Polar Power DC Generator Set

Troubleshooting Guide

Updated: August 2024

This document covers key requirements for troubleshooting and servicing of a Polar Power DC Generator Set powered by Diesel, Propane or Natural Gas

PREFACE

Please use this document for safe troubleshooting and servicing of this DC generator set manufactured by Polar Power Inc. Specifications of the components used to build this Generator Set (genset) may be different for each unit depending on customer requirements at the time of installation and the revision history of each Genset. Please refer to the service manuals from the original equipment manufacturers (OEM) for each component used inside this Genset.

The customer is responsible for maintaining the genset according to the periodic inspection and adjustment schedule as well as maintaining functional levels of fluid consumables such as the coolant, lube oil, and fuel.

The Isuzu 3C series of engine has been certified by the United States Environmental Protection Agency (US EPA), the California Air Resources Board (CARB) and the European Parliament Council Directive (97/68/EC) for use in stationary industrial non-road applications.

The specifications and components used in this generator set may be subject to change without notice. If the contents in this manual are modified by Polar Power customers who have registered their products with Polar Power will be notified with an update. All current manuals are available on Polar Power's web site at:

http://www.polarpowerinc.com/products/generators/index.htm

California
Proposition 65 Warning
Diesel engine exhaust and some of its constitute components are known to the State of California to cause cancer, birth defects, and other reproductive harm.

DISCLAIMER: The troubleshooting and servicing guide is designed for use by generator service professionals and others who are familiar with engine-generator sets and their controls. Working on engines, generators and their controls presents certain hazards to equipment and personnel. It is assumed that the generator set user is adequately trained in the proper use of test equipment and the management of risks inherent in generator servicing.

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Safety Precautions for Trained Personnel and nomenclature per ISO/EN 7010

(1) SERVICE AREA

WARNING

- **Sufficient Ventilation**

Inhalation of exhaust fumes and dust particles may be hazardous to your health.

CAUTION

- **Safety Equipment**

Fire extinguisher(s), first aid kits and an eye wash / shower station should be close at hand (or easily accessible) in case of an emergency.

(2) WORK – WEAR (GARMENTS)

WARNING

- **Safe Work Clothing**

Appropriate safety wear (gloves, special shoes/boots, eye and ear protection, head gear, harness', clothing, etc.) should be used/worn to match the task at hand. Avoid wearing watches, jewelry, rings, unbuttoned cuffs, ties or loose fitting clothes around moving / rotating machinery. A serious accident may occur if clothing or jewelry is caught in moving/rotating machinery or completes an electrical circuit. The battery and Supercapacitor used in the generator set can deliver a jolt of energy in excess of 3000 amps at 50 volts which will instantaneously vaporize metal jewelry.

(3) TOOLS

WARNING

- **Appropriate Lifting / Holding**

When lifting a generator set, use only a lifting device (crane, backhoe etc.) with sufficient lifting capacity. Do not overload the device. Use only a chain, cable, or lifting strap as an attaching device. Do not use rope, serious injury may result. To hold or support a generator set, secure it to a cart designed to carry the weight of the generator set. Do not overload this device, serious injury may result. Never run the generator set without it being properly secured, serious injury may result.

CAUTION

- **Appropriate Tools**

Always use tools that are designed for the task at hand. Incorrect usage of tools may result in damage to the generator set and or serious personal injury.

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Safety Precautions for Trained Personnel (continued)

(4) GENUINE PARTS and MATERIALS

CAUTION

- **Genuine Parts**

Always use genuine Polar Power Inc. recommended parts and goods. Damage to the generator set, shortened the service life and or personal injury may result.

(5) FASTENER TORQUE

WARNING

- **Torque Specifications on Fasteners**

Always follow the torque values and procedures as designated in the service manual OR referenced in this installation manual. Incorrect torque values, procedures and or tools may cause damage to the generator set and or personal injury.

(6) ELECTRICAL

WARNING

- **Short Circuits**

Always **disconnect** the Positive (+) battery cable before working on the electrical system. An accidental “short circuit” may cause damage, fire and or personal injury. Remember to connect the Positive (+) battery cable (back onto the battery) last. Fasten the terminals tightly.

WARNING

- **Charging Batteries**

Charging wet celled batteries produces hydrogen gas. Hydrogen gas is extremely explosive. Keep sparks, open flame and any other form of ignition away. Explosion may occur causing severe personal injury. Keep Lithium Batteries dry and stored away from all sources of water vapor, moisture or condensation.

WARNING

- **Battery Electrolyte**

Batteries contain sulfuric acid. Do NOT allow it to come in contact with clothing, skin and or eyes, severe burns will result.

(7) WASTE MANAGEMENT

CAUTION

- Observe the following instructions with regards to hazardous waste disposal. Negligence of these regulations will have a serious impact on the environment.

1) Waste fluids such as lube oil, fuel and coolant shall be carefully put into separate sealed containers and disposed of properly.

2) Do NOT dispose of waste materials irresponsibly by dumping them into the sewer, overland or into natural waterways.

3) Waste materials such as oil, fuel, coolant, solvents, filter elements and batteries, must be disposed of properly according to local ordinances. Consult the local authorities or reclamation facility.

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Safety Precautions for Trained Personnel (continued)

(8) FURTHER PRECAUTIONS

WARNING

● Fueling / Refueling
Keep sparks, open flames or any other forms of ignition (match, cigarette, etc.) away when fueling/refueling the unit.

Fire and or an explosion may result.

WARNING

● Hot Surfaces.
Do NOT touch the top of the generator set (or any of its components) during running or shortly after shutting it down. *Scalding / serious burns may result.*
Allow the generator set to cool down before attempting to approach the unit.

WARNING

● Rotating Parts
Be careful around moving/rotating parts. Loose clothing, jewelry, ties or tools may become entangled causing damage to the engine and or severe personal injury.

WARNING

● Preventing burns from scalding
1) Never open the radiator filler cap shortly after shutting the engine down. Steam and hot water will spurt out and seriously burn you. Allow the engine to cool down before attempt to open the filler cap.
2) Securely tighten the filler cap after checking the radiator.
Steam can spurt out during engine running, if the radiator cap is loose or improperly secured.

Codes and Standards

The following list of Codes and Standards applies to the installation and operation of the generator sets. This list is for reference only and not intended to be inclusive of all applicable codes and standards. Codes and recommendations are subject to change and may vary by location over time.

NFPA 30	**Flammable and Combustible Liquids Code**
NFPA 37	**Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines**
NFPA 54	**National Fuel Gas Code**
NFPA 58	**Liquefied Petroleum Gas Code**
NFPA 70	**National Electrical Code**
NFPA 70E	**Standard for Electrical Safety in the Workplace**
UL 2200	**Stationary Engine Generator Assemblies**

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DC Genset Model Numbers

Table 1 – DC Generator Model Numbers and Specifications

Enclosure	Output	Diesel	Natural Gas	Propane
88-25-0603	10KW	8220-603-D-10-02	N/A	N/A
	12KW	N/A	8220-603-NG-12-02	8220-603-LP-12-02
	15KW	8220-603-D-15-02	8340-603-NG-15-02	8340-603-LP-15-02
88-25-0200	10KW	8220-200-D-10-02	N/A	N/A
	12KW	N/A	8220-200-NG-12-02	8220-200-LP-12-02
	15KW	8220-200-D-15-02	8340-200-NG-15-02	8340-200-LP-15-02
88-25-0100	10KW		N/A	N/A
	12KW	N/A	8220-100-NG-12-02	8220-100-LP-12-02
	15KW	8220-100-D-15-02	8340-100-NG-15-02	8340-100-LP-15-02

88-25-0603 - Vertical enclosure (**Figure 5: Outdoors installation ONLY**)
88-25-0200 - Open frame enclosure (**Figure 6: Indoors* installation ONLY**)
88-25-0100 - Horizontal all-weather enclosure (**Figure 7: Outdoors installation ONLY**)
***** Indoors means that the unit is sheltered but the exhaust still vents out

Figure 5 – Vertical Enclosure 88-25-0603

Figure 6 – Open Enclosure 88-25-0200

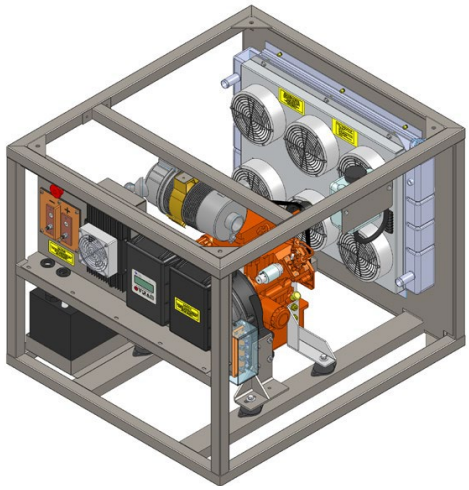

Figure 7 – Horizontal Enclosure 88-25-0100

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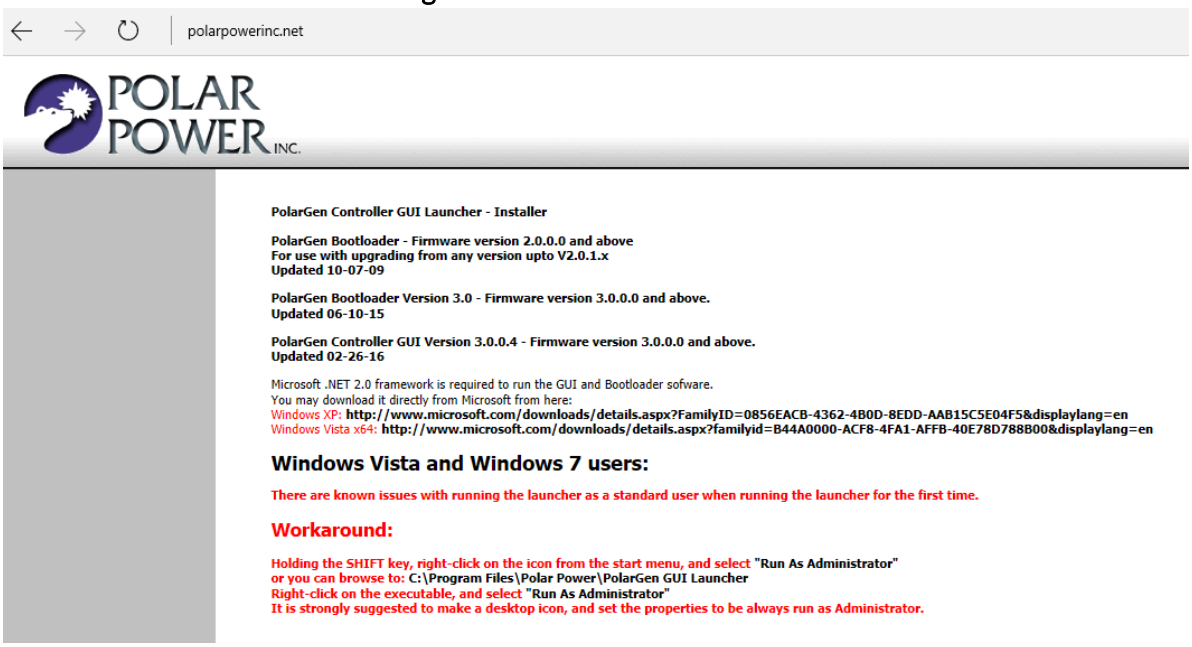
Section 1: Polar GUI Software Installation, Compatibility, and Connectivity

Figure 1 – Polar Power Software Website



***Please Note:** Microsoft .NET 2.0 framework is required to run the GUI and Bootloader software

You may download it directly from Microsoft from here:
Windows XP:
https://msdn.microsoft.com/en-us/library/bb417255(v=winembedded.5).aspx
Windows Vista x64:
http://www.microsoft.com/downloads/details.aspx?familyid=B44A0000-ACF8-4FA1-AFFB-

Instructions on what to download and how to run the Polar Power GUI.
Step 1 – Click on the first link - PolarGen Controller GUI Launcher - Installer
Step 2 – Click on the forth link - PolarGen Controller GUI Version 3.0.0.4 - Firmware version 3.0.0.0 and above. Updated 02-26-16
For Windows 8 users, once the executable file has been downloaded and installed the only way to properly run it is to press Shift and Right-click on the mouse and "**Run As Administrator**"

Additional instructions:

- When Opening GUI 3.0.0.4 – run as **Administrator**
- After connecting RS232 serial cables from PC's male connector (**Figure 2**) to female connector (**Figure 3**) on the Genset:
    - A. Make sure to choose: **'Direct Connect'** in Communications Page
    - B. Go to Edit → Preference → Communications, and select the correct COM port for your PC. *

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* To determine what COM port the Genset is connected to on your PC you can:
    - Right click **This PC (This Computer)**
    - Go to Properties → Device Manager
    - Click on the **Ports (COM & LPT)** dropdown
    - Select _____??_____

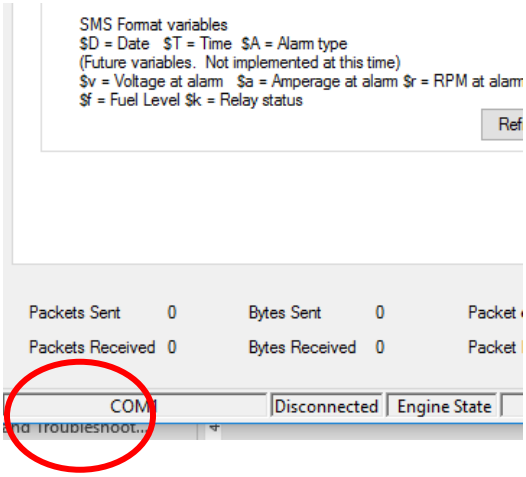
An efficient way make sure that the GUI software is on the correct COM port is to reference with the bottom left corner of the software's dialogue box (Figure 4).

Figure 2 – RS232 Male Serial Connector

Figure 3 – RS232 Female Serial Connector

.

Figure 4 – GUI Software COM port Reference



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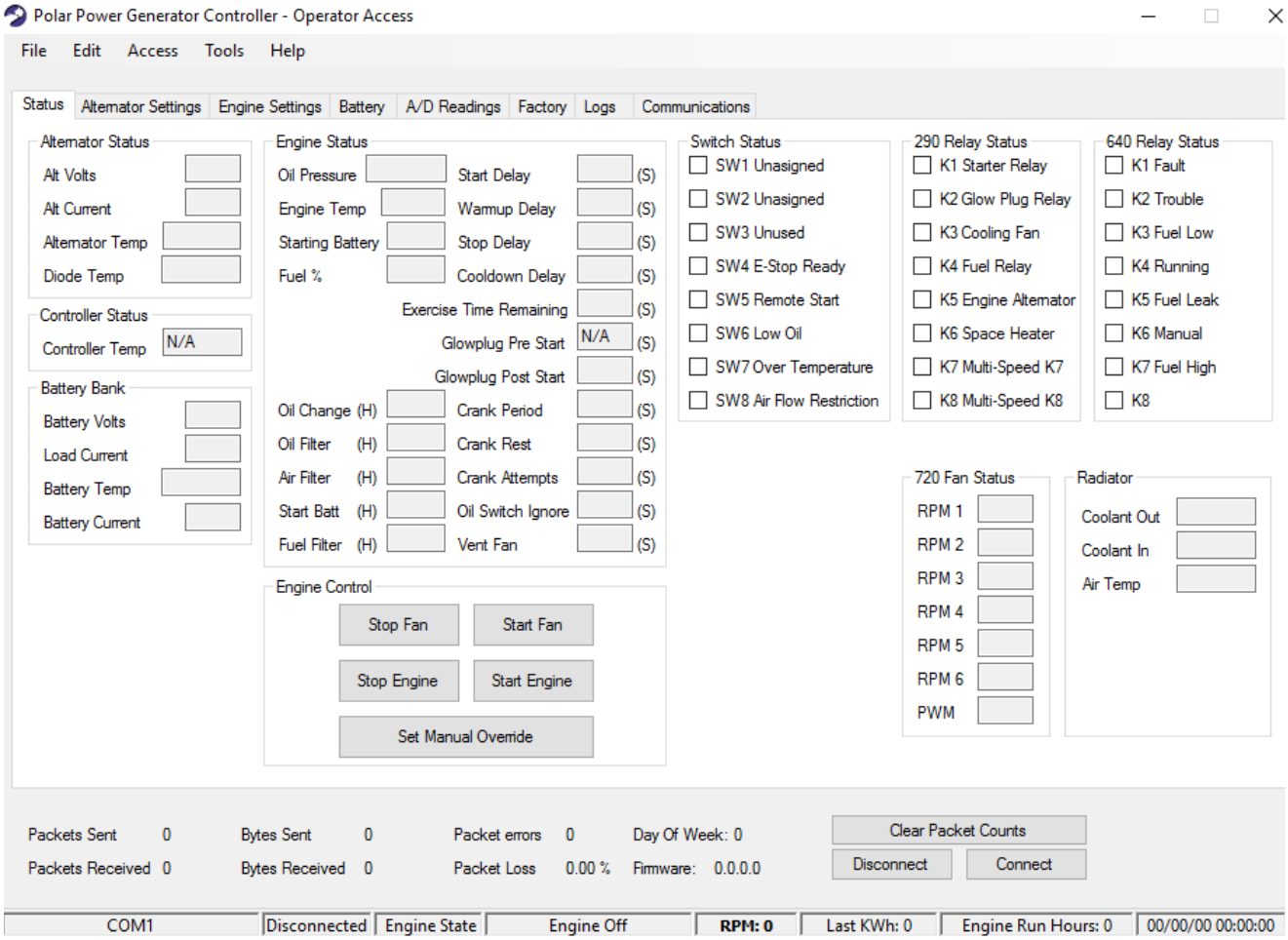
GUI Software Tabs

Upon start-up of the application, it will be at the ***Status*** screen. This will be the most common screen used for monitoring the operation of the Genset **(Figure 5 - GUI Software Main Status Screen).**

Figure 5 - GUI Software Main Status Screen



GUI Software Tabs

The Polar Power generator controller software consists of the following tabs:

Status – Monitor general operation of genset.

Alternator Settings – Set variables to control the alternator section of the controller

- Voltage/Current
- Warm-Up/Cool-Down time
- Over Temp Power Reduction
- Weekly/Monthly Exercise Time

Engine Settings - Set variables to control the engine section of the controller

- RPM
- Crank Time
- Speed Control
- Fault Settings (Low Oil Pressure/High Temp)

Battery - Describes the function of the remote battery monitoring and temperature compensation system

A/D Readings - Gives uncompensated readings of temperature and outputs of the Genset for troubleshooting

Factory - Allows the user to calibrate the readings from the Supra Controller.

- Calibration
- PID

Logs – Contains the last run logs of the Genset

Communications - Contains information for setting up the Controller to work over a network

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Section 2: DC Genset Startup Circuit Operation and Troubleshooting

Because one of the main reasons for Genset failure to start is failure of the starting battery, the DC Genset Startup Circuit is based on the Supercapacitor module and 48V-12V DC –DC power supply.

Supercapacitor

- Replaces Starting Battery

Figure 8 – Supercapacitor Module

Main Features and Specifications:

- Max Voltage: 16VDC
- Operating Voltage 13.8 – 14.7 VDC
- Capacitance: 500F
- Service life 15 – 20 years or 500,000 start cycles
- Operating range -40°C to +65°C

The DC-DC Power Supply (Figure 12) is required for both Battery and Supercapacitor starting systems.

With any standby generator (AC or DC), a float charger is required to keep the battery or Supercapacitor charged and, at the same time, provide power for the monitoring / alarm system.

Polar monitors the voltage output of the DC-to-DC power supply, should it drop below 12.0 VDC (8 VDC was the previous set point), an alarm will be triggered.

Main Features and Specifications:

- Input voltage range for nominal 48Vdc systems is 25 – 60 VDC
- Maximum steady state input current is 8 amps at 48 VDC
- Max Output current: 23 amps
- Output charging voltage is 13.8 -14.4 VDC
- Protection from short circuit, overload and reverse polarity
- Fully isolated
- IP67 protection

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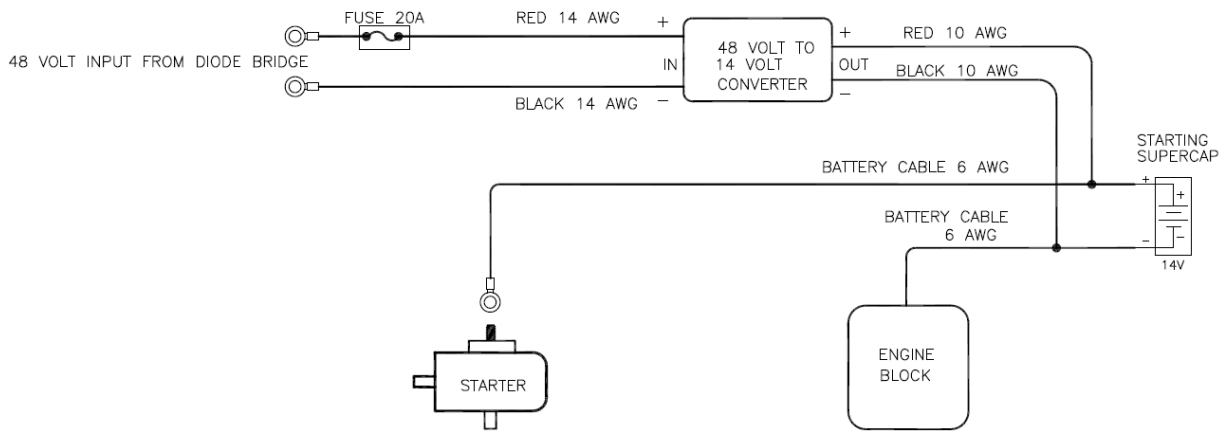
Normal Operation

For either +24 or -48 Volts systems, the Supercapacitor is charged from the main DC Power Plant through DC-DC power supply (23Amps).

Figure 9 – Circuit Diagram for Supercapacitor Operation



The 20 Amp fuse is located between output of the Diode Bridge connected to the 48V DC Bus terminals and DC-DC power supply. The Supercapacitor is isolated trough the DC-DC power supply.

During commissioning, when the DC Genset in connected for the first time to the site's Power Plant, the Supercapacitor is charged per the following scheme:

- From 0V to 7.5V with 1 amp input current from -48 buss.
- From 7.5 to 14V with 10-12 amps (peak) input current from -48 buss (up to 23 amps output).

**Please note during the initial startup it will take approximately 10 – 15 min to charge the Supercapacitor.*

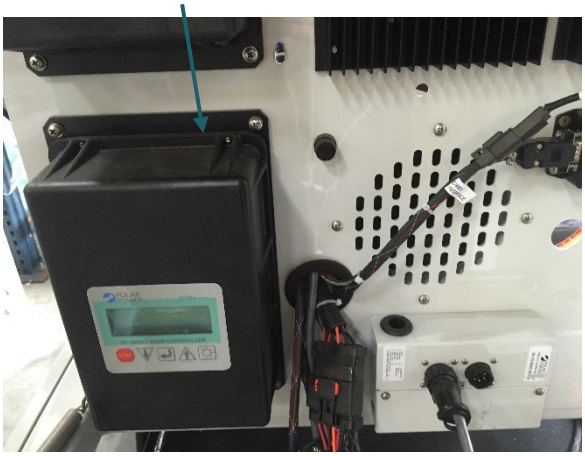
Once the Supercapacitor is fully charged (reaches 14VDC), the DC-DC power supply keeps it charged and powers the monitoring / alarm circuits with a total input current of 500mA or less.

Case 1: Troubleshooting Supercapacitor when Generator Will Not Start:

An alarm is sent when the battery or Supercapacitor voltage drops below 12.0 VDC (previous calibrations were set at 8 VDC) In the event of this happening and the **generator will not start**, the basic steps to take are:

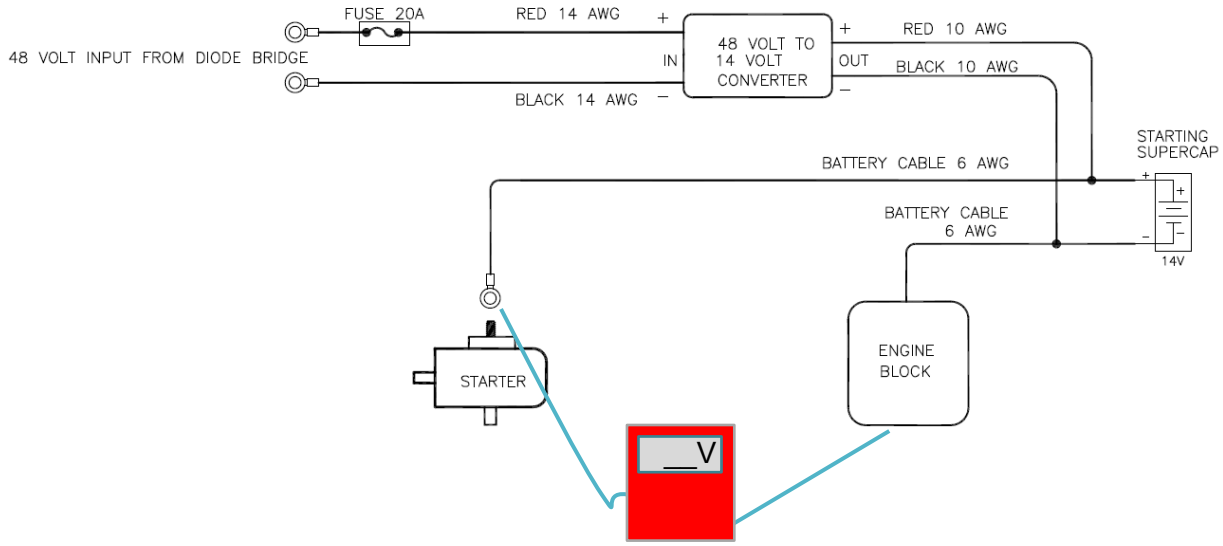
1) Check the panel mount fuse.
   - Take the fuse out from its position in the generator
   - Use an ohmmeter and check the fuse for continuity (see **Figure 10**).

Figure 10 - 20Amps Fuse



2) Confirm Voltage
   - Using a multimeter, measure the voltage across the starter and the engine block (see **Figure 11**)

Figure 11 – Measuring Voltage from Starter to Engine Block



If it is above 12V, proceed to checking the input voltage to the DC- DC power supply (see **Figure 12**).

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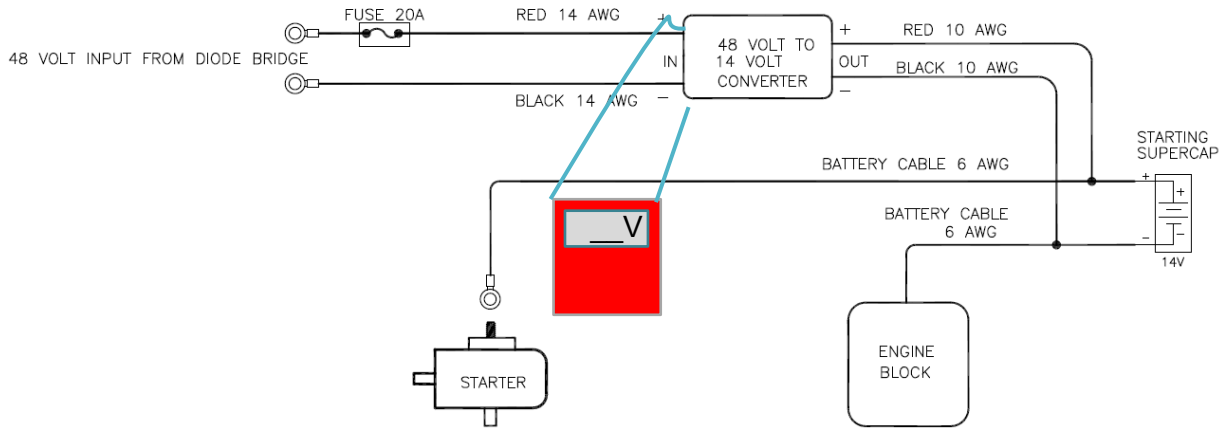
Figure 12 - DC to DC power supply

3) Confirm the input voltage to the DC-DC power supply:

- Disconnect the plug from the DC-DC power supply
- Locate the input positions on the power supply plug
- Measure the voltage using a voltmeter

Figure 13 – Measuring Voltage input at DC to DC Power Supply



The DC-DC power supply input voltage is equal to the power plant's battery floating voltage. If the Supercapacitor is being charged, the voltage will be low. With a voltmeter measuring voltage at the input to the DC2DC converter, it is possible to confirm whether or not the Supercapacitor is possibly being charged.

<u>If the DC-DC power supply fails, replace the power supply</u>.

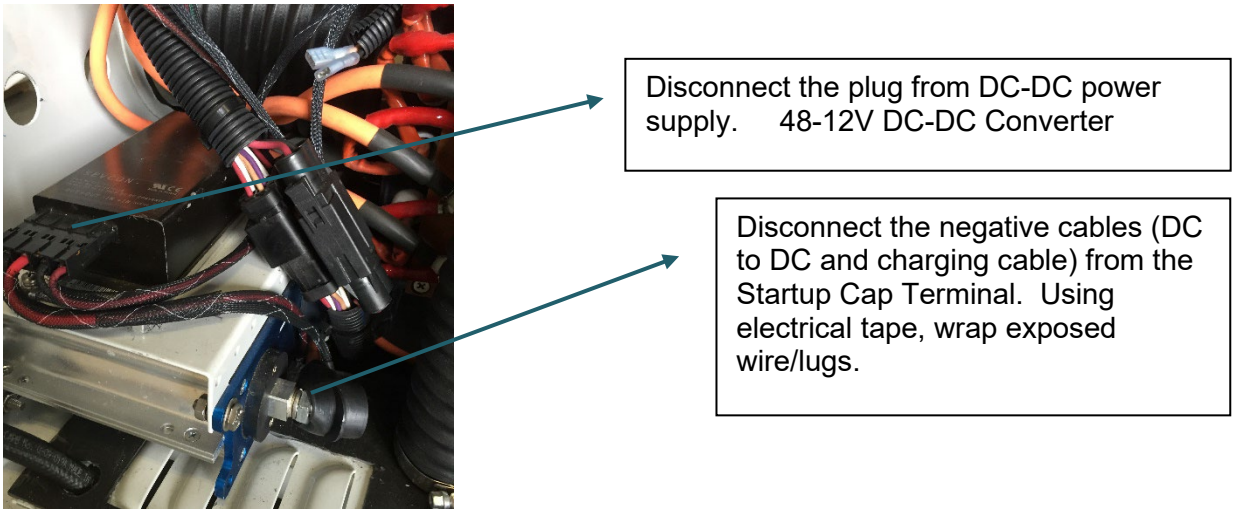
* In an emergency, the Supercapacitor circuit can be disabled, and a conventional 12V car battery can be used to start the generator.

Disabling the Supercapacitor for temporary use of a conventional 12V car battery.

To connect a conventional starting battery:

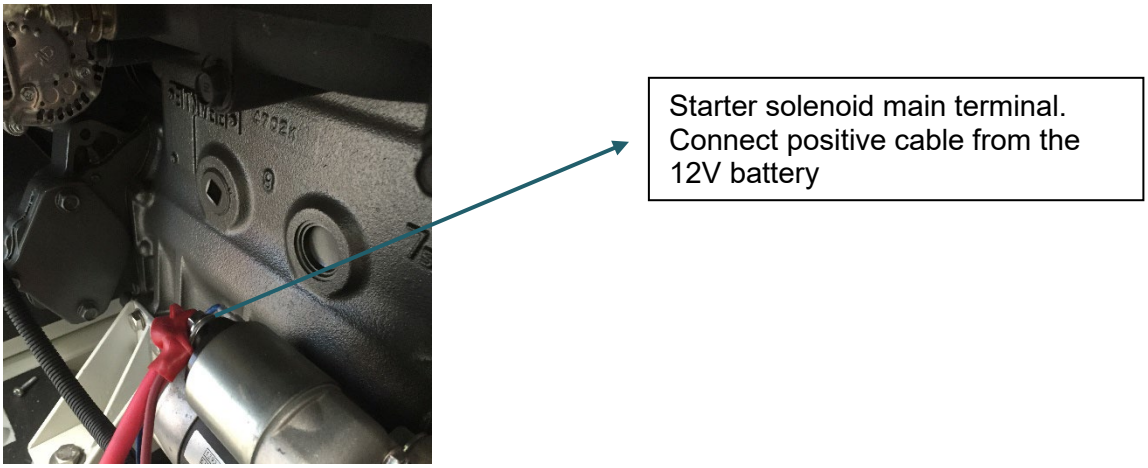
- Disconnect the negative cable from the Startup Cap terminal (see **Figure 12**)

Figure 14 - DC to DC plugs and Startup Cables



- Connect Negative lead of the 12V car battery to the engine block at convenient location make sure there is a good electrical connection.
- Connect Positive lead of the 12V car battery to the Positive terminal of the Starter solenoid main terminal (see **Figure 15**).

Figure 15 – Starter Solenoid Main Terminal



***** *Jumper clamps may be used in place of lugs; be careful of vibration shaking jumpers loose and shorting.*

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Disabling the Supercapacitor for temporary use of Jumper Clamps

To connect jumper clamps to start the generator, the process is similar to that of connecting a Conventional 12V lead acid battery:

- Disconnect the negative cable from the Startup Cap terminal (See **Figure 14**)
- Disconnect the plug from DC-DC power supply 48-12V DC-DC Converter (See **Figure 14**)
- Connect Negative clamp of the jumper cables to the engine block at convenient location.
- Connect Positive clamp of the jumper cables to the Positive terminal of the Starter solenoid main terminal (see **Figure 15**).

Figure 16 – Supercapacitor Terminals

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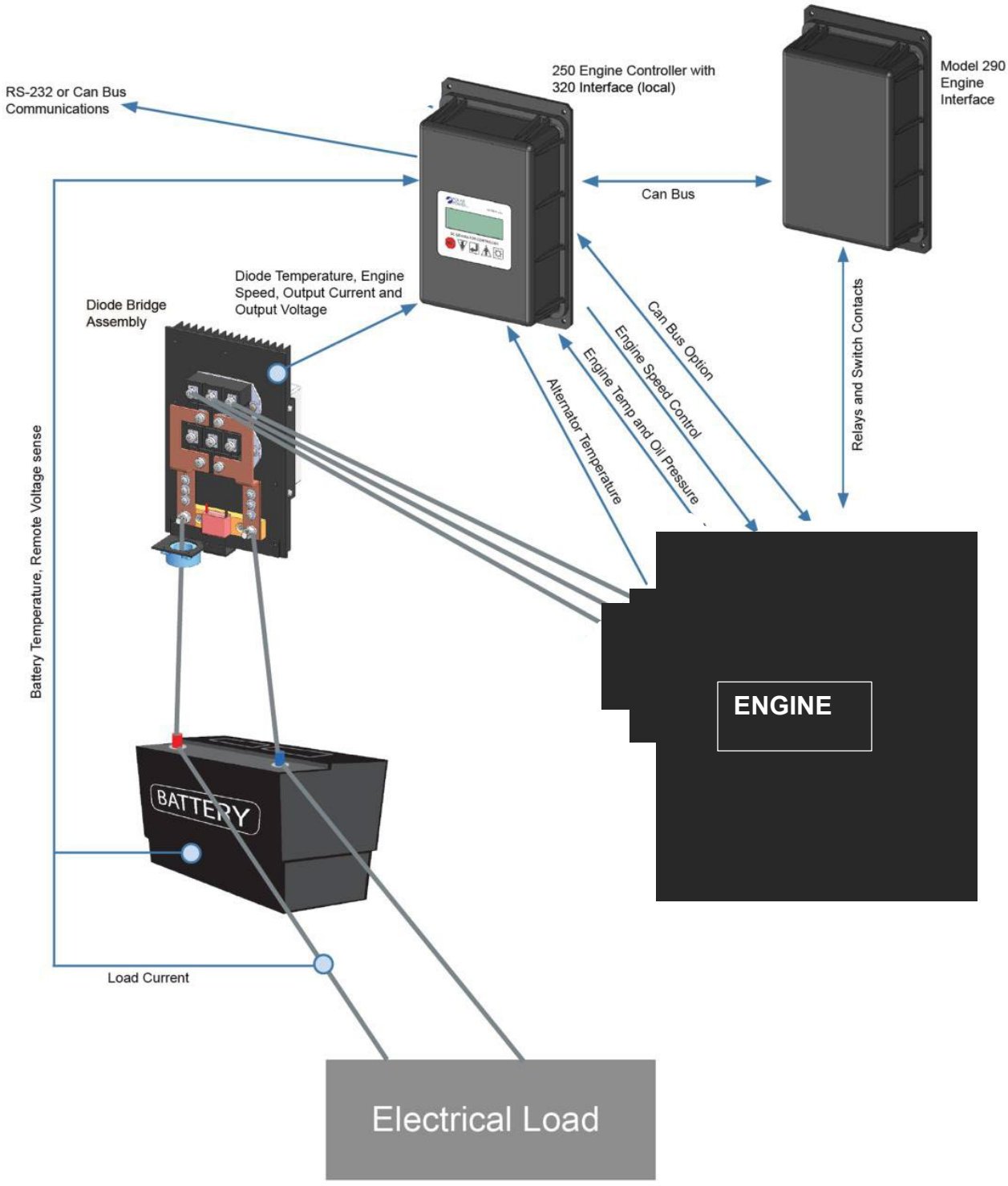
Section 3: Supra Control System Operation and Troubleshooting

Figure 17 - Supra Control System



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Overview:

As depicted in **Figure 17 - Supra Control System**, the Supra Control System controls power to DC loads and serves as a fuel based programmable battery charging system. Its features include **integration of engine control, alternator, and external communications** into one control system. It also allows **precise control of voltage and current** and accepts a **power input ranging from 12 to 65 volts**.

The Supra Digital Control System provides a complete log of alarms and operating parameters at the completion of a charge cycle or **Automatic Generator Shut Down** - if certain preprogrammed faults and-or limits are detected. It offers **Automatic Warnings** - when certain services are required. Alarms can be reset and the generator exercised to help identify potential problems before scheduling a site visit. If an unscheduled maintenance is required, the technician can arrive at the site prepared, reducing the need for a second visit.

The Control System Integrates:

- Engine Control
- Alternator Voltage Regulation
- Auxiliary Power Inputs
- Operator Interface
- Remote Site Monitoring and
- Communications

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Figure 18 - Supra 250 Controller and Connections

The Supra 250 Controller module **(Figure 18)** is the center of the Supra Control system providing the primary logic control, analog and switching inputs, and communication. Its power supply is controlled by the microprocessor to also provide the generator's voltage and current regulation. Analog to digital converters read the various engine, alternator, and control sensors for temperature, pressure, voltage, current, and speed

Figure 19 - Supra 290 Engine Interface and Connections

The Supra 290 Engine Interface module **(Figure 19)** is designed as a separate module to facilitate access to replaceable fuses used to protect the system against catastrophic damage from shorts, over current, or operator error. This assembly contains the relays and switched contact inputs for the engine control as required for fully automated operation. Starter solenoids, fans, glow plugs, and fuel valves are typical devices that are fuse protected within the 290 module

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Possible Problems and Troubleshooting Supra 250 Controller Module

Case (1): Controller Display is blank

In the event that the Display of the 250 Supra Controller is blank and does not show any power, the possible causes and steps to take to troubleshoot this issue are:

Possible Causes:	Troubleshooting Instructions:
No power flowing to controller	• Verify that controller connections are correct and tighten by checking all wiring • Verify voltage is flowing to the controller (Reference Supra 250 controller pinout diagram)
Unit reaches over 70V, causing controller to short	• Replace controller
Short in one of the unit's internal Sensors, causing controller to lose power	• Check current sensor for proper connectivity (Verify or replace current sensor) • Check temperature sensor for proper connectivity or replace temperature sensor (connection sometimes becomes loose)

Case (2): Controller shows an inaccurate current reading on display

Possible Causes:	Troubleshooting Instructions:
Incorrect current calibration	• In the *Alternator Settings* tab, make sure that the 'max Current' set to corresponding amperage setting for that specific unit. (see Testing data). • In the A/D Readings tab, if the output current is a 0, as if there is no reading, the current sensor may be faulty and may need to be replaced

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Case (3): Controller displays an inaccurate fuel reading

Possible Causes:	Troubleshooting Instructions:
1. Fuel not feeding to unit	• Check Fuel pump for proper line connection and potential blockage (Diesel Applications) See **Section 7: DC Genset Fuel Tank, Gauge, and Sensor Operation and Troubleshooting**
2. Fuel sensor not calibrated	• Calibrate fuel sensor in GUI software *See **Section 7: DC Genset Fuel Tank, Gauge, and Sensor Operation and Troubleshooting**
3. Improper Wiring or connections	• Check the wiring harness and connectivity of the fuel sensor
4. Controller Malfunction	• Check fittings for Supra 250 controller and 290 engine interface for proper connections

*Reference **Section 7: DC Genset Fuel Tank, Gauge, and Sensor Operation and Troubleshooting** when dealing with fuel reading

***If Supra 250 controller still displays inaccurate value readings even after calibration, then the controller may be faulty.**

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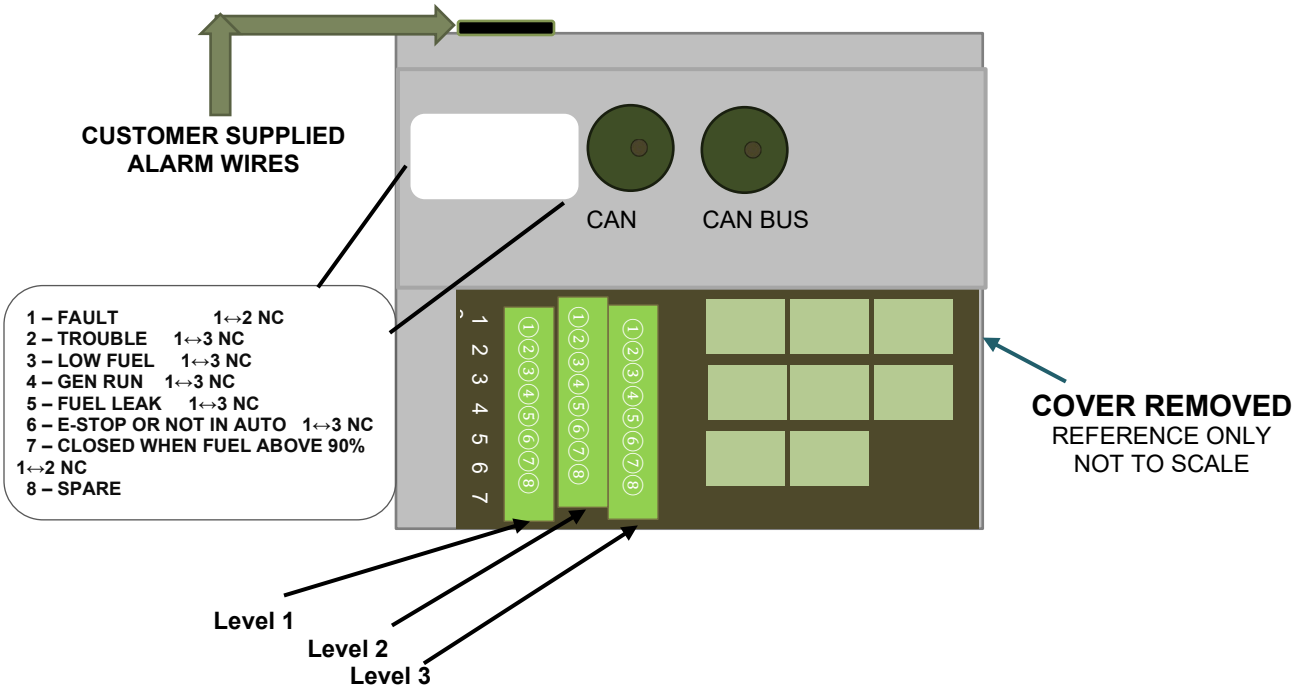
Section 4: DC Genset Alarm Board Operation and Troubleshooting

Figure 19 - Connections to Customer Alarm Box:

Some general explanation of this box purpose is needed



- Please note that only the ***Fault*** alarm is Normally Closed (NC) when connected through Level 1 and Level 2. For all other alarm positions, NC is between Level 1 and Level 3
- "1↔2" refers to the connection between Level 1 and Level 2
- "1↔3" refers to the connection between Level 1 and Level 3
- Each position in use has a respective connection between levels
- The program logic for the ***Fault*** alarm is inverted. The controller is told to energize the relay when no fault is present. At ***Fault*** position 1, the connection from Level 1 to Level 2 will resultantly be Normally Closed under normal operation.
- The program logic for the ***Trouble*** alarm is set up to have the controller energize the relay when there is a trouble present. At ***Trouble*** position 2, the connection from Level 1 to Level 3 will resultantly be Normally Closed under normal operation.

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Figure 20 - Example #1: For Normally Closed 'Fault' and Normally Closed 'Trouble' connections, the configuration is depicted below

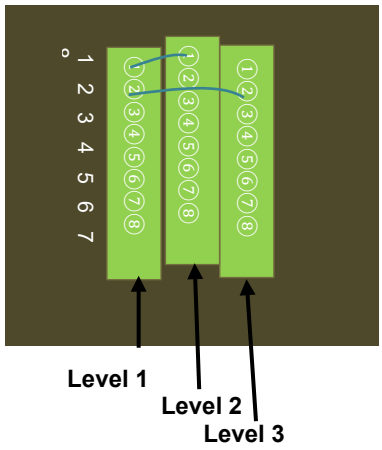
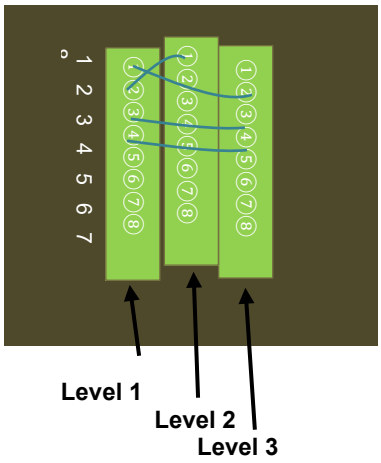


Figure 21 - Example #2: For Verizon connections, the configuration is depicted below



The alarm bar will only output 'Fault', 'Trouble', and, 'Gen Run' positions due to this specific configuration.

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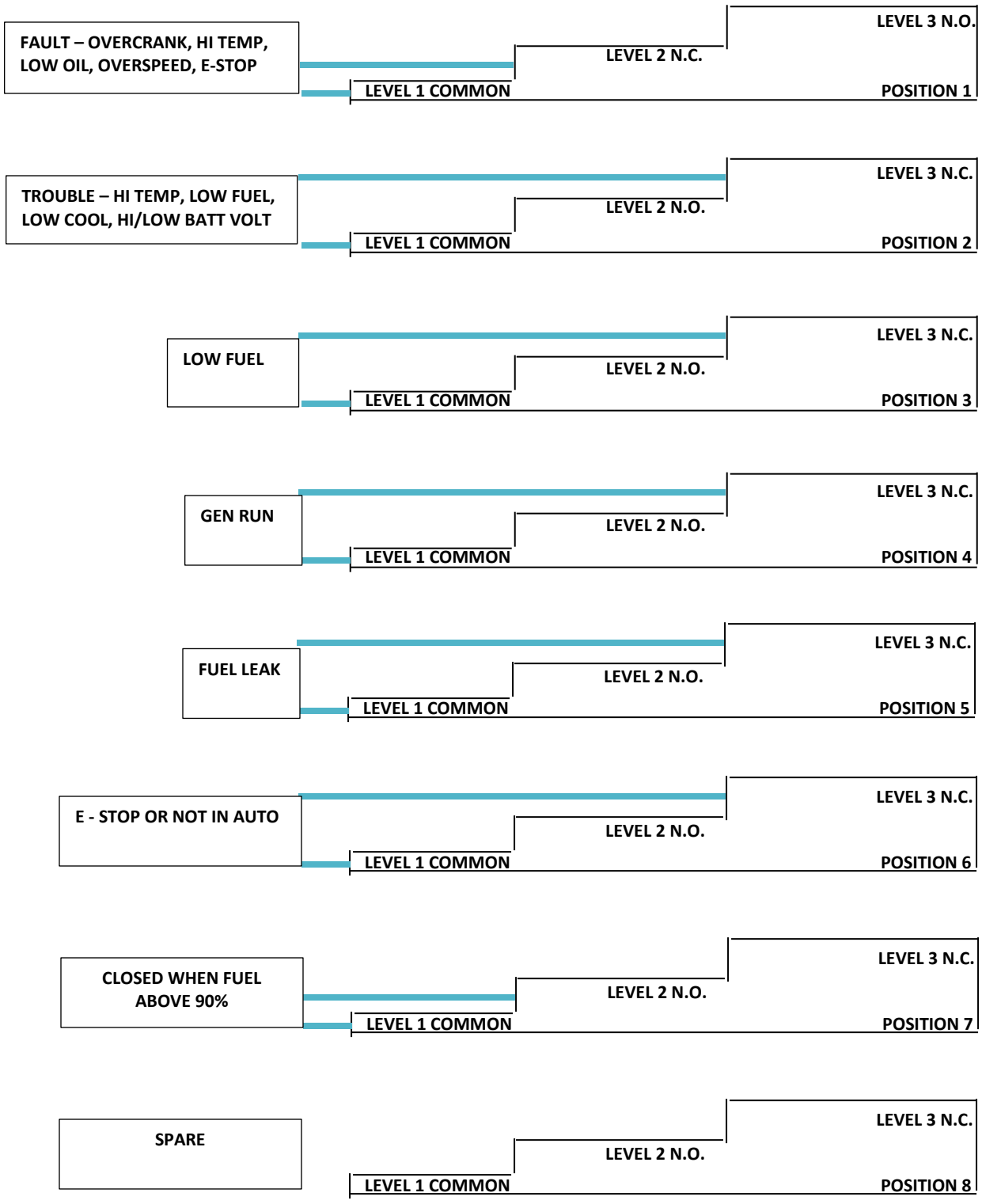
DC Genset Alarm Board Configuration (General -NC) (I don't get this section)



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DC Genset Alarm Board Configuration (Verizon -NC)

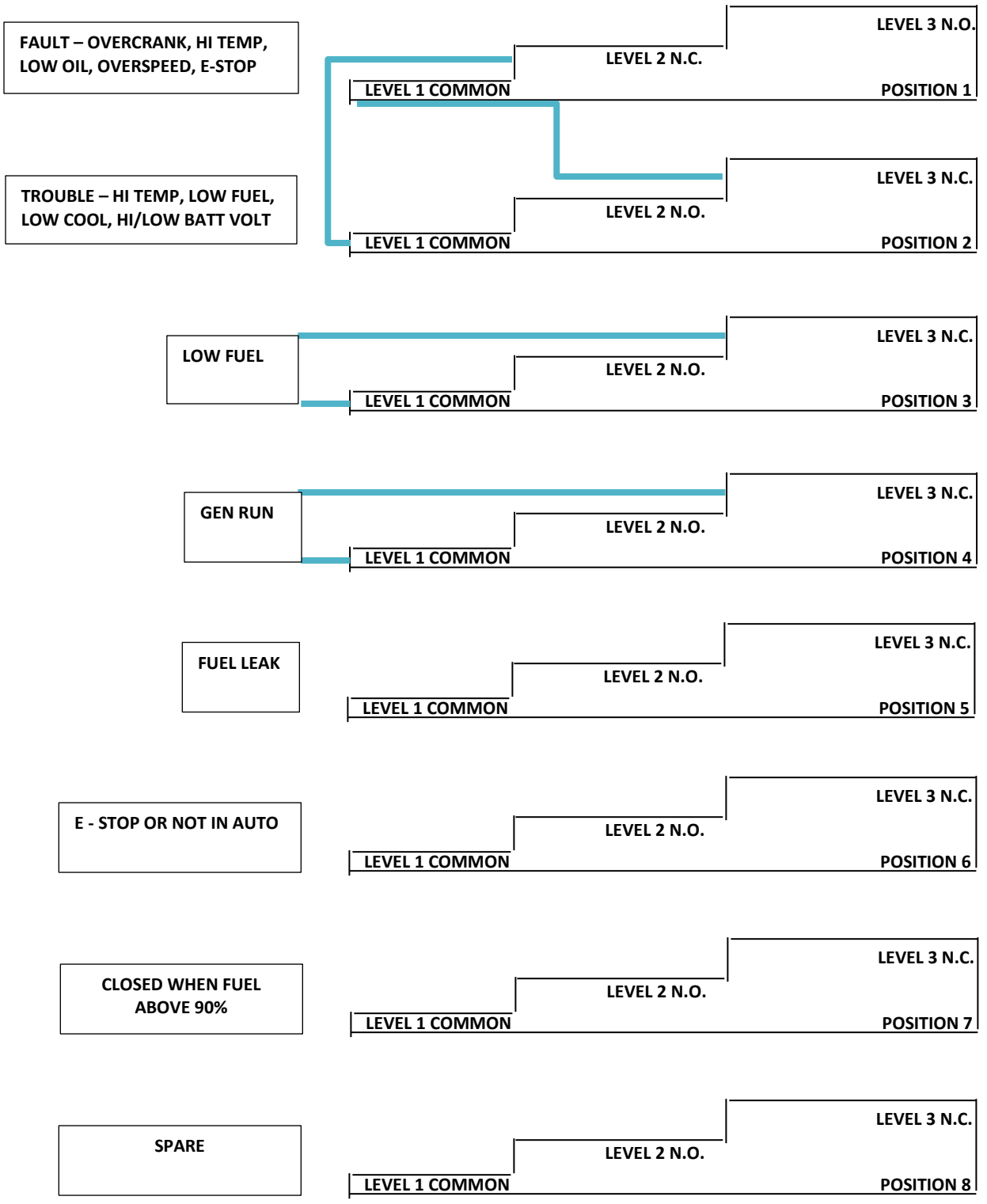

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Table 3 - Relay Alarm Board Logic for Polar Power DC Generator Set

RELAY POSITION	DESCRIPTION	INPUT POSITIONS TO TRIGGER	ALARM RELAY POWER DURING FAULT	TERMINAL POSITION
1	FAULT	OVERCRANK (FAIL TO START)	OFF	LEVEL 1, LEVEL 2 (NO)
1	FAULT	HIGH ENGINE TEMPERATURE SHUTDOWN	OFF	LEVEL 1, LEVEL 2 (NO)
1	FAULT	LOW OIL PRESSURE	OFF	LEVEL 1, LEVEL 2 (NO)
1	FAULT	OVERSPEED	OFF	LEVEL 1, LEVEL 2 (NO)
1	FAULT	NOT IN AUTO	OFF	LEVEL 1, LEVEL 2 (NO)
1	FAULT	E-STOP DEPRESSED	OFF	LEVEL 1, LEVEL 2 (NO)
2	TROUBLE	HIGH ENGINE TEMP PRE ALARM TEMP ABOVE 95%	ON	LEVEL 1, LEVEL 3 (NC)
2	TROUBLE	LOW FUEL BELOW 15%	ON	LEVEL 1, LEVEL 3 (NC)
2	TROUBLE	LOW COOLANT LEVEL CONTROLLER SWITCH 2	ON	LEVEL 1, LEVEL 3 (NC)
2	TROUBLE	HIGH STARTING BATTERY VOLTAGE (ABOVE 15 VOLTS)	ON	LEVEL 1, LEVEL 3 (NC)
2	TROUBLE	LOW STARTING BATTERY VOLTAGE (BELOW 8 VOLTS)	ON	LEVEL 1, LEVEL 3 (NC)
2	TROUBLE	FAN FAIL	ON	LEVEL 1, LEVEL 3 (NC)
2	TROUBLE	AIR FLOW RESTRICTION	ON	LEVEL 1, LEVEL 3 (NC)
3	LOW FUEL	FUEL LEVEL BELOW LOW FUEL LEVEL (45%)	ON	LEVEL 1, LEVEL 3 (NC)
4	GENERATOR RUNNING	GENERATOR RUNNING VARIABLE	ON	LEVEL 1, LEVEL 3 (NC)
5	FUEL LEAK	CONTROLLER SWITCH 1	ON	LEVEL 1, LEVEL 3 (NC)
6	E-STOP OR NOT IN AUTO	E-STOP DEPRESSED OR NOT IN AUTO	ON	LEVEL 1, LEVEL 3 (NC)
7	FUEL LEVEL OVER 90%	FUEL LEVEL OVER 90%	ON	LEVEL 1, LEVEL 2 (NO)
8				

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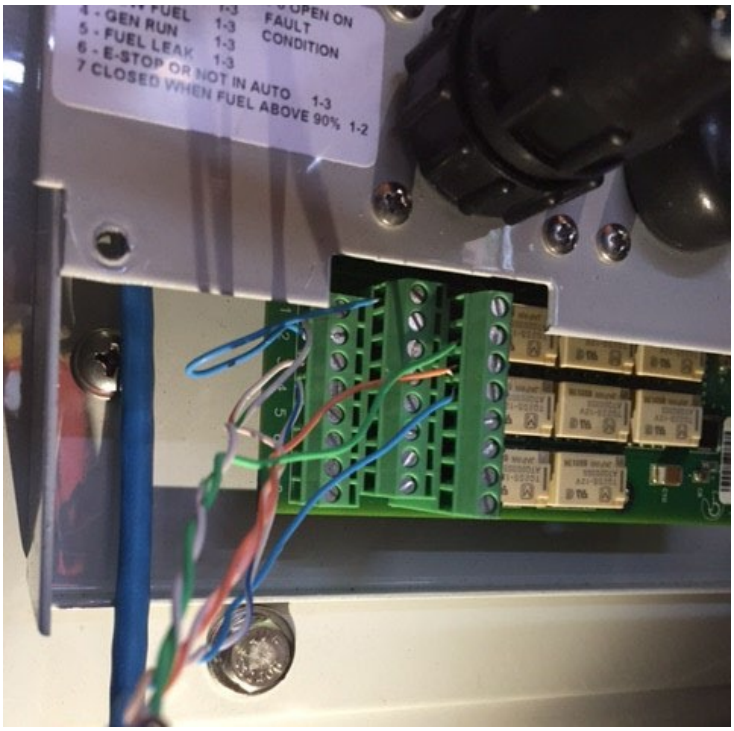
Possible Problems and Troubleshooting DC Genset Alarm Board

When beginning to troubleshoot the DC Genset Alarm board you should first:

- Evaluate the controller display to determine the alarm that is being triggered
- Identify if symptom is coming from the ***Fault*** alarm or the ***Trouble*** alarm
- Test each relay individually for continuity when the controller is powered up
- Check the wiring from the alarm board to the alarm interface (**often inverted**)
  Refer to **Table 3 - Relay Alarm Board Logic for Polar Power DC Generator Set when going through troubleshooting process*

Figure 22 – Example of open DC Relay Alarm Board



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Issue (1): Fault Alarm

*PLEASE NOTE: A FAULT ON THE ALARM BOARD IS NOT THE SAME AS A K1 FAULT IN THE GUI SOFTWARE

The basic initial steps to take in order to mediate a 'Fault' Alarm would be to:

1) Make sure that power is flowing to the unit correctly
2) Verify that the generator is in fact in 'Automatic' mode

The 'Fault' alarm can be triggered by a number of different occurrences:

Case 1. Overcrank when the generator fails to start after *6 cranks*

Table 4 – *Overcrank* Causes and Troubleshooting Instruction

Possible Causes	Troubleshooting Instruction
1. Supercapacitor not at proper voltage level (Should be between 8VDC – 15VDC)	• Measure voltage across supercapacitor using multimeter *See **Section 2: DC Genset Startup Circuit Operation and Troubleshooting** section
2. Low fuel level (Diesel Applications)	• Check Fuel pump for proper line connection and potential blockage • Verify fuel level in tank • Calibrate fuel sensor in GUI software *See **Issue (2): Case 2. Low Fuel** *See **DC Genset Fuel Sensor Operation and Troubleshooting** section
3. Spark/Glow Plug failure	For Spark Plugs: a) Look for any signs of rust, corrosion and/or looseness at the connector and pins (which??) b) Check each coil (??) for current continuity using ohmmeter For Glow Plugs: a) Look for any signs of rust, corrosion and/or looseness at the connector and pins (??) b) Check glow plug for 12V o Connect negative lead of multimeter to ground point of engine Connect positive lead of multimeter to the top of the Glow plug

Case 2. High Temp Shutdown

- If the temperature of the generator's engine reaches over *105 degrees*, the system will Fault and shutdown

Table 5 – *High Temp Shutdown* Causes and Troubleshooting

Possible Causes	Troubleshooting Instruction
1. Fan Malfunction	• Check fans to make sure they are spinning properly and have clear airways. *If one of the fans is not functioning, then all six may need to be replaced
2. Coolant Issue	In the top of the unit under the hood: • Check Coolant lines for any apparent leaks • Make sure reservoir tank is pressurized by applying pressure with a pump to the radiator fill to ensure that coolant is at an adequate level *See Issue (2): Case 3. Low Cool *See Figure 24 – Reservoir Tank in Top of Unit
3. Temperature Sensor Malfunction	• Using a multimeter, measure the continuity of temperature sensor (where, value??) • Evaluate wiring harness and connectivity (TO BE EXPANDED)
4. Controller Malfunction	• Check fittings for Supra 250 controller and 290 engine interface for proper connections • Check Supra 250 Controller for proper functionally

Case 3. Low Oil

- If the oil pressure of the engine falls below a certain value. ____*2 BAR*___ (how to verify??)

Table 6 – *Low Oil* Causes and Troubleshooting (check level first then RPM)

Possible Causes	Troubleshooting Instruction
1. Engine RPM too low	Verify RPM Settings in software *See DC Genset Alarm Board Operation and Troubleshooting section, Issue 1. Case 4)
2. Inadequate Oil Level	• Verify there is oil in the unit See Section 5: Oil Pressure Switch/Sensor Operation and Troubleshooting

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Case 4. Overspeed

- If the RPM's of the generator's engine do not fall between the predetermined range for the specific system, the system will Fault.

Table 7 – *Overspeed* Causes and Troubleshooting

Possible Causes	Troubleshooting Instruction
1. RPM exceeds max RPM range	• Verify RPM settings in GUI software
2. Load Bank Malfunction	• Replace or Reduce load to prevent RPM fluctuation
3. Controller Malfunction	4. Check fittings for Supra 250 controller and 290 engine interface for proper connections 5. Check Supra 250 Controller for proper functionally (???) *See **Section 3: Supra Control System Operation and Troubleshooting**

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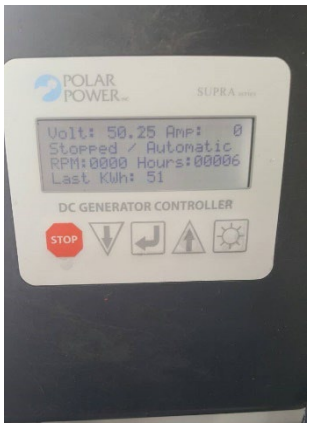
Case 5. Not in Auto

- If the Generator is left in 'Manual' mode instead of 'Automatic' mode

Please Note: For any fault, power cycling, or occurrence that causes the unit to fail to start, it will switch from Automatic Mode to Manual Mode.

Instruction to Switch Modes:

Figure 23 – DC Generator Controller Display



*See **Figure 23-DC Generator Controller Display**

- Press center button on controller
- Use button to Scroll down to 'Mode'
- Press center Button to change the mode from Manual to Automatic
- Scroll Down to Exit

Press Center button to exit

Case 6. E – Stop Depressed

- If the Emergency Stop button (on the exterior of the generator door) is pushed in, the system will Fault and the generator will not run.

Table 8 – *E-Stop Depressed* Causes and Troubleshooting

Possible Causes	Troubleshooting Instruction
1. Emergency Stop button is in fact depressed	• Pull out Emergency Stop button from depressed position
2. Supercap/battery starting voltage below 8VDC	• Check voltage of supercapacitor using multimeter *See DC Genset Startup Circuit Operation and Troubleshooting section
3. Improper Wiring	• Check the wiring harness and connectivity of the Emergency stop button
4. Controller Malfunction	• Check fittings for Supra 250 controller and 290 engine interface for proper connections • Check Supra 250 Controller for proper functionally *See Section 3: Supra Control System Operation and Troubleshooting

If the alarm persists, you would need to evaluate the mechanical and electrical components of the unit as well as the generator settings in the GUI software in order to verify that set-up and system settings are correct.

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Issue (2): Trouble Alarm

The basic initial steps to take in order to mediate a 'Trouble' Alarm would be to:

1) Verify that the fuel tank is above 15% full and the fuel sensor is reading properly (how/where??)
2) Check the battery?? voltage

The 'Trouble' alarm can also be triggered by several different occurrences:

Case 1. High Temp

- If the temperature of the generator's engine reaches over *95(C ??) degrees,* the system will output a 'Trouble' statement

Table 9 – *High Temp* Causes and Troubleshooting

*See Issue (1): Case 2. High Temp Shutdown

Case 2. Low Fuel

- If the fuel sensor reads that the fuel in the tank has fallen below *15%*

Table 10 – *Low Fuel* Causes and Troubleshooting

Possible Causes	Troubleshooting Instruction
5. Inadequate fuel amount in tank	• Verify fuel level in tank • Check Fuel pressure *(14psi minimum) (where/how?)*
6. Fuel not feeding to unit	• Check Fuel pump for proper line connection and potential blockage
7. Fuel sensor not calibrated	• Calibrate fuel sensor in GUI software *See Section 7: DC Genset Fuel Tank, Gauge, and Sensor Operation and Troubleshooting
8. Improper Wiring	• Check the wiring harness and connectivity of the fuel sensor (??)
9. Controller Malfunction	• Check fittings for Supra 250 controller and 290 engine interface for proper connections • Check Supra 250 Controller for proper functionally *See Section 3: Supra Control System Operation and Troubleshooting

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Case 3. Low Cool

- If the coolant level is too low

Table 11 - *Low Cool* Causes and Troubleshooting (switch the bullets)

Possible Causes	Troubleshooting Instructions
1. Coolant Issue	In the top of the unit under the hood: • Check Coolant lines for any apparent leaks, build-up bulges, cracks, and looseness at ends of hoses • Make sure reservoir tank is pressurized to ensure that coolant is at an adequate level and cap is secure (See **Figure 25 - Reservoir Tank Cap)** *See **Figure 29 - Reservoir Tank in Top of Unit** ***Pressurization will require external tool**

***** *If the high temp shutdown is activated without a Trouble alarm, it is most likely responding to the coolant level*

Case 4. Hi/Low Batt/Supercapacitor Volt

- If the starting battery voltage is too high (*above 15VDC*)
- If the starting battery voltage is too low (*below 8VDC*)

Table 12 - *Hi/Low Batt Volt* Causes and Troubleshooting

Possible Causes	Troubleshooting Instructions
1. Voltage is not within the Hi/Low range	• Check voltage at supercapacitor using a voltmeter • Check voltage from Starter to ground using a multimeter *See **DC Genset Startup Circuit Operation and Troubleshooting** section
2. Controller Malfunction	• Check fittings for Supra 250 controller and 290 engine interface for proper connections • Check Supra 250 Controller for proper functionally *See **Section 3: Supra Control System Operation and Troubleshooting**

Please note during the initial startup it will take approximately 10 – 15 min to charge the Supercapacitor

If the alarm persists, you would need to evaluate the mechanical and electrical components of the unit as well as the generator settings in the GUI software to verify that set-up and system settings are correct.

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Issue (3): Low Fuel Alarm

A 'Low Fuel' Alarm can be triggered when the fuel sensor reads that the fuel in the fuel tank has fallen below 15%. The basic initial step to take to mediate a 'Low Fuel' alarm would be to verify that the fuel sensor is calibrated correctly in the GUI software (how??). If the alarm persists, then you should continue with troubleshooting the Fuel Sensor itself.

*See Issue (2). Case 2. Low Fuel

Figure 24– Fuel Level Gauge on Fuel Tank

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Section 5: Oil Pressure Switch/Sensor Operation and Troubleshooting

Each unit consists of an oil pressure switch that responds based on a specified pressure range. If oil pressure falls below set level it will open and if it is above set level it will close. Most units are also equipped with an analog pressure sender, which sends and analog pressure value to the controller.

To Troubleshoot the oil pressure switch to make sure it is working properly:

- Start the engine, and carry out idling at a low revolution (700 to 900 rpm) for a few minutes
- Disconnect the connector from the oil pressure switch.
- Using an ohmmeter, place one lead on the switch terminal and the other lead on the cylinder block

The circuit should be open if it is normally operating.

Figure 26 – Testing Oil Pressure Switch for Continuity

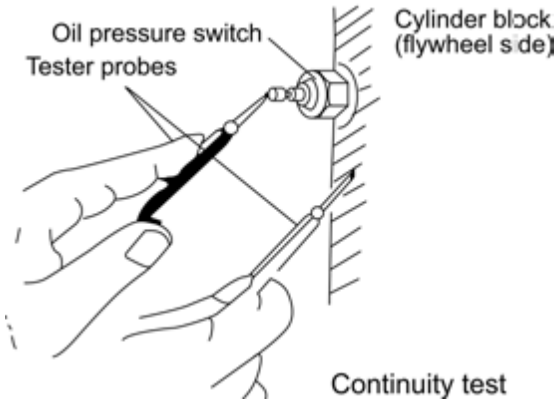

Figure 27- Oil Pressure Sensor Cable

Figure 28- Oil Pressure Sensor Cable Unplugged

For Kubota engine applications:

The Normal Oil pressure at Rated Engine speed is 0.20-0.45 Mpa = 2-4.5 bar = 29-64 psi

The Normal Oil pressure at low idle speed is 0.5 Mpa = 5 bar = 73 psi

For the Izuzu Engine Applications:

The Normal Oil pressure at Rated Engine speed is 0.29-0.44 Mpa = 2.9-4.4 bar = 42-64 psi

The Normal Oil pressure at low idle speed is 0.06 Mpa = .6 bar = 8.5 psi

For the Yanmar Engine Applications:

The Normal Oil pressure at Rated Engine speed is 0.29-0.44 Mpa = 2.9-4.4 bar = 42-64 psi

The Normal Oil pressure at low idle speed is 0.06 Mpa = .6 bar = 8.5 psi

For Daihatsu Engine Applications

The Normal Oil pressure at Rated Engine speed is .2-.48 Mpa = 2-4.8 bar = 28-70 psi

Oil Pressure Switch Operating Pressure

0.05 ± 0.01 Mpa = .5 ± .1 bar

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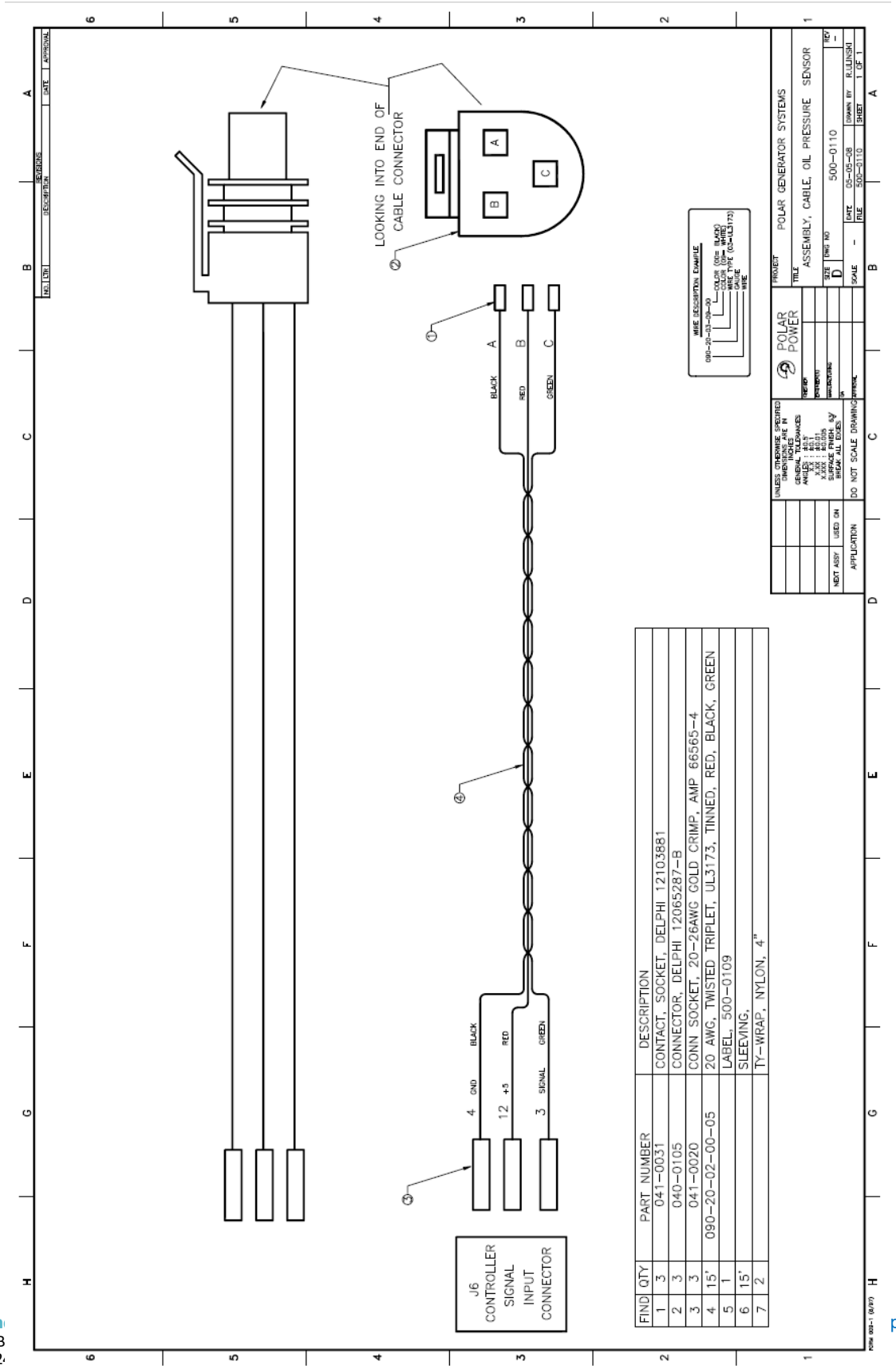
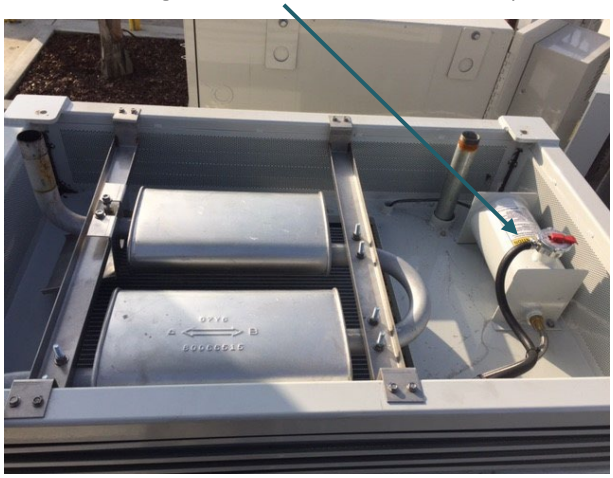
Figure 28- Oil Pressure Sensor Cable Assembly



Section 6: Coolant System Operation and Troubleshooting

Figure 29 - Reservoir Tank in Top of Unit



Each Genset is equipped with a coolant system. This system consists of a radiator and Reservoir tank for vertical units (**Figure 29 - Reservoir Tank in Top of Unit)**, and a radiator and recovery tank for horizontal units (**Figure 30 - Radiator Cap and Recovery Tank for Horizontal Unit)**.

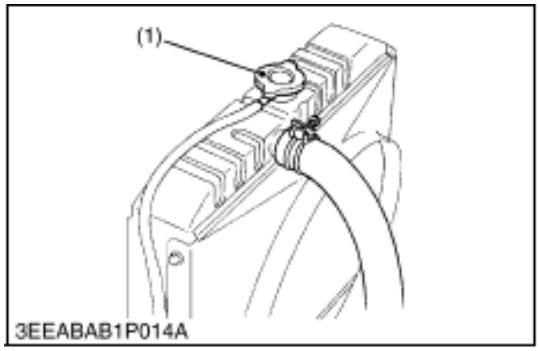
Figure 30 - Radiator Cap and Recovery Tank for Horizontal Unit

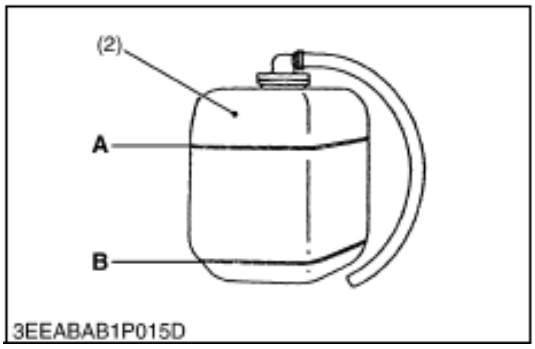
*Checking and Replenish Coolant

1. *Without recovery tank*:

Remove the radiator cap (1) and check to see that the coolant level is just below the port.

Figure 33 - (1) Radiator cap and (2) Recovery Tank





2. *With recovery tank:*

Check to see that the coolant level in the recovery tank (2) lies between FULL"A" and LOW "B".

If coolant level is too low, check the reason for decreasing coolant.

(Case 1) -

If coolant is decreasing by evaporation, replenish only fresh, soft water.

(Case 2) -

If coolant is leaking, replenish coolant of the same manufacture and type. If the coolant brand cannot be identified, drain out all the remaining coolant and refill with a totally new brand of coolant mix.

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Figure 34 – Reservoir Tank Cap (Vertical Unit)

Figure 35 – Coolant Lines (Vertical Unit)

Figure 36 Radiator (Vertical Unit)

Section 7: DC Genset Fuel Tank, Gauge, and Sensor Operation and Troubleshooting

For **Diesel** applications, the fuel sensor **(Figure 29 - Fuel Sensor)** that comes with the DC Generator set is supposed to help in measuring the amount of fuel that is present in the tank at a given time using a mechanical gauge. The reading from the fuel sensor should be approximately around the same value that the fuel level gauge **(Figure 24 - Fuel Level Gauge on Fuel Tank)** reads. Being that the fuel tank itself is stationary, the mechanical components of the fuel sensor may need some sort of vibrations or movement to reposition for an accurate reading. ***This configuration only pertains to Diesel units as Propane and Natural Gas units get their fuel from external tanks***

In order for the fuel sensor to work correctly, it must first be calibrated in the Polar Power GUI software. To calibrate the Fuel senor, you would need to:

1. Open the **Factory** tab in the GUI software
2. Find the fuel sensor calibration row
3. Compare the ***Actual*** value to the ***From the Controller*** value
4. If there is a deviation of more than 5, you may need to adjust the ***multiplier*** value
    a. Enter a value between the range of *0.6 ↔ 1.5* into the ***multiplier*** dialog box
    b. Click ***Store***
    c. Click ***Calculate***
    d. Repeat steps until ***Actual*** and ***From the Controller*** values are within a value of 5

If this range does not result in an accurate reading, then the fuel sensor itself may be defective or damaged and may need repair or replacement.

Figure 29 – Fuel Sensor (Diesel Applications)

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Supply and Return Lines from Diesel Fuel Tank

The ‘Supply’ and ‘Return’ lines of the fuel tank are the primary points of the exchange of fuel for the genset system.
The ‘Supply’ Line throughout the fuel system ensures a continuous and clean supply of fuel to the engine system.
The ‘Return’ line throughout the fuel system carries excess fuel back to the diesel fuel tank

Supply and Return Lines to Electronic Fuel Pump (Diesel Applications)

The electronic fuel pump feeds fuel from the fuel tank to the engine system. It allows for a visual indication of the level and quality of fuel going into the system with the transparent fuel filter bowl

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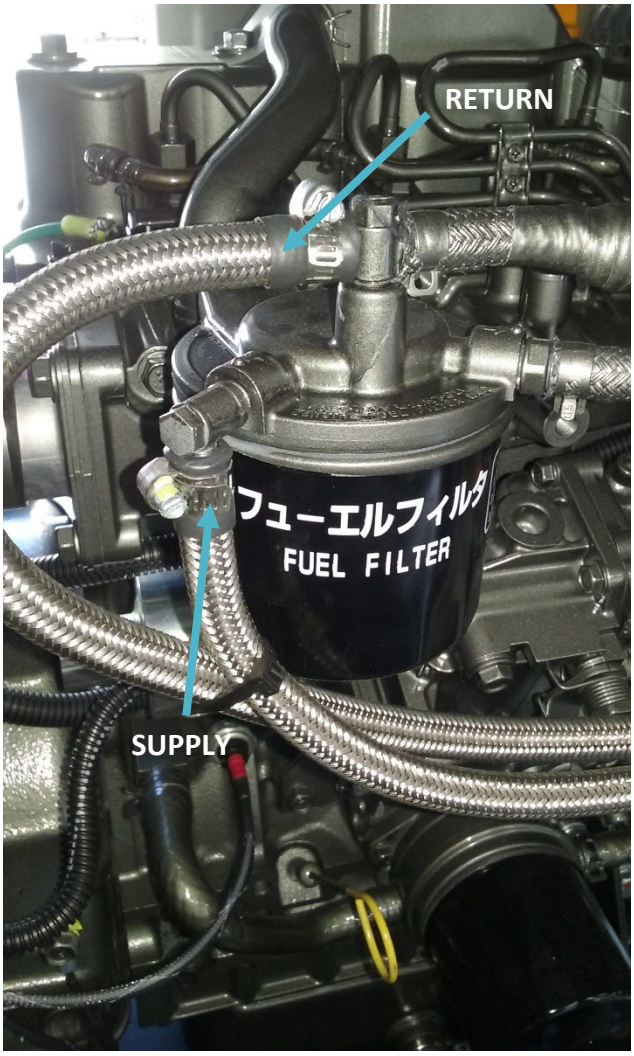
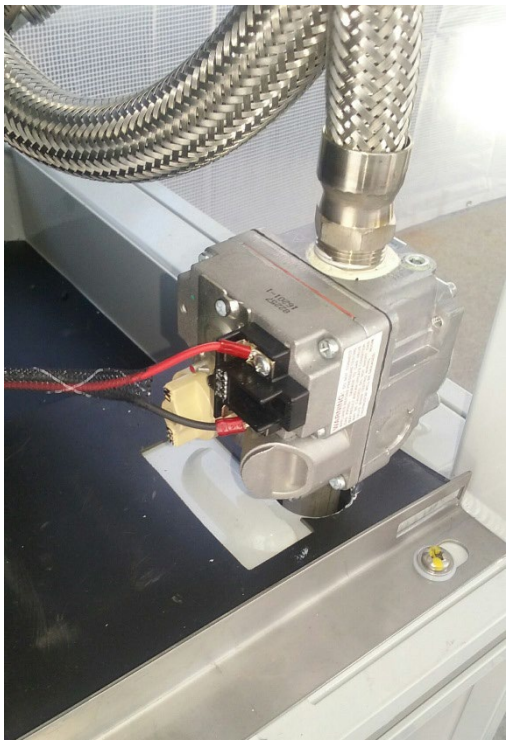
Supply and Return Lines to Engine (Diesel Applications)



The supply fuel line at the engine system feeds fuel into a fuel filter that ensures the quality of the fuel and then allows it to flow through the unit.



Fuel Valve (Propane/Natural Gas applications)

Valve must have 14V across in order for fuel to flow

On/Off Switch must be set in On position.

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