



It's all about
connections

Manual 5400

400 Hz Gasoline Generator Set Ground Power Unit



Specification.: ACE5400 60 – 90 kVA

Type: OM2253

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SAME PEOPLE - SAME PRODUCTS - SAME COMPANY

Operation Manual - ITW GSE 5400

IMPORTANT NOTICE

We recommend that the battery that safeguards GPU settings etc. is changed **after 5 years** of use in order not to lose data.

Diagrams and drawings are subject to change without prior notice.
Latest diagram versions can be found at www.itwgse.com

Operation Manual – ITW GSE 5400

Introduction

This manual contains operation and maintenance information for a gasoline engine-generator manufactured by ITW GSE, Palmetto, Florida 34221

This manual, including all information contained therein, is exclusive and confidential property of ITW GSE. This manual is not to be copied, reproduced, or delivered or disclosed to others, in whole or in part, except with express written permission of ITW GSE.

This manual is not intended to be a textbook on electricity or electronics. Its primary purpose is to provide information and instructions to experienced operators, electricians, and mechanics that have never operated this equipment. It is the intent of this manual to guide and assist operators and maintenance personnel in the proper use and care of the equipment.

Use of the manual should not be put off until trouble or a need for help develops. Read the instructions before starting the unit. Learn to use the manual and to locate information contained in it. Its style and arrangement are very similar to commercial aircraft manuals.

The manual is divided into three chapters plus appendices. Each chapter is divided into as many sections as required. Each page is identified by chapter, section and page number, which are located in the lower, outside corner.

When information is located in another portion of the manual it is referred to by a chapter, section, and paragraph or figure number identify its location. For example: “(see Section 2-3, Paragraph 1.a.)” refers to information located in Chapter 2, Section 3, Paragraph 1.a. If a chapter and section are not indicated in a reference, the referenced material is located in the same section as the reference, for example: “(see Paragraph 1.a.).”

Contents of the manual are arranged as follows:

Chapter 1 Description/Operation

Chapter 2 Servicing/Troubleshooting

Chapter 3 Manufacturer’s Literature

Appendix A Transformer Rectifier Unit (TRU)

Appendix B Options

Appendix C Operation in Unusual Service Conditions

Appendix D Software Installation Procedures

Appendix E Schematics

Safety Warnings and Cautions.

WARNING

ELECTRIC SHOCK can KILL. Do not touch electrical parts unless Energy Reservoir is drained and/or disconnected. Power is maintained indefinitely even when the engine is NOT running.

ELECTRIC ARC FLASH can injure eyes, burn skin, cause equipment damage, and ignite combustible material. **DO NOT** use power cables to break load. Prevent tools from causing short circuits.

IMPROPER PHASE CONNECTION, PARALLELING, OR USE can damage this and attached equipment.

IMPORTANT

Protect all operating personnel. Read, understand, and follow all instructions in the Operating/Instruction Manual before installing, operating, or servicing the equipment. Keep the manual available for future use by all operators.

WARNING

CALIFORNIA PROPOSITION 65 – GASOLINE ENGINES. Gasoline engine fuels and exhaust contain Proposition 65-listed chemicals, including benzene and carbon monoxide, which are known to cause cancer, birth defects and other illnesses.

1) General

Equipment that supplies electrical power can cause serious injury or death, damage to other equipment or property. The operator must strictly observe all safety rules and take precautionary actions. Safe practices have been developed from past experience in the use of power source equipment. While certain practices below apply only to electrically powered equipment, other practices apply to engine-driven equipment, and some practices to both.

2) Shock Prevention

Bare conductors, terminals in the output circuit, or ungrounded, electrically live equipment can fatally shock a person. Have a certified electrician verify that the equipment is adequately grounded and learn what terminals and parts are electrically **HOT**. Avoid hot spots on machine. Use proper safety clothing, procedures and test equipment.

The electrical resistance of the body is decreased when wet, permitting dangerous currents to flow through it. When inspecting or servicing the equipment, do not work in damp areas. Stand on a dry rubber mat or dry wood, and use insulating gloves when dampness or sweat cannot be avoided. Keep clothing dry, and never work alone.

a) Output Cables and Terminals

Inspect cables frequently for damage to the insulation and the connectors. Replace or repair cracked or worn cables immediately. Do not overload cables. Do not touch output terminal while equipment is energized.

3) Service and Maintenance

This equipment must be maintained in good electrical condition to avoid hazards stemming from disrepair. Report any equipment defect or safety hazard to the supervisor and discontinue use of the equipment until its safety has been assured. Repairs should be made by qualified personnel only. Before inspecting or servicing this equipment, take the following precautions:

- a) Shut off all power at the battery disconnect before inspecting or servicing the equipment.
- b) Lockout the equipment at the battery disconnect switch if it is out of service.
- c) If troubleshooting must be done with the unit energized, have another person present who is trained in turning off the equipment and providing or calling for first aid.
- d) Check electrical assemblies with a meter to verify voltages are not present before performing maintenance in or related to enclosed electrical compartments.

4) Fire and Explosion Prevention.

Fire and explosion are caused by electrical short circuits, combustible material near engine exhaust pipes, misuse of batteries and fuel, or unsafe operating or fueling conditions.

a) Electrical Short Circuits and Overloads.

Overloaded or shorted equipment can become hot enough to cause fires by self-destruction or by causing nearby combustibles to ignite.

b) Batteries.

Batteries may explode and/or give off flammable hydrogen gas. Acid and arcing from a ruptured battery can cause fires and additional failures. When servicing, do not smoke, cause sparking, or use open flame near the battery.

c) Engine Fuel.

Use only approved fuel container or fueling system. Fires and explosions can occur if the fuel tank is not grounded prior to or during fuel transfer. Shut unit **DOWN** before opening fuel tank cap. **DO NOT** completely fill tank, because heat from the equipment may cause fuel expansion overflow. Remove all spilled fuel **IMMEDIATELY**, including any that penetrates the unit. After clean-up, open equipment doors and blow fumes away with compressed air.

5) Toxic Fume Prevention.

Carbon monoxide - Engine exhaust fumes can kill and cause health problems. Pipe or vent the exhaust fumes to a suitable exhaust duct or outdoors. Never locate engine exhausts near intake ducts of air conditioners.

6) Bodily Injury Prevention.

Serious injury can result from contact with fans or hot spots inside some equipment. Shut **DOWN** such equipment for inspection and routine maintenance. When equipment is in operation, use extreme care in doing necessary troubleshooting and adjustment. Do not remove guards while equipment is operating.

7) Medical and First Aid Treatment.

First aid facilities and a qualified first aid person should be available for each shift for immediate treatment of all injury victims. Electric shock victims should be checked by a physician and taken to a hospital immediately if any abnormal signs are observed.

EMERGENCY FIRST AID

SEEK ADDITIONAL ASSISTANCE. Use First Aid techniques recommended by American Red Cross until medical help arrives.

IF BREATHING IS DIFFICULT, give oxygen, if available, and have victim lie down.

FOR ELECTRICAL SHOCK, turn off power. Remove victim; if not breathing, begin artificial respiration, preferably mouth-to-mouth. If no detectable pulse, begin external heart massage.

8) Equipment Precautionary Labels

Inspect all precautionary labels on the equipment monthly. Order and replace all labels that cannot be easily read.



Means Warning! Watch Out! There are possible hazards with this procedure! The possible hazards are shown in the adjoining symbols.



ELECTRIC SHOCK can kill!

- Touching live electrical parts can cause fatal shocks or severe burns.
- Do not touch live electrical parts.
- Disconnect output power or stop engine before servicing this equipment.
- When making output connections, ensure that output power is off.
- Frequently inspect output power cables for damage or bare wiring – replace cable immediately if damaged – bare wiring can kill.
- Do not use worn, damaged, undersized, or cables in poor condition.
- Do not drape cables over your body.
- Use only well-maintained equipment. Repair or replace damaged parts at once. Maintain unit per the manual.
- Keep all panels and covers securely in place.



MOVING PARTS can cause injury.

- Keep away from fans, belts, and rotors.
- Keep doors, panels, covers, and guards closed and securely in place.
- Stop engine before installing or connecting unit.
- Have only qualified people remove guards or covers when maintenance or troubleshooting is necessary.
- To prevent accidental engine starting during servicing, disconnect negative (-) battery cable from the battery.
- Keep hands, hair, loose clothing, and tools away from moving parts.
- Reinstall interior panels or guards and replace exterior panels when servicing is finished and before starting engine.



ENGINE EXHAUST GASES can be hazardous.

- Engine driven generator sets produces toxic exhaust gases. Breathing these gases can be hazardous to your health.
- If operated in an enclosed area, pipe or duct exhaust gases outside.
- If operating indoors, use an approved air-supplied respirator.
- Work in a confined space only if it is well ventilated, or while wearing an air-supplied respirator. Engine exhaust gases can displace air and lower the oxygen level causing injury or death. Be sure the breathing air is safe.



NOISE can damage hearing.

- Noise from some processes or equipment can damage hearing.
- Wear approved ear protection if noise level is high.



HOT PARTS can cause severe burns.

- Allow a cooling period before maintaining.
- Wear protective gloves and clothing when working on a hot engine.
- Do not touch hot engine parts with bare hand.



Fuel can cause FIRE or an explosion.

- Stop engine and let it cool off before adding fuel.
- Do not add fuel while smoking or if unit is near any sparks or open flames.
- Do not overfill tank – allow room for fuel to expand.
- Do not spill fuel. If fuel is spilled, clean up before starting engine.
- Dispose of rags in a fireproof container.
- ENGINE HEAT can cause fire.
- Do not locate unit on, over, or near combustible surface of flammables.
- Keep exhaust and exhaust pipes away from flammables.



Free-falling tow bar can cause injury and damage equipment.

- Secure tow bar in the locking upright position.
- Carefully lower tow bar towards the ground, ensure that feet are not below tow bar.
- Proper safety shoes should be worn to prevent foot injury.

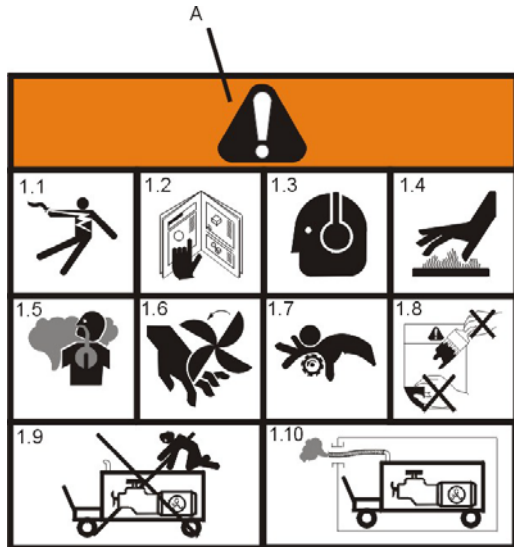


Read Instructions.

- Use only genuine equipment manufacturer's replacement parts.
- Perform GPU maintenance and service according to the Operation and Maintenance Manual.

Label Identification

1. General Identification Label



A. Warning! Watch Out! There are possible hazards as shown by the symbols.

1.1 Electrical Shock can kill!

1.2 Become trained and read the instruction manual before operating or maintaining the equipment.

1.3 Wear approved ear protection when around high noise areas.

1.4 Some surfaces may be hot. Allow surfaces to cool before touching.

1.5 Breathing exhaust fumes can be hazards to your health.

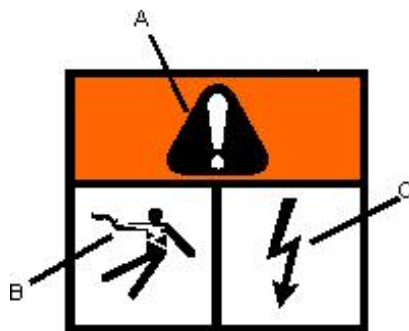
1.6 Moving parts can cause injury. Keep hands away from moving parts.

1.7 Beware of areas that could pull hands, clothing, etc. into moving pulleys or belts.

1.8 Do not paint over or remove safety labels. Replace if destroyed.

1.9 Do not climb on unit or cable trays.

1.10 If unit is in an enclosed area, vent exhaust gases outside.



2. Danger High Voltage Label

A. Warning! Watch Out! There are possible hazards as shown by the symbols.

B. Electrical Shock can kill!

C. Danger High Voltage.



3. Fuel Warning Label

A. Warning! Watch Out! There are possible hazards as shown by the symbols.

1.1 Engine fuel plus flames or sparks can cause fire.

1.2 Do not smoke while fueling or if near fuel.

1.3 Stop engine before fueling.

1.4 Do not fuel a hot engine.

1.5 Use Unleaded Fuel only.



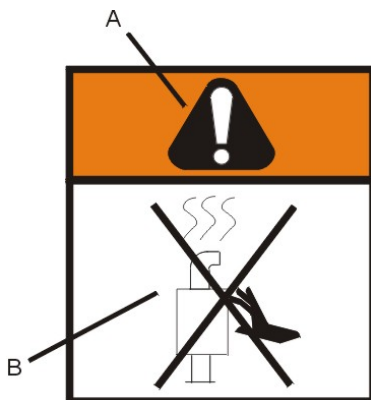
4. Engine Coolant Label

A. Warning! Watch Out! There are possible hazards as shown by the symbols.

1.1 Engine coolant radiator location.

1.2 Hot engine coolant!

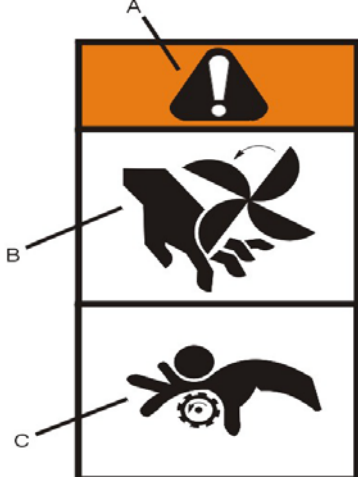
1.3 Do not open a hot radiator cap. Allow coolant to cool before removing cap.



5. Hot Muffler Label

A. Warning! Watch Out! There are possible hazards as shown by the symbols.

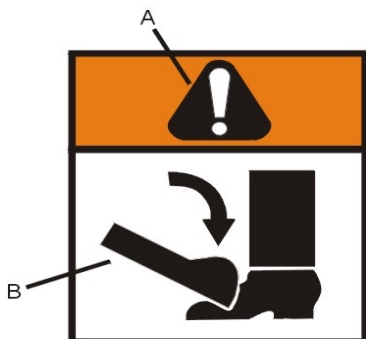
B. Hot muffler and exhaust pipes can cause severe burns. Do not touch hot muffler or pipes.



The label is a vertical rectangle divided into three sections. The top section is orange with a black exclamation mark inside a triangle, labeled 'A'. The middle section is white with a black silhouette of a hand being cut by a fan blade, labeled 'B'. The bottom section is white with a black silhouette of a hand being pulled into a pulley, labeled 'C'.

6. Fan and Moving Parts Label

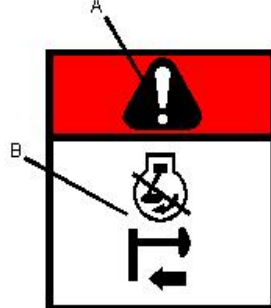
- A. Warning! Watch Out! There are possible hazards as shown by the symbols.
- B. Moving parts, such as fans, rotors, and belts, can cut fingers and hands and cause injury. Keep away from moving parts.
- C. Beware of areas that could pull hands, clothing, etc. into moving pulleys or belts.



The label is a vertical rectangle divided into two sections. The top section is orange with a black exclamation mark inside a triangle, labeled 'A'. The bottom section is white with a black silhouette of a tow-bar falling from a vertical position, labeled 'B'.

7. Falling Objects Label

- A. Warning! Watch Out! There are possible hazards as shown by the symbols.
- B. Free-falling tow-bar can cause injury and damage equipment. Secure tow-bar in the locking upright position. Carefully lower the tow-bar towards the ground, ensure that feet are not below the tow-bar. Proper safety shoes should be worn to prevent foot injury.



The label is a vertical rectangle divided into two sections. The top section is red with a black exclamation mark inside a triangle, labeled 'A'. The bottom section is white with a black silhouette of a hand pressing a button, labeled 'B'.

8. Emergency Stop Label

- A. Warning! Watch Out! There are possible hazards as shown by the symbols.
- B. Push the red emergency stop button to shut the unit down completely. Pull button out to reset the unit.

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Chapter 1 Description/Operation

Section 1 Description

1) General

The basic generator sets covered in this manual, manufactured by ITW GSE, are rated at 90kVA and are designed to produce and deliver 115/200-volt, 400 Hz, 3-phase AC power to a parked aircraft or other load. Some generator models with the Transformer Rectifier Unit (TRU) option also provide 28.5 volts DC for aircraft having those requirements. A comprehensive review of the 28VDC output Transformer Rectifier Unit (TRU) is located in Appendix A.

Model Number	kVA	Mounting	Outputs	28.5 DC Output
ACE5490S	90	Trailer	Single 400Hz	No
ACE5490S28	90	Trailer	Single 400Hz	Yes
ACE5490D	90	Trailer	Dual 400Hz	No

Table 1-1-1: ITW GSE 5400 Series Generator Set Part Number Descriptions

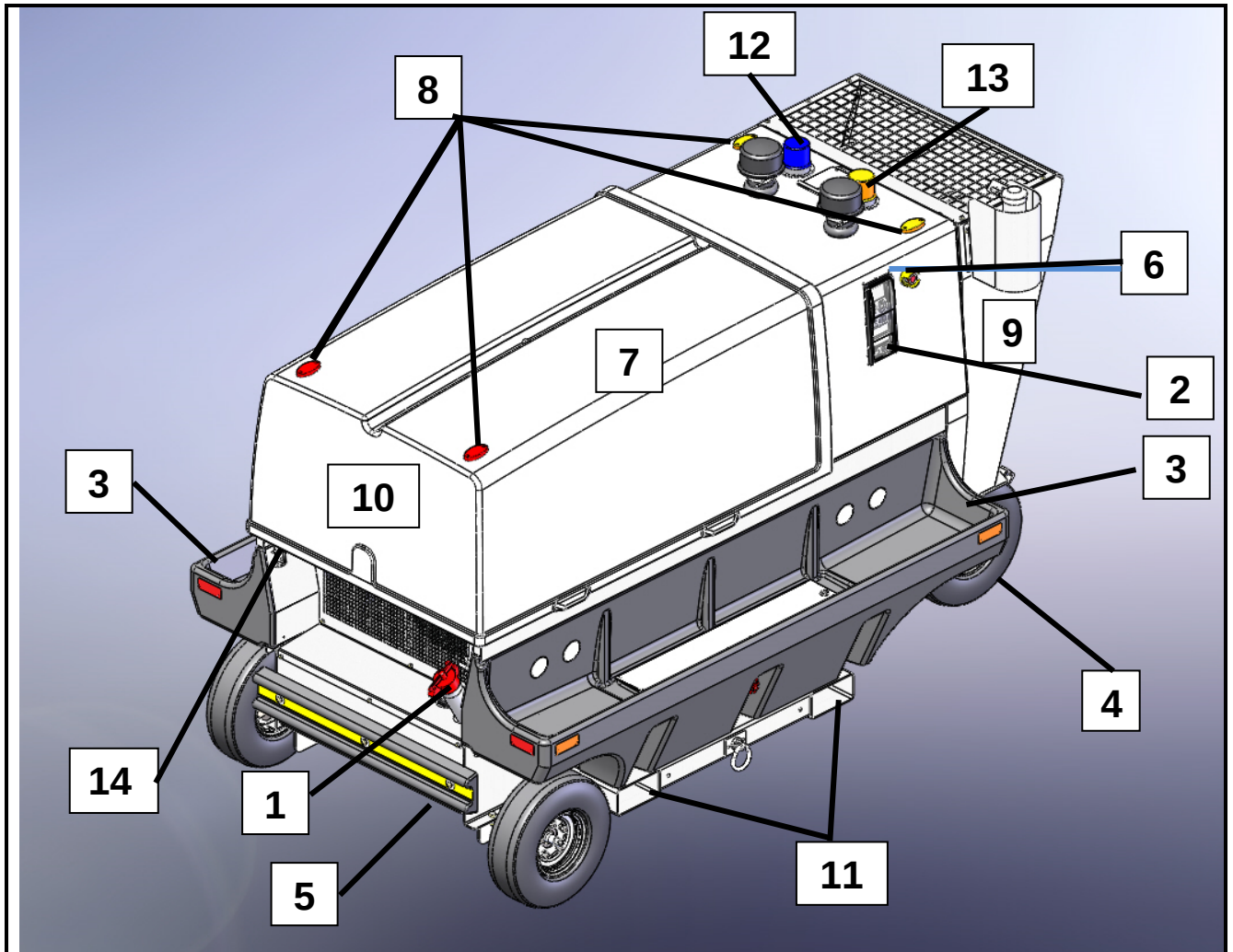
2) Optional Equipment - Appendix A and B

Chapters 1 through 3 of this Operation and Maintenance Manual identify only the basic version of the ITW GSE 5400 generator set. Appendix A describes the Transformer Rectifier Unit (28.5 VDC) option. Appendix B contains a list of the rest of the optional equipment that can be ordered with the unit. Each item also includes a brief description.

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3) Component Locations

For purpose of orientation when designating RIGHT and LEFT throughout this manual, the radiator is considered to be at the FRONT of the unit and the generator is at the REAR. RIGHT and LEFT are determined by standing at the REAR facing the machine. As an example, the control panel is mounted on the RIGHT FRONT side of the unit.

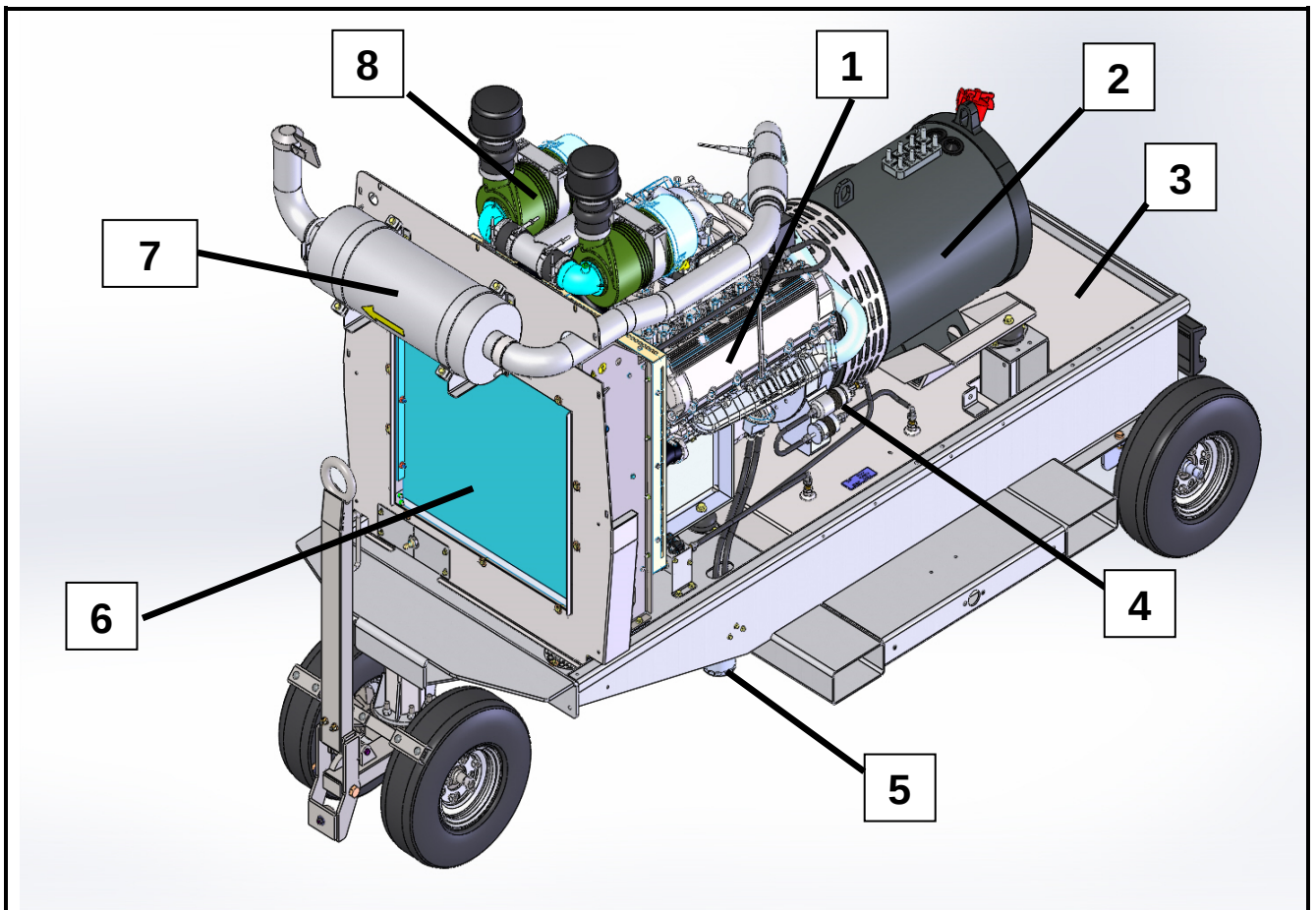


1. Fuel Filler Neck / Manual Gauge
2. Operator Control Panel
3. Composite Output Cable Trays
4. Fifth Wheel Assembly
5. Rear Axle Assembly
6. Emergency Stop Switch
7. Sliding/Removable Canopy

8. Clearance Lights (Option)
9. Radiator End
10. Generator End
11. Forklift Pockets
12. Low Fuel Beacon (Option)
13. Operating Beacon (Option)
14. Canopy Locking Latch

Figure 1-1-1: General Assembly of Generator Set

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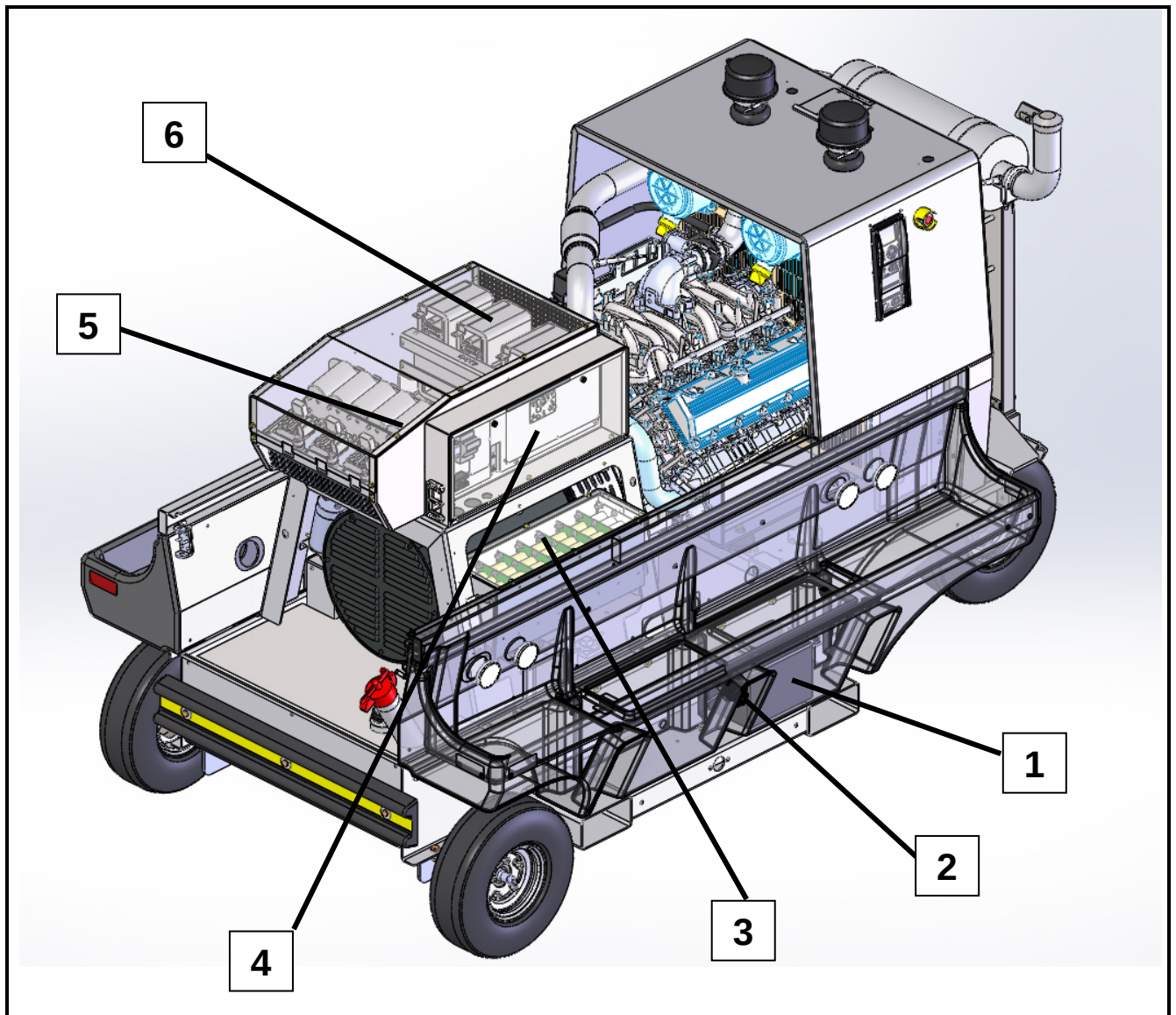


1. Ford WSG1068 Engine
2. Mecc Alte Generator
3. Stainless Steel Fuel Tank
4. Fuel Pump and Fuel Filter

5. Remote Oil Filter
6. Radiator
7. Muffler/Catalytic Converter
8. Air Intake Hoods and Air Filters

Figure 1-1-2: Main Components of Engine-Generator Set

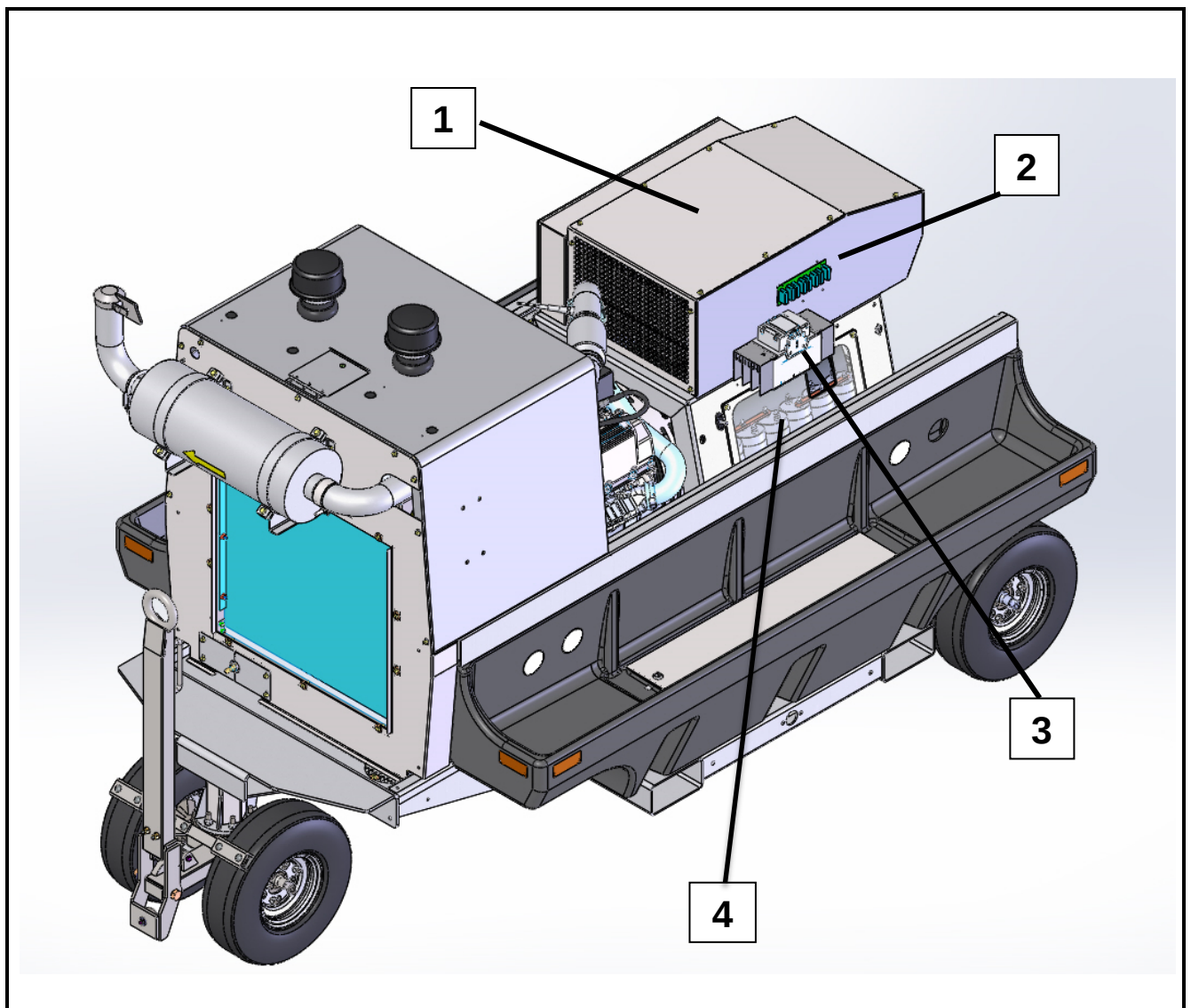
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- | | |
|------------------------------|-------------------------|
| 1. 12 VDC Battery | 4. Control Box |
| 2. Battery Disconnect Switch | 5. 400Hz Power Inverter |
| 3. Energy Reservoir | 6. Output Transformer |

Figure 1-1-3: Main Electrical Components (Right Side)

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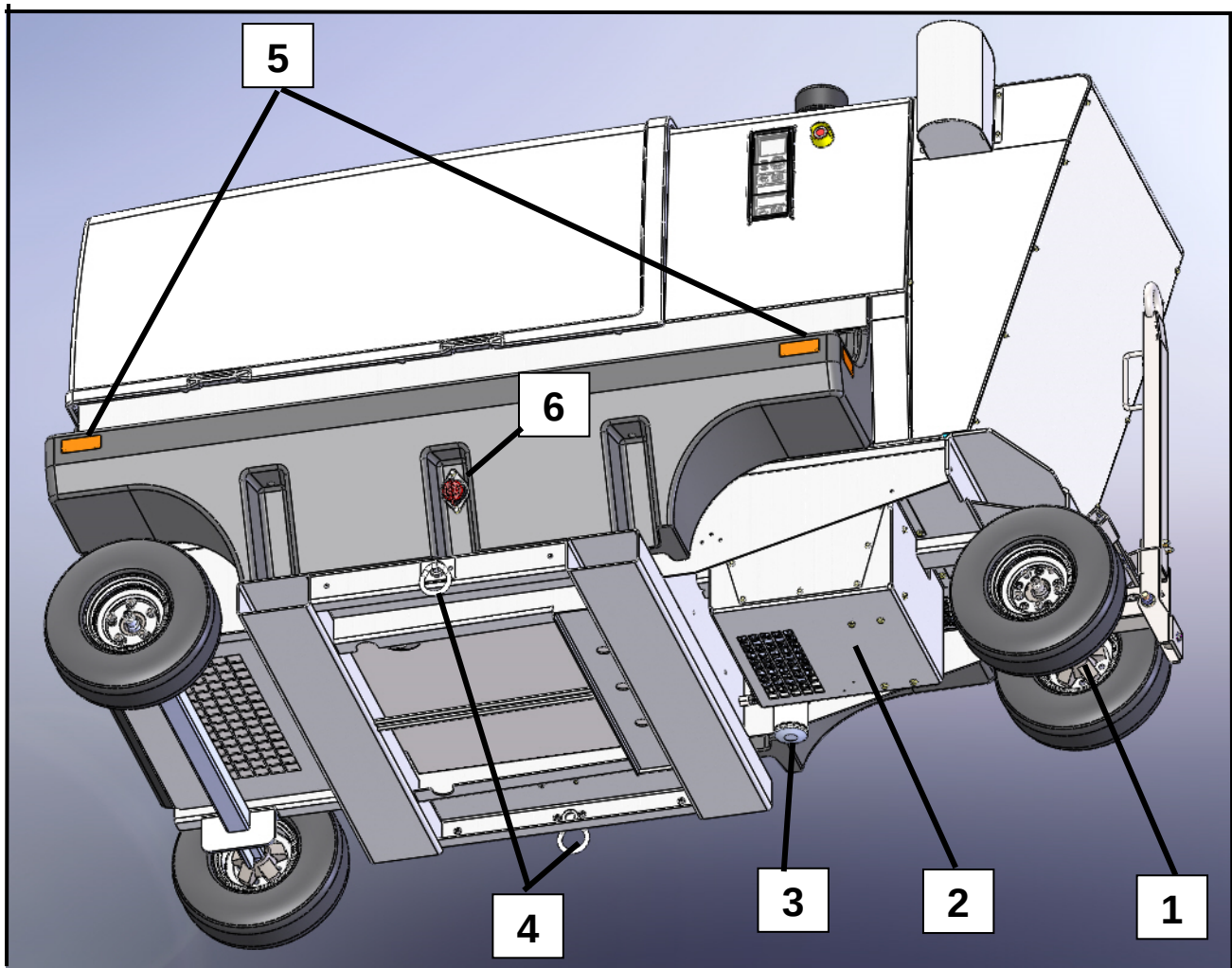


- 1. 400Hz Power Inverter Assembly
- 2. 400Hz Output Filter

- 3. Output Contactor(s)
- 4. Input and Output Capacitors

Figure 1-1-4: Main Electrical Components (Left Side)

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- | | |
|-----------------------------------|------------------------------|
| 1) 5 th Wheel Assembly | 4) Tie Down Rings |
| 2) TRU (Optional) | 5) Reflectors |
| 3) Remote Oil Filter | 6) Battery Disconnect Switch |

Figure 1-1-5: Main Components (Bottom View)

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4) Specifications

a) Standards

These units have been designed to be in compliance with the following standards:

EPA/CARB Compliant
US MIL-STD-704F, SAE ARP5015
ISO 6858
CE compliance certified

b) Physical Specifications

Length	116.2 in. (2952 mm) w/ towbar up
Width	66.2 in. (1682 mm)
Height	70.4 in. (1789 mm)
Weight (dry)	4500 lb. (2041 kg.)
Weight with optional TRU	4800 lb. (2177 kg.)
Operating Temperatures	-25°F* to +125°F -32°C to +52°C
*Low temperature option - Battery Blanket & Block Heater	-40°F/C

c) AC Output Specifications

Output Power Rating	90 kVA (72 kW)
Output Voltage	115 / 200 VAC
Rated Load Capacity	260 Amps
Frequency	400 Hz.
Power Factor	0.8
Duty Cycle	100%
Operating Speed	1700 – 3200 RPM
Overload Capacity 125% rated load	325 Amps
Output Cable Size	2/0 – if banded or JB8816-xxx
Insulation Class	H

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d) AC Protective System Specifications

Condition	Trip Point	Time Delay
Over Voltage	130 volts	250 milliseconds
	140 volts	15 milliseconds
Under Voltage	any voltage below 104 volts	500 milliseconds
Over Frequency	380 Hz to 420 Hz	1 second
	above 480 Hz	immediate
Under Frequency	380 Hz. or less	5 seconds
90 kVA		
Output Overload	100% load at PF 0.7 to 0.8	Continuous
	80% load at PF 0.8 to 1.0	Continuous
	100% load at PF 0.8 to 1.0	5 minutes
	100% to 120% load 0.7 to 0.8	10 seconds
	121% to 150% load 0.7 to 0.8	2 seconds

e) DC Output Specifications (with optional TRU)

Output Power Rating	17.1 kW
Output Voltage	28.5 VDC
Load Capacity (Continuous)	600 A
Current Limiting Capability	300 to 2000 A in selectable steps (50/100/200/300A)
Peak/Starting Load Capacity	2000 A for 5 seconds
Output Cable Size	4/0 for continuous loads up to 400A 2x 4/0 for continuous loads up to 600A

f) DC Protective System Specifications

Condition	Trip Point	Time Delay
Over Voltage	32 - 40 VDC	4 seconds
	Over 40 VDC	150 ms
Output Overload	2000 A	5 seconds
	1800 A	10 seconds
	1200 A	30 seconds
	800 A	120 seconds

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g) Engine Specifications

Manufacturer and Model	Ford (EDI) WSG-1068 Gasoline Engine
Type	V-10 6.8 Liter
Bore and Stroke	4.21 in. x 4.88 in. (90.215 mm x 105.8 mm)
Displacement	415 in ³ (6.8 L)
Horsepower	201 hp (150 kW) maximum
Altitude derating (Engine Power)	4% per 1000 ft. above 350 ft.
Idle Speed	1000 ± 50 rpm
Normal Governed Speed	Variable based on load (1700 – 3200 rpm)
Firing Order	1-6-5-10-2-7-3-8-4-9
Electrical System	12 VDC
Lubricating Oil Capacity (w/ filter)	7.5 quarts (7.1 liters)
Coolant Capacity System	20 quarts (18.9 liters)
Fuel Tank Capacity	75 gallons (284 liters)

h) Normal Operating Characteristics

Engine Oil Pressure (warm and at rated speed 200 RPM)	45 to 60 PSI (275 to 414 kPa).
Engine Coolant Temperature (normal operation)	160 to 200° F (71 to 93° C).

5) Special Features

The generator set has special features that are described more fully under the assemblies in which they appear.

a) Protective Monitoring

The protective monitoring system receives signals from the fault sensing components in the generator output circuit and functions to cause the load to be disconnected from the generator if an abnormal condition of voltage, frequency, or load develops. The nature of that abnormal condition is then presented on the graphical display.

b) Voltage Regulator

A microprocessor-type, adjustable voltage regulator provides automatic voltage regulation at the aircraft. The regulated output is also adjustable for a variety of output cable sizes and lengths.

c) Engine Global Control Platform (GCP)

The engine is equipped with a Global Control Platform (GCP) that monitors, records, and controls engine performance.

d) Battery System Disconnect Switch

The generator set is equipped with a battery disconnect switch outside the unit on the RIGHT side. The disconnect switch should be placed in the OFF position for long periods of shutdown.

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NOTE: DO NOT disconnect the batteries when the engine is running or within two (2) minutes after the engine stops.

e) Energy Reservoir

This unit contains a bank of supercapacitors that assists the engine during transient in the output current. These capacitors will deplete in power over time and during load jumps in which the engine requires assistance. The status of these capacitors is depicted as a battery icon at the bottom of the default screens.

Note: The Energy Reservoir should always be considered 'hot' as it can take months to discharge to safe handling levels. Always discharge capacitors and check voltage is not present with a meter before working on the Energy Reservoir.

The charging of the Energy Reservoir is accomplished when the engine speed is at least 2800 rpm. Whenever the engine is running and the capacitor need to be charged, the engine will ramp up to 2800 rpm and charge the capacitors. While in the charging process, a blue lightning bolt will appear next to the reservoir icon. If the engine speed is already above 2800 rpm, the engine rpm will not change. Once the Energy Reservoir has been fully charged, the engine will resume normal speed.

6) Canopy

A composite enclosure, identified as a canopy, provides protection for the engine, generator and electrical controls. The canopy is also designed to reduce the operational noise level in the immediate area of the machine. The canopy is equipped with a bolted latch on the back, left corner, requiring the use of a wrench to remove. Once the bolt is loosened the canopy can be slid to the rear and removed by two people for easy access to all engine and generator components.

We recommend using Simple Green® Industrial Cleaner & Degreaser or an equivalent to clean the canopy and cable trays.

7) Engine and Generator

The engine and generator comprise the principal components of the generator set. They are mounted on a galvanized, welded steel frame chassis. The previous figures (1-1-1 through 1-1-4) show the locations of all major components and sub-assemblies.

a) Gasoline Engine

The gasoline engine is a fuel injection, 10-cylinder, electronically controlled engine rated at 201 horsepower. The engine speed is load based and can vary between 1700 and 3200 rpm.

b) Engine Manufacturer's Components

As received from the engine manufacturer, the engine includes some of the following components, which are more fully described in the engine manufacturer's manual.

1) Electrical System

The 12 VDC electrical generating and starting system includes an alternator and starter with solenoid switch.

2) Remote Oil Filter

The engine oil filter is a spin-on, full-flow type, located for convenience, under the front shelf on the left side of the galvanized chassis.

4) Pre-programmed Global Control Platform (GCP)

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The GCP is a pre-programmed engine control module, mounted directly to the engine block.

CAUTION

The use of low lubricity fuels can shorten life and/or damage the engine's fuel pump. Only diesel fuel is recommended by the engine manufacturer. Refer to engine manufacturer's manual for approved fuels.

c) Factory Installed Components and Protective Systems

This generator set is assembled with the following components and protective systems:

1) Shutdown/Reset Systems

• Emergency Shutdown

The emergency shutdown switch is to provide instant manual shut off of the generator set by disconnecting power to the GCP and other critical controls through the control box. It is located on the FRONT RIGHT of the generator set next to the control box.

To operate the **EMERGENCY SHUTDOWN**

- Push button in until engine stops or until button travel stops
- Pull the button back out to reset

CAUTION

Do not use the "**EMERGENCY STOP BUTTON**" as a normal shutdown device. Damage to the engine turbo charger may result without proper cooling time. Use the Engine ON/OFF push-button for all normal engine shutdowns.

• Low Fuel Warning System

The low fuel warning system monitors the fuel level in the fuel tank. When the fuel tank level reaches approximately 10%, a warning is generated signifying it is time to put fuel in the tank. Once the engine is not running, a low fuel fault is generated and the engine is not allowed to start.

2) Radiator and Charge-Air-Cooler (CAC)

The radiator and charge-air-cooler is a two-piece type designed for long periods of operation without servicing.

3) Engine-Cooling Fan

The engine fan is designed to blow air outward through the radiator, rather than pulling air inward like a conventional fan.

4) Master [Battery] Disconnect Switch

The master disconnect switch is designed to isolate the batteries from the entire electrical system to eliminate the possibility of battery current draw by the engine ECM or any other components during long periods of no operation. The switch can also be used to lock-out the starting circuit of the equipment for maintenance safety purposes.

d) Warnings/Faults

The control system reacts appropriately to different detected issues. These types can be generalized between warnings and faults. Warnings are given when the system is able to function but requires servicing/user interaction. Faults are generated when the unit cannot or should not supply regulated power to the aircraft.

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All faults prevent the engine from starting. However, in order to protect the engine and other components, they react differently to an operating unit.

Active engine generated warnings and faults are also monitored and their respective engine fault numbers are shown on the display.

e) Generator

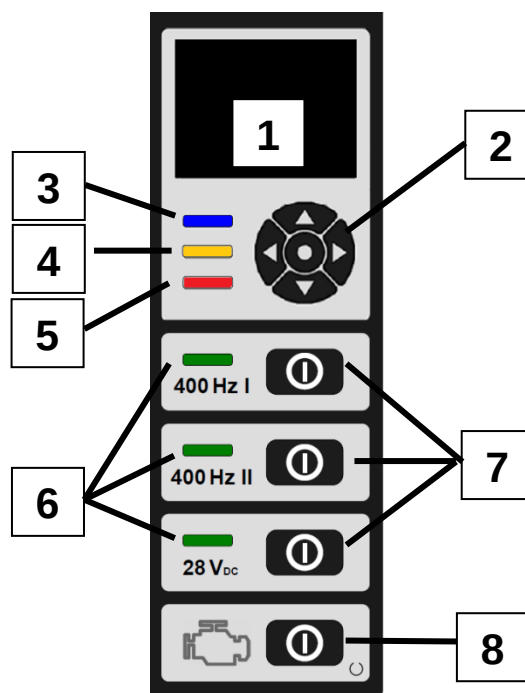
The generator is a 2-pole 50/60 Hz Mecc Alte generator. This generator is a brushless, single bearing, revolving field, three-phase, alternating current type unit. The front end of the rotor shaft extends forward beyond the front bearing and is coupled to the engine flywheel by a flexible coupling assembly. The rear end of the rotor shaft extends rearward beyond the rear bearing and into the exciter stator housing.

A centrifugal, radial-blade fan draws cooling air over all internal windings. Air enters at the exciter end and is discharged at the drive end. The complete generator assembly is bolted to the engine's flywheel and housing.

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8) Operator Controls

The control box is a protected enclosure on the right front panel of the GPU with a modern graphical display and easy to understand controls. The display allows the user to easily have access to all critical operational information as well as providing textual descriptions of all warnings and failures.



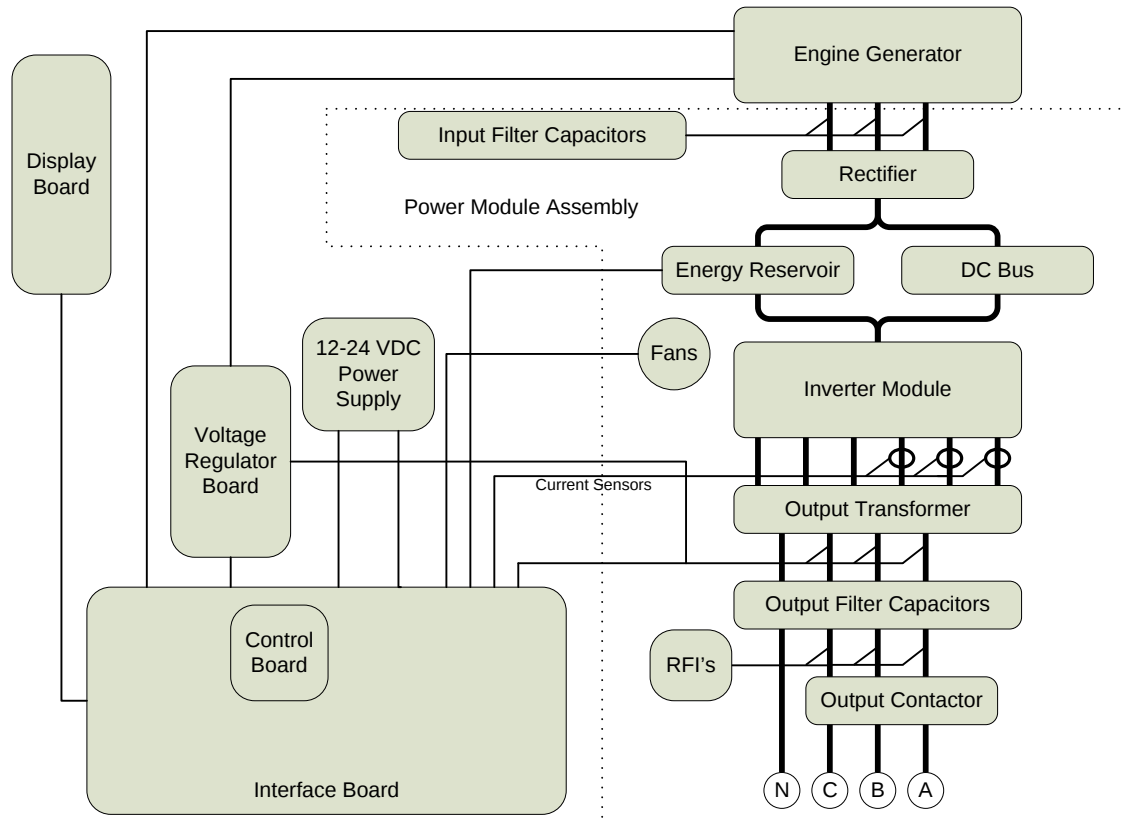
- 1) LED Graphical Display
- 2) Navigation Keypad
- 3) Power ON "Blue" LED
- 4) Warning "Amber" LED

- 5) Alert/Failure "Red" LED
- 6) Output ON "Green" LEDs
- 7) Output ON/OFF (Reset)
- 8) Power ON & Engine Start/Stop (Reset)

Figure 1-1-6 Control Panel

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9) Power Module Assembly



The figure above shows a unique design that combines an engine driven GPU with a line power GPU.

The engine-generator creates AC power that is immediately rectified to provide the DC bus for the inverter. To assist the gasoline engine during transients, an energy reservoir is included. The energy reservoir is also charged by the rectifier. But, is only activated when a transient is detected or if the engine is sensed to be unintentionally slowing down.

The inverter module takes the voltage from the DC bus and creates the 3-phase 400Hz output voltage.

The Power Module Assembly is mounted on the output table located to the rear of the machine over the generator. The panel assembly provides a means of connecting and disconnecting the generator output to and from the aircraft.

a) Rectifier

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The Engine-Generator provides 3-phase AC power to the Power Module Assembly. The first stage takes that AC power and rectifies it to DC. This voltage is regulated to voltages between 190V and 365V by the Voltage Regulator Board. The voltage setting is typically load based but goes to 365 whenever the Energy Reservoir needs to be charged.

b) Voltage Regulator Board

The voltage regulator board provides the exciter voltage for the Engine Generator. The voltage is the battery voltage until the output exceeds that voltage. During normal operation the rectified 400Hz output is fed to the generator exciter circuit using pulse width modulation.

c) Energy Reservoir

To assist the gasoline engine during transients, an energy reservoir is included. The energy reservoir is also charged by the rectifier.

d) Inverter Module

The 3-phase inverter module inverts the voltage from the DC bus to generate a 400Hz voltage system with very low harmonic content and individual phase control. Two PCBs (gate drive top & gate drivebottom) are used to interface between the control unit and the IGBTs.

e) Output Transformer

The output transformer steps up the voltages from the Inverter Module into the required aircraft voltage (3-phase 115/200 VAC).

f) Current Sensors

A set of current transformers are used to monitor and control the line-drop compensation, ammeter, and overload circuit.

1) Line-Drop Compensation

The current transformers detect the magnitude and power factor of current flowing from generator to load. They feed a signal to the voltage regulator that interprets the signal and alters the exciter field current as required to maintain a constant predetermined voltage at the load. These values are accessible on the color display.

2) Ammeter

The current transformers convert a current signal to a voltage signal, which is sent to the interface board and read by the processor boards. This signal is digitized and sent to the display board where it is able to be read by the user on the color display in phase to phase or phase to N format.

3) Overload

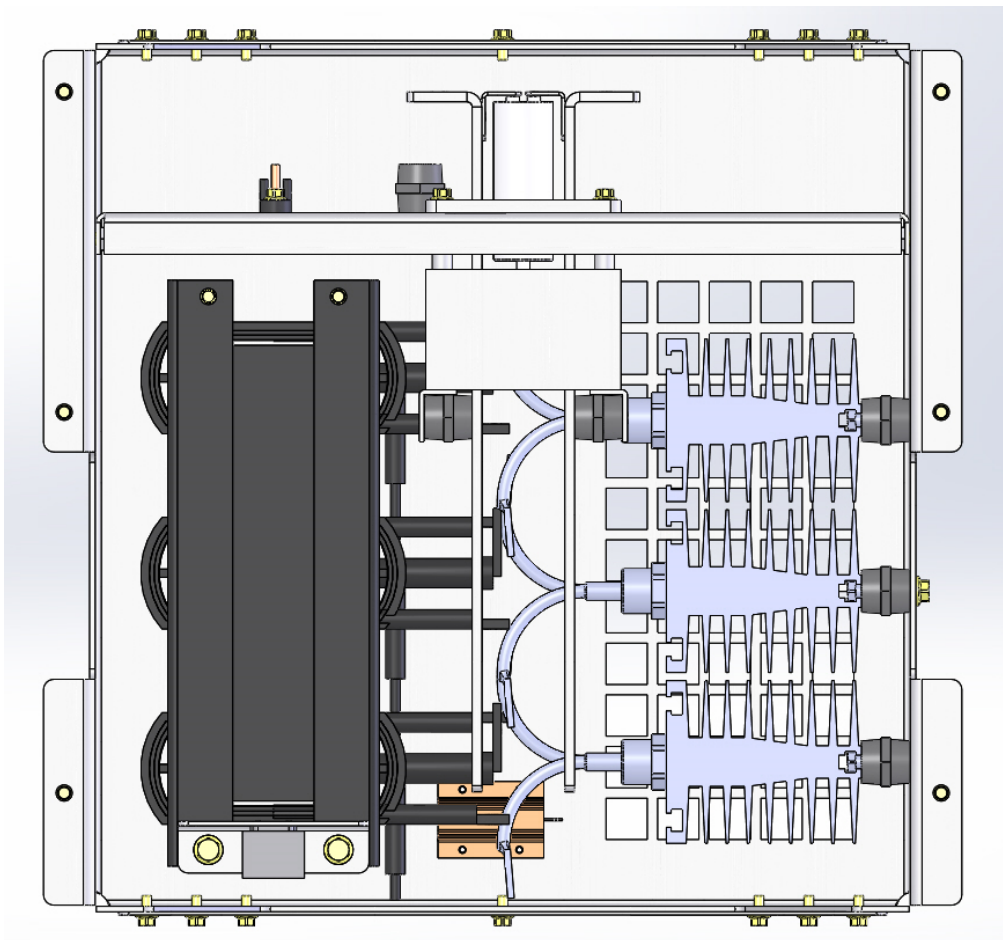
The digitized signal is also processed to determine if the generator output is within defined specifications. If the current is within the following values, then output contactor(s) are opened at the prescribed time.

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100% load at PF 0.7 to 0.8	Continuous
80% load at PF 0.8 to 1.0	Continuous
100% load at PF 0.8 to 1.0	5 minutes
100% to 120% load 0.7 to 0.8	10 seconds
121% to 150% load 0.7 to 0.8	2 seconds

10)Transformer Rectifier Unit (TRU)

The 28 VDC power is provided by a TRU which is supplied from the 400 Hz output and activated via the second output contactor.



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- | | | | |
|----|---------------------|----|-----------------|
| 1. | 28.5 VDC Output (+) | 5. | Transformer |
| 2. | 28.5 VDC Output (-) | 6. | Output Choke |
| 3. | Options Block | 7. | Diodes |
| 4. | Output Capacitors | 8. | Output Resistor |

Figure 1-1-7 TRU Top View

TRU Specifications

Output:

Voltage: 28 VDC
 Current: 600 A continuously
 Voltage regulation: < 0,5%
 Voltage ripple: < 1%
 Voltage transient recovery: Complies with ISO 6858 / MIL-704E

Overload capability: 1200 A for 30 seconds (minimum)
 1800 A for 10 seconds (minimum)
 2100 A for 5 seconds (minimum)
 2400 A for 2 seconds (minimum)

To protect the aircraft, the output voltage is decreased by 1 V per 300 A in the overload range (600-2400 A).

Setup:

Output voltage: 20-32 V
 Voltage compensation: 0-4 V per 600 A
 Current limit: 600-2000 A in steps of 50 A

Protections:

Rectifier temperature to high
 Short circuit at output
 Over-and under voltage at output in case:
 U < 20 VDC for more than 4 seconds
 U > 32 VDC for more than 4 seconds
 U > 40 VDC for more than 1 second

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Section 2 Preparation for Use, Storage, or Shipping

1) Preparation for use after receipt of unit

a) Inspection/Check

Inspect unit thoroughly prior to operation.

- 1) Remove blocking, banding, ties, and other securing material.
- 2) If Tie Down Rings are present, make sure they are secured with both bolts. (Typically one bolt is used to secure middle blocks to unit during shipping.)
- 3) Inspect exterior for shipping damage such as broken lights, damaged sheet metal, etc.
- 4) Slide the canopy open and inspect the interior for foreign material such as rags, tools, shipping papers, etc.
- 5) Check fuel, coolant, oil hoses and connections for visible leaks. Visually inspect compartment floor and ground surface under unit for signs of leakage. Correct any leaks by tightening hose clamps, tube fitting, etc., as required.
- 6) Check tightness of generator set retaining components.
- 7) Check fuel level. (A manual quick reference fuel gauge is located at back of unit.
NOTE: For recommended fuel specifications, refer to Engine Manufacturers Operation and Maintenance Manual provided with this manual.
- 8) Check engine coolant. Remove radiator cap (under hatch on top of operator section) to check coolant level. Coolant level should be at bottom of filler neck.

CAUTION

Be sure cooling system antifreeze solution is adequate to protect below lowest temperature expected.

NOTE: For antifreeze protection, use a solution of 50% permanent antifreeze (Ethylene glycol) and 50% clean water.

Lubricating oil capacity (w/ filter)	7.5 quarts (7.1 liters)
Coolant capacity system	20 gallons (18.9 liters)

Figure 1-2-1: Engine Oil and Coolant Capacities

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- 9) Check engine lubricating oil level. The oil gauge rod has “H” high-level and “L” low-level marks to indicate operating lubrication oil supply. Oil level should be kept as near the high mark as possible, without going over. See Figure 1-2-1 for capacity.

CAUTION

NEVER operate engine with oil level below “L” level or above “H” level mark.

NOTE: See Engine Manufacturer's Operation Maintenance Manual for oil recommendations.

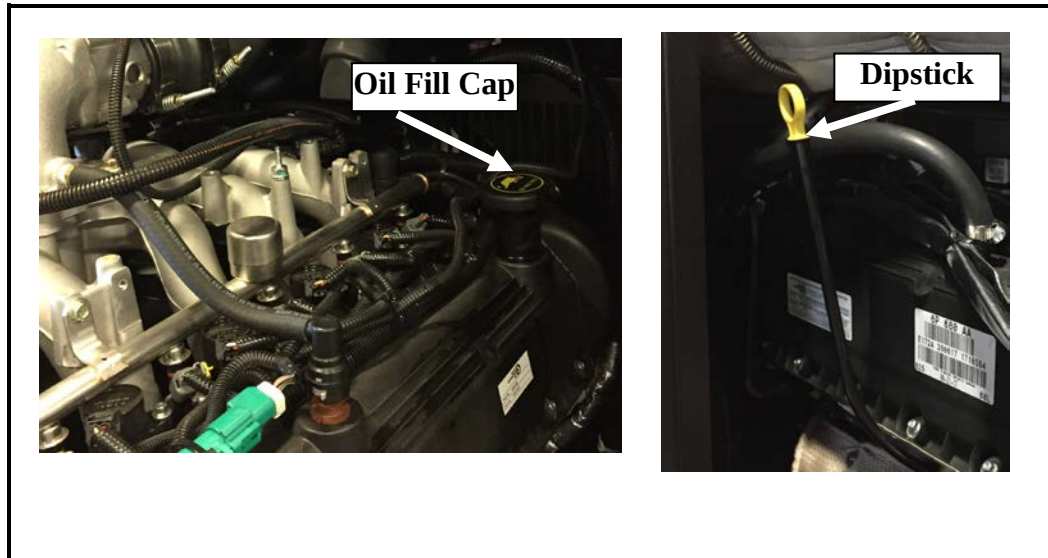


Figure 1-2-2: Oil Fill and Oil Level Check Locations

- 10) Check batteries located inside the right-side cable tray. Inspect batteries for proper connection of terminals. Service or replace if necessary.

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b) Installing Three-Phase AC Output Cables

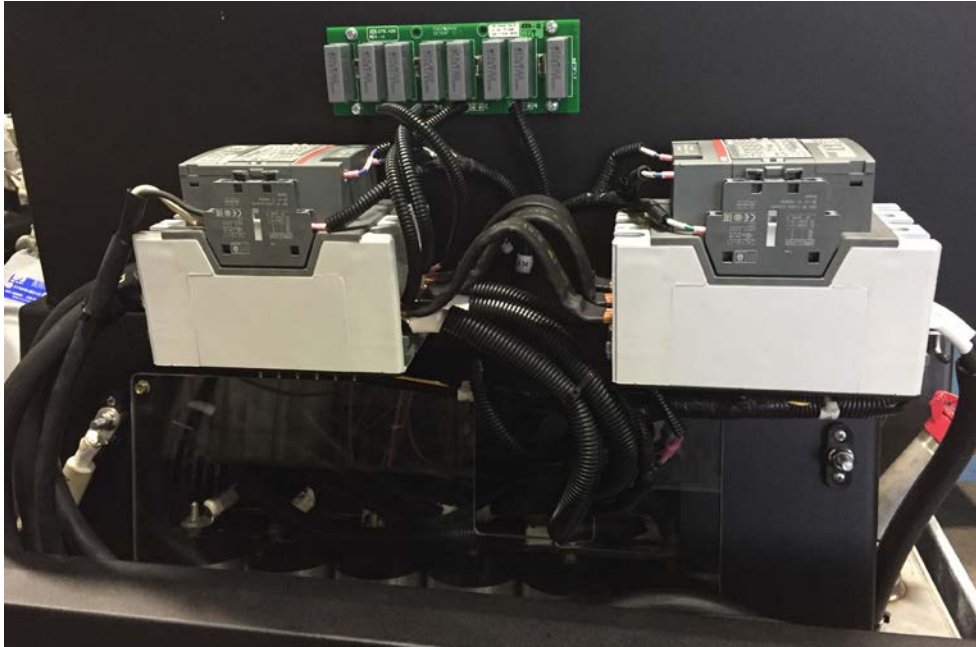


Figure 1-2-3 Load Contactor

The generator set may be shipped without aircraft cables. Output cables connect to the load contactors, which are located at rear of unit. (See Figure 1-2-3)

The conductor size recommended for AC output cables is 2/0 AWG. Use No. 12 AWG for E and F terminals. Lugs require a minimum 3/8-inch diameter hole to fit into the output contactor. The E and F wires should be fitted with 16 gauge forks or into a double ferrule and then inserted into the normally open auxiliary contact block attached to the side of the output contactor.

AC output cables installation:

- 1) Remove canopy. (While not necessary, it greatly simplifies the process.)
- 2) Route cables through hole in cable tray, through cable clamps up to load side of output contactor(s).
- 3) Connect phase cable terminal lugs to appropriate terminal studs on contactor(s): cable lug A to terminal stud A, B to B, and C to C.
- 4) Connect cable's neutral terminal lug securely to neutral (ground) stud on power module assembly.
- 5) Connect E and F cables into the auxiliary contact block on side of output contactor.
- 6) Replace canopy.

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c) Installing DC Output Cable (optional)

- 1) Remove canopy. (While not necessary, it greatly simplifies the process.)
- 2) Loosen clamp screws.
- 3) For normal aircraft service, use cable assembly JB2840-30 (which meets Mil-C-7974D Assembly Specification) with 30 feet of AWG 4/0 cables having a positive and negative connection.
- 4) Cable extends through frame via supplied hole in cable tray, down thru strain relief. (See Figure 1-2-4)
- 5) Cables connect to output bus bar located on TRU assembly located left front of unit. (See Figure 1-2-4)
- 6) Replace canopy.

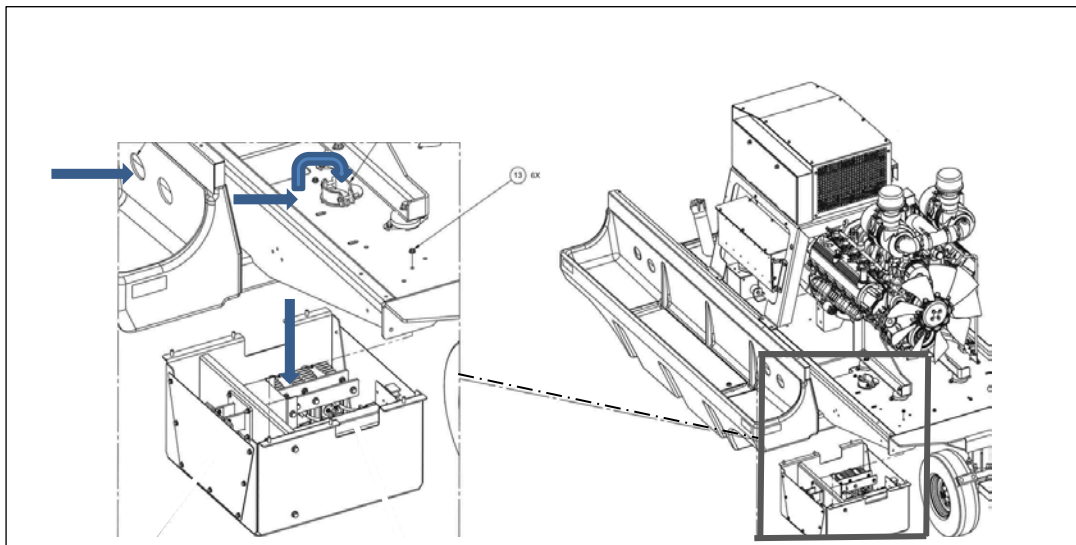


Figure 1-2-4

2) Preparation for Storage

A generator set in storage or removed from operation, has special precautions that should be taken to protect internal and external parts from rust, corrosion, and gumming in the engine fuel system.

a) General

Open battery disconnect switch and disconnect battery negative terminal at battery.

- 1) The unit should be prepared for storage as soon as possible after being removed from service.
- 2) The unit should be stored in a building that is dry and can be heated during winter months.
- 3) Moisture-absorbing chemicals should be used where excessive dampness is a problem; however, the unit must be completely packaged and sealed if moisture-absorbing chemicals are to be effective.

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b) Temporary Storage (30 days or less)

- 1) Lubricate unit completely in accordance with instructions in Chapter 2-2. This will include changing engine oil, and all filter elements.
- 2) Start engine and operate a minimum of two minutes so all internal engine components are coated with new oil. (Note: if unit is operated outside of diagnostic mode, it will run for 30 seconds in cool down mode after stop button is pressed.)
NOTE: Do not drain fuel system or crankcase after this run.
- 3) Leave spark plugs in holes or seal spark plug holes with suitable threaded metal plugs and cover all openings into the engine with dust-proof caps or shields (of suitable non-hygroscopic material strong enough to resist puncture damage from air pressure changes).
- 4) Cooling system antifreeze solution **must** be adequate to protect below lowest temperatures expected during storage period. Be sure solution is thoroughly mixed.
- 5) Spray flywheel and ring gear with mixture of one part recommended engine oil, and one part Stoddard Solvent or equivalent.
- 6) Clean exterior of engine. Dry with clean rags and compressed air.

c) Long-Term Storage (Over 30 Days)

To protect the generator and other electrical components, the complete unit should be packaged using moisture proof packaging and sealing material. Place containers of moisture-absorbing chemicals in unit before packaging.

- 1) Drain crankcase completely and refill with recommended engine oil or equivalent.
- 2) Run engine and treat upper cylinders by spraying fogging agent into the air intake for about two minutes. Open throttle for short burst of speed, shut off engine and allow it to come to a stop while continuing to spray into air intake.
- 3) Check coolant protection
- 4) Disconnect and remove battery.
- 5) Clean exterior surface of engine.
- 6) Leave spark plugs in holes or seal spark plug holes with suitable threaded metal plugs.
- 7) Seal all openings in engine and accessories with non-hygroscopic material. Mask off all areas to be used for electrical contacts.
- 8) Make sure all surfaces are dry, then spray all taped openings, all engine accessories including ignition wiring, and all exterior surfaces of engine with Insulation Compound.

d) Standby Long-Term Storage

The unit can be stored for long periods without the above preparation if engine can be operated once a week.

When operating once a week:

- 1) Make certain the cooling system is adequately protected.

WARNING

ENSURE adequate ventilation before starting the engine.

- 2) Start engine and operate under full load (using a resistive load bank or aircraft) until coolant temperature has reached a minimum 176°F (80°C).

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- 3) While engine is running, ensure normal operating controls are in good working condition before shutdown and storage. If weekly operation is not possible, contact nearest engine manufacturer distributor for instructions.

3) Preparation for Shipment

- a) Disconnect battery negative terminal before shipping.
- b) During long shipments, vibration, jolting, etc may loosen the generator set retaining hardware.

CAUTION	When shipping unit, provide sufficient retaining materials to ensure generator set cannot roll out or off the vehicle in which it is being transported.
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NOTE: It is suggested strong banding is used to secure generator set.

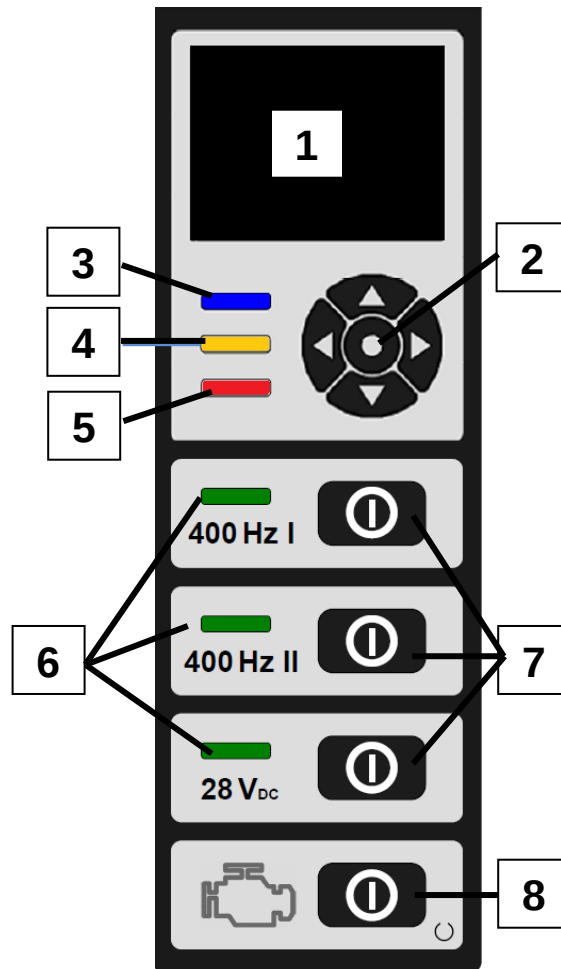
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Section 3 Operation

1) General

This section contains information and instructions for safe and efficient operation of the equipment. Operating instructions are presented in systematic sequence of procedures to be followed in supplying 400-Hz or 28.5 VDC power.

NOTE: Read ALL operating instructions before attempting operation of equipment.



1. LED Graphical Display
2. Navigation Keypad
3. Power ON "Blue" LED
4. Warning "Amber" LED

5. Alert/Failure "Red" LED
6. Output ON "Green" LEDs
7. Output ON/OFF (Reset) *
8. Power ON & Engine Start/Stop (Reset) *

* All output and engine buttons are multitasking buttons dependent on the status of the unit. The displayed screen is NOT important. These buttons are always active.

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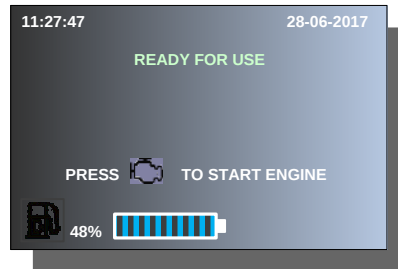
- 1: The color LED Graphical Display and easy to use menu system places all required operational information at the fingertips of the operator/maintenance personnel. Its color presentation accents critical data and simplifies the troubleshooting process by giving textual descriptions of any potential issues.
- 2: The Navigation Keypad is used to navigate through the simple menu systems.
- 3: The Blue LED indicates that power is ON. (It is off in sleep mode)
- 4: The Amber LED indicates a warning. The details of that warning are available on the display. Up to five warnings can be displayed at one time.
- 5: The Red LED indicates a fault. The details of this fault are also visible on the graphics display. Only one fault can be displayed at one time.
- 6: The Green LED's indicate that the respective output is ON.
- 7: The ON/OFF buttons are used to turn on and off their respective outputs. If a specific output has a fault, the corresponding ON/OFF button will also reset that fault.
- 8: The Power ON & Engine Start/Stop button will wake the unit from low-power sleep mode. Pressing it again will begin the start-up sequence for the gasoline engine. Pressing it again will shut down the engine. If the engine is running, it will begin the required smart 5-minute cool down. If the unit has a fault, this button will reset the fault.

NOTE! – The screens shown in this manual reflect the current software version at the time of publication. The screens on your unit might differ slightly based on the software version running on your unit. Any changes will be described in a Service Bulletin which should be placed in the back of this manual.

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Default Screen:

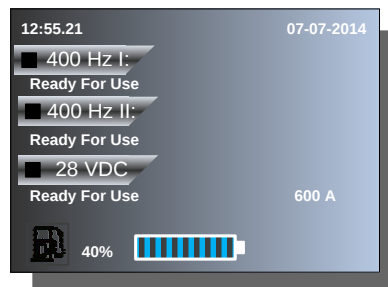
There are two default displays depending on whether the engine is running or not. When the unit finishes its self-check after first being powered up, the display will show the number of hours the engine has been operating. After a short delay, the engine hours are replaced with the current time. This then becomes the default display when engine is off. (The engine operating hours are always available on the “Engine” information screen.)



During the engine start process, the screen will be modified to show the current status until the engine is running and the unit is ready to output power.

Note: The engine is configured to go to idle until an output is activated. It will still say it is ready for use. However, the engine will have to ramp up to 1700 RPM and the voltage stabilized before the output contactor will close.

When engine has obtained idle speed, the screen will appear as follows showing all available outputs:



Both default screens enable the user to quickly have access to other pertinent information by pressing ▼ or ▲ to cycle through the display screens below:

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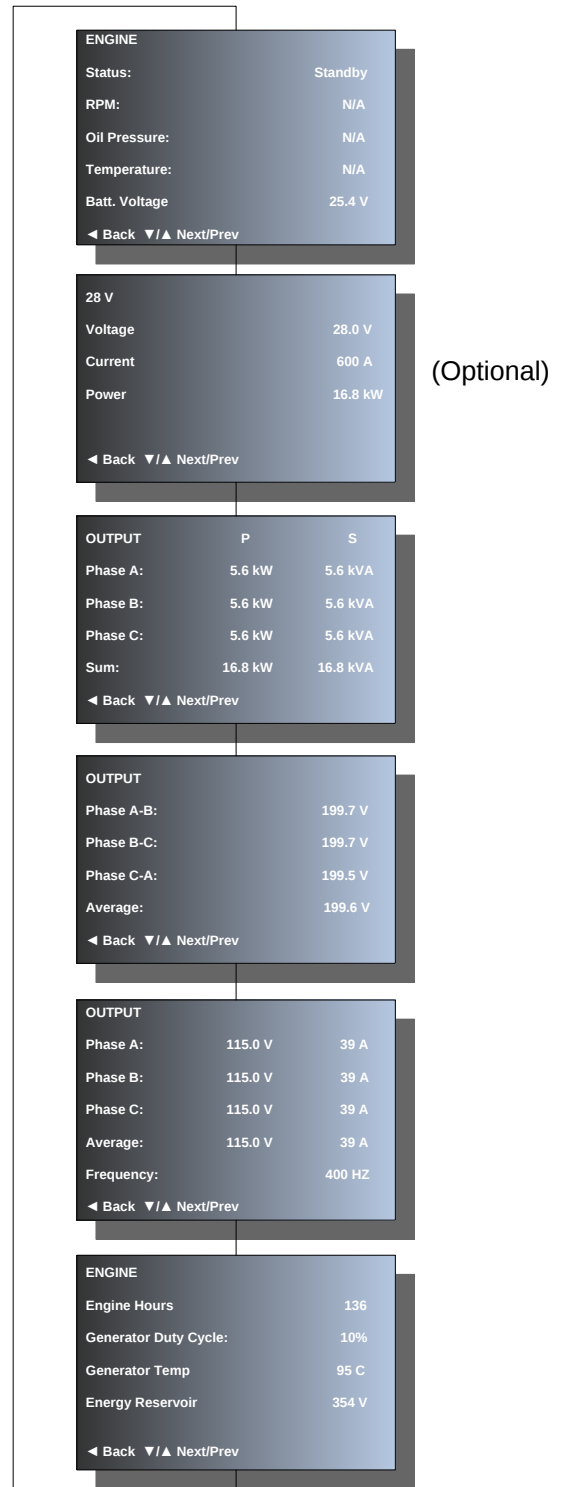
The 28V data page will only be displayed if that option is available.

Pressing ◀ will return to the default menu screen.

Unit information is displayed using the Parameter Information icon. To access the information icon, press the ● from the default menu and hold it down for approximately 5 seconds.

To select a submenu, simply use the navigation keys ◀▼▲▶ to highlight the icon and then press the ● to enter the sub-menu.

To leave the Icon Menu highlight the "Home" icon and press ●



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WARNING

Ear protection equipment may be necessary when working close to this equipment.

2) 400 Hz. Operating Procedure

a) Pre-start Inspection

- i) Check engine and generator compartments to make certain they are free of rags or other foreign materials.
- ii) Make certain sufficient lubricating oil and coolant is in the engine.
- iii) Be sure that the battery isolation switch is closed, ensuring that 12 VDC power is available to the engine starting and control systems.
- iv) Make certain the control panel is on. If not, press the Power ON/Engine Start-Stop button to wake the unit.

b) Normal Engine Starting Procedures

- i) Press and release engine “Start” button. The remaining portion of the startup procedure is automated. Startup status is shown on the display. The procedure will begin by providing power to the engine and other vital components. Next it will check the engine to insure proper operation. Once verified, the key switch is engaged and engine data begins to be processed. The engine will begin its initialization procedures. When finished, the starter will begin to crank.
- ii) Once the engine is running, check the oil pressure to make certain it is normal and observe all other engine values on the display screen for normal operation.

c) Failed Starting Procedure

If an error during initialization occurs the engine fails to start after 3 automatic attempts (15 seconds crank, 15 seconds wait per attempt), the display will show a fault. Diagnose and treat the reason for the fault, clear the fault, and press the engine start button again.

d) Variable Engine Speed

i) Normal Operation

To conserve fuel and maximize efficiency, the engine will automatically adjust its speed as the load is increased or decreased. It will respond immediately to increases in loads but will delay slightly following a decrease in load.

ii) Energy Reservoir

(1) Purpose

This unit contains a bank of supercapacitors that assists the engine through jumps in the output current when the engine is unable to respond quickly enough. These capacitors will deplete in power over time and during load jumps in which the engine requires assistance. The status of these capacitors is depicted as a battery icon at the bottom of the default screens.

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(2) Recharging

To recharge these capacitors, the engine speed must be at least 2800 rpm. If the engine is running and the capacitors need to be charged, the engine will ramp up to 2800 rpm and charge the capacitors. While in the charging process, a blue lightning bolt will appear next to the reservoir icon. If the engine speed is already above 2800 rpm, the engine rpm will not change. Once they have reached full charge, the engine will resume normal speed.

d) Power Delivery

After the engine has started and the display has changed to the output status default screen, any output ON/OFF buttons can be pressed. If the unit is already at rated speed, the contactor will immediately close. If at idle speed the engine will ramp up to rated speed, the generator will set output voltage and the contactor will close. The green LED will turn ON next to the active output. In addition, current power status information will appear on the output status default screen.

WARNING

All output ON/OFF buttons are active regardless of the displayed screen.

- 1) Early in the power delivery run it is recommended that the operator check output voltage and current in each of the three phases. Use ▼ ▲ pushbuttons to view either the line-to-line or line-to-neutral voltage. If the load is changing, observe the display until load conditions stabilize.
- 2) A condition of over-voltage, under-voltage, under-frequency, over-frequency, or overload in the output circuit will automatically open the load contactor and display a fault code to signal the operator which of the above faults caused the protective monitor system to operate. After the fault has been corrected, press the respective output pushbutton to reset the system. Proceed with power delivery by pressing the same switch.

WARNING

NEVER disconnect the output cable while power is being delivered. Output contactor's must be open prior to removal of the cable from the aircraft.

CAUTION

The generator set must be shut down so the failed power delivery problems can be diagnosed. Only personnel who are trained or qualified on this type of equipment should work on this GPU.

e) Failed Power Delivery

If the contactor indicator light goes out and EF fault is shown on the display, this indicates the aircraft is not supplying the 28.5 VDC interlock signal to the plug interlock circuit. Correct the condition and press the output pushbutton to reset the fault. Press the button again to close the output contactor and provide 400Hz to the aircraft/load bank.

If the aircraft (or load bank) does not provide a 28.5 VDC signal, set the **EF Bypass ON** through the Setup Icon menu.

- 1) Press and hold ● for approximately 5 seconds. (See paragraph 4.23 if this step doesn't result in the Icon menu being displayed.)
- 2) Use the navigation keys (◀▼▲▶) to highlight the setup icon.  Press ● to select.
- 3) Use the navigation keys (▼▲) to highlight the 400 Hz EF Interlock line. Press ● to select.
- 4) Set the 400 Hz EF interlock to bypass.

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- 5) Press ● to accept the change.
- 6) Use the ◀ navigation key to go back to the Icon screen.
- 7) Use the navigation keys (◀ ▼ ▲ ▶) to highlight the  setup icon. Press ● to select.
- 8) The display will return to the default screen after a period of inactivity.

f) Discontinue Power Delivery with Unit Shutdown

1) Normal conditions

Push the Output ON/OFF pushbutton next to the lit green LED indicator to open the output load contactor. The indicator light next to the button will go OFF, indicating the load contactor has opened and power is no longer being delivered to the aircraft.

- a) When all the contactors are open, the generator will deactivate and the engine will return to idle after a short delay.
- b) Push the engine Start/Stop push-button switch once to begin the automatic shutdown sequence to shut off the engine after approximately 30 seconds.

2) Emergency conditions

- a) Depress the “**EMERGENCY STOP BUTTON**” located on front of the unit to the right of the control panel. When pushed, this button shuts the generator set off. Pull the button back out to reset it before restarting the generator set.

CAUTION

Do not use the “**EMERGENCY STOP BUTTON**” as a normal shutdown device. Damage to the engine turbo charger may result without proper cooling time. Use the Engine ON/OFF pushbutton for all normal engine shutdowns.

- b) A condition of over-voltage, under-voltage, under-frequency, over-frequency, or overload in the output circuit will automatically open the load contactor and display a fault code to signal the operator which of the above faults caused the protective monitor system to operate. After the fault has been corrected, press the respective output pushbutton to reset the system. Proceed with power delivery by pressing the same switch.

g) Low Power Mode

- h) The display will automatically turn off after 10 minutes as the unit goes into low power mode. If the display is off and the battery disconnect switch is on, press the Engine pushbutton to wake the unit and turn the display back on.

i) Low Fuel Warning and Fault

- 1) A Low Fuel Warning occurs when the unit is running and fuel levels drops below 10% in the fuel tank. The unit will continue to operate until it is out of fuel or the operator shuts off the engine.
- 2) A Low Fuel Fault will display if the fuel level is below 10% and the engine is off. The engine can't be started until the fuel level is above 10%.

j) Display

- 1) The display will automatically turn off if the engine has been off at least 10 minutes. Pushing any button will return the display to full brightness. However, if there is a warning or fault message on the display, it will not turn off.
- 2) If the display is off, and the battery disconnect switch is closed, press the Engine pushbutton to return the display to full brightness.

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k) Battery Disconnect Switch

If the unit is not going to be used for a long period of time, open the battery disconnect switch to remove 24 VDC power to the control board and Cummins ECM controller. **DO NOT** open the battery disconnect switch while the engine is running or within two minutes after the engine has shut down.

3) Transformer Rectifier Unit (TRU) – 28.5 VDC Power Supply

a) See Appendix A for TRU Operation

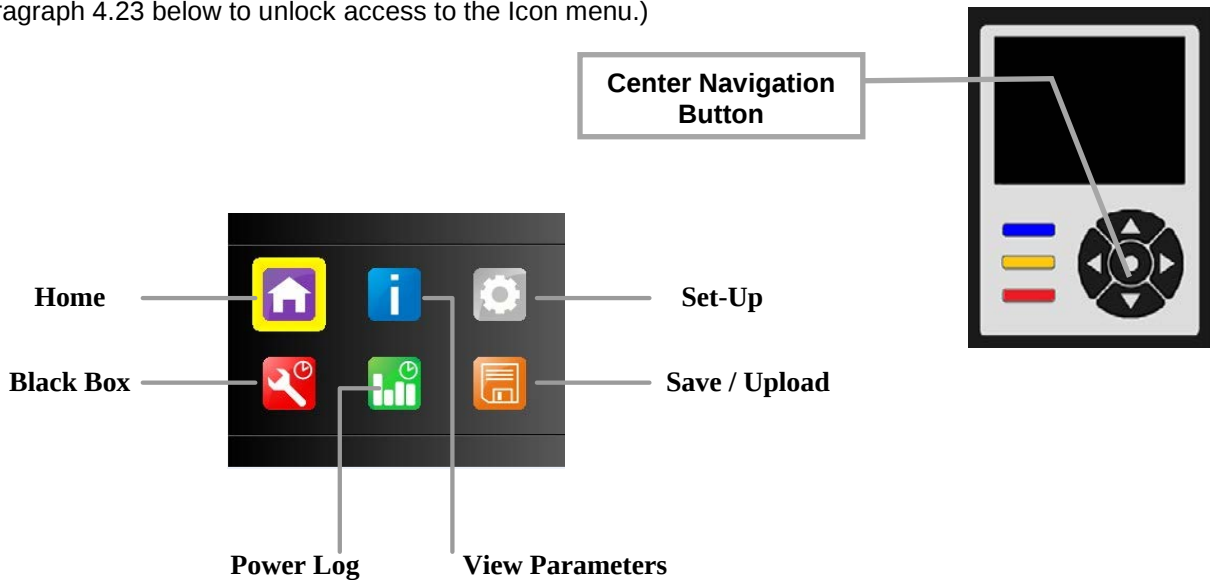
CAUTION

The TRU can deliver up to 2000 amps of current during the starting of an aircraft engine. This much current will shear the propeller shaft of some aircraft. Therefore, make sure that the current limit is correctly set for the aircraft that is being powered.

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4) Icon Menu

The Icon Menu is accessed from the default screen. Press the center navigation button ● while in the default menu and hold it down for approximately 5 seconds. (If the Icon menu doesn't appear after 5 seconds, see paragraph 4.23 below to unlock access to the Icon menu.)



The basic Icon Menu is shown above with the available sub-menus.

To enter the Icon Menu, press the ● from the default menu and hold it down for approximately 5 seconds.

To Select a sub-menu, simply use the navigation keys ◀▼▲▶ to highlight the icon and then press the ● to enter the sub-menu.

To leave the Icon Menu highlight the "Home" icon and press ●

Icon explanation:

-  Back to Default screen
-  Viewing actual converter parameters
-  Set-up menu for changing converter parameters
-  Black Box with last 100 failures / errors
-  Power Log with last 100 operations
-  Save "Black Box" / "Power Log" records or update control card software

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a) View Parameters Menu

The View Parameters Menu is accessed from the Icon screen. Press the center navigation button ● while in default menu and hold down for approximately 5 seconds. The Icon menu is displayed, press the right navigation button to highlight the icon.

Parameters – Menu structure



Highlight the  by using the navigation ◀▶ keys.

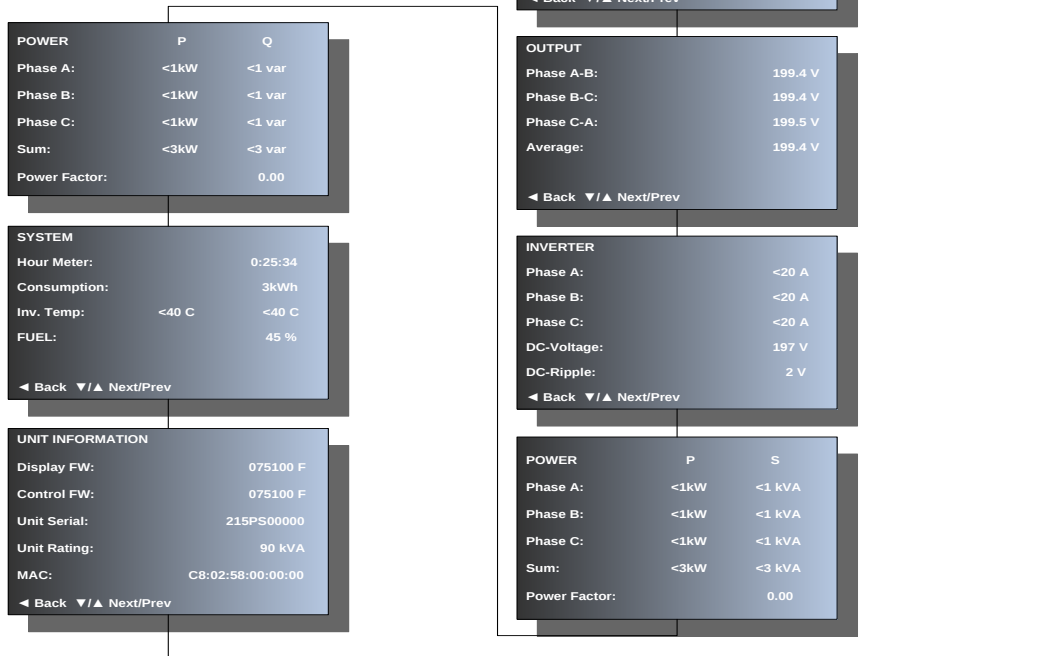
Press ● to select "View parameters" sub-menu.

Use the the ▼/▲ to browse through the various screens.

Use ◀ to leave the sub-menu and return to basic Icon Menu.

Notice!

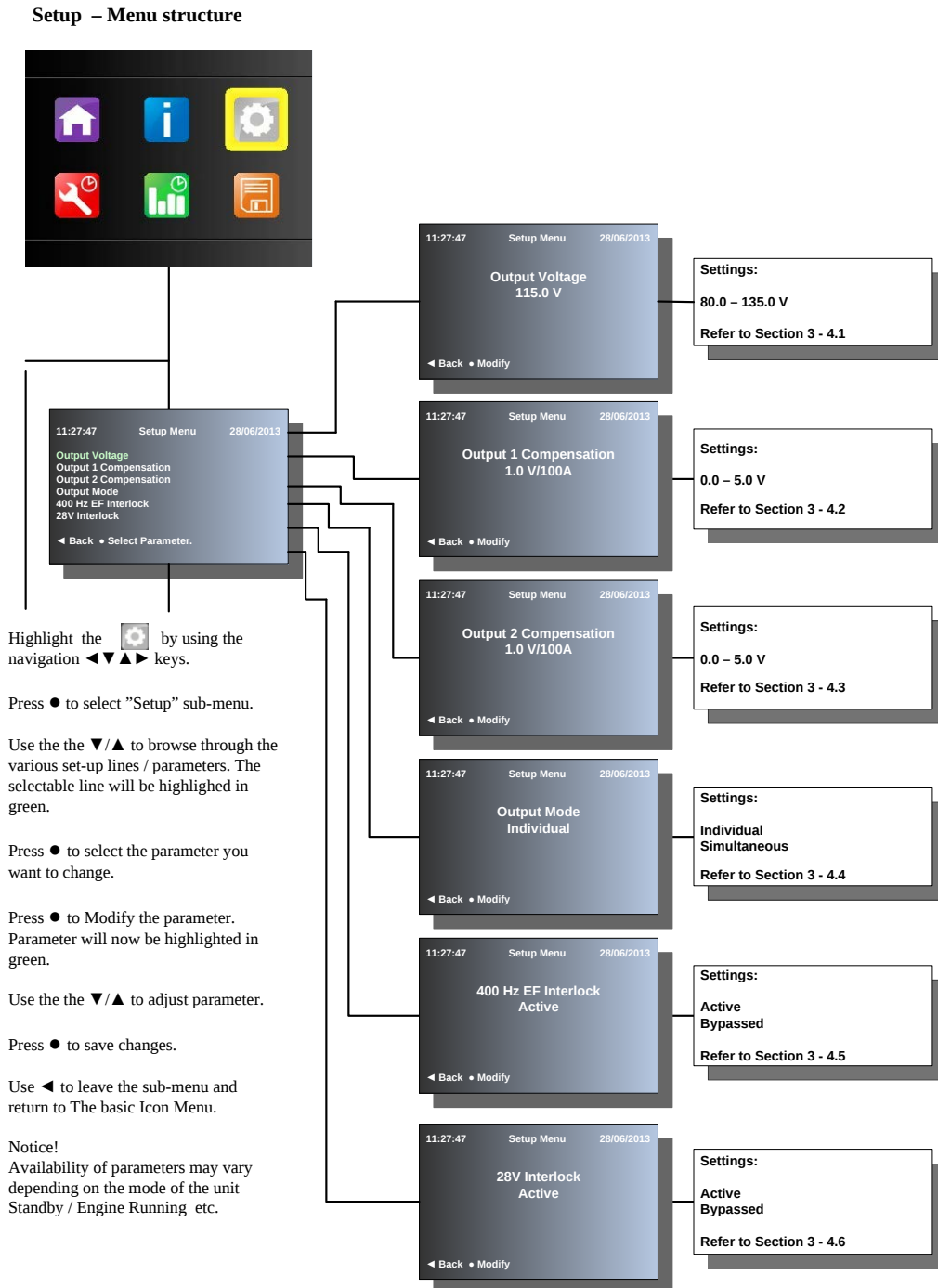
Parameters may vary depending on the mode of the unit Standby / operating / load profile etc.



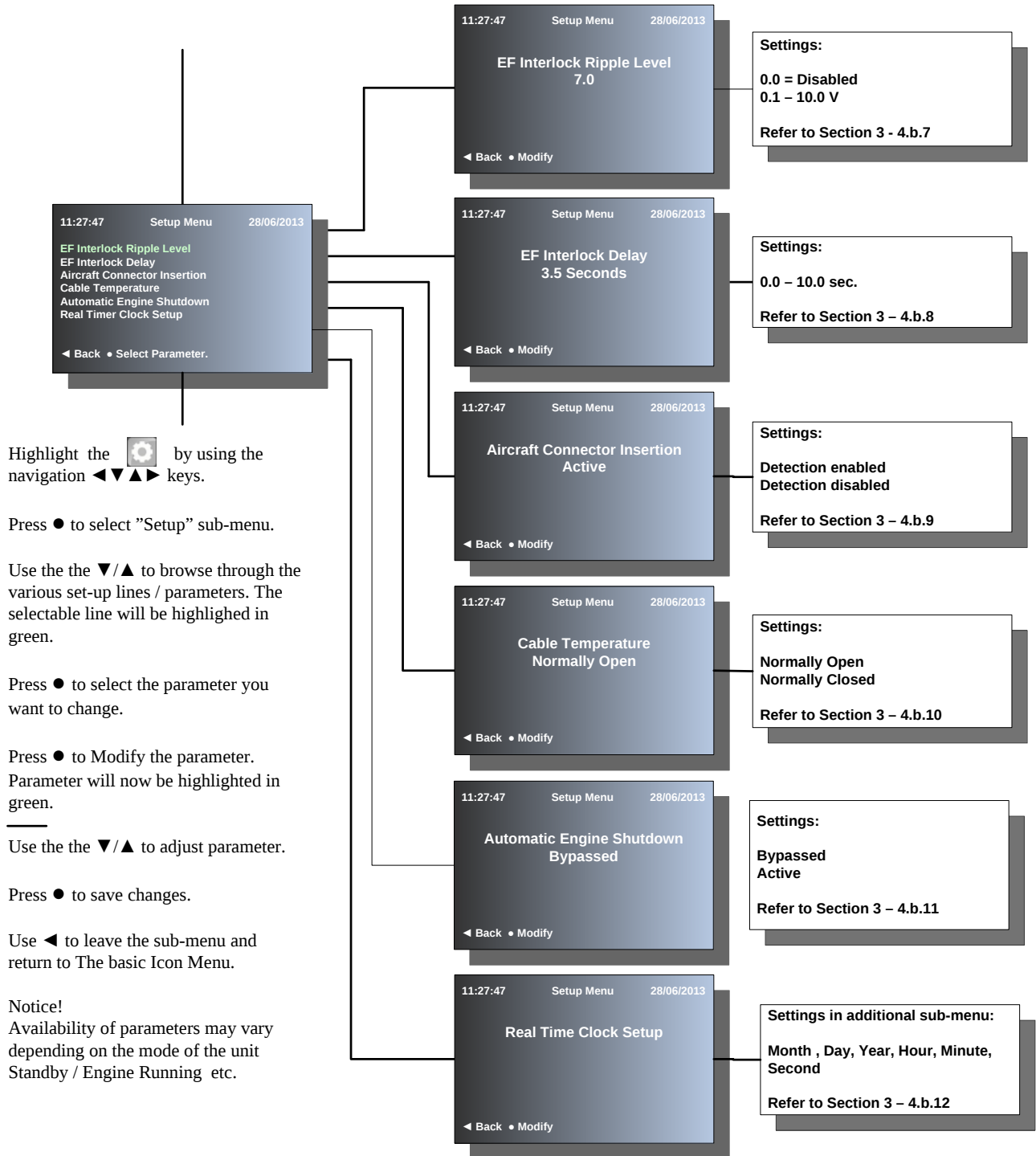
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b) Setup Menu

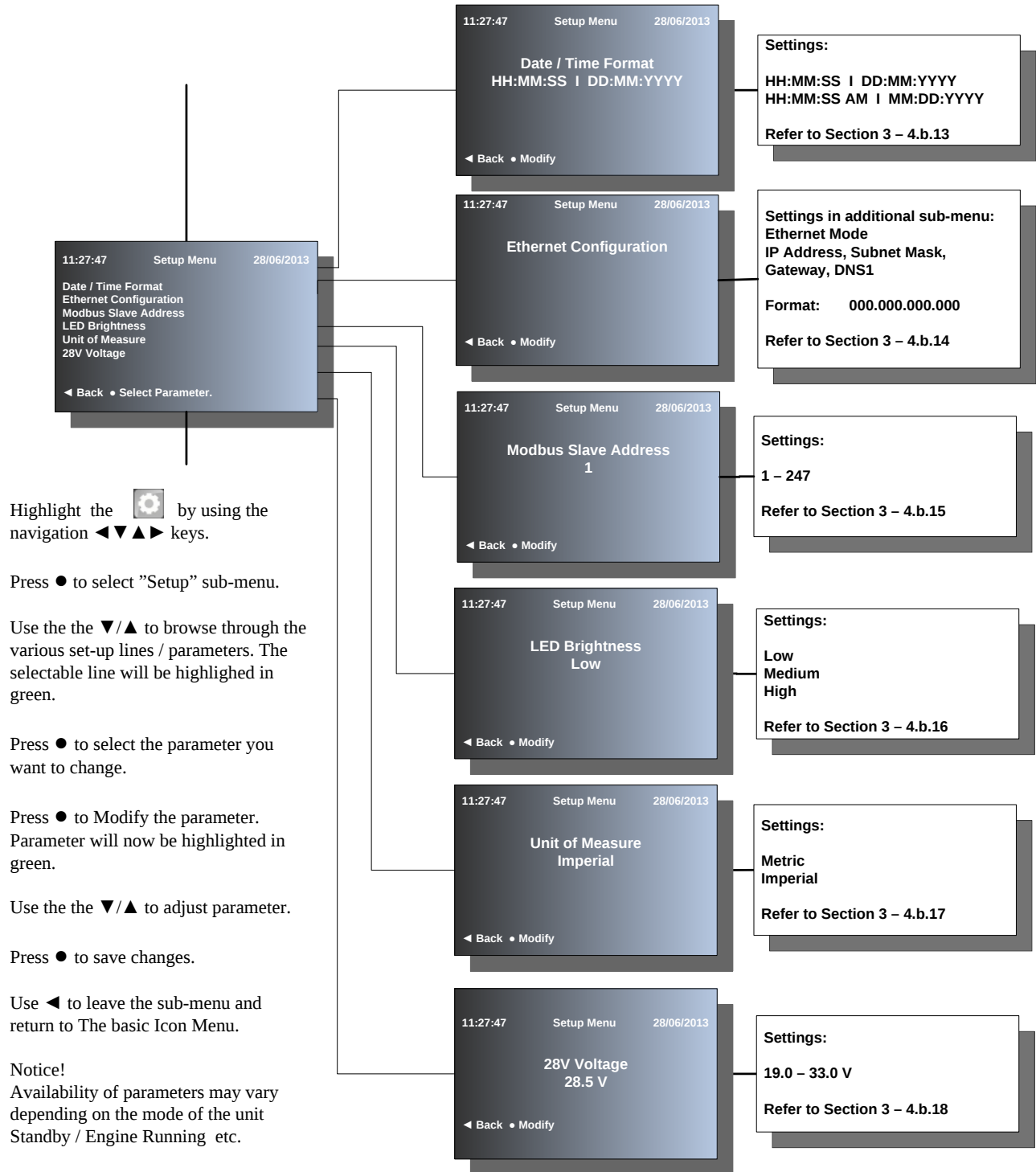
The Setup Menu is accessed from the Icon screen. Press the center navigation button ● while in the default menu and hold down for approximately 5 seconds. The Icon menu is displayed, press the right navigation button to highlight the Setup icon.



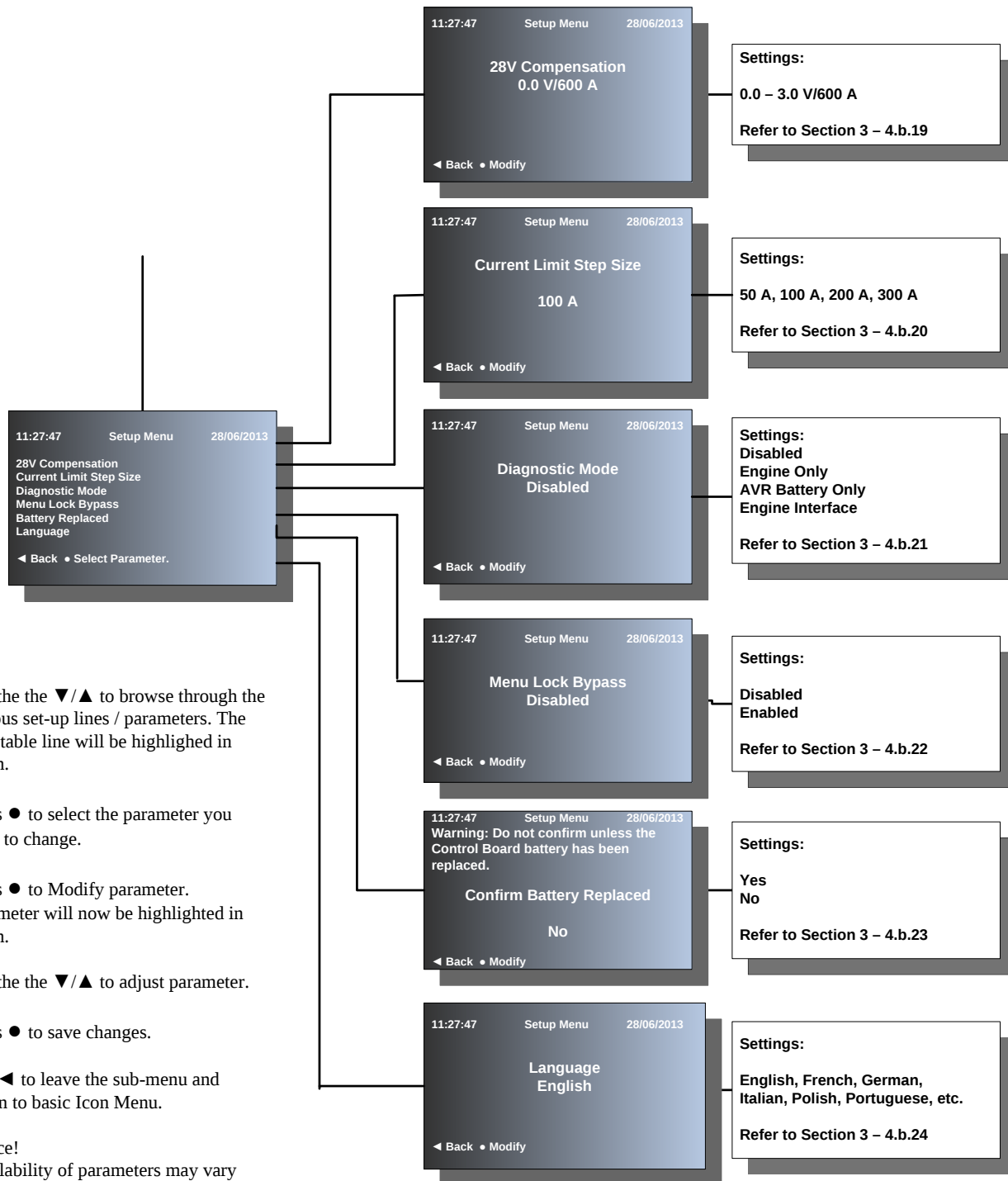
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Use the the ▼/▲ to browse through the various set-up lines / parameters. The selectable line will be highlighted in green.

Press ● to select the parameter you want to change.

Press ● to Modify parameter. Parameter will now be highlighted in green.

Use the the ▼/▲ to adjust parameter.

Press ● to save changes.

Use ◀ to leave the sub-menu and return to basic Icon Menu.

Notice!
Availability of parameters may vary depending on the mode of the unit Standby / Engine Running etc.

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1) Output Voltage

This Setup submenu allows the output voltage to be adjusted between 80.0 VAC and 135 VAC using the UP and DOWN navigation buttons. (Please note that the acceptable voltage range for all commercial aircraft is 115V $\pm$ 3V. This range is even tighter for some aircraft.)

Enter the Setup Menu and then scroll up or down to the Output Voltage submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

2) Output 1 Compensation

The output voltage is increased in proportion to the load current (Volt / 100 A).

- a) Apply full load to output 1.
- b) Enter the “OUTPUT 1 COMPENSATION” submenu. Press the center button to allow the value to be adjusted.
- c) Adjust the compensation using the vertical arrow buttons until the voltage at the aircraft connector equals the no load value. Press center ● button to accept and record this value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

3) Output 2 Compensation:

The output voltage is increased in proportion to the load current (Volt / 100 A).

- a) Apply full load to output 2.
- b) Enter the “OUTPUT 2 COMPENSATION” submenu. Press the center button to allow the value to be adjusted.
- c) Adjust the compensation using the vertical arrow buttons until the voltage at the aircraft connector equals the no load value. Press center ● button to accept and record this value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

4) Output Mode

- a) When the unit has 2 outputs, the “Output Mode” submenu is used to set either “Individual” or “Simultaneous” mode of operation.
- b) If the output mode has been set to “Individual”, the outputs can be used individually. If the output mode has been set to “Simultaneous”, both outputs can be used at the same time.
- c) Enter the Setup Menu and then scroll up or down to the Output Mode submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

5) 400 Hz EF Interlock

- a) The EF interlock is a personnel and equipment safety feature that is found in all commercial aircraft. This 28VDC signal will not be present until the GPU closes its output contactor and provides 400 Hz power to the aircraft. The aircraft will evaluate the 400 Hz power and if it is within the aircrafts tolerance limits it will then close a relay in the aircraft to provide a 28VDC signal to the “F” pin/wire in the power connector plug/cable.
- b) Some load banks do not provide this EF Interlock so the EF interlock function in the unit has to be bypassed. Do not set this value to Bypassed for normal operation with aircraft. This setting is only

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to be used by qualified personnel for testing the GPU unit or when the unit will be providing power to equipment outside of an aircraft.

Note! The value will be automatically reset to Active if the unit detects 28 volts on the "F" pin input of the I/O board.

- c) Go into the Setup Menu and then scroll up or down to the EF Interlock submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

6) 28V Interlock

- a) The 28V interlock is a personnel and equipment safety feature that is found on some commercial turboprop aircraft. This 28VDC signal will not be present until the GPU closes its output contactor and provides power to the aircraft connector. The connector typically has a split "F" socket with +28VDC on one side and a jumper to the return wire on the other side of the socket. The GPU will not keep the output contactor closed if this voltage is not detected on the return wire in the cable. (This option requires a special cable such as the JB2840-30CS, JB2840-40CS or JB2840-50CS.)

Note! The value will be automatically reset to Active if the unit detects 28 volts on the "F" pin input of the I/O board.

- b) Go into the Setup Menu and then scroll up or down to the 28V Interlock submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

7) EF Interlock Ripple Level

- a) The EF Interlock Ripple Level is part of the Neutral Voltage Displacement circuit. If an aircraft has a large unbalanced load and the aircraft power cable has a broken neutral, then it is possible for the aircraft frame to be energized to a dangerous level. This condition will result in an AC voltage induced onto the EF DC signal.
- b) This sub-menu sets the trip level for the AC ripple on the DC EF interlock signal. The default value is 7.0 volts and a setting of 0.0 volts disables the function.
- c) Go into the Setup Menu and then scroll up or down to the EF Interlock Ripple Level submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

8) EF Interlock Delay

- a) Some of the newer aircraft take a longer time between when 400 Hz power is supplied to the aircraft and when the aircraft returns the 28 VDC EF Interlock signal. This setting allows the adjustment of the amount of time the unit will wait until determining that the EF signal is not present and that the output power should be shut off. The default value is 3.5 seconds.
- b) Go into the Setup Menu and then scroll up or down to the EF Interlock Delay submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

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9) Aircraft Connector Insertion

- a) Some aircraft power cables are equipped with a micro-switch or split "F" socket in the connector. This device sends a 28 VDC signal to the unit when the connector is inserted at least 90% of the way into the aircraft power receptacle. Set this sub-menu value to Enable when such a cable is connected to the unit. The default value is set to Disable.
- b) Go into the Setup Menu and then scroll up or down to the Aircraft Connector Insertion submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

10) Cable Temperature

- a) Some aircraft cables have temperature sensors installed in the connector body and/or replaceable nose. This sub-menu allows the unit to accept Normally Opened or Normally Closed temperature sensor switches to be used.
- b) Go into the Setup Menu and then scroll up or down to the Plug Temperature submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

12) Automatic Engine Shutdown

If the engine is running at its rated speed and all outputs are off for ten (10) minutes or the total load is less than 5 amps, the engine will automatically go into its 30 second shutdown mode when this function is active. The Setup submenu allows this option to be activated or bypassed.

Enter the Setup Menu and then scroll up or down to the Automatic Engine Shutdown submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

13) Real Time Clock Setup

This set of sub-menu s allows the user to adjust the internal clock to the correct local time.

Go into the Setup Menu and then scroll up or down to the Real-Time Clock Setup submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

14) Date/Time Format

The date and time format that is displayed on all the screens and reports can be adjusted using this submenu. The selection is a 24 hour clock and DD:MM:YYYY date format or a 12 hour clock with the MM:DD:YYYY date format.

Go into the Setup Menu and then scroll up or down to the Date/Time Format submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

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15) Ethernet Configuration

This set of sub-menu s allows the user to enter the Ethernet IP address, Subnet Mask, Gateway address and DNS1 values for TCP/IP communications with a BMS or RMS central monitoring system.

Go into the Setup Menu and then scroll up or down to the Ethernet Configuration submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

16) Modbus Slave Address

If the unit will be part of an RS-485 Modbus RTU BMS/RMS monitoring system, it must be assigned a Modbus Slave Address. This sub-menu allows the user to enter the slave address.

Go into the Setup Menu and then scroll up or down to the Modbus Slave Address submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

17) LED Brightness

The unit status LED's have three brightness levels. The default is set to medium.

Go into the Setup Menu and then scroll up or down to the LED Brightness submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

18) Unit of Measure

This submenu is used to set the unit of measurements to Metric or Imperial.

Go into the Setup Menu and then scroll up or down to the Unit of Measure submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

19) 28V Voltage

This Setup submenu allows the 28 volt output to be adjusted between 19.0 VDC and 33.0 VDC using the UP and DOWN navigation buttons. (Please note that the acceptable voltage range for all commercial DC powered aircraft is 26V to 29V.

Enter the Setup Menu and then scroll up or down to the ARU Voltage submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

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20) 28V Compensation

DC voltage drops quickly as the current increases over a given length of cable. This Setup submenu allows the 28 volt output to be automatically adjusted as the load increases. The allowed setting is between 0.0 and 3.0 VDC at the rated continuous load of the unit. Note that the maximum output voltage of the unit is 33 VDC.

Enter the Setup Menu and then scroll up or down to the 28V Compensation submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

21) Current Limit Step Size

If too much current is supplied to an aircraft engine, it is possible for the engine to shear the propeller shaft. The Current Limit should be set to the maximum current the aircraft to be powered can take (per the aircraft manufacturers recommendations). The Current Limit is set using the UP and Down arrows on the Operators Panel. This submenu is used to set the step size the current limit is changed by every time the UP or Down button is pressed. The current limit settings are from 300 amps to 2000 amps in steps of 50/100/200/300 amps. This menu selects the size of the steps that the operator uses to adjust the current limit before turning on the 28 VDC to the aircraft.

Enter the Setup Menu and then scroll up or down to the Current Limit Step Size submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

22) Diagnostic Mode

This setup submenu is used to assist in the troubleshooting procedure. The default setting is “Disabled”; use the “Engine Only” to verify engine performance; use the “AVR Battery Only” to verify the operation of the generator (with engine operation). The “Engine Interface” allows read only access to the engine ECM module. In the “Engine Interface” mode, the engine ECM will perform a self-test and then enter its Run mode. (The display will indicate running in the engine screen). In this mode each of the output contactors can be toggled on and off to verify that they are functioning correctly.

The engine must be stopped before any of these modes can be changed.

Enter the Setup Menu and then scroll up or down to the Diagnostic Mode submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

23) Menu Lock Bypass

This submenu is used to lock out the center button on the navigation keypad which will prevent access to the ICON screen. Disabled allows access to the Icon screen when the center button is pressed for 5 seconds. Enabled locks out the center button. When the center button is pressed the screen will display DISABLED. Technicians can gain temporary access to the Icon menu by performing the following sequence of button presses: Right Arrow, Up Arrow, Down Arrow, Down Arrow. Holding the center button again (approx. 5 seconds) will take you to the main Icon menu. The default is set to disabled.

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Go into the Setup Menu and then scroll up or down to the Menu Lock Bypass submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

24) Confirm Battery Replaced

Situated on the back of the control board, is a coin type lithium battery which ensures that Firmware / Set-up data etc. are not lost during utility drop-outs. The expected life of the battery is approximately 7 years. Note, a low battery voltage does not affect the internal safety system of the GPU that monitors the output voltage, among others. Thus, aircraft connected to the GPU are not exposed to any danger. However, to avoid loss of data and Control Board lock up *, we recommend changing the battery after **5 years** of use.

Note!

A time stamp is stored in the ID chip (A6) upon production and after 5 years a warning occurs at the display, telling the user/operator to replace the Control Board battery. It is strongly recommended to change the battery when this message is shown:

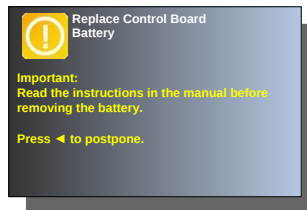


Fig. 8.2.1

To allow the user/operator to use the converter, it is possible to postpone the battery change, by pressing the ◀ (left arrow) push button. The warning message occurs 90 seconds after the unit is powered on or the output contactor(s) are opened (the unit is in Standby Mode). If this message is ignored for 6 months, the controls will be locked out and the below failure message will be displayed.

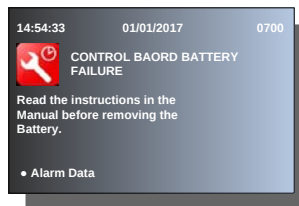


Fig. 8.2.2

The battery must be changed before the unit can be operated again.



To ensure high reliability of the back-up battery, the only type of battery that can be used on the Control Board is the Panasonic BR-2032

Go into the Setup Menu and then scroll up or down to the Confirm Battery Replaced submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be

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changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

25) Language

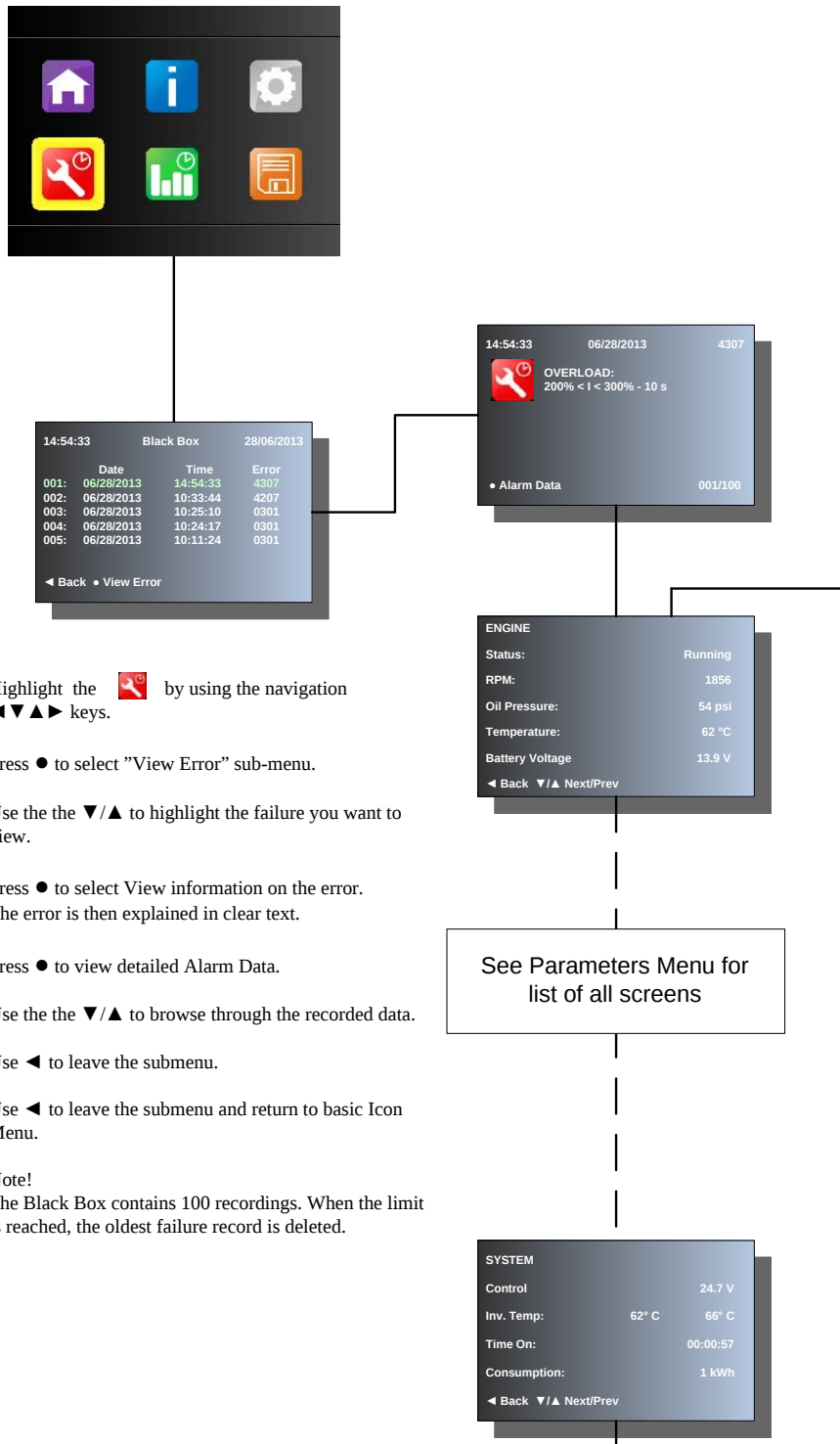
This submenu is used to change the language that all of the display screens, messages, alarms and reports are displayed in. The unit comes with English, French, German, Italian, Polish, Portuguese, Czech, Russian, Turkish and Spanish already installed. Other languages can be added as required. The default is set to English.

Go into the Setup Menu and then scroll up or down to the Language submenu. Press the center ● button to enter the submenu, and then press the ● button again to allow the value to be changed. Press the up or down arrow buttons to change the selection. Press the center ● button to record the new value. Press the LEFT arrow button to exit the submenu and return to the submenu list.

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c) Black Box

Black Box – Menu structure



Highlight the  by using the navigation **◀ ▽ ▹ ▹** keys.

Press **•** to select "View Error" sub-menu.

Use the the **▽/▲** to highlight the failure you want to view.

Press **•** to select View information on the error.
The error is then explained in clear text.

Press **•** to view detailed Alarm Data.

Use the the **▽/▲** to browse through the recorded data.

Use **◀** to leave the submenu.

Use **◀** to leave the submenu and return to basic Icon Menu.

Note!

The Black Box contains 100 recordings. When the limit is reached, the oldest failure record is deleted.

The Power Log Menu is accessed from the Icon screen. Press the center navigation button **•** while in the default menu and hold it down for approximately 5 seconds. The Icon menu is displayed, press the right navigation button to highlight the Power Log icon.

The sequence of screenshots illustrates the navigation path through the Power Log sub-menu. The path starts from the main menu, goes to the Power Log list, then to a specific Power Log entry (001/100), and finally to the Graph view. The screenshots show the progression of the user interface as they navigate through the system.

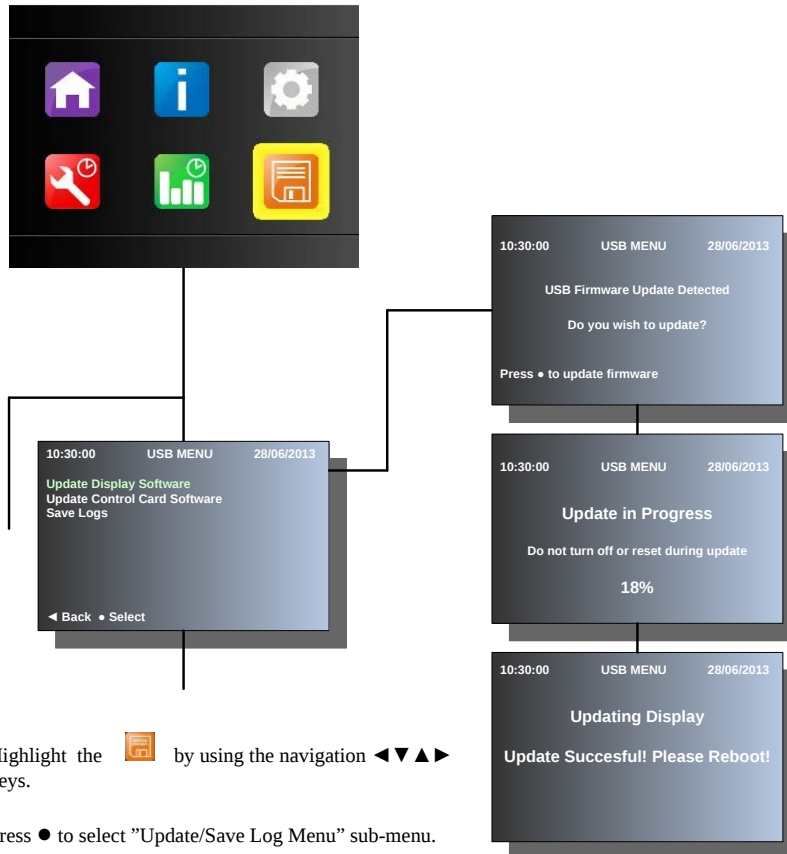
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e) Update/Save Log Menu

The Update/Save Log Menu is accessed from the Icon screen. Press the center navigation button ● while in the default menu and hold it down for approximately 5 seconds. The Icon menu is displayed, press the right navigation button then the down button to highlight the Update/Save Log icon.

Update/Save Log – Menu structure



Highlight the  by using the navigation ◀▼▲▶ keys.

Press ● to select "Update/Save Log Menu" sub-menu.

The default function "Update Display Software" is green highlighted. If another function is wanted, use the the ▼/▲ to highlight the function.

Before pressing ● to select "Update Display Software", please remember to insert a USB stick into the USB port on the Display (located on the side of the Display enclosure inside the unit).

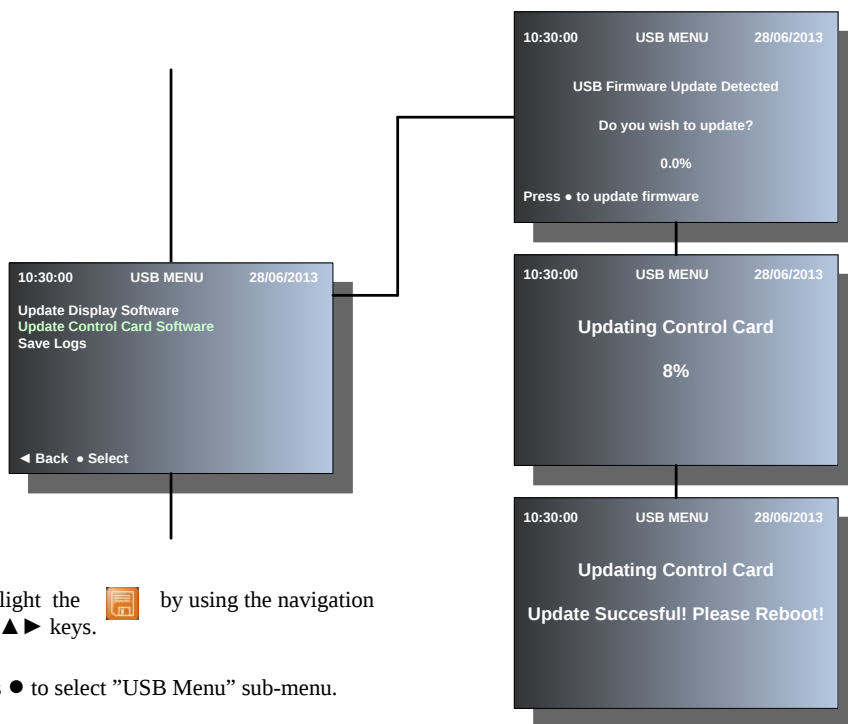
Press ● to select the function.

Press ● to confirm update firmware.

The firmware is now being uploaded to the display card. Upload % is counting from 0% to 100%. The system automatically reboots if the update is successful. Otherwise, an Update has failed! Message is displayed.

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Update/Save Log (continued) – Menu structure



Highlight the  by using the navigation ◀▼▲▶ keys.

Press ● to select "USB Menu" sub-menu.

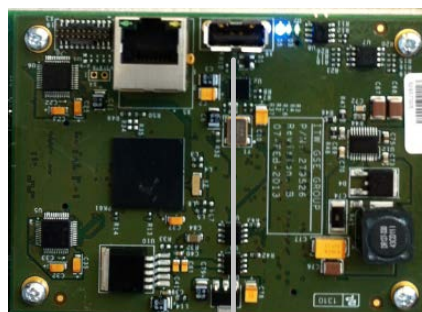
Use the the ▼/▲ to highlight the function "Update Control Card software".

Before pressing ● to select "Update control card software", please remember to insert an USB stick into the USB port on the control card (located on the interface board).

Press ● to select function.

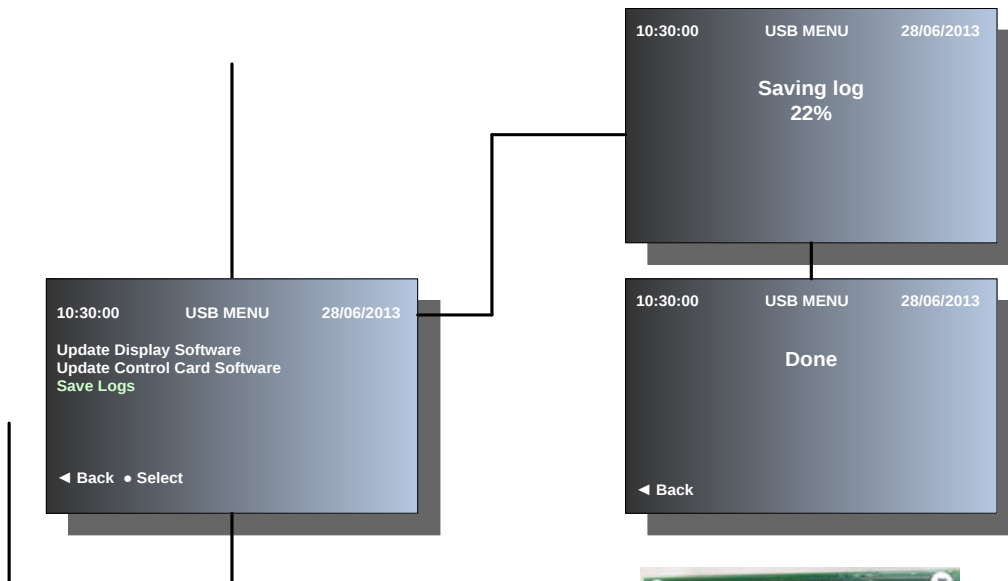
Press ● to confirm update firmware.

The firmware is now being uploaded to the display card. Upload % is counting from 0% to 100%. The system automatically reboots if the update is successful. Otherwise, an Update has failed! Message is displayed.



USB connection
Control card

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Highlight the  by using the navigation ◀▼▲▶ keys.

Press ● to select "USB MENU" sub-menu.

Use the the ▼/▲ to highlight the function "Save Logs".

Before pressing ● to select Save logs, please remember to insert an USB stick into the USB port on the display (located on backside of the front door).

Press ● to select function.

The logs are now saved to the USB stick. Saving log % is counting from 0% to 100% and "Done" is displayed, when the saving has been completed.

The logs are saved as one CSV File. Use the ITW GSE Service Tool to properly display this file.

Note!

The USB stick can be inserted while the unit is powered.



USB connection Display

Chapter 2 Service and Troubleshooting

Section 1 Maintenance Inspection/Check

1) General

To make certain the generator set is always ready for operation, it must be inspected and maintained regularly and systematically so that defects may be discovered and corrected before they result in serious damage to components, or failure of the equipment.

Warning

STOP operations at once if a serious or possibly dangerous fault is discovered

2) Maintenance Schedule

a) General

A periodic maintenance schedule should be established and maintained. A suggested schedule is provided in Figure 2-1-1 on the following pages. It may be modified, as required to meet varying operating and environmental conditions. It is suggested that generator set and vehicle inspections be coordinated as much as possible.

b) Maintenance Schedule Check Sheet

It is strongly recommended that the customer use a maintenance schedule check sheet such as the one in the engine manufacture's operation manual. The check sheet will provide a record and serve as a guide for establishment of a schedule to meet the customer's maintenance requirements for his specific operation.

c) Time Intervals.

The schedule is based on both hours of operation and calendar intervals. These two intervals are not necessarily the same. For example, in normal operation the oil change period, based on hours of operation, will be reached long before the three months calendar period. The calendar period is included to make certain services are performed regularly when the equipment is stored, or being operated infrequently. Lubricating oil standing in engines that are stored, or used very little, may tend to oxidize and may require changing although it is not dirty. Perform all services on a whichever- comes-first basis.

d) Identification of Interval Periods.

Each interval period is identified by a letter A, B, C, etc. For example, services under B schedule should be performed at the end of each 250 hours of operation, or every three months, BR service is performed during the BREAK IN period (first 50-150 hours), G service is Extended Life (10,000 + hours) and AR service is performed AS REQUIRED.

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Hourly Interval		50	100	200	400	800	2400	max
Calendar Interval	Daily	Once		3 Mo.	6 Mo.	1 Yr.	1.5 Yr.	4 Yr.
Symbol	D	BR	A	B	C	D	E	F
Engine								
Check engine oil level – top off if needed	X	X	X	X	X	X		
Check Coolant level – top off if needed	X	X	X	X	X	X		
Check for oil, fuel or coolant leaks	X	X	X	X	X	X		
Lubricate PTO release bearing	X	X	X	X	X	X		
Check control & warning lights	X	X	X	X	X	X		
Check all hoses & pipes for leaks, damage or deterioration.		X	X	X	X	X		
Check all wiring for security and evidence of chafing or heat damage		X	X	X	X	X		
Change engine oil & filter					X	X		
Lubricate PTO bearing			X	X	X	X		
Check condition & adjust tension of drive belt				X	X	X		
Check fuel filter element – renew as necessary				X	X	X		
Renew air cleaner element					X	X		
Spark plugs – clean, adjust or replace					X	X		
Check all nuts & bolts for tightness					X	X		
Adjust PTO clutch release & shaft bearings					X	X		
Renew PCV valve								
Clean PCV hoses, tubes and fittings								
Clean coolant filler cap. Replace cap if seal has deteriorated								X
Check Water Pump		X				X		
Steam Clean Engine		X					X	
Clean Fuel System							X	
Check Alternator							X	
Check Starter Motor							X	
Check Vibration Damper								X

**Figure 2-1-1 Maintenance Schedule
(Sheet 1 of 2)**

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Hourly Interval	AR	50	100	200	400	800	2400	Max
Calendar Interval		Once	Daily	3 Mo.	6 Mo.	1 Yr.	1.5 Yr.	4 Yr.
Symbol	AR	B	A	B	C	D	E	F
Engine (continued)								
Flush and Change Coolant								X
Drain & Inspect Fuel Tank	X					X		
Check Fan Mounting				Spring & Fall				
Clean Cooling System				Spring & Fall				
Check Hoses				Spring & Fall				
Clean Electrical Connections				Spring & Fall				
Check Thermostats and Seals				Fall				
Electrical (24 VDC System)								
Check All Lights			X					
Check Alternator Charging Rate			X					
Check Battery				X				
Clean Battery Terminals	X			X				
Check Wiring and Connections					X			
Check All Engine Meters			X					
Electrical (400-Hz System)								
Check E-F By-Pass Operation				X				
Check Output Cable and Connectors			X					
Check Volt, Amp & Frequency Displays			X					
Check and/or Adjust Output Voltage	X				X			
Inspect Wiring and Connectors					X			
Clean and Inspect Generally					X			

Note: “G” service (10,000+ hours) items are covered in section j) below.

Figure 2-1-1 Maintenance Schedule
(Sheet 2 of 2)

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3) Inspection/Checks

a) General

- 1) See Chapter 2-2 for detailed maintenance procedures.
- 2) See Chapter 2-3 for adjustment and test procedures.

b) “AR” Checks and Operations (As Required)

- 1) Engine
 - a) Change Air Cleaner
 - i. Replace the air filter when the “Air Filter Clogged” warning is displayed. These filters should not be washed because washing breaks down the material inside the filters.
 - ii. Check and tighten, as required, all coolant hose clamps, air intake hose clamps and exhaust clamps. Check all coolant hoses, air intake hoses and exhaust pipes for leaks.
 - b) Electrical System (24 VDC) – Check Battery Terminals
 - i. Periodically, open the battery compartment panel in the right cable tray and visually check the battery cable connectors and battery posts. If corrosion is observed, disconnect the cables and clean battery posts and connectors with a wire brush or special battery post-cleaning tool. Coat the posts and connectors with a light film of petroleum lubricant before reconnecting the cables.
 - c) Electrical (400 Hz System) -- Check Output Voltage
 - i. Check the output voltage and be sure it is set for 115 VAC $\pm$ 1 V. Adjustment can be made using the Setup menu. (See Chapter 1-3, paragraph 4.1.)

c) “BR” Checks and Operations (Break-In Period, Once After 50-150 hrs.)

The following procedures are precautionary measures taken on most new engines. If a problem occurs with any of the following issues, be sure to recheck it after the next 50-150 hours.

- 1) Engine
 - a) Check for leaks and correct. This involves an overall inspection of the engine and may require some maintenance if leaks are found. Refer to the engine manufacturer's operations manual for assistance.
 - b) Change all fuel filter elements. Metal shavings from the new fuel tank can clog the filter.
 - c) Change crankcase oil. New engines often release metal shavings more frequently. Therefore, the crankcase oil must be changed as a precautionary measure.
 - d) Change oil filter element. The oil filter should be changed with the oil.
 - e) Check engine and generator mounts to ensure they are properly installed and they have not worked loose. (Torque is set at 100 N-m, 73.7 ft-lb.).
 - f) Check coolant additive concentration. Refer to the engine manufacturer's operations manual for assistance.
 - g) Steam clean the engine to free it of oil and dirt to prevent uneven engine cooling “hot spots”. The oil and dirt can also fall into the engine and fuel system when covers are removed during repair work.
 - h) Inspect the water pump weep hole for indication of a steady leak. If a steady flow of coolant or oil is observed, replace the water pump with a new or rebuilt unit. Refer to the engine manufacturer's operations manual for assistance.
-

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d) “A” Checks and Operations (10 Hours or Daily).

1) Engine.

a) Check Crankcase Oil Level.

CAUTION

DO NOT overfill. **DO NOT** operate the engine with oil level below the lower bar or above the upper bar on the dipstick.

- i. Check oil level daily with oil gauge dipstick.
- ii. Oil level should not be checked until 3 to 5 minutes after engine shutdown. Keep oil level as near the upper bar as possible.

b) Check Coolant Level

- i. Check coolant level daily or at each fuel fill interval. Investigate for cause of any coolant loss.

WARNING

Cooling system is pressurized. To avoid personal injury, **DO NOT** remove radiator cap when engine is hot.

c) Check for Leaks and Correct

At each daily start-up, check for coolant, fuel, and oil leaks. Coolant leaks may be more noticeable when components are cold. Observe pumps, hoses, fittings, gasket connections, etc., for signs of leakage. Correct as required.

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d) Check Fault Code Meter.

At each daily start-up, observe the fault screen on the display of the control panel. If the display shows "AIR FILTER CLOGGED", change the air filter. See Chapter 2-4 for other fault codes.

e) Check Exhaust System.

Visually inspect muffler and exhaust pipes for rust and signs of approaching failure. Listen for any gasket or joint leaks.

WARNING

A leaking and defective exhaust system could be a fire hazard.

2) Electrical System (12 VDC)

a) Check All Lights.

Check all indicating lights to be sure they operate when they should. If any light fails to operate, check the indicator and insure proper power is being given. If power is present and the light does not activate, replace the light fixture.

b) Check Engine Battery Voltage.

Observe the engine voltmeter each time the engine is started to be sure the alternator is functioning correctly and charging the batteries. If the batteries need to be replaced, be sure the replacements meet the specifications for Cold Cranking Amps (CCA) and Reserve Capacity.

c) Check the operation of all the engine indicators.

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3) Electrical (400 Hz System).

a) Check Output Cables and Connector.

Check the output cable and plug connection for damaged insulation and contacts each time the connector is detached from the aircraft.

b) Monitoring sensors.

Verify that the voltage, amps and frequency readings are displaying correctly (use up and down arrows) each time the unit is started.

e) “B” Check and Operations (250 Hours or 3 Months).

1) Engine.

a) Check and record oil pressure.

After each oil change, check and record oil pressure at operating speed after oil has warmed to approximately 140° F. Record oil pressure under identical conditions at each oil change interval. A comparison of pressure at idle speed with previous readings will give an indication of progressive wear of oil pump, bearings, shafts, etc. Investigate any abnormal change in pressure readings.

b) Check Radiator Core and Hoses.

- i. Inspect the radiator core for dirt and debris blocking the fins. Clean as necessary. Check for cracks, holes, or other damage.

c) Check Fuel Pump.

- i. Inspect the fuel injection pump mounting nuts for loose or damaged hardware.

2) Electrical (12 VDC system).

NOTE: The battery furnished with this generator set is MAINTENANCE FREE. Check battery terminals and clean if necessary.

3) Electrical (400 Hz System).

a) Check the operation of the E-F bypass system.

f) “C” Checks and Operations (500 Hours or 6 Months)

1) Engine.

a) Check Engine and Generator Mounts

CAUTION

An unstable or loosely mounted engine can create hazardous environment and may damage equipment.

- i. Engine mount bolts must be torqued to 100 N-m (73.7 ft-lb.).
- ii. Generator mount bolts must be torqued to 100 N-m (73.7 ft-lb.).
- b) Change oil and oil filters.
- c) Change all fuel filters.
- d) Check Coolant Additive Concentration.

The cooling system protective liquid (nitrite-, amine- and phosphate free) provides effective protection against corrosion, cavitation, and freezing. See engine manufacturer's operation manual for ordering and mixture details.

2) Electrical (12 VDC system).

- a) Wiring.
 - i) Inspect all cables and leads for worn or damaged insulation.
- b) Connections.
 - i) Inspect connectors for damaged or corroded condition.

3) Electrical (400 Hz System).

a) Protective Monitoring Circuits.

Check operation of all protective monitoring circuits to make certain they will function if a fault occurs in the output circuit. Procedures for testing these circuits are contained in the Adjustment/Test section of this manual.

b) Inspect Wiring and Connections.

Check all cables, leads, and wiring for broken, worn and damaged insulation. Check all connections for tightness.

c) Clean and inspect generally.

g) "D" Checks and Operations (1000 Hours or 1 Year)

1) Engine.

a) Check Fan Hub and Drive Pulley.

Inspect for loose bolts or worn features. Tighten bolts and replace parts if necessary. Refer to the engine manufacturer's operations and maintenance manual for assistance and the most update to date information.

b) Check Hose Clamps on Air Intake Side.

Be sure that all clamps are properly secured to prevent leaks and all hose are in good condition.

c) Check Belt Condition and Tensioner.

Refer to the engine manufacturer's operations and maintenance manual for assistance and the most update to date information.

d) Check and/or Adjust Valve Clearance.

Refer to the engine manufacturer's operations and maintenance manual for assistance and the most update to date information.

e) Check Water Pump.

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- f) Inspect the water pump weep hole for indication of a steady leak. If a steady flow of coolant or oil is observed, replace the water pump with a new or rebuilt unit. Refer to the engine manufacturer's operations manual for assistance.

- g) Drain and Inspect Fuel Tank

Annually drain the fuel tank and inspect it for dirt or debris. Clean the tank if necessary. (See Chapter 2-2, section 5.f)

h) "E" Checks and Operations (1500 Hours or 1.5 Years)

- 1) Engine.

- a) Steam Clean Engine.

There are several reasons why the engine exterior should be kept clean. Dirt on the outside will enter fuel and oil filter cases and rocker housings when covers are removed, unless dirt is removed first. A clean engine will run cooler and develop fewer hot-spots. Steam cleaning is one of the most satisfactory methods of cleaning and engine; however, there are some **CAUTIONS** to be observed.

WARNING

Exercise care to avoid injury and damage to eyes and skin

CAUTION

1. If a cleaning compound is used, select one that is free from acid and will not remove paint.
2. Protect (or remove) all electrical accessories, such as voltage regulator, alternator, and electrical wiring.
3. Seal all openings. **DO NOT** use a flammable solvent.
4. **DO NOT** use mineral spirits or solvents on a hot engine.
5. Remove or protect bottom panel of unit (belly pan) to protect insulation.

- b) Clean Fuel System.

See engine manufacturer's operation manual for instructions.

- c) Check Alternator and Cranking Motor.

The alternator and cranking motor on this engine require no periodic lubrication.

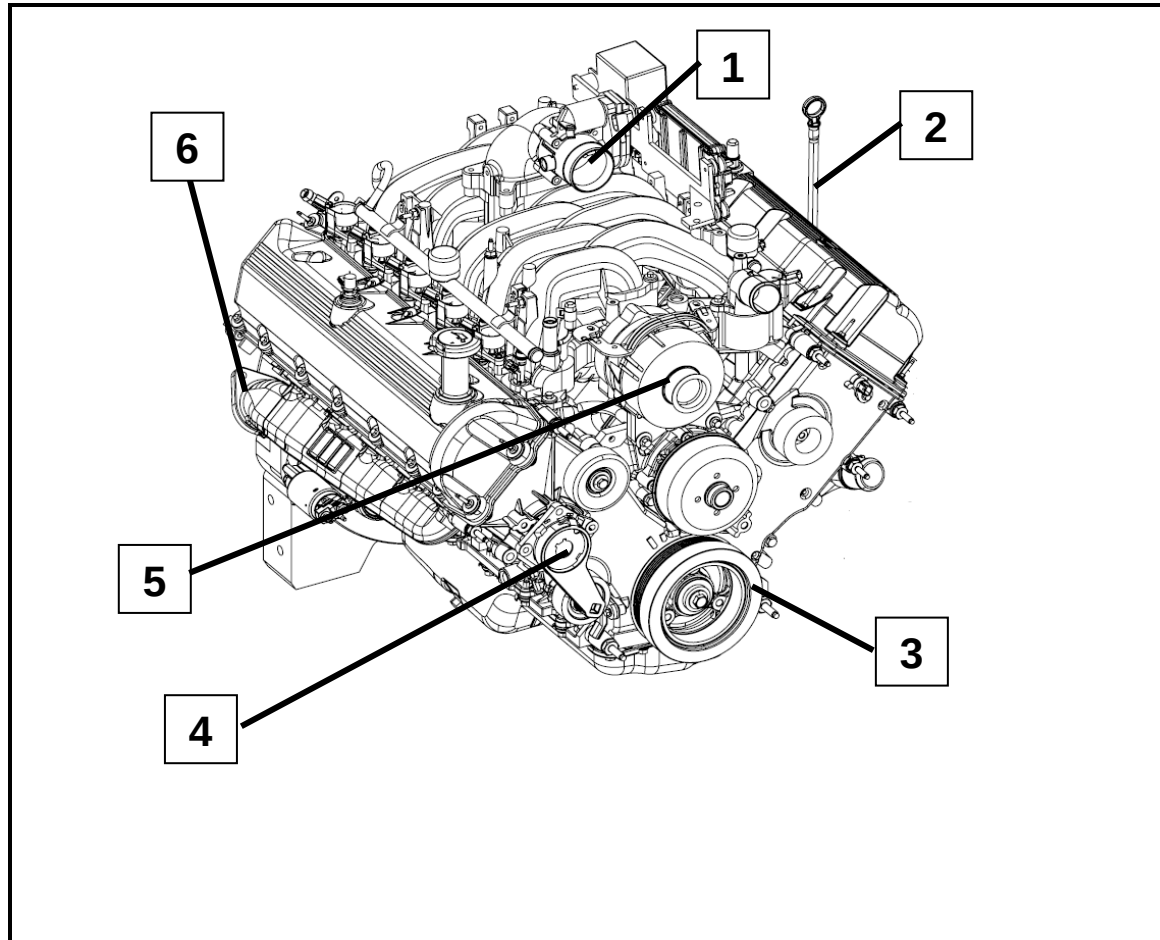
i) "F" Checks and Operations (2000 Hours or 2 Years).

- 1) Engine.

- a) Check Vibration Damper.

Check vibration damper for looseness, wobble, chunking and streaking. Also verify the hub bolts are tightened to the engine manufacturer's specifications.

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- | | |
|--------------------|---------------------------|
| 1. Air Intake | 4. Belt Tensioner |
| 2. Oil Dipstick | 5. Alternator |
| 3. Engine Flywheel | 6. Exhaust Outlet (right) |

Figure 2-1-3 Engine Accessories

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j) “G” Checks and Operations (Over 10,000 Hours).

1) Engine.

- a. Refer to Engine OEM Service Center for recommended testing and maintenance.

2) Engine/ Generator Assembly

Note: All Generator Overhaul items to be performed by a qualified generator/ motor facility

- a. Replace Generator Bearings
- b. Inspect Front and Rear Bearing Housings
- c. Inspect Generator Shaft for Wear
 - i. Replace Rotor Assembly if required.
- d. Replace engine and generator shock mounts.

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k) Seasonal Maintenance Checks Spring/Fall (Engine).

- 3) Check Fan Mounting.
 - a) Check fan to be sure it is securely mounted.
 - b) Check for fan wobble and/or broken/cracked blades.
 - c) Check fan hub and crankshaft pulley for secure mounting. (2) Check cooling system each spring and fall. Clean if necessary. (3) Check All Hoses.
- 4) In addition to daily checks of hoses for leaks, inspect hoses thoroughly each time the cooling system is cleaned and serviced.
 - a) Inspect for signs of deterioration and collapse. Inspect for cracks and cuts. Inspect for cutting and deformation caused by hose clamps. Replace hoses as required.
- 5) Check thermostat and seals each fall when cooling system is serviced.

l) Lamps and Fuses:

- 1) Check all lamps daily.
- 2) Check fuses as required.
- 3) The fuse chart lists all fuses with their location, size, and type.

Item Protected	Location	Schematic Identifier	Type	ITW PART NO.
24V Devices	Interface Board	F1	20A	AP-SI2083
Display Board	Interface Board	F2	2A	AP-SI2076
Control Board	Interface Board	F3	5A	AP-SI2075
FANS (not used)	Interface Board	F4	5A	AP-SI2075
Contactors	Interface Board	F5	5A	AP-SI2075
12V I/O	Interface Board	F6	10A	AP-SI2066
Engine Dongle (not used)	Interface Board	F7	5A	AP-SI2075
Engine Power	Interface Board	F8	20A	AP-SI2083
Energy Reservoir	Control Box	F10	C14M32	FU11728
Energy Reservoir	Control Box	F11	C14M32	FU11728
U (L1)	Inverter Box	F12	315A	AP-SI4929
V (L2)	Inverter Box	F13	315A	AP-SI4929
W (L3)	Inverter Box	F14	315A	AP-SI4929

Figure 2-1-4 Fuse Identification Chart

Section 2 Maintenance Procedures

1) General

A suggested maintenance schedule is provided in Section 1 of this Servicing Chapter. Each step of the schedule is also covered in general in Section 1. This Section covers maintenance in more detail, where necessary.

Item	Maintenance Required
Engine Oil	Check oil level daily or after every 10 hours of use. Change oil and the oil filter after the first 50 to 150 hours of use, then at 500 hours or 6 months intervals thereafter. Engine oil capacity is approximately 7.5 quarts (7.1 liters).
Coolant	Check coolant level daily. Service and maintain coolant system according to Section 2-2, paragraph 6. Engine coolant capacity is approximately 20 quarts (18.9 liters)
Coolant hoses and connections	Check coolant hoses and connections daily for leaks.
Air Cleaner	Change air cleaner filter as required when the fault code display on engine control panel shows the "Air" code.
Fan Belt	Check fan belt condition and tension every 1000 hours or 1 year of use.
Alternator	Alternator bearings are sealed and require no periodic lubrication.
Starter	Starter motor bearings are sealed and require no periodic lubrication.
Water Pump	The water pump is packed at assembly and requires no periodic lubrication.
Fan Hub	The fan hub is lubricated at assembly and requires no periodic lubrication.
AC Generator	Periodic cleaning – no lubrication or adjustment required
Generator Controls	No periodic maintenance is required. Adjustments are covered in Section 2-3.
Trailer	Annually grease the wheel bearings.

Figure 2-2-1: Lubrication and Maintenance Chart

WARNING

STOP all operations at once if a serious or dangerous fault is discovered.

2) Lubrication

a) General

Proper lubrication is one of the most important steps in good maintenance procedure. Proper lubrication means the use of correct lubricants and adherence to a proper time schedule. Lubrication points, frequency of lubrication, recommended lubricants and filters are indicated in Figures 2-2-1 and 2-2-2.

This section incorporates the engine maker's, engine lubrication recommendations from their Operation and Maintenance Manual.

b) Lubrication schedule

Time schedules indicated on the Maintenance Schedule, Figure 2-2-1, are approximate and based on average operating conditions. It may be necessary to lubricate more frequently under severe operating conditions such as: low engine temperatures, high oil temperatures, or intermittent operation. However, time intervals should not exceed those indicated in the chart without careful evaluation.

c) Oil specification

The engine lubricating oil that is recommended by the engine manufacturer is identified by an API (American Petroleum Institute) classification designation. The manufacturer does not recommend any specific brand of lubricating oil.

The use of quality lubricating oil, combined with appropriate lubricating oil drain and filter change intervals, are important factors in extending engine life.

Oil Type	Use Ford/Motorcraft "Formula E" SAE 5W-20 Engine Oil or equivalent that meets Ford Specification ESEM2C153-C (API Classification -SJ). If SJ oils are not available, SH oils are acceptable. Use only engine oil displaying the American Petroleum Institute Certification Mark on the front of the container, or API specification SH, or SJ. Refer to the manufacturer's operation manual.
Capacity	Approximately 7.5 quarts (7.1 liters)
Oil Filter Replacement Part Number	Part Number: FA11686
Lube Oil Viscosity Required as per Ambient Temperatures	<u>VISCOSITY</u> <u>AMBIENT TEMPERATURE CONDITIONS</u> SAE 5W-20 is recommended for all temperatures
Synthetic Oils	See the engine manufacturer's operations manual for usable synthetic oils and instructions.

Figure 2-2-2: Lubrication Specifications

d) Changing engine oil

Change the oil once after the first 50 - 150 hours of use and then every 500 hours of engine operation thereafter. The generator set is equipped with an hour meter to record actual engine operating time.

The ideal time to change engine oil is soon after a power delivery run, when the engine is at operating temperature. If lubricating oil is drained immediately after the unit has been run for some time, most of the sediment will be in suspension and will drain readily.

Change the oil filter element each time the oil is changed.

CAUTION

- High ash oils may produce harmful deposits on valves that can cause valve burning.
- Do not use solvents as flushing oils in running engines.
- Always use clean containers, funnels, etc.

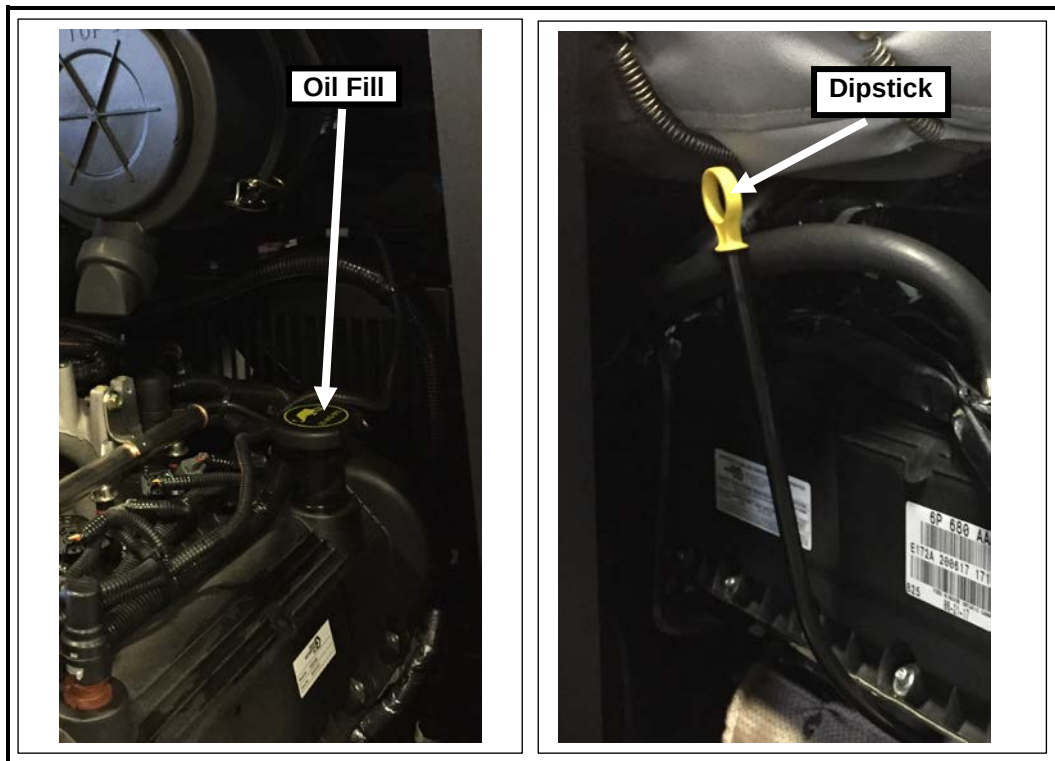
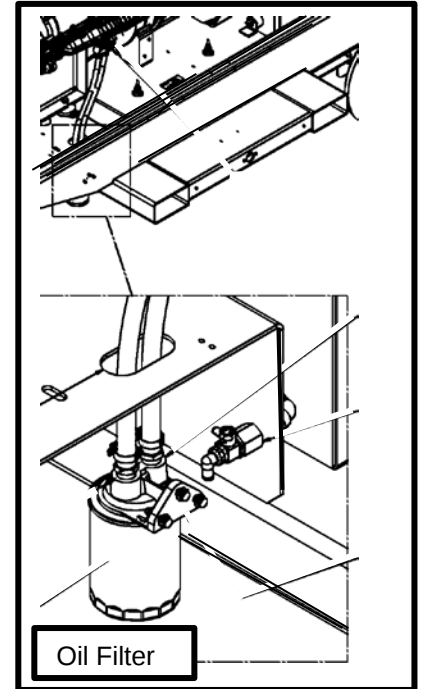


Figure 2-2-3: Oil Fill and Check Locations

Change oil as follows:

- 1) Provide an open container for catching the old oil below the oil drain plug. Container capacity must be greater than 30 quarts (28.4 liters).
- 2) The oil drain tube can be found by the muffler at the front of the unit.
- 3) Remove the drain cap (older models or turn the valve handle).
- 4) While oil is draining, change the oil filter element. See instructions below.
- 5) Provide a container for catching spilled oil from the filter.
- 6) Remove the oil filter by turning it counter-clockwise and inspecting it.
- 7) NOTE: The gasket can stick to the filter head. Make sure it is removed before installing a new filter.
- 8) Fill the new filter with clean lubricating oil before installation.
- 9) Apply a light coating of lubricating oil to the gasket-sealing surface and install the filter. DO NOT over tighten the filter.
- 10) Clean the drain cap and install when engine oil has completely drained or close the drain valve.
- 11) Refill the engine with new, clean oil that meets engine manufacturer's recommendations. Use the oil fill tube by the filter or the oil fill opening at the top of the engine.



CAUTION

Remember to close the drain cap and install the new oil before starting the engine.

- 12) Start engine and check oil pressure at once. Allow engine to run for 5 minutes, check for leaks then stop the engine.
- 13) After the engine has been stopped for about 5 minutes, recheck the oil level. Add oil, if required, to bring the level up to the high bar on the oil dipstick.

CAUTION

If bearing metal particles are found on the element or in the shell, the source should be determined before a failure.

WARNING

STOP operations at once, if a serious or possibly dangerous fault is discovered.

e) Engine Accessories Lubrication

1) Alternator

Most alternators contain sealed bearings and require no periodic lubrication, however, check to make certain there are no lubrication points on your particular alternator.

2) Starter

Most starting motors are lubricated at assembly and should be re-lubricated only when the starter is removed and disassembled, however, inspect the starter to make certain it has no lubrication points.

3) Water Pump

The water pump is packed at assembly and requires no periodic lubrication. Replace pump if signs of lubricant leakage are found.

4) Fan Pulley

The fan hub is also lubricated at assembly and requires no periodic lubrication. Replace hub if lubricant is leaking.

f) Trailer Lubrication

1) Wheel bearings

Inspect each wheel bearing annually to ensure that there is sufficient grease in the assembly.

2) Fifth Wheel Hub Bearings

Inspect the Fifth Wheel Hub bearing every three years to ensure that there is sufficient grease in the assembly.

Paragraph	Name	Specification	Notes
d)	Grease, General Purpose	MIL-G-3545	Excludes those of sodium or soda soap thickness.
e)	Grease, Wheel Bearing	ASTM D-4950	NLGI #2 Grade Lithium Complex EP Grease

3) Servicing the Air Cleaner

A definite time schedule for cleaning or changing the air cleaner cannot be determined because of varying operating conditions. Pull the yellow tab out (about 1 inch) then rotate the hub counter-clockwise about one inch and pull it off of the housing to access the air cleaner filter. It may be inspected either at prescribed service intervals or at any time deemed necessary.

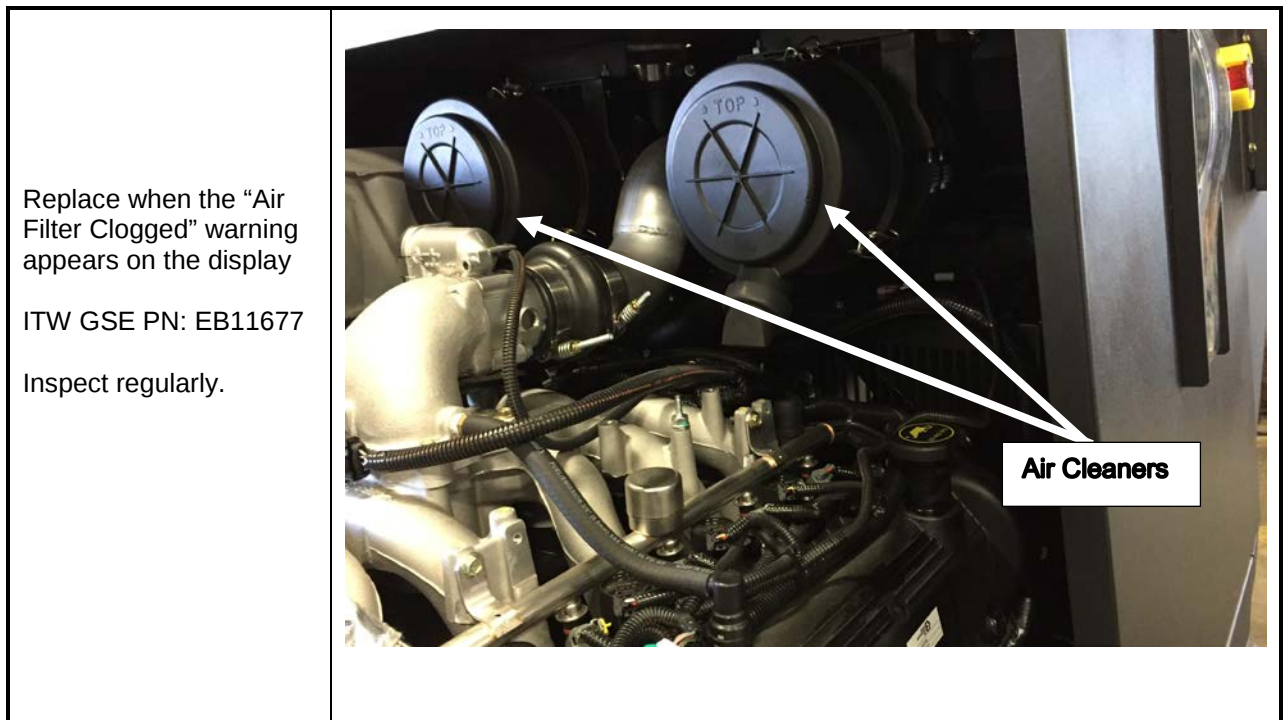


Figure 2-2-4: Air Cleaner Assemblies

a) Inspecting the Air Cleaner

- 1) Make periodic checks of air cleaner inlet screen for obstructions. If any obstructions are present, remove them.
- 2) Check outlet connection for proper seal.

b) Changing the Air Filter

- 1) Pull out the latch and rotate the back cover to the unlocked position (counterclockwise as viewed from the rear). The cover has padlock symbols to show the locked and unlocked positions.
- 2) Remove the end cover of housing.
- 3) Pull out air filter elements and replace.
- 4) Replace end cover on housing, making certain that the filter is centered in the housing.
- 5) Replace the end cover and rotate it to the locking position.
- 6) Push the yellow latch back in to lock the cover.

c) Disposal

Normal trash pick-up should be acceptable. **NEVER** burn the air filter for disposal.

4) Engine Fuel

a) How to select Fuel—Quality

The quality of fuel oil used in the gasoline engine is a major factor in engine performance and life. Fuel oil must be clean, completely distilled, stable and non-corrosive.

Use commercially available unleaded gasoline, 87 or 89 Octane.

CAUTION

Due to the precise tolerances of fuel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the injection pump and the injection nozzles.

CAUTION

System must be operated with gasoline fuel meeting 87 A.K.I. specifications.

5) Engine Fuel System

The fuel system consists of five primary components: fuel tank, primary fuel filter, fuel lift pump, and the fuel return line. The following are maintenance procedures for each of these items.

a) Fuel Tank

Be sure that no foreign objects are permitted in the fuel tank.

1) To change the lubricity filter:

b) Primary Fuel Filter

A primary fuel filter is mounted above the engine starter in the engine compartment. The filter's function is to remove foreign material from the fuel before it enters the fuel lift pump.

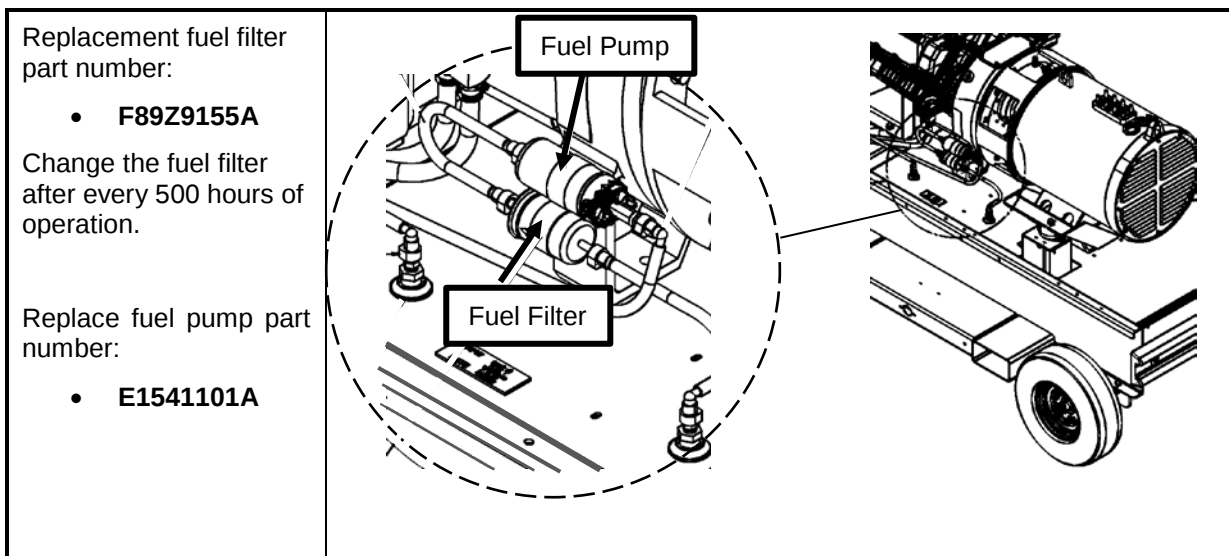


Figure 2-2-5: Primary Fuel Filter

1) To change the fuel filter:

- a) Shut off fuel valve.
- b) Place a pan underneath the fuel filter to catch spilled fuel.
- c) Undo fuel filter with commercial tool and spin off.
- d) Catch any fuel.
- e) Clean any dirt from the filter carrier rim
- f) Apply a light film of oil or gasoline on the rubber seal on the new filter.

CAUTION

When installing new element, do not over tighten it; mechanical tools may distort or crack filter head.

CAUTION

Make sure that all rags, or absorbent sheets, are clear of moving engine parts and cannot be drawn in to the radiator fan.

- g) Fill new filter with gasoline. Screw in the new fuel filter “snug”. Check that the cartridge is seated correctly against the gasket and tighten with a final half turn.
- h) Open fuel valve.

c) Fuel Pump

The fuel pump supplies high pressure to the fuel system so the gasoline can circulate freely. This engine is equipped with a common rail fuel system that is under very high pressure. **DO NOT** attempt to crack fuel lines.

WARNING

DO NOT attempt to crack fuel lines. This engine is equipped with a common rail fuel system that is under very high pressure. Failure to follow this guideline could result in injury or death.

d) Fuel Return

The fuel return is a fuel line (tube) that takes unused fuel from the engine, and delivers it to the fuel tank. No maintenance is required.

e) Fuel Level Indicators

There are two fuel level indicators in the unit; a mechanical dial indicator on the back of the unit and an electronic sensor in the fuel tank that is used to display the actual fuel level on the operator's screen.

f) Draining the Fuel Tank

- 1) The fuel tank should be drained and cleaned out annually, when the various fuel filters start to become excessively fouled and before storing the unit for long periods of time.
- 2) Before draining the fuel tank, we recommend pumping at least 90% of the fuel out of the tank (use the operator display to determine the amount of fuel remaining). The fuel tank has a 1/2" NPT fitting with thread sealant (Use a 11/16" wrench or socket to remove the fitting.) that is accessible under the trailer, once it is lifted.



- 3) Once the tank is fully drained, verify that there is no debris in the bottom of the tank on either side. If any dirt, material or build up exists inside the tank, flush with gasoline to remove the foreign material.
- 4) Use the following procedure to re-install the fittings:
 - a) The proper method of assembling tapered threaded connectors is to assemble them finger tight, then wrench tighten to the specified number of turns from finger tight. The following assembly procedure is recommended to minimize the risk of leakage and/or damage to components.
 - i. Inspect components to ensure that male and female port threads and sealing surfaces are free of burrs, nicks and scratches, or any foreign material.
 - ii. Apply sealant/lubricant to male pipe threads if not pre-applied.
 - b) With any sealant, the first one to two threads should be left uncovered to avoid system contamination. If PTFE tape is used it should be wrapped 1-1/2 to 2 turns in clockwise direction when viewed from the pipe thread end. (Caution: More than two turns of tape may cause distortion or cracking of the port.)
 - c) Screw the connector into the port to the finger tight position.
 - d) Wrench tighten the connector to 1.5 - 3 turns past finger tight. Never back off (loosen) pipe threaded connectors to achieve alignment.
 - e) If leakage persists after following the above steps, check for damaged threads and total number of threads engaged.
 - f) If threads on the fitting are badly nicked or galled, replace the fitting. If port threads are damaged, re-tap, if possible, or replace the component. If the port is cracked, replace the component.
 - g) Normally, the total number of tapered threads engaged should be between 3-1/2 and 6. Any number outside of this range may indicate either under or over tightening of the joint or out of tolerance threads. If the joint is under tightened, tighten it further but no more than one full turn. If it is over tightened, check both threads, and replace the part which has out-of-tolerance threads.

6) Engine Cooling System

a) General

Cooling system service requires more than maintaining the proper coolant level in the radiator and protecting the system against freezing. Water should be clean and free of any corrosive chemicals such as chloride, sulfate, and acids. It should be kept slightly alkaline with a pH value in the range of 8.0 to 9.5. Any water, which is suitable for drinking, can be used in the engine when properly treated as described in engine maker's operation manual. The engine maker's representative should be consulted regarding the selection of satisfactory brand, permanent-type antifreeze for use in the cooling system.

b) Radiator Cap

1) General

A pressure relief valve is built into the radiator cap. It is designed to open at a pressure of approximately 15 psi (103.4 Kpa).

WARNING

When removing cap from a very hot radiator, **DO NOT** turn cap past safety stop until the pressure or steam has escaped.

2) Removal

To remove, turn the cap to the left (counterclockwise) to the safety stop. When all pressure is released, press down on the cap and continue to turn until the cap is free to be removed.

CAUTION

Allow engine to cool before adding coolant.

CAUTION

Do not attempt to repair the valve in a radiator cap in case of failure. Replace with a new cap.

3) Installation

When installing the cap, be sure it is turned clockwise as far as it will go so that the pressure retaining valve will be functional.

c) Coolant

The preparation and maintenance of the coolant solution is important to engine life and is completely covered in the engine manufacturer's operation manual. For information regarding coolant specifications, testing equipment, antifreeze, etc., refer to engine maker's operation manual that accompanies the equipment's manual or consult the local engine maker's representative.

CAUTION

Never use soluble oil in the cooling system.

1) General.

A permanent type antifreeze is recommended for use in the cooling system.

CAUTION

1. **DO NOT** use methanol or alcohol as antifreeze.

2. **DO NOT** mix brands or type of antifreeze. A solution containing two or more types of antifreeze is impossible to test accurately.

2) Selecting antifreeze.

- a) Select a permanent type antifreeze known to be satisfactory for use with chromate corrosion resistor.
- b) When it is not known if the antifreeze is satisfactory for use with chromate resistor, check with local engine manufacturer's representative for a list of compatible antifreezes.

(3) Checking antifreeze solution.

Check the solution with a reliable tester when in doubt about antifreeze protection.

d) Draining the Cooling System

To completely empty the cooling system requires draining the radiator assembly. Follow these steps to drain the cooling system:

- 1) Remove radiator cap.
- 2) Place a drain pan with at least a 40 quarts (28.4 liters) capacity under radiator to catch coolant.
- 3) Remove front grill to locate and remove 2 pc cover in bottom left of radiator panel to access hose & valve. Place the drain hose into the drain pan.
- 4) Open the radiator drain valve.
- 5) Allow the system to drain completely.

NOTE: Be sure the drain valve doesn't clog during draining.

- 6) When the system is completely drained, close the drain valve and coil the hose back up.

- 7) Replace the front canopy cover.



e) Flushing the Cooling System

Flushing the cooling system should be a yearly maintenance procedure. By flushing the system, clean water is forced through the engine block to remove expired coolant and other contaminants.

f) Cleaning the Radiator Core

Blow out accumulated dirt from the radiator core air passages, using water. Bent or clogged radiator fins often cause engine overheating. When straightening bent fins, be careful not to damage the tubes or to break the bond between fins and tubes.

NOTE: Direct the water in a reverse direction to normal air flow. Normal flow on this installation is from the engine compartment out ward.

g) Filling the Cooling System

The preparation and monitoring of coolant in liquid-cooled engines is especially important because corrosion, cavitation, and freezing can lead to engine damage. For coolant system protection details see the engine manufacturer's operations manual.

1) Install coolant

- a) Remove radiator cap. Be sure the radiator drain valve is closed (Front panel and covers must be removed to access this location).
- b) Pour coolant into radiator very slowly until it reaches the bottom of fill neck. Allow time for trapped air to escape from the system then continue filling until the coolant level remains at the bottom of the fill neck.
- c) Start the engine and bring up to rated speed and allow the thermostat to open. Add coolant as trapped air escapes from the system and the coolant level falls.
- d) Continue to check coolant level until all trapped air escapes. Add coolant if needed to fill to the bottom of fill neck. Install radiator cap.

2) Inspection/Check

- a) Check system for evidence of leaks.
- b) Inspect all hoses. Install new hoses as necessary. Tighten hose clamps as required.
- c) Check the condition of fan and water pump belts. Replace belts if necessary.

NOTE: It is good practice to attach a card, indicating the cooling system contents and date serviced, to the radiator filler neck.

h) Thermostat

The thermostat should be checked each fall, or as required. Refer to engine manufacturer's operations manual for recommended instructions.

7) Engine Drive Belt

a) General

The engine cooling fan, alternator, and water pumps are driven by one serpentine belt, which must be replaced if worn or damaged.

b) Preparation for Belt Check and Adjustment

All driven assemblies must be securely mounted in operating position before checking belt tension.

c) Checking Belt Tension

WARNING

DO NOT Check belt tension with engine running

Check belt tension every 1000 hours, or once year, whichever comes first. A belt that is too tight is destructive to bearings of the driven part. A loose belt will slip and cause inefficient operation of the part being driven as well as wear to the belt.

CAUTION

Inspect and replace the belt if it has unacceptable cracks, is frayed, or has pieces of material missing.

Belt tension may be checked by manually depressing the belt with an index finger to determine the amount of belt deflection obtained. When a force is applied at a point halfway between pulleys on the longest span of a belt, there should be no more than 1/2 inch of deflection attained. Refer to the engine manufacturer's operation manual for checking belt tension and changing worn belts.

8) Generator Maintenance

The 400 Hz generator requires no maintenance or service other than periodic cleaning. The unit is brushless and has bearings that are permanently lubricated and sealed.

a) Cleaning

The generator may be cleaned by careful use of compressed air and/or a good, SAFE commercial cleaner. Steam cleaning of the generator is not recommended because the use of steam and harsh chemical compounds may result in damage to insulation and other generator components.

WARNING

Never use solvents as this is a fire hazard

b) Adjustment

The generator itself requires no adjustment. Adjustment procedures for generator controls are covered in Section 2-3.

9) Replacing the Control Board Battery

Before removing the Control Board and to avoid any static discharge to the Control Board during the replacement of the battery, please take ESD (Electro Static Discharge) precautions.



* Important Note!

Before you remove the battery from the holder, make sure that the replacement battery is within reach, as the **Control Board must not be without battery power for more than 30 seconds.**

Otherwise, all software and the setup data will be erased. *

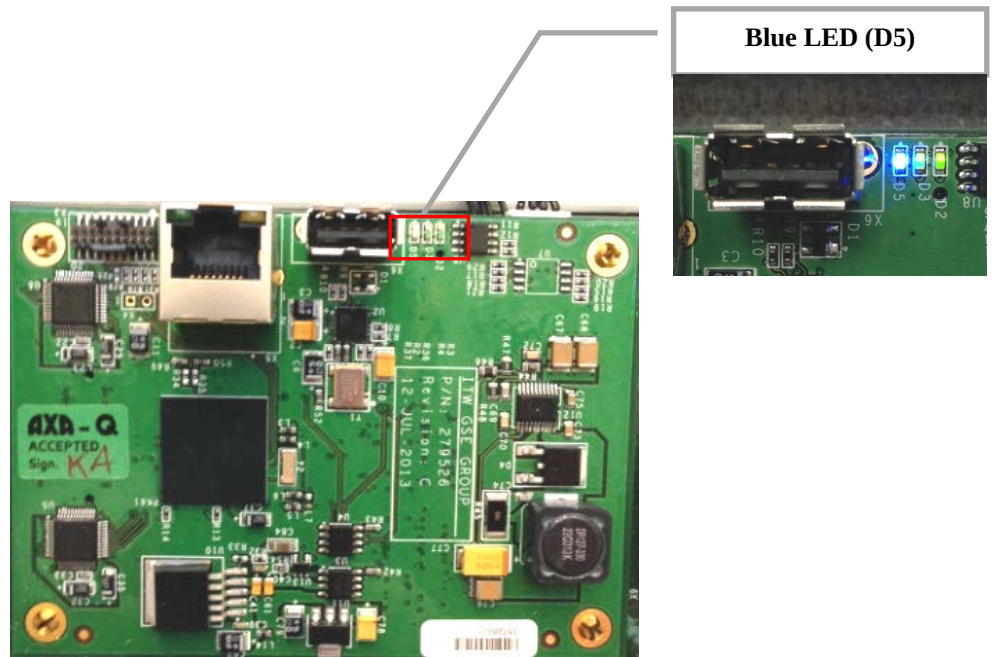


Fig. 8.2.3 Control Board (front view)

To replace the battery, **Switch OFF** the unit by means of Q1. Remove the Control Board from its 4 posts marked with a  in Figure 8.2.3. Place the PCB on an insulated surface, with the back side face up.

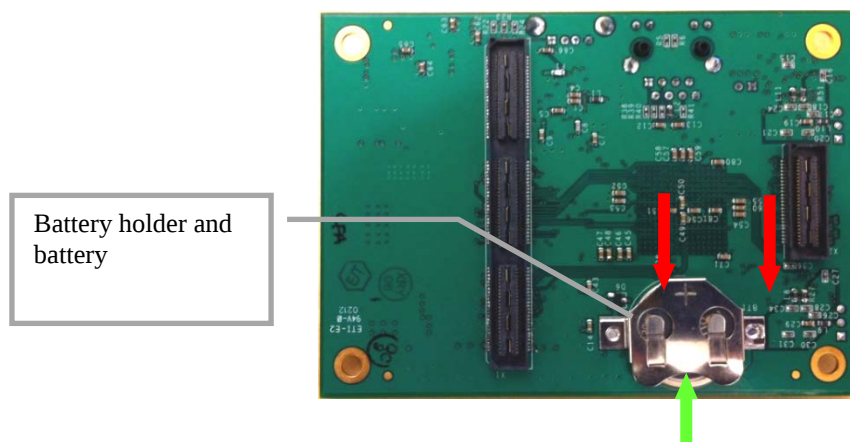


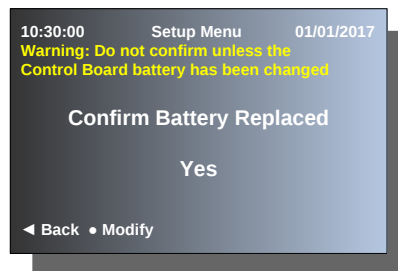
Fig. 8.2.4 Control Board (rear view)

Remove the battery from the holder using a small **insulated** screwdriver to push out the battery, direction indicated by the two red arrows on Figure 8.2.4 and insert the new battery in the direction of the single green arrow on Figure 8.2.4.

Mount the control board on the interface board again by gently pressing the PCB to its rest on the Interface Board. Make sure that all 4 corners are fully pressed towards the Interface Board.

Switch on the unit via the input switch Q1 and close the door. The unit now passes through the initialization test and goes into standby mode.

Enter the setup menu and select menu item “Battery Replaced” to confirm new battery installation.



* Important Note!

If the blue LED on the Control Board (location can be found on the Fig. 8.2.3) flashes with approximate 2 flashes per second and the display reports “Communication Error”, the firmware on the Control Board has been erased. The Control Board must be sent to ITW GSE to be reloaded.



To ensure high reliability of the back-up battery, the only type of battery that can be used on the Control Board is the Panasonic BR-2032

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Section 3 Adjustment/Test

1) General

These adjustments and test procedures are applicable to testing and adjusting the generator set after major repair, major parts replacements, or overhaul.

IMPORTANT

To perform most of the following tests, a load bank with an EF interlock circuit is required. If an EF interlock is not available on a load bank, see special procedure in the EF Bypass section (Chapter 1-3 paragraph 4.4) for disabling the EF circuit.

2) Testing the 60 Hz Generator Set

a) Pre-operational Test Procedures

- 1) Check engine oil level. Oil should be at high bar on the dipstick.
- 2) Check radiator coolant level, if not full then fill with appropriate climate mix of ethylene glycol and water. Total capacity is 20 quarts.
- 3) Check tension of drive belt.
- 4) Verify that there is at least a 1/4 tank of diesel fuel.
- 5) Make a general inspection of all wiring, and terminals. Inspect the equipment to be certain no damage will result from starting the engine.
- 6) Turn on battery disconnect switch.
- 7) Place unit in 'Engine Only' Diagnostic Mode. (See Menu Operating Instructions, Chapter 1-3 Paragraph 4.19) Return to home screen to view status. (Screen will display Generator Diagnostics.)

b) Engine Test Procedures

- 1) Press engine button to start engine. Engine should start and ramp up to 2000 RPM (± 5).
- 2) Check for coolant, fuel and oil leaks. Listen for air leaks and other engine issues.
- 3) Verify display voltage is over 27 VDC. (Battery is charging.)
 - a. Voltage _____ VDC
- 4) Press Output button (any Output) to make engine go to rated speed, 2000 RPM (± 5). (Output will not function.)
- 5) Check for coolant, fuel and oil leaks. Listen for air leaks and other engine issues.
- 6) Press engine button to shut down unit.

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c) 400Hz Initial Testing and Setup:

- 1) Connect Output cable(s) to the appropriate load bank(s) with interlock enabled (as required)
- 2) Press engine button to start engine. Engine should go straight to rated speed.
- 3) Verify Output frequency on power analyzer. (400Hz, ± 2 Hz)
Measured Frequency: _____ Hz
- 4) Verify Output voltage, line to N.
- 5) MEASURED Voltage A _____ VAC B _____ VAC C _____ VAC
- 6) Check PWM Duty Cycle reads 20%. ($\pm 5\%$)
Duty Cycle _____ %

d) Output 1 Verification:

- 1) Make sure that the EF switch is in the ON position on the load bank and turn on Output 1. Contactor must close and indicator on the display panel illuminate.
- 2) Verify 'ABC' phase rotation at the load bank.
- 3) Turn the EF switch OFF on the load bank and verify that contactor opens and fault is displayed. Red lamp on display should flash.
- 4) Reset Output 1 by pressing Output 1 button again. Display should resume normal operation with no faults.
- 5) If Output 2 is not available, skip to g) below.

e) Output 2 Verification:

- 1) Make sure that the EF switch is in the ON position on the load bank and turn on Output 2. Contactor must close and indicator on the display illuminate.
- 2) Verify 'ABC' phase rotation at the load bank.
- 3) Turn the EF switch OFF on the load bank and verify that contactor opens and fault is displayed. Red lamp on display should flash.
- 4) Reset Output 2 by pressing Output 2 button again. Display should resume normal operation with no faults.

f) Sensor Testing:

- 1) At rated speed, restrict the air cleaner intake to 5% of the normal inlet area. Blocked Filter warning shall appear with amber light flashing on display. Remove Restriction. Fault will reset automatically. (The left arrow will need to be pressed to remove it from the screen.)
- 2) Disconnect "Low Coolant" switch connector located on the top of the radiator and start your stopwatch. Verify Low Coolant Warning (amber) occurs in less than 1 minute.
- 3) Reconnect the low coolant switch and put on top canopy. Clear Low coolant warning by pressing the engine button.

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g) Re-checking the entire unit after testing:

- 1) Start the engine. With the engine running at normal rated speed, check the entire unit for vibration and for any parts that may have become loosened during the above checks. Tighten any loose hardware as required.
- 2) Check engine oil pressure at rated speed (2000 RPM). The oil pressure gauge should indicate at least 44.9 psi (3.1 bar) when engine is hot. Also at rated speed, check the engine coolant temperature. The temperature gage should indicate in the range of 180°F to 190°F (82°C to 88°C), depending upon operating conditions.

WARNING

If a metal sounding rod is used to detect bearing noises, exercise extreme care to avoid injury from moving components.

- 3) Check generator bearings using a stethoscope or metal sounding rod to listen for unusual noises. If using a metal rod, place one end on the generator housing and hold the other end near the ear. Hold the rod with three fingers and use the index finger and thumb to form a sounding chamber between the rod and the ear. Do NOT allow the rod to touch the ear. Listen for grinding or pounding sounds, which would indicate a defective bearing. An engine noise may be telegraphed to the generator and misinterpreted as a generator noise. Contact the equipment manufacturer if in doubt of bearing serviceability.

3) Generator Set Adjustment

a) Generator Adjustment

The generator is a brushless type requiring no adjustments of any kind.

For the following adjustment, the generator set must be running at rated speed (2000 RPM), under no-load conditions. Adjust the regulator as follows:

1) Output Voltage Adjustment

a) Adjust Voltage Control

The output voltage, at which the generator is regulated, is adjustable using the "Output Voltage" screen in the Setup Menu. (See Chapter 1-3, Paragraph 4.1)

Observe the output voltage using a true RMS multimeter. Set the output voltage at 115 VAC line-to-neutral (200 VAC line-to-line).

b) Adjust Line-Drop Compensation

Adjustment of line-drop compensation is made using the "Output 1 (or 2) Compensation" screens in the Setup Menu. (See Chapter 1-3 Paragraph 4.2 & 4.3) To adjust the line-drop compensation, proceed as follows:

- i. Connect the generator set output cables to a load (typically a load bank). Load the generator set with the largest available three-phase load of rated power factor not exceeding the maximum rating of the generator set. (i.e. 72 kW for a 90 kVA at 0.8 pf generator)
- ii. Measure the output voltage at the load end of the cables as you increase the load from zero to the maximum full load rating of the unit. If the voltage at the end of the cable rises or drops more than 1%, decrease or increase the line-drop compensation until the regulation is flat (115 VAC line-to-neutral).

b) Basic Engine Adjustments

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Adjustment procedures applicable to the diesel engine are included in the engine manufacturer's operation manual, which is referenced in Chapter 5. Refer to the engine operation manual for detailed information on the following engine adjustments.

NOTE: A stroboscope is required for engine idle speed checks.

Engine idle speed (for non-EU engines) is programmed at the factory. If adjustment is required, contact the local engine distributor. The recommended idle speed is 1000 RPM, +/- 25 RPM.

The speed limiting adjustment is also set and sealed at the Cummins factory. Speed should be limited to approximately 2350 RPM. If adjustment is required, contact your local engine distributor.

c) Engine Accessories Adjustment

Alternator and fan belt adjustment: Refer to Section 2-1 and engine manufacturer manual.

4) Generator and Exciter Test

The generator fields and exciter stator may be tested with a Kelvin bridge. This is a double-bridge type instrument required for the very low resistances encountered in this test. It is understood that zero (0) resistance indicates a **SHORTCIRCUITED** condition. An infinite resistance reading indicates an **OPEN CIRCUITED** condition.

- Disconnect generator stator leads at the back of the unit.
- Disconnect the two black exciter field leads (Connector J6/P6) that is located under the back right corner of the unit.
- Check resistance and compare to values.

Test Connection	Resistance (Ohms)
Generator Stator Phase A to N (G1)*	0.0026
Generator Stator Phase B to N (G1)*	0.0026
Generator Stator Phase C to N (G1)*	0.0026
Exciter Stator Field (L2)	29
A - B, B - C, C - A Exciter Armature (G2)	0.041
Generator Revolving Field (L1)	2.1
*NOTE: The two leads of a phase must be connected when the test is made. Take readings when the unit is cold and in an ambient temperature of 70 °F (21°C.).	

Figure 2-3-1: Generator and Exciter Test Readings

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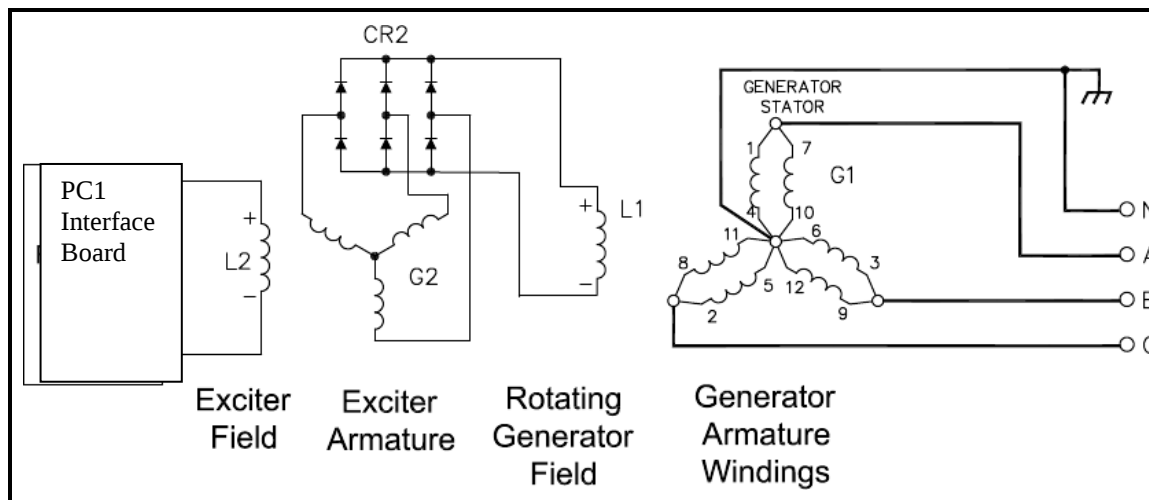


Figure 2-3-2: Generator Connections

5) Diode Test

Test values for diodes are not given here because they could be misleading. Test values may vary even between diodes of the same part number, rating, and manufacturer. General instructions for testing diodes are as follows:

- a) Disconnect exciter windings from diode lead(s).

NOTE: Use a good quality ohmmeter or multimeter. Verify that the instrument is set on its lowest scale. Make certain the battery is in good condition and for analog meters that the pointer is adjusted to zero when the test leads are shorted together.

- b) Hold one ohmmeter lead point on the threaded end of the diode. Hold the other lead point on the wire terminal end. Observe and note the indicated resistance. Now reverse the lead connection on the diode. Observe and note the ohmmeter indicated resistance. If an infinite or very high resistance was indicated with the leads connected one way and a low, readable resistance was indicated with the leads connected the opposite way, the diode may be considered good.

6) Testing the Transformer Rectifier Unit (TRU) (for units with the DC option)

The 28.5 VDC TRU is an optional add-on to the GPU. The following test procedures may be used for testing the TRU following repair, or for just checking performance.

a) Preparation for Testing

- 1) Connect the TRU to a DC load bank.
- 2) Start the GPU per the operating procedures in Chapter 1, Section 3.

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b) Operational Test Procedure

1) Power Delivery

- a) Press **“28 VDC”** pushbutton to close the DC output contactor. The green **“DC OUTPUT”** LED will glow indicating that DC power is being delivered to the load bank.
- b) Using a calibrated multimeter, measure the DC voltage at the load bank with no load. The voltage should be 28.5 VDC.
- c) Place a 600 Amp load on the GPU. The measured DC voltage at the load bank should still be 28.5 VDC. Observe the DC voltage and amps on the output screen of the display for accuracy.
- d) If the full load voltage reading is more than 0.5 VDC from the desired output voltage (typically 28.5 VDC) then adjust the line drop compensation using the **“28V Compensation”** screen in the Setup menu. (See Chapter 1-3 Paragraph 4.18)

2) Discontinue Power Delivery

Press **“28 VDC”** pushbutton to open the DC output contactor. The green LED will turn off, indicating that DC power has been removed from the load bank.

3) Current Limiting / Soft Start Control

The Current Limit default value is set using the **“28V Current Limit”** screen in the Setup Menu (See Chapter 1-3 Paragraph 4.19). To change the value for the current aircraft (and this test), use the RIGHT and LEFT navigation buttons when the diesel is running, the 28VDC ARU is NOT on and the “default” operator screen is displayed. The current limit settings are from 200 amps to 1600 amps for the 400 Amp version of the unit and from 400 amps to 2400 amps for the 600 Amp version.

- a) Start the diesel engine.
- b) Once the engine has stabilized at its running speed, use the Right or Left navigation buttons to set the current limit to 1400 amps.
- c) Press the **“28VDC”** pushbutton to close the contactor to apply the load to the load bank.
- d) Press the **“Engine Test”** switch on the load bank. Verify that the current never exceeds 1400 amps.
- e) Press **“28 VDC”** pushbutton to open the DC output contactor. The green LED will turn off, indicating that DC power has been removed from the load bank.

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Section 4 Troubleshooting Procedures

1) General

The Troubleshooting Chart located in this section covers the common faults and malfunctions that can be found during operation or maintenance of this equipment. The chart may not list all faults and malfunctions that can occur. If a fault or malfunction is not listed in the chart, start looking for the cause at the source of power in the affected circuit. Refer to the schematic and connection diagram in Chapter 5. Test the circuit systematically until the source of the malfunction is isolated.

The Troubleshooting Chart is arranged by Error code, Error text, Description and then four columns of possible corrective actions. Always try the 1st corrective action before proceeding to the next corrective action.

WARNING

High voltage is present even when engine is NOT running. Exercise extreme care to avoid contact with high voltage leads and components.
High voltage can kill!

CAUTION

Maintenance personnel must be very careful when performing terminal-to-terminal checks to be certain the proper terminals are being used, especially when using jumper leads. Damage to electrical components may result from the application of improper voltage and current.

2) Equipment for Troubleshooting

A good quality multimeter is the only instrument required for troubleshooting. At least two jumper leads with alligator, or similar clips, will be required. The engine electrical system can be used as a 12 VDC power source.

3) Parts Replacement

To lessen down time and get a faulty machine back on line as quickly as possible, the black box concept of parts replacement is reflected in the Troubleshooting Chart. For example, if a component on a control box board is defective, the quickest way to remedy the situation is to replace the complete board and send the old to stock.

4) Normal Operational Parameters

The system specifications, which are listed in Chapter 1-1, provide useful information when troubleshooting abnormal operation. The Protective System Specifications and Normal Operating Characteristics provide information about how the generator set should be operated.

5) Check Connections and Leads

ALWAYS check connections and leads to a component suspected of being faulty. Generally, it is assumed that connections and wiring have been checked first and that power has not been lost as a result of defective wiring or connections.

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6) Engine Troubleshooting

Remember that the ability of the engine to start and run properly depends upon the following:

- An adequate supply of 12 VDC power reaching a good starter and control board
- An adequate supply of air, compressed to a sufficiently high pressure
- The injection of the correct amount of clean fuel at the proper time

7) GPU Control Monitoring

The GPU control system performs complete diagnostic testing and continuous monitoring of all critical circuits and operating electrical values. If the control system senses a problem with one of the circuits or if any of the electrical values exceeds its safe operating limit, the control system will shut the GPU down, or may allow the GPU to continue operation depending on the severity of the condition.

a) Operating Modes

1) Self-Test Mode

When power is first applied to the control circuit, the GPU performs complete self-diagnostics of the internal circuitry. If a fault is detected during the self-test, the Alert/Failure LED will be lit and the first (if there are more than one) failure will be displayed on the LED display.

2) Engine Run Mode

When the **ENGINE** pushbutton is pressed, the blue power indicator LED and the Operating Beacon will start flashing. The starter will engage when the engine is ready. After the engine reaches its idle speed (1000 rpm) the GPU is ready to supply power to the aircraft. (Note that the engine will make three 15 second attempts to start the engine. If the engine doesn't successfully start after the third attempt, the fault LED will be lit and an Engine Start Failure message will be displayed.)

3) Engine Shutdown Mode

Pressing the **ENGINE** pushbutton starts the 30 second delayed shutdown period. If any output contactors are closed, they will open before starting the countdown. The shutdown period is required to cool the engine's turbocharger.

4) Automatic Engine Shutdown

Automatic Shutdown mode will turn off the engine after 10 minutes when all contactors are open or if they are closed and the total generator current is less than 5 amps. (This timer is internal and not visible.) After 10 minutes, it puts the engine in shutdown mode. (All contactors are opened and the generator is no longer regulating voltage.) A visible 30 second timer is displayed and the engine will turn off when the timer expires. The Automatic Engine Shutdown mode is changed in the Setup menu and the choices are enabled or disabled.

5) Engine Stop Mode

After the 30 seconds delayed shutdown period, the engine stops running.

6) System Off Mode

The power is removed from the GPU's entire control system when the battery disconnect is opened.

7) Low Power Mode

After 10 minutes of inactivity (engine not running and no buttons pressed) the display is turned off and power is removed from most of the GPU's control system. The unit can be awakened by pressing the engine start button. The unit can stay in this mode for up to a month and still have adequate power to restart the engine.

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b) Faults

Faults result when any of the fault limits are exceeded, an internal problem, or under certain conditions where an injury to personnel or damage to an aircraft or the GPU could occur. Faults are also stored in the Black Box memory as event records. The fault limits and conditions are preset at the factory.

1) Warning

Warning faults have no effect on the operation of the GPU. An example is an intake air restriction fault due to a dirty filter. Although the GPU continues to operate, the fault LED is lit and the fault text appears on the display. Pressing the **Engine** pushbutton or shutting down the GPU resets the fault.

2) Run Mode

Run mode faults remove power from the aircraft but do not change the operating speed of the engine. An example is an over voltage fault. Although the contactors open and remove power from the aircraft, the engine remains at rated speed, the fault LED is lit and the fault text appears on the display. Pressing the **Engine** pushbutton or shutting down the GPU resets the fault.

3) Stop Mode

Stop mode faults remove power from the aircraft and shut the engine down. An example is a low oil pressure fault. The contactors open and remove power from the aircraft, the engine shuts down, the Alert/Failure LED is lit and the fault text appears display. Pressing the **Engine** pushbutton or shutting down the GPU resets the fault.

8) EDI Engine Fault Codes & Trouble Shooting

The best source of information to aid in trouble shooting EDI engine issues is at www.edi-dist.com. This website gives you access to engine information, troubleshooting assistance by fault code, parts information and service bulletin information.

9) Fuses

Refer to section 2-3-I for a list of fuses.

If the displayed text does not provide sufficient information to solve the problem, the tables on the next pages suggest corrective actions to be carried out for each error code.

Additional error information can be derived from some error codes:

Phase codes:

- xx01 = Phase A
- xx02 = Phase B
- xx03 = Phase A & B
- xx04 = Phase C
- xx05 = Phase A & C
- xx06 = Phase B & C
- xx07 = Phase A, B & C

Example: Error Code 3501 refers to “Output Voltage Too Low” at phase A.

Energy Reservoir Board Errors:

Fault value 130x indicates faults on the first supercapacitor board to fail. The x value specifies a number between 1 and 7 which corresponds to a faulty board. A blue LED is typically lit on a failed board.

Example: Error Code 1305 indicates that the 5th board from the left has an error.

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10) Troubleshooting Chart

Error Code	Error Text in display	Description	1st Corrective Action	2nd Corrective Action	3rd Corrective Action	4th Corrective Action
For faults in this section: Disconnect from Aircraft (if connected). Do not stop engine (if running). Do not let engine start (if not running).						
100	LOGGING UNSUCCESSFUL	Communication Failure	Press Engine button to Reset			
200	CONTROL BOARD FAILURE	Watchdog Timeout	Press Engine Button to reset	Replace Control Board A1		
201	CONTROL BOARD FAILURE	ID chip is missing or unreadable	Inspect ID chip connection. for damage.	Contact ITWGSE		
202	WRONG SOFTWARE VERSION	Wrong Software Version Installed	Install correct software version			
250	FAILED SOFTWARE UPDATE	The new software didn't load properly	Try to install the software again	Replace display or control board		
300	CONTROL VOLTAGE LOW	Control Voltage < 20V (Running)	Press Engine button to reset	Check Alternator	Check Battery	Replace Battery
301	BATTERY LEVEL TOO LOW	Battery voltage level is too low to attempt startup sequence.	Press Engine button to Reset	Check battery cables	Charge Battery	Replace Battery
400	EMERGENCY STOP ACTIVATED		Release emergency stop and press Engine button to reset	Check emergency stop	Check user EPO (A2:X14)	Replace Control Board A1
500	CONTROL BOARD ADC1 FAILURE	ADC1 voltage reading out of range.	Press Engine button to reset	Replace Control Board A1	Replace Interface Board A2	
600	CONTROL BOARD ADC2 FAILURE	ADC2 voltage reading out of range.	Press Engine button to reset	Replace Control Board A1	Replace Interface Board A2	
700	CONTROL BOARD BATTERY FAILURE		Press Engine button to reset	Replace battery		
750	REAL-TIME CLOCK NOT SET	Please set to current time and date	Press Engine button to reset	Check / Set to current time and date		
1000	SOFTSTART ERROR	DC Voltage < 400V	Press Engine button to reset	Check input voltage	Check DC softstart charging voltage > 400V	Replace Control Board A1 Replace Interface Board A2 Replace Capacitor Module A5
1100	DC VOLTAGE TOO LOW	DC Voltage < 300V - 30ms	Press Engine button to reset	Check input voltage	Check Q5	Replace Control Board A1 Replace Interface Board A2

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Error Code	Error Text in display	Description	1st Corrective Action	2nd Corrective Action	3rd Corrective Action	4th Corrective Action
1200	DC VOLTAGE TOO HIGH		Press Engine button to reset			
1201	DC VOLTAGE TOO HIGH	DC Voltage > 800V – 30 s	Press Engine button to reset	Check input voltage	Replace Control Board A1	Replace Interface Board A2
1202	DC VOLTAGE TOO HIGH	DC Voltage > 850V - 2.5ms	Press Engine button to reset	Check input voltage	Replace Control Board A1	Replace Interface Board A2
1300	ENERGY RESERVOIR BOARD FAILURE		Press Engine button to reset	Discharge and Recharge Energy Reservoir	Replace defective ER board	
1450	ENERGY RESERVOIR VOLTAGE TOO HIGH	ER Voltage > 365V	Press Engine button to reset	Check ER Circuit. (K4, D1, etc)		
1500	DC RIPPLE TOO HIGH	Check connections between generator and inverter.	Check/replace DC Link diodes on inverter.	Check/replace DC Link capacitors.		
1601	INVERTER TEMP TOO HIGH	IGBT 1 Temperature > 110C	Press Engine button to reset	Check fuse F5	Check Heat sinks and fans to insure proper airflow	Replace Control Board A1 Replace Interface Board A2
1602	INVERTER TEMP TOO HIGH	IGBT 2 Temperature > 110C	Press Engine button to reset	Check fuse F5	Check Heat sinks and fans to insure proper airflow	Replace Control Board A1 Replace Interface Board A2
2000	GATE VOLTAGE ERROR	CPLD Unknown Fault	Press Engine button to reset	Replace Control Board A1	Replace Interface Board A2	Replace Inverter Module
2000+code	GATE VOLTAGE ERROR	IGBT XY Ready	Press Engine button to reset	Replace Control Board A1	Replace Interface Board A2	Replace Inverter Module
2000+code	GATE VOLTAGE ERROR	IGBT XY Fault	Press Engine button to reset	Replace Control Board A1	Replace Interface Board A2	Replace Inverter Module
3000	OUTPUT VOLTAGE TOO HIGH	400Hz voltage is greater than 130 volts for 250mS.	Press Output Button to Reset	Check voltage set-up value	Replace Control Board A1	Replace Interface Board A2

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Error Code	Error Text in display	Description	1st Corrective Action	2nd Corrective Action	3rd Corrective Action	4th Corrective Action
3100	OUTPUT VOLTAGE TOO HIGH	400Hz voltage is greater than 140 volts for 15mS.	Press Output Button to Reset	Replace Control Board A1	Replace Interface Board A2	
3500	OUTPUT VOLTAGE TOO LOW	400Hz voltage is less than 104 volts for 6 seconds.	Press Output Button to Reset	Check voltage set-up value	Replace Control Board A1	Replace Interface Board A2
4000	OVERLOAD: 100% < I < 125% - 600 s	Current was between 100% and 125% for 10 minutes.	Press Output Button to Reset	Remove overload and re-engage output	Replace Control Board A1	Replace Interface Board A2
4100	OVERLOAD: 125% < I < 150% - 10 s	Current was between 125% and 150% for 10 seconds	Press Output Button to Reset	Remove overload and re-engage output	Replace Control Board A1	Replace Interface Board A2
4200	OVERLOAD: 150% < I < 175% - 2 s	Current was between 150% and 175% for 2 seconds.	Press Output Button to Reset	Remove overload and re-engage output	Replace Control Board A1	Replace Interface Board A2
4050	OVERLOAD: 100% < I < 125% - 600 s	Current was between 100% and 125% for 10 minutes.	Press Output Button to Reset	Remove overload and re-engage output	Replace Control Board A1	Replace Interface Board A2
4150	OVERLOAD: 125% < I < 150% - 10 s	Current was between 125% and 150% for 10 seconds	Press Output Button to Reset	Remove overload and re-engage output	Replace Control Board A1	Replace Interface Board A2
4250	OVERLOAD: 150% < I < 175% - 2 s	Current was between 150% and 175% for 2 seconds.	Press Output Button to Reset	Remove overload and re-engage output	Replace Control Board A1	Replace Interface Board A2
4500	SHORT CIRCUIT AT OUTPUT	PHASE X	Press Output Button to Reset	Disconnect load / output cable	Replace Control Board A1	Replace Interface Board A2
4600	FILTER CURRENT TOO LOW	PHASE X	Press Output Button to Reset	Check output filter capacitors C7-C9	Check output transformer T2	Replace Control Board A1 Replace Interface Board A2
4700	FILTER CURRENT TOO HIGH	PHASE X	Press Output Button to Reset	Check output filter capacitors C7-C9	Check output transformer T2	Replace Control Board A1 Replace Interface Board A2
4800	INVERTER SOFTSTART FAILURE		Press Output Button to Reset	Check DC voltage	Check output voltage/feedback voltage	Replace Control Board A1 Replace Interface Board A2 Replace Inverter Module
5000	TRANSFORMER TEMP TOO HIGH		Press Output Button to Reset	Let the unit cool down and reset	Check Heat sinks and fans to insure proper airflow	Check (short circuit) temp sensor Replace Control Board A1 Replace Interface Board A2
5100	EARTH LEAKAGE FAULT AT OUTPUT		Press Output Button to Reset	Check set-up value	remove load and check output cabling	Replace T5 Replace Control Board A1 Replace Interface Board A2
5200	NEUTRAL VOLTAGE FAULT AT OUTPUT		Press Output Button to Reset	Check set-up value	Remove load and check output cabling for insulation error	Replace Control Board A1 Replace Interface Board A2

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Error Code	Error Text in display	Description	1st Corrective Action	2nd Corrective Action	3rd Corrective Action	4th Corrective Action
6001	EF OUTPUT 1 RIPPLE TOO HIGH	Ripple on EF from the aircraft on output 1 is beyond the defined limit.	Press Output 1 button to reset	Check set-up value	Remove load and check output cabling	Replace Control Board A1 Replace Interface Board A2
6002	EF OUTPUT 2 RIPPLE TOO HIGH	Ripple on EF from the aircraft on output 2 is beyond the defined limit.	Press Output 2 button to reset	Check set-up value	Remove load and check output cabling	Replace Control Board A1 Replace Interface Board A2
6101	PLUG 1 TEMPERATURE TOO HIGH	The temperature sensor in output 1 plug has tripped.	Press Output 1 button to reset	Remove load and let plug cool down	Check connector / output cabling for any malfunction	Replace Control Board A1 Replace Interface Board A2
6102	PLUG 2 TEMPERATURE TOO HIGH	The temperature sensor in output 2 plug has tripped.	Press Output 2 button to reset	Remove load and let plug cool down	Check connector / output cabling for any malfunction	Replace Control Board A1 Replace Interface Board A2
6103	28V PLUG TEMPERATURE TOO HIGH	The temperature sensor in output 2 plug has tripped.	Press ARU button to reset	Remove load and let plug cool down	Check connector / output cabling for any malfunction	Replace Control Board A1 Replace Interface Board A2
6301	EF SIGNAL DROP OUT - OUTPUT 1	EF Signal Disappeared at Output 1	Press Output 1 button to reset	Is output cable correctly inserted?	Check / correct installation	Replace Control Board A1 Replace Interface Board A2
6302	EF SIGNAL DROP OUT - OUTPUT 2	EF Signal Disappeared at Output 2	Press Output 2 button to reset	Is output cable correctly inserted?	Check / correct installation	Replace Control Board A1 Replace Interface Board A2
6303	28V INTERLOCK LEVEL TOO LOW	28V F Level too low	Press ARU button to reset	Verify that output cable is correct inserted	Check / correct installation	Replace Control Board A1 Replace Interface Board A2
7000	28V OUTPUT VOLTAGE TOO HIGH	Voltage > 32V - 4s	Press ARU button to reset	Check output voltage setup value	Check ARU Module and wiring	
7100	OUTPUT VOLTAGE TOO HIGH	Voltage > 40V - 1s	Press ARU button to reset	Check output voltage setup value	Check ARU Module and wiring	
7200	28V OUTPUT VOLTAGE TOO LOW	Voltage < 20V - 4s	Press ARU button to reset	Check output voltage setup value	Check ARU Module and wiring	
7300	SHORT CIRCUIT AT 28V OUTPUT	28V Short Circuited	Press ARU button to reset	Remove overload and re-engage output	Replace Control Board A1	Replace Interface Board A2
7400	28V OUTPUT CURRENT TOO HIGH	28V Output Voltage is too high	Press ARU button to reset	Remove overload and re-engage output	Replace Control Board A1	Replace Interface Board A2
7500	28V RECTIFIER TEMP TOO HIGH		Press ARU button to reset	Let the unit cool down and reset	Check airflow / air filters / fan	Check temp. sensor at rectifier heat sink.
8000	STARTER FAILURE	Engine rotation is not detected when starter was activated.	Press Engine button to Reset	Check starter circuit to insure that it is properly energized. (Replace Starter Solenoid)	Replace Starter	

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Error Code	Error Text in display	Description	1st Corrective Action	2nd Corrective Action	3rd Corrective Action	4th Corrective Action
	UNABLE TO START ENGINE	Engine did not start after 3 tries.	Press Engine button to Reset	Check fuel valve to ensure it is open.	Service Engine	
8300	FUEL LEVEL < 10%	Fuel Level is too low to attempt an engine start.	Add Fuel	Inspect fuel Sender wiring	Inspect fuel Sender	
8400	ECM COMMUNICATION FAILURE	J1939 Communication Failure	Check ECM Power (Replace Interface Board)	Service Engine		
8500	ENGINE RPM OUT OF SPEC	Engine RPM out of specification or stopped	Check fuel level	Service Engine		
8600	ECM ERROR CODE RECEIVED	Engine Error Code Received from ECM	Service Engine			
8700	Excessive Temp					
8800	AVR FAILURE	The duty cycle for the Exciter is too high	Inspect the generator and the exciter circuit for damage or bad connections.	Check fuses F8 and F3	Replace Interface Board A2	Replace Control Board A1

Chapter 3 Manufacturer's Literature

Vendor Literature

Type	Diagram Description
Engine	Industrial Engine Service Manual (Ford WSG-1068) Parts Manual (Ford WSG1068)

Diagram Number	Diagram Description
293390	Diagram, Schematic & Connection

Contact ITW GSE if copies of these drawings or manuals are not delivered with the unit (unless otherwise noted above). Refer to Appendix B for specific information on the ITW GSE 5400 Generator Set, optional equipment.

Appendix A Transformer Rectifier Unit (TRU)

1) Transformer Rectifier Unit (TRU) – 28.5 VDC Power Supply

CAUTION

The TRU can deliver up to 2,000 amps of current during the starting of an aircraft engine. This much current will shear the propeller shaft of some aircraft. Therefore, make sure that the current limit is correctly set for the aircraft that is being powered.

a) TRU Default Factory Settings:

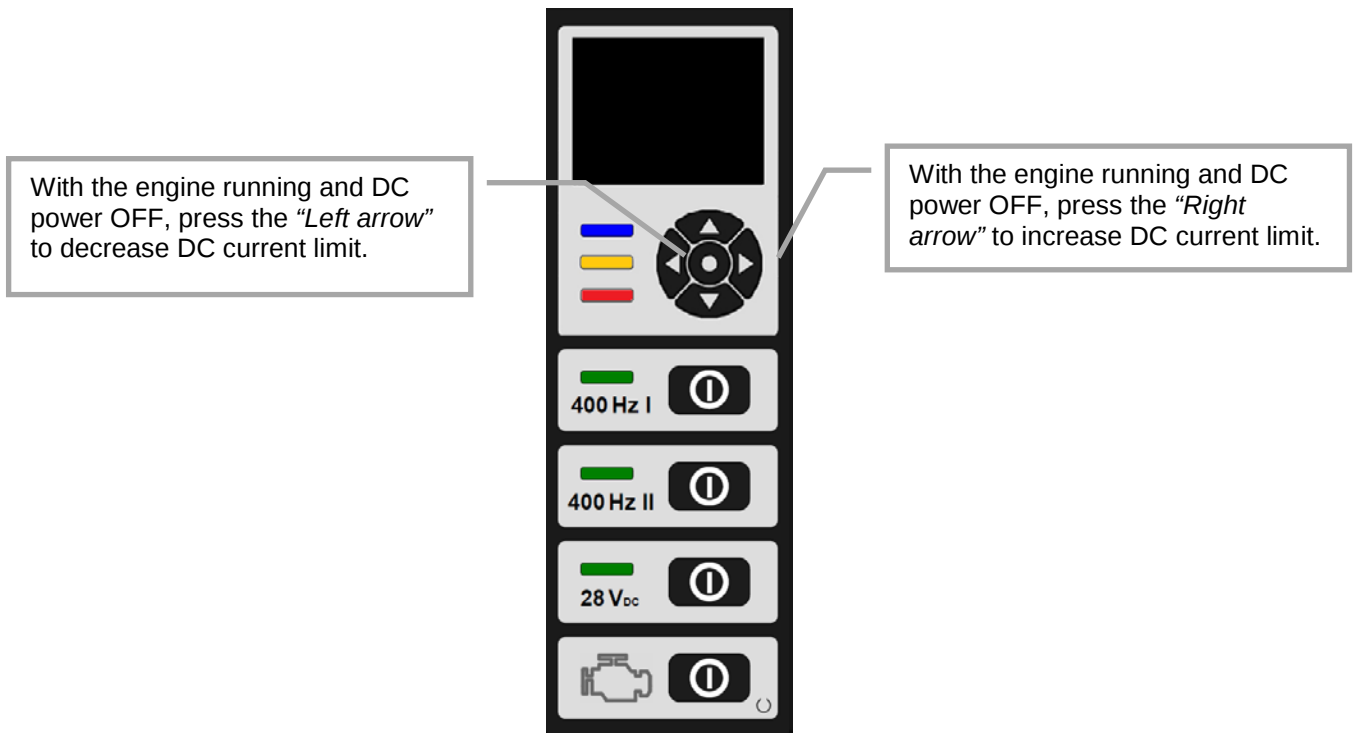
28 V Voltage (V):	28.5 VDC
28 V Compensation (V/600A):	0.0 (Set if GPU supplied with cable)
28 V Current Limit (A):	2000 A
Plug Temperature:	Normally Open

- Adjusting the Current Limit

- 1) The unit remembers the last current limit that was selected. This value will be used whenever the 28VDC output is turned on.
- 2) If the current limit needs changed, use the following procedure:
 - i. With the unit's engine running and the 28 VDC power off, the right or left arrows can be used to change the default current limit value. The step size used for changing the current limit is set in the Current Limit Step Size setup menu screen.
 - ii. Once the correct value is selected, use the below procedure to activate the TRU.

Note: To ensure hassle-free starting of the aircraft engine, the current limit function is delayed 0.7 seconds.

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- Starting the 28 VDC TRU
 - 1) Insert aircraft cable into aircraft. Cable is fully inserted when you feel a natural resistance. The plug may be equipped with a 90% insertion switch (split “C” pin). In this case, the unit will not function if the plug not is fully inserted.
 - 2) Press the 28 VDC Start/Stop button.
 - 3) The unit is now in operation and supplying power to the aircraft. This is also indicated via the green LED located close to the 28VDC Start/Stop button.
 - 4) If the unit shuts off and is no longer supplying power to the aircraft, a report in clear text and a corrective action will be displayed on the screen.
 - 5) During operation, various parameters can be viewed via the display. Use the navigation keys ▼▲ to browse through the available screens.
 - 6) Turn off the unit by pressing the 28VDC Start/Stop button. Always ensure that the output is off before removing the aircraft plug.

Note: The 28 VDC Start/Stop button also functions as a Reset push button for faults directly related to the TRU.

If for some reason the unit stops due to an error / failure, record the fault number and message and forward the information to your maintenance personnel. If the fault is no longer active, press the Start/Stop/Reset to reset the alarm and the unit.

Appendix B Options

The following is a list of options available for the ITW GSE 5400, 400 Hz. Generator Set. This chart contains the description and part number of the option. The description of each option follows on the pages below.

Option/Features Available	
Description	Part Number
DIN40 Towbar	293148
Kit, Clearance Lights	293098
Kit, Beacon, Unit Operating, Amber	293099-001
Kit, Beacon, Unit Operating, Blue	293099-002
Kit, Beacon, Unit Operating, Clear	293099-003
Kit, Beacon, Unit Operating, Red	293099-004
Kit, Beacon, Low Fuel, Amber	293100-001
Kit, Beacon, Low Fuel, Blue	293100-002
Kit, Beacon, Low Fuel, Clear	293100-003
Kit, Beacon, Low Fuel, Red	293100-004
Kit, Battery Blanket, 120V	293498-01
Kit, Battery Blanket 240 Volt	293498-03
Kit, Battery Blanket 230 Volt	293498-05
Kit, Towbar Interlock - Single Output	293485-01
Kit, Towbar Interlock - 28V & Single Output or Dual Output	293485-02

293148 DIN40 Tow bar

This option replaces the standard Towbar with a 40mm diameter eye version.

293098 Kit, Clearance Lights

This option adds clearance lights to the four top corners of the canopy.

293099-001	Kit, Beacon, Unit Operating, Amber
293099-002	Kit, Beacon, Unit Operating, Blue
293099-003	Kit, Beacon, Unit Operating, Clear
293099-004	Kit, Beacon, Unit Operating, Red

This option adds the selected color beacon light to the top of the front canopy. These beacons are delivered with a flashing light. If a steady light is desired, the jumper in the bottom of the light should be cut.

293100-001	Kit, Beacon, Low Fuel, Amber
293100-002	Kit, Beacon, Low Fuel, Blue
293100-003	Kit, Beacon, Low Fuel, Clear
293100-004	Kit, Beacon, Low Fuel, Red

This option adds the selected color beacon light to the top of the front canopy. These beacons are delivered with a flashing light. If a steady light is desired, the jumper in the bottom of the light should be cut.

293498-01 Kit, Battery Blanket, 120V

This option adds an independently powered 120 VAC powered battery blanket on top of the batteries in the right cable tray.

293498-03 Kit, Battery Blanket, 240V

This option adds an independently powered 240 VAC powered battery blanket on top of the batteries in the right cable tray.

293498-05 Kit, Battery Blanket, 230V

This option adds an independently powered 230 VAC powered battery blanket on top of the batteries in the right cable tray.

293485-01 Kit, Single Output Tow Hitch Interlock

This option adds a lock to the tow bar assembly to prevent it from being lowered if the single 400 Hz cable isn't properly inserted into the receptacle at the front of the cable tray.

NOTE: When this option is installed, the unit will not close the 400 Hz contactor if the tow bar hitch isn't up and locked in place.

293485-02 Kit, Dual Output or 28VDC & 1 Output Tow Hitch Interlock

This option adds a lock to the tow bar assembly to prevent it from being lowered if both the 400 Hz and/or 28VDC cables aren't properly inserted into the receptacles at the front of their respective cable trays.

NOTE: When this option is installed, the unit will not close either output contactor if the tow bar hitch isn't up and locked in place.

Appendix C Operating in Unusual Service Conditions

This information is a general guideline and cannot cover all possible conditions of equipment use. The specific local environments may be dependent upon conditions beyond the manufacturer's control. The manufacturer should be consulted if any unusual conditions of use exist which may affect the physical condition or operation of the equipment or safety to surrounding personnel.

Among such conditions are:

1) Exposure to:

- a) Combustible, explosive, abrasive or conducting dusts.
- b) Environments where the accumulation of lint or excessive dirt will interfere with normal ventilation.
- c) Chemical fumes, flammable, or explosive gases.
- d) Nuclear radiation.
- e) Steam, salt-laden air, or oil vapor.
- f) Damp or very dry locations, radiant heat, vermin infestation, or atmospheres conducive to fungus growth.
- g) Abnormal shock, vibration or mechanical loading from external sources during equipment operation.
- h) Abnormal axial or side thrust imposed on rotating equipment shafts.
- i) Low and/or high ambient temperatures.
- j) High electromagnetic fields

2) Operation at:

- a) Voltages above or below rated voltage.
- b) Speeds other than rated speed.
- c) Frequency other than rated frequency.
- d) Standstill with rotating equipment windings energized.
- e) Unbalanced voltages.
- f) Operation at loads greater than rated.

3) Operation where low acoustical noise levels are required.

4) Operation with:

- a) Improper fuel, lubricants or coolant.
- b) Parts or elements unauthorized by the manufacturer.
- c) Unauthorized modifications.

5) Operation in poorly ventilated areas.

Appendix D Initial Software Installation Procedure

Introduction:

The ITW GSE 5400 GPU contains two circuit boards that may need to be programmed if they are replaced. (The Control Board (P/N AP-579526) and the Display Board (P/N AP-579536).

This document instructs you how to perform this task. Make sure to program the boards with the correct software number and revision. Install the Control Board software first, then the Display Board software.

First time programming of the Control Board (P/N AP-579526):

- 1) Make sure the Control Board is installed onto the Interface Board (P/N AP-579550), and the GPU is powered.
- 2) Copy the correct Control Board software onto a USB stick. The file must be located in the root folder of the USB stick, and the filename must be XXXXX.itw. Other files, e.g. the Display Board software, may also be on the USB stick.
- 3) Inspect the blue LED next to the USB socket on the Control Board. The blue LED must be flashing in a sequence of two rapid flashes, then a pause, then two rapid flashes, and so on.
- 4) Insert the USB stick into the USB socket on the Control Board. Check that the blue LED turns off. Wait until the blue LED turns on (this may take some time).
- 5) When the blue LED turns constantly on, the software has been programmed into the Control Board. Remove the USB stick from the Control Board.

If the blue LED is constantly on, the Control Board has already been programmed. Use the update function on the Display Board to program the Control Board. (The Display Board must be programmed first)

If the blue LED is flashing slowly in a sequence of one flash, a pause, one flash and so on, the microcontroller on the Control Board has lost its internal programming, most likely due to a faulty or missing battery. Contact ITW GSE technical support and request a replacement control board.

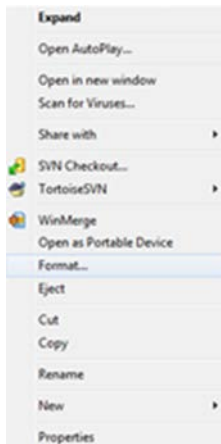
First time programming of the Display Board (P/N AP-579536):

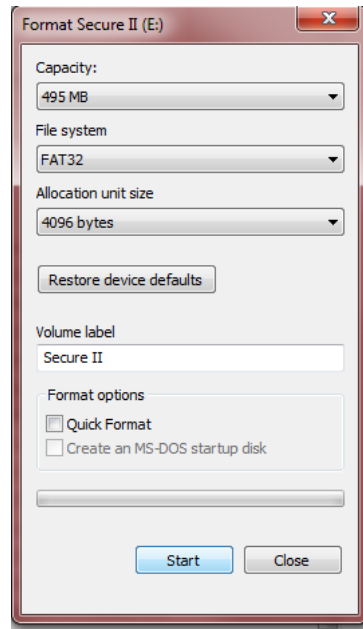
- 1) Make sure that switch 1 on DIP-switch SW2 is in the ON position. This allows access to the Display Board menu.
- 2) Copy the correct Display Board software onto a USB stick. The Display Board software consists of two files: a XXXXX.itw file, and a file like AAxxxxxx.pbe, where xxxxxx is a number.
- 3) Do not change the filenames. The two files will only work together.
- 4) The files are located in the root folder of the USB stick. Other files, e.g. the Control Board software, may also be on the USB stick.
- 5) Insert the USB stick into the USB socket on the Display Board.
- 6) Press and hold the center navigation key on the GPU to access the update function.
- 7) Press the center navigation key again to confirm the software update.
- 8) Wait for the software update to complete. Press the center navigation key when instructed to reset the Display Board.
- 9) If the software update does not complete, start over from step 4.

Verify the software is installed correctly.

- 1) Hold the center navigation key to access the menu on the Display Board.
- 2) Access the Parameter Info, and navigate up/down to the Unit Information page.
- 3) Verify that the display reports the expected software number and revision for both Display Board (Display FW) and Control Board (Control FW).

Possible issues that may be encountered during this procedure:

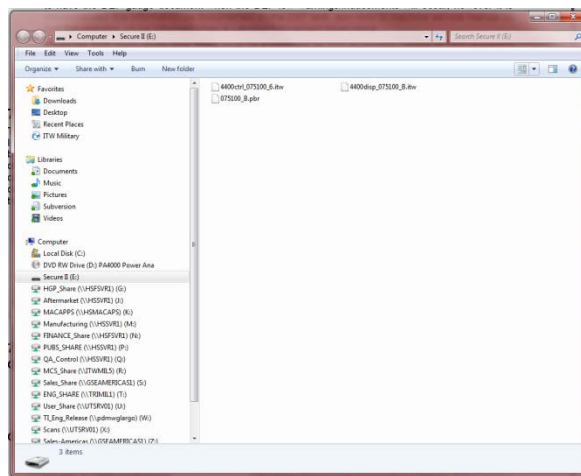
- Error 201 "CRITICAL": Memory Error. Call Technician".
This is caused by the Control Board being unable to read the GPU configuration from the EEprom Board (P/N 579.533). The error should disappear after the configuration step. If the error persists even after configuring the GPU (remember to save), the EEprom Board may be defective.
- Error 250 "Update Failed". This is caused by an issue that may happen during the Display Board software update. Perform the software update again.
- The Setup Tool is unable to connect to the GPU. Using the Display Board menu, make sure the GPU Ethernet settings are set correctly. The correct settings are:
 - o Ethernet mode: Manual
 - o IP Address: 192.168.1.100
 - o Subnet Mask: 255.255.255.0
 - o Gateway: No significance
 - o DNS 1: No significance
- The displays shows a "COMMUNICATION ERROR" screen.
This is caused by a failure in CAN-bus communication between the Control Board and the Display Board, usually because the Control Board is not programmed or has halted its execution. Check for faulty/un-programmed Control Board (flashing blue LED), and replace or program if necessary. Check that the cable from the Display Board to the Interface Board is fully seated at both ends, and try restarting the GPU. If the issue persists, try replacing the Control Board even if the blue LED is not flashing.
- The unit can't detect the USB stick or read any files on it. Reformat the USB stick using the below procedure and then copy the needed files back into the root folder.
 1. Insert the USB stick into a computers USB port.
 2. Open the File Explorer window and right click on the drive for the USB stick.
 3. select, 'Format...'.


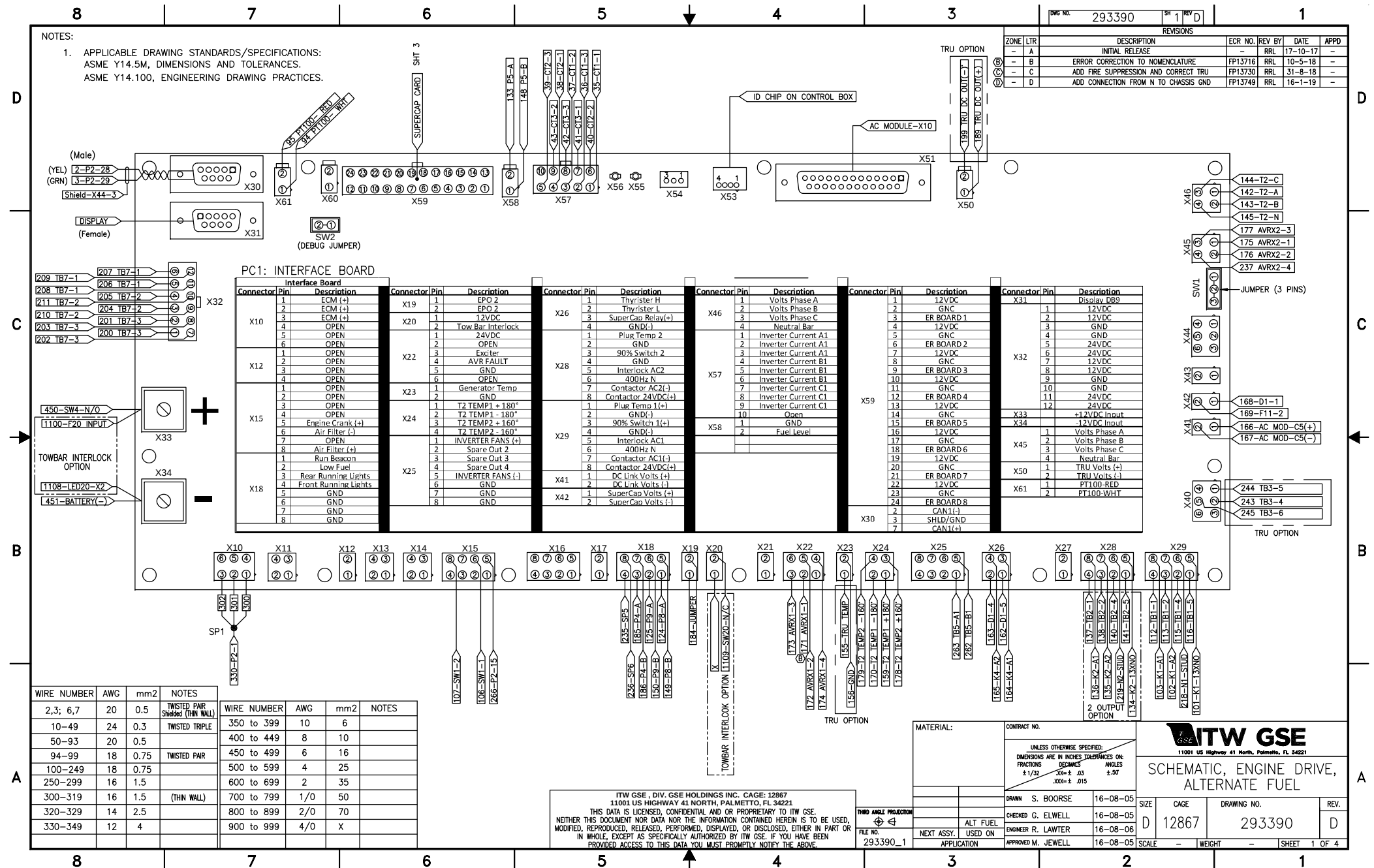


4. Set File system to FAT32 and make sure that Quick Format is NOT clicked. Press start.

(The USB should function without issue after the format is complete. This may take several minutes to complete on larger drives.)

5. Copy the files into the root drive and it is ready.





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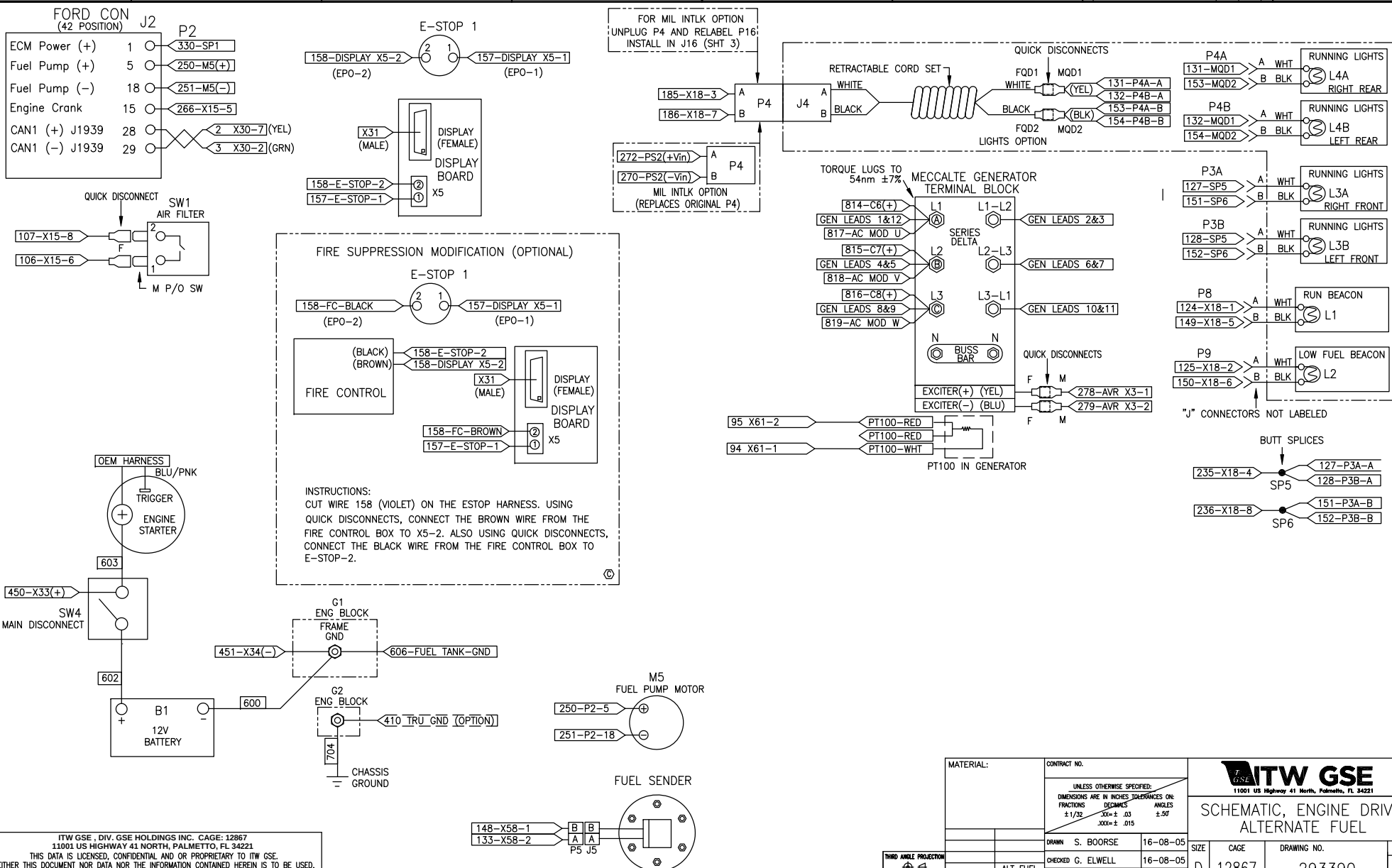
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1

DWG NO. 293390

REV 2

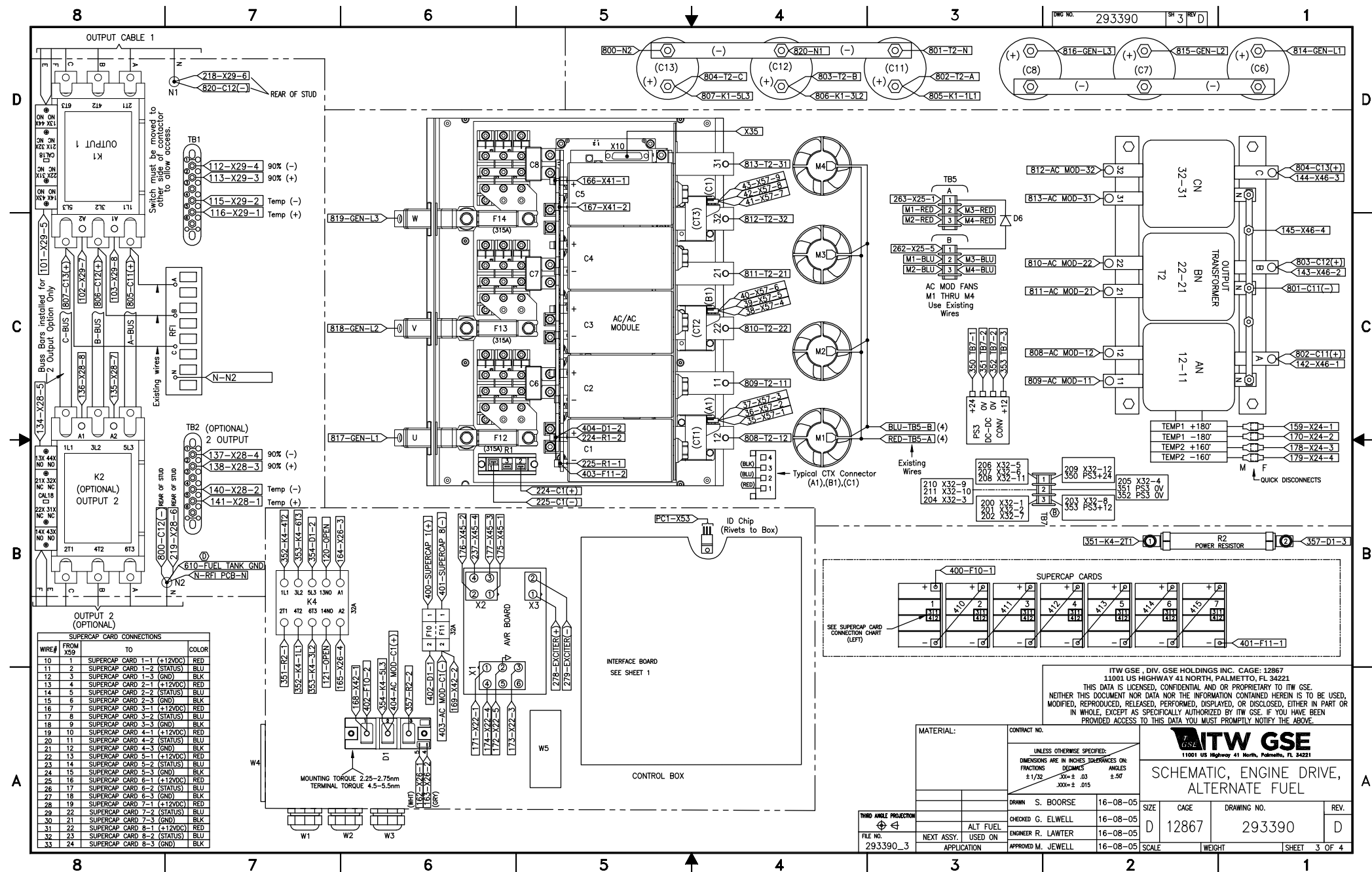
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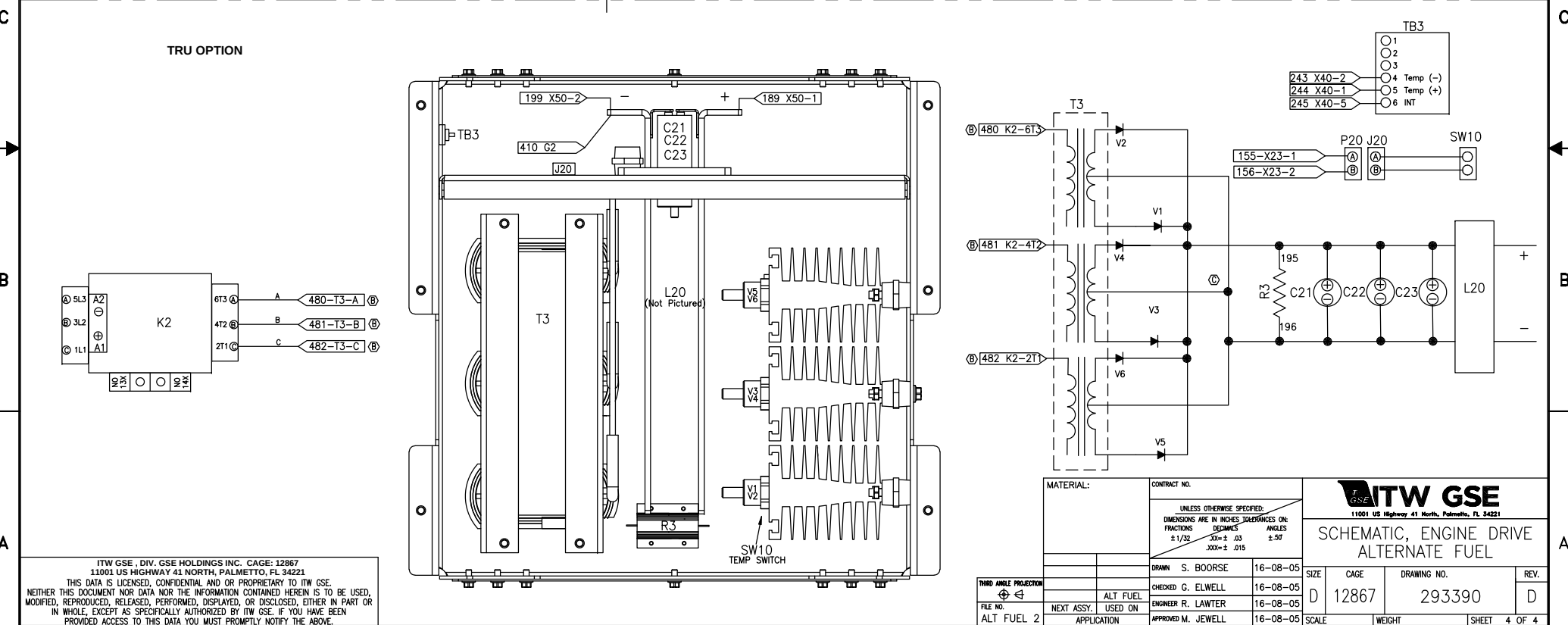
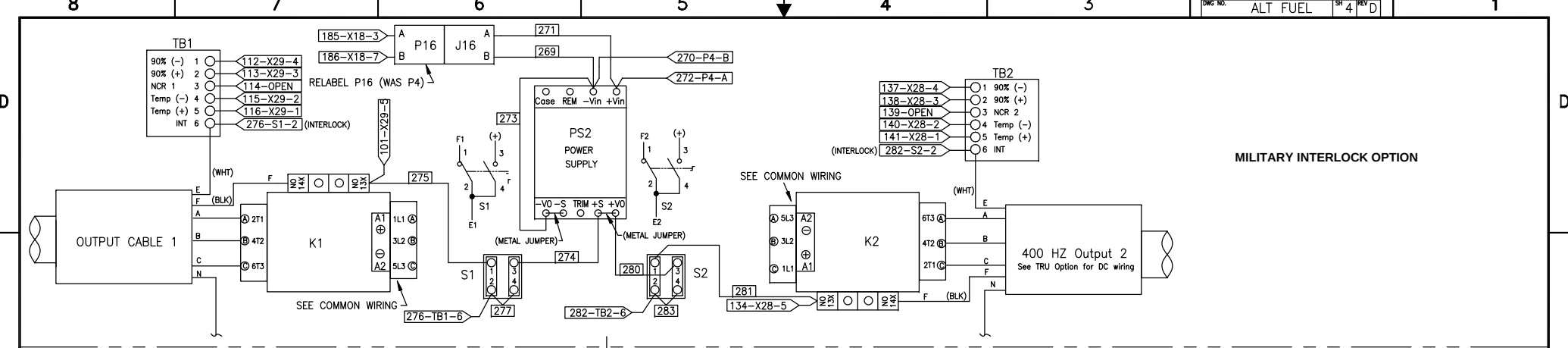


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		DRAWN S. BOORSE		16-08-05	SIZE	CAGE	DRAWING NO.	REV.
		CHECKED G. ELWELL		16-08-05	D	12867	293390	D
		ENGINEER R. LAWTER		16-08-05				
		APPROVED M. JEWELL		16-08-05	SCALE	WEIGHT		SHEET 2 OF 4
ALT FUEL								
NEXT ASSY. USED ON								
APPLICATION								





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		DRAWN S. BOORSE		16-08-05			
		CHECKED G. ELWELL		16-08-05			
		ENGINEER R. LAWTER		16-08-05			
THIRD ANGLE PROJECTION		ALT FUEL		SIZE D	CAGE 12867	DRAWING NO. 293390	REV. D
FILE NO. ALT FUEL 2		NEXT ASSY. USED ON APPLICATION		APPROVED M. JEWELL		16-08-05	
				SCALE		WEIGHT	
						SHEET 4 OF 4	