a high-resolution oscilloscope. The bad signal is caused by termination problems (no termination, wrong termination, or bad termination).

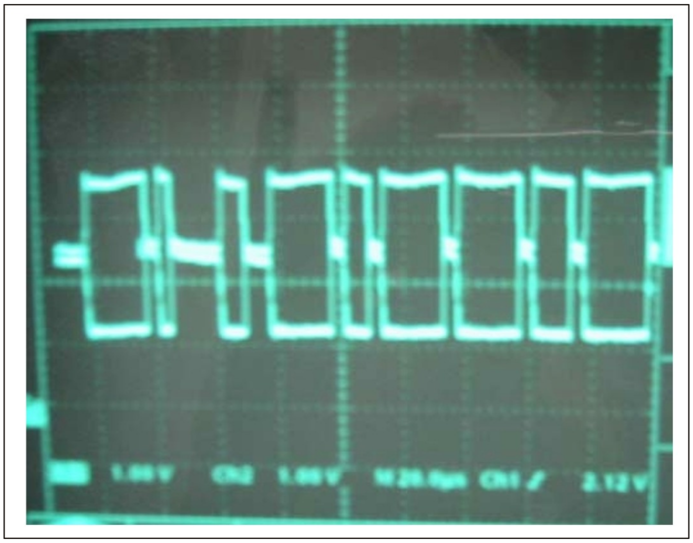


FIGURE 75. CAN DATALINK: GOOD SIGNAL

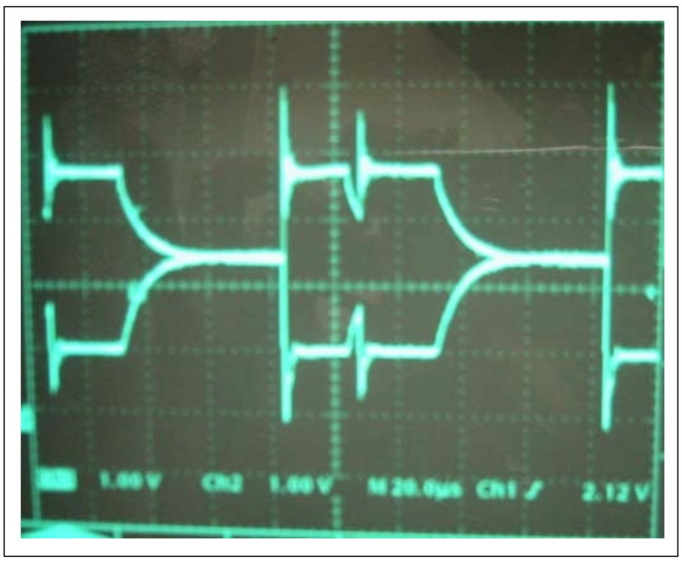


FIGURE 76. CAN DATALINK: BAD SIGNAL

6.7.2 J26 Connections

The CAN datalink connects to the PCC baseboard via connector J26. J26 pin connections are identified in the table below.

TABLE 41. CONNECTOR J26

Description	Pin
CAN +	J26-11
CAN -	J26-10
CAN Shield	J26-1
Keyswitch -	J26-15

The PCC uses this data to display engine status (sensor, warning and shutdown conditions). The datalink must remain active at all times. If not, the PCC will detect the inactive datalink and display a datalink error shutdown condition.

7 Manufacturing Facilities

U.S. and CANADA	EMEA, CIS	BRAZIL
Cummins Inc. 1400 73rd Ave. NE Minneapolis, MN 55432 USA	Cummins Inc. Royal Oak Way South Daventry Northamptonshire NN11 8NU United Kingdom	Rua Jati, 310, Cumbica Guarulhos, SP 07180-900 CNPJ: 43.2201.151/0001-10 Brazil
Toll Free 1-800-CUMMINS™ (1-800-286-6467) Fax +1 763-574-5298	Phone +44 1327 88-6453 Fax +44 1327 88-6125	Phone 0800 286 6467
CHINA	**INDIA**	**ASIA PACIFIC**
Cummins Inc. No.118 South Quanli Road , Wuhan Economic& Technological Development Zone , Hubei, P.R.China 430058	Cummins Inc. Plot No B-2, SEZ Industrial Area, Village-Nandal & Surwadi, Taluka-Phaltan Dist- Satara, Maharashtra 415523 India	Cummins Sales and Service Singapore Pte Ltd 85 Tuas South Avenue 1 Singapore 637419
Phone + 86 (27) 8421 4008 Fax + 86 (27) 8421 4804	Phone +91 021 66305514	Fax +65 6265 6909
LATIN AMERICA	**MEXICO**	
3350 Southwest 148th Ave. Suite 205 Miramar, FL 33027 USA	Eje 122 No. 200 Zona Industrial San Luis Potosi, S.L.P. 78395 Mexico Eje 120 No. 201 Zona Industrial San Luis Potosi, S.L.P. 78395 Mexico	
Phone +1 954 431 551 Fax +1 954 433 5797	Phone +52 444 870 6700 Fax +52 444 824 0082	

7.1 How to Obtain Service

When a product requires servicing, contact the nearest Cummins service provider. To locate the distributor, go to **www.cummins.com/support** and select Find a Sales or Service Location. When contacting the service provider, always supply the complete model, specification, and serial number as shown on the nameplate.

7.1.1 Locating a Distributor

In the U.S. and Canada

To easily locate the nearest certified distributor/dealer for Cummins generator sets in your area, or for more information, contact us at 1-800-CUMMINS™ (1-800-286-6467) or visit **www.cummins.com/support**.

If unable to contact a distributor using the automated service, consult the Internet.

If unable to arrange a service or resolve an issue, contact the Service Manager at the nearest Cummins distributor for assistance.

When contacting the distributor, always supply the complete Model, Specification, and Serial Number as shown on the product nameplate.

7.1.2 Fuel Information Needed for Service Issue

When servicing is needed on a failed fuel tank, the following questions must be answered and conveyed via the submission of the Technical Support Request form (TSR).

1. Is there an actual confirmed leak?
    - Has the rupture basin alarm gone off?
    - What Fault Code(s) are present?
    - Is the sensor functioning properly?
    - Is there visible fuel in the basin or outside the tank (i.e. is there an EPA concern)?
    - If so, what is the leak rate?
    - Is the fluid fuel and NOT water?
    - What is the level of the fuel, in inches, in the tank and basin? A dipstick may be required to obtain an accurate reading.
    - Can the leak locale be identified?

⚠ CAUTION
High Pressure
Excessive pressurization can rupture tanks or basins which can result in severe personal injury or death.
Remove all liquids before pressure testing. Do not exceed 2 psig when testing a tank or basin.

    - Has the tank been previously repaired?
    - Is there evidence of physical damage that may be contributing to the leak?
    - Pictures may convey a great deal of information and should be considered.
2. What are the Cummins and manufacturer's details associated with the tank? Include the following in the Issue:
    - Cummins part number.
    - Manufacturer's part number, model, serial number and date of manufacture.
3. What time frame is required for the needed repair or replacement (i.e. how sensitive of an issue is this with the client and do they have any flexibility in the repair timing)?
    - If replacement, has there been an order placed for a new tank?
    - If ordered, is it categorized as machine down?
    - If not, then please update the order accordingly.

- If an order has been placed, the Issue is to reflect this data (order number) as well.

7.1.2.1 Obtaining Information Needed for Fuel Tank Service Issues

⚠ CAUTION

High Pressure

Excessive pressurization can rupture tanks or basins which can result in severe personal injury or death.

Remove all liquids before pressure testing. Do not exceed 2 psig when testing a tank or basin.

NOTICE

Third party tank certifications do not allow anyone other than the manufacturer to make structural modifications to the tank (Cutting, Welding, Drilling, etc.). Any structural modification made by any other party, except UA, would void the certification. Accessories and tank maintenance can be completed by Cummins or the end user.

NOTICE

Before refueling the fuel tank after cleaning, make sure all drain plugs are properly fitted to prevent leaks or operational issues.

To aid in identifying/isolating the leak or obtaining some of the information needed for Fuel Tank Service Issues:

1. Seal all penetrations/fittings with plugs except for one.
2. For the remaining penetration, fit up a regulated pressure source with a calibrated pressure gauge and a pressure relief valve (set to no more than 2.5 psig).
3. Pressurize the tank or basin to 2 psig and observe for the following:
   - For secondary tank (basin) work, spray all exterior weld seams with a soap water solution. Observe the pressure gauge for no change in a 30 minute period and visually observe the exterior seams for bubbling. Results are to be conveyed in the Issue details.
   - For the primary fuel tank, spray all exterior weld seams with a soap water solution. Observe the pressure gauge for no change in a 30 minute period and visually inspect the interior of the basin to the maximum extent possible. Results are to be conveyed in the Issue details.

NOTICE

For further questions or concerns regarding the information stated above, please contact (in the following order):

1. Your local Service Manager
2. Cummins Field Service Engineer (CFSE) or counterpart
3. Inside the U.S. and Canada: The Cummins Distributor Technical Support Line at 1-800-CUMMINS™ (1-800-286-6467)

   Outside the U.S. and Canada: Refer to **www.cummins.com/support** and select Sales and Service Locator, or send an email to ask.powergen@cummins.com.

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Appendix A. Outline Drawings

Table of Contents

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

A.1 Outline Drawing A073W614

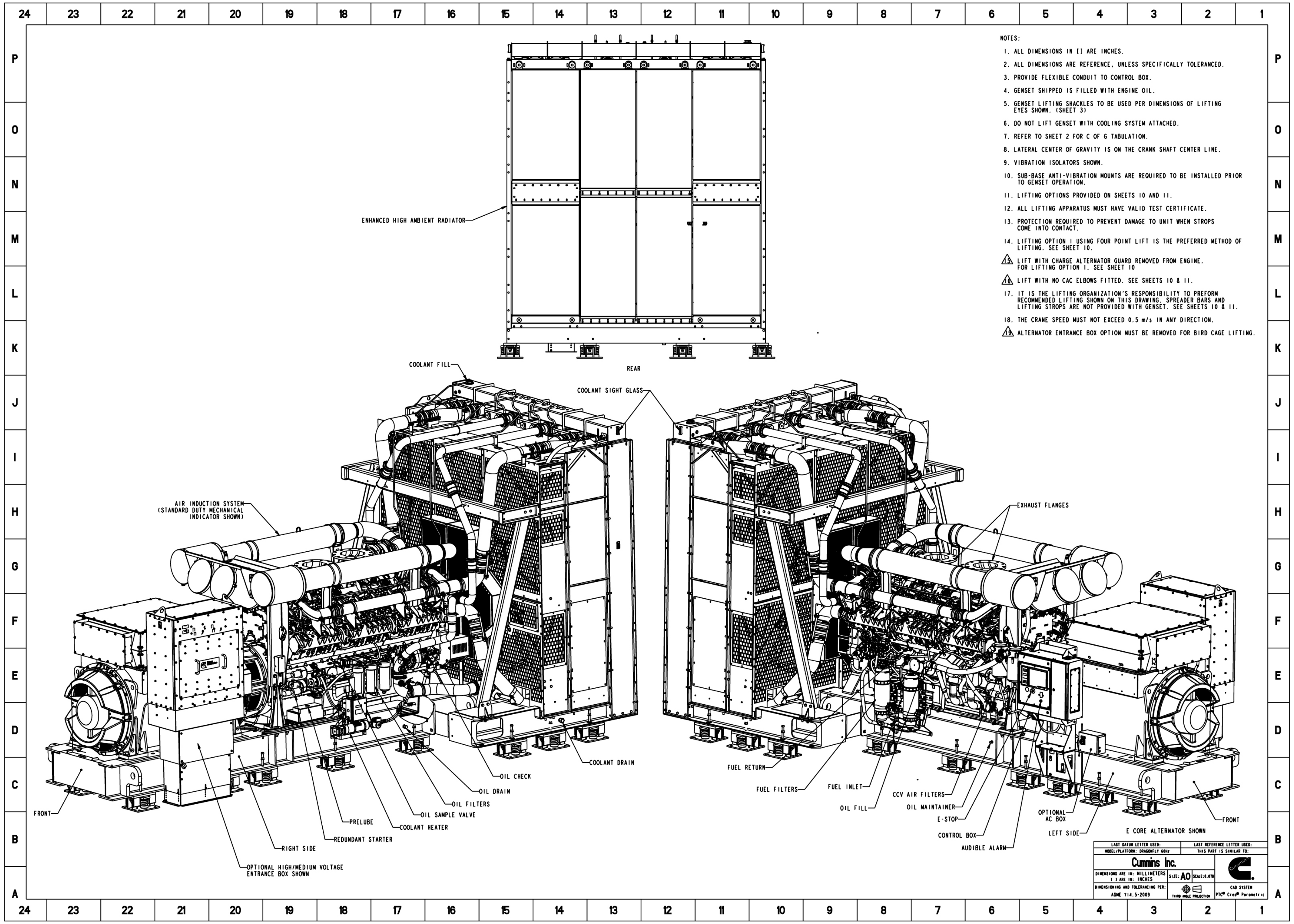
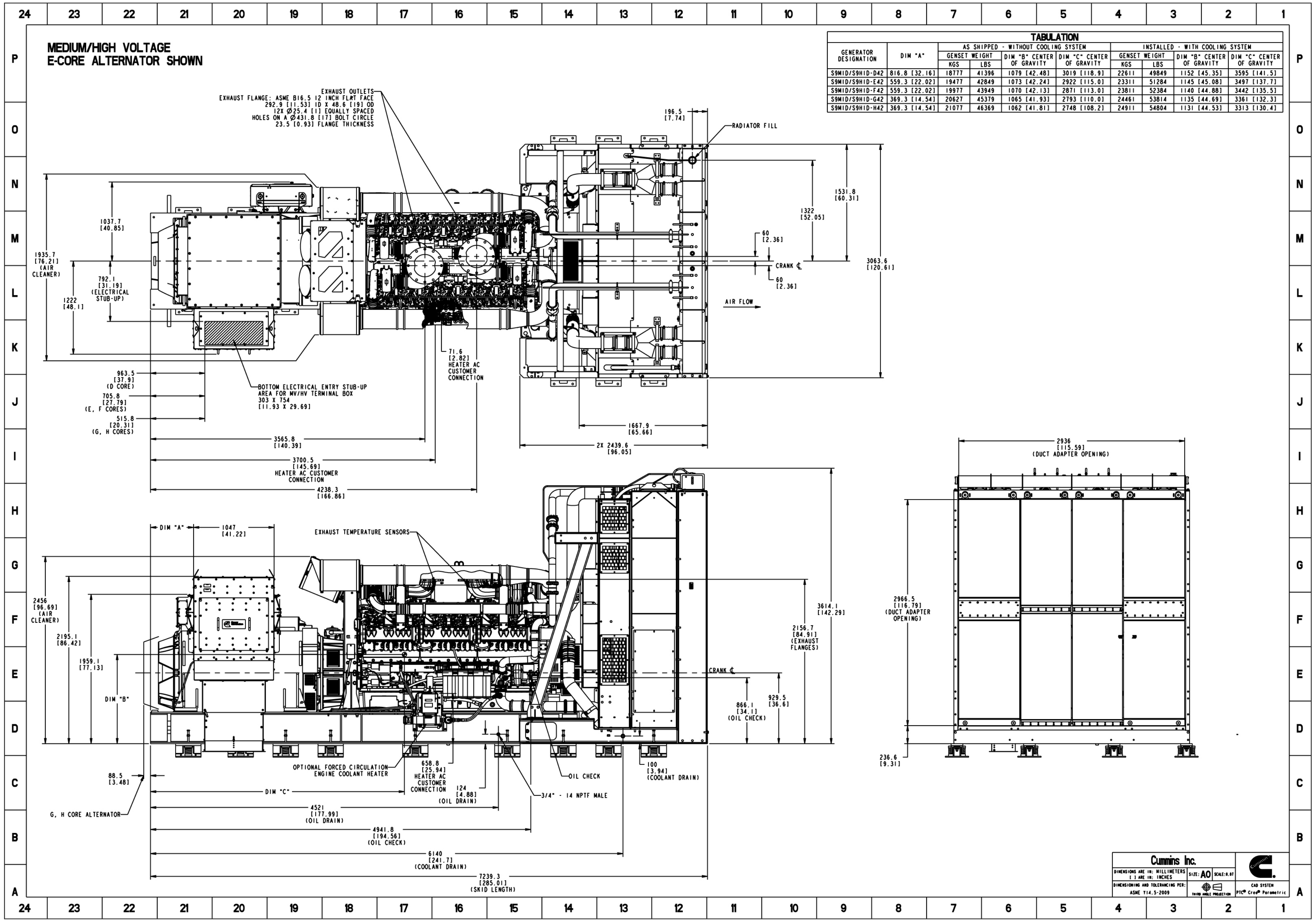
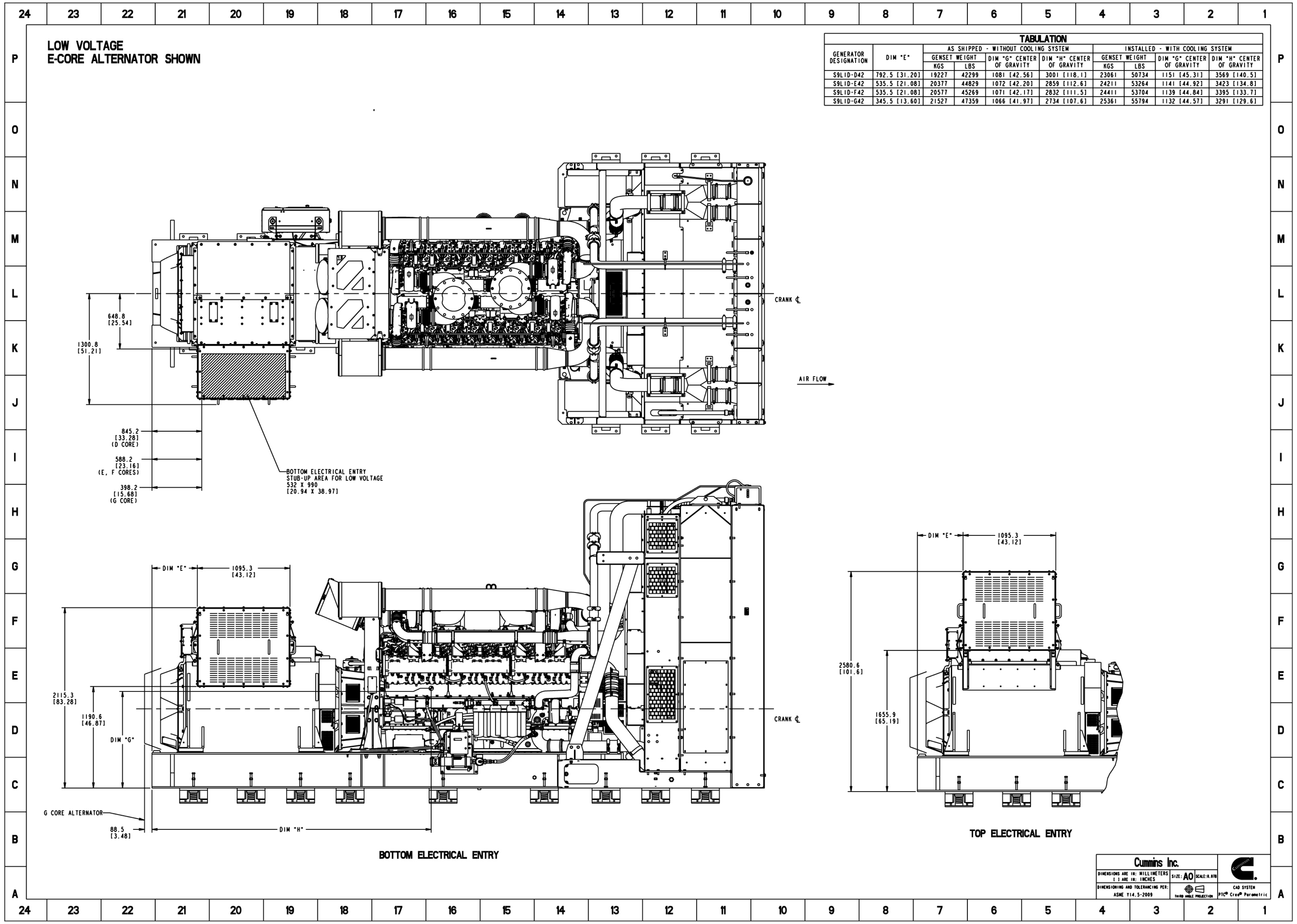


FIGURE 77. OUTLINE DRAWING (SHEET 1 OF 8)



GENERATOR DESIGNATION	DIM "A"	AS SHIPPED - WITHOUT COOLING SYSTEM				INSTALLED - WITH COOLING SYSTEM			
		GENSET WEIGHT KGS	GENSET WEIGHT LBS	DIM "B" CENTER OF GRAVITY	DIM "C" CENTER OF GRAVITY	GENSET WEIGHT KGS	GENSET WEIGHT LBS	DIM "B" CENTER OF GRAVITY	DIM "C" CENTER OF GRAVITY
S9MID/S9HID-D42	816.8 [32.16]	18777	41396	1079 [42.48]	3019 [118.9]	22611	49849	1152 [45.35]	3595 [141.5]
S9MID/S9HID-E42	559.3 [22.02]	19477	42849	1073 [42.24]	2922 [115.0]	23311	51284	1145 [45.08]	3497 [137.7]
S9MID/S9HID-F42	559.3 [22.02]	19977	43949	1070 [42.13]	2871 [113.0]	23811	52384	1140 [44.88]	3442 [135.5]
S9MID/S9HID-G42	369.3 [14.54]	20627	45379	1065 [41.93]	2793 [110.0]	24461	53814	1135 [44.69]	3361 [132.3]
S9MID/S9HID-H42	369.3 [14.54]	21077	46369	1062 [41.81]	2748 [108.2]	24911	54804	1131 [44.53]	3313 [130.4]

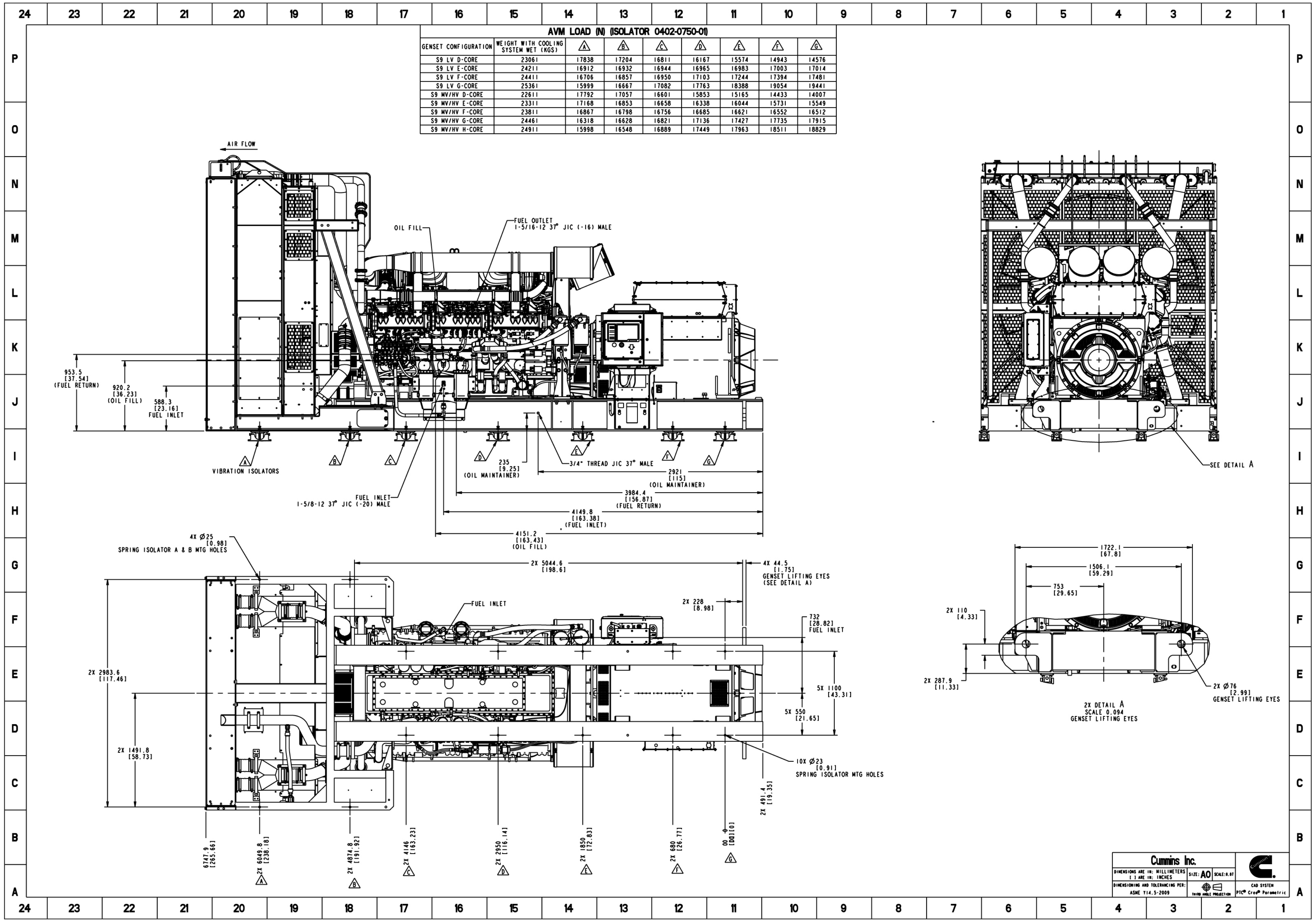
FIGURE 78. OUTLINE DRAWING (SHEET 2 OF 8)



TABULATION

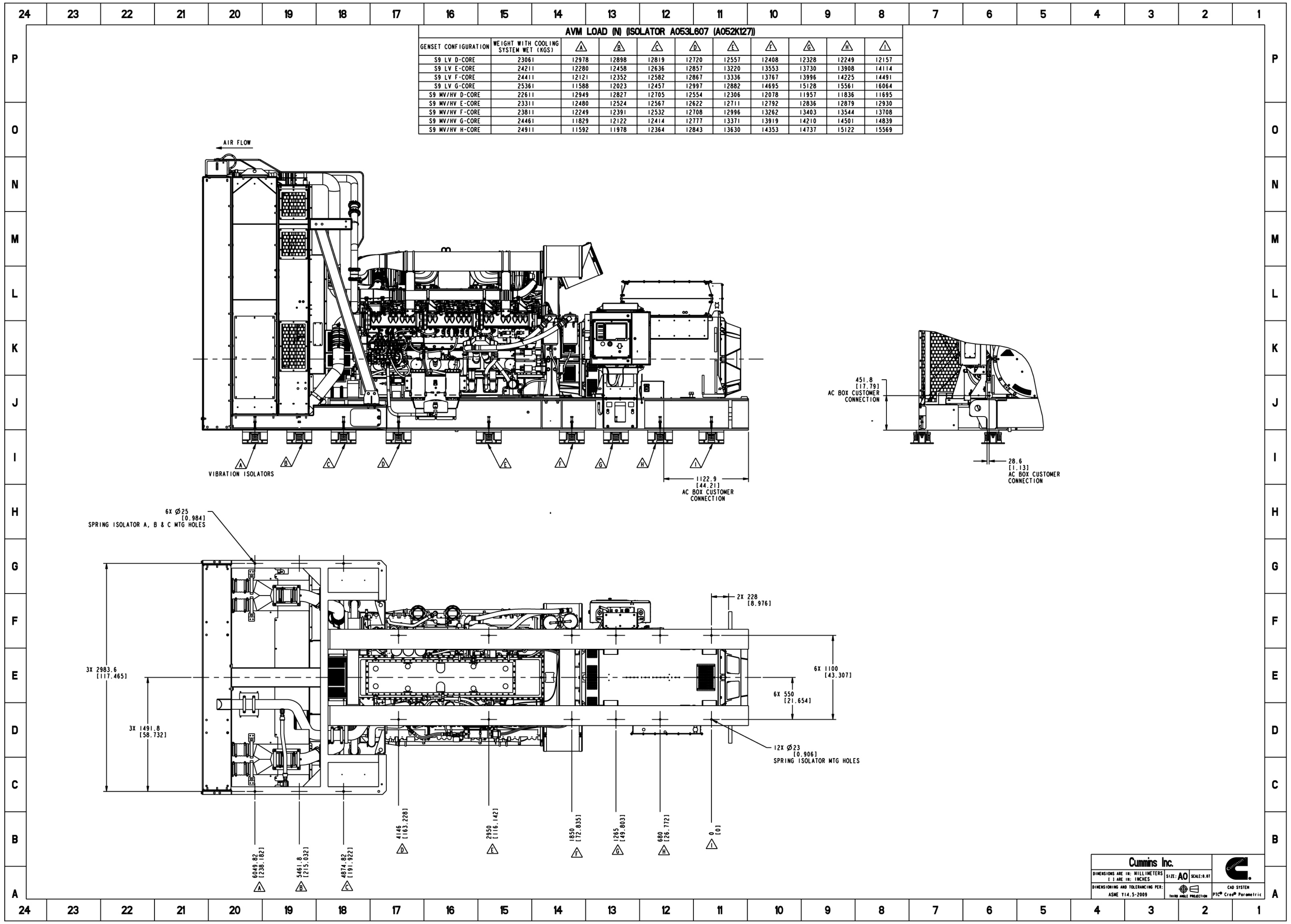
GENERATOR DESIGNATION	DIM "E"	AS SHIPPED - WITHOUT COOLING SYSTEM				INSTALLED - WITH COOLING SYSTEM			
		GENSET WEIGHT		DIM "G" CENTER OF GRAVITY	DIM "H" CENTER OF GRAVITY	GENSET WEIGHT		DIM "G" CENTER OF GRAVITY	DIM "H" CENTER OF GRAVITY
		KGS	LBS			KGS	LBS		
S9L1D-D42	792.5 [31.20]	19227	42299	1081 [42.56]	3001 [118.1]	23061	50734	1151 [45.31]	3569 [140.5]
S9L1D-E42	535.5 [21.08]	20377	44829	1072 [42.20]	2859 [112.6]	24211	53264	1141 [44.92]	3423 [134.8]
S9L1D-F42	535.5 [21.08]	20577	45269	1071 [42.17]	2832 [111.5]	24411	53704	1139 [44.84]	3395 [133.7]
S9L1D-G42	345.5 [13.60]	21527	47359	1066 [41.97]	2734 [107.6]	25361	55794	1132 [44.57]	3291 [129.6]

FIGURE 79. OUTLINE DRAWING (SHEET 3 OF 8)



AVM LOAD (N) (ISOLATOR 0402-0750-01)								
GENSET CONFIGURATION	WEIGHT WITH COOLING SYSTEM WET (KGS)	A	B	C	D	E	F	G
S9 LV D-CORE	23061	17838	17204	16811	16167	15574	14943	14576
S9 LV E-CORE	24211	16912	16932	16944	16965	16983	17003	17014
S9 LV F-CORE	24411	16706	16857	16950	17103	17244	17394	17481
S9 LV G-CORE	25361	15999	16667	17082	17763	18388	19054	19441
S9 MV/HV D-CORE	22611	17792	17057	16601	15853	15165	14433	14007
S9 MV/HV E-CORE	23311	17168	16853	16658	16338	16044	15731	15549
S9 MV/HV F-CORE	23811	16867	16798	16756	16685	16621	16552	16512
S9 MV/HV G-CORE	24461	16318	16628	16821	17136	17427	17735	17915
S9 MV/HV H-CORE	24911	15998	16548	16889	17449	17963	18511	18829

FIGURE 80. OUTLINE DRAWING (SHEET 4 OF 8)



AVM LOAD (N) (ISOLATOR A053L607 (A052K127))

GENSET CONFIGURATION	WEIGHT WITH COOLING SYSTEM WET (KGS)	A	B	C	D	E	F	G	H	I
S9 LV D-CORE	23061	12978	12898	12819	12720	12557	12408	12328	12249	12157
S9 LV E-CORE	24211	12280	12458	12636	12857	13220	13553	13730	13908	14114
S9 LV F-CORE	24411	12121	12352	12582	12867	13336	13767	13996	14225	14491
S9 LV G-CORE	25361	11588	12023	12457	12997	12882	14695	15128	15561	16064
S9 MV/HV D-CORE	22611	12949	12827	12705	12554	12306	12078	11957	11836	11695
S9 MV/HV E-CORE	23311	12480	12524	12567	12622	12711	12792	12836	12879	12930
S9 MV/HV F-CORE	23811	12249	12391	12532	12708	12996	13262	13403	13544	13708
S9 MV/HV G-CORE	24461	11829	12122	12414	12777	13371	13919	14210	14501	14839
S9 MV/HV H-CORE	24911	11592	11978	12364	12843	13630	14353	14737	15122	15569

FIGURE 81. OUTLINE DRAWING (SHEET 5 OF 8)

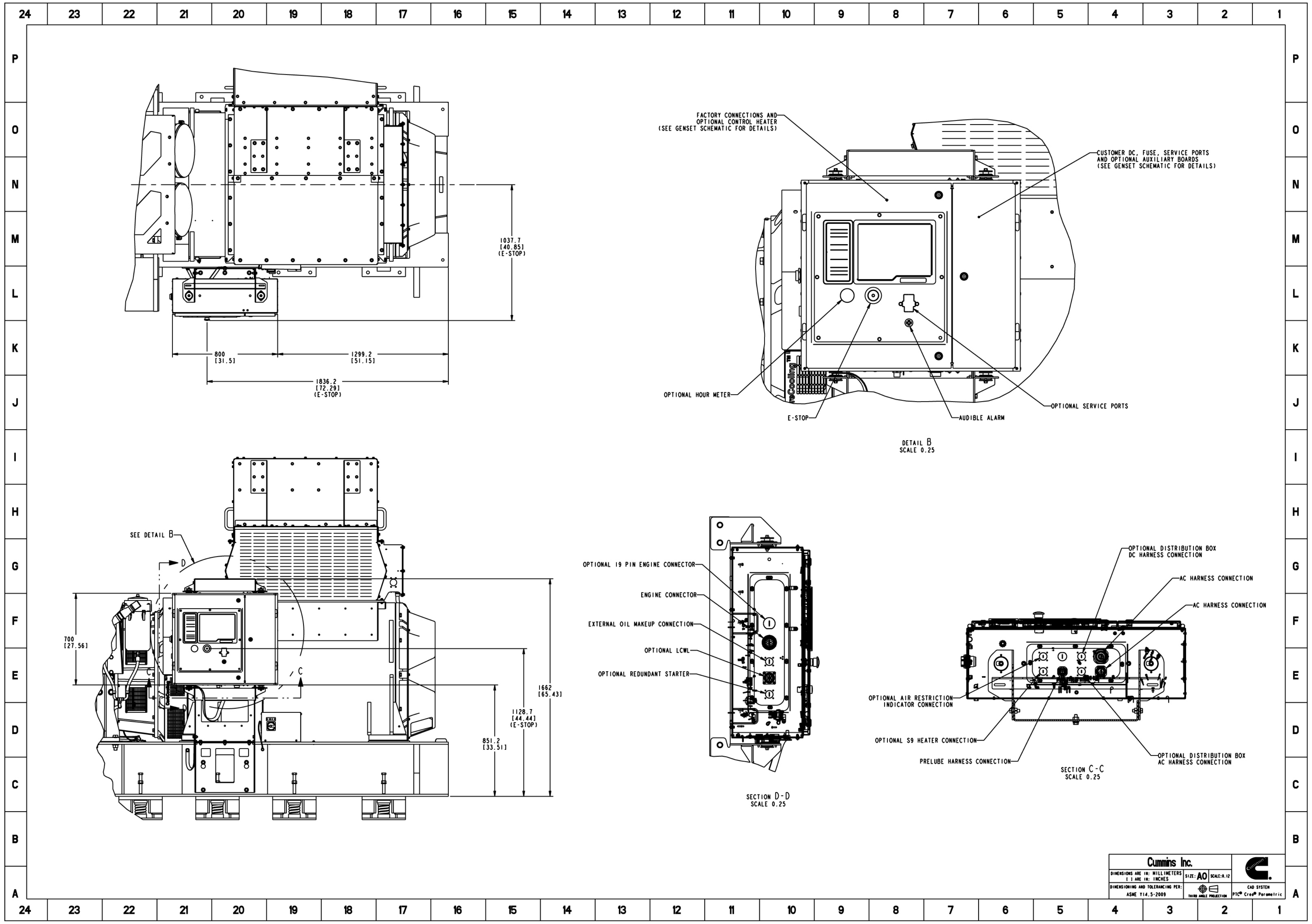


FIGURE 82. OUTLINE DRAWING (SHEET 6 OF 8)

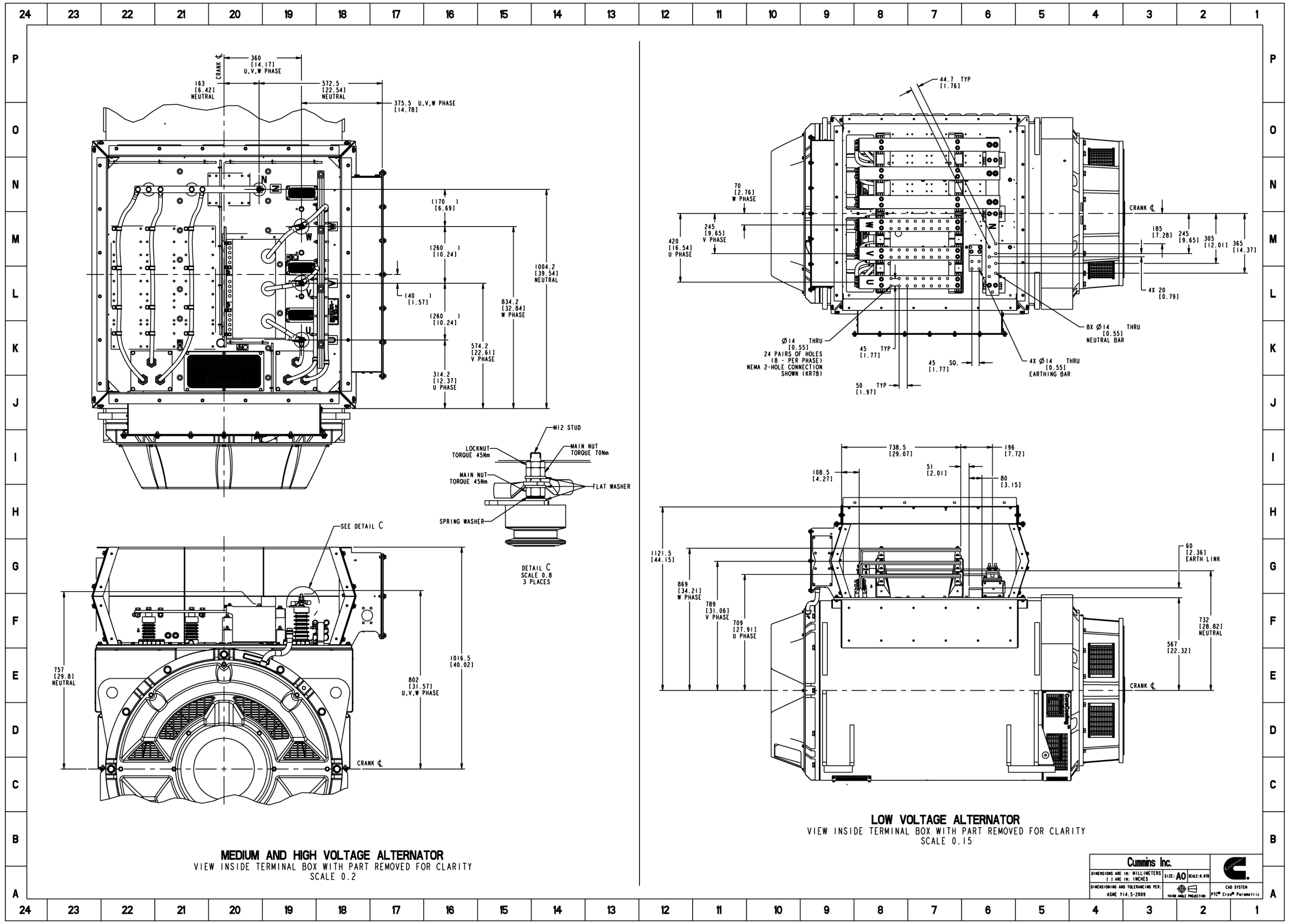


FIGURE 83. OUTLINE DRAWING (SHEET 7 OF 8)

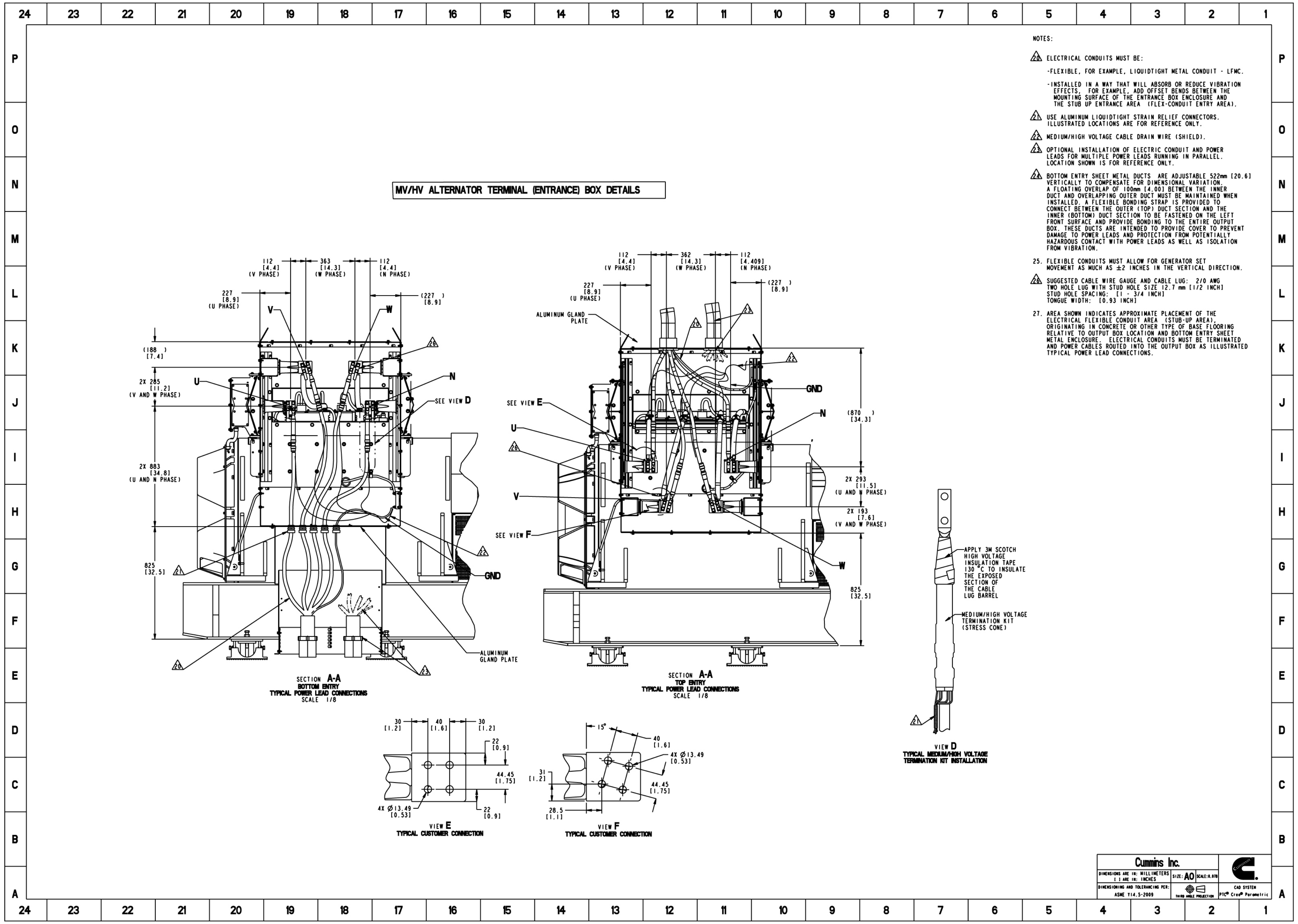


FIGURE 84. OUTLINE DRAWING (SHEET 8 OF 8)

Appendix B. Wiring Diagrams

Table of Contents

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

B.1 QSK78 Wiring Diagram with PowerCommand 3.3 Control

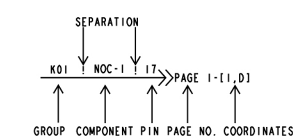
RELAY INDEX

RELAY NO	DESCRIPTION
K1	PRELUBE
K3	CRANK (STARTER)
K4	CRANK
K5	SWITCH B+
K10	CUSTOMER CONFIG
K11	CUSTOMER CONFIG
K12	CUSTOMER CONFIG
K13	CUSTOMER CONFIG
K18	CB CLOSE CONTROL
K19	CB OPEN CONTROL
K24	PRELUBE (CONTROL PANEL)
K3A	CRANK(REDUNDANT STARTER)
S2	MAGNETIC SWITCH
K3B	READY TO LOAD

9. AUX101 BOARD SPECIFICATIONS (SHEET 11)
   - 9.1 CUSTOMER INPUTS
   - 9.1.1 TYPE=DISCRETE OR ANALOG
     NUMBER=8
     MAX. VOLTAGE ALLOWED AT ANY INPUT: -10-24 VDC (1-6)
     40 VDC (7,8)
     DIFFERENTIAL VOLTAGE RANGE: -4.9-5V (INPUTS 1,2)
     0-5V (INPUTS 3-6)
     0-38V (INPUTS 7,8)
     INPUTS CONNECTIONS=J11
   - 9.2 CUSTOMER OUTPUTS
   - 9.2.1 CURRENT SOURCES=J10-3,4,5,6 (1mA- 20mA)
   - 9.2.2 VOLTAGE SOURCES=J1-7,8 (5VDC, 20mA)
   - 9.2.3 GROUND=J10-9,10,11,12
   - 9.3 OUTUPUT RELAYS
   - 9.3.1 TYPE=NON-LATCHING
   - 9.3.2 NUMBER=8
   - 9.3.3 CONTACTS=1 FORM C
     250VAC OR 30VDC
     NC CONTACTS=3A
     NO CONTACTS=5A
   - 9.3.4 CONNECTIONS=J2, J3, J4
10. ALL RELAYS SHOWN IN RESET OR DE-ENERGIZED POSITION DO NOT MAINTAIN THE LAST STATE WHEN POWER IS LOST (SHEET 11).
11. OUTPUT RELAYS ARE CONTROLLED VIA THE NETWORK (SHEET 11).
12. TIE J1-1 AND J1-5 TO HOLD DEVICE IN WAKE UP STATE (SHEET 11).
13. DISPLAYS THE DEVICE NUMBER. IF MORE THAN ONE AUX 101 IS CONNECTED ON NETWORK BOTH NEED A UNIQUE DEVICE NUMBER (SHEET 11).
14. CONNECT J2 RING TERMINAL TO A GOOD EARTH GROUND. USE AN EXTERNAL TOOTH LOCKWASHER BETWEEN RING AND GROUNDING SURFACE (SHEET 11).
15. DIGITAL INPUTS NEED THE (-) INPUT GROUNDED (SHEET 11).
16. DS1 INDICATES ACTIVE NETWORK COMMUNICATION.
    DS2 INDICATES NO NETWORK CONNECTIVITY (SHEET 11).
17. DS3-DS10 (GREEN) INDICATE WHICH RELAYS ARE ENERGIZED (SHEET 11).
18. RTD SENDERS CAN ONLY BE USED ON INPUTS 3-6 (SHEET 11).
19. PROGRAMMABLE CURRENT SOURCE USE (SHEET 11)
    CS1 IS USED FOR INPUT 3 ONLY
    CS2 IS USED FOR INPUT 4 ONLY
    CS3 IS USED FOR INPUT 5 ONLY
    CS4 IS USED FOR INPUT 6 ONLY
20. REFER SHEET 5 FOR THREE STARTERS OPTION & SHEET 16 FOR FOUR STARTERS OPTION.
21. FOR HEATER OPTION REFER SHEET 13

NOTES

1. REMOVABLE JUMPER WIRE FOR REMOTE E-STOP IS CONNECTED ON THE LOAD SIDE
2. CTB2,3,4,5,6-4 OUTPUTS FUSED AT 20 AMPS (F02)
3. NOMINAL CONDUCTOR SIZE PER TERMINAL 26-12 AWG
4. WIRE TYPE, USE 60 %%127C RATED MINIMUM, STRANDED COPPER WIRE
5. STRIP WIRE LENGTH TO 10.0MM
6. TO REMOVE WIRES FROM TERMINAL BLOCK, PUSH IN ORANGE TAB NEXT TO WIRE TERMINATION
7. LOW SIDE DRIVER OUTPUT RATED AT 250mA, 3A IN-RUSH 30VDC, 100 MICRO-A LEAKAGE IN OFF STATE. SURGE SUPPRESION DIDOE REQUIRED FOR INDUCTIVE COILS.
8. CROSS REFERENCE WIRES ARE ON THE FOLLOWING FORMAT:



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SIZE: D

FIGURE 85. WIRING SCHEMATIC (SHEET 1)

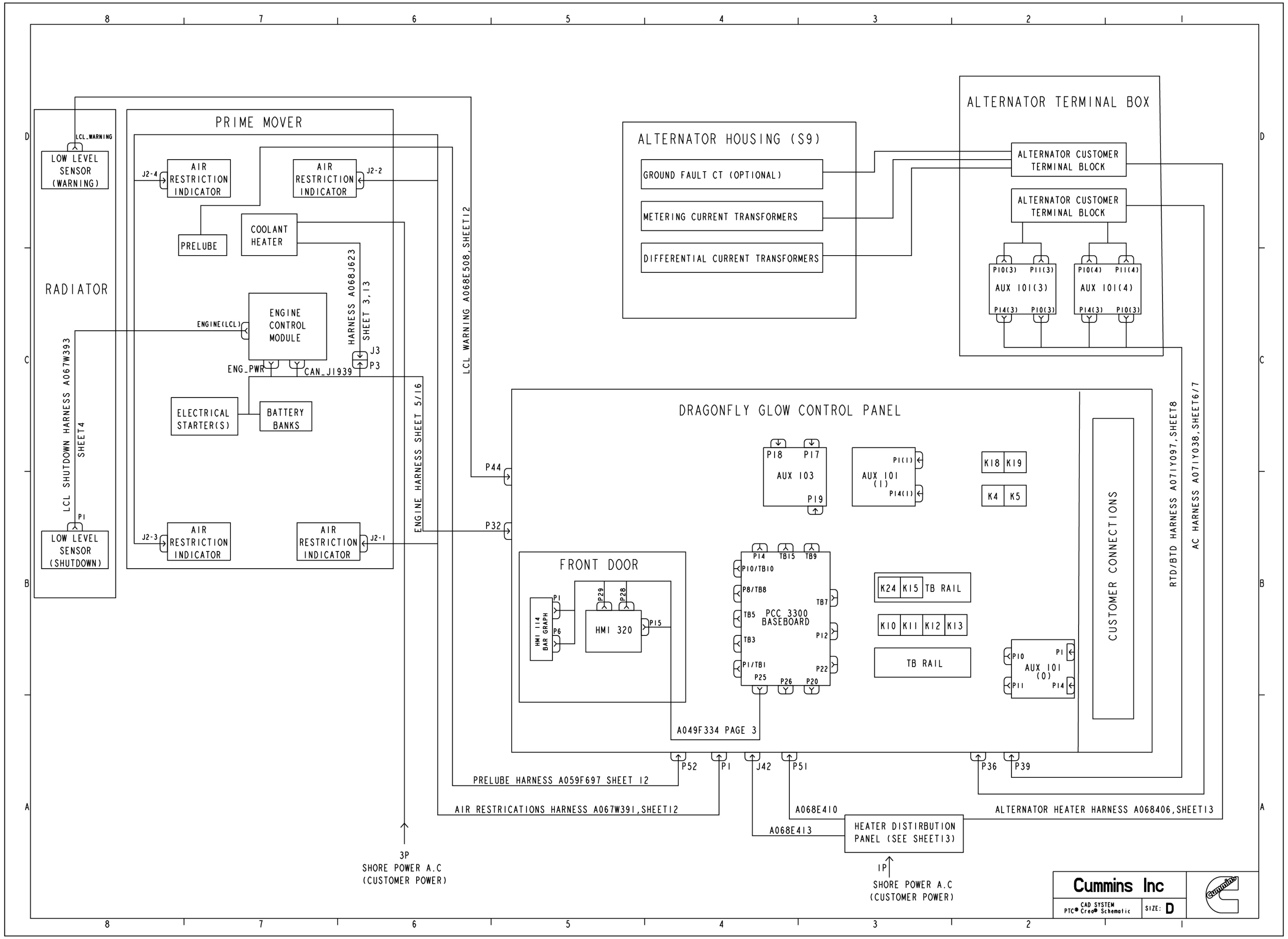


FIGURE 86. WIRING SCHEMATIC (SHEET 2)

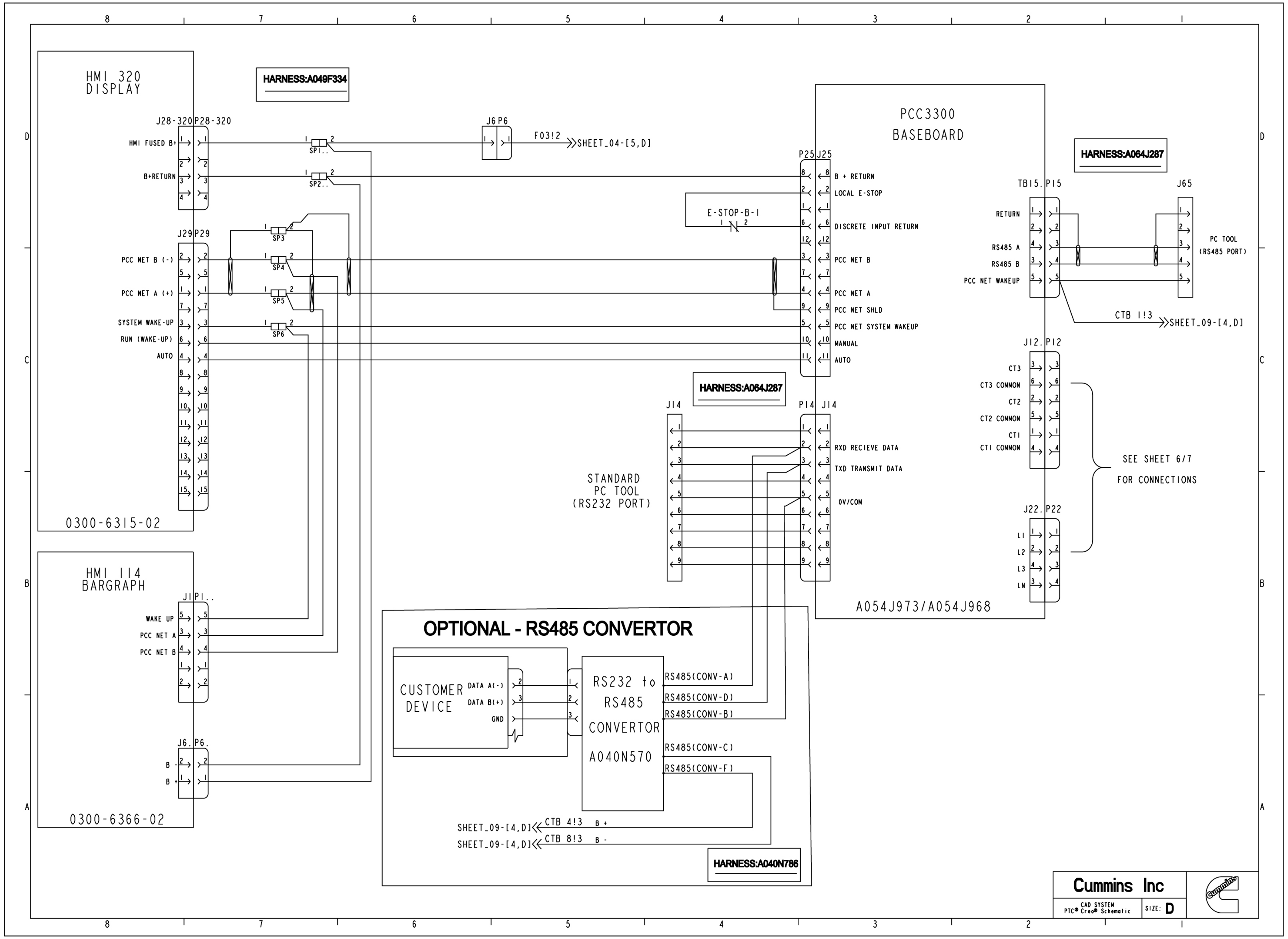


FIGURE 87. WIRING SCHEMATIC (SHEET 3)

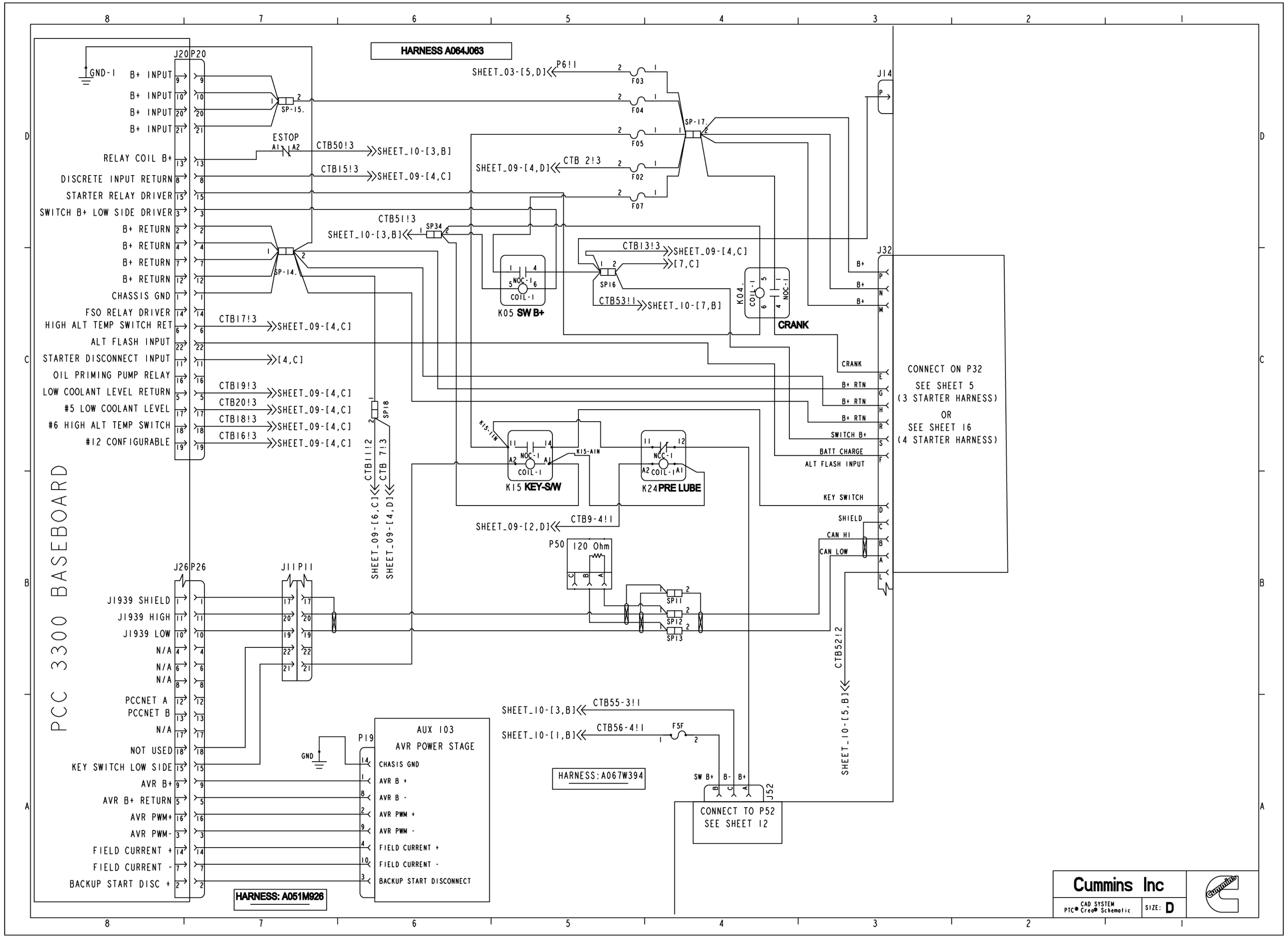


FIGURE 88. WIRING SCHEMATIC (SHEET 4)

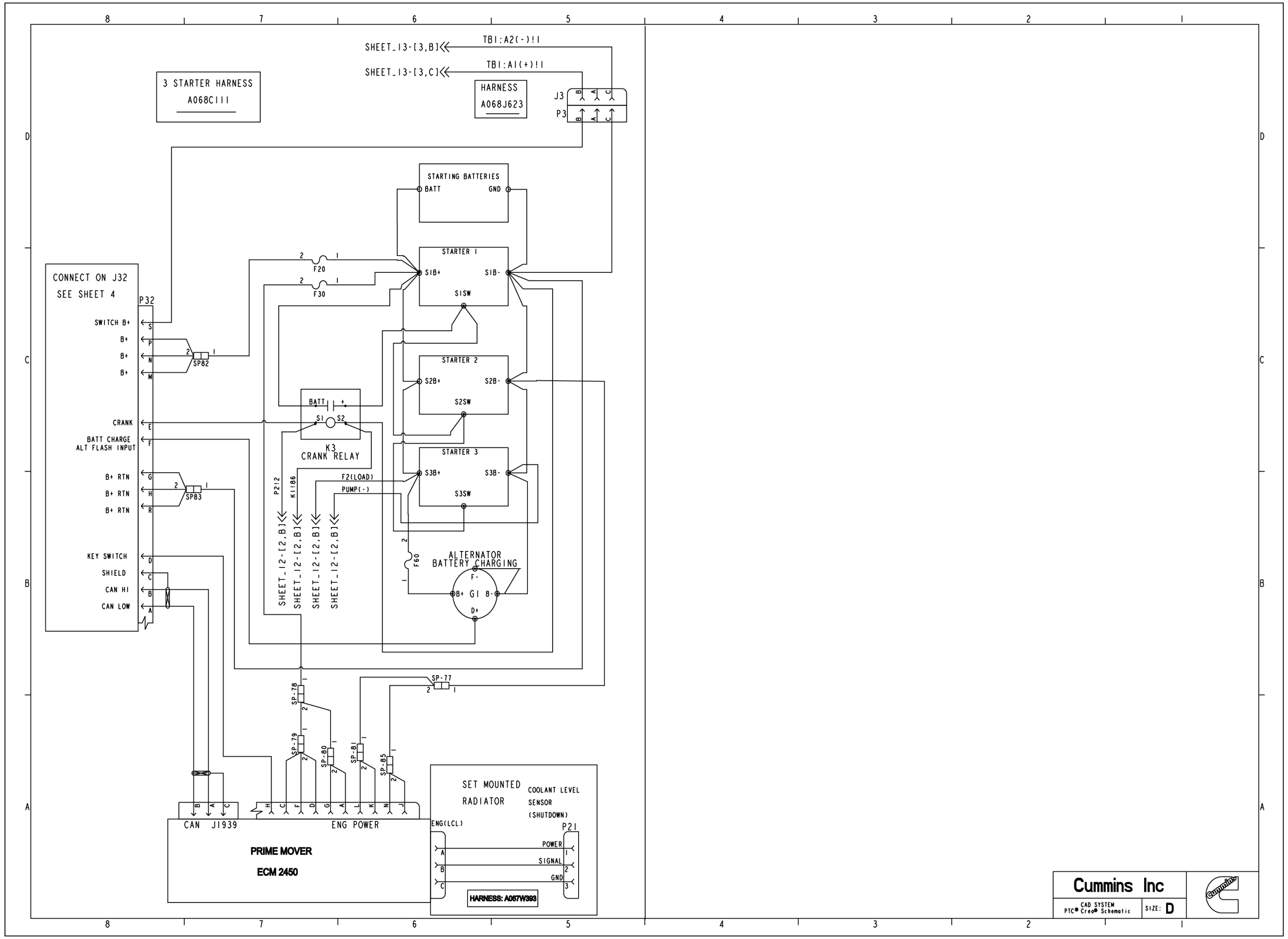


FIGURE 89. WIRING SCHEMATIC (SHEET 5)

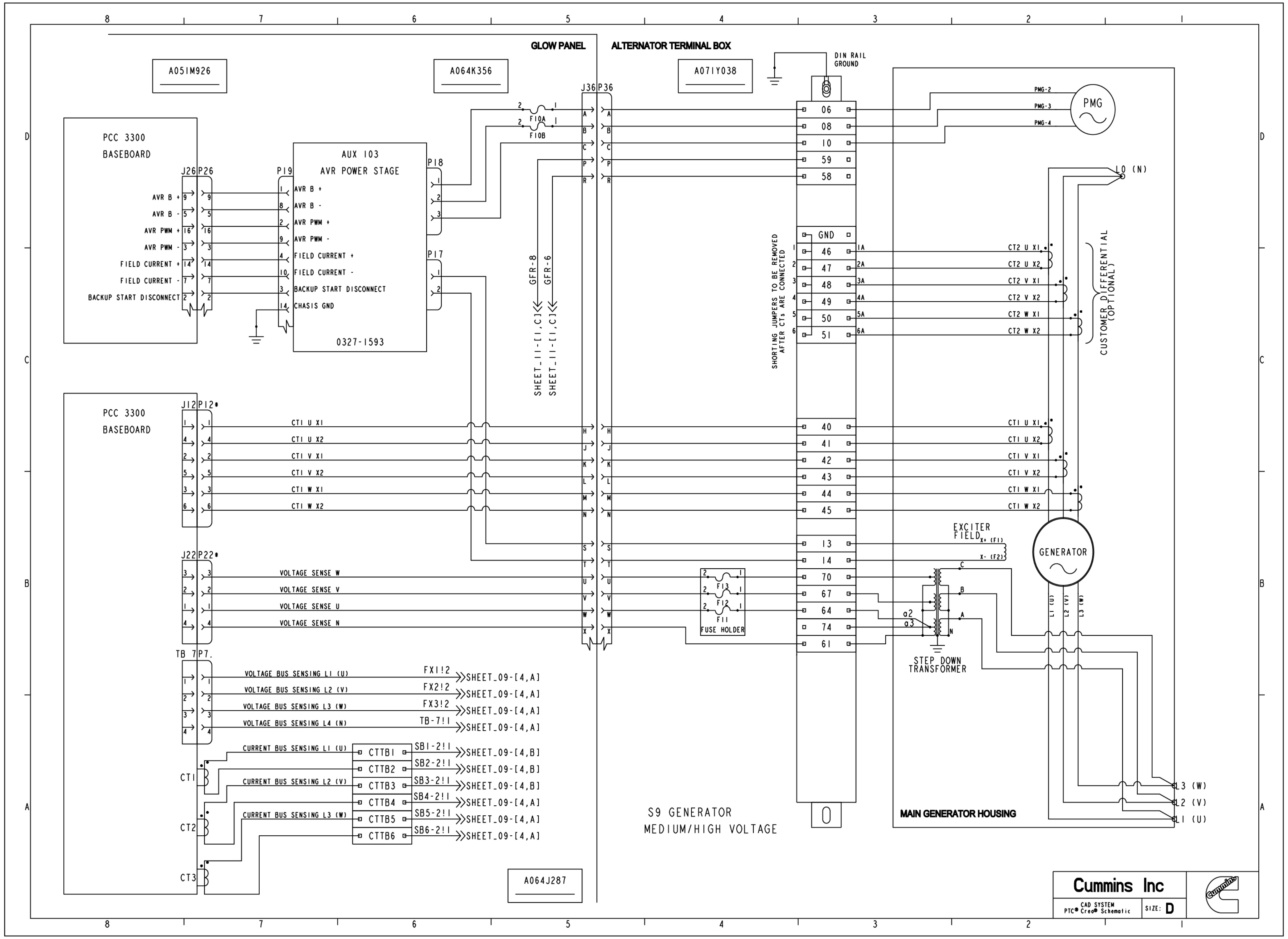


FIGURE 90. WIRING SCHEMATIC (SHEET 6)

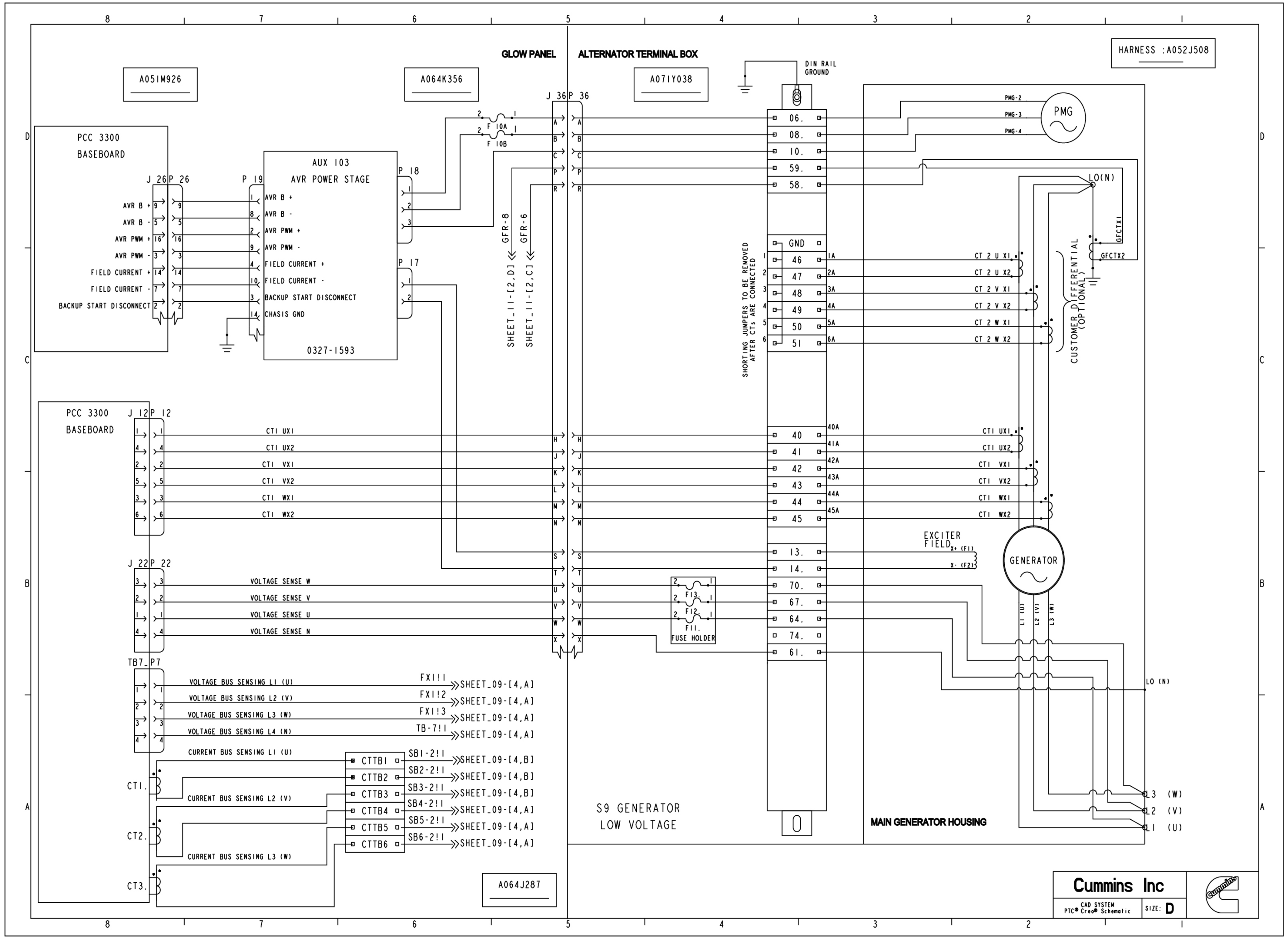


FIGURE 91. WIRING SCHEMATIC (SHEET 7)

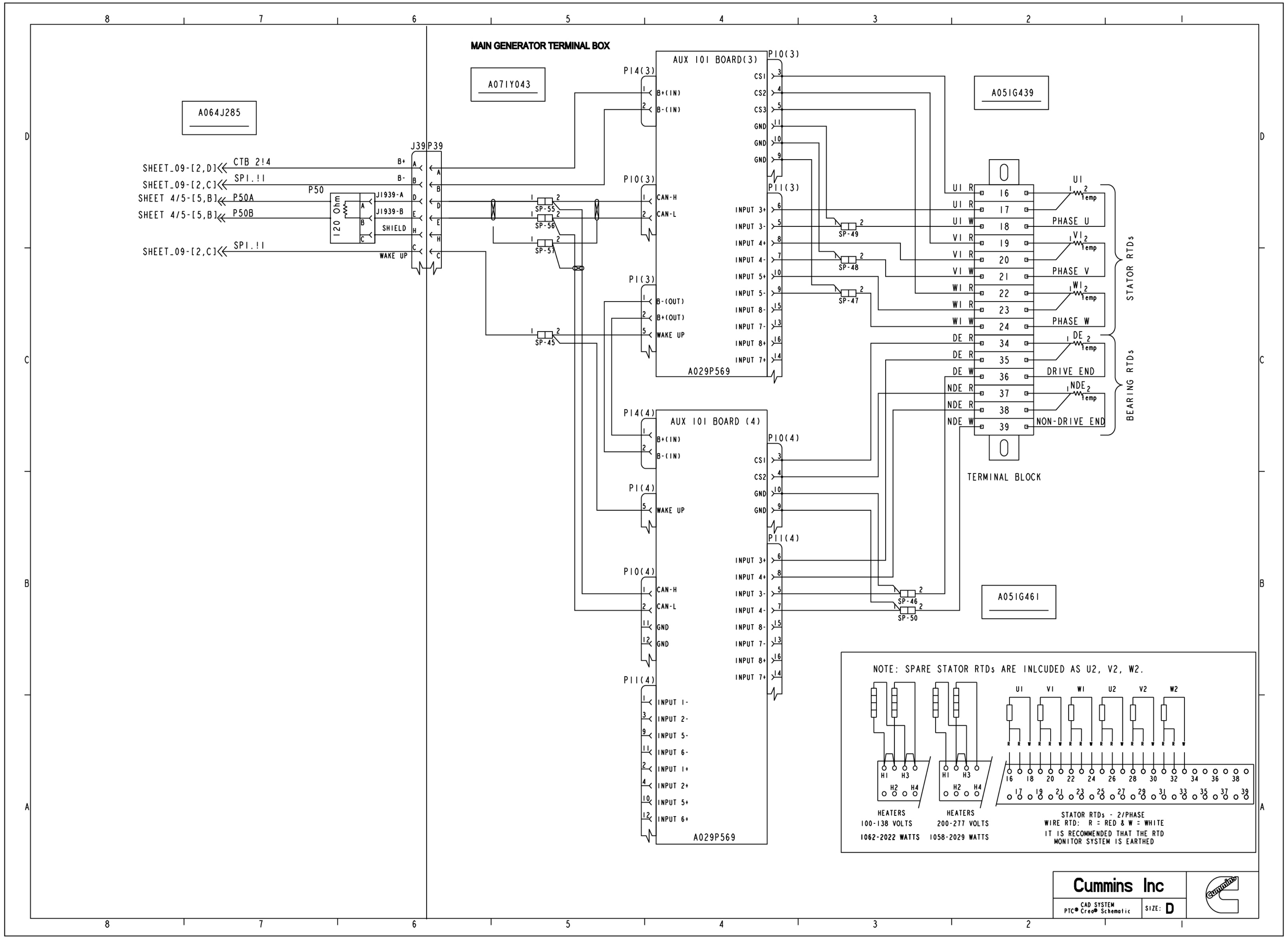


FIGURE 92. WIRING SCHEMATIC (SHEET 8)

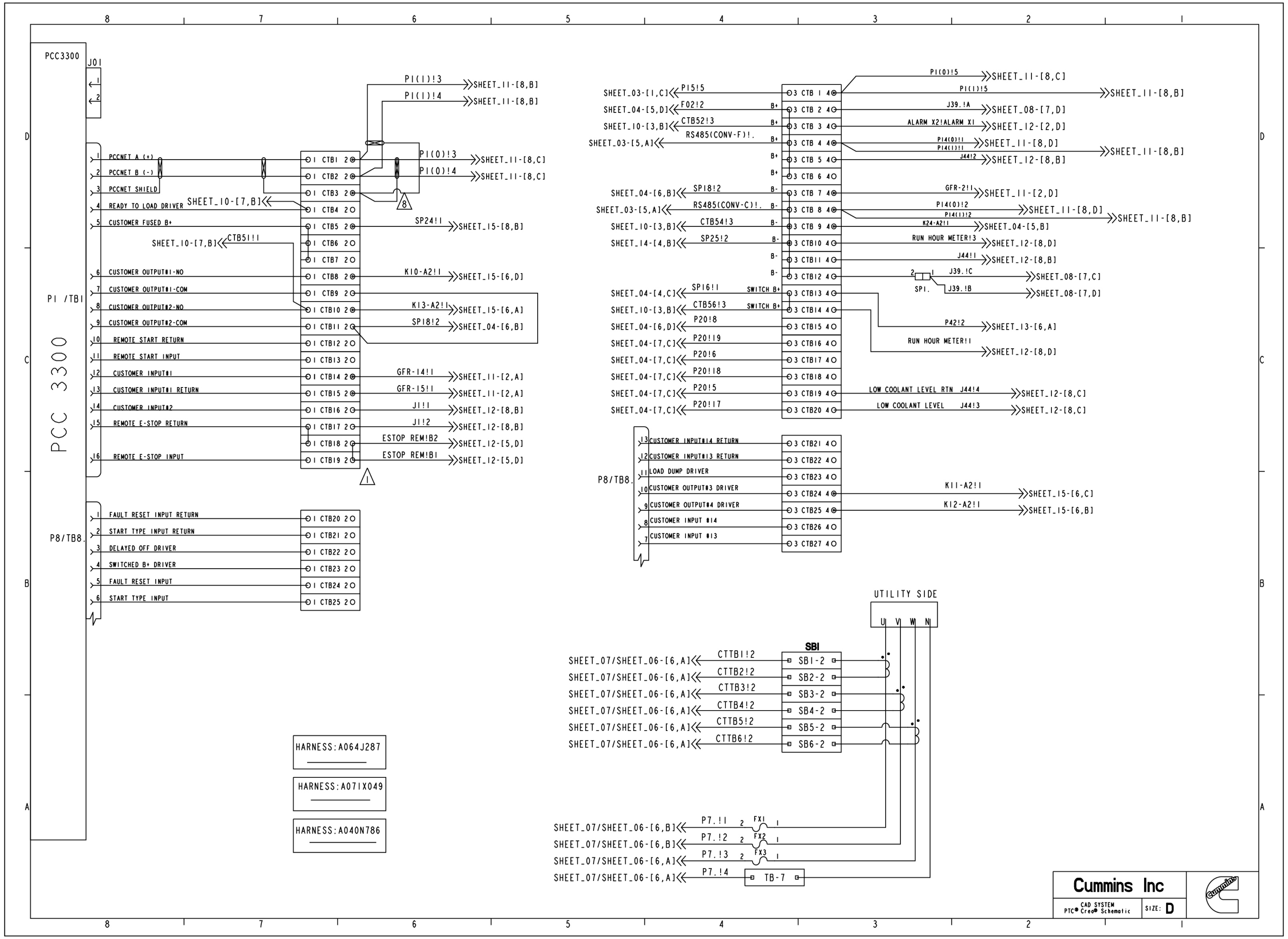


FIGURE 93. WIRING SCHEMATIC (SHEET 9)

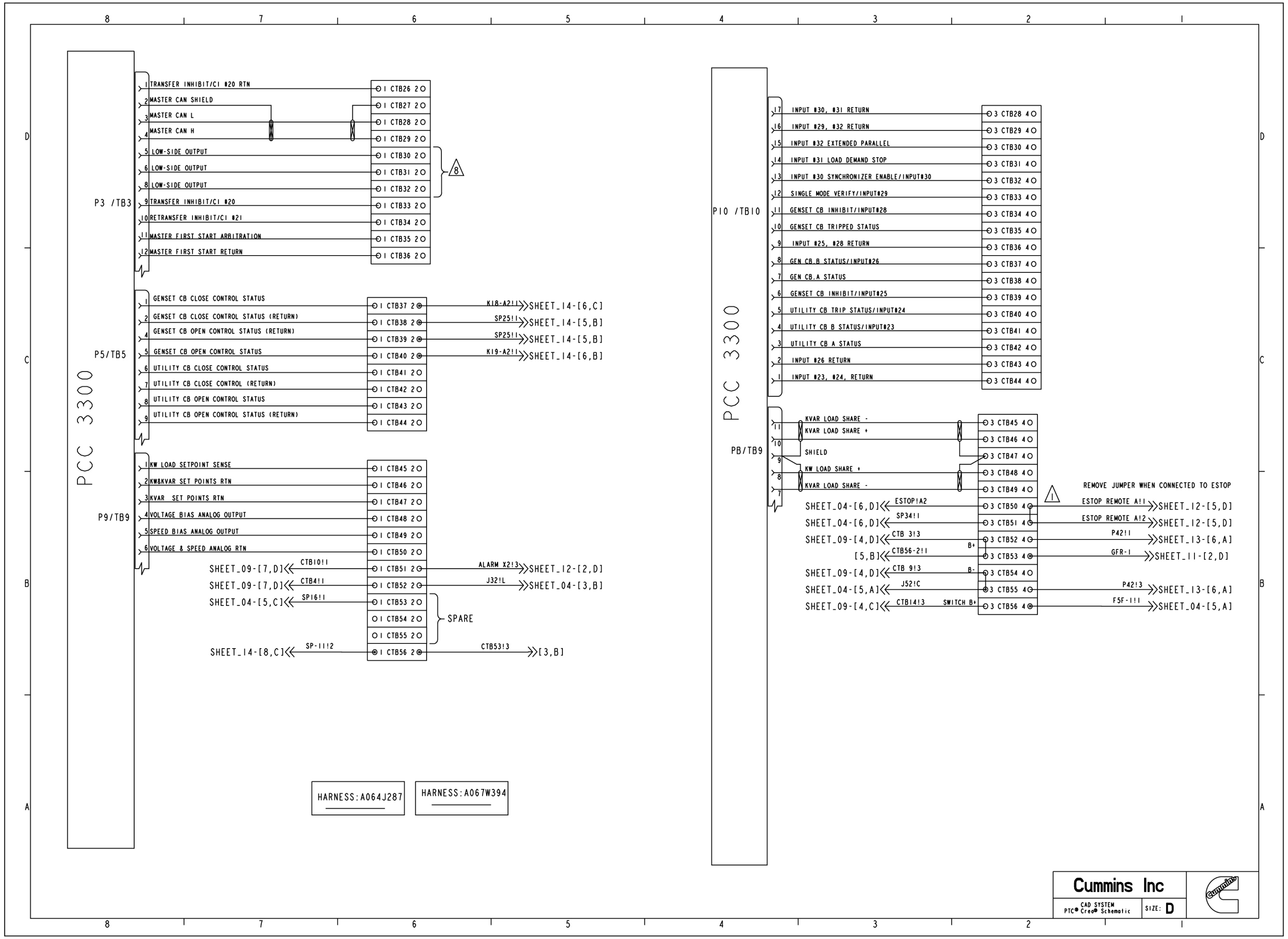


FIGURE 94. WIRING SCHEMATIC (SHEET 10)

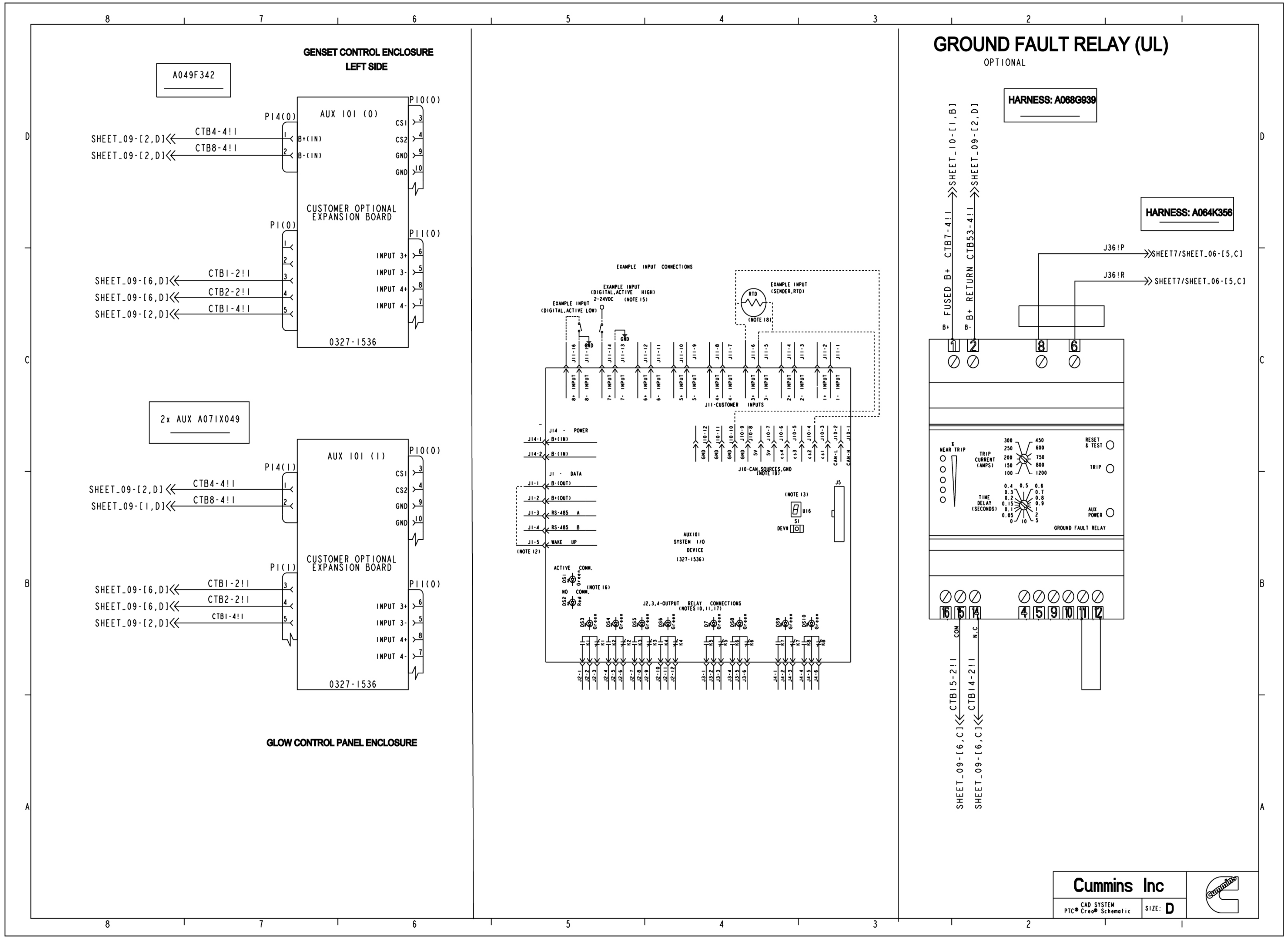


FIGURE 95. WIRING SCHEMATIC (SHEET 11)

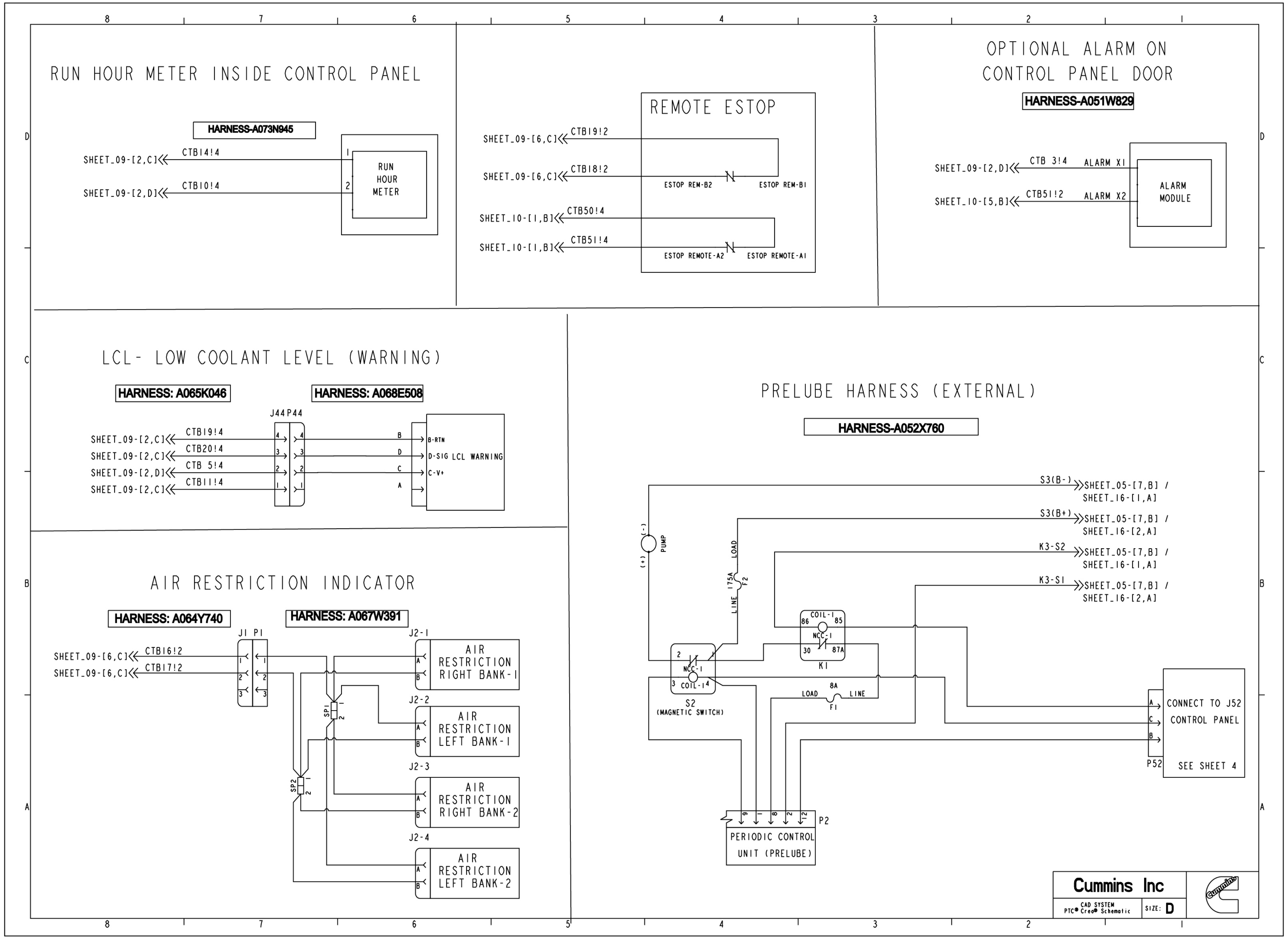


FIGURE 96. WIRING SCHEMATIC (SHEET 12)

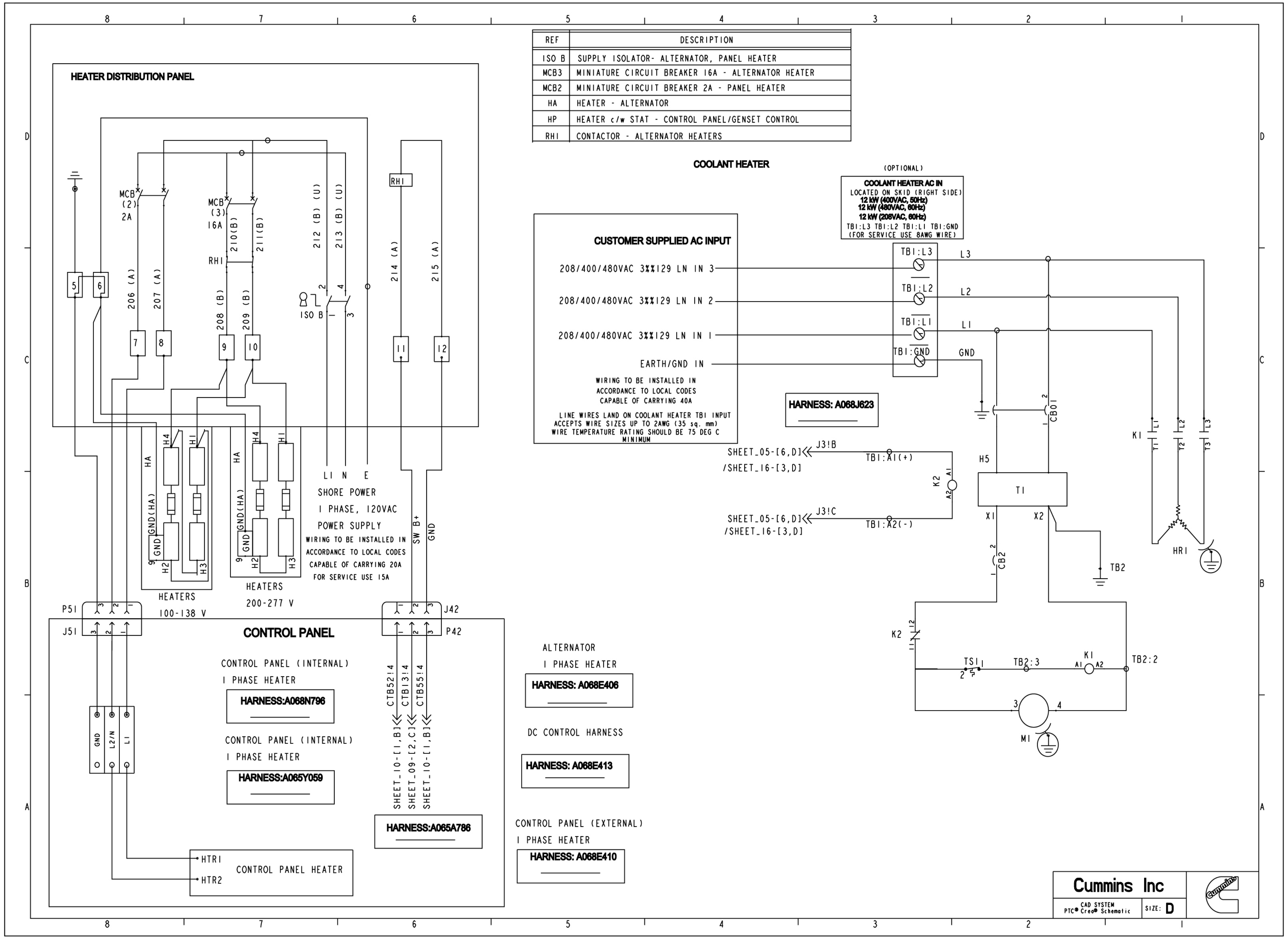


FIGURE 97. WIRING SCHEMATIC (SHEET 13)

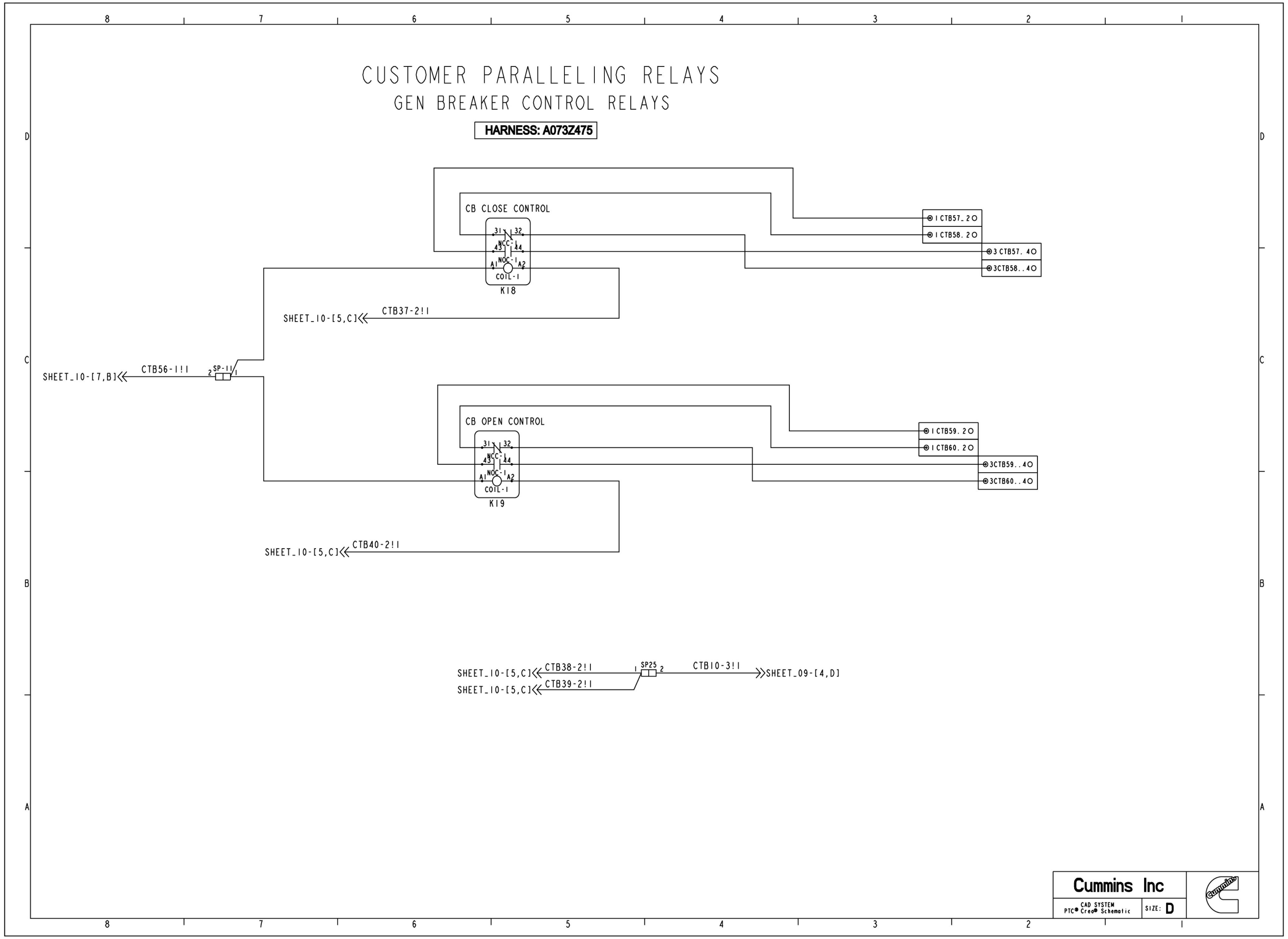


FIGURE 98. WIRING SCHEMATIC (SHEET 14)

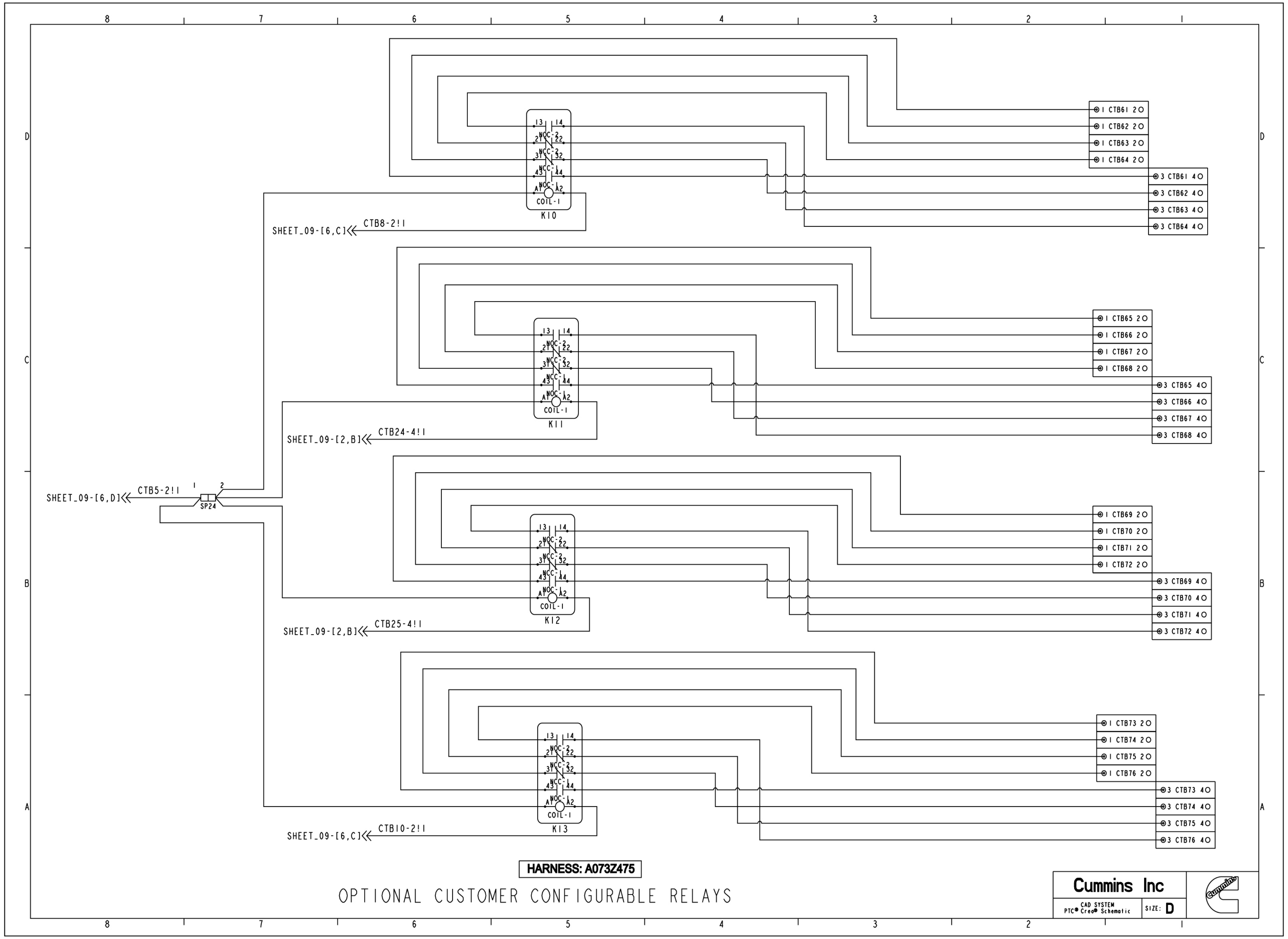


FIGURE 99. WIRING SCHEMATIC (SHEET 15)

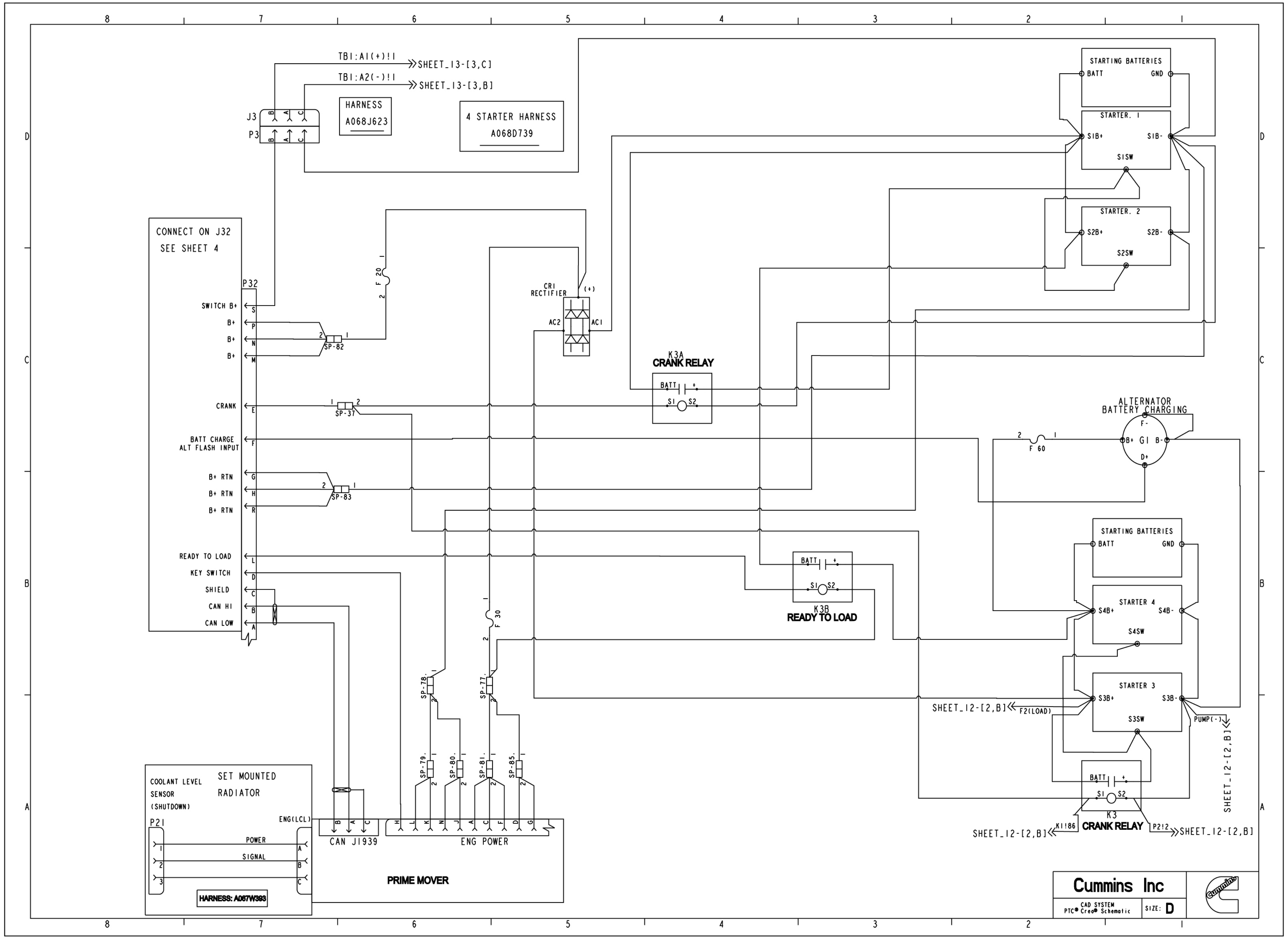


FIGURE 100. WIRING SCHEMATIC (SHEET 16)

B.2 Control Wiring Diagrams (0630-3440)

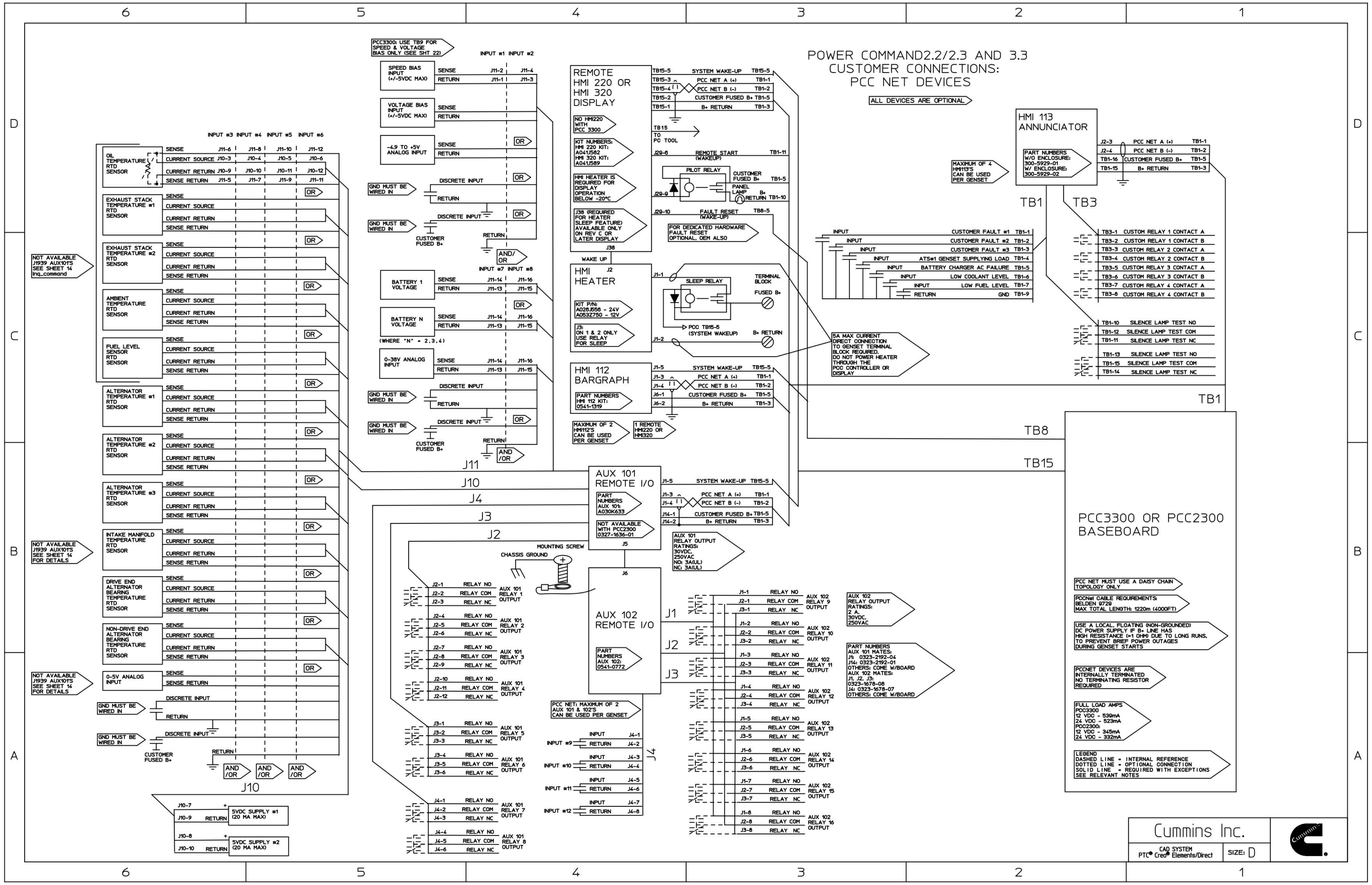


FIGURE 101. CONTROL CUSTOMER CONNECTIONS - PCC NET DEVICES

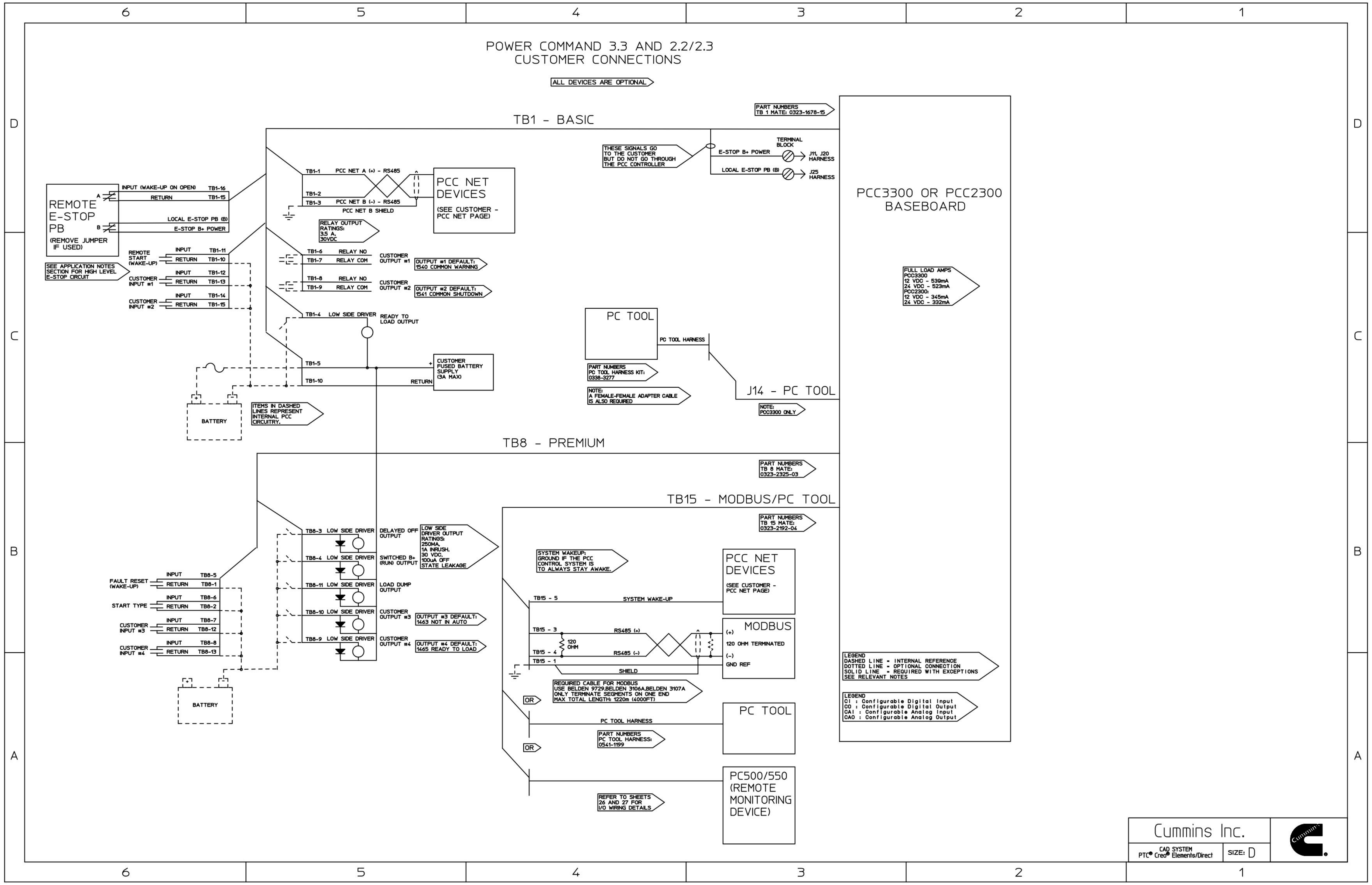


FIGURE 102. CUSTOMER CONNECTIONS

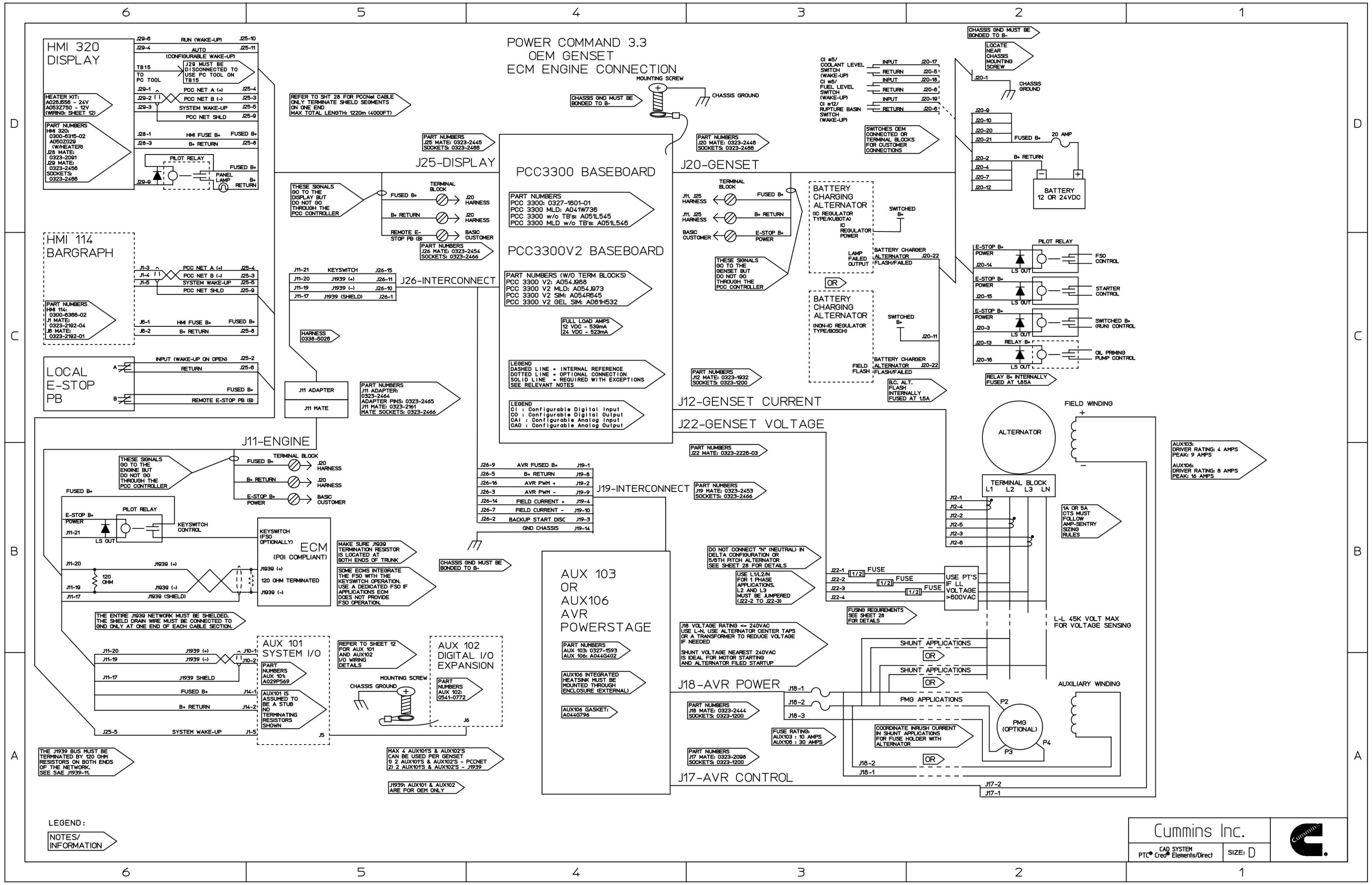


FIGURE 103. POWERCOMMAND 3.3 CONNECTIONS - ECM-BASED ENGINES

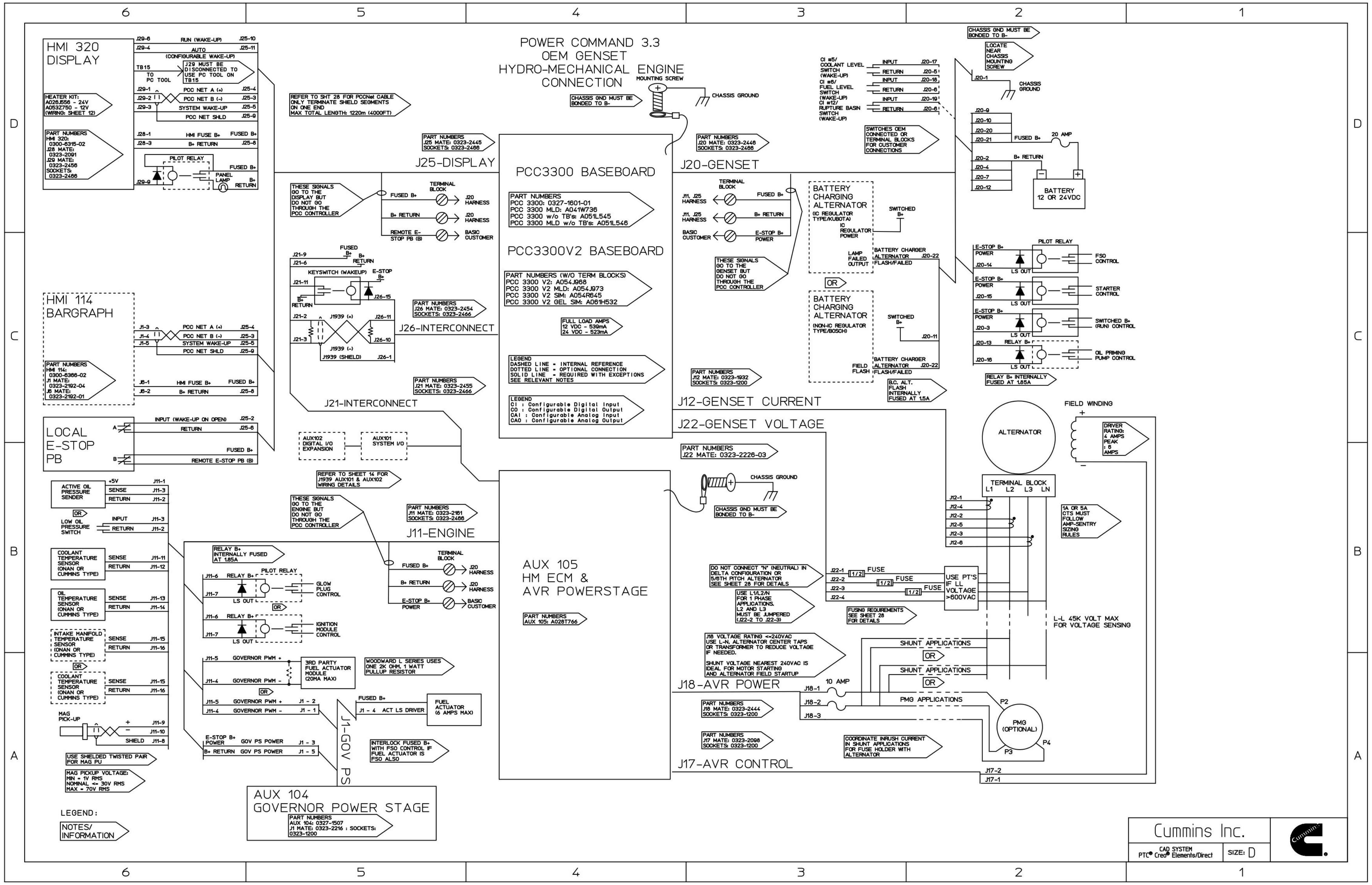


FIGURE 104. POWERCOMMAND 3.3 CONNECTIONS - HYDROMECHANICAL ENGINE

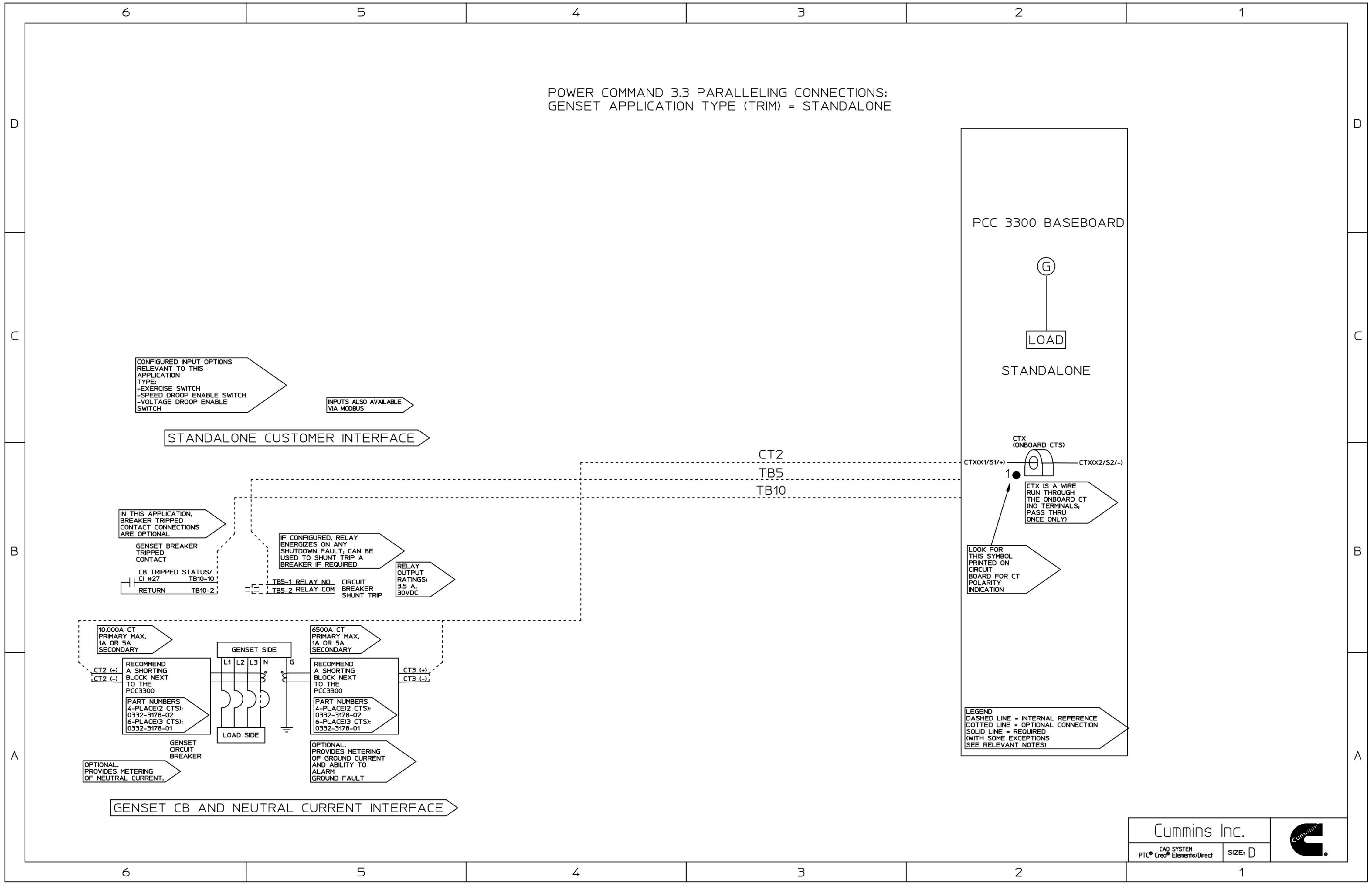


FIGURE 105. POWERCOMMAND 3.3 PARALLELING CONNECTIONS - STANDALONE GENERATOR SET

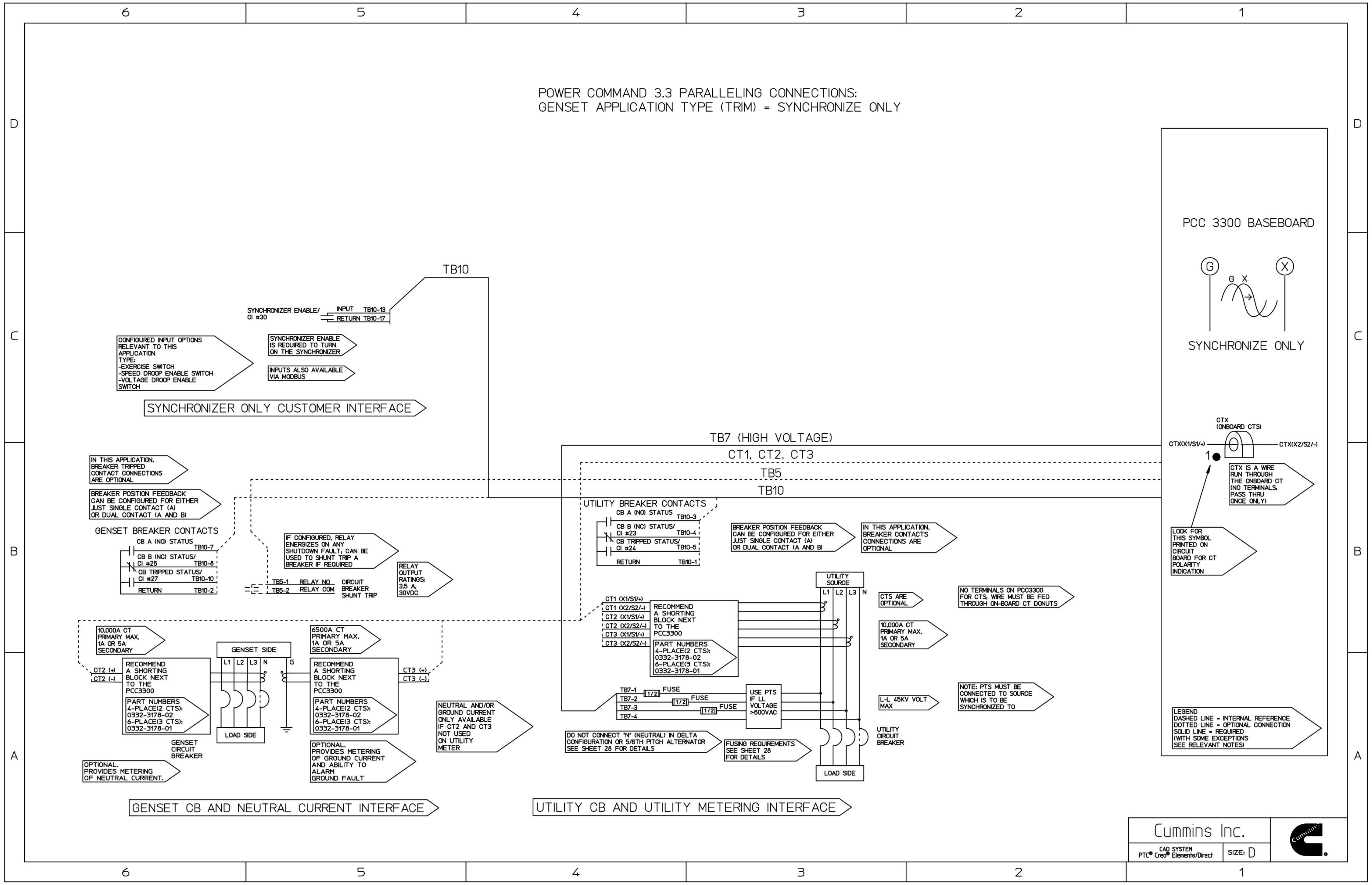


FIGURE 106. POWERCOMMAND 3.3 PARALLELING CONNECTIONS - SYNCHRONIZE ONLY

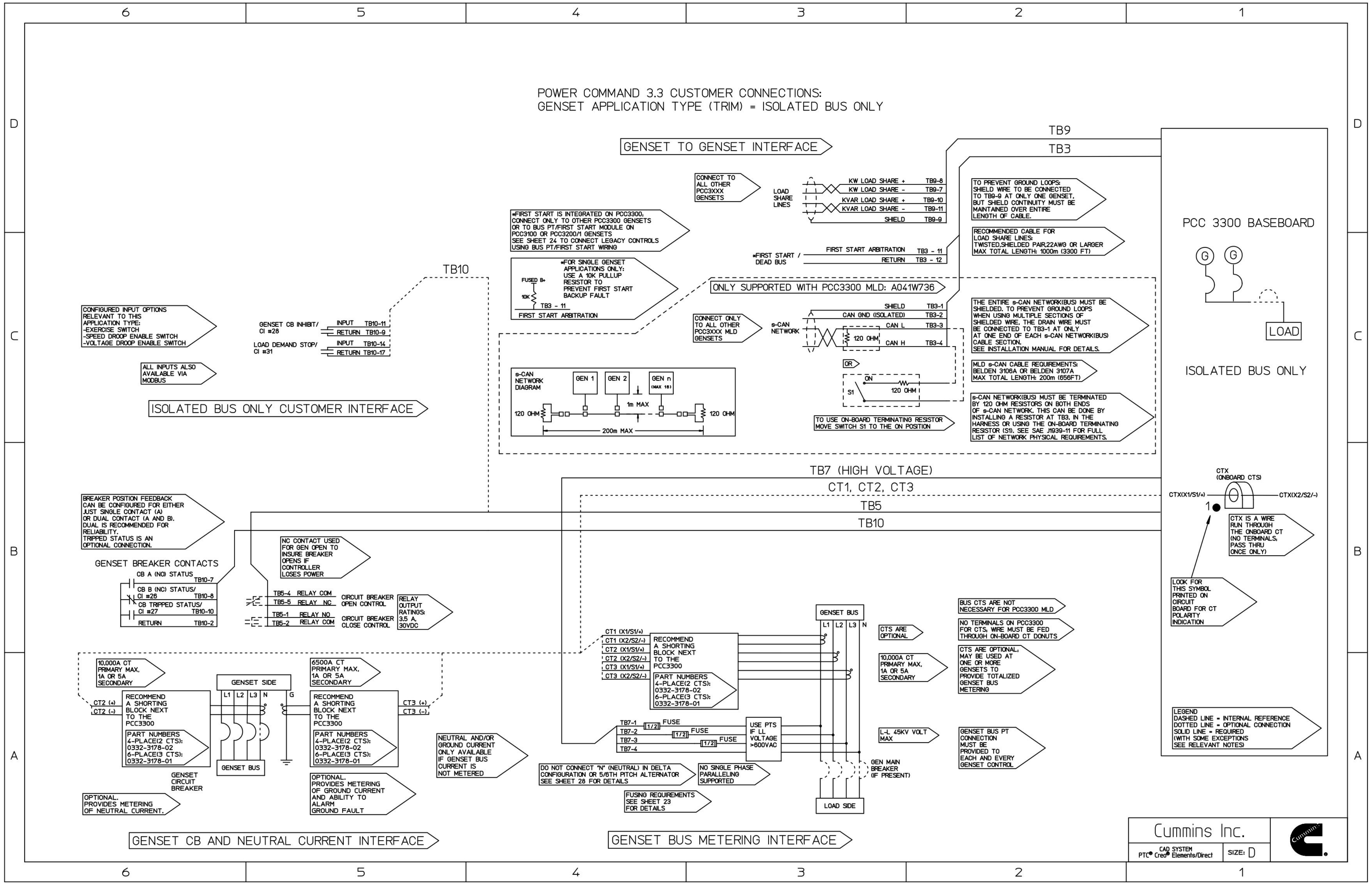


FIGURE 107. POWERCOMMAND 3.3 PARALLELING CONNECTIONS - ISOLATED BUS ONLY

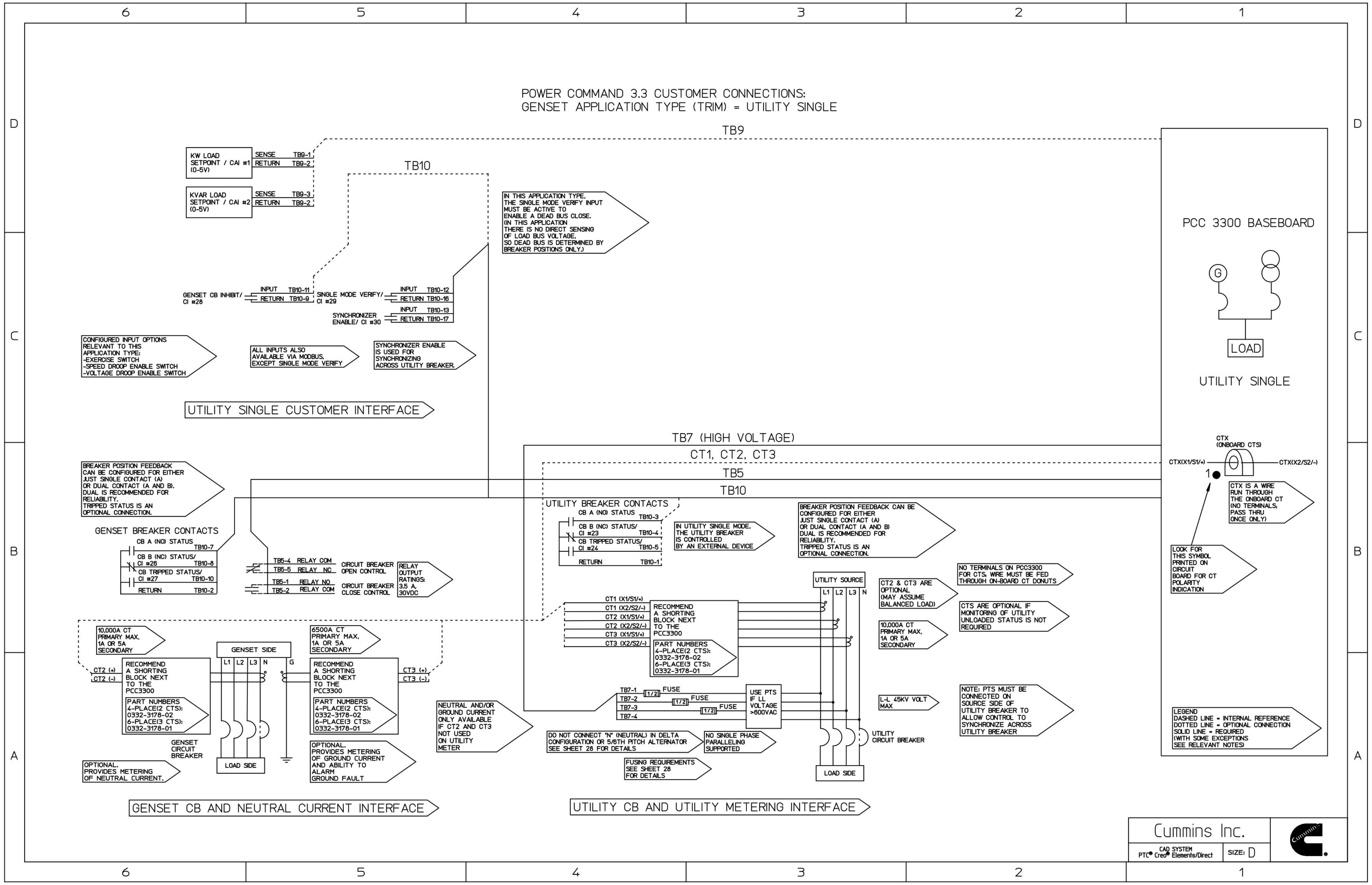


FIGURE 108. POWERCOMMAND 3.3 PARALLELING CONNECTIONS - UTILITY SINGLE

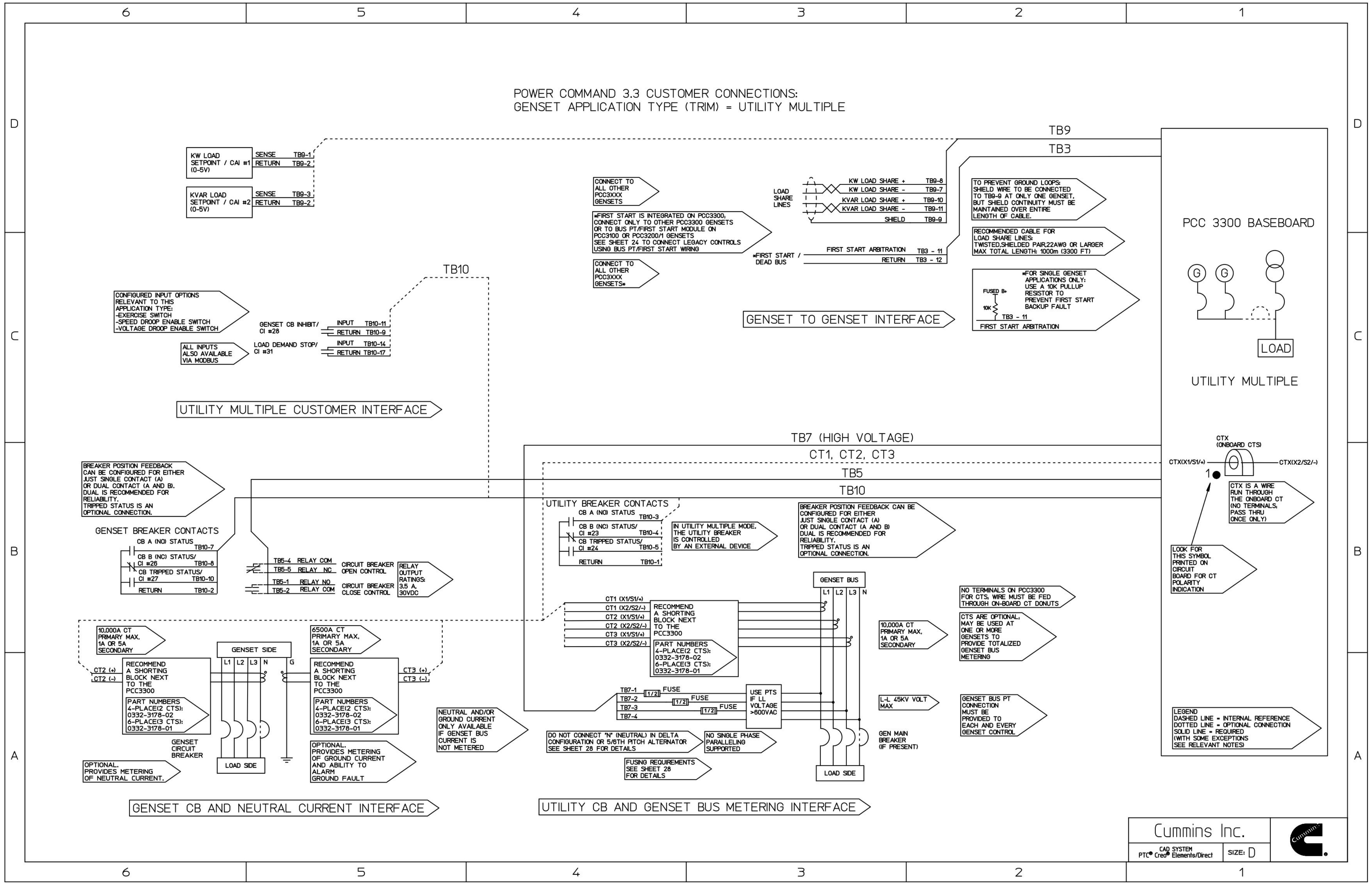


FIGURE 109. POWERCOMMAND 3.3 PARALLELING CONNECTIONS - UTILITY MULTIPLE

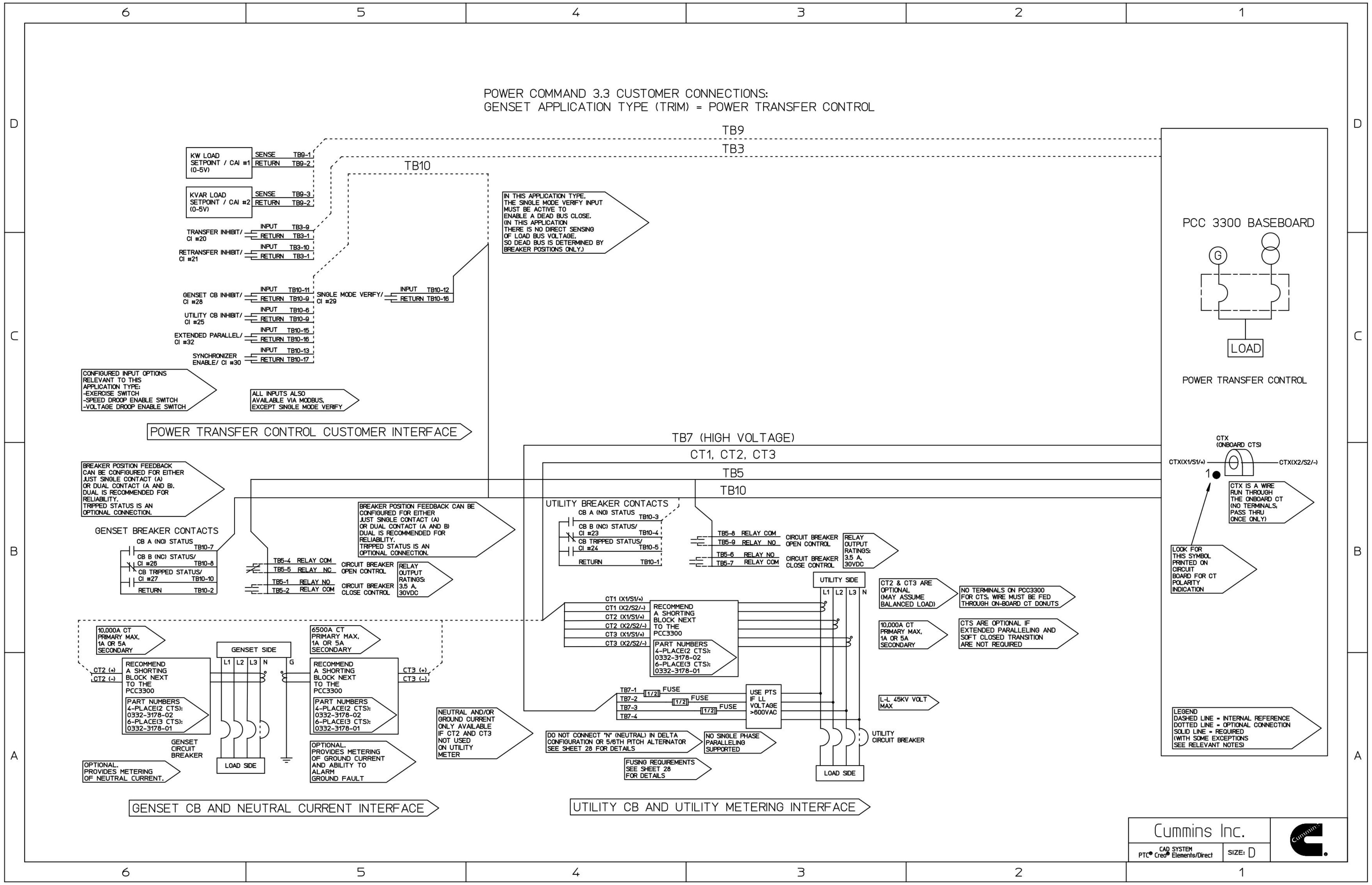


FIGURE 110. POWERCOMMAND 3.3 PARALLELING CONNECTIONS - POWER TRANSFER CONTROL

Rules for Configurable Paralleling IO - When Can IO be configured for non-default functionality?

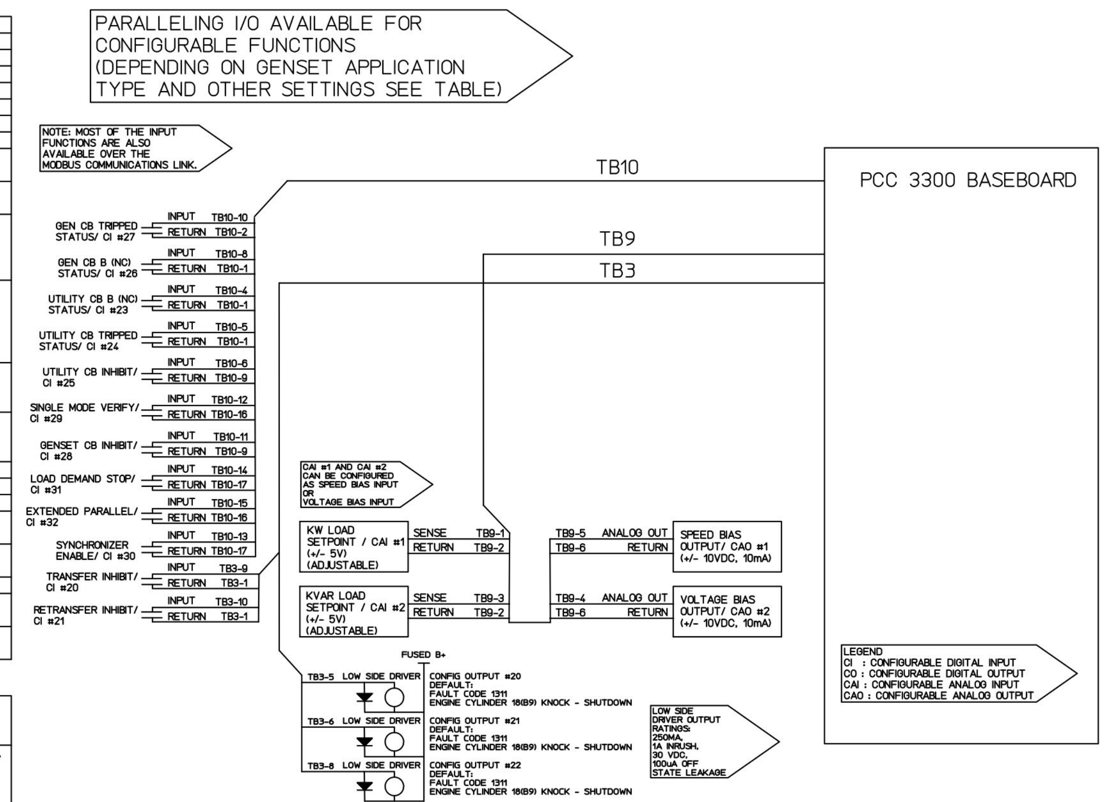
Signal	Can be Configured for non-default function if:
SWITCH INPUTS	
Genset CB B (NC) Status / CI#26	Only 'a' contact feedback will be used to monitor Genset breaker position.
Genset CB Tripped Status / CI #27	Genset breaker tripped indication will not be used.
Genset CB Inhibit / CI #28	Genset breaker inhibit control will not be used.
Utility CB B (NC) Status / CI#23	Only 'a' contact feedback will be used to monitor Utility breaker position.
Utility CB Tripped Status / CI #24	Utility breaker tripped indication will not be used.
Utility CB Inhibit / CI #25	Utility breaker inhibit control will not be used.
Single Mode Verify / CI #29	Genset Application Type (trim) is NOT Utility Single, or Power Transfer Control.
Load Demand Stop / CI #31	External control of load demand will not be needed, or if MLD is used for load demand control
Extended Parallel/ CI#32	This input default function is applicable only for "PTC" application. Thus in most applications (Non-PTC) this input can be configured for a non-default function.
Synchronizer Enable / CI #30	Genset Application Type (trim) is NOT Synchronize Only. Or Genset Application Type (trim) is Utility Single, but control system never needs to synchronize across utility breaker. Or Genset Application Type (trim) is Power Transfer Control and synchronizing when genset control is in Manual running mode is not required.
Transfer Inhibit / CI #20	Genset Application Type (trim) is NOT Power Transfer Control. Or Genset Application Type is Power Transfer Control, but transfer inhibit function is not needed.
Retransfer Inhhibit / CI #21	Genset Application Type (trim) is NOT Power Transfer Control. Or Genset Application Type is Power Transfer Control, but retransfer inhibit function is not needed.
LOW SIDE DRIVER OUTPUTS	NO CONFIGURABLE LOW SIDE DRIVER PARALLELING IO.
RELAY OUTPUTS	NO CONFIGURABLE RELAY OUTPUT PARALLELING IO.
ANALOG INPUTS	
kW Load Setpoint / CAI #1	Can be reconfigured when input is not needed for controlling genset kW output when utility paralleled.
kVAR Load Setpoint / CAI #2	Can be reconfigured when input is not needed for controlling genset kVAR output when utility paralleled.
ANALOG OUTPUTS	
Speed Bias Output / CAO #1	Can be reconfigured when input is not needed for speed bias interface to 3rd party speed governor.
Voltage Bias Output / CAO #2	Can be reconfigured when input is not needed for voltage bias interface to 3rd party voltage regulator.

Switch Input Functions (for Paralleling) only available by Configuring a Switch Input

Configurable Switch Input Paralleling Functions (functions only available by configuring an input to one of these)	Description / when used:
Exercise Switch	Will cause genset to start and run for a trimmable amount of fixed time. Control will function just as if the Remote Start input had been turned on for this fixed amount of time. For example, can be used when Genset Application Type = Power Transfer Control to cause genset to start and transfer load and after fixed time will automatically retransfer to utility and stop.
PTC Mode Switch	When Genset Application Type (trim) is Power Transfer Control, this will allow putting the breaker pair into a Manual operation mode, thereby causing the control to relinquish operation of the breakers.
Extended Parallel Switch	When Genset Application Type (trim) is Power Transfer Control, this input acts like Remote Start except instead of doing a load transfer it will parallel to the utility source and remain paralleled and control the kW and kVAR as programmed.
Speed Droop Enable Switch	Use to put genset into Speed Droop operation.
Voltage Droop Enable Switch	Use to put genset into Voltage Droop operation.
Load Demand Inhibit Switch	3300MLD systems ONLY. When LD system enable (trim) is enabled, and input is ACTIVE: Load Demand System Enable is inhibited. All the gensets will start.
Load Demand Spare Capacity Request	3300MLD systems ONLY. When LD system enable (trim) is enabled, and input is ACTIVE: Additional spare capacity (set by Load Demand Spare Capacity Request Value) is requested on the Genset Bus.

Switch Output Functions (for Paralleling) only available by Configuring a Switch Output

Configurable Switch Output Paralleling Functions (functions only available by configuring an output to one of these)	Description / when used:
Load Demand Spare Capacity Available	3300MLD systems ONLY. When LD system enable (trim) is enabled, and output is ACTIVE: Current load and spare capacity requirements are satisfied.



Analog Input Functions only available by Configuring an Analog Input

Configurable Analog Input Paralleling Functions (functions only available by configuring an input to one of these)	Description / when used:
External Speed Bias Input	Use when external biasing of engine speed is required.
External Voltage Bias Input	Use when external biasing of voltage is required.

Analog Output Functions only available by Configuring an Analog Output

Configurable Analog Output Paralleling Functions (functions only available by configuring an input to one of these)	Description / when used:
Genset Average Voltage	
Genset Average Current	
Genset Total Power Factor	
Genset Frequency	
Genset Total kW	
Genset Total kVAR	
Engine Speed	
Coolant Temperature	
Oil Pressure	
Oil Temperature	
Intake Manifold Temperature	

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FIGURE 111. POWERCOMMAND 3.3 PARALLELING CONNECTIONS - CONFIGURABLE PARALLELING I/O

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Appendix C. Seismic Requirements

Table of Contents

The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.

C.1 Seismic Installation Instructions

SPRING-ISOLATED GENERATOR SETS: GROUND LEVEL INSTALLATIONS

CUMMINS GENSET MODEL	CONFIGURATION	SEISMIC ISOLATOR		ATTACHMENT TO STEEL		ATTACHMENT TO CONCRETE					
		MODEL	QTY	SEISMIC LEVEL	ISOLATOR ATTACHMENT TO STEEL	SEISMIC LEVEL	ISOLATOR ATTACHMENT TO CONCRETE	MINIMUM ANCHOR EMBEDMENT	MINIMUM EDGE DISTANCE (FROM ANCHOR LOCATION)	CONCRETE COMPRESSIVE STRENGTH	MINIMUM SLAB THICKNESS
C2750D6E C3000D6EB	SET-MOUNTED COOLING	A053L607	18	SDS<=2.2 Z/H=0.0	4 PER ISOLATOR (72 TOTAL) Ø3/4" HEX HEAD STEEL BOLT (ASTM A325, GRADE 5)	SDS<=2.2 Z/H=0.0	4 PER ISOLATOR (72 TOTAL) HILTI HIT-RE 500 V3 +HAS-E-55, Ø3/4"	12.8"	18"	5000 PSI	18"

SPRING-ISOLATED GENERATOR SETS: ROOF LEVEL INSTALLATIONS

CUMMINS GENSET MODEL	CONFIGURATION	SEISMIC ISOLATOR		ATTACHMENT TO STEEL		ATTACHMENT TO CONCRETE					
		MODEL	QTY	SEISMIC LEVEL	ISOLATOR ATTACHMENT TO STEEL	SEISMIC LEVEL	ISOLATOR ATTACHMENT TO CONCRETE	MINIMUM ANCHOR EMBEDMENT	MINIMUM EDGE DISTANCE (FROM ANCHOR LOCATION)	CONCRETE COMPRESSIVE STRENGTH	MINIMUM SLAB THICKNESS
C2750D6E C3000D6EB	SET-MOUNTED COOLING	A053L607	18	SDS<=1.9 Z/H=1.0	4 PER ISOLATOR (72 TOTAL) Ø3/4" HEX HEAD STEEL BOLT (ASTM A325, GRADE 5)	SDS<=1.5 Z/H=1.0	4 PER ISOLATOR (72 TOTAL) HEAVY HEX HEAD, ASTM F1554 Gr105, Ø3/4"	12"	24"	10000 PSI	18"

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SIZE: D SCALE: 1/1
DIMENSIONING AND TOLERANCING PER: ASME Y14.5-2009
THIRD ANGLE PROJECTION
CAD SYSTEM PTC® Creo® Parametric

FIGURE 112. SEISMIC INSTALLATION INSTRUCTIONS (SHEET 1 OF 2)

SEISMIC INSTALLATIONS NOTES:

1. THE INSTALLATION GUIDELINES IN THIS DRAWING ARE RECOMMENDATIONS FROM THE ISOLATOR SUPPLIER AND SHOULD BE CONTACTED IF IN DOUBT.
2. THE DESIGN OF POST-INSTALLED ANCHORS IN CONCRETE USED FOR THE COMPONENT ANCHORAGE IS PRE-QUALIFIED FOR SEISMIC APPLICATIONS IN ACCORDANCE WITH "ACI 355.2" AND DOCUMENTED IN A REPORT BY A REPUTABLE TESTING AGENCY. (EX. THE EVALUATION SERVICE REPORT ISSUED BY THE INTERNATIONAL CODE COUNCIL)
3. EQUIPMENT ANCHORAGE MUST BE INSTALLED PER THE MANUFACTURER'S INSTRUCTIONS.
4. ANCHORS MUST BE INSTALLED IN MINIMUM 4000 PSI COMPRESSIVE STRENGTH NORMAL WEIGHT CONCRETE EXCEPT WHERE OTHERWISE INDICATED. CONCRETE AGGREGATE MUST COMPLY WITH "ASTM C33". INSTALLATION IN STRUCTURAL LIGHTWEIGHT CONCRETE IS NOT PERMITTED UNLESS OTHERWISE APPROVED BY THE STRUCTURAL ENGINEER OF RECORD.
5. ANCHORS MUST BE INSTALLED TO THE TORQUE SPECIFICATION AS RECOMMENDED BY THE ANCHOR MANUFACTURER TO OBTAIN MAXIMUM LOADING.
6. ANCHORS MUST BE INSTALLED IN LOCATIONS SPECIFIED ON THIS INSTALLATION DRAWING.
7. WIDE WASHERS MUST BE INSTALLED AT EACH ANCHOR LOCATION BETWEEN THE ANCHOR HEAD AND EQUIPMENT FOR TENSION LOAD DISTRIBUTION. WIDE WASHERS MUST BE SERIES "W" OF AMERICAN NATIONAL STANDARD TYPE "A" PLAIN WASHERS (ANSI B18.22.1-1965, R1975) WITH THE NOMINAL WASHER SIZE SELECTED TO MATCH THE SPECIFIED NOMINAL ANCHOR DIAMETER.
8. CONCRETE FLOOR SLAB AND CONCRETE HOUSEKEEPING PADS MUST BE DESIGNED AND REBAR REINFORCED FOR SEISMIC APPLICATIONS IN ACCORDANCE WITH "ACI 318".
9. ALL HOUSEKEEPING PAD THICKNESSES MUST BE DESIGNED IN ACCORDANCE WITH THE PRE-QUALIFICATION TEST REPORT AS DEFINED IN NOTE 1 OR A MINIMUM OF 1.5X THE ANCHOR EMBEDMENT DEPTH, WHICHEVER IS LARGEST.
10. ALL HOUSEKEEPING PADS MUST BE DOWELLED OR CAST INTO THE BUILDING STRUCTURAL FLOOR SLAB AND DESIGNED FOR SEISMIC APPLICATION PER "ACI 318" AND AS APPROVED BY THE STRUCTURAL ENGINEER OF RECORD.
11. FLOOR MOUNTED EQUIPMENT (WITH OR WITHOUT A HOUSEKEEPING PAD) MUST BE INSTALLED TO A REBAR REINFORCED STRUCTURAL CONCRETE FLOOR THAT IS SEISMICALLY DESIGNED AND APPROVED BY THE ENGINEER OF RECORD TO RESIST THE ADDED SEISMIC LOADS FROM COMPONENTS BEING ANCHORED TO THE FLOOR.
12. WHEN INSTALLING TO A FLOOR, REBAR INTERFERENCE MUST BE CONSIDERED.
13. ATTACHING SEISMIC CERTIFIED EQUIPMENT TO ANY FLOOR OR WALL OTHER THAN THOSE CONSTRUCTED OF STRUCTURAL CONCRETE AND DESIGNED TO ACCEPT THE SEISMIC LOADS FROM SAID EQUIPMENT IS NOT PERMITTED BY THIS SPECIFICATION AND BEYOND THE SCOPE OF THIS CERTIFICATION.
14. ATTACHING SEISMIC CERTIFIED EQUIPMENT TO ANY FLOOR CONSTRUCTED OF LIGHT WEIGHT CONCRETE OVER STEEL DECKING IS NOT PERMITTED BY THIS SPECIFICATION AND BEYOND THE SCOPE OF THIS CERTIFICATION.
15. ATTACHING SEISMIC CERTIFIED EQUIPMENT TO ANY CONCRETE BLOCK WALLS OR CINDER BLOCK WALLS IS NOT PERMITTED BY THIS SPECIFICATION AND BEYOND THE SCOPE OF THIS CERTIFICATION.
16. INSTALLATION UPON ANY STEEL DUNNAGE SHALL BE COORDINATED WITH THE STRUCTURAL ENGINEER OF RECORD. STEEL DUNNAGE MUST BE CERTIFIED BY OTHERS AS IS BEYOND THE SCOPE OF THIS REPORT.
17. INSTALLATION UPON ANY ROOFTOP CURB SHALL BE COORDINATED WITH THE CURB MANUFACTURER AND THE STRUCTURAL ENGINEER OF RECORD. ANY CURB OR CONCRETE PAD THAT SUPPORTS THE GENSET UNIT IS BEYOND THE SCOPE OF THIS CERTIFICATION.
18. ALL ACCESSORY ATTACHMENTS (PIPE, CONDUIT, ETC.) TO THE EQUIPMENT SHALL BE ATTACHED IN A MANNER THAT ALLOWS RELATIVE MOTION (FLEX, SWING, JOIN/ELBOW, ETC.) TO PREVENT FAILURE DUE TO DIFFERENTIAL MOVEMENT BETWEEN THE EQUIPMENT AND ATTACHED ACCESSORY CAUSED BY SEISMIC LOADING ON THE SYSTEM.
19. REFER TO THE MANUFACTURER'S INSTALLATION INSTRUCTIONS FOR ANCHOR REQUIREMENTS AND MOUNTING CONSIDERATIONS FOR SEISMIC APPLICATIONS. MOUNTING REQUIREMENT DETAILS SUCH AS BRAND, TYPE, EMBEDMENT DEPTH, EDGE SPACING, ANCHOR SPACING, CONCRETE STRENGTH, WALL BRACING, AND SPECIAL INSPECTION MUST BE OUTLINED AND APPROVED BY THE PROJECT STRUCTURAL ENGINEER OF RECORD. THE INSTALLING CONTRACTOR IS RESPONSIBLE FOR THE PROPER INSTALLATION OF ALL ANCHORS AND MOUNTING HARDWARE, OBSERVING THE MOUNTING REQUIREMENT DETAILS OUTLINED BY THE ENGINEER OF RECORD. CONTACT THE MANUFACTURE'S REPRESENTATIVE IF A DETAILED SEISMIC INSTALLATION CALCULATION PACKAGE IS REQUIRED.

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FIGURE 113. SEISMIC INSTALLATION INSTRUCTIONS (SHEET 2 OF 2)