FOREWORD

This manual contains information for the correct operation and maintenance of your Powerlink generator sets which with 501K, 701HC, PLC-5110, PLC-5220, PLC-5310 and PLC-55X control panels. It also includes important safety information, installation instruction and troubleshooting guidelines.

Keep this manual with the equipment. If the equipment is traded or sold, give the manual to the set owner.

This manual does not cover diesel engine and alternator maintenance procedures. Consult the engine and the alternator operation and maintenance manuals.

To make certain that your expectations are matched, we ask that you read carefully through the instruction book before starting and operating the generating sets.

Sincerely
POWERLINK MACHINE COMPANY

Generating Set Data

Generating Set **Model……** **Product No……**
Power (kva)**……** Power (kva)**…… …**
Engine **Model……** **Cotrol Panel Type……**

Customer Information

Name**……**
Address……
City/ State……
Zip Code……
Email Address……

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SECTION 1 GENERAL SAFETY INFORMATION

All users of mechanical and electrical equipment will realize the importance of safety and the health of operators and others involved with such equipment. It is essential that sensible precautions are taken in this regard whenever generating sets are supplied and installed.

In addition, there is considerable legislation in existence regarding this. It is impossible to specify it in detail for each country due to the complex nature and continual changes occurring, but users are advised to check up on special requirements pertaining to their own country.

Read this chapter very carefully. It concerns your safety. How safety information is presented in the instruction book and on the product is described here. You will also find an overall picture of the basic safety which marked on the generating sets for operation of the generating sets.

CLARIFICATION OF NOTATION USED WITHIN THIS PUBLICATION.

Incorrect operation can lead to injuries and/or property damage. It is therefore important to read through the instruction book very carefully before you installate, start or operate the generating sets and maintenance or service work.

NOTE:	Highlights an essential element of a procedure to ensure correctness.
CAUTION!	**CAUTION!** Indicates a procedure or practice which, if not strictly observed, could result in damage or destruction of equipment.
WARNING!	**WARNING!** Indicates a procedure or practice, which could result in injury to personnel or loss of life if not followed correctly.
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SAFETY INSTRUCTIONS FOR INSTALLATION, OPERATION & MAINTENANCE

GENERAL

A) Check that all necessary or available guards are correctly fitted.
B) Check generating set is securely mounted.
C) Check all mechanical connections are satisfactory.
D) Check all electrical connections are correct, safely insulated and suitably earthed.
E) Check service and maintenance persons are competent and adequately trained.
F) Keep generating set clean and generator house tidy.
G) Always disconnect starter battery before commencing maintenance operations.

TRANSPORTING

Always shutdown engine before transporting.
Never transport generator with air intake doors open.
Tighten fuel tank cap securely.
Drain fuel when transporting generator over long distances or bad roads.
Always tie-down the generator during transportation by securing the generator.
If generator is mounted on a trailer, make sure trailer complies with all local and state safety transportation laws. See the page for basic towing procedures.

FUEL & OIL

A) Rectify any fuel or lubricating oil leaks immediately observed.
B) Clean up any fuel or lubrication oil spillages immediately.
C) Avoid contact with fuel or lubricating oils. Wash fully if contact made. Persons with allergies should wear protective gloves.

STARTING BATTERIES

D) Handle batteries with care and in accordance with the recommendations given. When preparing for use wear protective clothing, in particular guard the eyes.
E) Lead acid batteries contain dilute sulphuric acid. Wash well with water if spilt and contact made with eyes wash well and obtain medical attention.
F) Alkaline batteries contain alkaline which is corrosive and can cause burns. Wash well with water if spilt, cover any burns and obtain medical attention.
G) Keep battery areas well ventilated as they produce explosive gases. Avoid sparks, flames and smoking near batteries. Break circuits before connecting or disconnecting or disconnecting and ensure connections are sound.
H) If mixing acid and water it is essential to dilute acid by adding to water and stirring well. Never add water to the acid. Wear protective clothing.

ELECTRIC POWER

A) Only qualified electricians should be allowed to work on electrical equipment. All connections should be insulated and wiring boxes and panels should be fully protected.
B) Operators should be trained for trained for treatment of electrical shocks.

Emergencies

Always know the location of the nearest ***fire extinguisher*** and ***first aid kit*****.** Know the location of the nearest telephone.
Also know the phone numbers of the nearest ***ambulance***, ***doctor*** and ***fire department***.

Maintenance Safety

NEVER lubricate components or attempt service on a running machine.
Always allow the machine a proper amount of time to cool before servicing.
Keep the machinery in proper running condition.
Fix damage to the machine immediately and always replace broken parts.
Dispose of hazardous waste properly. Examples of potentially hazardous waste are used motor oil, coolant, fuel, and fuel filters.

DO NOT use plastic containers to dispose of hazardous waste.

DO NOT pour waste, oil, coolant or fuel directly onto the ground, down a drain or into any water source

Loading and Unloading (Crane)

Before lifting, make sure the generator's lifting hook is secure and that there is no apparent damage to the generator itself (loose screws, nuts and bolts). If any part is loose or damaged, please take corrective action before lifting.
Always drain fuel prior to lifting.
Always make sure crane or lifting device has been properly secured to the hook of guard frame on generator.

NEVER lift the machine while the engine is running.

Use adequate lifting cable (wire or rope) of sufficient strength.
When lifting the generator, always use the balanced center-point suspension hook and lift straight upwards.

NEVER allow any person or animal to stand underneath the machine while lifting.
When loading the generator on a truck, be sure to use the front and back frame bars as a means to secure the generator during transport.

NOTE:
When the generator is not in use, close the rain doors to keep the internal area clean and protected from rodents.

DIESEL ENGINE

Improper practices, carelessness, or ignoring the warnings can cause burns, curs, mutilation, asphyxiation or other personal injury or death.
Read and understand all of the safety precautions and warnings before performing any repair.
This list contains the general safety precautions that must be followed to provide personal safety .
Special safety precautions are included in the procedures when they apply.

1 Work in an area surrounding the product that is dry, well lit, ventilated, free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.

2 Always wear protective glasses and protective shoes when working.

3 Rotating parts can cause cuts, mutilation or strangulation.

4 Do not wear loose-fitting or torn clothing .Remove all jewelry when working.

5 Disconnect the battery (negative [-]cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting, Put a “Do Not Operate ” tag in the operator’s compartment or on the controls.

6 Use ONLY the proper engine barring techniques for manually rotating the engine. Do not attempt to rotate the crankshaft by pulling or prying on the fan .This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.

7 If an engine has been operating and the coolant is hot, allow the engine to cool before slowly loosening the filler cap to relieve the pressure from the cooling system.

8 Always use blocks or proper stands to support the product before performing any service work. Do not work on anything that is supported ONLY by lifting jacks or a hoist.

9 Relieve all pressure in the air, oil, fuel, and cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do not check for pressure leaks with your hand .High pressure oil or fuel can cause personal injury.

10 To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect liquid refrigerant (Freon) lines in a well ventilated area .To protect the environment ,liquid refrigerant systems must be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the lifting atmosphere. Federal law requires capturing and recycling refrigerant.

11 To reduce the possibility of personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks or slings are in good condition and are of the correct capacity .Make sure hooks are positioned correctly. Always use a spreader bar when necessary. The lifting hooks must not be side –loaded.

12 Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do not get the substance in eyes .Avoid prolonged or repeated contact with skin. Do not swallow

internally .In case of contact , immediately wash skin with soap and water, In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes IMMEDIATELY CALL A PHYSICIAN . KEEP OUT OF REACH OF CHILDREN.

13 Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and must be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. KEEP OUT OF REACH OF CHILDREN.

14 To reduce the possibility of burns, be alert for hot parts on products that have just been turned off, and hot fluids in lines , tubes , and compartments.

15 Always use tools that are in good condition .Make sure you understand how to use the tools before performing any service work .Use ONLY genuine Cummins or Cummins ReConr replacement parts.

16 Always use the same fastener part number (or equivalent) when replacing fasteners. Do not use a fastener of lesser quality if replacements are necessary.

17 Do not perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.

18 Some state an federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.

19 Liquified petroleum gas is heavier than air and can accumulate near the floor, in sumps , and low-lying areas.

20 Natural gas is lighter than air and can accumulate under hood and awnings.

21 To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect natural gas and liquefied petroleum gas lines in a well ventilated area.

22 Coolant is toxic. If not reused, dispose of in accordance with local environmental regulations.

SYMBOL MEANINGS ON THE GENERATING SETS

To reduce the risk of electrical shock, injury or death caused by explosion of fuel or moving parts, and to ensure the safe operation of this unit, the following symbols have been placed throughout the manual. Where these symbols appear, servicing must be performed only by qualified personnel.

DANGEROUS VOLTAGE
This symbol indicates a "dangerous voltage" exists in this area of the product. Use caution whenever working in the area to prevent electrical shock.

ATTENTION
This symbol indicates important installation, operation or maintenance instructions. Always follow these instructions closely.

CAUTION HAND INJURED
This symbol indicates the need for following approved procedures for handling electrostatic-sensitive components.

NO MATCHES OR OPEN FLAMES

This symbol indicate a fire or explosive hazard exists in this area of the product. Use caution whenever working in the area to prevent the possible combustion of fuel or vapors.

NO LIFTING & MECHANICAL OR MOVING PARTS HAZARD

These symbols indicate the presence of a “mechanical or moving parts hazard” in this area of the product. Use caution whenever working in the area to prevent possible injury to the operator or service personnel.

MAINTENANCE MARK & LEAK HAZARD

This symbol indicates a “leak hazard” exists in this area of the product. Use caution whenever working in the area to prevent and correct any leaks detected.

CAUTION HAND INJURED

This symbol indicates the presence of high temperatures which result from the operation of the system. To prevent burns, do not touch these areas while the system is in operation or immediately after it has been turned off.

REFER THE MANUAL

This symbol is used in certain cases on our products and refer to important information in the instruction book and the manual when you operating the generator sets or when you have some trouble.

BE CAREFUL OPEN

This symbol indicates this area of the product must be carefully opened.

LIFTING POINT

This symbol indicates here is the place you can lift the product and transport it.

EMERGENCY STOPPING

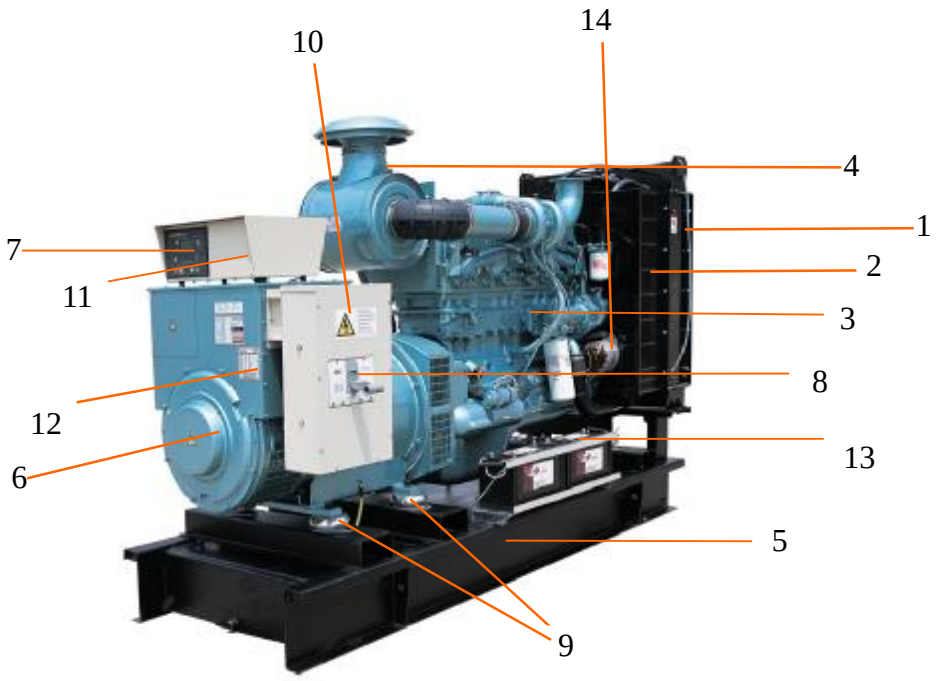
This symbol indicates this is the button for stopping the generator sets emergently when there is dangerous or you have some trouble.

SECTION 2 GENERATORS INTRODUCTION

Generator introduction is a power plant equipment which provide electric power for oneself，internal-combustion engine provide power，drive alternator generate electricity.

Contemporaneity generator is made up of engine, alternator and control system and so on mostly parts. internal-combustion is power equipment, it drive the generator run, alternator generate electricity, control system control and monitor generators running. Particularly, whole generator include three phase AC dynamotor, control box, radiator, joint-axes, fuel trunk, common base and otherwise.

Brief describe standard fittings as follow：



1	Water tank and radiator	8	Air Switch
2	Heat Shield Protection	9	Anti Vibration-mounting
3	Engine	10	Warring and notes
4	Air cleaner	11	Control panel box
5	Generators base and daily oil trunk	12	Alternator brand and notes
6	Alternator	13	Storage Battery
7	Control panel	14	Battery Charger

SECTION 3 INSTALLATION

3.1 INTRODUCTION & OVERVIEW

This section of the manual provides installation instructions for Powerlink's Industrial generator sets (gensets). This manual will contain the following information:

1. **Mounting Recommendations** — This section provides mounting recommendations for fastening the generator set to a mounting skid (base), allowing the proper space requirements for normal operation, and service requirements.

2. **Mechanical Connections** — This section provides the location of connection points for fuel, exhaust, ventilation, and cooling. The contents of this section as follow:

3. **Electrical Connections** — This section provides the location of electrical connection points for the control, generator, and starting system.

4. **Transfer Switch** — It provides the location of electrical connection points for Transfer switch.

5. **Initial Start-Up** — This section provides information to test the complete system to ensure proper installation, satisfactory performance, and safe operation. Refer to the Operation manual for troubleshooting information.

6. **Installation Checklist** — This section provides reference checks upon completion of installation.

7. **Installation Checklist** —This section provides the location of electrical connection points for battery starting system.

3.2 Mounting Foundation & Mounting

Room Size

Open frame generators must be protected from the environment while having good ventilation and cooling. Here are some considerations for planning a generator room or enclosure:

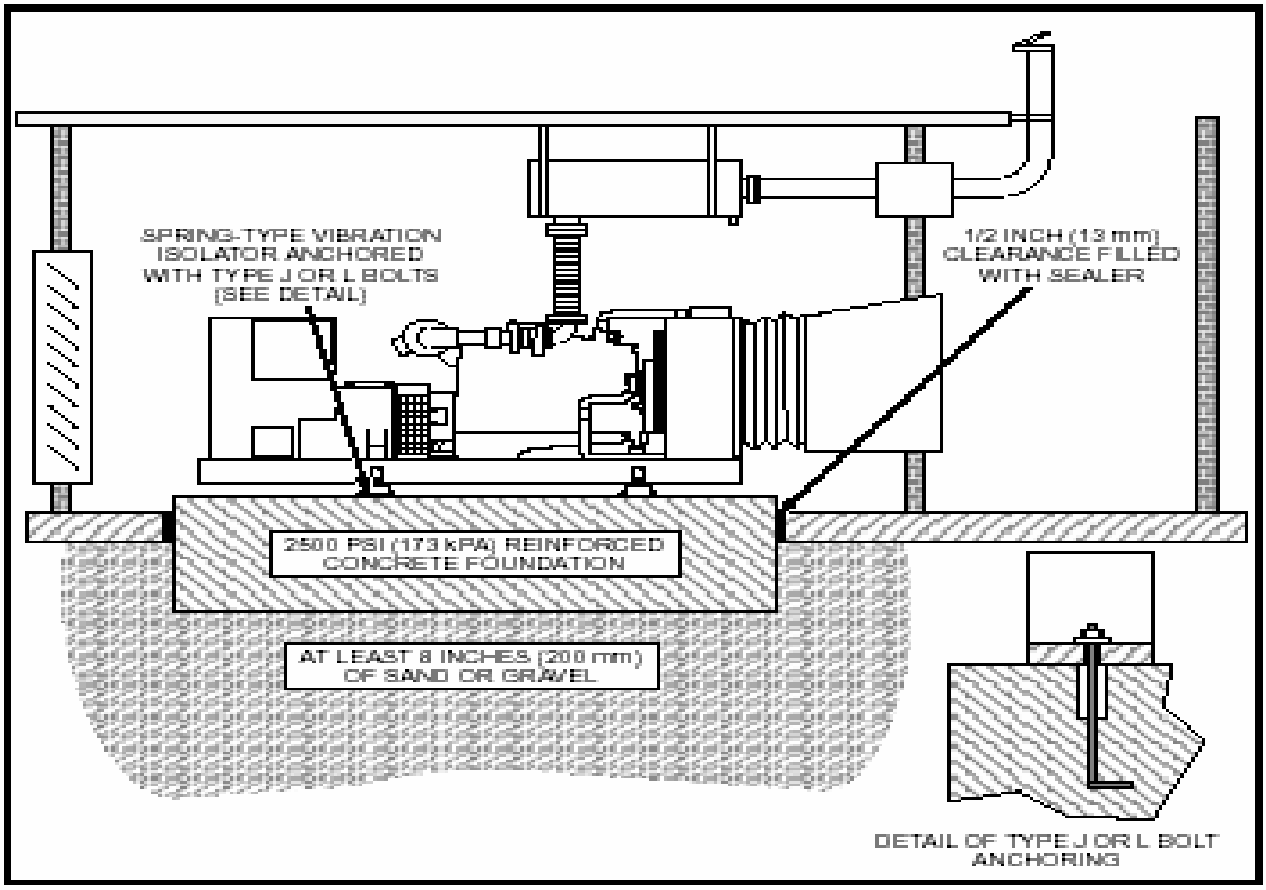
- Never use the Genset room for storage.
- The room must be large enough to contain the Genset and all the accessories, such as batteries and their charging system, transfer switch and other controls, and elements of the cooling and fuel systems.
- 2 feet minimum (preferably 4 feet), must be allowed on the two sides and the front of the engine for service access. Allow clearance between hot parts of the system (exhaust) and structural members of the building.
- On the generator end of the engine, allow a space equal to the length of the generator (generator length only, not the entire Genset).
- Certain safety and building codes may require the Genset room not to be used to house any other mechanical or electrical equipment.

Room Location

Often a separate building located on the site away from the main building is the most simple and cost effective. Major considerations when housing the Genset in a separate building are:

• Maintain the building at a satisfactory temperature year round (to meet applicable codes).
• Assure the Genset is not located so far from the emergency loads that reliability is compromised.

The floor's load carrying capacity must be checked and must exceed the weight of the Genset and its associated equipment.



Typical Mount Design for Stationary Genset Applications

NOTE: Number of mount locations depends on genset size/weight.

NOTE: Consult Mount Suppliers or Powerlink Application Engineering for further details.

Utility Power

During periods when the generator is not running, utility power must be provided to power critical components. Battery chargers, block heaters, space heaters and other devices must have power to maintain the generator set components and allow fast easy starting.

Mounting the Generator Set

Generator sets are mounted on a steel skid that provides proper support. Vibration isolators are recommended between the skid and the foundation to provide stable operation and avoid installation damage. Bolting the generator set directly to the floor or foundation can result in excessive noise and vibration, and possible damage to the genset and floor foundation.

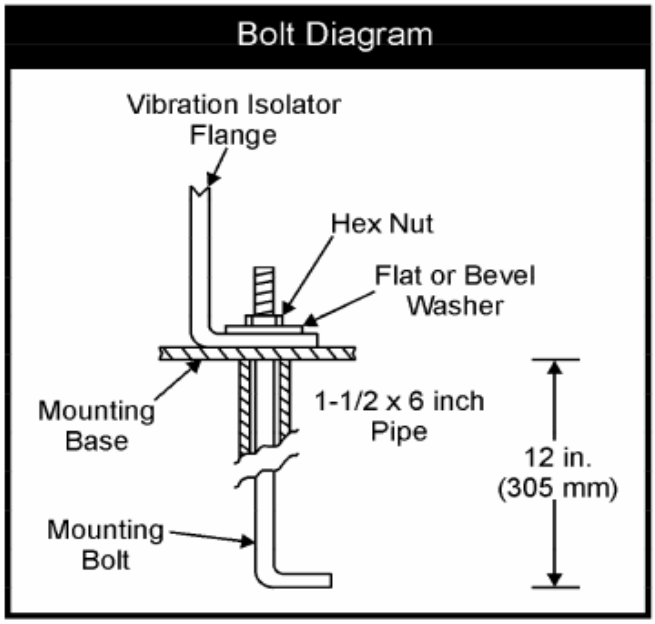


Figure XX. Bolt Diagram

Mount the generator set on a substantial and level base such as a concrete pad. Use 3/4 inch anchored mounting bolts to secure the vibration isolators to the skid using flat or bevel washers and hexagonal nut for each bolt. (See Figure XX left.)

The isolators should be located as shown on the genset outline drawing.

Engine Mounting Guidelines

Mount Requirements:

Must support weight of engine/generator assembly (engine + generator + frame + accessories)

Must limit the static bending moment at the rear face of the block (engine data sheet)

Must provide vibration and noise isolation

Weight of assembly:

Refer to engine data sheet for engine

Refer to Generator set assembler for package weight

Foundation:

Concrete pad minimum 6” above existing floor and extend 12” beyond Genset base

Concrete, floor, or roof must be designed to support at least 2.0 times Genset weight

Must be Flat to prevent genset base deflection

Type ‘J’ or ’L’ bolts need to be used to anchor the Genset base/isolators to concrete.

Vibration Isolators:

Must be used to reduce noise and vibration transmitted to the foundation or building.

Engine speed, assembly size and weight must be considered when designing mounts

Suggest visit to www.lordmpd.com, www.aeroflex.com for mount information.

NOTE: Check local building codes for specific mounting requirements.

NOTE: If ground freezing is possible, the foundation must extend below the frost line.

Genset Location Considerations

Both Indoor and Outdoor issues to consider:

Generator set mounting
Location of switchgear
Branch circuits for coolant heaters, battery charger, etc.
Security from flooding, fire, icing, and vandalism.
Containment of spilled or leaked fuel and coolant.
Possible simultaneous damage to normal and emergency services.
Service access for general maintenance and inspections.
Access and working space for major work such as overhauls or component removal/ replacement.

Typical Outdoor Considerations:

Airborne noise and noise treatment - check local codes
Types of housings - container, drop over, sound attenuation features
Service access - housing design and placement close to other equipment or structures
Property line distances - check local codes
Engine exhaust - away from buildings and building openings
Grounding - electrodes or grounding rings may be required
Lightning protection
Security fences and site barriers

Typical Indoor Considerations:

Dedicated generator room - airflow required for genset and other equipment
Room requires fire rating - check local codes for fire resistance requirements
Working space - check local codes, space for genset repairs
Genset cooling system design - genset or remote mounted, required air flow through room
Room fresh air ventilation - remote cooling systems will require room fans
Engine exhaust - may require insulation to contain room heat, routed away from buildings
Fuel storage and piping - check local codes, accessibility for refueling
Temporary load bank connection - recommended for exercising
Access for installation, service and maintenance - large access doors for equipment
Rooftop installations - building structural design for vibration, weight, fuel delivery

Access to Set

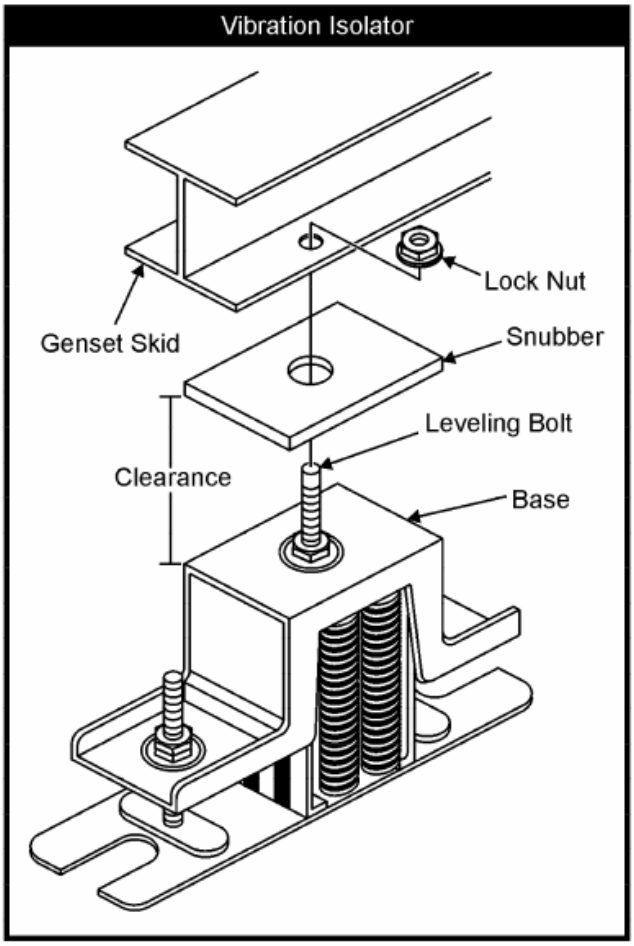
Whenever choosing a generator site location, always allow room for service personnel and operators to gain the proper access to the unit. Always provide adequate lighting around the unit.

For convenience in general servicing such as radiator, fan belt, and oil filter maintenance, the surface of the mounting base should be at least 6 inches (152mm) above the floor.

Vibration Isolators

Installation and Adjustment Procedure

1. Place the vibration isolators on the genset support structure. The isolators should be shimmed or grouted to ensure that all of the isolator bases are within 0.25 inch (6 mm) elevation of each other. The surface the isolator bases rest on must also be flat and level. (See Figure XX to the left and below.)



2. Loosen the snubber lock nuts so that the top plate of the isolator is free to move vertically and horizontally. Be sure the top plate is correctly aligned with the base and springs.

3. Place the genset onto the isolators while aligning the skid's mounting with the threaded isolator hole. The top plates will move down and approach the base of the isolator as the weight of the generator is applied.

4. Once the genset is in position, the isolators may require adjusting so that the set is level. The isolators are adjusted by inserting the leveling bolt through the skid and into the isolator (the leveling bolt's locking nut should be threaded up towards the bolt head). The leveling bolt will adjust the clearance between the top plate and the isolator base. A nominal clearance of 0.25 inch (6 mm) or greater is desired. This will provide sufficient clearance for the rocking that occur during start-up and shutdown. If the 0.25 inch clearance is not present, turn the leveling bolt until the desired clearance is achieved.

Figure XX. Vibration Isolator

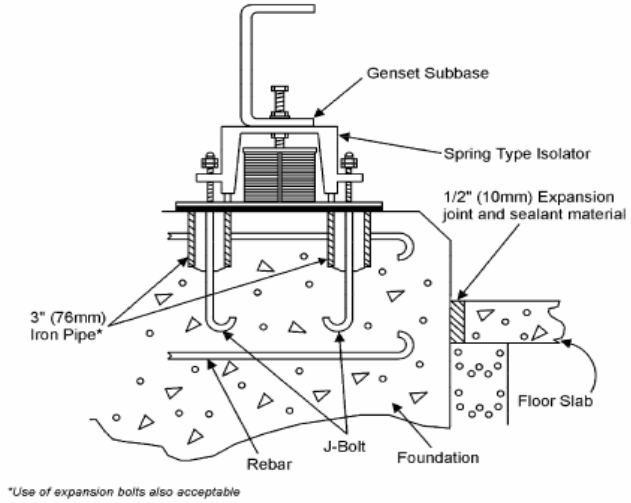


Figure XX. Vibration Isolator Installation

Set mounted radiator-cooled generator sets:
Make sure radiator skid and engine/ alternator skid are level with each other after adjusting isolators. Improper fan belt alignment may occur is the unit is not level.

5. Adjust the leveling bolts until the set is level and sufficient clearance still remains. The clearance on all isolators should be roughly equal. Once all isolators have been set, lock the leveling bolt in place with the lock nut.

6. The snubber nuts must remain loose and therefore provide better isolation between the genset and support structure.

3.3 Exhaust System

The exhaust system must minimize exhaust restriction. Exhaust restriction must be correct to ensure proper engine operation. Refer to product specifications for correct exhaust pressure (inches Hg). The exhaust system should be as short and have as few bends as possible. Engine exhaust must be directed away from occupied buildings, windows and doorways.
For aesthetic reasons, consider exhaust placement in relation to the building. Over a period of time, exhaust gas carbon deposits will tend to accumulate on any nearby wall or structure. Attention must also be given to exhaust noise in selecting placement of the exhaust system.

Level Of Attenuation

In general, manufacturers offer three grades of silencers: industrial, residential, and critical. Check the attenuation curves for the silencer to assure the desired level of silencing is met.

Multi−Engine Installations

Caution: Do not connect multi−engine exhaust systems together. Each engine must have its own exhaust system for proper operation.
Exhaust gases from an operating engine will migrate back through a non−operating engine and cause a hydraulic lock. This may interfere with starting of the second engine. The migrating gases will also tend to turn the turbos which are not being provided lubrication if the engine is not running. Do not use check valves in the exhaust system because they can .stick.

Exhaust System Installation

Proper exhaust system installation will ensure safe working conditions and maximum engine efficiency. Always pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlets away from any air inlets to avoid gases re-entering the enclosure. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation, and light loads.

Once the exhaust system has been installed, it is important to regularly inspect the exhaust system both visually and audibly to see that the entire system remains fume tight and safe for operation.

WARNING:
Inhalation of exhaust gases can result in sever personal injury or death.

Use extreme care during installation to provide a tight exhaust system. Terminate exhaust pipe away from enclosed or sheltered areas, windows, doors, and vents.

Use an approved thimble where exhaust pipes pass through wall or partitions. Insulated wall/roof thimbles are used where exhaust pipes pass through a combustible roof or wall. This should include structures, such as wood framing or insulated steel decking, etc. Uninsulated wall/roof thimbles are used where exhaust pipes pass through a noncombustible wall or roof, such as concrete. Refer to NFPA 37, Section 6-3 "Stationary Combustion Engines and GAs

Turbines" for accepted design practices. Build according to the code requirements in effect at the installation site.

WARNING:

Do not use exhaust heat to warm a room, compartment, or storage area. Weight applied to the engine manifold can result in turbocharger damage. Support the muffler and exhaust piping so no weight or stress is applied to the engine exhaust elbow.

Rain caps are available for the discharge end of the vertical exhaust pipes. The rain cap clamps onto the end of the pipe and opens from the exhaust discharge force from the generator set. When the generator set is stopped, the rain cap automatically closes, protecting the exhaust system from rain, snow, etc.

When installing the exhaust system, use a section of flexible exhaust pipe between the engine and remainder of the exhaust system. Support exhaust system to minimize weight applied to engine exhaust outlet elbow/turbocharger connection.

When installing the exhaust system, avoid sharp bends by using sweeping, long radius elbows and provide adequate support for muffler and tail pipe. Pitch a horizontal run of exhaust pipe DOWNWARD to allow any moisture condensation to drain away from the engine. If an exhaust pipe must be turned upward, install a condensation trap at the point where the rise begins.（See Figure XX Left.） Shield or insulate exhaust lines if there is any possibility of personal contact. Allow at least twelve inches (12" or 305 mm) of clearance if the pipes pass close to a combustible wall or partition.

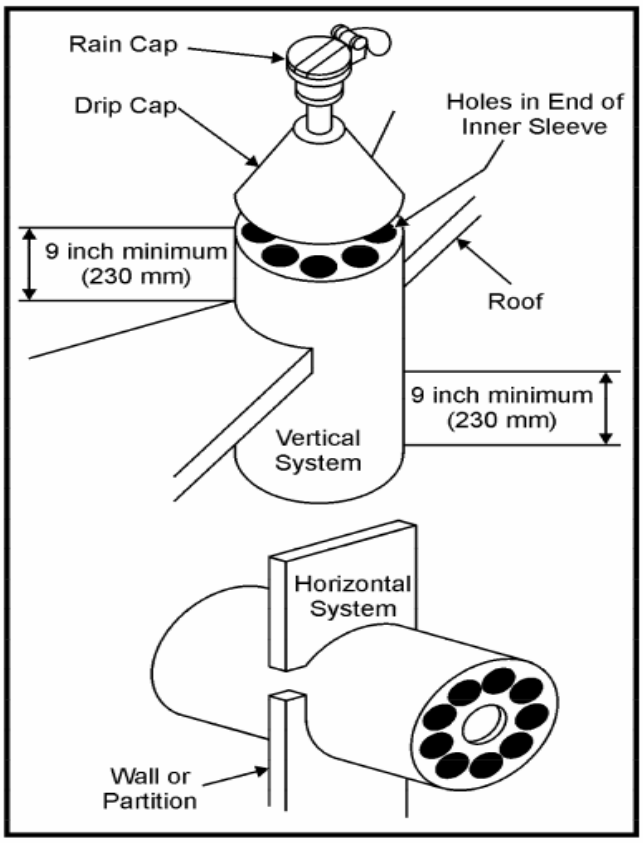


Figure XX. Mounting Exhaust Thimble

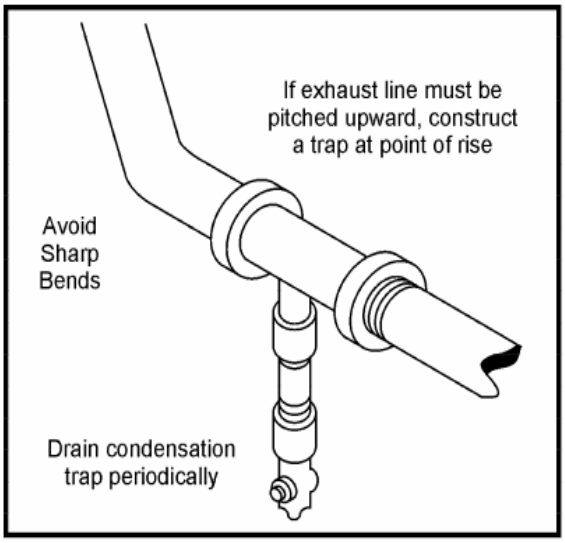


Figure XX. Condensation Trap

WARNING:

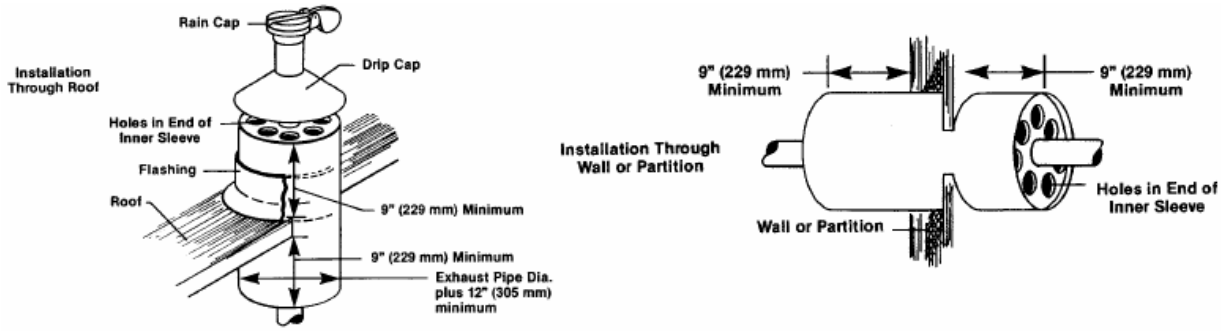
Exhaust pipes are very hot and they can cause severe personal injury or death from direct contact or from fire hazard. Shield or insulate exhaust pipes if there is danger of personal contact or when routed through walls or near other combustible materials.

Wind Barrier

Wind blowing against air exhaust or intake openings of the Genset room must be considered, especially where the radiator and fan are located on the engine. Wind blowing against an exhaust opening creates restriction to the fan. Wind blowing against intake openings can blow open gravity louvers causing low temperature and moisture problems in bad weather. A turning vane may be required to prevent exhaust air recirculation between the exhaust louvers and the barrier surface. This will route the exhaust upward into the atmosphere.

Rain Protection

Moisture entering the engine through an exhaust system can cause extensive damage. Exhaust outlets must have a rain cap or be horizontal to prevent such damage. （See Figure below）.



3.4 Fuel System

The fuel system must provide adequate and continuous quantities of clean fuel to the Generator Set. Bulk fuel is stored in large tanks, usually outside the building, and fuel is transferred to a smaller tank (day tank) located near the engine.

MECHANICAL CONNECTIONS

After considering all applicable laws and finding a suitable location site for the generator set, the installer should consider the mechanical connections that will be necessary to make during installation. The four (4) systems that will require mechanical connections are the following:

- Fuel system
- Exhaust system
- Ventilation system
- Cooling system

Fuel System Installation

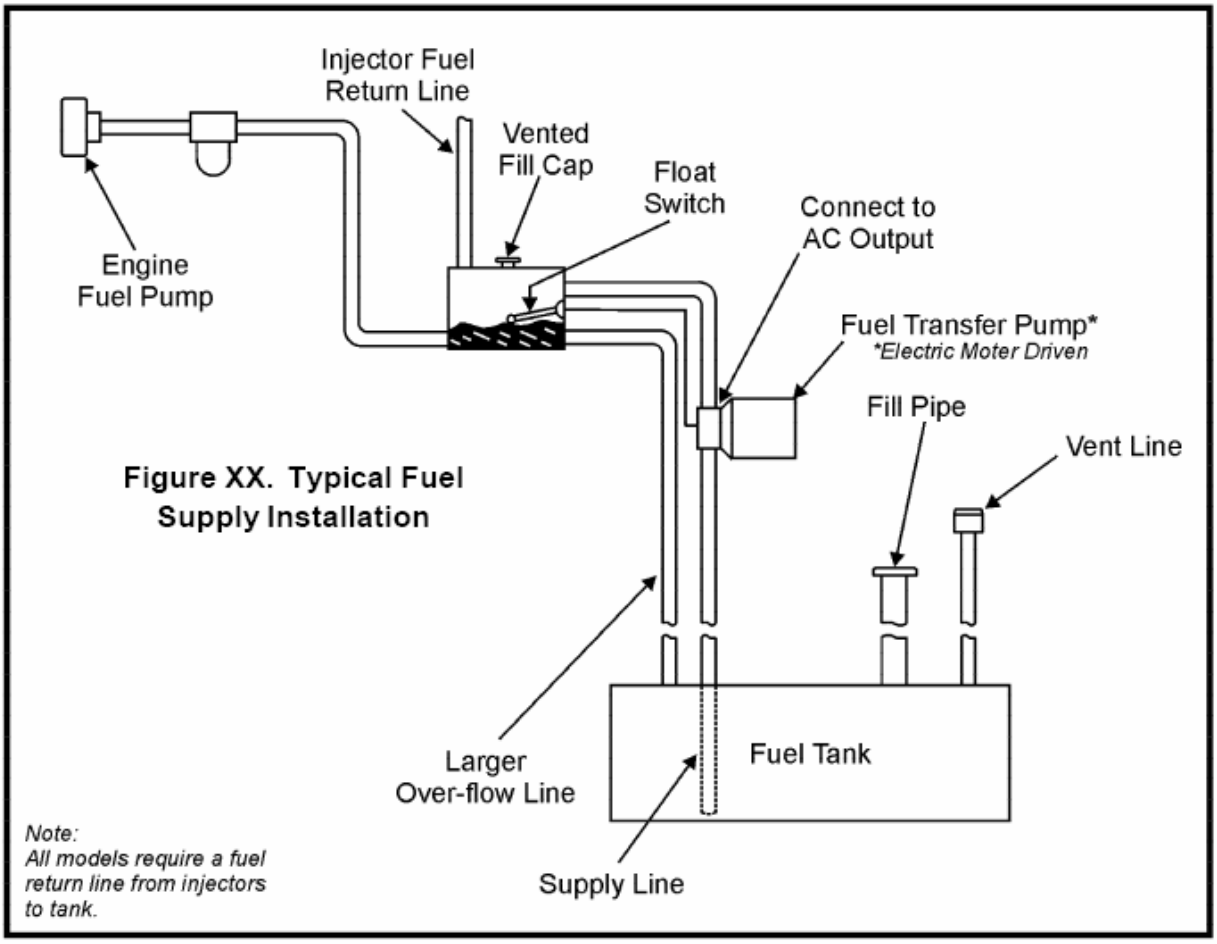
Proper installation of the fuel system is essential in obtaining proper genset performance, safe working conditions, and preventing property and environmental damage.

It is important to have a clean installation, making every effort to prevent entrance of moisture, dirt, or contaminants of any kind. Clean all fuel system components before installing.
Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Buried fuel lines must be protected from corrosion. Use a flexible section of tubing between the engine and fuel supply line to provide vibration isolation.

Refer to the generator set manual for outline drawings and detailed information.

WARNING:

Never use galvanized or copper fuel lines, fittings, or fuel tanks. Condensation in the tank and lines combines with the sulfur in diesel fuel to produce sulfuric acid. The molecular structure of the copper or galvanized lines or tanks reacts with the acid and contaminates the fuel.



Supply Tank Lower than Engine Installation

If a supply tank is lower than the engine, the day tank is installed near the generator set and within the engine fuel pump lift capability, but below the fuel injection system. Install an auxiliary fuel pump as close as possible to the supply tank to pump fuel from the supply tank to the day tank. A float switch in the day tank controls operation of the auxiliary fuel pump.

The supply tank top must be below the day tank top to prevent siphoning from the fuel supply to the day tank. Provide a return line from the engine injection system return connection to the day tank (near the top). Provide a day tank overflow line to supply tank in case the float switch fails to shut off the fuel transfer pump.

WARNING:

Failure to provide an overflow line to the supply tank from the day tank can cause spilled fuel, safety hazards, and damage to equipment.

Supply Tank Higher than Engine Installation

If a supply tank is higher than the engine, the day tank is installed near the generator set, but below the fuel injection system. Fuel lines should at least be as large as the fuel pump inlet. The engine fuel return line must enter the day tank. Include a shutoff valve in the fuel line between the fuel supply tank and the day tank to stop fuel flow when the generator set is off.

Supply Tank

Locate the supply fuel tank as close as possible to the generator set and within the five (5') foot (1.5 m) lift capacity of the engine fuel pump. Install a fuel tank that has sufficient capacity to keep the genset operating continuously at full load for at least 36 hours. Refer to the generator set manual for detailed fuel consumption data.

WARNING:

Fuel leaks create fire and explosion hazards which can result in severe personal injury or death. Always use flexible tubing between engine and fuel supply to avoid line failure and leaks due to vibration. The fuel system must meet applicable codes.

If the main fuel tank is installed below the lift capabilities of the standard engine fuel pump, a transfer tank (referred to as a day tank) and auxiliary pump will also be required.
If an overhead main fuel tank is installed, a transfer tank and float valve will be required to prevent fuel head pressures from being placed on the fuel system components.

For critical start applications, where generator sets are paralleled or must satisfy emergency start-time requirements, it is recommended that a fuel tank or reservoir be located such that the lowest possible fuel level is not less than six (6") inches (150 mm) above the fuel pump inlet. This will prevent air from accumulating in the fuel line while the set is in standby, eliminating the period during start-up when it has to be purged.

Day Tank (if used)

Fuel day tanks are used when the standard engine fuel pump does not have the capacity to draw the fuel from the supply tank; or the supply tank is overhead and presents problems of high fuel head pressure for the system.

Engine fuel Connections

Identification tags are attached to the fuel supply line and fuel return line connections by the factory. Flexible lines for connecting between the engine and stationary fuel line are supplied as standard equipment.

WARNING:

Fuel leaks and spills can cause environmental contamination. Make sure the area surrounding the fuel tanks and lines will prevent fuel from entering soil, sewers, and water.

3.5 Cooling System

Cooling System Checklist

A. Has noise been considered?
B. Has system piping been properly sized?
C. Has system been properly protected from freeze up and corrosion?
D. Have standby equipment heaters been specified?
E. Have all electrically driven devices been connected to load side of EPS connection points?
F. Have system drain valves and air eliminators been installed?
The system consists of the cooling medium which is generally a solution of water and ethylene glycol, a method of rejecting engine produced heat, and a means to transport cooling medium between the engine and heat rejection system. The first determination is the type of cooling system to use − radiator cooling or heat exchanger cooling.

Radiator Set Requirements

Radiator set cooling air is drawn past the rear of the set by a pusher fan that blows air through the radiator (See Figure XX next page). Locate the air inlet to the rear of the genset. Make the inlet vent opening 1-1/2 to 2 times larger than the radiator area to ensure proper cooling.

Locate the cooling air outlet (as close as possible) directly in front of the radiator. The outlet opening must be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow.

The radiator has an air discharge duct adapter flange. Attach a canvas or sheet metal duct to the flange and the air outlet opening using screws and nuts so duct can be removed for maintenance purposes. The duct prevents circulation of heated air. Before installing the duct, remove the radiator core guard.

Engine Mounted Radiator Cooling

The most simple is the engine mounted radiator shown in Figure 2-5. The radiator, water circulating pump, fan and fan drive are mounted to the Generator Set base rails by the factory. This method of engine cooling is the most economical, but may require large ventilation vents and ducts. An added advantage of this arrangement is that the cooling air removes radiated heat from the engine, generator, and other equipment located in the emergency power system room.
The only remaining design work with the engine mounted radiator is arranging a method of providing air to the room, and exhausting it from the radiator. (See Figure XX Duct air installation below).

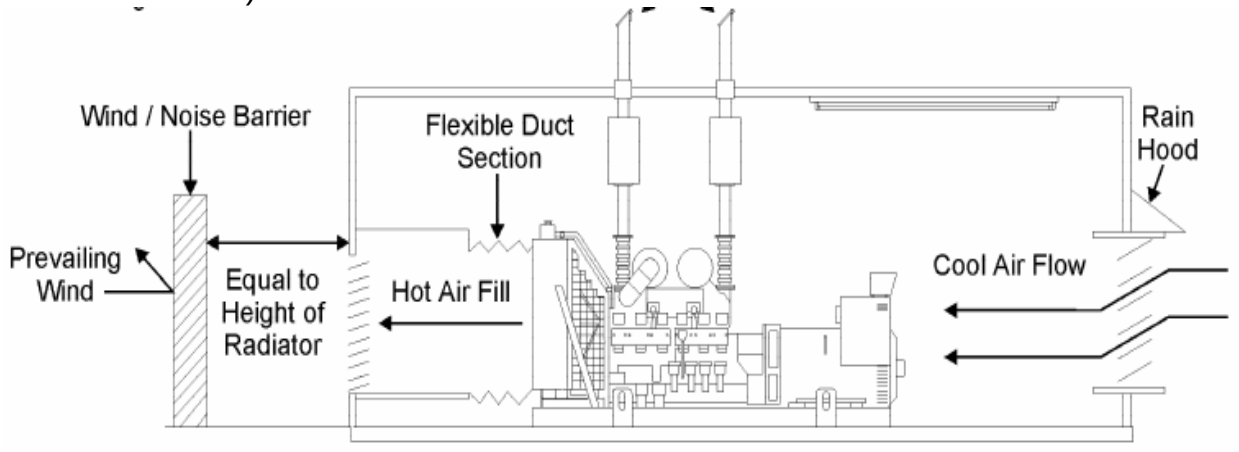


Figure XX. Mounted Radiator Installation

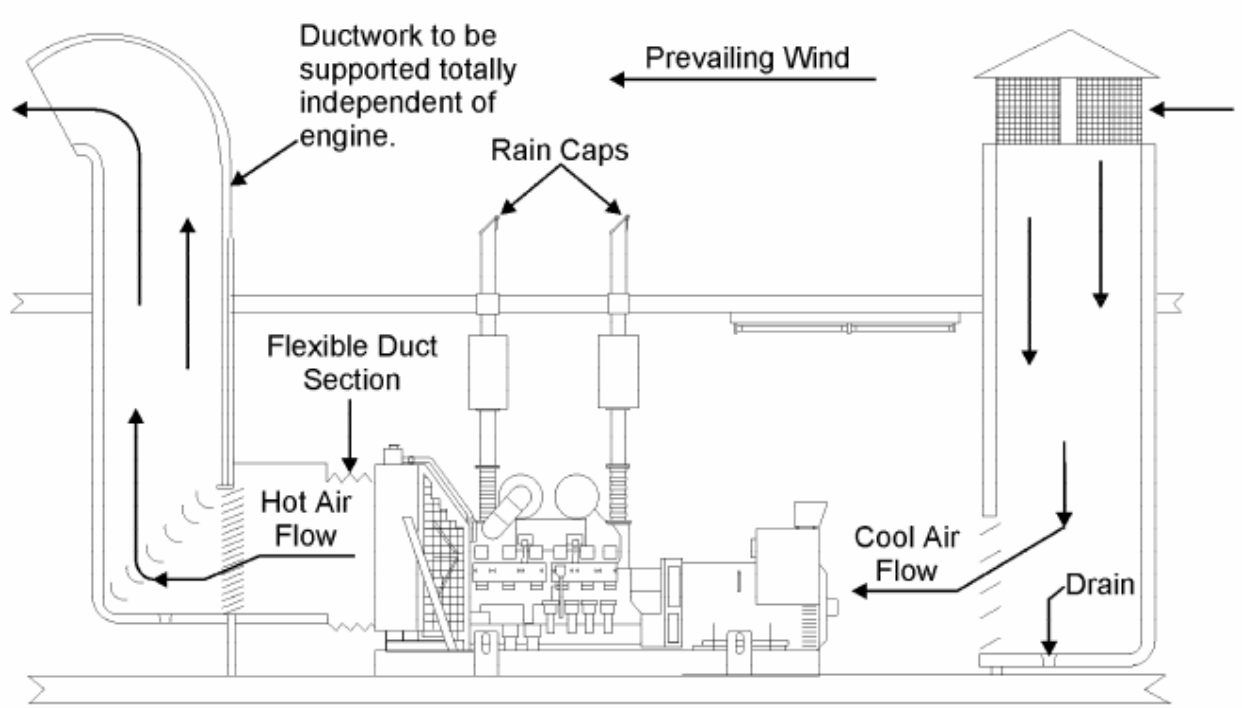
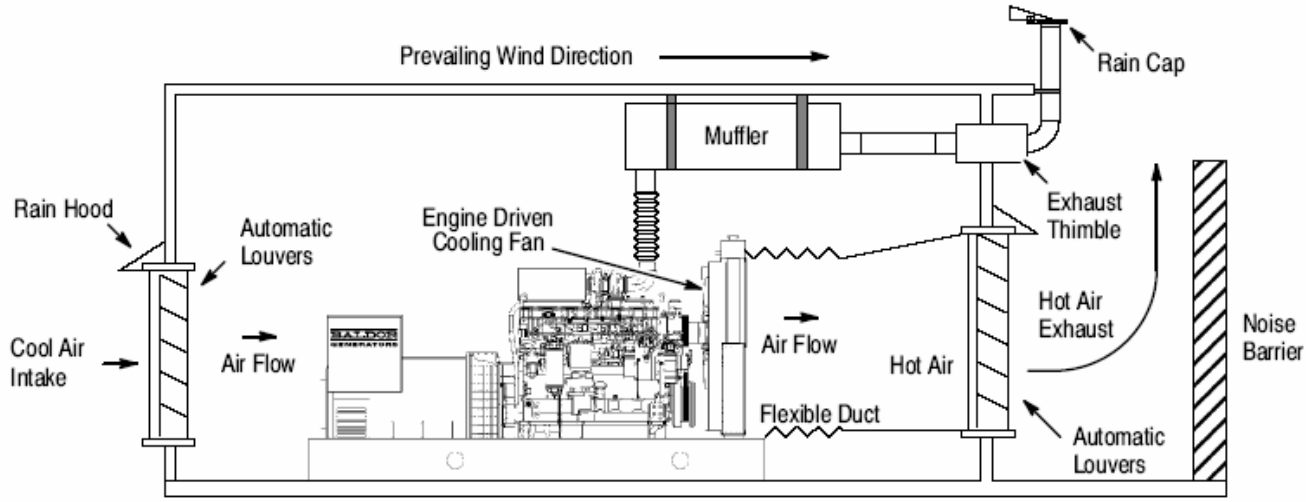


Figure XX. Duct Air Installation

Engine Mounted Radiator Cooling (With Wind/Noise Barrier)



Engine Mounted Radiator Cooled System With Wind/Noise Barrier

The ideal setup for cooling air would be to arrange the inlet or inlets such that relatively clean, cool, dry air is drawn across the electrical switchgear, generator, and engine. The air is then drawn into the radiator fan, and is blown through the radiator and exhausted by duct work outside the building. Air inlets must be sized to minimize air restriction and provide the quantity of air required by the radiator fan, engine combustion air, and any other air exhausts which might be used in the room. On engine mounted radiator cooled systems, the engine mounted fan will handle 0.25 of water column. This is combined intake and exhaust restriction.

The room air intakes must be located so as to minimize drawing exhaust fumes and other outside contaminants into the room. Be very cautious about the location of the engine exhausts in relation to room air intakes. Also, when locating the inlet and outlet, the consultant should consider prevailing winds and noise. Motor operated louvers or properly designed and sized gravity louvers should be used on the air intake and exhaust to minimize static pressure drop.

CAUTION! In cold climates, the high volume of outside air drawn into the Genset room can quickly reduce temperatures in the room to freezing. Any water piping or other equipment susceptible to freeze damage should be properly insulated or located elsewhere.

Remote Mounted Radiator Cooling (optional)

The radiator can be mounted remotely (not mounted directly at the engine). The remote/close system uses the same radiator type except it is mounted in another room or outside the building,
but within close proximity to the Genset (See Figure XX Remote Radiator Cooled Installation).
The remote radiator may be mounted either vertically or horizontally. In general, the radiator will have an electric fan to provide cooling air and may be able to utilize the engine mounted coolant pump to provide coolant flow.

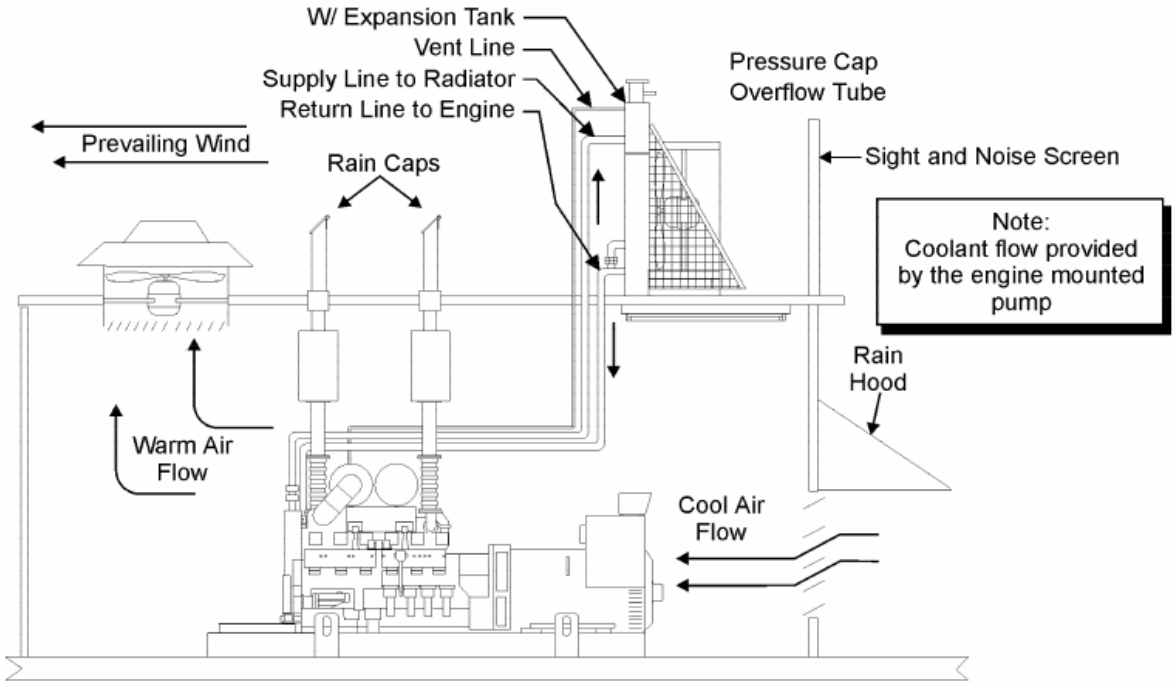


Figure XX. Remote Radiator Installation

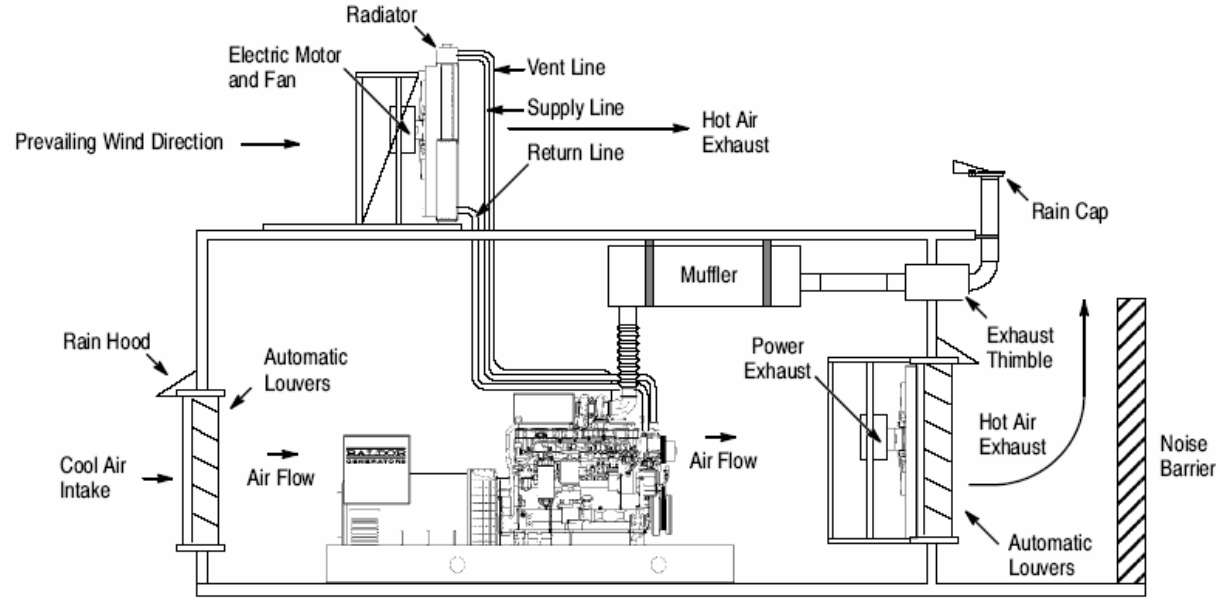


Figure XX Remote Radiator Cooled System Installation

The piping system friction and head loss between engine and radiator must be calculated and not exceed the capacity of the engine pump. If the maximum coolant friction head loss external to the engine is exceeded, a hot well system must be used. Before designing the piping system using an auxiliary pump and hot well, the consultant should look very closely at increasing the systems pipe size.

Electric motorized Power Exhaust louvers should be connected to the standby Genset and controlled to open whenever the Genset is running. Operable outlet louvers should be temperature actuated on remote radiator or heat exchanger cooled units. Louvers have resistance to air flow. Openings with louvers should be twice the area of an unobstructed opening to provide proper air flow. At times duct work is necessary to provide cooling air for the room.

Duct work must be sized and installed according to SMACNA Standards.
The electric fan and auxiliary pump, if used, must be connected to the emergency power system.

Radiator and cooling fan must be sized to provide the cooling capacity required at an acceptable sound level, driven fan. As a result, the consultant must provide a means of supplying air to the room, and exhausting it. The air movement must be provided by an electrically driven fan. This fan may be located in the air inlet or exhaust opening. If the fan is located on the exhaust side, care must be taken to not create a high negative pressure in the room and starve the engine of combustion air.

Heat Exchanger (optional)

The optional heat exchanger uses a shell and tube type heat exchanger instead of the standard radiator and fan (see Figure XX). Engine jacket and LTA coolant circulates through the shell side of the two heat exchangers while the cooling water is pumped through the tubes. Engine coolant and raw water do not mix. This type of cooling separation is necessary because raw water can contain scale forming lime or other impurities.

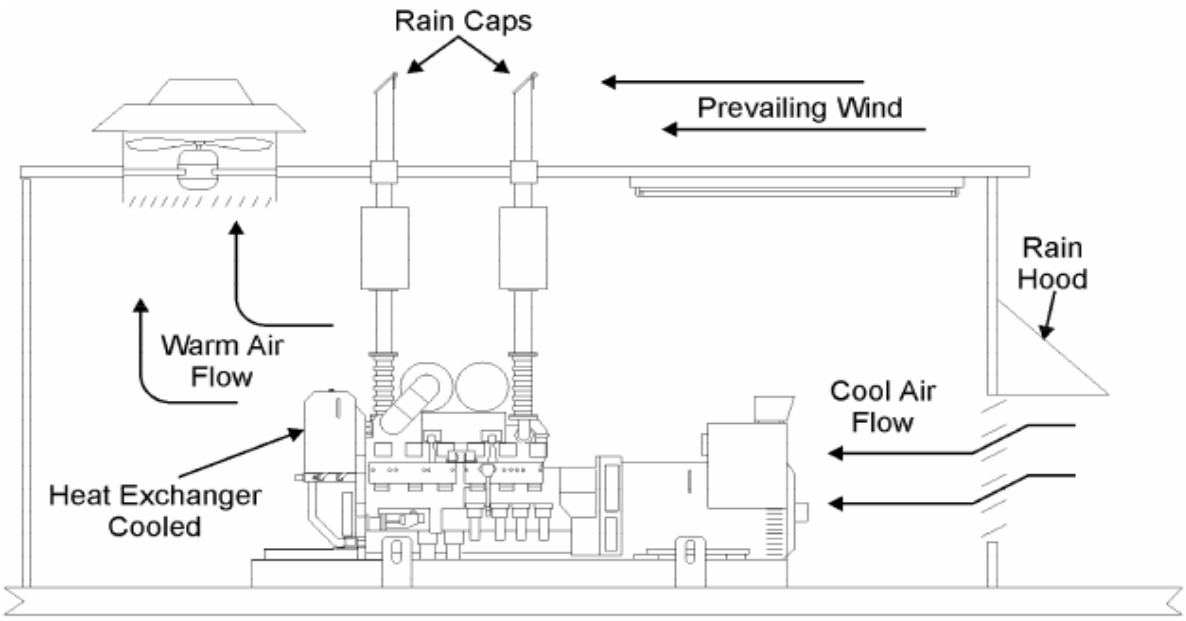


Figure XX. Heat Exchanger Installation

This system can reduce set enclosure airflow requirements and noise levels. Proper operation depends on a constant supply of raw water for heat removal. Adjust the flow to maintain the proper engine jacket water coolant temperature and the LTA coolant temperature. The engine coolant side of the system can be protected from freezing; the rqw water side cannot be protected.

The heat exchanger cooling system can be used with a cooling tower. These systems are complex, and consists of circulating pumps, heat exchanger for engine coolant, and cooling tower for heat rejection. The system design requires that several pieces of equipment be sized and installed. Overall, this system is more expensive than other methods of engine cooling.

Hot Well Installations

The following diagram shows a typical installation of a hot well cooling system.

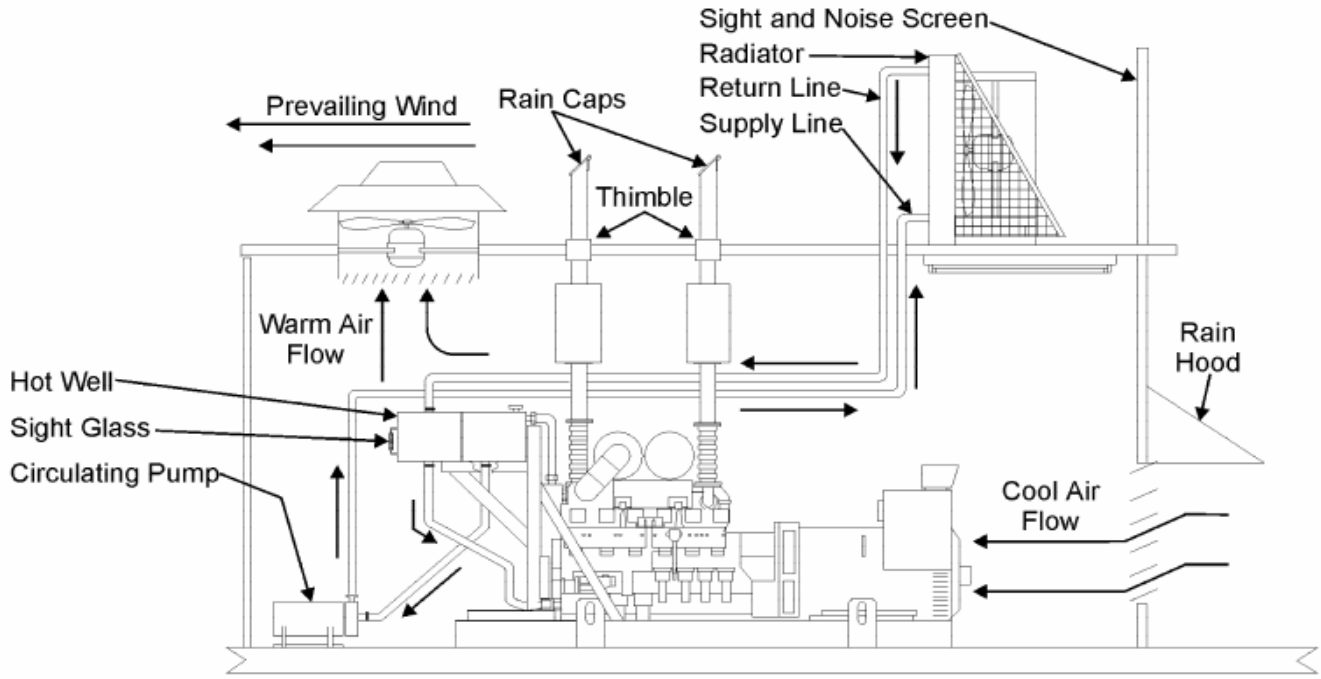


Figure XX. Hot Well Installation

One final consideration on the water side is the Maximum Static Head. This is the maximum height allowable from the engine crank center line to the highest point in the coolant system. The maximum static head is specified on generator specification sheets. If this number must be exceeded, a hot well tank system must be used.

The design of hot well tanks and piping systems is somewhat complex. Your authorized Powerlink Distributor has experience in the design and installation of hot well systems. Consult your Powerlink Distributor if the static head of the coolant system in your Genset application exceeds this criteria and requires a hot well system.

Cooling System Design

Remote Radiator Cooling

Remote Radiator Airflow generally assumed there will be no external restrictions to airflow. If this is not true, restriction must be considered in sizing and selection of a cooling fan and drive

motor. Typical examples of restrictions include landscaping, nearby buildings, air turbulence created by buildings or other structures, and sight or noise .screens.. See Figure Remote Radiator Fan Motor. Remote radiator cooling systems require the use of an electrically driven fan. This fan must be connected to the emergency power source. Size of the motor is determined by the fan size and fan speed.

1. To specify a radiator to cool the coolant you will need to determine the amount of heat rejected to the coolant. This is listed on the Engine Data Sheet as Heat Rejected to Coolant in BTU/min. for engines using dry or water cooled type exhaust manifolds, as applicable.

2. Determine the minimum water flow required at the engine, and the maximum top tank temperature. Using this information, determine the heat rejection capacity required of the radiator. Radiator systems should be sized with approximately 15% greater capacity than the engine's maximum full load heat rejection to allow for overload and cooling system deterioration. Whether water flow is produced by an engine mounted or auxiliary pump, total piping system friction loss must be calculated. To do this, Genset location, remote radiator location and friction loss within the radiator, and piping system must be estimated.

3. Pressure drop through the radiator must be obtained from radiator manufacturer.

4. If total piping system pressure exceeds the allowable Maximum Coolant Friction Head External to the engine as listed on the Engine Data Sheet, the coolant piping size should be increased and/or a radiator with less restriction must be used.

5. Pressure drop in pipelines and friction of water tables may be found in most mechanical handbooks such as. Cummins Engine Data handbook.

Other Considerations

1. Deaeration of the coolant. This can be accomplished through the use of the system deaerators in very large systems, or simply ensuring the radiator top tank or surge tank is at the highest point in the piping system. Unvented piping systems can create air pockets which reduce coolant flow and can lead to engine overheating. Powerlink furnished radiators are equipped with deaerating top tanks.

2. Flexible hoses must be installed at all engine connections and to the radiator to isolate vibration and allow for thermal expansion.

3. Drain valves must be installed at the lowest point of the cooling system to facilitate system cleaning and flushing.

4. Water treatment and antifreeze must be added to system coolant. Powerlink recommends 50/50 ethylene glycol and coolant treatment for all engines.
5. Thermostatically controlled engine coolant heaters are optional to be installed on all standby Gensets. These will increase starting reliability under cold conditions, and improve the start−up load handling ability.

6. According the NFPA 110, priority level 1 equipment jacket water heaters shall maintain coolant at a minimum of 90 °F (32 °C). In outdoor installations where temperatures will be

expected to drop below 32 °F (0 °C), a battery heater should be employed to keep the batteries at a minimum of 50 °F (10 °C), and will shut off at 90 °F (32 °C). All heaters will shut off when the engine is operating. Adequate antifreeze protection will be provided and ether starting aids will not be permitted.

7. The consultant should also consider oil sump heaters if conditions warrant.

3.6 Ventilation System

Sufficient ventilation is essential for all generating sets. Air inlet and outlet systems should be positioned to provide a direct cooling flow past both the engine and alternator. A generous flow of fresh inlet air as cool as possible must be provided for by vents, ducts or windows at low level.

Outlet systems should normally be adjacent to the engine end of the set and inline with the radiator fitted. These should preferably be close and a canvas plenum connecting to the outlet is ideal.

Any inlet or outlet ducts should be protected with mesh or louvers and allowance for any obstruction by these should be made. Outlets should be at least as the radiator cross sections. Inlet ducts should preferably be 50% larger than outlets.

Ventilation and Cooling

Generator Sets create considerable heat that must be removed by proper ventilation. Outdoor installations rely on natural air circulation but indoor installations need properly sized and positioned vents for adequate air flow.

Vents and Ducts

For indoor installations, locate vents so incoming air passes through the immediate area of the installation before exhausting. Install the air outlet higher than the air inlet to allow for convection air movement. Size the vents and ducts so they are large enough to allow the required flow rate of air. The "free area" of ducts must be as large as the exposed area of the radiator.

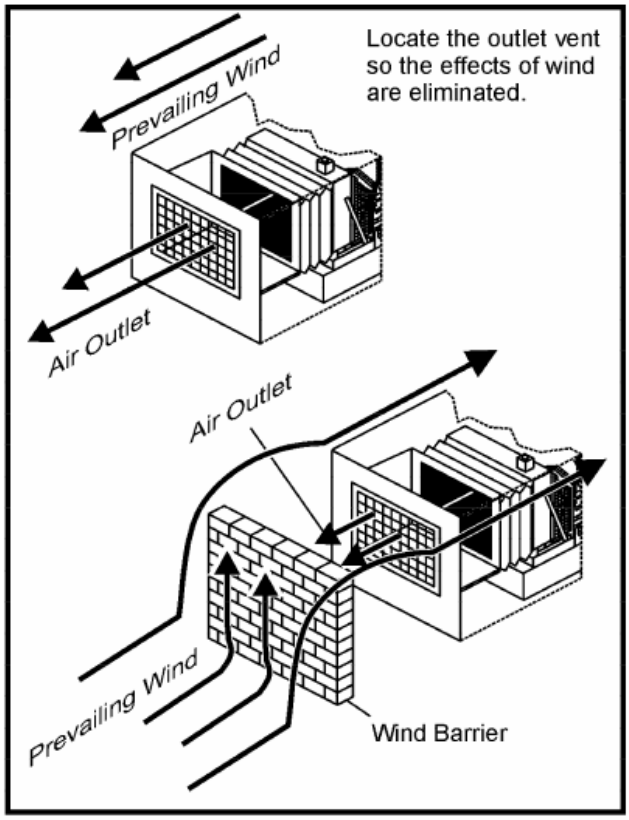


Figure XX. Wind Barrier

Wind will restrict free airflow if it blows directly into the air outlet vent. Locate the outlet vent so the effects of wind are eliminated (See Figure XX wind barrier and see Figure XX wind barrier installation).

For outdoor installations, weather and silenced housings are available for the generator.

Louvers

Louvers are automatic ventilation doors that open when the engine engages and close while not in use. Louvers protect the genset and equipment room from the outside environment. Their operation of opening and closing should be controlled by operation of the genset. In cooler climates movable or discharge louvers are used.

These louvers allow the air to be recirculated back to the equipment room. This enables the equipment room to be heated while the genset engine is still cold, increasing the engine efficiency.

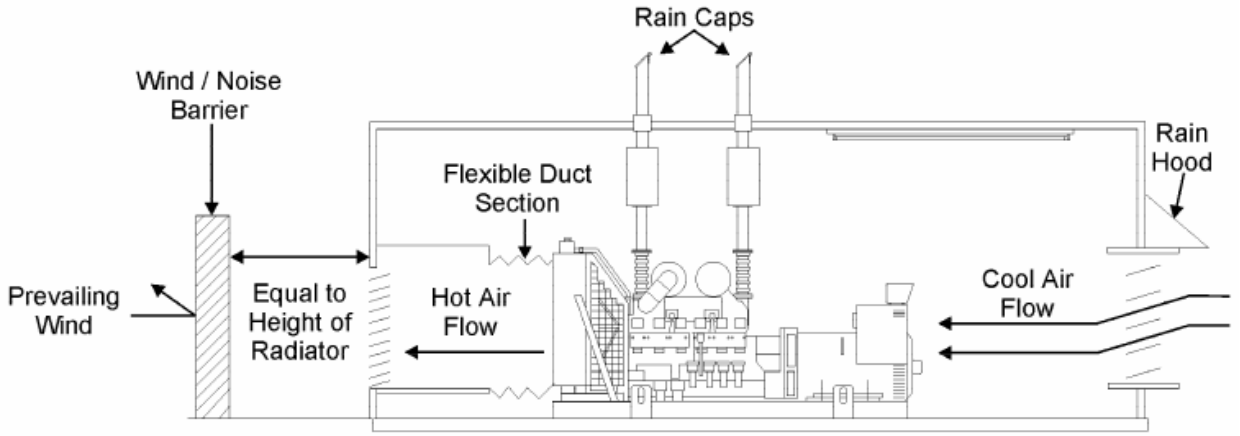


Figure XX. Wind Barrier Installation

Air System Checklist

A. Air inlet faces the direction of prevailing winds.
B. Air outlet does not face noise sensitive areas without noise attenuating devices.
C. All heat loads have been taken into consideration in sizing air flow.
D. Gravity louvers face inward for air intake and outward for discharge.
E. Where electrically operated ventilation devices are used, power must be present under all operating situations. Be certain these devices are on the emergency circuit.

The room in which the Generator Set is to be installed must have adequate air flow through it to provide combustion air, and remove heat radiated from the engine, exhaust system and generator. See Figure next page for air flow calculations.

BTU/minute $V\ (cfm) = \frac{Q_M}{0.0181 \times \Delta T_{F°}}$ Kilowatt•Hours $V\ (m^3/min) = \frac{kW \cdot hr}{0.02015 \times \Delta T_{C°}}$

BTU/Hour $V\ (cfm) = \frac{Q_H}{1.085 \times \Delta T_{F°}}$

Where:
V = Ventialting air flow ft^3/min (m^3/min)
Q_M = Heat disipated by the engine, generator and other equipment BTU/min
Q_H = Heat disipated by the engine, generator and other equipment BTU/hr
kW•h = Heat disipated by the engine, generator and other equipment Kilowatt Hours
ΔT = Premissible temperature rise in the room in °F or °C
D = Inside diameter of pipe in (mm)
S = Specific weight of gas lb/ft^3 (kg/m^3)

Notes:
1 These calculations assume room ambient of 100°F (38°C)
2 Increase V by 10% for each 2,500 ft (762m) above sea level
3 Increase V by 10% if uninsulated mufflers are inside room
4 Engine data sheet specifies .Radiated heat to ambient. In BTU/min. This value is dry type ad water cooled exhaust manifolds.
5. Generator efficiency is 88 to 95% for Gensets 50kW to 1200kW. 1kW loss = 56.88 BTU/min.

3.7 Soundproofing

The best quality / price ratio is achieved when soundproofing is part of the initial design of the room. On the other hand if soundproofing is added to an existing room, it will inevitably be more expansive and not as good. Two techniques should be used to soundproof the genset room.

Insulation

Its purpose is to prevent sound travelling through the walls by providing mass and adequate thickness.

Absorption

Sound energy is absorbed by specialist materials and reduces reverberation. For a soundproofed room the openings have to be larger and carefully designed to provide adequate ventilation without allowing excessive noise to pass through the openings. A properly designed soundproofed door is also needed.

General

- Building structure: cast concrete or concrete blocks, min. 20 cm thick.
- Anti-vibration mounts under the generating set, when installed close to sensitive areas.
- Walls and ceiling may be lined with absorbent materials such as rockwool.
- Selection of one or more suitable exhaust mufflers.
- When required soundproof doors should be fitted to reach the required sound level.
- Noise attenuators mounted in the air inlet and outlet openings. EXAMPLES: Measures to be taken.
- Basic noise level of genset : 105 to 11O dBA 1m.

Non sensitive areas

Generating set soundproofing by means of a canopy bringing the noise down to 85dBA at 1 m (useful for low and medium powered sets), or Room soundproofing: noise attenuator on air inlet, about lm long, soundproofed access door, 30dB exhaust muffler. Outside noise level : 75 dBA about 1m.

Noise sensitive areas (in town, close to houses)

Noise reduction depends on the distance between the noise source and the sensitive areas 6dB on average every time you double the distance: 1m (0); 2m (-3dB); 4m (-12dB); 8m (-18dB).

This calculation done, the following elements must be specified:

- From 60 to 70 dBA at about 1m
- Walls and ceiling made of 20 cm concrete blocks or cast concrete,
- Noise attenuators about 1.80 m long,
- High efficiency soundproof door,
- 40 and 19dB mufflers in series
- From 40 to 60dBA at about 1m

Noise attenuators (about 2.50 m) with baffles in ventilation shafts if possible.
- Inside walls and ceiling lined with absorbent material.
- Soundproof door and airlock.
- Floating slab beneath the generating set (vibration).
- 40 and 30dB mufflers in series. Sometimes 40dB and 19dB

mufflers are sufficient. or generating set soundproofed by means of a canopy, in which case, the sound traps are smaller and the airlock unnecessary.
When lower noise levels are required a special study must be
carried out.

SOUND LEVEL REGULATIONS
Please refer to appropriate regulations in your area.

3.8 Transfer Switch

Transfer Switch Transfer Switch Checklist

A. Locate transfer switch in a clean, dry place, near the emergency load. B. Provide a circuit breaker between the Genset and the transfer switch. C. Put a flexible connection between the conduit and Genset. D. Observe applicable codes in wiring−in the transfer switch and Genset. The transfer switch connects the Genset to the emergency power system. The emergency power system may include several Gensets and several transfer switches. Typically, the Genset is wired to the emergency power system through a transfer switch as shown in Figure xx Typical Emergency Power System Installations.

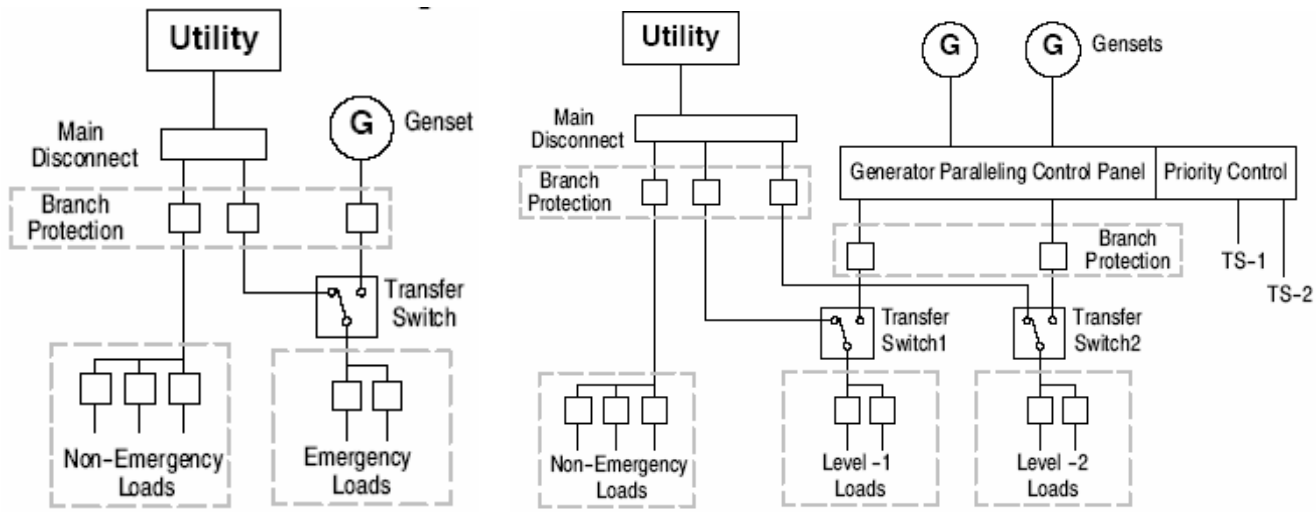


Figure xx Typical Emergency Power System Installations

Multiple Gensets can be arranged either in parallel or separately connected to dedicated emergency loads. Figure xx Typical Emergency Power System Installations also shows a typical arrangement of two Gensets in parallel with transfer switches for loads that have different levels of priority. A typical multiple Genset installation is shown for NFPA 110 Level 1 and Level 2 emergency power circuits and a priority control to select the appropriate transfer switch. Wattmeters should be installed on each Genset so load sharing can be checked. The control system should include an automatic paralleling control. Paralleling identical Gensets is not difficult, but paralleling dissimilar sets can cause load sharing problems. When designing an installation that includes the paralleling of dissimilar generators, contract your nearby Powerlink Distributor.

Transfer Switch Location

The transfer switch location is important and key considerations are:

1. Locate the transfer switch as close to the emergency load as practical to avoid interruptions of the emergency power system due to natural or man−made disasters, or to equipment failures. Consider several small transfer switches instead of one large one to increase reliability.
2. Locate the transfer switch in a clean, dry, well ventilated location, away from excessive heat. When the ambient air is above 104 °F (40 °C), fuses and circuit breakers must be derated. Allow adequate working space around the transfer switch.
3. A circuit breaker (or fuses) should be installed in the line between the generator and the transfer switch. Baldor Gensets are available with properly sized circuit breaker built into the generator control. The circuit breaker can be separately mounted. In the case of very large circuit breakers, a separate floor mounted circuit breaker is easier to wire up than a wall mounted breaker.
4. Install power and control wires in separate solid conduit with flexible sections at the Genset. The flexible sections prevent vibration from damaging the conduit. All power conduits from the Genset must contain all three phases.
5. Never install control wires in the same conduit as power conductors.
6. Conduit, wire, circuit protective device sizes, insulation etc. must conform to applicable local and national codes and regulations.
7. Be certain to seal around conduits that penetrate the walls of the Genset room to reduce the amount of noise that is transmitted to the surrounding areas of the building and maintain site fire code rating.

3.9 Battery Starting System

This section describes the battery starting system (nominal 12 volt rating of the battery supply) for the engine, battery charger, and precautions to take if the ambient temperature is expected to be below 70 °F (20°C).

WARNING:

If batteries are not mounted in the battery rack supplied with the Genset, protect batteries from vibration and do not locate them near a source of flame or spark. A battery presents a risk of fire and explosion because they generate hydrogen gas. Hydrogen gas is extremely explosive. Never jump start a battery, smoke in the area around the battery or cause any spark to occur in the area around the battery.

Battery Location

Locate batteries as close as possible to the Genset to minimize starting circuit resistance, see Figure xx Battery Starting System right. High starting circuit resistance substantially reduces starting cranking ability. The Genset data sheet lists the maximum allowable cranking system resistance. Mount batteries on a level rack away from dirt and liquids. Allow space for servicing (checking water level and level of charge). Powerlink Gensets can be ordered with battery racks already installed. Cold ambient temperature at the battery location substantially reduces the battery output.

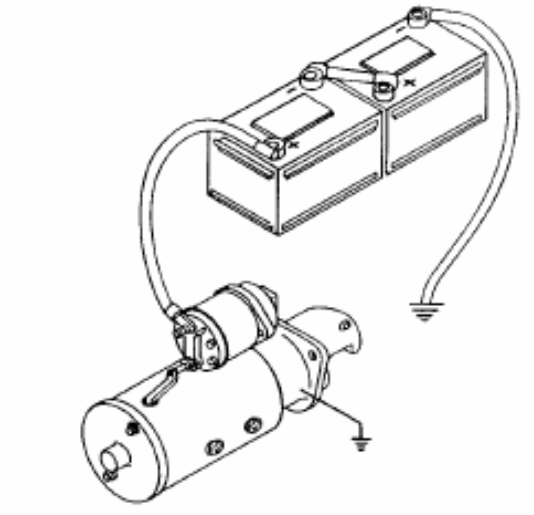


Figure xx Battery Starting System

Battery Size

The ability to start the engine depends upon battery capacity, ambient temperature and coolant and oil temperatures. The Engine/Generator Set Data Sheet lists minimum recommended battery capacity at various ambient temperatures. The recommended battery capacities are listed in the Electric Systems section of the Engine Data Sheet, cold cranking amps (CCA) at 0 °F (−18 °C).

Battery capacities decrease as ambient temperatures decrease so it is important to specify batteries with the appropriate CCA rating at a temperature no higher than the minimum ambient temperature for the application. Powerlink requires thermostatically controlled coolant heaters on all after cooled standby Gensets. After cooling is called out on the Engine Data Sheet under General Engine. Data section as “aspiration”. Oil pan immersion heaters are recommended for standby Gensets housed outside where ambient temperatures may drop below 0 °F (−18 °C). Coolant heaters and oil pan immersion heaters are available from Powerlink as factory installed options.

Battery Charger

An engine mounted alternator to charge the batteries during operation is an available option. Standby Gensets require a solid state battery charger that is connected to utility power so the battery is charged continuously while the Genset is not running. The battery charger should be connected to the emergency circuit. The batteries on prime power Gensets are charged by the engine mounted alternator, if equipped.

Harmonic wave forms from solid state battery charges and belt driven alternators can cause the electronic governor on the engine to act erratically. To avoid this, the output of the battery charger or the belt driven alternator must be connected directly to the battery or to the battery terminals on the starter. Make control connections to the Genset control using a conduit with a flexible section at the Genset to avoid damage due to Genset vibrations.

Battery Cables

The wire size (wire gauge) of the cables connecting the starter to the batteries must be large enough to ensure the resistance of the cranking circuit is less than the “Maximum Allowable

Resistance of the Cranking Circuit" as shown on the Engine−Generator Set Data Sheet. The total cranking circuit resistance includes the resistance of the cables from the starting motor to the battery and the resistance of all relays, solenoids, switches, and connections. The resistance of various sizes of cables is shown in Figure xx Typical Battery Cable Calculations (next page). For purposes of calculating cranking circuit resistance to select cable size, the resistance of each connection can be taken as 00001 ohms and the resistance of each relay, solenoid, and switch can be taken as 0002 ohms. Figure 2-10 illustrates an example of a typical cranking circuit resistance calculation.

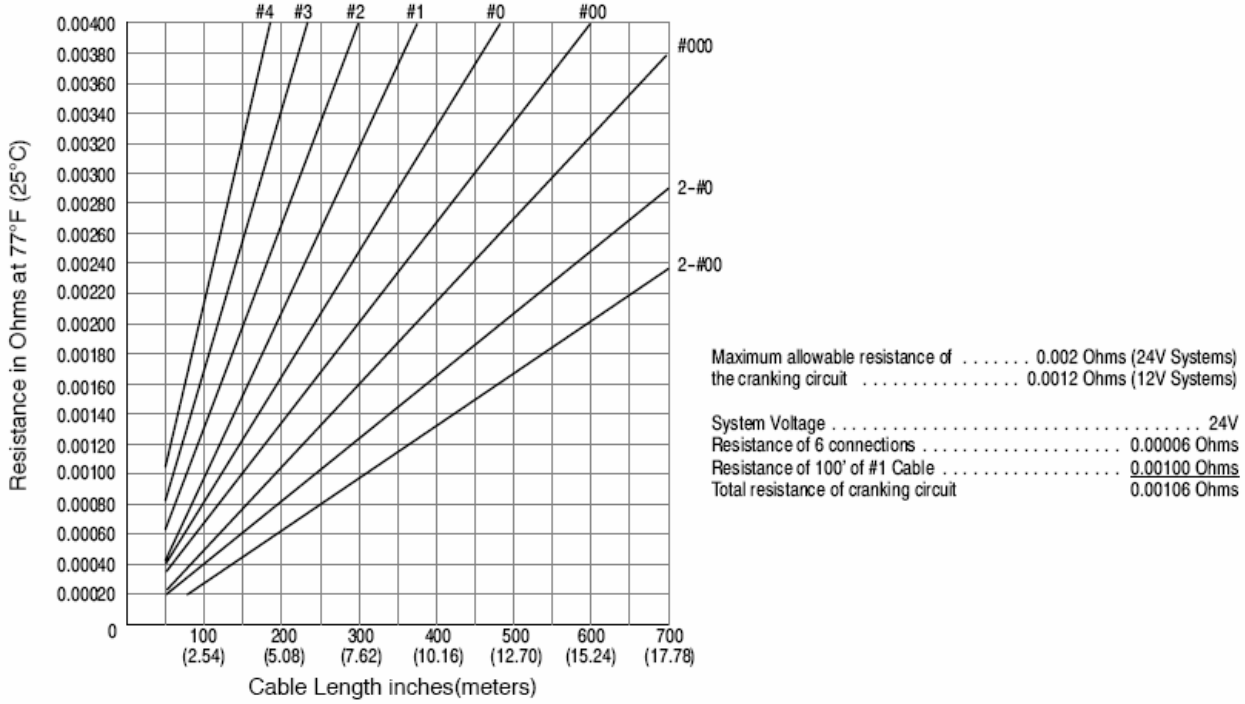


Figure xx Typical Battery Cable Calculations

3.10 STARTING

Starting an engine is easy when it succeeds, but may cause untold problems when unsuccessful. The operation of highly complex equipment may depend on the reliability of the genset particularly in applications such as hospitals, factory processes and building protection systems.

That is why there are many starting processes and devices on a generating set to ensure reliable starting every time. We make a distinction between a manual start procedure and an emergency start procedure, which is triggered by the failure of the mains supply (generally in automatic mode three 5 second cranks are provided).

The starting system design depends on the engine temperature. For a start in very cold temperatures it is sometimes necessary to use starting aids, such as heating the intake air, heating the fuel, injecting ether into the air intake. As well as these the engine coolant is heated, and in very cold conditions also the oil is kept warm.

Generating sets can be provided with three types of start systems
- Electric Starting : This is the most widely used system and consists of a 12V or 24V starter

motor supplied by one or more lead acid, or in exceptional cases, alkaline batteries.

The starter motor rotates the ring gear of the engine flywheel moving on receiving the signal from an electric contact.

Once the diesel engine has started and the flywheel has run up to its required speed, the starter motor pinion disengages automatically from the ring gear. The batteries are recharged automatically by an alternator or static charger.

- Pneumatic Starting : Pneumatic starting relies on an air starter that is operated by a flow of compressed air from one or two compressed air bottles and an air compresser. The engine is started in the same way as for electric starting.

The air bottles and air compresser are located as near as possible to the generating set.

- Mechanical Starting : Several mechanical starting system exist, i.e. spring, crank, inertia etc. All of these are only used with low power generating sets.

The three systems above can be coupled to each other in the following way:
- electric/ pneumatic starting
- electric/ mechanical starting.

- Generating Set Starting :

CHECK BEFORE START

Before generator start, please check following thing;

1. Generator normally consume 0.25%-1% of foil wastage lubricating oil.
2. check lubricating oil and coolant water capacity,

Warning

When putting foil into trunk, do not smoking nearby or using fire.

3. check oil capacity,
4. check engine cooling fan and rap degree of tightness,
5. check all ripe, ensure not leaking out,
6. check battery pole ,ensure no cauterization,

Warning

When packing up battery, do not smoking nearby or using fire, hydrogen which battery produce will blow up. Don't mistake battery pole,

7. Check battery liquid, if necessary, put into pure water. If battery is new , please add beforehand mixed b attery liquid
8. Check control panel and generators, please ensure aforesaid parts clean. These dust maybe damnous, etc, tip-and-run accident.
9. Check air cleaner, if emphraxis, please change a new.
10. Ensure surroundings of generators clean, coolant aeration unhindered.
11. Check fuel system ,coolant system and lubricating oil system ,
12. If exhaust system have exhaust water device, please letting termly.
13. Ensure alternator's output switch is off.

Formulas

Single Phase – Electric

Single Phase Power Factor is typically 1.0
1 kW = 1 kilo Watt = 1,000 Watts

$$\text{Watts} = \text{Volts} \times \text{Amps} \times \text{Power Factor}$$

$$\text{Amps} = \frac{\text{Watts}}{\text{Volts} \times \text{Power Factor}}$$

Three Phase – Electric

Three Phase Power Factor is typically 0.8
1 kW = 1 kilo Watt = 1,000 Watts

$$\text{Watts} = (\text{Volts} \times \text{Amps} \times \text{Power Factor}) \times 1.732$$

$$\text{Amps} = \frac{\text{Watts}}{\text{Volts} \times \text{Power Factor} \times 1.732}$$

Length	inches x 25.40 = mm feet x 0.305 = m yard x 0.914 = m	mm x 0.03937 = inches m x 3.280 = feet m x 1.094 = yard
Area	$inches^2$ x 6.451 = cm^2 $feet^2$ x 0.0929 = m^2	cm^2 x 0.394 = $inches^2$ m^2 x 10.764 = $feet^2$
Pressure	$pounds/ft^2$ x 0.006944 = $pounds/in^2$ psi x 6.8948 = kPa psi = 0.4912 inches Hg	$pounds/in^2$ x 144 = $pounds/ft^2$ kPa x 0.1450 = psi kPa = 0.1333 x inches Hg
Temperature	°C = (°F–32) x 0.55555	°F = (°C x 1.8) + 32
Torque	oz–in x 0.007062 = Nm lb–in x 0.11296 = Nm lb–ft x 1.356 = Nm	Nm x 141.6029 = oz–in Nm x 8.8495 = lb–in Nm x 0.7376 = lb–ft
Velocity	ft/sec x 0.3048 = m/sec miles/hr x 1.6093 = km/hr miles/hr x 0.44704 = m/sec	m/sec x 3.2808 = ft/sec km/hr x 0.6214 = miles/hr m/sec x 3.2808 = ft/sec m/sec x 2.2369 = miles/hr
Volume	$inches^3$ x 16.388 = mm^3 $feet^3$ x 0.0283 = m^3 gallons x 3.785 = liter gallons x 0.13337 = ft^3	cm^3 x 0.06102 = $inches^3$ m^3 x 35.315 = $feet^3$ liter x 0.2642 = gallon
Miscellaneous	Watt x 0.00134 = hp BTU/hr x 0.293 = Watts BTU/hr x 0.0003929 = hp	Watts x 3.4122 = BTU/hr hp x 2545.177 = BTU/hr

SECTION 4 CONTROL PANEL INTRODUCTION

4.1 CONTROL PANEL INTRODUCTION

Control Panel For Special Genset

Model / Gensets	701k	plc5110	plc5220	plc5310	plc55x	plc55xx
cummins Range	○	•	○	×	○	×
Volvo Range	×	○	○	•	×	○
Perkins Range	•	○	○	×	○	×
John Deere Range	•	○	○	×	○	×

• Standard ○ Option × No

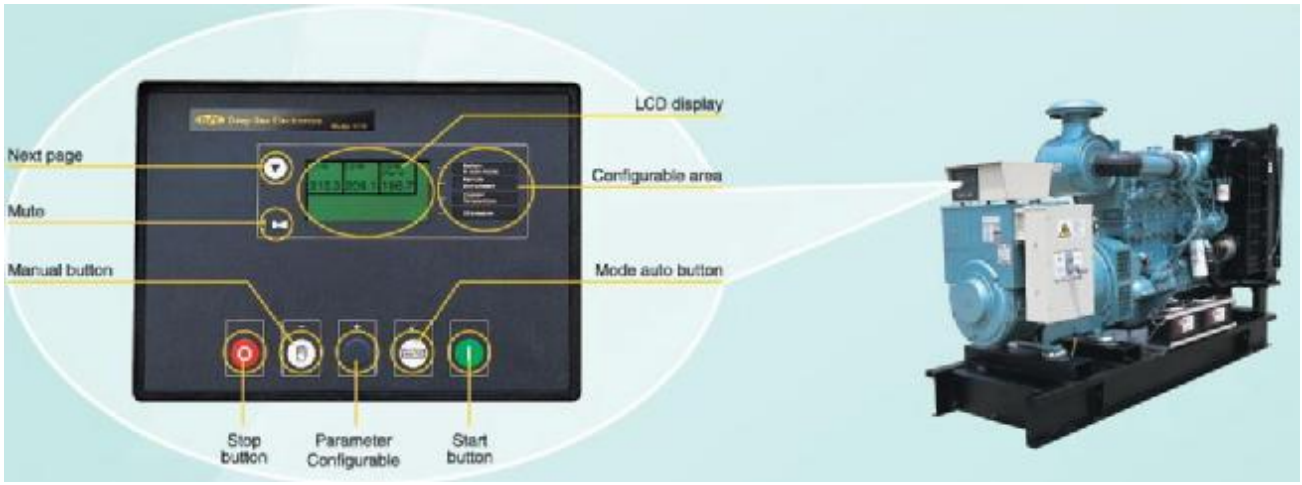
701 KEY MANUAL START SYSTEM

The Model 701 is a Manual Engine Control Module designed to control the engine via a key switch and pushbuttons on the front panel. The module is used to start and stop the engine and indicate fault conditions, automatically shutting down the engine and indicating the engine failure by LED, giving true, firstup fault annunciation.

PLC-5110 CONTROL SYSTEM

The PLC-5110 control system is used to automatically start and stop the generator via remote control signal, configurable three position includes manual, auto and stop position.

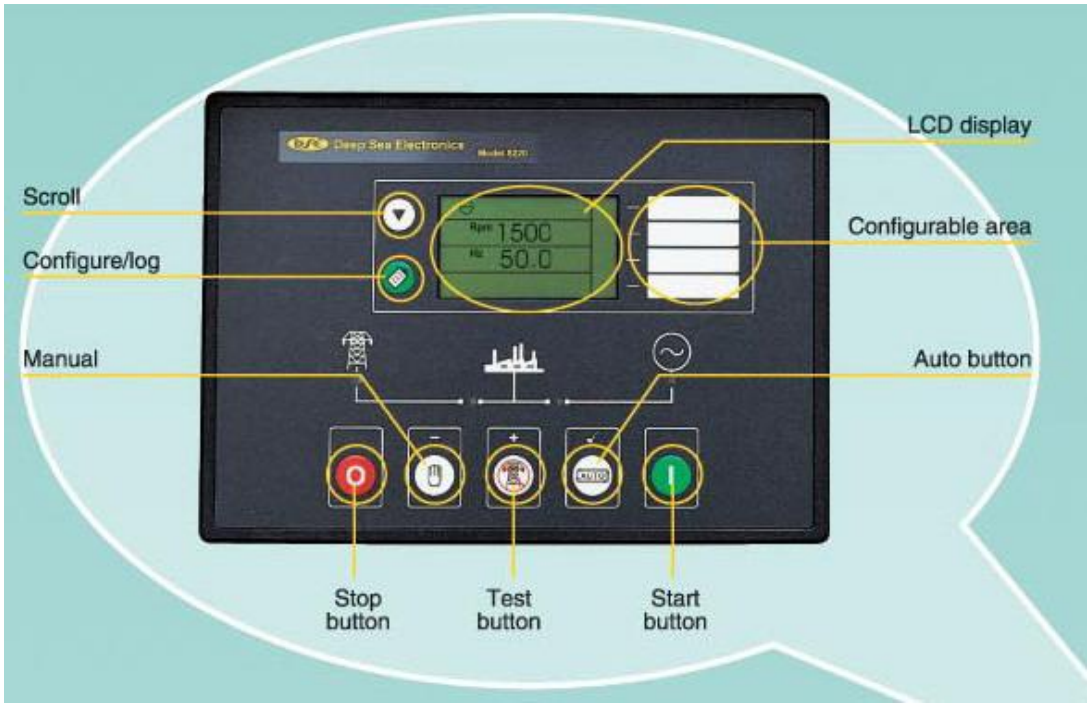
Stop: stop generator / failure
Manual: only green manual button to start generator
Auto /remote control: under working condition when it is energize, auto start generator if receiving remote control signal.



PIC-5220 Automatic Mains Failure Control System

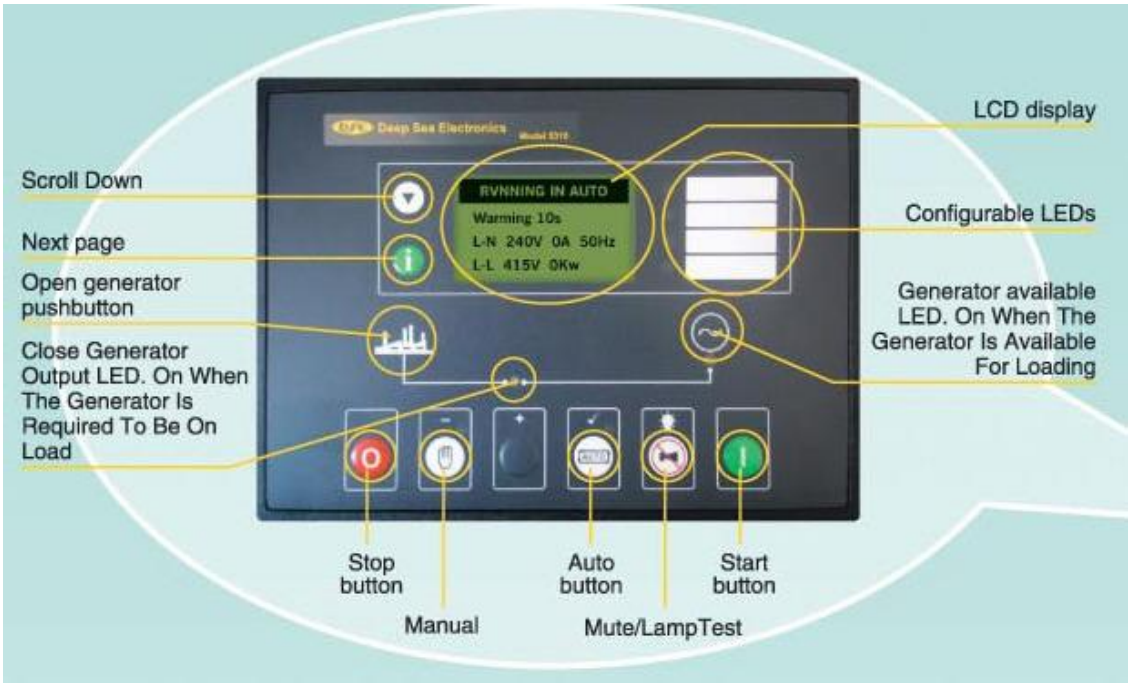
The PLC-5220 is an Automatic Mains Failure Control Module. It is used to monitor a mains supply and automatically start and stop the engine. It indicates the operational status and fault conditions, automatically shutting down the engine and indicating engine failure by means of an LCD display, and flashing LED on the front panel.

The PLC-5220 mold can monitor city-electricity function. When the city-electricity get high voltage/ low voltage or the high frequency/ low frequency, it can start automatically the generator, and can send signal to ATS, to cut or add the generator's load quickly.



PLC5310 ELECTRONIC ENGINE COMPATIBLE AUTO-START MODULE

The Model 5310 is an ***Autostart Control Module.*** The module is used to automatically start a generator set upon application of a remote signal or by manual control. The module also provides indication of operational status and fault conditions automatically shutting down the genset and indicating failures by means of an LCD display.



PLC-555 Automatic Mains Failure Control Module

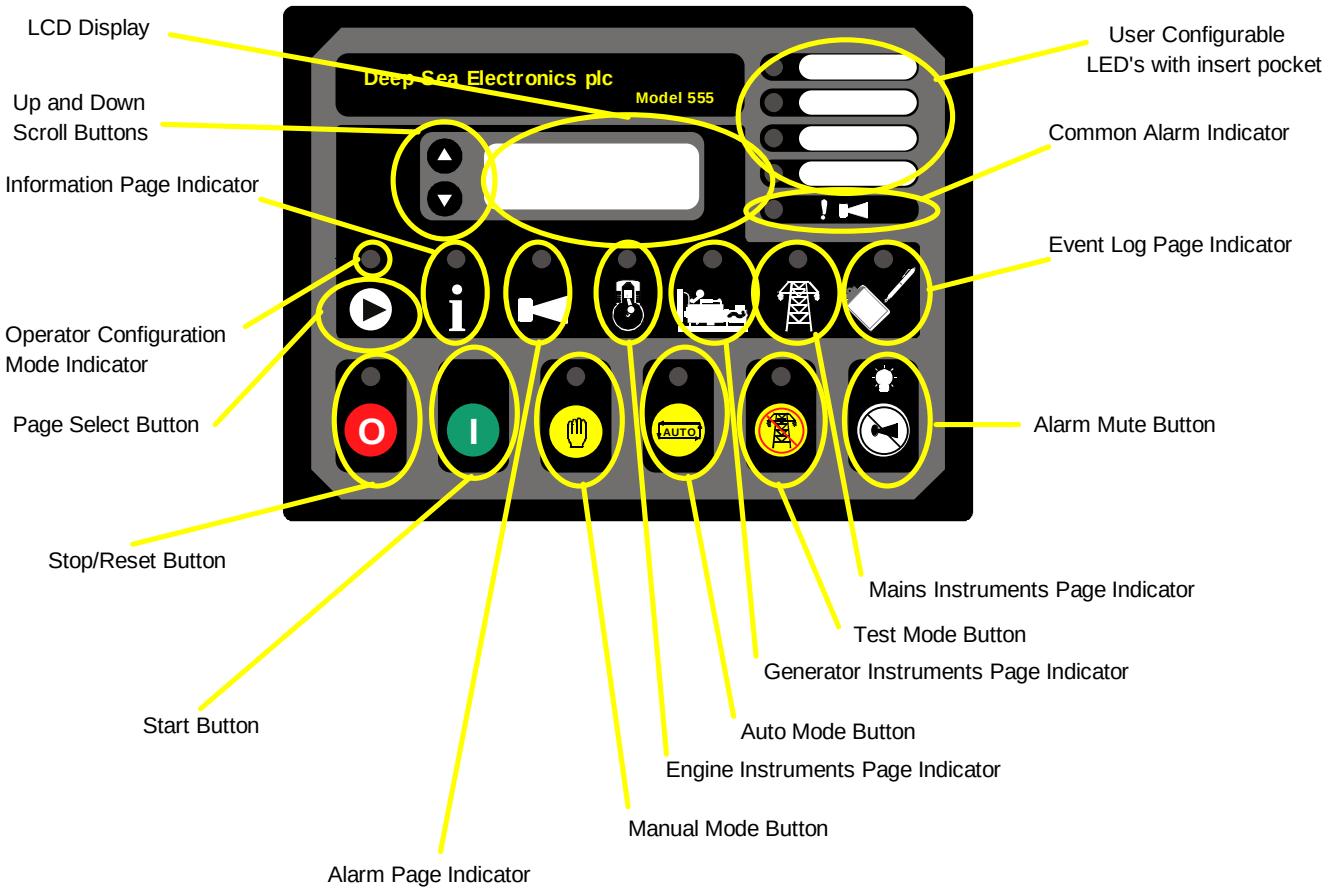
The module 555 is an Automatic Mains Failure Control Module, and the module is used to monitor a mains supply . It indicates

The DSE 555 module also 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.

PLC-555 control system link to PC via optional RS232 port or 485 port provides Modem via either PSTN line or GSM network, comprehensive remote communication via WINDOWS by LINK500 software .

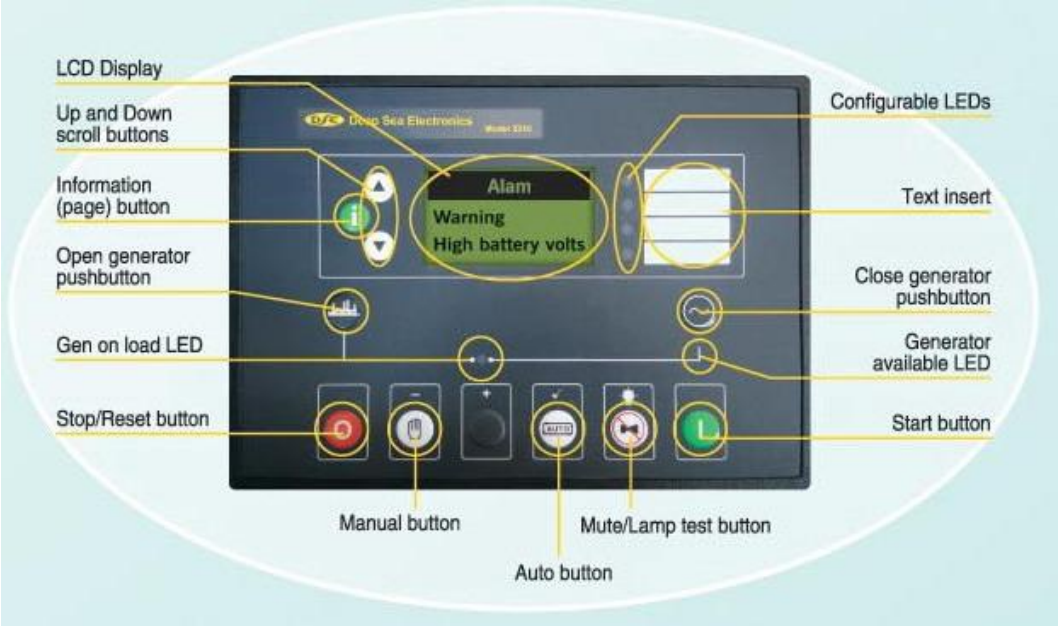
SPECIFICATIONS

The PLC-555 Automatic Mains Failure Control Module possesses all of the basic function, please refer to the table (cf. table page 16)



PLC-5510 Automatic Mains Failure Control Module

The Model 5510 is an Automatic Engine Control Module. The module is used to automatically start and stop the engine, indicating the operational status and fault conditions by means of an LCD display and a flashing LED on the front panel.



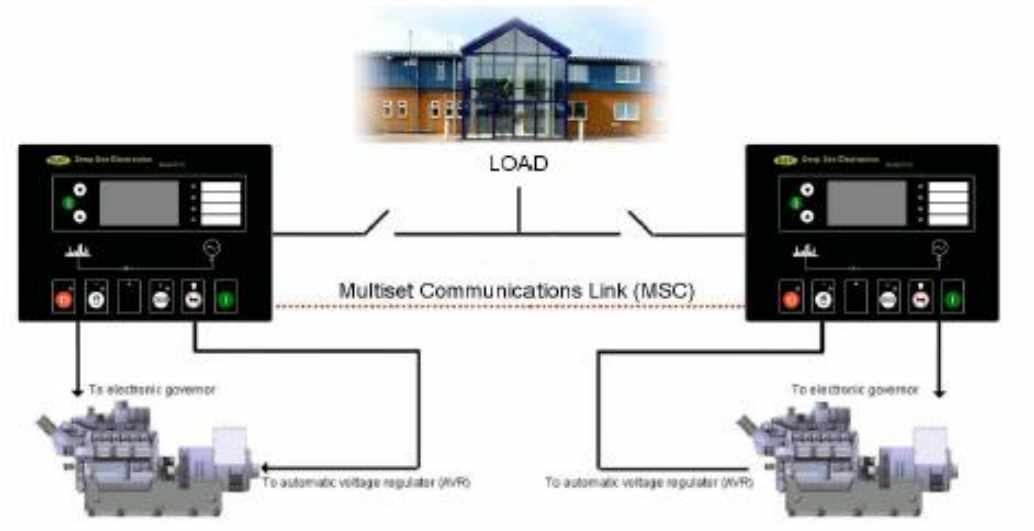
ADDITIONAL SPECIFICATIONS
SYNCHRONISING AND LOAD SHARING

Optionally, the PLC-550 and PLC-5510 controller can be configured to synchronise, volts match and parallel with the mains supply. This facility can be used to supply a fixed amount of power to the load and/or mains supply or share load with other 5510 or 550 enabled generator systems.

Synchroscope with auto sync control.
Volts and Frequency matching
Phase angle and Phase rotation indication.
Dead bus sensing
Multi-set load demand operation
KW and Kva load sharing with multiple generators.
Direct communication from the module to the governor and AVR.
KW export when in parallel with the mains supply.

INDICATION OF SYNCHRONISING AND LOAD SHARING

For Example as PLC-5510 Control Panel

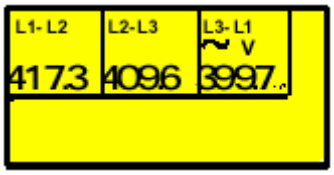
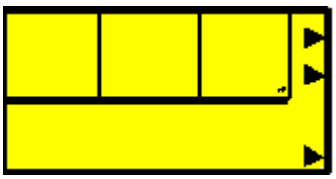
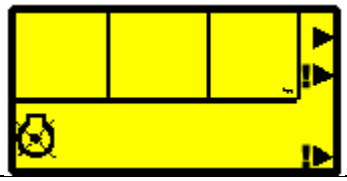


4.2 SPECIFICATION OF CONTROL PANELS

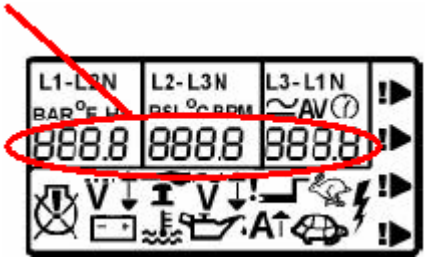
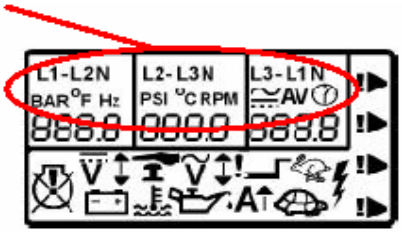
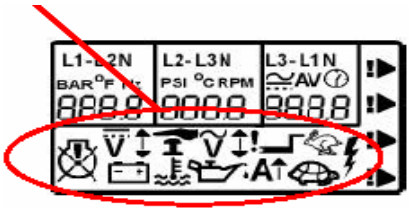
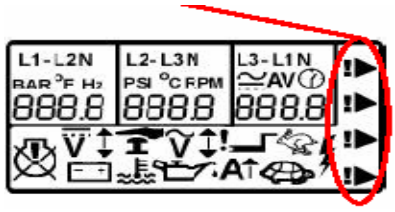
PLC MODEL		PLC701K	PLC5110	PLC5220	PLC5310	PLC550	PLC5510
measurements	current	●	●	●	●	●	●
	Frequency	●	●	●	●	●	●
	Wire voltage	●	●	●	●	●	●
	Phrase voltage	●	●	●	●	●	●
	Genset KVAr	×	×	●	×	●	●
	Genset KW	×	×	●	●	●	●
	Generator output capacity	×	×	●	●	●	●
	Output KWh	×	×	×	●	●	●
	Output KW	×	×	×	●	●	●
	KW factor	×	×	×	●	●	●
	Mains wire Volts	×	×	●	×	×	×
	Mains phrase Volts	×	×	●	×	×	×
	Mains frequency	×	×	●	×	×	×
Engine figure	Oil pressure	●	●	●	●	●	●
	Cooling fluid temperature	●	●	●	●	●	●
	Battery voltage	●	●	●	●	●	●
	Engine rotating speed	●	●	●	●	●	●
	Engine hours run	●	●	●	●	●	●
Monitor FUNCTION	Under / Over Mains Volts	×	×	●	×	×	×
	Under / Over Mains Frequency	×	×	●	×	×	×
	External Remote control start output (load / un-load)	×	×	●	●	●	●
	Configurable relay outputs	×	●	●	●	●	●
	Synchronization auto / synchronization output	×	×	×	×	●	●
	All function telecom remote control	×	×	●	●	●	●
	Engine instrumentation monitor	×	●	●	●	●	●
	Alternator instrumentation monitor	×	×	●	●	●	●
	Configurable input trip point by 9 users	×	●	●	●	●	●
	4 user output trip point	×	●	●	●	●	●
	Control LCD brightness in low brightness environment	×	●	●	●	●	●
	PIN password	×	×	●	●	●	●
	RS232/485 Interface	×	×	●	●	●	●
	All function control button on panel – including user adjustable language	×	×	●	●	●	●
	Multi-language function	×	×	●	●	●	●
Warning/Shutdown	Alternator Under / Over Volts	×	×	●	●	●	●
	Alternator Under / Over Frequency	×	×	●	●	●	●
	Under / Over Speed	●	●	●	●	●	●
	Low Oil Pressure	●	●	●	●	●	●
	High Engine Temp	●	●	●	●	●	●
	High/Low Battery Volts	●	●	●	●	●	●
	Over-current	●	●	●	●	●	●
	Electrical Trip	●	●	●	●	●	●
	Reverse Power Electrical Trip	×	×	×	×	●	●
	Phase Sequence Electrical Trip	×	×	×	×	●	●
	Earth Fault Shutdown	×	×	×	×	●	●
	Adjustable start periodic/times	×	●	●	●	●	●
	Periodic maintenance alarm	×	×	×	●	●	●

4.3 CONTROL PANEL INTRODUCTION
(FOR PLC 5110, 560, 5220, 5310SERIES)

TYPICAL LED/LCD DISPLAY *(FOR PLC 5110, 560, 5220 SERIES)*

LED SCREEN	INSTRUMENTS
	The LCD displays the various engine parameters such as **'ENGINE SPEED'**, **'OIL PRESSURE', 'HOURS RUN'**, etc Each instrument is displayed with the appropriate units of measure In this example, the values being displayed are Generator phase to phase AC voltages V
	**ALARM ICONS** The LCD also displays the exact nature of any alarm condition that may have occurred such as **LOW OIL PRESSURE** using appropriate icons. This allows very specific alarm conditions to be brought to the operators' attention. Refer to the 'Protections' section of this manual for details of the alarms.
	**USER DEFINED INDICATIONS** The LCD displays the user-defined indications when configured and active. The icons will illuminate and point to the appropriate text insert label. These indications can be used to indicate internal states (i.e. Engine Running, Safety On, etc).
	**USER DEFINED ALARMS** The LCD displays the user-defined alarms when configured and active. The icons will illuminate and point to the appropriate text insert label. These alarms can be used to indicate the operation of external alarms (i.e. 'Low Fuel Level', 'Low Coolant level' etc) or to indicate internal alarms (i.e. Fail to Stop, MPU fault, etc).

LCD DISPLAY AREAS

Instrument Values	Units of Measure& Display Information
	
Alarm Icons	**User Definable Alarms/Indicators**
	

NOTE: The Engine Hours Run counter will only display the accumulated hours to the nearest 12 Minutes (0.2Hr). The accumulated time will be recorded in HH:MM however.

CAUTION!: -If the DC supply to the module is interrupted the hours run counter will not remember any 'undisplayed' minutes accumulated since the last 12 Minute display update.i.e. 10 Hours 38 Minutes accumulated before DC supply is removed.(10.6 Hours displayed) would become 10 Hours 36Minutes on restoration of DC supply.(10.6 Hours still displayed).

This will only occur in the event of a total DC supply break and will NOT occur if the module is simply switched to the Stop/Reset position.

TYPICAL LED/LCD DISPLAY *(FOR PLC 5310 SERIES ONLY)*

TYPICAL STATUS DISPLAY

Waiting in auto	Indicates that the module is in Automatic. The unit will respond to an active remote start.
Starting remote Cranking attempt 1	Indicates that the module is in automatic and that a start sequence has been initiated, with an active remote start. The module is attempting to crank the generator.
Running in auto Generator on load L-N 230V 240A 50Hz L-L 400V 133kW	Indicates that the module is in Automatic, and that the generator is running on load. This default screen also indicates the average line to neutral voltage, highest of the 3 phase currents, generator frequency, average line to line voltage and total kilo Watts.

TYPICAL INSTRUMENT DISPLAY

Coolant temperature 60 ºC 140ºF	The display of coolant temperature in both degrees centigrade and Fahrenheit.
Oil pressure 6 Bar 87 PSI 600 kPa	The display of engine oil pressure in Bar, Pounds Per Square Inchand kilo Pascal.
Generator Amps L1 L2 L3 238 241 241	The display of all three generator line currents.

TYPICAL ALARM DISPLAY

Alarm Warning Low oil pressure	The module is warning that the engine oil pressure has fallen below a pre set level. The generator is not shutdown.
Alarm Shutdown Low oil pressure	The oil pressure has fallen below a second pre set value and has shutdown the generator.
Alarm Warning Low battery Volts	The module is warning that the battery volts is below a pre set value.

TYPICAL EVENT DISPLAY

Event log 21:15:00 10th September 2003 Low oil pressure Shutdown	On the 10th September 2003 at 21:15 the unit detected that the oil pressure was below the pre-set trip level, and has shutdown the generator.
Event log 20:10:00 8th September 2003 Emergency stop Shutdown	On the 8th September 2003 at 20:10. The emergency stop button was pressed and the generator was shutdown.
Event log 08:46:00 7th September 2003 Over Volts Shutdown	On the 7th September 2003 at 08:46 the unit detected that the generator out put volts exceeded pre-set trip level, and has shutdown the generator.

VIEWING THE INSTRUMENTS

VIEWING THE INSTRUMENTS *(FOR PLC 5110, 5220, 560 SERIES)*
It is possible to manually scroll to display the different instruments by repeatedly operating the scroll button. Once selected the instrument will remain on the LCD display until the user selects a different instrument or after a period of inactivity the module will revert to the initial display (Hz/RPM).
Page order:
refer to the table next page.

VIEWING THE INSTRUMENTS *(FOR PLC 5310 SERIES ONLY)*
It is possible to manually scroll to display the different pages of information by repeatedly operating the next page button**.**

Page order:
refer to the table next page.
It is possible to manually scroll to display the different instruments by repeatedly operating the next page button . Once selected the instrument will remain on the LCD display until the user selects a different instrument or after a period of inactivity for the duration of the configurable Page Timer, the module will revert to the default display.
Alternatively, to auto scroll through all instruments on the currently selected page, press and hold the scroll button.
To disable auto scroll, press and hold the scroll button, or select another page with the page select button.

When auto scroll is disabled, the display will automatically return to the Status/Alarms page if no buttons are pressed for the duration of the configurable Page Timer. If an alarm becomes active while viewing instruments, the Status/Alarms page will be automatically displayed to draw the operator's attention to the alarm condition.

Instrument Page Order (For PLC5110, 560)	Instrument Page Order/ Content (For PLC5310)	Instrument Page Order (For PLC 5220)
Frequency / RPM *AC Voltage Line-Neutral* *AC Voltage Line-Line* *AC Line Current* *Oil Pressure* *Coolant temperature* *Engine Hours Run* *DC Battery Voltage*	*Status display* *Instrument display* *Alarms display* *Event log* *Engine speed* *Oil Pressure* *Coolant temperature* *Engine Hours Run* *Number of starts* *DC Battery Voltage* *Generator AC Voltage Line-Neutral* *Generator AC Voltage Line-Line* *AC Line Current* *Generator Output* *Fuel level (%)*	*Generator RPM / Frequency (Hz)* *Generator AC Voltage Line-Neutral* *Generator AC Voltage Line-Line* *Oil Pressure* *Coolant temperature* *Fuel level (%)* *Engine Hours Run* *DC Battery Voltage* *AC Line Current* *Total kW* *Total VA* *AC phase angle (cos ∅)* *Mains (Utility) Frequency (Hz)* *Mains (Utility) AC Voltage Line-Neutral* *Mains (Utility) AC Voltage Line-Line*

VIEWING THE EVENT LOG

(FOR PLC 5220 AND 5310 SERIES)

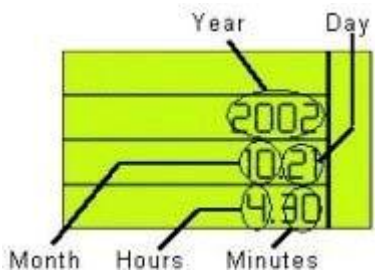
The model 5220 remote start module maintains a log of the last 15 shutdown alarms and mains fail/returns to enable the operator or engineer to view the past alarms history. Only shutdown and electrical trip alarms are logged; warning alarms are not logged. Once the log is full (15 shutdown alarms), any subsequent shutdown alarms will overwrite the oldest entry in the log. Hence the log will always contain the 15 most recent shutdown alarms. The alarm is logged, along with the date and time of the event in the format shown in this example.

To view the event log, press the log button . The LCD display will flash the log symbol to confirm that the event log has been entered.
In this example, the oil can symbol represents an oil pressure shutdown, backed up by the flashing shutdown symbol in the LCD display. The value displayed means that the oil pressure shutdown occurred on November 1st 2002 at 8:17.

Press down to view the next most recent shutdown alarm:

In this example, the hand/button symbol represents an emergency stop shutdown, backed up by the flashing shutdown symbol in the LCD display. The value displayed means that the emergency stop button was pressed on November 1st 2002 at 11:50.

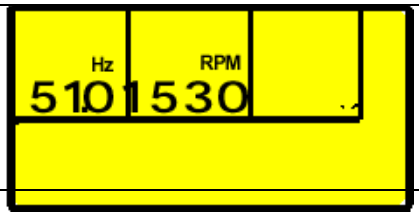
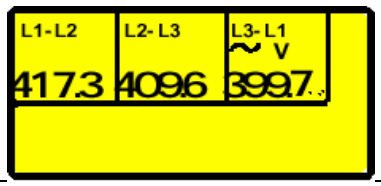
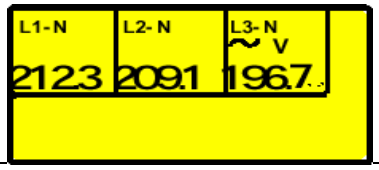
Mains Failure is logged using a flashing symbol. Mains Return is logged by illuminating the mains available LED.



Continuing to press down will cycle through the past alarms until all 15 logged alarms have been viewed, after which the most recent alarm will again be showed and the cycle will begin again.

To exit the event log and return to viewing the instruments, press the log button.

Manually Selecting an Instrument *(FOR PLC 5110, 5220, 560 SERIES)*

Initial display (Hz/RPM)		
Pressing the **DOWN** button the LCD will then show (Generator L-N voltages)		
Pressing the **DOWN** button the LCD will then show (Generator L-L voltages)		

Pressing the button  again will scroll through each individual instrument eventually returning to the original instrument displayed.

NOTE: Once selected the instrument will remain on the LCD display until the user selects a different instrument or after a period of inactivity the module will revert to the initial display.

Manually Selecting an Instrument *(FOR PLC 5310 SERIES ONLY)*

Default display		Running in auto Generator on load L-N 230V 240A 50Hz L-L 400V 133kW
Pressing the **DOWN** button the LCD will then show Engine speed		Engine speed 1500 RPM 50 Hz
Pressing the **DOWN** button the LCD will then show Oil pressure		Oil pressure 6 Bar 87 PSI 600 Kpa

Pressing the button again will scroll through each individual instrument eventually returning to the original instrument displayed.

NOTE: Once selected the instrument will remain on the LCD display until the user selects a different instrument or after a period of inactivity for the duration of the configurable Page Timer, the module will revert to the initial display.

CANBUS ERROR MESSAGES *(FOR PLC 5310 SERIES ONLY)*

On J1939 enabled 53xx controllers connected to a suitable J1939 CanBus ECU, alarm status messages are transmitted to the 53xx controller and displayed on the alarms page.

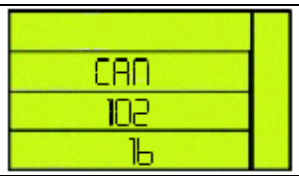
Alarm AlarmAlarm		Alarm
CAN ECU error Exhaust hi temp	Here the ECU code is interpreted by the module, which displays the warning as text. An error is like a warning, and does not shutdown the generator. The display will alternate between the text display and the manufacturers error codes	CAN ECU error SPNnnnnn FMInnnnn

Alarm		Alarm
CAN ECU fail Fuel pressure low	A CAN ECU fail is a shutdown and the module stops the generator. The display will alternate between the text display and the manufacturers error codes	CAN ECU fail SPNnnnnn FMInnnnn
Alarm	Where the module does not recognise the ECU error / fail code the SPN and FMI codes are displayed. These codes then have to be cross referenced with engine manufactures literature to determine the exact problem.	
CAN ECU error SPNnnnnn FMInnnnn		

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.

CANBUS MESSAGES *(FOR PLC 5220 SERIES ONLY)*

On J1939 enabled 52xx controllers connected to a CanBus ECU, alarm status messages are transmitted to the 52xx controller and displayed on the CanBus message instrumentation page.

Can alarm message Suspect Parameter Number (SPN) = 102 Failure Mode Indicator (FMI) = 16	
Examples of SPN / FMI numbers, taken from the Volvo Penta TAD12 manual are :	**SPN 110 – Engine coolant temperature** FMI 0 – Out of range FMI 3 – Above normal FMI 4 – Below normal

NOTE: For details on these code meanings, refer to the ECU instructions provided by the engine manufacturer.

NOTE: When using 52xx configuration and instrumentation PC software, 'hovering' the mouse cursor over the SPN/FMI numbers will display the J1939 messages where appropriate.

LCD INDICATORS

COMMON ALARM LCD indicators

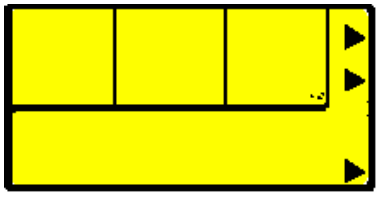
These indicate when an alarm condition is present. The Alarm icons or LEDs will detail the exact nature of the alarm. (warning) or (shutdown)

USER CONFIGURABLE LCD INDICATORS

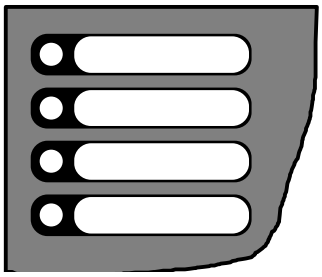
These LCD's can be configured by the user to indicate any on of the ***different functions*** based around the following:-

WARNINGS and **SHUTDOWNS** - 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, Generator Available, etc.*



USER CONFIGURABLE INDICATORS *(FOR PLC 5310 SERIES ONLY)*



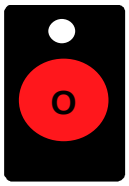
These LEDs can be configured by the user to indicate any one of ***100+ different functions*** based around the following:-
Indications - Monitoring of a digital input and indicating associated functioning user's equipment - *Such as Battery Charger On or Louver's Open, etc*.

WARNINGS And **SHUTDOWNS** –
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, Preheating, Panel Locked, Generator Available, etc.*

ICONS and LED IDENTIFICATION

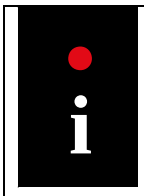
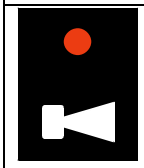
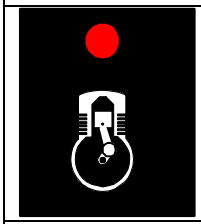
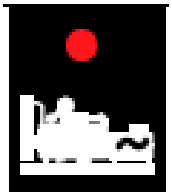
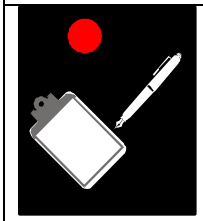
Symbol	Meaning	Description
O	Stop/Reset	Stop the generator and reset any alarm conditions. Refer to Section 1 of this Manual.
I	Start	Start the generator (if in an appropriate mode).
AUTO	Auto	The controller will automatically start the generator when given a remote start command.
	Manual	The controller will start the generator under manual control. *(Separate Start command may be necessary)*
	Common Alarm	An alarm condition has been detected. (**Warning** = Steady, **Shutdown** = *Flashing*)
	Mains Failure Simulation (Test)	On AMF modules this is used to simulate a mains failure event. (On load test)
	Alarm Mute	Silences the audible warning device.
	Lamp Test	Causes all indicating LED's to illuminate to test for correct operation
	Engine Instruments	Instruments page for engine details such as Oil pressure, Engine temperature.
	G enerator Instruments	Instruments page for generator details such as frequency and voltage
	Mains Instruments	Instruments page for mains supply details such as frequency and voltage.
	Event Log	Details recorded history of generator operation.

BUTTONS & CONTROLS

Stop / Reset This button places the module into its **Stop/reset** mode. This will clear any alarm conditions for which the triggering criteria have been removed. If the engine is running and this position is selected, the module will automatically instruct the changeover device to un-load the generator *('**Close Generator**' becomes inactive (if used))*. The fuel supply will be removed and engine will be brought to a standstill. Should a **remote start signal** be present while operating in this mode, a remote start will not occur.	
Manual This mode is used to allow manual control of the generator functions. Once in **Manual mode** the module will respond to the start (I) button and start the engine and run off load. If the engine is running off-load in the **Manual mode** and a **remote start signal** becomes present, the module will automatically instruct the changeover device to place the generator on load *('**Close Generator**') becomes active (if used))*. Should the **remote start signal** then be removed the generator will remain on load until either the **'STOP/RESET'** or **'AUTO'** positions is selected.	
Auto This button places the module into its **'Automatic'** mode. This mode allows the module to control the function of the generator automatically. The module will monitor the **remote start input** and once a start condition is signalled the set will be automatically started and placed on load *('**Close Generator**') becomes active (if used))*. If the starting signal is removed the module will automatically transfer the load from the generator and shut the set down observing the **stop delay timer** and **cooling timer** as necessary. The module will then await the next start event. *For further details please see the more detailed description of 'Auto Operation' earlier in this manual.*	
Test This button places the module into its 'Test' mode. This mode allows the operator to perform an 'on load' test of the system. Once in Test mode the module will respond to the start I button and start the engine, and run on load ('Close Generator') becomes active (if used)). The generator will continue to run on load until Auto mode is selected. Then, If the starting signal is removed the module will automatically transfer the load from the generator and shut the set down observing the stop delay timer and cooling timer as necessary. The module will then await the next start event. For further details please see the more detailed description of 'Test Operation' earlier in this manual.	
Start This button is only active in MANUAL or TEST mode. Pressing this button in manual or test mode will start the engine and run off load (manual) or on load (test).	
Mute / Lamp Test This button silences the audible alarm if it is sounding and illuminates all of the LEDs. If there is no audible alarm this button will only illuminate all the LEDs.	

4.4 CONTROL PANEL INSTRUCTION *(FOR PLC 550SERIES)*

LCD DISPLAY

	**INFORMATION PAGE** The LCD display normally indicates the status of the generator such as **'GENERATOR AT REST**', **'PRE-HEATING'**, '**GENERATOR AVAILABLE**', etc. This is the default display and is always automatically returned to after a pre-set period of operator inactivity.
	**ALARM PAGE** The LCD also displays the exact nature of any alarm condition which have occurred such as '**SHUTDOWN LOW OIL PRESSURE**'. This allows very specific alarm conditions to be brought to the operators' attention. Refer to the 'Protections' section of this manual for details of how to interact with the alarm page.
	**ENGINE INSTRUMENTS PAGE** The LCD displays the various engine parameters such as **'ENGINE SPEED'**, **'OIL PRESSURE', 'HOURS RUN'**, etc.
	**GENERATOR INSTRUMENT PAGE** The LCD displays the various generator output values such as **'GENERATOR VOLTAGE'**, **'GENERATOR CURRENT'**, etc. If the enhanced instrumentation option is fitted the LCD will also display the values of **'GENERATOR KW**', **'GENERATOR pF'**, **'GENERATOR KVAr'**, etc.
	MAINS INSTRUMENT PAGE The LCD displays the various mains supply values such as **'MAINS VOLTAGE'**, **'MAINS FREQUENCY'**, etc.
	**EVENT LOG PAGE** In the event of a shutdown alarm occurring the triggering alarm will be recorded in the Event Log Memory. The Memory will record the last 25 such shutdowns. Subsequent alarms will then over-write the oldest previous alarm. This feature allows service engineers arriving on site a detailed look at the recent history of the gen-set or plant.

VIEWING THE INSTRUMENT AND EVENT LOG PAGES

To view a particular instrument operate the "**Page**" button to move to the required page. Each press of the button will move the page indicator LED along. The LCD will also indicate the page title.	

i.e. To view the Engine Coolant temperature move to the '*Engine Instruments Page*'.

The LCD will display the page title and then will automatically commence scrolling down the various instrument . These will automatically scroll round, on reaching the last instrument the LCD display will then jump back to the page title and resume scrolling down the page. This sequence will be repeated until either the user moves off the page or after a period of inactivity the module will revert to the '*Information Page*'

It is also possible to manually scroll to display the different instruments, once selected the instrument will remain on the LCD display until the user selects a different instrument or page, or after a period of inactivity the module will revert to the '*Information Page*'.

NOTE:-This description of operation is also true for the other instrument pages and for viewing the records in the event log.

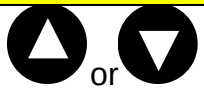
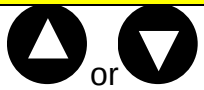
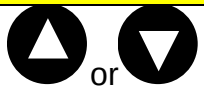
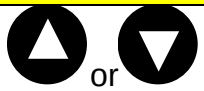
Manually Selecting an Instrument

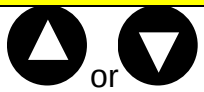
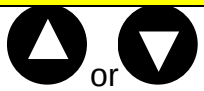
Initial Display	**>>>>>**	**ENGINE INSTRUMENTS**
Pressing the **DOWN** button the LCD will then show…		ENGINE SPEED 1503 RPM
Pressing the **DOWN** button again the LCD will then show…		ENG OIL PRESSURE 2.5Bar 56psi
Pressing the **DOWN** button again the LCD will then show…		COOLANT TEMP 78deg C 105deg f
Pressing the **DOWN** button again the LCD will then show…		BATTERY VOLTAGE 24.5 V
Pressing the **DOWN** button again the LCD will then show…		CHARGE ALT VOLTAGE 27.5 V
Pressing the **UP** button the LCD will then show…etc, etc, etc.		BATTERY VOLTAGE 24.5 V

If the **DOWN** button is pressed while the LCD display is showing '**ENGINE RUN TIME**' then the display will jump round to the top of the page and display the page title; '**ENGINE INSTRUMENTS**'. Pressing the **DOWN** button again will then display; **'ENGINE SPEED'**

OPERATOR CONFIGURATION MODE

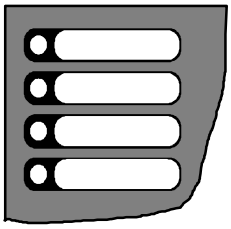
This configuration mode allows the operator limited customising of the way the module operates.

Operation	Detail
To enter the **'Operator configuration mode'** press both the **UP** and **DOWN** scroll buttons together.	
The module will enter **'Operator Configuration mode'** and the **'Operator configuration mode indicator'** will illuminate above the **PAGE** button.	
The LCD will then display:	CONFIGURATION
To view the different configuration functions press the **PAGE** button.	
The LCD will then display:	LANGUAGE ENGLISH
Pressing the **UP** or **DOWN** Button will then change the selected language.	
The LCD will then display the new language:	LANGUAGE FRENCH
Repeat until the required language is displayed.	LANGUAGE GERMAN
To view the next function press the **PAGE** button.	
The LCD will then display:	CONTRAST
Pressing the **UP** or **DOWN** Button will move the sliding bar **UP** *(Darker)* or **DOWN** *(Lighter)* - set this to the desired position.	
When correct, to view the next function press the **PAGE** button.	
The LCD will then display:	AUTO SCROLL TIME 3.0 Seconds
This is the duration each instrument will be displayed for during the automatic scrolling. Use the **UP** and **DOWN** buttons to set this to the required value.	
When correct, to view the next function press the **PAGE** button.	
The LCD will then display:	INDICATIONS ON LCD **YES**
Digital inputs configured as indications can be viewed on the LCD by pressing the **UP** or **DOWN** button when the **'Information Page'** is active. To disable this function set to 'NO' by pressing the **UP** or **DOWN** button.	

When correct, to view the next function press the **PAGE** button.	
The LCD will then display:	ABANDON CHANGES AND EXIT
To exit the **'Operator configuration mode'** with-out storing any changes made press the **UP** or **DOWN** button.	
If you wish to save the changes you have made to the configuration press the **PAGE** button.	
The LCD will then display:	SAVE CHANGES AND EXIT
To exit the **'Operator configuration mode'** and store the changes you have made press the **UP** or **DOWN** button.	

The module will then return to the '**Information Page'** display and the **'Operator Configuration Mode Indicator'** will extinguish.

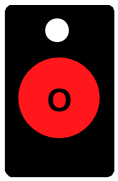
LED INDICATORS

COMMON ALARM LED This LED indicates when an alarm condition is present. The Alarms Page on the LCD will detail the exact nature of the alarm. • '*OFF*' - no alarm active. • '*FLASHING*' - A shutdown alarm is present, but has not been muted. • '*STEADY*' - A warning alarm is present or a shutdown alarm which has been muted is present.	
USER CONFIGURABLE LED's These LED can be 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 Louver's Open, etc*. • **WARNINGS** and **SHUTDOWNS** - 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, Generator Available, etc.*	

CONTROL PUSH-BUTTONS

STOP/RESET

This push-button places the module into it's **Stop/reset** mode. This will clear any alarm conditions for which the triggering criteria have been removed. If the engine is running and this push-button is operated, the module will automatically instruct the change-over device to un-load the generator *('**Load transfer**' becomes in-active (if used))*. The fuel supply will be removed and engine will be brought to a standstill. Should a **remote start signal** be present while operating in the mode, a remote start will not occur.



MANUAL

This push-button is used to allow manual control of the generator functions. Entering this mode from any other mode will initially not cause any change of operating state, but allows further push-buttons to be used to control the generator operation. For example once in **Manual mode** it is possible to manually start the engine by using the **'START'** push-button. If the engine is running off-load in the **Manual mode** and a **remote start signal** becomes present, the module will automatically instruct the change-over device to place the generator on load *('**Load transfer**' becomes active (if used))*. Should the **remote start signal** then be removed the generator will remain on load until either the **'STOP/RESET'** or **'AUTO'** push-buttons are operated.

START

This push-button is used to manually start the engine. The module must first be placed in the **'MANUAL**' mode of operation. The **'START'** button should then be operated. The engine will then automatically attempt to start. Should it fail on the first attempt it will re-try until either the engine fires or the pre-set number of attempts have been made. To stop the engine the **'STOP/RESET'** button should be operated. It is also possible to configure the modules such that the start push-button must be held to maintain engine cranking.

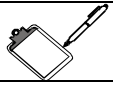
NOTE:-Different modes of operation are possible - Please refer to your configuration source for details.

AUTO

This push-button places the module into it's **'Automatic'** mode. This mode allows the module to control the function of the generator automatically. The module will monitor the **remote start input** and once a start condition is signalled the set will be automatically started and placed on load *('**Load transfer**' becomes active (if used))*. If the starting signal is removed the module will automatically transfer the load from the generator and shut the set down observing the **stop delay timer** and **cooling timer** as necessary. The module will then await the next start event. *For further details please see the more detailed description of 'Auto Operation' earlier in this manual.*

TEST This push-button places the module into it's **'Test'** mode. This mode is used to test the function and timing of the generator start and load sequence. The mode is initiated by pressing the **'Start' Button** and the set will be automatically started and placed on load. The set will run on load continuously. To test the off-loading and stopping sequence return the set to the **'Auto'** mode, the module will automatically transfer the load from the generator and shut the set down observing the **stop delay timer** and **cooling timer** as necessary. The module will then await the next start event. *For further details please see the more detailed description of 'Test Operation' earlier in this manual.*	
ALARM MUTE This push-button is used to silence the internal alarm sounder and also any external sounder devices fed from the **audible alarm output**. Any further alarm conditions will re-active the sounder. Once the alarm has been muted and investigated it may then be cleared. *Refer to the 'Protections' section of this manual for details.* When the **Alarm Mute** is operated a **Lamp test function** will also be implemented and all LED indicators will be illuminated.	

ICONS AND LED IDENTIFICATION DESCRIPTION

Symbol	Meaning	Description
	Stop/Reset	Stop the generator and reset any alarm conditions. Refer to Section 1 of this Manual.
	Start	Start the generator (if in an appropriate mode).
	Auto	The controller will automatically start the generator when given a remote start command.
	Manual	The controller will start the generator under manual control. *(Separate Start command may be necessary)*
	Common Alarm	An alarm condition has been detected. (**Warning** = Steady, **Shutdown** = *Flashing*)
	Mains Failure Simulation (Test)	On AMF modules this is used to simulate a mains failure event. (On load test)
	Alarm Mute	Silences the audible warning device.
	Lamp Test	Causes all indicating LED's to illuminate to test for correct operation
	Engine Instruments	Instruments page for engine details such as Oil pressure, Engine temperature.
	Generator Instruments	Instruments page for generator details such as frequency and voltage
	Mains Instruments	Instruments page for mains supply details such as frequency and voltage.
	Event Log	Details recorded history of generator operation.

SECTION 5 OPERATION

The following description details 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 STARTING

Starting an engine is easy when it succeeds, but may cause untold problems when unsuccessful. The operation of highly complex equipment may depend on the reliability of the genset particularly in applications such as hospitals, factory processes and building protection systems.
That is why there are many starting processes and devices on a generating set to ensure reliable starting every time. We make a distinction between a manual start procedure and an emergency start procedure, which is triggered by the failure of the mains supply (generally in automatic mode three 5 second cranks are provided).

The starting system design depends on the engine temperature. For a start in very cold temperatures it is sometimes necessary to use starting aids, such as heating the intake air, heating the fuel, injecting ether into the air intake. As well as these the engine coolant is heated, and in very cold conditions also the oil is kept warm.

Generating sets can be provided with three types of start systems
- Electric Starting : This is the most widely used system and consists of a 12V or 24V starter motor supplied by one or more lead acid, or in exceptional cases, alkaline batteries.

The starter motor rotates the ring gear of the engine flywheel moving on receiving the signal from an electric contact.

Once the diesel engine has started and the flywheel has run up to its required speed, the starter motor pinion disengages automatically from the ring gear. The batteries are recharged automatically by an alternator or static charger.

- Pneumatic Starting : Pneumatic starting relies on an air starter that is operated by a flow of compressed air from one or two compressed air bottles and an air compresser. The engine is started in the same way as for electric starting.

The air bottles and air compresser are located as near as possible to the generating set.

- Mechanical Starting : Several mechanical starting system exist, i.e. spring, crank, inertia etc. All of these are only used with low power generating sets.

The three systems above can be coupled to each other in the following way:
- electric/ pneumatic starting
- electric/ mechanical starting.

Generating Set Starting :

CHECK BEFORE START

Before generator start, please check following thing;

14. Generator normally consume 0.25%-1% of foil wastage lubricating oil.
15. check lubricating oil and coolant water capacity,

Warning
When putting foil into trunk, do not smoking nearby or using fire.

16. check oil capacity,
17. check engine cooling fan and rap degree of tightness,
18. check all ripe, ensure not leaking out,
19. check battery pole ,ensure no cauterization,

Warning
When packing up battery, do not smoking nearby or using fire, hydrogen which battery produce will blow up. Don't mistake battery pole,

20. Check battery liquid, if necessary, put into pure water. If battery is new , please add beforehand mixed b attery liquid
21. Check control panel and generators, please ensure aforesaid parts clean. These dust maybe damnous, etc, tip-and-run accident.
22. Check air cleaner, if emphraxis, please change a new.
23. Ensure surroundings of generators clean, coolant aeration unhindered.
24. Check fuel system ,coolant system and lubricating oil system ,
25. If exhaust system have exhaust water device, please letting termly.

Ensure alternator's output switch is off.

COMMISSIONING *(FOR DSE-501K, 701HC SERIES)*

Before the system is started, it is recommended that the following checks are made:-

1. The unit is adequately cooled and all the wiring to the module is of a standard and rating compatible with the system.
2. The unit **DC** supply is fused and connected direct to the battery and of correct polarity.
3. The Emergency Stop input is wired to an external normally closed switch connected to **DC** positive.

NOTE:- If Emergency Stop feature is not required link this input to the DC Positive.

4. To check the start cycle 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. Turn the key switch to **"RUN"**. The unit starts to preheat if selected.
5. Press and hold the '**START**' push-button for a short time, starter will engage and operate for the duration that the button is operated for. After the safety on timer has expired the module will generate an alarm and the **"COMMON ALARM" LED** will be illuminated (if fitted). Turn to **OFF** to reset the unit.

6. Restore the engine to operational status (reconnect the fuel solenoid), again select **"RUN"** and operate the **"START"** push-button and 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.

7. Select **OFF** on the front panel, the engine will then shutdown.

8. All internal timers and selections should now be adjusted to the customers specifications or to the engine and alternator manufacturers recommendations.

9. If despite repeated checking of the connections between the **DSE P511** and the customers system, satisfactory operation cannot be achieved, then the customer is requested to contact the factory for further advice.

COMMISSIONING *(FOR OTHER CONTROL PANEL SERIES)*

10.1.1 PRE-COMMISSIONING

Before the system is started, it is recommended that the following checks are made:-

10.1. The unit is adequately cooled and all the wiring to the module is of a standard and rating compatible with the system.

10.2. The unit DC supply is fused and connected to the battery and that it is of the correct polarity.

10.3. The Emergency Stop input is wired to an external normally closed switch connected to DC positive.

NOTE:- If Emergency Stop feature is not required link this input to the DC Positive. The module will not operate unless either the Emergency Stop is fitted correctly OR Pin 3 is connected to DC positive (+ve)

10.4. 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. Select "MANUAL", the unit start sequence will commence.

10.5. The starter will engage and operate 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 will display 'Failed to start. Select the STOP/RESET position to reset the unit.

10.6. Restore the engine to operational status (reconnect the fuel solenoid), again select "MANUAL", 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 will be possible at this time to view the engine and alternator parameters - refer to the 'Description of Controls' section of this manual.

10.7. Select "AUTO" on the front panel, the engine will run for the pre-set cooling down period, then stop. The generator should stay in the standby mode. If not check that there is not a signal

present on the Remote start input.
10.8. Initiate an automatic start by supplying the remote start signal. The start sequence will commence and the engine will run up to operational speed. Once the generator is available a load transfer will take place, the Generator will accept the load. If not, check the wiring to the Generator Contactor Coil (if used). Check the Warming timer has timed out.

10.9. Remove the remote start signal, the return sequence will start. After the pre-set time period, the load will be removed from the generator. The generator will then run for the pre-set cooling down period, then shutdown into it's standby mode.

10.10.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 – Editing the date and time.

10.11. If, despite repeated checking of the connections between the 5310 and the customer's system, satisfactory operation cannot be achieved, then the customer is requested to contact the factory for further advice.

5.2 OPERATION *(FOR DSE-501K, 701HC SERIES)*

To start the generator turn the key switch to the hand position, which will power up the unit.
If at this time the auxiliary input is active the led will be illuminated, preventing the start of the generator.

Pressing the **pre-heat** button will energise the **pre-heat** output. Releasing the button will de-energise the output.

Pressing the **start** button will energise the **Fuel Solenoid** output**,** then the **Starter Motor** output. The button should be pressed for the duration of the crank period.

When the engine fires, the starter motor is disengaged and locked out at 20 Hz measured from the Alternator output.

After the starter motor has disengaged, the **Safety On** timer is activated (which is fixed at 12 seconds), allowing Oil Pressure, High Engine Temperature and Charge Fail to stabilise without triggering the fault.

Turning the key to **STOP** de-energises the **FUEL SOLENOID**, bringing the generator to a stop.

NOTE: - The safety on time (used for delayed alarms) is pre set to 12 seconds and can not be changed.

NOTE: - If the generator has not started when the start button has been released or the generator fails once it is running, the key switch must be turned to STOP and then back to before another start can be invoked.

NOTE: - If pre-heat is required during cranking, the pre-heat button should be pressed at the

same time as the start button.

NOTE: - The 701HC start button is represented by

WARNINGS
Warnings are used to warn the operator of an impending fault
BATTERY CHARGE FAILURE, if the module does not detect a voltage from the warning light terminal on the auxiliary charge alternator, the icon will illuminate.

SHUTDOWNS
Shutdowns are latching and stop the Generator. The alarm must be cleared, and the fault removed to reset the module. In the event of a shutdown the appropriate icon will be illuminated **Auxiliary Input**, if the auxiliary input is energised an immediate shutdown will occur. The icon will illuminate.

NOTE: - If the Auxiliary input is used to shutdown the engine, the fault must be cleared before the unit can be reset and the generator restarted.

LOW OIL PRESSURE, if the module detects that the engine oil pressure has fallen below the low oil pressure switch setting, after the **Safety On** timer has expired, a shutdown will occur.
The icon will illuminate.

HIGH ENGINE TEMPERATURE if the module detects that the engine coolant temperature has exceeded the high engine temperature switch setting, after the **Safety On** timer has expired, a shutdown will occur.
The icon will illuminate.

OVERSPEED, if the engine speed exceeds the pre-set trip (14% above the nominal frequency) a shutdown is initiated. Overspeed is not delayed, it is an **immediate shutdown.**
The icon will illuminate.

NOTE: - During the start-up sequence the overspeed trip level is extended to 24% above the normal frequency for the duration of the safety timer to allow an extra trip level margin. This is used to prevent nuisance tripping on start-up.

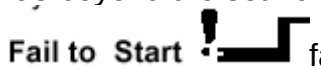
NOTE: - The safety on time (used for delayed alarms) is pre set to 12 seconds and can not be changed.

5.3 OPERATION *(FOR PLC 5110, 560 SERIES)*

AUTOMATIC MODE OF OPERATION

This mode is activated by pressing the pushbutton. An LED indicator beside the button confirms this action.
When a **Remote Start** signal is applied to the remote start input, the following sequence is initiated: The **Remote Start Active** indicator illuminates (if configured).

To allow for false signals the Start Delay timer is initiated. After this delay, if the pre-heat output option is selected then the pre-heat timer is initiated, and the corresponding auxiliary output (if configured) will energise.

NOTE: If the Remote Start signal is removed during the Start Delay timer, the unit will return to a stand-by state. After the above delays the **Fuel Solenoid** is energised, then one second later, the **Starter Motor** is engaged. The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and **Fail to Start** 

fault will be displayed accompanied by a flashing shutdown symbol.

When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing can be used for speed detection (This is selected using the front panel editor).

After the starter motor has disengaged, the **Safety On** timer is activated, allowing Oil Pressure, High Engine, Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

Once the engine is running, the **Warm Up** timer, if selected is initiated, allowing the engine to stabilise before accepting the load.

If an auxiliary output has been selected to give a **load transfer** signal, this would then activate.

NOTE: A load transfer will not be initiated until the Oil Pressure has risen. Thus preventing excessive wear on the engine.

On removal of the **Remote Start** signal, the **Stop** delay timer is initiated, once it has timed out, the **load Transfer** signal is de-energised, removing the load. The **Cooling** timer is then initiated, allowing the engine a cooling down period off load before shutting down. Once the **Cooling** timer expires the **Fuel Solenoid** is de-energised, bringing the generator to a stop.

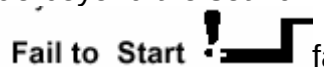
Should the **Remote Start** signal be re-activated during the cooling down period, the set will return on load.

MANUAL OPERATION

To initiate a start sequence in **MANUAL**, press the pushbutton. When the controller is in the manual mode (indicated by an LED indicator beside the button), pressing the **START** (I) button will initiate the start sequence.

NOTE: There is no Start Delay in this mode of operation.
If the **pre-heat** output option is selected this timer is then initiated, and the auxiliary output selected is energised.

After the above delay the **Fuel Solenoid** is energised, then the **Starter Motor** is engaged.

The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and **Fail to Start** 

fault will be displayed accompanied by a flashing shutdown indicator.

When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing can be used for speed detection (This is selected using the front panel editor). Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for underspeed or overspeed detection.

After the starter motor has disengaged, the **Safety On** timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

Once the engine is running, the **Warm Up** timer, if selected is initiated, allowing the engine to stabilise before it can be loaded.

The generator will run off load, unless a **Remote Start** signal is applied, and if **Load Transfer** has been selected as a control source, the appropriate auxiliary output selected will activate.

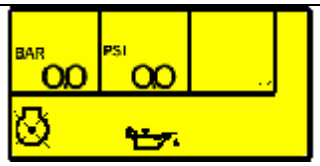
If the **Remote Start** signal is removed, the generator will continue to run **On** load until the **Auto** mode is selected.

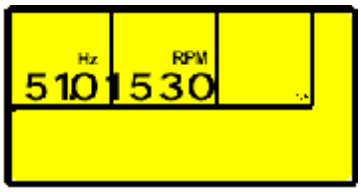
The **Remote Stop Delay Timer** will time out, the load is then disconnected. The generator will then run **off** load allowing the engine a **cooling** down period.

Selecting **STOP (O)** de-energises the **FUEL SOLENOID**, bringing the generator to a stop.

PROTECTIONS

The module will indicate that an alarm has occurred in several ways;

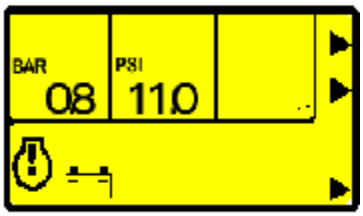
The “Common alarm” LED will illuminate (**Warning** = *Red steady*, **Shutdown** = *Red Flashing)*	
If appropriate, the LCD display or LED indicators will display the appropriate alarm icon i.e. for battery charging failure :	



If no alarms are present the LCD will extinguish any alarm icons.

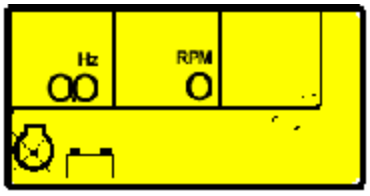
In the event of a warning alarm the LCD will display the appropriate icon. If a shutdown then occurs the module will display the appropriate icon. The original warning alarm icon will remain displayed.

Example:-



Charge alternator warning (all symbols steady)

Followed by….



Charge alternator warning indicator still present, common alarm indicator has changed to a shutdown symbol and is now flashing. Also present is the flashing overspeed LED.

Overspeed and Shutdown alarm Icons are displayed flashing. The original warning will remain displayed as long at the triggering conditions remain. Any subsequent warnings or shutdowns that occur will be displayed steady, therefore only the first-up shutdown will appear flashing.

WARNING! Warnings are non-critical alarm conditions and do not affect the operation of the generator system, they serve to draw the operators attention to an undesirable condition.

In the event of a warning alarm the LCD will display:- 

BATTERY CHARGE FAILURE, if the module does not detect a voltage from the warning light terminal on the auxiliary charge alternator the icon will illuminate.

FAIL TO STOP, If the module detects the engine is still running when the ‘Fail to stop timer’ expires, then the module will display:-

NOTE: **‘Fail to Stop’ could indicate a faulty oil pressure sender - If engine is at rest check oil sender wiring and configuration.**

AUXILIARY INPUTS, if an auxiliary input has been configured as a warning the appropriate LCD segment will be displayed:

SHUTDOWNS

Shutdowns are latching and stop the Generator. The alarm must be cleared, and the fault removed to reset the module.
In the event of a shutdown alarm the LCD will display:-

The appropriate icon will also be displayed flashing

NOTE: The alarm condition must be rectified before a reset will take place. If the alarm condition remains it will not be possible to reset the unit (The exception to this is the Low Oil Pressure alarm and similar 'delayed alarms', as the oil pressure will be low with the engine at rest). Any subsequent warnings or shutdowns that occur will be displayed steady, therefore only the first-up shutdown will appear flashing.

FAIL TO START, if the engine does not fire after the pre-set number of attempts has been made a shutdown will be initiated.
The icon  will illuminate.

EMERGENCY STOP, removal of the **+ve DC** Supply from the Emergency Stop input initiates the following sequence, firstly it will initiate a controlled shutdown of the Generator and prevent any attempt to restart the Generator until the Emergency Stop push-button has been reset. Secondly it removes the **+ve DC** supply from boththe Fuel Solenoid and Starter Solenoid. The icon  will illuminate

NOTE: **The Emergency Stop +Ve signal must be present otherwise the unit will shutdown.**

LOW OIL PRESSURE, if the module detects that the engine oil pressure has fallen below the low oil pressure trip setting level after the **Safety On** timer has expired, a shutdown will occur.
The icon will illuminate. 

HIGH ENGINE TEMPERATURE if the module detects that the engine coolant temperature has exceeded the high engine temperature trip setting level after the **Safety On** timer has expired, a shutdown will occur.

The icon  will illuminate.

OVERSPEED, if the engine speed exceeds the pre-set trip a shutdown is initiated.
The icon will illuminate. Overspeed is not delayed,
it is an **immediate shutdown**. 

NOTE: During the start-up sequence the overspeed trip logic will allow for a small amount of overshoot. This temporarily raises the overspeed trip point during the safety delay timer. This is used to prevent nuisance tripping on start-up.

UNDERSPEED, if the engine speed falls below the pre-set trip after the Safety On timer has

expired, a shutdown is initiated.
The icon will illuminate.

OIL PRESSURE SENDER OPEN CIRCUIT, if the module detects a loss of signal from the oil pressure sender (open circuit) a shutdown is initiated. The LCD will indicate:
(Steady) (And '-----' on the engine oil pressure instrument). Sender failure is not delayed, it is an **immediate shutdown**.

AUXILIARY INPUTS, if an auxiliary input has been configured as a shutdown the appropriate LCD segment will be displayed:

LOSS OF SPEED SIGNAL, if the speed sensing signal is lost during cranking, a shutdown is initiated.

The icon will illuminate. (Steady) (And '-----' on the engine RPM instrument).

NOTE: This will only occur if the speed sensing signal is lost during cranking or during the safety on timer. If the signal is lost during normal operation the Generator will shutdown with an Under-speed alarm.

ELECTRICAL TRIPS
Electrical trips are latching and stop the Generator but in a controlled manner. On initiation of the electrical trip condition the module will de-energise the **'Load Transfer'** Output to remove the load from the generator. Once this has occurred the module will start the Cooling timer and allow the engine to cool, off-load before shutting down the engine. The alarm must be accepted and cleared, and the fault removed to reset the module.

In the event of a shutdown alarm the LCD will display:-

The **COMMON ALARM LED** will also illuminate (Red steady) and the generator will be removed from the load. Once the cooling timer has expired the **COMMON ALARM LED** will flash (*Red*).

AUXILIARY INPUTS, if an auxiliary input has been configured as an electrical trip the appropriate LCD segment will be displayed: The **COMMON ALARM LED** will illuminate (red Steady) until the engine is shutdown (red flashing).

SPECIAL ALARM CONDITIONS
The microprocessor has a 'watchdog' facility which continually monitors the operation of the module. Should an error occur and the microprocessor is still functioning, an alarm will be indicated by the LCD back-light flashing and the common alarm LED being illuminated RED.
If the module is being configured and does not receive the correct information via the 808 interface the 'watchdog' will halt the module operation and signal a corrupt user configuration by flashing the LCD back-light and illuminating the common alarm LED GREEN (steady). Attempting to re-send the configuration should rectify the alarm unless a problem exists with the configuration transfer (such as a broken cable, etc).

TO STOP YOUR GENERATOR:

To Stop your Generator:
Turn the circuit breaker off.
Turn the engine switch off.
Turn the fuel valve off.

5.4 OPERATION *(FOR PLC-5310 SERIES)*

AUTOMATIC MODE OF OPERATION *(FOR PLC 5310 SERIES)*

NOTE: If a digital input configured to panel loc k is active, changing module m odes will not be possible. Viewing the instruments and is NOT affected by panel lock. If pane l lock is active the Panel lock indicator (if cor ured) illuminates.

This mode is activated by pressing the AUTO pushbutton. An LED indicator beside the button confirms this action

If the Remote Start input (if configured) is active the relevant indicator (if configured) illuminates To allow for false remote start signals, the Start Delay timer is initiated. After this delay, if the pre-heat output option is selected then the pre-heat timer is initiated, and the corresponding auxiliary output (if configured) will energise.

NOTE: If the Remote Start signal is remove d during the Start Delay timer, the unit will re turn to a stand-by state.

After the above delays the Fuel Solenoid (or enable ECU output if configured) is energised, then one second later, the Starter Motor is engaged.

NOTE: If the Remote Start signal is remove d during the Start Delay timer, the unit will re turn to a stand-by state.

After the above delays the Fuel Solenoid (or enable ECU output if configured) is energised, then one secondlater, the Starter Motor is engaged.

NOTE: If the unit has been configured for J1939, compatible ECU's will receive the start comma nd via J1939.

The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and Fail to Start fault will be displayed.

When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing

can be used for speed detection (This is selected by PC using the 52/53xx series configuration software). Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for underspeed or overspeed detection.

NOTE: If the unit has been configured for J193 9, spe ed sensing is via J193 9.

Once the engine is running, the Warm Up timer, if selected is initiated, allowing the engine to stabilise before accepting the load.
If an auxiliary output has been selected to give a load transfer signal, this would then activate

NOTE: A load transfer will not be initiated until the Oil Pressure has risen. Thus preventing excessive wear on the engine.

On removal of the Remote Start signal, the Stop delay timer is initiated, once it has timed out, the load Transfer signal is de-energised, removing the load. The Cooling timer is then initiated, allowing the engine a cooling down period off load bef ore shutting down. Once the Cooling timer expires the Fuel Solenoid is de-energised, bringing the generator to a stop.

Should the Remote Start signal be re-activated during the cooling down period, the set will return on load

After the starter motor has disengaged, the Safety On timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault

MANUAL OPERATION *(FOR PLC 5310 SERIES)*

NOTE: If a digital input configured to panel lock is active, changing module modes will not be possible. Viewing the instruments and event logs is NOT affected by pane l lock. If panel lock is active the Panel lock indicator (if configured) illuminates.

To initiate a start sequence in MANUAL, press the pushbutton. When the controller is in the manual mode (indicated by an LED indicator beside the button), pressing the START (I) button will initiate the start sequence.

NOTE: **There is no Start Delay in this mode of operation.**
If the pre-heat output option is selected this timer is then initiated, and the auxiliary output selected is energized.
After the above delay the Fuel Solenoid (or ECU output if configured) is energised, then one second later, the Starter Motor is engaged.

NOTE: If the unit has been configured for J1939, compatible ECU's will receive the start. comma nd via J1939.

The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and Fail to Start will be displayed.

When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing can be used for speed detection (This is selected by PC using the 52/53xx series configuration software). Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for underspeed or overspeed detection.

NOTE: If the unit has been configured for J193 9, spe ed sensing is via J193 9.

After the starter motor has disengaged, the Safety On timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

Once the engine is running, the Warm Up timer, if selected, is initiated, allowing the engine to stabilise before it can be loaded.

The generator will run off load, unless the Remote Start on load signal is applied or, if Close generator has been selected as a control source, the appropriate auxiliary output will then activate.

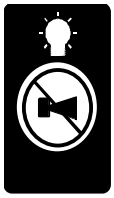
The generator will continue to run On load, until the Auto mode is selected.

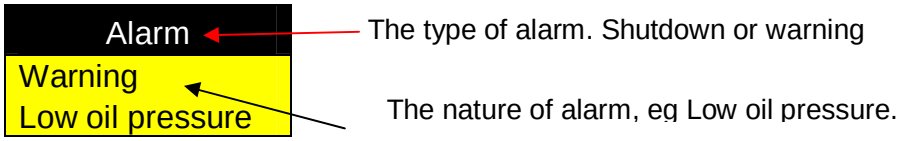
If Auto mode is selected, and the remote start on load signal is not active, then the Stop Delay Timer begins, after which, the load is disconnected. The generator will then run off load allowing the engine a cooling down period.
Selecting STOP (O) de-energises the FUEL SOLENOID, bringing the generator to a stop.

PROTECTIONS

When an alarm is present the Audible Alarm will sound and the Common alarm LED if configured will illuminate.

The audible alarm can be silenced by pressing the '**Mute**' button
The LCD display will jump from the 'Information page' to display the Alarm Page





The LCD will display multiple alarms E.g. "High Engine Temperature shutdown", "Emergency Stop" and "Low Coolant Warning" alarms have been triggered. These will automatically scroll round in the order that they occurred.

Running in Auto
Generator on load L-N 230V 240A 50Hz L-L 400V 133kW

If no alarms are present the LCD will display this default page.

In the event of a warning alarm the LCD will display the appropriate text. If a shutdown then occurs the module will again display the appropriate text.

Example:-

Alarm
Shutdown High engine temperature

Followed by….

Alarm
Shutdown Emergency stop

Followed by….

Alarm
Warning Low coolant level

The unit will scroll through all active alarms in a continuous loop.

Alarm
Shutdown High engine temperature

WARNINGS

Warnings are non-critical alarm conditions and do not affect the operation of the generator system, they serve to draw the operators attention to an undesirable condition.
In the event of an alarm the LCD will jump to the alarms page, and scroll through all active warnings and shutdowns.

BATTERY CHARGE FAILURE, will be displayed if the module does not detect a voltage from the warning light terminal on the auxiliary charge alternator.

Alarm
Warning Charge fail

BATTERY LOW VOLTAGE, will be displayed if the module detects that the plant DC supply has fallen below the low volts setting level. The Battery Low Voltage alarm is delayed by the

Low DC Volts Delay timer.

Alarm
Warning Low battery volts

BATTERY HIGH VOLTAGE, will be displayed if the module detects that the plant DC supply has risen above thehigh volts setting level. The Battery High Voltage alarm is delayed by the High DC Volts Delay timer.

Alarm
Warning High battery volts

FAIL TO STOP, will be displayed if the module detects the engine is still running when the 'Fail to stop timer'expires.

Alarm
Fail to stop

NOTE: 'Fail to Stop' could indicate a faulty oil pressure sender - If engine is at rest check oil sender wiring and configuration.

AUXILIARY INPUTS, auxiliary inputs can be user configured and will display the message as written by the user.

Example

Alarm
Warning Bearing temp high

LOW FUEL LEVEL, will be displayed if the fuel level detected by the fuel level sender falls below the low fuel level setting.

Alarm
Warning Low fuel level

ANALOGUE PRE-ALARMS

The following alarms are termed 'pre-alarms' as they pre warn the operator of a potentially more serious alarm condition. For instance, if the engine temperature rises past the pre alarm level, a warning condition will occur to notify the operator. If the temperature falls below this level, then the alarm ceases, and the set will continue to run as normal. However if the temperature continues to rise until the coolant temperature trip point is reached, the warning is escalated and

a high coolant temperature shutdown is initiated.

LOW OIL PRESSURE, if the module detects that the engine oil pressure has fallen below the low oil pressure prealarm setting level after the **Safety On** timer has expired, a warning will occur. Alarm Warning Low Oil Pressure will be displayed.

Alarm
Warning
Low oil pressure

HIGH ENGINE TEMPERATURE if the module detects that the engine coolant temperature has exceeded the high engine temperature pre-alarm setting level after the **Safety On** timer has expired, a warning will occur. Alarm Warning High Coolant Temperature will be displayed.

Alarm
Warning
High temperature

LOW ENGINE TEMPERATURE if the module detects that the engine coolant temperature has fallen below the engine temperature pre-alarm setting level after the **Safety On** timer has expired, a warning will occur. Alarm Warning Low Coolant Temp will be displayed.

Alarm
Warning
Low Coolant Temp

OVERSPEED, if the engine speed exceeds the pre-alarm trip a warning is initiated. Alarm Warning Overspeed will be displayed. It is an **immediate warning**.

Alarm
Warning
Overspeed

UNDERSPEED, if the engine speed falls below the pre-set pre-alarm after the Safety On timer has expired, a warning is initiated. Alarm Warning Underspeed will be displayed.

Alarm
Warning
Underspeed

GENERATOR HIGH FREQUENCY if the module detects a generator output frequency in excess of the pre-set pre-alarm, a warning is initiated. Alarm Warning High frequency will be displayed, it is an **immediate warning**.

Alarm
Warning
Over frequency

GENERATOR LOW FREQUENCY if the module detects a generator output frequency below the pre-set pre-alarm after the Safety On timer has expired, a warning is initiated. Alarm

Warning Low Frequency will be displayed

Alarm
Warning Under frequency

GENERATOR HIGH VOLTAGE if the module detects a generator output voltage in excess of the pre-set prealarm,a warning is initiated. Alarm Warning High voltage will be displayed, it is an **immediate warning**

Alarm
Warning AC Overvolts

GENERATOR LOW VOLTAGE if the module detects a generator output voltage below the pre-set pre-alarm after the Safety On timer has expired, a warning is initiated. Alarm Warning Low Voltage will be displayed.

Alarm
Warning AC Undervolts

CAN ECU ERROR If the module is configured for **J1939 instruments** and receives an “error” message from the engine control unit, ‘Can ECU error” is shown on the module’s display and a warning alarm is generated.
Example

Alarm
Can ECU error Exhaust high temperature

The display will alternate between the text display and the manufacturers error codes **Can ECU error**

Alarm
SPNnnnnnnn FMInnnnnnn

HIGH CURRENT WARNING ALARM

GENERATOR HIGH CURRENT, if the module detects a generator output current in excess of the pre-set trip a warning is initiated. Alarm Warning High Current will be displayed. If this high current condition continues for an excess period of time, then the alarm is escalated to a shutdown condition. For further details of the high current alarm, please see High Current Shutdown Alarm.】

Alarm
Warning High current

SHUTDOWNS

Shutdowns are latching and stop the Generator. The alarm must be cleared, and the fault removed to reset the module.

NOTE: The alarm condition must be rectified before a reset will take place. If the alarm condition remains it will not be possible to reset the unit (The exception to this is the Low Oil Pressure alarm and similar 'delayed alarms', as the oil pressure will be low with the engine at rest).

FAIL TO START, if the engine does not fire after the pre-set number of attempts has been made a shutdown will be initiated. Alarm Shutdown Fail To Start will be displayed.

Alarm
Shutdown
Failed to start

EMERGENCY STOP, removal of the **+ve DC** Supply from the Emergency Stop input initiates the following sequence, firstly it will initiate a controlled shutdown of the Generator and prevent any attempt to restart the Generator until the Emergency Stop push-button has been reset. Secondly it removes the **+ve DC** supply from both the Fuel Solenoid and Starter Solenoid. Alarm Shutdown Emergency Stop will be displayed.

Alarm
Shutdown
Emergency stop

NOTE: **The Emergency Stop +Ve signal must be present otherwise the unit will shutdown.**

LOW OIL PRESSURE, if the module detects that the engine oil pressure has fallen below the low oil pressure trip setting level after the **Safety On** timer has expired, a shutdown will occur. Alarm Shutdown Low Oil Pressure will be displayed.

Alarm
Shutdown
Low oil pressure

HIGH ENGINE TEMPERATURE if the module detects that the engine coolant temperature has exceeded the high engine temperature trip setting level after the **Safety On** timer has expired, a shutdown will occur. Alarm Shutdown High Engine Temperature will be displayed.

Alarm
Shutdown
High temperature

OVERSPEED, if the engine speed exceeds the pre-set trip a shutdown is initiated. Alarm Shutdown Overspeed will be displayed. Overspeed is not delayed, it is an **immediate shutdown**.

Alarm

Shutdown
Overspeed

NOTE: During the start-up sequence the overspeed trip logic can be configured to allow an extra trip level margin. This is used to prevent nuisance tripping on start-up - Refer to the 53xx series configuration software manual under heading 'Overspeed Overshoot' for details.

UNDERSPEED, if the engine speed falls below the pre-set trip after the Safety On timer has expired, a shutdown is initiated. Alarm Shutdown Underspeed will be displayed.

Alarm
Shutdown
Underspeed

GENERATOR HIGH FREQUENCY if the module detects a generator output frequency in excess of the pre-set trip a shutdown is initiated. Alarm Shutdown High Frequency will be displayed, it is an **immediate shutdown**.

Alarm
Shutdown
Over frequency

GENERATOR LOW FREQUENCY, if the module detects a generator output frequency below the pre-set trip after the Safety On timer has expired, a shutdown is initiated. Alarm Shutdown Low Frequency will be displayed.

Alarm
Shutdown
Under frequency

GENERATOR HIGH VOLTAGE if the module detects a generator output voltage in excess of the pre-set trip a shutdown is initiated. Alarm Shutdown High Volts will be displayed, it is an **immediate shutdown**.

Alarm
Shutdown
AC Overvolts

GENERATOR LOW VOLTAGE if the module detects a generator output voltage below the below the pre-set trip after the Safety On timer has expired, a shutdown is initiated. Alarm Shutdown Low Volts will be displayed.

Alarm
Shutdown
AC Undervolts

OIL PRESSURE SENDER OPEN CIRCUIT, if the module detects a loss of signal from the oil pressure sender (open circuit) a shutdown is initiated. Alarm Shutdown Sender Fault will be

displayed. Sender failure is not delayed, it is an **immediate shutdown**.

Alarm
Shutdown
Oil pressure
sender fault

AUXILIARY INPUTS, if an auxiliary input has been configured as a shutdown the appropriate message will be displayed as configured by the user.

Alarm
Shutdown
Bearing temp high

LOSS OF SPEED SIGNAL, if the speed sensing signal is lost during cranking, a shutdown is initiated. Alarm Shutdown Loss Of Speed Signal will be displayed.

Alarm
Shutdown
Loss of speed signal

NOTE:- This will only occur if the speed sensing signal is lost during cranking or during the safety on timer. If the signal is lost during normal operation the Generator will shutdown with an Under-speed alarm

.

CAN DATA FAIL If the module is configured for J1939 operation and does not detect data on the engine CANbus data link, a shutdown will occur and 'Can data fail' is shown on the module's display.

Alarm
Shutdown
Can data fail

CAN ECU FAIL If the module is configured for **J1939 instruments** and receives a "fail" message from the engine control unit, the engine is shutdown and 'Can ECU fail" is shown on the module's display.

Example

Alarm
Can ECU fail
Fuel pressure low

The display will alternate between the text display and the manufacturers error codes

Alarm
Can ECU fail SPNnnnnnnn FMInnnnnnn

NOTE: If the CAN message is a manufacturers specific code, it may not be displayed as text. If this is the case the display will show the generic manufacturers code, which must be cross referenced with the engine manufacturers literature. . Please contact the engine manufacturer

for further assistance.

HIGH CURRENT SHUTDOWN ALARM

GENERATOR HIGH CURRENT, if the module detects a generator output current in excess of the pre-set trip a warning is initiated. This warning will continue for a period of time depending upon the level of overload that the generator is subjected to, and the configuration setting for Generator High Current in the 52/53xx series configuration software.

Alarm
Shutdown
High current trip

For instance the factory default settings for Generator High Current allow for a loading of the generator to 110% for one hour. That is to say if the generator load level exceeds the trip point by 10%, a warning alarm will occur while the overload condition exists. If the load level does not drop to normal levels within one hour, the set is stopped, the 5310 module displaying either shutdown alarm or electrical trip alarm depending upon module configuration.

NOTE:- Higher overload levels will result in a faster acting shutdown condition. For instance with the factory default configuration, an overload level twice that of the trip level (typically 200%) will result in a Generator High Current shutdown condition after 36 seconds. For details of the relationship between the overload and the shutdown time, please see the Appendix section of this manual.

ELECTRICAL TRIPS

Electrical trips are latching and stop the Generator but in a controlled manner. On initiation of the electrical trip condition the module will de-energise the **'Close Generator'** Output to remove the load from the generator. Once this has occurred the module will start the Cooling timer and allow the engine to cool off-load before shutting down the engine. The alarm must be accepted and cleared, and the fault removed to reset the module.

AUXILIARY INPUTS, if an auxiliary input has been configured as an electrical trip the appropriate message will be displayed as configured by the user.
Example

Alarm
Electrical trip
Phase rotation

GENERATOR HIGH CURRENT. If the module detects a generator output current in excess of the pre-set trip a warning is initiated. If this high current condition continues for an excess period of time, then the alarm is escalated to either a shutdown or electrical trip condition (depending upon module configuration). For further details of the high current alarm, please see High Current Shutdown Alarm.

Alarm
Electrical trip
High current

5.5 OPERATION *(FOR PLC-5220 SERIES)*

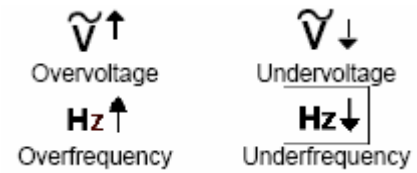
The following description details the sequences followed by a module containing the standard '*factory configuration*'. Always refer to your configuration source for the exact sequences and timers observed by any particular module in the field.

AUTOMATIC MODE OF OPERATION

NOTE:- If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing module modes will not be possible. Viewing the instruments and event logs and event logs is NOT affected by panel lock.

This mode is activated by pressing the AUTO pushbutton. An LED indicator beside the button confirms this action.

Should the mains (utility) supply fall outside the configurable limits for longer than the period of the mains transient delay timer, the mains (utility) failure indicator will illuminate and the mains (utility) available GREEN indicator LED extinguishes. Additionally, while in AUTO mode, the remote start input (if configured) is monitored. If active, the Remote Start Active indicator (if configured) illuminates.



To allow for short term mains supply transient conditions or false remote start signals, the Start Delay timer is initiated. After this delay, if the pre-heat output option is selected then the pre-heat timer is initiated, and the corresponding auxiliary output (if configured) will energise.

NOTE:- If the mains supply returns within limits, (or the Remote Start signal is removed if the start sequence was initiated by remote start) during the Start Delay timer, the unit will return to a stand-by state.

After the above delays the **Fuel Solenoid** is energised, then one second later, the **Starter Motor** is engaged.

The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and **Fail to Start** fault will be displayed accompanied by a flashing shutdown symbol.
When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing can be used for speed detection (This is selected by PC using the 5200 series configuration software). Rising oil pressure can also be used to disconnect the starter motor, however it

cannot be used for underspeed or overspeed detection.

After the starter motor has disengaged, the **Safety On** timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

Once the engine is running, the **Warm Up** timer, if selected is initiated, allowing the engine to stabilise before accepting the load.

If an auxiliary output has been selected to give a **load transfer** signal, this would then activate.

NOTE:-A load transfer will not be initiated until the Oil Pressure has risen. Thus preventing excessive wear on the engine.

On the return of the mains supply, (or removal of the **Remote Start** signal if the set was started by remote signal) , the **Stop** delay timer is initiated, once it has timed out, the **load Transfer** signal is de-energised, removing the load. The **Cooling** timer is then initiated, allowing the engine a cooling down period off load before shutting down. Once the **Cooling** timer expires the **Fuel Solenoid** is de-energised, bringing the generator to a stop.

Should the mains supply fall outside limits again (or the **Remote Start** signal be re-activated) during the cooling down period, the set will return on load.

MANUAL OPERATION

NOTE:- If a digital input configured to panel lock is active, the LCD will display the  icon. When in panel lock, changing module modes will not be possible. Viewing the instruments  and event logs  is NOT affected by panel lock.

To initiate a start sequence in **MANUAL**, press the  pushbutton. When the controller is in the manual mode (indicated by an LED indicator beside the button), pressing the **START** (**I**) button will initiate the start sequence.

NOTE:- There is no Start Delay in this mode of operation.
If the **pre-heat** output option is selected this timer is then initiated, and the auxiliary output selected is energised. After the above delay the **Fuel Solenoid** is energised, then the **Starter Motor** is engaged. The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and **Fail to Start**  fault will be displayed accompanied by a flashing shutdown  indicator.

When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing can be used for speed detection (This is selected by PC using the 5200 series configuration software). Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for underspeed or overspeed detection.

After the starter motor has disengaged, the **Safety On** timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

Once the engine is running, the **Warm Up** timer, if selected, is initiated, allowing the engine to stabilise before it can be loaded.

The generator will run off load, unless the mains supply fails or a **Remote Start on load** signal is applied. If **Close generator** has been selected as a control source, the appropriate auxiliary output will then activate.

The generator will continue to run **On** load regardless of the state of the mains supply or remote start input until the **Auto** mode is selected. If Auto mode is selected, and the mains supply is healthy with the remote start on load signal not active, then the **Remote Stop Delay Timer** begins, after which, the load is disconnected. The generator will then run **off** load allowing the engine a **cooling** down period.

Selecting **STOP (O)** de-energises the **FUEL SOLENOID**, bringing the generator to a stop.

TEST OPERATION

NOTE:- If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing module modes will not be possible. Viewing the instruments and event logs is NOT affected by panel lock.

 NOTE:- If a digital input configured to panel lock is active, the LCD will display the  icon. When in panel lock, changing module modes will not be possible. Viewing the instruments  and event logs  is NOT affected by panel lock.

To initiate a start sequence in **TEST**, press the  pushbutton. When the controller is in the test mode (indicated by an LED indicator beside the button), pressing the **START** (**I**) button will initiate the start sequence.

 **NOTE:-** There is no Start Delay in this mode of operation.

NOTE:- There is no Start Delay in this mode of operation.

If the **pre-heat** output option is selected this timer is then initiated, and the auxiliary output selected is energised. After the above delay the **Fuel Solenoid** is energised, then the **Starter Motor** is engaged. The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and **Fail to Start**  fault will be displayed accompanied by a flashing shutdown  indicator.

When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency

from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing can be used for speed detection (This is
selected by PC using the 5200 series configuration software). Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for underspeed or overspeed detection.
After the starter motor has disengaged, the **Safety On** timer is activated, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

Once the engine is running, the **Warm Up** timer, if selected, is initiated, allowing the engine to stabilise before it can be loaded.
The generator will continue to run **On** load regardless of the state of the mains supply or remote start input until the **Auto** mode is selected.
If Auto mode is selected, and the mains supply is healthy with the remote start on load signal not active, then the **Remote Stop Delay Timer** begins, after which, the load is disconnected. The generator will then run **off** load allowing the engine a **cooling** down period.

Selecting **STOP (O)** removes the Close Generator output (if configured) and de-energises the **FUEL SOLENOID**, bringing the generator to a stop.

PROTECTIONS

The module will indicate that an alarm has occurred in several ways;

The LCD display will indicate a 'common alarm' either :	 (warning),  (shutdown) or  (electrical trip)
If appropriate, the LCD display or LED indicators will display the appropriate alarm icon i.e. for battery charging failure :	

NOTE:- Alarm icons in the LED display area are 'hid until lit'. This means that the display area appears totally clear, and 'free from clutter'. The advantage of this is that when an alarm does occur, the respective LED icon will illuminate on the otherwise blank fascia. This makes alarm identification much clearer.

NOTE:- Alarm icons in the LED display area are 'hid until lit'. This means that the display area appears totally clear, and 'free from clutter'. The advantage of this is that when an alarm does occur, the respective LED icon will illuminate on the otherwise blank fascia. This makes alarm identification much clearer.

If no alarms are present the LCD will extinguish any alarm icons.

In the event of a warning alarm the LCD will display the appropriate icon. If a shutdown then occurs the module will display the appropriate icon. The original warning alarm icon will remain displayed.

Example:-

Followed by….

Low battery volts warning indicator still present, common alarm indicator has changed to a shutdown symbol and is now flashing.
Also present is the flashing underspeed LED.

Underspeed and Shutdown alarm Icons are displayed flashing. The original warning will remain displayed as long at the triggering conditions remain. Any subsequent warnings or shutdowns that occur will be displayed steady, therefore only the first-up shutdown will appear flashing.

WARNINGS

Warnings are non-critical alarm conditions and do not affect the operation of the generator system, they serve to draw the operators attention to an undesirable condition.

In the event of a warning alarm the LCD will display:-

BATTERY CHARGE FAILURE, if the module does not detect a voltage from the warning light terminal on the auxiliary charge alternator the  icon will illuminate.
BATTERY LOW VOLTAGE, if the module detects that the plant DC supply has fallen below the low volts setting level, the module will display:-

The Battery Low Voltage alarm is delayed by the Low DC Volts Delay timer.
BATTERY HIGH VOLTAGE, if the module detects that the plant DC supply has risen above the high volts setting level, the module will display:-

The Battery High Voltage alarm is delayed by the High DC Volts Delay timer.
FAIL TO STOP, If the module detects the engine is still running when the ‘Fail to stop timer’

expires, then the module will display:-

NOTE:- 'Fail to Stop' could indicate a faulty oil pressure sender - If engine is at rest check oil sender wiring and configuration.

AUXILIARY INPUTS, if an auxiliary input has been configured as a warning the appropriate LCD segment will be displayed:-

LOW FUEL LEVEL. If the fuel level detected by the fuel level sender falls below the low fuel level setting, a warning will occur.

The icon will illuminate.

ANALOGUE PRE-ALARMS

The following alarms are termed 'pre-alarms' as they pre warn the operator of a potentially more serious alarm condition. For instance, if the engine temperature rises past the pre alarm level, a warning condition will occur to notify the operator. If the temperature falls below this level, then the alarm ceases, and the set will continue to run as normal. However if the temperature continues to rise until the coolant temperature trip point is reached, the warning is escalated and a high coolant temperature shutdown is initiated.

During a pre-alarm condition, the warning symbol is displayed on the LCD display, along with the appropriate icon:

LOW OIL PRESSURE, if the module detects that the engine oil pressure has fallen below the low oil pressure pre-alarm setting level after the **Safety On** timer has expired, a warning will occur.

The icon will illuminate.

HIGH ENGINE TEMPERATURE if the module detects that the engine coolant temperature has exceeded the high engine temperature pre-alarm setting level after the **Safety On** timer has expired, a warning will occur.

The icon will illuminate.

OVERSPEED, if the engine speed exceeds the pre-alarm trip a warning is initiated.

The icon will illuminate.

Overspeed is not delayed, it is an **immediate warning**.

UNDERSPEED, if the engine speed falls below the pre-set pre-alarm after the Safety On timer has expired, a warning is initiated.

The icon will illuminate.

GENERATOR HIGH FREQUENCY if the module detects a generator output frequency in excess of the pre-set pre-alarm, a warning is initiated.

The Hz icon will illuminate.

Generator High Frequency is not delayed, it is an immediate warning.

GENERATOR LOW FREQUENCY, if the module detects a generator output frequency below

the pre-set pre-alarm after the Safety On timer has expired, a warning is initiated.
The Hz↓ icon will illuminate.

GENERATOR HIGH VOLTAGE if the module detects a generator output voltage in excess of the pre-set trip a shutdown is initiated.
The V↑ icon will illuminate.
High voltage is not delayed, it is an **immediate shutdown**.

GENERATOR LOW VOLTAGE if the module detects a generator output voltage below the below the pre-set pre-alarm after the Safety On timer has expired, a warning is initiated.
The V↓ icon will illuminate.

J1939 **CAN ECU ERROR** If the module is configured for J1939 operation and receives an “error” message from the engine control unit, ‘Can ECU fail” is shown on the module’s display and a warning alarm is generated. Usually, an associated alarm code is also displayed, detailing the exact alarm detected. For details on these code meanings, refer to the ECU instructions provided by the engine manufacturer.

HIGH CURRENT WARNING ALARM

GENERATOR HIGH CURRENT, if the module detects a generator output current in excess of the pre-set trip a warning is initiated.
The A↑ icon will illuminate.
If this high current condition continues for an excess period of time, then the alarm is escalated to a shutdown condition. For further details of the high current alarm, please see High Current Shutdown Alarm.

SHUTDOWNS

Shutdowns are latching and stop the Generator. The alarm must be cleared, and the fault removed to reset the module.
In the event of a shutdown alarm the LCD will display:-
(flashing).
The appropriate icon will also be displayed flashing

NOTE:- The alarm condition must be rectified before a reset will take place. If the alarm condition remains it will not be possible to reset the unit (The exception to this is the Low Oil Pressure alarm and similar ‘delayed alarms’, as the oil pressure will be low with the engine at rest). Any subsequent warnings or shutdowns that occur will be displayed steady, therefore only the first-up shutdown will appear flashing.

FAIL TO START, if the engine does not fire after the pre-set number of attempts has been made a shutdown will be initiated.
The ! icon will illuminate.

EMERGENCY STOP, removal of the **+ve DC** Supply from the Emergency Stop input initiates the following sequence, firstly it will initiate a controlled shutdown of the Generator and prevent

any attempt to restart the Generator until the Emergency Stop push-button has been reset. Secondly it removes the **+ve DC** supply from both the Fuel Solenoid and Starter Solenoid.
The icon will illuminate.

NOTE:- The Emergency Stop +Ve signal must be present otherwise the unit will shutdown.

LOW OIL PRESSURE, if the module detects that the engine oil pressure has fallen below the low oil pressure trip setting level after the **Safety On** timer has expired, a shutdown will occur.
The icon will illuminate.

HIGH ENGINE TEMPERATURE if the module detects that the engine coolant temperature has exceeded the high engine temperature trip setting level after the **Safety On** timer has expired, a shutdown will occur.
The icon will illuminate.

OVERSPEED, if the engine speed exceeds the pre-set trip a shutdown is initiated.
The icon will illuminate.
Overspeed is not delayed, it is an **immediate shutdown**.

NOTE:-During the start-up sequence the overspeed trip logic can be configured to allow an extra trip level margin. This is used to prevent nuisance tripping on start-up - Refer to the 5200 series configuration software manual under heading 'Overspeed Overshoot' for details.

UNDERSPEED, if the engine speed falls below the pre-set trip after the Safety On timer has expired, a shutdown is initiated.
The icon will illuminate.

GENERATOR HIGH FREQUENCY if the module detects a generator output frequency in excess of the pre-set trip a shutdown is initiated.
The Hz icon will illuminate.

Generator High Frequency is not delayed, it is an immediate shutdown.
GENERATOR LOW FREQUENCY, if the module detects a generator output frequency below the pre-set trip after the Safety On timer has expired, a shutdown is initiated.
The Hz icon will illuminate.

GENERATOR HIGH VOLTAGE if the module detects a generator output voltage in excess of the pre-set trip a shutdown is initiated.
The V icon will illuminate.
High voltage is not delayed, it is an immediate shutdown.

GENERATOR LOW VOLTAGE if the module detects a generator output voltage below the below the pre-set trip after the Safety On timer has expired, a shutdown is initiated.
The V icon will illuminate.
OIL PRESSURE SENDER OPEN CIRCUIT, if the module detects a loss of signal from the oil pressure sender (open circuit) a shutdown is initiated. The LCD will indicate:-
(Steady) (And '-----' on the engine oil pressure instrument). Sender failure is not delayed, it is an **immediate shutdown**.

AUXILIARY INPUTS, if an auxiliary input has been configured as a shutdown the appropriate LCD segment will be displayed:-

LOSS OF SPEED SIGNAL, if the speed sensing signal is lost during cranking, a shutdown is initiated.
The icon will illuminate. (Steady) (And '-----' on the engine RPM instrument).

NOTE:- This will only occur if the speed sensing signal is lost during cranking or during the safety on timer. If the signal is lost during normal operation the Generator will shutdown with an Under-speed alarm.

CAN DATA FAIL If the module is configured for J1939 operation and does not detect data on the engine CANbus datalink, a shutdown will occur and 'Can data fail' is shown on the module's display

CAN ECU FAIL If the module is configured for J1939 operation and receives a "fail" message from the engine control unit, the engine is shutdown and 'Can ECU fail" is shown on the module's display. Usually, an associated failure code is also displayed, detailing the exact failure detected. For details on these code meanings, refer to the ECU instructions provided by the engine manufacturer.

HIGH CURRENT SHUTDOWN ALARM

GENERATOR HIGH CURRENT, if the module detects a generator output current in excess of the pre-set trip a warning is initiated. This warning will continue for a period of time depending upon the level of overload that the generator is subjected to, and the configuration setting for Generator High Current in the 5200 series configuration software.
For instance the factory default settings for Generator High Current allow for a loading of the generator to 110% for one hour. That is to say if the generator load level exceeds the trip point by 10%, a warning alarm will occur while the overload condition exists. If the load level does not drop to normal levels within one hour, the set is stopped, the 5220 module displaying either shutdown alarm or electrical trip alarm depending upon module configuration.
Additionally, the icon will illuminate.

NOTE:- Higher overload levels will result in a faster acting shutdown condition. For instance with the factory default configuration, an overload level twice that of the trip level (typically 200%) will result in a Generator High Current shutdown condition after 36 seconds.

For details of the relationship between the overload and the shutdown time, please see the Appendix section of this manual.

ELECTRICAL TRIPS

Electrical trips are latching and stop the Generator but in a controlled manner. On initiation of the electrical trip condition the module will de-energise the **'Close Generator'** Output to remove the load from the generator. Once this has occurred the module will start the Cooling timer and allow the engine to cool off-load before shutting down the engine. The alarm must be accepted and cleared, and the fault removed to reset the module.

In the event of an electrical trip alarm the icon will illuminate. Additionally, During the cooling timer the warning symbol is displayed followed by the flashing shutdown symbol when the cooling timer has expired.

AUXILIARY INPUTS, if an auxiliary input has been configured as an electrical trip the appropriate LCD segment will be displayed:-

GENERATOR HIGH CURRENT. If the module detects a generator output current in excess of the pre-set trip a warning is initiated.
The icon will illuminate.

If this high current condition continues for an excess period of time, then the alarm is escalated to either a shutdown or electrical trip condition (depending upon module configuration). For further details of the high current alarm, please see High Current Shutdown Alarm.

5.6 OPERATION *(FOR PLC-55X SERIES)*
NORMAL MANUAL OPERATION

Operation	Detail
To initiate a start sequence, press the **'Manual'** push-button.	
The LED above the button will illuminate and the LCD display will briefly indicate:	MANUAL MODE

Operation	Detail
The LED above the button will illuminate and the LCD display will then indicate:	GENERATOR AT REST
Then, press and hold the **START** push-button, once the module has commenced the start sequence the button may then be released. (However, it is possible to configure the module such the start-button must be held pressed to maintain engine cranking until disconnect speed is reached - Refer to your configuration Source)	
The LED above the button will illuminate and the LCD display will briefly indicate:	START
If the **pre-heat** output option is configured, the Pre-heat timer is then initiated, and the auxiliary output selected is energised.	PRE-HEATING 00:09
After the pre-heat timer has expired the module will de-energise the pre-heat output and commence engine starting; the following sequence occurs.	PRE-HEATING 00:00

The **Fuel Solenoid** is energised, then after a 1 second delay the **Starter Motor** is engaged	FUEL ON
The engine is cranked for the duration of the crank timer	CRANKING ATTEMPT.1 00:08

When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing can be used for terminating cranking, along with options of Charge alternator voltage and oil pressure.

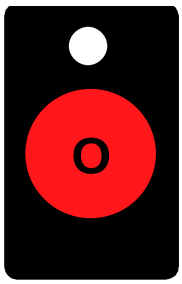
If a Magnetic Pick-up is utilised it is also possible to configure the module so that if the starter motor fails to engage on the first attempt, the starter relay will be de-energised and the a second attempt to engage will be made. For further details on this function please refer to the P810 for Windows™ configuration manual.

Operation	Detail
Should the engine not fire on the first attempt and the crank timer expires, the module will rest the starter for the duration of the crank rest timer.	CRANK REST. 1 00:04
Once this has expired the module will once again attempt to start the engine.	CRANKING ATTEMPT 2 00:07

This will be repeated until either the engine fires or the pre-set number of attempts to start have been completed…

Operation	Detail
In this instance the module will indicate a **'Fail to start'** alarm.	SHUTDOWN FAILED TO START

NOTE:- Should a 'Fail to start' alarm occur the module must be placed into STOP/RESET mode by pressing the STOP/RESET



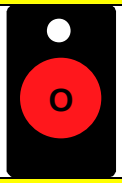
PUSHBUTTON. Determine why the engine failed to fire before making any further attempts to start.

If the engine start is successful, the following sequence oc

Operation	Detail
After the starter motor has disengaged, the **Safety On** timer is activated.	WAITING FOR SAFETY ON 00:08

This timer allows Oil Pressure, High Engine Temperature, Underspeed, Undervolts, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

Operation	Detail

Once the engine is running and the Safety on timer has expired, full fault protection is made available.	GENERATOR AVAILABLE IN MANUAL
Pressing the **STOP/RESET PUSHBUTTON** will de-energise the **Fuel Solenoid** and bring the engine to rest.	
The LCD screen will acknowledge the button press…	STOP/RESET
While the engine runs down the module will start it's 'Fail to stop' timer.	STOPPING 00:24
If the engine is still running when the 'Fail to stop' Timer expires the module will alarm.	SHUTDOWN FAIL TO STOP

NOTE: The Load Transfer Output will not normally become active during a 'Manual' start. However, if the 'Remote Start' input is activated once the engine is running then the Load Transfer Output will be activated and remain active until the engine is stopped.

AUTOMATIC OPERATION (*(FOR PLC 5110, 5220, 560 SERIES)* Mains Failure*/* REMOTE)

Operation	Detail
If the module is placed in **'AUTO'** mode by pressing the **'AUTO' PUSHBUTTON**, it will monitor the auxiliary inputs for a **'REMOTE START'** signal. In addition the module will monitor the incoming AC mains supply.	
The LCD display will briefly indicate	AUTO MODE
The LCD display will then indicate	GENERATOR AT REST

Should the **'REMOTE START'** signal be detected, or the Mains supply become outside of acceptable limits, the following sequence will occur…

The module will start its 'Start Delay' timer, this is used to ensure that the start event is really required and not just a momentary transient signal.	START DELAY 00:09

Once this timer has expired the module will continue with its normal start sequence as detailed below. Should the remote start signal be removed or the mains return to within limits during either the start delay timer or pre-heat timer, the module will terminate its start sequence and return to its standby **'AUTO'** state until such time as a start is signalled again.

Operation	Detail
If the **pre-heat** output option is configured, then the pre-heat timer is then initiated, and the auxiliary output selected is energised.	PRE-HEATING 00:09
After the pre-heat timer has expired the module will de-energise the pre-heat output and commence engine starting; the following sequence occurs.	PRE-HEATING 00:00
The **Fuel Solenoid** is energised, then after a 1 second delay the **Starter Motor** is engaged	FUEL ON
The engine is cranked for the duration of the crank timer	CRANKING ATTEMPT.1 00:06

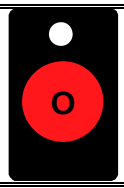
When the engine fires, the starter motor is disengaged and locked out at a pre-set frequency from the Alternator output. Alternatively a Magnetic Pickup mounted on the flywheel housing can be used for terminating cranking, along with options of Charge alternator voltage and oil pressure.
If a Magnetic Pick-up is utilised it is also possible to configure the module so that if the starter motor fails to engage on the first attempt, the starter relay will be de-energised and the a second attempt to engage will be made. For further details on this function please refer to the P810 For Windows™ configuration manual.

Operation	Detail
Should the engine not fire on the first attempt and the crank timer expires, the module will rest the starter for the duration of the crank rest timer.	CRANK REST. 1 00:04
Once this has expired the module will once again attempt to start the engine.	CRANKING ATTEMPT 2 00:07

This will be repeated until either the engine fires or the pre-set number of attempts to start have been completed…

Operation	Detail
In this instance the module will indicate a **'Fail to start'** alarm.	SHUTDOWN FAIL TO START

NOTE:- Should a 'Fail to start' alarm occur the module must be placed into STOP/RESET mode by pressing the STOP/RESET PUSHBUTTON. Determine why the engine failed to fire before making any further attempts to start.



If the engine start is successful, the following sequence occurs:-

Operation	Detail
After the starter motor has disengaged, the **Safety On** timer is activated.	WAITING FOR SAFETY ON 00:09

This timer allows Oil Pressure, High Engine Temperature, Underspeed, Undervolts, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault. Once the engine is running and the safety on timer has expired, full fault protection is made available.

Operation	Detail
Once the generator is running at the correct speed and up to voltage the Warm-up timer is then initiated	**WARMING UP** **00:08**

Should the remote start signal be removed or the mains return to within limits during either of the cranking or warm-up timers, the module will terminate its normal auto start sequence will initialise its 'Cooling Timer' and eventually return to its standby **'AUTO'** state until such time as a start is signalled again.

Operation	Detail
After the warm-up timer has expired the module will open the mains contactor relay.	GENERATOR AVAILABLE IN AUTO
After a short transfer delay to allow the mains contactor to open the generator contactor will close.	GENERATOR AVAILABLE

The generator in now up and running and is selected to supply the load.

Operation	Detail
Should the remote start signal be removed, or the mains return the module will first initiate a return timer to ensure that it is safe to stop the generator.	**GENERATOR AVAILABLE** **00:06**

Should the remote start input become active again or the mains fall outside of acceptable limits again within this time the module will continue to run the generator on load and ignore the fluctuating remote start signal or mains supply until such time as it remains in-active for the duration of the stop delay timer.

Once the return timer has expired, the module will de-energise the **Load Transfer** output.

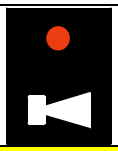
Operation	Detail
The module will then commence its cooling timer, this allows the engine to run off load to ensure that it has adequately cooled before being brought to a standstill.	**COOLING DOWN** **2:34**
Once the cooling timer has expired the module will de-energise the **fuel solenoid** and the engine will be brought to rest.	**STOPPING** **00:27**
If the engine is still running when the 'Fail to stop' Timer expires the module will alarm.	**SHUTDOWN** **FAIL TO STOP**
Should the engine come to rest within the time allow by the fail to stop timer the screen will revert to	**GENERATOR AT REST**

Note:- It is possible that the module has been configured to perform regular exercise runs automatically. This may be used to exercise the engine periodically in standby applications or to assist in peak-lopping arrangements. Therefore even though the remote start input is not active and the mains supply is healthy, it is possible that if the system is in the 'Auto' mode the engine may start unexpectedly if a scheduled run is configured to occur.

WARNING!:- Before commencing work on the generating set it is important to take steps to ensure that a scheduled run cannot start the engine unexpected. The system should at a minimum be taken out of the 'Auto' mode and 'Stop' selected. Depending on the nature of the work to be performed - further steps to ensure safety while working may be necessary.

PROTECTIONS

The module will indicate that an alarm has occurred in several ways;

The Audible Alarm will sound. This can be silenced by pressing the '**Mute**' button	
The "Common alarm" LED will illuminate(**Warning** = *Steady*, **Shutdown** = *Flashing [steady when Muted])*	
The LCD display will jump from the 'Information page' to display the Alarm Page and the LED above the page icon will illuminate	
The LCD will the display	**ALARM**
Followed by the appropriate alarm text	**SHUTDOWN** **LOW OIL PRESSURE**

If no alarms are present the LCD will display the following message and will then return to the '**Information Display**' page;

NO ALARM PRESENT

The LCD will display multiple alarms E.g. "High Engine Temperature shutdown", "Emergency Stop" and "Low Coolant Warning" alarms have been triggered. These will automatically scroll round in the order that they occurred;

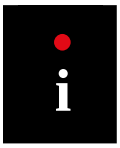
ALARM
SHUTDOWN HIGH ENGINE TEMP
SHUTDOWN EMERGENCY STOP
WARNING LOW COOLANT LEVEL

It is also possible to manually scroll to display the different alarms

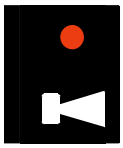
Initial display	>>>>>	ALARM
Pressing the DOWN button the LCD will then show…		SHUTDOWN HIGH ENGINE TEMP
Pressing the DOWN button again the LCD will then show…		SHUTDOWN EMERGENCY STOP
Pressing the DOWN button again the LCD will then show…		WARNING LOW COOLANT LEVEL
Pressing the DOWN button again the LCD will then show…		ALARM
Pressing the UP button the LCD will then show…etc, etc, etc.		WARNING LOW COOLANT LEVEL

ALARMS

If the module is operating in the normal '**INFORMATION PAGE**' display any alarm condition will automatically be displayed.

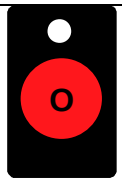


Jumps to >>>



If the user is viewing instrumentation, e.g.

Then the alarm page will not automatically be displayed and must be viewed by the operator.

To view an alarm operate the page button to move to the 'Alarm' page.	
To clear an alarm the original triggering conditions must be removed before the alarm can be reset. Alarms are reset by pressing the 'Stop/Reset' pushbutton.	

WARNINGS

Warnings are non-critical alarm conditions and do not affect the operation of the generator system, they serve to draw the operators attention to an undesirable condition.

BATTERY CHARGE FAILURE, if the module does not detect a voltage from the warning light terminal on the auxiliary charge alternator, the module will display '**WARNING CHARGE ALT FAILURE**' on the LCD. The **COMMON ALARM LED** will also illuminate.

BATTERY LOW VOLTAGE, if the module detects that the plant DC supply has fallen below the low volts setting level , the module will display '**WARNING LOW BATTERY VOLTAGE**' on the LCD. The **COMMON ALARM LED** will also illuminate.

BATTERY HIGH VOLTAGE, if the module detects that the plant DC supply has risen above the high volts setting level , the module will display '**WARNING HIGH BATTERY VOLTAGE**' on the

LCD. The **COMMON ALARM LED** will also illuminate.

OIL PRESSURE SENDER/SWITCH, the module can be configured to only attempt to crank the engine if the Oil Pressure is initially low, (engine at rest, not running). The module will display '**FAIL TO STOP'** on the LCD. The **COMMON ALARM LED** will also illuminate.
LOW OIL PRESSURE, if the module detects that the engine oil pressure has fallen below the low oil pressure pre-alarm level after the **Safety On** timer has expired, a warning alarm will occur. The LCD will indicate '**WARNING LOW OIL PRESSURE**' and the **COMMON ALARM LED** will illuminate.

HIGH ENGINE TEMPERATURE, if the module detects that the engine coolant temperature has exceeded the high engine temperature pre-alarm level after the **Safety On** timer has expired, a warning alarm will occur. The LCD will indicate '**WARNING HI COOLANT TEMP.**' and the **COMMON ALARM LED** will illuminate.

OVERSPEED, if the engine speed exceeds the pre-alarm level a warning is initiated. The LCD will
indicate **'WARNING OVERSPEED**' and the **COMMON ALARM LED** will illuminate.

UNDERSPEED, if the engine speed falls below the pre-alarm level after the Safety On timer has expired, a warning alarm is initiated. The LCD will indicate '**WARNING UNDERSPEED**' and the **COMMON ALARM LED** will illuminate.

GENERATOR HIGH FREQUENCY, if the module detects a generator output frequency in excess of the pre-alarm level a warning is initiated. The LCD will indicate **'WARNING GEN HIGH FREQUENCY'** and the **COMMON ALARM LED** will illuminate.

GENERATOR LOW FREQUENCY, if the module detects a generator output frequency below the pre-alarm level after the Safety On timer has expired, a warning is initiated. The LCD will indicate **'WARNING GEN LOW FREQUENCY'** and the **COMMON ALARM LED** will illuminate.

GENERATOR HIGH VOLTAGE, if the module detects a generator output voltage in excess of the pre-alarm level a warning is initiated. The LCD will indicate **'WARNING GEN HIGH VOLTAGE WARNING'** and the **COMMON ALARM LED** will illuminate.

GENERATOR LOW VOLTAGE, if the module detects a generator output voltage below the pre-alarm level after the Safety On timer has expired, a warning is initiated. The LCD will indicate **'WARNING GEN LOW VOLTAGE WARNING**' and the **COMMON ALARM LED** will illuminate.

MAINS PHASE SEQUENCE WRONG  **,** if the module detects a generator phase rotation error a warning is initiated. The LCD will indicate **'MAINS PHASE SEQ WRONG'** and the **COMMON ALARM LED** will illuminate.

MAINTENANCE DUE ALARM, if the engine exceed the allowed running hours or time between periodic maintenance a warning is initiated. The LCD will indicate **'MAINTENANCE NOW DUE'** and the **COMMON ALARM LED** will illuminate. To clear the alarm a 'MAINTENANCE RESET'

must be performed (refer to config source or P810 for Windows software manual for more detail)

AUXILIARY INPUTS, if an auxiliary input has been configured as a warning the appropriate LCD message will be displayed and the **COMMON ALARM LED** will illuminate.

SHUTDOWNS

Shutdowns are latching and stop the Generator. The alarm must be accepted and cleared, and the fault removed to reset the module.

NOTE:- The alarm condition must be rectified before a reset will take place. If the alarm condition remains it will not be possible to reset the unit (The exception to this is the Low Oil Pressure alarm and the like, as the oil pressure will be low with the engine at rest).

FAIL TO START, if the engine does not fire after the pre-set number of attempts has been made a shutdown will be initiated. The LCD will indicate '**SHUTDOWN FAIL TO START**' and the **COMMON ALARM** and **LED** will flash.

EMERGENCY STOP, removal of the **+ve DC** Supply from the Emergency Stop input initiates the following sequence, firstly it will initiate a controlled shutdown of the Generator and prevent any attempt to restart the Generator until the Emergency Stop push-button has been reset. Secondly it removes the **+ve DC** supply from both the Fuel Solenoid and Starter Solenoid. The LCD will indicate '**SHUTDOWN EMERGENCY STOP**' and the **COMMON ALARM LED** will flash.

NOTE:- The Emergency Stop +Ve signal must be present otherwise the unit will shutdown。

LOW OIL PRESSURE, if the module detects that the engine oil pressure has fallen below the low oil pressure trip setting level after the **Safety On** timer has expired, a shutdown will occur. The LCD will indicate '**SHUTDOWN LOW OIL PRESSURE**' and the **COMMON ALARM LED** will flash.

HIGH ENGINE TEMPERATURE, if the module detects that the engine coolant temperature has exceeded the high engine temperature trip setting level after the **Safety On** timer has expired, a shutdown will occur. The LCD will indicate '**SHUTDOWN HIGH COOLANT TEMP**' and the **COMMON ALARM LED** will flash.

OVERSPEED, if the engine speed exceeds the pre-set trip a shutdown is initiated. The LCD will indicate **'SHUTDOWN OVERSPEED**' and the **COMMON ALARM LED** will flash. Overspeed is not delayed, it is an **immediate shutdown**.

NOTE:-However during the start-up sequence the overspeed trip logic can be configured to allow an

extra trip level margin, this is used to prevent nuisance tripping on start-up - Refer to the P810 for Window™ Configuration Manual under heading 'Overspeed Overshoot' for details.

UNDERSPEED, if the engine speed falls below the pre-set trip after the Safety On timer has expired, a shutdown is initiated. The LCD will indicate '**SHUTDOWN UNDERSPEED**' and the **COMMON ALARM LED** will flash.

GENERATOR HIGH FREQUENCY, if the module detects a generator output frequency in excess of the pre-set trip a shutdown is initiated. The LCD will indicate **'SHUTDOWN GEN HIGH FREQUENCY'** and the **COMMON ALARM LED** will flash. High frequency is not delayed, it is an **immediate shutdown**.

GENERATOR LOW FREQUENCY, if the module detects a generator output frequency below the pre-set trip after the Safety On timer has expired, a shutdown is initiated. The LCD will indicate **'GEN LOW FREQUENCY'** and the **COMMON ALARM LED** will flash.

GENERATOR HIGH VOLTAGE, if the module detects a generator output voltage in excess of the pre-set trip a shutdown is initiated. The LCD will indicate **'GEN HIGH VOLTAGE'** and the **COMMON ALARM LED** will flash. High voltage is not delayed, it is an **immediate shutdown**.

GENERATOR LOW VOLTAGE, if the module detects a generator output voltage below the pre-set trip after the Safety On timer has expired, a shutdown is initiated. The LCD will indicate **'GEN LOW VOLTAGE**' and the **COMMON ALARM LED** will flash.

OIL PRESSURE SENDER OPEN CIRCUIT, if the module detects a loss of signal from the oil pressure sender (open circuit) a shutdown is initiated. The LCD will indicate **'OIL PRESS SENDER FAULT**' and the **COMMON ALARM LED** will flash. Sender failure is not delayed, it is an **immediate shutdown**.

GENERATOR EARTH FAULT⚠, if the module detects a generator earth fault current in excess of the pre-set trip a shutdown is initiated. The LCD will indicate '**GEN EARTH FAULT**' and the **COMMON ALARM LED** will flash.

GENERATOR PHASE SEQUENCE WRONG⚠, if the module detects a generator phase rotation error

a shutdown is initiated. The LCD will indicate **'GEN PHASE SEQ WRONG'** and the **COMMON ALARM LED** will flash.

AUXILIARY INPUTS, if an auxiliary input has been configured as a Shutdown the appropriate LCD message will be displayed and the **COMMON ALARM LED** will flash.

⚠= Enhanced Instrumentation Versions only.

ELECTRICAL TRIPS

Electrical trips are latching and stop the Generator but in a controlled manner. On initiation of the electrical trip condition the module will de-energise the 'Load Transfer' Output to remove the load from the generator. Once this has occurred the module will start the Cooling timer and allow the engine to cool, off-load before shutting down the engine. The alarm must be accepted

and cleared, and the fault removed to reset the module.

GENERATOR REVERSE POWER⚡, if the module detects a generator reverse power current in
excess of the pre-set trip a shutdown is initiated. The LCD will indicate '**GEN REVERSE POWER**' and the **COMMON ALARM LED** will flash.

GENERATOR OVER CURRENT, if the module detects a generator output current in excess of the pre-set trip a shutdown is initiated. The LCD will indicate '**GEN OVER CURRENT**' and the **COMMON ALARM LED** will flash.

GENERATOR SHORT CIRCUIT, if the module detects a generator fault current in excess of the pre-set trip a shutdown is initiated. The LCD will indicate '**GEN SHORT CIRCUIT**' and the **COMMON ALARM LED** will flash.

AUXILIARY INPUTS, if an auxiliary input has been configured as an Electrical Trip the appropriate LCD message will be displayed and the **COMMON ALARM LED** will illuminate.

⚡= Enhanced Instrumentation Versions only.

PRE-ALARMS AND OPTIONS

During module configuration it is possible to select pre-alarm levels for all of the above shutdowns and electrical trips to give a warning that the trip value is being approached. This allows the operator to take steps to prevent the shutdown from ultimately occurring by rectifying the triggering condition.

If the module is fitted with the optional RS232 communication board, then the following alarm is available:-

MODEM POWER FAULT, if the module detects a modem supply current in excess of 350mA warning is initiated. The LCD will indicate **'MODEM POWER FAULT'** and the **COMMON ALARM LED** will illuminate. The power supply to the modem will be removed until the alarm is reset.

If the module is fitted with the option of Check Sync or Auto Sync , then the following alarm is available:-

FAILED TO SYNCHRONISE, if the module cannot synchronise within the timer allowed by the Synchronising timer a warning is initiated. The LCD will indicate **'FAILED TO SYNC'** and the **COMMON ALARM LED** will illuminate.

SYNCHRONISING NOTES

CHECK SYNC VERSIONS

A special version of the module provides the function of Check Sync relay and Synchroscope display. The module will control the operation of the load switching device to allow parallel operation with the mains supply only when the two supplies are in Sync. These functions can

be used to provide manual Peak lopping/ Peak shaving and short duration no-break or bump-less transfers back to the mains supply following a mains failure.

AUTO SYNC VERSIONS

A special version of the module provides the function of Automatic synchronising. The module features all the functions associated with the Check sync version and in addition it provides control signals to the Engine Governor and the Alternator AVR to control the speed and voltage output from the generating set.

These functions can be used to provide peak lopping/ peak shaving (without load share control) and true no-break or bump-less transfers back to the mains supply following a mains failure.

The Auto-sync 55x module provides the ability to control the generator by adjusting the speed (frequency) and voltage being output. Several method of providing this control are available. The following pages give typical examples of interfacing with the engine governor and alternator AVR.

Refer to the P810 software manual for further details.

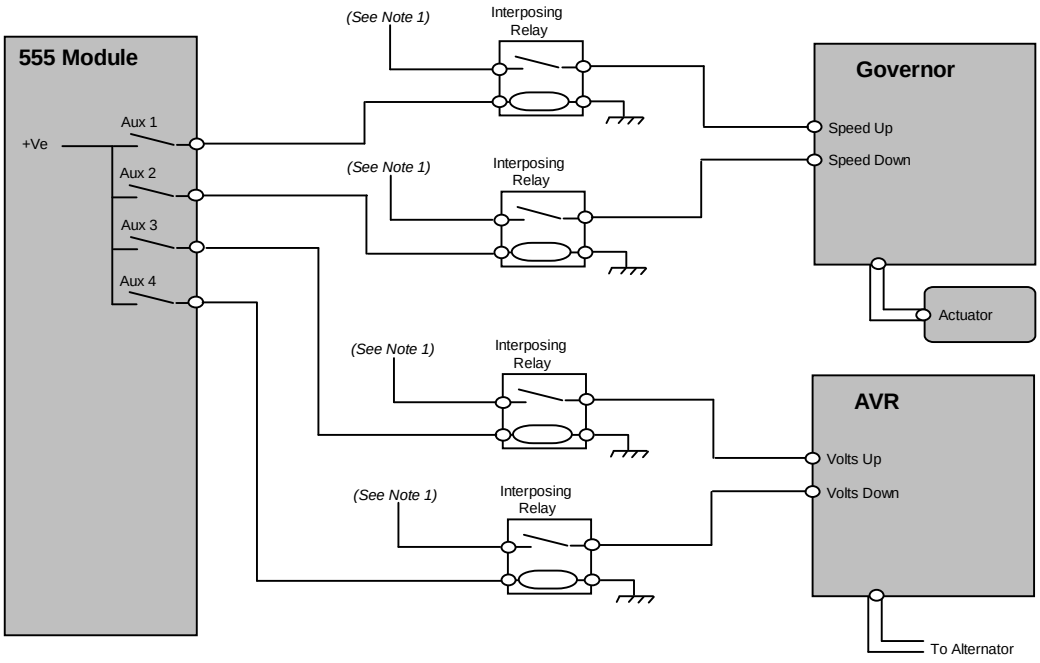
NOTE:- To verify if your particular 55x module has any of the above special features fitted please refer to page 26 for the Power Up LCD display information.

1) GOVERNOR AND AVR CONTROL USING INTERNAL RELAYS DIRECTLY.

This scheme uses the 55x modules own internal relays to control the speed and voltage output. It is only possible to use this system of control if the Governor or AVR in question supports speed up/speed down and volts up/volts down via control input.

CAUTION!:- It is essential to use only the modules own internal relays for this type of control (Auxiliary outputs 1-4). Use of the 157 relay expansion module outputs to do the same could result in instability due to the much slower response of the 157 expansion modules control relays.

TYPICAL CONNECTIONS



Note 1:- Interposing relay should connect to recommended polarity and voltage for Governor/AVR input. Refer to Governor or AVR manufacturer for details.

MODULE CONFIGURATION SETTING FOR 555 AUXILIARY RELAYS

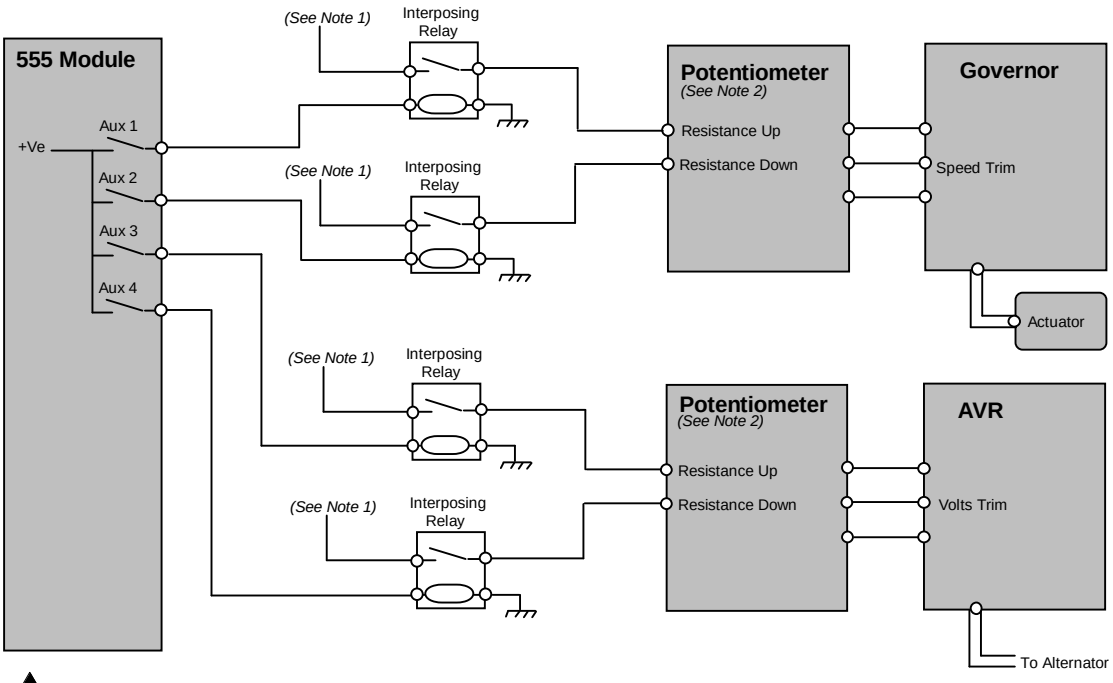
Aux 1	Energise	Speed Raise Relay
Aux 2	Energise	Speed Lower Relay
Aux 3	Energise	Voltage Raise Relay
Aux 4	Energise	Voltage Lower Relay

2) GOVERNOR AND AVR CONTROL USING INTERNAL RELAYS TO DRIVE MOTORISED/ELECTRONIC POTENTIOMETER.

This scheme uses the 55x modules own internal relays to control the speed and voltage output via an external motorised or electronic potentiometer. It is only possible to use this system of control if the Governor or AVR in question supports speed or voltage control via an external potentiometer.

CAUTION!:- It is essential to use only the modules own internal relays for this type of control (Auxiliary outputs 1-4). Use of the 157 relay expansion module outputs to do the same could result in instability due to the much slower response of the 157 expansion modules control relays.

TYPICAL CONNECTIONS



Note 1:- Interposing relay should connect to recommended polarity and voltage for potentiometer input. Refer to potentiometer manufacturer for details.

Note 2:- The Potentiometer output should be a suitable resistance as recommended by the Governor/AVR manufacturer.

MODULE CONFIGURATION SETTING FOR 555 AUXILIARY RELAYS

Aux 1	Energise	Speed Raise Relay
Aux 2	Energise	Speed Lower Relay
Aux 3	Energise	Voltage Raise Relay
Aux 4	Energise	Voltage Lower Relay

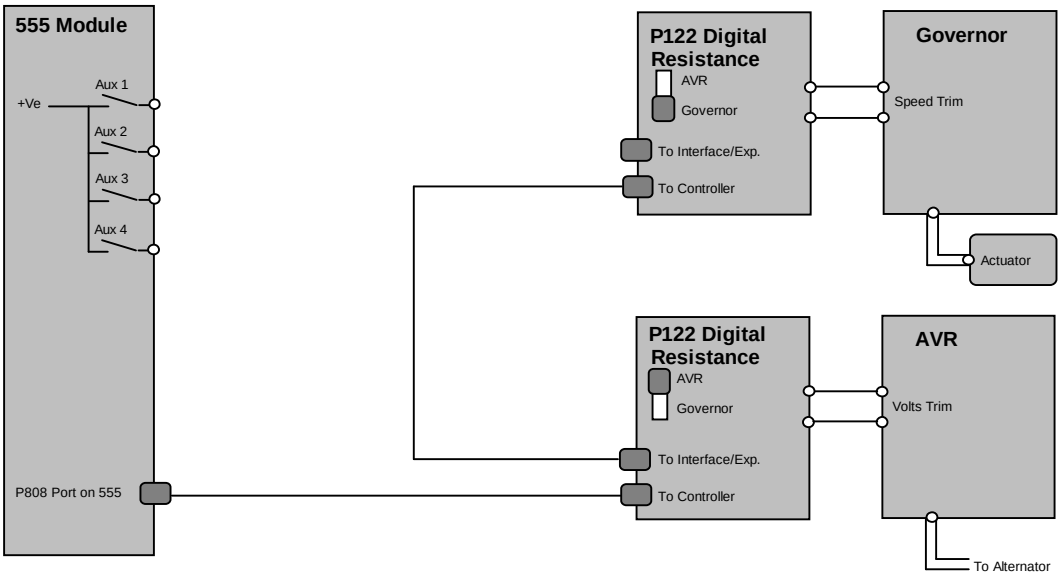
3) GOVERNOR AND AVR CONTROL USING P122 DIGITAL RESISTANCE MODULES

This scheme uses the 55x modules to control the speed and voltage output via the P122 (Governor and AVR) digital resistance boxes. This devices gives a simple modular approach to solving the problem of interfacing to the Governor and AVR. This also negates the need to fit interposing relays and motorised potentiometers and have the additional benefit of leaving the modules own internal relays available for other functions. It is only possible to use this system of control if the Governor or AVR in question supports speed or voltage control via an external potentiometer.

CAUTION!:- When used in conjunction with the P122 Digital Resistance Modules, only P157 Relay Expansion modules with Part Number 81xxxxx MUST be used. The digital resistance requires a different set of data commands to operate and the 55x module will change the data output by the 808 port to suit the P122 when selected. The older P157 relay modules (Part No. 80xxxxx) will only function if the P122 module is not configured for use by the 555.

CAUTION!:- When used in conjunction with the P122 Digital Resistance Modules, only P548 Relay Expansion modules with Part Number 81xxxxx MUST be used. The digital resistance requires a different set of data commands to operate and the 55x module will change the data output by the 808 port to suit the P122 when selected. The older P548 relay modules (Part No. 80xxxxx) will only function if the P122 module is not configured for use by the 555.

TYPICAL CONNECTIONS



CAUTION :
The P122 digital resistance output should be a suitable resistance as recommended by the Governor/AVR manufacturer. This should be specified on ordering from DSE.
The P122 digital resistance has a selector switch for AVR or Governor connection, this should be set to the correct position, otherwise auto-sync control will not be possible. Refer to the diagram above.

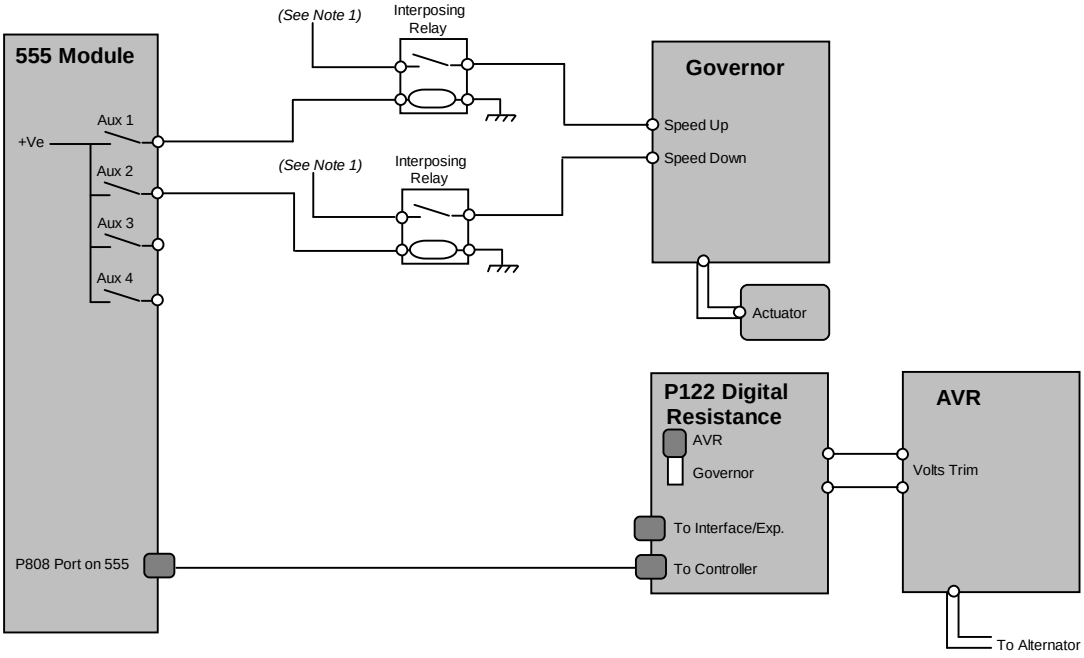
AUTO-SYNC CONTROL WILL NOT BE POSSIBLE. REFER TO THE DIAGRAM ABOVE.

4) DIRECT GOVERNOR CONTROL AND AVR CONTROL USING P122 DIGITAL RESISTANCE MODULES

CAUTION! This scheme uses a mixture of the possible control options from the 55x modules to control the speed and voltage output via the P122 (Governor and AVR) digital resistance boxes. This method gives a cost effective solution to interfacing to the Governor and AVR. It is only possible to use this system of control if the Governor supports speed up/down inputs and the AVR in question supports voltage control via an external potentiometer.

CAUTION! When used in conjunction with the P122 Digital Resistance Modules, only P157 Relay Expansion modules with Part Number 81xxxxx MUST be used. The digital resistance requires a different set of data commands to operate and the 55x module will change the data output by the 808 port to suit the P122 when selected. The older P157 relay modules (Part No. 80xxxxx) will only function if the P122 module is not configured for use by the 555.
When used in conjunction with the P122 Digital Resistance Modules, only P548 Relay Expansion modules with Part Number 81xxxxx MUST be used. The digital resistance requires a different set of data commands to operate and the 55x module will change the data output by the 808 port to suit the P122 when selected. The older P548 relay modules (Part No. 80xxxxx) will only function if the P122 module is not configured for use by the 555.

TYPICAL CONNECTIONS



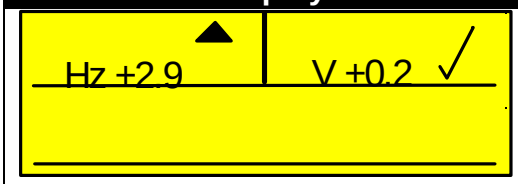
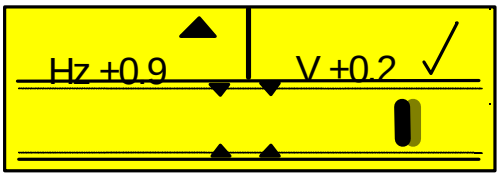
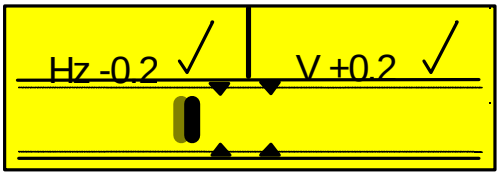
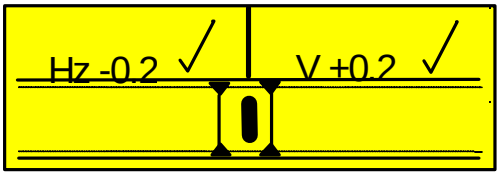
CAUTION! The P122 digital resistance output should be a suitable resistance as recommended by the AVR manufacturer. This should be specified on ordering from DSE. The P122 digital resistance selector switch for AVR or Governor connection, should be set to the correct position. Refer to the diagram above.

CAUTION! Interposing relay should connect to recommended polarity and voltage for Governor input. Refer to Governor manufacturer for details.

MODULE CONFIGURATION SETTING FOR 555 AUXILIARY RELAYS

Aux 1	Energise	Speed Raise Relay
Aux 2	Energise	Speed Lower Relay

SYNCHROSCOPE OPERATION *(IF FITTED)*

Display	Detail
	Initial stage of Synchronising display will only show the difference between the Mains Supply and the Generator Output. Here the display is showing a frequency mis-match of +2.9Hz - The gen-set frequency is too high and should be reduced (indicated by the arrow). The voltage is +0.2 volts high, but is within the limits set for synchronising.
	Once the difference between the Mains supply and the Generator output has been reduced the 'Synchroscope' display will become active. The moving bar will roll from left to right or right to left depending on the mis-match between the Mains supply and the generator output. The area in the centre of the scope indicates the set limits for synchronising to occur.
	Synchronising will only occur when both the Frequency and the voltage differences are within acceptable limits - Indicated by 'Tick' marks on the top of the display. Then the moving bar display will show the phase difference. The engine speed should be adjusted until the moving bar enters the centre of the scope.
	Once the Mains and the generator are synchronised the moving bar will be in the centre of the scope and the bar will be 'locked' into the synchronising window. While the bar is 'locked' the module will initiate a breaker close to load the generator onto the Mains. Should synchronism be broken the moving bar will pass out of the synchronising window and the 'locked' indication will clear.

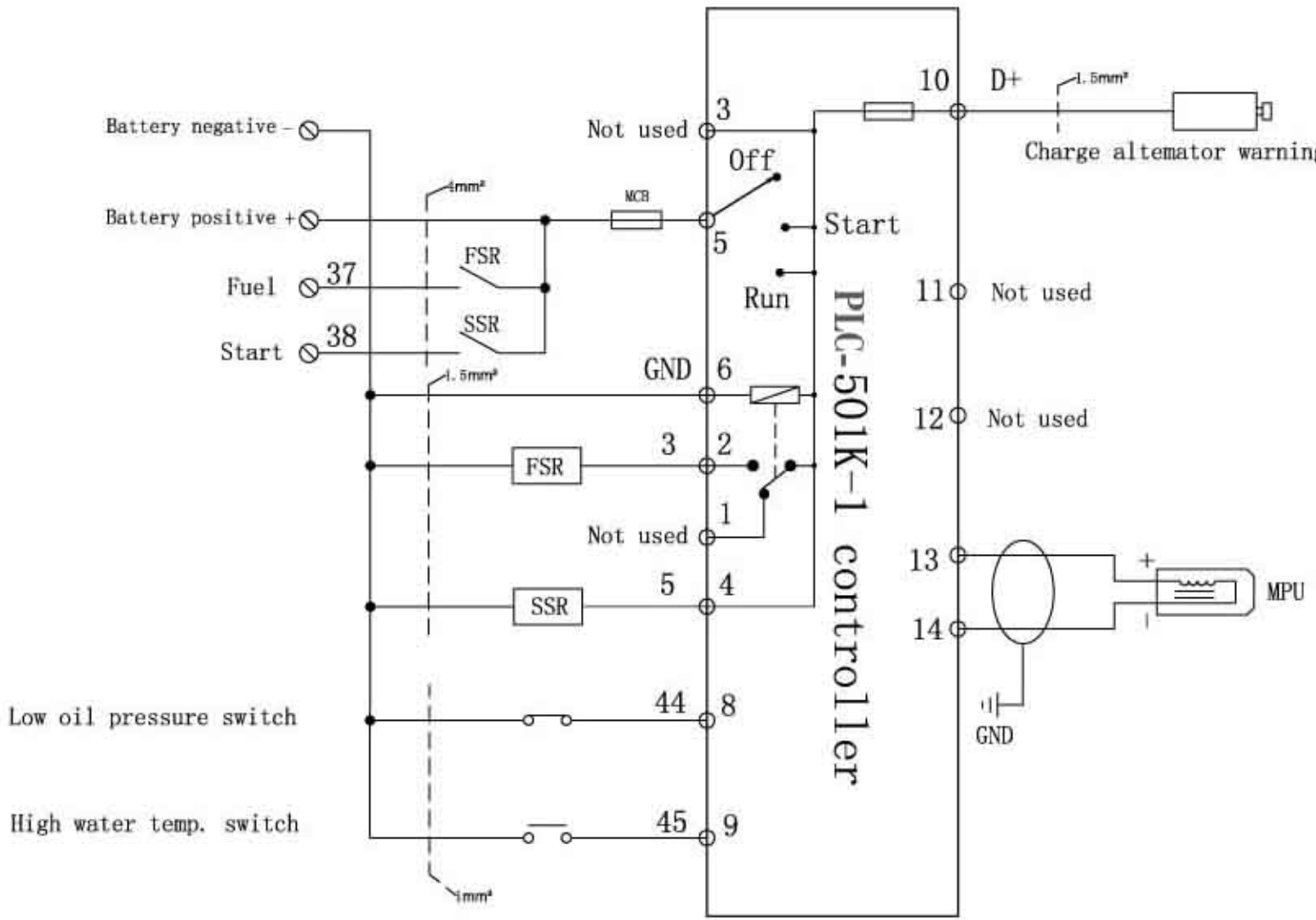
SECTION 6 FAULT FINDING

Unit is inoperative	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 9Volts Check the operating temperature is not above 55 °C. Check the DC fuse.
Unit locks out on Emergency Stop	If an Emergency Stop Switch is not fitted, ensure that a positive is connected to the Emergency Stop input. Check emergency stop switch is functioning correctly. Check Wiring is not open circuit.
Intermittent Magnetic Pick-up sensor fault	Ensure that Magnetic pick-up screen is only connected at one end, if connected at both ends, this enables the screen to act as an aerial and will pick up random voltages.
Low oil Pressure fault operates after engine has fired	Check engine oil pressure. Check oil pressure switch/sender and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sender is compatible with the Module and is correctly configured.
High engine temperature fault operates after engine has fired	Check engine temperature. Check switch/sender and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed).
Shutdown 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.
Fail to Start is activated after preset number of attempts to start	Check wiring of fuel solenoid. Check fuel. Check battery supply. Check attery supply is present on the Fuel output of the module. Check the speed sensing signal is present.
Continuous starting of generator when in AUTO	Check that there is no signal present on the “Remote Start” input. Check configured polarity is correct
Generator fails to start on receipt of Remote Start signal	Check Start Delay timer has timed out. If remote start fault, check signal is on “Remote Start” input. Confirm input is configured to be used as “Remote Start”.

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 has been selected in your configuration.
Starter motor inoperative	Check wiring to starter solenoid. Check battery supply. Check battery supply is present on the Starter output of module. Ensure that the Emergency Stop input is at +Ve
Engine runs but generator will 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: The above fault finding is provided as a guide check-list only. As it is possible for the module to be configured to provide a wide range of different features always refer to the source of your module configuration if in doubt.

NO.	CODE	DESCRIPTION
5	SSR	Motor relay
4	FSR	Fuel supply relay
3	MPU	Rotate speed sensor
2	MCB	Miniature circuit breaker
1	DSE501K-1	Gen-set controller



TITLE: The connecting diagram of PLC-501 K-1 controller for diesel Gen-set

CONTROLLER: DEEP SEA ELECTRONICS PLC	JOB NO: 386806
CONTROLLER MODEL: DSE/501K-1 MODULE	JOB REF:
MODULE DIMENSIONS:72mm×72mm×116.5mm(2.8"×2.8"×4.7")	CUSTOMER:
PANEL CUTOUT DIMENSIONS:68mm×68mm(2.7"×2.7")	
SUPPLY SOURCE: DC-12/24V	

REV		CHKD	DRN	DATE
B				
A		-	LY	4.8.06
0	SET LIFTED BY 3.5mm.	-	LY	16.7.06
	ORIG. ISSUE			

DRAWN	DATE	CHECKED	SCALE
	16.6.06		

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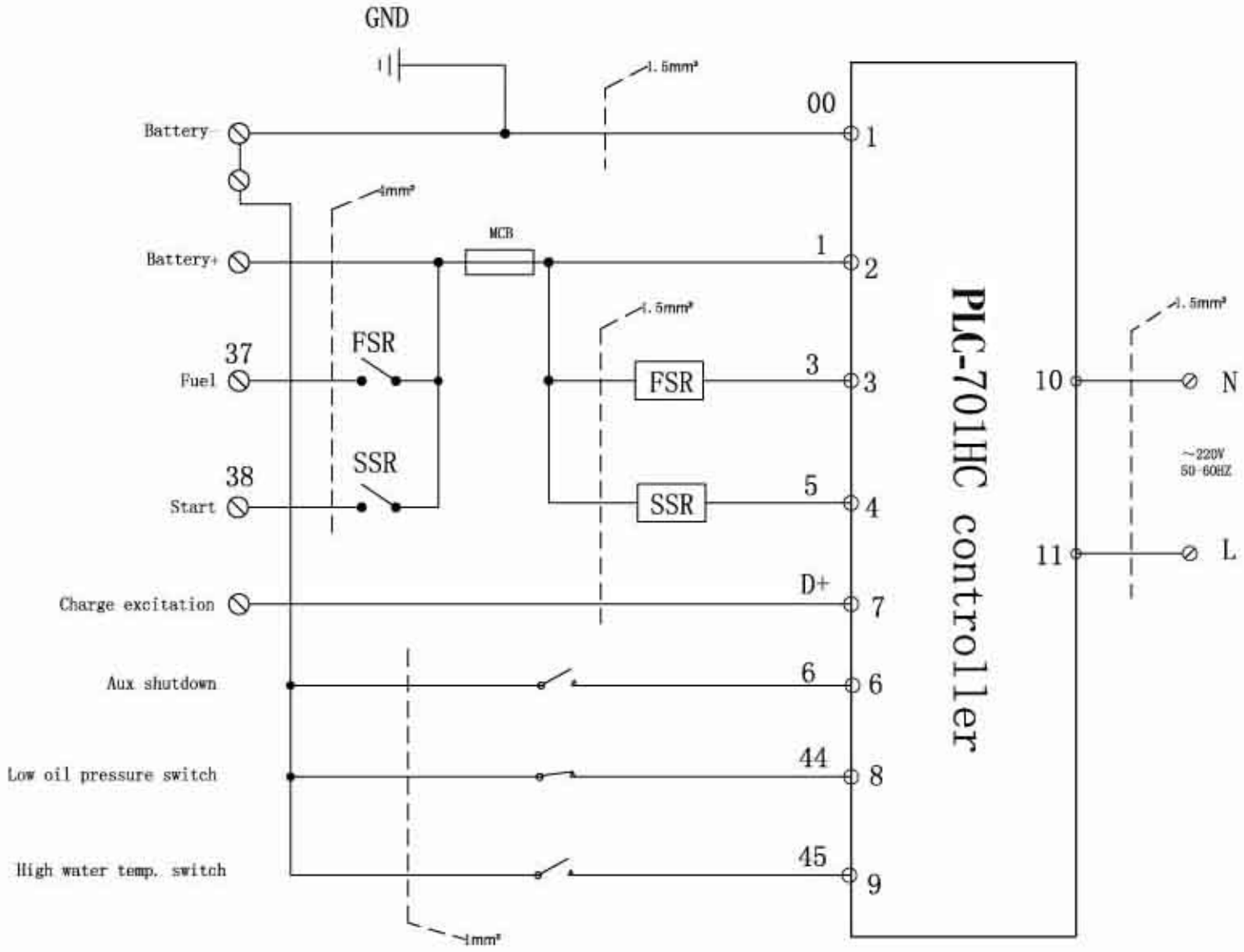

NO.	CODE	DESCRIPTION
4	SSR	Motor relay
3	FSR	Fuel supply relay
2	MCB	Miniature circuit breaker
1	DSE701HC	Gen-set controller

TITLE: The connecting diagram of PLC-70-1HC controller for diesel Gen-set

CONTROLLER: DEEP SEA ELECTRONICS PLC	JOB NO: 386806
CONTROLLER MODEL: DSE/701HCMODULE	JOB REF:
MODULE DIMENSIONS:72mm×72mm×37.8mm(2.8"×2.8"×1.5")	CUSTOMER:
PANEL CUTOUT DIMENSIONS:68mm×68mm(2.7"×2.7")	
SUPPLY SOURCE: DC-12/24V	

REV		CHKD	DRN	DATE
B				
A		-	LY	4.8.08
0	SET LIFTED BY 3.5mm.	-	LY	16.7.08
	ORIG. ISSUE			

DRAWN	DATE	CHECKED	SCALE
	16.6.08		

DRG. NO. LDKT386806-07

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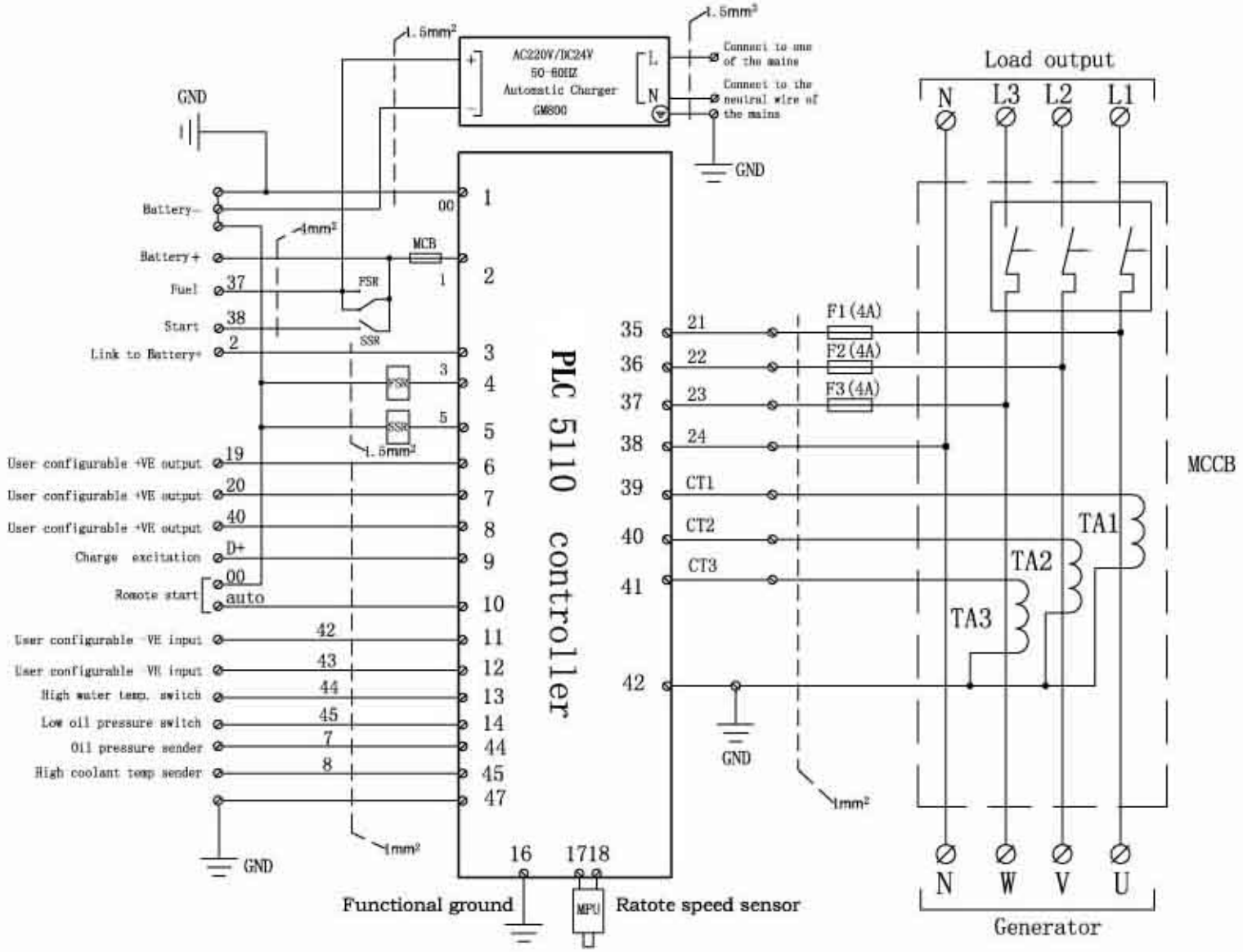

NO.	CODE	DESCRIPTION
9	SSR	Motor relay
8	FSR	Fuel supply relay
7	GM800	Automatic battery charger
6	F1-F3	Fuse
5	MPU	Rotate speed sensor
4	MCB	Miniature circuit breaker
3	TA1-TA3	Current transformer
2	MCCB	Mould case circuit breaker
1	DSE5110	Gen-set controller

TITLE: The connecting diagram of PLC 5110 controller for diesel Gen-set

CONTROLLER: DEEP SEA ELECTRONICS PLC	JOB NO: 386806
CONTROLLER MODEL: DSE/5110 MODULE	JOB REF:
MODULE DIMENSIONS:240mm×172mm×57mm(9.5"×6.8"×2.25")	CUSTOMER:
PANEL CUTOUT DIMENSIONS:220mm×160mm(8.7"×6.3")	
SUPPLY SOURCE: DC-12/24V	
AUTOMATIC BATTERY CHARGER: AC220V/DC24V	

REV		CHKD	DRN	DATE
B				
A		-	LY	4.8.06
0	SET LIFTED BY 3.5mm.	-	LY	16.7.06
	ORIG. ISSUE			

DRAWN	DATE	CHECKED	SCALE
	16.6.06		

DRG. NO. LDKT386806-01

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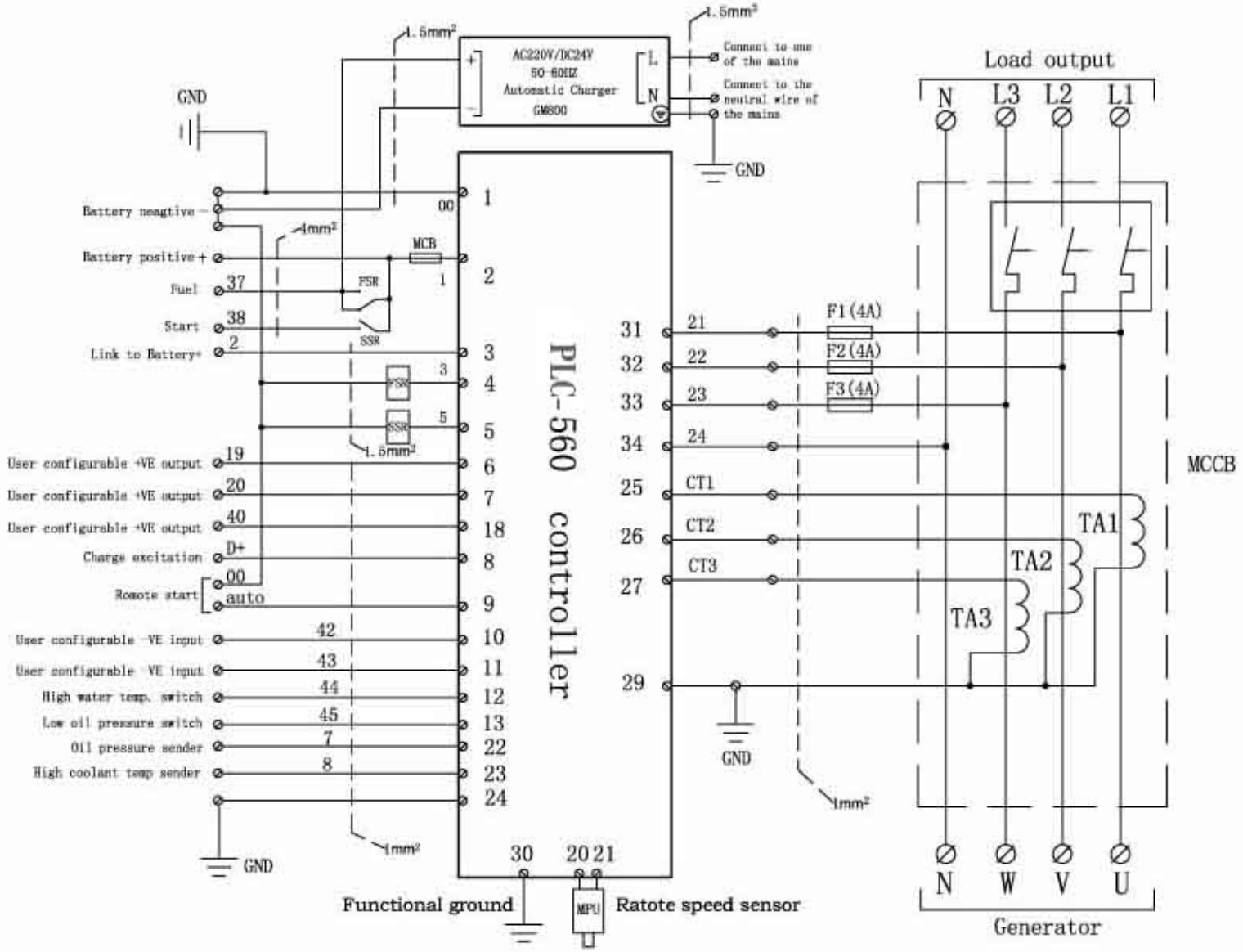

NO.	CODE	DESCRIPTION
9	SSR	Motor relay
8	FSR	Fuel supply relay
7	GM800	Automatic battery charger
6	F1-F3	Fuse
5	MPU	Rotate speed sensor
4	MCB	Miniature circuit breaker
3	TA1-TA3	Current transformer
2	MCCB	Mould case circuit breaker
1	DSE560	Gen-set controller

TITLE: The connecting diagram of PLC-560 controller for diesel Gen-set

CONTROLLER: DEEP SEA ELECTRONICS PLC	JOB NO: 386806
CONTROLLER MODEL: DSE560 MODULE	JOB REF:
MODULE DIMENSIONS:192mm×144mm×117.5mm(7.6"×5.7"×4.6")	CUSTOMER:
PANEL CUTOUT DIMENSIONS:185mm×138mm(7.3"×5.4")	
SUPPLY SOURCE: DC-12/24V	
AUTOMATIC BATTERY CHARGER: AC220V/DC24V	

REV		CHKD	DRN	DATE
B				
A		-	LY	4.8.06
0	SET LIFTED BY 3.5mm.	-	LY	16.7.06
	ORIG. ISSUE			

DRAWN	DATE	CHECKED	SCALE
	16.6.06		

DRG. NO. LDKT386806-04

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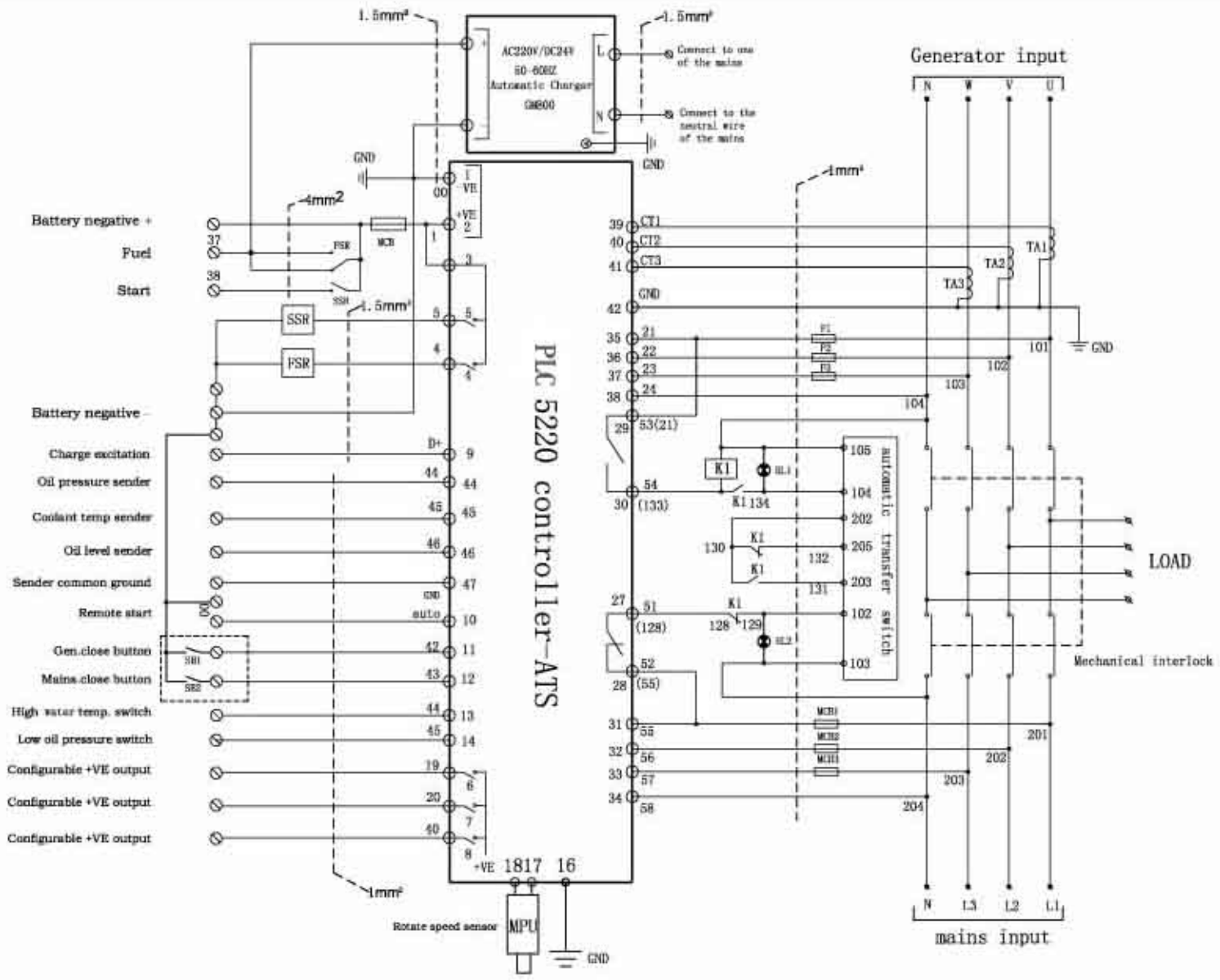

NO.	CODE	DESCRIPTION
13	HL1-2	Indicator lamps
12	MCB1-3	Miniature circuit breaker
11	SB1-2	Close buttons
10	K1	AC relay
9	SSR	Motor relay
8	FSR	Fuel supply relay
7	GM800	Automatic battary charger
6	F1-F3	Fuse
5	MPU	Rotate speed sensor
4	MCB	Miniature circuit breaker
3	TA1-TA3	Current transformer
2	ATS	Automatic transfer switch
1	DSE5220	Gen-set controller

TITLE: The connecting diagram of PLC 5220 controller for diesel Gen-set

CONTROLLER: DEEP SEA ELECTRONICS PLC	JOB NO: 386806
CONTROLLER MODEL: DSE/5220 MODULE	JOB REF:
MODULE DIMENSIONS:240mm×172mm×57mm(9.5"×6.8"×2.25")	CUSTOMER:
PANEL CUTOUT DIMENSIONS:220mm×160mm(8.7"×6.3")	
SUPPLY SOURCE: DC-12/24V	
AUTOMATIC BATTERY CHARGER: AC220V/DC24V	

REV		CHKD	DRN	DATE
B				
A		-	LY	4.8.06
0	SET LIFTED BY 3.5mm.	-	LY	16.7.06
	ORIG. ISSUE			

DRAWN	DATE	CHECKED	SCALE
	16.6.06		

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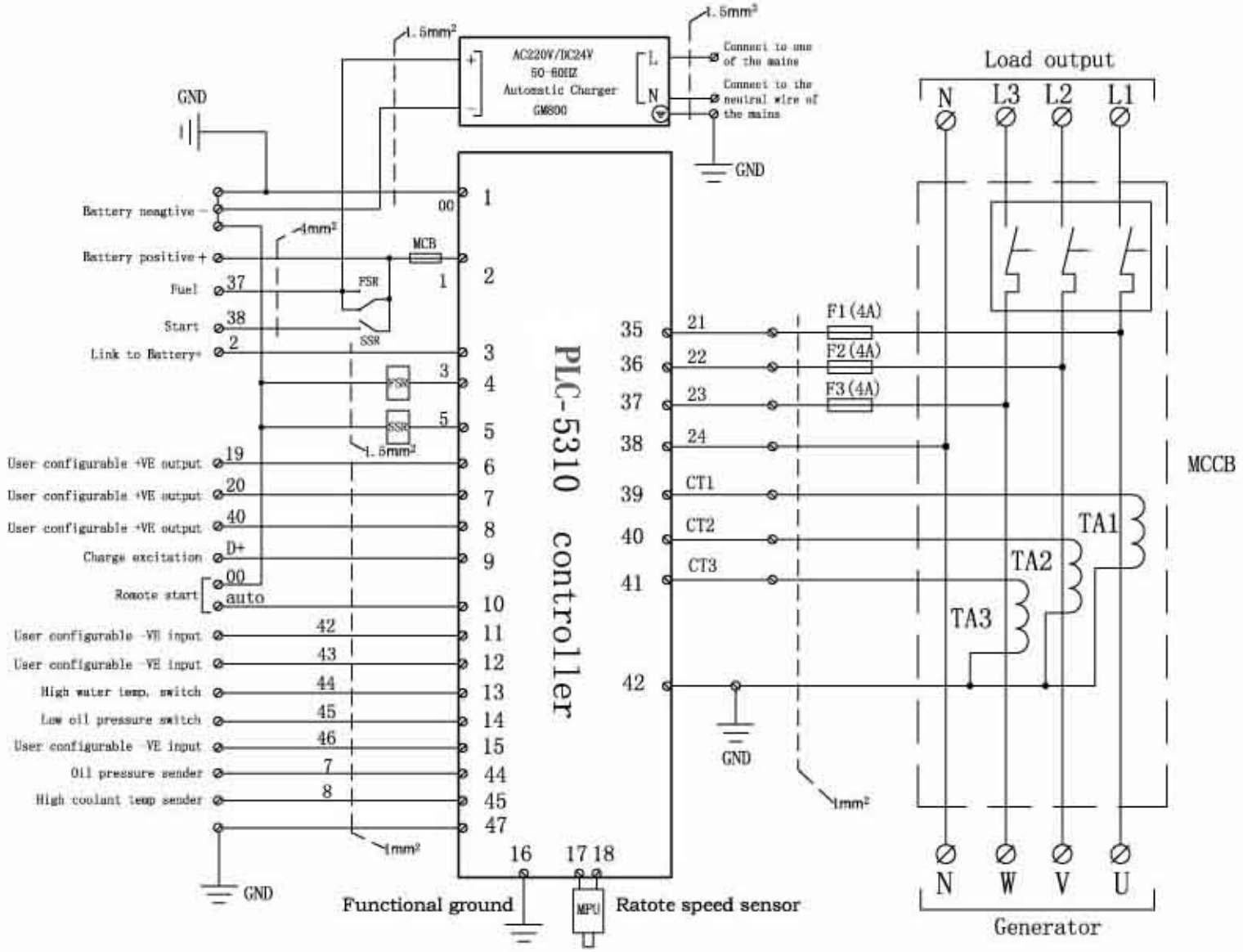

NO.	CODE	DESCRIPTION
9	SSR	Motor relay
8	FSR	Fuel supply relay
7	GM800	Automatic battery charger
6	F1-F3	Fuse
5	MPU	Rotate speed sensor
4	MCB	Miniature circuit breaker
3	TA1-TA3	Current transformer
2	MCCB	Mould case circuit breaker
1	DSE5310	Gen-set controller

TITLE: The connecting diagram of PLC-5310 controller for diesel Gen-set

CONTROLLER: DEEP SEA ELECTRONICS PLC	JOB NO: 386806
CONTROLLER MODEL: DSE/5310 MODULE	JOB REF:
MODULE DIMENSIONS:240mm×172mm×57mm(9.45"×6.77"×2..25")	CUSTOMER:
PANEL CUTOUT DIMENSIONS:220mm×160mm(8.7"×6.3")	
SUPPLY SOURCE: DC-12/24V	
AUTOMATIC BATTERY CHARGER: AC220V/DC24V	

REV		CHKD	DRN	DATE
B				
A		-	LY	4.8.06
0	SET LIFTED BY 3.5mm.	-	LY	16.7.06
	ORIG. ISSUE			

DRAWN	DATE	CHECKED	SCALE
	16.6.06		

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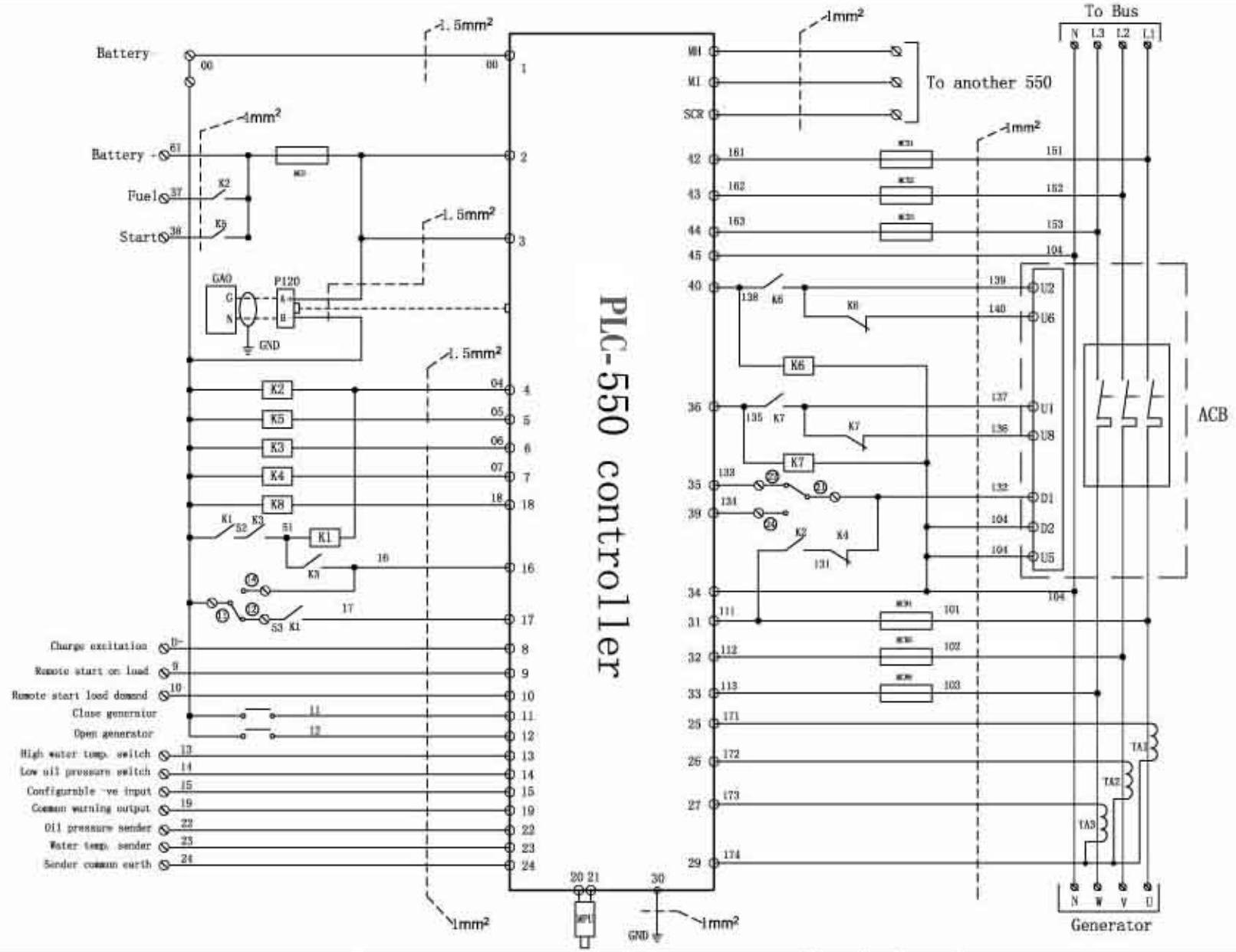

NO.	CODE	DESCRIPTION
9	MPU	Rotate speed sensor
8	P120	Verify speed module
7	K6-K7	AC relay
6	K1-5,K8	DC relay
5	MCB1-6	Miniature circuit breaker
4	TA1-TA3	Current transformer
3	MCB	Miniature circuit breaker
2	ACB	Air circuit breaker
1	DSE550	Gen-set controller

TITLE The connecting diagram of PLC-550 controller for diesel Gen-set

CONTROLLER: DEEP SEA ELECTRONICS PLC	*JOB NO:* 386806
CONTROLLER MODEL: DSE/550 MODULE	*JOB REF:*
MODULE DIMENSIONS:192mm×144mm×117.5mm(7.6"×5.7"×4.6")	*CUSTOMER:*
PANEL CUTOUT DIMENSIONS:185mm×137mm(7.3"×5.4")	
SUPPLY SOURCE: DC-12/24V	

REV		CHKD	DRN	DATE
B				
A		-	LY	4.8.06
0	SET LIFTED BY 3.5mm.	-	LY	16.7.06
	ORIG. ISSUE			

DRAWN	DATE	CHECKED	SCALE
	16.6.06		

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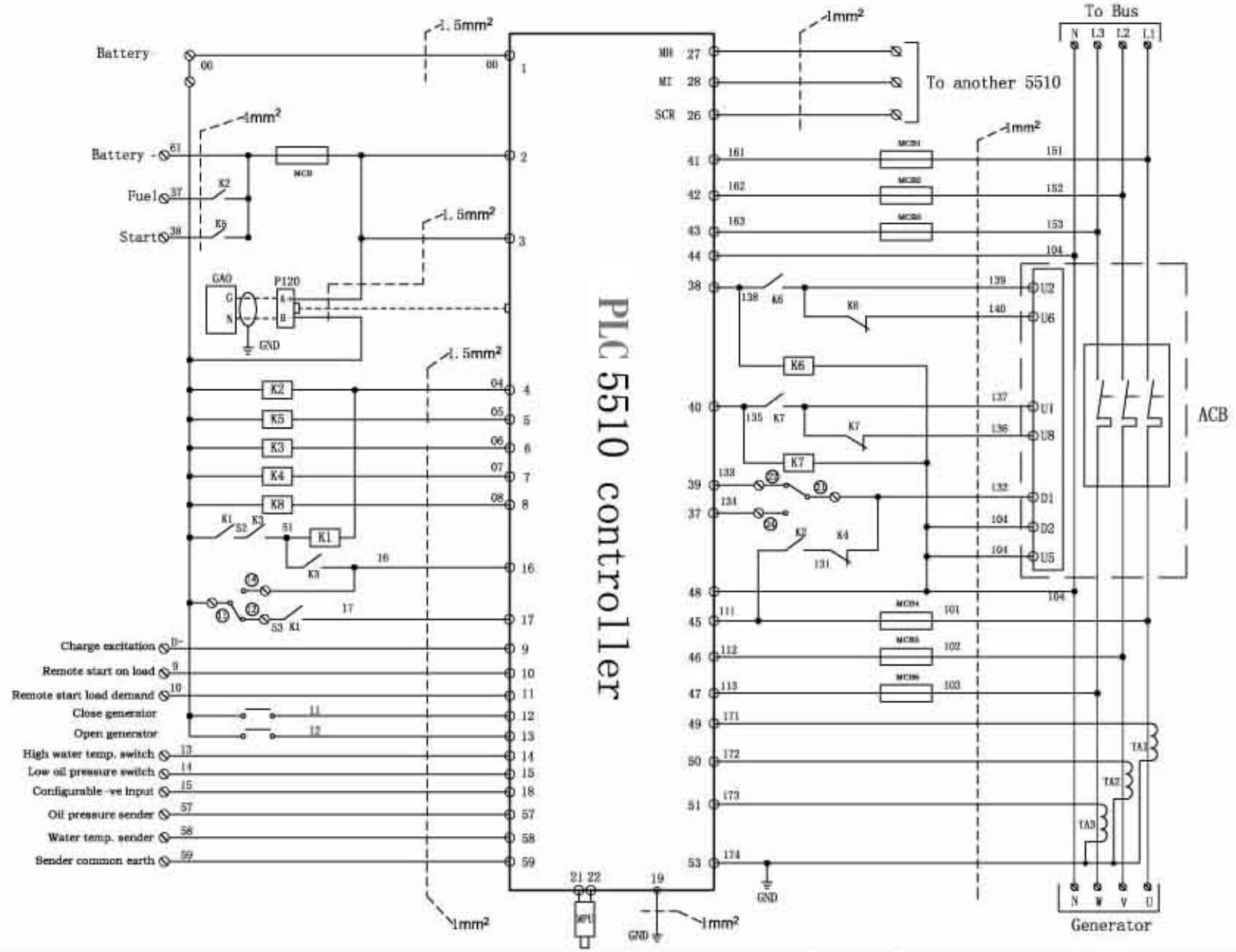

NO.	CODE	DESCRIPTION
9	MPU	Rotate speed sensor
8	P120	Verify speed module
7	K6-K7	AC relay
6	K1-5,K8	DC relay
5	MCB1-6	Miniature circuit breaker
4	TA1-TA3	Current transformer
3	MCB	Miniature circuit breaker
2	ACB	Air circuit breaker
1	DSE5510	Gen-set controller

TITLE: The connecting diagram of PLC 5-510 controller for diesel Gen-set

CONTROLLER: DEEP SEA ELECTRONICS PLC	JOB NO: 386806
CONTROLLER MODEL: DSE/5510 MODULE	JOB REF:
MODULE DIMENSIONS:240mm×172mm×57mm(9.45"×6.77"×2.25")	CUSTOMER:
PANEL CUTOUT DIMENSIONS:220mm×160mm(8.7"×6.3")	
SUPPLY SOURCE: DC-12/24V	

REV		CHKD	DRN	DATE
B				
A		-	LY	4.8.06
0	SET LIFTED BY 3.5mm.	-	LY	16.7.06
	ORIG. ISSUE			

DRAWN	DATE	CHECKED	SCALE
	16.6.06		

DRG. NO. LDKT386806-08

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REMARK

Please contact us if there's any question.

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