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BLUE STAR
Power Systems Inc.

Engine Generator Set
Owners & Operators Manual

Model Number: VD500-01
Serial Number: 116385-2-1

Document Sections

Start-Up Instructions & Warranty Validation

BLUE STAR Power Systems Inc.

Start-Up Date: ________ / ________ / ________

This form must be filled out completely by factory authorized personnel during the startup and returned to Blue Star Power Systems Inc. to activate the factory warranty. Signing this form represents acceptance of unit and that all information on the start-up is correct. The owner representative signature acknowledges review and understanding of this Start-up Inspection and Warranty Validation form. Please return a copy of the completed form to Blue Star Power Systems, Inc. within 30 days of start-up.

AUTHORIZED BLUE STAR POWER SYSTEMS, INC. REPRESENTATIVE PERFORMING START-UP			OWNER/SITE LOCATION		
Company Name:			Company/Site Name:		
Street Address:			Street:		
City:	State:	Zip:	City:	State:	Zip:
Phone Number:			Phone Number:		
Technician Name:			Owner or Owner's Representative Name:		

GENSET DATA		ENGINE DATA	
Model Number:		Engine Model:	
Serial Number:		Engine Serial Number (Found on Engine Block):	
Application: ☐ Stationary ☐ Mobile		Fuel Type:	Fuel Pressure:
Rating: ☐ Standby ☐ Prime		AUTOMATIC TRANSFER SWITCH DATA	
RPM:	Hz:	Manufacturer:	
kWe:	kVa:	Model Number:	
Volts:	Phase:	Serial Number (Found on ATS Cabinet):	
Amps Per Terminal:		UTILITY SERVICE DATA	
GENERATOR/ALTERNATOR DATA		Volts:	Phase:
Generator Model Number:		Phase Rotation	Amps:
Generator Serial Number:		Monitoring System (If Applicable):	
Phase Rotation:		Serial Number (If Applicable):	

The Blue Star Power Systems, Inc. Limited Warranty will be void if the installation does not meet the general guidelines, standards and recommendations as laid out in the Installation Guide (provided with generator set) and all local standards and codes applicable in the location of the installation.

Note - The start of the warranty period can be adjusted to the date of the unit start-up (limited to 180 days from invoice date) provided that the following information is provided to Blue Star Power Systems, Inc. within 30 days of start-up: (1) A copy of the Blue Star Power Systems, Inc. start-up validation checklist must be properly and completely filled out and returned Blue Star Power Systems, Inc. within 30 days of start-up. (2) The engine manufacturer engine registration form must be completed and returned to the engine manufacturer as stated in the instructions with the registration form.

** Upon completion, return the white copy of this form to Blue Star Power Systems, Inc. to activate product warranty. The yellow copy is to be retained by the person performing the start-up, and the pink copy is to be left with the customer.**

This agreement is deemed made and executed in North Mankato, Nicollet County, Minnesota and shall be construed and interpreted in accordance with the laws of the state of Minnesota without giving effect to its conflicts of laws principals. Each of the parties submits to the exclusive personal jurisdiction and venue with respect to any action or proceeding arising out of, in connection with, relating to, or by reason of this agreement before the district court of the state of Minnesota, located in Nicollet County and agrees that all claims in respect of the action or proceeding may be heard and determined in any such court.

Installation Checks

BLUE STAR
Power Systems Inc.

Check only those that apply to the specific application.

Yes No N/A

MOUNTING

☐ ☐ ☐ 1. Wood shipping skid removed.

☐ ☐ ☐ 2. Mounting structure constructed of non-combustible material.

☐ ☐ ☐ 3. Mounting surface level.

☐ ☐ ☐ 4. Vibration isolation mounts installed between unit and mounting structure.

☐ ☐ ☐ 5. Anchor bolts installed, snugged down and double nutted.

ENVIRONMENTAL

☐ ☐ ☐ 6. Equipment room protected from freezing temperatures during unit operation (water lines Etc).

☐ ☐ ☐ 7. Adequate clearance around the unit for service and proper operation.

☐ ☐ ☐ 8. Equipment room protected with a fire suppression system.

☐ ☐ ☐ 9. Adequate ventilation for engine starting battery(ies).

COOLING SYSTEM

☐ ☐ ☐ 10. Ample inlet and outlet airflow (motorized louvers adjusted and ventilation fan motor(s) connected to an available source of power of the correct voltage.

☐ ☐ ☐ 11. Radiator ductwork properly sized and connected to the air vent or exhaust louver to prevent air recirculation and transmission of vibration.

☐ ☐ ☐ 12. Flexible connectors installed in the cooling water lines (remote radiator applications).

FUEL SYSTEM

☐ ☐ ☐ 13. Adequate dedicated fuel supply of proper type, volume and pressure. Record type and pressure above.

☐ ☐ ☐ 14. Fuel filters/drain leg installed.

☐ ☐ ☐ 15. Adequate fuel transfer pump lift capacity (diesel units).

☐ ☐ ☐ 16. Fuel transfer pump connected to available source of power with the correct voltage (diesel units).

☐ ☐ ☐ 17. Flexible connectors installed in fuel piping (supply and return and diesel systems).

☐ ☐ ☐ 18. Diesel fuel storage tanks properly installed and vented according to local codes.

Yes No N/A

EXHAUST SYSTEM

☐ ☐ ☐ 19. Flexible connector installed in extended exhaust piping.

☐ ☐ ☐ 20. Condensation trap with drain installed.

☐ ☐ ☐ 21. Silencer installed, hanger and mounting hardware tight and secure.

☐ ☐ ☐ 22. Heat-isolating wall thimble (per local code) installed where exhaust piping penetrates combustible walls.

☐ ☐ ☐ 23. Exhaust piping free of excessive bends and restriction.

☐ ☐ ☐ 24. Exhaust installed with a downward slope away from the engine.

☐ ☐ ☐ 25. Exhaust piping wall penetration protected from entry of rain, snow and pests.

☐ ☐ ☐ 26. Exhaust outlet termination suitable to prevent entrance of rain and pests (Rain cap Etc)

☐ ☐ ☐ 27. Exhaust outlet termination location prevents re-entry of exhaust gases into buildings or structures.

☐ ☐ ☐ 28. Personnel protection from hot surfaces and gases installed or accounted for.

ELECTRICAL

☐ ☐ ☐ 29. Generator and transfer switch nameplate electrical data matches normal/utility source ratings.

☐ ☐ ☐ 30. Generator set load conductors are of adequate ampacity and are correctly connected to the output means and the emergency side terminals of the transfer switch.

☐ ☐ ☐ 31. Generator load conductors, remote start contacts, battery charger, engine heater and remote monitoring panel wiring installed in separate conduits.

☐ ☐ ☐ 32. Battery charger AC supply connected to a circuit of the proper voltage and amperage, and energized.

☐ ☐ ☐ 33. Engine jacket water heater AC supply connected to a circuit of the proper voltage and amperage and energized.

☐ ☐ ☐ 34. Engine starting battery(ies) fully charged and connected to the engine and battery charger.

☐ ☐ ☐ 35. Transient Voltage Surge Suppression protection devices installed to protect the equipment against voltage spikes.

Pre-Start/Running Checks

BLUE STAR
Power Systems Inc.

Yes No N/A

☐ ☐ ☐ 1. Inspect unit for freight damage (ensure components are tight).

☐ ☐ ☐ 2. Engine is filled with oil, cooling system is filled with coolant/antifreeze and the battery(ies) are filled with acid.

☐ ☐ ☐ 3. Inspect belts, hoses and clamps for proper alignment and tension.

☐ ☐ ☐ 4. Gas solenoid valve functions when energized.

☐ ☐ ☐ 5. Inspect all electrical connections to verify tightness and security.

☐ ☐ ☐ 6. Open all water and fuel valves. Temporarily remove the radiator cap to eliminate air in the cooling system.

☐ ☐ ☐ 7. Prime the fuel system.

☐ ☐ ☐ 8. Place the generator set engine control switch in the OFF/RESET position. Observe Not-In-Auto display and alarm, if equipped on the controller.

☐ ☐ ☐ 9. Open the generator main line circuit breakers.

☐ ☐ ☐ 10. Verify power to the water/oil heaters and fuel lift pumps.

☐ ☐ ☐ 11. Place the generator set engine control switch in the RUN position. Allow the engine to start and run.

☐ ☐ ☐ 12. Check the battery charging voltmeter for battery charging indication.

☐ ☐ ☐ 13. Verify sufficient oil pressure.

☐ ☐ ☐ 14. If the speed is unstable, adust.*

☐ ☐ ☐ 15. Adjust the AC output voltage to match the utility voltage using the voltage adjusting control on the automatic voltage regulator.

☐ ☐ ☐ 16. Allow the engine to reach normal operating temperature. Check for oil, coolant, and exhaust leaks. Check and tighten all hose connectors and clamps.

☐ ☐ ☐ 17. Check the operating temperature on city water-cooled models and adjust the thermostatic valve as necessary.

☐ ☐ ☐ 18. Manually overspeed (if applicable) the engine to cause an engine shutdown. Place the generator set in the OFF/RESET position.*

☐ ☐ ☐ 19. Check the coolant level, add coolant as necessary, and replace the radiator cap. Verify that all hose clamps are tight and secure.

☐ ☐ ☐ 20. Place generator set in the RUN position.

☐ ☐ ☐ 21. Verify the engine low oil pressure and high coolant temperature shutdowns.*

☐ ☐ ☐ 22. Check the overcrank shutdown.*

☐ ☐ ☐ 23. Check and verify any additional protection devices. List them:_________,_________,__________

Yes No N/A

☐ ☐ ☐ 24. Check the utility source voltage, frequency, and phase sequence on three-phase models. The generator set must match the utility source and load.

☐ ☐ ☐ 25. Place the generator set engine control switch in the OFF/RESET position.

☐ ☐ ☐ 26. Close the generator set main line circuit breakers connected to the transfer switch.

☐ ☐ ☐ 27. Place the generator set engine control switch in the RUN position.

☐ ☐ ☐ 28. Check the generator set voltage, frequency, and phase sequence on three-phase models. The generator set must match utility source and load.

☐ ☐ ☐ 29. Place the generator set engine control switch in the OFF/RESET position.

☐ ☐ ☐ 30. Record fuel pressure while running __________.

☐ ☐ ☐ 31. Place the transfer switch in the Test Position. NOTE: Obtain permission from the building authority before proceeding. This procedure tests transfer switch operation and connects building load to generator set power.

☐ ☐ ☐ 32. Readjust frequency to 60 Hz with total building loads.* Verify no load frequency to be no more than 62.0. Adjust if necessary (Mechanical governor only).

☐ ☐ ☐ 33. Verify that the AC current is balanced for three phase systems and record. L1_____L2_____L3_____.

☐ ☐ ☐ 34. Release the transfer switch test switch. The transfer switch should retransfer to the utility source after appropriate time delay(s).

☐ ☐ ☐ 35. Allow the generator set to run and shut down automatically after the appropriate cool down time delay(s).

☐ ☐ ☐ 36. Perform a proper fuel system setup with a wide range O2 sensor. Record air/fuel ratio (AFR) NO LOAD_____ BUILDING or FULL LOAD_____ With Load Bank_____. If Building Load used list AMPS_____(only required on gas units 80 kilowatts and larger).

☐ ☐ ☐ 37. If equipped, set the plant exerciser with load to the customer's required exercise period.

☐ ☐ ☐ 38. Verify that all options on transfer switch are adjusted and functional per the customer's requirements. Transfer Switch delay setting: TDES____TDE____ TDN____TDEC____.

☐ ☐ ☐ 39. In phase monitor ON____ Setting______OFF____ .

☐ ☐ ☐ 40. If possible, run the building loads with the generator set or perform the load bank test if required.

☐ ☐ ☐ 41. Verify that the customer has the appropriate engine/generator set and transfer switch literature and manuals. Instruct the customer in the operation and maintenance of the system.

Pre-Start/Running Checks

BLUE STAR Power Systems Inc.

Check only those that apply to the specific application.

Time of Day	Gen. Amps	Gen. Volts	Gen Freq.	Amb. Temp.	Oil Press.	DC Charg. Volts.	Water Temp.	Run Time Meter	Notes:

Instruct customer on function and operation of total system.

Was the mode switch left in the automatic position for auto start? Yes_____ No_____(Explain)

NOTES

I ACKNOWLEDGE THAT I HAVE RECEIVED TRAINING ON THIS UNIT

Please Print Customer Name	Company Name	Customer Signature	Date

I ACKNOWLEDGE THAT I HAVE ADMINISTERED TRAINING TO THE CUSTOMER ON THIS UNIT Yes_____ No_____

Please Print Factory Authorized Personnel Name	Company Name	Factory Authorized Personnel Signature	Date

THIS UNIT HAS BEEN INSTALLED TO FACTORY SPECIFICATIONS

Please Print Customer Name	Company Name	Customer Signature	Date

THIS UNIT HAS BEEN INSTALLED TO FACTORY SPECIFICATIONS

Please Print Factory Authorized Personnel Name	Company Name	Factory Authorized Personnel Signature	Date

Volvo Registration

Product Registration Update Form

This form is to be used to update owner information with Volvo Penta of the Americas in the event of a change of address or transfer of ownership.

Product Information:

Engine serial number(s) ______________________________

Other components serial number(s) ______________________________

Request Type:

☐ Change of address ☐ Change of ownership

New owner and / or new address information (proof of ownership required):

Name ______________________________

Address ______________________________

City ____________ State ____________ ZIP ____________

For transfer of ownsership only:

Original owner (if known) ______________________________

Reselling dealer (if any) ____________ Transfer date ____________

Contact in the event additional information is needed (proof of ownership required):

Contact Name ______________________________

Telephone ____________ Fax ____________ E-mail ____________

Mail-In Registration

MAILING INFORMATION
(Return Address)

____
____
____
____

Volvo Penta of the Americas, LLC

1300 Volvo Penta Drive

Chesapeake, VA 23320

This Engine Registration Form must be filled out completely and mailed in to Volvo Penta of Americas to receive engine warranty.

Gen-Set Installation Guide

BLUE STAR
Power Systems Inc.

IMPORTANT SAFETY INSTRUCTIONS - SAVE THESE INSTRUCTIONS

This guide contains important instructions for Blue Star Power Systems, Diesel and Gaseous Engine Driven Electric Generators. It should be followed during installation and maintenance of the generator unit.

Blue Star Power Systems, Inc. | 2250 Carlson Drive, North Mankato, Minnesota 56003 | Phone + 1 507 345 1776 | bluestarps.com

WARNING:

California Proposition 65 WARNING:

Engine exhaust produced by this product contains chemicals known to the state of California to cause cancer, birth defects and other reproductive harm.

California Proposition 65 WARNING:

Battery Posts, Terminals and related accessories contain chemicals known to the state of California to cause cancer, birth defects and other reproductive harm.

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FOREWORD

This installation guide is intended to provide general instructions for the safe and reliable installation of your Blue Star engine generator set. It is of the utmost importance that each and every person who performs work on this equipment is trained and familiar with the equipment and the contents of this entire installation guide.

Each installation is unique in some ways and may require variance or modification from the suggestions presented within this guide. If you are in doubt in any way during the installation process, please take a moment to consult with your authorized Blue Star Power Systems representative. They are trained and experienced in the installation and operation/maintenance of this equipment.

Note: The procedures presented in this guide are suggestions. They are not intended to address every circumstance that can and will arise during the installation process. It is the responsibility of the Owner/Operator to arrange for these to be performed by licensed individuals that regularly engage in this type of work.

It is the responsibility of the Owner/Operator to ensure that all aspects of the installation are performed in accordance with all Federal/State/county and local codes, and in accordance with the requirements of the authorities having jurisdiction.

APPLICABLE CODES AND STANDARDS

Prior to installation, you should obtain and familiarize yourself with the following codes and standards that are referenced within this guide and that may/will govern how the equipment is installed:

National Fire Protection Association (NFPA)

NFPA 30: Storage, handling and use of flammable liquids.

NFPA 37: Stationary combustion engines and gas turbines.

NFPA 54: National Fuel Gas Code.

NFPA 70: National Electrical Code.

NFPA 77E: Arc Flash Safety.

NFPA 99: Essential Electrical Systems for Health Care Facilities.

NFPA 101: Life Safety Code Number Systems.

NFPA 110 2010: Emergency and Standby Systems.

National Electrical Manufacturers Association (NEMA)

Local codes enforced by the authority having jurisdiction.

The information presented within this guide is of the latest and up to date as of the publication date. Blue Star Power Systems, Inc. reserves the right to change/update this publication and the information contained within, without notice, obligation or liability whatsoever. Blue Star Power Systems does not guarantee the satisfactory results of any installation performed using the information contained in this guide. Nor will Blue Star Power Systems assume responsibility for any injury or damage to property as a result of the use of this guide. Persons engaging in product installation do so at their own risk.

Once again, if you are in doubt in any way about the procedures for safe and proper installation of this product, stop now and consult your authorized Blue Star Power Systems representative. They are trained and experienced in the installation and operation/maintenance of this equipment.

PRODUCT IDENTIFICATION

Locate and record the unit model and serial numbers from the unit nameplate (usually affixed near the controller) immediately after unpacking the equipment. Record the information in the space provided below for future reference when requesting assistance or information regarding this equipment.

Unit Model Number:______________________________________

Unit Serial Number:______________________________________

SAFETY PRECAUTIONS AND WARNINGS

Important safety Instructions: Electromechanical equipment, including generator sets, transfer switch equipment and accessories can cause bodily harm and pose life threatening danger when improperly installed, operated, maintained or accessed.

The terms **DANGER**, **WARNING** and **CAUTION** are used throughout this guide to alert the installer/operator to special instructions concerning particular procedures that may be hazardous if performed incorrectly. These safety alerts alone cannot eliminate the hazards that they signal. Strict adherence to these special instructions and common sense operation of the equipment are the best accident prevention measures.

Observe all warning labels found on the equipment. Ensure that all warning labels remain affixed and intact, and are not obstructed with dirt, grease or other equipment.

Blue Star Power Systems Inc. cannot anticipate every possible circumstance that may involve a hazardous situation. The warnings contained in this guide as well as the tags and labels affixed to the equipment, are therefore not to be considered all inclusive.

Definitions:

DANGER: Indicates the presence of a hazard that WILL cause severe personal injury, death or substantial property damage.

WARNING: Indicates the presence of a hazard that CAN cause severe personal injury, death or substantial property damage.

CAUTION: Indicates the presence of a hazard that CAN or WILL cause minor personal injury or property damage.

HIGH VOLTAGE: Indicates that high voltage may be present in this vicinity or while performing this procedure.

Additional Safety Precautions:

DANGER: Risk of Electrical Shock. The equipment ground connection on this equipment must be suitably connected to earth ground in accordance with NFPA 70. This equipment shall not be used in “floating neutral” applications.

WARNING: Be aware that once the engine starting batteries are connected, this equipment can and will start automatically. Use extreme caution or disconnect the engine starting batteries prior to servicing or making adjustments.

CAUTION: Prior to servicing the unit, remove power to all energized circuits, such as a battery charger, coolant heaters, or any device that remains energized during servicing functions.

CAUTION: Wear eye protection when operating or servicing this equipment. Flying debris and/or acid/gases from the engine starting batteries could be present during equipment operation and normal battery charging.

SITE PLANNING AND SELECTION

Outdoor, enclosed units:

Choose a site that allows adequate clearance around the unit for ancillary equipment, fuel storage/supply and routine servicing. The site should be level, not subject to flooding and in compliance with local codes and ordinances.

The Unit is to be installed in a location that minimizes the risk of people coming in contact with hot surfaces. **Unless specified otherwise**, the maximum ambient operating temperature rating of the unit is 50° C/ 122°F.

Allow adequate clearance for engine radiator air discharge so as not to restrict cooling air flow.

CAUTION: Allow adequate clearance for engine exhaust discharge, keeping in mind the high temperatures and fumes associated with engine exhaust. Do not direct engine exhaust toward other structures or their air intake means.

CAUTION: Internal combustion engines can produce high noise levels. Choose a location where sound levels during operation will not be objectionable.

CAUTION: In northern climates, provide a suitable means to prevent the accumulation and penetration of blowing snow.

WARNING: Open bottomed stationary engine generator sets must be installed over/on non combustible materials and shall be located such that it prevents the accumulation of combustible materials under or inside the generator set. Provide a suitable means to prevent the accumulation of leaves and debris.

See the Mounting Pad Construction Section for typical foundation/inertia pad construction details. For any other application, consult a structural engineering firm for proper design to meet the application requirements.

Indoor Units:

Engine generator sets must be protected from the elements, and be provided with adequate ventilation and cooling air.

Considerations when selecting a room size and location:

DO NOT USE THE GENERATOR ROOM FOR STORAGE OF ANY MATERIALS NOT ASSOCIATED WITH THE GENERATOR SET.

The room should be sized to adequately accommodate the unit and all of the ancillary equipment such as fuel supply/storage, starting batteries and charging equipment, cooling and exhaust system components and automatic transfer switch equipment.

Allow a minimum of three feet of clearance on each side and radiator end, and five feet on the end opposite the radiator for servicing

The fuel storage tank for diesel driven units should be located as close as possible to the unit.

Allow for clearance between hot components (such as exhaust system) and combustible materials.

Consult local building/safety codes for specific applicable requirements. Fire rating codes and requirements must be adhered to.

Utilizing a generator set with a unit mounted radiator/cooling system is the most cost effective solution when allowable. However, the room must be situated such that sufficient cooling air can be brought into and exhausted to allow proper cooling of the equipment. Utilizing opposing exterior walls for radiator cooling air supply and radiator discharge is the most effective and cost efficient when possible. Avoid utilizing the same wall for air intake and discharge.

Consult your Blue Star Power Systems representative for installation guidance for remote cooled unit applications.

Verify the load carrying capacity of the floor. Involve a structural engineering firm if in doubt or for applications where an inertia pad similar in Figure 2 in the Appendices cannot be utilized.

See the exhaust system section for pertinent information regarding exhaust system considerations.

Utility Power: Make sure there is an adequate source of utility power available to supply the ancillary equipment necessary for support while the gen-set is not in operation (Heaters, Chargers, Etc).

WARNING: Open bottomed stationary engine generator sets must be installed over/on non combustible materials and shall be located such that it prevents the accumulation of combustible materials from accumulating under or inside the generator set.

UNIT LIFTING PROVISIONS

For safety and convenience, all Blue Star generator sets are provided with a means to lift the unit from the skid base. There are two basic types of lifting devices (See Figure 1 in the Appendices). Smaller units are provided with holes in the skid base by which to attach chain hooks. Larger units are provided with removable lifting brackets for chain attachment. In both instances, the use of chain spreader bars or equipment to suit the particular situation is required to prevent the lifting chains from damaging the unit during lifting. Due to the vast amount of variation in units, lifting equipment and circumstances; the safest means to lift the equipment without damage is at the sole discretion of the lifting equipment operator.

The use of the individual engine and generator lifting devices shown on the diagrams are NOT to be used to lift the entire engine generator set. These devices were designed to lift only their respective component and not the complete unit. Lifting a complete unit by means of the engine and generator lifting devices will be done solely at the lifting equipment operator's discretion and assumed risk.

See Figure 1 in the Appendices for typical lifting devices drawing.

MOUNTING PAD CONSTRUCTION

Blue Star Engine Generator Sets should be installed on a concrete pad that is properly sized to support the weight load of the unit and all associated accessories that will be installed with it as well as reduce transmitted vibration to acceptable levels. The weight of your particular unit can be found on the unit specification sheet provided in the operator's manual provided with the unit. If your unit is equipped with a sub-base fuel tank, you must include the weight of the fuel tank and fuel in your weight calculations.

CAUTION: The design criteria presented within this guide are general guidelines only. Check local building codes and ordinances for proper composition, design criteria and clearances. Consult a structural engineering firm for assistance with the design and certification of any supporting structure that is not placed directly on the ground.

CAUTION: The unit dimensions listed on the model specification sheets provided in the operators manuals are general dimensions for open type units. The overall dimensions of any particular unit can vary greatly depending on the configuration and accessories ordered. If in doubt about the physical size of any particular unit, contact your local Blue Star Power Systems Inc representative for unit specific drawings prior to proceeding.

Common specifications require 2500 PSI concrete, reinforced with eight gauge wire mesh or #6 reinforcing bars on 12 inch centers. The minimum recommended thickness of the pad can be calculated by using the formula below. If the weight per Ft^3 of the specific concrete being used is unknown, use 145 pounds per Ft^3, (which is a general average) for the calculations below.

To reduce vibration transmission to the surrounding areas, a sub-surface layer of sand or gravel should be used. Consult a qualified structural engineer for recommendations.

The overall width and length of the mounting pad should be a minimum of 12 inches longer and wider than the skid base of the unit being mounted. It is normally desirable to extend the mounting pad three to six inches above the surrounding concrete or grade for ease of service and cleaning.

Formula for calculating minimum mounting pad thickness:

$$Minimum\,Pad\,Thickness\,(Ft) \;=$$
$$\left[\frac{(Weight\,Of\,Unit\,(Lbs) + Accessories\,(Lbs))}{[(Concrete\,Wt\,/\,Ft^3) \times (Pad\,Width\,(Ft)) \times (Pad\,Length\,(Ft))]}\right]$$

See Figure 2 in the Appendices for Typical Indoor Genset Installation.

MOUNTING AND VIBRATION ISOLATION

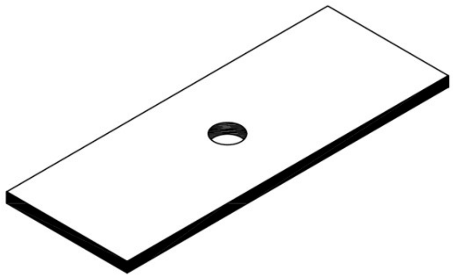
Also see vibration isolation requirements in subsequent sections relative to fuel, exhaust and electrical.

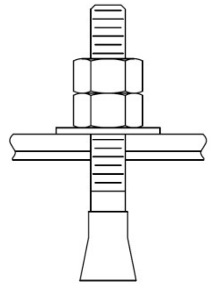
Noise and vibration are normal by-products of any internal combustion engine driven generator.

Vibration reducing mounts are generally used to secure the engine generator set to the concrete mounting pad. The purpose of such mounts is to reduce the amount of noise and vibration that is transmitted to the mounting pad during unit operation. Installations within buildings that have adjacent areas designated for other uses should be reviewed by a structural engineer to ensure that transmitted noise and vibration are reduced to unobjectionable levels.

There are typically two types of vibration reducing mounts used:

Pad type vibration mounts, which are simple and effective for most applications, are placed between the engine generator set base frame and the concrete mounting pad. They are sized according to the weight of the unit and accessories and should be placed at each mounting point designed into the generator set skid base. To allow the vibration isolation pads to function properly, the nuts on the anchor bolts holding the unit to the mounting pad should be left loose and "double-nutted" as opposed to being tightened down. Refer to the illustration below.

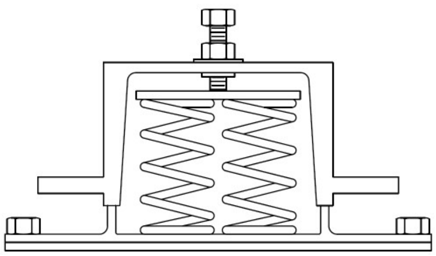




Pad Type Vibration Mount

Expanding Anchor Bolt

Spring type vibration mounts are designed for a higher level of vibration and noise isolation for critical installations. If your particular generator set was provided with spring type mounts, please refer to the operator's manual provided with the unit for installation details for the particular mount that was provided.



Spring Type Vibration Mount

COOLING SYSTEMS AND AIR REQUIREMENTS

CAUTION: In cold climate areas, the high volume of outside air that will be drawn into the generator room can quickly reduce temperatures within the room to sub-freezing levels. All water piping and other equipment subject to damage by freezing temperatures should be relocated or properly insulated to prevent damage.

The cooling system is one of the most critical aspects of any generator set installation. Careful planning must be exercised to insure that adequate ventilation will be available during operation under all possible climatic conditions.

Cooling systems can range in complexity from the simplest and most common "unit mounted radiator" to the most elaborate, remote mounted radiator, heat exchanger or heat recovery system. It would be inconceivable to properly cover all possible cooling system applications in a guide of this type. For that reason, only unit mounted radiator cooling systems will be described within. Please consult your local Blue Star Power Systems representative for design, application and installation assistance for all cooling system applications other than unit mounted radiator cooling.

Installation considerations for unit mounted radiator cooling systems:

Prevailing wind: should be a key factor in deciding which direction to discharge the cooling air that will be exhausted out through the unit mounted radiator. Wind pressure may reduce the amount of air the engine mounted cooling fan can discharge through the unit mounted radiator, causing poor performance or overheating. Consider which direction the wind is usually out of during the hottest days of the year, when the cooling system will require the maximum amount of cooling airflow possible.

Noise: The fans required to move air through a unit mounted radiator cooling system will produce a fair amount of noise. Consider positioning the radiator exhaust in a direction less subject to objectionable noise levels.

Hot air discharge: At times, the cooling air discharged through a unit mounted radiator cooling system can reach levels that could damage shrubs, bushes and plantings. This is of particular a concern if the unit will be operated for extended periods of time during high ambient temperature periods. Choose the placement direction accordingly.

Recirculation of cooling air: The most common cause of unit overheating is cooling air recirculation. When hot air that's discharged through the radiator is allowed to re-circulate back into the cooling air intake means and through the radiator again, the cooling air can exceed the temperature capabilities of the cooling system causing overheating. If at all possible, the cooling air intake and discharge means should be located on opposing walls or be drawn from and exhausted to opposing directions.

Excessive external static pressure within the cooling system: The location of the unit relative to the cooling air intake and exhaust should be such that the need for air ducting is kept to a minimum. For proper operation, all extended air ducting should be sized to maintain the total cooling system external restriction to less than 0.50 inches H_2O. Indoors, the radiator discharge must be ducted with flexible material when installing to the wall opening.

See Figure 1 in the Appendices for Typical Unit Mounted Radiator Installation

Sizing cooling air inlet and exhaust openings for unit mounted radiator cooling systems:

Adequate cooling air flow is critical to the proper operation of any engine generator set. These recommendations are presented in terms of "effective opening" which is the amount of open area of which air is allowed to flow through a device.

Air intake: As a general rule, the "effective opening" of any device used as an air intake means to the engine generator set should be a **minimum of 75% larger in "effective opening"** than the units' radiator core . (See example)

Air exhaust: As a general rule, the "effective opening" of any device placed in front of the unit mounted radiator as an air discharge device should be a **minimum of 50% larger in "effective opening"** than the radiator core itself. The device and the radiator core duct adapter should be connected by ductwork of minimal length, and shall be fitted with a flexible section installed at the radiator end.

FORMULA:

$$(Radiator\ Core\ Length(In.)) \times (Radiator\ Core\ Width(In.)) = (Radiator\ Core\ Area(In.^2))$$
$$(Radiator\ Core\ Area(In.^2)) \times (1.75) = (Effective\ Opening\ Required(In.^2))$$
$$(Effective\ Opening\ Required(In.^2)) \div (Required\ Effectiveness(\%)) = (\text{Required Louver Size}(In.^2))$$

Next, the louver dimensions (In^2) can be converted to ft^2 by dividing the 'Required Louver Size' by 144. Louvers can then be chosen based on the physical layout of the room and what's available for louver sizes, so long as the length x width is equal to the 'Required Louver Size' in Ft^2.

See Figure 2 in the Appendices for drawing of typical fixed louver installation.

Various types of air intake and exhaust devices:

Fixed Blade Louvers: Generally used as air intake devices. The angled stationary blades allow cooling air to flow into a room or enclosure while keeping out the elements and debris. A bird/rodent screen should be installed on the back (inside) of the louver to prevent pest activity within the generator room.

Gravity Operated Louvers: Can only be used as air exhaust devices. The hinged louver blades are held open by the discharge airflow during unit operation and fall shut by gravity when not in operation. The use of ductwork to prevent cooling air recirculation is an absolute must when using gravity exhaust louvers.

Motor Operated Intake Louvers: Perform the same basic function as fixed intake louvers except that they close to keep out the elements when the unit is not in operation. The desired mode of operation is such that the louver motor is "energized to close" and opens when power is removed.

Motor Operated Exhaust Louvers: Differ from motor operated intake louvers as the blades open to a full 90° position to allow the higher velocity, exhausted air to flow with less restriction. The desired mode of operation is such that the louver motor is "energized to close" and opens when power is removed.

CAUTION: Care should be taken to verify the mode of operation of the motorized louver being installed (Either energize to close or energize to open) to insure that power is supplied or removed as needed in all modes of operation. IE: During periods of test/exercise, actual power failure, simulated power failure Etc. Improper control sequence/wiring could cause the louvers to remain closed while the unit is in operation causing an overheat condition, shutdown or damage to the unit or accessories.

In some extreme cold climatic applications, the use of thermostatically controlled louvers may be used to reduce problems associated with fuel system icing/gelling, engine overcooling Etc. Contact your Blue Star Power Systems Representative for assistance in these applications.

EXHAUST SYSTEMS

The purpose of the exhaust system is to safely discharge the engine combustion exhaust gasses to a safe area outside of the building or structure.

WARNING: Engine combustion exhaust fumes are deadly. Never allow the exhaust outlet termination to be positioned such that exhaust gasses will be directed toward any air entry routes (doors, windows, air intake vents, Etc) of an occupied building. When choosing the location for the discharge termination, do not direct it towards anything that could catch fire or be damaged by high temperatures.

See Figure 3 in the Appendices for a Typical Exhaust Systems Drawing

Exhaust system consideration checklist:

A. Exhaust outlet terminations are not located upwind or near any building air intakes.
B. A flexible piping section of suitable design is used to prevent the transmission of vibration to the exhaust piping which is extended beyond what was provided with the unit from the factory.
C. The exhaust piping materials are suitable for the temperatures expected and as published for the particular unit. These temperatures can sometimes exceed 1200°F (649°C).
D. Extended piping is adequately sized to prevent excessive engine exhaust system back pressure as published for the particular unit. Consult your Blue Star Power Systems representative for assistance in the design of lengthy or elaborate exhaust system requirements.
E. Exhaust piping components are properly insulated to prevent operator exposure to excessive temperatures.
F. Ventilated wall thimbles, piping sleeves or other suitable fire-proof materials are used where piping passes through building materials as per all state and local codes.
G. Exhaust pipe termination includes a rain cap or other suitable means to prevent the entrance of rain, debris and pests when not in operation.
H. All exhaust system components and extended piping beyond what was provided with the unit from the factory is adequately supported to prevent damage to these components during operation.
I. The overall exhaust system is oriented to provide a slight downward slope away from the engine to prevent condensation from draining back into the engine.

FUEL SYSTEMS

General:

The fuel delivery system must be adequately sized and properly installed to provide an ample supply of fuel for starting and running the unit throughout the duration of any emergency event. Prior to connecting the fuel lines, ensure that the fuel connections are free of dirt, grease, water or other foreign matter that could damage the engine.

The components required for a complete fuel system will vary depending on the fuel type, unit location and applicable state and local codes. The aforementioned is to be used only as a guide. It is the fuel system installers' responsibility to ensure that the overall fuel delivery system is of a safe and code compliant design.

DIESEL FUEL SYSTEMS

The following components comprise a typical diesel fuel delivery system:

A. Main fuel storage tank, sized for the desired length of run time.
B. Main fuel tank fill pipe with a suitable cap.
C. Main fuel tank vent line.
D. Fuel supply line with a foot/check valve.
E. Fuel return line.
F. Fuel storage "Day Tank" with transfer pump if required.
G. Fuel level switches as required for controls.

Main Fuel Storage Tank:

The ideal location for the main fuel storage tank is as close to the unit as possible. Provided that applicable building and fire codes permit, the tank could be located within the same, or in an adjoining room to the unit. If this is not feasible, the tank should be located in a suitable location according to applicable state and local codes.

The fuel level in the main tank should be at the same height as the engines fuel transfer pump inlet. If located within the generator room, the tank should be placed on the same general level as the unit, but lower than the engine's fuel injectors. If the tank must be placed at a level above or below this, a separate priming or float tank may be required. When the main fuel storage tank can be located close to the unit and the vertical "fuel lift" is five feet or less, the engines' fuel pump may be adequate for supplying fuel to the engine without additional means. If the horizontal run is excessive or the vertical lift exceeds five feet, a fuel "Day Tank" and fuel transfer pump will be required.

All fuel storage tanks must be vented to a safe area to allow air and other gasses to escape to atmosphere. The vent termination must be plumbed to a level above the highest point in the system to prevent spillage in the event of an overfill situation. The vent pipe termination should be suitable to prevent dust, dirt, moisture and pests from entering the tank.

GASEOUS FUEL SYSTEMS

Gaseous fuel systems should be sized and installed by qualified/authorized personnel only. Fuel piping shall be rigidly supported along its entire length and protected against damage from vibration. An AGA or UL approved flexible connector should be installed at the fuel inlet to the unit to prevent the transmission of vibration to the fuel piping.

Gaseous fuel systems are grouped into four basic types.

1. Natural Gas
2. LP - Vapor Withdrawal
3. LP – Liquid Withdrawal
4. LP/NG Dual Fuel

Each fuel system type is covered below.

Natural Gas Fuel Systems: Natural gas is a vapor fuel that is supplied primarily by utilities. The BTU content of the natural gas available in most locations is 1000 BTU/Ft^3. If the BTU content at the site location is below 1000 BTU/Ft^3 the unit may have to be derated accordingly. The local gas utility will provide fuel piping from the gas main to the site location. A primary gas regulator should be provided by the utility. It is the responsibility of the gas utility to ensure that adequate volume and gas pressure are available at all times to insure proper operation. Consult the unit specification sheet located in the Operation & Maintenance Manual provided with your particular unit for the required fuel type, volume, and pressure requirements.

LP – Vapor Withdrawal Fuel Systems: Liquefied Petroleum Gas is a liquid fuel that is supplied primarily by fuel distributors. Vapor Withdrawal is the most common type of LP fuel system. The LP fuel within the tank is vaporized within the tank and is drawn under pressure from the top of the tank, above the level of the fuel. The BTU content of LP Gas is 2500 BTU/Ft^3. The local gas provider will provide fuel piping from the storage tank to the site location. A primary gas regulator should be provided by the fuel provider. It is the responsibility of the fuel provider to ensure that adequate volume and gas pressure are available at all times to insure proper operation. Consult the unit specification sheet located in the Operation & Maintenance Manual provided with your particular unit for the required fuel type, volume, and pressure requirements.

See Figure 4 in the Appendices for SINGLE FUEL NG/LP VAPOR WITHDRAWL Drawing

LP – Liquid Withdrawal Fuel Systems: Liquefied Petroleum Gas is a liquid fuel that is supplied primarily by fuel distributors. Liquid Withdrawal is the most commonly used type of LP fuel system when large volumes of fuel are required. The LP fuel within the tank is drawn under pressure (in the liquid form) from the bottom of the tank, below the level of the fuel and is converted to vapor by a fuel converted mounted on the engine. The BTU content of LP Gas is 2500 BTU/Ft^3. The local gas provider will provide fuel piping from the storage tank to the site location. It is the responsibility of the fuel provider to ensure that adequate volume and gas pressure are available at all times to insure proper operation. Consult the unit specification sheet located in the Operation & Maintenance Manual provided with your particular unit for the required fuel type, volume, and pressure requirements.

Fire regulations prohibit the installation or entrance of high pressure or liquid LP fuel piping into an occupied building or enclosure.

See Figure 5 in the Appendices for SINGLE FUEL LP LIQUID WITHDRAWL Drawing

LP/NG Dual Fuel Systems: Dual fuel systems allow for Natural gas to be used as the primary fuel and LP gas to be used as a backup should the natural gas supply be interrupted. There are two types of dual fuel systems available. Manual changeover systems which require qualified personnel to manually open and close valves and switches to change fuels and automatic changeover systems which monitor the primary fuel pressure and changeover automatically should the pressure be reduced to an unacceptable level. Consult the operation and Maintenance Manual that was provided with your particular unit for further instruction, system type, and volume and pressure requirements.

See Figure 6 in the Appendices for DUAL FUEL NG/LP VAPOR WITHDRAWL AUTO CHANGEOVER Drawing

See Figure 7 in the Appendices for DUAL FUEL NG/LP LIQUID WITHDRAWL AUTO CHANGEOVER Drawing

Gas Fuel System Design Considerations:

Gas piping shall not be used as a grounding means for electrical equipment.

The fuel system should incorporate a manual fuel lock-off valve to allow for maintenance of the system.

Refer to the typical installation drawings below for recommended fuel system components.

All gas piping should be sized to maintain adequate volume and pressure at the engine fuel inlet while operating under full load. Overall length of run and number of elbows and fittings must be taken into consideration.

General Guidelines for Determining Pipe Size for Gaseous Vapor Fuel Systems

1. Obtain the engine fuel consumption in cubic feet per hour at 100% load from the unit model specification sheet for the type of fuel used.
2. Refer to the correction factor chart below to determine the proper correction factor for the type of fuel being used.

Correction Factors For Fuel Specific Gravity		
Fuel Type	Specific Gravity	Correction Factor
Natural Gas	0.65	0.962
Air	1.00	0.775
Propane	1.50	0.633
Butane	2.10	0.535

3. Divide the fuel consumption from step 1 by the appropriate correction factor to obtain the corrected flow rate.
4. Determine the "straight pipe equivalent length" for all of the fittings in the piping system from the chart below.

Equivalent Length of Straight Pipe for Valves and Fittings (in Feet)												
Screwed Fittings		Pipe Size (Nominal)										
		1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Elbows	Regular 90˚	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0
	Long Radius 90˚	1.5	2.0	2.2	2.3	2.7	3.2	3.4	3.6	3.6	4.0	4.6
	Regular 45˚	0.3	0.5	0.7	0.9	1.3	1.7	2.1	2.7	3.2	4.0	5.5
Tees	Line Flow	0.8	1.2	1.7	2.4	3.2	4.6	5.6	7.7	9.3	12.0	17.0
	Branch Flow	2.4	3.5	4.2	5.3	6.6	8.7	9.9	12.0	13.0	17.0	21.0
Valves	Globe	21.0	22.0	22.0	24.0	29.0	37.0	42.0	54.0	62.0	79.0	110.0
	Gate	0.3	0.5	0.6	0.7	0.8	1.1	1.2	1.5	1.7	1.9	2.5
	Angle	12.8	15.0	15.0	15.0	17.0	18.0	18.0	18.0	18.0	18.0	18.0
Strainer		4.1	4.6	5.0	6.6	7.7	18.0	20.0	27.0	29.0	34.0	42.0

5. Add the "equivalent length" to the total length of straight pipe within the system.
6. From the table below, choose the column with the nearest "total" pipe length.
7. Move down the column until the capacity figure in cubic feet per hour is encountered.
8. Move horizontally to the left to obtain the suggested pipe size.

Gaseous Fuel Pipe Capacities in Cubic Feet Per Hour												
Pipe Size (Inches)	Total Equivalent Length of Pipe in Feet											
	10	20	30	40	50	60	70	80	90	100	150	200
1/4	43	29	24	20	18	16	15	14	13	12	10	8
3/8	95	65	52	45	40	36	33	31	29	27	22	19
1/2	175	120	97	82	73	66	61	57	53	50	40	35
3/4	360	250	200	170	151	138	125	118	110	103	84	72
1	680	465	375	320	385	260	240	220	205	195	160	135
1 1/4	1400	950	770	660	580	490	460	460	430	400	325	280
1 1/2	2100	1460	1180	990	900	810	750	690	650	620	500	430
2	3950	2750	2200	1900	1680	1520	1400	1300	1220	1150	950	800
2 1/2	6300	4350	3520	3000	2650	2400	2250	1050	1950	1850	1500	1280
3	11000	7700	6250	5300	4750	4300	3900	3700	3450	3250	2650	2280
4	23000	15800	12800	10900	9700	8800	8100	7500	7200	6700	5500	4600

See following page for an example

Example:

Engine Generator set fuel consumption at 100% load running on natural gas equals 1600 Cubic feet per hour.

The correction factor for natural gas is 0.962. Therefore 1600 ÷ 0.962 = 1633 (adjusted flow rate).

Reading down the 100 foot pipe length column in the capacity table until a capacity equal to or greater than 1633 is obtained, which is 1850.

Reading across to the left, we see that 2 ½ inch piping will be required.

BATTERIES AND STARTING SYSTEMS

Engine starting batteries need to supply adequate current and voltage to the engine starter motor as indicated on the specific model specification sheet located in the operation and maintenance manual provided with the unit. If the unit has one battery, the DC system voltage is 12VDC Nominal. If the unit has two or four batteries, the DC system voltage is 24VDC Nominal.

When supplied, all lead acid batteries are shipped pre filled with electrolyte unless specified otherwise.

After installation, coat battery terminal connections with anti-corrosion compound to minimize corrosion.

Check battery electrolyte level and ensure all vent caps are in place and secure weekly.

Servicing of batteries are to be performed or supervised by personnel knowledgeable of batteries and the required precautions. Keep unauthorized personnel away from batteries.

When replacing batteries, use the same number and the following type batteries: Vented Lead Acid Engine Starting. Refer to the specific unit specification sheet provided in the operator manual with the particular unit for the battery size.

CAUTION – Do not dispose of battery or batteries in a fire. The battery is capable of exploding.

CAUTION – Do not open or mutilate the battery or batteries. Released electrolyte has been known to be harmful to the skin and eyes and to be toxic.

CAUTION – A battery presents a risk of electrical shock and high short circuit current. The following precautions are to be observed when working on batteries:

1) Remove watches, rings, or other metal objects,
2) Use tools with insulated handles,
3) Wear rubber gloves and boots,

4) Do not lay tools or metal parts on top of batteries,

5) Disconnect charging source prior to connecting or disconnecting battery terminals, and

The installation of the engine generator shall provide enough ventilation to ensure that gases generated by vented batteries during charging, or caused by equipment malfunction are removed.

CAUTION – The electrolyte is a dilute sulfuric acid that is harmful to the skin and eyes. It is electrically conductive and corrosive. The following procedures are to be observed:

1) Wear full eye protection and protective clothing,

2) Where electrolyte contacts the skin, wash it off immediately with water,

3) Where electrolyte contacts the eyes, flush thoroughly and immediately with water and seek medical attention.

4) Spilled electrolyte is to be washed down with an acid neutralizing agent. A common practice is to use a solution of one pound (500 grams) bicarbonate of soda to one gallon (4 liters) of water. The bicarbonate of soda solution is to be added until the evidence of reaction (foaming) has ceased. The resulting liquid is to be flushed with water and the area dried.

CAUTION – Lead-acid batteries present a risk of fire because they generate hydrogen gas.

The following procedures are to be followed:

1) DO NOT SMOKE when near batteries,

2) DO NOT cause flame or spark in battery area, and

3) Discharge static electricity from body before touching batteries by first touching a grounded metal surface.

CUSTOMER SUPPLIED BATTERY REQUIREMENTS

Customer supplied engine starting batteries must meet the performance criteria listed below.

Diesel Gen-set Models	No. of Batteries	Battery Voltage	Minimum CCA
JD30-XX	1	12	750
JD40-XX	1	12	640
JD50-XX	1	12	640

JD60-XX	1	12	640
JD60-XX	1	12	750
JD80-XX	1	12	800
JD100-XX	1	12	800
JD125-XX	1	12	800
JD150-XX	1	12	800
JD200-XX	1	12	800
JD250-XX	1	12	1100
JD275-XX	1	12	1100
JD300-XX	1	12	1100
PD20-XXX	1	12	600
PD30-XXX	1	12	600
PD50-XXX	1	12	600
PD60-XXX	1	12	600
PD80-XXX	1	12	600
PD100-XXX	1	12	600
PD125-XXX	1	12	1000
PD150-XXX	1	12	1000
PD160-XXX	1	12	1000
PD180-XXX	1	12	1000
PD200-XXX	1	12	1000
PD20-XXX	1	12	600
PD30-XXX	1	12	600
PD50-XXX	1	12	600
PD60-XXX	1	12	600
CD300-XX	2	24	750
JD350-XX	2	24	925
JD415-XX	2	24	925
CD500-XX	2	24	1425
VD100-XX	2	24	680
VD150-XX	2	24	750
VD200-XX	2	24	750
VD250-XX	2	24	900
VD300-XX	2	24	900
VD350-XX	2	24	900
Diesel Gen-set Models	No. of Batteries	Battery Voltage	Minimum CCA
VD400-XX	2	24	900
VD450-XX	2	24	900
VD500-XX	2	24	900
VD550-XX	2	24	900
VD600-XX	2	24	900
VD100-XXFT4	2	24	680
VD125-XXFT4	2	24	680
VD150-XXFT4	2	24	750
VD200-XXFT4	2	24	800
VD250-XXFT4	2	24	900
VD300-XXFT4	2	24	900

VD350-XXFT4	2	24	900
VD400-XXFT4	2	24	900
VD550-XXFT4	2	24	900
VD600-XXFT4	2	24	900
TD250-XX	2	24	800
TD275-XX	2	24	800
TD300-XX	2	24	800
TD350-XX	2	24	800
TD400-XX	2	24	800
TD450-XX	2	24	800
TD500-XX	2	24	800
TD550-XX	2	24	800
TD600-XX	2	24	800
MD800-XX	4	24	1100
MD1000-XX	4	24	1100
MD1250-XX	4	24	1100
MD1600-XX	4	24	1100
MD2000-XX	4	24	1100
Gas Gen-set Models	No. of Batteries	Battery Voltage	Minimum CCA
GM25-XX	1	12	650
PS25	1	12	650
PS40-XX	1	12	650
GM40-XX	1	12	650
GM50-XX	1	12	650
GM60-XX	1	12	650
GM100-XX	1	12	650
PS125-XX	1	12	650
PS130-XX	1	12	650
PS150-XX	1	12	650
NG150-XX	2	24	900
NG200-XX	2	24	900
NG265-XX	2	24	1000
NG300-XX	2	24	1000
NG350-XX	2	24	1000
NG400-XX	2	24	1000
NG425-XX	2	24	1000
NG500	2	24	1000
NG600	2	24	1000
NG650	2	24	1000

ELECTRICAL REQUIREMENTS

AC Output Connections:

Verify that the generator output voltage and phase as listed on the unit nameplate match the system voltage and phase to which it is to be connected.

Note: If the gen-set was provided from the factory without a main line circuit breaker, a main line circuit breaker must be provided by the installing contactor downstream of the gen-set load output terminals. The maximum number of circuit breakers installed downstream of the load output terminals is limited to six. The output load connection point on units supplied without a main line circuit breaker will be located in an externally mounted terminal block within an enclosure and will be permanently marked as such. The output load conductors must be connected to this connection point.

Note: The enclosures supplied with main line breakers in excess of 1200 amps are intended for bottom conduit/connection access only.

All wiring must be sized and installed in accordance with all applicable electrical code requirements and UL2200 requirements (See "Wire Sizing Guidelines" below). All conductors must be sized, insulated and supported in an approved manner.

Wire Sizing Guidelines (Based on UL2200 Requirements):
(Reference Section 12.1.3 & Table 62.3 of UL2200 Standard)

Load connection wires to circuit breaker / gen-set should be sized based on UL2200 requirements. The requirements are as follows:

Formula:

$$\frac{\text{Genset rated output} \;*\; 115\%}{0.88\ \text{(40C ambient correction)}}$$

Example:

$$\frac{\text{100A Rated Output} \;*\; 115\%}{0.88\ \text{(40C ambient correction)}} = 130.68181\ \text{Amps (Round up to 131 Amps)}$$

Note:

- If mainline circuit breaker is rated below calculated amps of formula, use calculated amps for wire sizing.
- If mainline circuit breaker is rated above calculated amps of formula, use circuit breaker rating for wire sizing.

Wire Sizing Selection Pre UL2200:

- Use 75C column of NEC (Table 310-16) (Even when using 90C or greater wire)
- Wire selection must have amperage rating above calculated amps or circuit breaker, whichever is greater.

A suitable earth ground must be connected to the grounding terminal marked with the symbol shown below:

All conduits terminating at the generator connection points must incorporate a flexible section to eliminate the transmission of vibration.

Refer to output circuit breaker nameplate data for wire sizing/type and pressure terminal torque values.

The tightening torque tables shown below are to be used as a guide.

Tightening torque for pressure wire connectors having screws

Size of wire that is to be used for connection of the unit		Tightening torque, pound-inches (N·m)			
		Slotted head no. 10 (4.7 mm) and larger[a]		Hexagonal head – external drive socket wrench	
AWG /kcmil	(mm^2)	Slot width – 0.047 inch (1.2 mm) or less; and slot length – 1/4 inch (6.4 mm) or less	Slot width – over 0.047 inch (1.2 mm); or Slot length – over 1/4 inch (6.4 mm)	Split-bolt connectors	Other connections
18 – 10	(0.82 – 5.3)	20 (2.3)	35 (4.0)	80 (9.0)	75 (8.5)
8	(8.4)	25 (2.8)	40 (4.5)	80 (9.0)	75 (8.5)
6 – 4	(13.3 – 21.2)	35 (4.0)	45 (5.1)	165 (18.6)	110 (12.4)
3	(26.7)	35 (4.0)	50 (5.6)	275 (31.1)	150 (16.9)
2	(33.6)	40 (4.5)	50 (5.6)	275 (31.1)	150 (16.9)
1	(42.4)	–	50 (5.6)	275 (31.1)	150 (16.9)
1/0 – 2/0	(53.5 – 67.4)	–	50 (5.6)	385 (43.5)	180 (20.3)
3/0 – 4/0	(85.0 – 107.2)	–	50 (5.6)	500 (56.5)	250 (28.2)
250 – 350	(127 – 177)	–	50 (5.6)	650 (73.4)	325 (36.7)
400	(203)	–	50 (5.6)	825 (93.2)	325 (36.7)
500	(253)	–	50 (5.6)	825 (93.2)	375 (42.4)
600 – 750	(304 – 380)	–	50 (5.6)	1000 (113.0)	375 (42.4)
800 – 1000	(406 – 508)	–	50 (5.6)	1100 (124.3)	500 (56.5)
1250 – 2000	(635 – 1016)	–	–	1100 (124.3)	600 (67.8)

NOTE – Connectors having a clamping screw with multiple tightening means (for example, a slotted, hexagonal head screw) are to be tested using both values of torque.

[a] For values of slot width or length not corresponding to those specified, select the largest torque value associated with the conductor size. Slot width is the nominal design value. Slot length is to be measured at the bottom of the slot.

Tightening torque for pressure wire connectors having internal drive socket head screws

Socket size across flats, inch (mm)[a]		Tightening torque, pound-inches (N·m)	
1/8	(3.2)	45	(5.1)
5/32	(4.0)	100	(11.4)
3/16	(4.8)	120	(13.8)
7/32	(5.6)	150	(17.0)
1/4	(6.4)	200	(22.6)
5/16	(7.9)	275	(31.1)
3/8	(9.5)	375	(42.4)
1/2	(12.7)	500	(56.5)
9/16	(14.3)	600	(67.8)

[a] See note a in Table 62.1 for screws with multiple tightening means.

Accessory Wiring:

It is recommended that all accessories requiring power be wired to a local panel being supplied by the load side of the transfer switch. This ensures that the accessories will be powered by whichever electrical source is available.

All accessory wiring should per Class 1 wiring methods and should be run in conduits separate of the generator output conductors. AC and DC accessory circuits should also be run in separate conduits.

All accessory wiring is to be terminated within the interface connection box provided and labeled as such.

Verify that the nameplate voltage of the accessories match the system voltage that will be supplying them.

Refer to the electrical wiring diagrams provided in the Operation and Maintenance Manual provided with the particular unit for further wiring details.

AUTOMATIC TRANSFER SWITCHES

Automatic transfer switch installation should be provided by a licensed electrician. Refer to the detailed wiring diagrams and installation instructions that are provided with the equipment.

1) Unbalanced load capability when the output has a neutral conductor.

The Appendices

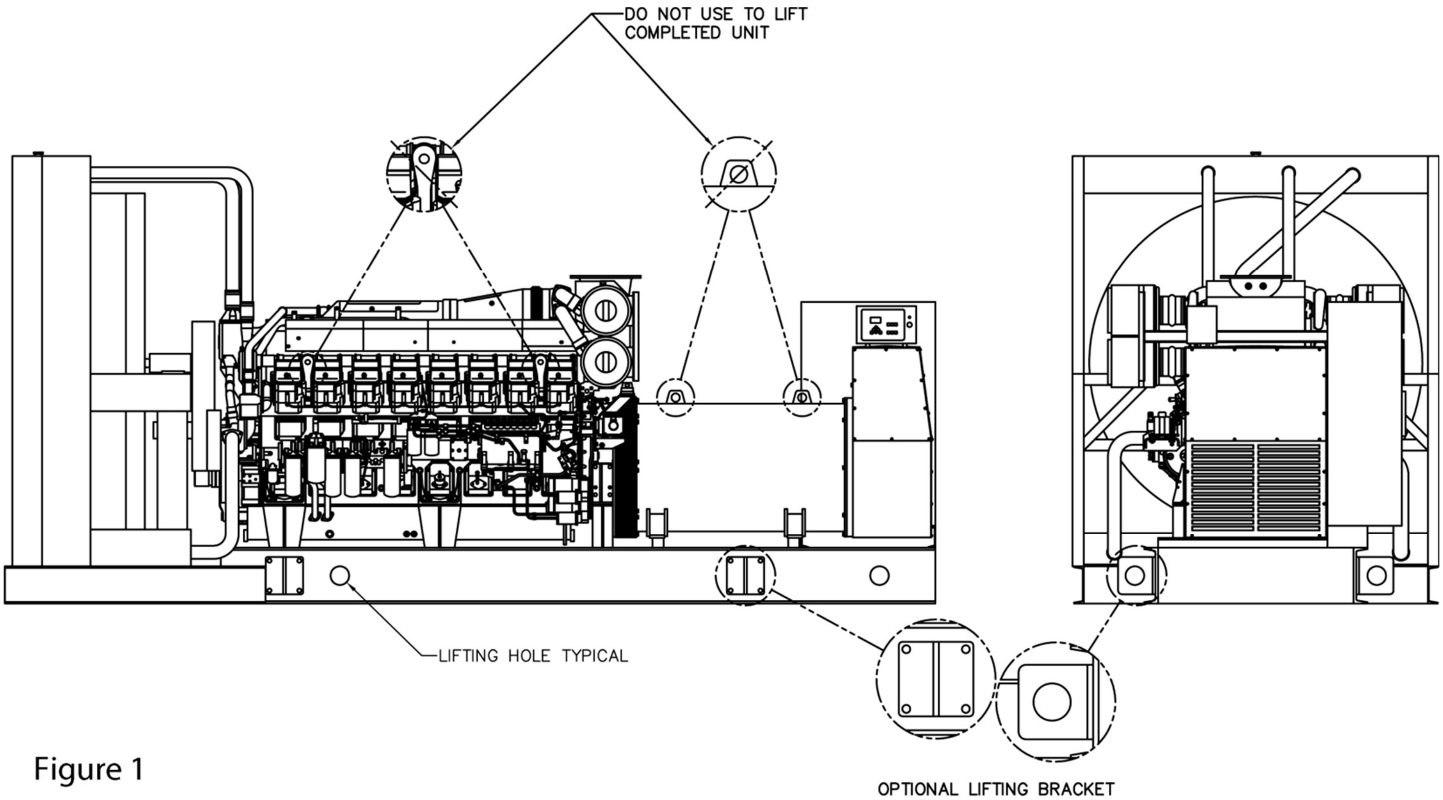


Figure 1

Typical Lifting Devices

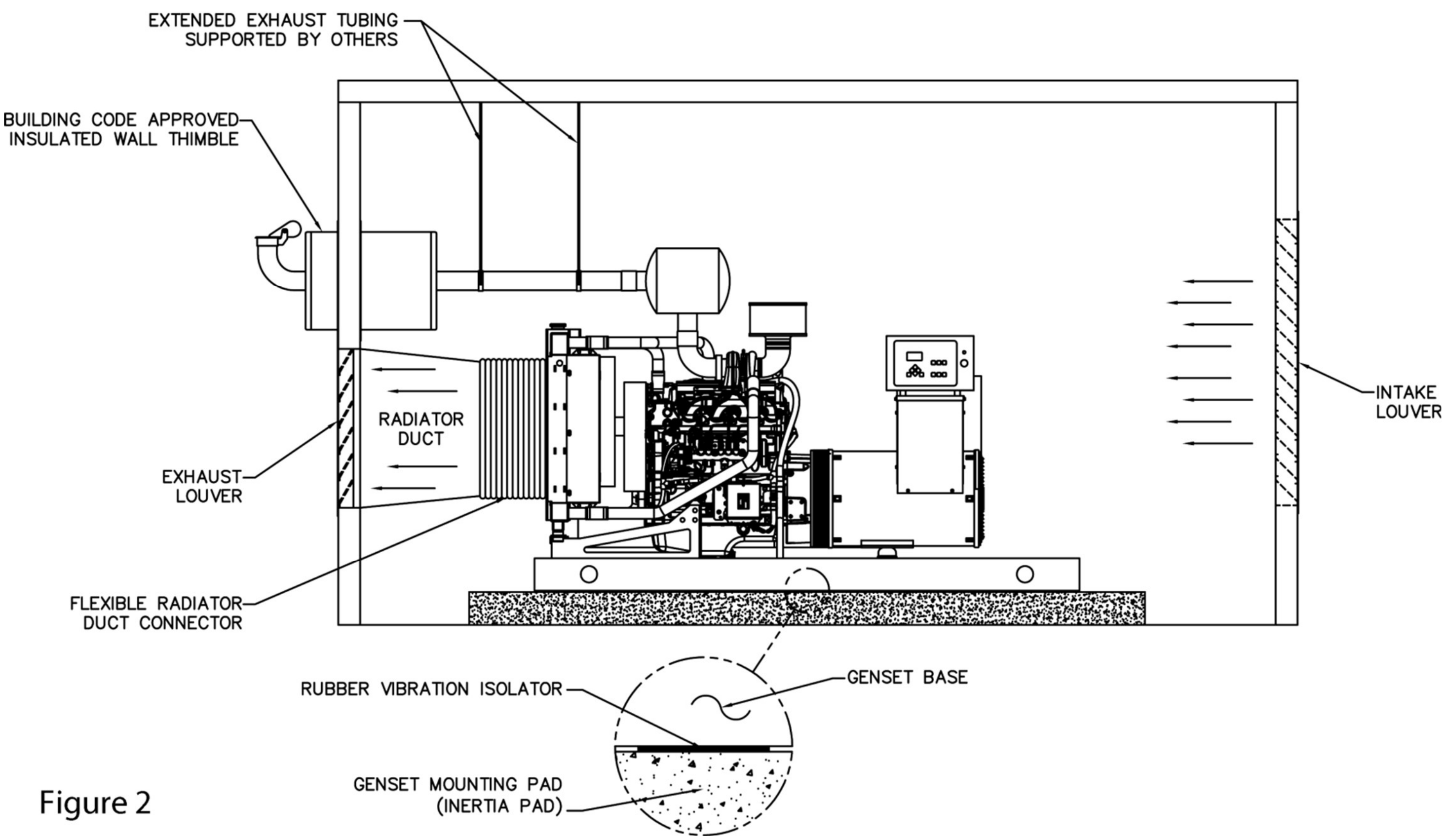
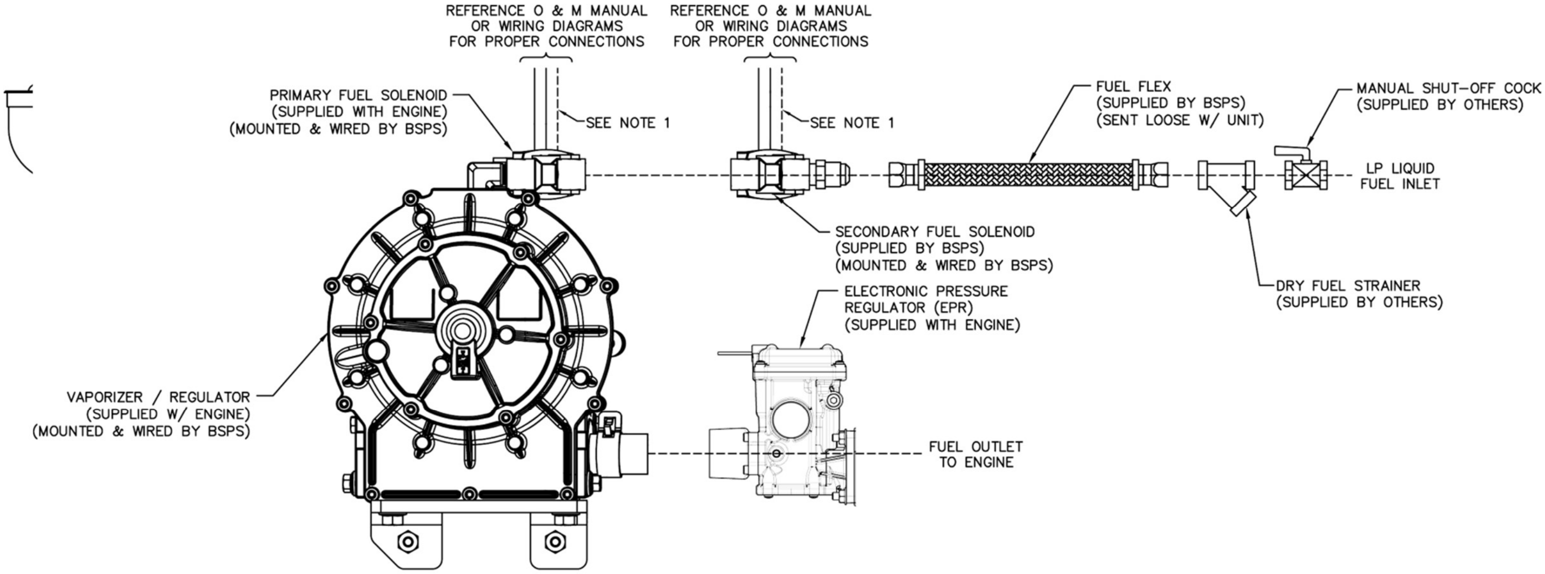


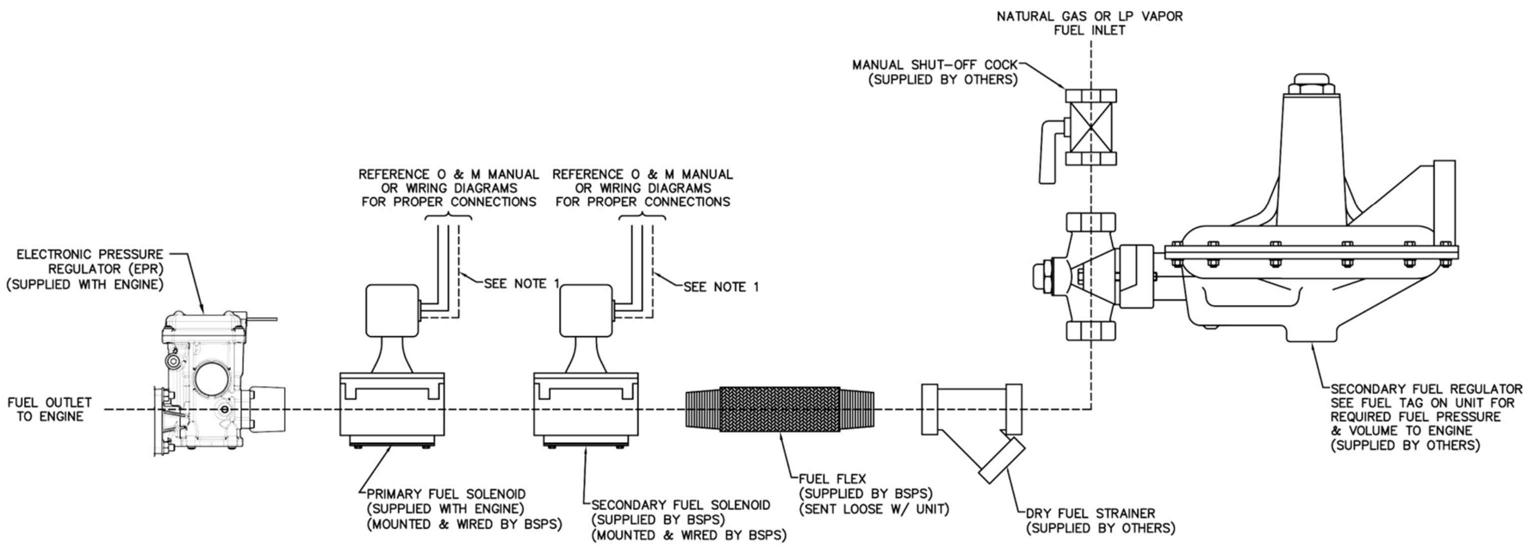
Figure 2

Typical Indoor Genset Installation



NOTES:
1. OPTIONAL 3-WIRE SOLENOID – GREEN WIRE CASE GROUND

Typical Exhaust Systems



NOTES:
1. OPTIONAL 3-WIRE SOLENOID – GREEN WIRE CASE GROUND

Figure 4

Single Fuel NG/LP Vapor Withdrawl

Figure 5

Single Fuel LP Liquid Withdrawl

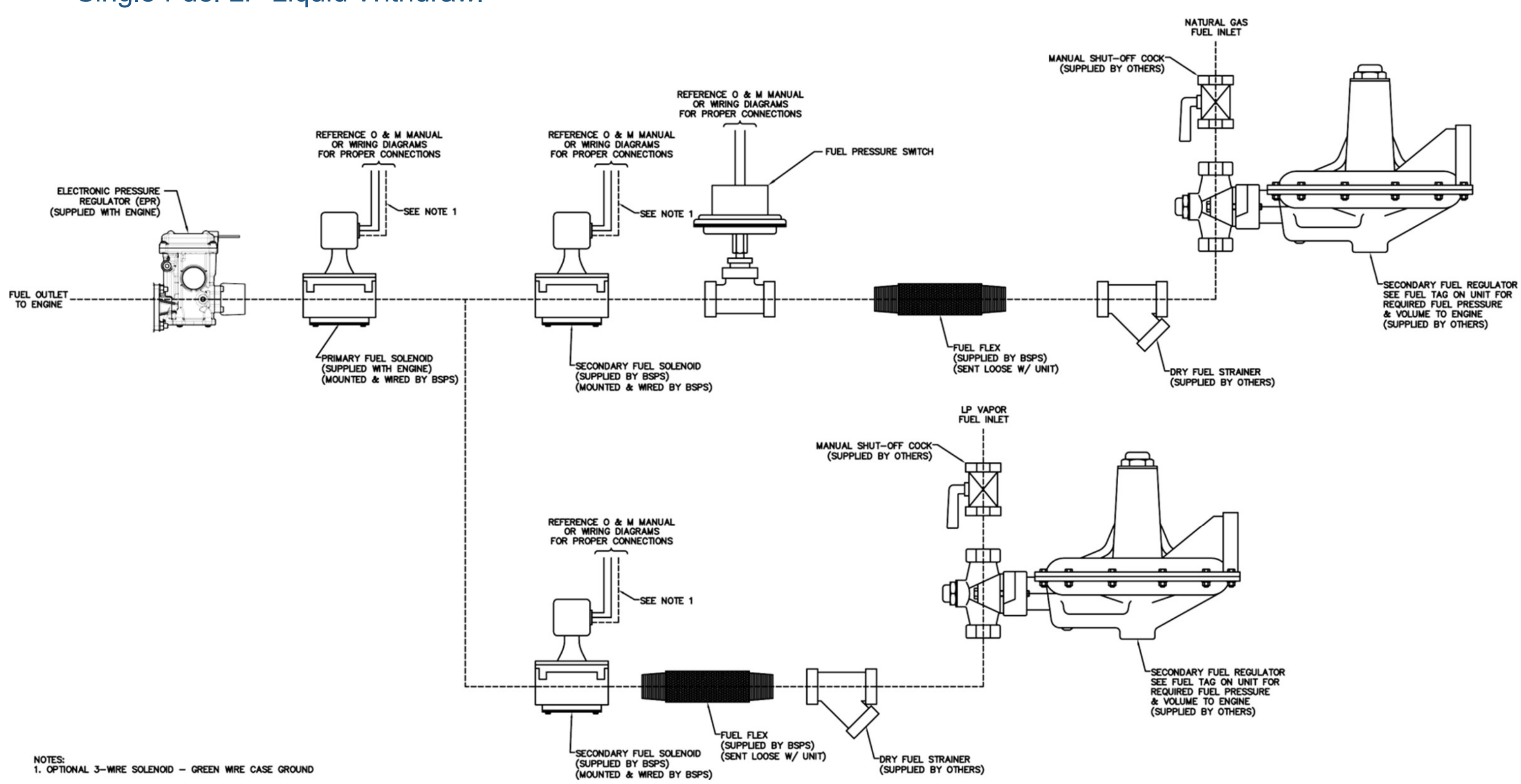
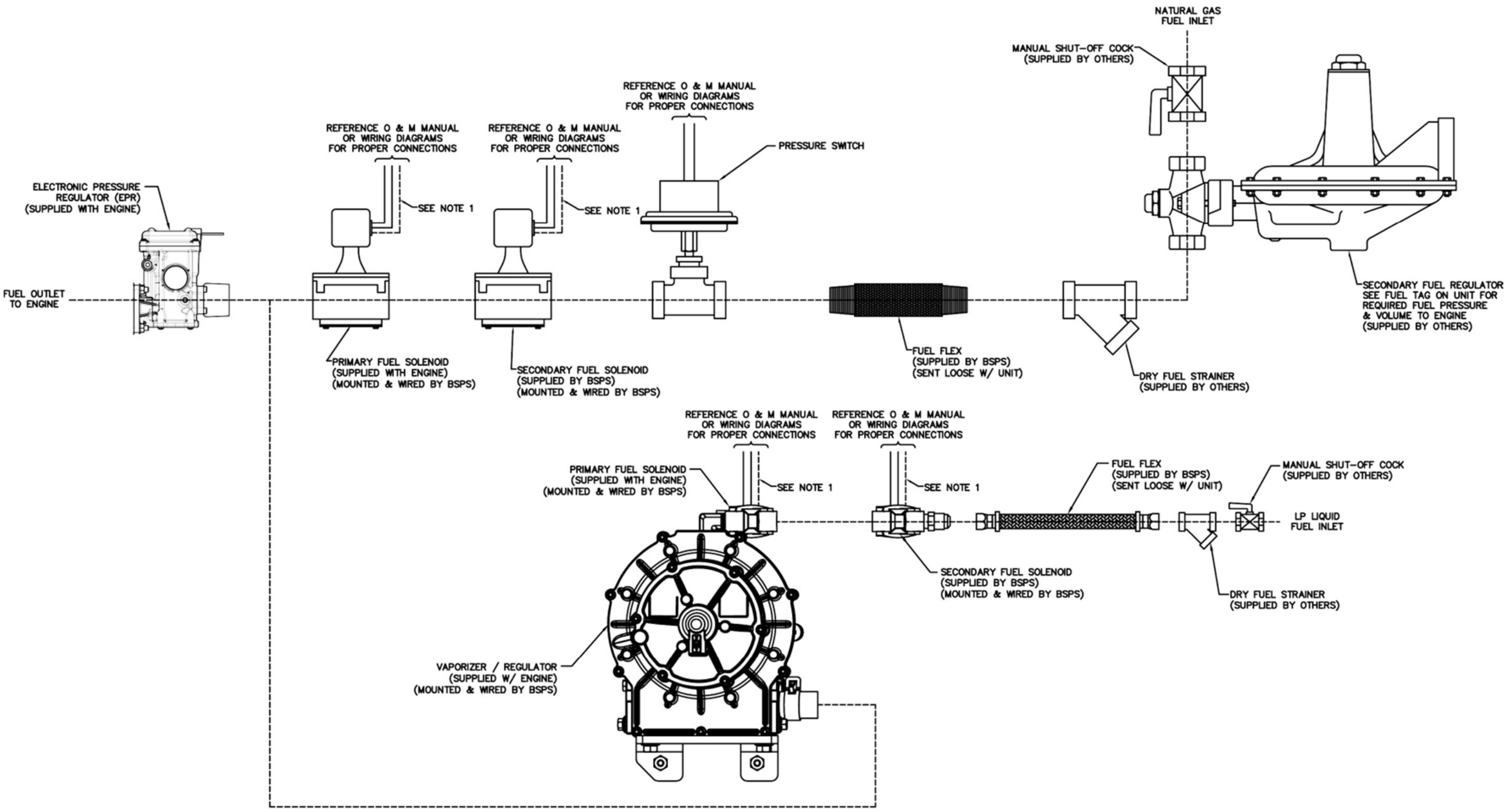


Figure 6

Dual Fuel NG/LP Vapor Withdrawl Auto Changover



NOTES:
1. OPTIONAL 3-WIRE SOLENOID – GREEN WIRE CASE GROUND

Figure 7

Dual Fuel NG/LP Liquid Withdrawl Auto Changover

Gen-Set Weekly Test & Inspection Checklist

BLUE STAR
Power Systems Inc.

Caution: Improper operation of equipment can result in serious injury or death. Operation should be performed by trained personnel only.

Date:	-Fill in the date of the inspection.
Ambient Temp:	-Record outside or room air temperature.
Oil Level:	-Record the level from the oil dipstick and the amount of oil added to engine if needed.
Coolant Level:	-Record the level of the coolant in radiator and the amount added to radiator if needed.
Heaters:	-Feel the block heater inlet and outlet hoses to make sure they are warm.
Belts:	**Make sure the engine control is in the “OFF” position and E-Stop button is depressed.** -Check belts to make sure they are tight and in alignment.
Radiator:	-Inspect for leaks, corrosion and foreign matter. Inspect all hoses and clamps.
Battery Charger:	-Visual inspection of charger to verify operation. If equipped with a dial type meter verify charge rate. If equipped with LED’s verify LED’s lit.
Battery & Cables:	-Make sure cables are tight and battery posts are clean. Check electrolyte level.
Leaks (Oil-Water-Fuel):	-Check all hoses and connections for leaks, tighten hose clamps as needed.
Amps:	-When the unit is running with load, record the amperage reading.
Volts:	-When the unit is running with load, record the voltage reading.
Frequency:	-When the unit is running with load, record the frequency reading.
Oil Pressure:	-When the unit is running with load, record the oil pressure.
Water Temperature:	-When the unit is running with load, record the water temperature reading once stabilized.
Alternator Volts:	-Record engine Alternator DC voltage reading.
RTM:	-Running time meter total should be recorded before each test –this will allow you to determine if the unit has run since the last exercise. Length of weekly runtime should be a minimum of 30 minutes.
ATS:	-Automatic transfer switch should be filled in as “OK” if the test performed a load transfer properly.
By:	-Should be initialed by the person doing the test.

WEEKLY ENGINE GENERATOR INSPECTION AND EXERCISE CHECK LIST

Date:	Ambient Temp:	Oil Level:	Coolant Level:	Heaters:	Belts:	Radiator:	Battery Charger:	Battery Levels & Cables:	Leaks – Oil, Water or Fuel:	Amp:	Volts:	Freq:	Oil Pressure:	Water Temp:	BC Volts:	RTM:	ATS:	By:	Comments:

****CLEAN GENERATOR ROOM OR ENCLOSURE OF ANY FOREIGN MATERIAL****

Note: Please be aware this form may be required for warranty purposes.

Operating Instructions

BLUE STAR
Power Systems Inc.

Caution: Improper operation of equipment can result in serious injury or death. Operation should be performed by trained personnel only.

MANUAL START

If the Gen-Set is located in a closed space, start the ventilation fan or open the air intake and exhaust means to allow an ample supply of air to the unit.

A. Check Gen-Set vitals (refer to weekly checklist)

B. Place the generator circuit breaker in the OPEN position

C. Put the engine control in the MANUAL / RUN position. NOTE: If the engine does not start, check the Operator's Manual

D. Check the unit frequency. Speed should be within 0 – 3% of rated speed (60 Hz). If not, refer to Operator's Manual for governor adjustment

E. Check the unit AC voltage on control panel

F. Check engine parameters, via gauges or by scrolling through the microprocessor control panel for proper readings

G. Close the generator circuit breaker

The Engine-Generator Set is now ready to supply power to the load and will continue to supply power until the operator shuts down the set or an engine failure occurs.

MANUAL SHUTDOWN

Open the generator circuit breaker, move handle to the DOWN position.

A. Put the engine control in the OFF position.

NOTE: Following daily service or other maintenance on the generator set, place the engine control to the desired operating mode. When desired operating mode is automatic, reset the generator circuit breaker by placing its handle in the UP position.

EMERGENCY STOP PUSH BUTTON: (OPTIONAL EQUIPMENT)

In case of emergency the operator may shutdown the generator set by pushing the red mushroom head button. If equipped, this is located in the lower right corner of the control panel. This will stop and lock out the generator set. The red push button may also be pulled out to reset the generator set. Place the engine control to the "OFF" position to reset the engine control before restarting the unit. Reset the main line circuit breaker before returning the generator set to "AUTOMATIC" operation.

AUTOMATIC OPERATIONS

For automatic operation the Engine-Generator Set will be controlled by the automatic transfer switch and the automatic engine control.

A. For detailed operations of the transfer switch, refer to the Operations Manual supplied with the transfer switch

B. For detailed operations of the automatic engine control, refer to Operations Manual supplied with the Genset.

    I. Standby State
        a. Leave the engine control in the "AUTO" position.
        b. Leave the generator set circuit breaker in the "ON" position

    II. Power Fails
        a. The remote start contact in the transfer switch will close and complete a circuit to the automatic start control terminals marked "E" in the control panel.
        b. This will cause the engine to start and come up to speed and voltage, then transfer the load to the Gen-Set.

    III. Power Returns
        a. The load transfers back to normal power after a time delay (if provided).
        b. The remote start contact in the transfer switch will open after a time delay (if provided), and the unit will cool down for 5 minutes then shut down and be ready for the next power failure.

C. Perform weekly maintenance in accordance with the Gen-Set Weekly Test and Inspection Checklist provided in the Operation and Maintenance manual

BLUE STAR
Power Systems Inc.

Diesel Product Line

208-4160 Volt

VD500-01

60 Hz / 1800 RPM

500 kWe

Standby

Ratings

	208V	240V	480V	600V	4160V
Phase	3	3	3	3	3
PF	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60
Generator Model	572RSL6429	572RSL6429	572RSL6427	572RSS4270	573FSM4354
Connection	12 LEAD WYE	12 LEAD DELTA	12 LEAD WYE	4 LEAD WYE	6 LEAD WYE
kWe	500	500	500	500	500
AMPS	1737	1505	753	602	87
Temp Rise	130˚C / 27˚C	130˚C / 27˚C	130˚C / 27˚C	130˚C / 27˚C	130˚C / 27˚C

Standard Equipment

Engine
- Radiator Cooled Unit Mounted (55˚C)
- Blower Fan & Fan Drive
- Starter & Alternator
- Oil Pump & Filter
- Oil Drain Extension w/Valve
- Governor - Electronic Isochronous
- 24V Battery System & Cables
- Air Cleaner (Dry Single Stage)
- Flexible Fuel Connector
- EPA Certified Tier 2

Listing Certifications
- UL 2200 Listed*
- cUL Listed*
- CSA Certified*
- Seismic Certified to IBC 2021

**Through 600 VAC*

Generator
- Brushless Single Bearing
- Automatic Voltage Regulator
- ± .25% Voltage Regulation
- 4 Pole, Rotating Field
- 130˚C Standby Temperature Rise
- 100% of Rated Load - One Step
- 5% Maximum Harmonic Content
- NEMA MG 1, IEEE and ANSI Standards Compliance for Temperature Rise

Additional
- Single Source Supplier
- Microprocessor Based Digital Control
- Interface Connection Box
- Control Panel Mounted in NEMA 12 Enclosure
- Base - Structural Steel
- Main Line Circuit Breaker Mounted & Wired*
- Critical Grade Silencer Mounted
- Battery Charger 24V 5 Amp
- Jacket Water Heater -20˚F 5000W 240V w/Isolation Valves
- Vibration Isolation Mounts
- Radiator Duct Flange (OPU Only)
- 2YR / 2000HR Standby Warranty
- Standard Colors - White / Gray

Diesel Product Line

500 kWe

BLUE STAR
Power Systems Inc.

Application Data

Engine			
Manufacturer:	Volvo Penta	Displacement - Cu. In. (lit):	984 (16.1)
Model:	TAD1641GE-B	Bore - in. (cm) x Stroke - in. (cm):	5.67 (14.4) x 6.50 (16.5)
Type:	4-Cycle	Compression Ratio:	16.8:1
Aspiration:	Turbo Charged, CAC	Rated RPM:	1800
Cylinder Arrangement:	6 Cylinder Inline	Max HP Stby (kWm):	768 (573)

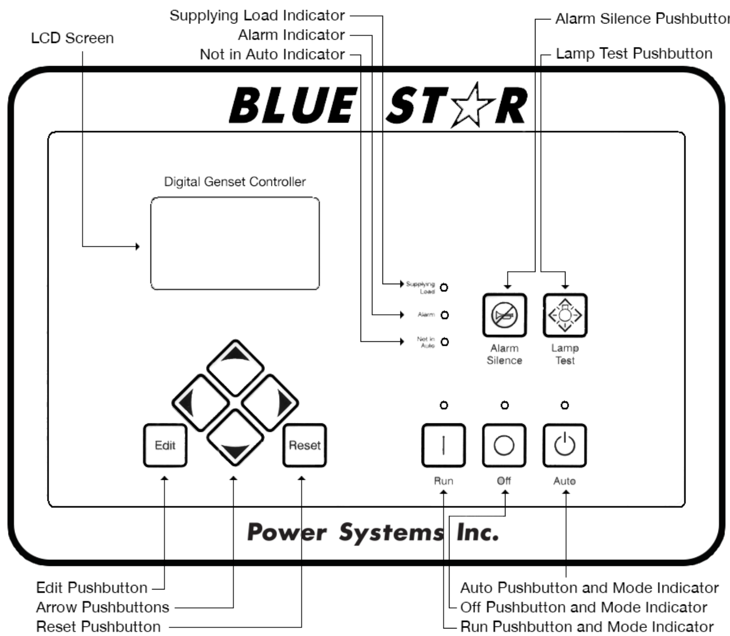
Exhaust System	**Standby**
Gas Temp. (Stack): °F (°C)	876 (469)
Gas Volume at Stack Temp: CFM (m^3/min)	3,899 (110)
Maximum Allowable Exhaust Restriction: in. H_2O (kPa)	40.2 (10.0)
Cooling System	
Ambient Capacity of Radiator: °F (°C)	131 (55.0)
Maximum Allowable Static Pressure on Rad. Exhaust: in. H_2O (kPa)	0.50 (0.12)
Water Pump Flow Rate: GPM (lit/min)	122 (461)
Heat Rejection to Coolant: BTUM (kW)	13,137 (230)
Heat Rejection to CAC: BTUM (kW)	8,360 (146)
Heat Radiated to Ambient: BTUM (kW)	9,937 (174)
Air Requirements	
Aspirating: CFM (m^3/min)	1,617 (45.8)
Air Flow Required for Rad. Cooled Unit: CFM (m^3/min)	18,869 (534)
Air Flow Required for Heat Exchanger/Rem. Rad. CFM (m^3/min)	Consult Factory For Remote Cooled Applications
Fuel Consumption	
At 100% of Power Rating: gal/hr (lit/hr)	34.3 (130)
At 75% of Power Rating: gal/hr (lit/hr)	25.8 (97.7)
At 50% of Power Rating: gal/hr (lit/hr)	17.4 (65.9)
Fluids Capacity	
Total Oil System: gal (lit)	12.7 (48.1)
Engine Jacket Water Capacity: gal (lit)	8.70 (33.0)
System Coolant Capacity: gal (lit)	15.9 (60.0)

Deration Factors
Rated Power is available up to 4,920 ft (1,500 m) at ambient temperatures to 122°F (50°C).
Consult factory for site conditions above these parameters.

DGC-2020 Control Panel

Standard Features

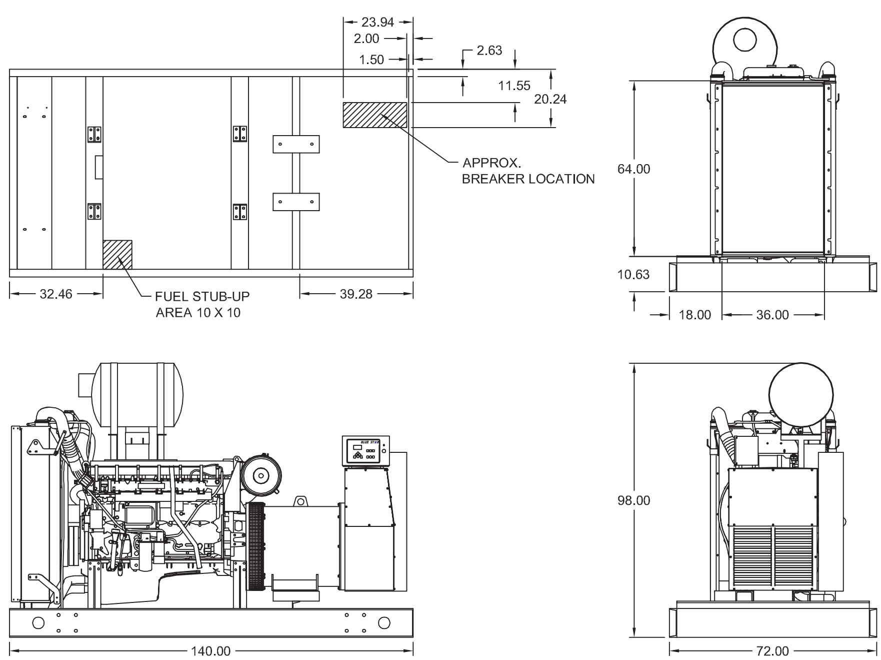
- Digital Metering
- Engine Parameters
- Generator Protection Functions
- Engine Protection
- CAN Bus (J1939) ECU Communications
- Windows-Based Software
- Multilingual Capability
- Remote Communications to RDP-110 Remote Annunciator
- 16 Programmable Contact Inputs
- 15 Contact Outputs
- RS485 Communicator Interface
- UL Recognized, CSA Certified, CE Approved
- Event Recording
- IP 54 Front Panel Rating with Integrated Gasket
- NFPA 110 Level 1 Compatible



Weights / Dimensions / Sound Data

	L x W x H	Weight lbs
OPU	140 x 72 x 98 in	9,425
Level 1	180 x 72 x 103 in	11,075
Level 2	180 x 72 x 103 in	11,175
Level 3	225 x 72 x 103 in	11,575

Please allow 6-12 inches for height of exhaust stack.

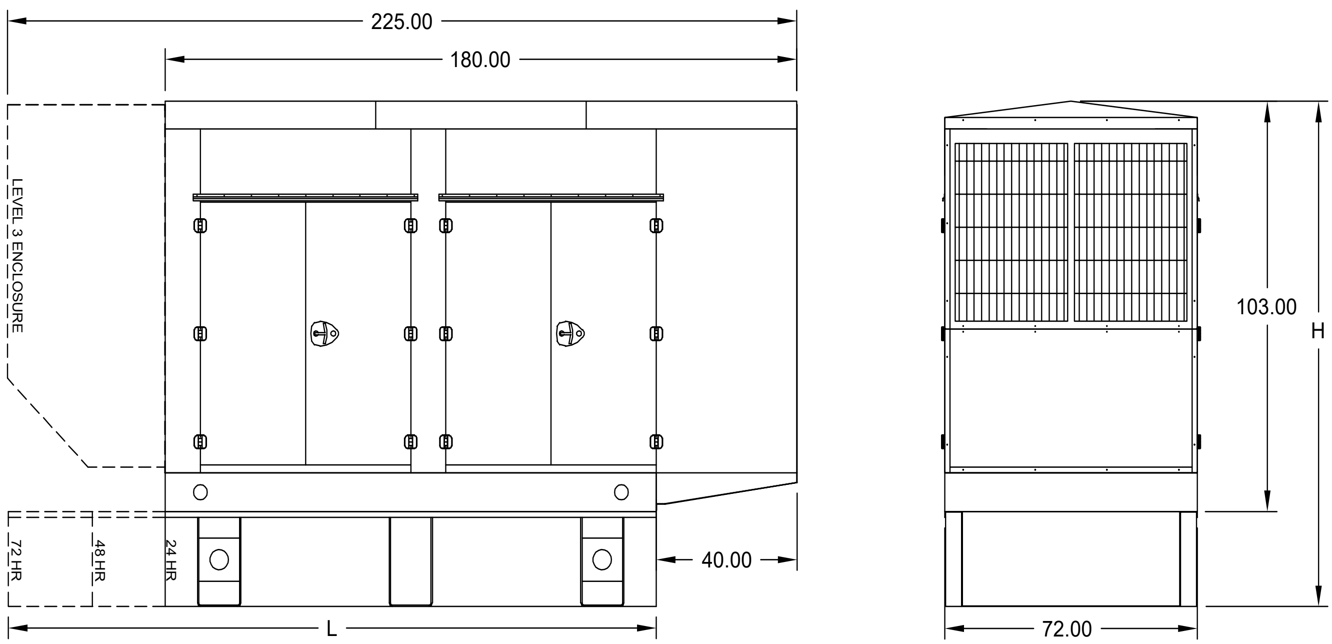


	No Load	Full Load
OPU	91 dBA	94 dBA
Level 1	86 dBA	89 dBA
Level 2	81 dBA	83 dBA
Level 3	73 dBA	75 dBA

Drawings based on standard open power 480 volt standby generator. Lengths may vary with other voltages. Subject to change without notice.
Sound data as measured at 23 feet (7 meters) in accordance with ISO 8528-10 at standby rating.

BLUE STAR Power Systems Inc.

Enclosures & Fuel Tanks



All enclosure models are 200 MPH wind rating certified in accordance with IBC2018 and ASCE/SEI 7-16 standards.

Level 2 & 3 enclosures include sound attenuation foam.

Level 3 enclosure includes frontal sound & exhaust hood.

*Enclosure height does not include exhaust stack.

	24 Hour 900 Gallon	48 Hour 1800 Gallon	72 Hour 2700 Gallon
L	140.00	216.00	330.00
H	135.00	139.00	139.00

All specification sheet dimensions are represented in inches.
All enclosures and fuel tanks are based on the standard standby unit configuration. Any deviation can change dimensions.
Materials and specifications subject to change without notice.

American Owned

American Made

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OPERATOR'S MANUAL
16L

WARNING! Operating, servicing and maintaining an engine can expose you chemicals including engine exhaust, carbon monoxide, phthalates, and lead which are known to the State of California to cause cancer and birth defects or other reproductive harm.

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

To minimize exposure, avoid breathing exhaust when operating, servicing and maintaining the engine.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Wear gloves or wash your hands frequently when servicing the vessel.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to
www.P65warnings.ca.gov
www.p65warnings.ca.gov/products/diesel

Table of Content

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Foreword

Welcome!

Volvo Penta engines are designed to fulfill Volvo's core values; quality, safety and environmental care. After more than 100 years as an engine manufacturer, the Volvo Penta brand has also become a symbol of reliability, technical innovation, top-of-the-range performance and long service life. Volvo Penta engines are used all over the world, in all possible operating conditions.

Make sure to thoroughly read through the Operator's Manual regarding operating and maintenance. It contains the information you need to be able to operate and maintain the engine safely and correctly. Pay careful attention to the safety instructions included in the manual.

As the owner of a Volvo Penta engine, you become part of a worldwide network of dealers and service workshop that assist you with technical advice, service requirements and replacement parts. Contact your nearest authorized Volvo Penta dealer for assistance.

It is possible to buy additional literature about your Volvo Penta engine, e. g. the Service & Maintenance manual. More information on how to do this can be found at www.volvopenta.com.

Information about your closest Volvo Penta dealer and other useful news and information can be found at www.volvopenta.com and by following Volvo Penta on Facebook.

VOLVO PENTA

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Safety Information

This chapter describes how safety precautions are presented in the manual and on the product. Read the chapter through very carefully before you start the engine or do any maintenance or service. It has to do with your safety; an incorrect operation can lead to personal injury and damage to products or property. It also gives you an introduction to the basic safety rules for using and looking after the engine.

If anything remains unclear or if you are unsure of something, contact your Volvo Penta dealer for assistance.

IMPORTANT:
Always follow local safety instructions and regulations.

Safety texts have the following order of priority:

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

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

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

IMPORTANT:
Indicates a situation, which, if not avoided, could result in property damage.

NOTICE! Used to draw attention to important information that facilitates work or operations.

This symbol is may be used on the product to call your attention to the fact that this is safety information. Always read such information very carefully.

Make sure that warning and information symbols on the engine are clearly visible and legible. Replace symbols that have been damaged or have been painted over.

In some cases, this symbol is used on our products and refers to important information in the Operator’s Manual.

Most chemicals such as engine and transmission oils, glycol, petrol and diesel oil and chemicals used in workshops such as degreasing agents, paint and solvents are harmful to health.

Carefully read the instructions on the product packaging! Always follow the safety regulations, such as the use of protective masks, goggles, gloves, etc. Make sure that other personnel are not exposed to substances that are hazardous to health. Ensure good ventilation.

Manage used and leftover chemicals in the prescribed manner.

Daily Checks

⚠ WARNING!

Do not start the engine if there is reason to suspect fuel leaks or if there is explosive material nearby.

Make it a habit to give the engine and engine compartment a visual check before the engine is started and after operations, once the engine has stopped. This helps you to quickly discover fuel, coolant or oil leakages or any other abnormality that has occurred, or is about to occur.

Personal safety equipment

P0024482

⚠ CAUTION!

Always use appropriate safety equipment. Personal protective equipment does not eliminate the risk of injury but it will reduce the degree of injury if an accident does happen.

Some examples are ear protection, eye and face protection, protective footwear, personal protective equipment, head protection, protective clothing, gloves and respirators.

⚠ WARNING!

Ensure that all machine guards and safety devices are in place and are functional.

⚠ CAUTION!

Never use tools or products that show signs of damage.

Protect your eyes

⚠ CAUTION!
Wear safety glasses.

Always wear safety glasses if there is a risk of splintering, sparks and spray from the electrolyte (so-called battery acid), or other chemicals. Your eyes are very delicate and damage can result in loss of sight!

Protect your skin

⚠ CAUTION!
Risk of skin damage.

Avoid getting oil on your skin! Prolonged or repeated exposure to oil can dry out the skin. Thereafter, irritation, dryness and eczema and other skin problems may occur.

Use protective gloves and avoid oil-soaked clothes and rags. Wash regularly, especially before eating. Wear suitable protective creams to prevent skin from drying out and to facilitate cleaning.

Fire safety

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⚠ WARNING!
Fire and Explosion Risk!
Accidental spark could ignite fuel vapors.

All fuels – as well as many lubricants and chemicals – are flammable. Do not allow open flames or sparks near them. **Smoking forbidden!** Hydrogen from the batteries is also very flammable and explosive in certain mixture with air.

Ensure that the workplace is well ventilated and take the necessary precautions before welding or grinding begins. Always ensure that there is a fire extinguisher close at hand in the work area.

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Spare parts — safety

⚠ WARNING!
Always use spare parts with the same quality as genuine Volvo Penta parts to minimize the risk of an explosion or fire.

Components in fuel systems and electrical systems on Volvo Penta engines are designed and manufactured to minimize the risk of explosions and fire, in accordance with applicable legal requirements.

Used oils, filters and chemicals etc.

⚠ WARNING!
Risk of fire.
Store fuel soaked rags and other flammable material so that there is no danger of them catching fire.

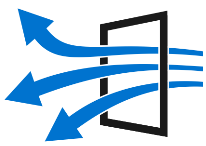
Oil-soaked rags can spontaneously ignite under certain circumstances.

IMPORTANT:
Used fuel and oil filters are environmentally hazardous waste and must be taken to an approved waste management facility for correct handling, as must any used lubricating oil, contaminated fuel, paint residue, solvents, degreasers and wash residue.

Prevent start of the engine

⚠ WARNING!
Immobilize the engine by turning off the power supply with the main switch(es) and lock it (them) in the off position before starting work. Place a warning notice at the main switch.
If the engine is equipped with BMS (Battery Management System), always disconnect both battery cables from the battery terminals.

Ventilation when running the engine



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⚠ WARNING!
Only start the engine in a well-ventilated area. If operating the engine in a closed area ensure that there is exhaust ventilation leading out of the work area to remove exhaust gases and crankcase ventilation emissions.

The engine must not be operated in areas where there are explosive materials or stored gas.

P0024808

Rotating parts and hot surfaces

DANGER!

Working with or approaching a running engine is a safety risk. Watch out for rotating components and hot surfaces.
If the engine is in operation and operates another device, you must not, under any circumstances, staying close to the engine.

Work on running engines is strictly prohibited. There are however adjustments that require the engine to be run. Approaching a running engine is a safety risk. Loose clothing and long hair can get caught in the rotating parts; careless movements or a dropped tool can lead to serious personal injury.

Be careful to avoid hot surfaces (exhaust pipes, turbochargers, charge air manifolds, start elements etc.) and hot fluids in pipes and hoses on engines that are running or have just stopped. Re-install all protective covers that were removed during maintenance work before starting the engine.

Information on the engine

IMPORTANT:

Make sure that all warning and information decals on the product are always visible. Replace decals which have been damaged or painted over.

P0024483

Prohibition on use of start spray

WARNING!

Never use start spray or similar agents to start an engine. This may cause an explosion in the inlet manifold. Risk of personal injury.

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P0024688

Before start of engine

⚠ WARNING!

Never start the engine if there is reason to suspect fuel and/or gas leaks, or if there is explosive material nearby.

IMPORTANT:

Only start the engine with the air filter and protective caps fitted. Foreign objects in the inlet line could cause machine damage. Also make sure that no tools or other parts have been left next to the engine.

⚠ WARNING!

Never start the engine with the valve cover removed. There is a risk of personal injury.
For engines with turbochargers, the rotating compressor turbine can in addition cause serious personal injuries.

Before any work on the electrical system

⚠ WARNING!

Always stop the engine first. Then disconnect the current at the main switches and any external power supply before working on the electrical system – to minimize the risk of electrical hazards.

IMPORTANT:

Never disconnect the current using the main switches when the engine is running or by disconnecting the battery cables.
The alternator and electronics could be damaged.

Avoid damage to the engine control module and other electronics

IMPORTANT:

Switch off the main switch before connecting or disconnecting a connector.

Before welding work

IMPORTANT:

Before any work with electric weld can begin, the connection to all control units must be disconnected. After finished welding, re-connect the connection to all control units before connecting any battery cable.

Before any work on the cooling system

⚠ WARNING!

Stop the engine and let it cool before starting work on the cooling system. Hot fluids and hot surfaces can cause burns.

Hot coolant under pressure

⚠ CAUTION!

Hot coolant can cause burns. Avoid opening the filler cap for the coolant when the engine is still hot. Steam or hot coolant can spray out and system pressure is lost.

Open the filler cap slowly and release the pressure in the cooling system if the filler cap or valve must be opened – or if a plug or a coolant hose must be removed from a hot engine.

Hot oil under pressure

⚠ CAUTION!

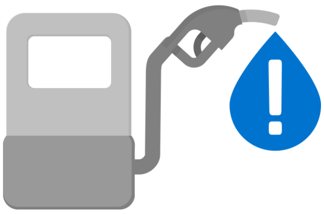
Hot oil can cause burns. Avoid getting hot oil on the skin. Ensure that the lubrication system is not pressurized before starting any work. Never start or operate the engine without the oil filler cap is on. There is a risk that hot oil can spray out.

Refueling

⚠ WARNING!

There is always a risk of fire and explosion during refueling. Smoking is forbidden and the engine must be stopped.

Proper fuel quality



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IMPORTANT:

Always use the fuel recommended by Volvo Penta. See *Technical Data* in Operator's Manual. Other fuel can damage the engine.
Wrong fuel quality can also lead to higher service costs.

⚠ WARNING!

Risk of personal injury.
Wrong fuel quality in a diesel engine can cause the fuel control mechanism to bind which can cause the engine to overspeed!

Legal requirements to use proper fuel

IMPORTANT:

To meet regulatory requirements for certified emission levels must always recommended fuel according to *Technical Data* in the Operator's Manual be used.

P0024488

At any leak detection on the fuel system

⚠ WARNING!

Wear safety goggles!
Be extremely careful when searching for leaks in the fuel system high-pressure circuits. There is very high pressure in the jet from pipes and injectors. The fuel may penetrate the tissue and cause serious risk of blood infection (septicemia).

Handling of fuel pipes

IMPORTANT:

High pressure pipes for fuel must not be bent or straightened under any circumstances. Cracks may occur. Damaged pipes must be replaced.

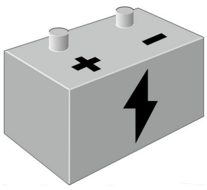
Safe handling of batteries

⚠ WARNING!

Risk of fire and explosion. Never allow an open flame or electric sparks near the batteries.

A spark caused by an incorrectly connected battery can be enough for the battery to explode with serious injuries.

Do not touch the connections during start attempts. Sparking hazard! Do not lean over batteries.



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Correct polarity of the batteries

IMPORTANT:

Make sure that the positive (+) and negative (–) battery cables are correctly connected to the corresponding battery terminals. Wrong connection may cause severe damage to electrical equipment.

Risks of electrolyte in batteries

⚠ WARNING!

Always wear protective goggles when charging or handling batteries.
Battery electrolyte is highly corrosive.

Rinse immediately with copious amounts of water if the electrolyte gets in your eyes. Search directly after the rinsing help by medical staff.

If it comes electrolyte to unprotected skin, wash immediately with soap and water.

Layout of the battery compartment

IMPORTANT:

Make sure the battery compartment is designed according to current safety standards.

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P0024486

Cleaning the engine and components

IMPORTANT:
Never use a high pressure washer for cleaning of engine or engine components.

Cleanliness for sensitive components

IMPORTANT:
Observe meticulous cleanliness when handling system components.
Even minimal amounts of dirt could cause a breakdown.

Adjustment of the clutch

CAUTION!
Clutch adjustments must be carried out with the engine stopped.

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Introduction

Check that you have received the correct operator's manual before continuing reading. If not, please contact your Volvo Penta dealer.

For engine designations, refer to *Engine*. The designation is stated on the engine plate, refer to *Technical Data, page 98*.

The illustrations in this book may cover several product types, which means that there may be slight differences between the illustrations and the purchased product. This does, however, not affect the validity of the information and/or instructions in the manual. Volvo Penta reserves the right to make alterations to specifications, design features, and illustrations without prior notice.

At service, software that affects the functionality described in this manual can be updated.

About this manual

This Operator's Manual contains the information required for the correct, safe operation and maintenance of your Volvo Penta engine. Read the Operator's manual carefully and learn to handle the engine and other equipment in a safe manner before you start the engine.

Warranty

Your new Volvo Penta engine is covered by a limited warranty, subject to the conditions compiled in the Warranty Information. AB Volvo Penta's liability is limited to the specification in the Warranty Information and Emission Control System Warranty Statement.

Read the information carefully, as soon as possible after delivery. It includes important information about service and maintenance; the owner is responsible for being familiar with checking and implementing these. Otherwise AB Volvo Penta may deny its warranty obligations in part or in full.

Contact your Volvo Penta dealer if you have not received information on how to access the Warranty Information or recived the Service Book.

Running in the engine

The engine must be run in during its first 10 operating hours, as follows:

Run the engine in normal operations. However, full load may not be applied other than for short periods. Never run the engine for long stretches at constant speeds during this period.

Higher oil consumption is normal during the first 100–200 hours of operation. For this reason, check the oil level more frequently than the normal recommendation.

When a disengageable clutch is installed, it should be checked more carefully during the first days. Adjustments may be necessary to compensate bedding-in of the friction plates.

Fuel, oils and coolant

Only use the fuels and oils recommended in the Operator's Manual, since other grades may cause malfunctions, increased fuel consumption and possibly shorten the life of the engine.

Always change the oil, oil filters and fuel filters at the specified maintenance intervals.

Make sure to always use suitable and correctly mixed coolant.

Future warranty claims related to engine and accessories may be denied if an unsuitable coolant has been used, or if the instructions for coolant mixture have not been followed.

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Maintenance and replacement parts

Volvo Penta engines are designed for maximum reliability and long life and built to withstand a demanding environment. The engines are also designed to have a minimal environmental impact. These qualities will be maintained through regular servicing and the use of spare parts with the same quality as genuine Volvo Penta parts. If reliable and purpose-built parts are not used, your safety, health, and the machine's function may be compromised. Volvo Penta has a world-wide network of authorized dealers.

The authorized dealers are Volvo Penta product specialists, and have the accessories, genuine parts, test equipment and special tools needed for high quality service and repair work. Always observe the maintenance intervals in the manual, the complete Service Protocol can be found at *volvopenta.com*. Remember to note the engine / transmission identification number when you **order service and spare parts.**

Excessive strain on a product and components

Volvo Penta products and components are not dimensioned for external loads. Never stand or step onto an engine, transmission or its components. Loads can bring about damage and the malfunction of a product or property.

Environmental care

Environmental care is a core value at Volvo Penta. Energy efficiency and low emissions are among the most important product related aspects and priority focus areas for Volvo Penta business. Several of the global challenges the world faces are directly or indirectly related to power industries and transports. We recognize that Volvo Penta is part of the environmental problems, but we are also convinced that we are a part of the solution.

Volvo Penta currently has a broad engine program in which great advances have been made in reducing exhaust emissions in the same time as the fuel consumption has been improved. Through regular maintenance, the Volvo Penta engines retain its low fuel consumption and low emissions. We hope that you will be keen to preserve these qualities.

Always follow the directions in the Operator’s Manual regarding fuel grades, operation and maintenance to avoid unnecessary environmental impact. Contact your Volvo Penta dealer if you notice any changes such as increased fuel consumption or exhaust smoke.

Remember always to hand in environmental hazardous waste such as drained oil, coolant, old batteries, etc. for treatment at a recycling facility. Our united efforts can make a valuable contribution to the environment.

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Certified engines

If you own an emission-certified engine used in an area where exhaust emissions are regulated by law, this places special demands on the care and maintenance you provide your engine.

NOTICE! Neglects or failure to follow the points listed here may invalidate the engine emission certificate. This means AB Volvo Penta can no longer guarantee engine conformity with the certified model. Volvo Penta is not responsible for damages or costs arising as a result of this.

- Certification means that an engine type has been checked and approved by the relevant authority. The engine manufacturer guarantees that all engines of the same type are equivalent to the certified engine.
- It is the responsibility of the operator/user to ensure that no intentional misuse of the engine takes place.
- Volvo Penta maintenance and service intervals must be complied with.
- Any case of malfunction must be rectified without delay.
- Only use genuine Volvo Penta parts or spare parts with the same quality as genuine Volvo Penta parts.
- Volvo Penta recommends that service to injection pumps, pump settings and injectors always are carried out by a qualified workshop.
- The engine must not be converted or modified in any way, except with accessories and service kits that Volvo Penta has approved for the engine.
- No installation changes to the exhaust pipe and engine air inlet ducts may be made.
- No warranty seals (where present on the product) may be broken by unauthorized persons.
- The general instructions in the Operator's Manual concerning operation, service and maintenance apply.

Volvo Penta Dealer Network

The Volvo Penta global network of authorized dealers is at your service. We strongly recommend that you take your product to an authorized Volvo Penta dealer for service and repair. They are specialists in Volvo Penta products and have the accessories, genuine Volvo Penta parts, the special tools and the latest service information for high quality service and repair work.

Dealer Locator Services

Locate the nearest Volvo Penta dealer through our dealer locator on ***www.volvopenta.com*** or download the dealer locator app to your smartphone.

Volvo Penta Action Service

Our global dealer network, your first line of contact, is backed up by Volvo Penta Action Service, a phone based breakdown and support service providing assistance 24 hours a day, every day of the year.

How it works

A dedicated operator will support you all the way through your case and keep you updated on status and progress.
Whenever on-site assistance or technical support is needed, the operator will put you in contact with the closest Volvo Penta dealer that can support your product.

Phone numbers

Find your Volvo Penta Action Service phone number and more information on ***www.volvopenta.com***.

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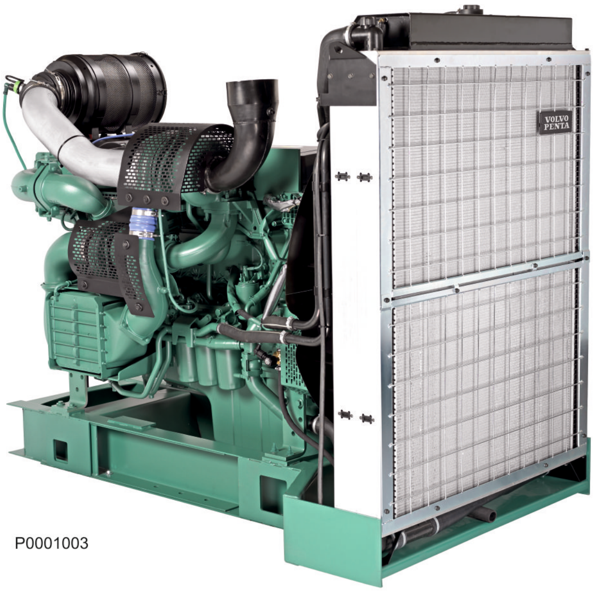
Presentation

TWD1643GE



P0001003

TAD1643VE-B

P0022328

Engines

This Operator's Manual contains industrial engines TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE,
TAD1643VE-B, TAD1650VE, TAD1651VE, TAD1650VE-B
TAD1640GE-B, TAD1641GE-B, TAD1642GE-B, TAD1650GE, TAD1651GE
TWD1643GE, TWD1644GE, TWD1645GE, TWD1652GE, TWD1653GE

These are in-line, directly injected, 6-cylinder industrial diesel engines. The engines are all equipped with electronically controlled fuel management, turbocharger, charge air cooler, thermostatically controlled cooling systems and electronic speed control.

TAD1650VE, TAD1650VE-B, TAD1651VE, TWD1652GE, TWD1653GE, TAD1650GE and TAD1651GE are equipped with EGR (Exhaust Gas Recirculation).

EMS (Engine Management System)

EMS is an electronic system with CAN communication (Controller Area Network) for diesel engine control. The system has been developed by Volvo Penta and includes fuel regulation and diagnostic functions. The system consists of a control unit, injectors, a number of sensors that supply the control unit with information, and connectors for diagnostics and functional checks. The engine can be connected to a communication interface comprising a CAN link and a serial link.

Input/Output signals

The information from the sensors provides precise data about prevailing operating conditions and allows the processor in the control module to, among other things, calculate correct injection amount, injection timing and check the engine's condition.

Fuel regulation

The engine fuel requirement is analyzed up to 100 times per second. The engine injection volume and injection timing are controlled electronically via the fuel valves in the injectors. The control unit receives signals from sensors and monitors in order to determine when the fuel valve must open and close. This means the engine always receives the correct fuel volume under all operating conditions, which means lower fuel consumption and the lowest possible exhaust emission.

Diagnostic function

The purpose of the diagnostic function is to detect and locate any malfunctions in the EMS system, as well as to protect components from damage.
If a malfunction is detected, this is announced by warning lamps, a flashing diagnostic lamp or a text message on the instrument panel, depending on the equipment fitted. If a fault code is displayed it is used for guidance in any fault tracing. Fault codes can also be read by Volvo’s VODIA tool at authorized Volvo Penta workshops.
If there is a serious malfunction, the engine will be shut down completely or the control unit may reduce power output (depending on the application). Fault codes are registered as an aid to fault tracing.

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Instruments and Controls

Display Control Unit

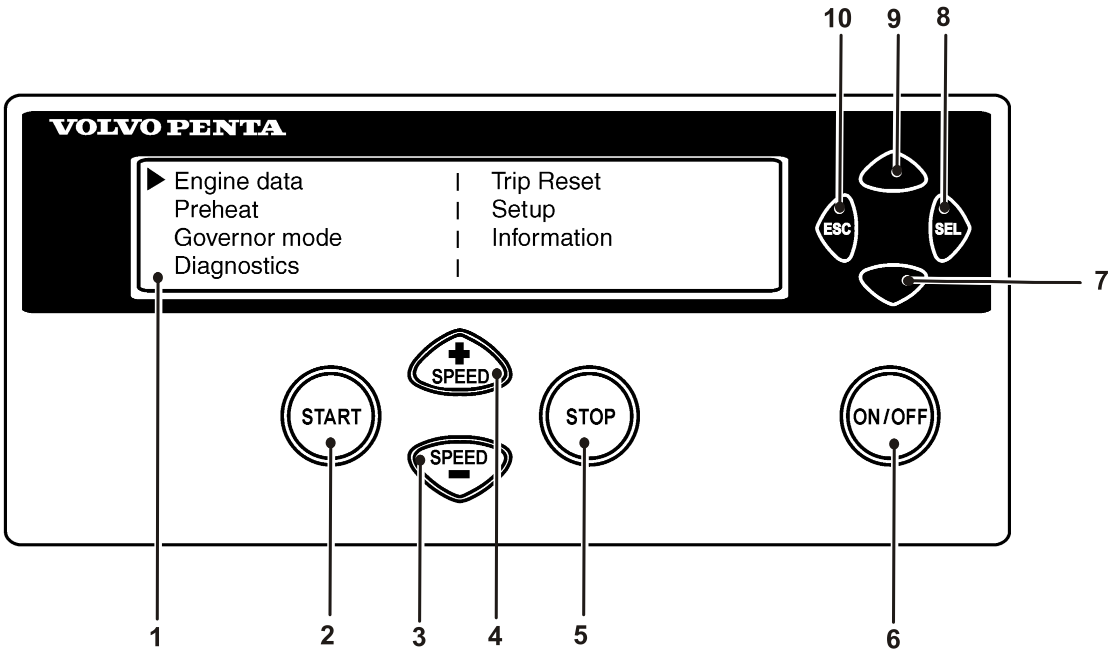
TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1643VE-B, TAD1650GE, TAD1650VE, TAD1651GE, TWD1643GE, TWD1652GE, TWD1653GE

The DCU control panel is available as an optional accessory for the EMS (Engine Management System) electronic control system.
The DCU is a digital instrument panel which communicates with the engine control unit. The DCU has several functions, such as engine control, monitoring, diagnostics, and parameter setting.

The menus in the DCU system can be used to check, and in some cases to set, a number of different functions in the EMS system.

NOTICE! Settings and what engine data that appears in the display may vary depending on installation and engine model.

NOTICE! The menus and illustrations shown here are the English version. The language can be changed, however; refer to the *Setup* menu.



P0002062

Start
When the DCU panel is started, the “Engine Data” menu is displayed; press “ESC” to come to the main menu.

1 LED display
2 START. Starts the engine
3 SPEED - . Reduces engine rpm
4 SPEED +. Increases engine rpm
5 STOP. Stops the engine
6 ON/OFF. Starts and stops the system
7 Scroll downwards in menus
8 SEL. Selects in menus
9 Scroll upwards in menus
10 ESC. Return to previous menu selection

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Menus

There are several sub-menus under each main menu. There is not space for all the menu choices on the display. To scroll through the menus, use the **7** and **9** buttons on the display. Press the **SEL** button **8** to make a selection. Refer to the illustration on the previous page.

NOTICE! The **Setup** menu can be used to select the language that you want to use on the display.

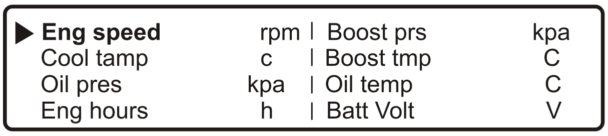
Main menu

P0002063

- **Engine data**, current engine data
- **Preheat**, manual activation of pre-heating. Must be activated with temperatures below 0°C (32°F)
- **Governor mode**, activation of droop
- **Diagnostics**, shows fault codes as text
- **Trip reset**, resets trip data
- **Setup**, parameter setting
- **Information**, shows the currently applicable hard/ software, data sets and engine identification for the engine and DCU data

Engine data

shows relevant engine data.



P0002064

- Engine speed, can be controlled with the **SPEED+** and **SPEED–** buttons (rpm)
- Charge pressure (kPa)
- Coolant temperature (°C)
- Charge air temperature (°C)
- Oil pressure (kPa)
- Oil temperature (°C)
- Engine hours (h)
- Battery voltage (V)
- Fuel consumption (l/h)
- Instantaneous fuel consumption (trip fuel) (l)

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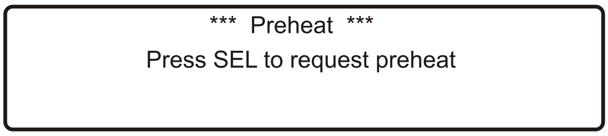


P0002065

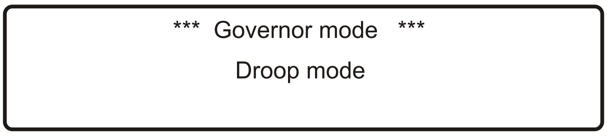
Preheat

manual activation of pre-heating. When it is activated, the EMS system senses at start-up if pre-heating is needed. For automatic pre-heating, refer to the *Setup / Preheat on ignition* menu.

NOTICE! Must be activated with temperatures below 0°C (32°F).

The pre-heating time is adjusted to suit the engine temperature, and can last for up to 50 seconds both before and after starting. Refer also to *Starting procedure EMS 2*.

- Press **SEL**, the text **Preheat requested** will be shown
- The display automatically returns to the **Engine Data** menu.

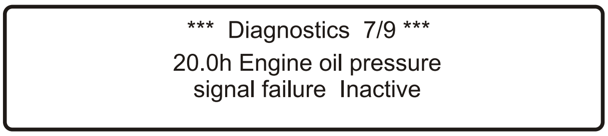


P0002066

Governor mode

activates/shuts off droop. To set the droop level, refer to the *Setup / Governor gradient or Governor droop* menu.

- Select **Isochronous mode** or **Droop mode** with the SEL button.

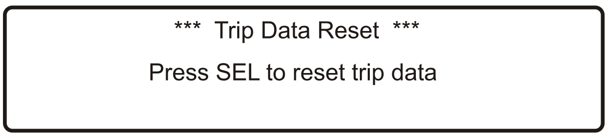


P0002067

Diagnostics

shows the error list containing the 10 latest active and inactive faults. The fault codes are shown as text on the display.

- Scroll through the fault list with the arrow keys.



P0002068

Trip Data reset

resets trip data, such as fuel consumption.

- Press the **SEL** button to reset trip data

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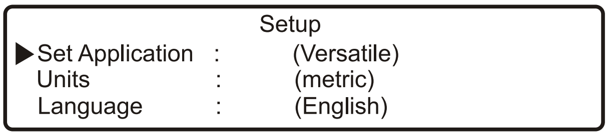


P0002069

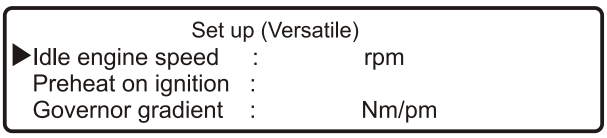
Setup

parameter setting in the engine's control systems. Different menus appear under **Customer parameter**, depending on whether **Versatile** or **Gen set** has been selected from **Set application**. See below.

The parameters that can be set/selected (choice is made with the SEL button) are:

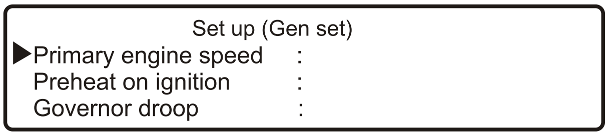
- **Set application**, setting **Versatile** or **Gen set**. Depending on the selection made here, different menus will appear under **Customer parameter**.
- **Unit**, setting of units (metric or US imperial).
- **Language**, setting the language used on the display. Choose between English, French, German and Spanish.
- **Stop energized to**, setting of external stop input. Activated by **Stop** or **Run**.
  Stop: The stop input must be connected to voltage to stop the engine.
  Run: The stop input must be connected to voltage to run the engine.
- **Customer parameter**, setting alarm limits. Refer to *Customer parameter / Versatile and Customer parameter / Gen set*.
- **Throttle input setting**, setting of engine-speed control and voltage limits. Refer to *Throttle input setting*.
- *Display setting*, setting the display. refer to *Display setting*.

Customer parameter / Versatile



P0002070

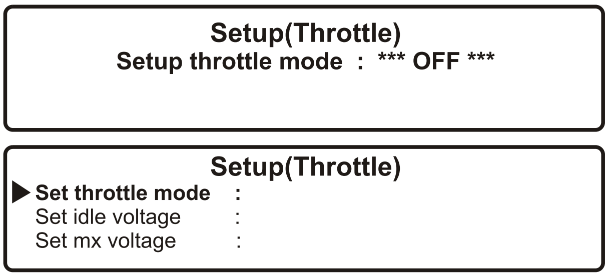
- **Idle engine speed** - setting idle speed.
- **Preheat on ignition** - activation of automatic pre-heating. The engine control system senses if pre-heating is needed and activates it directly at switch-on.
- **Governor gradient (Nm/rpm)** - setting of droop level, when activated. For activation, refer to *Governor droop* in the main menu.
- **Oil temp warning limit (°C)** - setting alarm limit for oil temperature.
- **Coolant temp warning limit (°C)** - setting alarm limit for coolant temperature.



P0002071

Customer parameter / Gen set

- **Primary engine speed** - selection of engine rpm, 1500 or 1800 rpm.
- **Preheat on ignition** - activation of automatic pre-heating. The engine control system senses if pre-heating is needed and activates it directly at switch-on.
- **Governor droop (%)** - setting of droop level, when activated. For activation, refer to “Governor droop” in the main menu.
- **Overspeed limit (%)** - setting of limit for overspeed alarm, % of set engine rpm.
- **Overspeed shutdown** - activation of engine shut-down with overspeed alarm. Refer to “Overspeed limit” to activate the alarm limit for the excess rpm alarm.
- **Oil temp warning limit (°C)** - setting alarm limit for oil temperature.
- **Coolant temp limit (°C)** - setting alarm limit for coolant temperature.

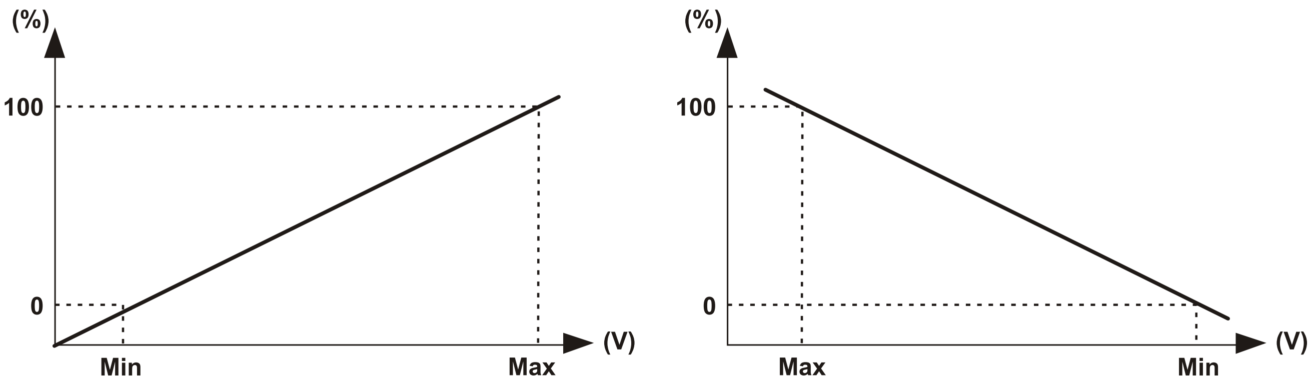


P0002955

Throttle input setting

rpm control setting (throttle operation).

- **Set throttle mode** - OFF - engine rpm is controlled via the DCU panel.
  ext throttle input - engine speed is controlled with a potentiometer (accelerator).
  ext voltage input - engine rpm is controlled by an external unit.
- **Set idle voltage (V)** - idle voltage level setting.
- **Set max voltage (V)** - full throttle voltage level setting.



P0002074

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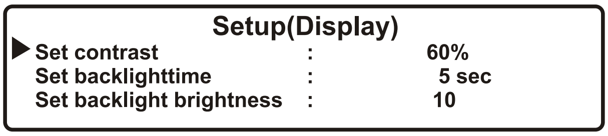
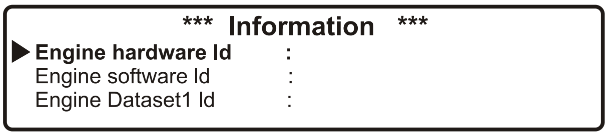


P0002075

Display setting

settings for the display. Adjustment is made with the **7** and **9** buttons; see DCU panel illustration.

- **Set contrast (%)** - contrast setting.
- **Set backlight time (sec)** - time setting (in seconds) for display backlighting on, lighting is then shut off if the panel is not used.
- **Set backlight brightness** - display backlighting brightness setting.



P0002076

Information

shows the data for the engine and DCU.

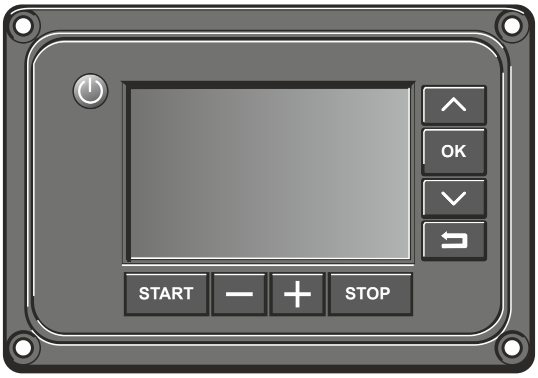
- **Engine hardware Id** - engine control unit part number.
- **Engine software Id** - engine control unit software part number.
- **Engine dataset1 Id** - engine data set 1 part number.
- **Engine dataset2 Id** - engine data set 2 part number.
- **Vehicle Id** - chassis number.
- **DCU hardware Id** - DCU part number.
- **DCU software Id** - DCU software part number.
- **DCU dataset1 Id** - DCU data set 1 part number.
- **DCU dataset2 Id** - DCU data set 2 part number.

TAD1641GE-B, TAD1642GE-B, TAD1643VE-B, TAD1650VE-B, TAD1651VE, TWD1644GE, TWD1645GE

The Volvo Penta DCU II instrument panel communicates with the engines control unit and has a number of functions as control, monitoring and diagnostics.

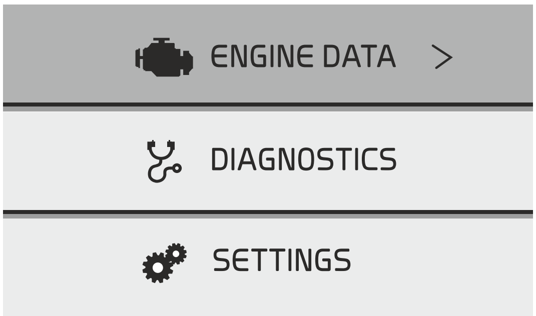
NOTICE! Settings and the type of engine data presented on the display may vary depending on the installation and engine model.
Depending on the installation the DCU II can also be used as presentation display only.

NOTICE! The menus and illustrations shown here are the English version. Refer to the section *Settings* to change the display language.



P0018811

- Turn On/Off the ignition
- START Start the engine
- — Reduce engine rpm
- + Increase engine rpm
- STOP Stop the engine
- Scroll upwards in menus
- OK Select and confirm in menus
- Scroll downwards in menus
- Return to previous menu selection



P0018295

Display

The DCU II basic view shows three main menus.

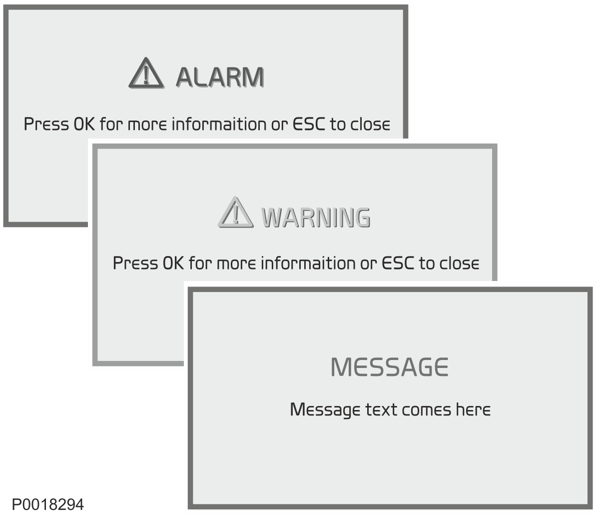
- **ENGINE DATA** (ENGINE DATA), shows current engine data.
- **DIAGNOSTICS** (DIAGNOSTICS), shows active fault codes.
- **SETTINGS** (SETTINGS), shows display and engine settings.

Press OK to proceed in the submenus and scroll using the panel arrow buttons.
Press to return to previous menu.

Status bar

The status bar with symbols for active malfunctions is shown in the top right of the display.

	Emission related malfunction
	EMS system malfunction

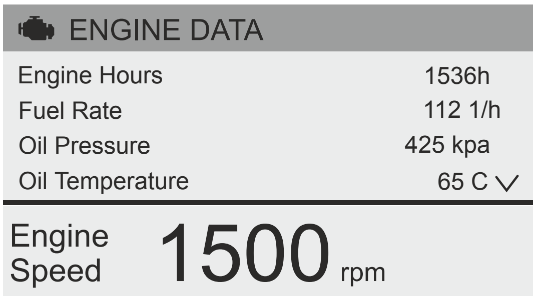


P0018294

Alarms and messages

Messages to the operator are of three types, color coded according to degree of severity.
When a message is shown on the display, press OK to reach the diagnostic menu to get more information regarding registered faults and instructions for remedial actions.

- **ALARM** (ALARM), red text, the system has detected a serious fault — Volvo Penta recommends to immediately contact a qualified workshop .
- **VARNING** (WARNING), yellow text, the system has detected a fault — Volvo Penta recommends to contact a qualified workshop as soon as possible.
- **MEDDELANDE** (MESSAGE), blue text, non-critical engine message for the operator.



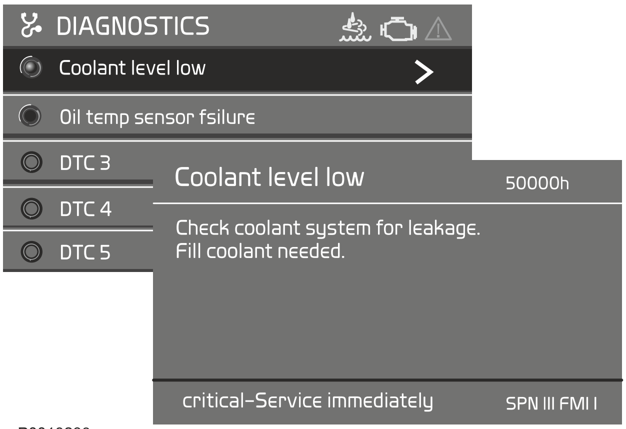
P0018291

Menus

ENGINE DATA (ENGINE DATA)

Engine data shown may vary depending on the engine installation.

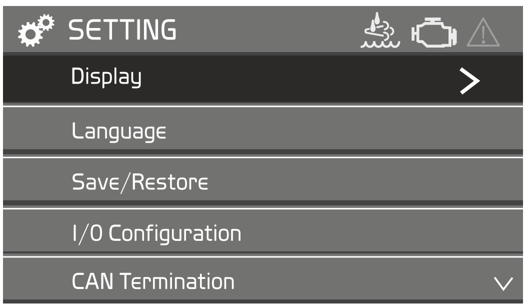
- **Engine Hours** (Engine Hour) (tim)
- **Engine Speed** (Engine Speed) (rpm)
- **Coolant Temperature** (Coolant Temperature) (°C)
- **Oil Pressure** (Oil Pressure) (kPa)
- **Fuel Rate** (Fuel Rate) (l/h)
  Current fuel consumption.
- **Boost Temperature** (Boost Temperature) (°C)
- **Boost Pressure** (Boost Pressure) (kPa)
- **Oil Temperature** (Oil Temperature) (°C)



P0018293

DIAGNOSTICS (DIAGNOSTICS)

If the system detects a malfunction, the operator is informed via a pop-up message on the display. The fault codes are listed in the diagnostics menu; active fault codes are at the top of the list and are denoted be a green dot. For more information regarding cause and remedies, use the arrow button to scroll to the fault concerned and press OK. This will also provied information about number of engine hours when the fault became active and the SPN and FMI codes.



P0018292

SETTINGS (SETTINGS)

Display (Display)

- **Set backlight time** (Set backlight time). On/OFF, sets backlight to run in standby mode. *On* is the default setting.
- **Set backlight brightness** (Set backlight brightness). Adjust display backlight brightness using the panel arrow buttons.
- **Set Instrument Brightness** (Set Instrument Brightness). Sets backlighting in the display instrument.
- **Change background color** (Change background color). Select background color, gray or white.

Language (Language)

Sets the display language; chooses between English, French, German, Spanish and Chinese.

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Save/Restore (Save/Restore)

- **Save current configuration** (Save current configuration). Save the current display settings.
- **Restore last configuration** (Restore last configuration). Restore the last displayed settings saved.
- **Restore default configuration** (Restore default configuration). Restores *all* display setting menus to factory settings.

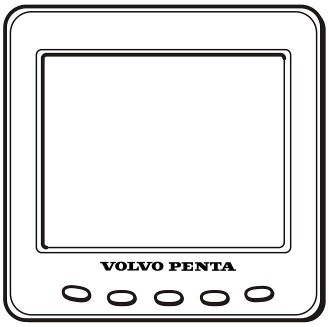
NOTICE! The settings in the following menus do not normally need to be changed; should a change be necessary it must be carried out by an authorized Volvo Penta technician. Refer to the installation manual for further engine information.

Authorized Volvo Penta dealer or OEM only

- I/O Status (I/O Status)
- CAN Termination (CAN Termination)
- Stop Logic DCU (Stop Logic DCU)
- Potentiometer supply (Potentiometer supply)
- Speed Control (Speed Control)
- Control display unit (Control display unit)
- Genset/VE (Genset/VE)
- Buzzer (Buzzer)
- Information (Information)

DU (Display Unit)

TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1650GE, TAD1650VE, TAD1651GE, TWD1643GE, TWD1652GE, TWD1653GE



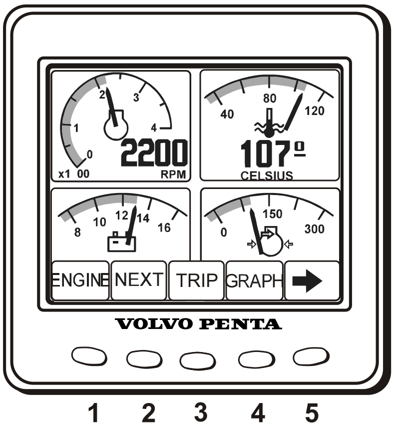
P0002061

The DU is an computerized instrument panel which shows engine working values on an LCD screen. In the display it is possible to show multiple windows with different information, i. g. engine rpm, coolant temperature, fuel consumption and fault messages.

At start up, the display performs a self-test. If an constant signal is heard, the system has discovered a malfunction. The display will work but may act in an unexpected way.

The DU is connected between the engine control unit and the CIU or DCU.

Display modes



P0002382

Press any of button 1–4 to view the function menu for the buttons, apperaring in the lower part of the display. To leave the menu, wait a few seconds or press button 5 (EXIT).

1 Engine

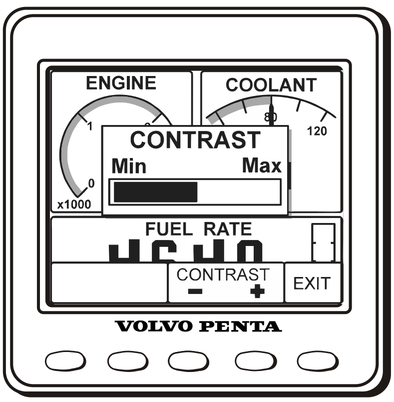
2 Multi

3 Trip

4 Graph

5 Exit

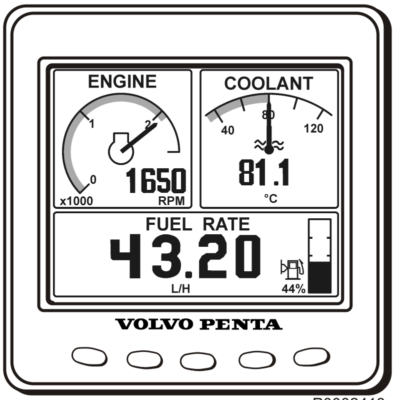
Contrast



P0002403

In the display modes Engine, Trip and Graph, it is possible to adjust the contrast.
Press button 5 outside the menu and then + (button 4) or – (button 3) to adjust the contrast.

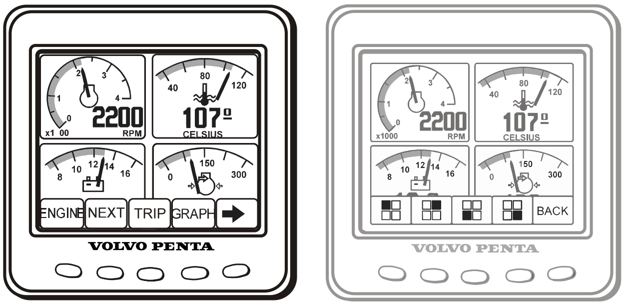
Engine



P0002413

Rpm and coolant temperature is shown in the upper part of the display. In the lower part it will show trip computer and a fuel level indicator, if these function are installed.

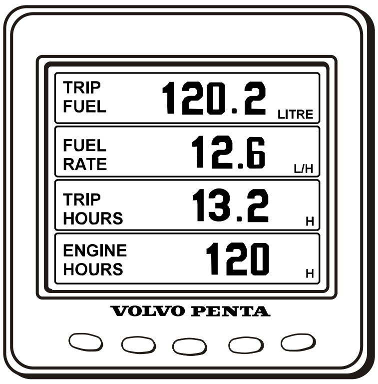
Multi



P0014208

In the multi mode, button 2, the information can be shown in four windows,analogue or digital. The display toggles between the two when button 2 is pressed repeatedly.
By pressing button 5, the right arrow, you choose what information to be shown in the different windows.
Press repeatedly on the button that correspond to the window, until desired information is shown.

Trip



P0002418

To display the trip computer press button 3, Trip

Trip Fuel, since last reset

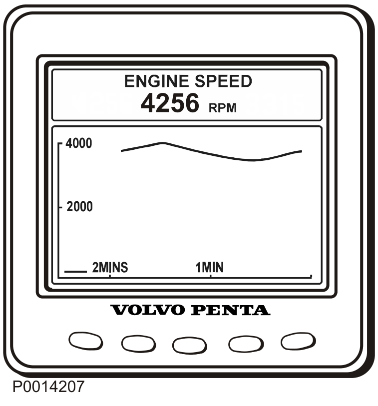
Fuel Rate, fuel consumption

Trip hours, since last reset

Engine hours, total amount of operating hours

Reset by pressing button 3 for three seconds until a beep is heard.

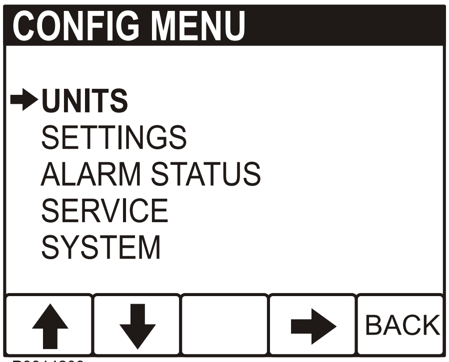
Graph



P0014207

The information is shown as graphs. Press button 4 repeatedly to choose what information will be shown.
The time interval is set in the Configuration menu.
If the connection is broken there will be a straight line in the display.

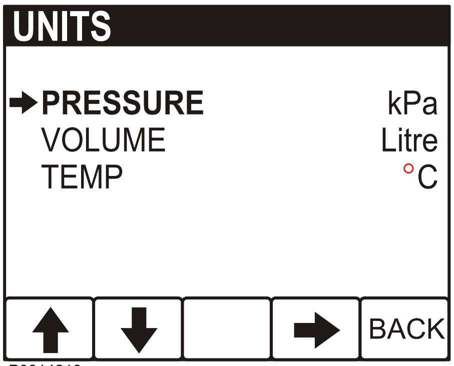
Configuration menu



P0014209

Press button 5 for three seconds to enter the Configuration menu. Navigate with the up and down arrows, select with the right arrow.

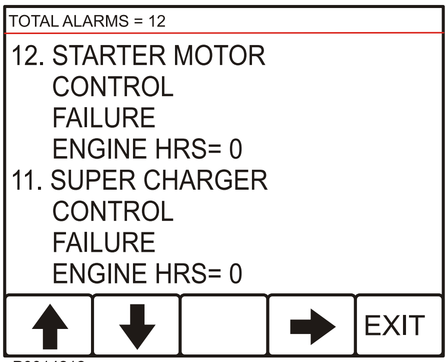
Units



P0014210

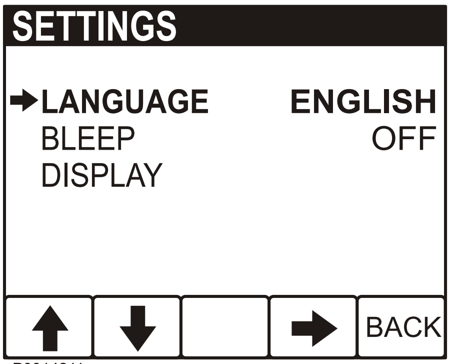
- PRESSURE; kPa, PSI
- VOLUME; LITRE, GAL, Imperial GAL.
  Fuel rate is adjusted according to volume unit, L/H, GAL/H, IGAL/H.
- TEMPERATURE; °C, °F

Alarm Status



P0014212

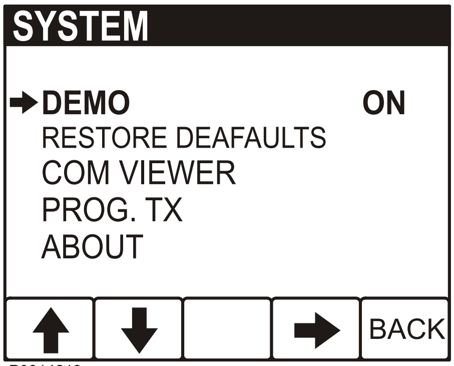
List of active alarms, refer to *Reading fault codes via the DU (Display Unit)*



P0014211

Settings

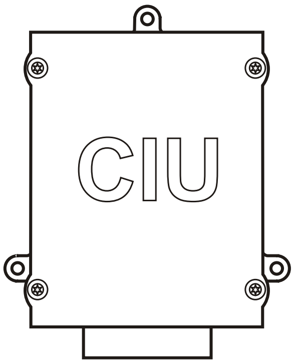
- LANGUAGE; setting of what language is to be used in the display.
- BLEEP; On/Off, setting if pressing the instrument buttons will be followed by a beep or not.
- DISPLAY; setting of ENGINE RPM gauges
  RPM ENGINE, 2500–9000 RPM, in steps of 500 RPM
  GRAPH RANGE, 2 minutes– 8 hours in the following steps,
  2MINS, 10MINS, 30MINS, 60MINS, 2HRS, 4HRS, 8HRS



P0014213

SYSTEM

- DEMO, switches the DEMO mode ON/OFF.
- RESTORE DEAFAULTS, reset all configuration to default values.
- COM VIEWER, displays latest message on communication ports
- PROG TX, transfers content of the application on Flash memory to other CAN units on the same CAN bus.
- ABOUT, displays
  ID NO – display serial number
  EEPROM – number of write on EEPROM
  VERS – software version number
  CHK – Flash memory checksum
  PART No – Volvo software part number
  SOURCE – source of received data
  LABLE – Allocated Label on the same bus.



P0002060

CIU (Control Interface Unit)

TAD1640VE-B, TAD1641GE-B, TAD1641VE-B, TAD1642GE-B, TAD1642VE-B, TAD1643VE, TAD1650GE, TAD1650VE, TAD1651GE, TWD1643GE, TWD1652GE, TWD1653GE

The CIU is a "translator" between the control unit (EMS) and the customer's own control panel. The CIU has two serial communication links, one fast and one slow.

The fast one is a so-called CAN link. All data related to instruments, indication lamps, connectors and potentiometers is controlled by this link.

The slow link manages diagnostic information for flashing codes etc.

Easy Link Instruments

The following Easy Link instruments are available:

- Tachometer / hours counter (fault codes are also displayed on the tachometer display when the diagnostic button is pressed)
- Coolant temperature
- Oil pressure
- Oil temperature
- Battery voltage
- Alarm panel
- Turbo pressure

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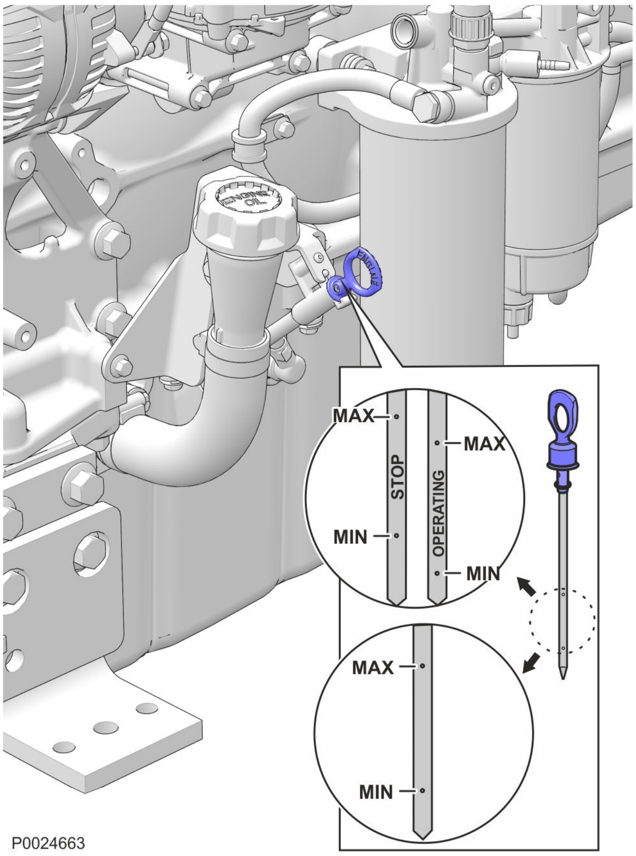
Starting

Make it a habit of giving the engine and engine room a visual check before starting. This will help you to discover quickly if anything abnormal has happened, or is about to happen.
Also check that instruments and warning displays show normal values after you have started the engine.

⚠ WARNING!
Never use start spray or similar agents to start an engine. This may cause an explosion in the inlet manifold. Risk of personal injury.



P0024663

Before Starting

- Check that the oil level is between the MIN and MAX marks.
  For filling refer to *Oil level, checking and topping up*.

NOTICE! Dipstick marked STOP/OPERATING can be read both when the engine is stopped and when it is running. Use the STOP side of the dipstick when engine is stopped and the OPERATING side when in operation.

- Open the fuel valves.
- Check the fuel pre-filter; refer to *Draining condensate, fuel system, page 73*.
- Check the coolant level and that the radiator is not blocked externally. Refer to *Coolant Level, Checking and Topping Up, page 78* and *Charge Air Cooler, External Cleaning, page 80*

  ⚠ WARNING!
  Do not open the coolant filler cap when the engine is hot, except in emergencies, as this could cause serious personal injury. Steam or hot fluid could spray out.

- Check that no leakage of oil, fuel or coolant is present.
- Turn the main switch(es) on.
- Move the engine speed control to idle, and open the disengageable clutch/gearbox if installed.

IMPORTANT:
Never break the circuit with the main switch while the engine is running.
Alternator and electronics could be damaged.

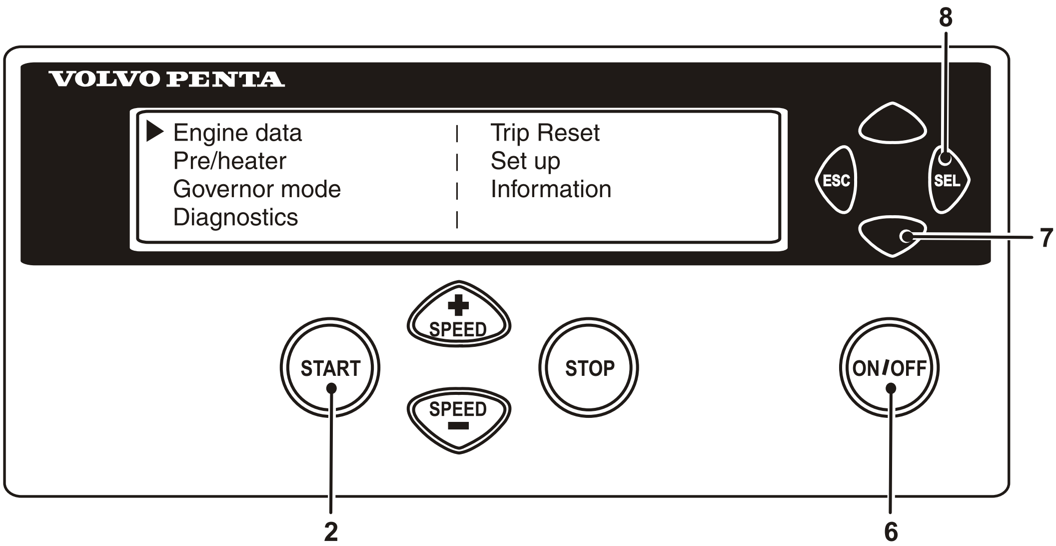
Starting the Engine

The pre-heating time is adjusted to suit the engine temperature, and can last for up to 50 seconds both before and after starting.

The starter motor cranking time is maximized to 20 seconds. After that, the starter motor circuit is temporarily cut to protect the starter motor from overheating.

DCU (Display Control Unit)

TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1650GE, TAD1650VE, TAD1651GE, TWD1643GE, TWD1652GE, TWD1653GE



P0002079

With pre-heating

1. Depress the **ON/OFF**-button (6).
2. Press the **SEL** button (8) to come to the mainmenu.
3. Scroll down to **Pre/heater** with scroll button (7),press **SEL**-button (8)
4. In the **pre-heater** menu, press the **SEL**-button (8) to select pre-heating.
5. Press the **START**- button (2).

Without pre-heating

1. Depress the **ON/OFF**-button (6).
2. Press the **START**-button (2).

Leave the engine to idle for the first 10 seconds. Then warm the engine up at low speed and under low load. Never race the engine when it is cold.

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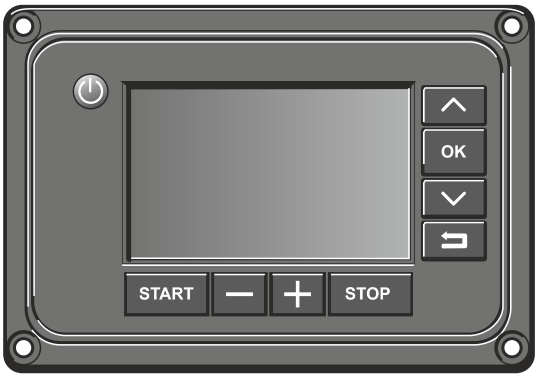


P0018811

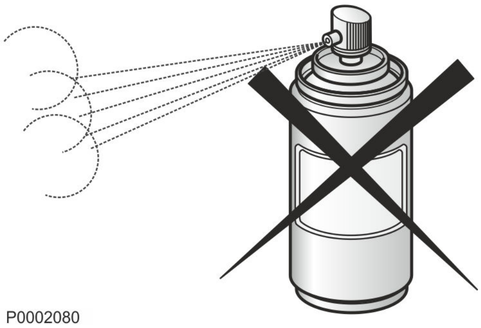
TAD1641GE-B, TAD1642GE-B, TAD1643VE-B, TAD1650VE-B, TAD1651VE, TWD1644GE, TWD1645GE

1 Press the ⏻ button to switch on the ignition. The display switches on at the same time.
2 If preheat is activated, wait until heating icon has disappeared until START is requested.
3 Press the START button to start the engine.

Starting in Extreme Cold

Certain preparations must be made to enable engine starting in extreme cold, and in some cases to make starting possible at all:

- Use a winter grade fuel (of a well-known make) that is approved for the prevailing temperature. This reduces the risk of paraffin wax precipitation in the fuel system. At extremely low temperatures, we recommend the use of a fuel heater.
- Use a synthetic engine oil of a viscosity recommended for the prevailing temperature to achieve satisfactory lubrication. Refer to *Viscosity, page 92*. Synthetic lubricants are able to handle a wider temperature range than mineral-based lubricants.
- Pre-heat the coolant with a separately-installed electric engine heater. In extreme cases, a diesel-fired engine heater may be necessary. Ask your Volvo Penta dealer for advice.
- Make sure the cooling system is filled with a coolant mixture. Refer to *Maintenance, page 77*.
- The batteries must be in good condition. Cold weather reduces battery capacity. Increased battery capacity may be necessary.



P0002080

Never Use Start Spray

⚠ WARNING!

Never use start spray or similar agents to start an engine. This may cause an explosion in the inlet manifold. Risk of personal injury.

Starting Using Auxiliary Batteries

⚠ WARNING!

Explosion hazard. Batteries contain and give off an explosive gas which is highly flammable and explosive. A short circuit, open flame or spark could cause a violent explosion. Ventilate well.

1 Check that the auxiliary batteries are connected (series or parallel) so that the rated voltage corresponds to the engine system voltage.

2 First connect the red (+) jumper cable to the auxiliary battery, then to the flat battery. Then connect the black (-) jumper cable to the auxiliary battery and to a location that is **somewhere away from the discharged battery**, e.g. the main switch negative terminal or the negative terminal on the starter motor.

3 Start the engine.

   ⚠ WARNING!

   Do not touch the connections during the start attempt: Risk of arcing.
   Do not bend over any of the batteries either.

4 Remove the cables in the reverse order.

IMPORTANT:

The ordinary cables to the standard batteries must not under any circumstances be loosened.

Operation

Correct operating technique is very important for both fuel economy, environmental protection and engine life. Always let the engine warm up to normal operating temperature before operating at full power. Avoid sudden throttle openings and operation at high engine speed.

Reading the Instruments

Check all instruments directly after starting, and then regularly during operation.

NOTICE! On engines in continuous operation, it is recommended that the lubrication oil level is checked at least every 24 hours. Refer to *Oil level, checking and topping up*.

Alarms

If the EMS receives abnormal signals from the engine, the control unit generates fault codes and alarms, in the form of lamps and audible warnings. This is done by means of CAN signals to the instrument.

More information about fault codes and fault tracing can be found in the chapter *Fault handling, page 46*.

Maneuvering

Operation at low load

Avoid long-term operation at idle or at low load. It takes a long time for the engine to reach working temperature, resulting in high viscosity of the oil and large clearances in the engine mechanics. In cold climate, it takes even longer.

The combustion temperature and cylinder pressure can become so low that an effective combustion cannot be ensured. At these conditions unburned fuel could dilute the lubricant oil. Because of the low cylinder pressure, the piston ring performance could be affected causing oil from the crankcase to pass the rings and go further out with the exhaust gases. This mixture of unburned fuel and oil in exhaust gases is referred to as “slobber”. A new engine produces more “slobber” at low load compared to an engine with more hours of operation.

At low load, the pressure in the turbocharger is low and oil could seep past the turbocharger seals and mix with the air into the engine. The consequences can be carbon build-up on valves, piston crowns and the exhaust turbine, which could affect engine performance.

Both conditions can lead to increased oil consumption and eventually external oil leakage from joints in the exhaust system. For example, leakage could be seen at the exhaust manifold, before and after the turbo, around the muffler and in worse case even in the exhaust end pipe. Consequences could lead to clogged exhaust gas recirculation systems and exhaust aftertreatment systems.

Signs of oil leaking caused by "slobber" do not indicate an engine problem but indicates low load operation. To minimize the risk of malfunctions caused by operation at low load, follow these points as a complement to normal maintenance:

- Run in the engine as soon as possible.
- Load the engine so it reaches working temperature as soon as possible.
- Turn off the engine instead of running on idle for longer periods.
- Avoid load levels below 20% as constant operation.
- If the engine is regularly tested without load, limit the duration of the operation to 5 minutes. Run the engine at full load for about 4 hours once a year, for the carbon deposits in the engine and exhaust system to burn off.
- If visible slobber has occurred, it can be burned off by running the engine on at least 30% load for about 40-60 minutes.

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Engine Shutdown

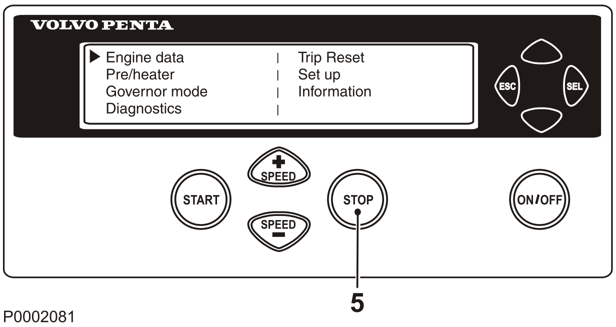
During longer breaks in operation, the engine must be warmed up at least once every two weeks. This prevents corrosion in the engine. If you expect the engine to remain unused for two months or more, it must be preserved: Refer to the chapter *Storage, page 87*.

Before Engine Shutdown

Let the engine run at high idle (1500 or 1800rpm) for a minimum of 5 minutes before the shutdown after normal use. Normal use is defined as minimum 50% load. After use with less than 50% load, high idle for approximately 3 minutes is sufficient. This allows engine temperature equalization and prevents boiling once stopped and also allows the turbochargers to cool down. This contributes to long, fault-free service life.

NOTICE! Do not turn off the main switch within 30 seconds after turning off the ignition. This is in order to save engine data to the engine control unit.

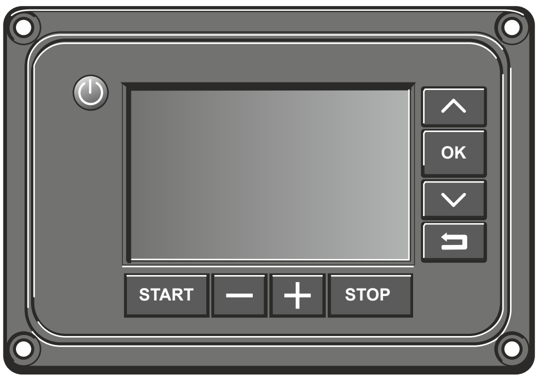
Stop the Engine



P0002081

TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1650GE, TAD1650VE, TAD1651GE, TWD1643GE, TWD1652GE, TWD1653GE

- Disengage the clutch (if possible).
- Depress the **STOP**-button (5).



P0018811

TAD1641GE-B, TAD1642GE-B, TAD1643VE-B, TAD1650VE-B, TAD1651VE, TWD1644GE, TWD1645GE

1 Disengage the clutch, if possible.
2 Press the STOP button to turn off the engine.
3 Press the ⏻ button to turn off the ignition.

P0025697

Auxiliary Stop

For location of the extra stop, refer to *Maintenance, page 60*.

WARNING!
Working with or approaching a running engine is a safety risk. Watch out for rotating components and hot surfaces.

After Engine Shutdown

1 Check the engine and engine compartment for leaks.

2 Turn off the main switches before any long stoppage.

3 Carry out maintenance in accordance with the schedule.

For longer breaks in operation

During longer breaks in operation, it is recommended that the engine is warmed up at least once every two weeks. This prevents corrosion in the engine.
If you expect the engine to be unused for two months or more, it should be conserved. Refer to *Storage, page 87* .

IMPORTANT:
If there is a risk of freezing, the coolant in the cooling system must have adequate antifreeze protection.

Refer to *Maintenance, page 77*.

IMPORTANT:
A poorly charged battery can freeze and burst.

Refer to *Battery, page 85*.

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Fault handling

Despite regular service in accordance with the planned maintenance schedule and perfect operating conditions, faults may occur that must be remedied before operations continue. This chapter describes the diagnostics function, simple fault tracing and the fault code register.

Diagnostic Function

The purpose of the diagnostic function is to monitor, control and protect the engine and its surrounding system and components from damage, as well as to ensure a minimal environmental impact.

If a malfunction is detected the diagnostic function informs of the occurred fault in the form of a fault code. The fault code provides guidance when fault tracing. All fault codes and fault messages can be found in the *Fault Code Register*.

The operator is warned that there is a malfunction via the instruments. Depending on the instrumentation in use, the fault message is shown in various ways. Fault codes can also be read out by the Volvo Penta diagnostic tool.

Depending on the severity of the fault, the diagnostic function will take various actions to protect the engine and limit emissions (e.g. torque derate, idle speed only, engine shut down etc.)

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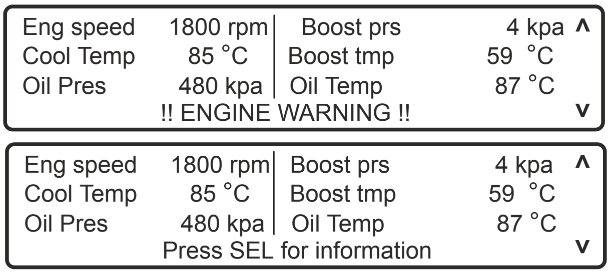
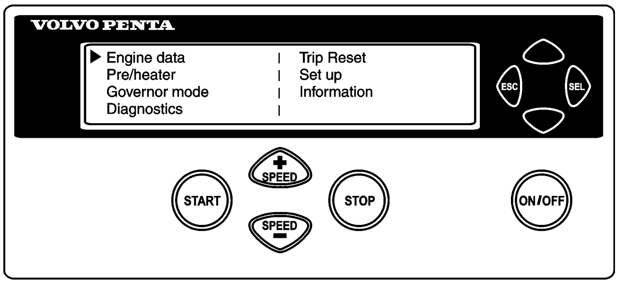
DCU (Display Control unit)



P0020406

1. When a fault is detected the following text is displayed:
   !! ENGINE WARNING !! alternating with
   Press SEL for information.
2. Reduce engine speed to idle or shut down the engine.



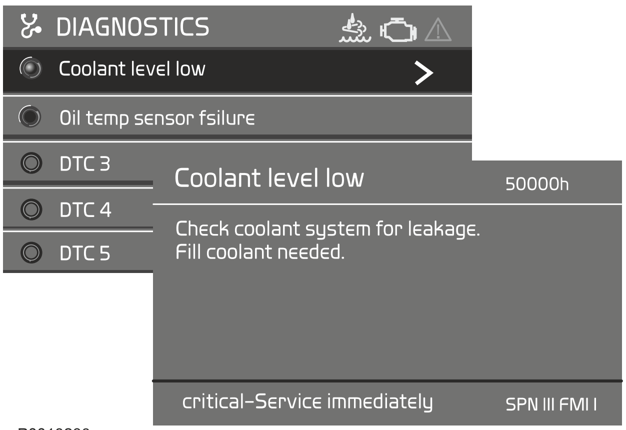
P0014039

3. Press the **SEL** button to get to the fault list.
   The fault list shows:
   – hours of operation
   – fault messages
   – active/non-active faults
4. Look up the fault code in the *Fault Code Register* and take the necessary actions.
5. Press **ESC** to leave the fault list.

NOTICE! To get to the fault list when no fault codes are set, press the **SEL** button and select **Diagnostics** from the menu.

DCU II (Display Control Unit)

TAD1641GE-B, TAD1642GE-B, TAD1643VE-B, TAD1650VE-B, TAD1651GE, TWD1644GE, TWD1645GE



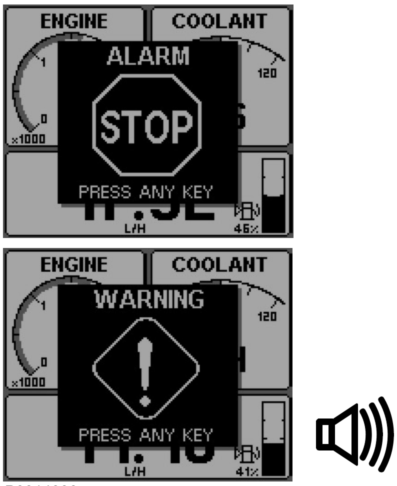
P0018293

DIAGNOSTICS

If the system detects a malfunction the driver/operator is informed via a pop-up message on the display. The fault codes are listed in the diagnostics menu; active fault codes are at the top of the list and are denoted by a green dot. For more detailed information regarding the cause and remedies, use the arrow buttons to scroll to the fault concerned and press OK. This will also provide information about the number of engine hours when the fault became active and the SPN and FMI codes.

DU (Display Unit)

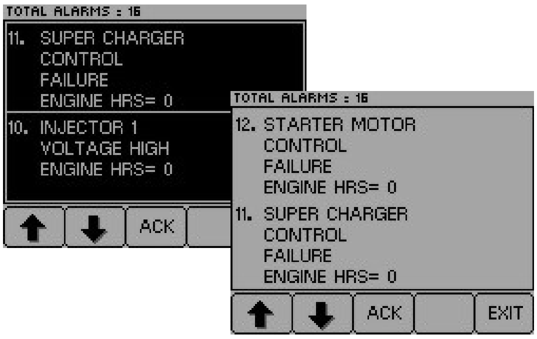
TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1650GE, TAD1650VE, TAD1651GE, TWD1643GE, TWD1652GE, TWD1653GE



P0014030

1 If the system detects a fault, a pop-up is shown on the display. Depending on the severity of the fault the following text will appear **ALARM STOP / PRESS ANY KEY** or **WARNING! / PRESS ANY KEY**; a buzzer will sound.

2 Reduce engine speed to idle or shut down the engine.

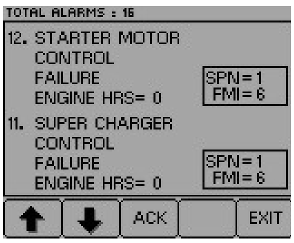


P0014029

3 Press the SEL button to get to the fault list. The fault list shows fault messages and the number of hours of operation when the fault occurred.

4 Press **ACK** to acknowledge the fault code. The display background changes color (and the buzzer stops). The fault must be acknowledged before it can disappear from the fault list.

5 Look up the fault code in the *Fault Code Register* and take the necessary actions.



P0014038

6 Press button 4 for at least three seconds to view SPN and FMI codes.

7 Press **EXIT** to leave the fault list.

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CIU (Control Interface Unit)

When the system detects a malfunction, the diagnostics lamp flashes. If the diagnostics button is pressed and then released, a fault code is flashed out.

The fault code consists of two groups of flashes, separated by a pause of two seconds. A fault code is obtained by counting the number of flashes in each group.

Example

☼ ☼ pause ☼☼☼☼ = fault code 2.4

The fault code is stored and can be read off as long as the malfunction remains. Information about causes, effects and actions required is available in the Fault Code chapter.

Do as follows to read off the fault code:

1 Press the diagnostics button.

2 Release the diagnostics button and note down the fault that is flashed out.

3 Repeat items 1–2. A new fault code will be flashed out if more faults are stored. Repeat until the first fault code reappears.

NOTICE! When the first fault code reappears, all fault codes have been read off.

If the diagnostics button is pressed after the fault has been rectified and the fault codes have been erased, code 1.1 “No fault” will be displayed.

Easy Link Instruments

1 When a malfunction is detected this is reported by the diagnostic lamp which starts to flash.

2 Press the diagnostics button. The fault code is shown as text in the tachometer display.

3 Look up the fault code in the *Fault Code Register* and take the necessary actions.

4 When the fault has been rectified, the fault code disappears from the display and the diagnostics lamp goes out.

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Erasing fault codes

The memory of the diagnostic function is reset when the power to the engine is disconnected. When the power is switched on again, the diagnostic function will check if there are any malfunctions in the system. If so a new fault codes is registered.

If a malfunction has not been corrected it will be registered once again and has to be acknowledged again.

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Fault Tracing

A number of symptoms and possible causes of engine malfunctions are described in the table below. Always contact your Volvo Penta dealer if any problems occur which you can not solve by yourself.

IMPORTANT!

Read through the safety advice for care and maintenance work in the chapter *Safety precautions for maintenance and service operations* before you start work.

Symptoms and possible causes	
The diagnosis button lamp flashes	Please refere to *Diagnostic Function*
Engine can not be stopped	2, 5
Starter motor does not rotate	1, 2, 3, 4, 5, 6, 7, 24
Starter motor rotates slowly	1, 2
Starter motor rotates normally but engine does not start	8, 9, 10, 11,
Engine starts but stops again	8, 9, 10, 11, 13
Engine does not reach correct operating speed at full throttle	9, 10, 11, 12, 13, 21, 25, 26
Engine runs roughly	10, 11
High fuel consumption	12, 13, 15, 25
Black exhaust smoke	12, 13
Blue or white exhaust smoke	15, 22
Too low lubrication oil pressure	16
Excessive coolant temperature	17, 18, 19, 20, 28
Too low coolant temperature	20
No, or poor charge	2, 23
Too high exhaust temperature TWD1643GE, TWD1652/53	13, 17, 18, 19, 21, 25, 27, 28, 29, 30

1 Discharged batteries

2 Poor contact/open circuit in electrical wiring

3 Main switch turned off

4 Main fuse faulty

5 Faulty ignition lock

6 Faulty main relay

7 Faulty starter motor/-solenoid

8 No fuel:
– fuel cocks closed
– fuel tank empty/wrong tank connected

9 Blocked fuel fine-filter/pre-filter (due to contaminations, or stratification in the fuel at low temperature)

10 Air in the fuel system

11 Water/contamination in fuel

12 Faulty fuel injectors

13 In sufficient air supply to the engine:
– blocked air filter
– air leakage between the turbo and the engine's intake manifold
– dirty compressor part in the turbocharger
– faulty turbo compressor
– poor engine room ventilation

14 Coolant temperature too high

15 Coolant temperature too low

16 Oil level too low

17 Coolant level too low

18 Air in the coolant system

19 Faulty circulation pump

20 Defective thermostat

21 Blocked charge air cooler

22 Oil level too high

23 Alternator drive belt slips

24 Water entry into engine

25 High back pressure in the exhaust system

26 Break in ”Pot+” cable to throttle

27 High temperature, charge air cooler

28 Blocked radiator

29 No pressure in cooling system

30 Check wastegate function

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Fault Code Register

TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1650GE, TAD1650VE, TAD1651GE, TWD1643GE, TWD1652GE, TWD1653GE

	SPN	PID	PPID	SID	PSID	Flash code Electrical fault/Value fault	FMI
Coolant Water Pressure	20	20					1,3,4,5,18
Percent Accelerator Pedal Position	91	91				2.7/- (EMS) 2.8/- (CIU)	9
Fuel Delivery Pressure *Maintenance, page 73*	94	94				3.6/3.8	1, 3, 5, 7
Water in fuel indicator *Draining condensate, fuel system, page 73*	97	97				2.9/2.1	0, 3, 4
Engine Oil Level *Oil level, checking and topping up, page 70*	98	98				5.9/5.7	1, 3, 4, 5
Engine Oil Filter Differential Pressure	99						0
Engine Oil Pressure *Oil level, checking and topping up, page 70*	100	100				3.1/6.6	1, 3, 5, 18
Boost pressure	102	102					0, 3, 5, 16
Boost temperature	105	105				3.2/6.2	0, 4, 5, 16
Boost pressure	106	106				3.4/3.5	0, 3, 5, 16
Air filter pressure	107	107				5.5/5.5	0, 3, 4, 5
Ambient air pressure	108	108				-/-	2, 3, 4
Coolant Temperature *Coolant Level, Checking and Topping Up, page 78*	110	110				3.3/6.1	0, 4, 5, 16
Coolant Level *Coolant Level, Checking and Topping Up, page 78*	111	111				2.3/2.2	1, 3, 5
Crankcase pressure	153	153				7.8/7.7	0, 2, 3, 5
Battery voltage *Battery, Charging*	158	158				-/3.9 (EMS) -/6.9 (CIU)	1, 3, 4
Injection control pressure	164	164				8.3	2, 4, 5
Ambient Air Temperature Sensor	171	171					14
Ambient Air Temperature Sensor	172	172				7.9/-	4, 5
Engine Oil Temperature *Oil level, checking and topping up, page 70*	175	175				3.7/5.8	0, 4, 5, 16
Engine Speed	190	190				-/2.6	0, 16
Throttle position	608		98			-/-	9
Throttle calibrated position	608		132			2.8/-	9
SAE J1708 Data Link	608			250		9.2/-	
SAE J1939 Data Link	608				201		9
+5 V sensor supply	620			232		9.3/-	3, 4

	SPN	PID	PPID	SID	PSID	Flash code Electrical fault/Value fault	FMI
Inlet Air Temperature	626	45				5.4/-	3, 4, 5
Program Memory	628			240		9.9/-	2, 12
Controller error	629			254		9.9/- (EMS) 9.8/- (CIU)	8, 12
Calibration Memory EEPROM	630			253		9.9/- (EMS) 9.8/- (CIU)	2, 12, 14
Camshaft sensor	636			21		2.5/-	2, 3, 8
Flywheel sensor	637			22		2.4/-	2, 3, 8
SAE J1939 Data Link	639			231		6.5/- (EMS) 6.4/- (CIU)	2
Engine Fan Driver	647			33			3, 4, 5
Fuel Injector, Cylinder #1	651			1		7.1/-	3, 4, 5, 12
Fuel Injector, Cylinder #2	652			2		7.2/-	3, 4, 5, 12
Fuel Injector, Cylinder #3	653			3		7.3/-	3, 4, 5, 12
Fuel Injector, Cylinder #4	654			4		7.4/-	3, 4, 5, 12
Fuel Injector, Cylinder #5	655			5		7.5/-	3, 4, 5, 12
Fuel Injector, Cylinder #6	656			6		7.6/-	3, 4, 5, 12
Starter motor relay	677			39		4.6/-	3, 4, 5
Injection Control Pressure Regulator	679				42	8.3/-	3, 4, 5, 6,
Pressure Release Valve	679				97	8.3	0, 7, 11, 14
Starter element	729			70		8.6	3, 4, 5
Stop Input, EMS	970		6			4.8/- (EMS)	4
Fan speed	975	26					3
Compression break	1072		122				1, 3, 4, 5
+5 V sensor supply	1079			232		9.3/-	3, 4
+5 V sensor supply 2	1080			211		9.3/-	3, 4
ECU temperature	1136		55			8.4	16
Exhaust gas temperature	1184	173				4.9/1.9	0, 4, 5, 16
Wastegate Valve	1188			32			3, 4, 5
SAE J1939 Data Link	1231				232		2
SAE J1939 Data Link	1231				229		9
Rail pressure system	1239				96	8.3	0, 1, 4, 7, 12, 16
Engine synchronizing	1377		98				9
Main relay output	1485		5			5.1/-	
Starter Output	1675		3				0, 3, 4, 5, 10
Starter Output	1675			39			0, 3, 4, 5, 10
Data Link	2017				201		9
Internal EGR	2791		19			8.5	3, 4, 5, 7
Starter Output	2898		3				3, 4, 5
Starter Output	2899		3				3, 4

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	SPN	PID	PPID	SID	PSID	Flash code Electrical fault/Value fault	FMI
Thermostat bypass valve	2988		332				3, 4, 5
Exhaust gas temperature sensor #1	3241		386				0, 7, 4, 5
Sensor Supply Voltage #1 (+5 V DC)	3509			232			3, 4
Sensor Supply Voltage #2 (+5V DC)	3510			211			3, 4
Piston cooling oil pressure	4811		8				1, 2, 3, 5, 18
Piston cooling pressure	520192					6.8/6.7	1, 3
Starter input sensor	520194		4			4.7/- (EMS) 5.2/-(CIU)	
Stop Input, CIU	520195		6			5.3/- (CIU)	4
Frequency select input			113				
Diagnostic request switch input			259				
Oil pressure warning lamp status			260			4.1/-	
Coolant level warning lamp status			261			4.5/-	
Diagnostic lamp status			262				
Run indication lamp status			263			4.3/-	
Over speed indication lamp status			264			4.4/-	
Coolant temperature warning lamp output			7			4.2/-	

TAD1641GE-B, TAD1641VE-B, TAD1642GE-B, TAD1642VE-B, TAD1643VE-B, TAD1650VE-B, TAD1651VE, TWD1643GE, TWD1644GE, TWD1645GE, TWD1652GE, TWD1653GE

Fault codes, engine

SPN	Component	FMI
20	Coolant Water Pressure	1, 3, 5, 18
51	Engine Throttle position (cold)	3, 5, 7, 12, 13
91	Accelerator Pedal position	0, 9, 19
94	Fuel Delivery Pressure *Maintenance, page 73*	3, 5, 12, 18
97	Water in fuel indicator *Draining condensate, fuel system, page 73*	0, 4, 12
98	Engine Oil Level *Oil level, checking and topping up, page 70*	1, 4, 5, 18
99	Engine Oil Filter Differential Pressure	0
100	Engine Oil Pressure *Oil level, checking and topping up, page 70*	1, 3, 4, 5, 18
101	Crankcase pressure	0, 3, 5
102/106	Boost pressure	0, 3, 4, 5, 16
105	Boost temperature	0, 4, 5, 16
107	Air filter pressure	0, 3, 4, 5, 12
108	Ambient air pressure	5
110	Coolant Temperature *Coolant Level, Checking and Topping Up, page 78*	0, 4, 5, 16
111	Coolant Level *Coolant Level, Checking and Topping Up, page 78*	1, 3, 4, 5, 18

SPN	Component	FMI
131	Exhaust back pressure	3, 5, 12
153	Crankcase pressure	0, 2, 3, 5
158	ECU battery potential *Battery, Charging*	0,1, 2
164	Injection control pressure	2, 4, 5
171	Ambient Air Temperature Sensor	14
172	Ambient Air Temperature Sensor	4, 5
173	Exhaust gas temperature	0, 16
175	Engine Oil Temperature *Oil level, checking and topping up, page 70*	0, 3, 4, 5, 16
190	Engine Speed	0, 16
608	Throttle position	9
626	Preheat relay	3, 4, 5
626	Inlet Air Temperature	3, 4, 5
628	Program Memory	2
629	Controller error	8, 12
636	Camshaft sensor	7, 8, 9
637	Crankshaft sensor	2, 8, 9
639	J1939 Network #1 Primary Vehicle Network	2
647	Engine Fan Driver	3, 4, 5
651	Fuel Injector, Cylinder #1	3, 5
652	Fuel Injector, Cylinder #2	3, 5
653	Fuel Injector, Cylinder #3	3, 5
654	Fuel Injector, Cylinder #4	3, 5
655	Fuel Injector, Cylinder #5	3, 5
656	Fuel Injector, Cylinder #6	3, 5
677	Starter motor relay	3, 4, 5, 6
679	Injection Control Pressure Regulator	3, 4, 5, 6
679	Pressure Release Valve	0, 7, 11, 14
729	Preheater	5, 6, 7, 12
970	Engine stop switch	3, 4, 5, 11, 14
1136	ECU temperature	16
1184	Exhaust gas temperature	0, 4, 5, 16
1188	Wastegate Valve	3, 4, 5
1485	ECM Main Relay	7
1639	Fan speed	3
1668	J1939 Network #4 (engine subnet)	2
2017	Lost Communication (Source Address 17)	9
2036	Lost Communication (Source Address 36)	9
2659	Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate	18
2791	Internal EGR	7
2988	Thermostat bypass valve	3, 4, 5
3241	Exhaust gas temperature	19
3364	Aftertreatment Tank Reagent Quality	2, 17
3464	Engine throttle actuator (cold) Engine Throttle Actuator	3, 4, 5, 7, 10, 12
3509	Sensor Supply Voltage #1 (+5 V DC)	3, 4

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SPN	Component	FMI
3510	Sensor Supply Voltage #2 (+5V DC)	3, 4
3511	Sensor Supply Voltage #3 (+5V DC)	3, 4
520193	Sea Water Pressure	1, 3, 4, 5, 18
520335	ECU battery potential	5
520416	Lost communication with reductant control module on engine subnet	9
520567	Aftertreatment Exhaust Temperature - Wet	0, 3, 4, 5, 16
520570	Engine Oil Pressure Before Filter	3, 4, 5, 11
520688	Aftertreatment Exhaust Temperature - Dry	0, 3, 4, 5, 16
520689	EGR "A" / Volvo Compression Brake (VCB) Control Circuit	3, 4, 5
520690	EGR "A" Control / Turbocharger/Supercharger Wastegate Solenoid "A"	3, 5
520691	Torque Speed Control 1 Received With Errors (Counter or Checksum)	14

Maintenance Schedule

Your Volvo Penta engine and its equipment are designed for high reliability and long life. The engines are built to have the smallest possible environmental impact. If given preventive maintenance, according to the maintenance schedule, these qualities will be retained and unnecessary malfunctions will be avoided. In order for the warranty to be valid, the owner must make sure that the services in the service intervals are performed.

NOTICE! For emission related warranty rights see Emission Control System Warranty Statement.

Service Intervals

Service intervals are shown below. The service content can be found in the Service Protocol available for download at **www.volvopenta.com**.

NOTICE! More information on how to perform service and maintenance can be found in the Service and Maintenance handbook. Information on how to purchase the Service and Maintenance handbook can be found at www.volvopenta.com.

Extended service intervals

The interval between engine oil changes may be extended in certain circumstances. To determine whether the service interval may be extended, Volvo Penta's conditions for extended service intervals must be met and an oil analysis performed. Contact your Volvo Penta dealer for further information.

S1, S2, S3 = Special Interval Service
A - D = Type of service (regular service)

S1 Service	Every 150–600 hours of operation/ at least every 12 month.(1)(2)
S2 Service	Oil Analysis.
S3 Service	After the first 1000 hours.

Type **A** Service	Every 500 hours of operation.
Type **B** Service	Every 1000 hours of operation.
Type **C** Service	Every 2000 hours of operation.
Type **D** Service	Every 8000 hours of operation.

IMPORTANT!
Make sure that the service book is stamped after each performed service.

1) Oil change intervals vary, depending on oil grade, sulfur content of the fuel and running conditions.

2) TAD1643VE-B, TAD1650VE-B, TAD1651VE: Every 125–500 Hours / at least every 12 months.

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Maintenance

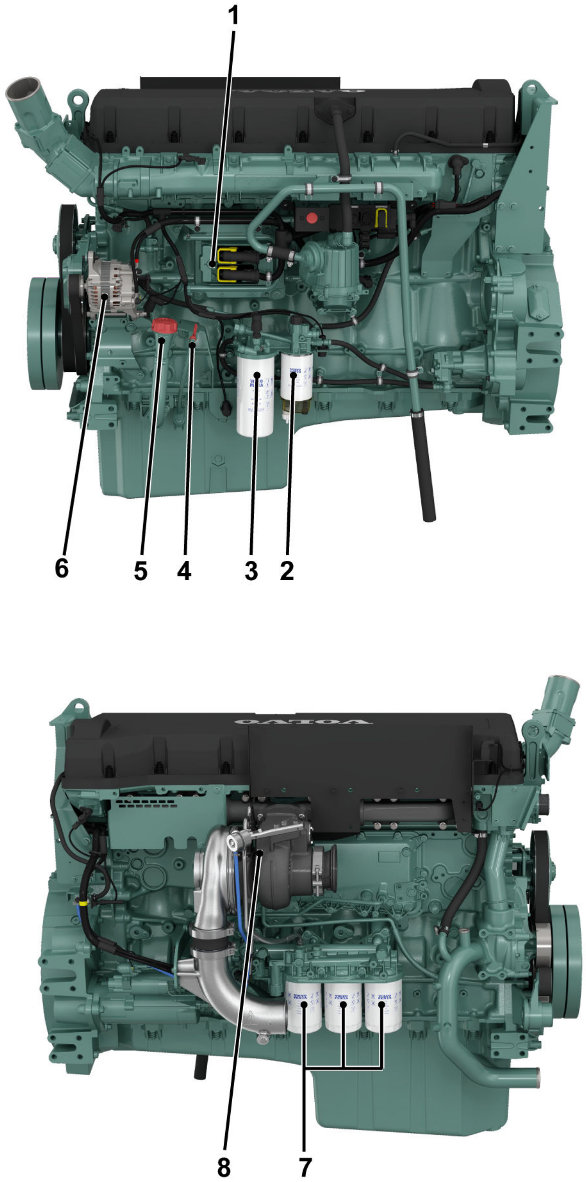
This chapter describes the most common maintenance items. Refer to *Maintenance Schedule, page 58* for service intervals.

NOTICE! More information on how to perform service and maintenance can be found in the Service and Maintenance handbook. Information on how to purchase the Service and Maintenance handbook can be found at www.volvopenta.com.

⚠ CAUTION!
Read through the safety advice before starting any work.

⚠ WARNING!
Care and maintenance work should be done with the engine stopped unless otherwise specified. Stop the engine before opening or removing the engine hatch/hood. Make it impossible to start the engine by removing the start key and cutting the system voltage with the main switches.

When ordering service or spare parts, always specify the engine and transmission identification number. Refer to *Technical Data, page 98*.

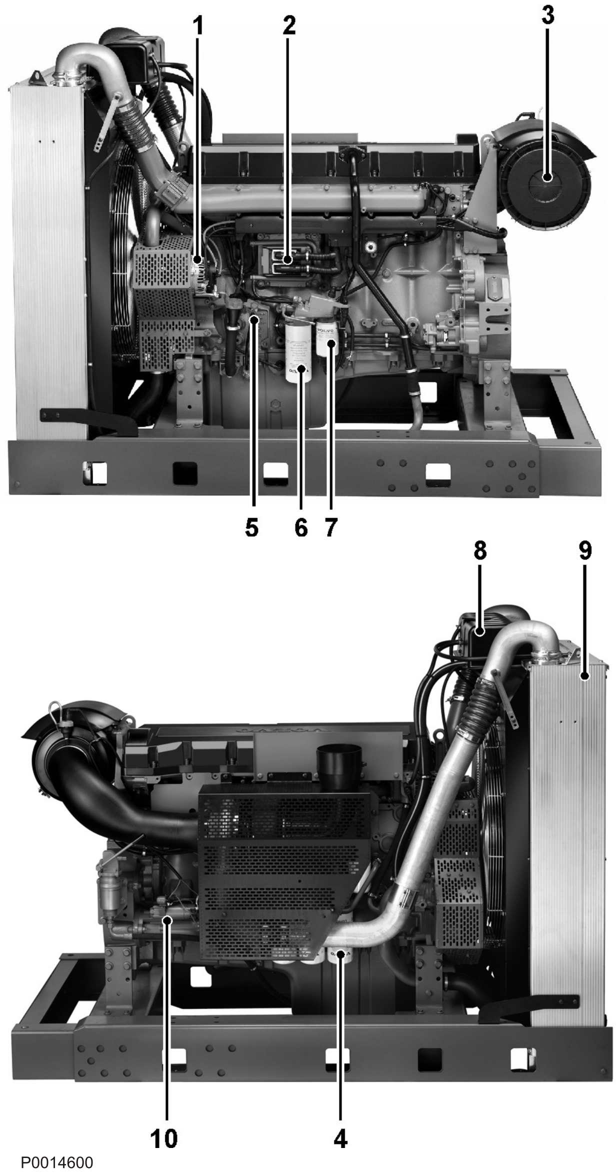


P0022324

Orientation

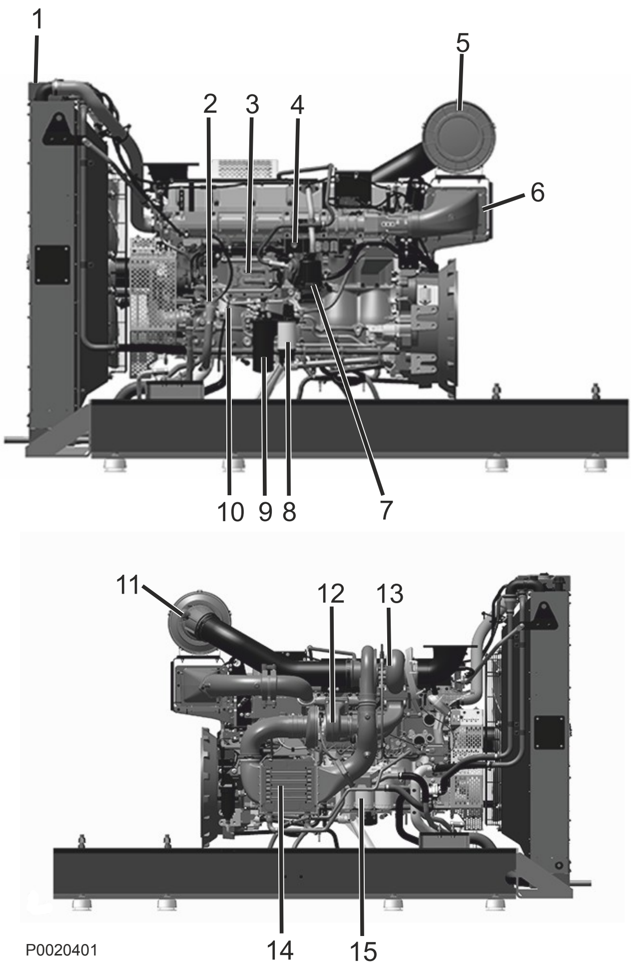
TAD1643VE-B

1 Control unit, EMS
2 Fuel pre-filter with water separator
3 Fuel filter
4 Oil dipstick
5 Oil filler cap
6 Alternator
7 Oil filter
8 Turbo



TAD1640VE-B, TAD1641GE-B, TAD1641VE-B, TAD1642GE-B, TAD1642VE-B, TAD1643VE

1 AC generator
2 Control unit EMS 2
3 Air Filter
4 Oil filter
5 Oil dipstick
6 Fuel filter, with fuel pressure monitor
7 Fuel prefilter with water monitor
8 Expansion tank
9 Radiator
10 Starter motor



TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE

1 Expansion tanks
2 Oil filler cap, engine
3 Control Unit, EMS
4 Auxiliary Stop
5 Air Filter
6 Charge air cooler (High-Pressure Turbo)
7 Crankcase ventilation
8 Fuel filter, with fuel pressure monitor
9 Fuel prefilter with water monitor
10 Oil dipstick
11 Air filter indicator
12 Low-Pressure Turbo
13 High-Pressure Turbo
14 Charge air cooler (Low-Pressure Turbo)
15 Oil filter

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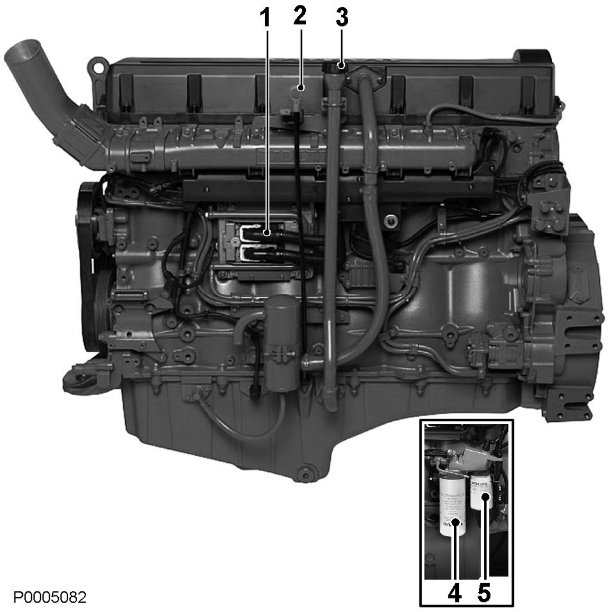
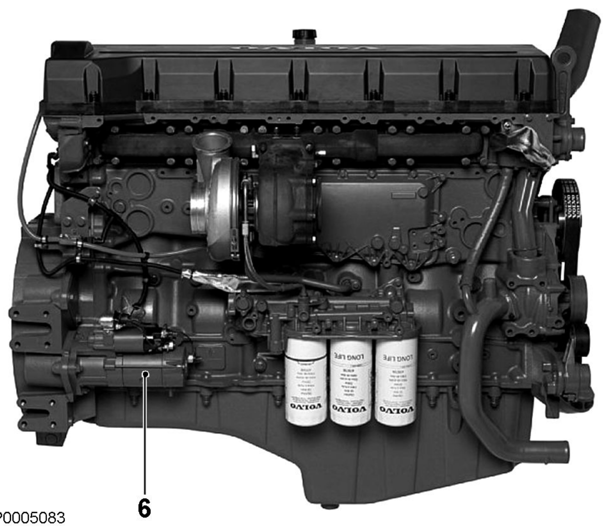
TAD1650GE, TAD1650VE, TAD1651GE

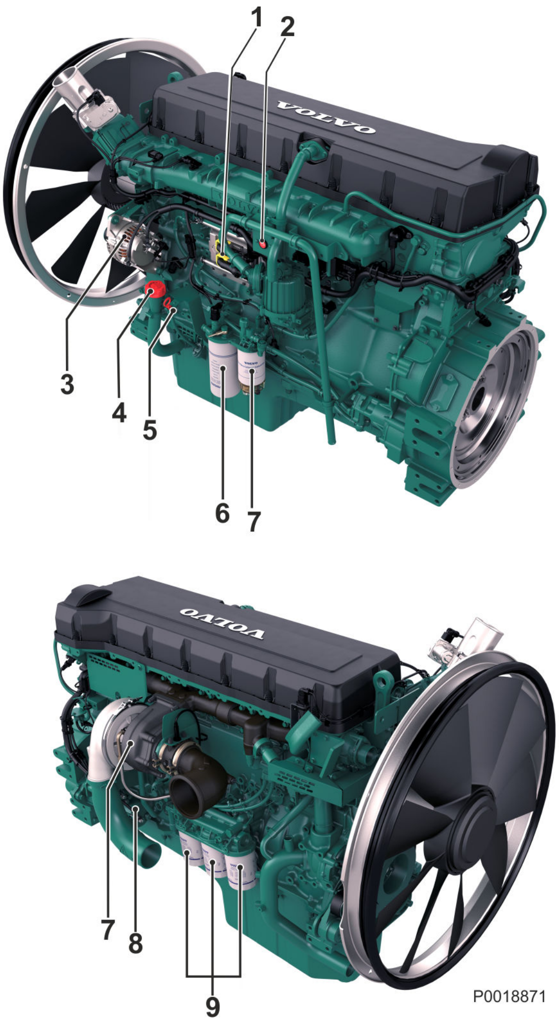


P0005082

1 Control unit, EMS
2 Oil filler
3 Oil dipstick
4 Fuel filter, to be installed separately
5 Fuel pre-filter with water monitor, to be installed separately
6 Starter motor



P0005083



TAD1650VE-B, TAD1651VE

1 Control Unit, EMS

2 Auxiliary stop

3 Alternator

4 Oil filler cap, engine

5 Oil dipstick

6 Fuel Filter

7 Fuel pre-filter with water separator

8 Turbo

9 Starter motor

10 Oil filter

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Engine, General

General inspection

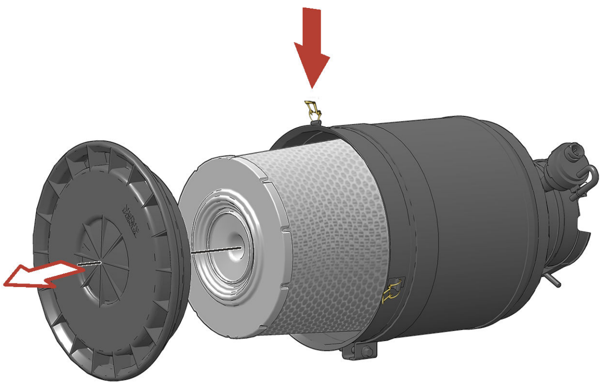
Make it a habit to give the engine and engine compartment a visual inspection before starting the engine and after operation once the engine has stopped. This will help you to discover quickly if anything abnormal has happened, or is about to happen.
Look especially carefully at oil, fuel and coolant leakage, loose bolts, worn or poorly tensioned drive belts, loose connections, damaged hoses and electrical cables. This inspection only takes a few minutes and can prevent serious malfunctions and expensive repairs.

⚠ WARNING!
Risk of fire.
Remove all accumulations of fuel, oil and grease when detected on the engine or in the engine room.

⚠ WARNING!
If an oil, fuel or coolant leak is detected, the cause must be investigated and the fault rectified before the engine is started.

IMPORTANT:
Washing with a power washer: Never aim the water jet at radiators, charge air cooler, seals, rubber hoses or electrical components.

Air Filter, Check and Replace

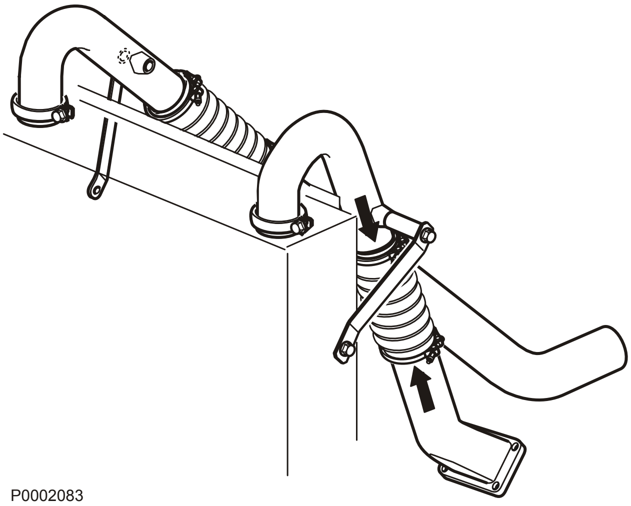


P0018636

The engine is equipped with electronic air filter indication.
The control unit provides an output signal which is announced as a warning on the instrument panel. The warning indicates a pressure drop in the air filter, which must then be checked and possibly changed.

- Scrap the old filter. No cleaning or re-use is permissible
- In continuous operation, the filter should be checked every 8 hours. For operations in extremely dirty environments such as coal mines and rock crushing mills, special air filters must be used.

Charge Air Pipe, Leakage Check



P0002083

Inspect the condition of the charge air hoses, hose unions and clamps for cracks and other damage. Change as necessary.

Clamps must be tightened using a torque wrench to 9 ±2 Nm (6.6 ±1.5 lbf.ft.).

Drive Belt and Alternator Belt, Inspection

⚠ WARNING!
Working with or approaching a running engine is a safety risk. Watch out for rotating components and hot surfaces.

IMPORTANT:
Always change a belt which looks worn or cracked.

Inspections must be carried out after operations, while the belts are hot.
You should be able to depress the alternator belt and the drive belt about 3-4 mm between the pulleys.
The alternator belts and drive belts have automatic belt tensioners and do not need to be adjusted.
Check the condition of the drive belts. Replace as necessary; refer to *Alternator Belt, Replace, page 68* and *Drive belt, change, page 67*.

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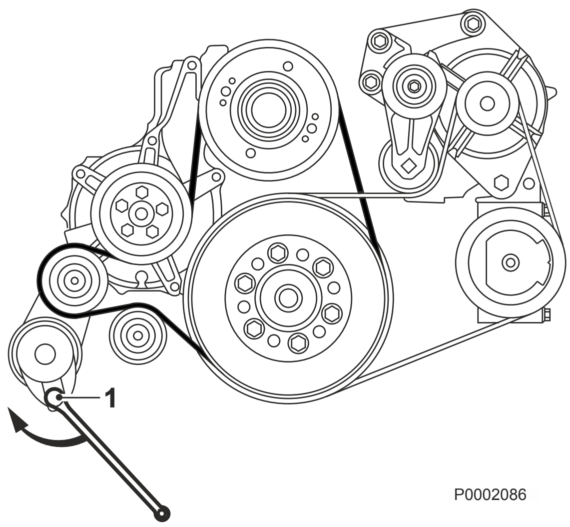
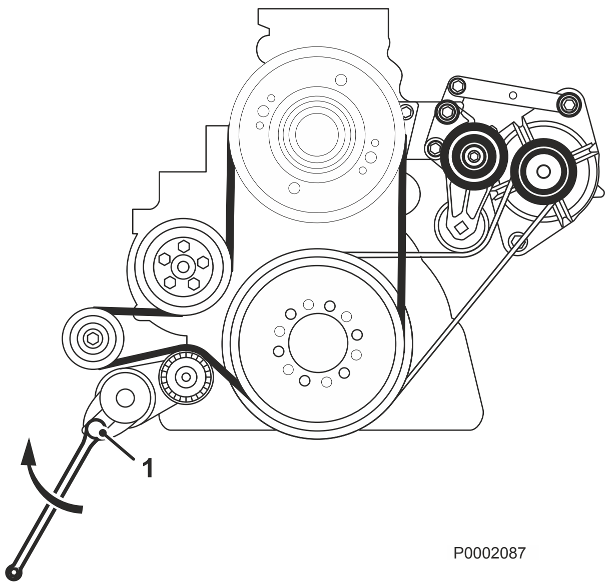


TAD1640GE-B, TAD1641GE-B, TAD1642GE-B, TAD1650GE, TAD1651GE, TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1643VE-B, TAD1650VE, TAD1650VE-B, TAD1651VE



TWD1643GE, TWD1644GE, TWD1645GE, TWD1652GE, TWD1653GE

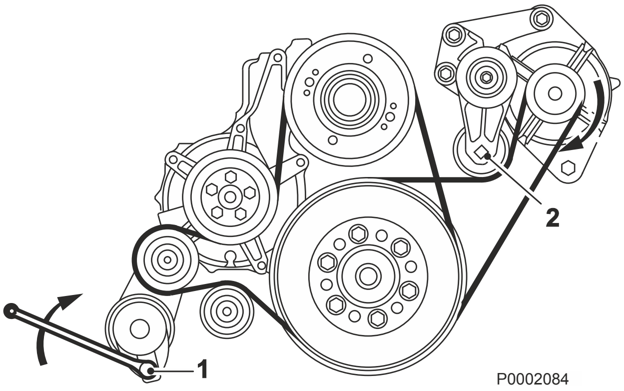
Drive belt, change

1 Disconnect the main switch(es) and check that the engine is not connected to system voltage.
2 Remove the fan guard and fan ring round the cooling fan.
3 Remove the belt guard.
4 Insert a 1/2” square wrench in the belt tensioner (1). Lift the wrench and remove the drive belt.
5 Thread the drive belt round the fan and remove it.
6 Check that the pulleys are clean and undamaged.
7 Thread the new drive belt over the fan.
8 Lift the 1/2" wrench and install the new drive belt.
9 Install the belt guards.
10 Install the fan guard and fan ring round the cooling fan.
11 Start the engine and do a function check.

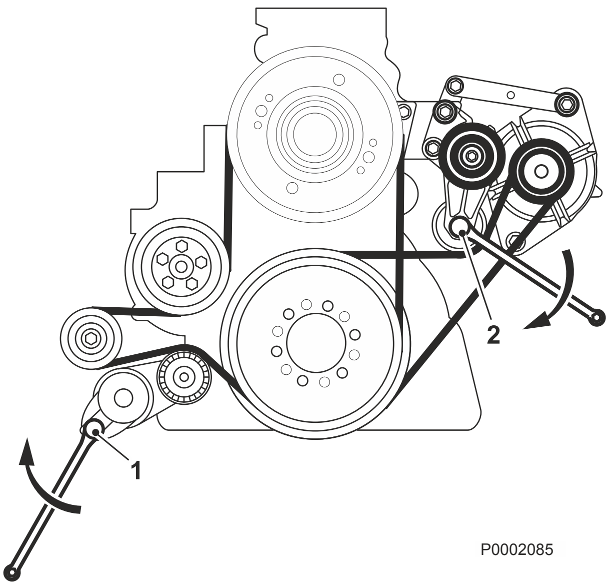
Alternator Belt, Replace

IMPORTANT!

Always change a drive belt which appears worn or cracked.



TAD1640GE-B, TAD1641GE-B, TAD1642GE-B, TAD1650GE, TAD1651GE, TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1643VE-B, TAD1650VE, TAD1650VE-B, TAD1651VE



TWD1643GE, TWD1644GE, TWD1645GE, TWD1652GE, TWD1653GE

1. Disconnect the main switch(es) and check that the engine is not connected to system voltage.
2. Remove the fan guard and fan ring round the cooling fan.
3. Remove the belt guard.
4. Insert a 1/2” square wrench in the belt tensioner (1). Lift the wrench up and lift the water pump drive belt off.
5. Insert a 1/2” square wrench in the belt tensioner (2). Press the wrench down and remove the alternator belts.
6. Check that the pulleys are clean and undamaged.
7. Press the 1/2” wrench in the belt tensioner (2) down and install the new alternator drive belt.
8. Lift the 1/2” wrench in the belt tensioner (2) and install the new water pump drive belt.
9. Install the belt guards.
10. Install the fan guard and fan ring round the cooling fan.
11. Start the engine and do a function check.

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Lubrication System

P0002089

Oil change intervals may vary according to the lubrication oil grade, fuel sulfur content and running conditions. Refer to *Oil recommendations*.

The oil change interval may under certain conditions be increased. To see if the engine complies Volvo Penta oil analysis needs to be performed. Contact your Volvo Penta dealer for further information.

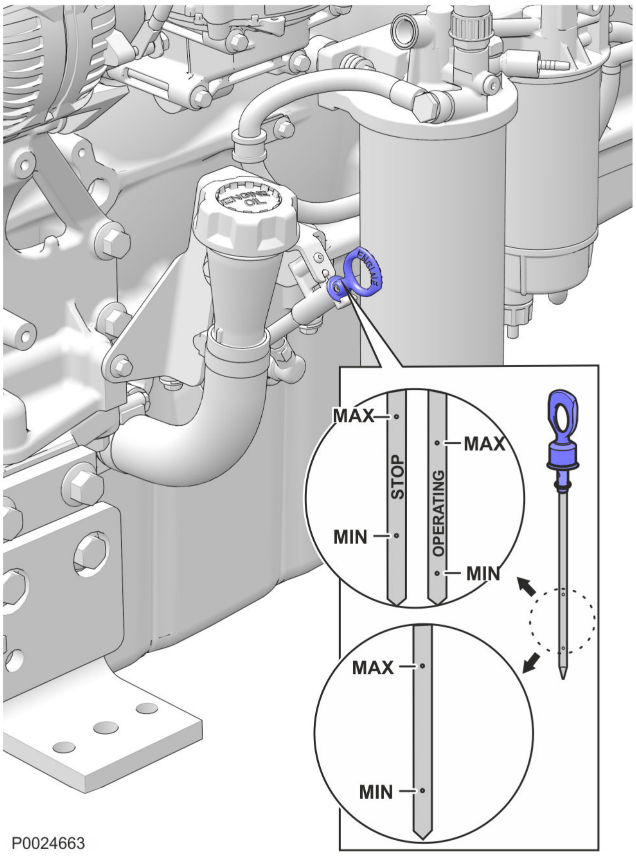
NOTICE! Oil change intervals must never exceed a period of 12 months.

P0002089

Oil change intervals may vary according to the lubrication oil grade, fuel sulfur content and running conditions. Refer to *Oil recommendations*.

The oil change interval may under certain conditions be increased. To see if the engine complies Volvo Penta oil analysis needs to be performed. Contact your Volvo Penta dealer for further information.

NOTICE! Oil change intervals must never exceed a period of 12 months.



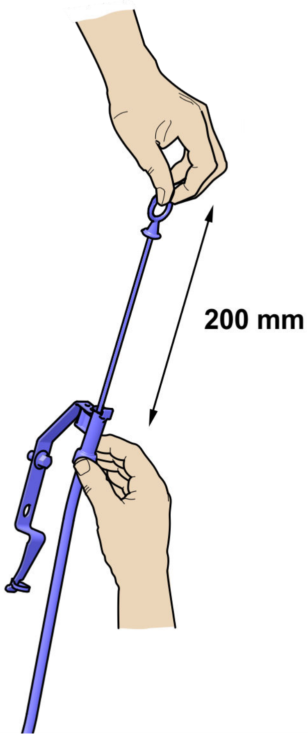
P0024663

Oil level, checking and topping up

⚠ WARNING!

Working with or approaching a running engine is a safety risk. Watch out for rotating components and hot surfaces.

- Normally the oil level is to be checked when the engine is stopped. Wait a few minutes before reading off the level, so that the oil has time to run down into the oil sump.
- Dipstick marked **STOP/OPERATING** can be read both when the engine is stopped and when it is running. Use the STOP side of the dipstick when the engine is stopped and the OPERATING side when in operation.
- The oil level must be inside the marked area on the dipstick. Never fill above the maximum limit on the oil dipstick.
- Only fill oil when the engine is stopped.
- Only use Volvo Penta recommended oils; refer to *Technical Data, page 92*.
- The oil level sensor only measures the oil level when the ignition is switched to on, not continuously during operation.



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Checking the oil with a flexible dipstick

IMPORTANT:

Insert the dipstick in increments of around 200 mm, without bending the wire, for the entire length of the plastic tube.

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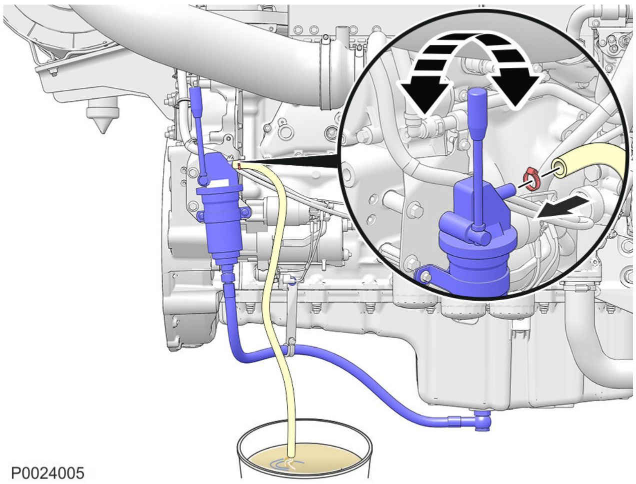


P0024005

Engine Oil, Change

⚠ WARNING!
Hot oil and hot surfaces can cause burns.

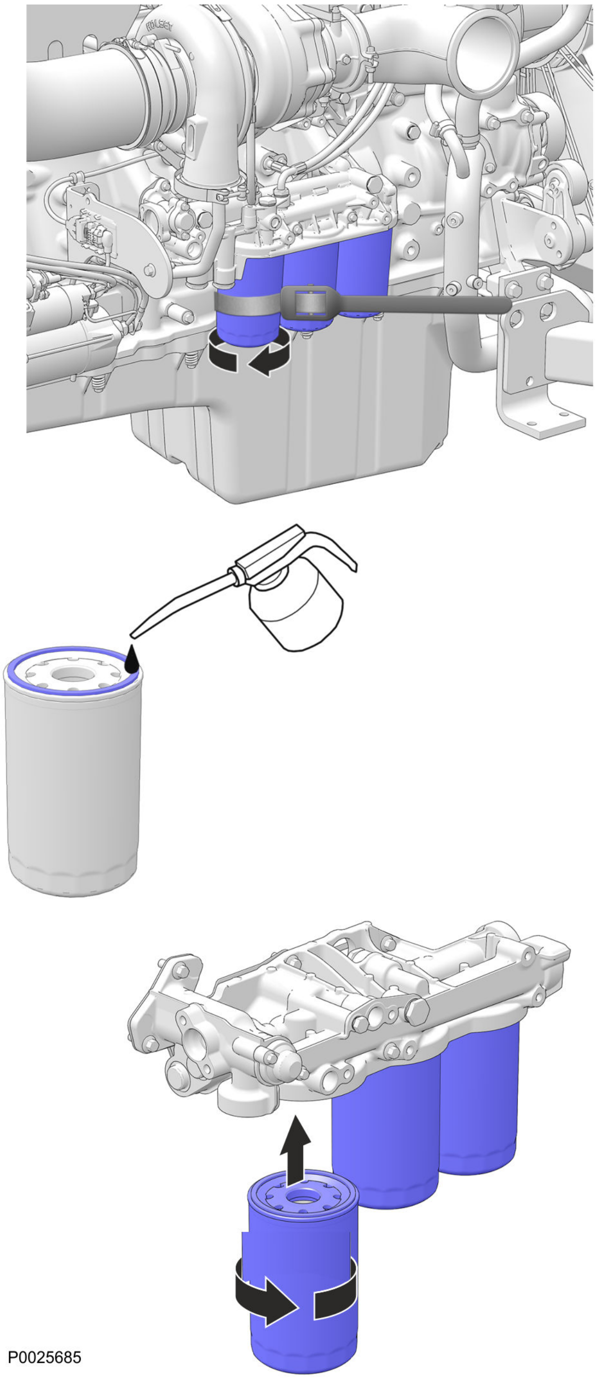
Oil changes must be done when the engine is hot.

1 Connect the drain hose to the oil drain pump and check that no leakage can occur.

2 Pump the oil out (or remove the bottom drain plug and drain the oil).
Collect all the old oil and old filters, and hand them to a re-cycling station for destruction.

3 Remove the drain hose (or install the bottom drain plug).

4 Fill with engine oil.
For change volume, please refer to *Technical Data, page 92*.


P0025685

Oil Filter/By-pass Filter, Change

⚠ WARNING!

Hot oil and hot surfaces can cause burns.

1 Clean the oil filter bracket (2).

2 Remove all oil filters with a suitable oil filter extractor (1).

3 Clean the mating surface of the oil filter bracket. Make sure that no pieces of old oil seal are left behind. Carefully clean round the inside of the protective rim (2) on the oil filter bracket.

4 Put a thin layer of engine oil on the seal rings of the new fuel filters.

5 Install the new oil filters. Tighten the filters ¾–1 turn after they touch.

6 Top up with engine oil, start the engine and let it run for 20-30 seconds.

7 Turn off the engine, check the oil level and top up as required.

8 Check sealing round the oil filters.

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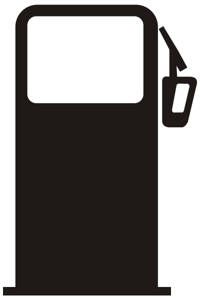
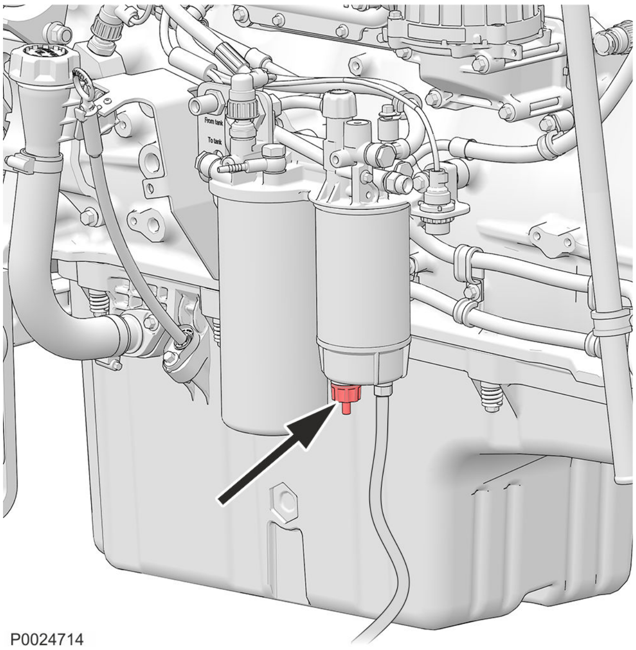

P0002101

Fuel System

⚠ WARNING!
Fire hazard. When carrying out work on the fuel system make sure the engine is cold. A fuel spill onto a hot surface or an electrical component can cause a fire. Store fuel soaked rags so that they cannot cause fire.

IMPORTANT:
Always observe the greatest cleanliness during refueling and work on the fuel system.
Only use the grades of fuel recommended in the fuel specification.

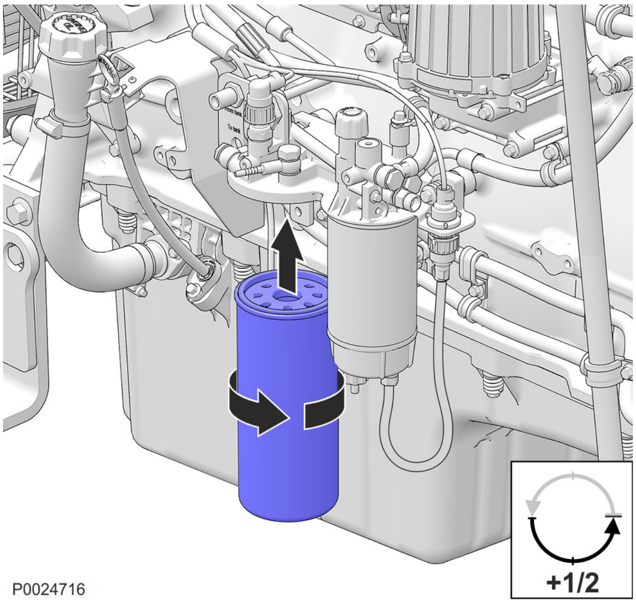

P0024714

Draining condensate, fuel system

NOTICE! Put a collection vessel under the fuel filter tocollect the condensate and fuel.

1 Open the drain nipple in the base of the fuel pre-filter.

2 Tighten the drain tap when fuel without water starts to run out.



P0024716

Engine Fuel Filter Replacement

⚠ WARNING!

Fire hazard. When carrying out work on the fuel system make sure the engine is cold. A fuel spill onto a hot surface or an electrical component can cause a fire. Store fuel soaked rags so that they cannot cause fire.

IMPORTANT:

Do not fill the new fuel filter with fuel before assembly. There is a risk that contamination could get into the system and cause malfunctions or damage.

1 Clean round the fuel filter.

2 Remove the filter with a suitable filter remover. Collect any spilled fuel in a collection vessel.

3 Clean the filter mating surface on the filter bracket.

4 Lubricate the seal with diesel fuel and install the new fuel filter. Tighten the fuel filter in accordance with the instructions on the fuel filter.

5 If necessary, vent the fuel system, please refer to *Fuel system, bleeding, page 76*.

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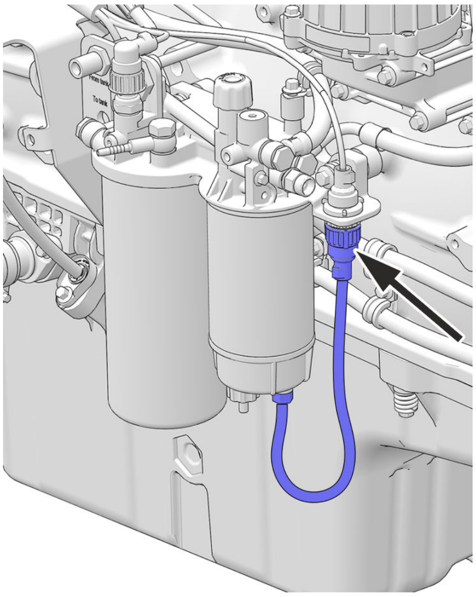
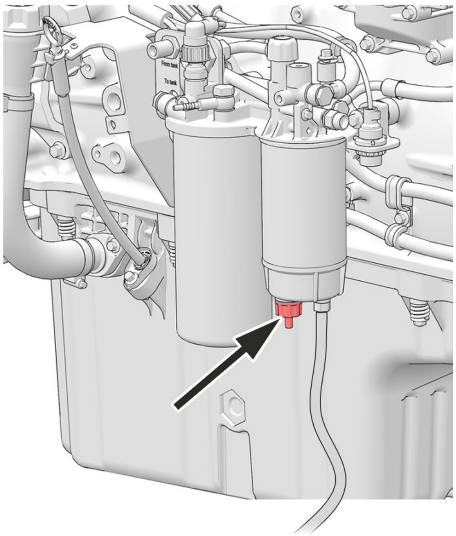
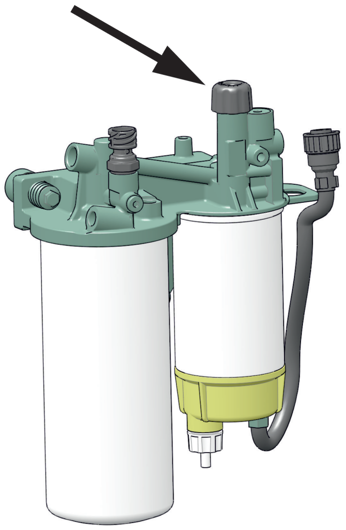




P0025686

Fuel Pre-filter, Change

1. Undo the cable from the water trap sensor.
2. Remove the water trap filter from the filter housing. Collect any spilled fuel in a container.
3. Remove the lower part of the water trap from the filter.
4. Clean the lower part of the water trap with a soft rag. Check that the drain hole in the lower part is not blocked.
5. Install a new seal on the lower part and lubricate the seal with diesel fuel. Re-install the lower part of the filter.
6. Lubricate the seal with diesel fuel. Screw the filter onto the filter bracket by hand until the rubber seal just touches the mating surface. Then tighten a further half turn, no more.
7. Connect the cable to the water trap sensor.
8. If necessary, vent the fuel system, please refer to *Bleeding the Fuel System*.



P0025497

Fuel system, bleeding

1. Check that there is sufficient fuel in the tank, and that any fuel taps are open.
2. Release the hand pump on the fuel bracket by pushing down and twisting the plastic handle.
3. Vent the fuel system by pumping with the hand pump.
   Air is vented to the tank via the fuel return pipe. No breathing nipples need be opened.
4. Lock the hand pump, push down and twist the handle.
5. Start the engine and allow it to idle fast for about 10 minutes.
6. Perform a leakage and function check.

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Cooling System

P0013077

The cooling system ensures that the engine operates at the correct temperature. It is a closed system that should always be filled with a coolant mixture.

IMPORTANT:
Coolant of a suitable chemical composition must be used all year round to protect the engine against internal corrosion, cavitation and freeze bursting. This even applies when there is no risk for freeze damage, to make sure the engine always has a complete corrosion protection.

Therefore, the use of anti-corrosion agents alone, or water alone as a coolant, is not permitted in Volvo Penta engines.

The coolant must be based on Organic Acid Technology (OAT). Using an improper coolant or mixing with another coolant will rapidly reduce the performance and lifetime of the engine. Material incompatibility can lead to leakages, which - in the worst case - can cause engine breakdown.

Volvo Penta strongly recommend the use of our own coolants, ”Volvo Penta Coolant VCS Ready Mixed” or the concentrate ”Volvo Penta Coolant VCS”, which ensure the protection of the cooling system components from corrosion, ageing, swelling and cracking, thereby ensuring optimal engine lifetime.

Over time the corrosion protection additives become less effective, and consequently the coolant must be changed at regular intervals to maintain sufficient protection of the engine. The latest Service Protocol that specifies service intervals can be found at *volvopenta.com*.

Coolant, Mixing

It is extremely important that the system is filled with the correct coolant concentration; refer to *Coolant, Mixing, page 96*.
The coolant should be mixed with distilled, deionized water. For Volvo Penta specified water requirements; refer to *Coolant, Mixing, page 96*.

NOTICE! If water quality can not be guaranteed, use ready mixed coolant.

Coolant Level, Checking and Topping Up

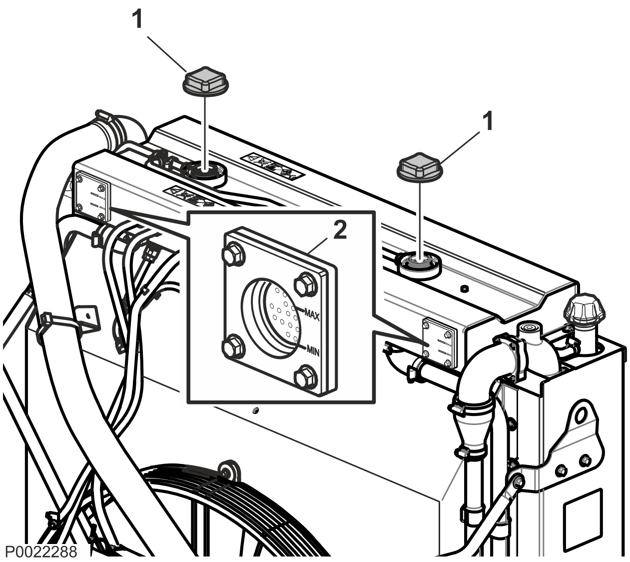
⚠ WARNING!

Do not open the coolant filler cap when the engine is hot, except in emergencies, as this could cause serious personal injury. Steam or hot fluid could spray out.

IMPORTANT!

Only use coolant recommended by Volvo Penta. Fill up with the same type of coolant that is in the system. Different types of coolant **must not** be mixed with each other.

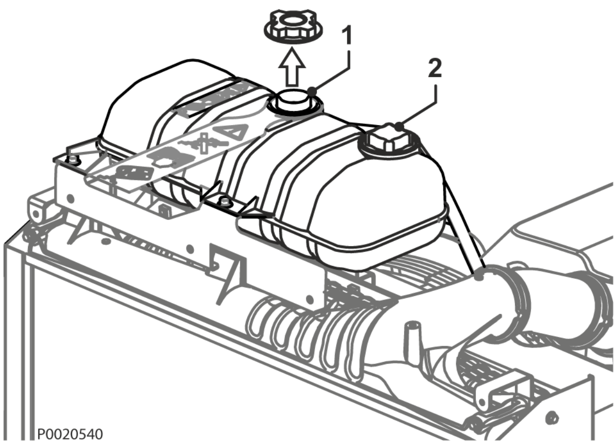
Filling of coolant must be performed with the engine stopped. Fill up slowly, to allow the air to flow out. Check the coolant level daily before start.



TWD16

TWD16

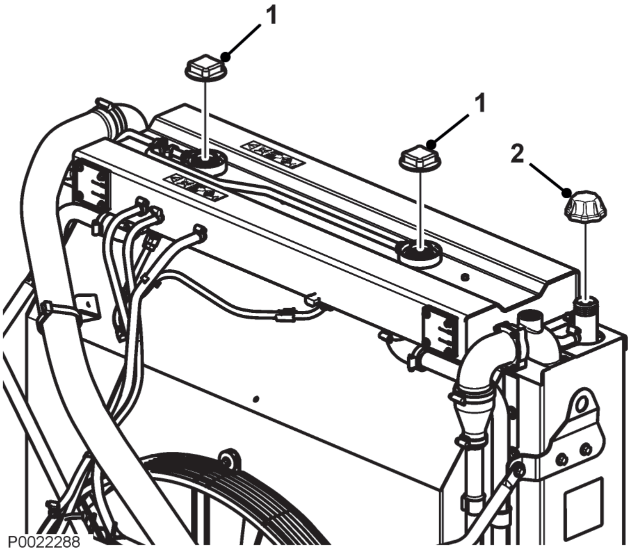
1 Open the filler caps (**1**).
2 Check that the coolant reaches the MAX mark on the sight glass (**2**). Top up with coolant as required.
3 Close the filler caps.



TAD16

TAD16

1 Open **only** the filler cap (**1**). Do not open the pressure cap (**2**).
2 Check that the coolant level is between the MIN and MAX marks on the expansion tank (**1**). Top up with coolant as required.
3 Close the filler cap.

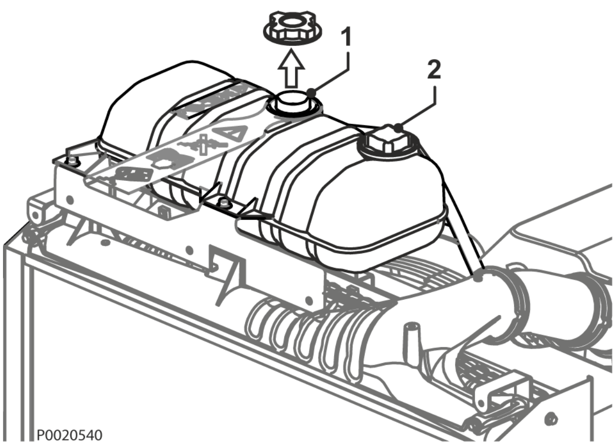


TWD16

Filling a completely empty system

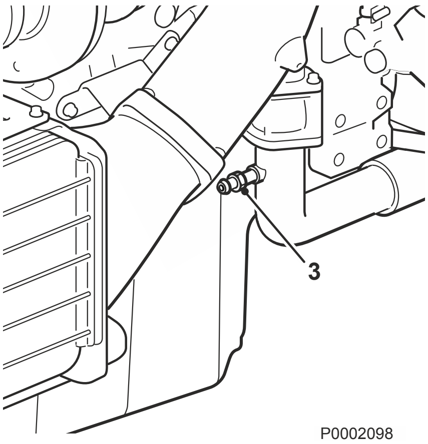
NOTICE! Mix the correct amount of coolant in advance, to ensure that the cooling system is completely filled. Refer to *Technical Data, page 95* for the correct coolant volume.
Do not start the engine until the cooling system is completely filled and vented.

NOTICE! If a heating unit is connected to the engine cooling system, the heating control valve should be opened and the installation vented during filling.

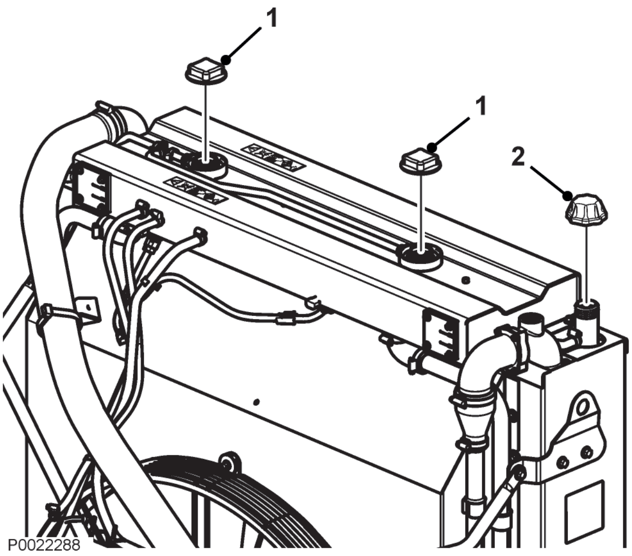


TAD16

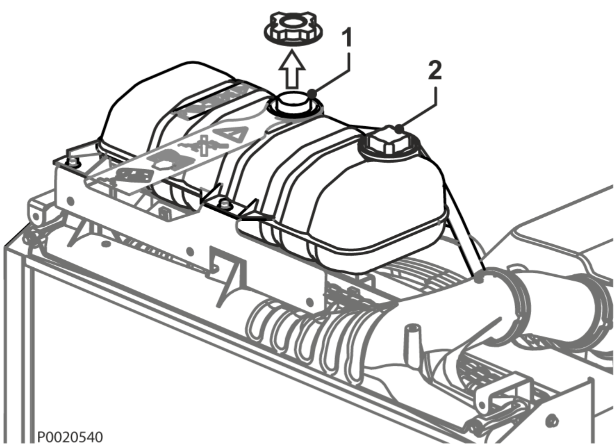
1 Check that all drain points are closed.
2 **TWD16**
Open the caps to both the expansion tank (**1**) and the radiator (**2**). Fill the expansion tank so that the coolant reaches the MAX mark on the sight glass. Close the filler caps.
TAD16
Open **only** the filler cap (**1**). Fill the expansion tank so that the coolant level is between the MIN and MAX marks. Close the filler cap.



3 Bleed the system at the bleeding nipple (**3**).
4 Start the engine when the coolant system i completely filled and vented.
Open any bleeding nipples a short while after starting, to allow trapped air to escape.
5 Start the engine after approx. one hour and check the coolant level. Top up with coolant as required.



TWD16



TAD16

Coolant, Draining

⚠ WARNING!

Do not open the coolant filler cap when the engine is hot, except in emergencies, as this could cause serious personal injury. Steam or hot fluid could spray out.

IMPORTANT!

On engines which are to be put in storage, the engine cooling system should **not** be drained. the coolant contains corrosion inhibiting additives.

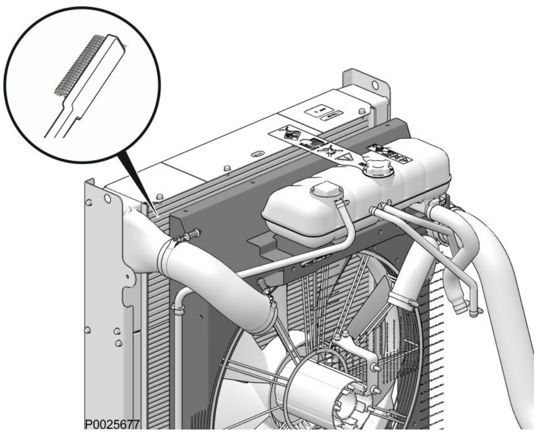
1 Stop the engine before draining.

2 **TWD16**
Open both the pressure caps on the expansion tank (**1**) and the filler cap to the radiator (**2**).
TAD16
Open the filler cap (**1**). Do not remove the pressure cap (**2**).

3 Open all drain points. Drain the coolant from the radiator and engine block, using the drain hose. The drain nipples are situated under the radiator on the right side of the engine block.

4 Check that all coolant drains out. Deposits may be found inside the drain plug/tap, and need to be cleared away. There is otherwise a risk that the coolant could remain and cause frost damage. Check whether the installation has any further taps or plugs at the lowest points of the cooling water pipes.

5 Close any taps and check that the spring-loaded covers on the nipples close completely. Install the rubber plugs and the filler cap(s).



Charge Air Cooler, External Cleaning

IMPORTANT:

Do not use a high pressure power washer.

Remove guards as necessary, to access the radiator. Clean with water and a mild detergent. Use a soft brush. Be careful not to damage the radiator vanes. Reinstall removed parts.

Cooling System, Cleaning

⚠ WARNING!
All coolant is hazardous and harmful to the environment. Do not consume. Coolant is flammable.

IMPORTANT:
Never clean the cooling system if there is any risk of freezing, since the cleaning solution does not have any antifreeze properties.

IMPORTANT:
It is extremely important that the correct concentration and volume of coolant is added to the system.
Mix in a separate clean vessel before filling the cooling system. Make sure that the liquids mix.

IMPORTANT:
Always follow local safety instructions and regulations.

Cooling performance is reduced by deposits in the radiator and cooling galleries. The cooling system should be cleaned out when the coolant is changed.

1. Empty the cooling system. Refer to *Coolant, Draining, page 80*.
2. Put a hose into the expansion tank filling hole and flush with clean water, as specified by Volvo Penta– refer to section Water quality in *Technical Data, page 95* until the water draining out is completely clear.
3. If there should still be some contamination left after flushing for a long time, cleaning can be done with coolant. Otherwise, continue as in item 8 below.
4. Fill the cooling system with 15-20 % mixture of concentrated coolant. Use only Volvo Penta recommended concentrated coolant mixed with clean water.
5. Drain the coolant after 1-2 days of operation. Remove the filler cap and possibly the lower radiator hose to increase the speed of emptying. To prevent suspended material from settling back in the system emptying should be done rapidly, within the space of 10 minutes, when the engine has not been standing still for a long time.
6. Flush the system immediately and thoroughly with clean hot water to prevent dirt from settling in the inner areas. Flush until the water that runs out is completely clean. Make sure that any heater controls are set to full heating during emptying.
7. If contamination should still be left after a long period of flushing, cleanout using Volvo Penta radiator cleaner, followed by finishing-off with Volvo Penta neutralizer. Carefully follow the instructions on the package. Otherwise, continue as in item 8 below.
8. When the cooling system is completely free from contamination, close the drain taps and plugs.

9 Fill up with Volvo Penta recommended coolant, following the instructions in the chapters entitled *Maintenance, page 77* and *Coolant Level, Checking and Topping Up, page 78*.

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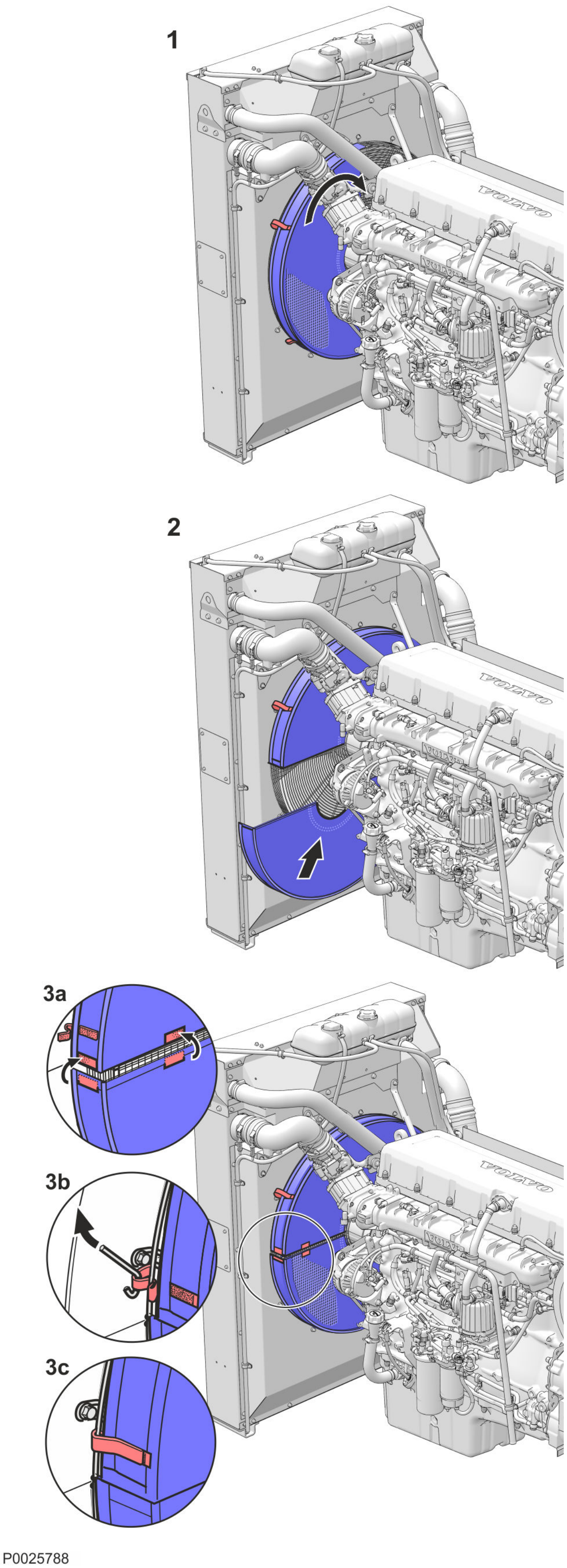


Cooling air filter

⚠ WARNING!

Stop the engine before doing any maintenance work.

A newly-installed cooling air filter reduces cooling performance by 4 %.

Installation

1 Slide one half of the filter over the fan cover (as in fig.1).

2 Turn the half filter until it is able to hang loosely on the fan cover (see fig. 2).

3 Slide on the other filter half and secure the two halves together with self-affixing velcro tape (as in fig. 3a).

4 Fasten the outer velcro tape around the fan cover guard (as in fig. 3b and 3c).

Removal and cleaning

1 Remove the cooling filter.

2 Brush away any heavy dirt with a soft brush.

3 Rinse the filter with water.

NOTICE! If a cleaning agent is necessary, an eco-friendly degreaser (e.g. coconut oil based) must be used as a first choice. Alternatively, use a paraffin fraction as a second choice.
Spray on the degreaser or apply it using a sponge. Allow it to act for a few minutes and then rinse with tap water.

IMPORTANT:

Do not use gasoline, steam, a high-pressure washer or other cleaning agents.

4 Re-install the filter according to instructions.

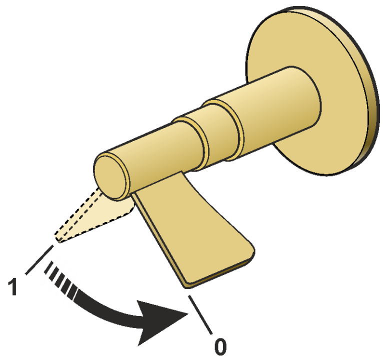
Electrical System

The engine is equipped with a 2-pole electrical system and an alternator.

WARNING!
Always stop the engine and break the current using the main switches before working on the engine.

IMPORTANT:
Contact a Volvo Penta dealer for information if any arc welding will be performed on the application.
Arc welding can cause damage to the engine and the electronics.

Main switch



P0002576

IMPORTANT:
Never disconnect the current using the main switches when the engine is running or by disconnecting the battery cables.
The alternator and electronics could be damaged.

The main switches must never be switched off before the engine has stopped. If the circuit between the alternator and the battery is disconnected when the engine is running, the alternator and electronics may be damaged. For the same reason, the charging circuits must never be re-connected with the engine running.

Fuses

The engine is equipped with a 10 A circuit breaker which cuts the current if overloaded.
The circuit breaker is located on the left-hand side of the engine.

The engine stops if the fuse trips. If the circuit breaker trips frequently, an authorized Volvo Penta workshop should be contacted to investigate the cause of the overload.

Electrical Connections

Check that electrical connections are dry, free from oxide, and that they are securely tightened.

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P0002107

Battery

⚠ WARNING!

Risk of fire and explosion. Never allow an open flame or electric sparks near the batteries.

⚠ WARNING!

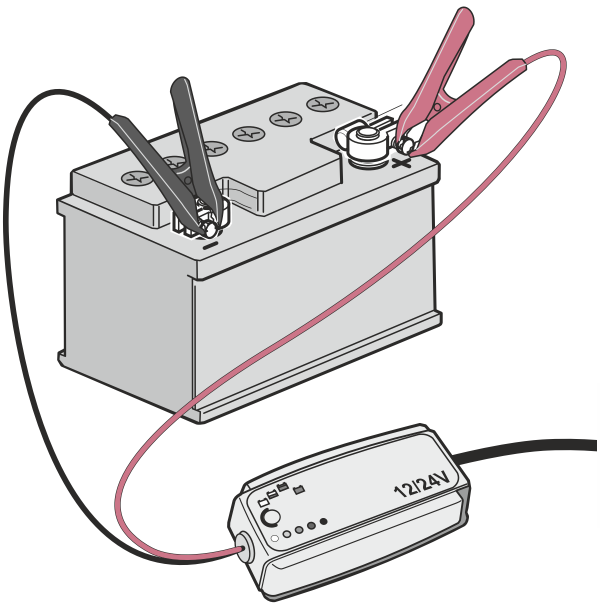
Battery electrolyte is a corrosive acid and should be handled with care. If you spill or splash electrolyte on any part of the body, immediately flush the exposed area with liberal amounts of water and seek medical attention as soon as possible.

⚠ WARNING!

Ventilate the engine compartment before working on batteries or battery connections.

IMPORTANT:

Batteries can be damaged if they are left discharged, and can also freeze and burst easier in cold weather. If the engine is not going to be used for a longer period of time, the batteries should be fully charged, trickle charged if possible.

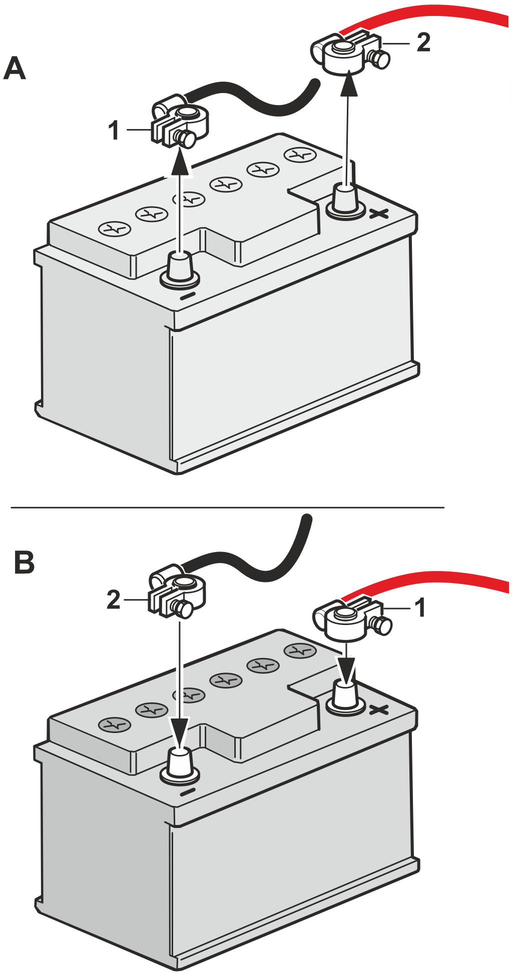


P0022892

Maintenance

It is important to always follow the battery manufacture's recommendation and instruction when replacing and charging batteries. Depending on battery type, the instructions for maintenance and charging may vary.
Modern batteries are normally maintenance free, but there are some actions that are recommended to increase the battery service life and avoid accidents:

- Keep the batteries clean and dry. Contamination and oxide on the batteries and battery poles can result in stray currents, voltage drop and discharge, especially in wet weather.
- Remove oxidation from the battery poles and terminals, using a brass brush.
- Tighten the terminals securely and grease them with terminal grease or petroleum jelly. Loose battery connections may cause damage to the engine's electrical system.
- Charge the battery regularly. A battery that is kept fully loaded has a maximum service life. The easiest way to check if a battery needs charging is to use a voltmeter.



P0022893

Replacing Battery

IMPORTANT:
Make sure that the new battery fulfills the specifications in *Technical Data*. Read the information supplied with the battery before you begin the installation.

IMPORTANT:
Do not disconnect the batteries with the engine running.
Sensitive electrical components can be immediately damaged.

WARNING!
Never confuse the positive and negative poles on the batteries. Risk of arcing and explosion.

Disconnecting (A)

1 Untighten the nut and remove the – cable (black).

2 Untighten the nut and remove the + cable (red).

Remove the battery.

Connecting (B)

Place the new battery.

1 Connect the + cable (red) to the + pole on the battery and tighten the nut.

2 Connect the – cable (black) to the – pole on the battery and tighten the nut.

NOTICE! Hand in the old battery to a re-cycling station.

Storage

To prevent the engine and other equipment from being harmed during long (2 months or more) periods out of service, it must be conserved. Conservation protects the engine from freezing and corrosion damages.

It is of utmost importance that the conservation is performed correctly, therefore we have compiled a checklist covering the most important points. Before taking the engine out of service for long periods, Volvo Penta recommends that the engine is checked by a qualified workshop for possible need for overhaul or repair.

⚠ CAUTION!

Read the chapter on Maintenance in the Operator`s Manual before starting work. It contains instructions on how to carry out maintenance and service operations in a safe and technical correct manner.

⚠ WARNING!

Conservations oils can be flammable and dangerous to inhale. Ensure good ventilation. Use a protective face mask when spraying.

IMPORTANT:

Washing with a power washer: Never aim the water jet at radiators, charge air cooler, seals, rubber hoses or electrical components.

P0002089

- **For up to 8 month's stoppage:**
  Change the oil and oil filter on the engine, then run the engine until warm.
  More than 8 month's stoppage:
  Conserve the lubrication and fuel systems with conservation oil. Refer to the section *Conservation of the lubrication and fuel systems for more than 8 months' stoppage.*
- Make sure the coolant has adequate antifreeze properties. Top up as necessary.
  Alternatively, you can drain the coolant (also drain the coolant filter).
- Drain any water and contamination from the fuel filters and fuel tank. Fill the fuel tank completely, to avoid condensation.
- Disconnect the battery cables, clean and charge the batteries. Trickle charge the batteries while the equipment is in storage. **A poorly charged battery can freeze and burst**.
- Clean the outside of the engine. Do not use a high pressure washer for engine cleaning. Touch up paint damage with Volvo Penta original paint.
- Put a note on the engine with the date, type of conservation and the conservation oil used.
- Cover the air filter, exhaust pipe and engine if necessary.
- Empty the AdBlue/DEF tank and rinse it with distilled water.

Bringing Out of Storage

- Remove any covers from the engine, air filter and exhaust pipe.
- Fill the engine with the correct quality and viscosity oil into the engine, as necessary, refer to *Technical Data, Lubrication System*. Install a new oil filter if the filter was not changed during conservation.
- Install new fuel filters and bleed the fuel system.
- Check the drive belt(s).
- Check the condition of all rubber hoses, and retighten the hose clamps.
- Close the drain taps and install any drain plugs.
- Check the coolant level. Top up as necessary.
- Connect the fully charged batteries.
- Start the engine and warm it up at fast idle with no load.
- Check that no oil, fuel or coolant leakage occurs.
- Fill the AdBlue/DEF tank. The solution must fulfill ISO 22241 standards.

Conservation of the lubrication and fuel systems for more than 8 months' stoppage:

- Drain the engine oil and fill up with **conservation oil*** to just over the MIN marking on the dipstick.
- Connect the fuel suction and return hoses to a 1/3 full jerrican containing **conservation oil*** and 2/3 diesel fuel.
- Bleed the fuel system.
- Start the engine and run at a fast idle until about 2 liters (0.6 US gal) of the fluid in the jerrican have been used. Stop the engine and re-connect the fuel suction and return lines.
- Drain the conservation oil from the engine.
- Follow the other instructions on the previous page.

* Conservation oils are sold by oil companies.

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Technical Data

Engines

Type designation	TAD1640GE-B	TAD1641GE-B	TAD1642GE-B	TWD1643GE
Power	Refer to the sales literature			
Torque	Refer to the sales literature			
No. of cylinders	6	6	6	6
Bore, mm (inch)	144 (5.67)	144 (5.67)	144 (5.67)	144 (5.67)
Stroke, mm (inch)	165 (6.50)	165 (6.50)	165 (6.50)	165 (6.50)
Displacement, liter (inch^3)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)
Weight, dry, kg (lb)	1480 (3263)	1480 (3263)	1480 (3263)	1700 (3748)
Weight, wet, kg (lb)	1550 (3417)	1550 (3417)	1550 (3417)	1770 (3902)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Compression ratio	17.5:1	16.5:1	16.5:1	16.5:1
Low idle, r/min.	900	900	900	900

Type designation	TWD1644GE	TWD1645GE
Power	Refer to the sales literature	
Torque	Refer to the sales literature	
No. of cylinders	6	6
Bore, mm (inch)	144 (5.67)	144 (5.67)
Stroke, mm (inch)	165 (6.50)	165 (6.50)
Displacement, liter (inch^3)	16.12 (983.9)	16.12 (983.9)
Weight, dry, kg (lb)	1700 (3748)	1700 (3748)
Weight, wet, kg (lb)	1770 (3902)	1770 (3902)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4
Compression ratio	16.8:1	16.8:1
Low idle, r/min.	900	900

Type designation	TAD1650GE	TAD1651GE	TWD1652GE	TWD1653GE
Power	Refer to the sales literature			
Torque	Refer to the sales literature			
No. of cylinders	6	6	6	6
Bore mm (inch)	144 (5.67)	144 (5.67)	144 (5.67)	144 (5.67)
Stroke mm (inch)	165 (6.50)	165 (6.50)	165 (6.50)	165 (6.50)
Displacement liter (inch^3)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)
Weight, dry kg (lb)	1550 (3417)	1550 (3417)	1755 (3869)	1755 (3869)
Weight, wet kg (lb)	1751 (3860)	1751 (3860)	2065 (4553)	2065 (4553)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Compression ratio	16.5:1	16.5:1	16.5:1	16.5:1
Low idle, r/min.	900	900	900	900

Type designation	TAD1640VE-B	TAD1641VE-B	TAD1642VE-B	TAD1643VE
Power	Refer to the sales literature			
Torque	Refer to the sales literature			
No. of cylinders	6	6	6	6
Bore mm (inch)	144 (5.67)	144 (5.67)	144 (5.67)	144 (5.67)
Stroke mm (inch)	165 (6.50)	165 (6.50)	165 (6.50)	165 (6.50)
Displacement liter (inch^3)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)
Weight, dry kg (lb)	—	—	—	1440 (3175)
Weight, wet kg (lb)	1440 (3175)	1440 (3175)	1440 (3175)	1510 (3329)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Compression ratio	16.8:1	16.8:1	16.8:1	17.5:1
Low idle, r/min.	600	600	600	600–900

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Type designation	TAD1643VE-B	TAD1650VE	TAD1650VE-B,	TAD1651VE
Power	Refer to the sales literature			
Torque	Refer to the sales literature			
No. of cylinders	6	6	6	6
Bore mm (inch)	144 (5.67)	144 (5.67)	144 (5.67)	144 (5.67)
Stroke mm (inch)	165 (6.50)	165 (6.50)	165 (6.50)	165 (6.50)
Displacement liter (inch^3)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)
Weight, dry kg (lb)	—	1425 (3142)	—	—
Weight, wet kg (lb)	1440 (3175)	—	1395 (3075)	1395 (3075)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Compression ratio	17.0:1	18.0:1	17.0:1	17.0:1
Low idle, r/min.	600–900	600–900	600–900	600–900

Lubrication System

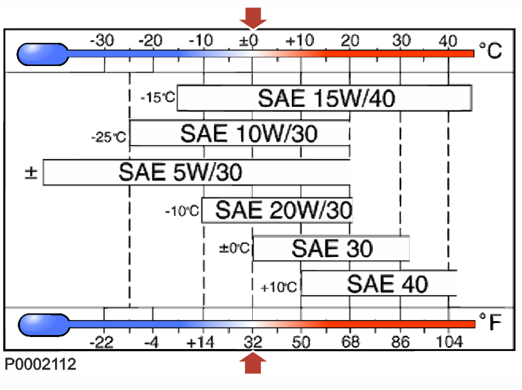
Oil change volume, including filter change	
Composite sump (Standard)	48 liters (12.68 US gal)
Aluminum sump (Optional)	55 liters (14.53 US gal)
TAD1650VE (Aluminum sump, Standard)	55 liters (14.53 US gal)
Additional volume: Remote oil filters (Optional)	3 liters (0.80 US gal)
Oil pressure, hot engine	
at operating speed	300-650 kPa (44–94 psi)
TAD1650VE	400–650 kPa (58–94 psi)
Oil filter	
Full flow filter	2
By-pass filter	1
Lube oil pump	
Type	Gear driven

Oil recommendations

Type designation	Oil quality	Oil change interval, reached first in operation:
TAD1640GE-B, TAD1641GE-B, TAD1642GE-B, TWD1643GE, TWD1644GE, TWD1645GE, TAD1650GE, TAD1651GE, TWD1652GE, TWD1653GE TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE, TAD1650VE	VDS-3 VDS-2	**600** hours or 12 months
TAD1650VE-B, TAD1651VE TAD1643VE-B	VDS-3 VDS-4.5	**500** hours or 12 months

VDS = Volvo Drain Specification

Viscosity



Select the viscosity according to the table.

The temperature values refer to stable ambient temperatures.

* SAE 5W/30 refers to synthetic or semi-synthetic oils.

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Fuel System

Feed pump	
Feed pressure at 900 rpm	min 100 kPa (14.5 psi)
Feed pressure at 1800 rpm	min 300 kPa (43,5 psi)
Feed pressure at full load	min 300 kPa (43,5 psi)
Bypass valve	
Opening pressure	400-550 kPa (58–80 psi)

General requirements

Volvo Penta diesel engines are certified for compliance with emission legislations with the diesel test fuels specified by law. These fuels correspond with diesel fuel standards EN 590, ASTM D975, JIS K2204 and paraffinic diesel fuel standard EN 15940. Volvo Penta guarantees compliance with emission legislation and fulfillment of expected lifetime as long as the specified restrictions are followed.

It is the responsibility of the fuel suppliers to always ensure that their fuels meet relevant requirements and are fit for their intended purpose. Their responsibility includes any use of additives for proper engine performance and function.
Special requirements are placed on cold-flow properties, that is, temperature limit values of fuel filterability during operation in winter conditions.

Restrictions for specified diesel fuels

- **Max density for ASTM D975 No 2-D: 860 kg/m^3**
  Insufficient density reduces the power and increases the fuel consumption. Excessive density endangers the durability and function of the fuel injection equipment.
- **Max lubricity (wsd 1.4) for JIS K 2204: 460 µm**
  Sufficient fuel lubricity is essential to protect the fuel injection system against excessive wear.

Restrictions for other diesel fuels

Volvo Penta also approves the use of other diesel fuels as long as the here specified restrictions are followed. However Volvo Penta does not guarantee compliance with emission legislation or fulfillment of expected lifetime with these other diesel fuels.

NOTICE! Operators must check permission for usage of these fuels according to regional, national or local regulations.

- **Min cetane number: 40**
  An insufficient cetane number (“ignitability”) leads to poor startability and increased exhaust emissions.
- **Max density at 15 °C: 860 kg/m^3**
  Insufficient density reduces the power and increases the fuel consumption. Excessive density endangers the durability and function of the fuel injection equipment.
- **Viscosity between 1.9 to 4.6 mm/s^2 at 40 °C**
  Insufficient viscosity reduces the power and increases the fuel consumption. Excessive viscosity endangers the durability and function of the fuel injection equipment.
- **Max lubricity (wsd 1.4): 520 µm**
  Sufficient fuel lubricity is essential to protect the fuel injection system against excessive wear.
- **Max FAME (biodiesel) content: 10% (V/V)**
  FAME is blended into diesel fuel.
- **Max sulfur content: 5000 mg/kg**

Paraffinic fuels - HVO and GTL

Paraffinic diesel fuels (“Synthetic Diesel”) have higher cetane numbers and lower densities than diesel fuels. HVO (Hydrotreated Vegetable Oils) is renewable paraffinic fuels. GTL (Gas-To-Liquid) is fossil paraffinic fuels.

Volvo Penta approves the use of paraffinic diesel fuels that complies with standard EN 15940. The fuel guarantees compliance with emission legislation and fulfills the expected lifetime as long as the service requirements are followed.
Volvo Penta also approves the use of fuel blends between these paraffinic fuels and diesel fuels that comply with the quality requirements.

Service requirements

- When shifting from diesel fuel to paraffinic fuel, the fuel hoses and sealings must be replaced.

Biodiesel fuels

Alternative fuels, including biodiesel, that are not substantially similar to the required test fuels may adversely affect engine emissions compliance. As a result, Volvo Penta does not warrant the engine will conform to applicable emissions limits when operated on, or having been operated on, biodiesel or other alternative fuels that are not substantially similar to specified test fuels used for certification.

The use of biodiesel up to maximum 10% (B10) in and of itself, will not affect the manufacturers mechanical warranty, provided the biodiesel used in blend conforms to EN590, EN16734, ASTM D975 and ASTM D7467. Other relevant local fuel standards that fulfill the above mentioned standards may also be used. A minor drop in engine power will occur when using biodiesel.
NOTICE! Biodiesel manufactured by FAME (Fatty Acid Methyl Esther) process is hygroscopic and therefore increase the risk of bacterial growth in the fuel. This may lead to blocked fuel filters. Engine not consuming a full fuel tank within 4 weeks must not use biodiesel.

Higher levels of biodiesel, up to B30, may be used with restrictions. Fuel according to EN 16709 or ASTM D7467, or relevant local fuel standards that fulfill mentioned biodiesel fuel standards, must be used. Volvo Penta does not warrant the engine will conform to applicable emissions limits when operated on biodiesel or another alternative fuels, that are not substantially similar to specified test fuels used for certification.

Service restrictions for diesel fuel with FAME content between 11% and 30% (B11 to B30)

- Lube oil quality VDS-4 or VDS-4.5 shall be used.
- Oil dilution may occur. Make sure that oil level is not exceeding maximum level, in that case change the oil.
- Lube oil change intervals shall be halved, or utilize oil sampling analysis.
- The engines should be fitted with fuel filters with water separators.
- A fuel heater is required, when high FAME diesel fuels are used below freezing point.
- Biodiesel is aggressive to some materials used in fuel system components. Inspect seals, hoses, rubber and plastic components daily. Replace any component that is damaged, softened or leaking. Clean biodiesel from painted surfaces immediately to prevent paint damage.
- Do not use these fuels for engines with long downtime periods.
- If the engine has not been used for a period of 4 weeks or more, the tank and the fuel system shall be flushed clean by running the engine on at least one full tank of diesel fuel.
- When shifting from diesel fuel to high FAME diesel fuel.
  – The fuel hoses and sealings shall be replaced.
  – The fuel tank shall be cleaned and the fuel filter shall be replaced after 50 h.

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Cooling System

Type	Pressurized, sealed
Pressure cap, max opening pressure	75 kPa (10.88 PSI)
Volume (Volvo Penta cooling system)	
TAD1640GE-B, TAD1641GE-B, TAD1642GE-B, TAD1650GE, TAD1651GE	
Engine with standard radiator and hoses (Pusher system)	61 liters (16.1 US gal)
Engine with HD radiator and hoses (Pusher system)	56 liters (14.8 US gal)
TAD1643VE TAD1650VE, TAD1651VE TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1643VE-B, TAD1650VE-B	
Engine with standard radiator and hoses (Pusher system)	61 liters (16.1 US gal)
Engine with standard radiator and hoses (Puller system)	54 liters (14.3 US gal)
Engine with HD radiator and hoses (Pusher and puller system)	56 liters (14.8 US gal)
TWD1643GE, TWD1644GE, TWD1645GE, TWD1652GE, TAD1653GE	
Engine circuit (Engine with radiator, hoses and expansion tank) (Pusher system)	86 liters (22.7 US gal)
Charge air cooler circuit (Charge air coolers, hoses and expansion tank) (Pusher system)	64 liters (16.9 US gal)
Thermostat	
Qty	1 st
Opening temperature	82 °C (179.6 °F)

P0013077

Coolant, Mixing

⚠ WARNING!
All coolant is hazardous and harmful to the environment. Do not consume. Coolant is flammable.

IMPORTANT:
Always use the same type of coolant that is already in the engine.
Different types of coolant must not be mixed with each other.
Risk of reduced cooling function and performance by clogging and isolation.

Coolant shall be based on Organic Acid Technology (OAT).

Follow the mixing recommendation on the product.

The coolant should be mixed with distilled, deionized water. For Volvo Penta specified water requirements; refer to *Water Quality, page 96*.

NOTICE! Always use “Ready Mixed” coolant if water quality cannot be determined or if it does not fulfill ASTM D4985.

NOTICE! Never mix more than 60% concentrated coolant with water. A greater concentration provides reduced cooling effect with the risk for overheating and reduced freeze protection.

P0002463

Water Quality

P0002094

ASTM D4985:

Total solid particles	<340 ppm
Total hardness	<9,5° dH
Chloride	<40 ppm
Sulfate	<100 ppm
pH value	5.5–9
Silica (acc. ASTM D859)	<20 mg SiO_2/l
Iron (acc. ASTM D1068)	<0.10 ppm
Manganese (acc. ASTM D858)	<0.05 ppm
Conductivity (acc. ASTM D1125)	<500 µS/cm
Organic content, COD_{Mn} (acc. ISO8467)	<15 mg $KMnO_4$/l

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Electrical System

System voltage	24V
Alternator	
Voltage/max. amperage	28V/110A
Power	2800W
Alternative generating equipment (optional)	
Voltage/max. amperage	28V/150A
Power	4000W
Battery capacity	2 pcs. series connected 12 V, max. 220 Ah
Battery electrolyte density at +25°C °	
Fully charged battery	1,28 g/cm^3 (1,24 g/cm^3)*
Battery recharged at	1,20 g/cm^3 (1,20 g/cm^3)*

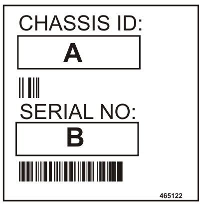
NOTICE! * Applies to batteries with tropical acid.

Electrical platform

EMS 2.0	TAD1643VE, TWD1643GE
EMS 2.2	TAD1640VE-B, TAD1641VE-B, TAD1642VE-B TAD1650VE TAD1650GE, TAD1651GE TWD1652GE, TWD1653GE
EMS 2.3	TAD1643VE-B TWD1644GE, TWD1645GE TAD1650VE-B TAD1651VE
EMS 2.4	TAD1640GE-B, TAD1641GE-B, TAD1642GE-B

Identification Numbers

NOTICE! The engine labels are placed on the valve cover.



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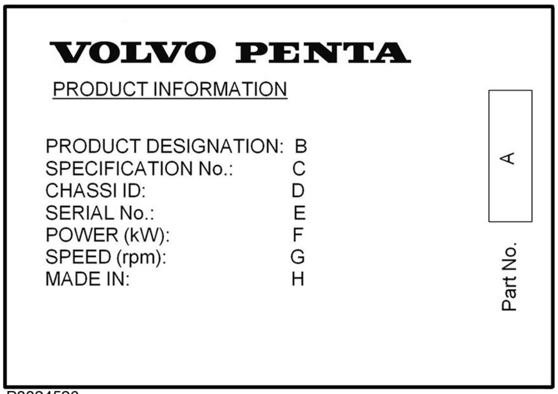
A Chassis ID

B Serial number



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A Label part number

B Product designation

C Specification number

D Chassis ID

E Serial number

F Power (kW)

G Engine speed (rpm)

H Country of manufacturing

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VOLVO PENTA

Declaration for the installation of partially-completed machinery in accordance with
Machinery Directive 2006/42/EC

Engine Manufacturer:
AB Volvo Penta
Gropegårdsgatan, SE 405 08 Gothenburg, Sweden

Description of engine 4-cycle diesel engine. Engine types covered by this declaration:

TAD540VE	TAD840VE	TAD940VE	TAD1140VE	TAD1340VE	TAD1341GE-B	TAD1640GE-B	TAD1650GE
TAD541VE	TAD841VE	TAD941VE	TAD1141VE	TAD1341VE	TAD1342GE-B	TAD1641GE-B	TAD1651GE
TAD542VE	TAD842VE	TAD943VE	TAD1142VE	TAD1342VE	TAD1343GE-B	TAD1642GE-B	TWD1643GE
TAD550VE	TAD843VE	TAD950VE	TAD1150VE	TAD1343VE	TAD1344GE-B	TAD1640VE-B	TWD1644GE
TAD551VE	TAD850VE	TAD951VE	TAD1151VE	TAD1344VE	TAD1345GE-B	TAD1641VE-B	TWD1645GE
TAD552VE	TAD851VE	TAD952VE	TAD1152VE	TAD1345VE	TAD1350GE	TAD1642VE-B	TWD1652GE
TAD570VE	TAD852VE		TAD1170VE	TAD1350VE	TAD1351GE	TAD1643VE-B	TWD1653GE
TAD571VE	TAD853VE		TAD1171VE	TAD1351VE	TAD1352GE	TAD1650VE-B	TWD1672GE
TAD572VE	TAD870VE		TAD1172VE	TAD1352VE	TAD1353GE	TAD1643VE	TWD1673GE
	TAD871VE			TAD1353VE	TAD1354GE	TAD1650VE	
	TAD872VE			TAD1360VE	TAD1355GE	TAD1651VE	
	TAD873VE			TAD1361VE	TAD1371VE	TAD1660VE	
				TAD1362VE	TAD1372VE	TAD1661VE	
				TAD1363VE	TAD1373VE	TAD1662VE	
				TAD1364VE	TAD1374VE	TAD1670VE	
				TAD1365VE	TAD1375VE	TAD1671VE	
						TAD1672VE	

Fundamental health and safety requirements applied to, and fulfilled by, the above-mentioned engines are described in the following items in Annex I:
1.1.3, 1.1.5, 1.5.1, 1.5.2, 1.5.3, 1.5.4, 1.5.6, 1.5.13, 1.6.1, 1.6.2, 1.6.4, 1.7.1, 1.7.1.1, 1.7.1.2, 1.7.4, 1.7.4 and 1.7.4.3.
The relevant technical documentation is compiled as described in part B of Annex VII.
Relevant information concerning the partially completed machinery will be provided in suitable form upon justified requests from competent national authorities. The individual authorized to compile the relevant technical documentation is the signer of this declaration.

The harmonized standards applied are:
EN ISO 12100:2010: Safety of machinery – General principles for design – Risk assessment and risk reduction.
EN 1679–1+A1:2011: Reciprocating internal combustion engines – Safety – Part 1: Compression ignition engines.

The partially completed machinery also complies with the following relevant Directive:
2014/30/EU – Electromagnetic Compatibility (EMC) Directive.
Applied standards: EN 61000–6–1:2007, EN 61000–6–2:2005, EN 61000–6–3:2007, EN 61000–6–4:2007, EN 12895:2015, EN-ISO 14982:2009 and EN 13309:2010.

For engines equipped with the Volvo Penta Start/Stop System the responsibility for the functional safety of the system lies with the machine manufacturer performing the integration.

The engines covered by this declaration may not be put into operation before the completed machinery into which they are to be installed has been declared to conform with the provision of Machinery Directive 2006/42/EC.

Name and function:
Jennifer Åhlberg, Regulatory Affairs and Safety Compliance
(The identity of the individual authorized to sign on behalf of the engine manufacturer or the latter's authorized representative.)

Signature and title:

Date and place of issue: (yyyy-mm-dd) 2018–11–22 Gothenburg

LR-09/18

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ENG This Operator’s Manual may be ordered in a different language free of charge up to 12 months after delivery, via internet.

http://manual.volvopenta.com/coupon/

If internet access isn‘t possible, please contact your Volvo Penta dealer.

GER Diese Betriebsanleitung kann bis zu 12 Monate nachder Lieferung über Internet kostenlos in einer anderen Sprache bestellt werden.

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Wenn Sie keinen Internet-Zugriff haben, kontaktieren Sie bitte Ihren Volvo Penta-Händler.

FRE Ce manuel d‘utilisation peut être commandé gratuitement sur Internet en différentes langues, jusqu‘à 12 mois après la date de livraison.

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Veuillez contacter votre Distributeur Volvo Penta si vous avez un problème d‘accès à l‘Internet.

SPA El presente libro de instrucciones puede solicitarse en otro idioma diferente, libre de cargo, hasta 12 meses después de la entrega, mediante internet.

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Si no se tiene acceso a internet, contacten al su concesionario Volvo Penta.

ITA Il manuale per l‘operatore può essere ordinato tramiteInternet, in varie lingue e per consegna gratuita, entro 12 mesi dalla consegna del prodotto

http://manual.volvopenta.com/coupon/

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SWE Denna instruktionsbok kan beställas via internet på ett annat språk gratis i upp till 12 månader efter leverans.

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Kontakta din Volvo Penta-återförsäljare om du inte har tillgång till internet.

DUT Dit instructieboek kan gratis via internet in een a dere taal worden besteld tot 12 maanden na aflevering.

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Als toegang tot het internet niet mogelijk is, neem dan contact op met uw Volvo Penta dealer.

DAN Denne instruktionsbog kan bestilles gratis på et andet sprog via Internettet i op til 12 måneder efter leveringen.

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Hvis det ikke er muligt at bestille via Internettet, bedes du kontakte din Volvo Penta forhandler.

FIN Tämä käyttöohjekirja on tilattavissa Internetin kautta veloituksetta eri kielillä 12 kuukauden ajan toimituksen jälkeen.

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POR Este Manual do Operador pode ser encomendad em idiomas diferentes isento de custos até 12 meses após entrega, via internet.

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GRC Το παρόν Βιβλίο Χρήσης μπορεί να παραγγελθεί δωρεάν σε άλλη γλώσσα μέχρι 12 μήνες μετά την παράδοση,μέσω διαδικτύου.

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Εάν δεν είναι δυνατή η πρόσβαση στο ιαδίκτυο,παρακαλούμε επικοινωνήστε με το δικό σας αντιπρόσωπο της Volvo Penta.

RUS Данное руководство по эксплуатации можно бесплатно заказать на другом языке по Интернету в течение 12 месяцев после доставки.

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Если доступ к Интернету отсутствует, обратитесь к своему дилеру компании Volvo Penta.

TUR Bu Kullanım Kılavuzu, teslimden 12 ay sonrasına kadar İnternet yoluyla ücretsiz olarak farklı bir dilde sipariş edilebilir.

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İnternet mümkün değilse, lütfen Volvo Penta yetkili satıcınızla tmasa geçin.

CHI 本操作手册可通过互联网以不同的言进行订购，交付后可免费使用达12 个月。

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如果无法访问互联网，请与沃尔沃遍达经销商联系。

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JPN このオペレーターズ マニュアルの他言語版が、発行後最高12か月間、インターネットより無料で発注可能です。

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ARA

من الممكن طلب دليل المشغل بلغة أخرى مجانًا عبر الإنترنت لفترة تصل إلى ١٢ شهرًا من بعد التسليم.

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إذا كان الوصول إلى الإنترنت غير متاح، فالرجاء الاتصال بوكيل Volvo Penta.

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AB Volvo Penta
SE-405 08 Göteborg, Sweden
www.volvopenta.com

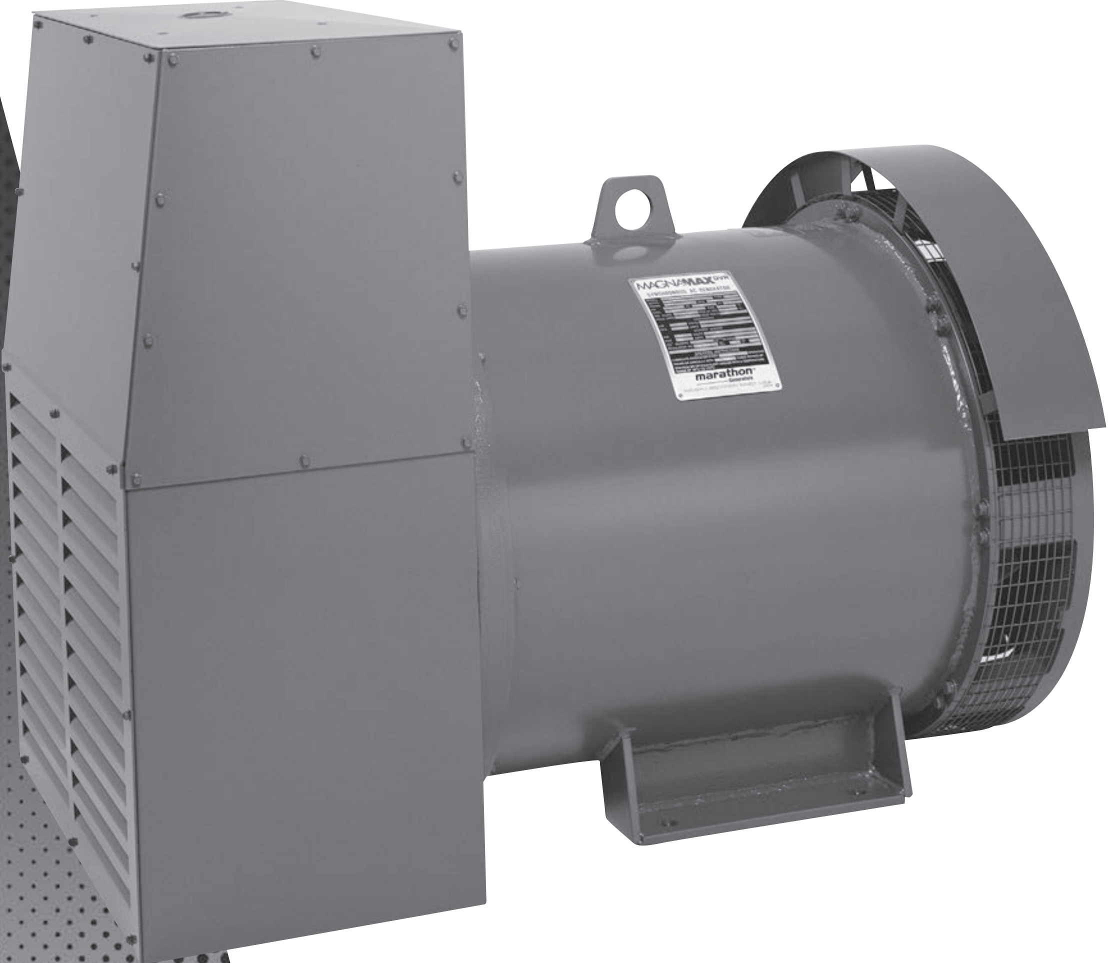
47711296 English 01-2019

marathon™

Generators

MagnaMax DVR®

Installation, Operation, and Maintenance Manual



A Regal Brand

REGAL

Table of Contents

A Few Words About Safety

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation and maintenance of the MAGNAMAX$^{DVR®}$ generator.

Each section has caution and warning messages. These messages are for your safety and the safety of the equipment involved. If any of the cautions or warnings are not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and, where appropriate, lock out all controls to prevent an unexpected start-up of the generator set. Proper grounding in compliance with local and national electrical codes must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving the MAGNAMAX$^{DVR®}$ generator are pointed out in the installation and service sections; incorrect lifting or moving can result in personal injury or property damage.

Whenever the generator is running, always assume and proceed as if voltage is present. Residual voltage is present at the generator leads and at the regulator panel connections, even with the regulator fuse removed. Caution must be observed. Otherwise, serious personal injury or death can result.

Whenever solvents, cleaners, or flammable liquids are present, adequate ventilation must be available to avoid fire, explosion, and health hazards. Always avoid breathing vapors and use suitable personal protective equipment to prevent personal injuries (such as eyes, face, and hand protection).

This manual is not intended to be a substitute for properly trained personnel. Repairs should only be attempted by qualified, trained people. The cautions and warnings point out known conditions that are potentially dangerous. Each installation will create its own set of circumstances. No manual can cover every possible situation.

When in doubt, ask. Don't be embarrassed to ask "dumb questions." Remember, dumb questions are much easier to handle than dumb mistakes.

General Information

2

Mechanical Design

General
All single and two bearing units are manufactured with cast iron end brackets and adapters and fabricated steel frames. Flexible drive discs and SAE adapters are machined to SAE standards. Prelubricated, regreasable, shielded ball bearings are used on MAGNAMAX$^{DVR®}$ generators. Standard units are fully guarded. Dripproof shields are available as an option.

Conduit Box
The large, front end-mounted conduit box is constructed of formed sheet steel, which will allow the addition of top-mounted control packages. Refer to Marathon Electric for top mounted controls of more than 240 lbs. There is ample room inside the conduit box for a circuit breaker (through 800 amp ratings) and other options. The conduit box cover properly directs outside ven-tilating air through the generator.

MAGNAMAX$^{DVR®}$ Uni-rotor Construction
An aluminum die cast rotor core affords high mechanical integrity and low vibration at operating speeds. Amortisseur winding and coil supports are die cast as an integral part of the rotor. Laminations are 4-pole, one piece laminations which are shrunk fit and keyed to the shaft. No dovetails, cross bolts or other pole to shaft connecting devices are used. The cast unidirectional aluminum alloy ventilating fan provides even air distribution to maximize cooling and generator efficiency.

Adapters and Drive Discs
All single bearing units are available with several adapter and drive disc arrangements. These can be shipped to order or can be changed in the field with standard shop tools. When changing flexible drive discs, spacers are used between the discs and the cast iron hub to maintain SAE standard dimensions.

Electrical Design

General
All standard products have 2/3 pitch main windings to eliminate the third harmonic. This serves to lower operating temperatures, give lower harmonic content and better wave form, and extend the overall life of the generator. The phase sequence is ABC when rotated counterclockwise viewing exciter end.

Temperature Rise
All ratings and frame sizes are based on NEMA and CSA Class F and Class H temperature rises on both the rotor and stator windings. Ratings for international and marine applications are available.

Standby Generator
Synchronous generators used on emergency backup power can have temperature rises up to 25°C above those for continuous operation (NEMA MG1-22.40 and MG 1-22.84).

Premium Insulation System
All MAGNAMAX$^{DVR®}$ generators are built with Class H or better insulation materials. All standard generators are suitable for continuous duty at Class F temperature rise and will give equivalent or better winding life expectancy to generators supplied with Class A or B insulation systems operated within their temperature limits. The varnishes and epoxies used are synthetic, nonhygroscopic. Multiple dip and bake cycles of the main winding, plus a final coat of epoxy, make the standard winding moisture and fungus resistant. The MAGNAMAX$^{DVR®}$ rotor is wet wound with thermosetting epoxy applied between each layer, plus a final coating of epoxy for moisture and abrasion resistance. MAGNAMAX$^{DVR®}$ generators can be ordered with an epoxy vacuum pressure impregnated (VPI) insulation system as an option (MAGNAMAX$^{DVR®}$ generators with form wound coils include VPI as standard).

Power Factor
All standard generators are designed for operation at rated kVA at 0.8 lagging power factor but can be operated at rated kVA over the 0.8 to 1.0 power factor range.

MAGNAMAX$^{DVR®}$ Voltage Regulator
The standard voltage regulator is a fully encapsulated, static type with a solid state build up circuit. Standard features include 3 phase RMS sensing, paralleling, adjustable underfrequency protection, and overexcitation protection. Refer to the regulator manual for more information.

How to Read a Model Number

It is extremely important to properly identify the machine when requesting parts or service.

Always have available the generator model number and serial number when requesting information from the factory. We cannot help you without this information. It is also beneficial to know the mounting arrangement code (see figure 2-1).

An Example for MAGNAMAX$^{DVR®}$ Generators

Example: 431 RSL 4000 AA
① ②③④ ⑤⑥ ⑧

① Frame Number

② R – Random Wound
F – Form Wound

③ S – 1 Bearing
D – 2 Bearings

④ L – Up to 480 volts
S – 600 volts
M – 1000-6900 volts

⑤ Style
4-Magna (slant type conduit box)
8-Magna (square conduit box)

⑥ Model in Series

⑧ Electrical/mechanical modification–minor modification, used in sequence A, B, C, etc. (must specify when requesting WK^2)

Arrangement	Adapter SAE Size	Drive Disc SAE Size
A	3	11-1/2
B	2	11-1/2
C	4	8
D	3	10
E	1	11-1/2
F	1	14
G	4	7-1/2
H	1	Delco
J	1/2	14
K	2	10
L	1/2	Delco
M	0	14
N	2	Small Delco
O	None	None
P	0	18
S	0	Delco
U	00	18
V	4	6-1/2
W	00	21
Y	4	10

Figure 2-1

Installation

3

Receiving Your MAGNAMAX$^{DVR®}$ Generator

Upon receipt of the generator, it is recommended that it be carefully examined for possible damage incurred in shipment. The generator was given to the freight company in good condition, and they are responsible for the product from our dock to yours. Any damage should be noted on the freight bill before accepting the shipment. Claims for damage must be promptly filed with the freight company.

Unpacking and Handling

Read all instruction cards carefully. When lifting, attach an overhead crane to the lifting lugs on the generator frame. Apply lifting forces in a vertical direction.

WARNING **The lifting lugs on the generator are designed to support the generator only. Do not lift complete generator set by means of lifting lugs on generator. Personal injury or equipment damage may result.**

Storage

In the event that the generator is not to be installed on the prime mover immediately, it is recommended that it be stored in a clean, dry area which is not subject to rapid changes in temperature and humidity. See Section 11 for more information.

Preparation for Use

Although the generator is carefully inspected and tested in operation before it leaves the factory, it is recommended that the unit be thoroughly inspected. The insulation on the wire should be inspected and all bolts should be checked for tightness.

Remove all shipping tapes, bags, blocks, and skids which are used to prevent vibration and rotor movement during shipment. Dry, low-pressure compressed air of approximately 30 psi (206 KPa) can be used to blow out the interior of the generator. In the case of two bearing machines, it is possible to turn the rotor by hand to make sure that it rotates smoothly without binding.

If the machine has been in storage for a year or longer, it is recommended that it be lubricated according to the lubrication instructions and chart found in Section 5.

If the machine has been exposed to damp, humid conditions, the insulation resistance should be checked. Refer to Section 8.

Generator Mounting – Single Bearing

Single bearing generators are provided with an SAE flywheel adapter and flexible drive discs. Very close tolerances are maintained in the manufacture of the generator so that the alignment procedure is extremely simple. A coupling hub of nodular iron is shrunk onto the shaft and special steel drive discs are bolted to the hub. Holes are provided in the periphery of the coupling disc which correspond to tapped holes in the flywheel. The outside diameter of the discs fits in a rabbet in the flywheel so that concentricity is assured in all cases.

WARNING **Do not apply any force to generator fan for lifting or rotating generator rotor. Rotate engine flywheel or use slots on fan hub for rotation. Disregarding these instructions may cause personal injury or equipment damage.**

CAUTION

Grade 8 capscrews and heavy series lockwashers or grade 8 placebolts and hardened washers are recommended to mount the drive discs to the flywheel.

The SAE adapter and the flywheel housing are designed to match each other with no further alignment necessary. Shims may be necessary under the feet of the generator to insure a solid mounting. See Section 6 for more information.

Generator Mounting – Two Bearing

Two bearing generators are provided with a shaft extension and keyway. For direct-coupled units, the assembler furnishes a flexible coupling which is installed between the driver and the generator shaft.

Important: Aligning the two machines as accurately as possible will reduce the vibration, increase bearing life, and insure minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

Belt Drive

430 frame, two bearing generators can be belt driven. Please refer to Marathon Electric for application assistance involving belt driven installations. Sheave diameters should be chosen according to the table below.

MAGNAMAX DVR® Sheave Application for Two Bearing Units ①

Model	Min. Sheave Dia. In Inches @ 10,000 Hr. B-10 Life ③		Min. Sheave Dia. In Inches @ 20,000 Hr. B-10 Life ③		Max. Sheave Width Inches
	60 Hz	50 Hz	60 Hz	50 Hz	
431RDL4005	13.0 ②	10.9	16.9 ②	14.2	8.5
431RDL4007	15.2 ②	13.3	19.8 ②	17.3 ②	8.5
432RDL4009	17.0 ②	14.8	22.5 ②	19.5 ②	8.5

① Assumptions:
- A. Belting factor is 1.3.
- B. The drive and the driven sheaves are the same diameter.
- C. The sheave load is located at the center of the shaft extension.
- D. Based upon continuous kW ratings.

② These sheave diameters exceed the maximum recommended belt speed of 6000 ft/min.

③ B-10 Life means 90% of the bearings will last this long or longer.

Environmental Considerations

Dirt, moisture, heat, and vibration are enemies of electrical equipment. Excessive exposure to the elements will shorten the life of the generator. The ambient temperature should not exceed the value shown on the generator nameplate. The MAGNAMAX DVR® is built in a NEMA open type enclosure. Generators for outdoor application should be protected from the elements by housings with proper openings for ventilation. This protection should be designed to prevent the direct contact of wind driven rain, snow, or dust with the generator. In moist or humid areas, such as the tropics and marine service, additional protection is recommended. Although the standard windings are humidity and moisture resistant, special insulations and accessories such as space heaters can increase generator life significantly. In extremely dirty and dusty environments, a means of providing filtered cooling air to the generator is recommended. When generators are marked Ex, II, 3, G, T3, X they must be installed in a clean environment. If not possible, a means to providing filtered cooling air to the generator is mandatory for safe use. Refer to Marathon Electric for more information.

Electrical Connections

The generator conduit box construction allows conduit to enter the top, bottom, or either side of the box. A hole-saw or any suitable tool can be used to provide for the conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit.

To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical entrance to the generator.

Refer to the connection diagram supplied with the generator and/or the proper diagrams shown in this section. Install all intercomponent and external wiring in accordance with the regulations of the national and local electrical codes. Clean all contact surfaces to assure good electrical bonding with the generator lugs or bus bars. Use heavy duty terminal lugs or good quality clamps for making all connections. Insulate all connections in accordance with national and local regulations.

Be sure the generator frame is grounded to all the other components of the system with a ground wire in accordance with national and local regulations.

Generator Lead Connections

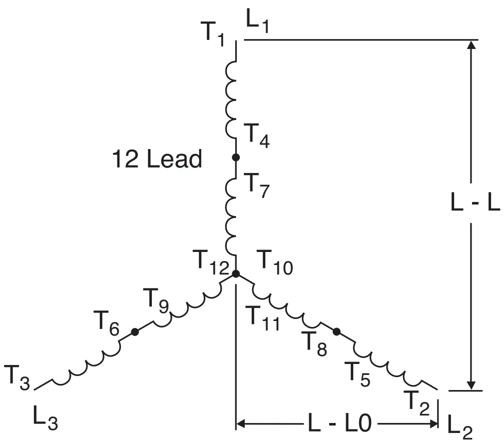
The electrical connections in the conduit box should be made in accordance with the appropriate "connection diagram." Use the diagram appropriate for the number of leads and voltage range required. Refer to the drawings supplied with the generator and to drawings in this section.

The final voltage setting is established within the selected range by an adjustment of the voltage regulator.

CAUTION Some generators have multiple, identically marked cables for each lead. Connect all identically marked cables together when making connections.

3

12 Lead High Wye

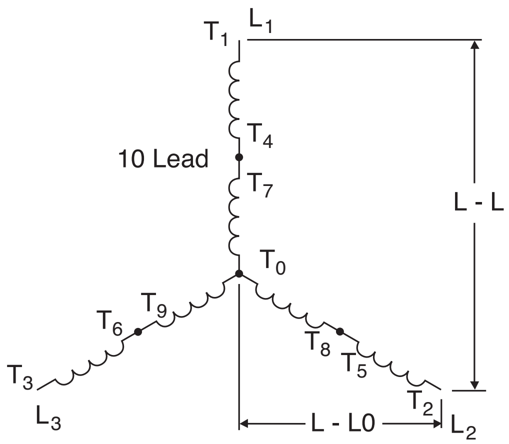


Twelve lead generators are dual voltage generators with six coils which don't have the connection of the three inner coils. There are 12 or 24 cables coming out of the generator.

	Voltage	
	L-L	L-L0
60 HZ	380	219
	416	240
	440	254
	460	266
	480	277
50 HZ	380	219
	400	231
	416	240

Connect	L_1	L_2	L_3	L-L0
T_{10} T_{11} T_{12}	T_1	T_2	T_3	T_{10}
T_4 T_7				T_{11}
T_5 T_8				T_{12}
T_6 T_9				

10 Lead High Wye

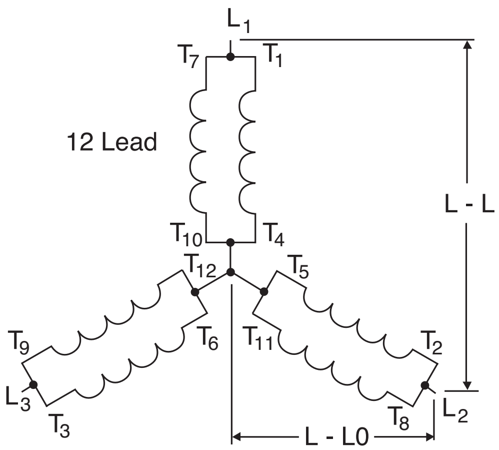


Ten lead generators are dual voltage generators with six coils. One end of the three inner coils is connected together. There are 10 or 20 cables coming out of the generator.

	Voltage	
	L-L	L-L0
60 HZ	380	219
	416	240
	440	254
	460	266
	480	277
50 HZ	380	219
	400	231
	416	240

Connect	L_1	L_2	L_3	L-L0
T_4 T_7				
T_5 T_8	T_1	T_2	T_3	T_0
T_6 T_9				

12 Lead Low Wye

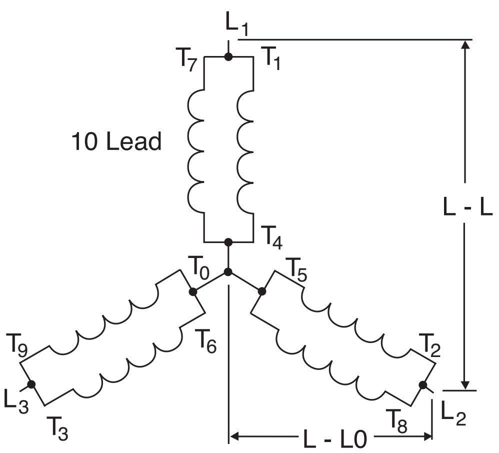


Twelve lead generators are dual voltage generators with six coils which don't have the connection of the three inner coils. There are 12 or 24 cables coming out of the generator.

Voltage	L-L	L-L0
60 HZ	190	110
	208	120
	220	127
	230	133
	240	139
50 HZ	190	110
	200	115
	208	120

Connect	L_1	L_2	L_3	L-L0
T_{10} T_{11} T_{12} T_4 T_5 T_6	T_1	T_2	T_3	T_{10} T_{11} T_{12} T_4 T_5 T_6
T_1 T_7				
T_2 T_8				
T_3 T_9				

10 Lead Low Wye

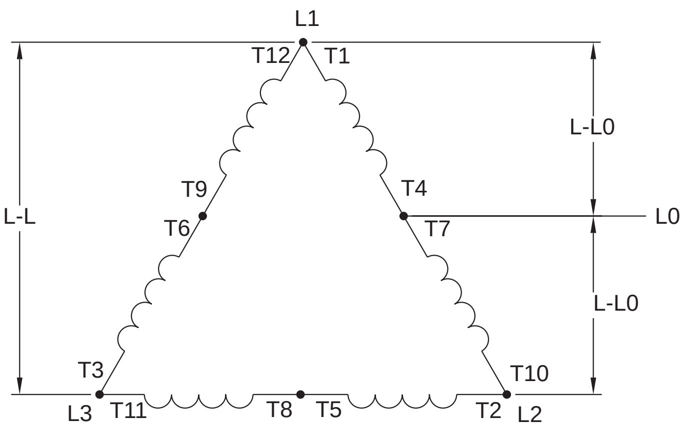


Ten lead generators are dual voltage generators with six coils. One end of the three inner coils is connected together. There are 10 or 20 cables coming out of the generator.

Voltage	L-L	L-L0
60 HZ	190	110
	208	120
	220	127
	230	133
	240	139
50 HZ	190	110
	200	115
	208	120

Connect	L_1	L_2	L_3	L-L0
T_1 T_7	T_1	T_2	T_3	T_4
T_2 T_8				T_5
T_3 T_9				T_6
T_4 T_5 T_6 T_0				T_0

12 Lead High Delta

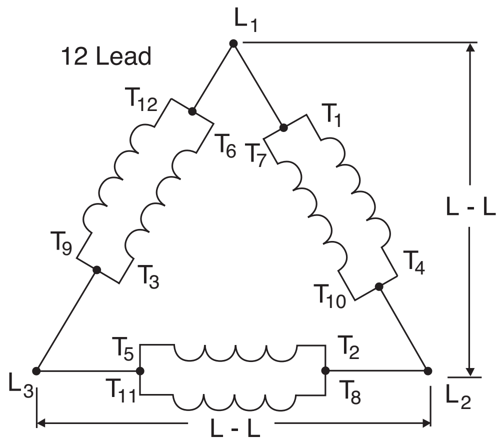


Delta connection with 12 lead generators only.

Voltage		
	L-L	L-L0
60 HZ	240	120
	277	139
50 HZ	200	100
	220	110
	240	220

Connect	L_1	L_2	L_3
T_4 T_7	T_1	T_2	T_3
T_5 T_8			
T_6 T_9			
T_1 T_{12}			
T_2 T_{10}			
T_3 T_{11}			

12 Lead Low Delta

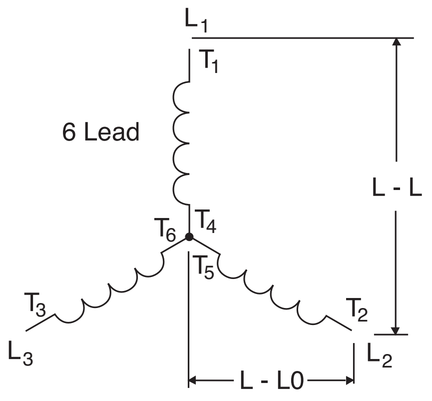


Delta connection with 12 lead generators only.

Voltage	
	L-L
60 HZ	120
	139
50 HZ	100
	120

Connect	L_1	L_2	L_3
T_1 T_7 T_6 T_{12}	T_1	T_2	T_3
T_2 T_8 T_4 T_{10}			
T_3 T_9 T_5 T_{11}			

6 Lead Wye

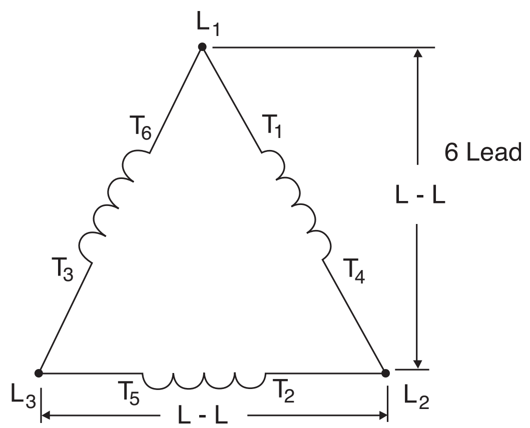


Six lead generators have 3 coil groups with 6 or 12 cables or bus bars coming out of the generator.

Voltage		
	L-L	L-L0
60 HZ	190	110
	203	120
	220	127
	230	133
	240	139
	3300	1905
	4160	2400
50 HZ	190	110
	200	115
	208	120
	3300	1905

Connect	L_1	L_2	L_3	L-0
T_4 T_5 T_6	T_1	T_2	T_3	T_4 T_5 T_6

6 Lead Delta

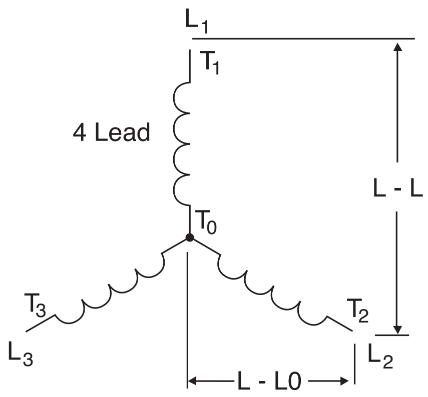


Six lead generators have 3 coil groups with 6 or 12 cables coming out of the generator.

Voltage	
	L-L
60 HZ	2400
50 HZ	1905

Connect	L_1	L_2	L_3
T_1 T_6	T_1	T_2	T_3
T_2 T_4			
T_3 T_5			

4 Lead Wye

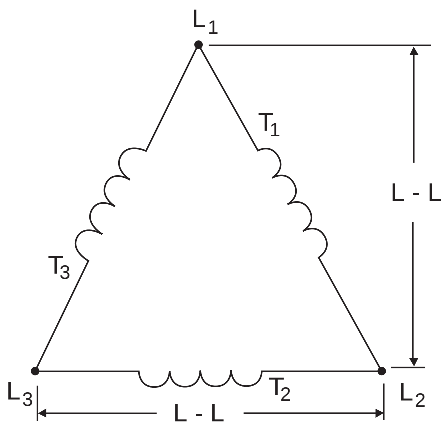


Four lead generators have 3 coil groups with one end of each group connected together. There are 4, 8, or 16 cables or 4 bus bars coming out of the generator.

Voltage		
	L-L	**L-L0**
60 HZ	380	219
	416	240
	440	254
	460	266
	480	277
	600	346
50 HZ	380	219
	400	231
	416	240
	480	277

L_1	L_2	L_3	L-L0
T_1	T_2	T_3	T_0

3 Lead Delta

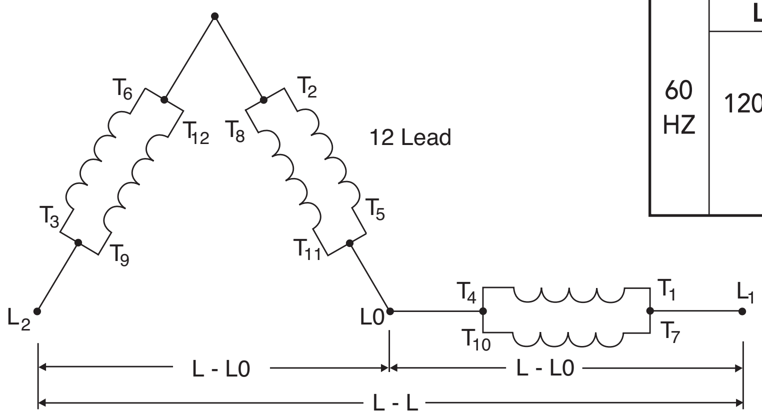


Three lead generators have 3 coil groups with one end of each group connected into a Delta internally. There are 3, 6, or 12 cables or 3 bus bars coming out of the generator.

Voltage	
	L-L
60 HZ	480

L_1	L_2	L_3
T_1	T_2	T_3

12 Lead Zigzag

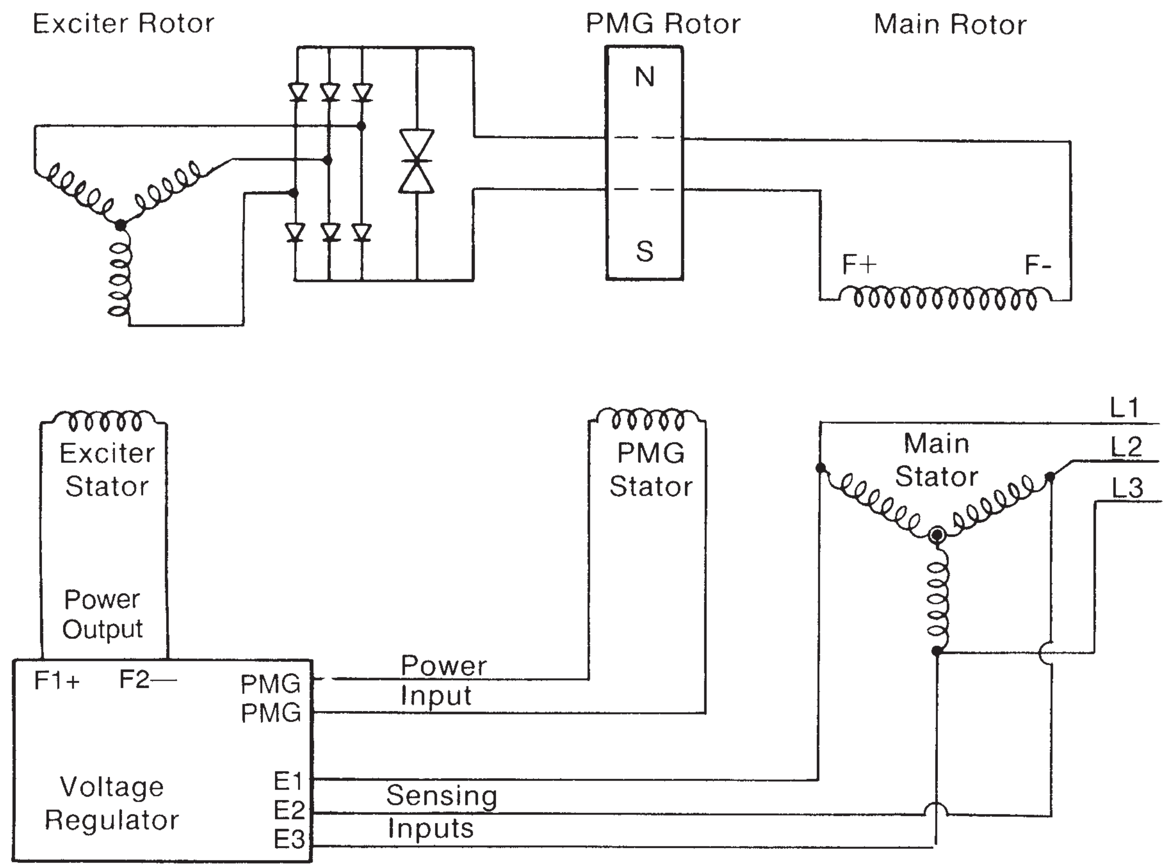


Zigzag connection with 12 lead machine only.

Voltage		Connect	L_1	L_2	L-L0
	L-L				
60 HZ	120/240	T_1 T_7	T_1	T_3	T_4
		T_2 T_8 T_6 T_{12}			
		T_4 T_{10} T_5 T_{11}			
		T_3 T_9			

CAUTION The generator kW/kVA rating is approximately 50% of it's 3 phase rating when connected for single phase.

Typical System Diagram



Paralleling Operations

MAGNAMAX[DVR®] generators come standard with amortisseur windings die cast as an integral part of the rotor. This exclusive uni-rotor construction makes all MAGNAMAX[DVR®] generators suitable for paralleling operations when the proper control equipment is added. Paralleling with other generator sets and/or with the utility power grid offers a number of advantages. Multiple unit installations increase power capacity; they can be added or removed from the line depending on the load requirements; they can be better maintained and repaired (since single source breakdown would mean total loss of power), and they often provide more reliable, efficient, and economical operation.

Successful parallel operation means that the generators deliver power to the external system without delivering power to each other, or accepting power from the load bus or power grid. Additional equipment is necessary to insure safe and successful operation.

Prime Mover

The prime mover provides the speed and torque which will be necessary to keep the machines in synchronized operation. The governor will directly control the watt or kW load and frequency of the unit. The prime mover speed is controlled by a governor. The governor must have special paralleling provisions to permit parallel operation with the other machines.

Voltage Regulator

The voltage regulator controls the generator output voltage and the reactive power supplied by the generator. When two or more AC generators operate in parallel, the voltage regulator must have paralleling provisions (either internally or external to the regulator) to allow the voltage regulator to control the reactive or VAR load while it is in parallel operation. A separate paralleling current transformer is required to sense the reactive current and signal the voltage regulator. This additional paralleling circuitry is absolutely necessary to control the reactive current flowing between the generator sets.

Switchgear

There are additional relays and breaker controls which are necessary to insure safe, trouble free operation of paralleled units. Reverse power relays monitor the direction of power flow to insure that the generator is delivering the power, not accepting it. These power relays control breakers, which are a means of connecting and disconnecting the generator from the load. The total system can include over-voltage, over-current protection, under frequency protection, power factor correction provision and various associated control equipment from manual switchgear to microprocessors. The amount of control gear and level of sophistication will be determined by the needs and requirements of the particular application.

Paralleling Basics

The following points are basic criteria which must be met before two units can be paralleled. THIS IS NOT MEANT TO BE SPECIFIC INSTRUCTIONS FOR PARALLELING OPERATION.

1. Additional paralleling circuitry
    A. Voltage regulator-paralleling provisions
    B. Paralleling current transformer(s)
    C. Paralleling provisions on governor controls
    D. Switchgear
2. The voltage and frequency must be the same for all sets with voltages in phase.
3. The voltage regulation characteristics of the individual generators should be similar.
4. The generators must have the same phase rotation.
5. The driving engines should have the same speed regulation characteristics and the governors should be adjusted to give the same speed regulation.

Before operating generator sets in parallel, each set should be checked by starting, operating, and adjusting the sets as individual units before attempting paralleling.

Reactive Load Control

When two identical generators are operating together in parallel and an unbalance occurs in field excitation, circulating currents begin to flow between the generators. This current will appear as a lagging power factor or inductive load to the highly excited generator, and as a leading power factor or capacitive load to the generator with the lower field current. This is known as the reactive circulating current, and there are two methods of controlling it in parallel operation:

1. Reactive droop compensation (formerly known as parallel droop compensation) – the bus voltage droops, or decreases, as the reactive lagging power factor load is increased.
2. Reactive differential compensation (formerly known as cross current compensation) – the reactive differential compensation circuit allows parallel generators to share reactive loads with no decrease or droop in generator voltage. The circuit must meet the following criteria:
   A. All paralleling current transformers for all the generators being paralleled must be included in the secondary interconnection loop.
   B. When different size generators are paralleled, all paralleling current transformers must have the same or proportional ratios that give approximately the same secondary current.
   C. Voltage regulator paralleling circuitry must be the same.
   D. Current transformer secondaries and the generator lines must be isolated electrically.

      Because of the preceding criteria, reactive differential compensation cannot be used when paralleling with the utility power grid. There is no limit, however, in the number of generators that can be included in this type of circuit.
   E. It is also desirable to have an auxiliary contact on the main generator breaker to short the parallel CT secondary when that breaker is open (not connected to the load bus).

Paralleling Circuitry

Because of the number of variables involved in paralleling generator sets, every installation will have its own circuitry and methods or procedure of bringing paralleled units on line. There are numerous ways of connecting paralleled units and an almost unlimited variety of applications and associated equipment.

When parallel operation is desired, it is important that the control manufacturer, the generator manufacturer, and the systems engineer work together to insure the proper selection of all components. Please refer to Marathon Electric for application assistance.

Thyristor or SCR Loading

Solid state electronic control devices which utilize thyristors or SCR firing circuits (such as variable frequency induction motor controls, precision motor speed controls, no-break powered battery chargers, etc.) can introduce high frequency harmonics which adversely affect or destroy the normal waveform of the generator. This creates additional heat in the generator stator and rotor and can cause overheating.These devices can and do present problems to non-utility power generating equipment or any limited power bus system. The problems which can occur are not limited to the generator itself, but can effect the solid state control device, the equipment it controls, other associated loads, monitoring devices, or a number of combinations over the entire system.

MAGNAMAX$^{DVR®}$ generators can supply power to thyristor or SCR loads when properly applied. When SCR loads are more than 25% of the total load, select the generator based on the 80°C R/R rating. The standard voltage regulator is PMG powered and senses 3 phase RMS voltages for maximum stability against severely distorted wave forms. SCR type applications such as cranes, shovels, etc., require special consideration of the generator insulation system due to greater dielectric stress and severe environmental conditions. It is important that the control manufacturer, the generator manufacturer, and the systems engineer work together to insure the proper selection of all components. Please refer to Marathon Electric for application assistance.

Pre-Start Inspection

Before operating the generator for the first time, the following checks are recommended:

1. A visual inspection should be made to check for any loose parts, connections, or foreign materials. Refer to section 8.
2. Check for clearance in the generator and exciter air gap. Be sure the generator set turns over freely. Bar the generator over by hand at least 2 revolutions to be sure there is no interference.

WARNING Do not apply any force to generator fan when rotating generator rotor. Disregarding these instructions may cause personal injury or equipment damage.

3. Check all wiring against the proper connection diagrams and make sure all connections are properly insulated. Support and tie leads to keep them from being damaged by rotating parts or by chafing on sharp corners.
4. Be sure the equipment is properly grounded.
5. Inspect for any remaining packing materials and remove any loose debris, building materials, rags, etc., that could be drawn into the generator.
6. Check fasteners for tightness.
7. Check to be sure no tools or other hardware have been left inside or near the machine.
8. Install and check to be sure all covers and guards are in place and secure.

WARNING Residual voltage is present at the generator leads and at the regulator panel connections, even with the regulator fuse removed. Caution must be observed or serious personal injury or death can result. Consult qualified personnel with any questions.

Starting Up the Generator

The following procedure should be followed for starting up the generator for the first time:

1. The generator output must be disconnected from the load. Be certain that the main circuit breaker is open.
2. Disable the voltage regulator by removing the fuse.

WARNING Do not overspeed the generator. Excessive centrifugal forces could damage the rotating fields. Be prepared for an emergency shut-down.

3. Follow the manufacturer’s instructions and start the prime mover. Check the speed and adjust the rpm shown on the generator nameplate.
4. Replace the regulator fuse and adjust the voltage to the required value (figure 4-2). Check all line to line and line to L0 voltages to be sure they are correct and balanced. If the voltages are not correct, shut down immediately and recheck all connections. See section 3.
5. Close the main circuit breaker and apply the load.
6. Monitor the generator output current to verify it is at or below nameplate amps.
7. Adjust engine speed at full load to 1800 rpm for 60 Hz, 1500 rpm for 50 Hz (refer to prime mover/governor instruction manuals).
8. Before stopping the engine, remove the load by tripping the main circuit breaker.

Voltage Adjustments

The generator output voltage is controlled by the voltage regulator. There is a cover to access the control panel on the side of the generator conduit box (figures 4-1 and 4-2). Refer to the regulator manual for detailed information. In cases where special or remote mounted regulators are used, refer to instructions supplied by the generator set assembler and to the voltage regulator manual.

Other Adjustments

Depending upon application, adjustments to other protective and control gear may be required. Refer to instructions supplied by the generator set manufacturer.

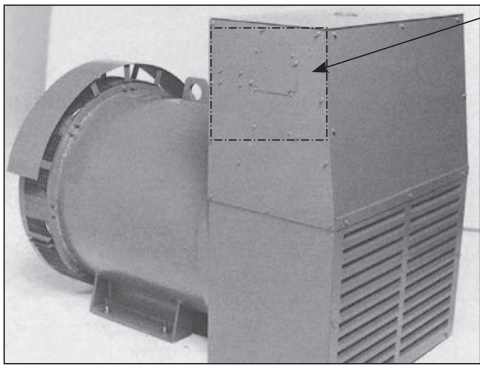
The standard MAGNAMAX[DVR®] voltage regulator also has many protective and control circuits built in. Refer to the regulator manual for further details.

Field Flashing

The standard MAGNAMAX[DVR®] generator is supplied with a PMG (permanent magnet generator). It will never require field flashing.

In rare cases where a special generator may be furnished without a PMG, refer to the factory for more detailed information. Include the complete generator model and serial number (see page 3).

Regulator Access



See Figure 4-2 for enhanced view of this area.

Figure 4-1

Standard Marathon Electric Regulator

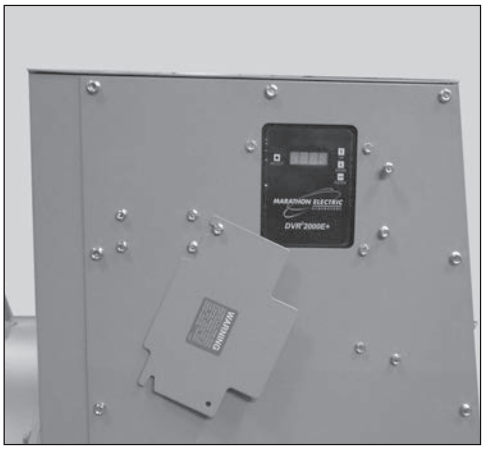


Figure 4-2

Maintenance

5

Maintenance – General Information

Dirt, heat, moisture, and vibration are common enemies of a generator. Keeping the generator clean and dry, maintaining proper alignment of the generator and its prime mover, and preventing overloads will result in efficient operation and long life.

Generators that are outdoors should be protected from the elements by suitable houses or enclosures.

Dirt and dust will conduct electricity between points of different electrical potential. Moisture will aggravate the problem further. Insulation system failure can result if corrective action is not taken. The condition of the insulation system can be tested by measuring insulation resistance (see section 8 - Generator Testing).

Insulation resistance should be checked when putting the generator into service after it has been in storage and any time contamination by moisture and dirt is suspected. Normally, moisture buildup is not a problem when the generator is running since heat produced internally will tend to keep it dry. Moisture can collect in the generator when it is shut down. The problem will be worse in humid environments or in areas where extreme temperature changes cause condensation (dew) to form inside the generator. Space heaters, air filters, and premium insulation systems, such as our VPI process, should be considered in difficult environments.

Accumulations of dust and dirt not only contribute to insulation breakdown, but they can also increase temperature by restricting ventilation and by blocking the dissipation of heat. Some machines are exposed to accumulations of materials such as talc, lint, rock dust, or cement dust which may obstruct the ventilation. The most harmful type of foreign materials include carbon black, metallic dust and chips, and similar substances which not only impede the ventilation, but also form a conductive film over the insulation, increasing the possibility of insulation failure. Machines operating in dirty places should be disassembled and cleaned periodically.

Air Intake and Exhaust

Check the area around the air intake and exhaust openings to be sure they are clean and unobstructed. Remove all foreign material and clean all screens (figure 5-1).

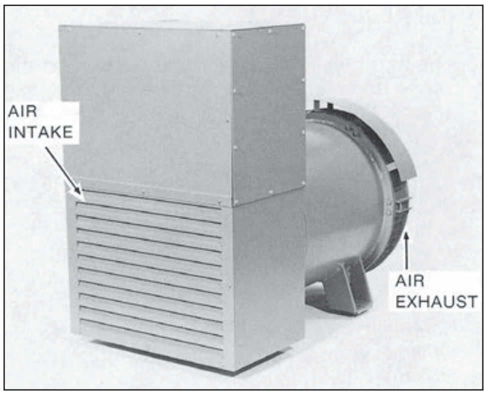


Figure 5-1

Electrical Connections and Windings

Inspect for loose or contaminated connections. Check wires for cracked or frayed insulation. Tighten connections and replace defective or oil-soaked insulation.

If inspection shows that varnish coatings on the windings have deteriorated, they should be recoated with insulating varnish. Please refer to Marathon Electric for insulation system requirements.

Lubrication

All generators are lubricated before leaving the factory and are ready for operation. As a general rule, bearings should be relubricated annually or at the indicated intervals in table 5-3, whichever occurs first. Unusually severe operating conditions, such as high ambient or dusty environments, require more frequent lubrication (every six months or one-half the table intervals, whichever occurs first).

Use Mobil® Polyrex® EM or equivalent anti-friction type, high quality grease with a lubrication temperature range of -22° to +350°F (-30° to +175°C).

During an overhaul, the grease reservoir should be thoroughly cleaned and new grease added. The reservoir should be 1/3 to 1/2 filled with new grease.

NOTE: *Mobil and Polyrex are registered trademarks of Exxon Mobil Corporation or one of its subsidiaries.*

Lubrication

CAUTION Follow the generator nameplate recommendations for grease interval and amount. Table 5-3 intervals and amounts are general guidelines.

CAUTION Generators are pre-greased with Mobil® Polyrex® EM NGLI 2 grease unless stated otherwise on the generator nameplate. Non-compatible lubricants can break down polyurea thickened grease and cause bearing failure. Compatible greases include, but are not limited to, Chevron® SRI, Shell® Gadus® S5 T100, Rykon® Premium EP NLGI 2, Texaco® Polystar® RB NLGI 2, and Shell® Oil Dolium R. Use only non-contaminated grease and prevent contamination while regreasing.

CAUTION Overgreasing bearings can cause premature bearing and/or generator failure. The quantity of grease added must be carefully controlled.

Generators are properly lubricated at the time of manufacture. It is not necessary to lubricate at the time of installation unless the generator has been in storage for a period of 12 months or longer.

Lubrication Procedure

1. Read CAUTION statements at left.
2. Stop generator and lock-out of service.
3. Remove contaminants from fill and drain plugs and surrounding area.
4. Remove fill and drain plugs. (Figure 5-2)
5. Check fill and drain holes for blockage and clean as necessary to allow unobstructed grease flow.
6. Insert 1/8” N.P.T. grease fitting in fill pipe.
7. Add proper type and amount of grease per generator nameplate or see Table 5-3
8. Start unit with drain plug removed. Allow unit to run 15 minutes to allow excess grease to drain.
9. Wipe off excess grease and replace fill and drain plugs. Generator is ready for operation.

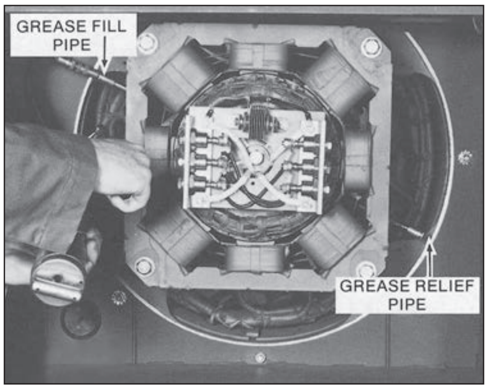


Figure 5-2

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Table 5-3

Type	Frame Size	Bearing Size	Amount of Grease: Ounces	Cubic Inches	Teaspoons	Intervals ①: 60 Hz	50 Hz
Single Bearing Units	431, 432 433	314	1.2	2.1	7.0	6500	8400
	571, 572 573, 574	316	1.5	2.6	8.3	5600	7200
	741, 742 743, 744	322	2.4	4.2	14.0	3000	4500
Double Bearing Units	431, 432 433	318	1.7	3.0	9.9	4600	6200
	571, 572 573, 574	318	1.7	3.0	9.9	4600	6200
	741, 742 743, 744	322	2.4	4.2	14.0	3000	4500

① Hours of running time or annually, whichever occurs first.

Drying Electrical Insulation

Electrical components must be dried before placing in operation if tests indicate that the insulation resistance is below a safe value (see section 8 – generator testing for test procedure).

Machines that have been idle for sometime in unheated and damp locations may have absorbed moisture. Sudden changes in temperature can cause condensation or the generator may have become wet by accident. Windings should be dried out thoroughly before being put into service. The following are recommended drying methods.

Space Heaters

Electric space heaters can be installed inside of the generator. When energized (from a power source other than the generator), they will heat and dry the inside of the generator. If an alternate source of electricity is not available, enclose the generator with a covering and insert heating units to raise the temperature 15–18°F (8–10°C) above the temperature outside of the enclosure. Leave a hole at the top of the enclosure to permit the escape of moisture.

Oven

Place the machine in an oven and bake it at a temperature not to exceed 194°F (90°C). The composite fan, voltage regulator and any electronic component accessories must be removed from the generator when using this method.

Forced Air

A portable forced air heater can be used by directing heat into the air intake (conduit box) and running the generator with no load and without excitation (this can be accomplished by removing the regulator fuse). Heat at point of entry should not exceed 150°F (66°C).

“Short Circuit” Method

The generator can be dried out quickly and thoroughly by using this method.

WARNING Be sure that all of the following steps are performed and all precautions taken as personal injury or serious damage to the generator could result.

1. Disconnect exciter leads F1 and F2 from the regulator.
2. Connect a battery or other DC power source of approximately 20–35 volts to the exciter leads F1 and F2. An adjustable voltage source is desirable, however a rheostat (rated approximately 2 amps) in series with the DC power source will work.
3. Short circuit the generator output lead wires to each other (L1 to L2 to L3). If using jumpers, be sure they are large enough to carry full load amperage.
4. Start the generator and measure the current through the output leads with a clip-on ammeter.
5. Adjust the voltage source to produce approximately 80% of the rated AC nameplate amps, but in no case exceed nameplate amps. If an adjustable source is not available and current is excessive, use a lower DC source voltage or a larger resistor in series with the source.

   Running time will be determined by the amount of moisture present in the machine. Insulation resistance checks should be taken every one to four hours until a fairly constant value is obtained (see section 8 – Generator Testing for instructions on measuring insulation resistance).
6. After the generator is dry and the insulation resistance is brought up to specifications, remove the short circuit from the line leads, disconnect the DC source, and reconnect the F1 and F2 leads at the regulator. Be sure all connections are tight and correct before attempting to run the generator.

Cleaning Methods

When electrical components get dirty, the insulation must be cleaned. There are a number of acceptable methods for cleaning the generator, each of which will necessitate disassembly of the unit. The method of cleaning will be determined by the kind of dirt and when the unit must be returned to service. Drying after cleaning is necessary.

Whenever the generator is disassembled, the windings should be given a thorough inspection and the insulation cleaned, if necessary. The inspection should include the connection of the windings, insulation, and varnish coverage. Check the winding ties and coil supports. Look for any signs of coil movement or looseness and repair as required.

An electric motor repair shop in your area can normally assist with the proper cleaning of the generator windings. They may also be experienced in special problems (such as seacost, marine, oil rig, mining, etc.) that may be peculiar to a certain area.

Solvents

A solvent is usually required to remove accumulated soil containing oil or grease.

Only petroleum distillates should be used for cleaning electrical components.

Petroleum solvents of the safety type with a flash point greater than 100°F (38°C) are recommended.

CAUTION **Winding varnishes are epoxy or polyester based. A solvent that does not attack these materials should be used.**

WARNING **Adequate ventilation must be available to avoid fire, explosion, and health hazards where solvents are used. Avoid breathing solvent vapors. Rubber gloves or other suitable protection for the hands should be used. Wear eye protection.**

Apply the solvent with a soft brush or rag. Be careful not to damage the magnet wire or insulation on the windings.

Dry components thoroughly with moisture-free, low pressure compressed air.

Cloth and Compressed Air

Cleaning with a dry cloth may be satisfactory when components are small, the surfaces are accessible, and only dry dirt is removed.

Blowing dirt out with compressed air is usually effective particularly when the dirt has collected in places which cannot be reached with a cloth. Use clean dry air at 30 psi (206 KPa).

Brushing and Vacuum Cleaning

Dry dust and dirt may be removed by brushing with bristle brushes followed by vacuum cleaning. **Do not use wire brushes.** Vacuum cleaning is an effective and desirable method of removing dry and loose dirt.

Shell Blasting

Air blasting with ground nut shells may be satisfactory for removal of hard dirt deposits from insulation. Use mild abrasives such as 12–20 mesh ground walnut shells.

Steam Cleaning

If the generator is completely disassembled, including bearings and electronic components, steam cleaning of the major parts and windings is very effective. However, before the generator can be put back into service, the machine must be thoroughly dried in an oven to remove all moisture.

Service

Removal from Prime Mover

WARNING Be sure all power is off before servicing. Failure to follow all safety instructions can result in serious personal injury or death.

Note: Before disconnecting any electrical wiring, be sure it is marked and can be identified for reinstallation. Remark as required.

1. Remove conduit box covers (figures 6-1 and 6-2).
2. Disconnect all external wiring from the generator leads (or bus bars) inside the conduit box.
3. Remove all conduit or ducting from the conduit box.
4. Attach a suitable hoist to the generator lifting lugs.
5. a. For single bearing generators, remove the bolts mounting the screen assembly to the SAE adapter and remove the screen (figure 6-3). (**Note:** Do not remove the dripcover from the screen assembly if so equipped.) Remove the capscrews attaching the drive discs to the flywheel and remove the capscrews attaching the SAE adapter to the flywheel housing.

   b. For two-bearing generators, disconnect the coupling or sheave and belts between the generator and prime mover (follow the coupling manufacturer's instructions for disconnection).

WARNING Do not apply any force to the generator fan for lifting or rotating the generator rotor. Disregarding these instructions may cause personal injury or equipment damage.

6. Remove the mounting bolts which secure the generator to the base. To make reinstallation easier, note the position of and save any shims that were used under the feet for alignment.
7. Raise the generator slightly and move the generator away from the prime mover. Raise or lower the generator to take pressure off of the drive discs so they slide easily out of the flywheel.
8. On single bearing generators, if generator is to be shipped, see Shipping Instructions (section 11) for proper rotor support.

Figure 6-1

Figure 6-2

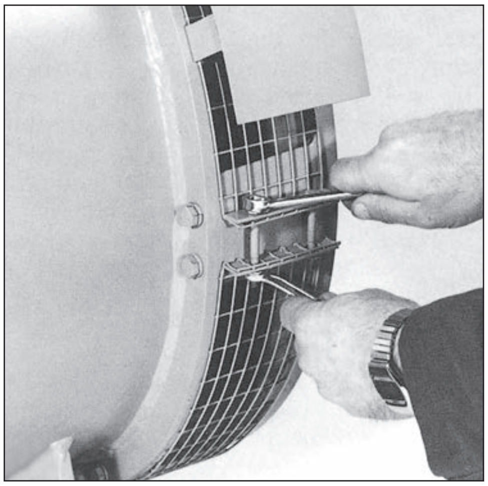


Figure 6-3

Conduit Box Removal

1. Note the location and markings (remark as required) and remove connections from voltage regulator, capacitor, and any other conduit box mounted control (figures 6-4 and 6-5).
2. On generators equipped with bus bars, mark all connections and disassemble main stator (power) leads from the generator side of the bus bars.
3. Remove bolts holding conduit box in place (figure 6-6).
4. Remove conduit box (figure 6-7).

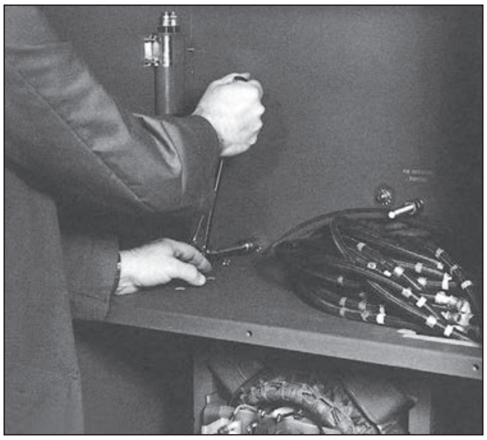


Figure 6-6

Figure 6-4

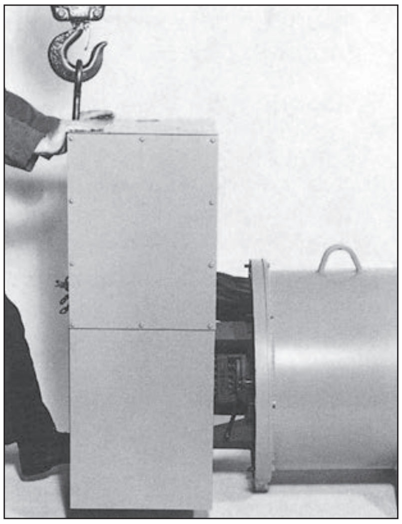


Figure 6-7

Figure 6-5

Exciter Stator (Field) Removal

1. Disconnect F1 and F2 leads from the corresponding F1 and F2 terminals on the regulator.
2. Remove all cable ties so the F1 and F2 leads can be removed with the exciter stator. Remove the four capscrews and belleville washers holding the exciter stator in place (figure 6-8). Remove the exciter stator using a lifting strap or fixture (figure 6-9).

Exciter Armature (Rotor) Removal

1. Note markings and disconnect the main rotor leads coming out of the aluminum standoff plate lead hole from the rectifier aluminum angle (figure 6-10).
2. Remove the capscrew and belleville washer which holds the exciter (rotor) armature to the generator shaft (figure 6-11).
3. Use a six inch, 7/8-14NF capscrew for a puller (see section 9). The hole that the mounting bolt goes through is threaded. Screw the puller bolt into the hole and it will push against the end of the shaft (figure 6-12). Carefully feed the main rotor leads through the hole as the exciter armature is removed (figure 6-13).

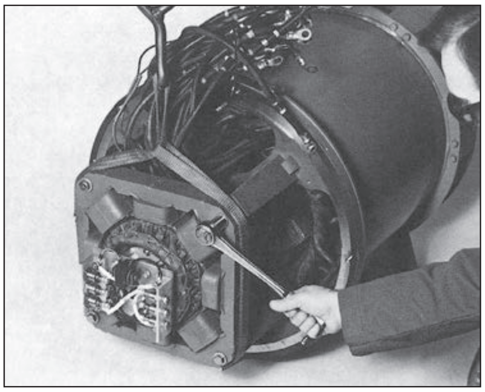


Figure 6-8

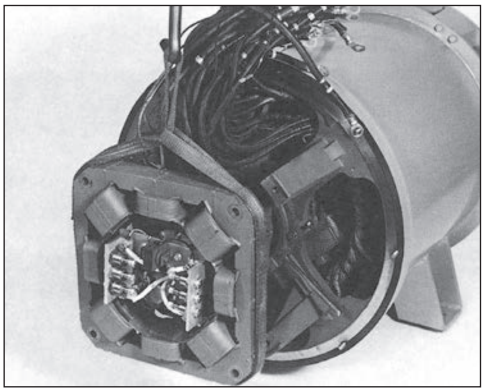


Figure 6-9

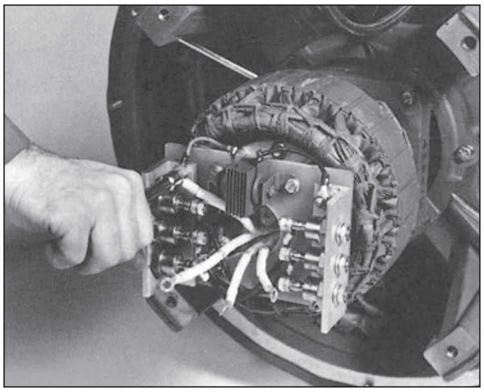


Figure 6-10

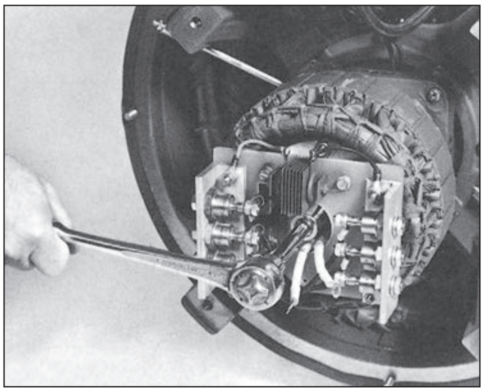


Figure 6-11

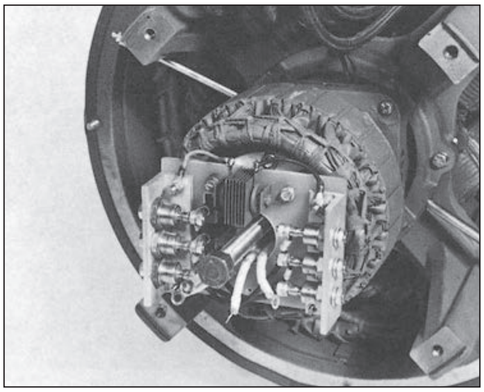


Figure 6-12

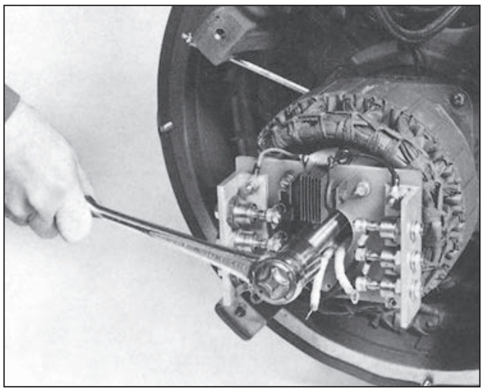


Figure 6-13

CAUTION **Do not tighten the puller bolt beyond the end of the threads. If a bolt with sufficient thread length cannot be found, use a piece of threaded rod with a nut welded on the end.**

PMG Stator Removal

1. Remove exciter armature (follow instructions found earlier in this section).
2. Remove the PMG output leads from the capacitor (figure 6-14) and loosen all cable ties so the leads can be removed with the PMG stator.
3. Note the position of the PMG stator leads which exit at the left inboard side or mark the stator so it can be reinstalled in the same position.
4. Remove the four mounting capscrews (see figure 6-15).
5. Carefully remove the PMG stator from its mounting pads and slide over the PMG rotor. The magnets used in the PMG are very strong. They will resist removal of the PMG stator (figure 6-16).

PMG Rotor Removal

1. Remove the exciter armature and PMG stator (follow instructions found earlier in this section).
2. Remove the snap ring which holds the PMG rotor in place on the shaft (figures 6-17 and 6-18).

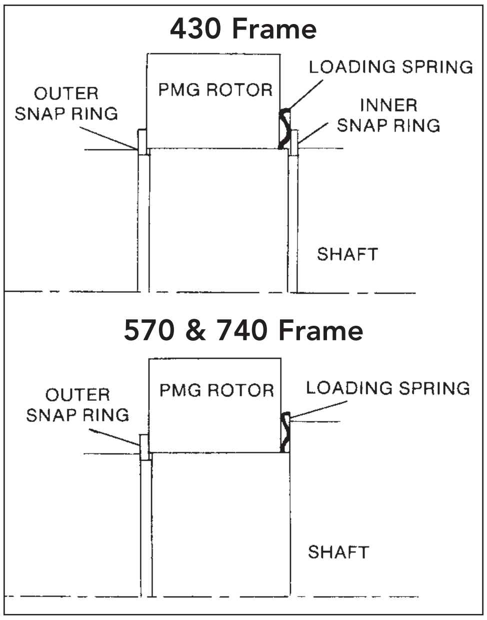


Figure 6-18

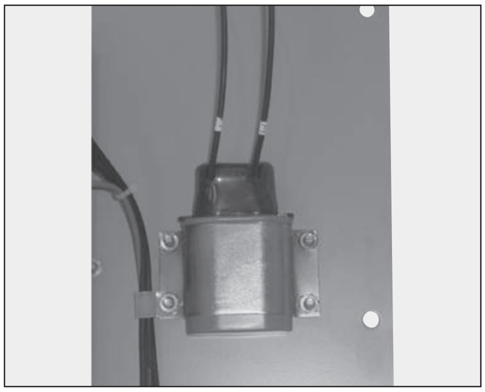


Figure 6-14

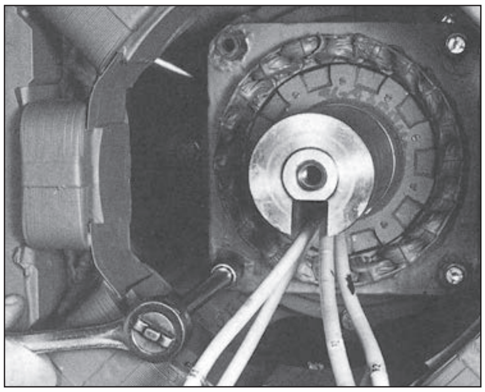


Figure 6-15

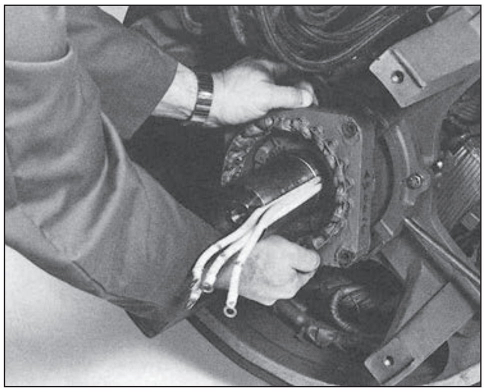


Figure 6-16

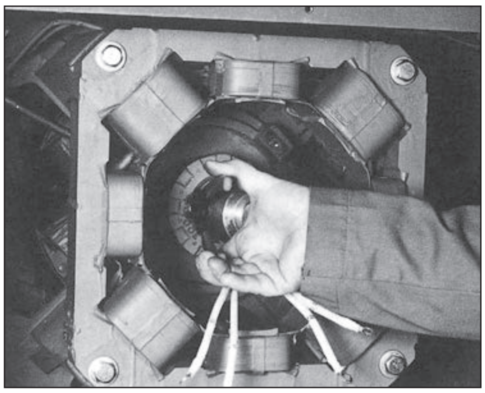


Figure 6-17

3. Slide the PMG rotor off of the shaft (figure 6-19).
4. Remove the loading spring (if the loading spring is not on the shaft, check to see if it is stuck on the back of the PMG rotor).
5. On 430 frame generators, a second snap ring is used inboard of the PMG rotor (larger generators have a step on the shaft). This snap ring must be removed before the generator's main rotor can be removed (figure 6-20).

Main Rotor Removal

1. Remove the exciter armature and PMG (follow instructions found earlier in this section).
2. a. For single bearing generators, remove the four capscrews holding the bearing caps to the front end bracket (figure 6-21). Remove the outer cap (figure 6-22).

   b. For two-bearing generators, remove the drive coupling or sheave and key from the shaft extension. Remove the four capscrews holding the bearing lock to the drive end bracket (figure 6-23). Remove the four capscrews holding the bearing caps to the front end bracket (figure 6-21). Remove the outer cap (figure 6-22).

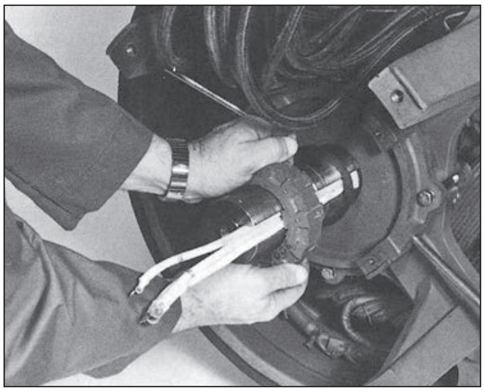


Figure 6-19

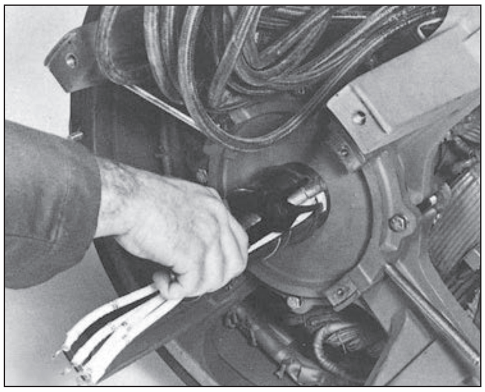


Figure 6-20

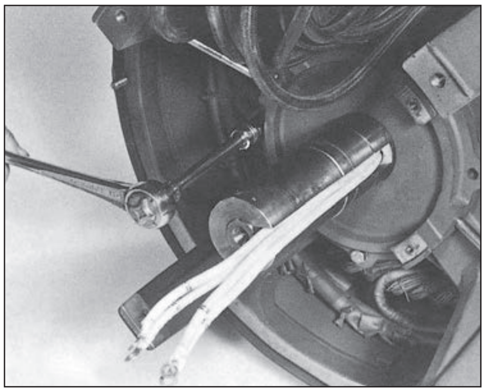


Figure 6-21

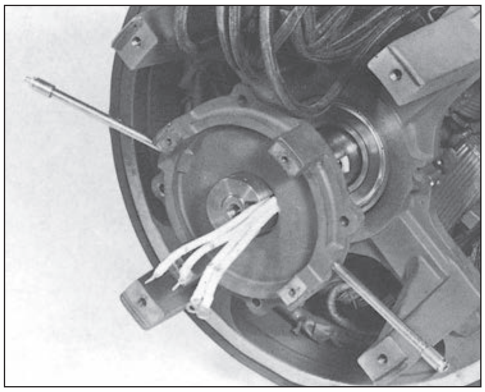


Figure 6-22

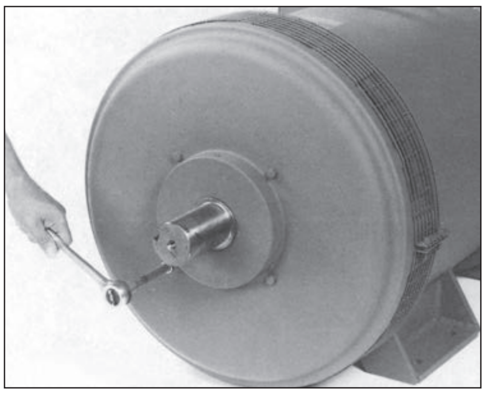


Figure 6-23

3. If the screen assembly is still mounted, remove the bolts securing the screen assembly to the drive end bracket or the SAE adapter and remove the screen assembly (figure 6-24). (**Note:** Do not remove the drip cover from the screen assembly if so equipped).
4. For single bearing generators, remove the capscrews and hardened washers holding the drive discs to the drive hub (figure 6-25). Remove all drive discs (and spacers, if any).
5. a. For single bearing generators, remove the capscrews holding the SAE adapter to the generator and remove the adapter (figures 6-26 and 6-27).

   b. For two-bearing generators, remove the capscrews holding the drive end bracket to the generator and remove the bracket (figures 6-26 and 6-28).

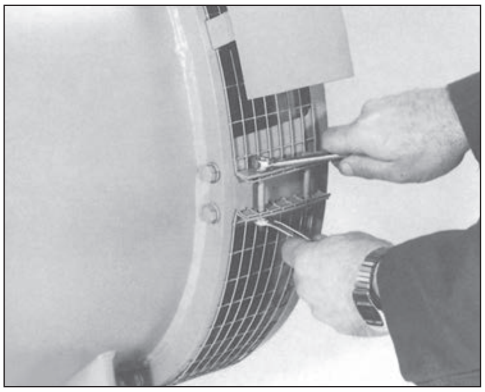


Figure 6-24

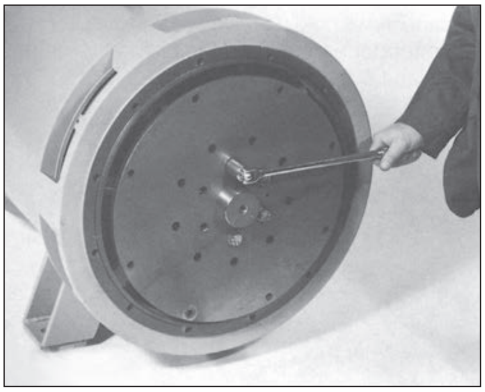


Figure 6-25

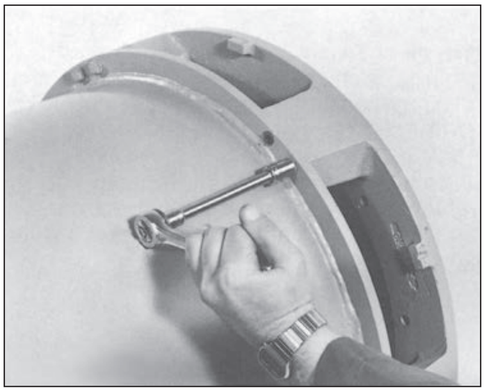


Figure 6-26

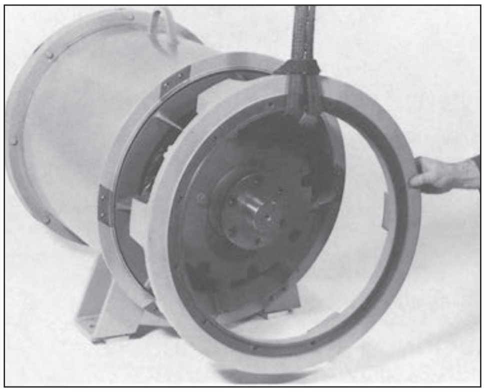


Figure 6-27

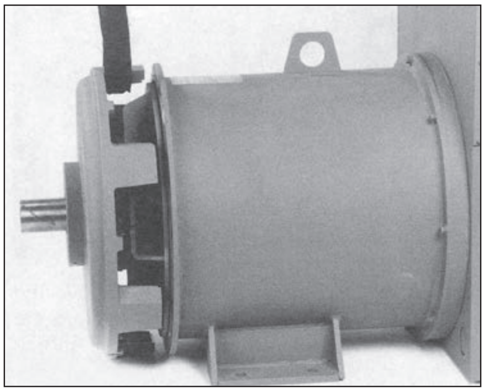


Figure 6-28

CAUTION **On large generators, a hoist and lifting strap should be used to assist in drive end bracket or SAE adaptor removal.**

6. Using a rotor lifting fixture and a suitable hoist, carefully remove the rotor assembly from the main stator and frame assembly through the drive end (figure 6-29).

CAUTION **Special care should be taken when removing the main rotor, winding damage could result if the rotor is allowed to hit the main stator.**

WARNING **Do not apply any force to the generator fan for lifting or steering the generator rotor. Disregarding these instructions may cause personal injury or equipment damage.**

Front End Bracket Removal

1. Remove front bracket mounting screws (figure 6-30).
2. Remove the front end bracket from the main stator assembly (figure 6-31).

CAUTION **On large generators, a hoist and lifting strap should be used to assist in the front end bracket removal.**

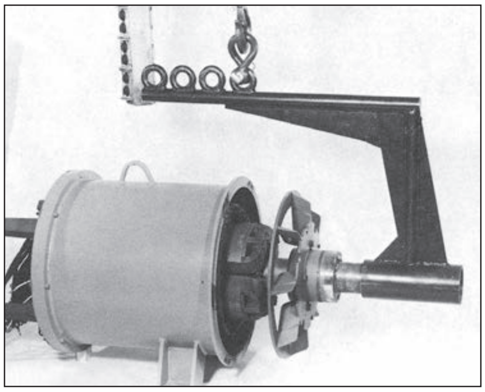


Figure 6-29

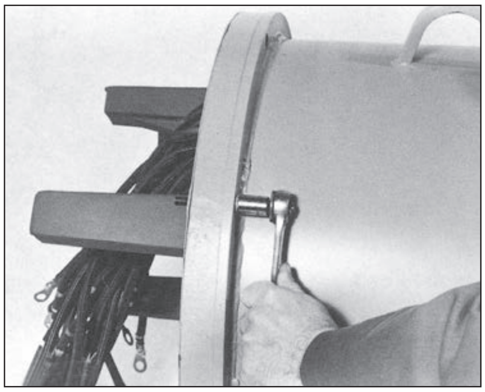


Figure 6-30

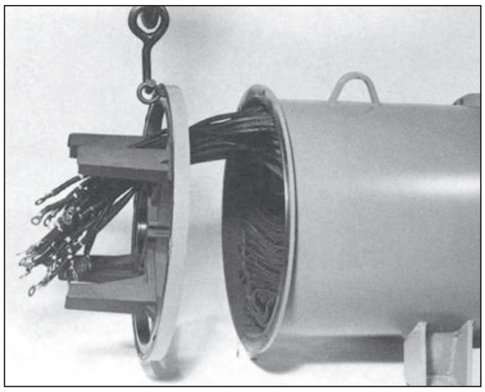


Figure 6-31

Exciter Inspection

A. Exciter Stator

1. Clean dust and dirt from the stator winding (see figure 6-32 and section 5).
2. Check the exciter stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance (see section 8). Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.
3. Look for score marks in the bore of the exciter core caused by rubbing (this could indicate bearing or assembly problems and should be investigated).

B. Exciter (Rotor) Armature

1. Clean dust and dirt from the exciter armature and rectifier assembly (see figure 6-32 and section 5).
2. Check the exciter armature for burrs on the mating surfaces.
3. Check the rectifiers and surge protector for proper operation (see section 8). Replace defective parts.

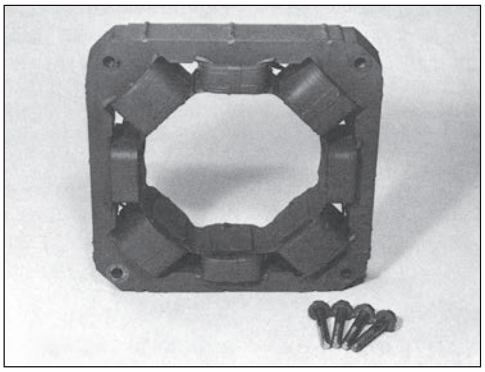


Figure 6-32

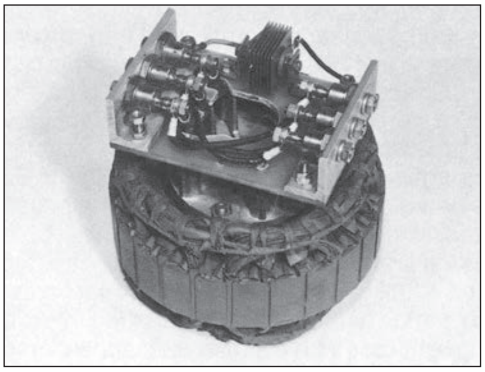


Figure 6-33

CAUTION Three forward polarity and three reverse polarity diodes are used. Be sure you have the correct part installed in the correct location. The surge suppressor is polarized. Observe polarity markings when changing the surge suppressor (figure 6-34).

Torque mounting nuts to 80 in-lb.
Torque lead terminal nuts to 25 in-lb.
Never torque against the diode terminal – use a 7/16 inch wrench to support the terminal (figure 6-35).

4. Check the exciter armature and rectifier assembly for a loose, frayed, or burnt winding or loose connections. Measure winding resistance and insulation resistance (see section 8). DO NOT megger diodes or surge suppressor. Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.
5. Look for score marks on the outside diameter of the armature core caused by rubbing (this could indicate bearing or assembly problems and should be investigated).

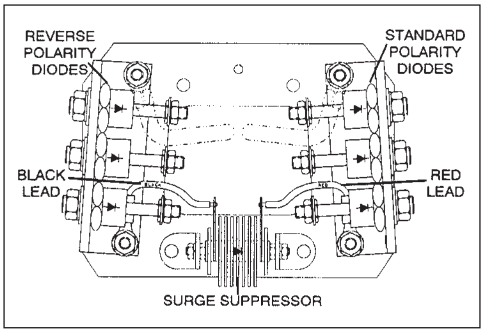


Figure 6-34

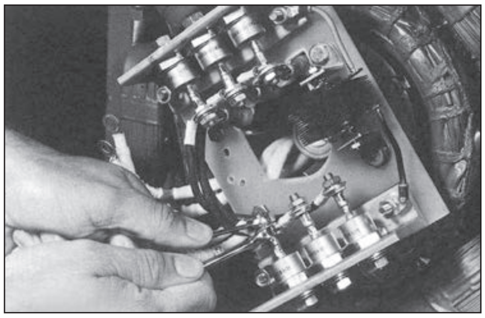


Figure 6-35

6

PMG Inspection

A. PMG Stator (figure 6-36)

1. Clean dust and dirt from the PMG stator winding (see section 5).
2. Check PMG stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance (see section 8). Repair or replace as necessary. Contact Marathon Electric for special winding procedures and materials.
3. Look for score marks in the bore caused by rubbing (this could indicate bearing or assembly problems and should be investigated).

B. PMG Rotor (figure 6-37)

WARNING The PMG rotor uses very strong magnets. Keep away from iron and steel parts that could be drawn to the magnets. Keep away from other components that can be damaged by strong magnetic fields.

1. Clean dust and dirt from the PMG rotor (see section 5).
2. Check to be sure all magnets are tightly bonded to the PMG rotor.
3. Check for burrs or corrosion in the bore and keyway where the rotor mounts to the shaft.
4. Look for score marks on the outside diameter caused by rubbing (this could indicate bearing or assembly problems and should be investigated).
5. Inspect snap rings and loading spring; replace as required.

Main Rotor Inspection

A. Bearing

1. Check the bearing for damage or wear. Clean the old grease from the bearing cap, and fill the bearing cap grease cavity 1/3 to 1/2 full of new Mobil® Polyrex® EM (or equivalent-see page 17).

CAUTION If the bearing needs to be removed for any reason, always install a new bearing.

2. If the bearing is to be replaced, remove with a suitable puller (figure 6-38).
3. **Be sure the inner bearing cap is on the shaft before installing the new bearing.**
4. Heat the new bearing in an oven to a maximum temperature of 212°F (100°C). Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder (figure 6-39). The bearing should slide on the shaft and be seated without excessive force. If the bearing binds on the shaft before being fully seated, a piece of tubing, slightly larger than the press-fit area, can be used to drive the bearing into place. Using light taps with a soft mallet, apply pressure to the inner race only.

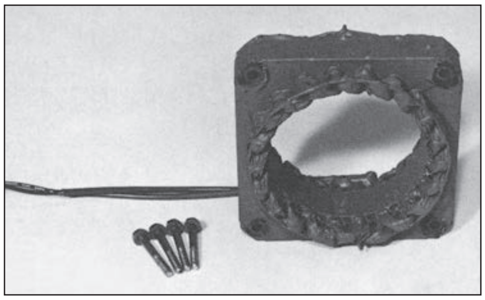


Figure 6-36

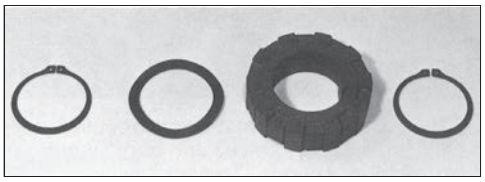


Figure 6-37

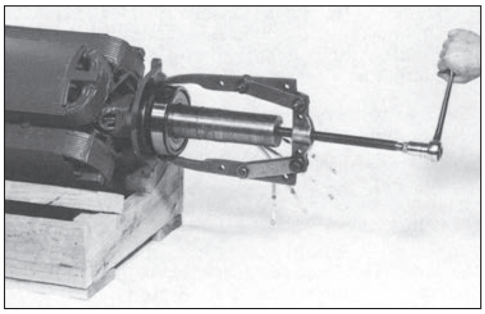


Figure 6-38

NOTE: *Mobil and Polyrex are registered trademarks of Exxon Mobil Corporation or one of its subsidiaries.*

CAUTION Under no circumstances should pressure be applied to the outer race of the bearing, as permanent bearing damage could result.

Allow the bearing to cool for one hour before attempting to assemble the generator.

B. Fan
1. Check the fan for cracks or broken blades. Replace the fan if defective.
2. Mark the hub and fan for alignment. This is necessary to be sure the balance weights will be in the same position when the fan is reinstalled.
3. a. For single bearing generators, remove the fan mounting capscrews (figure 6-40) and slide the fan off the shaft (figure 6-41).

   b. For two-bearing generators, remove the drive end bearing and bearing cap (see bearing removal instructions). Remove the fan mounting capscrews and slide fan off the shaft (figure 6-40 & 6-41).
4. To install, slide the fan on the shaft making sure the fan mounting surface is toward the drive hub. Align reference marks and mount the fan to the drive hub with the capscrews and belleville washers (figure 6-42). Torque Aluminum fan capscrews to 60 ft-lb (81 N-m). Torque Composite fan capscrews to 25 ft-lb (34 N-m).
5. **Note:** Balance weights on the fan are for balance of the complete rotor assembly. The rotor assembly should be rebalanced if a new fan has been installed.
6. On two-bearing generators, install bearing cap and new bearing according to the bearing assembly instructions (Item A).

C. Drive Hub (Single Bearing Generators Only)
1. Check the drive hub for cracks or stripped drive disc mounting holes. Replace the hub if defective.

Figure 6-39

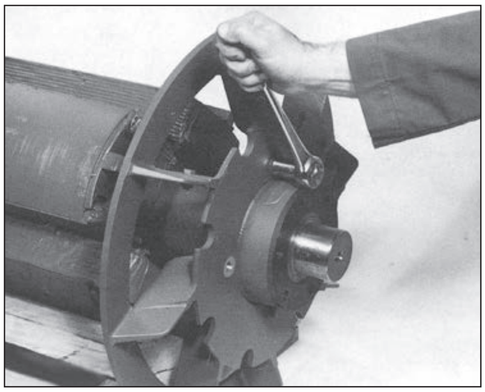


Figure 6-40

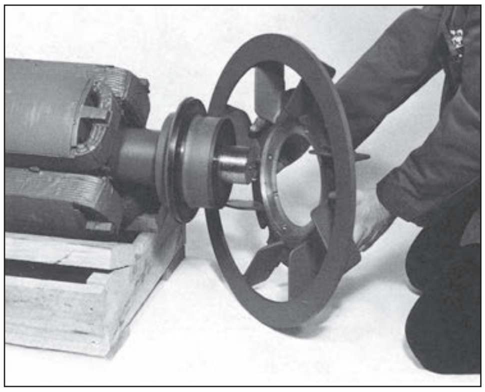


Figure 6-41

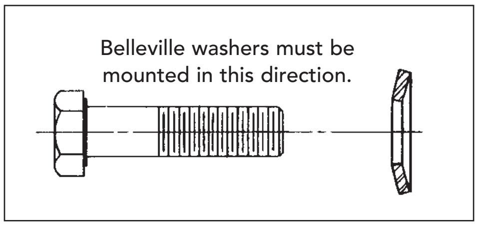


Figure 6-42

6

2. If the hub is to be replaced, remove the fan (see Item B) and install a suitable puller to the hub. Remove the two setscrews in the hub over the key. Using a torch, rapidly heat the hub at the outer diameter while tightening the puller (this must be done rapidly before the heat can expand the shaft). Remove the hub (figure 6-43).

3. To insure proper fan location, mark the new hub in the same place as the old hub relative to the keyway. Install key in shaft. Heat the new hub in an oven to 500-600°F (260-316°C). Using suitable heat resistant gloves, slide the hub over the key in the shaft until it seats against the shaft shoulder (figure 6-44).

4. Allow the hub to cool for one hour. After the hub has cooled, tighten the setscrews in the hub to 50 ft-lb (68 N-m) torque. Match the alignment marks on the fan and hub and mount the fan (see Item B).

5. Rebalancing the rotor assembly is not necessary if only the hub is replaced and the fan is mounted in the same location relative to the hub and shaft.

D. Main Rotor Core and Windings

1. Clean all parts. Remove dust and dirt from the rotor windings (see section 5).

   Remove any accumulated dust or dirt in the winding air passages with a piece of wire or with low-pressure, moisture-free air (figure 6-45).

CAUTION **If a piece of wire is used for cleaning the air passages, care must be taken not to scratch the winding as this could cause an insulation failure.**

2. Check the rotor for loose, frayed, or burnt windings. Measure winding resistance and insulation resistance (see section 8). Test for shorted turns using an AC impedance test (see section 8). A defective rotor winding must be rewound by Marathon Electric. The rotor assembly must be rebalanced after any rework or repair has been completed.

E. Drive Discs (Single Bearing Generators Only)

1. Inspect the drive discs for distorted or bent edges (figure 6-46). Inspect for worn mounting holes. Replace all defective discs as necessary.

2. Inspect the drive disc mounting capscrews for damaged threads. Replace capscrews if damaged.

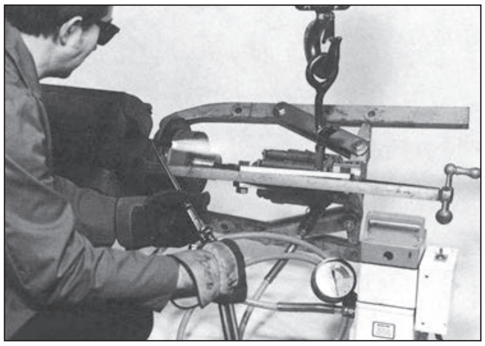


Figure 6-43

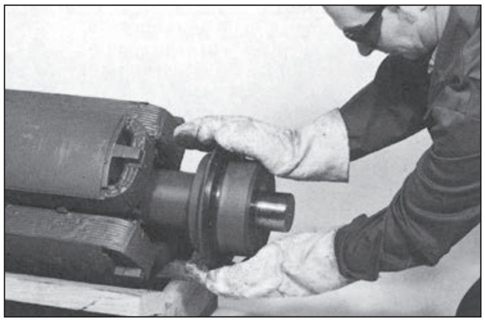


Figure 6-44

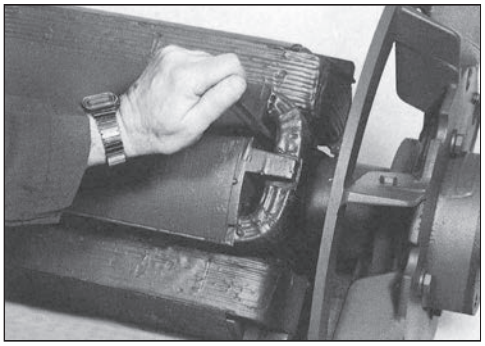


Figure 6-45

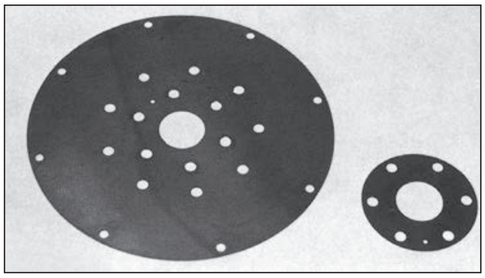


Figure 6-46

Front (Exciter) End Bracket Inspection

1. Remove the filler and drain grease pipes and the grease plugs from outer bearing cap (figure 6-47).
2. Clean the end bracket, outer bearing cap, grease pipes, and capscrews to remove all dust, dirt, and grease.
3. Inspect the capscrews for stripped threads and replace if defective.
4. Inspect the end bracket for stripped threads, cracks, and burred or rough mating surfaces. Inspect the bearing bore for burrs or wear. If the bracket shows excessive bearing bore wear, it should be repaired or replaced (figure 6-48).
5. Inspect the mounting pads for the PMG stator and exciter stator. Be sure they are smooth, clean, and free of any burrs or rust that could interfere with proper alignment (figures 6-47 and 6-48).
6. Reassemble the grease pipes and fittings to the bearing cap.

Drive End Bracket or SAE Adapter Inspection

1. For two-bearing generators, remove the grease plugs from the bracket.
2. Clean the bracket or adapter, capscrews, and screen assembly to remove all dust, dirt, and grease.
3. Inspect the capscrews for stripped threads and replace if defective.
4. Inspect the bracket or adapter for stripped threads, cracks, and burred or rough mating surfaces (figures 6-49 and 6-50).
5. For two-bearing generators, inspect the bearing bore for burrs or wear. If the drive end bracket shows excessive bearing bore wear, it should be repaired or replaced.

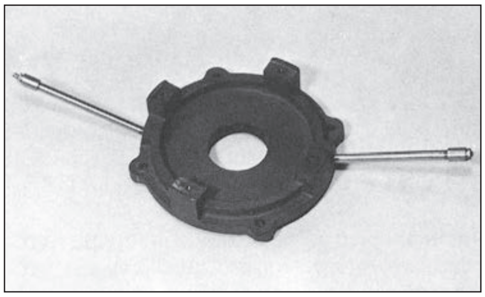


Figure 6-47

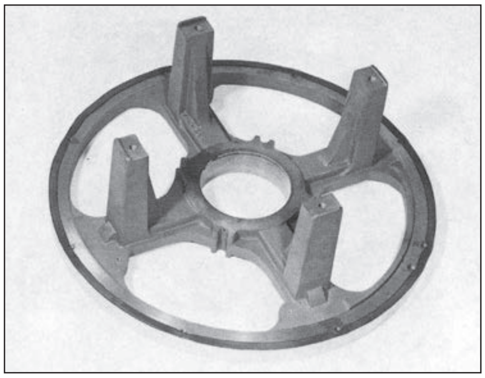


Figure 6-48

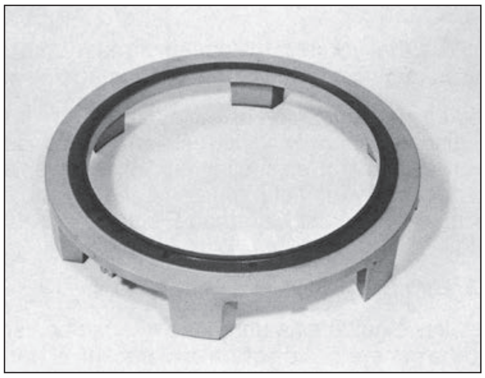


Figure 6-49

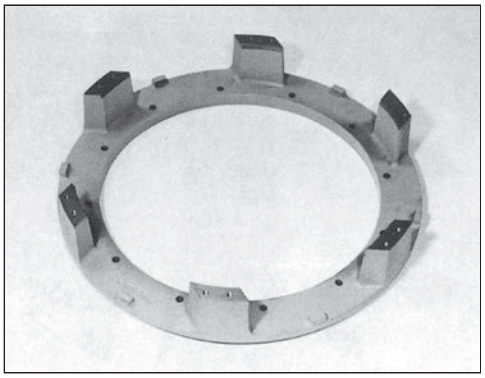


Figure 6-50

Main Stator Inspection

1. Clean dust and dirt from the stator frame and winding (see figure 6-51 and section 5).
2. Inspect the frame for stripped threads, cracks, burred mating surfaces, or other damage.
3. Inspect the stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance (see section 8). Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for winding data.

Front End Bracket Installation

1. Install two guide pins (threaded rod can be used) into the generator side of the end bracket mounting holes. Align the guide pins with the holes in the generator frame and slide the bracket onto the frame (figure 6-52). Install bracket mounting capscrews (figure 6-53).

CAUTION On large generators, a hoist and lifting strap should be used to assist in the front end bracket installation.

2. Remove the two guide pins and insert the remaining capscrews and torque to specifications given in section 12.

Main Rotor Installation

1. Grease bearing cavity and bearing with Mobil® Polyrex® EM grease (or equivalent - see page 17).
2. Using a rotor lifting fixture and a suitable hoist, carefully install the rotor assembly into the main stator assembly through the drive end (figure 6-54). Carefully feed the rotor leads through the front end bracket shaft hole as the rotor is installed.

CAUTION Special care should be taken when installing the rotor assembly. Winding damage could result if the rotor is allowed to hit the main stator.

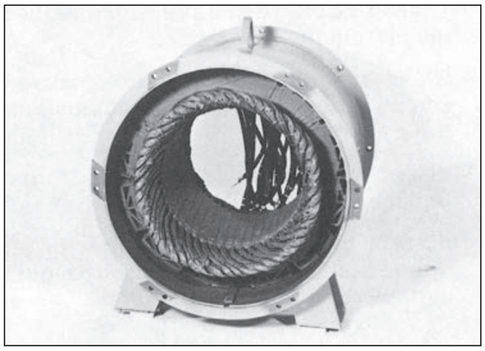


Figure 6-51

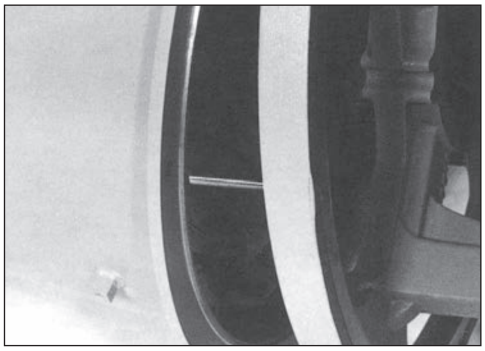


Figure 6-52

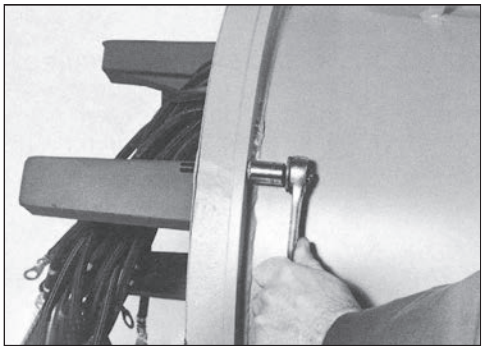


Figure 6-53

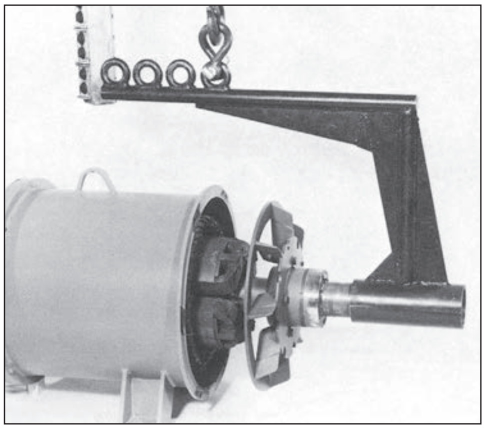


Figure 6-54

NOTE: *Mobil and Polyrex are registered trademarks of Exxon Mobil Corporation or one of its subsidiaries.*

WARNING Do not apply any force to the generator fan for lifting or rotating the generator rotor. Disregarding these instructions may cause personal injury or equipment damage.

3. a. For single bearing generators, slide the SAE adapter over the fan and secure to the main stator and frame assembly with capscrews torqued per section 12 (figures 6-55 and 6-56). It may be necessary to raise the rotor assembly slightly to allow the mounting of the SAE adapter.

   b. For two-bearing generators, insert two guide pins in the rear bearing lock holes (figure 6-57). Fill the grease cavity of the drive end bracket 1/3 to 1/2 full of Mobil® Polyrex® EM grease (or equivalent - see page 17). Assemble all grease plugs in the bracket. Mount the bracket on the bearing and guide the bearing lock pins through the bracket holes (figure 6-58). Align the drive end bracket and mount with the capscrews (figure 6-59). Insert two capscrews with lockwashers into the bearing lock and tighten. Remove the guide pins and replace with the remaining two capscrews with lock washers. Torque bearing capscrews to 25 ft-lb (34 N-m). Torque bracket mounting capscrews per specifications given in section 12.

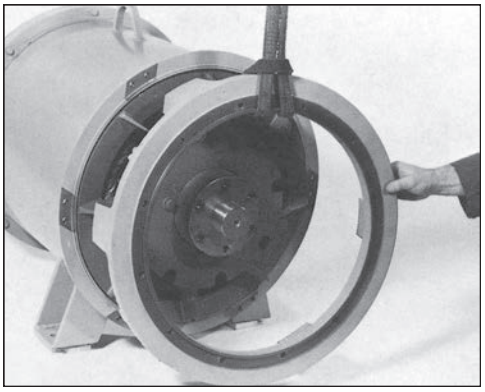


Figure 6-55

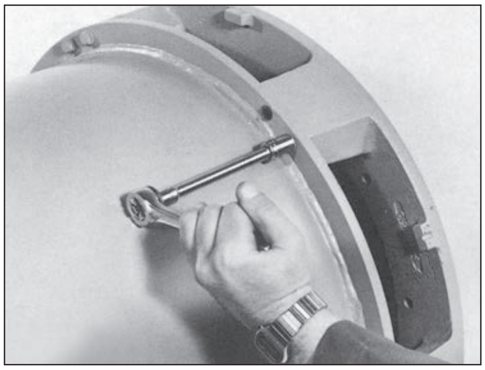


Figure 6-56

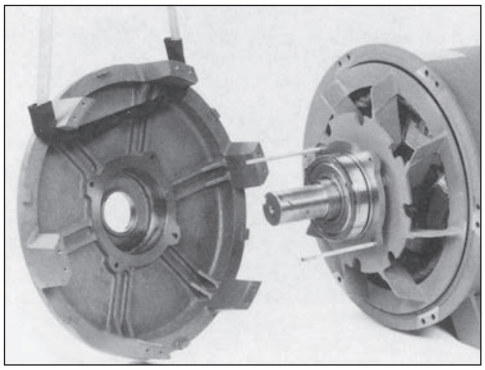


Figure 6-57

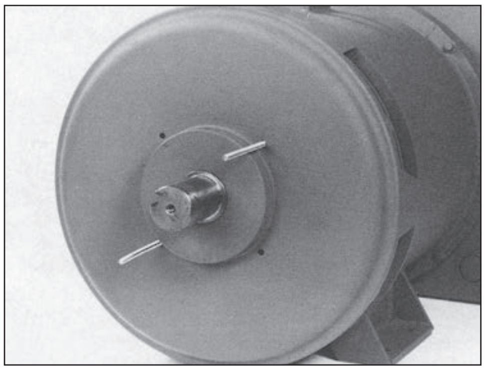


Figure 6-58

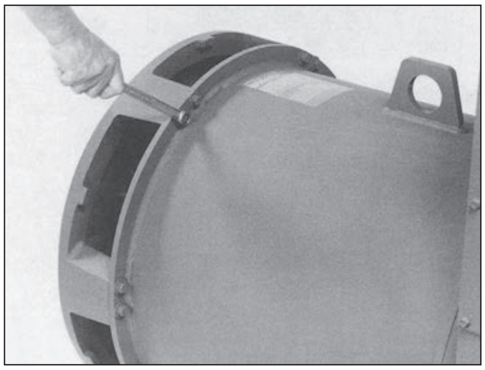


Figure 6-59

NOTE: Mobil and Polyrex are registered trademarks of Exxon Mobil Corporation or one of its subsidiaries.

CAUTION **On large generators, a hoist and lifting strap should be used to assist in the drive end bracket or the SAE adapter assembly.**

4. a. For single bearing generators, insert a guide stud into the drive hub. Position all spacers (if any), then all drive discs, one at a time until all discs are installed (figure 6-61). Make sure that all disc mounting holes at the inner and outer diameter are properly aligned. Secure the discs with the grade 8 5/8-18 capscrews and hardened washers. Torque to 192 ft-lb (260 N-m) (see figure 6-62 for torquing sequence).

5. Install the outer bearing cap on the exciter end (figure 6-63). Align holes in inner and outer bearing cap and install cap screws. Torque to 25 ft-lb (34 N-m) – see figure 6-64.

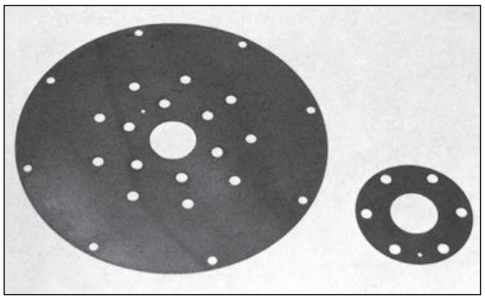
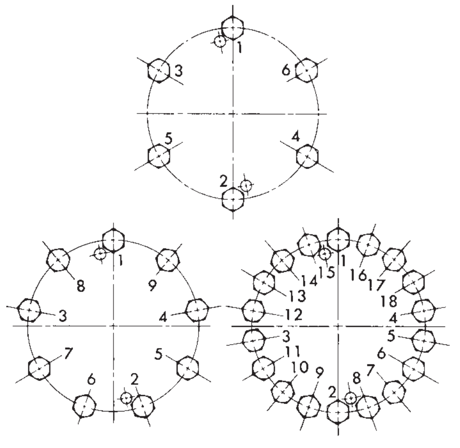


Figure 6-61



Torque the bolts in the above sequence according to the correct bolt pattern.

Then check the torque in each bolt in a clockwise direction around the bolt circle to insure that all the bolts are properly torqued.

Figure 6-62

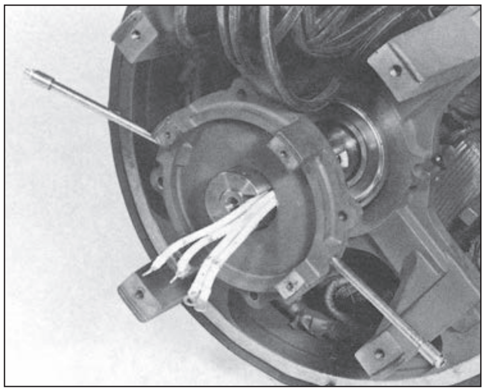


Figure 6-63

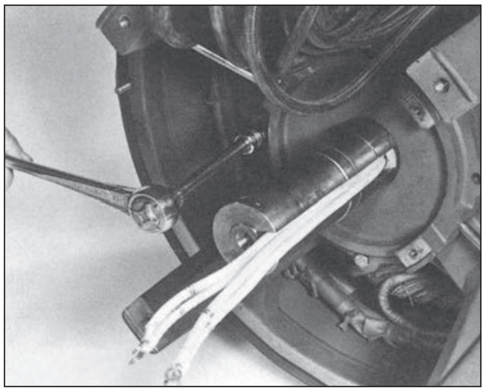


Figure 6-64

PMG Installation

1. Install inboard snap ring (430 frame generators) and loading spring on shaft (figure 6-65).
2. Slide PMG rotor onto shaft (figure 6-66).
3. Install snap ring (figure 6-67). Use a piece of pipe slightly larger than the shaft (2-3/4 inches) to push the rotor back against the loading spring until the snap ring seats in the slot (figure 6-68).
4. Install the PMG stator on it's mounting pads, with the leads in the left (9 o'clock) inboard position, and secure with the four mounting capscrews and belleville washers (figures 6-69 and 6-72). Torque to 6 ft-lb (8 N-m).
5. Route and secure PMG stator leads away from moving parts.

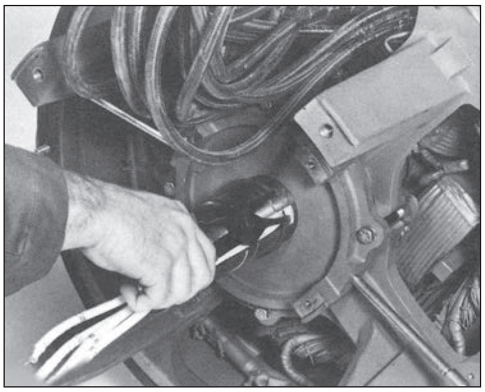


Figure 6-65

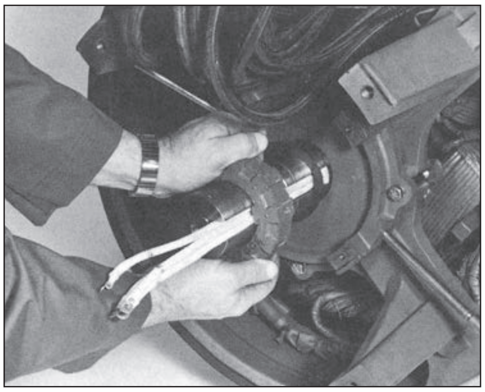


Figure 6-66

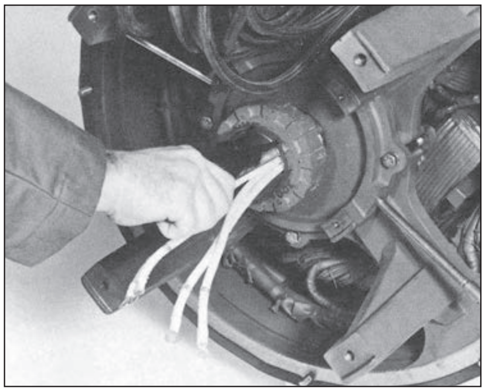


Figure 6-67

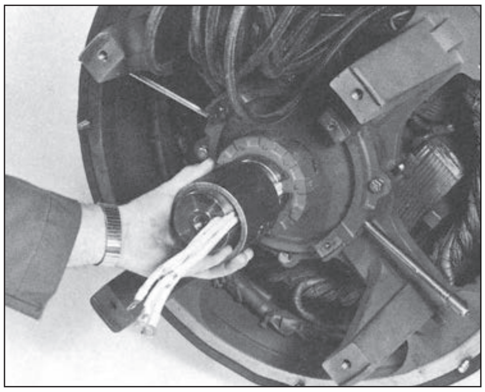


Figure 6-68

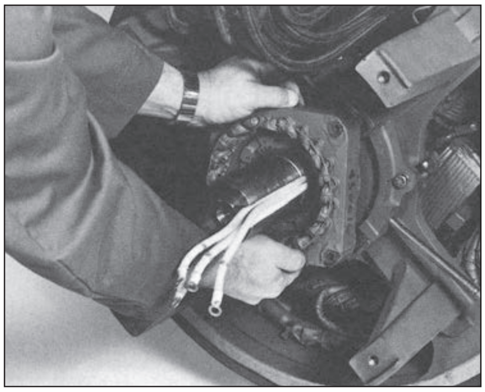


Figure 6-69

Exciter Installation

1. Attach a wire to the main rotor leads and feed the wire through the armature bore and out the lead hole in the aluminum standoff plate. On larger exciters, it will be helpful to install a guide pin in the end of the shaft to support the armature while fishing the rotor leads through (figure 6-70). Align the key in the armature bore to the keyway in the shaft. Slide the armature on the shaft while feeding the main rotor leads through the lead hole in the aluminum standoff plate (figure 6-71).

   Insert the capscrew and belleville washer (figure 6-72) through the mounting hole in the aluminum standoff plate and secure to the shaft (figure 6-73). Tighten the capscrew until the armature seats on the shaft. Torque to 84 ft-lb (114 N-m) for 1/2” bolt or 300 ft-lb (407 N-m) for 3/4” bolt.

2. Observe the polarity markings and connect the main rotor leads to the rectifier assembly (figure 6-74). Torque the nuts to 4 ft-lb (5.4 N-m).

3. Position the exciter field leads at the left (9 o’clock) inboard position. Using a suitable lifting device, mount the exciter stator on the front end bracket mounting pads and align the mounting holes (figure 6-75). Mount with the capscrews and belleville washers (figure 6-72). Torque the capscrews to 60 ft-lb (81 N-m). Route and secure the exciter stator leads away from any moving parts.

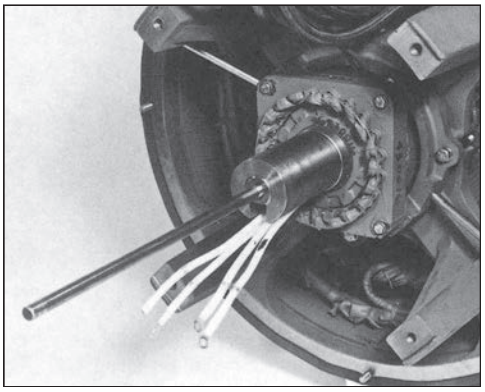


Figure 6-70

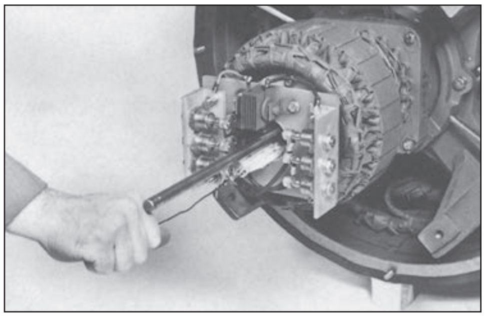


Figure 6-71

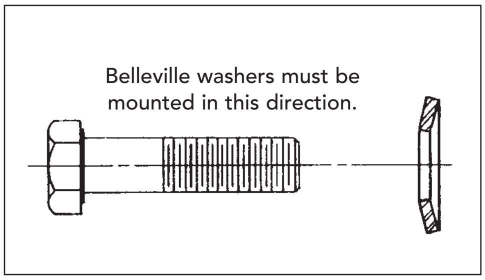


Figure 6-72

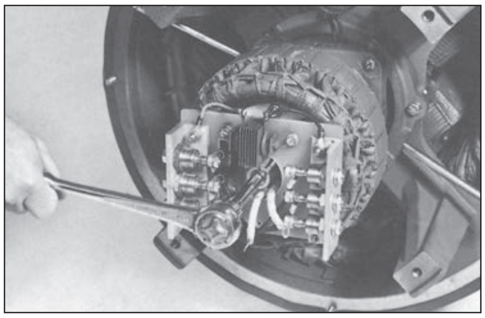


Figure 6-73

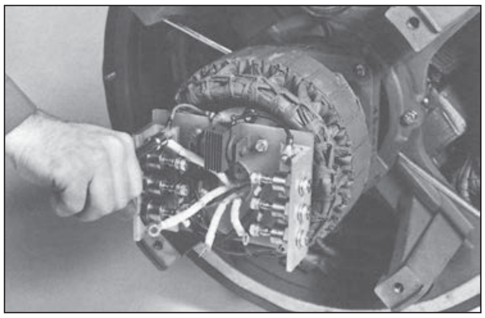


Figure 6-74

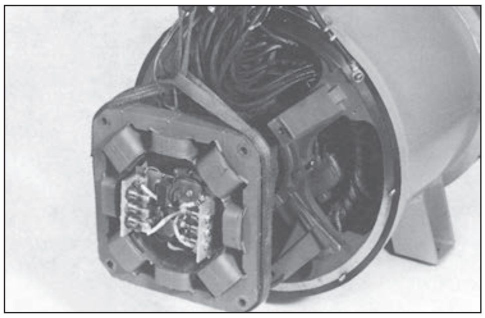


Figure 6-75

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Conduit Box Installation

1. Install the conduit box over the main stator leads (be sure leads are in upper compartment). Secure with bolts and lock washers (figures 6-76 and 6-77).
2. On generators with bus bar assemblies, reassemble main stator leads and insulating blocks to bus bars (figure 6-78).
3. Reconnect exciter leads, PMG leads, and other accessories according to the connection diagrams and markings installed before disassembly.

Assembly to Prime Mover

1. Attach a suitable hoist to the generator lifting lugs and move the generator until the generator foot mounting holes are aligned with the base and slightly above.
2. a. For single bearing generators, if the screen assembly is mounted on the adapter, remove the mounting bolts and remove the screen (figure 6-79). (**Note:** Do not remove the drip cover from the screen assembly if so equipped.) Insert two guide pins in the flywheel and two in the flywheel housing. Adjust the generator position until the drive discs are piloted in the flywheel. Remove the guide pins and secure the discs with Grade 8 place bolts and hardened washers or Grade 8 capscrews and heavy series lockwashers. Torque per specifications given in section 12.

WARNING Do not apply any force to the generator fan for lifting or rotating the generator rotor. Disregarding these instructions may cause personal injury or equipment damage.

Position the generator so that the SAE adapter mates with the flywheel housing.

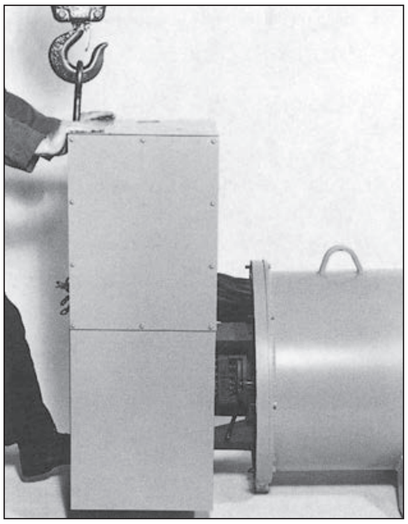


Figure 6-76

Figure 6-77

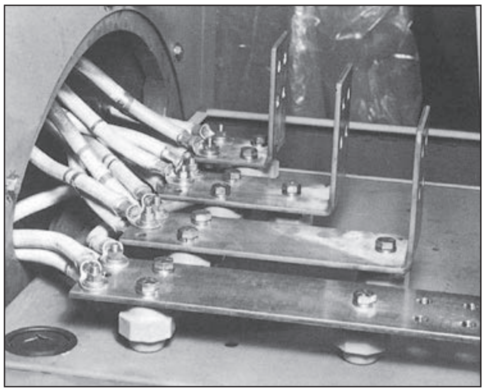


Figure 6-78

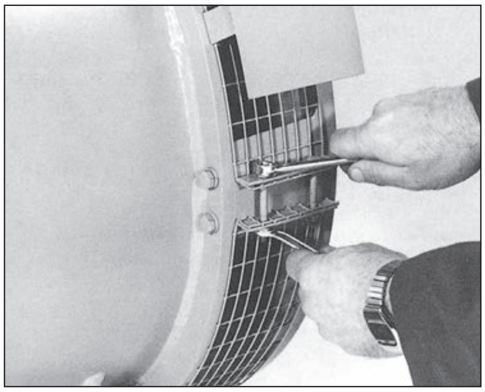


Figure 6-79

6

CAUTION Do not force the alignment of the units. Shift the generator from side to side or raise or lower with a lifting device as necessary.

It may be necessary to use shims under the mounting feet of either the generator or the prime mover to obtain proper alignment; use the same shims as removed under disassembly or proceed as follows: using the extreme bottom four capscrews, mount the SAE adapter to the flywheel housing. With a .0015 to .002 inch feeler gauge placed at the extreme top of the adapter, between the adapter and flywheel housing, raise the generator or lower the prime mover until the gauge is snug. Relieve just enough to release the feeler gauge and torque the remaining SAE adapter cap-screws to the flywheel housing (torque specifications given in section 12).

Mount the screen assembly and tighten the mounting bolts.

b. For two-bearing generators, align the coupling halves or sheaves between the generator and the prime mover by adding shims under the feet.

3. Shim under the generator feet for proper support, ensuring that the generator mounting surfaces are level.
4. Install the mounting bolts which secure the generator to the base.
5. For two bearing generators, assemble the coupling halves or sheave belts between the generator and the prime mover (follow the coupling manufacturer's instructions for assembly and alignment).
6. Connect all existing conduit or ducting to the conduit box.
7. Connect all external wiring to the generator inside the conduit box.
8. Check the exciter air gap (gap between the exciter armature and stator) by inserting a .010 inch feeler gauge in the gap and rotating it around the armature diameter to ensure that a minimum air gap is available (see figure 6-80). If the feeler gauge cannot be rotated on full revolution, then check for a "cocked" exciter stator or loose stator mounting capscrews.

   Note: On single bearing units, the exciter air gap cannot be checked properly until the generator is mounted to the prime mover.
9. Install the conduit box covers.

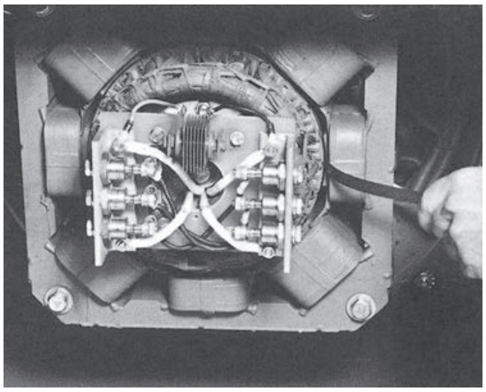


Figure 6-80

Introduction

This section is intended to suggest a systematic approach to locating and correcting generator or regulator malfunctions. The sections are arranged according to the symptoms of the problem. The steps in each section have been arranged in an attempt to:

1) Do the easy checks first.
2) Prevent further damage when troubleshooting a disabled machine.

The first and perhaps most important step of trouble-shooting should be to gather as much information as possible from personnel who may have been present during the failure. Information on how long the generator had been running, what loads were on the line, weather conditions, what protective equipment operated, etc., can help isolate the problem.

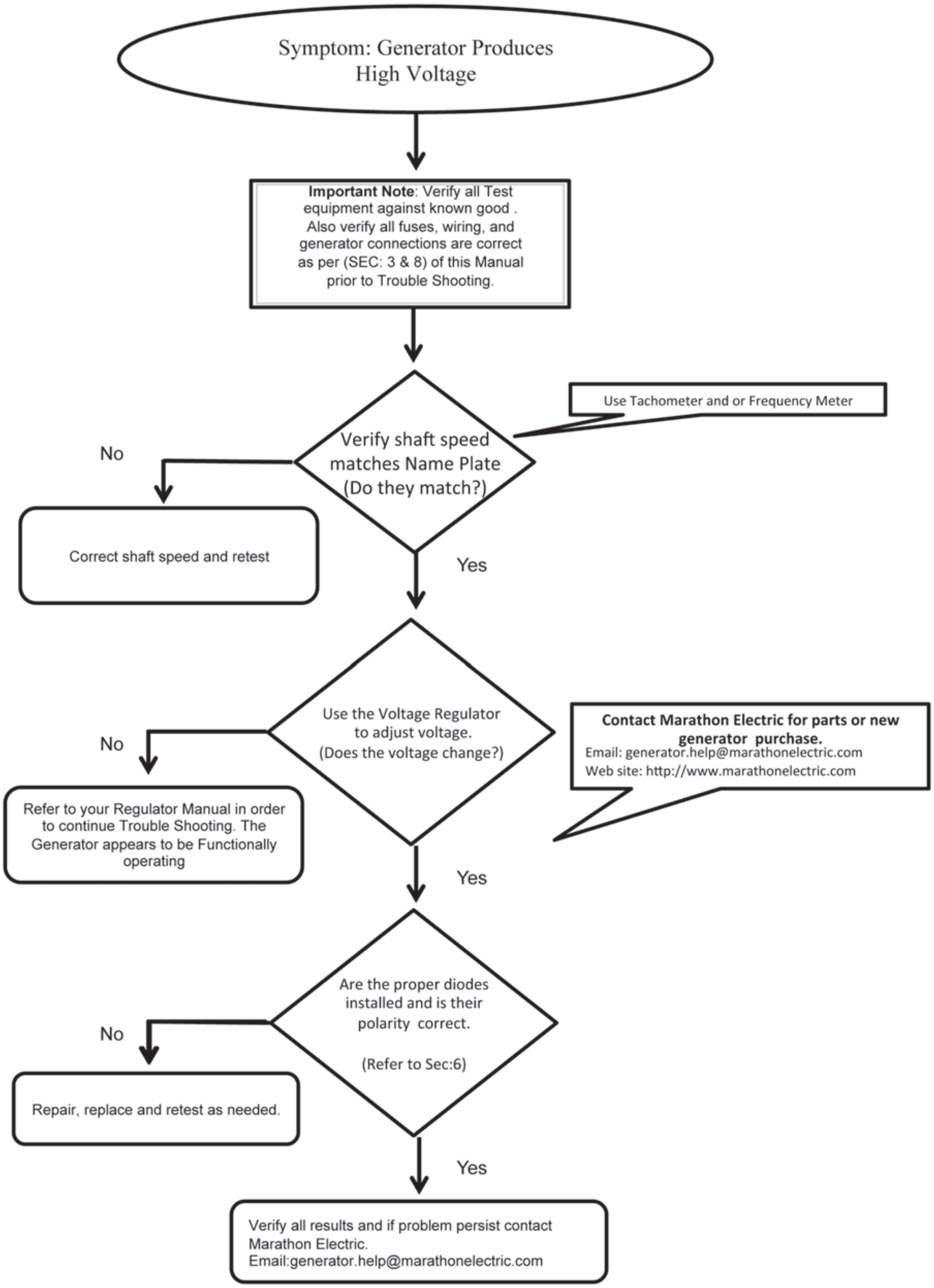
Always make a thorough visual inspection to check for any obvious problems before attempting to run the generator.

WARNING High voltages can be present at the generator and regulator terminals. High residual voltages can be present even with the regulator disconnected or its fuses removed. Some equipment (such as space heaters) may be energized when the generator is off. Tools, equipment, clothing, and your body must be kept clear of rotating parts and electrical connections.

WARNING Special caution must be taken curing troubleshooting since protective covers and safety devices may be disabled to gain access and make tests.

WARNING Be careful. Serious personal injury or death can result from these hazards. Consult qualified personnel with any questions.

Troubleshooting



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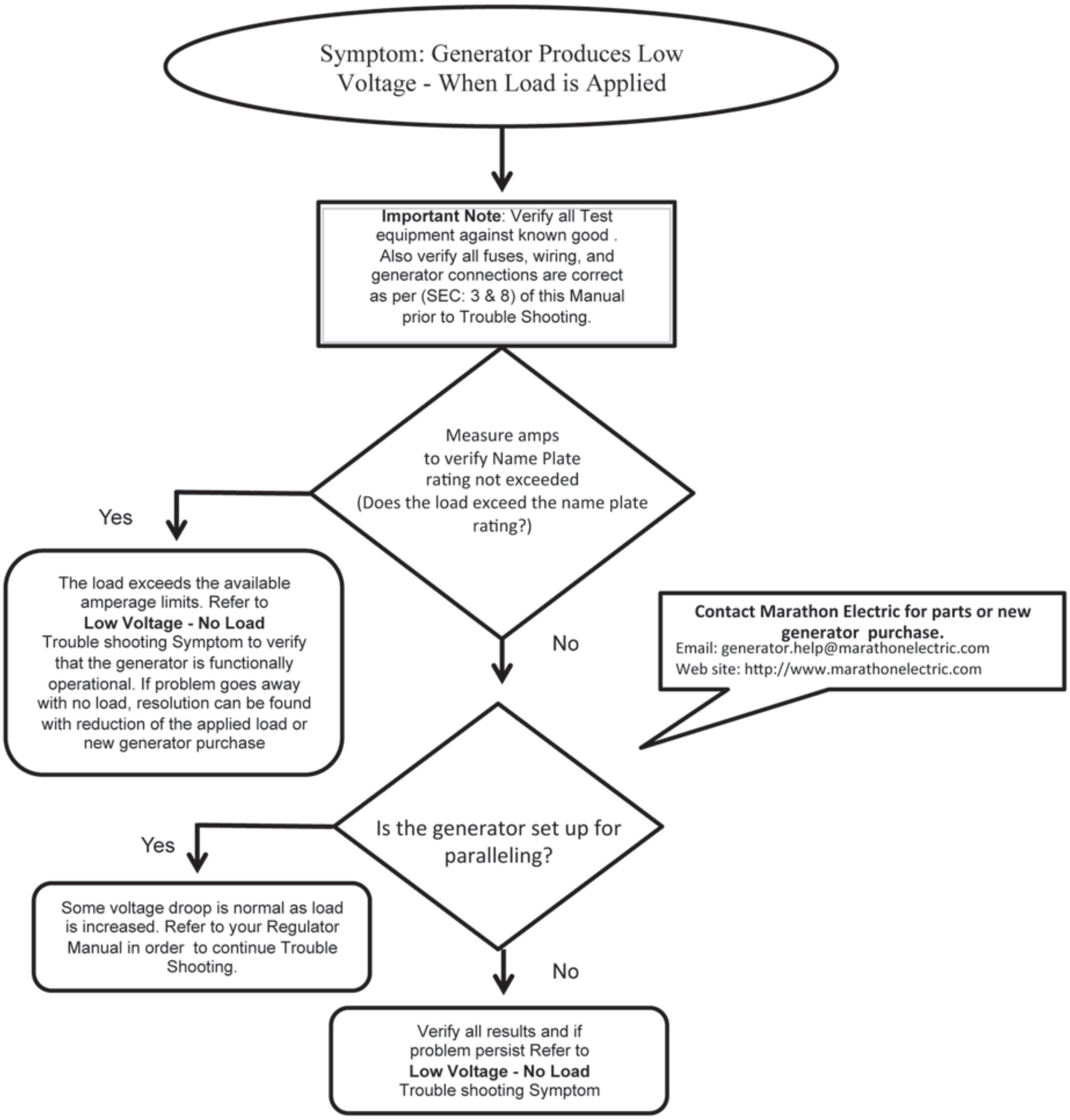
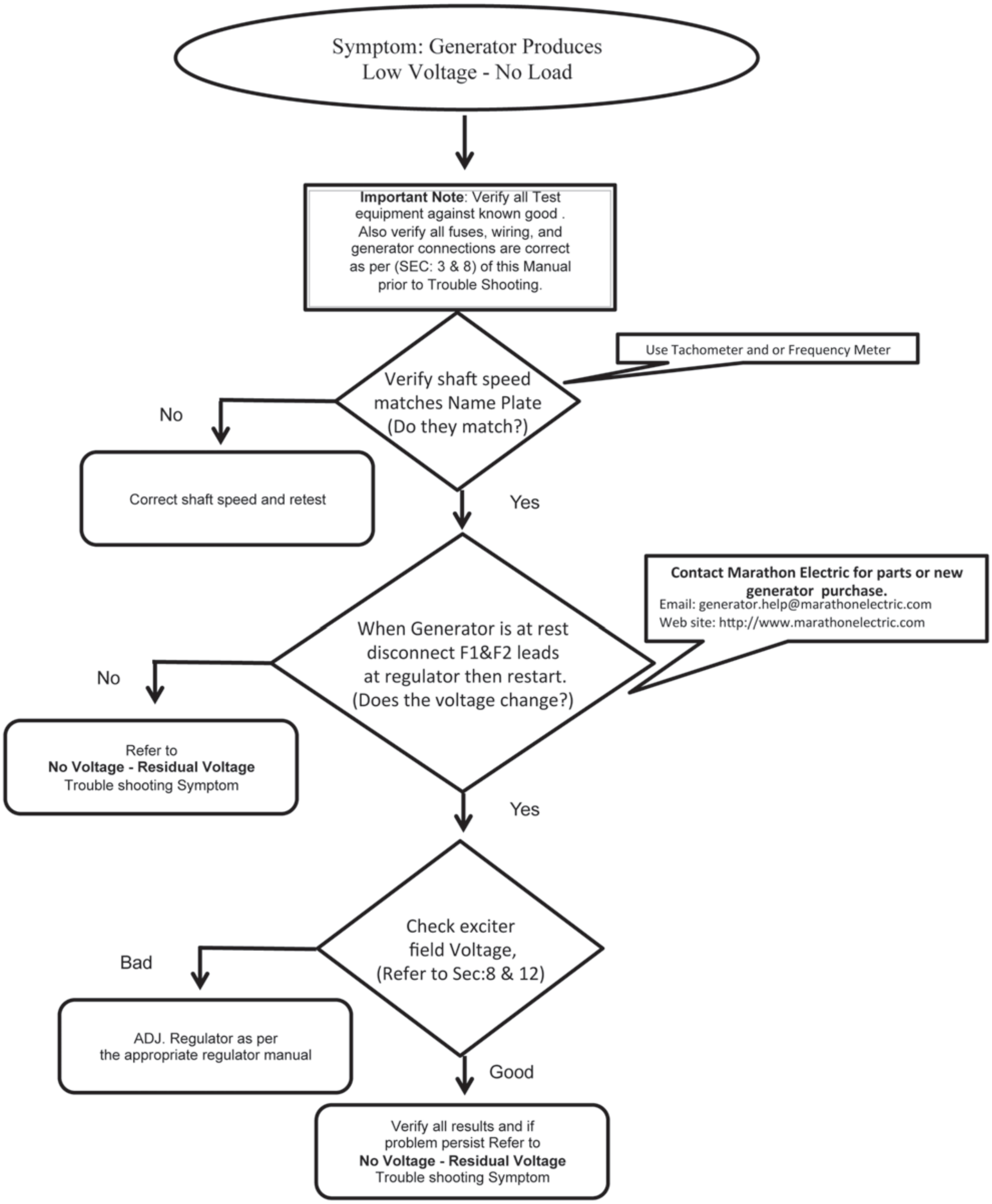


Symptom: Generator Produces Low Voltage - When Load is Applied
Important Note: Verify all Test equipment against known good . Also verify all fuses, wiring, and generator connections are correct as per (SEC: 3 & 8) of this Manual prior to Trouble Shooting.
Measure amps to verify Name Plate rating not exceeded (Does the load exceed the name plate rating?)
Yes
The load exceeds the available amperage limits. Refer to **Low Voltage - No Load** Trouble shooting Symptom to verify that the generator is functionally operational. If problem goes away with no load, resolution can be found with reduction of the applied load or new generator purchase
No
Contact Marathon Electric for parts or new generator purchase.
Email: generator.help@marathonelectric.com
Web site: http://www.marathonelectric.com
Is the generator set up for paralleling?
Yes
Some voltage droop is normal as load is increased. Refer to your Regulator Manual in order to continue Trouble Shooting.
No
Verify all results and if problem persist Refer to **Low Voltage - No Load** Trouble shooting Symptom

Troubleshooting



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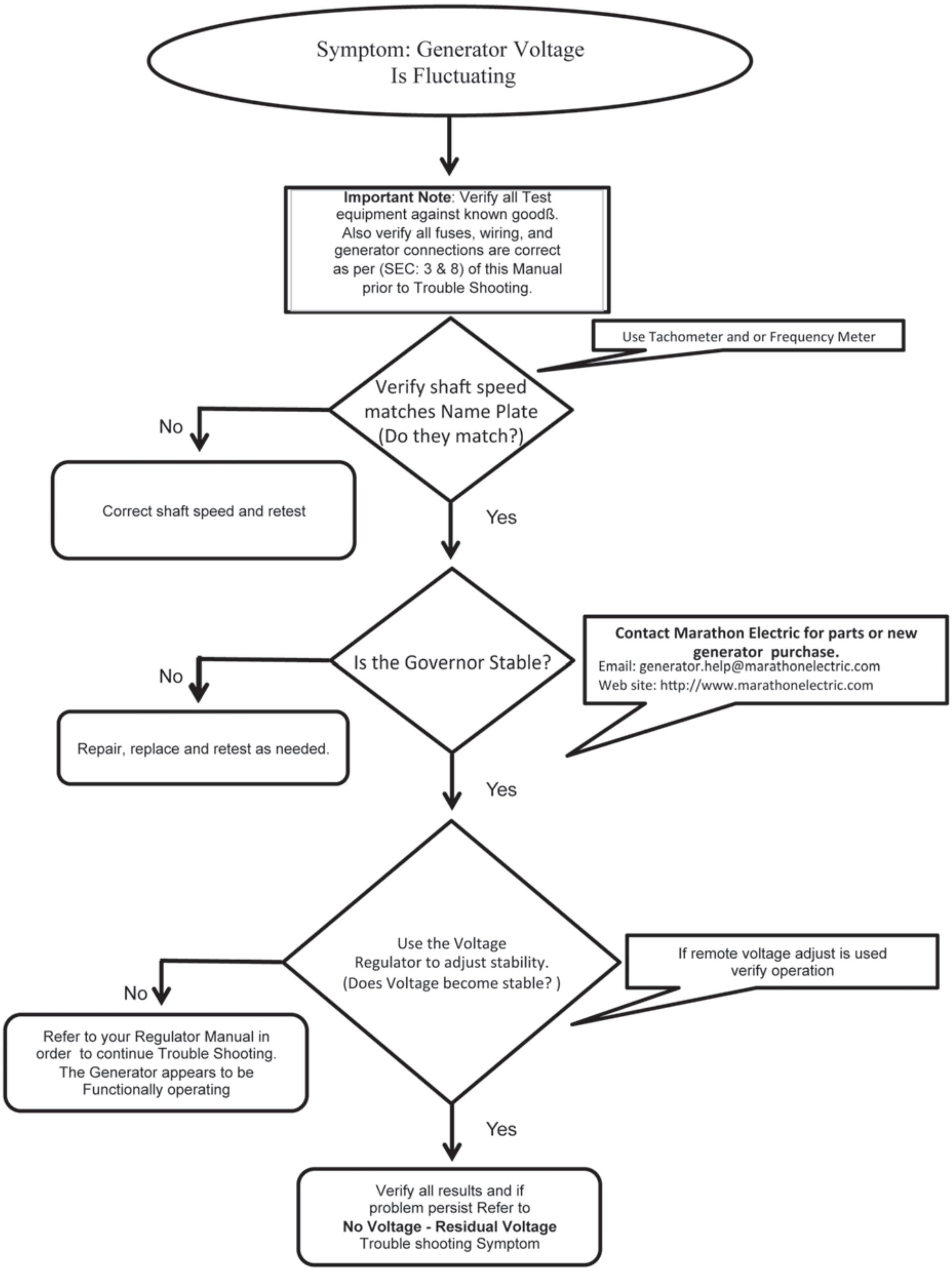
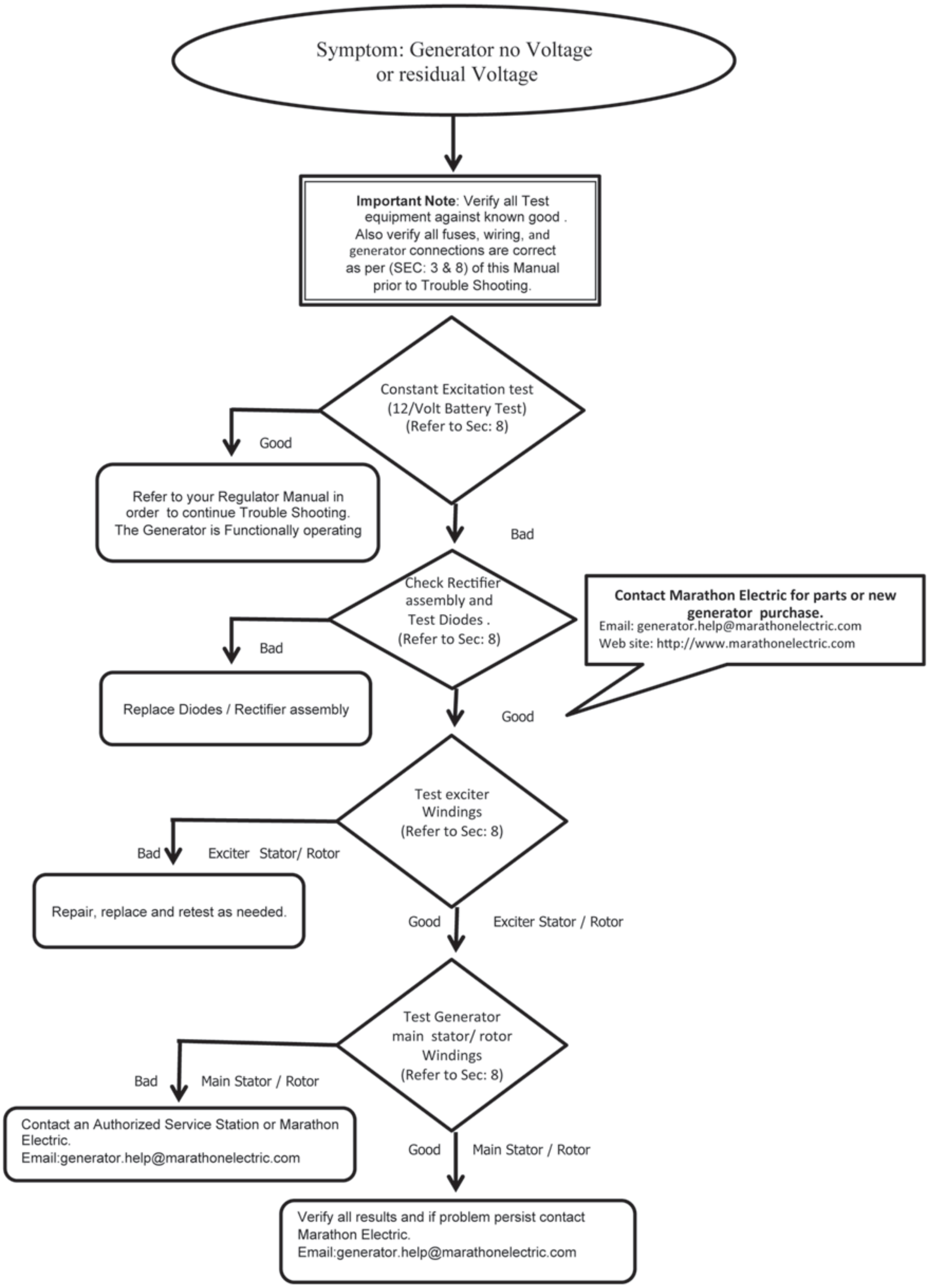

Symptom: Generator Voltage Is Fluctuating
Important Note: Verify all Test equipment against known goodß. Also verify all fuses, wiring, and generator connections are correct as per (SEC: 3 & 8) of this Manual prior to Trouble Shooting.
Use Tachometer and or Frequency Meter
Verify shaft speed matches Name Plate (Do they match?)
No
Correct shaft speed and retest
Yes
Is the Governor Stable?
Contact Marathon Electric for parts or new generator purchase.
Email: generator.help@marathonelectric.com
Web site: http://www.marathonelectric.com
No
Repair, replace and retest as needed.
Yes
Use the Voltage Regulator to adjust stability. (Does Voltage become stable?)
If remote voltage adjust is used verify operation
No
Refer to your Regulator Manual in order to continue Trouble Shooting. The Generator appears to be Functionally operating
Yes
Verify all results and if problem persist Refer to **No Voltage - Residual Voltage** Trouble shooting Symptom

Troubleshooting



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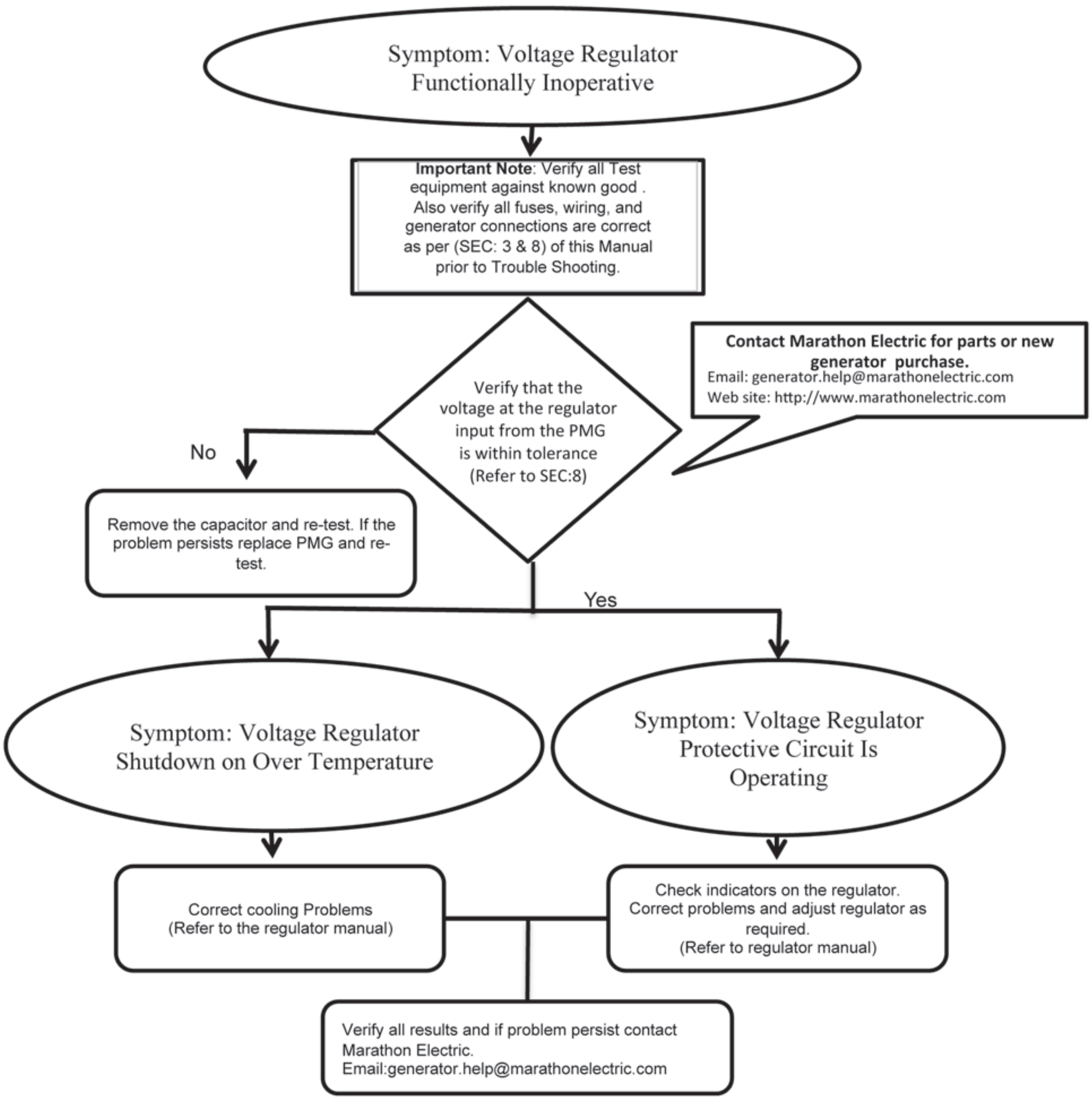

Symptom: Voltage Regulator Functionally Inoperative
Important Note: Verify all Test equipment against known good . Also verify all fuses, wiring, and generator connections are correct as per (SEC: 3 & 8) of this Manual prior to Trouble Shooting.
Verify that the voltage at the regulator input from the PMG is within tolerance (Refer to SEC:8)
Contact Marathon Electric for parts or new generator purchase.
Email: generator.help@marathonelectric.com
Web site: http://www.marathonelectric.com
No
Remove the capacitor and re-test. If the problem persists replace PMG and re-test.
Yes
Symptom: Voltage Regulator Shutdown on Over Temperature
Symptom: Voltage Regulator Protective Circuit Is Operating
Correct cooling Problems (Refer to the regulator manual)
Check indicators on the regulator. Correct problems and adjust regulator as required. (Refer to regulator manual)
Verify all results and if problem persist contact Marathon Electric. Email:generator.help@marathonelectric.com

Symptom: Equipment Runs Normally On Utility Power, But Will Not Run On Generator Set. (Voltage Wave Form Distorted)

↓

Important Note: Verify all Test equipment against known good . Also verify all fuses, wiring, and generator connections are correct as per (SEC: 3 & 8) of this Manual prior to Trouble Shooting.

↓

Analyze load. Excessive SCR (Thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Verify all results and if problem persist contact Marathon Electric. Email:generator.help@marathonelectric.com

Visual Inspection

Whenever testing and troubleshooting a generator set, it is always a good practice to make a thorough visual inspection. Remove covers and look for any obvious problems. Burnt windings, broken connectors, leads, mounting brackets, etc., can usually be identified. Look for any loose or frayed insulation, loose or dirty connections, and broken wires. Be sure all wiring is clear of rotating parts.

Verify that the generator is connected for the voltage required. This is especially important on new installations.

Check for any foreign objects, loose nuts, bolts, and electrical connectors. Clear paper, leaves, building materials, etc., that could be sucked into the generator. (Generator is air cooled; air enters the lower portion of the conduit box.) Check the air gap for clearance or obstructions (main generator and exciter)

If possible, rotate the generator rotor by hand to be sure it turns freely.

If serious problems can be identified before attempting to operate the machine, additional damage can be avoided.

Constant Excitation (12V Battery) Test

Theory: The generator output voltage is dependent on generator speed, generator design, load, and exciter input current. If the generator speed and exciter input are known, the output voltage at no load can be measured and compared to the design value. Problems can be isolated to either the generator or regulator system by using this test.

Test Procedure:

1. Shut the generator set down.
2. Connect a voltmeter to the generator output.
3. Disconnect the F1 and F2 leads at the regulator.
4. Connect a 12 volt battery capable of supplying 1 amp to the F1 and F2 leads. F1 is plus (+), F2 is minus (–).

⚠CAUTION Beware of arcing when connecting leads. Stay clear of battery vents. Escaping hydrogen gas can explode. If hazardous conditions exist, use a suitable switch to connect or disconnect the battery.

5. With no load applied to on the generator (main breakers open), run generator at rated speed (1800 rpm – 60 Hz or 1500 rpm – 50 Hz).
6. Measure the generator output voltage.
7. Shut generator down.
8. Disconnect battery (see preceding CAUTION statement).
9. Compare voltage reading with value shown in section 12.

Conclusion: If voltage readings are normal, the main generator and exciter are operating properly. Troubleshooting should continue with the regulator. If readings are not normal, the problem is in the generator. Continue testing diodes, surge suppressor, and windings.

Measuring Voltages

When testing the generator and regulator, the most frequent (and usually easiest) measurement will be a voltage. The generator will need to be running at rated speed and may have some of the protective guards and covers removed. **Be Careful.** Keep yourself and your test leads out of the way. It is best to shut the unit down when connecting meters. When using alligator clips or push-on terminals, be sure the leads are supported so vibration does not shake them loose when running the generator set.

See figure 8-1 for measurement points and expected meter range settings. When in doubt, start with a higher range and work down.

Consult meter instruction manual to verify its operation and limitations.

Generator Testing

Figure 8-1: Typical Voltage Measurements

Voltage Measurement	Test Point	Meter/Range Selection Requirement
Generator Output Voltage	Output "T" leads or bus bars, also main circuit breaker "line" side.	System voltage – volts AC (see generator nameplate and connection diagram).
Regulator Output (Excitor Stator Input)	F1 and F2 terminals at the regulator.	200 volts DC range. F1 is plus (+) and F2 is minus (–).
Regulator Sensing Voltage	E1, E2, and E3 terminals at the regulator.	Usually the same as the system voltage (generator output volts); however, in some cases, sensing is taken from winding center taps or instrument potential transformers. Maximum 600 volts AC. **Example:** Center tap of 480 volt system would give 240 volts at E1, E2, or E3. **Example:** A 4160 volt system must use a transformer to step voltage down below 600 volts. See the connection diagram supplied with generator set.
Regulator Input Volts (PMG Output Volts)	"PMG" leads at the regulator or capacitor.	200-240 VAC 300 Hz @ 1800 rpm 180-220 VAC 250 Hz @ 1500 rpm

Current (Amp) Measurements

Current measurements (AC) can be easily taken with a clamp-on type meter.

Note: Most clamp-on ammeters will not measure DC.

When measuring generator output current, be sure the clamp is around all cables **for each phase**. If the physical size of the conductors or the capacity of the meters will not permit all cables to be measured at once, each one can be measured individually. Add the individual readings together to get the total. Compare readings to the generator nameplate (nameplate ratings are always given per phase).

Amperage should never exceed the nameplate rating when running the intended load (amperage may go above nameplate momentarily when starting large motors).

When measuring exciter field amps (F1 and F2 leads), a DC meter is required. The maximum field current under full regulator forcing is 6.5 amps DC. Normal full load reading is approximately 3 amps DC.

Measuring Resistance

The generator windings can be measured and compared to the values shown in the service specification section 12.

Main Stator

The main stator winding resistance is very low. A meter capable of readings in the milliohm range would be required; however, a standard VOM (volt ohm meter) can be used to check for continuity, shorts, or grounds.

Example: With leads disconnected, a measurement from T1 to T4 should be very low (continuity on most VOMs). Measured from T1 or T4 to any other lead should be infinite. Measure from the "T" lead to the generator frame to check for grounds (reading should be infinite).

Exciter Stator

The exciter stator resistance is measured by disconnecting the F1 and F2 leads at the regulator. Measure the resistance between the leads (this value is 22–24 ohms on standard generators). Measure from the leads to the frame to check for grounds.

Main Rotor
Note markings and disconnect the main rotor leads (F1 leads and F2 leads) from the rectifier assembly. Measure the resistance of the main rotor winding. Compare reading to value shown in service specification, section 12. Measure from the leads to the exciter mounting bolt to check for grounds.

Exciter Rotor
Disconnect the exciter rotor leads at the diodes (leave leads disconnected if proceeding to check diodes). Measure resistance between phases. Compare value to service specifications, section 12. Measure from the leads to the exciter mounting bolt to check for grounds.

Testing Diodes (Rectifiers)

Diodes perform the function of an "electrical check valve." They conduct in one direction only and are used to "rectify" AC current into DC current. To test, measure the resistance first in one direction and then reverse the leads and test in the other direction. The reading should be high in the reverse direction and low in the forward direction. A shorted diode will read low in both directions. An open diode will read high in both directions.

Notes:

1. Two different polarities of diodes are used. The only difference is in the way the device is mechanically placed in the case. When changing diodes, be sure the correct polarity is used (refer to section 6, figure 6-34).
2. Some meters do not have enough voltage output from their internal batteries to turn the diode on (about 0.6 volts is required), and the voltage can change with different range settings. Consult the instruction manual for your meter.
3. Polarities supplied by the meter's internal battery may or may not correspond to the (+) (–) markings on the meter.

Insulation Resistance – General

Insulation resistance is a measurement of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or due to contaminants (dust, dirt, oil, grease, and especially moisture). Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shut down. The problem can be corrected simply by drying out the windings (see section 5).

Normally the resistance of the insulation system is on the order of millions of ohms. It is measured with a device called a "megger" which is a megaohm meter (meg is for million) and a power supply. The power supply voltage varies, but the most common is 500 Vdc. A megger voltage over 500 is not recommended, except for measuring medium voltage (2400/4160) stators only.

CAUTION **First disconnect any electronic components. Regulators, diodes, surge protectors, protective relays, etc., will be destroyed if subjected to the high megger voltages.**

To measure insulation resistance, connect the red or positive megger lead to the leads for the winding to be tested, connect the back or negative megger lead to the generator frame. Be sure the leads of the part being tested are not touching any metal parts of the generator (if the neutral is grounded, it must be disconnected). Take megger reading (refer to the manual for the megger).

Insulation Resistance – Main Stator

CAUTION **Be sure the regulator, and any other electric components, metering, protective relays, etc., are disconnected before meggering. High megger voltages will destroy these parts.**

All stator leads must be isolated from ground and connected together (on most systems with grounded neutrals, the neutral can be isolated from ground and used as a test point). Connect the positive megger lead to the main stator leads. Connect the negative megger lead to the generator grounding stud. Take the megohm reading (refer to instructions for the megger).

The minimum acceptable value for random wound coils is 5 megohms. For form wound coils, the value is 100 megohms.

If the reading is below the recommended value, the winding must be dried out or repaired.

Insulation Resistance – Main Rotor

Disconnect the main rotor leads from the diode bridge on the exciter rotor. Connect the leads together with the positive megger lead. Connect the negative megger lead to a good ground on the rotor assembly such as the exciter mounting bolt. Take the megohm reading (refer to instructions for the megger).

The minimum value is 5 megohms.

If the reading is low, the winding must be dried out or repaired.

Insulation Resistance – Exciter Stator

Disconnect the exciter leads F1 and F2 from the regulator. Never subject the regulator to a megger. Connect F1 and F2 together with the positive megger lead. Connect the negative megger lead to the ground stud. Take the megohm reading (refer to instructions for the megger).

The minimum value is 5 megohms.

If the reading is low, the winding must be dried out or repaired.

Insulation Resistance – Exciter Rotor

Disconnect the exciter rotor windings (6 leads from the diodes). Connect all leads together with the positive megger lead. Connect the negative megger lead to a good ground on the rotor assembly such as the mounting bolt. Take the megohm reading (refer to the instructions for the megger).

The minimum value is 5 megohms.

If the reading is low, the winding must be dried out or repaired.

Main Rotor Field AC Impedance Test

Theory: The main rotor resistance can be measured with a very accurate meter that is able to measure low (1 ohm) resistance, but it is difficult to determine if there are turn-to-turn shorts in the field pole windings. One shorted turn would only change a resistance reading on the order of one half of one percent.

The AC impedance test measures the impedance (inductance and resistance) of the field pole coils. Shorted turns in the field pole windings change the coil inductance to a much greater degree than the resistance.

Procedure:

Step 1: The rotor must be supported on a non-magnetic surface such as a wooden skid. Do not use a steel table that would create a magnetic "short circuit" between the poles.

Step 2: Apply 120 volts AC to disconnected main rotor leads F1 and F2.

Step 3: Measure and record voltages across each pole. Between points"A" and "B", "B" and "C", "C" and "D", and "D" and "E" (figure 8-1).

Step 4: The voltage readings should balance within one volt.

Results: If the AC voltages are not balanced (30V ± 1V AC with 120V AC input) across each pole, the winding has shorted turns and should be rewound.

Refer to Marathon Electric for further information.

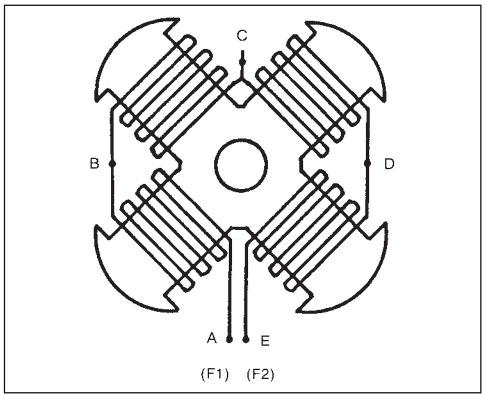
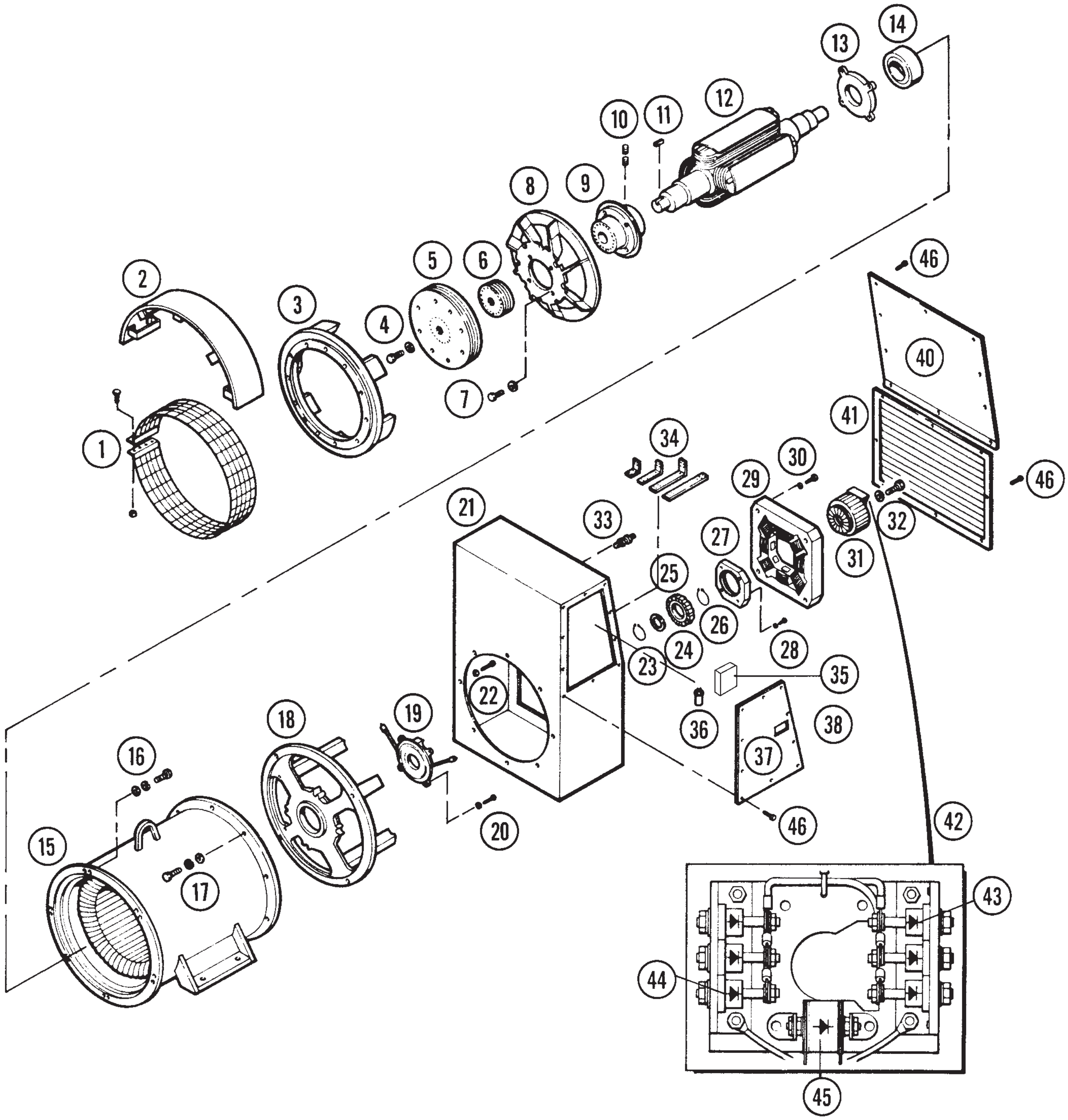


Figure 8-1

MAGNAMAX[DVR®] Exploded View



Parts

Table 9-1: Parts List

Item	Part Description
1	Screen Assembly
	Screen
	Screen Mounting Bolt
	Screen Mounting Nut
2	Drip Cover Assy (Option)
3	SAE Adapter
	#3 Adapter
	#2 Adapter
	#1 Adapter
	#1/2 Adapter
	#0 Adapter
	#00 Adapter (#18 Disc)
	#00 Adapter (#21 Disc)
4	Disc Mounting Fasteners
	Capscrew for #11-1/2
	Capscrew for #14
	Capscrew for #18
	Capscrew for #21
	Capscrew for Delco
	Hardened Washer
5	Drive Discs
	#11-1/2 Disc
	#14 Disc
	#18 Disc
	#21 Disc
	Delco Disc (17.75” OD)
6	Spacers
	For #11-1/2 Disc
	For #14 Disc
	For #18 Disc
	For #21 Disc
	For Delco Disc
7	Fan Mounting Fasteners
	Capscrew
	Capscrew (2 brg. only)
	Belleville Washer
8	Fan
9	Hub
	Drive Hub (single brg. only)
	Fan Hub (2 brg. only)
10	Drive Hub Set Screws
11	Drive Hub Key
12	Main Rotor Assembly With Windings
13	Front Bearing Cap
14	Front Ball Bearing
15	Main Body Assembly
16	Adapter Mtg Fasteners
	Capscrew
	Lock Washer
	Flat Washer
17	Bracket Mtg Fasteners
	Capscrew
	Lock Washer
	Flat Washer
18	Front Bracket
19	PMG Bearing Cap
20	Bearing Cap Fasteners
	Capscrew
	Lock Washer
21	Conduit Box
22	Conduit Box Mounting Fasteners
	Capscrew
	Lock Washer
23	Snap Ring – Inner
24	Loading Spring
25	PMG Rotor
26	Snap Ring – Outer
27	PMG Stator
28	PMG Stator Mtg Fasteners
	Capscrew
	Belleville Washer
29	Exciter Stator
30	Exciter Stator Fasteners
	Capscrew
	Belleville Washer
31	Exciter Rotor Assembly (incl. 42)
	430 Frame – All
	570 Frame – Low Voltage
	570 Frame – Medium Voltage
32	Exciter Rotor Fastener
	Capscrew
	Belleville Washer
33	Grounding Stud Assembly
	Stud
	Washer
	Nut
34	Bus Bar Assembly
35	Voltage Regulator
36	Capacitor
37	Side Panels
	Blank
	Machined For Regulator
38	Fuse
40	Solid Cover
41	Louvered Cover
42	Exciter Rect. Assembly (incl. 43, 44, 45)
43	Diode Standard Polarity
44	Diode Reverse Polarity
45	Surge Suppressor
46	Cover Mounting Screws

Note: This parts list is for reference only. Always give complete generator model and serial numbers when ordering parts.

Standard Tools

The MAGNAMAX$^{DVR®}$ generator is assembled with American standard SAE hardware. Wrench sizes from 5/16 inch to 7/8 inch are used. A socket head set screw is used in the drive hub. A 1/4 inch allen type wrench is required to remove it.

All fasteners should be properly torqued (see section 12). Torque wrenches ranging from 25 in-lb through 200 ft-lb should be available.

Electrical test equipment should include a voltmeter or multimeter (VOM), clamp on ammeter, accurate frequency meter or tachometer and a megohmmeter. (See section 8 – Generator Testing for more information.)

Special Tools

In addition to the standard tools mentioned above, the following special tools will facilitate removal and installation of large and/or special parts. These tools can be obtained from the Marathon Electric parts department.

Exciter Stator Lifting Fixture (figure 10-1) – In cases where the exciter stator is to be serviced without removing the generator conduit box, this fixture can be used with overhead rigging to remove and reinstall the exciter stator.

Exciter Rotor Puller Bolt (figure 10-2) – The exciter rotor has a built-in pulling system. With the use of this bolt, the rotor can be easily removed from the shaft without damage to the winding.

Snap Ring Pliers (figure 10-3) – The PMG rotor is installed to the generator shaft with a snap ring. The nominal shaft diameter is 2-3/4 inches and the ring must be spread approximately 3/4 inches for removal. To install the snap ring, use a piece of pipe with a 2-3/4 inch ID (figure 10-4). Push the PMG rotor and snap ring onto the shaft until the ring snaps into the groove.

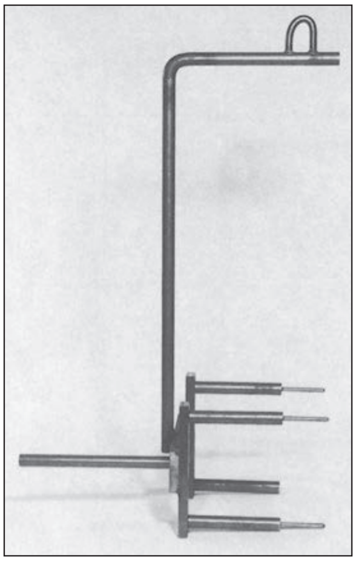


Figure 10-1

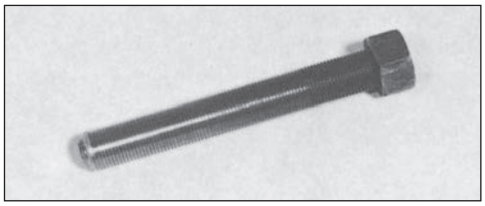


Figure 10-2

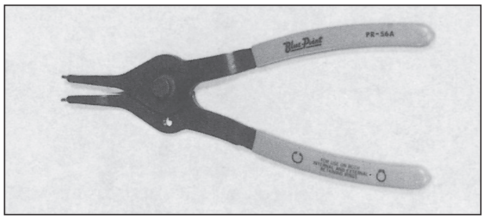


Figure 10-3

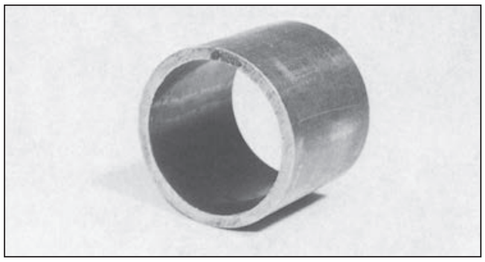


Figure 10-4

Rotor Lifting Fixture (figure 10-5) – The main generator rotor is heavy (approx. 1/2 the weight of the generator) and difficult to handle. The proper fixture should be used whenever removing or installing the main rotor into the main stator. Without proper care and equipment, the windings can be easily damaged.

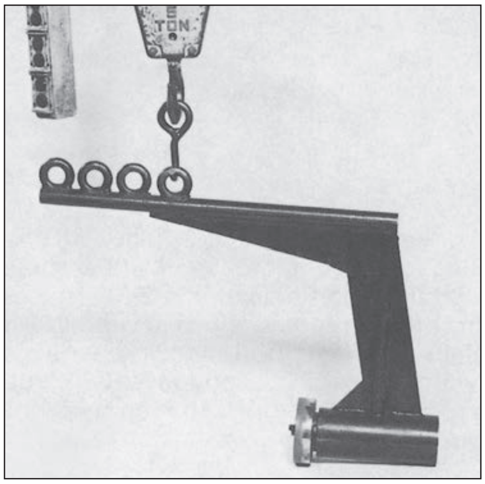


Figure 10-5

Miscellaneous

A selection of wiring devices such as electric connectors, tape, cable ties, crimping and stripping tools, etc., should also be a part of the generator service tool kit. The standard regulator uses flat 1/4 inch female insulated terminals for AWG #14 wire.

Shipping Instructions

Shipping and handling will be much easier if the generator is fastened to a suitable shipping skid that will allow handling by a forklift. The skid should extend beyond the generator in all directions. If the original skid is available, it should be used. Marathon Electric will supply shipping skid drawings upon request.

Overseas shipping may require special export crating. Check with your freight carrier.

When installed, single bearing generator rotors are supported on the drive end by the drive discs bolted to the engine flywheel. When the engine is removed, the rotor must be supported by an appropriate fixture to prevent main rotor, main stator, or exciter damage (figure 11-1). Before shipping any single bearing generator, the main rotor must be supported by the adapter using an appropriate fixture.

⚠CAUTION Do not attempt to transport any generator without proper rotor support. Extensive equipment damage can occur.

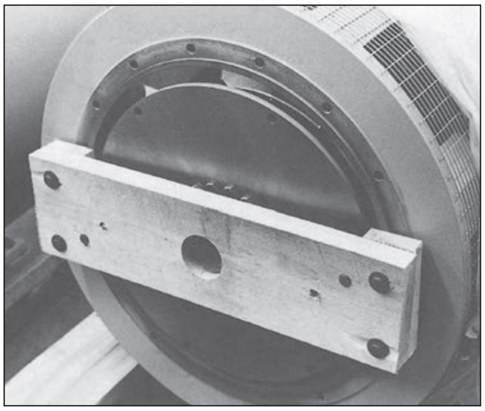


Figure 11-1

Storage Instructions

If the generator or gen-set is placed into storage, the following precautions should be taken to protect it:

A. Equipment must be kept clean.
   1. Store indoors.
   2. Keep covered to eliminate airborne dust and dirt.
   3. Cover openings for ventilation, conduit connections, etc., to prevent entry of rodents, snakes, birds, insects, etc.

B. Equipment must be kept dry.
   1. Store in a dry area indoors.
   2. Temperature swings should be minimal to prevent condensation.
   3. If stored in an unheated or damp building, space heaters will be required to prevent internal condensation.
   4. Treat unpainted flanges, shafts, drive discs, and fittings with a rust inhibitor.
   5. Check insulation resistance of all windings **before** starting the generator. If readings are low, the windings must be dried (see section

C. Keep bearings lubricated.
   1. Every six months, rotate shaft several turns to distribute grease in bearings.
   2. If unit has been stored more than one year, add grease before start-up.

D. Review and follow instructions in sections 3 and 4 before putting the gen-set into service.

Specifications

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Table 12-1: MAGNAMAX DVR® – Fastener & Torque Specifications

Part Description	Fastener Spec. ③	430-570 Frames Size ① Dia.–Thread	430-570 Frames Torque ② Ft-Lb	740 Frames Size ① Dia.–Thread	740 Frames Torque ② Ft-Lb
Front Bracket	Grade 5 capscrews with flat and lock washers	3/8-16	25	1/2-13	60
Bearing Caps	Grade 5 capscrews with lock washers	3/8-16	25	3/8-16	25
Drive Disc	Grade 8 capscrews with hardened washers	5/8-18	192	5/8-18	192
Adapter (or Rear Bracket)	Grade 5 capscrews with flat and lock washers	3/8-16	25	1/2-13	60
Conduit Box	Grade 5 capscrew with star type lock washer	3/8-16	25	1/2-13	60
PMG Stator	Grade 5 capscrews with belleville washers	1/4-20	6	1/4-20	6
Exciter Stator	Grade 5 capscrews with belleville washers	1/2-13	60	1/2-13	60
Exciter Armature (Rotor)	Grade 8 capscrew with belleville washer	1/2-13 3/4-10	84 300	1/2-13 3/4-10	84 300
Cooling Fan	Grade 5 capscrews with belleville washers	3/8-16 1/2-13 - Alum.	25 60	1/2-13	60
Main Rotor Coil Supports ④	Grade 8 capscrews with belleville washers	5/16-18	19	3/8-16	35
Rectifier Assembly Mounting	Grade 5 capscrews	1/4-20	4	1/4-20	4
Drive Hub Set Screw	Socket head set screw – 1/4 in. hex key	1/2-13	50	1/2-13	50

NOTES:

① All fasteners are SAE (American) standard.

② All torque values are for plated hardware which is standard on the MAGNAMAX DVR®. If hardware is replaced with non-plated, refer to Table 12-2.

③ Always use quality hardware of the grade specified.

④ 570 and 740 frame only. Not used on 430 frames.

Table 12-2: Capscrew Torque Values

Capscrew Dia. and Ultimate Tensile Strength (PSI)	To 1/2 – 69,000 PSI To 3/4 – 64,000 PSI To 1 – 55,000 PSI			To 3/4 – 120,000 PSI To 1 – 115,000 PSI			150,000 PSI		
SAE Grade Number	1 or 2			5			8		
Capscrew Head Markings									
Capscrew Body Size (Inches) – (Thread)	Torque Ft-Lb (N-m)			Torque Ft-Lb (N-m)			Torque Ft-Lb (N-m)		
	Dry	**Oiled**	**Plated**	**Dry**	**Oiled**	**Plated**	**Dry**	**Oiled**	**Plated**
1/4 - 20	5 (7)	4.5 (6)	4 (5)	8 (11)	7 (9)	6 (8)	12 (16)	11 (15)	10 (14)
- 28	6 (8)	5.4 (7)	4.8 (6)	10 (14)	9 (12)	8 (11)	14 (19)	13 (18)	11 (15)
5/16 - 18	11 (15)	10 (14)	9 (12)	17 (23)	15 (20)	14 (19)	24 (33)	22 (30)	19 (26)
- 24	13 (18)	12 (16)	10 (14)	19 (26)	17 (23)	15 (20)	27 (37)	24 (33)	22 (30)
3/8 - 16	18 (24)	16 (22)	14 (19)	31 (42)	28 (38)	25 (34)	44 (60)	40 (54)	35 (47)
- 24	20 (27)	18 (24)	16 (22)	35 (47)	32 (43)	28 (38)	49 (66)	44 (60)	39 (53)
7/16 - 14	28 (38)	25 (34)	22 (30)	49 (66)	44 (60)	39 (53)	70 (95)	63 (85)	56 (76)
- 20	30 (41)	27 (37)	24 (33)	55 (75)	50 (68)	44 (60)	78 (106)	70 (95)	62 (84)
1/2 - 13	39 (53)	35 (47)	31 (42)	75 (102)	68 (92)	60 (81)	105 (142)	95 (129)	84 (114)
- 20	41 (56)	37 (50)	33 (45)	85 (115)	77 (104)	68 (92)	120 (163)	108 (146)	96 (130)
9/16 - 12	51 (69)	46 (62)	41 (56)	110 (149)	99 (134)	88 (119)	155 (210)	140 (190)	124 (168)
- 18	55 (75)	50 (68)	44 (60)	120 (163)	108 (146)	96 (130)	170 (230)	153 (207)	136 (184)
5/8 - 11	83 (113)	75 (102)	66 (89)	150 (203)	135 (183)	120 (163)	210 (285)	189 (256)	168 (228)
- 18	95 (129)	86 (117)	76 (103)	170 (230)	153 (207)	136 (184)	240 (325)	216 (293)	192 (260)
3/4 - 10	105 (142)	95 (130)	84 (114)	270 (366)	243 (329)	216 (293)	375 (508)	338 (458)	300 (407)
- 16	115 (156)	104 (141)	92 (125)	295 (400)	266 (361)	236 (320)	420 (569)	378 (513)	336 (456)
7/8 - 9	160 (217)	144 (195)	128 (174)	395 (535)	356 (483)	316 (428)	605 (820)	545 (739)	484 (656)
- 14	175 (237)	158 (214)	140 (190)	435 (590)	392 (531)	348 (472)	675 (915)	608 (824)	540 (732)
1 - 8	235 (319)	212 (287)	188 (255)	590 (800)	531 (720)	472 (640)	910 (1234)	819 (1110)	728 (987)
- 14	250 (339)	225 (305)	200 (271)	660 (895)	594 (805)	528 (716)	990 (1342)	891 (1208)	792(1074)

NOTES:

① Capscrews threaded into aluminum may require reductions in torque of 30% or more.

Table 12-3: Excitation Data – 60 Hz – 1800 RPM

Model Number Low Volts	Exciter Field Resistance Ohms @ 25°C	Exciter Field Volts F1 & F2 at Regulator No Load① 240/480 Volts	No Load Output Voltage W/Fixed Excitation High Wye Connection② 12V DC	24V DC
431RSL4005	22.5	13.3	460	550
431RSL4007	22.5	14.2	450	545
432RSL4009	22.5	15.3	445	535
432RSL4011	22.5	13.5	460	550
432RSL4013	22.5	11.3	490	580
432RSL4015	22.5	13.1	440	530
432RSL4017	22.5	14.4	450	545
433RSL4019	22.5	16.9	430	525
433RSL4021	22.5	13.7	450	550
572RSL4024	23.0	16.1	440	520
572RSL4027	23.0	16.1	440	520
572RSL4028	23.0	17.5	425	510
572RSL4030	23.0	15.2	440	530
573RSL4032	23.0	15.0	445	530
573RSL4034	23.0	17.0	430	520
574RSL4036	23.0	18.2	420	510
574RSL4038	23.0	15.0	440	540
575RSL4044	23.0	18.8	410	510
740RSL4046	23.0	18.9	410	510
741RSL4045	22.0	15.2	440	540
742RSL4046	22.0	15.6	430	540
742RSL4048	22.0	17.4	410	525
742RSL4050	22.0	13.7	460	565
743RSL4052	22.0	19.4	400	510
744RSL4054	22.1	18.6	400	510
744RSL4056	22.1	19.4	400	515
744RSL4058	22.1	20.3	400	515
744FSL4060	22.1	15.1	420	570
744FSL4062	22.1	16.6	410	535

Model Number Medium Volts	Exciter Field Resistance Ohms @ 25°C	Exciter Field Volts F1 & F2 at Regulator No Load① 4160 Volts	No Load Output Voltage W/Fixed Excitation Wye Connection③ 12V DC	24V DC
573FSM4352	23.0	23.5	3100	4200
573FSM4354	23.0	20.3	3300	4400
574FSM4356	23.0	20.7	3200	4300
574FSM4358	23.0	17.3	3500	4600
741FSM4360	22.0	16.7	3600	4600
742FSM4364	22.0	15.4	3700	4700
742FSM4366	22.0	16.3	3600	4600
743FSM4368	22.1	17.7	3200	4600
743FSM4370	22.1	17.0	3500	4600
744FSM4374	22.1	17.5	3600	4650
744FSM4376	22.1	17.5	3600	4650

NOTES: ① For rated load exciter field volts – see generator nameplate; ② For low wye connection: divide value shown in table by 2; For high delta connection: divide value shown in table by 1.732; ③ For delta connection: divide value shown in table by 1.732.

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Table 12-4: Excitation Data – 50 Hz – 1500 RPM

Model Number Low Volts	Exciter Field Resistance Ohms @ 25°C	Exciter Field Volts F1 & F2 at Regulator No Load① 415 Volts	No Load Output Voltage W/Fixed Excitation High Wye Connection② 12V DC	24V DC
431RSL4005	22.5	15.6	380	460
431RSL4007	22.5	17.1	370	450
432RSL4009	22.5	18.0	360	445
432RSL4011	22.5	16.0	380	455
432RSL4013	22.5	13.1	400	480
432RSL4015	22.5	18.7	360	440
432RSL4017	22.5	17.4	370	450
433RSL4019	22.5	20.7	340	430
433RSL4021	22.5	16.7	360	450
572RSL4024	23.0	19.8	360	430
572RSL4027	23.0	20.0	355	430
572RSL4028	23.0	21.2	370	430
572RSL4030	23.0	18.4	360	440
573RSL4032	23.0	18.9	360	440
573RSL4034	23.0	20.7	350	430
574RSL4036	23.0	21.6	345	425
574RSL4038	23.0	17.7	365	450
575RSL4044	23.0	21.8	340	420
740RSL4046	23.0	21.9	340	420
741RSL4045	22.0	18.0	360	450
742RSL4046	22.0	18.7	350	445
742RSL4048	22.0	20.0	340	440
742RSL4050	22.0	16.1	370	470
743RSL4052	22.0	22.9	330	420
744RSL4054	22.1	22.6	320	420
744RSL4056	22.1	23.3	330	415
744RSL4058	22.1	24.3	330	415
744FSL4060	22.1	17.0	350	470
744FSL4062	22.1	19.5	330	440

Model Number Medium Volts	Exciter Field Resistance Ohms @ 25°C	Exciter Field Volts F1 & F2 at Regulator No Load① 3300 Volts	No Load Output Voltage W/Fixed Excitation High Wye Connection③ 12V DC	24V DC
573FSM4352	23.0	21.2	2600	3400
573FSM4354	23.0	18.2	2700	3600
574FSM4356	23.0	18.4	2700	3600
574FSM4358	23.0	15.7	2800	3800
741FSM4360	22.0	15.4	3000	3800
742FSM4364	22.0	14.5	3000	3900
742FSM4366	22.0	15.6	2800	3800
743FSM4368	22.1	15.5	2800	3900
743FSM4370	22.1	15.5	2900	3800
744FSM4374	22.1	16.8	2700	3800
744FSM4376	22.1	16.8	2700	3800

NOTES: ① For rated load exciter field volts – see generator nameplate; ② For low wye connection: divide value shown in table by 2; For high delta connection: divide value shown in table by 1.732; ③ For delta connection: divide value shown in table by 1.732.

Specifications

Table 12-5: Resistance Values Main Windings Nominal Cold (25°C) Resistance in Ohms

Base Model Low Voltage	Winding H-SG-	Main Stator ①	Main Rotor
431RSL4005	430049	.0855	.153
431RSL4007	430048	.0648	.173
432RSL4009	430046	.0418	.190
432RSL4011	430018	.0410	.186
432RSL4013	430015	.0370	.189
432RSL4015	430017	.0260	.225
432RSL4017	430016	.0240	.226
433RSL4019	430042	.0140	.286
433RSL4021	430039	.0137	.297
572RSL4024	570078	.0132	.376
572RSL4027	570072	.0126	.398
572RSL4028	570080	.0092	.423
572RSL4030	570074	.0089	.426
573RSL4032	570075	.0074	.472
573RSL4034	570076	.0059	.507
574RSL4036	570077	.0049	.584
574RSL4038	570069	.0048	.601
575RSL4044	570111	.0030	.704
740RSL4046	570111	.0030	.704
741RSL4045	740062	.0045	.692
742RSL4046	740042	.0036	.748
742RSL4048	740043	.0030	.776
742RSL4050	740051	.0023	.889
743RSL4052	740045	.0018	.979
744RSL4054	740046	.0015	1.100
744RSL4056	740066	.0012	1.250
744RSL4058	740066	.0012	1.250
744FSL4060	740306	.0026	.892
744FSL4062	740307	.0018	1.044

Base Model Medium Voltage	Winding H-SG-	Main Stator ①	Main Rotor
573FSM4352	570213	1.030	.383
573FSM4354	570214	.854	.411
574FSM4356	570215	.568	.508
741FSM4360	740230	.277	.667
742FSM4364	740204	.233	.768
742FSM4366	740206	.151	.888
743FSM4368	740207	.127	.954
743FSM4370	740208	.101	1.053
744FSM4374	740240	.072	1.196
744FSM4376	740260	.072	1.196

NOTES: ① Main stator values shown are line to line on the high wye connection. For low wye connection, divide value shown in table by 4.

Table 12-6: Resistance Values Exciter Windings Nominal Cold (25°C) Resistance in Ohms

Low Voltage	Exciter Stator (Field)	Exciter Rotor (Armature)	PMG Stator
430 Frames	22.5	0.022	2.1
570 Frames	23.0	0.045	2.1
740 Frames	23.0	0.045	2.1
741 Frames	22.0	0.043	2.1
742 Frames	22.0	0.043	2.1
743 Frames	22.0	0.043	2.1
744 Frames	22.1	0.048	2.1

Medium Voltage	Exciter Stator (Field)	Exciter Rotor (Armature)	PMG Stator
570 Frames	23.0	0.070	2.1
740 Frames	23.0	0.070	2.1
741 Frames	22.0	0.043	2.1
742 Frames	22.0	0.043	2.1
743 Frames	22.1	0.048	2.1

Generator Formulas①

To Find	Known Values	Three Phase
kWe	Volts, Current, Power Factor	$\frac{E \times 1 \times 1.73 \times PF}{1000} = kVA \times PF$
kVA	Volts, Current	$\frac{E \times 1 \times 1.73}{1000} = \frac{kWe}{PF}$
RkVA	Volts, Current, Power Factor	$\frac{E \times 1 \times 1.73 \times \sqrt{1 - (PF)^2}}{1000}$
HP – Engine Output	Generator kWe Generator Efficiency Radiator Cooling Fan HP Battery Charging Generator HP	$\frac{kWe}{Efficiency \times .746} + \text{Rad. Cooling Fan HP} + \text{Bat. Chg. Gen. HP}$
kWe – Required for Motor	Motor HP, Eff.	$\frac{HP \times .746}{Efficiency}$
kVA – Required for Motor	Motor HP, Eff., Power Factor	$\frac{HP \times .746}{Efficiency \times PF}$
Amps	HP, Volts	$\frac{HP \times .746}{1.73 \times E \times Efficiency \times PF}$
Amps	kWe, Volts, Power Factor	$\frac{kWe \times 1000}{E \times 1.73 \times PF}$
Amps	kVA, Volts	$\frac{kVA \times 1000}{E \times 1.73}$
Frequency (Hz)	rpm, Poles	$\frac{rpm \times Poles}{2 \times 60}$
Poles	Hz, rpm	$\frac{2 \times 60 \times Hz}{rpm}$
rpm	Hz, Poles	$\frac{2 \times 60 \times Hz}{Poles}$

① E = Volts
I = Current (Amps)
PF = Power Factor

Warnings & Cautions

WARNING

IMPORTANT INFORMATION
Please Read Carefully

CAUTION

This catalog is not intended to provide operational instructions. Appropriate Marathon Electric instructions provided with the motor and precautions attached to the motor should be read carefully prior to installation, operation and/or maintenance of the equipment. Injury to personnel or motor failure may be caused by improper installation, maintenance or operation.

The following WARNING and CAUTION information is supplied to you for your protection and to provide you with many years of trouble free and safe operation of your Marathon Electric product:

WARNING

- Disconnect power and lock out driven equipment before working on a motor.
- Always keep hands and clothing away from moving parts.
- The lifting support on the motor is not to be used to lift the entire machine. Only the motor attached directly to the support may be safely lifted by the support.
- Install and ground per local and national codes.
- Discharge all capacitors before servicing a single phase motor.
- Misapplication of a motor in a hazardous environment can cause fire or an explosion and result in serious injury. Only the end user, local authority having jurisdiction, and/or insurance underwriter are qualified to identify the appropriate class(es), group(s), division and temperature code. Marathon Electric personnel cannot evaluate or recommend what motors may be suitable for use in hazardous environments. If a motor is nameplated for hazardous locations, do not operate the motor without all of the grease and drain plugs installed.
- Never attempt to measure the temperature rise of a motor by touch. Temperature rise must be measured by thermometer, resistance, imbedded detector or thermocouple.
- Motors with automatic reset thermal protectors will automatically restart when the protector temperature drops sufficiently. Do not use motors with automatic reset thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.
- Motors with manual reset thermal protectors may start unexpectedly after the protector trips when the surrounding air is at +20°Fahrenheit or lower. If the manual reset protector trips, disconnect motor from its power supply. After the protector cools (five minutes or more), it can be reset and power may be applied to the motor.
- Connect all protective device leads, marked P1, P2, etc., per instructions supplied with the motor.
- Operation of a motor at other than its nameplate rating may result in fire, damage to equipment or serious injury to personnel.
- For safety, Buyer or User should provide protective guards over all shaft extensions and any moving apparatus mounted thereon. The User is responsible for checking all applicable safety codes in his area and providing suitable guards. Failure to do so may result in bodily injury and/or damage to equipment.

CAUTION

- Consult qualified personnel with questions and all electrical repairs must be performed by trained and qualified personnel only.
- For motors nameplated as “belted duty only”, do not operate the motor without belts properly installed.
- Motors and/or driven equipment should not be operated faster than their rated speed.
- For inverter applications, follow the inverter manufacturer’s installation guidelines.
- Make sure the motor is properly secured and aligned before operation.

Important Information

Resale of Goods

In the event of the resale of any of the goods, in whatever form, Resellers/Buyers will include the following language in a conspicuous place and in a conspicuous manner in a written agreement covering such sale:

The manufacturer makes no warranty or representations, express or implied, by operation of law or otherwise, as to the merchantability or fitness for a particular purpose of the goods sold hereunder. Buyer acknowledges that it alone has determined that the goods purchased hereunder will suitably meet the requirements of their intended use. In no event will the manufacturer be liable for consequential, incidental or other damages. Even if the repair or replacement remedy shall be deemed to have failed of its essential purpose under Section 2-719 of the Uniform Commercial Code, the manufacturer shall have no liability to Buyer for consequential damages.

Resellers/Buyers agree to also include this entire document including the warnings and cautions above in a conspicuous place and in a conspicuous manner in writing to instruct users on the safe usage of the product.

This information should be read together with all other printed information supplied by Marathon Electric.

For more information contact: Regal Beloit America, Inc., a subsidiary of Regal-Beloit Corporation, 100 E. Randolph St., Wausau, WI 54401 Phone: 715-675-3311 or Fax: 715-675-8030.

Generators

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marathon® Generators

DVR®2400 and DVR2500 Digital Voltage Regulator

Quick Start Guide

Regal Beloit America, Inc.
100 East Randolph Street
Wausau, WI 54402-8003
www.marathonelectric.com

FORM
SB0057E
Revised
October 2017

⚠ WARNING

- Read and follow all instructions carefully.
- Disconnect and lock-out power before installation and maintenance. Working on or near energized equipment can result in severe injury or death.
- Do not operate equipment without guards in place. Exposed equipment can result in severe injury or death.

⚠ CAUTION

- Periodic inspections should be performed. Failure to perform proper maintenance can result in premature product failure and personal injury.

NOTICE

- Notice indicates a situation not related to personal injury which, if not avoided, may result in generator or equipment damage.

SAFETY

READ AND SAVE THESE INSTRUCTIONS

SAFETY INSTRUCTIONS

Before installing, using, or servicing this product, carefully read and fully understand the instructions including all warnings, cautions, and safety notice statements. To reduce risk of personal injury, death and/or property damage, follow all instructions for proper generator installation, operation and maintenance.

Although you should read and follow these instructions, they are not intended as a complete list of all details for installations, operation, and maintenance. If you have any questions concerning any of the procedures, or if you have a safety concern not covered by the instructions, STOP, and contact the generator manufacturer.

WARNING! DEFINITION: The words "generator" or "generators", as used in this publication, refers to only Marathon® generator or generators, respectively. Marathon generators are manufactured and/or sold by Regal Beloit America,Inc. or its affliated companies. Marathon generators do not include the prime mover or any of the prime mover related systems or accessories.

ELECTRICAL SAFETY

WARNING! ELECTRICAL HAZARD
Failure to connect the voltage regulator in accordance with the manufacturer's documentation may result in serious personal injury, death, and/or property damage.

WARNING! ELECTRICAL SHOCK HAZARD
Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.

Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.

Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.

Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

WARNING! MAGNETIC FIELD HAZARD
Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which may cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

WARNING! EXPLOSION HAZARD
Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

MECHANICAL SAFETY

WARNING! ROTATING PARTS HAZARD
Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING! OVERSPEED HAZARD
Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING! DO NOT DISASSEMBLE
Only qualified personnel who know local, national, international and/or other applicable codes, rules or regulations and sound practices should install or repair electric generators and voltage regulators. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

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DVR®2400 and DVR2500 Digital Voltage Regulator

Quick Start Guide

GENERAL

OVERVIEW

This guide provides introductory details on installation and commissioning of the DVR®2400 or DVR2500 digital voltage regulator with Marathon® synchronous generators. A separate, full length Installation, Operation and Maintenance Manual (SB056E) is available at http://www.marathonelectric.com/generators/iomManuals.jsp

The digital voltage regulator is a control device that regulates the output voltage of a brushless, AC generator by controlling the current into the generator exciter field. Input power to the digital voltage regulator is derived from a single phase permanent magnet generator (PMG).

The digital voltage regulator is supplied in an encapsulated package designed for behind-the-panel mounting. It is held in place by thread-forming screws that thread into mounting holes in the face of the digital voltage regulator. The front panel display annunciates regulator status and system conditions.

REGULATION MODES

Five regulation modes:

- Single phase automatic voltage regulation (AVR1)
- Three phase automatic voltage regulation (AVR3)
- Field current regulation (FCR)
- Reactive power regulation (VAR)
- Power factor regulation (PF)

FEATURES

The digital voltage regulator has the following features:

- Preset stability settings based on generator frame size
- Adjustable soft start in AVR1 or AVR3 regulation modes
- Under frequency (Volts/Hertz) regulation
- True RMS three-phase or single-phase generator voltage sensing
- True RMS current sensing, single phase on DVR2400, three phase on DVR2500; (optional CT's required)
- True RMS power metering, single phase on DVR2400, three phase on DVR2500; (optional CT's required)
- Field current sensing
- Contact inputs for system interface capability
- Contact output for fault indication
- Generator paralleling with reactive droop compensation and reactive differential compensation
- Front-panel human-machine interface (HMI) for status and configuration
- MODBUS protocol via USB2.0 for external communication
- DVRPortal™ Windows*-based software for configuration and monitoring
- "Power on" LED indicator
- Configurable auxiliary input for metering and control
- Simulated reactive power for droop set-up
- CAN interface with CAN 2.0B J1939 protocol for metering and control (DVR2500 only)
- Generator power limiting mode (DVR2500 only)
- Configurable Parameter Presets selectable through digital inputs (DVR2500 only)
- 8 Channel 3-wire PT100 RTD metering (DVR2500 only) through an external module

PROTECTION

The digital voltage regulator has the following protection features:

- Field Over Excitation Shutdown
- Field Under Excitation Shutdown
- Generator Over Voltage Shutdown
- Generator Under Voltage Shutdown
- Generator Voltage Imbalance Shutdown
- Generator Reverse Power Shutdown
- Loss of Generator Sensing Shutdown
- Instantaneous Field Over Current Shutdown
- Regulator Over Temperature Shutdown
- Generator Parallel Start-Up Shutdown
- Generator Parallel Shutdown Shutdown
- RTD Over Temperature Shutdown (DVR2500 only)
- Loss of CAN Communication Alarm (DVR2500 only)
- RTD Pre Alarm Temperature (DVR2500 only)
- Loss of Aux Input Control Current Alarm (DVR2500 only)
- Loss of RTD Element -Open Alarm (DVR2500 only)
- Loss of RTD Element - Short Alarm (DVR2500 only)
- Genset Battery Low Alarm (DVR2500 only)

LIMITERS

- Exciter Field Current Limit
- Generator Under Frequency Limit
- Generator Power Limit (DVR2500 only)

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DVR®2400 and DVR2500 Digital Voltage Regulator

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SPECIFICATIONS

Voltage Regulation – 0.25% over load range at rated power factor and constant generator frequency.

Output Power – 100 Vdc, 4.0 Adc continuous rating and 190 Vdc, 7.5 Adc forcing capability for 10 seconds.

Exciter Field DC Resistance – 16 to 35Ω range

Voltage Adjustment – ±30% of nominal via analog input, ±15% via external contacts

Input Power – 180 to 240 Vac, 250 to 300 Hz PMG power supply

Regulator Sensing – 100 to 600 Vac, 50/60 Hz, 1-phase/3-phase

Operating Temperature – From -40°C to +70°C (-40°F to +158°F)

Storage Temperature – From -40°C to +85°C (-40°F to +185°F)
Ingress Protection – IP52 (front side mounted in conduit box along with swing cover); IP10 (rear side with protective cover)

Shock – 20 G in 3 perpendicular planes

Vibration – 2.5 G at 5 to 26 Hz; 0.050” double amplitude (27 to 52 Hz); 7 G at 53 to 500 Hz

Weight – 3.5 lb. (1590 g)

Humidity Testing – Per MIL- STD-705B, Method 711-D

Salt Fog Testing – Per MIL- STD-810E

CAN Protocol – SAE J1939

EMI Compatibility

Immunity

- Meets EN 61000-6-2: 2005 Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – immunity for industrial environments.
Emission
- Meets EN 61000-6-4: 2007 Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – emission standard for industrial environments

EMI Compatibility Tests

Immunity

- Electrostatic Discharge (ESD): IEC 61000-4-2
- Radiated RF: IEC 61000-4-3
- Electrical Fast Transient (EFT) / Burst: IEC 61000-4-4
- Conducted RF: IEC 61000-4-6
- Power Frequency and Magnetic Field: IEC 61000-4-8
- Immunity to conduct transients on Power leads

SAE J1113-11, test pulse waveforms 1c, 2a, 2b, 3a, 3b,

4 & 5a (DVR2500)

Emission

- Radiated RF: EN 61000-6-4: 2007, 30 MHz to 1000 MHz

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CONNECTIONS

Digital voltage regulator connections are dependent on the application.

MOUNTING GUIDELINES:

- Wires performing common functions, such as voltage sensing leads, should be grouped together.
- The 14 and 18 position plugs P1 and P2 need to be screwed down to the regulator during operation.
- Maximum recommended torque for the P1 and P2 mounting screws is 2.7 inch•lbf [0.3 N•m].
- Wiring terminated to P1 and P2 needs to be strain relieved to reduce stress on the wiring due to vibration.
- P1 and P2 can accept either bare wire (stranded only) or ferrules.
- Recommended strip/ferrule length of 0.393 in (10 mm) should be used for connections terminated to P1 and P2.
- Wiring routed to P1 and P2 should be strain relieved at least 6 inches from the P1 and P2.
- Wiring terminated to P1 needs to be bundled together with tie wraps to reduce strain. This is applicable to P2 also. Do not bundle wiring connected to P1 and P2 together as this adds more strain to the connections.
- Loctite* 242 or similar should be used on the screws before connecting the DB25 cable to the RTD module and DVR for better vibration withstand.
- Recommended torque for the DB25 cable connecting digital voltage regulator and RTD module is 7.0 inch•lbf [0.8 N•m].

REMOTE MOUNTING GUIDELINES:

- All digital and analog inputs connected to the digital voltage regulator should be separately routed from F+, F-, E1, E2, E3, 3 and 4 terminals.
- All digital and analog input wiring needs to be shielded.
- Shield needs to be grounded at remote end of wiring.
- For digital voltage regulator to detect the digital inputs properly, the resistance of the cable used for wiring should not exceed 50 ohms.
- Analog input may be supplied from a source up to 150 feet away.
- USB communication has a limited range of about 3 meters. For longer distance communication please use USB booster cables.
- IOGEAR GUE2118 (39 feet) is recommended for longer distances with the DVR2400/2500.
- Digital voltage regulator may need to be externally powered (DVR2500 only) for proper communication during setup.

Refer to the section on Grounding Practices for additional information.

GROUNDING AND CONNECTION PRACTICES

The following practices must be adhered to in order to ensure proper operation of the digital voltage regulator and related systems.

1. The chassis ground terminals (2) (GND) must always be connected.
2. Chassis ground (GND) near P1 and P2 needs to be terminated as close to the digital voltage regulator as possible.
3. Unstable operation might be observed if the GND terminal is not connected.
4. AUX Shield must be grounded at the source only not at the digital voltage regulator.
5. CAN shield must be connected to GND on both end of the cable.

DVR® CONNECTORS

DVR® units have five types of interface connectors:

1. Nine (9) (DVR2400), Eleven (11) (DVR2500) 1/4" quick-connect terminals for generator connections;
2. One (1) 14 position 5.08mm cage clamp style plug for B-phase CT and system interface connections;
3. One (1) 18 position 5.08mm cage clamp style plug for A and C-phase CTs, system interface and Controlled Area Network (CAN) bus interface connections (DVR2500 only);
4. One (1) 5-pin USB 2.0 Mini B type connector for the communication between the digital voltage regulator and DVRPortal™ software on the front panel; and,
5. One (1) 25 position d-sub connector for 3-wire eight (8) channel measurement through RTD module. (DVR2500 only).

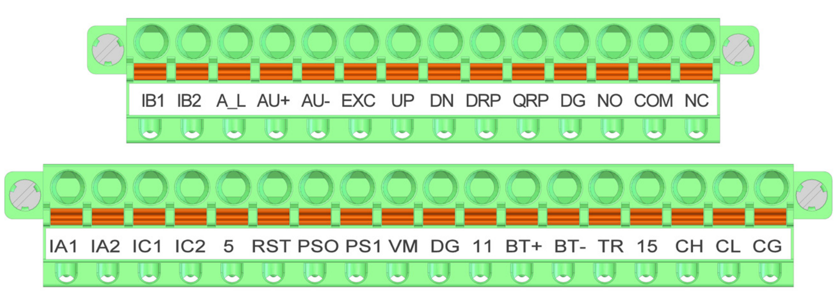

Figure 1. System Connectors P1 (top) and P2 (bottom) Terminal Positions

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QUICK CONNECT TERMINALS		APPLICATION NOTES
TERMINAL NAME	**DESCRIPTION**	
GND	Chassis ground	Use #12 AWG (4 mm²) minimum conductor.
4	PMG/External power input – terminal 2	Protected by fuse.
3	PMG/External power input – terminal 1	Protected by fuse. 180-240Vac, 250 - 300Hz, 350VA
E1	Generator armature – terminal T1	Phase A for 3 phase output. L1 input for single phase.
E2	Generator armature – terminal T2	Phase B for 3 phase output. L2 input for single phase.
E3	Generator armature – terminal T3	Phase C for 3 phase output. Jumper to E2 for single phase.
	Reserved	
	Reserved	
F-	Exciter stator – terminal F1	Excitation output. Observe polarity. **NOTICE** Never apply a voltage to these terminals.
F+	Exciter stator – terminal F2	

Table 1. Quick Connect Terminals

SENSING	PHASE	CT "X1" TERMINAL	CT "X2" TERMINAL
3-Phase (DVR2500 only)	A	P2-1 (IA1)	P2-2 (IA2)
	B	P1-1 (IB1)	P1-2 (IB2)
	C	P2-3 (IC1)	P2-4 (IC2)
1-Phase	B	P1-1 (IB1)	P1-2 (IB2)

Table 2. Current Transformer Connection Terminals
Note: The CT primaries are aligned such that the "H1" (on the CT) face is facing the generator for typical donut-style CT's.

TERMINAL NAME	NAME	DESCRIPTION
IB1	CT-B1	Generator Phase B CT – terminal 1
IB2	CT-B2	Generator Phase B CT – terminal 2
A_L	AUX_LOOP	Auxiliary current loop (DVR2500 only)
AU+	AUX IN +	Auxiliary input positive
AU-	AUX IN -	Auxiliary input negative
EXC	EXCITATION_OFF	Excitation disable contact input (active closed)
UP	UP	UP contact input (active closed)
DN	DOWN	DOWN contact input (active closed)
DRP	DROOP_OFF	Droop disable contact input (active closed)
QRP	VAR/PF_OFF	VAR/PF mode disable (active closed)
DG	DGND	Digital ground
NO	K1-NO	Contact output normally open
COM	K1-COM	Contact output common
NC	K1-NC	Contact output normally closed

Table 3. Connector P1 Terminals

TERMINAL NAME	NAME	DESCRIPTION
IA1	CT-A1	Generator Phase A CT – terminal 1
IA2	CT-A2	Generator Phase A CT – terminal 2
IC1	CT-C1	Generator Phase C CT – terminal 1
IC2	CT-C2	Generator Phase C CT – terminal 2
-	-	Reserved
RST	DVR_RESET	Reset Regulator (active closed)
PS0	PS0	Preset select line 0 (active closed)
PS1	PS1	Preset select line 1 (active closed)
VM	-	Reserved
DG	DGND	Digital ground
-	-	Reserved
BT+	BAT+	Battery input – positive
BT-	BAT-	Battery input – negative
TR	CAN_TR1	CAN terminating resistor - terminal 1
-	-	Reserved
CH	CAN_H	CAN high data line
CL	CAN_L	CAN low data line
CG	CAN_GND	CAN GND

Table 4. Connector P2 Terminals (DVR2500 only)

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HUMAN-MACHINE INTERFACE (HMI)

GENERAL

The digital voltage regulator HMI consists of four buttons and a four-character LED display as illustrated in Figure 2. The display indicates status conditions and parameter settings. Button function descriptions are given in Table 5.

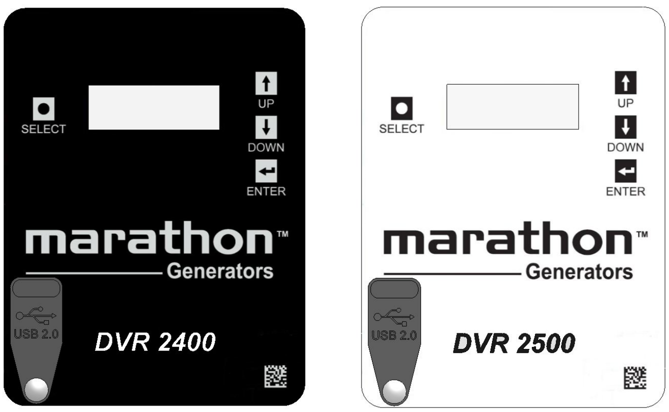

Figure 2. DVR2400 and DVR2500 HMI Shown

BUTTON	DESCRIPTION
SELECT	This button steps the user through a menu list of editable parameters. It also serves as an escape key in EDIT mode.
UP	This button increases the setting level of the parameter being adjusted.
DOWN	This button decreases the setting level of the parameter being adjusted.
ENTER	This button stores the current value of the parameter being adjusted and returns the user to the main menu list.

Table 5. DVR® HMI Button Function Descriptions

FRONT PANEL DISPLAY

The HMI display has three display modes:

1. **STATUS mode** – the HMI displays the non-editable operating state of the digital voltage regulator as described in Table 6. The display flashes while in STATUS mode.
2. **EDIT mode** - The HMI displays a multi-layer menu for reading and editing operating parameters of the digital voltage regulator as described in Table 7. The display is steady-on while in EDIT mode.
3. **SLEEP mode** – The HMI turns off the display after 60 seconds of button-press inactivity.

DISPLAY	DESCRIPTION
(no display)	No display is the default mode of the HMI. No display indicates that the regulator is operating normally, but operating in a sleep mode.
STBY	This display indicates that the regulator is operating normally and is in stand-by mode waiting for the STRT state.
STRT	This display indicates that the regulator is in a soft start state.
RUN.V	This display indicates that the regulator is operating normally with excitation in AVR mode.
RUN.I	This display indicates that the regulator is operating normally with excitation in FCR mode.
RUN.P	This display indicates that the regulator is operating normally with excitation in VAR or PF mode.
FLSH	This display indicates that the regulator is operating in field flashing mode.
IDLE	This display indicates that the regulator is operating normally and is in idle state waiting for the speed to take off.
AXXX	This display indicates that the regulator is in an alarm state. During this state, the regulator continues to provide excitation if excitation is enabled. Where xxx indicates a three-digit alarm code. See Appendix for description of Alarm Codes.
FXXX	This display indicates that the regulator is in a fault state. During this state, the regulator ceases to provide excitation. Where xxx indicates a three-digit fault code. See Appendix for description of Fault Codes.

Table 6. DVR® regulator HMI STATUS Mode Display Descriptions

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HMI PARAMETERS:

PARAMETER NAME	PARAMETER VALUE	DESCRIPTION
SIZE	281 to 1040	Frame size of generator
rEG	AVR3	AVR3 – Voltage regulation with three-phase sensing.
	AVR1	AVR1 – Voltage regulation with single-phase sensing.
	FCR	FCR – Field current regulation.
	VAR	VAR – Reactive VAR regulation.
	PF	PF – Power Factor regulation.
StPt	100.0 to 630.0	Voltage set point (Vrms) in AVR3 and AVR1 mode.
	0.000 to 4.000	Field current set point (Adc) in FCR mode.
	0% to 100%	VAR set point (% of rated VAR) in VAR mode.
	-0.600 to 0.600	PF set point (PU) in PF mode.
UFrQ	40.0H to 70.0H	Under frequency knee (Hz).
SLoP	1.00U to 5.00U	Under frequency slope multiplier.
Pr	0 to 6000	Rated power of generator (kW).
PFr	0.600 to 0.900	Rated power Factor of generator (per unit).
Pt	1.0 to 150.0	Potential transformer ratio.
Ct	1 to 2000	Current transformer ratio.
droP	0.0% to 10.0%	Voltage droop (%) at rated reactive power.
AU	OFF	Auxiliary Off – Auxiliary input is disabled.
	CNT1	Auxiliary Control-1 – Auxiliary input modifies regulation set point (±3 or ±5 or ±10 Vdc input).
	CNT2	Auxiliary Control-2 – Auxiliary input modifies regulation set point (4 to 20 mA input) (DVR2500 only).
	SLOP	Dynamic Slope - Auxiliary input modifies under frequency slope multiplier (0 - 5V) (DVR2500 only).

Table 7. DVR® regulator HMI EDIT Mode Parameters

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DVR®2400 and DVR2500 Digital Voltage Regulator

Quick Start Guide

Preliminary Setup

As the digital voltage regulator is designed to work on many Marathon® generators in many different applications, it is necessary to program the regulator prior to putting it in service. Please observe the following procedure to program the regulator through the Human-Machine Interface or HMI:

ON GENERATOR (Powering DVR® regulator through PMG):

The digital voltage regulator may be configured on the generator using the following procedure:

1. Before starting the engine, disconnect regulator leads 3, 4, F+ and F-. Temporarily insulate them to prevent accidental shorting. This will prevent the generator's PMG from energizing the regulator and prevent unintended operating functions from occurring.
2. Perform all preliminary engine governor adjustments with the regulator de-energized.
3. After initial governor adjustments are complete, shut down the prime mover. Reconnect 3 and 4 leads.
4. Start and run the generator at rated speed. The regulator may indicate rUn.i or status on the display.
5. At this time, initial adjustments can be made via the HMI.
6. After the initial adjustments are made, shut down the generator and reconnect the regulator leads removed in Step 1. The generator may be started and final adjustments may be performed on the regulator.

ON BENCH:

The digital voltage regulator may be configured on a bench using the following procedure:

1. Connect a 100-120 Vac 50/60 Hz source to terminals 3, 4 and GND as follows:
   a. 120 V hot – terminal 3
   b. 120 V neutral – terminal 4
   c. 120 V ground – terminal GND

   (OR)

   If configuring through DVRPortal™ software, DVR communication circuit can be powered through the USB port. This will eliminate the necessity of powering the DVR regulator through terminals 3, 4 and GND.

   Note: USB should be capable of providing 0.4 Adc to the digital voltage regulator for proper communication. HMI, power on LED indicator and other functions will be non-operational.

   (OR)

   Connect a 12/24-volt battery input to terminals P2-12 (BT+) and P2-13 (BT-) for DVR2500.

   Note: Battery should be capable of providing 0.8 Adc.

   Applying voltage larger than 120 Vac without in-rush current limiting may damage the unit.

2. If the regulator is in AVR1 or AVR3 regulation mode, the regulator will indicate STBY on the display. If the regulator is in FCR regulation mode, the regulator will indicate rUn.i on the display.

3. At this time, initial adjustments can be made. If adjusting through HMI see instructions below. If adjusting via the DVRPortal™ Windows* communication software, see IOM Manual.

After the initial adjustments are made, disconnect the power source and install the regulator onto the generator. The generator may be started and final adjustments may be performed on the regulator.

MAKING SETTINGS CHANGES THROUGH HMI

1. The default state of the HMI display is SLEEP mode. The HMI will enter the SLEEP mode after 60 seconds of inactivity (no button presses). Any HMI button press will place the HMI into STATUS mode. In order to make changes to settings, the following procedure is used:
2. Repeatedly press the SELECT button, stepping through the main menu until the desired parameter is displayed (see Table 7).
3. Press the ENTER button to place the HMI into EDIT mode. In EDIT mode, the HMI will display the current value of the selected parameter.
4. Press or hold the UP and DOWN buttons to modify the displayed parameter to its desired value. Parameter changes take immediate effect.
5. To store the displayed parameter value to non-volatile memory, press the ENTER button. The stored parameter value will flash three times to confirm the entry.

NOTE: While in STATUS mode, pressing either the UP or DOWN button places the regulator directly into StPt EDIT mode. This feature allows a shortcut to set point adjustment.

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APPENDIX A

ALARM CODES

During an alarm condition, the HMI will display the code of the corresponding alarm condition. The table can be used to determine what condition is causing the alarm.

Alarm Codes

A001	Unused
A002	Field Under Excitation
A003	Real Time Clock Battery Low
A004	Generator Battery Low
A005	RTD Pre-Alarm/ Over Temperature/ Open / Short Circuit
A006	Loss of CAN Communication
A007	Regulator Over Temperature
A008	Field Over Excitation
A009	Unused
A010	Unused
A011	Loss of Auxiliary Current Sensing
A012	Generator Under Voltage
A013	Generator Over Voltage
A014	Generator Reverse Power Flow
A015	Generator Under Frequency
A016	Generator Voltage Imbalance

Table A-1. Alarm Codes

FAULT CODES

During a fault condition, the HMI will display the code of the corresponding fault condition. The table can be used to determine what condition is causing the fault.

Fault Codes

F001	Unused
F002	Field Under Excitation
F003	Generator Parallel Shutdown
F004	Generator Parallel Start Up
F005	RTD Over Temperature
F006	Unused
F007	Regulator Over Temperature
F008	Field Over Excitation
F009	Instantaneous Field Over Current
F010	Unused
F011	Generator Loss of Sensing
F012	Generator Under Voltage
F013	Generator Over Voltage
F014	Generator Reverse Power Flow
F015	Unused
F016	Generator Voltage Imbalance

Table A-2. Fault Codes

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GENERAL SAFETY INSTRUCTIONS

Before installing, using, or servicing this product, carefully read and fully understand the instructions including all warnings, cautions, and safety notice statements. To reduce risk of personal injury, death and/or property damage, follow all instructions for proper generator installation, operation and maintenance.

Although you should read and follow these instructions, they are not intended as a complete list of all details for installations, operation, and maintenance. If you have any questions concerning any of the procedures, or if you have a safety concern not covered by the instructions, STOP, and contact the generator manufacturer.

DEFINITION: The word Generator, as used in this publication, includes only the products of Regal Beloit America, Inc., and does not include the prime mover or any of the prime mover related systems or accessories.

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

EXPLOSION HAZARD

- Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

ROTATING PARTS HAZARD

- Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

OVERSPEED HAZARD

- Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

DO NOT DISASSEMBLE

- Only qualified personnel who know local, national, international and/or other applicable codes, rules or regulations and sound practices should install or repair electric generators and voltage regulators. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ WARNING

MAGNETIC FIELD HAZARD

- Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which could cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

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GENERAL

OVERVIEW

This manual provides details on how to install, operate and maintain a DVR®2400 or DVR®2500 digital voltage regulator with Marathon® synchronous generators. A separate publication is available for Controller Area Network (CAN) communications.

The regulator is a control device that regulates the output voltage of a brushless, AC generator by controlling the current into the generator exciter field. Input power to the regulator is derived from a single phase permanent magnet generator (PMG).

The regulator is supplied in an encapsulated package designed for behind-the-panel mounting. It is held in place by thread-forming screws that thread into mounting holes in the face of the regulator. The front panel display annunciates regulator status and system conditions.

MANUAL CONVENTIONS

This manual describes details of the DVR®2400 and DVR®2500 voltage regulators. Features that are exclusive to the DVR®2500 regulator are noted.

REGULATION MODES

Five regulation modes:

- Single phase automatic voltage regulation (AVR1)
- Three phase automatic voltage regulation (AVR3)
- Field current regulation (FCR).
- Reactive power regulation (VAR)
- Power factor regulation (PF)

FEATURES

The DVR® regulator has the following features:

- Preset stability settings based on generator frame size
- Adjustable soft start in AVR1 or AVR3 regulation modes
- Under frequency (Volts/Hertz) regulation
- True RMS Three-phase or single-phase generator voltage sensing
- True RMS current sensing, single phase on the 2400, three phase on the 2500; (optional CT's required)
- True RMS power metering, single phase on the 2400, three phase on the 2500; (optional CT's required)
- Field current sensing
- Contact inputs for system interface capability
- Contact output for fault indication
- Generator paralleling with reactive droop compensation and reactive differential compensation
- Front-panel human-machine interface (HMI) for status and configuration
- MODBUS protocol via USB2.0 for external communication
- DVRPortal™ software for configuration and monitoring
- "Power on" LED indicator
- Configurable auxiliary input for metering and control
- Simulated reactive power for droop set-up
- CAN interface with CAN 2.0B J1939 protocol for metering and control (2500)
- Generator power limiting mode (2500)
- Configurable Parameter Presets selectable through digital inputs (2500)
- 8 Channel 3-wire PT100 RTD metering (2500) through an external module

PROTECTION

The DVR® regulator has the following protection features:

- Field Over Excitation Shutdown
- Field Under Excitation Shutdown
- Generator Over Voltage Shutdown
- Generator Under Voltage Shutdown
- Generator Voltage Imbalance Shutdown
- Generator Reverse Power Shutdown
- Loss of Generator Sensing Shutdown
- Instantaneous Field Over Current Shutdown
- Regulator Over Temperature Shutdown
- Generator Parallel Start-Up Shutdown
- Generator Parallel Shutdown Shutdown
- RTD Over Temperature Shutdown (2500)
- Loss of CAN Communication Alarm (2500)
- RTD Pre Alarm Temperature (2500)
- Loss of Aux Input Control Current Alarm (2500)
- Loss of RTD Element -Open Alarm (2500)
- Loss of RTD Element - Short Alarm (2500)
- Genset Battery Low Alarm (2500)

LIMITERS

- Exciter Field Current Limit
- Generator Under Frequency Limit
- Generator Power Limit (2500)

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100 East Randolph Street
Wausau, WI 54402-8003
www.regalbeloit.com/Brands/
Marathon-Generators

FORM
SB0056E
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SPECIFICATIONS

OPERATING POWER

PMG Input:	
Type:	1-phase, ungrounded PMG
Range:	180 - 240 Vac, 250 - 300 Hz
Burden:	350 VA
Fuse Type:	Time delay 250V - 5.0 A
Terminals:	3, 4

GENERATOR VOLTAGE SENSING

Type:	1-phase/3-phase
Range:	100 to 600 Vac, 50/60 Hz
Burden:	<1 VA per phase
Terminals:	E1, E2, E3

GENERATOR CURRENT SENSING

Type:	1-phase (Bø) (2400) / 3-phase (2500)
Rating:	5 Aac continuous, 50/60Hz
Input Impedance:	<10 mΩ
Terminals:	IB1, IB2 for 1-phase (BØ) IA1, IA2 for 3-phase (AØ) (2500) IC1, IC2 for 3-phase (CØ) (2500)

BATTERY INPUT (DVR 2500 REGULATOR)

Type:	DC
Range:	12 - 24 Vdc
Burden:	10 VA
Terminals:	P2-12 (BT+), P2-13 (BT-)

CONTACT INPUTS

Type:	Dry Contact
Input PU Voltage:	3.3 Vdc
Source Current:	up to 5mA DC
Terminals:	
EXCITATION_OFF:	P1-6 (EXC), P1-11 (DG)
UP:	P1-7 (UP), P1-11 (DG)
DOWN:	P1-8 (DN), P1-11 (DG)
DROOP_OFF:	P1-9 (DRP), P1-11 (DG)
VAR/PF_OFF:	P1-10 (QPF), P1-11 (DG)
DVR® RESET:	P2-6 (RST), P2-10 (DG) (2500)
PS0 (Presets):	P2-7 (PS0), P2-10 (DG) (2500)
PS1 (Presets):	P2-8 (PS1), P2-10 (DG) (2500)

FAULT CONTACT OUTPUT

Type:	Form C
Carry Current:	7 Aac/5 Adc continuous
Break Current:	7 Aac / 0.1 Adc
Operating Voltage:	240 Vac / 30 Vdc maximum
Terminals:	P1-12 (NO), P1-13 (COM), P1-14 (NC)

FIELD OUTPUT

Continuous Rating:	100 Vdc, 4.0 Adc
10 Second Forcing Rating	
200 Vac Power Input:	190 Vdc, 7.5 Adc
Field Resistance:	15 to 35 Ω
Terminals:	F+, F-

AVR1 and AVR3 OPERATING MODES

Range:	100.0 to 630.0 Vac
Voltage Regulation:	±0.25 % over load range at rated power factor and constant generator frequency.
Temperature Drift:	±0.0125 % per degree C
Soft-Start Range:	2 to 120 seconds
Under frequency (V/Hz)	
Under Frequency Slope:	1.00 to 5.00 PU
Under Frequency Knee:	40.0 to 70.0 Hz

FCR OPERATING MODE

Range:	0.000 to 4.000 Adc
Current Regulation:	±1.0% over 15 to 35 Ohms of exciter resistance
Temperature Drift:	±0.0125% per degree C
Setpoint Integration Time:	0.0 to 15.0 seconds

VAR OPERATING MODE

Range:	-100.0% to +100.0% of rated kVAR
VAR Regulation:	±3.0 % of rated kVAR
Temperature Drift:	±0.0125 % per degree C

PF OPERATING MODE

Range:	-0.600 to +0.600 PU
PF Regulation:	±0.02 PU
Temperature Drift:	±0.0125 % per degree C

PARALLEL COMPENSATION

Modes:	Reactive droop and reactive differential (cross-current)
Droop Range:	0.0 to 10.0 %

PC COMMUNICATION PORT

Interface:	USB 2.0
Connector:	Mini B type (HMI/front panel access)

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CAN COMMUNICATION PORT (2500)

Connector:	P2-14 (TR), 16 (CH), 17 (CL), 18 (CG)
Protocol:	SAE J1939
Data Rate:	250 kbits/sec

AUXILIARY INPUT

Auxiliary – Control1 Mode

AVR3, AVR1, VAR or PF regulation:

Voltage Range:	-3.00 Vdc to +3.00 Vdc -10.00 Vdc to +10.00 Vdc (2500)
Set Point Range:	-X to +X % shift where X = 1.0 to 30.0
Burden:	2260 Ω
Terminals:	P1-4 (AU+), P1-5 (AU-)

FCR regulation:

Voltage Range:	0.000 Vdc to +4.000 Vdc
Set Point Range:	0.000 Adc to + 4.000 Adc
Increment:	1 mA per 1mV
Burden:	2260 Ω
Terminal:	P1-4 (AU+), P1-5 (AU-)

Auxiliary – Control2 Mode (2500):

AVR3, AVR1, VAR or PF regulation

Current Range	4 mA to 20 mA
Set Point Range:	-X to +X % shift where X = 1.0 to 30.0
Burden:	250 Ω
Terminals:	P1-4 (AU+), P1-5 (AU-)
Jumper:	P1-3 (A_L) to P1-4 (AU-)

FCR regulation

Current Range	4 mA to 20 mA
Set Point Range:	0.000 Adc to + 4.000 Adc
Increment:	1 mA per 2.0 uA
Burden:	250 Ω
Terminal:	P1-4 (AU+), P1-5 (AU-)
Jumper:	P1-3 (A_L) to P1-4 (AU-)

Dynamic Under-Frequency (UF) Slope Modifier

(AVR1 and AVR3 modes) (2500)

Voltage Range:	0.00 Vdc to +5.00 Vdc
UF Slope Range:	0.0 to 5.0
Increment:	0.8 PU slope per 1.00 V
Burden:	2260 Ω
Terminals:	P1-4 (AU+), P1-5 (AU-)

METERING

Accuracy of all metering values assumes 25° C, 50/60 Hz and less than 20 % THD.

Regulator-side Metering

<u>Generator Voltage</u>

Range:	10 Vac to 600 Vac
Resolution:	0.1V
Accuracy:	0.5 %

<u>Generator Current</u>

Range:	0.1 to 5.000 Aac (5 Aac CTs)
Accuracy:	0.5 %

<u>Power (Apparent, Real and Reactive)</u>

Range:	0 to 5200 VA and W 0 to 4160 VAR leading/lagging
Accuracy:	3.0 %

<u>Power Factor</u>

Range:	0.6 to 1.0 leading/lagging
Accuracy:	0.02

<u>Frequency</u>

Range:	40 to 75 Hz
Accuracy:	0.2 Hz

<u>Field Current</u>

Range:	0 to 8.0 Adc
Accuracy:	0.5 %

Generator-side (Scaled) Metering

<u>Generator Voltage</u>

Range:	10 V to 15 kV
Accuracy:	0.5 %

<u>Generator Current</u>

Range:	0.1 to 5,000 Aac (5 Aac CTs)
Accuracy:	0.5 %

<u>Power (Apparent, Real and Reactive)</u>

Range:	0 to 10 MVA and MW 0 to 8 MVAR leading/lagging
Accuracy:	3.0 %

ENVIRONMENTAL

Operating Temperature:
-40°C to +70°C (-40°F to +158°F)
Storage Temperature:
-40°C to +85°C (-40°F to +185°F)

Relative Humidity:	< 95 %, non-condensing
Ingress Protection:	IP52 (Front, mounted) IP10 (rear with cover)

ENVIRONMENTAL TESTS

Humidity:	Tested per MIL-STD-705B, Method 711-D in vertically mounted position
Salt Fog:	Tested per MIL-STD-810F Method 509 in vertically mounted position

ELECTROMAGNETIC COMPATIBILITY

Immunity: Meets EN 61000-6-2: 2005 Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments

Emission: Meets EN 61000-6-4: 2007 Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments

Electromagnetic Compatibility Tests

Immunity

Electrostatic Discharge (ESD):	IEC 61000-4-2
Radiated RF:	IEC 61000-4-3
Electrical Fast Transient (EFT) / Burst:	IEC 61000-4-4
Conducted RF:	IEC 61000-4-6
Power Frequency and Magnetic Field:	IEC 61000-4-8

Emission

Radiated RF: EN 61000-6-4: 2007, 30 MHz to 1000 MHz

SAE J1113-11:2007 (2500) (BT+ & BT- Terminals)
Immunity to conducted transients on power leads.
Pulse 1c, 2a, 2b, 3A, 3B, 4 and 5a

MECHANICAL TESTS

Shock:	20 Gs in 3 perpendicular planes
Vibration:	2.5 Gs at 5 to 26 Hz 0.050” double amplitude (27 to 52 Hz) 7 Gs at 53 to 500 Hz

PHYSICAL

Weight: 3.5 lb. (1590 g)

MATING CONNECTORS

H1:
Mating Plug Housing: P1, Phoenix®* Contact 1873320 or equivalent

H2:
Mating Plug Housing: P2, Phoenix* Contact 1707942 or equivalent

USB:

Mating Cable:	Molex®* Connector 88732-8900 or equivalent
Maximum Length:	3 meters

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⚠ WARNING

Before proceeding forward, carefully read and fully understand the warnings, cautions, & safety notice statements in this manual. Failure to do so could cause severe injury, death, and/or equipment damage.

FEATURES AND PROTECTION

INTRODUCTION

This section describes how the regulator functions and explains its operating features. Regulator functions are illustrated in the block diagram of Figure 4-1.

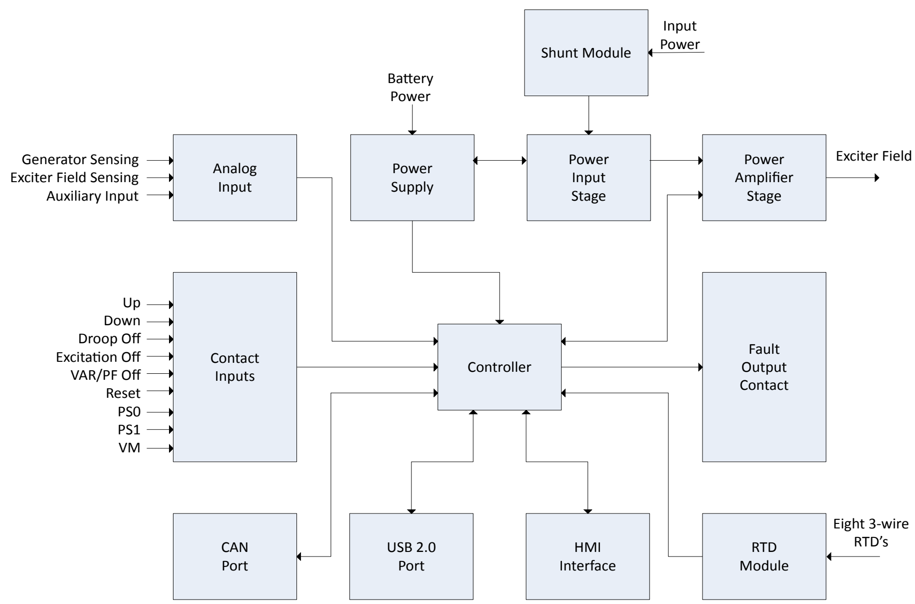

Figure 4-1. Simplified Block Design

DVR® REGULATOR FUNCTION BLOCKS

The following paragraphs describe each of the function blocks, inputs and outputs. Refer to Figure 4-1.

Generator Voltage

Generator voltage is measured at terminals E1 (A-phase), E2 (B-phase), and E3 (C-phase), for ABC rotation, or E1 (C-phase), E2 (B-phase), and E3 (A-phase) for CBA rotation. Nominal voltages of up to 600Vac may be sensed at these terminals. Voltage applied to these inputs is scaled, conditioned and applied to the controller.

Line Currents

Generator line currents (IA, IB, IC) are measured via CTs at connectors P1 and P2. Current up to 5 Arms may be monitored at these terminals. These currents are scaled, conditioned and applied to the controller. Refer to Section - Specifications, for connector pin assignments.

Field Current

Current through the exciter field winding is measured at terminal F+. Field current is scaled, conditioned and applied to the input of the controller.

Contact Input Circuits

Nine contact input circuits powered from an internal 3.3 Vdc supply provide input control from user-supplied contacts: UP, DOWN, DROOP_OFF, EXCITATION_OFF, VAR/PF_OFF, *PS0, *PS1, *DVR_RESET and *VM (*2500 only)

UP

Closing the UP contact across terminals P1-7 (UP) and P1-11 (DG) causes the active operating set point to increase.

DOWN

Closing the DOWN contact across terminals P1-8 (DN) and P1-11 (DG) causes the active operating set point to decrease.

Keeping either contact closed will continue to increase (UP) or decrease (DOWN) the operating set point until a limit is reached. The limit is determined by the Maximum External Contact Adjust field of DVRPortal™ software. The effect generated by the contacts is displayed in DVRPortal™ software on the Set Points Tab as the value "Contact Offset."

Note:
1. The regulator incorporates an adjustable ramp rate for UP/DOWN contacts. This value can be used to adjust ramp rate at which the setpoint changes when a UP or DOWN contact is closed. This can be adjusted from 0.1 %/sec to 15.0 %/Sec.
2. The regulator incorporates a RETAIN/ RESET feature for external contact adjust (UP and DOWN) which allows the regulator to either save (RETAIN) the offset caused by UP or DOWN contact or forget (RESET) the offset after power cycle. This feature is only enabled in AVR1/AVR3 modes. Refer to Section 8 - Graphical User Interface, Digital I/O.
3. In FCR mode, UP/DOWN contact can be used to adjust the field current between 0 and 4.000 Adc. Maximum external contact adjust setting is not applicable in FCR mode.

Note: Saving the offset will happen once the UP/DOWN contact change is detected and the the regulator is in AVR1/AVR3 mode.

DROOP_OFF
This function enables reactive load sharing between generators operating in parallel. Closing the DROOP_OFF contact across terminals P1-9 (DRP) and P1-11 (DG) disables voltage droop. Opening the contact enables voltage droop. Reactivate load sharing is enabled in AVR1, AVR3, PF and VAR regulation modes through this contact. Ensure that QPF contact sets the VAR/PF regulation to disable.

EXCITATION_OFF
This contact input disables field excitation without removing power to the regulator. Closing the EXCITATION_OFF contact across terminals P1-6 (EXC) and P1-11 (DG) disables field excitation. Opening the contact enables field excitation with a soft start and clears any alarms or faults.

VAR/PF_OFF
Caution: Operation in VAR or PF modes should only be enabled when generator is paralleled with utility (infinite bus).

This function enables VAR or PF regulation when the generator is paralleled to utility. Opening the VAR/PF_OFF contact across terminals P1-10 (QPF) and P1-11 (DG) enables VAR or PF control. Closing the contact disables VAR or PF regulation and defaults to AVR3 regulation.

Note: DROOP OFF, EXCITATION OFF and VAR/PF OFF polarity can be configured using DVRPortal™ software. By default, these are set to active low. Polarities of these contacts can be set only in Preset 1 in case of the 2500. Refer to Section - Graphical User Interface, Digital I/O.

PS0 & PS1:
The DVR®2500 voltage regulator provides the ability for the user to select one of the four available configurations in the regulator. This is achieved by changing the contact inputs P2-7 (PS0) and P2-8 (PS1) with respect to P2-10 (DG).

PS1	PS0	Preset
Open	Open	Preset1
Open	Closed	Preset2
Closed	Open	Preset3
Closed	Closed	Preset4

Note: Changes will only take effect when in standby mode.

DVR_RESET:
The DVR®2500 voltage regulator provides the ability for user to reset the regulator without requiring a power cycle by toggling the RESET contact across terminals P2-6 (RST) and P2-10 (DG).

Communication Port (USB 2.0)
The communication port provides an interface for user programming the regulator through DVRPortal™ software. The connection is made to the female USB mini B type connector with a user-supplied, standard USB 2.0 A to mini B type USB cable.

Note:
A. The DVR®2500 voltage regulator can be programmed through the USB connection without additional power provided by an AC supply or a battery (2500).
   Note: Power ON LED or HMI will not be illuminated
B. USB port should be able to provide 400mAdc current while powering only through the USB.
C. In case of using USB extender/booster cable, the regulator needs to be powered either through AC power or battery (2500). Recommended USB 2.0 booster cable GUE2118 or similar.
D. In order for the regulator to communicate properly via USB, proper USB drivers need to be installed. Driver is typically installed during DVRPortal™ software installation. This can be downloaded from the following link http://www.ftdichip.com/Drivers/VCP.htm for FT232 chipset.
E. Use of USB hubs is not recommended for communication purposes.

CAN Port (2500)

The CAN port provides an isolated interface for communication and control of the regulator. This permits the integration of the regulator as a node on a CAN network. The connection is made to the P2-14 (TR), 16 (CH), 17(CL) 18 (CG) terminals. The CAN communication is powered from an on-board isolated supply.

Note: Jumpering terminals CL and TR will provide an internal terminating resistor of 120 ohms.

Controller

The controller portion of the regulator includes the microprocessor and performs measurement, computation, control and communication functions.

Power Input Stage

Input power is applied to terminals 3 and 4 from a PMG. It is rectified and filtered before being applied to the power amplifier and the power supply.

Power Supply

The internal switch-mode power supply is fed from the power input stage and supplies power at the required DC voltage levels to the internal circuitry of the regulator.

Note: Sudden loss of excitation power could lead to the 2500 RESET even though battery voltage is present.

Power Amplifier Stage

The power amplifier is fed from the power input stage and supplies a controlled amount of power to the exciter field via terminals F+ and F-.

HMI Interface

A four-character light-emitting-diode (LED) display indicates various operating modes, protective functions, and adjustments. Section - Human-Machine Interface provides more information about the front panel display. Changes to settings can be made at the front panel using the four buttons:

- SELECT, UP, DOWN and ENTER
  Refer to Section - Human-Machine Interface for more information about the front panel switches.

- RTD Module (2500):
  An eight (8) three-wire RTD interface to the 2500 can be provided through the RTD module. This module is interfaced to the J2 connector on the regulator via a DB25 cable. Refer to Section - Auxiliary Modules for more information about RTD protection configuration.

Fault Output Contact

A fault output contact is provided through terminals P1-12, P1-13 and -P1-14. This Form-C relay closes contacts between P1-12 and P1-13 or opens contacts between P1-13 and P1-14 in the event of a protective shutdown.

DVR® REGULATOR OPERATING FEATURES

REGULATION MODES

The 2400 and 2500 provide five modes of regulation selectable through the HMI or through the DVRPortal™ software.

Automatic Voltage Regulation Modes (AVR)

There are two automatic voltage regulation modes. AVR1 should be selected if the regulator is connected for single phase voltage sensing and AVR3 should be selected if the regulator is connected for three phase voltage sensing. In either mode, the regulator regulates the generator RMS output voltage. Regulation is accomplished by sensing generator output voltage and adjusting dc output excitation current to maintain voltage at the regulation set point. The regulation set point is adjusted via the UP and DOWN contact inputs, the auxiliary input (when enabled), the HMI or DVRPortal™ software. The Droop and Under Frequency functions may influence the regulation set point.

Field Current Regulation Mode (FCR)

In FCR mode, the regulator maintains DC excitation current at a commanded level. The regulation set point is adjusted via the UP and DOWN contact inputs, the auxiliary input (when enabled), the HMI or the portal.

Reactive Power Regulation Mode (VAR)

In Reactive Power Regulation (VAR) mode, the regulator maintains the generator's reactive power at a commanded level. The regulation set point is adjusted via the UP and DOWN contact inputs, the auxiliary input (when enabled), the HMI or the portal. This mode can only be entered by selecting "VAR" as the regulation mode and opening the VAR/PF_OFF contact input.

Power Factor Regulation Mode (PF)

In Power Factor Regulation (PF) mode, the regulator maintains the generator's power factor at a commanded level. The regulation set point is adjusted via the UP and DOWN contact inputs, the auxiliary input (when enabled), the HMI or the portal. This mode can only be entered by selecting "PF" as the regulation mode and opening the VAR/PF_OFF contact input.

AUXILIARY INPUT

Note: If the DC voltage is removed from the auxiliary input, the operating set point will no longer be modified and the regulator will regulate to the programmed regulation set point.

Functionality of the auxiliary input is dependent on the configuration of the modes described below. The auxiliary input can be set to Off, Control1, Control2 or Dynamic Slope mode through the HMI or the DVRPortal™ software. The effect of the auxiliary input on the set point is displayed in DVRPortal™ software.

Auxiliary – Off

In this mode, any signal applied to the auxiliary input will be displayed in DVRPortal™ software, but will have no effect on the set point of the regulator.

Auxiliary – Control1

This mode allows modification of the regulation set point by the application of a positive or negative DC voltage across terminals P1-4 (AU+) and P1-5 (AU-). A voltage up to +/- 3 Vdc may be applied at this input.
Note: The 2500 provides selectable ranges of +/-5 Vdc or +/-10 Vdc through DVRPortal™ software and configurable range up to 30%. These ranges are selectable only for AVR1, AVR3, VAR of PF regulation modes.

When in AVR3 or AVR1:
The application of a +/- 3.000 Vdc signal corresponds to a percentage offset of up to +/- 30.0% to the set point. If the voltage range is selected as +/-10V in the 2500, the application of a +/-10.000 signal will correspond to a percentage offset of up to +/-30% to the set point.

Example: A programmed regulation set point of 480 Vrms, with an auxiliary input scale factor of 30% and an auxiliary input of -1 Vdc will result in a -10% (–48 Vrms) offset to the set point. Therefore, the regulator will regulate to a reference voltage of 432 Vrms.

When in FCR:
The application of a -/+ 4.000 Vdc signal corresponds to a 0.000 to +4.000 Adc field current set point. The auxiliary input scale factor is disabled in FCR mode.

Note: Any field current reference less than 0.000 Adc will become 0.000 Adc.

Example: The application of a 1.25 Vdc signal will result in a field current of 1.250 Adc.

When in VAR:
The application of a +/- 3.000 Vdc signal corresponds to a percentage offset of up to +/- 30.0% to the VAR set point.

Example: A programmed VAR regulation set point of 50.0% with an auxiliary input scale factor of 30.0% and an auxiliary input of -1 Vdc will result in a –10.0% offset to the VAR set point. Therefore, the regulator will regulate to 40.0% of rated VAR's.

When in PF:
The application of a +/- 3.000 Vdc signal corresponds to an offset of up to +/- 0.300 PU to the power factor set point.

Example: A programmed power factor regulation set point of 0.950 (lagging power factor) with an auxiliary input scale factor of 30.0% and an auxiliary input of -1 Vdc will result in a –0.100 offset to the power factor set point. Therefore, the regulator will regulate to a power factor of -0.950. In this case, the power factor has gone from a lagging to a leading state.

Auxiliary – Control2 (DVR®2500 regulator only)

This mode allows modification of the regulation set point by the application of a 4 mA to 20 mA current control signal at terminals P1-4 (AU+) and P1-5 (AU-). This mode requires the placement of a jumper across terminals P1-3 (A_L) and P1-4 (AU+).

Note: If loss of auxiliary control current alarm is enabled and if the sensed current is below the alarm threshold the auxiliary bias will be set to zero. If the alarm is disabled, the bias will saturate to lower end of the user chose bias limit.

When in AVR3 or AVR1:
The application of a 4 mA to 20 mA input corresponds to a percentage offset of up to +/- 30.0% to the voltage set point.

Example: A programmed regulation set point of 480 Vrms, with an auxiliary input scale factor of 30% and an auxiliary input of 9.33 mA will result in a –48 Vrms offset to the set point. Therefore, the regulator will regulate to a reference voltage of 432 Vrms.

When in FCR:
The application of a 4 mA to 20 mA signal corresponds to a 0.000 to +4.000 Adc field current set point. The auxiliary input scale factor is disabled in FCR mode.

Note: Any field current reference less than 0.000 Adc will become 0.000 Adc.

Example: A field current set point of 1.000 Adc with the application of a 11.00 mA signal will result in a total field current of 0.500 Adc.

When in VAR:
The application of a 4 mA to 20 mA signal corresponds to a percentage offset of up to +/- 30.0% to the VAR set point.

Example: A programmed VAR regulation set point of 50.0% with an auxiliary input scale factor of 30.0% and an auxiliary input of 9.33 mA will result in a –10.0% offset to the VAR set point. Therefore, the regulator will regulate to 40.0% of rated VARs.

When in PF:
In the PF regulation mode, the application of a 4 mA to 20 mA signal corresponds to an offset of up to +/- 0.300 PU to the power factor set point.

Example: A programmed power factor regulation set point of 0.950 (lagging power factor) with an auxiliary input scale factor of 30.0% and an auxiliary input of 9.33 mA will result in a –0.100 offset to the power factor set point. Therefore, the regulator will regulate to a power factor of -0.950. In this case, the power factor has gone from a lagging to a leading state.

Auxiliary - Dynamic Slope (DVR®2500 regulator only):
The 2500 regulator provides a mode in which an auxiliary voltage of 0 to +5V supplied between terminals P1-4 (AU+) and P1-5 (AU-) can be used to influence the under-frequency slope multiplier from 1.0 - 5.0 or 5.0 - 1.0 based on dynamic slope polarity while in AVR1 and AVR3 regulation modes. See Figure 4-2.

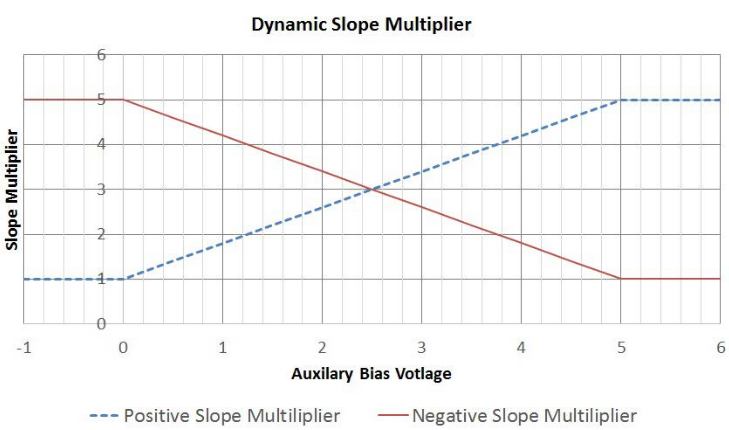

Figure 4-2. Dynamic Slope Multiplier

LOAD SHARING

Note: The machine nameplate rated power, rated power factor, CT Ratio and PT Ratio (if applicable) MUST be entered to calculate the proper rated reactive power for the droop reference.

The regulator provides a reactive droop compensation feature to enable reactive load sharing during parallel generator operation. When this feature is enabled, the regulator calculates the reactive portion of the generator load using the sensed generator output voltage and current quantities and then modifies the voltage regulation set point accordingly.

A unity power factor generator load results in almost no change in generator output voltage. A lagging power factor generator load (inductive) results in a reduction of generator output voltage. A leading power factor generator load (capacitive) results in an increase of generator output voltage.

Droop is adjustable up to 10.0% with rated reactive power (VAR's) and rated power factor. The effect of droop on the set point is displayed in the DVRPortal™ software. The droop feature is enabled and disabled through the DROOP_OFF contact input circuit (terminals P1-9 (DRP) and P1-11 (GND). When single-phase current sensing is used, the droop function responds to phase B current. When three-phase current sensing is used, the droop function responds to the average phase current. Reactive load sharing in AVR1, AVR3, VAR and PF modes.

GENERATOR SOFT START

The regulator incorporates an adjustable soft start feature that controls the time for generator voltage to ramp to the regulation set point. This feature is enabled in AVR3 and AVR1 regulation modes. The ramp rate is adjustable from 2 to 120 seconds (default of 3 seconds). This adjustment is made through the portal and cannot be made through the HMI. The Generator Under Frequency feature is also active during Generator Soft Start and takes priority in control of the generator voltage.

⚠ WARNING

Before proceeding forward, carefully read and fully understand the warnings, cautions, & safety notice statements in this manual. Failure to do so could cause severe injury, death, and/or equipment damage.

⚠ WARNING

Incorrect setting for the protective functions can harm the DVR regulator and the alternator and can cause severe injury, death, and/or equipment damage.

PROTECTION FUNCTIONS

CONFIGURABLE SHUTDOWNS

Protection Feature	Customer Disable/ Enable	Alarm Variable	Alarm Threshold Range	Alarm Reset Hysteresis	Threshold Units	Basis	Timer Range	Timer Units	Alarm Code	Fault Code
Field Over-excitation	No	Exciter Field Current	0.50 to 5.00	0.5 - 5.0	A	N/A	1.0 to 15.0	S	A008	F008
Field Under-excitation	Yes	Total Reactive Power	-100.0 to -5.0	0.0 - 5.0	%	Rated Reactive Power (kVAR)	1.0 to 15.0	S	A002	F002
Generator Over-voltage	No	AVR1: Generator Line-line Voltage AVR3: Average of Generator Line-line Voltage	5.0 to 20.0	0.0 - 5.0	%	Voltage Set-point	0.1 to 15.0	S	A013	F013
Generator Under-voltage	Yes		5.0 to 50.0	0.0 - 5.0	%	Voltage Set-point	1.0 to 15.0	S	A012	F012
Generator Voltage Imbalance	No	AVR1: Not Enabled AVR3: Difference of Max. & Min. Line-line voltage	20.0 to 35.0	0.0 - 5.0	%	AVR3: Average of Three Generator Line-line Voltages	1.0 to 15.0	S	A016	F016
Generator Loss of Sensing AVR1	Yes	Yes	10.0 - 40.0	N/A	%	Voltage Set Point	2X LOS AVR3 timer	mS	N/A	F011
Generator Loss of Sensing AVR3	Yes	Yes	20.0 - 35.0	N/A	%	Voltage Set Point	10 - 1000	mS	N/A	F011
Generator Reverse Power	Yes	Total Real Power	-5.0 to -100.0	5.0	%	Rated Power (kW)	1.0 to 15.0	S	A014	F014
RTD Over Temperature (1-8)	Yes	RTD Temperature	0 to 260	(0- 100) %	Deg C	N/A	0 to 3600	S	A005	F005

Table 4-2

NON CONFIGURABLE SHUTDOWNS

Protection Feature	Customer Disable/ Enable	Shutdown Variable	Shutdown Threshold	Threshold Units	Alarm Code	Fault Code
Instantaneous Field Over-current	No	Regulator Main Switch Current	11	A	N/A	F009
Regulator Over-temperature	No	DSP Core Temperature	150	Deg C	A007	F007
Generator Parallel Start-up	No	VAR/PF_OFF contact input	VAR/PF_OFF Inactive in STANDBY state *AND* VAR/PF Regulation mode	N/A	N/A	F004
Generator Parallel Shutdown	Yes	EXC_OFF contact input	VAR/PF_OFF Inactive *AND" EXC_OFF active in RUN.P state	N/A	N/A	F003

Table 4-3

CONFIGURABLE ALARMS

Alarm	Customer Disable/ Enable	Alarm Variable	Alarm Threshold Range	Reset Hysteresis	Threshold Units	Timer Range	Timer Units	Alarm Code
Genset Battery Low	Yes	Battery Voltage	10.5 - 13.0	N/A	V	N/A	N/A	A004
RTD Pre Alarm Temperature (1-8)	Yes	RTD temperature	0 to 260	(0-100) %	Deg C	(0- 3600)	S	A005
Loss of CAN	Yes	Time period between incoming CAN messages	No incoming CAN messages	N/A	N/A	1.0 to 45.0	S	A006
Loss of Aux Input Control Current	Yes	Auxiliary Input Current	0.002 - 0.004	N/A	A	N/A	N/A	A011

Table 4-4

NON-CONFIGURABLE ALARMS

Alarm	Customer Disable/ Enable	Alarm Variable	Alarm Threshold	Threshold Units	Alarm Code
Loss of RTD Element - Open	Yes	RTD Resistance	Greater Than 201.48	Ohm	A005
Loss of RTD Element - Short	Yes	RTD Resistance	Less than 69.87	Ohm	A005
Real Time Clock Battery Low	Yes	RTC Battery Voltage	Less than 2.5	V	A003

Table 4-5

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CONFIGURABLE LIMITERS

Limiter	Customer Disable/Enable	Limit Variable	Limit Threshold	Limit Units	Limiter Code
Exciter Field Current Limit	No	Exciter Field Current	0.500 - 7.500	A	N/A
Power Limit of Generator Voltage	Yes	Generator Real Power	5.0 - 115.0	V	N/A
Under-frequency Limit of Generator Voltage	No	Generator Frequency	40.0 - 70.0	V	A015

Table 4-6

Note: When limits are active, no event is recorded in the event log.

Configurable Protection Shutdowns

All configurable protection features have a user-defined threshold, hysteresis and timer value. By default, all these protections are enabled, but some of the protections can be disabled by using ENABLE/DISABLE. If the threshold condition for a particular protection feature is met, an alarm is triggered. The regulator displays an alarm signal on the HMI and in the DVRPortal™ software. An independent timer starts at the moment the alarm condition is triggered. The regulator stays in alarm condition unless the measured value recovers to above or below hysteresis value depending on the protection function.

If the timer threshold is exceeded before the alarm condition is resolved, a fault is then triggered and the excitation current to the field is shut down. A fault signal is displayed on the HMI and in the portal. Refer to Section - DVR® Protection Functions for details of the timer-based protection features in the regulator.

Field Over Excitation Shutdown

The Field Over Excitation protection feature is triggered if the field current exceeds the threshold. The fault is triggered if the field current doesn't fall below the set hysteresis level within the timer period.

Field Under Excitation Shutdown

The Field Under Excitation protection feature is triggered if the absorbed VAR's exceeds the threshold. The fault is triggered if the absorbed VAR's do not fall below the hysteresis level within the timer period.

Generator Over Voltage Shutdown

The Generator Over Voltage protection feature is triggered if the generator voltage exceeds the threshold. The fault is triggered if the generator voltage does not fall below the hysteresis level within the timer period.

Generator Under Voltage Shutdown

The Generator Under Voltage protection feature is triggered if the generator voltage drops below the threshold. The fault is triggered if the generator voltage stays below the hysteresis level for the duration of the timer.

Generator Voltage Imbalance Shutdown

The Generator Voltage Imbalance protection feature is triggered if a voltage imbalance is detected in AVR3, VAR or PF regulation modes, imbalance difference between any single phase and the average of the three phases is more than the threshold is interpreted as a voltage imbalance. The fault is triggered if the voltage imbalance condition continues and the average voltage stays below the hysteresis level for the duration of the timer.

In AVR1 and FCR regulation modes, generator voltage imbalance protection is disabled.

Generator Reverse Power Shutdown

The Generator Reverse Power protection feature is triggered if generator reverse power exceeds the threshold. The fault is triggered if generator reverse power stays above the hysteresis level for the duration of the timer.

RTD Over Temperature (2500)
The RTD Over Temperature protection alarm is triggered if the measured RTD temperature exceeds the set threshold on a particular channel. The fault is triggered if RTD temperature stays above the hysteresis level for the duration of the timer. These over temperature protections can be enabled/disabled using ENABLE/DISABLE found under Thermal Protection tab in the DVRPortal™ software.

Loss of Generator Sensing Shutdown
The Loss of Generator Sensing protection feature is triggered if the sensed voltage difference between any single phase and the average of the three phase is more than the percentage threshold of the voltage setpoint. In AVR1 this protection is triggered if the voltage difference between line-line is more than the percentage threshold of the voltage setpoint.
There is no alarm for this condition – the fault and shutdown is triggered shortly after the condition is met and the timer expires.
Note: In AVR1, AVR3, VAR and PF regulation modes, Loss of Sensing is not enabled until a soft start is complete.

Non-Configurable Protection Shutdowns
Non-configurable protection features have factory-defined settings for thresholds and timers, if applicable. Each shutdown feature shown in Non-Configurable Shutdowns describes the details of the conditions for the shutdown event to occur. Refer to Section - DVR® Protection Functions for details of the timer-based protection features in the DVR® regulator.

Instantaneous Field Over Current Shutdown
The Instantaneous Field Over Current protection feature triggers a fault if generator field current exceeds 11 Adc. There is no alarm for this condition – the fault and shutdown is triggered shortly after the condition is met.

Regulator Over Temperature Shutdown
The Regulator Over Temperature protection feature is triggered if the internal regulator temperature exceeds a factory default alarm threshold. A fault is triggered if the regulator temperature exceeds a factory default shutdown threshold.

Generator Parallel Start Up Shutdown
The Generator Start Up Shutdown protection feature is triggered if the generator is started up in either VAR or PF regulation mode with the QPF contact active.

Generator Parallel Shutdown Shutdown
The Generator Parallel Shutdown protection feature is triggered if excitation is shut off using EXC contact input when the regulator is performing VAR or PF regulation.

Configurable Limiters
All configurable limiter features have a user-defined threshold value. By default, most of these are enabled, but can be disabled by using ENABLE/DISABLE (except UF and Field Current Limit). If the threshold condition for a particular limiter feature is met, an indicator is triggered in the portal. Refer Section - DVR® Protection Functions to for details of the limiters.

Generator Under Frequency (UF) Limit
The Generator Under Frequency Limit triggers if the generator frequency drops below the under frequency knee. The voltage set point is automatically adjusted by the regulator so that generator voltage follows the selected V/Hz curve. If generator frequency drops below cut-out frequency, the regulator will stop providing generator excitation and AC metering.

- For an under frequency knee between 40.0 and 50.0 Hz, the base slope is 1/50 (0.02) VPU/Hz
- For an under frequency knee between 50.1 and 60.0 Hz, the base slope is 1/60 (0.0167) VPU/Hz
- For an under frequency knee between 60.1 and 70.0 Hz, the base slope is 1/70 (0.0143) VPU/Hz

Where VPU = 1.0 at regulator voltage set point. The base slope is modified by the slope multiplier to achieve a desired voltage roll-off characteristic. See Figure 4-4 for examples.

To calculate resulting voltage dip:
Vdip = (Base Slope) *(Slope Multiplier) *(Operating Voltage) *(Hz dip below the knee point)

Example: 480V, 59 Hz knee, Slope = 2, 56 Hz output.
(0.0167) *(2) *(480V) *(3Hz) = 48.1V dip or 431.9V

Note: If generator frequency drops below a detectable level and generator speed is greater than run cut-in speed, a short circuit condition is assumed and the regulator will force current up to the Field Current Limit value (see Field Current Limiting).

The V/Hz slope is dependent upon the under frequency knee and the slope multiplier. The base slope is defined according to the following (see Figure 4-3).

Field Current Limiting

The Field Current Limit protection feature limits the amount of DC current that flows into the exciter. It is engaged if load conditions require a field current larger than the limit. Under such conditions, the current is limited to the Field Current Limit value which can be configured through DVRPortal™ software. The portal displays this alarm condition, no HMI indication.

Power Limiting Alarm

The Power Limit protection feature limits the amount of output power from the generator by modifying voltage to maintain constant output power at the limit. The portal displays this alarm condition, no HMI indication.

This limiter can be enabled or disabled in the Protection Settings Tab in portal under the Limits panel. The limiter dynamics (PID gains) can also be adjusted in the Operating Modes Tab in portal.

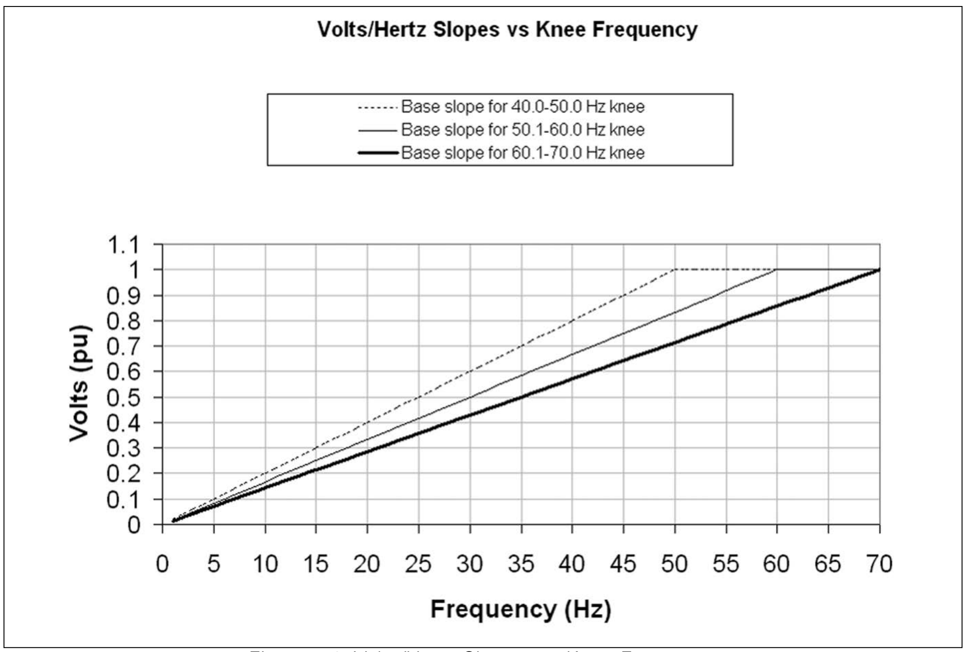

Figure 4-3. Volts/Hertz Slopes vs. Knee Frequency

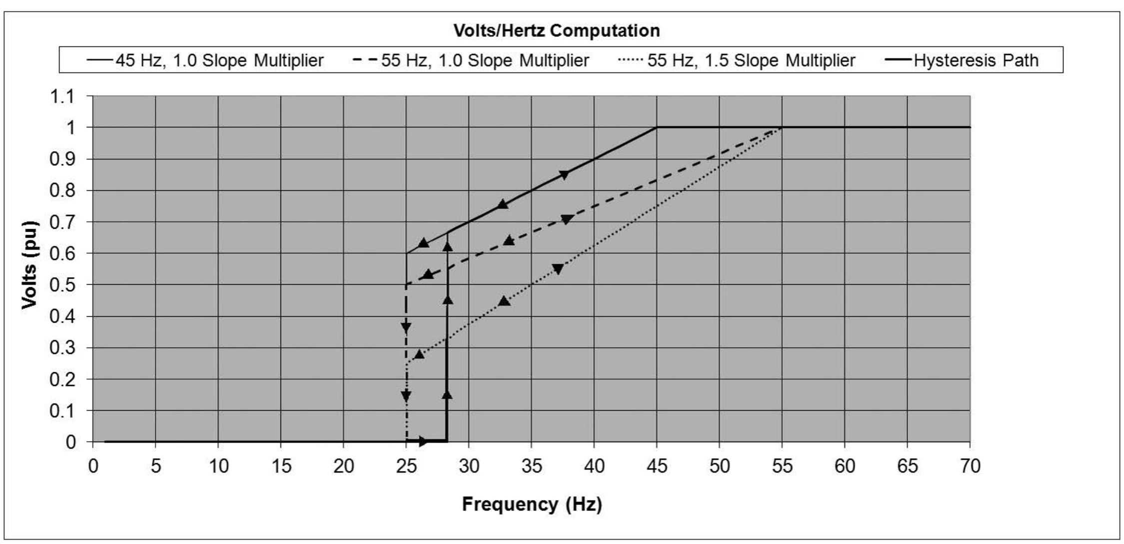

Figure 4-4. Examples of Under Frequency and Slope
Note: Arrows indicate hysteresis of cut-in and cut-out transitions between IDLE and RUN states.

Configurable Protection Alarms

Genset Battery Low Alarm

The Genset Battery Low Alarm is triggered if the measured battery voltage is less than factory defined threshold. The regulator stays in this condition until the battery voltage recovers above the threshold value. This alarm can be enabled or disabled using ENABLE/DISABLE under the protection tab in the DVRPortal™ software.

RTD Pre-Alarm Temperature Alarms

The RTD Pre-Alarm Temperature Alarms are triggered if the measured temperature of the RTD element is greater than the threshold and the set timer expired. The regulator stays in this alarm condition until the measured temperature is below the set alarm hysteresis level. These Pre-Alarms can be enabled/ disabled using ENABLE/DISABLE found under Thermal Protection tab in the portal.

Loss of CAN Communication Alarm

The Loss of CAN Communication protection feature indicates an alarm if communication traffic between the regulator and any Electronic Control Unit (ECU) on the CAN bus is lost. The alarm is triggered if the regulator does not receive a "VR Heartbeat" message within the threshold time. Refer to the DVR®2500 CAN Bus Interface User Guide for details.

Loss of AUX Input Control Current

The Loss of AUX Input Control Current is triggered if the measured control current in AUX Control Mode 2 falls below the user set threshold value mentioned in Configurable Alarms. This alarm can be enabled or disabled using ENABLE/DISABLE under the protection tab in the portal.

Note: If loss of auxiliary control current alarm is enabled and if the sensed current is below the alarm threshold, the auxiliary bias will be set to zero.

Non Configurable Protection Alarms

Loss of RTD Element - Open Alarms

The loss of RTD element open alarm is triggered if the measured RTD element resistance is greater than factory defined threshold. The regulator latches this alarm and stays in this condition until the measured resistance is within the measurable range of the regulator after power cycling. These Loss of RTD Element Alarms can be enabled/disabled using ENABLE/DISABLE found under Thermal Protection tab in the portal.

Note:

1. If the regulator detects an open circuit RTD, the metering for that channel would be saturated to 500°C.
2. If RTDs are not connected to the regulator, the metering would read -200°C for all channels.
3. The regulator detects an open circuit only if either '+' or ' -' terminals are open. If the "C" terminal is open, the regulator saturates to -200°C.

Loss of RTD Element - Short Alarms:

The loss of RTD element short alarm is triggered if the measured RTD element resistance is less than factory defined threshold. The regulator latches this alarm and stays in this condition until the measured resistance is within the measurable range of the regulator after power cycling. These Loss of RTD Element Alarms can be enabled/disabled using ENABLE/DISABLE found under Thermal Protection tab in the portal.

Note:

1. If the regulator detects a short circuit RTD, the metering for that channel would be saturated to -200°C.
2. The regulator detects a short circuit only if '+' and ' -' terminals are short.

Real Time Clock Battery Low Alarm:

The Real Time Clock (RTC) Battery Low Alarm is triggered if the measured RTC battery voltage is less than factory defined threshold. The regulator stays in this condition until the battery voltage recovers above the threshold value. This alarm can be enabled or disabled using ENABLE/DISABLE under the protection tab in the portal.

Note: The battery alarm is cleared once the measured battery voltage is above factory set threshold on power-up.

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INSTALLATION

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

EXPLOSION HAZARD

- Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

ROTATING PARTS HAZARD

- Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

OVERSPEED HAZARD

- Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

DO NOT DISASSEMBLE

- Only qualified personnel who know local, national, international and/or other applicable codes, rules or regulations and sound practices should install or repair electric generators and voltage regulators. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ WARNING

MAGNETIC FIELD HAZARD

- Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which could cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

GENERAL

Generally, the DVR® voltage regulator is supplied mounted to the conduit box of the generator. The purpose of this section is to provide mounting information to customers replacing an existing regulator with the 2400/2500 or those wishing to mount the regulator remotely.

If the unit is not installed immediately, store it in the original shipping package in an environment free of moisture and dust.

MOUNTING

The regulator is normally located in the generator conduit box. It is designed for behind-the-panel mounting and requires a cutout for front panel viewing and access. Mounting hardware consists of six customer-supplied, #12 thread-forming screws that pass through holes in the conduit box and thread into the mounting holes in the regulator. The recommended torque range for the steel mounting screws is 36 to 40 inch-pounds (4.1 to 4.5 Newton-meters). Refer to Section - Specifications, for environmental requirements.

The 2400/2500 front panel and uncovered rear dimensions are shown in Figure 5-1.

The 2400/2500 rear panel with cover dimensions are shown in Figure 5-2. Cutout and drilling dimensions are shown in Figure 5-3.

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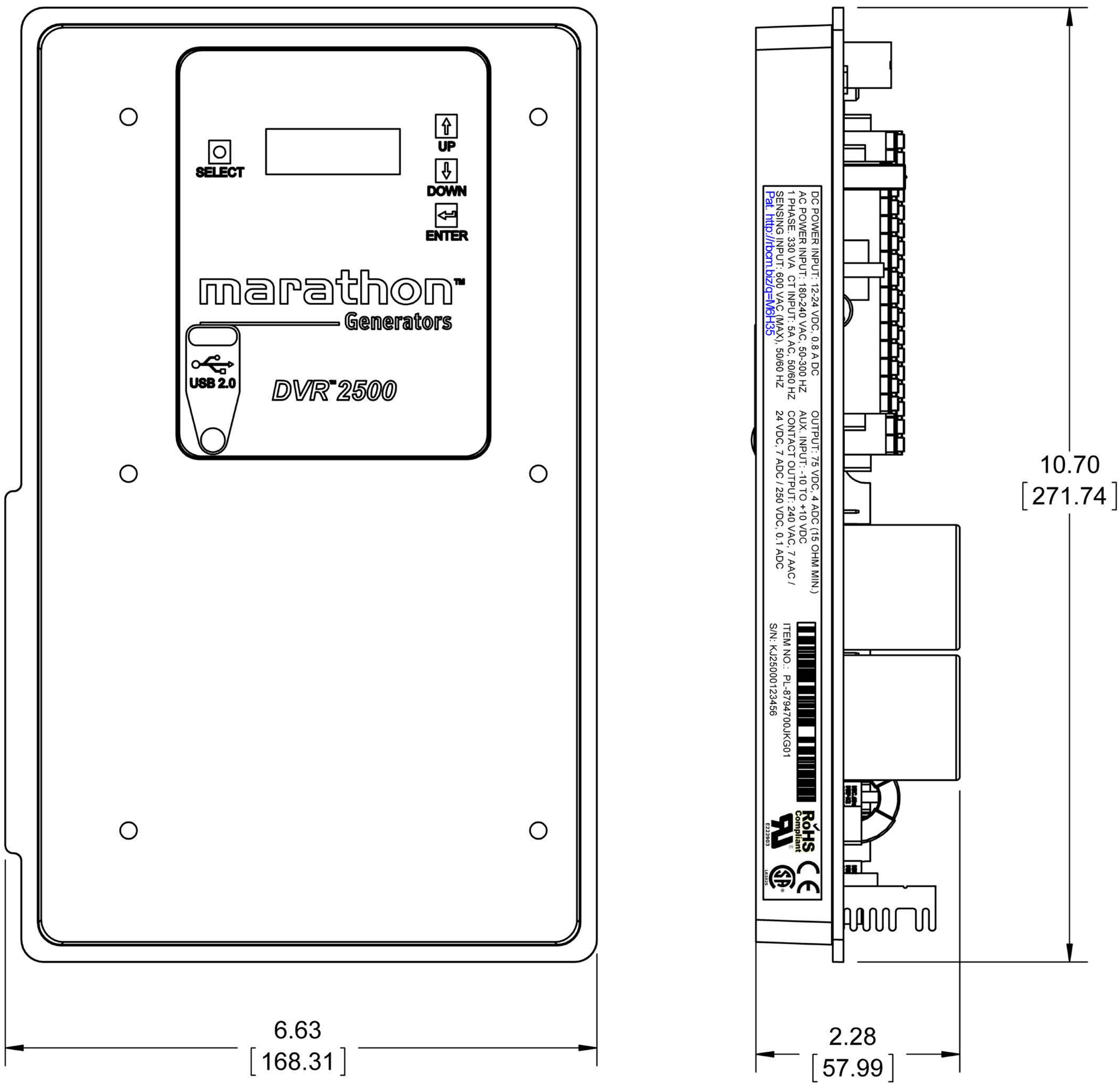

Figure 5-1. The 2500 front dimensions without cover. Valid for 2400 & 2500 versions.

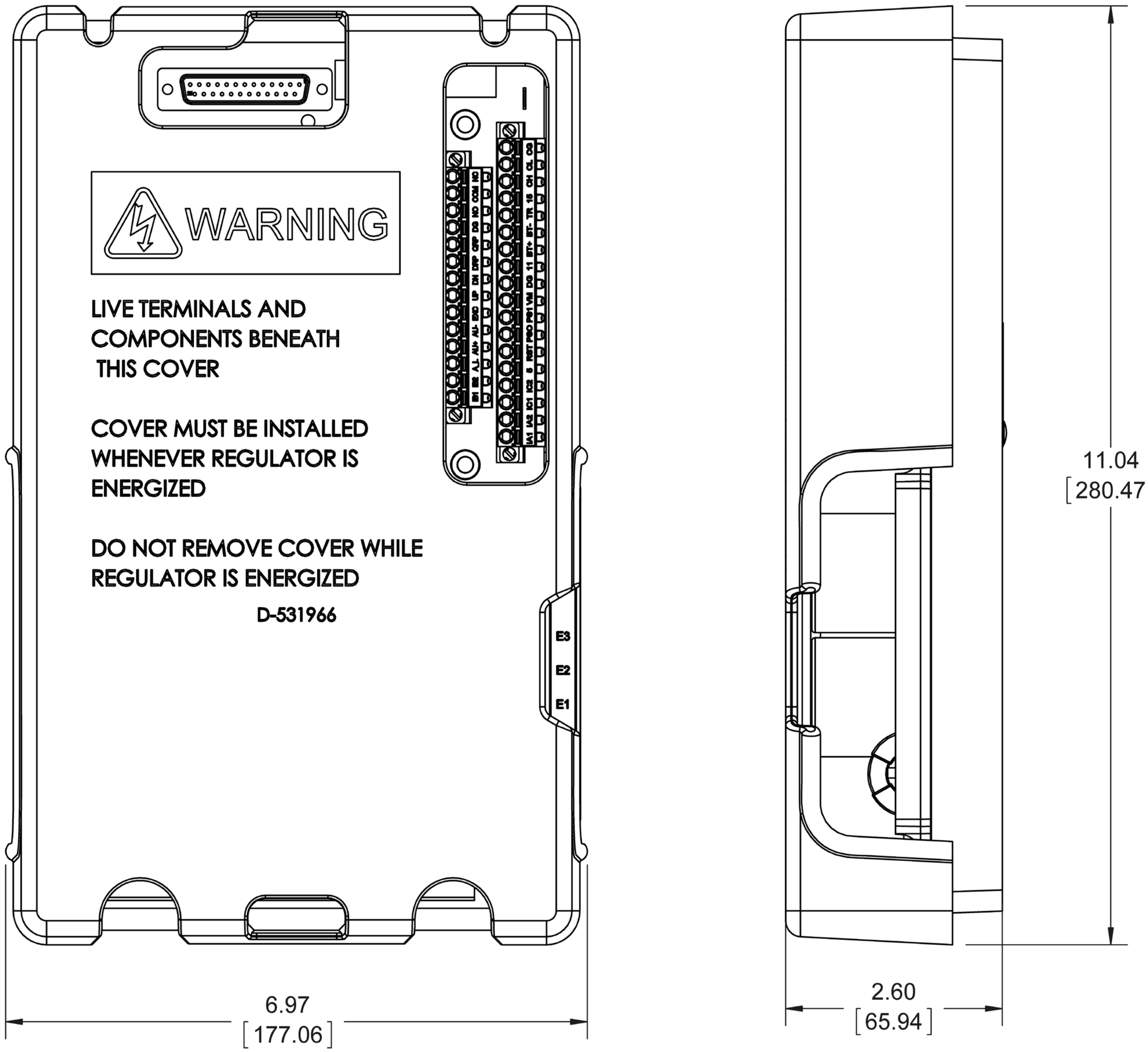

Figure 5-2. The 2500 rear dimensions with cover. Valid for 2400 & 2500 versions.

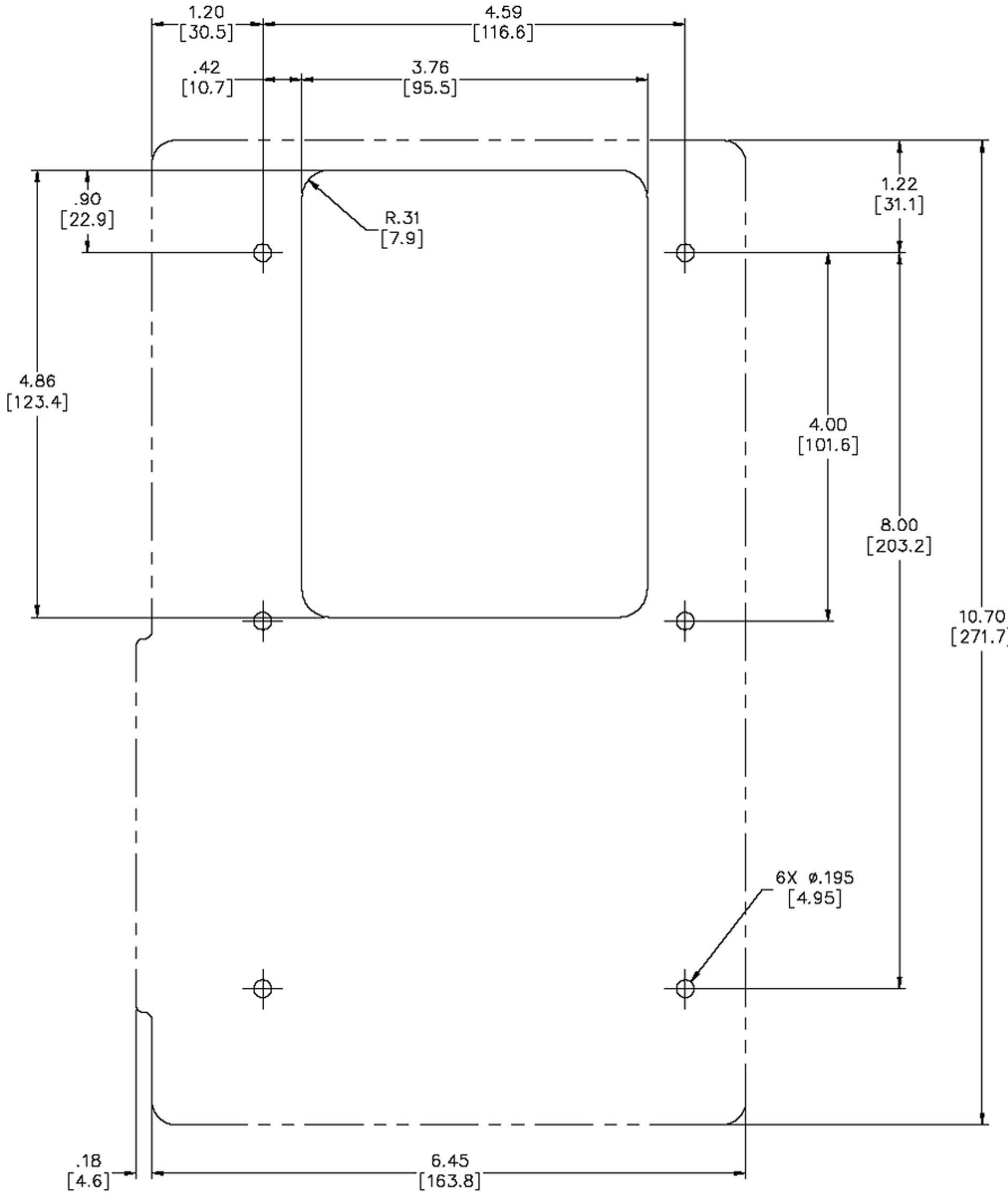

Figure 5-3. Cutout and Drilling Dimensions. Valid for 2400 & 2500 versions.

CONNECTIONS

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

NOTICE

- Incorrect wiring may damage the unit.

Note: Be sure that the regulator is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the unit case. When the unit is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each device.

The DVR® voltage regulator connections are dependent on the application.

The 2400/2500 Connectors

The 2400/2500 regulators have five types of interface connectors.

1. Nine (9) (2400), Eleven (11) (2500) 1/4", quick-connect terminals for generator connections.
2. One (1) 14 position 5.08mm cage clamp style plug for B-phase CT and system interface connections.
3. One (1) 18 position 5.08mm cage clamp style plug for A and C-phase CTs, system interface and Controlled Area Network (CAN) bus interface connections (2500 only).
4. One (1) 5-pin USB 2.0 Mini B type connector for the communication between the regulator and the DVRPortal™ software on the front panel.
5. One (1) 25 position d-sub connector for 3-wire eight (8) channel measurement through RTD module (only).

- Wires performing common functions, such as voltage sensing leads, should be grouped together.
- The 14 and 18 position plugs P1 and P2 need to be screwed down to P1 and P2 during operation.
- Wiring terminated to P1 and P2 need to be strain relieved to reduce stress on the wiring due to vibration.
- P1 and P2 can accept either bare wire (stranded only) or ferrules.
- Recommended strip/ferrule length of 0.393 in (10 mm) should be used for connections terminated to P1 and P2.
- Wiring routed to P1 and P2 should be strain relieved at least 6 inches from the P1 and P2.
- Wiring terminated to P1 need to be bundled together with tie wrap to reduce strain. This is applicable to P2 also. Do not bundle wiring connected to P1 and P2 together this adds more strain to the connections.
- Loctite®* 242 or similar should be used on the screws before connecting the DB25 cable to the RTD module and regulator for better vibration withstand.
- Recommended torque for the DB25 cable connecting regulator and RTD module is 7.0 inch·lbf [0.8 N·m].

Figure 5-4 shows the quick disconnect terminal connections located on the rear panel of the regulator.

*Loctite is believed to be the trademark and/or trade name of Henkel IP & Holding GmbH and is not owned or controlled by Regal Beloit Corporation.

Remote Mounting Guidelines:

- All digital and analog inputs connected to the regulator should be separately routed from F+, F-, E1, E2, E3, 3 and 4 terminals
- All digital and analog input wiring needs to be shielded
- Shield needs to be grounded at remote end of wiring
- For the DVR® regulator to detect the digital inputs properly, the cable resistance should not exceed 50 ohms
- Analog input may be supplied from a source up to 150 feet away
- USB communication has a limited range of about 3 meters. For longer distance communication please used USB booster cables
    - » IOGEAR®* GUE2118 (39 feet) is recommended for longer distances with the DVR2400/2500 voltage regulators
    - » The regulator may need to be externally powered for proper communication

Refer to the section on Grounding Practices for additional information.

Grounding and Connection Practices

The following practices must be adhered to in order to ensure proper operation of the regulator and related systems.

1. The chassis ground terminals (2) (GND) must always be connected.
2. Chassis ground (GND) near P1 and P2 need to be terminated as close to the DVR® regulator as possible.
3. Unstable operation might be observed if the GND terminals are not connected.
4. AUX Shield must be grounded at the source only (not at the DVR regulator).
5. CAN shield has to be connected to GND on both end of the cable.

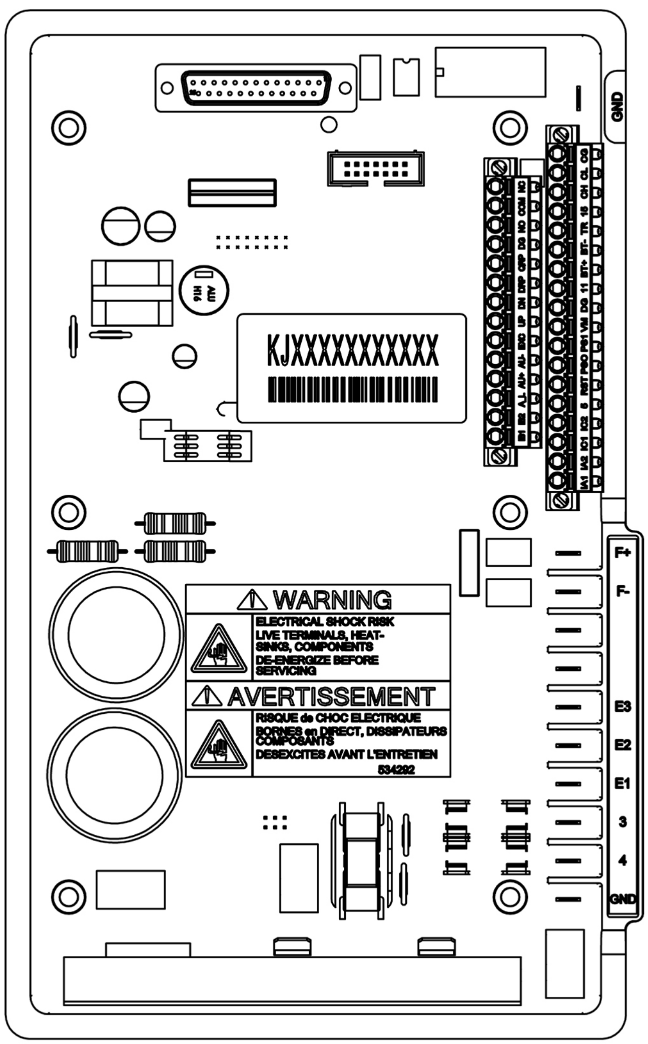

Figure 5-4. The regulator Rear Panel Connectors (DVR®2500 regulator shown)

REGAL®

*IOGEAR is believed to be the trademark and/or trade name of ATEN Technology, Inc. and is not owned or controlled by Regal Beloit Corporation.

Quick Connect Terminals		Application Notes
Terminal Name	**Description**	
GND	Chassis ground	Use #12 AWG (4 mm^2) minimum conductor.
4	PMG/External power input – terminal 2	Protected by fuse.
3	PMG/External power input – terminal 1	Protected by fuse. 180-240Vac, 250-300Hz, 350VA
E1	Generator armature – terminal T1	Phase A for 3 phase output. L1 input for single phase.
E2	Generator armature – terminal T2	Phase B for 3 phase output. L2 input for single phase.
E3	Generator armature – terminal T3	Phase C for 3 phase output. Jumper to E2 for single phase.
	Reserved	
	Reserved	
F -	Exciter stator – terminal F1	Excitation output. Never apply a voltage to these terminals. Observe polarity.
F +	Exciter stator – terminal F2	

Table 5-1. Quick Connect Terminals

Chassis Ground (GND)

The chassis ground terminal is labeled GND. Two chassis grounds are available on the regulator. GND closer to the P1 and P2 need to be terminated to chassis as close to the regulator as possible.

Power Supply Inputs (3 and 4)

Power input terminals are labeled 3 and 4.

Generator Voltage Sensing Inputs (E1, E2 and E3)

The generator voltage sensing terminals are labeled E1, E2, and E3. A single-phase sensing connection is obtained by connecting the phase C sensing input to terminals E2 and E3.

Exciter Field Output (F+ and F-)

The field output terminals for connection to the generator exciter field are labeled F+ and F-.

Single Phase Current Sensing Input (IB1 and IB2)

Generator line current is stepped down through a user-supplied CT on Phase B. Secondary current (5A) from that transformer is applied to P1 connector terminals labeled IB1 and IB2. Consult current transformer instruction manuals for CT polarity identification and install per Figure 5-7. See Figure 5-5 and Table 5-2 for terminal assignments.

Three Phase Current Sensing Input (2500 only)

Generator line current is stepped down through user-supplied CT's. Secondary current (5A) from these transformers are applied to the P1 connector terminals labeled IB1 and IB2 and P2 connector terminals labeled IA1, IA2 and IC1, IC2. Consult CT instruction manuals for polarity identification and install per Figure 5-6. See Figure 5-5 and Table 5-2 for terminal assignments.

Note: All transformers must have the same CT ratio.

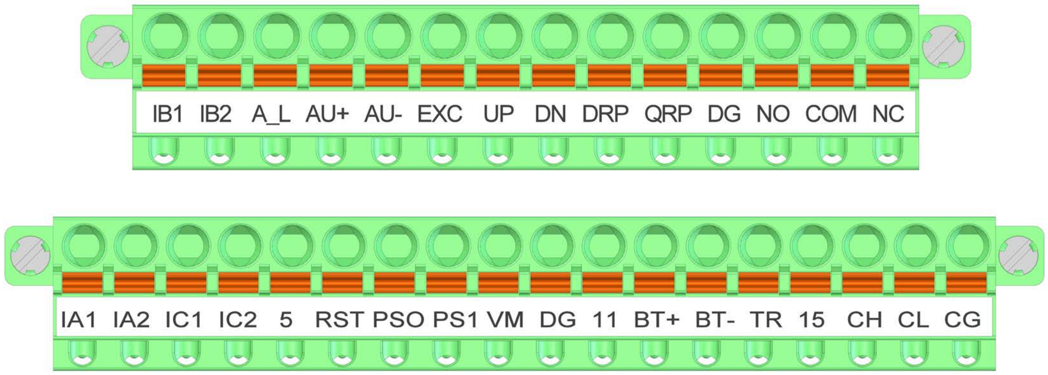

Figure 5-5. System Connectors P1 (top) and P2 (bottom) Terminal Position

Sensing	Phase	CT "X1" Terminal	CT "X2" Terminal
3-Phase (DVR®2500 regulator only)	A	P2-1 (IA1)	P2-2 (IA2)
	B	P1-1 (IB1)	P1-2 (IB2)
	C	P2-3 (IC1)	P2-4 (IC2)
1-Phase	B	P1-1 (IB1)	P1-2 (IB2)

Table 5-2. Current Transformer Connection Terminals

Note: The CT primaries are aligned such that the "H1" (on the CT) face is facing the generator for typical donut-style CT's.

Pin Number	Terminal Name	Name	Description
1	IB1	CT-B1	Generator Phase B CT – terminal 1
2	IB2	CT-B2	Generator Phase B CT – terminal 2
3	A_L	AUX_LOOP	Auxiliary current loop (DVR®2500 regulator only)
4	AU+	AUX IN +	Auxiliary input positive
5	AU-	AUX IN -	Auxiliary input negative
6	EXC	EXCITATION_OFF	Excitation disable contact input (active closed)
7	UP	UP	UP contact input (active closed)
8	DN	DOWN	DOWN contact input (active closed)
9	DRP	DROOP_OFF	Droop disable contact input (active closed)
10	QPF	VAR/PF_OFF	VAR/PF mode disable (active closed)
11	DG	DGND	Digital ground
12	NO	K1-NO	Contact output normally open
13	COM	K1-COM	Contact output common
14	NC	K1-NC	Contact output normally closed

Table 5-3. Connector P1 Terminals

Pin Number	Terminal Name	Name	Description
1	IA1	CT-A1	Generator Phase A CT – terminal 1
2	IA2	CT-A2	Generator Phase A CT – terminal 2
3	IC1	CT-C1	Generator Phase C CT – terminal 1
4	IC2	CT-C2	Generator Phase C CT – terminal 2
5	-	-	Reserved
6	RST	DVR_RESET	Reset Regulator (active closed)
7	PS0	PS0	Preset select line 0 (active closed)
8	PS1	PS1	Preset select line 1 (active closed)
9	VM	-	Reserved
10	DG	DGND	Digital ground
11	-	-	Reserved
12	BT+	BAT+	Battery input – positive
13	BT-	BAT-	Battery input – negative
14	TR	CAN_TR1	CAN terminating resistor - terminal 1
15	-	-	Reserved
16	CH	CAN_H	CAN high data line
17	CL	CAN_L	CAN low data line
18	CG	CAN_GND	CAN GND

Table 5-4. Connector P2 Terminals (2500 only)

Note:

Active Low/Closed: Function is active when connection between the digital input and Digital Ground (DG) is closed

Active Hi/Open: Function is active when connection between the digital input and Digital Ground (DG) is open

E.g.: To enable Drop-off function, close connection between DRP and DG assuming that the polarity of drop-off contact is set to Active Low.

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UP and DOWN Contact Inputs

Remote set point adjustment may be accomplished by connecting a SPDT momentary contact switch to the P1 connector UP and DOWN contacts. To connect this switch, the common terminal must be connected to P1-11 (DG). The other two switch terminals are connected to P1-7 (UP) and P1-8 (DN). Refer to Section – Features and Protection for a detailed description of the UP and DOWN contact function.

Parallel Generator Compensation Enable/Disable (DROOP OFF)

A user can enable or disable the integrated load sharing function of the regulator by connecting a contact between P1-9 (DRP) and P1-11 (DG) terminals. Activation polarity (Open/Close) determined by configuration settings. Refer to Section – Features and Protection for a detailed description of the Load Sharing function.

Excitation Enable/Disable (EXCITATION OFF)

A user can enable or disable excitation by connecting a contact between terminals P1-6 (EXC) and P1-11 (DG).

Activation polarity (open/close) determined by configuration setting. Refer to Section – Features and Protection for a detailed description of the Excitation Off function.

Auxiliary Input (AUX_IN (+), AUX_IN (-), and AUX_LOOP)

This input allows a user to control the regulator with an auxiliary piece of equipment by connecting a voltage source to P1-4 (AU+) and P1-5 (AU–). The regulator can also be configured to accept a voltage or current to be metered on this input. Refer to Section – Features and Protection for a detailed description of the Auxiliary input function.

VAR/PF Enable/Disable (VAR/PF_OFF)

A user can enable or disable the VAR or PF regulation modes by connecting a contact between terminals P1-10 (QPF) and P1-11 (DG). Activation polarity (open/close) determined by configuration setting. Refer to Section – Features and Protection for a detailed description of the VAR/PF regulation function.

Note: Operation in VAR or PF modes should only be enabled when the generator is paralleled with utility (infinite bus). If the VAR/PF_OFF is disabled during power up of the regulator in VAR or PF regulation modes, a Generator Start Up Fault occurs.

Contact Output (NO, COM and NC)

The output contact may be accessed at connector P1, via terminals (P1-12 (NO), P1-13 (COM) and P1-14 (NC). The NO-COM / NC-COM output is normally open/closed and closes/opens when the regulator goes into a fault condition.

USB 2.0 Communication Port: The USB 2.0 port on the front panel uses a Mini B type female connector. A standard USB A communication cable terminated with a USB Mini male connector is used for PC interface with the regulator.

CAN J1939 Communication Port (P2-14,16,17,18)

The CAN port can be accessed on the connector P2. Table 5-4 illustrates the pin assignments and functions of the CAN port.

The Regulator Connections for Typical Applications

Figures 5-6 through 5-10 illustrate typical applications using the DVR® regulator.

- Figure 5-6 shows an application where the regulator is connected for three-phase voltage sensing without current sensing.
- Figure 5-7 shows an application where the regulator is connected for three-phase voltage sensing and single-phase current sensing.
- Figure 5-8 shows an application where the regulator is connected for three-phase voltage sensing and three-phase current sensing.
- Figure 5-9 shows an application where the regulator is connected for single-phase voltage sensing without current sensing.
- Figure 5-10 shows an application where the regulator is connected for single-phase voltage sensing and single-phase current sensing.

Figures 5-11 and 5-12 illustrate how the regulators can be interconnected for use in Cross-Current (Reactive Differential) applications. When operating in Cross-Current mode, attention must be paid to the use of the burden resistor shown in Figures 5-10 and 5-11. The burden resistor should have a value of approximately 10 times the cross current loop resistance for proper differential operation. The value of 0.1 ohm is a suggested value. The volt-ampere (VA) capacity of the paralleling current transformers should be considered when sizing the burden resistor.

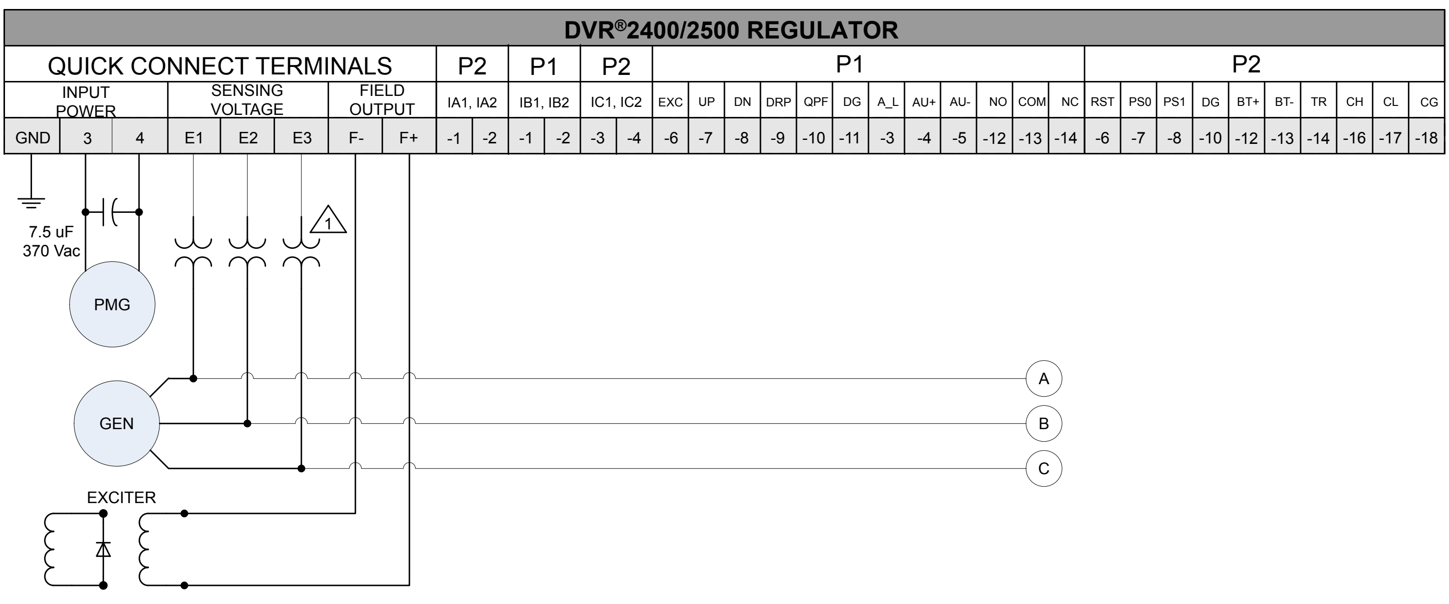

Figure 5-6. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing Without Current Sensing

Note:

1. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.

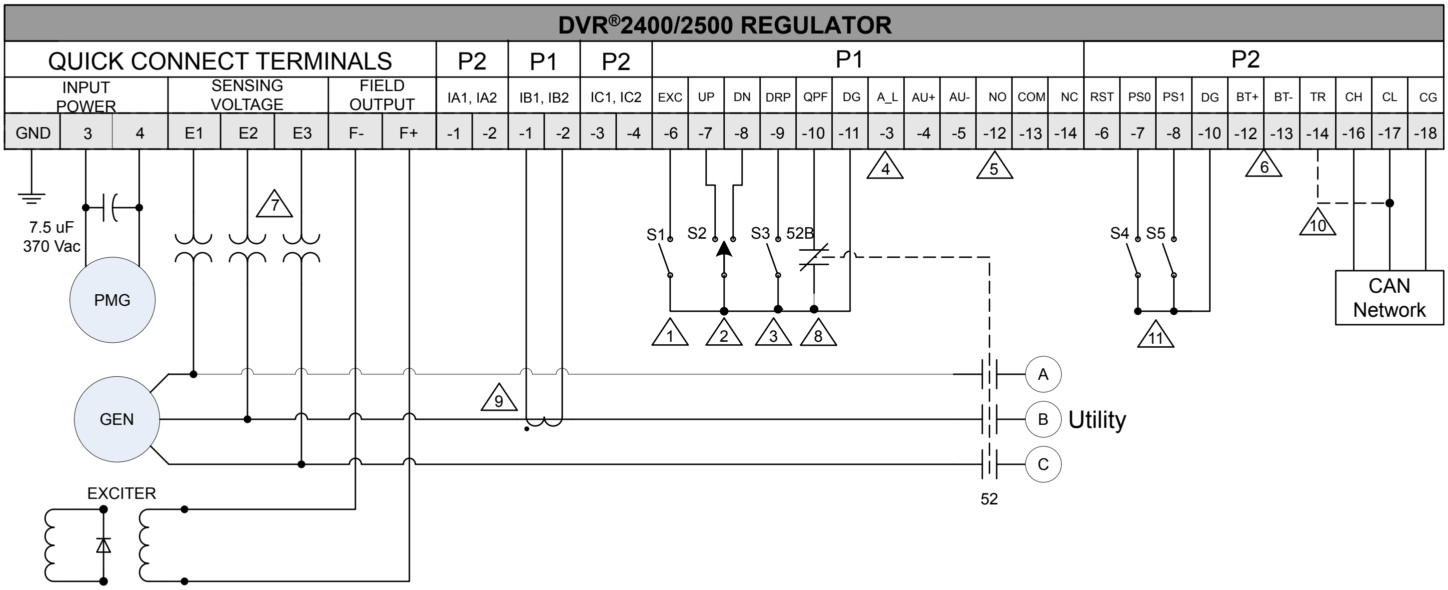

Figure 5-7. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing and Single-Phase Current Sensing

Notes:

1. Excitation enabled/disabled by S1. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
2. SPDT spring return to center-OFF position type switch (S2) for remote set point adjustment.
3. Droop enabled/disabled by S3. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
4. Analog signal input when Auxiliary is configured for control. A_L and AU+ need to be shorted for Auxiliary 4-20 mA control.
5. Normally Open (NO)/Normally Closed (NC) contact closes/opens in a fault condition.
6. Genset battery may be connected to keep the 2500 powered on for control and monitoring. Required for shunt operation.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.
8. VAR/PF regulation enabled/disabled by auxiliary contact 52B. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
9. Current transformer is optional and is necessary only if the application requires Droop, VAR, PF or Power Limiting features.
10. The 2500 is at the end of CAN network, jumpering CL and TR provides an Internal 120 Ohm, 0.25 Watt terminating resistor for the CAN network. Required only for CAN communication.
11. PS0 and PS1 can be used to configure presets. Closing and opening S4 and S5 configures the 2500 in one (1) of the four (4) preset configurations (refer to Digital I/O section).
12. Optional S1, S2, S3, S4, S5, 52 and "52B" contacts/relays supplied by customers. Current and voltage transformers may be installed by Regal.
13. P1 is common for both 2400 and 2500. P2 available only on the 2500.

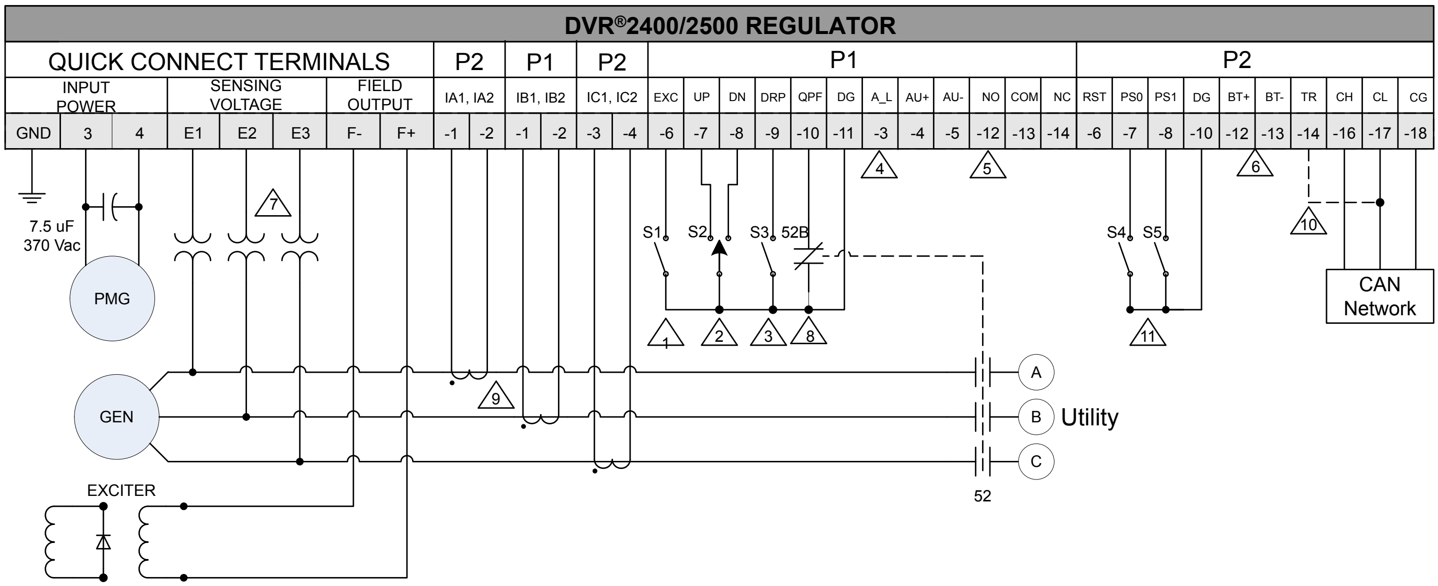

Figure 5-8. Typical Connections with ABC Rotation, Three-Phase Voltage Sensing and Three-Phase Current Sensing

Notes:

1. Excitation enabled/disabled by S1. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
2. SPDT spring return to center-OFF position type switch (S2) for remote set point adjustment.
3. Droop enabled/disabled by S3. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
4. Analog signal input when Auxiliary is configured for control. A_L and AU+ need to be shorted for Auxiliary 4-20 mA control.
5. Normally Open (NO)/Normally Closed (NC) contact closes/opens in a fault condition.
6. Genset battery may be connected to keep the 2500 powered on for control and monitoring. Required for shunt operation.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.
8. VAR/PF regulation enabled/disabled by auxiliary contact 52B. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
9. Current transformers are optional and are necessary only if the application requires Droop, VAR, PF or Power Limiting features.
10. If the 2500 is at the end of CAN network, jumpering CL and TR provides an Internal 120 Ohm, 0.25 Watt terminating resistor for the CAN network. Required only for CAN communication.
11. PS0 and PS1 can be used to configure presets. Closing and opening S4 and S5 configures the 2500 In one (1) of the four (4) preset configurations (refer to Digital I/O section).
12. Optional S1, S2, S3, S4, S5, 52 and "52B" contacts/relays supplied by customers. Current and voltage transformers may be installed by Regal.
13. P1 is common for both 2400 and 2500. P2 available only on the 2500.

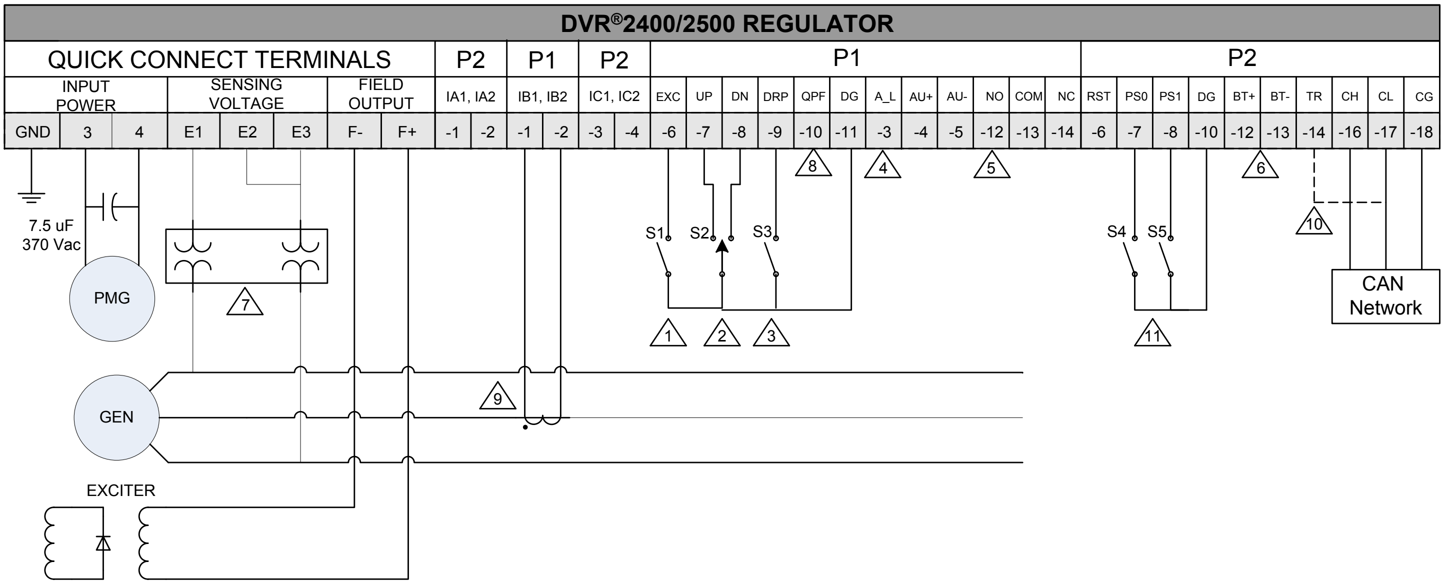

Figure 5-9. Typical Connections to a Single-Phase Generator

Notes:

1. Excitation enabled/disabled by S1. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
2. SPDT spring return to center-OFF position type switch (S2) for remote set point adjustment.
3. Reactive Droop is not possible in this configuration.
4. Analog signal input when Auxiliary is configured for control. A_L and AU+ need to be shorted for Auxiliary 4-20 mA control.
5. Normally Open (NO)/Normally Closed (NC) contact closes/opens in a fault condition.
6. Genset battery may be connected to keep the 2500 powered on for control and monitoring. Required for shunt operation.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.
8. VAR/PF regulation is not possible In this configuration
9. If the 2500 is at the end of CAN network, jumpering CL and TR provides an Internal 120 Ohm, 0.25 Watt terminating resistor for the CAN network. Required only for CAN communication.
10. PS0 and PS1 can be used to configure presets. Closing and opening S4 and S5 configures the 2500 In one (1) of the four (4) preset configurations (refer to Digital I/O section).
11. Optional S1, S2, S4 and S5 contacts supplied by customers. Voltage transformers may be installed by Regal.
12. P1 is common for both 2400 and 2500. P2 available only on the 2500.

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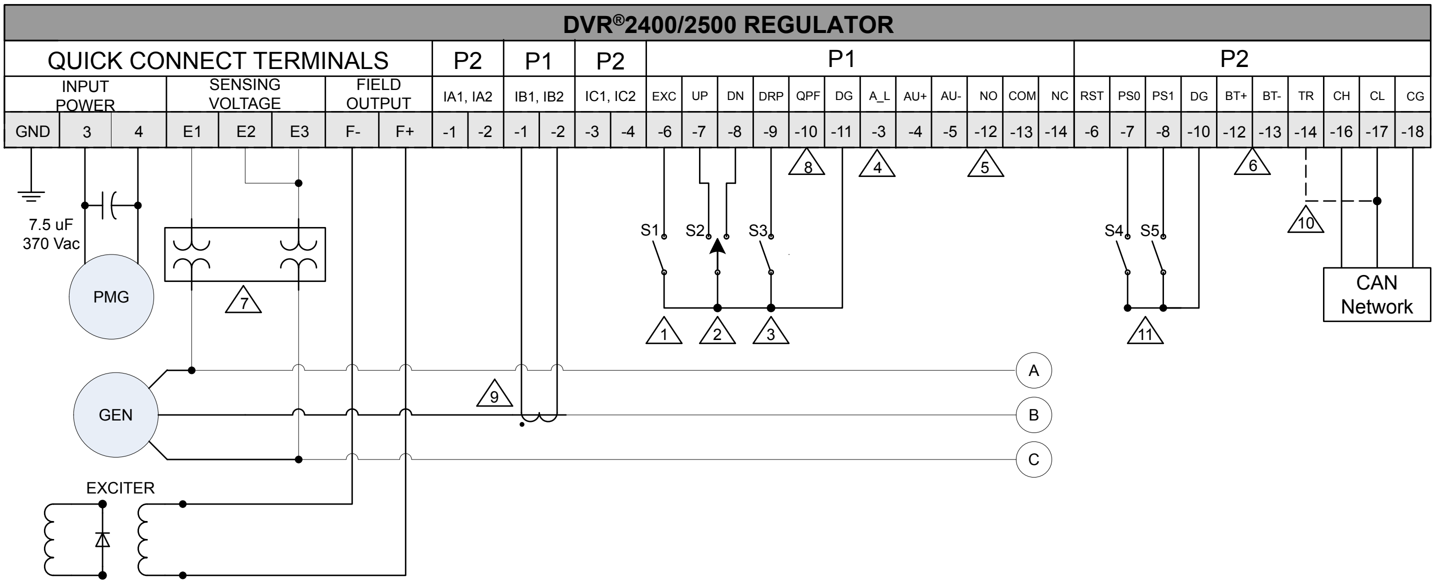

Figure 5-10. Typical Connections with ABC Rotation, Single-Phase Voltage Sensing and Single-Phase Current Sensing

Notes:

1. Excitation enabled/disabled by S1. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
2. SPDT spring return to center-OFF position type switch (S2) for remote set point adjustment.
3. Droop enabled/disabled by S3. Activation polarity (open/close) determined by configuration settings (refer to Digital I/O section).
4. Analog signal input when Auxiliary is configured for control. A_L and AU+ need to be shorted for Auxiliary 4-20 mA control.
5. Normally Open (NO)/Normally Closed (NC) contact closes/opens in a fault condition.
6. Genset battery may be connected to keep the 2500 powered on for control and monitoring. Required for shunt operation.
7. Sensing potential transformer is required if generator output voltage exceeds 600 Volts.
8. VAR/PF regulation not possible in this configuration.
9. Current transformer is optional and is necessary only if the application requires Droop, VAR, PF or Power Limiting features.
10. If the 2500 is at the end of CAN network, jumpering CL and TR provides an Internal 120 Ohm, 0.25 Watt terminating resistor for the CAN network. Required only for CAN communication.
11. PS0 and PS1 can be used to configure presets. Closing and opening S4 and S5 configures the 2500 In one (1) of the four (4) preset configurations (refer to Digital I/O section).
12. Optional S1, S2, S3, S4, S5, 52 and "52B" contacts/relays supplied by customers. Current and voltage transformers may be installed by Regal.
13. P1 is common for both 2400 and 2500. P2 available only on the 2500.

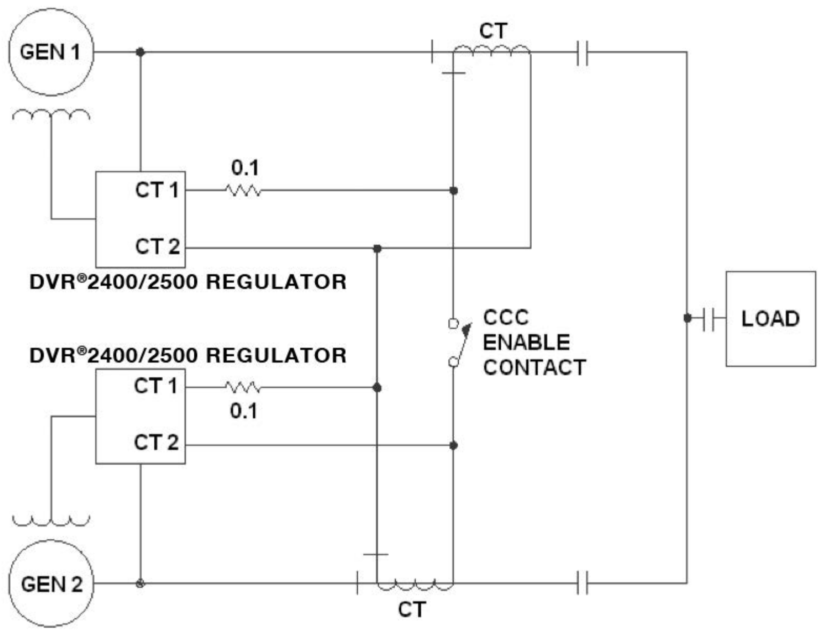

Figure 5-11. Cross-Current (Reactive Differential) Connections for Two Generators

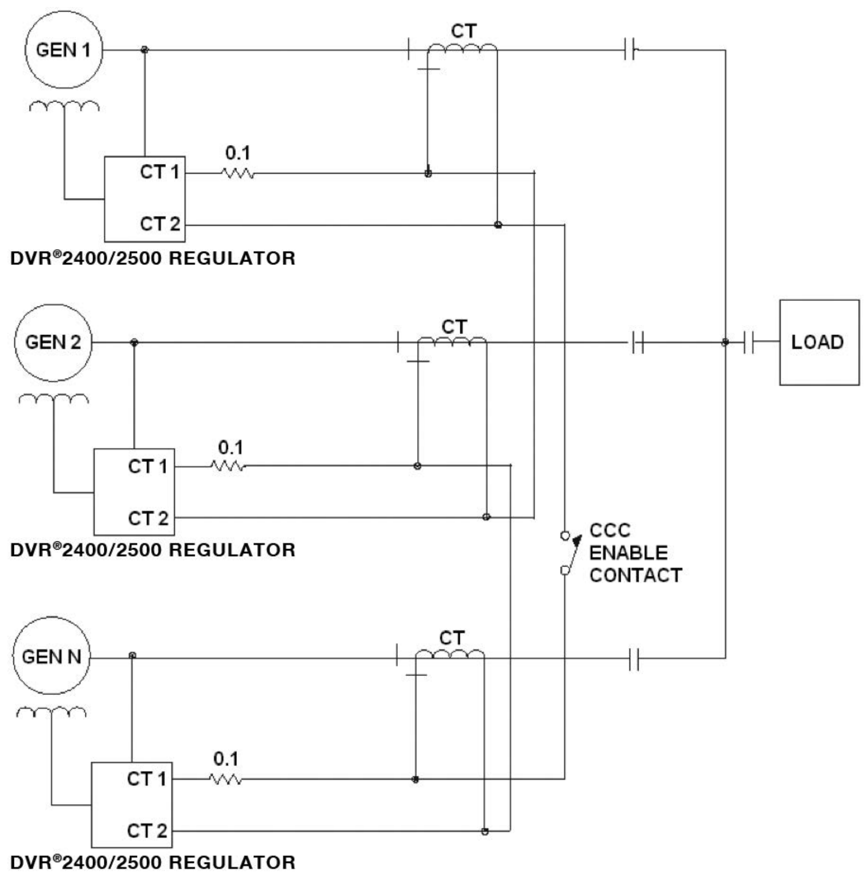

Figure 5-12. Cross-Current (Reactive Differential)
Connections for Three or More Generators

PRELIMINARY SETUP – SAFETY

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.
- Use caution when working around the component side of the DVR® regulator. Voltage levels may be present at the exposed components when the unit is energized. The protective cover MUST be installed whenever the regulator is energized.

Note: Read and understand the operation of the individual adjustments before attempting any adjustments.

PRELIMINARY SETUP – ON GENERATOR (Powering the regulator through PMG)

The regulator may be configured on the generator using the following procedure:

1. Before starting the engine, remove the regulator's 5.0 A fuse. This will prevent the generator's PMG from energizing the regulator and prevent unintended operating functions from occurring.
2. Perform all preliminary engine governor adjustments with the regulator de-energized.
3. After initial governor adjustments are complete, shut down the prime mover. Reinstall the 5.0 A fuse. Disconnect the E3 and F+ terminal connectors from the regulator and temporarily insulate them to prevent accidental shorting.
4. Start and run the generator at rated speed. The regulator may enter a Loss of Sensing shutdown mode, indicated by rUn.i / F011 on the display.
5. At this time, initial adjustments can be made. If adjusting via the HMI, see Section – Making Settings Changes. If adjusting via the DVRPortal™ communication software, see Section DVRPortal Graphical User Interface.
6. After the initial adjustments are made, shut down the generator and reconnect the regulator leads removed in Step 3. The generator may be started and final adjustments may be performed on the regulator.

PRELIMINARY SETUP – ON GENERATOR (When generator is not spinning)

1. Before following the instructions below, ensure that the generator is not spinning.
2. Open swing cover and locate the USB mini connector on the regulator.
3. Connect USB cable from your computer to the regulator. This powers up the communication.
4. Establish communication via DVRPortal software and make necessary changes to the setting and save them to the regulator.
5. After necessary changes are made, disconnect from the regulator. The generator may be started to verify proper operation.

Note:

1. Neither HMI or power ON LED will light up when DVR regulator communication is powered only through USB.
2. If cable length greater then 10ft is needed, IOGEAR®* GUE2118 (39 feet) or similar is recommended with the regulator.

PRELIMINARY SETUP – ON BENCH

The regulator may be configured on a bench using the following procedure:

1. Connect a 100-120 Vac 50/60 Hz source to terminals 3, 4 and GND as follows:
   a. 120 V hot – terminal 3
   b. 120 V neutral – terminal 4
   c. 120 V ground – terminal GND

   (OR)

   If configuring through the DVRPortal™ software, regulator communication circuit can be powered through the USB. This will eliminate the necessity of powering the regulator through terminals 3, 4 and GND.

   Note: USB should be capable of providing 0.4 Adc. HMI, power on LED indicator and other functions will be non-operational while powering through USB.

   (OR)

   Connect a 12/24-volt battery input to terminals P2-12 (BT+) and P2-13 (BT-) (2500 only).

   Note: Battery should be capable of providing 0.8 Adc.

   Note: Sudden loss of excitation power on terminals 3 & 4 could lead to the DVR2500 regulator RESET even though battery voltage is present.

NOTICE **Applying voltage larger than 120 Vac without current inrush limiting may damage the unit.**

2. If the regulator is in AVR1 or AVR3 regulation mode, the regulator will indicate **STBY** on the display. If the regulator is in FCR regulation mode, the regulator will indicate **rUn.i** on the display.

3. At this time, initial adjustments can be made. If adjusting via the HMI, see Section – Making Settings Changes. If adjusting via the DVRPortal™ communication software, see Section DVRPortal Graphical User Interface.

After the initial adjustments are made, disconnect the power source and install the regulator onto the generator. The generator may be started and final adjustments may be performed on the regulator.

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HUMAN-MACHINE INTERFACE (HMI)

GENERAL

The DVR® regulator HMI consists of four buttons and a four-character LED display as illustrated in Figure 6-1. The display indicates status conditions and parameter settings. Button function descriptions are given in Table 6-1.

Figure 6-1. DVR®2400/2500 HMI shown

Button	Description
SELECT ●	This button steps the user through a menu list of editable parameters. It also serves as an excape key in EDIT mode.
UP ↑	This button increases the setting level fo the parameter being adjusted.
DOWN ↓	This button decreases the setting level of the parameter being adjuted.
ENTER ↵	This button stores the current value of the parameter being adjusted and returns the user to the main menu list.

Table 6-1. DVR® Regulator HMI Button Function Descriptions

FRONT PANEL DISPLAY

The HMI display has three display modes:

1. **STATUS mode** – the HMI displays the non-editable operating state of the DVR® regulator as described in Table 6-2. The display flashes while in STATUS mode.
2. **EDIT mode** - The HMI displays a multi-layer menu for reading and editing operating parameters of the regulator as described in Table 6-3. The display is steady-on while in EDIT mode.
3. **SLEEP mode** – The HMI turns off the display after 60 seconds of button-press inactivity.

Display	Description
(no display)	No display is the default mode of the HMI. No display indicates that the regulator is operating normally, but operating in a sleep mode.
STBY	This display indicates that the regulator is operating normally and is in stand-by mode waiting for the STRT state.
STRT	This display indicates that the regulator is in a Soft Start State.
RUN.V	This display indicates that the regulator is operating normally with excitation in AVR mode.
RUN.I	This display indicates that the regulator is operating normally with excitation in FCR mode.
RUN.P	This display indicates that the regulator is operating normally with excitation in VAR or PF mode.
FLSH	This display indicates that the regulator is operating in field flashing mode.
IDLE	This display indicates that the regulator is operating normally and is in Idle mode waiting for the speed to take off.
AXXX (where xxx indicates a three-digit alarm code)	This display indicates that the regulator is in an alarm state. During this state, the regulator continues to provide excitation if excitation is enabled. See Appendix for description of Alarm Codes.
FXXX (where xxx indicates a three-digit alarm code)	This display indicates that the regulator is in a fault state. During this state, the regulator ceases to provide excitation. See Appendix for description of Fault Codes.

Table 6-2. DVR® Regulator HMI STATUS Mode Display Descriptions

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Parameter Name	Parameter Value	Description
SIZE	281 to 1040	Frame size of generator
rEG	AVR3	AVR3 – Voltage regulation with three-phase sensing
	AVR1	AVR1 – Voltage regulation with single-phase sensing
	FCR	FCR – Field current regulation
	VAR	VAR – Reactive VAR regulation
	PF	PF – Power factor regulation
StPt	100.0 to 630.0	Voltage set point (Vrms) in AVR3 and AVR1 mode
	0.000 to 4.000	Field current set point (Adc) in FCR mode
	0% to 100%	VAR set point (% of rated VAR) in VAR mode.
	-0.60 to 0.60	PF set point (PU) in PF mode.
UFrQ	40.0H to 70.0H	Under frequency knee (Hz)
SLoP	1.00U to 5.00U	Under frequency slope multiplier
Pr	0 to 6000	Rated power of generator (kW)
PFr	0.600 to 0.900	Rated power factor of generator (per unit)
Pt	1.0 to 150.0	Potential transformer ratio
Ct	1 to 2000	Current transformer ratio
droP	0.0% to 10.0%	Voltage droop (%) at rated reactive power
AU	OFF	Auxiliary Off – Auxiliary input is disabled
	CNT1	Auxiliary Control-1 – Auxiliary input modifies regulation set point (±3 or ±5 or ±10 Vdc input) (±5 or ±10Vdc for 2500 only)
	CNT2	Auxiliary Control-2 – Auxiliary input modifies regulation set point (4 to 20 mA input)
	SLOP	Auxiliary Dynamic Slope - Auxiliary input modifies under frequency slope multiplier (0 - 5V)

Table 6-3. DVR® Regulator HMI EDIT Mode Parameters

MAKING SETTINGS CHANGES

1. The default state of the HMI display is SLEEP mode. The HMI will enter the SLEEP mode after 60 seconds of inactivity (no button presses). Any HMI button press will place the HMI into STATUS mode. In order to make changes to settings, follow the procedure described in items 2-5 below.
2. Repeatedly press the SELECT button, stepping through the main menu until the desired parameter is displayed (see Table 6-3). If no button is pressed within 60 seconds, the display will return to STATUS mode.
3. Press the ENTER button to place the HMI into EDIT mode. In EDIT mode, the HMI will display the current value of the selected parameter.
4. Press or hold the UP ↑ and DOWN ↓ buttons to modify the displayed parameter to its desired value. Parameter changes take immediate effect. For parameters other than StPt, pressing the SELECT button escapes EDIT mode without modifying the parameter. For StPt, pressing the SELECT button escapes EDIT mode but preserves any modification.
5. To store the displayed parameter value to non-volatile memory, press the ENTER button. The stored parameter value will flash three times to confirm the entry.

Note: While in STATUS mode, pressing either the UP ↑ or DOWN ↓ button places the regulator directly into **STPT** EDIT mode. This feature allows a shortcut to set point adjustment.

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AUXILIARY MODULES

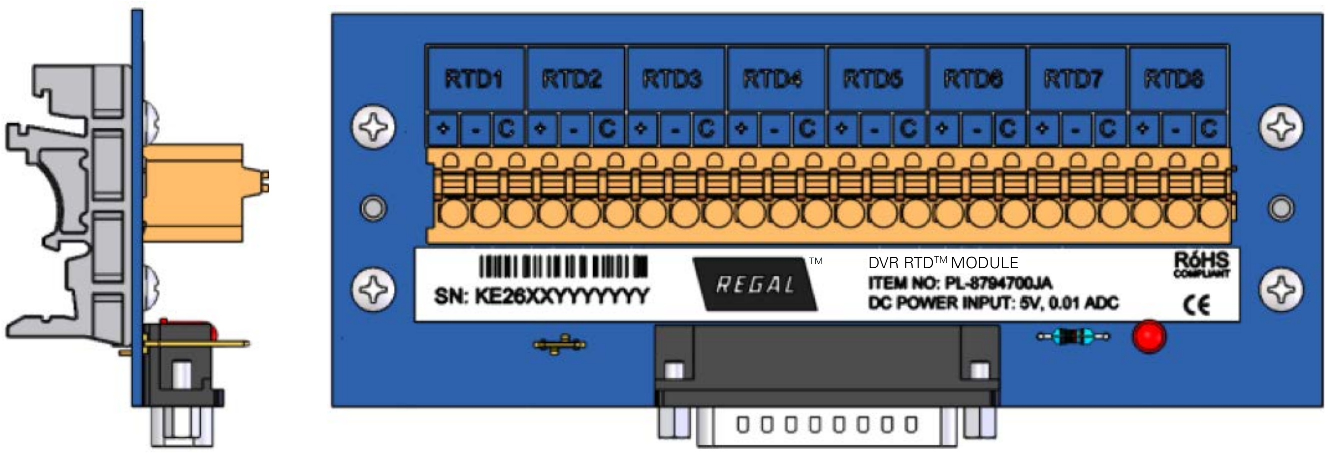
GENERAL

The DVR®2500 regulator is equipped with features that require the use of external auxiliary modules which are supplied separately from the base regulator.

RTD INTERFACE MODULE

The RTD Interface Module is a DIN rail-mounted component that provides termination points for up to eight 3-wire 100 Ohm Platinum RTDs. The RTD wires are terminated via PCB mounted screwless spring clamp connectors. The RTD module and DVR®2500 regulator are interconnected via onboard 25 pole D-sub connectors (DB25) and a cable supplied with the module.

See Section - Protection Functions for RTD protections features.



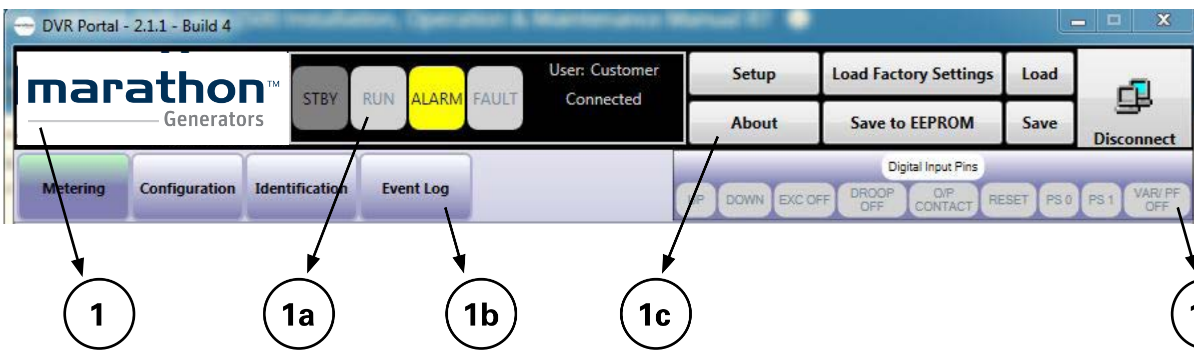
Note: Loctite®* 242 or similar should be used on the screws before connecting the DB25 cable to the RTD module and DVR® regulator for better vibration withstand. Recommended torque is 7.0 inch·lbf [0.8 N·m].

*Loctite is believed to be the trademark and/or trade name of Henkel IP & Holding GmbH and is not owned or controlled by Regal Beloit Corporation.

DVRPORTAL™ GRAPHICAL USER INTERFACE (GUI)

The DVRPortal™ software offers a means of programming the regulator and monitoring generator performance. This Windows® application software is available as a free download from the website https://www.marathongenerators.com/generators/dvrDownload.jsp. With this software, the user will be able to change all of the programmable parameters.

DVRPortal™ software consists of a header, and four panels (Metering, Configuration, Identification and Event Log). The header displays regulator status and basic administration functions. The Metering tab displays metered quantities and fault information. The Configuration tab permits editing of all programmable parameters. The Identification tab contains information specific to the regulator and allows for custom identification tags. The Event Log tab allows user to access the Event Log information saved in the regulator memory.



PARAMETER EDIT BUTTONS

On some of the parameter selection screens, you will find the following buttons:

Apply – Pressing this button sends the values in the currently active tab of the DVRPortal software to the regulator RAM.

Undo – Pressing this button displays the values just prior to the last edit in the currently active tab of the DVRPortal software. These values can then be sent to the regulator RAM by clicking on the Apply button.

Refresh – Pressing this button loads the values that are presently in the regulator RAM into the currently active tab of the DVRPortal software.

HEADER (1)

This is the main panel in the DVRPortal software. It is present on all screens.

Regulator Status (1a)

The header panel includes four indicators that enunciate the regulator status:

- Run State: If the regulator is in a run state, the header will display a green RUNV/ RUNI/ RUNP indicator, respectively, for Voltage/Field Current/ VAR or PF regulation.
- Alarm State: If the regulator is in an alarm state, the header will display a yellow alarm indicator.
- Fault State: If the regulator is in a fault state, the header will display a red fault indicator.
- STBY: If the regulator is in Standby State, the header will display STBY indicator.
- IDLE: If the regulator is in Idle State, the header will display IDLE indicator.
- STRT: If the regulator is in Soft Start State, the header will display STRT indicator.
- FLSH: If the regulator is in Field Flashing state, the header will display FLSH Indicator.

Configuration tabs (1b)

The configuration tabs are buttons that access the Metering, Configuration, Identification and Event Log tabs.

Administrative Buttons (1c)

The administrative buttons provide communication port settings, file manipulation and storing to regulator non-volatile memory.

Setup

This button allows the user to change serial port communication settings.

About

Provides information about the DVRPortal™ software.

Load Factory Settings

When this button is pressed, the default factory settings for the regulator are loaded into the regulators Random Access Memory (RAM). These factory settings can be transferred to the user settings in Electrically Erasable Programmable Read Only Memory (EEPROM) by pressing the “Save to EEPROM” button.

Note: If Load Factory Settings is selected, all setting for various presets will be lost. Make sure that you have saved these settings to an ".xml" file if these are needed in future.

Save to EEPROM

When this button is pressed, all parameter values in the regulators RAM (Configuration and Identification tabs) are transferred to the regulator’s user settings in EEPROM. These user settings are loaded into RAM whenever the regulator is powered up.

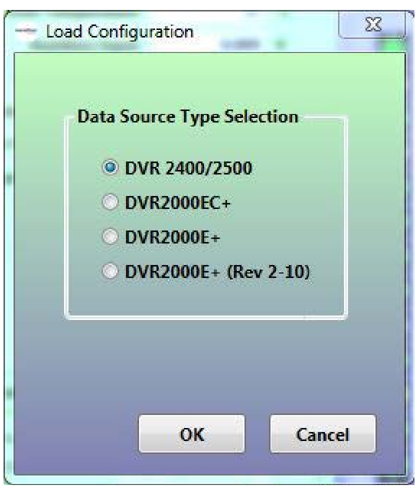


Figure 8-1

Load

When this button is pressed, the user will be given the option (see Figure 8-1) to choose the configuration(s) to load from a previously saved .xml file. When the file is selected, all user-adjustable settings from the selected .xml file are loaded into the volatile RAM memory of the regulator. These settings can be transferred to the user settings in non-volatile EEPROM by pressing the “Save to EEPROM” button.

Notes:

1. The regulator needs to be in Standby Mode to load configurations.
2. When a file is transferred from a computer to the regulator, the operating status will switch to “STBY” and excitation is disabled. To enable excitation with the new settings, save settings to EEPROM and then click the “Excitation ON” button on the Operating Modes sub panel of the Configure tab.

Save Config

When this button is pressed, the user will be prompted to save the configuration(s) to an .xml file. When the file is selected, all user adjustable settings presently in the volatile RAM memory are saved into the selected .xml file. These settings can be edited and loaded to the regulator’s volatile RAM memory by pressing the “Load Config” button.

Notes:

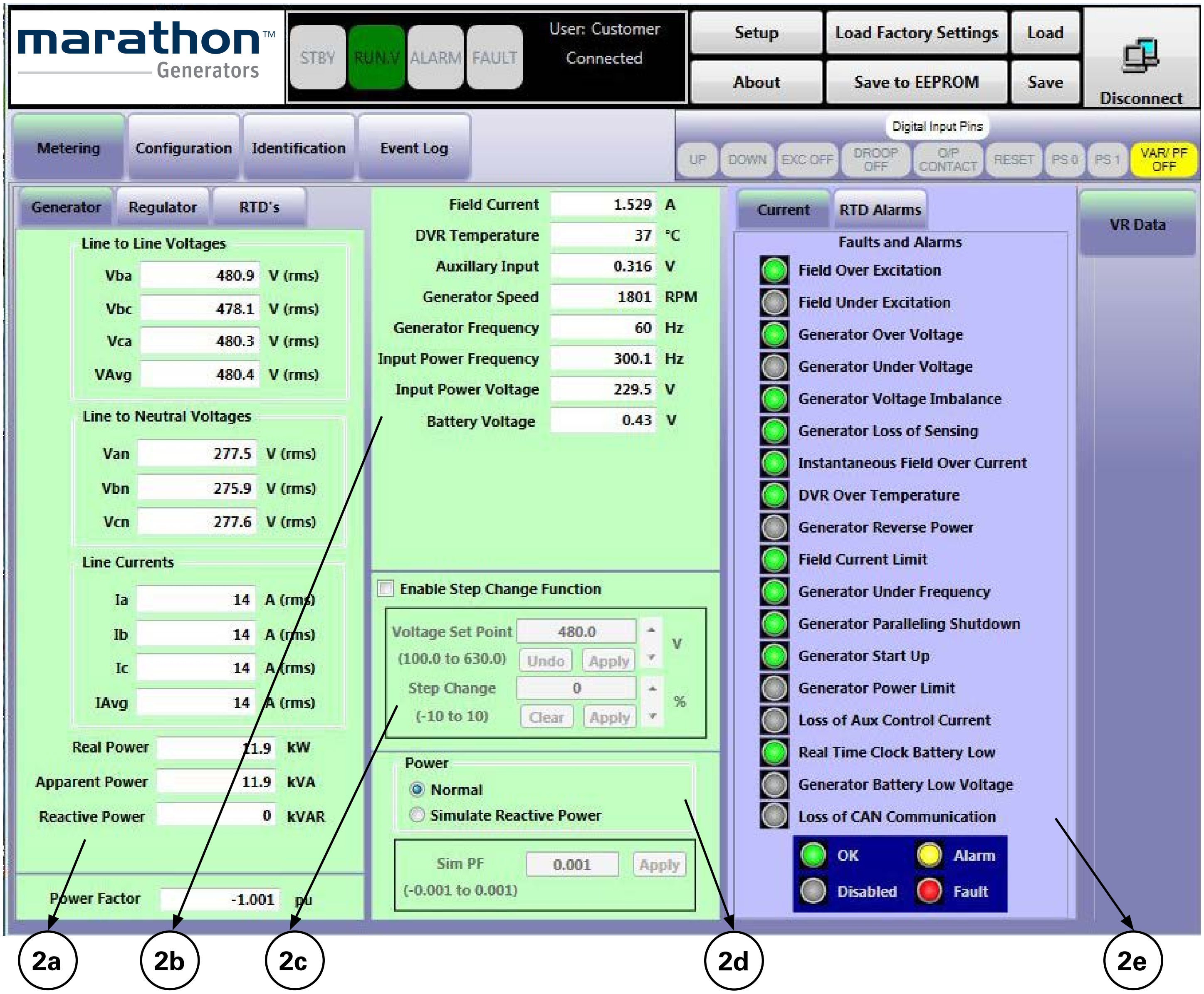
1. The regulator needs to be in Standby Mode if multiple presets are to be saved.
2. .xml files are text files that can be printed for reference.

Connect

When this button is pressed, the DVRPortal software establishes communication with the regulator. Communication must be established before data can be transferred between the regulator and the DVRPortal software. When connected, this button displays “Disconnect” to permit disconnection of communication.

Digital Input Status Indicators (1d)

There are nine indicators labeled UP, DOWN, EXC OFF, DROOP OFF, O/P CONTACT, RESET (2500), PS0 (2500), PS1 (2500) and VAR/PF OFF in the header. These indicators show the status of the nine input/output signals to/from the regulator. If their corresponding input contacts are closed, they will show as yellow. If the corresponding input contacts are open, they will show as gray (depending upon whether the inputs are configured as active high or active low under the Digital I/O tab).



METERING (2)

This panel has five sub-panels: AC and RTD Metering, DC and Input Metering, Step Change and Simulated Reactive Power, and the Alarms/Faults.

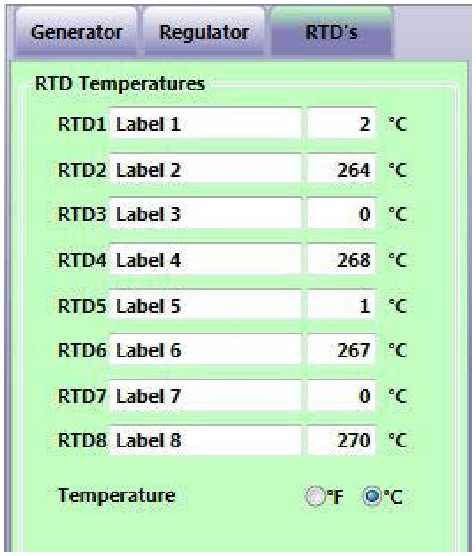
AC and RTD Metering (2a)

This Generator and Regulator panel displays the measured AC quantities of the generator and regulator respectively. Specifically, the panel displays line-to-line voltages, line-to-neutral voltages, line currents, real power, apparent power, reactive power and power factor. The RTD panel (2500 only) displays the measured temperatures of the 8 RTD channels (additional RTD module required). When the Generator tab is active (default), the values displayed correspond to the generator output terminals (primaries of potential and current transformers). When the Regulator tab is active, the values displayed correspond to the regulator input terminals (secondary sides of potential and current transformers).

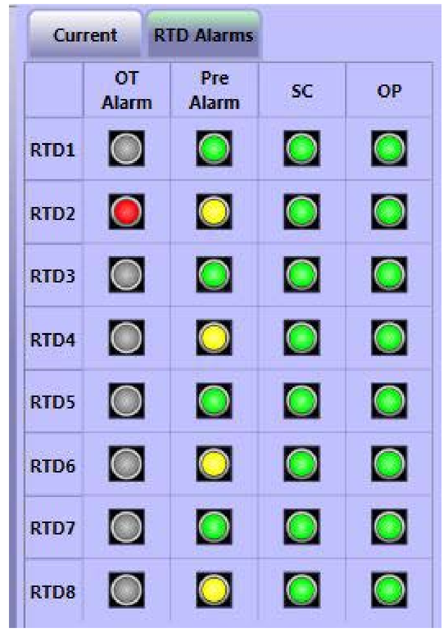
Note: If the regulator detects an OPEN or a SHORT on RTDs, the measured temperature saturates to a very low or very high value, respectively, and the corresponding SC or OP circuit indicator/'s may be indicated if the SC or OP detection is enabled. When the regulator is only powered by USB for communication, RTD's temperatures are measured as -200° C. If RTD SC alarms are enabled, this may trigger an event in the event log.

DC and Input Metering (2b)

This panel displays the measured DC values of field current and field voltage, regulator temperature, generator speed, auxiliary input voltage, Generator frequency, input power frequency, input power voltage and battery voltage (2500 only).



RTD Metering



RTD Faults and Alarms

Step Change (2c)

This panel enables a voltage step function intended for monitoring the regulator performance. This function is only utilized in AVR1 or AVR3 regulation modes. The panel displays the voltage set point reference from the Configurations panel with arrow keys to permit voltage adjustment up and down. Below the set point is a field called Step Change with a valid range of -10 to 10%. When the "Apply" button below this field is clicked, the regulator will add the given percentage as an offset to the voltage set point. Pressing "Clear" will remove the offset and restore the original set point.

Simulated Reactive Power (2d)

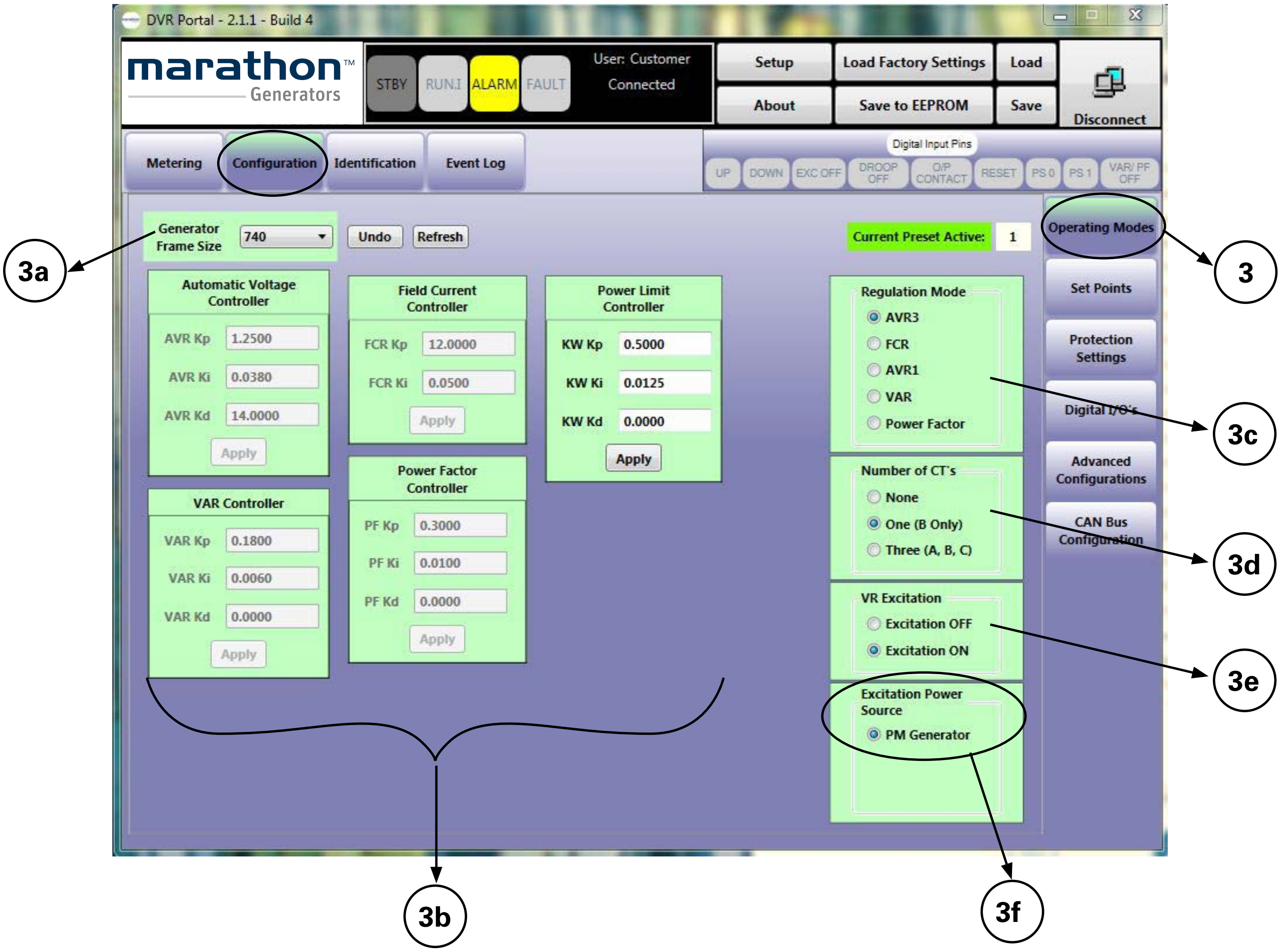
This panel enables the simulation of reactive power. The radio button for reactive power has two options. In Normal mode, the metering panels will display the currents and powers in their actual sense. In Simulated Reactive Power, a flashing indicator will appear in the metering panel that indicates this mode has been selected. The apparent power is calculated just as in Normal mode. The real and reactive powers are created with the simulated power factor. This is intended as a diagnostic mode to assist with the setup of paralleling generators in droop compensation mode with the use of a resistive load bank. Enabling this condition simulates a reactive load on the generator.

Faults/Alarms (2e)

This panel displays alarms and faults. When the "Current" tab is active, the panel displays faults and alarms that are currently active on the regulator. The alarms and faults can be in any of four possible states:

- OK State: If the regulator is in a run state, there will be a green indicator next to all enabled alarm and fault conditions.
- Disabled State: If a given alarm or fault condition is disabled (for example Generator Voltage Imbalance in AVR1 regulation mode), that condition will display a gray indicator.
- Alarm State: If the regulator is in an alarm state, there will be a yellow indicator next to the corresponding condition causing the alarm.
- Fault State: If the regulator is in a fault state, there will be a red indicator next to the corresponding condition causing the fault.

When the RTD Alarm's tab is active, the panel displays faults and alarms that are active for the RTD thermal protections. This tab displays OT (Over Temperature) Alarms, Pre Alarms, SC (RTD Short Circuit) Alarms, OC (RTD Open Circuit) Alarms.



CONFIGURATION

This panel has six sub panels: Operating Modes, Set Points, Protection Settings, Digital I/O, Advanced

Configurations and CAN Bus Configuration.

OPERATING MODES (3)

This panel contains controls for altering the operating mode of the regulator including dynamic response and regulation.

Generator Frame Size (3a)

This pull down menu selects stability settings for the chosen frame size in AVR1 or AVR3 regulation modes. Gains for the controller are displayed with gray numbers in the panel below the pull-down menu. Selecting the appropriate frame size chooses appropriate proportional, integral and derivative gain values. These gain values are not editable. For editable custom gains, Generator Frame Size "CUST" should be selected. Choosing "CUST" will copy the gains from the previous selected frame size. The grayed gains will then become active for editing. Saving to EEPROM will store the edited gains to the user settings.

PID Controller Gains (3b)

There is a separate panel for adjusting the PID controller gains for each regulation mode as well as for power limiting, if that feature is enabled. The PID gains for AVR3 and AVR1 are described above in "Generator Frame Size." For FCR and Power Limiting, gains are editable when the corresponding regulation mode is selected. Some rounding may occur for gain values due to fixed point arithmetic.

Regulation Modes (3c)

This panel contains a radio button for selecting the regulation mode:

- **AVR3 Regulation Mode** is used for Automatic Voltage Regulation with three-phase generator voltage sensing.
- **AVR1 Regulating Mode** is used for Automatic Voltage Regulation with single phase generator voltage sensing.
- **FCR Regulation Mode** is used for field current regulation. In this mode the DVR® regulator will maintain a fixed level of field current.
- **VAR Regulating Mode** is used for reactive VAR regulation. This mode is only enabled when the VAR/PF_OFF input is open. Otherwise, the regulator will regulate as if AVR3 mode were selected.
- **PF Regulating Mode** is used for power factor regulation. This mode is only enabled when the VAR/PF_OFF input is open. Otherwise, the regulator will regulate as if AVR3 mode were selected.

Number of CT's (3d)

This panel contains a radio button for selecting the number of CT's to be used for current and power measurement.

- **Three (A, B, C)** is used for metering of all three phase currents independently. This sensing mode should only be selected when using three current transformers. This is only available on the 2500.
- **One (B Only)** is used for metering of phase B current only. This sensing mode should only be selected when using one current transformer in phase B. Currents for phases A and C will not be metered and power measurements will be based on the assumption phase B current flows equally in phases A and C.
- **None** is used if no current transformers are connected.

VR Excitation (3e)

This panel contains a radio button for disabling or enabling excitation to the field.

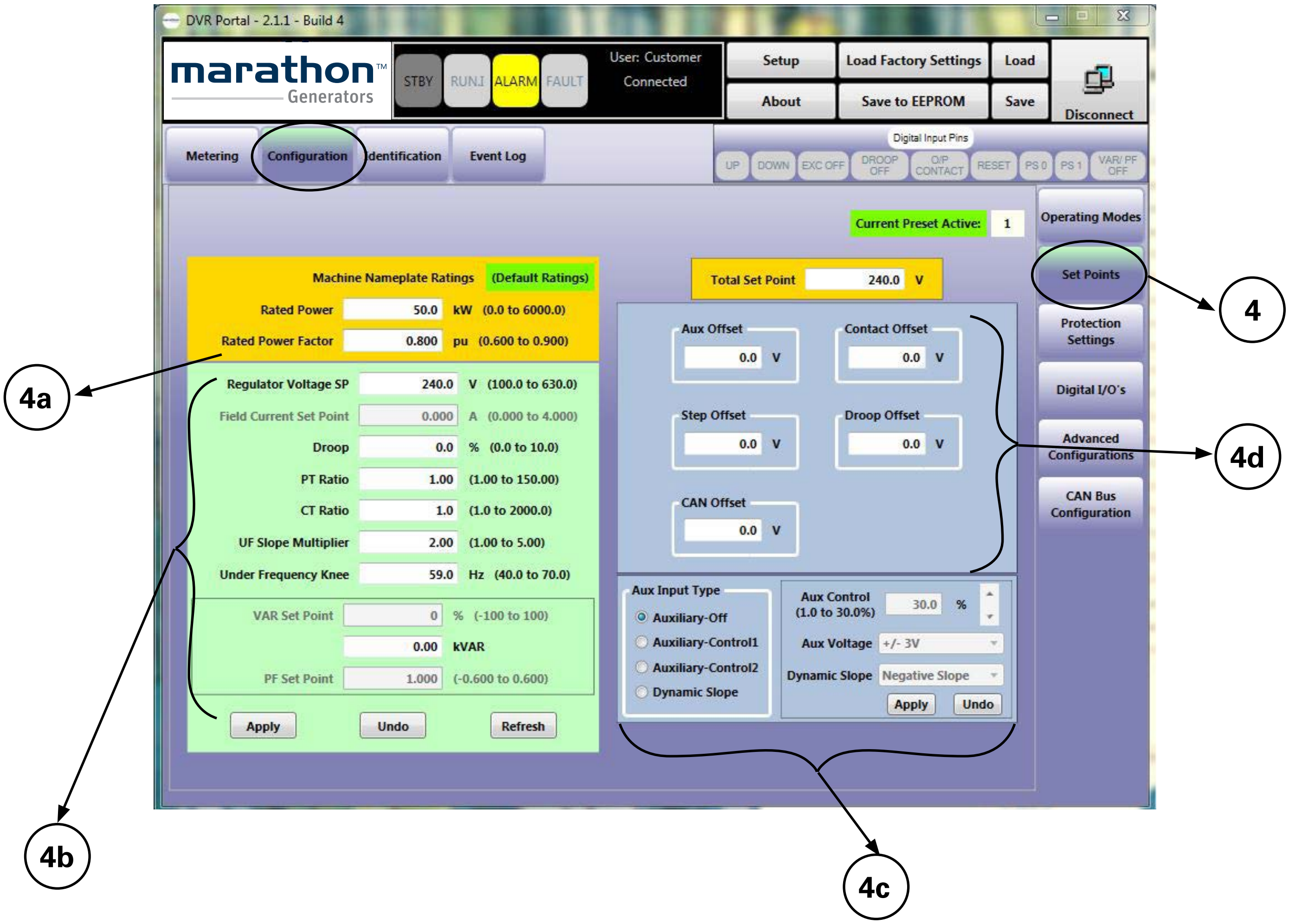
- **Excitation Off** is used to disable excitation to the generator exciter field. The status indicator in the header will display a "STBY" state. This state is recommended for making adjustments to the regulator settings.
- **Excitation On** is used to enable excitation to the generator exciter field. If the regulator was previously "Off," selecting this state will initiate a new soft start for AVR1 and AVR3 regulation modes.

Note: Any changes to the regulator settings made prior to selecting "Excitation On" will be lost unless they are saved to EEPROM. See the Header section above for details on saving settings to EEPROM.

Input Power Source (3f)

This panel contains a radio button for selecting the input power source type.

- **PM Generator** is selected if the input power is derived from a permanent magnet generator.



SET POINTS (4)

This panel contains editable fields for configuring the regulator and displays adjustments to the regulator set points.

Machine Nameplate Rating (4a)

This panel contains the fields for the rated power and rated power factor of the machine the regulator is regulating. If the rated power selected matches the default rated power for a given frame size, an indicator will specify this condition.

Note: These fields are critical for proper regulation in droop compensation, VAR and PF regulation modes. For protection features like reverse power and under excitation, nameplate ratings are used as the basis for these protections.

Regulation Set Points (4b)

This panel contains the editable fields for selecting the regulator set point for the various regulation modes and the frequency characteristics of the regulator.

- Regulator Voltage Set Point is editable in AVR1, AVR3, VAR and PF regulation modes. This value represents the desired voltage at the regulator voltage sensing terminals, regardless of PT ratio. Offsets from the UP and DOWN contacts, auxiliary input, droop, step change and/or the CAN bus are derived from this set point.

- If there are no PT's and the regulator sensing leads are connected line-to-line, the desired generator output voltage is identical to the Regulator Voltage Set Point. If the regulator sensing leads are connected midpoint-to-midpoint of a series wye configuration, the desired generator output voltage is twice the Regulator Voltage Set Point.

  If there are PT's in the sensing circuit, the desired generator output voltage is determined by the multiplication of the PT ratio and the Regulator Voltage Set Point.

- **Field Current Set Point** is editable in FCR Regulation Mode. This value represents the desired field current of the regulator.

- **Droop** is the maximum percentage of Regulator Voltage Set Point allowed for adjustment of voltage during load sharing. Refer to Section – Features and Protection for a detailed description of Load Sharing.

- **PT Ratio** is the value of the potential transformer ratio of the system. The generator output voltages displayed in the Generator tab of the Metering panel are equivalent to the voltages displayed in the Regulator tab multiplied by this value.

Example: A PT with a 13,200 Volt primary rating and a 240 Volt secondary rating would have a PT Ratio of 55.

- **CT Ratio** is the value of the current transformer ratio of the system. The generator output currents displayed in the Generator tab of the Metering panel are equivalent to the currents displayed in the Regulator tab multiplied by this value.

Example: A CT with an 800 A primary rating and a 5 A secondary rating would have a CT ratio of 160.

- **Slope Multiplier** is the factor applied to the base slope for voltage roll-off with respect to frequency in a V/Hz mode. Refer to Section – Features and Protection for a detailed description of Generator Under Frequency.

- **Under Frequency Knee** is the value of frequency below which the regulator operates in a Volts-per-Hertz mode. Refer to Section – Features and Protection for a detailed description of Generator Under Frequency.

Auxiliary Input Configuration (4c)

This panel contains controls for modifying the functionality of the auxiliary input.

- **Auxiliary Input Type** configures the auxiliary input as a set point modifier, a slope multiplier modifier or disabled. Refer to Section – Features and Protection for a detailed description of the Auxiliary Input function.

Note: If Aux input type is selected as Dynamic Slope (2500 only), the UF Slope setpoint field will be locked as this register dynamically updates with the applied AUX voltage.

- ***Aux. Control Scale Factor*** is used when the auxiliary input port is configured as "Auxiliary Control1" or "Auxiliary Control2" This value scales the auxiliary input. Refer to Section – Features and Protection for a detailed description of the Auxiliary Input function.

- **AUX Voltage** is used to select the range of AUX voltage applied to the regulator. This feature is only available in the 2500. For the 2400 this is by default set to +/-3V. The 2500 provides additional selections of +/-5V and +/-10V.

- **Dynamic Slope** Is used to select the polarity of the dynamic slope feature. This determines the direction of slope variation when a 0 - 5V is applied to Aux Input. This feature is only available in the 2500. Refer to Section – Features and Protection for a detailed description of the Dynamic Slope function.

Offset Display (4d)

This panel displays the offsets contributing to the modification of the set point for the currently selected regulation mode.

- **Contact Offset** displays the effect that the contact inputs have on the regulator set point value. Refer to Section – Features and Protection for a detailed description of the UP and DOWN contact input functions.

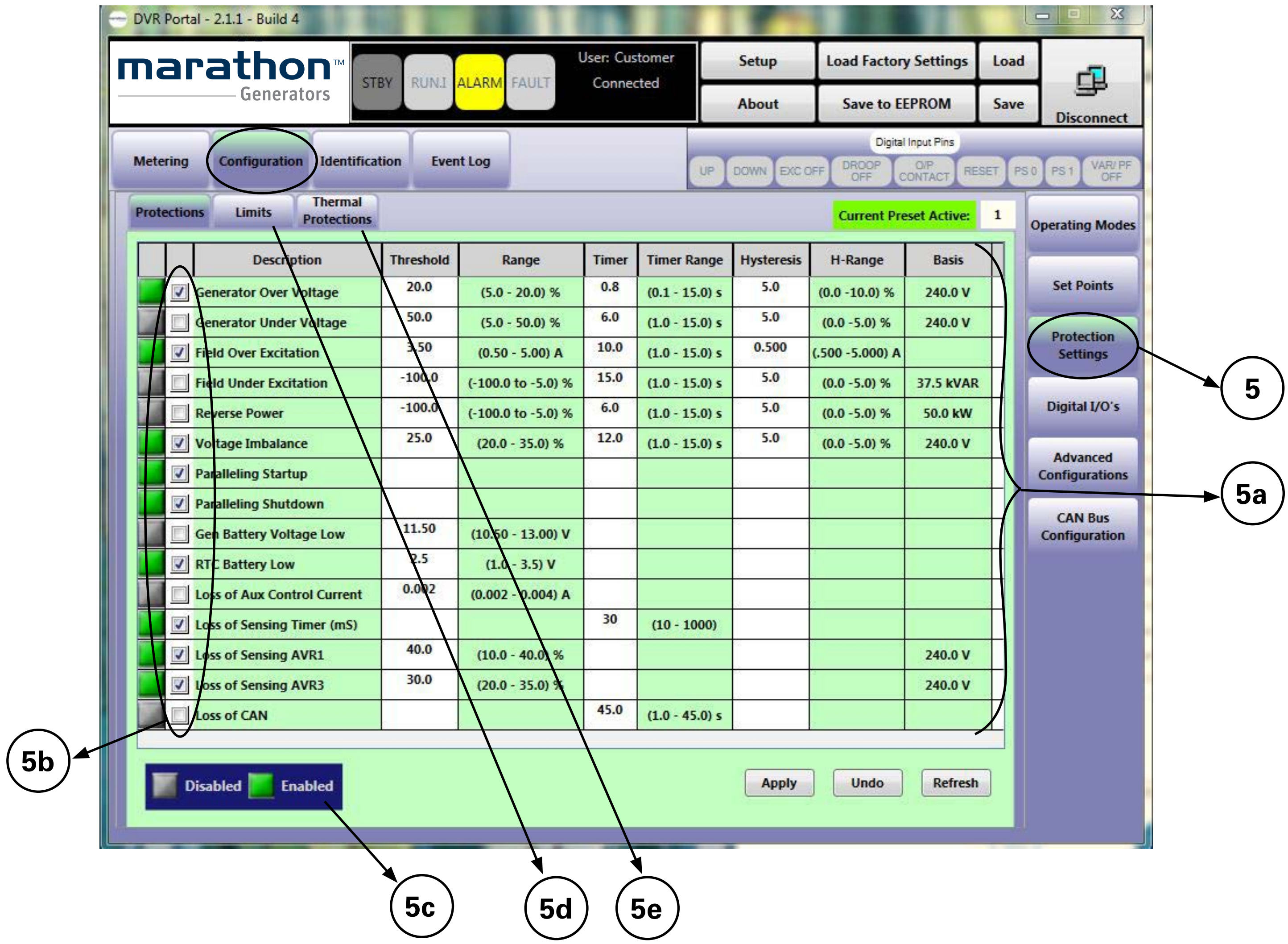
- **Auxiliary Offset** displays the effect that the auxiliary input has on the regulator set point value. Refer to Section – Features and Protection for a detailed description of the Auxiliary Input function.

- **Droop Offset** displays the effect that the regulator's droop function has on the regulator set point value. Refer to Section – Features and Protection for a detailed description of the Load Sharing function.

- **CAN Offset** displays the effect that the Set Point Adjust CAN message has on the regulator set point value. Refer to the DVR®2500 CAN Bus Interface User Guide for a detailed description of the Set Point Adjust message.

- **Step Offset** displays the effect that the step change from the Metering tab has on the regulator set point value. Refer to Section – Features and Protection for a detailed description of the step change input functions.

- **Total Set Point** displays the total reference to the controller. This reference value is comprised of the set point and any offsets currently active.



PROTECTION SETTINGS (5)

This panel contains three sub panels for protection settings, limit settings and thermal protection settings.

Protections (5a)

This panel contains editable Enable/disable threshold, hysteresis and timer fields for configurable faults and alarms. For most applications, the default values of these parameters can be used. For protection settings that have a threshold as a percentage, the "Basis" column indicates the regulator parameter used for the percentage related to that protection feature. Refer to Section 4 for detailed description of these protections.

Enable/Disable (5b)

The panel contains enable/disable options for all protections. Most of these can be either enabled or disabled. But some of the protections can't be disabled. Please refer to Section – Features and Protection to see which protections can be disabled by customers.

Protection Table Legend (5c)

This legend indicates which protection settings are disabled (gray) and enabled (green). The state of protection features is dependent on the selected regulation mode.

Note: Even if the enable is checked, some protections might be shown as disabled as these may not be applicable for that particular regulation mode. For example, in FCR mode, Under Voltage is disabled as this mode is doing field current regulation. Therefore, if this is enabled by user in FCR mode the indicator will shows this as disabled.

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Limits (5d)

This panel contains editable limit thresholds for field current and generator power as well as the soft start time. For most applications, the default values of these parameters should be used.

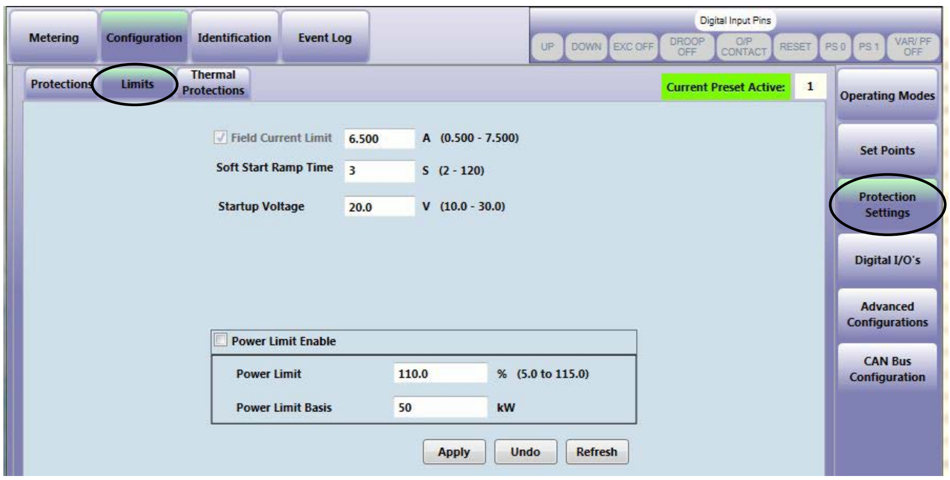
- **Field Current Limit** is the maximum allowable field current output of the regulator. Refer to Section – Features and Protection for a detailed description of the Field Current Limiting feature.

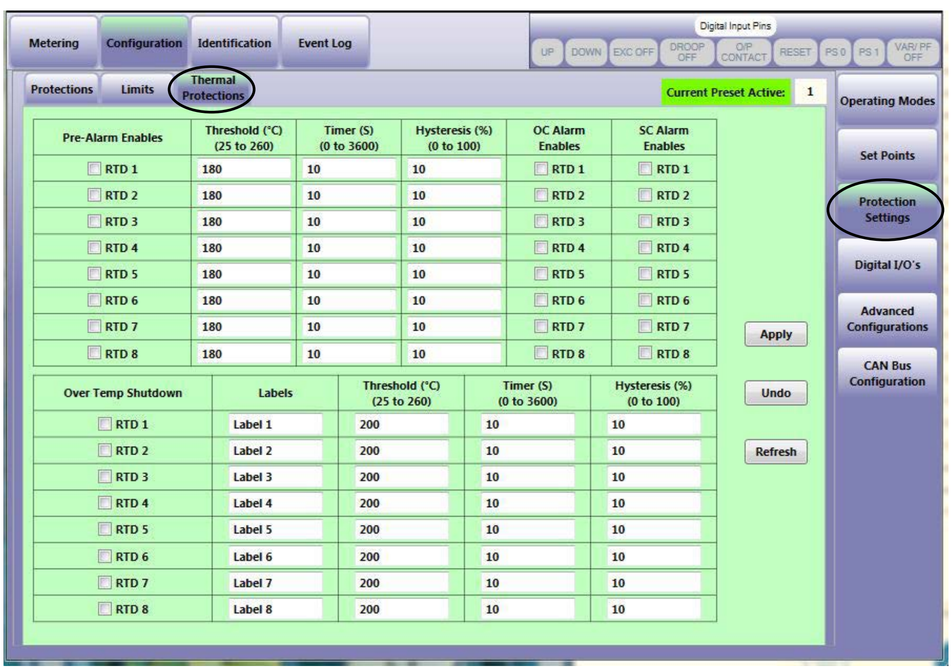
- **Soft Start RampTime** Is the amount of time taken to ramp to the desired voltage at the generator output terminals in AVR1 and AVR3 regulation modes. Refer to Section – Features and Protection for a detailed description of the Generator Soft Start function.

- **Power Limit** is the maximum allowable power output of the generator. The checkbox above the Power Limit permits enabling/disabling of this limit. Enabling the limit also enables the PID controller associated with it on the Operating Modes panel. Refer to Section – Features and Protection for a detailed description of the Power Limiting feature.

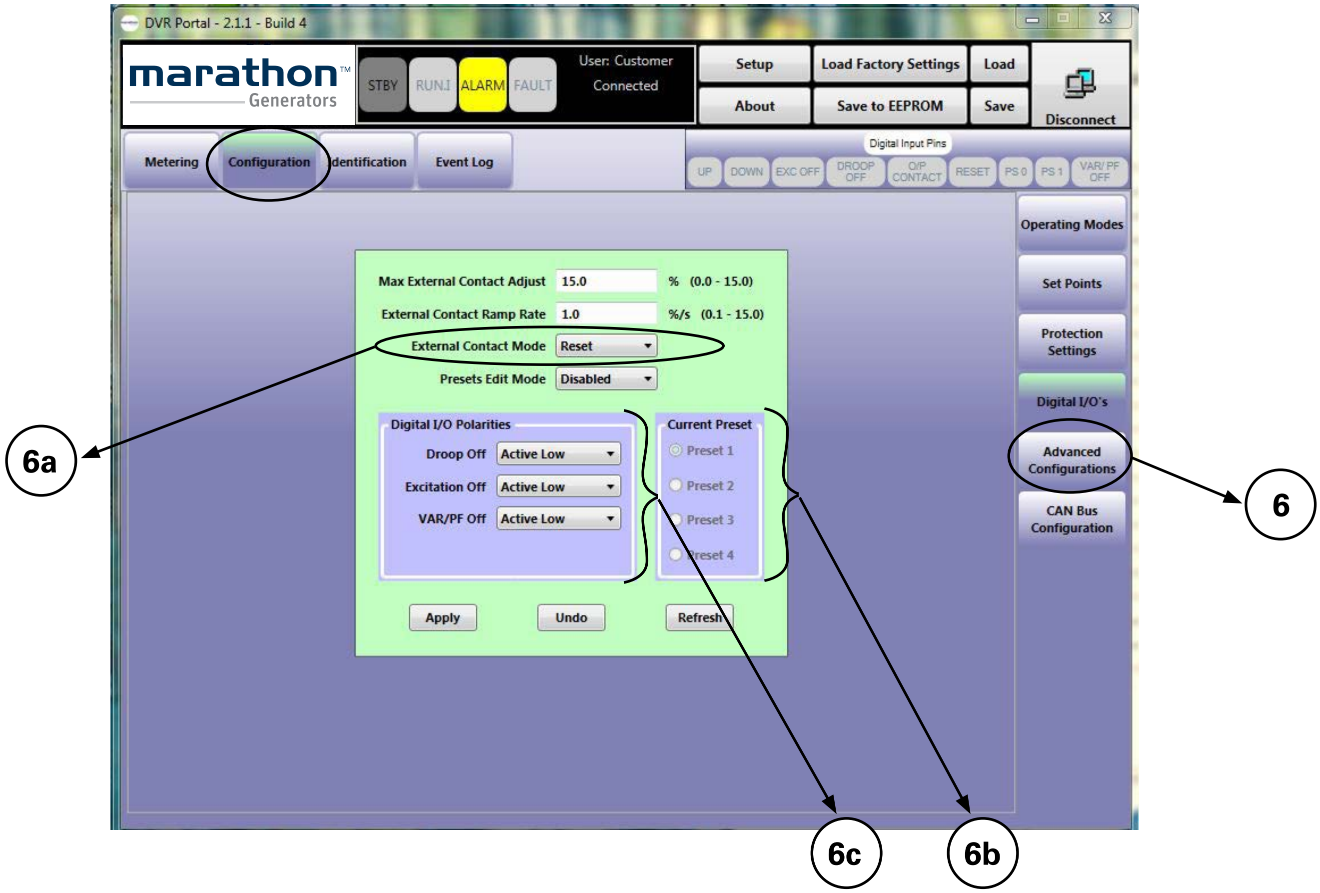
Thermal Projections (5e)

This panel contains editable Enable/Disable, Thresholds, Hysteresis and timer fields for RTD Pre-Alarms and RTD Over Temperature Shutdowns. This panel also contains editable Enable/Disable for RTD Open Circuit and RTD Short Circuit Alarms. Refer to features and protection for further details.





REGAL®



DIGITAL I/O (6)

This panel contains configurations related to the regulator digital inputs and output.

External Contact Mode (6a)

This field provides users a way to configure UP/DOWN contact mode. Setting this to RETAIN will save contact offset after a change is made to the UP/DOWN contact. The DVR® regulator clears the offset after power cycle if this is set to RESET.

Current Preset (6b)

These radio buttons show which preset is currently active in the 2500. These provide users the ability to set the configurations for each of the presets using these radio buttons. Here the steps that need to be followed in order to edit the preset configurations.

a. Place the regulator is stand-by mode
b. Connect to regulator through the DVRPortal™ software
c. Set “Preset Edit Mode” to “Enable”
d. Select the preset that you would like to edit (6b)
e. Navigate through various tabs and modify the configurations
f. Once the configurations are modified to this particular preset, hit “Save to EEPROM”
g. Repeat steps “c - f” for other presets

Note: Configurations will be lost if current preset is changed in the DVRPortal software program before saving to EEPROM.

Digital I/O Polarity (6c)

This panel provides users the ability to change polarity of the digital inputs to either Active Low or Active High.

Example: Default configuration of Excitation OFF contact is Active Low (excitation turned OFF when contact between EXC and GND is closed). If the user configures this to Active High, excitation will be disabled when the contact is Active High (excitation turned OFF when contact Is open between EXC and GND).

Notes:

1. Digital I/O polarity changes are allowed in Preset 1 only.
2. EXC_OFF polarity change won’t take effect until a power cycle
3. Presets 2 through 4 will have same settings as Preset One (1).

ADVANCED CONFIGURATION (7)

This panel contains editable fields for parameters associated with generator and engine operation.

Soft Start Cut in Frequency:
This is the speed at which the regulator will initiate voltage soft start. The HMI and DVR® regulator will show "START" as a status indicator during the soft start.

Run Cut Out Hysteresis:
This is the speed at which the regulator stops providing excitation current to generator.

Idle Cut in Frequency:
This is the speed at which the regulator transitions from Stand-by to Idle mode.

Idle Cut out Hysteresis:
This is the speed at which the regulator transitions from Idle to Stand-by mode.

No. of Generator Poles:
This field lets you select if the generator is a 4 or a 6 pole machine. Changing this would impact the frequency and speed measurement of the regulator.

CAN BUS CONFIGURATION (8)

This panel contains editable fields for parameters associated with the CAN Bus communication of the 2500. Refer to the DVR2500 CAN Bus Interface User Guide for a detailed description of these features.

CAN Addresses (8a)

This panel allows editing of CAN addresses and message times.

- CAN Address is the CAN address of the regulator.
- ECU1 Source Address is the CAN address of the highest priority Electronic Control Unit that the regulator will respond to.
- ECU16 Source Address is the CAN address of the sixteenth-highest priority Electronic Control Unit that the DVR® regulator will respond to.

Note: The ECU addresses can all be assigned to the same control unit. They should only be different if the regulator needs to communicate with more than one ECU.

Time and Priorities (8b)

DVR CAN messaging is divided into seven (7) different groups. Each group time and priorities can be configured through this panel.

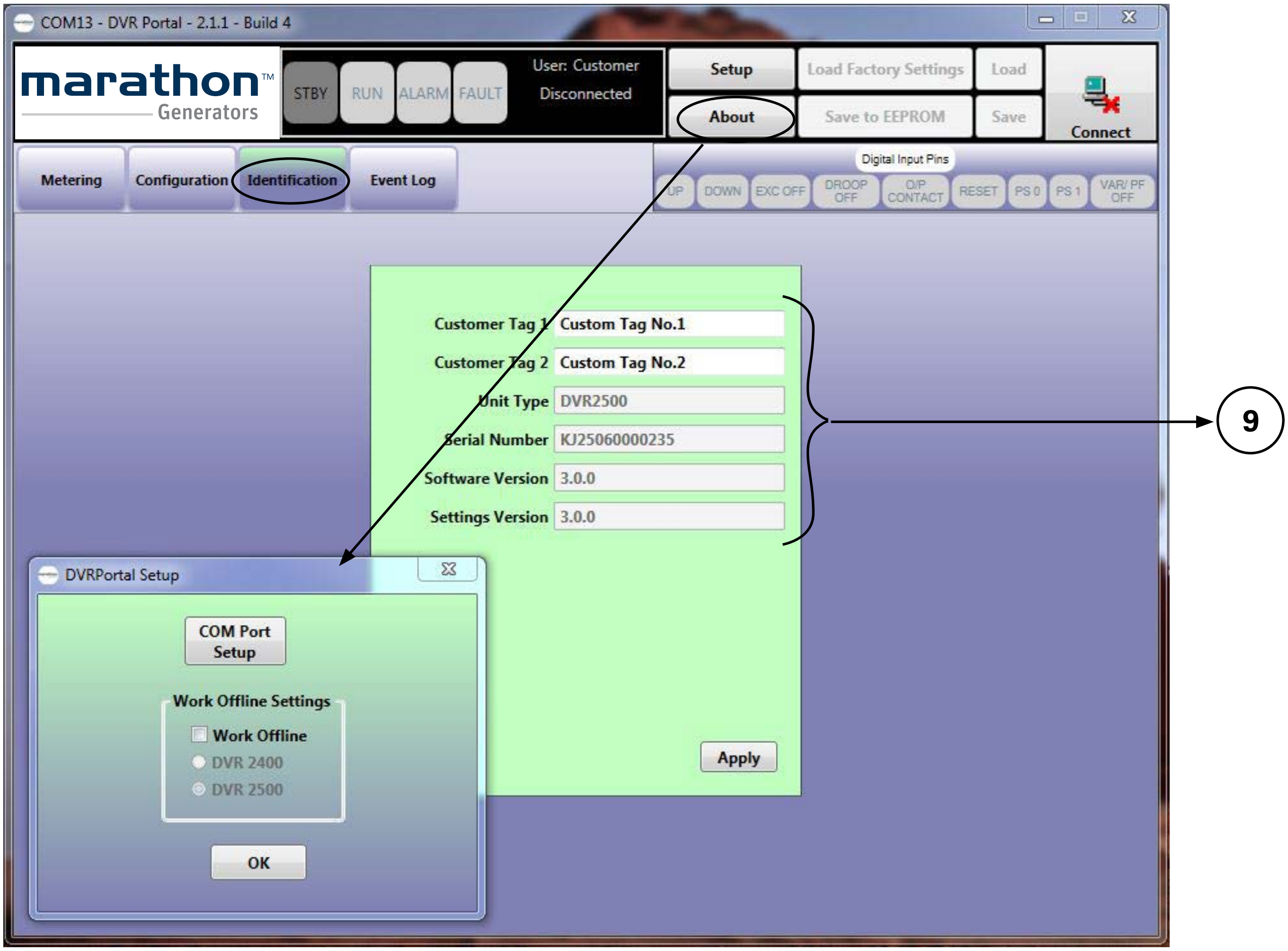
- Message Time is the amount of time between transmission of messages in that particular message group.
- Message Priority is the priority given to this particular message group. Zero (0) being highest priority and Five (5) being the lowest priority.

Refer to the CAN user manual for additional information regarding message groups.

CAN Message Timing (8c)

This panel allows users to edit additional timing settings through this panel. For further information, please refer to standard SAE J1939.

Note: When enabling multiple message groups, care must be taken to ensure that the regulator CAN bus is not over loaded.



IDENTIFICATION TAB (9)

This panel contains non-editable fields for the regulator serial number, software version, and settings version. It also contains editable fields for custom tags.

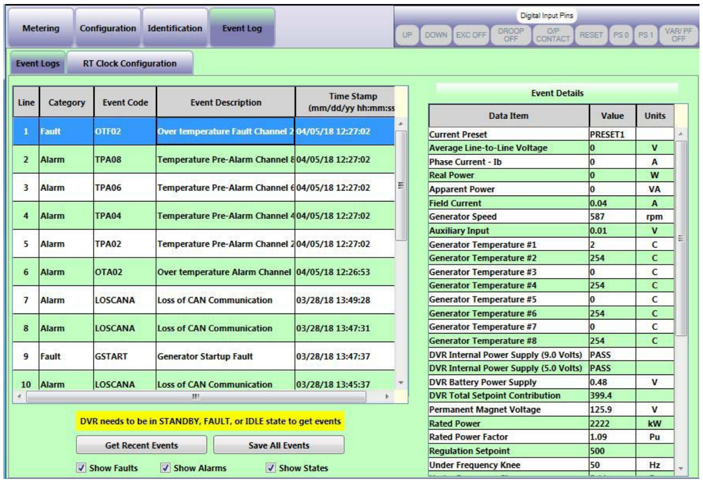
- **Serial Number** is the serial number of the regulator.
- **Software Version** is the version of regulator firmware.
- **Settings Version** is the version of factory default settings for the regulator.

- **Customer Tag 1** is a 15-character string that can be stored to the regulator.
- **Customer Tag 2** is a 15-character string that can be stored to the regulator.

Note: The Apply button will write the string into the regulator RAM, but a Save to EEPROM is needed to store the tag in the non-volatile memory.

EVENT LOG TAB (10)

This panel provide user access to event information logged by the regulator and ability to set the Real Time Clock (RTC) for the 2500.



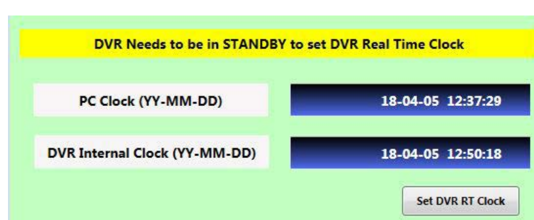
- **Get Recent Events** button lets the DVR®Portal software read events from the regulator. Make sure that the regulator is in either STANDBY, IDLE or FAULT state to ensure the regulator does not malfunction as reading events is memory intensive
- **Save all Events** button lets you export events data from the portal to a .CSV file. This allows users to share event log data.
- The check boxes "Show Faults", "Show Alarms" and "Show States" will allow user to filter the events in the portal.
- Event details can be access by selecting the event user is interested in, event details space will load the details.

Note: If the regulator measures temperatures above 254°C (in case of open circuit), the temperatures under event log are statured to 254°C due to limited memory. Metering will display actual temperature though.

Event Details

Data Item	Value	Units
Current Preset	PRESET1	
Average Line-to-Line Voltage	0	V
Phase Current - Ib	0	A
Real Power	0	W
Apparent Power	0	VA
Field Current	0.043	A
Generator Speed	587	rpm
Auxiliary Input	5.11	V
Generator Temperature #1	2	C
Generator Temperature #2	254	C
Generator Temperature #3	0	C
Generator Temperature #4	254	C
Generator Temperature #5	0	C
Generator Temperature #6	254	C
Generator Temperature #7	0	C
Generator Temperature #8	254	C
DVR Internal Power Supply (9.0 Volts)	PASS	
DVR Internal Power Supply (5.0 Volts)	PASS	
DVR Battery Power Supply	0.48	V
DVR Total Setpoint Contribution	399.4	
Permanent Magnet Voltage	125.9	V
Rated Power	2222	kW
Rated Power Factor	1.09	Pu
Regulation Setpoint	500	
Under Frequency Knee	50	Hz
Under Frequency Slope	5.11	Pu
Droop Percentage	0	%
PT Transformer Turns Ratio	22	V
CT Transformer Turns Ratio	22	A
Regulation Mode	AVR1	
Digital IO UP	INACTIVE	
Digital IO DOWN	INACTIVE	
Digital IO Excitation OFF	INACTIVE	
Digital IO Droop OFF	INACTIVE	
Digital IO VAR/PF OFF	INACTIVE	
Digital IO Reset	INACTIVE	
Digital IO Voltage Match	INACTIVE	
Digital IO Output Contact	INACTIVE	
Generator Frame Size	571	
Threshold Value for Event	200	
Threshold Timer Value for event	10	

- RT Clock Configuration tab lets user synch system clock with the regulator's internal clock for accurate event time stamp. This is only available in the 2500.



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Marathon-Generators

MAINTENANCE AND TROUBLESHOOTING

⚠ WARNING

ELECTRICAL HAZARD

- Failure to connect the voltage regulator in accordance with the manufacturer's documentation could result in serious personal injury, death, and/or property damage.

ELECTRICAL SHOCK HAZARD

- Failure to follow these instructions could result in serious personal injury, death, and/or property damage.
- Installation and repair of electrical generators and voltage regulators should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lock out and tag prime mover and input power supplies before installing or servicing voltage regulator. Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) the regulator in accordance with local, national, international and/or other applicable codes, rules or regulations.

EXPLOSION HAZARD

- Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

ROTATING PARTS HAZARD

- Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

OVERSPEED HAZARD

- Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

DO NOT DISASSEMBLE

- Only qualified personnel who know local, national, international and/or other applicable codes, rules or regulations and sound practices should install or repair electric generators and voltage regulators. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ WARNING

MAGNETIC FIELD HAZARD

- Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which could cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

PREVENTATIVE MAINTENANCE

The only preventive maintenance required on the regulator is to periodically check that the connections between the regulator and the system are clean and tight. The only user serviceable parts on the regulator are the fuse and RTC coincell battery. Regal recommends that no repair procedures, other than replacing the fuse or coincell battery if needed, be attempted by anyone other than Regal personnel.

TROUBLESHOOTING

⚠ WARNING

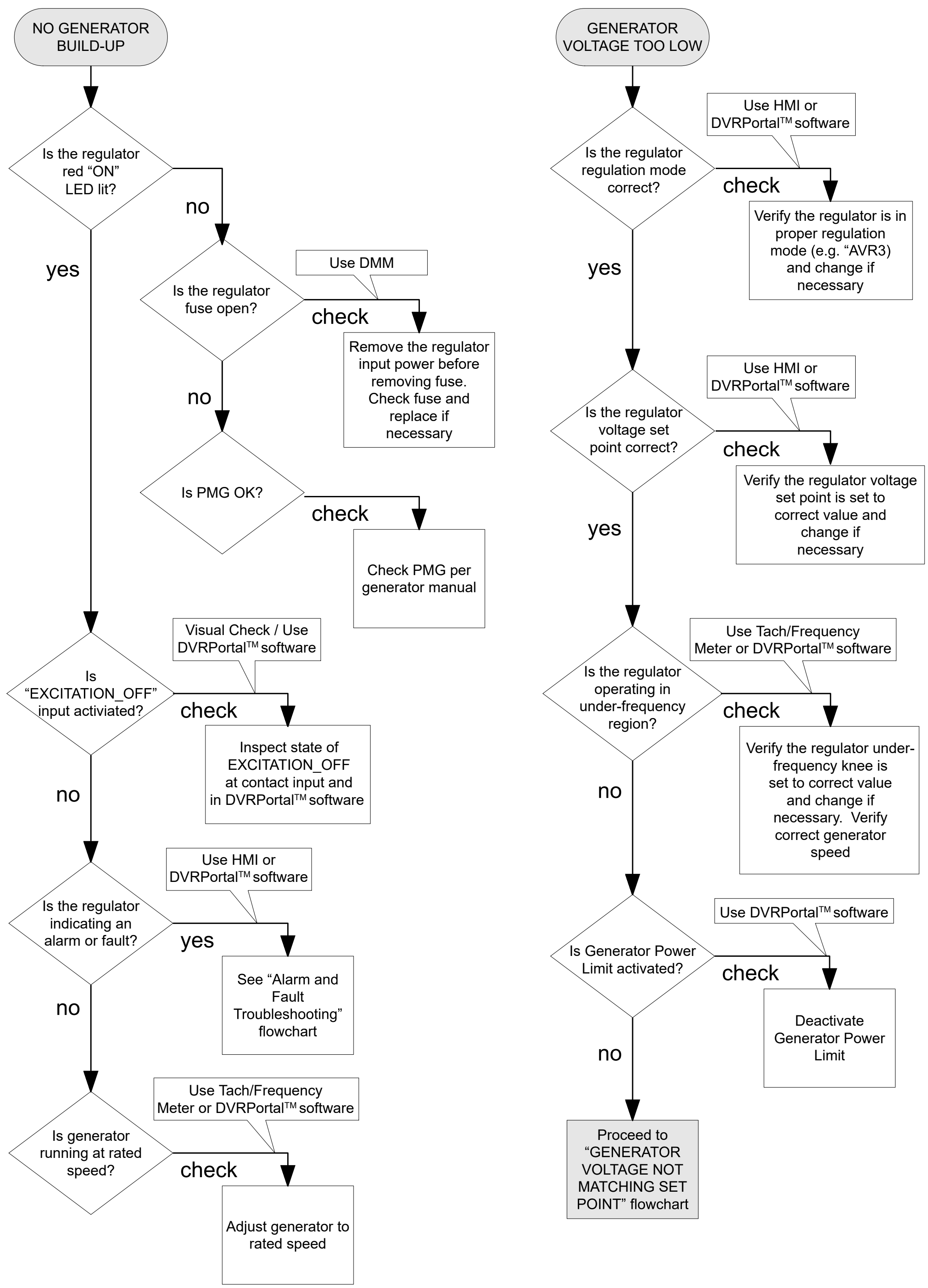
Read and follow all applicable safety instructions. Failure to do so may result in serious personal injury, death, and/or property damage, particularly when working with safety barriers removed.

If the output of the generator does not meet specifications, the first level of troubleshooting is to verify proper generator and regulator connections. This Installation, Operation and Maintenance Manual of generator should be referenced.

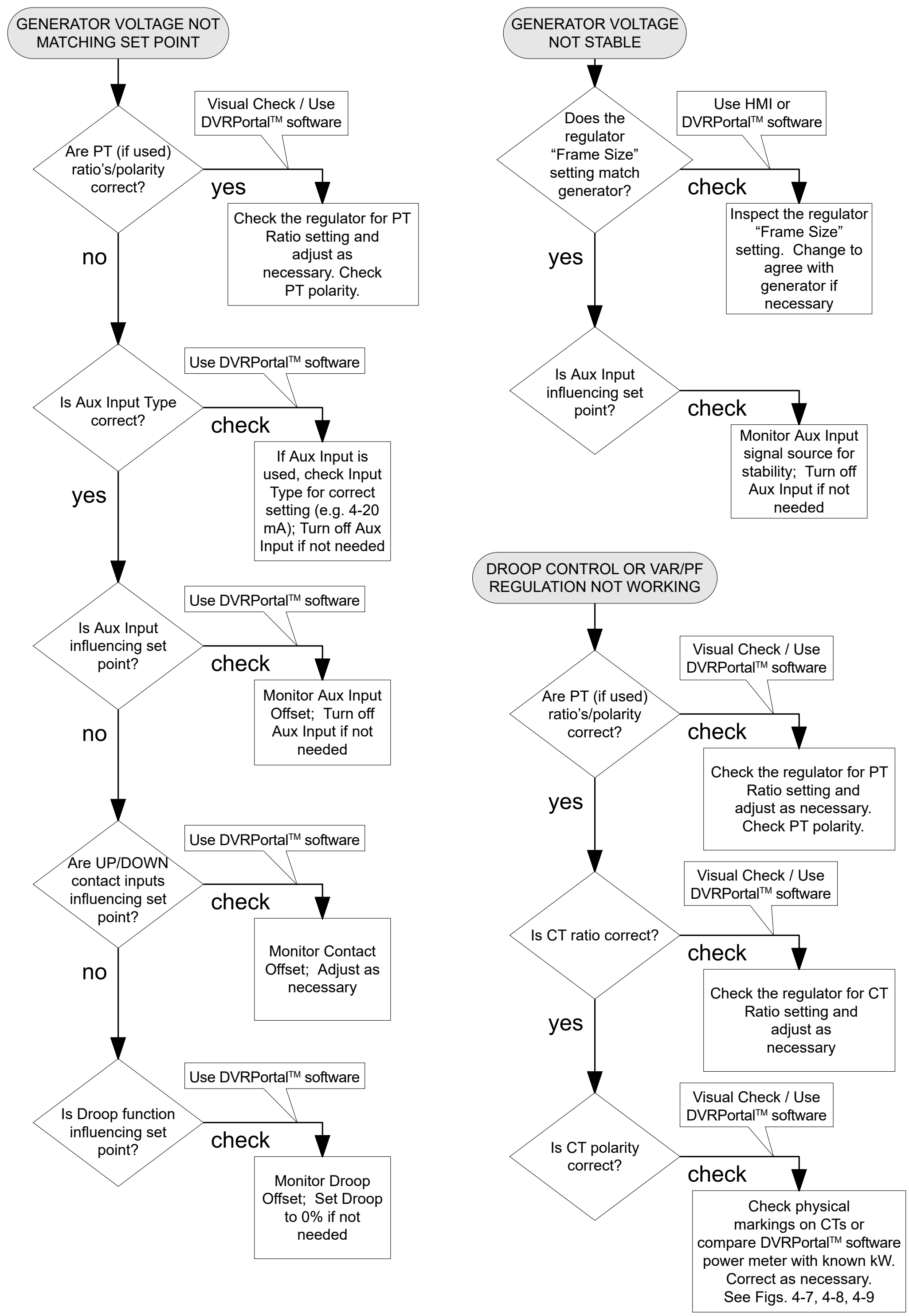
The following steps should be taken if the generator output is incorrect:

1. Verify meter is operating properly.
2. Check the programmable settings of the regulator are correct.
3. Verify the speed of rotation of the generator is correct.
4. Stop the generator and verify that the wiring of the generator and regulator is correct and the connections are good and insulated properly.
5. **Follow all applicable safety warnings and cautions while performing this test.**
   Carefully perform a constant excitation test of the generator and verify the output meets specifications, in accordance with the Installation, Operation and Maintenance Manual for the generator.
6. **Follow all applicable safety warnings and cautions while performing this test.**
   Verify the output of the PMG (input power of the regulator) is within specification.
7. Continue with the following troubleshooting flow charts.

TROUBLESHOOTING FLOWCHART

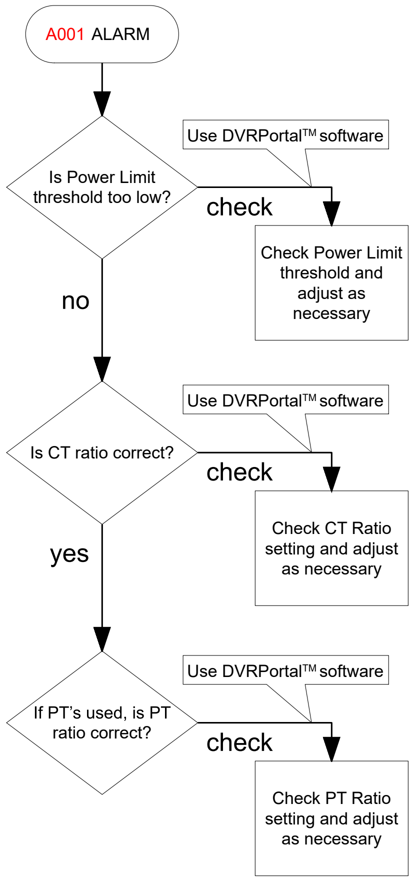


TROUBLESHOOTING FLOWCHART

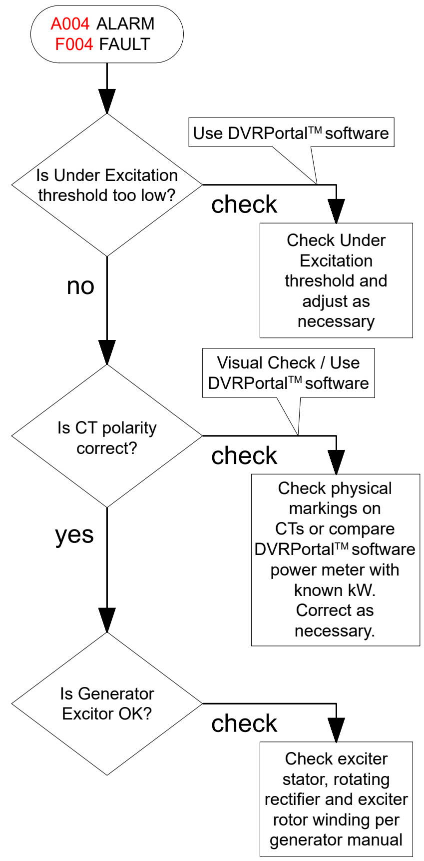


ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

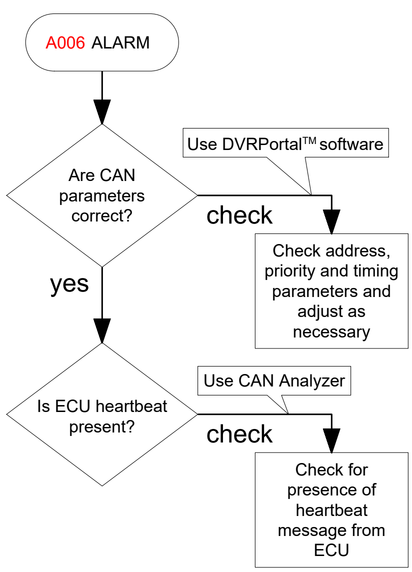
Generator Power Limit Alarm



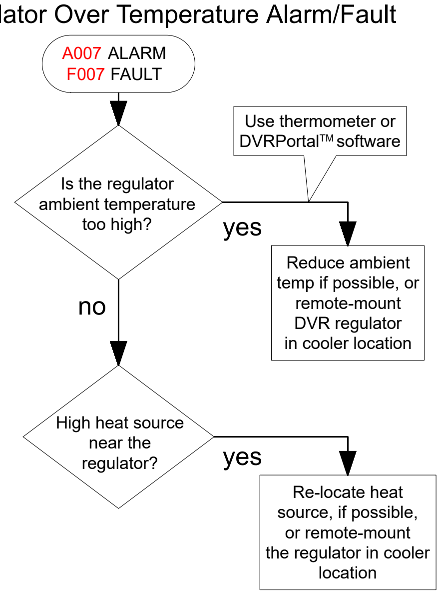
Under Excitation Alarm/Fault



Loss of CAN Communication Alarm

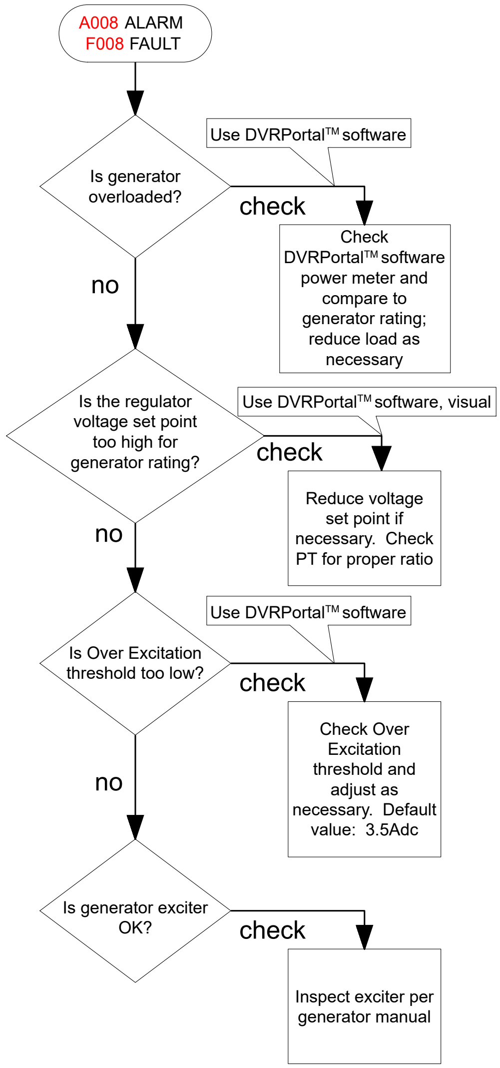


Regulator Over Temperature Alarm/Fault

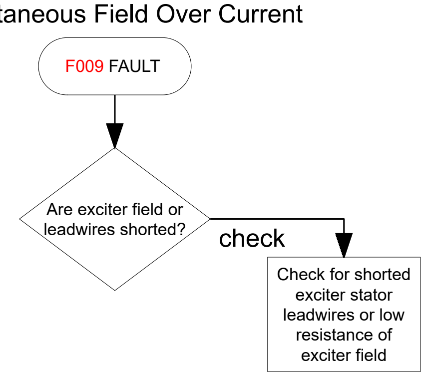


ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

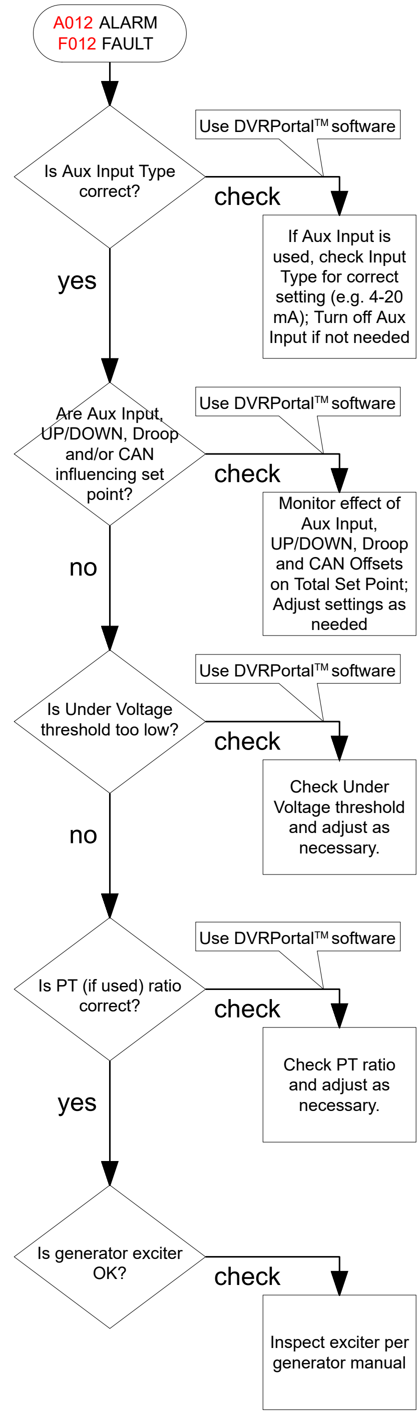
Field Over Excitation Alarm/Fault



Instantaneous Field Over Current

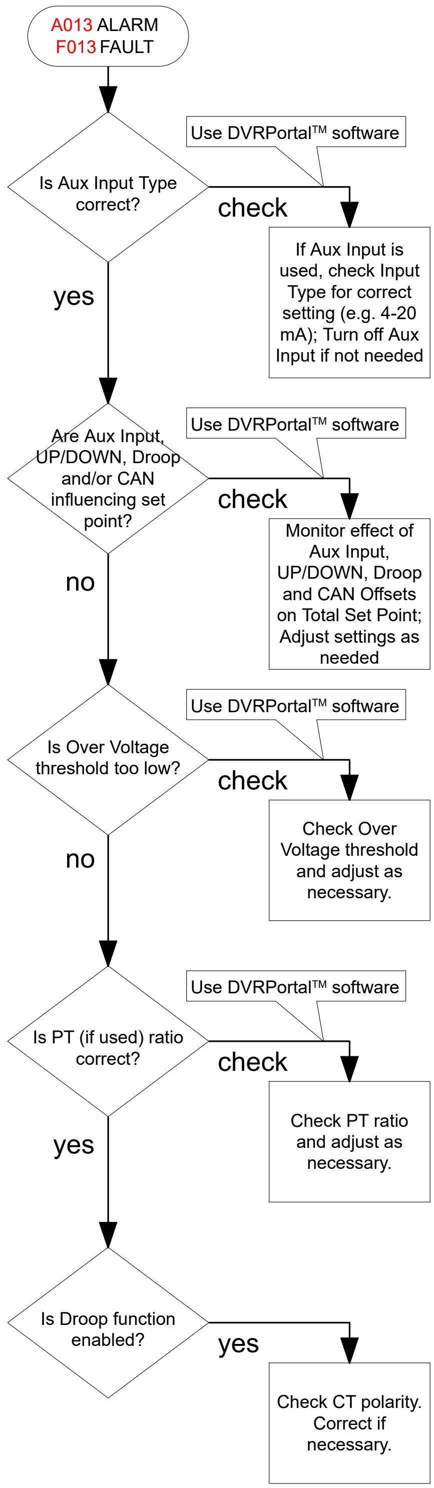


Generator Under Voltage Alarm/Fault

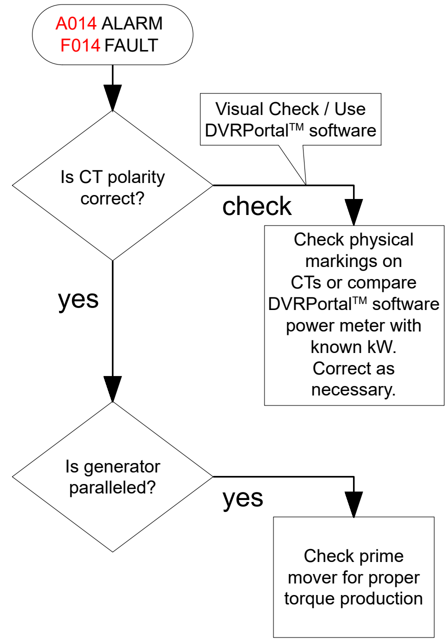


ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART

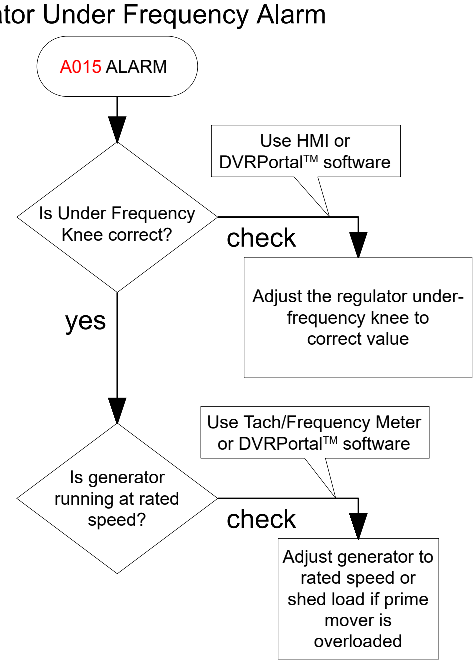
Generator Over Voltage Alarm/Fault



Reverse Power Flow Alarm/Fault



Generator Under Frequency Alarm



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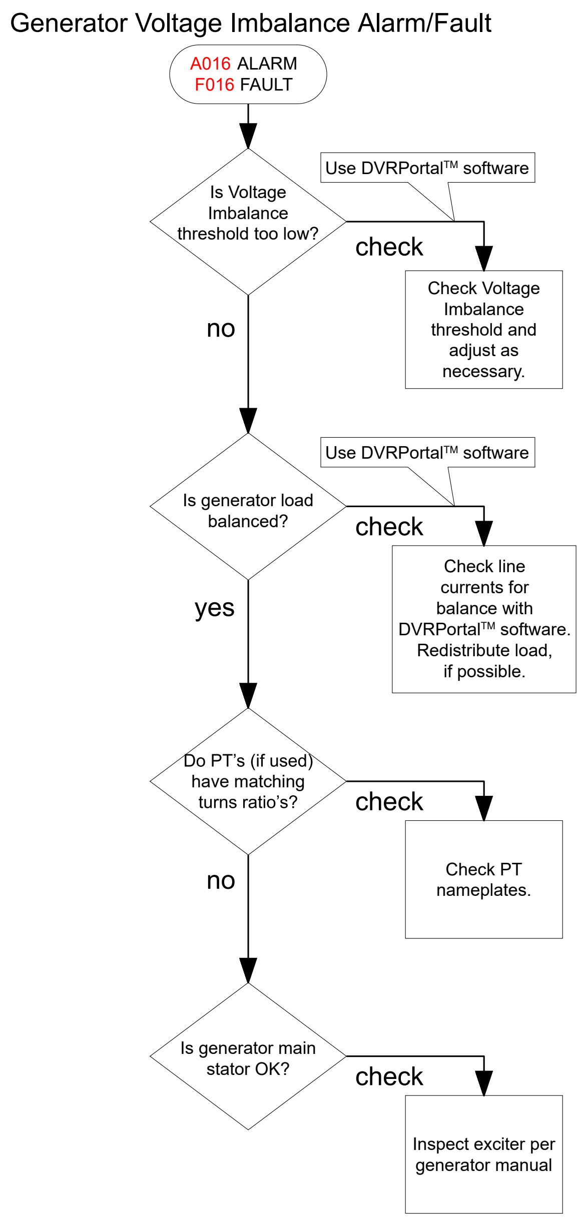
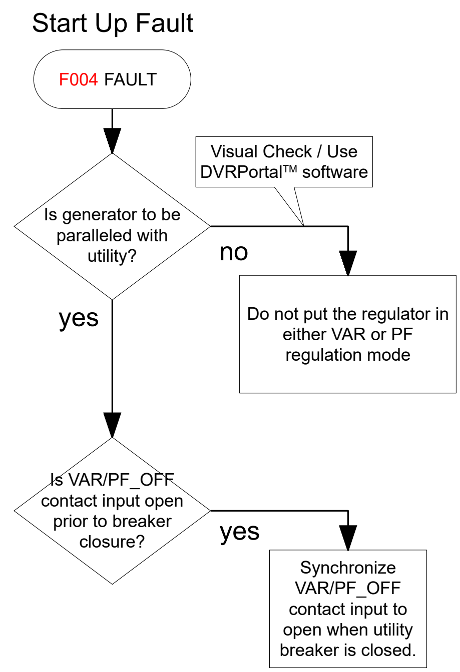
ALARMS AND FAULTS TROUBLESHOOTING FLOWCHART





APPENDIX A

ALARM CODES

During an alarm condition, the HMI will display the code of the corresponding alarm condition. The table can be used to determine what condition is causing the alarm.

Alarm Codes

A001	Unused
A002	Field Under Excitation
A003	Real Time Clock Battery Low
A004	Generator Battery Low
A005	RTD Pre-Alarm/ Over Temperature/ Open / Short Circuit
A006	Loss of CAN Communication
A007	Regulator Over Temperature
A008	Field Over Excitation
A009	Unused
A010	Unused
A011	Loss of Auxiliary Current Sensing
A012	Generator Under Voltage
A013	Generator Over Voltage
A014	Generator Reverse Power Flow
A015	Generator Under Frequency
A016	Generator Voltage Imbalance

Table A-1. Alarm Codes

FAULT CODES

During a fault condition, the HMI will display the code of the corresponding fault condition. The table can be used to determine what condition is causing the fault.

Fault Codes

F001	Unused
F002	Field Under Excitation
F003	Generator Parallel Shutdown
F004	Generator Parallel Start Up
F005	RTD Over Temperature
F006	Unused
F007	Regulator Over Temperature
F008	Field Over Excitation
F009	Instantaneous Field Over Current
F010	Unused
F011	Generator Loss of Sensing
F012	Generator Under Voltage
F013	Generator Over Voltage
F014	Generator Reverse Power Flow
F015	Unused
F016	Generator Voltage Imbalance

Table A-2. Fault Codes

APPENDIX B

CONNECTOR PIN-OUT FIGURES AND TABLES

The following figures can be used to determine the pin locations for the pin-integrated connectors used on the DVR® regulator. Refer to Section - Specifications, for mating connector part numbers.

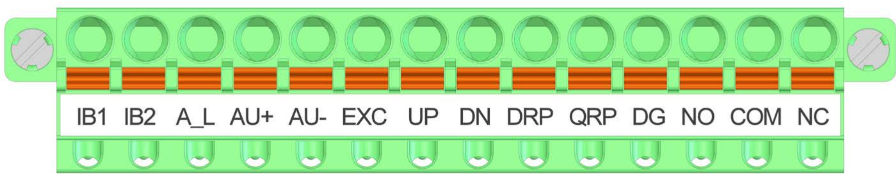


Figure B-1. Connector P1

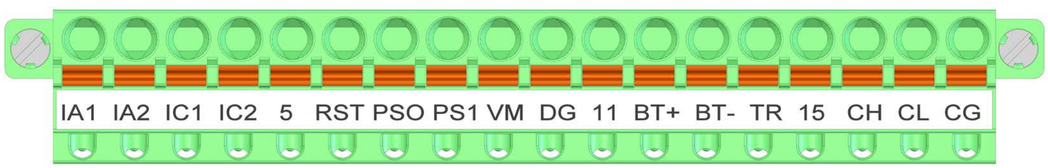


Figure B-2. Connector P2

The following table should be used when making connections via quick disconnect terminals to the regulator.

Terminal	Description
GND	Protective earth ground
4	PMG – terminal 1 (Fused)
3	PMG – terminal 2 (Fused)
E1	Generator armature – Phase A
E2	Generator armature – Phase B
E3	Generator armature – Phase C
-	UNUSED
-	UNUSED
F-	Exciter stator field (-)
F+	Exciter stator field (+)

Table B-1. Quick Disconnect Terminals

The following table should be used when making connections to the regulator.

Terminal	Name	Description
1	**IB1**	Generator Phase B CT – terminal 1
2	**IB2**	Generator Phase B CT – terminal 2
3	**A_L**	Auxiliary current loop (2500 only)
4	**AU+**	Auxiliary input positive
5	**AU-**	Auxiliary input negative
6	**EXC**	Excitation disable contact input (active closed)
7	**UP**	UP contact input (active closed)
8	**DN**	DOWN contact input (active closed)
9	**DRP**	Droop disable contact input (active closed)
10	**QPF**	VAR/PF mode disable (active closed)
11	**DG**	Digital ground
12	**NO**	Contact output normally open
13	**COM**	Contact output common
14	**NC**	Contact output normally closed

Table B-2. Connector P1

The following table should be used when making connections to the DVR®2500 regulator.

Terminal	Name	Description
1	**IA1**	Generator Phase A CT – terminal 1
2	**IA2**	Generator Phase A CT – terminal 2
3	**IC1**	Generator Phase C CT – terminal 1
4	**IC2**	Generator Phase C CT – terminal 2
5	**5**	Reserved
6	**RST**	Reset Regulator (active closed)
7	**PS0**	Preset select line 0 (active closed)
8	**PS1**	Preset select line 1 (active closed)
9	**VM**	Reserved
10	**DG**	Digital ground
11	**11**	Reserved
12	**BT+**	Battery input – positive
13	**BT-**	Battery input – negative
14	**TR**	CAN terminating resistor - terminal 1
15	**15**	Reserved
16	**CH**	CAN high data line
17	**CL**	CAN low data line
18	**CG**	CAN GND

Table B-3. Connector P2

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FORM
SB0056E
Revised
November 2018

⚠ WARNING

Before proceeding forward, carefully read and fully understand the warnings, cautions, & safety notice statements in this manual. Failure to do so could cause severe injury, death, and/or equipment damage.

APPENDIX C

QUICK START PROGRAMMING GUIDE

As the regulator is designed to work on many Marathon® generators in many different applications, it is necessary to program the regulator prior to putting it in service. Please observe the following procedure to program the regulator through the Human-Machine Interface or HMI:

1. Disconnect all connections to the regulator.
2. Apply power to terminals 3 and 4 of the regulator. There are two acceptable ways to power the regulator for programming:
   a. Reconnect the ground lead and the leads from the capacitor in the PMG circuit to regulator terminals 3 and 4. This is how the regulator receives power for normal operation. If using this method, be sure the generator RPM is between 1500 and 1800 RPM to provide proper input power to the regulator.
   b. Connect a 120 Volt AC source to regulator terminals 3 and 4. This will provide the regulator with enough power to accept programming, but not enough power for normal operation. **Note:** Ensure F+ and F- terminals on the regulator are disconnected before powering the regulator for programming.
3. Press SELECT. The word **SIZE** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate generator frame size and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **SIZE**.
4. Press SELECT. The word **REG** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate regulation mode (**AVR3** for 3 phase Automatic Voltage Regulation; **AVR1** for single phase Automatic Voltage Regulation or **FCR** for Field Current Regulation) and then press ENTER. The entered value will flash3 times to indicate that your selection has been saved. The display will again read **REG**.
5. Press SELECT. The word **STPT** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate set point (Sensed Voltage for AVR3 and AVR1 regulation modes; Field Current level for FCR regulation mode or **VAR** for Reactive Power Regulation or **PF** for Power Factor Regulation) and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **STPT**.
6. Press SELECT. The word **UFRQ** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate Under-frequency threshold and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **UFRQ**.
7. Press SELECT. The word **SLOP** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate under-frequency Slope multiplier and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **SLOP**.
8. Press SELECT. The word **PR** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the nameplate Power Rating in kW and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **PR**.
9. Press SELECT. The word **PFR** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate Power Factor and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **PFR**.
10. Press SELECT. The word **PT** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate Potential Transformer ratio and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **PT**.
11. Press SELECT. The word **CT** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate Current Transformer ratio and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **CT**.
12. Press SELECT. The word **DROP** will appear in the display. Press ENTER. Use the UP and DOWN arrows to select the appropriate level of droop as a percentage of desired sensed voltage and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **DROP**.
13. Press SELECT. The word **AU** will appear in the display. Press ENTER.

    Use the UP and DOWN arrows to select the appropriate auxiliary input mode and then press ENTER. The entered value will flash 3 times to indicate that your selection has been saved. The display will again read **AU**.
14. Remove power from the regulator.
15. Complete reconnecting the regulator to the generator.

The regulator is now ready to be placed in service.

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APPENDIX D

ABBREVIATIONS & ACRONYMS

° C	Degrees Celsius
° F	Degrees Fahrenheit
A	Amperes
Aac	AC Current
AC	Alternating Current
Adc	DC Current
AVR1	Automatic Voltage Regulation, Single-phase Sensing
AVR3	Automatic Voltage Regulation, Three-phase Sensing
CAN	Controlled Area Network
CT	Current Transformer
DC	Direct Current
ECU	Electronic Control Unit
EEPROM	Electrically Erasable Programmable Read Only Memory
FCR	Field Current Regulation
g	Gram
G	Unit of gravitational acceleration
HMI	Human Machine Interface.
Hz	Hertz
k	Kilo- (1,000x)
lb	Pound
LED	Light Emitting Diode
LSB	Least Significant Byte
M	Mega- (1,000,000x)
m	Milli- (0.001x)
MSB	Most Significant Byte
PDU	Protocol Data Unit
PF	Power Factor
PMG	Permanent Magnet Generator
PT	Potential Transformer
PU	Per Unit
RAM	Random Access Memory
RMS	Root Mean Square
SPDT	Single Pole, Double Throw
THD	Total Harmonic Distortion
u	Micro- (0.000001x)
V	Volts
VA	Volt-Amps, for Apparent Power
Vac	AC Voltage
VAR	Reactive Volt-Amps, for Reactive Power
Vdc	DC Voltage
W	Watts
Ω	Ohms

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Generators

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APPLICATION CONSIDERATIONS

The proper selection and application of power generation products and components, including the related area of product safety, is the responsibility of the customer. Operating and performance requirements and potential associated issues will vary appreciably depending upon the use and application of such products and components. The scope of the technical and application information included in this publication is necessarily limited. Unusual operating environments and conditions, lubrication requirements, loading supports, and other factors can materially affect the application and operating results of the products and components and the customer should carefully review its requirements. Any technical advice or review furnished by Regal Beloit America, Inc. and/or its affiliates ("Regal") with respect to the use of products and components is given in good faith and without charge, and Regal assumes no obligation or liability for the advice given, or results obtained, all such advice and review being given and accepted at customer's risk.

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DEEP SEA ELECTRONICS

DSE7310 MKII & DSE7320 MKII
Operator Manual

Document Number: 057-253

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DSE7310 MKII & DSE7320 MKII Operator Manual

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Amendments Since Last Publication

Amd. No.	Comments
1	Initial Release
2	Added E-Stop spec, updated FPE information and EPA screen.
3	Added DSE2131, DSE2133, DSE2152 expansion units support and DSE Intelligent Battery Chargers support on the DSEnet. Alternative configuration edit from FPE and Fuel efficiency instrumentation support.
4	Added User Defined Strings, PLC Instruments, Configurable Can, 25xx MKII support. Updated Applicable Standards, J1939-75, Breaker Operation in Manual Mode and Alarms.
5	Updated the EPA Icons screen and J1939-75 section.
6	Updated sections ECU Port (J1939), DSENet (Expansion Modules), Typical Arrange of CAN, Configurable Status Screens, Default DPF Regeneration Lamps, Changeover Functionality (DSE7320 MKII), Protections and Front Panel Configuration.
7	Updated to match specification of DSE73xx V6.

TABLE OF CONTENTS

Section **Page**

1 INTRODUCTION

This document details the installation and operation requirements of the DSE7310 MKII & DSE7320 MKII modules, part of the DSEGenset® range of products.

The manual forms part of the product and should be kept for the entire life of the product. If the product is passed or supplied to another party, ensure that this document is passed to them for reference purposes.
This is not a *controlled document.* DSE do not automatically inform on updates. Any future updates of this document are included on the DSE website at www.deepseaelectronics.com

The DSE73xx MKII series is designed to provide differing levels of functionality across a common platform. This allows the generator OEM greater flexibility in the choice of controller to use for a specific application.

The DSE73xx MKII series module has been designed to allow the operator to start and stop the generator, and if required, transfer the load to the generator either manually or automatically. Additionally, the DSE7320 MKII automatically starts and stops the generator set depending upon the status of the mains (utility) supply.

The user also has the facility to view the system operating parameters via the text LCD display.

The DSE73xx MKII module monitors the engine, indicating the operational status and fault conditions, automatically shutting down the engine and giving a true first up fault condition of an engine failure by the text LCD display.

The powerful ARM microprocessor contained within the module allows for incorporation of a range of complex features:

Text based LCD display
True RMS Voltage
Current and Power monitoring
USB Communications
Engine parameter monitoring.
Fully configurable inputs for use as alarms or a range of different functions.
Engine ECU interface to ***electronic engines****.*
Data Logging

Using a PC and the DSE Configuration Suite software allows alteration of selected operational sequences, timers, alarms and operational sequences. Additionally, the module’s integral front panel configuration editor allows adjustment of this information.

Access to critical operational sequences and timers for use by qualified engineers, can be protected by a security code. Module access can also be protected by PIN code. Selected parameters can be changed from the module’s front panel.

The module is housed in a robust plastic case suitable for panel mounting. Connections to the module are via locking plug and sockets.

1.1 CLARIFICATION OF NOTATION

Clarification of notation used within this publication.

NOTE:	**Highlights an essential element of a procedure to ensure correctness.**
CAUTION!	**Indicates a procedure or practice, which, if not strictly observed, could result in damage or destruction of equipment.**
WARNING!	**Indicates a procedure or practice, which could result in injury to personnel or loss of life if not followed correctly.**

1.2 GLOSSARY OF TERMS

Term	Description
DSE7000 MKII, DSE7xxx MKII	All modules in the DSE7xxx MKII range.
DSE7300 MKII, DSE73xx MKII	All modules in the DSE73xx MKII range.
DSE7310 MKII	DSE7310 MKII module/controller
DSE7320 MKII	DSE7320 MKII module/controller
AVR	Automatic Voltage Regulator An electronic device that is contained within a generator and automatically maintains its voltage level to a pre-determined level.
CAN	Controller Area Network Vehicle standard to allow digital devices to communicate to one another.
CDMA	Code Division Multiple Access. Cell phone access used in small number of areas including parts of the USA and Australia.
CT	Current Transformer An electrical device that takes a large AC current and scales it down by a fixed ratio to a smaller current.
BMS	Building Management System A digital/computer based control system for a building's infrastructure.
DEF	Diesel Exhaust Fluid (AdBlue) A liquid used as a consumable in the SCR process to lower nitric oxide and nitrogen dioxide concentration in engine exhaust emissions.
DM1	Diagnostic Message 1 A DTC that is currently active on the engine ECU.
DM2	Diagnostic Message 2 A DTC that was previously active on the engine ECU and has been stored in the ECU's internal memory.
DPF	Diesel Particulate Filter A filter fitted to the exhaust of an engine to remove diesel particulate matter or soot from the exhaust gas.
DPTC	Diesel Particulate Temperature Controlled Filter A filter fitted to the exhaust of an engine to remove diesel particulate matter or soot from the exhaust gas which is temperature controlled.
DTC	Diagnostic Trouble Code The name for the entire fault code sent by an engine ECU.
ECU/ECM	Engine Control Unit/Management An electronic device that monitors engine parameters and regulates the fuelling.

Continued over page…

Term	Description
FMI	Failure Mode Indicator A part of DTC that indicates the type of failure, e.g. high, low, open circuit etc.
GSM	Global System for Mobile communications. Cell phone technology used in most of the World.
HEST	High Exhaust System Temperature Initiates when DPF filter is full in conjunction with an extra fuel injector in the exhaust system to burn off accumulated diesel particulate matter or soot.
HMI	Human Machine Interface A device that provides a control and visualisation interface between a human and a process or machine.
IDMT	Inverse Definite Minimum Time
MSC	Multi-Set Communication
OC	Occurrence Count A part of DTC that indicates the number of times that failure has occurred.
PGN	Parameter Group Number A CAN address for a set of parameters that relate to the same topic and share the same transmission rate.
PLC	Programmable Logic Controller A programmable digital device used to create logic for a specific purpose.
SCADA	Supervisory Control And Data Acquisition A system that operates with coded signals over communication channels to provide control and monitoring of remote equipment
SCR	Selective Catalytic Reduction A process that uses DEF with the aid of a catalyst to convert nitric oxide and nitrogen dioxide into nitrogen and water to reduce engine exhaust emission.
SIM	Subscriber Identity Module. The small card supplied by the GSM/CDMA provider that is inserted into the cell phone, GSM modem or DSEGateway device to give GSM/GPRS connection.
SMS	Short Message Service The text messaging service of mobile/cell phones.
SPN	Suspect Parameter Number A part of DTC that indicates what the failure is, e.g. oil pressure, coolant temperature, turbo pressure etc.

1.3 BIBLIOGRAPHY

This document refers to, and is referred by the following DSE publications which are obtained from the DSE website: www.deepseaelectronics.com or by contacting DSE technical support: support@deepseaelectronics.com .

1.3.1 INSTALLATION INSTRUCTIONS

Installation instructions are supplied with the product in the box and are intended as a 'quick start' guide only.

DSE Part	Description
053-032	DSE2548 LED Expansion Annunciator Installation Instructions
053-033	DSE2130 Input Expansion Installation Instructions
053-125	DSE2131 Ratiometric Input Expansion Installation Instructions
053-126	DSE2133 RTD / Thermocpuple Input Expansion Installation Instructions
053-134	DSE2152 Analogue Output Expansion Installation Instructions
053-034	DSE2157 Output Expansion Installation Instructions
053-064	DSE2510 and DSE2520 Remote Display Expansion Installation Instructions
053-181	DSE7310 MKII & DSE7320 MKII Installation Instructions
053-147	DSE9460/DSE9461 Enclosed Intelligent Battery Charger Installation Instructions
053-049	DSE9xxx BatteryCharger Installation Instructions

1.3.2 TRAINING GUIDES

Training guides are provided as 'hand-out' sheets on specific subjects during training sessions and contain specific information regarding to that subject.

DSE Part	Description
056-005	Using CTs With DSE Products
056-006	Introduction to Comms
056-010	Over Current Protection
056-018	Negative Phase Sequence
056-019	Earth Fault Protection
056-022	Breaker Control
056-023	Adding New CAN Files
056-024	GSM Modem
056-026	kW, kvar, kVA and pf.
056-029	Smoke Limiting
056-030	Module PIN Codes
056-051	Sending DSEGencom Control Keys
056-053	Recommended Modems
056-055	Alternate Configurations
056-069	Firmware Update
056-075	Adding Language Files
056-076	Reading DSEGencom Alarms
056-079	Reading DSEGencom Status
056-080	MODBUS
056-090	DSE73xx MKI to DSE73xx MKII Conversion
056-091	Equipotential Earth Bonding
056-092	Recommended Practices for Wiring Resistive Sensors
056-095	Remote Start Input Functions
056-096	Engine Speed Control Over CAN for DSEGenset
056-097	USB Earth Loops and Isolation
056-098	DSE73xx MKII, DSE74xx MKII & DSE86xx MKII John Deere T4
056-099	Digital Output to Input Connection

1.3.3 MANUALS

Product manuals are obtained from the DSE website: www.deepseaelectronics.com or by contacting DSE technical support: support@deepseaelectronics.com .

DSE Part	Description
N/A	DSEGencom (MODBUS protocol for DSE controllers)
057-004	Electronic Engines and DSE Wiring Guide
057-082	DSE2130 Input Expansion Operator Manual
057-139	DSE2131 Ratiometric Input Expansion Operator Manual
057-140	DSE2133 RTD / Thermocouple Input Expansion Operator Manual
057-141	DSE2152 Analogue Output Expansion Operator Manual
057-083	DSE2157 Output Expansion Operator Manual
057-084	DSE2548 Annunciator Expansion Operator Manual
057-278	DSE73xx MKII Conversion to DSE25xx MKII Remote Display Manual
057-279	DSE2510 MKII and DSE2520 MKII Configuration Suite PC Software Manual
057-151	DSE Configuration Suite PC Software Installation & Operation Manual
057-175	PLC Programming Guide For DSE Controllers
057-220	Options for Communications with DSE Controllers
057-243	DSE7310 MKII & DSE7320 MKII Configuration Suite PC Software Manual
057-176	DSE9460/DSE9461 Enclosed Intelligent Battery Charger Operators Manual
057-085	DSE94xx Series Battery Charger Operator Manual

1.3.4 THIRD PARTY DOCUMENTS

The following third party documents are also referred to:

Reference	Description
ISBN 1-55937-879-4	IEEE Std C37.2-1996 IEEE Standard Electrical Power System Device Function Numbers and Contact Designations. Institute of Electrical and Electronics Engineers Inc
ISBN 0-7506-1147-2	Diesel generator handbook. L.L.J. Mahon
ISBN 0-9625949-3-8	On-Site Power Generation. EGSA Education Committee.

2 SPECIFICATION

2.1 OPERATING TEMPERATURE

Module	Specification
DSE73xx MKII	-30 ºC +70 ºC (-22 ºF +158 ºF)
Display Heater Variants	-40 ºC +70 ºC (-40 ºF +158 ºF)

2.1.1 OPTIONAL SCREEN HEATER OPERATION

Screen Heater Function	Specification
Turn On When Temperature Falls Below	-10 ºC (+14 ºF)
Turn Off When Temperature Rises Above	-5 ºC (+23 ºF)

2.2 REQUIREMENTS FOR UL

Description	Specification
Screw Terminal Tightening Torque	4.5 lb-in (0.5 Nm)
Conductors	Terminals suitable for connection of conductor size AWG 20 to AWG 13 (0.5 mm² to 2.5 mm²). Conductor protection must be provided in accordance with NFPA 70, Article 240 Low voltage circuits (35 V or less) must be supplied from the engine starting battery or an isolated secondary circuit. The communication, sensor, and/or battery derived circuit conductors shall be separated and secured to maintain at least ¼” (6 mm) separation from the generator and mains connected circuit conductors unless all conductors are rated 600 V or greater.
Current Inputs	Must be connected through UL Listed or Recognized isolating current transformers with the secondary rating of 5 A max.
Communication Circuits	Must be connected to communication circuits of UL Listed equipment
Output Pilot Duty	0.5 A
Mounting	Suitable for use in type 1 Enclosure Type rating with surrounding air temperature -22 ºF to +158 ºF (-30 ºC to +70 ºC) Suitable for pollution degree 3 environments when voltage sensing inputs do not exceed 300 V. When used to monitor voltages over 300 V device to be installed in an unventilated or filtered ventilation enclosure to maintain a pollution degree 2 environment.
Operating Temperature	-22 ºF to +158 ºF (-30 ºC to +70 ºC)
Storage Temperature	-40 ºF to +176 ºF (-40 ºC to +80 ºC)

2.3 TERMINAL SPECIFICATION

<table>
<tr><th>Description</th><th>Specification</th><th></th></tr>
<tr><td>Connection Type</td><td>Two part connector.
Male part fitted to module
Female part supplied in module packing case - Screw terminal, rising clamp, no internal spring.</td><td rowspan="5">
Example showing cable entry and screw terminals of a 10 way connector</td></tr>
<tr><td>Minimum Cable Size</td><td>0.5 mm² (AWG 20)</td></tr>
<tr><td>Maximum Cable Size</td><td>2.5 mm² (AWG 13)</td></tr>
<tr><td>Tightening Torque</td><td>0.5 Nm (4.5 lb-in)</td></tr>
<tr><td>Wire Strip Length</td><td>7 mm (9/32”)</td></tr>
</table>

2.4 POWER SUPPLY REQUIREMENTS

Description	Specification
Minimum Supply Voltage	8 V continuous, 5 V for up to 1 minute.
Cranking Dropouts	Able to survive 0 V for 100 ms providing the supply was at least 10 V before the dropout and recovers to 5 V afterwards.
Maximum Supply Voltage	35 V continuous (60 V protection)
Reverse Polarity Protection	-35 V continuous
Maximum Operating Current	340 mA at 12 V 160 mA at 24 V
Maximum Standby Current	160 mA at 12 V 80 mA at 24 V
Maximum Current When In Sleep Mode	100 mA at 12 V 50 mA at 24 V
Typical Power (Controller On, Heater Off)	3.8 W to 4.1 W
Typical Power (Controller On, Heater On)	6.8 W to 7.1 W

2.4.1 MODULE SUPPLY INSTRUMENTATION DISPLAY

Description	Specification
Range	0 V to 70 V DC (Maximum continuous operating voltage of 35 V DC)
Resolution	0.1 V
Accuracy	1 % full scale (±0.35 V)

2.5 VOLTAGE & FREQUENCY SENSING

Description	Specification
Measurement Type	True RMS conversion
Sample Rate	5 kHz or better
Harmonics	Up to 11th or better
Input Impedance	450 kΩ phase to phase
Phase To Neutral	15 V (minimum required for sensing frequency) to 415 V AC (absolute maximum) Suitable for 345 V AC nominal (±20 % for under/overvoltage detection)
Phase To Phase	25 V (minimum required for sensing frequency) to 720 V AC (absolute maximum) Suitable for 600 V AC nominal (±20 % for under/overvoltage detection)
Common Mode Offset From Earth	100 V AC (max)
Resolution	1 V AC phase to neutral 1 V AC phase to phase
Accuracy	±1 % of full scale phase to neutral ±1 % of full scale phase to phase
Minimum Frequency	3.5 Hz
Maximum Frequency	75.0 Hz
Frequency Resolution	0.1 Hz
Frequency Accuracy	±0.2 Hz

2.6 CURRENT SENSING

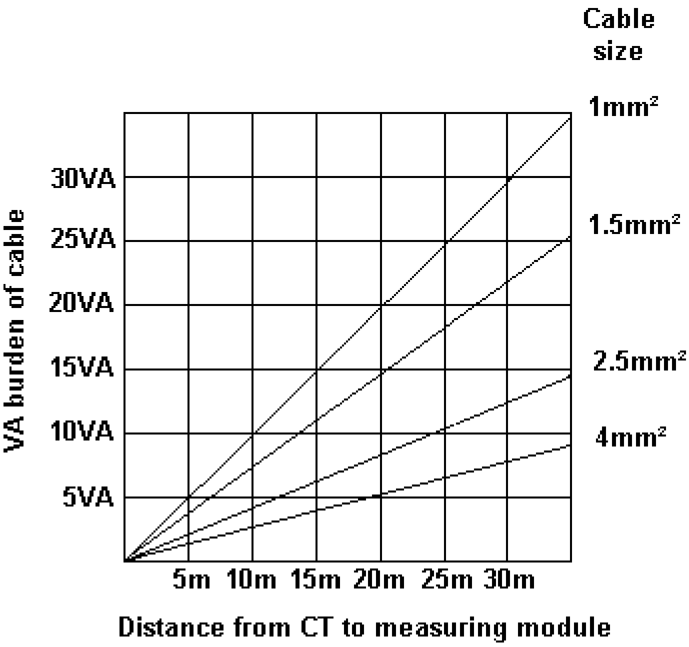
Description	Specification
Measurement Type	True RMS conversion
Sample Rate	5 kHz or better
Harmonics	Up to 10th or better
Nominal CT Secondary Rating	1 A and 5 A
Maximum Continuous Current	1 A and 5 A
Overload Measurement	15 A
Absolute Maximum Overload	50 A for 1 second
Burden	0.25 VA (0.01 Ω current shunts)
Common Mode Offset	±1 V peak plant ground to CT common terminal
Resolution	25 mA
Accuracy	±1 % of Nominal (excluding CT error)

2.6.1 VA RATING OF THE CTS

NOTE: Details for 4 mm² cables are shown for reference only. The connectors on the DSE modules are only suitable for cables up to 2.5 mm².

The VA burden of the module on the CTs is 0.25 VA. However depending upon the type and length of cabling between the CTs and the module, CTs with a greater VA rating than the module are required.

The distance between the CTs and the measuring module should be estimated and cross-referenced against the chart opposite to find the VA burden of the cable itself.



If the CTs are fitted within the alternator top box, the star point (common) of the CTs should be connected to system ground (earth) as close as possible to the CTs. This minimises the length of cable used to connect the CTs to the DSE module.

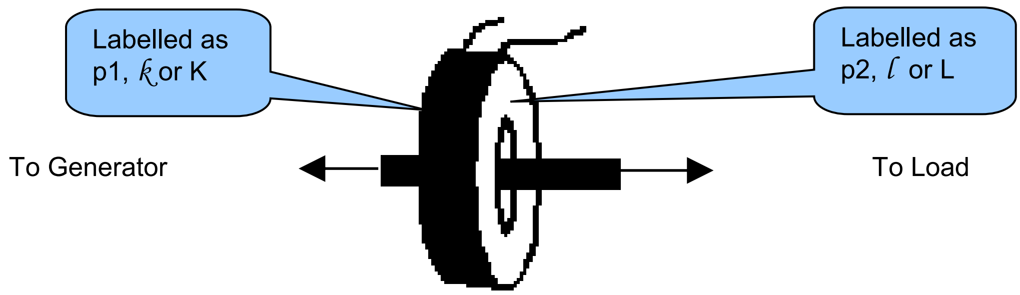
Example:
If 1.5 mm² cable is used and the distance from the CT to the measuring module is 20 m, then the burden of the cable alone is approximately 15 VA. As the burden of the DSE controller is 0.25 VA, then a CT with a rating of at least 15 VA + 0.25 VA = 15.25 VA must be used. If 2.5 mm² cables are used over the same distance of 20 m, then the burden of the cable on the CT is approximately 7 VA. CT's required in this instance is at least 7.25 VA (7 + 0.25).

2.6.2 CT POLARITY

NOTE: Take care to ensure correct polarity of the CT primary as shown above. If in doubt, check with the CT supplier.

Take care to ensure the correct polarity of the CTs. Incorrect CT orientation leads to negative kW readings when the set is supplying power. Take note that paper stick-on labels on CTs that show the orientation are often incorrectly placed on the CT. It is more reliable to use the labelling in the case moulding as an indicator to orientation (if available).

To test orientation, run the generator in island mode (not in parallel with any other supply) and load the generator to around 10 % of the set rating. Ensure the DSE module shows positive kW for all three individual phase readings.



Polarity of CT Primary

2.6.3 CT PHASING

Take particular care that the CTs are connected to the correct phases. For instance, ensure that the CT on phase 1 is connected to the terminal on the DSE module intended for connection to the CT for phase 1.

Additionally ensure that the voltage sensing for phase 1 is actually connected to generator phase 1. Incorrect connection of the phases as described above results in incorrect power factor (pf) measurements, which in turn results in incorrect kW measurements.

One way to check for this is to make use of a single-phase load. Place the load on each phase in turn, run the generator and ensure the kW value appears in the correct phase. For instance if the load is connected to phase 3, ensure the kW figure appears in phase 3 display and not in the display for phase 1 or 2.

2.6.4 CT CLASS

Ensure the correct CT type is chosen. For instance if the DSE module is providing over current protection, ensure the CT is capable of measuring the overload level required to protect against, and at the accuracy level required.

For instance, this may mean fitting a protection class CT (P15 type) to maintain high accuracy while the CT is measuring overload currents.

Conversely, if the DSE module is using the CT for instrumentation only (current protection is disabled or not fitted to the controller), then measurement class CTs can be used. Again, bear in mind the accuracy required. The DSE module is accurate to better than 1% of the full-scale current reading. To maintain this accuracy, fit a Class 0.5 or Class 1 CT.

Check with the CT manufacturer for further advice on selecting CTs.

2.7 INPUTS

2.7.1 DIGITAL INPUTS

Description	Specification
Number	8 configurable digital inputs (14 when *Analogue Inputs* are configured as digital inputs)
Arrangement	Contact between terminal and ground
Low Level Threshold	2.1 V minimum
High Level Threshold	6.6 V maximum
Maximum Input Voltage	+60 V DC with respect to plant supply negative
Minimum Input Voltage	-24 V DC with respect to plant supply negative
Contact Wetting Current	5 mA typical
Open Circuit Voltage	12 V typical

2.7.2 EMERGENCY STOP

Description	Specification
Arrangement	Contact between terminal and module supply positive
Closed Threshold	5 V minimum
Open Threshold	3 V maximum
Maximum Input Voltage	+35 V DC with respect to plant supply negative (60 V protection for 1 minute)
Minimum Input Voltage	-24 V DC with respect to plant supply negative
Open Circuit Voltage	0 V

2.7.3 ANALOGUE INPUTS

All of the analogue inputs are flexible within the DSE7310 MKII & 7320 MKII modules

2.7.3.1 ANALOGUE INPUT A

Description	Specification
Input Type	Flexible: Configured for *Oil Sensor* in the DSE default configuration. Flexible Options: Not used, Digital Input, Flexible Analogue, Fuel Sensor, Oil Sensor & Temperature Sensor.
Flexible Input Selection	Pressure Sensor Percentage Sensor Temperature Sensor
Flexible Measured Quantity	Current Restive (Only for Pressure Sensors) Voltage

Resistive Configuration

Description	Specification
Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	15 mA ±10 %
Full Scale	240 Ω
Over Range / Fail	350 Ω
Resolution	1 % of full scale
Accuracy	±2 % of full scale resistance (±4.8 Ω) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

0 V to 10 V Configuration

Description	Specification
Full Scale	0 V to 10 V
Resolution	1% of full scale
Accuracy	±2% of full scale voltage (±0.2 V) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

4 mA to 20 mA Configuration

Description	Specification
Full Scale	0 mA to 20 mA
Resolution	1% of full scale
Accuracy	±2% of full scale current (±0.4 mA) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

2.7.3.2 ANALOGUE INPUT B

Description	Specification
Input Type	Flexible: Configured for *Temperature Sensor* in the DSE default configuration Flexible Options: Not used, Digital Input, Flexible Analogue, Fuel Level Sensor & Temperature Sensor
Flexible Input Selection	Pressure Sensor Percentage Sensor Temperature Sensor
Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	8 mA ±10 %
Full Scale	3 kΩ
Over Range / Fail	5 kΩ
Resolution	1 % of full scale
Accuracy	±2 % of full scale resistance (±60 Ω) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

2.7.3.3 ANALOGUE INPUT C

Description	Specification
Input Type	Flexible: Configured for *Fuel Level Sensor* in the DSE default configuration Flexible Options: Not used, Digital Input, Flexible Analogue, Fuel Level Sensor & Temperature Sensor
Flexible Input Selection	Pressure Sensor Percentage Sensor Temperature Sensor
Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	10 mA ±10 %
Full Scale	480 Ω
Over Range / Fail	600 Ω
Resolution	1 % of full scale
Accuracy	±2 % of full scale resistance (±9.6 Ω) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

2.7.3.4 ANALOGUE INPUT D

Description	Specification
Input Type	Flexible: Configured for *Flexible Sensor* in the DSE default configuration Flexible Options: Not used, Digital Input, Flexible Analogue, Fuel Level Sensor & Temperature Sensor
Flexible Input Selection	Pressure Sensor Percentage Sensor Temperature Sensor
Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	10 mA ±10 %
Full Scale	480 Ω
Over Range / Fail	600 Ω
Resolution	1 % of full scale
Accuracy	±2 % of full scale resistance (±9.6 Ω) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

2.7.3.5 ANALOGUE INPUT E

Description	Specification
Input Type	Flexible: Configured for *Flexible Sensor* in the DSE default configuration Flexible Options: Not used, Digital Input, Flexible Analogue, Fuel Level Sensor & Temperature Sensor
Flexible Input Selection	Pressure Sensor Percentage Sensor Temperature Sensor
Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	8 mA ±10 %
Full Scale	3 kΩ
Over Range / Fail	5 kΩ
Resolution	1 % of full scale
Accuracy	±2 % of full scale resistance (±60 Ω) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

2.7.3.6 ANALOGUE INPUT F

Description	Specification
Input Type	Flexible: Configured for *Flexible Sensor* in the DSE default configuration. Flexible Options: Not used, Digital Input, Flexible Analogue, Fuel Sensor & Temperature Sensor.
Flexible Input Selection	Pressure Sensor Percentage Sensor Temperature Sensor
Flexible Measured Quantity	Current Restive Voltage

<u>Resistive Configuration</u>

Description	Specification
Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	8 mA ±10 %
Full Scale	3 kΩ
Over Range / Fail	5 kΩ
Resolution	1 % of full scale
Accuracy	±2 % of full scale resistance (±60 Ω) excluding transducer error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

<u>0 V to 10 V Configuration</u>

Description	Specification
Full Scale	0 V to 10 V
Resolution	1% of full scale
Accuracy	±2% of full scale voltage (±0.2 V) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

<u>4 mA to 20 mA Configuration</u>

Description	Specification
Full Scale	0 mA to 20 mA
Resolution	1% of full scale
Accuracy	±2% of full scale current (±0.4 mA) excluding sensor error
Max Common Mode Voltage	±2 V
Display Range	Configurable by PC Software

2.7.4 CHARGE FAIL INPUT

The charge fail input is actually a combined input and output. Whenever the generator is required to run, the terminal provides excitation current to the charge alternator field winding.

When the charge alternator is correctly charging the battery, the voltage of the terminal is close to the plant battery supply voltage. In a failed charge situation, the voltage of this terminal is pulled down to a low voltage. It is this drop in voltage that triggers the *Charge Failure* alarm. The level at which this operates and whether this triggers a warning or shutdown alarm is configurable using the DSE Configuration Suite Software.

Description	Specification
Minimum Voltage	0 V
Maximum Voltage	35 V
Resolution	0.2 V
Accuracy	±1 % of full scale
Excitation	Active circuit constant power output
Output Power	2.5 W nominal at 12 V and 24 V
Current At 12V	210 mA
Current At 24V	105 mA

2.7.5 MAGNETIC PICK-UP

NOTE: DSE supply a suitable magnetic pickup device, available in two body thread lengths:
DSE Part number 020-012 - Magnetic Pickup probe 5/8 UNF 2 ½” thread length
DSE Part number 020-013 - Magnetic Pickup probe 5/8 UNF 4” thread length

Magnetic Pickup devices can often be ‘shared’ between two or more devices. For example, one device can often supply the signal to both the DSE module and the engine governor. The possibility of this depends upon the amount of current that the magnetic pickup can supply.

Description	Specification
Type	Differential input
Minimum Voltage	0.5 V Peak
Maximum Voltage	70 V Peak
Max Common Mode Voltage	±2 V Peak
Minimum Frequency	5 Hz
Maximum Frequency	20,000 Hz
Resolution	1 Hz
Accuracy	±1%
Flywheel Teeth	10 to 500

2.8 OUTPUTS

2.8.1 DC OUTPUTS A & B (FUEL & START)

Description	Specification
Type	Normally used as Fuel & Start outputs. Fully configurable for other purposes if the module is configured to control an electronic engine.
Rating	15 A resistive at plant supply.

2.8.2 CONFIGURABLE VOLT-FREE RELAY OUTPUTS C & D

Description	Specification
Type	Normally used for load switching control Fully configurable volt-free relays. Output C normally closed and Output D normal open.
Rating	8 A resistive at 250 V AC

2.8.3 CONFIGURABLE DC OUTPUTS E, F, G, H, I & J

Description	Specification
Type	Fully configurable, supplied from DC supply terminal 2.
Rating	2 A resistive at plant supply.

2.9 COMMUNICATION PORTS

NOTE: All communication ports can be used at the same time.

Description	Specification
USB Slave Port	Type B USB 2.0 For connection to PC running DSE Configuration Suite Max distance 6 m (20 feet)
RS232 Serial Port	Non – isolated Max Baud rate 115 kbaud subject to configuration TX, RX, RTS, CTS, DSR, DTR, DCD Male 9 way D type connector Max distance 15 m (50 feet)
RS485 Serial Port	Isolated Data connection 2 wire + common Half Duplex Data direction control for Transmit (by s/w protocol) Max Baud Rate 115 kbaud subject to configuration Parity subject to configuration Stop Bits subject to configuration External termination required (120 Ω) Max common mode offset 70 V (on board protection transorb) Max distance 1.2 km (¾ mile)
ECU Port	**NOTE: For additional length, the DSE124 CAN Extender is available. For more information, refer to DSE Publication: *057-116 DSE124 Operator Manual*** Engine CAN Port Standard implementation of 'Slow mode', up to 250 kb/s Non-Isolated. Internal Termination provided (120 Ω) Max distance 40 m (133 feet)
DSENet® (Expansion Comms) Port	Non-isolated Data connection 2 wire + common Half Duplex Data direction control for Transmit (by s/w protocol) Baud Rate of 115 kbaud Internal termination fitted (120 Ω) Max common mode offset ±5 V Max distance 1.2 km (¾ mile)

2.10 COMMUNICATION PORT USAGE

2.10.1 USB SLAVE PORT (PC CONFIGURATION)

NOTE: DSE stock 2 m (6.5 feet) USB type A to type B cable, DSE Part Number: 016-125. Alternatively they are purchased from any PC or IT store.

NOTE: The DC supply must be connected to the module for configuration by PC.

NOTE: For further details of module configuration, refer to DSE Publication: 057-243 *DSE7310 MKII & 7320 MKII Configuration Software Manual.*

The USB port is provided to give a simple means of connection between a PC and the controller. Using the DSE Configuration Suite Software, the operator is then able to control the module, starting or stopping the engine, selecting operating modes, etc.

Additionally, the various operating parameters (such as coolant temperature, oil pressure, etc.) of the engine are available to be viewed or changed.

To connect a module to a PC by USB, the following items are required:

DSE73xx MKII Controller

DSE Configuration Suite PC Software
(Available from www.deepseaelectronics.com).

USB cable Type A to Type B.
(This is the same cable as often used between a PC and a USB printer)

2.10.2 RS232 PORT

NOTE: For direct connection an RS232 null modem (crossover) cable is required. This is rated to a maximum cable length of 15 m.

The RS232 port on the controller supports the MODBUS RTU protocol and is for connection to a single MODBUS master device only.

The MODBUS register table for the controller is available upon request from the DSE Technical Support Department.

RS232 is for short distance communication (max 15m) and is typically used to connect the controller to a telephone or GSM modem for more remote communications.

The various operating parameters (such as coolant temperature, oil pressure, etc.) of the remote engine are viewed or changed.

NOTE: For a single module to PC connection and distances up to 6 m (20 feet) the USB connection method is more suitable and provides for a lower cost alternative to RS485 (which is more suited to longer distance connections).

Many PCs are not fitted with an internal RS232 serial port. DSE DOES NOT recommend the use of USB to RS232 convertors but can recommend PC add-ons to provide the computer with an RS232 port.

2.10.2.1 RECOMMENDED EXTERNAL MODEMS

NOTE: For GSM modems a SIM card is required, supplied by the GSM network provider:

For SMS only, a 'normal' voice SIM card is required. This enables the controller to send SMS messages to designated mobile phones upon status and alarm conditions.

For a data connection to a PC running DSE Configuration Suite Software, a 'special' CSD (Circuit Switched Data) SIM card is required that enables the modem to answer an incoming data call. Many 'pay as you go' services do not provide a CSD (Circuit Switched Data) SIM card.

Multitech Global Modem – MultiModem ZBA (PSTN)
DSE Part Number 020-252
(Contact DSE Sales for details of localisation kits for these modems)

Sierra Fastrak Xtend GSM modem kit (PSU, Antenna and modem)*
DSE Part number 0830-001-01

2.10.2.2 RECOMMENDED PC RS232 SERIAL PORT ADD-ONS

NOTE: DSE have no business tie to Brainboxes. Over many years, our own engineers have used these products and are happy to recommend them.

NOTE: For further details of setting up the devices below, refer to the manufacture whose details are below.

Remember to check these parts are suitable for your PC. Consult your PC supplier for further advice.

Brainboxes PM143 PCMCIA RS232 card (for laptop PCs)

Brainboxes VX-001 Express Card RS232 (for laptops and nettops PCs)

Brainboxes UC246 PCI RS232 card (for desktop PCs)

Brainboxes PX-246 PCI Express 1 Port RS232 1 x 9 Pin (for desktop PCs)

Supplier:
Brainboxes
Tel: +44 (0)151 220 2500
Web: http://www.brainboxes.com
Email: Sales: sales@brainboxes.com

2.10.2.3 RS232 USED FOR DUAL MUTUAL STANDBY CONNECTION

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

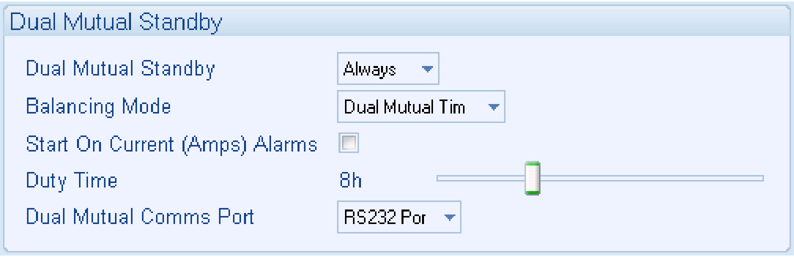
NOTE: To connect two modules by RS232 for *Dual Mutual Standby* operation, a null modem cable must be used.

The dual mutual system utilises the RS232 or RS485 hardware interface to allow multiple modules to communicate to one another. The R232 port can be configured for connection to a modem or remote monitoring equipment (i.e. Building Management System, PLC or PC RS232 port).

Using the RS232 port for dual mutual communication frees up the RS485 interface for connection to a MODBUS engine or remote monitoring equipment (i.e. Building Management System, PLC or PC RS485 port).

While this is a very useful feature in some applications, the obvious drawback is that the RS232 port is no longer available connection to a modem or remote monitoring equipment (i.e. Building Management System, PLC or PC RS232 port).

Example of configuring the dual mutual for connection by RS232 using the DSE Configuration Suite Software:



2.10.2.4 RS232 USED FOR THE DSE25XX MKII REMOTE DISPLAY

> **NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.***

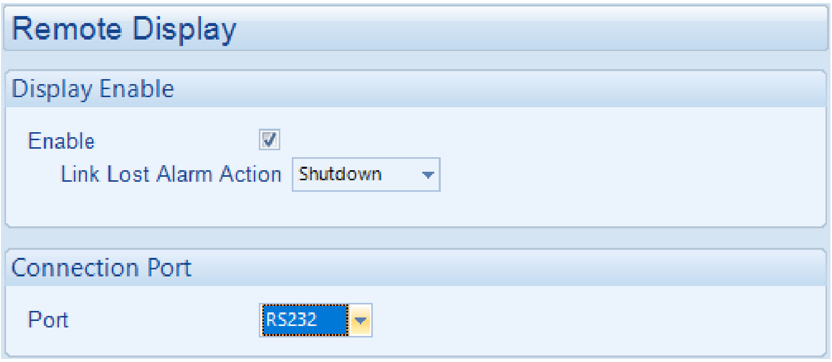
> **NOTE: DSE25xx MKII Remote Displays utilise the same hardware as DSE73xx MKII modules. Conversion between either module type is possible via a firmware upgrade. For further details refer to DSE Publication: *057-278 DSE73xx MKII Conversion to DSE25xx MKII Remote Display Manual.***

The DSE25xx MKII remote display utilises the RS232 or RS485 hardware interface to allow connection to the DSE73xx MKII genset controller. The R232 port can be configured for connection to a modem or remote monitoring equipment (i.e. Building Management System, PLC or PC RS232 port).

Using the RS232 port for DSE25xx MKII remote display communications frees up the RS485 interface for connection to a MODBUS engine or remote monitoring equipment (i.e. Building Management System, PLC or PC RS485 port).

While this is a very useful feature in some applications, the obvious drawback is that the RS232 port is no longer available connection to a modem or remote monitoring equipment (i.e. Building Management System, PLC or PC RS232 port).

Example of configuring the DSE25xx MKII remote display for connection by RS232 using the DSE Configuration Suite Software:



2.10.3 RS485 PORT

The RS485 port on the controller supports the MODBUS RTU protocol and is for connection to a single MODBUS master device only.

The DSE MODBUS register table for the controller is available upon request from the DSE Technical Support Department.

RS485 is used for point-to-point cable connection of more than one device (maximum 32 devices) and allows for connection to PCs, PLCs and Building Management Systems (to name just a few devices).

One advantage of the RS485 interface is the large distance specification (1.2 km when using Belden 9841 (or equivalent) cable. This allows for a large distance between the module and a PC running the DSE Configuration Suite software. The operator is then able to control the module, starting or stopping the engine, selecting operating modes, etc.

The various operating parameters (such as coolant temperature, oil pressure, etc.) of the remote engine are viewed or changed.

NOTE: For a single module to PC connection and distances up to 6 m (20 feet) the USB connection method is more suitable and provides for a lower cost alternative to RS485 (which is more suited to longer distance connections).

Many PCs are not fitted with an internal RS485 serial port. DSE DOES NOT recommend the use of USB to RS485 convertors but can recommend PC add-ons to provide the computer with an RS485port.

2.10.3.1 CABLE SPECIFICATION

NOTE: DSE recommend Belden 9841 (or equivalent) cable for RS485 communication. This is rated to a maximum cable length of 1.2 km. DSE Stock Belden 9841 cable, DSE Part Number: 016-030.

Description	Specification
Cable Type	Two core screened and shielded twisted pair
Cable Characteristics	120 Ω impedance Low capacitance
Recommended Cable	Belden 9841 Belden 9271
Maximum Cable Length	1200 m (¾ mile) when using Belden 9841 or direct equivalent. 600 m (656 yards) when using Belden 9271 or direct equivalent.
RS485 Topology	“Daisy Chain” Bus with no stubs (spurs)
RS485 Termination	120 Ω. Not fitted internally to module. Must be fitted externally to the ‘first’ and ‘last’ device on the RS485 link.

2.10.3.2 RECOMMENDED PC RS485 SERIAL PORT ADD-ONS

NOTE: DSE have no business tie to Brainboxes. Over many years, our own engineers have used these products and are happy to recommend them.

NOTE: For further details of setting up the devices below, refer to the manufacture whose details are below.

Remember to check these parts are suitable for your PC. Consult your PC supplier for further advice.

Brainboxes PM154 PCMCIA RS485 card (for laptops PCs)
Set to 'Half Duplex, Autogating" with 'CTS True' set to 'enabled'

Brainboxes VX-023 ExpressCard 1 Port RS422/485 (for laptops and nettop PCs)

Brainboxes UC320 PCI Velocity RS485 card (for desktop PCs)
Set to 'Half Duplex, Autogating" with 'CTS True' set to 'enabled'

Brainboxes PX-324 PCI Express 1 Port RS422/485 (for desktop PCs)

Supplier:
Brainboxes
Tel: +44 (0)151 220 2500
Web: http://www.brainboxes.com
Email: Sales: sales@brainboxes.com

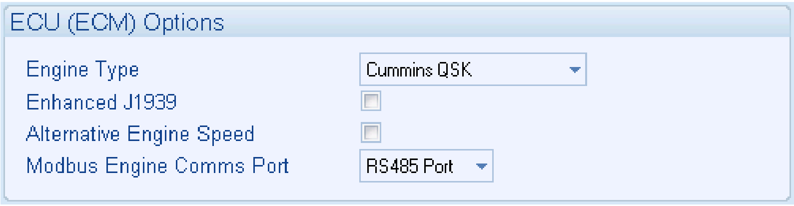
2.10.3.3 RS485 USED FOR MODBUS ENGINE CONNECTION

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

The RS485 port can be configured for connection to Cummins MODBUS engines (Engines fitted with Cummins GCS (G-Drive Control System)).
This leaves the DSENet® interface free for connection to expansion devices.

While this is a very useful feature in some applications, the obvious drawback is that the RS485 interface is no longer available connection or remote monitoring equipment (i.e. Building Management System, PLC or PC RS232 port) or dual mutual system.

Example of configuring the DSENet® for connection to Cummins QSK GCS using the DSE Configuration Suite Software:



2.10.3.4 RS485 USED FOR DUAL MUTUAL STANDBY CONNECTION

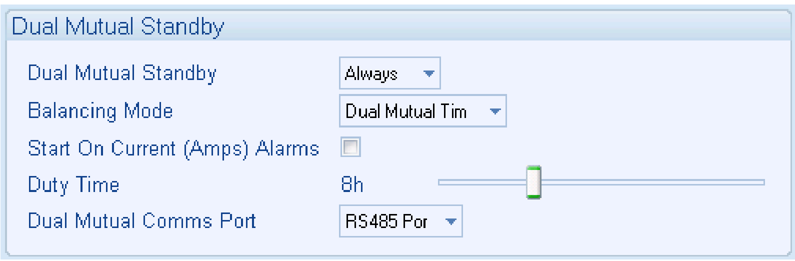
NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

The dual mutual system utilises the RS232 or RS485 hardware interface to allow multiple modules to communicate to one another. The R485 port can be configured for connection to a MODBUS engine or remote monitoring equipment (i.e. Building Management System, PLC or PC RS485 port).

Using the RS485 port for dual mutual communication frees up the RS232 interface for connection to a Modem or remote monitoring equipment (i.e. Building Management System, PLC or PC RS232 port).

While this is a very useful feature in some applications, the obvious drawback is that the RS485 port is no longer available connection to a MODBUS ECU or remote monitoring equipment (i.e. Building Management System, PLC or PC RS485 port).

Example of configuring the dual mutual for connection by RS485 using the DSE Configuration Suite Software:



2.10.3.5 RS485 USED FOR THE DSE25XX MKII REMOTE DISPLAY

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

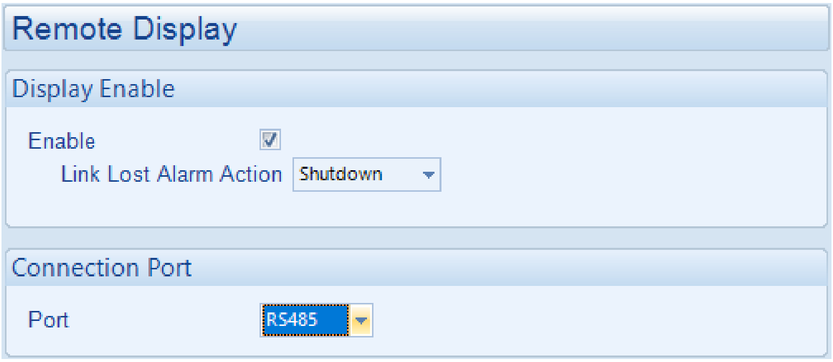
NOTE: DSE25xx MKII Remote Display units utilise the same hardware as DSE73xx MKII modules. Conversion between either module type is possible via a firmware upgrade. For further details refer to DSE Publication: *057-278 DSE73xx MKII Conversion to DSE25xx MKII Remote Display Manual.*

The DSE25xx MKII remote display utilises the RS232 or RS485 hardware interface to allow connection to the DSE73xx MKII genset controller. The R485 port can be configured for connection to a MODBUS engine or remote monitoring equipment (i.e. Building Management System, PLC or PC RS485 port).

Using the RS485 port for DSE25xx MKII remote display communications frees up the RS232 interface for connection to a Modem or remote monitoring equipment (i.e. Building Management System, PLC or PC RS232 port).

While this is a very useful feature in some applications, the obvious drawback is that the RS485 port is no longer available connection to a MODBUS ECU or remote monitoring equipment (i.e. Building Management System, PLC or PC RS485 port).

Example of configuring the DSE25xx MKII remote display for connection by RS485 using the DSE Configuration Suite Software:



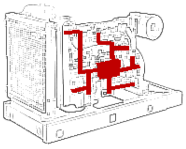
2.10.4 ECU PORT (J1939)

NOTE: Screened 120 Ω impedance cable specified for use with CAN must be used for the CAN link. DSE stock and supply Belden cable 9841 which is a high quality 120 Ω impedance cable suitable for CAN use (DSE part number 016-030)

The *ECU Port* is used for connection of more than one device and allows for connection to engine ECU/ECMs, alternator AVRs, CAN Scanner, PLC and CAN controllers (to name just a few devices). The operator is then able to view the various operating parameters.

2.10.4.1 CAN SUPPORTED ENGINES

NOTE: For further details on connection to electronic engines, refer to DSE Publication: *057-004 Electronic Engines And DSE Wiring*



The modules are fitted with a CAN interface as standard and are capable of receiving engine data from engine ECU/ECMs compliant with the CAN J1939 standard.

ECU/ECMs monitor the engine's operating parameters such as speed, oil pressure, coolant temperature (among others) in order to closely monitor and control the engine. The industry standard communications interface (CAN) transports data gathered by the engine's ECU/ECM using the J1939 protocol. This allows engine controllers such as DSE to access these engine parameters with no physical connection to the sensor device.

2.10.4.2 CAN SUPPORTED AVRS

NOTE: For further details on connection to supported CANbus AVRs, contact DSE technical support: support@deepseaelectronics.com.

The modules are fitted with a CAN interface as standard and are capable of receiving alternator data from certain AVRs compliant with the CAN J1939 standard.

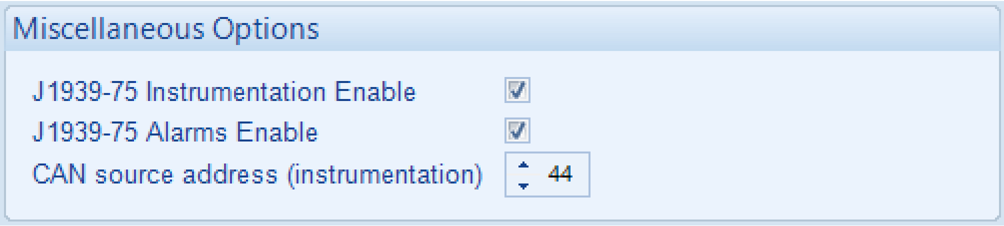
AVRs are used to maintain the alternators' output voltage by controlling the excitation current in addition to closely monitoring and protecting the alternator. The industry standard communications interface (CAN) transports data gathered by the alternators' AVR using the J1939 protocol. This allows generator controllers such as DSE to access these alternator parameters with no physical connection to the sensor device.

2.10.4.3 J1939-75

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

NOTE: For further details of CAN communication, see the section entitled *CAN Interface Specification (J1939-75)* elsewhere in this document.

When the J1939-75 is enabled in the module's configuration, the module's AC measurements and alarms are sent onto the CANbus using the *ECU Port* to be received by an external monitoring device. There are two check boxes to enable each of the two parts of the interface as shown below, AC measurement and AC related alarms. The module AC alarms are translated into J1939 DM1 diagnostic messages. There are no additional display screens visible on the module when these options are selected. The default CAN source address for additional J1939-75 messages is 44 however this may be changed by the generator supplier.

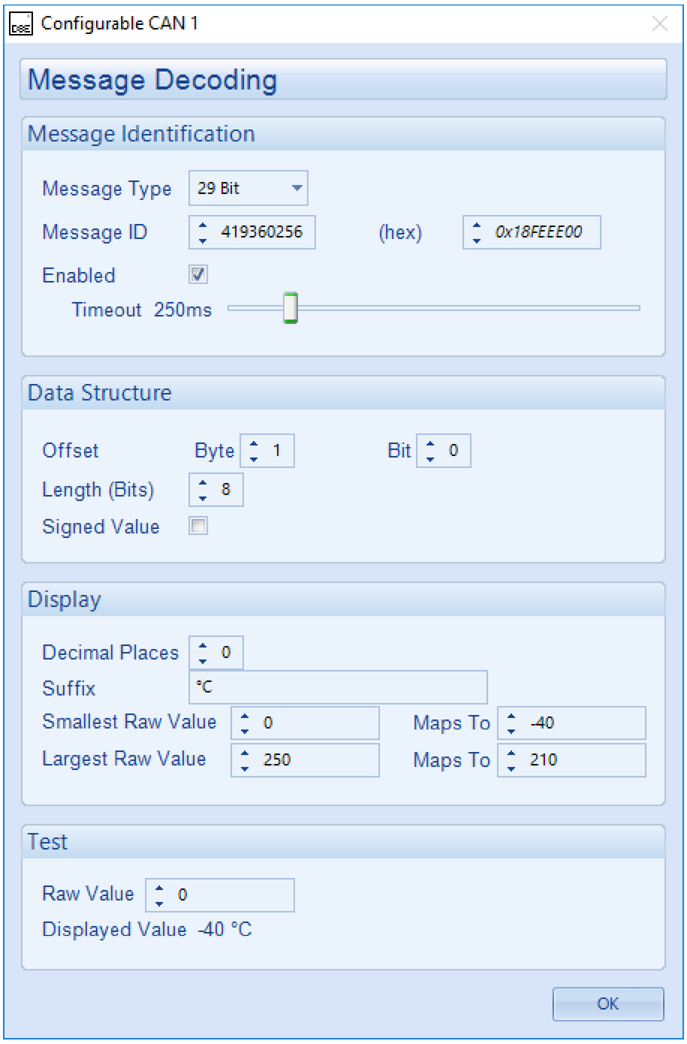


2.10.4.4 CONFIGURABLE CAN

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

The module's CAN port is used to connect third-party CAN devices (controllers, battery chargers…) and allows the module to read and transmit configurable CAN instruments.

The DSE module supports connection to a CAN device and is able to read up to 30 parameters and transmit up to 10 parameters; these parameters are configurable and the read instrumentation is displayable on the module LCD and/or in SCADA.



2.10.5 DSENET® (EXPANSION MODULES)

> **NOTE: For further details of module configuration, refer to DSE Publication:** ***057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.***

> **NOTE: As a termination resistor is internally fitted to the controller, the controller must be the 'first' unit on the DSENet® link. A termination resistor MUST be fitted to the 'last' unit on the DSENet® link. For connection details, refer to section entitled** ***Typical Wiring Diagram*** **elsewhere in this document.**

> **NOTE: DSE recommend Belden 9841 (or equivalent) cable for DSENet® communication. This is rated to a maximum cable length of 1.2 km. DSE Stock Belden 9841 cable, DSE Part Number: 016-030.**

DSENet® is the interconnection cable between the host controller and the expansion module(s) and must not be connected to any device other than DSE equipment designed for connection to the DSENet®

Description	Specification
Cable Type	Two core screened and shielded twisted pair
Cable Characteristics	120 Ω Low capacitance
Recommended Cable	Belden 9841 Belden 9271
Maximum Cable Length	1200 m (¾ mile) when using Belden 9841 or direct equivalent. 600 m (656 yards) when using Belden 9271 or direct equivalent.
DSENet® Topology	"Daisy Chain" Bus with no stubs (spurs)
DSENet® Termination	120 Ω. Fitted internally to host controller. Must be fitted externally to the 'last' expansion module.
Maximum Expansion Modules	**NOTE: Only supported DSE Intelligent Battery Chargers may be connected to the DSENet®. Contact DSE Technical Support for further information.** **NOTE: When connecting a DSE25xx MKII Remote Display on DSENet, the maximum number of supported expansion modules reduces from 20 down to 5 (including only 1 battery charger).** Total 20 devices made up of DSE2130 (up to 4), DSE2131 (up to 4), DSE2133 (up to 4), DSE2152 (up to 4), DSE2157 (up to 10), DSE2510 or DSE2520 (up to 3), DSE2548 (up to 10), DSE25xx MKII (upto 1) and DSE Intelligent Battery Chargers (up to 4). This gives the possibility of : Maximum 32 additional 0 V to 10 V or 4 mA to 20 mA outputs (DSE2152) Maximum 80 additional relay outputs (DSE2157) Maximum 80 additional LED indicators Maximum 24 additional RTD or thermocouple inputs (DSE2133). Maximum 32 additional inputs (Can be configured as either digital, or resistive when using DSE2130) Maximum 40 additional flexible inputs (All can be configured as either digital, resistive, 0 V to 10 V or 4 mA to 20 mA when using DSE2131) Maximum 1 DSE25xx MKII Remote Display. Maximum 4 DSE Intelligent Battery Chargers.

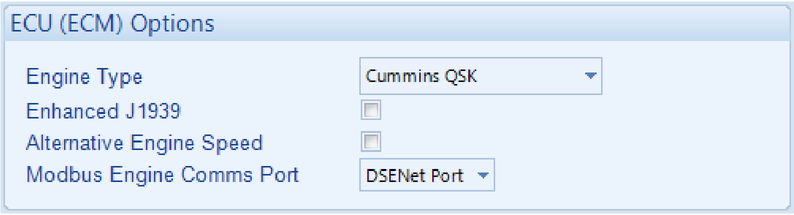
2.10.5.1 DSENET® USED FOR MODBUS ENGINE CONNECTION

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

As DSENet® utilises an RS485 hardware interface, this port can be configured for connection to Cummins MODBUS engines (Engines fitted with Cummins GCS (G-Drive Control System)).
This leaves the RS485 interface free for connection to remote monitoring equipment (i.e. Building Management System, PLC or PC RS485 port).

While this is a very useful feature in some applications, the obvious drawback is that the DSENet® interface is no longer available for connection to expansion devices.

Example of configuring the DSENet® for connection to Cummins QSK GCS using the DSE Configuration Suite Software:



2.11 SOUNDER

The module features an internal sounder to draw attention to warning, electrical trip and shutdown alarms.

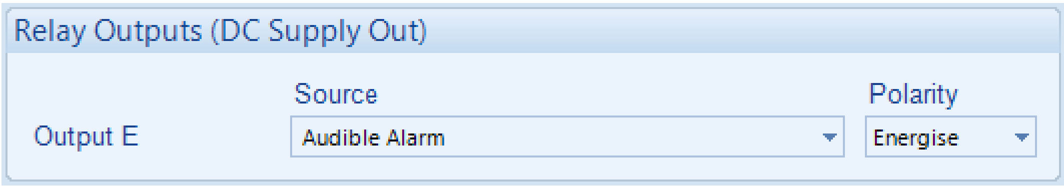
Description	Specification
Sounder Level	64 db at 1 m

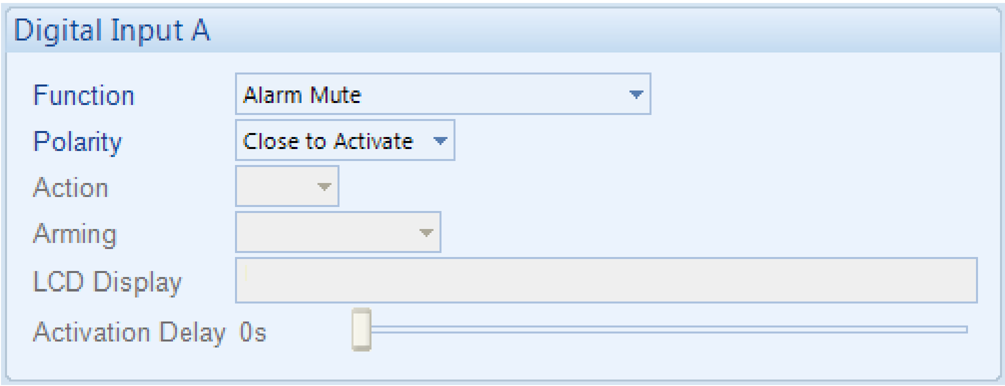
2.11.1 ADDING AN EXTERNAL SOUNDER

Should an external alarm or indicator be required, this can be achieved by using the DSE Configuration Suite PC software to configure an auxiliary output for *Audible Alarm,* and by configuring an auxiliary input for *Alarm Mute* (if required).

The audible alarm output activates and de-activates at the same time as the module's internal sounder. The Alarm mute input and internal ***Lamp Test / Alarm Mute*** button activate 'in parallel' with each other. Either signal mutes both the internal sounder and audible alarm output.

Example of configuration to achieve external sounder with external alarm mute button:





2.12 ACCUMULATED INSTRUMENTATION

NOTE: When an accumulated instrumentation value exceeds the maximum number as listed below, the value is reset and begins counting from zero again.

The number of logged *Engine Hours* and *Number of Starts* can be set/reset using the DSE Configuration Suite PC software. Depending upon module configuration, this may have been PIN number locked by the generator supplier.

Description	Specification
Engine Hours Run	Maximum 99999 hrs 59 minutes (Approximately 11yrs 4 months)
Number of Starts	1,000,000 (1 Million)
Accumulated Power	999999 kWh / kvarh / kVAh

2.13 DIMENSIONS AND MOUNTING

2.13.1 DIMENSIONS

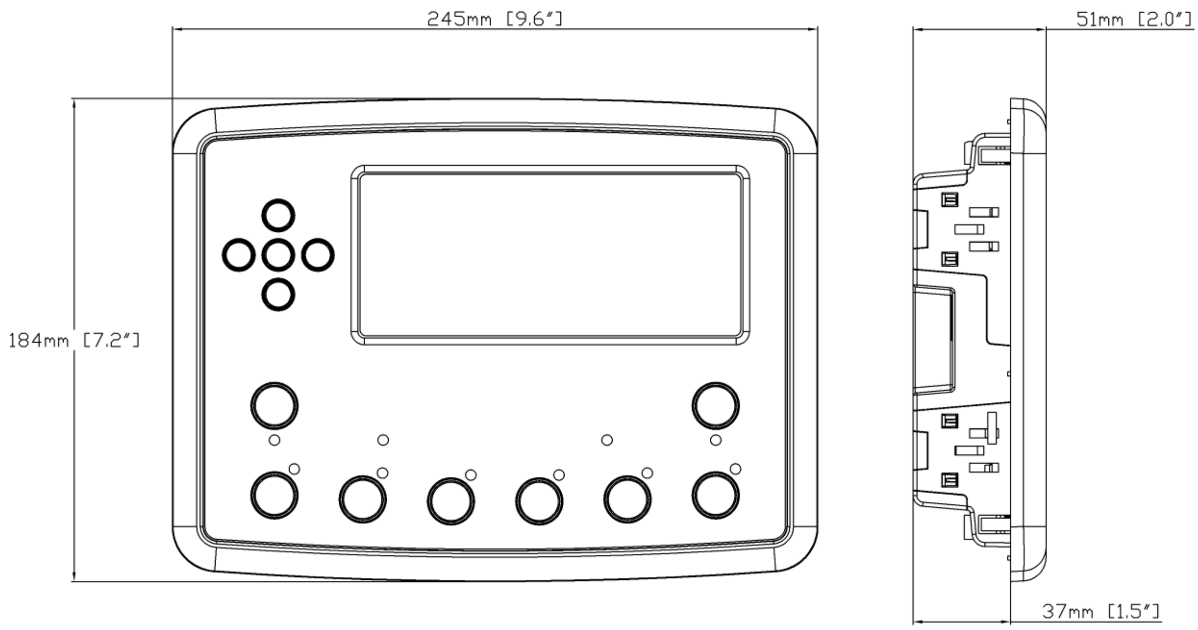
245 mm x 184 mm x 51 mm
(9.6 ” x 7.2 ” x 2.0 ”)

2.13.2 PANEL CUTOUT

220 mm x 160 mm
(8.7” x 6.3”)

2.13.3 WEIGHT

0.98 kg
(2.16 lb)

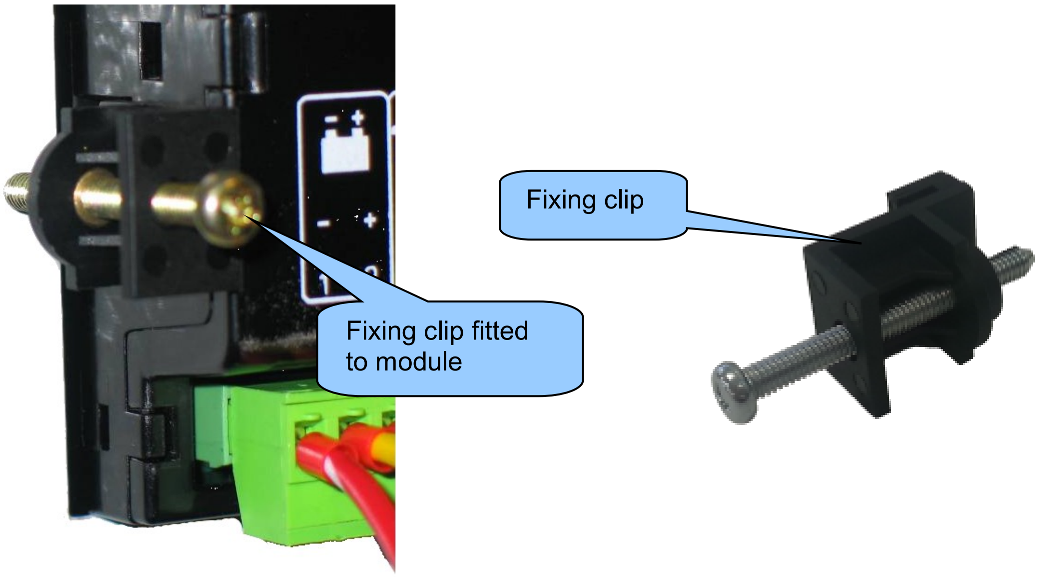


2.13.4 FIXING CLIPS

NOTE: In conditions of excessive vibration, mount the module on suitable anti-vibration mountings.

The module is held into the panel fascia using the supplied fixing clips.

Withdraw the fixing clip screw (turn anticlockwise) until only the pointed end is protruding from the clip.
Insert the three 'prongs' of the fixing clip into the slots in the side of the module case.
Pull the fixing clip backwards (towards the back of the module) ensuring all three prongs of the clip are inside their allotted slots.
Turn the fixing clip screws clockwise until they make contact with the panel fascia.
Turn the screw a quarter of a turn to secure the module into the panel fascia. Care must be taken not to over tighten the fixing clip screws.

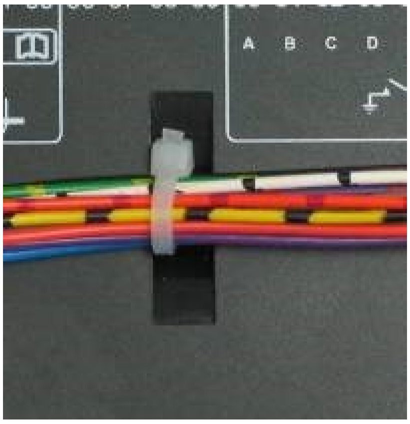


2.13.5 CABLE TIE FIXING POINTS

Cable tie fixing points are included on the rear of the module's case to aid wiring. This additionally provides strain relief to the cable loom by removing the weight of the loom from the screw connectors, reducing the chance of future connection failures.

Care must be taken not to over tighten the cable tie (for instance with cable tie tools) to prevent the risk of damage to the module case.

Cable Tie Fixing Point

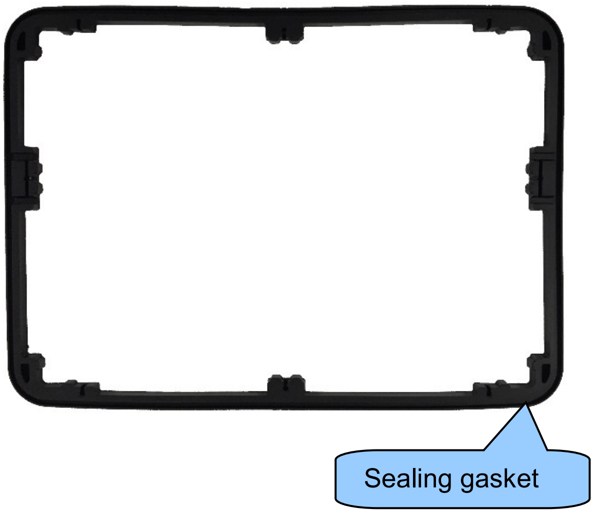


With Cable And Tie In Place

2.13.6 SILICON SEALING GASKET

NOTE: For purchasing a silicon gasket from DSE, see the section entitled Maintenance, Spares, Repair and Servicing elsewhere in this document.

The silicon gasket provides improved sealing between module and the panel fascia. The gasket is fitted to the module before installation into the panel fascia. Take care to ensure the gasket is correctly fitted to the module to maintain the integrity of the seal.



2.14 APPLICABLE STANDARDS

Standard	Description
BS 4884-1	This document conforms to BS4884-1 1992 Specification for presentation of essential information.
BS 4884-2	This document conforms to BS4884-2 1993 Guide to content
BS 4884-3	This document conforms to BS4884-3 1993 Guide to presentation
BS EN 60068-2-1 (Minimum temperature)	-30 °C (-22 °F)
BS EN 60068-2-2 (Maximum temperature)	+70 °C (158 °F)
BS EN 60068-2-6 (Vibration)	Ten sweeps in each of three major axes 5 Hz to 8 Hz at ±7.5 mm 8 Hz to 500 Hz at 2 gn
BS EN 60068-2-27 (Shock)	Three shocks in each of three major axes 15 gn in 11 ms
BS EN 60068-2-30 (Damp heat cyclic)	20˚C to 55 ˚C at 95% relative humidity for 48 hours
BS EN 60068-2-78 (Damp heat static)	40 ˚C at 95% relative humidity for 48 hours
BS EN 60950 (Electrical safety)	Safety of information technology equipment, including electrical business equipment
BS EN 61000-6-2 (Electro-magnetic Compatibility)	EMC Generic Immunity Standard (Industrial)
BS EN 61000-6-4 (Electro-magnetic Compatibility)	EMC Generic Emission Standard (Industrial)
BS EN 60529 (Degrees of protection provided by enclosures)	IP65 (front of module when installed into the control panel with the optional sealing gasket) IP42 (front of module when installed into the control panel WITHOUT being sealed to the panel)
UL508 NEMA rating (Approximate)	12 (Front of module when installed into the control panel with the optional sealing gasket). 2 (Front of module when installed into the control panel WITHOUT being sealed to the panel)
IEEE C37.2 (Standard Electrical Power System Device Function Numbers and Contact Designations)	Under the scope of IEEE 37.2, function numbers can also be used to represent functions in microprocessor devices and software programs. The controller is device number 11L-8000 (Multifunction device protecting Line (generator) –module). As the module is configurable by the generator OEM, the functions covered by the module vary. Depending on module configuration, the device numbers included within the module could be: 2 – Time Delay Starting Or Closing Relay 3 – Checking Or Interlocking Relay 5 – Stopping Device 6 – Starting Circuit Breaker 8 – Control Power Disconnecting Device 10 – Unit Sequence Switch 11 – Multifunction Device 12 – Overspeed Device 14 – Underspeed Device

Continued over the page...

Standard	Description
IEEE C37.2 (Standard Electrical Power System Device Function Numbers and Contact Designations)	Continued… 49 – Machine or Transformer Thermal Relay 50 – Instantaneous Overcurrent Relay 51 – AC Time Overcurrent Relay 52 – AC Circuit Breaker 53 – Exciter Or DC Generator Relay 54 – Turning Gear Engaging Device 55 – Power Factor Relay **(USING INTERNAL PLC EDITOR)** 59AC – AC Overvoltage Relay 59DC – DC Overvoltage Relay 62 – Time Delay Stopping Or Opening Relay 63 – Pressure Switch 71 – Level Switch 74 – Alarm Relay 78 – Phase-Angle Measuring Relay 79 – Reclosing Relay **(USING INTERNAL PLC EDITOR)** 81 – Frequency Relay 83 – Automatic Selective Control Or Transfer Relay 86 – Lockout Relay

In line with our policy of continual development, Deep Sea Electronics, reserve the right to change specification without notice.

2.14.1 ENCLOSURE CLASSIFICATIONS

2.14.1.1 IP CLASSIFICATIONS

The modules specification under BS EN 60529 Degrees of protection provided by enclosures

IP65 (Front of module when module is installed into the control panel with the optional sealing gasket).
IP42 (front of module when module is installed into the control panel WITHOUT being sealed to the panel)

First Digit Protection against contact and ingress of solid objects		Second Digit Protection against ingress of water	
0	No protection	0	No protection
1	Protected against ingress solid objects with a diameter of more than 50 mm. No protection against deliberate access, e.g. with a hand, but large surfaces of the body are prevented from approach.	1	Protection against dripping water falling vertically. No harmful effect must be produced (vertically falling drops).
2	Protected against penetration by solid objects with a diameter of more than 12 mm. Fingers or similar objects prevented from approach.	2	Protection against dripping water falling vertically. There must be no harmful effect when the equipment (enclosure) is tilted at an angle up to 15° from its normal position (drops falling at an angle).
3	Protected against ingress of solid objects with a diameter of more than 2.5 mm. Tools, wires etc. with a thickness of more than 2.5 mm are prevented from approach.	3	Protection against water falling at any angle up to 60° from the vertical. There must be no harmful effect (spray water).
4	Protected against ingress of solid objects with a diameter of more than 1 mm. Tools, wires etc. with a thickness of more than 1 mm are prevented from approach.	4	Protection against water splashed against the equipment (enclosure) from any direction. There must be no harmful effect (splashing water).
5	Protected against harmful dust deposits. Ingress of dust is not totally prevented but the dust must not enter in sufficient quantity to interface with satisfactory operation of the equipment. Complete protection against contact.	5	Protection against water projected from a nozzle against the equipment (enclosure) from any direction. There must be no harmful effect (water jet).
6	Protection against ingress of dust (dust tight). Complete protection against contact.	6	Protection against heavy seas or powerful water jets. Water must not enter the equipment (enclosure) in harmful quantities (splashing over).

2.14.1.2 NEMA CLASSIFICATIONS

NOTE: There is no direct equivalence between IP / NEMA ratings. IP figures shown are approximate only.

12 (Front of module when module is installed into the control panel with the optional sealing gasket).
2 (Front of module when module is installed into the control panel WITHOUT being sealed to the panel)

1 **IP30**	Provides a degree of protection against contact with the enclosure equipment and against a limited amount of falling dirt.
2 **IP31**	Provides a degree of protection against limited amounts of falling water and dirt.
3 **IP64**	Provides a degree of protection against windblown dust, rain and sleet; undamaged by the formation of ice on the enclosure.
3R **IP32**	Provides a degree of protection against rain and sleet:; undamaged by the formation of ice on the enclosure.
4 (X) **IP66**	Provides a degree of protection against splashing water, windblown dust and rain, hose directed water; undamaged by the formation of ice on the enclosure. (Resist corrosion).
12/12K **IP65**	Provides a degree of protection against dust, falling dirt and dripping non corrosive liquids.
13 **IP65**	Provides a degree of protection against dust and spraying of water, oil and non corrosive coolants.

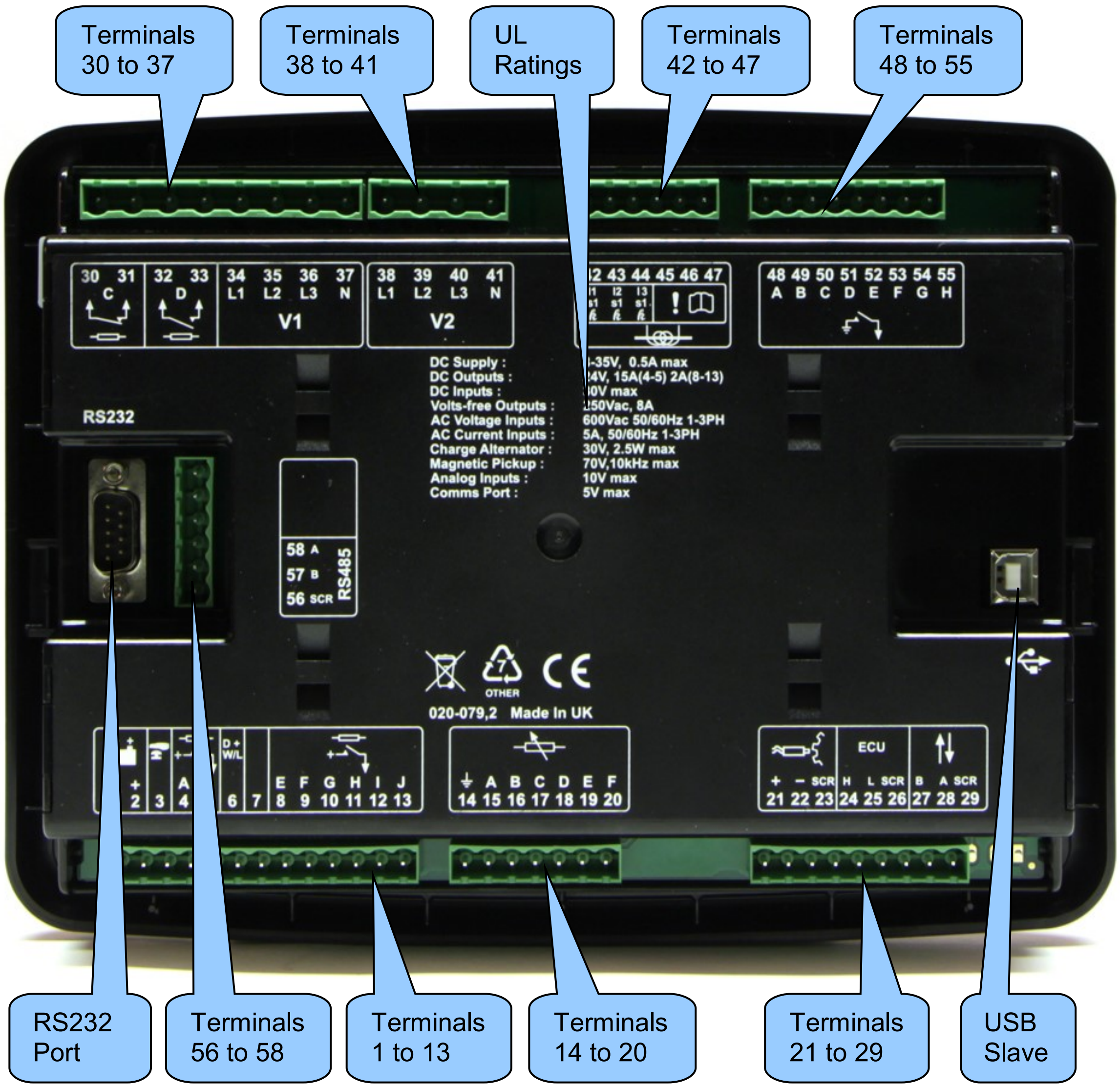
3 INSTALLATION

The module is designed to be mounted on the panel fascia. For dimension and mounting details, see the section entitled *Dimension and Mounting* elsewhere in this document.

3.1 USER CONNECTIONS

NOTE: Availability of some terminals depends upon module version. Full details are given in the section entitled *Terminal Description* elsewhere in this manual.

To aid user connection, icons are used on the rear of the module to help identify terminal functions. An example of this is shown below.



3.2 CONNECTION DESCRIPTIONS

3.2.1 DC SUPPLY, E-STOP INPUT, DC OUTPUTS & CHARGE FAIL INPUT

NOTE: When the module is configured for operation with an electronic engine, *Fuel* and *Start* output requirements may be different. For further details on connection to electronic engines, refer to DSE Publication: *057-004 Electronic Engines And DSE Wiring*

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

	Pin No	Description	Cable Size	Notes
	1	DC Plant Supply Input (Negative)	2.5 mm² AWG 13	Connect to ground where applicable.
	2	DC Plant Supply Input (Positive)	2.5 mm² AWG 13	Supplies the module and DC Outputs E, F, G, H, I & J
	3	Emergency Stop Input	2.5 mm² AWG 13	Plant Supply Positive. Supplies DC Outputs A & B.
	4	DC Output A (FUEL)	2.5 mm² AWG 13	Plant Supply Positive from terminal 3. 15 A DC rated Fixed as fuel relay if electronic engine is not configured.
	5	DC Output B (START)	2.5 mm² AWG 13	Plant Supply Positive from terminal 3. 15 A DC rated Fixed as start relay if electronic engine is not configured.
D+ W/L	6	Charge Fail / Excite	2.5 mm² AWG 13	Do not connect to ground (battery negative). If charge alternator is not fitted, leave this terminal disconnected.
	7	DO NOT CONNECT		
	8	DC Output E	1.0 mm² AWG 18	Plant Supply Positive from terminal 2. 2 A DC rated.
	9	DC Output F	1.0 mm² AWG 18	Plant Supply Positive from terminal 2. 2 A DC rated.
	10	DC Output G	1.0 mm² AWG 18	Plant Supply Positive from terminal 2. 2 A DC rated.
	11	DC Output H	1.0 mm² AWG 18	Plant Supply Positive from terminal 2. 2 A DC rated.
	12	DC Output I	1.0 mm² AWG 18	Plant Supply Positive from terminal 2. 2 A DC rated.
	13	DC Output J	1.0 mm² AWG 18	Plant Supply Positive from terminal 2. 2 A DC rated.

3.2.2 ANALOGUE SENSOR INPUTS

> **NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.***

> **NOTE: It is VERY important that terminal 14 (sensor common) is connected to an earth point on the ENGINE BLOCK, not within the control panel, and must be a sound electrical connection to the sensor bodies. This connection MUST NOT be used to provide an earth connection for other terminals or devices. The simplest way to achieve this is to run a SEPARATE earth connection from the system earth star point, to terminal 14 directly, and not use this earth for other connections.**

> **NOTE: If PTFE insulating tape is used on the sensor thread when using earth return sensors, ensure not to insulate the entire thread, as this prevents the sensor body from being earthed via the engine block.**

	Pin No	Description	Cable Size	Notes
	14	Sensor Common Return	0.5 mm² AWG 20	Ground Return Feed For Sensors
	15	Analogue Sensor Input A	0.5 mm² AWG 20	Connect To Oil Pressure Sensor
	16	Analogue Sensor Input B	0.5mm² AWG 20	Connect To Coolant Temperature Sensor
	17	Analogue Sensor Input C	0.5 mm² AWG 20	Connect To Fuel Level Sensor
	18	Analogue Sensor Input D	0.5 mm² AWG 20	Connect To Additional Sensor (User Configurable)
	19	Analogue Sensor Input E	0.5 mm² AWG 20	Connect To Additional Sensor (User Configurable)
	20	Analogue Sensor Input F	0.5 mm² AWG 20	Connect To Additional Sensor (User Configurable)

3.2.3 MPU, ECU & DSENET®

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

NOTE: For further details on connection to electronic engines, refer to DSE Publication: *057-004 Electronic Engines And DSE Wiring*

NOTE: Screened 120 Ω impedance cable specified for use with CAN must be used for the CAN link.
DSE stock and supply Belden cable 9841 which is a high quality 120 Ω impedance cable suitable for CAN use (DSE part number 016-030)

NOTE: As a termination resistor is internally fitted to the controller, the controller must be the 'first' unit on the DSENet® link. A termination resistor MUST be fitted to the 'last' unit on the DSENet® link. For connection details, refer to section entitled *Typical Wiring Diagram* elsewhere in this document.

	Pin No	Description	Cable Size	Notes
	21	Magnetic Pickup Positive	0.5 mm² AWG 20	Connect To Magnetic Pickup Device
	22	Magnetic Pickup Negative	0.5 mm² AWG 20	Connect To Magnetic Pickup Device
	23	Magnetic Pickup Screen	Shield	Connect To Ground At One End Only
ECU	24	ECU Port H	0.5 mm² AWG 20	Use only 120 Ω CAN or RS485 approved cable
	25	ECU Port L	0.5 mm² AWG 20	Use only 120 Ω CAN or RS485 approved cable
	26	ECU Port Screen	Shield	Use only 120 Ω CAN or RS485 approved cable
	27	DSENet® Expansion B	0.5 mm² AWG 20	Use only 120 Ω CAN or RS485 approved cable
	28	DSENet® Expansion A	0.5 mm² AWG 20	Use only 120 Ω CAN or RS485 approved cable
	29	DSENet® Expansion Screen	Shield	Use only 120 Ω CAN or RS485 approved cable

3.2.4 OUTPUT C & D & V1 (GENERATOR) VOLTAGE & FREQUENCY SENSING

NOTE: The below table describes connections to a three phase, four wire alternator. For alternative wiring topologies, see the section entitled *Alternate Topology Wiring Diagrams* elsewhere in this document.

	Pin No	Description	Cable Size	Notes
	30	Normally Closed Volt-Free Relay Output C	1.0mm² AWG 18	Normally configured to control mains contactor coil
	31		1.0mm² AWG 18	
	32	Normally Open Volt-Free Relay Output D	1.0mm² AWG 18	Normally configured to control generator contactor coil
	33		1.0mm² AWG 18	
V1	34	Generator L1 (U) Voltage Sensing	1.0 mm² AWG 18	Connect to generator L1 (U) output (AC) (Recommend 2 A fuse)
	35	Generator L2 (V) Voltage Sensing	1.0 mm² AWG 18	Connect to generator L2 (V) output (AC) (Recommend 2 A fuse)
	36	Generator L3 (W) Voltage Sensing	1.0 mm² AWG 18	Connect to generator L3 (W) output (AC) (Recommend 2 A fuse)
	37	Generator Neutral (N) Input	1.0 mm² AWG 18	Connect to generator Neutral terminal (AC)

3.2.5 V2 (MAINS) VOLTAGE & FREQUENCY SENSING

NOTE: Terminals 38 to 41 not fitted to DSE7310 MKII

NOTE: The below table describes connections to a three phase, four wire mains supply. For alternative wiring topologies, see the section entitled *Alternate Topology Wiring Diagrams* elsewhere in this document.

	Pin No	Description	Cable Size	Notes
V2	38	Mains L1 (R) Voltage Sensing	1.0 mm² AWG 18	Connect to mains L1 (R) output (AC) (Recommend 2 A fuse)
	39	Mains L2 (S) Voltage Sensing	1.0 mm² AWG 18	Connect to mains L2 (S) output (AC) (Recommend 2 A fuse)
	40	Mains L3 (T) Voltage Sensing	1.0 mm² AWG 18	Connect to mains L3 (T) output (AC) (Recommend 2 A fuse)
	41	Mains Neutral (N) Input	1.0 mm² AWG 18	Connect to Mains Neutral terminal (AC)

3.2.6 CURRENT TRANSFORMERS

WARNING!: Do not disconnect this plug when the CTs are carrying current. Disconnection open circuits the secondary of the C.T.'s and dangerous voltages may then develop. Always ensure the CTs are not carrying current and the CTs are short circuit connected before making or breaking connections to the module.

NOTE: The module has a burden of 0.25 VA on the CT. Ensure the CT is rated for the burden of the controller, the cable length being used and any other equipment sharing the CT. If in doubt, consult with the CT supplier.

NOTE: Take care to ensure correct polarity of the CT primary as shown below. If in doubt, consult with the CT supplier.

	Pin No	Description	Cable Size	Notes
	42	CT Secondary for L1	2.5 mm² AWG 13	Connect to s1 secondary of L1 monitoring CT
	43	CT Secondary for L2	2.5 mm² AWG 13	Connect to s1 secondary of L2 monitoring CT
	44	CT Secondary for L3	2.5 mm² AWG 13	Connect to s1 secondary of L3 monitoring CT

NOTE: The function of terminals 45 and 46 changes depending upon what type of earth fault protection (if any) is being used:

	Topology	Pin No	Notes	Cable Size
	No earth fault measuring	45	DO NOT CONNECT	
		46	Connect to s2 of the CTs connected to L1,L2,L3,N	2.5mm² AWG 13
		47	DO NOT CONNECT	
	Restricted earth fault measuring	45	Connect to s2 of the CTs connected to L1,L2,L3,N	2.5mm² AWG 13
		46	Connect to s1 of the CT on the neutral conductor	2.5mm² AWG 13
		47	DO NOT CONNECT	
	Un-restricted earth fault measuring (Earth fault CT is fitted in the neutral to earth link)	45	Connect to s2 of the CT on the neutral to earth link.	2.5mm² AWG 13
		46	Connect to s1 of the CT on the neutral to earth link. Also connect to the s2 of CTs connected to L1, L2, L3.	2.5mm² AWG 13
		47	DO NOT CONNECT	

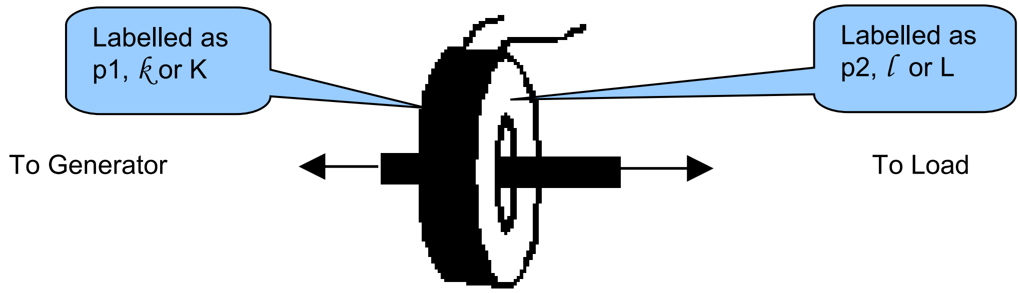
3.2.6.1 CT CONNECTIONS

p1, k or K is the primary of the CT that 'points' towards the Generator

p2, ℓ or L is the primary of the CT that 'points' towards the Load

s1 is the secondary of the CT that connects to the DSE Module's input for the CT measuring

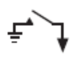
s2 is the secondary of the CT that should be commoned with the s2 connections of all the other CTs and connected to the CT common terminal of the module.



Polarity of CT Primary

3.2.7 DIGITAL INPUTS

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

	Pin No	Description	Cable Size	Notes
	48	Configurable Digital Input A	0.5 mm² AWG 20	Switch To Negative
	49	Configurable Digital Input B	0.5 mm² AWG 20	Switch To Negative
	50	Configurable Digital Input C	0.5 mm² AWG 20	Switch To Negative
	51	Configurable Digital Input D	0.5 mm² AWG 20	Switch To Negative
	52	Configurable Digital Input E	0.5 mm² AWG 20	Switch To Negative
	53	Configurable Digital Input F	0.5 mm² AWG 20	Switch To Negative
	54	Configurable Digital Input G	0.5 mm² AWG 20	Switch To Negative
	55	Configurable Digital Input H	0.5 mm² AWG 20	Switch To Negative

3.2.8 RS485

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

NOTE: A 120 Ω termination resistor must be fitted across terminals A and B if the DSE module is the first or last device on the R485 link.

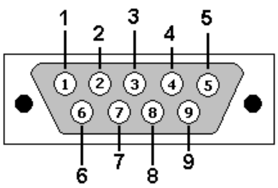
NOTE: Screened 120 Ω impedance cable specified for use with RS485 must be used for the RS485 link.
DSE stock and supply Belden cable 9841 which is a high quality 120 Ω impedance cable suitable for CAN use (DSE part number 016-030)

	Pin No	Description	Cable Size	Notes
RS485	56	RS485 Port Screen	Shield	Use only 120 Ω CAN or RS485 approved cable
	57	RS485 Port B (+)	0.5 mm² AWG 20	Connect to RXD+ and TXD+ Use only 120 Ω CAN or RS485 approved cable
	58	RS485 Port A (-)	0.5 mm² AWG 20	Connect to RXD- and TXD- Use only 120 Ω CAN or RS485 approved cable

3.2.9 RS232

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

	Description	Notes
	Socket for connection to a modem or PC with DSE Configuration Suite Software	Supports MODBUS RTU protocol or external modem



View looking into the male connector on the module

PIN No	Notes
1	Received Line Signal Detector (Data Carrier Detect)
2	Received Data
3	Transmit Data
4	Data Terminal Ready
5	Signal Ground
6	Data Set Ready
7	Request To Send
8	Clear To Send
9	Ring Indicator

3.2.10 USB SLAVE (PC CONFIGURATION) CONNECTOR

NOTE: The USB connection cable between the PC and the module must not be extended beyond 5 m (yards). For distances over 5 m, it is possible to use a third party USB extender. Typically, they extend USB up to 50 m. The supply and support of this type of equipment is outside the scope of Deep Sea Electronics Ltd.

CAUTION!: Care must be taken not to overload the PCs USB system by connecting more than the recommended number of USB devices to the PC. For further information, consult your PC supplier.

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

	Description	Cable Size	Notes
	Socket for connection to PC with DSE Configuration Suite Software	0.5 mm² AWG 20	This is a standard USB type A to type B connector. 

3.3 TYPICAL WIRING DIAGRAM

As every system has different requirements, these diagrams show only a typical system and do not intend to show a complete system.

Genset manufacturers and panel builders may use these diagrams as a starting point; however always refer to the completed system diagram provided by the system manufacturer for complete wiring detail.

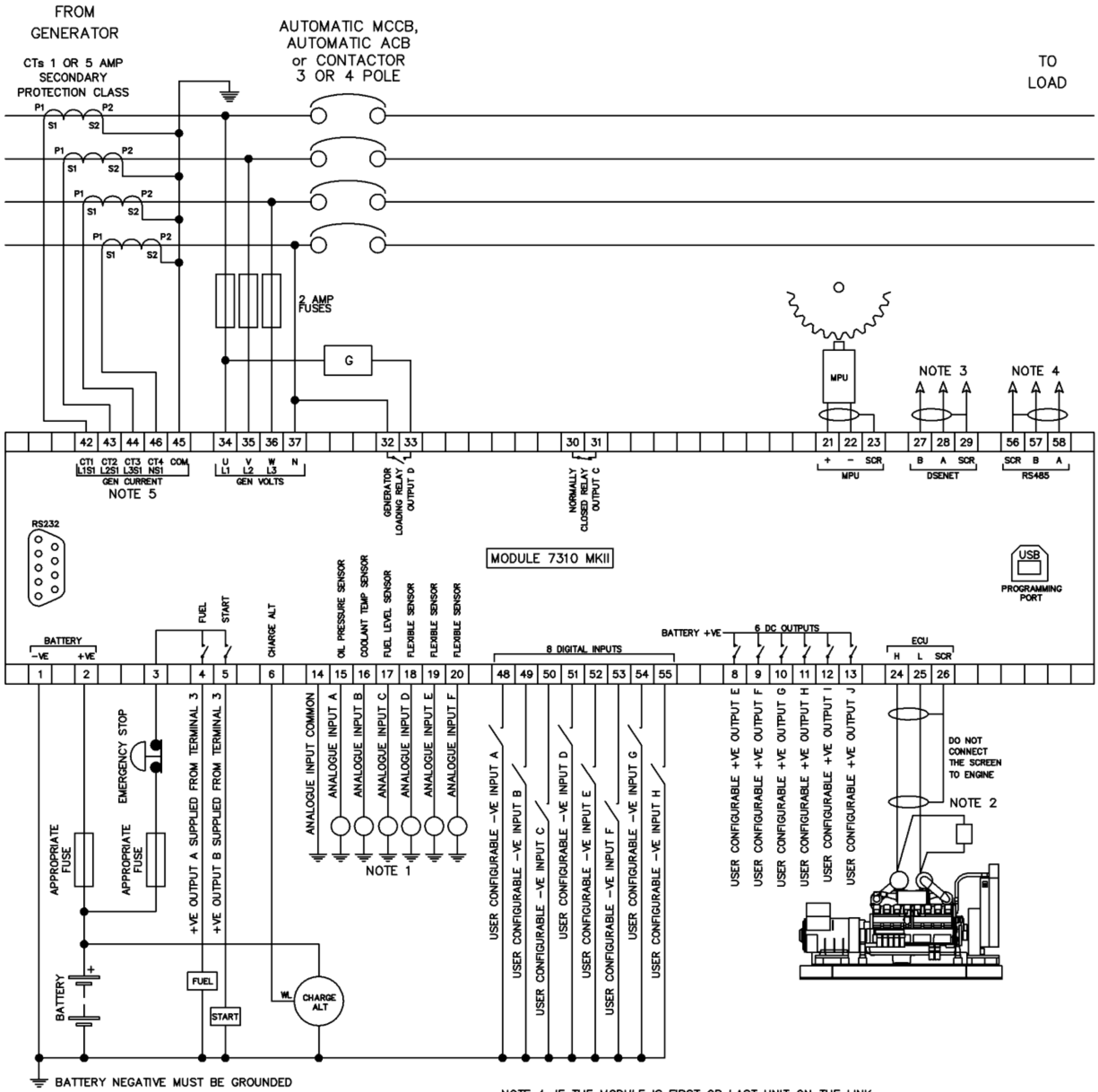
Further wiring suggestions are available in the following DSE publications, available at www.deepseaelectronics.com to website members.

DSE Part	Description
056-005	Using CTs With DSE Products
056-022	Breaker Control
056-091	Equipotential Earth Bonding
056-092	Best Practices for Wiring Resistive Sensors

3.3.1 DSE7310 MKII (3 PHASE 4 WIRE) WITH RESTRICTED EARTH FAULT

NOTE: The below diagram is applicable for the following AC topologies: 3 Phase 4 Wire Star, 3 Phase 4 Wire Delta L1-N-L2, 3 Phase 4 Wire Delta L1-N-L3 and 3 Phase 4 Wire Delta *L2-N-L3*. For further details of module configuration to suit these different topologies, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

NOTE: Earthing the neutral conductor 'before' the neutral CT allows the module to read earth faults 'after' the CT only (Restricted to load / downstream of the CT)
Earthing the neutral conductor 'after' the neutral CT allows the module to read earth faults 'before' the CT only (Restricted to generator / upstream of the CT)



NOTE 1. THESE GROUND CONNECTIONS MUST BE ON THE ENGINE BLOCK, AND MUST BE TO THE SENSOR BODIES.

NOTE 2. A 120 OHM TERMINATING RESISTOR MAY BE REQUIRED EXTERNALLY, SEE ENGINE MANUFACTURERS LITERATURE.

NOTE 3. MUST BE FITTED AS FIRST OR LAST UNIT ON THE DSENET LINK WITH NO EXTERNAL TERMINATION RESISTOR. THE SUBSEQUENT FIRST OR LAST UNIT ON DSENET MUST BE FITTED WITH A 120 OHM TERMINATION RESISTOR ACROSS TERMINALS A AND B.

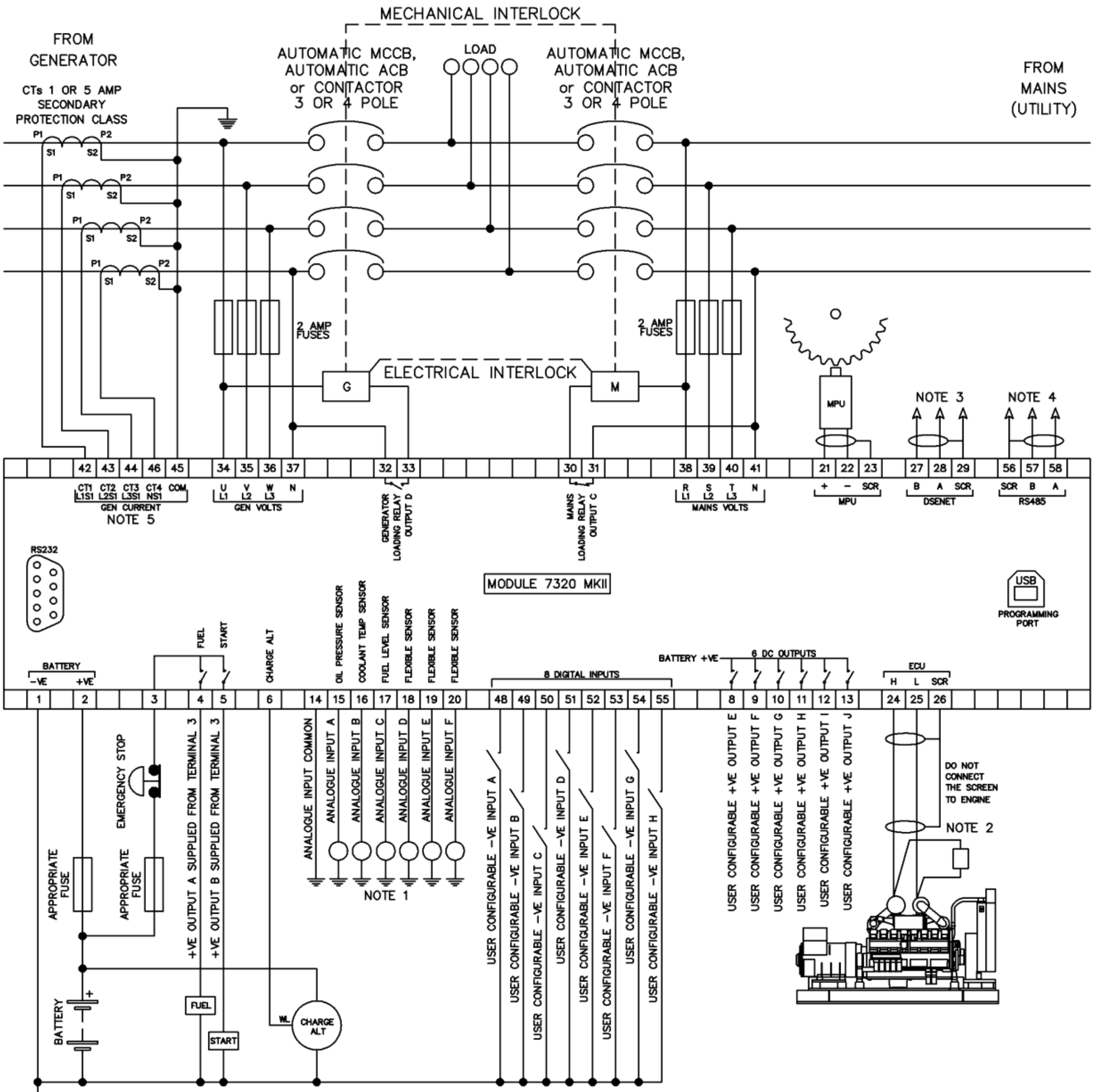
NOTE 4. IF THE MODULE IS FIRST OR LAST UNIT ON THE LINK IT MUST BE FITTED WITH AN EXTERNAL 120 OHM TERMINATION RESISTOR ACROSS TERMINALS A AND B OR H AND L.

NOTE 5. WHEN THE 4TH CT IS PLACED ON THE NEUTRAL, TERMINAL 45 IS THE CT COMMON. WHEN THE 4TH IS NOT IN USE OR PLACED ON THE EARTH CONNECTION, TERMINAL 46 IS THE CT COMMON

3.3.2 DSE7320 MKII (3 PHASE 4 WIRE) WITH RESTRICTED EARTH FAULT

NOTE: The below diagram is applicable for the following AC topologies: 3 Phase 4 Wire Star, 3 Phase 4 Wire Delta L1-N-L2, 3 Phase 4 Wire Delta L1-N-L3 and 3 Phase 4 Wire Delta *L2-N-L3*. For further details of module configuration to suit these different topologies, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

NOTE: Earthing the neutral conductor ‘before’ the neutral CT allows the module to read earth faults ‘after’ the CT only (Restricted to load / downstream of the CT)
Earthing the neutral conductor ‘after’ the neutral CT allows the module to read earth faults ‘before’ the CT only (Restricted to generator / upstream of the CT)



BATTERY NEGATIVE MUST BE GROUNDED

NOTE 1. THESE GROUND CONNECTIONS MUST BE ON THE ENGINE BLOCK, AND MUST BE TO THE SENSOR BODIES.

NOTE 2. A 120 OHM TERMINATING RESISTOR MAY BE REQUIRED EXTERNALLY, SEE ENGINE MANUFACTURERS LITERATURE.

NOTE 3. MUST BE FITTED AS FIRST OR LAST UNIT ON THE DSENET LINK WITH NO EXTERNAL TERMINATION RESISTOR. THE SUBSEQUENT FIRST OR LAST UNIT ON DSENET MUST BE FITTED WITH A 120 OHM TERMINATION RESISTOR ACROSS TERMINALS A AND B.

NOTE 4. IF THE MODULE IS FIRST OR LAST UNIT ON THE LINK IT MUST BE FITTED WITH AN EXTERNAL 120 OHM TERMINATION RESISTOR ACROSS TERMINALS A AND B OR H AND L.

NOTE 5. WHEN THE 4TH CT IS PLACED ON THE NEUTRAL, TERMINAL 45 IS THE CT COMMON. WHEN THE 4TH IS NOT IN USE OR PLACED ON THE EARTH CONNECTION, TERMINAL 46 IS THE CT COMMON

3.3.3 EARTH SYSTEMS

3.3.3.1 NEGATIVE EARTH

The typical wiring diagrams located within this document show connections for a negative earth system (the battery negative connects to Earth).

3.3.3.2 POSITIVE EARTH

When using a DSE module with a Positive Earth System (the battery positive connects to Earth), the following points must be followed:

Follow the typical wiring diagram as normal for all sections ***except*** the earth points.
All points shown as Earth on the typical wiring diagram should connect to ***battery negative*** (not earth).

3.3.3.3 FLOATING EARTH

Where neither the battery positive nor battery negative terminals are connected to earth the following points must to be followed:

Follow the typical wiring diagram as normal for all sections ***except*** the earth points.
All points shown as Earth on the typical wiring diagram should connect to ***battery negative*** (not earth).

3.3.4 TYPICAL ARRANGEMENT OF DSENET®

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

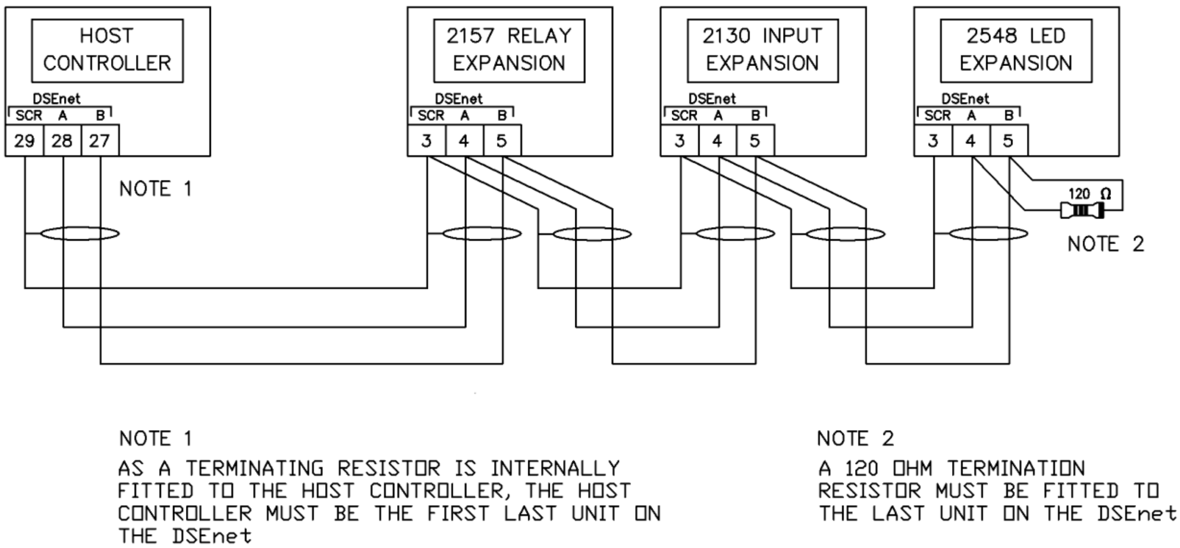
NOTE: This feature is not available if the DSE73xx MKII module has been configured to use the DSENet® port as the interface to a Cummins MODBUS GCS ECU.

NOTE: Screened 120 Ω impedance cable specified for use with CAN must be used for the DSENet® (RS485) connection.

DSE stock and supply Belden cable 9841 which is a high quality 120Ω impedance cable suitable for DSENet® use (DSE part number 016-030)

Twenty (20) devices can be connected to the DSENet®, made up of the following devices :

Device	Maximum Number Supported
DSE2130 Input Expansion	4
DSE2131 Ratiometric Input Expansion	4
DSE2133 RTD/Thermocouple Input Expansion	4
DSE2152 Analogue Output Expansion	4
DSE2157 Relay Output Expansion	10
DSE2510 or DSE2520 Remote Display	3
DSE2548 LED Expansion	10
DSE Intelligent Battery Chargers	4



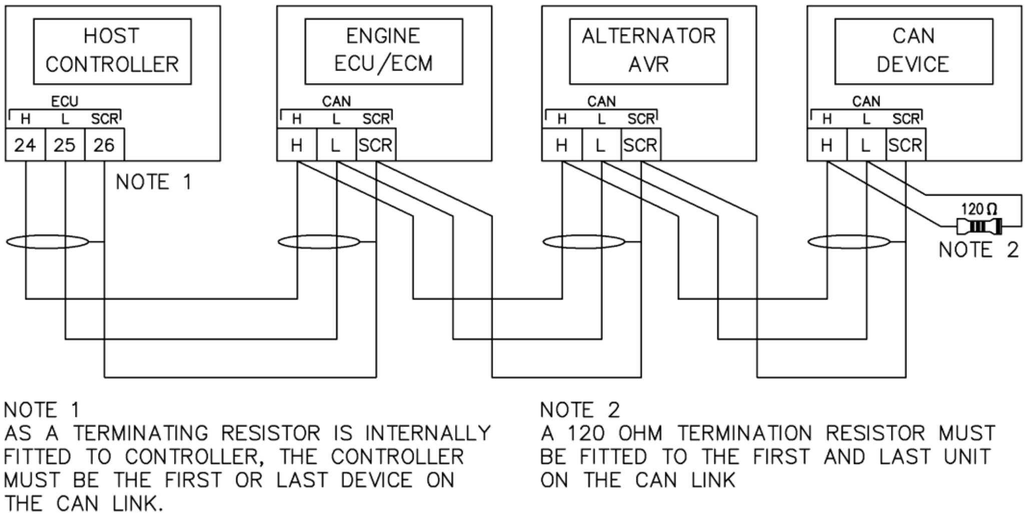
3.3.5 TYPICAL ARRANGEMENT OF CAN

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

NOTE: Screened 120 Ω impedance cable specified for use with CAN must be used. DSE stock and supply Belden cable 9841 which is a high quality 120 Ω impedance cable suitable for DSENet® use (DSE part number 016-030)

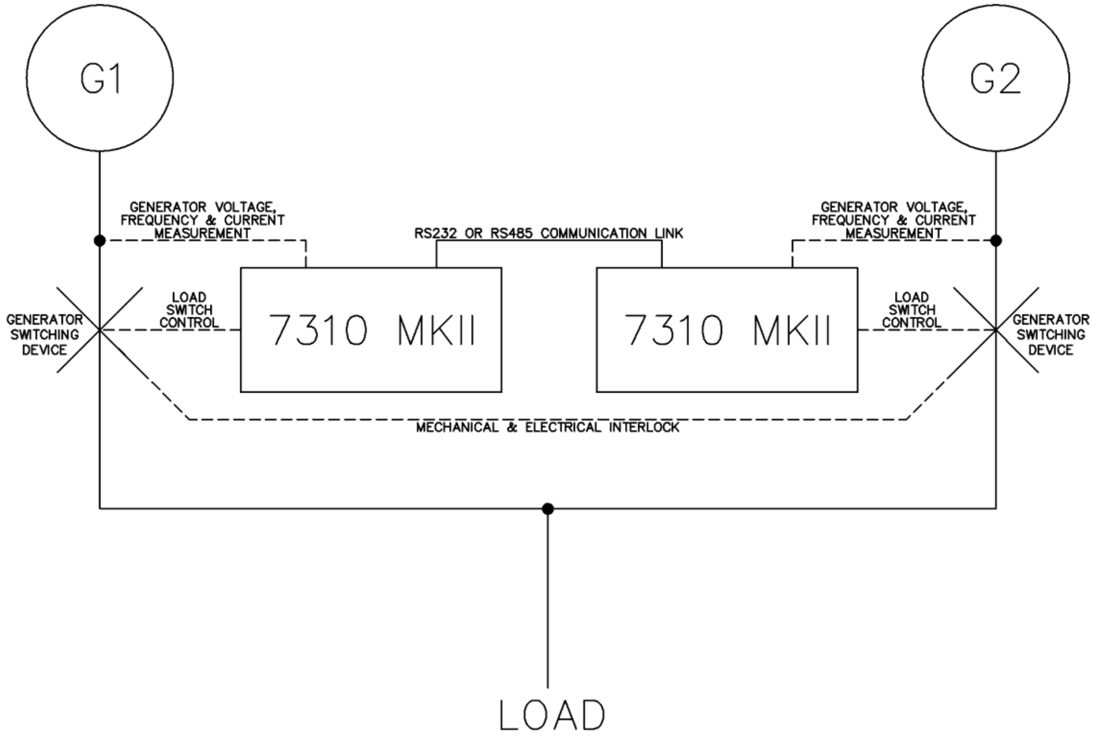
3.3.5.1 ECU PORT

Typically the ECU port on the controller is used for connection to an engine ECU/ECM though depending upon module configuration, may be connected to additional CAN devices.



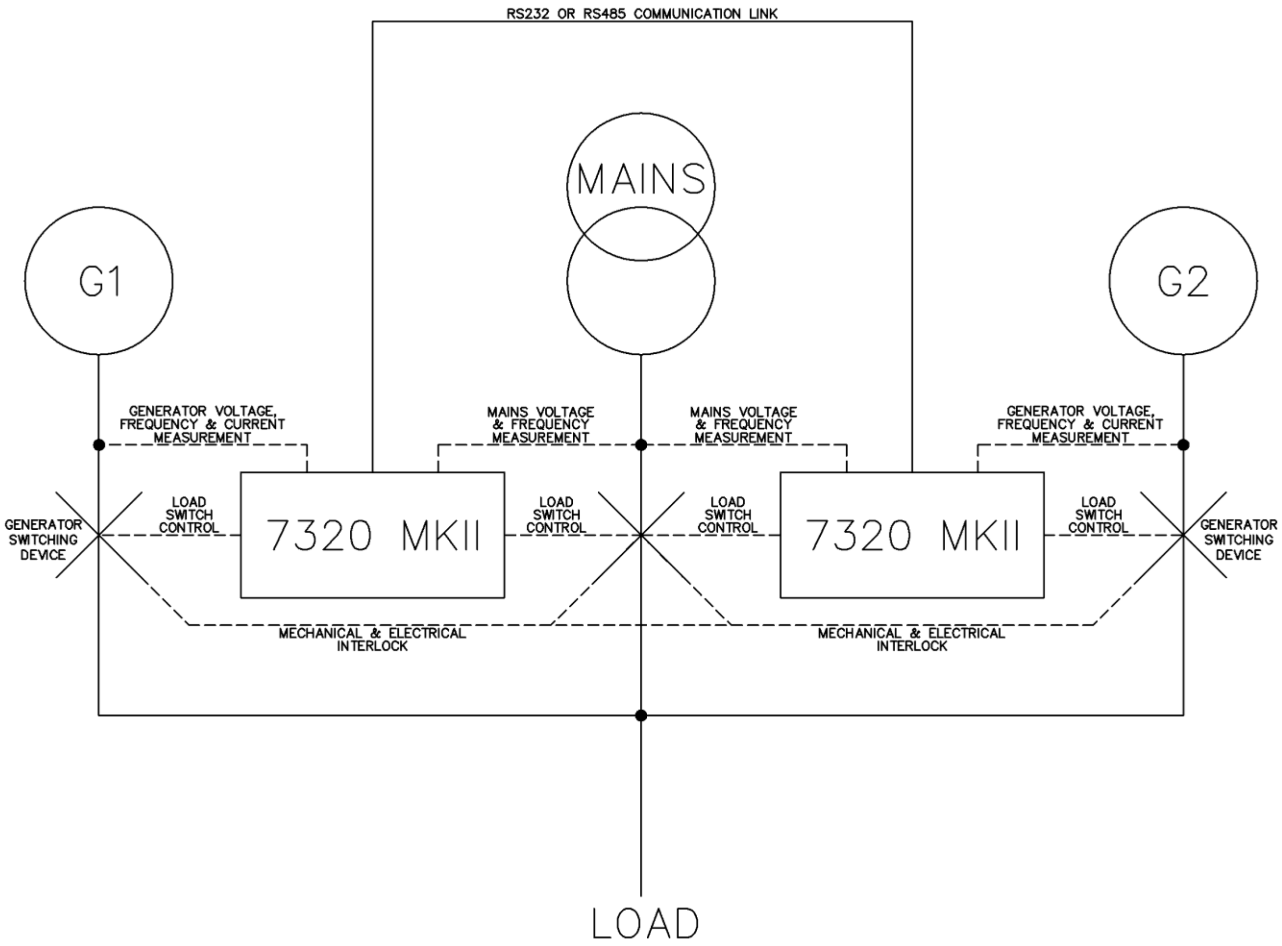
3.3.6 DUAL MUTUAL STANDBY SINGLE LINE DIAGRAMS

3.3.6.1 TWO DSE7310 MKII



3.3.6.2 TWO DSE7320 MKII

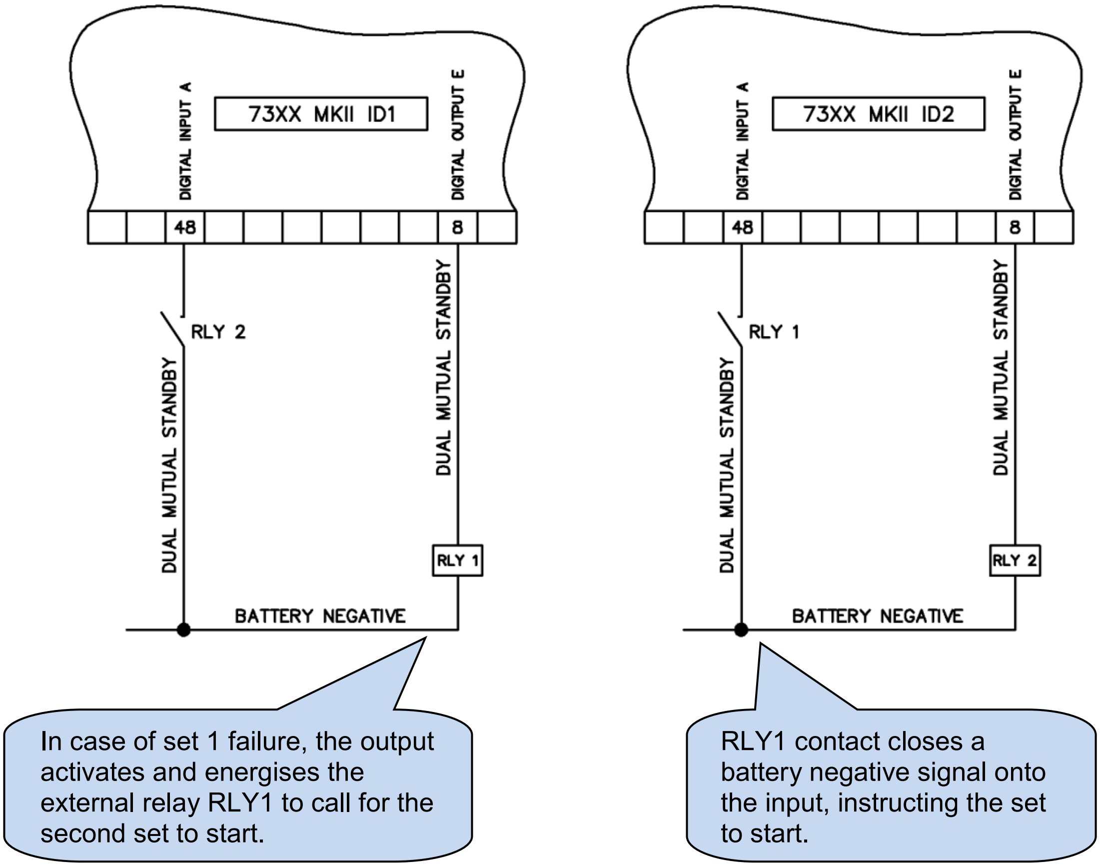
NOTE: Mains load switch control signals are required from both DSE7320 MKII. However, only one DSE7320 MKII control the mains load switch at any time to avoid conflicting control signals. For more details refer to the section entitled *Operation (Dual Mutual Standby)* elsewhere in this document.



3.3.6.3 TWO DSE73XX MKII USING DIGITAL INPUTS AND OUTPUTS

NOTE: The *Dual Mutual Standby* input or output functions are configured on any of the DSE73xx MKII module's Digital Inputs or Digital Outputs.

The hardwired input and output signals between the controllers are used to provide a failsafe for the system. In the event of a module being out of service (battery removed), communication failure or generator failure, the output of that controller de-energises, giving the ok to run signal to the other controller.

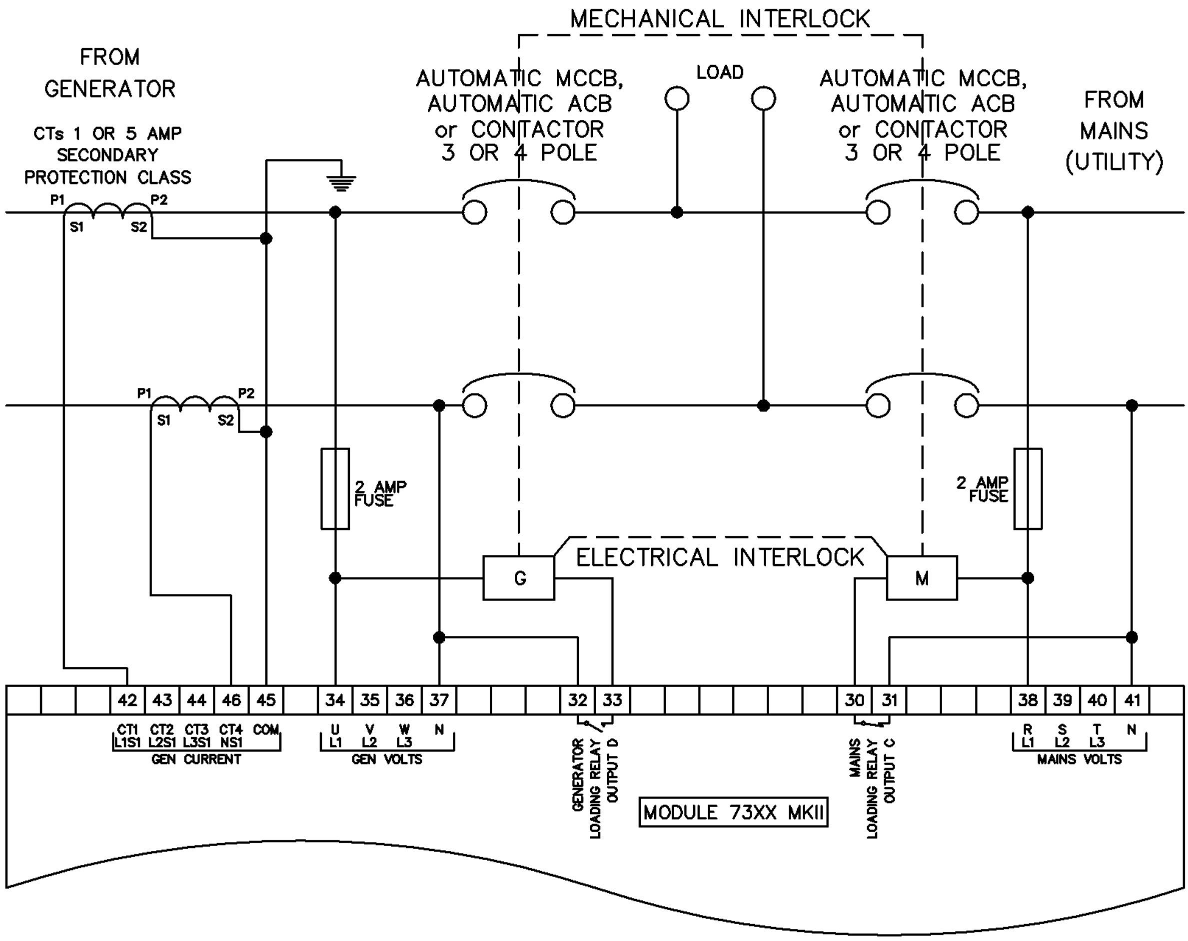


3.4 ALTERNATE TOPOLOGY WIRING DIAGRAMS

3.4.1 SINGLE PHASE 2 WIRE WITH RESTRICTED EARTH FAULT

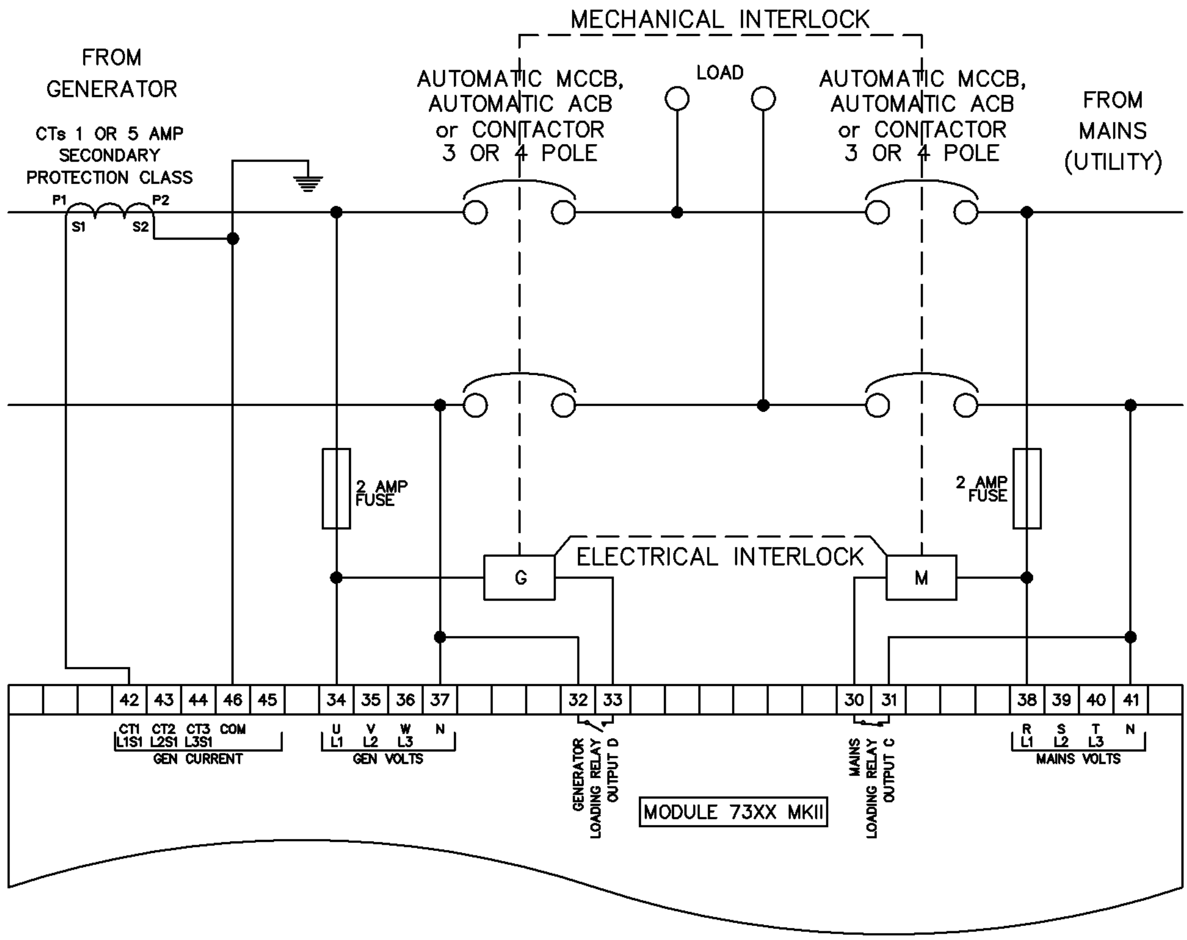
NOTE: Earthing the neutral conductor 'before' the neutral CT allows the module to read earth faults 'after' the CT only (Restricted to load / downstream of the CT)
Earthing the neutral conductor 'after' the neutral CT allows the module to read earth faults 'before' the CT only (Restricted to generator / upstream of the CT)

NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.2 SINGLE PHASE 2 WIRE WITHOUT EARTH FAULT

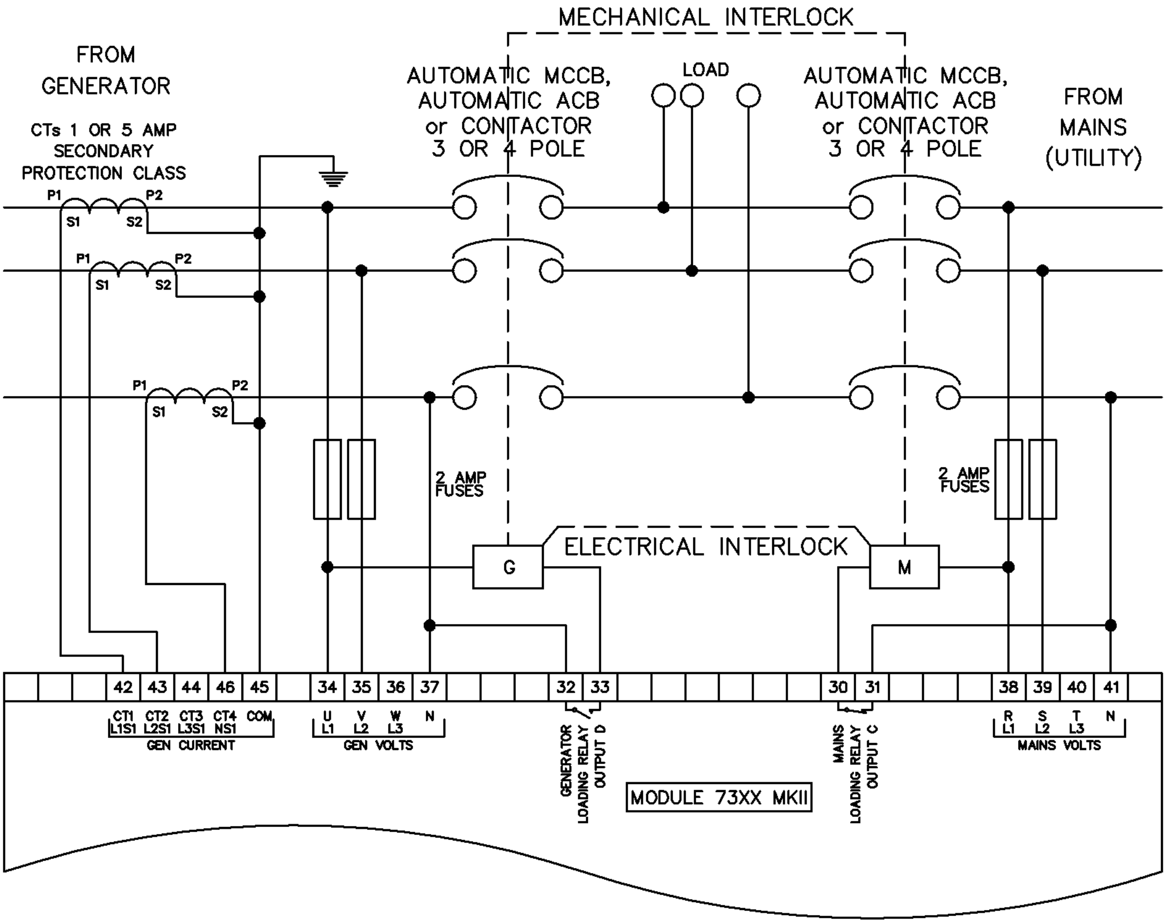
NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.3 SINGLE PHASE (L1 & L2) 3 WIRE WITH RESTRICTED EARTH FAULT

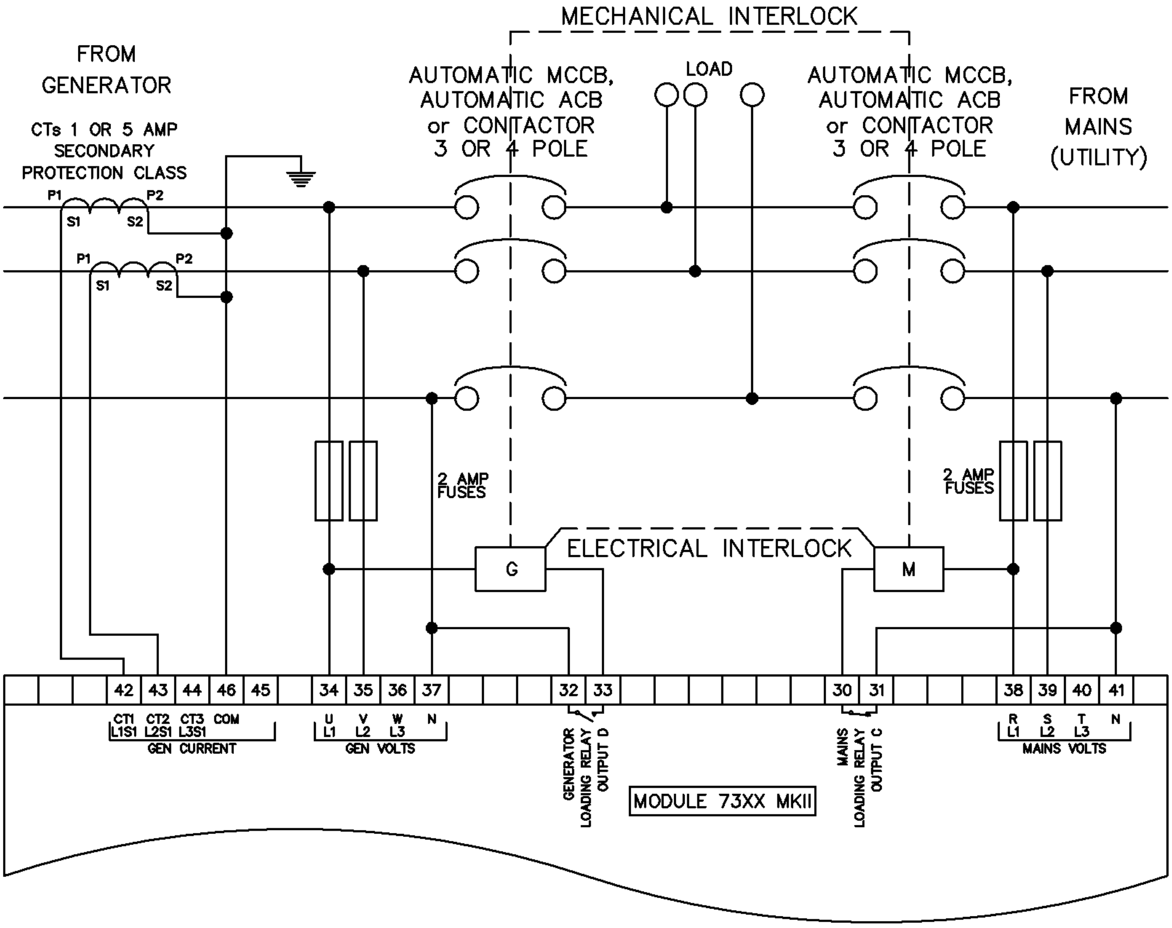
NOTE: Earthing the neutral conductor 'before' the neutral CT allows the module to read earth faults 'after' the CT only (Restricted to load / downstream of the CT)
Earthing the neutral conductor 'after' the neutral CT allows the module to read earth faults 'before' the CT only (Restricted to generator / upstream of the CT)

NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.4 SINGLE PHASE (L1 & L2) 3 WIRE WITHOUT EARTH FAULT

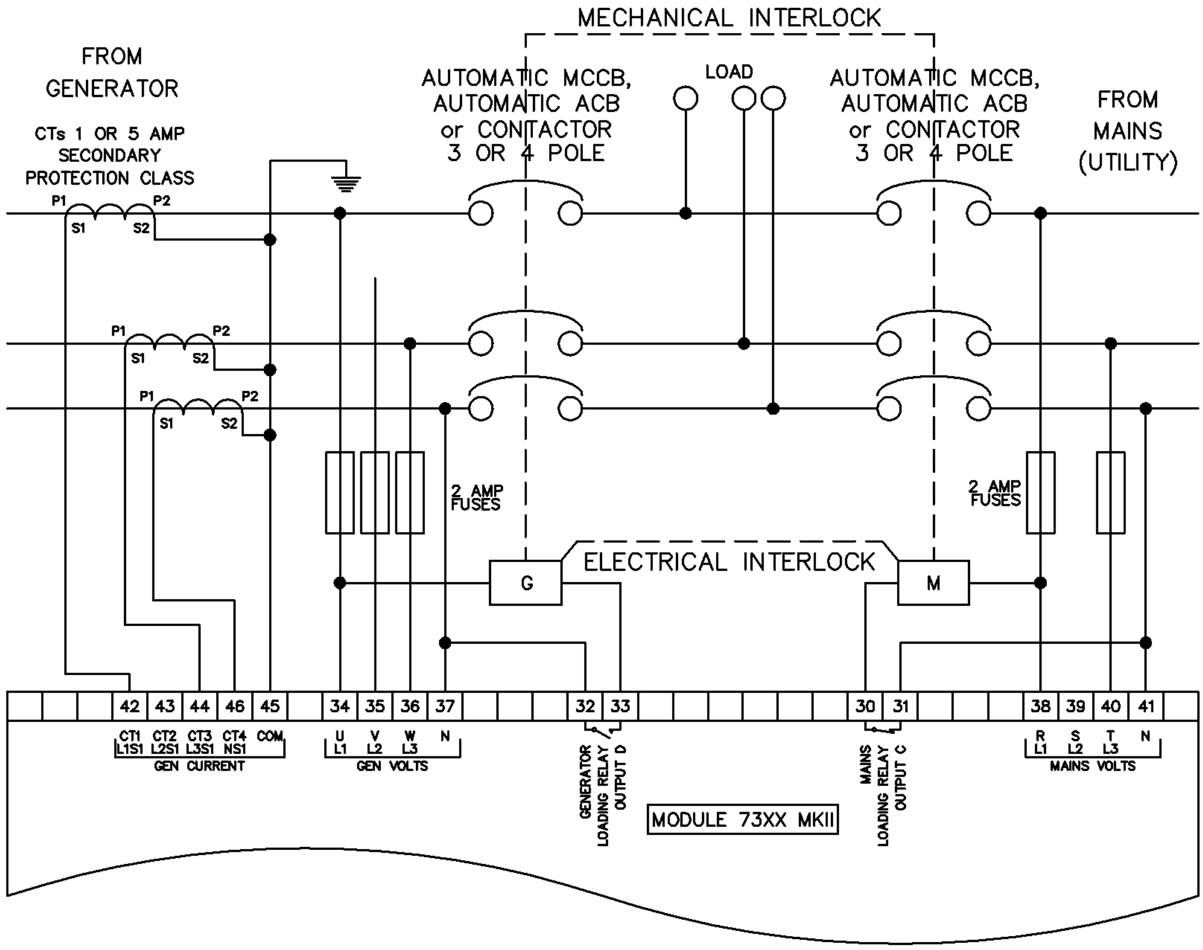
NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.5 SINGLE PHASE (L1 & L3) 3 WIRE WITH EESTRICTED EARTH FAULT

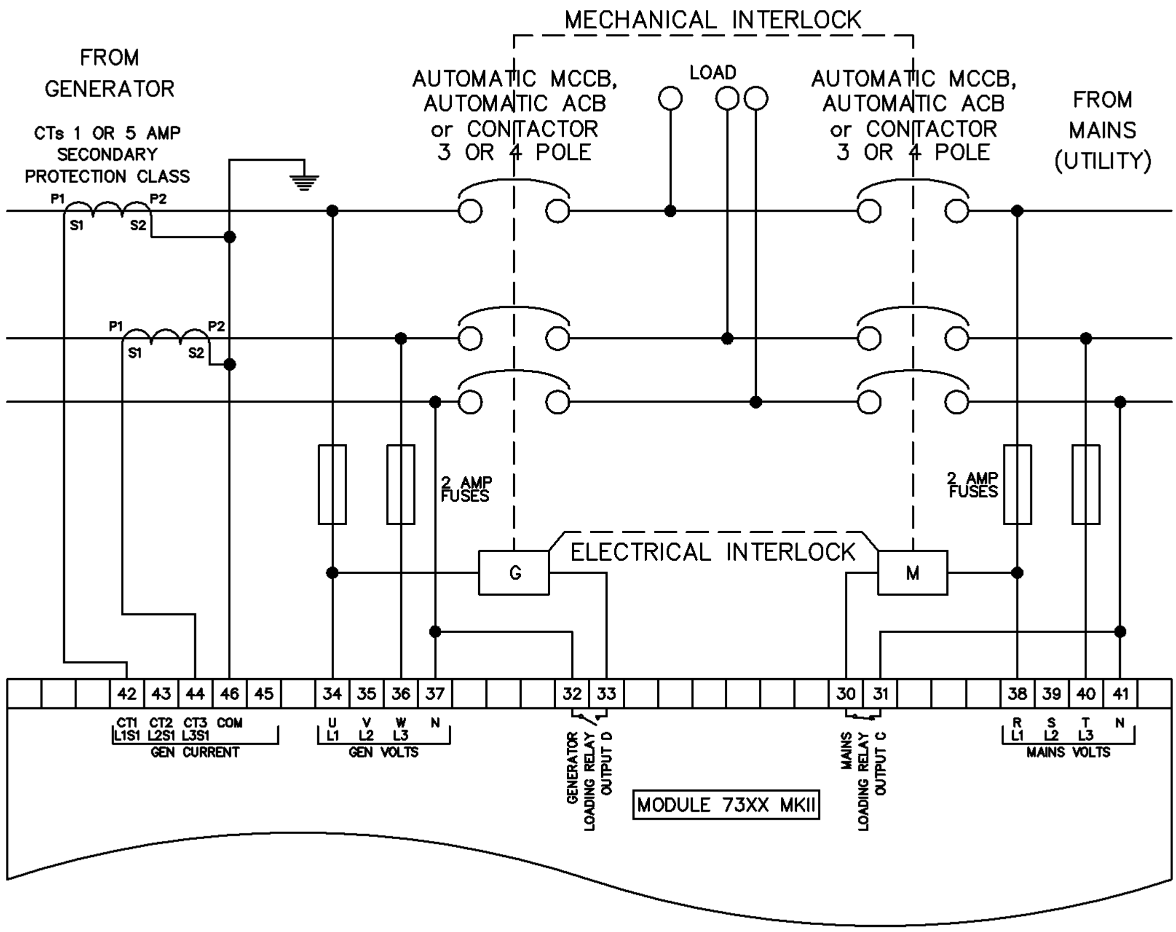
NOTE: Earthing the neutral conductor 'before' the neutral CT allows the module to read earth faults 'after' the CT only (Restricted to load / downstream of the CT)
Earthing the neutral conductor 'after' the neutral CT allows the module to read earth faults 'before' the CT only (Restricted to generator / upstream of the CT)

NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.6 SINGLE PHASE (L1 & L3) 3 WIRE WITHOUT EARTH FAULT

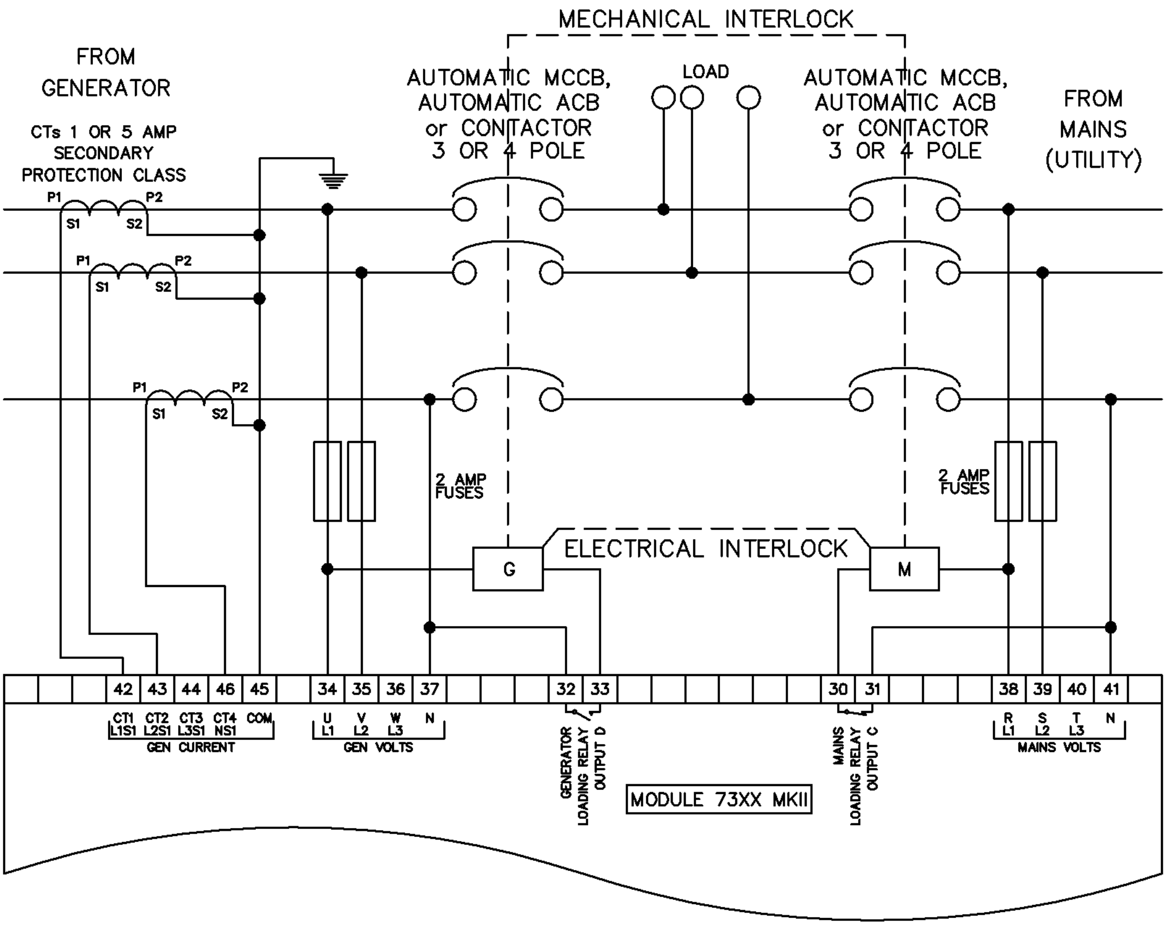
NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.7 2 PHASE (L1 & L2) 3 WIRE WITH RESTRICTED EARTH FAULT

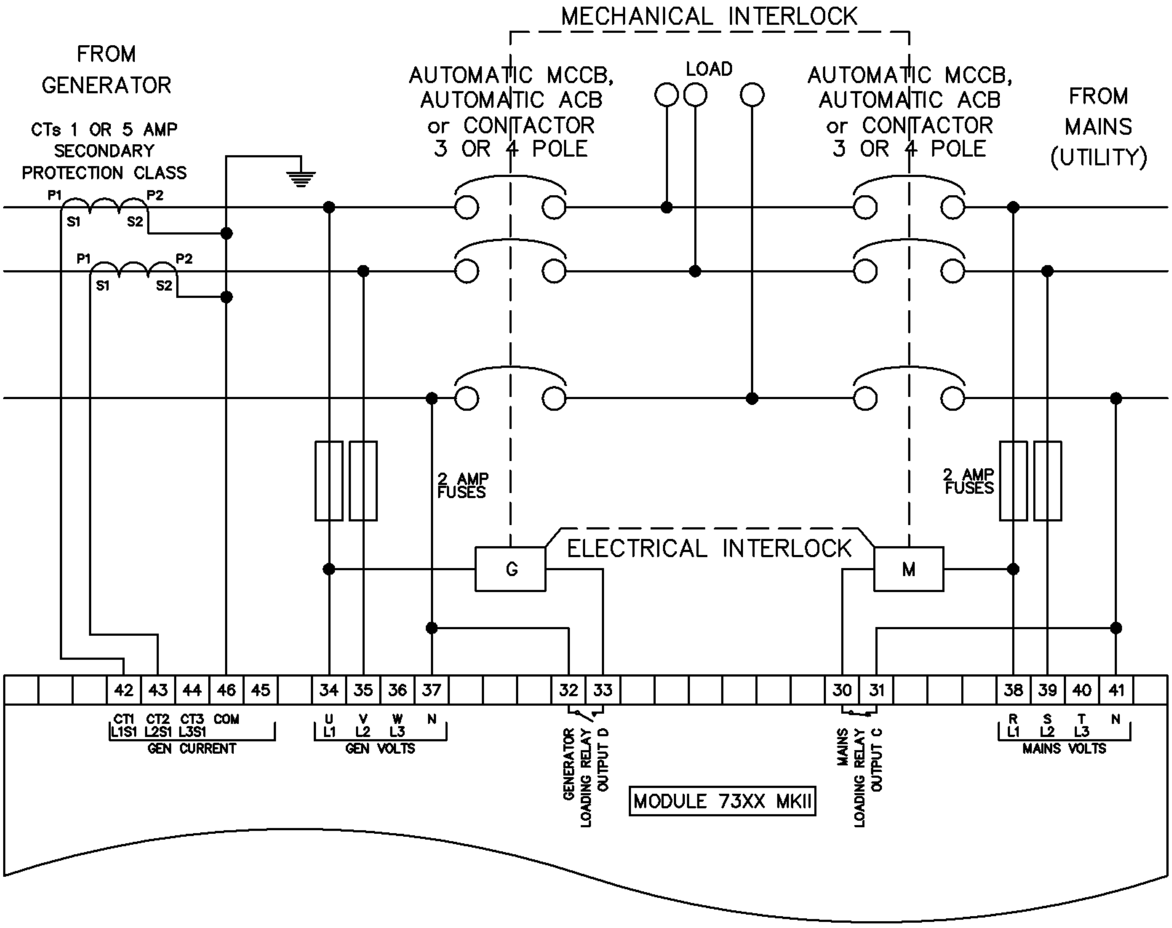
NOTE: Earthing the neutral conductor 'before' the neutral CT allows the module to read earth faults 'after' the CT only (Restricted to load / downstream of the CT)
Earthing the neutral conductor 'after' the neutral CT allows the module to read earth faults 'before' the CT only (Restricted to generator / upstream of the CT)

NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.8 2 PHASE (L1 & L2) 3 WIRE WITHOUT EARTH FAULT

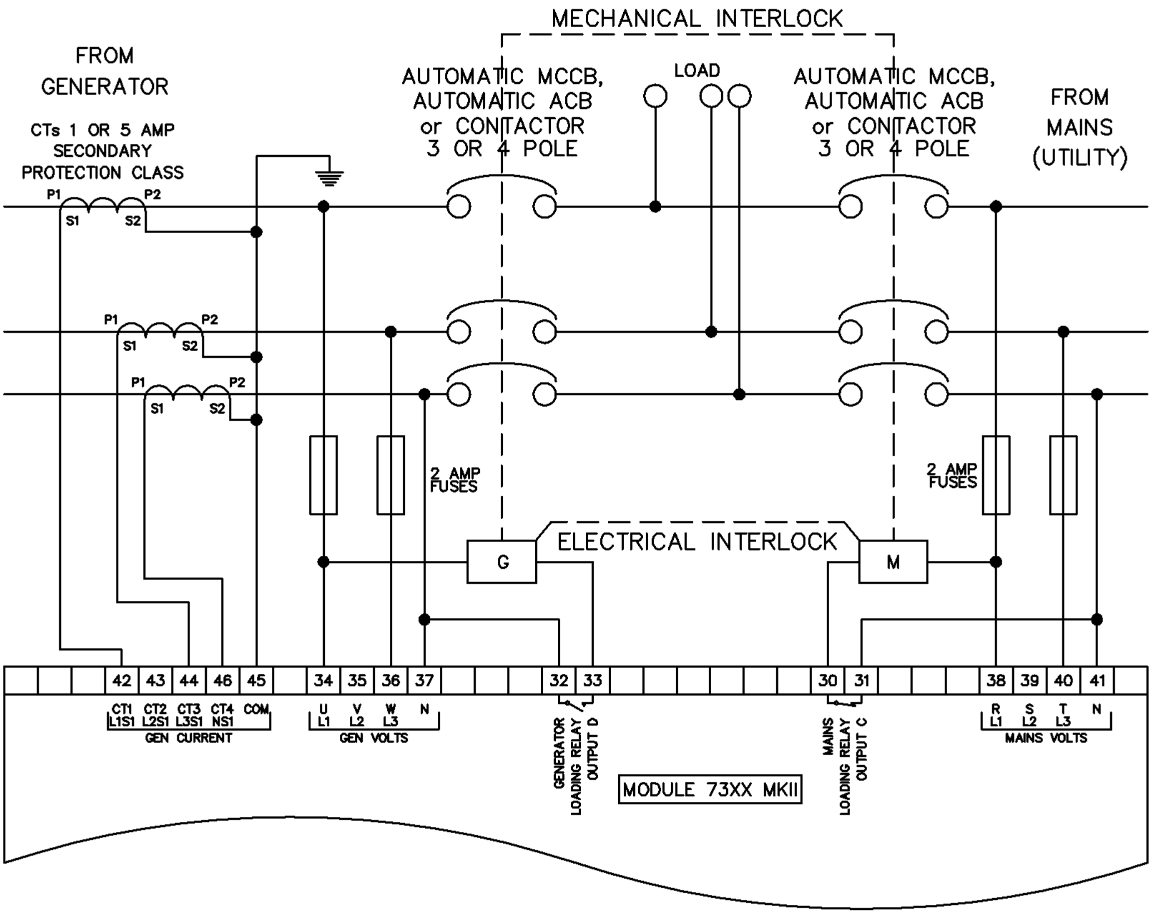
NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.9 2 PHASE (L1 & L3) 3 WIRE WITH RESTRICTED EARTH FAULT

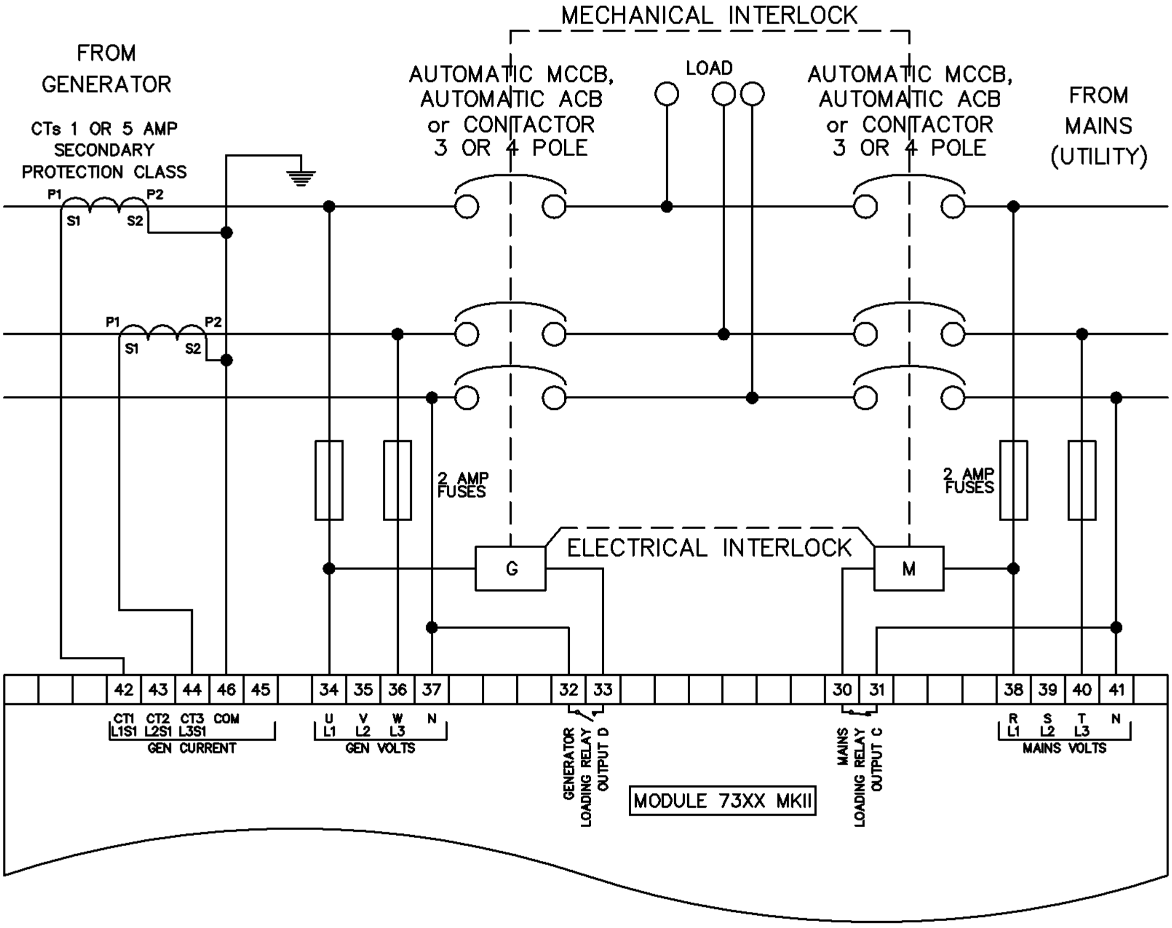
NOTE: Earthing the neutral conductor 'before' the neutral CT allows the module to read earth faults 'after' the CT only (Restricted to load / downstream of the CT)
Earthing the neutral conductor 'after' the neutral CT allows the module to read earth faults 'before' the CT only (Restricted to generator / upstream of the CT)

NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



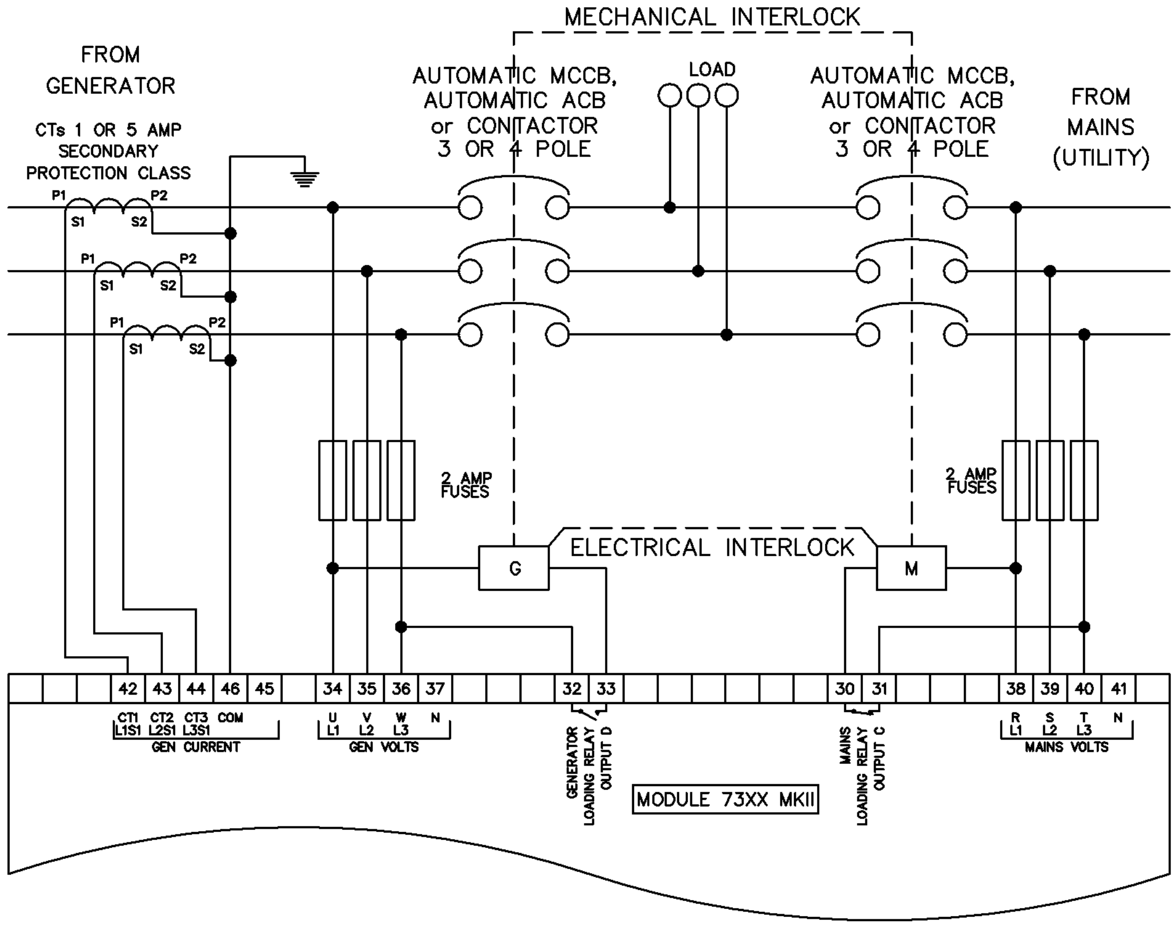
3.4.10 2 PHASE (L1 & L3) 3 WIRE WITHOUT EARTH FAULT

NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.11 3 PHASE 3 WIRE DETLA WITHOUT EARTH FAULT

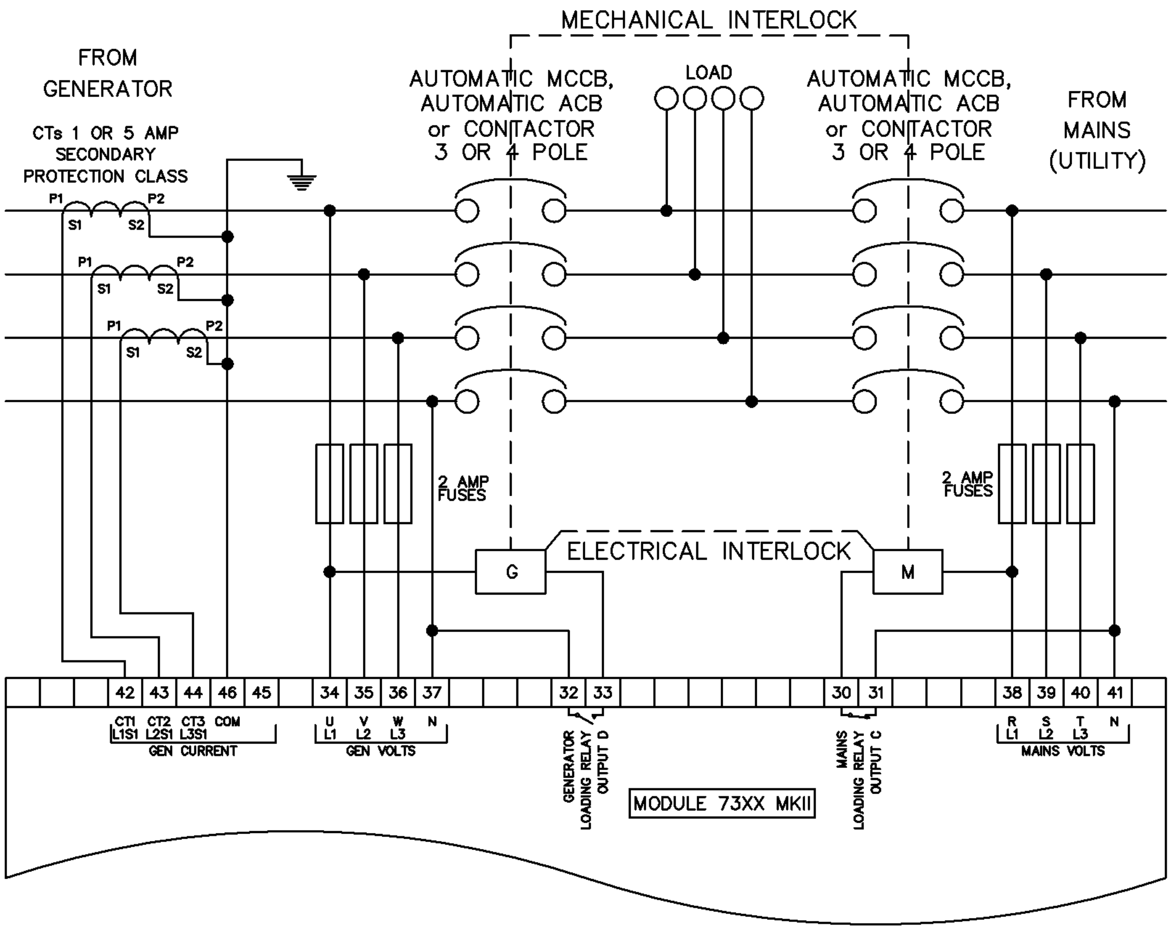
NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.



3.4.12 3 PHASE 4 WIRE WITHOUT EARTH FAULT

NOTE: The below diagram is applicable for the following AC topologies: 3 Phase 4 Wire Star, 3 Phase 4 Wire Delta L1-N-L2, 3 Phase 4 Wire Delta L1-N-L3 and 3 Phase 4 Wire Delta *L2-N-L3*. For further details of module configuration to suit these different topologies, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.

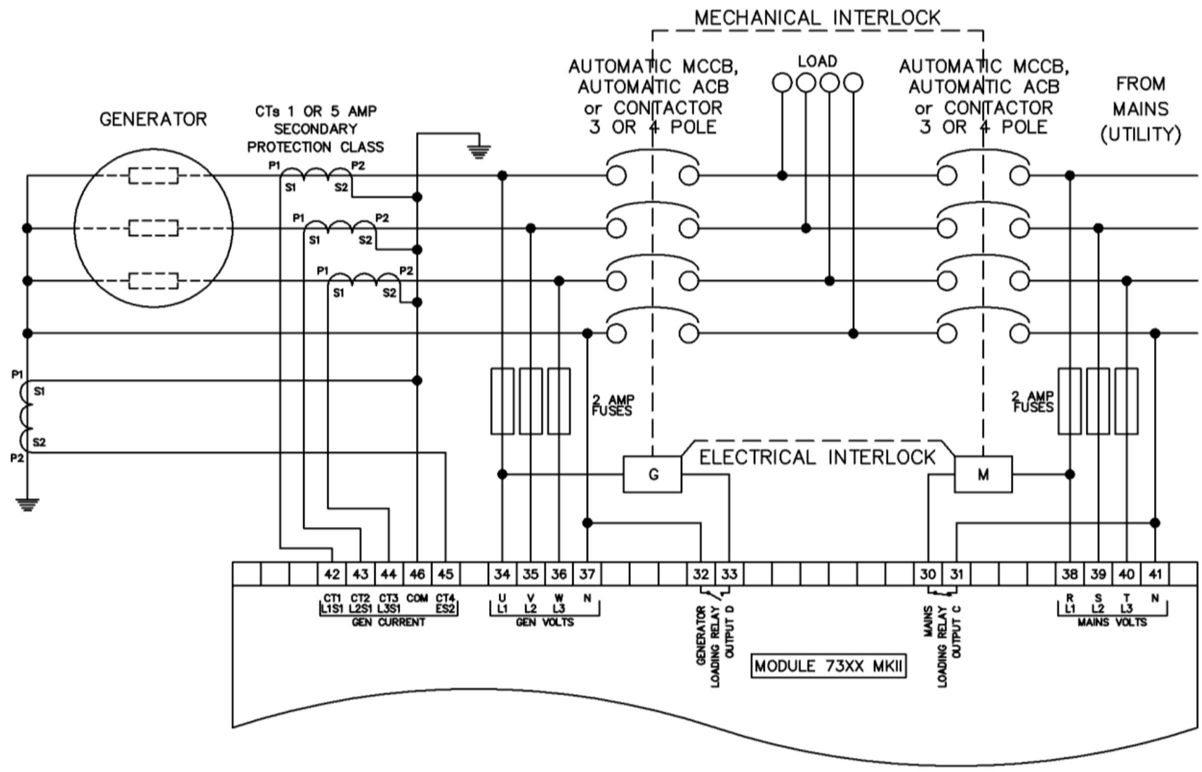


3.4.13 3 PHASE 4 WIRE WITH UNRESTRICTED EARTH FAULT

NOTE: The below diagram is applicable for the following AC topologies: 3 Phase 4 Wire Star, 3 Phase 4 Wire Delta L1-N-L2, 3 Phase 4 Wire Delta L1-N-L3 and 3 Phase 4 Wire Delta *L2-N-L3*. For further details of module configuration to suit these different topologies, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

NOTE: The mains sensing terminals 38 to 41 are not fitted to the DSE7310 MKII.

This example shows the CTs in the neutral to earth link for a three phase four wire system to provide unrestricted earth fault protection but the same philosophy is applicable to the other topologies.



3.4.14 CT LOCATION

NOTE: CT Location is not applicable to DSE7310 MKII.

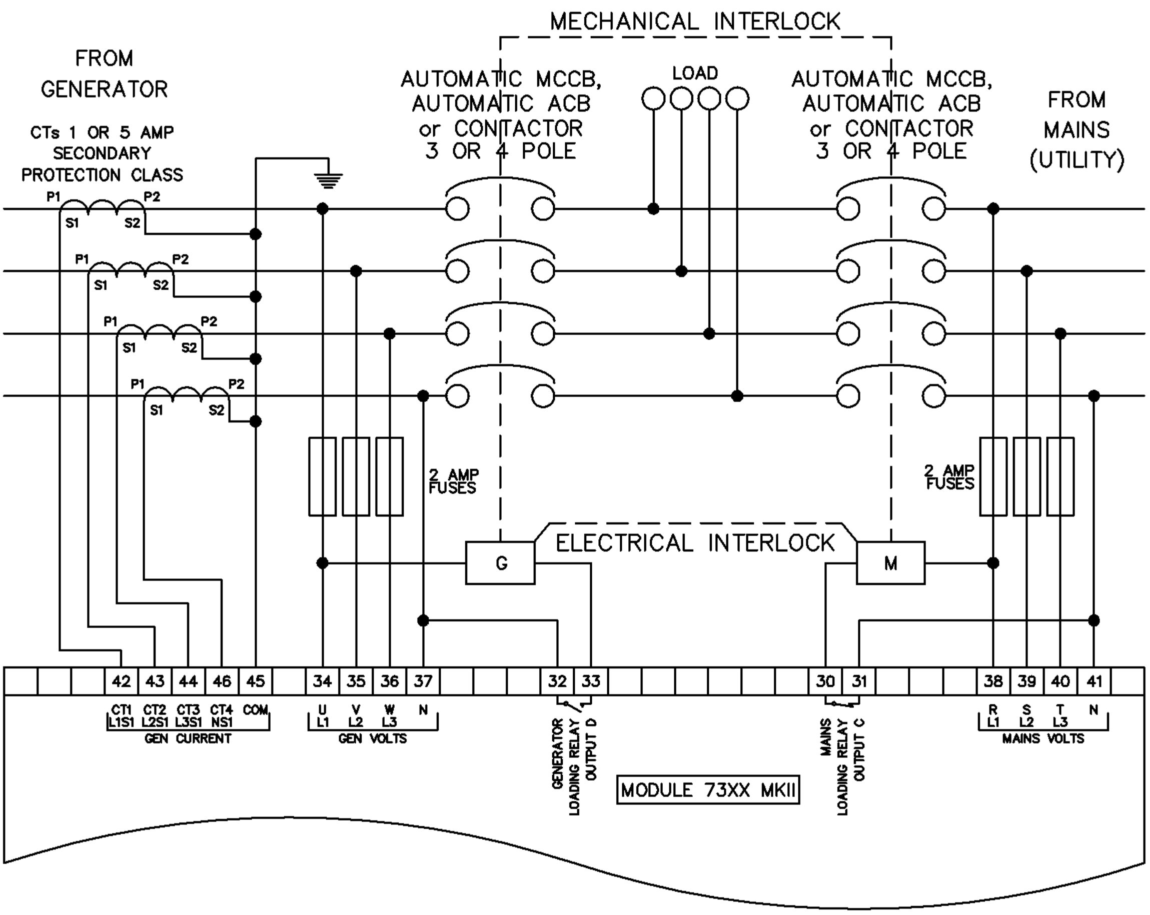
There are two possible locations for the current transformers to be installed in the system:

3.4.14.1 GENERATOR

NOTE: Earthing the neutral conductor 'before' the neutral CT allows the module to read earth faults 'after' the CT only (Restricted to load / downstream of the CT)
Earthing the neutral conductor 'after' the neutral CT allows the module to read earth faults 'before' the CT only (Restricted to generator / upstream of the CT)

NOTE: The below diagram is applicable for the following AC topologies: 3 Phase 4 Wire Star, 3 Phase 4 Wire Delta L1-N-L2, 3 Phase 4 Wire Delta L1-N-L3 and 3 Phase 4 Wire Delta *L2-N-L3*. For further details of module configuration to suit these different topologies, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.*

The CTs are used to measure and display generator current and power only. This example shows the CTs in the generator for a three phase four wire system with restricted earth fault protection but the same philosophy is applicable to the other topologies.

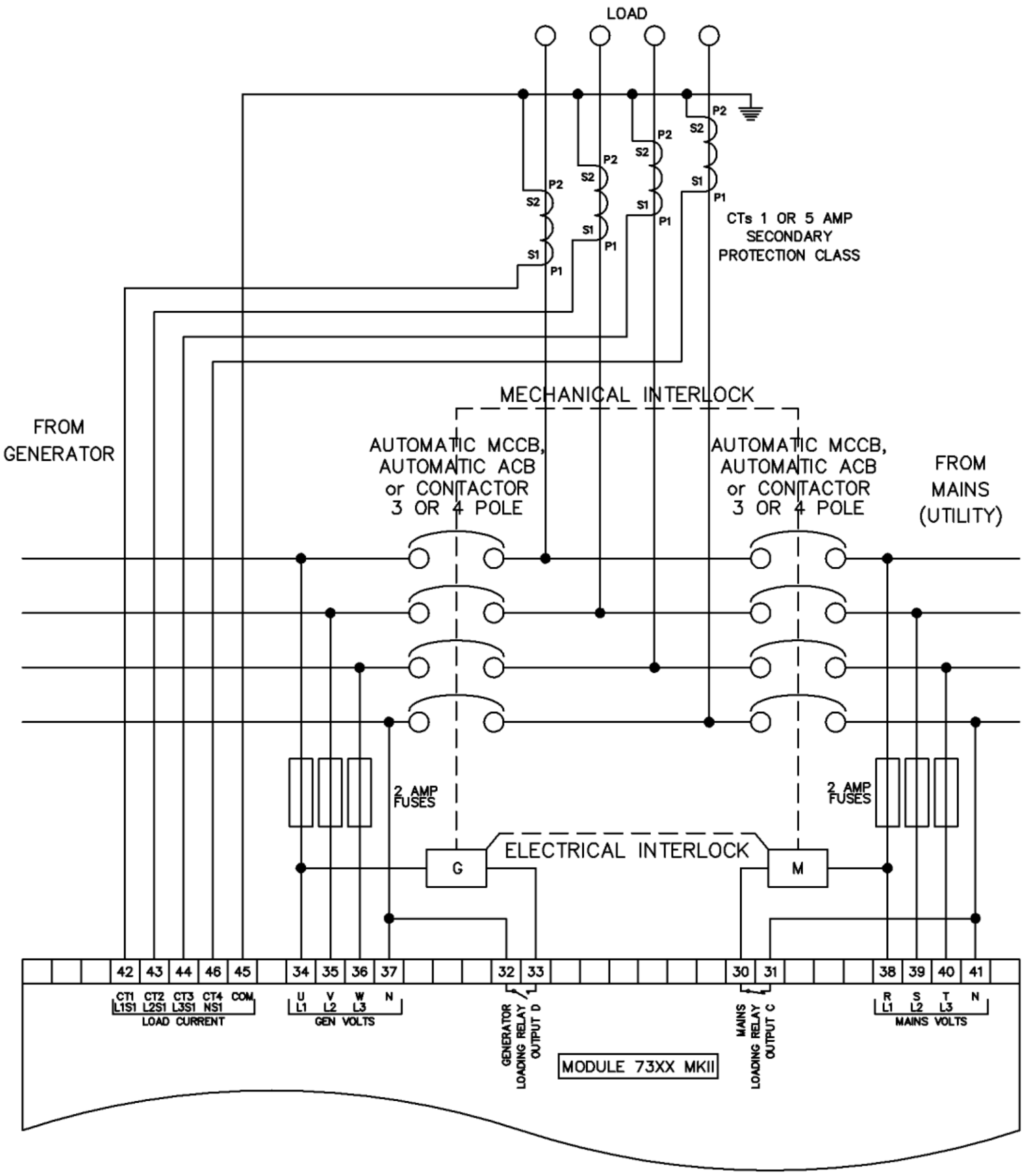


3.4.14.2 LOAD

> **NOTE: Earthing the neutral conductor 'before' the neutral CT allows the module to read earth faults 'after' the CT only (Restricted to load / downstream of the CT)**
> **Earthing the neutral conductor 'after' the neutral CT allows the module to read earth faults 'before' the CT only (Restricted to generator / mains / upstream of the CT)**

> **NOTE: The below diagram is applicable for the following AC topologies: 3 Phase 4 Wire Star, 3 Phase 4 Wire Delta L1-N-L2, 3 Phase 4 Wire Delta L1-N-L3 and 3 Phase 4 Wire Delta *L2-N-L3*. For further details of module configuration to suit these different topologies, refer to DSE Publication: *057-243 DSE7310 MKII & 7320 MKII Configuration Software Manual.***

The CTs are used to measure and display generator current and power when the generator is on load and mains current and power when the mains is on load. The module display automatically changes to display the current and power in the relevant instrumentation page. This example shows the CTs in the 'load' for a three phase four wire system with restricted earth fault protection but the same philosophy is applicable to the other topologies.



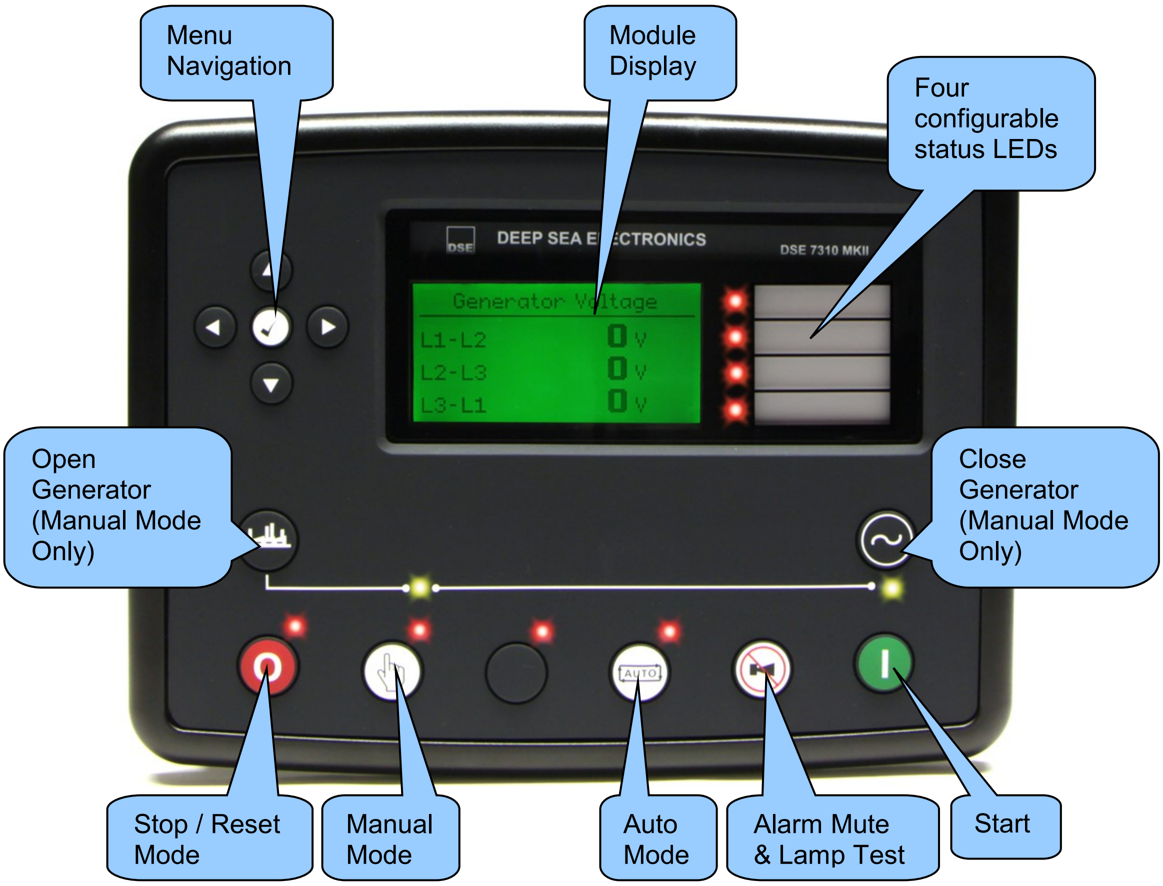
4 DESCRIPTION OF CONTROLS

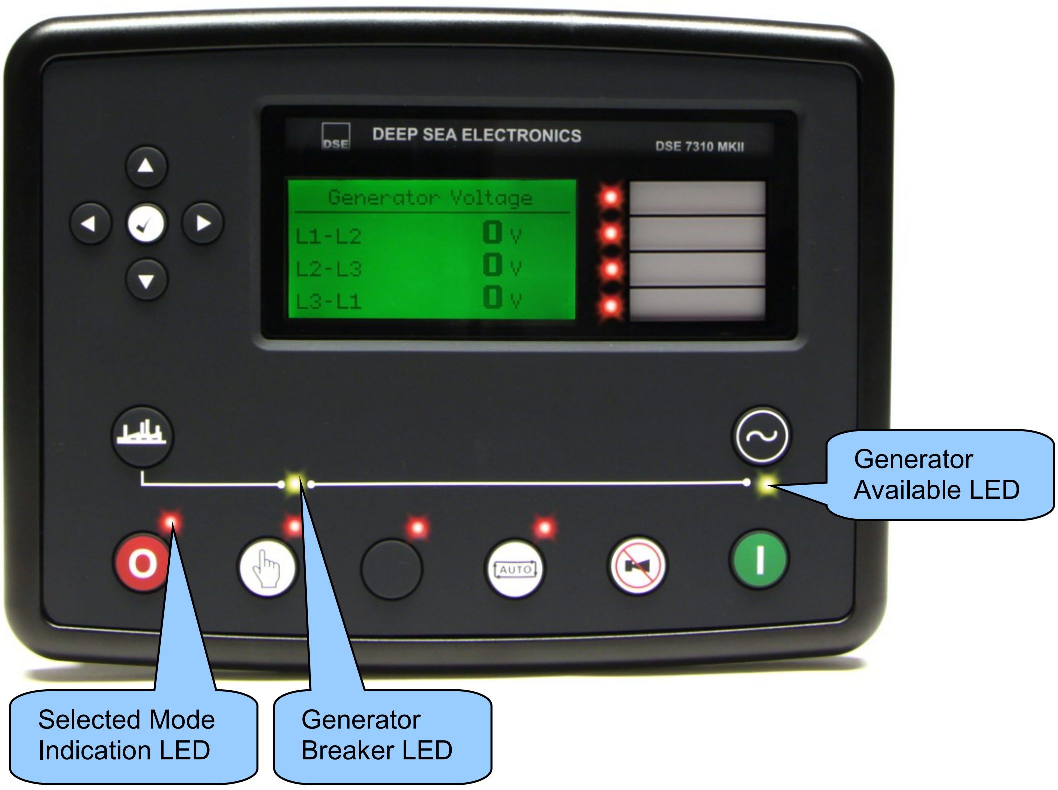
CAUTION: The module may instruct an engine start event due to external influences. Therefore, it is possible for the engine to start at any time without warning. Prior to performing any maintenance on the system, it is recommended that steps are taken to remove the battery and isolate supplies.

NOTE: The following descriptions detail the sequences followed by a module containing the standard 'factory configuration'. Always refer to your configuration source for the exact sequences and timers observed by any particular module in the field.

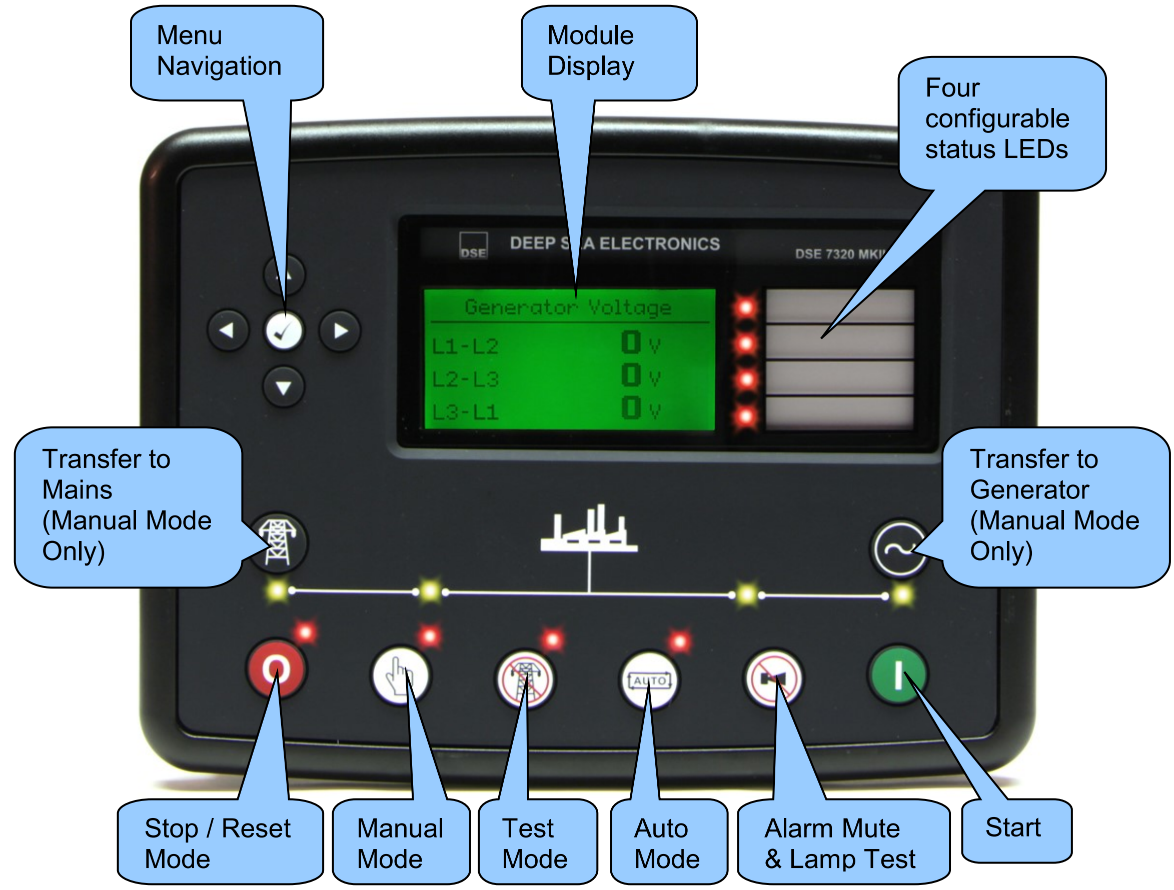
Control of the module is via push buttons mounted on the front of the module with ***Stop/Reset Mode*** , ***Manual Mode*** , ***Test Mode*** (DSE7320 MKII Only), ***Auto Mode*** and ***Start*** functions. For normal operation, these are the only controls which need to be operated. Details of their operation are provided later in this document.

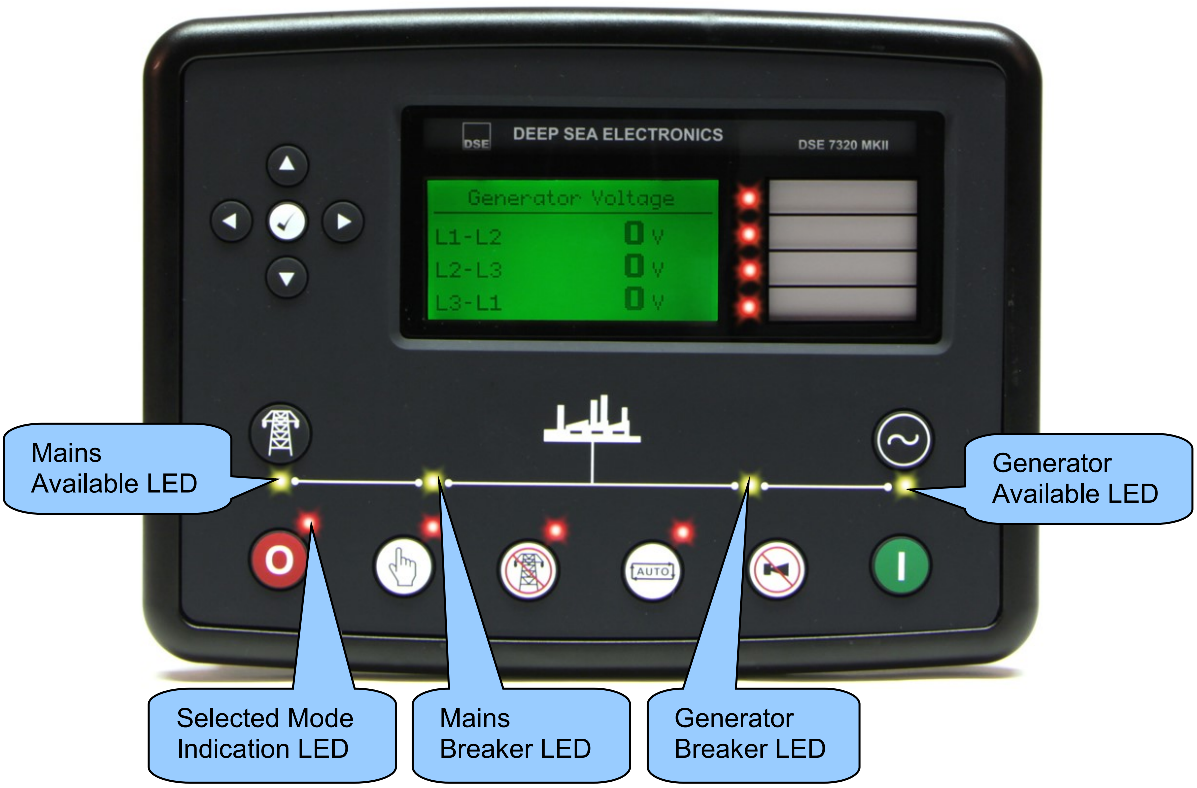
4.1 DSE7310 MKII





4.2 DSE7320 MKII



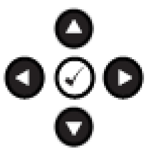


4.3 CONTROL PUSH BUTTONS

NOTE: For further details, see section entitled *Operation* elsewhere in this manual.

Icon	Description
	**Stop / Reset Mode** This button places the module into its ***Stop/Reset Mode***. This clears any alarm conditions for which the triggering criteria has been removed. If the engine is running and the module is put into ***Stop/Reset Mode***, the module automatically instructs the generator off load *(‘**Close Generator Output’** becomes inactive (if used on))* and place the mains on load *(‘**Close Mains Output’** becomes active (DSE7320 MKII)).* The fuel supply de-energises and the engine comes to a standstill. Should any form of *start signal* be present when in ***Stop/Reset Mode*** the generator remains at rest
	**Manual Mode** This button places the module into its ***Manual Mode***. Once in ***Manual Mode***, the module responds to the ***Start*** button to start the generator and run it off load. To place the generator on load, use the ***Transfer to Generator*** button. The module automatically instructs the changeover device to take the mains off load *(‘**Close Mains Output**’ becomes inactive (if used on DSE7320 MKII))* and place the generator on load *(‘**Close Generator Output**’ becomes active (if used)).* To place the generator off load, use the ***Transfer to Mains*** or ***Open Generator*** buttons. The module automatically instructs the changeover device to take the generator off load *(‘**Close Generator Output**’ becomes inactive (if used on))* and place the mains on load *(‘**Close Mains Output**’ becomes active (DSE7320 MKII)).* Additional digital inputs can be assigned to perform these functions. If the engine is running off-load in ***Manual Mode*** and on load signal becomes active, the module automatically instructs the changeover device the changeover device to take the mains off load *(‘**Close Mains Output**’ becomes inactive (if used on DSE7320 MKII))* and place the generator on load *(‘**Close Generator Output**’ becomes active (if used))*. Upon removal of the on load signal, the generator remains on load until either selection of the ***Stop/Reset Mode*** or ***Auto Mode***.
	**Test Mode (DSE7320 MKII Only)** This button places the module into its ***Test Mode***. Once in ***Test Mode***, the module responds to the ***Start*** button to start the generator. Once the set has started and becomes available, it is automatically placed on load (Close Mains Output becomes inactive (if used on DSE7320 MKII) and Close Generator Output becomes active (if used)). The generator remains on load until either the ***Stop/Reset Mode*** or ***Auto Mode*** is selected.

NOTE: For further details, see section entitled *Operation* elsewhere in this manual.

Icon	Description
	**Auto Mode** This button places the module into its ***Auto Mode*** . This mode allows the module to control the function of the generator automatically. The module monitors numerous start requests and when one has been made, the set is automatically started. Once the generator is available, the mains is taken off load *(‘**Close Mains Output**’ becomes inactive (if used on DSE7320 MKII))* and the generator is placed on load *(‘**Close Generator Output**’ becomes active (if used)).* Upon removal of the starting signal, the module starts the *Return Delay Timer* and once expired, takes the generator off load *(‘**Close Generator Output**’ becomes inactive (if used on))* and place the mains on load *(‘**Close Mains Output**’ becomes active (DSE7320 MKII)).* The generator then continues to run for the duration of the *Cooling Timer* until it stops. The module then waits for the next start event.
	**Alarm Mute / Lamp Test** This button silences the audible alarm in the controller, de-activates the *Audible Alarm* output (if configured) and illuminates all of the LEDs on the module’s facia as a lamp test function.
	**Start** This button is only active in the ***Stop/Reset Mode*** , ***Manual Mode*** and Test Mode . Pressing the ***Start*** button in ***Stop/Reset Mode*** powers up the engine’s ECU but does not start the engine. This can be used to check the status of the CAN communication and to prime the fuel system. Pressing the ***Start*** button in ***Manual Mode*** or ***Test Mode*** starts the generator and runs it off load in ***Manual Mode*** or on load in ***Test Mode*** .
	**Menu Navigation** Used for navigating the instrumentation, event log and configuration screens.

NOTE: For further details, see section entitled *Operation* elsewhere in this document.

Icon	Description
	**Transfer To Generator** The ***Transfer to Generator*** button controls the operation of the generator load switch is only active in the ***Manual Mode*** once the generator is available. **'Normal' Breaker Button Control** Pressing the ***Transfer to Generator*** button when the Generator is available and off load, the Mains load switch is opened *('**Close Mains**' becomes inactive)* and the Generator load switch is closed *('**Close Generator**' becomes active)*. Further presses of the ***Transfer to Generator*** button have no effect. **'Alternative' Breaker Button Control** Pressing the ***Transfer to Generator*** button when the Generator is available and off load, the Mains load switch is opened *('**Close Mains**' becomes inactive)* and the Generator load switch is closed *('**Close Generator**' becomes active)*. Further presses of the ***Transfer to Generator*** button opens and closes the Generator load switch *('**Close Generator**' changes state)* and leaves the Mains load switch in the open position *('**Close Mains**' remains inactive)*.
	**Open Generator (DSE7310 MKII Only)** The ***Open Generator*** button is only active in the ***Manual Mode*** and allows the operator to open the generator load switch. Pressing the ***Open Generator*** button when the Generator is on load, the generator load switch is opened *('**Close Generator**' becomes inactive).* Further presses of the ***Open Generator*** button have no effect.
	**Transfer To Mains (DSE7320 MKII Only)** The ***Transfer to Mains*** button controls the operation of the mains load switch and is only active in ***Manual Mode***. **'Normal' Breaker Button Control** Pressing the ***Transfer to Mains*** button when the Mains is available and off load, the generator switch is opened *('**Close Generator**' becomes inactive)* and the mains switch is closed *('**Close Mains**' becomes active)*. Further presses of the ***Transfer to Mains*** button have no effect. **'Alternative' Breaker Button Control** Pressing the ***Transfer to Mains*** button when the Mains is available and off load, the generator load switch is opened *('**Close Generator**' becomes inactive)* and the mains load switch is closed *('**Close Mains**' becomes active)*. Further presses of the ***Transfer to Mains*** button opens and closes the mains load switch *('**Close Mains**' changes state)* and leaves the generator load switch in the open position *('**Close Generator**' remains inactive)*.

4.4 VIEWING THE INSTRUMENT PAGES

> **NOTE: Depending upon the module's configuration, some display screens, or specific instrumentation may be disabled. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.***

It is possible to scroll to display the different pages of information by repeatedly operating the

Next & Previous Page buttons.

If you want to view one of the instrument pages towards the end of the list, it may be quicker to scroll left through the pages rather than right!

Example

Status **Generator** **Mains**

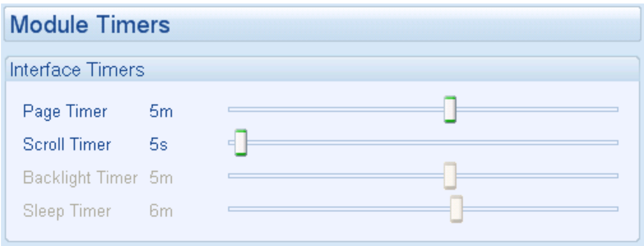
And so on until the desired page is reached. Further presses of the ***Next Page Button*** returns the Status page.

The complete order and contents of each information page are given in the following sections

Once selected, the page remains on the LCD display until the user selects a different page, or after an extended period of inactivity (*LCD Page Timer*), the module reverts to the status display.

If no buttons are pressed upon entering an instrumentation page, the instruments displayed are automatically subject to the setting of the *LCD Scroll Timer*.

The *LCD Page* and *LCD Scroll* timers are configurable using the DSE Configuration Suite Software or by using the Front Panel Editor.



The screenshot shows the factory settings for the timers, taken from the DSE Configuration Suite PC Software.

Alternatively, to scroll manually through all instruments on the currently selected page, press the

Instrumentation Scroll buttons. The 'auto scroll' is disabled.

To re-enable 'auto scroll' press the ***Instrumentation Scroll*** buttons to scroll to the 'title' of the instrumentation page (ie Mains). A short time later (the duration of the *LCD Scroll Timer*), the instrumentation display begins to auto scroll.

When scrolling manually, the display automatically returns to the Status page if no buttons are pressed for the duration of the configurable *LCD Page Timer*.

If an alarm becomes active while viewing the status page, the display shows the Alarms page to draw the operator's attention to the alarm condition.

4.4.1 STATUS

> **NOTE: Press the *Instrumentation Scroll* buttons on the *Status Page* to view other Configurable Status Screens if configured. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.***

This is the 'home' page, the page that is displayed when no other page has been selected, and the page that is automatically displayed after a period of inactivity (*LCD Page Timer)* of the module control buttons.

This page changes with the action of the controller for example when the generator is running and available:

Status	**22:31**
Generator at Rest	
Stop Mode	

Factory setting of *Status* screen showing engine stopped...

Status	**22:31**
Generator Available	

...and engine running

4.4.1.1 GENERATOR LOCKED OUT

Status	**22:31**
Generator Locked Out	

Generator Locked Out indicates that the Generator cannot be started due to an active *Shutdown* or *Electrical Trip Alarm* on the module. Press the ***Next or Previous Page*** button to scroll to the alarms page to investigate. Press the ***Stop/Reset Mode*** button to clear the alarm, if the alarm does not clear the fault is still active.

4.4.1.2 WAITING FOR GENERATOR

> **NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.***

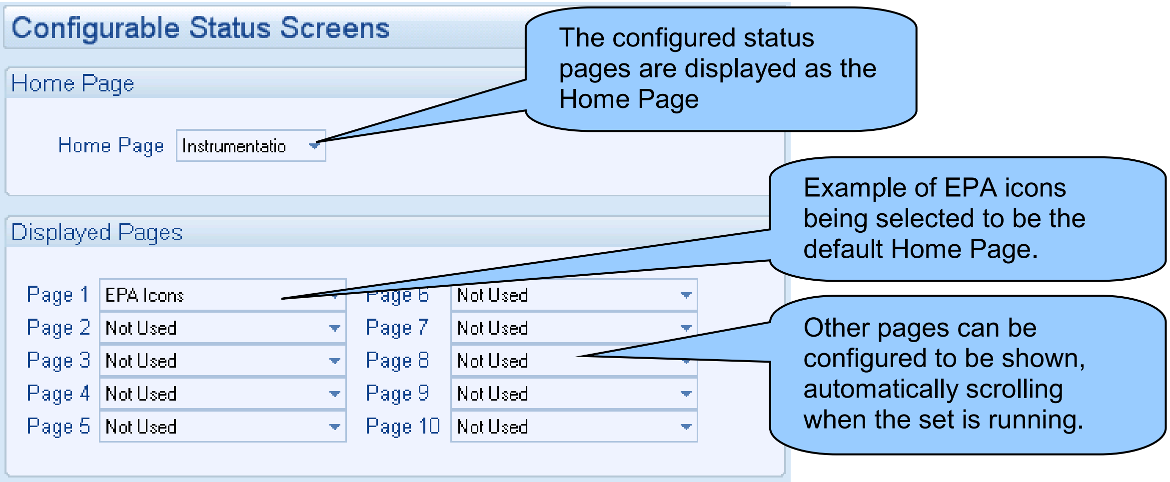
Status	**22:31**
Waiting For Generator	

Waiting For Generator indicates that the Generator has started but has not reached the required *Loading Voltage* and or *Loading Frequency* as set in the module's configuration. Press the ***Next or Previous Page*** buttons to scroll to the *Generator* page to check to see if the generator voltage and frequency is higher then the configured *Loading Voltage* and *Loading Frequency*.

4.4.1.3 CONFIGURABLE STATUS SCREENS

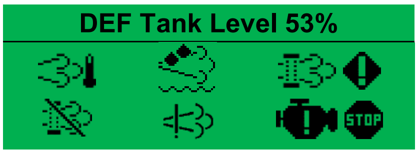
NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

The contents of the Home Page may vary depending upon configuration by the generator manufacturer or supplier. Below is an example of the Home Page being changed to show engine CAN related information.

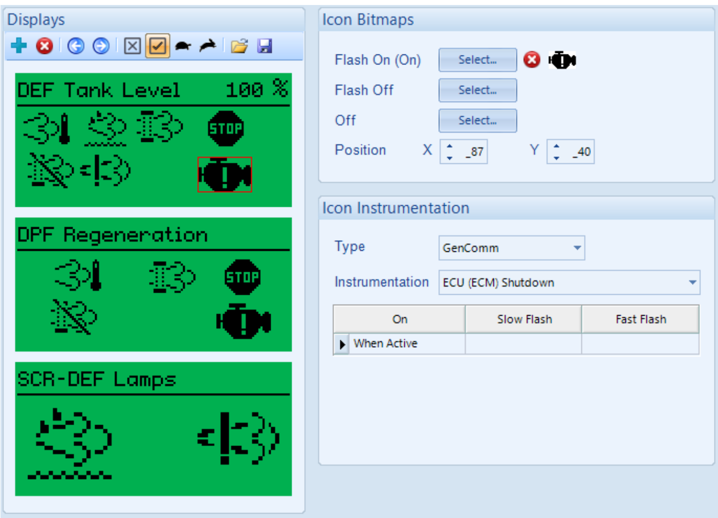


<u>EPA Home Screen Example:</u>

NOTE: The EPA Icons is only available as a *Configurable Status Screen*.



For further information about the default icons, refer to *Engine* section elsewhere in this manual. Depending upon module configuration, the icons displayed and their functions may differ from the default. An example of icon configuration is shown:



4.4.2 ENGINE

NOTE*: For further details of supported engines, refer to DSE Publication: *057-004 Electronic Engines and DSE Wiring Guide.*

These pages contain instrumentation gathered about the engine measured or derived from the module's inputs, some of which may be obtained from the engine ECU.

Engine

1500 RPM

Engine Speed
Oil Pressure
Coolant Temperature
Engine Battery Volts
Engine Run Time
Engine Fuel Level
Oil Temperature*
Coolant Pressure*
Inlet Temperature*
Exhaust Temperature*
Fuel Temperature*
Turbo Pressure*
Fuel Pressure*
After Treatment Fuel Used*
After Treatment Exhaust Gas Temperature*
Engine Reference Torque*
Engine Percentage Torque*
Engine Demand Torque*
Engine Percentage Load*
Accelerator Pedal Position*
Nominal Friction Torque*
Engine Oil Level*
Engine Crank Case Pressure*
Engine Coolant Level*
Engine Injector Rail Pressure*
EGR Flow Rate*
Pre Filter Oil Pressure*
Instant Brake Power (kW) *
Exhaust Gas Temperature*
Turbo Oil Temperature*
ECU Temperature*
Cooling Fan Speed*
Engine Total Revolutions*
Atmospheric Pressure*
Water In Fuel*
Air Inlet Pressure*
Air Filter Differential Pressure*

Continued over page…

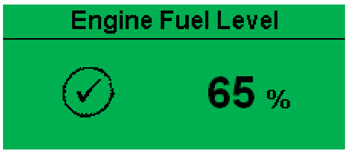
Particulate Trap Pressure*
Manifold Pressure*
Intercooler Level*
Electrical Potential*
Electrical Current*
PGI Information*
ECM Operation*
DPF Regeneration*
DPF Regeneration Lamps*
DPF Soot and Ash Load*
Pre-heat Status*
Engine Rated Power*
Engine Rated Speed*
Idle Speed*
Desired Operation Speed*
DEF Tank Level*
DEF Tank Temperature*
DEF Level Status*
DEF Reagent Consumption*
SCR After Treatment Status*
SCR-DEF Lamps*
SCR Action Timer*
EGR Pressure*
EGR Temperature*
Ambient Air Temperature*
Air Intake Temperature*
ECM Name*
ECM Number*
ECU Shutdown Status*
ECU Lamps ext*
ECU Lamps*
CAN Bus Information*
Fuel Consumption*
Fuel Used*
Flexible Sensors*
Engine Maintenance Alarm 1*
Engine Maintenance Alarm 2*
Engine Maintenance Alarm 3*
Engine Exhaust Temperature*
Intercooler Temperature*
Turbo Oil Pressure*
Fan Speed*
ECU Regeneration*
ECU Regeneration Icons*
Engine Soot Levels*
ECU ECR DEF Icons*
DEF Counter Minimum*
DPF Filter Status*
DPF Regen Inhibit*
DPF Regen Inhibit ET*
Torque Mode*
Instant Fuel Rate*
Gas Fuel Pressure*
Throttle Position*
Engine ECU Link*
Tier 4 Engine Information*
Escape Mode*

4.4.2.1 MANUAL FUEL PUMP CONTROL

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

Depending upon module configuration, the *Fuel Level* page may include a ***Tick*** icon. This denotes that *Manual Fuel Pump Control* is available by pressing and holding the ***Tick*** button.

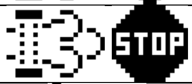
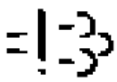
Example:



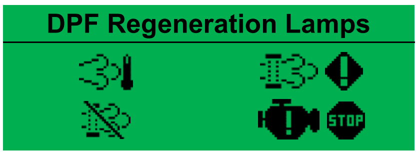
4.4.2.2 DPF REGENERATION LAMPS

> **NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.***

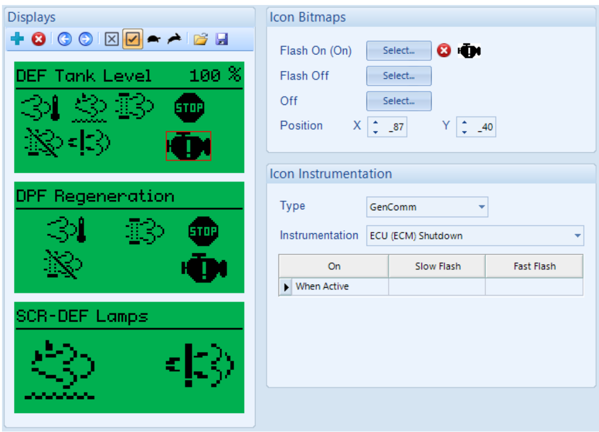
Depending upon the *Engine Type* selected in the module's configuration, the *Engine* section may include the *DPF Regeneration Lamps* page. This page contains icons to show the status of various ECU functions, some of which are applicable to Tier 4 engine requirements. The icons flash at different rates to show the status of the ECU function, refer to the engine manufacturer for more information about this.

Icon	Fault	Description
	**ECU Amber Alarm**	The module received an Amber fault condition from the engine ECU.
	**ECU Red Alarm**	The module received a Red fault condition from the engine ECU.
	**DPF Active**	The module received a fault indication from the engine ECU informing that the *Diesel Particulate Filter* is active.
	**DPF Warning**	The module received a fault condition from the engine ECU informing that the *Diesel Particulate Filter* has a fault condition.
	**DPF Stop**	The module received a fault indication from the engine ECU informing that the *Diesel Particulate Filter* has been stopped.
	**DPF Inhibited**	The module received a fault indication from the engine ECU informing that the *Diesel Particulate Filter* has been inhibited.
	**HEST Active**	The module received a fault indication from the engine ECU informing that the *High Exhaust System Temperature* is active.
	**DEF Low Level**	The module received a fault condition from the engine ECU informing that the *Diesel Exhaust Fluid Low Level* is active.
	**SCR Inducement**	The module received a fault indication from the engine ECU informing that the *Selective Catalytic Reduction Inducement* is active.

Example:



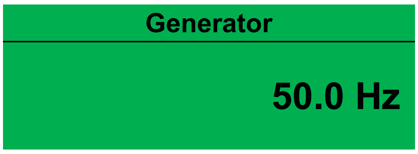
Depending upon module configuration, the icons displayed and their functions may differ from the default as documented above. An example of icon configuration is shown:



4.4.3 GENERATOR

Contains electrical values of the mains (utility), measured or derived from the module's voltage and current inputs.

Press the ***Instrumentation Scroll***  buttons scroll through the ***Generator*** parameters.

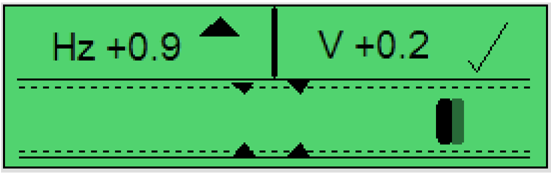


Generator Voltage (ph-N)
Generator Voltage (ph-ph)
Generator Frequency
Generator Current (A)
Generator Load ph-N (kW)
Generator Total Load (kW)
Generator Load ph-N (kVA)
Generator Total Load (kVA)
Generator Single Phase Power Factors
Generator Power Factor Average
Generator Load ph-N (kvar)
Generator Total Load (kvar)
Generator Accumulated Load (kWh, kVAh, kvarh)
Generator Loading Scheme
Generator Phase Rotation
Generator Nominal
Generator Active Configuration

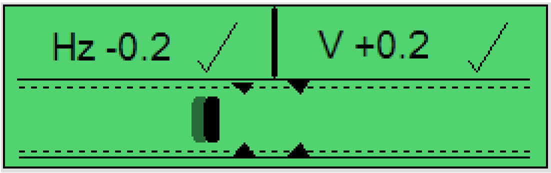
4.4.3.1 SYNCHROSCOPE (DSE7320 MKII ONLY)

NOTE: The *Synchroscope* and associated operation is only available when *Check Sync* has been enabled in the module's configuration. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

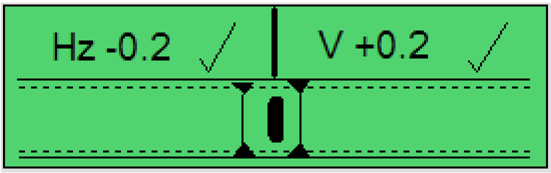
NOTE: If the module display is showing the status page when the synchronising process begins, the module automatically switches to the *Synchroscope* page.



Initially the synchroscope display shows the difference between the bus and generator supplies. Here the display is showing a frequency mismatch of +0.9 Hz and a voltage mismatch of +0.2 V. The genset frequency is too high (indicated by the arrow) and must be reduced. The voltage is high, but is within the check sync limits set for synchronising (indicated by the tick). In most cases, the DSE module then waits for the frequency, voltage and phase to drift into synchronism.



If the DSE module is configured to do so, it actively controls the synchronising using a CANbus engine and CANbus AVR. The module first matches the frequency and voltage and when they are within acceptable limits, the phase matching begins as indicated by the moving bar which shows the phase difference between the two supplies. The engine speed is automatically adjusted, altering the phase, until the moving bar enters the centre of the scope.



Once the supplies are in sync, the module initiates a breaker close signal placing the two supplies in parallel. If synchronism is broken or not achieved, the moving bar passes out of the synchronising window.

4.4.4 MAINS (DSE7320 MKII ONLY)

NOTE*: Mains current and powering monitoring is only available when the CTs are configured for, and placed in the load. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

Contains electrical values of the mains (utility), measured or derived from the module's voltage and current inputs.

Press the ***Instrumentation Scroll***  buttons scroll through the ***Mains*** parameters.

Mains

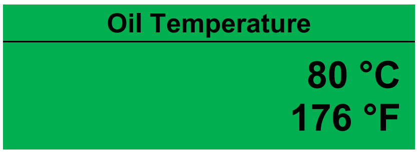
50.0 Hz

Mains Voltage (ph-N)
Mains Voltage (ph-ph)
Mains Frequency
Mains Current (A)*
Mains Phase Rotation
Mains Active Configuration
Mains Load ph-N (kW)*
Mains Total Load (kW)*
Mains Load ph-N (kVA)*
Mains Total Load (kVA)*
Mains Single Phase Power Factors*
Mains Average Power Factor*
Mains Load ph-N (kvar)*
Mains Total Load (kvar)*
Mains Accumulated Load (kWh, kVAh, kvarh)*

4.4.5 EXPANSION

Contains measured values from various input expansion modules that are connected to the DSE module.

Press the ***Instrumentation Scroll***  buttons scroll through the ***Expansion*** parameters if configured.

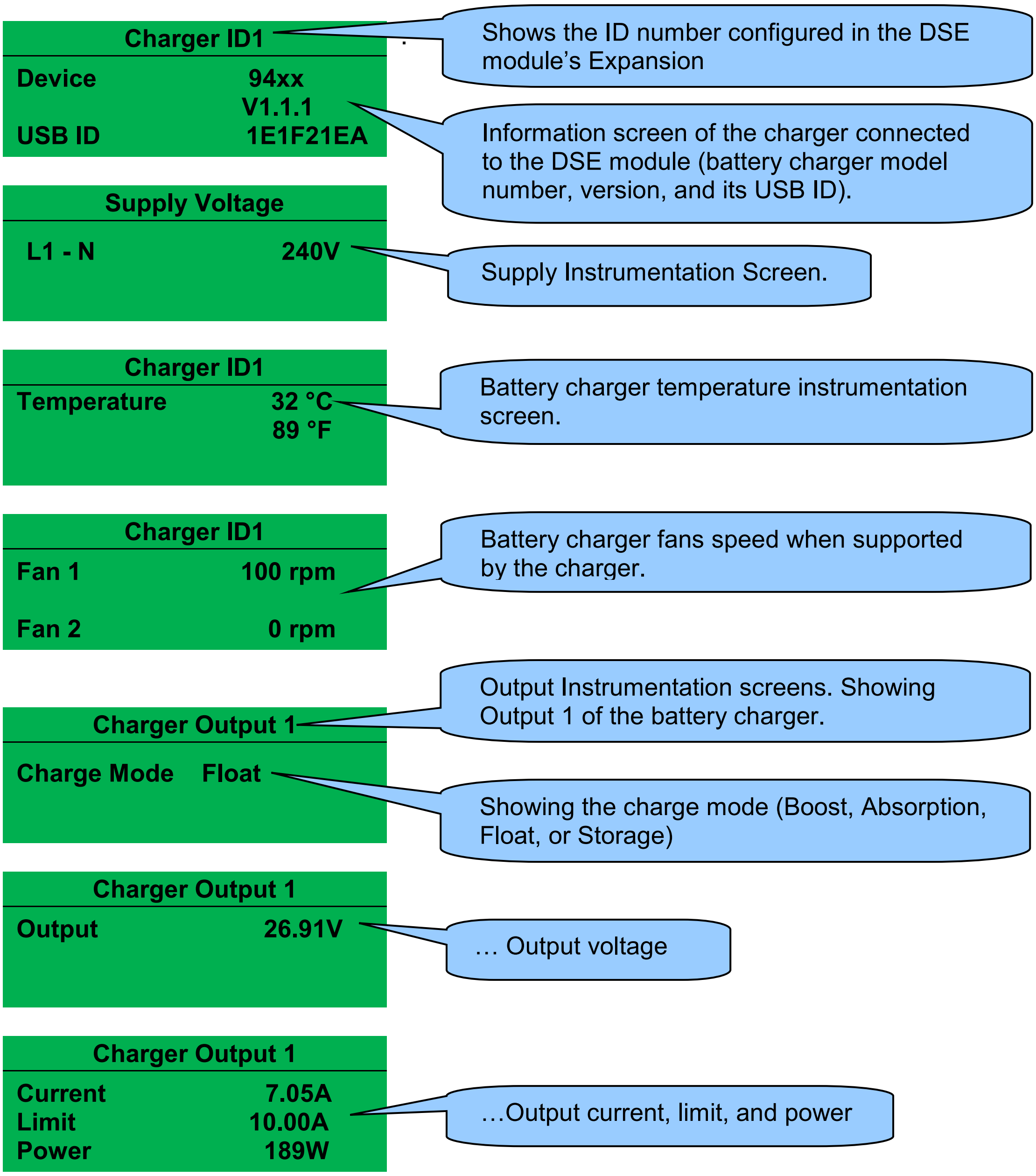


DSE2130 Analogue Inputs (Only appears if configured)
DSE2131 Analogue Inputs (Only appears if configured)
DSE2133 RTD / Thermocouple Inputs (Only appears if configured)

4.4.5.1 CHARGER

Contains the information and instrumentation of the DSE Intelligent Battery Chargers that are connected to the DSE controller.

Press the ***Instrumentation Scroll*** buttons scroll through the ***Charger*** parameters if configured.

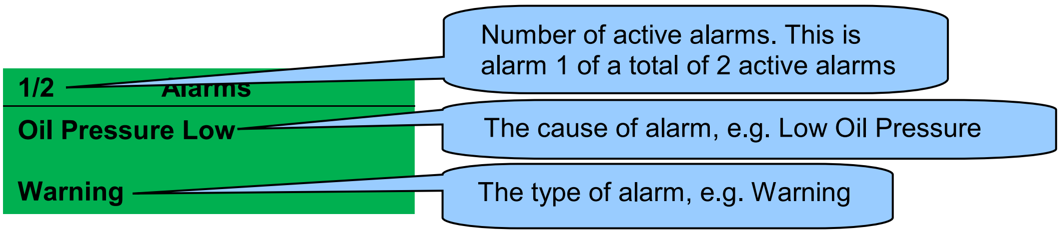


4.4.6 ALARMS

When an alarm is active, the *Internal Audible Alarm* sounds and the Common Alarm LED, if configured, illuminates.

The audible alarm is silenced by pressing the ***Alarm Mute / Lamp Test*** button.

The LCD display jumps from the 'Information page' to display the Alarm Page



The LCD displays multiple alarms such as "*Coolant Temperature High*", "*Emergency Stop*" and "*Low Coolant Warning*". These automatically scroll in the order that they occurred or press the ***Instrumentation Scroll*** buttons scroll through manually.

In the event of an alarm, the LCD displays the appropriate text. If an additional alarm then occurs, the module displays the appropriate text.

Example:

1/2 Alarms
Low Oil Pressure
Warning

2/2 Alarms
Coolant Temp High
Shutdown

4.4.6.1 ECU ALARMS (CAN FAULT CODES / DTC)

NOTE: For details on these code/graphic meanings, refer to the ECU instructions provided by the engine manufacturer, or contact the engine manufacturer for further assistance.

NOTE: For further details on connection to electronic engines, refer to DSE Publication: *057-004 Electronic Engines And DSE Wiring*

When connected to a suitable CAN engine, the controller displays alarm status messages from the ECU in the *Alarms* section of the display.

1/1 Alarms
ECU Amber

Warning

Type of alarm that is triggered on the DSE module, e.g. Warning

Press the ***Next Page*** button to access the list of *Current Engine DTCs* (Diagnostic Trouble Codes) from the ECU which are DM1 messages.

1/2 ECU Current DTCs
Water Level Low

SPN=131166 , FMI=8, OC=127

The DM1 DTC is interpreted by the module and is shown on the module's display as a text message. In addition to this, the manufacturer's DTC is shown below.

Press the ***Next Page*** button to access the list of *ECU Prev. DTCs* (Diagnostic Trouble Codes) from the ECU which are DM2 messages.

1/10 ECU Prev. DTCs
Water Level Low

SPN=131166 , FMI=8, OC=127

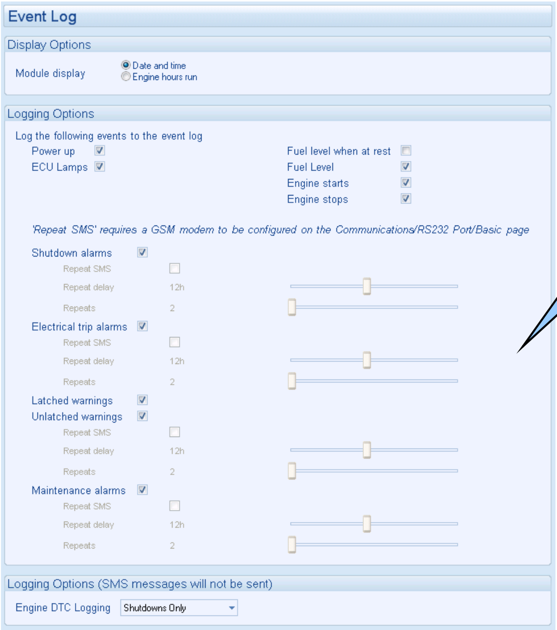
The DM2 DTC is interpreted by the module and is shown on the module's display as a text message. In addition to this, the manufacturer's DTC is shown below.

4.4.7 EVENT LOG

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

The module maintains a log of past alarms and/or selected status changes.
The log size has been increased in the module over past module updates and is always subject to change. At the time of writing, the modules log is capable of storing the last 250 log entries.

Under default factory settings, the event log is configured to include all possible options; however, this is configurable by the system designer using the DSE Configuration Suite software.

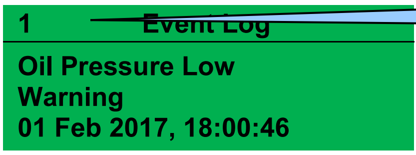


Example showing the possible configuration of the event log (DSE Configuration Suite Software).

This also shows the factory settings of the module.

When the event log is full, any subsequent event overwrites the oldest entry. Hence, the event log always contains the most recent events. The module logs the event type, along with the date and time (or engine running hours if configured to do so).

To view the event log, repeatedly press the ***Next or Previous Page*** buttons until the LCD screen displays the *Event Log* page.



This is event 1

Press the ***Scroll Down*** button to view the next most recent event.

Continuing to press the ***Scroll Down*** button cycles through the past events after which, the display shows the most recent alarm and the cycle begins again.

To exit the event log and return to viewing the instruments, press the ***Next or Previous Page*** buttons to select the next instrumentation page.

4.4.8 SERIAL PORT

4.4.8.1 RS232 SERIAL PORT

This section is included to give information about the RS232 serial port and external modem (if connected).

The items displayed on this page change depending upon configuration of the module. Refer to the system supplier for further details.

> **NOTE: Factory Default settings are for the RS232 port to be enabled with no modem connected, operating at 19200 baud, MODBUS slave address 10.**

<u>Connected To an RS232 Telephone Modem</u>

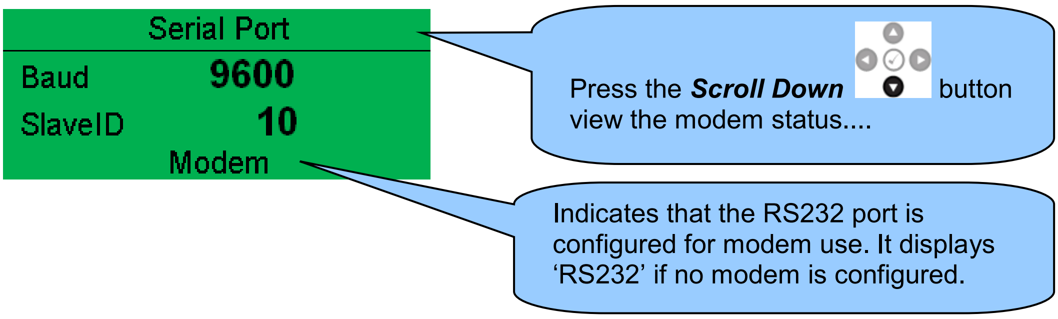
When the module is powered up, it sends 'initialisation strings' to the connected modem. It is important therefore that the modem is already powered, or is powered up at the same time as the module. At regular intervals after power up, the modem is reset, and reinitialised, to ensure the modem does not 'hang up'.

If the module does not correctly communicate with the modem, "Modem initialising' appears on the Serial Port instrument screen as shown overleaf.

If the module is set for "incoming calls" or for "incoming and outgoing calls", once the modem is dialled, it answers after two rings (using the factory setting 'initialisation strings). Once the call is established, all data is passed between the dialling PC and the module.

If the module is set for "outgoing calls" or for "incoming and outgoing calls", then the module dials out whenever an alarm is generated.

> **NOTE: Not all alarms generate a dial out command; this is dependant upon module configuration of the event log. Any event configured to be recorded in the event log causes the modem to dial out to a PC.**



Connected to an RS232 GSM Modem

When the module is powered up, it sends 'initialisation strings' to the connected modem. It is important therefore that the modem is already powered, or is powered up at the same time as the module. At regular intervals after power up, the modem is reset, and reinitialised, to ensure the modem does not 'hang up'.

If the module does not correctly communicate with the modem, "Modem initialising' appears on the Serial Port instrument screen as shown overleaf.

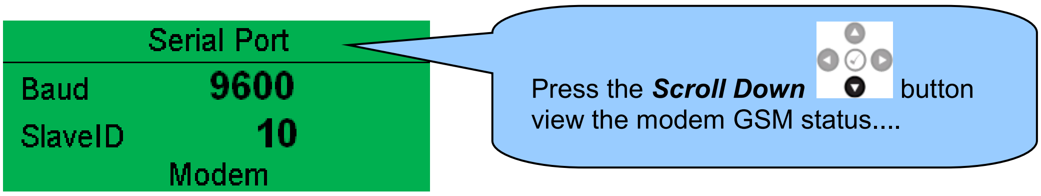
If the module is set for "incoming calls" or for "incoming and outgoing calls", once the modem is dialled, it answers after two rings (using the factory setting 'initialisation strings). Once the call is established, all data is passed between the dialling PC and the module.

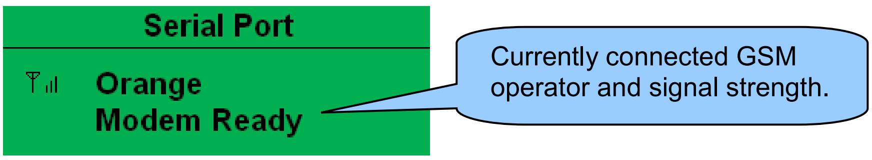
If the module is set for "outgoing calls" or for "incoming and outgoing calls", then the module dials out whenever an alarm is generated.

NOTE: Not all alarms generate a dial out command; this is dependant upon module configuration of the event log. Any event configured to be recorded in the event log causes the modem to dial out to a PC.

Many GSM modems are fitted with a status LED to show operator cell status and ringing indicator. These are a useful troubleshooting tool.

In the case of GSM connection problems, try calling the DATA number of the SIMCARD with an ordinary telephone. There should be two rings, followed by the modem answering the call and then 'squealing'. If this does not happen, check all modem connections and double check with the SIM provider that it is a DATA SIM and can operate as a data modem. DATA is NOT the same as FAX or GPRS and is often called Circuit Switched Data (CSD) by the SIM provider.





NOTE: In the case of GSM modems, it is important that a DATA ENABLED SIM is used. This is often a different number than the 'voice number' and is often called Circuit Switched Data (CSD) by the SIM provider.

If the GSM modem is not purchased from DSE, ensure that it has been correctly set to operate at 9600 baud.

Modem Initialisation Sequence

The modem attempts to communicate to the module

Serial Port

Modem Initialising

If the Modem and module communicate successfully:

Serial Port

Modem ready

In case of communication failure between the modem and module, the modem is automatically reset and initialisation is attempted once more:

Serial Port

Modem Reset

Serial Port

Modem Initialising

In the case of a module that is unable to communicate with the modem, the display continuously cycles between 'Modem Reset' and 'Modem Initialising' as the module resets the modem and attempts to communicate with it again, this continues until correct communication is established with the modem. In this instance, check connections and verify the modem operation.

Modem Diagnostics

Modem diagnostic screens are included; press the ***Scroll Down*** button when viewing the *RS232 Serial Port* instruments to cycle to the available screens. If experiencing modem communication problems, this information aids troubleshooting.

Serial Port

DTR

CTS **DCD**

DSR

Shows the state of the modem communication lines. These can help diagnose connection problems.
Example:

RTS A dark background shows the line is active.
RTS A grey background shows that the line is toggling high and low
RTS No background indicates that the line is inactive

Line	Description	
RTS	Request to Send	Flow Control
CTS	Clear to Send	Flow Control
DSR	Data Set Ready	Ready to Communicate
DTR	Data Terminal Ready	Ready to Communicate
DCD	Data Carrier Detect	Modem is Connected

Modem Commands

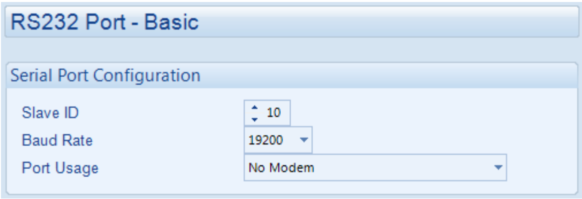
Rx: OK
Tx: AT+IPR=9600
Rx: OK

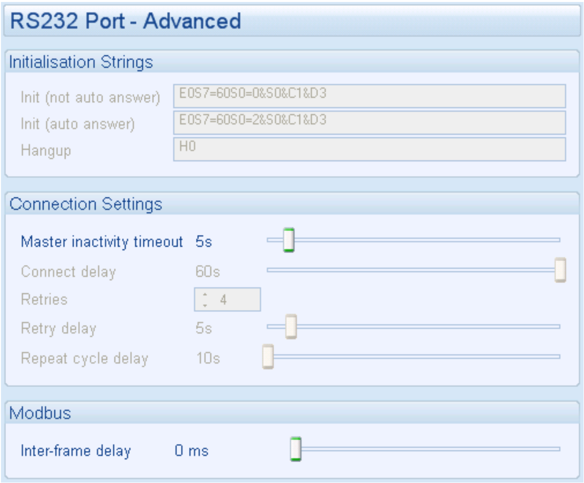
Shows the last command sent to the modem and the result of the command.

Connected to An RS232 MODBUS Master

The modules operate as a MODBUS RTU slave device. In a MODBUS system, there is only one Master, typically a PLC, HMI system or PC SCADA system.

This master requests for information from the MODBUS slave (The module) and may (in control systems) also send request to change operating modes etc. Unless the Master makes a request, the slave is 'quiet' on the data link.





The factory settings are for the module to communicate at 19200 baud, MODBUS slave address 10.

To use the RS232 port, ensure that 'port usage' is correctly set using the DSE Configuration Suite Software.

'Master inactivity timeout' should be set to at least twice the value of the system scan time. For example if a MODBUS master PLC requests data from the module once per second, the timeout should be set to at least 2 seconds

The DSE MODBUS document containing register mappings inside the DSE module is available upon request from support@deepseaelectronics.com. Email the request along with the serial number of the DSE module to ensure the correct information is sent.

4.4.8.2 RS485 SERIAL PORT

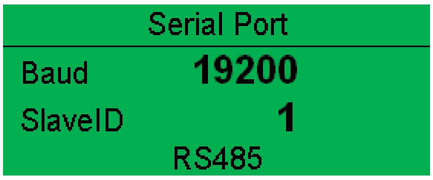
This section is included to give information about the currently selected serial port

The items displayed on this page change depending upon configuration of the module. Refer to the system supplier for further details.

> ⚠ **NOTE: Factory Default settings are for the RS485 port to operate at 19200 baud, MODBUS slave address 10.**

<u>Connected to an R485 MODBUS Master</u>

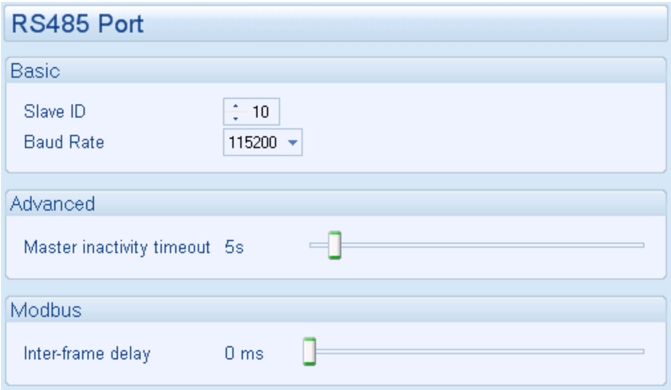
The modules operate as a MODBUS RTU slave device.
In a MODBUS system, there is only one Master, typically a PLC, HMI system or PC SCADA system.



This master requests for information from the MODBUS slave (The module) and may (in control systems) also send request to change operating modes etc. Unless the Master makes a request, the slave is 'quiet' on the data link.

The factory settings are for the module to communicate at 115200 baud, MODBUS slave address 10.

'Master inactivity timeout' should be set to at least twice the value of the system scan time. For example if a MODBUS master PLC requests data from the module once per second, the timeout should be set to at least 2 seconds.



The DSE MODBUS document containing register mappings inside the DSE module is available upon request from support@deepseaelectronics.com. Email the request along with the serial number of the DSE module to ensure the correct information is sent.

<u>Typical Requests (Using Pseudo Code)</u>

`BatteryVoltage=ReadRegister(10,0405,1)`: reads register (hex) 0405 as a single register (battery volts) from slave address 10.

`WriteRegister(10,1008,2,35701, 65535-35701)`: Puts the module into AUTO mode by writing to (hex) register 1008, the values 35701 (auto mode) and register 1009 the value 65535-35701 (the bitwise opposite of auto mode)

`Warning=(ReadRegister(10,0306,1) >> 11) & 1)`: reads (hex) 0306 and looks at bit 12 (Warning alarm present)

`ElectricalTrip=(ReadRegister(10,0306,1) >> 10) & 1)`: reads (hex) 0306 and looks at bit 11 (Electrical Trip alarm present)

`ControlMode=ReadRegister(10,0304,2)`: reads (hex) register 0304 (control mode).

4.4.9 USER DEFINED STRINGS

> **NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.***

The user define strings are intended to contain generic important information about the generator such as oil service internal information. The contents of these screens vary depending upon configuration by the engine manufacturer or supplier.

Under default factory settings the support strings are not viewable. They are configurable by the system designer using the DSE Configuration Suite software.

The display below example screen is achieved using the settings shown in the below screen shot of the DSE Configuration Suite Software:

Oil Service

Every 500 Hours

Every 5 Months

4.4.10 SCHEDULE

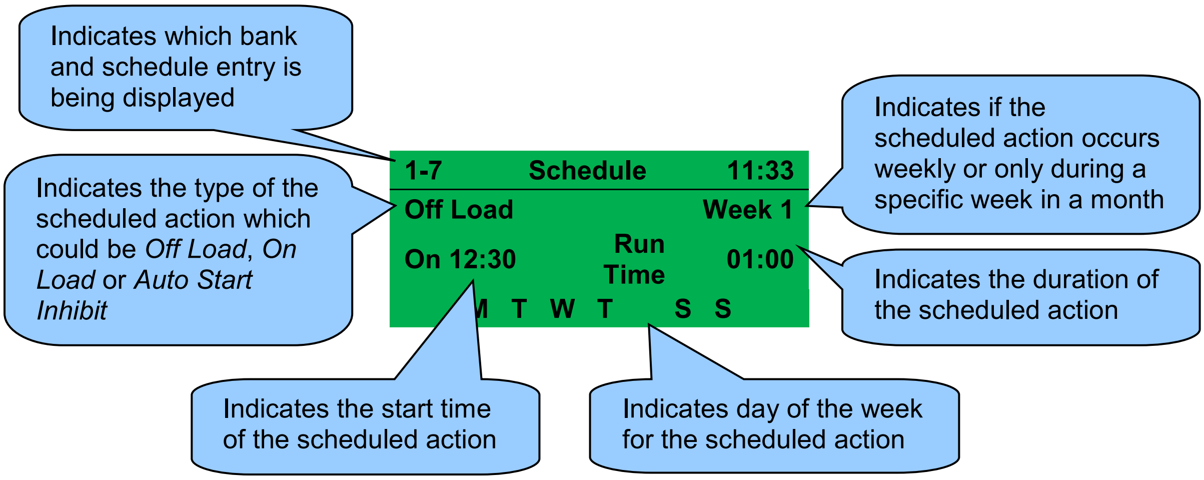
NOTE: For further details on the operation of the inbuilt scheduler feature, refer to section entitled *Scheduler* in the *Operation* section of this document.

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

The controller contains an inbuilt exercise run scheduler, capable of automatically starting and stopping the set or inhibiting the set from starting. Up to 16 scheduled (in two banks of 8) start/stop/inhibiting start sequences can be configured to repeat on a 7-day or 28-day cycle.

Scheduled runs may be on load or off load depending upon module configuration.

This section of the module's display shows how exactly the scheduler (if enabled) is configured. Under default factory settings the Schedule is not viewable. It is enabled by the system designer using the DSE Configuration Suite software.



4.4.11 PLC INSTRUNMENTS

> **NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.***

Contains values from various elements from the module's internal PLC editor to enable the user to view them from the module's facia.

Press the ***Instrumentation Scroll*** buttons scroll through the ***PLC Instruments*** parameters if configured.

Counter Example:

PLC Instruments	
Counter 1	
Actual	**5**
Set Point	**15**

Counter 1: The name of the counter as configured in the PLC.
Actual: The number the counter has currently reached.
Set Point: The number at which the counter stops incrementing

Register Example:

PLC Instruments
Register 1
58

Register 1: The name of the register as configured in the PLC.
Value: The value the register currently contains.

Store Example:

PLC Instruments
Store 1
127

Store: The name of the store as configured in the PLC.
Value: The value the store currently contains. This value can be edited from the fascia by pressing and holding the ***Tick*** ***and then using the Instrumentation Scroll*** button to change the value.

Timer Example:

PLC Instruments	
Timer 1	
Actual	**00:34:17**
Set Point	**01:50:30**

Timer 1: The name of the timer as configured in the PLC.
Actual: The time the timer has currently reached.
Set Point: The time at which the timer stops incrementing

4.4.12 CONFIGURABLE CAN

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

The configurable CAN instruments are intended to display CAN information from external third party CAN devices such as fuel flow meters. The contents of these screens vary depending upon configuration by the engine manufacturer or supplier.

Under default factory settings the configurable CAN instruments are not viewable. They are configurable by the system designer using the DSE Configuration Suite software.

Example:

Fuel Flow
84 **L/h**

Configurable CAN Instrument 1 to 30

4.4.13 AVR CAN

NOTE: For further details of module configuration, refer to DSE Publication: *057-262 DSE7410 MKII & DSE7420 MKII Configuration Software Manual.*

These pages contain instrumentation gathered from the AVR when connected by CAN and covers generator instrumentation and AVR configuration.

Under default factory settings the AVR CAN instruments are not viewable. They are configurable by the system designer using the DSE Configuration Suite software.

Press the ***Instrumentation Scroll***  buttons scroll through the ***PLC Instruments*** parameters if configured.

Generator Voltage

230

Voltage Set Point Preset Enable
Voltage Set Point
Droop Preset Enable
Droop (% of Set Point)
Offset Angle
Full Load Current
External Bias Pot Enable
External Pot Range (%)
External Bias Voltage Enable
External Voltage Range (%/V)
External Voltage Offset
UFRO Preset Enable
UFRO Knee Point
Instantaneous Mode Enable
Instantaneous Step
Ramp Rate (%/Hz)
Dwell Time
Ramp Up Rate After Dwell (%/s)
Trip Point
Proportional Preset Enable
Proportional Preset Range
Proportional Set Point
Integral Preset Enable
Integral Preset Range
Integral Set Point
Derivative Set Point
Off Load Duty Cycle
Maximum Duty Cycle
Output Limit Overshoot %
Output Limit Overshoot Delay
Soft Start Ramp Start Point (%)
Soft Start Ramp Rate (%/Hz)
Start-up Fail Delay
Loss of Feedback Delay
Over Excite Trip

Continued over page…

Over Excite Delay
External Pot OC Alarm Enable
Generator Frequency
Generator Voltage
Droop Current
Excitation Voltage
Auxiliary Voltage
External Potentiometer
External Voltage
Alternative Configuration
Stability Selection
Software Version

4.4.13.1 AVR CURRENT DTCS

NOTE: For details on these code/graphic meanings, refer to the AVR instructions provided by the manufacturer, or contact the manufacturer for further assistance.

When connected to a suitable CAN AVR, the controller displays alarm status messages from the AVR in the *Alarms* section of the display.

1/1 Alarms
AVR Fault

Warning

Type of alarm that is triggered on the DSE module, e.g. Warning

Press the ***Next Page*** button until the *AVR Current DTCs* (Diagnostic Trouble Codes) page is displayed to access the list of DTCs from the AVR which are DM1 messages.

1/2 AVR Current DTCs
Start-up Failed Trip
Fault Exists
SPN=520193 , FMI=31, OC=1

The DM1 DTC is interpreted by the module and is shown on the module's display as a text message. In addition to this, the manufacturer's DTC is shown below.

4.4.14 ABOUT

4.4.14.1 MODULE INFORMATION

Contains important information about the module and the firmware versions. This information may be asked for when contacting DSE Technical Support Department for advice.

About	
Variant	**7320H**
Application	**V1.1.11**
USB ID	**BC614E**

Variant: 73xx MKII
Application Version: The version of the module's main firmware file (Updatable using the Firmware Update Wizard in the DSE Configuration Suite Software).
USB ID: Unique identifier for PC USB connection

Press the ***Scroll Down***  button to access more information about the module.

About	
Bootloader	**V3.0.18**
Analogue	**V1.0.14**

Bootloader: Firmware Update bootloader software version
Analogue: Analogue measurements software version

About	
Engine Type	**Volvo EMS2b**
Version	**V1.21**

Engine Type: The name of the engine file selected in the configuration
Version: Engine type file version.

4.4.14.2 DUAL MUTUAL

Whilst in the *About* section, press ***Scroll Down***  button to access more information about the Dual Mutual Standby.

About	
Dual Mutual	**V2.0.0**
No of Sets	**2**
Run Time	**4h 38m**

Dual Mutual: Dual Mutual Software version
No of Sets: Number of sets detected on the comms link.
Run Time: Number of accumulated engine hours or dual mutual hours.

4.5 USER CONFIGURABLE INDICATORS

These LEDs are configured by the user to indicate any one of ***100+ different functions*** based around the following:-

Indications - Monitoring of a digital input and indicating associated functioning user's equipment - *Such as Battery Charger On or Louvres Open, etc*.

Warnings, Electrical Trips & Shutdowns Alarms - Specific indication of a particular warning or shutdown condition, backed up by LCD indication - *Such as Low Oil Pressure Shutdown, Low Coolant level, etc.*

Status Indications - Indication of specific functions or sequences derived from the modules operating state - *Such as Safety On, Pre-heating, Panel Locked, etc.*

5 OPERATION

NOTE: The following descriptions detail the sequences followed by a module containing the standard 'factory configuration'. Always refer to your configuration source for the exact sequences and timers observed by any particular module in the field.

5.1 QUICKSTART GUIDE

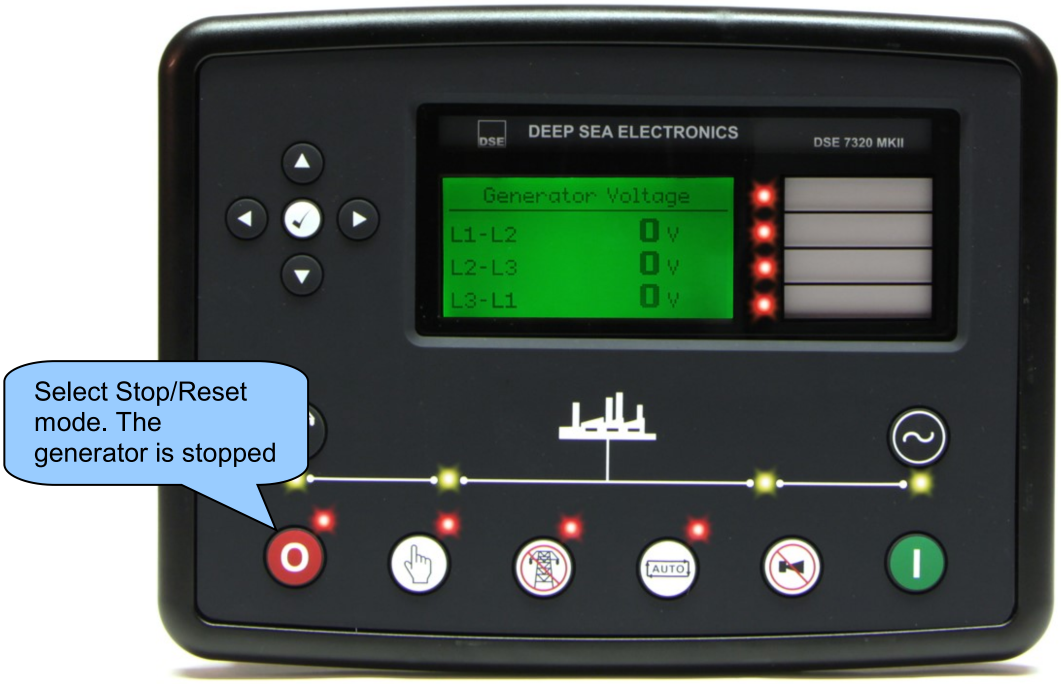
This section provides a quick start guide to the module's operation.

5.1.1 STARTING THE ENGINE

NOTE: For further details, see the section entitled *Operation* elsewhere in this document.

5.1.2 STOPPING THE ENGINE

NOTE: For further details, see the section entitled *Operation* elsewhere in this document.



5.2 STOP/RESET MODE

NOTE: If a digital input configured to *Panel Lock* is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by *Panel Lock*.

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

Stop/Reset Mode is activated by pressing the ***Stop/Reset Mode*** button.
The LED above the ***Stop/Reset Mode*** button illuminates to indicate ***Stop/Reset Mode*** operation.

In ***Stop/Reset Mode***, the module removes the generator from load (if necessary) before stopping the generator.

If the generator does not stop when requested, the *Fail To Stop* alarm is activated (subject to the setting of the *Fail to Stop* timer). To detect the engine at rest the following must occur:

- Engine speed is zero as detected by the CAN ECU
- Generator AC Voltage and Frequency must be zero.
- Engine Charge Alternator Voltage must be zero.
- Oil pressure sensor must indicate low oil pressure

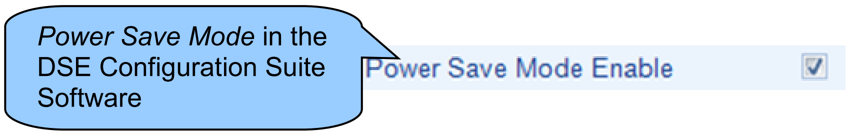
When the engine has stopped and the module is in the ***Stop/Reset Mode***, it is possible to send configuration files to the module from DSE Configuration Suite PC software and to enter the Front Panel Editor to change parameters.

Any latched alarms that have been cleared are reset when ***Stop/Reset Mode*** is entered.

The engine is not started when in ***Stop/Reset Mode***. If start signals are given, the input is ignored until ***Auto Mode*** is entered.

If *Immediate Mains Dropout* is enabled and the module is in ***Stop/Reset Mode***, the mains load switch is opened and closed as appropriate when the mains fails or becomes available to take load.

When left in ***Stop/Reset Mode*** with no presses of the fascia buttons, no form of communication active and configured for *Power Save Mode,* the module enters *Power Save Mode*. To 'wake' the module, press any fascia control buttons.



5.2.1 ECU OVERRIDE

Pressing the ***Start*** button in ***Stop/Reset Mode*** powers up the engine's ECU but does not start the engine. This can be used to check the status of the CAN communication and to prime the fuel system.

5.3 MANUAL MODE

NOTE: If a digital input configured to Panel Lock is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Manual Mode is activated by pressing the ***Manual Mode*** button.
The LED above the ***Manual Mode*** button illuminates to indicate ***Manual Mode*** operations.

In ***Manual Mode*** the generator does not start automatically
To begin the starting sequence, press the ***Start*** button.

5.3.1 STARTING SEQUENCE

NOTE: There is no *Start Delay* in this mode of operation.

NOTE: If the unit has been configured for CAN, compatible ECU's receives the start command via CAN.

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

The fuel relay is energised and the engine is cranked.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *Crank Rest Timer* duration after which the next start attempt is made. Should this sequence continue beyond the set *Number Of Attempts*, the start sequence is terminated and the display shows *Fail to Start.*

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CANbus link to the engine ECU depending on module configuration.

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

After the starter motor has disengaged, the *Safety On Delay* timer activates, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

5.3.2 ENGINE RUNNING

NOTE: The load transfer signal remains inactive until the generator is available. This prevents excessive wear on the engine and alternator.

NOTE: For further infomration on enabling Manual Breaker Control, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.

When in ***Manual Mode*** the load is transferred to the generator whenever a 'loading request' is made. The possible sources for 'loading requests' are limited dependant on the state of the *Manual Breaker Control* function.

5.3.2.1 MANUAL BREAKER CONTROL DISABLED

A loading request may come from any of the following sources:

- Press the Transfer to Generator button.
- Failure of mains supply (DSE7320 MKII only)
- Activation of an auxiliary input that has been configured to *Remote Start On Load, Transfer To Generator / Open Mains* or *Auxiliary Mains Fail* (DSE7320 MKII Only).
- Activation of the inbuilt exercise scheduler if configured for 'on load' runs.
- Activation of *Dual Mutual Standby Balance Mode*, see section entitled *Operation* (*Dual Mutual Standby*) elsewhere in this document for more information.
- Instruction from external remote telemetry devices using the RS232, RS485 or Ethernet interface.

Once the generator is placed on load, it will not automatically be removed. Depending on loading request state, one of the following methods is used to manually open the load switch:

- If the loading request has been removed:
  - Press the ***Open Generator*** (DSE7310 MKII Only) or ***Transfer to Mains*** (DSE7320 MKII Only) button
  - Activation of an auxiliary input that has been configured to *Transfer To Mains / Open Generator.*
  - Press the ***Auto Mode*** button to return to automatic mode. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the *Auto Mode Stopping Sequence*.
- If the loading request remains active:
  - Press the ***Stop/Reset Mode*** button to remove load and stop the generator.
  - Activation of an auxiliary input that has been configured to *Generator Load Inhibit.*

5.3.2.2 MANUAL BREAKER CONTROL ENABLED

Loading request sources are limited to:

- Press the Transfer to Generator button.
- Activation of an auxiliary input that has been configured to *Transfer To Generator / Open Mains.*

Once the generator is placed on load, it will not automatically be removed. Any one of the following methods are used to manually open the load switch:

- Press the ***Open Generator*** (DSE7310 MKII Only) or ***Transfer to Mains*** (DSE7320 MKII Only) button
- Activation of an auxiliary input that has been configured to *Transfer To Mains / Open Generator.*
- Press the ***Auto Mode*** button to return to automatic mode. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the *Auto Mode Stopping Sequence*.
- Press the ***Stop/Reset Mode*** button to remove load and stop the generator.
- Activation of an auxiliary input that has been configured to *Generator Load Inhibit.*

5.3.3 STOPPING SEQUENCE

In ***Manual Mode*** the set continues to run until either:

- The ***Stop/Reset Mode*** button is pressed – The delayed load outputs are de-activated immediately and the set immediately stops.
- The ***Auto Mode*** button is pressed. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the *Auto Mode Stopping Sequence*.

5.4 TEST MODE

NOTE: If a digital input configured to *Panel Lock* is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by *Panel Lock*.

Test Mode is activated by pressing the ***Test Mode*** button.
The LED above the ***Test Mode*** button illuminates to indicate ***Test Mode*** operations.

In ***Test Mode***, the set does not start automatically.
To begin the starting sequence, press the ***Start*** button.

5.4.1 STARTING SEQUENCE

NOTE: There is no *Start Delay* in this mode of operation.

NOTE: If the unit has been configured for CAN, compatible ECU's receives the start command via CAN.

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

The fuel relay is energised and the engine is cranked.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start sequence is terminated and the display shows *Fail to Start.*

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CANbus link to the engine ECU depending on module configuration.

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

After the starter motor has disengaged, the *Safety On Delay* timer activates, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

5.4.2 ENGINE RUNNING

NOTE: The load transfer signal remains inactive until the generator is available. This prevents excessive wear on the engine and alternator.

In ***Test Mode***, the load is automatically transferred to the generator.

Once the generator has been placed on load, it is not automatically removed. To manually remove the load either:

Press the ***Manual Mode*** button followed by the ***Open Generator*** (DSE7310 MKII Only) or ***Transfer to Mains*** (DSE7320 MKII Only) button.

- Press the ***Auto Mode*** button to return to automatic mode. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the *Auto Mode Stopping Sequence*.
- Press the ***Stop/Reset Mode*** button to remove load and stop the generator.
- Activation of an auxiliary input that has been configured to *Generator Load Inhibit.*

5.4.3 STOPPING SEQUENCE

In ***Test Mode*** the set continues to run until either:

- The ***Stop/Reset Mode*** button is pressed – The delayed load outputs are de-activated immediately and the set immediately stops.
- The ***Auto Mode*** button is pressed. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the *Auto Mode Stopping Sequence*.

5.5 AUTOMATIC MODE

> **NOTE: If a digital input configured to external *Panel Pock* is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by *Panel Lock*.**

Auto Mode is activated by pressing the ***Auto Mode*** button.
The LED above the ***Auto Mode*** button illuminates to indicate ***Auto Mode*** operations.

Auto Mode allows the generator to operate fully automatically, starting and stopping as required with no user intervention.

5.5.1 WAITING IN AUTO MODE

If a starting request is made, the starting sequence begins.
Starting requests can be from the following sources:

- Failure of mains supply (DSE7320 MKII only)
- Activation of an auxiliary input that has been configured to *Remote Start*
- Activation of an auxiliary input that has been configured to *Auxiliary Mains Fail* (DSE7320 MKII Only).
- Activation of the inbuilt exercise scheduler.
- Instruction from external remote telemetry devices using the RS232 or RS485 interface.
- Activation of *Dual Mutual Standby Balance Mode*, see section entitled *Operation (Dual Mutual Standby)* elsewhere in this document for more information.

5.5.2 STARTING SEQUENCE

NOTE: If the unit has been configured for CAN, compatible ECU's receive the start command via CAN and transmit the engine speed to the DSE controller.

NOTE: For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

To allow for 'false' start requests, the *Start Delay* timer begins.

Should all start requests be removed during the *Start Delay* timer, the unit returns to a stand-by state.

If a start request is still present at the end of the *Start Delay* timer, the fuel relay is energised and the engine is cranked.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *Crank Rest* duration after which the next start attempt is made. Should this sequence continue beyond the *Set Number Of Attempts*, the start sequence is terminated and the display shows *Fail to Start.*

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CAN link to the engine ECU depending on module.

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

After the starter motor has disengaged, the *Safety On Delay* timer activates, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

5.5.3 ENGINE RUNNING

> **NOTE: The load transfer signal remains inactive until the generator is available. This prevents excessive wear on the engine and alternator.**

The generator is placed on load if configured to do so.

If all start requests are removed, the *Stopping Sequence* begins.

5.5.4 STOPPING SEQUENCE

The *Return Delay* timer operates to ensure that the starting request has been permanently removed and isn't just a short term removal. Should another start request be made during the cooling down period, the set returns on load.

If there are no starting requests at the end of the *Return Delay* timer, the load is transferred from the generator to the mains supply and the *Cooling Down* timer is initiated.

The *Cooling Down* timer allows the set to run off load and cool sufficiently before being stopped. This is particularly important where turbo chargers are fitted to the engine.

After the *Cooling Down* timer has expired, the set is stopped.

5.6 SCHEDULER

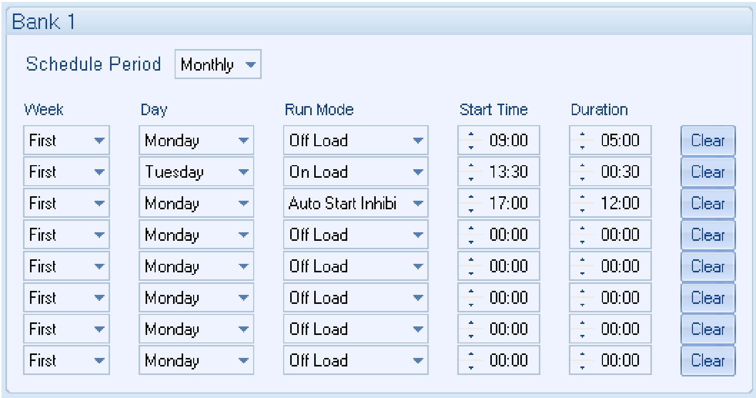
The controller contains an inbuilt exercise run scheduler, capable of automatically starting and stopping the set or inhibiting the set from starting. Up to 16 scheduled (in two banks of 8) start/stop/inhibiting start sequences can be configured to repeat on a 7-day or 28-day cycle.

Scheduled runs may be on load or off load depending upon module configuration.

Example:

Screen capture from DSE Configuration Suite Software showing the configuration of the Exercise Scheduler.

In this example the set starts at 09:00 on Monday and run for 5 hours off load, then start at 13:30 on Tuesday and run for 30 minutes one load and is inhibited from automatically starting on Monday from 17:00 for 12 hours.



5.6.1 STOP MODE

- Scheduled runs do not occur when the module is in ***Stop/Reset Mode***.

5.6.2 MANUAL MODE

- Scheduled runs do not occur when the module is in ***Manual Mode*** waiting for a start request.
- Activation of a Scheduled Run 'On Load' when the module is operating Off Load in ***Manual Mode*** forces the set to run On Load.

5.6.3 TEST MODE

- Scheduled runs do not occur when the module is in ***Test Mode*** waiting for a start request.

5.6.4 AUTO MODE

- Scheduled runs operate only if the module is in ***Auto Mode*** with no *Shutdown* or *Electrical Trip* alarm active.
- If the module is in ***Stop/Reset Mode*** or ***Manual Mode*** when a scheduled run begins, the engine is not started. However, if the module is moved into ***Auto Mode*** during a scheduled run, the engine is called to start.
- Depending upon configuration by the system designer, an external input can be used to inhibit a scheduled run.
- If the engine is running *Off Load* in ***Auto Mode*** and a scheduled run configured to 'On Load' begins, the set is placed *On Load* for the duration of the Schedule.

5.7 ALTERNATIVE CONFIGURATIONS

Depending upon the configuration of the system by the generator supplier, the system may have selectable configurations (for example to select between 50 Hz and 60 Hz). If this has been enabled the generator supplier will advise how this selection can be made (usually by operating an external selector switch or by selecting the required configuration file in the module's front panel configuration editor).

5.8 DUMMY LOAD / LOAD SHEDDING CONTROL

If the load is low, 'dummy loads' (typically resistive load banks) are introduced to ensure the engine is not too lightly loaded. Conversely, as the load increases towards the maximum rating of the set, non-essential loads are shed to prevent overload of the generator.

5.8.1 DUMMY LOAD CONTROL

The *Dummy Load Control* feature (if enabled) allows for a maximum of five dummy load steps. When the set is first started, all configured *Dummy Load Control* outputs are de-energised. Once the generator is placed onto load, the generator loading is monitored by the *Dummy Load Control* scheme.

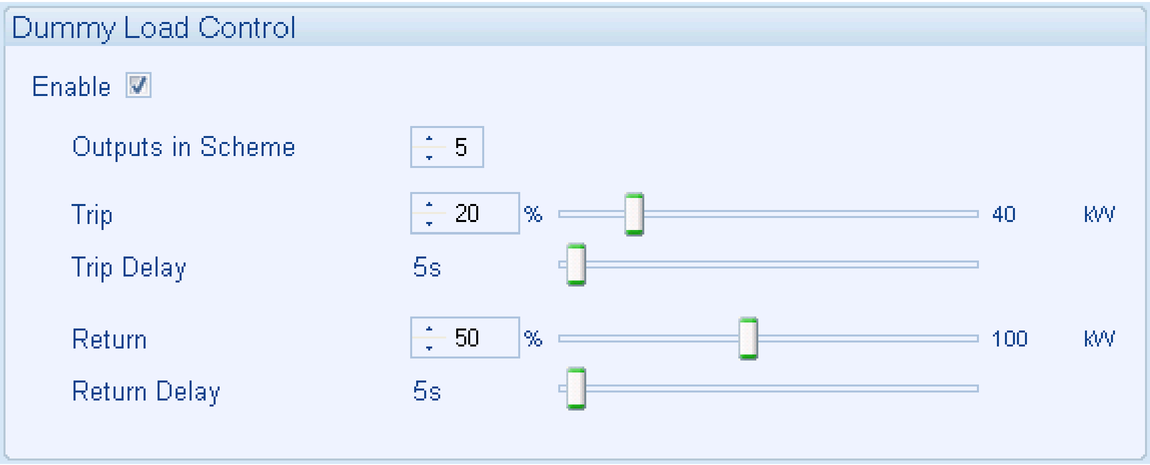
If the generator loading falls below the *Dummy Load Control Trip* setting (kW), the *Dummy Load Control Trip Delay* begins. If the generator loading remains at this low level for the duration of the timer, the first *Dummy Load Control* output is energised. This is used to energise external circuits to switch in a resistive load bank.

The first dummy load has increased the generator loading. Again, the generator loading is monitored. This continues until all configured *Dummy Load Control* outputs are energised.

When the generator loading rises above the *Dummy Load Return* level, the *Dummy Load Return Delay* begins. If the generator loading remains at these levels after the completion of the timer, the 'highest' active *Dummy Load Control* output is de-energised. This continues until all *Dummy Load Control* outputs have been de-energised.

When the generator enters a stopping sequence for any reason, all the *Dummy Load Control* outputs de-energise at the same time as the generator load switch is signalled to open.

Example screen shot of *Dummy Load Control* setup in the DSE Configuration Suite



5.8.2 LOAD SHEDDING CONTROL

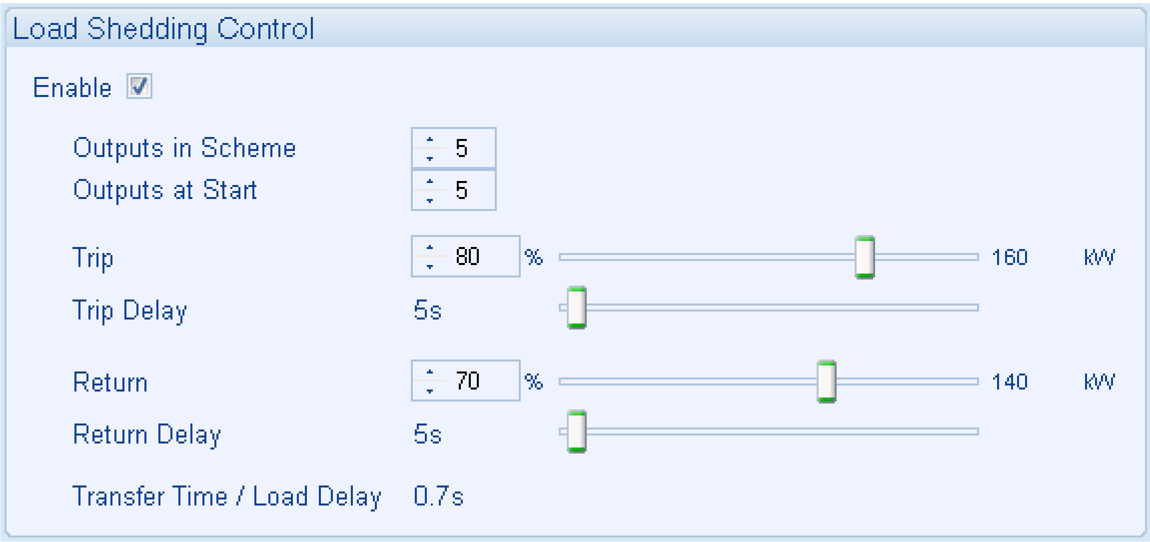
The *Load Shedding Control* feature (if enabled) allows for a maximum of five load shedding steps. When the generator is about to take load, the configured number of *Load Shedding Control Outputs at Start* will energise. This allows certain none-essential loads to be removed prior to the generator's load switch being closed. This is used to ensure the initial loading of the generator is kept to a minimum, below the *Load Acceptance* specification of the generator.

The generator is then placed on load. The *Load Shedding Control* scheme begins.
When the generator loading exceeds the *Load Shedding Trip* level the *Trip Delay* timer will start. If the generator loading is still high when the timer expires, the first *Load shedding Control* output energises. When the generator loading been above the trip level for the duration of the timer the 'next' *Load Shedding Control* output energises and so on until all *Load Shedding Control* outputs are energised.

When the generator loading falls below the *Load Shedding Return* level, the *Return Delay Time* starts. If the generator load remains below the *Load Shedding Return* level when the timer has expired, the 'highest' *Load Shedding Control* output de-energises. This process continues until all outputs have been de-energised.

When the generator enters a stopping sequence for any reason, all the *Load Shedding Control* outputs de-energise at the same time as the generator load switch is signalled to open.

Example screen shot of *Load Shedding Control* setup in the DSE Configuration Suite:



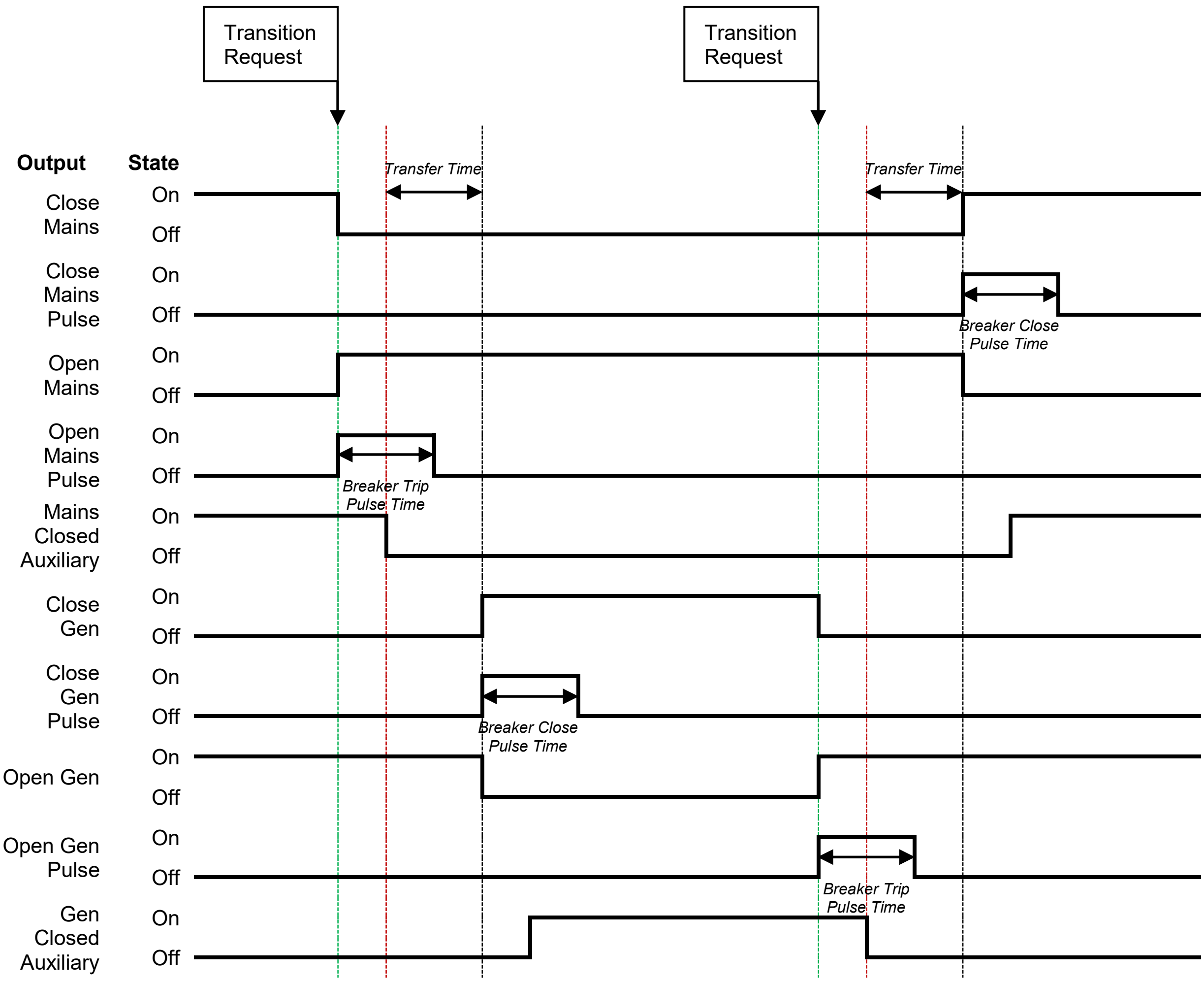
5.9 CHANGEOVER FUNCTIONALITY (DSE7320 MKII ONLY)

The change over functionality between mains and generator is dependant on how the DSE module is configured. A brief description of the operation of each scheme is detailed in the following sections.

5.9.1 OPEN TRANSITION WITHOUT CHECK SYNC

NOTE: When using *Open Transition*, it is recommended that digital inputs are configured for *Generator Closed Auxiliary* and *Mains Closed Auxiliary* to provide additional interlock protection.

By default the DSE module performs an open transition without check sync, with a pre-configured transfer delay between opening one load switch, and closing the other. When changing over from mains to generator, the module requests that the mains load switch opens. Once the *Mains Closed Auxiliary* indicates the mains load switch has opened, the *Transfer Time* begins. After the *Transfer Time* expires, the module attempts to close the generator load switch. The operating philosophy is the same when going from generator to mains and the complete transition is shown below in the timing diagram.



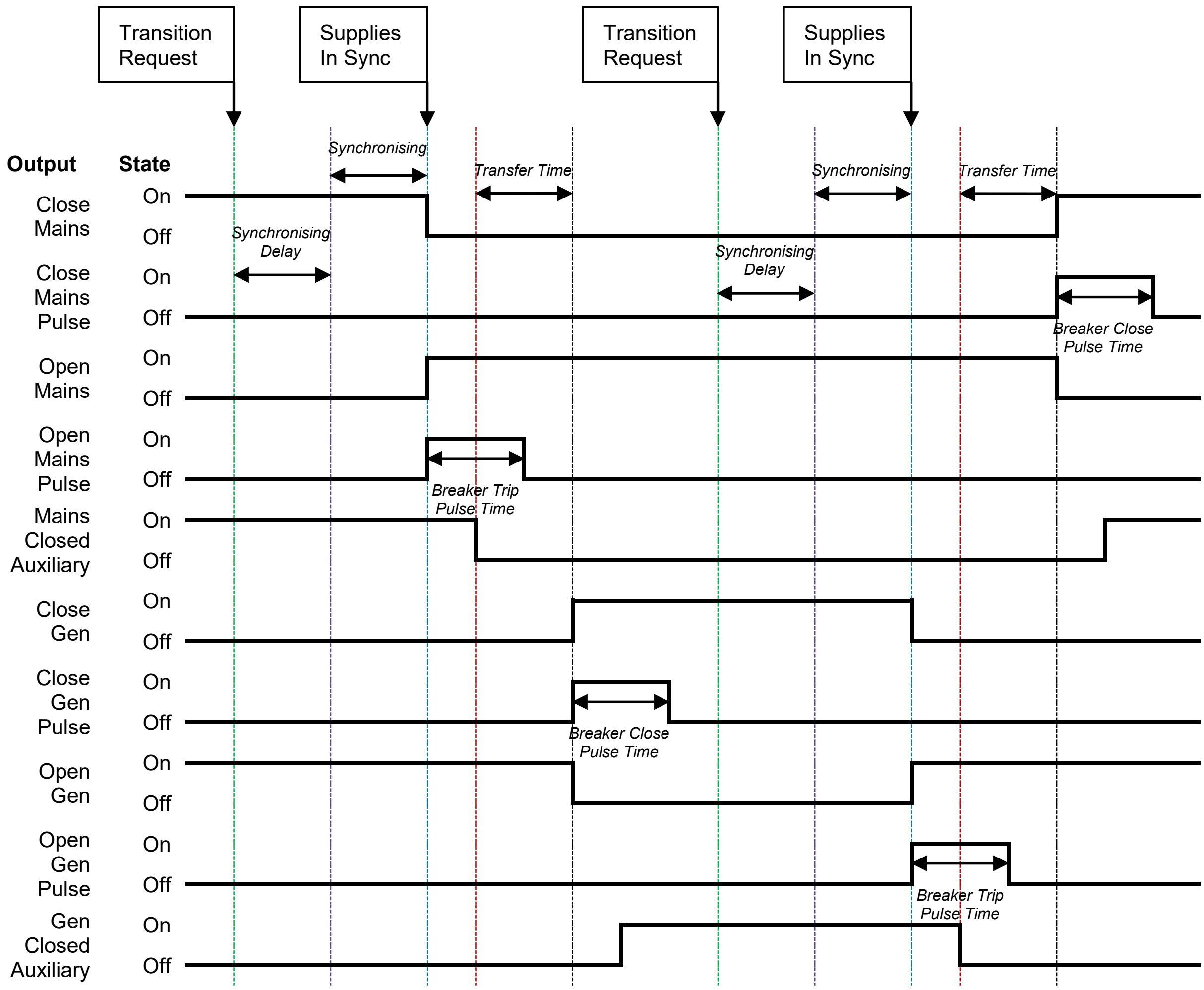
5.9.2 OPEN TRANSITION WITH CHECK SYNC

NOTE: When using *Open Transition*, it is recommended that digital inputs are configured for *Generator Closed Auxiliary* and *Mains Closed Auxiliary* to provide additional interlock protection.

NOTE: *Check Sync* is not available when using the *Dual Mutual Standby* feature.

NOTE: When using *Open Transition With Check Sync* without enabling the *Check Sync Assist* to actively control the synchronising, it is advised that the *Return to Open Transition* is enabled. If *Return to Open Transition* is enabled, the module performs an open transition without check sync if the supplies fail to synchronise within the configured time. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

It is possible to configure the DSE module to perform an open transition with check sync, with a pre-configured transfer delay between opening one load switch, and closing the other. When changing over from mains to generator, the module waits for the two supplies to become in sync (by passive or actively synchronising depending on configuration). After the supplies become in sync, the module requests that the mains load switch opens. Once the *Mains Closed Auxiliary* indicates the mains load switch has opened, the *Transfer Time* begins. After the *Transfer Time* expires, the module attempts to close the generator load switch. The operating philosophy is the same when going from generator to mains and the complete transition is shown below in the timing diagram.



5.9.3 CLOSED TRANSITION WITH CHECK SYNC

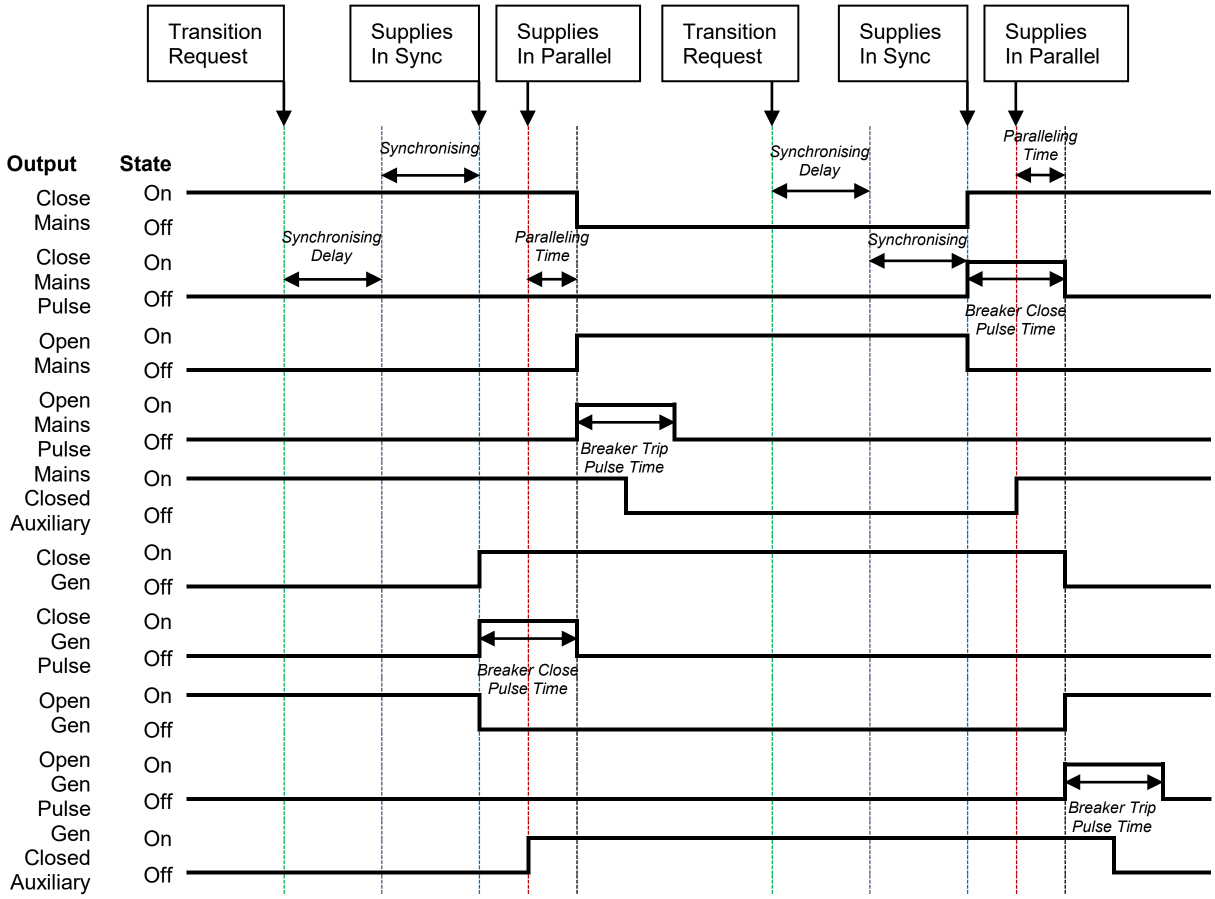
NOTE: *Closed Transition With Check Sync* is not available when using the *Dual Mutual Standby* feature.

NOTE: When using *Closed Transition With Check Sync*, digital inputs must be configured for *Generator Closed Auxiliary* and *Mains Closed Auxiliary*.

NOTE: When using *Closed Transition With Check Sync*, mechanical interlock must not be fitted. It is recommended that external electrical interlock provided but overridden using and output configured as *Interlock Override.*

NOTE: When using *Closed Transition With Check Sync* without enabling the *Check Sync Assist* to actively control the synchronising, it is advised that the *Return to Open Transition* is enabled. If *Return to Open Transition* is enabled, the module performs an open transition without check sync if the supplies fail to synchronise within the configured time. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*

It is possible to configure the DSE module to perform a closed transition with check sync, with a pre-configured parallel time when both load switches are closed. When changing over from mains to generator, the module waits for the two supplies to become in sync (by passive or actively synchronising depending on configuration). After the supplies become in sync, the module requests that the generator load switch closes. Once the *Generator Closed Auxiliary* indicates the generator load switch has closed, the *Paralleling Time* begins. After the *Paralleling Time* expires, the module attempts to open the mains load switch. The operating philosophy is the same when going from generator to mains and the complete transition is shown in the timing diagram overleaf.


Transition Request
Supplies In Sync
Supplies In Parallel
Transition Request
Supplies In Sync
Supplies In Parallel
Output
State
Synchronising
Synchronising Delay
Paralleling Time
Synchronising Delay
Paralleling Time
Synchronising
Breaker Close Pulse Time
Breaker Trip Pulse Time
Breaker Close Pulse Time
Breaker Trip Pulse Time
Close Mains
Close Mains Pulse
Open Mains
Open Mains Pulse
Mains Closed Auxiliary
Close Gen
Close Gen Pulse
Open Gen
Open Gen Pulse
Gen Closed Auxiliary
On
Off

5.10 SMS CONTROL

The *SMS Control* feature (if enabled) allows the user to send control commands to the module via SMS message. There are five control commands that the user is able to send to the module shown in the table below.

NOTE: Multiple SMS Control Commands CANNOT be sent in a single SMS message.

Control Command Number	Module Action
1	Start the generator and run off load if the controller is in the ***Auto Mode***.
2	Start the generator and run on load if the controller is in the ***Auto Mode***.
3	Cancel the SMS start request leaving the module in its current operating mode.
4	Put the module into the ***Stop/Reset Mode***.
5	Put the module into the ***Auto Mode***.

To send an SMS command, the user requires (if configured) the *SMS Control Pin* and the *Control Command Number.* Only these numbers must be included in the SMS, the module does not respond to any SMS with extra characters or missing PIN (if configured). Below is an example showing how to start and run the generator on load by SMS message.

NOTE: There MUST be a space between the SMS PIN and the Control Command Number

PIN

Control Command Number

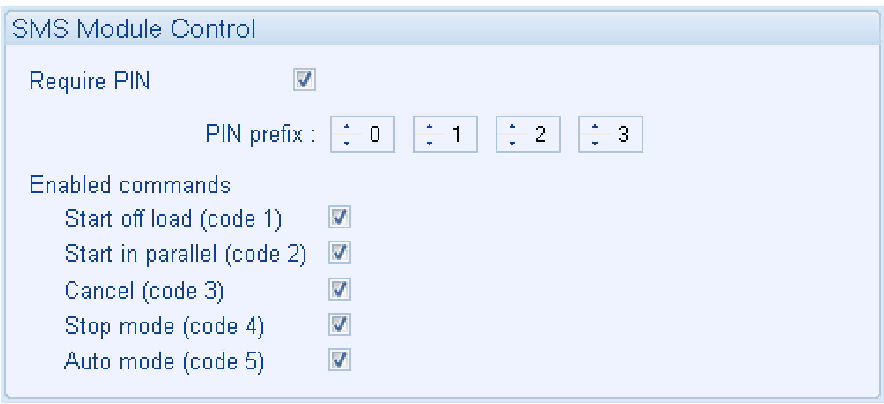
SMS Message 1	
0123 5	This SMS message places the module into the ***Auto Mode***.

SMS Message 2	
0123 2	This SMS message will start generator and run it on load.

SMS Message 3	
0123 3	This SMS message will remove the start and run command given by the previous SMS message and leave the module in the ***Auto Mode***.

SMS Message 4	
0123 4	This SMS message will place the module into the ***Stop/Reset Mode***.

Example screenshot of *SMS Control* setup in the DSE Configuration Suite:



6 OPERATION (DUAL MUTUAL STANDBY)

The following description details the sequences followed by a module containing the default factory settings modified to allow two controllers to operate in *Dual Mutual Standby*. The operating modes are as per the standard operation documented in the section *Operation* elsewhere in the manual with the addition of the *Dual Mutual Standby* functions detailed below.

If the completed generator set or control panel has been purchased from a third party supplier, the module's configuration would have been changed by them to suit their particular requirements. Always refer to the module's configuration source for the exact sequences and timers observed by any particular module in the field.

6.1 USING TWO DSE7310 MKII

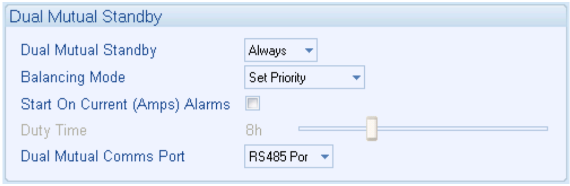
NOTE: In all operating modes, only one DSE7310 MKII is permitted to close its Generator load switching device at any time.

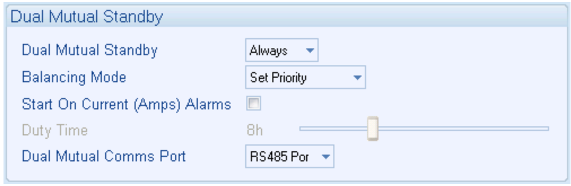
NOTE: Mechanical and/or electrical interlocks between the load switches is required.

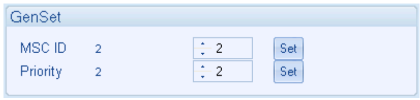
When using the two DSE7310 MKII modules, one on each generator, the *Dual Mutual Standby* feature allows a priority generator to be backed up. The generators starting and stopping to achieve this occurs automatically with no user intervention. Depending upon module configuration, the priority changes between the generators based on engine hours or an internal dual mutual timer.

6.1.1 BALANCING MODE: SET PRIORITY

Highest Priority | **Next Highest Priority**







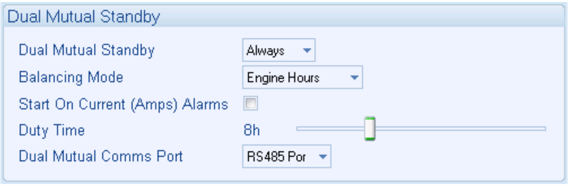
If a starting request is made, the starting sequence begins.
Starting requests are made from the following sources:

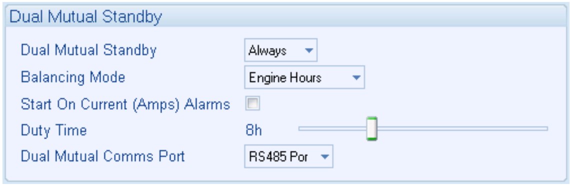
- Activation of a digital input that has been configured to *Remote Start On Load:*
  - The *Remote Start On Load* signal (connected to a digital input on both modules) controls the starting/stopping of both modules when they are in ***Auto Mode*** . In this instance, the *Highest Priority* starts its generator. If the *Highest Priority* fails, it instructs the *Next Highest Priority* to start and take the load using the digital communications link.
  - If the *Highest Priority* is running and the *Remote Start Signal On Load* signal is given to the *Next Highest Priority*, the *Next Highest Priority* does not start its generator until the *Highest Priority* generator fails.

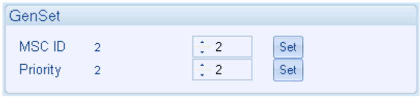
- Activation of the inbuilt scheduler:
  - In the *Dual Mutual Standby* operation, the inbuilt scheduler operates totally independently to the *Priority* scheme. Both generators could start, but only the *Highest Priority* is allowed to close its load switch to power the load.

6.1.2 BALANCING MODE: ENGINE HOURS/DUAL MUTUAL TIME

Highest Priority | **Next Highest Priority**







If a starting request is made, the starting sequence begins. Starting requests are made from the following sources:

- Activation of a digital input that has been configured to *Remote Start On Load:*
    - The *Remote Start On Load* signal (connected to a digital input on both modules) controls the starting/stopping of both modules when they are in ***Auto Mode***. In this instance, the generator with the lowest number of *Engine Hours* or *Dual Mutual Time* starts. If all generators have the same number of *Engine Hours* or *Dual Mutual Time*, the highest *Priority* starts. If the generator with the lowest number of *Engine Hours* or *Dual Mutual Time* fails, it instructs the next generator with the lowest number of *Engine Hours* or *Dual Mutual Time* to start and take the load using the digital communications link.
    - If a generator is running and the *Remote Start Signal On Load* signal is given to another generator with a lower number *Engine Hours* or *Dual Mutual Time*, it does not start until the generator fails. If the running generator's *Engine Hours* or *Dual Mutual Time* is greater than another generator's by the configured *Duty Time*, it instructs the next generator with the lowest number of *Engine Hours* or *Dual Mutual Time* to start and take the load using the digital communications link.

- Activation of the inbuilt scheduler:
    - In the *Dual Mutual Standby* operation, the inbuilt scheduler operates totally independently to the *Engine Hours* or *Dual Mutual Time* scheme. Both generators could start, but only the generator with the lowest number of *Engine Hours* or *Dual Mutual Time* is allowed to close its load switch to power the load.

6.2 USING TWO DSE7320 MKII

NOTE: In all operating modes, only one DSE7320 MKII is permitted to close a generator load switching device at any time.

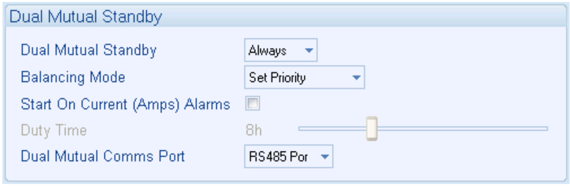
NOTE: In all operating modes, only one DSE7320 MKII is permitted to operate the mains load switching device at any time.

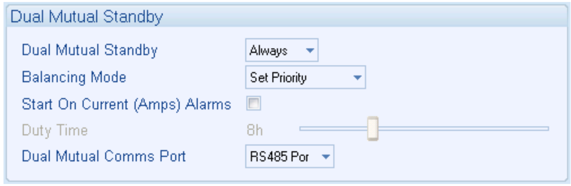
NOTE: Mechanical and/or electrical interlocks between all the load switches is required.

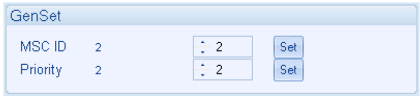
When using the two DSE7320 MKII modules, one on each generator, the *Dual Mutual Standby* feature allows a priority generator to be backed up whilst also backing up a mains supply. The generators starting and stopping to achieve this occurs automatically with no user intervention. The priority can be configured change between the generators based on engine hours or an internal dual mutual timer. The DSE7320 MKII which controls the mains load switch is the one which has the highest priority in that instant or whose generator is running on load.

6.2.1 BALANCING MODE: SET PRIORITY

Highest Priority	**Next Highest Priority**







If a starting request is made, the starting sequence begins. Starting requests are made from the following sources:

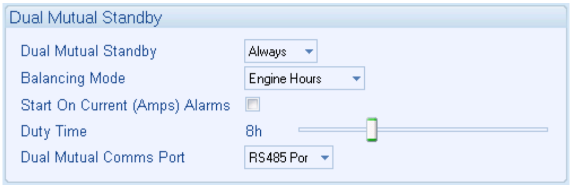
- No activation of a digital input configured to *Remote Start On Load* or no *Mains Failure Detection:*
  - If the *Highest Priority* module is not in the ***Stop/Reset Mode*** or does not have an *Electrical Trip Alarm* or *Shutdown Alarm* active, it controls the mains load switch by activating the required close or open signal. The other module ensures its close and open signals are turned off so no conflicting control signals are sent to the mains load switch.
  - If the *Highest Priority* module is in the ***Stop/Reset Mode*** or has an *Electrical Trip Alarm* or *Shutdown Alarm* active, it passes control of the mains load switch to *Next Highest Priority*. The *Next Highest Priority* activates the required close or open signal prior to the *Highest Priority* de-activating its control signal. This is done to ensure that the mains load switch is maintained in the required position whilst changing over control between the modules.

- Activation of a digital input configured to *Remote Start On Load or Mains Failure Detection:*
  - The *Remote Start On Load* signal (connected to a digital input on both modules) or *Mains Failure* detection (loss of mains sensing on both modules) controls the starting/stopping of both modules when they are in ***Auto Mode*** AUTO. In this instance, the *Highest Priority* starts its generator. If the *Highest Priority* generator fails to start, control is passed to the *Next Highest Priority* using the digital communications link. The *Next Highest Priority* takes control of the mains load switch and starts its generator. Once the generator is available, the load is then transferred.
  - If the *Highest Priority* is running and the *Remote Start Signal On Load* signal or *Mains Failure* detection occurs on the *Next Highest Priority*, the *Next Highest Priority* does not attain control nor start its generator until the *Highest Priority* generator fails.

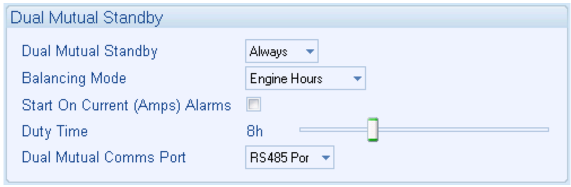
- Activation of the inbuilt scheduler:
  - In the *Dual Mutual Standby* operation, the inbuilt scheduler operates totally independently to the *Priority* scheme. Both generators could start, but only the *Highest Priority* is allowed to control the mains load switch and transfer the load to its generator.

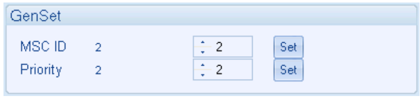
6.2.2 BALANCING MODE: ENGINE HOURS/DUAL MUTUAL TIME

Highest Priority



Next Highest Priority





If a starting request is made, the starting sequence begins. Starting requests are made from the following sources:

- No activation of a digital input configured to *Remote Start On Load* or no *Mains Failure Detection:*
  - If the module with the lowest number of *Engine Hours* or *Dual Mutual Time* is not in the ***Stop/Reset Mode*** or, does not have an *Electrical Trip / Shutdown Alarm* active, it controls the mains load switch by activating the required close or open signal. The other module ensures its close and open signals are turned off so no conflicting control signals are sent to the mains load switch.
  - If the module with the lowest number of *Engine Hours* or *Dual Mutual Time* is in the ***Stop/Reset Mode*** or, has an *Electrical Trip / Shutdown Alarm* active, it passes control of the mains load switch to the next generator with the lowest number of *Engine Hours* or *Dual Mutual Time*. The next generator with the lowest number of *Engine Hours* or *Dual Mutual Time* activates the required close or open signal prior to generator with the lowest number of *Engine Hours* or *Dual Mutual Time* de-activating its control signal. This is done to ensure that the mains load switch is maintained in the required position whilst changing over control between the modules.

- Activation of a digital input configured to *Remote Start On Load or Mains Failure Detection:*
    - The *Remote Start On Load* signal (connected to a digital input on both modules) or *Mains Failure* detection (loss of mains sensing on both modules) controls the starting/stopping of both modules when they are in ***Auto Mode*** . In this instance, the module with the lowest number of *Engine Hours* or *Dual Mutual Time* starts its generator. If the module with the lowest number of *Engine Hours* or *Dual Mutual Time* generator fails to start, control is passed to the next generator with the lowest number of *Engine Hours* or *Dual Mutual Time* using the digital communications link. The next generator with the lowest number of *Engine Hours* or *Dual Mutual Time* takes control of the mains load switch and starts its generator. Once the generator is available, the load is then transferred.
    - If the module with the lowest number of *Engine Hours* or *Dual Mutual Time* generator is running and the *Remote Start Signal On Load* signal or *Mains Failure* detection occurs on the next generator with the lowest number of *Engine Hours* or *Dual Mutual Time*, it does not attain control or start its generator until module with the running generator fails.

- Activation of the inbuilt scheduler:
    - In the *Dual Mutual Standby* operation, the inbuilt scheduler operates totally independently to the *Engine Hours* or *Dual Mutual Time* scheme. Both generators could start, but only the with the lowest number of *Engine Hours* or *Dual Mutual Time* is allowed to control the mains load switch and transfer the load to its generator.

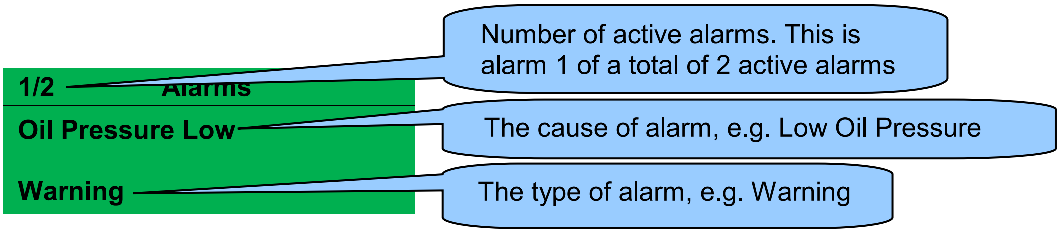
7 PROTECTIONS

7.1 ALARMS

When an alarm is active, the *Internal Audible Alarm* sounds and the *Common Alarm* output if configured, activates.

The audible alarm is silenced by pressing the ***Alarm Mute / Lamp Test*** button.

The LCD display jumps from the 'Information page' to display the Alarm Page



The LCD displays multiple alarms such as "*Coolant Temperature High*", "*Emergency Stop*" and "*Low Coolant Warning*". These automatically scroll in the order that they occurred or press the ***Instrumentation Scroll*** buttons to scroll through manually.

In the event of an alarm, the LCD displays the appropriate text. If an additional alarm then occurs, the module displays the appropriate text.

Example:

7.1.1 PROTECTIONS DISABLED

User configuration is possible to prevent *Shutdown* and *Electrical Trip* alarms from stopping the generator. Under such conditions, *Protections Disabled* appears on the module display to inform the operator. *Shutdown* and *Electrical Trip* alarms still appear however, the operator is informed the alarms are blocked.

Example:

1/1	**Alarms**
Oil Pressure Low	
Shutdown Blocked	

This feature is provided to assist the system designer in meeting specifications for *Warning Only, Protections Disabled*, *Run to Destruction*, *War Mode* or other similar wording.

When configuring this feature in the PC software, the system designer chooses to make the feature permanently active or only active upon operation of an external switch. The system designer provides this switch (not DSE) so its location varies depending upon manufacturer, however it normally takes the form of a key operated switch to prevent inadvertent activation. Depending upon configuration, a warning alarm may be generated when the switch is operated.

The feature is configurable in the PC configuration software for the module. Writing a configuration to the controller that has “Protections Disabled” configured, results in a warning message appearing on the PC screen for the user to acknowledge before the controller’s configuration is changed. This prevents inadvertent activation of the feature.

7.1.2 ECU ALARMS (CAN FAULT CODES / DTC)

NOTE: For details on these code meanings, refer to the ECU instructions provided by the engine manufacturer, or contact the engine manufacturer for further assistance.

NOTE: For further details on connection to electronic engines, refer to DSE Publication: *057-004 Electronic Engines And DSE Wiring*

When connected to a suitable CAN engine, the controller displays alarm status messages from the ECU in the *Alarms* section of the display.

1/1 Alarms
ECU Warning

Warning

Type of alarm that is triggered on the DSE module, e.g. Warning

Press the ***Next Page***  button to access the list of *ECU Current DTCs* (Diagnostic Trouble Codes) from the ECU which are DM1 messages.

1/2 ECU Current DTCs
Water Level Low

SPN=131166 , FMI=8, OC=127

The DM1 DTC is interpreted by the module and is shown on the module's display as a text message. In addition to this, the manufacturer's DTC is shown below.

Press the ***Next Page***  button to access the list of *ECU Prev. DTCs* (Diagnostic Trouble Codes) from the ECU which are DM2 messages.

1/10 ECU Prev. DTCs
Water Level Low

SPN=131166 , FMI=8, OC=127

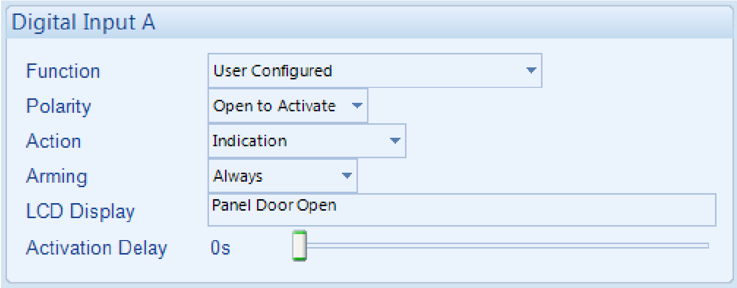
The DM2 DTC is interpreted by the module and is shown on the module's display as a text message. In addition to this, the manufacturer's DTC is shown below.

7.2 INDICATIONS

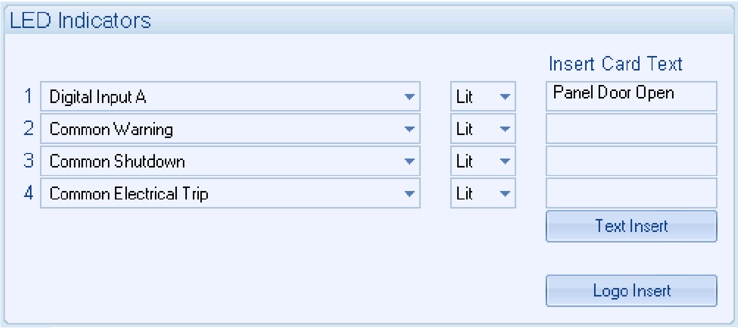
Indications are non-critical and often status conditions. They do not appear on the LCD display of the module as a text message in the *Status, Event Log* or *Alarms* pages. However, an output or LED indicator is configured to draw the operator's attention to the event.

Example:

- Input configured for indication.
- The LCD text does not appear on the module display but can be added in the configuration to remind the system designer what the input is used for.
- As the input is configured to *Indication* there is no alarm generated.



- LED Indicator 1 illuminates when Digital Input A is active.
- The Insert Card Text allows the system designer to print an insert card detailing the LED function.



- Example showing operation of the LED.

7.3 WARNING ALARMS

Warnings are non-critical alarm conditions and do not affect the operation of the engine system, they serve to draw the operators attention to an undesirable condition.

Example:

1/2 Alarms
Coolant Temp High
Warning

In the event of an alarm the LCD jumps to the alarms page, and scroll through all active alarms.

By default, warning alarms are self-resetting when the fault condition is removed. However enabling *All Warnings Are Latched* causes warning alarms to latch until reset manually. This is enabled using the DSE Configuration Suite in conjunction with a compatible PC.

If the module is configured for **CAN** and receives an "error" message from the ECU, 'ECU Warning" is shown on the module's display as a warning alarm.

Fault	Description
2130 ID 0 to 3 Analogue Input E to H High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2130 had risen above the *Flexible Sensor High Pre-Alarm Trip* level.
2130 ID 0 to 3 Analogue Input E to H Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2130 had fallen below the *Flexible Sensor Low Pre-Alarm Trip* level.
2130 ID 0 to 3 Digital Input A to H	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a digital input configured to create a fault condition on a DSE2130 expansion module became active and the appropriate LCD message displayed.

Continued over page…

Fault	Description
DSE2131 ID 0 to 3 Analogue Input A to J High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2131 had risen above the *Flexible Sensor High Pre-Alarm Trip* level.
DSE2131 ID 0 to 3 Analogue Input A to J Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2131 had fallen below the *Flexible Sensor Low Pre-Alarm Trip* level.
DSE2131 ID 0 to 3 Digital Input A to J	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a digital input configured to create a fault condition on a DSE2131 expansion module became active and the appropriate LCD message displayed.
DSE2133 ID 0 to 3 Analogue Input A to H High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2133 had risen above the *Temperature Sensor High Pre-Alarm Trip* level.
DSE2133 ID 0 to 3 Analogue Input A to H Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2133 had fallen below the *Temperature Sensor Low Pre-Alarm Trip* level.
Charger ID 0 to 3 Common Warning	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a battery charger connected by DSENet® had issued a *Common Warning Alarm*.

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Fault	Description
Analogue Input A to F (Digital)	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.** The module detected that an analogue input configured as a digital input to create a fault condition became active and the appropriate LCD message is displayed.
AVR Data Fail	The module is configured to communicate to the generator's AVR by CAN but has not detected data being sent from the generator's AVR.
AVR Fault	The module received a red fault condition from the alternators AVR.
Battery Detect Failure	The module detected that a battery charger connected by DSENet® had issued a *Battery Detect Failure* alarm.
Battery Failure Detection Output 1	The module detected that a battery charger connected by DSENet® had issued a *Battery Failure Detection* alarm on its Output 1.
Battery Failure Detection Output 2	The module detected that a battery charger connected by DSENet® had issued a *Battery Failure Detection* alarm on its Output 2.
Battery High Current Output 1	The module detected that a battery charger connected by DSENet® had issued a *Battery High Current* alarm on its Output 1.
Battery High Current Output 2	The module detected that a battery charger connected by DSENet® had issued a *Battery High Current* alarm on its Output 2.
Battery High Temperature Output 1	The module detected that a battery charger connected by DSENet® had issued a *Battery High Temperature* alarm on its Output 1.
Battery High Temperature Output 2	The module detected that a battery charger connected by DSENet® had issued a *Battery High Temperature* alarm on its Output 2.
Battery High Voltage Output 1	The module detected that a battery charger connected by DSENet® had issued a *Battery High Voltage* alarm on its Output 1.
Battery High Voltage Output 2	The module detected that a battery charger connected by DSENet® had issued a *Battery High Voltage* alarm on its Output 2.
Battery Low Voltage Output 1	The module detected that a battery charger connected by DSENet® had issued a *Battery Low Voltage* alarm on its Output 1.
Battery Low Voltage Output 2	The module detected that a battery charger connected by DSENet® had issued a *Battery Low Voltage* alarm on its Output 2.
Battery Temperature Sensor Fail Output 1	The module detected that a battery charger connected by DSENet® had issued a *Battery Temperature Fail* alarm on its Output 1.
Battery Temperature Sensor Fail Output 2	The module detected that a battery charger connected by DSENet® had issued a *Battery Temperature Fail* alarm on its Output 2.
Calibration Fault	The module detected that its internal calibration has failed. The unit must be sent back to DSE to be investigated and repaired. Contact DSE Technical Support for more details.
Charge Alt Failure IEEE 37.2 – 27 DC Undervoltage Relay	The module detected that the output voltage of the charge alternator had fallen below the *Charge Alternator Warning Trip* level for the configured delay timer.
Charger Fan Locked	The module detected that a battery charger connected by DSENet® had a *Failure* alarm.
Charger High Temperature	The module detected that a battery charger connected by DSENet® had a *High Temperature* alarm.
Charger Mains High Current	The module detected that a battery charger connected by DSENet® had a *Mains High Current* alarm.
Charger Mains High Voltage	The module detected that a battery charger connected by DSENet® had a *Mains High Voltage* alarm.

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Fault	Description
Charger Mains Low Voltage	The module detected that a battery charger connected by DSENet® had a *Mains Low Voltage* alarm.
Charger Voltage Drop Charging Cable Output 1	The module detected that a battery charger connected by DSENet® had issued a *Voltage Drop Charging Cable* alarm on its Output 1.
Charger Voltage Drop Charging Cable Output 2	The module detected that a battery charger connected by DSENet® had issued a *Voltage Drop Charging Cable* alarm on its Output 2.
Coolant Temp High IEEE C37.2 – 26 Apparatus Thermal Device	The module detected that the engine coolant temperature had risen above the *High Coolant Temperature Pre-Alarm Trip* level after the *Safety On Delay* timer had expired.
DC Battery High Voltage IEEE 37.2 – 59 DC Overvoltage Relay	The module detected that its DC supply voltage had risen above the *Plant Battery Overvolts Warning Trip* level for the configured delay timer.
DC Battery Low Voltage IEEE 37.2 – 27 DC Undervoltage Relay	The module detected that its DC supply voltage had fallen below the *Plant Battery Undervolts Warning Trip* level for the configured delay timer.
DEF Level Low	The module received a fault condition from the engine ECU alerting about the DEF level or the module detected that the *DEF Level* had fallen below the *DEF Level Low Pre-Alarm Trip* level for the configured delay timer.
Digital Input A to H	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.** The module detected that a digital input configured to create a fault condition became active and the appropriate LCD message is displayed.
DPTC Filter	The module received a fault condition from the engine ECU alerting that the DPF/DPTC had activated.
Earth Fault IEEE C37.2 – 51G or 51N Generator IDMT Earth Fault Relay	**NOTE: For more details, see section entitled Earth Fault IDMT Alarm elsewhere in this document.** The module detected that the generator earth fault current had risen above the *Earth Fault Trip Level* for the duration of the IDMT function.
ECU Amber	The module received an amber fault condition from the engine ECU.
ECU Data Fail	The module is configured for CAN operation but has not detected data being sent from the engine's ECU.
ECU Malfunc.	The module received a malfunction fault condition from the engine ECU.
ECU Protect	The module received a protect fault condition from the engine ECU.
ECU Red	The module received a red fault condition from the engine ECU.
Engine Over Speed IEEE C37.2 - 12 Overspeed Device	The module detected that the engine speed had risen above the *Over Speed Pre-Alarm Trip* level for the configured delay timer.
Engine Over Speed Delayed IEEE C37.2 - 12 Overspeed Device	The module detected that the engine speed had risen above the *Over Speed Trip* level but was below the *Over Speed Overshoot Trip* for the configured *Overshoot Delay* timer during starting.
Engine Under Speed IEEE C37.2 - 14 Underspeed Device	The module detected that the engine speed had fallen below the *Under Speed Pre-Alarm Trip* level for the configured delay timer after the *Safety On Delay* timer had expired.
Escape Mode	The module detected that an *Escape Mode* request has been sent to the engine ECU.
Exp. Unit Failure	The module detected that communications to one of the DSENet® expansion modules had been lost.

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Fault	Description
Fail to Synchronise	The module failed to synchronise the generator to the mains before the *Fail to Sync Delay* timer had expired. The generator continues to run until it has successfully synchronised to the mains.
Flexible Sensor A to F High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value had risen above the *Flexible Sensor High Pre-Alarm Trip* level.
Flexible Sensor A to F Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value had fallen below the *Flexible Sensor Low Pre-Alarm Trip* level.
Fuel Level High IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine fuel level rose above the *High Fuel Level Trip* level.
Fuel Level Low IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine fuel level had fallen below the *Low Fuel Level Trip* level.
Fuel Level Low Switch IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine low fuel level switch had activated.
Fuel Tank Bund Level High IEEE C37.2 - 71 Liquid Level Switch	The module detected that the fuel tank bund level switch had activated.
Fuel Usage IEEE C37.2 – 80 Flow Switch	The module detected that the fuel consumption was more then the configured *Running Rate* or *Stopped Rate*.
Gen Failed to Close IEEE C37.2 – 52b AC Circuit Breaker Position (Contact Open when Breaker Closed)	The module detected that the generator load switch had failed to close as the Generator Closed Auxiliary input did not activate within the Generator Fail to Close Delay time after the Close Gen Output activated.
Gen Failed to Open IEEE C37.2 – 52b AC Circuit Breaker Position (Contact Open when Breaker Closed)	The module detected that the generator load switch had failed to open as the Generator Closed Auxiliary input did not deactivate within the Generator Fail to Open Delay time after the Close Gen Output deactivated.
Gen Loading Voltage	The module detected that the generator output voltage had not risen above the *Generator Loading Voltage* setting after the *Warming Up* timer had expired.
Gen Over Current IEEE C37.2 – 50 Instantaneous Overcurrent Relay IEEE C37.2 – 51 IDMT Overcurrent Relay	**NOTE: For more details, see section entitled Over Current Alarm elsewhere in this document.** The module detected that the generator output current had risen above the *Generator Over Current Trip*.
Gen Over Frequency IEEE C37.2 – 81 Frequency Relay	The module detected that the generator output frequency had risen above the *Over Frequency Pre-Alarm Trip* level for the configured delay timer.
Gen Over Frequency Delayed IEEE C37.2 – 81 Frequency Relay	The module detected that the generator output frequency had risen above the *Over Frequency Trip* level but was below the *Over Frequency Overshoot Trip* for the configured *Overshoot Delay* timer during starting.
Gen Over Voltage IEEE C37.2 – 59 AC Overvoltage Relay	The module detected that the generator output voltage had risen above the *Over Voltage Pre-Alarm Trip* level for the configured delay timer.

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Fault	Description
Gen Reverse Power IEEE C37.2 – 32 Directional Power Relay	The module detected that the generator output kW had fallen below the *Reverse Power Trip* for the configured delay timer.
Gen Short Circuit IEEE C37.2 – 51 IDMT Short Circuit Relay	**NOTE: For more details, see section entitled *Short Circuit IDMT Alarm* elsewhere in this document.** The module detected that the generator output current had risen above the *Short Circuit Trip* for the duration of the IDMT function.
Gen Under Frequency IEEE C37.2 – 81 Frequency Relay	The module detected that the generator output frequency had fallen below the *Under Frequency Pre-Alarm Trip* level for the configured delay timer after the *Safety On Delay* timer had expired.
Gen Under Voltage IEEE C37.2 – 27 AC Undervoltage Relay	The module detected that the generator output voltage had fallen below the *Under Voltage Pre-Alarm Trip* level for the configured delay timer after the *Safety On Delay* timer had expired.
HEST Active	The module received a fault condition from the engine ECU alerting that the HEST had activated.
Inlet Temperature	The module detected that the engine's ECU measurement of inlet temperature had risen above the *Inlet Temperature Alarm Pre-Alarm Trip* level.
kW Overload IEEE C37.2 – 32 Directional Power Relay	The module detected that the generator output kW had risen above the *Overload Protection Trip* for the configured delay timer
Loss of Mag-PU	The module detected that the magnetic pick up was not producing a pulse output after the required *Crank Disconnect* criteria had been met.
Low Coolant Warning	The module detected that the engine coolant temperature had fallen below the *Low Coolant Temperature Pre-Alarm Trip* level.
Low Load IEEE C37.2 – 37 Undercurrent ot Underpower relay	The module detected that the load had fallen below the *Low Load Alarm Trip* level.
Mains Earth Fault IEEE C37.2 – 51 IDMT Overcurrent Relay	**NOTE: For more details, see section entitled Earth Fault IDMT Alarm elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that the generator earth fault current had risen above the *Mains Earth Fault Trip Level* for the duration of the IDMT function.
Mains Failed to Close IEEE C37.2 – 52b AC Circuit Breaker Position (Contact Open when Breaker Closed)	The module detected that the mains load switch had failed to close as the Mains Closed Auxiliary input did not activate within the Mains Fail to Close Delay time after the Close Mains Output activated.
Mains Failed to Open IEEE C37.2 – 52b AC Circuit Breaker Position (Contact Open when Breaker Closed)	The module detected that the mains load switch had failed to open as the Mains Closed Auxiliary input did not deactivate within the Mains Fail to Open Delay time after the Close Mains Output deactivated.

Continued over page…

Fault	Description
Mains Over Current IEEE C37.2 – 50 Instantaneous Overcurrent Relay IEEE C37.2 – 51 IDMT Overcurrent Relay	**NOTE: For more details, see section entitled *Over Current Alarm* elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-262 DSE7410 MKII & DSE7420 MKII Configuration Software Manual.*** The module detected that the mains output current had risen above the *Mains Over Current Trip*.
Mains Phase Seq Wrong	The module detected that the phase rotation of the mains was different to the configured *Mains Phase Rotation Alarm* setting.
Mains Short Circuit IEEE C37.2 – 51 IDMT Short Circuit Relay	**NOTE: For more details, see section entitled *Short Circuit IDMT Alarm* elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that the mains output current had risen above the *Short Circuit Trip* for the duration of the IDMT function.
Maintenance Due	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.** The module detected that one of the configured maintenance alarms is due as its configured maintenance interval has expired.
MSC Failure	The module detected that *Dual Mutual Standby* communication link had failed.
Negative kvar IEEE C37.2 – 40 Field Under Excitation Relay	The module detected that the generator output kvar had fallen below the *Negative var Pre-Alarm Trip* for the configured delay timer.
Negative Phase Sequence IEEE C37.2 - 46 Phase-Balance Current Relay	The module detected that there was an imbalance of current across the generator phases greater than the *Negative Phase Sequence Trip Level* percentage setting.
Oil Pressure Low IEEE C37.2 - 63 Pressure Switch	The module detected that the engine oil pressure had fallen below the *Low Oil Pressure Pre-Alarm Trip* level after the *Safety On Delay* timer had expired.
Positive kvar IEEE C37.2 – 40 Field Over Excitation Relay	The module detected that the generator output kvar had risen above the Positive var Pre-Alarm Trip for the configured delay timer.
Protections Disabled	The module detected that an input configured for Protections Disable became active.
SCR Inducement	The module received a fault condition from the engine ECU alerting about the SCR Inducement.
Water in Fuel	The module received a fault condition from the engine ECU alerting that water in the fuel had been detected.

7.4 ELECTRICAL TRIP ALARMS

> **NOTE: The fault condition must be resolved before the alarm can be reset. If the fault condition remains, it is not possible to reset the alarm (the exception to this is the *Coolant Temp High* alarm and similar *Active From Safety On* alarms, as the coolant temperature could be high with the engine at rest).**

Electrical Trip Alarms are latching and stop the Generator but in a controlled manner. On initiation of the electrical trip condition the module de-activates the ***Close Gen Output*** outputs to remove the load from the generator. Once this has occurred the module starts the *Cooling Timer* and allows the engine to cool off-load before shutting down the engine. To restart the generator the fault must be cleared and the alarm reset.

Example:

1/2 Alarms
Gen Over Current

Electrical Trip

In the event of an alarm the LCD jumps to the alarms page and scrolls through all active alarms.

Electrical Trip Alarms are latching alarms and to remove the fault, press the ***Stop/Reset Mode*** button on the module.

Fault	Description
2130 ID 1 to 4 Analogue Input E to H High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2130 had risen above the *Flexible Sensor High Alarm Trip* level.
2130 ID 1 to 4 Analogue Input E to H Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2130 had fallen below the *Flexible Sensor Low Alarm Trip* level.
2130 ID1 to 4 Digital Input A to H	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a digital input configured to create a fault condition on a DSE2130 expansion module became active and the appropriate LCD message displayed.

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Fault	Description
DSE2131 ID 0 to 3 Analogue Input A to J High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2131 had risen above the *Flexible Sensor High Alarm Trip* level.
DSE2131 ID 0 to 3 Analogue Input A to J Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2131 had fallen below the *Flexible Sensor Low Alarm Trip* level.
DSE2131 ID 0 to 3 Digital Input A to J	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a digital input configured to create a fault condition on a DSE2131 expansion module became active and the appropriate LCD message displayed.
DSE2133 ID 0 to 3 Analogue Input A to H High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2133 had risen above the *Temperature Sensor High Alarm Trip* level.
DSE2133 ID 0 to 3 Analogue Input A to H Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2133 had fallen below the *Temperature Sensor Low Alarm Trip* level.
Charger ID 0 to 3 Common Electrical Trip	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a battery charger connected by DSENet® had issued a *Common Electrical Trip Alarm*.

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Fault	Description
Analogue Input A to F (Digital)	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.** The module detected that an analogue input configured as a digital input to create a fault condition became active and the appropriate LCD message is displayed.
Auto Sense Fail	The module detected that the output voltage of the generator had risen above the *Over Voltage During Auto Sensing Trip* level during starting whilst attempting to detect which alternative configuration to use.
AVR Data Fail	The module is configured to communicate to the generator's AVR by CAN but has not detected data being sent from the generator's AVR.
AVR Fault	The module received a red fault condition from the alternators AVR.
Calibration Fault	The module detected that its internal calibration has failed. The unit must be sent back to DSE to be investigated and repaired. Contact DSE Technical Support for more details.
Coolant Temp High IEEE C37.2 – 26 Apparatus Thermal Device	The module detected that the engine coolant temperature had risen above the *High Coolant Temperature Electrical Trip* level after the *Safety On Delay* timer had expired.
DEF Level Low	The module received a fault condition from the engine ECU alerting about the DEF level or the module detected that the *DEF Level* had fallen below the *DEF Level Low Alarm Trip* level for the configured delay timer.
Digital Input A to H	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.** The module detected that a digital input configured to create a fault condition became active and the appropriate LCD message is displayed.
DPTC Filter	The module received a fault condition from the engine ECU alerting that the DPF/DPTC had activated.
Earth Fault IEEE C37.2 – 51G or 51N Generator IDMT Earth Fault Relay	**NOTE: For more details, see section entitled Earth Fault IDMT Alarm elsewhere in this document.** The module detected that the generator earth fault current had risen above the *Earth Fault Trip Level* for the duration of the IDMT function.
ECU Amber	The module received an amber fault condition from the engine ECU.
ECU Data Fail	The module is configured for CAN operation but has not detected data being sent from the engine's ECU.
ECU Malfunc.	The module received a malfunction fault condition from the engine ECU.
ECU Protect	The module received a protect fault condition from the engine ECU.
ECU Red	The module received a red fault condition from the engine ECU.
Exp. Unit Failure	The module detected that communications to one of the DSENet® expansion modules had been lost.
Fail to Synchronise	The module failed to synchronise the generator to the mains before the Fail to Sync Delay timer had expired. A break changeover occurs and the generator goes into a cooling run.

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Fault	Description
Flexible Sensor A to F High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value had risen above the *Flexible Sensor High Alarm Trip* level.
Flexible Sensor A to F Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value had fallen below the *Flexible Sensor Low Alarm Trip* level.
Fuel Level High IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine fuel level rose above the *High Fuel Level Trip* level.
Fuel Level Low IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine fuel level had fallen below the *Low Fuel Level Trip* level.
Fuel Level Low Switch IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine low fuel level switch had activated.
Fuel Tank Bund Level High IEEE C37.2 - 71 Liquid Level Switch	The module detected that the fuel tank bund level switch had activated.
Fuel Usage IEEE C37.2 – 80 Flow Switch	The module detected that the fuel consumption was more then the configured Running Rate or Stopped Rate.
Gen Loading Frequency	The module detected that the generator output frequency had not risen above the Generator Loading Frequency setting after the Warming Up timer had expired.
Gen Loading Voltage	The module detected that the generator output voltage had not risen above the Generator Loading Voltage setting after the Warming Up timer had expired.
Gen Over Current IEEE C37.2 – 51 IDMT Overcurrent Relay	**NOTE: For more details, see section entitled Over Current Alarm elsewhere in this document.** The module detected that the generator output current had risen above the Generator Over Current Trip for the duration of the IDMT function.
Gen Phase Seq Wrong IEEE C37.2 – 47 Phase Sequence Relay	The module detected that the phase rotation of the generator was different to the configured Generator Phase Rotation Alarm setting.
Gen Reverse Power IEEE C37.2 – 32 Directional Power Relay	The module detected that the generator output kW had fallen below the *Reverse Power Trip* for the configured delay timer.
Gen Short Circuit IEEE C37.2 – 51 IDMT Short Circuit Relay	**NOTE: For more details, see section entitled *Short Circuit IDMT Alarm* elsewhere in this document.** The module detected that the generator output current had risen above the *Short Circuit Trip* for the duration of the IDMT function.

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Fault	Description
Inlet Temperature	The module detected that the engine's ECU measurement of inlet temperature had risen above the *Inlet Temperature Alarm Trip* level.
kW Overload IEEE C37.2 – 32 Directional Power Relay	The module detected that the generator output kW had risen above the Overload Protection Trip for the configured delay timer.
Loss of Mag-PU	The module detected that the magnetic pick up was not producing a pulse output after the required Crank Disconnect criteria had been met.
Low Load IEEE C37.2 – 37 Undercurrent ot Underpower relay	The module detected that the load had fallen below the *Low Load Alarm Trip* level.
Mains Earth Fault IEEE C37.2 – 51G or 51N IDMT Earth Fault Relay	**NOTE: For more details, see section entitled Earth Fault IDMT Alarm elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that the generator earth fault current had risen above the *Mains Earth Fault Trip Level* for the duration of the IDMT function.
Mains Over Current IEEE C37.2 – 51 IDMT Overcurrent Relay	**NOTE: For more details, see section entitled Over Current Alarm elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that the mains output current had risen above the *Mains Over Current Trip* for the duration of the IDMT function.
Mains Phase Seq Wrong IEEE C37.2 – 47 Phase Sequence Relay	The module detected that the phase rotation of the mains was different to the configured *Mains Phase Rotation Alarm* setting.
Mains Short Circuit IEEE C37.2 – 51 IDMT Short Circuit Relay	**NOTE: For more details, see section entitled *Short Circuit IDMT Alarm* elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that the mains output current had risen above the *Short Circuit Trip* for the duration of the IDMT function.

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Fault	Description
Maintenance Due	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.** The module detected that one of the configured maintenance alarms is due as its configured maintenance interval has expired.
MSC ID Error	The module detected that another module on the *Dual Mutual Standby* communication link had the same *GenSet MSC ID* configured.
MSC Old Version Unit	The module detected that another module on the *Dual Mutual Standby* communication link had an incompatible *Dual Mutual Standby* version to its own.
Negative kvar IEEE C37.2 – 40 Field Under Excitation Relay	The module detected that the generator output kvar had fallen below the *Negative var Alarm Trip* for the configured delay timer.
Negative Phase Sequence IEEE C37.2 - 46 Phase-Balance Current Relay	The module detected that there was an imbalance of current across the generator phases greater than the *Negative Phase Sequence Trip Level* percentage setting.
Positive kvar IEEE C37.2 – 40 Field Over Excitation Relay	The module detected that the generator output kvar had risen above the *Positive var Alarm Trip* for the configured delay timer.
Priority Selection Error	The module detected that another module on the *Dual Mutual Standby* communication link had the same *GenSet Priority* configured.
SCR Inducement	The module received a fault condition from the engine ECU alerting about the SCR Inducement.
Water in Fuel	The module received a fault condition from the engine ECU alerting that water in the fuel had been detected.

7.5 SHUTDOWN ALARMS

NOTE: The fault condition must be resolved before the alarm can be reset. If the fault condition remains, it is not possible to reset the alarm (the exception to this is the *Oil Pressure Low* alarm and similar *Active From Safety On* alarms, as the oil pressure is low with the engine at rest).

Shutdown Alarms are latching and immediately stop the Generator. On initiation of the shutdown condition the module de-activates the ***Close Gen Output*** outputs to remove the load from the generator. Once this has occurred, the module shuts the generator set down immediately to prevent further damage. To restart the generator the fault must be cleared and the alarm reset.

Example:

1/2 Alarm
Oil Pressure Low **Shutdown**

In the event of an alarm the LCD jumps to the alarms page and scrolls through all active alarms.

Shutdown Alarms are latching alarms and to remove the fault, press the ***Stop/Reset Mode*** button on the module.

Fault	Description
2130 ID 1 to 4 Analogue Input E to H High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2130 had risen above the *Flexible Sensor High Alarm Trip* level.
2130 ID 1 to 4 Analogue Input E to H Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2130 had fallen below the *Flexible Sensor Low Alarm Trip* level.
2130 ID1 to 4 Digital Input A to H	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a digital input configured to create a fault condition on a DSE2130 expansion module became active and the appropriate LCD message displayed.

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Fault	Description
DSE2131 ID 0 to 3 Analogue Input A to J High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2131 had risen above the *Flexible Sensor High Alarm Trip* level.
DSE2131 ID 0 to 3 Analogue Input A to J Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2131 had fallen below the *Flexible Sensor Low Alarm Trip* level.
DSE2131 ID 0 to 3 Digital Input A to J	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a digital input configured to create a fault condition on a DSE2131 expansion module became active and the appropriate LCD message displayed.
DSE2133 ID 0 to 3 Analogue Input A to H High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2133 had risen above the *Temperature Sensor High Alarm Trip* level.
DSE2133 ID 0 to 3 Analogue Input A to H Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value of a DSE2133 had fallen below the *Temperature Sensor Low Alarm Trip* level.
Charger ID 0 to 3 Common Shutdown	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that a battery charger connected by DSENet® had issued a *Common Shutdown Alarm*.

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Fault	Description
Analogue Input A to F (Digital)	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input configured as a digital input to create a fault condition became active and the appropriate LCD message is displayed.
Auto Sense Fail	The module detected that the output voltage of the generator had risen above the *Over Voltage During Auto Sensing Trip* level during starting whilst attempting to detect which alternative configuration to use.
AVR Data Fail	The module is configured to communicate to the generator's AVR by CAN but has not detected data being sent from the generator's AVR.
AVR Fault	The module received a red fault condition from the alternators AVR.
Battery Temp	The module detected that a battery charger connected by DSENet® had issued a *Battery Temperature* alarm
Calibration Fault	The module detected that its internal calibration has failed. The unit must be sent back to DSE to be investigated and repaired. Contact DSE Technical Support for more details.
Charge Alt Failure IEEE C37.2 – 27DC Undervoltage Relay	The module detected that the output voltage of the charge alternator had risen above the *Charge Alternator Shutdown Trip* level for the configured delay timer.
Charger Failure	The module detected that a battery charger connected by DSENet® had a *Failure* alarm.
Charger Fan Locked	The module detected that a battery charger connected by DSENet® had a *Failure* alarm.
Charger High Temperature	The module detected that a battery charger connected by DSENet® had a *High Temperature* alarm.
Charger Input Fuse Fail	The module detected that a battery charger connected by DSENet® had an *Input Fuse Fail* alarm.
Charger Mains High Current	The module detected that a battery charger connected by DSENet® had a *Mains High Current* alarm.
Charger Mains High Voltage	The module detected that a battery charger connected by DSENet® had a *Mains High Voltage* alarm.
Charger Mains Low Voltage	The module detected that a battery charger connected by DSENet® had a *Mains Low Voltage* alarm.
Charger Reverse Polarity	The module detected that a battery charger connected by DSENet® had a *Reverse Polarity* alarm.
Charger Short Circuit	The module detected that a battery charger connected by DSENet® had a *Short Circuit* alarm.
Charger Short Circuit / Reverse Polarity	The module detected that a battery charger connected by DSENet® had a combined *Short Circuit* and *Reverse Poloarity* alarm.
Coolant Sender O/C	The module detected that circuit to the engine coolant temperature sensor had become open circuit.
Coolant Temp High IEEE C37.2 – 26 Apparatus Thermal Device	The module detected that the engine coolant temperature had risen above the *High Coolant Temperature Shutdown Trip* level after the *Safety On Delay* timer had expired.
Coolant Temp High Switch IEEE C37.2 – 26 Apparatus Thermal Device	The module detected that the high engine coolant temperature switch had activated after the *Safety On Delay* timer had expired.

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Fault	Description
DEF Level	The module received a fault condition from the engine ECU alerting about the DEF level or the module detected that the *DEF Level* had fallen below the *DEF Level Low Alarm Trip* level for the configured delay timer.
Digital Input A to H	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.** The module detected that a digital input configured to create a fault condition became active and the appropriate LCD message is displayed.
DPTC Filter	The module received a fault condition from the engine ECU alerting that the DPF/DPTC had activated.
Earth Fault IEEE C37.2 – 51G or 51N Generator IDMT Earth Fault Relay	**NOTE: For more details, see section entitled Earth Fault IDMT Alarm elsewhere in this document.** The module detected that the generator earth fault current had risen above the *Generator Earth Fault Trip Level* for the duration of the IDMT function.
ECU Amber	The module received an amber fault condition from the engine ECU.
ECU Data Fail	The module is configured for CAN operation but has not detected data being sent from the engine's ECU.
ECU Malfunc.	The module received a malfunction fault condition from the engine ECU.
ECU Protect	The module received a protect fault condition from the engine ECU.
ECU Red	The module received a red fault condition from the engine ECU.
Emergency Stop IEEE C37.2 - 5 Stopping Device	The module detected that emergency stop button had been pressed removing a positive voltage supply from the emergency stop input terminal. This input is failsafe (normally closed to emergency stop) and immediately stops the generator when the signal is removed.
Engine Over Speed IEEE C37.2 - 12 Overspeed Device	The module detected that the engine speed had risen above the *Over Speed Alarm Trip* level for the configured delay timer.
Engine Over Speed Overshoot IEEE C37.2 - 12 Overspeed Device	The module detected that the engine speed had risen above the *Over Speed Overshoot Trip* during the configured *Overshoot Delay* timer whilst starting.
Engine Under Speed IEEE C37.2 - 14 Underspeed Device	The module detected that the engine speed had fallen below the *Under Speed Alarm Trip* level for the configured delay timer after the *Safety On Delay* timer had expired.
Exp. Unit Failure	The module detected that communications to one of the DSENet® expansion modules had been lost.
Fail to Synchronise	The module failed to synchronise the generator to the mains before the Fail to Sync Delay timer had expired.

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Fault	Description
Failed to Start IEEE C37.2 - 48 Incomplete Sequence Relay	The module detected that the generator had failed to start as it did not meet the required Crank Disconnect criteria during the configured number of Crank Attempts.
Failed to Stop IEEE C37.2 - 48 Incomplete Sequence Relay	**NOTE: *Fail to Stop* could indicate a faulty oil pressure sensor. If engine is at rest, check the oil pressure sensor wiring and configuration.** The module detects a condition that indicates the generator is running when the DSE module has instructed it to stop.
Flexible Sensor A to F Fault	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that circuit to the flexible sensor had become open circuit.
Flexible Sensor A to F High	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value had risen above the *Flexible Sensor High Alarm Trip* level.
Flexible Sensor A to F Low	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that an analogue input value had fallen below the *Flexible Sensor Low Alarm Trip* level.
Fuel Level High IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine fuel level rose above the *High Fuel Level Trip* level.
Fuel Level Low IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine fuel level had fallen below the *Low Fuel Level Trip* level.
Fuel Level Low Switch IEEE C37.2 - 71 Liquid Level Switch	The module detected that the engine low fuel level switch had activated.
Fuel Sensor Fault	The module detected that circuit to the engine fuel level sensor had become open circuit.
Fuel Tank Bund Level High IEEE C37.2 - 71 Liquid Level Switch	The module detected that the fuel tank bund level switch had activated.
Fuel Usage IEEE C37.2 – 80 Flow Switch	The module detected that the fuel consumption was more then the configured Running Rate or Stopped Rate.

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Fault	Description
Gen Loading Frequency	The module detected that the generator output frequency had not risen above the Generator Loading Frequency setting after the Warming Up timer had expired.
Gen Loading Voltage	The module detected that the generator output voltage had not risen above the Generator Loading Voltage setting after the Warming Up timer had expired.
Gen Over Current IEEE C37.2 – 51 IDMT Overcurrent Relay	**NOTE: For more details, see section entitled Over Current Alarm elsewhere in this document.** The module detected that the generator output current had risen above the *Generator Over Current Trip* for the duration of the IDMT function.
Gen Over Frequency IEEE C37.2 – 81 Frequency Relay	The module detected that the generator output frequency had risen above the *Over Frequency Alarm Trip* level for the configured delay timer.
Gen Over Frequency Overshoot IEEE C37.2 – 81 Frequency Relay	The module detected that the generator output frequency had risen above the *Over Frequency Overshoot Trip* during the configured *Overshoot Delay* timer whilst starting.
Gen Over Voltage IEEE C37.2 – 59 AC Overvoltage Relay	The module detected that the generator output voltage had risen above the *Over Voltage Alarm Trip* level for the configured delay timer.
Gen Phase Seq Wrong IEEE C37.2 – 47 Phase Sequence Relay	The module detected that the phase rotation of the generator was different to the configured *Generator Phase Rotation Alarm* setting.
Gen Reverse Power IEEE C37.2 – 32 Directional Power Relay	The module detected that the generator output kW had fallen below the *Reverse Power Trip* for the configured delay timer.
Gen Short Circuit IEEE C37.2 – 51 IDMT Short Circuit Relay	**NOTE: For more details, see section entitled *Short Circuit IDMT Alarm* elsewhere in this document.** The module detected that the generator output current had risen above the *Short Circuit Trip* for the duration of the IDMT function.
Gen Under Frequency IEEE C37.2 – 81 Frequency Relay	The module detected that the generator output frequency had fallen below the *Under Frequency Alarm Trip* level for the configured delay timer after the *Safety On Delay* timer had expired.
Gen Under Voltage IEEE C37.2 – 27 AC Undervoltage Relay	The module detected that the generator output voltage had fallen below the *Under Voltage Alarm Trip* level for the configured delay timer after the *Safety On Delay* timer had expired.
Inlet Temperature	The module detected that the engine's ECU measurement of inlet temperature had risen above the *Inlet Temperature Alarm Trip* level.
kW Overload IEEE C37.2 – 32 Directional Power Relay	The module detected that the generator output kW had risen above the Overload Protection Trip for the configured delay timer.
Loss of Mag-PU	The module detected that the magnetic pick up was not producing a pulse output after the required Crank Disconnect criteria had been met.
Low Load IEEE C37.2 – 37 Undercurrent ot Underpower relay	The module detected that the load had fallen below the *Low Load Alarm Trip* level.

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Fault	Description
Mag-PU Fault	The module detected that circuit to the magnetic pick up sensor had become open circuit.
Mains Earth Fault IEEE C37.2 – 51G or 51N IDMT Earth Fault Relay	**NOTE: For more details, see section entitled Earth Fault IDMT Alarm elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that the generator earth fault current had risen above the *Mains Earth Fault Trip Level* for the duration of the IDMT function.
Mains Failed to Close IEEE C37.2 – 52b AC Circuit Breaker Position (Contact Open when Breaker Closed)	The module detected that the mains load switch had failed to close as the Mains Closed Auxiliary input did not activate within the Mains Fail to Close Delay time after the Close Mains Output activated.
Mains Over Current IEEE C37.2 – 51 IDMT Overcurrent Relay	**NOTE: For more details, see section entitled Over Current Alarm elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that the mains output current had risen above the *Mains Over Current Trip* for the duration of the IDMT function.
Mains Phase Seq Wrong IEEE C37.2 – 47 Phase Sequence Relay	The module detected that the phase rotation of the mains was different to the configured *Mains Phase Rotation Alarm* setting.
Mains Short Circuit IEEE C37.2 – 51 IDMT Short Circuit Relay	**NOTE: For more details, see section entitled *Short Circuit IDMT Alarm* elsewhere in this document.** **NOTE: Mains current protection is only available when the CT location is set for *Load*. For further details of module configuration, refer to DSE Publication: *057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.*** The module detected that the mains output current had risen above the *Short Circuit Trip* for the duration of the IDMT function.
Maintenance Due	**NOTE: Due to module configuration the alarm message that appears on the display may be different. For further details of module configuration, refer to DSE Publication: 057-243 DSE7310 MKII & DSE7320 MKII Configuration Software Manual.** The module detected that one of the configured maintenance alarms is due as its configured maintenance interval has expired.

Continued over page…

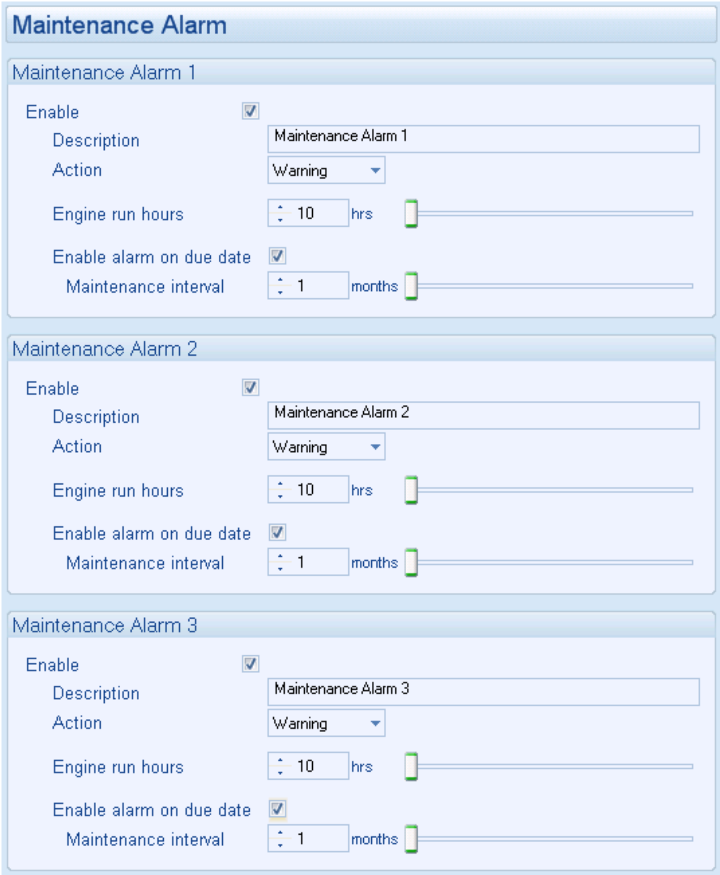
Fault	Description
Negative kvar IEEE C37.2 – 40 Field Under Excitation Relay	The module detected that the generator output kvar had fallen below the *Negative var Alarm Trip* for the configured delay timer.
Negative Phase Sequence IEEE C37.2 - 46 Phase-Balance Current Relay	The module detected that there was an imbalance of current across the generator phases greater than the *Negative Phase Sequence Trip Level* percentage setting.
Oil Press Sender Fault	The module detected that circuit to the engine oil pressure sensor had become open circuit.
Oil Pressure Low IEEE C37.2 - 63 Pressure Switch	The module detected that the engine oil pressure had fallen below the *Low Oil Pressure Shutdown Trip* level after the *Safety On Delay* timer had expired.
Oil Pressure Low Switch IEEE C37.2 - 63 Pressure Switch	The module detected that the low oil pressure switch had activated after the *Safety On Delay* timer had expired.
Over Frequency Runaway IEEE C37.2 – 81 Frequency Relay	The module detected that the generator output frequency had risen above the *Run Away Trip* level.
Over Speed Runaway IEEE C37.2 - 12 Overspeed Device	The module detected that the engine speed had risen above the *Run Away Trip* level.
Positive kvar IEEE C37.2 – 40 Field Over Excitation Relay	The module detected that the generator output kvar had risen above the *Positive var Alarm Trip* for the configured delay timer.
Priority Selection Error	The module detected that another module on the *Dual Mutual Standby* communication link
SCR Inducement	The module received a fault condition from the engine ECU alerting about the SCR Inducement.
Water in Fuel	The module received a fault condition from the engine ECU alerting that water in the fuel had been detected.

7.6 MAINTENANCE ALARMS

Depending upon module configuration one or more levels of engine maintenance alarm may occur based upon a configurable schedule.

Example 1:

Screen capture from DSE Configuration Suite Software showing the configuration of the Maintenance Alarm for 1, 2 and 3.



When activated, the maintenance alarm can be either a **warning** (set continues to run) or **shutdown** (running the set is not possible).

Resetting the maintenance alarm is normally actioned by the site service engineer after performing the required maintenance.
The method of reset is either by:

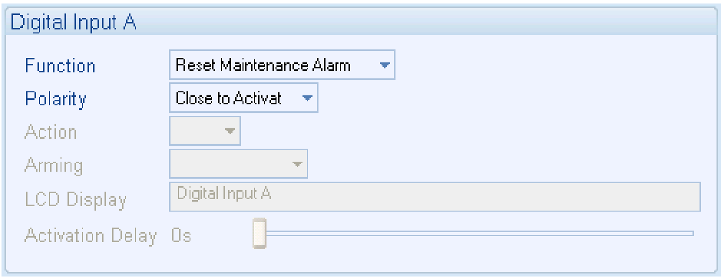
Activating an input that has been configured to Maintenance Reset Alarm 1, 2 or 3.

Pressing the maintenance reset button in the DSE Configuration Suite, Maintenance section.

Pressing and holding the ***Stop/Reset Mode*** button for 10 seconds on the desired Maintenance Alarm status page. This may be protected by a PIN number.

Example 2:

Screen capture from DSE Configuration Suite Software showing the configuration of a digital input for Reset Maintenance Alarm.

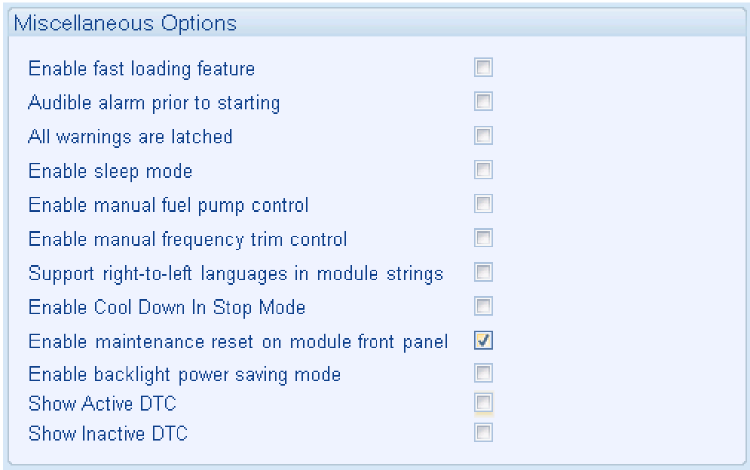


Example 3:

Screen capture from DSE Configuration Suite Software showing the Maintenance Alarm Reset 'button' in the DSE Configuration Suite SCADA | MAINTENANCE section.

Example 4:

Screen capture from DSE Configuration Suite Software showing the configuration holding stop button to reset the maintenance alarm.



7.7 OVER CURRENT ALARM

The *Over Current Alarm* combines a simple warning trip level with a fully functioning IDMT curve for thermal protection.

7.7.1 IMMEDIATE WARNING

If the *Immediate Warning* is enabled, the controller generates a *warning alarm* as soon as the *Trip* level is reached. The alarm automatically resets once the generator loading current falls below the *Trip* level (unless *All Warnings are latched* is enabled). For further advice, consult the generator supplier.

7.7.2 INVERSE DEFINITE MINIMUM TIME (IDMT) ALARM

If the *Over Current IDMT Alarm* is enabled, the controller begins following the IDMT 'curve' when the current on any phase passes the *Trip* setting.

If the *Trip* is surpassed for an excess amount of time, the *IDMT Alarm* triggers (*Shutdown* or *Electrical Trip* as selected in *Action*).

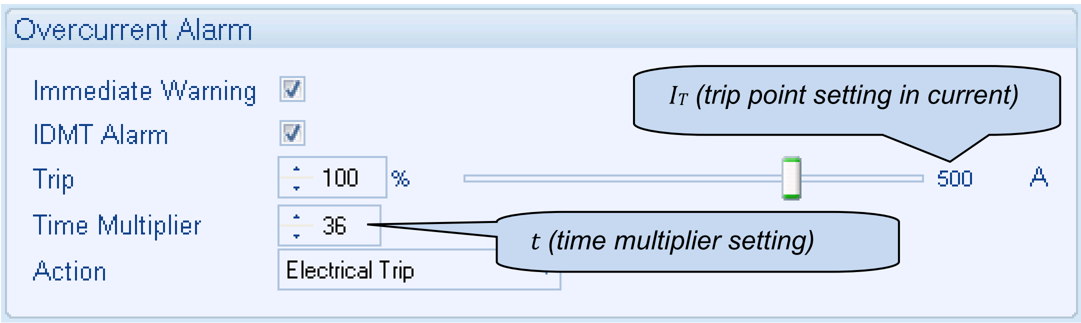
The larger the over circuit fault, the faster the trip. The speed of the trip is dependent upon the fixed formula:

$$T = \frac{t}{\left(\frac{I_A}{I_T} - 1\right)^2}$$

Where:

T is the tripping time in seconds
I_A is the actual measured current of the most highly loaded line (L1, L2 or L3)
I_T is the delayed trip point setting in current
t is the time multiplier setting and also represents the tripping time in seconds at twice full load (when ${}^{I_A}/_{I_T} = 2$).

The settings shown in the example below are a screen capture of the DSE factory settings, taken from the DSE Configuration Suite PC Software for a brushless alternator.



These settings provide for normal running of the generator up to 100% full load. If full load is surpassed, the *Immediate Warning* alarm is triggered and the set continues to run.

The effect of an overload on the generator is that the alternator windings begin to overheat; the aim of the *IDMT Alarm* is to prevent the windings being overload (heated) too much. The amount of time that the alternator can be safely overloaded is governed by how high the overload condition is.

The default settings as shown above allow for an overload of the alternator to the limits of the *Typical Brushless Alternator* whereby 110% overload is permitted for 1 hour or 200% overload is permitted for 36 seconds.

If the alternator load reduces, the controller then follows a cooling curve. This means that a second overload condition may trip soon after the first as the controller knows if the windings have not cooled sufficiently.

For further details on the *Thermal Damage Curve* of your alternator, refer to the alternator manufacturer and generator supplier.

7.7.2.1 CREATING A SPREADSHEET FOR THE OVER CURRENT IDMT CURVE

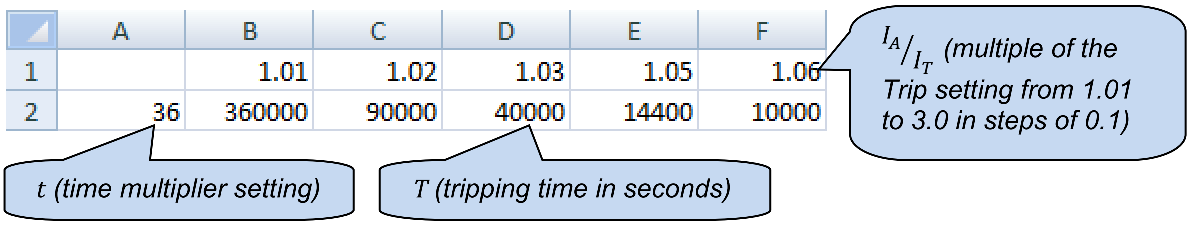
The formula used:

$$T = \frac{t}{\left(\frac{I_A}{I_T} - 1\right)^2}$$

Where:

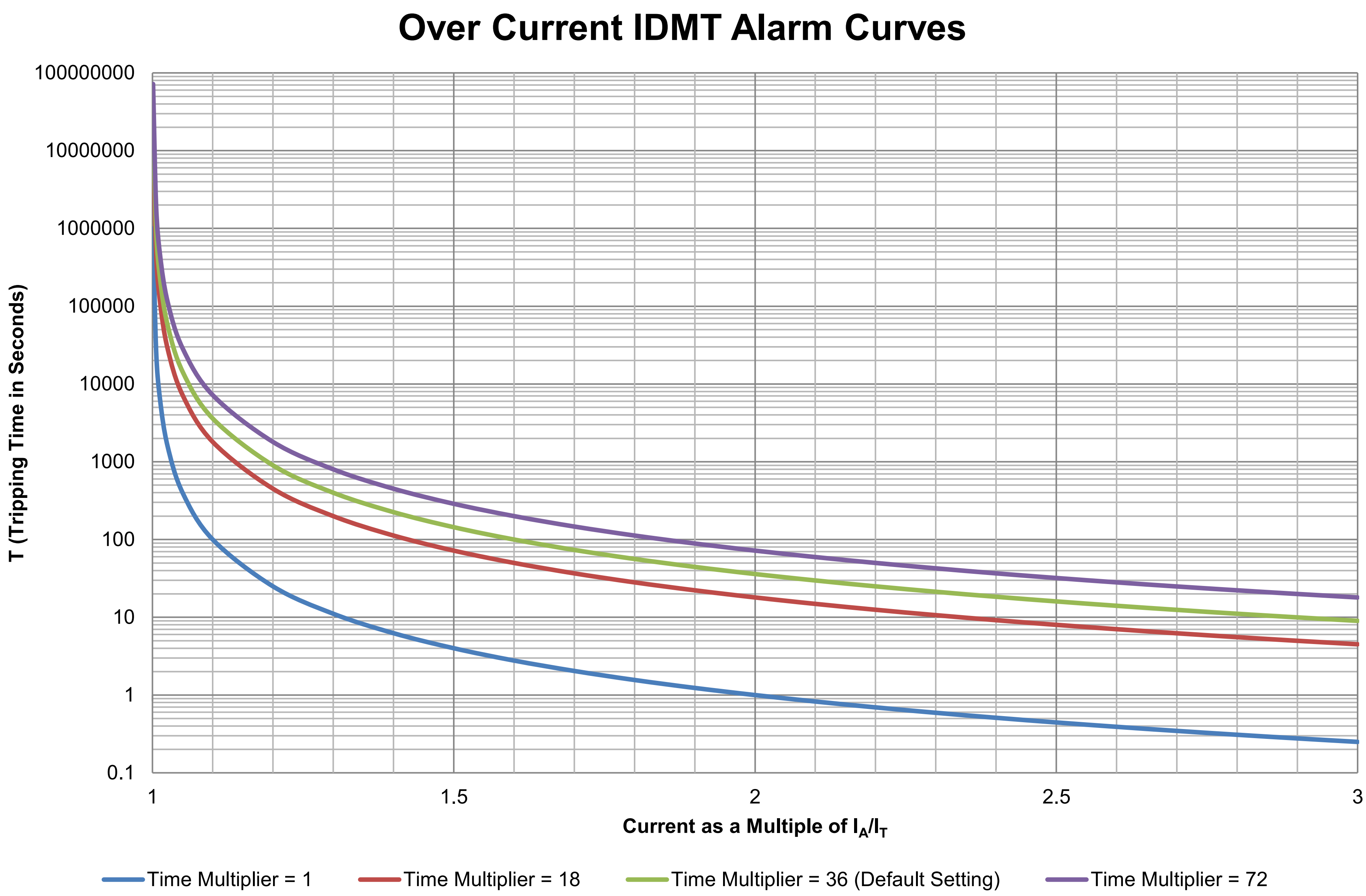
T is the tripping time in seconds
I_A is the actual measured current of the most highly loaded line (L1, L2 or L3)
I_T is the delayed trip point setting in current
t is the time multiplier setting and also represents the tripping time in seconds at twice full load (when ${}^{I_A}/_{I_T} = 2$).

The equation can be simplified for addition into a spreadsheet. This is useful for 'trying out' different values of t *(time multiplier setting)* and viewing the results, without actually testing this on the generator.



The formula for the *Tripping Time* cells is:

`=$A2/POWER((B$1-1),2)`


Over Current IDMT Alarm Curves
100000000
10000000
1000000
100000
10000
1000
100
10
1
0.1
T (Tripping Time in Seconds)
1
1.5
2
2.5
3
Current as a Multiple of I_A/I_T
Time Multiplier = 1
Time Multiplier = 18
Time Multiplier = 36 (Default Setting)
Time Multiplier = 72

7.8 SHORT CIRCUIT IDMT ALARM

If the *Short Circuit Alarm* is enabled, the controller begins following the IDMT 'curve' when the current on any phase passes the *Trip* setting.

If the *Trip* is surpassed for an excess amount of time, the *IDMT Alarm* triggers (*Shutdown* or *Electrical trip* as selected in *Action*).

The larger the short circuit fault, the faster the trip. The speed of the trip is dependent upon the fixed formula:

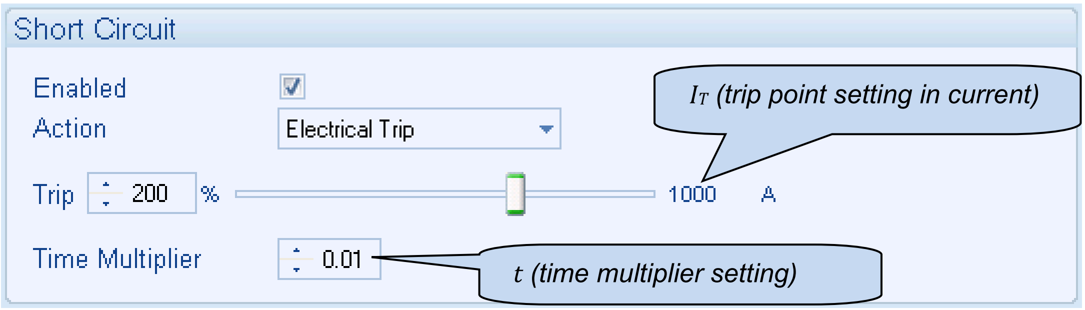
$$T = \frac{t \times 0.14}{\left(\left(\frac{I_A}{I_T}\right)^{0.02} - 1\right)}$$

Where:

T is the tripping time in seconds (accurate to +/- 5% or +/- 50 ms (whichever is the greater))
I_A is the actual measured current
I_T is the trip point setting in current
t is the time multiplier setting

The settings shown in the example below are a screen capture of the DSE factory settings, taken from the DSE Configuration Suite software.

NOTE: Due to large inrush currents from certain loads, such as motors or transformers, the default settings for the *Short Circuit* alarm may need adjusting to compensate.



The effect of a short circuit on the generator is that the alternator stator and rotor begin to overheat; the aim of the *IDMT alarm* is to prevent the stator and rotor being overload (heated) too much. The amount of time that the alternator can be safely overloaded is governed by how high the short circuit condition is.

For further details on the *Thermal & Magnetic Damage Curve* of your alternator, refer to the alternator manufacturer and generator supplier.

7.8.1 CREATING A SPREADSHEET FOR THE SHORT CIRCUIT IDMT CURVE

The formula used:

$$T = \frac{t \times 0.14}{\left(\left(\frac{I_A}{I_T}\right)^{0.02} - 1\right)}$$

Where:

T is the tripping time in seconds (accurate to +/- 5% or +/- 50 ms (whichever is the greater))
I_A is the actual measured current
I_T is the trip point setting in current
t is the time multiplier setting

The equation can be simplified for addition into a spreadsheet. This is useful for ‘trying out’ different values of t *(time multiplier setting)* and viewing the results, without actually testing this on the generator.

	A	B	C	D	E	F
1		1.01	1.02	1.03	1.05	1.06
2	0.01	7.034242	25	11.11111	4	2.777778

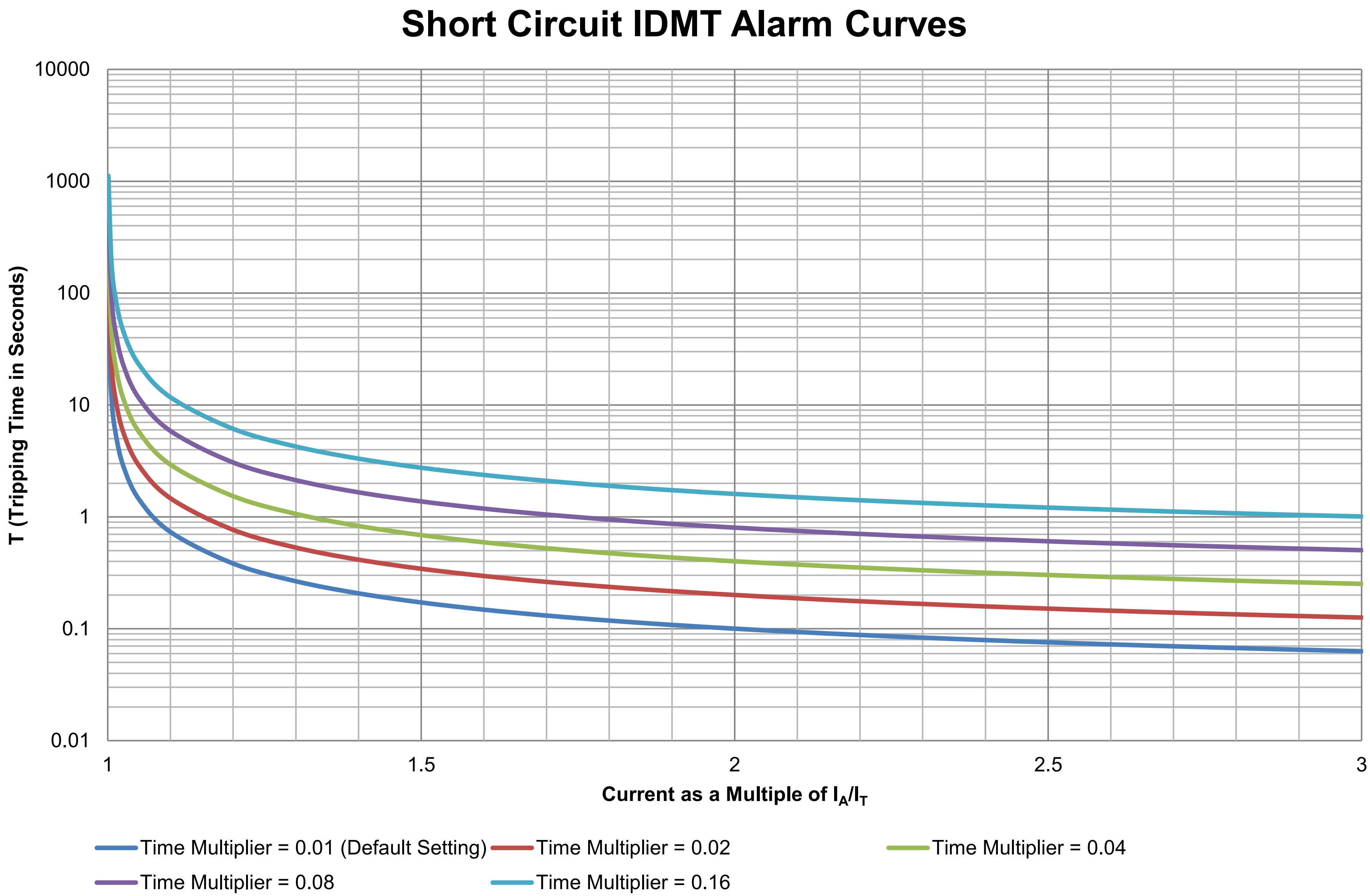
I_A/I_T (multiple of the Trip setting from 1.01 to 3.0 in steps of 0.1)

t (time multiplier setting)

T (tripping time in seconds)

The formula for the *Tripping Time* cells is:

```
fx  =($A2*0.14)/(POWER((B$1),0.02)-1)
```


Short Circuit IDMT Alarm Curves
10000
1000
100
10
1
0.1
0.01
T (Tripping Time in Seconds)
1
1.5
2
2.5
3
Current as a Multiple of I_A/I_T
Time Multiplier = 0.01 (Default Setting)
Time Multiplier = 0.02
Time Multiplier = 0.04
Time Multiplier = 0.08
Time Multiplier = 0.16

7.9 EARTH FAULT IDMT ALARM

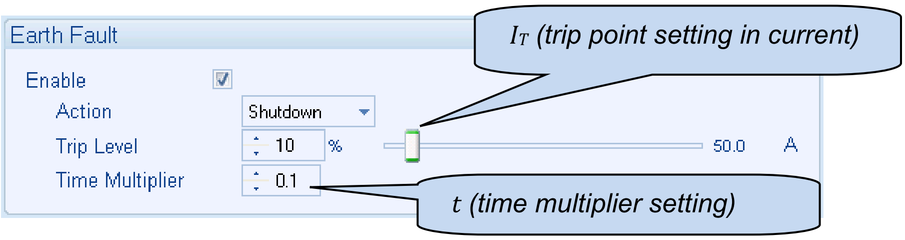
When the module is suitably connected using the 'Earth Fault CT'. The module measures Earth Fault and optionally configured to generate an alarm condition (shutdown or electrical trip) when a specified level is surpassed.

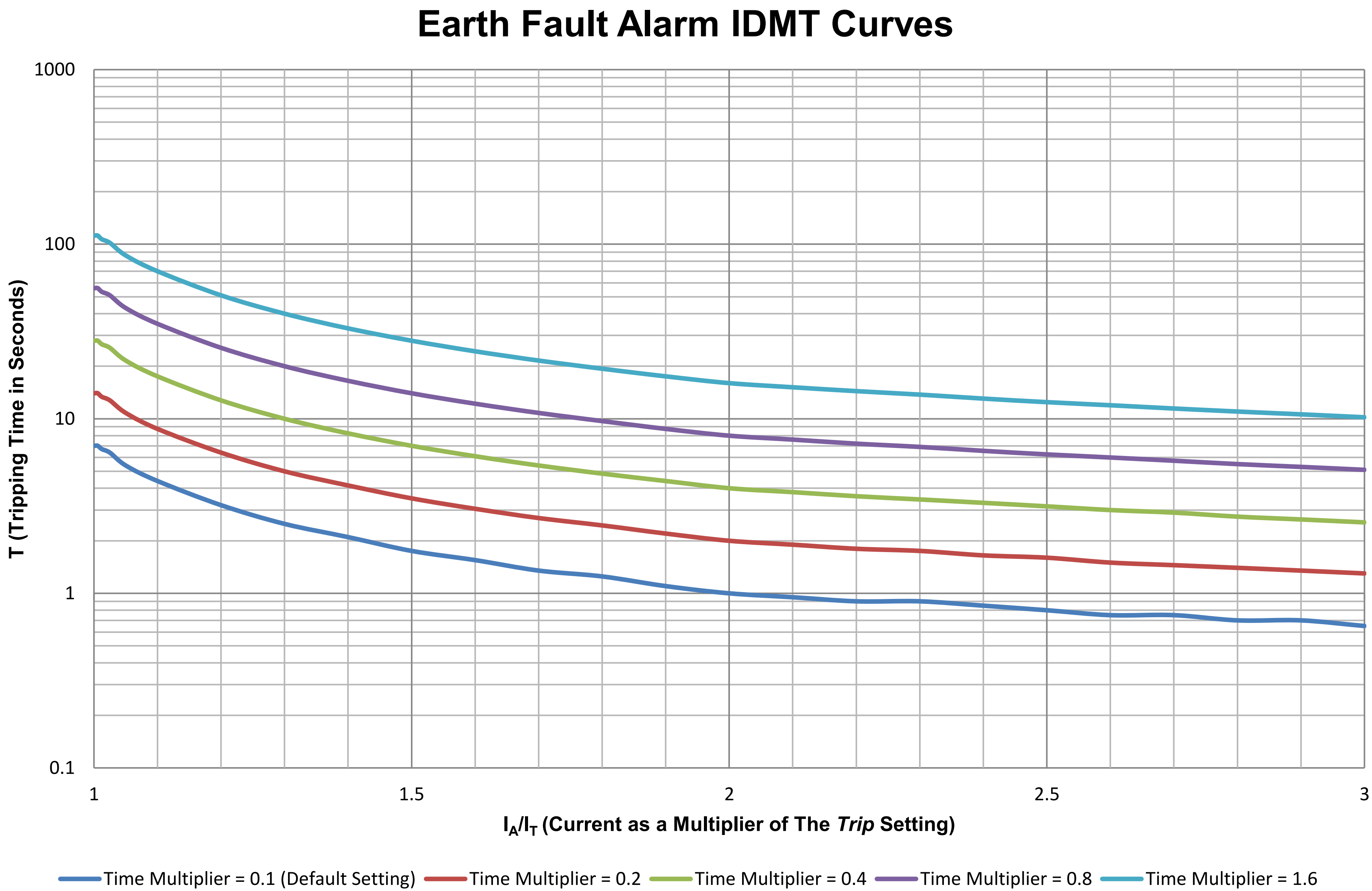
If the *Earth Fault Alarm* is enabled, the controller begins following the IDMT 'curve' when the earth fault current passes the *Trip* setting.

If the *Trip* is surpassed for an excess amount of time, the *IDMT Alarm* triggers (*Shutdown* or *Electrical Trip* as selected in *Action*).

The larger the earth fault, the faster the trip.

The settings shown in the example below are a screen capture of the DSE factory settings, taken from the DSE Configuration Suite software.




Earth Fault Alarm IDMT Curves
1000
100
10
1
0.1
T (Tripping Time in Seconds)
1
1.5
2
2.5
3
IA/IT (Current as a Multiplier of The Trip Setting)
Time Multiplier = 0.1 (Default Setting)
Time Multiplier = 0.2
Time Multiplier = 0.4
Time Multiplier = 0.8
Time Multiplier = 1.6

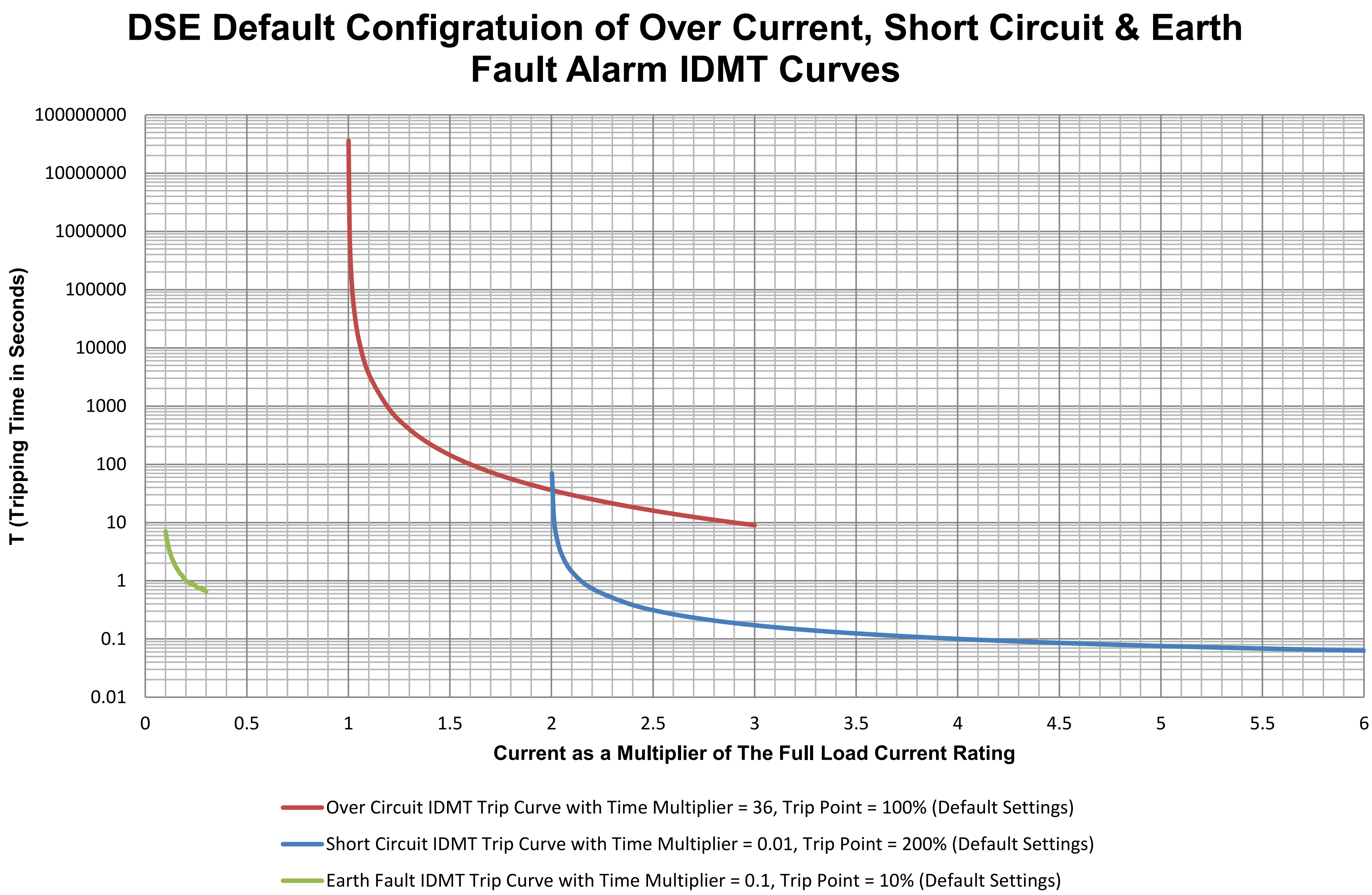
7.10 DEFAULT CURRENT PROTECTION TRIPPING CHARACTERISTICS

The graph on the following page shows the default settings for the IDMT tripping curves for the *Over Current, Short Circuit* and *Earth Fault* protections.

The default setting for the *Over Current* alarm allows for an overload of an alternator to the limits of the *Typical Brushless Alternator* whereby 110% overload is permitted for 1 hour or 200% overload is permitted for 36 seconds. In an over current situation the alternator begins to overheat. The aim of the *Over Current IDMT Alarm* is to prevent the windings being overload (heated) too much. The amount of time that the alternator can be safely overloaded is governed by how high the overload condition is.

The default setting for the *Short Circuit* alarm allows for an alternator to supply a high current caused by a genuine short circuit or an inrush current of a motor/transformer. Whereby 300% overload is permitted for 0.17 seconds or 600% overload is permitted for 0.06 seconds. In a short circuit situation the alternator begins to overheat to the point the insulation breaks down, potentially causing a fire. The aim of the *Short Circuit IDMT Alarm* is to prevent the insulation from melting due to excessive heat. The amount of time that the alternator can be safely in a short circuit condition is governed by the alternator's construction.

The default setting for the *Earth Fault* alarm allows for an alternator to supply a fault current caused by a high impedance short to earth or motor drives. Whereby 15% fault current is permitted for 1.75 second or 20% fault current is permitted for 1 second.

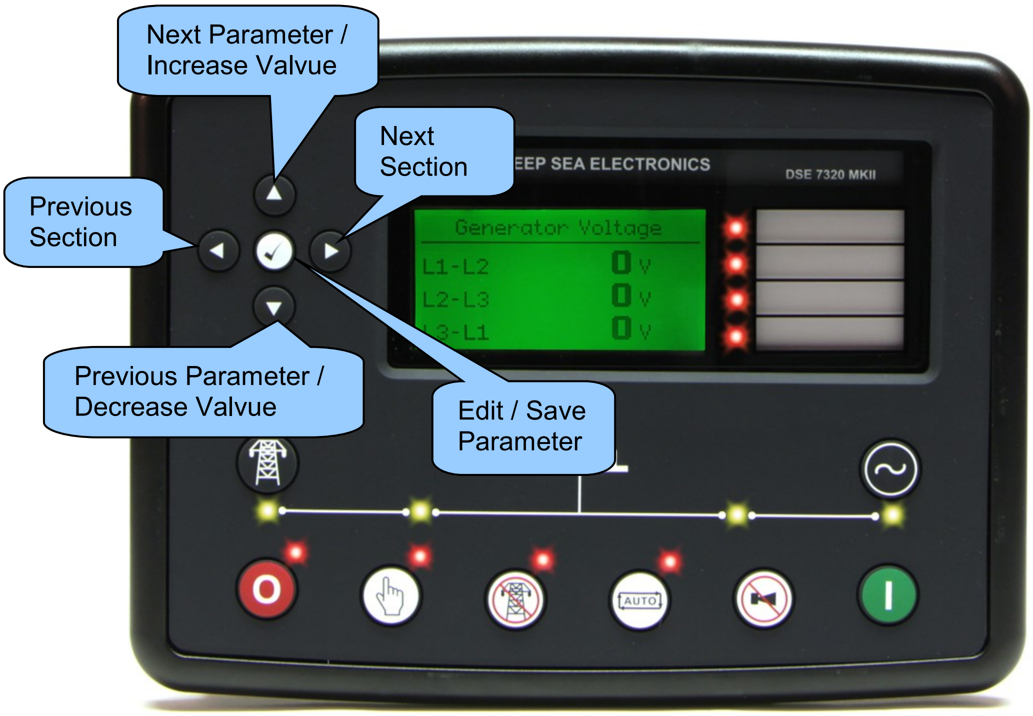

DSE Default Configratuion of Over Current, Short Circuit & Earth Fault Alarm IDMT Curves
T (Tripping Time in Seconds)
100000000
10000000
1000000
100000
10000
1000
100
10
1
0.1
0.01
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
Current as a Multiplier of The Full Load Current Rating
Over Circuit IDMT Trip Curve with Time Multiplier = 36, Trip Point = 100% (Default Settings)
Short Circuit IDMT Trip Curve with Time Multiplier = 0.01, Trip Point = 200% (Default Settings)
Earth Fault IDMT Trip Curve with Time Multiplier = 0.1, Trip Point = 10% (Default Settings)

8 FRONT PANEL CONFIGURATION

NOTE: Depending upon module configuration, some values in the *Mains & Running Configuration Editors* may not be available. For more information refer to DSE publication *057-243 DSE7310 MKII & DSE7320 MKII Configuraiton Suite PC Software Manual*

This configuration mode allows the operator to partially configure the module through its display without the use of the DSE Configuration Suite PC Software.

Use the module's facia buttons to traverse the menu and make value changes to the parameters:



8.1 MAIN CONFIGURATION EDTIOR

8.1.1 ACESSING THE MAIN CONFIGURATION EDTIOR

NOTE: More comprehensive module configuration is possible via PC configuration software. For further details of module configuration, refer to DSE Publication: 057- 224 DSE7310 MKII & DSE7310 MKII Configuration Software Manual.

- Ensure the engine is at rest and the module by pressing the ***Stop/Reset Mode*** button.
- Press the ***Stop/Reset Mode*** and ***Tick*** buttons together to enter the main configuration editor.

8.1.2 ENTERING PIN

NOTE: The PIN is not set by DSE when the module leaves the factory. If the module has a PIN code set, the generator supplier has entered this. Contact the generator supplier if the code is required. If the code has been 'lost' or 'forgotten', the module must be returned to the DSE factory to have the PIN removed. A charge is made for this procedure. This procedure cannot be performed away from the DSE factory.

NOTE: The PIN is automatically reset when the editor is exited (manually or automatically) to ensure security.

- If a module security PIN has been set, the PIN request is then shown.
- The first '#' changes to '0'. Press the ***Up*** or ***Down*** buttons to adjust it to the correct value.
- Press the ***Right*** button when the first digit is correctly entered. The digit previously entered now shows as '#' for security.
- Repeat this process for the other digits of the PIN number. Press the ***Left*** button to move back to adjust one of the previous digits.
- When the ***Tick*** button is pressed after editing the final PIN digit, the PIN is checked for validity. If the number is not correct, the PIN must be re-entered.
- If the PIN has been successfully entered (or the module PIN has not been enabled), the editor is displayed.

8.1.3 EDITING A PARAMETER

NOTE: Pressing and holding the *Menu Navigation* buttons provides the auto-repeat functionality. Values can be changed quickly by holding the navigation buttons for a prolonged period of time.

- Select the configuration that is required to be edit by pressing the ***Up*** or ***Down*** buttons.

Editor
Config to Edit
Main Configuration

- Press the ***Right*** or ***Left*** buttons to cycle to the section to view/change.
- Press the ***Up*** or ***Down*** buttons to select the parameter to view/change within the currently selected section.
- To edit the parameter, press the ***Tick*** button to enter edit mode. The parameter begins to flash to indicate editing.
- Press the ***Up*** or ***Down*** buttons to change the parameter to the required value.
- Press the ***Tick*** button to save the value. The parameter ceases flashing to indicate that it has been saved.

8.1.4 EXITING THE MAIN CONFIGURATION EDITOR

NOTE: The editor automatically exits after 5 minutes of inactivity to ensure security.

- Press and hold the ***Stop/Reset Mode*** button to exit the editor without saving changes.
- Press and hold the ***Tick*** button to exit the editor and save the changes.

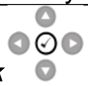
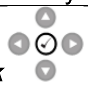
8.1.5 ADJUSTABLE PARAMETERS

Section	Parameter As Shown On Display	Value
Display	Contrast	0 %
	Language	English
	Current Date and Time	dd:mm:yyyy, hh:mm:ss
	Dual Mutual Mode	Set Priority / Run Time / Engine Hours
	Dual Mutual Priority	0
	Dual Mutual Duty Time	0 h 0 m 0 s
Alt Config	Config To Edit	Main Configuration / Alt Config 1,2,3,4 or 5
	Default Configuration	Main Configuration / Alt Config 1,2,3,4 or 5
Engine	Oil Pressure Low Shutdown	0.00 bar 0 psi 0 kPa
	Oil Pressure Low Pre Alarm	0.00 bar 0 psi 0 kPa
	Coolant Temperature Low Warning	0 ºC 0 ºF
	Coolant Temperature High Pre Alarm	0 ºC 0 ºF
	Coolant Temperature High Electrical Trip	0 ºC 0 ºF
	Coolant Temperature High Shutdown	0 ºC 0 ºF
	Fuel Usage Running Rate	0 %
	Fuel Usage Stopped Rate	0 %
	Specific Gravity	0.00
	Pre Heat Temp	0 ºC 0 ºF
	Pre Heat Timer	0 h 0 m 0 s
	Post Heat Temp	0 ºC 0 ºF
	Post Heat Timer	0 h 0 m 0 s
	Droop Control	Active / Inactive
	Droop Control	0.0 %
	Crank Disconnect Oil Pressure Delay	0.0 s
	Crank Disconnect	0 V
	Under Speed Shutdown	Active / Inactive
	Under Speed Shutdown	0 RPM
	Under Speed Warning	Active / Inactive
	Under Speed Warning	0 RPM
	Under Speed Delay	0.0 s
	Over Speed Warning	Active / Inactive
	Over Speed Warning	0 RPM
	Over Speed Shutdown	0 RPM
	Over Speed Delay	0.0 s
	Overspeed Overshoot	0 %
	Overspeed Overshoot Delay	0 m 0.0 s
	Battery Under Voltage Warning	Active / Inactive
	Battery Under Voltage Warning	0.0 V
	Battery Under Voltage Warning Delay	0 h 0 m 0 s
	Battery Over Voltage Warning	Active / Inactive
	Battery Over Voltage Warning	0.0 V
	Battery Over Voltage Warning Delay	0 h 0 m 0 s
	Charge Alternator Failure Warning	Active / Inactive
	Charge Alternator Failure Warning	0.0 V
	Charge Alternator Warning Delay	0 h 0 m 0 s
	Charge Alternator Failure Shutdown	Active / Inactive
	Charge Alternator Failure Shutdown	0.0 V
	Charge Alternator Shutdown Delay	0 h 0 m 0 s
	Inlet Temperature Shutdown	0 ºC 0 ºF
	Inlet Temperature Pre-Alarm	0 ºC 0 ºF

Continued over page...

Section	Parameter As Shown On Display	Value
Generator	AC System	3 Phase, 4 Wire
	Under Voltage Shutdown	0 V
	Under Voltage Pre Alarm	0 V
	Under Voltage Delay	0.0 s
	Nominal Voltage	0 V
	Over Voltage Pre Alarm	0 V
	Over Voltage Shutdown	0 V
	Over Voltage Delay	0.0 s
	Under Frequency Shutdown	0.0 Hz
	Under Frequency Pre Alarm	0.0 Hz
	Under Frequency Delay	0.0 s
	Nominal Frequency	0.0 Hz
	Over Frequency Pre Alarm	0.0 Hz
	Over Frequency Shutdown	0.0 Hz
	Over Frequency Delay	0.0 s
	Frequency Overshoot	0 %
	Frequency Overshoot Delay	0.0 s
	CT Primary	0 A
	CT Secondary	0 A
	Earth CT Primary	0 A
	Full Load Rating	0 A
	Delayed Over Current	Active / Inactive
	Delayed Over Current	0 %
	Earth Fault Trip	Active / Inactive
	Earth Fault Trip	0 %
	kW Overload Trip	0 %
Mains DSE7320 MKII Only	AC System	3 Phase, 4 Wire
	Under Voltage Trip	0 V
	Over Voltage Trip	0 V
	Under Frequency Trip	0.0 Hz
	Over Frequency Trip	0.0 Hz
Timers	Start Delay Off Load	0 h 0 m 0 s
	Start Delay On Load	0 h 0 m 0 s
	Start Delay Mains Fail	0 h 0 m 0 s
	Start Delay Telemetry	0 h 0 m 0 s
	Mains Transient Delay	0 m 0 s
	Engine Cranking	0 m 0 s
	Engine Cranking Rest	0 m 0 s
	Engine Smoke Limiting	0 m 0 s
	Engine Smoke Limiting Off	0 m 0 s
	Engine Safety On Delay	0 m 0 s
	Engine Warming	0 h 0 m 0 s
	ECU Override	0 m 0 s
	Mains Transfer Time	0 m 0.0 s
	Return Delay	0 h 0 m 0 s
	Engine Cooling	0 h 0 m 0 s
	Engine Fail To Stop Delay	0 m 0 s
	LCD Page Delay	0 h 0 m 0 s
	LCD Scroll Delay	0 h 0 m 0 s
	Sleep Timer	0 h 0 m 0 s
	Backlight Timer	0 h 0 m 0 s

Continued over page...

Section	Parameter As Shown On Display	Value
Schedule	Schedule	Active / Inactive
	Schedule Period Bank 1	Weekly / Monthly
	On Load / Off Load / Auto Start Inhibit, Week, On, Run Time and Day Selection (1 to 8)	Press ***Tick***  to begin editing then up or down when selecting the different parameters in the scheduler.
	Schedule Period Bank 2	Weekly / Monthly
	On Load / Off Load / Auto Start Inhibit, Week, On, Run Time and Day Selection (1 to 8)	Press ***Tick***  to begin editing then up or down when selecting the different parameters in the scheduler.

8.2 'RUNNING' CONFIGURATION EDITOR

8.2.1 ACCESSING THE 'RUNNING' CONFIGURATION EDITOR

- The *Running Editor* is enterable whilst the generator is running. All protections remain active when the generator is running while the *Running Editor* is entered
- Press and hold the ***Tick*** button to access the *Running Editor.*

8.2.2 ENTERING PIN

NOTE: The PIN is not set by DSE when the module leaves the factory. If the module has a PIN code set, this has been affected by your engine supplier who should be contacted if you require the code. If the code has been 'lost' or 'forgotten', the module must be returned to the DSE factory to have the module's code removed. A charge is made for this procedure.
NB - This procedure cannot be performed away from the DSE factory.

NOTE: The PIN is automatically reset when the editor is exited (manually or automatically) to ensure security.

Even if a module security PIN has been set, the PIN is not requested whilst entering the *Running Editor*.

8.2.3 EDITING A PARAMETER

NOTE: Pressing and holding the *Menu Navigation* buttons provides the auto-repeat functionality. Values can be changed quickly by holding the navigation buttons for a prolonged period of time.

- Press the ***Right*** or ***Left*** buttons to cycle to the section to view/change.
- Press the ***Up*** or ***Down*** buttons to select the parameter to view/change within the currently selected section.
- To edit the parameter, press the ***Tick*** button to enter edit mode. The parameter begins to flash to indicate editing.
- Press the ***Up*** or ***Down*** buttons to change the parameter to the required value.
- Press the ***Tick*** button to save the value. The parameter ceases flashing to indicate that it has been saved.

8.2.4 EXITING THE 'RUNNING' CONFIGURATION EDITOR

NOTE: The editor automatically exits after 5 minutes of inactivity to ensure security.

- Press and hold the ***Tick***  button to exit the editor and save the changes.

8.2.5 RUNNING EDITOR PARAMETERS

Section	Parameter As Shown On Display	Values
Display	Contrast	0 %
	Language	English
	Dual Mutual Status	Set Priority (1 to 8)
Engine	Manual Frequency Trim	0.0 Hz
	Speed Bias	0.0
	Governor Gain	0
	Frequency Adjust	0.0 %
	DPF Auto Regen Inhibit	Active / Inactive
	DPF Manual Regeneration Request	Active / Inactive
	ECU Service Mode	Active / Inactive
AVR	Droop (% of Set Point)	0.0
	Proportional Set Point	0.0
	Integral Set Point	0.0
	Derivative Set Point	0.0
	Off Load Duty Cycle	0.0
	Maximum Duty Cycle	0.0
	Soft Start Ramp Start Point	0.0
	Soft Start Ramp Rate (%/Hz)	0.0
	Alternative Configuration	0
	Stability Selection	0

9 COMMISIONING

9.1 BASIC CHECKS

NOTE: If Emergency Stop feature is not required, link the input to the DC Positive.

Before the system is started, it is recommended that the following checks are made:

The unit is adequately cooled and all the wiring to the module is of a standard and rating compatible with the system. Check all mechanical parts are fitted correctly and that all electrical connections (including earths) are sound.

The unit DC supply is fused and connected to the battery and that it is of the correct polarity.

The Emergency Stop input is wired to an external normally closed switch connected to DC positive.

To check the start cycle operation, take appropriate measures to prevent the engine from starting (disable the operation of the fuel solenoid). After a visual inspection to ensure it is safe to proceed, connect the battery supply. Press the ***Manual Mode*** button followed by the ***Start*** I button the unit start sequence commences.

The starter engages and operates for the pre-set crank period. After the starter motor has attempted to start the engine for the pre-set number of attempts, the LCD displays *Failed to Start*. Press the ***Stop/Reset Mode*** O button to reset the unit.

Restore the engine to operational status (reconnect the fuel solenoid). Press the ***Manual Mode*** button followed by the ***Start*** I button. This time the engine should start and the starter motor should disengage automatically. If not then check that the engine is fully operational (fuel available, etc.) and that the fuel solenoid is operating. The engine should now run up to operating speed. If not, and an alarm is present, check the alarm condition for validity, then check input wiring. The engine should continue to run for an indefinite period. It is possible at this time to view the engine and alternator parameters - refer to the 'Description of Controls' section of this manual.

Press the ***Auto Mode*** AUTO button, the engine runs for the pre-set cooling down period, then stop. The generator should stay in the standby mode. If it does not, check that the *Remote Start* input is not active.

Initiate an automatic start by supplying the remote start signal (if configured). The start sequence commences and the engine runs up to operational speed. Once the generator is available the delayed load outputs activate, the Generator accepts the load. If not, check the wiring to the delayed load output contactors. Check the Warming timer has timed out.

Remove the remote start signal. The return sequence begins. After the pre-set time, the generator is unloaded. The generator then runs for the pre-set cooling down period, then shutdown into its standby mode.

Set the modules internal clock/calendar to ensure correct operation of the scheduler and event logging functions. For details of this procedure see section entitled *Front Panel Configuration*.

If, despite repeated checking of the connections between the controller and the customer's system, satisfactory operation cannot be achieved, then contact DSE Technical Support Department:

Tel: +44 (0) 1723 890099
Fax: +44 (0) 1723 893303
E-mail: support@deepseaelectronics.com
Website: www.deepseaelectronics.com

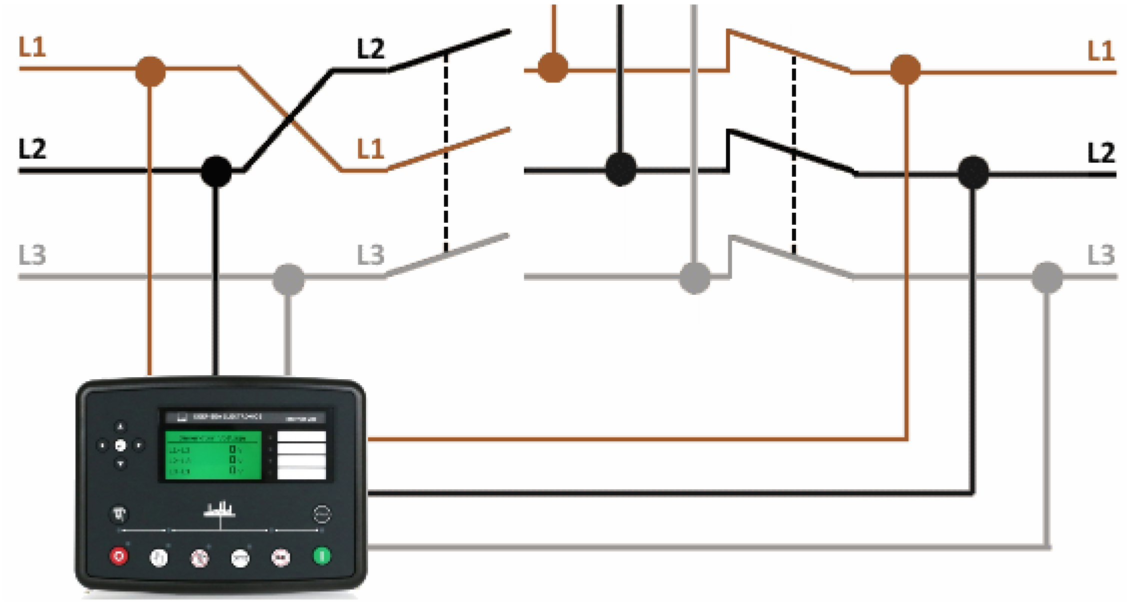
9.2 CLOSED TRANSITION

NOTE: The following commissioning steps are not applicable to the DSE7310 MKII, they are only applicable to the DSE7320 MKII when *Closed Transition* has been enabled.

9.2.1 SYNC CHECKS

CAUTION!: Failure to perform the Sync Check results in in serious damage to the system (breakers, bus bars, alternators, engines etc) caused by out of sync closures.

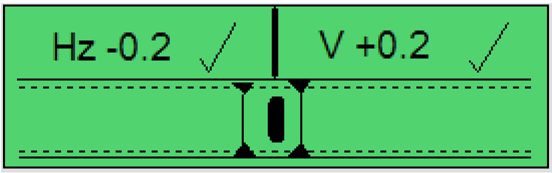
Check to ensure that all the module's sensing cables have been connected to the correct phases and that the generator and mains switchgear has been correctly connected. Failing to perform such tests may lead to the DSE module sensing both sides of the switchgear as in sync.

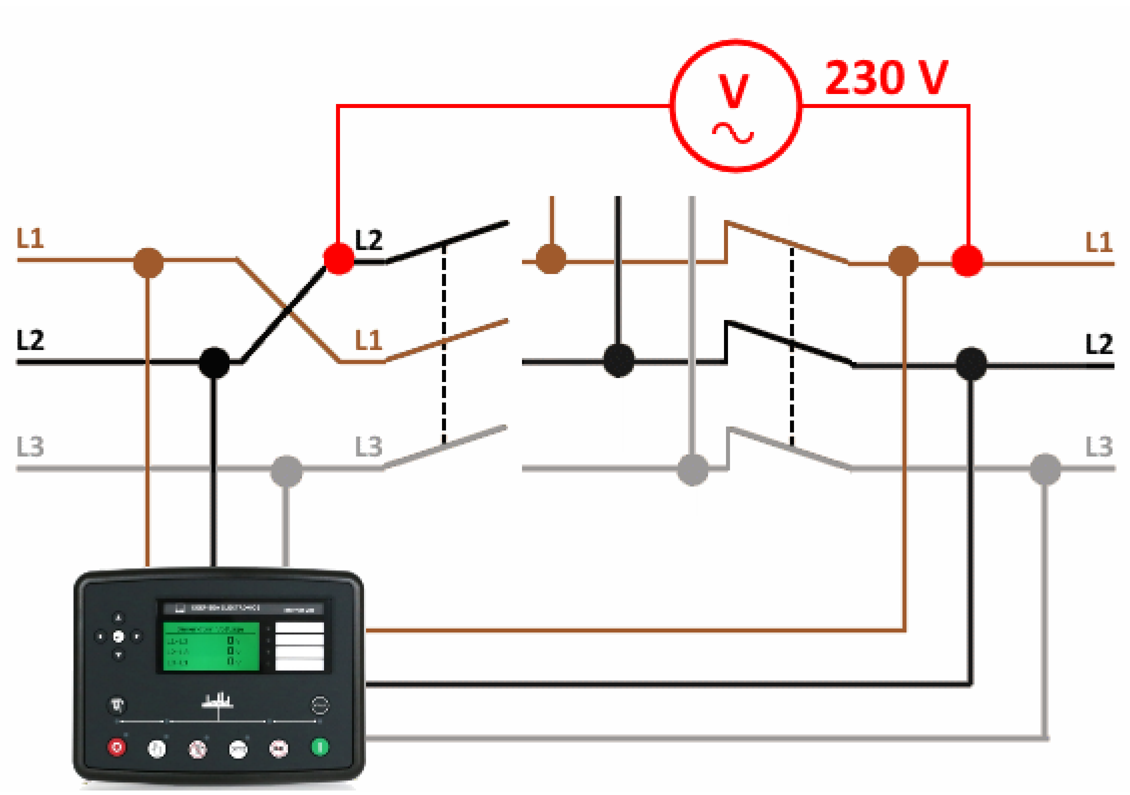


This is tested by starting the generator with the DSE module and ensuring the generator switchgear is left open (activate an input configured for *Generator Load Inhibit*). Then the load bus is to be made live, this is achieved by ensuring the mains switchgear is closed. Across the switchgear, connect a voltage meter to measure the AC voltage when the DSE module shows the two supplies in sync.

9.2.1.1 INCORRECTLY WIRED BREAKER

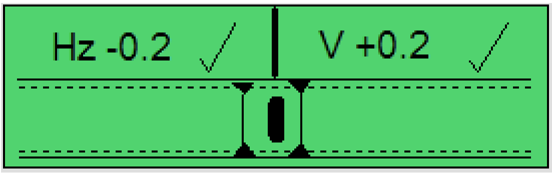
When the DSE module's synchroscope shows the two supplies in sync, if the voltage meter shows a voltage difference the switchgear is wired incorrectly. This is shown in the example below.

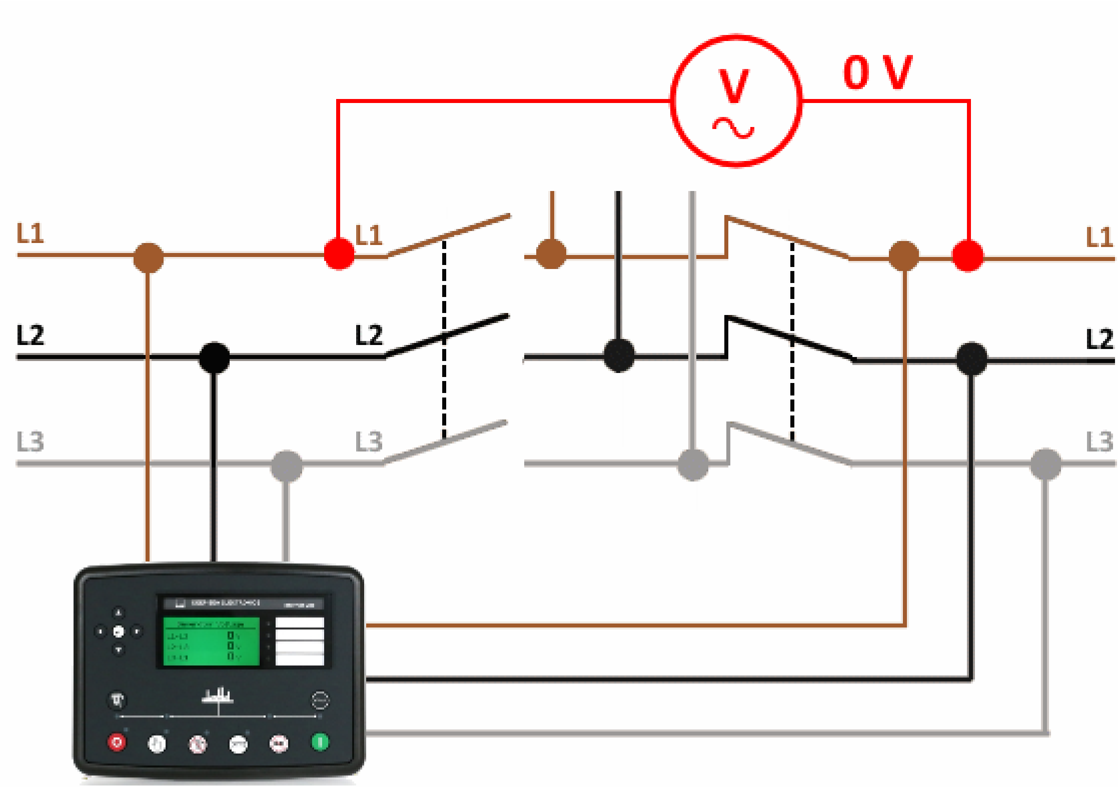




9.2.1.2 CORRECTLY WIRED BREAKER

When the DSE module's synchroscope shows the two supplies in sync, if the voltage meter shows no voltage difference the switchgear is wired correctly. This is shown in the example below.





10 FAULT FINDING

NOTE: The below fault finding is provided as a guide check-list only. As the module can be configured to provide a wide range of different features, always refer to the source of the module configuration if in doubt.

10.1 STARTING

Symptom	Possible Remedy
Unit is inoperative Read/Write configuration does not operate	Check the battery and wiring to the unit. Check the DC supply. Check the DC fuse.
Unit shuts down	Check DC supply voltage is not above 35 Volts or below 9 Volts Check the operating temperature is not above 70°C. Check the DC fuse.
Fail to Start is activated after pre-set number of attempts to start	Check wiring of fuel solenoid. Check fuel. Check battery supply. Check battery supply is present on the Fuel output of the module. Check the speed-sensing signal is present on the module's inputs. Refer to engine manual.
Continuous starting of generator when in the ***Auto Mode***	Check that there is no signal present on the "Remote Start" input. Check configured polarity is correct. Check the mains supply is available and within configured limits
Generator fails to start on receipt of Remote Start signal.	Check Start Delay timer has timed out. Check signal is on "Remote Start" input. Confirm correct configuration of input is configured to be used as "Remote Start". Check that the oil pressure switch or sensor is indicating low oil pressure to the controller. Depending upon configuration, the set does not start if oil pressure is not low.
Pre-heat inoperative	Check wiring to engine heater plugs. Check battery supply. Check battery supply is present on the Pre-heat output of module. Check pre-heat configuration is correct.
Starter motor inoperative	Check wiring to starter solenoid. Check battery supply. Check battery supply is present on the Starter output of module. Ensure oil pressure switch or sensor is indicating the "low oil pressure" state to the controller.

10.2 LOADING

Symptom	Possible Remedy
Engine runs but generator does not take load	Check Warm up timer has timed out. Ensure generator load inhibit signal is not present on the module inputs. Check connections to the switching device. Note that the set does not take load in ***Manual Mode*** unless there is an active load signal.
Incorrect reading on Engine gauges Fail to stop alarm when engine is at rest	Check engine is operating correctly. Check that sensor is compatible with the module and that the module configuration is suited to the sensor.

10.3 ALARMS

Symptom	Possible Remedy
Oil pressure low fault operates after engine has fired	Check engine oil pressure. Check oil pressure switch/sensor and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sensor is compatible with the module and is correctly configured.
Coolant temp high fault operates after engine has fired.	Check engine temperature. Check switch/sensor and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sensor is compatible with the module.
Shutdown fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Electrical Trip fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Warning fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
ECU Amber ECU Red	This indicates a fault condition detected by the engine ECU and transmitted to the DSE controller.
ECU Data Fail	Indicates failure of the CAN data link to the engine ECU. Check all wiring and termination resistors (if required).
Incorrect reading on Engine gauges Fail to stop alarm when engine is at rest	Check engine is operating correctly. Check sensor and wiring paying particular attention to the wiring to terminal 14. Check that sensor is compatible with the module and that the module configuration is suited to the sensor.

10.4 COMMUNICATIONS

Symptom	Possible Remedy
ECU Data Fail	Indicates failure of the CAN data link to the engine ECU. Check all wiring and termination resistors (if required).

10.5 INSTRUMENTS

Symptom	Possible Remedy
Inaccurate generator measurements on controller display	Check that the CT primary, CT secondary and VT ratio settings are correct for the application. Check that the CTs are wired correctly with regards to the direction of current flow (p1,p2 and s1,s2) and additionally ensure that CTs are connected to the correct phase (errors occur if CT1 is connected to phase 2). Remember to consider the power factor (kW = kVA x powerfactor). The controller is true RMS measuring so gives more accurate display when compared with an ‘averaging’ meter such as an analogue panel meter or some lower specified digital multimeters. Accuracy of the controller is better than 1% of full scale. Generator voltage full scale is 415 V ph-N, accuracy is ±4.15 V (1 % of 415 V).

10.6 MISCELLANEOUS

Symptom	Possible Remedy
Module appears to 'revert' to an earlier configuration	When editing a configuration using the PC software it is vital that the configuration is first 'read' from the controller before editing it. This edited configuration must then be "written" back to the controller for the changes to take effect. When editing a configuration using the fascia editor, be sure to press the ***Tick*** button to save the change before moving to another item or exiting the fascia editor

11 CAN INTERFACE SPECIFICATION (J1939-75)
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The ECU port is used for live operational communications between the DSE module and other CAN enabled devices. The specification below details all broadcast messages which are transmitted when the J1939-75 is enabled and the relevant engine file is selected.

Parameter	Description
Protocol	S.A.E. J1939 with PGNs as listed in the following subsections.
Bit Rate	250 kb/s
Isolation	±2.5 kVrms
Termination	120 Ω termination resistor, with the option for switchable reistor by software.

11.1 BROADCAST MESSAGES J1939-75

NOTE: All broadcast CAN messages are priority 6 by default, it is not possible to change the priority of the configurable CAN messages. For further details of module configuration, refer to DSE Publication: 057- 224 DSE7310 MKII & DSE7310 MKII Configuration Software Manual.

NOTE: SPNs that are not implemented in the module have all bits set to '1'.

NOTE: *PDU Format* and *PDU Specific* are shown in Hexadecimal.

NOTE: Values larger than 8 bits utilise *Little-Endian* format. For example a 16 bit value, occupying two Bytes has Byte1 as the least significant Byte and Byte2 as the most significant Byte.

Parameter Groups below are broadcast by the module and are detailed in the following subsections.

11.1.1 ACS - AC SWITCHING DEVICE STATUS

PGN 64913

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	91	8	250 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0DD9	3545	Generator Breaker Status - This parameter indicates the measured state of the generator circuit breaker	Byte 1 Bits 1 to 3	***000:*** Open ***001:*** Closed ***010:*** Locked Out ***011-101:*** Available for SAE assignment ***110:*** Error ***111:*** Not available	0	N/A
0DDA	3546	Utility Circuit Breaker Status - This parameter indicates the measured state of the utility circuit breaker.	Byte 1 Bits 4 to 6	***000:*** Open ***001:*** Closed ***010:*** Locked Out ***011-101:*** Available for SAE assignment ***110:*** Error ***111:*** Not available	0	N/A

11.1.2 GC1 - GENERATOR CONTROL 1

PGN 64915

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	93	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0DEF	3567	Generator Control Not In Automatic Start State - This parameter indicates whether or not the generator set is in a condition to automatically start up and provide power. If not, this status parameter is in the ACTIVE state.	Byte 1 Bits 4 to 5	***00:*** Inactive (ready to start automatically) ***01:*** Active (not ready to start automatically) ***10:*** Error ***11:*** Not available	0	N/A

11.1.3 GAAC - GENERATOR AVERAGE BASIC AC QUANTITIES

PGN 65030

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	06	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0988	2440	Generator Avg. L-L AC Voltage	Byte 1 to 2	1	0	V
098C	2444	Generator Avg. L-N AC Voltage	Byte 3 to 4	1	0	V
0984	2436	Generator Avg. AC Frequency	Byte 5 to 6	1/128 Hz/bit	0	Hz
0990	2448	Generator Avg. AC RMS Current	Byte 7 to 8	1	0	A

11.1.4 GPAAC - GENERATOR PHASE A BASIC AC QUANTITIES

PGN 65027

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	03	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0985	2437	Generator Phase A AC Frequency	Byte 5 to 6	128	0	V
0989	2441	Generator Phase A Line Line AC RMS Voltage	Byte 1 to 2	1	0	V
098D	2445	Generator Phase A Line Neutral AC RMS Voltage	Byte 3 to 4	1	0	A
0991	2449	Generator Phase A AC RMS Current	Byte 7 to 8	1	0	Hz

11.1.5 GPAACP - GENERATOR PHASE A AC POWER

PGN 65026

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	02	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0993	2453	Generator Phase A Real Power	Byte 1 to 4	1	$-2*10^9$	W
099D	2461	Generator Phase A Apparent Power	Byte 5 to 8	1	$-2*10^9$	W

11.1.6 GPAACR - GENERATOR PHASE A AC REACTIVE POWER

PGN 65025

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	00	8	100 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0999	2457	Generator Phase A Reactive Power	Byte 1 to 4	1	$-2*10^9$	var

11.1.7 GPBAC - GENERATOR PHASE B BASIC AC QUANTITIES

PGN 65024

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	00	8	100 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0986	2438	Generator Phase B AC Frequency	Byte 5 to 6	0.0078125	0	Hz
098A	2442	Generator Phase B Line Line AC RMS Voltage	Byte 1 to 2	1	0	V
098E	2446	Generator Phase B Line Neutral AC RMS Voltage	Byte 3 to 4	1	0	V
0992	2450	Generator Phase B AC RMS Current	Byte 7 to 8	1	0	A

11.1.8 GPBACP - GENERATOR PHASE B AC POWER

PGN 65023

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	FF	8	100 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0996	2454	Generator Phase B Real Power	Byte 1 to 4	1	$-2*10^9$	W
099E	2462	Generator Phase B Apparent Power	Byte 5 to 8	1	$-2*10^9$	W

11.1.9 GPBACR - GENERATOR PHASE B AC REACTIVE POWER

PGN 65022

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	FE	8	100 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
099A	2458	Generator Phase B Reactive Power	Byte 1 to 4	1	$-2*10^9$	var

11.1.10 GPCAC - GENERATOR PHASE C BASIC AC QUANTITIES

PGN 65021

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	FD	8	100 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0987	2439	Generator Phase C AC Frequency	Byte 5 to 6	0.0078125	0	Hz
098B	2443	Generator Phase C Line Line AC RMS Voltage	Byte 1 to 2	1	0	V
098F	2447	Generator Phase C Line Neutral AC RMS Voltage	Byte 3 to 4	1	0	V
0993	2451	Generator Phase C AC RMS Current	Byte 7 to 8	1	0	A

11.1.11 GPCACP - GENERATOR PHASE C AC POWER

PGN65020

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	FF	8	100 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0997	2455	Generator Phase C Real Power	Byte 1 to 4	1	$-2*10^9$	W
099F	2463	Generator Phase C Apparent Power	Byte 5 to 8	1	$-2*10^9$	W

11.1.12 GPCACR - GENERATOR PHASE C AC REACTIVE POWER

PGN 65019

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	FB	8	100 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
099B	2459	Generator Phase C Reactive Power	Byte 1 to 4	1	$-2*10^9$	var

11.1.13 GTACPP - GENERATOR TOTAL AC PERCENT POWER

PGN 64911

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	8F	8	250 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0E06	3590	Generator Total Percent kW as a percentage of rated power	Byte 1 to 2	0.0078125	-251	%

11.1.14 GTACE - GENERATOR TOTAL KW HOURS EXPORT

PGN 65018

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	FA	8	100 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
09A4	2468	Generator Total kW Hours Export	Byte 1 to 4	1	0	kWh

11.1.15 GTACER - GENERATOR TOTAL AC REACTIVE ENERGY

PGN64910

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	8E	8	250 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0E09	3593	Generator Total kVAr Hours Export	Byte 1 to 4	1	0	kvarh

11.1.16 GTACP - GENERATOR TOTAL AC POWER

PGN65029

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	05	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0994	2452	Generator Total Real Power	Byte 1 to 4	1	$-2*10^9$	W
099C	2460	Generator Total Apparent Power	Byte 5 to 8	1	$-2*10^9$	VA

11.1.17 GTACR - GENERATOR TOTAL AC REACTIVE POWER

PGN65028

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	04	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0988	2456	Generator Total Reactive Power	Byte 1 to 4	1	$-2*10^9$	var
09A0	2464	Generator Overall Power Factor	Byte 5 to 6	-1	$6.103515625*10^{-5}$	pF
09D6	2518	Generator Overall Power Factor Lagging	Byte 7 to 8	1	0	+/-

11.2 BROADCAST MESSAGES ENGINE INSTRUMENTATION

NOTE: The availability of the Engine Instrumentation PGNs are dependant upon the engine file selected within the DSE module's configuration. Contact DSE technical support: support@deepseaelectronics.com for more information.

11.2.1 DD - DASH DISPLAY

PGN 65276

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	FC	8	1000 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
060	96	Ratio of volume of fuel to the total volume of fuel storage container.	Byte 2	0.4	0	%

11.2.2 EC2 - ENGINE CONFIGURATION 2

PGN64895

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	7F	8	Request

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0E56	3670	Maximum Crank Attempts per Start Attempt	Byte 1	1	0	N/A

11.2.3 EEC1- ENGINE SPEED

PGN61444

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	F0	04	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0BE	190	Engine Speed	Byte 4 to 5	0.125	0	RPM

11.2.4 EEC4 - CRANK ATTEMPT COUNT ON PRESENT START ATTEMPT

PGN65214

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	FB	8	Request

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0E57	3671	Crank Attempt Count on Present Start Attempt	Byte 6	1	0	N/A

11.2.5 EFL_P1 - OIL PRESSURE

PGN65263

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	EF	8	500 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
064	100	Oil Pressure	Byte 4	4	0	kPa

11.2.6 EOI - EMERGENCY STOP

PGN64914

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FD	92	8	250 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0E17	3607	Emergency Stop ***00:*** Off (No Shutdown Requested) ***01:*** On (Shutdown Requested) ***10:*** Reserved ***11:*** Don't care / take no action	Byte 6 Bit 6 to 8	1	0	N/A

11.2.7 ET1 - COOLANT TEMPERATURE

PGN65262

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	EE	8	1000 ms

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
06E	110	Engine Coolant Temperature	Byte 1	1	-40	°C

11.2.8 HOURS - ENGINE HOURS REVOLUTIONS

PGN65253

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	E5	8	Request

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0F7	247	Engine Total Hours of Operation	Byte 1 to 4	0.05	0	hr

11.2.9 VEP1 - VEHICLE ELECTRICAL POWER

PGN65271

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6	0	0	FE	F7	8	1000 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0A7	167	Charge Alternator Voltage	Byte 3 to 4	0.05	0	V
0A8	168	Plant Battery Voltage	Byte 5 to 6	0.05	0	V

11.2.10 DM01 - CONDITIONS ACTIVE DIAGNOSTIC TROUBLE CODES

NOTE: The availability of the Engine Alarm SPN and FMI is dependant upon the engine file selected within the DSE module's configuration. Contact DSE technical support: support@deepseaelectronics.com for more information.

NOTE: If only one DM1 alarm is active the DM1 priority will remain as six. If two or more DM1 alarms are active the priority will be seven.

PGN65226

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
6/7	0	0	FE	CA	8	1000 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
04BE	1214	Suspect Parameter Number	Byte 3 Bits 1 to 19	1	0	N/A
04BF	1215	Failure Mode Identifier	Byte 5 Bits 1 to 5	1	0	N/A
06AA	1706	SPN Conversion Method	Byte 6 Bit 7	1	0	N/A

DM1 Conditions

Key	Value
Low Fault - Least Severe	17
High Fault - Least Severe	15
Low Fault - Most Severe	1
High Fault - Most Severe	0
Erratic - Incorrect Data	2

Generator Alarm Condition	SPN	Warning FMI	Shutdown FMI
Generator Average AC Frequency Under	2436	17	1
SPN Generator Average Line-Line AC RMS Voltage Over	2436	15	0
Generator Average Line-Line AC RMS Voltage Under	2440	17	1
Generator Average Line-Line AC RMS Voltage Over	2440	15	0
Generator Average Line-Neutral AC RMS Voltage Under	2444	17	1
Generator Average Line-Neutral AC RMS Voltage Over	2444	15	0
Generator Average AC RMS Current Over	2448	15	0

Parameters continued overleaf…

Engine Alarm Condition	SPN	Warning FMI	Shutdown FMI
Fuel Level Low	96	17	1
Oil Pressure Low (Analogue Sensor)	100	17	1
Oil Pressure Low (Digital Input)	100	17	1
Oil Pressure Sensor Fault	100	2	2
Coolant Temperature High (Analogue Sensor)	110	15	0
Coolant Temperature High (Digital Input)	110	15	0
Coolant Temperature Sensor Fault	110	2	2
Charge Alternator Failed	167	17	1
Plant Battery Voltage High	168	15	0
Plant Battery Voltage Low	168	17	1
Overspeed	190	15	0
Underspeed	190	17	1

12 MAINTENANCE, SPARES, REPAIR AND SERVICING

The controller is *Fit and Forget*. As such, there are no user serviceable parts within the controller.
In the case of malfunction, you should contact your original equipment manufacturer (OEM).

12.1 PURCHASING ADDITIONAL CONNECTOR PLUGS FROM DSE

If you require additional plugs from DSE, please contact our Sales department using the part numbers below.

12.1.1 PACK OF PLUGS

Module Type	Plug Pack Part Number
DSE7310 MKII	007-877
DSE7320 MKII	007-876

12.1.2 INDIVIDUAL PLUGS

Module Terminal Designation	Plug Description	Part No.
1 to 13 D+ W/L	13 way 5.08 mm	007-166
14 to 20	7 way 5.08 mm	007-447
21 to 29 ECU	9 way 5.08 mm	007-167
30 to 37 V1	8 way 7.62 mm	007-454
38 to 41 **V2** DSE7320 MKII Only	4 way 7.62 mm	007-171
42 to 47	6 way 5.08 mm	007-446
48 to 55	8 way 5.08 mm	007-164
56 to 58 **RS485**	6 way 5.08 mm	007-446
	PC Configuration interface lead (USB type A – USB type B)	016-125

12.2 PURCHASING ADDITIONAL FIXING CLIPS FROM DSE

Item	Description	Part No.
	Module Fixing Clips (Packet of 4)	020-294

12.3 PURCHASING ADDITIONAL SEALING GASKET FROM DSE

Item	Description	Part No.
	Module Silicon Sealing Gasket	020-564

12.4 DSENET® EXPANSION MODULES

NOTE: A maximum of twenty (20) expansion modules and DSE Intelligent Battery Chargers can be connected to the DSE7310 MKII & DSE7320 MKII DSENet® Port.

NOTE: When connecting a DSE25xx MKII Remote Display on DSENet, the maximum number of supported expansion modules reduces from 20 down to 5 (including only 1 battery charger).

NOTE: The DSENet® port is also used to connect to the Battery Chargers. This document does not cover the Battery Chargers ranges. For more information about the Battery Chargers refer to the relevant Chargers Operators and Software manuals.

NOTE: DSENet® utilises an RS485 connection. Using Belden 9841 (or equivalent) cable allows for the expansion cable to be extended to a maximum of 1.2 km.
DSE Stock and supply Belden 9841 cable. DSE Part Number 016-030.

			DSE Part Numbers		
Item	**Max No. Supported**	**Description**	**Model Order Number**	**Operator Manual**	**Installation Instructions**
	4	Model DSE2130 input module provides additional analogue and digital inputs for use with the controller.	2130-01	057-082	053-033
	4	Model DSE2131 Ratio-metric input expansion module provides additional resistive, digital, 0 V to 10 V and 4 mA to 20mA inputs for use with the controller.	2131-01	055-115	057-139
	4	Model DSE2133 RTD/Thermocouple input expansion module provides additional RTD and thermocouple inputs for use with the controller.	2133-01	055-114	057-140
	4	Model DSE2152 Ratio-metric output expansion module provides additional 0 V to 10 V and 4 mA to 20mA outputs for use with the controller.	2152-01	055-112	057-141

Expansion modules continued overleaf…

Item	Max No. Supported	Description	DSE Part Numbers Model Order Number	Operator Manual	Installation Instructions
	10	Model DSE2157 expansion relay module provides eight additional voltage free relays for use with the controller	2157-01	057-083	053-034
	10	Model DSE2548 expansion LED module provides additional LED indications, internal sounder and remote lamp test/alarm mute for use with the controller.	2548-01	057-084	053-032
	1	Model DSE25xx MKII Expansion Display modules provide remote control / display capability for the DSE74xx MKII controllers. A DSE25xx MKII is a standard DSE73xx MKII unit after a firmware upgrade. DSE2510 MKII is for DSE7410 MKII DSE2520 MKII is for DSE7420 MKII	7310-03 7320-03	057-278	-
	4	Intelligent Battery Charger monitored over the DSENet® Port.	-	-	-

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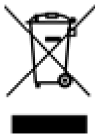
13 WARRANTY

DSE Provides limited warranty to the equipment purchaser at the point of sale. For full details of any applicable warranty, refer to the original equipment supplier (OEM)

14 DISPOSAL

14.1 WEEE (WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT)

If you use electrical and electronic equipment you must store, collect, treat, recycle and dispose of WEEE separately from your other waste.



COMPLEX SOLUTIONS
MADE SIMPLE

DEEP SEA ELECTRONICS

DSEEXTRA®

DSE2548 LED expansion module

057-084

Author : Anthony Manton

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E-mail : sales@Deepseaplc.com
Website : www.deepseaplc.com

DSE2548 relay output expansion module

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1 BIBLIOGRAPHY

This document refers to and is reffered to by the following DSE publications which can be obtained from the DSE website www.deepseaplc.com

DSE PART	DESCRIPTION
057-074	7000 series operators manual
057-077	7000 series configuration software manual

2 INTRODUCTION

This document details the installation requirements of the DSE2548 LED expansion module part of the DSEExtra® range of ancilliary modules.

DSE2548 LED expansion module is used in conjunction with compatible DSE controllers to provide additional LED indication functionality. The LEDs are configured in the 'host controller', the DSE2548 module is not itself configured aside from the 'ID switch' detailed below.
For further details on configuring the 'host controller' you are referred to the relevant configuration software manual.

3 SPECIFICATIONS

3.1 PART NUMBERING

2548 - 001 - 00

Product type

DSE 2548 relay expansion module — 2548

Variant

Standard product — 00

Hardware revision

Revision 1 — 001

At the time of this document production, there are no variants of this product and there have been no revisions of the module hardware.

3.2 POWER SUPPLY

Minimum supply voltage	8V continuous, 4V for up to 5 minutes.
Cranking dropouts	Able to survive 0V for 50mS providing the supply was at least 10V before the dropout and recovers to 5 volts afterwards.
Maximum supply voltage	35V continuous (protection to 60V)
Maximum operating current	112mA at 12V, 53mA at 24V Conditions: All LED's lit and sounder active.
Maximum standby current	74mA at 12V, 35mA at 24V Conditions:All LED's off and sounder inactive.

3.3 TERMINAL SPECIFICATION

Connection type	Screw terminal, rising clamp, no internal spring
Min cable size	0.5mm² (AWG 20)
Max cable size	2.5mm² (AWG 14)
Recommended cable size	Refer to table below

3.4 DSENET®

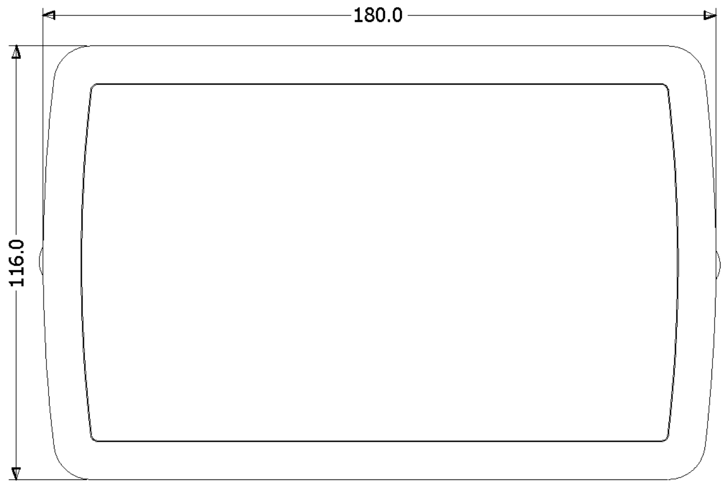
DSEnet is the interconnection cable between the host controller and the expansion module(s) and must not be connect to any device other than DSE equipment designed for connection to the DSEnet.

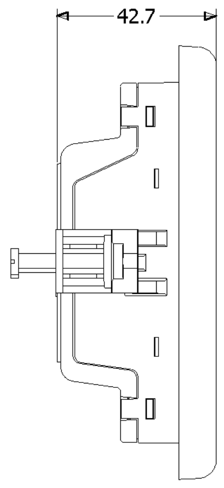
Cable type	Two core screened twisted pair
Cable characteristic impedance	120Ω
Recommended cable	Belden 9841 Belden 9271
Maximum cable length	1000m (1km) when using Belden 9841 or direct equivalent. 500m (0.5km) when using Belden 9271 or direct equivalent.
DSEnet topology	Bus with no stubs (spurs)
DSEnet termination	120Ω. Fitted internally to host controller. Must be fitted externally to the 'last' expansion module by the customer .
Maximum expansion modules	Refer to host controller documentation

NOTE : As a termination resistor is internally fitted to the host controller, the host controller must be the 'first' unit on the DSEnet. A termination resistor MUST be fitted to the 'last' unit on the DSEnet. See the section entitled*'Typical Wiring Diagram'* elsewhere in this manual for details.

3.5 DIMENSIONS

Overall size	180.0mm x 116.0mm x 42.7mm (7.07" x 4.57" x 1.68")
Mounting type	Panel mounting
Panel cutout	154mm x 98mm (6.06" x 3.86")





3.6 APPLICABLE STANDARDS

BS EN 60068-2-1 (Minimum temperature)	-30°C (-22°F)
BS EN 60068-2-2 (Maximum temperature)	+70°C (158°F)
BS EN 60950	Safety of information technology equipment, including electrical business equipment
BS EN 61000-6-2	EMC Generic Immunity Standard (Industrial)
BS EN 61000-6-4	EMC Generic Emission Standard (Industrial)
BS EN 60529 (Degrees of protection provided by enclosures)	IP65 when mounted into panel with optional gasket IP42 when mounted into panel WITHOUT gasket
UL508 **NEMA rating**	Enclosure type 2 when mounted into panel WITHOUT gasket Enclosure type 12 when mounted into panel with gasket

In line with our policy of continual development, Deep Sea Electronics, reserve the right to change specification without notice.

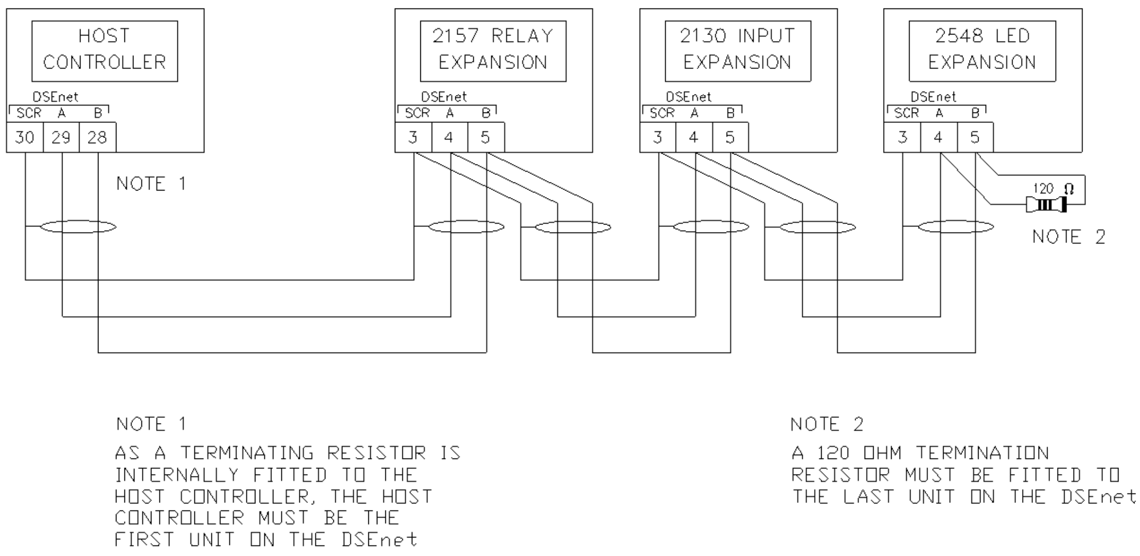
4 INSTALLATION

4.1 USER CONNECTIONS

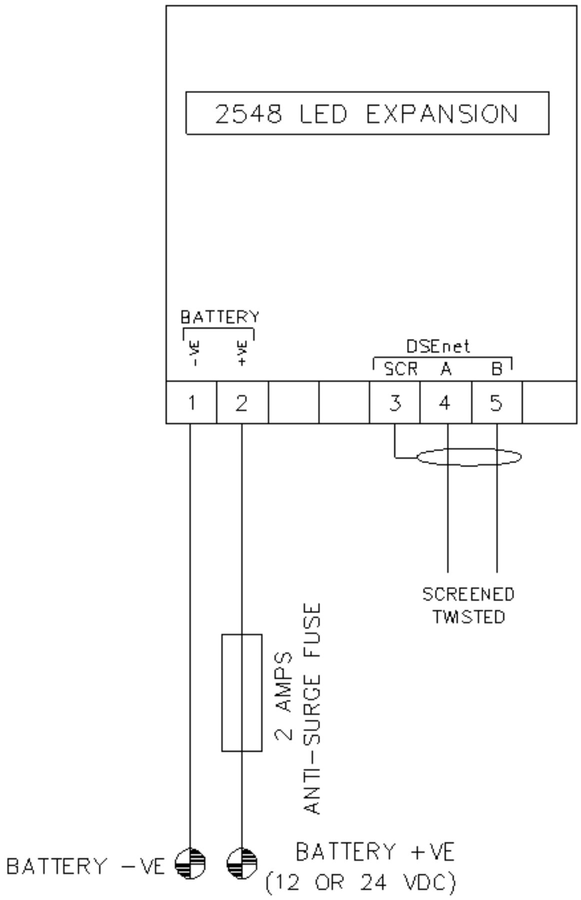
4.1.1 CONNECTOR A

Terminal	Function	Recommended size	
1	DC supply positive	1.0mm² (AWG 18)	
2	DC supply negative	1.0mm² (AWG 18)	
3	Screen		DSEnet only
4	A	0.5mm² (AWG 20)	DSEnet only
5	B	0.5mm² (AWG 20)	DSEnet only

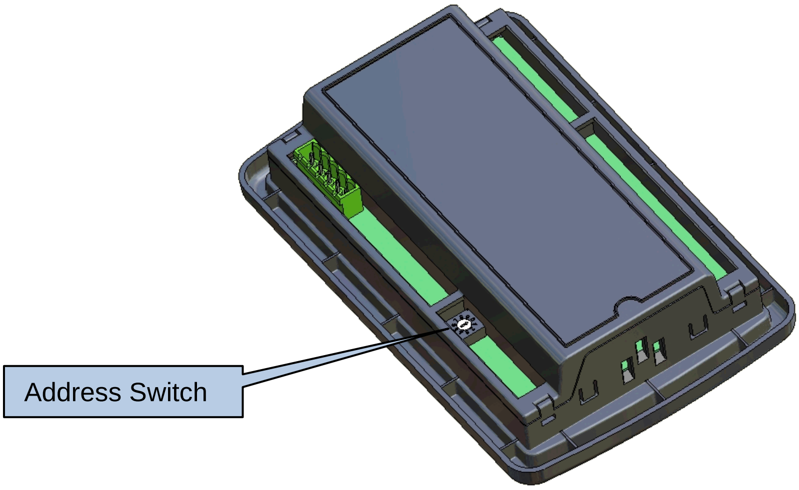
4.2 SCHEMATIC INTERCONNECTION DIAGRAM



4.3 TYPICAL WIRING DIAGRAM



5 CONTROLS AND INDICATIONS



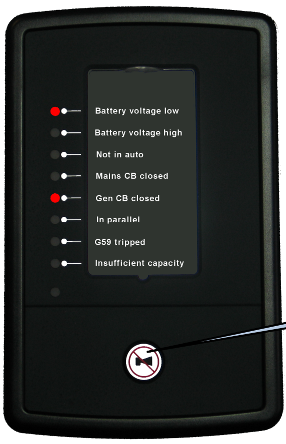
5.1 LED INDICATIONS

Function	Colour	Action
Power on / Link lost	RED	Steady when DC supply is connected and data is being received from the host controller. Flashing when the DC supply is connected and the data connection to the host controller is not operating.
Status 1-8	RED	Lit when the corresponding channel is active

5.2 SOUNDER

The 2548 LED expansion module has an integral sounder, activated upon a signal from the 'host controller'. The controller will activate the sounder when an alarm becomes active and silence the sounder when an alarm mute button (local or remote) is pressed.

5.3 PUSH BUTTON



Pressing the button will signal to the host controller that the button is pressed. The controller will respond by lighting all LEDs on the 2548 module (lamp test) and silencing the sounder (alarm mute).
If configured to do so, the host controller will also perform a lamp test and alarm mute function.

Lamp test/alarm mute

5.4 ID SWITCH

The rotary ID switch is used to select the ‘Identification’ of the 2548 expansion module as the host controller is capable of giving instructions to a number of 2548 expansion modules at the same time (consult relevant modules instructions for further details on number of supported expansion units).

The switch (located at the rear of the module) should be operated using a small screwdriver and set to match the required ID.

NOTE : The ID MUST be a unique number, different from the ID of any other 2548 module connected to the host controller.
If two or more 2548 controllers are required to ‘mimic’ each other then they should be configured with different IDs, and both configured the same in the host controller.

NOTE : The selection of the ID of *other types* of expansion modules WILL NOT interfere/clash with the ID of the 2548. For instance if the 2548 is set to ID4, it is acceptable to have a *different type* of expansion module (for instance 2130) set to ID4 also.

6 FAULT DIAGNOSIS

Nature of problem	Suggestion
LEDs don't activate on the 2548 module	Ensure the host controller is correctly configured to send signals to the 2548
Power LED indication does not illuminate	Check polarity and size of the connected DC supply are within the specifications of the DSE2548
Power LED flashes	This means the the communications link to the host controller has been lost. Check the connection of the DSEnet paying particular attention to the cable type being used and the positioning of the termination resistors.

7 MAINTENANCE, SPARES, REPAIR AND SERVICING

The DSE2548 is designed to be *Fit and Forget*. As such, there are no user serviceable parts. In the case of malfunction you should contact your original equipment supplier (OEM).

8 WARRANTY

DSE provides limited warranty to the equipment purchaser at the point of sale. For full details of any applicable warranty, you are referred to your original equipment supplier (OEM).

9 DISPOSAL

9.1 WEEE (WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT)

Directive 2002/96/EC
If you use electrical and electronic equipment you must store, collect, treat, recycle and dispose of WEEE separately from your other waste.

9.2 ROHS (RESTRICTION OF HAZARDOUS SUBSTANCES

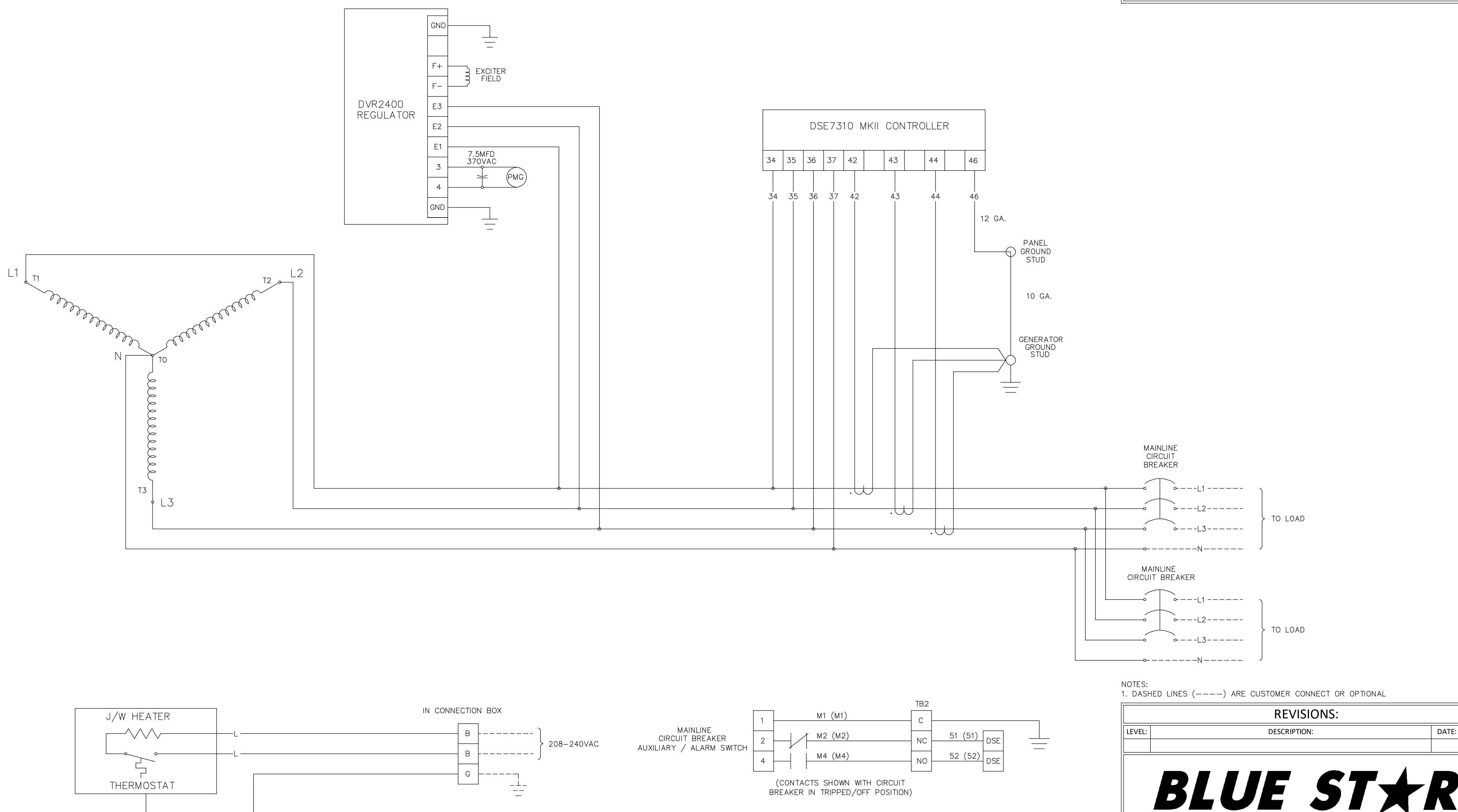
Directive 2002/95/EC:2006
To remove specified hazardous substances (Lead, Mercury, Hexavalent Chromium, Cadmium, PBB & PBDE´s)

Exemption Note: Category 9. (Monitoring & Control Instruments) as defined in Annex 1B of the WEEE directive will be exempt from the RoHS legislation. This was confirmed in the August 2005 UK´s Department of Trade and Industry RoHS REGULATIONS Guide (Para 11).

Despite this exemption DSE has been carefully removing all non RoHS compliant components from our supply chain and products.
When this is completed a Lead Free & RoHS compatible manufacturing process will be phased into DSE production.

This is a process that is almost complete and is being phased through different product groups.

DRAWING: E-AC-02134



NOTES:
1. DASHED LINES (————) ARE CUSTOMER CONNECT OR OPTIONAL

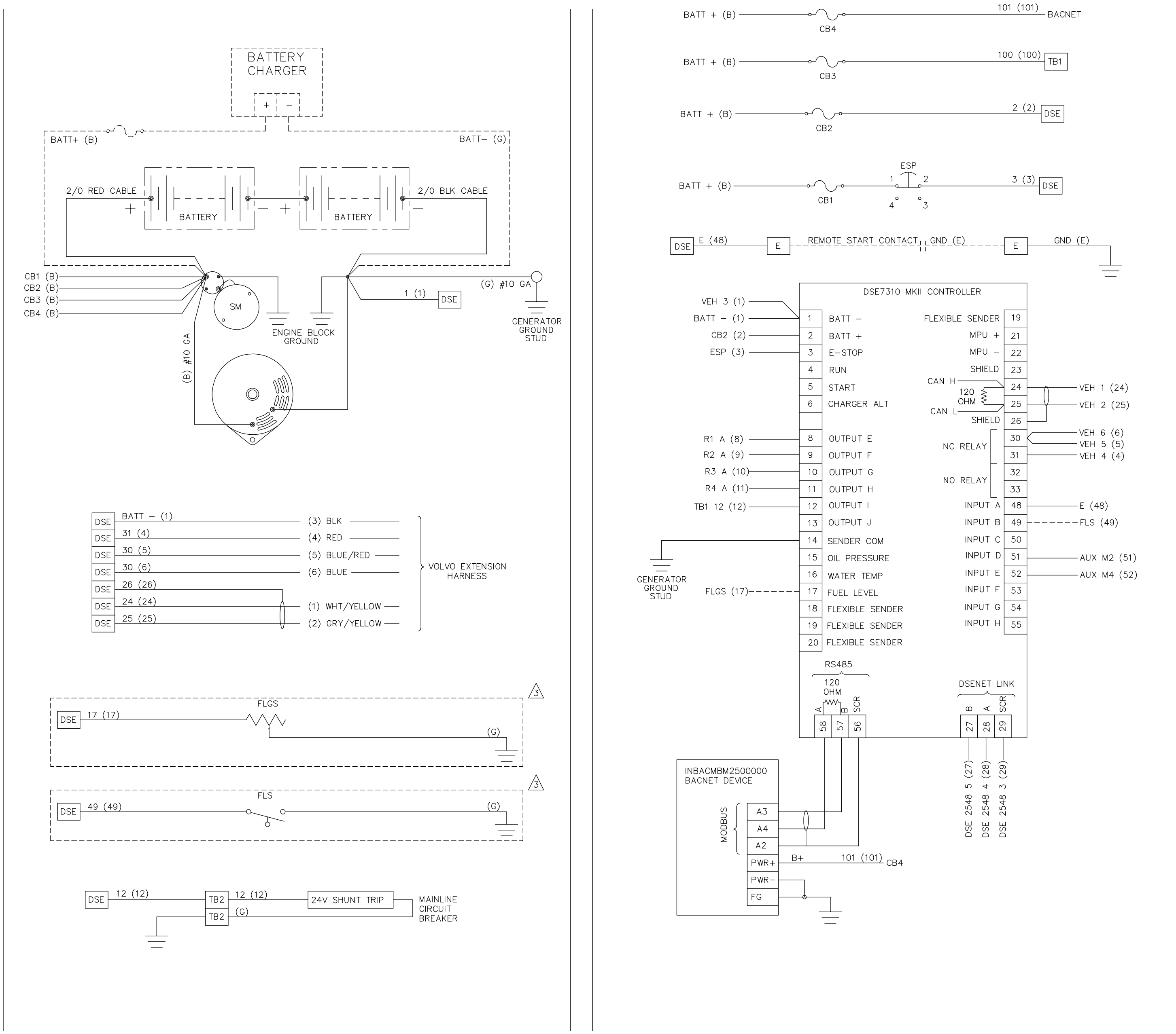
REVISIONS:			
LEVEL:	DESCRIPTION:	DATE:	BY:

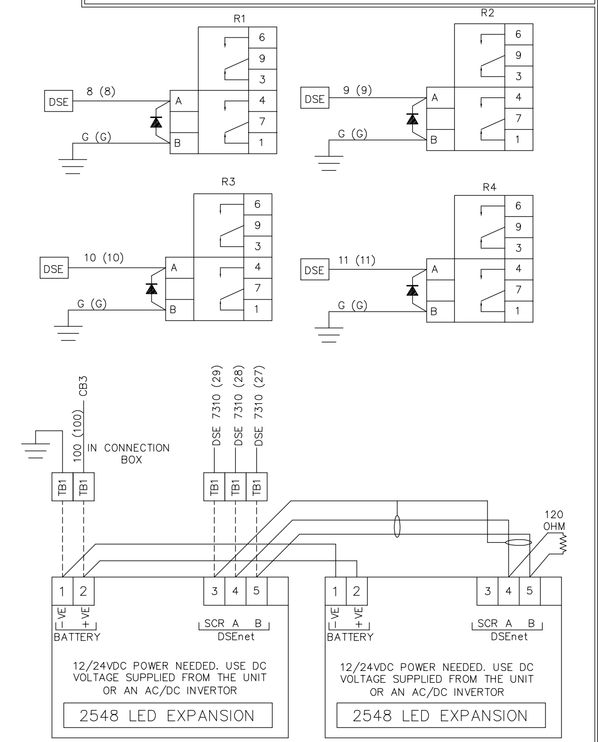
BLUE STAR
Power Systems Inc.

600V AC WIRING DIAGRAM

AVR: DVR2400

DATE: 04-30-21 | BY: JPJ | SCALE: N/A





LEGEND:

ESP – EMERGENCY STOP PUSHBUTTON
CB1 – CIRCUIT BREAKER #1 (15A)
CB2 – CIRCUIT BREAKER #2 (15A)
CB3 – CIRCUIT BREAKER #3 (15A)
CB4 – CIRCUIT BREAKER #4 (5A)
FLGS – FUEL LEVEL GAUGE SENDER
FLS – FUEL LEAK SWITCH

R1 – RELAY #1
R2 – RELAY #2
R3 – RELAY #3
R4 – RELAY #4
SM – STARTER MOTOR
VEH – VOLVO EXTENSION HARNESS
TB1 – TERMINAL BLOCK #1
TB2 – TERMINAL BLOCK #2

NOTES:
1. DASHED LINES (– – – –) ARE CUSTOMER CONNECT OR OPTIONAL
2. ALL WIRES TO BE #16 GA UNLESS NOTED OTHERWISE
3. INSTALL WITH FUEL TANK (SEE DIMENSIONAL DRAWING) OR WHEN NOTED

REVISIONS:

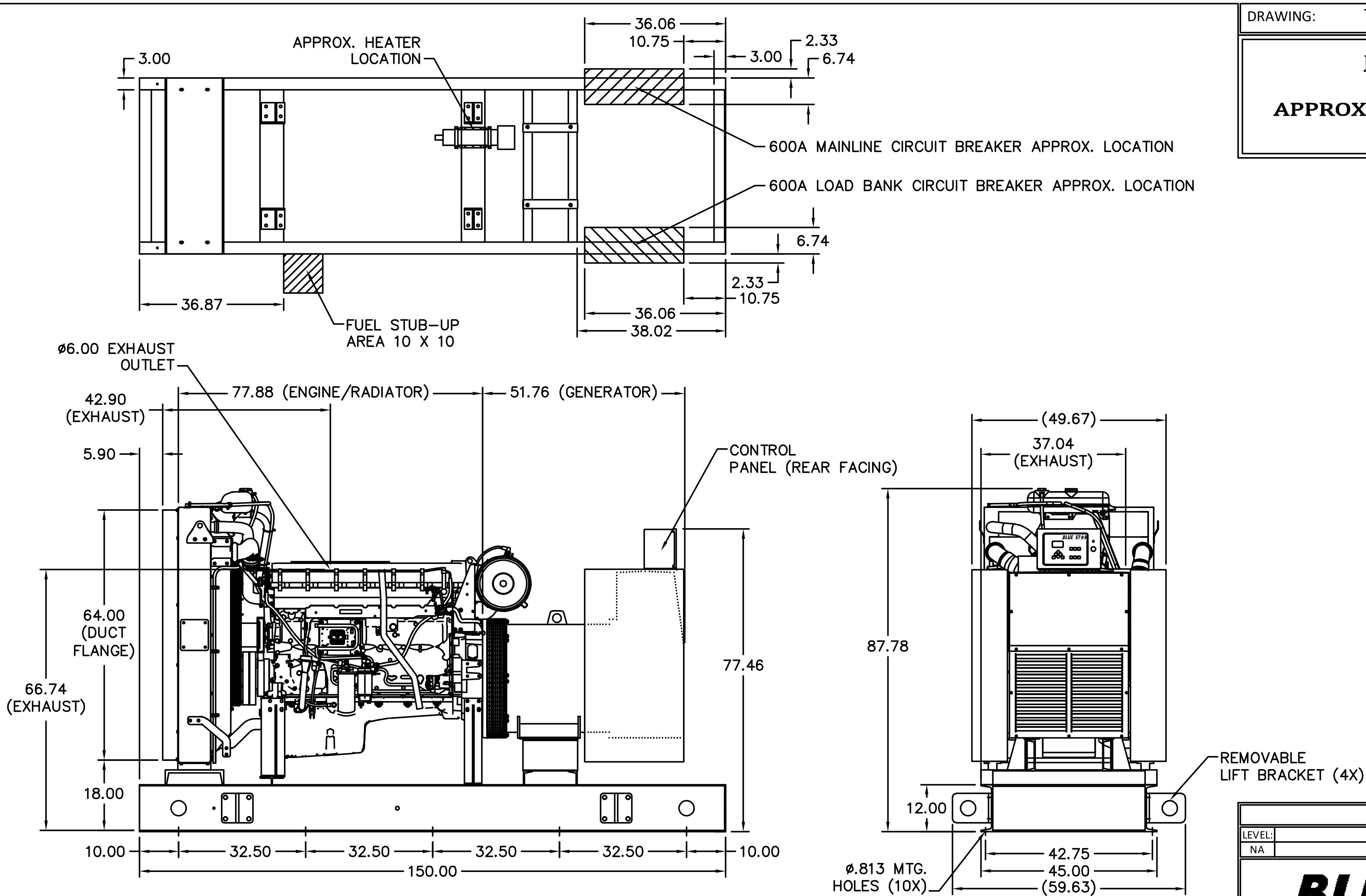
LEVEL:	DESCRIPTION:	DATE:	BY:
NA	NA	NA	NA

BLUE STAR

Power Systems Inc.

DC LADDER DIAGRAM

ENG: T3 VOLVO ENGINES		FUEL: BOTH	
DATE: 6-23-21	BY: MJK	SCALE: N/A	



NOTES:
1. BREAKER LOCATIONS ARE APPROXIMATE
2. FUEL SUPPLY: 3/8" FUEL RETURN: 1/4"
3. DUCT FLANGE WIDTH 36.00"
4. (XX.XX) DIMENSIONS ARE FOR REFERENCE ONLY

DRAWING: **VD500-01-LV0-23**

JOB NUMBER:
116385-2-1
APPROXIMATE SHIP WEIGHT:
9500 LBS.

REVISIONS:

LEVEL:	DESCRIPTION:	DATE:	BY:
NA	NA	NA	NA

BLUE STAR
Power Systems Inc.

ENG: TAD1642GE	GEN: 572	
RAD: W/ ENG	BASE: 2-0772	HSG: NA
DATE: 07-21-21	BY: ATB	DRAWN TO SCALE

DEEP SEA ELECTRONICS PLC
DSE ENCLOSED INTELLIGENT BATTERY CHARGER OPERATOR MANUAL

Document Number: 057-176

Author: Anthony Manton

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E-mail: sales@deepseaplc.com
Website: www.deepseaplc.com

DSE Enclosed Intelligent Battery Charger Operator Manual

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Amendments since last publication

Issue. No.	Comments
1	First Release
2	Added new FPE table
3	Added new FPE item to table
4	Added note to FPE table section
5	Updated to the new screen displays and charger FPE removed

Typeface : The typeface used in this document is *Arial*. Care should be taken not to mistake the upper case letter **I** with the numeral 1. The numeral 1 has a top serif to avoid this confusion.

TABLE OF CONTENTS

1 BIBLIOGRAPHY

This document refers to and is referred to by the following DSE publications which can be obtained from the DSE website www.deepseaplc.com

1.1 INSTALLATION INSTRUCTIONS

Installation instructions are supplied with the product in the box and are intended as a 'quick start' guide only.

DSE PART	DESCRIPTION
053-147	DSE9460 / DSE9461 Enclosed Intelligent Battery Charger Installation Instructions
053-154	DSE2541 Remote Battery Charger Display Installation Instructions

1.2 MANUALS

DSE PART	DESCRIPTION
057-159	DSE9400 Series Configuration Suite PC Software Manual

2 INTRODUCTION

This document details the installation requirements of the DSE range of enclosed intelligent battery chargers.
The manual forms part of the product and should be kept for the entire life of the product. If the product is passed or supplied to another party, ensure that this document is passed to them for reference purposes.
This is not a *controlled document.* You will not be automatically informed of updates. Any future updates of this document will be added to the DSE website at www.deepseaplc.com.

The enclosed intelligent battery chargers fulfill the most common functions required of a charger in the generating set industry. Combining a range of display options, protected outputs, intelligent charging and power supply operation with a robust enclosure.

3 SPECIFICATIONS

NOTE: Chargers are factory preconfigured to suit 12V or 24V batteries. However a charger can be freely changed from 12V to 24V using DSE Configuration Suite PC Software.

NOTE: Chargers are supplied configured to be suitable for Lead Acid batteries. Configuration to suit other battery types is performed using DSE Configuration Suite PC Software.

3.1 PROTECTION

- High Output Voltage (DC) detection.
- High / Low Input Voltage (AC) detection.
- Current limit to charger specification (5A or 10A depending upon charger model) with High Output Current detection.
- High Ambient Temperature detection.
- High Battery Temperature detection (when enabled).
- Short circuit protection. Charger automatically restarts operation after the fault is removed.
- Reverse battery polarity protection. Charger automatically restarts operation after the fault is removed.
- Battery Charger Failure. Informs of an internal fault with the battery charger.
- Common Fault Relay output.

3.2 ELECTRICAL SPECIFICATIONS

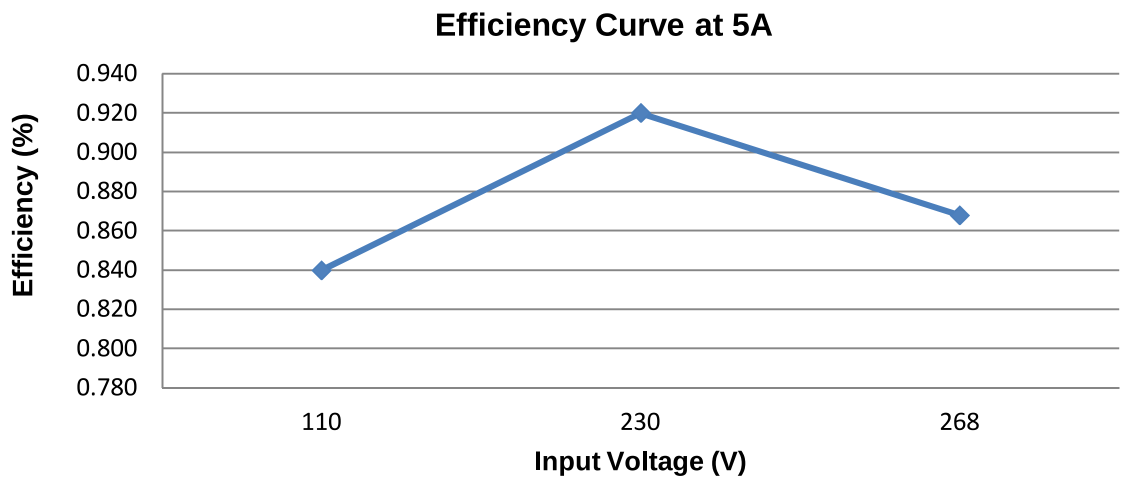
Parameter	Min	Nominal	Max
AC Input Voltage (V)	95V	110V-277V	305V
Operating Temperature	-30°C		85℃ with de-ratings
Input Frequency (Hz)	48Hz		64Hz
Output Ripple and Noise		1% Vo	
Load Regulation		1% Vo	
Line Regulation		<0.01% Vo	
Output Voltage Overshoot %		<5%Vo	
Transient Response Peak Deviation (mV) (at 50% to 100% load step)		<4% Vo	
Warm Up Voltage (V)		<1% Vo	
Output Voltage Rise Time (ms)		<200ms	
Short Circuit Protection		Hiccup	
Switching Frequency (kHz)		67kHz	
Efficiency %		>85%	
Temperature Sensor Input		PT1000	

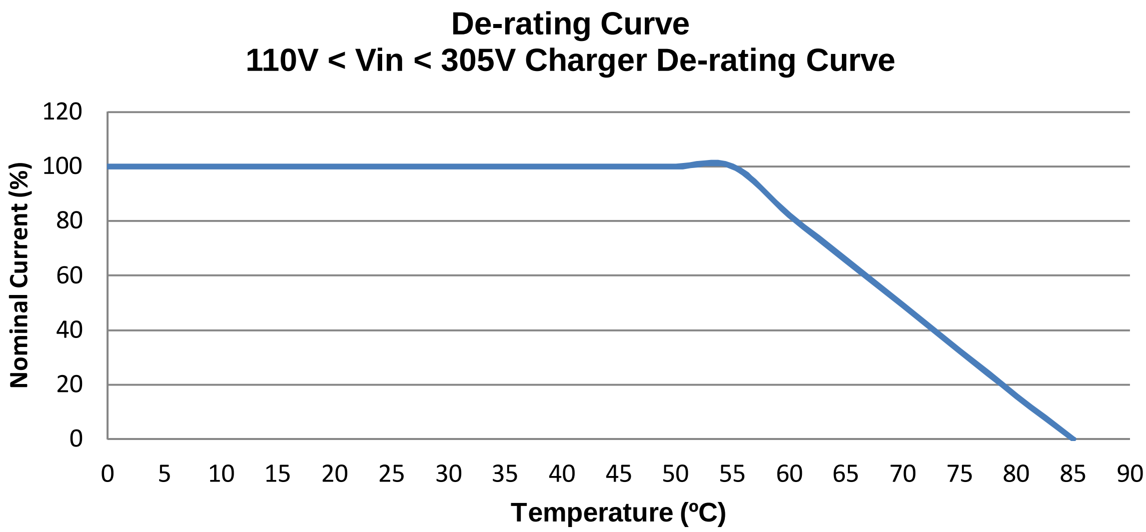
NOTE: Check the de-rating and efficieny curves in the following sections of this manual.

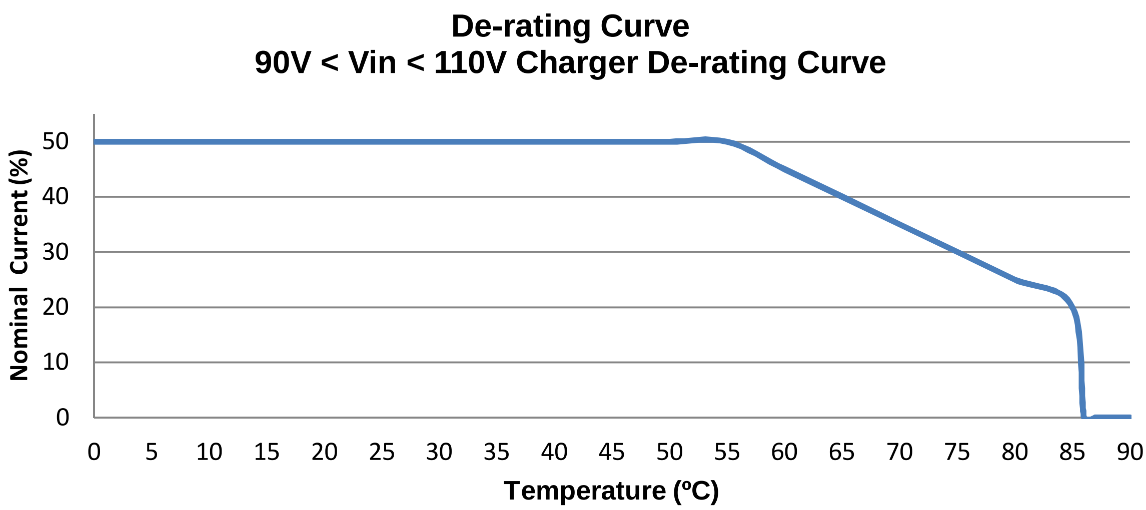
3.3 OUTPUT SPECIFICATIONS

3.3.1 DSE9460 24V/12V 5A

Parameter	Min	Nominal	Max	Comments
Output Voltage	9V	Configurable	29.5V	
Output Charging Current (A)	2A	5A	6A	
Current limit threshold (A)		5A	6A	
Recovery from current limit (A)	5A		6A	
Full load AC input current (A)			1.5A	At Vin=230 V, Vo=28.2 V, Io=5 Amp
Full load AC input current (A)			2.5A	At Vin=110 V, Vo=28.2 V, Io=10 Amp
AC Input Inrush (10ms) current (A)		60A		For 10ms

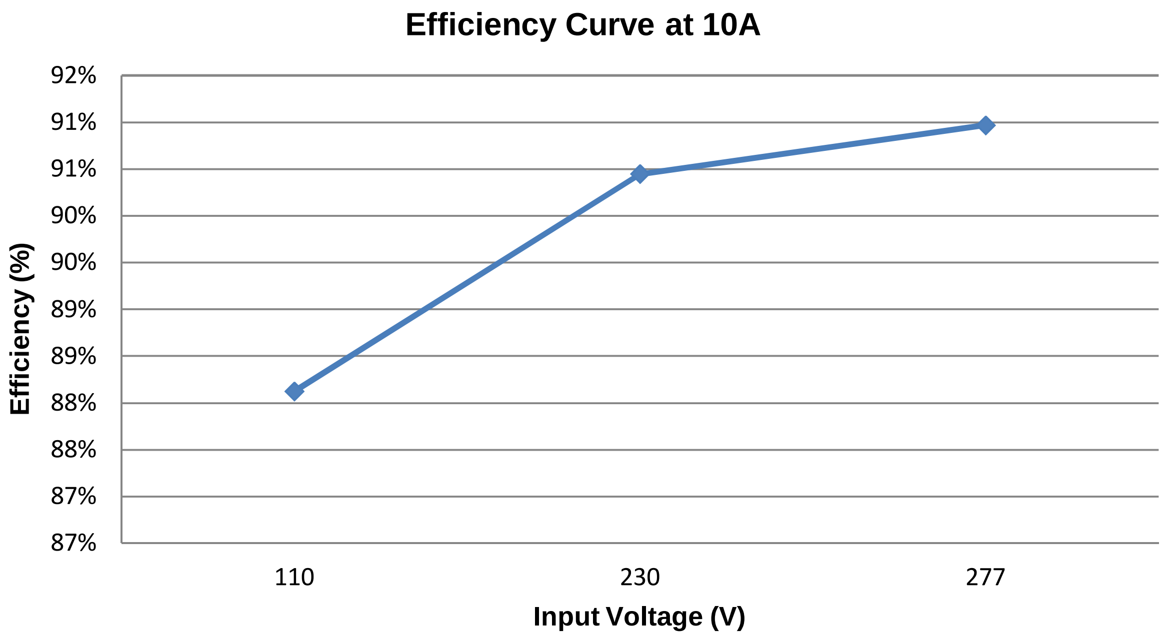



De-rating Curve
110V < Vin < 305V Charger De-rating Curve
Nominal Current (%)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Temperature (ºC)

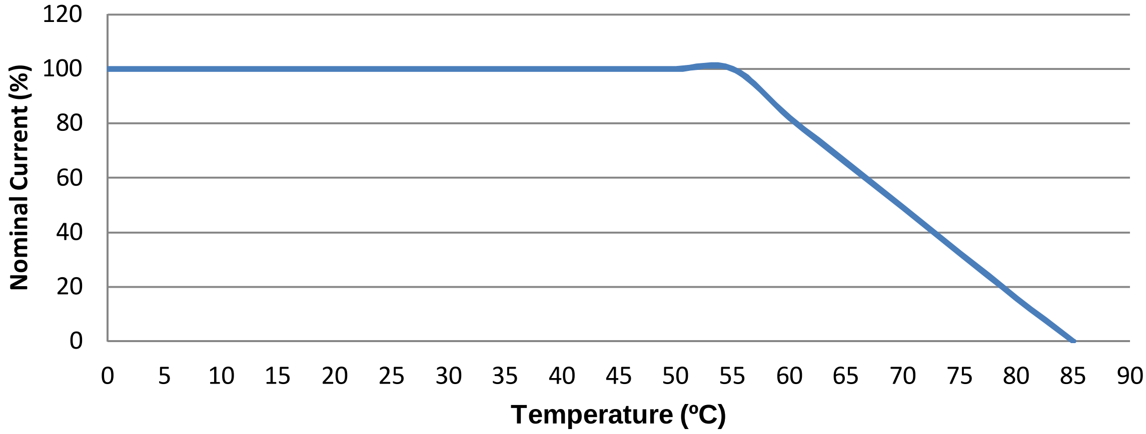

De-rating Curve
90V < Vin < 110V Charger De-rating Curve
Nominal Current (%)
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Temperature (ºC)

3.3.2 DSE9461 24V/12V 10A

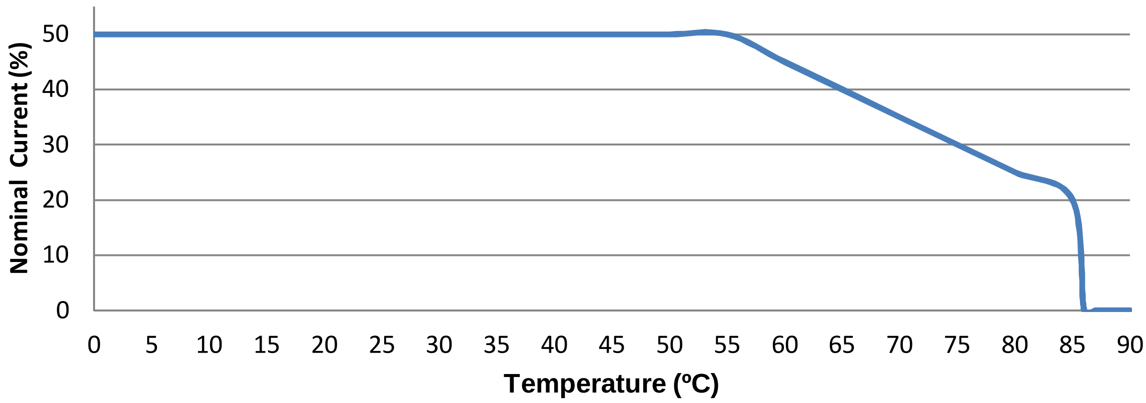
Parameter	Min	Nominal	Max	Comments
Output Voltage	9V	Configurable	30.5V	
Output Charging Current (A)	2A	10A	11A	
Current limit threshold (A)		10A	11A	
Recovery from current limit (A)	10A		11A	
Full load AC input current (A)			1.2A	At Vin=230V, Vo=14.4V, Io=10Amp
Full load AC input current (A)			2.2A	At Vin=110V, Vo=14.4V, Io=10Amp
AC Input Inrush (10ms) current (A)		60A		For 10ms



De-rating Curve
110V < Vin < 305V Charger De-rating Curve



De-rating Curve
90V < Vin < 110V Charger De-rating Curve



3.4 COMMUNICATION PORTS

Communication	Specification
USB Port	USB2.0 Device for connection to PC running DSE Configuration Suite Max distance 6m (20 feet)
RS485 Serial Port	Isolated Data connection 2 wire + common Half Duplex Data direction control for Transmit (by s/w protocol) Max Baud Rate 19200 External termination required (120Ω) Max common mode offset 70V (on board protection transorb) Max distance 1.2km (¾ mile)
Display Communication Port	Reserved for connection to fascia mounted LCD display module.

3.4.1 USB CONNECTION

The USB port is provided to give a simple means of connection between a PC and the DSE9400 series battery charger. Using the DSE Configuration Suite Software, the operator is then configure and monitor the state of the battery charger.

To connect a DSE9400 series battery charger to a PC by USB, the following items are required:

- DSE Enclosed Intelligent Battery Charger.

- DSE Configuration Suite Software
  (Supplied on configuration suite software CD or available from www.deepseaplc.com).

- USB cable Type A to Type B.
  (This is the same cable as often used between a PC and a USB printer)

  DSE can supply this cable if required :
  PC Configuration interface lead (USB type A – type B)
  DSE Part No 016-125

> **NOTE: Refer to Enclosed Intelligent Battery Charger PC Software Configuration Manual for further details on configuring and monitoring.**

3.4.2 RS485

The RS485 port on the battery charger supports the Modbus RTU protocol.

RS485 is used for point-to-point cable connection of more than one device (maximum 32 devices) and allows for connection to PCs, PLCs and Building Management Systems (to name just a few devices).

One advantage of the RS485 interface is the large distance specification (1.2km) when using Belden 9841 (or equivalent) cable. This allows for a large distance between the battery charger and a PC running the DSE Configuration Suite software. The operator is then able to view the various operating parameters.

NOTE: For distances up to 6m (8yds) the USB connection method is more suitable and provides for a lower cost alternative to RS485 (which is more suited to longer distance connections).

Cable Type	Two core screened twisted pair
Cable Characteristic Impedance	120Ω
Recommended Cable	Belden 9841 Belden 9271
Maximum Cable Length	1200m (¾ mile) when using Belden 9841 or direct equivalent. 600m (666 yds) when using Belden 9271 or direct equivalent.
RS485 Topology	“Daisy Chain” Bus with no stubs (spurs)
RS485 Termination	120Ω. Termination resistor must be fitted externally to the ‘first’ and ‘last’ expansion module by the customer as required by the RS485 specification.

3.4.2.1 RECOMMENDED RS485 EXPANSION FOR DESKTOP AND LAPTOP PC'S

- Brainboxes PM154 PCMCIA RS485 card (for laptops PCs)
  Set to 'Half Duplex, Autogating" with 'CTS True' set to 'enabled'

- Brainboxes VX-023 ExpressCard 1 Port RS422/485 (for laptops and nettop PCs)

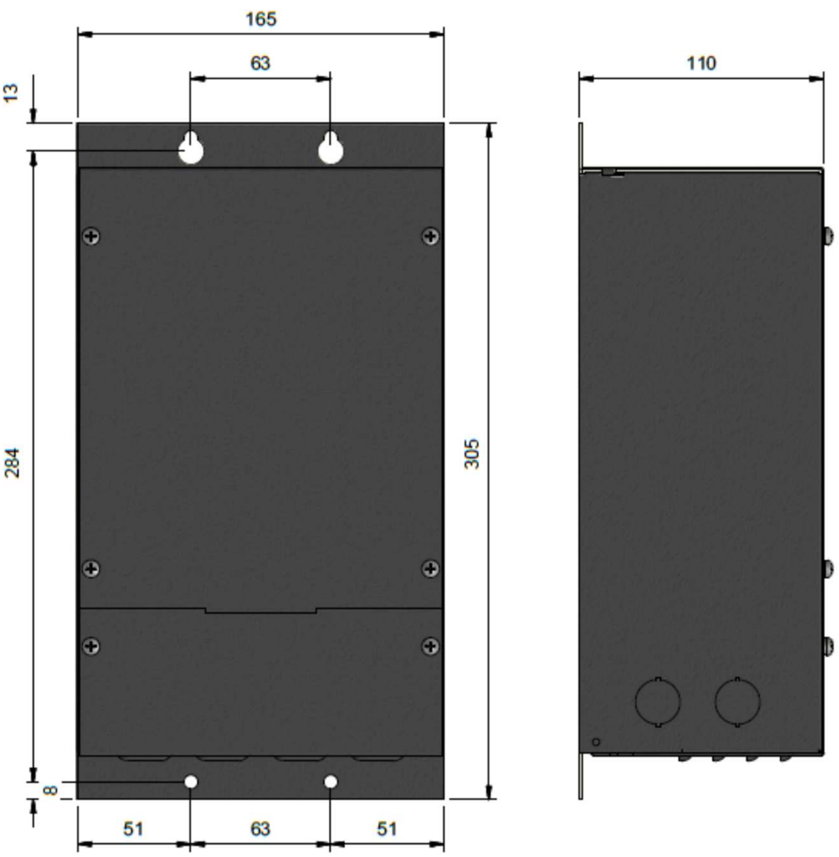
- Brainboxes UC320 PCI Velocity RS485 card (for desktop PCs)
  Set to 'Half Duplex, Autogating" with 'CTS True' set to 'enabled'

- Brainboxes PX-324 PCI Express 1 Port RS422/485 (for desktop PCs)

Supplier:
Brainboxes
Tel: +44 (0)151 220 2500
Web: http://www.brainboxes.com
Email: Sales: sales@brainboxes.com

3.6 DIMENSIONS AND MOUNTING

Parameter	Comment
Cabinet type	Custom cabinet for indoor use only
Overall size (see below for diagram)	165 mm x 305 mm x 110 mm (6.5" x 12" x 4.3")
Material:	Sheet steel enclosure of all-round solid construction
Surface finish:	Powder-coated black
Protection category:	IP20 NEMA 1
Weight	2.3 kg (5 lb 1 oz)
Mounting type	Wall mounting
Mounting holes	Diameter 6 mm (0.2") 63 mm x 284 mm (3.4" x 11.2") centres
Operating Temperature	-30 °C to +85 °C with deratings (-22 °F to +185 °F with deratings)



Measurements in mm

3.7 APPLICABLE STANDARDS

BS 4884-1	This document conforms to BS4884-1 1992 Specification for presentation of essential information.
BS 4884-2	This document conforms to BS4884-2 1993 Guide to content.
BS 4884-3	This document conforms to BS4884-3 1993 Guide to presentation.
BS EN 60068-2-1 (Minimum temperature)	-30°C (-22°F)
BS EN 60068-2-2 (Maximum temperature)	+85°C (185°F)
BS EN 60950	Safety of information technology equipment, including electrical business equipment.
BS EN 61000-6-2	EMC Generic Immunity Standard (Industrial).
BS EN 61000-6-4	EMC Generic Emission Standard (Industrial).
BS EN 60529 (Degrees of protection provided by enclosures)	IP20 Protected against penetration by solid objects with a diameter of more than 12 mm. Fingers or similar objects prevented from approach. No protection against water
UL508 **NEMA rating**	Enclosure type 1 Provides a degree of protection against contact with the enclosure equipment and against a limited amount of falling dirt
UK WEEE REGULATIONS	Producer Registration Number WEE/BE0052TQ

In line with our policy of continual development, Deep Sea Electronics, reserve the right to change specification without notice.

4 INSTALLATION

The DSE battery charger is *fit-and-forget.* It can be permanently connected to the supply and the load, with no requirement to disable the charger during times of heavy load (such as engine cranking).

4.1 BATTERY SUITABILITY

The charger is factory set by DSE to suit Lead Acid batteries but can be adjusted to suit other battery types using the Configuration Suite PC Software.
Care should be taken to ensure the batteries connected to the charger are of the correct 'technology' to suit the setting of the charger.

NOTE: Ensure any Standing Load (loads connected to the battery charger other than the battery) are less 75% of the battery charger configured rating. This helps to ensure the charger correctly detects the battery charge state.

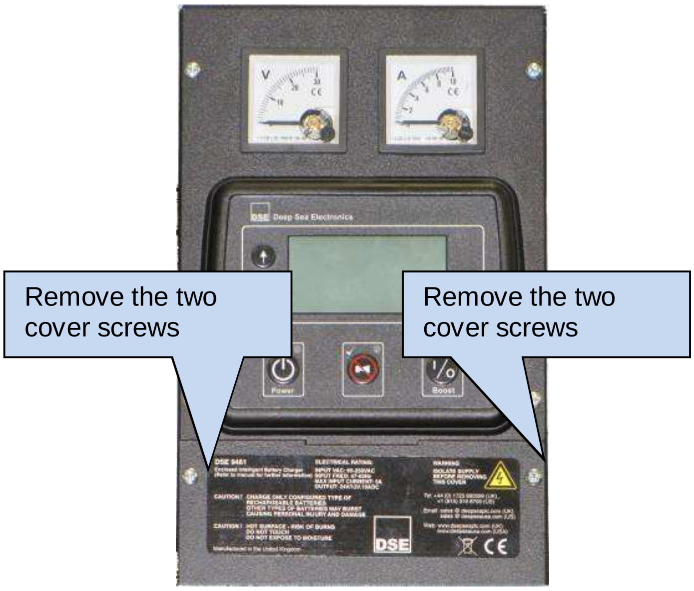
4.2 USER CONNECTIONS

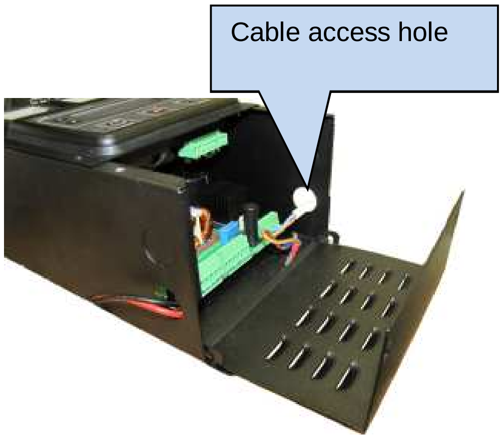
Parameter	Comment	
Connection type	Screw terminal, rising clamp, no internal spring	
Min cable size	0.5mm² (AWG 20)	
Max cable size	2.5mm² (AWG 14)	
Recommended AC fuse DSE9461 24V/12V 10A charger DSE9460 24V/12V 5A charger	**230V AC Input** 3.5A anti-surge 2.0A antisurge	**110V AC Input** 6.3A anti-surge 3.5A anti-surge

4.2.1 BATTERY CHARGER

DANGER OF DEATH: LIVE PARTS exist within the enclosure. The enclosure cover must not be removed when connected to an AC supply.

Battery Charger connections are available by removing the screws identified below and hinging the cover down.
'Push Outs' are available on the side of the charger case to enable the installer to fit rubber grommets to facilitate cable entry.





Cover hinged open

4.2.1.1 CONNECTOR A

> ⚠**NOTE: Connection from battery charge must be directly connected to the battery.**

Terminal	Function	Recommended size	Comments
⊖	Load negative	1mm² (AWG 16)	Battery negative terminal
⊕	Load Positive	1mm² (AWG 16)	Battery positive terminal

4.2.1.2 CONNECTOR B / C

> ⚠**NOTE: Screened 120Ω impedance cable specified for use with RS485 must be used for the RS485 link.**
> **DSE stock and supply Belden cable 9841 which is a high quality 120Ω impedance cable suitable for RS485 use (DSE part number 016-030)**

Terminal	Function	Recommended size	Comments
0V	Supply for a remote (locally fitted) DSE2541 display	1mm² (AWG 16)	**Do not connect to these terminals on chargers having LCD displays**
12V		1mm² (AWG 16)	
SCR	RS485 screen	N/A	Use only 120Ω RS485 approved cable
B	RS485 +ve	0.5mm² (AWG20)	
A	RS485 -ve	0.5mm² (AWG20)	
LK	Connect together to activate Digital Input	0.5mm² (AWG20)	Function Configurable using DSE Configuration Suite PC Software
LK		0.5mm² (AWG20)	
NTC	PT1000 connection terminals	0.5mm² (AWG20)	Use only PT1000
NTC		0.5mm² (AWG20)	
N/C	Fault relay Normally Closed terminal	0.5 mm² (AWG 22)	De-energises under Fault Conditions
Common	Fault relay Common Terminal	0.5 mm² (AWG 22)	
N/O	Fault relay Normally Open terminal	0.5 mm² (AWG 22)	

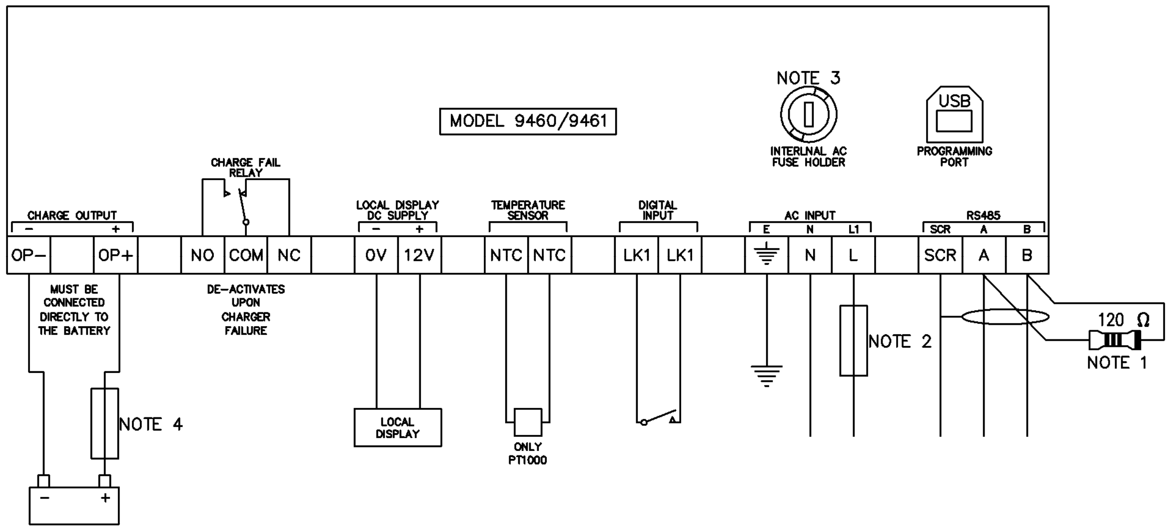
4.2.1.3 CONNECTOR D

> ⚠**CAUTION: Ensure Earth Terminal is connected to Battery negative (for negative earth systems) or Battery positive (for positive earth systems)**
> **Where no system earth exists, Earth Terminal must be connected to battery negative**

Parameter	Comment	
Recommended AC fuse	**230V AC Input**	**110V AC Input**
DSE9461 24V/12V 10A charger	3.5A anti-surge	6.3A anti-surge
DSE9460 24V/12V 5A charger	2.0A antisurge	3.5A anti-surge

Terminal	Function	Recommended Size
L	AC Live	1mm² (AWG 16)
N	AC Neutral	1mm² (AWG 16)
⏚	Earth	1mm² (AWG 16)

4.2.2 TYPICAL CONNECTION DIAGRAM



TERMINALS SUITABLE FOR 22–16 AWG ($0.6mm^2$ – $1.3mm^2$) FIELD WIRING
TIGHTENING TORQUE = 0.5Nm (4.5lb–in)

NOTE 1
A 120 OHM TERMINATION RESISTOR MUST BE FITTED IF IT IS THE FIRST OR LAST DEVICE ON AN RS485 LINK

NOTE 2

AC INPUT	ANTI-SURGE FUSE RATING
110V	6.3A
230V	3.5A

FUSE APPROPRIATELY WHEN CURRENT LIMIT IS CONFIGURED BELOW 10A AND AS CLOSE TO THE BATTER CHARGER AS POSSIBLE TO PROTECT THE CABLES

NOTE 3
FACTORY FITTED WITH 6.3A ANTI-SURGE FUSE, FUSE APPROPRIATELY

NOTE 4
FUSE APPROPRIATELY AND AS CLOSE TO THE BATTERY AS POSSIBLE TO PROTECT THE CABLES AND BATTERY

4.3 DSE2541 ENCLOSURE MOUNTED DISPLAY MODULE

NOTE: LCD display is fitted to specific models only.

NOTE: Where factory fitted to the enclosure, the DSE2541-01 must not be removed. Should an external, remote display be required, use DSE Part Number 2541-02 suitable for remote location up to 1.2km from the host battery charger.

NOTE: These connections are made by the DSE factory and are included for information only.

Terminal	Function	Recommended Size	Comments
1	Plant Supply Negative	1mm² (AWG16)	
2	Plant Supply Positive	1mm² (AWG16)	
3	RS485 (Screen)	N/A	Use only 120Ω RS485 approved cable
4	RS485 (B)	0.5mm² (AWG20)	
5	RS485 (A)	0.5mm² (AWG20)	

NOTE: Screened 120Ω impedance cable specified for use with RS485 must be used for the RS485 link.
DSE stock and supply Belden cable 9841 which is a high quality 120Ω impedance cable suitable for RS485 use (DSE part number 016-030)

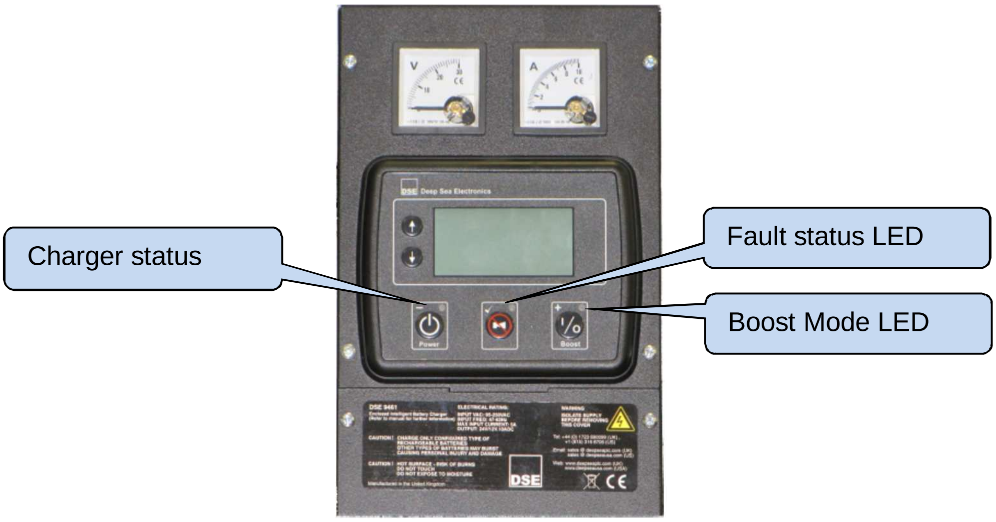
5 INDICATIONS

5.1 LCD DISPLAY

NOTE: LCD display is fitted to specific models only.

NOTE: For details of controls and LCD indication, see the section entitled *Operation* elsewhere in this document.

NOTE: When the lamp test on the Enclosed Battery Charger is active, all three LEDs on the display illuminate.



5.1.1 CHARGER STATUS

Condition	LED State
Charger off	OFF
Charger on	Constant Red

5.1.2 FAULT STATUS

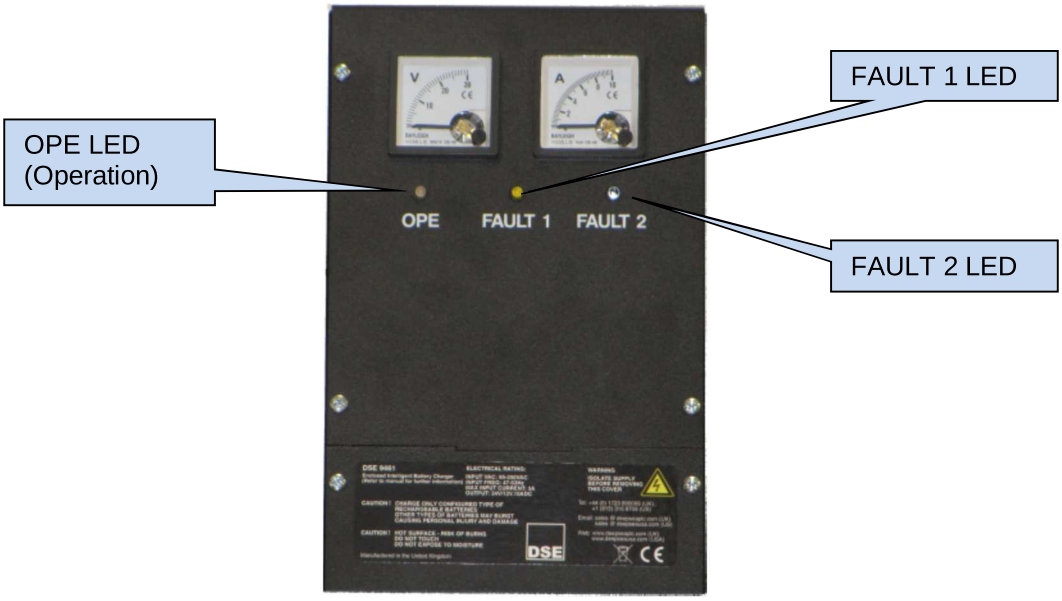
Condition	LED State
No Fault	OFF
Warning Fault	Constant Red
Shutdown Fault	Flashing Red

5.1.3 BOOST MODE

Condition	LED State
No Boost	OFF
In Boost Mode	Constant Red

5.2 ENCLOSURE MOUNTED LEDS

NOTE: Enclosure mounted LED indicators are fitted to specific models only.



5.2.1 STATUS

Condition	LED DESIGNATION OPE Yellow/Green	FAULT 1 Yellow	FAULT 2 Red
Charger Off	Off	Off	Off
Battery not Detected (Battery Detection Mode)	Green Flashing	Yellow Flashing	Red Flashing
Battery Connected (Battery Detection Mode)	Green Constant	Yellow Constant	Red Constant
Not Charging (Charger is operating correctly but the ouput has been disconnected from the battery)	Off	Yellow Constant	Red Constant

5.2.2 CHARGE MODE

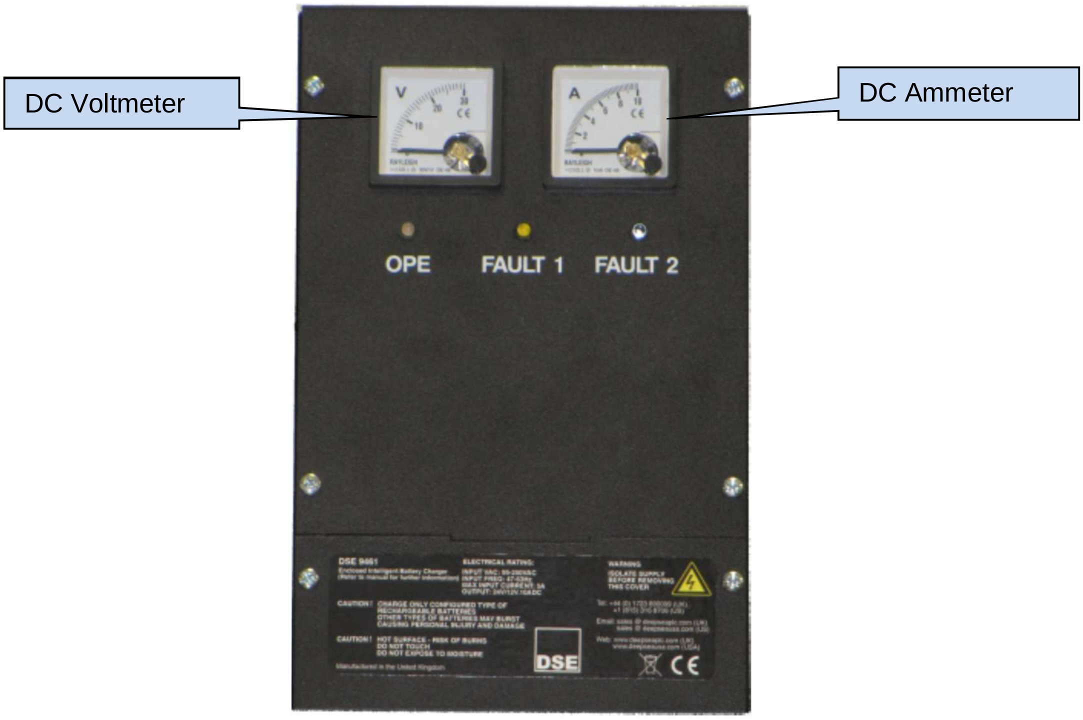
Mode	LED DESIGNATION OPE
Bulk Charge in progress	Yellow Constant
Absorption Charge in progress	Yellow Flashing
Float Charge in Progress	Green Constant
Storage Charge in Progress	Green Flashing

5.2.3 FAULT CONDITIONS

Condition	LED DESIGNATION	
	FAULT 1	FAULT 2
High Output Voltage (DC)	Red Constant	Off
High / Low Input Voltage (AC) or High Output Current (DC)	Red Flashing	Off
High Ambient / Charger Temperature, High Battery Temperature (if enabled)	Off	Red Constant
Short Circuit/ Reverse Polarity (DC Output Connection)	Off	Red Flashing

5.3 ENCLOSURE MOUNTED ANALOGUE METERS

NOTE: Enclosure mounted analogue meters are fitted to specific models only.



6 OPERATION

The DSE battery charger can be used as a battery charger, DC power supply, or both at the same time. For instance, the unit can be used to power the generator control panels and charge the panel batteries or starter batteries at the same time.

With no AC input to the charger, the *Charge fail* relay is de-energised. This can be used to provide indication of charger failure which operates upon mains supply AC supply failure or battery charging failure.
When a suitable AC supply is connected, operation of the unit will depend upon the load connected to the unit's output terminals :

Battery connected – The charging operation will begin (Charge mode)
No Battery connected – The output voltage will be enabled. (PSU mode)
Reverse connected battery – The charger will remain in charge fail mode.
Short circuit – The charger will remain in charge fail mode.
AC under/over voltage – The charger will remain in charge fail mode.
DC over current/voltage – The charger will remain in charge fail mode.
Over temperature - The charger will remain in charge fail mode.
Battery Charger Failure - The charger will remain in charge fail mode.

Depending upon the model variant, the battery charger can be operated using either the remote or enclosure mounted DSE2541.

Operation of the LCD display module is covered later in this section.

6.1 OPERATING MODES

6.1.1 PSU MODE

If no battery is connected to the output terminals, the DSE battery charger will operate as a DC power supply only, current limit is factory set. See the section entitled *Specification* elsewhere in this manual for output specifications.

6.1.2 CHARGE MODE

NOTE: Ensure any Standing Load (loads connected to the battery charger other than the battery) are less 75% of the battery charger configured rating. This helps to ensure the charger correctly detects the battery charge state.

Constant Voltage
The DSE battery charger operates in *Constant voltage current limited* mode.
The charger output voltage is maintained at a constant level to allow the battery to charge while the load does not exceed the maximum rating of the charger.
Once the battery is fully charged, the battery charger switches to *ECO-POWER* mode. This is a low power use *standby* mode.

Current Limit
If the load on the battery charger (*battery charge demand+standing load*) exceeds the maximum current rating of the charger, the charging current is limited to the maximum rating of the charger and the voltage is reduced.
The voltage will rise to the rated voltage again once the load drops below the maximum rating of the charger.

Charging time
Charge time is often of little consequence when the battery is used in a *standby* operation. An example of this is when the battery is used to supply the starting system of a diesel generator. During normal operation, the battery is at full capacity and the battery charger is used to maintain the float voltage of the battery. The battery is only drained when the generator is called to start. As the generator has a DC charging alternator fitted, the battery is quickly recharged when the generator is running. Should the generator stop before the battery is fully recharged, the battery charger continue sto recharge the battery until it is fully charged.

Typically a battery will charge from flat to 80% capacity in 16hrs when when charged at C/10.
For example charging a 50Ah battery for 16hrs at 5A will charge the battery to 80% of its full capacity.
Remember to take into account any other standing load such as control panel requirements when calculating how much power is 'left' to charge the battery.

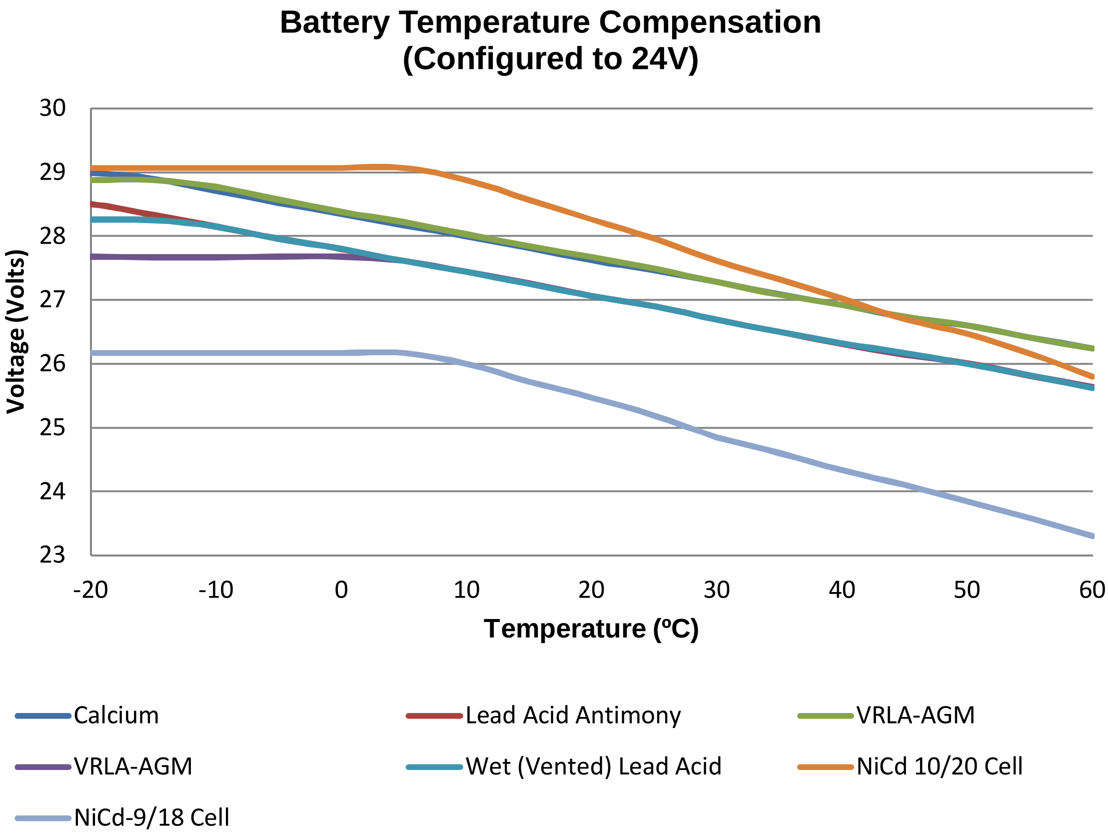
6.1.3 BOOST MODE

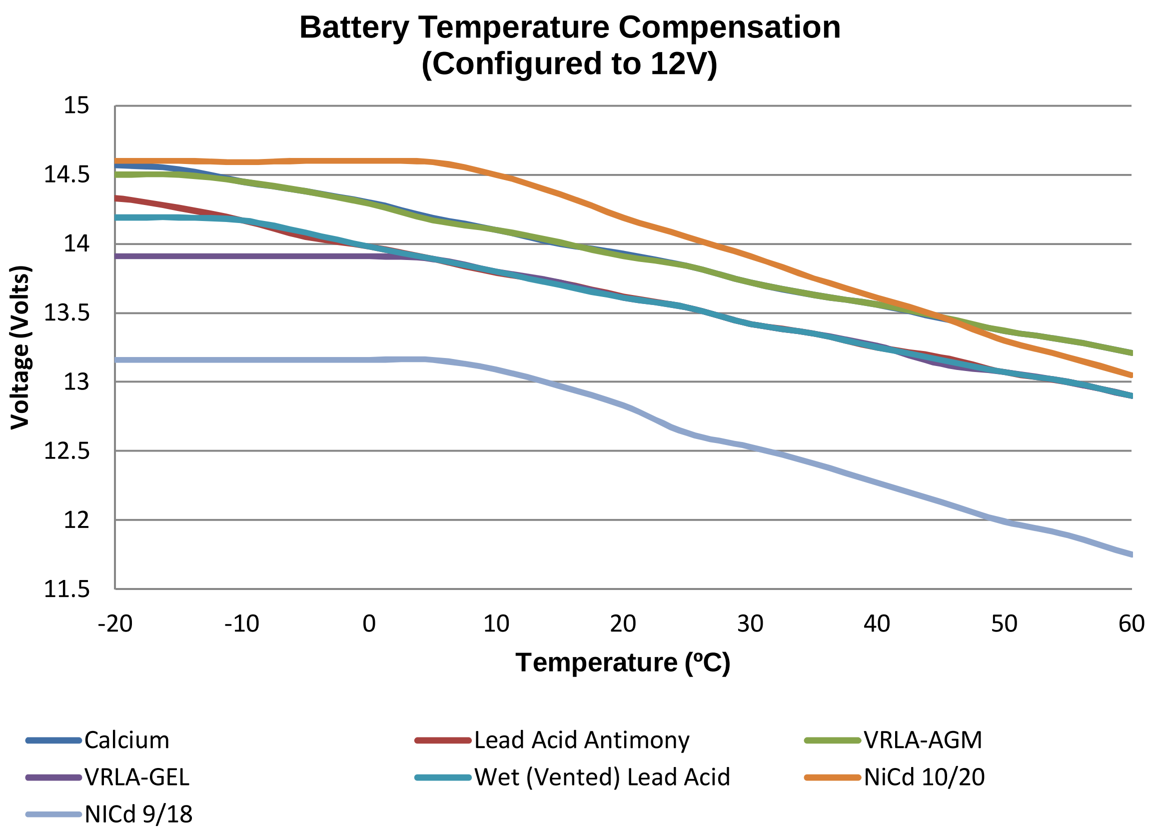
Boost mode is operated automatically or by activation of the digital input (if configured to perform this function). This raises the battery charger voltage to the *boost* voltage setting. It will stay in boost mode until the current drawn from the charger drops below 75% of the rated output, it will then go into a timed run-on charge.

The battery charger will go back into boost mode, if the charge voltage is detected to drop below 1.8V per battery cell.

6.1.4 TEMPERATURE COMPENSATION

If temperature compensation is enabled through configuration, and remote temperature sensor is connected, the output voltage automatically varies by a configured mV per cell per 1℃ deviation from 20℃, within the range of -20℃ to 60℃. Increasin g temperature give decreasing outputs and decreasing temperatures give increasing outputs.
The battery temperature will be measured by a temperature sensor (2 wire PT1000 sensor) which will be placed on the battery


Battery Temperature Compensation
(Configured to 24V)
Voltage (Volts)
30
29
28
27
26
25
24
23
-20
-10
0
10
20
30
40
50
60
Temperature (ºC)
Calcium
Lead Acid Antimony
VRLA-AGM
VRLA-AGM
Wet (Vented) Lead Acid
NiCd 10/20 Cell
NiCd-9/18 Cell


Battery Temperature Compensation
(Configured to 12V)
Voltage (Volts)
15
14.5
14
13.5
13
12.5
12
11.5
-20
-10
0
10
20
30
40
50
60
Temperature (ºC)
Calcium
Lead Acid Antimony
VRLA-AGM
VRLA-GEL
Wet (Vented) Lead Acid
NiCd 10/20
NICd 9/18

6.2 OPERATION OF LCD DISPLAY

NOTE: LCD display is fitted to specific models only.

NOTE: An external remotely connected LCD display can be added to models without the enclosure mounted display. DSE Part Number 2541-02.

6.2.1 BACKLIGHT

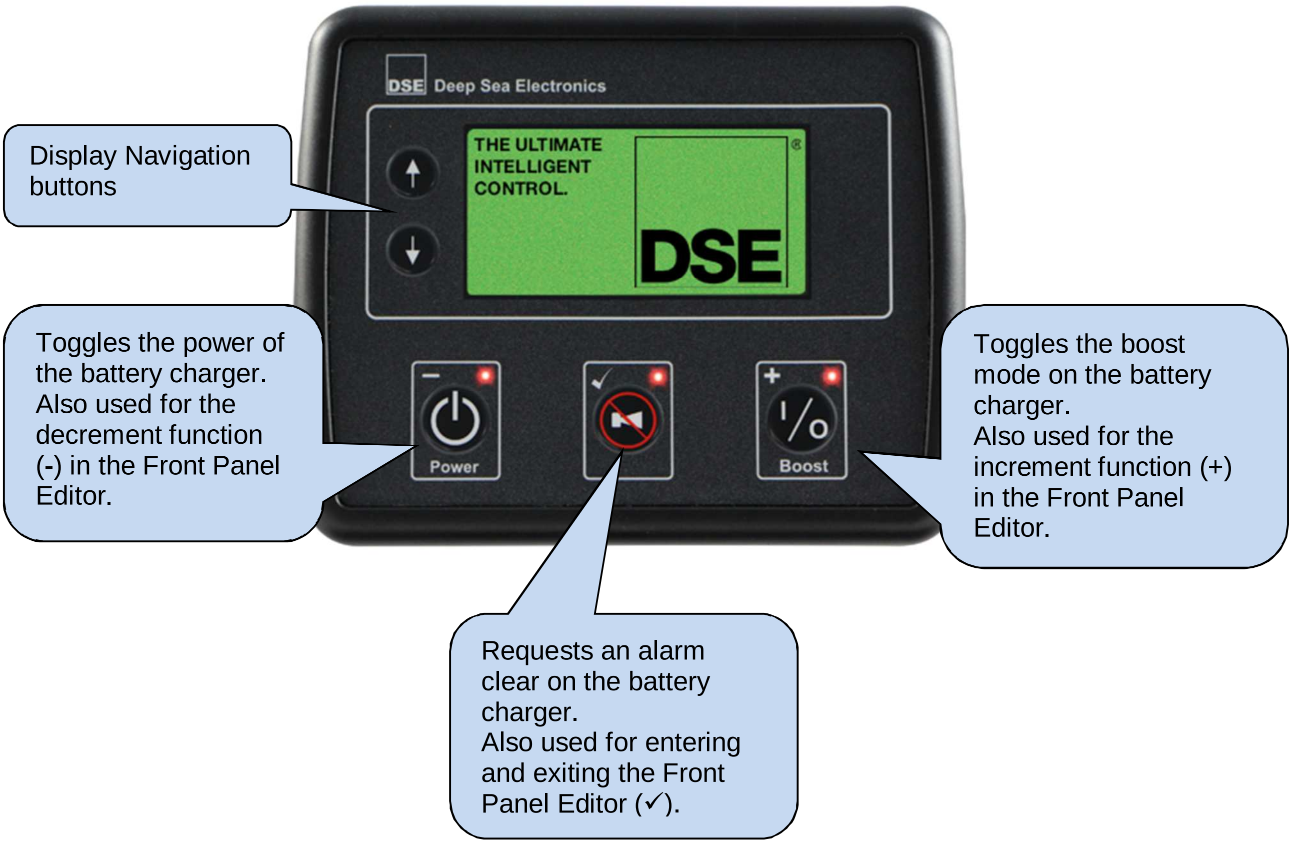
The LCD backlight is ON while the module is powered and flashes up detection of an alarm condition.

6.2.2 LED

The Display Module has three integral LEDs to show operation status and fault conditions. Full details are contained in the section entitled *Indications* elsewhere in this document.

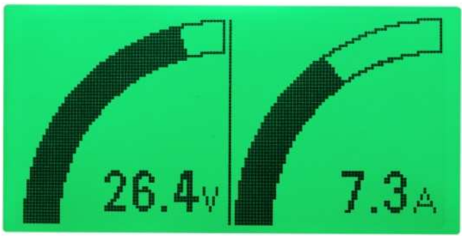
6.2.3 CONTROL BUTTONS

The LCD display has five control buttons :



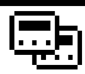
6.2.4 HOME SCREEN

The home screen shows the visual representation dials of the charger output voltage and current, relative to their maximum outputs.



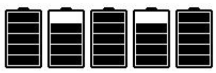
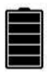
6.2.5 LINK ICON

The link icon indicates a successful link to the battery charger over the RS485 link. If there is no link active the icon is not shown.

Alarm Condition	Icon
RS485 Active	

6.2.6 BATTERY ICON

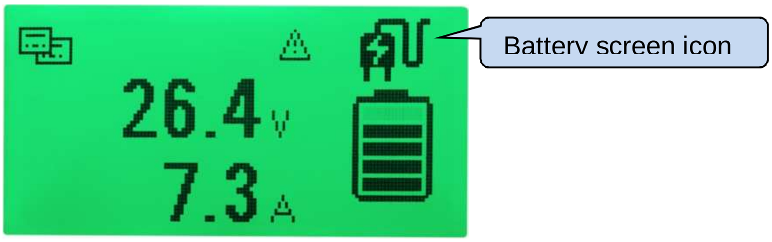
The battery icon indicates the current state of charging.

Battery State	Icon graphic
Not Charging	
Bulk/boost	
Absorption	
Float	
Storage	
Fault	

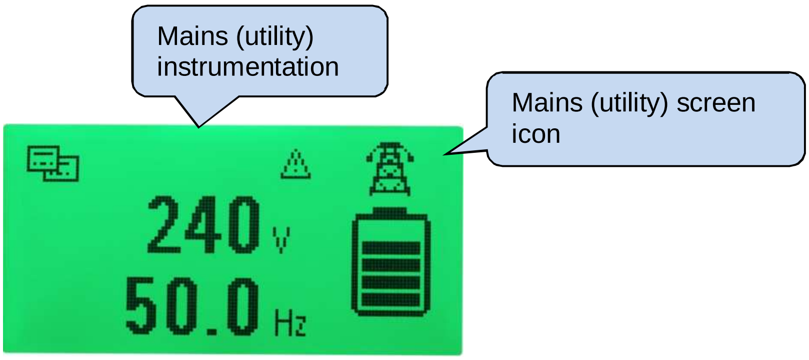
6.2.7 VIEWING THE INSTRUMENTATION

Press the navigation buttons (up) and (down) to cycle through the available instrumentation screens.
An icon is used to show the meaning of the currently visible screen as shown in the following sections.

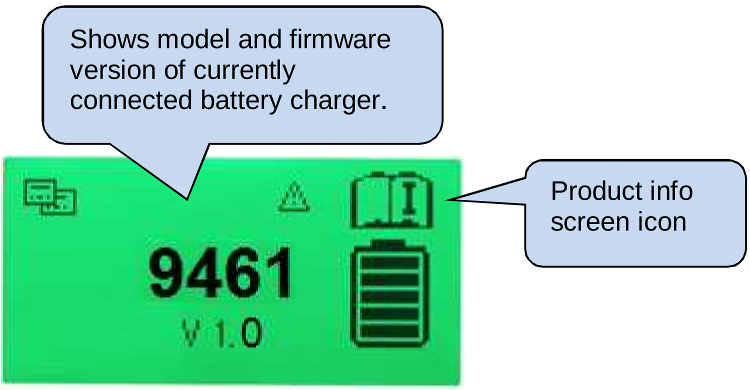
6.2.7.1 BATTERY



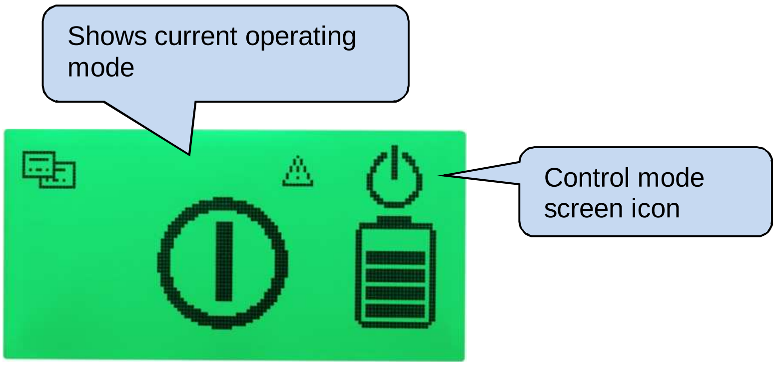
6.2.7.2 MAINS



6.2.7.3 PRODUCT INFO



6.2.7.4 CONTROL MODE

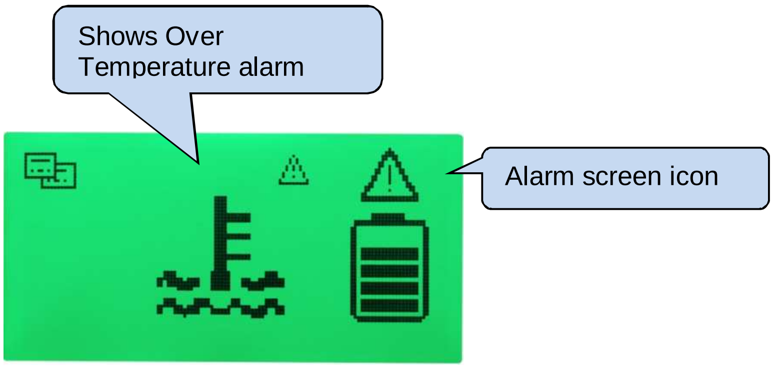


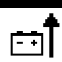
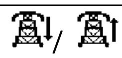
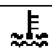
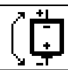
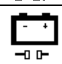
Control State	Icon displayed
On	
Off	
Boost	

6.2.7.5 ALARMS

When a new alarm is detected, the LCD displays the alarm screen and the LCD backlight flashes.

Press the  (✓) button to accept the alarm, exit the alarm screen and return to the summary screen.



Alarm condition	Icon displayed
DC Over Volts	
DC Over Current	
AC Under or Over Volts	
Over Temperature	
Short Circuit or Reverse polarity	
Battery open circuit	
Battery Charger Failure	

6.2.7.6 ENGINEERING PAGE 1

Item	String	Units
Output voltage	OPV	V
Output current	OPC	A
Output Voltage Limit (if available)	OPVL	V
Output current Limit	OPCL	A
Charger output power	OPPW	W
Remote battery sense voltage	BSV	V
Battery Temperature	BTMP	℉ or ℃ (depends on config)
Module Temperarure	MTMP	℉ or ℃ (depends on config)

6.2.7.7 ENGINEERING PAGE 2

Item	String	Units
AC supply voltage	ACSV	V
AV Supply frequency	ACSF	Hz
AC supply current	ACSC	A
Fan 1 Speed	FSP1	rpm
Fan 2 Speed	FSP2	rpm

6.3 FRONT PANEL EDITOR

6.3.1 ACCESSING THE FRONT PANEL EDITOR

The front panel editor (FPE) is accessed by pressing and holding the (✓) button.

The first parameter is displayed.

6.3.2 SELECTING A PARAMETER

- Press (+) or (-) to change between parameter pages (listed overleaf).
- Press (up) or (down) to cycle through the available parameters (listed overleaf).

6.3.2.1 EDITING A PARAMETER

- Press (✓) to edit a parameter when it is being viewed on the screen. The value flashes to show edit mode is in progress.
- Press (+) or (-) to change the parameter to the required value.
- Press (✓) to save the currently selected value. The value ceases flashing to show editing is complete.

Other parameters can now be selected and edited in the same manner.

6.3.2.2 EXITING THE EDITOR

- Press and hold (✓) to exit the editor.
- The *File Transfer* screen shown progress as the configuration is uploaded from the display module to the battery charger.

6.3.3 FRONT PANEL EDITOR PARAMETERS

NOTE: On previous versions of the DSE2541 some charger configuration paramters are available. All charger parameters must be configured using the DSE Configuration Suite PC Software., refer to DSE Publication *057-159 DSE94xx Battery Charger Series Configuration Suite PC Software Manual*.

6.3.3.1 PAGE 1 – MISCELLANEOUS

Index	Configuration item	Icon
100	Contrast	
101	Temperature Units	
102	Slave ID	
103	Baud Rate	
104	Enable Alarm Splash Screen	
105	Page Timout Screen	
106	Page Timeout	
107	Sleep Mode Timeout	
108	Enable Engineering Page	

Parameter 105 – Page Timeout Screen selects the 'main' display screen. This is the screen that is displayed after a period of inactivity (no buttons are pressed for the duration of *Page* Timeout (parameter 106). It has the following possible selections :

Value	Function
0	Analogue Meters
1	Output Voltage And Current
2	Output Power And Battery Charger Temperature
3	Battery Sensed Voltage And Battery Temperature
4	Mains AC Voltage And Frequency
5	Battery Charger Model And Charger Software Version
6	Control Page
7	Alarms Page
8	Engineering Page 1
9	Engineering Page 2

Parameter 108 – Digital Input Function has the following possible selections :

Value	Function
0	Lamp Test
1	Charger Off
2	Enable Battery Detection
3	Manual Boost
4	Switch Voltage Mode (12V / 24V)

7 MODBUS

The DSE Battery Charger supports the modbus RTU protocol over half-duplex RS485 communications.

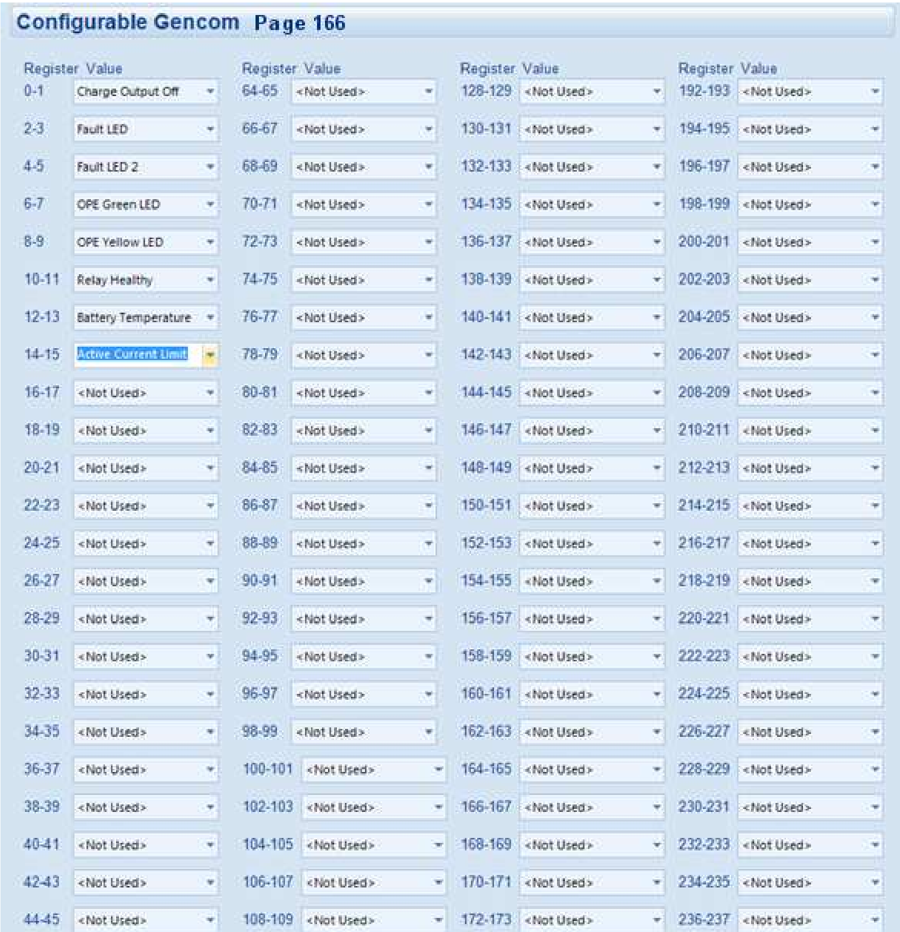
RS485 parameter	Setting
Start Bits	1
Data Bits	8
Parity	None
Stop Bits	2
Baud Rate	Configurable using DSE Configuration Suite PC Software *(1200, 2400/ 4800, 9600, 19200, 28800, 38400, 57600, 115200)* Factory setting : 9600
Modbus Slave ID	Configurable using DSE Configuration Suite PC Software *(1-247)* Factory Setting : 10

7.1 READING VALUES

Values must bre read using Modbus *Function Code 3 – Read Multiple Registers*.

Using the DSE Configuration Suite PC Software, modbus registers are defined by the system designer in modbus Page 166.

An example of customer configuration is shown below, the screen image is take from the SE Configuration Suite PC Software.



Modbus parameter	Value
Modbus Register Start	Address Page 166 Absolute HexaDecimal Address A600 Absolute Decimal Address 42496 (166 x 256). **NOTE: Some Legacy Modbus Master devices may require a suffix of 40,000 to the address, making the base address 82496.** **NOTE: Some Modbus Master devices may require '1' to be added to the address.**
Modbus Register Size / Sign	32 bit, signed
Modbus Register Type	Holding Registers (modbus function code 3 supported)

7.2 WRITING VALUES

Writing values to the battery charger is used to perform functions below.
Two values must be written using the same write function.

Using Modbus *Function Code 16 – Write Multiple Registers*, write the required Control Key and One's Compliment of the Control key to the specified registers:

7.2.1 TOGGLE BOOST MODE

Writing this control key enables or disables boost mode. When in boost mode, the battery is charged at the configured *boost voltage*.

Single Modbus Write using Modbus *Function Code 16 – Write Multiple Registers*

Address to write to	Control Key	One's Compliment of Control Key
Decimal Address 4104 & 4105 (Hexadecimal 1008 & 1008)	35772	27963

7.2.2 TOGGLE CHARGER ON/OFF

Writing this control key enables or disables the charger's DC output.

Single Modbus Write using Modbus *Function Code 16 – Write Multiple Registers*.

Address to write to	Control Key	One's Compliment of Control Key
Decimal Address 4104 & 4105 (Hexadecimal 1008 & 1008)	35773	29762

8 FAULT DIAGNOSIS

Nature of problem	Suggestion
The charger is not operating	Check that the incoming AC supply is correctly connected and within limits and check the integrity of any external fuse that may be fitted. Ensure the charger is not being operated above the maximum temperature specification.
Charge fail relay continuously operated	Check the connected load of the charger is not reverse connected or short circuit.
Batteries fail to charge	Check the batteries using the battery manufacturers recommendations.
Charge time is too long	Typically a battery will charge from flat to 80% capacity in 16hrs when when charged at C/10. For example charging a 50Ah battery for 16hrs at 5A will charge the battery to 80% of its full capacity. Remember to take into account any other standing load such as control panel requirements when calculating how much power is ‘left’ to charge the battery.

9 MAINTENANCE, SPARES, REPAIR AND SERVICING

The DSE battery chargers are designed to be *Fit and Forget*. As such, there are no user serviceable parts. In the case of malfunction you should contact your original equipment supplier (OEM).

10 WARRANTY

DSE provides limited warranty to the equipment purchaser at the point of sale. For full details of any applicable warranty, you are referred to your original equipment supplier (OEM).

11 DISPOSAL

11.1 WEEE (WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT)

If you use electrical and electronic equipment you must store, collect, treat, recycle and dispose of WEEE separately from your other waste.

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HOTSTART® ENGINE HEATING

216061-066 rev4

CUSTOMER SERVICE: 509.536.8660
sales@hotstart.com | www.hotstart.com

Read carefully for proper installation and operation.

INSTALLATION INSTRUCTIONS

THERMOSIPHON HEATER
CB/CL, SB/SL, WL & EE SERIES

BEFORE YOU INSTALL

Your industrial tank heater uses thermosiphon action – *the natural expansion and rising action of a heated fluid* – to circulate heated coolant throughout an engine's water jacket. With no moving parts, thermosiphon heaters require little maintenance. However, initial installation of the heating system is critical; even seemingly minor adjustments to port location, hose routing or heater positioning may help ensure your thermosiphon heater preheats your engine effectively.

⚠ CAUTION

Hazardous voltage: Before wiring, servicing or cleaning the heating system, turn off the power and follow your organization's lockout and tagout procedure. Failure to do so could allow others to turn on the power unexpectedly, resulting in harmful or fatal electrical shock.

Electrical hazard: Power source must be properly grounded and in accordance with national and local electrical codes. Do not connect heater prior to installation.

Personal injury: If equipped with isolation valves, ensure valves are open before energizing heater. Obstructed flow may result in an unexpected release of heated coolant, potentially causing serious injury.

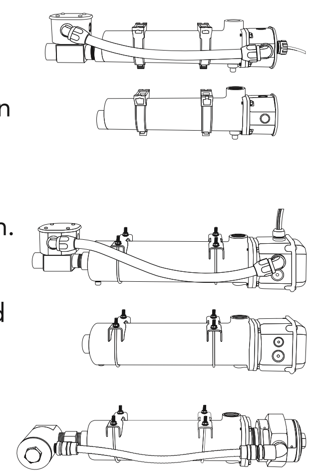
NOTICE

Read instructions carefully: The HOTSTART warranty does not cover any damage that a heating system may sustain from improper installation, improper operation, improper specification or corrosion. Before installing your heater, be sure you have the right heating system for your application. Carefully read all instructions before installing and energizing your heater.

Safety devices: The high-limit thermostat (enclosed in the element assembly) is intended only to prevent hazardous temperatures. A bi-directional ball valve (installed at the tank inlet) allows a minimal amount of coolant to reverse flow when the engine is running, protecting the element from overheating. Do not alter or misuse safety devices.

Proper operation: The HOTSTART heating system is intended to be activated only while the engine is not in operation. Preheating while the engine is running may reduce heater longevity. For automatic-start engines, a control box with automatic shut-off device is recommended.

Figure 1. Typical industrial tank heater model configurations. Your model may vary.

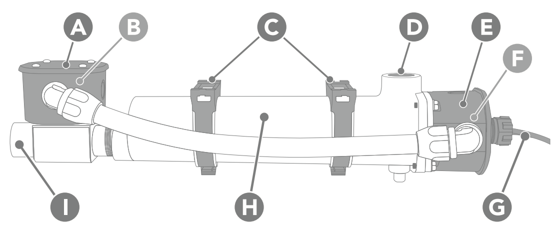


SB model (with power cord) and CB model (conduit connection, shown without control thermostat).

SL model (with power cord) and CL model (conduit connection, shown without control thermostat).

EE model (shown with optional control thermostat).

Figure 2. Typical SB model thermosiphon heater. Style and configuration may vary.



- A. *Thermostat enclosure*
- B. *Thermostat (in element assembly)*
- C. *Mounting brackets*
- D. *Outlet*
- E. *Element assembly*
- F. *High-Limit Thermostat (in element assembly)*
- G. *Cord*
- H. *Tank*
- I. *Inlet*

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INSTALLING THE HEATER

PREPARE COOLANT SYSTEM

1. Drain and flush cooling system to remove any debris present in the engine's cooling system.

SELECT PORTS

2. Select return port. The return port will allow heated coolant to return to the engine. *See Fig 3 on following page*. The return port should be located:
    - away from the engine thermostat
    - toward the rear (flywheel) of the engine
    - high on the engine's water jacket
    - away from the supply port

3. Select supply port. The supply port will allow coolant to flow from the engine to the heater. *See Fig 3 on opposite page*. The supply port should be located:
    - toward the front (radiator) of the engine
    - at the lowest point of the engine's water jacket
    - away from the return port.

SELECT HOSE, FITTINGS & VALVES

4. Select fittings. Use the following table to determine the proper engine port fitting size for your heater:

CB/CL/SB/SL	500–3000 watts	1/2 inch NPT
CB/CL/SB/SL	3750–5000 watts	3/4 inch NPT
WL/EE	1500–5000 watts	3/4 inch NPT

5. Select hoses. Use the following table to determine the minimum hose inner diameter for your heater:

CB/CL/SB/SL	500–3000 watts	3/4 inch
CB/CL/SB/SL	3750–5000 watts	1 inch
WL/EE	1500–5000 watts	1 inch

NOTE: Select hoses rated for 250 °F (121 °C) and 100 psi (690 kPa) minimum.

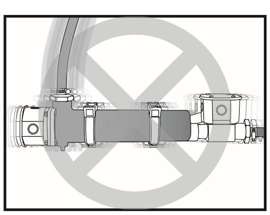
6. Select optional, user-supplied isolation valves.

NOTE: HOTSTART recommends installing valves to isolate the heating system in case of service. To minimize flow restriction, select full-flow ball isolation valves.

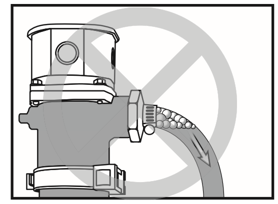
MOUNT HEATER

NOTICE

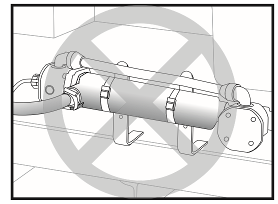
Vibration damage: Do not mount heater directly to engine. Engine vibration will damage heater. If the heater is installed with rigid pipe, connect flexible hose to inlet and outlet to isolate from vibration.



Vertical orientation: If mounted vertically, all dips and horizontal hose routing **must** be eliminated. An incorrectly oriented heater may cause heater failure.

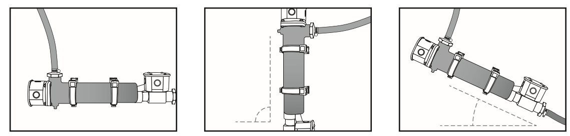


Outlet orientation: If mounting heater horizontally or at an angle, outlet must face upward. If mounting heater vertically, ensure outlet is at top of heater. Do not attempt to reverse flow through heater. An incorrectly oriented outlet may cause heater failure.



7. Select a heater mounting position directly below the return port and at least 6 inches (15 cm) below the lowest point of the engine's water jacket.

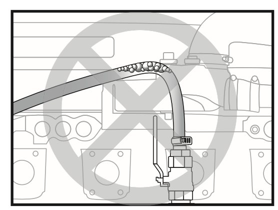
8. Mount heater using the supplied mounting brackets and fasteners. The heater may be mounted:
    - straight horizontally (HOTSTART recommended)
    - straight vertically
    - horizontally at an angle *(see* **TROUBLESHOOTING***)*



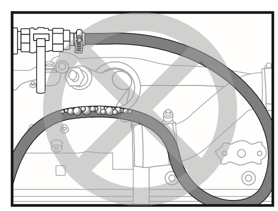
PLUMB HEATER

NOTICE

High points: Do not allow high points along heater plumbing. High points will create hot spots, restricting coolant flow and damaging heater.



Dips and bends: Do not allow dips or bends along heater plumbing. Dips or bends will allow air pockets to form, restricting coolant flow and damaging heater.



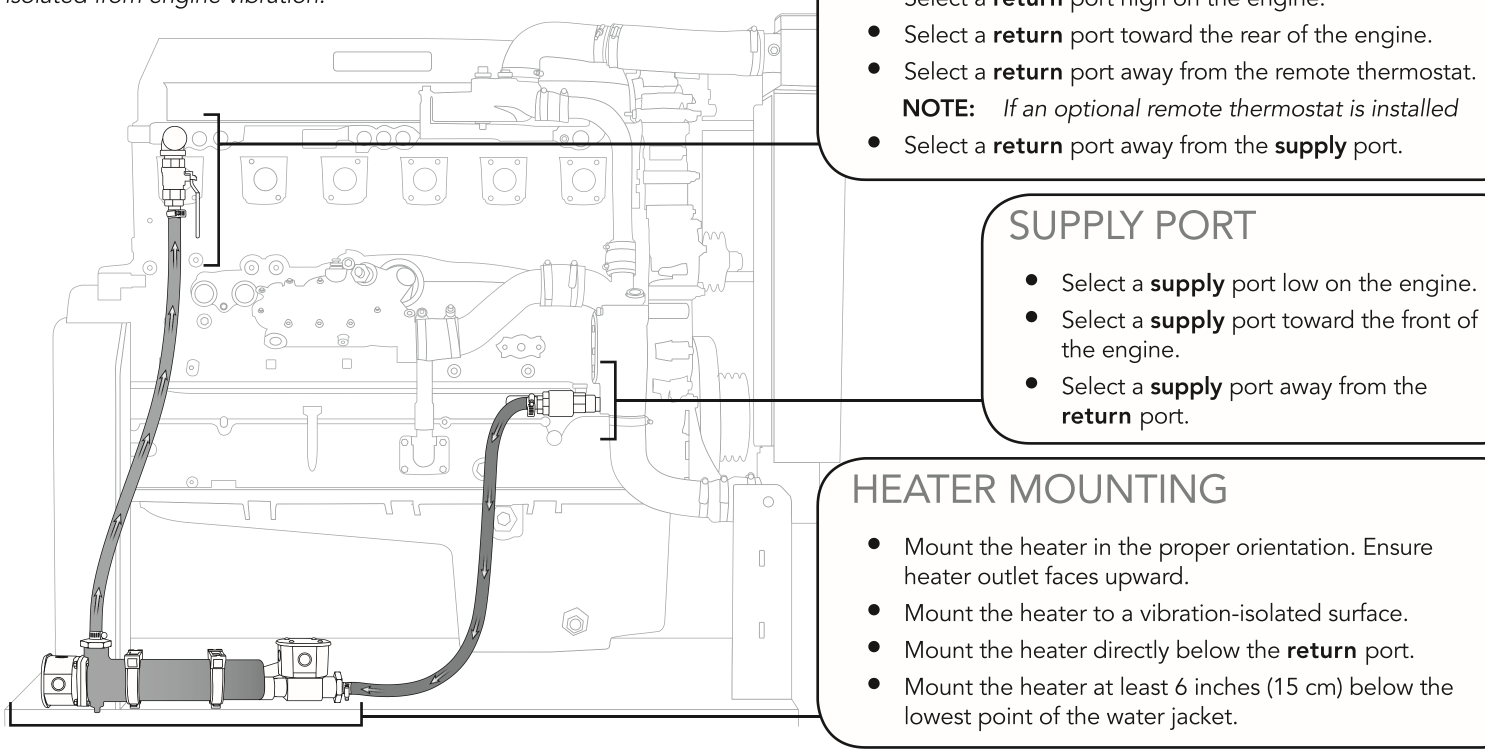
9. Install isolation valves to port fittings.

10. Route and install return hose. The return hose should continuously rise from the heater to the return port.

11. Route and install supply hose. The supply hose should continuously descend from the supply port to the heater.

NOTE: For V-type engines, it is acceptable to select a supply port on the opposite side of the engine as long as the supply hose is routed properly.

Figure 3. Example heater installation. The return hose continuously rises to the engine and supply hose continuously descends to the heater; the hoses have no dips, bends or high points. The heater is mounted in the correct orientation and is isolated from engine vibration.



RETURN PORT

- Select a **return** port away from the engine thermostat.
- Select a **return** port high on the engine.
- Select a **return** port toward the rear of the engine.
- Select a **return** port away from the remote thermostat.

  NOTE: *If an optional remote thermostat is installed*
- Select a **return** port away from the **supply** port.

SUPPLY PORT

- Select a **supply** port low on the engine.
- Select a **supply** port toward the front of the engine.
- Select a **supply** port away from the **return** port.

HEATER MOUNTING

- Mount the heater in the proper orientation. Ensure heater outlet faces upward.
- Mount the heater to a vibration-isolated surface.
- Mount the heater directly below the **return** port.
- Mount the heater at least 6 inches (15 cm) below the lowest point of the water jacket.

REFILL COOLANT

NOTICE

Heater damage: When mixing coolant, only use deionized or distilled water and low-silicate antifreeze. Refer to your engine's manufacturer recommendations. Do not exceed 60% antifreeze to 40% water ratio. **Never** add unmixed water and antifreeze to an engine. Do not add anti-leak or other coolant additives.

12. Mix coolant according to your engine manufacturer's recommendations. Refill cooling system with coolant. To prevent air pockets, refill coolant with return hose removed. *See Fig 4.*

    NOTE: HOTSTART recommends using a 50% deionized or distilled water to 50% low-silicate antifreeze mixture.

13. Start engine. Allow engine to run until engine thermostat opens, purging air from cooling system. **NOTICE!** Engine must be run to eliminate air from heating system before energizing heater.

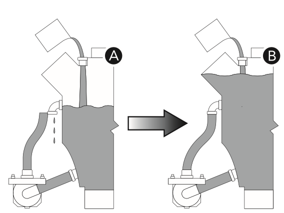


Figure 4. When refilling engine with coolant, remove heater return hose **(A)**. *Once filled to level of return port, reconnect return hose to ensure no air remains in heating system* **(B)**.

14. When engine has reached operating temperature, shut engine off and check for coolant leaks.

15. Allow engine to cool. Check coolant level and top off as needed. Secure heater power cord to avoid contact with all hot or moving parts.

WIRE HEATER

16. Connect heater to an appropriately rated power source. Ensure power source is grounded and in accordance with local and national electrical codes. If necessary, install control box:

- If your heater is **single-phase** and **rated up to 480 volts**, your heater may be powered directly without the use of a control relay or contactor. *See Fig. 5.*

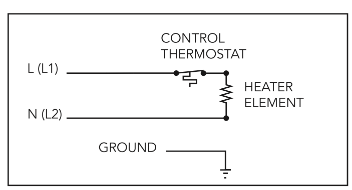


Figure 5 (left). Wiring schematic for single-phase heaters rated for up to 480 volts.

- If your heater is **three-phase** or is **single-phase and rated for over 480 volts**, the heater thermostats must be used in a control circuit with a contactor for switching the main power to the heating elements. See *Fig. 6 and 7 on following page.*

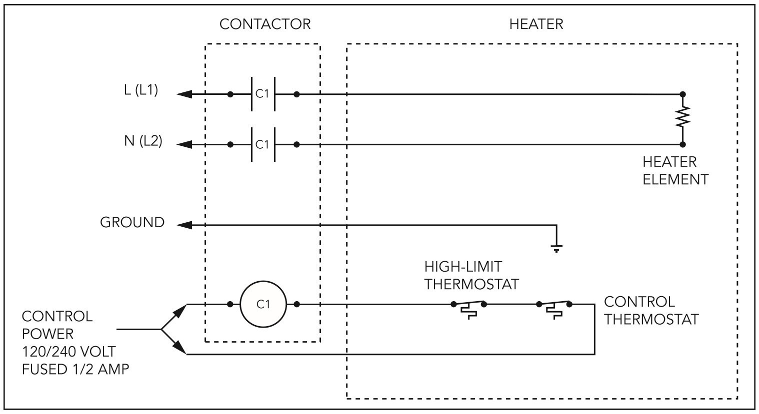
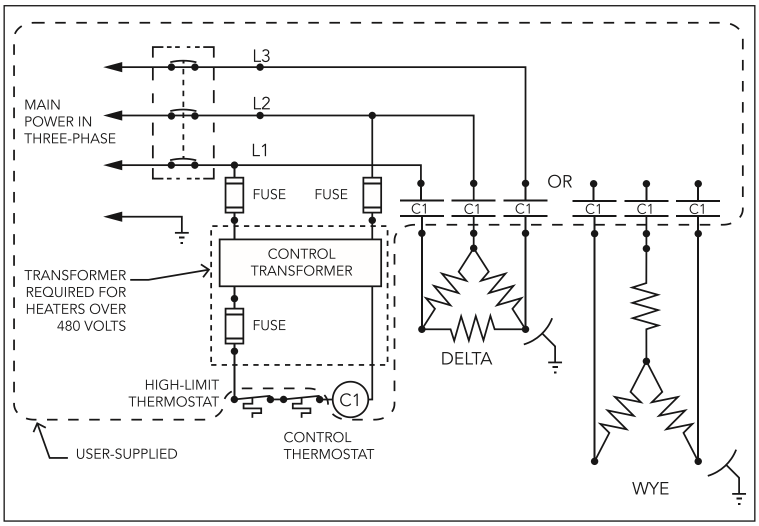


Figure 6 (above) and Figure 7 (below). Wiring schematics for three-phase heaters or single-phase heaters rated for over 480 volts. Note the contactor schematic (above) and the recommended wiring schematic (below).



TROUBLESHOOTING

To ensure coolant is flowing, check the outlet temperature. If the coolant temperature along the return hose exceeds 180 °F (82 °C) or the heater cycles more than four times per hour, it may indicate:

- Air pockets are restricting flow. Air may collect due to loops in hose, routing hose over the top of the engine, excessive hose lengths, or kinks. Reroute hoses or change port locations.
- Heater is mounted too high. Lower heater position.
- Heater is not mounted in the proper orientation. If heater is horizontal, ensure the outlet is pointed directly upward. If vertical, ensure the outlet is at the top of the tank.
- Contaminants in the coolant are restricting flow. Flush coolant system and refill.
- Flow is restricted. To improve flow, horizontally installed heaters may be installed at an angle to raise the heater outlet above the heater inlet. **NOTICE!** All angled installations must raise the heater outlet above the inlet and position the heater outlet facing upward.

MAINTENANCE & PARTS

⚠ CAUTION

Electrical hazard: Before wiring, servicing or cleaning the heating system, turn off the power and follow your organization's lockout and tagout procedure. Failure to do so could allow others to turn on the power unexpectedly, resulting in harmful or fatal electrical shock.

Personal injury: If equipped with isolation valves, ensure valves are open before energizing heater. Obstructed flow may result in an unexpected release of heated coolant, potentially causing serious injury.

PREVENTATIVE MAINTENANCE

Annually:

- Check and replace cracked or weakened hoses.
- Check electrical wiring for wear and excessive heat
- Remove element and clean element and tank

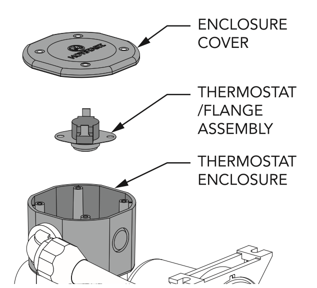
Every three years or 25,000 hours of operation:

- Replace control thermostat sensing unit.

THERMOSTAT REPLACEMENT

To replace the control or high-limit thermostat: *(See Fig. 8.)*

1. Disconnect heater from power source. Allow heating system to cool.
2. Remove thermostat enclosure cover. For control thermostat, remove thermostat enclosure cover. For high-limit thermostat, remove element assembly cover. **NOTE:** For EE heaters, unscrew thermostat enclosure or element assembly cap.
3. Disconnect terminals from control thermostat sensing unit spade connectors.
4. Remove sensing unit (and flange assembly, if equipped). To remove high-limit thermostat, loosen or remove mounting clip. **NOTE:** For EE heaters, remove high-limit thermostat from plug.
5. Place new sensing unit and flange assembly in recessed space. For high-limit thermostats, place and tighten thermostat mounting clip to secure.
6. Reconnect electrical connections. Reattach enclosure cover.
7. Reconnect heater to power source.



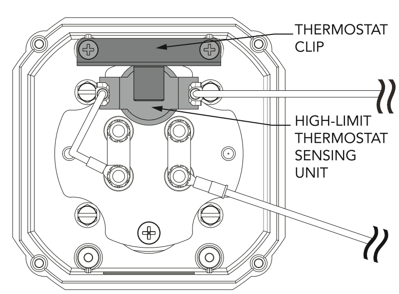


Figure 8. Replacing control (above) and high-limit (left) thermostats. For EE models, unscrew enclosure cap and remove high-limit from plug. (EE model not pictured).

BCI Group Size	Type	Battery Wholesale P/N	CCA at 0°	CA at 32°	RC MIN @25A	Overall Dimensions (inches)			Battery Terminal Type
						Length	Width	Height	
Platinum automotive batteries feature 12 month free replacement									
78DT	**78DT-60P**	**78DT-HD**	800	960	120	10 11/16	7 1/16	8 1/18	A, S

Platinum heavy duty commercial & farm batteries - 12 month warranty - 12 volt									
4D	**COM-4D-P**	**4D-HD**	1000	1200	320	19 9/16	8 5/16	10	A
8D	**COM-HD**	**8D-HD**	1300	1560	435	20 3/4	11	10	A

BLUE STAR
Power Systems Inc.

Job Number: 116385-2-1

Model Number: VD500-01-116385-2

DESCRIPTION:
Dimensional Dwg: VD500-01-LV0-23
AC Diagram: E-AC-02134
DC Diagram: E-DC-02232
KWe: 500
KVA: 625
PF: 0.8
Full Load Amps: 601
Amps Per Terminal: 600/600
Temp Rise: 130/27
Emergency Stationary Standby
UL2200 / cUL Required: No
Model: VD500-01
TAD1641GE - Volvo
Voltage: 600/347V 3 PH
572RSS4270 600V 3 PH 130^{o}C 4 Lead Wye
Voltage Regulator: DVR2400
Generator Heater: Not Included
Deep Sea DSE7310 - Rear Facing
DSE 2548 (x2) in common box for Remote Annunciator to NFPA-110
Low Water Level
Remote Annunciator: Not Included
Unit Painted: Gray
Enclosure: Open Power Unit
Sound Attenuation: Not Included
50^{o}C Radiator Unit Mounted with Duct Flange
Coolant Drain: Not Included
Oil Drain: Plumbed to Base
(2) 600A 100% Rated Circuit Breakers-
Water Heater: -20^{o}F 240VAC with Isolation Valves
Air Cleaner: Dry Single Stage
Air Restriction Indicator: Installed
Exhaust: Silencer Not Included
Starting Battery: 24V with Racks & Cables
Battery Charger: DSE 24V 10A Shipped Loose
Fuel System: No Tank - Standard Fuel Flexes
Factory Test: Standard Commercial
Warranty: 5 Year / 3000 Hour Limited
Standard Print Manual: 1
CD Rom: 0
Flash Drive: 1

Blue Star Power Systems, Inc. | 2250 Carlson Drive, North Mankato, Minnesota 56003 |Phone + 1 507 345 1776 | bluestarps.com

Part Number	Rev	Description	Qty	UOM
19376	R00	24V Shunt Trip S33659 (Square-D P & R Frame Breakers)	1.00	EA
13085	R00	Adapter Tank Heater 3/4 NPT (Volvo TWD1643GE)..Use with 13086 O-ring	1.00	EA
19377	R00	Auxiliary Contact / Alarm Switch S29450 (Square-D H, J. L. P Frame Breakers) (Not Field Installable in Electrically Operated P-Frame Breakers)	1.00	EA
29292	R00	Base Channel PD450-550-01 150"L x 45"W x 12" Channel OPU 572FR 2-0772	1.00	EA
10982	R01	Battery COM-4D-P 1000CCA/320RC	2.00	EA
16546	R06	Box Handy 6 x 8 x 4 Screw Cover NEMA 1 No Knockouts DWG: 1-1151 (Use with Blank Cover 17688)	1.00	EA
12608	R00	Box Handy 8 x 12 x 4 Screw Cover NEMA 1 No Knockouts (Hoffman Only)	1.00	EA
13166	R00	Bracket Battery Rack / Heater Mount, Use (2) with Rack 10071, 14134,13291	4.00	EA
13204	R02	Bracket Generator Barrel Bar 572 Frame DWG: 1-0514	1.00	EA
13204	R02	Bracket Generator Barrel Bar 572 Frame DWG: 1-0514	1.00	EA
11009	R00	Bracket Lifting Small 8.00 x 7.50 x .75 Plate	4.00	EA
13291	R03	Bracket Tank Heater CL Horizontal 4IN Dia.	1.00	EA
11656	R00	Breaker Circuit 15A UL 1/4" Quick Connect Terminals	2.00	EA
11655	R00	Breaker Circuit 5A UL 1/4" Quick Connect Terminals	1.00	EA
11655	R00	Breaker Circuit 5A UL 1/4" Quick Connect Terminals	1.00	EA
25637	R00	Breaker Circuit 600A 3P 600V 100% Rated Square D PGL36060CU31A	2.00	EA
10257	R00	Cable Battery 18" #2/0 Black Jumper Battery Lugs both ends	1.00	EA
10252	R00	Cable Battery 60" #2/0 Black 1/2" Ring x Std Battery Lug	1.00	EA
10251	R00	Cable Battery 60" #2/0 Red 1/2 " Ring x Std Battery Lug	1.00	EA
12497	R00	Cap #10 37 Deg Flare (Steel)	1.00	EA
16941	R00	Charger Battery 12V / 24V 10A DSE 9461-12 LCD & Meters 120/208-240VAC 60hz	1.00	EA
12216	R00	Clamp 1/4" ID Fuel Hose Gap-Free Pinch Type (15/32" - 37/64")	2.00	EA
12218	R00	Clamp 3/8" ID Fuel Hose Gap-Free Pinch Type (39/64" - 47/64")	2.00	EA
12220	R00	Clamp 5/8" ID Fuel Hose Gap-Free Pinch Type (7/8" - 1-1/64")	2.00	EA
19389	R02	Cover Enclosure for P-Frame Above 800A-1200A Square D Breaker (Use with 19373)	2.00	EA
14680	R02	Cover Plate DVR DVR2000E+ (Use with 13966)	1.00	EA

Blue Star Power Systems, Inc. | 2250 Carlson Drive, North Mankato, Minnesota 56003 |Phone + 1 507 345 1776 | bluestarps.com

17688	R02	Cover Plate for Handy Box 16546 & 19471 & 23530 Blank DWG 1-1579	1.00	EA
17872	R00	DSENET Output Expansion Module 2548-01 (Remote Annunciator) (Used w/ Deep Sea Panels)	2.00	EA
17558	R04	Elbow Exhaust 5.00 OD to 6.00 OD (Used on VD450-01 thru VD600-01 Engine Supplied Flange)	1.00	EA
25009	R00	Enclosure Annunciator Dual DSE 2548 (Black Hammered)	1.00	EA
19373	R03	Enclosure Breaker NEMA 1 Square D P-Frame 100% Rated 49.00H x 25.00 W x 9.00 D	2.00	EA
11066	R15	Enclosure Panel with Hinged Door 10H x 16 x 8 NEMA 1 DGC2020	1.00	EA
13817	R00	Engine (1 Out) TAD1641GE 768 HP Std VD500-01 With Unit mounted cooling system, 24VDC starter and alternator, SAE 1 & 14 FW & Hsg, Air Cleaner, Exhaust Turbo Flange	1.00	EA
16931	R06	Face Panel Deep Sea 7310, 7410 Hinged W/ E-Stop	1.00	EA
17402	R00	Filter Coolant Volvo TAD1642GE (550kW) (21192875)	6.00	EA
14336	R00	Filter Fuel Volvo TAD1642GE (550kW) (20976003) (22480372)	6.00	EA
14337	R00	Filter Fuel Volvo TAD1642GE (550kW) (20998367)	6.00	EA
14334	R00	Filter Oil Volvo TAD1642GE (550kW) (21707132)	6.00	EA
14335	R00	Filter Oil Volvo TAD1642GE (550kW) (21707133)	12.00	EA
11902-1	R00	Fitting 1" Hose Barb x 1"NPT Male Brass	2.00	EA
11901-1	R00	Fitting 1" Hose Barb x 3/4NPT Male Brass	2.00	EA
12174-1	R00	Fitting 1/2 NPT Male x #6 Male 37 Deg Flare Steel	1.00	EA
11896-1	R00	Fitting 1/4 Hose Barb x #4 Female 37 Deg Flare Steel	1.00	EA
11889-1	R00	Fitting 1/4 NPT Male x #4 Male 37 Deg Flare Steel	1.00	EA
12719	R00	Fitting 22mm-1.5 Male x 1/2 NPT Female Steel	1.00	EA
11044-1	R00	Fitting 3/8 Hose Barb x #6 Female 37 Deg Flare Steel	1.00	EA
11047-1	R00	Fitting 5/8 Hose Barb x #10 Female 37 Deg Flare Steel	1.00	EA
12173-1	R00	Fitting 5/8 Hose Barb x 3/4 NPT Male Brass	1.00	EA
12441	R00	Fitting Bulkhead #10 Male 37 Deg Flare x #10 Male 37 Degree Flare Steel (w/ lock nut)	1.00	EA
12970	R00	Fitting M24 x 1.5 Male to 3/4 NPT Female Steel	1.00	EA
16865	R02	Flange Duct for VD450-01 / VD500-01 / VD550-01 **4 Loose Pieces**	1.00	EA
11845	R00	Gasket D-foam w/Adhesive (EPDM)..23/64" W x 17/64" H	3.00	FT
25298	R00	Generator 572RSS4270 SAE 1 FW 14 DVR2400 600V UL/cUL Rated 510 kW @ 600VAC 130/27 Deg C	1.00	EA

16446	R01	Harness Wiring for Volvo TAD/TWD Engines (570FR)	1.00	EA
10595	R00	Heater Tank JW 5000W 240V Horizontal w/T-Stat On 100� Off 120� (CL150210-200)	1.00	EA
11903	R00	Hose Fuel Line 1/4" ID Black SAE 30R7	1.00	FT
11904	R00	Hose Fuel Line 3/8" ID Black SAE 30R7	1.00	FT
12118	R00	Hose Fuel Line 5/8" ID Black SAE 30R7	3.00	FT
29352	R00	Kit Base Conversion PD500 to VD500 (Use with Base 29292) (7 Piece Kit)	1.00	EA
11686	R00	Lanyard 8" 3/16 Eye x 3/16 Eye Steel	1.00	EA
10121	R00	Lug Ground Copper L250	3.00	EA
27069	R00	Modbus TCP & RTU Master to BACnet IP & MS/TP Server Gateway - 250 points (intesis) (INBACMBM2500000)	1.00	EA
19390	R02	Mount Breaker for P-Frame Above 800A-1200A Square D Breaker (use with 19373)	2.00	EA
10157	R00	Mount Vibe Pad Type 2 x 8 x 0.25 PSI = 1015# max	10.00	EA
10966	R00	Mount Vibe Panel 1.00� 1.00H 45 Duro Neoprene 2x3/4 5/16-18 Studs	4.00	EA
26107	R00	Nameplate Gen-Set BSPS (Non-UL) (North Mankato)	1.00	EA
12454	R00	Neutral Bar 1200A SN1200	2.00	EA
13086	R00	O-Ring Buna-N AS568A (used w/13085)	1.00	EA
16950	R00	Panel Control Deep Sea DSE 7310-34 Auto Start Control Module-Heated Display	1.00	EA
13966	R07	Plate DVR2000E+ Cover for 8 X 12 Handy Box	1.00	EA
12607	R00	Plug Vented Black Finishing Plug 1.00 Diameter Hole (Used for DVR Handy Boxes)	2.00	EA
10071	R04	Rack Battery 4D & 8D	2.00	EA
11314	R00	Relay 24VDC 2 Pole 10A Ice Cube Style Spade Terminals	4.00	EA
11320	R00	Socket Relay 11 Pin 10A Screw Terminals	4.00	EA
10398	R00	Standoff 3/8" Electrical Glastic	4.00	EA
10979	R00	Strap Braided Ground 9" Center to Center of 1/2" hole	2.00	EA
14800	R00	Switch Push Button E-Stop 10A 600V Maintained **2 N/C and 1 N/O** (Replaces 11115)	1.00	EA
10042	R00	Transformer Current 800:5 25VA	3.00	EA
10967	R00	Valve Ball Brass .75 NPT Full Port	1.00	EA
10967	R00	Valve Ball Brass .75 NPT Full Port	2.00	EA
10964	R00	Valve Fumoto engine oil drain with nipple 22mm - 1.5 (5/8" ID Hose Adapter)	1.00	EA

20530	R00	V-belt For Volvo 3838617	2.00	EA
20528	R00	V-belt Volvo 20430376	2.00	EA
16535	R00	Wire Bail for Relay Socket 11320	4.00	EA

Engine Generator Set Five (5) Year 3000 Hour Standby Limited Warranty

BLUE STAR Power Systems Inc.

Your Blue Star Power Systems, Inc. product has been designed and manufactured with care by people with many years of experience. Blue Star Power Systems, Inc. warrants to its Buyer that the product is free from defects in materials and/or workmanship for the period of time outlined below. If the product should prove defective within the time period outlined below, it will be repaired, adjusted or replaced at the option of Blue Star Power Systems, Inc., provided that the product, upon inspection by Blue Star Power Systems, Inc., has been properly installed, maintained and operated in accordance with Blue Star Power Systems, Inc.'s Installation and Operating Manuals. This limited warranty is not valid or enforceable unless: (1) all supporting maintenance records are kept on file with the end user and made available upon request from factory, and (2) the generator set is routinely exercised in accordance with operating instructions. This warranty does not apply to malfunctions caused by physical damage, misuse, improper installation, repair or service by unauthorized persons, or normal wear and tear. The warranty is not assignable.

Blue Star Power Systems, Inc. product warranty period: Engine generator set: Parts and Labor for two (2) years from the date of factory invoice or 2000 hours (whichever occurs first). Warranty coverage for years three (3) thru five (5) or up to 3000 hours is parts only. Accessories (installed on the engine generator set or shipped loose): Parts and Labor for one (1) year from the date of factory invoice or 2000 hours (whichever occurs first). Transfer Switches: If purchased with a generator set (same order number): Parts and Labor for two (2) years from the date of factory invoice or 2000 hours (whichever occurs first).

The start of the warranty period can be adjusted to the date of unit start-up (limited to 180 days from invoice date) provided that the following information is provided to Blue Star Power Systems, Inc. within 30 days of start-up. The warranty will not be effective unless a copy of the Blue Star Power Systems, Inc. start-up validation checklist is properly and completely filled out and returned to Blue Star Power Systems, Inc. within 30 days of start-up. Additionally, the engine manufacturer's engine registration form must be completed and returned to the engine manufacturer as stated in the instructions with the registration form.

To obtain warranty service: Contact your nearest Blue Star Power Systems, Inc. Service Representative. For assistance in locating your nearest authorized service representative, contact Blue Star Power Systems, Inc., Attention: Service Department (see contact information below).

Warranty service may be performed by authorized Blue Star Power Systems, Inc. service providers only. Service work performed by unauthorized persons will void all warranties.

Blue Star Power Systems, Inc. shall not be liable for any claim in amount greater than the purchase price of the product. In no event shall Blue Star Power Systems, Inc. be held liable for any special, indirect, consequential or liquidated damages including but not limited to: loss of profits, loss of time, increased overhead, delays, loss of business opportunity, good will, or any commercial or economic loss.

Blue Star Power Systems, Inc. shall not be liable for any claim that requires replacement of engine, part, or component of the gen-set that is no longer manufactured or available. Additionally, Blue Star Power Systems, Inc. will not be liable for any engine replacement that may require emissions tier level change.

THERE ARE NO EXPRESS WARRANTIES OTHER THAN THOSE DESCRIBED HEREIN. THERE ARE NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, OR OTHERWISE CREATED UNDER THE UNIFORM COMMERCIAL CODE, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY, OR WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE.

The following items and/or circumstances are excluded from this limited warranty:

- Engine starting batteries: The battery manufacturers' warranty applies. Consult your local battery supplier for warranty service.
- Fuel system and/or governing system adjustments performed during or after start-up.
- Normal maintenance items: Consumable items such as belts, filters, fluids, and hoses.
- Adjustments and tune–ups performed during start-up or thereafter. Start-up, training, tuning, and adjustments for any paralleling or bi-fuel system.
- Loose connections (electrical and mechanical) not found during start-up.
- All fluid level related items including low coolant not found during start-up or checked during regular maintenance intervals.
- Shipping damage of any type. All equipment is shipped F.O.B. Blue Star Power Systems, Inc. and risk of loss transfers to the carrier once loaded for shipment. It is the responsibility of the receiving party to sign for the receipt of, and note any shipping damage to the equipment. Freight damage claim filing is the responsibility of the receiving party. In the rare event that damage occurs during shipment, Blue Star Power Systems, Inc. will not warrant any damage to the unit resulting from shrink wrap.
- Any special access fees, equipment, requirements or after hours scheduling to gain access to the equipment for warranty service purposes.
- Buyer requested rental generators used while warranty work is being performed.
- Damages caused by acts of nature, such as lightning, wind, flood, or earthquake.
- Any damage due to situations beyond the control of the manufacturing and/or workmanship of the product.
- Use of non-protected steel enclosure within 10 miles of the coast.
- Improper installation or operation as outlined in the Installation and Operation Manuals.
- Misapplication of the equipment such as usage outside the original design parameters as stated on the nameplate of the equipment.
- Equipment purchased at the standby rating that is being used in a prime power application(s).
- Diesel engine "Wet Stacking" or Regeneration issues due to lightly loaded diesel engines.
- Travel labor and mileage for mobile generator sets.
- More than one trip to the job site because a service vehicle was not stocked with normal service parts.
- Lodging expense associated with unit repair and excessive mileage charges (limit to 300 miles round trip from nearest service center).
- Failure to properly exercise and maintain your equipment per manufacturer's specifications will void all warranty.
- Equipment modifications made without the written consent of Blue Star Power Systems, Inc. will void all warranties.
- Any equipment or components added including fuel tanks and enclosures not installed at the Blue Star Power Systems, Inc. factory.

This agreement is deemed made and executed in North Mankato, Nicollet County, Minnesota and shall be construed and interpreted in accordance with the laws of the state of Minnesota without giving effect to its conflicts of laws principals. Each of the parties submits to the exclusive personal jurisdiction and venue with respect to any action or proceeding arising out of, in connection with, relating to, or by reason of this agreement before the district court of the state of Minnesota, located in Nicollet County and agrees that all claims in respect of the action or proceeding may be heard and determined in any such court.

CUSTOM POWER GENERATION

GENERATOR LOAD TEST REPORT

Date: Nov 18 2021
Project Name: Iqaluit Sewage Treatment
Work Order:
Technician: Erik-Jon Wathen
Customer: Arctic Electric

Genset Make: Blue Star
Genset Model: VD500-01
Genset SN: 116385-2-1
Engine Make: Volvo
Engine Model:
Engine SN: 2016137079

Rated kW: 500
Rated kVA: 625
Rated Hz: 60
Phase:
Rated Volts: 600
Rated RPM: 1800

	0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00	2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00
Time	15:52	16:07	16:23	16:38	16:53	17:08	17:23	17:38	18:53	19:08	19:23	19:38	19:53	20:08	20:23	20:38
Run Time Meter		5:42	5:57	6:12	6:27	6:42	6:57	7:12	7:27	7:42	7:57	8:12	8:27	8:42	8:57	9:12
kW	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510
Frequency Hz	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60,1	60.1	60.1
Power Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RPM		1800	1801	1800	1800	1800	1801	1800	1801	1800	1800	1801	1800	1801	1800	1800
Fuel Consumption (L/Hr)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Level (%)	100	100	100	100	99	99	99	99	99	98	98	98	98	98	97	97
A-B Voltage (V)	601	600	601	603	601	600	603	601	601	603	601	601	601	602	601	601
B-C Voltage (V)	603	602	602	602	603	602	602	603	602	602	603	603	602	602	602	602
C-A Voltage (V)	602	603	602	603	602	602	603	602	602	603	603	602	602	602	602	603
A-N Voltage (V)	347	347	347	348	347	348	347	348	348	348	347	348	348	347	348	347
B-N Voltage (V)	348	348	348	348	348	348	348	348	348	348	348	347	348	348	348	348
C-N Voltage (V)	348	348	348	348	348	347	348	348	348	347	348	348	348	347	347	348
A Current (A)	500	501	500	501	500	501	501	501	501	500	501	500	500	500	500	500
B Current (A)	500	500	500	501	500	500	500	500	500	500	500	500	500	501	500	500
C Current (A)	500	501	501	502	501	501	501	501	501	501	500	501	501	500	500	501
Ambient/Intake Temp. C	33	33	36	35	35	35	35	35	35	35	35	35	35	35	35	35
Coolant Temp C	84	85	85	85	85	85	845	85	85	85	85	85	85	85	85	85
Exhaust Temp C	486	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Alternator Cooling Air Outlet Temp C	14	14	14	14	15	15	15	15	15	15	15	15	15	15	15	15
Oil Temp C	103	109	110	110	110	110	110	110	110	110	110	110	110	110	110	110
Oil Pressure kPA	520	516	504	488	478	476	476	476	476	476	476	476	476	476	476	476
Battery Voltage (V)	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
Battery Charger Current (A)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DC Alternator Amperage (A)	5.2	5	5	5	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9

Notes:
The unit performed successfully.
Generator commissioning performed per CSA 282
Generator performance meets CSA 282 requirements

Standard Factory Load Test

BLUE STAR
Power Systems Inc.

CUSTOMER: CPG		JOB: 116385-2-1
UNIT MODEL: VD500-01	TESTED BY: MIKE	DATE: 08-03-21

VISUAL INSPECTION CHECK LIST:

MTG & CPLG	☑	EXH SYSTEM	☑	cULus (UL 2200) Required	☐
FUEL SYSTEM	☑	DRAIN PLUGS	☑	Hipot Tested	☐
LUBE SYSTEM	☑	12VDC ☐ 24VDC ☑		Over Current Set 631 Amps	☑
COOLING SYSTEM	☑	PANEL S/N: 7955131		Generator UL Listed	☐

ENGINE: VOLVO	ENGINE CONTROL: 2020	GENERATOR: MARATHON
MODEL: TAD1641GE	HWT ☑ LOP ☑	MODEL: 572/4270 LEADS: 4
S/N: 2016137079	BATT.VOLTS: Off 25.5 Run 28.1	S/N: MT-0105002-0621
FUEL: DIESEL	O'CRANK: CYCLIC ☐ 45 SEC ☐	REGULATOR: DVR2400
GOV MODEL: ECM	O'SPEED: 71 CPS ☐ OTHER_______	TEMP RATING: RISE: 130 AMB 27

RATED:

KW	KVA	P.F.	RPM	PHASE	WIRE	HZ	VOLTS	AMPS
500	625	.8	1800	3	4	60.1	600	601

	ACV	ACI	KVA	KW	P.F.	HZ	EFV	EFI	RUN TIME	OIL PSI	COOLANT Temp° F	AMBIENT Temp° F
NO LOAD		N/A	N/A	N/A	N/A							
LOW		N/A	N/A	N/A	N/A							
HIGH		N/A	N/A	N/A	N/A							
SET	600	N/A	N/A	N/A	N/A	60.1			30	100	115	73.2
25% LOAD	600	142	149	125	.8	60.1			35	100	180	74.7
50% LOAD	600	310	323	250	.8	60.1			36	97	180	74.8
75% LOAD	600	458	476	374	.8	60.1			37	92	181	75.4
100% LOAD	600	600	624	500	.8	60.1			39	85	185	75.7
MAX AT 1.0 PF	600	506	530	530	1.0	60.1			40	81	187	76.8
MAX AT .8 PF	600	616	641	519	.8	60.1			42	80	187	77.5
NO LOAD	600	-	-	-	1.0	60.1			42	85	187	77.9
MAX PICKUP	600	614	637	515	.8	60.1			43	81	187	78.4
END OF TEST	600	-	-	-	1.0	60.1			60	94	180	83.7

REMARKS:

PHASE BALANCE: RATED LOAD

PH	VOLTS			AMPS	
1-2	600	1-N	346	L1	600
2-3	600	2-N	346	L2	601
3-1	600	3-N	345	L3	606

FINAL VISUAL INSPECTION ☑

TESTED BY: MIKE ANTHONY

ACCESSORIES: CHECK WHEN TESTED

REMOTE START	☑	REMOTE ALARM PANEL	☐
GROUND STUD	☑	EMERGENCY STOP SW	☑
WATER HEATER	☐	TAP CHANGING SWITCH	☐
BATTERY CHARGER	☐	RECEPTACLES	☐
PRE-ALARMS	☐	RUN/IDLE SWITCH	☐
LOW FUEL LEVEL	☐	PANEL DISCONNECT SW.	☐
FUEL LEAK SW TEST	☐	FAN BLADES	☑
	☐		☐
BREAKER LINES LABELED	☑	GND LABEL IN BKR ENCL	☑