

DIAGNOSTIC REPAIR MANUAL



Commercial Liquid-Cooled Product with Power Zone® 410 Control



Applicable Models Include:

150 kW and Below
Power Zone® 410 Controlled
Liquid-Cooled Gaseous/Diesel Units

STANDBY GENERATORS

Safety

Throughout this publication and on tags and decals affixed to the generator, DANGER, WARNING, and CAUTION blocks are used to alert personnel to special instructions about a particular operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully. Their definitions are as follows:

**DANGER**

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

(000001)

**WARNING**

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

(000002)

**CAUTION**

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

(000003)

NOTE: Notes provide additional information important to a procedure or component.

These safety alerts cannot eliminate the hazards they indicate. Observing safety precautions and strict compliance with the special instructions while performing the action or service are essential to preventing accidents.

Read This Manual Thoroughly

This diagnostic manual has been written and published by Generac to aid dealer technicians and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures for these products, or like or similar products manufactured and marketed by Generac, and that they have been trained in the recommended servicing procedures for these products, including the use of common hand tools and any special Generac tools or tools from other suppliers.

Generac could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a procedure or tool not recommended by Generac must first satisfy themselves that neither his nor the products safety will be endangered by the service procedure selected.

All information, illustrations and specifications in this manual are based on the latest product information available at the time of publication.

When working on these products, remember that the electrical system and engine ignition system are capable of violent and damaging short circuits or severe electrical shocks. If you intend to perform work where electrical terminals could be grounded or touched, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings of the engine are exposed during service, they should be covered to prevent accidental entry of foreign material. Entry of such materials will result in extensive damage when the engine is started.

During any maintenance procedure, replacement fasteners must have the same measurements and strength as the fasteners that were removed. Metric bolts and nuts have numbers that indicate their strength. Customary bolts use radial lines to indicate strength while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can cause damage, malfunction and possible injury.

Replacement Parts

When servicing this equipment, it is extremely important that all components be properly installed and tightened. If improperly installed and tightened, sparks could ignite fuel vapors from fuel system leaks.

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Section 1.1 Generator Basics

Introduction

This diagnostic repair manual has been prepared especially for the purpose of familiarizing service personnel with the testing, troubleshooting, and repair of 150 kW and below generator systems with the PZ410 Controller.

The information in this manual is accurate based on products produced at the time of publication. The manufacturer reserves the right to make technical updates, corrections, and product revisions at any time without notice.

The manual has been divided into several Sections. Each Section consists of two or more Subsections.

It is not the manufacturers intent to provide detailed disassembly and reassembly instructions in this manual. It is the manufacturers intent to:

- Provide the service technician with an understanding of how the various assemblies and systems work.
- Assist the technician in finding the cause of malfunctions.
- Expedite repair of the equipment.

Sections

Section 1 – General Information

Provides the basic understanding of the generator as well as basic installation information and operating instructions.

Section 2 – AC Generators

Provides the troubleshooting and diagnostic testing procedure for brushed and brushless alternators.

Section 3 – Engine/DC Control

Provides the troubleshooting and diagnostic testing procedure for engine related problems and the PZ410 Controller.

Section 4 – Adjustments and Maintenance


Provides basic adjustments and wireless remote troubleshooting.

Section 5 – Electrical Data

Illustrates all of the electrical and wiring diagrams for the various kW ranges.

Data Plate

A data plate affixed to the generator contains important information pertaining to the unit, including model number, serial number, amperage rating, and voltage rating. The information from this data plate may be required when requesting information, ordering parts, etc.

GENERATOR UNIT			
GEN MODEL: _____			
MODEL: _____			
SERIAL: _____			
ALTERNATE NO: _____			
PROD DATE: _____			
COUNTRY OF ORIGIN: _____			
GENERATOR DATA			
KW	KVA	HZ	PF
UPSIZING ALT	0 KW	0 KVA	
VOLT		/	AMP
ENG RPM		ALT RPM	
BRK LMT	KW	CB	AMP
X'D		X'D	
3 PHASE DELTA			
UNBALANCED LOAD CAPACITY-25%			
ROTOR	H	STATOR	H CLASS
WINDINGS @	40°C	AMBIENT	TEMP
			MANUF. LOC. EAGLE, WI
<small>GENERAC POWER SYSTEMS, INC WAUKESHA, WI USA</small>			

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Figure 1-1. Typical Data Plate

Rotor And Stator Resistance Tables

kW	Phase	Voltage (V)	Excitation	Power resistance (Ω)	Connection for power resistance	Excitation resistance (Ω)	Rotor resistance (Ω)
130	1	120/240 (A)	PME	0.0070 - 0.0082	Line-to-line (11-44)	0.3433 - 0.3989	2.09 - 2.31
130	3	120/208 (G)	PME	0.0092 - 0.0107	Line-to-line, parallel-wye	0.4664 - 0.5420	2.09 - 2.31
130	3	120/240 (J)	PME	0.0092 - 0.0107	Individual winding, disconnected	0.4664 - 0.5420	2.09 - 2.31
130	3	277/480 (K)	PME	0.0464 - 0.0536	Line-to-line, series-wye	0.4664 - 0.5420	2.09 - 2.31
150	1	120/240 (A)	PME	0.0070 - 0.0082	Line-to-line (11-44)	0.3433 - 0.3989	2.09 - 2.31
150	3	120/208 (G)	PME	0.0092 - 0.0107	Line-to-line, parallel-wye	0.4664 - 0.5420	2.09 - 2.31
150	3	120/240 (J)	PME	0.0092 - 0.0107	Individual winding, disconnected	0.4664 - 0.5420	2.09 - 2.31
150	3	277/480 (K)	PME	0.0512 - 0.0596	Line-to-line, series-wye	0.4664 - 0.5420	2.09 - 2.31

Alarm Displays and Descriptions

E-Code	Displayed Alarm	Alarm/Warning A = Alarm W = Warning	Description
134	Emissions/Airfuel DTC	W	O2 sensor stuck open/closed DTC logged in eeprom. Warning will clear after engine runs with no DTC codes 3 times.
1000	Controller Fault	A	The system has experienced an internal fault. Contact an IASD.
1001	Controller Fault	A	Internal Harness Loop Broken —Internal harness connecting external display board to main board has become disconnected. Triggered when main board does not see communication from display board.
1005	Watchdog Timeout	A	Watchdog Timeout —An internal watchdog timeout occurred. Controller will reboot and transition to the same key state it was previously in and resume operation.
1006	Controller Fault	A	An Exception Occurred —Controller will reboot and transition to the same key state it was in before and resume operation.
1100	Overcrank	A	Default—Engine/Starter Problem The default for overcrank alarm, because of the nature of cranking there is almost no insight into the cause of an overcrank alarm with the current sensors.
1200	Overspeed	A	Prolonged Over 72 Hz for three seconds. Possible cause: broken stepper wire.
1205	Overspeed	A	Instantaneous —Over 75 Hz for one second. Possible cause: broken stepper wire.
1207	Overspeed	A	Instantaneous —Over 75 Hz for 150 milliseconds based on measuring zero cross to zero cross times.
1208	Overspeed	A	Frequency (DPE measured) > 20% of target frequency for 5 seconds.

E-Code	Displayed Alarm	Alarm/Warning A = Alarm W = Warning	Description
1300	Low Oil Pressure	A	Occurred while running—Default The default extended alarm for low oil pressure. Check the oil level.
1301	Low Oil Pressure	W	Occurred while running—Default The default extended alarm for low oil pressure. Check the oil level.
1400	High Temperature	A	Air Flow Impeded / Flow Issue —Check the inlet/outlet for debris. Coolant temp greater than 246 °F (119 °C) for 1 second. Check coolant sensor circuit for proper operation.
1403	Engine Coolant Temperature	W	High Coolant Temp —Data valid but above normal operating range; least severe level
1404	Engine Coolant Temperature	W	Low Coolant Temp —Data valid but below normal operating range; least severe level
1405	Engine Coolant Temperature Sensor Open	W	Coolant Temp Sensor is not reporting any change in value even when unit is running. The reported value is also stuck at minimum, indicating sensor is wiring is stuck open.
1521	RPM Sensor	A	Missing pulses during running While running, no tooth pulses for 75 consecutive milliseconds. Possible causes: stator motor issue, RPM sensor alignment, low battery
1522	RPM Sensor	A	After crank command, RPM and DPE frequency both read 0. Possible cause - failed motor.
1523	RPM Sensor	A	After crank command flywheel teeth count and DPE frequency both read 0. Possible cause - failed motor.
1600	Underspeed	A	Unit Overloaded <83.3% speed (60 Hz) or <66.6% speed (50 Hz) for 30 seconds. Unit is overloaded slowing engine speed. Possible cause: highly inductive loads.
1800	Overvoltage	A	Voltage has 5 sec hold-off on startup, then > 130% for 1/5 seconds or >110% for 3 seconds
1801	Overvoltage	A	Instantaneous —Set by an instantaneous measurement 30% over nominal.
1900	Undervoltage	A	Prolonged Undervoltage; Generator voltage below 80% of nominal for 10+ seconds. CPL/CD, Voltage has 5 sec hold-off on startup, then < 60% for 1/5 sec
1901	Undervoltage	A	Instantaneous Generator voltage less than 15V. Hold off time of two seconds.
1902	Undervoltage	A	Both Zero Crosses missing Undervoltage due to faulty excitation winding, or zero cross circuit, or circuit in general. Both zero crosses must be missing for 1.5 seconds. Possible cause: loose wiring, field boost hardware failure
1903	Undervoltage	A	Little / No Voltage (<TBDV) Controller measuring no voltage resulting in undervoltage. Generator voltage less than 120V when undervoltage set. Possible cause: loose connections, broken wire
1904	Undervoltage	A	No Field Current But Have DPE No field current during undervoltage alarm. Possible cause: Wire loose, brush failure

E-Code	Displayed Alarm	Alarm/Warning A = Alarm W = Warning	Description
1905	Undervoltage	A	Low Speed Generator running underspeed for > 30 seconds when undervoltage alarm set. Possible cause: fuel supply/control system, engine intake exhaust or mechanical issues.
1906	Undervoltage	A	Single Zero Cross missing Undervoltage due to faulty excitation winding, or zero cross circuit, or circuit in general. One zero cross missing for greater than 1.5 seconds. Possible cause: field boost hardware failure.
1907	Undervoltage	A	After resuming from a load shed event (i.e., generator is commanded at full speed again), still undervoltage because of overload condition.
2000	Transfer Switch Position Error	A	Transfer Switch Position —Both Gen and Utility stuck open.
2001	Transfer Switch Position Error	A	Transfer Switch Position —Both Gen and Utility stuck closed.
2002	Transfer Switch Position Error	A	Transfer Switch Position —Gen stuck closed/Utility stuck open.
2003	Transfer Switch Position Error	A	Transfer Switch Position —Gen stuck open/Utility stuck closed.
2060	3 Wire Switch Position Error	A	3 Wire Start NO NC switches are not in desired position.
2070	Keypad Missing	A	Keypad is missing.
2098	Wiring Error	A	Miswired —Generator Xfer Enabled Output has been miswired.
2099	Wiring Error	A	Miswired —Problem with customer connections.
2100	Overload Remove Load	A	Overload CT's (2 Alternator Output Current Transformers) Output current measured value is above threshold. Possible cause: Overload.
2109	Ground Fault	A	Ground + Neutral Current is above threshold.
2111	Overload Over-current	A	When current exceeds 150% of rated current (most likely because of P-P or P-N short), control PID regulates the output current to 300% rated output current to clear downstream circuit breakers in a fault condition.
2112	Overload Over-current	A	I2T based detection - generator output current above rated limit accumulates to 300% within 11 seconds
2501	Governor Fault	A	Stuck Open Command and position feedback not matching or taking too much time to achieve. Governor in open position for greater than one second. Possible causes: governor wire loose, governor module
2502	Governor Fault	A	Stuck Closed Command and position feedback not matching or taking too much time to achieve. Governor in closed position (commanded otherwise) for greater than one second. Possible cause: governor wire loose, governor module
2670	CAN Bus Error	A	Problem with CANBus interface. There is a 1 second hold off on startup. If no message received for 1 second, alarm activated.
2674	12/24V Battery Config Error	W	Dealer Config and the Digital Input for confirming a 12/24 V Battery Type system mismatch.

E-Code	Displayed Alarm	Alarm/Warning A = Alarm W = Warning	Description
2675	I/O Extender 1 Loss Of Comm	W	No response from I/O Extender for 3 seconds after a hold-off duration of 30 seconds.
2676	I/O Extender 2 Loss of Comm	W	No response from I/O Extender for 3 seconds after a hold-off duration of 30 seconds.
2677	I/O Extender 3 Loss of Comm	W	No response from I/O Extender for 3 seconds after a hold-off duration of 30 seconds.
2678	I/O Extender 4 Loss of Comm	W	No response from I/O Extender for 3 seconds after a hold-off duration of 30 seconds.
2679	External Charger Failure	W	External Charger is enabled and the External Charger Fail digital input is True for 3 seconds.
2680	Low Fuel Level	W	Default - Fuel level above 10% but lower than 20% for greater than 60 seconds Low fuel level is triggered when the low fuel switch is triggered for 1 minute. The sensor triggers at 20% fuel remaining.
2681	Extremely Low Fuel Level	A	Fuel Level is less than 10%.
2682	Diesel High Fuel Level	W	High Diesel Fuel Level
2683	External Warning - 1	W	System detected a common warning indicator true for 1 second from one of the configured external source (I/O Extender).
2684	External Warning - 2	W	System detected a common warning indicator true for 1 second from one of the configured external source (I/O Extender).
2685	Fluid Basin Over- fill	W	Fluid basin overflow indicator is true for 1 second from one of the configured external source (I/O Extender).
2686	Fluid Basin Miss- ing	W	Fluid basin overflow indicator is true for 5 seconds from one of the configured external source (I/O Extender).
2687	MLCB Aux Con- tact	W	Main Line Circuit Breaker is open or tripped
2688	Enclosure Damper Actuator Aux Contact	A	Enclosure Damper Actuator is stuck
2690	Low Fuel Pres- sure	W	Default - Low fuel pressure detected for greater than 60 seconds. Low fuel pressure is triggered when the switch is active. The switch is designed to trigger when pressure falls below 5.2" water column +/- 0.4" (below 0.19 psi).
2710	Ruptured Tank	A	Default - The system detected fuel in the outer basin tank and has triggered the alarm.
2720	Low Coolant	A	Default - Low coolant digital input detected low coolant for greater than five seconds.
2725	High Oil Tempera- ture	A	Default - Triggers when oil temperature is > 320 °F while the engine is running. Has a 10 second hold-off.
2735	Low Oil Level	A	Default - Triggers when oil level is below limit, detected after a 60 sec hold-off since power-on.

E-Code	Displayed Alarm	Alarm/Warning A = Alarm W = Warning	Description
2740	Check Engine	W	Default - where applicable (emissions certified) If O2 sensor exists and is faulted (O2 sensor stuck open/closed) for 90 seconds, this will trigger as an emissions failure. Warning will clear after engine runs with no O2 sensor stuck open/closed for 4 minutes.
2745	Lid Open/Theft Alarm	W	Lid or door is open.
2746	SPI Flash Abuse	W	Controller wrote to the SPI Flash more than 500 times in less than 4 minutes.
2750	Low Battery	W	Default - Battery voltage below 12.1V for greater than 60 seconds
2751	Very Low Battery	A	Default - The system detected battery voltage level less than 9.0 for 60 seconds and has triggered the alarm.
2760	Battery Problem	W	Default - Battery is >16V or charge current is >600mA at end of 26 hour charge cycle, which is started after battery voltage falls to <12.5V or the controller is initially powered. This indicates battery may be bad.
2770	Charger Warning	W	Default - Battery voltage is <12.5V after 26 hour charge cycle.
2780	Charger Missing AC	W	Default - During charging, AC input to battery charger missing for greater than 5 minutes.
2790	SEEPROM Abuse	W	Default - Controller wrote to the EEPROM more than 500 times in less than 4 minutes.
2793	Config EEPROM CRC Mismatch	W	Config computed CRC unequal to stored EEPROM CRC.
2800	ESTOP Pressed/	A	Default - The system detected the E-Stop button was pressed and shutdown. E-Stop detected when pressed for greater than 300 ms
2801	Auxiliary Shutdown	A	The system detected the Auxiliary Shutdown button was pressed and shutdown. Shutdown detected when pressed for greater than 300ms
2802	External Common Alarm - 1	A	System detected a common shutdown alarm indicator true for 1 second from one of the configured I/O Extender modules.
2803	External Common Alarm - 2	A	System detected a common shutdown alarm indicator true for 1 second from one of the configured I/O Extender modules.
2804	External Common Alarm - 3	A	System detected a common shutdown alarm indicator true for 1 second from one of the configured I/O Extender modules.
2810	Hall Calibration	W	The system detected on power up that hall calibration was not performed and has triggered the alarm.

Section 1.2 Testing, Cleaning, and Drying

Visual Inspection

Perform a thorough visual inspection before testing or troubleshooting an alternator. Remove the access covers and look closely for any obvious problems. Look for the following:

- Burned or broken wires, broken wire connectors, damaged mounting brackets, etc.
- Loose or frayed wiring insulation, loose or dirty connections.
- Check that all wiring is well clear of rotating parts.
- Verify that the generator's voltage output matches utility voltage.
- Look for foreign objects, loose nuts, bolts, and other fasteners.
- Clean the area around the generator. Clear away paper, leaves, snow, and other objects that might blow against the generator and obstruct air flow.
- Verify that the generator is properly connected for the current rated voltage, especially on new installations.

Measuring Voltages



▲ DANGER

Electrocution. High voltage is present at transfer switch and terminals. Contact with live terminals will result in death or serious injury.

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The technician will be required to measure both AC and DC voltages when troubleshooting and testing the generator set. Measurement of voltage requires that the user be thoroughly familiar with the meter being used for such tests. Consult the instruction manual for the meter being used.

When measuring voltage, it is best to connect the meter test leads to the terminals being tested while the generator is shut down or while power to those terminals is turned off.

DANGER: Do not attempt to read power voltages while standing on wet or damp ground, or while hands or feet are wet. The use of insulative rubber mats to stand on while testing is recommended. **(Partially alert 000129)**

Measuring Current

Alternating current (AC) can be measured with a clamp-on ammeter. Most clamp-on ammeters will not measure direct current (DC). Load current readings should never exceed the generator's data plate rating for continuous operation. However, momentary surges in load current may be encountered when starting electric motors.

On 1-phase generators, the data plate generally lists rated line-to-line and line-to-neutral current.

Measuring Resistance

The resistance (in ohms) of generator stator and rotor windings can be measured using an ohmmeter or an accurate digital multimeter (DMM).

The resistance of some windings is extremely low. Some readings are so low that a meter capable of reading in the "milliohms" range would be required. Many meters will simply read CONTINUITY. However, a standard digital multimeter (DMM) may be used to test for continuity, or for a shorted or grounded condition.

Insulation Resistance

The insulation resistances of stator and rotor windings are a measurement of the integrity of the insulating material that separates the electrical windings from the generator steel core. This resistance can degrade over time or due to contaminants such as dust, dirt, oil, grease, and especially moisture. In most cases, failures of stator and rotor windings are due to a break down in the insulation. In many cases, a low insulation resistance is caused by moisture that collects while the generator is shut down. Problems caused by moisture buildup on the windings can usually be corrected by drying the windings. Cleaning and drying the windings can usually eliminate dirt and moisture that has built up in the generator windings.

The Megohmmeter

A megohmmeter consists of a meter calibrated in megohms and a power supply.

IMPORTANT NOTE: When testing stators and rotors, set the megohmmeter to 500 volts and apply voltage for a maximum of one second. Follow the megohmmeter manufacturers instructions carefully. Do not exceed 500 volts or apply voltage longer than one second. Megohmmeter HIGH voltages could cause damage to other components on the generator. Take the proper precautions before testing.

Stator Insulation Tests

Introduction

Units with liquid-cooled engine and 1-phase stator windings are equipped with:

- Dual stator AC power windings*
- An excitation or DPE winding

Stator winding insulation tests consist of:

- testing all windings to ground,

- testing between isolated windings,
- testing between parallel windings.

Figure 1-2 represents the various stator AC output leads on 1 and 3-phase units with liquid-cooled engines.

* 3-phase units will have 3 stator AC power windings.

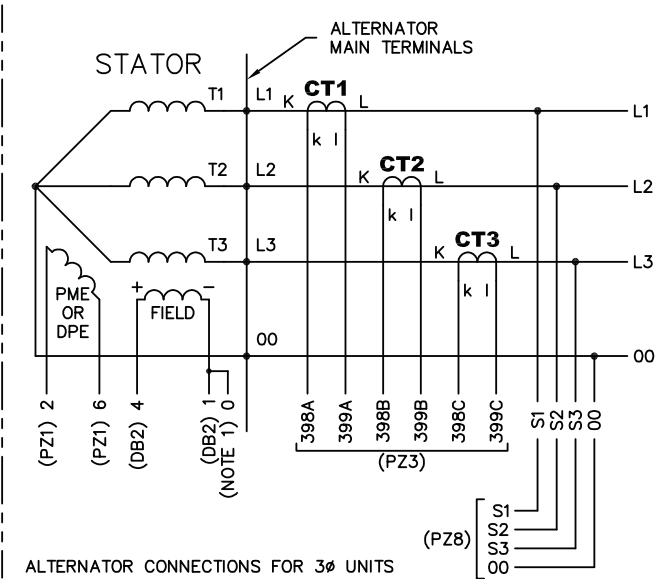
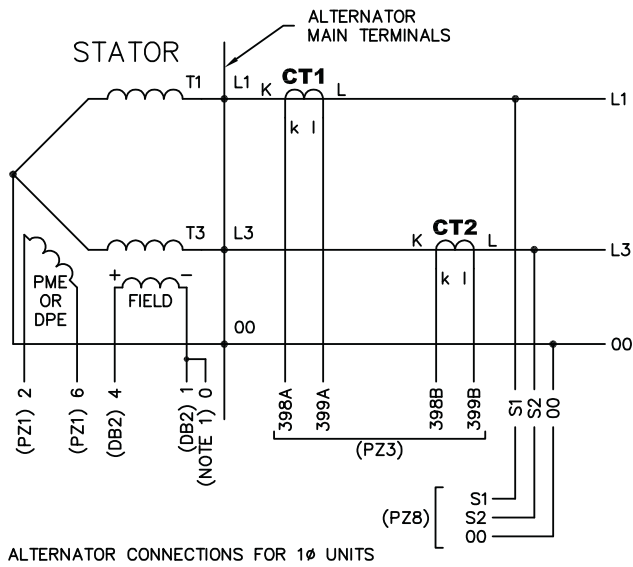
Test All Windings To Ground

1. Disconnect and isolate all stator leads.
2. Make sure all wire terminal ends are completely isolated from frame ground.
3. Connect the black tester probe to a clean frame ground on the stator can. Test each stator lead by

connecting the red test probe to the terminal end of each stator lead. Then, proceed as follows:

- a. Turn the switch OFF.
- b. Turn the tester switch ON and record the resistance indicated by the megohmmeter. After one second, turn the tester switch OFF.
- c. Repeat a and b for each lead.

If the resistance indicated is below the minimum resistance, clean and dry the stator. Then repeat the test. If resistance continues to be low during the second test, replace the stator assembly.



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Figure 1-2. Stator Winding Leads

Test Between Isolated Windings

Each winding consists of two leads. Use the matrix below as an aid in connecting and testing all windings.

1. Connect red and black probes of the megohmmeter according to the matrix.
2. Isolate all lead ends from each other. Be sure that the leads at the other ends of the winding being tested do not touch each other or ground.
3. Turn the megohmmeter switch ON and record the resistance indicated by the megohmmeter.
4. Wait one second while observing the resistance lamp. **DO NOT EXCEED ONE SECOND.** After one second, turn the tester switch OFF.

Example: Connect the red test probe to stator lead 2, the black probe to stator lead 11. Then, repeat steps 2–4. Repeat for each pair of leads as shown in the matrix.

Lead	1-Phase	3-Phase
Red	2	2
Black	11	S1
Red	2	2
Black	33	S3
Red	11	2
Black	33	S5
Red		S1
Black		S3
Red		S1
Black		S5
Red		S3
Black		S5

If the resistance indicated during any of the tests does not meet the minimum resistance during any one second test, the stator should be cleaned and dried. After cleaning and drying, repeat the test. If the resistance indicated during the second test does not meet the minimum values, replace the stator assembly.

Testing Rotor Insulation



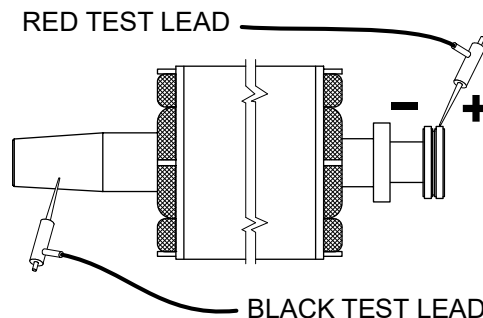
Equipment damage. Disconnect and isolate all winding leads. High megohmmeter voltages could cause equipment damage.

(000332)

Before attempting to test rotor insulation, remove the brush leads completely from the brushes or remove the brush holders completely. The rotor must be completely isolated from other components before starting the test.

1. Connect the red tester lead to the positive (+) slip ring (nearest the rotor bearing).
2. Connect the black tester probe to a clean frame ground, such as a clean metal part of the rotor.
3. Turn the tester switch OFF.
4. Turn the tester switch ON and measure and record the resistance indicated.
5. Observe the megohmmeter, then turn the tester switch OFF. **DO NOT APPLY VOLTAGE LONGER THAN ONE SECOND.**

If any resistance was indicated during the one second test, clean and dry the rotor. After cleaning and drying, repeat the insulation breakdown test. If breakdown lamp comes on during the second test, replace the rotor assembly.



003198

Figure 1-3. Testing Rotor Insulation

Apply a voltage of 500 volts across each rotor slip ring separately, and a clean frame ground (i.e. the rotor shaft).

IMPORTANT NOTE: When testing stators and rotors, set megohmmeter to 500 volts and apply voltage for a maximum of one second. Follow the megohmmeter manufacturers instructions carefully. Do not exceed 500 volts or apply voltage longer than 1 second. Megohmmeter HIGH voltages could cause damage to other components on the generator. Take the proper precautions before testing.

**Rotor Minimum Insulation Resistance:
1.5 Megohms**

Cleaning the Generator



Equipment damage. Never spray water to clean unit. Do not introduce water into generator windings, terminals, or fuel system during the cleaning process. Doing so will result in equipment damage. (000325a)

Caked or greasy dirt may be loosened with a soft brush or a damp cloth. A vacuum system may be used to clean up loosened dirt. Dust and dirt may also be removed using dry, low-pressure air of 25 psi (172.3 kPa) maximum.

Drying the Generator

Procedure

1. Open the generator main circuit breaker.

NOTE: Generator should have no electrical loads applied while drying.

2. Disconnect all wires so that the alternator is completely disconnected.
3. Provide an external source to blow warm, dry air through the generator interior (around the rotor and stator windings).

NOTE: Do not exceed 185 °F (85 °C).

4. Connect stator lead.
5. Start the generator and let it run for two or three hours.
6. Shut down the generator and repeat the insulation resistance tests.

Section 1.3 Menu System Navigation

Control Panel



Automatic start-up. Disconnect normal power source and render unit inoperable before working on unit. Failure to do so will result in death or serious injury.

(000236)

NOTE: The control panel is intended for use by qualified service personnel only.

NOTE: To prevent possible injury that might occur during sudden starts, always set the control panel to OFF and remove the control panel fuse before working on or around the generator or transfer switch. For added security, place a DO NOT OPERATE tag or placard on both the control panel and transfer switch.

Introduction

The Power Zone 410 Control Panel is an electronic control box that functions as an advanced standby generator controller.

Specialized programs are built into the Power Zone 410 Control Panel to allow customers to configure spare I/O (inputs/outputs) to their own needs. Some pre-defined functions can be user customized from measurements to alarms to special functionality.

Features

The Generac Power Zone Digital Control Platform is a fully integrated and multipurpose family of controllers for Generac generator systems.

Standard Features

- 128 x 64 Graphical Display with Heater
- Multi-Lingual
- Full System Status
- Three-Phase Sensing Digital Voltage Regulator
- Full Range Standby Operation
- Full System Status
 - Three-Phase AC Volts
 - Three-Phase Amps
 - kW
 - Power Factor
 - Oil Pressure
 - Water Temperature
 - Oil Temperature*
 - Oil Level*
 - Fuel Pressure and Level
 - Engine Speed

- Battery Voltage
- Alternator Frequency
- Time
- Date
- Line Power and Gen Power
- Run Hours
- Service Reminders
- Fault History (Alarm Log)
- Remote Communications
- Programmable Auto Crank
- Emergency Stop
- On/Off Manual Switch
- Not in Auto Flashing Light
- Selectable Low Speed Exercise
- NFPA 110 Capable**
- 5 A Integrated Battery Charger***

Standard Protections

- Low Oil Pressure
- Low Coolant Level
- High/Low Coolant Temperature
- Oil Temperature
- Over/Under Speed
- Over/Under Voltage
- Over Frequency
- Over Current
- Over Load
- Battery Voltage
- Battery Charger Current
- Phase-to-Phase and Phase-to-Neutral Short Circuits (I²T Algorithm)
- Ground Fault

* If equipped; when available

** See modular NFPA 110 components section

*** Operation disabled when optional 10A Battery Charger is installed

Display

- Easy Menu Structure
- Multi-Lingual
- On Screen Editable Parameters
- Key Function Monitoring
 - Three-Phase Voltage, Amperage, kW, kVA, and kVAr
 - Selectable Average or Line to Neutral Voltage Measurements
 - Frequency

- RPM
- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Oil Temperature
- Battery Voltage
- Warning and Alarm Indication
- Diagnostics
- Maintenance Events/Information
- Hourmeter

Control Panel

- AUTO/OFF/MANUAL
 - Operation Through On-board Buttons or Optional Key Switch
 - Indication Through Display Screen and LEDs
- Audible Alarm and SILENCE†
- Auxiliary Shutdown Rocker Switch
- Not in AUTO Indication

† If equipped; see modular NFPA 110 components section

Voltage Regulation (Single or Three-Phase Module Options)

- Digital Control
- Three-Phase Sensing
- Variable V/F Slope Settings
- Negative Power Limit
- Loss of Sensing Protection
- Fault Protection (I2T Function)
- High Voltage Limit
- Low Voltage Limit
- Maximum Power Limit
- $\pm 0.5\%$ Voltage Regulation
- $\pm 0.5\%$ Stability
- Governor Functionality
- Speed Control through ECM Integration
- Soft Start Ramping (Multiple Steps)

Communication Ports

- 2 RS-232
- 2 RS-485
- 1 CANBus

Qualification Testing

- Life Test in Environmental Chamber
- Temperature Rating $-40\text{ }^{\circ}\text{C}$ to $+70\text{ }^{\circ}\text{C}$
- Vibration Tested and Protected

Connections‡

- 7 Analog Inputs
- 1 Analog Output (0-10 VDC)
- 6 AC Voltage Sensing Inputs
- 3 CT Inputs
- 16 Digital Inputs
- 13 Digital Outputs
- Comms Ports
 - 1 CANBus Port
 - 1 USB Port (for Configuration Transfer and Firmware Upgrades)
 - 1 RS-485 Modbus Master Port (for External RAP/RRP/External I/O Modules)
 - 1 RS-485 Modbus Slave Port (for other uses, e.g. Building Management)
 - 2 RS-232 Communication Ports (for Tether or other uses)

‡ Actual I/O may vary due to configuration

Codes And Standards

- UL 6200
- CE
- NFPA 110 Capable

Modular NFPA 110 Components§

- Remote Annunciator
- NFPA Accessory Module
 - Key Switch
 - Alarm Horn
 - Emergency Stop
- 10A External Battery Charger

§ If equipped; not standard on all models

Panel Setup

The Power Zone 410 Control Panel controller is setup in the factory to match the product it is shipped with and generally no changes are required. For spares purposes the controller can be re-configured in the field using Display functions.

To change the function of the panel, the only way to get a basic setup for a product is to use the controller's display. This will setup all the basic parameters and just leave customization and calibration to be done. Contact customer support for other customizations not available through the display.

Below are examples of some of the configurations adjustable using the display:

- Setting Display Contrast
- Setting System Time and Date
- Setting Up/Enabling Internal Exercise

Customization

Other customization and calibrations are done through configuration files. Configuration files are generated at the factory and not all are accessible using the controller. To change the controller on one unit, use the “save/load config” menu on the controller.

Engine Management

The engine management module is very similar to that used in the manufacturer's other products. It controls engine cranking, engine starting, engine running and engine stopping. These functions are performed to a set of “rules”.

NOTE: The engine management module is ECM dependent and may vary.

Engine Definition

- **Preheat Time** - The time preheat is applied for before cranking if enabled.
- **Start Detection RPM** - The Engine must reach this RPM before disengaging the starter.
- **Crank Time** - The maximum time in seconds that each crank will last
- **Alarm Hold-off Time** - The time after starting at which the hold-off alarms become enabled.
- **Engine Warm up Time** - The engine will run for at least this time before issuing the “Accept load” signal.
- **Target Frequency** - The target generator frequency (Hz).
- **Target Voltage** - The target generator voltage (RMS).
- **Preheat Enable** - The following four options are selectable (only for Diesel):
 - Preheat disabled.
 - Preheat before cranking.
 - Preheat during cranking.
 - Preheat before and during cranking.
- **Engine Cool down Time** - The generator will run for at least this time after remote start becomes inactive.
- **Pause Between Cranks Time** - The time between each successive crank operation.
- **Number of Start Attempts** - The maximum number of times the engine will attempt to start (crank) before faulting out with overcrank.
- **Load Accept Frequency** - The generator must reach this frequency before issuing the “Accept load” signal.
- **Load Accept Voltage** - The generator must reach this voltage before issuing the “Accept load” signal.

Table 3-1. Engine Settings

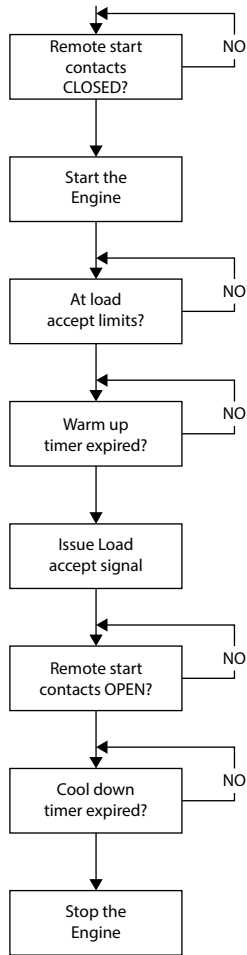
Number	Parameter	Units
1	Preheat Time	(S)seconds
2	Start Detection RPM	RPM
3	Crank Time	S
4	Alarm Hold-Off Time	S
5	Engine Warm Up Time	S
6	Target Frequency	Hz
7	Target Voltage	Vrms
8	Preheat Enable	-
9	Engine Cool Down Time	S
10	Pause Between Cranks Time	S
11	Number of Start Attempts	-
12	Load Accept Frequency	HZ
13	Load Accept Voltage	Vrms

Table 3-2. Programmable Timers

Description	Limits
Startup Delay	10–1500 seconds
Return Delay	15–1500 seconds
Crank Pause Time	7–20 seconds
Cooldown Time	60–1500 seconds
Warmup Time	0–60 seconds
Preheat Time	0–60 seconds

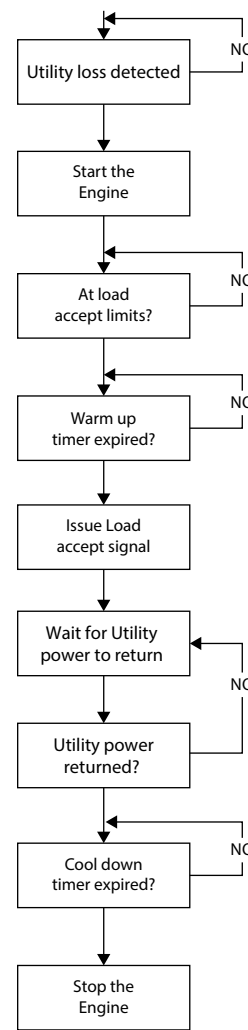
Starting and Stopping Sequence Diagrams

NOTE: Shutdown Alarms will cause the engine to turn off or not start.



012976

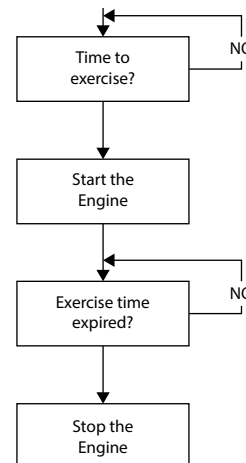
Figure 1-4. 2-Wire Starting and Stopping Sequence Key Switch in AUTO Position



015303

Figure 1-5. RTS Starting and Stopping Sequence Key Switch in AUTO Position

NOTE: A Remote Start signal will terminate exercise and proceed to normal running mode.



012977

Figure 1-6. Exercise without Transfer Starting and Stopping Sequence Key Switch in AUTO Position

NOTE: Shutdown Alarms will cause the engine to turn off or not start.

Controller

The controller consists of an LCD display and buttons to navigate through screens, make selections, and start or stop the generator as shown in **Figure 1-7**.

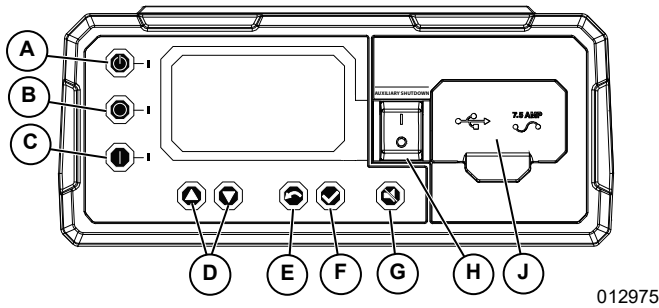


Figure 1-7. Front Panel Display

A	AUTO mode
B	STOP mode
C	MANUAL mode
D	Navigation arrows
E	ESCAPE
F	ENTER
G	SILENCE
H	Auxiliary shutdown
J	USB port and 7.5 A fuse

Navigation

Use the navigation arrows (⬅️ ➡️) to navigate between the screens. Use the ESCAPE button (⏪) to go back to the previous screen or selection and use the ENTER button (⏩) to confirm a selection.

Screens

There are six screen types which contain all available pages as shown in **Figure 1-8**. Each page may contain sub-pages containing additional information or settings to modify.

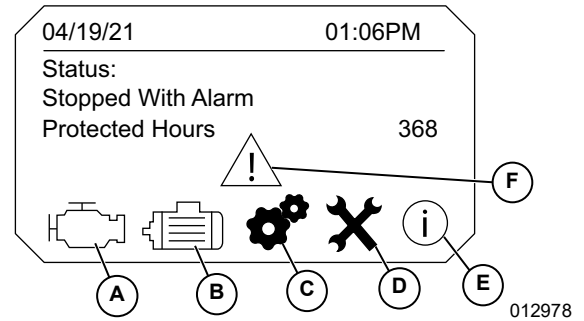


Figure 1-8. Home Screen

A	Engine Screen
B	Power Screen
C	Setting Screen
D	Dealer Screen
E	Info Screen
F	Alarm Screen

NOTE: Any data or values shown on the screens throughout this manual are for reference only.

Wizard Screens

The Wizard Screens are displayed at controller startup. See **Figure 1-9**. Use page 1 to set the language for the screens.

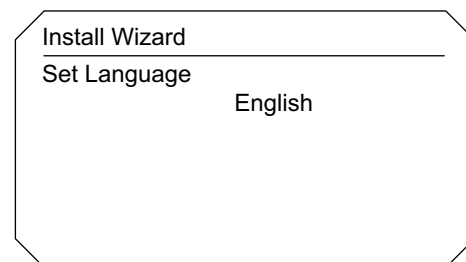
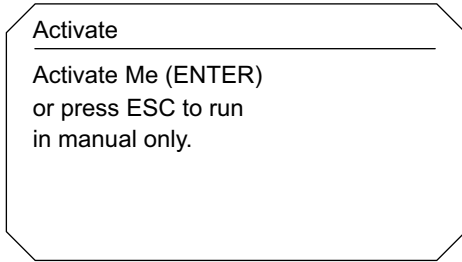


Figure 1-9. Wizard Screen (Page 1)

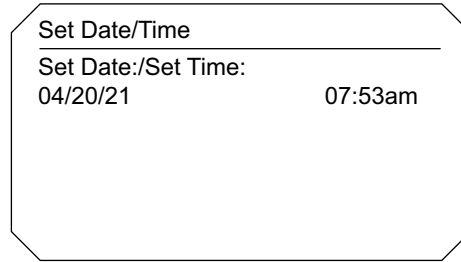
See **Figure 1-10**. This screen will display only if the unit is not activated. Use page 2 to activate the unit or choose to run in MANUAL mode (⏻) only. Activation is required to run the unit in AUTO mode (⏻).



012980

Figure 1-10. Wizard Screen (Page 2)

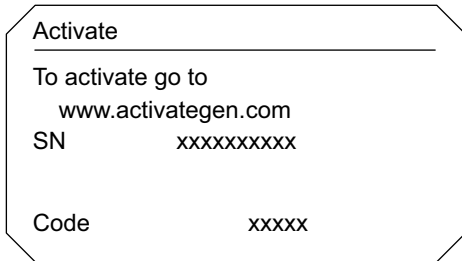
See **Figure 1-11**. This screen will display only if the unit is not activated. Use page 3 to enter the unit serial number and activation code. See the unit Owner's Manual to locate the unit serial number. The activation code can be obtained at www.activategen.com.



012983

Figure 1-13. Wizard Screen (Page 5)

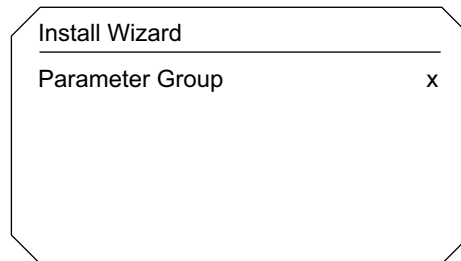
See **Figure 1-14**. This screen will display only if Vcode settings have never been set. Use page 6 to set the parameter group.



012981

Figure 1-11. Wizard Screen (Page 3)

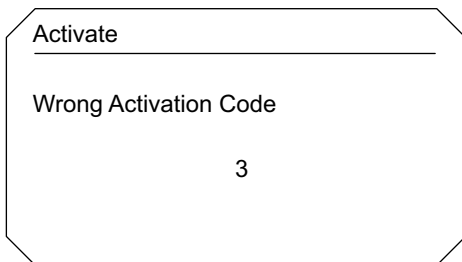
See **Figure 1-12**. Page 4 will display only if an incorrect activation code was entered. Three attempts are given to enter the correct code.



012984

Figure 1-14. Wizard Screen (Page 6)

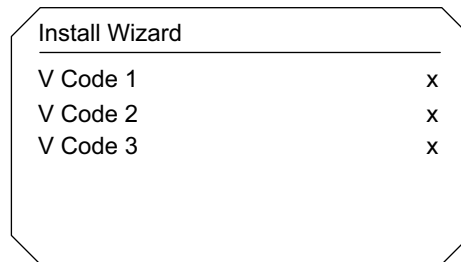
See **Figure 1-15**. This screen will display only if Vcode settings have never been set. Use page 7 to set the Vcodes.



012982

Figure 1-12. Wizard Screen (Page 4)

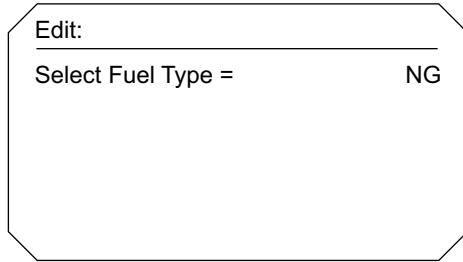
See **Figure 1-13**. Use page 5 to set the date and time that will appear on the Home Screen.



012985

Figure 1-15. Wizard Screen (Page 7)

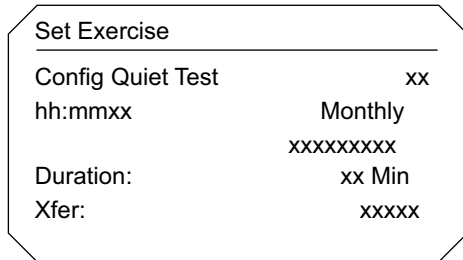
See **Figure 1-16**. This screen will display only if Vcode settings have never been set. Use page 8 to set the fuel type to liquid propane or natural gas.



012986

Figure 1-16. Wizard Screen (Page 8)

See [Figure 1-17](#). This screen will display only if Vcode settings have never been set. Use page 9 to configure quiet test, set exercise time and duration, and transfer frequency.



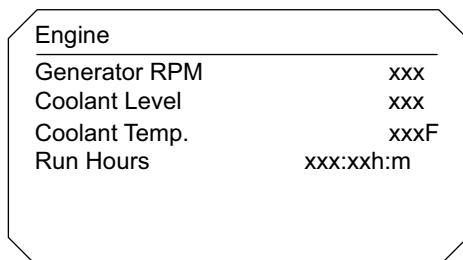
012987

Figure 1-17. Wizard Screen (Page 9)

Engine Screen

The pages within the Engine Screen contain information for viewing only. Use the navigation arrows (⏪ ⏩) to navigate between the screens.

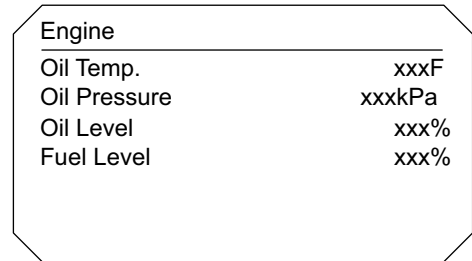
See [Figure 1-18](#). Page 1 displays the generator RPM, coolant level, coolant temperature, and unit run time.



012988

Figure 1-18. Engine Screen (Page 1)

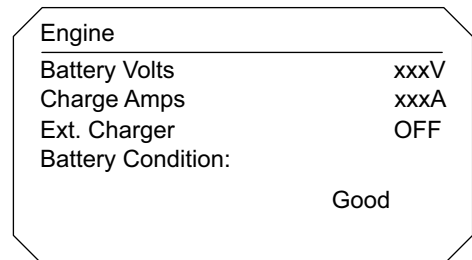
See [Figure 1-19](#). Page 2 displays the engine oil temperature, oil pressure, oil level ("N/A" is displayed instead of "xxx%" when oil sensor is not detected), and fuel level ("Fuel Level" is displayed for diesel units, "Gas Pressure" is displayed for propane and natural gas units).



012989

Figure 1-19. Engine Screen (Page 2)

See [Figure 1-20](#). Page 3 displays the battery volts, internal battery charge amps, external battery charger status (OFF = not connected, ON = connected), and battery condition for the battery charger.

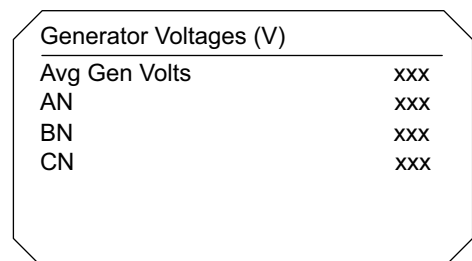


012990

Figure 1-20. Engine Screen (Page 3)

Power Screen

See [Figure 1-21](#). Page 1 displays the measured phase-to-neutral voltages and calculated average phase-to-phase voltage.



012991

Figure 1-21. Power Screen (Page 1)

See [Figure 1-22](#). Page 2 displays average generator current in Amps.

Generator Current (A)	
Avg Gen Amps	xxx
A	xxx
B	xxx
C	xxx

012992

Figure 1-22. Power Screen (Page 2)

See [Figure 1-23](#). Page 3 displays the generator kW, kVA, kVAR, and power factor.

Generator Power	
Gen. kW	xxx
Gen. kVA	xxx
Gen. kVAR	xxx
Gen. PF	x.xx

012993

Figure 1-23. Power Screen (Page 3)

See [Figure 1-24](#). Page 4 displays the measured phase-to-neutral voltages and calculated average phase-to-phase voltage.

Utility Voltages (V)	
Avg UT Volts	xx
Util. Volts AN	xx
Util. Volts BN	xx
Util. Volts CN	xx

012994

Figure 1-24. Power Screen (Page 4)

See [Figure 1-25](#). Page 5 displays total kWh, last kWh, and generator Hz.

General Info	
Total kWh	xxx
Last kWh	xxx
Gen. Hz	x.x

012995

Figure 1-25. Power Screen (Page 5)

Setting Screen

The pages within the Setting Screen contain settings that can be modified by the user. To modify a page setting see [Modify a Page Setting](#).

See [Figure 1-26](#). Use page 1 to adjust unit voltage, and set language, date/time, and exercise schedule.

User Edit	
Adjust Voltage	
Set Language	
Set Date/Time	
Set Exercise	

012996

Figure 1-26. Setting Screen (Page 1)

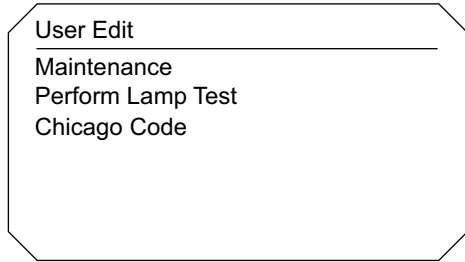
See [Figure 1-27](#). Use page 2 to update firmware, set a startup delay timer, set a warmup timer, and select fuel type.

User Edit	
Firmware Update	
Startup Delay	
Warmup Time	
Select Fuel	

012997

Figure 1-27. Setting Screen (Page 2)

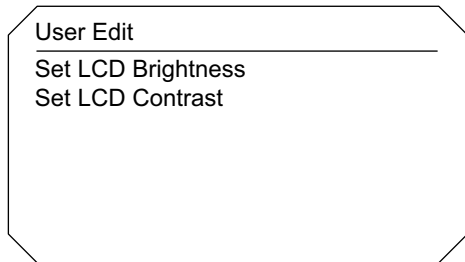
See [Figure 1-28](#). Use page 3 to view when the next battery maintenance is due, perform a lamp test, and enable or disable Chicago code.



012998

Figure 1-28. Setting Screen (Page 3)

See [Figure 1-29](#). Use page 4 to change the LCD display brightness and contrast.



012999

Figure 1-29. Setting Screen (Page 4)

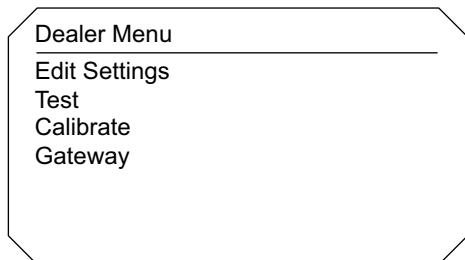
Dealer Screen

The Dealer Screen and sub-pages contain settings that can be modified by authorized technicians.

Password for Dealer Level access:

Level 1	Up, Up, ESC, Dn, Up, ESC, Up.
Level 2	ESC, Up, Up, Dn, Dn, ESC, ESC.

See [Figure 1-30](#). The Dealer Screen contains sub-pages to edit settings, test, calibrate, and gateway. To modify a page setting see [Modify a Page Setting](#) .

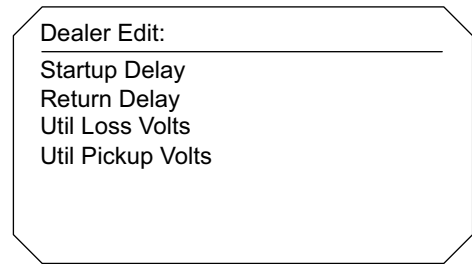


013000

Figure 1-30. Dealer Screen

“Edit Settings” Sub-Pages

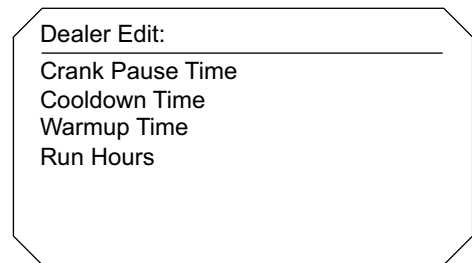
See [Figure 1-31](#). Use page 1 to modify startup delay, return delay, utility loss volts, and utility pickup volts.



013001

Figure 1-31. Edit Settings (Page 1)

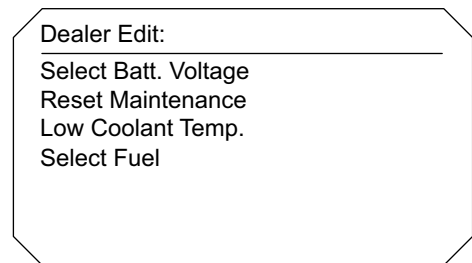
See [Figure 1-32](#). Use page 2 to modify crank pause time, cooldown time, warmup time, and run hours.



013002

Figure 1-32. Edit Settings (Page 2)

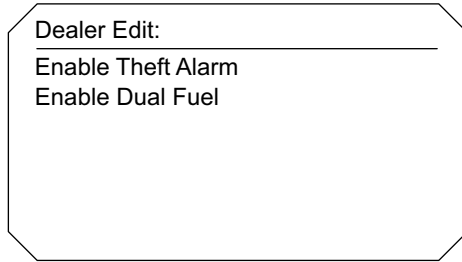
See [Figure 1-33](#). Use page 3 to modify battery voltage, reset maintenance, reset the low coolant temperature warning, and select fuel.



013003

Figure 1-33. Edit Settings (Page 3)

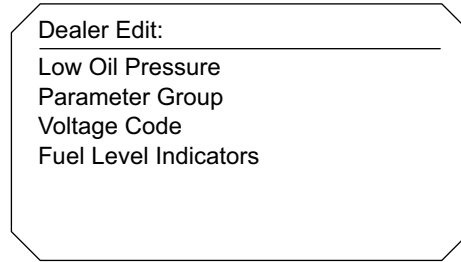
See [Figure 1-34](#). Use page 4 to enable or disable the theft alarm and dual fuel.



013004

Figure 1-34. Edit Settings (Page 4)

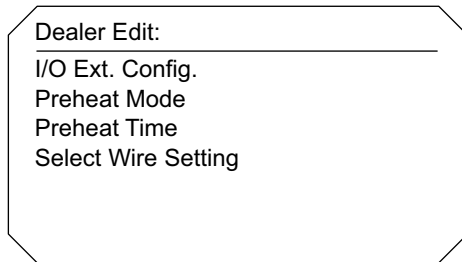
See [Figure 1-35](#). Use page 5 to modify I/O Extender preheat mode, preheat time, and wire setting.



013006

Figure 1-37. Edit Settings (Page 6)

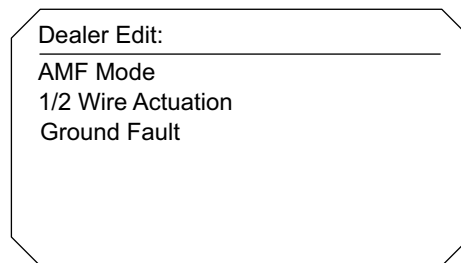
See [Figure 1-38](#). Use page 7 to enable or disable AMF (Auto Mains Failure) mode, and switch between 1 and 2 wire actuation.



013005

Figure 1-35. Edit Settings (Page 5)

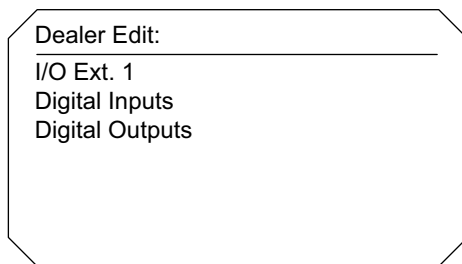
See [Figure 1-36](#). I/O Ext. Config. sub-page can be used for the special units that have the Generac I/O extender. Once the function is enabled, each input or output can be associated to a pre-defined function.



013007

Figure 1-38. Edit Settings (Page 7)

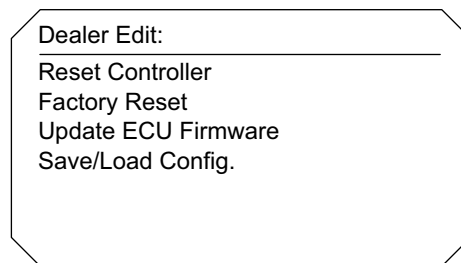
See [Figure 1-39](#). Use page 8 to reset the controller, perform a factory reset, update ECU (Engine Control Unit) firmware, and save or load a configuration to or from a USB drive.



013067

Figure 1-36. I/O Ext. Config. Sub-Page

See [Figure 1-37](#). Use page 6 to modify low oil pressure warning, alarm, and hold off time, modify parameter group, voltage code, and high fuel warning, low fuel warning and alarm.

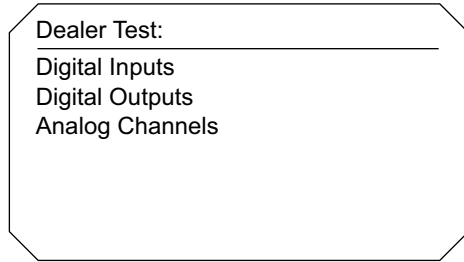


013008

Figure 1-39. Edit Settings (Page 8)

“Test” Sub-Pages

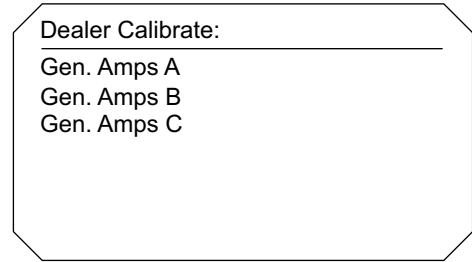
See [Figure 1-40](#). Use page 1 to test digital inputs and outputs, and view analog channels.



013009

Figure 1-40. Test (Page 1)

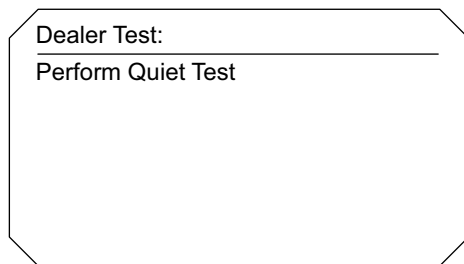
See [Figure 1-41](#). Use page 2 to perform a quiet test.



013012

Figure 1-43. Calibrate (Page 2)

See [Figure 1-44](#). Use page 3 to calibrate utility voltage.

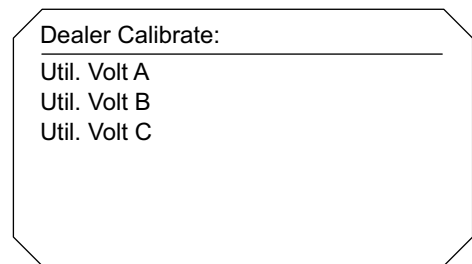


013010

Figure 1-41. Test (Page 2)

“Calibrate” Sub-Pages

See [Figure 1-42](#). Use page 1 to calibrate generator volts.

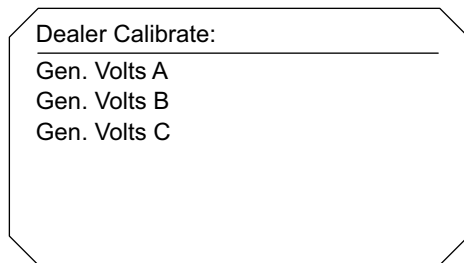


013013

Figure 1-44. Calibrate (Page 3)

“Gateway” Sub-Pages

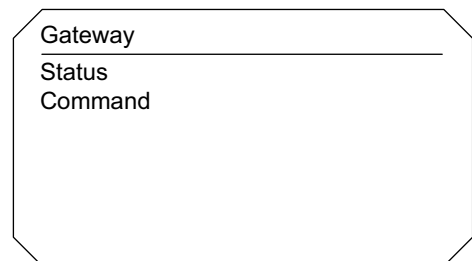
See [Figure 1-45](#). Use page 1 to view the status of the connectivity server, Ethernet, Wi-Fi®, and Bluetooth®. Page 1 is also used to perform a factory reset for the connectivity server, enable or disable Restore Dfit Nw Configuration, and enable or disable wired or wireless network.



013011

Figure 1-42. Calibrate (Page 1)

See [Figure 1-43](#). Use page 2 to calibrate generator amps.



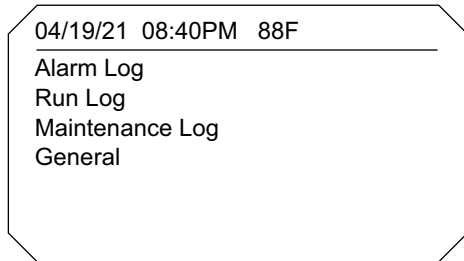
013014

Figure 1-45. Gateway (Page 1)

Info Screen

The pages within the Info Screen contain information for viewing only. Use the navigation arrows (⬆️ ⬇️) to navigate between the screens.

See [Figure 1-46](#). Page 1 displays the alarm log, run log, maintenance log, and general information about the generator, battery condition, hardware/firmware version, and I/O Extender versions.

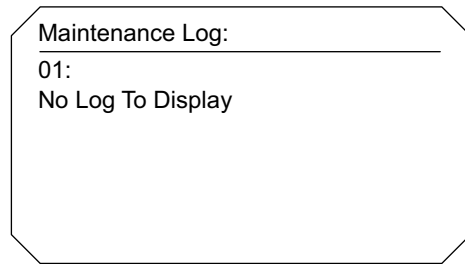


013016

Figure 1-46. Info Screen (Page 1)

“Maintenance Log” Sub-Page

See [Figure 1-49](#). Use this page to view a list of maintenance occurrences organized by time and date.

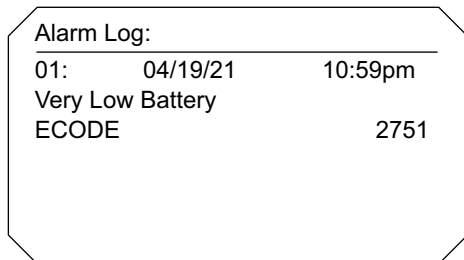


013019

Figure 1-49. Maintenance Log

“Alarm Log” Sub-Page

See [Figure 1-47](#). Use this page to view a list of alarms and warnings that have been triggered organized by time and date.

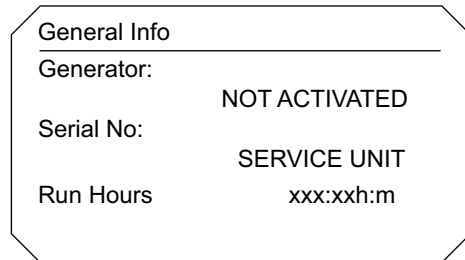


013017

Figure 1-47. Alarm Log

“General Info” Sub-Pages

See [Figure 1-50](#). Use page 1 to view generator status, serial number, and run hours.

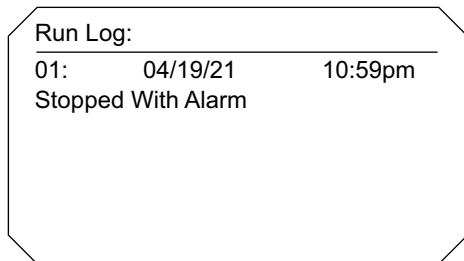


013020

Figure 1-50. General Info (Page 1)

“Run Log” Sub-Page

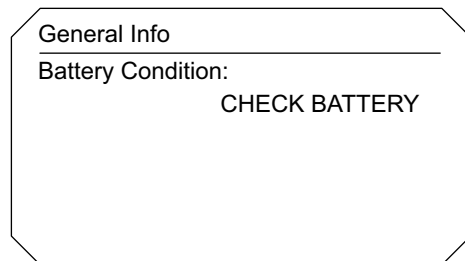
See [Figure 1-48](#). Use this page to view a list of run occurrences organized by time and date.



013018

Figure 1-48. Run Log

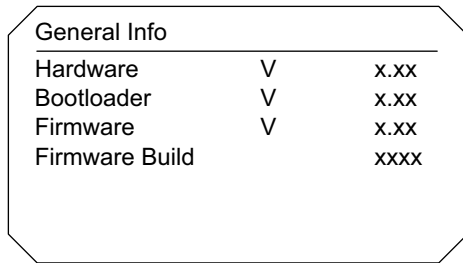
See [Figure 1-51](#). Use page 2 to view battery condition.



013021

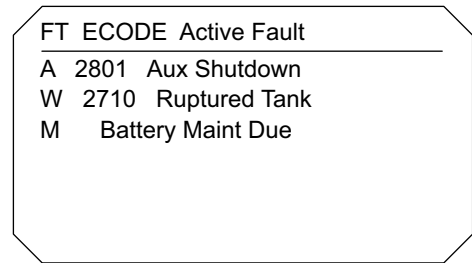
Figure 1-51. General Info (Page 2)

See [Figure 1-52](#). Use page 3 to view the currently installed versions of hardware, bootloader, firmware, and firmware build.



013022

Figure 1-52. General Info (Page 3)



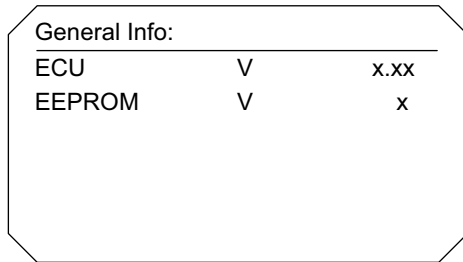
013025

Figure 1-55. Alarm Screen (Page 1)

See **Figure 1-53**. Use page 4 to view the currently installed versions of the ECU (Engine Control Unit) and EEPROM (Electrically Erasable Programmable Read-only Memory).

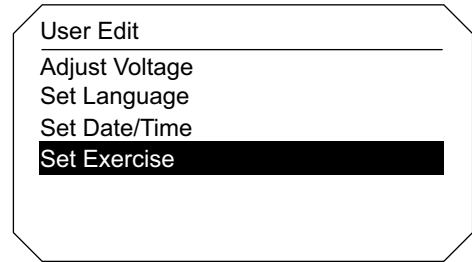
Modify a Page Setting

1. See **Figure 1-56**. Verify the desired setting is highlighted on the page and press the ENTER button (↵).



013023

Figure 1-53. General Info (Page 4)

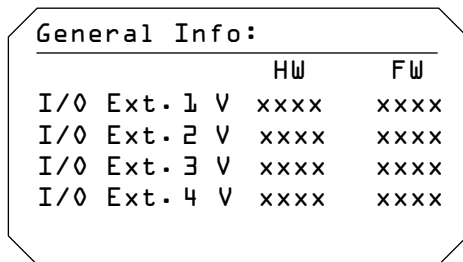


013026

Figure 1-56. Highlight Page Setting

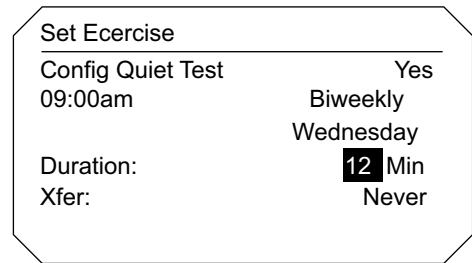
See **Figure 1-54**. Use page 5 to view the currently installed versions of I/O Extender hardware and firmware.

2. See **Figure 1-57**. Press the ENTER button again to highlight the value if needed. If multiple settings are available, continue pressing the ENTER button until the desired value is highlighted.



013024

Figure 1-54. General Info (Page 5)



013027

Figure 1-57. Highlight Desired Value

Alarm Screen

See **Figure 1-55**. The Alarm Screen contains information for viewing only. Use the navigation arrows (⬅️ ➡️) to scroll through alarms. Press STOP (⏹️) and then ENTER (↵) while on the Alarm Screen to clear all alarms present.

3. Use the navigation arrows (⬅️ ➡️) to change the value.
4. To confirm the change, press the ENTER button until the previous page is displayed as shown in **Figure 1-56**. To cancel the change, press the ESCAPE button (⏏️) until the previous page is displayed.

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Section 1.4 General Troubleshooting Guidelines

Introduction

This section familiarizes the service technician with recommended procedures for testing and evaluating various problems that can occur on liquid-cooled home standby products. Become familiar with these guidelines before attempting to troubleshoot any of the three main generator components: AC generator, liquid-cooled engine, transfer switch.

Troubleshooting flow charts provide the simplest and quickest means of troubleshooting typical problems that might occur on liquid-cooled home standby products. Performing the appropriate tests as indicated by the flow charts will help identify faulty components and systems. The components or systems can be repaired or replaced as necessary once identified.

The test procedures in each section require a basic knowledge of electricity and electrical safety, hand tool skills, and use of multimeters.

Testing and troubleshooting methods covered in this manual are not exhaustive. No attempt has been made to discuss, evaluate, or advise the home standby service trade of all conceivable ways in which service and trouble diagnosis must be performed. Any test method not recommended herein must be deemed safe for personnel and equipment.

Recommended Tools

In addition to standard hand tools, some test procedures require the use of specialized test equipment as follows:

- A meter that measures AC voltage and frequency, DC voltage and current, and has the ability to record minimum and maximum values. Digital multimeters (DM) are recommended.
- Standard meter test leads, and appropriate testing probes.

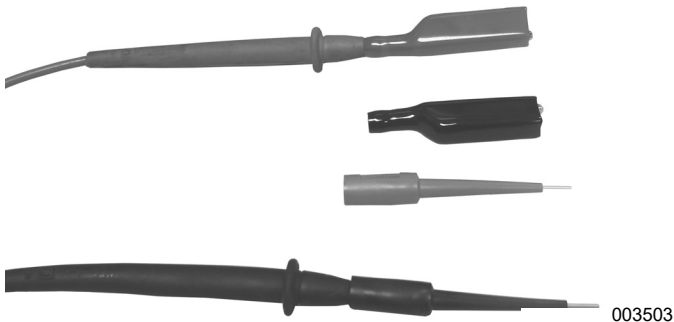


Figure 1-58. Test Probes

NOTE: The manufacturer carries flexible pin leads (P/N 0J09460SRV or A0000683522) for use with AMP connector plugs. These can also be used and are recommended for back probing MOLEX (white)

connectors. Optionally, but least recommended, the manufacturer also carries a set of acceptable piercing probes (P/N 0G7172). Other suppliers piercing probes may be used but are not the optimal solution. Piercing probes will leave holes in the insulation of the conductor, which could cause failures.

Liquid-Cooled Engine Troubleshooting Requirements

- A manometer which measures low pressure in inches of water column (inch WC or in H₂O).
- An ignition spark tester (P/N 0C5969).
- Mag Pickup Test Kit (P/N 0G41800SRV)

Recommended Tools Check List

- General mechanics tool box
- A meter capable of measuring frequency (Hz), AC and DC volts, DC amps, and Ohms
- A clamp-on AC/DC ammeter
- A 1/4" and 3/8" metric and SAE socket set
- Allen wrenches (metric and SAE)
- Manometer
- Spark tester
- Compression gauge
- Oil pressure gauge
- Leak down tester

Troubleshooting Reminders and Tips

The most important step in troubleshooting is to correctly identify the problem. Use the history capability of the control panel to help identify what the panel is seeing. Use the alarm log to view the faults that caused the warning or alarm shutdown. The Date/Time stamp provides the date and time (to the second) that the alarm event occurred. If there are several alarms that all have the same date-time stamps, go to the first in the series of alarms for that time. Some failures can cause a cascading series of faults to occur, one right after the other. Compare the alarm log and the run log to each other to see the operational sequence of events.

For example: If the unit shut down on "ALARM - Low Oil Pressure", look to see what time the unit started. If it started at 8/20/10 14:27:30 (2:27 pm), and shut down on low oil pressure on 8/30/10 10:15:22 (10:15 am), then the most likely cause of the loss of oil pressure was low oil level. The unit ran, providing power, for 10 days straight (approximately 234 hours). This could be validated by checking the oil level of the unit. Liquid-cooled engines will use oil while running. If run for extended periods of

time (several weeks for instance) they will require periodic shut-down to check oil level and do a general inspection.

Determine the applicable flow chart to use to help diagnose the problem. Use the flow chart index for the part of the generator you are working with.

- Use **Section 2 – Brushless Troubleshooting Flowcharts** for problems involving voltage.
- Use **Section 3 – DC Troubleshooting Flowcharts** for engine problems.

The index for each section will help clarify the problem and which flow chart to use. For each flow chart, start at the top and use the indicated test to verify whether or not a component or control item is working properly. At the end of each test follow the GOOD or BAD arrows and perform the next test.

It is a good practice to continue to ask questions during the troubleshooting process. When evaluating a problem, these questions may help identify the problem more quickly.

- What is it doing? (low voltage; not cranking; not transferring; etc)
- What should it do? (run and start; transfer; shutdown; etc)
- Does the same thing happen each time?
- When is it happening?
- What could or would cause this?
- What type of test will either prove or disprove the cause of the fault?

Important Note Concerning Connectors

A number of the tests require the use of a multimeter/volt-meter and a set of wire piercing probes.

It is very easy to damage the female pins in the connectors on the control panel (AMP connectors) and C1 connector (Molex connector) which goes to the alternator stator.

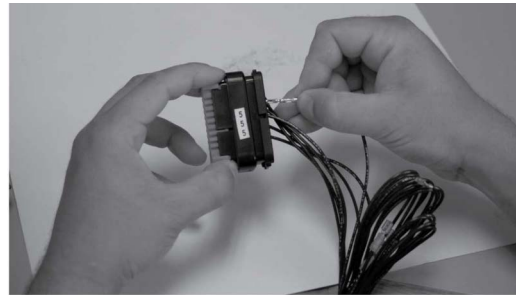
IMPORTANT NOTE: Do not attempt to push probe tips into the connector pins of any AMP or MOLEX connectors. Doing so will damage the female pin. Use the appropriate probes on specific wires to check voltage. Use the flexible pin leads, available from the manufacturer (PN 0J09460SRV or A0000683522) to work with AMP connector plugs. Another alternative is to use approved back probes from the back side of the connector.

Repairing Amp Style Connector Pins

Wires can be removed from the AMP style connector. Lift the tabs at the end of the connector and gently slide the connector face forward, photo shows forward position. Use caution when lifting tabs to prevent breakage.

A stop will keep the face from sliding off the connector body. Do not completely remove the face because it is extremely difficult to put it back on a populated connector.

If the face on a populated connector must be replaced, it is imperative to match the wire lugs with the connector face to prevent damage to the lugs.



003501

Figure 1-59. Removing Pin

The wire to be removed should be pushed, rotated, and pulled. The rotating action releases the wire from the lock. When replacing the wire, insert the wire into the appropriate location and push until it locks, then push the face of the connector back until it locks. Gently tug the inserted wire and inspect. The lug will be just below the face of the connector if inserted fully and can be seen through the face of the connector.

A special tool is required similar to that shown in **Figure 1-60** to repair a damaged socket.

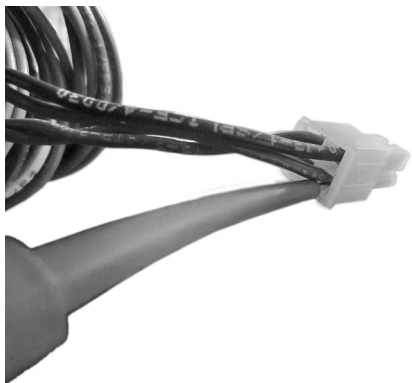


003500

Figure 1-60. Pin Crimping Tool

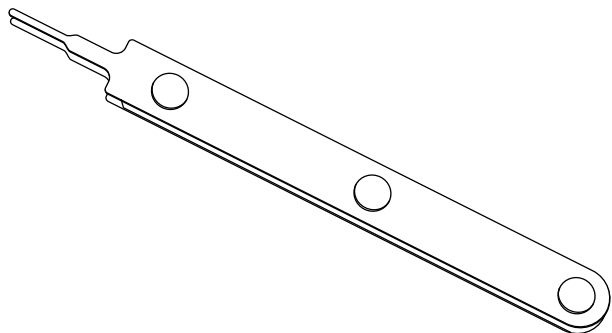
Probing and Pin Extraction

If probing and/or back-probing results in a BAD condition, before condemning the controller, remove the pin/plug in question and verify the pin/plug is not distorted, bent, and/or not making electrical contact. Repair as needed.



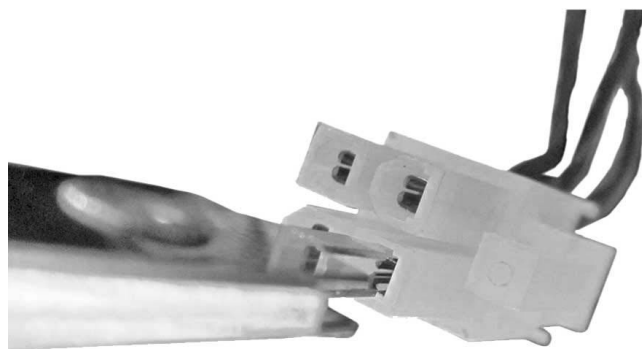
002450

Figure 1-61. Back-Probing Molex Connector



002452a

Figure 1-62. Molex Pin Extractor Tool P/N 0K4445



002453

Figure 1-63. Using Molex Pin Extractor Tool

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Section 2.1 Brushless Troubleshooting Flowcharts

Use the “Flow Charts” in conjunction with the detailed instructions in Section 2.2 **AC Diagnostic Tests** . Test numbers used in the flow charts correspond to the numbered tests in Section 2.2.

The first step in using the flow charts is to correctly identify the problem. Once that has been done, locate the problem on the following pages. For best results, perform all tests in the exact sequence shown in the flow charts.

Preliminary Output Voltage Test

General Theory

When an Alarm of the 1900 group (Undervoltage) is displayed on the controller, certain tests need to be performed to determine the actual fault. Measuring output voltage as described in this test will help determine the next step in troubleshooting. Refer to **Table 2-3**.

When measuring output voltage, it is important to look at the output voltage displayed on the control panel as well as measuring actual output voltage of the generator.

NOTE: If the unit enters a shutdown during this procedure, acknowledge the alarm by pressing the OFF button and then ENTER. Restart unit if necessary to complete the test.

Procedure

1. Gain access to the main line circuit breaker (MLCB) on the generator.
2. Set the MLCB to the OPEN (OFF) position to avoid any possible output voltage to the load.
3. Navigate to Display Voltage on controller.
4. Set a digital multimeter (DMM) to measure AC voltage.
5. Connect one meter test lead to Wire S1 and the other meter test lead to Wire S2 at the alternator side of the MLCB.
6. Set the controller to MANUAL. Allow generator to start and come up to speed and frequency.
7. Measure and record the voltage indicated on the DMM.
8. Visually monitor the output volts displayed on the controller.
9. Record the value indicated.

Voltage Indicated on the Controller: _____

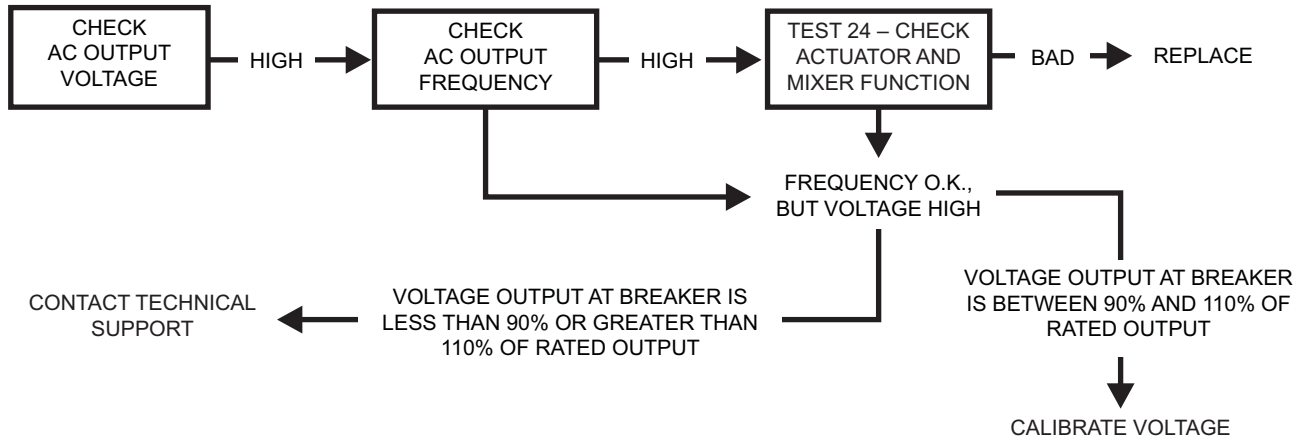
Measured Voltage Output at MLCB: _____

10. Shut the unit down by pressing the OFF button on the controller.
11. Use **Table 2-3** to determine which test to perform.

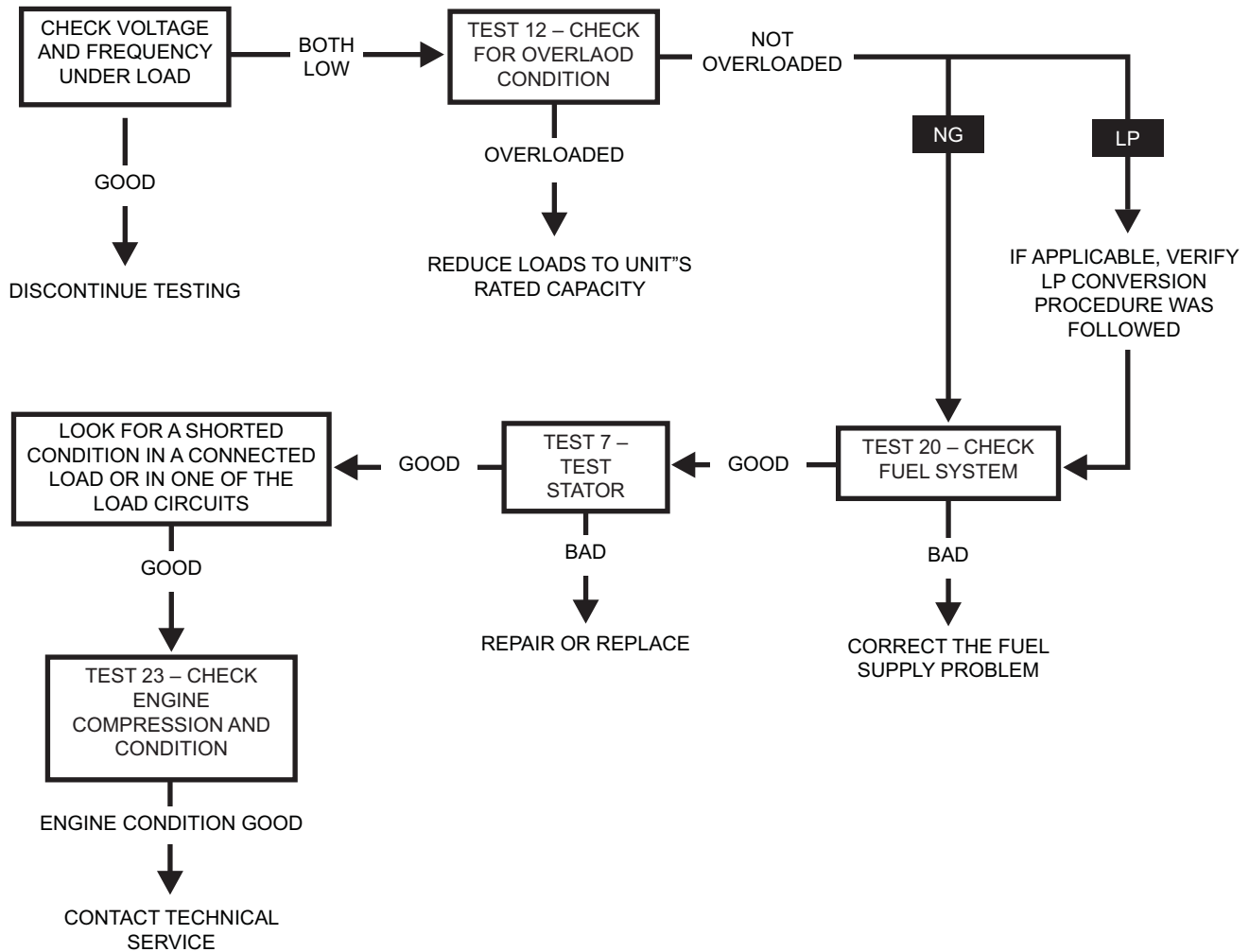
Table 2-3. Preliminary Output Voltage Test Results

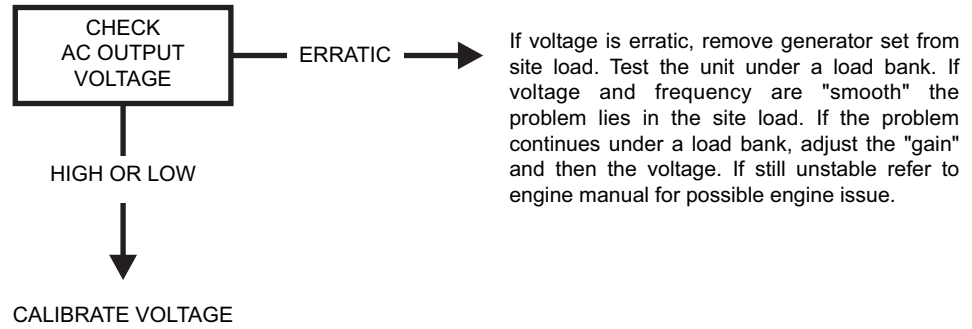
Controller Voltage	MLCB Voltage	Starting Test
0 (+10%)	20–30% (+ or – 10%)	Test 5 – Test AC Sensing Circuit
20–30% (+ or – 10%)	20–30% (+ or – 10%)	Test 4 – Test AC Excitation (DPE) Circuit
0 (Residual voltage may be present)	0 (Residual voltage may be present)	Test 1 – Troubleshooting Field Flash Circuit
~50% of measured voltage	Overtoltage	Test 5 – Test AC Sensing Circuit

Problem 1 – Generator Produces Low Voltage at No-Load



Problem 2 – Generator Shuts Down for Over Voltage



Problem 3 – Voltage and Frequency Drop Excessively When Loads Are Applied

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Section 2.2 AC Diagnostic Tests

Introduction

This section is provided to familiarize the service technician with acceptable procedures for testing and evaluating of various problems that could be encountered on standby generators with liquid-cooled engines. Use this section of the manual in conjunction with Section 2.1 [Brushless Troubleshooting Flowcharts](#). The numbered tests in this section correspond with those of Section 2.1.

Most tests can be performed with a digital multimeter (DMM). An AC frequency meter is required, where frequency readings must be taken. A clamp-on ammeter may be used to measure AC loads on the generator.

Testing and troubleshooting methods covered in this section are not exhaustive. We have not attempted to discuss, evaluate, and advise the home standby service trade of all conceivable ways in which service and trouble diagnosis might be performed. We have not undertaken any such broad evaluation. Accordingly, anyone who uses a test method not recommended herein must first satisfy themselves that the procedure or method they have selected will not jeopardize their or the product's safety.

Safety

Service personnel who work on this equipment must be made aware of the dangers of such equipment. Extremely high and dangerous voltages are present that can kill or cause serious injury. Gaseous fuels are highly explosive and can be ignited by the slightest spark. Engine exhaust gases contain deadly carbon monoxide gas that can cause unconsciousness or even death. Contact with moving parts can cause serious injury.

When working on this equipment, use common sense and remain alert at all times. Never work on this equipment while you are physically or mentally fatigued. If you don't understand a component, device, or system, do not work on it.

IMPORTANT NOTE: All tests are to be performed with the main line circuit breaker in the OPEN position unless otherwise specified.

NOTE: Before performing any test, do a visual and physical inspection of the connection box and the connections into the panel. If a faulty connection is detected, reference the specific wiring/schematic diagram before making any connections.

NOTE: "True Ground" or "System Ground" is available at the negative battery terminal. When performing a test, if the reading obtained is suspicious, or does not indicate a "Clean Frame Ground," use the negative battery terminal.

Test 1 – Troubleshooting Field Flash Circuit

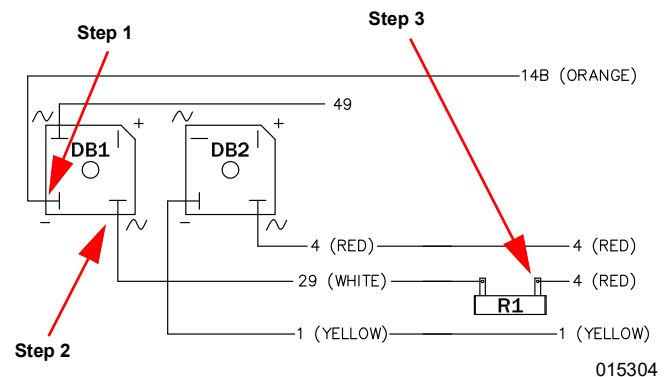


Figure 2-64. Field Flash Circuit Test Points

Step 1

NOTE: Verify wiring is correct prior to testing.

1. With unit running measure for DC voltage (battery) at Wire 14B on Diode 1 (DB1) without disconnecting wire.
 - a. If voltage is present continue test.
 - b. If voltage is not present proceed to [Test 15 – Troubleshooting Run Circuit](#).

Step 2

1. With unit running measure for DC voltage (battery) at Wire 29 on DB1.
 - a. If voltage is present continue test.
 - b. If no voltage measured proceed to [Test 2 – Test DB1 Field Boost Diode](#)

Step 3

1. With unit running measure for DC voltage (battery) at Wire 4 on Resistor 1 (R1).
 - a. If battery voltage is present continue test.
 - b. If no voltage is present remove both wires from R1 and test for resistance across terminals of resistor.
 - Approximately 0.025 ohm should be measured. Replace R1 if bad.
 - c. If approximately 2–4 VDC is measured field flash circuit is functioning normally. Test rotating diode bridge, exciter armature and main rotor.
 - [Test 8 – Test Brushless Exciter Field](#)
 - [Test 9 – Test Brushless Exciter Armature](#)
 - [Test 10 – Test Brushless Rectifier Assembly](#)
 - [Test 11 – Test Brushless Rotor Assembly](#)

Test 2 – Test DB1 Field Boost Diode

General Theory

The bridge rectifier installed in the field flash circuit allows for a field flash to occur on the rotor, and a field flash to occur on the engine alternator. It also acts to block voltage so that regulated DC voltage from the voltage regulator/control panel does not flow back to the run circuit or engine alternator during normal operation. If any of these diodes failed (shorted) closed, it would allow for a high DC voltage to flow back to the run circuit, potentially damaging critical components.

Procedure

1. Disconnect Wire 29 (white) from DB1 located in connection box.
2. Set DMM to measure DC voltage.
3. Connect one meter test lead (red) to DB1 where Wire 29 (white) was disconnected in step 1 and the other meter test lead (black) to the ground terminal in connection box.

IMPORTANT NOTE: The engine will crank and possibly start when the AUTO-OFF-MANUAL switch is set to MANUAL.

4. Set the AUTO-OFF-MANUAL switch to MANUAL. Measure and record the voltage. Battery voltage should be measured.
5. Set the AUTO-OFF-MANUAL switch to OFF (OPEN).
6. Reconnect Wire 29 (white) to DB1.
7. Disconnect Wire 14 (orange) from DB1.
8. Connect one meter test lead to the disconnected Wire 14 (orange) and the other meter test lead to the ground terminal in the connection box.
9. Set the AUTO-OFF-MANUAL switch to MANUAL.

⚠ DANGER

Automatic start-up. Disconnect normal power source and render unit inoperable before working on unit. Failure to do so will result in death or serious injury.

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10. Measure and record the voltage. Battery voltage should be measured.

Results

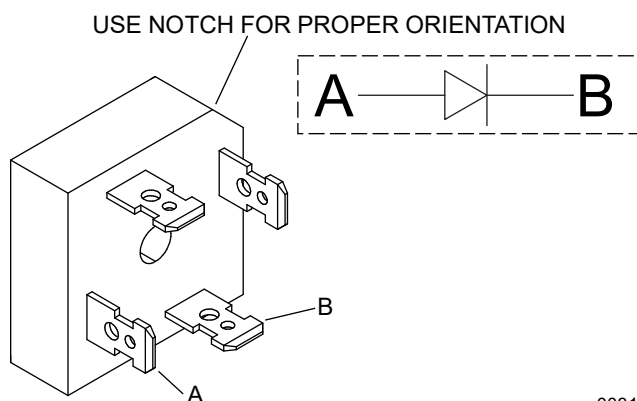
1. If battery voltage was measured in Step 4, repair or replace Wire 29 (white) between DB1 and R4.
2. If battery voltage was not measured in step 4, but was measured in Step 10, replace DB1.
3. If battery voltage was not measured in Step 10, refer to the flow chart.

Test 3 – Test DB2 Fly Back Diode

General Theory

A kick back voltage is created when any magnetic field collapses. The fly back diode is connected to Wires 1 and 4 and serves to shunt this kick back voltage to ground when the rotor's magnetic field collapses. The diode is connected to allow current to be blocked during normal operation and shunt to ground when the polarity reverses during the collapse of the magnetic field. If the diode is connected improperly and allows current to flow during normal operation, field boost voltage will be shunted to ground and the output at the breaker will remain minimal.

1. Disconnect yellow Wire 4 (B on DB2) and black Wire 1 (A on DB2) from the diode.
2. Set DMM to the diode test position.
3. Connect the red meter test lead to test point A and the black meter test lead to test point B. Measure and record the voltage indicated.
4. Connect the black meter test lead to test point A and the red meter test lead to test point B. Measure and record the voltage indicated.



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Figure 2-65. DB2 Test Points

Results

1. If the DMM indicated 0.4–0.5 VDC in Step 3 and 0 VDC (OPEN) in Step 4, refer to the flow chart.
2. Replace the DB1 diode if any other results are measured.

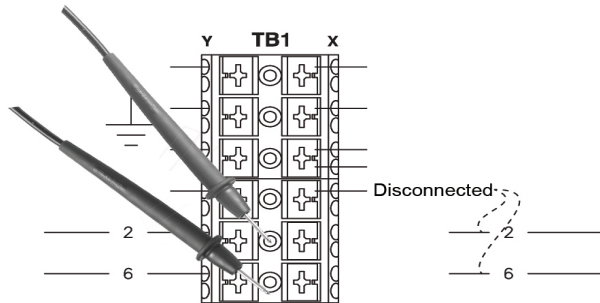
Test 4 – Test AC Excitation (DPE) Circuit

General Theory

The AC excitation circuit (DPE) is the power supply to the voltage regulator. The voltage regulator also rectifies the AC voltage to a varying controlled value of DC field excitation. This testing procedure is going to verify the integrity of the DPE winding.

Procedure

1. Set DMM to measure resistance.
2. Locate the TB1 terminal block (WAGO Block) in the customer connection box.
3. Locate and disconnect Wires 2 and 6 from the TB1 terminal strip that connect to the control panel. Insert test leads into the WAGO block test ports that correspond to Wires 2 and 6. Measure and record the value indicated by the DMM.

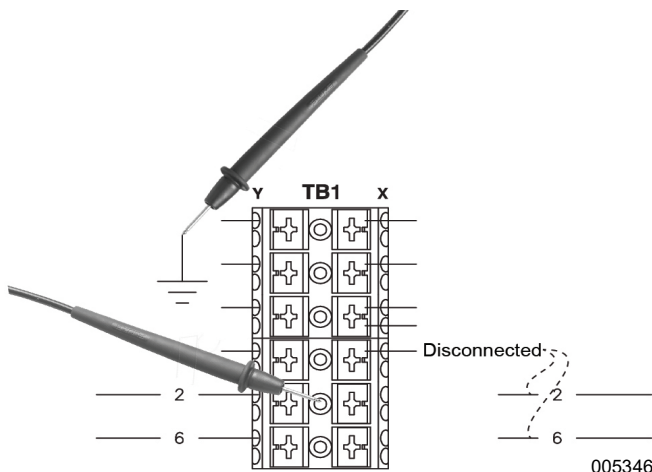


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Figure 2-66. Test TB1 Wire 2 and Wire 6 Test Ports

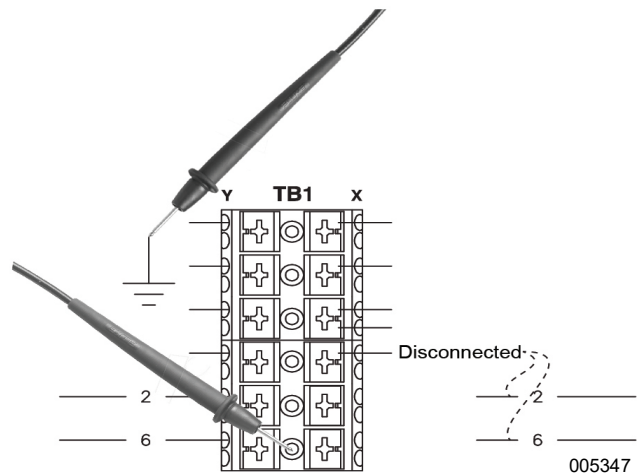
NOTE: Leave the control panel wires disconnected from the WAGO block.

- a. If the DMM indicated the resistance of the DPE winding indicated in Section 1.1 **Rotor And Stator Resistance Tables** within $\pm 10\%$, proceed to step 4.
 - b. If the DMM indicated INFINITY, or lower or higher than expected resistance, verify the integrity of the connections at the TB1 terminal block and the integrity of the wire running to the stator. If the DMM continues to indicate a value out of range of the specifications, replace stator.
4. Locate Wires 2 and 6 on the WAGO block. Set meter to measure resistance. Using the test ports on the WAGO block, measure Wire 2 to ground and Wire 6 to ground. Record the results.



005346

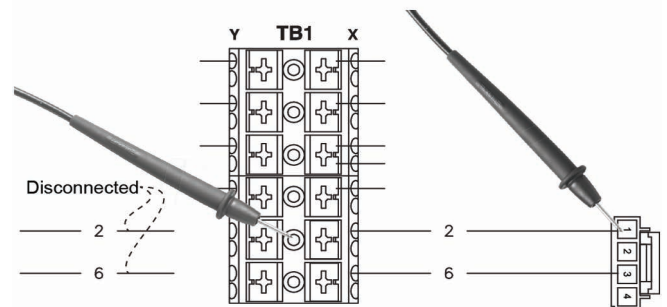
Figure 2-67. Test TB1 Wire 2 Test Port to Ground



005347

Figure 2-68. Test TB1 Wire 6 Test Port to Ground

- a. If low ohms or low K ohms are measured to ground, the winding is shorted to ground. Replace the stator.
 - b. If INFINITY is measured to ground, go to the next step.
5. Reconnect the control panel Wires 2 and 6 to the TB1 terminal block (WAGO block) and disconnect Wires 2 and 6 on the WAGO block that come from the stator.
 6. Connect one meter test lead to Wire 2 at PZ-1 Pin 1 at the back of the control panel. Connect the other meter test lead to TB1 Wire 2. Measure and record the resistance indicated.



005348

Figure 2-69. Test TB1 Wire 2 Test Port to J-connector

- a. If the DMM indicated CONTINUITY, proceed to Step 7.
 - b. If the DMM indicated INFINITY or a high resistance, repair or replace the wire between Wire 2 on the back of the control panel and the TB1 Wire 2 connections.
7. Connect one meter test lead to Wire 6 at PZ-1 Pin 3 at the harness connections to the control panel. Connect the other meter test lead to TB1 Wire 6. Measure and record the resistance indicated.
 - a. If the DMM indicated CONTINUITY, refer to flow chart.

- b. If the DMM indicated INFINITY or a high resistance, repair or replace the wire between Wire 6 at the harness connections to the control panel and the TB1 Wire 6 connections.
- 8. Reconnect control panel Wires 2 and 6 to the TB1 terminal block (WAGO block).

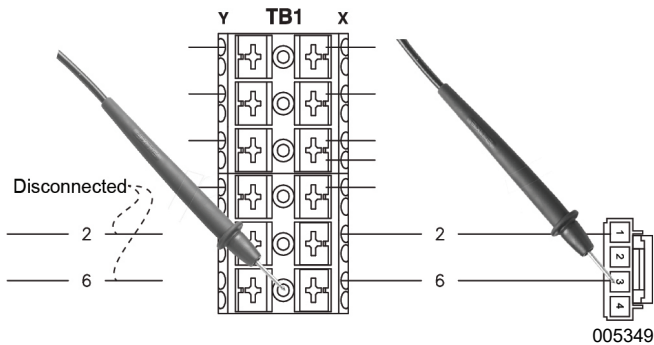


Figure 2-70. Test TB1 Wire 6 Test Port to J-connector

Test 5 – Test AC Sensing Circuit

General Theory

The AC sensing circuit serves to provide a reference of stator output voltage at the main circuit breaker. The regulator reacts to the change in AC sensing voltage by increasing DC field excitation if voltage goes low, and

decreasing DC field excitation if output is too high. If the regulator does not receive this voltage, output at the breaker will be minimal.

Procedure

1. Set a digital multimeter (DMM) to measure resistance.
2. Connect one meter test lead to Wires S1/S2 (1-Phase) or Wires S1/S2/S3 (3-Phase) at the MLCB and the other meter test lead to the appropriate AC sensing input to the control board. Measure and record the resistance indicated.
 - a. If the DMM indicated CONTINUITY, proceed to Step 3.
 - b. If the DMM indicated INFINITY on any sensing lead, repair or replace the wire between MLCB and the control board.
3. Connect one meter test lead to Wire 00 at the neutral bar and the other meter test lead to neutral sensing input PZ8 Pin 4. Measure and record the resistance indicated.
 - a. If the DMM indicated CONTINUITY, contact Technical Support.
 - b. If the DMM indicated INFINITY on PZ8 Pin 4, repair or replace the wire between neutral bar and the control board.

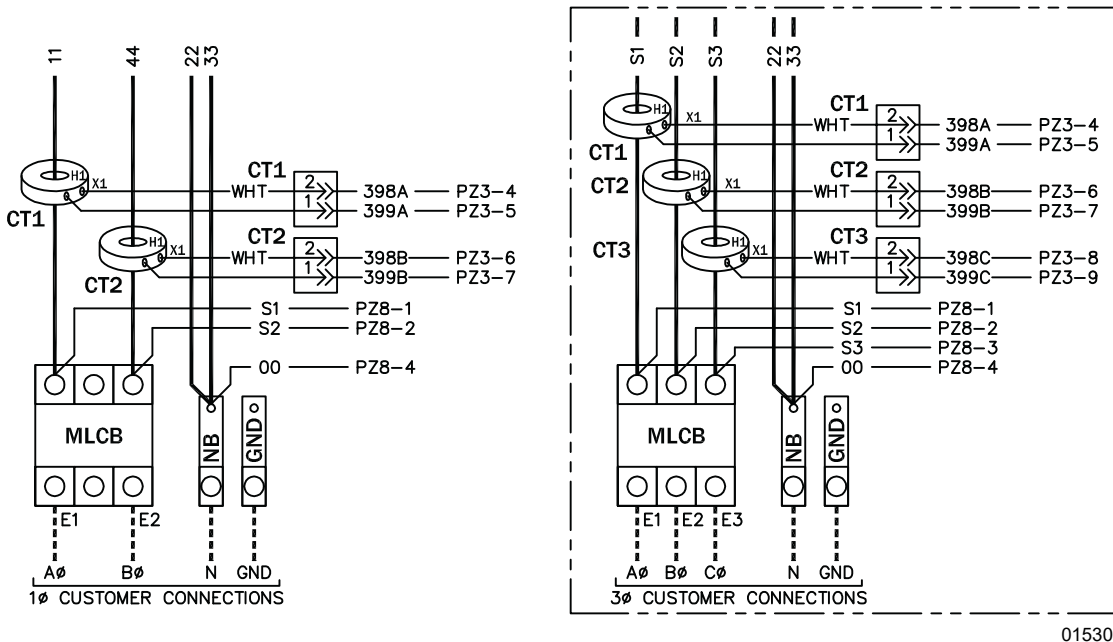


Figure 2-71. Brushless AC Connections

Test 6 – Test Regulator Output

General Theory

An electrical connection to the rotor is required in order for the regulator circuit to regulate DC field excitation voltage to the rotor. This procedure will test the integrity of the wire between the TB1 terminal block and the controller.

Procedure

1. Locate and disconnect the PZ1 connector from the controller that contains Wire 1 and Wire 4.
2. Set a digital multimeter (DMM) to measure resistance.
3. Connect one meter test lead to Wire 4 and the other meter test lead to Wire 1 of the Harness. Measure and record the resistance indicated.

Results

1. If the DMM indicated the rotor resistance indicated in Section 1.1 [Rotor And Stator Resistance Tables](#), replace the controller.
2. If the DMM indicated INFINITY or an unexpected resistance, check Wire 1 and Wire 4 individually between the connector and TB1 and repair as needed.

Test 7 – Test Stator Assembly

General Theory

A digital multimeter (DMM) can be used to test the stator windings for the following faults:

- An open circuit condition
- A “short-to-ground” condition
- A short circuit between windings

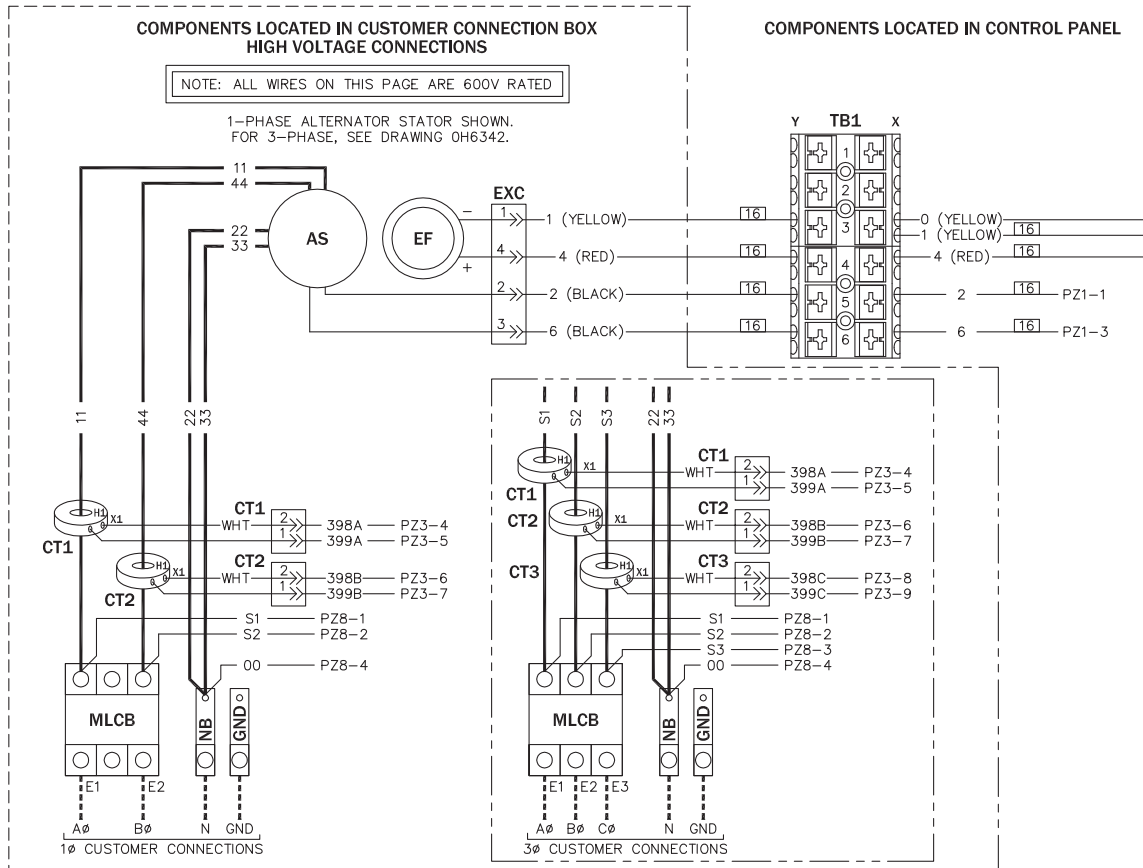
NOTE: The resistance of stator windings is very low. Some meters will not read such a low resistance, and will simply indicate CONTINUITY. A high quality, digital type meter capable of reading very low resistances is recommended.

NOTE: Some wire numbers may be different than those illustrated or described in the test. Refer to the appropriate alternator connection diagram of the unit being serviced.

Testing 1-Phase Stators

1. Open the main line circuit breaker.
2. Disconnect stator leads 22 and 33 from the 00 neutral blocks.
3. Disconnect the appropriate connector containing the sensing wires from the panel.

NOTE: Verify wires are isolated and not touching any components.



015306

Figure 2-72. 1-Phase and 3-Phase Stator and DPE Windings

4. Set DMM to measure resistance between the windings
 - a. Connect one meter test lead to stator lead 11 and connect the other meter test lead to stator lead 22. Measure and record resistance.
 - b. Connect one meter test lead to stator lead 44 and connect the other meter test lead to stator lead 33. Measure and record resistance.
 - c. Connect one meter test lead to stator lead 2 at TB1 of the spring loaded interconnection block and connect the other meter test lead to stator lead 6 at TB1 of the spring loaded interconnection block. Measure and record resistance.
 - d. Refer to chart in the front of this manual for correct resistance readings for your particular stator. If reading is INFINITY or a high ohm reading, then an open is possible across that winding.

NOTE: If the DPE winding is open it can be temporarily bypassed by connecting stator lead Wire 5 in place of Wire 6 on TB1, but the stator will need to be replaced.

5. Set DMM to a high resistance scale to check for a short to ground.

NOTE: Most multimeters will need to be taken out of the auto scaling feature and set to the manual K (1000) ohm scale.

- a. Connect one meter test lead to stator lead 11 and connect the other meter test lead to a clean frame ground. INFINITY should be measured.
 - (1) If CONTINUITY is measured, disconnect sensing Wire 11 from the MLCB that runs to TB1 and see if the short is still in stator lead Wire 11 or is it located in sensing Wire 11.
- b. Connect one meter test lead to stator lead 44 and connect the other meter test lead to a clean frame ground. INFINITY should be measured.
 - (1) If CONTINUITY is measured, disconnect sensing Wire 44 from the MLCB that runs to TB1 and see if the short is still in stator lead Wire 44 or is it located in sensing Wire 44.
- c. Connect one meter test lead to stator lead 2 at TB1 and connect the other meter test lead to a clean frame ground. INFINITY should be measured.
- d. Connect one meter test lead to stator lead 11 and connect other meter test lead to stator lead 44, INFINITY should be measured.
- e. Connect one meter test lead to stator lead 11 and connect other meter test lead to Wire 2 of TB1. INFINITY should be measured.
- f. Connect one meter test lead to stator lead 44

and connect other meter test lead to Wire 2 of TB1. INFINITY should be measured.

Stator lead 11 to Wire 2 of TB1
Stator lead 44 to Wire 2 of TB1

- g. If CONTINUITY is measured between any two points, then there is a short between the main AC winding and the DPE winding.

Testing 3-Phase Stators

1. Open the main line circuit breaker.
2. Disconnect all neutral wires from the neutral block.
3. Disconnect the appropriate connector containing the sensing wires from the control panel.

NOTE: Verify wires are isolated and not touching any components.

4. Set DMM to measure resistance between the windings.
 - a. Connect one meter test lead to stator lead S1 and connect the other meter test lead to stator lead to S4. Measure and record the resistance.
 - b. Repeat step 4a between the following points.

Stator lead S6 and stator lead S3
Stator lead S5 to stator lead S2
Wire 2 of TB1 and Wire 6 of TB1

- c. Refer to chart in the front of this manual for correct resistance readings for your particular stator. If reading is INFINITY or a high ohm reading, then an open is possible across that winding.
5. Set DMM to a high resistance scale to check for a short to ground.
 - a. Connect one meter test lead to stator lead S1 and connect the other meter test lead to a clean frame ground. INFINITY should be measured.
 - (1) If CONTINUITY is measured, disconnect sensing Wire 11 from the MLCB that runs to TB1 and see if the short is still in stator lead S1 or is it located in sensing Wire 11.
 - b. Connect one meter test lead to stator lead S2 and connect the other meter test lead to a clean frame ground. INFINITY should be measured.
 - c. Connect one meter test lead to stator lead S3 and connect the other meter test lead to a clean frame ground. INFINITY should be measured.
 - (1) If CONTINUITY is measured, disconnect sensing Wire 44 from the MLCB that runs to

TB1 and see if the short is still in stator lead Wire S3 or is it located in sensing Wire 44.

- d. If CONTINUITY is measured then a short exists to ground inside the stator.
6. Set DMM to a high resistance scale to check for a short between the windings.

NOTE: Most multimeters will need to be taken out of the auto scaling feature and set to the manual K ohm scale.

1. Connect one meter test lead to stator lead S1 and connect the other meter test lead to S2. INFINITY should be measured.
2. Repeat step (1) between the following points:

Stator lead S2 and stator lead S3
Stator lead S1 and stator lead S3
Wire 2 of TB1 and stator lead S1
Wire 2 of TB1 and stator lead S6
Wire 2 of TB1 and stator lead S5

NOTE: Refer to [General Troubleshooting Guidelines](#) for proper procedures in testing connector plugs and incoming wires.

3. For units with 208, 220, or 240 voltages, proceed to Step 8. For units with 400 or 480 voltages, proceed to Step 9.
4. Disconnect Wire 11 (S1) and Wire 44 (S2) from the main breaker (sensing wires to TB1).
 - a. Disconnect the appropriate connector containing the sensing wires from the control panel.
 - b. Set DMM to measure resistance.
 - c. Connect one meter test lead to sensing Wire 11 that was disconnected in step 7 and connect the other meter test lead to Wire 11 of TB1. CONTINUITY should be measured, if INFINITY is measured repair or replace wire between main breaker and Wire 11 of TB1.
 - d. Connect one meter test lead to sensing Wire 44 that was disconnected in step 7 and connect the other meter test lead to Wire 44 of TB1. CONTINUITY should be measured. If INFINITY is measured, repair or replace wire between main breaker and Wire 44 of TB1.
5. Disconnect Wire S15 and Wire S16 from the TB1 terminal block.
 - a. Set DMM to measure resistance ().
 - b. Connect one meter test lead to sensing Wire S15 and the other meter lead to disconnect stator lead 00. CONTINUITY should be measured. If INFINITY is measured, repair or replace Wire S15. If no damage is visible on

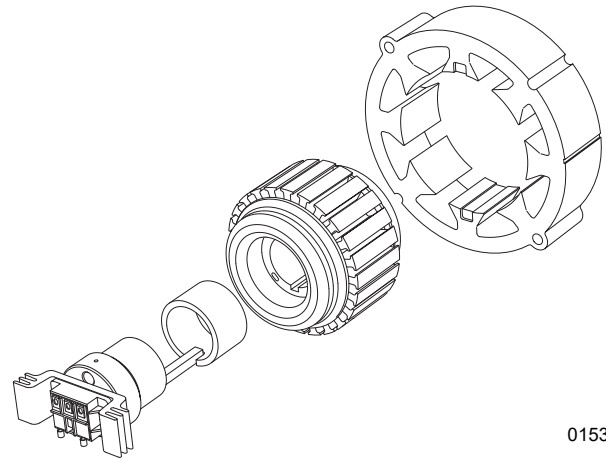
Wire S15, replace stator.

- c. Connect one meter test lead to sensing Wire S16 and the other meter lead to disconnect stator lead 00. CONTINUITY should be measured. If INFINITY is measured, repair or replace Wire S16. If no damage is visible on Wire S16, replace stator.

Test 8 – Test Brushless Exciter Field

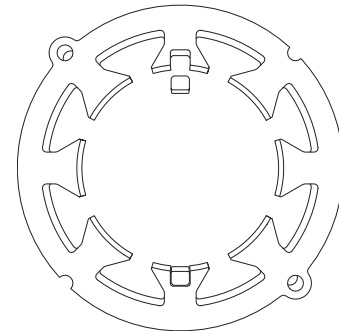
General Theory

Brushless alternators use an exciter assembly to create a magnetic field in the main rotor. This test procedure is for testing the connection to the exciter field.



015307

Figure 2-73. Brushless Exciter



015308

Figure 2-74. Brushless Exciter Field

Procedure

1. Set digital multimeter (DMM) to measure resistance.
2. Disconnect the Wires 1 and 4 from TB1.
3. Connect one meter test lead to Wire 1 and the other meter test lead to Wire 4. Measure and record the resistance indicated.
4. Connect one meter test lead to clean frame ground. Connect the other lead to Wire 4.
5. Connect one meter test lead to clean frame ground. Connect the other lead to Wire 1.

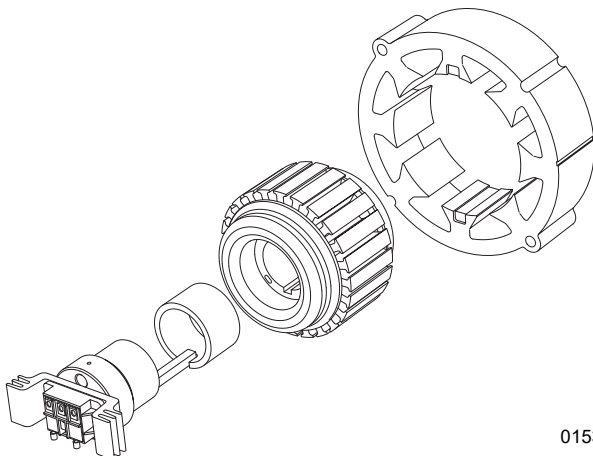
Results

- If the DMM indicated the resistance indicated in Section 1.1 **Rotor And Stator Resistance Tables**, continue testing.
- If the DMM indicated INFINITY or a high resistance, check and verify connection EXC. If connections are correct and tight, replace exciter field.
- If DMM indicated resistance in Steps 4 or 5 replace the exciter field.

Test 9 – Test Brushless Exciter Armature

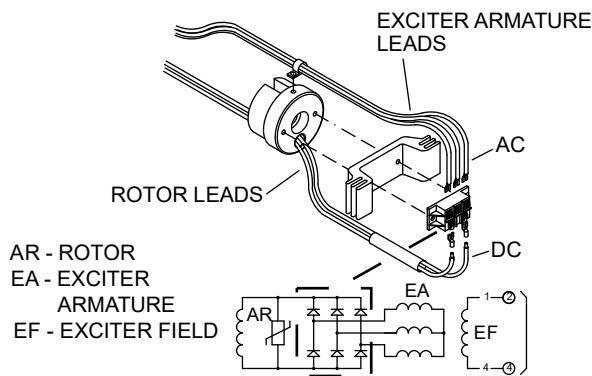
General Theory

The exciter armature is connected directly to the main rotor. The armature has three windings connected in a Y configuration. The armature provides AC voltage to the rotating bridge rectifier where it is rectified into DC voltage and passed on to the main rotor assembly. This test only checks the integrity of the windings.



015307

Figure 2-75. Brushless Exciter



003199

Figure 2-76. Rotating Bridge Rectifier

Procedure

- Disconnect all three wires from the rotating bridge rectifier.

- Set a digital multimeter (DMM) to measure resistance.
- Connect one meter test lead to one wire and the other meter test lead to either of the other wires.

NOTE: Wires will not be marked with any identification and resistance values of a good armature are consistent between each winding.

- Repeat Step 3 until each winding has been tested against the other two windings.
- Connect one meter test lead to the body of the exciter armature and the other meter lead to one of the armature wires.
- Repeat Step 5 until each winding has been tested against the other two windings.

Results

- If the DMM indicated the resistance values indicated in DMM indicated the resistance indicated in Section 1.1 **Rotor And Stator Resistance Tables**, refer to the flow chart.
- If the DMM indicated INFINITY or high resistance, replace exciter armature.
- If DMM indicated resistance in Steps 5 or 6, replace the armature.

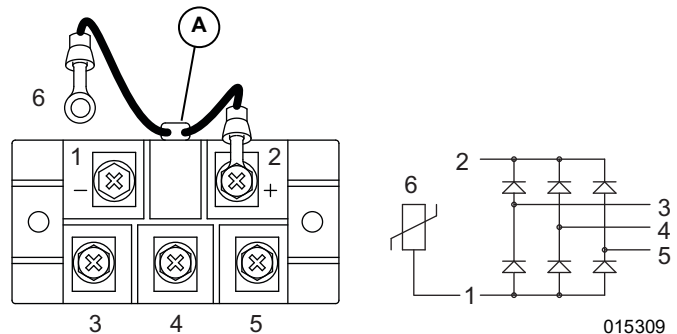
Test 10 – Test Brushless Rectifier Assembly

General Theory

The rotating bridge rectifier rectifies AC voltage from the exciter armature and provides the required DC field excitation voltage to the main rotor.

Procedure

- See **Figure 2-77**. Disconnect all wires from the rotating bridge rectifier and from terminal 6 of the MOV (A) connected across terminals 1 and 2.



015309

Figure 2-77. Bridge Rectifier Test Points

- Set a digital multimeter (DMM) to diode function.
- Connect meter test leads according to **Table 2-1** and record the results indicated in Step 3 results.
- Set DMM to measure resistance.

- Connect one meter test lead to point 6 and the other meter test lead to point 2. Measure and record the results indicated in Step 5 results.

Results

- If the DMM indicated the expected results given in [Table 2-1](#), refer to the flow chart.
- If the DMM indicated INFINITY or an unexpected resistance, replace rotating rectifier assembly.

Table 2-1. Test 22 Results			
RED	BLACK	EXPECTED	RESULTS
STEP 3—ROTATING BRIDGE RECTIFIER TEST			
1	3	0.4–0.5 VDC	
1	4	0.4–0.5 VDC	
1	5	0.4–0.5 VDC	
2	3	OPEN	
2	4	OPEN	
2	5	OPEN	
3	1	OPEN	
4	1	OPEN	
5	1	OPEN	
3	2	0.4–0.5 VDC	
4	2	0.4–0.5 VDC	
5	2	0.4–0.5 VDC	
STEP 5—MOV TEST			
6	2	INFINITY	

Test 11 – Test Brushless Rotor Assembly

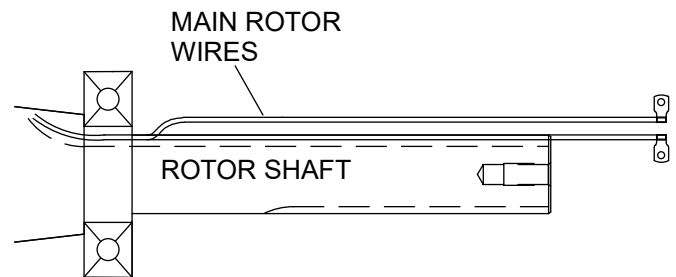
General Theory

The main rotor assembly is connected to the rotating rectifier assembly where it receives DC field excitation voltage to create the magnetic field required to create the desired output from the stator.

Procedure

- Disconnect the rotor wires from the rotating bridge rectifier.
- Set digital multimeter (DMM) to measure resistance.
- Connect one meter test lead to one wire and the other meter test lead to the other. Measure and record the resistance.
- Continue to have one meter test lead connected to the rotor and the other meter test lead to a clean rotor shaft. Measure and record the resistance.

- Visually inspect the rotor wires along the channel of the main rotor for any cracks or breaks in the wire. Record findings as needed.



003201

Figure 2-78. Brushless Rotor Wires

Results

- If the DMM indicated the resistance shown in the [Rotor And Stator Resistance Tables](#), refer to the flow chart.
- If the DMM indicated INFINITY, low, or high resistance, replace main rotor assembly.
- If the main rotor wires have any cracks or breaks in the wire, attempt repair or replace main rotor assembly.

Test 12 – Test for an Overload Condition

General Theory

An “overload” condition is one in which the generator rated wattage/amperage capacity has been exceeded. To test for an overload condition on an installed unit, the best method is to use an ammeter.

Procedure

Use a clamp-on ammeter to measure load current draw, with the generator running and all normal electrical loads turned on.

Results

- If the unit is overloaded, reduce loads to the unit’s rated capacity.
- If unit is not overloaded, but rpm and frequency drop excessively when loads are applied, refer to [Problem 10 –Unit Starts Hard and Runs Rough / Lacks Power](#).

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Section 3.1 Controller Identification

Introduction

Information in this section is provided to familiarize the reader with the various components that make up the DC control system on units having a liquid-cooled engine. These components may be divided into four broad categories:

- Generator customer connection box components
- Control panel components
- Engine mounted components
- Engine protective devices

Customer Connection Box

Description

The customer connection box includes:

- Quick disconnect blocks TB1, TB2, and TB3
- Mounting location for control panel
- High and low voltage plugs and receptacles
- Flash circuit and fly back diode assemblies

Quick Disconnect Blocks

See [Figure 3-79](#). Quick disconnect blocks provide a convenient connection point for AC and DC control system wiring. Terminals, associated wires, and their functions are listed in [Table 3-2](#).

Pin #	Wire #	Function
TB1-1		
TB1-2		
TB1-3	1	(-) Side of DC to rotor from AVR
TB1-4	4	(+) Side of DC to rotor from AVR
TB1-5	2	AC excitation to DPE breaker for AVR
TB1-6	6	AC excitation to AVR
TB2-1	N1	Utility from transfer switch
TB2-2	N2	
TB2-3	N3	
TB2-4	NEU	
TB2-5		Fused 120 VAC source for battery charger
TB2-6		
TB3-1	194	Transfer relay
TB3-2	23	Transfer relay coil
TB3-3	183	Remote start option
TB3-4	178	

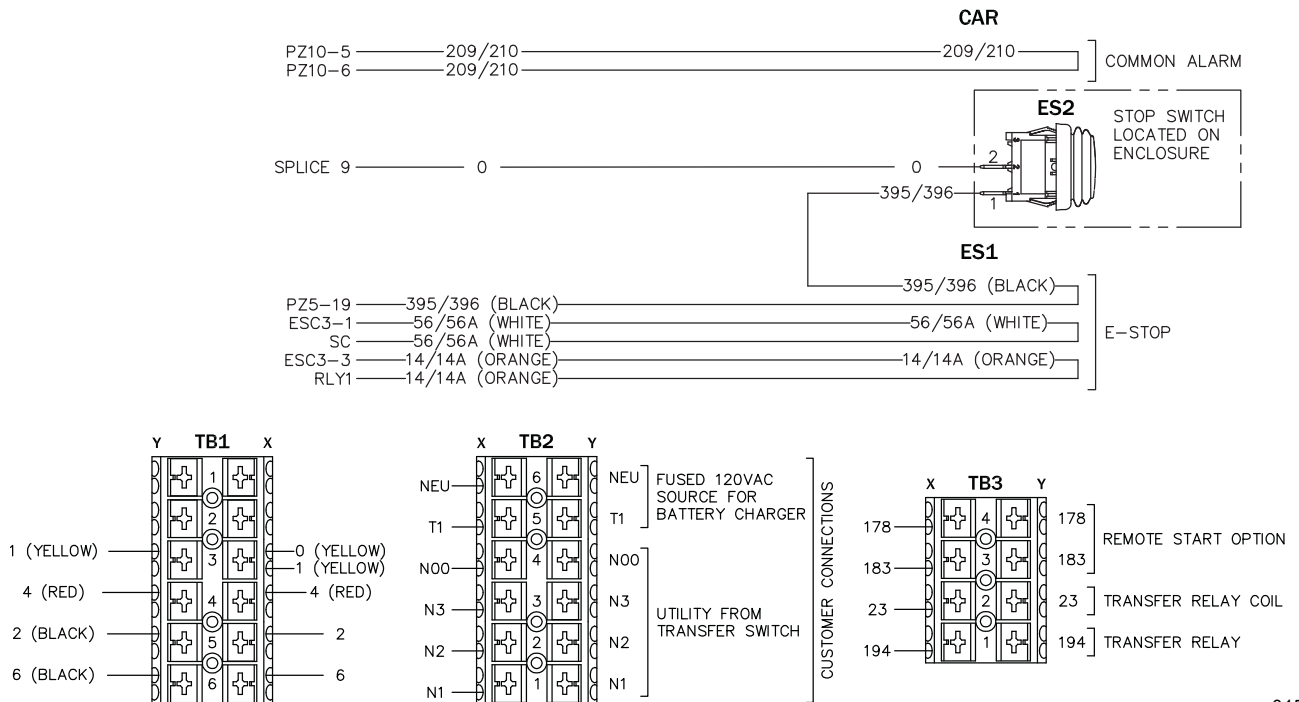


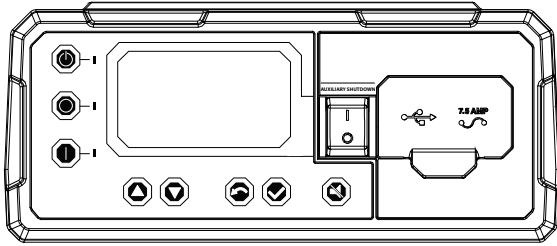
Figure 3-79. Customer Connection Box

015310

Control Panel Components

PZ410 Controller

This solid state circuit board controls all standby electric system operations, including voltage regulation, speed governing, engine cranking, startup, running, automatic transfer, shutdown, and battery charging.

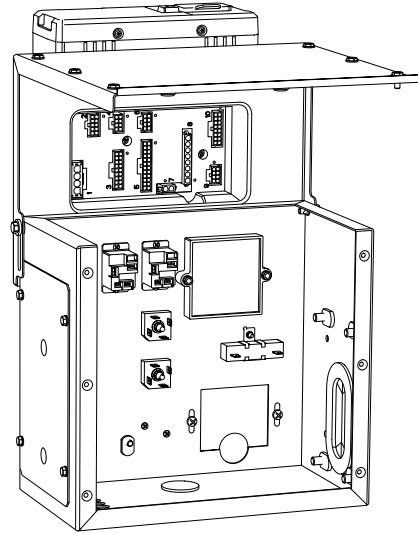


012975

Figure 3-80. PZ410 Controller

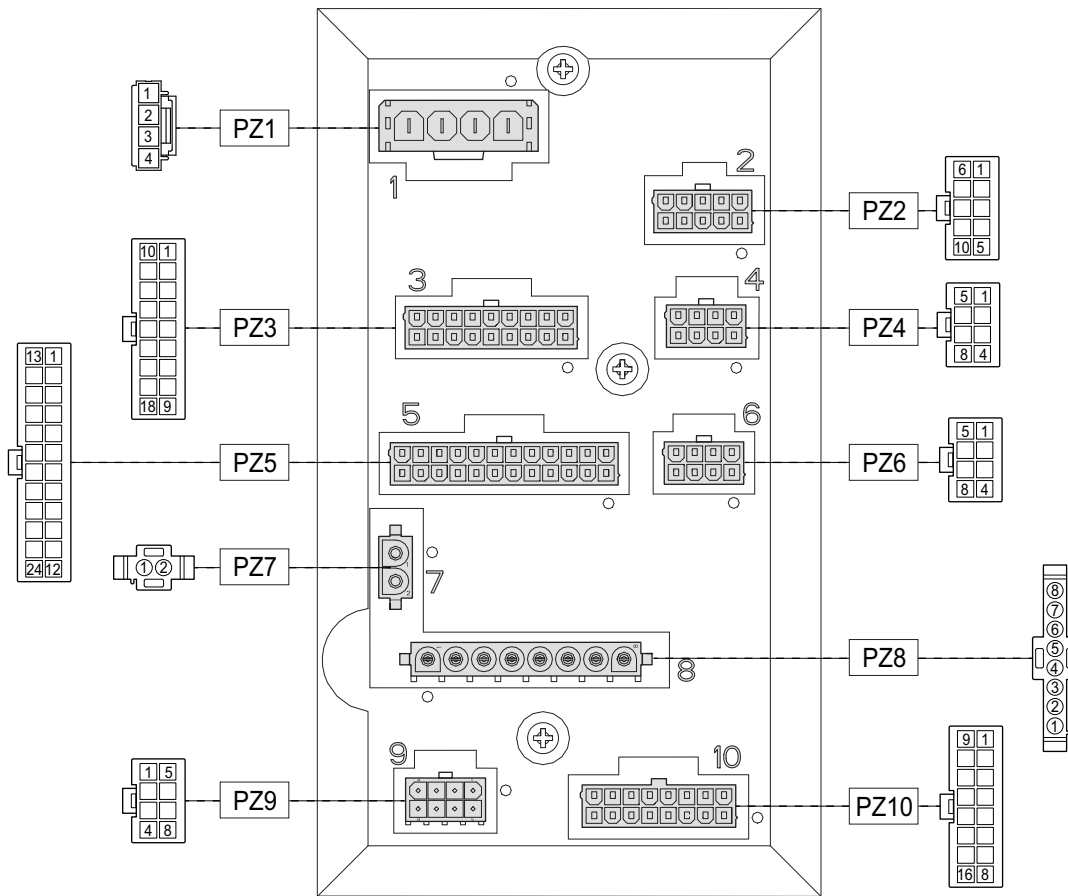
The circuit board also provides automatic engine shutdown in the event of (a) low engine oil pressure, (b) high engine coolant temperature, (c) low coolant level, (d) overspeed, (e) overcrank, (f) under voltage, and (g) rpm sensor loss. See [Engine Protective Devices/](#)

Shutdowns . On occurrence of any one or more of these engine faults, the controller will display the fault via a 2-line digital display.



015311

Figure 3-81. Control Panel



All connectors shown viewed from harness side

015312

Figure 3-82. Controller Pinouts

Connector Pin Descriptions

The various functions handled by the controller are listed in the following charts, along with appropriate connector pin numbers and wire numbers.

J5 Connector 24-pin DIGITAL/ANALOGS			
Pin	Signal	Board Connection Description	Wire #
1	Ruptured Tank	5 V pullup	567
2	2-wire (ret)	GND	0
3	2-wire Start(1)	5 V pullup (NO)	183
4	2-wire Start(2)	5 V pullup (NC)	183A
5	Xfer Position1	5 V pullup (GEN)	525
6	Xfer Position2	5 V pullup (UTILITY)	524
7	Theft	5 V pullup (door closed pulled to GND)	A1
8	Extern Charger	5 V pullup (ext charger pulled to GND)	BC1
9	TriclopsYEL	Open collector with 240 Ω resistor	819
10	TriclopsGRN	Open collector with 240 Ω resistor	817
11	TriclopsRED	Open collector with 240 Ω resistor	818
12	Triclops+5V	+5 V for Triclops with 50 mA fuse	820
13	DualFuel1/Low Fuel Lvl	NG/LO_FUEL (open drain)	502
14	DualFuel2/High Fuel Lvl	LP/HI_FUEL (open drain)	730
15	Oil Temp(analog)	3.3 V pullup via 499 Ω resistor	523
16	Oil Level(analog)	3.3 V pullup via 499 Ω resistor	–
17	Ext Charger Current	voltage from external charger	803
18	SYSTEM24V	5 V pullup	–
19	Rocker In (Auxiliary Shutdown)	5 V pullup on switch terminal	R15
20	Rocker Loop	switch dry contact	15
21	Rocker Loop	switch dry contact	15
22	External-ChargerFail	5 V pullup	505
23	CoolantLvl(+)	switched analog input	573V
24	CoolantLvl(-)	switched analog input	573R

J3 Connector 18-pin CAN/CURRENT/ANALOGS			
Pin	Signal	Board Connection Description	Wire #
1	Can-HI	120 Ω between CAN HI & CAN LO	743
2	Can-LO	120 Ω between CAN HI & CAN LO	744
3	Can-Shield	–	SHLD
4	CurrentA(+)	–	398A
5	CurrentA(-)	–	399A
6	CurrentB(+)	–	398B
7	CurrentB(-)	–	399B
8	CurrentC(+)	–	398C
9	CurrentC(-)	–	399C
10	Coolant-Temp(analog)	max input 3.3 V	68V
11	Coolant-Temp(ret)	–	68R
12	Oil Pressure(+5V)	Fused for 50 mA	69V
13	Oil Pressure(analog)	max input 5.0 V	69S
14	Oil Pressure(ret)	–	69R
15	FuelPressure/Level(+5)	+5 V through 499 Ω resistor	590
16	FuelPressure/Level(signal)	Feedback from pot or switch	575
17	FuelPressure/Level(ret)	–	591
18	Spare DigIn/Chicago Code	5 V pullup	735

J9 Connector 8-pin USER			
Pin	Signal	Board Connection Description	Wire #
1	E-Stop 12V	Dry contact	–
2	E-Stop In	Dry contact	–
3	KeypressPresent(in)	5 V pullup	–
4	KeypressPresent(gnd)	–	–
5	+12V Alarm	–	–
6	Audible Alarm	open drain	–
7	Keypress(1)	5 V pullup	–
8	Keypress(2)	5 V pullup	–

J10 Connector 16-pin POWER/RELAYS			
Pin	Signal	Board Connection Description	Wire #
1	+12VBatt	on board 7.5 Amp fuse	SPLICE 4
2	+12VBatt	on board 7.5 Amp fuse	SPLICE 4
3	+VBatt	externally fuse for 10 A	SPLICE 11
4	GND	–	GND
5	Alm Relay	Alarm relay contact	SPLICE 2
6	Alm Relay	Alarm relay contact	AHC-1
7	Start Relay	Relay contact connected to +VBATT	C01-4
8	Fuel Relay	Relay contact connected to +VBATT	CO1-6
9	Enrichment/Pre-heat	Relay contact connected to +VBATT, 5 A fuse	150
10	Analog Out(signal)	–	–
11	Analog Out(ret)	–	–
12	ECU On	Relay contact connected to +VBATT, 5 A fuse	395A
13	Spare DigOut/ Fan Out	open drain	244
14	Xfer(12V)	–	194
15	Xfer Drive/ AMF(1)	–	23A
16	AMF(2)	Relay contact pulls to GND	23B

J2 Connector 10-pin THROTTLE			
Pin	Signal	Board Connection Description	Wire #
1	Position Signal	analog input	766
2	Position 3V3	filtered +3.3 V	765
3	Position Ret	filtered GND	767
4	–	–	–
5	Speed(12V)	+12 V supply	79V
6	–	–	–
7	Throttle PWM	open drain	769
8	–	–	–
9	Speed(ret)	speed input GND	SHLD
10	Speed(signal)	speed input signal	79S

J6 Connector 8-pin COMMS1			
Pin	Signal	Board Connection Description	Wire #
1	GND (filtered comms)	–	–
2	GND	–	SHLD
3	+12VBATT	–	–
4	GND (filtered comms)	–	SHLD
5	RS4851_N	Standard RS-485	391
6	RS4851_P	Standard RS-485	390
7	RS232-RX2	Standard RS-232	–
8	RS232-TX2	Standard RS-232	–

J4 Connector 8-pin COMMS2			
Pin	Signal	Board Connection Description	Wire #
1	GND (filtered comms)	–	–
2	GND	–	SHLD
3	+12VBATT	–	–
4	GND (filtered comms)	–	SHLD
5	RS4852_N	Standard RS-485	391B
6	RS4852_P	Standard RS-485	390B
7	RS232-RX4	Standard RS-232	387
8	RS232-TX4	Standard RS-232	388

J1 Connector 4-pin AVR			
Pin	Signal	Board Connection Description	Wire #
1	DPE1	–	2
2	FIELD(-)	–	1
3	DPE2	–	6
4	FIELD(+)	–	4

J11 Connector 6-pin USB

Pin	Signal	Board Connection Description	Wire #
1	VBUS	Switch +5 V VBUS	–
2	USB D(-)	–	–
3	USB D(+)	–	–
4	GND	–	–
5	Shield	–	–
6	Shield	–	–

J8 Connector 8-pin VOLTAGES

Pin	Signal	Board Connection Description	Wire #
1	GEN A	–	S1
2	GEN B	–	S2
3	GEN C	–	S3
4	GEN Neutral	–	0
5	UTIL Neutral	–	T00
6	UTIL A	–	T1
7	UTIL B	–	T2
8	UTIL C	–	T3

J7 Connector 2-pin CHARGER

Pin	Signal	Board Connection Description	Wire #
1	HOT	Do not connect if ext charger used	L1
2	Neutral	Do not connect if ext charger used	NEU

Digital Outputs

Default Signal Name	Range/Level	Connection
Engine Preheat (Diesel)	Relay Contacts (30 V, 5 A max)	J10-9
Fuel On Relay	Relay Contacts (30 V, 5 A max)	J10-8
Start On Relay	Relay Contacts (30 V, 5 A max)	J10-7
Low Fuel Level	Open Drain (+VBATT, 1.7 A device limited)	J5-13
High Fuel Level	Open Drain (+VBATT, 1.7 A device limited)	J5-14
Audible Alarm	Open Drain (+VBATT, 1.7 A device limited)	J9-6
Alarm On Relay	Relay Contacts (30 V, 5 A max)	J10-5 J10-6
Spare Digital Output	Open Drain (+VBATT, 1.7 A device limited)	J10-13
Engine Control Unit Relay	Relay Contacts (30 V, 5 A max)	J10-12
Utility Transfer Relay	Relay Contacts (30 V, 5 A max)	J10-16
Generator Transfer Relay 1 A Device Limited	Relay Contacts (30 V, 5 A max)	J10-14 J10-15
Throttle Drive (PWM signal)	Open Drain (+VBATT, 1.7 A device limited)	J2-6
Throttle Enable	Open Drain (+VBATT, 1.7 A device limited)	J2-7
AVR Field +	Field+	J1-4
AVR Field -	Field-	J1-2

Analog Outputs

Default Signal Name	Range/Level	Connection
Spare Analog Output	0 to 10 V	J10-10 (signal) J10-11 (return)

Digital Inputs

Default Signal Name	Range/Level	Connection
Coolant Level	0 to 5 V (switched 5 V clock signal)	J5-23 coolant+ J5-24 coolant-

Run Relay (RLY1)

The run relay is energized by Wire 14A and controls Wire 14B. The relay will close its contacts when the control board energizes Wire 14/14A. When these contacts close, it allows voltage to go from Wire 15A to Wire 14B. Wire 14B is the run circuit.

Start Relay (RLY2)

The Ignition relay is energized by Wire 15A and is controlled by Wire 25. The relay will close its contacts when the control board pulls Wire 25 low. When these contacts close, it allows voltage to go from Wire 15A to Wire 25A, energizing the HEI distributor. The ignition system is independently controlled from the run circuit, This allows the ignition to run after the unit has been shut down to purge the fuel system of residual fuel.

Field Boost Circuit

The power for the field boost circuit comes from battery voltage on the run circuit (Wire 14B). This voltage is applied from the run circuit to the diode bridge (the diodes block reverse voltage/current), and then to the resistor, which reduces the battery voltage to a lower value. The flash voltage will typically produce approximately 25% to 50% of unit rated voltage.

Fly Back Diode (DB2)

When any magnetic field collapses a kick back voltage is created. The fly back diode is connected to Wire 1 and Wire 4 and serves to shunt this kick back voltage to ground when the magnetic field collapses. The diode is connected to allow current to be blocked during normal operation and shunt to ground when the polarity reverses during the collapse of the magnetic field.

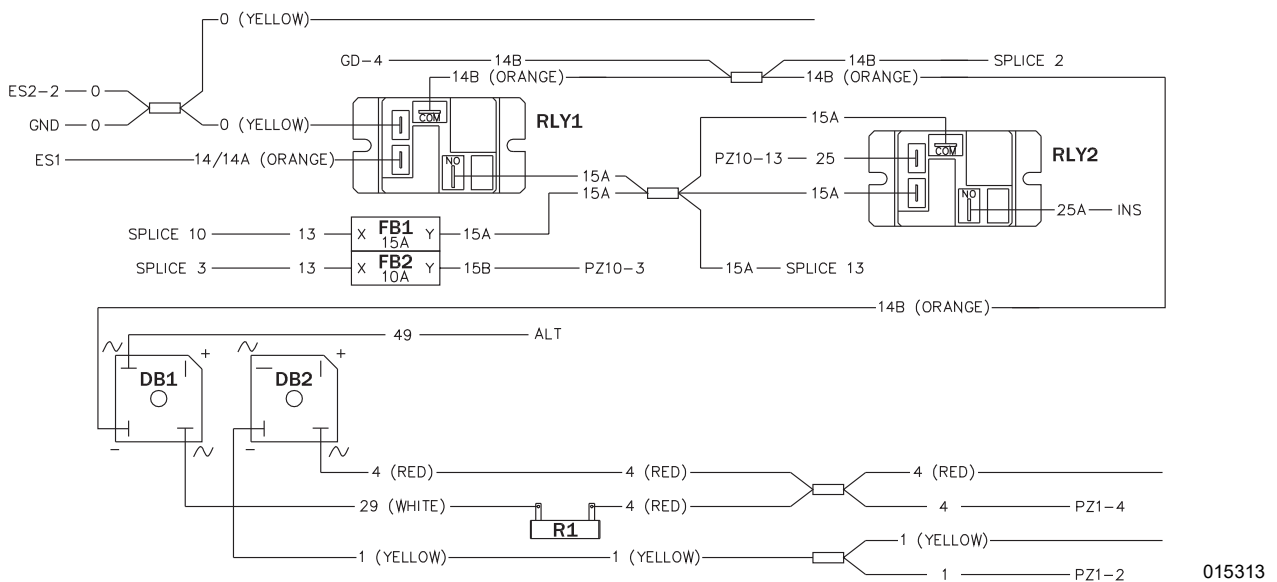


Figure 3-83. Run Relay, Start Relay, and Field Boost Circuits

Governor Control Circuit

The PZ410 controller governor control circuit monitors unit frequency and engine RPM and adjusts the governor to maintain the unit's frequency/RPM set point, as the applied load changes. The internal governor provides a PWM signal to the governor driver (GD). The governor driver will then send a drive signal to change the position of the governor actuator (GA).

Wire 14B is the run wire which powers the governor driver. The PZ410 controller supplies a pulse width modulated (PWM) signal to the governor driver on Wire 769. The governor driver then increases or decreases the voltage applied to the governor actuator on Wire 770 (+) and Wire 771 (-) to move the throttle plate. Wire 766 is the position feedback signal, Wire 765 is a +3.3 VDC supply for the feedback signal and Wire 767 is a filtered ground.

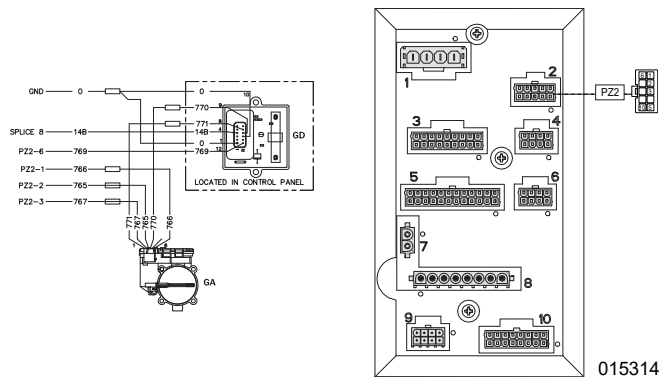


Figure 3-84. Governor Driver and Governor Actuator

Internal Battery Charger (BCH)

See **Figure 3-85**. The charger voltage will adjust based on ambient temperature sensed by the controller.

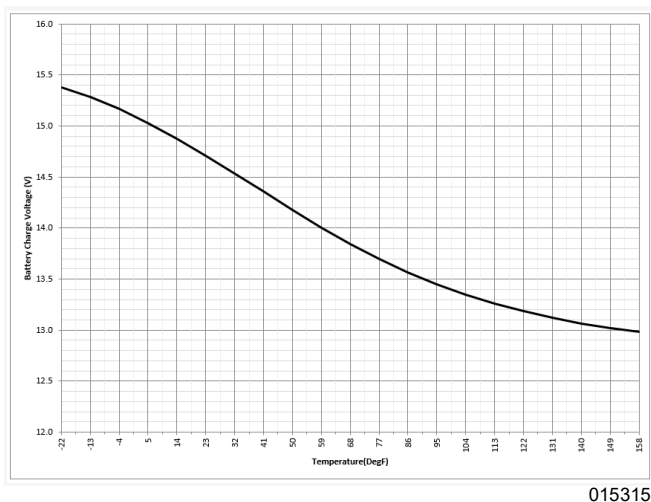


Figure 3-85.

The battery charger is powered from a 120 VAC load connection through a fuse (F3) in the transfer switch. This 120 VAC source must be connected to the generator in order to operate the charger.

During a utility failure, the charger will momentarily be turned off until the generator is connected to the load. During normal operation, the battery charger supplies all the power to the controller.

The internal battery charger begins the charge cycle when battery voltage drops below approximately 12.6V. The charger provides current directly to the battery dependent on temperature, and the battery is charged at the appropriate voltage level. At the end of the charge cycle, battery charge current is measured while the generator is off. If battery charge current at the end of the charge cycle is greater than a pre-set level, a battery problem warning will be displayed. If the battery open-circuit voltage is less than approximately 12.5V, a charger problem warning will be displayed and the charge cycle will restart. The message will self clear if the condition is not present after the next charge cycle completion.

NOTE: The charge cycle is restarted if the engine cranks during the charge cycle.

Charge Period
26 hours

At the end of the charge cycle, the charger does one of two things. If the temperature is less than approximately 40 °F (4 °C), the battery is continuously charged at a voltage of 14.1V (i.e. the charge voltage is changed from

14.6V to 14.1V after the appropriate charge cycle has elapsed). If the temperature is above approximately 40 °F (4 °C), the charger will stop charging the battery.

The battery has a similar role as that found in an automobile application. It does nothing until it either self-discharges below 12.6V, or an engine crank cycle occurs (i.e. such as occurs during the weekly exercise cycle). If either condition occurs the battery charger will begin the charge cycle.

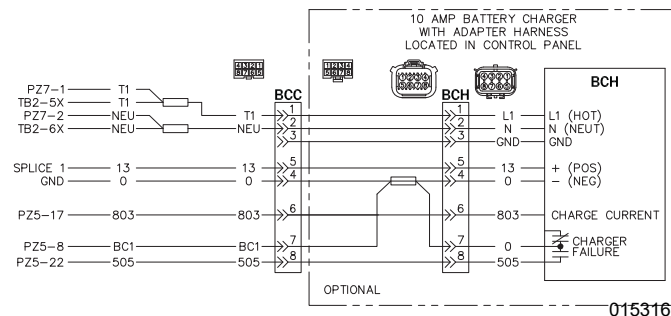


Figure 3-86. Optional External Battery Charger

Common Alarm Relay

The common alarm relay (CAR) provides a set of contacts to drive a customer provided external alarm indication. When the control is powered up, if there are no alarms, the relay contacts will be open. Any alarm (not warning) will trigger the common alarm relay to operate, closing the contacts.

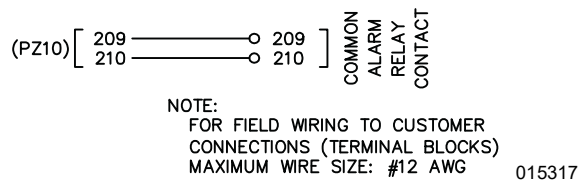


Figure 3-87.

Specifications		
Contact Rating	5A at 250 VAC	5A at 30 VDC

Engine Mounted Components

Engine mounted DC control system components include the following:

- DC charge alternator
- Starter motor and starter contactor
- Magnetic pick-up (MPU)
- Oxygen sensor if equipped (OS)
- Air/fuel solenoid if equipped (AFS)
- Oil pressure sensor (if equipped)

DC Charge Alternator

See **Figure 3-88**. The externally excited belt driven DC charge alternator delivers a charging voltage to the battery during engine operation.

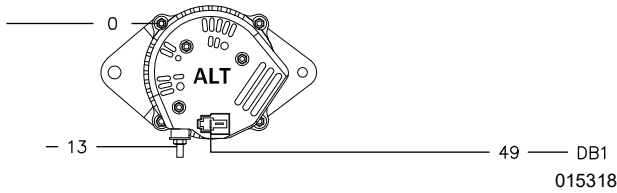


Figure 3-88. Battery Charging System

Charging voltage is regulated and rectified by an internal regulator in the DC charge alternator. Wire 49 from the flash circuit delivers the initial excitation to the alternator field circuit. Without this initial “flash” there will be no output from the alternator. Alternator troubleshooting is limited to verifying proper inputs and outputs of the alternator.

Starter Motor (SM) and Starter Contactor (SC)

During manual or automatic startup, control board action delivers 12 VDC to a starter contactor (SC) coil. When the coil energizes, its contacts close, and battery power is delivered to the starter motor (SM). The starter motor energizes and the engine cranks.

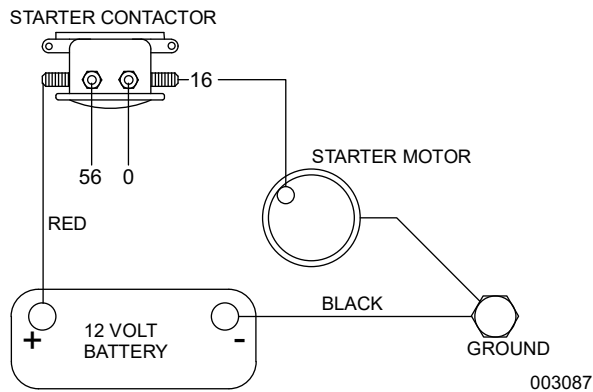


Figure 3-89. Engine Cranking Circuit

Fuel Primer Solenoid (if equipped)

The fuel primer solenoid provides fuel to the mixer during cranking only. The solenoid is energized OPEN to provide fuel to the engine by either the control board energizing or grounding a control wire to the solenoid coil. This is to allow fuel into the engine before the diaphragm in the fuel regulator has a chance to open and will improve generator starting on the first crank attempt. Fuel will not be delivered to the engine if an ignition fault is present.

NOTE: The fuel primer solenoid is controlled by the control panel and will only go active if the ignition system is operational.

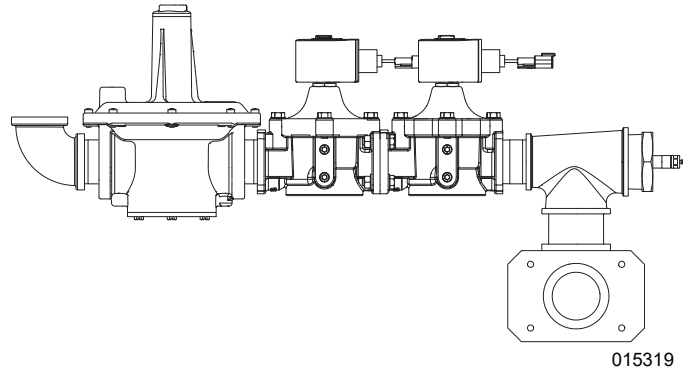


Figure 3-90. Fuel Solenoid (FS)

Magnetic Pick-Up (MPU)

The magnetic pick-up (MPU) is installed on the flywheel housing. As the engine is running, the MPU receives a signal every time a flywheel tooth passes the tip of the pickup. It utilizes this signal for a speed signal to regulate the engine at the desired speed.

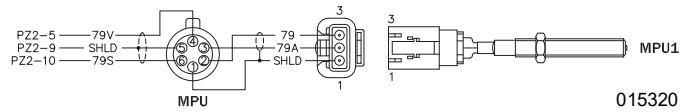


Figure 3-91. Magnetic Pick-Up

Oxygen Sensor (OS) (If equipped)

The oxygen sensor (OS) measures the difference in oxygen levels between the exhaust gas and the external air. The OS generates a voltage determined by the difference between the two levels. The OS output is on Wire 804 and Wire 178.

- A high voltage (~0.6–0.9 V) indicates a fuel rich condition in the exhaust flow (the oxygen content is low).
- A low voltage (~0.1–0.4 V) indicates a fuel lean condition in the exhaust flow (oxygen content is high).

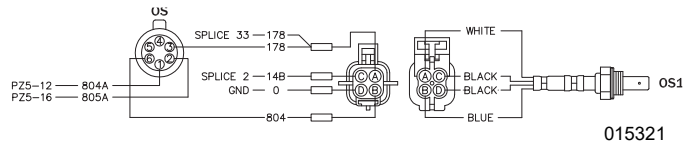


Figure 3-92. Oxygen Sensor

Wire 804 and Wire 178 from the OS connect to the OS signal conditioner. The signal conditioner sends the signal to the PZ410 controller.

Wires 14B and 0 are the OS heater circuit. The heater maintains the temperature of the OS to allow for more consistent resolution.

Air/Fuel Solenoid (AFS) (If equipped)

On emissions enabled units, a 12 VDC PWM signal is applied to the solenoid that will either enrich the mixture or lean the mixture out depending on the input from the oxygen sensor.

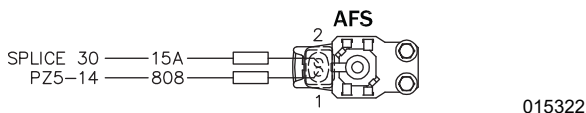


Figure 3-93. Air/Fuel Solenoid

Auxiliary Engine Shutdown Switches

Units can be equipped with auxiliary engine shutdown switches. If installed there will be two switches, wired in series. When the circuit is actuated, it will go from a closed state to an open state. This will shut the unit down and the control panel will announce the shutdown message and error code.

Engine Protective Devices/Shutdowns

Standby electric power generators will often run unattended for long periods of time. Because engine operation will not be monitored, the use of engine protective safety devices is required to prevent engine damage in the event of a problem. Operating parameters include (a) engine oil pressure, (b) engine temperature, (c) engine operating speed, (d) engine cranking and startup, and (e) under and over voltage.

Generator engines mount several engine protective devices. These devices work in conjunction with a control circuit board, to protect the engine against such operating faults as (a) low engine oil pressure, (b) high temperature, (c) overspeed, (d) overcrank, and (e) under and over voltage. On occurrence of any one or more of those operating faults, control board action will effect an engine shutdown.

Low Oil Pressure Switch (LOS)

The low oil pressure switch (LOS) has normally closed contacts which are held open by engine oil pressure during cranking and running conditions. Should engine oil pressure drop below approximately 8–12 psi, the switch contacts will close. The controller will then initiate a 10 second hold-off timer. At the end of 10 seconds, an automatic engine shutdown will occur, and the low oil pressure shutdown message will be displayed.

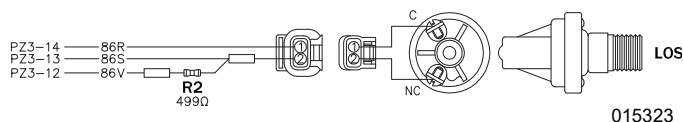


Figure 3-94. Low Oil Pressure Switch

Low Fuel Pressure (If equipped)

The low fuel pressure warning message will turn ON if the fuel supply pressure drops below approximately 5 in. water column (i.e. occurs when the low fuel pressure sensing switch on the fuel regulator opens). This is a non-latched fault (visual warning only) and does not trigger the controller alarm output. Low fuel pressure sensing is active in all generator operating modes (i.e. MANUAL, OFF, and AUTO).

Low Battery Alarm

While running, if the average battery voltage falls below 11.9 volts for one minute, the low battery alarm will be displayed.

High Coolant Temperature Sensor (WTS)

The engine temperature sensor is a variable resistance sensor. At 70 °F (21 °C) the sensor will have a resistance of approximately 2.6 K ohm. As the temperature increases, the resistance decreases. The control board will send a DC voltage signal to the sender. When the voltage drops to near 0 the unit will shut down.

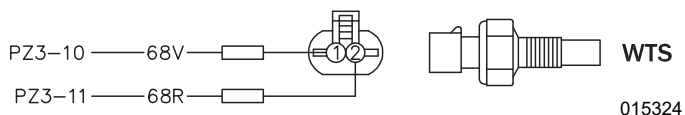


Figure 3-95. High Coolant Temperature Switch Sensor

Low Coolant Level Sensor (WLS)

It is possible the engine coolant level may drop low enough so that the high temperature sensor is no longer immersed in the liquid coolant. If this happens, engine temperatures could increase rapidly but the temperature switch would not sense the high temperature condition and the engine would continue to run. To prevent this occurrence, a low coolant level sensor is provided. The sensor is immersed in cooling system liquid. If coolant level drops below the level of the low coolant level sensor, the engine will shutdown and the low coolant level message will be displayed.

This is a shutdown alarm. The sensor will be continuously monitored. If an error condition is seen for five consecutive seconds, the alarm will be displayed.

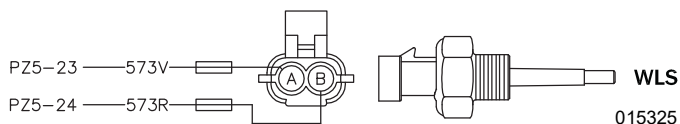


Figure 3-96. Low Coolant Level Switch

Air Temperature Sensor (ATS)

The air temperature sensor (ATS) is used on turbo charged units.

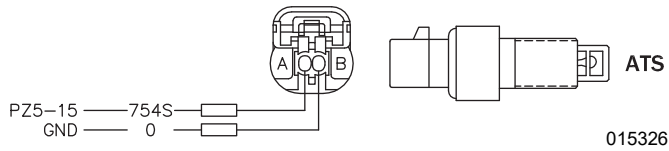


Figure 3-97. Air Temperature Sensor

Overspeed

Warning indicator is measured and calculated by the microprocessor.

Overspeed is defined as +20% of nominal engine speed for three seconds, or +25% immediate.

Nominal engine speed = 60.0 Hz

RPM Sensor Failure Shutdown Alarm

During cranking: If the board does not see a valid rpm signal within four seconds of cranking, it will shut down and lock out on rpm sensor loss.

RPM Signal Failure During Running

During running: If the rpm signal is lost for one full second while the unit is in AUTO, the board will shut the engine down, wait 15 seconds, then crank the engine. It will not crank in MANUAL.

If no rpm signal is detected within the first four seconds of cranking, the control board will shut the engine down and latch out on rpm sensor loss.

If the rpm signal is detected the engine will start and run normally.

If the rpm signal is subsequently lost, the control board will try two more cranks before latching out and flashing the rpm sensor failure message (if it is in AUTO).

Overcrank

If the unit fails to start during a cranking period, it will display the overcrank shutdown alarm. The system will control the cranking cycles as follows:

The first crank cycle is a 16 second crank time followed by a 7 second rest. The next 5 cycles will be 7 seconds of cranking time each followed by a 7 second rest time.

If the unit fails to start by the end of the 6 crank/rest cycles the overcrank shutdown alarm will display and the unit will not attempt to crank until the alarm is reset.

CAN Bus Alarm (If equipped)

Where applicable, if the CAN bus communications link fails to communicate, a "CAN Bus Alarm" will be generated. This only applies to systems with external ignition modules or engine control modules (ECM). The alarm may be generated if:

1. The physical link is broken.
2. The ignition module fails or resets.
3. The controller fails or resets.
4. Having the battery charger's 120 VAC connected without a battery installed.

NOTE: The CAN Bus Alarm will not clear on its own. To clear the alarm, press the ENTER button to acknowledge the alarm. The alarm will clear and if the fault is still present, the alarm will reoccur.

Check Engine (If equipped)

Liquid-cooled units that are equipped with the Generac emission system have a fault annunciation named "Check Engine." In the event that the emissions system is not operating within set parameters the Check Engine message will appear on the display. This message is annunciation only and will not shut the unit down. The Check Engine annunciation has two distinct modes of operation, one for natural gas and the other for vaporous propane.

For natural gas emissions units—If the panel does not see a signal from the O₂ sensor for one minute after the four minute warm up period, the check engine warning will turn on. The warning will not shut the unit down.

For propane emissions units—If the panel does not see a signal from the O₂ sensor for one minute after the four minute warm up period, the check engine warning will turn on. The warning will not shut the unit down. The check engine will also turn on if the panel does not see the output of the O₂ sensor modulating. The warning will not shut the unit down.

Check engine is a self resetting warning and will clear automatically if the condition which caused the warning is cleared.

To manually clear the alarm, start and run the unit in MANUAL four (4) times for six (6) minutes each time. If the unit is clear of fault, the warning will not re-populate. If the warning is still present, the fault condition still exists.

Clearing an Alarm

When the generator is shut down due to a latching alarm, the AUTO-OFF-MANUAL switch must be set to OFF and the ENTER key pressed to unlatch any active fault and clear the corresponding fault alarm message.

Section 3.2 *Operational Analysis*

Introduction

The following schematic diagrams and verbiage show the DC control system in four modes of operation:

- Utility Source Voltage Available, Controller in AUTO
- Utility Failure—Engine Cranking, Controller in AUTO
- Utility Failure, Engine Running and Transfer to Emergency, Controller in AUTO
- Return Of Utility, Engine Cool Down and Engine Shutdown, Controller in AUTO

Utility Source Voltage Available— Controller in AUTO

Positive (+) 12 VDC is supplied from the battery through Wire 13 to the starter motor (SM) and the starter contactor (SC). The starter contactor is not active at this point. Wire 13 also goes to the B+ on the DC – ALT.

NOTE: Fused 120 VAC is supplied from a customer based source and connected to TB2 - T1 (Hot) and NEU (Neutral). It is then directed to the BCH 1 and 2 connector then to the control board.

Positive (+) 12 VDC from the battery charger built into the controller feeds Wire 13. This is back-fed to Wire 13 to the starter contactor (SC), starter motor (SM) and then the battery (BAT). This circuit keeps the battery properly charged.

For RTS transfer switches utility voltage from the transfer switch N1 and N2 is connected to the controller. The controller monitors this voltage to fall below the adjustable voltage dropout. The 2-wire start is ignored in this mode.

For non-RTS and other manufacturer's transfer switches, the controller looks for a 2-wire start signal and ignores the input of N1 and N2. The controller supplies a 5 VDC signal input from Wire 183 and waits for a dry contact closure to the remote start return Wire 178. The dry contact closure is provided by the transfer switch circuitry.

The controller display and menu allow for programming parameters.

Utility Source Voltage Available—Controller in AUTO

LEGEND							
AFS	- AIR FUEL SOLENOID	ES1	- REMOTE EMERGENCY STOP (OPT)	GND	- GROUND CONNECTION	R_	- RESISTOR
ALT	- DC CHARGE ALTERNATOR	ES2	- STOP SWITCH (ON ENCLOSURE)	INS	- IGNITION NOISE SUPPRESSION	RLY_	- RELAY
ATS	- AIR TEMPERATURE SENSOR	ES3	- EMERGENCY STOP (NFPA MODULE)	LFP	- LOW FUEL PRESSURE SWITCH	SC	- STARTER CONTACTOR
BAT	- BATTERY	ESC3	- E-STOP CONNECTOR	LOS	- LOW OIL PRESSURE SWITCH	SM	- STARTER MOTOR
BCC	- BATTERY CHARGER CONNECTOR	ESJ	- E-STOP CONNECTOR JUMPER	MLCB	- MAIN LINE CIRCUIT BREAKER	WLS	- COOLANT LEVEL SENSOR
BCH	- BATTERY CHARGER	F2	- FUSE, RESETTABLE	MPU	- MAGNETIC PICK-UP	WM	- WIFI MODULE
CT_	- CURRENT TRANSFORMER	FB_	- FUSE BLOCK	NB	- NEUTRAL BLOCK	WTS	- COOLANT TEMPERATURE SENSOR
DB_	- DIODE BRIDGE	FS_	- FUEL SOLENOID	OS	- OXYGEN SENSOR		
DIST	- DISTRIBUTOR CAP	GA	- GOVERNOR ACTUATOR	PME	- PERMANENT MAGNET EXCITEP		
DPE	- DISPLACED PHASE EXCITATION	GD	- GOVERNOR DRIVER	PZ_	- POWER ZONE 410 CONNECTOR		

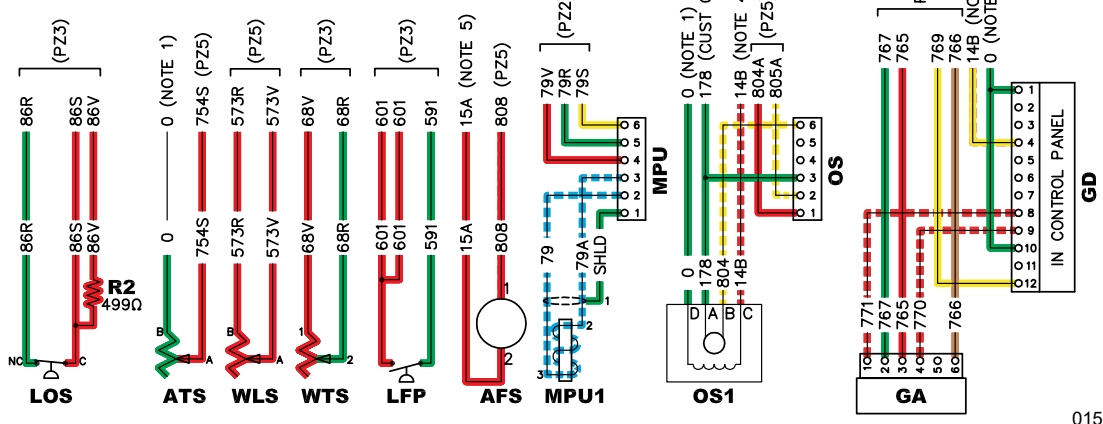
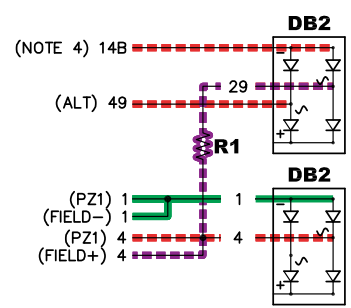
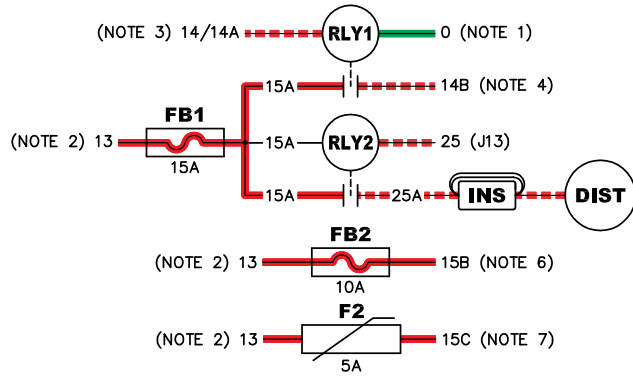
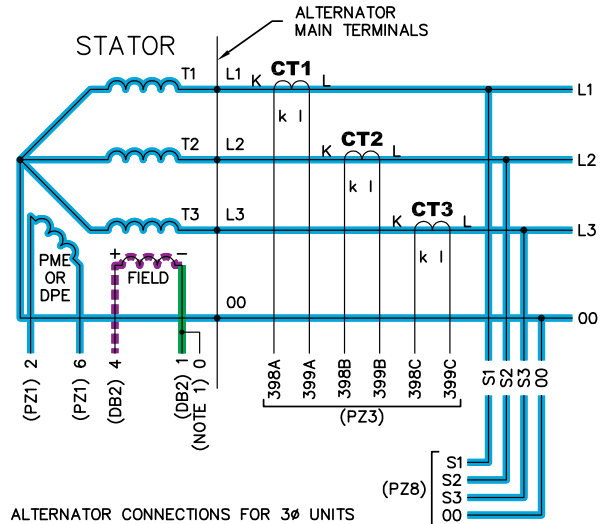
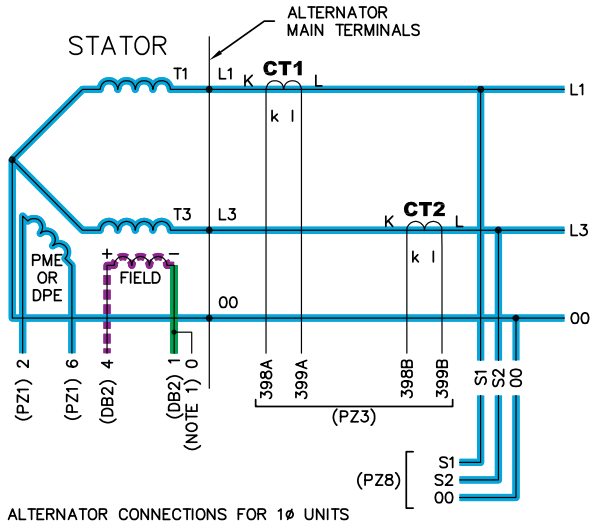


Figure 3-98. Utility Source Voltage Available—Controller in AUTO

015327

Utility Source Voltage Available—Controller in AUTO

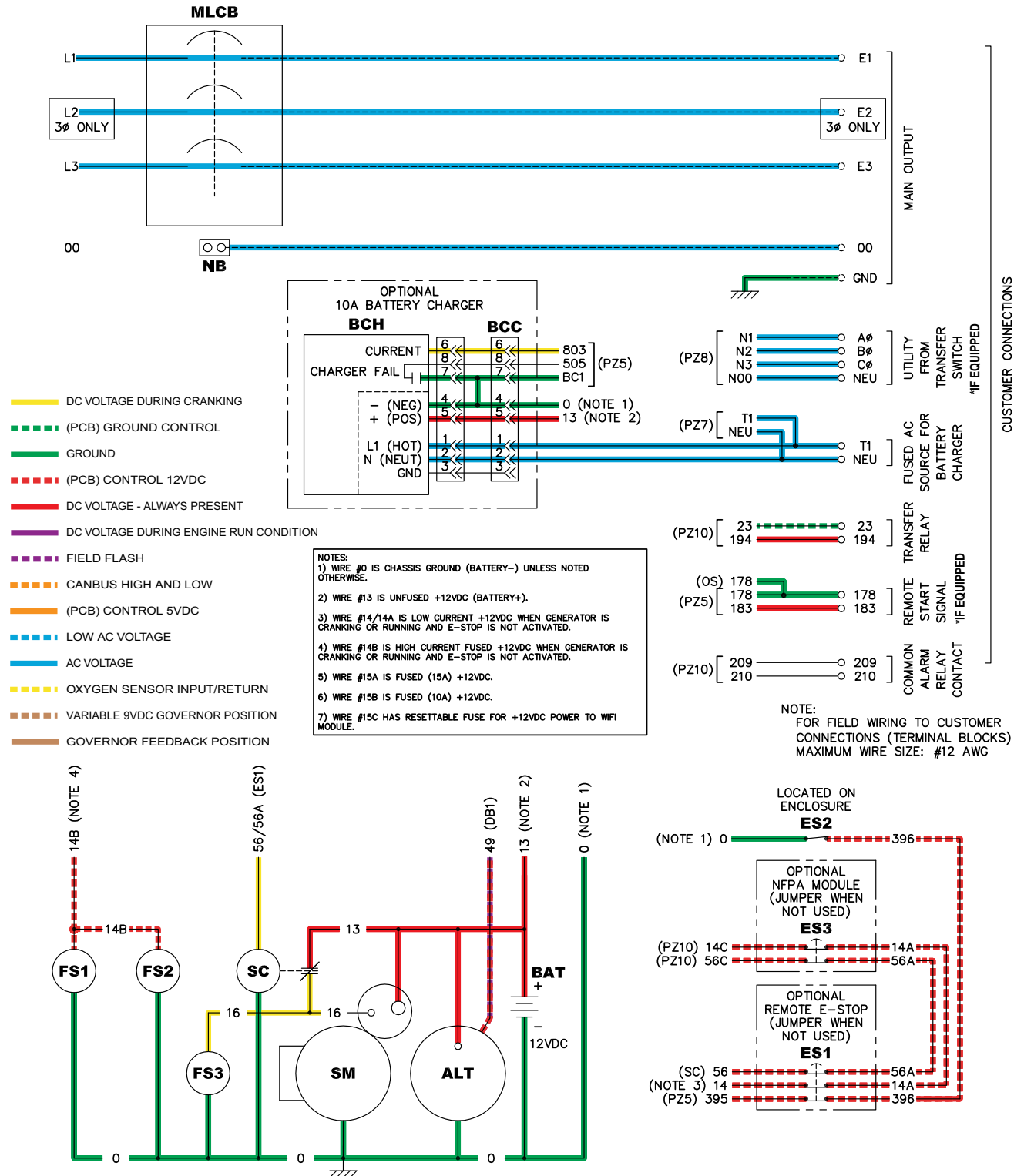


Figure 3-99. Utility Source Voltage Available—Controller in AUTO

015328

Utility Failure—Engine Cranking, Controller in AUTO

Initial Utility Failure

For RTS transfer switches, line-to-line voltage on wires N1 and N2 fall below the voltage and the controller starts a 2–1500 second (programmable) line interrupt timer. If the utility voltage is above the set point of nominal utility voltage, the engine will not crank at the end of the line interrupt timer. The engine will crank and start if the utility voltage is below the set point of nominal utility voltage at the end of the timer.

The unit will abort further crank cycles if it cranks for more than 10 seconds and utility rises above the set point of nominal (programmable) and the unit has not started.

For non-RTS and other manufacturer's transfer switches, the utility voltage sensing is performed by the circuitry in the transfer switch. Nothing happens at the generator until the transfer switch signals the generator to start by closing the dry contact(s) on Wires 183 and 178 (the 5–1500 second programmable line interrupt timer will still apply before unit cranks and starts). All other timers are controlled by the transfer switch.

Cranking and Initial Start Up

For RTS Transfer Switches – After utility voltage is below the adjustable voltage dropout setpoint and the startup delay timer has been met the engine will crank.

For non-RTS and Other Manufacturer's Transfer Switches – After utility voltage is below a programmed percentage and programmed time period, the utility voltage sensing circuit will signal the generator to crank by closing the dry contact on Wires 183 and 178 (5 VDC circuit from controller).

The start circuit is now activated and the following steps occur:

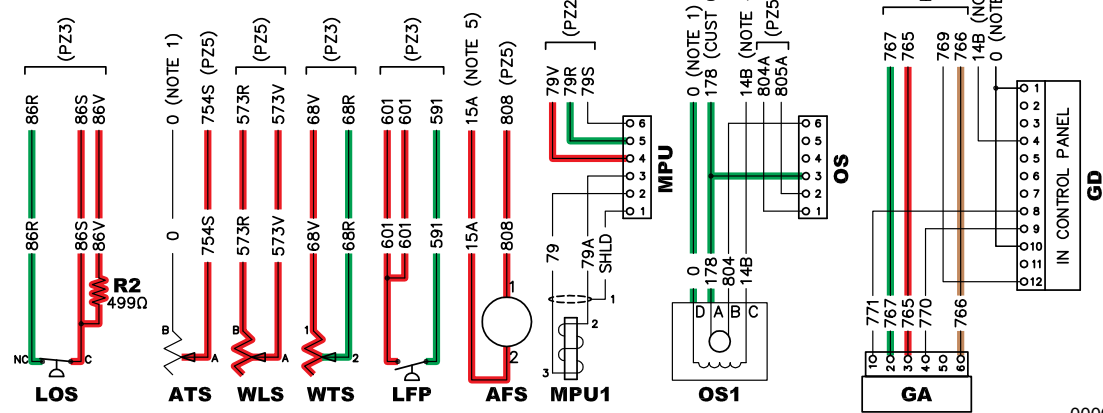
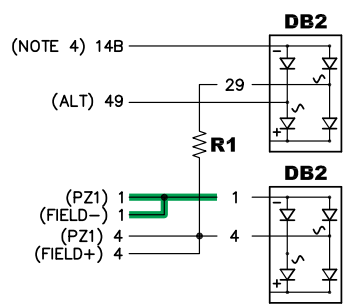
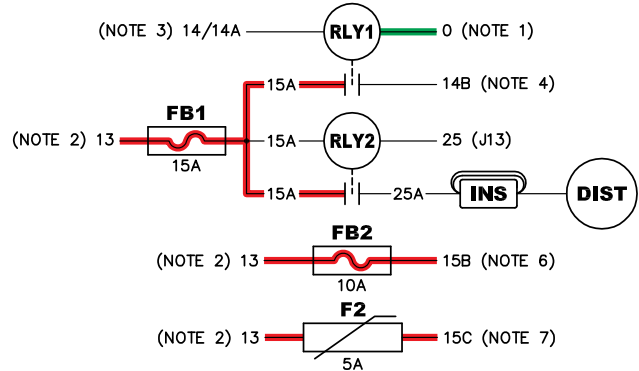
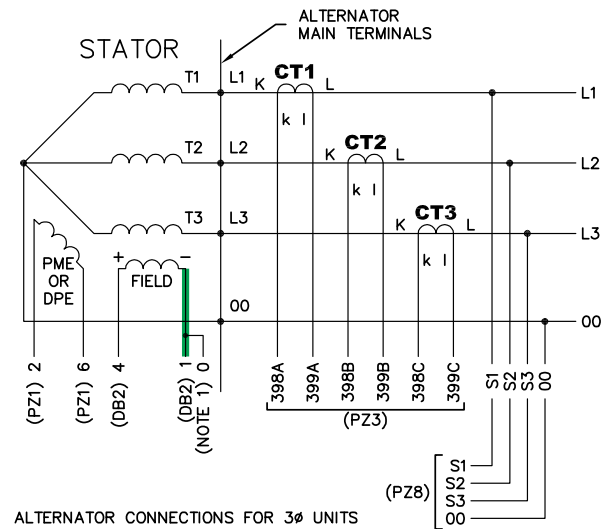
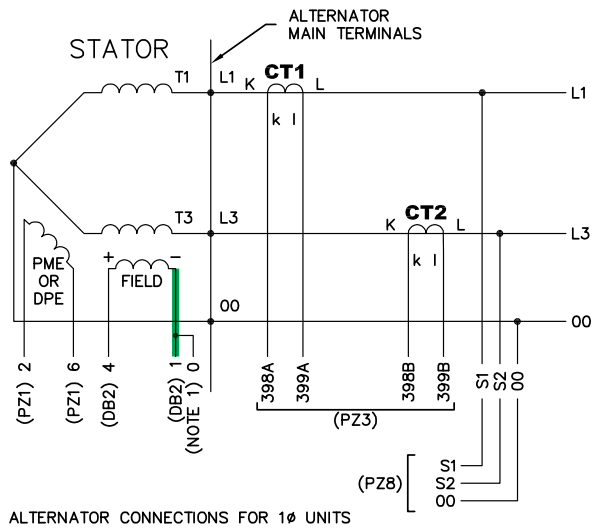
1. The controller energizes positive (+) 12 VDC to Wire 56. Wire 56 is directed to the starter contactor, which energizes the internal electromagnetic coil causing its dry contact to close and connect Wire 13 to Wire 16.
2. Wire 16 is directed to the starter motor (SM) which causes the starter motor to energize, spin, engage the flywheel, and crank the engine.
 - The initial crank cycle is 16 seconds followed by a seven second rest.
 - The next five cycles will be seven seconds of crank time followed by seven seconds rest time.
 - If the unit fails to start after the six crank cycles it will stop and annunciate an overcrank shutdown alarm.
 - The unit will not attempt to crank until the alarm is reset (AUTO-OFF-MANUAL switch set to OFF and the ENTER key pressed).

3. The controller energizes positive (+) 12 VDC to Wire 14C from PZ10-8. Wire 14C is connected to ES3 and loops through ES1 to Wire 14A, then connects to the RLY1. The RLY1 main coil will energize and close Wire 15A to Wire 14B. Wire 14B then goes to splice 8 which will go to 3 locations:

NOTE: The Wire 14 circuit activates the field boost, fuel and governor driver (GA).

4. The electronic governor actuator (GA) is controlled by the controller. When the unit is cranking, the throttle position is approximately 1/8 – 1/4 open and as it starts, the throttle plate will open and readjust quickly to maintain a no load running speed (50 or 60 Hz). Wire 770 is the positive (+) or throttle high signal to the actuator. Wire 771 is the negative (-) or throttle low to the actuator. The feedback circuit allows the controller to monitor the throttle plate position. Wire 765 is the 3 VDC source to the actuator feedback circuit. Wire 766 from the actuator provides a 0–3 VDC feedback circuit back to the controller. Wire 767 is the 0 VDC return wire. Utility Failure—Engine Cranking, Controller in AUTO

LEGEND		
AFS - AIR FUEL SOLENOID	ES1 - REMOTE EMERGENCY STOP (OPT)	GND - GROUND CONNECTION
ALT - DC CHARGE ALTERNATOR	ES2 - STOP SWITCH (ON ENCLOSURE)	INS - IGNITION NOISE SUPPRESSION
ATS - AIR TEMPERATURE SENSOR	ES3 - EMERGENCY STOP (NFPA MODULE)	LFP - LOW FUEL PRESSURE SWITCH
BAT - BATTERY	ESC3 - E-STOP CONNECTOR	LOS - LOW OIL PRESSURE SWITCH
BCC - BATTERY CHARGER CONNECTOR	ESJ - E-STOP CONNECTOR JUMPER	MLCB - MAIN LINE CIRCUIT BREAKER
BCH - BATTERY CHARGER	F2 - FUSE, RESETTABLE	MPU - MAGNETIC PICK-UP
CT_ - CURRENT TRANSFORMER	FB_ - FUSE BLOCK	NB - NEUTRAL BLOCK
DB_ - DIODE BRIDGE	FS_ - FUEL SOLENOID	OS - OXYGEN SENSOR
DIST - DISTRIBUTOR CAP	GA - GOVERNOR ACTUATOR	PME - PERMANENT MAGNET EXCITEP
DPE - DISPLACED PHASE EXCITATION	GD - GOVERNOR DRIVER	PZ_ - POWER ZONE 410 CONNECTOR
		R_ - RESISTOR
		RLY_ - RELAY
		SC - STARTER CONTACTOR
		SM - STARTER MOTOR
		WLS - COOLANT LEVEL SENSOR
		WM - WIFI MODULE
		WTS - COOLANT TEMPERATURE SENSOR



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015329

Figure 3-100. Utility Failure—Engine Cranking, Controller in AUTO

Utility Failure—Engine Cranking, Controller in AUTO

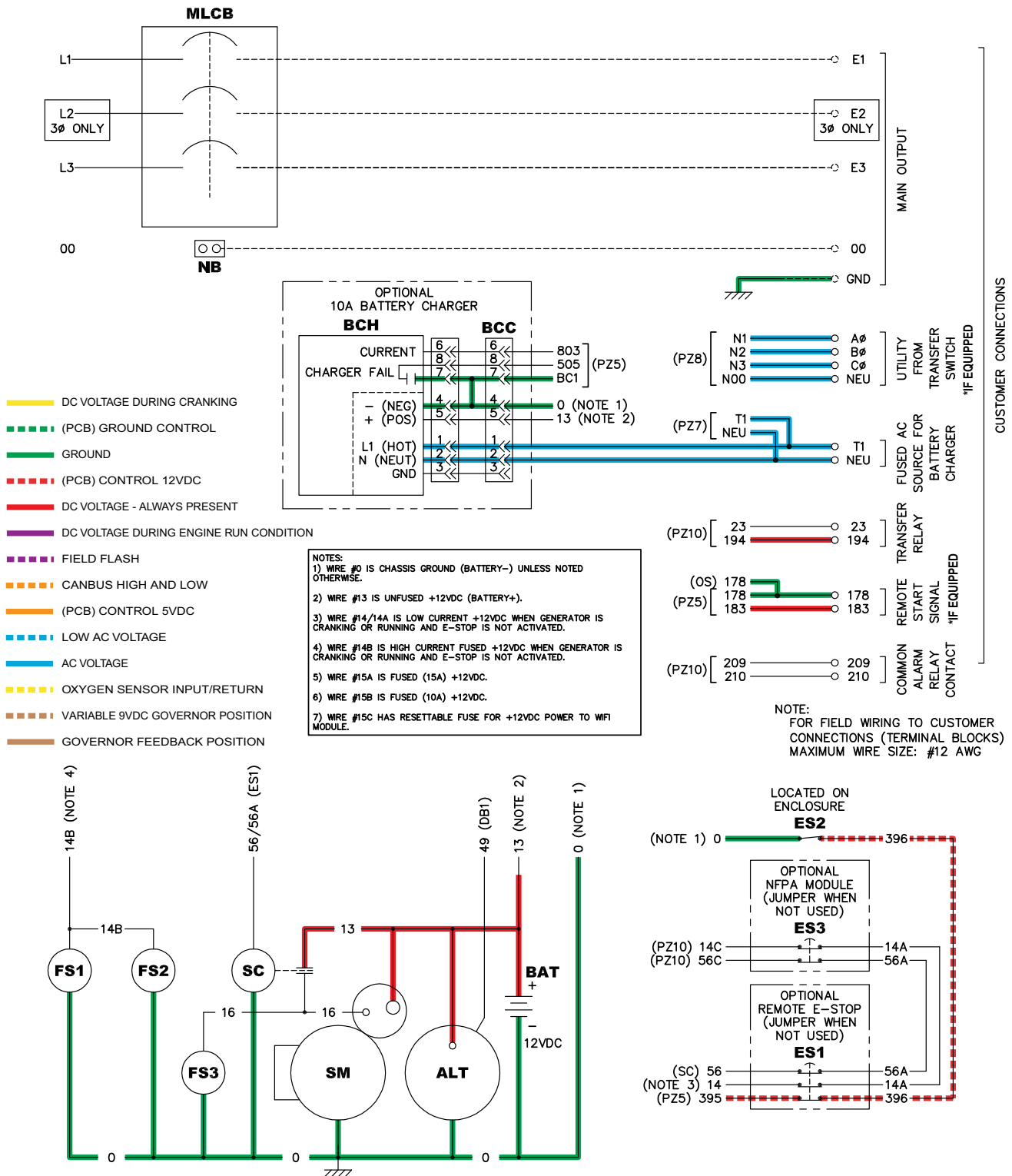


Figure 3-101. Utility Failure—Engine Cranking, Controller in AUTO

015330

Utility Failure—Engine Running, Transfer To Emergency, Controller In AUTO

When the engine reaches approximately 600–800 rpm, the controller will deactivate the crank circuit Wire 56 (positive 12 VDC) and will start the adjustable warm-up timer. The engine speed is sensed by the MP1 magnetic pickup (flywheel) Wire 79 and Wire 0. Crank termination, overspeed, and governed speed are all functions of the MP1 and the controller speed referencing circuit.

There is a 10 second hold-off timer for the oil pressure to buildup and the contacts of the LOS (low oil pressure switch) to open.

While the engine begins its crank/run operation, Wire 14B provides a positive (+) 12 VDC supply to DB1 which is connected to Wire 29 (white) and the R1 resistor (if so equipped). This resistor steps the DC voltage down so the automatic voltage regulator (AVR) in the controller can take over operation. Wire 4 and Wire 1 are also connected to the controller and continue to the BA brush assembly or field assembly. This is the field boost/field excitation circuit and provides DC voltage to the rotor.

The field boost circuit magnetizes the rotor which will create AC voltage on the DPE displaced phase excitation winding—this winding is the power supply for the AVR in the controller.

The AC sensing circuit is Wire 11 and Wire 44 which turns into Wire SA sensing “A” and SB sensing “B”. The AVR uses this circuit to monitor the generators AC output and adjusts the DC field excitation to maintain the correct output.

For RTS operation, Wire 194 is positive (+)12 VDC, and is connected from the controller to one side of the TR transfer relay coil. Wire 23 comes from the other side of the TR transfer relay coil and is connected to the controller. After the programmable warm up timer is expired, the controller will take Wire 23 to ground and activate the TR relay causing the transfer switch mechanism (contactor) to transfer the load from the utility position to the emergency standby position.

When equipped with a non-RTS or other manufacturer's switch, all transfer control and timers are controlled by the transfer switch circuitry (the 2–1500 second programmable line interrupt timer will still apply before unit cranks and starts).

Utility Failure—Engine Running, Transfer To Emergency, Controller In AUTO

LEGEND		
AFS - AIR FUEL SOLENOID	ES1 - REMOTE EMERGENCY STOP (OPT)	GND - GROUND CONNECTION
ALT - DC CHARGE ALTERNATOR	ES2 - STOP SWITCH (ON ENCLOSURE)	INS - IGNITION NOISE SUPPRESSION
ATS - AIR TEMPERATURE SENSOR	ES3 - EMERGENCY STOP (NFPA MODULE)	LFP - LOW FUEL PRESSURE SWITCH
BAT - BATTERY	ESC3 - E-STOP CONNECTOR	LOS - LOW OIL PRESSURE SWITCH
BCC - BATTERY CHARGER CONNECTOR	ESJ - E-STOP CONNECTOR JUMPER	MLCB - MAIN LINE CIRCUIT BREAKER
BCH - BATTERY CHARGER	F2 - FUSE, RESETTABLE	MPU - MAGNETIC PICK-UP
CT_ - CURRENT TRANSFORMER	FB_ - FUSE BLOCK	NB - NEUTRAL BLOCK
DB_ - DIODE BRIDGE	FS_ - FUEL SOLENOID	OS - OXYGEN SENSOR
DIST - DISTRIBUTOR CAP	GA - GOVERNOR ACTUATOR	PME - PERMANENT MAGNET EXCITEP
DPE - DISPLACED PHASE EXCITATION	GD - GOVERNOR DRIVER	PZ_ - POWER ZONE 410 CONNECTOR
		R_ - RESISTOR
		RLY_ - RELAY
		SC - STARTER CONTACTOR
		SM - STARTER MOTOR
		WLS - COOLANT LEVEL SENSOR
		WM - WIFI MODULE
		WTS - COOLANT TEMPERATURE SENSOR

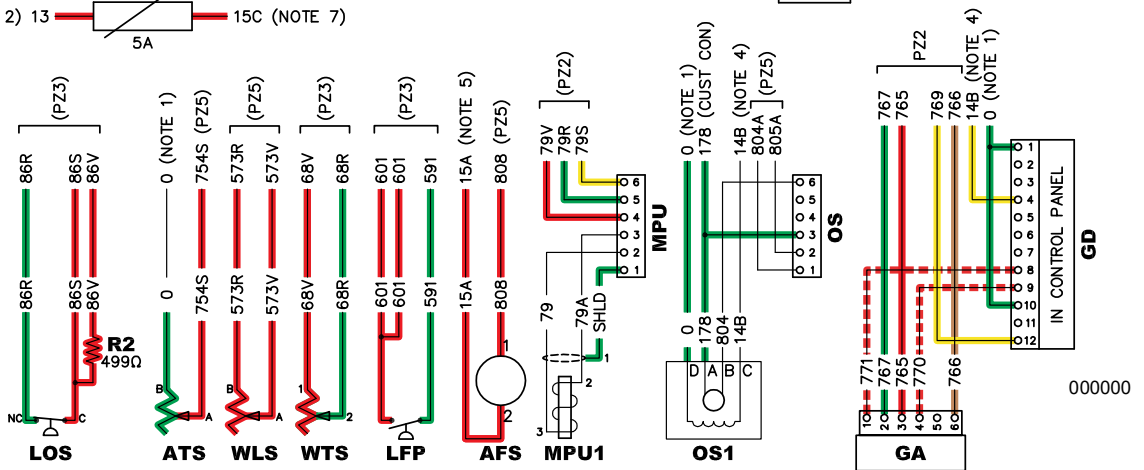
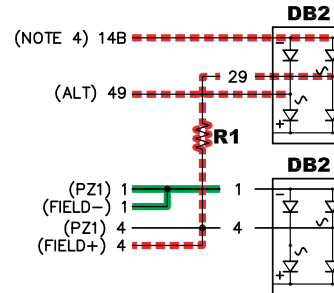
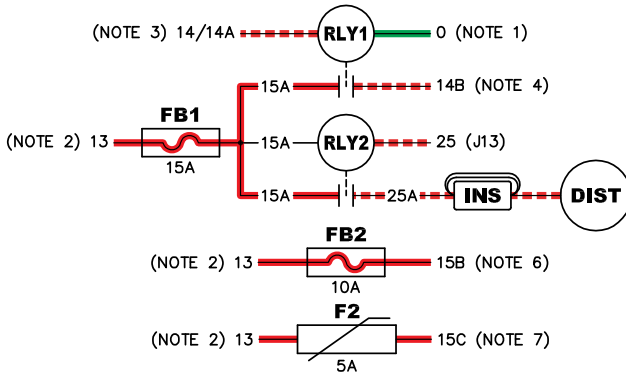
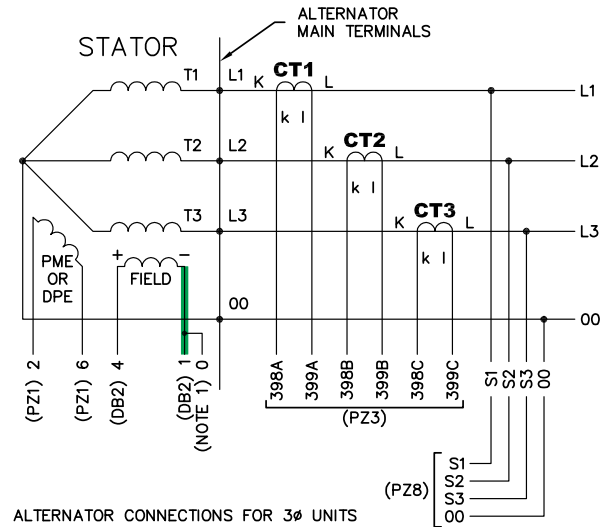
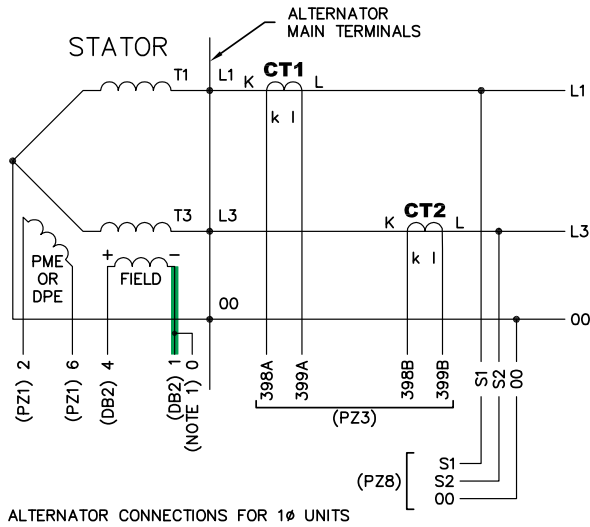


Figure 3-102. Utility Failure Engine Running, Transfer To Emergency, Controller In AUTO

015331

Utility Failure—Engine Running, Transfer To Emergency, Controller In AUTO

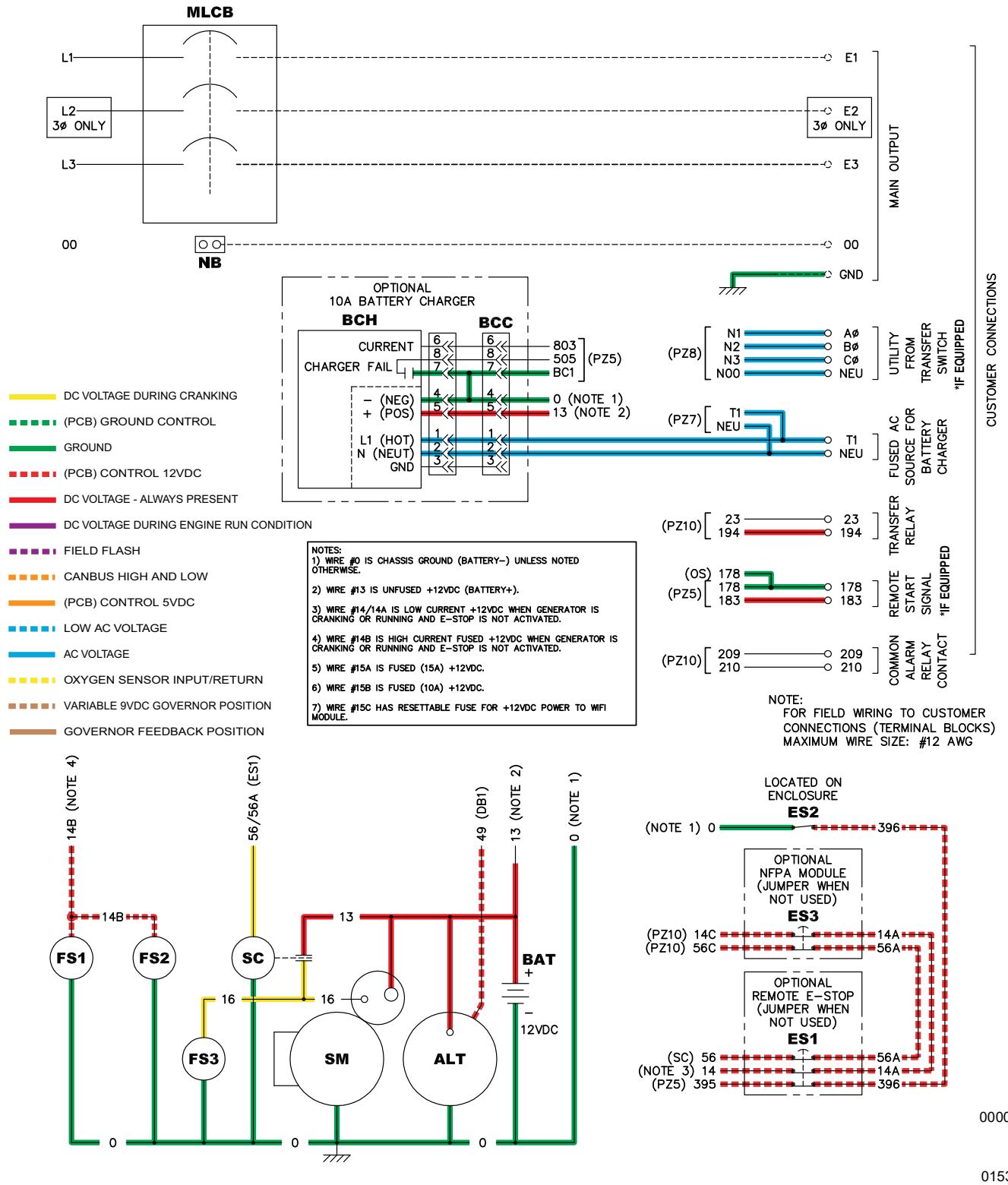


Figure 3-103. Utility Failure Engine Running, Transfer To Emergency, Controller In AUTO

Return Of Utility—Engine Cool Down And Engine Shutdown, Controller In AUTO

Return of Utility

For RTS transfer switches, when utility returns the controller will monitor N1 and N2 to rise above the limits (programmable) of nominal voltage. This will initiate a 15 second return to utility timer. At the end of the return to utility timer, if the utility voltage is still greater than the programmable limits of nominal voltage (programmable) the controller will lift the ground on Wire 23 which will cause the TR relay to de-energize and the transfer switch mechanism (contactor) to transfer the load from the emergency standby position back to the utility position.

When equipped with a non-RTS or other manufacturer's switch, all transfer control and timers are controlled by the transfer switch circuitry.

Engine Cool Down

The controller will then initiate an engine cool down timer.

- Naturally aspirated = one minute
- Turbo charged units = five minutes

NOTE: During this cooldown period, the generator runs at target voltage but at no load as the transfer switch is on utility power.

NOTE: If utility voltage drops below the voltage drop out set point, the controller will initiate the warm-up timer and then will connect Wire 23 to ground causing the transfer switch mechanism (contactor) to transfer the load from the utility position back to the emergency standby position.

When equipped with a non-RTS or other manufacturer's transfer switch, all transfer control and timers are controlled by the transfer switch circuitry.

Shutdown

For RTS transfer switch applications, the unit will shut down after the cool down timer expires.

For non-RTS and other manufacturer's transfer switches, all transfer control and timers are controlled by the transfer switch circuitry. When the timers expire it will open the dry contacts on Wire 183 and Wire 178.

Return Of Utility—Engine Cool Down And Engine Shutdown, Controller In AUTO

LEGEND

AFS - AIR FUEL SOLENOID	ES1 - REMOTE EMERGENCY STOP (OPT)	GND - GROUND CONNECTION	R_ - RESISTOR
ALT - DC CHARGE ALTERNATOR	ES2 - STOP SWITCH (ON ENCLOSURE)	INS - IGNITION NOISE SUPPRESSION	RLY_ - RELAY
ATS - AIR TEMPERATURE SENSOR	ES3 - EMERGENCY STOP (NFPA MODULE)	LFP - LOW FUEL PRESSURE SWITCH	SC - STARTER CONTACTOR
BAT - BATTERY	ESC3 - E-STOP CONNECTOR	LOS - LOW OIL PRESSURE SWITCH	SM - STARTER MOTOR
BCC - BATTERY CHARGER CONNECTOR	ESJ - E-STOP CONNECTOR JUMPER	MLCB - MAIN LINE CIRCUIT BREAKER	WLS - COOLANT LEVEL SENSOR
BCH - BATTERY CHARGER	F2 - FUSE, RESETTABLE	MPU - MAGNETIC PICK-UP	WM - WIFI MODULE
CT_ - CURRENT TRANSFORMER	FB_ - FUSE BLOCK	NB - NEUTRAL BLOCK	WTS - COOLANT TEMPERATURE SENSOR
DB_ - DIODE BRIDGE	FS_ - FUEL SOLENOID	OS - OXYGEN SENSOR	
DIST - DISTRIBUTOR CAP	GA - GOVERNOR ACTUATOR	PME - PERMANENT MAGNET EXCITEP	
DPE - DISPLACED PHASE EXCITATION	GD - GOVERNOR DRIVER	PZ_ - POWER ZONE 410 CONNECTOR	

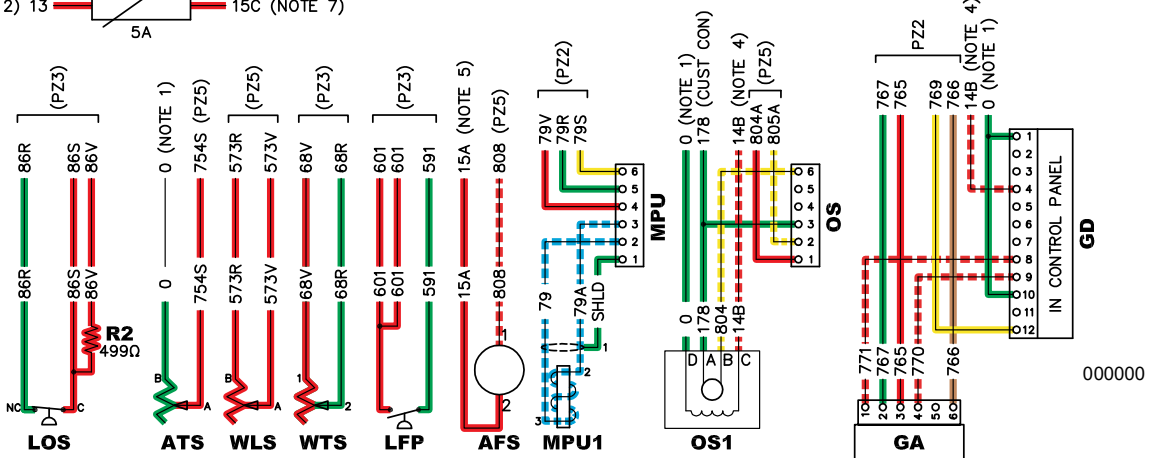
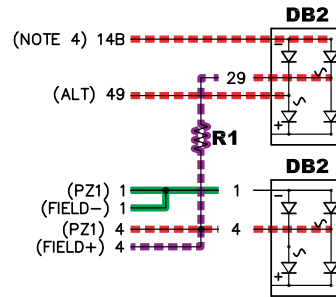
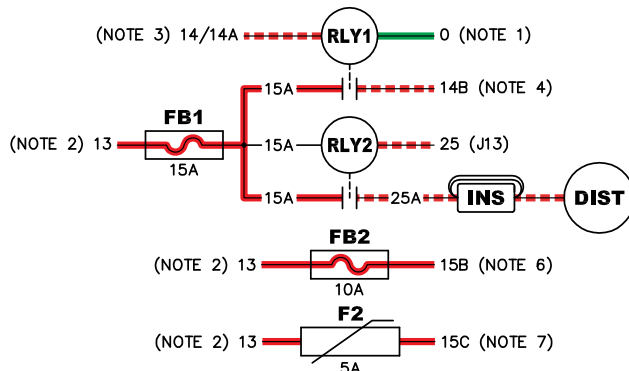
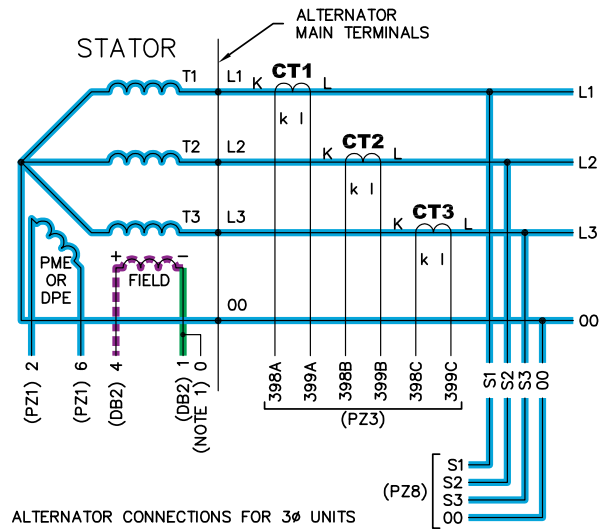
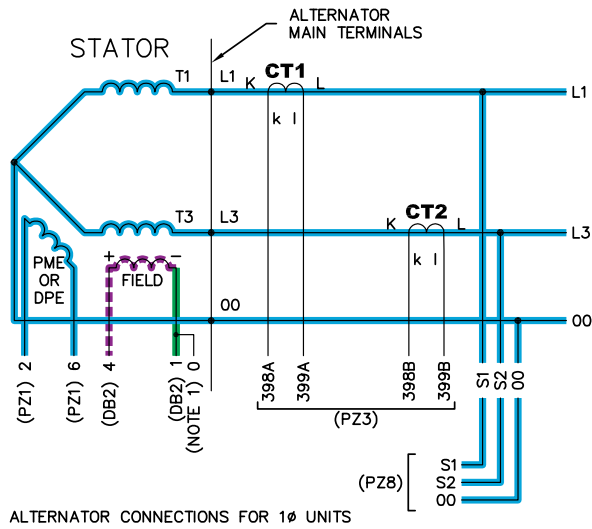


Figure 3-104. Return Of Utility, Engine Cool Down And Engine Shutdown, Controller In AUTO

Return Of Utility—Engine Cool Down And Engine Shutdown, Controller In AUTO

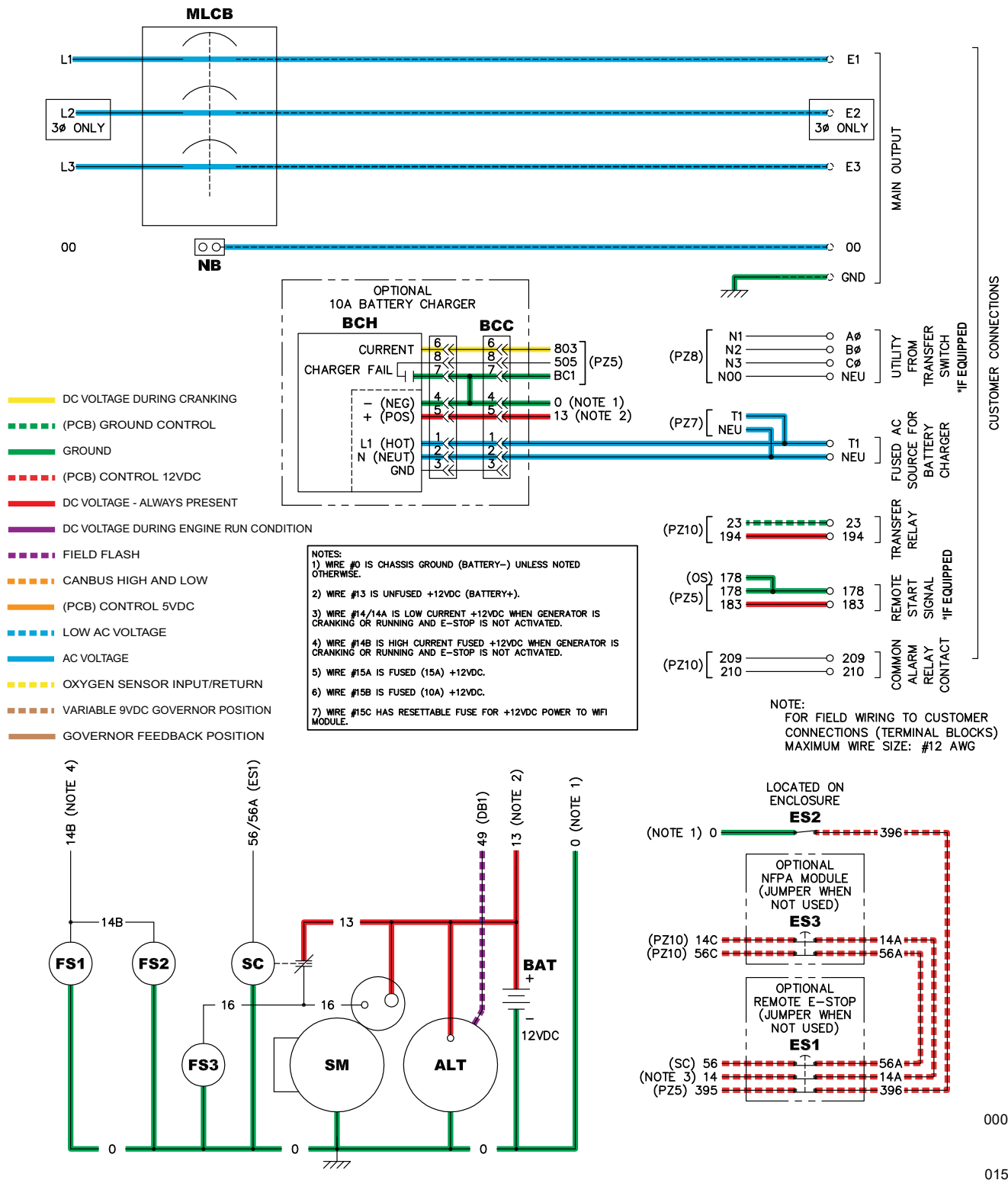
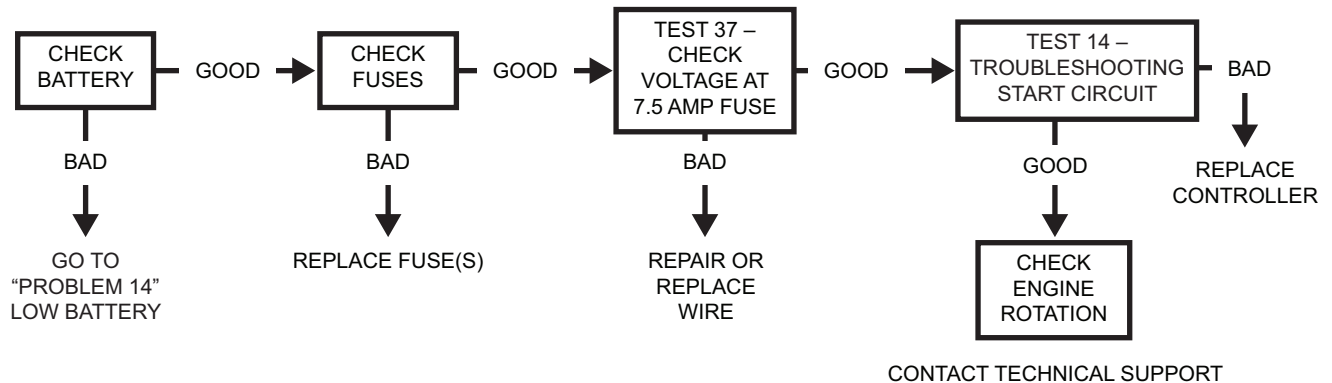


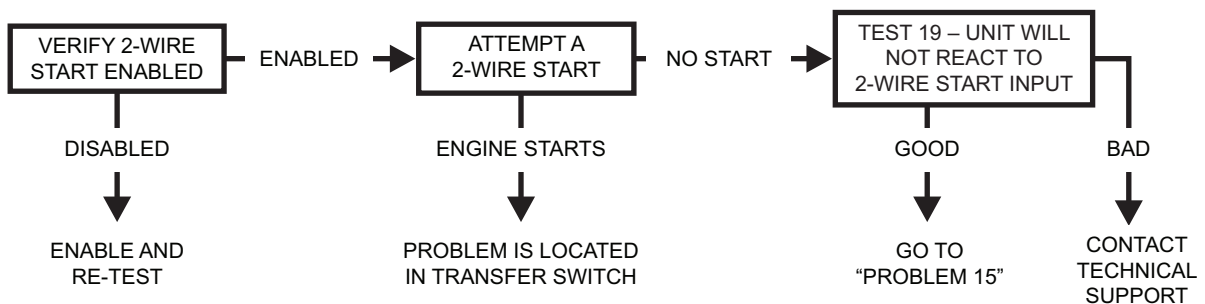
Figure 3-105. Return Of Utility, Engine Cool Down And Engine Shutdown, Controller In AUTO

Section 3.3 DC Troubleshooting Flowcharts

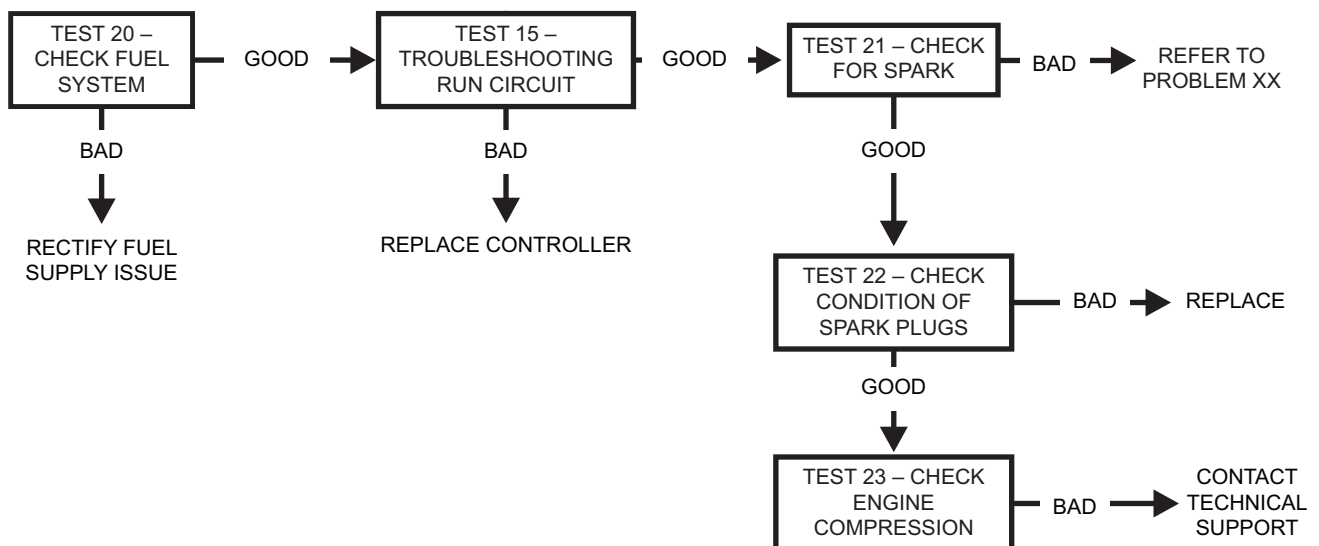
Problem 4 – Unit Will Not Crank When AUTO-OFF-MANUAL Mode is Set to MANUAL



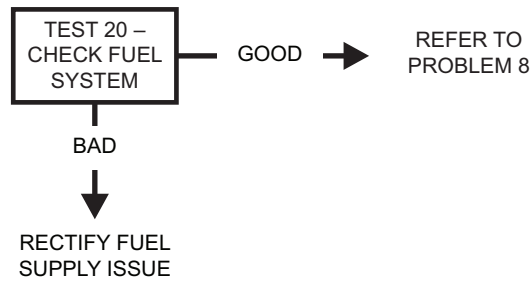
Problem 5 – Engine Will Not Crank With a Utility Loss or 2-Wire Start



Problem 6 – Unit Cranks But Will Not Start (Overcrank Alarm)

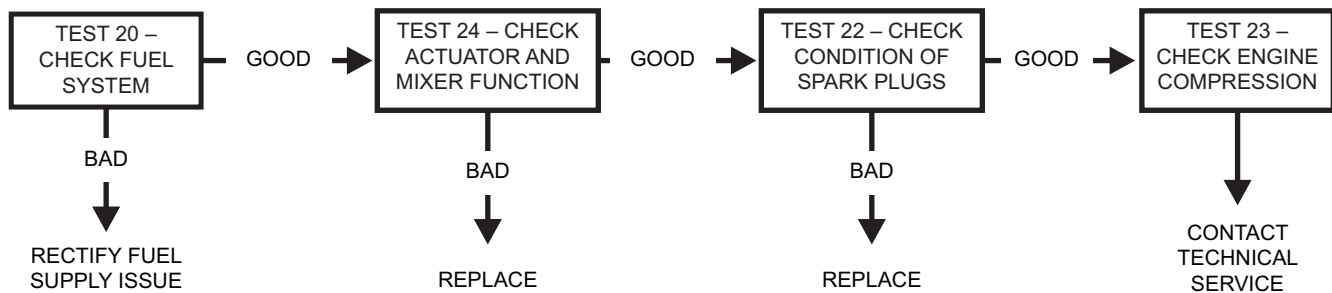


Problem 7 – Unit Starts And Runs, Then Shuts Down With No Fault Indicated

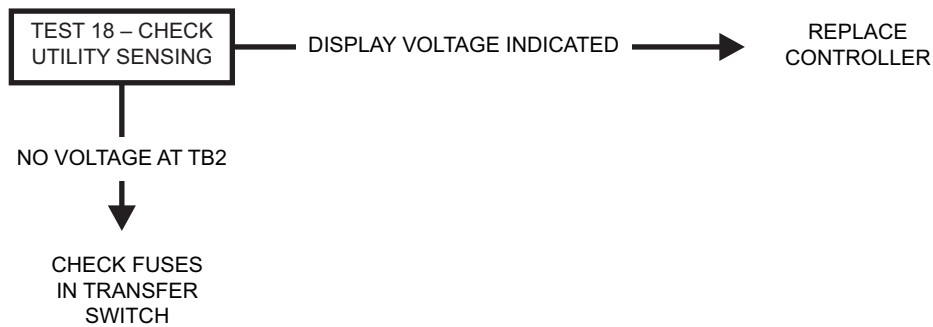


Problem 8 – Unit Starts Hard and Runs Rough / Lacks Power

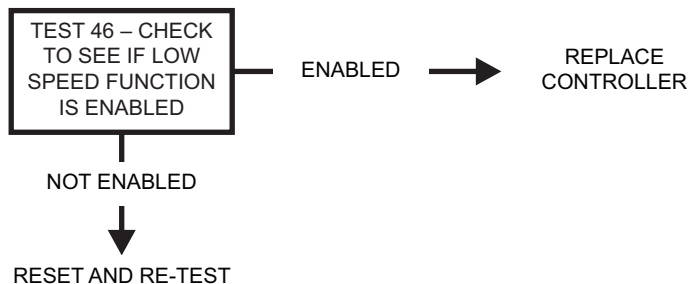
NOTE: Verify E-code is present



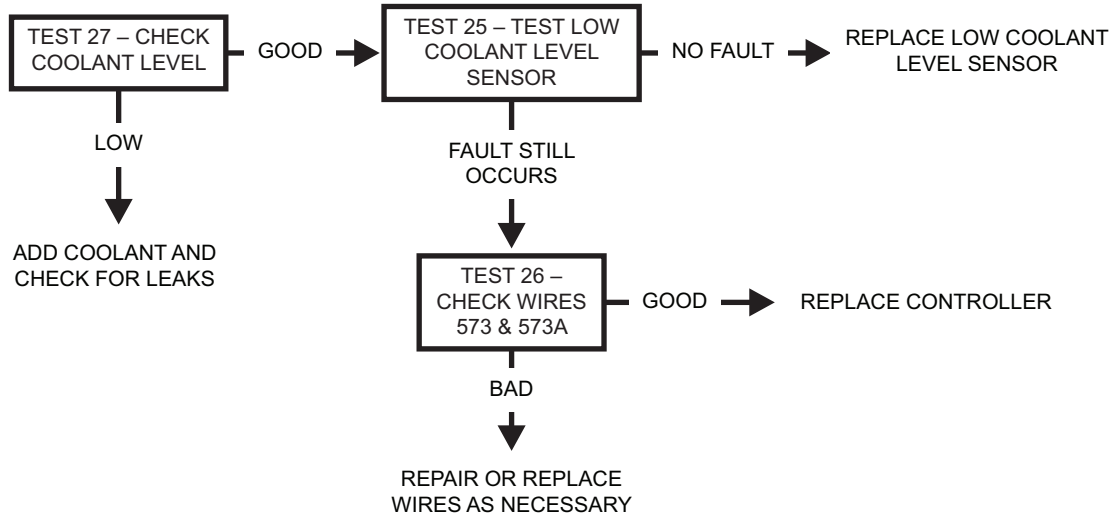
Problem 9 – Unit Starts and Transfer Occurs When Utility Power is Available



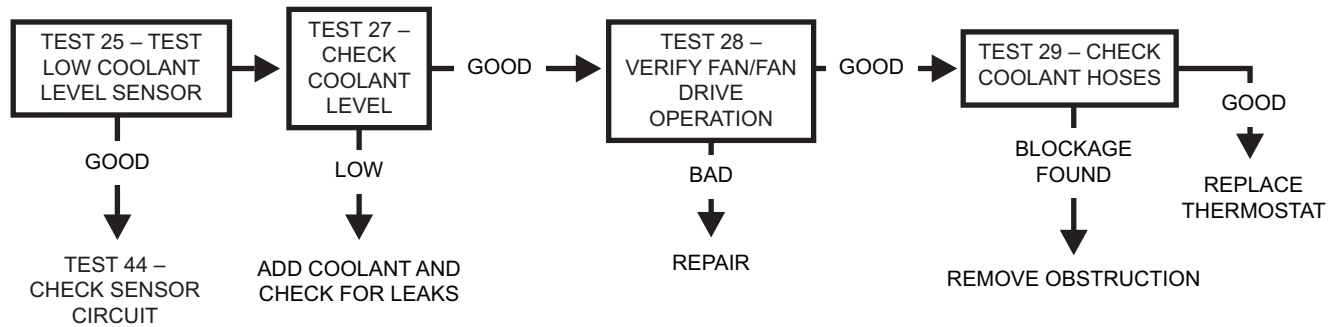
Problem 10 – Generator Will Not Low Speed Exercise



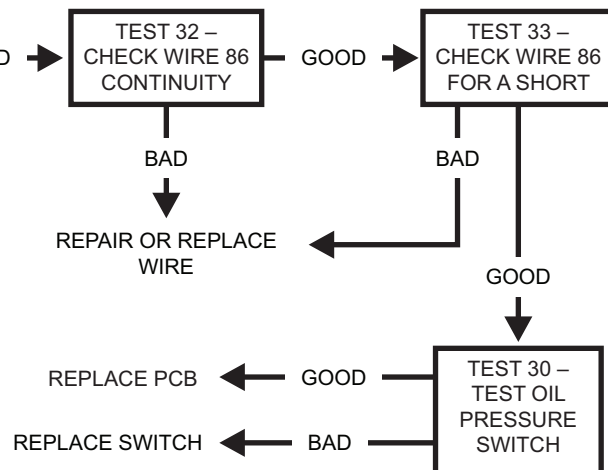
Problem 11 – Low Coolant Level



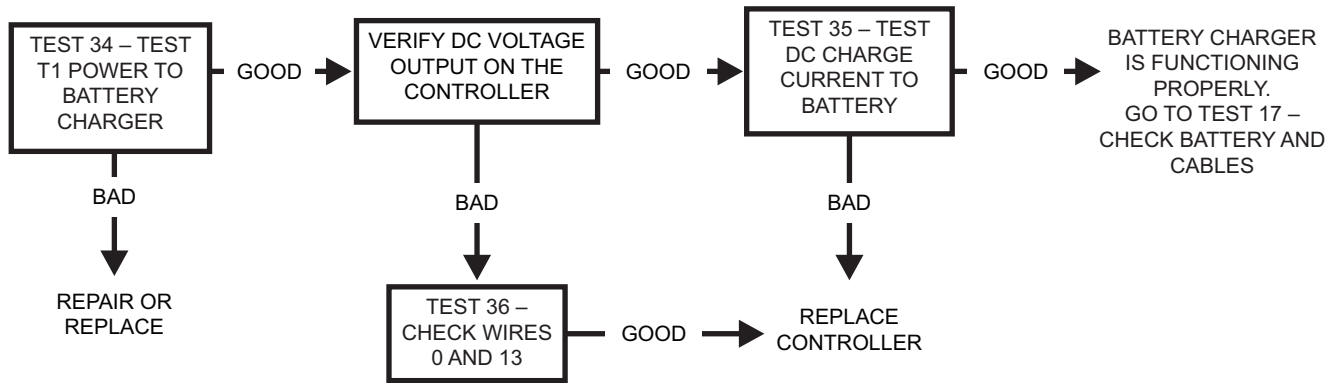
Problem 12 – High Temperature



Problem 13 – Low Oil Pressure

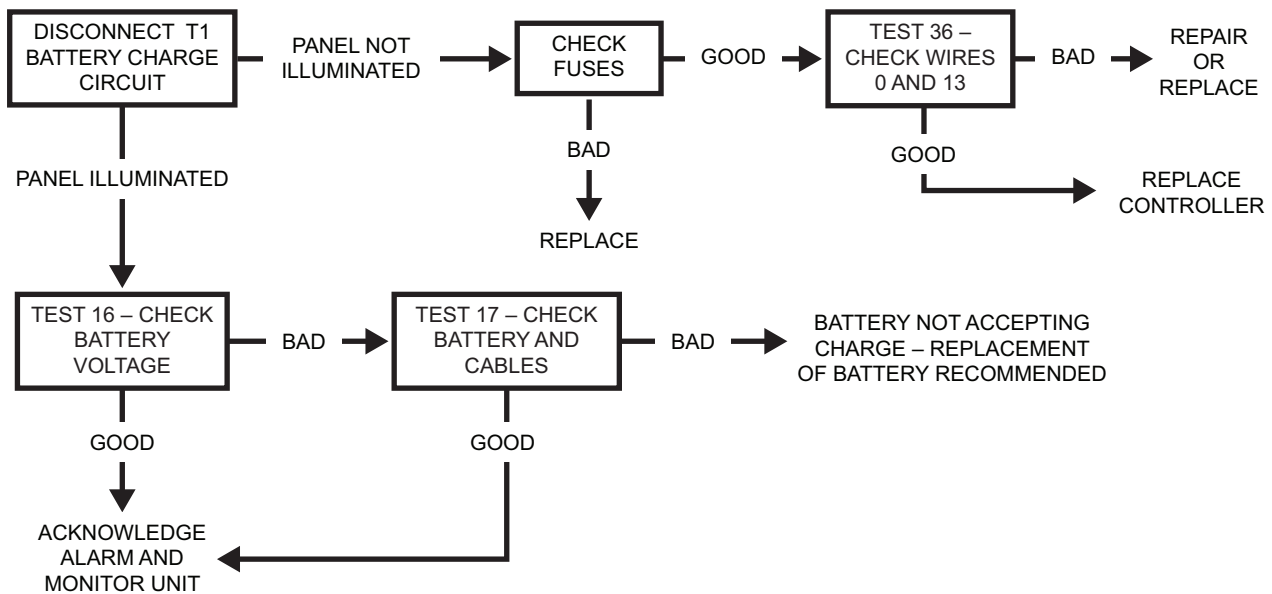


Problem 14 – Low Battery Alarm/Dead Battery



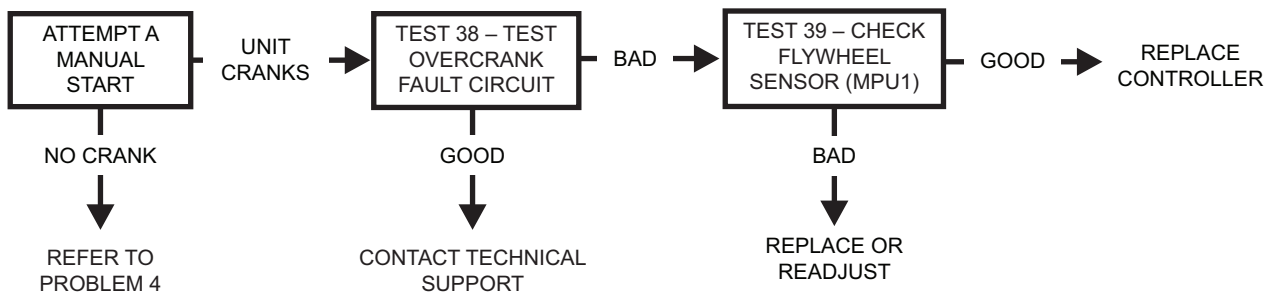
Problem 15 – Inspect Battery*

* "INSPECT BATTERY" IS A ONE YEAR AUTO GENERATED ALARM.

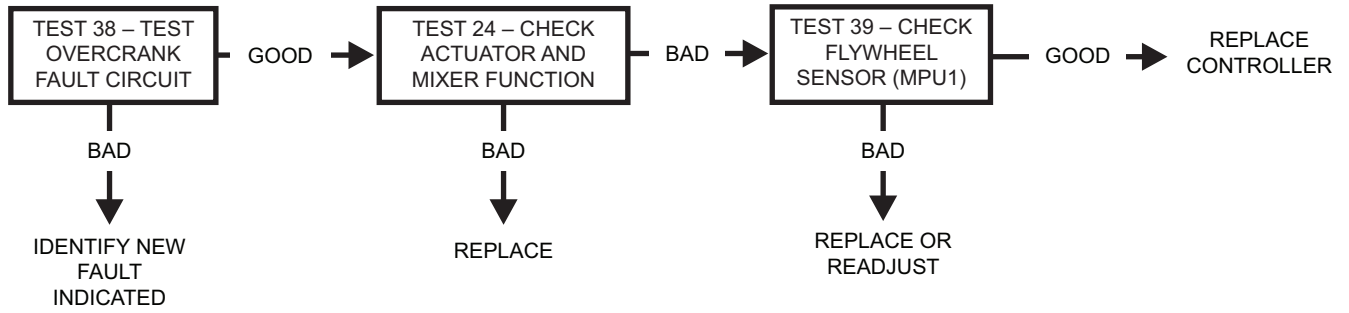


Problem 16 – RPM Sensor Loss

NOTE: VERIFY PANEL IS PROGRAMMED CORRECTLY BEFORE TROUBLESHOOTING.



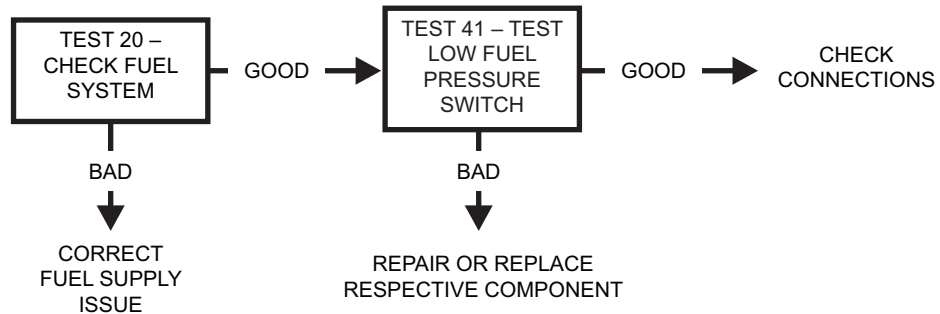
Problem 17 – Overspeed



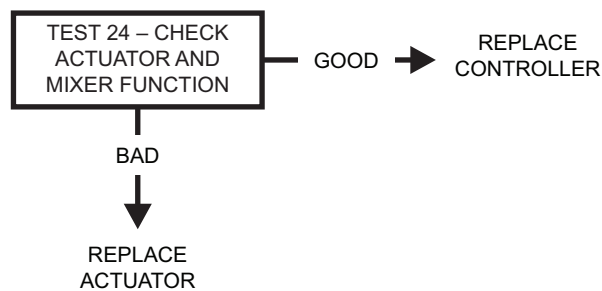
Problem 18 – Blown Fuse(s)



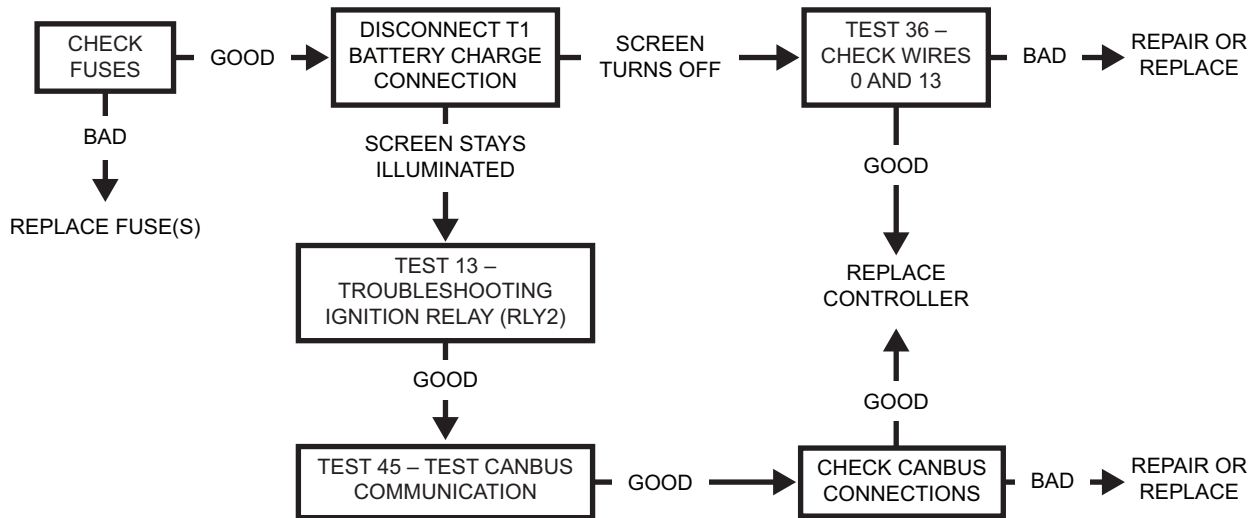
Problem 19 – Low Fuel Pressure



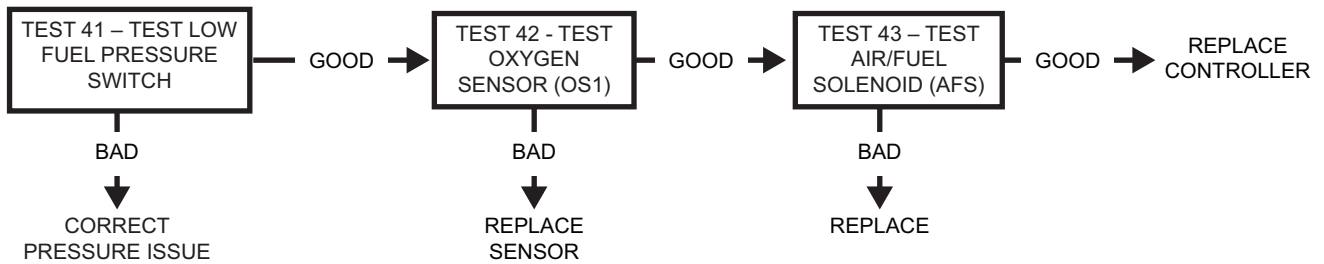
Problem 20 – Governor Fault



Problem 21 – CANBus Alarm



Problem 22 – Check Engine



Section 3.4 *DC Diagnostic Tests*

Introduction

This section is provided to familiarize the service technician with acceptable procedures for the testing and evaluation of various problems that could be encountered on standby generators with liquid-cooled engines. Use this section of the manual in conjunction with Section 3.3 DC Troubleshooting Flowcharts. The numbered tests in this section correspond with those flowcharts.

Most tests can be performed with a digital multimeter (DMM). An AC frequency meter is required, where frequency readings must be taken. A clamp-on ammeter may be used to measure AC loads on the generator.

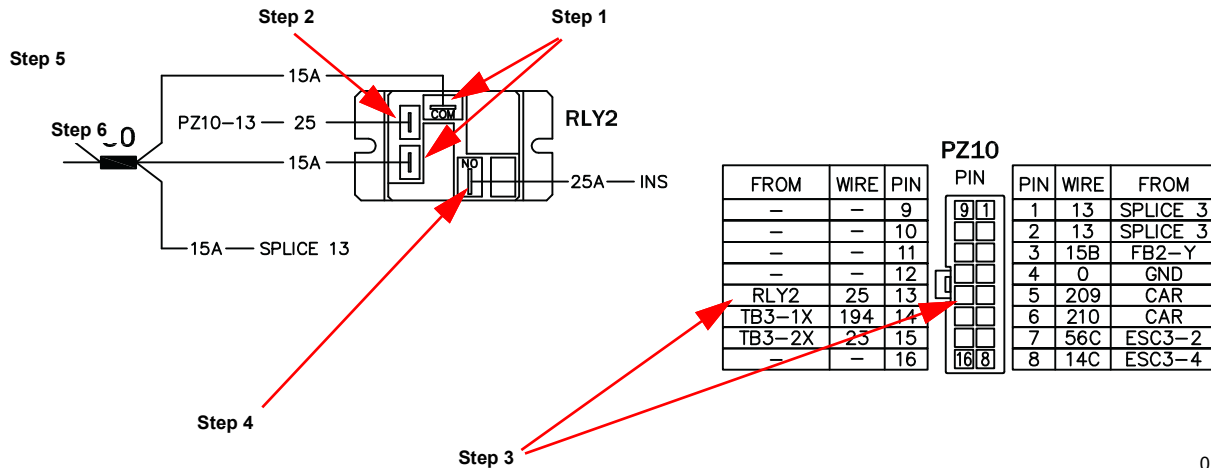
Testing and troubleshooting methods covered in this section are not exhaustive. No attempt has been made to discuss, evaluate and advise the standby service trade of all conceivable ways in which service and trouble diagnosis must be performed. Accordingly, anyone who uses a test method not recommended herein must first satisfy himself that the procedure or method he has selected will jeopardize neither his nor the products safety.

Safety

Service personnel who work on this equipment must be made aware of the dangers of such equipment. Extremely high and dangerous voltages are present that can kill or cause serious injury. Gaseous fuels are highly explosive and can be ignited by the slightest spark. Engine exhaust gases contain deadly carbon monoxide gas that can cause unconsciousness or even death. Contact with moving parts can cause serious injury.

When working on this equipment, use common sense and remain alert at all times. Never work on this equipment while physically or mentally fatigued. If a component, device, or system is not understood, do not work on it.

Test 13 – Troubleshooting Ignition Relay (RLY2)



015335

Figure 3-106. Ignition Relay (RLY2) Test Points

Step 1

- Set meter to read DC volts.
- Place black lead on chassis ground.
- Place red lead on Wire 15A at RLY2.
- Measure for DC voltage.
 - If DC volts measured continue to next step.
 - If DC volts not measured check for open or short between Fuse FB1 and Wire 15A at RLY2.

Step 2

- Set meter to read DC volts.
- Place black lead on chassis ground.
- Place red lead on Wire 25 at RLY2.
- Measure for DC voltage.
 - Approximately 12 VDC should be measured.
 - If voltage is present continue test.
 - If voltage is not present measure coil of RLY2 for continuity.
- Place unit in MANUAL mode.
 - Wire 25 voltage should appear near 0 VDC
 - If voltage does appear to near 0 VDC, continue test.
 - If voltage does not appear near 0 VDC troubleshoot contacts of RLY2 (Test 47).

Step 3

- Set meter to read DC volts.
- Place black lead on chassis ground.
- Place red lead on Wire 25 at connector PZ10-13.
- Measure for DC voltage.
 - If 12 VDC is present continue test.

- If 12 VDC not present check Wire 25 for continuity.
- Place unit in MANUAL mode.
 - Wire 25 voltage should appear near 0 VDC.
 - If voltage does appear to near 0 VDC, continue test.
 - If voltage does not go appear 0 VDC, verify pin connections to controller.
 - If connections are tight replace controller.
 - If pin connections are not tight or open with no continuity repair or replace harness.

Step 4

- Set meter to read DC volts.
- Place black lead on chassis ground.
- Place red lead on Wire 25A at RLY2.
- Measure for DC voltage.
 - Approximately 12 VDC should be measured.
 - If voltage is present continue test.
 - If voltage is not present test RLY2 again.

Test 14 – Troubleshooting Start Circuit (continued)

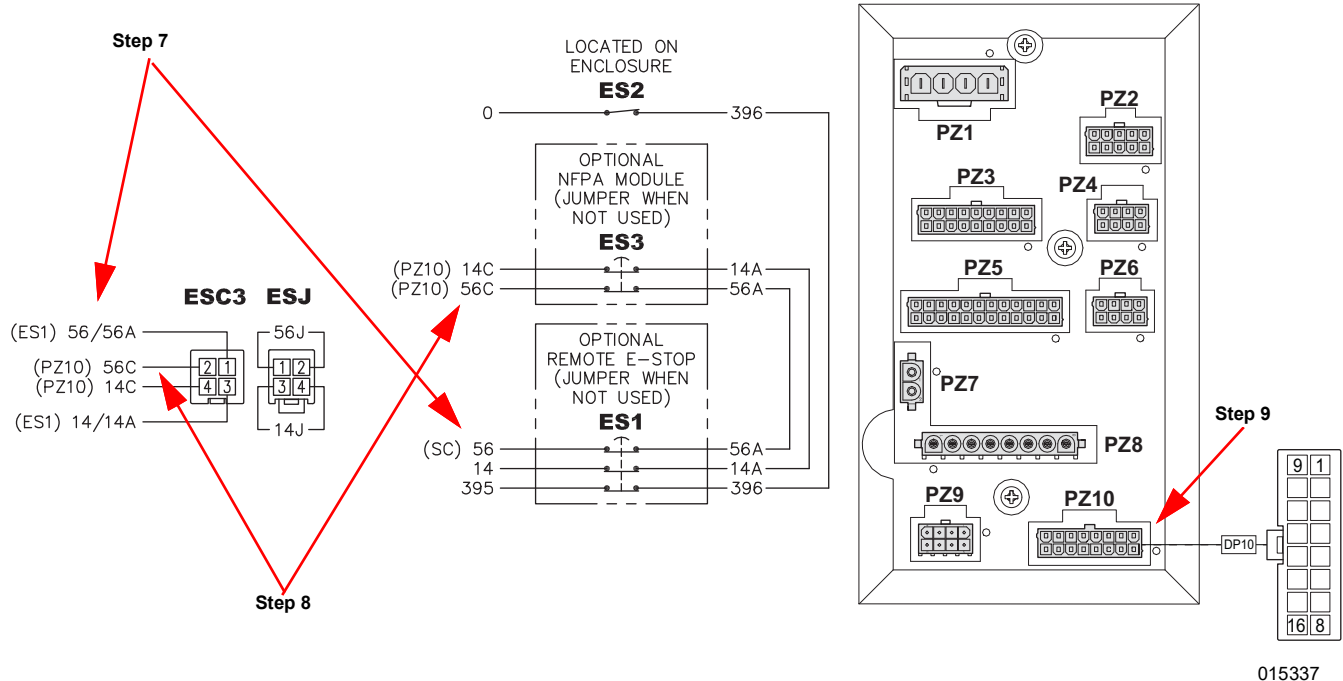


Figure 3-108. Start Circuit Test Points

Step 7

1. Place black lead on engine common ground and red lead on Wire 56 at ES1.
2. Place unit in manual.
3. Verify battery voltage is present.
 - a. If battery voltage is present the problem is with Wire 56 between ES1 and the SC. Test Wire 56 for continuity and replace, as necessary.
 - b. If battery voltage is not present, continue testing.

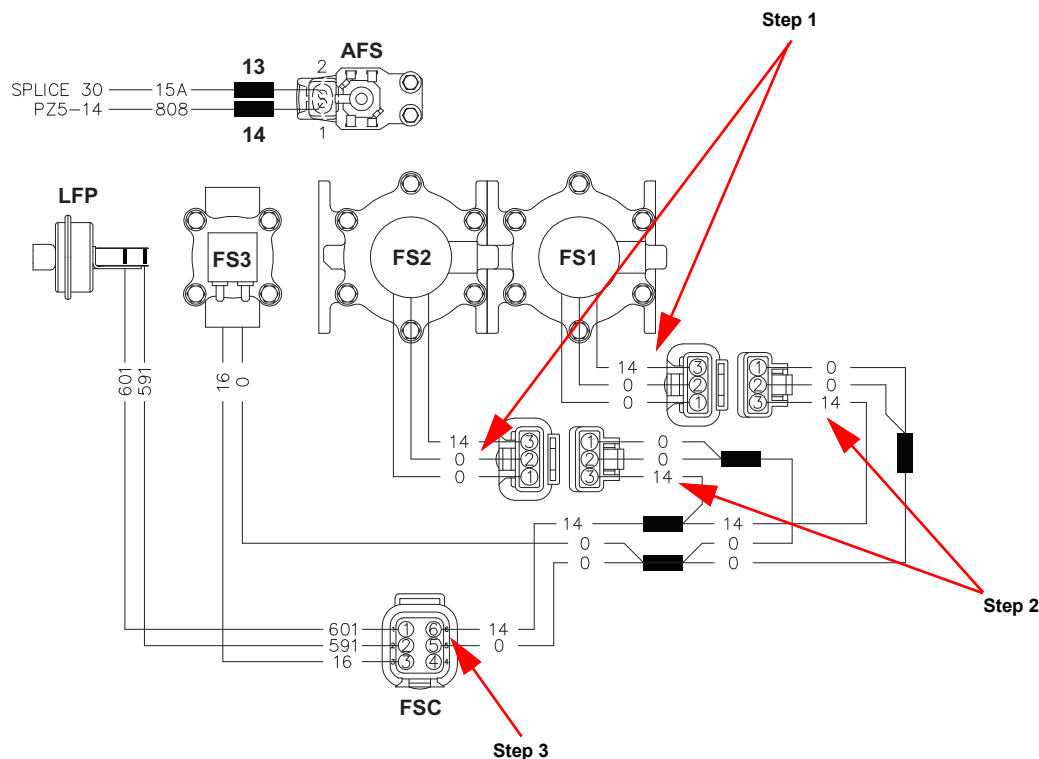
Step 8

1. Place black lead on ground (Wire 0) and red lead on Wire 56C at ESC3.
2. Place unit in manual.
3. Verify battery voltage is present.
 - a. If battery voltage is present the problem is with Wire 56 between ESC3 and the ES3. Test Wire 56 for continuity and replace, as necessary.
 - b. If battery voltage is not present, continue testing.

Step 9

1. Place black lead on ground (Wire 0) and red lead on Wire 56C at DP10 pin 7.
2. Place unit in manual.
3. Verify battery voltage is present.
 - If battery voltage is present the problem is with the PZ410 controller. Replace, as necessary.

Test 15 – Troubleshooting Run Circuit



015338

Figure 3-109. Run Circuit Test Points

Step 1

1. Disconnect two plugs that connect fuel solenoids FS1 and FS2 to the wiring harness.
2. Set meter to measure resistance.
3. Measure across Wire 14 and Wire 0 (two red wires).
 - a. Approximately 10 ohms of resistance should be present.
 - b. Verify that the solenoids are not shorted to ground (measure one of one of the red leads to ground).
 - c. If resistance is out of specifications or if the solenoid coil is shorted to ground, replace and retest unit.
4. Keep the solenoid plugs disconnected.
5. Set meter to measure resistance.
6. Place black lead on the engine common ground point and red lead on Wire 0.
 - a. CONTINUITY should be measured.
 - b. If CONTINUITY is not measured, troubleshoot Wire 0 back to the common ground point until the break in the circuit is found.

Step 2

1. Reconnect the fuel solenoid plugs.
2. Place black lead on the common ground point.

3. Place red lead on Wire 14 at the fuel solenoid plug (use needle probe).

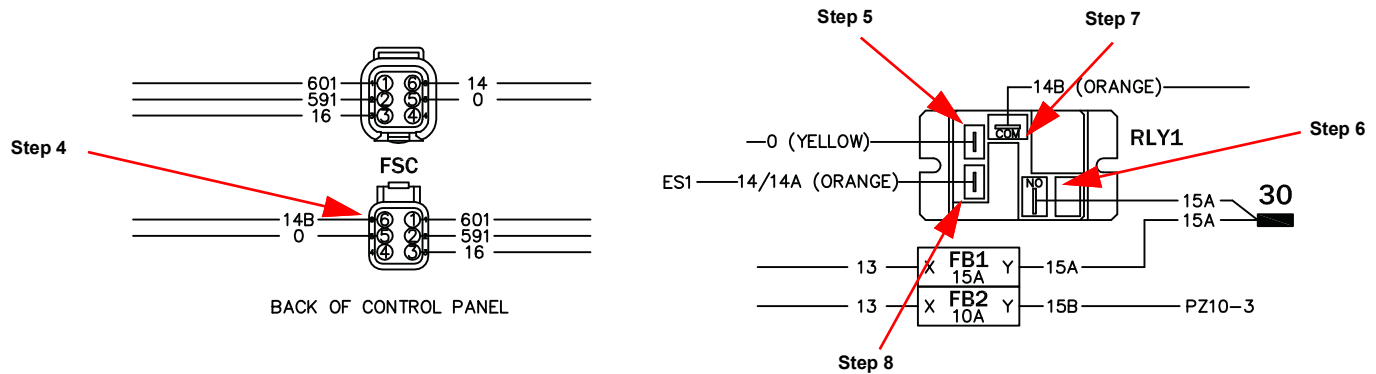
NOTE: There are 2 solenoid plugs. Test both circuits.

4. Place the unit in manual.
 - a. If voltage is present (minimum 10 VDC) go back to Step 1.
 - b. If voltage is not present, continue to next test.

Step 3

1. Place black lead Wire 0 (ground) pin position 5 at the FSC (use needle probe).
2. Place red lead on Wire 14 pin position 6 (use needle probe).
3. Place the unit in manual.
 - a. If voltage is present (minimum 10 VDC) test Wire 14 between the FSC and the and the solenoid plugs for resistance. Replace, as necessary.
 - b. If voltage is not present, continue to next step.

Test 15 – Troubleshooting Run Circuit (continued)



015339

Figure 3-110. Run Circuit Test Points

Step 4

1. Locate the main harness end of the FSC connector.
2. Place black lead on ground.
3. Place red lead on Wire 14 pin position 6 (use needle probe).
4. Place the unit in manual
 - a. If voltage is present (minimum 10 volts DC) test pin connection between the two FSC connectors.
 - b. If voltage is not present, continue to the next test.

Step 5

1. Locate the RLY1 relay in the control panel.
2. Place black lead on ground (Wire 0) and red lead on Wire 0 at the RLY1 and measure for continuity.
 - a. If Wire 0 is measured as an open, replace Wire 0 as needed.
 - b. If CONTINUITY is measured continue to next step.

Step 6

1. Locate the RLY1 relay in the control panel.
2. Place black lead on ground (Wire 0).
3. Place red lead on Wire 15A at RLY1.
4. Measure for D.C voltage.
 - a. If 0 VDC is measured at Wire 15A test Wire 15A back to FB1, checking the wire for continuity and checking FB1 for continuity.
 - b. If battery voltage is measured continue to next step.

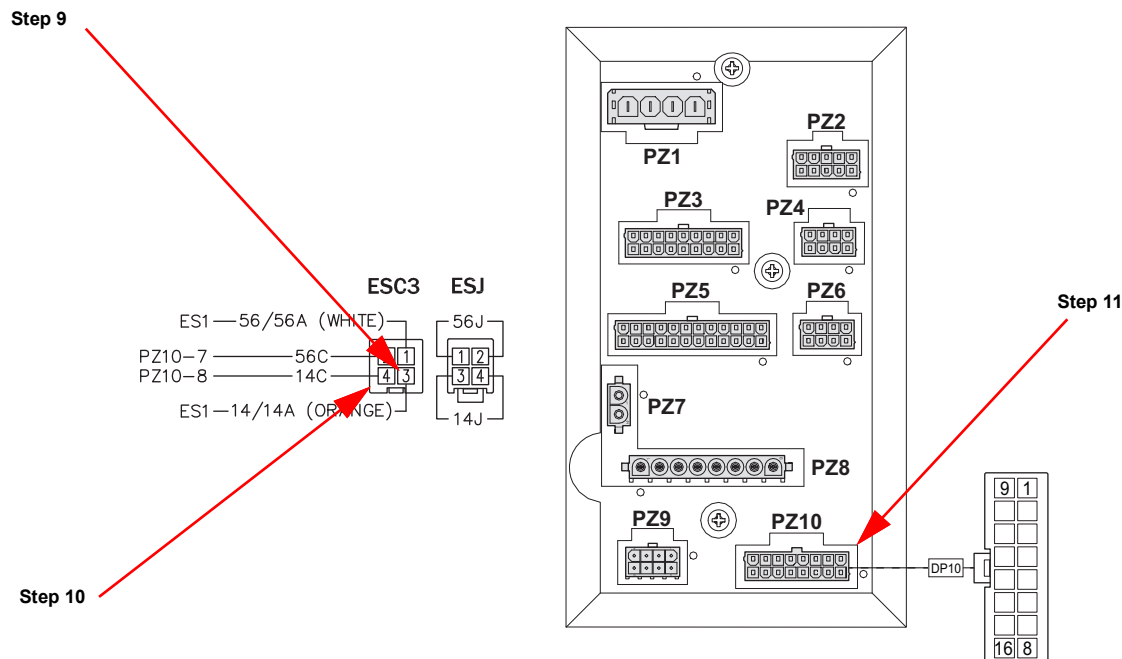
Step 7

1. Locate the RLY1 relay in the control panel.
2. Place black lead on ground (Wire 0)
3. Place red lead on Wire 14B at RLY1.
4. Measure for DC voltage.
5. Place the unit in manual.
 - a. If battery voltage is measured, Wire 14B is faulty between RLY1 and the FSC connector. Test and inspect the wire for breaks or faulty splices.
 - b. If 0 VDC is measured, continue to next step.

Step 8

1. Locate the RLY1 relay in the control panel.
2. Place black lead on ground (Wire 0).
3. Place red lead on Wire 14/14A at RLY1.
4. Measure for DC voltage.
5. Place the unit in manual.
 - a. If battery voltage is measured, then RLY1 relay is faulty, remove, bench test and replace as needed.
 - b. If 0 VDC is measured, continue to the next step.

Test 15 – Troubleshooting Run Circuit (continued)



015340

Figure 3-111. Run Circuit Test Points

Step 9

1. Locate the ESC3/ESJ connector in the control panel.
2. Place black lead on Wire 0 (ground).
3. Place red lead on Wire 14/14A at ESC3 pin position 3.
4. Place the unit in manual.
 - a. If battery voltage is measured, the problem lies in Wire 14/14A between the ESC3 connector and RLY1.
5. Test Wire 14/14A for continuity. If Wire 14/14A is open, repair or replace wire.
 - a. If 0 VDC is measured, continue to next step.

Step 10

1. Locate the ESC3/ESJ connector in the control panel.
2. Place black lead on Wire 0 (ground).
3. Place red lead on Wire 14C at ESC3 pin position 4.
4. Place the unit in manual.
 - a. If battery voltage is measured, the problem lies in the ESC3/ESJ connector.
5. Test ESC3/ESJ connector for continuity. If CONTINUITY is not measured repair Wire 14J.
 - a. If 0 VDC is measured, continue to the next step.

Step 11

1. Place black lead on Wire 0 (ground).
2. Place red lead on Wire 14C at DP10 pin position 8.
3. Place the unit in manual.
4. Verify battery voltage is present.
 - a. If battery voltage is present the problem is with PZ410 controller. Replace as needed

Test 16 – Check Battery Voltage

Procedure

1. Set a DMM to measure DC voltage.
2. Connect the red test lead to the positive terminal of the battery, and connect the black test lead to the negative terminal on the battery. Measure and record the voltage.
3. Set the AUTO-OFF-MANUAL switch to MANUAL. Measure and record the voltage.

IMPORTANT NOTE: The engine will crank and possibly start when the AUTO-OFF-MANUAL switch is set to MANUAL.

Results

1. If voltage was above 12 VDC in Step 2, but dropped below 10 VDC, the battery may have a dead cell or a direct short between the cells and needs to be replaced. The battery can be load tested using a hand held device or taken to a facility with the capability of testing the state of a battery.
2. If voltage was above 12 VDC in Step 2 and above 10 VDC in Step 3, refer to the flow chart.

Test 17 – Check Battery and Cables

General Theory

Battery power is used to crank the engine and to power the circuit board. Low or no battery voltage can result in failure of the engine to crank, either manually or during automatic operation. The battery charger in the control panel is not designed to recharge a dead battery. If there is a loose connection or corrosion associated with a wire (positive or negative), battery voltage may be present, but because of the high resistance, will not allow current to flow. Electrical voltage drop varies according to current flow. Unless the circuit is operated so current flows through it, voltage drop cannot be measured. To properly measure voltage drop, a crank attempt will need to be performed. This test will determine whether the battery, battery cables, or both are at fault.

Procedure A – Perform Starter Circuit Voltage Drop Test

1. De-energize the T1 circuit by whatever means necessary.
2. Set a DMM to measure DC voltage.
3. Connect the red meter test lead to the positive battery post and connect the black meter test lead to the negative battery post.
 - a. If battery voltage is 12.1 VDC or below, proceed to Procedure C or Procedure D.
 - b. If battery voltage is 12.2 VDC or above, proceed to next step.

NOTE: (For this test, battery voltage should be at least 12.2 VDC)

4. Turn off the fuel source and remove Wire 14 from the fuel solenoid to inhibit any possible startup.
5. See [Figure 3-112](#). Perform a voltage drop test as illustrated.

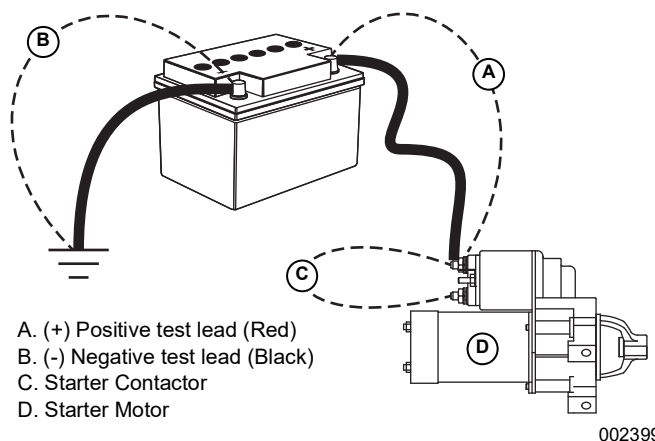


Figure 3-112. Starter Circuit Voltage Drop Test

6. Set the controller to MANUAL; measure and record the voltage.
7. Record readings from test points A, B, and C as depicted in Figure 3-58. Although resistance-free connections, wires, and cables would be ideal, most of them will contain at least some voltage drop. The maximum voltage readings you should see are as follows:
 - a. 0.00–0.10 VDC across a connection
 - b. 0.10–0.20 VDC on a ground connection
 - c. 0.20–0.30 VDC across a wire or cable (A, B)
 - d. 0.20–0.30 VDC across a switch or starter contactor (C).
 - e. 0.40–0.50 VDC across the entire circuit
8. If voltage drop is greater than the above, based on the circuit or component, proceed to step B. If voltage drop is within the above, based on the circuit or component, proceed to Procedure C or Procedure D.

Procedure B – Inspect Battery Cables, Terminals, and Connections

1. Inspect battery cables and battery posts.
2. If cable clamps or terminals are corroded, clean away all corrosion.
 - If corrosion cannot be cleaned or eliminated, replace the component in question.
3. Verify all cable clamps are tight. The red battery cable from the starter contactor (SC) must be securely attached to the positive (+) battery post; the black cable from the frame ground stud must be tightly attached to the negative (-) battery post.

Procedure C – Perform a Load Test on the Battery (All Lead-Acid Type Batteries)

1. Remove 7.5 amp fuse from the controller.



WARNING

Explosion. Batteries emit explosive gases. Always disconnect negative battery cable first to avoid spark. Failure to do so could result in death or serious injury. (000238)

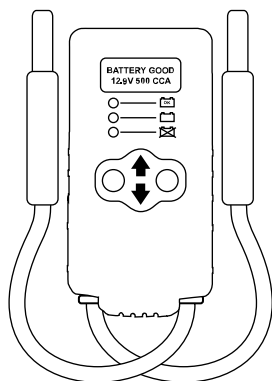
2. Remove the T1 fuse from the transfer switch.
3. Disconnect both negative and positive cables.

NOTE: Disconnect negative cable first.

NOTE: Use of a quality conductance battery tester is highly recommended. A conductance battery tester places less stress on a battery during testing, and takes less time than other methods

4. Using a suitable load tester, test the load capability of the battery.
5. Follow the load tester manufacturer's instructions carefully.
6. Reconnect both positive and negative cables.

NOTE: Reconnect positive cable first.



003391

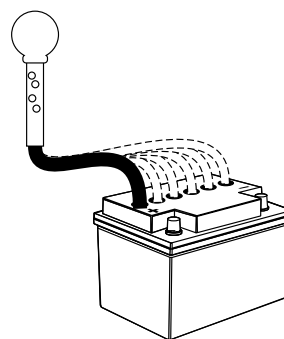
Figure 3-113. Typical Battery Load Tester

Procedure D – Test Battery State of Charge (Non-Maintenance Free Battery Only)

1. Use an automotive type battery hydrometer to test battery state of charge.

NOTE: Use a temperature compensated hydrometer. Check each cell after charging.

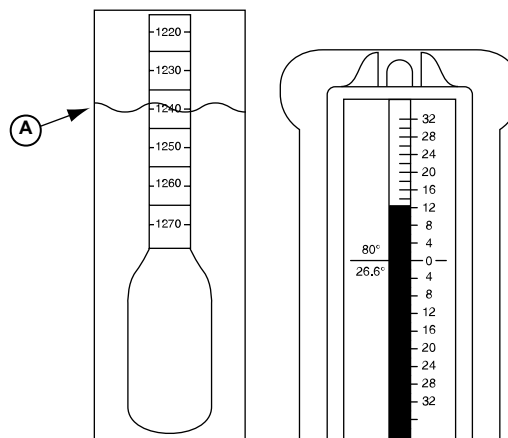
2. Follow the hydrometer manufacturer's instructions carefully. Read the specific gravity of the electrolyte fluid in all battery cells.
3. If cells are low, distilled water can be added to refill cell compartment.



002410

Figure 3-114. Using a Battery Hydrometer

4. If the hydrometer does not have a percentage of charge scale, compare the reading obtained to the following:
 - a. An average reading of 1.260 indicates the battery is 100% charged.
 - b. An average reading of 1.230 means the battery is 75% charged.
 - c. An average reading of 1.200 means the battery is 50% charged.
 - d. An average reading of 1.170 indicates the battery is 25% charged.



A. Liquid Level

002411

Cell #	Specific Gravity
1	1.255
2	1.260
3	1.235
4	1.250
5	1.240
6	1.225

HIGH READING
 ↑
 35 POINTS DIFFERENCE
 ↓
 LOW READING

Figure 3-115. Reading a Battery Hydrometer

5. Test battery condition.
 - a. If the difference between the highest and lowest reading cells is greater than 0.050 (50 points), battery condition has deteriorated and the battery should be replaced.

- b. However, if the highest reading cell has a specific gravity of less than 1.230, the test for condition is questionable. Recharge the battery to a 100% state of charge, and then repeat the test for condition.

Results from Procedure C or Procedure D

1. If the DMM indicated less than 10.5 VDC in Procedure C, remove the battery and recharge with an automotive battery charger.
2. If battery fails tests in Procedure C or D, replace with a new battery.
3. If battery condition is good, refer to the flow chart.

Test 18 – Check Utility Sensing

Procedure

1. Navigate to the digital input display screen.
2. Observe the voltage indicated on the display.
 - a. If the display indicates the approximate utility voltage, replace controller.
 - b. If the display does not indicate the approximate utility voltage, proceed to Step 3.
3. Set the DMM to measure AC voltage.
4. Locate the TB2 terminal strip in the customer connection box.
5. Connect one meter test lead to terminal 1 and the other meter test lead terminal 2. Measure and record the voltage indicated.

Results

1. If the voltage observed in Step 2 was good, replace controller.
2. If the voltage observed in Step 2 was not good, and utility voltage was measured in Step 5, repair or replace the wiring between the TB2 terminal block and the J1 connector.
3. If the DMM did not indicate proper voltage in Step 5, check fuses in transfer switch.

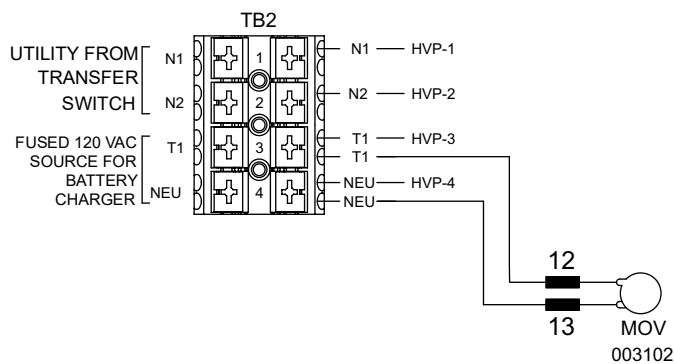


Figure 3-116. AC Customer Connections

Test 19 – Unit Will Not React To 2-Wire Start Input

Procedure

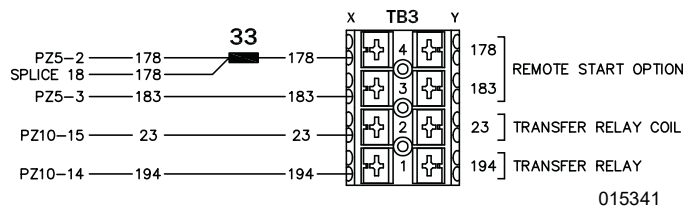
1. Verify controller is set for 2-wire start
2. Verify Wire 183 has 5 VDC at TB3.
 - a. If 5 VDC is not present measure for 5 VDC at PZ5 Pin 3.

PZ5		PIN	WIRE	FROM	FUNCTION
13	1	1	—	—	—
		2	178	CUST CON	2-WIRE START (COM)
		3	183	CUST CON	2-WIRE START (N/O)
		4	—	—	—
		5	—	—	—
		6	—	—	—
		7	—	—	—
		8	BC1	BCC-7	EXT. BATT. CHARGER PRESENT
		9	—	—	—
		10	—	—	—
		11	—	—	—
24	12	12	804A	OS-1	OXYGEN SENSOR

000000

Figure 3-117. PZ5 Connector Pin 3

- b. If 5 VDC is not present the controller is faulty.
 - c. If 5 VDC is present perform a point-to-point resistance test on Wire 183.
3. Attempt a 2-wire start by jumping across Wire 178 and Wire 183 on TB3.



015341

Figure 3-118. TB3 Terminal Block

- a. If units starts and runs inspect the wiring and circuitry in the transfer switch.
- b. If unit does not crank, use diagnostic digital inputs to verify controller is seeing the 2-wire start go active.

NOTE: When jumping between Wires 178 and 183 the digital input signal should change state. Closed will display “0” and Open will display “1”.

Results

Refer to flow chart.

Test 20 – Check Fuel System

General Theory

The engine-generator set was factory tested and adjusted using the primary fuel source (natural gas or LP) as the fuel supply.

- An adequate gas supply and sufficient fuel pressure must be available or the engine will not start or run properly.
- Minimum gaseous fuel pressure at the generator fuel inlet connection is 5 in water column.
- Maximum gaseous fuel pressure at the generator fuel inlet connection is 14 in water column.
- The gaseous fuel system must be properly tested for leaks following installation and periodically thereafter. No leakage is permitted. Leakage testing methods must strictly comply with gas codes. Maximum allowed deviation of fuel pressure at no-load or full load is 1 in of water column.


⚠ DANGER

Explosion and fire. Fuel and vapors are extremely flammable and explosive. No leakage of fuel is permitted. Keep fire and spark away. Failure to do so will result in death or serious injury. (000192)

Procedure

A water manometer or a gauge that is calibrated in inches of water column may be used to measure the fuel pressure. Fuel pressure at the inlet side (top port—where the low fuel pressure switch is located) on the fuel regulator should be between 5–14 in water column when measured with a manometer. Refer to appropriate unit specification sheet for proper fuel pressures.

The fuel pressure can be checked using the recommended fuel pressure tester kit or any fuel pressure tester that measures inches of water column.

1. Turn off fuel to primary regulator by whatever means are provided.
2. See **Figure 3-119**. Connect a manometer to test port B.

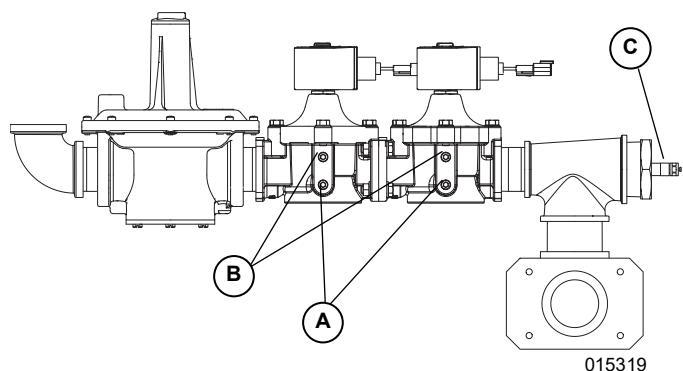


Figure 3-119. Fuel Regulator Test Points

Test Port A	Running Pressure
Test Port B	Static Pressure
Test Port C	Pete's Plug Test Port

3. Turn fuel supply on.
4. Measure and record the Static Pressure (not running).
5. Set AUTO-OFF-MANUAL switch to MANUAL.

IMPORTANT NOTE: The engine will crank and possibly start when the AUTO-OFF-MANUAL switch is set to MANUAL.

6. Measure and record the Running Pressure.

NOTE: The difference in pressure between Not Running and Running should not be greater than 1 in of water column and must remain within specifications.

NOTE: Where a primary regulator is used to establish fuel inlet pressure, adjustment of that regulator is usually the responsibility of the fuel supplier or the fuel supply system installer.

Results

1. If fuel supply and pressure are adequate, but engine will not start, refer to flow chart.
2. If generator starts, but runs rough or lacks power, repeat the above procedure with the generator running and under load. The fuel system must be able to maintain the proper fuel pressure at all load requirements. If proper fuel supply and pressure is maintained, refer to flow chart.

Test 21 – Check for Spark

IMPORTANT NOTE: When checking for spark on the unit verify the fuel supply to the unit is turned off.

Procedure

1. Locate the spark plug wires on top of the valve cover and mark them so they can be placed in the proper location.
2. Remove spark plug wires from the valve cover.
3. Working one cylinder at a time, connect a commercially available spark plug tester that is capable of measuring spark on the specific engine and test each cylinder for good spark.

NOTE: Verify the spark plug tester is secure to get the most accurate spark reading.

4. Turn the AUTO-OFF-MANUAL switch to MANUAL.

⚠ DANGER

Automatic start-up. Disconnect normal power source and render unit inoperable before working on unit. Failure to do so will result in death or serious injury.

(000236)

5. Observe the spark plug tester window while the engine is cranking over.
6. Repeat Steps 3–5 on the remaining cylinders.

Results

1. If spark is bright and strong for each plug, then it is good. Refer to the flow chart.
2. If any of the spark plugs have no spark or a weak spark, replace the respective plug and refer to the flow chart.

Test 22 – Check Condition of Spark Plugs

Procedure

1. Locate the spark plug wires on top of the valve cover and mark them so they can be replaced in the proper location.
2. Remove spark plug wires.
3. See [Figure 3-120](#). Remove the spark plugs one at a time and inspect for the conditions shown.

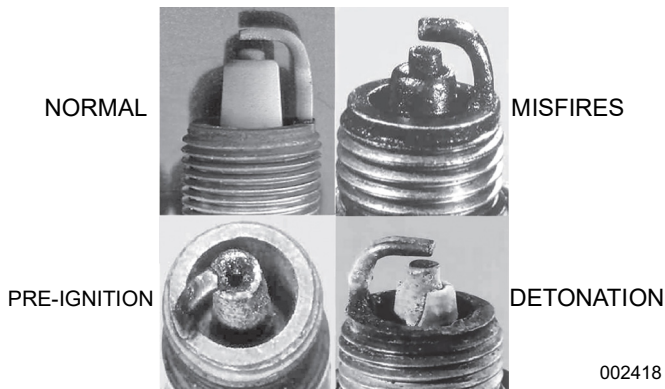


Figure 3-120. Spark Plug Conditions

4. Check the gap of each plug. Refer to [Table 3-3](#) for the correct plug gap.

Engine Liter	Spark Plug Gap
9.0L	0.015 in. (0.381 mm)

NOTE: Refer to the unit specific owner's manual for the proper spark plug gap.

Results

1. If the spark plugs exhibit any possible signs of any of the symptoms shown in [Figure 3-112](#), replace the spark plugs and investigate the possible cause of the problem.
2. Refer to the flowchart.

Assembly

1. Install the spark plugs into the cylinder head.
2. Torque each spark plug to 18 ft-lbs (24.4 Nm).
3. Reconnect the spark plug wires to the spark plugs.

Test 23 – Check Engine Compression and Condition

Discussion

If the engine cranks but will not start, or if it starts hard and runs rough, one possible cause of the problem is a mechanical failure or excessive wear in the engine.

Procedure

1. Warm up the engine, if it will start and run.
2. Shut engine down and remove all spark plugs.
3. Use an automotive type compression tester to check engine compression.
4. Compression pressure should be as follows:

Standard	160 psi (12.1 kg/cm ²) at 350 rpm
Minimum	120 psi (8.4 kg/cm ²) at 350 rpm

NOTE: Difference between cylinders should not exceed 15 psi (1.1 kg/cm²)

If compression is low in any cylinder, pour a small amount of clean engine oil into the spark plug opening. Then, retest compression and evaluate as follows:

- If compression pressure increases after adding the oil, check for worn or damaged piston rings.
- If compression pressure did NOT increase after adding the oil, check for sticking or improperly seated valves.
- If compression in any two adjacent cylinders is low and adding oil did NOT increase the compression pressure, check for a leaking head gasket (possibly indicated by oil in the coolant).

Test 24 – Check Actuator and Mixer Function

General Theory

The governor actuator (GA) is an electronically controlled throttle-valve. The GA controls the amount of fuel and air mixture allowed into the engine to maintain proper speed through the entire load range of the unit. It is comprised of a throttle valve with electric drive, and a feedback circuit for throttle position back to the controller.

Terms

- Throat—The path where air flows through the governor.
- Throttle Plate—The butterfly valve in the throat of the governor.
- Rest Position—Position of the throttle plate with no power to unit. (Throttle plate almost perpendicular to the direction of air flow)

- Open Position—Throttle plate parallel to the direction of air flow.
- Upper Mechanical Stop (UMS)—Internal mechanical stop to prevent over rotation of throttle plate in the opening direction. (Past the open position)
- Lower Mechanical Stop (LMS)—Internal mechanical stop to prevent over rotation of throttle plate in the closing direction. (Past the rest position)
- Feedback circuit—The circuit between pins 2, 3, and 6 on the governor.

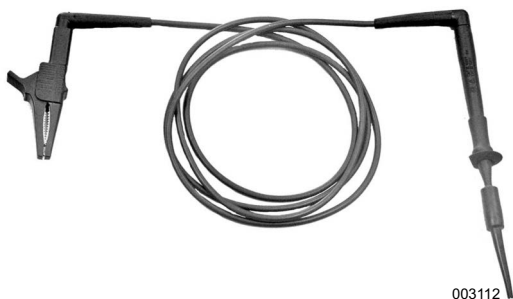
Tools Required

- 0J09460SRV test lead kit or equivalent narrow test leads 2 EA
- Miscellaneous test leads
- Digital multimeter (DMM)



003104

Figure 3-121. Test Lead Adapters



003112

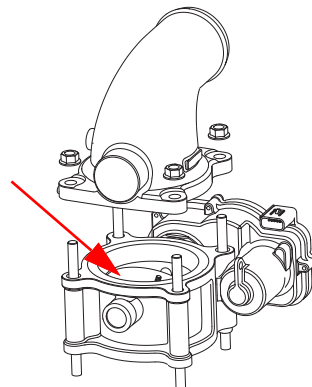
Figure 3-122. Bosch Testing Harness for Wires 770 and 771

Table 3-4. Governor Actuator Pin-out at Actuator

Pin #	Wire #	Function
Pin 1	Wire 771	Negative (-) DC voltage actuator power.
Pin 2	Wire 767	Throttle position feedback return.
Pin 3	Wire 765	Throttle position feedback source.
Pin 4	Wire 770	Positive (+) DC voltage actuator power.
Pin 6	Wire 766	Throttle position feedback signal.

Procedure A

1. Set the generator to OFF. (Verify the generator is not in AUTO or MANUAL.)
2. Shut off the fuel line(s) to the generator.
3. Remove the air intake assembly or remove governor throttle arm to expose the throttle plate of the GA.



015343

Figure 3-123. Throttle Plate

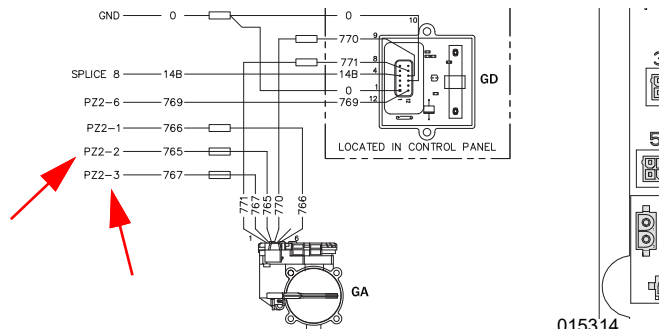
4. Disconnect the harness from the GA.
5. Carefully move the internal throttle plate by hand with a non-metallic object. Watch for the throttle plate snapping back due to the internal spring. The throttle plate should rotate open and return to the rest position.
 - If the throttle plate does not move smoothly through the total range (from LMS to UMS), replace the governor actuator (GA).
6. Reconnect the harness to the GA.

Procedure B (Part 1) – Verify Governor Actuator Voltage Supply

This test will verify that the actuator has 3 VDC supplied to the actuator feedback circuit from the control panel. 3 VDC should be present between Wires 765 and 767.

NOTE: Use appropriate back probes to avoid damaging the mini amp connector.

1. Use the appropriate wiring schematic / drawing to identify the pin out locations for Wire 765 Pin 2 and Wire 767 Pin 3 at the controller.



015314

Figure 3-124.

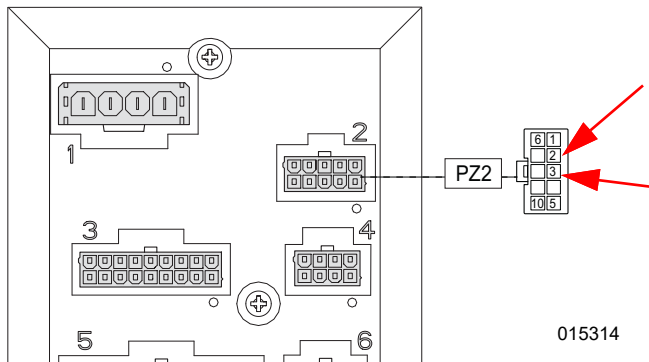


Figure 3-125.

1. Use the appropriate wiring schematic / drawing to identify the pin out locations for Wire 766 Pin 1 and Wire 767 Pin 3 at the controller.

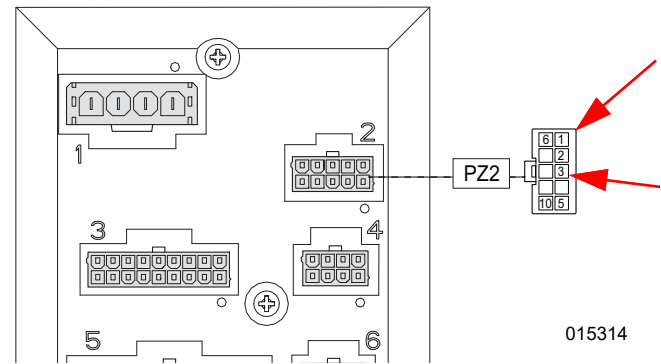


Figure 3-127.

2. Set a DMM to read DC voltage (If applicable in a 0–5V range).
3. Using appropriate back probe test leads,
 - a. use the black lead (-) to back probe the negative / ground Wire 767.
 - b. use the red test lead (+) to back probe the positive Wire 765.
 - c. The measured voltage should be 3 VDC \pm 15%.

2. Set a DMM to read DC voltage (If applicable in a 0–5V range).
3. Using appropriate back probe test leads,
 - a. use the black lead (-) to back probe the negative / ground Wire 767 Pin 3.
 - b. use the red lead (+) to back probe the positive Wire 766 Pin 1.
4. Moving the throttle plate from LMS to UMS, verify that there are no spikes or sharp drops in voltage through the entire range of motion.
5. Measure and record values for LMS, Rest, and UMS. Verify the results with the table below.

Results

1. If the appropriate voltage is present, go to Procedure B (Part 2) – Verify Governor Actuator Voltage Supply.
2. If the appropriate voltage is not present, verify the female pins are making tight contact with their corresponding male pins on the control board.
3. If connection is good replace controller.

Voltage Value vs. Throttle Plate/Arm Position Voltage Tolerance	
LMS	0.467V \pm 10%
Rest	0.482V \pm 10%
UMS	3.000V \pm 10%



Figure 3-126. Back Probes in Use

Procedure B (Part 2) – Verify Governor Actuator Voltage Supply

This test will verify that feedback voltage from the governor actuator is being sent from the actuator and that the control panel is receiving this voltage. A modulating voltage should be measured between Wires 766 and 767.

NOTE: Use appropriate back probes to avoid damaging the mini amp connector.

Results

1. If feedback voltage is out of tolerance, replace the GA.
2. If feedback voltage is not present, perform a point to point resistance check of the harness from the connector on the actuator to the corresponding pins connected to the control panel.
3. If there is an open in the circuit, repair or replace the harness as needed.

NOTE: Female connectors can easily get flared out or damaged, preventing contact with the male pins on the GA or control panel. Thoroughly inspect the connections before condemning any components.

Voltage Value vs. Throttle Plate/Arm Position Voltage Tolerance	
LMS	0.467V ± 10%
Rest	0.482V ± 10%
UMS	3.000V ± 10%

Procedure C – Test Throttle Motor Operation

1. See **Figure 3-128**. Disconnect plug from governor driver (GD). This may cause a warning or alarm condition to appear on the control panel display.

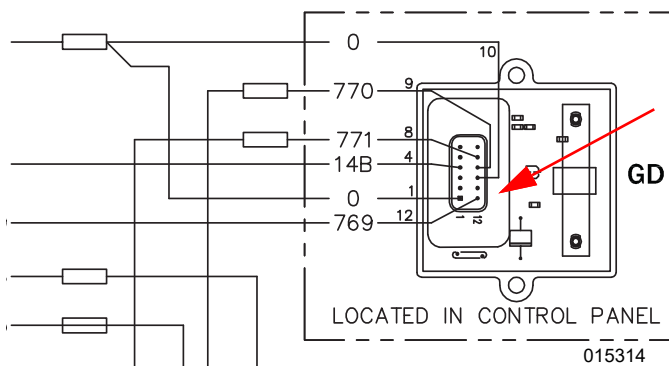


Figure 3-128.

See **Figure 3-129**. Identify Wire 770 Pin 8 and 771 Pin 9 in the harness.

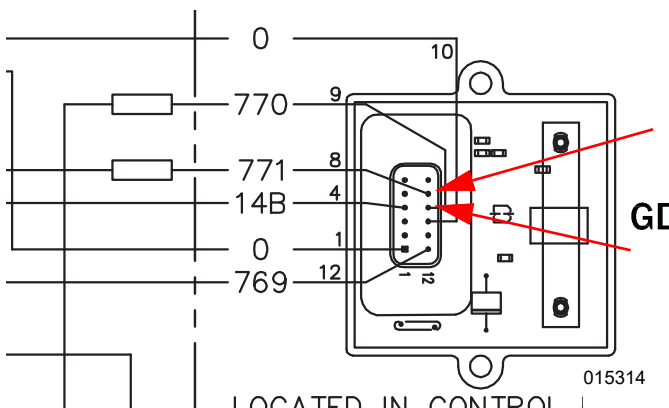


Figure 3-129.

2. Using a harness with an in-line 7.5 amp fuse, momentarily apply 12 VDC to wires 770 and 771. Wire 771 is negative (-) and Wire 770 is positive (+).

IMPORTANT NOTE: Needle probes must be used.

NOTE: The throttle should move to its full open position.

NOTE: If the actuator goes to the fully closed position when performing this test, reverse the wiring.

Results

1. If the governor actuator does not move, isolate the harness and perform a point to point resistance

check from the connector on the GA to the corresponding pins that are connected to the control panel.

2. If there is an open in the circuit, repair or replace the harness as needed.
3. If no open is detected, perform Procedure D – Test Throttle Motor Resistance.

Procedure D – Test Throttle Motor Resistance

1. Disconnect the appropriate harnesses containing Wires 770 and 771 from the GD. Using needle probes back probe the connector at the GA (Wires 770/771). A resistance measurement of 2.8 ohms ± 15% should be present.
 - If the harness and drive motor tests are within tolerance, and the GA has movement replace the GD.

NOTE: Female connectors can easily get flared out or damaged, preventing contact with the male pins on the actuator / control panel. Thoroughly inspect the connections before condemning any components.

Test 25 – Test Low Coolant Level Sensor

Tools Required

- 1 – 1000 Ohm, ¼ Watt Resistor

Procedure

1. Locate and disconnect the low coolant level switch from the radiator.
2. Install the 1000 ohm resistor between wires 573 and 573A on the engine harness side.

Results

1. If the coolant level fault went away, replace sensor.
2. If the coolant level fault remained, refer to the flow chart.

Test 26 – Check Wires 573 and 573A

Procedure

1. Set a DMM to measure resistance.
2. Locate and disconnect the appropriate connector from the back of the controller.
3. Locate and disconnect the low coolant level sensor.
4. Connect one meter test lead to Wire 573A in the harness at the controller and the other meter test lead to Wire 573A located at the coolant sensor connector plug (engine harness side). Measure and record the resistance indicated by the DMM.
5. Connect one meter test lead to Wire 573 in the harness at the controller and the other meter test

lead to Wire 573 located at the coolant sensor connector plug (engine harness side). Measure and record the resistance indicated by the DMM.

6. Connect one meter lead to connector on Wire 573 and the other lead to the connector on Wire 573A. Check for a short between the wires.

Results

1. If the DMM indicated CONTINUITY in steps 4 and 5, replace controller.
2. If the DMM indicated INFINITY or a high resistance in either Step 4 or 5, repair or replace wire as needed.

Test 27 – Check Coolant Level

General Theory

The coolant is used to cool the engine by dissipating heat away from the engine. The coolant is then cooled by passing through the radiator. If the coolant is not filled to the proper level for cooling, the engine may become damaged from excess heat build up over a period of time.

Procedure

1. Remove the black rain cap on top of the generator housing.



⚠ WARNING

Risk of burns. Contents under pressure. Do not remove the radiator pressure cap while engine is hot. Doing so could result in death or serious injury. (000322a)

2. Remove the radiator cap from the top of the radiator.
3. Verify the coolant filled to the bottom of the filler neck.

Results

1. If coolant level is low, fill the radiator with coolant prescribed by owners manual. Check for leaks. Check oil for a milky color (this may be a sign of a leak internal to the engine).
2. If coolant level is normal, refer to the flow chart.

NOTE: The age of the coolant may also effect how well it operates with the coolant level sensor. If the coolant becomes dirty, this can cause intermittent faults to occur.

Test 28 – Verify Fan/Fan Drive Operation (If Equipped)

Procedure

1. Locate the fan mounted either directly to the engine or on the opposite of the radiator.
2. Set AUTO-OFF-MANUAL switch to MANUAL.

3. Verify fan and proper belt operation.

Results

1. Repair or replace failed components as identified.
2. If operation is good, refer to the flow chart.

Test 29 – Check Coolant Hoses

General Theory

If maintenance is not performed regularly, the radiator hoses can become cracked or dry rotted, and may even break down due to weather exposure. The hose clamps can also become loose, causing coolant leaks. Check the radiator hoses when troubleshooting coolant issues.

Procedure

1. Locate and inspect the upper and lower radiator hoses.

Results

1. If no problem is found with either the upper or lower hoses on the generator and the problem continues, replace the thermostat.
2. If the hose displays blockage, remove the blockage from the area that is being affected.

Test 30 – Test Oil Pressure Switch

Procedure A

1. Locate the low oil pressure switch.
2. Set a DMM to measure DC voltage.
3. Connect one meter test lead to Wire 86 at the low oil pressure switch and the other meter test lead to a clean frame ground. 0 VDC should be measured.
4. Set the AUTO-OFF-MANUAL switch to MANUAL.

⚠ DANGER

Automatic start-up. Disconnect normal power source and render unit inoperable before working on unit. Failure to do so will result in death or serious injury.

(000236)

5. The DMM should read 0 VDC while cranking and should read approximately 5 VDC once the unit is at its rated speed and oil pressure is above 10 psi (69 kPa).

Results

1. The voltage that should be measured should start at 0 VDC, indicating the switch is closed. The voltage should climb to 5 VDC, indicating proper function of the switch.
2. If the voltage at the switch remained at 0 VDC, replace the switch.

- If the voltage at the switch rose to 5 VDC, replace the controller.

Procedure B

- Set a DMM to measure continuity.
- Connect one meter test lead to Wire 86 at the low oil pressure switch and the other meter test lead to Wire 0.
 - With engine off CONTINUITY should be measured.
- Set unit to Manual.
 - With engine running INFINITY should be measured.

Results

- If values in Steps 2 and 3 are not measured replace OPS.
- If values in Steps 2 and 3 are measured refer to Test 45.

Test 31 – Check Engine Oil Pressure

General Theory

If the engine can't maintain a certain oil pressure range, engine damage may result due to improper lubrication. If the engine has too much oil pressure the engine may suffer severe internal and/or external damage during running operations.

Tools Required

- Oil pressure gauge

Procedure

- Remove the oil pressure switch from the engine block.
- Insert oil pressure gauge.
- Turn the AUTO-OFF-MANUAL switch to MANUAL.

IMPORTANT NOTE: *The engine will crank and possibly start when the AUTO-OFF-MANUAL switch is set to MANUAL.*

NOTE: With the oil pressure switch removed, the engine will shut down for low oil pressure after 10 seconds.

- Record the results.

Results

- If the unit doesn't have oil pressure after 10 seconds, shut the unit down and reference the engine service manual.
- If the oil pressure is within operating range between 58–90 psi (399-620 kPa), refer to the flow chart.

Test 32 – Check Wire 86 for Continuity

General Theory

The control board uses Wire 86 to monitor the low oil pressure switch for a possible problem with the engine internal oil pressure. If wire 86 is shorted or pinched, the unit will shutdown after 10 seconds of running.

Procedure

- Turn the AUTO-OFF-MANUAL switch to OFF.
- Locate the low oil pressure switch and the appropriate connector located on the back of the controller.
- Disconnect Wire 86 from the low oil pressure switch. Disconnect the appropriate connector from the control board in the control panel.
- Set DMM to measure resistance.
- Connect the positive lead to Wire 86 on the harness oil pressure switch end and the negative lead to the appropriate Wire 86 at the controller end. Measure and record the resistance.

Results

- If the DMM indicated CONTINUITY, refer back to flow chart.
- If the DMM indicated open or high resistance, repair or replace Wire 86 between low oil pressure switch and controller connections.

Test 33 – Check Wire 86 for a Short to Ground

Procedure

- Disconnect the appropriate connector from the controller.
- Isolate Wire 86 from the low oil pressure switch.
- Set a DMM to measure resistance.
- Connect one meter test lead to disconnected Wire 86 and the other meter test lead to a clean frame ground.

Results

- If resistance is measured to ground, repair or replace Wire 86.
- If the DMM indicated INFINITY, refer to the flow chart.

Test 34 – Test T1 Power To Battery Charger

General Theory

Fused 120 VAC must be supplied from a source that is always available (downstream of the transfer switch). The source connects to the customer terminal block

(TB2) at terminals T1 (Hot) and NEU (dedicated neutral required). T1 and NEU connect to the control board via Connector PZ7 Pin 1 (T1) and Pin 2 (neutral).

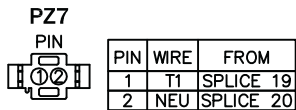
NOTE: This voltage must be ALWAYS PRESENT. The control panel will issue a Battery Charger AC Failure Alarm if 120 VAC is not present.

NOTE: Some RTS style switches have a dedicated T1 output at the load side of the contactor. If the switch does not have a dedicated T1 output then a breaker protected 120 VDC source must be supplied to T1 and neutral to the TB2 at the generator. This source must get power from the load side of the transfer switch.

Procedure

Perform the following steps to troubleshoot the circuit in the event of a Battery Charger AC Failure Alarm.

1. Set DMM to measure AC volts.
2. Place red test lead in PZ7 Pin 1 (T1).



015349

Figure 3-130. PZ7 Connector

IMPORTANT NOTE: Place black test lead on PZ7 Pin 2 (NEU).

3. Measure for AC volts at Connector PZ7.

Results

1. If 120 VAC is present at Connector PZ7 the problem is in the control panel.
2. If 120 VAC is not present measure for AC volts
 - at the corresponding locations on the TB2 connector.
 - at the source of the fused 120 VAC for T1 and neutral wire (if TB2 test is good).

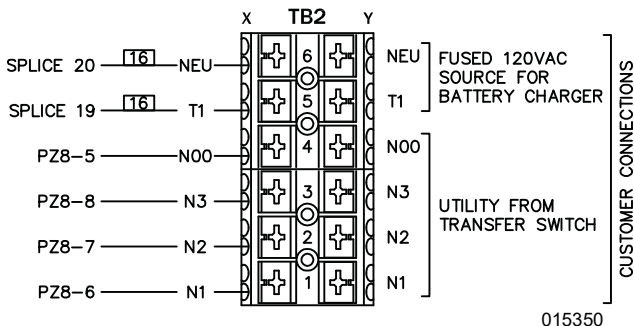


Figure 3-131. TB2 Terminal Block

Test 35 – Test DC Charge Current to the Battery

General Theory

Previous testing has verified the 120 VAC input connection and the battery connection. This test procedure will determine if there is a negative draw on the battery or a positive one, which will indicate successful operation of the charger.

Procedure

NOTE: An inspect battery alarm may be generated during this test procedure. It will not effect the results of the test and can be acknowledged when testing is complete.

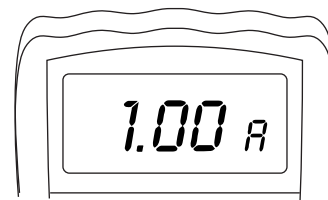
1. Set the AUTO-OFF-MANUAL switch to MANUAL and crank the engine for 2–3 seconds.
2. Disconnect the negative cable battery.
3. Set the DMM to measure DC amperage.

NOTE: Consult the meters owner’s manual to verify proper setup of meter and that the internal fuse is good before proceeding.

4. Connect the positive (red) meter test lead to the negative battery post and connect the negative (black) meter test lead to disconnected negative battery cable. Measure and record the amperage.

Results

1. If the DMM indicated positive DC amperage between 50 milliamps to 2.5 amps, stop testing. The charger is functioning properly.
2. If the DMM indicated negative DC amperage, replace the controller.



002435

Figure 3-132. Positive DC Amps



002436

Figure 3-133. Negative DC Amps

Test 36 – Check Wires 0 and 13

General Theory

If the controller did not register voltage on the display, or voltage was less than required, a possible cause could be a bad connection at the controller.

Procedure

1. Disconnect the PZ10 connector from the controller.
2. Set a DMM to measure DC voltage.
3. Connect one meter test lead to PZ10-1 (Wire 13) and the other meter test lead to a clean frame ground. Measure and record the voltage.
4. Connect one meter test lead to PZ10-2 (Wire 13) and the other meter test lead to a clean frame ground. Measure and record the voltage.
5. Connect one meter test lead to PZ10-4 (Wire 0) for and the other meter test lead to the positive post of the battery. Measure and record the voltage.

Results

6. If the DMM indicated battery voltage in Steps 3–5, replace controller.
7. If the DMM did not indicate battery voltage in any one of Steps 3–5, repair or replace respective wire as needed.

Test 37 – Check T1 Voltage at Customer Connections

Procedure

1. Set a DMM to measure AC Voltage.
2. Connect one meter test lead to TB2 terminal 3 (Wire T1) at the customer connections in the generator. Connect the other meter test lead to TB2 terminal 4 (Wire NEU). Measure and record the voltage.

Results

1. If the DMM indicated 120 VAC, proceed to check voltage at the J2 connector. Refer to the flow chart (Good).
2. If the DMM indicated less than 120 VAC or 0, refer to the flow chart (Bad).

Test 38 – Test Overcrank Fault Circuit

Procedure

1. Turn off the fuel supply to the generator.
2. Set the AUTO-OFF-MANUAL switch to MANUAL and let generator crank through an entire cycle.

Results

1. If overcrank alarm is not present and rpm sense continues return to flow chart.
2. If overcrank alarm is present contact Technical Support.

Test 39 – Check Flywheel Sensor (MPU1)

General Theory

The flywheel sensor (MPU1) is an rpm sensor.

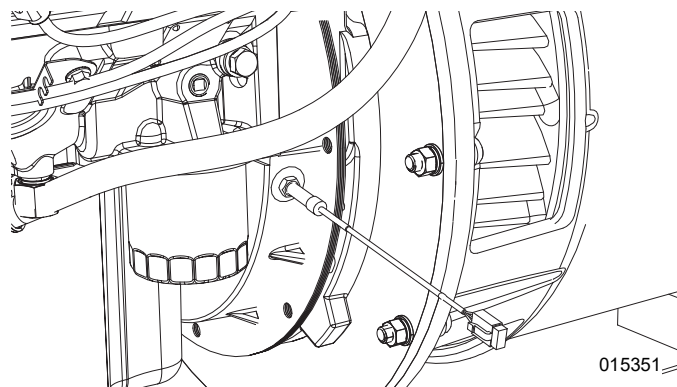


Figure 3-134. G9.0L Engine Flywheel Sensor (MPU1)

NOTE: Refer to Section 1.4 [General Troubleshooting Guidelines](#) for procedures on testing connector plugs and incoming wires.

Tools Required

- 0G41800SRV Breakout Harness

Procedure A

1. Disconnect the flywheel sensor (MPU1) from the engine harness.
2. Set the DMM to measure resistance (Ω).
3. Using needle probes connect one meter test lead to Wire 79 Pin 3 and the other meter test lead to Wire 79A Pin 2 on MPU1. Measure and record the resistance.

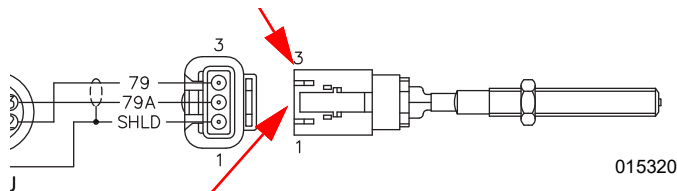


Figure 3-135.

- a. If the flywheel sensor resistance is approximately 700-1000 ohms, proceed to Step 4.
- b. If the flywheel sensor resistance is not within limits, replace MPU1 and refer to PIB08-15-S for proper installation and adjustment procedures.

4. Set a DMM to measure AC voltage.
5. See [Figure 3-136](#). Connect the breakout harness (P/N 0G41800SRV) to the MPU1, in-line with the engine control harness.
6. Set the AUTO-OFF-MANUAL switch to MANUAL.

NOTE: If acceptable flywheel sensor resistance was measured in Step 3 and acceptable voltage was measured in Step 5, an issue may still exist whereby the tip of the flywheel sensor is dirty and may need to be cleaned. Refer to PIB08-15-S for proper installation and adjustment procedures.



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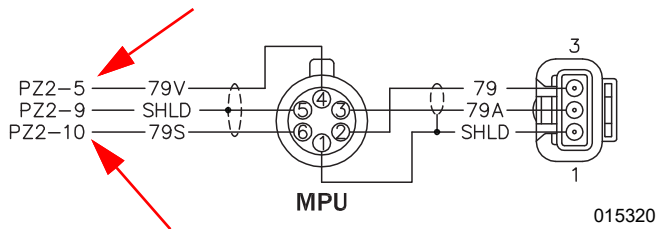
Figure 3-136. Breakout Harness

Results

1. If the DMM did not indicate approximately 1000 ohms in Step 3, replace the MPU1.
2. If the DMM indicated acceptable resistance in Step 3, but little or no voltage was measured in Step 5, refer to PIB08-15-S for proper installation and adjustment procedures.
3. If acceptable resistance was measured in Step 3 and acceptable voltage was measured in Step 5, refer to the flow chart.

Procedure B

1. Disconnect connector from MPU1.
2. Measure point to point for continuity from signal conditioner to MPU1.



015320

Figure 3-137.

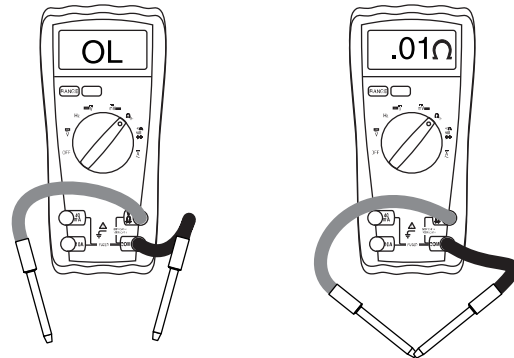
3. See [Figure 3-137](#). Back probe for DC voltage between PZ2-5 and PZ2-10.
 - a. Without engine running approximately 12 VDC should be measured.
 - b. With engine running approximately 10 VDC should be measured.

NOTE: Alternatively AC voltage measurement between PZ2-5 and PZ2-10 will be 2.0 VAC and a frequency of approximately 5 kHz for 9.0L engine.

Test 40 – Check for Short Circuits

General Theory

If any fuse has opened, the most likely cause is a short to ground in the circuit that the fuse is protecting. Troubleshooting an open requires an understanding of the resistance differences between INFINITY and CONTINUITY. [Figure 3-138](#) shows the DMM in two different states.



002397

Figure 3-138. Infinity vs. Continuity

The left DMM indicates an OPEN circuit or INFINITY. The right DMM indicates CONTINUITY. Since the resistance is very low it can be considered that 0.03 ohms equals a direct short, or a short to ground. A short to ground will usually cause a fuse to open.

In order to troubleshoot a circuit that has a short to ground the various legs and components of the circuit must be isolated. For example, if a circuit that includes a fuel solenoid has an open fuse in it, the cause could be the fuel solenoid itself or the positive power source wire. Begin troubleshooting by checking the resistance across the coil and the resistance from the coil to a clean frame ground. The resistance on the coil can be found in [Table 3-5](#).

NOTE: When measuring resistance the component must be completely isolated.

Table 3-5. Coil Resistances (± 5%)	
Component	Resistance
Starter contactor	4.6 Ω
Main fuel solenoid	15 Ω
Cold start fuel solenoid	6.7 Ω
Oxygen sensor heater	5.4 Ω
Air/fuel solenoid	27 Ω
Transfer relay	110 Ω

The coil should read INFINITY to ground. If it reads CONTINUITY to ground the problem has been located. If the coil tests good, test the positive power source wire for continuity to ground. Remove one end of the wire and place a meter lead on it, and place the other meter lead on a clean frame ground. The meter should read open if the wire is isolated, or if the coil resistance if the component is still connected. If very low resistance is present the wire is shorted to ground. Locate the short and repair it or replace the wire.

Test 41 – Test Low Fuel Pressure Switch

General Theory

The low fuel pressure switch is a normally open switch that will CLOSE when pressure is above 5 inches of water column. Wires 601 and 0 are connected to the switch. The controller will monitor Wire 601 for a ground, indicating the unit has 5 inches of water column or greater. When the switch is OPEN, 5 VDC will be present on Wire 601 indicating a low fuel pressure condition has occurred. This fault will not shutdown the engine. It will only indicate that there is an issue with fuel.

Procedure

1. Remove Wire 601 and Wire 0 from the switch.
2. Turn off the fuel supply to the generator.
3. Set a DMM to measure resistance (Ω).
4. Connect one meter test lead to one terminal of the switch and the other meter test lead to the other terminal on the switch where Wires 601 and 0 were removed. INFINITY should be measured.
5. Turn on the fuel supply to the generator.
6. Repeat Step 4.
 - CONTINUITY should be measured.
7. Set the AUTO-OFF-MANUAL switch to AUTO.
8. Set a DMM to measure DC voltage.

NOTE: Wires 601 and 0 should still be removed.

9. Connect one meter test lead to wire 601 and connect the other meter test to a clean frame ground. 5 VDC should be measured.
10. Set a DMM to measure resistance (Ω).
11. Connect one meter test lead to wire 0 and the other meter test lead to a clean frame ground. CONTINUITY should be measured.
 - a. If 5 VDC was measured in Step 9, proceed to the results.
 - b. If 5 VDC was not measured, proceed to step 12.
12. Disconnect the appropriate connector from the controller.
13. Set a DMM to measure resistance (Ω).

14. Connect one meter test lead to wire 601 that was removed from the switch and connect the other meter test lead to Wire 601. CONTINUITY should be measured.

Results

1. If Steps 4, 6, 9, and 11 tested good, check for bad crimps on connectors or possibly a switch that has gone out of calibration in which case the switch would need to be replaced.
2. If either Steps 4 or 6 failed, replace the switch.
3. If Steps 4 and 6 tested good, but no voltage was measured in Step 11, and Step 14 was good, replace printed circuit board.
4. If Steps 4 and 6 tested good, but no voltage was measured in Step 11, and Step 14 tested bad, repair or replace Wire 601 between the controller and the low fuel pressure switch.

Test 42 – Test Oxygen Sensor (OS1)

Tools Required

- Resistive load of 20% or greater of unit capacity.

Procedure

1. Locate and disconnect the oxygen sensor (OS1) connector. Keep it accessible for the duration of this testing procedure.
2. Set a DMM to measure resistance.
3. See [Figure 3-139](#). Connect one meter test lead to terminal C of the sensor and the other meter test lead to terminal D. Measure and record the resistance.
 - a. If the DMM indicated INFINITY, replace sensor.
 - b. If the DMM indicated 6 ohms of resistance, proceed to Step 4.

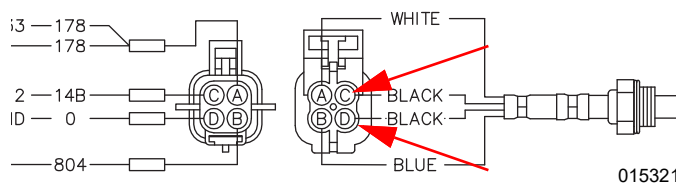


Figure 3-139. Oxygen Sensor

4. Reconnect OS connector.
5. Connect a resistive load bank.
6. Set the DMM to measure DC voltage.
7. Using needle probes back probe one meter test lead to terminal A of the sensor and back probe the other meter test lead to terminal B.

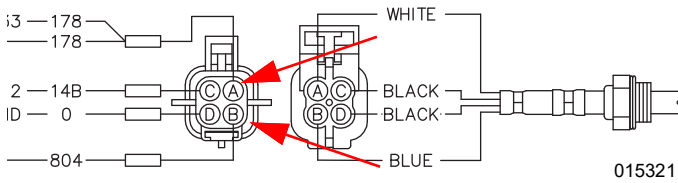


Figure 3-140. Oxygen Sensor

8. Set the AUTO-OFF-MANUAL switch to MANUAL.
9. Once engine is running and stabilized, load the generator with 20% or greater of unit capacity.
10. With the generator running under load, measure and record the DC voltage indicated by the DMM.
 - a. If the DMM indicated a varying DC voltage between 0.3–0.9 VDC, the system is operational.
 - b. If the DMM indicates approximately 0 VDC, replace OS1.
 - c. If the DMM indicates a steady voltage of approximately 0.8–0.9 VDC perform **Test 43 – Test Air/Fuel Solenoid (AFS)**.

NOTE: Only a short window exists (approximately two minutes) after the engine shuts off to test the wiring harness.

11. Set the AUTO-OFF-MANUAL switch to OFF.
12. Locate the PZ-5 connector on the controller.
13. Set a DMM to measure DC voltage.
14. Back probe one meter test lead to Wire 804A (Pin12) and the other meter test lead to Wire 805A (Pin 16).
15. Set the AUTO-OFF-MANUAL switch to MANUAL.
16. Once engine is running and stabilized, load the generator with 20% or greater of unit capacity. Measure and record the voltage.
 - a. If the DMM indicated a modulating voltage of 2.5–5 VDC, replace controller?
 - b. If the DMM did not indicate the proper voltage, repair or replace wiring between the controller connector and the oxygen sensor signal conditioner.

Test 43 – Test Air/Fuel Solenoid (AFS)

Tools Required

- Resistive load of 20% or greater of unit capacity.

NOTE: Check all vacuum lines for any signs of deterioration or deformation.

Procedure

1. Locate the air/fuel solenoid (AFS) on the fuel regulator.
2. Set the AUTO-OFF-MANUAL switch to MANUAL.

NOTE: Minimum load on the unit should be minimum 20 percent unit capacity.

3. Place a hand on the AFS to feel for pulsations.
 - a. If the solenoid is not pulsating, proceed to Step 4.
4. Using needle probes place red meter lead to 15A Pin 2 and black lead to frame ground. Approximately 12 VDC should be present.
 - If voltage is not measured on 15A troubleshoot the harness.

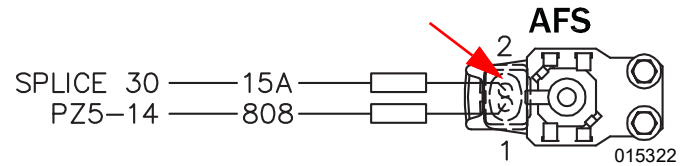


Figure 3-141. Air/Fuel Solenoid

5. See **Figure 3-142**. Locate and disconnect the PZ5 connector from the back of the controller.

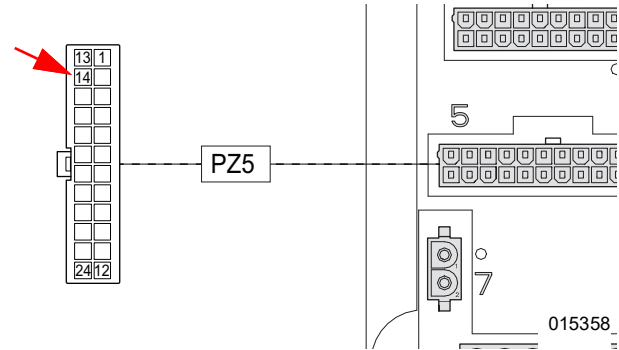


Figure 3-142. PZ5 Connector

6. Set a DMM to measure resistance.
7. Connect one meter test lead to Wire 808 PIN 14 and the other meter test lead to Wire 15A. Measure and record the resistance.
 - a. If the DMM indicated approximately 27 ohms, replace the control panel.
 - b. If the DMM did not indicate the proper resistance, proceed to Step 8.
8. See **Figure 3-143**. Locate the air/fuel solenoid on the fuel regulator and disconnect the connector.

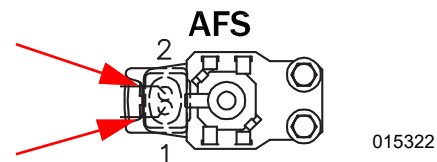


Figure 3-143. Air/Fuel Solenoid

9. Connect meter test leads across the terminals of the AFS. Measure and record the resistance.
 - a. If the DMM indicated, approximately 27 ohms, repair or replace wiring between the PZ5 connector and the AFS.

- b. If the DMM did not indicate the proper resistance, replace AFS.

Test 44 – Coolant Sensor Circuit

The controller monitors the coolant sensor circuit for overheating. The coolant sensor is located near the thermostat and has one supply wire and one ground wire. The controller supplies a 3.3 VDC sensing voltage to the coolant sensor and monitors the changes in resistance based on the temperature of the engine. As the engine temperature goes up the resistance of the sensor goes down, pulling the supply voltage of the controller down. When the voltage reaches a predetermined level the High Temperature Alarm (E-Code 1400) is triggered. The engine begins overheating at approximately 246 °F (119 °C) with a resistance value of 102 ohms ($\pm 2.6\%$) and 2.17 VDC at the controller.

Procedure

1. Verify proper operation of the coolant sensor circuit by back probing between Wire 68 and Wire 0 at the controller to monitor voltage. As the engine warms up, use an external temperature measuring device, such as an infrared temperature gun, to monitor the engine temperature near the coolant sensor. Voltage will go down as the engine is warming up. When the engine temperature reaches 246 °F (119 °C) the voltage will be approximately 2.1 VDC.
2. With the controller connector disconnected, measure the resistance of the coolant sensor circuit between Wire 68 and Wire 0 at the controller connector and compare the resistance value Table 3-5 based on the temperature at the sensor.

Results

1. If the voltage value matches the temperature reading and the unit shuts down High Temperature Alarm the coolant sensor circuit is working correctly. Check other areas for causing the overheating issue.
2. With the coolant sensor connected record the voltage at the controller. If the voltage is high 3.3 VDC check the wires, connections to the coolant sensor and the sensor itself and repair or replace as needed.
3. Disconnect the coolant sensor connector. The voltage should go to 3.3 VDC (+/- 0.2). If the voltage is still low verify that Wire 68 is not shorted to ground or shorted to another wire. If still low extract Wire 68 from the controller connector and measure the voltage out of the controller. If voltage is not 3.3 VDC (+/- 0.2) replace controller.
4. With the controller connector disconnected measure the resistance of the coolant circuit to ground. Compare the resistance value with Table 5-20 at the designated temperature value. If not

within $\pm 2.6\%$ verify the condition of the wires and connections to the sensor. If the wires and connections are good take a measurement directly at the sensor terminals. If the sensor resistance value and the temperature of the sensor do not match Table 3-5 replace the sensor.

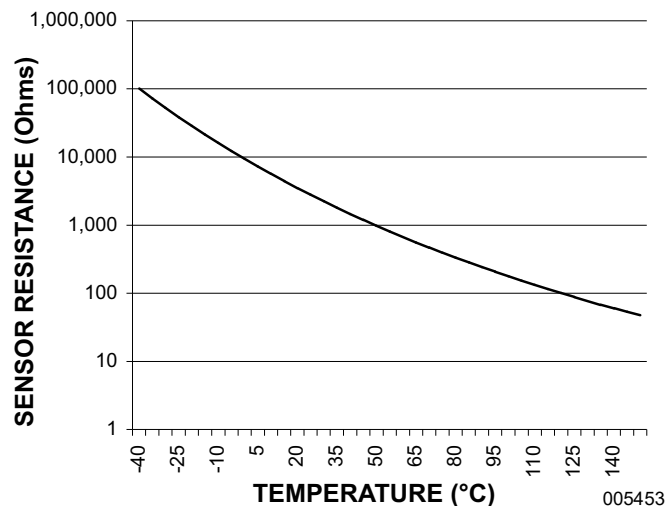


Figure 3-144. Unloaded Resistance vs Temperature Characteristic Chart

Temperature °F (°C)	Resistance (Ohms)	Resistance ($\pm\%$)	Accuracy ($\pm\%$)
5 (-15)	21,371	3.8	(± 0.7)
14 (-10)	16,120	3.6	(± 0.6)
23 (-5)	12,261	3.4	(± 0.6)
32 (0)	9,399	3.21	(± 0.6)
41 (5)	7,263	3.06	(± 0.6)
50 (10)	5,658	2.92	(± 0.6)
59 (15)	4,441	2.78	(± 0.6)
68 (20)	3,511	2.64	(± 0.6)
77 (25)	2,795	2.5	(± 0.6)
86 (30)	2,240	2.45	(± 0.6)
95 (35)	1,806	2.4	(± 0.6)
104 (40)	1,465	2.36	(± 0.6)
113 (45)	1,195	2.31	(± 0.6)
122 (50)	980	2.27	(± 0.6)
131 (55)	809	2.23	(± 0.6)
140 (60)	671	2.19	(± 0.6)
149 (65)	559	2.15	(± 0.6)
158 (70)	469	2.11	(± 0.6)
167 (75)	395	2.07	(± 0.6)
176 (80)	334	2.04	(± 0.6)
185 (85)	283	2	(± 0.6)
194 (90)	241.8	2.1	(± 0.7)

Table 3-6. Unloaded Resistance vs Temperature Characteristics

Temperature °F (°C)	Resistance (Ohms)	Resistance (±%)	Accuracy (±%)
203 (95)	207.1	2.21	(±0.7)
212 (100)	178	2.31	(±0.8)
221 (105)	153.6	2.42	(±0.8)
230 (110)	133.1	2.52	(±0.9)
239 (115)	115.7	2.61	(±0.9)
248 (120)	100.9	2.68	(±1)
257 (125)	88.3	2.75	(±1)
266 (130)	77.5	2.8	(±1.1)

Test 45 – Test CAN Bus Communication

Procedure

1. Identify Wire 744 (Can Bus low) and Wire 743 (Can Bus High) on the Evolution / Nexus controller connector. With the connector still connected to the control panel and the system active, measure for DC voltage at Wire 744 and Wire 743 to ground. Record the measured voltages.
2. If Wire 744 measures approximately 1.67 VDC to ground and Wire 743 measures approximately 2.57 VDC to ground then verify DC voltage is present at Wire 15B (Battery +). Verify Wire 0 has continuity to ground. If battery voltage and ground are present then replace the ICM.
3. If Wire 744 measures approximately 1.88 VDC to ground and wire 743 measures approximately 3.315 VDC to ground then verify continuity in Wire 744 and Wire 743 from the controller to the ICM (verify male and female pins are making connection).
4. If approximately 0 volts are measured then disconnect the harness from the control panel and measure pins 744 to 743. If 120 ohms is not measured then replace controller.
5. Before replacing the ICM, disconnect all harnesses and measure at the ICM pins 744 to 743. A resistance of approximately 138 Ohms should be present.

Test 46 – Check to See if Low Speed Function is Enabled

Discussion

When enabled, the low speed exercise function allows the generator to exercise at the following speeds:

- 1800 rpm units will exercise at 1500 rpm

If the low speed exercise function is disabled, the generator will run at its rated speed during exercise.

If **xfer** is selected in the Set Exercise screen, an interval can be chosen:

- never,
- 3 months
- 6 months
- 9 months
- 12 months

When a setting is chosen, the generator will perform a normal speed exercise every interval chosen and perform a load transfer during the designated exercise time.

Procedure

1. Press the ESC button until the main menu is reached.
2. Scroll up or down until the User Edit icon (Gear) is selected.
3. Press Enter (Check).
4. Scroll down to Set Exercise.
5. Press Enter (Check).
6. Verify Config Quiet Test is set to Yes.
7. If it is set to Yes, press the Enter button to scroll through and save settings or just press the escape button to exit without saving.

Results

Refer to the flow chart.

Section 4.1 Generator Adjustments

Calibrate Voltage Regulator

Discussion

When voltage output is too high, it is possible to adjust voltage output of the generator. To access this menu a password will be required to be entered into controller. Replacement controllers should not require calibration unless output is not within the specifications.

Procedure

1. Set a digital multimeter (DMM) to measure AC voltage.
2. Set up the DMM to measure output voltage on the breaker.

NOTE: Measure voltage at the input side of the breaker.

3. Open the main line circuit breaker (MLCB) on the generator.
4. Refer to the programming section for the specific panel being used. Use the voltage adjust for Evolution panel or the calibration for the Nexus panel to set the units voltage.
5. Set AUTO-OFF-MANUAL switch to MANUAL.

IMPORTANT NOTE: *The engine will crank and possibly start when the AUTO-OFF-MANUAL switch is set to MANUAL.*



Equipment damage. Do not adjust calibration factor below 990 or above 1040. Doing so could result in equipment damage.

(000326)

6. While the unit is running, use the up or down arrow buttons to adjust the calibration setting. A higher value will create a lower voltage at the breaker and vice versa a lower value will create a higher voltage at the breaker.
7. Once a desired output voltage has been achieved, press ENTER to save the new setting.

NOTE: The calibration setting will reset to being a password protected option after the controller is left idle.

Verification

While the unit is running, verify that the output voltage at the breaker is consistent within 5 volts to what the controller displays in the DEBUG menu under OUTPUTS.

Results

1. If during the verification process the output voltage at the breaker and the display match and the calibration setting was not adjusted outside of the window, stop testing.
2. If a correct voltage output was not achieved using the window specified, refer to “**Problem 1 – Test 4 Fixed Excitation Test.**”

Crank and Flywheel Sensor Installation and Adjustments (All Engines)

Refer to product information bulletin PIB08-15-S “Installation and adjustment instructions for the magnetic pick-up used as an RPM sensor.”

AUX Shutdown

New specifications in Article 445.18(B) of the 2017 National Electrical Code (NEC) require generators to be equipped with an independent means of shutting down the prime mover (engine). The shutdown mechanism, when activated, requires a mechanical reset. Generators 15 kW and larger require two engine shutdown switches.

NOTE: Some Authorities Having Jurisdiction (AHJs) and local codes require Protector diesel generators to be equipped with an optional Emergency Stop Switch (E-stop). The E-stop is offered separately from this kit as model G0065100.

Firmware Update (if required)

The generator controller may require a firmware update. Firmware version 1.19 or later is required.

Verify controller firmware version. If an update is required, install latest version before testing engine shutdown switches.

1. Connect negative battery terminal and tighten nut.
2. Install 7.5 A fuse and configure install wizard.
3. With generator controller OFF, enter Edit menu.
4. Scroll through the options and select “Update Firmware.” Press Enter.
5. Insert a USB drive with current firmware into controller port. Follow prompts.
6. After firmware has been updated, press “Escape” until sub menu screen displays.
7. Enter dealer menu.
8. Select “Dealer/Edit” menu.
9. Scroll through the options and select “Auxiliary Stop Setting.”
10. Select “Auxiliary Shutdown.”
11. Press Escape until submenu screen displays.

Activate Engine Shutdown Functionality

The controller must detect the installed switches to activate the engine shutdown functionality.

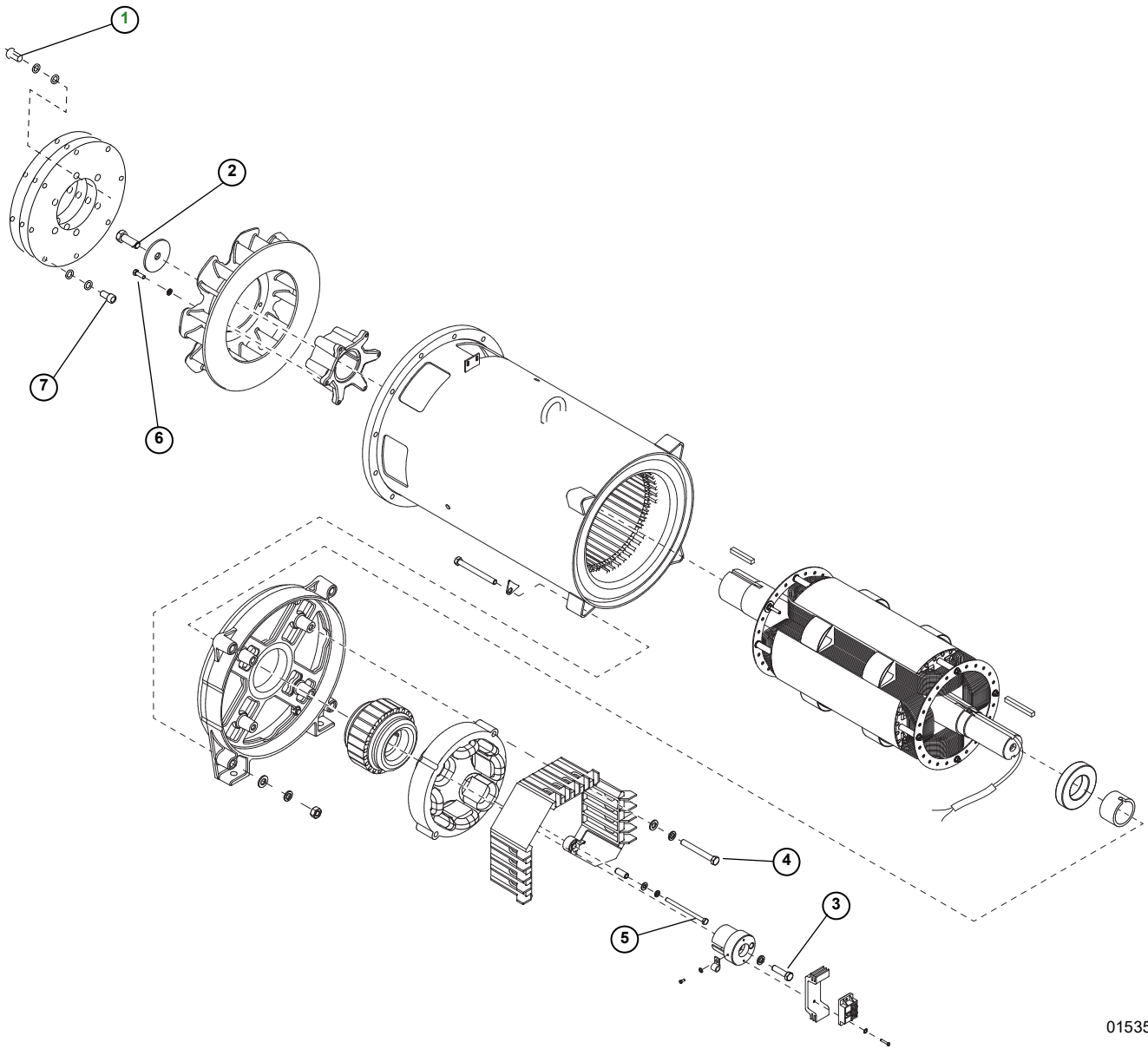
1. Verify controller is powered and generator is OFF.
2. Turn rocker switches ON to verify switches are disengaged.
3. Turn one rocker switch OFF. The controller should detect that the switch has been engaged and will display "Auxiliary Shutdown."
 - If alarm appears on controller screen, turn rocker switch ON and clear alarm.
 - If alarm does not appear on controller screen, engine shutdown switch is not functioning. Verify firmware version meets requirements. Disconnect power and re-check wiring installation. Contact Generac Technical Support if the problem cannot be identified or if you need assistance.
4. Repeat steps 1–3 for second rocker switch.

Test Switch Operation

Test engine shutdown switches after installation to verify proper operation.

1. Verify rocker switches are ON.
2. Press MANUAL key on control panel keypad to start engine.
3. With engine running, press one of the engine shutdown switches to OFF. Engine should shut down immediately.
 - **If engine stops**, press engine shutdown switch to ON, clear alarm on controller, and restart engine to verify generator is operating normally. After verifying normal operation of first switch, verify operation of second switch.
 - **If engine does not stop**, engine shutdown switch is not functioning correctly. Stop generator through the control panel, and re-check wiring installation. Contact Generac Technical Support if the problem cannot be identified or if you need assistance.
4. Show homeowner how to operate engine shutdown switches. Remind him or her that the engine shutdown switches are not intended to be the primary means to shut down the generator under normal operating conditions. Accidental activation of an engine shutdown switch will prevent the generator from operating during a power outage.

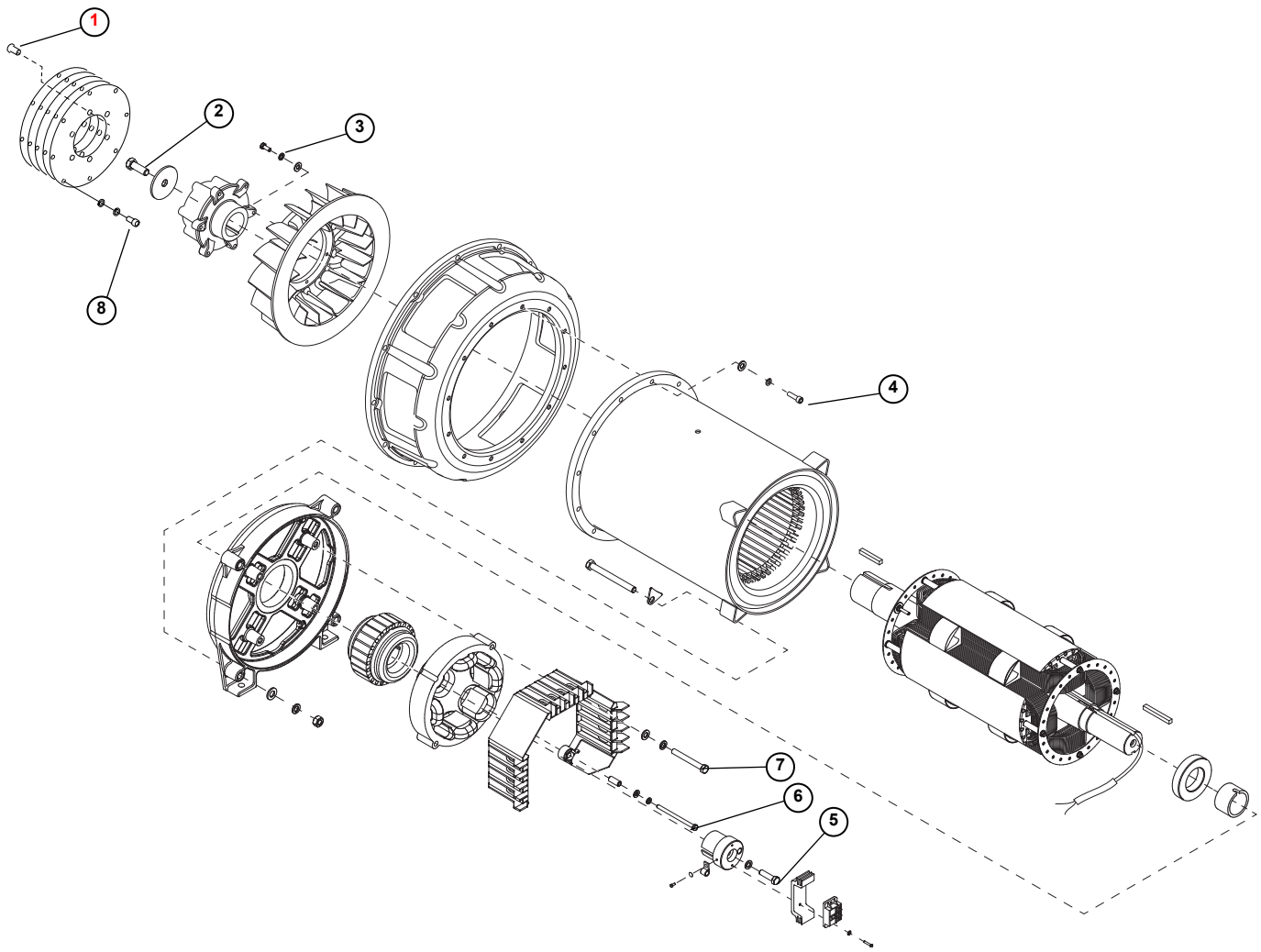
Section 4.2 Torque Specs



015359

Figure 4-145. 130 kW PME Alternator Torque Specs (Gaseous Units)

1	Screw HHC M12-1.75 X 25 C10.9	
2	Screw HHC M16-2.0 x 45 C8.8 (see Note)	144 ft-lbs (195 Nm)
3	Screw HHC M12-1.75 x 45 C8.8 (see Note)	64 ft-lbs (87 Nm)
4	Screw HHC M12-1.75 x 100 PC8.8	58 ft-lbs (78 Nm)
5	Screw HHC M8-1.25 x 115 C8.8	222 in-lbs (25 Nm)
6	Screw HHC M10-1.5 x 40 C10.9 (see Note)	25 ft-lbs (34 Nm)
7	Screw SHC M10-1.5 X 25 C8.8 (see Note)	28 ft-lbs (37 Nm)
NOTE: Apply LocTite® 242		



015360

Figure 4-146. 150 kW PME Alternator Torque Specs (Gaseous Units)

1	Screw HHC M14-1.5 X 35 C10.9 (see Note)	83 ft-lbs (113 Nm)
2	Screw HHC M16-2.0 x 45 C8.8 (see Note)	144 ft-lbs (195 Nm)
3	Screw HHC M10-1.5 x 40 C10.9 (see Note)	25 ft-lbs (34 Nm)
4	Screw HHC M10-1.5 x 40 C8.8	37 ft-lbs (50 Nm)
5	Screw HHC M12-1.75 x 45 C8.8 (see Note)	64 ft-lbs (87 Nm)
6	Screw HHC M8-1.25 x 115 C8.8	222 in-lbs (25 Nm)
7	Screw HHC M12-1.75 x 100 PC8.8	58 ft-lbs (78 Nm)
8	Screw SHC M10-1.5 X 25 C8.8 (see Note)	28 ft-lbs (37 Nm)
NOTE: Apply LocTite® 242		

Thread	Class 5.8		Class 6.8		Class 8.8		Class 10.9		Class 12.9	
	Torque ft-lbs (Nm)		Torque ft-lbs (Nm)		Torque ft-lbs (Nm)		Torque ft-lbs (Nm)		Torque ft-lbs (Nm)	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
M4-0.7	17 (23)	13 (17.6)	20 (27.1)	15 (20.3)	27 (36.6)	20 (27.1)	38 (51.5)	29 (39.3)	45 (61)	33 (44.7)
M5-0.8	35 (47.5)	26 (25.2)	41 (55.5)	31 (42)	54 (73.2)	40 (54.2)	77 (104.4)	58 (78.6)	90 (122)	68 (92.2)
M6-1.0	60 (81.3)	45 (61)	69 (93.5)	52 (70.5)	92 (124.7)	69 (93.5)	131 (177.6)	98 (132.8)	153 (207.4)	115 (155.9)
M7-1.0	101 (136.9)	75 (101.6)	117 (158.6)	87 (117.9)	154 (208.8)	115 (155.9)	220 (298.3)	165 (223.7)	21 (28.4)	193 (261.6)
M8-1.0	156 (211.5)	117 (158.6)	181 (245.4)	136 (184.4)	20 (27.1)	179 (242.6)	28 (37.9)	21 (28.4)	33 (44.7)	25 (33.9)
M8-1.25	146 (197.9)	109 (147.7)	169 (229.1)	127 (172.1)	222 (300.9)	167 (226.4)	27 (36.6)	20 (27.1)	31 (42)	23 (31.1)
M10-1.0	27 (36.6)	20 (27.1)	31 (42)	23 (31.1)	41 (55.5)	31 (42)	59 (79.9)	44 (59.6)	69 (93.5)	51 (69.1)
M10-1.25	25 (33.9)	19 (25.7)	29 (39.3)	22 (29.8)	39 (52.8)	29 (39.3)	56 (75.9)	42 (56.9)	65 (88.1)	49 (66.4)
M10-1.5	24 (32.5)	18 (24.4)	28 (37.9)	21 (28.4)	37 (50.1)	28 (37.9)	53 (71.8)	39 (52.8)	61 (82.7)	46 (62.3)
M12-1.25	46 (62.3)	35 (47.5)	53 (71.8)	40 (54.2)	70 (94.9)	53 (71.8)	101 (136.9)	75 (101.6)	118 (159.9)	88 (119.3)
M12-1.5	44 (59.6)	33 (44.7)	51 (69.1)	38 (51.5)	67 (90.8)	50 (67.7)	96 (130.1)	72 (97.6)	112 (151.8)	84 (113.8)
M12-1.75	42 (56.9)	31 (42)	49 (66.4)	36 (48.8)	64 (86.7)	48 (65)	92 (124.7)	69 (93.5)	107 (145)	80 (108.4)
M14-1.5	73 (98.9)	54 (73.2)	84 (113.8)	63 (85.4)	111 (150.4)	83 (112.5)	159 (215.5)	119 (161.3)	185 (250.8)	139 (188.4)
M14-2.0	67 (90.8)	50 (67.7)	78 (105.7)	58 (78.6)	102 (138.2)	77 (104.4)	147 (199.3)	110 (149.1)	171 (231.8)	128 (173.5)
M16-1.5	112 (151.8)	84 (113.8)	129 (174.9)	97 (131.5)	176 (238.6)	132 (178.9)	244 (330.8)	183 (248.1)	285 (386.4)	214 (290.1)
M16-2.0	104 (141)	78 (105.7)	121 (164)	91 (123.3)	165 (223.7)	123 (166.7)	228 (309.1)	171 (231.8)	266 (360.6)	200 (271.1)
M18-1.5	163 (220.9)	122 (165.4)	188 (254.8)	141 (191.1)	257 (348.4)	192 (260.3)	355 (481.3)	266 (360.6)	415 (562.6)	311 (421.6)
M18-2.5	144 (195.2)	108 (146.4)	167 (226.4)	125 (169.4)	227 (307.7)	170 (230.4)	314 (425.7)	236 (319.9)	367 (497.5)	276 (374.2)
M20-1.5	227 (307.7)	170 (230.4)	236 (319.9)	197 (267)	358 (485.3)	269 (364.7)	496 (672.4)	372 (504.3)	579 (785)	434 (588.4)
M20-2.5	204 (276.5)	153 (207.4)	236 (319.9)	177 (239.9)	322 (436.5)	241 (326.7)	445 (603.3)	334 (452.8)	520 (705)	390 (528.7)
M22-1.5	306 (414.8)	230 (311.8)	355 (481.3)	266 (360.6)	484 (656.2)	363 (492.1)	669 (907)	502 (680.6)	782 (1060.2)	586 (794.5)
M22-2.5	278 (376.9)	208 (282)	322 (436.5)	241 (326.7)	439 (595.2)	329 (446)	607 (822.9)	455 (616.8)	709 (961.2)	532 (721.2)
M24-2.0	385 (521.9)	289 (391.8)	446 (604.6)	335 (454.1)	608 (824.3)	456 (618.2)	841 (1140.2)	631 (855.5)	983 (1332.7)	737 (999.2)
M24-3.0	352 (477.2)	264 (357.9)	407 (551.8)	306 (414.8)	556 (753.8)	417 (565.3)	769 (1042.6)	576 (780.9)	898 (1217.5)	674 (913.8)
M30-2.0	779 (1056.1)	584 (791.7)	902 (1222.9)	677 (917.8)	1230 (1667.6)	923 (1251.4)	1702 (2307.6)	1276 (1730)	1989 (2696.7)	1492 (2022.8)
M30-3.5	700 (949)	525 (711.8)	811 (1099.5)	608 (824.3)	1105 (1498.1)	829 (1123.9)	1529 (2073)	1147 (1555.1)	1787 (2422.8)	1340 (1816.7)
M36-3.0	1300 (1762.5)	975 (1321.9)	1505 (2040.5)	1129 (1530.7)	2053 (2783.4)	1540 (2087.9)	2840 (3850.5)	2130 (2887.8)	3318 (4498.6)	2489 (3374.6)
M36-4.0	1225 (1660.8)	918 (1244.6)	1418 (1922.5)	1063 (1441.2)	1933 (2620.8)	1450 (1965.9)	2675 (3626.8)	2006 (2719.7)	3126 (4238.2)	2344 (3178)

Thread	Grade 2		Grade 5		Grade 7		Grade 8	
	Torque ft-lbs (Nm)		Torque ft-lbs (Nm)		Torque ft-lbs (Nm)		Torque ft-lbs (Nm)	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
1/4-20	66 (89.4)	49 (66.4)	101 (136.9)	76 (103)	125 (169.4)	94 (127.4)	143 (193.8)	107 (145)
1/4-28	75 (101.6)	56 (75.9)	116 (157.2)	87 (117.9)	143 (193.8)	107 (145)	164 (222.3)	123 (166.7)

Section 4.2 Torque Specs

5/16-18	135 (183)	101 (136.9)	209 (283.3)	157 (212.8)	21 (28.4)	193 (261.6)	25 (33.9)	221 (299.6)
5/16-24	150 (203.3)	112 (151.8)	231 (313.1)	173 (234.5)	24 (32.5)	214 (290.1)	27 (36.6)	20 (27.1)
3/8-16	20 (27.1)	180 (244)	31 (42)	23 (31.1)	38 (51.5)	29 (39.3)	44 (59.6)	33 (44.7)
3/8-24	23 (31.1)	204 (276.5)	35 (47.5)	26 (25.2)	43 (58.3)	32 (43.3)	49 (66.4)	37 (50.1)
7/16-14	32 (43.3)	24 (32.5)	49 (66.4)	37 (50.1)	61 (82.7)	46 (62.3)	70 (94.9)	52 (70.5)
7/16-20	36 (48.8)	27 (36.6)	55 (74.5)	41 (55.5)	68 (92.2)	51 (69.1)	78 (105.7)	58 (78.6)
1/2-13	49 (66.4)	37 (50.1)	75 (101.6)	57 (77.2)	93 (126)	70 (94.9)	106 (143.7)	80 (108.4)
1/2-20	55 (74.5)	41 (55.5)	85 (115.2)	64 (86.7)	105 (142.3)	79 (107.1)	120 (162.6)	90 (122)
9/16-12	70 (94.9)	53 (71.8)	109 (147.7)	82 (111.1)	134 (181.6)	101 (136.9)	153 (207.4)	115 (155.9)
9/16-18	78 (105.7)	59 (79.9)	121 (164)	91 (123.3)	150 (203.3)	112 (151.8)	171 (231.8)	128 (173.5)
5/8-11	97 (131.5)	73 (98.9)	150 (203.3)	113 (153.2)	185 (250.8)	139 (188.4)	212 (287.4)	159 (215.5)
5/8-18	110 (149.1)	82 (111.1)	170 (230.4)	127 (172.1)	210 (284.7)	157 (212.8)	240 (325.3)	180 (244)
3/4-10	172 (233.2)	129 (174.9)	266 (360.6)	200 (271.1)	329 (446)	247 (334.8)	376 (509.7)	282 (382.3)
3/4-16	192 (260.3)	144 (195.2)	297 (402.6)	223 (302.3)	367 (497.5)	275 (372.8)	420 (569.4)	315 (427)
7/8-9	167 (226.4)	125 (169.4)	429 (581.6)	322 (436.5)	530 (718.5)	398 (539.6)	606 (821.6)	454 (615.5)
7/8-14	184 (249.4)	138 (187.1)	474 (642.6)	355 (481.3)	585 (793.1)	439 (595.2)	669 (907)	501 (679.2)
1 - 8	250 (338.9)	187 (253.5)	643 (871.7)	483 (654.8)	795 (1077.8)	596 (808)	908 (1231)	681 (923.3)
1 - 12	273 (370.1)	205 (277.9)	704 (954.4)	528 (715.8)	870 (1179.5)	653 (885.3)	994 (1347.6)	746 (1011.4)
1 1/8-7	354 (479.9)	266 (360.6)	794 (1076.5)	596 (808)	1127 (1528)	845 (1145.6)	1288 (1746.2)	966 (1309.7)
1 1/8-12	397 (538.2)	298 (404)	890 (1206.6)	668 (905.6)	1263 (1712.4)	948 (1285.3)	1444 (1957.8)	1083 (1468.3)
1 1/4-7	500 (677.9)	375 (508.4)	1120 (1518.5)	840 (1138.8)	1590 (2155.7)	1192 (1616.1)	1817 (2463.5)	1363 (1847.9)
1 1/4-12	553 (749.7)	415 (562.6)	1240 (1681.2)	930 (1260.9)	1760 (2386.2)	1320 (1789.6)	2012 (2727.9)	1509 (2045.9)
1 3/8-6	655 (888)	491 (665.7)	1469 (1991.7)	1101 (1492.7)	2084 (2825.5)	1563 (2119.1)	2381 (3228.2)	1786 (2421.4)
1 3/8-12	746 (1011.4)	559 (757.9)	1672 (2266.9)	1254 (1700.1)	2372 (3216)	1779 (2412)	2711 (3675.6)	2034 (2757.7)
1 1/2-6	869 (1178.2)	652 (883.9)	1949 (2642.4)	1462 (1982.2)	2766 (3750.1)	2075 (2813.3)	3161 (4285.7)	2371 (3214.6)
1 1/2-12	978 (1325.9)	734 (995.1)	2193 (2973.3)	1645 (2230.3)	3112 (4219.3)	2334 (3164.4)	3557 (4822.6)	2668 (3617.3)
1 3/4-5	1371 (1858.8)	1028 (1393.7)	3074 (4167.7)	2306 (3126.5)	4362 (5914)	3272 (4436.2)	4985 (6758.7)	3739 (5069.4)
2 - 4 1/2	2061 (2794.3)	1546 (2096)	4621 (6265.2)	3466 (4699.2)	6557 (8890.1)	4918 (6667.9)	7493 (10159.1)	5620 (7619.7)

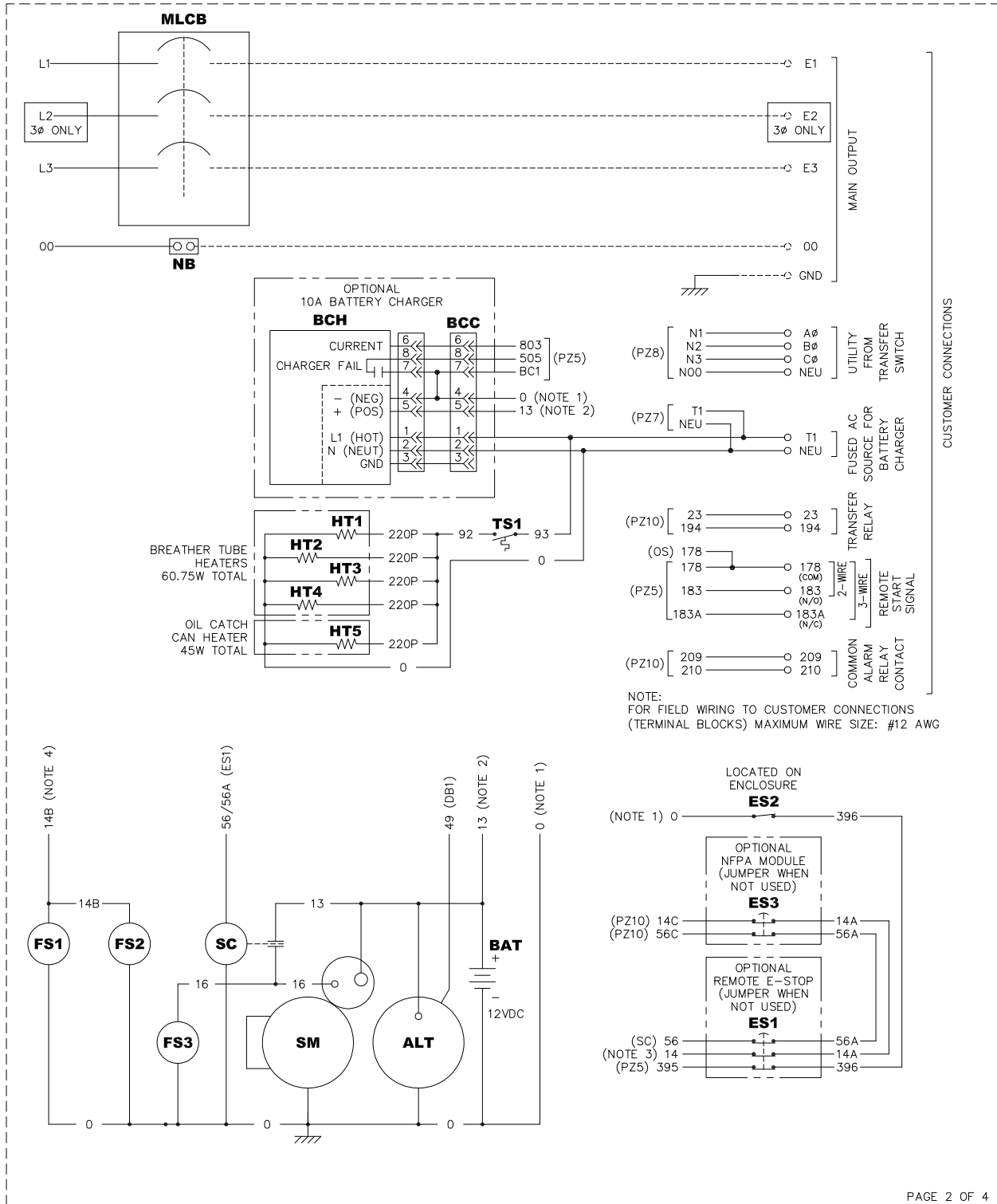
Section 4.3 Engine Maintenance

Engine Maintenance

Refer to 9.0L Gaseous Engine (G26) Service Manual For Generators – P/N 1000004273

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GROUP G



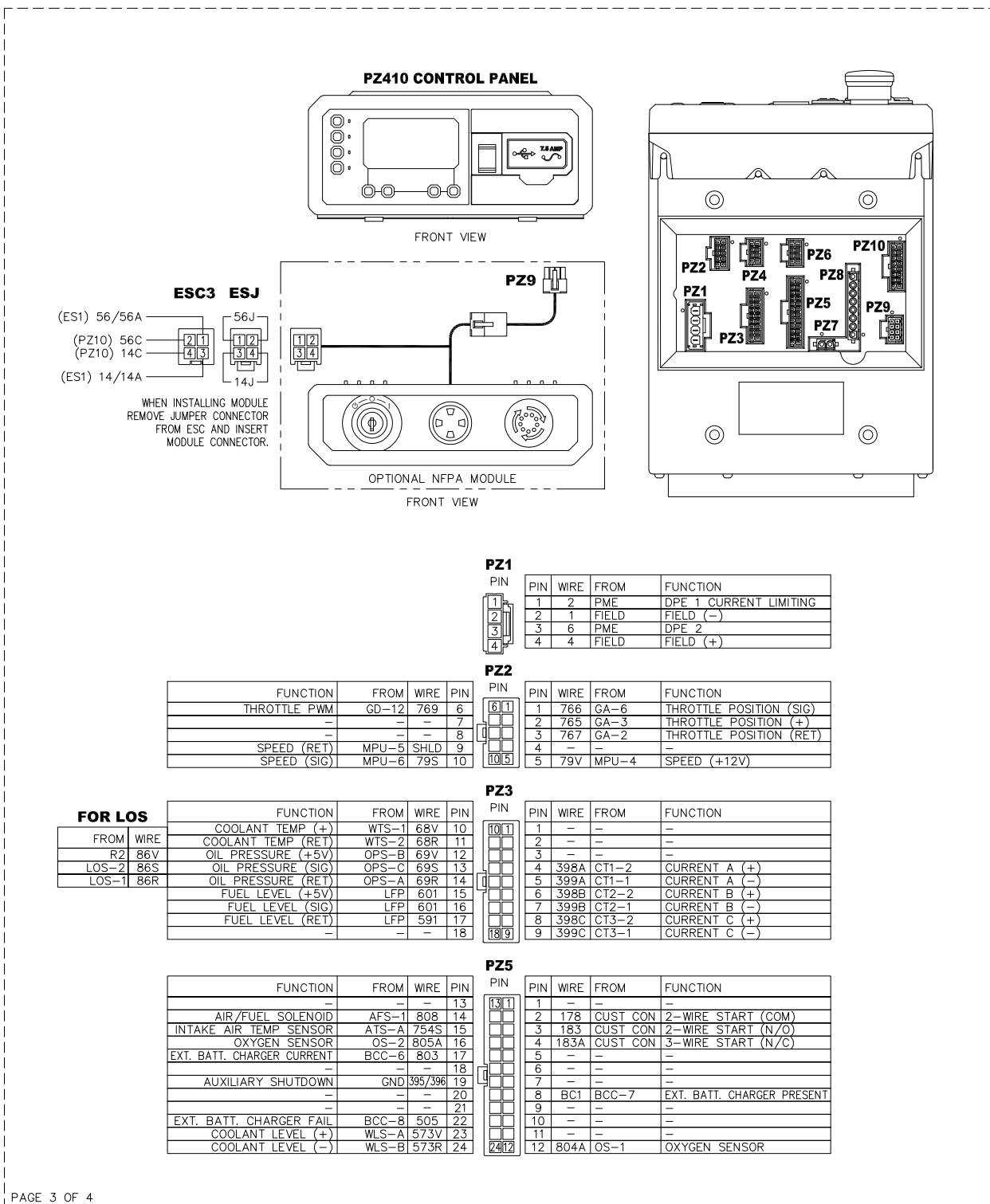
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DATE: 3/24/23

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SCHEMATIC - DIAGRAM
G9.0L G26 PZ 410 CPL
DRAWING #: A0002511125

GROUP G



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SCHEMATIC - DIAGRAM

G9.0L G26 PZ 410 CPL

DRAWING #: A0002511125

REVISION: CN-0068499-C


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GROUP G


PZ410 CONTROL PANEL (CONT.)

PZ7



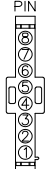
PIN	WIRE	FROM	FUNCTION
1	T1	BCC-1/CUST CON	BATTERY CHARGER HOT
2	NEU	BCC-2/CUST CON	BATTERY CHARGER NEUTRAL

PZ9




RESERVED FOR
OPTIONAL
NFFPA MODULE

PZ8



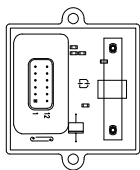
PIN	WIRE	FROM	FUNCTION
8	N3	CUST CON	CØ VOLTAGE SENSE (UTIL)
7	N2	CUST CON	BØ VOLTAGE SENSE (UTIL)
6	N1	CUST CON	AØ VOLTAGE SENSE (UTIL)
5	N00	CUST CON	NEUTRAL VOLTAGE SENSE (UTIL)
4	00	NEU	NEUTRAL VOLTAGE SENSE (GEN)
3	S3	MLCB CØ	CØ VOLTAGE SENSE (GEN)
2	S2	MLCB BØ	BØ VOLTAGE SENSE (GEN)
1	S1	MLCB AØ	AØ VOLTAGE SENSE (GEN)

PZ10



FUNCTION	FROM	WIRE	PIN
--	--	--	9
--	--	--	10
--	--	--	11
--	--	--	12
DISTRIBUTOR ENABLE	RLY2	25	13
TRANSFER RELAY COIL (12V)	CUST CON	194	14
TRANSFER RELAY COIL (RET)	CUST CON	23	15
--	--	--	16

PIN	WIRE	FROM	FUNCTION
1	13	BATTERY+	NOTE 2
2	13	BATTERY+	NOTE 2
3	15B	FB2	NOTE 6
4	0	GND	NOTE 1
5	209	CUST CON	ALARM RELAY (COM)
6	210	CUST CON	ALARM RELAY (NO) HELD OPEN
7	56C	ESC3	START RELAY
8	14C	ESC3	FUEL RELAY



GD CONNECTOR

PIN	WIRE	FROM	FUNCTION
1	0	GND	NOTE 1
4	14B	RLY1	NOTE 4
8	771	GA-1	THROTTLE DRIVE LOW
9	770	GA-4	THROTTLE DRIVE HIGH
10	0	GND	NOTE 1
12	769	PZ2	THROTTLE PWM

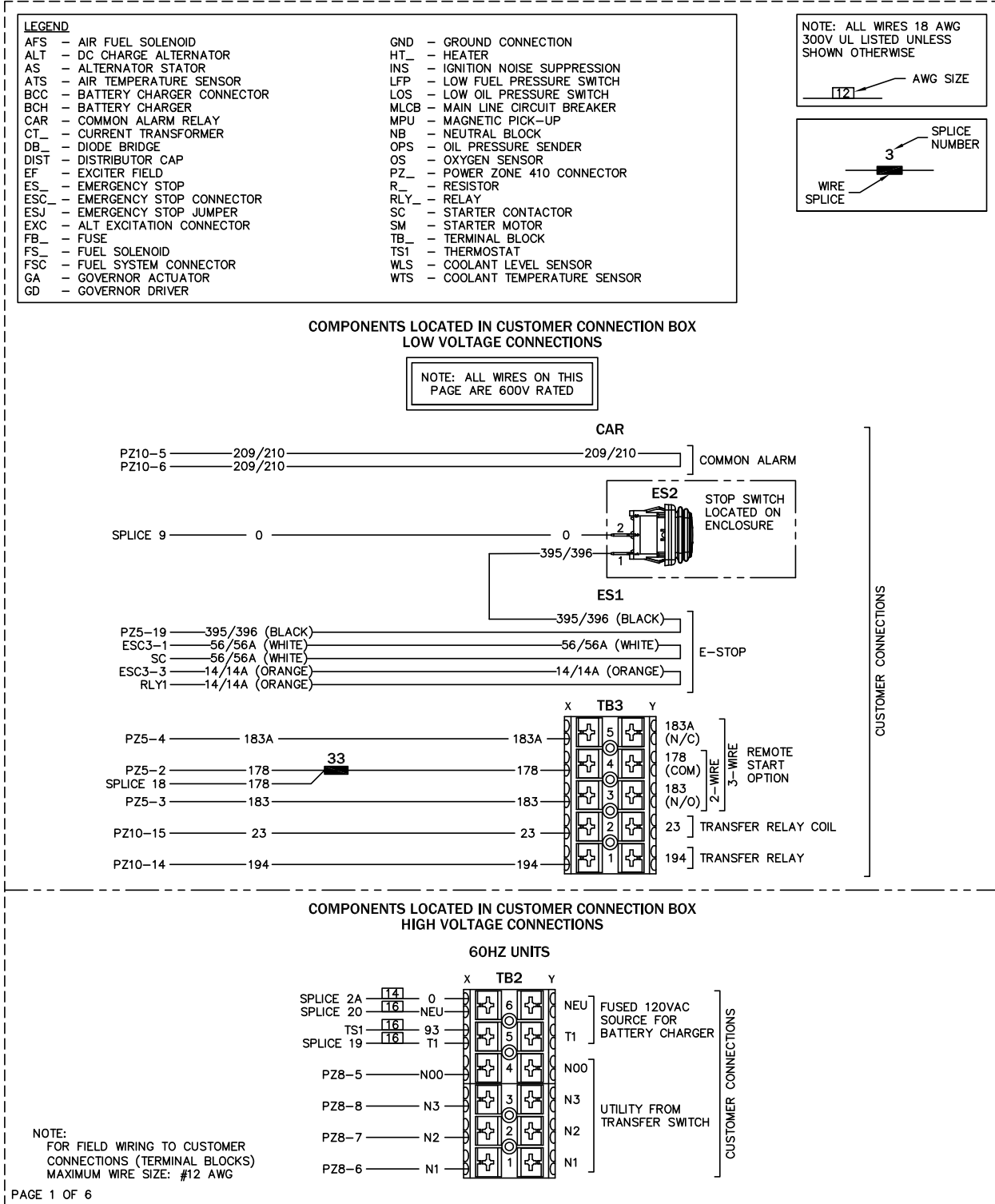
- NOTES:
- 1) WIRE #0 IS CHASSIS GROUND (BATTERY-) UNLESS NOTED OTHERWISE.
 - 2) WIRE #13 IS UNFUSED +12VDC (BATTERY+).
 - 3) WIRE #14/14A IS LOW CURRENT +12VDC WHEN GENERATOR IS CRANKING OR RUNNING AND E-STOP IS NOT ACTIVATED.
 - 4) WIRE #14B IS HIGH CURRENT FUSED +12VDC WHEN GENERATOR IS CRANKING OR RUNNING AND E-STOP IS NOT ACTIVATED.
 - 5) WIRE #15A IS FUSED (15A) +12VDC.
 - 6) WIRE #15B IS FUSED (10A) +12VDC.

Section 5.2 A0002511120-C Wiring Diagram G9.0L G26 PZ410 CPL

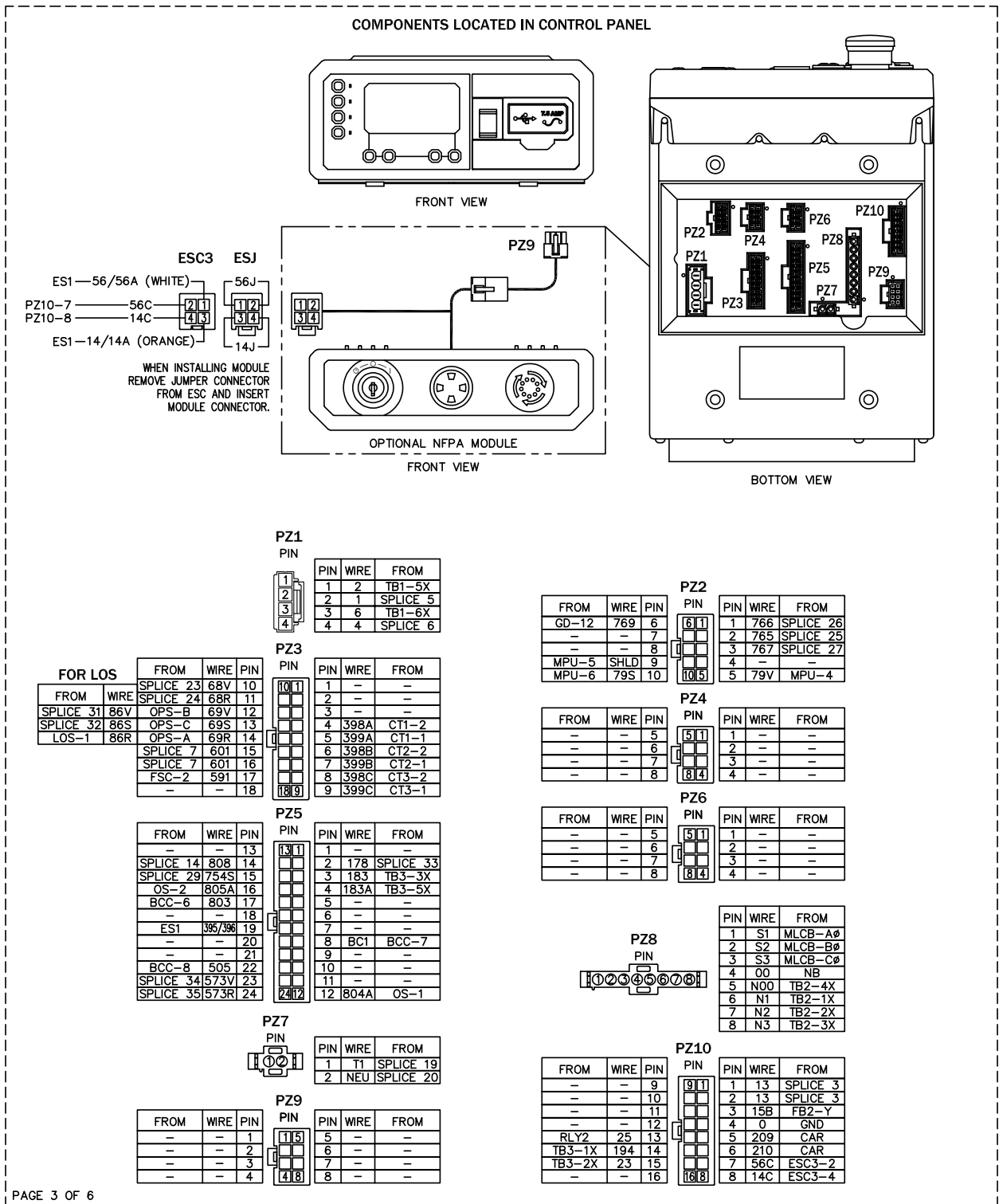
Introduction

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer's website.

GROUP G



GROUP G



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WIRING - DIAGRAM

REVISION: CN-0068499-C

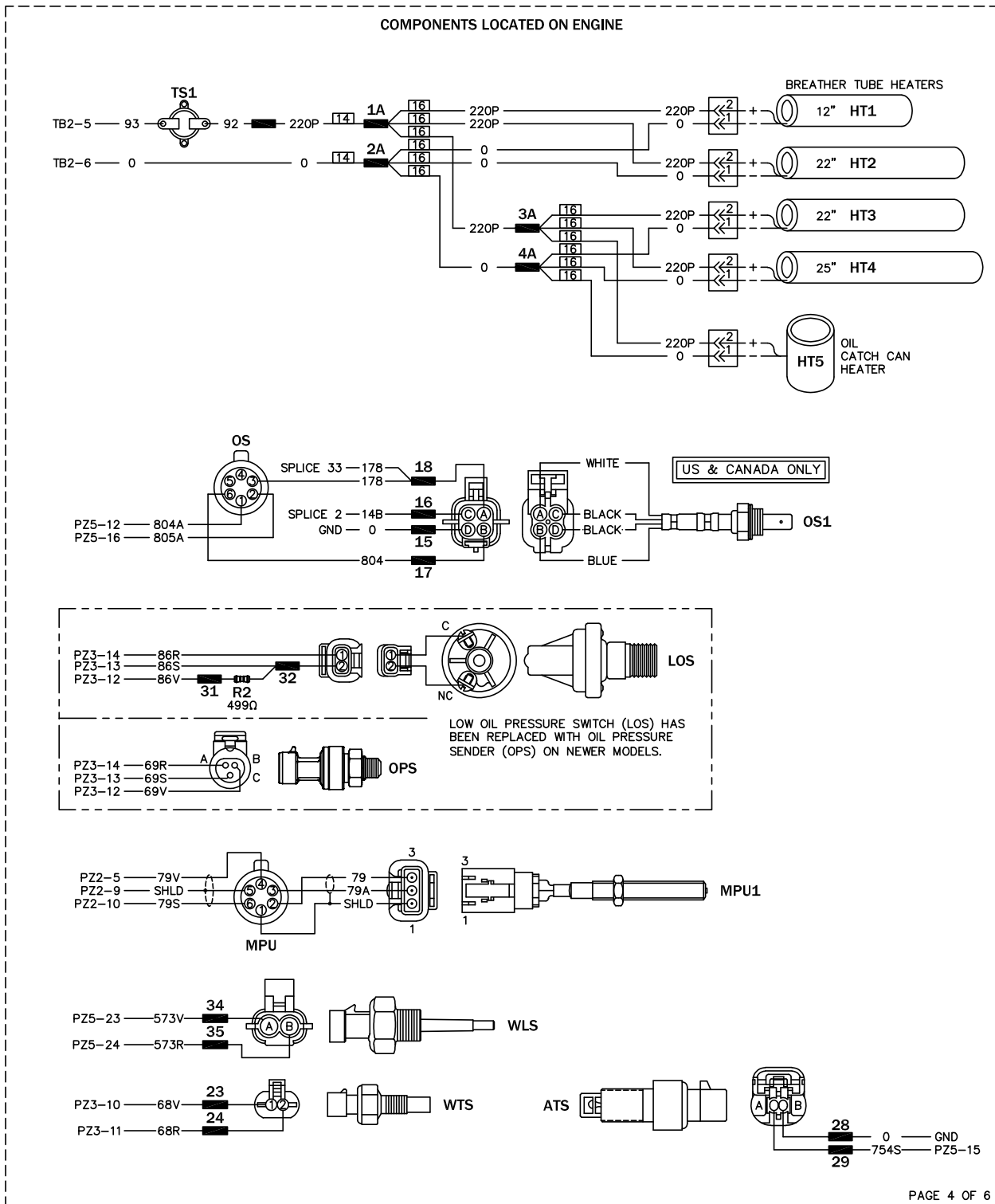
G9.0L G26 PZ 410 CPL

DATE: 3/24/23

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DRAWING #: A0002511120

GROUP G



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WIRING - DIAGRAM

G9.0L G26 PZ 410 CPL

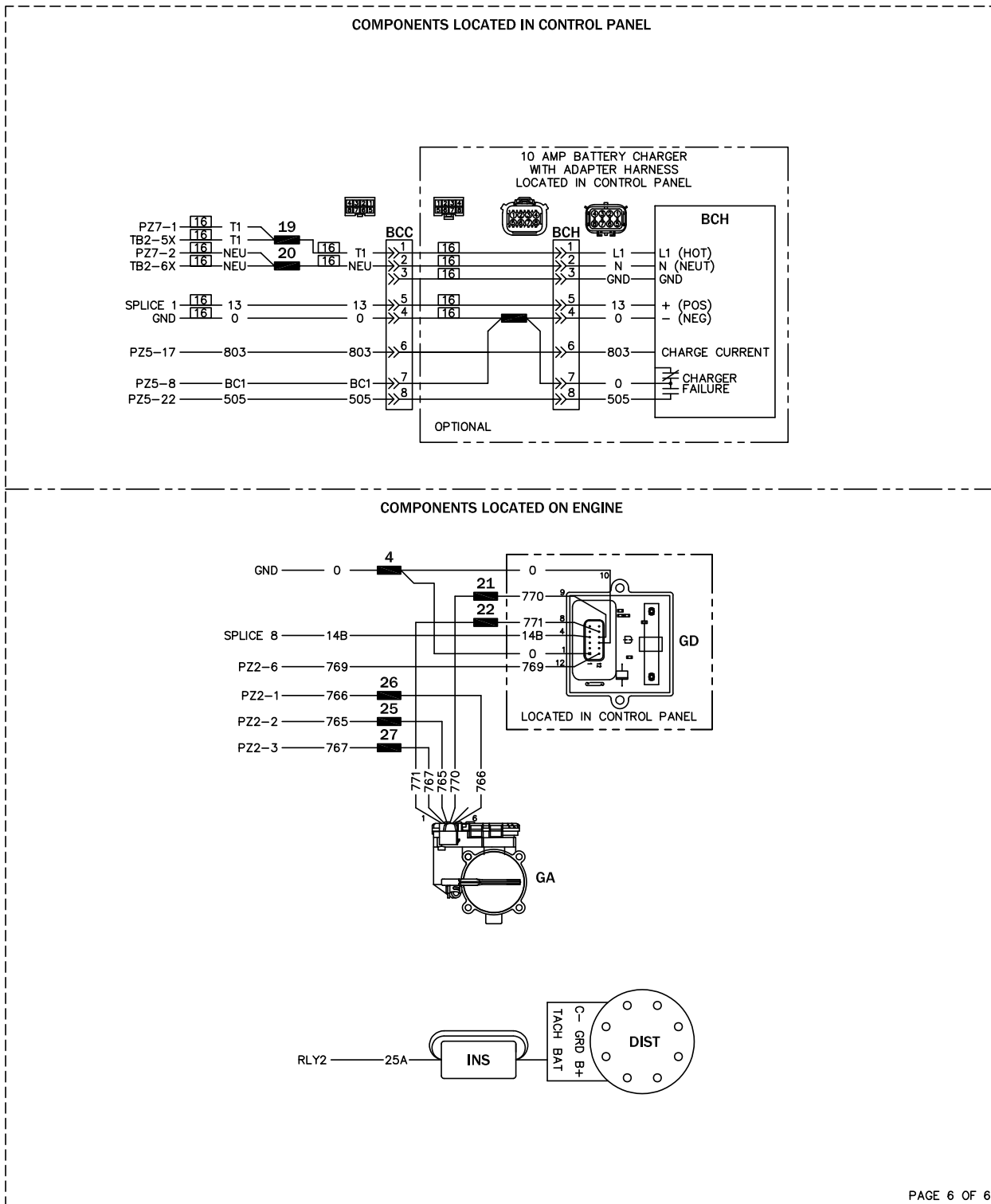
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REVISION: CN-0068499-C

DATE: 3/24/23

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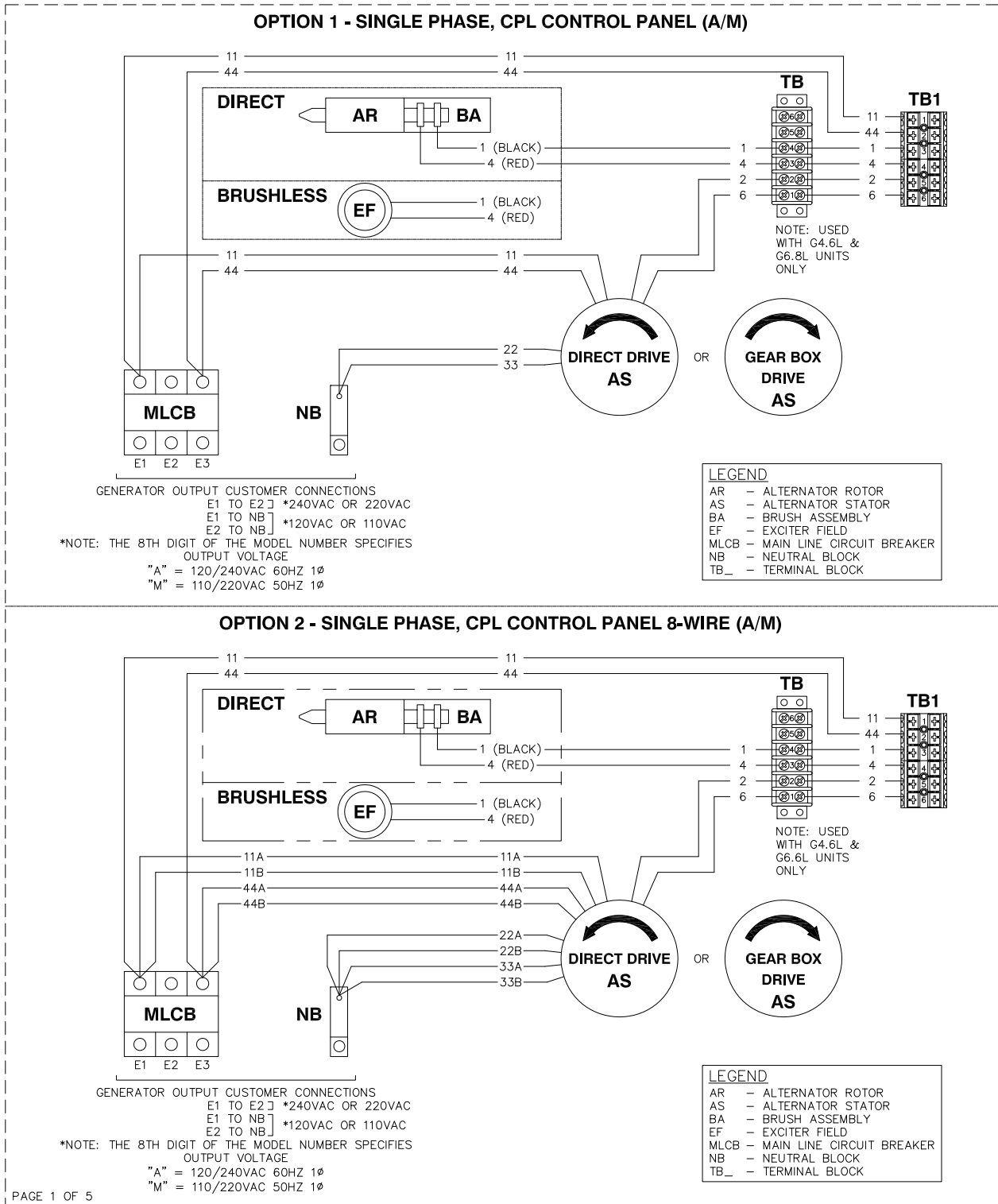


Section 5.3 0H6342-H Wiring Diagram CPL Alternator

Introduction

The diagrams in this section are provided for general reference only. For unit specific diagrams refer to the Service and Support page at the manufacturer's website.

GROUP G



REVISION: CN-0049482-H

DATE: 7/19/21

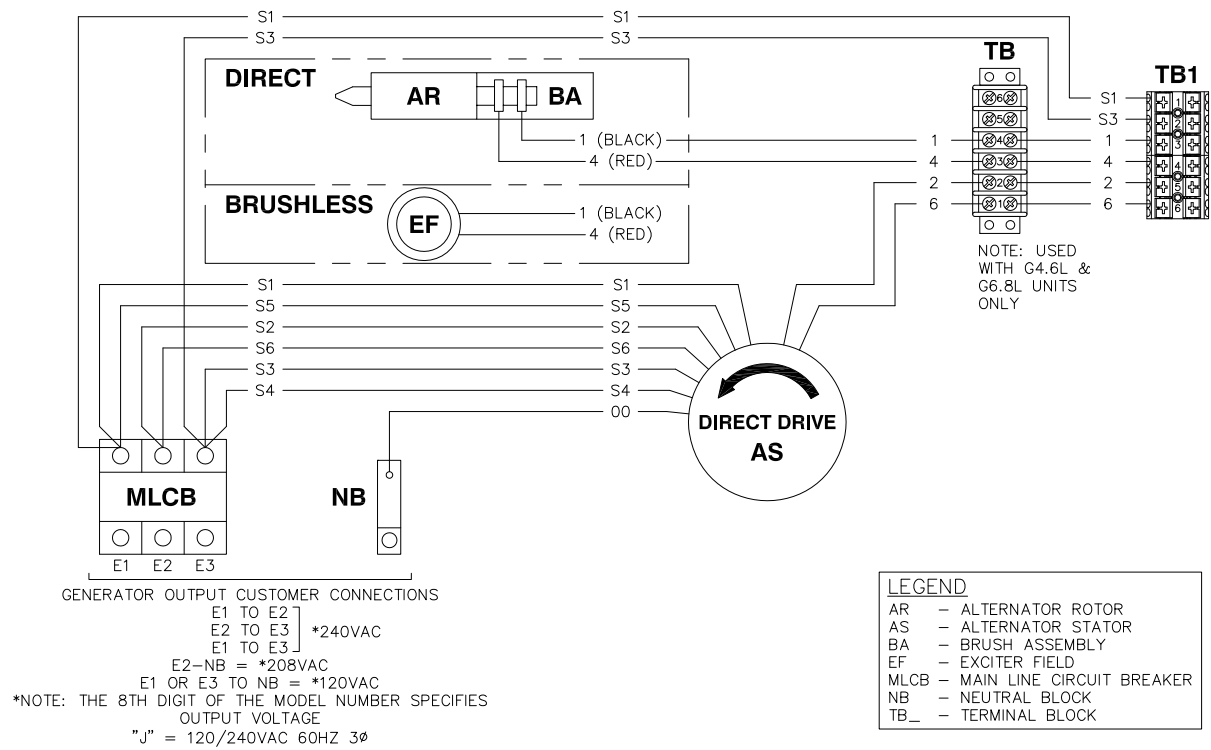
WIRING - DIAGRAM

CPL ALTERNATOR

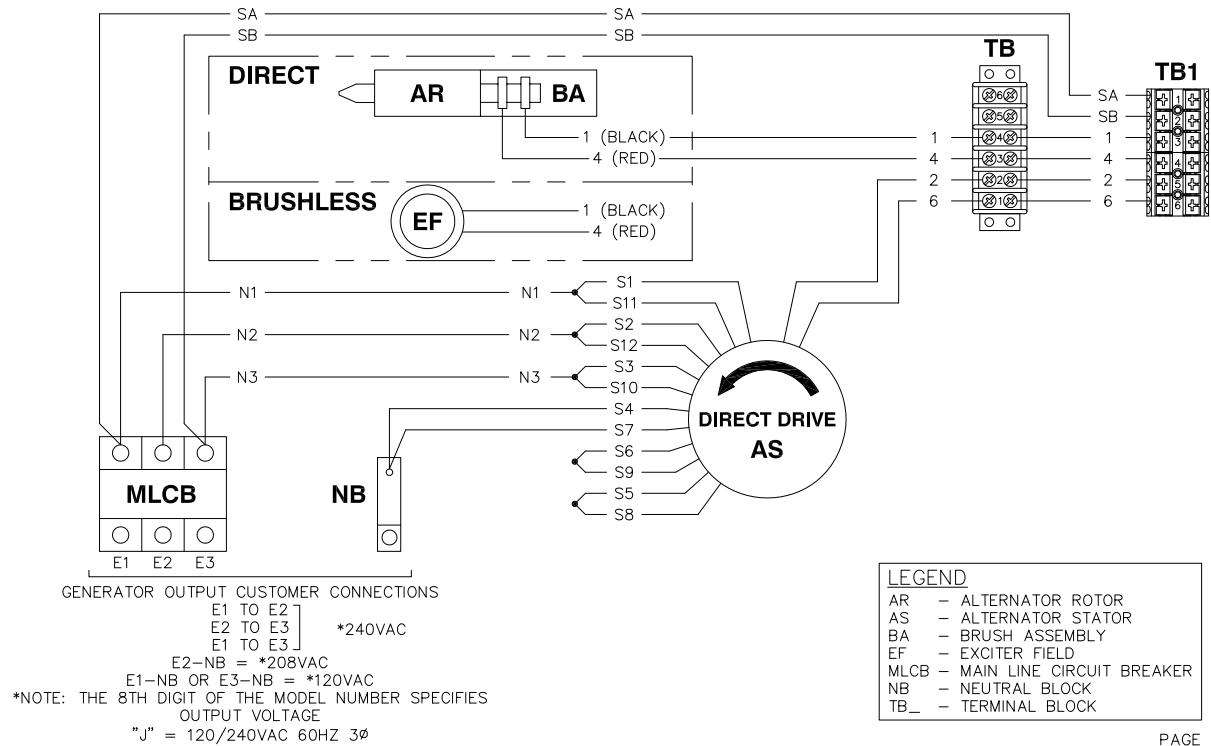
DRAWING #: 0H6342

GROUP G

OPTION 3 - THREE PHASE DELTA, CPL CONTROL PANEL, DIRECT DRIVE 7-WIRE 120/240V (J)

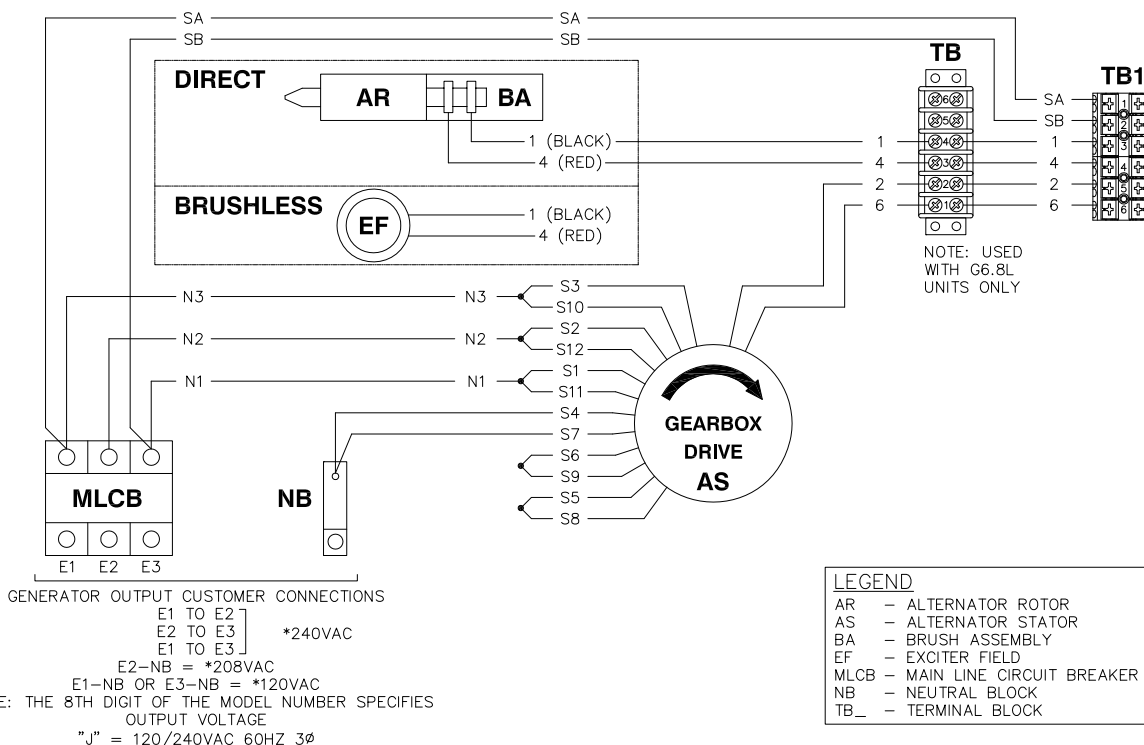


OPTION 4 - THREE PHASE SERIES DELTA, CPL CONTROL PANEL, DIRECT DRIVE 12-WIRE 120/240V (J)

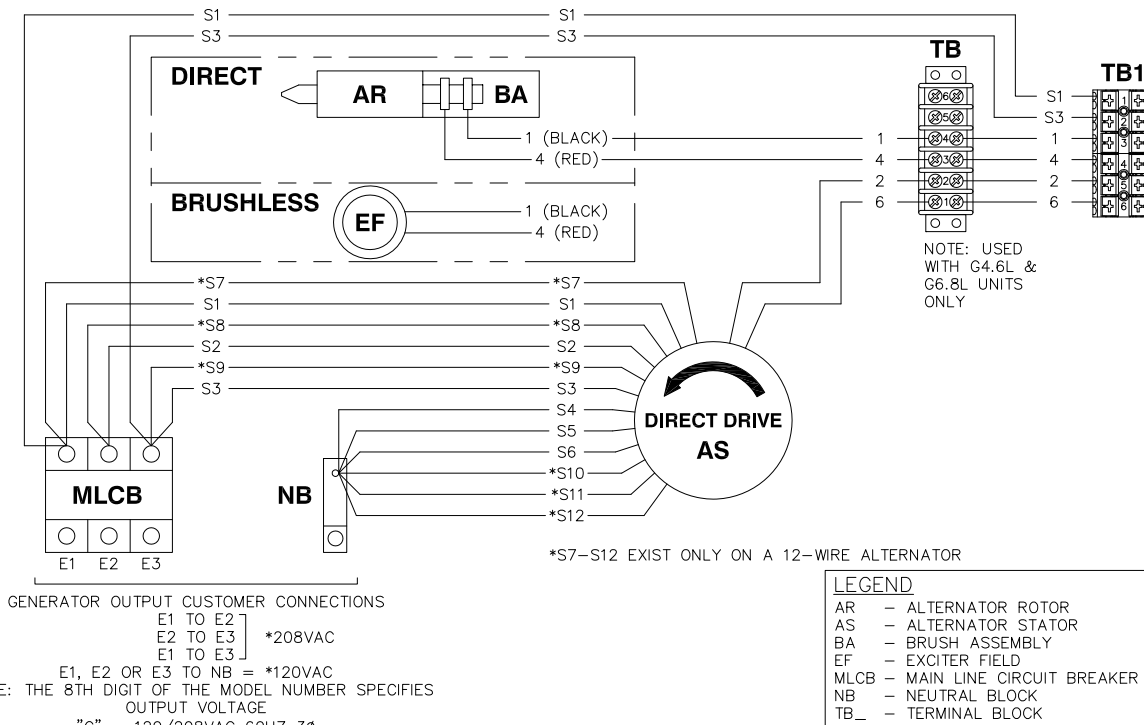


GROUP G

OPTION 5 - THREE PHASE SERIES DELTA, CPL CONTROL PANEL, GEARBOX (REVERSE ROTATION), 120/240V (J)

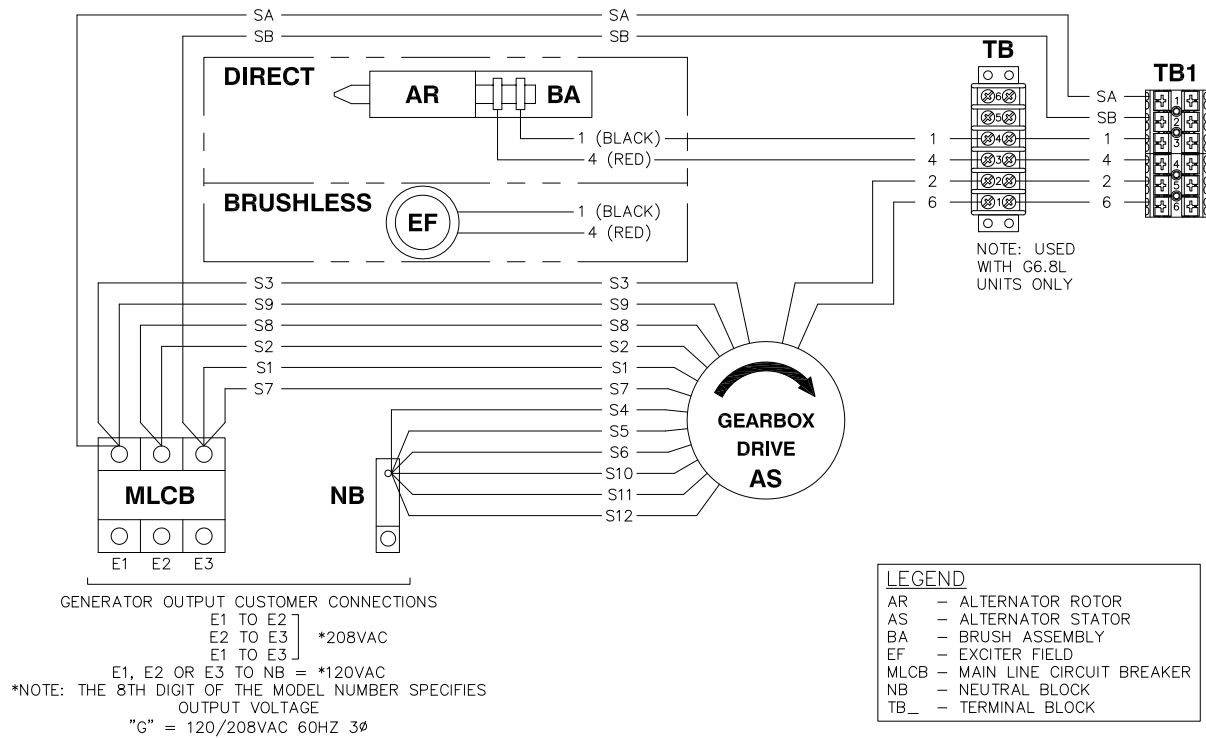


OPTION 6 - THREE PHASE, CPL CONTROL PANEL, DIRECT DRIVE 120/208V (G)

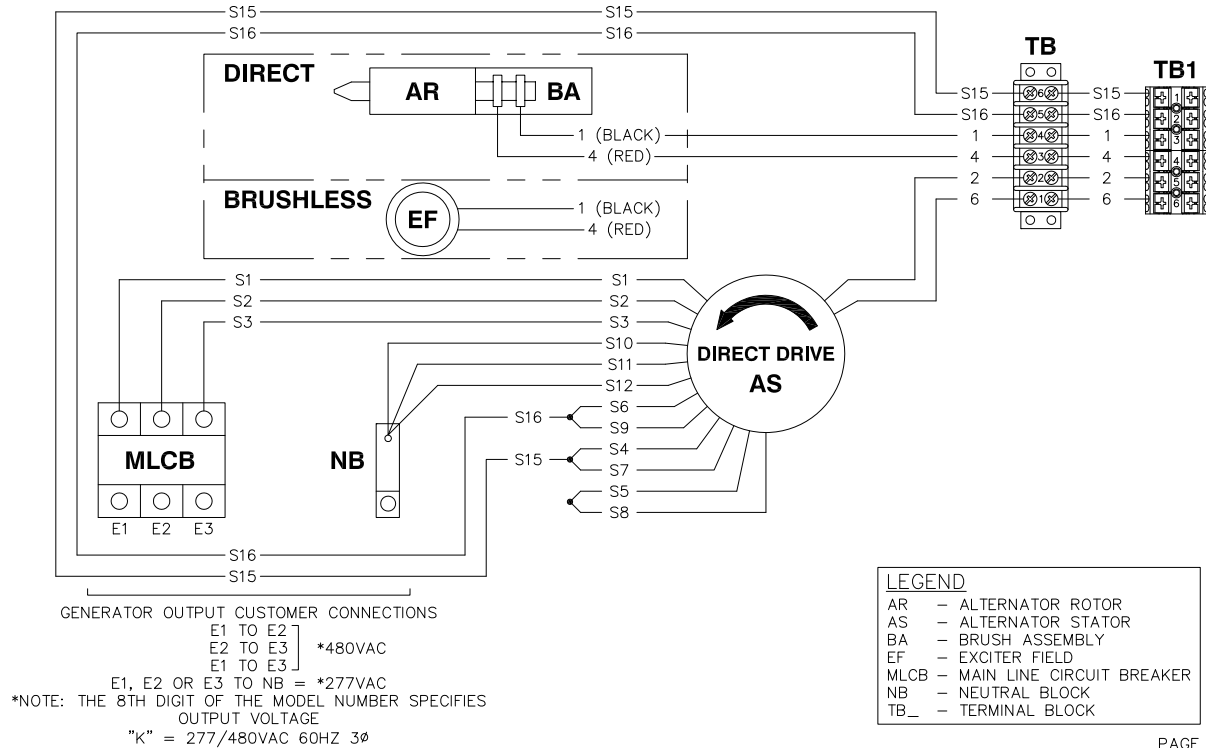


GROUP G

OPTION 7 - THREE PHASE, CPL CONTROL PANEL, GEARBOX (REVERSE ROTATION), 120/208V (G)

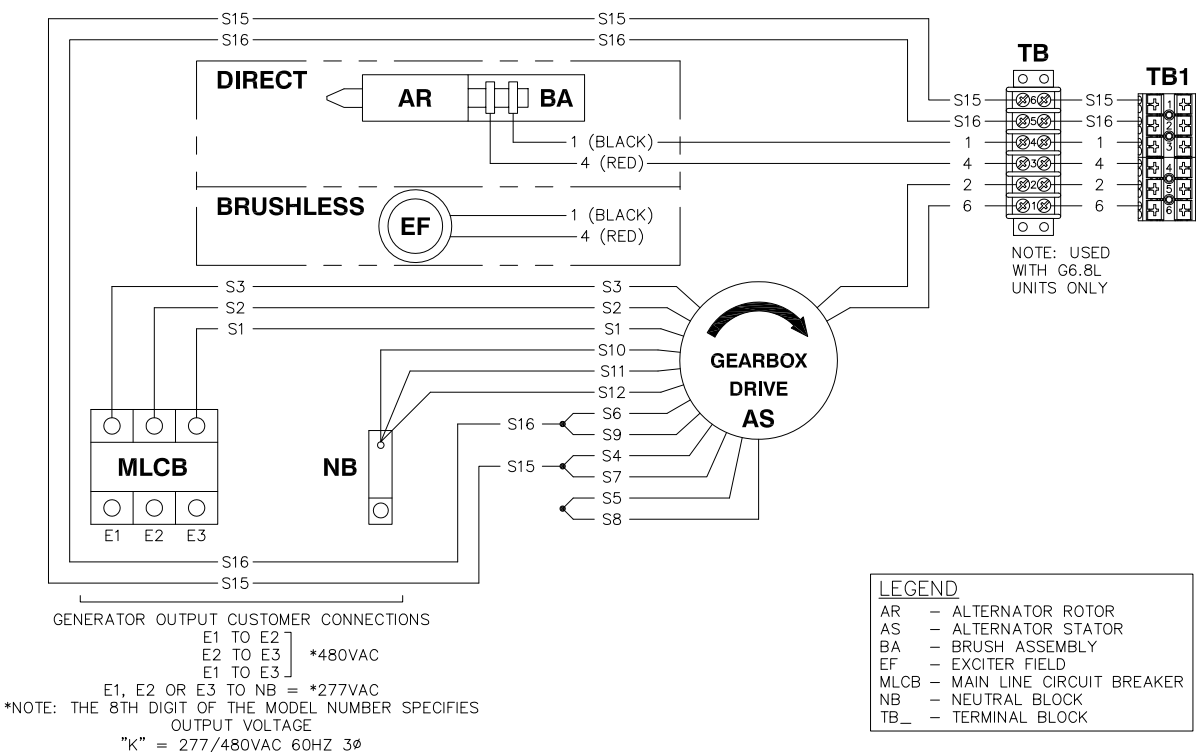


OPTION 8 - THREE PHASE, CPL CONTROL PANEL, DIRECT DRIVE 12-WIRE 277/480V (K)

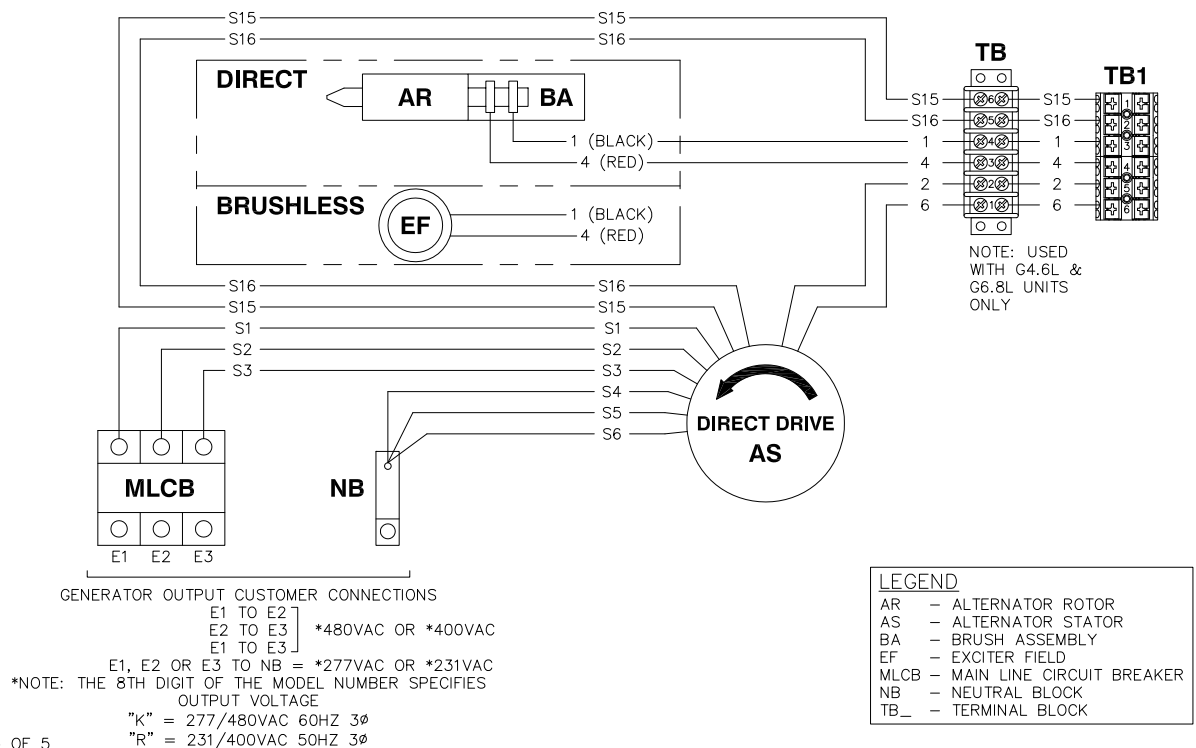


GROUP G

OPTION 9 - THREE PHASE, CPL CONTROL PANEL, GEARBOX (REVERSE ROTATION), 277/480V (K)



OPTION 10 - THREE PHASE, CPL CONTROL PANEL, DIRECT DRIVE 6-WIRE 277/480V (K/R)



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Electrical Formulas

To Find	Known Values	1-phase	3-phase
Kilowatts (kW)	Volts, Current, Power Factor	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73 \times PF}{1000}$
KVA	Volts, Current	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73}{1000}$
Amperes	kW, Volts, Power Factor	$\frac{kW \times 1000}{E}$	$\frac{kW \times 1000}{E \times 1.73 \times PF}$
Watts	Volts, Amps, Power Factor	Volts x Amps	$E \times I \times 1.73 \times PF$
No. of Rotor Poles	Frequency, RPM	$\frac{2 \times 60 \times \text{Frequency}}{\text{RPM}}$	$\frac{2 \times 60 \times \text{Frequency}}{\text{RPM}}$
Frequency	RPM, No. of Rotor Poles	$\frac{\text{RPM} \times \text{Poles}}{2 \times 60}$	$\frac{\text{RPM} \times \text{Poles}}{2 \times 60}$
RPM	Frequency, No. of Rotor Poles	$\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$	$\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$
kW (required for Motor)	Motor Horsepower, Efficiency	$\frac{HP \times 0.746}{\text{Efficiency}}$	$\frac{HP \times 0.746}{\text{Efficiency}}$
Resistance	Volts, Amperes	$\frac{E}{I}$	$\frac{E}{I}$
Volts	Ohm, Amperes	$I \times R$	$I \times R$
Amperes	Ohms, Volts	$\frac{E}{R}$	$\frac{E}{R}$

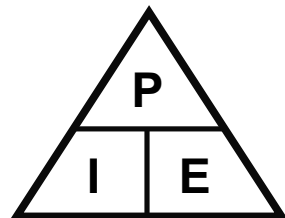
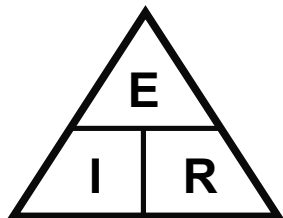
E = Volts

I = Amperes

R = Resistance (Ohms)

PF = Power Factor

Term	Symbol	Measurement
Current	I	Amps
Wattage	P	Watts
Voltage	E	Volts
Resistance	R	Ohms



003003

Constant	Shift		Result	
Voltage E	Resistance Increase	↑	Current Decrease	↓
Voltage E	Resistance Decrease	↓	Current Increase	↑
Resistance R	Voltage Decrease	↓	Current Decrease	↓
Resistance R	Voltage Increase	↑	Current Increase	↑
Current I	Resistance Decrease	↓	Voltage Decrease	↓
Current I	Resistance Increase	↑	Voltage Increase	↑
Power P	Voltage Increase	↑	Power Increase	↑
Power P	Voltage Decrease	↓	Power Decrease	↓
Power P	Current Increase	↑	Power Increase	↑
Power P	Current Decrease	↓	Power Decrease	↓

Part No. A0003109811 Rev. A 05/05/2023
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