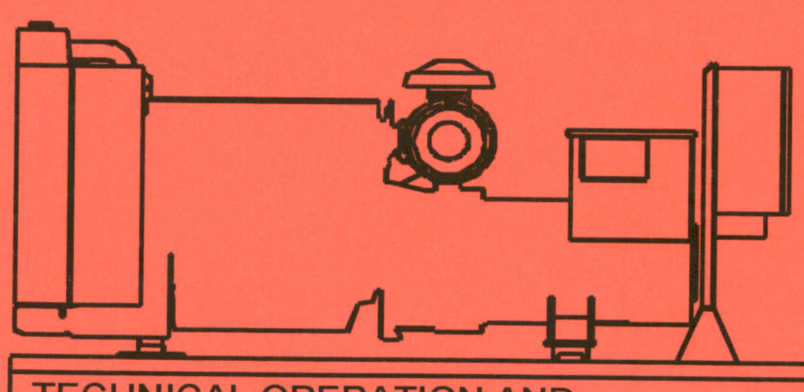
OLYMPIAN™



TECHNICAL OPERATION AND
MAINTENANCE MANUAL - PERKINS SETS

This manual has been designed as a technical guide to operating, servicing and maintaining the generator set. It should be used in conjunction wi[illegible] Engine and Alternator Manuals.

An Operator's Manual is also included with these manuals to aid the operator specifically in starting, stopping and otherwise operating the set. The Operator's manual is available in any of a number of languages for non-English speaking operators.

Generator Set Serial Number:

Date of Purchase:	Date of Initial Startup/Commissioning:
Name & Address of Owner or Operator:	Name & Address of Generator set Dealer/Distributor:

GENERATOR SET
TECHNICAL OPERATION
AND MAINTENANCE MANUAL

Document: TMANP_US
Issue Date: 05/98

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
2.	SAFETY	1
2.1	General	1
2.2	Installation, Handling, and Towing	1
2.3	Fire and Explosion	1
2.4	Mechanical	2
2.5	Chemical	2
2.6	Noise	2
2.7	Electrical	2
2.8	First Aid For Electric Shock	3
3.	GENERAL DESCRIPTION	5
3.1	Generator set Description and Identification	5
3.2	Diesel Engine	5
3.3	Engine Electrical System	5
3.4	Cooling System	5
3.5	Alternator	5
3.6	Fuel Tank and Baseframe	5
3.7	Vibration Isolation	5
3.8	Silencer and Exhaust System	5
3.9	Control System (Identification)	5
3.10	Output Circuit Breaker	5
4.	INSTALLATION, HANDLING, TOWING AND STORAGE	6
4.1	General	6
4.2	Enclosures	6
4.3	Moving the Generator set	6
4.4	Location	7
4.5	Foundations and Vibration Isolation	7
4.6	Combustion Air Inlet	8
4.7	Cooling and Ventilation	8
4.8	Exhaust	10
4.9	Fuel System	10
4.10	Fire Precautions	12
4.11	Starting Batteries	12
4.12	Electrical Connection	12
4.13	Acoustic Silencing	13
4.14	Towing (Portable Generator sets)	13
4.15	Storage	14
5.	OPERATION	15
5.1	General	15
5.2	Pre-Start Checks (applicable to all control systems)	15
5.3	Initial Startup/Shutdown - Key Start Panel (1001 Series)	15
5.4	Normal Startup/Shutdown - Key Start Panel (1001 Series)	16
5.5	Initial Startup/Shutdown - Autostart Panel (2001, 4001, or 4001E Series)	17
5.6	Normal Manual Startup/Shutdown - Autostart Panel (2001, 4001 or 4001E Series)	18
5.7	Automatic Startup/Shutdown - Autostart Panel (2001, 4001 or 4001E Series)	19
6.	GENERATOR SET MAINTENANCE	20
6.1	General	20
6.2	Preventative Maintenance	20
6.3	Removal of Engine and/or Alternator	20
7.	ENGINE DESCRIPTION AND MAINTENANCE	22
7.1	Engine Description	22
7.2	Engine Maintenance	22
7.3	Radiator Maintenance	22
8.	ALTERNATOR DESCRIPTION AND MAINTENANCE	24
8.1	Alternator Description	24
8.2	Alternator Maintenance	24

9. CONTROL SYSTEM DESCRIPTION AND TROUBLE SHOOTING 25
9.1 Control System Description and Identification 25
9.2 Functional Description 1001 Series Control System 27
9.3 Functional Description 2001, 4001 and 4001E Series Control Systems ..... [illegible]
9.4 Control System Options and Upgrades 35
9.5 Control System Fault Finding/Trouble Shooting Guide 38
9.6 Load Transfer Panel 43
9.7 Engine Interface Module Description 45
9.8 Output Circuit Breaker Description 46
10. BATTERY DESCRIPTION AND MAINTENANCE 47
10.1 Battery Theory 47
10.2 Battery Maintenance 47
10.3 Charging the Battery 47
10.4 Battery Charging System Fault Finding/Trouble Shooting Chart 49
10.5 Jump Starting Procedures 50
HAZARD LABEL LEGEND 51
INDEX 52

1. INTRODUCTION

; generator set is one of a family of heavy duty industrial ، ierator sets designed to be ready to run when it arrives, requiring only the addition of coolant, fuel and battery acid. Years of diesel generator set experience has gone into the set to produce a quality source of electrical power that is efficient and reliable.

This Technical Operation and Maintenance Manual has been prepared to assist in maintenance and operation of the generator set. Using this manual in conjunction with the Engine Manual, Alternator Manual and the Generator set Operator's Manual, will help to ensure that the generator set keeps operating at maximum performance and efficiency for a long life. Please note that in dirty or dusty environments more attention must be paid to frequent servicing to keep the set running properly.

Always ensure that adjustments and repairs are done by personnel who are authorized to do the work and have been properly trained.

Every generator set is uniquely defined by a model number and serial number indicated on a rating plate generally affixed to the alternator housing. This information is required when ordering spare parts or when service or warranty work is required. See Section 3.1 for further information.

2. SAFETY

2.1 General

The generator set is designed to be safe when used in the correct manner. Responsibility for safety, however, rests with the personnel who install, use and maintain the set. The following safety precautions, if followed, will minimize the possibility of accidents. Before performing any procedure or operating technique, it is up to the user to ensure that it is safe. The generator set should only be operated by personnel who are authorized and trained.

WARNING:

! Read and understand all safety precautions and warnings before operating or performing maintenance on the generator set.

! Failure to follow the instructions, procedures, and safety precautions in this manual may increase the possibility of accidents and injuries.

! Never start the generator set unless it is safe to do so.

! Do not attempt to operate the generator set with a known unsafe condition.

! If the generator set is unsafe, fit danger notices and disconnect the battery negative (-) lead so that it cannot be started until the condition is corrected.

! Disconnect the battery negative (-) lead prior to attempting any repairs or cleaning inside the enclosure, if equipped.

! Install and operate this generator set only in full compliance with relevant National, Local, or Federal Codes, Standards or other requirements.

2.2 Installation, Handling, and Towing

Chapter 4 of this manual covers procedures for installation, handling, and towing of generator sets. That chapter should be read before installing the generator set, moving/lifting the generator set, or towing a mobile set. The following safety precautions should be noted:

WARNING:

! Make electrical connections in compliance with relevant Electrical Codes, Standards or other requirements. This includes requirements for grounding and ground/earth faults.

! For stationary generator sets with remote fuel storage systems, make sure such systems are installed in compliance with relevant Codes, Standards or other requirements.

! Engine exhaust emissions are hazardous to personnel. The exhaust for all indoor generator sets must be piped outdoors via leak-free piping in compliance with relevant Codes, Standards and other requirements. Ensure hot exhaust silencers, piping and turbochargers, if equipped, are clear of combustible material and are guarded for personnel protection per safety requirements. Ensure that fumes from the exhaust outlet will not be a hazard.

! Never lift the generator set by attaching to the engine or alternator lifting lugs. Use a sling with a "spreader bar" connected to the baseframe.

! Ensure the lifting rigging and supporting structure is in good condition and has a capacity suitable for the load.

! Keep all personnel away from the generator set when it is suspended.

! Make sure all personnel are out of the generator set canopy or container, if equipped, before closing and latching enclosure doors.

! When towing a mobile generator set, observe all Codes, Standards or other regulations and traffic laws. These include those regulations specifying required equipment and maximum and minimum speeds. Ensure brakes, if fitted, are in good order.

! Do not permit personnel to ride in or on the mobile generator set. Do not permit personnel to stand or ride on the drawbar or to stand or walk between the generator set and the towing vehicle

! Do not install or use the generator set in any classification of hazardous environment unless it has been specifically designed for that environment.

2.3 Fire and Explosion

Fuels and fumes associated with generator sets can be flammable and potentially explosive. Proper care in handling these materials can dramatically limit the risk of fire or explosion. However, safety dictates that fully charged BC and ABC fire extinguishers are kept on hand. Personnel must know how to operate them.

WARNING:

! Ensure the generator set room is properly ventilated.

! Keep the room, the floor and the generator set clean. When spills of fuel, oil, battery electrolyte or coolant occur, they should be cleaned up immediately.

! Never store flammable liquids near the engine.

- Store oily rags in covered metal containers.
- Do not smoke or allow sparks, flames or other sources of ignition around fuel or batteries. Fuel vapors are explosive. Hydrogen gas generated by charging batteries is also explosive.
- Turn off or disconnect the power to the battery charger before making or breaking connections with the battery.
- Keep grounded conductive objects, such as tools, away from exposed live electrical parts, such as terminals, to avoid arcing. Sparks and arcing might ignite fuel or vapors.
- Avoid refilling the fuel tank while the engine is running.
- Do not attempt to operate the generator set with any known leaks in the fuel system.
- The excessive build-up of unburned fuel gases in the exhaust system can create a potentially explosive condition. This build-up can occur after repeated failed start attempts, air flap valve testing, or hot engine shutdown. Open exhaust system purge plugs, if equipped, and allow the gases to dissipate before attempting to restart the generator set.

2.4 Mechanical

The generator set is designed with guards for protection from moving parts. Care must still be taken to protect personnel and equipment from other mechanical hazards when working around the generator set.

WARNING:

- Do not attempt to operate the generator set with safety guards removed. While the generator set is running do not attempt to reach under or around the guards to do maintenance or for any other reason.
- Keep hands, arms, long hair, loose clothing and jewelry away from pulleys, belts and other moving parts.

  Attention: Some moving parts can not be seen clearly when the set is running.
- Keep access doors on enclosures, if equipped, closed and locked when not required to be open.
- Avoid contact with hot oil, hot coolant, hot exhaust gases, hot surfaces and sharp edges and corners.
- Wear protective clothing including gloves and hat when working around the generator set.
- Do not remove the radiator filler cap until the coolant has cooled. Then loosen the cap slowly to relieve any excess pressure before removing the cap completely.
- Ethyl Ether starting aids **must not** be used on engines with combustion air preheating devices or on engines manufactured by the Detroit Diesel Corporation (DDC). In general these starting aids are not recommended on any engine. They will reduce the efficient working life of the engine.

2.5 Chemical

Fuels, oils, coolants, lubricants and battery electrolyte used in this generator set are typical of the industry. However, they can be hazardous to personnel if not treated properly.

WARNING:

- Do not swallow or have skin contact with fuel, oil, coolant, lubricants or battery electrolyte. If swallowed, seek medical treatment immediately. Do not induce vomiting if fuel is swallowed. For skin contact, wash with soap and water.
- Do not wear clothing that has been contaminated by fuel or lube oil.
- Wear an acid resistant apron and face shield or goggles when servicing the battery. If electrolyte is spilled on skin or clothing, flush immediately with large quantities of water.

2.6 Noise

Generator sets that are not equipped with sound attenuating enclosures can produce noise levels in excess of 105 dBA. Prolonged exposure to noise levels above 85 dBA is hazardous to hearing.

WARNING:

- Ear protection must be worn when operating or working around an operating generator set.

2.7 Electrical

Safe and efficient operation of electrical equipment can be achieved only if the equipment is correctly installed, operated and maintained.

WARNING:

- The generator set must be connected to the load only by trained and qualified electricians who are authorized to do so, and in compliance with relevant Electrical Codes, Standards and other regulations. Where required, their work should be inspected and accepted by the inspection agency prior to operating the generator set.
- Ensure the generator set, including a mobile set, is effectively grounded/earthed in accordance with all relevant regulations prior to operation.
- The generator set should be shutdown with the battery negative (-) terminal disconnected prior to attempting to connect or disconnect load connections.
- Do not attempt to connect or disconnect load connections while standing in water or on wet or soggy ground.
- Do not touch electrically energized parts of the generator set and/or interconnecting cables or conductors with any part of the body or with any non insulated conductive object.
- Replace the generator set terminal box cover as soon as connection or disconnection of the load cables is complete. Do not operate the generator set without the cover securely in place.
- Connect the generator set only to loads and/ electrical systems that are compatible with its electrical characteristics and that are within its rated capacity.

- ! Be sure all electrical power is disconnected from electrical equipment being serviced.
- ! Keep all electrical equipment clean and dry. Replace any wiring where the insulation is cracked, cut, abraded or otherwise degraded. Replace terminals that are worn, discolored or corroded. Keep terminals clean and tight.
- ! Insulate all connections and disconnected wires.
- ! Use only Class BC or Class ABC extinguishers on electrical fires.

2.8 First Aid For Electric Shock

WARNING:

- ! Do not touch the victim's skin with bare hands until the source of electricity has been turned off.

- Switch off power, if possible.
- Otherwise pull the plug or pull the cable away from the victim.
- If this is not possible, stand on dry insulating material and pull the victim clear of the conductor, preferably using insulated material such as dry wood.
- If victim is breathing, turn the victim into the recovery position described below.
- If victim is unconscious, perform resuscitation as required:

OPEN THE AIRWAY:

1. Tilt the victim's head back and lift the chin upwards.
2. Remove objects from the mouth or throat (including false teeth, tobacco, or chewing gum).

BREATHING:

1. Check that the victim is breathing by looking, listening and feeling for the breath.

CIRCULATION:

1. Check for pulse in the victim's neck.

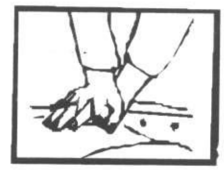
IF NO BREATHING BUT PULSE IS PRESENT:

1. Pinch the victim's nose firmly.
2. Take a deep breath and seal your lips around the victim's lips.
3. Blow slowly into the mouth watching for the chest to rise. Let the chest fall completely. Give breaths at a rate of 10 per minute.
4. If the victim must be left to get help, give 10 breaths first and then return quickly and continue.

5. Check for pulse after every 10 breaths.
6. When breathing restarts, place the victim into the recovery position described later in this section.

IF NO BREATHING AND NO PULSE:

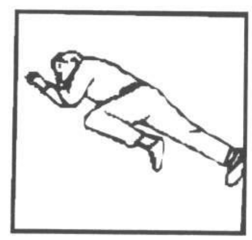
1. Call or telephone for medical help.
2. Give two breaths and start chest compression as follows:
3. Place heel of hand 2 fingers breadth above ribcage/breastbone junction.
4. Place other hand on top and interlock fingers.
5. Keeping arms straight, press down 4-5 cm (1.5-2 inch) 15 times at a rate of 80 per minute.



6. Repeat cycle (2 breaths, 15 compressions) until medical help takes over.
7. If condition improves, confirm pulse and continue with breaths. Check for pulse after every 10 breaths.

8. When breathing restarts, place the victim into the recovery position described below.

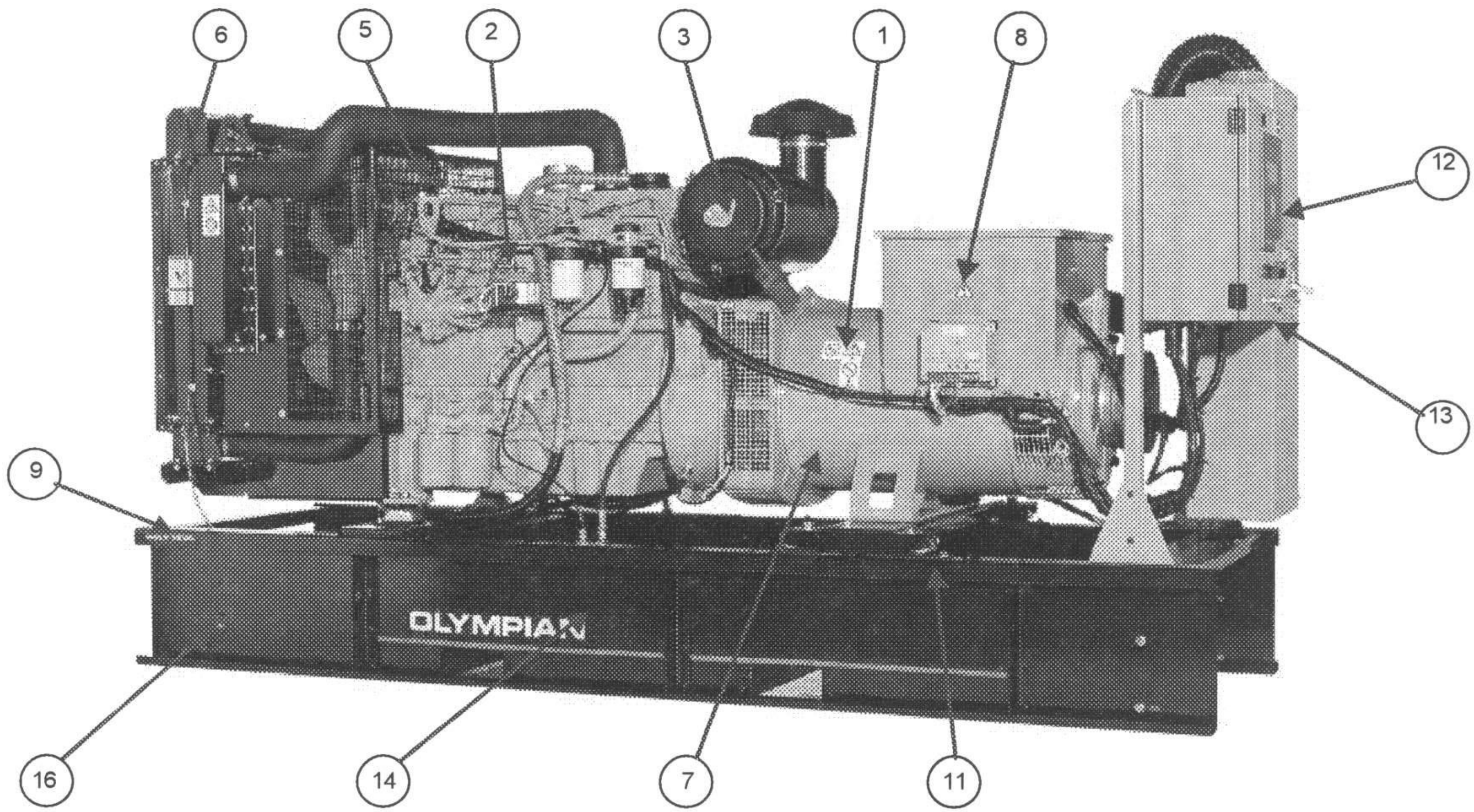
RECOVERY POSITION:



1. Turn the victim onto the side.
2. Keep the head tilted with the jaw forward to maintain the open airway.
3. Make sure the victim cannot roll forwards or backwards.
4. Check for breathing and pulse regularly. If either stops, proceed as above.

WARNING:

- ! Do not give liquids until victim is conscious.



Item	Description	Item	Description	Item	Description
1.	Generating Set Rating Label (generally affixed to alternator)	5.	Battery charging Alternator	9.	Baseframe
2.	Diesel Engine	6.	Radiator	10.	Fuel Tank
3.	Air Filter	7.	Alternator	11.	Vibration Isolators
4.	Battery	8.	Terminal Box	12.	Control Panel
				13.	Circuit Breaker

Figure 3.1: Typical Generator set Configuration (Photo taken without enclosure to aid identification of component)

3. GENERAL DESCRIPTION

Generator set Description and Identification

This generator set has been designed as a complete package to provide superior performance and reliability. Figure 3.1 identifies the major components. This figure is of a typical generator set. However, every set will be slightly different due to the size and configuration of the major components. This section briefly describes the parts of the generator set. Further information is provided in later sections of this manual.

Each generator set is provided with a Rating Label (item 1) generally affixed to the alternator housing. This label contains the information needed to identify the generator set and its operating characteristics. This information includes, but is not limited to, the model number, serial number, output characteristics such as voltage, phase and frequency, output rating in kVA and kW, and rating type (basis of the rating). For reference, this information is repeated on the Technical Data Sheet provided with this manual. The model and serial numbers uniquely identify the generator set and are needed when ordering spare parts or obtaining service or warranty work for the set.

3.2 Diesel Engine

The diesel engine powering the generator set (item 2) has been chosen for its reliability and the fact that it has been specifically designed for powering generator sets. The engine is of the heavy duty industrial type with 4 stroke or 2 stroke compression ignition and is fitted with all accessories to provide a reliable power supply. These accessories include, among others, a cartridge type dry air filter (item 3), a turbocharger fitted on some engines (item 4), and a mechanical or electronic close control engine speed governor (item 5).

3.3 Engine Electrical System

The engine electrical system is negative ground/earth and either 12 or 24 volts DC depending on the size of the set. This system includes an electric engine starter (item 6), battery and battery rack (item 7) which may also be located on the floor next to the set for some of the larger generator sets, and a battery charging alternator (item 8). Most sets are provided with lead-acid batteries which are discussed more fully in Section 10, however other types of batteries may be fitted if they had been specified.

3.4 Cooling System

The engine cooling system is comprised of a radiator (item 9), a high capacity pusher fan and a thermostat. The alternator has its own internal fan to cool the alternator components. Note that the air is "pushed" through the radiator so that the cooling air is drawn past the alternator, then past the engine and finally through the radiator.

3.5 Alternator

The output electrical power is normally produced by a screen protected and drip-proof, self-exciting, self-regulating, brushless alternator (item 10) fine tuned to the output of this generator set. Mounted on top of the alternator is a sheet steel terminal box (item 11).

3.6 Fuel Tank and Baseframe

The engine and alternator are coupled together and mounted on a heavy duty steel baseframe (item 12). Except for the largest sets, this baseframe includes a fuel tank with a capacity of approximately 8 hours operation at full load. An extended capacity fuel tank of approximately 24 hours operation may be fitted. Where a fuel tank is not provided with the baseframe, a separate fuel tank must be provided.

3.7 Vibration Isolation

The generator set is fitted with vibration isolators (item 13) which are designed to reduce engine vibration being transmitted to the foundation on which the generator set is mounted. These isolators are fitted between the engine/alternator feet and the baseframe. Alternately, on larger models the engine/alternator is rigidly mounted on the baseframe and the vibration isolators are supplied loose to be fitted between the baseframe and the foundation.

3.8 Silencer and Exhaust System

An exhaust silencer is provided loose for installation with the generator set. The silencer and exhaust system reduce the noise emission from the engine and can direct exhaust gases to safe outlets.

3.9 Control System (Identification)

One of several types of control systems and panels (item 14) may be fitted to control the operation and output of the set and to protect the set from possible malfunctions. Section 9 of this manual provides detailed information on these systems and will aid in identification of the control system fitted on the generator set.

3.10 Output Circuit Breaker

To protect the alternator, a suitably rated circuit breaker (item 15) selected for the generator set model and output rating is supplied mounted in a steel enclosure. In some cases the output circuit breaker may be incorporated in the automatic transfer system or control panel.

4. INSTALLATION, HANDLING, TOWING AND STORAGE

4.1 General

This section discusses factors important in the effective and safe installation of the generator set. Further information is available in the **Generator set Installation Manual** which is available upon request.

4.2 Enclosures

Installation and handling is greatly simplified when the generator set has been equipped with an enclosure. Two basic types may be fitted. The first type is a close fitting canopy enclosure. This may be a weatherproof version or designed for sound attenuation. The other enclosure type is a walk-in type container, similar to a shipping container. It may also be weatherproof or sound attenuated.

These enclosures provide a self contained generator set system that is easily transportable and requires minimal installation. They also automatically give protection from the elements and protection from unauthorized access.

WARNING:

! **Make sure all personnel are out of the canopy or container, if equipped, before closing and latching enclosure doors.**

! **Before closing canopy or enclosure doors, ensure all obstructions (especially hands and fingers) are clear to prevent damage or injury.**

Because the canopied generator sets are easily transportable and may be installed and operated in a temporary location, many of the fixed installation details given in this chapter may not apply. The following considerations must be still given when temporarily installing the generator set:

- Locating the generator set where it will be protected from damage and away from exhaust fumes from other engines or other airborne contaminants such as dust, lint, smoke, oil mist or vapors.
- Locating the generator set on firm, level ground that will support the weight of the generator set and avoid movement due to the vibration of the operating set.
- Ensuring that fumes from the exhaust outlet will not be a hazard especially when wind is taken into account.
- Electrical grounding of the generator set at all times.
- Providing access to refill the fuel tank when required.
- Protecting electrical cables installed between the generator set and the load. If these are laid on the ground ensure they are boxed in or covered to prevent damage or injury to personnel.

If the enclosed generator set is installed inside a building, adequate fresh cooling air must be provided and the engine exhaust and hot coolant air exhaust must be ducted outside the building. The ducting and exhaust pipework must be designed to minimize back pressure which would have a detrimental effect on generator set performance.

4.3 Moving the Generator set

The generator set baseframe is specifically designed for ease of moving the set. Improper handling can seriously damage components.

Using a forklift, the generator set can be lifted or carefully pushed/pulled by the baseframe. If pushing, do not push the baseframe directly with fork. Always use wood between forks and the baseframe to spread the load and prevent damage. If the set will be regularly moved, it should be fitted with the optional "Oil Field Skid" which provides fork lift pockets in the baseframe along with eyes for pulling. The smaller sets have fork lift pockets in the baseframe as standard.

WARNING:

! **Never lift the generator set by attaching to the engine or alternator lifting lugs.**

! **Ensure the lifting rigging and supporting structure is in good condition and is suitably rated.**

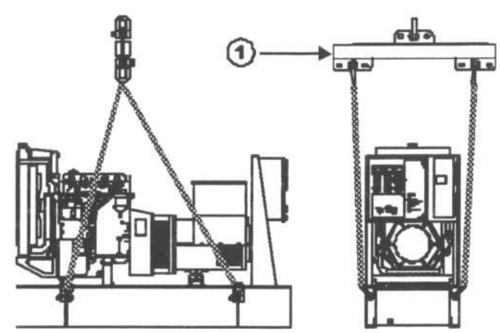
! **Keep all personnel away from the generator set when it is suspended.**

For ease of lifting, canopied sets have a single point lifting facility as standard.

For walk-in type enclosures lifting attachment is by means of corner fittings on the enclosure. Generator sets in these enclosures are fitted with restraining angles to rigidly attach the engine and alternator to the baseframe during transit. Ensure the restraints are fitted securely in place before moving the generator set. Once the generator set has been moved these restraints must be removed before attempting to operate the set.

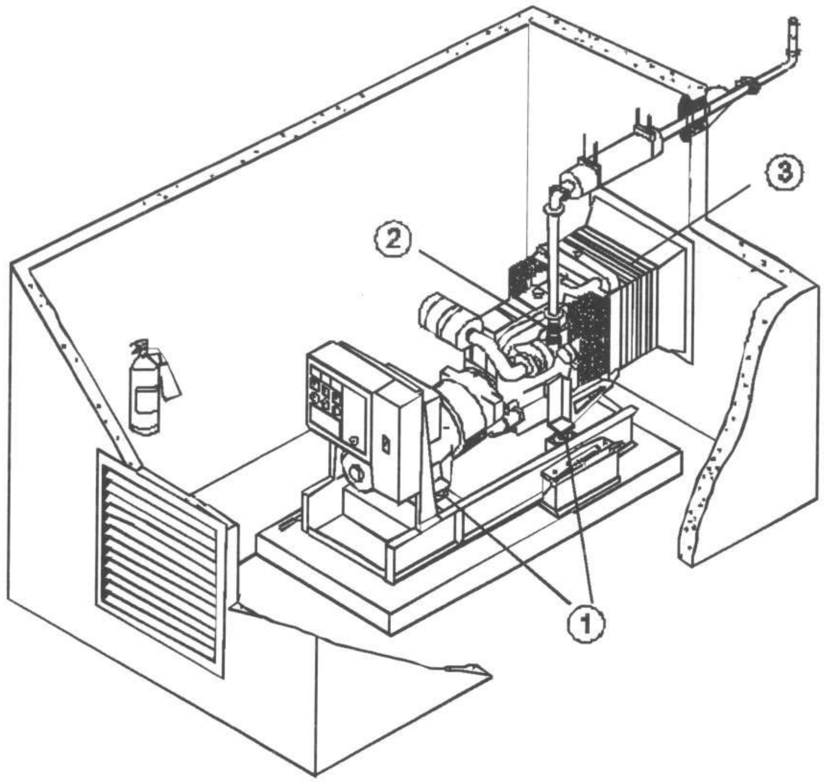
For a single lift such as lifting the set to install it, the lift points provided on the baseframe may be used. Points of attachment should be checked for cracked welds or loose nuts and bolts before lifting. A spreader bar is required to prevent damaging the set (see Figure 4.1). It should be positioned over the center of gravity (nearer the e[illegible]), not the center of the set, to allow a vertical lift. Gu[illegible]opes should be used to prevent twisting or swinging of the set once it has been lifted clear of the ground - do not attempt to lift in high winds. Place the generator set down on a level surface capable of supporting its weight. This manner of lifting should only be used for a single lift for installation.

Generator sets to be air lifted by helicopter should be lifted by sling.



Item	Description
1.	Spreader Bar

Figure 4.1: Proper Lifting Arrangement for Installing the Set



Item	Description
1.	Vibration Isolators
2.	Flexible Exhaust Coupling
3.	Flexible Air Discharge Duct

Figure 4.2: Typical Installation Highlighting Vibration Reduction Techniques

4.4 Location

Selecting a location for the generator set can be the most important part of any installation procedure. The following factors are important in determining the location:

- Adequate ventilation.
- Protection from the elements such as rain, snow, sleet, wind driven precipitation, flood water, direct sunlight, freezing temperatures, or excessive heat.
- Protection from exposure to airborne contaminants such as abrasive or conductive dust, lint, smoke, oil mist, vapors, engine exhaust fumes or other contaminants.
- Protection from impact from falling objects such as trees or poles, or from motor vehicles or lift trucks.
- Clearance around the generator set for cooling and access for service: at least 1 meter (3.3 feet) around the set and at least 2 meters (6.6 feet) headroom above the set.
- Access to move the entire generator set into the room. Air inlet and outlet vents can often be made removable to provide an access point.
- Limited access to unauthorized personnel.

If it is necessary to locate the generator set outside of the building, the generator set should be enclosed in a weatherproof canopy or container-type housing which is available for all sets. These enclosures are also useful for temporary installations inside or outside the building.

4.5 Foundations and Vibration Isolation

The generator set is shipped assembled on a rigid baseframe that precisely aligns the alternator and engine and needs only be bolted down to a suitably prepared surface (see Figure 4.2).

4.5.1 Foundation: A reinforced concrete pad makes the best foundation for the generator set. It provides a rigid support to prevent deflection and vibration. Typically the foundation should be 150 mm to 200 mm (6 to 8 inches) deep and at least as wide and long as the generator set. The ground or floor below the foundation should be properly prepared and should be structurally suited to carry the weight of the foundation pad and the generator set. (If the generator set is to be installed above the ground floor the building structure must be able to support the weight of the generator set, fuel storage and accessories.) Relevant building codes should be consulted and complied with. If the floor may be wet from time to time, such as in a boiler room, the pad should be raised above the floor. This will provide a dry footing for the generator set and for those who connect, service or operate it. It will also minimize corrosive action on the baseframe.

4.5.2 Vibration Isolation: To minimize engine vibrations being transmitted to the building, the generator set is fitted with vibration isolators. On small and medium sized sets these isolators are fitted between the engine/alternator feet and the baseframe. This allows the frame to be rigidly bolted to the foundation. On larger sets the coupled engine/alternator is rigidly attached to the baseframe and the vibration isolators are supplied loose for fitting between the baseframe and the foundation. In all cases the sets should be securely bolted to the ground (either through the baseframe or through the vibration isolators) to prevent movement.

Vibration isolation is also required between the generator set and its external connections. This is achieved by use of flexible connections in the fuel lines, exhaust system, radiator air discharge duct, electrical conduit for control and power cables and other externally connected support systems (see Figure 4.2).

On mobile sets the generator set should be mounted using "captivation mounts". These mounts minimize vibration and include a captivation feature that prevents the set breaking away in case of road accident.

4.6 Combustion Air Inlet

Air for engine combustion must be clean and as cool as possible. Normally this air can be drawn from the area surrounding the generator set via the engine mounted air filter.

However, in some cases due to dust, dirt, or heat, the air around the set is unsuitable. In these cases an inlet duct should be fitted. This duct should run from the source of clean air (outside the building, another room, etc.) to the engine mounted air filter. Do not remove the air filter and mount it at a remote location as this can increase the possibility of dirt leaking through the ductwork and into the engine inlet. To ensure that this type of installation will not have a detrimental effect on the operation of the generator set, the design of the inlet duct should be approved by the factory.

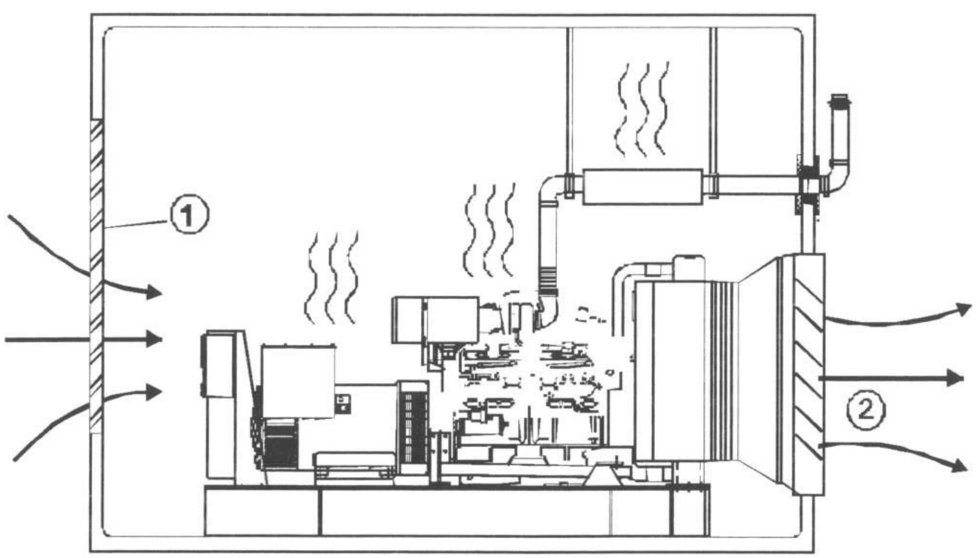
4.7 Cooling and Ventilation

The engine, alternator, and exhaust piping radiate heat which can result in a temperature high enough to adversely effect the performance of the generator set. It is therefore important that adequate ventilation is provided to keep the engine and alternator cool. Proper air flow, as shown in Figure 4.3, requires that the air comes in at the alternator end of the set, passes over the engine, through the radiator and out of the room via a flexible exhaust duct. Without the ducting of the hot air outside the room, the fan will tend to draw that hot air around and back through the radiator, reducing the cooling effectiveness.

The air inlet and exit openings should be large enough to ensure free flow of air into and out of the room. As a rough guide the openings should each be at least 1.5 times the area of the radiator core.

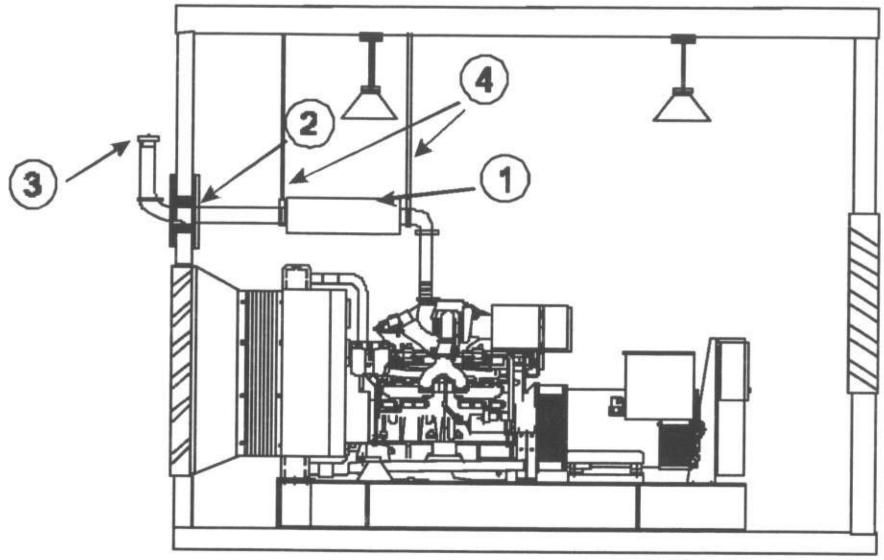
Both the inlet and exit openings should have louvres for weather protection. These may be fixed but preferably should be movable in cold climates so that while the generator set is not operating the louvres can be closed. This will allow the room to be kept warm which will assist starting and load acceptance. For automatic starting generator sets, if the louvres are movable they must be automatically operated. They should be programmed to open immediately upon starting the engine. The force of radiator air should not be depended upon to open the louver vanes unless the system has been specifically designed for this.

When a remote radiator or heat exchanger cooling [illegible]em is used, the radiated heat from the generator set must still be removed from the room.



Item	Description
1.	Air Inlet Opening
2.	Air Exit Opening

Figure 4.3: Air Ventilation



Item	Description
1.	Exhaust Silencer
2.	Wall Sleeve and Expansion Joint
3.	Rain Cap
4.	Silencer/Pipework Supports

Figure 4.4: Typical Exhaust System Installation

4.8 Exhaust

The purpose of the engine exhaust system is to direct the exhaust outside to a location and height where the fumes and odors will not become an annoyance or hazard, and to reduce noise. A suitable exhaust silencer must be incorporated into the exhaust piping to reduce the noise level from the engine. It can be fitted either inside or outside the building (see Figure 4.4). Canopied generator sets include exhaust system within the enclosure.

Open generator sets will generally be supplied with a loose industrial class silencer, a stub pipe and a bellows (if required). An optional "Overhead Mounting Kit" includes a bend, silencer support brackets and a bellows (if not standard). An optional "Silencer Installation Kit" includes the wall sleeve, bend and rain cap for directing the exhaust outside (see Figure 4.4). In all cases, the straight sections of pipe and screw rods for the support brackets are supplied by the customer.

WARNING:

! **Engine exhaust emissions are hazardous to personnel.**

! **The engine exhaust for all indoor generator sets must be piped outdoors via leak-free piping in compliance with relevant Codes, Standards and other requirements.**

! **Ensure hot exhaust silencers, piping and turbochargers, if fitted, are clear of combustible material and are guarded for personnel protection per safety requirements.**

! **Ensure that fumes from the exhaust outlet will not be a hazard.**

In designing an exhaust system, the primary consideration is to not exceed the allowable back pressure permitted by the engine manufacturer. Excessive back pressure seriously affects engine output, durability and fuel consumption. To limit the back pressure the exhaust piping should be as short and straight as possible. Any required bends should have a curve radius of at least 1.5 times the inside diameter of the pipe. Any designed exhaust extensions over 3 meters should be approved by the factory.

Other exhaust design criteria are as follows:

- Exhaust components including turbochargers can be very hot and must be guarded where they could be accidentally touched.
- A flexible connection between the exhaust manifold and the piping system should be used to prevent transmission of engine vibration to the piping and the building and to allow for thermal expansion and any slight misalignment of the piping. (See Figure 4.2)
- Ensure that the silencer and all pipes are well supported to limit strain on the connectors which could result in cracks or leaks.
- Exhaust system components located within the generator room should be insulated to reduce heat radiation and noise levels. Pipes and the silencer, whether located inside <u>or</u> outside the building, should be located well clear of any combustible material.
- Any long horizontal or vertical piping should slope away from the engine and include drain traps at their lowest points to prevent water from reaching the engine or silencer.
- On generator sets above 150 kVA the silencer installation must include a purge plug for venting of the exhaust system in the event of difficult startinr 'e plug should be located adjacent to the exhaus ge and positioned to allow access.
- Where the pipe goes through a wall there should be a sleeve in the opening to absorb vibration and isolate combustible material from the hot pipes (See Figure 4.4). There may also be an expansion joint in the pipe to compensate for lengthwise thermal expansion or contraction.
- The outer end of the exhaust pipe, if horizontal, should be cut at 60° to the horizontal or should be fitted with a rain hood or cap, if vertical, to prevent rain or snow from entering the exhaust system.
- The exhaust pipe must not be connected to exhausts from other generator sets or other equipment, such as a furnace or boiler.

4.9 Fuel System

The fuel system for the generator set must be capable of delivering a clean and continuous supply of fuel to the engine. For most installations, this will include a small day tank (usually incorporated in the baseframe), a bulk storage tank and the associated pumps and plumbing.

WARNING:

! **For stationary generator sets with remote fuel storage systems, make sure such systems are installed in compliance with relevant Codes, Standards or other requirements.**

! **Do not smoke or allow sparks, flames o. er sources of ignition around fuel. Fuel vapors and oil vapors are explosive.**

4.9.1 Day Tank: Day tanks provide a readily available supply of fuel directly to the generator set and should therefore be located within the generator room. The steel baseframe of all but the largest sets are designed with a steel or polyethylene day tank built in with the engine fuel lines connected. These "basetanks" provide for at least 8 hours operation at full load or approximately 24 hours if an extended capacity basetank has been fitted.

WARNING:

! **Never connect a remote fuel system to polyethylene fuel tanks incorporated in the baseframe on smaller generator sets.**

4.9.2 Bulk Storage Tanks: For extended operation, a separate bulk fuel storage tank is required. Especially for standby generator sets it is not advisable to depend on regular delivery of fuel. The emergency that requires use of the standby set may also interrupt the delivery of fuel.

The bulk tank should generally be located outside the building where it will be convenient for refilling, cleaning and for inspection. It should not, however, be exposed to freezing weather because fuel flow will be restricted as viscosity increases with cold temperatures. The tank may be located either above or below ground.

A vent must be installed on the bulk tank to relieve air pressure created by filling the tank or created by evaporation and expansion. It will also prevent a vacuum as the fuel is consumed. The tank bottom should be rounded and placed on a 2° tilt to assure a concentrated settling of water and sediment. A sludge drain valve should be installed at the low point to allow removal of water and sediment on a regular basis. Underground tanks should have this water and sediment pumped out regularly.

4.9.3 Fuel Lines: The fuel lines can be of any fuel compatible material such as steel pipe or flexible hoses that will tolerate environmental conditions.

WARNING:

! **Do not use galvanized pipe or fittings for the fuel system.**

Fuel delivery and return lines should be at least as large as the fitting sizes on the engine, and overflow piping should be one size larger. For longer runs of piping or low ambient temperatures the size of these lines should be increased to ensure adequate flow. Flexible piping should be used to connect to the engine to avoid damage or leaks caused by engine vibration.

The fuel delivery line should pick up fuel from a point no lower than 50 mm (2") from the bottom at the high end of the tank (away from the drain plug).

4.9.4 Remote Fuel Systems: Most sets are supplied equipped with a diesel fuel tank in the baseframe. Certain installations, however, require the addition of remote fuel supplies. The manufacturer recommends the 3 types of systems detailed below. It must be noted that polyethylene fuel tanks are not compatible with remote fuel systems, so a metal fuel tank must be fitted.

Fuel System 1: Installations where the bulk fuel tank is lower than the day tank.

Fuel System 2: Installations where the bulk fuel tank is higher than the day tank.

Fuel System 4: Installations where fuel must be pumped from a free standing bulk fuel tank to the day tank.

Fuel System 1: The bulk fuel tank is lower than the day tank. With this system the fuel must be pumped up from the bulk tank to the day tank which is integrated into the baseframe. See figure 4.5.

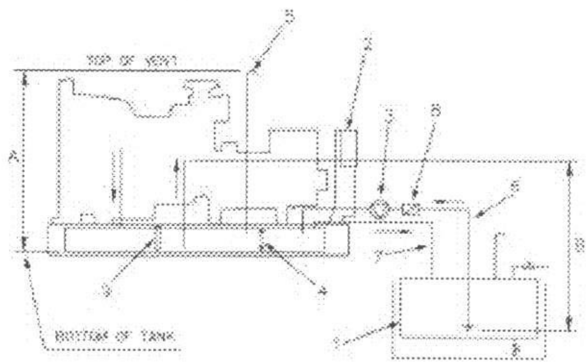


Figure 4.5: Typical Layout with **Fuel System 1**

The key components are the bulk fuel tank (item 1), which is lower than the basetank, remote fuel system controls (item 2) located in the generator set control panel, an AC powered electric fuel pump (item 3), fuel level switches in the basetank (item 4), an extended vent on the basetank (item 5), the fuel supply line (item 6), the fuel return line (item 7), and a fuel strainer (item 8) on the inlet side of the pump.

When set to automatic, the system operates as follows: low fuel level in the basetank is sensed by the fuel level sensor. The pump begins to pump fuel from the bulk tank to the basetank through the fuel supply line. To help ensure that clean fuel reaches the engine, fuel from the bulk tank is strained just prior to the electric fuel pump. When the basetank is full, as sensed by the fuel level sensor, the pump stops. If there should be any overflow of fuel in the basetank, the excess will drain back into the bulk tank via the return line.

With this system, the basetank must include the overflow (via the return line), a 1.4 meter extended vent to prevent overflow through the vent, sealed fuel level gauges on the basetank and no manual fill facility All other connections on top of the tank must be sealed to prevent leakage. Fuel System 1 is not compatible with the polyethylene fuel tanks sometimes used on smaller generator sets. The optional metal tank is required.

The position of the bulk fuel tank should take into account that the maximum suction lift of the fuel transfer pump is approximately 3 meters and that the maximum restriction caused by the friction losses in the return fuel line should not exceed 2 psi.

Also available as an upgrade to the fuel transfer system is a manual backup system. Upon failure of the automatic transfer system, the manual backup can be used to transfer fuel from the main bulk tank to the generator set basetank. The key components in the manual backup system are isolating valves (item 9), manual fuel pump (item 10), and non-return valve (item 11). When the fuel level in the generator basetank is low (as observed by using the mechanical fuel gauge), open the manual pump isolating valves and operate the manual pump. When the required fuel level is reached, cease operating the manual fuel pump and close the isolating valves.

Fuel System 2: The bulk tank is located higher than the basetank. With this system the fuel is gravity fed from the bulk tank to the basetank. See figure 4.6.

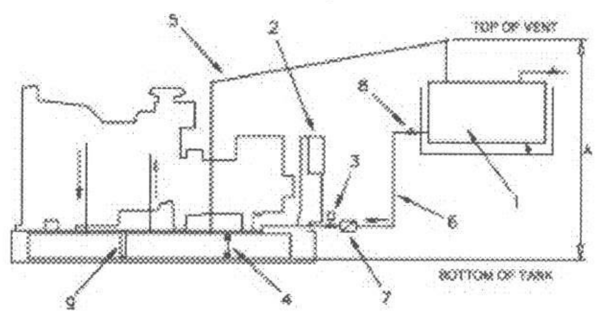


Figure 4.6: Typical Layout with **Fuel System 2**

The key components are the bulk fuel tank (item 1), which is higher than the basetank, remote fuel system controls (item 2) located in the generator set control panel, a DC motorized fuel valve (item 3), fuel level switches in the basetank (item 4), an extended vent/return line (continuous rise) on the basetank (item 5), the fuel supply line (item 6), a fuel strainer (item 7) and an isolating valve at the bulk tank (item 8).

When set to automatic, the system operates as follows: low fuel level in the basetank is sensed by the fuel level sensor. The DC motorized valve is opened and fuel is allowed to flow from the high level bulk tank to the basetank by the force of gravity. To help ensure that clean fuel reaches the engine, fuel from the bulk tank is strained just prior to the motorized valve. When the basetank is full, as sensed by the fuel level sensor, the motorized valve is closed. Any overflow into the basetank or overpressure in the basetank will flow back to the bulk tank via the extended vent.

With this system, the basetank must include an overflow via the return line, sealed fuel level gauges and no manual fill facility. All other connections on top of the tank must be sealed to prevent leakage. Fuel System 2 is not compatible with the polyethylene fuel tanks sometimes used on smaller generator sets. The optional metal tank is required.

Distance 'A' in Figure 4.6 is limited to 1400mm for all generator sets with metal basetanks.

Also available as an upgrade to the fuel transfer system is a manual backup system. Upon failure of the automatic transfer system, the manual backup can be used to transfer fuel from the main bulk tank to the generator set basetank. The manual backup system consists of a bypass with a manually operated shutoff valve. When the fuel level in the generator basetank is low (as observed by using the mechanical fuel gauge), open the manual shut-off valve in the bypass circuit. When the required fuel level is reached close the manual shut-off valve in the bypass circuit.

Fuel System 4: Some installations may require a system where fuel is pumped from a free standing bulk tank (see Figure 4.7). This pumped system would only be used if gravity feed is not possible from the bulk tank to the basetank.

The key components are the above ground bulk fuel tank (item 1), remote fuel system controls (item 2) located in the generator set control panel, an AC Fuel Pump (item 3), a DC motorized fuel valve (item 4), fuel level switches in the basetank (item 5), the fuel supply line (item 6), an extended vent/return line (continuous rise) on the basetank (item 7), a fuel strainer (item 8) and an isolating valve at the bulk tank (item 9).

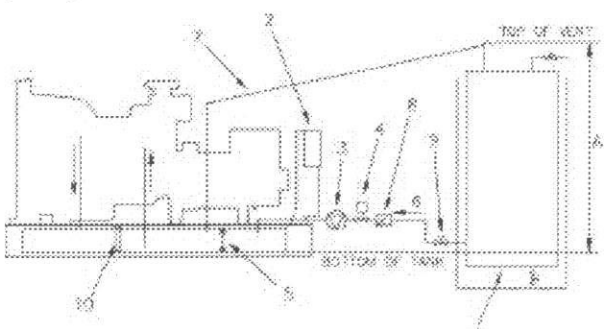


Figure 4.7: Typical Layout with **Fuel System 4**

When set to automatic, the system operates as follows: low fuel level in the basetank is sensed by the fuel level sensor. The DC motorized valve is opened and the pump begins to pump fuel from the bulk tank to the basetank through the supply line. To help ensure that clean fuel reaches the engine, fuel from the bulk tank is strained just prior to the motorized valve. When the basetank is full, as sensed by the fuel level sensor, the pump stops and the motorized valve is closed. Any overflow into the basetank or overpressure in the basetank will flow back to the bulk tank via the extended vent.

With this system, the basetank must include an ov[illegible]ow via the return line, sealed fuel level gauges and no manual fill facility. All other connections on top of the tank must be sealed to prevent leakage. Fuel System 4 is not compatible with the polyethylene fuel tanks sometimes used on smaller generator sets. The optional metal tank is required.

Distance 'A' on Figure 4.7 is limited to 1400mm for all generator sets. Note that the maximum restriction caused by friction losses and height of the return line should not exceed 2 psi.

Also available as an upgrade to the fuel transfer system is a manual backup system. Upon failure of the automatic transfer system, the manual backup can be used to transfer fuel from the main bulk tank to the generator set basetank. The key components in the manual backup system are isolating valves (item 10), manual fuel pump (item 11), and non-return valve (item 12). When the fuel level in the generator basetank is low (as observed by using the mechanical fuel gauge), open the manual pump isolating valves and operate the manual pump. When the required fuel level is reached, cease operating the manual fuel pump and close the isolating valves.

4.10 Fire Precautions

When designing the generator set installation the following points should be considered:

- The room should be designed so that there is [illegible]asy escape route for operating personnel in the event of fire within the room.
- Supply a Class BC or Class ABC fire extinguisher and/or fire extinguishing system.
- Gravity operated fire valves released by temperature operated fusible links mounted above the engine can be installed in the fuel lines.

4.11 Starting Batteries

WARNING:

! **Do not smoke or allow sparks, flames or other sources of ignition around batteries. Hydrogen gas generated by charging batteries is explosive.**

The starting batteries should be located as close as possible to the generator set while still being accessible for servicing. This will prevent electrical losses from long cables that could impact on the engine starting capability of the batteries. See Section 10.

4.12 Electrical Connection

Onsite electrical installation will generally consist only of connecting up the site load to the generator set output terminals. Only fully qualified and experienced electrical technicians should carry out electrical installation, service and repair work.

WARNING:

! **Make electrical connections in compliance with relevant Electrical Codes, Standards or other requirements. This includes requirements about grounding and ground/earth faults.**

4.12.1 Cabling: Due to movement of generator sets on their vibration mounts, the electrical connection to the set should be made with flexible cable. This will prevent transmission of vibrations and possible damage to the alternator or circuit breaker terminals. If flexible cabling can not be used throughout the installation then a link box should be installed close to the set with a flexible connection to the set.

The cable should be protected by laying it in a duct or cable tray. However, the duct or tray should never be rigidly connected to the generator set. When bending cable, reference must be made to the recommended minimum bending radius.

The cable must be suitable for the output voltage of the generator set and the rated current of the set. In determining the size, allowances should be made for ambient temperature, method of installation, proximity of other cables, etc. When single core cables are used the gland plates must be of non-ferrous material such as aluminum, brass or a non-metallic material such as tufnol. Alternatively slots can be cut between gland holes of cables to prevent circulating (eddy) currents in magnetic gland plates.

All connections should be carefully checked for integrity. Phase rotation must be checked for compatibility with the installation. This is vitally important when connection is made to an automatic transfer switch, or if the machine is to be paralleled.

4.12.2 Protection: The cables connecting the generator set with the distribution system are protected by means of a circuit breaker to automatically disconnect the set in case of overload or short circuit.

4.12.3 Loading: When planning the electrical distribution system it is important to ensure that a balanced load is presented to the generator set. If loading on one phase is substantially higher than the other phases it will cause overheating in the alternator windings, imbalance in the phase to phase output voltage and possible damage to sensitive 3 phase equipment connected to the system. Ensure that no individual phase current exceeds the current rating of the generator set. For connection to an existing distribution system, it may be necessary to reorganize the distribution system to ensure these loading factors are met.

4.12.4 Power Factor: The power factor (cos Φ) of the connected load should be determined. Power factors below 0.8 lagging (inductive) can overload the generator. The set will provide its kilowatt rating and operate satisfactorily from 0.8 lagging to unity power factor (1.0).

Particular attention must be given to installations with automatic or manual power factor correction equipment such as capacitors to ensure that a leading power factor is never present. This will lead to voltage instability and may result in damaging overvoltages. Generally, whenever the generator set is supplying the load any power factor correction equipment should be switched off.

4.12.5 Grounding Requirements: Regulations vary for different locations. The frame of the generator set must be positively connected to an earth ground. Since the set is mounted on vibration isolators, the ground connection must be flexible to avoid possible breakage due to vibration. On the majority of self contained sets the ground connection is located inside the circuit breaker box.

Ground connection cables or straps should have at least full load current carrying capacity and meet applicable regulations.

4.12.6 Alternator Reconnection: Most alternators can be reconnected to suit different output voltages. The reconnection procedures are given in the Alternator Manual. Ensure that all other components such as circuit breakers, current transformers, cables and ammeters are suitable before operating at a different voltage.

4.12.7 Parallel Running: Extra equipment must be fitted for the standard generator sets to be operated in parallel with other generator sets or with mains power.

4.12.8 Insulation Test: Before starting the generator set after installation, test the insulation resistance of the windings. The Automatic Voltage Regulator (AVR) should be **disconnected** and the rotating diodes either shorted out with temporary links or disconnected. Any control wiring must also be disconnected.

A 500V Megger or similar instrument should be used. Disconnect any earthing conductor connected between neutral and earth and megger an output terminal to earth. The insulation resistance should be in excess of 5MΩ to earth. Should the insulation resistance be less than 5MΩ the winding must be dried out. See the Alternator Manual for procedures.

4.13 Acoustic Silencing

Control of generator set noise is becoming very important in most installations. There is a range of options available to control the noise level.

WARNING:

! **Ear protection must be worn when operating or working around an operating generator set.**

4.13.1 Exhaust Silencers: As discussed in Section 4.8 the exhaust silencer will decrease sound levels from the engine. Varying degrees of sound attenuation are available from different types of silencers. These levels are often described by terms such as industrial, residential, critical or supercritical.

4.13.2 Enclosures: Section 4.2 discusses enclosures that are available in either weatherproof or sound attenuating versions. These enclosures can be designed to meet a specific sound level requirement.

4.13.3 Other Sound Attenuation: For installations in buildings there are other types of equipment such as acoustic louvers, splitter vents and fan silencers, as well as sound absorbing wall coverings, that can be used to reduce the noise levels of generator sets.

4.14 Towing (Portable Generator sets)

4.14.1 Preparing to Tow: Inspect all components of the coupling equipment on the towing vehicle and the generator set for defects such as excessive wear, corrosion, cracks, bent metal, or loose bolts. Ensure that the towing vehicle is rated for towing a load of at least the weight of the mobile generator set plus a 10% safety factor.

Couple the towing vehicle to the trailer and ensure the coupling device is engaged, closed and locked. Attach electrical connector for indicator lights, etc. Attach chains, if provided, by crossing them under the drawbar and attaching to the towing vehicle. Attach any "break away" safety wire, if fitted.

Fully retract the front screw jack, if equipped, and secure with the pin or locking device. Lock the front castor wheel, if equipped, in the full up position. Ensure that the rear stabilizer jacks, if equipped, are raised and locked.

Inspect tyres for condition and proper inflation. Check all tail lights, if equipped, are operating properly and that all reflectors are clean and functional.

Ensure load and grounding/earthing cables are disconnected and that all windows, access doors, and tool box covers are closed, latched and locked. Ensure any external fuel pipes are disconnected.

Release trailer parking brakes, if equipped, and remove any blocks or chocks under the wheels.

4.14.2 Towing: Whenever towing a mobile generator set, remember that the set may approach or exceed the weight of the towing vehicle so maneuverability and stopping distance will be affected.

WARNING:

- ! **When towing a mobile generator set, observe all Codes, Standards or other regulations and traffic laws. These include those regulations specifying required equipment and maximum and minimum speeds.**
- ! **Ensure brakes, if fitted, are in good order.**
- ! **Do not permit personnel to ride in or on the mobile generator set. Do not permit personnel to stand or ride on the drawbar or to stand or walk between the generator set and the towing vehicle.**

Avoid gradients in excess of 15° (27%) and avoid potholes, rocks or other obstructions and soft or unstable terrain.

Ensure the area behind and under the mobile set is clear before reversing.

4.14.3 Parking: Park the set on a dry level area that can support it's weight. If it must be located on a slope, park it across the grade so that it does not tend to roll do[illegible]. Do not park the set on grades exceeding 15° (27%).

Set the parking brake and block or chock both sides of all wheels. Lower front screw jack, castor wheel and/or rear stabilizer jacks, as fitted.

Unhook chains, if equipped, from the towing vehicle, disconnect electrical connection, disconnect the coupling device and move the towing vehicle clear of the mobile generator set.

4.15 Storage

Long term storage can have detrimental effects on both the engine and alternator. These effects can be minimized by properly preparing and storing the generator set.

4.15.1 Engine Storage: The engine should be put through an engine "preservation" procedure that includes cleaning the engine and replacing all the fluids with new or preserving fluids. See the Engine Manual for the proper procedure.

4.15.2 Alternator Storage: When an alternator is in storage, moisture tends to condense in the windings. To minimize condensation, store the generator set in a dry storage area. If possible use space heaters to keep the windings dry.

After removing the generator set from storage, perform an insulation check as discussed in Section 4.12.8. If the readings are lower than prior to storage, it may be necessary to dry out the windings. See the Alter[illegible] Manual for procedures.

If the megger reading is below 1MΩ after drying, the insulation has deteriorated and should be reconditioned.

4.15.3 Battery Storage: While the battery is stored, it should receive a refreshing charge every 12 weeks (8 weeks in a tropical climate) up to a fully charged condition.

5. OPERATION

5.1 General

The generator set is equipped with an advanced electronic control system. This will be one of a range of systems such as a 1001, 2001, 4001 or 4001E control system. See Section 9 of this manual to identify which system is fitted on the generator set and for a functional description of each.

These control systems allow the operator to manually or automatically control the generator set. They have protection circuits to sound an optional alarm and even shutdown the set if problems occur. Details of the capabilities of each system are contained in Section 9.

The following procedures detail the steps required to prepare the set for operation, start and stop it for the first time after installation, and start and stop it normally. Section 5.2, Pre-Start Checks are applicable with all control systems. Section 5.3 and 5.4 cover operation of the Keystart Control Systems (1001 Series). Section 5.5, 5.6 and 5.7 cover operation of the Autostart Control Systems (2001, 4001 and 4001E Series).

5.2 Pre-Start Checks (applicable to all control systems)

The following checks should be performed prior to starting the generator set:

WARNING:

! **For generator sets in walk-in type enclosures ensure that all vibration isolator restraints are removed before starting the generator set.**

! **As generator sets with autostart control panels (2001 Series or above) can be remotely started without warning, always ensure the control panel is switched off before carrying out any checks.**

1. Ensure the Control Switch/Key Switch is Off.

WARNING:

! **Do not remove the radiator cap when the coolant is hot. Do not add large amounts of cold coolant to a hot system as serious damage could result.**

2. Check the engine oil and coolant levels - replenish as necessary.

Note:

- Diesel engines normally consume lube oil at a rate of .25% to 1% of the fuel consumption.
- When adding coolant to the radiator system, always pour slowly to help prevent air from becoming trapped in the engine.

WARNING:

! **When filling the fuel tank, do not smoke or use an open flame in the vicinity.**

3. Check the fuel level - fill as necessary.

WARNING:

! **Before tightening fan belts, disconnect the battery negative (-) lead to ensure the engine cannot be accidentally started.**

4. Check the condition and tension of the fan and engine alternator belts - tighten as necessary.
5. Check all hoses for loose connections or deterioration - tighten or replace as necessary.
6. Check the battery terminals for corrosion - clean as necessary.

WARNING:

! **When working with the batteries, do not smoke or use an open flame in the vicinity. Hydrogen gas from batteries is explosive.**

! **Do not short the positive and negative terminals together.**

7. Check the battery electrolyte level - fill with distilled water as necessary. If the battery is new and has never been wet charged, fill with suitable premixed electrolyte and charge as per instructions in Section 10.2.2.
8. Check the control panel and the generator set for heavy accumulation of dust and dirt - clean as necessary. These can pose an electrical hazard or give rise to cooling problems.
9. Check the air filter restriction indicator, if fitted - replace the filter as necessary.
10. Clear the area around the generator set of any insecure items that could inhibit operation or cause injury. Ensure cooling air ventilation screens are clear.
11. Visually check the entire generator set for signs of leaks from the fuel system, cooling system or lubrication seals.
12. Periodically drain exhaust system condensate traps, if equipped.
13. Ensure the Alternator Output Circuit Breaker is in the "OFF" (handle down) position.

5.3 Initial Startup/Shutdown - Key Start Panel (1001 Series)

The following procedure should be used when starting a generator set equipped with a 1001 Series Key Start Control System for the first time or when it has been out of service for a time for maintenance purposes:

Note:

- The generator set may be stopped at any time by pressing the Emergency Stop button or by turning the Key Switch to Position "O" (Off).

1. Complete Pre-Start checks as per Section 5.2.
2. Connect the batteries to the engine, positive lead first then the negative lead.
3. Prime the lube oil system by first removing one wire from the fuel solenoid or actuator. This prevents the engine from starting. Then crank the engine by turning the Key Switch to Position "↷" (Start) for 5 to 7 seconds. Return the Key Switch to Position "O" (Off). Repeat the cranking attempt up to 4 times, if required, until oil pressure is registered on the gauge. Should the oil pressure still not have built up after 4 cranking attempts, investigate the reason for lack of oil pressure

prior to further cranking. Reconnect the wire to the fuel solenoid or actuator.

WARNING:

! **Excessive cranking with an unprimed fuel system may cause a build-up of unburned fuel gases in the exhaust system which could be potentially explosive.**

4. Prime the fuel system using the hand priming pump and bleed entrapped air from the fuel filter - see Engine Manual for details.
5. Start: Turn the Key Switch from Position "O" (Off) through Position "I" (On) to Position "" (Thermo) to activate the thermostart, if fitted. Hold for 7 seconds to preheat the induction air. After this time, the Key Switch should be further turned to Position "" (Start) to crank the engine. When the engine starts, release the Key Switch immediately allowing it to return to Position "I" (On).

   Do not crank the engine for more than 5 to 7 seconds should the engine fail to start. Allow an interval of 10 seconds and always turn Key Switch to Position "O" (Off) between cranking attempts. If, after 4 cranking attempts, the engine still has not started, refer to the trouble shooting guide in Section 9 or the Engine Manual to determine the cause of failure to start.

WARNING:

! **Unburned fuel gases can build-up in the exhaust system after multiple failed attempted starts. Unscrew the plugs on the exhaust outlet elbows or stub pipes and allow the unburned fuel to dissipate. Once all signs of unburned fuel (white smoke) have disappeared and any other problems causing the failure to start have been rectified, replace the plugs and repeat the cranking procedure.**

WHEN ENGINE HAS STARTED

6. After approximately 1 minute shutdown the generator set by pressing the Emergency Stop or by turning the Key Switch to Position "O" (Off). Remove the radiator cap and wait 5 minutes for the system to settle and any trapped air to escape. Re-check the coolant level and refill as necessary.

Note:

- A newly filled coolant system can have air locks that must be cleared by running the engine for a short time and the system refilled prior to extended running of the engine.

7. Restart the engine following the procedure in step 5 above.
8. Check for any abnormal noise or vibration.
9. Check for fluid leakage or leaks in the exhaust system.
10. Check the control panel for indications of abnormal operation, particularly abnormally high temperature or abnormally low oil pressure. The oil pressure should be in the normal range within about 10 seconds of starting.
11. Check the control panel for output voltage and frequency. The voltage is factory set and should indicate the rated voltage. The **no load** frequency is approximately 52 Hz for 50 Hz units and approximately 62 Hz for 60 Hz units. Adjustments should only be carried out by a qualified technician.

    Three means of voltage adjustment are availa!

    Fine adjustment is achieved by varying the settıng of the speed potentiometer on the control panel, if fitted.

    Coarse adjustment is achieved by varying the setting of a potentiometer mounted inside the automatic voltage regulator which is fitted to the alternator terminal box.

    Gross adjustment to completely change the voltage setting of the alternator is achieved by reconnecting the alternator windings at the alternator terminal box. Details of these connections can be found in the Alternator Manual.

WARNING:

! **Do not close the circuit breaker during the phase rotation check if load cables have already been connected.**

12. While the generator set is producing voltage, check the phase rotation of the set by connecting a phase rotation meter to the terminals on the generator side of the circuit breaker. This check should be carried out by a qualified technician.
13. **Shutdown:** To shutdown the generator set press the Emergency Stop button or turn the Key Switch to Position "O" (Off).

WARNING:

! **Always switch off the circuit breaker, shut down the generator set and disconnect the battery negative (-) lead prior to connection or disconnection of the load cables.**

14. The load cables can now be connected to the generator set in preparation for normal operation.

5.4 Normal Startup/Shutdown - Key Start Panel (1001 Series)

The following procedure should be used for subsequent starts on a generator set equipped with a 1001 Series Key Start Control System:

Note:

- The generator set may be stopped at any time by pressing the Emergency Stop button or by turning the Key Switch to Position "O" (Off).
- Prior to restarting the set, the Emergency Stop Pushbutton must be released by turning it clockwise.

1. Complete Pre-Start checks as per Section 5.2.
2. Check the battery voltage by turning the Key Switch from Position "O" (Off) to Position "I" (On) and reading the battery voltmeter. A fully charged battery will indicate 12 to 14 volts on a 12 volt system or 24 to 28 volts on a 24 volt system. Return the Key Switch to Position "O" (Off).

Note:

- The engine will not start if any fault indicators are illuminated. Reset the control system by turning the Key Switch to Position "O" (Off). Ensure the faults have been corrected prior to attempting to start the rator set.

WARNING:

! **The Key Switch must not be turned to position "" or position "", while the engine is running.**

3. **Start:** Turn the Key Switch from Position "O" (Off) through Position "I" (On) to Position "" (Thermo) to activate the thermostart, if fitted. Hold for 7 seconds to preheat the induction air. After this time, the Key Switch should be further turned to Position "" (Start) to crank the engine. When the engine starts, release the Key Switch immediately allowing it to return to Position "I" (On).

   Do not crank the engine for more than 5 to 7 seconds should the engine fail to start. Allow an interval of 10 seconds and always turn the Key Switch to Position "O" (Off) between cranking attempts. If, after 4 cranking attempts, the engine still has not started, refer to the trouble shooting guide in Section 9 or the Engine Manual to determine the cause of failure to start.

WARNING:

! **Unburned fuel gases can build-up in the exhaust system after multiple failed attempted starts. Unscrew the plugs on the exhaust outlet elbows or stub pipes and allow the unburned fuel to dissipate. Once all signs of unburned fuel (white smoke) have disappeared and any other problems causing the failure to start have been rectified, replace the plugs and repeat the cranking procedure.**

WHEN ENGINE HAS STARTED

4. Check for any abnormal noise or vibration.
5. Check for fluid leakage or leaks in the exhaust system.
6. Check the control panel for indications of abnormal operation, particularly abnormally high temperature or abnormally low oil pressure. The oil pressure should be in the normal range within about 10 seconds of starting.
7. Switch the Alternator Output Circuit Breaker to "ON" (handle up).

Note:

- Load can now be applied to the generator set. However the maximum step load that can be accepted in any one step is dependent on the operating temperature of the set. With the generator cold (not more than 20°C (68°F)) the maximum step load acceptance is approximately 50% of rated output. However with the set at normal operating temperature (approximately 80°C (176°F)) the maximum step load can be 70-100% of the rated load depending on the generator set model. Typically generator sets up to 100 kVA can accept a 100% load.

8. **Shutdown:** To shut the generator set down, turn off the load by switching the Alternator Output Circuit Breaker to "OFF" (handle down). Allow the generator set to run without load for a few minutes to cool. Then turn the Key Switch to Position "O" (Off). The generator set will shutdown.

   In case of an emergency where immediate shutdown is necessary, push the Emergency Stop button or turn the Key Switch to Position "O" (Off) immediately without disconnecting the load.

Note:

- Turning the Key Switch to Position "O" (Off) will also reset the protective circuits after a fault has been detected. Ensure that the fault has been rectified prior to restarting the generator set.

5.5 Initial Startup/Shutdown - Autostart Panel (2001, 4001, or 4001E Series)

The following procedure should be used when manually starting a generator set equipped with a 2001, 4001 or 4001E Series Autostart Control System for the first time or when it has been out of service for a time for maintenance purposes:

Note:

- The generator set may be stopped at any time by pressing the Emergency Stop Pushbutton or turning the Control Switch to "STOP".
- Prior to restarting the set, the Emergency Stop Pushbutton must be released by turning it clockwise. The fault lamp must also be reset by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.

1. Complete Pre-Start checks as per Section 5.2.
2. Connect the batteries to the engine, positive lead first then the negative lead.
3. Prime the lube oil system by first removing one wire from the fuel solenoid or actuator. This prevents the engine from starting. Turn the Control Switch to "RUN". The engine will automatically crank. When oil pressure is registered on the gauge, turn the Control Switch back to "OFF" and reconnect the wire to the fuel solenoid or actuator. Should the oil pressure still not have built up after 3 automatic cranking attempts and illumination of the "FAIL TO START" fault lamp, investigate the reason for lack of oil pressure prior to further cranking attempts.

WARNING:

! **Excessive cranking with an unprimed fuel system may cause a build-up of unburned fuel gases in the exhaust system which could be potentially explosive.**

4. Prime the fuel system using the hand priming pump and bleed entrapped air from the fuel filter - see Engine Manual for details.
5. **Start:** Ensure the Emergency Stop Pushbutton and any remote Stop Pushbuttons are released. Turn the Control Switch to "RUN". If the engine is cold, prior to turning the Control Switch to "RUN" push in the thermostart button, if fitted, for 15 seconds and then turn the Control Switch to "RUN". Continue holding the thermostart button in until the engine fires.

   The engine will automatically crank up to 3 times or until the engine fires. If the engine does not fire, the control system locks-out on "FAIL TO START" and illuminates a fault lamp on the control panel. If this happens refer to the trouble shooting guide in Section 9 or the Engine Manual to determine the cause of failure to start.

WARNING:

! **Unburned fuel gases can build-up in the exhaust system after multiple failed attempted starts. Unscrew the plugs on the exhaust outlet elbows or stub pipes and allow the unburned fuel to dissipate. Once all signs of unburned fuel (white smoke) have disappeared and any other problems causing the failure to start have been rectified, replace the plugs and repeat the cranking procedure.**

WHEN ENGINE HAS STARTED

6. After approximately 1 minute shutdown the generator set by pressing the Emergency Stop Pushbutton or by turning the Control Switch to "STOP". Remove the radiator cap and wait 5 minutes for the system to settle and any trapped air to escape. Re-check the coolant level and refill as necessary.

Note:

- A newly filled coolant system can have air locks that must be cleared by running the engine for a short time and the system refilled prior to extended running of the engine.

7. Restart the engine following the procedures in step 5 above.
8. Check for any abnormal noise or vibration.
9. Check for fluid leakage or leaks in the exhaust system.
10. Check the control panel for indications of abnormal operation, particularly abnormally high temperature or abnormally low oil pressure. The oil pressure should be in the normal range within about 10 seconds of starting.
11. Check the control panel for output voltage and frequency. The voltage is factory set and should indicate the rated voltage. The **no load** frequency is approximately 52 Hz for 50 Hz units and approximately 62 Hz for 60 Hz units. Adjustments should only be carried out by a qualified technician.

    Three means of voltage adjustment are available:-

    Fine adjustment is achieved by varying the setting of a speed Potentiometer on the control panel, if fitted.

    Coarse adjustment is achieved by varying the setting of a Potentiometer mounted inside the automatic voltage regulator which is fitted to the alternator terminal box.

    Gross adjustment to completely change the voltage setting of the alternator is achieved by reconnecting the alternator windings at the alternator terminal box. Details of these connections can be found in the Alternator Manual.

WARNING:

! **Do not close the circuit breaker during the phase rotation check if load cables have already been connected.**

12. While the generator set is producing voltage, check the phase rotation of the set by connecting a phase rotation meter to the terminals on the generator side of the circuit breaker. This check should be carried out by a qualified technician.
13. **Shutdown:** To shutdown the generator set press the Emergency Stop Pushbutton or turn the Control Switch to "STOP".
14. To check any remote start facilities ensure the Emergency Stop Pushbutton and any remote Stop Pushbuttons are released and turn the Contro' 'tch to "AUTO".

    Apply the remote start signal and the engine should automatically go through its startup sequence as previously described. Remove the remote start signal and the engine should stop.

Note:

- On 4001 and 4001E Series Control System a Run On Timer will allow the set to run for a short duration to cool prior to stopping automatically.

  To shutdown the generator set remove the remote start signal, press the Emergency Stop Pushbutton or turn the Control Switch to "STOP".

WARNING:

! **Always switch off the circuit breaker, shut down the generator set and disconnect the battery negative (-) lead prior to connection or disconnection of the load cables.**

15. The load cables can now be connected to the generator set in preparation for normal operation.

5.6 Normal Manual Startup/Shutdown - Autostart Panel (2001, 4001 or 4001E Series)

The following procedure should be used for subsequent manual starts on a generator set equipped with a 2001, 4001 or 4001E Series Autostart Control System:

Note:

- The generator set may be stopped at any time pressing the Emergency Stop Pushbutton or turning the Control Switch to "STOP".
- Prior to restarting the set, the Emergency Stop Pushbutton must be released by turning it clockwise. The fault lamp must also be reset by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.

1. Complete Pre-Start checks as per Section 5.2.

Note:

- The engine will not start if any fault indicators are illuminated. Reset the control system by turning the Control Switch to "STOP". Ensure the faults have been corrected prior to attempting to start the generator set.

2. **Manual Start:** Ensure the Emergency Stop Pushbutton and any remote Stop Pushbuttons are released. Turn the Control Switch to "RUN". If the engine is cold, prior to turning the Control Switch to "RUN" push in the thermostart button, if fitted, for 15 seconds and then turn the Control Switch to "RUN". Continue holding the thermostart button in until the engine fires.

   The engine will automatically crank up to 3 times or until the engine fires. If the engine does not fire, the control system locks-out on "FAIL TO START" and illuminates a fault lamp on the control panel. If this happens refer to the trouble shooting guide in Section 9 or the Engine Manual to determine the cause of failure to sta"

WARNING:

! **Unburned fuel gases can build-up in the exhaust system after multiple failed attempted starts. Unscrew the plugs on the exhaust outlet elbows**

or stub pipes and allow the unburned fuel to dissipate. Once all signs of unburned fuel (white smoke) have disappeared and any other problems causing the failure to start have been rectified, replace the plugs and repeat the cranking procedure.

WHEN ENGINE HAS STARTED

3. Check for any abnormal noise or vibration.
4. Check for fluid leakage or leaks in the exhaust system.
5. Check the control panel for indications of abnormal operation, particularly abnormally high temperature or abnormally low oil pressure. The oil pressure should be in the normal range within about 10 seconds of starting.
6. Switch the Alternator Output Circuit Breaker to "ON" (handle up).

Note:

- Load can now be applied to the generator set. However the maximum step load that can be accepted in any one step is dependent on the operating temperature of the set. With the generator cold (not more than 20°C (68°F)) the maximum step load acceptance is approximately 50% of rated output. However with the set at normal operating temperature (approximately 80°C (176°F)) the maximum step load can be 70-100% of the rated power depending on the generator set model. Typically generator sets up to 100 kVA can accept a 100% load.

7. **Shutdown:** To shut the generator set down, turn off the load by switching the Alternator Output Circuit Breaker to "OFF" (handle down). Allow the generator set to run without load for a few minutes to cool. Then turn the Control Switch to "STOP". The generator set will shutdown.

   In case of an emergency where immediate shutdown is necessary, the Emergency Stop Pushbutton should be pushed immediately without disconnecting the load.

5.7 Automatic Startup/Shutdown - Autostart Panel (2001, 4001 or 4001E Series)

The following procedure should be used for preparing a generator set equipped with a 2001, 4001 or 4001E Series Autostart Control System to be started from a remote location.

Note:

- The generator set may be stopped at any time by pressing the Emergency Stop Pushbutton or turning the Control Switch to "STOP".
- Prior to restarting the set, the Emergency Stop Pushbutton must be released by turning it clockwise. The fault lamp must also be reset by turning the Control Switch to "STOP" on the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.

1. Complete Pre-Start checks as per Section 5.2.

Note:

- The engine will not be able to start if any fault indicators are illuminated. Reset the control system by turning the Control Switch to "STOP" on the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.

  Ensure the faults have been corrected prior to attempting to start the generator set.

2. **Automatic Start:** Ensure the Emergency Stop Pushbutton and any remote Stop Pushbuttons are released. Turn the Control Switch to "AUTO".
3. Switch the Alternator Output Circuit Breaker to "ON" (handle up).

The generator set is now ready to automatically start when it receives a remote start signal. When the start signal is removed it will automatically stop.

Note:

- On 4001 and 4001E Series Control Systems a Run On Timer will allow the set to run for a short duration to cool prior to stopping automatically.

6. GENERATOR SET MAINTENANCE

6.1 General

A good maintenance program is the key to long generator set life. Maintenance and service should only be carried out by qualified technicians. Records of this work should be kept to aid in developing an efficient maintenance program.

In general, the generator set should be kept clean. Do not permit liquids such as fuel or oil film to accumulate on any internal or external surfaces or on, under or around any acoustic material, if fitted. Wipe down surfaces using an aqueous industrial cleaner. Do not use flammable solvents for cleaning purposes.

Any acoustic material with a protective covering that has been torn or punctured should be replaced immediately to prevent accumulation of liquids or oil film within the material.

6.2 Preventative Maintenance

Depending on the application of the generator set, requirement for preventative maintenance will vary. The preventative maintenance requirements associated with the engine are detailed in the Engine Manual which should be reviewed in conjunction with this section. Maintenance intervals for the engine may be more frequent than those shown in this section.

6.2.1 Daily or at Each Startup: (For standby sets these procedures may be performed weekly.) A walk around inspection should be performed on a daily basis and prior to starting the engine. The pre-start checks contained in Section 5.2 should be performed during this walk around. Procedures for performing the checks on the engine can be found in the Engine Manual which may contain additional requirements to those in Section 5.2.

6.2.2 Every Two Weeks: (For standby sets that have not been run.) Perform an operational check on the generator set by starting and running the set for only 5 minutes.

WARNING:

! Do not run diesel engines at low loads for long periods.

6.2.3 Every Month: (For standby sets that have not been run on load.) Perform an operational and load check on the generator set by starting and running the set on at least 50% load for 1 to 2 hours.

6.2.4 Every Six Months or 250 Hours: Repeat the daily procedures plus the following:

1. Check all control system safety devices by electrically simulating faults.
2. Clean all battery cap vents.
3. Tighten all exhaust connections.
4. Tighten all electrical connections.
5. Perform other engine maintenance as specified in the Engine Manual.
6. Start the engine and observe the instrument panel to ensure that all gauges and meters are operating properly.
7. If a spark arrestor has been fitted, this should be removed and thoroughly cleaned to remove any carbon build-up.

6.2.5 Alternator Preventative Maintenance: There is no routine maintenance required on the alternator, however periodic inspection of the alternator winding condition and periodic cleaning is recommended. See Section 8.2, Alternator Maintenance, and the Alternator Manual.

6.2.6 Engine Preventative Maintenance: See the Engine Manual provided with this manual for information on regular maintenance required to keep the engine operating efficiently.

6.3 Removal of Engine and/or Alternator

The following procedures should be used for removal of the engine and/or alternator.

1. Isolate and disconnect electrical power supply to auxiliary equipment such as a water heater.
2. Isolate the battery charger supply. Disconnect the battery (negative lead first) and remove if necessary.
3. If the generator set is equipped with a canopy, remove the fixing bolts on each side, disconnect the exhaust system and then remove the canopy.
4. Isolate and disconnect the control panel and remove together with stand from the generator set, ensuring that all cables have been adequately identified to facilitate reconnection.
5. If the engine and alternator are both to be removed, they may be lifted out as one unit using the lifting eyes provided on **both** the engine and alternator. First the bolts holding the engine/alternator to the baseframe have to be removed.

6.3.1 Engine Removal Only:

1. If only the engine is to be removed, the wiring loom should first be removed from the engine.
2. If the alternator is fitted with only one set of feet then the front end of the alternator will have to be firmly supported before removing the engine.
3. Remove the bolts holding the engine to the base. It may also be advantageous to loosen the alternator mounting bolts.
4. Remove the alternator fan guards.
5. Support the rotor assembly using a sling or wooden supports taking care not to damage the fan.
6. Remove the bolts between the flexible coupling and the engine flywheel.
7. Support the rear of the engine using an overhead crane or similar device.
8. Remove the coupling housing bolts.
9. The engine is now moved forward until it is clear of the alternator and may be lifted away from the base.

6.3.2 Alternator Removal Only:

1. If the alternator only is to be removed, the rear of the engine must be firmly supported.
2. Remove the wiring loom.

3. Remove the bolts holding the alternator to the baseframe. Loosen the engine bolts as well.
4. Remove the alternator fan covers and support the rotor and the front of the alternator. Ensure that the rotor is positioned with a pole at the bottom center line. This is to avoid any damage to the bearing or exciter by limiting the rotor movement to that of the air gap.
5. Uncouple the alternator from the engine as per Section 6.3.1.
6. Support the alternator using a sling or similar device and slide the complete alternator back on the base before lifting.

7. ENGINE DESCRIPTION AND MAINTENANCE

7.1 Engine Description

7.1.1 General: The engine that powers the generator set is an industrial, heavy duty diesel engine that has been selected for its reliability and efficiency in operation. It is specifically designed and optimized to power generator sets. The engine is either a 4 stroke or 2 stroke compression ignition type with all the accessories necessary to provide a reliable power supply. Full details of the engine and associated equipment is provided in the Engine Manual. This section gives a brief discussion of the major systems and how they are integrated into the generator set.

If regular preventative maintenance is performed as per the Engine Manual, the diesel engine will continue to provide reliable power for many years.

7.1.2 Cooling System: The engine cooling system is comprised of a radiator, high capacity pusher fan, a mechanically driven water pump and a thermostat. The fan is a pusher type that pushes the air through the radiator. This system provides for cooling of the surface heat of the engine and alternator, and internal cooling of the engine by the water circulating in the radiator. The alternator also has an integral fan that circulates cool air inside the housing. The thermostat maintains coolant temperature at a level for efficient operation of the engine.

It is important to pay careful attention to air flow around the generator set to ensure proper cooling. Following the installation instructions in Section 4.7 should ensure satisfactory performance.

7.1.3 Engine Governing: The engine governor is either a mechanical or electronic device designed to maintain a constant engine speed in relation to load requirements. The engine speed is directly related to the frequency of the alternator output, so any variation in engine speed will effect the frequency of the power output.

The governor senses engine speed and controls the fuel rate. As load increases on the alternator the governor will increase fuel flow to the engine. As load is reduced the governor reduces fuel flow.

7.1.4 Fuel System: On most generator sets, the engine fuel system is connected directly to a fuel tank that is built into the baseframe. This tank is designed to provide sufficient fuel for approximately 8 hours operation at full load unless an extended capacity tank has been fitted. In this case approximately 24 hours operation is possible.

The basetank is provided with fittings to facilitate either manual or automatic filling from a larger bulk storage tank. See Section 4.9 for a discussion of the entire fuel system.

On larger sets, the baseframe does not include a fuel tank so the engine fuel system must be connected to a separate tank located next to the set.

7.1.5 Exhaust System: Exhaust systems are provided to reduce the noise level of the engine and to direct the exhaust gases to where they will not be a hazard.

On smaller sets the exhaust silencer and piping are mounted directly on the engine. On larger engines the exhaust system is supplied loose for installation on site.

7.1.6 Air Flap Valve: An air flap valve, if fitted, prevents overspeeds due to ingestion of gas or fumes by cutting off the air supply. Functional testing of these combus‘ air intake valves should not be performed on engines ɔad. A functional test should only be carried out when the engine is not running. If it is necessary to demonstrate air valves closing when the engine is running this should be done at no load. The engine should absolutely **not** be restarted immediately afterwards.

WARNING:

! **The closing of the air flap valve while the engine is running can cause oil carry over into the exhaust system which is highly volatile. The engine should be left for a period of time to allow these gases to dissipate.**

7.1.7 Starting Aids: Ethyl Ether starting aids are not recommended. They will reduce the efficient working life of the engine.

7.2 Engine Maintenance

The Engine Manual supplied with this manual contains detailed information on maintaining the engine. It also includes a comprehensive Trouble Shooting guide for engine faults.

7.3 Radiator Maintenance

7.3.1 General Notes: Corrosion in the radiator can be a prime cause of failure. This is prompted by air in the water. Always ensure pipe connections are free of leaks and bleed air from top of the radiator regularly to keep ᵗ' system "air free".

Radiators should not be left standing in a partially filled condition. Radiators left partly filled with water will suffer much more rapidly from the effects of corrosion. For an inoperative generator set, either drain the radiator completely or ensure that it is maintained full. Wherever possible, radiators should be filled with distilled or naturally soft water, dosed with suitable corrosion inhibitors.

WARNING:

! **Radiator coolant is normally very hot and under pressure. Do not work on the radiator or disconnect pipework until it has cooled. Do not work on the radiator or remove any guarding while the fan is in motion.**

7.3.2 External Cleaning: In dusty or dirty conditions the radiator fins can become blocked with loose debris, insects, etc. and this fouling will have an effect on the performance of the radiator.

For regular removal of light deposits use a low pressure steam jet. More difficult deposits may need a detergent with a low pressure hot water hose. Spray steam jet or water from the front of the radiator towards the fan. Spraying in the opposite direction will force debris further into the core. Covering the engine/alternator during this process will keep them clean.

Stubborn deposits, which cannot be removed by ᵗ' ᵃbove methods may require removal of the radiator and i. rsion in a heated alkali degreasing solution for about 20 minutes and then washing off with a hot water hose.

7.3.3 Internal Cleaning: If, due to leaky joints for instance, indiscriminate topping-up with hard water has been carried out for some time, or if the generator set has been run without inhibitors the system may become fouled by scale.

To descale the radiator, use the following procedure:

1. Drain the water system and disconnect and blank off the pipe connections to the engine.
2. Prepare a 4% solution of inhibited acid solvent and fresh water. Add the acid to the water, never vice versa.
3. Allow several minutes for mixing, then heat the solution to 49°C (120°F) maximum.
4. Run the solution slowly into the radiator via the filler cap or a branch in the manifold. Effervescence will occur. When it ceases, fill the radiator completely with the heated solvent.
5. Allow to stand for several minutes; then drain the solvent back into the original container through the bottom manifold or drain plug.
6. Examine the interior of the headers. If scale remains repeat the process outlined above with the solvent strength increased to 8%.
7. After descaling the acid solution has to be neutralized as follows:-

   Fill the mixing container with fresh water, heat to boiling point then add common washing soda crystals at the following strength: 0.5 kg of soda to 20 liters water (1 lb. soda to 4 gallons water). Fill the radiator with this solution, then drain it back into the container.
8. Flush the radiator in this manner several times, finally leaving the radiator full for at least an hour. Drain until empty and wash out the radiator with hot fresh water.
9. Before putting the radiator into service again, fill with water and apply a test pressure equal to twice that of the working pressure. Examine carefully for any leaks which may have been revealed by descaling.
10. Prior to recommissioning, the coolant must have any necessary corrosion inhibitors and/or the correct proportion of antifreeze added.

8. ALTERNATOR DESCRIPTION AND MAINTENANCE

8.1 Alternator Description

8.1.1 General: The alternator fitted on the generator set is of the brushless self-excitation type which eliminates the maintenance associated with slip rings and brushes. The control system consists of an automatic voltage regulator, protective circuits and the necessary instruments to allow monitoring of the output of the generator set.

8.1.2 Construction/Major Components: The alternator unit is completely self-contained and is designed and constructed to provide trouble free operation, ease of maintenance and long service life.

The stator core is produced from insulated low loss electrical grade sheet steel laminations. These are built and welded under a fixed pressure to give an extremely rigid core to withstand vibrations and load impulses. The complete wound stator is, after impregnation, pressed into the frame and pinned into position.

A high grade precision machined shaft carries the rotor assembly which comprises the alternator rotating field systems, the exciter rotator/rotating diode system and the cooling fan. The rotor is mechanically wedged and supported on the winding end to allowan overspeed of up to 2250 RPM. The complete rotor assembly is dynamically balanced to ensure vibration-free running.

At the drive end of the rotor assembly a cast-aluminum centrifugal fan draws cooling air through screened/louvered covers at the non drive end and discharges it through similar side mounted covers at the drive end.

8.1.3 Alternator Method of Operation: The electrical power produced by the generator set is derived from a closed loop system consisting principally of the exciter rotor, the main revolving field and the automatic voltage regulator (See Figure 8.1).

The process begins when the engine starts to rotate the internal components of the alternator. The residual magnetism in the main rotor (item 1) produces a small alternating voltage (AC) in the main stator (item 2). The automatic voltage regulator (item 3) rectifies this voltage (converts it to DC) and applies it to the exciter stator (item 4).

This DC current to the exciter stator creates a magnetic field which, in turn, induces an AC voltage in the exciter rotor (item 5). This AC voltage is converted back to DC by the rotating diodes (item 6).

When this DC voltage appears at the main rotor, a stronger magnetic field than the original residual field is created which induces a higher voltage in the main rotor.

This higher voltage circulates through the system inducing an even higher DC voltage back at the main rotor. This cycle continues to build up the voltage until it approaches the proper output level of the generator set. At this point the automatic voltage regulator begins to limit the voltage being passed to the exciter stator which, in turn, limits the overall power output (item 7) of the alternator.

This build-up process takes place in less than one second.

8.1.4 Automatic Voltage Regulator: The Automatic Voltage Regulator (AVR) maintains a no load to full load steady state voltage to tight tolerances. The AVR has a volts/hertz characteristic which proportionally reduces the regulated voltage at reduced speeds. This feature aids the engine during sudden large additions of load.

8.2 Alternator Maintenance

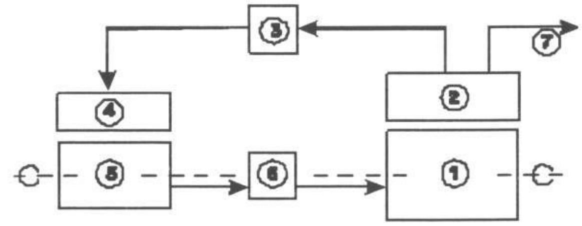
Although maintenance is rarely required, periodic inspection and cleaning is recommended.

Perform a winding insulation test according to procedures provided in the Alternator Manual before the initial start, after generator set storage, and every 3 to 6 months depending on humidity levels (more often in higher humidity). In high humidity areas, installing space heaters to operate when the generator set is not running will help keep the windings dry.

The alternator air filters, if fitted, should be inspected regularly depending on site conditions. If cleaning is necessary, remove the filter elements from the filter frames. Immerse or flush the element with a suitable detergent agent until the element is clean. Dry the elements thoroughly before refitting.

Additionally the alternator unit should be cleaned on a regular basis. The frequency of such cleanings depends on the environmental conditions of the operating site. The following procedure should be followed when cleaning is necessary: Disconnect all power. Wipe dust, dirt, oil, water and any other liquids from the external surfaces of the alternator unit and from the ventilation screens. These materials can work their way into the windings and may cause overheating or insulation breakdown. Dust and dirt is best removed using a vacuum cleaner. Do not use compressed air, steam or high pressure water!

The separate Alternator Manual provided with this manual contains more detailed information on alternator maintenance. It also includes a trouble shooting guide for alternator faults.



Item	Description	Item	Description
1.	Main Rotor	5.	Exciter Rotor
2.	Main Stator	6.	Rotating Diodes
3.	Automatic Voltage Regulator	7.	Power Output
4.	Exciter Stator		

Figure 8.1: Block Diagram of Alternator Operation

9. CONTROL SYSTEM DESCRIPTION AND TROUBLE SHOOTING

9.1 Control System Description and Identification

9.1.1 Description: An advanced electronic control system has been designed and installed to control and monitor the generator set. Depending on the requirements of the set, one of several different standard control systems may be fitted. These include the 1001 Series Keystart System, 2001 Series Autostart System, 4001 Series Deluxe Autostart System and the 4001E Series Enhanced Deluxe Autostart System. Other more specialized systems may be installed for specific installations in which case separate documentation is provided.

These control systems consist of three major components working together - a control panel, an engine interface module (EIM), and an alternator output circuit breaker.

The control panel provides a means of starting and stopping the generator set, monitoring its operation and output, and automatically shutting down the set in the event of a critical condition arising such as low oil pressure or high engine coolant temperature. A 1001, 2001, 4001 or 4001E Series Panel is installed as appropriate for the requirements of the generator set installation.

The Engine Interface Module is a sealed, engine mounted module that provides switching relays for the Starter Motor Solenoid, Glow Plug and Fuel Solenoid. Each of these circuits is protected with individual fuses mounted in the module. Individual LED's illuminate when each circuit is energized. The Engine Interface Module is available in three models depending on the type of control panel being used - the 12 volt EIM SR, the 12 volt EIM Plus and the 24 volt EIM Plus. The table below indicates which EIM module is used on which generator sets:

Panel Fitted	Sets up to 150kVA (12 volt systems)	Sets above 150kVA (24 volt systems)
1001	12 Volt EIM SR	24 Volt EIM Plus
2001	12 Volt EIM Plus	24 Volt EIM Plus
4001	12 Volt EIM Plus	24 Volt EIM Plus
4001E	12 Volt EIM Plus	24 Volt EIM Plus

The power output circuit breaker serves to protect the alternator by automatically disconnecting the load in the event of overload or short circuit. It also provides a means of switching the generator set output.

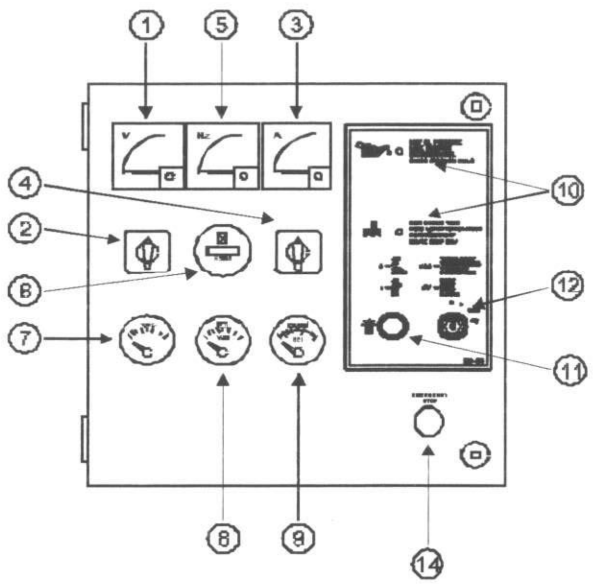
9.1.2 Identification: Figure 9.1 shows each of the control panels to aid in identifying the system fitted on the generator set. The 1001 Series Panel, being a "Key Start" panel has a removable key to control the system. Only two fault lamps are provided on this panel. The 2001 Series Panel has a Control Switch, instead of a Key Switch, located below 5 fault lamps. The 4001 Series Panel is similar to the 2001 except the Control Switch is located below the gauges and there are 7 fault lamps. The 4001E Series Panel also has the Control Switch located below the gauges but has up to 16 fault lamps.

9.1.3 Panel Equipment: Before starting or running the generator set, the operator should become fully acquainted with the instruments and controls. The instruments should be observed from time to time while the generator set is running so that any abnormal readings can be detected before problems arise.

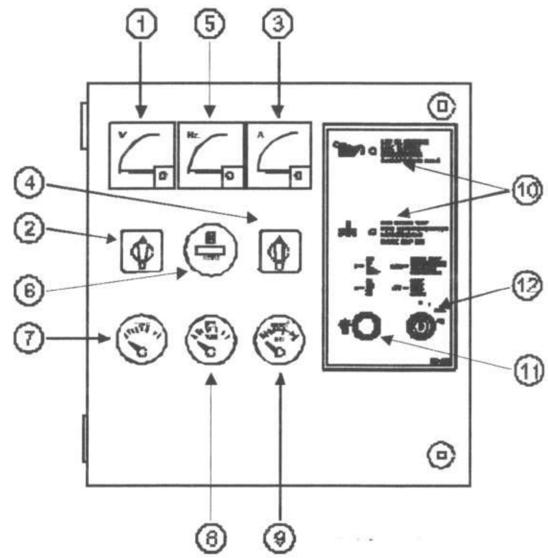
Figure 9.1 shows typical diagrams of each of the control panels. Addition of optional equipment will add items to the panel so the panel fitted on the generator set may be slightly different from the typical ones shown. The following descriptions explain the function of each item on the panels:

<u>Item</u> <u>Description</u>

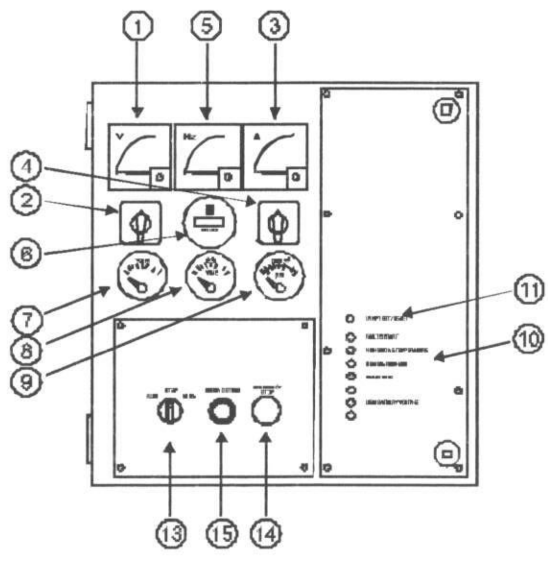
1. AC VOLTMETER - A voltmeter that indicates the AC voltage generated at the alternator output terminals. The reading indicated on the voltmeter will vary depending on the connections made inside the alternator terminal box, the setting of the voltage regulator and the position of the voltmeter selector switch (item 2). It should not, however, vary while the set is operating. In the event of alternator excitation failing, the output voltage will fall to approximately 20 to 40 volts. If the meter gives no reading while the generator set is running, ensure that the AC voltmeter selector switch is not in the OFF position.
2. AC VOLTMETER SELECTOR SWITCH - A selector switch allowing the operator to select voltage reading between phases or between a phase and neutral. The OFF position allows the voltmeter "zero" position to be checked while the generator set is running.
3. AC AMMETER - An ammeter that indicates the AC electrical current being delivered which is dependent on the connected load. A separate reading from each of the phases is possible using the ammeter selection switch (item 4). If the meter gives no reading while the generator set is running, ensure that the AC ammeter selector switch is not in the OFF position.
4. AC AMMETER SELECTOR SWITCH - A selector switch allowing the operator to select a current reading from each of the phases. The OFF position allows the ammeter "zero" position to be checked while the generator set is running.
5. FREQUENCY METER - A meter that indicates the output frequency of the generator set. The engine maintains a relatively constant speed under governor control so as to provide the proper operating frequency of 50 Hz or 60 Hz when the generator set is operating at full rated load. At partial load the frequency will be slightly higher than normal, depending on the droop of the governor. In practice, no load frequencies of approximately 52 and 62 Hz for 50 Hz and 60 Hz respectively, are considered normal. The frequencies will fall, as the set is loaded, to 50 Hz and 60 Hz at full load.
6. HOURS RUN METER - A meter that indicates the total number of hours of generator set operation to aid in maintenance.
7. ENGINE WATER TEMPERATURE GAUGE - A temperature gauge connected to a sensor in the engine to monitor engine coolant temperature. The normal operating temperature should be approximately 85°C (185°F).



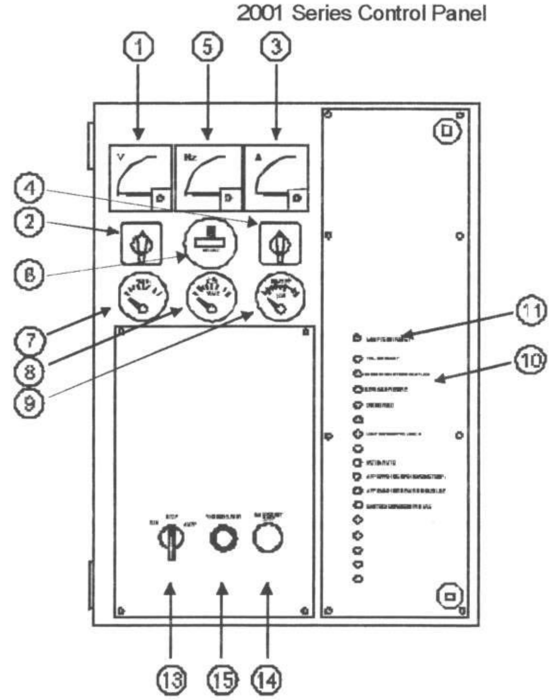
1001 Series Control Panel



2001 Series Control Panel



4001 Series Control Panel



4001E Series Control Panel

Figure 9.1 Design of Typical Control Panels

8. DC BATTERY VOLTMETER - A voltmeter that indicates the state of charge of the battery. When the engine is at standstill the normal battery voltage will be 12 to 14 volts on a 12 volt system and 24 to 28 volts on a 24 volt system. During starting, the needle will drop to about 70% of normal and oscillate as the engine cranks. Once the engine has started, the needle should return to its normal value. If the battery charging alternator is charging correctly, the voltage reading will always be higher with the generator set running than when it is stopped.

9. ENGINE OIL PRESSURE GAUGE - A gauge to monitor engine oil pressure from the moment the engine is cranked. The proper oil pressure rating should be approximately 35 to 60 p.s.i. for 50 Hz and 45 to 65 p.s.i. for 60 Hz. On cold engines the oil pressure will be significantly higher until the engine warms up.

10. FAULT INDICATOR LAMPS - Fault lamps that illuminate to indicate that the protective circuitry has sensed the indicated condition. The lamp should be red on conditions for which the system will initiate a shutdown of the set. For alarms, the lamp can be red or amber.

11. LAMP TEST PUSHBUTTON - A button to test the fault lamps and to reset an alarm warning lamp and circuitry after an alarm has been initiated.

12. KEY SWITCH (1001 Series Only) - A four position switch that provides a means of controlling or interrupting the battery supply to the control system, thermostart and starter motor.

    Position "O" Off/Reset
    Power is turned off and protection circuitry is reset in this position.

    Position "I" On
    DC power is supplied to the control system and the fault protection timer relay is initiated.

    Position "" Thermostart
    DC power is supplied to the thermostart circuit, if fitted.

    Position "" Start
    DC power is supplied to the starter motor to crank the engine. The thermostart circuit is also powered, if fitted.

13. CONTROL SWITCH (2001, 4001 and 4001E Series Only) - A three position switch that provides a means of controlling the generator set functions.

    Position 1 "RUN"
    The auto start function is initiated to immediately start and run the generator set.

    Position 2 "STOP"
    The generator set is shut down if running, and automatic start is inhibited. The fault protection circuitry is reset in this position.

    Position 3 "AUTO"
    The control circuitry is ready to initiate an automatic start upon receiving a remote start signal.

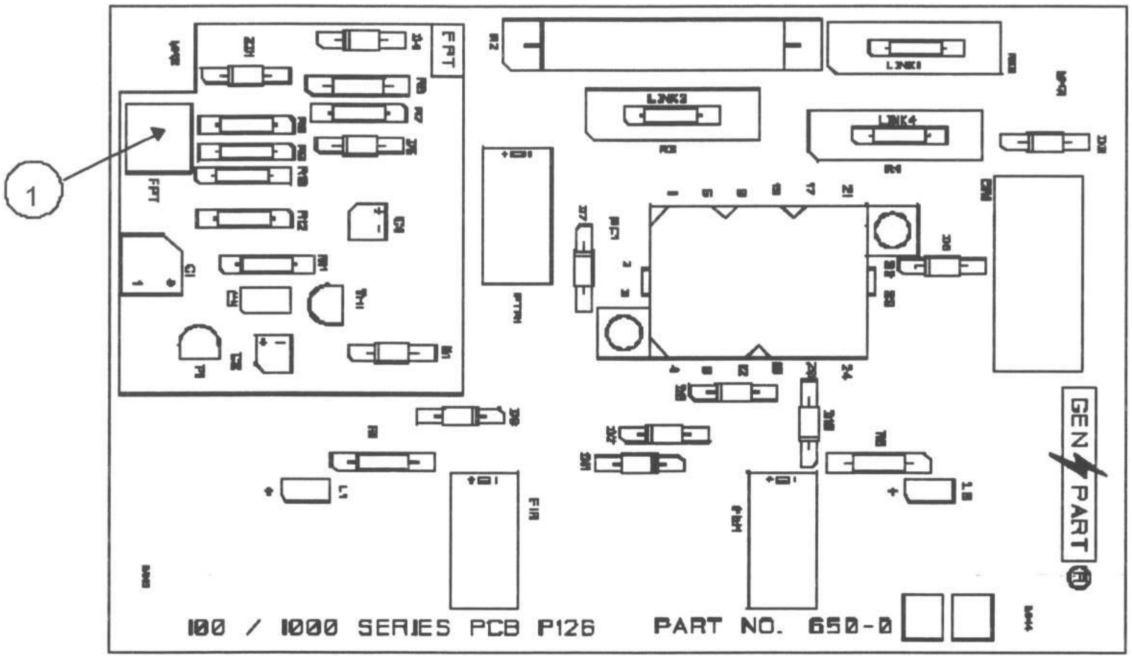
14. EMERGENCY STOP PUSHBUTTON (1001,2001, 4001 and 4001E Series) - A red lock-down pushbutton that immediately shuts down the generator set and will inhibit start until the pushbutton has been released by turning it clockwise. Prior to restarting the set, the fault lamp must be reset by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.

15. THERMOSTART PREHEAT BUTTON (2001, 4001 and 4001E Series Only) - A button to power the thermostart preheat circuit, if fitted.

9.2 Functional Description 1001 Series Control System

The 1001 Series Control System provides for manual starting and stopping of the generator set and provides protection for the engine against both high engine coolant temperature and low oil pressure.

The control system is of the relay timer type based on a Printed Circuit Board (P.C.B.). The P.C.B. is off board fuse protected and controls the starting, stopping and fault protection of the engine. Figure 9.2 shows the layout of the 1001 Series P.C.B.



Item	Description
1.	FPT: Fault Protection Timer Adjust Range: 1-70 seconds Set: 15 ± 1 second

Figure 9.2: Layout of the 1001 Series P.C.B.

9.2.1 Function (1001 Series): Section 5 of this manual provides detailed guidance and checklists for the operation of the generator set. This section provides a more detailed description of the functions of the control system during operation.

During starting, turning the Key Switch from Position "O" (Off) to Position "I" (On) applies voltage to the P.C.B. and energizes Control Relay CR. With relay CR energized, contact CR/1 closes to energize the fuel control solenoid and the engine gauges.

WARNING:

! **The Key Switch must not be turned to position "" (Thermo) or "" (Start) while the engine is running.**

During start, turning the Key Switch through Position "I" (On) to Position "" (Thermo) activates the thermostart, if fitted. This preheats the induction air and should be held for 7 seconds. Turning the Key Switch further to Position "" (Start) provides power to the starter motor which cranks the engine. The starter motor will be disengaged when the Key Switch is released so it must be held in this position until the engine starts and then immediately released and allowed to return to Position "I" (On).

To prevent overheating of the starter motor the engine should not be cranked for more than 5 to 7 seconds. An interval of 10 seconds should be allowed between start attempts. If the engine has not started after 4 attempts, refer to the trouble shooting guide or Engine Manual to determine the cause of failure to start.

Turning the Key Switch past Position "I" (On) initiates the Fault Protection Timer (FPT) relay. This timer is set at 15 seconds but is adjustable on the P.C.B. Until the FPT times out the high engine coolant temperature and low oil pressure protective circuits are inhibited. This will keep the low oil pressure of a starting engine from causing the protection circuits to initiate a shutdown during start.

Should the oil pressure not have reached the proper specified operating point by the time FPT times out or, when running, should the pressure drop below this level, the protective circuitry will initiate a shutdown. The "LOW OIL PRESSURE" fault lamp will illuminate. Start up will be inhibited and no attempt should be made to start the set until the cause of the fault has been traced and remedied. High engine coolant temperature (and/or low coolant level on some larger models) will also shut down the generator set in the same way and will illuminate the "HIGH ENGINE TEMP" fault lamp.

WARNING:

! **If at any time the generator set stops because of a fault, the fault should be rectified before trying to restart the generator.**

These protective circuits will prevent start of the generator set until they are reset. Turning the Key Switch to Position "O" (Off) resets the protective circuits of the control system.

Once the generator set is running properly, the electrical load is applied to the set by switching the alternator output circuit breaker to "ON" (handle in the up position).

When shutting down the generator set, the load should be turned off by switching the alternator output circuit breaker to "OFF" (handle down). The engine should be allowed to cool prior to stopping it. After a few minutes the Key Switch is turned to Position "O" (Off) which shuts the generator set down.

In case of emergency where immediate shutdown is necessary, the Emergency Stop button should be pressed immediately without first disconnecting the load.

9.2.2 Protective Circuits (1001 Series): Engine coolant temperature is monitored by the high temperature switch located on the engine. This is a normally open switch designed to close at 95°C (203°F). On closing, relay R1 energizes and self latches, illuminating the red colored fault lamp labeled "HIGH ENGINE TEMPERATURE". The second set of contacts on R1 (R1/2) opens to break the circuit that was energizing the control relay (CR). This closes the fuel solenoid valve, shutting down the engine. The fault lamp will remain illuminated and the engine locked out until the fault has been acknowledged and reset by turning the Key Switch to Position "O" (Off). On some larger models a low coolant level sensor will also cause the generator set to shut down and will also illuminate the "HIGH ENGINE TEMPERATURE" fault lamp even though the temperature may be in the normal range.

Engine lubricating oil pressure is also monitored to check for an excessively low pressure condition. This is monitored by an engine mounted, normally closed, switch that opens under normal running conditions. Should the oil pressure fall to or below about 22 p.s.i. (1.6 bar) the switch will close. This in turn energizes relay R5 which self latches, illuminating the "LOW OIL PRESSURE" fault lamp. The second set of contacts (R5/2) opens de-energizing the CR relay. This causes the fuel solenoid valve to close and the engine to shutdown. Reset is effected by turning the Key Switch to Position "O" (Off).

9.3 Functional Description 2001, 4001 and 4001E Series Control Systems

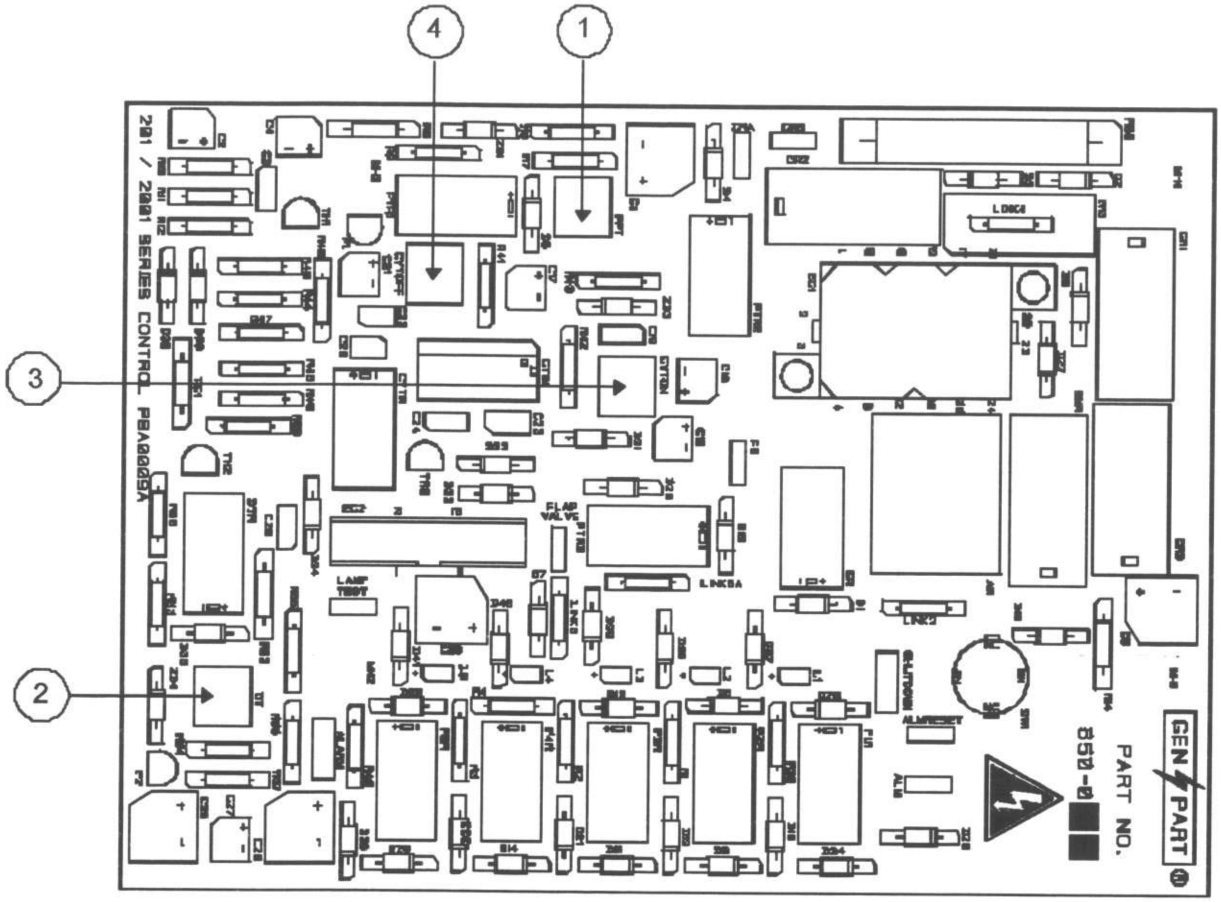
The 2001, 4001 and 4001E Series Control Systems provide for automatic starting and stopping of the generator set from a remote signal as well as manual starting and stopping. This makes it appropriate for standby generating systems. Protection is provided by the control system against high engine coolant temperature, low oil pressure, fail to start and overspeed. On the 4001 and 4001E Series Control Systems alarm protection is also provided for Low Battery Voltage. On 4001E Series Control Systems there are additional alarms for Approaching Low Oil Pressure, Approaching High Engine Temperature, Battery Charger Failure and Not in Auto Mode.

These control systems are of the relay timer type based on a double sided Printed Circuit Board (P.C.B.). The P.C.B. is off board fuse protected and controls the starting, stopping and fault protection of the engine. Figures 9.3, 9.4 and 9.5 show the layout of the 2001 Series P.C.B., the 4001 Series P.C.B. and the 4001E Series Expansion P.C.B. respectively.

Since these control systems are designed for automatic starting, they are fitted with connections for remote control. Included are terminals for Remote Emergency Stop and an interface to an Intelligent Load Transfer Panel. Additionally, the 4001 and 4001E Series Control Systems are fitted with an interface to Remote Annunciators which are described in Section 9.4.8.

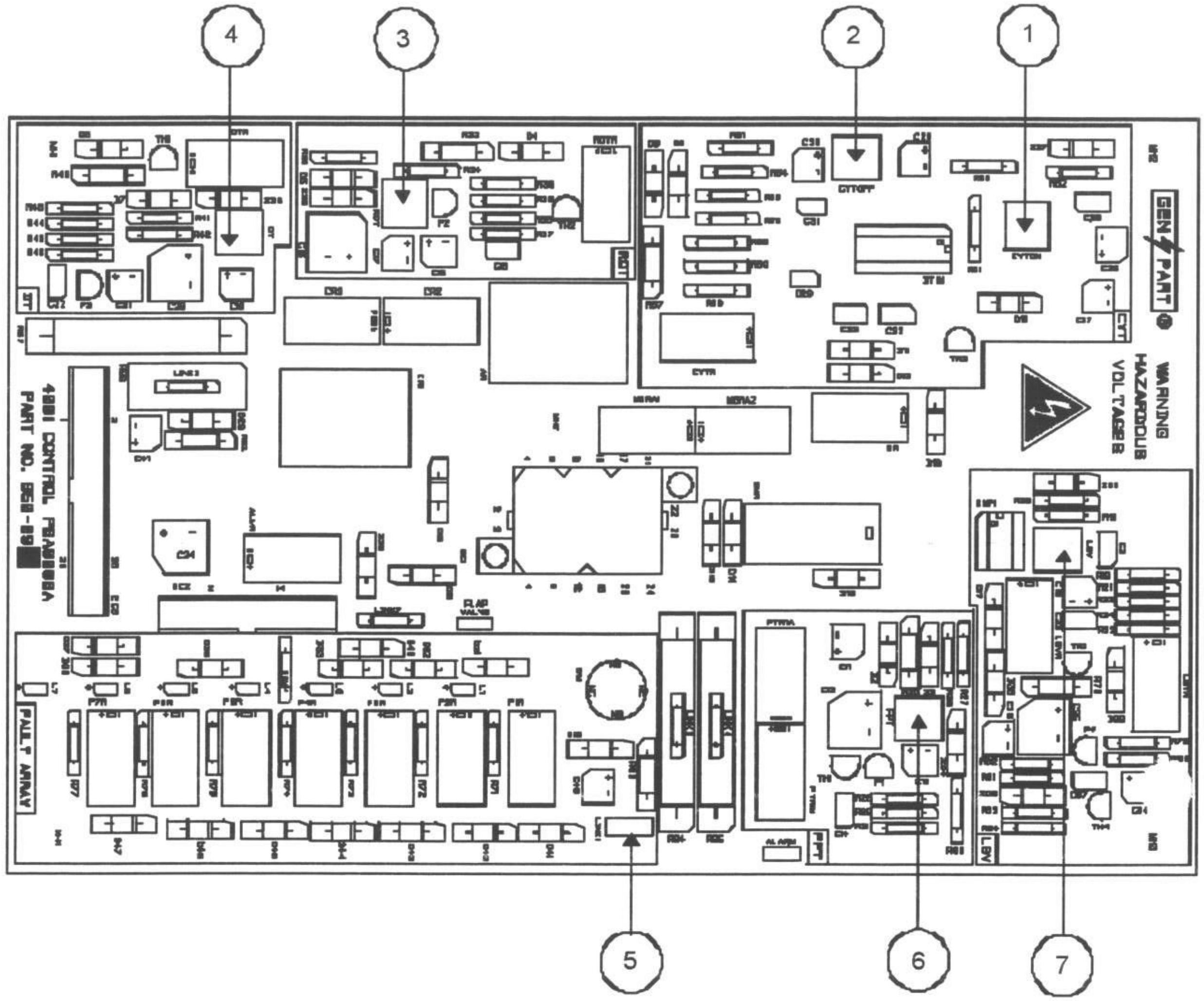
9.3.1 Function (2001, 4001 and 4001E Series): Section 5 of this manual provides detailed guidance and checklists for the operation of the generator set. This section provides a more detailed description of the functions of the control system during operation.

When the Control Switch is turned to "RUN" or a remote start signal is received with the Control Switch in the "AUTO" position, the control system will initiate its automatic start sequence. The fuel control solenoid is turned on providing fuel to the engine. The starter motor is then energized via the auxiliary start solenoid (ASS) to crank the engine. If the engine does not start after a preset duration (CYTON) then a delay of a preset duration (CYTOFF) will elapse before cranking again.



Item	Description
1.	FPT: Fault Protection Timer Adjust Range: 1-70 seconds Set: 15 ± 1 second
2.	DT: Duration Timer (sets duration of cranking sequence) Range: 1-90 seconds Set: 27.5 ± 2.5 seconds
3.	CYTON: Crank On Period Range: 0.25-20 seconds Set: 5 ± 1 second
4.	CYTOFF: Crank Off Period Range: 0.25-20 seconds Set: 5 ± 1 second

Figure 9.3: Layout of the 2001 Series P.C.B.



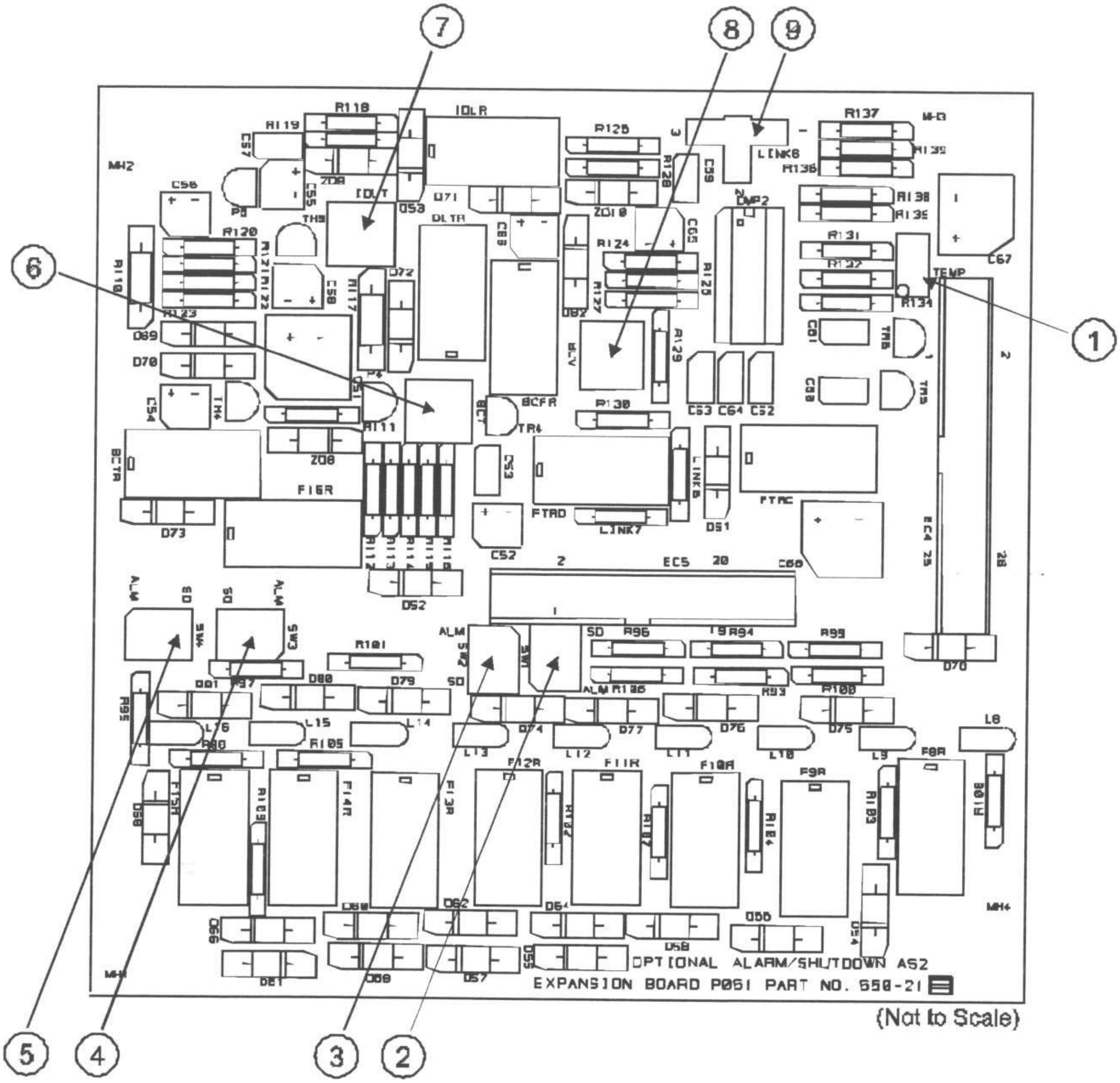
Item Description

1. CYTON: Crank On Period
   Range: 1-65 seconds
   Range: 1-20 seconds
   Set: 5 ± 1 second
2. CYTOFF: Crank Off Period
   Range: 1-20 seconds
   Set: 5 ± 1 second
3. ROT: Run On Timer (sets cool down period)
   Range: 3-330 seconds
   Set: 240 ± 15 seconds

Item Description

4. DT: Duration Timer (sets duration of cranking sequence)
   Set: 27.5 ± 2.5 seconds
5. LINK 1: Remove for 4001E system
   where expansion board is used
6. FPT: Fault Protection Timer Adjust.
   Range: 1-70 seconds
   Set: 15 ± 1 second
7. LBV: Low Battery Voltage Monitor Adjust
   Set: 10.75 volts for 12 volt systems 22.75 volts for 24 volt systems

Figure 9.4: Layout of the 4001 Series P.C.B.



(Not to Scale)

Item	Description
1.	TEMP: Approaching High Engine Temperature Set Point Set: 90°C ± 1°C
2.	SW1: Shutdown/Alarm Selector for Fault L12
3.	SW2: Shutdown/Alarm Selector for Fault L13
4.	SW3: Shutdown/Alarm Selector for Fault L14 volts for
5.	SW4: Shutdown/Alarm Selector for Fault L15
6.	BCT: Battery Charger Timer Set Range: 3-330 seconds Set: 180 ± 15 seconds

Item	Description
7.	IDLT: Input Delay Timer Set Range: 0.25-30 seconds Set: 1 ± 0.5 seconds
8.	BCV: Battery Charger Failure Detection Set Point Set: 11.75 volts for 12 volt systems 22.25 24 volt systems
9.	LINK 6: Battery Charger Failure Operating Mode

Figure 9.5: Layout of the 4001E Series Expansion P.C.B.

If the engine fails to fire after 3 start attempts then the "FAIL TO START" fault lamp will illuminate. The number of starts is dependent on the setting of CYTON, CYTOFF and the Duration Timer DT. With CYTON and CYTOFF set at 5 seconds and DT set at 27.5 seconds, this gives 3 crank attempts before FAIL TO START - 5 seconds on, 5 seconds off, 5 seconds on, 5 seconds off, 5 seconds on, 2½ seconds off, "FAIL TO START". Refer to the trouble shooting guide or Engine Manual to determine the cause of failure to start. Start will be inhibited until the protection circuits of the control system are reset by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button for the 4001 and 4001E panels. All time periods are approximate.

When the engine fires and is above cranking speed the starter motor is automatically disengaged. This condition is detected from the W/L terminal of the engine driven battery charging alternator. In addition, when the generator is providing voltage a back up signal is sent to cancel the start sequence. The voltage of the alternator is detected via relay AR.

Note:

- As soon as the generator starts, the power supply to the engine auxiliaries is disconnected via contactor HC, when fitted. Whenever the generator stops contactor HC re-energizes and reconnects the supply to the auxiliaries.

The beginning of the start sequence initiates the Fault Protection Timer (FPT) relay. Until the FPT times out (factory set at 15 seconds) the low oil pressure and high engine coolant temperature protective circuits are inhibited. This will keep the low oil pressure of a starting engine from causing the protection circuits to initiate a shutdown.

Should the oil pressure not have reached the proper specified operating point by the time FPT times out or, when running, should the pressure drop below this level, the protective circuitry will initiate a shutdown. The "LOW OIL PRESSURE" fault lamp will illuminate. Startup will be inhibited and no attempt should be made to start the set until the cause of the fault has been traced and remedied. High engine coolant temperature (and/or low coolant level on some larger models) will shut down the generator set and will illuminate the "HIGH ENGINE TEMPERATURE" fault lamp. An overspeed condition will, in the same way, shut down the set and illuminate the "OVERSPEED" fault lamp.

WARNING:

! If at any time the generator set stops because of a fault, the fault should be rectified before trying to restart the generator.

These protective circuits will prevent start of the generator set until they are reset. Turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button for the 4001 and 4001E panels resets the system.

Manually the generator set can be stopped at any time by pressing the Emergency Stop Pushbutton or by turning the Control Switch to "STOP". The set will also automatically shutdown when the remote start signal is removed. On 4001 and 4001E Control System the Run On Timer (ROT) will allow a cool down period at low power prior to shutdown.

9.3.2 Protective Circuits (2001, 4001 and 40 Series): Engine coolant temperature is monitored by the high temperature switch located on the engine. This is normally an open switch designed to close at 95°C (203°F). On closing, a relay energizes and self latches, which illuminates the "HIGH ENGINE TEMPERATURE" fault lamp. It also breaks the circuit energizing the control relay (CR). This closes the fuel solenoid valve, shutting down the engine. The fault lamp will remain illuminated and the engine locked out until the fault has been acknowledged and reset by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels. On some larger models a low coolant level sensor will also cause the generator set to shut down and will also illuminate the "HIGH ENGINE TEMPERATURE" fault lamp even though the temperature may be in the normal range.

Engine lubricating oil pressure is also monitored to check for an excessively low pressure condition. This is monitored by an engine mounted, normally closed, switch that opens under normal running conditions. Should the oil pressure fall to or below about 22 p.s.i. (1.6 bar) the switch will close. This in turn energizes a relay which self latches, and illuminates the "LOW OIL PRESSURE" fault lamp. Again the relay CR is de-energized which causes the fuel solenoid valve to close and the engine to shutdown. Reset is effected by turning the Control Switch to "STOP" for the 2001 panel or by pressing the RESET button on the P.C.B for the 4001 and 400[illegible] panels.

The OVERSPEED fault is monitored by the E.I.M via the speed signal from the magnetic pick-up. If the engine speed rises above a certain pre-setable value, the module sends a zero volt signal to the generator set control panel to activate the Overspeed Fault circuitry. Upon this signal a relay energizes and self latches, which illuminates the "OVERSPEED" fault lamp. Again the relay CR is de-energized which causes the fuel solenoid valve to close and the engine to shutdown. Reset is effected by turning the Control Switch to "STOP" for the 2001 panel or by pressing the RESET button on the P.C.B for the 4001 and 4001E panels.

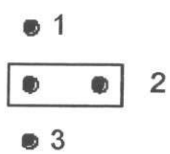
The Low Battery Voltage alarm which is fitted as standard on the 4001 and 4001E Series Control Systems detects the battery voltage and compares it to an adjustable reference (LBV) which is factory set at 10.75 volts for 12 volt systems and 22.75 volts for 24 volt systems. This alarm has a built in time delay to prevent spurious tripping such as when the engine is cranking.

Four additional Alarm circuits are provided on the 4001E Series Control System. The Approaching Low Oil Pressure and Approaching High Engine Temperature alarms work off the sensors fitted for the gauges. The temperature alarm is factory set to go off at 90°C ± 1°C. The Not in Auto Mode Alarm senses the position of the Control Switch. The Battery Charger Failure Alarm detects low voltage from the charger. This level (BCV) is factory set at 11.75 volts for 12 volt systems a[illegible] 25 volts for 24 volt systems. This alarm can be operated in one of 3 modes depending on the position of Link 6 on the 4001E Expansion P.C.B. (see diagrams below):

Mode 1: Link in Position 1

For generator sets with trickle charger and engine driven charging alternators. In this position the charger failure circuit only monitors when the engine is not running.

Mode 2: Link in Position 2



For generator sets fitted with AC powered chargers only (no engine driven charging alternator.)

Mode 3 Link in Position 3

For generator sets with no battery charger fitted. In this position the charger failure circuit is **disabled**.

The 2001 Series Control System has one additional channel beyond the standard that can be either a Shutdown circuit or an Alarm circuit depending on how it is programmed at the factory.

The 4001 Series Control System has one additional Shutdown circuit and one additional Alarm circuit beyond the standard. The use of these circuits is programmed at the factory.

The 4001E Series Control System has two additional Shutdown circuits, one additional Alarm circuit and four additional circuits that can be either Shutdown or Alarm circuit. Each of these is programmed at the factory.

The additional possible Shutdown circuits (not all available on all sets) include shutdown on:
High Lube Oil Temperature
Low Coolant Level
Low Fuel Level
Underspeed
Overvoltage
Undervoltage
Earth Fault
Earth Leakage
Combined Over/Under Voltage

The additional possible Alarm circuits (not all available on all sets) include alarms for:
Low Fuel Level
Low Coolant Temperature

For the 2001 Series Control System, the Fault Indicating Lamps are grouped on the control panel as follows-
L1 Fail To Start Shutdown
L2 High Engine Temperature Shutdown
L3 Low Oil Pressure Shutdown
L4 Overspeed Shutdown
L5 Additional Shutdown or Alarm (programmed at factory)

For the 4001 Series Control System, the Fault Indicating Lamps are grouped on the control panel as follows-
L1 Fail To Start Shutdown
L2 High Engine Temperature Shutdown
L3 Low Oil Pressure Shutdown
L4 Overspeed Shutdown
L5 Additional Shutdown
L6 Low Battery Alarm
L7 Additional Alarm

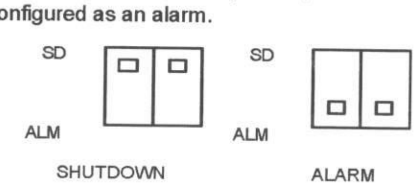
For the 4001E Series Control Systems nine additional Fault Indicating Lamps are included on the separate 4001E expansion P.C.B. which are grouped on the control panel as follows-
L8 Not In Auto Alarm
L9 Approaching High Engine Temperature Alarm
L10 Approaching Low Oil Pressure Alarm
L11 Battery Charger Failure Alarm
L12 Programmable Channel 1
L13 Programmable Channel 2
L14 Programmable Channel 3
L15 Programmable Channel 4
L16 Additional Shutdown

Indicators L12-L14 are programmed for shutdown or alarm functions using the Dil switches on the P.C.B.

The DIL switches are assigned as follows:

Fault Channel	Dil Switch
L12	SW1
L13	SW2
L14	SW3
L15	SW4

The setting of these programmable Fault Indicator Lamps can be checked on the P.C.B. With both poles in "SD" position, the fault channel is configured as a shutdown. With both poles in "ALM" position, the fault channel is configured as an alarm.



9.4 Control System Options and Upgrades

A large variety of options may be fitted to customize the control system to a specific installation. The following sections cover the use and operation of some of these options.

9.4.1 Battery Trickle Chargers: These chargers are designed to ensure that the starter batteries maintain their charge even if the generator set is not operated for long periods.

The chargers are generally available with a 5 Amp nominal rating and are usually mounted within the control panel. A 10 Amp nominal rating battery charger may be fitted in some circumstances but would be located in a separate box placed adjacent to the control panel. These chargers require a continuous electrical power supply of either 220/240 volts AC or 120 volts AC depending on the charger.

Control switches for the chargers are not normally fitted to prevent inadvertent switching off of the charger. The control system will automatically disconnect the charger on startup of the generator set. While the engine is running the batteries are charged by the engine driven battery charging alternator.

As additional options, an "ON"/"OFF" switch and a battery charger boost control may be fitted. The boost control overrides the automatic control mechanism of the charger that would normally reduce charging level as the battery becomes charged. This can allow faster charging of the battery, however care must be taken to only use the boost control for a short time to avoid overcharging the battery and/or boiling the battery dry.

As an option, a battery charger ammeter may be fitted to the control panel in order for the operator to monitor the functioning of the battery charger.

9.4.2 Heaters: In addition to conventional space heaters that are useful in keeping the generator set warm and dry in cold or humid environments, four types of heater may be fitted on the generator set.

For water cooled engines, immersion type heaters (engine heaters) may be fitted in the engine coolant system to ensure that the engine is easy to start and able to take load more quickly. These heaters are provided with an integral non-adjustable thermostat set at approximately 40°C (104°F).

Alternator anti-condensation heaters (alternator heaters) may be fitted to the alternator stator winding to keep them dry in humid conditions. These are in the form of "heat-tracing" tape and operate at relatively low temperatures so they do not require a thermostat.

Lube oil sump heaters (sump heaters) may be fitted to the sump when the generator is to be sited in a low ambient temperature environment. The heater maintains the engine lubricating oil at a temperature which facilitates rapid starting and load acceptance.

AC Powered Battery heater (Battery Heater) may be fitted to the battery when the generator is sited in a low ambient temperature environment. The heater maintains the battery at an optimum operating temperature allowing full rated current to be drawn (providing that the battery is in a fully charged condition). The heater includes a thermostatic controller to regulate the output temperature to within safe limits.

All of these heater types require a continuous AC power source. The heaters are automatically disconnected on engine start-up.

9.4.3 Electric Fuel Transfer Pumps: Fuel transfer pumps are required when fuel must be transferred from a bulk storage tank to the generator set day tank. An AC pump requiring a 220/240 volt AC power supply may be fitted. These pumps are generally mounted on the baseframe and float switches are fitted in the day tank. Control relays, switches, lamps and overloads are fitted in the control panel.

The controls consist of two illuminated pushbuttons on the control panel door. The red button is a combined trip lamp and stop button. The green button is a run lamp and manual start pushbutton.

To operate the pump manually, ensure the red pushbutton is in the "ON" position (pulled out). Press and hold the green pushbutton to manually run the pump. The pump will only run in the manual mode while the green button is held in.

To operate the pump in automatic mode, just ensu.. that the red pushbutton is in the "ON" position (pulled out). A DC relay inside the panel (PR) is energized by a low level float switch in the day tank. This will start the pump running and will illuminate the green run lamp. A high level float switch in the day tank de-energizes relay PR when the tank is full. This stops the pump and turns off the green run lamp.

An electrical overload is sensed if the pump draws significantly more current than normal. When this occurs the red lamp will illuminate.

Care must be taken to ensure that the pump is primed with fuel prior to operation to lubricate the seals. Also, the pump should never be run when the bulk tanks are empty or when valves on the fuel fill lines are closed.

9.4.4 Meters/Gauges: When more information is required than that which is provided by the standard panels, the following meters or gauges may be fitted to the control panel:

3 Ammeters mounted on the panel instead of one ammeter and a selector switch. This allows a continuous indication of the current flowing in each phase.

Kilowatt (kW) Meter to provide accurate readings of the load being supplied by the generator set. The meter is mounted on the control panel and the transducer is mounted inside the panel.

Combined Tachometer and Frequency Meter tc ace the standard frequency meter. This meter allows ..n engine speed in revolutions per minute (RPM) and output frequency to be indicated on the front panel.

Lube Oil Temperature Gauge to monitor the lubricating oil temperature when the engine is operating. This is an electrical device powered by the generator set battery. The normal operating temperature should be approximately 90°-110°C (195°-230°F).

Ammeter for Battery Trickle Charger to monitor the current flow to the battery. It is used to observe the charging current being supplied by the battery trickle charger. When the batteries are fully charged this current will be small (less than 5 Amps) but with a partially discharged battery this current may be as high as 40 Amps.

9.4.5 Speed/Voltage Control: Three controls may be fitted to adjust the speed or voltage of the generator set.

The *speed adjust potentiometer* can only be used when the engine is controlled by an electronic governor. Clockwise adjustment increases the speed of the engine and anti-clockwise adjustment decreases it. The potentiometer is fitted with a dial mechanism which allows the potentiometer to be locked at the desired setting.

A *raise/lower switch* may be fitted on the control panel to control the speed of engines with mechanical or hydraulic governors. The governor must also be fitted with a motor operator. A "spring return to off" switch is then d to raise or lower the speed.

The *voltage adjust potentiometer* allows minor adjustments of voltage to be made from the control panel. About 3% adjustment is possible

9.4.6 Alarm Signaling: Three options may be fitted to the control panel to supplement the standard alarm indications of the alarm lamps:

A *panel mounted alarm siren* is DC operated and will sound when an alarm condition is indicated. An Alarm Mute pushbutton is fitted on the panel to silence the siren.

An *audible alarm siren supplied loose* is also DC powered and will sound when an alarm condition is indicated. It can be fitted at a convenient location. An Alarm Mute pushbutton is fitted on the panel to silence the siren.

A *set of volt free contacts for common alarm* change over in the event of an alarm condition. These are for connection to an existing alarm system. These contacts remain in the "alarm" state until the control system is reset.

9.4.7 Automatic Preheat Control: The thermostart induction air preheating operates automatically prior to and during engine cranking. The automatic cranking sequence will be delayed by the preheating period.

9.4.8 Remote Annunciator Panels: 8 or 16 channel remote annunciators may be fitted and connected to 4001 and 4001E Series Control Systems. These provide repeat indicators for the shutdown and alarm fault lamps on the control panel. They also include an audible alarm and alarm mute button. The connection is via a plug type terminal bar for easy installation.

Each channel is equipped with a LED that can display red, green or amber depending on the selection of the DIL switches. Each channel can also be selected to sound the audible alarm via a DIL switch.

Two further options may be fitted with the remote annunciators: A Normal/Run switch allows manual starting of the set from the remote location and an Emergency Stop Pushbutton allows manual stopping.

9.5 Control System Fault Finding/Trouble Shooting Guide

FAULT	SYMPTOM	REMEDY
Engine Fails to Start (1001 Series Only)	Engine Does Not Crank when Key Switch Turned to Position "↷" (Start)	1. Check all Emergency Stop Pushbuttons are released (including any remote buttons). 2. Check operation of Key Switch. 3. Check no fault lamps illuminated. Reset, if required, after remedying indicated fault. 4. Check battery voltage on control panel. If voltage is not registering check fuses F4 and F5. If voltage is registering but is low then recharge the batteries with separate battery charger and reconnect to the set. (Ensure Key Switch is in Position 'O' (Off) when disconnecting and reconnecting the battery leads.) 5. Check supply to slave solenoid on starter motor - connect a DC voltmeter between this connection and the battery negative terminal. Try starting the engine using the Key Switch. If the meter registers a voltage then the starter motor or solenoid is faulty and must be replaced. If no voltage registers, check wiring from panel for loose connections or broken/shorted wires.
Engine Fails to Start (2001, 4001, or 4001E Series Only)	Engine Does Not Crank when Start Signal Given, Either Manually Via Control Switch or Automatic-ally Via a Remote Signal	1. Check all Emergency Stop Pushbuttons are released (including any remote buttons). If no remote stop is used, ensure "Remote Stop" terminals are linked. 2. Check that Control Switch is not off. 3. Check no fault lamps illuminated. Reset, if required, after remedying indicated fault. 4. Check battery voltage on control panel. If voltage is not registering check fuse F5. If voltage is registering but is low then recharge the batteries with separate battery charger and reconnect to the set. (Ensure the Control Switch is off when disconnecting and reconnecting the battery leads.) 5. Check supply to slave solenoid on starter motor - connect a DC voltmeter between this connection and the battery negative terminal. Try starting engine manually by turning the Control Switch to RUN. If the meter registers a voltage then the starter motor or solenoid is faulty and must be replaced. If no voltage registers, check wiring from panel for loose connections or broken/shorted wires. 6. If wiring is not damaged then replace the P.C.B.
Engine Fails To Start (All control systems)	Engine Cranks But Does Not Fire or Engine Starts But Stops After 20 Seconds ("FAIL TO START" Fault Lamp Illuminates on 2001, 4001 or 4001E Panels.)	1. Check fuel level. 2. Check that Canopy External Emergency Stop Pushbuttons, if fitted, are not depressed (1001 Series). 3. Check wiring to the fuel control solenoid "FCS" and the voltage at the FCS. 4. Check fuses F1, F2, F3 on alternator side plate. 5. Check fuel lines and fuel filter for obstructions. 6. If white smoke comes from the exhaust then fuel is entering the engine but the engine is not firing. Refer to the Engine Manual for further checks. 7. If ambient temperature is low ensure thermostart aid is used, if fitted. 8. Check voltage output of P.C.B. to FCS. If signal not present, Replace the P.C.B. 9. Once the fault has been rectified, clear the fault lamp by turning the Control Switch to STOP for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.

F.	SYMPTOM	REMEDY
Engine Stops Due to High Engine Temp. (or on some larger models due to Low Coolant Level) (All control systems)	"HIGH ENGINE TEMP" Fault Lamp Illuminates	1. Check engine was not overloaded. 2. Check radiator obstructions. 3. Check fan belt tension. 4. Check ambient temperature is within the design limits of the generator set. 5. After engine has cooled, check coolant level. Do not add large amounts of cold water to a hot engine as serious damage could result. 6. Refer to Engine Manual. 7. Once fault has been rectified, clear the fault lamp by turning the Key Switch to position "O" (Off) for the 1001 panel , Turning the Control Switch to "STOP" for the 2001 panel or by Pressing the P.C.B RESET button on the 4001 and 4001E panels , as appropriate. 8. Cool the engine by starting and running it off-load for 10 minutes with the circuit breaker off (handle down).
Engine Stops Due to Low Oil Pressure (All control systems)	"LOW OIL PRESSURE" Fault Lamp Illuminates	1. Check oil level. 2. Refer to Engine Manual. 3. Check oil pressure switch with test gauge. Replace if faulty. 4. Once fault has been rectified, clear the fault lamp by turning the Key Switch to position "O" (Off) for the 1001 panel , Turning the Control Switch to "STOP" for the 2001 panel or by Pressing the P.C.B RESET button on the 4001 and 4001E panels as appropriate.
Engine Stops Due to Overspeed (2001, 4001 or 4001E Series Only)	"OVERSPEED" Fault Lamp Illuminates	Note: The "OVERSPEED" fault lamp will also illuminate after the Emergency Stop Pushbutton has been depressed even though there has been no overspeed condition. The Emergency Stop Pushbutton and any remote stop buttons must be released before the fault can be cleared. 1. Check if governor speed setting lever has moved. Re-adjust if required. 2. If electronic governor is fitted check linkage for free movement. Adjust if required. 3. Refer to Engine Manual. 4. Replace the P.C.B. 5. Once fault has been rectified, clear the fault lamp by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.
Engine Stops Due to High Lube Oil Temp (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"HIGH LUBE OIL TEMP" Fault Lamp Illuminates	1. See trouble shooting guide on "Engine Stops Due To High Engine Temp" to see if cooling system is operating efficiently. 2. After radiator has cooled, check coolant level. 3. Check oil level. 4. Ensure proper maintenance procedures have been carried out. 5. Refer to Engine Manual. 6. Once fault has been rectified, clear the fault lamp by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.
Engine Stops Due to Low Coolant Level (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"LOW COOLANT LEVEL" Fault Lamp Illuminates	1. Allow engine to cool. 2. Check coolant level. Fill as required with correct coolant mixture. Do not add large amounts of cold water to a hot engine as serious damage could result. 3. Check radiator, engine and pipework for leaks. Repair as necessary. 4. Once fault has been rectified, clear the fault lamp by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.

FAULT	SYMPTOM	REMEDY
Engine Stops Due to Low Fuel Level (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"LOW FUEL LEVEL" Fault Lamp Illuminates	1. Check fuel level in day tank. Fill as necessary. 2. Check operation of the fuel transfer system , if fitted, as described in Section 9.4.3. 3. Once fault has been rectified, clear the fault lamp by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.
Engine Stops Due to Underspeed (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"UNDERSPEED" Fault Lamp Illuminates	1. Ensure engine has not been overloaded. 2. Ensure there is an adequate supply of fuel to the engine. 3. Check if governor speed setting lever has moved. Re-adjust if required. 4. If electronic governor is fitted check linkage for free movement. Adjust if required. 5. Clear the fault by turning the Control Switch to "STOP" and restart the engine. 6. Ensure alternator is running at the correct voltage by checking on the panel meters. 7. With engine running set correct speed on the engine governor control. 8. Refer to the Engine Manual.
Engine Stops Due to Overvoltage (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"OVERVOLTAGE" Fault Lamp Illuminates	1. Disconnect the alternator from the load by turning off the circuit breaker (handle down), reset the fault by turning the Control Switch to "STOP" and restart engine. 2. Check voltage on panel meters. If voltage is normal, ensure that the load is non-capacitive (power factor correction equipment may inadvertently lead to a capacitive load). 3. If voltage remains high and can not be adjusted to the normal level using the voltage adjust potentiometer, if fitted, then refer to the Alternator Manual.
Engine Stops Due to Under-voltage (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"UNDERVOLTAGE" Fault Lamp Illuminates	1. Disconnect the alternator from the load by turning off the circuit break[illegible] (handle down), reset the fault by turning the Control Switch to "STOP" a[illegible]start engine. 2. Check voltage on panel meters. If voltage is normal check the load characteristics (i.e. ensure not overloaded). 3. If voltage remains low and can not be adjusted to the normal level using the voltage adjust potentiometer, if fitted, then check the voltage at the alternator terminals with an independent meter. If voltage is correct check wiring. 4 Check AVR. 5. Refer to Alternator Manual.
Engine Stops Due to Overvoltage /Under-voltage (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"OVERVOLTAGE/UNDER-VOLTAGE" Fault Lamp Illuminates	1. Disconnect the alternator from the load by turning off the circuit breaker (handle down), reset the fault by turning the Control Switch to "STOP" and restart engine. 2. Check voltage on panel meters. If voltage is normal check the load characteristics (i.e. not capacitive and not overloaded). 3. If voltage remains high or low and can not be adjusted to the normal level using the voltage adjust potentiometer, if fitted, then check the voltage at the alternator terminals with an independent meter. If voltage is correct check wiring. 4 Check AVR. 5. Refer to Alternator Manual.
Engine Stops Due to Earth Fault (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"EARTH FAULT" Fault Lamp Illuminates	1. Check all cable and wiring for bad connections or shorts to earth. 2. Check alternator windings - refer to Alternator Manual. 3. Once the fault has been rectified, clear the fault lamp by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.
Engine Stops Due to Earth Leakage (Optional Shutdown - 2001, 4001 or 4001E Series Only)	"EARTH LEAKAGE" Fault Lamp Illuminates	1. Check outgoing cable and wiring for faults. 2. Do not restart the generator set until fault has been found. 3. Once the fault has been rectified, clear the fault lamp by turning the Control Switch to "STOP" for the 2001 panel or by pressing the P.C.B RESET button on the 4001 and 4001E panels.

FAULT	SYMPTOM	REMEDY
Alarm for Low Battery Voltage (4001 or 4001E Series Only)	"LOW BATTERY VOLTAGE" Alarm Lamp Illuminates	1. Check battery voltage at least 12 volts for a 12 volt system or at least 24 volts for a 24 volt system. 2. If voltage is low and generator set is not running then recharge the battery by connecting a separate battery charger to the disconnected battery or run the engine. 3. If voltage is low and generator set is running then the battery charging alternator is not charging. Stop the set and check the fan belt tension. 4. If fan belt tension is correct then check battery charging alternator - refer to Engine Manual. 5. If battery does not hold a charge then replace battery. 6. Once the cause of the alarm has been rectified, clear the alarm lamp by pressing the "LAMP TEST" button.
Alarm for Not in Automatic Mode (4001E Series Only)	"NOT IN AUTO MODE" Alarm Lamp Illuminates	1. Check Control Switch is in "AUTO". 2. Check Emergency Stop Pushbuttons are not pressed. 3. Check Circuit Breaker is on (handle up). 4. Once the cause of the alarm has been rectified, clear the alarm lamp by pressing the "LAMP TEST" button.
Alarm for Approaching High Engine Temp. (4001E Series Only)	"APPROACHING HIGH ENGINE TEMP" Alarm Lamp Illuminates	1. Check engine is not overloaded. 2. Check radiator and ventilation for obstructions. 3. Check ambient temperature is within the design limits of the generator set. 4. If the above are okay, reduce load and stop the set as soon as possible. Check the fan belt tension. 5. Refer to Engine Manual. 6. Once the cause of the alarm has been rectified, clear the alarm lamp by pressing the "LAMP TEST" button.
Alarm for Approaching Low Oil Pressure (4001E Series Only)	"APPROACHING LOW OIL PRESSURE" Alarm Lamp Illuminates	1. Check oil level with engine stopped as soon as possible. 2. Refer to Engine Manual. 3. Once the cause of the alarm has been rectified, clear the alarm lamp by pressing the "LAMP TEST" button.
Alarm for Battery Charger Failure (4001E Series Only)	"BATTERY CHARGER FAILURE" Alarm Lamp Illuminates	1. Check trickle charger is switched on and producing power. 2. Carry out checks as per low battery voltage alarm. 3. Once the cause of the alarm has been rectified, clear the alarm lamp by pressing the "LAMP TEST" button.
Alarm for Low Fuel Level (Optional Alarm - 2001, 4001 or 4001E Series Only)	"LOW FUEL LEVEL" Alarm Lamp Illuminates	1. Check fuel level in day tank. Fill as necessary. 2. Check operation of the fuel transfer system, if fitted, as described in Section 9.4.3. 3. Once the cause of the alarm has been rectified, clear the alarm lamp by pressing the "LAMP TEST" button for the 4001 and 4001E panels or by turning the control switch to "STOP" for the 2001 panel.
Alarm for Low Coolant Temp. (Optional Alarm - 2001, 4001 or 4001E Series Only)	"LOW COOLANT TEMP" Alarm Lamp Illuminates	1. Check that the immersion heaters are switched on and are operating. 2. Once the cause of the alarm has been rectified, clear the alarm lamp by pressing the "LAMP TEST" button for the 4001 and 4001E panels or by turning the control switch to "STOP" for the 2001 panel.
No Voltage Produced When Generator set is Running (All control systems)	No Voltage On AC Voltmeter	1. Check voltmeter selector switch is not in the "OFF" position. 2. Check fuses F1, F2, and F3, usually located on the alternator terminal box. 3. Check voltage at alternator terminals with an independent meter. If voltage is correct check wiring between alternator and panel. Check voltmeter. Replace if necessary. 4. Check AVR and rotating diodes. Refer to Alternator Manual for details. 5. Check engine speed is correct.
Generator set Does Not Go On Load (All control systems)	Generator set is Running but the Load is Not Being Powered	1. Check circuit breaker is "ON" (handle up). 2. Check generator set is producing AC voltage. If not, see fault above.

FAULT	SYMPTOM	REMEDY
Generator set Does Not Stop Manually (All control systems)	Generator set Continues Running After Being Switched Off	1. Check Key Switch or Control Switch position, as appropriate. 2. Check fuel control solenoid (FCS). Replace if necessary.
Generator set Does Not Stop When In Auto Mode (2001, 4001 or 4001E Series Only)	Generator set Does Not Stop After Remote Start Signal is Removed	Note: On 4001 and 4001E Series Control Systems the generator set does not stop immediately on removal of the remote start signal. Removal of this signal first initiates the cool down period. 1. Wait 5 minutes to ensure cool down period has elapsed (4001 and 4001E Series Control Systems Only). 2. Check that generator set stops when the Emergency Stop Pushbutton is depressed or the Control Switch is turned off. 3. If the set does not stop as in step 2 above then check the fuel control solenoid (FCS). Replace if necessary.

9.6 Load Transfer Panel

When the generator set is installed to automatically provide standby power in the event of mains failure, a load transfer panel is required. This transfer panel is designed to sense when the mains have failed, signal the generator set to start, switch the load from the failed mains to the generator set and then switch it back after the mains are re-established. See Figure 9.6.

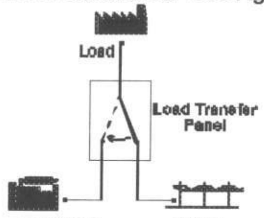


Figure 9.6: Function of a Load Transfer Panel

There is one standard range of Load Transfer Panel: The TI Series Intelligent Transfer Panel.

9.6.1 TI Intelligent Load Transfer Panel: The TI Intelligent Load Transfer Panel is designed to work with the Autostart Control Systems (2001, 4001, and 4001E Series) to form an automatic mains failure system. Only a two wire control interconnection is necessary between the generator set control panel and the TI panel making the installation very simple.

The control system consists of two Printed Circuit Boards (P.C.B.'s), control switches, a status panel and the contactors. The TI P.C.B. (see Figure 9.8) controls all the detection and monitoring circuits, the mode control switch and fuses. The P.C.B., switches and fuses are all mounted on the back of a hinged drop down door which is on the front of the transfer panel.

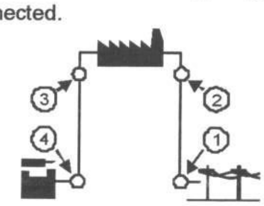
Status Panel: The front of the door has the status panel and main control switch. This status panel has four indicator lamps as shown in Figure 9.7. They are "Mains Available" (amber), "Mains on Load" (green), "Generator on Load" (red), and "Generator Available" (amber). Pressing the Lamp Test Button located below these indicator lamps will illuminate them for testing.

Controls: The main control switch on the front panel has three positions:-

AUTOMATIC MODE - The normal position for automatic operation.

TEST WITHOUT LOAD - For testing the generator set without connecting the load.

TEST WITH LOAD - For testing the generator set with the load connected.



Item	Description
1.	"Mains Available" Status Lamp
2.	"Mains on Load" Status Lamp
3.	"Generator on Load" Status Lamp
4.	"Generator Available" Status Lamp

Figure 9.7: TI Series Load Transfer Panel Status Display

In addition to the main control switch on the panel face, there is an internally mounted 3 position "Control Bypass" keyswitch for use by service personnel only. In the "normal" position the TI Panel operates normally. The other two positions allow the service personnel to manually connect the load to the operating generator set or to the mains supply. This switch would be used if the TI P.C.B. has been damaged.

WARNING:

! **The internal maintenance switch should only be operated by trained personnel due to the high voltages present inside the enclosure.**

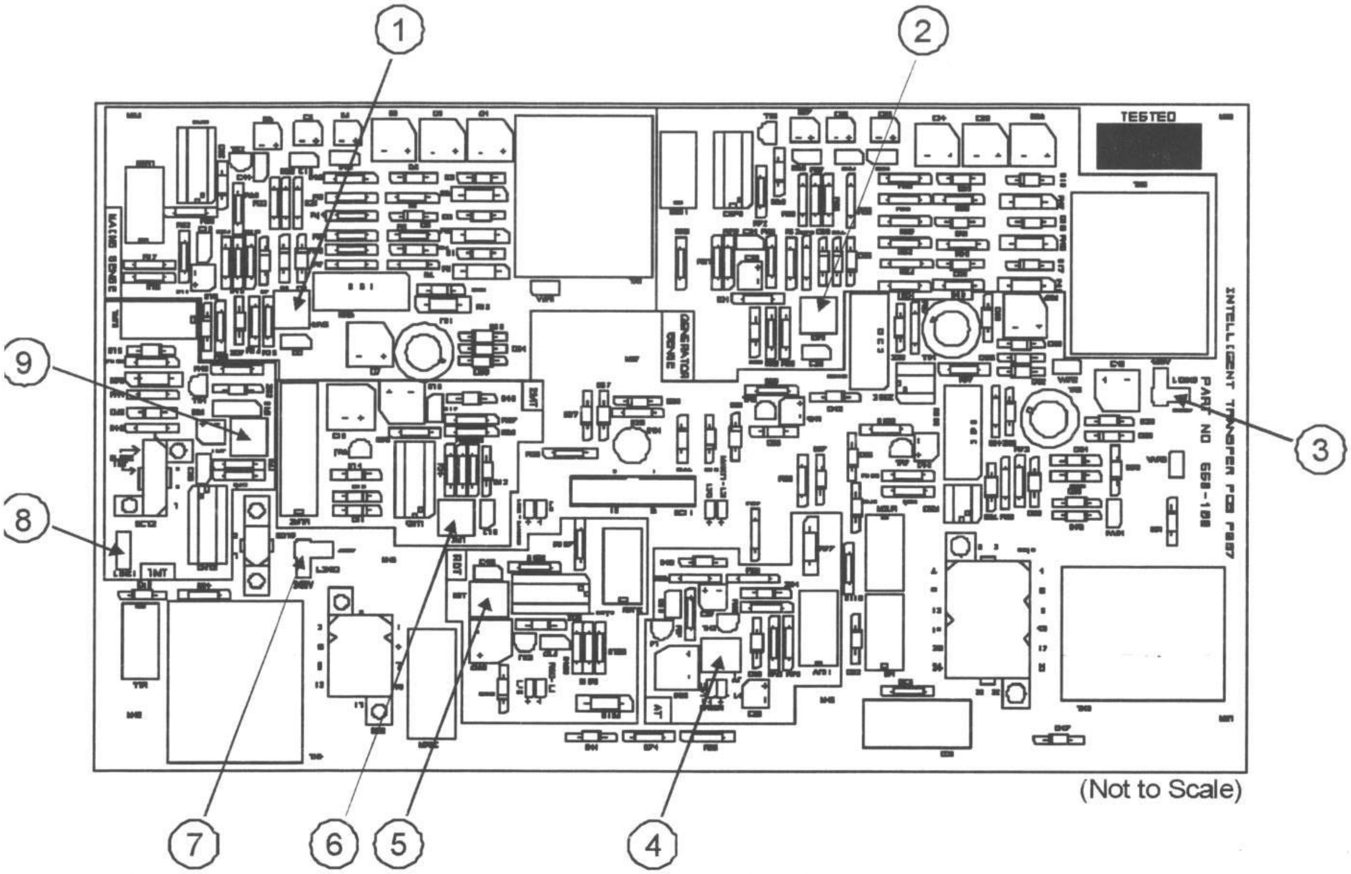
Functional Description: The TI Series Load Transfer Panel operates as follows:

With the mains supplying electrical power to the load, the "Mains Available" and "Mains on Load" Status Lamps will be illuminated. These lamps indicate that the mains supply voltage level is above the Mains Voltage Set point (MVS) on the P.C.B. and that the load is connected to the mains supply. Potentiometer MVS is factory set at the voltage trip point for all three phases.

When the mains voltage on any of the 3 phases drops below the trip level MVS, both the "Mains Available" and "Mains on Load" status lamps extinguish. The Delay on Start timer (2MT) is energized. This timer avoids false engine starts due to momentary mains fluctuations. If the mains have not returned by the time 2MT has timed out then the mains contactor is opened and a start signal is sent to the generator set control panel.

Once the generator set has started and is producing voltage the "Generator Available" status lamp is illuminated and the Delay on Transfer Timer (AT) is enabled. This timer permits alternator output to stabilize before the standby contactor is closed. Once AT has timed out, and as long as the generator set voltage is above the Generator Voltage Set point (GVS), then the standby contactor is closed. This allows the generator set to power the load. The "Generator on Load" status lamp will be illuminated at this time.

On restoration of mains power above the trip point MVS, the "Mains Available" status lamp will illuminate and the Delay on Retransfer Timer (1MT) will be energized. This timer allows a period of time to ensure that the mains supply is reliable before transferring the load back. If the mains voltage drops below MVS at any time during this period then 1MT will be reset and not restarted until the mains voltage again goes above MVS.



(Not to Scale)

Item	Description
1.	MVS: Mains Voltage Set (Factory Set)
2.	GVS: Generator Voltage Set (Factory Set)
3.	LINK 3: Operating Voltage Range Select
4.	AT: Delay on Transfer Timer (Factory Set)
5.	ROT: Run on Timer (cool down period) Range 23-315 seconds Set: 240 ± 15 seconds

Item	Description
6.	2MT: Delay on Start Timer Range: 1-25 seconds Set: 5 ± 1 second
7.	LINK 2: Operating Voltage Range Select
8.	LINK 1: Remove for Manual Retransfer Operation
9.	1MT: Delay on Retransfer Timer Range: 160 seconds-28 minutes Set: 160 seconds

Figure 9.8: Layout of TI Series Load Transfer Panel P.C.B.

After 1MT times out, the standby contactor is opened and the "Generator on Load" status lamp is extinguished. The mains contactor is then closed and the "Mains on Load" status lamp is illuminated. The load is now powered by the mains supply. The Run on Timer (ROT) is also energized at this point to allow the generator set to continue running and cool down at no load before stopping. After ROT times out the start signal is removed and the generator set automatically shuts down. The "Generator Available" status lamp extinguishes.

Configuring the TI P.C.B. for Different Supply Voltages: The TI P.C.B. operates in most systems from 190 volts to 480 volts phase to phase, 50 and 60 Hz and both single and 3 phases. Only a qualified technician should reconfigure the TI P.C.B. by moving links on the P.C.B. and wiring looms in addition to fitting additional fuses. Procedures for these changes are available from the factory.

Adjustment of MVS and GVS: These potentiometers control the trip points for the mains and generator voltage respectively. They are usually both set to the same values. These potentiometers are multi-turn type. Either of two types may be fitted:- round types have 4 turns, rectangular types have 15 turns.

It is possible for a qualified technician to reset these levels on site. Procedures for resetting these potentiometers are available from the factory.

Manual Retransfer Option: If fitted, this allows the operator to manually control the timing of the retransfer of the load from the generator set to the restored mains supply. The controls comprise a Manual/Auto Retransfer Selector Switch and a Retransfer Button. This option connects to the 4 pin connector EC12 on the TI P.C.B.

With the Retransfer Selector Switch in Manual or Auto, on mains failure the generator set will start and acc oad in the normal sequence. With the switch in Auto, load will be automatically retransferred back to the mains when available as described above.

With the Retransfer Selector Switch in Manual, the retransfer timer is bypassed and, on restoration of the mains, the "Mains Available" indicator will illuminate but the generator will continue to supply the load. When it is convenient for the retransfer to take place, the operator presses the Retransfer Button which causes the standby contactor to open and the mains contactor to close. This reconnects the load to the mains.

The set will continue to run for the cool down period before automatically shutting down and resetting.

Optional Remote Status Indicating Lamps: If fitted, this option allows a remote indication of the status lamps that are mounted on the TI panel. A 10 way ribbon cable connected to connector EC11 on the TI P.C.B. sends the appropriate signals to a matching status display P.C.B.

9.7 Engine Interface Module Description

The Engine Interface Module is a sealed, engine mounted module that provides switching relays for the Starter Motor Solenoid, Glow Plug and Fuel Solenoid. Each of these circuits is protected with individual fuses mounted in the module. Individual LED's illuminate when each circuit is energized.

This module is mounted on the engine with anti-vibration mounts and is easily connected to the engine via loom plugs. The fuses are automotive type. Use of the EIM means that heavy currents such as Fuel Solenoid power no longer go through the control panel enabling individual protection of each of the circuits. In addition to this the LED's will greatly aid in fault finding.

Item	Description	Item	Description
1.	Glow Plug Symbol	8.	Secondary Socket
2.	Fuel Symbol	9.	Starter Solenoid Fuse
3.	Fuel Solenoid Fuse	10.	Starter LED
4.	Fuel LED	11.	Overspeed Set-up LED
5.	Main Connector Socket	12.	Overspeed Adjuster
6.	Glow Plug Fuse	13.	Starter Symbol
7.	Glow Plug LED		

Figure 9.9: Engine Interface Module

9.7.1 Functional Description: There are three versions of the Engine Interface Module available - the 12 volt EIM SR, the 12 volt EIM Plus and the 24 volt EIM Plus.

The EIM SR is the basic level module that provides all the switching functionality. The EIM Plus provides the same functionality as the EIM SR plus the additional feature of Overspeed Sensing and an Overspeed Trip Adjuster. A magnetic pick-up on the engine flywheel housing provides the speed signal to the EIM Plus. When an overspeed situation is sensed, the EIM Plus signals the 2001, 4001 or 4001E generator set control panel to stop the engine. The Overspeed Trip Point can be easily set-up for 10% above the normal operating speed.

The overspeed feature on the EIM Plus, including the magnetic pickup is mandatory for all the Autostart control panels (2001, 4001 and 4001E). All generator sets above 150 kVA (with 24 volt engine electrical systems) are supplied with the EIM Plus and magnetic pickup as standard.

Status Indication: LED's on the module correspond to the Starter Motor Solenoid supply, the Glow Plug supply (where used) and the Fuel Control Solenoid supply. Each illuminates to show that the indicated circuit is energized. A fourth LED (only operational on the EIM Plus) is used to set-up the Overspeed Trip Point.

Starter Motor Solenoid (EIM SR): When the Keyswitch is turned to start, a relay in the module is energized providing power to the Starter Motor Solenoid. When the Keyswitch is released the relay is de-energized, stopping the starter motor.

Starter Motor Solenoid (EIM Plus): During automatic cranking the module receives a signal from the magnetic pick-up. When the signal rises above 1090 Hz, the starter motor is disengaged and the EIM Plus switches a zero volt signal to the generator set control panel to indicate that the engine is running.

Should the crank speed be less than 12 Hz, the module will only allow a crank of 0.6 seconds.

If the engine speed falls below 350 Hz (i.e. the engine has stopped) the EIM Plus will allow cranking only after a 5 second delay (lockout) which compliments the generator set control panel's 3 attempt crank.

Glow Plug (pre-heat): When the relay is energized power is provided to the Glow Plug (where fitted).

Fuel Control Solenoid: The generator set control panel energizes a relay in the module that provides power to the Fuel Control Solenoid allowing fuel flow to the engine.

Overspeed Signal (EIM Plus only): The EIM Plus monitors the speed signal from the magnetic pick-up. If the engine speed rises above a certain pre-setable value, the module sends a zero volt signal to the generator set control panel to activate the Overspeed Fault circuitry.

The Overspeed Set Point is factory set at 55Hz for 50Hz sets and 66Hz for 60Hz sets. This can be adjusted using the adjustment screw accessed through the hole beside the Overspeed Set-Up LED. While the engine is running at the rated speed (1500 rpm for 50Hz or 1800 rpm for 60Hz) the adjustment screw should be adjusted until the Overspeed Set-Up LED just goes out. This sets the overspeed value at 10% above the speed at which the generator set is operating.

Safety "Relay" Feature: The EIM SR and EIM Plus provide a safety check for any damaged contacts (i.e. welded contacts) using a "safety" relay. When the emergency stop pushbutton on the generator set control panel is pushed the EIM module automatically checks Fuel Control Solenoid and Starter Motor Solenoid to see if they are welded shut. A dimly lit LED on the module indicates the contacts are damaged and the module should be replaced.

9.8 Output Circuit Breaker Description

The alternator output circuit breaker is a molded case circuit breaker (MCB/MCCB) of sufficient rating for the generator set output. Electrical output is switchable through this device, with "ON" being indicated by the handle being up. The breaker will carry its rated current continuously but will trip to mid-position if the rating on any one phase is exceeded for a period depending on the percentage overload and the circuit breaker characteristics. The breaker must then be switched "OFF" (handle down) before reclosing.

10. BATTERY DESCRIPTION AND MAINTENANCE

10.1 Battery Theory

10.1.1 General: The battery is an assembly of "cells" containing a number of plates, immersed in an electrically conductive fluid. The electrical energy from the battery comes from chemical reactions taking place within the cells. These reactions are reversible which means that the battery can be repeatedly charged and discharged.

10.1.2 Electrolyte: The electrically conductive fluid, called electrolyte, in a lead-acid battery is a diluted sulphuric acid solution. It aids the chemical reactions occurring at the plates and it acts as the carrier for the electrical current.

10.1.3 Specific Gravity: Specific gravity is a unit of measurement for determining the sulphuric acid content of the electrolyte which compares the weight of the electrolyte compared to the weight of pure water. At 25°C (77°F) a fully charged battery should have a specific gravity of 1.270. The lower the concentration of sulphuric acid, the lower the specific gravity.

As the battery is discharged, the chemical reactions lower the specific gravity of the electrolyte. Therefore, this measurement can be used as a guide to the state of charge of the battery.

10.1.4 Hydrometer: Specific gravity can be measured directly using a hydrometer. This device is a bulb-type syringe which will extract electrolyte from a cell in the battery. A glass float in the hydrometer barrel is calibrated to indicate the specific gravity.

Hydrometer readings should not be taken immediately after water is added to the cell. The water must be thoroughly mixed with the underlying electrolyte, by charging, before hydrometer readings are reliable. Also, if the reading is being taken immediately after the battery has been subjected to prolonged cranking, the reading will be higher than the true value. The water formed in the plates during the rapid discharge will not have had time to mix with the electrolyte above the plates.

10.1.5 High or Low Temperatures: In tropical climates (frequently above 32°C (90°F)) a fully charged battery with a lower specific gravity of 1.240 is used. This milder strength electrolyte increases the service life of the battery. If subjected to low temperatures the battery will not have the same cranking power due to the lower concentration of sulphuric acid, but this situation should not occur in tropical climates.

Batteries prepared for service in extremely cold weather use stronger electrolyte. In some instances specific gravity's of 1.290 to 1.300 are used. The cold cranking performance increases as the specific gravity increases.

10.1.6 Temperature Correction: The hydrometer is calibrated to indicate properly for a specified electrolyte temperature, often 25°C (77°F). For temperatures higher or lower than the reference temperature, a correction must be made. For each 5.5°C (10°F) above the reference add 0.004 to the reading. For each 5.5°C (10°F) below the reference, subtract 0.004 from the reading.

10.2 Battery Maintenance

WARNING:

! **Wear an acid resistant apron and face shield or goggles when servicing the battery. If electrolyte is spilled on skin or clothing, flush immediately with large quantities of water.**

10.2.1 Filling: The battery will often be shipped dry. Pre-mixed electrolyte of the correct specific gravity will have to be added.

Remove the vent plugs and fill each cell with the electrolyte until the level is 8 mm (5/16 inch) above the top edge of the separators. Allow the battery to stand for 15 minutes. Check and adjust the level as necessary.

10.2.2 Initial Charging: Within 1 hour of filling, the battery must be charged for 4 hours at the current indicated below. This will ensure that the acid is sufficiently mixed within the battery. Failure to give this charge at this time may impair the capacity of the battery.

Battery Reference	Charge Current (Amps)
E017	9
E312	14
E324	20

The above 4 hour charge period may need to be extended as follows: to 8 hours if the battery has been stored for 3 months or more at temperatures in excess of 30°C (86°F) or humidity above 80%; to 12 hours if the storage has exceeded 1 year.

If the charger output is not sufficient then a lower current, which should not be less than 1/3 of that given above, may be used but the time increased in proportion (8 hours at 7 Amps instead of 4 hours at 14 Amps).

At the end of the charging period, the electrolyte levels should be checked and restored if necessary by addition of sulphuric acid electrolyte at the correct specific gravity. The vents should then be replaced.

10.2.3 Topping Up: Normal operation and charging of the battery will cause some of the water to evaporate. This will require occasional topping up of the battery.

Clean the battery first to avoid contamination and remove the vent plugs. Add distilled water, until the level is 8 mm (5/16 inch) above the separators. Replace vent plugs.

10.3 Charging the Battery

WARNING:

! **Always ensure battery charging is carried out in a well ventilated area away from sparks and naked flames.**

! **Never operate a battery charger where unprotected from rain or snow. The charger should never be used near water.**

! **Always switch the charger off prior to disconnecting the battery.**

The engine driven alternator and or a static battery charger, if fitted, should maintain the batteries in a charged state. However, if the battery has recently been filled or recharging is required the battery may be disconnected from the generator set and connected to an external battery charger.

10.3.1 Charger and Battery Connections: The battery charger should be connected to a suitable mains supply (13 Amps minimum) using a plug connected as indicated below.

Mains Connection

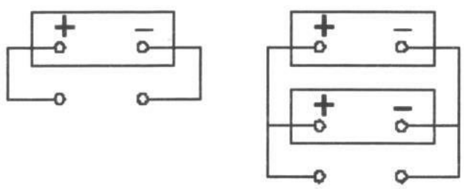
Live	Brown Lead
Neutral	Blue Lead
Earth	Green/Yellow Lead

Also ensure that the battery terminals are connected as indicated below:

Battery Connection

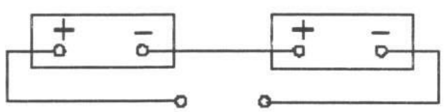
Positive (+) Terminal	Red Lead
Negative (-) Terminal	Black Lead

Connect the batteries to the charger as per the following chart:

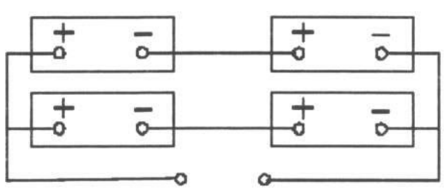


Single Battery Parallel

12 Volt Systems



Series



Series/Parallel

24 Volt Systems

10.3.2 Charger Operation: After the charger has been connected to the mains and the battery connected to the charger as indicated above, the charging procedure can be followed:

Remove the battery filler caps or vent cover during charging. Check electrolyte levels and adjust as necessary using distilled water.

Switch on the charger and observe rate of charge for normal operation. The charging rate depends on the Ampere-hour capacity of the battery, the condition of the battery and the present level of charge. The charging current will decrease as the battery starts charging and will continue to decrease as the battery voltage rises.

To check the state of charge, allow the battery to settle for a short period with the charger switched off. Then check the specific gravity of each cell using a hydrometer.

The battery charger should not overcharge or d e the batteries. High temperature, however, can damage the batteries. Care should be taken when charging batteries, especially in hot climates, that the battery temperature never rises above 45°C (113°F).

10.4 Battery Charging System Fault Finding/Trouble Shooting Chart

WARNING:

! Removal of the battery charger cover will expose dangerously high voltage terminals.

Symptom	Possible Fault	Remedy
No Charging Current	Incorrect or Bad Battery Connections	1. Check connections and clean terminals.
	Old or Sulfated Battery with Very Low Terminal Voltage	1. Remove battery and charge on specialist equipment.
	No Mains Supply	1. Check mains supply to charger.
	Blown Mains Fuse	1. Replace fuse.
	Faulty Diode Rectifier Unit	1. Remove output connections from each rectifier unit and test for output current into a known load.
No Charging Cu Sh on Indicator	Faulty Indicator	1. Check charging current with standard ammeter.
Charging Rate Too Low	Low Mains Voltage	1. Check mains voltage supply.
	Incorrect Mains Supply Tapping	1. Check the mains supply tapping with the supply voltage.
	Loose Heavy Current Connections	1. Check and tighten connections if necessary.
Charging Clamps Get Hot	Faulty Connections to the Battery	1. Clean terminals and reconnect.
	Loose Screws in Clamps	1. Clean and tighten screws in charging clamps.
Mains Supply Fuse Blows Repeatedly	Incorrect Fuse Rating	1. Replace with correct fuse.
	Wiring Short	1. Check and remake all connections.
Charging Rate Does Not Taper	Old or Damaged Battery	1. Charger is not faulty - battery will not rise to full charge voltage. Test battery and replace as necessary.

10.5 Jump Starting Procedures

WARNING:

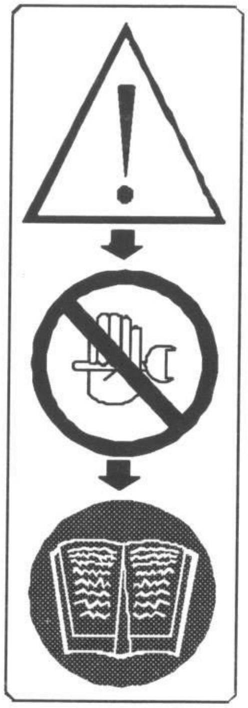
! **Do not attempt to jump start a battery if the electrolyte is frozen or slushy. Bring the batteries up to at least 5°C (41°F) before attempting a jump start.**

If the generator set battery has insufficient charge to start the generator set, a "jump start" from another battery is possible. Use the following procedures:

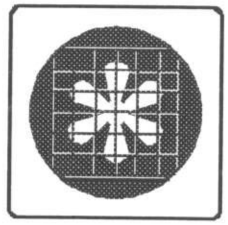
1. Remove all vent caps from the battery or batteries in the generator set. Do not permit dirt or foreign matter to enter the open cells.
2. Check the battery fluid level. If low add distilled water to bring it to the proper level.
3. Attempt to jump start only with a vehicle with a negative ground electrical system with the same voltage and that is equipped with a battery or batteries of comparable size or larger than those supplied with the generator set.
4. Bring the starting vehicle along side the generator set but do not allow metal to metal contact.
5. Place the starting vehicle in neutral or park, turn off all non-essential accessory loads and start the engine.
6. Connect one end of clean, heavy duty jumper cables to the positive battery terminal of the starting vehicle. If jump starting a 24 volt generator set and the starting vehicle is provided with two 12 volt batteries, then connect the jumper cable to the positive terminal of the battery that is not grounded.
7. Connect the other end of the same jumper cable to the positive terminal of the battery in the generator set. When jump starting 24 volt generator sets, connect to the positive terminal of the battery that is not grounded.
8. Connect one end of the other jumper cable to the grounded negative terminal of the battery in the starting vehicle. If jump starting a 24 volt g[illegible]tor set and the starting vehicle is provided with [illegible] 12 volt batteries, then connect the jumper cable to the negative terminal of the battery that is grounded.
9. Check the connections. Do not attempt to start a 24 volt generator set with one 12 volt battery in the starting vehicle. Do not apply 24 volts to one 12 volt battery in the generator set.
10. Connect the other end of this second jumper cable to a clean portion of the generator set engine block, away from fuel lines, the crank case breather opening or the battery.
11. With the engine of the starting vehicle running, start the generator set in accordance with the normal procedures. Avoid prolonged cranking.
12. Allow the generator set to warm up. When the set is warm and operating smoothly at normal RPM, disconnect the negative jumper cable from the engine block on the generator set. Then disconnect the other end of the same cable from the battery in the starting vehicle. Then disconnect the other cable for the positive terminal of the generator set battery and finally disconnect the cable from the starting vehicle battery.
13. Replace vent caps.

HAZARD LABEL LEGEND

Some or all of these hazard warning labels will appear on your generator set:



DO NOT TAMPER WITH UNLESS YOU HAVE READ THE INSTRUCTION MANUAL

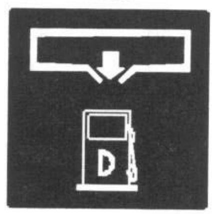


USE FAN GUARDS

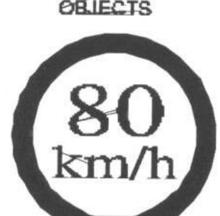
ELECTRIC SHOCK HAZARD

HOT EXHAUST GAS

LOW OVERHEAD OBJECTS

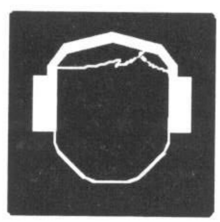


DIESEL FUEL SUPPLY LINE



RATED SPEED

NO NAKED FLAMES

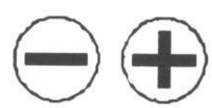


WEAR EAR PROTECTION

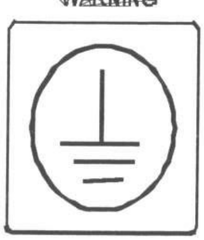
EMERGENCY/ PANIC EXIT

DIESEL FUEL WARNING

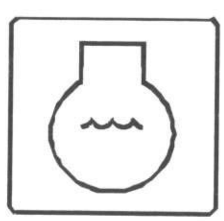
HOT SURFACES



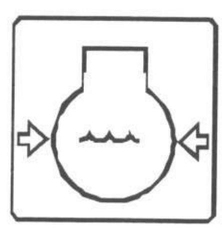
ELECTRIC TERMINALS



PROTECTIVE EARTH (GROUND)



ENGINE COOLANT



ENGINE COOLANT PRESSURE

Index

Air Flap Valve 16
Air Inlet 8
Air Inlet/Exit 8
Alarm Signalling 35
Alternator 5
Alternator Description 18
Alternator Maintenance 18
Alternator Method of Operation 18
Alternator Reconnection 13
Alternator Removal 14
Alternator Storage 14
Automatic Voltage Regulator 18
Baseframe 5
Basetank 5, 10
Batteries 12, 45
Battery Charger 45
Battery Charger Trouble Shooting 47
Battery Charging Fault Finding 47
Battery Maintenance 45
Battery Storage 14
Battery Trickle Chargers 33
Battery Voltmeter 25
Bulk Storage Tanks 10
Cabling 13
Chemical Safety 2
Circuit Breaker 5, 23, 44
Cleaning 14, 16, 18
Combustion Air 8
Control System 5, 14, 23
  1000 Series Panel 25
  2000, 4000, 4000E Series Panels 27
Cooling 8
Cooling System 5, 16
Day Tank 10
Electric Shock 3
Electrical Connection 12
Electrical Grounding 13
Electrical Loading 13
Electrical Protection 13
Electrical Safety 2
Emergency Stop 25
Enclosures 6, 13
Engine 5
Engine Description 16
Engine Electrical System 5
Engine Governing 16
Engine Maintenance 16
Engine Storage 14
Ethyl Ether 16
Exhaust Silencer/Muffler 5, 13
Exhaust System 5, 10, 16
Explosion Safety 1
Fault Finding 36
Fault Lamps 25
Fire Safety 1, 12
First Aid 3
Frequency Meter 23
Fuel System 10, 16
Fuel Tank 5
Fuel Transfer Pumps 34
General Description 5
General Safety 1
Generating Set Maintenance 14
Grounding 13
Handling 6
Handling Safety 1
Heaters 34
Hours Run Meter 23
Identification 5, 23
Installation 6
Installation Safety 1
Insulation Test 13, 18
Jump Starting 45
Load Transfer Panels 41
Locating the Generating Set 7
Maintenance
  Engine 16
  Generating Set 14
Mechanical Safety 2
Meters 34
Moving the Generating Set 6
Noise Safety 2
Oil Pressure Gauge 25
P.C.B. 25, 27, 41
Panel Equipment 23
Parallel Running 13
Parking 14
Power Factor 13
Pre-Start Checks 14
Preventative Maintenance 14
Radiator Maintenance 16
Rating Label 5
Remote Annunciator Panels 35
Safety 1
  Chemical 2
  Electric Shock 3
  Electrical 2
  Fire and Explosion 1
  First Aid 3
  Handling 1
  Installation 1
  Mechanical 2
  Noise 2
  Towing 1
Shutdown
  1000 Series Panel 15, 16
  2000, 4000, 4000E Series Panels 17, 18
Sound Attenuation 13
Speed Control 34
Spreader Bar 6
Starting Aids 16
Startup
  1000 Series Panel 14, 15
  2000, 4000, 4000E Series Panels 16, 17, 18
Storage 14
Thermostart Preheat 25
TI Intelligent Load Transfer Panel 41
Towing 13
Trouble Shooting 36
Vibration Isolation .... 5, [illegible] 11, 13
Voltage Control 34
Water Temperature Gauge 23

EMCP3
TECHNICAL OPERATION
AND MAINTENANCE MANUAL

This manual has been designed as a technical guide to operating, servicing and maintaining the generating set. It should be used in conjunction with the Engine and Alternator Manuals.

An Operator's Manual is also included with these manuals to aid the operator specifically in starting, stopping and otherwise operating th[illegible]. The Operator's manual is available in any of a number of languages for non-English speaking operators.

Generating Set Serial Number

Date of Purchase:	Date of Initial Startup/Commissioning:
Name & Address of Owner or Operator:	Name & Address of Generating Set Dealer/Distributor:

EMCP3
TECHNICAL OPERATION AND MAINTENANCE MANUAL

Document: PWTM1 - GB
Issue Date: 01/05
Part Number: 272-7932

Table of Contents

1. General Information 1
1.1. Illustration 1 1
1.2. Illustration 2 1

2. Electronic Control Module 1
2.1. Illustration 5 1

3. Navigation Keys 1

4. Alarm Indicators 2

5. Digital Inputs 2
5.1. Pressures 2
5.2. Temperatures 2
5.3. Levels 2
5.4. Other 2

6. Discrete Input/Output Module 2
6.1. General Information 2
6.2. Inputs 2
6.3. Table 5 4
6.4. Table 6 4
6.5. Outputs 5
6.6. Table 7 5

7. Configurability 5
7.1. Specifications 5

8. Annunciator Module 5
8.1. General Information 5
8.2. Basic Operation 5
8.3. Configuration 5
8.4. Custom Event Annunciation 5
8.5. Suspect Parameter Number (SPN) 5
8.6. Trigger Type 5
8.7. Trigger Severity Level 6
8.8. Table 12 6

9. Failure Mode Identifier (FMI) 7
9.1. Choose the FMI from Table 13 7

10. Data Link 7
10.1. Data Links 7
10.2. Primary Data Link - J1939 (CAN 1) 7
10.3. Accessory Data Link - J1939 (CAN2) 7
10.4. System Control and Data Acquisition (SCADA) Data Link -Modbus RS-485 7
10.5. Electronic Control Module (Engine) (J1939 ECM Engines Only) 7

11. System Operation 8
11.1. Engine Starting Sequence 8

12. Engine Stopping 8
12.1. Procedure 8
12.2. Password Entry 8
12.3. Drop to Minimum Security Level 8
12.4. Enter Level 1 or 2 Password 8
12.5. Enter level 3 password 9
12.6. Change level 1 or level 2 password 9
12.7. Event Viewing 10

13. Event Resetting **10**
13.1 Setpoint Programming 10
13.2. Illustration 8 10
13.3. Main Menu 10
13.4. Digital Input Programming 10
13.5. Programming the Active State of the Digital Input 11
13.6. Programming the Event Input Functions 11
13.7. Digital Output Programming 11
13.8. Programming the Active State of the Digital Output 11
13.9. Programming the Digital Selectors 11
13.10. Available Digital Selectors 12

14. Spare Analog Input Programming (not 1.0) **12**

15. Programming the Spare Analog Input **12**
15.1 Enable/Disable 12
15.2 Suspect Parameter Number (SPN) 12

16. Relay Output Programming **13**
16.1. Programming the Active State of the Relay Output 13
16.2. Programming the Digital Selectors 13
16.3. Available Digital Selectors 13

17. Frequency Adjustment **14**

18. Real Time Clock Programming **14**
18.1 General Points 15
18.2 Further SPN/FMI Codes 15

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A pe must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.TABLE OF CONTENTS

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

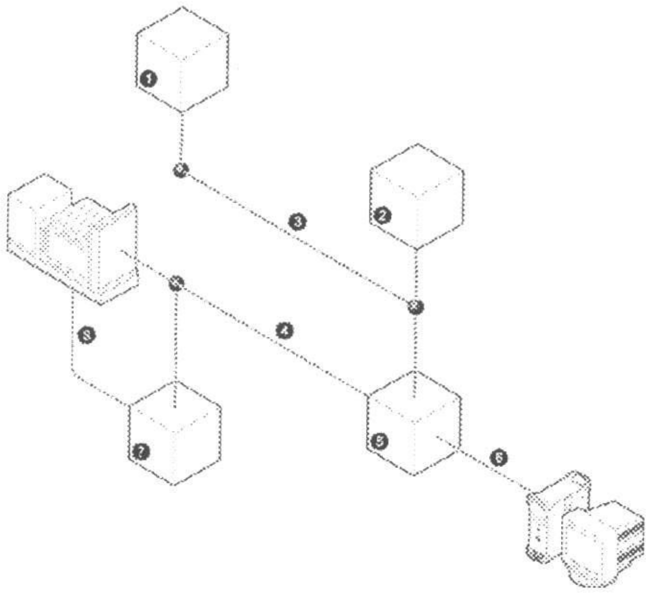
Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

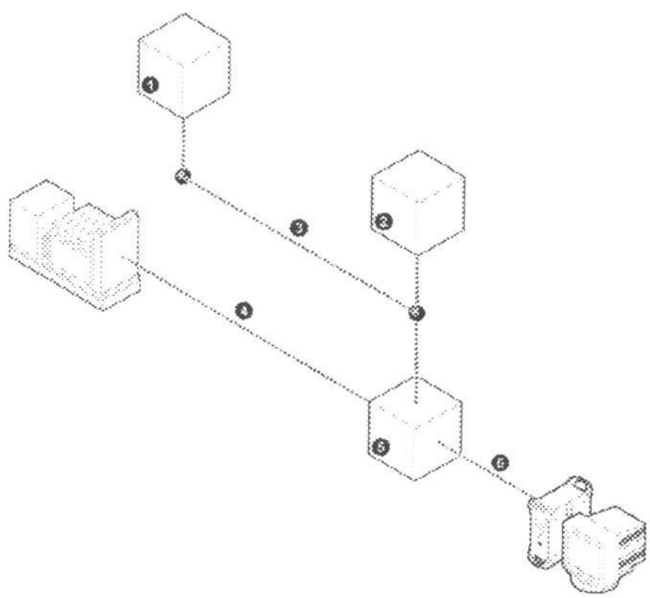
1. General Information



1.1. Illustration 1

Block diagram of a generator set with EMCP3 and Engine Electronic Control Module with J1939 Data Link

(1) Discrete Input Output I/O Module
(2) Annunicator Module
(3) J1939 Accessory Data Link (CAN 2) Not 1.0
(4) J1939 Accessory Data Link (CAN 1)
(5) EMCP3 - Electronic Control (ECM) for the generator set
(6) Modbus RS-485 SCADA Data Link Not 1.0
(7) J1939 Electronic Control Module (ECM) for the engine
(8) Sensors

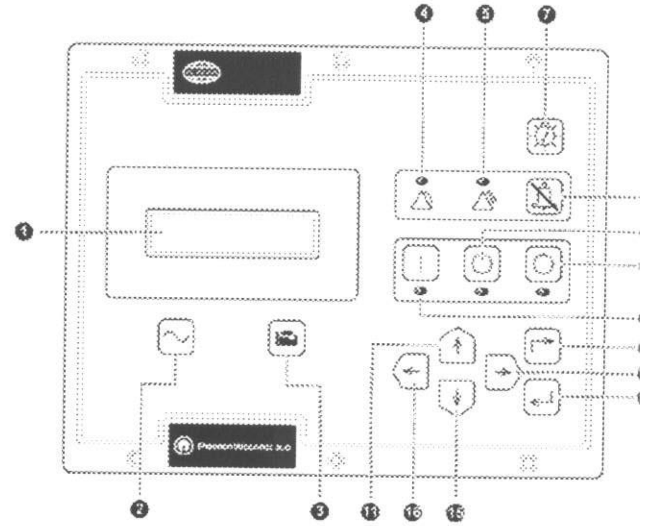


1.2. Illustration 2

Block diagram of a generator set with EMCP3 and Mechnanical or non J1939 complient ECM Engine

(1) Discrete Input Output I/O Module
(2) Annunicator Module
(3) J1939 Accessory Data Link (CAN 2) Not 1.0
(4) Sensors
(5) EMCP3 - Electronic Control (ECM) for the generator set
(6) Modbus RS-485 SCADA Data Link Not 1.0

2. Electronic Control Module (Generator Set)



2.1. Illustration 5

(1) Display Screen
(2) AC Overview Key
(3) Engine Overview Key
(4) Yellow Warning Lamp
(5) Red Shutdown Lamp
(6) Alarm Acknowledge/Silence Key
(7) Lamp Test Key
(8) Run Key
(9) Auto Key
(10) Stop Key
(11) Scroll Up Key
(12) Escape Key
(13) Scroll Right Key
(14) Enter Key
(15) Scroll Down Key
(16) Scroll Left Key

3. Navigation Keys

AC Overview – The AC Overview Key (2) will navigate the display the first screen of AC information. The AC Overview Key information contains various AC parameters that summarize the electrical operation of the generator set.

Engine Overview – The Engine Overview Key (3) will navigate the display to the first screen of engine information. The Engine Overview information contains various engine parameters that summarize the operation of the generator set.

Alarm Acknowledge/Silence – Pressing the Alarm Acknowledge/Silence Key (6) will cause the horn relay output to turn off and silence the horn. Pressing the key will also cause any yellow or red flashing lights to turn off or to become solid depending on the active status of the alarms. The Alarm Acknowledge/Silence Key may also be configured to send out a global alarm silence on the J1939 Data Link which will silence horns on annunciators.

Lamp Test – Pressing and holding the Lamp Test Key (7) will cause all of the LED's and the display screen pixels to turn on solid until the Key is released.

RUN – Pressing the "RUN" Key (8) will cause the engine to enter the "RUN" mode.

AUTO – Pressing the "AUTO" Key (9) will cause the engine to enter the "AUTO" mode.

STOP – Pressing the "STOP" Key (10) will cause the engine to enter the "STOP" mode.

Scroll Up – The Scroll Up Key (11) is used to navigate up through the various menus or monitoring screens. The Scroll Up Key is also used during setpoint entry. During numeric data entry the Scroll UpKey is used in order to increment the digits (0-9). If the setpoint requires selection from a list, the Scroll Up Key is used to navigate through the list.

Escape – The Escape Key (12) is used during menu navigation in order to navigate up through the menu/sub-menu structure. Each key press causes the user to move backwards/upwards through the navigation menus. The Escape Key is also used to cancel out of data entry screens during setpoint programming. If the Escape Key is pressed during setpoint programming, none of the changes made on screen will be saved to memory.

Scroll Right – The Scroll Right Key (13) is used during setpoint adjustment. During numeric data entry, the Scroll Right Key is used to choose which digit is being edited. The Scroll Right Key is also used during certain setpoint adjustments to select or deselect a check box. If a box has a check mark inside the box, pressing the Scroll Right Key will cause the check mark to disappear, disabling thefunction. If the box does not have a check mark inside the box, pressing the Scroll Right Key will cause a check mark to appear, Enabling the function.

Enter – The Enter Key (14) is used during menu navigation to select menu items in order to navigate forward/downward in the menu/sub-menu structure.The EnterKey is also used during setpoint programming in order to save setpoints changes. Pressing the Enter Key during setpoint programming causes setpoint changes to be saved to memory

Down – The Down Key (15) is used to navigate down through the various menus or monitoring screens. The Down Key is also used during setpoint entry. During numeric data entry the Down Key is used in order to decrement the digits (0-9). If the setpoint requires selection from a list, the Down Key is used to navigate down through the list.

Scroll Left – The Scroll Left Key (16) is used during setpoint adjustment. During numeric data entry, the Scroll Left Key is used to choose which digit is being edited. The Scroll Left Key is also used during certain setpoint adjustments to select or deselect a check box. If a box has a check mark inside the box, pressing the Scroll Left Key will cause the check mark to disappear, disabling the function. If the box does not have a check mark inside the box, pressing the Scroll Left Key will cause a check mark to appear, enabling the function.

4. **Alarm Indicators**

Yellow Warning Light – A flashing yellow light indicates that there are unacknowledged active warnings. A solid yellow light indicates that there are acknowledged warnings active. If there are any active warnings, the yellow light will change from flashing yellow to solid yellow after the alarm Alarm Acknowledge/Silence Key (6)is pressed. If there are no longer any active warnings, the yellow light will turn off after the Alarm Acknowledge/Silence Key (6) is pressed.

Shutdown Light – A flashing red light indicates that there are unacknowledged active shutdown events. A solid red light indicates that there are acknowledged shutdown events active. If there are any active shutdown events the red light will change from flashing red to solid red after the Alarm Acknowledge/Silence Key (6) is pressed. Any condition that has caused a shutdown event must be manually reset. If there are no longer any active shutdown events, the red light will turn off.

5. **Digital Inputs**

Note: There are 8 digital inputs on "EMCP3 2.0" and "EMCP3 3.0". There are 6 digital inputs on "EMCP3 1.0."

Digital Input #1 – Digital Input #1 is used for the emergency stop. This input should be wired to GROUND through an Emergency Stop switch. The input can be set to activate on an active high (normally closed contact) or an active low (normally open contact). If the operator wants to operate the genset in the Reduced Power Mode, The Emergency Stop must be configured for Active Low Refer to:Testing and Adjusting, "Electronic Control Module generator Set) Configure" Activating the emergency stop input will cause the generator set to stop immediately or prevent the generator set from starting. Once Digital Input #1 goes active, the engine will not start until the event is reset. Refer to: System Operation , "Event Resetting

Digital Input #2 – Digital Input #2 is used for remotely starting and stopping the generator set. This input should be wired to GROUND through a Remote Initiate switch.The input can be setto activate on an active high (normally closed contact) or an active low (normally open contact). If the input is active and the engine mode switch is in AUTO, the engine will attempt to startand run.Once theinput becomes inactive the engine will enter into cooldown (if programmed) and then stop.

The remainder of the inputs can be configured. The main purpose for the other "DIGITAL INPUTS" is to add additional monitoring capabilities of the parameters for the engine or generator. The inputs can be configured by going to the "EVENT I/P FUNCTIONS" parameter under the "SETPOINTS" menu. The "DIGITAL INPUTS" parameter can only be set to "ACTIVE HIGH" or "ACTIVE LOW" in order to initiate a High Warning, Low Warning, High Shutdown, Low Shutdown, or Status.

The inputs can be programmed to monitor the following parameters or components. Refer to:System Operation Troubleshooting Testing and Adjusting, "Digital Input Programming"

5.1. **Pressures**

- Air Filter Differential Pressure
- Engine Oil Pressure
- Fire Extinguisher Pressure
- Fuel Filter Differential Pressure
- Oil Filter Differential Pressure
- Starting Air Pressure

5.2. **Temperatures**

- Ambient Air Temperature
- Engine Coolant Temperature
- Engine Oil Temperature
- Exhaust Temperature
- Rear Bearing Temperature
- Right Exhaust Temperature
- Left Exhaust Temperature

5.3. **Levels**

- Engine Coolant Level
- Engine Oil Level
- Fuel Level
- External Tank Fuel Level

5.4. **Other**

- Air Damper Closed
- ATS in Normal Position
- ATS in Emergency Position
- Battery Charger Failure
- Generator Breaker Closed
- Utility Breaker Closed
- Fuel Leak Detected
- Custom Event

6. **Discrete Input/Output Module**

6.1. **General Information**

The Discrete Input/Output (I/O) Module is a module capable of reading twelve discrete inputs. The Discrete I/O Module is capable of operating eight relay outputs. The Discrete I/O Module can be mounted on the genset package or can be remote mounted away from the genset package.

6.3. Table 5

Configuration Parameters for Each Input		
Setpoint Parameter	Range	Default
Input #nn Active State Configuration	Active Low Active High	Active State Low
Input #nn Time Delay	0 to 120 sec.	0 sec.
put #nn Suspect parameter Number (SPN)	Any SPN Supported by EMCP3	N/A
Input #nn Failure Mode Identifier (FMI)	Any FMI supported by EMCP3	N/A

6.4. Table 6

Configuration Examples			
SPN	SPN Description	Input	Output
38	Fuel Level-SecondaryTank	X	X
82	Starting Air Pressure		X
94	Fuel Press		X
95	Fuel Filter differential Pressure		X
96	Fuel Level (Primary Tank)	X	X
98	Engine Oil Level		X
99	Oil Filter Differential Pressure		X
100	Engine Oil Pressure		X
101	Crankcase Pressure		X
107	Air Filter Differential Pressure		X
110	Engine Coolant Temperature		X
111	Engine Coolant Level	X	X
137	Extinguisher System Press	X	X
168	Battery Voltage		X
171	Ambient Air Temperature		X
172	Inlet Air Temperature		X
173	Exhaust Temperature		X
174	Fuel Temp		X
175	Engine Oil Temperature		X
190	Engine Overspeed		X
628	Voltage Regulator Failure		X
970	Emergency Stop Shutdown		X
1122	Generator Bearing Temperature #1		X
1124	Generator Winding Temperature #1		X
1125	Generator Winding Temperature #2		X
1126	Generator Winding Temperature #3		X
1237	Emergency Shutdown Override Mode Active Warning	X	X
12[illegible]	Ruptured Fuel Basin-Primary Tank	X	X
1383	Unexpected Engine Shutdown		X
1664	Engine Failure to Start Shutdown		X
2436	Generator Frequency		X
2440	Generator Voltage		X
2448	Generator ACCurrent		X
2452	Generator Reverse Power(kW)		X
2456	Generator Reactive Power(VAR)		X
2648	Service Interval Warning		X
4000	Air Shutoff Damper Close	X	X
4001	ATS in Normal Position	X	X
4002	Gen Supplying Load	X	X
4003	Battery Charger Failure	X	X
4004	Gen Breaker Closed	X	X
4005	Utility Breaker Closed	X	X
4006	Engine in Cooldown		X
4007	Generator Control Not in Auto		X
User Defined Input #1	Range701-716	X	
User Defined Input #2	Range701-716	X	
User Defined Input #3	Range701-716	X	
User Defined Input #4	Range701-716	X	

Configuration Examples			
SPN	SPN Description	Input	Output
User Defined Input #5	Range701-716	X	
User Defined Input #6	Range701-716	X	
User Defined Input #7	Range701-716	X	
User Defined Input #8	Range701-716	X	
User Defined Input #9	Range701-716	X	
User Defined Input #10	Range701-716	X	
User Defined Input #11	Range701-716	X	
User Defined Input #12	Range701-716	X	

8.7. Trigger Severity Level

The Trigger Severity Level defines how the LED pair will behave when a message associated with the programmed SPN is received (or not received).

8.8. Table 12

Supported SPNs	
SPN Description	SPN
Fuel Level (External Tank)	38
Aftercooler Temperature	52
Starting Air Pressure	82
Fuel Filter Differential Pressure	95
Fuel Level (Local Tank)	96
Engine Oil Level	98
Oil Filter Differential Pressure	99
Engine Oil Pressure	100
Crankcase Pressure	101
Air Filter Differential Pressure	107
Altitude	108
Engine Coolant Temperature	110
Engine Coolant Level	111
Fire Extinguisher Pressure	137
Battery Voltage (switched)	158
Battery Voltage	168
Ambient Air Temperature	171
Inlet Air Temperature	172
Exhaust Temperature	173
Engine Oil Temperature	175
Engine Speed	190
SCADA Data Link Fault	625
Primary Data Link (J1939 #1)	639
Event Input Function #1	701
Event Input Function #2	702
Event Input Function #3	703
Event Input Function #4	704
Event Input Function #5	705
Event Input Function #6	706
Event Input Function #7	707
Event Input Function #8	708
Event Input Function #9	709
Event Input Function #10	710
Event Input Function #11	711
Event Input Function #12	712
Event Input Function #13	713
Event Input Function #14	714
Event Input Function #15	715
Event Input Function #16	716
Emergency Stop Shutdown	970
Generator Bearing Temperature #1	1122
Generator Bearing Temperature #2	1123
Generator Winding Temperature #1	1124

Supported SPNs	
SPN Description	SPN
Generator Winding Temperature #2	1125
Generator Winding Temperature #3	1126
Exhaust Gas Port 1 Temperature	1137
Exhaust Gas Port 2 Temperature	1138
Exhaust Gas Port 3 Temperature	1139
Exhaust Gas Port 4 Temperature	1140
Exhaust Gas Port 5 Temperature	1141
Exhaust Gas Port 6 Temperature	1142
Exhaust Gas Port 7 Temperature	1143
Exhaust Gas Port 8 Temperature	1144
Exhaust Gas Port 9 Temperature	1145
Exhaust Gas Port 10 Temperature	1146
Exhaust Gas Port 11 Temperature	1147
Exhaust Gas Port 12 Temperature	1148
Exhaust Gas Port 13 Temperature	1149
Exhaust Gas Port 14 Temperature	1150
Exhaust Gas Port 15 Temperature	1151
Exhaust Gas Port 16 Temperature	1152
Exhaust Gas Port 17 Temperature	1153
Exhaust Gas Port 18 Temperature	1154
Exhaust Gas Port 19 Temperature	1155
Exhaust Gas Port 20 Temperature	1156
Accessory Data Link Fault (J1939 #2)	1231
Emergency Shutdown Override Mode Active Warning	1237
Ruptured Fuel Basin - Primary Tank	1239
Unexpected Engine Shutdown	1383
Engine Failure to Start Shutdown	1664
Right Exhaust Temperature	2433
Left Exhaust Temperature	2434
Generator Frequency	2436
Generator AC Voltage	2440
Generator AC Current	2448
Generator Reverse Power (kW)	2452
Generator Reverse Power (kVAr)	2456
Service Interval Warning	2648
Air Damper Closed	4000
ATS in Normal Position	4001
ATS in Emergency Position	4002
Battery Charger Failure	4003
Generator Control Not in Automatic Warning	4007
Generator Breaker Failure to Open	4009
Utility Breaker Failure to Open	4010
Generator Breaker Failure to Close	4011
Utility to Generator Transfer Failure Warning	4015
Utility to Generator Transfer Failure Shutdown	4015
Utility Breaker Failure to Close	4015
Generator to Utility Transfer Failure Warning	4016
Loss of Utility	4017

- Intake Manafold Temperature
- Oil Temperature
- Fuel Pressure
- Boost Pressure
- Oil Filter Differential Pressure
- Fuel Filter Differential Pressur
- Air Filter Differential Pressure
- Fuel Consumption

Note: 1.0 and 2.0 can only receive Engine Oil Pressure and Engine Coolant temperature. 3.0 can receive everything.

The EMCP3 also displays diagnostic codes from the ECMasa convenience to the operator. See Troubleshooting, "Diagnostic code Trouble Code List" for more information on the management of diagnostic codes by the EMCP3 and ECM.

11. System Operation

11.1Engine Starting Sequence

1. The EMCP3 receives an engine start signal. The signal will be one of three.
   - The operator presses the "RUN" Key.
   - The control is in "AUTO" and the remote initiate input (IC) becomes active.
   - The operator presses the "AUTO" Key and a start command is sent via the RS-485 SCADA DataLink.
2. The EMCP3 checks the system before eginning the cranking sequence. The EMCP3 checks that no system faults are present. The EMCP3 checks that all previous shutdown faults have been reset. The EMCP3 also checks that the engine is not already running.
3. The EMCP3 begins the crank sequence.

   a. On non J1939 ECM engines, theEMCP3 activates the starting motor relay (SMR) and the fuel control relay (FCR).

   b. On J1939 ECM engines, the EMCP3 activates the starting motor relay (SMR) and sends a start signal to the Engine ECM via the "Fuel Injection enable pin". The Engine ECM activates the fuel control relay (FCR).
4. The EMCP3 cycle cranks the engine until the cycle crank time reaches the setpoint for total crank time or until the engine starts.
5. The EMCP3 deactivates the starting motor relay (SMR) a when the engine speed reaches the setpoint for crank terminate speed.

12. Engine Stopping

12.1.Procedure

1. The EMCP3 will receive an engine stop signal. The signal will be one of three.
   - The operator presses the "STOP" Key.
   - The control is in "AUTO"andthe remote initiate input (IC) becomes inactive.
   - The operator presses the "AUTO" Key and a stop command is sent via the RS-485 SCADA Data Link.
2. After receiving the stop signal, the EMCP3 checks that there are no present system faults.
3. The EMCP3 begins the cooldown period. In order to bypassthe cooldown hold down the "STOP" Key. "PRESS ENTER TO BYPASS", "PRESS ESCAPE TO CONTINUE" will be shown on the display. Press the Enter Key to bypass the cooldown sequence or press the Escape Key to continue the cooldown sequence.
4. After the cooldown cycle, the EMCP3 initiates a engine shutdown by turning off the fuel supply.

   a. On the non J1939 ECM engines, the EMCP3 deactivates the fuel control relay (FCR) which shuts the engine down.

   b. On J1939 ECM engines, the EMCP3 sends a shutdown signal to the Engine ECM. The Engine ECM deactivates the Fuel Control Relay (FCR) which shuts down the engine.

12.2.Password Entry

There are 3 levels of password protection on the EMCP3 control panel. All of the adjustable parameters are associated with a specific level of security required to make an adjustment to the parameter.

The passwords only affect changing parameters from the EMCP3 control panel. Changing parameters with the Caterpillar Service Tool does not require passwords

The level of password protection that is required for each setpoint is identified on the parameter setpoint entry screen. A security level identification number "1", "2", or "3" next to a padlock symbol is displayed on the parameter setpoint entry screen. A Level 3 security is used for the most secure setpoints and Level 1 security is used for the least secure setpoints.

If the EMCP3 is currently at the required level of protection when viewing a parameter, the padlock will not appear.

If a parameter is displayed with a padlock but no security level identification number next to it, the parameter cannot be changed from the EMCP3 display.

Level 1 and Level 2 passwords are disabled when shipped from the factory. On initial start up of the EMCP3, Level 1 and Level 2 passwords can be user defined if desired.

12.3.Drop to Minimum Security Level

The first option on the security screen is "DROP TO MIN LEVEL". "DROP TO MIN LEVEL" refers to a process of placing the "EMCP3" into the lowest level of security authorized. This would be used when leaving the control. If "DROP TO MIN LEVEL" is not initiated manually, the control will automatically revert to minimum level after 10 minutes.

1. From the "MAIN MENU", press the "UP" key or the " DOWN" key to highlight the "CONFIGURE" menu.

a. Press the "ENTER" key in order to select "CONFIGURE". "SECURITY" will be highlighted.

b.Press the "ENTER" key in order to select "SECURITY". "DROP TO MIN LEVEL" will be displayed.

c. Press the "ENTER" key to select "DROP TO MIN LEVEL"

d.The "EMCP3" will now be at the minimum level of security

Note: The current level of security for the EMCP3 is displayed at the top of the display any time the EMCP3 is in the "SECURITY" screen.

12.4.Enter Level 1 or 2 Password

1. From the "MAIN MENU", press the "UP" key or the "DOWN" key to highlight the "CONFIGURE" menu.

a. Press the "ENTER" key in order to select "CONFIGURE". "SECURITY" will be highlighted.

b. Press the "ENTER" key in order to select "SECURITY". "DROP TO MIN LEVEL" will behighlighted.

c. Press the "DOWN" key in order to highlight "ENTERLEVEL 1 OR2"

d. Press the "ENTER" key in order to select "ENTERLEVEL 1 or 2". "ENTER PASSWORD FOR DESIRED LEVEL" is displayed. Also shown is a 16 digit display with 0 highlighted at the far right.

e. Press the "UP" or "DOWN" key in order to increment or decrement the highlighted digit to the desired number.

f. Press the "RIGHT" key in order to highlight the next character to be entered. Press the "UP" or "DOWN" key in

12.7.Event Viewing

Information from the EMCP3 is displayed on the display screen (1). The arrow keys on the keypad are used in order to navigate through the main menu.

Press the UP key (11) or the DOWN key (15) in order to highlight the main menu options. Press the "Enter" key (14) in order to select one of the main menu options. The arrow keys are used in order to view one of the setpoints.

The EMCP3 panel will power up to the main menu screen. If the EMCP3 panel is already powered up, press the "Escape" key (12) in order to return to the main menu.

The event system uses the following terms to describe the status of an Event:

PRESENT – The condition causing the event is present and affecting system behavior.

ACTIVE – The event was previously present but it is no longer. It has been latched by the event system and needs to be reset before the engine can be restarted.

INACTIVE – The eventwas activeat some time but is no longer active and is not affecting system behavior

Perform the following steps in order to view one of the events.

1. From the main menu, highlight "Event Log".

2. Press the "ENTER" key (14).

3. Select an ECM and press the "ENTER" key (14).

4. In order to scroll through the Events, use the "UP" and "DOWN" keys.

5. Press "ENTER" after highlighting an event to see additional information such as SPN, FMI, time and date of first occurrence, time and date of last occurrence, engine hours at first occurrence, and engine hours at last occurrence.

1_. _vent Resetting

A flashing red shutdown light indicates there is an unacknowledged shutdown event. The red shutdown light will change from flashing red to solid red when the Alarm Acknowledged key is pressed. Use the following procedure in order to reset the event.

1. Press the STOP Key (10). Enter the "EVENT LOG" option from the main menu.

2. Select an ECM from the list.

3. Scroll through the event conditions in order to high light the active events.

4. Make sure the condition that caused the event is no longer present

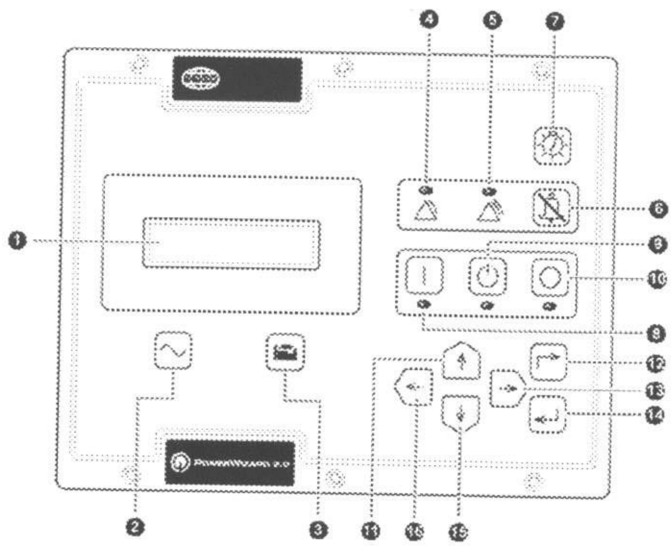
5. Press the Enter Key.

6. "RESET" will be highlighted if the condition is no longer present and the control is in "STOP".

7. Press the Enter Key again. The fault will clear and the red shutdown light will be turned off if there are no other active shutdowns.

Press the Escape Key 3 times in order to get back to the main menu

13.1 Setpoint Programming



13.2.Illustration 8

1 - Display Screen
2 - AC Overview Key
3 - Engine Overview Key
4 - Yellow Warning Lamp
5 - Red Shutdown Lamp
6 - Alarm Acknowledge/Silence Key
7 - Lamp Test Key
8 - Run Key
9 - Auto Key
10 - Stop Key
11 - Scroll Up Key
12 - Escape Key
13 - Scroll Right Key
14 - Enter Key
15 - Scroll Down Key
16 - Scroll Left Key

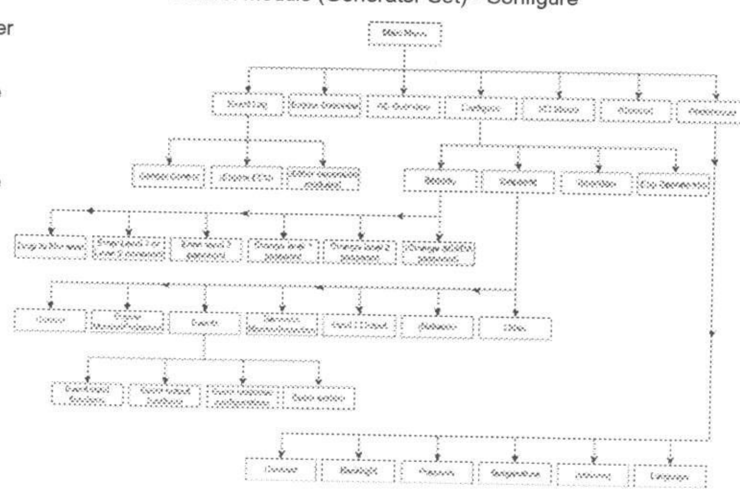
13.3.Main Menu

Information from the EMCP3 is displayed on the Display Screen (1). The arrow keys on the keypad are used in order to navigate through the main menu. Press the Scroll Up Key (11) or the Scroll Down Key (15) in order to highlight one of the main menu options.

Press the Enter Key (14) in order to select one of the main menu options. The arrow keys are used in order view or to select one of the setpoints listed on the main menu.

The engine/generator setpoints affect the proper operation and serviceability of the engine, and the accuracy of information shown on the display screen. The setpoints are programmed in the EMCP3 at the factory.

The setpoints may require changing when the EMCP3 is moved from one engine to another engine. The setpoints may also require changing in order to satisfy the requirements of the installation. The setpoints that are stored in the EMCP3 must match the specified setpoints of the particular generator set. The setpoints are programmable. See the Testing and Adjusting, "Electronic Control Module (Generator Set) - Configure"



13.4.Digital Input Programming

- Main Menu
- >Configure
- >Other
- >Digital Selectors

2. Select the Digital Selector that you want to program. Press the Enter Key

3. Press the Enter Key again. The current configuration will be highlighted.

4. Use the Scroll Up Key and the Scroll Down Key in order to change the current configuration to the desired setting

5. Press the Enter Key to save the setting.

13.10. Available Digital Selectors

13.10.1 Digital Selector # 7 Digital Selector #7 controls Digital Output #1. The available configuration options for Digital Selector #7 are shown in table 14.

Table 14

Digital Selector # 7 Configuration Options

Display Text	Condition
Disabled	Disabled
Use Input #1 (1)	Disable Shore Power (1)
Use Input #2	Start Aid
Use Input #3	Breaker #1
Use Input #4	Breaker #2
Use Input #5	Low Oil Pressure Warning
Use Data Link Input	Use SCADA Data Link Command

(1) Default

13.10.2 Digital Selector # 8 Digital Selector #8 controls Digital Output #2 The available configuration options for Digital Selector #8 are shown in table 15.

Table 15

Digital Selector # 7 Configuration Options

Display Text	Condition
Disabled (1)	Disabled (1)
Use Input #1	Breaker #1
Use Input #2	Breaker #2
Use Input #3	Common Alarm
Use Input #4	Auto Mode
Use Input #5	High Coolant Temperature Warning
Use Data Link Input	Use SCADA Data Link Command

(1) Default

14. Spare Analog Input Programming (not 1.0)

The Spare Analog Input is intended to be connected to a resistive sender such as the Coolant Temperature Sensor or the Oil Pressure Sensor.

15. Programming the Spare Analog Input

To program the Spare Analog Input, go through the following menu options:

- Main Menu
- >Configure
- >Setpoints
- >I/O
- >Spare Analog Input

The Spare Analog Input setpoints are shown below.

15.1 Enable/Disable

If you intend to use the Spare Analog Input, the Enable/Disable setpoint must first be enabled. If you do not intend to use the Spare Analog Input, the Enable/Disable setpoint MUST be disabled. If the Spare Analog Input is enabled and not being used, diagnostic codes will be logged

15.2 Suspect Parameter Number (SPN)

The following SPN's are available:

Pressures

- Air Filter Differential Pressure
- Fire Extinguisher Pressure
- Fuel Filter Differential Pressure
- Oil Filter Differential Pressure
- Starting Air Pressure

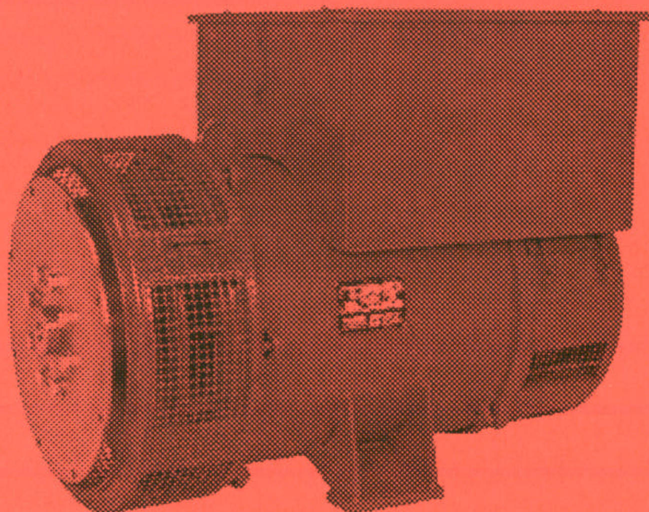
Temperatures

- Ambient Air Temperature
- Engine Oil Temperature
- Exhaust Temperature
- Right Exhaust Temperature
- Left Exhaust Temperature
- Rear Bearing Temperature

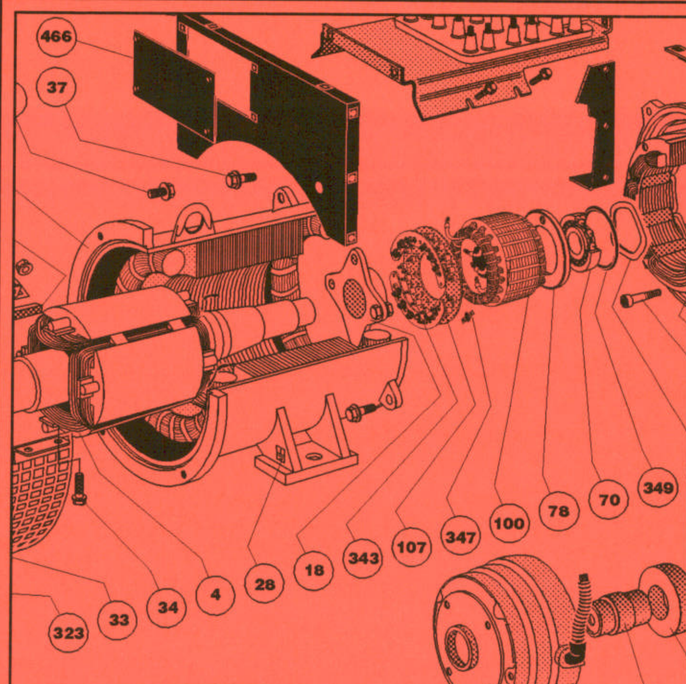
Levels

ALTERNATORS

Réf. 3458 GB - 4.33/b - 02.02



PART NUMBER 277-810



5000 - 6000
ALTERNATORS

Réf. 3458 GB - 4.33/b - 02.02

5000 - 6000
ALTERNATORS

This manual concerns the alternator which you have just purchased.

The latest addition to a whole new generation of alternators, this range benefits from the experience of the world's leading manufacturer, using advanced technology and incorporating strict quality control.

We wish to draw your attention to the contents of this maintenance manual. By following certain important points during installation, use and servicing of your alternator, you can look forward to many years of trouble-free operation.

1 - RECEIPT

1.1 - Standards and safety measures 3

1.2 - Checks 3

1.3 - Identification 3

1.4 - Storage 3

2 - TECHNICAL CHARACTERISTICS

2.1 - Electrical characteristics 4

2.2 - Mechanical characteristics 4

2.3 - Excitation system 5

3 - INSTALLATION - COMMISSIONING

3.1 - Assembly 7

3.2 - Inspection prior to first use 7

3.3 - Terminal connection diagrams 8

3.4 - Commissioning 10

3.5 - Settings 11

4 - SERVICING - MAINTENANCE

4.1 - Safety measures 13

4.2 - Regular maintenance 13

4.3 - Fault detection 14

4.4 - Mechanical defects 14

4.5 - Electrical faults 15

4.6 - Dismantling, reassembly 17

4.7 - Installation and maintenance of the PMG 19

4.8 - Table of characteristics 20

5 - SPARE PARTS

5.1 - First maintenance parts 21

5.2 - Technical support service 21

5.3 - Accessories 21

5.4 - Exploded views, parts list 22

ˎ RECEIPT

1.1 - Standards and safety measures

Our alternators comply with most international standards and are compatible with :
- the recommendations of the **International Electrotechnical Commission** IEC 34-1, (EN 60034).
- the recommendations of the **International Standards Organisation ISO 8528.**
- the European Community directive 89/336/EEC on Electromagnetic Compatibility (EMC).
- **the European Community directives 73/23/EEC and 93/68/EEC (Low Voltage Directive).**

They are CE marked with regard to the LVD (Low Voltage Directive) in their role as a machine component. A declaration of incorporation can be supplied on request.
Before using your generator for the first time, read carefully the contents of this installation and maintenance manual, supplied with the machine. All operations performed on the generator should be undertaken by qualified personnel with specialist training in the commissioning, servicing and maintenance of electrical and mechanical machinery. This maintenance manual should be retained for the whole of the m hine's life and be handed over with the contractual file.
. arious operations described in this manual are accompanied by recommendations or symbols to alert the user to potential risks of accidents. It is vital that you understand and take notice of the different warning symbols.

(WARNING)

Safety symbol for an operation capable of damaging or destroying the machine or surrounding equipment.

Safety symbol for general danger to personnel.

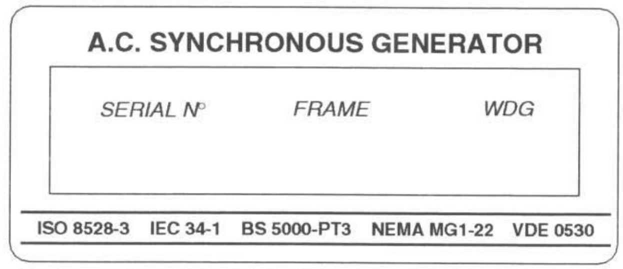
Safety symbol for electrical danger to personnel.

1.2 - Checks

On receipt of your alternator, check that it has not suffered any damage in transit.
If there are obvious signs of knocks, contact the transporter (you may be able to claim on their insurance) and after a vi al check, turn the machine by hand (if twin bearing) to t any malfunction.

1.3 - Identification

The alternator is identified by means of a nameplate fixed on the frame.
Make sure that the nameplate on the machine conforms to your order.
The machine name is defined according to various criteria (see below).



1.4 - Storage

Whilst awaiting installation, the machines should be stored away from humidity: in conditions of relative humidity of more than 90%, the machine insulation can drop very rapidly to just above zero at around 100% ; monitor the state of the anti-rust protection on unpainted parts.
For storage over an extended period, the machine can be placed in a sealed enclosure (heatshrunk plastic, for example) with dehydrating sachets inside, away from significant and frequent variations in temperature to avoid any condensation during storage.

2 - TECHNICAL CHARACTERISTICS

2.1 - Electrical characteristics

The 5000/6000 series alternators are machines without sliprings or revolving field brushes, wound as « 2/3 pitch»; 12 wires, with class H insulation and a field excitation system available in either "SHUNT", "AREP" or "PMG" version (see section 2.3). Interference suppression conforms to standard EN 55011, group 1, class B.

2.1.1 - Options

- Stator temperature detection probes
- Space heaters

2.2 - Mechanical characteristics

- Steel frame
- Cast iron end shields
- Ball bearings greased for life
- Mounting arrangement

MD 35 : single bearing with standard feet and SAE flanges/ coupling discs.

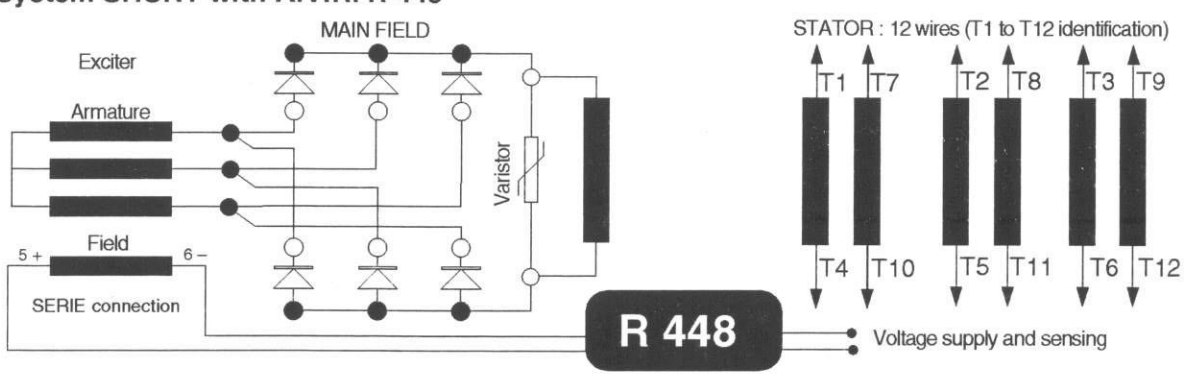
B 34 : two-bearing with SAE flange and standard cylindrical shaft extension.

- Drip-proof machine, self-cooled
- Degree of protection : IP 21

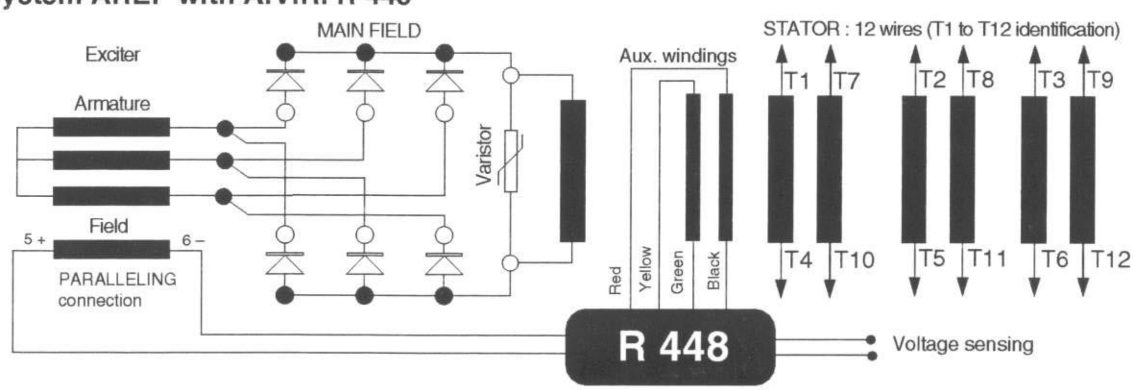
2.2.1 - Options

- IP 23,
- Air inlet filter,
- Greasable ball bearings,
- IP 44,
- Bearing probes,
- PT 100 stators.

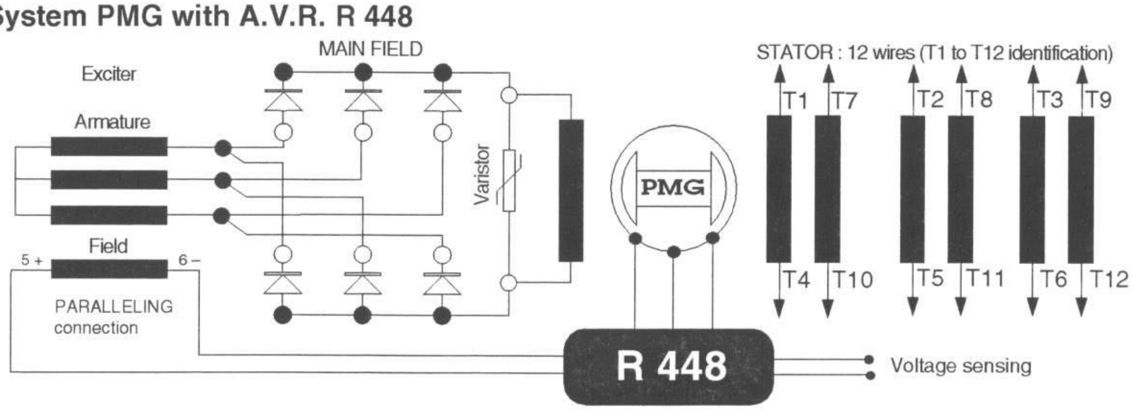
2.1.2 - System SHUNT with A.V.R. R 448



2.1.3 - System AREP with A.V.R. R 448



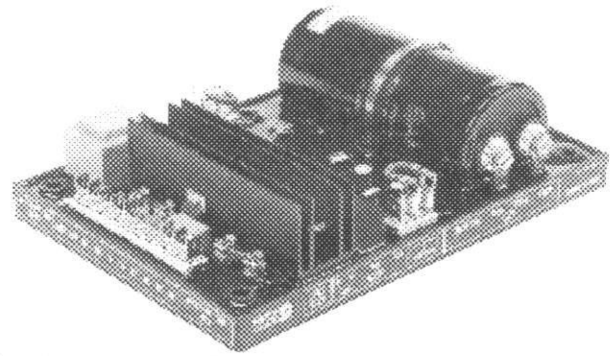
2.1.4 - System PMG with A.V.R. R 448



5000 - 6000
ALTERNATORS
TECHNICAL CHARACTERISTICS

2 - Excitation system

For both the SHUNT, AREP & PMG excitation systems, the alternator voltage regulator is the R 448.



The alternator with **SHUNT** field excitation is self-excited with a voltage regulator. The regulator monitors the exciter excitation current as a function of the alternator output voltage. Very simple in design, the alternator with Shunt excitation has no sustaining short-circuit capability.
With **AREP** excitation, the electronic AVR is powered by two auxiliary windings which are independent of the voltage detection circuit. The first winding (X1, X2) has a voltage proportional to that of the alternator (Shunt characteristic), the second (Z1, Z2) has a voltage in proportion with the stator current (compound characteristic : Booster effect). The power supply voltage is rectified and filtered before being used by the AVR monitoring transistor. As a result the machine has a short-circuit current capacity of 3 IN for 10 s, and good immunity to distortions generated by the load.
With **PMG** excitation, a permanent magnet generator (PMG) is added to the alternator. This is fitted at the rear of the machine and connected to the AVR. The PMG supplies the AVR with voltage which is independent of the main alternator winding. As a result the machine has a short-circuit current capacity of 3 IN for 10 s, and good immunity to distortions generated by the load.

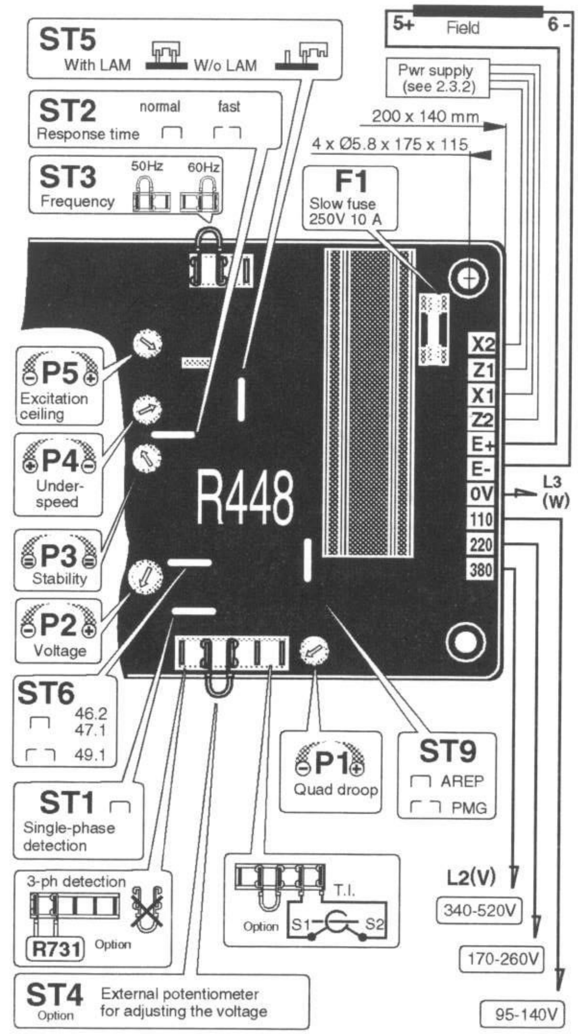
The AVR monitors and corrects the alternator output voltage by adjusting the excitation current.

2.3.1 - R448 AVR characteristics

- shunt power supply : max 140V - 50/60 Hz
- rated overload current : 10A - 10s
- electronic protection (overload, voltage detection opening short-circuit): excitation overload current for 10 s then return to approximately 1A

The alternator must be stopped (or the power switched off, see section 3.5.3.) in order to reset the protection.
- Fuse : F1 on X1,X2.
- voltage detection : 5 VA isolated via transformer

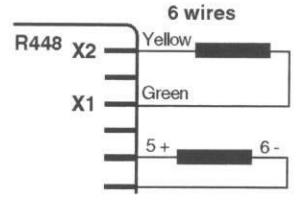
0-110 V terminals = 95 to 140 V
0-220 V terminals = 170 to 260 V
0-380 V terminals = 340 to 520 V
- voltage regulation ±0.5%
- normal or rapid response time via strap **ST2**
- voltage adjustment via potentiometer **P2**
  other voltages via adapter transformer
- current detection : (parallel operation) :
C.T. 2.5 VA cl1, secondary 1A (Option)
- quadrature droop adjustment via potentiometer **P1**
- underspeed protection (U/f) and LAM : frequency threshold adjustable via potentiometer **P4**
- max. excitation current adjustment via **P5** : 4 to 10A
- 50/60 Hz selection via strap **ST3**.



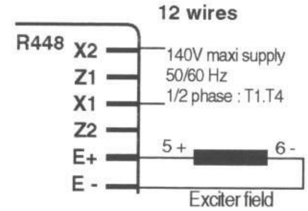
2.3.2 - R 448 power supply connection

SHUNT excitation

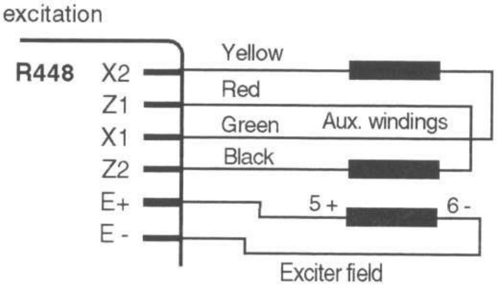
6 wires



12 wires

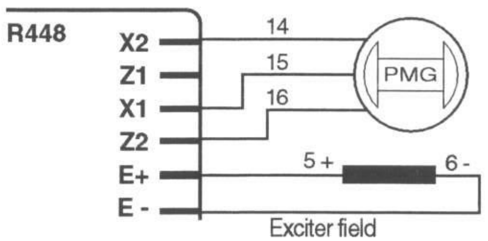


AREP excitation

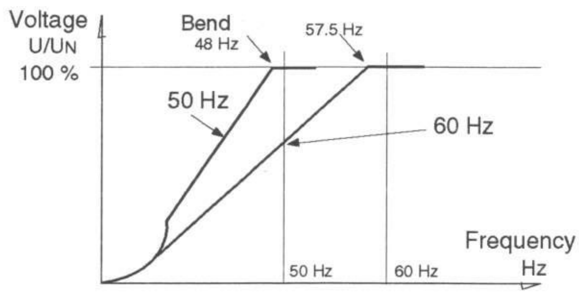


5000 - 6000
ALTERNATORS
TECHNICAL CHARACTERISTICS

PMG excitation



2.3.3 - Frequency compared with voltage (without LAM)



2.3.4 - LAM characteristics

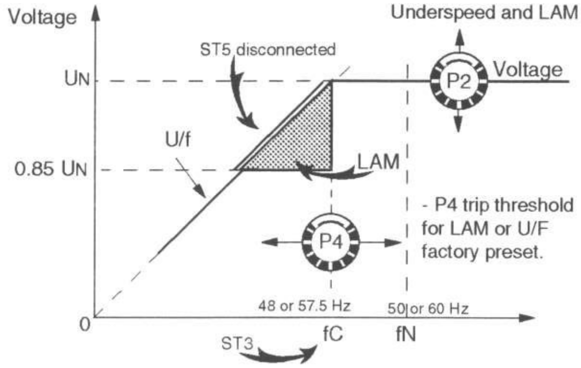
The LAM system is integrated in the regulator, as standard it is active (ST5 with bridge). It can be deactivated by removing the ST5 bridge.

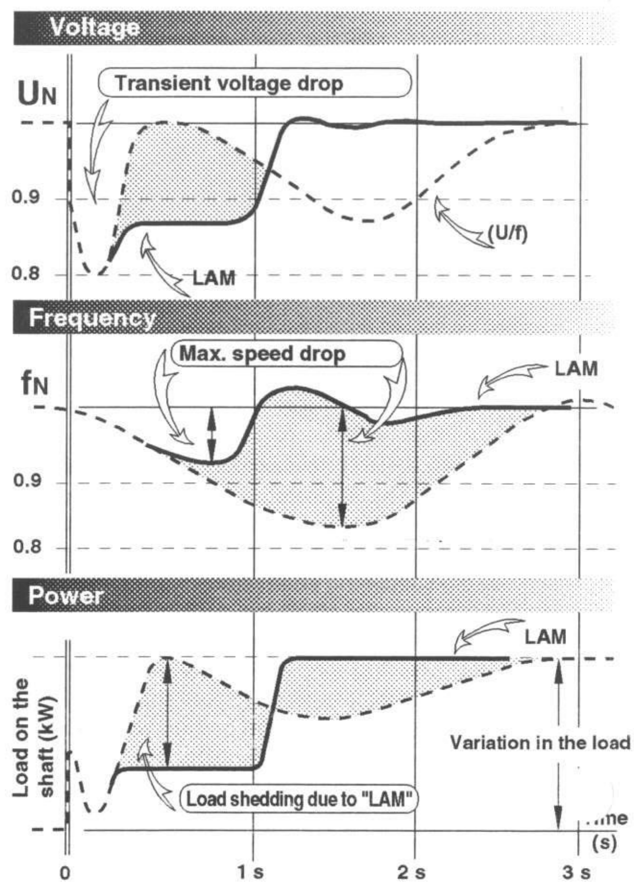
- Role of the "LAM" (Load Adjustment Module) :

On application of a load, the rotation speed of the generator set decreases. When it passes below the preset frequency threshold, the LAM causes the voltage to drop by approximately 15% and consequently the amount of active load applied is reduced by approximately 25%, until the speed reaches its rated value again.

Hence the LAM can be used either to reduce the speed variation (frequency) and its duration for a given applied load, or to increase the applied load possible for one speed variation (turbo-charged engine).

To avoid voltage oscillations, the trip threshold for the LAM function should be set approximately 2 Hz below the lowest frequency in steady state.





Typical effects of the "LAM" with a diesel engine -
—— with LAM - - - without LAM (U/F only)

2.3.5 - R 448 AVR options

- Current transformer for parallel operation of....../1 A -2.5 VA CL 1.

- Remote voltage adjustment potentiometer : 470 Ω, 3 W min. : adjustment range ± 5% (range limited by internal voltage potentiometer P2). Remove ST4 to connect the potentiometer. (A 1 kΩ potentiometer can also be used to extend the adjustment range by ± 10%)

- R 731 module : detection of 3-phase voltage 200 to 500V, compatible with parallel operation. Cut ST1 to connect the module; set the voltage via the module potentiometer.

- R 726 module : regulation system changed to "4-function" (See the maintenance manual and connection diagram).
- PF regulation (2F)
- equalization of voltages before paralleling (3 F).
- possibility of coupling alternators, already running in parallel, to the mains (4F).

R 726 module connected in place of ST4.

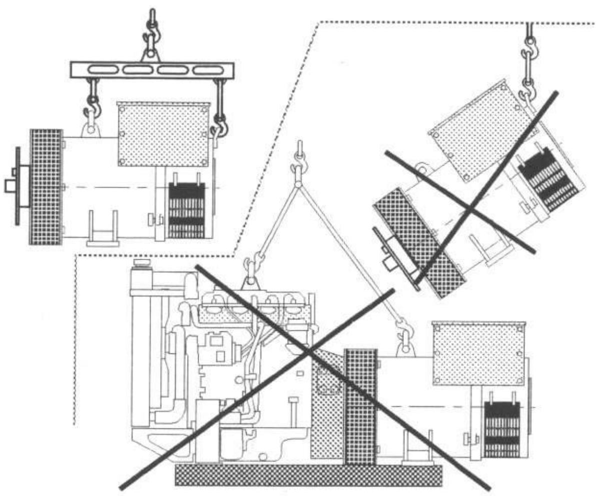
3 - INSTALLATION

3.1 - Assembly

All mechanical handling operations must be undertaken using approved equipment.
Whilst being handled, the machine should remain horizontal.

3.1.1 - Handling

The generously-sized lifting rings are for handling the alternator alone. They must not be used to lift the genset. Use a lifting system which respects the positioning of the rings.



3.1.2 - Coupling

3.1.2.1 - single bearing alternator

Before coupling the two machines, check that both are compatible by :
- undertaking a torsional analysis of the transmission
- checking the dimensions of the flywheel and its housing, the flange, coupling discs and the offset of the alternator

WARNING

When coupling the alternator to the prime mover, the holes of the coupling discs should be aligned with the flywheel holes by rotating the primary pulley on the thermal engine.
Do not use the alternator fan to turn the rotor.

Tighten the coupling disc screws to the recommended torque (see section 4.6.2.) and check that there is lateral play on the crankshaft.

3.1.2.2 - two-bearing alternator

- Semi-flexible coupling
Careful alignment of the machines is recommended, checking that the concentricity and parallelism of both parts of the coupling does not exceed 0.1 mm.

WARNING

This alternator has been balanced with a 1/2 key.

3.1.3 - Location

Ensure that the ambient temperature in the room where the alternator is placed cannot exceed 40°C for standard power ratings (for temperatures > 40°C, apply a derating coefficient). Fresh air, free from damp and dust, must be able to circulate freely around the air intake grilles on the opposite side from the coupling. It is essential to prevent not only the recycling of hot air from the machine or engine, but also exhaust fumes.

3.2 - Inspection prior to first use

3.2.1 - Electrical checks

Under no circumstances should an alternator, new or otherwise, be operated if the isolation is less than 1 megohm for the stator and 100,000 ohms for the other windings.

There are three possible methods for restoring these minimum values.
a) Dry out the machine for 24 hours in a drying oven at a temperature of 110 °C (without the AVR)
b) Blow hot air into the air intake, having made sure that the machine is rotating with the exciter field disconnected.
c) Run in short-circuit mode (disconnect the AVR) :
- Short-circuit the three output power terminals using connections capable of supporting the rated current (try not to exceed 6 A/mm2)
- Insert a clamp ammeter to monitor the current passing through the short-circuit connections.
- Connect a 24 Volt battery in series with a rheostat of approximately 10 ohms (50 W) to the exciter field terminals, respecting the polarity.
- Open fully all the alternator openings.
- run the alternator at its rated speed, and adjust the exciter field current using the rheostat to obtain the rated output current in the short-circuit connections.
Note : Prolonged standstill : In order to avoid these problems, we recommend the use of space heaters, as well as turning over the machine from time to time. Space heaters are only really effective if they are working continuously while the machine is stopped.

3.2.2 - Mechanical checks

Before starting the machine for the first time, check that :
- all fixing bolts and screws are tight
- cooling air is drawn in freely
- the protective louvres and housing are correctly positioned
- the standard direction of rotation is clockwise as seen from the shaft end (phase rotation in order 1 - 2 - 3).
For anti-clockwise rotation, swap 2 and 3.
- the winding connection corresponds to the site operating voltage (see section 3.3)

3.3 - Terminal connection diagrams

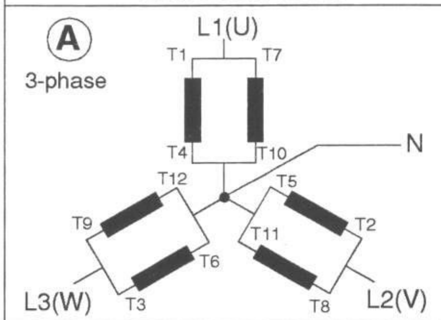
To modify the connections, change the position of the terminal links or shunts. The winding code is specified on the nameplate.

3.3.1 - Terminal connection : 5000 / 6000 -12-wire

The connection accessories are detailed in section 3.3.3.

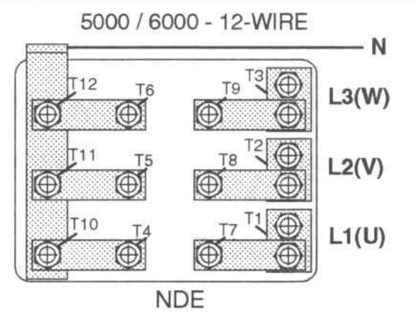
Any intervention on the alternator terminals during reconnection or checks should be performed with the machine stopped.

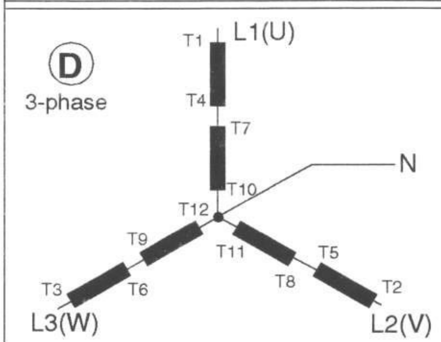
Connection codes | Voltage L.L | Factory connection



Winding	50 Hz	60 Hz
6	190 - 208	190 - 240
7	220	-
8	-	190 - 208

R 448 voltage detection :
0 => (T3) / 220 V => (T2)

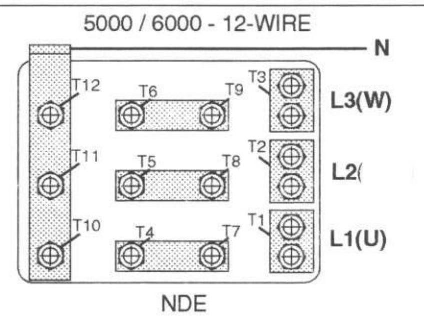


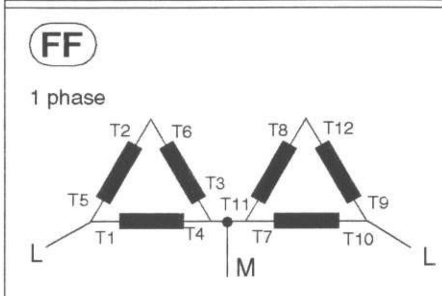


Winding	50 Hz	60 Hz
6	380 - 415	380 - 480
7	440	-
8	-	380 - 416
9		600

R 448 voltage detection :
0 => (T3) / 380 V => (T2)

Winding 9 : R 448 voltage detection + transformer (See specific diagram)

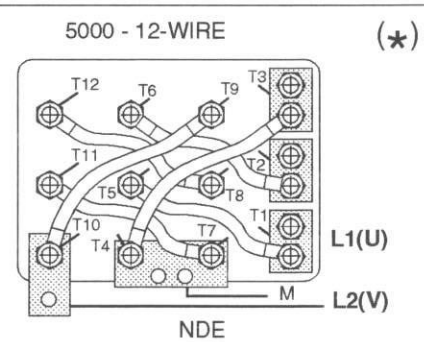


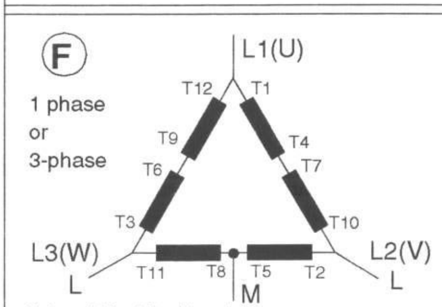


Voltage LM = 1/2 voltage LL

Winding	50 Hz	60 Hz
6	220 - 240	220 - 240
7	240 - 254	-
8	-	220 - 240

R 448 voltage detection :
0 => (T10) / 220 V => (T1)

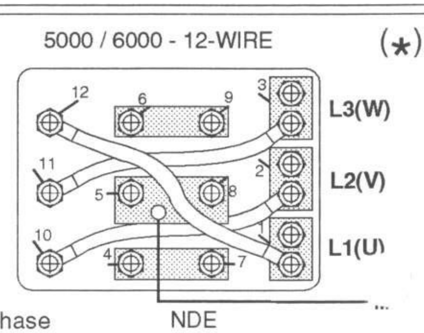




Voltage LM = 1/2 voltage LL

Winding	50 Hz	60 Hz
6	220 - 240	220 - 240
7	240 - 254	-
8	-	220 - 240

R 448 voltage detection :
0 => (T3) / 220 V => (T2)
Operating phases L2 (V), L3 (W) single phase

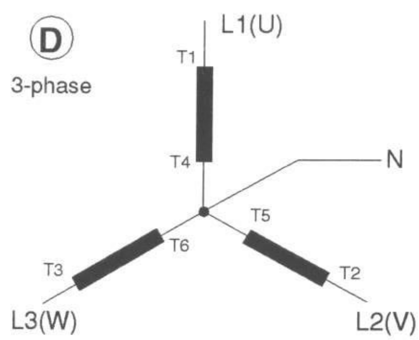


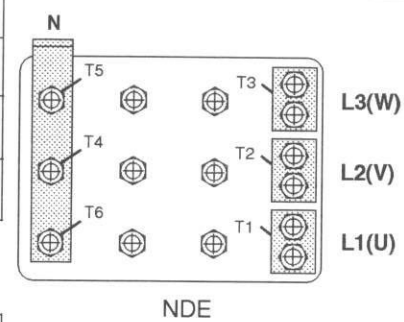
In case of reconnection, ensure that AVR voltage detection is correct !

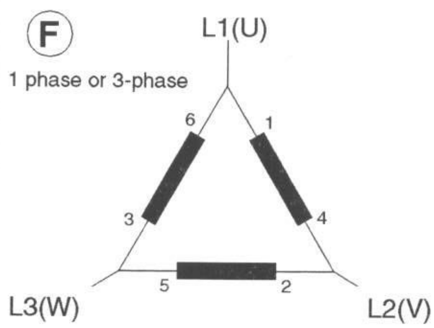
5000 - 6000
ALTERNATORS
INSTALLATION

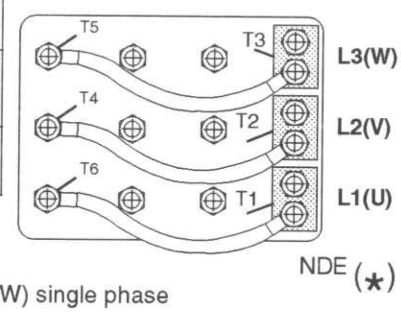
2 - Terminal connection :
5000 / 6000 - 6-wire

Connection codes	Voltage L.L			Factory connection
	Winding	50 Hz	60 Hz	
	6S	380 - 415	380 - 480	
	7S	440	-	
	8S	-	380 - 416	
	R 448 voltage detection : 0 => (T3) / 380 V => (T2)			
	9S		600	
	Winding 9 : R 448 voltage detection + transformer (See specific diagram)			
	Winding	50 Hz	60 Hz	
	6S	220 - 240	220 - 277	
	7S	240 - 254	-	
	8S	-	220 - 240	
	R 448 voltage detection : 0 => (T3) / 220 V => (T2) Operating phases : L2 (V), L3 (W) single phase			









In case of reconnection, ensure that the AVR voltage detection is correct !

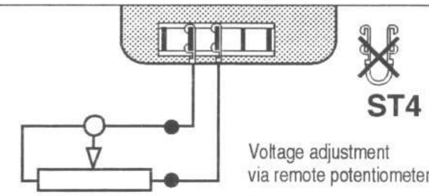
(*) The factory can supply a set of flexible shunts and special connection links as an option for making these connections. The standard alternator is fitted with 3 starting ranges, 6 connection links and one neutral link.

3.3.3 - Option connection diagram

R 791 T interference suppression kit (standard for CE marking)

Connections	(A)	(D)	(F)	(B)	(F/F)
Black	T1	T1	T1	T1	T1
Black	T2	T2	T2	T2	T9
Black	T3	T3	T3	T3	T3
Blue	N	N	⏚	⏚	⏚
White	⏚	⏚	⏚	⏚	⏚

Remote voltage potentiometer

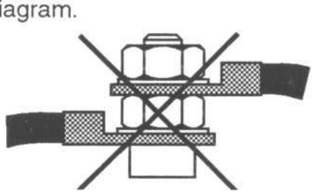


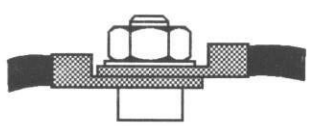
3.3.4 - Connection checks

Electrical installations must comply with the current legislation in the country of use.

Check that :

- the residual circuit-breaker conforms to legislation on protection of personnel, in force in the country of use, and has been correctly installed on the alternator power output as close as possible to the alternator. (In this case, disconnect the wire of the interference suppression module linking the neutral).
- Any protective devices in place have not been tripped.
- If there is an external AVR , the connections between the alternator and the cubicle are made in accordance with the connection diagram.
- There is no short-circuit between phase or phase-neutral between the alternator output terminals and the generator set control cabinet (part of the circuit not protected by circuit-breakers or cubicle relays).
- The machine should be connected with the busbar separating the terminals as shown in the terminal connection diagram.





3.3.5 - Electrical checks on the AVR

- Check that all connections have been made properly as shown in the attached connection diagram.

- Check that the frequency selection strap "ST3" is on the correct frequency setting.
- Check whether strap ST4 or the remote adjustment potentiometer have been connected.
- Optional operating modes
  - Strap ST1 : cut to connect the R 731 3-phase detection module.
  - Strap ST2 : cut for rapid response time
  - Strap ST5 : cut to suppress the LAM function.

3.4 - Commissioning

The machine can only be started up and used if the installation has been set up in accordance with the regulations and instructions defined in this manual.

The machine is tested and set at the factory. When first used with no load, make sure that the drive speed is correct and stable (see the nameplate). With the greaseable ball bearings option, we recommend greasing the bearings at the time of commissioning (see 4.2.3).

On application of the load, the machine should achieve its rated speed and voltage; however, in the event of abnormal operation, the machine setting can be altered (follow the adjustment procedure in section 3.5). If the machine still operates incorrectly, the cause of the malfunction must be located (see section 4.4).

3.5 - Settings

The various adjustments during tests must be made by a qualified engineer.

WARNING

Take care that the drive speed specified on the nameplate is reached before commencing adjustment

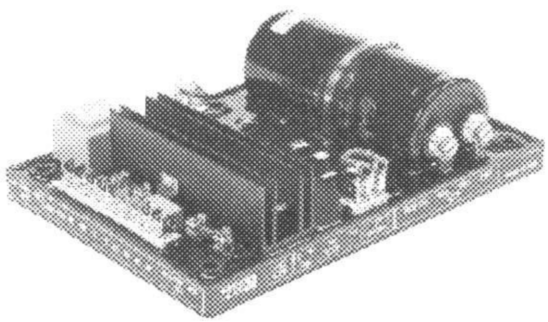
1500 min^{-1}/ 50Hz or 1800 min^{-1} / 60

Do not try to set the voltage if the frequency or speed is not correct (risk of irreparable rotor damage).

After operational testing, replace all access panels or covers.

The AVR should be used to make any adjustments to the machine.

3.5.1 - R 448 settings



a) Initial potentiometer settings (see table below)
- Remote voltage adjustment potentiometer : centre (strap ST4 removed).

Action	Factory setting	Pot.
Voltage minimum fully anti-clockwise	400V - 50 Hz (Input 0 - 380 V)	− + P2
Stability	Not set (centre position)	P3
Threshold/LAM or U/F Underspeed protection and "LAM" trip threshold Maximum frequency fully anti-clockwise	If ST3 = 50 Hz (factory) = 48 Hz If ST3 = 60 Hz (factory) = 58 Hz	+ − P4
Voltage quadrature droop (// operation with C.T.) - 0 quadrature droop fully anti-clockwise.	Not set (fully anti-clockwise)	− + P1
Excitation ceiling Limit of excitation and short-circuit current, minimum fully anti-clockwise	10 A maximum	− + P5

Adjustments in standalone operation

b) Install a D.C. analogue voltmeter (needle dial) cal. 100V on terminals E+, E- and an A.C. voltmeter cal 300 - 500 or 1000V on the alternator output terminals.

c) Make sure that strap ST3 is positioned on the desired frequency (50 or 60 Hz).

d) Voltage potentiometer P2 at minimum, fully anti-clockwise.

e) Turn the V/Hz potentiometer P4 fully clockwise.

f) Stability potentiometer P3 to approximately 1/3 anti-clockwise turn.

g) Start the engine and set its speed to a frequency of 48 Hz for 50 Hz, or 58 for 60 Hz.

h) Set the output voltage to the desired value using P2.
- Rated voltage UN for solo operation (eg. 400 V)
- Or UN + 2 to 4% for parallel operation with C.T. (eg. 410 V)
If the voltage oscillates, use P3 to make adjustments (try both directions) observing the voltage between E+ and E- (approx. 10V D.C.). The best response times are obtained at the limit of the instability. If no stable position can be obtained, try cutting or replacing strap ST2 (normal/fast).

i) Check LAM operation : ST5 closed.

j) Turn potentiometer P4 slowly anti-clockwise until there is a significant voltage drop (approximately 15%)

k) Vary the frequency (speed) around 48 or 58 Hz according to the operating frequency, and check the change in voltage from that observed previously (approximately 15%).

l) Readjust the speed of the unit to its rated no-load value.

Adjustments in parallel operation

WARNING

Before any intervention on the alternator, make sure that the speed droop is identical for all engines.

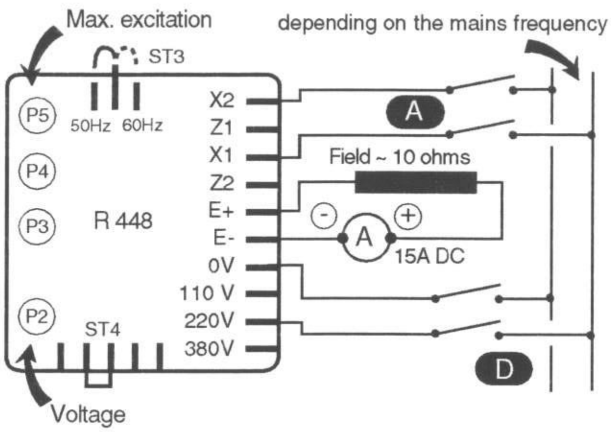
m) Preset for parallel operation (with C.T. connected to S1, S2 on connector J2)
- Potentiometer P1 (quadrature droop) in centre position.
Apply the rated load (cos Ø = 0.8 inductive).
The voltage should drop by 2 to 3%. If it increases, swap the 2 incoming wires from the C.T. secondary.

n) The no-load voltages should be identical for all the alternators intended to run in parallel.
- Couple the machines in parallel.
- By adjusting the speed, try to obtain 0 KW power exchange.
- By altering the voltage setting P2 or Rhe on one of the machines, try to cancel (or minimise) the current circulating between the machines.

From now on, do not touch the voltage settings.

o) Apply the available load (the setting is only correct if a reactive load is available)
- By altering the speed, equalise the KW (or divide the rated power of the units proportionally)
- By altering the quadrature droop potentiometer P1, equalise or divide the currents.

3.5.2 - Max. excitation setting (excitation ceiling)



Adjustment of the current limit

via potentiometer P5 (fuse rating : 8A-10 seconds).
The maximum factory setting corresponds to that of the excitation current required to obtain a 3-phase short-circuit current of approximately 3 IN at 50 Hz for industrial power, unless otherwise specified(*).
A static method can be used to reduce this value or adapt the Isc to the actual max. operating power (derated machine), which is safer for the alternator and the installation.
Disconnect power supply wires X1,X2 and Z1,Z2 and the voltage reference (0-110V-220V-380V) on the alternator.
Connect the mains power supply (200-240V) as indicated (X1,X2). Install a 10A D.C. ammeter in series with the exciter field. Turn P5 fully anti-clockwise and activate the power supply. If there is no output current from the AVR, turn potentiometer P2 (voltage) clockwise until the ammeter indicates a stable current. Switch the power supply off, then on again, turn P5 clockwise until the required max. current is obtained (no more than 10 A).

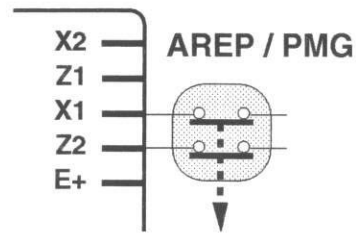
Checking the internal protection :

Open switch (D): the excitation current should increase to its preset ceiling, remain at that level for ≥ 10 seconds and then drop to < 1A.
To reset, switch off the power supply by opening switch (A).
Note : After setting the excitation ceiling as described, adjust the voltage again
(see section 3.5.2.) via P2.

(*): In some countries it is a legal requirement to have a short-circuit current, so as to offer discriminating protection.

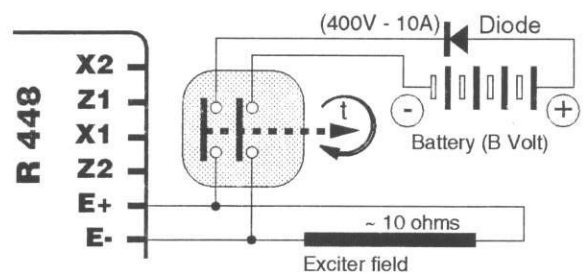
3.5.3 - Special type of use

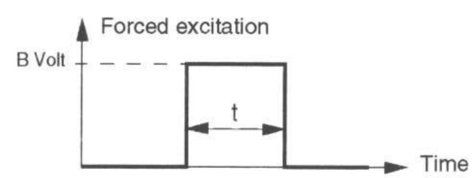
- Field weakening



The exciter is switched off by disconnecting the AVR power supply (1 wire on each auxiliary winding) – contact rating 16 A - 250V A.C.
Connection is identical for resetting the AVR internal protection

- Field forcing





Applications	B volts	Time t
Guaranteed voltage build-up	12 (1A)	1 - 2 s
Parallel operation, de-energized	12 (1A)	1 - 2 s
Parallel operation, at standstill	24 (2A)	5 - 10 s
Frequency starting	48 (4A)	5 - 10 s
Sustained voltage on overload	48 (4A)	5 - 10 s

4. SERVICING - MAINTENANCE

4.1 - Safety measures

Servicing or troubleshooting must be carried out strictly in accordance with instructions so as to avoid the risk of accidents and to maintain the machine in its original condition.

All such operations performed on the alternator should be undertaken by personnel trained in the commissioning, servicing and maintenance of electrical and mechanical components.

Before any intervention on the machine, ensure that it cannot be started by a manual or automatic system and that you understand how the operating system works.

4.2 - Regular maintenance

4.2.1 - Checks after start-up

After approximately 20 hours of operation, check that all fixing screws on the machine are still tight, plus the general condition of the machine and the various electrical connections in the installation.

4.2.2 - Cooling circuit

It is advisable to check that circulation of air is not reduced by partial blocking of the air intake and outlet grilles : mud, fibre, grease, etc.

4.2.3 - Bearings

The bearings are greasable (option). It is advisable to lubricate the machine during operation. Time intervals and quantity of grease are given in the table below.

DE bearing - 5000	6316 C3
Quantity of grease	33 g
Lubrication interval	4000 H

NDE bearing - 5000/6000	6315 C3
Quantity of grease	30 g
Lubrication interval	4500 H

DE bearing - 6000	6318 C3
Quantity of grease	41 g
Lubrication interval	3500 H

Lubrication intervals are given for a grease of grade
LITHIUM - standard - NLGI 3.

The factory lubrication is performed with grease :
SHELL - ALVANIA G3.
Before using another grease, check for compatibility with the original one. Monitor the temperature rise in the bearings, which should not exceed 50°C above the ambient temperature. Should this value be exceeded, the machine must be stopped and checks carried out.

4.2.4 - Electrical servicing

Cleaning product for the windings

WARNING

Do not use : trichlorethylene, perchlorethylene, trichloroethane or any alkaline products.

Certain strictly defined pure volatile degreasing products can be used, such as :
- Normal petrol (without additives)
- Toluene (slightly toxic); inflammable
- Benzene (or benzine, toxic); inflammable
- Ciclohexare (non toxic); inflammable

Cleaning of the stator, rotor, exciter and diode bridge
The insulating components and the impregnation system are not at risk of damage from solvents (see the above list of authorised products).
Avoid letting the cleaning product run into the slots. Apply the product with a brush, sponging frequently to avoid accumulation in the housing. Dry the winding with a dry cloth. Let any traces evaporate before reassembling the machine.

4.2.5 - Mechanical servicing

WARNING

Cleaning the machine using water or a high-pressure washer is strictly prohibited.
Any problems arising from such treatment are not covered by our warranty.

Degreasing : Use a brush and detergent (suitable for paintwork).
Dusting : Use an air gun.
If filters have been added to the machine after manufacture and do not have thermal protection, the service personnel should clean the air filters periodically and systematically, as often as is necessary (every day in very dusty atmospheres). Cleaning can be performed using water for dry dust or in a bath containing soap or detergent in the case of greasy dust. Petrol or chlorethylene can also be used.
After cleaning the alternator, it is essential to check the winding insulation (see sections 3.2. and 4.8.).

4.3 - Fault detection

If, when commissioned, the alternator does not work normally, the source of the malfunction must be identified.
To do this, check that :
- the protective devices are fitted correctly
- the connections comply with diagrams in the manuals supplied with the machine
- the speed of the unit is correct (see section 1.3).
Repeat the operations defined in section 3.

4.4 - Mechanical defects

Fault		Action
Bearing	Excessive overheating of one or both bearings (bearing temperature 50°C above the ambient temperature) (With or without abnormal bearing noise)	- If the bearing has turned blue or if the grease has turned black, change the bearing. - Bearing not fully locked (abnormal play in the bearing cage). - End shields incorrectly aligned.
Abnormal temperature	Excessive overheating of alternator frame (more than 40° C above the ambient temperature)	- Airflow (inlet-outlet) partially clogged or hot air is being recycled from the alternator or engine - Alternator operating at too high a voltage (> 105% of Un on load) - Alternator overloaded
Vibrations	Too much vibration	- Misalignment (coupling) - Defective mounting or play in coupling - Rotor balancing fault (Engine - Alternator)
	Excessive vibration and humming noise coming from the machine	- Phase imbalance - Stator short-circuit
Abnormal noise	Alternator damaged by a significant impact, followed by humming and vibration	- System short-circuit - Mis-paralleling Possible consequences - Broken or damaged coupling - Broken or bent shaft end. - Shifting and short-circuit of main field - Fan fractured or coming loose on shaft - Irreparable damage to rotating diodes or AVR.

- Electrical faults

Fault	Action	Effect	Check/Cause
No voltage at no load on start-up	Connect a new battery of 4 to 12 volts to terminals E- and E+, respecting the polarity, for 2 to 3 seconds	The alternator builds up and its voltage is still correct when the battery is removed.	- Lack of residual magnetism
		The alternator builds up but its voltage does not reach the rated value when the battery is removed.	- Check the connection of the voltage reference to the AVR - Faulty diode - Armature short-circuit
		The alternator builds up but its voltage disappears when the battery is removed	- Faulty AVR - Field windings open circuit (check winding) - Main field winding open circuit (check the resistance)
Voltage too low	Check the drive speed	Correct speed	Check the AVR connections (possible AVR failure) - Field windings short-circuited - Rotating diodes burnt out - Main field winding short-circuited - Check the resistance
		Speed too low	Increase the drive speed. (Do not touch the AVR voltage pot. (P2) before running at the correct speed.)
Voltage too high	Adjust AVR voltage potentiometer	Adjustment ineffective	Faulty AVR
[illegible]ge oscillations	Adjust AVR stability potentiometer	If no effect : try normal / fast recovery modes (ST2)	- Check the speed : possibility of cyclic irregularity - Loose connections - Faulty AVR - Speed too low when on load (or LAM set too high)
Voltage correct at no load and too low when on load (*)	Run at no load and check the voltage between E+ et E- on the AVR	Voltage between E+ and E- (DC) SHUNT<20V - AREP / PMG < 10V	- Check the speed (or LAM set too high)
		Voltage between E+ and E- SHUNT>30V - AREP / PMG > 15V	- Faulty rotating diodes - Short-circuit in the main field. Check the resistance- Faulty exciter armature. Check the resistance.
(*) Warning : During single-phase operation, check that the sensing wires from the AVR are connected to the correct output terminals.			
Voltage disappears during operation (**)	Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components	The voltage does not return to the rated value.	- Exciter winding open circuit - Faulty exciter armature - Faulty AVR - Main field open circuit or short-circuited
(**) Warning : The AVR internal protection may cut in (overload lost connection, short circuit).			

4.5.1 - Checking the winding

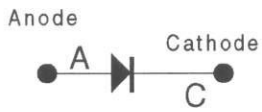
You can check the winding insulation by performing a high voltage test. In this case, you must disconnect all AVR wires.

WARNING

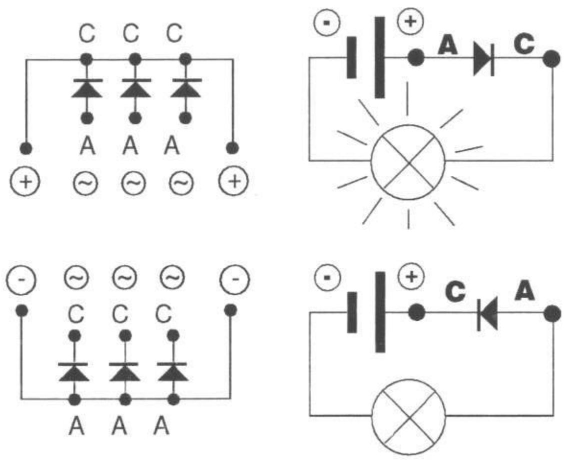
Damage caused to the AVR in such conditions is not covered by our warranty.

4.5.2 - Checking the diode bridge

DIODE BRIDGE



A diode in good working order must allow the current to flow from the anode to the cathode only.

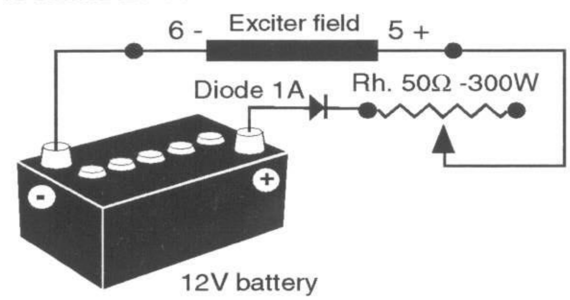


4.5.3 - Checking the windings and rotating diodes using separate excitation

During this procedure, make sure that the alternator is disconnected from any external load and inspect the terminal box to check that the connections are fully tightened.

1) Stop the unit, disconnect and isolate the AVR wires.
2) There are two ways of creating an assembly with separate excitation.
Assembly A : Connect a 12 V battery in series with a rheostat of approximately 50 ohms - 300 W and a diode on both exciter field wires (5+) and (6-).

ASSEMBLY A



Assembly B : Connect a "Variac" variable power supply and a diode bridge on both exciter field wires (5+) and (6-).

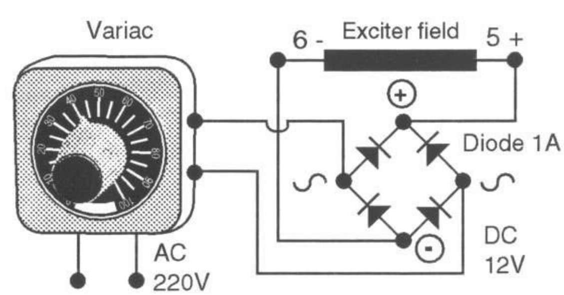
Both these systems should have characteristics which are compatible with the machine field excitation power (see the nameplate).

3) Run the unit at its rated speed.

4) Gradually increase the exciter field current by adjusting the rheostat or the variac and measure the output voltages on L1 - L2 - L3, checking the excitation voltage and current at no load and on load (see the machine nameplate or ask the factory test report).

When the output voltage is at its rated value and balanced within < 1 % for the rated excitation level, the machine is in good working order. The fault therefore comes from the AVR or its associated wiring (ie. sensing, auxiliary windings).

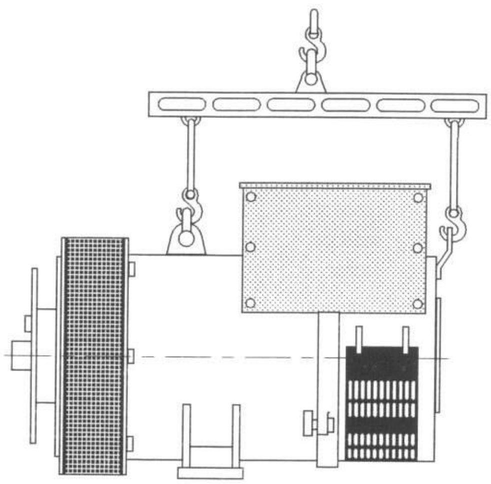
ASSEMBLY B



- Dismantling, reassembly (see sections 5.4.1. & 5.4.2.)

WARNING

During the warranty period, this operation should only be carried out in an approved LEROY-SOMER workshop or in our factory, otherwise the warranty may be invalidated.
Whilst being handled, the machine should remain horizontal (rotor not locked when moved).



4.6.1 - Tools required

To fully dismantle the machine, we recommend using the tools listed below :
- 1 ratchet spanner + extension,
- 1 torque wrench,
- 1 set of flat spanners : 8 mm, 10 mm, 18 mm,
- 1 socket set : 8, 10, 13, 16, 18, 21, 24, 30 mm
- 1 socket with male ferrule : 5 mm,
- 1 puller.

4.6.2 - Screw tightening torque

IDENTIFICATION	Screw Ø	Torque N.m
Exciter screw	M 6	10
Star diode bridge	M 6	10
Diode nut	M 6	4
Flange / Frame screw (5000 S, M)	M 14	80
Flange / Frame screw (5000 L, VL)	M 14	190
Flange / Frame screw (6000)	M 16	190
NDE bracket / frame screw	M 12	50
Discs / Sleeve screw	M 16	230
Earth screw	M 10	20
C[illegible]e screws	M 6	5
C[illegible]er screws	M 6	5
Terminal block nut	M 12	35

4.6.3 - Access to diodes

- Open the air inlet louvre (51)
- Disconnect the diodes.
- Check the diodes using an ohmmeter or a battery lamp (see section 4-5)

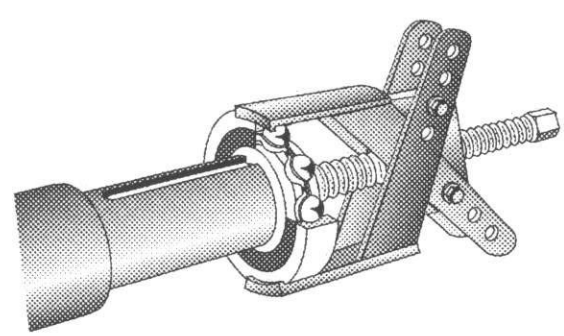
If the diodes are faulty
- Remove the surge suppressor (347).
- Remove the 6 "H" mounting nuts for the diode bridges on the support.
- Change the crescents, respecting the polarity.

4.6.4 - Access to connections and the regulation system

Access directly by removing the box lid (48) or the AVR access door (466).

4.6.5 - Replacing the NDE bearing on single bearing machines

- Remove the box lid (48) and the NDE panel (365) and remove the 2 screws from the part (122).
- Disconnect the stator outputs (T1 to T12).
- Disconnect the auxiliary winding wires with AREP (X1,X2,Z1,Z2).
- Disconnect the exciter wires (5+,6-).
- Remove the air inlet louvre (51)
- Remove the 2 bearing thrust screws (78).
- Remove all 4 screws (37).
- Remove the bearing (36).
- Remove the ball bearing (70) using a puller with a central screw (see drawing below).



- Check the condition of the "O" ring seal (349) and, if necessary, change it.
- Fit the new bearing, after heating it by induction to approximately 80°C.

WARNING

When dismantling the machine, always change the bearings.

4.6.6 - Replacing the DE bearing on two-bearing machines

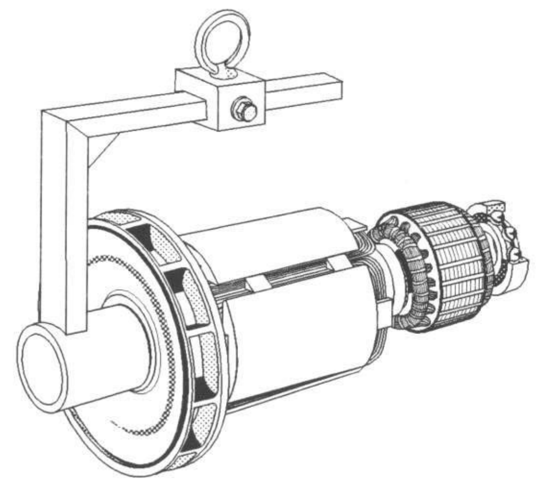
- Remove the screws (31) and (62).
- Remove the shield (30).
- Remove the circlips (284).
- Remove the ball bearing (60) using a puller with a central screw.
- Fit the new bearing, after heating it by induction to approximately 80°C.

WARNING

When dismantling the machine, always change the bearings.

4.6.7 - Complete dismantling

- Remove the DE shield (30) as described in section 4.6.6.
- Support the DE rotor (4) with a strap or a support constructed as shown in the drawing below.



- Remove the NDE shield bearing cover.
- Tap the shaft end lightly on the opposite side from the coupling using a small mallet.
- Pull the strap in order to move the rotor and ensure its weight is evenly supported.
- Remove the NDE shield following the instructions in section 4.6.5.

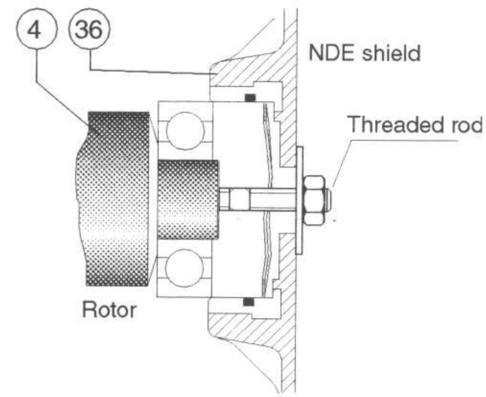
4.6.8 - Reassembling the end shields

- Place the "O" ring seal (349) and the preloading wavy washer (79) in the bearing seat (36).
- Position shields (30) and (36) on the stator (1).
- Tighten screws (31) and (37).
- Reconnect all the exciter wires, auxiliary windings, stator, etc.
- Fit the 2 support screws (122).
- Fit the air inlet louvre (51)
- Replace the cover.

4.6.9 - Reassembling the rotor

On single bearing machines :
- Mount the rotor (4) in the stator (1) (see drawing below)
- Check that the machine is correctly assembled and that all screws are tightened.

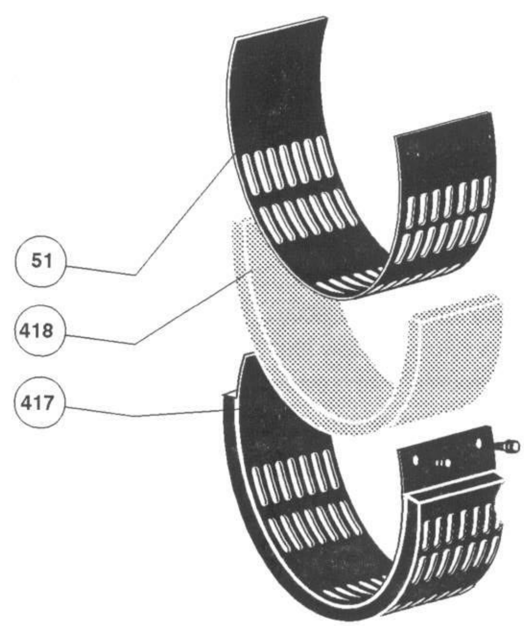
On two-bearing machines :
- Mount the rotor (4) in the stator (1).
- Position shield (30) on the stator (1).
- Tighten screws (31).
- Mount the inner bearing retainer (68) using the screws (62).



- Mount the circlips (284)
- Check that the machine is correctly assembled and that all screws are tightened.

4.6.10 - Dismantling and reassembly of the filters

- Remove the grille (417) then take out the filter (418) . Change the filter, if necessary, please refer to section 4.2.5 for cleaning the filter. To replace follow instructions in reverse order.



WARNING

When removal of the rotor involves changing parts or rewinding, the rotor must be rebalanced.

After operational testing, replace all access panels or covers.

4.7 - Installation and maintenance of the PMG

In 5000 and 6000, the PMG reference is : PMG 2.

4.7.1 - Mechanical characteristics

The components are :
- an adaptation shaft (to position the rotor on the alternator shaft).
- M16 tie rod and nut for assembling the rotor on the shaft.
- a rotor with 16 magnets.
- A housing + wound stator + plastic connection sleeve assembly + plastic ferrules.
- the housing cover (4 CBLXS M5 screws).
- 4 HM6 screws (mounting housing on the NDE shield).

If mounting in kit form, follow the instructions below.

1 - Remove the PMG cover [297] and the seal (71) on the alternator NDE shield.
2 - Mount the PMG housing assembly [290] on the shield using the 4 HM6 screws.
3 - Apply adhesive to the tie rod [295] and screw it fully into the tapped hole in the rear of the alternator shaft to a torque of 30 Nm.
4 - Mount the magnetised rotor on the adaptation shaft, then using 2 M10 threaded rods screwed into the rotor slide the assembly onto the tie rod.
5 - Once the rotor is in position, remove the 2 M10 rods.
6 - Fit the cable gland washer [296].
7 - Tighten the assembly with the M16 nut at 115 Nm.
8 - Close the PMG with the cover [297].
9 - Remove the plastic plug on the NDE panel and fit the plastic sleeve and its ferrule.
10 - Connect the PMG to the AVR (section 4.7.2.).

4.7.2 - Electrical connection

- Connect the 3 PMG wires (14/15/16), the 2 exciter wires (5/6) and the 2 previously mentioned voltage detection wires (2/3) in accordance with the connection diagram (see section 2.3.2).

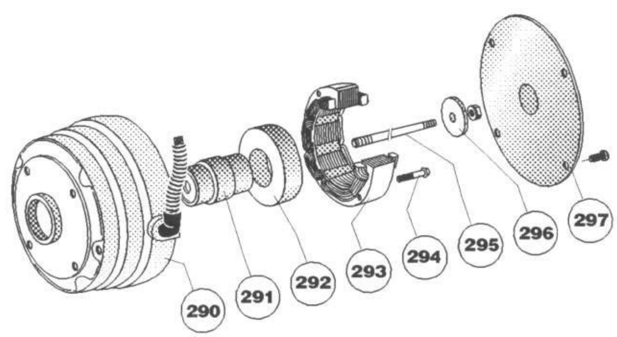
Mounting the PMG on an AREP machine
- Connect the 3 PMG wires (14/15/16), to terminals X1,X2,Z2 on the AVR. The 4 auxiliary winding wires X1.X2.Z1.Z2 should be isolated using the domino fitting supplied with the kit. Both exciter field wires (5/6) and the voltage sensing wires (2/3) remain in place.

Electrical characteristics of the PMG 2
Stator phase/phase resistance 20°C : 2.1 Ω
No-load A.C. voltage between phases at 1500 rpm : 125 V.

ATTENTION

With the PMG, check that strap ST9 has been disconnected.

4.7.3 - Exploded view of the PMG



4.8 - Table of characteristics

Table of average values
Alternator - 4 poles - 50 Hz - Standard winding No. 6.
(400V for the excitation values)
The voltage and current values are given for no-load operation and operation at rated load with separate field excitation. All values are given at ± 10% and may be changed without prior notification (for exact values, consult the test report).

4.8.1 - Average values for 5000

Resistances at 20°C (Ω)

5000	Stator L/N	Rotor	Field	Armature
M3	0.022	0.23	8.8	0.035
M5	0.0182	0.24	8.8	0.035
L6	0.0148	0.264	8.8	0.035
L9	0.012	0.295	8.8	0.035
VL12	0.0085	0.343	10	0.037

Resistance of AREP auxiliary windings at 20°C (Ω)

5000	Auxil wdg : X1, X2	Auxil wdg : Z1, Z2
M3	0.24	0.4
M5	0.215	0.36
L6	0.185	0.36
L9	0.19	0.32
VL12	0.17	0.32

Field excitation current i exc (A)
Symbols : "i exc": excitation current of the exciter field.

5000	No load	At rated load
M3	1.1	4
M5	1.1	3.8
L6	1.1	4.1
L9	1.2	4
VL12	1.1	3.5

For 60 Hz machines, the "i exc" values are approximately 5 to 10 % lower.

4.8.2 - Average values for 6000

Resistances at 20°C (Ω)

6000	Stator L/N	Rotor	Field	Armature
M4	0.0108	0.8	10.2	0.13
M6	0.0081	0.9	10.2	0.13
L9	0.006	1.04	10.2	0.13
L10	0.0053	1.1	10.2	0.13
L11	0.0053	1.1	10.2	0.13
VL 12	0.0028	1.13	10.2	0.13

Resistance of AREP auxiliary windings at 20°C (Ω)

6000	Auxil wdg : X1, X2	Auxil wdg : Z1, Z2
M4	0.23	0.405
M6	0.21	0.335
L9	0.175	0.34
L10	0.173	0.29
L11	0.173	0.29
VL 12	0.18	0.325

Field excitation current i exc (A)
Symbols : "i exc": excitation current of the exciter field.

6000	No load	At rated load
M4	0.9	3.8
M6	0.9	3.5
L9	0.9	3.2
L10	0.9	3.4
L11	0.9	3.7
VL 12	0.9	3.45

For 60 Hz machines, the "i exc" values are approximately 5 to 10 % lower.

4.8.3 - Voltage of auxiliary windings at no load

5000	Auxil wdg : X1, X2	Auxil wdg : Z1, Z2
50 Hz	70 V	10 V
60 Hz	85 V	12 V

6000	Auxil wdg : X1, X2	Auxil wdg : Z1, Z2
50 Hz	70 V	5 V
60 Hz	85 V	6 V

SPARE PARTS

5.1 - First maintenance parts

Emergency repair kits are available as an option.
They contain the following items :

Ref.	Description	Qty	5000	Part ref
	Emergency kit	1		
198	AVR	1	R 448	**ESC 220 CV019**
343	Diode bridge assembly	1	LSA 471. 9. 07 LSA 471.9 / 0.08	**ADE 461 EQ 004**
347	Surge suppressor	1	LSA 461.9.01	**CII 111 PM 005**
	AVR fuse	2	250 V - 10 A	**PEL 010 FG 008**
	Other spare parts			
60	DE bearing	1	6316 2RS/C3	**RLT 080 TS030**
70	NDE bearing	1	6315 2RS/C3	**RLT 075 TS030**

Ref.	Description	Qty	6000	Part ref
	Emergency kit	1		
198	AVR	1	R 448	**ESC 220 CV019**
343	Diode bridge assembly	1	LSA 471. 9. 07 LSA 471,90.08	**ADE 471 EQ 007**
347	Surge suppressor	1	LSA 461.9.01	**CII 111 PM 005**
	AVR fuse	2	250 V - 10 A	**PEL 010 FG 008**
	Other spare parts			
60	DE bearing	1	6318 2RS/C3	**RLT 090 TS030**
70	NDE bearing	1	6315 2RS/C3	**RLT 075 TS030**

5.2 - Technical support service

Our technical support service will be pleased to provide any additional information you may require.

When ordering spare parts, you should indicate the complete machine type, its serial number and the information given on the nameplate.

Address your enquiry to your usual contact.

Part numbers should be identified from the exploded views and their description from the parts list.
Our extensive network of service centres can dispatch the necessary parts without delay.
To ensure correct operation and the safety of our machines, we recommend the use of original manufacturer spare parts.
In the event of failure to comply with this advice, the manufacturer cannot be held responsible for any damage.

5.3 - Accessories

5.3.1 - Space heater for use when stopped

The space heater must start up as soon as the alternator stops. It is installed at the rear of the machine. Its standard power is 250W with 220V or 250W with 110V on request.

Warning : the power supply is present when the machine has stopped.

5.3.2 - Stator thermistor temperature probes (PTC)

These are thermistor triplets with a positive temperature coefficient installed in the stator winding (1 per phase). There can be a maximum of 2 triplets in the windings (at 2 levels : warning and trip) and 1 or 2 thermistors in the shields.
These probes must be linked to appropriate detection relays (supplied optionally)
Cold resistance of thermistor probes:
100 to 250 Ω per probe.

5.3.3 - Connection accessories

- 6-wire machines
Requirements for coupling (F) :
- 3 flexible shunts

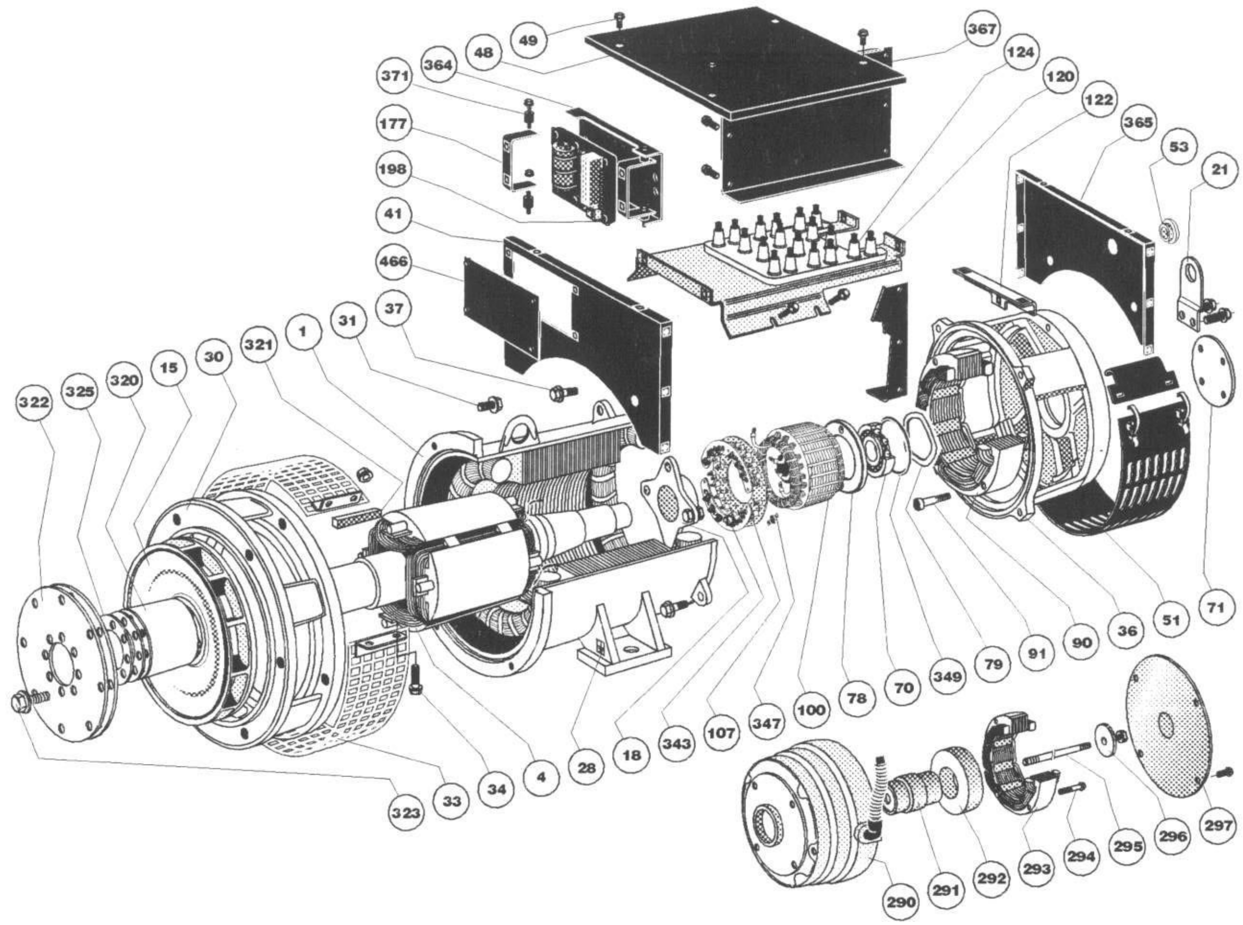
- 12-wire machines
Requirements for coupling (A) :
- 6 links
- 1 link for the neutral

Requirements for coupling (F.F) :
- 4 flexible shunts
- 2 flexible shunts
- 1 link for the central point
- 1 additional starting range
- 1 additional terminal

Requirements for coupling (F) :
- 3 flexible shunts
- 1 link for the central point

5.4 - Exploded view, parts list

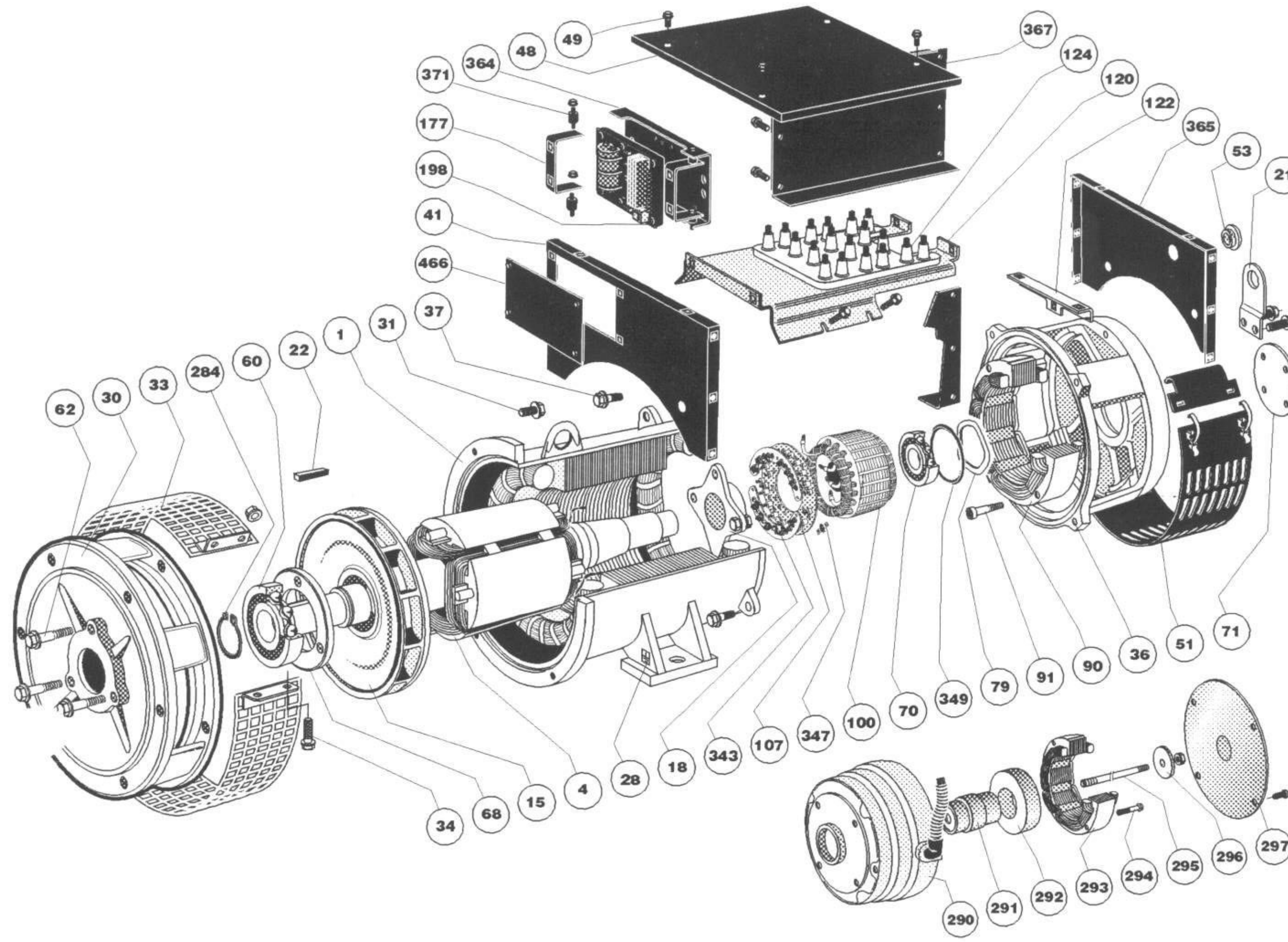
5.4.1 - Single bearing



Ref.	Qty	Description	Ref.	Qty	Description
1	1	Stator assembly	124	1	Terminal block with terminals
4	1	Rotor assembly	177	2	AVR support bracket
15	1	Turbine	198	1	Voltage regulator (AVR)
18	1	Balancing disc	290	1	PMG housing
21	1	Lifting ring	291	1	Adaptation shaft
28	1	Earth terminal	292	1	Magnetic rotor
30	1	DE shield	293	1	Stator
31	6 or 4	Fixing screw	294	2	Fixing screw
33	1	Fan guard	295	1	Tie rod
34	2	Fixing screw	296	1	Cable gland washer + nut
36	1	Exciter end shield	297	1	End plate
37	4	Fixing screw	320	1	Coupling sleeve
41	1	Cover front panel	321	1	Sleeve key
48	1	Cover top panel	322	3	Coupling disc
49	-	Cover screws	323	6	Fixing screw
51	1	Air intake louvre	325	-	Spacer shim
53	1	Plug	343	1	Diode bridge assembly
70	1	NDE bearing	347	1	Protection varistor (+ PCB)
71	1	Outer bearing retainer	349	1	“O” ring
78	1	Inner bearing retainer	364	1	AVR support
79	1	Preloading wavy washer	365	1	Cover rear panel
90	1	Exciter field	367	2	Side panel
91	4	Fixing screw	371	4	Damper
100	1	Exciter armature	416	1	Filter
107	1	Crescent support	417	1	Filter support
120	1	Terminal support	466	2	AVR inspection door
122	1	Console support			

5000 - 6000
ALTERNATORS
SPARE PARTS

2 - Two-bearing



Ref.	Qty	Description	Ref.	Qty	Description
1	1	Stator assembly	100	1	Exciter armature
4	1	Rotor assembly	107	1	Crescent support
15	1	Turbine	120	1	Terminal support
18	1	Balancing disc	122	1	Console support
21	1	Lifting ring	124	1	Terminal block with terminals
22	1	Shaft extension key	177	2	AVR support bracket
28	1	Earth terminal	198	1	Voltage regulator (AVR)
30	1	DE shield	284	1	Circlips
31	6 or 4	Fixing screw	290	1	PMG housing
33	1	Fan guard	291	1	Adaptation shaft
34	2	Fixing screw	292	1	Magnetic rotor
36	1	Exciter end shield	293	1	Stator
37	4	Fixing screw	294	2	Fixing screw
41	1	Cover front panel	295	1	Tie rod
48	1	Cover top panel	296	1	Cable gland washer + nut
49	-	Cover screws	297	1	End plate
51	1	Air intake louvre	343	1	Direct diode crescent
53	1	Plug	347	1	Protection varistor (+ PCB)
60	1	DE bearing	349	1	"O" ring
62	3 or 4	Fixing screw	364	1	AVR support
68	1	Inner bearing retainer	365	1	Cover rear panel
70	1	NDE bearing	367	2	Side panel
71	1	Outer bearing retainer	371	4	Damper
79	1	Preloading wavy washer	416	1	Filter
90	1	Exciter field	417	1	Filter support
91	4	Fixing screw	466	2	AVR inspection door

Perkins 1300 Series EDi

Models WK to WS

USER'S HANDBOOK

Six cylinder, turbocharged, diesel engines with an electronic management system for industrial and agricultural applications

Publication TPD 1352E, Issue 3.
© Proprietary information of Perkins Engines Company Limited, all rights reserved.
The information is correct at the time of print.
Published in August 1999 by Technical Publications,
Perkins Engines Company Limited, Peterborough PE1 5NA, England

This publication is written in
Perkins Approved Clear English

PACE

Contents

1 General information

Introduction ... 1
Safety precautions ... 2
How to care for your engine ... 3
Engine preservation ... 4
Parts and service ... 5
POWERPART recommended consumable products ... 6
Training ... 7
Service literature ... 7
Engine identification ... 8
Engine data ... 9

2 Engine views

Introduction ... 11
Location of engine parts ... 11

3 Operation instructions

How to start the engine ... 13
How to start an engine with an ether start system ... 15
How to stop the engine ... 16
Adjustment of engine speed range ... 16
Engine operation at idle speed ... 16
Running-in ... 16
Altitude ... 16

4 Preventive maintenance

Preventive maintenance periods ... 17
Schedules ... 18
How to drain the cooling system ... 19
How to fill the cooling system ... 20
How to renew the canister of the coolant filter / inhibitor ... 21
How to check the drive belt ... 22
How to renew the drive belt ... 22
Fuel pre-filter ... 23
How to renew the fuel strainer and the canister of the fuel filter ... 23
How to eliminate air from the fuel system ... 24
How to renew the lubricating oil ... 25
How to renew the canister of the lubricating oil filter ... 26
Air filter ... 27
Restriction indicator ... 27
How to set the valve tip clearances ... 28

5 Engine fluids

Fuel specification ... 29
Lubricating oil specification ... 30
Coolant specification ... 31

6 Fault diagnosis

Problems and possible causes ... 33
List of possible causes ... 34

1

General information

Introduction

The 1300 Series EDi is a family of engines which have an electronic management system. The engines are designed for industrial and agricultural applications from Perkins Engines Limited, a world leader in the design and manufacture of high-performance diesel engines.

Perkins approved assembly and quality standards, together with the latest technology, have been applied to the manufacture of your engine to give you reliable and economic power.

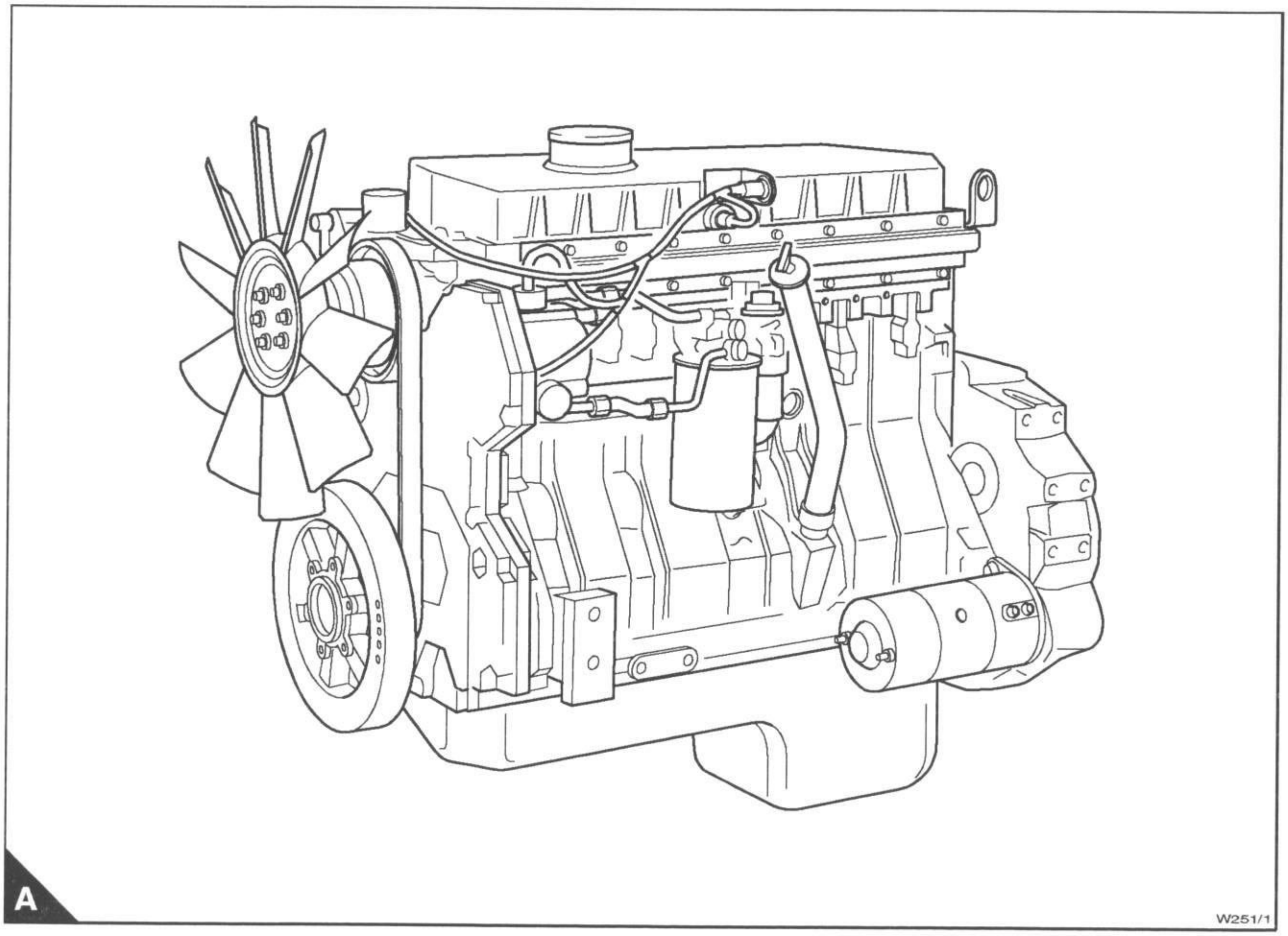
Note: To ensure that you use the relevant information for your specific engine type, refer to "Engine identification" on page 8.

Danger is indicated in the text by two methods:

Warning! *This indicates that there is a possible danger to the person.*

Caution: *This indicates that there is a possible danger to the engine.*

Note: Is used where the information is important, but there is not a danger.



Safety precautions

These safety precautions are important.

You must refer also to the local regulations in the country of use. Some items only apply to specific applications.

- Only use these engines in the type of application for which they have been designed.
- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away fuel which has been spilt. Material which has been contaminated by fuel must be moved to a safe place.
- Do not put fuel in the tank while the engine runs (unless it is absolutely necessary).
- Do not clean, add lubricating oil, or adjust the engine while it runs (unless you have had the correct training; even then extreme caution must be used to prevent injury).
- Do not make adjustments that you do not understand.
- Ensure that the engine does not run in a location where it can cause a concentration of toxic emissions.
- Other persons must be kept at a safe distance while the engine or auxiliary equipment is in operation.
- Do not permit loose clothing or long hair near moving parts.
- Keep away from moving parts during engine operation.

Warning! *Some moving parts cannot be seen clearly while the engine runs.*

- Do not operate the engine if a safety guard has been removed.
- Do not remove the filler cap or any component of the cooling system while the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not use salt water or any other coolant which can cause corrosion in the closed coolant circuit.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) because the gases from the electrolyte are highly flammable. The battery fluid is dangerous to the skin and especially to the eyes.
- Disconnect the battery terminals before a repair is made to the electrical system.
- Only one person must control the engine.
- Ensure that the engine is operated only from the control panel or from the operator's position. Discard used lubricating oil in a safe place to prevent contamination.
- Ensure that the control lever of the transmission drive is in the "out-of-drive" position before the engine is started.
- The combustible material of some components of the engine (for example certain seals) can become extremely dangerous if it is burned. Never allow this burnt material to come into contact with the skin or with the eyes.
- Diesel fuel and lubricating oil (especially used lubricating oil) can damage the skin of certain persons. Protect your hands with gloves or a special solution to protect the skin.
- Do not wear clothing which is contaminated by lubricating oil. Do not put material which is contaminated with oil into the pockets of clothing.
- Discard used lubricating oil in accordance with local regulations to prevent contamination.
- Use extreme care if emergency repairs must be made in adverse conditions.

Continued

- Always use a safety cage to protect the operator when a component is to be pressure tested in a container of water. Fit safety wires to secure the plugs which seal the hose connections of a component which is to be pressure tested.
- Do not allow compressed air to contact your skin. If compressed air enters your skin, obtain medical help immediately.
- Turbochargers operate at high speed and at high temperatures. Keep fingers, tools and debris away from the inlet and outlet ports of the turbocharger and prevent contact with hot surfaces.
- The fuel injector units of this engine are controlled electronically by a pulse of 110 volts.
- The fuel injector units are actuated by high-pressure engine lubricating oil. Do not remove any component of the high-pressure system while the engine oil is under pressure, because dangerous oil can be discharged.
- Fit only genuine Perkins parts.

How to care for your engine

This handbook has been written to assist you to maintain and operate your engine correctly.

To obtain the best performance and the longest life from your engine, you must ensure that the maintenance operations are done at the intervals indicated in Chapter 4, Preventive maintenance. If the engine works in a very dusty environment or other adverse conditions, certain maintenance intervals will have to be reduced. Renew the filter canisters and lubricating oil regularly in order to ensure that the inside of your engine remains clean.

Ensure that all adjustments and repairs are done by personnel who have had the correct training. Perkins distributors have this type of personnel available. You can also obtain parts and service from your Perkins distributor.

The terms "left side" and "right side" apply when the engine is seen from the flywheel end.

Warning! *Read the "Safety precautions" on page 2 and remember them. They are given for your protection and must be applied at all times.*

Engine preservation

Introduction

The recommendations indicated below are designed to prevent damage to the engine when it is withdrawn from service for a prolonged period. Use these procedures after the engine is withdrawn from service. The instructions for the use of POWERPART products are given on the outside of each container.

Procedure

Caution: *The procedure for this engine is different to the procedure for other Perkins engines, because of the design of the fuel injection units.*

1 Completely clean the outside of the engine.

2 Operate the engine until it is warm. Stop the engine and drain the lubricating oil from the sump. Ensure that the oil gallery of the high-pressure lubrication system is drained.

Caution: *If the gallery is not drained, the engine cylinders will be filled with engine lubricating oil when the fuel injector units are removed.*

3 Disconnect the battery.

4 Disconnect the air inlet pipe at the rocker cover. Release the setscrews and remove the rocker cover. Spray POWERPART Lay-Up 2 around the rocker shaft assembly and into the induction ports in the cylinder head, as indicated on the container label.

5 Drain the fuel supply gallery, fitted to the cylinder head.

Caution: *If the gallery is not drained, the engine cylinders will be filled with fuel when the fuel injector units are removed.*

6 Remove the fuel injector units, refer to the Workshop Manual, and spray POWERPART Lay-Up 2 for one to two seconds into each cylinder bore with the piston at bottom dead centre.

7 Slowly turn the crankshaft one revolution and then fit the fuel injector units, complete with new seat washers.

8 Fit the rocker cover and connect the air inlet pipe.

9 Renew the canister of the lubricating oil filter, see "How to renew the canister of the lubricating oil filter" on page 26.

10 Fill the sump to the full mark on the dipstick with new and clean lubricating oil and add POWERPART Lay-up 2 to the oil to protect the engine against corrosion. If POWERPART Lay-Up 2 is not available, use a correct preservative fluid instead of the lubricating oil. If a preservative fluid is used, this must be drained and the lubricating oil sump must be filled to the correct level with normal lubricating oil at the end of the storage period.

11 Drain the coolant circuit, see "How to drain the cooling system" on page 19. In order to protect the cooling system against corrosion, fill it with an approved antifreeze mixture because this gives protection against corrosion.

Caution: *If protection against frost is not necessary and a corrosion inhibitor is to be used, it is recommended that you consult the Technical Service Department, Perkins Engines Company Limited, Peterborough.*

12 Connect the battery, eliminate air from the fuel system. Operate the engine for a short period in order to circulate the lubricating oil and the coolant in the engine. Then correct leakages of fuel, lubricating oil or air.

13 Disconnect the battery. Then put the battery into safe storage in a fully charged condition. Before the battery is put into storage, protect its terminals against corrosion. POWERPART Lay-Up 3 can be used on the terminals.

14 Remove the air filter. Then, if necessary, remove the pipe(s) installed between the air filter and the turbocharger. Seal the air inlet to the turbocharger with waterproof tape.

Continued

15 Remove the exhaust pipe. Spray POWERPART Lay-Up 2 into the exhaust manifold or the turbocharger. It is recommended that the spray time for the turbocharger is 50% longer than the spray time for the manifold, which is indicated on the container label. Seal the manifold or the turbocharger with waterproof tape.

16 Clean the engine breather pipe and seal the end of the pipe.

17 When a preservative fuel is to be used, drain the fuel system and fill it with the preservative fuel. POWERPART Lay-Up 1 can be added to the normal fuel to change it to a preservative fuel. If preservative fuel is not used, the system can be completely filled with normal fuel but the fuel must be drained and discarded at the end of the storage period together with the fuel filter canister.

18 Remove the drive belts and put them into storage.

19 Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.

20 In order to prevent corrosion, spray the engine with POWERPART Lay-Up 3. Do not spray the area inside the alternator cooling fan.

If the engine protection is done correctly according to the above recommendations, no corrosion damage will normally occur. Perkins are not responsible for damage which may occur when an engine is in storage after a period in service.

Parts and service

If problems occur with your engine or with the components fitted onto it, your Perkins distributor can make the necessary repairs and will ensure that only the correct parts are fitted and that the work is done correctly.

POWERPART recommended consumable products

Perkins have made available the products recommended below in order to assist in the correct operation, service and maintenance of your engine and your machine. The instructions for the use of each product are given on the outside of each container. These products are available from your Perkins distributor.

POWERPART Antifreeze

Protects the cooling system against frost and corrosion. Part number 21825166.

POWERPART Easy Flush

Cleans the cooling system. Part number 21825001.

POWERPART Gasket and flange sealant

To seal flat faces of components where no joint is used. Especially suitable for aluminium components. Part number 21820518.

POWERPART Gasket remover

An aerosol for the removal of sealants and adhesives. Part number 21820116.

POWERPART Griptite

To improve the grip of worn tools and fasteners. Part number 21820129.

POWERPART Hydraulic threadseal

To retain and seal pipe connections with fine threads. Especially suitable for hydraulic and pneumatic systems. Part number 21820121.

POWERPART Industrial grade super glue

Instant adhesive designed for metals, plastics and rubbers. Part number 21820125.

POWERPART Lay-Up 1

A diesel fuel additive for protection against corrosion. Part number 1772204.

POWERPART Lay-Up 2

Protects the inside of the engine and of other closed systems. Part number 1762811.

POWERPART Lay-Up 3

Protects outside metal parts. Part number 1734115.

POWERPART Metal repair putty

Designed for external repair of metal and plastic. Part number 21820126.

POWERPART Pipe sealant and sealant primer

To retain and seal pipe connections with coarse threads. Pressure systems can be used immediately. Part number 21820122.

POWERPART Radiator stop leak

For the repair of radiator leaks. Part number 21820127.

POWERPART Retainer (high strength)

To retain components which have an interference fit. Currently Loctite 638. Part number 21820638.

Continued

POWERPART Safety cleaner

General cleaner in an aerosol container. Part number 21820128.

POWERPART Silicone adhesive

An RTV silicone adhesive for application where low pressure tests occur before the adhesive sets. Used for sealing flange where oil resistance is needed and movement of the joint occurs. Part number 21826038.

POWERPART Silicone RTV sealing and jointing compound

Silicone rubber sealant which prevents leakage through gaps. Currently Hylosil. Part number 1861108.

POWERPART Stud and bearing lock

To provide a heavy duty seal to components that have a light interference fit. Part number 21820119 or 21820120.

POWERPART Threadlock and nutlock

To retain small fasteners where easy removal is necessary. Part number 21820117 or 21820118.

POWERPART Universal jointing compound

Universal jointing compound which seals joints. Currently Hylomar. Part number 1861117.

Training

Local training for the correct operation, service and overhaul of engines is available at certain Perkins distributors. If special training is necessary, your Perkins distributor can advise you how to obtain it at the Perkins Customer Training Department, Peterborough, or other main centres.

Service literature

Workshop manuals, installation drawings and other service publications are available from your Perkins distributor at a nominal cost.

Engine identification

The 1300 Series EDi engines consist of a range of six cylinder in-line engines which are turbocharged or turbocharged/intercooled. The engines have an electronic management system.

In this handbook, the different engine types are indicated by their code letters, which are the first two letters of the engine number as indicated below:

Code letters	Capacity		Aspiration system
	Litre	in^3	
WK	7,6	466	Turbocharged
WL	7,6	466	Turbocharged / intercooled
WM	8,6	531	Turbocharged
WN	8,6	531	Turbocharged / intercooled
WP	7,6	466	Turbocharged
WQ	7,6	466	Turbocharged / intercooled
WR	8,6	531	Turbocharged
WS	8,6	531	Turbocharged / intercooled

The engine number is stamped on the left side of the cylinder block (A1), behind the high pressure pump.

An example of an engine number is **WP1296N123456**.

The components of the engine number are as follows:

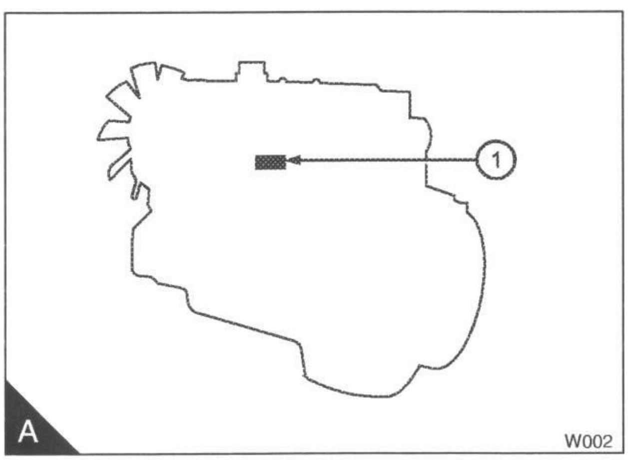
WP = Type code letters

1296 = Build list number

N = Built in the USA

123456 = Engine serial number

If you need parts, service or information for your engine, you must give the complete engine number to your Perkins distributor.



Engine data

Number of cylinders. ... 6
Cylinder arrangement.. ... .In line
Cycle ... Four stroke
Induction system.. ... ..Turbocharged or Turbocharged/intercooled
Combustion system. ... ...Direct injection

Nominal bore:

- WK and WL ... ..109,2 mm (4.301 in)
- WM, WN, WP, WQ, WR and WS .. ..116,6 mm (4.590 in)

Stroke:

- WK, WL , WP and WQ ... ..118,9 mm (4.681 in)
- WM, WN, WR and WS .. ..135,9 mm (5.350 in)

Compression ratio ... 16.5:1

Cubic capacity:

- WK, WL , WP and WQ .. ... .7,64 litres (466.4 in^3)
- WM, WN, WR and WS .. ... .8,71 litres (531.0 in^3)

Firing order 1, 5, 3, 6, 2, 4

Valve tip clearances (cold):

- Inlet and exhaust ... 0,64 mm (0.025 in)

Lubricating oil pressure (minimum):

- Idle. ... 137 kPa (20 $lbf\ in^2$) 1,4 kgf/cm^2
- maximum engine speed and normal engine temperature. ... 276 kPa (40 lbf/in^2) 2,8 kgf/cm^2

Capacity of a typical lubricating oil sump (1):

- Without filter canister. ... 22,7 litres (40.0 UK pints) 24 US quarts
- With filter canister.. ... 28,3 litres (49.9 UK pints) 28 US quarts

Typical coolant capacity (engine only). ... .12,8 litres (22.5 UK pints) 13,5 US quarts
Direction of rotation . ... Clockwise from the front

(1) The capacity of the sump may vary according to the application. Fill to the "Full" mark on the dipstick. Do not exceed the "Full" mark.

This page is intentionally blank

2

Engine views

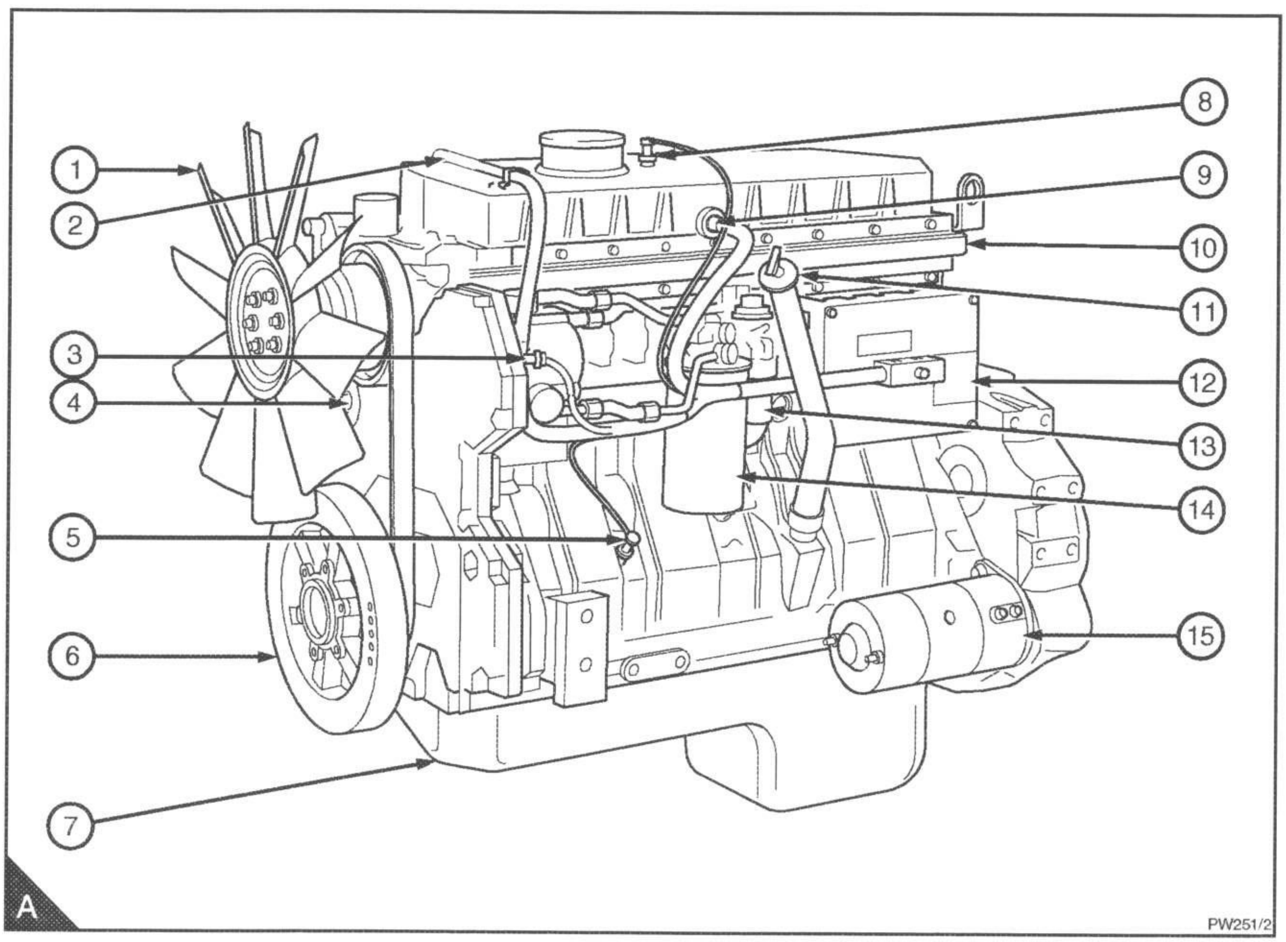
Introduction

Perkins engines are built for specific applications and the views which follow do not necessarily match your engine specification.

Location of engine parts

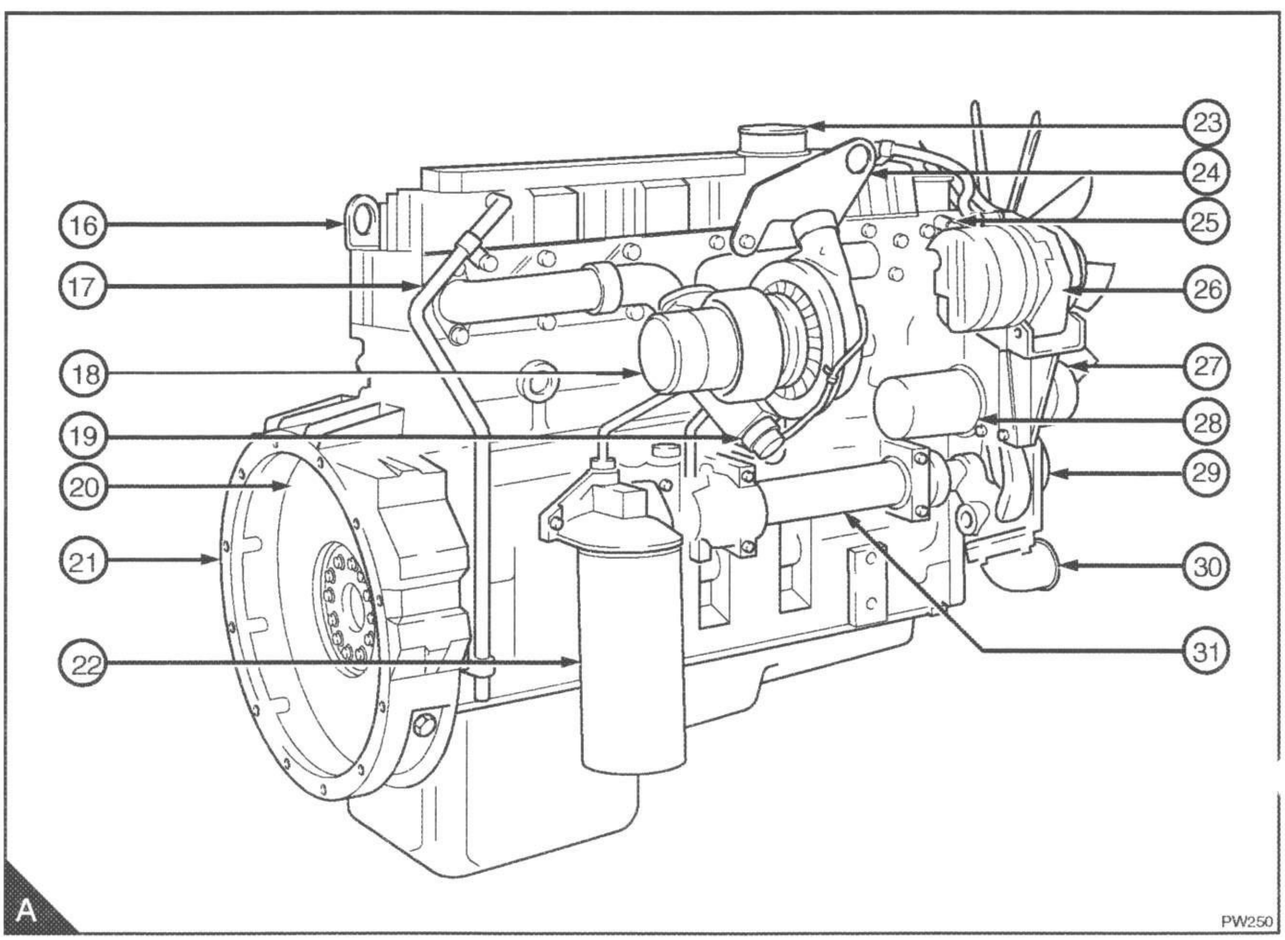
Front and left side view

1 Fan
2 Wiring harness to the sensor for injection control pressure
3 Sensor for engine oil temperature
4 Camshaft position sensor
5 Sensor for engine oil pressure
6 Crankshaft damper
7 Sump for the engine lubricating oil
8 Sensor for the inlet manifold air temperature
9 electrical connector for the injector units
10 Supply manifold
11 Lubricating oil filler and dipstick
12 Engine control module
13 Fuel strainer
14 Canister for the fuel filter
15 Starter motor



Rear and right side view

16 Rear lift bracket
17 Engine breather pipe
18 Turbocharger
19 Wastegate
20 Flywheel
21 Flywheel housing
22 Canister for the lubricating oil filter
23 Air inlet connection
24 Front lift bracket
25 Coolant temperature sensor
26 Alternator
27 Tensioner for the drive belt
28 Canister for the coolant filter / inhibitor
29 Coolant pump
30 Coolant inlet connection
31 Lubricating oil cooler



3

Operation instructions

How to start the engine

Temperature of 15°C (60°F) to -20°C (-4°F)

Several factors affect engine start, for example:

- The power of the batteries
- The performance of the starter motor
- The viscosity of the lubricating oil
- The installation of a cold start system.

The engine will start without a cold starting aid at temperatures as low as -20 °C (-4 °F). In conditions where the temperature is lower than this, an ether start system may be necessary.

Before the engine is started the operator should understand fully the reason for the controls and their use.

Before the engine is started:

- Check that there is sufficient coolant and, if necessary, add the correct coolant, see Chapter 4, Preventive maintenance.
- Check that there is sufficient lubricating oil in the sump and, if necessary, add lubricating oil. Refer to Chapter 4, Preventive maintenance. Ensure that the lubricating oil is of the correct grade for the ambient conditions.
- Fill the fuel tank with fuel of the correct specification, see Chapter 5, Engine fluids.
- Check the air filter and its connections.
- Ensure that all of the electrical connections are tight.

Notes:

- For the correct engine fluids, see Chapter 5, Engine fluids.
- The procedures to start the engine may vary according to the application. If possible, consult the User's Handbook for the application.

1 Apply the hand brake, if the application is fitted with one. Ensure that the transmission is in the out-of-drive position. Ensure that the engine speed control is in the minimum speed position.

2 Turn the start key to the "ON" position.

Note: Do not operate the engine speed control during engine start, the management system controls the supply of fuel, and it will ignore signals from the speed control until the engine starts.

3 Turn the start key further to engage the starter motor. If the application has a start button, press and hold the button.

4 Release the start key (or the button) as soon as the engine starts. The start key will return to the "ON" position.

Caution: *If the engine does not start within 30 seconds, release the start key and wait two to three minutes to allow the starter motor to cool. If after three tries the engine does not start, turn the key to the "OFF" position.*

Continued

5 Locate and correct the problem. Always ensure that the engine and starter motor are stationary before the starter motor is engaged again.

When the engine starts, check that the lubricating oil pressure exceeds 138 kPa (20 lbs/in^2) 1,4 kgf/cm^2 within the first 10 seconds, see "Engine data" on page 9 for the correct lubricating oil pressure.

If a gauge is not fitted, check that the warning light for low oil pressure is extinguished. If this does not occur, stop the engine and find and correct the fault. Allow the engine to warm at approximately 1000 rev/min for three to five minutes before load is applied.

How to start an engine with an ether start system

Ambient temperature below -20°C (-4°F)

Caution: *Ether is very flammable and is toxic. Apply the safety precautions on the container for the use and storage of ether and for the disposal of empty containers.*

1 Apply the hand brake. Ensure that the transmission is in the out-of-drive position. Check the ether container to ensure that a supply of ether is available under pressure.

2 Ensure that the engine speed control is still in the idle position.

Note: Do not operate the engine speed control during engine start, the management system controls fuel supply and it will ignore signals from the speed control until the engine starts.

3 Turn the start key to the "ON" position.

4 Turn the start key further to engage the starter motor. If the application has a start button, press and hold the button to engage the starter motor, and at the same time press the ether injection button. Allow one to two seconds for the ether injection system to fill then release the injection button to release a measured amount of ether into the engine.

Caution: *Release of ether into the cylinders before the starter motor is engaged may cause damage to the pistons and piston rings.*

5 Release the start key (or the start button, if one is fitted) as soon as the engine starts. The start key will return to the "ON" position.

Caution: *If the engine does not start within 30 seconds, release the start key and wait two to three minutes to allow the starter motor to cool. If after three tries the engine does not start, turn the key to the "OFF" position and locate and correct the problem. Always ensure that the engine and starter motor are stationary before the starter motor is engaged again.*

Note: In extemely cold conditions, it is permissible to inject further ether into the engine if the engine runs roughly after the initial start.

Caution: *Do not inject ether into a warm engine.*

6 When the engine starts check that the lubricating oil pressure exceeds 138 kPa (20 lbs/in^2) 1,4 kgf/cm^2 within the first 25 seconds, see "Engine data" on page 9 for the correct lubricating oil pressure. If a gauge is not fitted, check that the warning light for low oil pressure is extinguished. If this does not occur, stop the engine.

Find and correct the fault. Allow the engine to warm at approximately 1000 rev/min for three to five minutes before load is applied.

How to stop the engine

Turn the engine start key to the "OFF" position.

It is recommended that the engine is operated at idle speed for three to five minutes before the engine is stopped. This will allow the lubricating oil and the coolant to carry the heat away from large ferrous components.

Adjustment of engine speed range

The idle or maximum speed settings cannot be changed by the engine operator.

Engine operation at idle speed

Do not operate the engine for long periods at idle speed as this could have an adverse affect on the engine performance or damage the engine.

Running-in

A gradual running-in of a new engine is not necessary. Prolonged operation at light loads during the early life of the engine is not recommended.

Maximum load can be applied to a new engine as soon as the engine is put into service and the coolant temperature has reached a minimum of 76 °C (170 °F).

- Do not operate the engine at high speeds without a load.
- Do not overload the engine.

Altitude

The engine management system will automatically compensate for altitude.

4

Preventive maintenance

Preventive maintenance periods

These preventive maintenance periods apply to average conditions of operation. Check the periods given by the manufacturer of the equipment in which the engine is installed. Use the periods which are shortest . When the operation of the engine must conform to the local regulations these periods and procedures may need to be adapted to ensure correct operation of the engine.

It is good preventive maintenance to check for leakage and loose fasteners at each service.

These maintenance periods apply only to engines that are operated with fuel and lubricating oil which conform to the specifications given in this handbook.

Schedules

The schedules which follow must be applied at the interval (hours or months) which occur first.

A Every day or every 8 hours
B Every 450 hours or 6 months
C Every 900 hours or 12 months
D Every 3600 hours or 24 months
E Every 5000 hours
F Every 6700 to 7500 hours
G Annually

A	B	C	D	E	F	G	Operation
●							Ensure that the coolant is at the correct level
●							Check the intercooler and the coolant radiator for debris
	●						Check, and adjust if necessary, the antifreeze mixture (2)
	●						Test the level of coolant conditioner, and adjust if necessary (2)
	●						Check the condition of the drive belt
			●				Renew the coolant (4)
						●	Renew the canister of the coolant filter (3)
						●	Inspect the thermostat (2)
●							Drain water from the fuel pre-filter (1)
		●					Renew the canister of the fuel filter and renew the fuel strainer
●							Check the amount of lubricating oil in the sump
●							Check the lubricating oil pressure at the gauge (1)
	●						Renew the engine lubricating oil (5)
	●						Renew the canister of the lubricating oil filter
	●						Clean or renew the air filter element (or earlier if in extremely dusty conditions)
				●			Ensure that the valve tip clearances of the engine are checked and, if necessary, adjusted (2)
					●		Ensure that the turbocharger impeller and the turbocharger compressor casing are cleaned (2)
					●		Ensure that the alternator, the starter motor, and the turbocharger are checked
						●	Inspect the electrical system (2)

(1) If one is fitted.
(2) By a person who has had the correct training.
(3) Also if the coolant system has been drained.
(4) The system should be flushed and a new canister fitted.
(5) The oil change interval will change with the sulphur content of the fuel (see the table below and the "Fuel specification" on page 29). The interval to change the canister of the lubricating oil filter is not affected.
(6) Use the **POWERPART test-kit**, part number 26550004.

Fuel sulphur content (%)	Oil change interval
<0.5	Normal
0.5 to 1.0	75% of normal
>1.0	50% of normal

How to drain the cooling system

Warning! *Do not drain the coolant while the engine is still hot and the system is under pressure because dangerous hot coolant can be discharged.*

1 Ensure that the machine is on level ground.

2 Remove the filler cap of the cooling system.

3 Remove the drain plug (A1) from the side of the cylinder block (below the rear of the high-pressure pump) and the drain plug (B1) from the lubricating oil cooler in order to drain the engine. Ensure that the drain holes are not restricted.

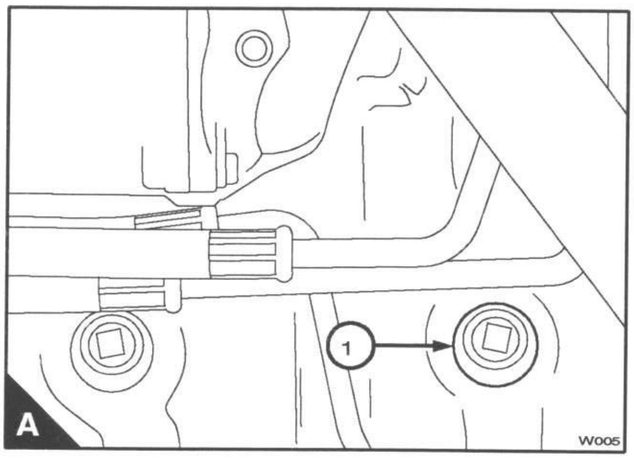
4 Open the tap or remove the drain plug at the bottom of the radiator in order to drain the radiator. If the radiator does not have a tap or drain plug, disconnect the hose at the bottom of the radiator.

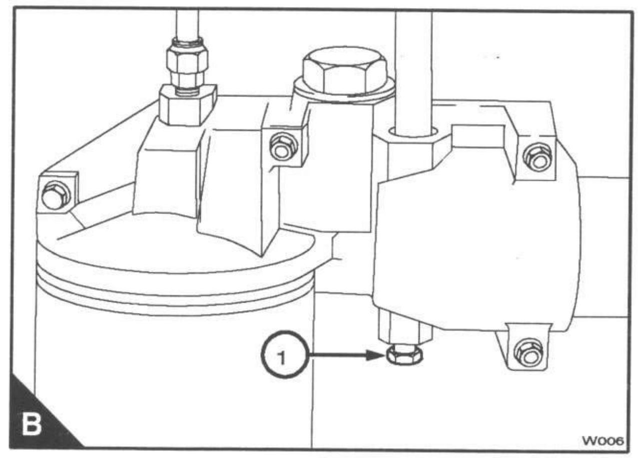
5 Flush the system with POWERPART Easy Flush.

6 Fit the drain plugs and the filler cap. Close the radiator tap or connect the radiator hose.

7 Renew the canister, part number 26550001, of the coolant filter.

Caution: *The canister contains a corrosion inhibitor which is circulated around the cooling system as the coolant passes through the canister. It is important that only the genuine correct Perkins canister is used.*





How to fill the cooling system

Caution: *See "Coolant specification" on page 31 for details of the correct coolant to be used in the cooling system. If coolant is added to the system during service, it must consist of the same original mixture as used to fill the system. The engine must be allowed to cool before coolant is added.*

Warning! *Do not remove the filler cap while the engine is still hot and the system is under pressure because dangerous hot coolant can be discharged.*

1 Remove the filler cap of the cooling system.

2 The cooling system must be filled very slowly in order to eliminate air. Fill the cooling system until coolant reaches the bottom of the filler tube. Fit the filler cap.

3 Start the engine. Allow the engine to operate at a fast idle until the engine reaches its normal temperature of operation. Stop the engine and allow it to cool.

Remove carefully the filler cap and add coolant until the level of the coolant reaches the filler tube. Fit the filler cap.

How to renew the canister of the coolant filter / inhibitor

Warning! *Do not remove the canister while the engine is still hot and under pressure because dangerous hot fluid can be discharged.*

Caution: *The canister contains a corrosion inhibitor which is circulated around the cooling system as the coolant passes through the canister. It is important that only the genuine correct Perkins canister is used.*

Note: There are two types of coolant filter head:

Type 1

1 When the engine has cooled, remove the radiator filler cap to release the system pressure.

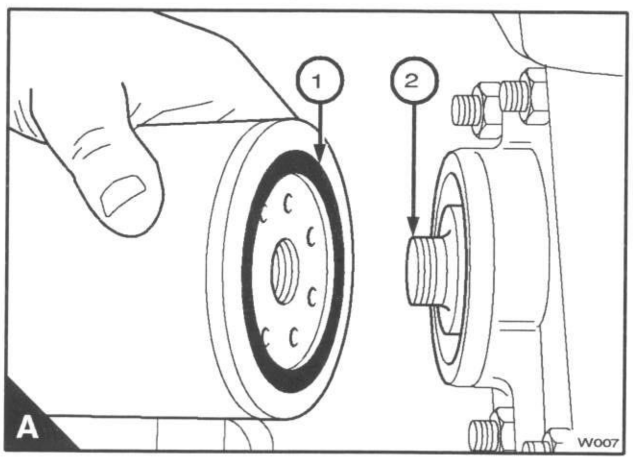
Note: When the system pressure is released, valves will close in the filter canister and in the housing for the canister. This will prevent the loss of coolant when the filter is removed.

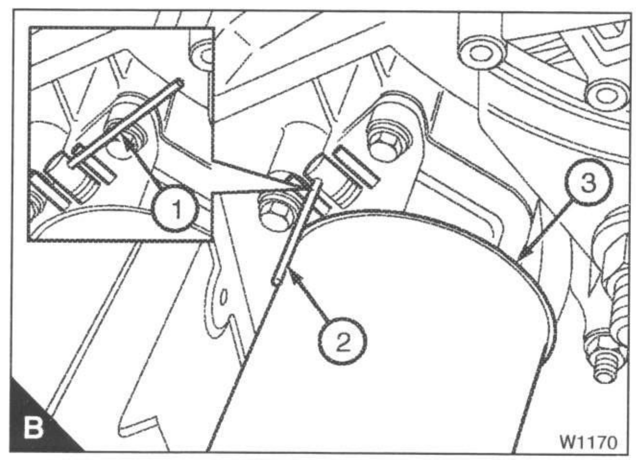
2 Thoroughly clean the outside surfaces of the coolant filter assembly.

3 Use a strap wrench or similar tool to loosen the filter canister and remove the canister. Valves in the filter head will prevent the loss of coolant when the canister is removed.

4 Ensure that the threaded adaptor (A2) is secure in the filter head and that the inside of the head is clean.

5 Lubricate lightly the seal (A1) on top of the new canister with clean engine coolant. Fit the new canister to the filter head and tighten, by hand only. Do not overtighten the canister.





Type 2

1 When the engine has cooled, remove the radiator filler cap to release the system pressure.

2 Turn the lever (B1) fully counter-clockwise, to the close the valve. This will prevent the loss of coolant when the canister (B3) is removed.

3 Thoroughly clean the outside surfaces of the coolant filter assembly.

4 Use a strap wrench or similar tool to loosen the filter canister and remove the canister.

5 Lubricate lightly the seal on top of the new canister with clean engine coolant. Fit the new canister to the filter head and tighten until the seal touches the filter head, tighten a further one rotation by hand only. Do not overtighten the canister.

6 Turn the lever (B2) fully clockwise, to the open the valve. This will allow the flow of coolant through the canister.

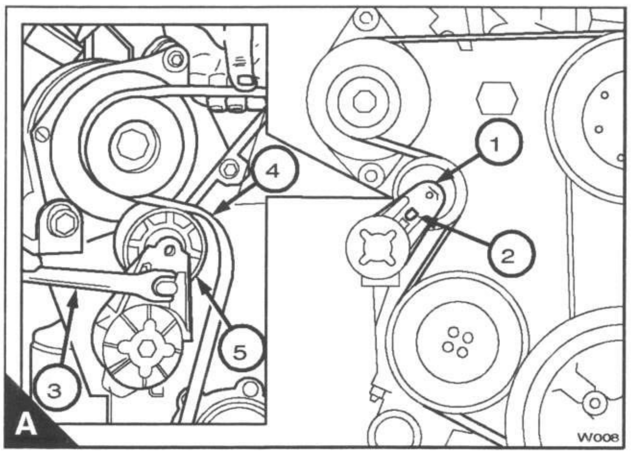
How to check the drive belt

There is no need to check the tension of the belt as the tension is set automatically. The condition of the belt should be checked. The belt should be renewed if there are cracks in the belt or if the belt is contaminated by oil or grease.

How to renew the drive belt

1 Fit a square headed lever (A3) into the 12,7 mm (0.5 in) hole (A2) in the tensioner assembly (A1). Operate the lever to release the tension from the belt (A4) and remove the belt. The tensioner will return to its original position by spring pressure. Remove the lever.

2 With the lever in the tensioner, pull the tensioner outwards. Put the new belt in position around all of the pulleys. Ensure that the tensioner pulley is on the outside of the belt. Allow the tensioner to return and tension the belt. Remove the lever.



Fuel pre-filter

This will normally be fitted between the fuel tank and the engine. Check the filter bowl for water at regular intervals and drain as necessary.

How to renew the fuel strainer and the canister of the fuel filter

The fuel filter assembly has a fuel strainer to remove larger particles from the fuel and a filter canister to remove the smaller particles. The fuel strainer can be cleaned, but the fuel filter must be renewed.

1 Thoroughly clean the outside surfaces of the fuel filter assembly.

2 Use a strap wrench or similar tool to loosen the filter canister, and remove the canister.

3 Use a 29 mm (1 $^{1}/_{8}$ in) socket spanner to remove the plastic cover (A5) from the fuel strainer. Remove the strainer (A3) and the 'O' ring (A4) from the cover.

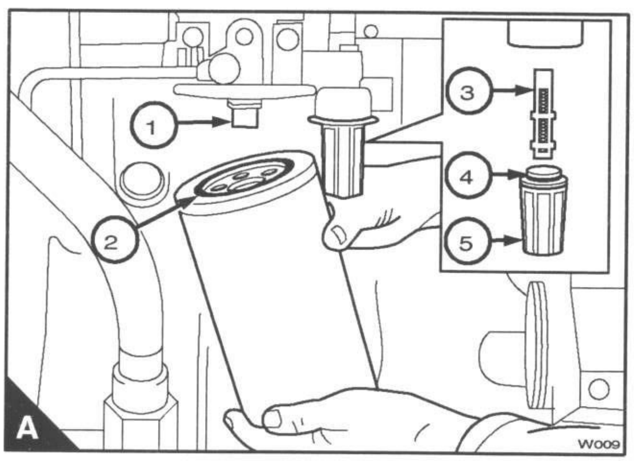
4 Fit a new strainer and a new 'O' ring to the cover and fit the cover to the filter head.

Caution: *Ensure that the open end of the new strainer is toward the filter head.*

5 Ensure that the threaded adaptor (A1) is secure in the filter head and that the inside of the head is clean. Lubricate lightly the seal (A2) of the new canister with clean diesel fuel. Fit the new canister to the filter head and tighten the canister by hand until the seal contacts the filter head. Tighten the canister a further $^{1}/_{2}$ turn by hand only. Do not use a strap wrench.

6 Eliminate the air from the fuel filter, see page 24.

Caution: *It is important that only the genuine Perkins parts are used. The use of wrong parts could damage the fuel injector units.*



How to eliminate air from the fuel system

If air enters the fuel system, it must be eliminated before the engine can be started.

Air can enter the system if:

- The fuel tank is drained during normal operation.
- The low-pressure fuel pipes are disconnected.
- A part of the low-pressure fuel system leaks during engine operation.

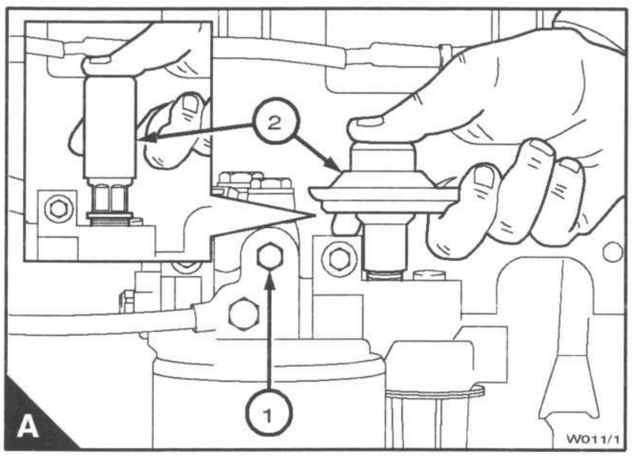
In order to eliminate air from the fuel system, proceed as follows:

1 Loosen the vent plug (A1) on the top of the fuel filter head.

2 Operate the plunger of the fuel priming pump (A2) until fuel, free from air, comes from the filter vent point. Tighten the vent plug.

3 Turn the start key to the "ON" position.

4 Operate the starter motor for intervals of 15 seconds until the engine starts. If the engine runs correctly for a short time and then stops or runs roughly, check for air in the fuel system. If there is air in the fuel system, there is probably a leakage in the low pressure system. Turn the start key to the "OFF" position to stop the engine. Rectify the leakage and repeat the procedure.



How to renew the lubricating oil

1 Operate the engine until it is warm.

2 Stop the engine.

3 Put a container with a capacity of approximately 30 litres (6.5 UK gallons) 32 US quarts beneath the sump. Remove the sump drain plug (A1) and its washer and drain the lubricating oil from the sump. Ensure that the 'O' ring is not damaged. Fit the drain plug and its washer and tighten the plug to 68 Nm (50 lbf ft) 6,9 kgf m.

4 Turn the handle on top of the filler cap (B2) counter-clockwise to release the filler cap and dipstick assembly from the filler tube.

5 Fill the sump to the "FULL" mark on the dipstick (B1) with new and clean lubricating oil of an approved grade, see "Lubricating oil specification" on page 30.

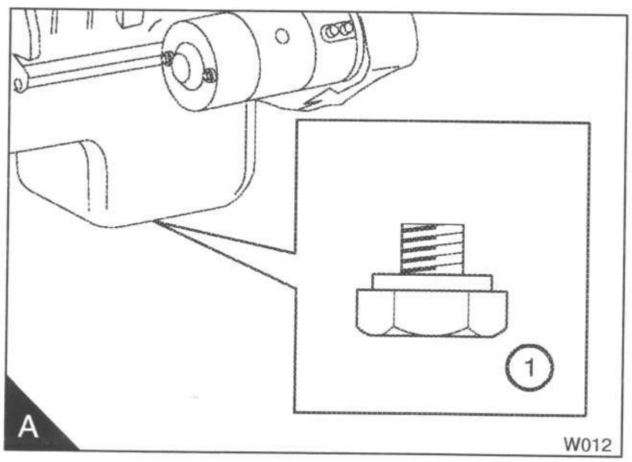
6 Fit the dipstick and filler cap assembly and turn the handle on the cap clockwise to tighten the filler cap in the filler tube.

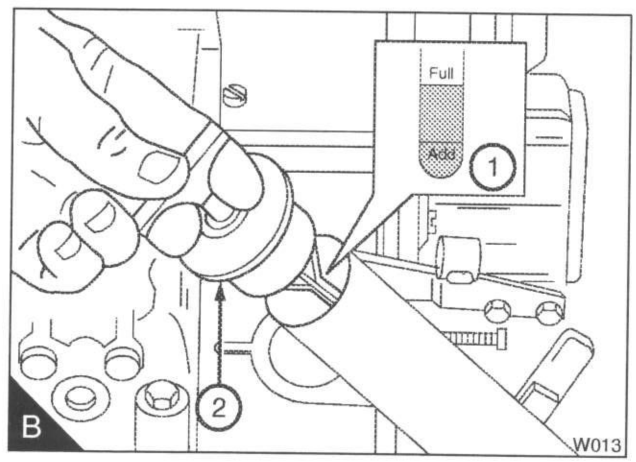
7 Remove the container of used lubricating oil from beneath the engine.

Warning! *Discard the used lubricating oil in a safe place and in accordance with local regulations.*

8 Start the engine and check for lubricating oil leakage. Stop the engine. After 15 minutes check the oil level on the dipstick and, if necessary, put more lubricating oil into the sump.

Caution: *Do not fill the sump past the "FULL" mark on the dipstick.*





How to renew the canister of the lubricating oil filter

1 Put a tray under the filter to retain spilt lubricating oil.

2 Clean thoroughly the outside surfaces of the filter assembly.

3 Use a strap wrench or similar tool to loosen the filter canister. Remove and discard the canister. Ensure that the adaptor (A1) is secure in the filter head.

Warning! *Discard the used canister and lubricating oil in a safe place and in accordance with local regulations.*

4 Clean inside the filter head

5 Lubricate the seal (A2) on top of the canister with clean engine lubricating oil.

6 Fill the new filter canister with clean engine lubricating oil. Fit the new canister and tighten by hand until the seal contacts the filter head. Tighten the canister a further $^1/_2$ to $^3/_4$ of a turn by hand only. Do not use a strap wrench.

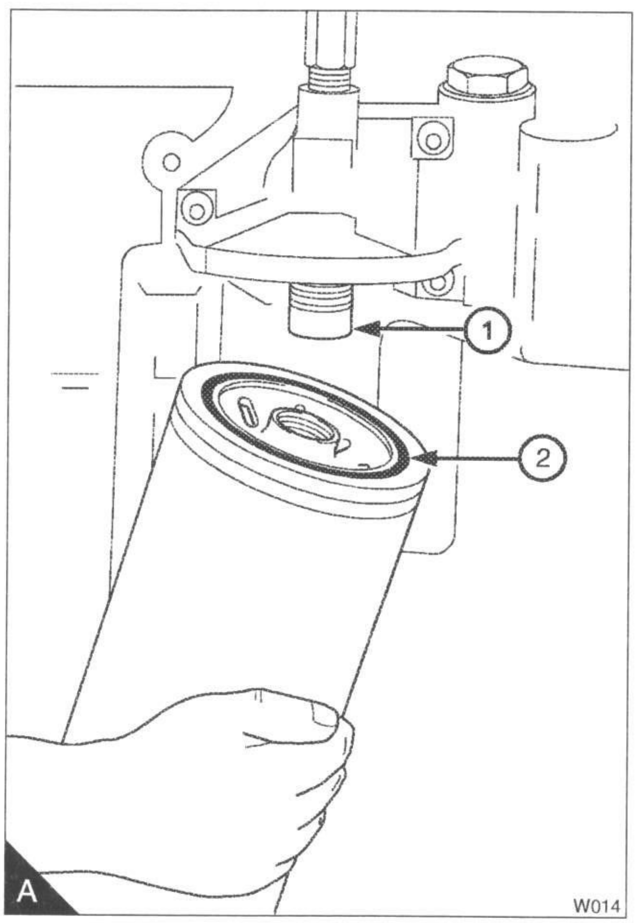
7 Ensure that there is lubricating oil in the sump.

8 Turn the start key to the "ON" position and start the engine.

Note: The engine will not start and operate until oil pressure is obtained. Oil pressure is indicated when the warning light is extinguished or by a reading on the gauge.

When the engine starts check for leakage from the filter. Stop the engine. After 15 minutes check the oil level on the dipstick and, if necessary, put more lubricating oil of an approved grade into the sump.

Caution: *Do not fill the sump past the "FULL" mark on the dipstick.*



Air filter

Environmental conditions have an important effect on the frequency at which the air filter needs service.

The filter element must be cleaned or renewed according to the manufacturer's recommendations.

Restriction indicator

The restriction indicator for these engines must work at a pressure difference of 635 mm (25 in) of water gauge. It is fitted on the air filter outlet or between the air filter and the induction manifold.

The restriction indicator should be tested according to the manufacturer's recommendations.

How to set the valve tip clearances

The valve tip clearance is checked with feeler gauges between the top of the valve stem and the rocker lever (B), with the engine cold. The correct clearance for the inlet valves and the exhaust valves is 0,64 mm (0.025 in). The valve positions are shown at (A).

The arrangement of the valves for each cylinder in sequence is inlet valve then exhaust valve.

Note: Number 1 cylinder is at the front of the engine.

1 Disconnect the air inlet pipe at the rocker cover/induction manifold.

2 Release the 13 cap screws which retain the rocker cover and remove the cover.

3 Turn the crankshaft in the normal direction of rotation until valve 11 (A) has just opened and valve 12 has not closed fully. Check/adjust the clearances of valves 1 and 2.

4 Set valves 3 and 4 as indicated above then check/adjust the clearances of valves 9 and 10.

5 Set valves 7 and 8 then check/adjust the clearances of valves 5 and 6.

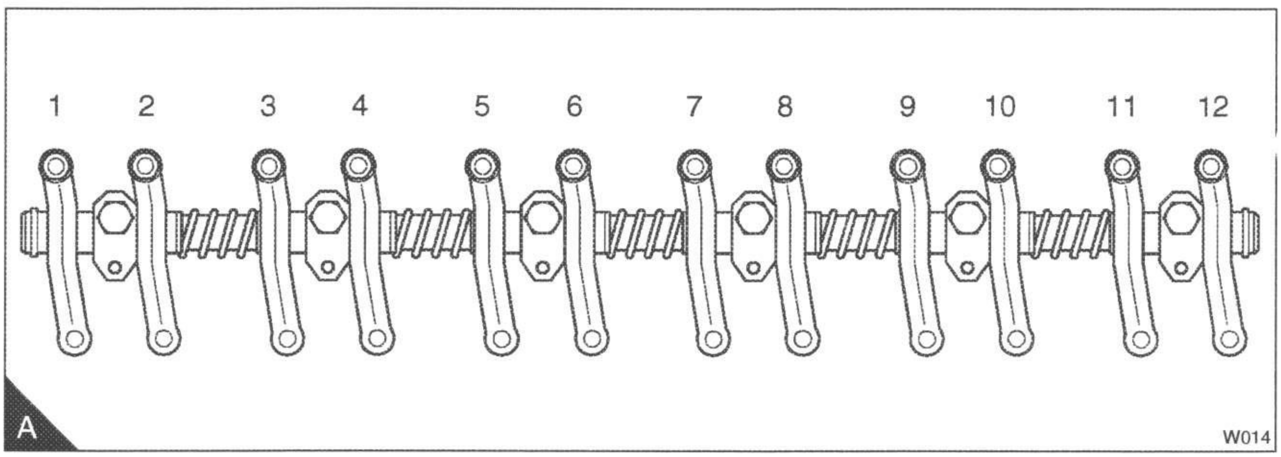
6 Set valves 1 and 2 then check/adjust the clearances of valves 11 and 12.

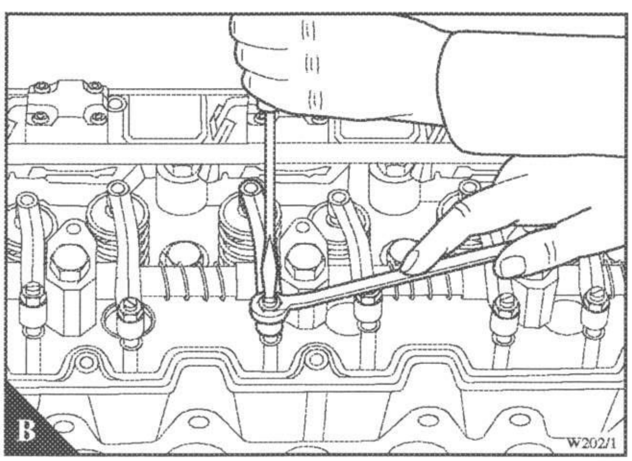
7 Set valves 9 and 10 then check/adjust the clearances of valves 3 and 4.

8 Set valves 5 and 6 then check/adjust the clearances of valves 7 and 8.

9 If necessary, put a new rocker cover/induction manifold gasket in position on the cylinder head. Align carefully the cover and the gasket. Fit the cap screws which retain the rocker cover and tighten them to 17 Nm (13 lbf ft) 1,7 kgf m.

10 Connect the air inlet pipe to the rocker cover





5

Engine fluids

Fuel specification

To get the correct power and performance from your engine, use good quality fuel. The recommended fuel specification for Perkins engines is indicated below:

Cetane number	50 minimum
Viscosity	2.0/4.5 centistokes at 40 °C
Density	0,835/0,855 kg/litre
Sulphur	0.2% of mass, maximum
Distillation	85% at 350 °C

Cetane number indicates ignition performance. A fuel with a low cetane number can cause cold start problems and affect combustion.

Viscosity is the resistance to flow and engine performance can be affected if it is outside the limits.

Density: A lower density reduces engine power, a higher density increases engine power and exhaust smoke.

Sulphur: A high sulphur content (not normally found in Europe, North America or Australasia) can cause engine wear. Where only high sulphur fuels are available, it is necessary to use a highly alkaline lubricating oil in the engine or to renew the lubricating oil more frequently, see "How to renew the lubricating oil" on page 25.

Distillation: This is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light-weight hydrocarbons can affect the combustion characteristics.

Low temperature fuels

Special winter fuels may be available for engine operation at temperatures below 0 °C. These fuels have a lower viscosity and also limit the wax formation in the fuel at low temperatures. If wax formation occurs, this could stop the fuel flow through the filter.

If you need advice on adjustments to an engine setting or to the lubricating oil change periods which may be necessary because of the standard of the available fuel, consult the Technical Service Department of Perkins International Limited at Peterborough or your nearest Perkins Distributor.

Aviation kerosene fuels

Caution: *Do not use aviation kerosene fuel JP4.*

JP5 and JP8 can be used, but they can affect engine performance and wear in the fuel injector units could increase. It is recommended that you consult the Technical Service Department of Perkins International Limited at Peterborough if aviation kerosene fuel is to be used.

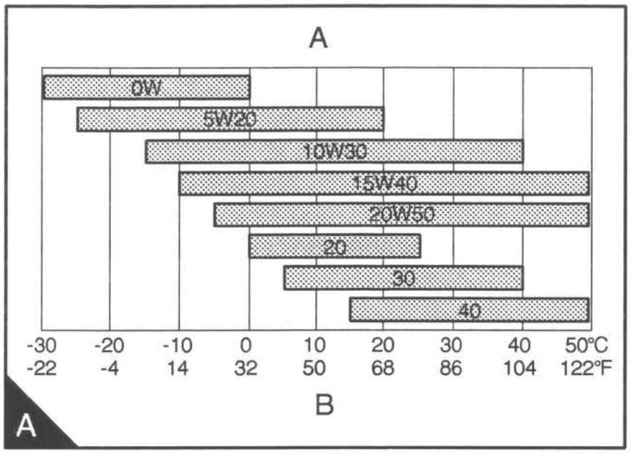
Aviation kerosene fuels are more flammable than diesel fuel and need careful storage and careful management.

Lubricating oil specification

Lubricating oil to the recommended specification API CG-4, API CH4 or ACEA E3 must always be used in countries where it is available for purchase. In countries where it is not available, API CF4 or ACEA E2 must be used.

Caution: *The type of lubricating oil to be used may be affected by the quality of the fuel which is available. For further details see "Fuel specification" on page 29.*

Always ensure that the correct viscosity grade of lubricating oil is used for the ambient temperature range in which the engine will run as shown in the chart (A).



Viscosity chart

A = Recommended viscosity

B = Ambient temperature

Coolant specification

The quality of the coolant which is used can have a great effect on the efficiency and life of the cooling system. The recommendations indicated below can help to maintain a good cooling system and to protect it against frost and/or corrosion.

If the correct procedures are not used, Perkins cannot be held responsible for frost or corrosion damage.

1 If it is possible, use clean soft water in the coolant.

2 If an antifreeze mixture, other than Perkins POWERPART, is used to prevent frost damage, it must have an ethanediol base (ethylene glycol) with a corrosion inhibitor. It is recommended that the corrosion inhibitor is of the sodium nitrite/sodium molybdate type. The antifreeze mixture must be an efficient coolant at all ambient temperatures and it must provide protection against corrosion. It must also have a specification at least as good as the requirements of either BS6580 or MOD AL39.

Perkins POWERPART antifreeze exceeds the requirements of the above standard.

The quality of the antifreeze coolant must be checked at least once a year, for example, at the beginning of the cold period. The coolant must be renewed every two years.

The antifreeze mixture must consist of equal quantities of antifreeze and water. Concentrations of more than 50% of antifreeze must not be used because these can affect adversely the performance of the coolant.

3 When frost protection is not necessary, it is still an advantage to use an approved antifreeze mixture because this gives a protection against corrosion and also raises the boiling point of the coolant. If an approved antifreeze mixture is not available, add a correct mixture of corrosion inhibitor to the water.

All 1300 Series EDi engines are supplied with a coolant filter / conditioner canister. Renew the coolant and the filter / conditioner canister in accordance with the maintenance "Schedules" on page 18. Test the level of coolant conditioner, and adjust if necessary in accordance with the maintenance "Schedules" on page 18.

This page is intentionally blank

6

Fault diagnosis

Problems and possible causes

Problem	Possible causes	
	Checks by the user	Checks by the workshop personnel
The starter motor turns the engine too slowly	1, 2, 3, 4	
The engine does not start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 17	37, 38, 42, 43, 44, 66, 67, 68, 69
The engine is difficult to start	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19	37, 38, 40, 42, 43, 44, 66
Not enough power	8, 9, 10, 11, 12, 13, 16, 8, 9, 20, 21	37, 38, 39, 42, 43, 44, 61, 63, 64, 66, 68, 69
Misfire	8, 9, 10, 12, 13, 15, 20, 22	37, 38, 39, 40, 43; 66, 69
High fuel consumption	11, 13, 15, 17, 18, 19, 23, 22	37, 38, 39, 40, 42, 43, 44, 63, 66
Black exhaust smoke	11, 13, 15, 17, 19, 21, 22	37, 38, 39, 40, 42, 43, 44, 61, 63, 66
Blue or white exhaust smoke	4, 15, 21, 23	37, 38, 39, 42, 43, 44, 45, 52, 58, 62, 66, 68
The pressure of the low pressure lubricating oil system is too low	4, 24, 25, 26	46, 47, 48, 50, 51, 59,
The engine knocks	9, 13, 15, 17, 20, 22, 23	37, 40, 42, 44, 46, 52, 53, 60, 66, 68
The engine runs erratically	8, 9, 10, 11, 12, 13, 15, 16, 18, 20, 22, 23	38, 40, 44, 52, 60, 66, 68, 69
Vibration	13, 18, 20, 27, 28	38, 39, 40, 44, 52, 54, 66, 68, 69
The pressure of the low pressure lubricating oil system is too high	4, 25	49
The engine oil temperature is too high	11, 13, 15, 19, 27, 29, 30, 32, 65	37, 39, 52, 55, 56, 57, 64, 69
Crankcase pressure	31, 33	39, 42, 44, 45, 52
Bad compression	11, 22	37, 39, 40, 42, 43, 44, 45, 53, 60
The engine starts and stops	10, 11, 12	66, 68, 69
The pressure of the high pressure lubricating oil system is too low	4, 24, 25, 26	66, 68, 69

List of possible causes

1 Battery capacity low.
2 Bad electrical connections.
3 Fault in starter motor.
4 Wrong grade of lubricating oil.
5 Starter motor turns engine too slowly.
6 Fuel tank empty.
7 Spare.
8 Restriction in a fuel pipe.
9 Fault in fuel lift pump.
10 Dirty fuel filter element.
11 Restriction in air induction system.
12 Air in fuel system.
13 Fault in the fuel injector units.
14 Cold start system used incorrectly.
15 Fault in cold start system.
16 Restriction in fuel tank vent.
17 Wrong type or grade of fuel used.
18 Restricted movement of engine speed control.
19 Restriction in exhaust pipe.
20 Engine temperature is too high.
21 Engine temperature is too low.
22 Incorrect valve tip clearances.
23 Too much oil or oil of the wrong type is used in wet type air cleaner, if one is fitted.
24 Not enough lubricating oil in sump.
25 Defective gauge.
26 Dirty lubricating oil filter element.
27 Fan damaged.
28 Fault in engine mounting or flywheel housing.
29 Too much lubricating oil in sump.
30 Restriction in air or water passages of radiator.
31 Restriction in breather pipe.
32 Insufficient coolant in system.
33 Fault in exhauster.
34 Spare.
35 Spare.
36 Spare.
37 Valve timing is incorrect.
38 Bad compression.
39 Cylinder head gasket leaks.
40 Valves are not free.
41 Spare.
42 Worn cylinder bores.
43 Leakage between valves and seats.
44 Piston rings are not free or they are worn or broken.
45 Valve stems and/or guides are worn.
46 Crankshaft bearings are worn or damaged.

47 Lubricating oil pump is worn.

48 Relief valve does not close.

49 Relief valve does not open.

50 Relief valve spring is broken.

51 Fault in suction pipe of lubricating oil pump.

52 Piston is damaged.

53 Piston height is incorrect.

54 Flywheel housing or flywheel is not aligned correctly.

55 Fault in thermostat or thermostat is of an incorrect type.

56 Restriction in coolant passages.

57 Fault in water pump.

58 Valve stem seal is damaged.

59 Restriction in sump strainer.

60 Valve spring is broken.

61 Turbocharger impeller is damaged or dirty.

62 Lubricating oil seal of turbocharger leaks.

63 Induction system leaks.

64 Turbocharger waste-gate does not work correctly, if one is fitted.

65 Drive belt for water pump is loose.

66 Faulty engine management system.

67 Broken drive on the high pressure pump.

68 Faulty injection control system

69 Faulty sensor

This page is intentionally blank

OLYMPIAN WARRANTY STATEMENT

This is a warranty which applies to Electric Power Generation Products sold by OLYMPIAN (herein after referred to as "the Company"). The products are warranted against defects in material and workmanship for a period of 12 months* (24 months for standby application limited to 500 hrs per annum) from the date of delivery to first user.

The Company's Responsibilities

If a defect in material or workmanship arises during the warranty period the Company will during normal working hours and through a place of business of a OLYMPIAN Dealer or other source approved by OLYMPIAN:

- Replace or at the Company's discretion repair the defective parts.
- Provide for reasonable and customary labour costs to correct the defect.
- Provide for the cost of service supplies such as coolant oil and filters which are made unserviceable by the defect.
- Provide travel labour, up to four hours and 250miles/400km round trip, if the engine is inoperative due to a defect and, in the opinion of the Company, it cannot reasonably be transported to an appropriate service location.

The User's Responsibilities

The User is responsible for:

- Installing, operating and maintaining the generator set in accordance with the manufacturer's instructions.
- Returning the Warranty Registration Form within one month of delivery.
- Ensuring initial startup is performed by an authorised representative of the company or it dealers. In exceptional circumstances, said startup will be waived but only if a Pre-Delivery Inspection has been completed. In such circumstances, warranty will be adjudged to have commenced one month and terminated 13 months after the date of shipment by the Company.
- Making the equipment available for repair as soon as the defect has become apparent.
- Accepting the Company's sole judgement as to whether the faulty part is defective in material or workmanship.
- Labour costs, except as stated under "The Company's Responsibilities," including costs beyond those required to disconnect the product from and reconnect the product to it's attached equipment, mountings and support systems.
- The costs and risks for transport/shipping and other charges associated with the replacement of the repair parts.
- Any costs in excess of the purchase price of the product.
- Other miscellaneous costs including but not limited to courier, travel, mileage, lodging, taxes, telephone calls, overtime, etc., except as stated under "The Company's Responsibilities."
- Completing any outstanding payments for the purchase of equipment, parts or services relating to the equipment under warranty.

Limitations

This warranty does not cover:

- Defects due to the user's improper installation, maintenance or use as adjudged by the Company
- Alterations or repairs not authorised by the Company in writing.
- Any operation in excess of the Company's rating or outside the stated site conditions.
- Normal wear and tear.
- Damage to parts, fixtures, housings, attachments and accessory items that are not part of the to Electric Power Generation Product.
- Any product specific hours limitations

* GEL power generating set models have an additional running hour limitation as follows: – 5000 hrs at 1500/1800 rpm, 2000 hours at 3000 rpm and 1000 hours at 3600 rpm. Either the 12 months limitations or the running hour limitation is applicable, depending on which occurs first.

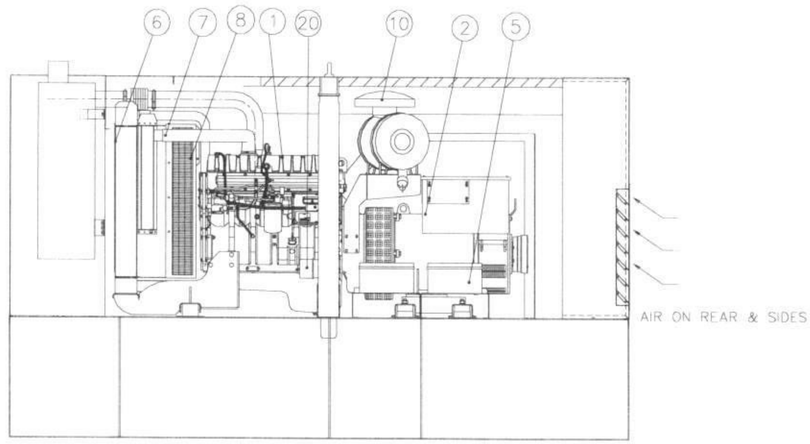
This warranty is expressly in lieu of all other warranties, express or implied, including, but not limited to, any warranty of merchantability or fitness for a particular purpose. All warranties which exceed the aforementioned obligations are hereby disclaimed by the Company and excluded from this warranty. The Company shall, under no circumstances, be held liable for any special direct, indirect, incidental or consequential damages. All claims made under this warranty should be made by contacting your local dealer or the Company who will outline the administration and scope.

Effective with sales to the first user on or after 1 September 2002

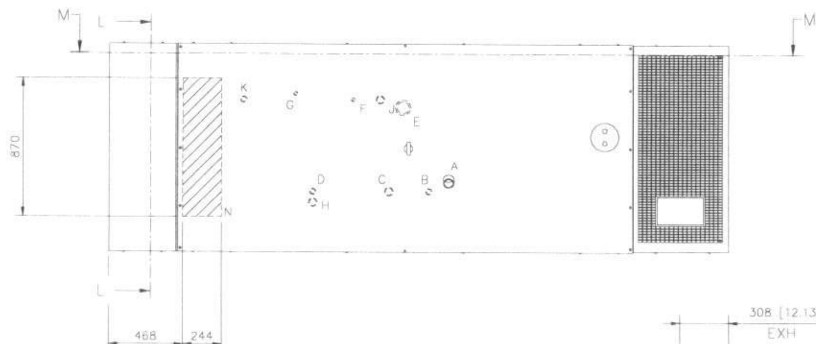
)MBINATION	WEIGHT (Kg)		CENTRE OF GRAVITY	
	WITH OIL	WITH OIL & WATER	DIM X	DIM Y
)0/ LL5014F	3805	3840	1790	1215
)0/ LL5014J	3047	3106	1790	1215

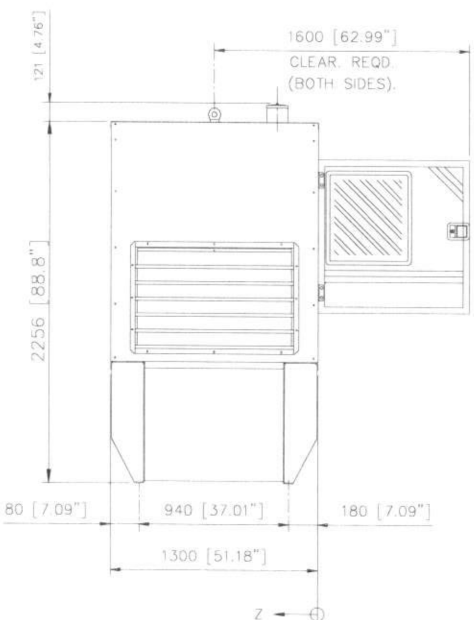
DESCRIPTION	DIM X	DIM Y	DIM Z
L FILL - 2" BSP SOCKET	2142	750	445
SWITCH - 1" BSP HALF SOCKET	2017	731	380
GAUGE - 1½" BSP HALF SOCKET	1767	720	380
L SUPPLY - 1" BSP HALF SOCKET	1287	704	380
RELIEF VENT - 3" BSP SOCKET	1855	750	905
N - ½" BSP SOCKET	1542	709	955
Y - ½" BSP SOCKET	1177	709	993
L RETURN - 1½" BSP HALF SOCKET	1287	704	310
BREATHER - 1¼" BSP SOCKET	1712	731	955
TION PROBE - 1" BSP HALF SOCKET	851	748	955
DRAIN - 1" BSP HALF SOCKET	3791	47	326
NK DRAIN - 2" BSP SOCKET	3791	93	650
REA (244 x 870)	590	756	650

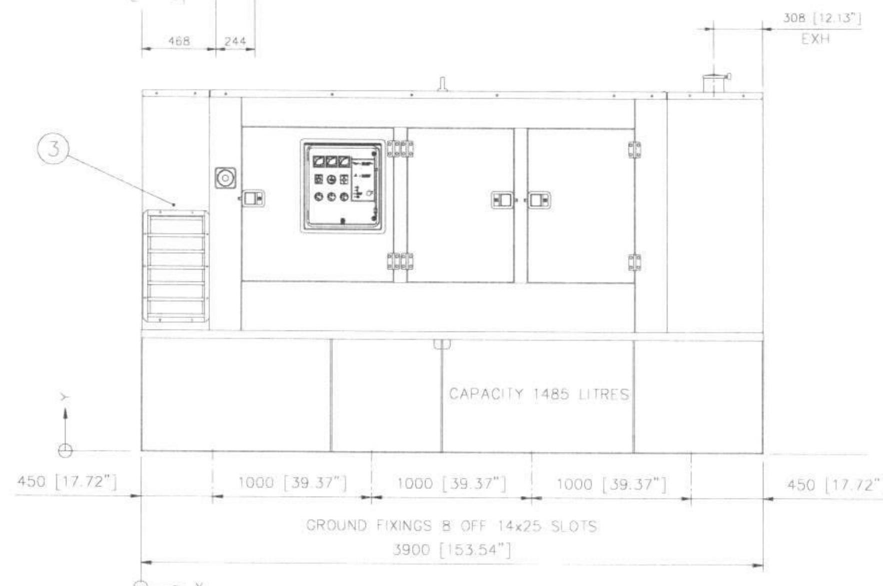
)R INFORMATION ONLY



SECTION M-M

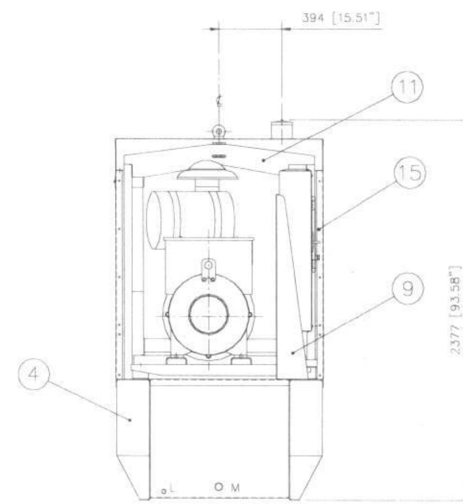






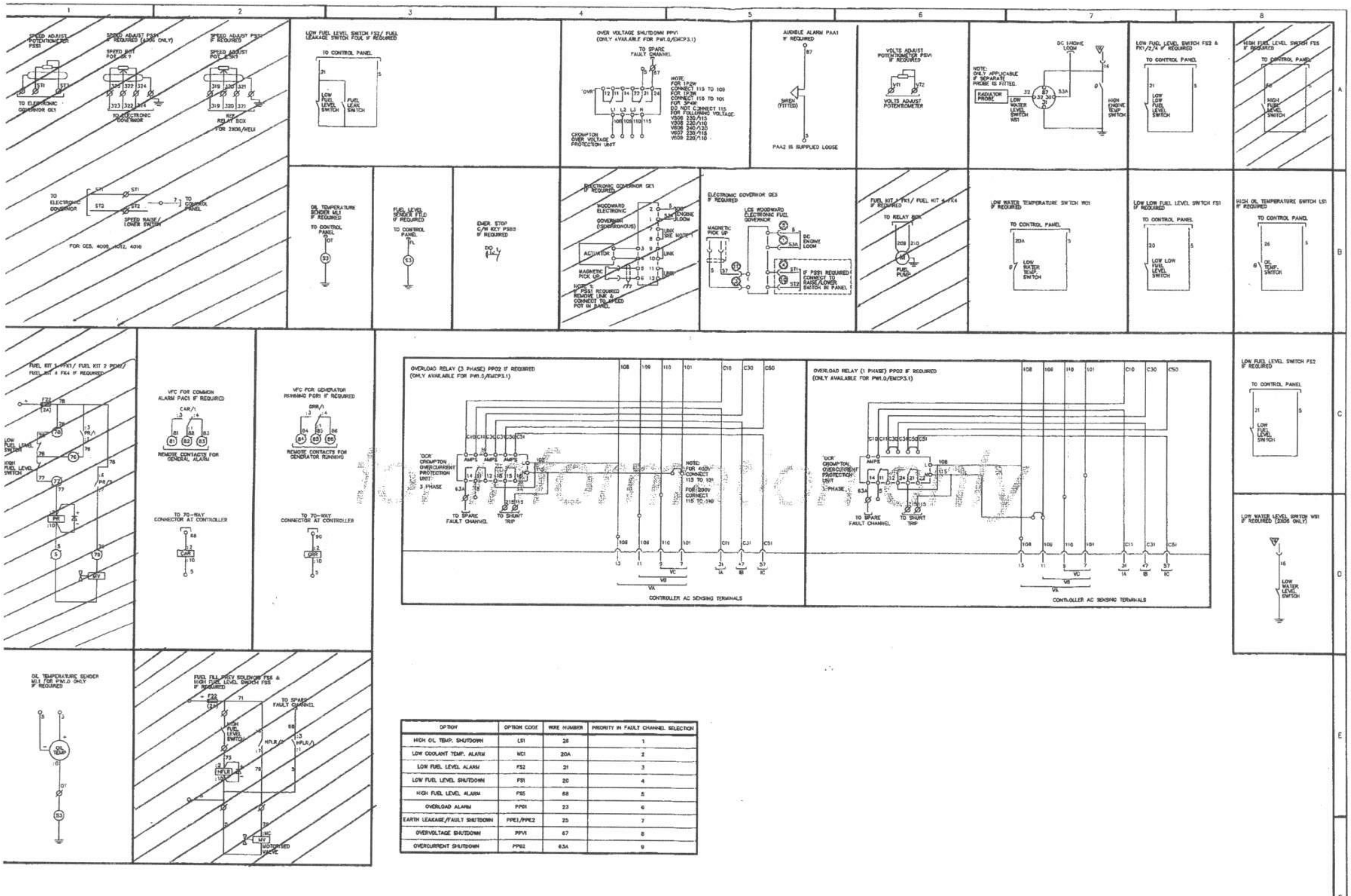
	ITEM	QTY.	DESCRIPTION	DW
	1	1	ENGINE - PERKINS 1306E87TA300	1
	2a	1	ALTERNATOR - LL5014F	1
	2b	1	ALTERNATOR - LL5014J	1
	3	1	CANOPY & EXHAUST SYSTEM	M
	4	1	BASEFRAME ARRANGEMENT	M
	5	1	BATTERY GROUP	M
	6	1	RADIATOR AND FAN SYSTEM	M
	7	1	CHARGE AIR SYSTEM	M
	8	1	FAN & PULLEY GUARD ARRANGEMENT	M
*	9	1	EXHAUST MANIFOLD GUARD(IF FITTED)	M
	10	1	PANEL STAND ARRANGEMENT	M
	11	1	AIR FILTER SYSTEM	M
	12	1	LIFTING ARRANGEMENT	M
*	13	1	COUPLING FOR ALTERNATOR/ENGINE	M
*	14	1	MAGNETIC PICKUP ARRANGEMENT	M
*	15	1	SENDERS & SENSORS SYSTEM	M
	16	1	CONTROL PANEL(IF FITTED)	
*	17	1	CIRCUIT BREAKER(IF FITTED)	
*	18	1	FUEL LINE SYSTEM	M
*	19	1	CHARGING ALTERNATOR - 24V	M
	20	1	HUEI STARTER MOTOR	M

* - ITEM NOT SHOWN



SECTION L-L

Drawing when printed is only valid for 14 Days from this Date 03/05/2006



OPTION	OPTION CODE	WIRE NUMBER	PRIORITY IN FAULT CHANNEL SELECTION
HIGH OIL TEMP. SHUTDOWN	LS1	26	1
LOW COOLANT TEMP. ALARM	WC1	20A	2
LOW FUEL LEVEL ALARM	FS2	21	3
LOW FUEL LEVEL SHUTDOWN	FS1	20	4
HIGH FUEL LEVEL ALARM	FS5	68	5
OVERLOAD ALARM	PP01	23	6
EARTH LEAKAGE/FAULT SHUTDOWN	PPE1/PPE2	25	7
OVERVOLTAGE SHUTDOWN	PPV1	67	8
OVERCURRENT SHUTDOWN	PP02	63A	9

REMARKS

(84) CUSTOMER TERMINAL
Ø TERMINAL IN CONTROL PANEL
A.C. CONNECTOR FROM ALTERNATOR
O INTERNAL PANEL TERMINAL

DESCRIPTION	ECR/DCR	BY	DATE
FS8 ADDED & WIRE NUMBER CHNAGES	25587	A.C	06/02/06
MODIFICATIONS MADE FOR COMMON DESIGN POLICY	24911	C.C.	11/10/05
FIRST ISSUE	-	J.E.	-

THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

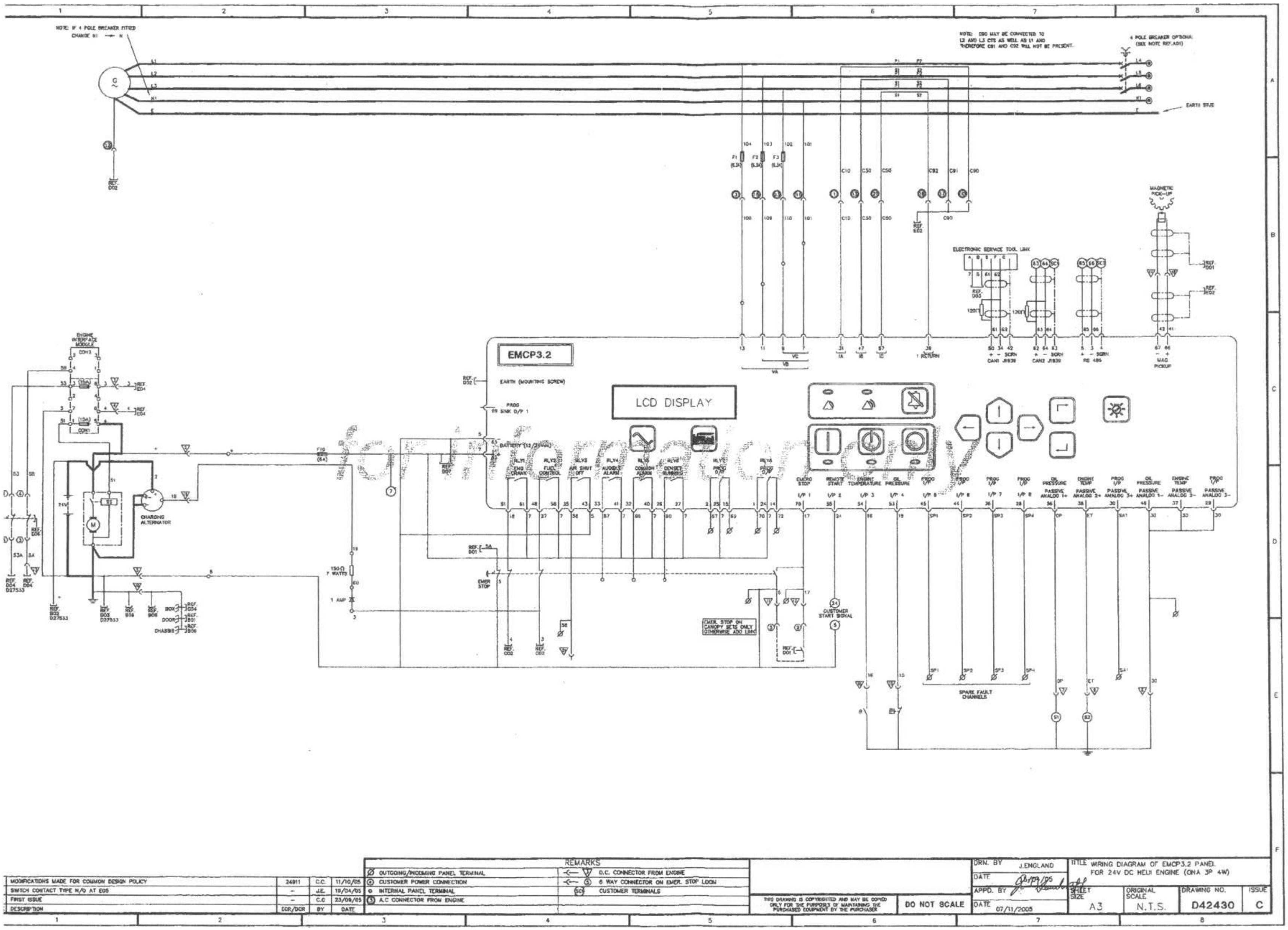
DO NOT SCALE

DRN. BY J.ENGLAND
DATE 25/04/05
APPD. BY
DATE 21/02/2006

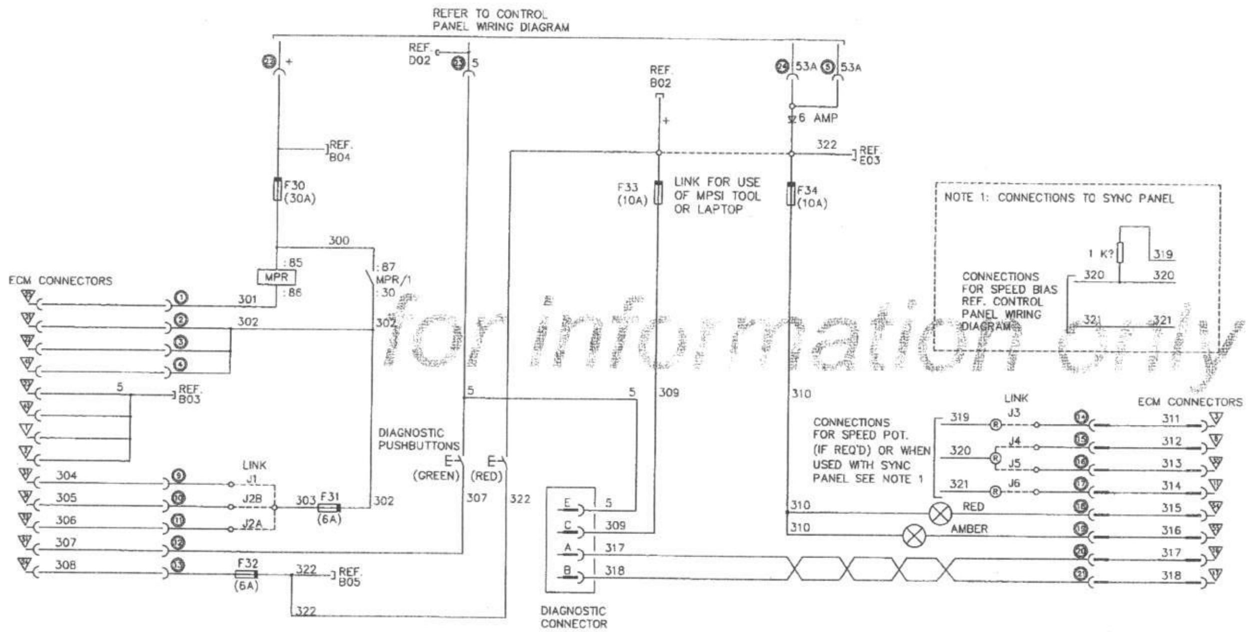
TITLE OPTIONS SCHEMATIC PANEL / ENGINE

SHEET SIZE A1 | ORIGINAL SCALE N.T.S. | DRAWING NO. D42812 | ISSUE C

Drawing when printed is only valid for 14 Days from this Date 03/05/2006



Drawing when printed is only valid for 14 Days from this Date 03/05/2006



for information only

DIAGNOSTICS: REFER TO MANUAL FOR DIAGNOSTIC TEST PROCEDURE AND FAULT FLASH CODES.
TO ENABLE ECM FOR USE OF MPSI TOOL OR LAPTOP LINK WIRES 322 AND +
NOTE: LINK NOT REQUIRED IF ENGINE IS RUNNING

ECM TYPE 1
1500RPM – LINKS J1 & J2A
1800RPM – LINKS J1 & J2B

ECM TYPE 2 & 3
ISOCHRONUS – J1 & J2A
MANUAL/DROOP LOADSHARE – J3, J4 & J6
AUTO./ISOC. LOADSHARE – J1, J3, J5 & J6

ECM TYPE 1 – 1500/1800RPM NON-LOADSHARING ISOCHRONUS
ECM TYPE 2 – 1500RPM MULTIFUNCTION
ECM TYPE 3 – 1800RPM MULTIFUNCTION

ISSUE	DESCRIPTION	ECR/DCR	BY	DATE
L	DIAGNOSTICS NOTE AMMENDED	21333	J.M.	20/03/03
K	TERMINATION CHANGED/TERMINAL REVIEWED	21333	GAW	20/01/03
J	CONNECTIONS TO SYNC PANEL ADDED	21002	J.M.	05-03-02
H	RELAY BOX LOOM AMENDED	6008	D.N.	30-03-01
G	TEXT ADDED TO PUSHBUTTONS		M.S.	09-11-99

▽ CONNECTOR FROM ECM
(11) CONNECTOR TO RELAY BOX
(R) INCOMING/OUTGOING RELAY BOX TERMINAL
o INTERNAL RELAY BOX TERMINAL

THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

DO NOT SCALE

DRN. BY	M.SLOAN	TITLE	WIRING DIAGRAM OF RELAY BOX FOR 24V DC HEUI ENGINE
DATE	30/03/00		
APPD. BY	[signature]		
DATE	20/03/03		

SHEET SIZE	ORIGINAL SCALE	DRAWING NO.	ISSUE
A3	N.T.S.	D27533	L

Drawing when printed is only valid for 14 Days from this Date 04/05/2006

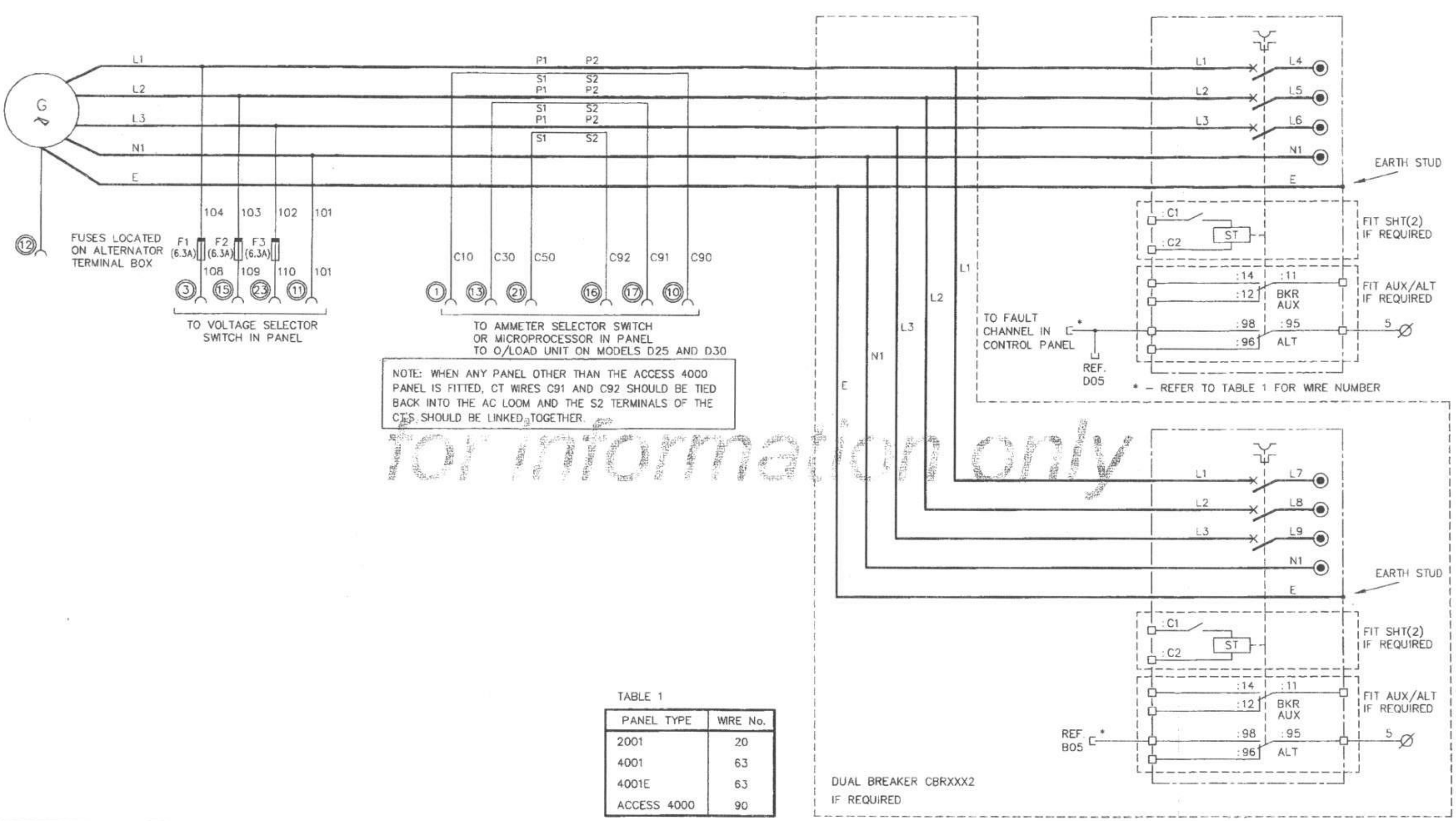


TABLE 1

PANEL TYPE	WIRE No.
2001	20
4001	63
4001E	63
ACCESS 4000	90

ISSUE	DESCRIPTION	ECR/DCR	BY	DATE
B	INFORMATION ADDED TO CT DETAIL FOR 1100 MODELS D25,D30	21455	G.M.	09/06/04
A	FIRST ISSUE	–	–	–

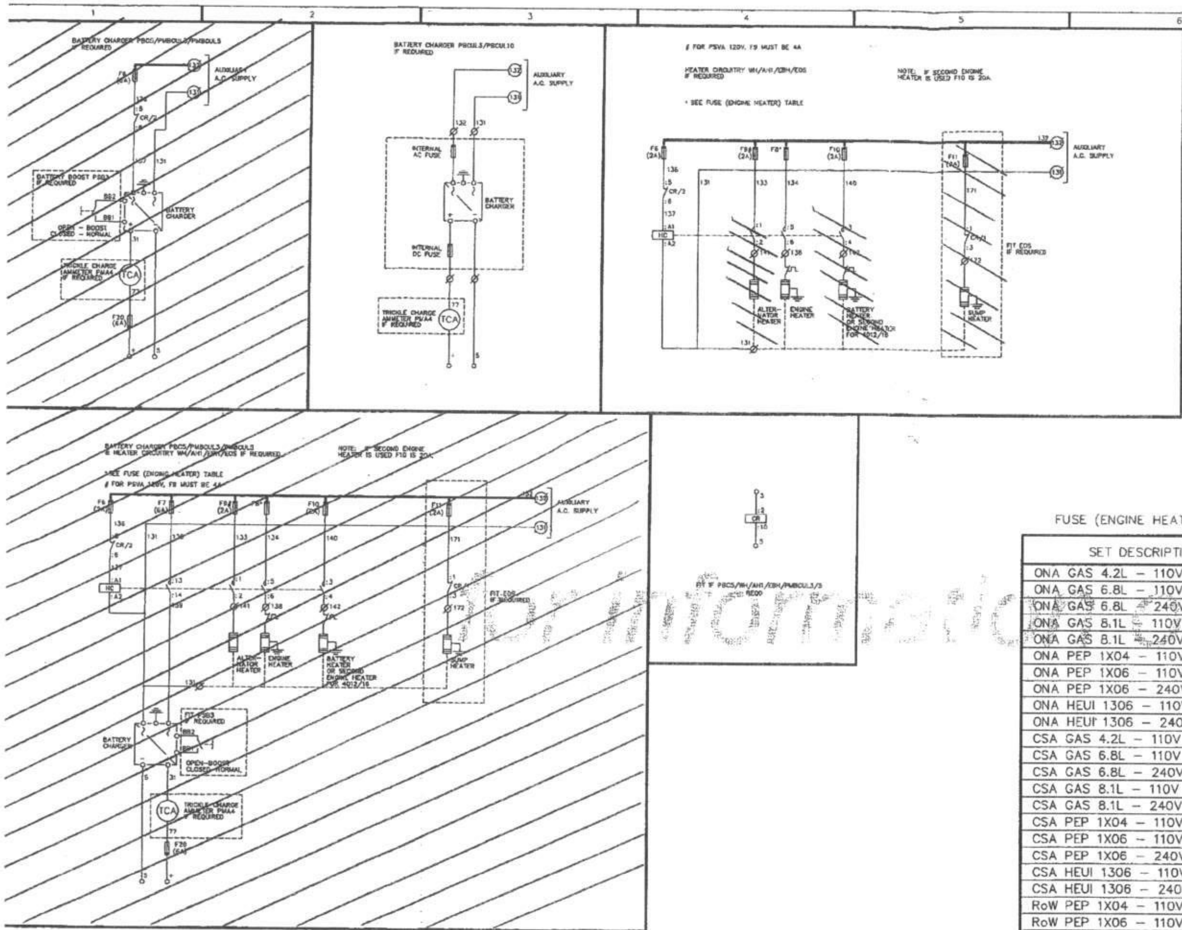
◉ CUSTOMER POWER CONNECTION
Ø TERMINAL IN CONTROL PANEL
–⑪ A.C. CONNECTOR FROM ALTERNATOR
□ BREAKER BOX TERMINAL

THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

DRN. BY	G. THOMPSON	TITLE	AC SECTION (3P 4W, ONA) (OPTIONALISED)		
DATE	28/02/02				
APPD. BY	Joanne Moore	SHEET SIZE	ORIGINAL SCALE	DRAWING NO.	ISSUE
DATE	17/06/2004	A4	N.T.S.	D35231	B

/A3/01

Drawing when printed is only valid for 14 Days from this Date 03/05/2006



FUSE (ENGINE HEATER)

SET DESCRIPTION	FUSE DESCRIPTION
ONA GAS 4.2L – 110V AND 240V	10A
ONA GAS 6.8L – 110V	20A
ONA GAS 6.8L – 240V	10A
ONA GAS 8.1L – 110V	20A
ONA GAS 8.1L – 240V	10A
ONA PEP 1X04 – 110V AND 240V	10A
ONA PEP 1X06 – 110V	16A
ONA PEP 1X06 – 240V	10A
ONA HEUI 1306 – 110V	20A
ONA HEUI 1306 – 240V	10A
CSA GAS 4.2L – 110V AND 240V	10A
CSA GAS 6.8L – 110V	20A
CSA GAS 6.8L – 240V	10A
CSA GAS 8.1L – 110V	20A
CSA GAS 8.1L – 240V	10A
CSA PEP 1X04 – 110V AND 240V	10A
CSA PEP 1X06 – 110V	15A
CSA PEP 1X06 – 240V	10A
CSA HEUI 1306 – 110V	20A
CSA HEUI 1306 – 240V	10A
RoW PEP 1X04 – 110V AND 240V	10A
RoW PEP 1X06 – 110V AND 240V	10A
RoW HEUI 1306 – 110V AND 240V	10A
RoW 2X06 – 240V	16A
RoW 4006 – 240V	20A
RoW 4008 – 240V	20A
RoW 4012 – 240V	20A
RoW 4016 – 240V	20A

DESCRIPTION	ECR/DCR	BY	DATE
FUSES FOR PEST UPDATED TO 20A	25555	ABA	18/01/06
MODIFICATIONS MADE FOR COMMON DESIGN POLICY	24911	C.C.	11/10/05
FIRST ISSUE	–	J.E.	–

REMARKS

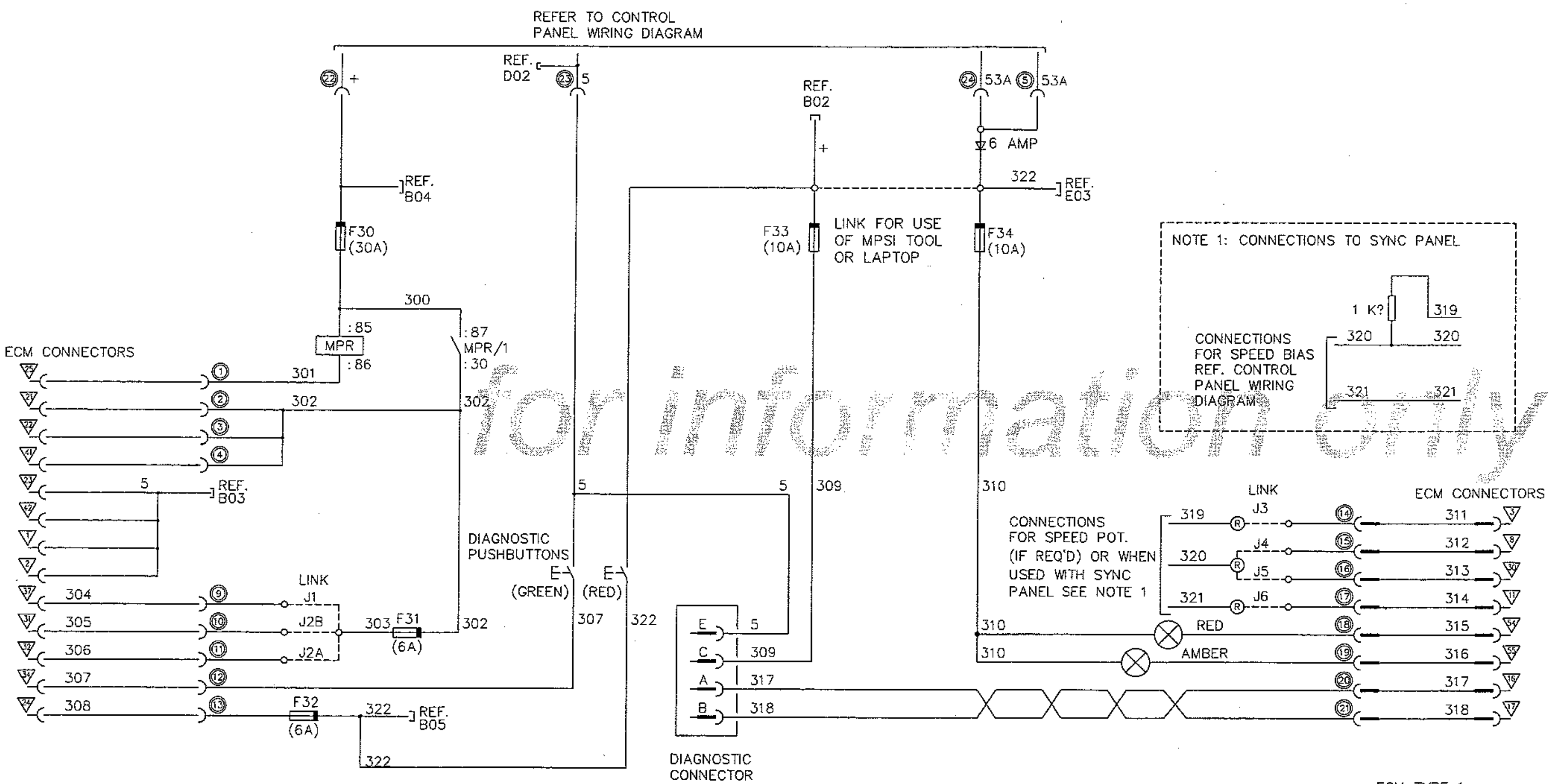
- CUSTOMER TERMINAL
- O INTERNAL PANEL TERMINAL
- Ø OUTGOING/INCOMING PANEL TERMINAL

THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

DO NOT SCALE

DRN. BY	J.ENGLAND
DATE	25/04/05
APPD. BY	[signature]
DATE	19/01/2006
TITLE	OPTIONS SCHEMATIC BATTERY CHARGER / HEATERS
SHEET SIZE	A3
ORIGINAL SCALE	N.T.S.
DRAWING NO.	D42811
ISSUE	C

Drawing when printed is only valid for 14 Days from this Date 03/05/2006



ECM TYPE 1
1500RPM – LINKS J1 & J2A
1800RPM – LINKS J1 & J2B

ECM TYPE 2 & 3
ISOCHRONUS – J1 & J2A
MANUAL/DROOP LOADSHARE – J3, J4 & J6
AUTO./ISOC. LOADSHARE – J1, J3, J5 & J6

DIAGNOSTICS: REFER TO MANUAL FOR DIAGNOSTIC TEST PROCEDURE AND FAULT FLASH CODES.
TO ENABLE ECM FOR USE OF MPSI TOOL OR LAPTOP LINK WIRES 322 AND +
NOTE: LINK NOT REQUIRED IF ENGINE IS RUNNING

ECM TYPE 1 – 1500/1800RPM NON-LOADSHARING ISOCHRONUS
ECM TYPE 2 – 1500RPM MULTIFUNCTION
ECM TYPE 3 – 1800RPM MULTIFUNCTION

ISSUE	DESCRIPTION	ECR/DCR	BY	DATE
L	DIAGNOSTICS NOTE AMMENDED	21333	J.M.	20/03/03
K	TERMINATION CHANGED/TERMINAL REVIEWED	21333	GAW	20/01/03
J	CONNECTIONS TO SYNC PANEL ADDED	21002	J.M.	05-03-02
H	RELAY BOX LOOM AMENDED	6008	D.N.	30-03-01
G	TEXT ADDED TO PUSHBUTTONS		M.S.	09-11-99

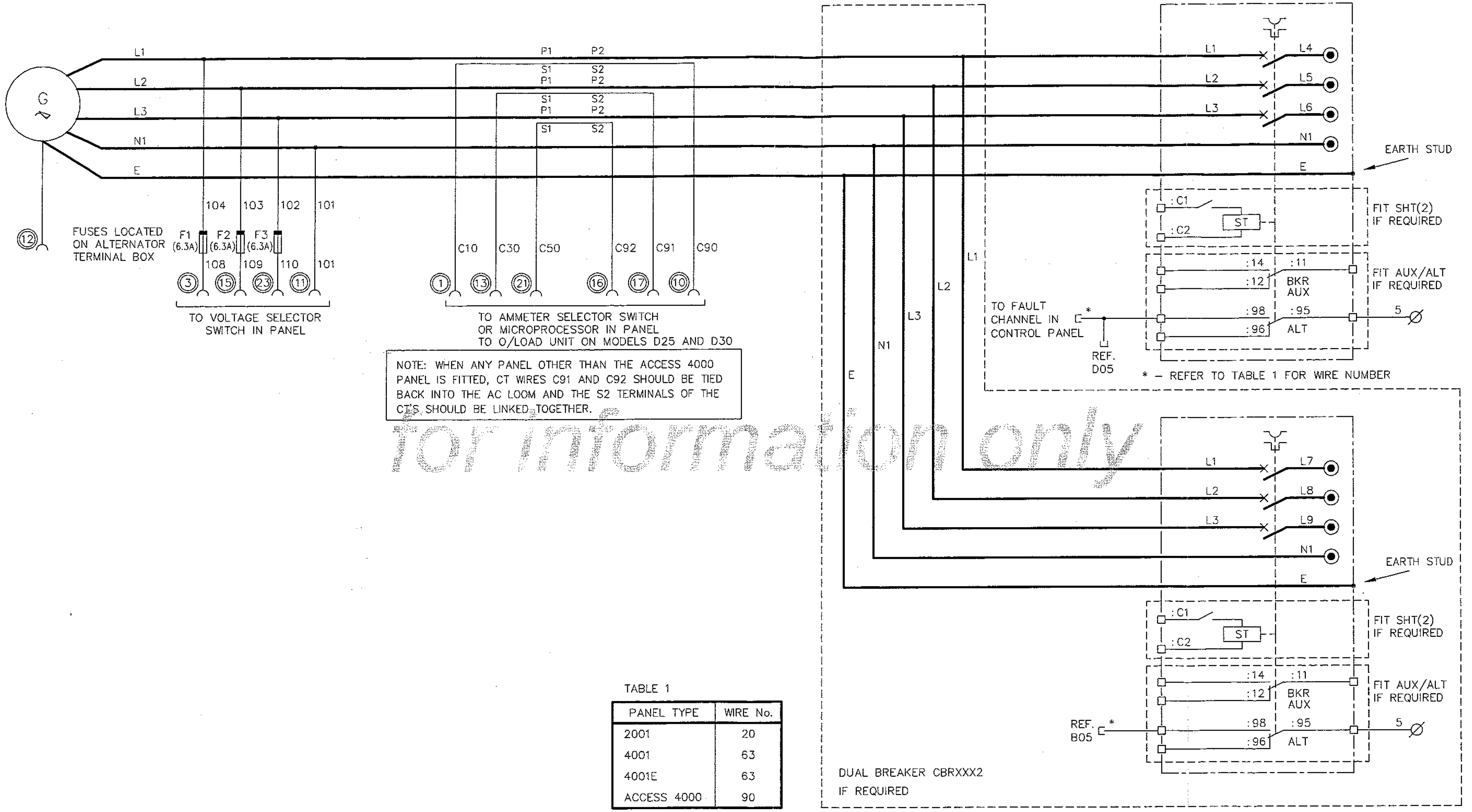
CONNECTOR FROM ECM
CONNECTOR TO RELAY BOX
INCOMING/OUTGOING RELAY BOX TERMINAL
INTERNAL RELAY BOX TERMINAL

THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

DO NOT SCALE

DRN. BY	M.SLOAN
DATE	30/03/00
APPD. BY	[signature]
DATE	20/03/03
TITLE	WIRING DIAGRAM OF RELAY BOX FOR 24V DC HEUI ENGINE
SHEET SIZE	A3
ORIGINAL SCALE	N.T.S.
DRAWING NO.	D27533
ISSUE	L

Drawing when printed is only valid for 14 Days from this Date 04/05/2006



NOTE: WHEN ANY PANEL OTHER THAN THE ACCESS 4000 PANEL IS FITTED, CT WIRES C91 AND C92 SHOULD BE TIED BACK INTO THE AC LOOM AND THE S2 TERMINALS OF THE CT'S SHOULD BE LINKED TOGETHER.

for information only

TABLE 1

PANEL TYPE	WIRE No.
2001	20
4001	63
4001E	63
ACCESS 4000	90

ISSUE	DESCRIPTION	ECR/DCR	BY	DATE
B	INFORMATION ADDED TO CT DETAIL FOR 1100 MODELS D25,D30	21455	G.M.	09/06/04
A	FIRST ISSUE	–	–	–

◉ CUSTOMER POWER CONNECTION
Ø TERMINAL IN CONTROL PANEL
–((11) A.C. CONNECTOR FROM ALTERNATOR
□ BREAKER BOX TERMINAL

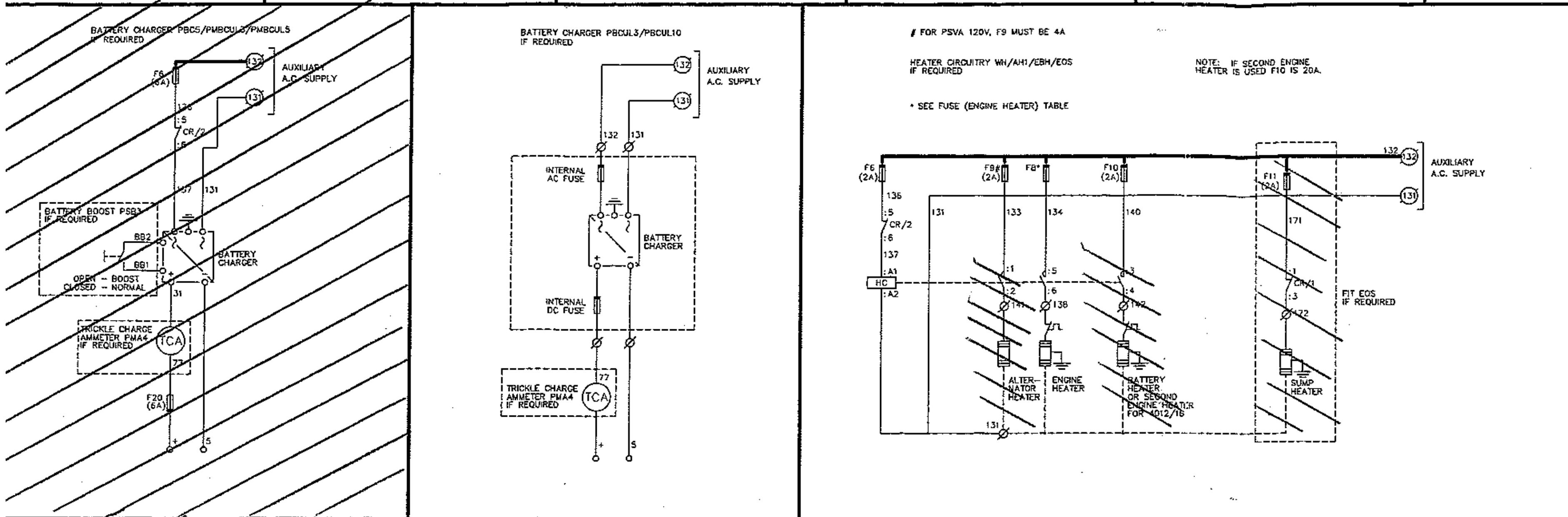
THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

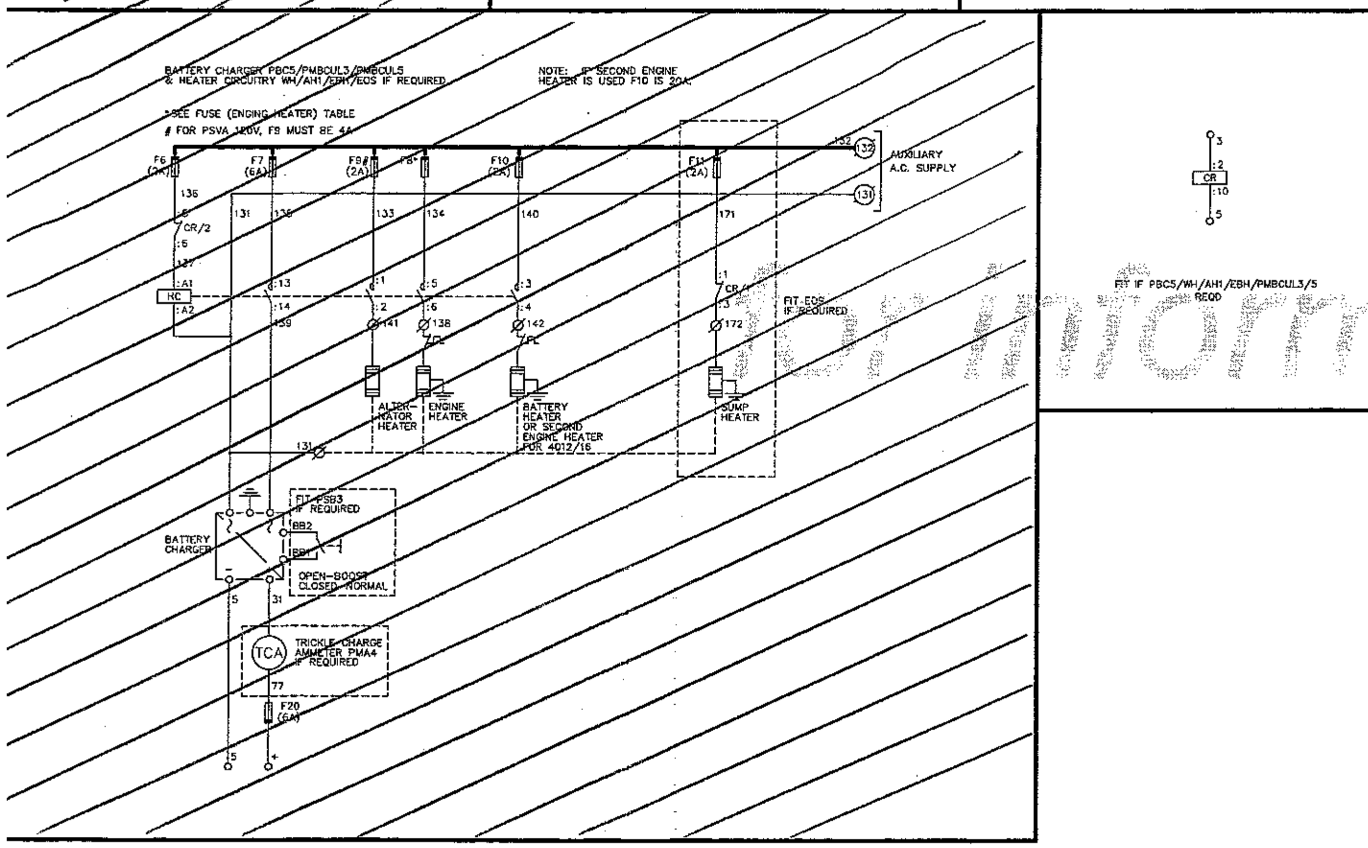
DRN. BY G. THOMPSON
DATE 28/02/02
APPD. BY [signature]
DATE 17/06/2004

TITLE AC SECTION (3P 4W, ONA) (OPTIONALISED)

SHEET SIZE A4
ORIGINAL SCALE N.T.S.
DRAWING NO. D35231
ISSUE B

Drawing when printed is only valid for 14 Days from this Date 03/05/2006





For Information Only

FUSE (ENGINE HEATER)

SET DESCRIPTION	FUSE DESCRIPTION
ONA GAS 4.2L – 110V AND 240V	10A
ONA GAS 6.8L – 110V	20A
ONA GAS 6.8L – 240V	10A
ONA GAS 8.1L – 110V	20A
ONA GAS 8.1L – 240V	10A
ONA PEP 1X04 – 110V AND 240V	10A
ONA PEP 1X06 – 110V	16A
ONA PEP 1X06 – 240V	10A
ONA HEUI 1306 – 110V	20A
ONA HEUI 1306 – 240V	10A
CSA GAS 4.2L – 110V AND 240V	10A
CSA GAS 6.8L – 110V	20A
CSA GAS 6.8L – 240V	10A
CSA GAS 8.1L – 110V	20A
CSA GAS 8.1L – 240V	10A
CSA PEP 1X04 – 110V AND 240V	10A
CSA PEP 1X06 – 110V	15A
CSA PEP 1X06 – 240V	10A
CSA HEUI 1306 – 110V	20A
CSA HEUI 1306 – 240V	10A
RoW PEP 1X04 – 110V AND 240V	10A
RoW PEP 1X06 – 110V AND 240V	10A
RoW HEUI 1306 – 110V AND 240V	10A
RoW 2X06 – 240V	16A
RoW 4006 – 240V	20A
RoW 4008 – 240V	20A
RoW 4012 – 240V	20A
RoW 4016 – 240V	20A

DESCRIPTION	ECR/DCR	BY	DATE
FUSES FOR PEST UPDATED TO 20A	25555	ABA	18/01/06
MODIFICATIONS MADE FOR COMMON DESIGN POLICY	24911	C.C.	11/10/05
FIRST ISSUE	–	J.E.	–

REMARKS

(2) CUSTOMER TERMINAL
o INTERNAL PANEL TERMINAL
Ø OUTGOING/INCOMING PANEL TERMINAL

THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

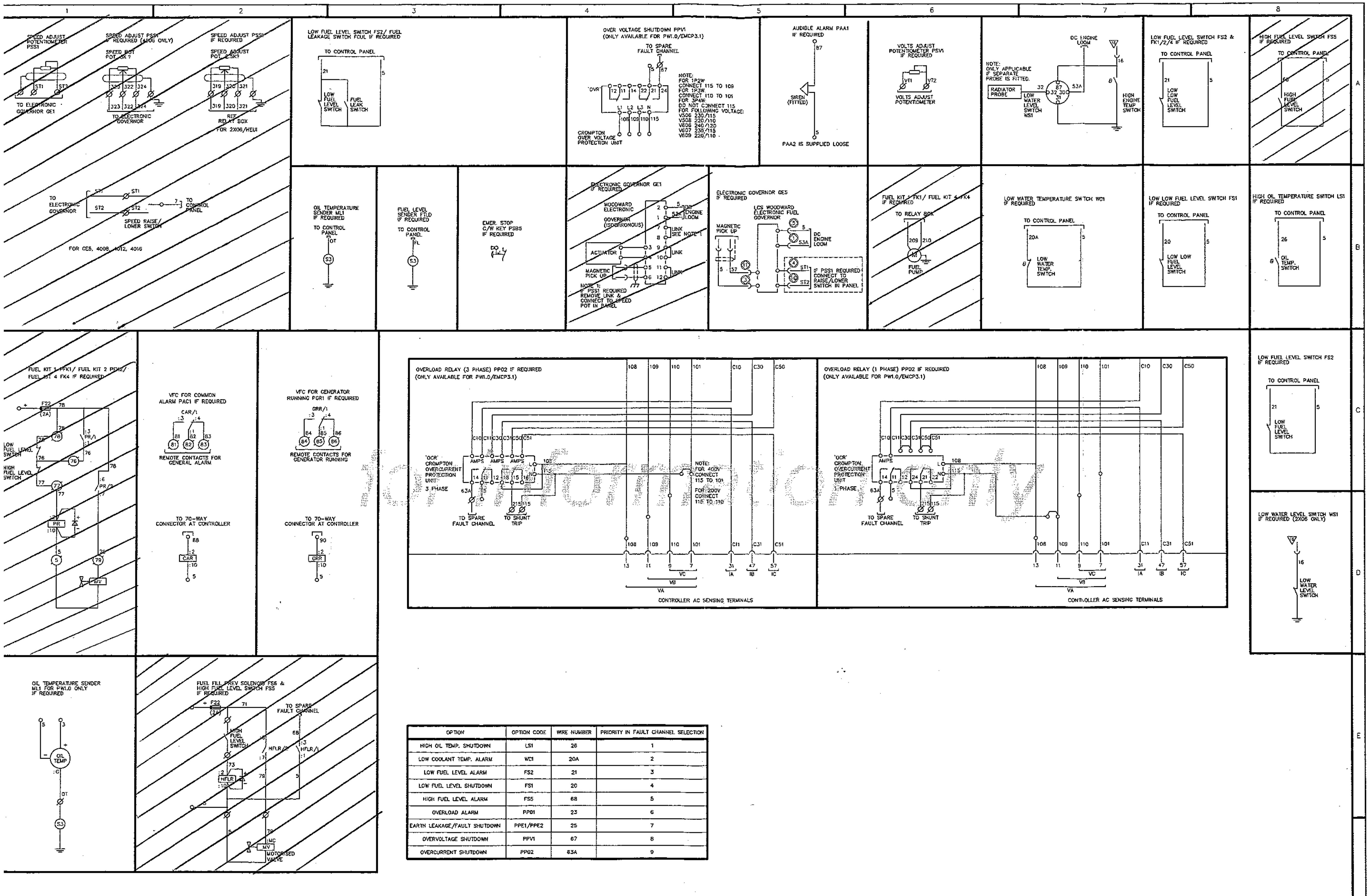
DO NOT SCALE

DRN. BY J.ENGLAND DATE 25/04/05
APPD. BY [signature] DATE 19/01/2006

TITLE OPTIONS SCHEMATIC BATTERY CHARGER / HEATERS

SHEET SIZE A3 | ORIGINAL SCALE N.T.S. | DRAWING NO. D42811 | ISSUE C

Drawing when printed is only valid for 14 Days from this Date 03/05/2006



OPTION	OPTION CODE	WIRE NUMBER	PRIORITY IN FAULT CHANNEL SELECTION
HIGH OIL TEMP. SHUTDOWN	LS1	26	1
LOW COOLANT TEMP. ALARM	WC1	20A	2
LOW FUEL LEVEL ALARM	FS2	21	3
LOW FUEL LEVEL SHUTDOWN	FS1	20	4
HIGH FUEL LEVEL ALARM	FS5	68	5
OVERLOAD ALARM	PP01	23	6
EARTH LEAKAGE/FAULT SHUTDOWN	PPE1/PPE2	25	7
OVERVOLTAGE SHUTDOWN	PPV1	67	8
OVERCURRENT SHUTDOWN	PP02	63A	9

DESCRIPTION	ECR/DCR	BY	DATE
FS6 ADDED & WIRE NUMBER CHNAGES	25587	A.C	06/02/06
MODIFICATIONS MADE FOR COMMON DESIGN POLICY	24911	C.C.	11/10/05
FIRST ISSUE	–	J.E.	–

REMARKS

(84) CUSTOMER TERMINAL

Ø TERMINAL IN CONTROL PANEL

(11) A.C. CONNECTOR FROM ALTERNATOR

o INTERNAL PANEL TERMINAL

THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

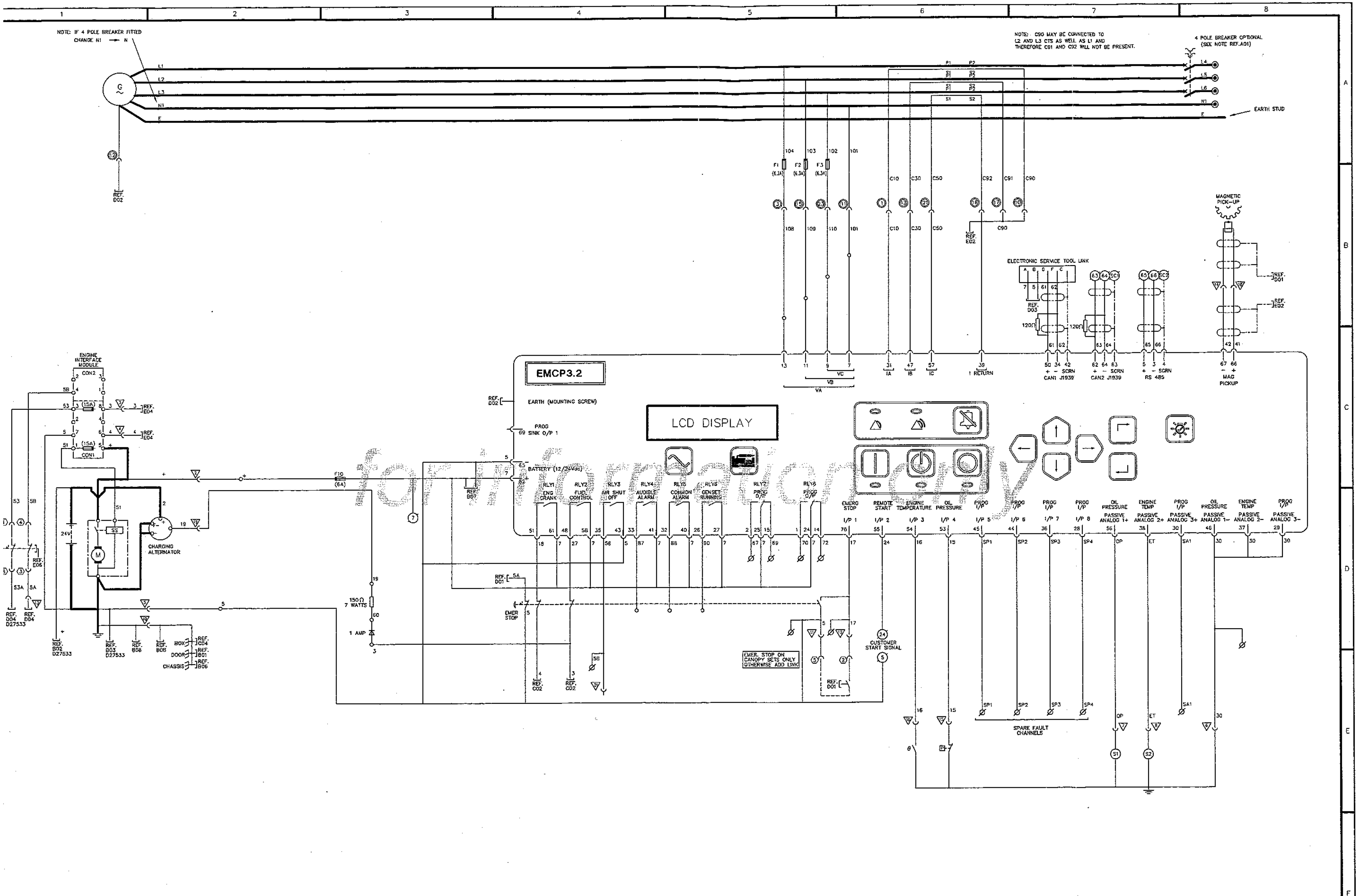
DO NOT SCALE

DRN. BY J.ENGLAND
DATE 25/04/05
APPD. BY
DATE 21/02/2006

TITLE OPTIONS SCHEMATIC PANEL / ENGINE

SHEET SIZE A1 | ORIGINAL SCALE N.T.S. | DRAWING NO. D42812 | ISSUE C

Drawing when printed is only valid for 14 Days from this Date 03/05/2006



MODIFICATIONS MADE FOR COMMON DESIGN POLICY	24911	C.C.	11/10/05
SWITCH CONTACT TYPE N/O AT E05	–	J.E.	19/04/05
FIRST ISSUE	–	C.C	23/09/05
DESCRIPTION	ECR/DCR	BY	DATE

REMARKS

- Ø OUTGOING/INCOMING PANEL TERMINAL
- ⊘ CUSTOMER POWER CONNECTION
- o INTERNAL PANEL TERMINAL
- (3) A.C CONNECTOR FROM ENGINE
- D.C. CONNECTOR FROM ENGINE
- (5) 6 WAY CONNECTOR ON EMER. STOP LOOM
- (SC) CUSTOMER TERMINALS

THIS DRAWING IS COPYRIGHTED AND MAY BE COPIED ONLY FOR THE PURPOSES OF MAINTAINING THE PURCHASED EQUIPMENT BY THE PURCHASER

DO NOT SCALE

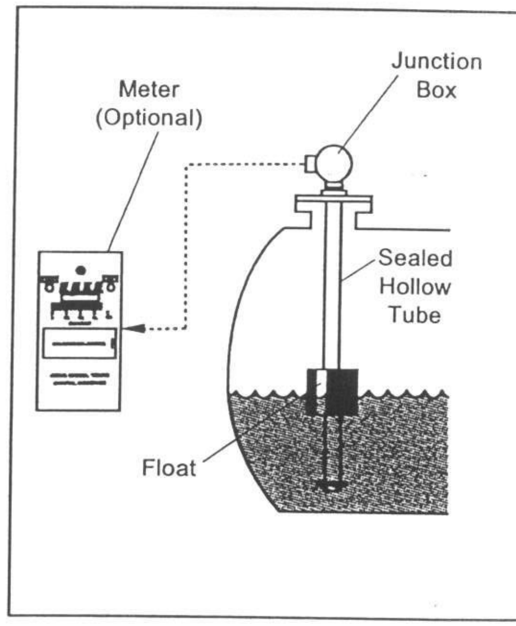
DRN. BY J.ENGLAND
DATE 23/09/05
APPD. BY
DATE 07/11/2005

TITLE WIRING DIAGRAM OF EMCP3.2 PANEL FOR 24V DC HEUI ENGINE (ONA 3P 4W)

SHEET SIZE A3 | ORIGINAL SCALE N.T.S. | DRAWING NO. D42430 | ISSUE C

Continuous Level Transmitters
Series CLT
Instruction Bulletin No. 203071
Rev. A

Designed for continuous liquid level sensing, Dwyer transmitters are considered "components".



Operating Principle

The CLT Series utilizes reed switch/magnet technology. A magnet-equipped float rises or lowers with corresponding liquid level. The magnetic field generated from the float actuates a series of reed switches mounted within a sealed hollow tube. The series of reed switches is combined with resistors to form a voltage divider.

When a regulated DC voltage is applied to an CLT, the resulting voltage output is directly proportional to liquid level.

Installation / Mounting

Units operate normally in any attitude, from vertical to a 30° inclination, up or down.

Thread Treatment

Sealing: When threading metal threads into a metal coupling , pipe sealant or Teflon tape is recommended. Due to potential compatibility problems, when sealing plastic threaded units, a compatible pipe sealant such as "No More Leaks" from Permatex is recommended.

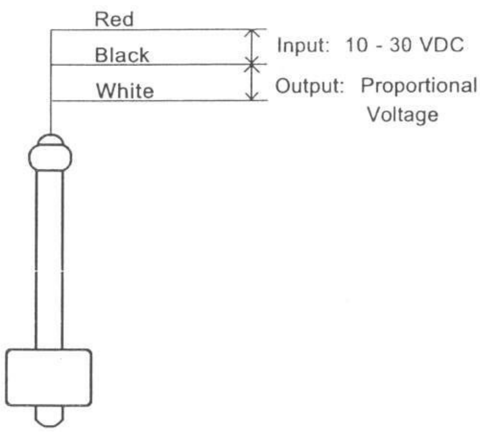
Tightening (Plastic to Metal): When threading a plastic sensor into a metal coupling, the installer should use a suitable wrench and tighten the threads 1 to 1-1/2 additional turns past hand-tight. Over-torquing of the threads will result in damage to the plastic mounting plug.

Tightening (Metal to Metal): When threading a metal sensor into a metal coupling, the installer should use a suitable wrench and tighten the threads 1-1/2 turns past hand-tight.

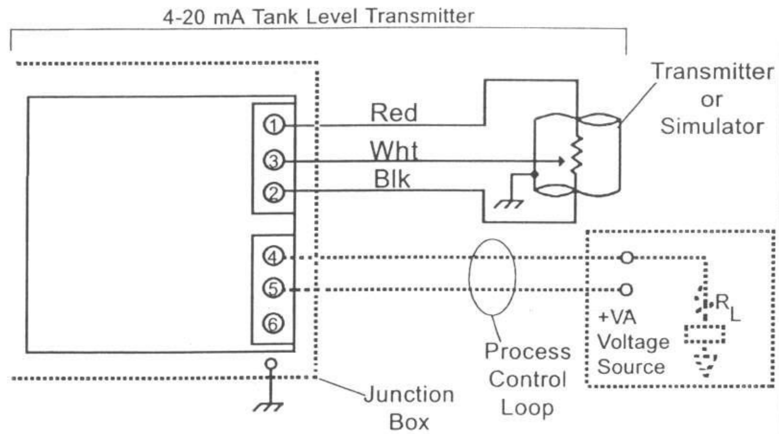
Wiring Diagrams

Note: For hazardous area applications, use an appropriate intrinsically safe interface device.

Wiring Diagram
Analog Output (Proportional Voltage)



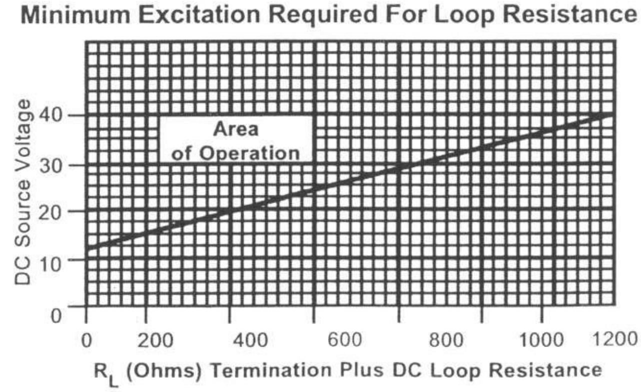
Wiring Diagram
(4-20mA Output)



Excitation Required for Transmitters Using 4-20 mA Signal Conditioners

The minimum excitation required for operation of transmitters with 4-20 mA, DC signal converters ***(See Chart)*** can be determined for a given total loop resistance from the graph shown. (Total loop resistance = the sum of the DC termination resistance plus loop resistance.) For optimum operation, which is a function of source voltage ($+V_A$) and total loop resistance, the source voltage value used should be above the minimum load line for the related loop resistance.

Minimum Excitation Required For Loop Resistance



Calibration

The signal conditioner on your CLT has been Factory-t. You do not need to calibrate.

Steps:

A. Calibration should be performed with the probe disconnected from the signal conditioner. Turn off power to loop. Disconnect the red, black and white wires from terminals 1, 2, and 3.

B. Adjust both the null and span potentiometers at approximately mid-range. ***(Figure 1)***

C. Wire as shown per ***Figure 2***, connecting a jumper wire in place of the black and white probe wires. Connect an ammeter in series to monitor loop current. Apply power to loop. Adjust null pot for 4mA.

D. Remove power from loop. Reposition the jumper wire in place of red and white probe wires. Reapply power and with the span pot, set the output current to 20mA.

E. Repeat Steps C and D for final adjustment.

If power is maintained during jumper connections, current level may increase to 36mA. This is normal. Current will return to regular readings when connections are made.

Figure 1

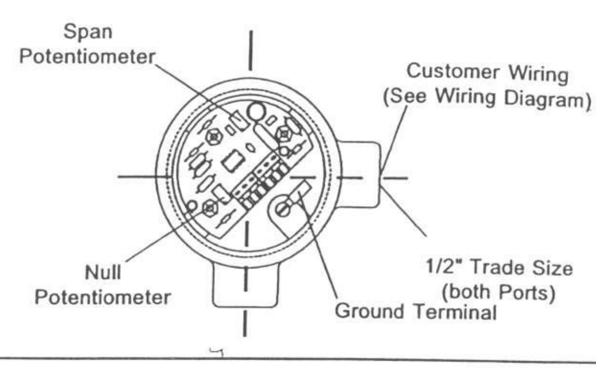
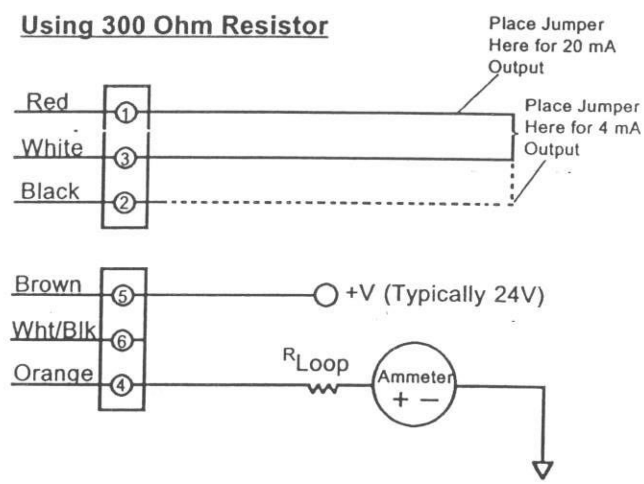


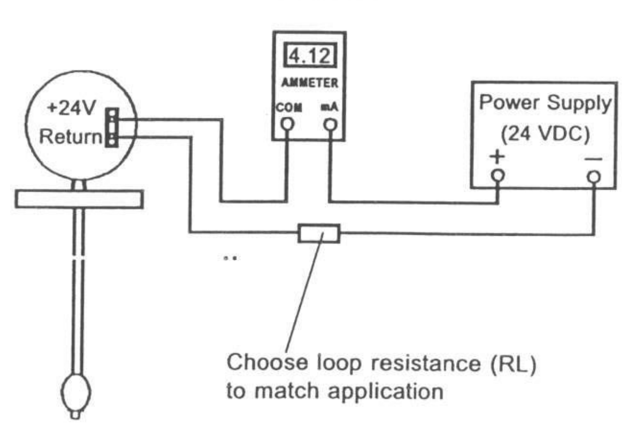
Figure 2



Troubleshooting

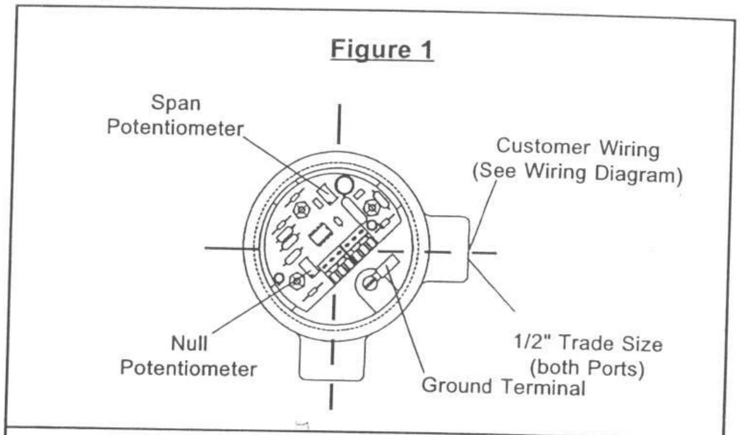
Verify proper wiring, power supply, and loop resistance. If transmitter is not functioning properly, isolate the transmitter from the system and wire per ***Figure 3.*** Meter should read 4mA with float at bottom and 20mA with float on top of transmitter. If unit is still not operating properly, please consult Factory for further troubleshooting details.

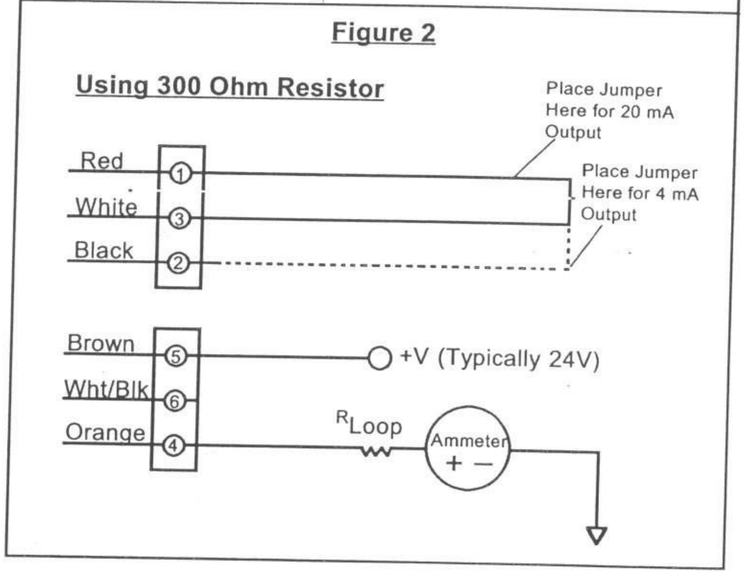
Figure 3



Calibration

The signal conditioner on your CLT has been Factory-set. You do not need to calibrate.





Steps:

A. Calibration should be performed with the probe disconnected from the signal conditioner. Turn off power to loop. Disconnect the red, black and white wires from terminals 1, 2, and 3.

B. Adjust both the null and span potentiometers at approximately mid-range. ***(Figure 1)***

C. Wire as shown per ***Figure 2***, connecting a jumper wire in place of the black and white probe wires. Connect an ammeter in series to monitor loop current. Apply power to loop. Adjust null pot for 4mA.

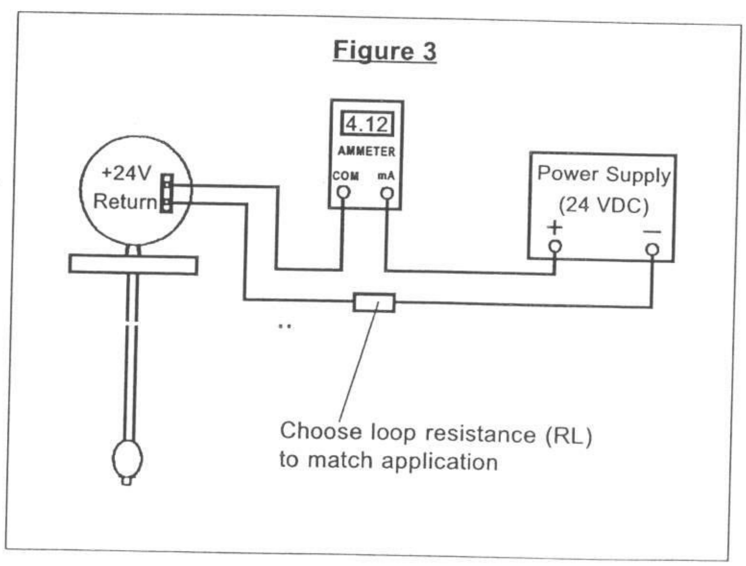
D. Remove power from loop. Reposition the jumper wire in place of red and white probe wires. Reapply power and with the span pot, set the output current to 20mA.

E. Repeat Steps C and D for final adjustment.

F. If power is maintained during jumper connections, current level may increase to 36mA. This is normal. Current will return to regular readings when connections are made.

Troubleshooting

Verify proper wiring, power supply, and loop resistance. If transmitter is not functioning properly, isolate the transmitter from the system and wire per ***Figure 3.*** Meter should read 4mA with float at bottom and 20mA with float on top of transmitter. If unit is still not operating properly, please consult Factory for further troubleshooting details.



MAINTENANCE/REPAIR

Important Points!

Regular maintenance of the total system is recommended to assure sustained optimum performance. These devices are not field repairable and should be returned to the factory if recalibration or other service is required. After first obtaining a Returned Goods Authorization (RGA) number, send the unit freight prepaid to the following. Please include a clear description of the problem plus any application information available.

Dwyer Instruments, Inc.
Attn: Repair Department
102 Highway 212
Michigan City, IN 46360

Important Points!

Product must be maintained and installed in strict accordance with the National Electrical Code and Dwyer product catalog and instruction bulletin. Failure to observe this warning could result in serious injuries or damages.

For hazardous area applications involving such things as (but not limited to) ignitable mixtures, combustible dust and flammable materials, use an appropriate explosion-proof enclosure or intrinsically safe interface device.

The pressure and temperature limitations shown on the individual catalog pages and drawings for the specified flow switches must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.

*** Warning: To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.

Selection of materials for compatibility with the media is critical to the life and operation of Dwyer products. Take care in the proper selection of materials of construction, particularly wetted materials.

Life expectancy of switch contacts varies with applications. Contact Dwyer if life cycle testing is required.

Ambient temperature changes do affect switch set points, since the specific gravity of a liquid can vary with temperature.

Dwyer Products have been designed to resist shock and vibration; however, shock and vibration should be minimized.

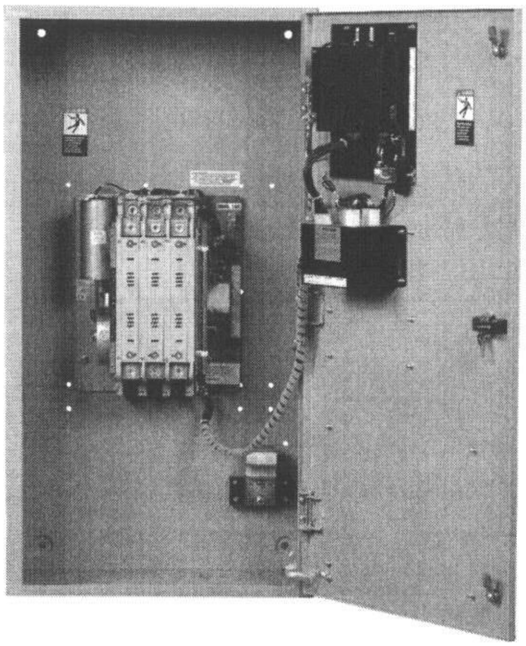
Filter liquid media containing particulate and/or debris to ensure the proper operation of our products.

Electrical entries and mounting points in an enclosed tank may require liquid/vapor sealing.

Dwyer Products must not be field-repaired.

Physical damage sustained by the product may render it unserviceable.

CATERPILLAR®



CTG SERIES AUTOMATIC TRANSFER SWITCH

The Caterpillar® CTG Series transfer switch is pre-configured for applications requiring the dependability and ease of operation found in a full feature power contactor type transfer switch.

FEATURES

- Ratings 40 to 3000 amps (2, 3 or 4 poles)
- UL 1008 listed at 480 VAC
- CSA certified at 600 VAC (200-225 amp – 480 V)
- IEC listed at 480 V
- Double throw, mechanically interlocked contactor mechanism
- Electrically operated, mechanically held
- Designed for emergency and standby applications
- Available in standard open transition (CTG) or delayed transition (CTGD) models

CTG switches are equipped with the next-generation MX150 microprocessor panel, which controls the operation and displays the status of the transfer switch's position, timers and available sources. As an embedded digital controller, the MX150 offers high reliability and ease of unattended operation across a range of applications. The MX150 features include:

- Timer and voltage/frequency settings adjustable without disconnection from power sources
- Built-in diagnostics with LCD display for immediate troubleshooting
- LED/LCD indicators for ease of viewing and long life
- Nonvolatile memory (exerciser battery backup not required for standard switch operation)
- Processor and digital circuitry isolated from line voltage
- Inputs optoisolated for high electrical immunity to transients and noise
- Communications header for network interface

FULLY APPROVED

- UL, CSA and IEC listed
- Ringing wave immunity per IEEE 472 (ANSI C37.90A)
- Conducted and Radiated Emissions per EN55022 Class B (CISPR 11) (Exceeds EN55011 & MILSTD 461 Class 3)
- ESD immunity test per EN61000-4-2 (Level 4)
- Radiated RF, electromagnetic field immunity test per EN61000-4-3 (ENV50140) 10v/m
- Electrical fast transient/burst immunity test per EN61000-4-4
- Surge immunity test per EN61000-4-5 IEEE C62.41 (1.2 X 50 ms, 5 & 8 kV)
- Conducted immunity test per EN61000-4-6 (ENV50141)
- Voltage dips and interruption immunity EN61000-4-11

DESIGN AND CONSTRUCTION FEATURES

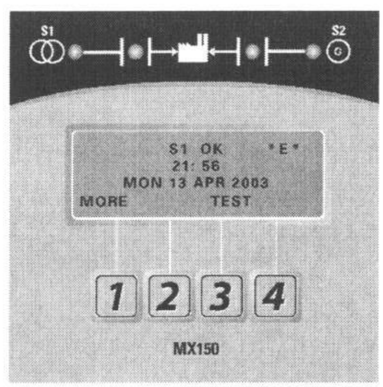
- Close differential 3 phase under-voltage sensing of the normal source – factory standard setting 90% pickup, 80% dropout (adjustable); under-frequency sensing of the normal source factory setting 95% pickup (adjustable)
- Voltage and frequency sensing of the emergency source – factory standard setting 90% pickup voltage, 95% pickup frequency (adjustable)
- Test switch (fast test/load/no load) to simulate normal source failure – automatically bypassed should the emergency source fail
- Type 1 enclosure is standard – also available in open style or Types 3R, 4, 4X, or 12.

STANDARD FEATURES AND OPTIONS

STANDARD FEATURES

- Auxiliary Contact: Closed when the switch is in the emergency position (Additional contacts optional)
- Auxiliary Contact: Closed when the switch is in the normal position (Additional contacts optional)
- 7, 14, 28 day interval timed exerciser, pushbutton/timer operation
- Engine Start Contact
- Indicating LED Pilot Lights:
  Switch in emergency position
  Switch in normal position
  Normal source available
  Emergency source available
- Time Delay to Engine Start: Standard setting 3 seconds, adjustable 0-10 seconds
- In-Phase Monitor, self-adjusting (Not available on CTGD models)
- Time Delay on Retransfer to Normal: To delay retransfer to normal source (immediate retransfer on generator set failure); standard setting 30 minutes, adjustable 0-60 minutes

MX150 CONTROL PANEL



(Front View)

- Time Delay for Engine Cool Down: Allows engine to run unloaded after switch retransfer to normal; standard setting 5 minutes, adjustable 0-60 minutes
- Time Delay on Transfer to Emergency: To delay transfer to emergency after verifying emergency source available; standard setting 1 second, adjustable 0-5 minutes

STANDARD FEATURES AND OPTIONS (continued)

- Pushbutton Bypass of time delay and normal emergency
- Test Switch – Momentary
- Event Log OD 16 Event that track date, time, reason and action taken
- Voltage and Frequency Indication for S1 and S2
- Peak Shave/Remote Load Test: Input for peak shave or remote load test; includes automatic return to normal if emergency source fails and normal is present; 120 VAC

When specified for use with a CTGD Series delayed transition switch, the control panel also includes the following:

- Time Delay from Neutral Switch Position to Normal on Retransfer: Standard setting 5 seconds, adjustable 1-10 minutes
- Time Delay from Neutral Switch Position to Emergency: Standard setting 5 seconds, adjustable 1-10 minutes
- Center-Off position/Off Delay Timing Indicators

OPTIONAL ATTACHMENTS

- 71 Plant Exerciser, clock type (load/no load): Allows the generator to start and run unloaded or to simulate a power failure, start generator and run under load (7-14-28-365 days, user selectable)
- Space heater and thermostat
- Inhibit Transfer to Emergency: Input circuit to inhibit transfer to emergency; 24 VDC or 120 VAC
- Network communications interface card (LonWorks/ModBus)
- Maintained Test Switch
- Maintained Test Switch w/Keypad
- Service entrance configuration
- Auxiliary Contact, operates on Source 1 line failure
- Auxiliary Contact, operates on Source 2 availability
- Auxiliary Contacts: Closed when the transfer switch is in Source 2 position
- Auxiliary Contacts: Closed when the transfer switch is in Source 1 position
- Disconnect Switch: Permits transfer in "AUTO" position and inhibits transfer in "INHIBIT" position. (Standard 800A and above)
- Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer
- Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-60 seconds prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both.
- Voltage Imbalance Monitor (Three Phase)
- Maintained test switch options
- Lockable, see-through cover for ATS controller

SERIES POWER MEASUREMENT METERS

- Digital Meter w/Display of Amps, Volts, Frequency
- Digital Meter w/Display of Amps, Watts, Volts, Frequency, kVA, kVAR, PF, etc.
- Digital Meter w/Display of Amps, Watts, Volts, Frequency, kVA, kVAR, PF, etc. Plus THD capability w/ModBus RS485 part

NOTE:

For applications requiring additional options or other configurations, see the CTS Series fully configurable transfer switch.

DIMENSIONAL SPECIFICATIONS

CTG and CTGD Series Transfer Switches								
			NEMA 1 Enclosed				Weight	
Model	Ampere Rating	Poles	Height (A)	Width (B)	Depth (C)	Reference Figure	NEMA 1	Application Notes
CTG	40, 80, 100 150, 200, 225	2, 3 4	61 (24) 61 (24)	46 (18) 46 (18)	28 (11.13) 28 (11.13)	A A	26 (57) 27 (60)	1 – 6
CTGD	40, 80, 100, 150, 225, 260, 400	2, 3 4	117 (46) 117 (46)	61 (24) 61 (24)	36 (14.13) 36 (14.13)	A A	82 (180) 84 (185) 102 (230)	1 – 5
CTG	260, 400	2, 3 4	116.84 (46) 117 (46)	61 (24) 61 (24)	36 (14.13) 36 (14.13)	A A	80 (175) 82 (180)	1 – 5
CTG/D	600	2, 3 4	168 (66) 168 (66)	61 (24) 61 (24)	50 (19.75) 50 (19.75)	B B	181 (400) 204 (450)	1 – 5, 7
	800, 1000, 1200	2, 3 4	188 (74) 188 (74)	101.6 (40) 102 (40)	50 (19.75) 50 (19.75)	B B	215 (475) 254 (560)	1 – 5, 7
	1600, 2000 2600, 3000	3 4	229 (90) 229 (90)	91.44 (36) 91 (36)	122 (48) 122 (48)	C C	458 (1010) 526 (1160)	1 – 5, 7, 8

APPLICATION NOTES:

1. English dimensions (inches) and weights (pounds) shown in parenthesis adjacent to Metric measurements in cm and Kg.
2. Includes 1.25" door projection beyond base depth. Allow a minimum of 3" additional depth for projection of handle, lights, switches, pushbuttons, etc.
3. All dimensions and weights are approximate and subject to change without notice.
4. Packing materials must be added to weights shown. Allow 15% additional weight for cartons, skids, crates, etc.
5. Special enclosure (NEMA 3R, 4, 4X, 12, etc.) dimensions and layouts may differ. Consult Caterpillar for details.
6. CTG 40-200 require larger 36" H X 24" W X 14" D enclosure depending on options specified. Consult Caterpillar for details.
7. Add 3" in height for lifting eyes.
8. Ventilation louvers on side/rear of 2600 and 3000A units require one side or rear of enclosure to be clear in order to afford proper airflow.

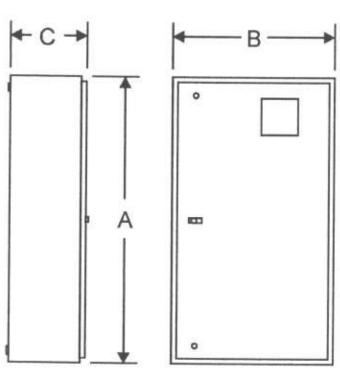


Figure A
CTG Series Transfer Switch
(40-400 amp)

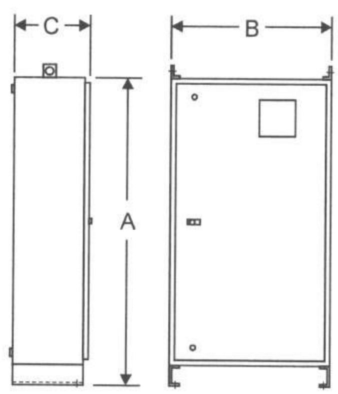


Figure B
CTG Series Transfer Switch
(600-1200 amp)

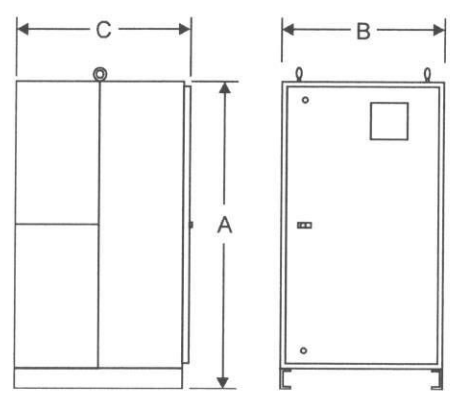


Figure C
CTG Series Transfer Switch
(1600-3000 amp)

Testing Standards	
UL, CSA and IEC listed	UL 1008, CSA 22.2 No. 178, IEC 947-6-1
Ringing wave immunity	IEEE 472 (ANSI C37.90A)
Conducted and Radiated Emissions	EN55022 Class B (CISPR 11) (Exceeds EN55011 & MILSTD 461 Class 3)
ESD immunity test	EN61000-4-2 (Level 4)
Radiated RF, electromagnetic field immunity test	EN61000-4-3 (ENV50140) 10v/m
Electrical fast, transient/burst immunity test	EN61000-4-4
Surge immunity test	EN61000-4-5 IEEE C62.41 1.2 X 50μs, 5 & 8 kV
Conducted immunity test	EN61000-4-6 (ENV50141)
Voltage dips and interruption immunity	EN61000-4-11

AL/CU UL Listed Solderless Screw-Type Terminals for External Power Connections		
	Normal, Emergency and Load Terminals	
Switch Size (Amps)	Cables per Pole	Range of Wire Sizes
40		
80		
100		#8 to 3/0 AWG
150	1	
200, 225, 260		#6 AWG to 250 MCM*
400		#4 AWG to 600 MCM
600	2	#2 AWG to 600 MCM
800, 1000, 1200	4	
1600, 2000, 2600, 3000	8	#2 AWG to 600 MCM

*260A to 350 MCM

MX150 Control Setting Ranges			
Control Function		Range	Factory Setting
Normal Line Sensing – Under-voltage	Dropout Pickup	75-98% 85-100%	80% 90%
Emergency Line Sensing – Under-voltage	Dropout Pickup	75-98% 85-100%	80% 90%
Emergency Line Sensing – Under-frequency	Dropout Pickup	2 Hz below pickup 90-100%	Set 95%
Time Delay – Engine Start		0-10 seconds	3 seconds
Time Delay – Engine Cool Down		0-60 minutes	5 minutes
Time Delay – Transfer to Emergency		0-5 minutes	1 second
Time Delay – Retransfer to Normal		0-60 minutes	30 minutes
Time Delay – Motor Disconnect or Transfer Presignal (When applicable)		0-60 seconds	20 seconds
Delayed Transition Time Delays (When applicable)		0-10 minutes	5 seconds

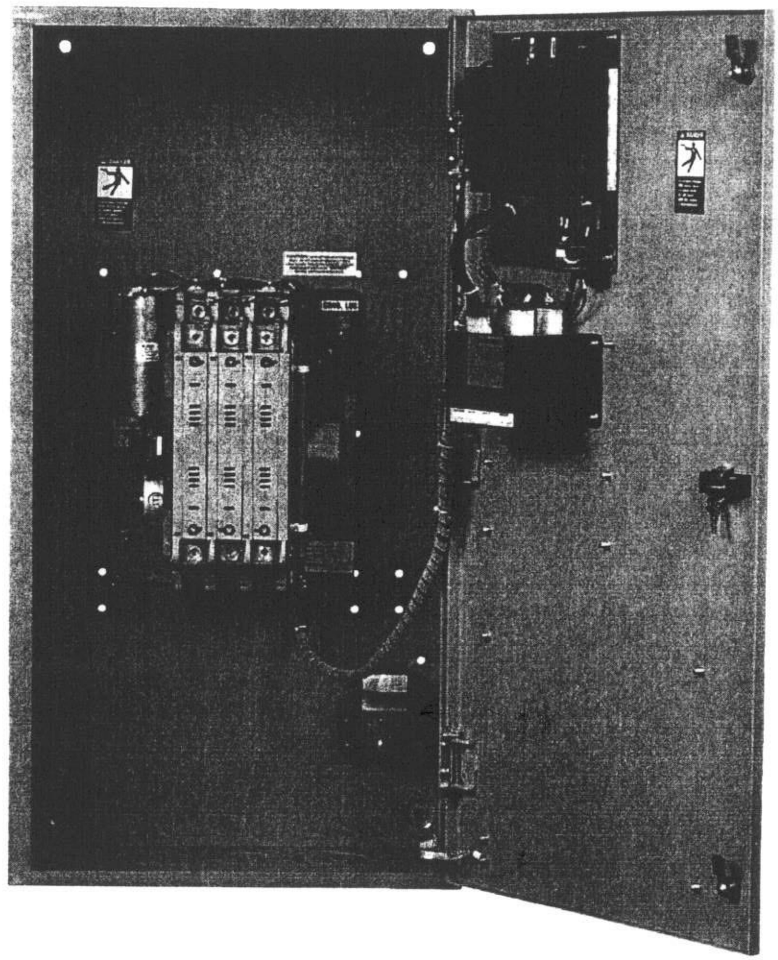
WITHSTAND CURRENT DATA

Withstand Current Ratings per UL 1008				
	Maximum Circuit Amps When Used With		Maximum Circuit Amps When Used With	
CTG Switch Ratings (Amps)	Current Limiting Fuse CTG/CTGD	Specific Coordinated Breaker Rating	CTGD Switch Ratings* (Amps)	Specific Coordinated Breaker Rating
40, 80, 100, 150, 200, 225		30,000	40, 80, 100	50,000
260		35,000	150, 225, 260	50,000
400, 600	200,000	50,000	400, 600	50,000
800		65,000	800	65,000
1000, 1200		85,000	1000, 1200	85,000
1600, 2000 2600, 3000		100,000	1600, 2000 2600, 3000	100,000

*CTGD WCR rated 200,000A on all sizes.

CATERPILLAR®

CTG/CTGD Series Transfer Switches
40-3000 Amps



70R-1000C
12/03

Operation and Maintenance Manual

Authorized Service

For Caterpillar parts and service, call: 1-866-883-3879

Table of Contents

	Page
Introduction	2
Safety	3
Equipment Inspection and Storage	3
Final Equipment Inspection	3
Installation	3
Mounting	3
Power Connections	4
Engine Start Control Connections	4-6
Initial Energization	6-7
MX150 Microprocessor Controller	8
Overview	8
LCD & Keypad	9
User Setting for Voltage & Frequency	10
Standard Features, MSTDG Option Pkg.	10-11
Standard Features, MEXEG Option Pkg.	12
Optional Accessories	13
How to Set the System Clock	14
CDT One Event Timer Exerciser	14-15
CDP Clock Exerciser	16
User Setup - CFG Menu	17
User Setup - SET Menu	18
User Setup - System Info	19
Testing	20
Standard Transition	20
Delayed Transition	20
Sequence of Operation	21
Standard Transition	21
Delayed Transition	21
Relay/Transformer (R/T Box)	22
Standard	22
Delay	23
Schematics	24
Troubleshooting & Diagnostics	25
Maintenance and Testing	26
Inspection and Cleaning	26
Servicing	26
Testing	26
Power Panel & Replacement Parts	27
Standard Transition	27
40-225 Amps	27
225-600 Amps	28
800-1200 Amps	29
1600-3000 Amps	30
Delayed Transition	31
40-600 Amps	31
800-1200 Amps	32
1600-3000 Amps	33

Introduction

Caterpillar Transfer Switches are used to provide a continuous source of power for lighting and other critical loads by automatically transferring from source 1 power to source 2 power in the event that source 1 voltage falls below preset limits

Voltage sensing and system control is performed via a state-of-the-art microcontroller located on the cabinet door. It is designed to give highly accurate control of the transfer switch system.

All Caterpillar transfer switches are designed for use on emergency or standby systems, and are rated for total system or motor loads. Transfer switches are UL Listed under Standard 1008 and CSA Certified under Standard C22.2 No. 178 and IEC Listed under Standard 947.

NOTES: A protective device such as a molded case circuit breaker or fused disconnect switch MUST be installed on both sources of incoming power for circuit protection and as a disconnection device.

All references made within this manual about the term "S1" or "Source 1" relate to a Normal Power Source. All references made about the term "S2" or "Source 2" relate to an Emergency or Alternative Power Source.

Safety / Installation

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

The safe operation of your switch is CATERPILLAR S focus. The proper storage, installation, operation and maintenance will help increase the life of the switch.

⚠ CAUTION ⚠

Due to hazardous voltage and current, CATERPILLAR recommends that a CATERPILLAR Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

Equipment Inspection and Storage

Once you have received the transfer switch, inspect it for any damage. This includes damage to the enclosure, power panel, control panel and wiring harness. If any damage is found or suspected, file a claim as soon as possible with the carrier and notify the nearest CATERPILLAR representative.

Before installation, if it is necessary, store the transfer switch in a clean dry place, protected from dirt and water. Provide ample air circulation and heat, if necessary, to prevent condensation.

Storage Temperature	Operating Temperature (Ambient)	Humidity
-30 C to +75 C (-22 F to +167 F)	**40-400 AMP** (molded shell) -20 C to +65 C (-4 F to +149 F)	5% to 95% (non-condensing)
	40-4000 AMP (all other frame and panel types) -20 C to +60 C (-4 F to +140 F)	

Final Equipment Inspection

Prior to energizing the transfer switch:

1. Remove any debris incurred, with a vacuum, due to shipment or installation.

⚠ WARNING ⚠

Do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

2. Verify that all cabled connections are correct and that phase rotation of both sources match.
3. Check engine start connections.
4. Verify the correct connection of all control wires.
5. Check settings of all timers and adjust as necessary.
6. Adjust any optional accessories as required.
7. Check the lug torque values of the power connections.

NOTE: Lug torque values are specified in table 2 on pg.4.

8. Make sure that all covers and barriers are installed and properly fastened.

NOTE: Power panels ship from Caterpillar in Source 1 Position.

Each Caterpillar transfer switch is factory wired and tested. A complete information package is furnished with each switch which includes:

a. Sequence of operation.
b. Description and operation of all accessories supplied.
c. Power panel connection diagram and schematic.
d. Description and identification of all customer field connections.

Installation of Caterpillar transfer switches includes:

a. Mounting the transfer switch cabinet.
b. Connection of Source 1, Source 2, and Load cables or bus bars.
c. Connection of external control circuits as required.

Mounting

Adequate lifting means must be used to mount the transfer switch into place. The recommended method for moving the transfer switch using the lifting eyes, where supplied, and a spreader bar is illustrated in Figure 1. Enough room should be allowed to open the cabinet doors fully for inspection and servicing of the switch per NEC and local codes.

⚠ CAUTION ⚠

Before drilling conduit entry holes or any accessory mounting holes, cover and protect the switch and control panel to prevent dirt and metal fragments from entering the mechanical and electrical components.

Failure to do so may result in damage and malfunction of the switch.

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Power Connections

Caterpillar transfer switches are supplied with UL listed solderless screw type terminals as standard for the Source 1, Source 2 and Load power connections.
Table 1 lists the number and sizes of cable lugs supplied as standard for each switch amp rating.

Connect the Source 1, Source 2, and Load conductors to the clearly marked terminals on the transfer switch. Remove surface oxides from cables by cleaning with a wire brush. Verify that all connections are correct before tightening the lugs. All cable lug connections must be tightened to the proper torque values as shown in
Table 2.

NOTE: **Do not run cables or wiring behind front-connected transfer switches.**

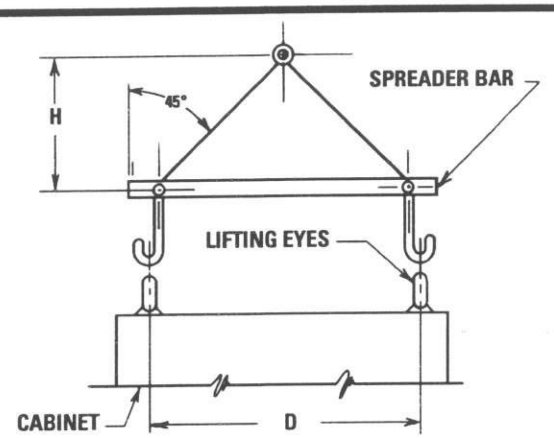


Figure 1

NOTE: **When lifting the switch using a spreader bar, height H must be equal to half of distance D.**

Power Connections: Screw Type Terminals for External Power Connections				
Switch Size (Amps)	Source 1, Source 2 & Load Terminals		Neutral Bar (When Required)	
	Cable Per Pole	Range of Wire Sizes	No. of Cables	Range of Wire Sizes
40	1	#8 to 3/0 AWG	3	#14 to 1/0 AWG
80	1	#8 to 3/0 AWG	3	#14 to 1/0 AWG
100	1	#8 to 3/0 AWG	3	#14 to 1/0 AWG
150	1	#8 to 3/0 AWG	3	#6 AWG to 350 MCM
200, 225	1	#6 AWG to 250 MCM	3	#6 AWG to 350 MCM
260	1	#6 AWG to 350 MCM	3	#6 AWG to 350 MCM
400	1	#4 AWG to 600 MCM	4	#4 AWG to 600 MCM
600	2	#2 AWG to 600 MCM	8	#4 AWG to 600 MCM
800, 1000, 1200	4	#2 AWG to 600 MCM	12	#4 AWG to 600 MCM
1600, 2000 2600, 3000	8	#2 AWG to 600 MCM	24	#4 AWG to 600 MCM

Table 1

Engine Start Control Connections

Engine-start control wires connect to control terminals beside the MX150. Engine start terminals are indicated by a schematic symbol (the symbol indicates the contact state for a de-energized normal source). Figure 3 shows the engine-start contacts

Make all other necessary control connections to the control panel terminal blocks per the schematics supplied with the ATS.

NOTE: **All control wires (18-12 AWG) must be torqued to 19 in/lbs.**

Tightening Torque for Lugs		
Socket Size Across Flats	Torque	
	Lb. - In.	Lb. - Ft.
1/8	45	4
5/32	100	8
3/16	120	10
7/32	150	12
1/4	200	17
5/16	275	23
3/8	375	31
1/2	500	42
9/16	600	50

Table 2

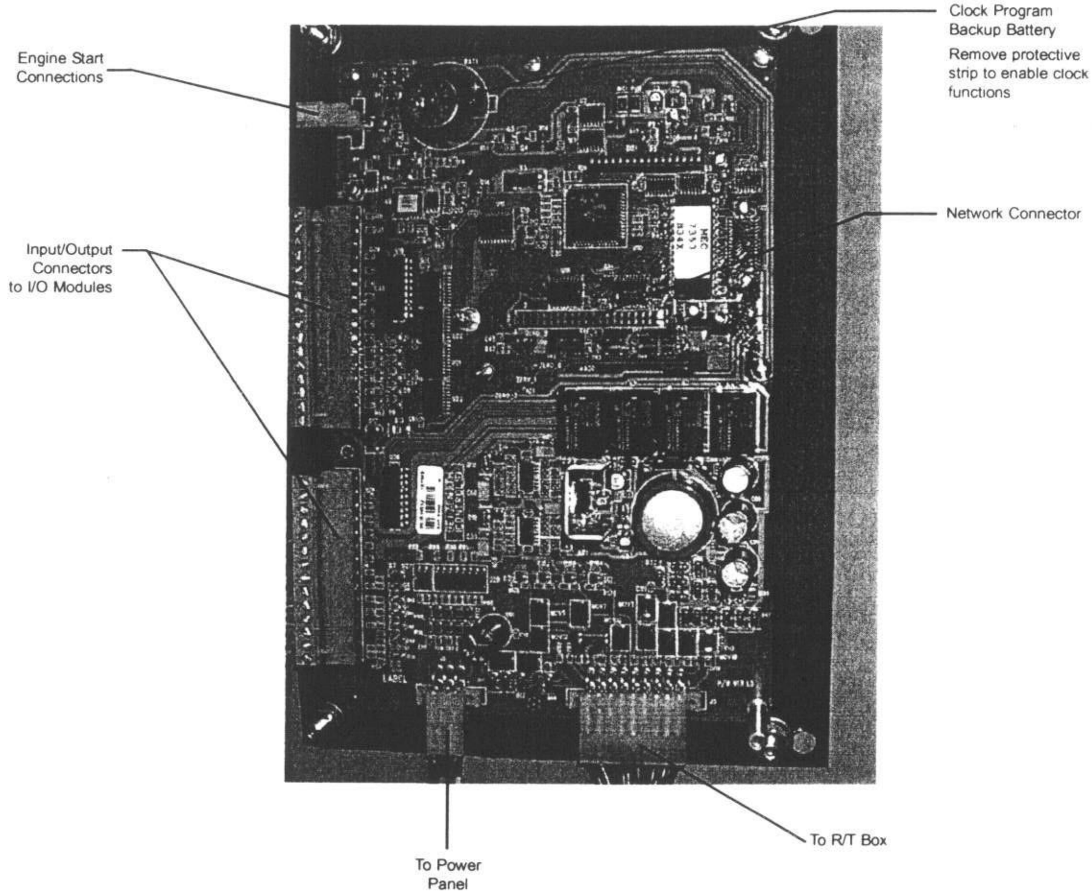
⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

Control Connections

Figure 2



A complete information package is furnished with each transfer switch including a complete connection diagram and schematic which details all necessary control circuit field connections.

The engine start control wires connect to the engine start relay terminals located to the left of the microprocessor. Figure 2 shows the location of these terminals.

The terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Installation (cont'd)

⚠ DANGER ⚠

HAZARDOUS VOLTAGE
(Can Cause Severe Injury or Death)

Turn OFF all power before installation, adjustment, or removal of transfer switch or any of its components.

E

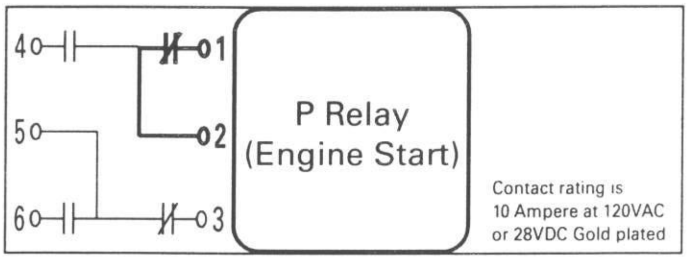


Figure 3

Engine Start Control Connections

The engine-start terminals are clearly identified by a label on the microcontroller backplate. In the case of manual transfer switches, or in other applications not requiring the microprocessor, clearly marked terminal blocks are provided in the upper left corner of the control panel for the engine start control wires.

Terminals for field connections to the A3 Source 2 auxiliary contacts and the A4 Source 1 auxiliary contacts are also provided. These terminals are clearly marked and appear on the side of the power panel. On 400 amp metal frame units these terminals appear on the bracket above the operator handle.

Initial Energization

Before proceeding, refer to the information package supplied with the ATS and read and understand the information on all accessories provided.

1. Unlock the enclosure.
2. Open the enclosure.
3. Verify the correct system voltage.

   NOTE: The equipment rating nameplate on the transfer switch lists the voltage. See *Figure 4*.

4. Close Source 1 circuit. breaker.

   NOTE: The controller will illuminate Source 1 Available LED if proper voltage is sensed.

5. Verify the phase to phase voltages at the Normal line terminals.
6. Close the Source 2 circuit breaker.
7. Start the generator engine.

   NOTE 2: The controller will illuminate Source Available LED when preset voltage and frequency levels are reached.

8. Verify the phase to phase voltages at Source 1 line terminals.
9. Verify that the phase rotation of Source 1 is the same as the phase rotation of Source 2.

10. Shut down the generator engine.
11. Place the starting control in the Automatic position.
12. Complete the visual inspection of the transfer switch.
13. Close the enclosure.
14. Lock the enclosure.

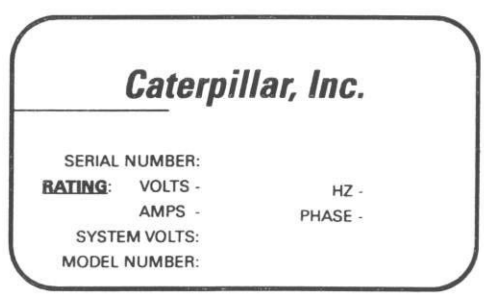


Figure 4

⚠ CAUTIONS ⚠

Certain accessories, per specific schematics, can inhibit automatic transfer. Engine Gen-Set could start when engine control wires are attached.

Initial Energization *(cont'd)*

After all options and accessories are checked and verified, follow these steps to set up the ATS. Refer to MX150 display Figure 5. The annunciation LEDs illuminate to indicate (1) source availability, (2) ATS position, and (3) MX150 control function (timing).

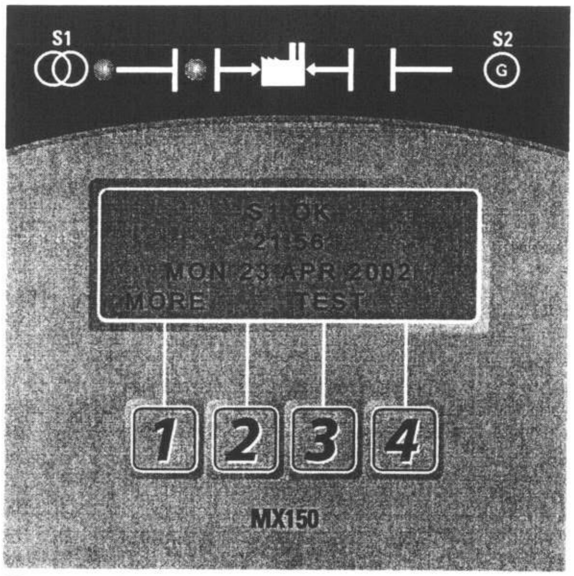


Figure 5 - LCD and keypad

1. Unlock the enclosure.
2. Open the enclosure.
3. Place the Disconnect Switch in the Inhibit.

   NOTE: This step is only performed if the "DS" Option was purchased.

4. Close the external (up-stream) Source 1 circuit breaker.

   NOTES: Source 1 Available and Source 1 Position LED's will illuminate.

   If Source 1 Available LED does not illuminate, verify that Source 1 Voltage is above the preset restore value.

   The Gen-Set will start and run while Source 2 stop Delay Timer is timing.

5. Close the External (up-stream) Source 2 line circuit breaker.
6. Start the engine generator in MANUAL mode.

   NOTE: When the voltage and frequency reach preset values, the Source 2 Available LED will illuminate.

7. Verify the phase to phase voltages at Source 2 line terminals.
8. Verify that the phase rotation of Source 2 is the same as the phase rotation of Source 1.

9. Shut down the generator's engine. (Place in Automatic Mode.)

   NOTE: Source 2 Available LED will turn off.

   NOTE: The engine generator will continue to run for the duration of Source 2 Stop Delay Timer.

10. Place the disconnect switch to ENABLE.
11. Complete the visual inspection of the transfer switch.
12. Close the enclosure.
13. Lock the enclosure.

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, <u>DISCONNECT</u> the control panel plugs from the microprocessor to avoid potential damage.

MX150 Microprocessor Controller

MX150 Controller

Consists of two major assemblies:

I The **Microprocessor** contains the following:

A. MX150 Board - Customer Input and Output (I/O) for system interface. Located on the left hand side of the back of the unit (see figure 6)
   1. I/O accessories that can be found here are:
      a. Engine start relay P output
      b. Pre-Signal to transfer T3, W3 and UMD output (optional)
      c. Transfer Inhibit Q3 and Q7 input (optional)
      d. Remote test Q2 input (optional)
      e. Network interface ZNET input/output (optional)

B. LCD and Keypad located on the exterior of the door (see figure 7)
   1. User accessibility to the following:
      a. LED indication of source availability
      b. LED indication of transfer switch position
      c. LCD screen indicates:
         (1) timer count down (numeric)
         (2) event reporting (text)
      d. Keypad provides user interface to: [in conjunction with LCD screen]
         (1) Setting sensors and timers
         (2) Configuring logic accessories

II The **R/T box** (relay transformer box) contains the following: (see figure 6)

A. Relays which are required for controller output to energize the transferring mechanism of the transfer switch at line voltage.

B. Transformers which drop line voltage to control level for controller input.

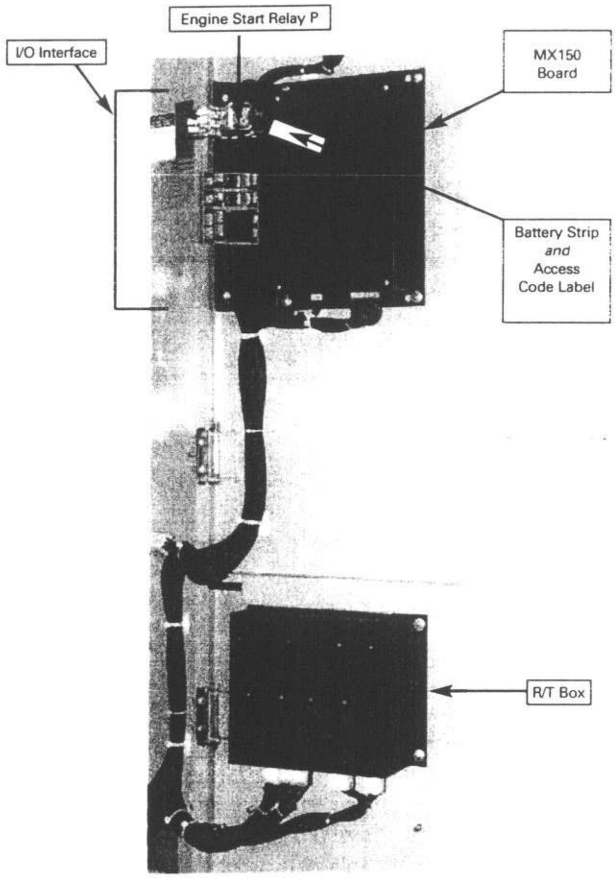


Figure 6

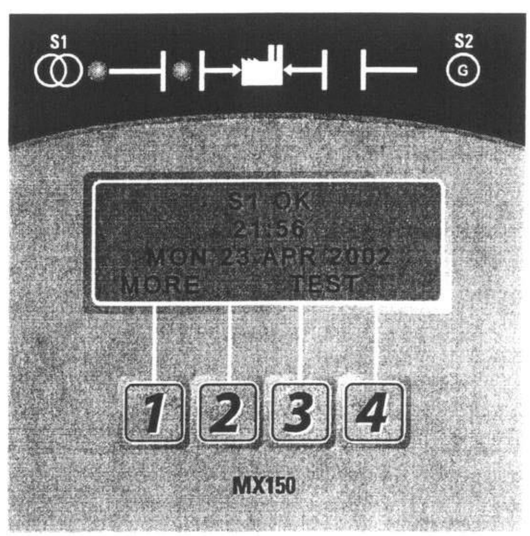


Figure 7

LCD & Keypad

These options are accessible through the LCD and keypad (see figure below). To become familiar with the options loaded into a particular unit, scrolling through the SET and CFG menu will show the descriptions of the options (see pages 17). These menus are the very same menus that are used to access the setting and/or configuration of these options. The SET (setting) menu is primarily used to show or change, time and voltage settings. The CFG menu is primarily used to turn an option on or off. When scrolling through these menus, no changes can be made without entry of the access code. The factory set six-digit access code is located on a white label on the back of the unit (see figure 9 pgs. 17-19).

The MX150 has many logic options. Each controller is downloaded with options at the time of manufacture. The collection of options that any one controller has is specified at the time of order placement. The following pages include all the options that can reside in the controller. Not all units include all options.

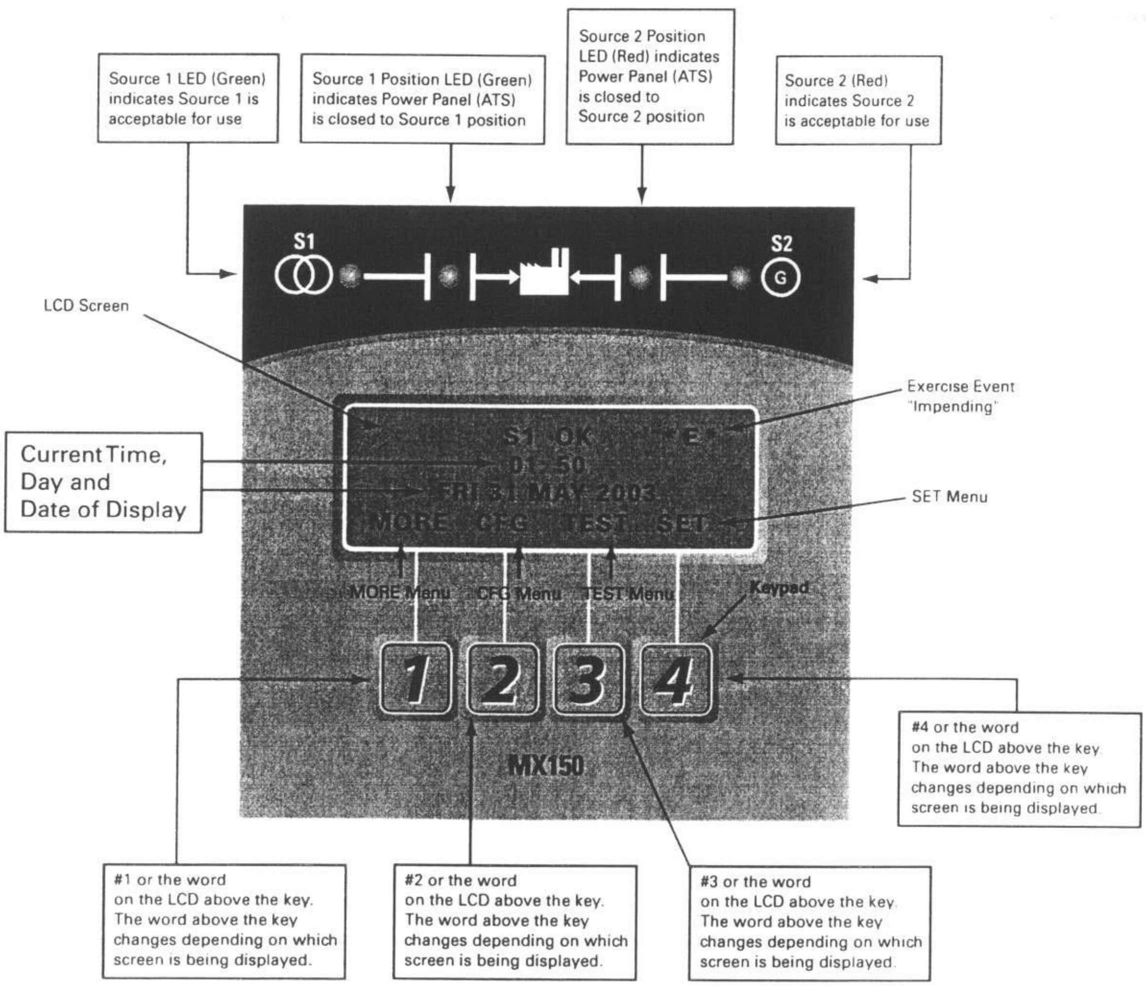


Figure 8

User Setting for Voltage & Frequency

Source 1

Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 1.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 18).
Once satisfied, the T timer will begin timing to transfer to Source 1.

Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold.
Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, P timer begins timing to signal Source 2 Generator to start.

Source 2

Voltage "Restore"
Factory Default: 90%
This adjustment determines the minimum acceptable voltage required to transfer to Source 2.
Adjust via the SET menu. Range is 85% to 100% in 1% increments (see page 18).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Voltage "Fail"
Factory Default: 80%
This adjustment determines the low voltage threshold.
Adjust via the SET menu. Range is 75% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once voltage falls below threshold, T timer will be bypassed to expedite the transfer to Source 1.

Frequency "Restore"
Factory Default: 95%
This adjustment determines the minimum acceptable frequency required to transfer to Source 2.
Adjust via the SET menu. Range is 90% to 100% in 1% increments (see page 18).
Once satisfied, the W timer will begin timing to transfer to Source 2.

Frequency "Fail"
Factory Default: 90%
This adjustment determines the low frequency threshold.
Adjust via the SET menu. Range is 88% to 98% in 1% increments (see page 18).
"Fail" must be a minimum of 2 % below "Restore" setting. Once satisfied, the W timer will begin timing to transfer to Source 2.

Standard Features, MSTDG Option Pkg.

6

Test Switch, Momentary

A3

Auxiliary Contact: Closed when the switch is in Source 2 position.

A4

Auxiliary Contact: Closed when the switch is in Source 1 position.

Calibrate

While monitoring the actual Phase to Phase voltage levels and Frequency with a calibrated test equipment, the Phase to Phase voltage sensing and Frequency can be adjusted accordingly. Calibration capabilities are available for Frequency and AB, BC, CA Phase to Phase voltage for both Sources. Adjust via SET menu (see page 18)

CDT

Load or NO-Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1, 7, 14, or 28 days. Factory Default is 20minutes. When exerciser is impending, (*E*) appears in the upper right hand corner of LCD screen. See page 14-15 for instructions. Configured via CFG (see page 17). Set via SET menu (see page 18).

DS

Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(800-4000 Amp units)

DT *(Delayed Transition Only)*

Time Delay from Neutral Switch position to Source 1 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds Adjust via SET menu (see page 18)

DW *(Delayed Transition Only)*

Time Delay from Neutral Switch position to Source 2 position. Adjustable 0-10 minutes in 1 second increments. Standard setting is 5 seconds.Adjust via SET menu (see page 18)

E

Engine Start Contact

EL/P

Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken

System Data: Total Life Transfers (N2P)
Days Powered Up
Total Transfers to S2
Total S1 Failures
Time S1 available in Hrs
Time S2 available in Hrs. (N1P)

K/P

Frequency Indication for S1 and S2

L

LNP Center-off position LCD-Indicator
Indicating LED lights
- **L1** Indicates Switch in Source 2 position.
- **L2** Indicates Switch in Source 1 position.
- **L3** Indicates Source 1 available.
- **L4** Indicates Source 2 available.

P1

Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting is 3 seconds.
Adjust via SET menu (see page 18)

Q2

Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present.

R2E

Under voltage sensing of Source 2 for single-phase. (R17 replaces R2E for Utility to Utility switches)

R50

In Phase Monitor this feature restricts Live to Live Source Transfers to occur unless both Sources are within 7 electrical degrees or less of each other. (live Source to live Source transfers usually occur during transfer back to Source 1 or during Testing). R50 does not change the operation of the Automatic Transfer Switch in a power failure mode. After all timer functions have elapsed, the CHECKING FOR SOURCE SYNCHRONISM will be displayed as well as the direction of transfer (S1-S2 for example denotes transfer from Source 1 to Source2). When synchronism is accomplished, transfer will take place.

Notes:
- If S2 Frequency is less than S1 Frequency, display will show a series of (- - - - - ..) symbols.
- If S2 Frequency is greater than S1 Frequency, display will show a series of (+++++ ..) symbols.
- Each (-) or (+) symbol represents 10 electrical degrees out of phase. A maximum of 18 symbols (180 electrical degrees) can be monitored.
- The number of (-) or (+) symbols decrease as the two sources approach synchronism and increase as the two sources drift out of synchronism.
- If S1 and S2 Frequencies are identical, the display will show a series of alternating symbols (‡‡‡‡) which also indicate the approximate out of phase degrees

In the event that the Sources do not come within 7 electrical degrees of each other within 60 seconds, the unit will display the message: SYNCH CHECKING and will allow the user to BYPASS. If the BYPASS button is pressed, the unit will display the message: WARNING MAY CAUSE DAMAGE TO THE LOAD. Pressing XFR will actually bypass the R50. Since R50 is a passive device, the length of time it takes to reach Synchronism is de-pendent on the frequency difference between the two Sources. Source 1 is usually a Utility and the frequency is not within the control of the consumer. Source 2 needs to be adjusted to create an adequate difference in order for the transfer to happen a timely fashion.

Note: For optimum performance, Source 2 Generator should be adjusted a Maximum of 2 Hertz above or below the Utility frequency, minimum of 0.1 Hertz. (58 to 59.9) or (60.1 to 62) Hertz. Adjustment of Generator to 60Hertz could cause lengthy transfer delay.

R50 Feature can be turned ON or OFF via CFG Menu (see page 17). Factory Default if OFF.

S13

Transfer Commit. Configured via CFG menu. (see page 17) When this Feature is set to OFF: The transfer Switch is not committed to transfer unless the outage duration is longer than the timers that precede the transfer to Source 2 position. This assumes that the outage will be an isolated event. When this Feature is set to ON: The transfer Switch is committed to transfer to Source 2 position once the W timer has begun timing, even if Source 1 power returns before the transfer to Source 2. This is to ensure that the transfer takes place, because one outage may be followed by another.

T

Time Delay (S1) Source 1 Stable Timer. To delay transfer to Source 1 (immediate retransfer on Source 2 failure). Adjustable 0-60 minutes in 1 second increments
Standard setting is 30 minutes. Adjust via SET menu (see page 18)

U

(S2) Source 2 Stop Delay Timer. Allows Engine to run unloaded after switch retransfer to Source 1. Adjustable 0-60 minutes in 1 second increments. Standard setting is 5 minutes. Adjust via SET menu (see page 18)

W

Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2. Adjustable 0-5 minutes in 1 second increments. Standard setting is 1 second. Adjust via SET menu (see page 18)

Standard Features, MEXEG Option Pkg.

In addition to the features listed under the MSTDG Option Package, this enhanced package includes the following features:

A3

Additional Auxiliary contact: closed when switch is in Source 2 position.

A4

Additional Auxiliary contact: Closed when the transfer switch is in Source 1 position.

CDP (replaces CDT)

Clock Exerciser Load/ No Load: Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load.
Can be configured by end user for 1, 7, 14, 28, 365 day cycle.

VI

Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between Fail and Restore settings.
Factory default: 10% Fail , 8% Restore, 30 Seconds.
See CFG Menu page 17 to configure ON or OFF.
See SET Menu page 18 to set Percentage and time windows

Optional Accessories

6A
Test Switch, Maintained / Momentary

6AP
Test Switch, Maintained / Momentary, utilizing Keypad

A1
Auxiliary Contact, operates on Source 1 line failure.

A1E
Auxiliary Contact, operates on Source 2 line failure.

A3
Auxiliary Contacts: Closed when the transfer switch is in Source 2 position.

A4
Auxiliary Contacts: Closed when the transfer switch is in Source 1 position.

A62
Sequential Universal Motor Load Disconnect Circuit. Normally closed Auxiliary contacts for Motor Loads. Open 0-60 seconds prior to transfer, after transfer, or both in either direction then re-close in timed sequence after transfer. Factory default: 20 seconds

CTAP
Alarm Panel on transfer to Source 2 with Silence button.

DS
Disconnect Switch, Auto/Inhibit.
Inhibits transfer in either direction when in inhibit.
Allows automatic operation when in Auto.
(40-600 Amp units)

HT
Heater and Thermostat.

Manual
Manual Transfer Switch transfers in either direction by depressing designated pushbuttons.

M80
Digital Power Meter with Display: Amps, Volts, and Frequency.

M82
Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.

M83A
Digital Meter w/Diplay of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/Modbus.

T3/W3
Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer. Factory default: 20 seconds

UMD
Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-5 minutes prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both. Factory default: 15 seconds

VI
Voltage Imbalance (Three Phase)
For a three phase source, this feature monitors phase voltage ratios based on a selected range within a selected time window. Should any phase fall below the selected lower window limit or exceed the selected higher window limit within the selected time frame, the controller initiates transfer to the other source.

Range: 5% to 20% of Nominal voltage,
10 to 30 seconds window, user adjustable.
Resolution: 1% Increments
Minimum Differential: 2% between Fail and Restore settings.
Factory default: 10% Fail , 8% Restore, 30 Seconds.
See CFG Menu page 17 to configure ON or OFF.
See SET Menu page 18 to set Percentage and time windows

ZNET
Network Communications Interface Card

How to Set the System Clock

How to Set the System Clock

Set System Clock, time and date

- If the clock is not set, the display will show SET SYSTEM CLOCK on the second line of the S1 OK screen.
- The S1 OK screen will show time (hours and minutes) on the second line if the system clock has been set. (Date on third line)

Setting the System Clock
(Start from S1 OK screen)

1. Remove battery protective white plastic strip near P relay. *
2. Press MORE then press SET.
3. Press MORE and scroll to SET SYSTEM CLOCK using the MORE key.
4. Press SEL.
5. ENTER ACCESS CODE located on the white label on the back of the controller.
6. Press SEL.
7. Use the up and down keys to change the hour value.
8. Press SAVE (this will enter this value and move cursor to minutes).
9. Use the up and down keys to change the minutes.
10. Press SAVE (this will enter this value and move cursor to month).
11. Use the up and down key up to change the month.
12. Press SAVE (This will enter this value and complete the clock setting).
13. Use the up and down keys to change the date.
14. Press SAVE (this will enter this value and move cursor to year).
15. Use the up and down keys to change year.
16. Press SAVE (this will enter this value and compete the clock setting).
17. To edit settings, press SEL and repeat steps 6-16.
18. If the setting is satisfactory, press MORE (unit then returns to the SET menu then press BACK, then ESC)

* Replacement battery part #K-4100
Battery will last 5 years and provides power to retain clock

CDT One Event Timer Exerciser

Load or No-Load
One event Exerciser with adjustable Timer. Exercise duration can be set between 5 and 60 minutes in 1 minute increments. Can be configured to run every 1,7,14, or 28 days. Factory default is 20 minutes.

How to CONFIGURE (CFG) and Set (SET) the Timer Exerciser

1. Beginning from the S1 OK screen, press MORE then CFG.
2. Press MORE to scroll to CONFIG TIMER EXERCISER screen.
3. The third line of the CONFG TIMER EXERCISER will show either DAILY,WEEKLY,14 DAY,28 DAY, or OFF.
4. If the third line of the CONFG TIMER EXERCISER shows DAILY,WEEKLY,14 DAY,or 28 DAY as desired, then proceed to step 10.
5. If the third line of the CONFG TIMER EXERCISER shows OFF or if another timer selection is desired, continue.
6. Press SEL.
7. Enter ACCESS code located on white label on the back of the controller.
8. Press UP or DOWN to select DAILY,WEEKLY, 14 DAY, or 28 DAY as desired.
9. Press SAVE.
10. Press MORE to scroll to CONFG TIMER EXERCISER (XFR) or (NO XFR).
11. Press Up or Down to select XFR (Load Transfer) or NO XFR (No Load Transfer).
12. Press SAVE.
13. Press MORE repeatedly to BACK then S1 OK screen.

Set (SET) the Exerciser:

14. Beginning from the S1 OK screen, press MORE then SET.
15. Press MORE repeatedly until EXER S2 RUN TIME screen.
16. Press SEL
17. Enter ACCESS code located on white label on the back of the controller.
18. Press SEL
19. Cursor is indicated as a line under character to be changed. Change values with up and down keys.
20. Press SAVE when complete.
21. Press MORE repeatedly until SET USER SETUP

then press BACK then ESC to the S1 OK screen.

How to Initiate CDT Exerciser and to start an exercise cycle every 1, 7, 14, or 28 days

From S1 screen

1) Press TEST
2) Press MORE
3) Press START TEST TIMER (to initiate Test).
   If the CDT Exerciser is Factory configured for a Load Exerciser, the Controller will immediately start a load exercise. The controller will start the generator, transfer the load to Source 2 and remain in Source 2 for the duration set for EXER S2 RUN TIME in the SET menu. The controller will retransfer the load back to Source 1 after the S1 stable timer has timed out and run the generator unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).
   If the CDT Exerciser is Factory configured for a No-Load Exerciser, the Controller will immediately start a No-load exercise. The controller will start the generator and run it unloaded for the duration of the S2 stop delay timer (Engine Cool Down Timer).

Exercise will be repeated at the same time as initiated on every 1, 7, 14, or 28 days according to the selection made in the Configure CFG menu.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press BPASS
2) Allow the controller to complete the Engine cool down cycle

If the CDT Exerciser is Factory configured for a No-Load Exerciser Or allow the controller to complete retransfer to Source 1 If the CDT Exerciser is Factory configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press Test
2) Press MORE
3) Press BYPASS EXER

To re-institute the next exercise event back, press CANCL BPASS

How to initiate a new exercise start time

1) Press TEST
2) Press MORE
3) Press EXER CANCL
4) Press START TIMER TEST

How to check the next exercise event

1) From S1 OK screen, press MORE three times.
2) The unit will display the PLANT EXERCISER NEXT event in DAYS, HOURS, and MINUTES
3) Press ESC to S1 OK Screen.

Notes:

- *E* appears in the upper right hand corner of LCD screen when exercise is impending.
- For Load Exerciser, actual exercise period (ATS in S2 position) = CDT (Exerciser)

CDP Clock Exerciser

Load / No-Load Clock Exerciser

Allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load. Can be configured by the end user for 1, 7, 14, 28, or 365 day cycles.

A total of 7 independent No Load exercise periods (up to 10 hours each) can be programmed for each of the daily, weekly, 14-day, and 28-day exercisers. A total of 12 independent No Load exercise periods (up to 10 hours) can be programmed for the 365-day Exerciser.

How to Configure (CFG) the Exerciser

1. Beginning from the S1 OK screen, press MORE then CFG.
2. Press MORE to scroll to CONFIG CLOCK EXERCISER screen.
3. The third line of the CONFG CLOCK EXERCISER will show either DAILY, WEEKLY, 14 DAY, 28 DAY, 365 DAY or OFF.
4. If the third line of the CONFG CLOCK EXERCISER shows DAILY, WEEKLY, 14 DAY, 28 DAY, or 365 DAY as desired, press MORE repeatedly to BACK. Press ESC then proceed to the SET menu to set the EXERCISER.
5. If the third line of the CONFG CLOCK EXERCISER shows OFF, continue.
6. Press SEL.
7. Enter ACCESS code located on white label on the back of the controller.
8. Press UP or DOWN to select DAILY, WEEKLY, 14 DAY, 28 DAY, or 365 DAY as desired.
9. Press SAVE.
10. Press MORE repeatedly to BACK then ESC to S1 OK screen.

How to set (SET) the DAILY Exerciser

1. Beginning from the S1 OK screen, press MORE then SET.
2. Press MORE repeatedly until SET EXERCISER screen.
3. Press SEL.
4. Enter ACCESS code located on white label on the back of the controller.
5. Press SEL
6. Cursor is indicated as a line under character to be changed. Change values with up and down keys. Press SAVE after each entry to save value and to move to the next value to be changed.
7. Press BACK when complete.
8. Press MORE repeatedly until SET USER SETUP. Press BACK then ESC to the S1 OK screen.

How to Bypass (Cancel) an exercise during an exercise cycle

1) Press BPASS
2) Allow the controller to complete the Engine cool down cycle.

If the CD Exerciser is configured or Set for a No-Load Exercise. Or allow the controller to complete retransfer to Source 1. If the CD Exerciser is configured for a Load Exerciser

How to Bypass the next exercise event and Keep the rest of scheduled events unchanged

1) Press TEST
2) Press MORE
3) Press BYPASS EXER

To re-institute the next exercise event back, press CANCL BPASS

How to check the next exercise event

1) From S1 OK screen, press MORE three times.
2) The unit will display the PLANT EXERCISER NEXT event in DAYS, HOURS, and MINUTES
3) Press ESC to S1 OK Screen.

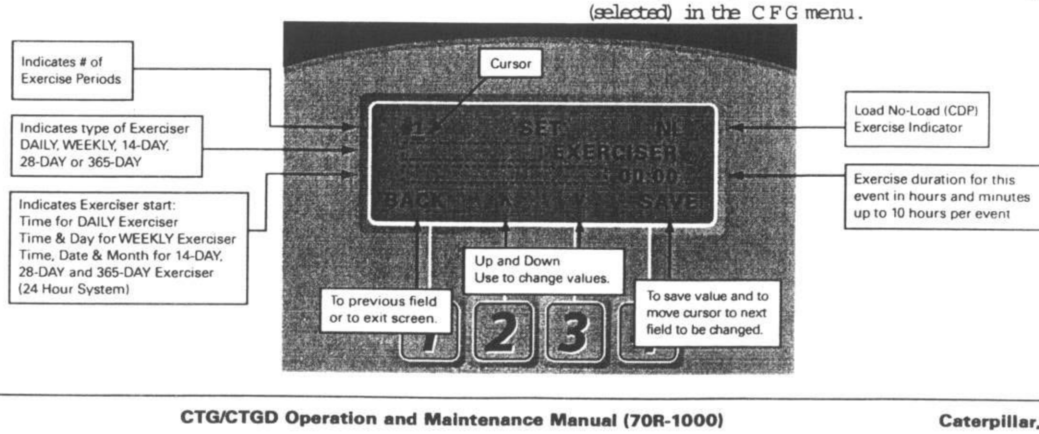
Notes:

In the S1 OK screen, an (*E*) appears in the upper right hand corner of LCD screen when exercise is impending.

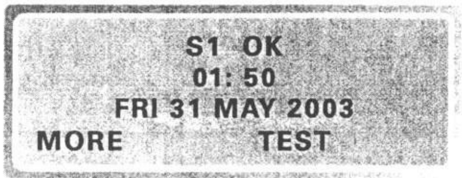
For Load Exerciser, actual exercise period (ATS in S2 position) = CDT (Exerciser) timing period +T (S1 Stable Timer) timing period.

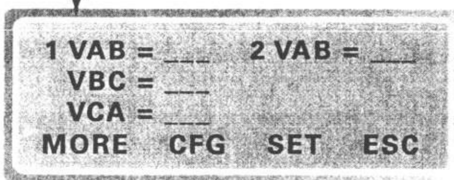
A value greater than zero must be entered in the Exerciser duration field to be accepted as a valid exercise period.

The Exercise cycle will be repeated on a regular basis as programmed and initiated in the SET menu depending on what Exerciser was configured (selected) in the CFG menu.



MX150 User Setup - CFG Menu





- TIMER EXERCISER (CDT)
  1, 7, 14, 28 Day (pg. 14 - 15)
- * CLOCK EXERCISER
  LOAD OR NO LOAD (CDP)
  1, 7, 14, 28, 365 Day (pg. 16)
- * TEST KEY (6)
  Maintained/Momentary (pg. 10)
- TRANSFER COMMIT (S13)
  ON/OFF (pg. 11)
- IN-PHASE MONITOR (R50)
  ON/OFF (pg. 11)
- * PHASE IMBALANCE (VI)
  ON/OFF (pg. 12)
- * LOAD DISCONNECT TD (UMD)
  (pg.13)
- * NETWORK (ZNET)
  ON/OFF (pg. 13)

* Optional Accessories

Turn options ON or OFF via keypad through the CFG menu

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

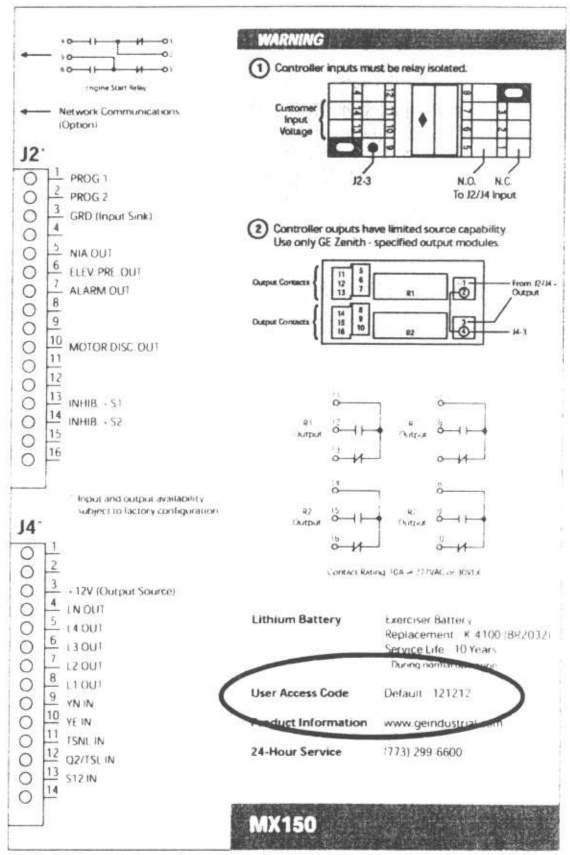


Figure 9

MX150 User Setup - SET Menu

S1 OK
01:50
FRI 31 MAY 2003
MORE TEST

1 VAB = ___ 2 VAB = ___
VBC = ___
VCA = ___
MORE CFG SET ESC

SET
USER SETUP
MORE BACK

- SET SYSTEM CLOCK (pg.14)
- DAYLIGHT SAVINGS ON/OFF
- * CLOCK EXERCISER (CDP) (pg.16)
- EXER S2 RUNTIME (CDT) (pg.14 - 15)
- S1 UNDER VOLTAGE (pg.10)
  Fail
  Restore
- S2 UNDER VOLTAGE (pg.10)
  Fail
  Restore
- S2 UNDER FREQUENCY (pg.10)
  Fail
  Restore
- * SET % PHASE IMBALANCE (VI) FAIL 5%, RESTORE 3% (pg.12)
- * SET PHASE IMBALANCE (VI) TIME DELAY 30 seconds (pg.12)
- TIME DELAY S2 START (P1) (pg.11)
- TIME DELAY S2 STABLE (W) (pg.11)
- * LOAD PRESIGNAL TD (T3/W3) (pg.13)
- * LOAD DISCONNECT TD (UMD) (pg.13)
- ATS OPEN TIME TO S2 (DW) DELAY units only (pg.10)
- TIME DELAY S1 STABLE (T) (pg.11)
- ATS OPEN TIME TO S1 (DT) DELAY units only (pg.10)
- S2 STOP DELAY (U) (pg.11)
- CALIBRATE S1 (pg.10)
- CALIBRATE S2 (pg.10)

* Optional Accessories

Change adjustable values through the SET menu.

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

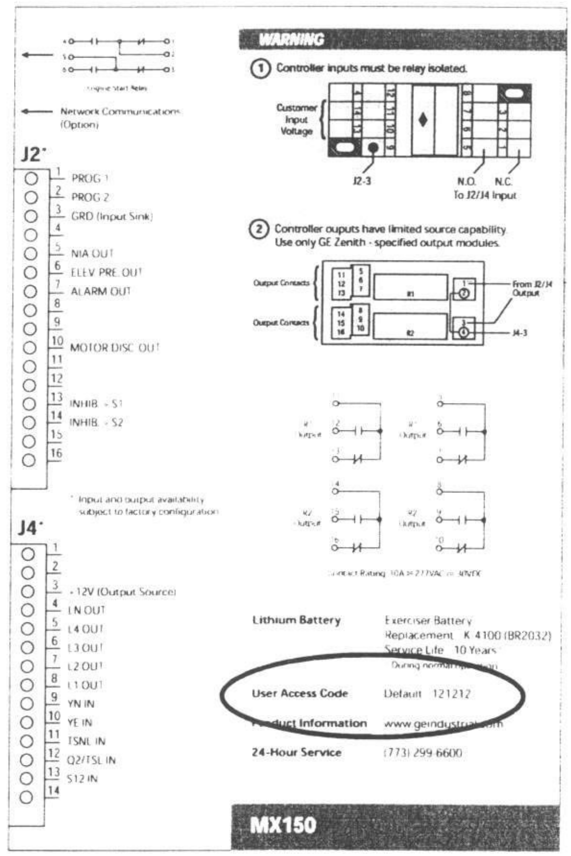
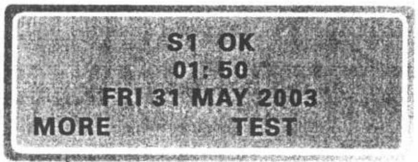


Figure 9

MX150 User Setup - System Info



- PHASE TO PHASE VOLTAGE, S1 & S2
- FREQUENCY INDICATION FOR S1 & S2 (K/P) (pg.11)
- PLANT EXERCISER:
  Next Impending Exerciser
  (shows only if set)
- SYSTEM INFO:
  - Serial #: Unit Serial #
  - Rev #: Software Revision #
  - Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
  - Data: Total Life Transfers (N2P)
    Days Powered Up
    Total Transfers to S2
    Total S1 Failures
    Time S1 available in Hrs
    Time S2 available in Hrs. (N1P)
- CHANGE USER ACCESS CODE

View System Data

Enter six digit access code
(The factory assigned six-digit access code is located on the back of the controller)

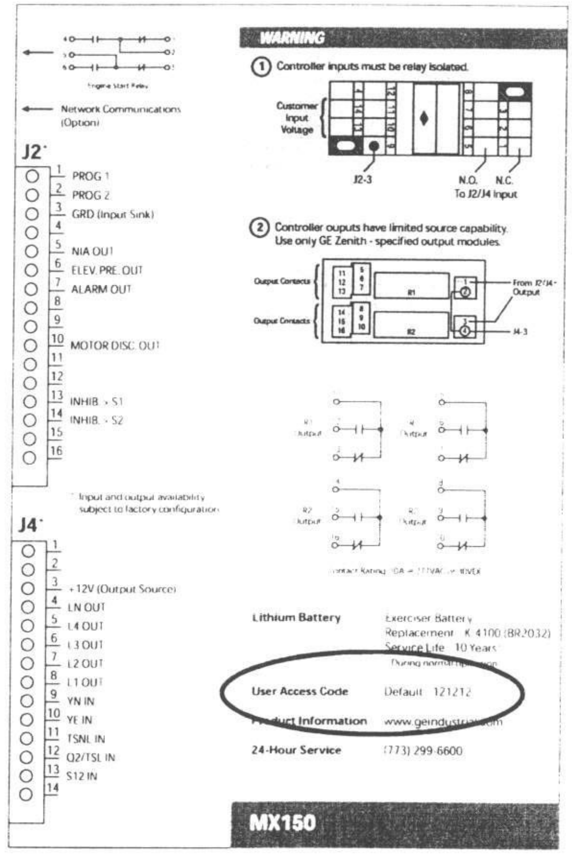


Figure 9

Testing

⚠ NOTICE ⚠

A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701)

ATS Testing

Start generator and verify proper voltage, frequency and phase sequence (match to Source 1). Shut down gen set and place in Auto. Complete the visual inspection of the transfer switch, and close the cabinet door.

Initiate the test by pressing the TEST button on the LCD keypad. The controller will then prompt for your access code. After entering the code, three test options will appear XFR LOAD, FAST TEST and NO XFR (See Figure 10).

> XFR LOAD test starts the generator and using the current timer settings, transfers the load to Source 2.
> FAST TEST test presets timer values to a maximum 30 seconds during the test. After completion of the test, all timers are reset to their original values. (T3, W3, DT and DW remain)
> NO XFR test starts the generator but does not transfer the load to the Source 2.

Press and hold the desired test option button until the switch transfers to Source 2 (load test) or until the generator has been run for the desired amount of time (no load test). Releasing the test button before W timer timeout will abort the test (Exception: when the transfer commit option, is configured ON).

To test lamps, press TEST then scroll through MORE, then press LAMP TEST. To cancel LAMP TEST press MORE.

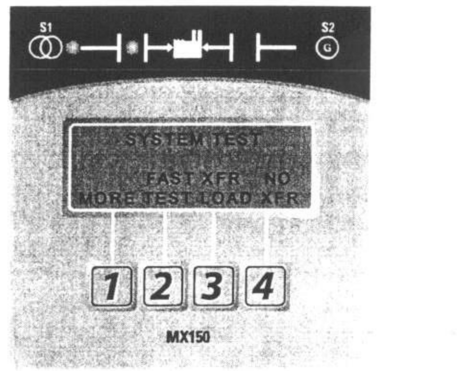


Figure 10

Standard Transition

When the test is initiated, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCE relay energizes the CE solenoid to close the transfer switch in to Source 2. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1 sequence. The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCN relay energizes the CN solenoid to retransfer the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:

When the test is initiated, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. A manual CANCEL button is provided to cancel the test if desired Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins its timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCNO relay energizes the CNO solenoid to open the transfer switch out of Source 1 position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the CCE relay energizes. The switch then completes transfer to Source 2 by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

Deactivating the test switch initiates re-transfer to Source 1sequence. The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCEO relay energizes the CEO solenoid to open the switch out of Source 2 position. The time delay to Source 1 timer (DT) begins tis timing cycle. After the (DT) time delay, the CCN relay energizes the CN solenoid to complete re-transfer of the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine

Sequence of Operation

Standard Transition

Source 1 Power Failure:

When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start Timer (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" Values, the time delay to Source 2 Timer (W) begins its timing cycle to ensure voltage and frequency stabilization before transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCE relay energizes the CE solenoid to close the transfer switch in to Source 2. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1sequence. The delay to Source 1 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCN relay energizes the CN solenoid to retransfer the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Delayed Transition

Source 1 Power Failure:

When Source 1 voltage or frequency has fallen below the preset "Fail" values, the controller initiates the Time Delay Source 2 Start (Engine Start Timer "P") cycle. Upon completion of the (P) time delay, an Engine start Signal is sent to Source 2. When Source 2 voltage and frequency reach the preset "Restore" values, the time delay to open Source 1 timer (W) begins tis timing cycle to ensure voltage and frequency stabilization before re-transfer. A manual pushbutton BYPASS is provided to bypass the "W" time delay if desired. After the (W) time delay, the CCNO relay energizes the CNO solenoid to open the transfer switch out of Source 1 position. The time delay to Source 2 timer (DW) begins its timing cycle. After the (DW) time delay, the CCE relay energizes. The switch then completes transfer to Source 2 by energizing the CE solenoid. The SE limit switch activates to de-energize the CCE relay.

Restoration of Source 1 Power:

When Source 1 power reach the preset "Restore" values, the controller initiates re-transfer to Source 1 sequence. The delay to open Source 2 Timer (T) begins its timing cycle to ensure voltage and frequency stabilization before retransfer. A manual pushbutton BYPASS is provided to bypass the "T" time delay if desired. After the (T) time delay, the CCEO relay energizes the CEO solenoid to open the switch out of Source 2 position. The time delay to Source 1 timer (DT) begins its timing cycle. After the (DT) time delay, the CCN relay energizes the CN solenoid to complete re-transfer of the switch to Source 1. The SN limit switch activates to de-energize the CCN relay.

Immediately after re-transfer, the S2 Stop Delay Timer (Delay to Engine Stop "U") begins its cycle to allow Source 2 Engine to run unloaded. A manual pushbutton BYPASS is provided to bypass the "U" time delay if desired. Upon completion of the (U) timing cycle, the controller sends an Engine stop signal.

Table 3

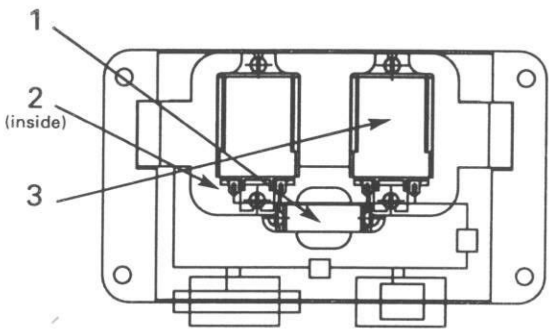
Timer Designations as they appear in the SET menu						
ATS Type	P	W	DW	T	DT	U
Standard	Time Delay S2 Start	Time Delay S2 Stable	→	Time Delay S1 Stable	→	S2 Stop Delay
Delay	Time Delay S2 Start	Time Delay S2 Stable	ATS Open Time to S2	Time Delay S1 Stable	ATS Open Time to S1	S2 Stop Delay
Source 1 Fails	Transfer to Source 2 →		Source 1 Returns	Transfer to Source 1 →		Engine Cooldown

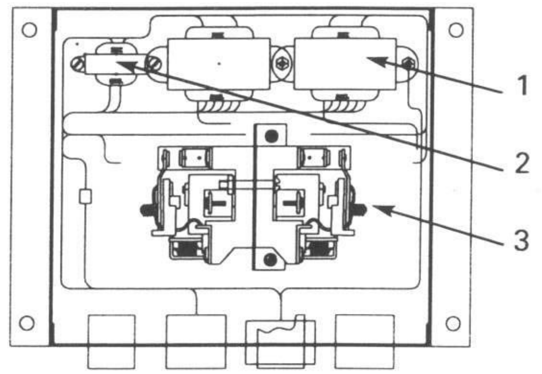
Relay/Transformer (R/T Box)

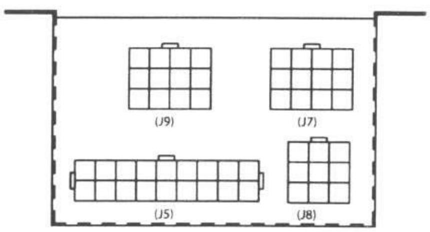
Standard Transition

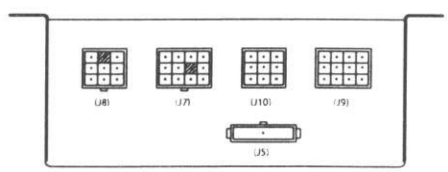
Each MX150 microprocessor based ATS controller requires a relay/transformer box to apply line voltage to the ATS operator via coil control relays. Also required is power for the MX150 printed circuit board and an application of sensing voltage proportional to line voltage. This is accomplished by the relay transformer box. This method of switching operator voltage and applying power and sensing voltage to the printed circuit board isolates the MX150 from the line voltage, further protecting the controller from harmful line transients. Two versions of the R/T box exist depending on the type of ATS (standard transition or delayed transition).

The following layout drawings of the R/T Box components (standard and delayed transition) include a bill of materials for replacement parts. Schematics are included to indicate proper wiring.









40-225 Amp Molded Power Section Transformer Usage *(see Figure 10)*

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
57P-1115	120V	K-3216	K-3224
57P-1116	208-220V	K-3217	K-3225
57P-1117	230-240V	K-3218	K-3226
57P-1118	277V	K-3219	K-3227
57P-1119	380-400V	K-3220	K-3228
57P-1120	416-440V	K-3221	K-3229
57P-1121	460-480V	K-3222	K-3230
57P-1122	575-600V	K-3223	K-3231

Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (1 VA)	1
2	See Chart	Transformer (25 VA)	2
3	K-1274	Relay Flange Mounted	2

40-3000 Amp - All Other Standard Types Transformer Usage *(see Figure 11)*

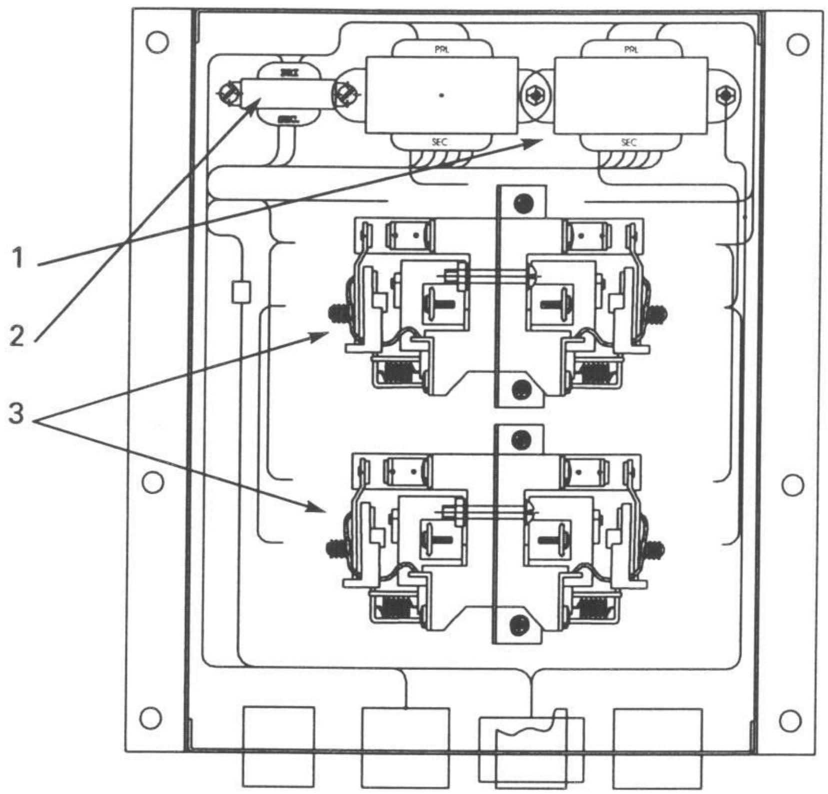
R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
50P-1005	120V	K-3216	K-3224
50P-1006	208-220V	K-3217	K-3225
50P-1007	230-240V	K-3218	K-3226
50P-1008	277V	K-3219	K-3227
50P-1009	380-400V	K-3220	K-3228
50P-1010	416-440V	K-3221	K-3229
50P-1011	460-480V	K-3222	K-3230
50P-1012	575-600V	K-3223	K-3231

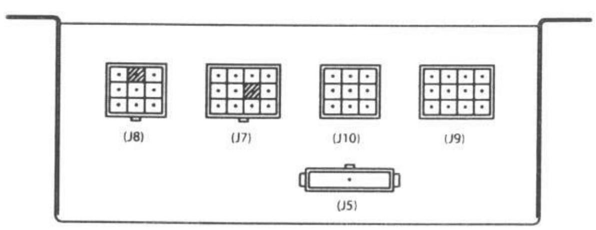
Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (25 VA)	2
2	See Chart	Transformer (1 VA)	1
3	K-1260	Coil Control Relay (24V)	2

Relay/Transformer (R/T Box) *(cont'd)*

Delayed Transition





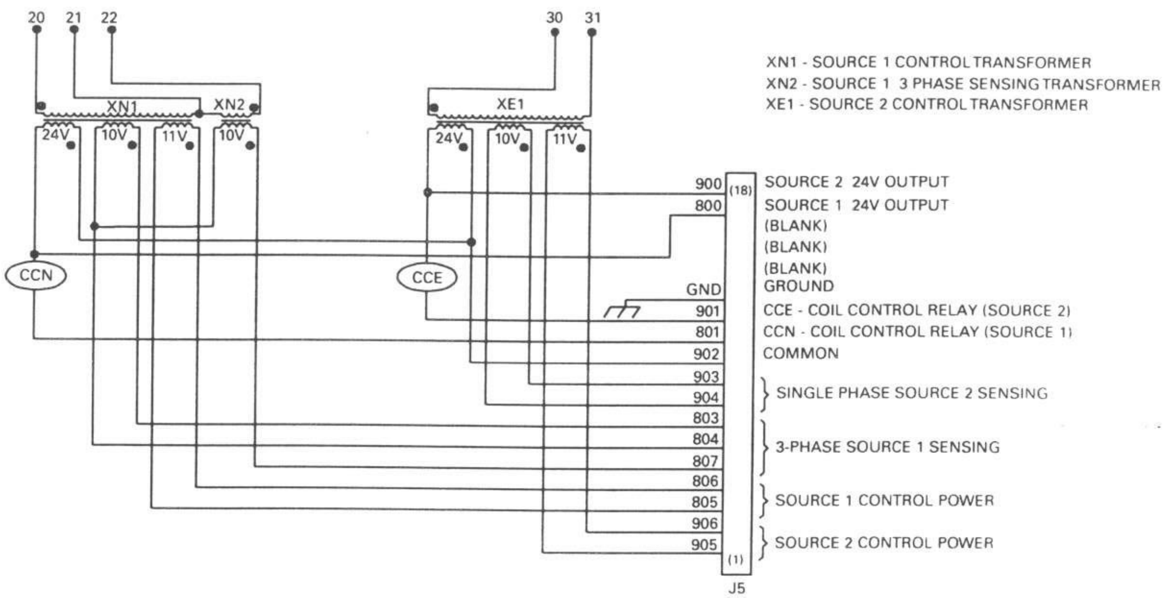
Transformer Usage

R/T Box Assembly Part No.	Primary Voltage at 50/60 Hz	1 VA XFMR Part No.	25 VA XFMR Part No.
50P-1013	120V	K-3216	K-3224
50P-1014	208-220V	K-3217	K-3225
50P-1015	230-240V	K-3218	K-3226
50P-1016	277V	K-3219	K-3227
50P-1017	380-400V	K-3220	K-3228
50P-1018	416-440V	K-3221	K-3229
50P-1019	460-480V	K-3222	K-3230
50P-1020	575-600V	K-3223	K-3231

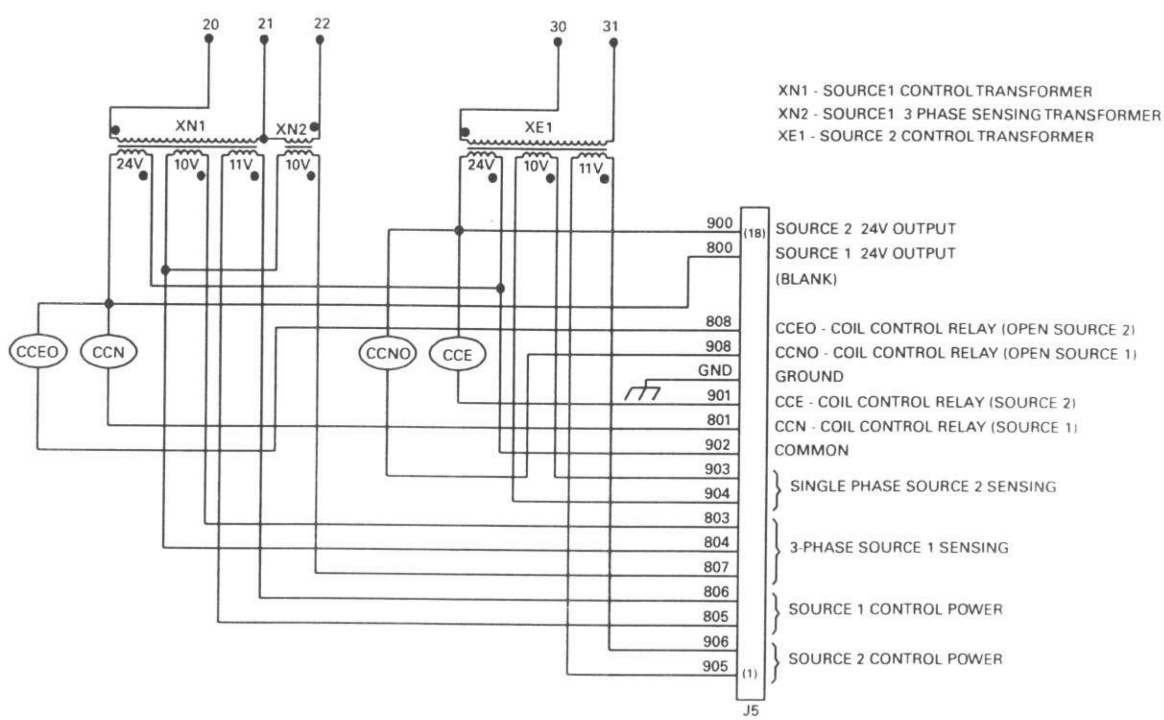
Bill of Material

Item	Part No.	Description	Qty
1	See Chart	Transformer (25 VA)	2
2	See Chart	Transformer (1 VA)	1
3	K-1260	Coil Control Relay (24V)	4

Standard Transition R/T Box Schematic



Delayed Transition R/T Box Schematic



Troubleshooting and Diagnostics

⚠ DANGER ⚠

<u>HAZARDOUS VOLTAGES CAN CAUSE SEVERE INJURY OR DEATH</u>.
These charts may indicate problems that require authorized GE Zenith service personnel.
Hazardous voltages may exist on termination plugs other than those that go into the MX150.

General Troubleshooting

The following troubleshooting guide is used to recognize, and determine basic faults. When using this guide, it will ask several questions about the condition of the switch. This guide will then list an order of the possible faults You will then look at the first suspected fault to determine if it is the problem. If it is not a fault, you go to the second suspected fault. If you go through all of the suspected faults, or the chart instructs you to, call a Caterpillar Representative for further assistance.

NOTE: When you use the troubleshooting charts, the Annunciation column refers to the LED's on the control panel.

Symptom	Annunciation	Possible Cause(s)	Corrective Action
Engine does not START	SOURCE 2 AVAILABLE LED off	Engine start wires not terminated properly	Check engine start connections
		Generator is in OFF position	Investigate why Engine Control Switch was turned off
Engine does not stop	LCD Display - "TD Engine Cool Down"	U timing cycle not complete	Check U timer setting
	SOURCE 1 POSITION, and SOURCE 1 and SOURCE 2 AVAILABLE LEDs on, but U timer has timed out	Engine start wires not terminated correctly	Check Engine Start Connections
		Generator in MANUAL	Place generator in AUTO
ATS will not transfer to SOURCE 2	SOURCE 2 AVAILABLE LED off	SOURCE 2 voltage or frequency not within acceptable parameters	Check: Engine Start Connections, Generator Breaker, Generator Output, and Engine Control Switch
ZTG Series	None	Power supply connector unplugged	Plug in connector
	LCD Display - "S1 _ _ _ _ TD XFR S1>S2 Time Remaining _ _ _ _"	**W** timing cycle not complete	Check **W** Timer setting
ATS will not transfer to SOURCE 1	LCD Display - "ATS Open Time Remaining _ _ _ _"	**DW** timing cycle not complete	Check **DW** Timer setting
ZTGD Series	SOURCE 1 AVAILABLE LED off	SOURCE 1 voltage or frequency not within acceptable parameters	Check utility and utility breakers
	None	Power supply connector unplugged	Plug in connector
	LCD Display - "Diagnostic Code 001"	Limit switch or RT box connector unplugged	Call Technical Services
	LCD Display - "S1 OK Time Remaining _ _ _ _ Bypass"	**T** timing cycle not complete	Check **T** Timer setting
	LCD Display - "ATS Open Time Remaining _ _ _ _"	**TD** timing cycle not complete	Check **DT** Timer setting

Maintenance and Testing

⚠ CAUTION ⚠

Due to hazardous voltage and current, CATERPILLAR recommends that a CATERPILLAR Certified technician or a qualified electrician must perform the installation and maintenance of the switch.

⚠ WARNING ⚠

Both power sources must be disconnected before manual operation of the switch.

A preventive maintenance program will insure high reliability and long life for the transfer switch. The preventive maintenance program for the transfer switch should include the following items:

Inspection and Cleaning

The switch should be inspected for any accumulation of dust, dirt, or moisture, and should be cleaned by vacuuming or wiping with a dry cloth or soft brush. do not use a blower since debris may become lodged in the electrical and mechanical components and cause damage.

Remove the transfer switch barriers and check the condition of the contacts. Any surface deposits must be removed with a clean cloth (do not use emery cloth or a file). If the contacts are pitted or worn excessively, they should be replaced. A general inspection of mechanical integrity should be made to include loose, broken or badly worn parts

Servicing

All worn or inoperative parts must be replaced using Caterpillar recommended replacement parts. Please refer to the Replacement Parts manual for specific part information and ordering procedures. Please contact the Caterpillar Technical Services Department for the Replacement Parts manual.

The operating mechanism of the transfer switch is lubricated with Lubriplate 105. The lubricant applied at the factory provides adequate lubrication for the lifetime of the switch. Should debris contaminate the mechanism, clean and apply additional Lubriplate.

Caterpillar can provide complete preventative maintenance services. Please contact the Caterpillar Technical Services Department for additional information.

CDT battery replacement - lithium batteries may last up to 10 years, however it is recommended that battery replacement be included in a 3-5 year service cycle. The battery maintains the exerceser memory only and does not otherwise affect the operation.

Testing

A manual operator handle is provided with the transfer switch for maintenance purposes only. Manual operation of the switch must be checked before it is operated electrically. **Both power sources must be disconnected before manual operation of the switch.** Insert the handle and operate the transfer switch between the Source 1 and Source 2 positions. The transfer switch should operate smoothly without binding. Return the switch to Source 1 position, remove the handle, and return it to the holder provided.

After completing the inspection, cleaning and servicing of the transfer switch, reinstall the switch cover, and close and lock the cabinet door. Reclose the circuit breakers feeding the utility and generator sources to the switch.

Initiate the electrical transfer test by activating the TS test switch. P timer will time out and the microcontroller will send an engine start signal. When the W time has elapsed, the switch will complete tis transfer by closing into Source 2.

Deactivating the test switch will start retransfer to Source 1. The switch will complete its retransfer to Source 1 after the time delay of the T timer. The U engine overrun timer allows the engine generator to run unloaded for a preset cool down period.

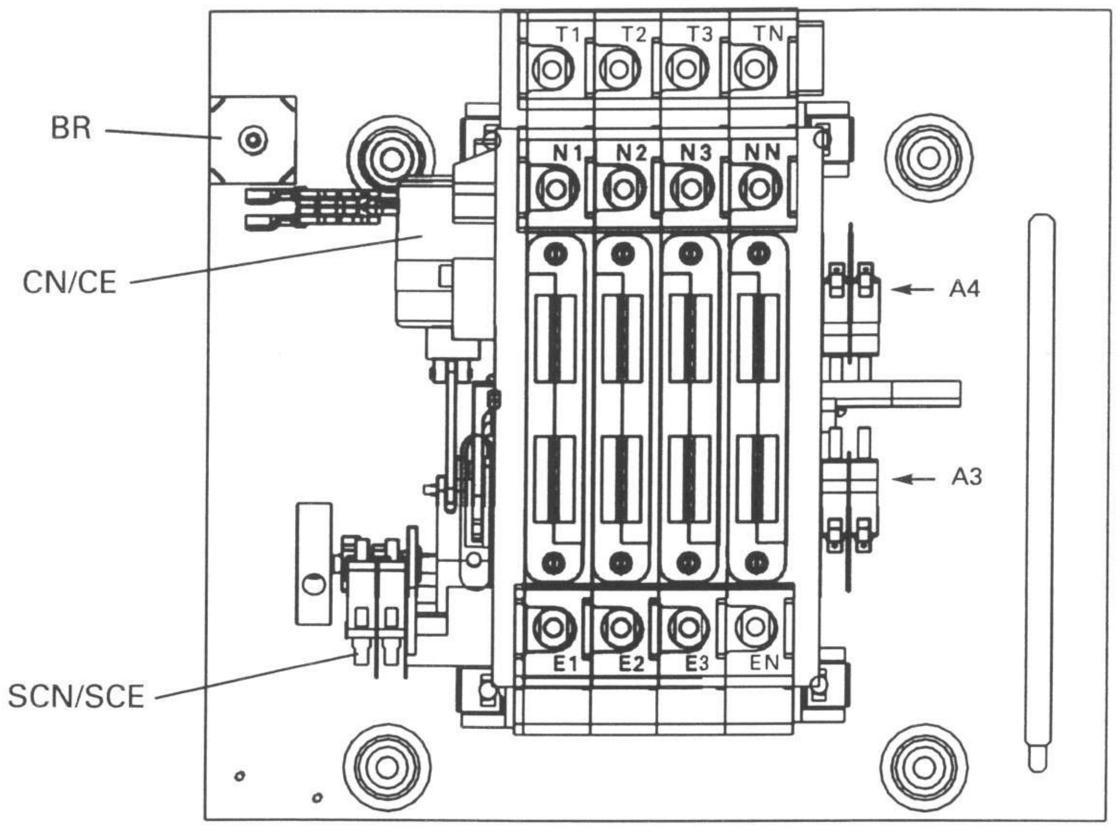
NOTE: A periodic test of the transfer switch under load conditions is recommended to insure proper operation. (See National Electric Code articles 700 and 701).

⚠ WARNING ⚠

When performing a hi-pot or dielectric test on the power section, DISCONNECT the control panel plugs from the microprocessor to avoid potential damage.

Power Panel and Replacement Parts

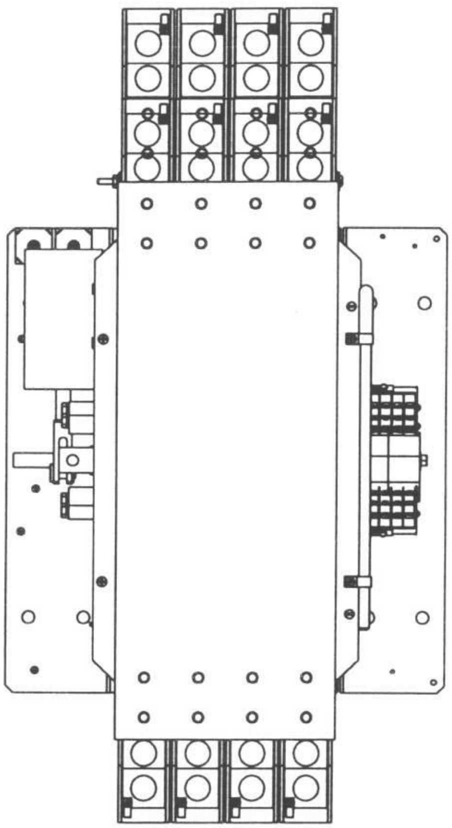
Standard Transition - 40 to 260 Amps Solenoid Type

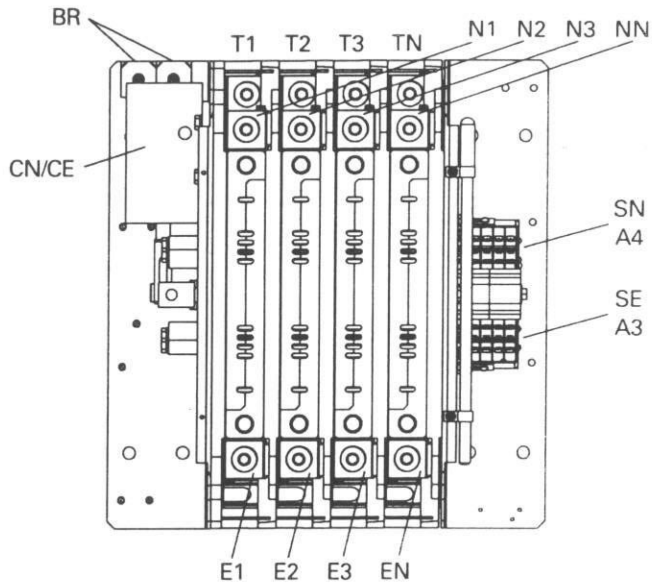


Tag	Description	Recommended as Spares	Voltage 40 to 260 Amps	Part #
CN/CE	Solenoid	*	120V	K-2207
			208V	K-2208
			220V	K-2208
			240V	K-2228
			277V	K-2211
			380/416V	K-2212
			440/480V	K-2209
			575/600V	K-2213
	Solenoid Plunger and Link	*	ALL V	57P-1030
SCN/SCE	Coil Cutout Switch		120-480V	L-3078
SCN/SCE	Coil Cutout Switch		600V	L-4027
BR	Rectifier	*	100-240V	PS-5152
BR	Rectifier	*	241-600V	PS-5076
A3/A4	Auxiliary Contacts		ALL V	L-3078

Power Panel and Replacement Parts *(cont'd)*

Standard Transition - 400 to 600 Amps Molded Type

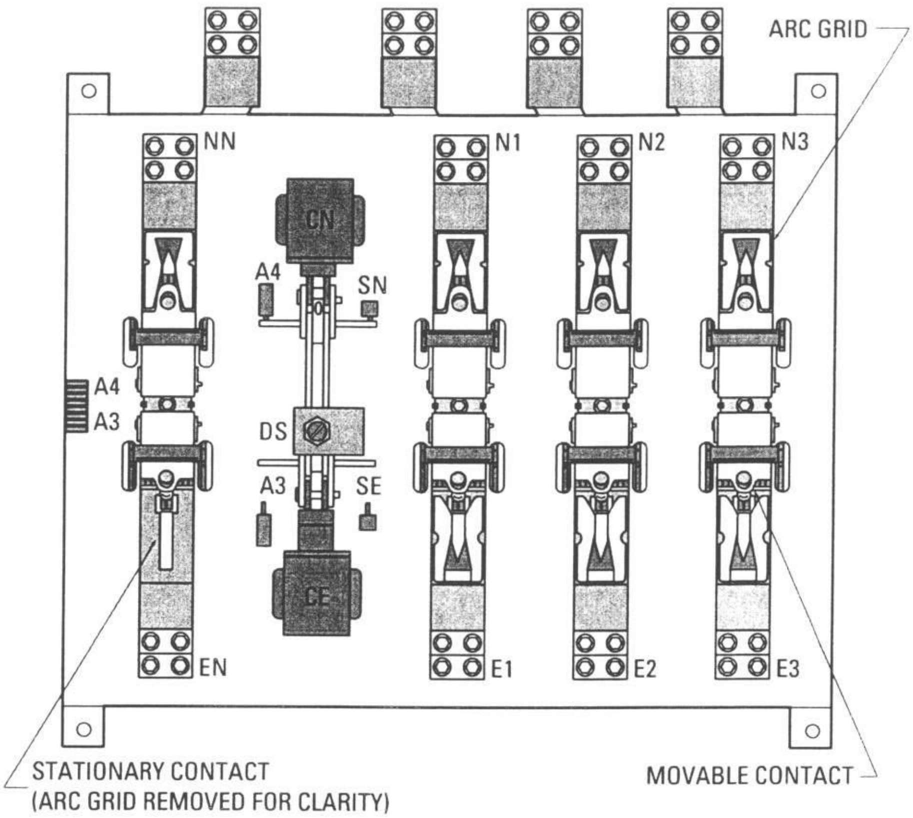




Tag	Description	Recommended as Spares	Stock Numbers by Amperage		
				400	600
N 1,2,3 N E 1,2,3 N T 1,2,3 N	Cable Connection Lug			S-2701	S-1393F
	Wire Size			#4-600 MCM	#2-600 MCM
			Coil Volts		
CN/CE	Solenoid	*	120	K-2245B	
			208/220	K-2246B	
			380/416	K-2247B	
			440/480	K-2248B	
			575/600	K-2249B	
SN/SE	Coil Cutout Switches		L-3078		
A3/A4	Auxiliary Contacts				
BR	Rectifier	*	PS-5076		

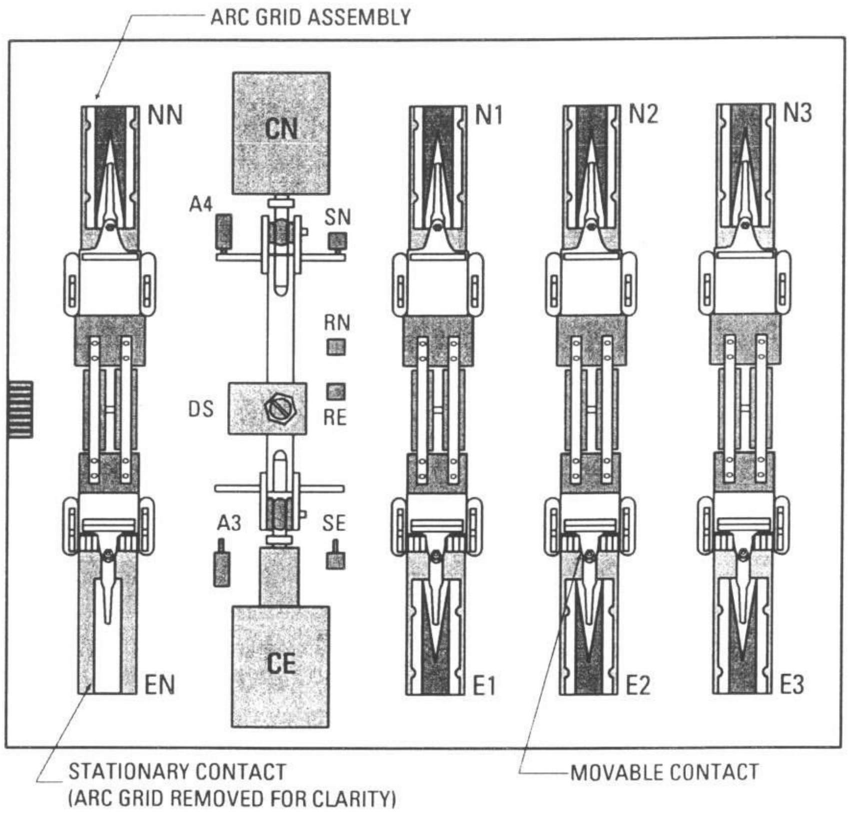
Power Panel and Replacement Parts *(cont'd)*

Standard Transition - 800 to 1200 Amps



Tag	Description			Recommended as Spares	Stock Numbers by Amperage 800	1000	1200
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug				S1392F (4)	S1392F (4)	S1392F (4)
	Wire Size				#2-600 MCM	#2-600 MCM	#2-600 MCM
	Stationary Contact Assembly Kit				Consult Factory		
	Arc Grid Assembly Kit				23P-1366		
	Movable Contact Assembly Kit				Consult Factory		
CN/CE	Main Operating Coils	Coil Volts	Poles	•			
		120	2		K-2073F	K-2073F	K-2073F
		240	2		K-2070F	K-2070F	K-2070F
			3		K-2070F	K-2070F	K-2070F
			4		K-2074F	K-2074F	K-2074F
		208	3,4		K-2074F	K-2074F	K-2074F
		575/600	3,4		K-2156	K-2155	K-2155
		480	3		K-2071F	K-2071F	K-2071F
			4		K-2071F	K-2071F	K-2071F
		416	3		K-2071F	K-2071F	K-2071F
SN	CCN Cutout Switch		23P-1333		23P-1333		
SE	CCE Cutout Switch		23P-1327		23P-1452		
A3	Emergency Position Auxiliary Contact		(Qty 1) 23P-1327 (Qty 2) 23P-1328 (Qty 3) 23P-1334 (Qty 4) 23P-1336				
A4	Normal Position Auxiliary Contact		(Qty 1) 23P-1333 (Qty 2) 23P-1334 (Qty 3) 23P-1328 (Qty 4) 23P-1330				
DS	Disconnect Switch (older versions)		Operator L-4009; Contact Block L-1020	•	Operator L-4009; Contact Block L-1020		

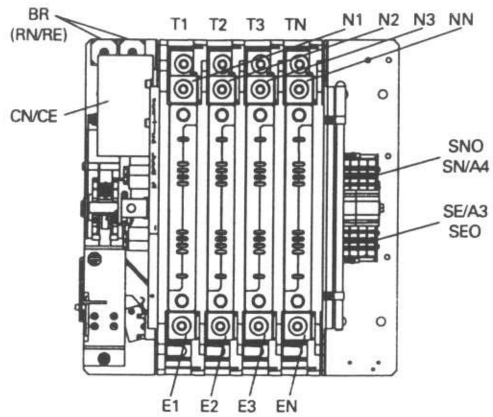
Standard Transition - 1600 to 3000 Amps



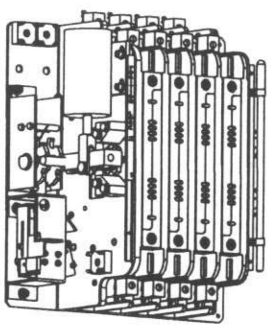
Tag	Description	Coil Volts	Poles	Recommended as Spares	Stock Numbers by Amperage 1600	2000	3000
N 1,2,3, N E 1,2,3, N T 1,2,3, N	Cable Connection Lug				S1126F (2) Optional	S1126F (2) Optional	S1126F (2) Optional
	Wire Size				(8) #2-600 MCM	(8) #2-600 MCM	(8) #2-600 MCM
	Stationary Contact Assembly Kit				23P-1594	23P-1594	23P-1594
	Arc Grid Assembly Kit				23P-1171	23P-1171	23P-1171
	Movable Contact Assembly Kit				23P-1400	23P-1400	23P-1400
CN/CE	Main Operating Coils	Coil Volts	Poles	*			
		120	2		SPO	SPO	SPO
		240	2,3		K-2123F	K-2123F	K-2123F
			4		K-2127F	K-2127F	K-2127F
		208	3		K-2125F	K-2125F	K-2125F
			4		K-2128F	K-2128F	K-2128F
		575/600	3		K-2153F	K-2153F	K-2153F
			4		K-2154F	K-2154F	K-2154F
		480	3		K-2120F	K-2120F	K-2120F
			4		K-2130F	K-2130F	K-2130F
		416	3		K-2126F	K-2126F	K-2126F
SN	CCN Cutout Switch		23P-1352		23P-1352		
SE	CCE Cutout Switch		23P-1356		23P-1356		
A3	Emergency Position Auxiliary Contact	(Qty 1) 23P-1356 (Qty 2) 23P-1357 (Qty 3) 23P-1353 (Qty 4) 23P-1355					
A4	Normal Position Auxiliary Contact	(Qty 1) 23P-1352 (Qty 2) 23P-1353 (Qty 3) 23P-1357 (Qty 4) 23P-1359					
DS	Disconnect Switch (older versions)		Operator L-4009; Contact Block L-1020	*	Operator L-4009; Contact Block L-1020		
RN, RE	Rectifier		23P-1473 (Up to 240V); 23P-1582 (Up to 600V)	*	23P-1473 (Up to 240V); 23P-1582 (Up to 600V)		

Power Panel and Replacement Parts *(cont'd)*

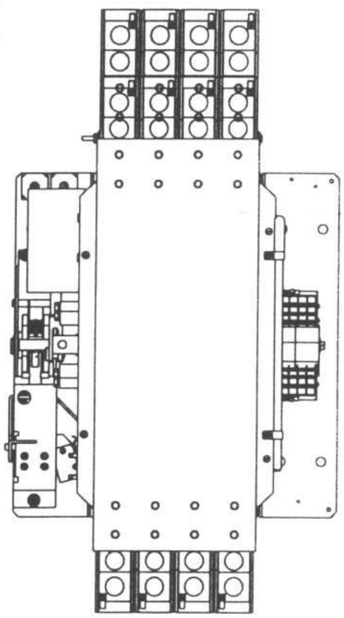
Delayed Transition - 40 to 600 Amps



100-400 Amps



40-80 Amps

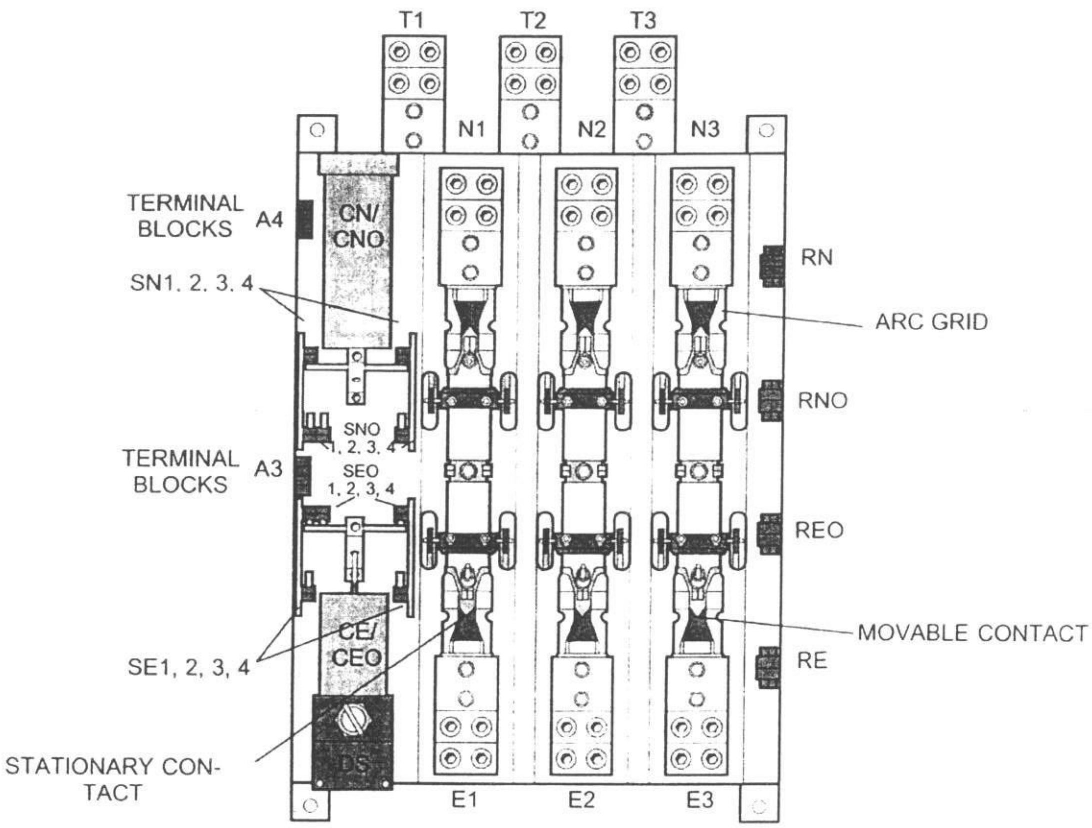


600 Amps

Tag	Description	Recommended as Spares		Stock Numbers by Amperage		
				40-80	100-400	600
N 1,2,3 N E 1,2,3 N T 1,2,3 N	Cable Connection Lug			S-2515	S-2701	S-1393F
	Wire Size			#8-3/0 AWG	#4-600 MCM	#2-600 MCM
			Coil Volts	MAIN	SECONDARY	
CN/CE	Solenoid	•	120	K-2245B	58P-1106	
			208/240	K-2246B	58P-1107	
			380/415	K-2247B	58P-1108	
			440/480	K-2248B	58P-1109	
			575/600	K-2249B	58P-1110	
			575/600	K-2249B	58P-1110	
	Handle-Manual		E-3054			
	Handle-Grip		L-3078			
A3/A4	Auxiliary Contacts		L-3078			
SNO/SEO	Coil Cutout Switch		E-3521			
BR	Rectifier (>380V)	•	PS-5076			
BR	Rectifier	•	PS-5152			

Power Panel and Replacement Parts *(cont'd)*

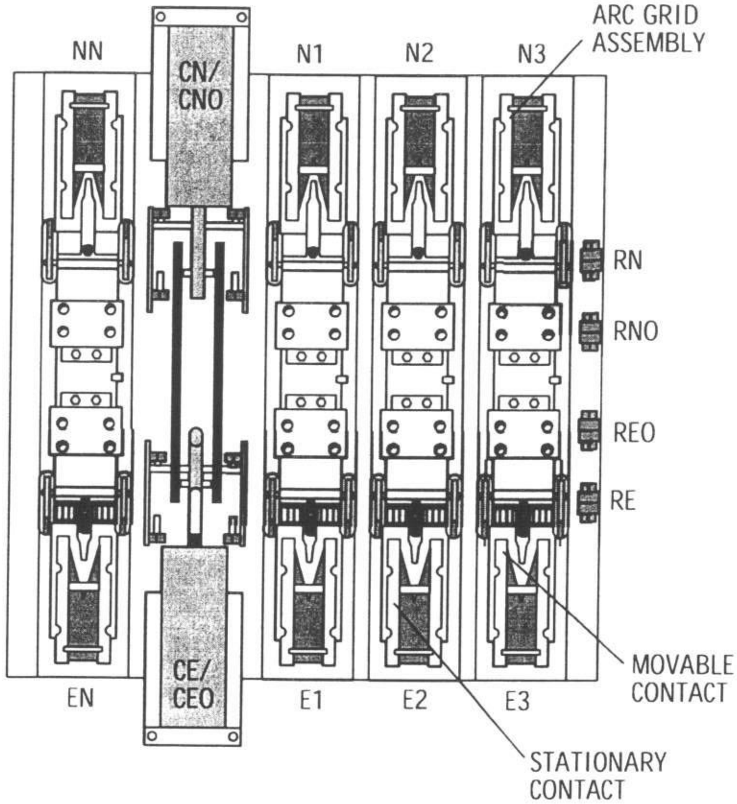
Delayed Transition - 800 to 1200 Amps



Tag	Description	Recommended as Spares	Stock Numbers by Amperage 1000-1200
NL 1,2,3 EL 1,2,3 T 1,2,3 NN, EN, TN	Cable Connection Lug, CU Wire		2-1392F (4) 600MCM-2
	Stationary Contact Assembly Kit		26P-1336
	Arc Grid Assembly Kit		23P-1366
	Movable Contact Assembly Kit		26P-1334
	Movable Contact		26P-1335
RN/RNO RE/REO	Coil Rectifier	•	23P-1473 (Up to 240 VAC) 23P-1582 (Up to 600 VAC)
SN/SNO	Limit Switch		23P-1535(L); 23P-1533(R)
SE/SEO	Limit Switch		23P-1536(L); 23P-1534(R)
A3	Emergency Position Auxiliary Contact		23P-1536
A4	Normal Position Auxiliary Contact		23P-1535
DS	Disconnect Switch	•	Operator: L-4009; Contact Block: L-1020
CN/CNO CE/CEO	Main Operator Solenoids	•	**See Chart Below**

Volts	Voltage System Ph	Wire	Coil VDC	Pole	Solenoid Part No. 800-1200
240	3	3	240	3	K-2147
120/208	3	4	208	3,4	K-2147
480	3	3	480	3	K-2157
277/480	3	4	480	3,4	K-2157
240/416	3	4	416	3	Consult Factory

Delayed Transition - 1600 to 3000 Amps



Tag	Description	Recommended as Spares	Stock Numbers by Amperage 1600	2000	3000
N1,2,3 E1,2,3 T1,2,3 NLN,ELN	Cable Connection Lug, CU Wire		S-1126F(2) Optional (8) 600MCM-2		
	Stationary Contact Assembly Kit		23P-4134X	23P-4134Y	23P-4134Z
	Arc Grid Assembly Kit		23P-1171	23P-1171	23P-1171
	Movable Contact Assembly Kit		23P-1400	23P-1400	23P-1344
CN/CNO CE/CEO	Main Operator Solenoids	•	See Chart Below		

Voltage System: Volts	Ph	Wire	Coil VDC	Pole	Solenoid Part No. 1600	2000	3000
120	1	2	120	2	S.P.O.	S.P.O.	S.P.O.
120/240	1	3	240	2,3	K-2151	K-2151	K-2151
240	3	3	240	3	K-2151	K-2151	K-2151
120/208	3	4	208	3,4	K-2151	K-2151	K-2151
480	3	3	480	3	K-2160	K-2160	K-2160
575	3	3	575/600	3	S.P.O.	S.P.O.	S.P.O.
277/480	3	4	480	3,4	K-2160	K-2160	K-2160
120/240	2	4	240	4	K-2151	K-2151	K-2151
240/416	3	4	416	3	Consult Factory		

Operating Coil Hardware Kit		1600	2000	3000
SN/SNO-1,2	Switch Bracket Assembly	23P-1540	23P-1540	23P-1540
SE/SEO-1,2	Switch Bracket Assembly	23P-1541	23P-1541	23P-1541
SN/SNO-3,4	Switch Bracket Assembly	23P-1542	23P-1542	23P-1542
SE/SEO-3,4	Switch Bracket Assembly	23P-1543	23P-1543	23P-1543

CATERPILLAR®

A Product of Caterpillar, Inc.
4016 Nine McFarland Drive, Alpharetta, GA 30004
770-442-9442 Fax: 770-664-6302

FC/FCA
12, 24, 32 & 48 VOLT, 6 & 10 AMP

BATTERY CHARGER

OPERATION & MAINTENANCE GUIDE

SENS part number:	101037
Document revision:	A
Engineering change number:	105073
Date:	1/13/2006

SENS
STORED ENERGY SYSTEMS

1840 Industrial Circle
Longmont, CO 80501
Fax: (303) 678-7504
Tel: (303) 678-7500
Email: service@sens-usa.com
Web: www.sens-usa.com

Installation or service questions? Call SENS at 1-800-742-2326 (303-678-7500) between 8 a.m. and 5 p.m. (Mountain Time) Monday through Friday, or visit our website.

Copyright © Stored Energy Systems LLC 2006

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This manual contains important safety and operating instructions for Stored Energy Systems (SENS) model FC. Before using the battery charger, read all instructions and cautionary markings on the battery charger, battery and equipment connected to the battery system.

Pay special attention to these three types of notices used in this document.

WARNING: is used in this manual to warn of possible personal or property injury

CAUTION: *is used in this manual to warn of possible equipment damage*

NOTE: is used in this manual to provide advice on how to obtain maximum performance, reliability or life from components of your system.

WARNING:
Please read these safety warnings and heed them. Failure to do so could result in either severe personal injury or equipment damage.

To reduce the risk of injury, charge only properly sized lead-acid or nickel cadmium batteries. Other types of batteries or under-sized batteries may burst causing personal injury and damage.

- Do not install or operate charger if it has been dropped or otherwise damaged. Return it to the factory for repair.
- Install the charger in accordance with all local codes.
- Do not expose charger to rain or snow.
- Do not disassemble charger; return to factory when service or repair is required. Incorrect assembly may result in a risk of electric shock or fire.
- To reduce risk of electric shock, de-energize and disconnect the AC input and the battery from the charger before attempting maintenance or cleaning.
- Use of an accessory not recommended or sold by SENS may result in a risk of fire, electric shock or personal injury.
- During normal operation, batteries may produce explosive hydrogen gas. *Never smoke, use an open flame, or create sparks near the battery or charger.*
- Remove jewelry, watches, rings, etc. before installing battery or charger.

Maintenance Instructions

User maintenance is limited to charger adjustment. All on-site servicing should be performed by qualified service personnel. If qualified personnel are not available, return the charger to the factory for repair, or contact the factory to arrange for field service.

1 READ THIS FIRST

CAUTION: Failure to follow installation instructions may cause equipment damage, or void the equipment warranty. READ THESE INSTRUCTIONS BEFORE PROCEEDING!

- The charger *must* be connected to a battery for it to operate properly (see Section 4.1). If the charger is feeding a load and charging a battery, disconnecting the battery will cause the output voltage to rise to unsafe levels with possible damage to connected loads. *Always disconnect the AC mains power before disconnecting the battery from the charger.* If the charger is not connected to a battery it will operate at approximately half its rated voltage, and the alarm relays (if the unit is so equipped) will chatter.

- Do not connect the battery leads to the charger backwards. Doing so will blow the output fuse when the charger is energized

- Changing factory-set potentiometers *voids the warranty.* Contact the factory if the settings on your charger are incorrect.

If you suspect a problem, check the following:

1. Is AC power available to the charger?
2. Are any fuses blown?
3. Is the charger connected to a battery of the correct voltage?
4. Was the charger damaged in transit or installation?
5. If you determine that the charger is not working because it is not putting out any current, check the battery's state of charge. If the battery is fully charged it is normal for the charger to produce zero current. See Figure 4.1.
6. If the battery is being over- or undercharged, check whether the output voltage settings have been tampered with. The pots should be covered with either white adhesive paper dots or a hard red varnish.

2 Description and Application

This manual covers installation, operation and troubleshooting of SENS model FC and FCA battery chargers rated at 6 or 10 amps output, 12, 24, 32 and 48 volts. Text, drawing of the housing mechanical layout, generic power circuit schematic, and circuit board replacement information are included. Complete parts lists and board-level documentation are available separately from SENS.

NOTE: The following units are UL listed to UL specification 1012:

- 12 or 24 volt output AND
- 120 volt input

3 Installation

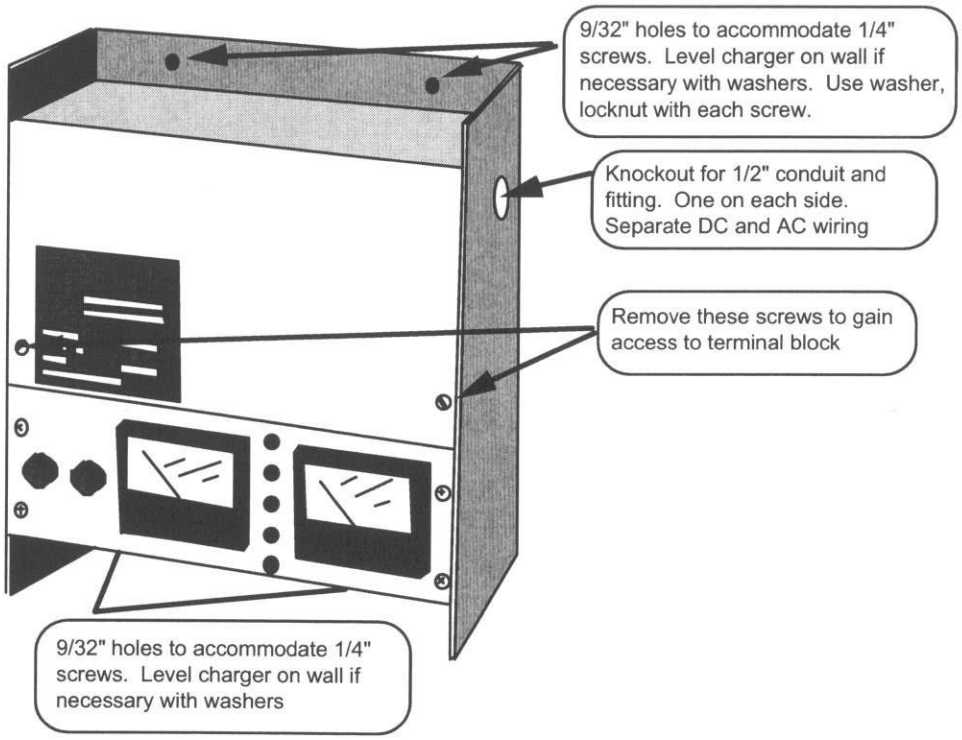
3.1 Mounting *(for dimensions, refer to drawings at end of manual)*

Mount on a clean, dry, fixed wall that is protected from extremes of temperature. Allow at least 6 inches above and below the unit, and 3 inches on either side for proper ventilation. The unit must be mounted vertically.

If the charger must be mounted on or in a vibrating enclosure, the mounting arrangement should be designed to provide full vibration isolation. ***Protect the charger from construction grit, metal chips, paint or other debris.*** Clean away debris after installation.

FIGURE 3.1

FC Charger Mounting *(see diagram at end of document for dimensions)*



3.2 Power Connections

WARNING: FC/FCA chargers use different fusing configurations as follows:

115 & 277 volt, 60 Hz	Single pole input fuse
220 volt, 60 Hz*	2-pole input fuses (to protect two live leads - there is no neutral lead used)
220 volt, 50 Hz**	Single pole input fuse

Ensure that you have the correct fusing configuration.

1. *The neutral must NEVER be fused*
2. *The live conductors must be fused*

* All 60 Hz voltages except 115 and 277 use this configuration
* All 50 Hz voltages use this configuration unless specially ordered

TABLE 3.2
AC Input Current Ratings

Charger Output		AC Input Current			
		120 V i/p	208 V i/p	240 V i/p	480 V I/p
V	A	Amps	Amps	Amps	Amps
12	6	3	1.0	0.9	0.4
12	10	3	1.6	1.4	0.7
24	6	4	2.0	1.7	0.9
24	10	6	3.3	2.9	1.4
32	6	4.6	2.6	2.3	1.1
32	10	7.6	4.4	3.8	1.9

Refer to the drawings at the back of this guide. Connection should be made by a qualified installer. Remove the two screws securing the charger's top front panel to gain access to the connections.

• Use AWG #12 or larger wire for DC (charger to battery) leads.
• Use AWG #14 or larger wire for AC input and ground connections

WARNING: The battery charger should be connected to a grounded permanent wiring system. A ground stud is provided for this purpose

Knockouts accommodating 1/2" conduit and fittings are located on each side of the charger. Run the AC wiring independent of the DC and alarm wiring.

The voltmeter will show battery voltage as soon as the DC connection is completed. *Check the voltmeter as soon as the FC connection has been made.* If the meter reads zero or is deflecting below zero, reverse the polarity of the battery connections. *Do not energize the charger with the battery connected backwards*--the DC fuse will blow.

3.3 Alarm Connections *(pertains only to FCA models)*

Caution: Connection to the alarms is somewhat delicate; complete instructions and detailed drawings are provided at the end of this guide. Use stranded wire, rather than solid, if it is available.

The alarm relays are rated for a maximum of 2 amps at 25 volts DC, or 0.5 amp at 120 volts AC (non-inductive loads only). Connect the alarm relay to customer-supplied supervisory system only -- *do not apply AC mains power to the relays and* do not exceed the relays' ratings.

Two versions of FCA alarm board are available:

Condition	LED Indicator	FCA model suffix
AC on	Green LED	-2211, -2411
Low battery voltage	Amber LED	-2211, -2411
Charger failure	Red LED	-2211, -2411
AC fail	Red LED	-2411 only
High battery voltage	Red LED	-2411 only

4 Using the Charger

4.1 Features of the Charger

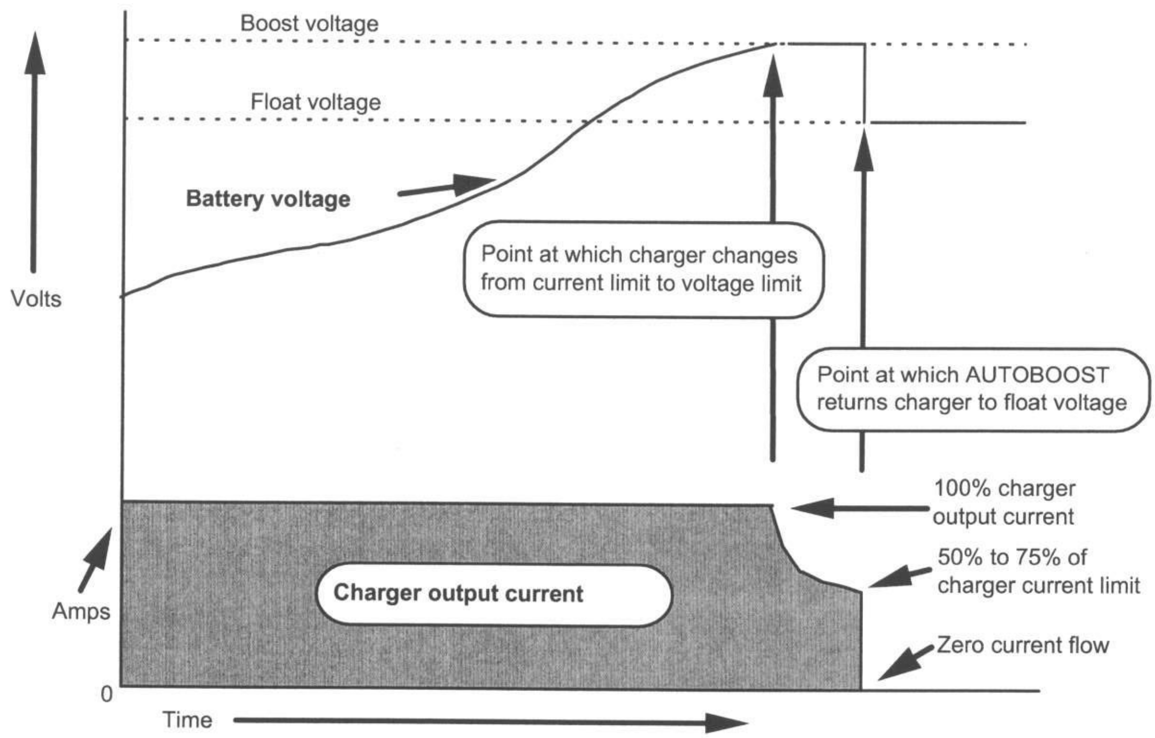
FC/FCA chargers feature **soft start circuitry** which causes a gradual increase in output power after application of AC power. The **Autoboost system** causes the charger initially to operate at the high rate. When the charger reaches the boost voltage set point, and current has dropped to approximately 50% to 70% of the charger's rating, the charger will revert to the float mode. The transition from boost to float will cause the output current of the charger to drop to zero amps until the battery voltage drops to the float level. Once the battery voltage nears the float setting, the charger will again deliver a small amount of current to the battery to maintain it at its fully charged state. Figure 3 is a graph of how the Autoboost system works.

NOTE: Autoboost is disabled on chargers shipped for use with sealed lead-acid batteries, per the recommendation of most battery manufacturers.

The battery charger is **temperature compensated** to match the negative temperature coefficient of the battery. Thus the float voltage will increase slightly as the temperature decreases, and decrease as temperature increases. The battery charger is electronically **current limited** to 110% of rated output. The charger will reduce its current output when the battery voltage is lower than normal so

that the charger's rated output power in watts is not exceeded. The charger uses **True Voltage Sensing** (TVS) to automatically compensate for voltage drop in the charging leads. TVS senses current flow between output current pulses, when current flow and voltage drop are zero. TVS interacts with the battery and therefore a battery is required for correct operation of the charger.

FIGURE 4.1



NOTE: When the charger switches from BOOST to FLOAT mode, no current will flow into the battery for a while due to the battery's high state of charge. **This is completely normal, and indicates that the charger is working properly.**

4.2 Ammeter, Voltmeter and Charger Troubleshooting

The voltmeter and ammeter (and alarm LEDs on the FCA models) provide indication of normal operation. Correct operation is indicated when the voltmeter reads 110% to 120% of nominal battery voltage. High current flow indicates that the battery has been discharged, and is being recharged. Lo current flow normally indicates that the battery is fully charged. The charger will at times read 0 amp This most commonly happens after the charger has reverted from the boost (or high rate) charge to flc charge. *Do not* automatically assume that the charger has failed if the ammeter reads 0 amps!

4.3 Alarm Operation *(pertains only to FCA models)*

The alarm LEDs have the following meanings:

Power on: AC power is available to the charger

Charge fail: The charger senses voltage rather than current to detect "failure"; once battery voltage drops approximately 1 volt below nominal the alarm activates. This may occur when:

a) The battery is fully discharged
b) The AC power has failed, and the battery has become discharged
c) There is an excessive load on the charger (not a charger failure)
d) The charger has failed

There is a time delay of approximately one minute between the start of the alarm condition and the actual alarm signal. This prevents spurious indications during short-term deep battery discharge (as would happen during engine cranking).

AC fail There is no AC power to the charger. This indicates either:

a) The AC power has failed
b) The input fuse is blown

High battery: Indicates that the output voltage is above a preset, adjustable point. The control circuit may have malfunctioned, or it could be misadjusted. In some cases, long leads of small gauge wire to the batteries cause a high battery alarm. The charger's *True Voltage Sensing* circuit automatically compensates for voltage drop in the charging leads. If charging leads are too small, the charger will operate at a high voltage to overcome high resistance in the leads. The alarm indication is made as soon as the alarm condition begins and lasts for approximately one minute after the alarm condition ends.

Low battery: Indication is made when the battery voltage is below a preset, adjustable point. This may occur when:

a) The AC power has failed and the battery has become discharged
b) The charger has malfunctioned
c) The battery is defective

There is a delay of approximately one minute between the start of the alarm condition and the alarm signal. This prevents false indications due to engine cranking or other temporary deep battery discharge. The delay period can be adjusted. Consult the factory.

The FCA's alarm system includes Form C contacts. The contacts change position whenever the associated alarm is activated.

When de-energized, the Form C contacts are in the "Failed" position (Fail and Com are connected)

5 Adjustments

Customer service of the charger is recommended only if the technician is experienced in electrical and electronic equipment. If a trained technician is not available, return the charger to the factory for adjustment. Note that adjustment of factory-set voltages without factory authorization voids the charger's warranty.

5.1 Adjusting the Charger Output Voltage *(refer to Figure 5)*

NOTE: There are two ways to adjust the charger voltage. The first method requires only an external precision voltmeter. The second method takes less time, but requires a 40 volt, 100,000 microfarad capacitor and an adjustable load.

NOTE: The charger *cannot* be correctly adjusted without either a battery or the capacitor mentioned above. This is because SENS' True Voltage Sensing circuit senses battery voltage only between charging current pulses.

All chargers *(adjustment procedure where capacitor and & load bank are **not** available)*

Connect an external precision voltmeter to the battery. Adjust the charger in small increments -- it takes time for the battery to adjust to new charger settings, so be patient.

1. Open upper front panel to gain access to control circuit.
2. Remove protective paper dots from potentiometers R30 and R34 (also labeled FLOAT and BOOST).
3. Turn boost voltage pot R34 fully counter-clockwise.
4. Adjust float pot R30 in small increments until the battery reaches the desired voltage. The voltage is not stable until the current drops to about 1 to 2 amps. *Do not consider the adjustment final until charger current is this low!*
5. Turn the boost pot R34 fully clockwise (maximum output voltage).
   Now adjust the boost charge voltage as described below:

Different adjustment procedures are used for AUTOBOOST and timed boost chargers.

AUTOBOOST chargers only *(not equipped with a timer)*

6. Put the charger in the AUTOBOOST mode by partially discharging the battery, then removing and restoring the charger's AC power source.
7. Allow the battery voltage to rise to the desired high rate charge level. Once at this voltage, carefully turn the boost pot counter-clockwise until the charger ammeter suddenly drops to approximately zero amps.
8. Charger is now adjusted. Replace paper dots and close front cover.

Chargers with timed boost

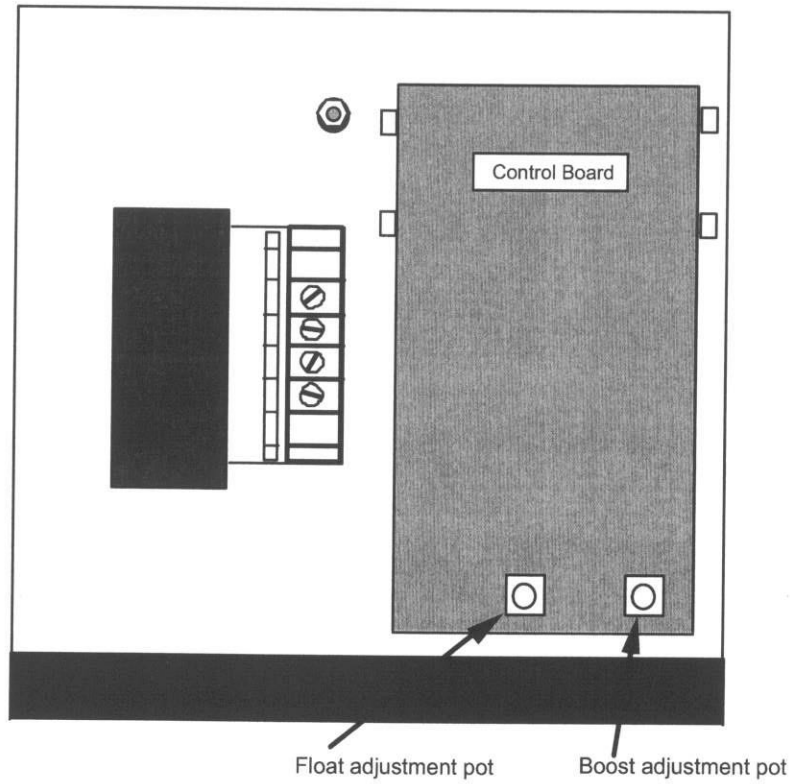
6. Turn timer knob to start high rate charging.
7. Allow the battery voltage to rise to the desired high rate charge level. The battery should be discharged so that charger is producing between 60% and 100% of its rated current. Once at the desired boost voltage, carefully turn the boost pot counter-clockwise until the charger ammeter drops noticeably (to between 1/2 and 2 amps).
8. Charger is now adjusted. Replace paper dots and close front cover.

Alternative adjustment procedure using capacitor and load bank -- all chargers

The capacitor and adjustable load take the place of a battery, so you do not have to wait for the battery voltage to increase or decrease to new output voltage levels. The time delays in the alarm circuit, however, cannot be defeated.

Connect the capacitor in parallel with the output terminals, making sure that the polarity is correct. Use the same general adjustment procedure as the "all chargers" section above; setting changes, however, do not have to be made in small increments. For the float adjustment, adjust the load bank so that the charger puts out about one amp. For the boost adjustment, adjust the load bank so that the charger puts out about 80% of its rated current. This high load causes AUTOBOOST chargers to switch to high rate charge.

FIGURE 5



View of FC charger with upper and lower doors open

5.2 Factory-Set Output Voltages

Chargers set for liquid-electrolyte lead-acid battery

	12 volt	24 volt	32 volt	48 volt
Float voltage	13.3	26.6	35.5	53.28
Boost voltage	14.0	28.0	37.3	56.00

Chargers set for sealed lead-acid battery

	12 volt	24 volt	32 volt	48 volt
Float voltage	13.5	27.0	36.0	54.24
Boost voltage	Boost should be turned all the way off for sealed battery			

Chargers set for nickel cadmium battery

	12 volt	24 volt	32 volt	48 volt
Float (# cells), voltage	(10) 14.3	(19) 27.2 (20) 28.6	(25) 35.8 (27) 38.6	(37) 52.91 (38) 54.34
Boost (# cells), voltage	(10) 15.2	(19) 28.6 (20) 30.0	(25) 37.5 (27) 40.5	(37) 56.24 (38) 57.76

5.3 Adjusting Alarm Voltage Levels

Three alarm adjustments are possible: charger failure alarm, low battery voltage alarm and high battery voltage alarm. The location of the adjustment potentiometers is shown in drawing no DIA\00066 at the end of this guide. Use an external precision voltmeter connected directly to the charger's output terminals.

To adjust the alarms, use an external adjustable DC power supply capable of providing up to 1/2 of an amp and an infinitely variable range of 10 to 50 volts.

De-energize the charger, disconnect the battery and connect the power supply's output leads to the charger's FC output terminals, being careful to observe correct polarity. Turn on the power supply. Verify on the external meter that polarity is correct.

Low battery alarm: Adjust the power supply to the desired alarm level. Turn the alarm pot counter-clockwise one revolution or so to increase the alarm voltage point. Wait until the alarm activates (about one minute). Now slowly turn the adjustment pot clockwise until the alarm light shuts off. This will be the voltage at which the adjustable power supply is set.

Charge fail alarm: Set this alarm using the same procedure as the low battery voltage alarm.

High battery alarm: Adjust the power supply to the desired level. Turn the alarm pot counter-clockwise one turn or so to reduce the alarm voltage to a low value. Now slowly turn the adjustment pot clockwise until the alarm light turns on. This will be the voltage at which the adjustable supply is set.

5.4 Factory-Set Alarm Voltages

Chargers set for lead-acid battery

	12 volt	24 volt	32 volt	48 volt
Low battery alarm voltage	11.0	22.0	29.3	44.0
High battery alarm voltage	16.5	33.0	44.0	60.0
Charge fail alarm voltage	12.5	25.0	34.0	50.0

Chargers set for nickel cadmium battery

	12 volt	24 volt	32 volt	48 volt
(# cells), low battery alarm voltage	(10) 11.9	(19) 22.61 (20) 23.8	25) 29.75 (27) 32.13	(37) 44.03 (38) 45.22
(# cells), high battery alarm voltage	(10) 16.5	(19) 33.0 (20) 36.0	(25) 40.8 (27) 44.0	(37) 50.7 (38) 52.1
(# cells), charge fail alarm voltage	(10) 13.5	(19) 26.0 (20) 27.0	(25) 34.5 (27) 37.0	(37) 60.3 (38) 61.9

6 Trouble-shooting Guide *(FC or FCA chargers)*

6.1 SENS' Field Assistance Policy

SENS' policy is to help field technicians correct problems as fast and inexpensively as possible. We encourage you to telephone SENS on our toll-free line for help--it will save you time and trouble.

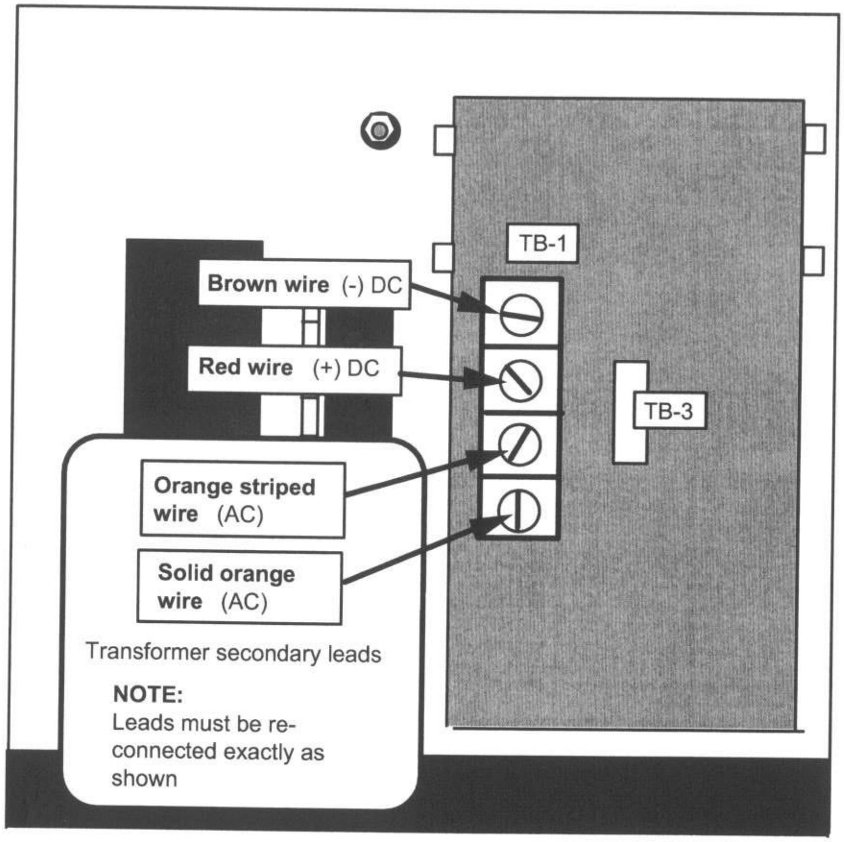
6.2 Troubleshooting Table

Symptom	Possible cause	Test	Repair procedure
No output	AC or DC fuse blown Battery not connected No AC power Ammeter disconnected TB-3 disconnected Defective control circuit Defective transformer	#1 #2	Replace fuse Connect battery Restore AC Reconnect Reconnect Call SENS for assistance Call SENS for assistance
AC fuse blows	Wrong input voltage Defective control circuit	#3	Connect to correct voltage Call SENS for assistance
DC fuse blows	Defective control circuit Battery leads reversed		Call SENS for assistance Call SENS for assistance
Overcharging	Improper boost/float settings Defective control circuit	#4	Adjust output voltages Call SENS for assistance
Undercharging	Improper boost/float settings Defective control circuit	#4	Adjust output voltages Call SENS for assistance

Alarm Indications (FCA units only)

Indication	Possible cause	Test	Repair procedure
AC fail	AC fuse blown No AC power Defective alarm circuit	**#1**	Replace AC fuse Restore AC Call SENS for assistance
Charge fail	AC or DC fuse blown No AC power Excessive load Battery voltage low Defective alarm circuit	#1 #5	Replace fuse Restore AC Reduce load Dead battery Call SENS for assistance
High DC	Improper voltage settings Defective control circuit Defective alarm circuit	#4	Adjust output/alarm voltages Call SENS for assistance Call SENS for assistance
Low DC	AC fuse blown DC fuse blown No AC power Excessive load Defective alarm circuit	#1 #1 #5	Replace AC fuse Replace DC fuse Restore AC Reduce load Call SENS for assistance

FIGURE 6



7
Test Procedures

Test #1: Remove the fuse and measure its resistance using an ohmmeter on the Rx1 range. Meter should read 0 ohms for a good fuse.

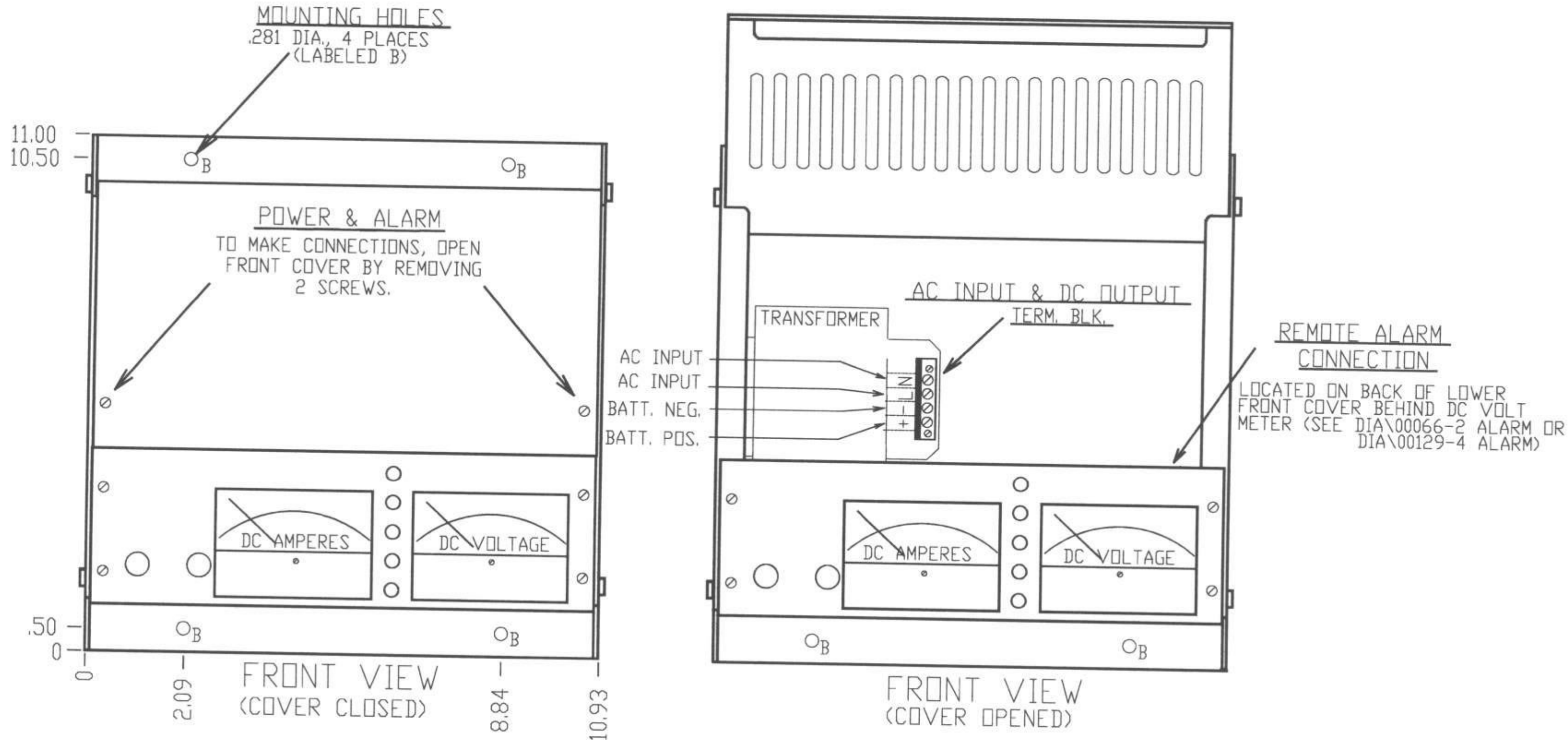
Test #2: Energize the charger after disconnecting the secondary leads from the control board and measure the secondary voltage. Do not short circuit the leads while performing this test. The AC voltage should be 1.5 to 2 times the nominal output voltage of the charger. The control winding (TB-3) should be approximately 10-14 volts AC rms. See Figure 6 for location of leads.

Test #3: Check the information on the nameplate to ensure it agrees with the AC voltage applied.

Test #4: Measure the battery voltage using a 1% accuracy voltmeter. If the charger's voltage is not set properly for your batteries, adjust float/boost settings according to the adjustment procedure.

Test #5: Loads greater than the charger's rating will cause the control circuit to reduce output voltage so that the total output power in does not exceed the charger's rating. This is normal with a dead or deeply discharged battery.

ltr	description	date	app
A	ENLRG DIMS,CHNG ALARM CONNECTION NOTES	6-92	WK



tolerances (unless otherwise specified)		
angles	±	
dec.	±.015	
fract.	±	

SENS STORED ENERGY SYSTEMS LONGMONT, CO

engineer:	description: FCA-1 CONN. & MOUNTING DIAGRAM
drawn: KAG	
checked:	
date: 6-19-91	code: 10 · size: N/A · drwg. no. DIA\00063A · rev
	DO NOT SCALE DRAWING · page: 1 of 1

Cat® Batteries

Cat Batteries—Greater Starting Power—Lower Maintenance—Longer Life

Cat Premium High Output (PHO) batteries are used in all Caterpillar Machines and Engine Gen-Sets. They are designed to meet stringent Caterpillar design specifications, which provide industry leading cold cranking amp (CCA) capability and maximum vibration resistance.

Maintenance Free or low maintenance designs are available in wet and dry configurations.

General Service Line batteries are available in Maintenance Free or low maintenance designs and in wet or dry configurations. Wide selections of BCI group sizes are available for automotive, light truck, bus, industrial, agricultural, marine, recreational and valve regulated (VRLA-AGM & Gel) applications.

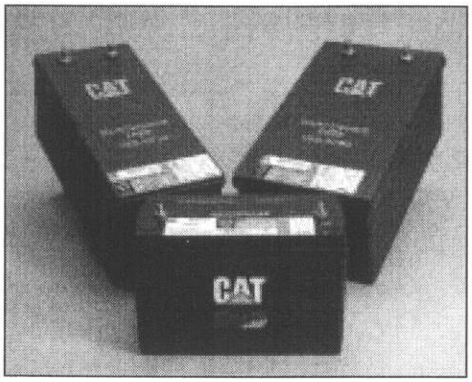
Caterpillar. The difference counts.™

Cat Dealers define world–class product support. We offer you the right parts and service solutions, when and where you need them.

The Cat Dealer network of highly trained experts keeps your entire fleet up and running to maximize your equipment investments.

CATERPILLAR®

World's Toughest Batteries



Premium High Output—Maximum Vibration Resistance

- Vibration Resistance...five times the Industry Standard
- Exclusive "flat top" BCI group 4D & 8D batteries are Maintenance Free and have the industries highest cold cranking amps (CCA)
- Popular BCI group 31 Maintenance Free batteries with industry leading cold cranking amps...up to 1000 (CCA), for electric power, machine or on-highway truck and bus applications. Deep cycle models available for truck, marine or recreational usage

Specifications for Cat Premium High Output Batteries-Available Worldwide

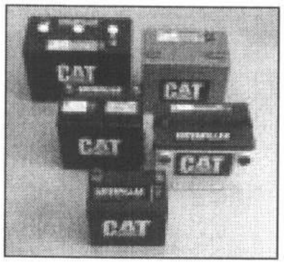
BCI Group Size	Part No.	Cold Cranking Amps"	Reserve Capacity Minutes'	Volts	Amp Hr. Capacity @ 20 Hrs.	Construction	Add Water Maintenance Check Hours	BCI Overall Dimensions: Length In (mm)	Width In (mm)	Height In (mm)	Nominal Weight: Wet Lb (kg)	Dry Lb (kg)	Nominal Acid to Fill Qt (liter)
8D	153-5720	1500	465	12	210	C	MF	20.47 (520)	10.8 (275)	9.76 (248)	132 (60)	–	–
8D	101-4000	1400	400	12	190	LAC+	1000	20.7 (526.5)	10.96 (278)	9.76 (248)	132 (60)	86 (39)	18.0 (17.0)
4D	153-5710	1400	425	12	200	C	MF	20.47 (520)	8.58 (218)	9.76 (248)	119 (54)	–	–
4D	153-5700	1125	305	12	145	C	MF	20.47 (520)	8.58 (218)	9.76 (248)	101 (46)	–	–
4D	9X-9730	1300	400	12	190	LAC+	1000	20.75 (527)	8.58 (218)	9.76 (248)	119 (54)	81 (37)	14.8 (14.0)
4D	9X-9720	1000	275	12	140	LAC+	1000	20.75 (527)	8.58 (218)	9.76 (248)	101 (46)	59 (27)	15.9 (15.0)
31	175-4390	1000	180	12	90	C/S	MFA	12.9 (328.4)	6.74 (171.2)	9.29 (236)	60 (27)	–	–
31	175-4370	825	190	12	100	C/S**	MFA	12.9 (328.4)	6.74 (171.2)	9.29 (236)	60 (27)	–	–
31	175-4360	710	185	12	100	C/S***	MFA	12.9 (328.4)	6.74 (171.2)	9.29 (236)	60 (27)	–	–
31	**250-0480**	710	185	12	100	C/SDT***	MF	12.9 (328.4)	6.74 (171.2)	9.29 (236)	60 (27)	–	–
31	115-2422	1000	170	12	90	C SAE	MFA	12.9 (328.4)	6.74 (171.2)	9.46 (240.3)	60 (27)	–	–
31	115-2421	950	170	12	90	C SAE +	MFA	12.9 (328.4)	6.74 (171.2)	9.46 (240.3)	60 (27)	44 (20)	6.6 (6.2)
31	9X-3404	950	165	12	100	C SAE	MF	13 (330.2)	6.77 (172)	9.46 (240.3)	58 (26)	–	–
31	3T-5760	750	165	12	100	C SAE	MF	13 (330.2)	6.77 (172)	9.46 (240.3)	55 (25)	–	–
24	153-5656	650	110	12	52	SC	MF	10.98 (278.9)	6.85 (174)	9.0 (229.1)	39 (18)	–	–
65	230-6368	880	140	12	80	SC	MF	11.9 (303.4)	7.5 (190.8)	7.5 (191.4)	45.5 (21)	–	–
74	153-5660	650	110	12	52	SC*	MF	10.98 (278.9)	7.0 (178.2)	8.15 (206.9)	39 (18)	–	–
58	175-4280	500	70	12	35	SC	MF	9.96 (253.1)	7.2 (182.5)	6.9 (176)	31 (14)	–	–
2	153-5690	765	210	6	90	LAC+	1000	10.24 (260)	6.8 (173)	8.72 (221.6)	37 (17)	22 (10)	4.8 (4.5)

Construction Notes:
LAC = Low Maintenance, Hybrid Construction
C=Calcium Lead Alloy Grid Design
MF=Maintenance Free
MFA=Maintenance Free with Accessible Vent Caps
S = Stud Terminals
+ = Shipped Dry Only
* = Side Terminals
** = Starting and Deep Cycle Battery
*** = Deep Cycle and Starting Battery
" = For 30 seconds at 0° F (-18° C)
' = Minimum of 25 amp output at 80° F (27° C)
SAE = Uses SAE Posts
SDT = Dual, Top mounted Terminals, Stud and SAE Post,
Marine Deep Cycle/Starting Battery
SC=Silver (Ag) Calcium Alloy Grids for resistance to high underhood temperatures

Rugged Design–Built Tough–Reliable Starting

- Positive and Negative plates are anchored to container bottom and locked at the top of cell element for maximum vibration resistance.
- Heavy-duty forged terminal post bushings provide maximum strength and resistance to acid seepage.
- Hefty full-frame grids, no sharp edges, optimum acid/paste combination provides better charge acceptance after deep discharge.
- Manifold vented cover with built-in Flame Arrestor...a safety feature that directs corrosive gases away from the battery and hold-downs.
- Thick, robust container resists rugged treatment typical of heavy-duty commercial use. Embossed part number & descriptors for easy serviceability.

Cat General Service Batteries—Available Worldwide



Premium Batteries for a Wide Range of Applications

Ideal for Automotive, Light Truck, Bus, Marine, Industrial, Agricultural, Stationary Power and Recreational Usage.

- Maintenance Free and low maintenance… Accessible or Sealed
- Deep Cycle and Valve Regulated (VRLA) Gelled or Absorbed Glass Mat (AGM) batteries
- Hefty full frame grids, no sharp edges. Optimum acid/paste combination provides better charge acceptance after deep discharge
- Silver (Ag) Calcium Grids for high temperature automotive usage
- Commercial batteries have Anchor Lock elements for vibration resistance
- Flame Arrestor Safety Vents to direct corrosive gases away from the battery and hold-downs

Wet Batteries

							BCI Overall Dimensions			Nominal Weight
BCI Group Size	Part No.	Cold Cranking Amps"	Reserve Capacity Minutes'	Volts	Amp Hr. Capacity @ 20 Hrs.	Construction	Length In (mm)	Width In (mm)	Height In (mm)	Wet Lb (kg)
Truck/Agricultural/Industrial										
1	8C-3617	650	180	6	100	C/MF	9.0 (229)	6.9 (175)	8.8 (224)	33.5 (15)
2	8C-3629	780	215	6	90	LA	10.4 (264)	6.9 (175)	8.8 (224)	36.5 (17)
3EE	8C-3620	400	95	12	54	LA	19.3 (490)	4.3 (109)	9.0 (229)	43 (20)
3EH	8C-3632	875	250	6	115	LA	19.3 (490)	4.3 (109)	10.0 (254)	47.5 (22)
4	8C-3633	1000	270	6	125	C/MF	12.5 (318)	6.9 (175)	9.5 (241)	47 (21)
4D	8C-3623	900	260	12	115	LA	20.8 (508)	8.5 (216)	10.1 (257)	97 (44)
4DLT	8C-3622	860	250	12	100	LA	20.0 (508)	8.2 (208)	8.2 (208)	79 (36)
7D	8C-3635	950	350	6	156	LA	15.8 (401)	7.0 (178)	9.2 (234)	59.5 (27)
8D	8C-3624	1300	430	12	190	LA	20.7 (526)	11.0 (279)	10.0 (254)	130 (59)
24F	3T-5858	650	120	12	55	SC/MF	10.6 (269)	6.8 (173)	9.0 (229)	40 (18)
27	8C-3601	675	120	12	65	SC/MF	12.0 (305)	6.7 (170)	9.0 (229)	45.5 (21)
27F	8C-3602	675	120	12	65	SC/MF	12.4 (315)	6.7 (170)	9.0 (229)	45.5 (21)
30H	8C-3627	850	180	12	100	C/MF	13.0 (330)	6.8 (173)	9.5 (241)	57.5 (26)
31	8C-3628	800	170	12	80	C/MF/S	13.0 (330)	6.8 (173)	9.5 (241)	54.5 (25)
Bus-Special Terminal										
8D	**250-0473**	1450	450	12	190	C/MFA/TB	20.7 (526)	11.0 (279)	10.0 (254)	134 (61)
Automotive/Light Truck & SUV										
22F	3T-5859	425	65	12	35	SC/MF	9.4 (239)	6.8 (173)	8.3 (211)	29.5 (13)
24	3T-5857	650	120	12	55	SC/MF	10.2 (259)	6.8 (173)	9.0 (229)	38.5 (17)
26	8C-3600	540	80	12	45	SC/MF	8.8 (224)	6.8 (173)	8.0 (203)	24.5 (11)
41	8C-3605	660	110	12	64	SC/MF	11.5 (292)	6.9 (175)	6.9 (175)	37 (17)
42	**250-0490**	475	70	12	40	SC/MF	9.5 (241)	6.9 (175)	6.9 (175)	29 (13)
55/56/62	8C-3611	585	95	12	52	SC/MF/DT	8.8 (224)	6.0 (152)	8.5 (216)	33 (15)
58	8C-3612	580	55	12	53	SC/MF	10.0 (254)	7.2 (183)	6.9 (175)	31.5 (14)
75	7X-6100	720	100	12	60	SC/MF *	9.0 (229)	7.0 (178)	7.3 (185)	34.5 (16)
75/86	**250-0489**	540	85	12	47	SC/MF/DT	9.7 (248)	7 (178)	8.1 (206) !	32 (15)
Automotive/Light Truck & SUV, Severe Service/High Temperature, Silver Lead Alloy Technology										
25	**250-0488**	600	90	12	45	ST/MF	9.1 (230)	6.8 (175)	8.8 (225)	31 (14)
35	**250-0487**	600	90	12	45	ST/MF	9.1 (230)	6.8 (175)	8.8 (225)	31 (14)
34/78	**250-0486**	690	100	12	60	ST/MF/DT	10.7 (273)	6.8 (175)	8 (203) !	39 (18)
65	**250-0484**	650	105	12	55	ST/MF	12 (304)	7.3 (187)	7.6 (194)	39 (18)

Construction Notes:
LA = Low Maintenance, Low Antimony Grids
LAC = Low Maintenance, Hybrid Construction
C = Calcium Lead Alloy Grid Design
MF = Maintenance Free

SC= Silver (Ag) Calcium Alloy Grids-for resistance to high underhood temperatures
MFA-Maintenance Free, Calcium Grids, Accessible Vent Caps
ST= Silver (Ag) Calcium Alloy Heavy Duty Grids

* = Side Terminals
S = Stud Terminals
DT= Dual Terminal
TB = Transit Bus one piece end Terminal. Right end of Battery.
1/2"-13 Steel positive stud
3/8"-16 Steel negative stud

" = For 30 seconds at 0° F (-18° C)
' = Minimum of 25 amp output at 80° F (27° C)
! For height with removable adapter, add 7/8" (22 mm)

Cat General Service Batteries—Available Worldwide

Wet Batteries Continued

BCI Group Size	Part No.	Cold Cranking Amps"	Reserve Capacity Minutes'	Volts	Amp Hr. Capacity @ 20 Hrs.	Construction	BCI Overall Dimensions Length In (mm)	Width In (mm)	Height In (mm)	Nominal Weight Wet Lb (kg)
Marine-Deep Cycle Capability										
24M	8C-3638	650	120	12	55	SC/MF/DT/~	10.8 (274)	6.8 (173)	9.4 (239)	40 (18)
27M	8C-3639	625	150	12	80	@/S/DT	12.5 (318)	6.8 (173)	9.4 (239)	49 (22)
Lawn & Garden										
U1	8C-3636	260	32	12	25	C/MF	7.8 (198)	5.1 (130)	7.3 (185)	16.5 (7)
Golf Cart/Scissor & High Lifts										
GC-2	8C-3641	75 amps @ 80° F 115 mins.	–	6	215	@ OP	10.3 (262)	7.1 (180)	10.9 (277)	63 (29)
Dual Terminal Batteries										
24/24F/74	127-0824	930	130	12	63	SC/MF/DT	10.9 (277)	7.0 (178)	9.0 (229)	45 (20)
34/78	127-0826	875	120	12	66	SC/MF/DT	10.8 (274)	6.9 (175)	8.0 (203) !	41 (19)
75/86	**250-0489**	540	85	12	47	SC/MF/DT	9.7 (248)	7 (178)	8.1 (206) !	32 (15)
34/78	**250-0486**	690	100	12	60	ST/MF/DT	10.7 (273)	6.8 (175)	8 (203) !	39 (18)

Dry Batteries

BCI Group Size	Part No.	Cold Cranking Amps"	Reserve Capacity Minutes'	Volts	Amp Hr. Capacity @ 20 Hrs.	Construction	BCI Overall Dimensions Length In (mm)	Width In (mm)	Height In (mm)	Nominal Weight Wet Lb (kg)	Dry Lb (kg)	Nominal Acid to Fill Qt (liter)
Truck/Agricultural/Industrial												
1	8T-9734	650	180	6	100	C/MF +	9.0 (229)	6.9 (175)	8.8 (224)	33.5 (15)	17.5 (8)	4.5 (4.3)
3D	8T-9730	1400	675	6	320	LA +	20.4 (518)	8.7 (221)	10.0 (254)	120 (54)	84 (38)	11.0 (10.4)
7D	8T-9731	950	350	12	156	LA +	15.7 (399)	7.0 (178)	9.1 (231)	59.5 (27)	34 (15)	7.5 (7.1)
24F	9X-1382	650	120	12	50	SC/MF +	10.6 (269)	6.8 (173)	9.0 (229)	40 (18)	26 (12)	6.0 (5.7
26	145-4517	540	80	12	48	SC/MF +	8.8 (224)	6.8 (173)	8.0 (203)	29.5 (13)	23 (10)	3.5 (3.3)
26R	145-4518	540	80	12	48	SC/MF +	8.8 (224)	6.8 (173)	8.0 (203)	29.5 (13)	23 (10)	3.5 (3.3)
27	3E-8925	675	120	12	55	SC/MF +	12.0 (305)	6.7 (170)	9.0 (229)	45.5 (21)	29.5 (13)	6.5 (6.2)
Automotive/Light Truck												
22F	9X-1384	425	65	12	32	SC/MF +	9.4 (239)	6.8 (173)	8.3 (211)	29.5 (13)	18 (8)	4.5 (4.3)
24	9X-1383	650	120	12	50	SC/MF +	10.2 (259)	6.8 (173)	9.0 (229)	40 (18)	26 (12)	6.0 (5.7)
Marine/Recreational												
8V	8C-3640	980	350	8	175	LA +	20.8 (528)	7.3 (185)	10.6 (269)	90 (41)	60 (27)	11.5 (10.9)

Construction Notes:
LA = Low Maintenance, Low Antimony Grids
LAC = Low Maintenance, Hybrid Construction
C = Calcium Lead Alloy Grid Design
MF = Maintenance Free
MFA= Maintenance Free, Calcium Grids, Accessible Vent Caps
ST= Silver (Ag) Calcium Alloy Heavy Duty Grids
SC= Silver (Ag) Calcium Alloy Grids-for resistance to high underhood temperatures
* = Side Terminals
S = Stud Terminals

DT=Dual Terminal
OP = Offset Post with Horizontal Hole Stainless Steel 5/16" Bolt & Hex Nut
" = For 30 seconds at 0° F (-18° C)
' = Minimum of 25 amp output at 80° F (27° C)
! For height with removable adapter, add 7/8" (22 mm)
@ = Deep Cycle-Antimony Grids
~ = Marine Starting
\+ = Shipped Dry Only
\# = Wing Nut for 8C-3638 & 8C-3639 is Part # 3B-0723

Valve Regulated Lead Acid (VRLA) Batteries

Gelled (GEL) Electrolyte, Marine/Recreational, Deep Cycle Capability

BCI Group Size	Part No.	Cold Cranking Amps"	Reserve Capacity Minutes'	Volts	Amp Hr. Capacity @20 Hrs.	Construction	BCI Overall Dimensions Length In (mm)	Width In (mm)	Height In (mm)	Nominal Weight Wet Lb (kg)
4D	**152-8006**	970	375	12	183	MF-G/VRLA	20.8 (528)	8.5 (216)	10 (254)	129.8 (59)
8D	**152-7242**	1150	475	12	225	MF-G/VRLA	20.8 (528)	11.1 (282)	10 (254)	160.8 (73)

Marine Cranking Amps (MCA) = cold cranking Amps divided by 0.8
MF-G/VRLA = Maintenance Free Gel Battery. Sealed, Valve-Regulated Lead Acid (VRLA) battery with gelled electrolyte.
Starting/Deep Cycle Marine or Recreational Use Battery. Could be used for Gen-Sets or UPS type applications requiring a sealed battery.
VRLA batteries use recombination reaction to prevent the escape of hydrogen and oxygen gases normally lost in a flooded lead acid battery.
They are non-spillable, never need watering and should never be opened.
" = For 30 seconds at 0° F (-18° C)
' = Minimum of 25 amp output at 80° F (27° C)

Important: Alternator and charger instructions:
For 12-volt Gel Batteries charge to 13.8 volts but no more than 14.1 volts at 68° F (20° C)

Absorbed Glass Mat (AGM) Batteries, Designed for High-rate Uninterruptible Power Supplies (UPS) or Standby Applications

BCI Group Size	Part No.	Discharge Ratings: Power Watts per Cell — For 15 mins. to 1.67 V.P.C. @ 77° F (25° C)	Discharge Rating in Amperes — For 15 mins. to end voltage of 1.67 V.P.C. @ 77 °F (25° C)	Amp Hour @ 20 hour rate to 1.75 volts per cell @ 77 °F (25° C)	Normal Voltage	Construction	Terminal	BCI Overall Dimensions Length In (mm)	Width In (mm)	Terminal Height In (mm)	Container Height In (mm)	Nominal Weight Wet Lb (kg)
U1	**250-0474**	116	62	1.63	12	MF-AGM/VRLA	1	7.71 (196)	5.18 (132)	7.18 (182)	6.18 (157)	24 (11)
45	**250-0475**	156	84.3	2.75	12	MF-AGM/VRLA	2	8.84 (225)	5.31 (135)	8.7 (221)	8.14 (207)	38.5 (18)
24	**250-0476**	262	140	3.95	12	MF-AGM/VRLA	2	10.2 (259)	6.8 (173)	9.14 (232)	8.12 (206)	53 (24)
27	**250-0477**	304	165	4.61	12	MF-AGM/VRLA	2	12.72 (323)	6.8 (173)	8.68 (220)	8.12 (206)	63 (29)
31	**250-0478**	350	186	5.25	12	MF-AGM/VRLA	3	12.93 (329)	6.75 (171)	8.75 (222)	8.58 (218)	69 (31)
31(A)	**250-0479**	475	261	6.66	12	MF-AGM/VRLA	3	13.5 (342)	6.77 (172)	11.25 (286)	11.08 (281)	98 (45)
4D(H)	**250-0483**	624	338	9.91	12	MF-AGM/VRLA	4	21.73 (552)	8.82 (210)	9.34 (237)	8.74 (22)	129 (59)

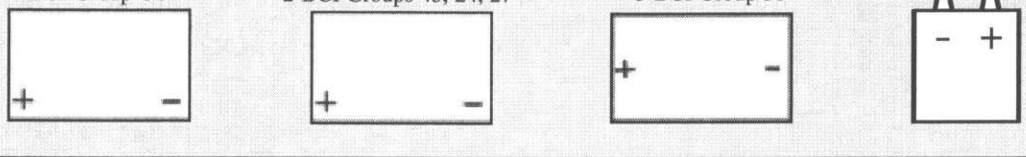
MF-AGM/VRLA = Maintenance Free-Absorbed Glass Mat (AGM) Battery. Battery has Flame Arrestor and is low-pressure self sealing
Housed in flame-retardant polypropylene (rated 28 LOI) 12-Volt Monoblocks
(A) = Battery is 2.5 in. (63.5 mm) taller and .57 in (13mm) longer than standard Group 31
(H) = Battery has handles
Sealed Valve-Regulated Lead Acid (VRLA) with electrolyte absorbed in separators consisting of a sponge-like mass of matted glass fibers
Preferred for high-rate performance in uninterruptible power supply (UPS) or standby applications
VPC = Volts per Cell
WPC = Watts per Cell. Ratings conform to IEEE-485 Standards
VRLA batteries use recombination reaction to prevent the escape of hydrogen and oxygen gases normally lost in a flooded lead acid battery. They are non-spillable, never need watering and should never be opened

UL Recognized Component

***Note: Availability of UPS batteries are planned for late 4th quarter 2004**
AGM batteries have a longer production lead time than regular lead-acid type batteries
Important: Alternator and charger instructions: for 12-volt AGM Batteries charge to 14.4 volts but no more than 14.6 volts at 68°F (20° C)

Valve Regulated AGM Batteries—Terminal Locations

1-BCI Group U1 | 2-BCI Groups 45, 24, 27 | 3-BCI Group 31 | 4-BCI Group

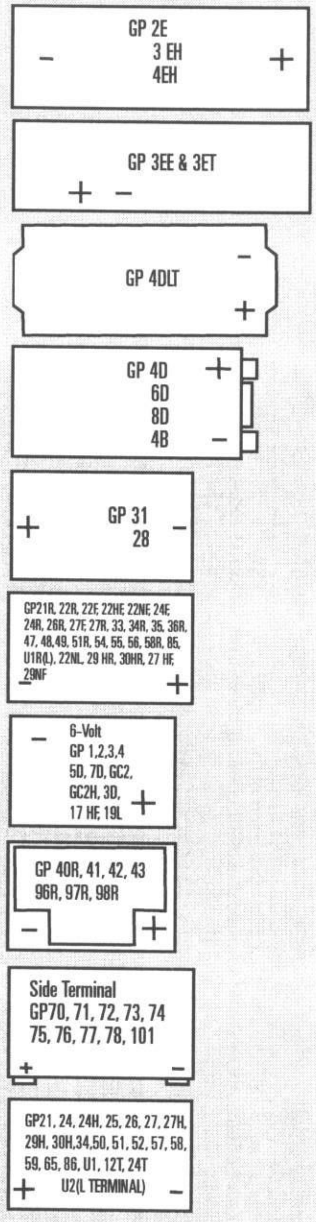


VRLA batteries are a UL Recognized Component and are I.C.C.O., I.M.D.E., I.A.T.A., and D.O.T. Air Transportable Approved.

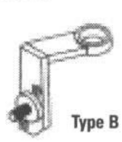
Terminals

1 = Lead terminal. L shaped. Terminals have square holes.
2 = Lead terminal with brass inserts. 1/4-20 x .25 Deep Female Thread.
3 = Lead terminal with brass inserts. Centerline terminals. 1/4-20 x .25 Deep Female Thread.
4 = End terminals with brass inserts. 1/4-20 (UNC) Female Thread. Ratings conform to IEEE-485 Standards.

BCI Terminal Locations



Transit Bus Terminal for 8D Part # 250-0473
One piece end terminal.
Right end of Battery.
1/2" - 13 Steel Positive Stud
3/8" - 16 Steel Negative Stud



Cat Premium High Output Batteries — Built Tough to Exceed Demanding Performance Test Requirements:

100 hour Vibration Testing – Five Times the Industry Standard

- Battery must be able to withstand vibration forces without suffering mechanical damage, loss of capacity, loss of electrolyte or without developing internal/external leaks
- Battery must pass a high rate discharge test after the vibration testing

Five 72-hour Deep Discharge/Recharge Test Cycles

- Battery must recover to 25 charging amps within 20 minutes and meet Industry Electrical Performance Standards

30 Day Complete Discharge Test

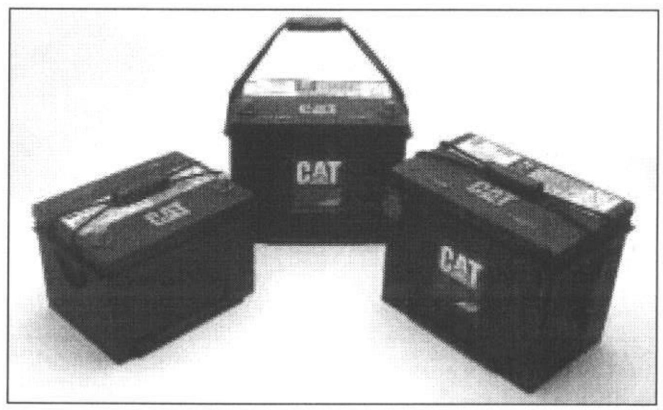
- Battery must recover to 25 charging amps within 60 minutes and meet Industry Electrical Performance Standards after recharging

SAE J2185 Life Cycle Test

- Battery subject to deeper discharge and charge cycles at extreme temperatures not normally encountered in starting a machine or vehicle

Cold Soak Test

- Battery cold soaked at sub-freezing temperatures and then tested by starting an equally cold engine



Battery Accessories

Group 31—Charging Posts for Stud Terminals—Part # 4C-5637
Screw-in Charging Posts for Side Terminals—Part # 4C-5638
Wing Nut—Part # 2B-9498 for Part #'s 175-4390/175-4370/175-4360/8C-3628
Wing Nut—Part # 3B-0723 for Part #'s 8C-3638 and 8C-3639
Digital Battery Analyzer—Part # 177-2330
Battery Voltmeter—Part # 4C-6600
Battery Load Tester—Part # 4C-4911
Booster Cable 12' (3.66 m)—Part # 4C-4933
Booster Cable 20' (6.00 m)—Part # 4C-4937
Heavy Duty Commercial Fast Charger (110V)—Part # 4C-4921
Heavy Duty Commercial Fast Charger (220V)—Part # 4C-4910

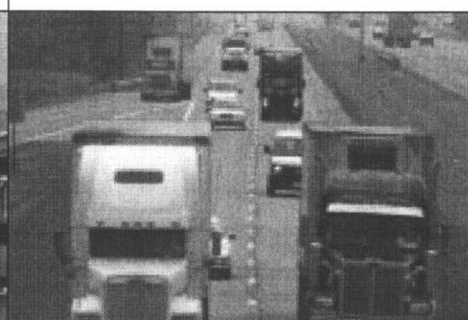
Note: Ratings and Part Numbers are subject to change without notice.

Recycle all scrap batteries. We accept lead-acid batteries for recycling.

World Wide Application Flexibility

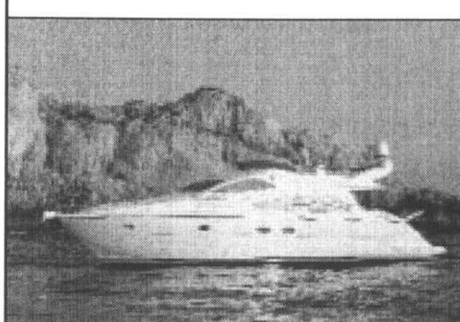
Marine Commercial Vessels
Maintenance Free 4D, 8D and Group 31 Batteries. General Service Line Line valve regulated (VRLA) Gel batteries. High Marine Cranking Amps (MCA) and Deep Cycling capabilities.

Automotive-Truck-Bus & RV
A wide selection of popular BCI group sizes. Maintenance Free, Severe Service and Deep Cycle models. Application Specific Group 31 Truck Batteries.

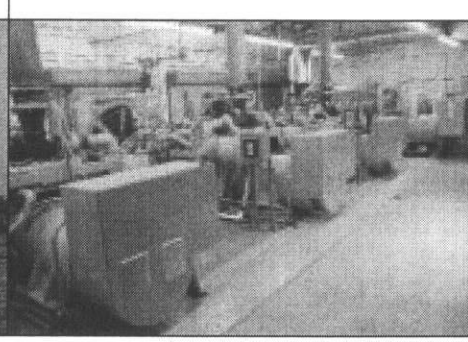


Commercial & Recreational
A wide selection of premium batteries in most BCI group sizes for light commercial, recreational, agricultural and industrial applications.

Marine Pleasure Craft
Premium High Output BCI Group 31, Dual Terminal Deep Cycle Batteries. General Service Line BCI group 24M, 27M and 8V sizes.

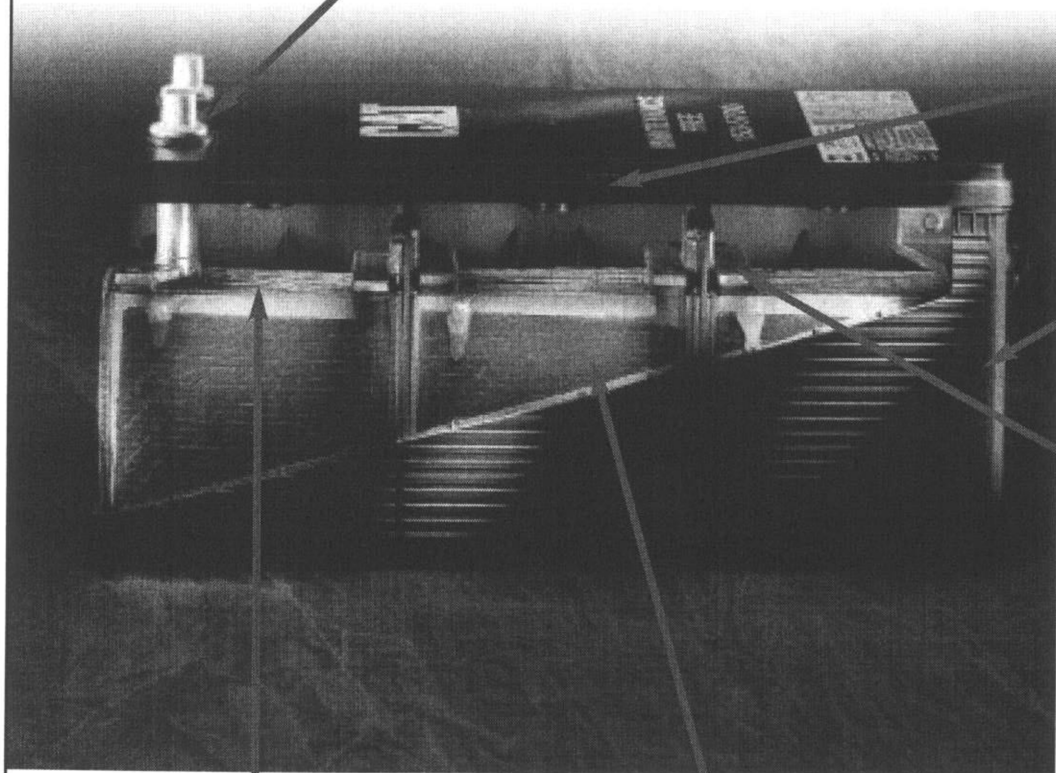


Electric Power Generation
Premium High Output Maintenance Free and Accessible batteries in BCI group 4D, 8D, & 31 sizes. High Cold Cranking Amp (CCA) Capability. General Service Line valve regulated (VRLA) AGM batteries for UPS or stationary power applications.



Construction & Mining
Premium High Output Maintenance Free batteries. BCI group 4D, 8D and 31 Sizes. Industry leading cold cranking amps (CCA) and maximum vibration resistance.

Cat Batteries



Robust Components = Long Life + Reliable Starts

- Heavy-duty forged terminal post bushings provide maximum strength and resistance to acid seepage that causes corrosion and black posts. Thicker internal terminal posts provide lower electrical resistance and higher cold cranking amp output.
- Rugged microporous polyethylene envelope separators protect against "shorts" and vibration damage. Deep Cycle batteries utilize double insulated Glass mat separators for longer cycling life.
- Maintenance Free batteries utilize calcium lead alloy on both positive and negative plates that reduces gassing and water consumption. Automotive batteries have Silver (Ag) Calcium Alloy Grids for resistance to high underhood temperatures.
- Heavy-duty, full frame battery grids with no sharp edges. An optimum acid/paste combination provides better charge acceptance after a deep discharge.
- Positive and Negative plates are anchored to the container bottom and the cell element is locked at the top for maximum vibration resistance. Straps are thicker, heavier and cast (not welded) into the plates.
- Manifold vented cover with built-in Flame Arrestor…a safety feature that directs corrosive gases away from the battery and hold-downs.
- Robust reinforced case provides extra strength in all temperature extremes. Brickwork design on sides reduces chance of punctures and case flexing. Embossed part number and descriptors for easy serviceability.

For more information, see us today or visit our web site at www.cat.com

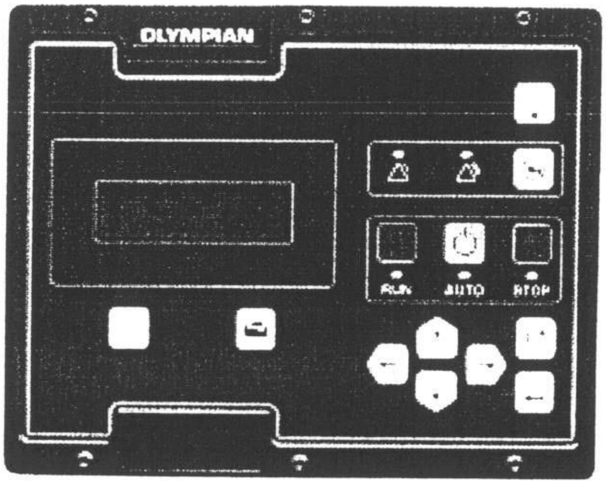
Caterpillar. The difference counts.™

CATERPILLAR®

PEHJ0073 Printed in the U.S.A.
© 2004 Caterpillar All Rights Reserved

CONTROLS **OLYMPIAN™**

EMCP 3.2
GENSET CONTROLLER



EMCP 3.2

The EMCP 3.2 control panel is a feature packed solution to control, monitor and communicate with your generator set. It includes both manual and automatic start / stop and an engine cool down timer. The 32-bit microprocessor-based system eliminates individual meters, gauges and switches, reduces wiring and results in a highly durable and robust system.

The EMCP 3.2 panel combines generator set control and monitoring in one module for easy access to controls, metering, protection device settings and diagnostic information.

The EMCP 3.2 panel has an accessory data link allowing the connection of annunciator modules and a Modbus data link allowing remote customer monitoring.

FEATURES

- Fully featured power metering, protective relaying and expanded AC metering
- Real-time clock allows for time stamping of diagnostics & events in the control's logs
- Programmable protective relaying, available as alarm and shutdown, protects against undervoltage, overvoltage, underspeed, overspeed, underfrequency, overfrequency
- Expanded remote customer communications are supported by MODBUS protocol using RS-485, which easily interfaces with existing plant systems and equipment
- Digital, 32-bit microprocessor-based system eliminates the need for multiple switches, meters, transducers, relays, and sending units, which translates to less wiring and fewer opportunities for mechanical failures
- Simultaneous viewing of all AC L-L voltages, all AC L-N voltages, or all AC line currents saves time
- User-friendly, convenient, customer programmability directs the customer to logical parameter groups (Ex. AC metering, protective relaying, engine monitoring) for quick keypad access
- Set points & software are stored in nonvolatile memory, preventing loss during a power outage
- True RMS sensing ensures AC metering accuracy of 1% for AC voltage, current, and power parameters
- Five levels of security allow operators to have different access privileges
- Display available in English, French or Spanish, switchable to Technician English for Service

STANDARD FEATURES

EMCP 3.2	
STANDARD FEATURES	
Panel construction and finish	**Components installed in a heavy duty sheet steel enclosure** **Phosphate chemical pre-coating of steel provides corrosion resistant surface** **Polyester composite powder topcoat forms high gloss and extremely durable finish**
Mounting	Mounted to generating set baseframe on robust steel stand Vibration isolated from generating set
Instrumentation	**LCD Display with adjustable contrast and backlight with auto power off** **AC metering: Volts 3-phase (L-L & L-N); Amps (per phase & average); Frequency; kW (total & per phase); kVA (total & per phase); kVAr (total & per phase); Power Factor (overall & per phase); kW hours; kVAr hours** **DC metering: Battery Volts; Engine Hours run; Engine Jacket Water Temperature (in °C or °F); Lube Oil Pressure (in psi, kPa or bar); Engine Speed (rpm); Crank attempt counter; Start counter**
Protection	Fail to start shutdown Low oil pressure shutdown High engine temperature Approaching high coolant temperature alarm Approaching low oil pressure alarm Not in auto mode alarm Underspeed / Overspeed Loss of Engine Speed Detection Low / High battery voltage Battery charger failure (if fitted) Under volts, Over volts Under frequency, Over frequency Overcurrent 4 spare fault channels 20 Event fault log (name of event, engine hours at first occurrence of event, time stamp at first occurrence, engine hours at latest occurrence of event, time stamp at latest occurrence, number of occurrences of event)
Controls	**2 LED status indicators (1 red shutdown, 1 amber warning)** **Run key and LED indicator** **Auto key and LED indicator** **Stop key and LED indicator** **Lamp test key** **Alarm acknowledge key** **Menu navigation keys** **Engine and AC metering shortcut keys** **All control module keys have tactile feedback** **Lock down emergency stop push button**
Languages	English, ~~French or Spanish~~
Other features	**Real time clock** **Service interval counter** **CAN 2 accessory data link - for additional modules; remote annunciator, discrete input/output module** **Modbus communications on 2 wire half duplex RS485 connection for remote customer monitoring**

OPTIONAL FEATURES

EMCP 3.2
OPTIONAL FEATURES
~~MCM5 Remote annunciator~~
~~MCM2 Close remote monitoring and control, MCM3 Distance remote monitoring and control via telephone line~~
Battery chargers: ~~PBC5L 120V AC, PBC3UL UL 3A 120V AC~~, PBC10UL UL 10A 120V AC, ~~PBC5 240V AC, PSB3 240V AC + Boost, PSB3L 110V AC + boost, PMBCUL5 UL 5A 120V AC~~
WHL Engine coolant heater controls
~~PAC1 Volt free contacts for common alarm~~
PGR1 Volt free contact for genset running
PAA1 Audible alarm
~~PSB5 Lockdown emergency stop button with security key~~
PSV1 Volts adjust potentiometer
~~PSS1 Speed adjust potentiometer~~
Spare shutdown/alarm channel can include FSS2 Low fuel level alarm, PFS2 Panel circuit for low fuel level alarm, ~~FSS1 Low fuel level shutdown, PFS1 Panel circuitry for low fuel level shutdown, FSS5 High fuel level, PFS5 Panel circuitry for high fuel level alarm, LGA1 Low gas pressure alarm, LUBS1 High lube oil temperature shutdown,~~ WCA1 Low coolant temperature alarm, WSS1 Low coolant level shutdown

Note: All options are not available on all genset models.

NFPA 110 requirements include:
PFS2/FSS2 Low fuel level alarm
WSS1 Low coolant level shutdown
WCA1 Low coolant temperature alarm
PSV1 Volts adjust potentiometer
PAA1 Panel mounted audible alarm
A battery charger and battery charger ammeter, an engine heater or battery heater may be required depending on the application

www.CAT-ElectricPower.com

© 2004 Caterpillar
All rights reserved. Printed in U.S.A.

LEXF4914-01 (10-04)

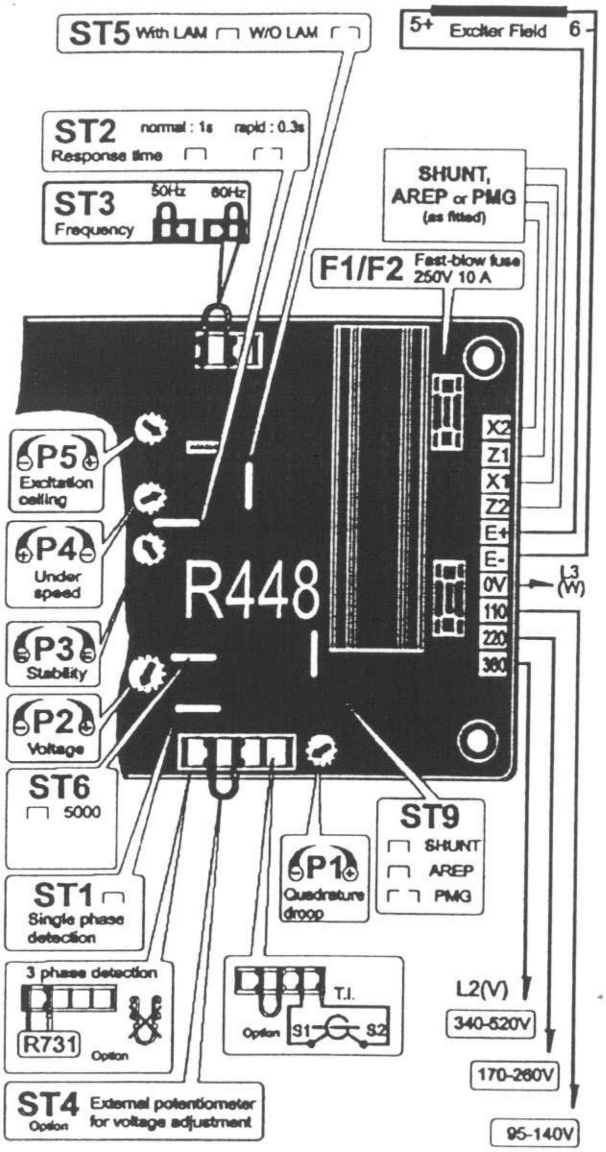
Materials and specifications are subject to change without notice.
The International System of Units (SI) is used in this publication.

OPTIONAL FEATURES

EMCP 3.2
OPTIONAL FEATURES
~~MCM5 Remote annunciator~~
~~MCM2 Close remote monitoring and control, MCM3 Distance remote monitoring and control via telephone line~~
Battery chargers: ~~PBC3UL UL 3A 120V AC~~, PBC10UL UL 10A 120V AC, ~~PBC5, PSB3 Boost, PMBCUL5 UL 5A 120V AC~~
WHL Engine coolant heater controls
~~PAC1 Volt free contacts for common alarm~~
~~PGR1 Volt free contact for genset running~~
PAA1 Audible alarm
~~PSB5 Lockdown emergency stop button with security key~~
PSV1 Volts adjust potentiometer
~~PSS1 Speed adjust potentiometer~~
Spare shutdown/alarm channel can include FSS2 Low fuel level alarm, PFS2 Panel circuit for low fuel level alarm, ~~FSS1 Low fuel level shutdown, PFS1 Panel circuitry for low fuel level shutdown, FSS5 High fuel level, PFS5 Panel circuitry for high fuel level alarm, LGA1 Low gas pressure alarm, LUBS1 High lube oil temperature shutdown,~~ WCA1 Low coolant temperature alarm, WSS1 Low coolant level shutdown

Note: All options are not available on all genset models.

NFPA 110 requirements include:
PFS2/FSS2 Low fuel level alarm
WSS1 Low coolant level shutdown
WCA1 Low coolant temperature alarm
PSV1 Volts adjust potentiometer
PAA1 Panel mounted audible alarm
A battery charger and battery charger ammeter, an engine heater or battery heater may be required depending on the application



ADJUSTMENT CAPABILITY:

- Potentiometer **P1** – Quadrature Droop Adjustment
- Potentiometer **P2** – Voltage Adjustment
- Potentiometer **P3** – Stability Adjustment
- Potentiometer **P4** – Underspeed/LAM Threshold Adjustment
- Potentiometer **P5** – Excitation ceiling
- Link **ST1** – Link IN for single phase voltage detection (standard)
- Link **ST2** – Link IN for Normal response time or CUT for Rapid response time
- Strap **ST3** – Strap between middle and left terminal for 50 Hz or between middle and right terminal for 60 Hz
- Strap **ST4** – Strap IN for no remote voltage adjustment or OUT and potentiometer (470Ω, 0.5W min., adjustment range ±5%) connected to the terminals for remote voltage adjustment
- Link **ST5** – Link IN for LAM or CUT to disable LAM
- Link **ST9** – Link IN for shunt and AREP or CUT for PMG

www.CAT-ElectricPower.com

© 2002 Caterpillar
All rights reserved.
Printed in U.S.A.

LEHX0481-03 (9-02)

Materials and specifications are subject to change without notice.
The International System of Units (SI) is used in this publication.

The ranges

The ABB moulded case circuit-breakers are proposed into eight sizes: T1, T2, T3, T4, T5, T6, S7 and S8. The rated ultimate breaking capacity under short-circuit, Icu, at 380/415V AC is available starting from 16kA up to 200kA.
To fulfil the various application requirements, they are available in the following ranges:

- *Circuit-breakers for AC and DC power distribution*
- *Circuit-breakers for motor protection*
- *Circuit-breakers for applications up to 1000 V AC and DC*
- *Switch-disconnectors.*

For each size, circuit-breakers are available in the three and four-pole versions. They are also equipped with a complete range of protection releases: thermomagnetic, magnetic only adjustable and electronic releases of the latest generation. T1, T2, T3, T4, T5 and T6 circuit-breakers fitted with TMD and TMA thermomagnetic releases can also be used in direct current plants, with a field of application from 1A to 800 A and a minimum operating voltage of 24V DC.

Power distribution circuit-breakers

The ABB SACE family of moulded case circuit breakers - Tmax and Isomax - is divided into different, perfectly integrated, ranges (Tmax T1B 1p, T1, T2, T3, T4, T5, T6 and Isomax S7, S8), able to cover a range of service currents from 1 to 3200 A. The power distribution circuit breakers are available in the fixed, plug-in or withdrawable, three-pole and four-pole versions. The Tmax T1 circuit breaker is also available in the single pole
Tmax T1B 1p version, with breaking capacities of 25 kA at 220/230 V AC.

Interchangeability of the releases

The Tmax T4,T5 and T6 circuit-breakers can be fitted either with thermomagnetic, magnetic only or electronic releases, which are all interchangeable with each other. In fact, thanks to the simplicity of their installation, the type of release can be replaced rapidly even by the end user, according to their requirements and needs: in this case, correct assembly remains the responsibility of the user himself. All this means increasing the flexibility of use of the circuit-breakers, with considerable savings thanks to the better rationalization of stock management.

Conformity with Standards

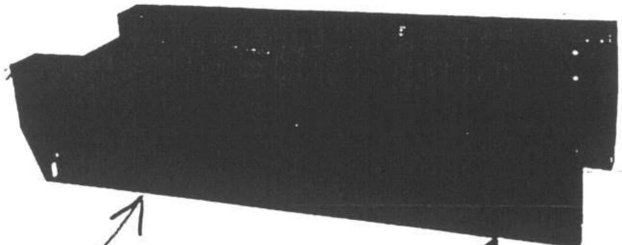
The moulded-case circuit-breakers and their accessories conform to the IEC 60947-2 international Standards and comply with the EC "Low Voltage Directives (LVD) no. 73/ 23 EEC" and "Electromagnetic compatibility Directives (EMC) no. 89/336 EEC". ABB SACE's Quality System conforms to the ISO 9001 International Standard and to the equivalent European EN ISO 9001 and Italian UNI EN ISO 9001 Standards. The certifying Body is the Italian Shipping Register (RINA - QUACER): ABB SACE has reached its third qualification confirmation. The ABB SACE Test Room is accredited by SINAL.
The apparatus conforms to the prescriptions of the on-board installations and approvals by the major Shipping Registers are in progress.

		T1 1p	T1	T2	T3	T4	T5	T6	S7	S8
Iu	[A]	160	160	160	250	250 320	400 630	630 800 1000	1250 1600	2000 2500 3200
N° of poles	No.	1	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4
Ue AC 50-60Hz	[V]	240	690	690	690	690	690	690	690	690
Ue DC	[V]	125	500	500	500	750	750	750	-	-
Uimp	[kV]	8	8	8	8	8	8	8	8	8
Ui	[V]	500	800	800	800	1000	1000	1000	1000	1000
Test voltage (50 Hz, 1 min.)	[kV]	3	3	3	3	3.5	3.5	3.5	3	3
Breaking capacities										
Icu AC 50-60 Hz 380/415	[kA]	25	16	36	36	36	36	36	50	85
V		(1)(2)	36	85	50	200	200	100	100	120

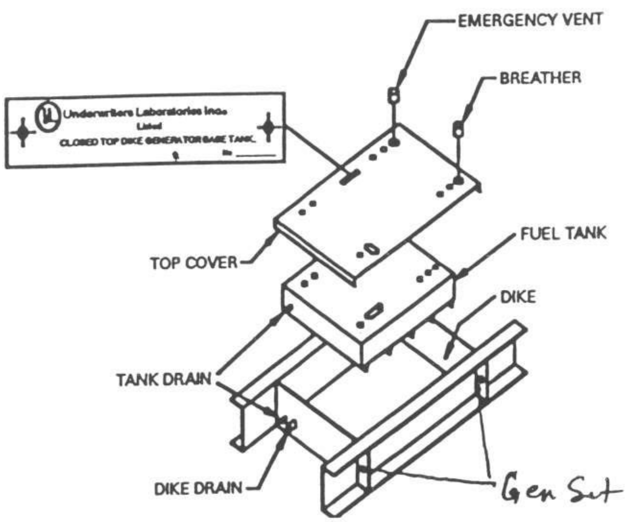
UL LISTED FUEL TANKS

~~FCUL1 — 12 HR~~

FCUL2 — 24 HR



Gen Set Lift Points



Gen Set Lift Points

CLOSED TOP DIKED SKID BASE FUEL TANK

The generator set skid base contains an integral, UL listed, double walled, steel fuel storage tank with diked rupture basin for the containment of fuel resulting from a tank leak or rupture. The rupture basin is integrally vented and has a closed top to prevent the ingress of precipitation, debris or other elements. The tank is leak tested to 3 psi and pressure tested to 15 psi. The base tank is UL142 listed for Steel Above Ground Tanks for Flammable and Combustible Liquids under the "Special Purpose Tanks" category. They are intended for installation in accordance with the Flammable and Combustible Liquids Code, NFPA 30 of the National Fire Protection Association.

FEATURES

CONSTRUCTION

- Manufactured entirely from 4 mm (8 gauge) steel
- Continuously welded seams
- Formed steel channel type side beams
- Unitized load bearing structure
- Integral lifting points
- Corrosion resistant precoat
- Listed to UL142
- Closed top diked base tank

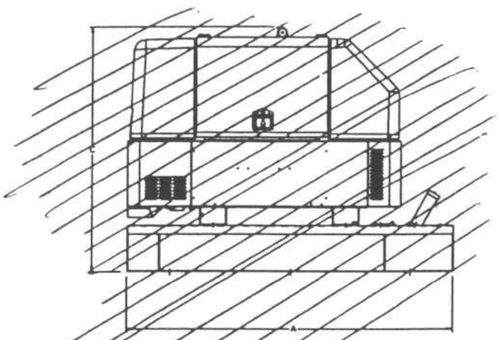
AESTHETICS

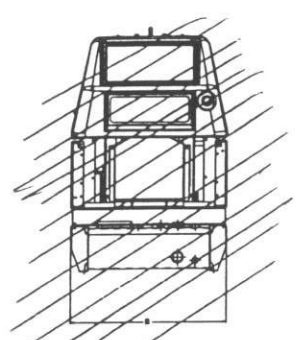
- Continuous high gloss finish
- Polyester powder composite
- Extremely durable and corrosion resistant

DESIGN FEATURES

- Unique integral base and tank design
- Developed specifically for open or enclosed generator sets
- Containment capacity for fuel
- Internal baffles arranged to prevent recirculation of heated return fuel
- Brass composite 2" filler cap
- Mechanical fuel gauge
- Fuel capacities to provide typically 12 and 24 hour standby operation
- Primary vent with breather
- Vent located accessible for adapting to remote venting
- Venting areas to UL142 specifications
- Leak detection switch
- Emergency vent for main tank
- Weatherproof diked containment basin
- External NPT drain fittings for fuel tank and containment basin
- Removable base-end cover plate encloses stub-up area when used with enclosures

LEHX0470-03 (09-02)

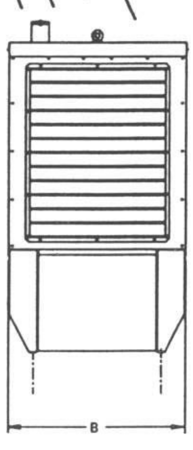


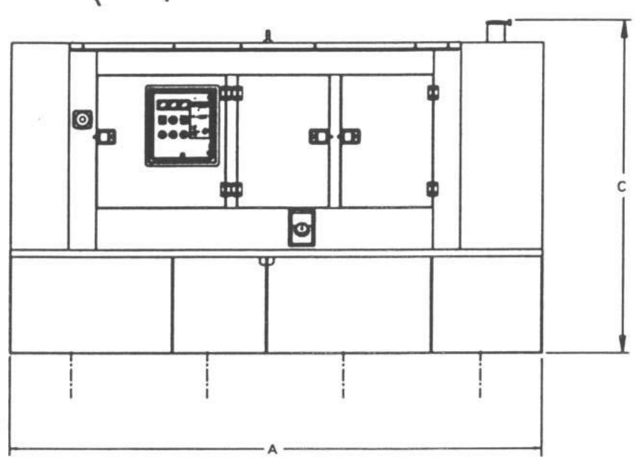


SOUND ATTENUATED ENCLOSED GENERATOR SETS WITH CAE ENCLOSURE DIMENSIONS AND WEIGHTS WITH UL LISTED FUEL TANK

Generator Set Model	Tank Capacity, US gallons (liters)		Generator Dimensions, in (mm)				Weight lb (kg)	
	12 hr	24 hr	Length A	Width B	Height, 12 hr C	Height, 24 hr C	12 hr	24 hr
D8L1	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1748 (793)
D12L1	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1836 (833)
D15L1, D17L1	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1958 (888)
D20L2	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1973 (895)
D25LH1	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1931 (876)
D8L1S	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1748 (793)
D12L1S	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1836 (833)
D15L1, D17L1S	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1958 (888)
D20L2S	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1973 (895)
D24LH1S	NA	52.3 (198)	74.8 (1900)	35.4 (900)	NA	55.3 (1405)	NA	1931 (876)

Weight with lube oil and coolant





SOUND ATTENUATED ENCLOSED GENERATOR SETS WITH CAE ENCLOSURE DIMENSIONS AND WEIGHTS WITH UL LISTED FUEL TANK

Generator Set Model	Tank Capacity, US gallons (liters)		Generator Dimensions, in (mm)				Weight lb (kg)	
	12 hr	24 hr	Length A	Width B	Height, 12 hr C	Height, 24 hr C	12 hr	24 hr
~~D125P1, D125P2, D150P1~~	~~200.0 (757)~~	~~392.3 (1485)~~	~~153.5 (3900)~~	~~51.2 (1300)~~	~~83.7 (2125)~~	~~95.7 (2432)~~	~~5279 (2395)~~	~~5732 (2601)~~
~~D150P4~~	~~200.0 (757)~~	~~392.3 (1485)~~	~~153.5 (3900)~~	~~51.2 (1300)~~	~~83.7 (2125)~~	~~95.3 (2420)~~	~~8111 (3680)~~	~~8335 (3780)~~
D200P4	200.0 (757)	392.3 (1485)	153.5 (3900)	51.2 (1300)	83.7 (2125)	95.3 (2420)	7945 (3605)	8463 (3840)

LEHX0470-03 (09-02)

MAINTENANCE/REPAIR

Important Points!

Regular maintenance of the total system is recommended to assure sustained optimum performance. These devices are not field repairable and should be returned to the factory if recalibration or other service is required. After first obtaining a Returned Goods Authorization (RGA) number, send the unit freight prepaid to the following. Please include a clear description of the problem plus any application information available.

Dwyer Instruments, Inc.
Attn: Repair Department
102 Highway 212
Michigan City, IN 46360

Important Points!

Product must be maintained and installed in strict accordance with the National Electrical Code and Dwyer product catalog and instruction bulletin. Failure to observe this warning could result in serious injuries or damages.

For hazardous area applications involving such things as (but not limited to) ignitable mixtures, combustible dust and flammable materials, use an appropriate explosion-proof enclosure or intrinsically safe interface device.

The pressure and temperature limitations shown on the individual catalog pages and drawings for the specified flow switches must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.

Selection of materials for compatibility with the media is critical to the life and operation of Dwyer products. Take care in the proper selection of materials of construction, particularly wetted materials.

Life expectancy of switch contacts varies with applications. Contact Dwyer if life cycle testing is required.

Ambient temperature changes do affect switch set points, since the specific gravity of a liquid can vary with temperature.

Dwyer Products have been designed to resist shock and vibration; however, shock and vibration should be minimized.

Filter liquid media containing particulate and/or debris to ensure the proper operation of our products.

Electrical entries and mounting points in an enclosed tank may require liquid/vapor sealing.

Dwyer Products must not be field-repaired.

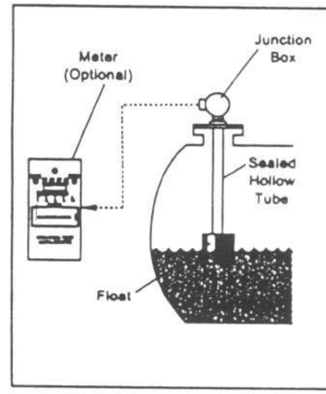
Physical damage sustained by the product may render it unserviceable.

DWYER INSTRUMENTS, INC.
P.O. BOX 373 MICHIGAN CITY, INDIANA 46361, U.S.A.
Phone: 219/879-8000
Fax: 219/872-9057
Lit-By Fax: 888/891-4963
www.dwyer-inst.com
e-mail: info@dwyer-inst.com

Continuous Level Transmitters
Series CLT

Designed for continuous liquid level sensing, Dwyer transmitters are considered "components".

Operating Principle



The CLT Series utilizes reed switch/magnet technology. A magnet-equipped float rises or lowers with corresponding liquid level. The magnetic field generated from the float actuates a series of reed switches mounted within a sealed hollow tube. The series of reed switches is combined with resistors to form a voltage divider.

When a regulated DC voltage is applied to an CLT, the resulting voltage output is directly proportional to liquid level.

Installation / Mounting

Units operate normally in any attitude, from vertical to a 30° inclination, up or down.

Thread Treatment

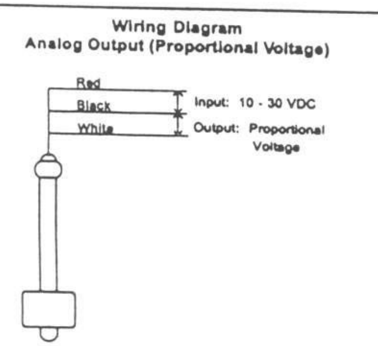
Sealing: When threading metal threads into a metal coupling , pipe sealant or Teflon tape is recommended. Due to potential compatibility problems, when sealing plastic threaded units, a compatible pipe sealant such as "No More Leaks" from Permatex is recommended.

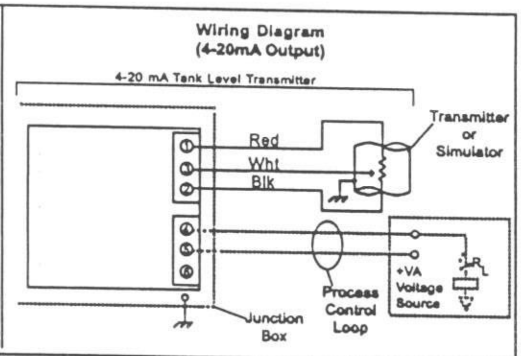
Tightening (Plastic to Metal): When threading a plastic sensor into a metal coupling, the installer should use a suitable wrench and tighten the threads 1 to 1-1/2 additional turns past hand-tight. Over-torquing of the threads will result in damage to the plastic mounting plug.

Tightening (Metal to Metal): When threading a metal sensor into a metal coupling, the installer should use a suitable wrench and tighten the threads 1-1/2 turns past hand-tight.

Wiring Diagrams

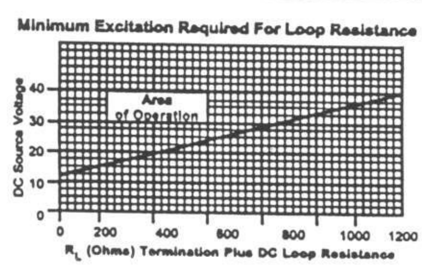
Note: For hazardous area applications, use an appropriate intrinsically safe interface device.





Excitation Required for Transmitters Using 4-20 mA Signal Conditioners

The minimum excitation required for operation of transmitters with 4-20 mA, DC signal converters *(See Chart)* can be determined for a given total loop resistance from the graph shown. (Total loop resistance = the sum of the DC termination resistance plus loop resistance.) For optimum operation, which is a function of source voltage (+V_A) and total loop resistance, the source voltage value used should be above the minimum load line for the related loop resistance.



Calibration

The signal conditioner on your CLT has been Factory-set. You do not need to calibrate.

Steps:

A. Calibration should be performed with the probe disconnected from the signal conditioner. Turn off power to loop. Disconnect the red, black and white wires from terminals 1, 2, and 3.

B. Adjust both the null and span potentiometers at approximately mid-range. ***(Figure 1)***

C. Wire as shown per ***Figure 2***, connecting a jumper wire in place of the black and white probe wires. Connect an ammeter in series to monitor loop current. Apply power to loop. Adjust null pot for 4mA.

D. Remove power from loop. Reposition the jumper wire in place of red and white probe wires. Reapply power and with the span pot, set the output current to 20mA.

E. Repeat Steps C and D for final adjustment.

F. If power is maintained during jumper connections, current level may increase to 36mA. This is normal. Current will return to regular readings when connections are made.

Figure 1

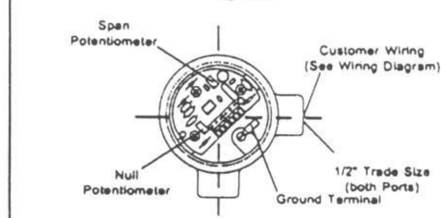
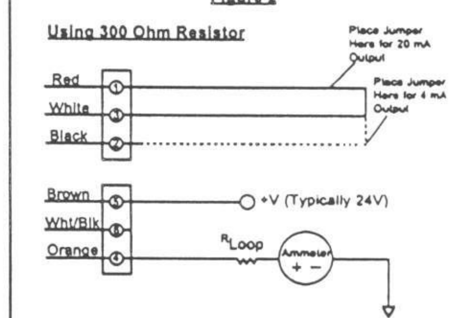


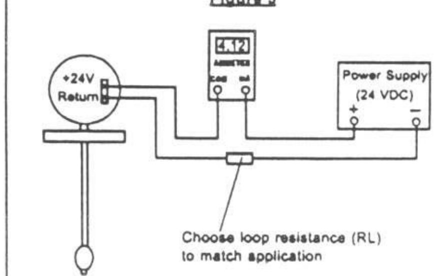
Figure 2



Troubleshooting

Verify proper wiring, power supply, and loop resistance. If transmitter is not functioning properly, isolate the transmitter from the system and wire per ***Figure 3.*** Meter should read 4mA with float at bottom and 20mA with float on top of transmitter. If unit is still not operating properly, please consult Factory for further troubleshooting details.

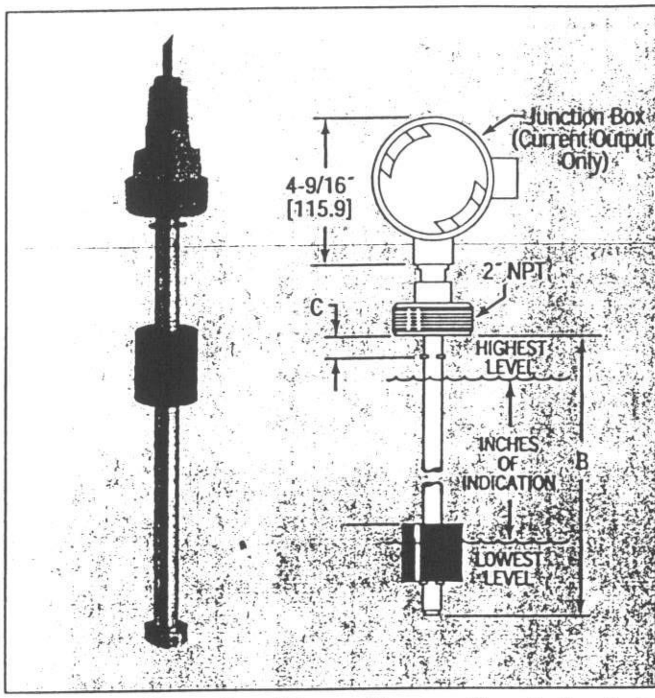
Figure 3

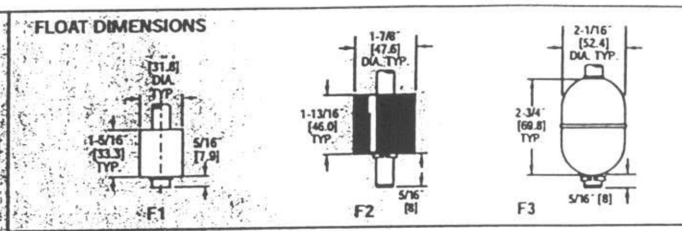


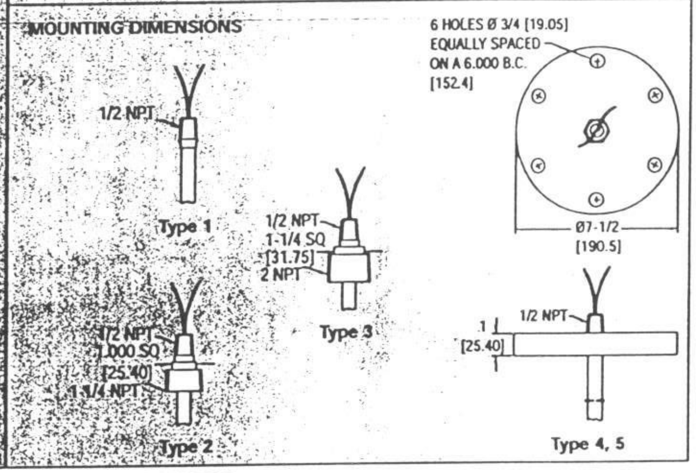
Series CLT Continuous Level Transmitter

Customize To Fit Application, 316 SS or Buna-N Floats

Level







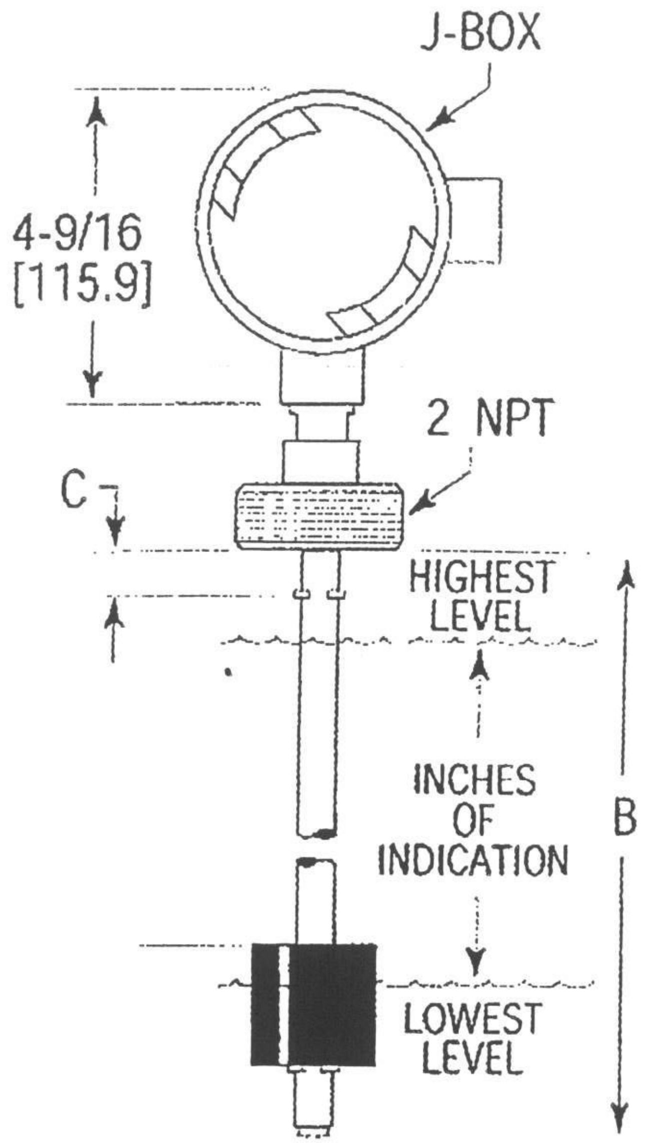
Continuous Output Level Transmitters provide up to the minute tank level monitoring. Customize level transmitters to meet application requirements. Transmitters can be configured for 4 to 20 mA or proportional voltage output, stainless steel or Buna-N floats, and lengths up to 72" (183 cm).

Models are built to your specifications.

SPECIFICATIONS

Service: Compatible liquids.
Resolution: 1/4".
Temperature Limits: Buna-N floats: 180°F (82°C) in water, -40 to 230°F (-40 to 110°C) in oil; SS stem: -40 to 230°F (-40 to 110°C).
Pressure Limits: Buna-N floats: 150 psig (10 bar); SS floats: 300 psig (21 bar).
Power Requirements: Proportional voltage output models: 10 to 30 VDC; 4-20 mA output models: 10 to 40 VDC.
Loop Resistance: 1.4 kΩ maximum.
Electrical Connections: Proportional voltage output: 24" (61 cm) free leads #22 AWG, TFE jacketed; 4-20 mA output: Junction box.
Enclosure Rating: 4-20 mA models, NEMA 4 junction box.
Mounting Orientation: Vertical ±20°.

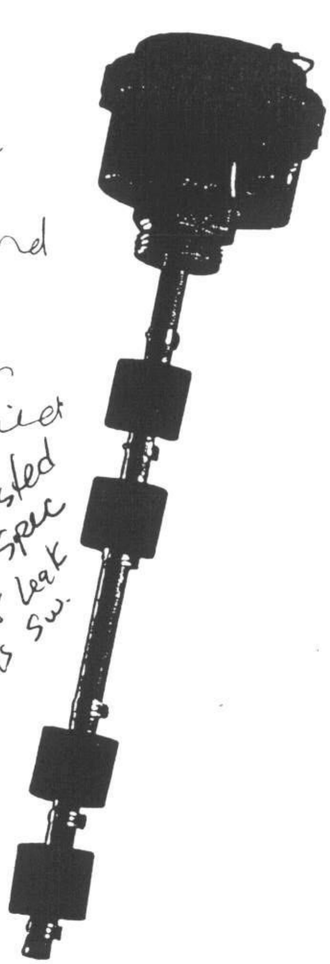
Example	CLT	V	S	5	F3	20.25	02.00	23.50	CLT-VS5F3-20.25-02.00-23.50
Construction	CLT								Continuous Level Transmitter
Output		V C							Voltage proportional signal of 0 to supply voltage 4-20 mA
Stem and Connection Material			B S						Brass with Beryllium copper stops 316 SS with SS ARMCO PH 15-7MO stops
Connection Type				1 2 3 4 5					1/2" NPT (Output Type V only) 1-1/4" NPT (Float F1 only) 2" NPT 3" 150# Flange, Carbon Steel (Connection material S only) (Max. pres. 150 psi (10.3 bar)) 3" 150# Flange, 316 SS (Connection material S only) (Max. pres. 150 psi (10.3 bar))
Float Type					F1 F2 F3				Material / Min s.g. / Max. Pres. psi (bar) / Float Factor in (mm) Buna N / 0.55 / 150 (10.3) / 2.0 (50.8) Buna N / 0.55 / 150 (10.3) / 2.5 (63.5) 316 SS / 0.75 / 300 (20.7) / 3.5 (52.4)
Indication Length						00.00			Length that the unit sends an output for level. Maximum is 68" (173 cm).
Top Float Stop "C" Dimension							00.00		Distance from bottom of mounting connection to upper float stop. Minimum is 1/4" (6.4 mm)
Overall Length "B"								00.00	To calculate overall length, add Indication Length, Top Float Stop Dimension "C", and Float Factor. Maximum length is 72" (1.82 m)


J-BOX
4-9/16
[115.9]
2 NPT
C
HIGHEST
LEVEL
INCHES
OF
INDICATION
B
LOWEST
LEVEL

FUEL SYSTEMS **OLYMPIAN™**

provide for low fuel and leak detection as specified

See UL Listed Fuel Tank Spec Sheet for leak detections sw.



FUEL LEVEL ALARMS – FSS1, FSS2, FSS5 & FSS6

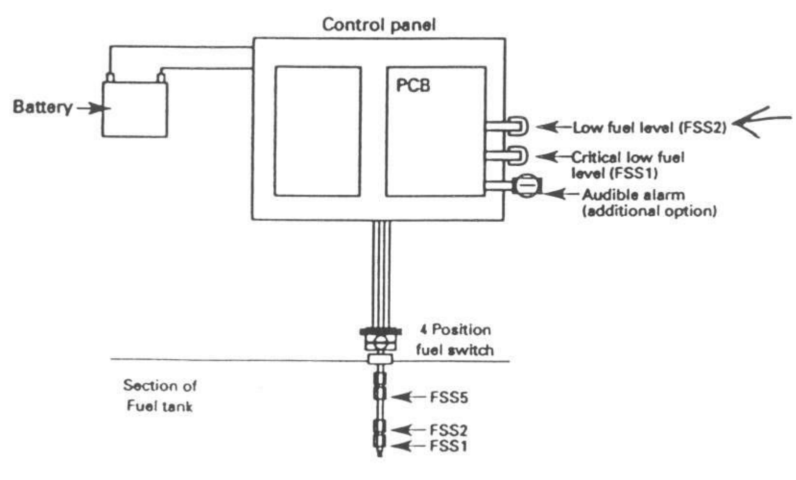
~~CRITICAL LOW FUEL LEVEL SHUTDOWN (FSS1~~) AND LOW FUEL LEVEL ALARM (FSS2)

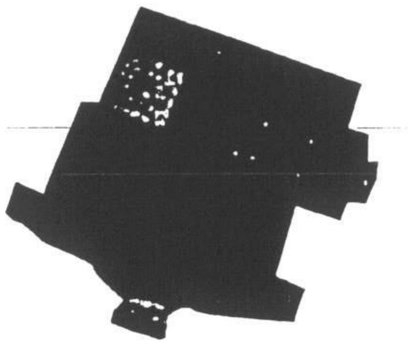
These options provide an alarm on low fuel level (FSS2) and a shutdown on critical low fuel level (FSS1). This warning is reported by an indicator light on the control panel with an audible alarm also available as an option. This warning can additionally be relayed to a remote annunciator.

Note: Low Fuel Level Alarm (FSS2) is included as standard on generator sets fitted with UL Listed Fuel tanks combined with the leakage detection alarm as a single 'FUEL ALARM'.

~~CRITICAL HIGH FUEL LEVEL ALARM (FSS5)~~

~~This option provides an alarm on critical high fuel level. This warning is reported by an indicator light on the control panel with an audible alarm also available as an option. This warning can additionally be relayed to a remote annunciator.~~



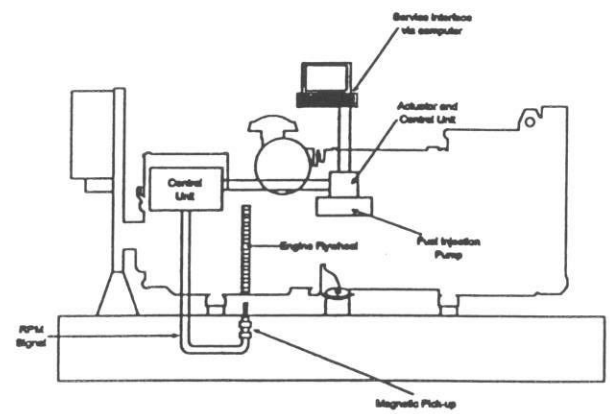


GOVE5 – ISOCHRONOUS ELECTRONIC GOVERNOR

While the standard mechanical governor regulates the steady state generator set speed within ± 0.8% with a speed droop from no load to full load of 4%, fitting an electronically governed actuator improves the steady state speed to within ±0.25%. This provides isochronous frequency regulation typically required when supplying electronic or other non-linear loads.

The GOVE5 is a combined actuator and control module suitable for use on engines fitted with a Delphi fuel pump.

GOVE5



Key Features:

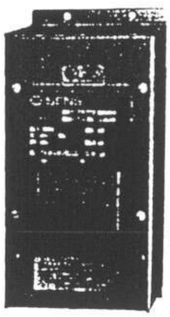
- Compact design
- Simple on-site installation
- 50/60 Hz selection
- Raise/lower speed capability
- External bias (synchronizing)

www.CATElectricPower.com

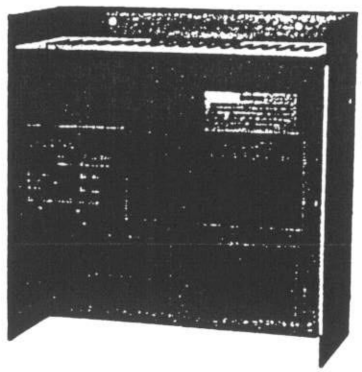
© 2002 Caterpillar
All rights reserved.
Printed in U.S.A.

LEHF2693-00 (09-02)

Materials and specifications are subject to change without notice.
The International System of Units (SI) is used in this publication.



LC 3.5 amp
Battery Charger



FC 10 amp
Battery Charger

UL LISTED BATTERY CHARGERS

~~PBC3UL (LC)~~, PBC10UL (FC)

Olympian UL battery chargers LC (3.5 amp) and FC (10 amp) are factory mounted and offer accurate, completely automatic charging of lead-acid batteries. The output voltage automatically adjusts to changing input, load and ambient conditions. This prevents battery over-charging and consequent loss of battery electrolyte.

FEATURES

- Automatic 2-rate float/equalize charging without manual switching. Quickly restores charge after power failures and prevents over charging.
- Temperature compensated to eliminate a major cause of premature battery failure.
- Current limited to protect from charger overload.
- Rugged Aluminum Housing gives modern appearance and corrosion protection.

SPECIFICATION

- 120 Volt, 60 Hz input
- 12 or 24 Volt DC output. Float voltage adjustable from 100% to 120%. Boost voltage is fixed at approximately 5% above float voltage for LC 3.5 amp chargers and adjusts to 15% above float voltage for FC 10 amp chargers.
- Output Voltage Regulation ± 1% from no load to full load.
- After battery discharge or AC failure, the charger operates in the high-rate constant current mode until the battery voltage rises to the pre-set Boost level. Once this level is reached, the charger operates in constant voltage boost mode until the battery's current acceptance falls to less than 80% (for LC 3.5 amp chargers) or 70% (for FC 10 amp chargers) of the charger's rated output. At this point the charger reverts to the lower float voltage, where it remains until another battery discharge or AC failure.
- Current Limiting and Overload Protection — Electronically current limited at 110% of rated output. AC and DC fuses.
- Adjustment — Internal adjustment for float voltage. Internal adjustment for boost voltage on FC 10 amp chargers (LC 3.5 amp chargers have a boost voltage fixed at 5% above float voltage).
- Indicators — DC ammeter: 2.5" (63 mm) scale. DC voltmeter: 2.5" (63 mm) scale (FC 10 amp chargers only).
- Ambient — Operating temperature: 14° F (–10° C) to 122° F (50° C). Humidity: 5% to 95% non-condensing.
- Mechanical — Housing: Clear-anodized aluminum. Mounted to the rear of the Control Panel.
- Approvals — UL Listed.

LEHX0439-03 (9-02)

UL LISTED BATTERY CHARGERS LC/FC
DIMENSIONS AND WEIGHTS

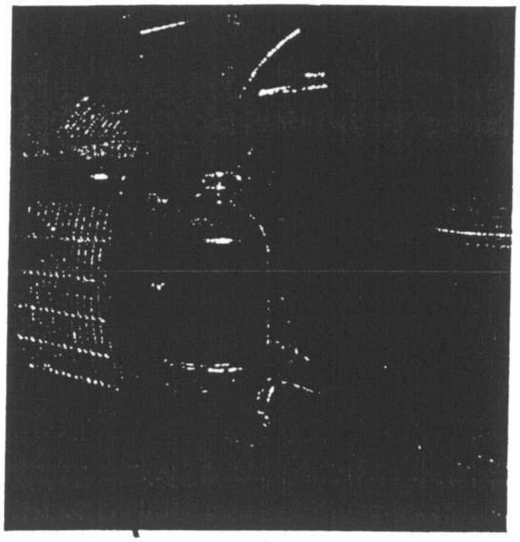
Option Code	Output		Input		Weight	Dimensions		
	Amps	Volts	Hz	Volts		Width	Depth	Height
[redacted]								
PBC10UL	10	12/24	60	120	12 volt: 17 lb (8 kg) 24 volt: 26 lb (12 kg)	11.0" (279 mm)	5.0" (127 mm)	11.0" (279 mm)

www.CAT-ElectricPower.com

© 2002 Caterpillar
All rights reserved.
Printed in U.S.A.

LEHX0439-03 (9-02)

Materials and specifications are subject to change without notice.
The International System of Units (SI) is used in this publication.



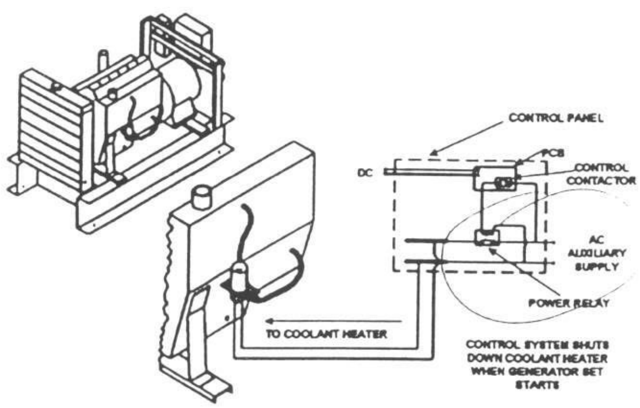
COOLANT HEATER WHL (110–120 V) OR ~~WHH (208–240 V)~~

120V for Battery chgr
240V indicated and specific.

Appropriate when the generator set is to be sited in a low ambient environment the heater maintains the engine coolant at a temperature (typically 100°F (38°C)) which facilitates rapid starting and load acceptance. The heater assembly uses UL compliant components (to UL1030) and has CSA certification which is to both CSA & UL standards.

The heater itself is powered by a 110–120 volt or 208–240 volt AC auxiliary supply protected by a safeguard breaker inside the main control panel. A thermostatic controller is included to regulate the output temperature to within safe limits. When the generator set is not running the heater is automatically connected to the AC supply through a power relay mounted in the control panel. Upon receiving a start signal the AC supply is automatically disconnected by the power relay and automatically reconnected when the start signal is removed and the engine has stopped.

— verify power relay is provided and mounted in control panel. See Drawing # 268-1686



FEATURES

- Molded from Polyphenylene Sulfide
- Rust free, corrosion resistant with exceptional tensile strength
- Vibration and shock tested to extreme limits to ensure durability
- Compatible with all coolant additives
- Incoloy element for longer service life

LEHX0484-03 (09-02)

110–120 V [WHL]

3 Phase Generator Set Models Diesel	3 Phase Generator Set Models Gas	Nominal Coolant Heater Power Consumption (Watts)
D8L1-D25LH1, D20L2	G12U3 - G25UH3	500
D20P1 – D75P3, D20P2 – D75P2	G20F3 – G25F3	1000
D90P1 – D150P1, D100P2 – D125P2	G30F3 – G100F3	1500
~~D150P4~~ – D230P4	NA	1800
Single Phase Generator Set Models Diesel	**Single Phase Generator Set Models Gas**	**Nominal Coolant Heater Power Consumption (Watts)**
D8L1S – D24LH1S, D20L2S	G10U3S – G25UH3S	500
D20P1S – D60P3S, D20P2S – D60P2S	G20F3S – G25F3S	1000
D75P1S – D100P1S, D75P2S – D100P2S	G30F3S – G75F3S	1500

208–240 V [WHH]

3 Phase Generator Set Models Diesel	3 Phase Generator Set Models Gas	Nominal Coolant Heater Power Consumption (Watts)	
		208 Volts	240 Volts
D8L1-D25LH1, D20L2	NA	375	500
D20P1 – D75P3, D20P2 – D75P2	NA	750	1000
D90P1 – D150P1, D100P2 – D125P2	G30F3 – G100F3	1125	1500
D150P4 – D230P4	NA	1500	2000
Single Phase Generator Set Models Diesel	**Single Phase Generator Set Models Gas**	**Nominal Coolant Heater Power Consumption (Watts)**	
		208 Volts	240 Volts
D8L1S – D24LH1S, D20L2S	NA	375	500
D20P1S – D60P3S, D20P2S – D60P2S	NA	750	1000
D75P1S – D100P1S, D75P2S – D100P2S	G30F3S – G75F3S	1125	1500

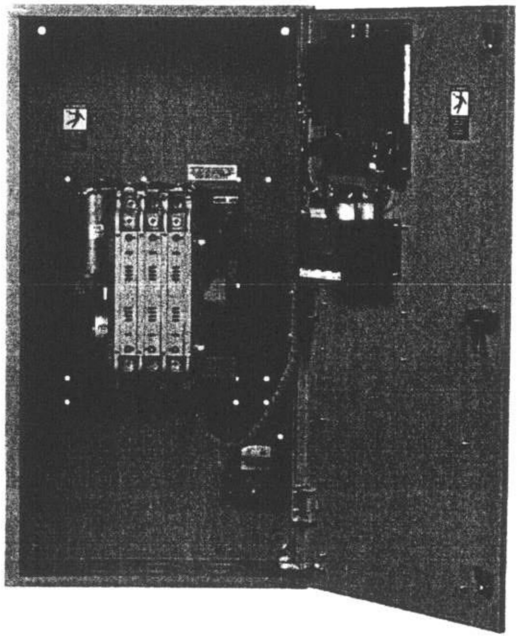
www.CAT-ElectricPower.com

© 2002 Caterpillar
All rights reserved
Printed in U.S.A.

LEHX0484-03 (09-02)

Materials and specifications are subject to change without notice
The International System of Units (SI) is used in this publication

CATERPILLAR®



CTG SERIES AUTOMATIC TRANSFER SWITCH

The Caterpillar® CTG Series transfer switch is pre-configured for applications requiring the dependability and ease of operation found in a full feature power contactor type transfer switch.

FEATURES

- Ratings 40 to 3000 amps (2, 3 or 4 poles)
- UL 1008 listed at 480 VAC
- CSA certified at 600 VAC (200-225 amp – 480 V)
- IEC listed at 480 V
- Double throw, mechanically interlocked contactor mechanism
- Electrically operated, mechanically held
- Designed for emergency and standby applications
- Available in standard open transition (CTG) or delayed transition (CTGD) models

CTG switches are equipped with the next-generation MX150 microprocessor panel, which controls the operation and displays the status of the transfer switch's position, timers and available sources. As an embedded digital controller, the MX150 offers high reliability and ease of unattended operation across a range of applications. The MX150 features include:

- Timer and voltage/frequency settings adjustable without disconnection from power sources
- Built-in diagnostics with LCD display for immediate troubleshooting
- LED/LCD indicators for ease of viewing and long life
- Nonvolatile memory (exerciser battery backup not required for standard switch operation)
- Processor and digital circuitry isolated from line voltage
- Inputs optoisolated for high electrical immunity to transients and noise
- Communications header for network interface

FULLY APPROVED

- UL, CSA and IEC listed
- Ringing wave immunity per IEEE 472 (ANSI C37.90A)
- Conducted and Radiated Emissions per EN55022 Class B (CISPR 11) (Exceeds EN55011 & MILSTD 461 Class 3)
- ESD immunity test per EN61000-4-2 (Level 4)
- Radiated RF, electromagnetic field immunity test per EN61000-4-3 (ENV50140) 10v/m
- Electrical fast transient/burst immunity test per EN61000-4-4
- Surge immunity test per EN61000-4-5 IEEE C62.41 (1.2 X 50 ms, 5 & 8 kV)
- Conducted immunity test per EN61000-4-6 (ENV50141)
- Voltage dips and interruption immunity EN61000-4-11

DESIGN AND CONSTRUCTION FEATURES

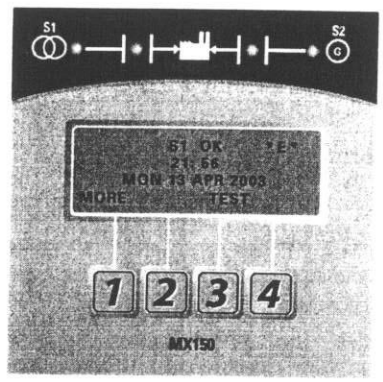
- Close differential 3 phase under-voltage sensing of the normal source – factory standard setting 90% pickup, 80% dropout (adjustable); under-frequency sensing of the normal source factory setting 95% pickup (adjustable)
- Voltage and frequency sensing of the emergency source – factory standard setting 90% pickup voltage, 95% pickup frequency (adjustable)
- Test switch (fast test/load/no load) to simulate normal source failure – automatically bypassed should the emergency source fail
- Type 1 enclosure is standard – also available in open style or Types 3R, 4, 4X, or 12.

STANDARD FEATURES AND OPTIONS

STANDARD FEATURES

- Auxiliary Contact: Closed when the switch is in the emergency position (Additional contacts optional)
- Auxiliary Contact: Closed when the switch is in the normal position (Additional contacts optional)
- 7, 14, 28 day interval timed exerciser, pushbutton/timer operation
- Engine Start Contact
- Indicating LED Pilot Lights:
  - Switch in emergency position
  - Switch in normal position
  - Normal source available
  - Emergency source available
- Time Delay to Engine Start: Standard setting 3 seconds, adjustable 0-10 seconds
- In-Phase Monitor, self-adjusting (Not available on CTGD models)
- Time Delay on Retransfer to Normal: To delay retransfer to normal source (immediate retransfer on generator set failure); standard setting 30 minutes, adjustable 0-60 minutes

MX150 CONTROL PANEL



(Front View)

- Time Delay for Engine Cool Down: Allows engine to run unloaded after switch retransfer to normal; standard setting 5 minutes, adjustable 0-60 minutes
- Time Delay on Transfer to Emergency: To delay transfer to emergency after verifying emergency source available; standard setting 1 second, adjustable 0-5 minutes

STANDARD FEATURES AND OPTIONS (continued)

- Pushbutton Bypass of time delay and normal emergency
- Test Switch – Momentary
- Event Log OD 16 Event that track date, time, reason and action taken
- Voltage and Frequency Indication for S1 and S2
- Peak Shave/Remote Load Test: Input for peak shave or remote load test; includes automatic return to normal if emergency source fails and normal is present; 120 VAC

When specified for use with a CTGD Series delayed transition switch, the control panel also includes the following:

- Time Delay from Neutral Switch Position to Normal on Retransfer: Standard setting 5 seconds, adjustable 1-10 minutes
- Time Delay from Neutral Switch Position to Emergency: Standard setting 5 seconds, adjustable 1-10 minutes
- Center-Off position/Off Delay Timing Indicators

OPTIONAL ATTACHMENTS

- Plant Exerciser, clock type (load/no load): Allows the generator to start and run unloaded or to simulate a power failure, start generator and run under load (7-14-28-365 days, user selectable)
- Space heater and thermostat
- Inhibit Transfer to Emergency: Input circuit to inhibit transfer to emergency; 24 VDC or 120 VAC
- Network communications interface card (LonWorks/ModBus)
- Maintained Test Switch
- Maintained Test Switch w/Keypad
- Service entrance configuration
- Auxiliary Contact, operates on Source 1 line failure
- Auxiliary Contact, operates on Source 2 availability
- Auxiliary Contacts: Closed when the transfer switch is in Source 2 position
- Auxiliary Contacts: Closed when the transfer switch is in Source 1 position
- Disconnect Switch: Permits transfer in "AUTO" position and inhibits transfer in "INHIBIT" position. (Standard 800A and above)
- Elevator Pre-Signal Auxiliary Contacts: Open 0-60 seconds prior to transfer to either direction, re-closes after transfer
- Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-60 seconds prior to transfer in either direction, re-closes after transfer. Can be configured by end user for Pre-transfer, Post-transfer, or both.
- Voltage Imbalance Monitor (Three Phase)
- Maintained test switch options
- Lockable, see-through cover for ATS controller

SERIES POWER MEASUREMENT METERS

- Digital Meter w/Display of Amps, Volts, Frequency
- Digital Meter w/Display of Amps, Watts, Volts, Frequency, kVA, kVAR, PF, etc.
- Digital Meter w/Display of Amps, Watts, Volts, Frequency, kVA, kVAR, PF, etc. Plus THD capability w/ModBus RS485 part

NOTE:

For applications requiring additional options or other configurations, see the CTS Series fully configurable transfer switch.

CATERPILLAR®

DIMENSIONAL SPECIFICATIONS

CTG and CTGD Series Transfer Switches								
			NEMA 1 Enclosed				Weight	
Model	Ampere Rating	Poles	Height (A)	Width (B)	Depth (C)	Reference Figure	NEMA 1	Application Notes
CTG	40, 80, 100 150, 200, 225	2, 3 4	61 (24) 61 (24)	46 (18) 46 (18)	28 (11.13) 28 (11.13)	A A	26 (57) 27 (60)	1 – 6
CTGD	40, 80, 100, 150, 225, 260, 400	2, 3 4	117 (46) 117 (46)	61 (24) 61 (24)	36 (14.13) 36 (14.13)	A A	82 (180) 84 (185) 102 (230)	1 – 5
CTG	260, 400	2, 3 4	116.84 (46) 117 (46)	61 (24) 61 (24)	36 (14.13) 36 (14.13)	A A	80 (175) 82 (180)	1 – 5
CTG/D	600	2, 3 4	168 (66) 168 (66)	61 (24) 61 (24)	50 (19.75) 50 (19.75)	B B	181 (400) 204 (450)	1 – 5, 7
	800, 1000, 1200	2, 3 4	188 (74) 188 (74)	101.6 (40) 102 (40)	50 (19.75) 50 (19.75)	B B	215 (475) 254 (560)	1 – 5, 7
	1600, 2000 2600, 3000	3 4	229 (90) 229 (90)	91.44 (36) 91 (36)	122 (48) 122 (48)	C C	458 (1010) 526 (1160)	1 – 5, 7, 8

APPLICATION NOTES:

1. English dimensions (inches) and weights (pounds) shown in parenthesis adjacent to Metric measurements in cm and Kg.
2. Includes 1.25" door projection beyond base depth. Allow a minimum of 3" additional depth for projection of handle, lights, switches, pushbuttons, etc.
3. All dimensions and weights are approximate and subject to change without notice.
4. Packing materials must be added to weights shown. Allow 15% additional weight for cartons, skids, crates, etc.
5. Special enclosure (NEMA 3R, 4, 4X, 12, etc.) dimensions and layouts may differ. Consult Caterpillar for details.
6. CTG 40-200 require larger 36" H X 24" W X 14" D enclosure depending on options specified. Consult Caterpillar for details.
7. Add 3" in height for lifting eyes.
8. Ventilation louvers on side/rear of 2600 and 3000A units require one side or rear of enclosure to be clear in order to afford proper airflow.

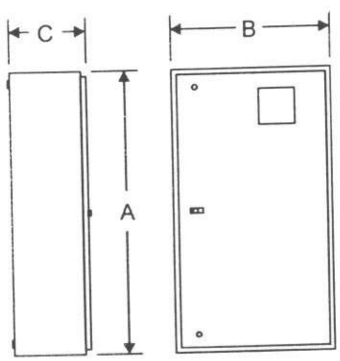


Figure A
CTG Series Transfer Switch
(40-400 amp)

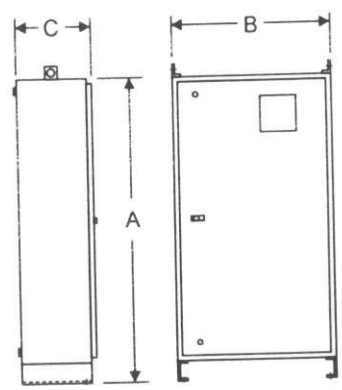


Figure B
CTG Series Transfer Switch
(600-1200 amp)

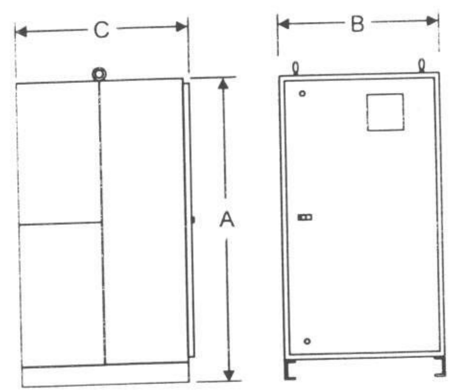


Figure C
CTG Series Transfer Switch
(1600-3000 amp)

Testing Standards		
UL, CSA and IEC listed	UL 1008, CSA 22.2 No. 178, IEC 947-6-1	
Ringing wave immunity	IEEE 472 (ANSI C37.90A)	
Conducted and Radiated Emissions	EN55022 Class B (CISPR 11) (Exceeds EN55011 & MILSTD 461 Class 3)	
ESD immunity test	EN61000-4-2 (Level 4)	
Radiated RF, electromagnetic field immunity test	EN61000-4-3 (ENV50140) 10v/m	
Electrical fast, transient/burst immunity test	EN61000-4-4	
Surge immunity test	EN61000-4-5 IEEE C62.41	1.2 X 50µs, 5 & 8 kV
Conducted immunity test	EN61000-4-6 (ENV50141)	
Voltage dips and interruption immunity	EN61000-4-11	

AL/CU UL Listed Solderless Screw-Type Terminals for External Power Connections		
	Normal, Emergency and Load Terminals	
Switch Size (Amps)	Cables per Pole	Range of Wire Sizes
40	1	#8 to 3/0 AWG
80		
100		
150		
200, 225, 260		#6 AWG to 250 MCM*
400		#4 AWG to 600 MCM
600	2	#2 AWG to 600 MCM
800, 1000, 1200	4	
1600, 2000, 2600, 3000	8	#2 AWG to 600 MCM

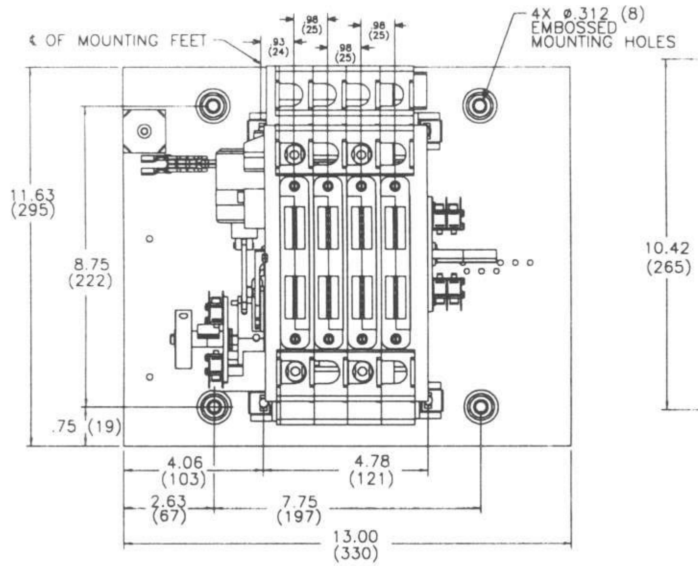
*260A to 350 MCM

MX150 Control Setting Ranges			
Control Function		Range	Factory Setting
Normal Line Sensing – Under-voltage	Dropout Pickup	75-98% 85-100%	80% 90%
Emergency Line Sensing – Under-voltage	Dropout Pickup	75-98% 85-100%	80% 90%
Emergency Line Sensing – Under-frequency	Dropout Pickup	2 Hz below pickup 90-100%	Set 95%
Time Delay – Engine Start		0-10 seconds	3 seconds
Time Delay – Engine Cool Down		0-60 minutes	5 minutes
Time Delay – Transfer to Emergency		0-5 minutes	1 second
Time Delay – Retransfer to Normal		0-60 minutes	30 minutes
Time Delay – Motor Disconnect or Transfer Presignal (When applicable)		0-60 seconds	20 seconds
Delayed Transition Time Delays (When applicable)		0-10 minutes	5 seconds

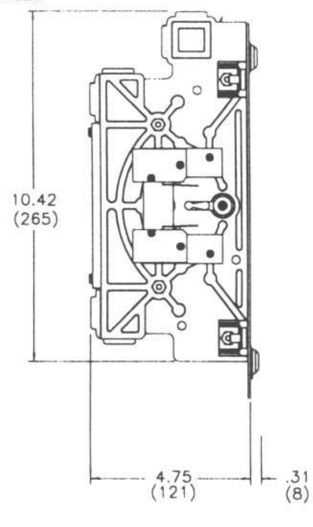
WITHSTAND CURRENT DATA

Withstand Current Ratings per UL 1008				
	Maximum Circuit Amps When Used With		Maximum Circuit Amps When Used With	
CTG Switch Ratings (Amps)	Current Limiting Fuse CTG/CTGD	Specific Coordinated Breaker Rating	CTGD Switch Ratings* (Amps)	Specific Coordinated Breaker Rating
40, 80, 100, 150, 200, 225	200,000	30,000	40, 80, 100	50,000
260		35,000	150, 225, 260	50,000
400, 600		50,000	400, 600	50,000
800		65,000	800	65,000
1000, 1200		85,000	1000, 1200	85,000
1600, 2000 2600, 3000		100,000	1600, 2000 2600, 3000	100,000

*CTGD WCR rated 200,000A on all sizes.



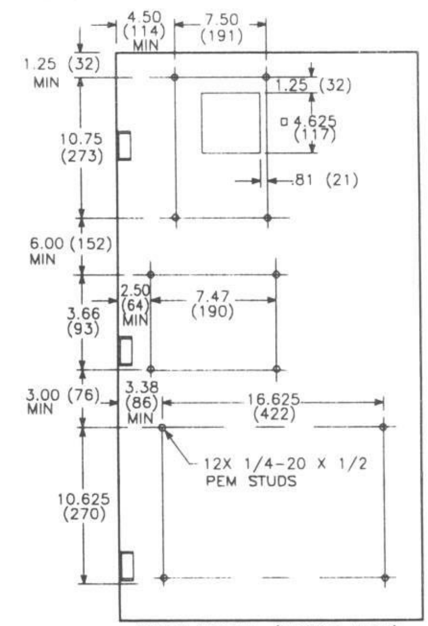
FRONT VIEW



RIGHT SIDE VIEW

AMPS	COPPER CABLE LUG SIZE
30	#14 TO 1/0 (2-53mm2)
40-150	#8 TO 3/0 (8-85mm2)
200-225	#6 TO 250 MCM (13-127mm2)

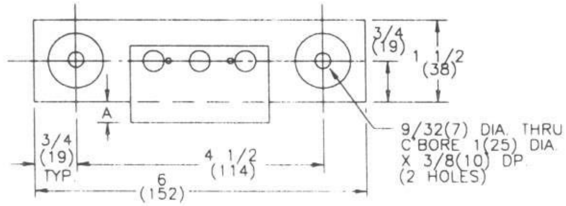
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
G	S-8074 REVISED SHEET 2	12/02/03	GG KL



DOOR DETAIL (INSIDE VIEW)

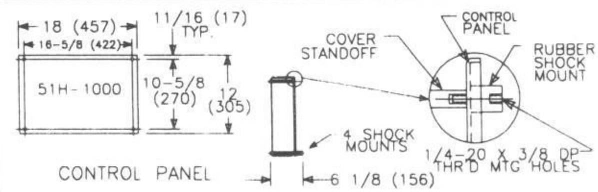
NOTES:

1. 4-POLE SWITCH SHOWN. FOR 2 OR 3 POLE OMIT RIGHT HAND POLES AS SHOWN.
2. OPEN TYPE SWITCH SUPPLIED WITH 6 FT. (1,8m) LONG HARNESS BETWEEN POWER AND CONTROL PANELS. HARNESS EXITS FROM LOWER RIGHT CORNER OF POWER PANEL.
3. DO NOT RUN CABLES IN FRONT OF SWITCH RUN ALL CABLES ON RIGHT SIDE.
4. ALL FRACTIONAL TOLERANCES ±1/64(0,5mm) UNLESS OTHERWISE SPECIFIED.
5. MAINTAIN ELECTRICAL CLEARANCE OF 1/2(13mm) MIN. BETWEEN LIVE METAL PARTS AND GROUNDED METAL.
6. ALL DIMENSIONS ARE FOR REFERENCE ONLY AND SHOWN IN INCHES(MILLIMETERS).



NEUTRAL BAR ASSEMBLY MOUNTING DETAIL

	A	LUG	QTY.
30-100A	-	#14-1/0 (2-53mm2)	3
150-225A	1	#6 TO 250 MCM (13-127mm2)	3



CONTROL PANEL

THIRD ANGLE PROJECTION

THIS DOCUMENT AND THE DETAILS EMBODIED THEREIN CONSTITUTE CONFIDENTIAL AND PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF CATERPILLAR, INC., AND IS NOT TO BE USED OR REPRODUCED BY ANY PART EXCEPT AND TO THE EXTENT IN THE MANNER AUTHORIZED BY CATERPILLAR, INC.

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL DECIMALS ± .020
3 PL DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH ✓
AutoCad Generated

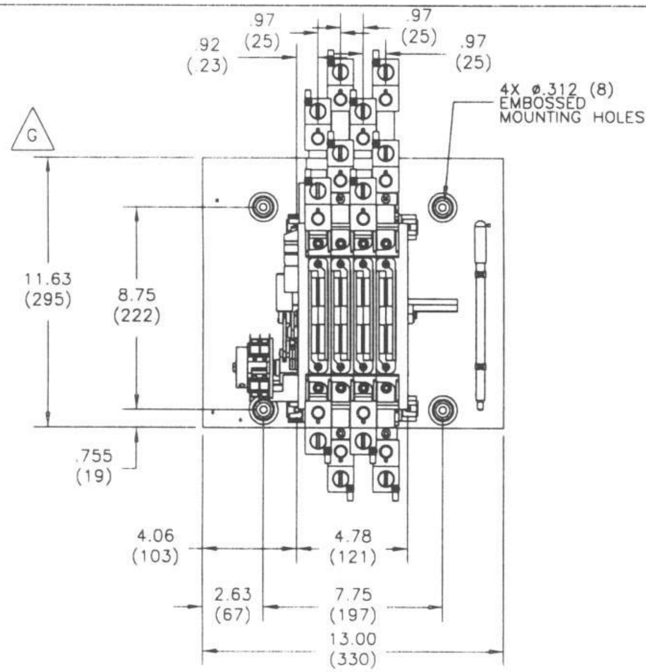
SIGNATURES		DATE
MODEL	SB	12/19/97
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE:
MODEL / ASSEMBLY FILE: CTG(2/3)A 30-225A 2,3,4P
CTQ= ⊖ CRITICAL TO QUALITY CHARACTERISTIC

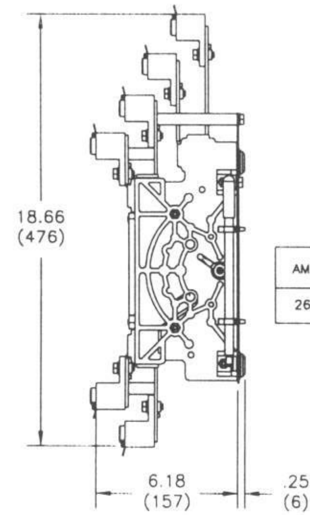
CATERPILLAR®

TITLE
TRANSFER SWITCH-
FRONT LUG

FIRST MADE FOR -
SIZE B | CAGE CODE | DWG NO 52C-2004
SCALE: NA | SHEET 1 OF 2



FRONT VIEW

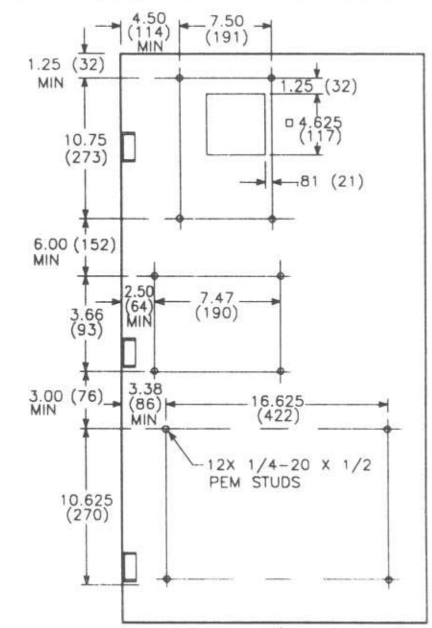


RIGHT SIDE VIEW

AMPS	COPPER CABLE LUG SIZE
260	#6 TO 350 MCM ($13-177mm^2$)

REVISIONS

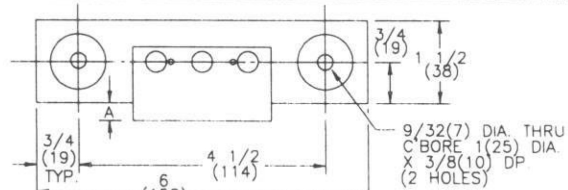
REV.	DESCRIPTION		DATE	APPROVED
G	S-8074	REVISED SHT 2	12/02/03	GG KL



DOOR DETAIL (INSIDE VIEW)

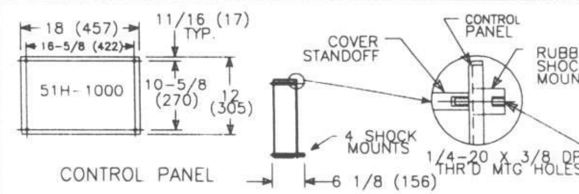
NOTES:

1. 4-POLE SWITCH SHOWN. FOR 2 OR 3 POLE OMIT RIGHT HAND POLES AS SHOWN.
2. OPEN TYPE SWITCH SUPPLIED WITH 6 FT. (1,8m) LONG HARNESS BETWEEN POWER AND CONTROL PANELS. HARNESS EXITS FROM LOWER RIGHT CORNER OF POWER PANEL.
3. DO NOT RUN CABLES IN FRONT OF SWITCH. RUN ALL CABLES ON RIGHT SIDE.
4. ALL FRACTIONAL TOLERANCES ±1/64(0,5mm) UNLESS OTHERWISE SPECIFIED.
5. MAINTAIN ELECTRICAL CLEARANCE OF 1/2(13mm) MIN. BETWEEN LIVE METAL PARTS AND GROUNDED METAL.
6. ALL DIMENSIONS ARE FOR REFERENCE ONLY AND SHOWN IN INCHES(MILLIMETERS).



NEUTRAL BAR ASSEMBLY MOUNTING DETAIL

	A	LUG	QTY.
260	1 (25)	#6-350 MCM ($13-177mm^2$)	3



CONTROL PANEL

THIRD ANGLE PROJECTION

THIS DOCUMENT AND THE DETAILS EMBODIED THEREIN CONSTITUTE CONFIDENTIAL AND PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF CATERPILLAR, INC., AND IS NOT TO BE USED OR REPRODUCED BY ANY PART EXCEPT AND TO THE EXTENT IN THE MANNER AUTHORIZED BY CATERPILLAR, INC.

FOR ADDITIONAL INFO REFER TO APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL DECIMALS ± .020
3 PL DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH ✓
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	12/19/97
DETAIL		
CHECKED		
ENGRG		
MFG		
QUALITY		
ISSUED		

DRAWING FILE:
MODEL / ASSEMBLY FILE: CTG3A 260A 2,3,4P
CTQs . ⊖ CRITICAL TO QUALITY CHARACTERISTIC

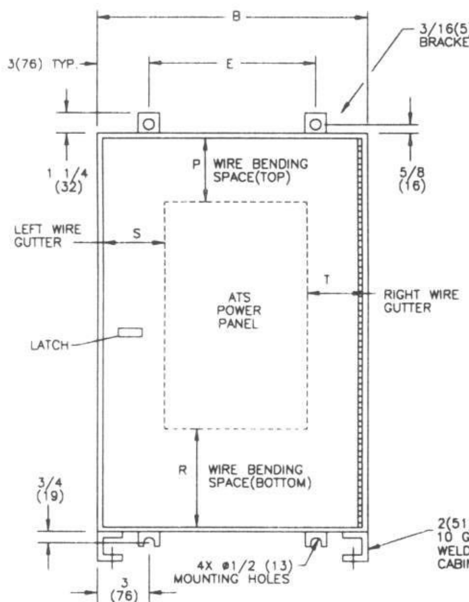
CATERPILLAR®

TITLE
TRANSFER SWITCH-FRONT LUG

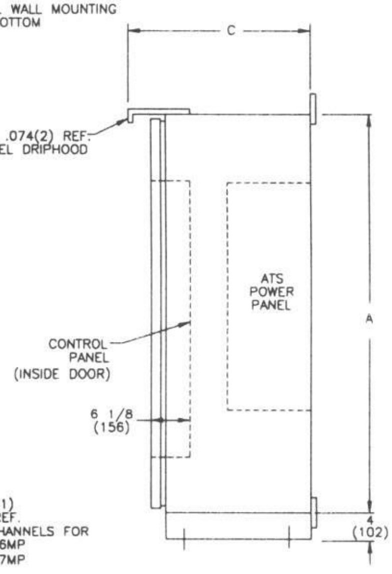
FIRST MADE FOR: 57C-2008
SIZE B | CAGE CODE | DWG NO 52C-2004
SCALE: NA | SHEET 2 OF 2

REV.	DESCRIPTION	DATE	APPROVED
K	S-7964 REVISED DWG	03/27/03	GG SM

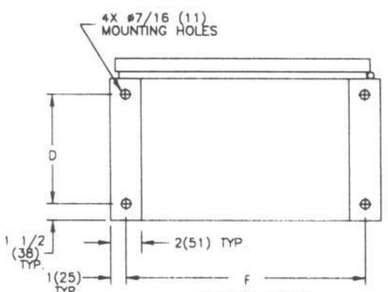
MODEL	AMPERAGE	NO. POLES	NEMA (3R) CABINET	LUG RANGE	WIRE BENDING SPACE P(TOP)	WIRE BENDING SPACE R(BOTTOM)	WIRE GUTTERS S(LEFT)	WIRE GUTTERS T(RIGHT)
CTG2 SWITCHES	40-150	2,3	F-1392MP	(40-150A) #8-3/0 (8-85mm2)	7 (178)	8 (203)	3 1/2 (89)	5 7/8 (149)
		4	F-1392MP					4 1/2 (114)
CTG3 SWITCHES	200	2,3	F-1459MP	(200A) #6-250 MCM (13-127mm2)			3 1/2 (89)	8 7/8 (225)
		4	F-1459MP					7 1/2 (191)
CTG3 SWITCHES	225	2,3	F-1395MP	#6-250 MCM (13-127mm2)	13 5/8 (346)	15 (381)	6 1/2 (165)	8 7/8 (225)
		4	F-1395MP					7 1/2 (191)
CTG2 SWITCHES CTG3 SWITCHES CTG4 SWITCHES	225	2	F-1238MP	#8-250 MCM (8-127mm^2)	14 3/4 (375)	14 5/8 (371)	4 7/8 (124)	7 5/8 (194)
		3					4 5/8 (117)	5 9/16 (141)
		4					2 3/4 (70)	5 9/16 (141)
	260-400	2	F-1238MP	#4-600 MCM (21-304mm^2)	14 3/4 (375)	14 5/8 (371)	4 7/8 (124)	7 5/8 (194)
		3					4 5/8 (117)	5 9/16 (141)
		4					2 3/4 (70)	5 9/16 (141)
	600	2,3	F-1216MP	(QTY 2) #2-600 MCM (33-304mm2)	17 1/2 (444)	17 5/8 (448)	10 7/8 (276)	7 13/16 (198)
		4					9 (229)	
	800	2,3	F-1217MP	(QTY 4) #2-600 MCM (33-304mm2)	18 11/16 (475)	18 5/8 (473)	9 1/2 (241)	1 1/8 (29)
		4	F-1219MP/FMP		16 11/16 (424)	20 5/8 (524)	8 3/4 (222.25)	6 1/8 (155.57)
CTGD2 SWITCHES CTGD3 SWITCHES	100-400	2	F-1238MP	#8-250 MCM (8-127mm^2)	14 3/4 (375)	14 5/8 (371)	4 7/8 (124)	7 5/8 (194)
		3					4 5/8 (117)	5 9/16 (141)
		4					2 3/4 (70)	5 9/16 (141)
	600	2,3	F-1216MP	(QTY 2) #2-600 MCM (33-304mm2)	17 1/2 (444)	17 5/8 (448)	10 7/8 (276)	7 13/16 (198)
		4					9 (229)	
	800	2,3	F-1217MP	(QTY 4) #2-600 MCM (33-304mm2)	18 11/16 (475)	18 5/8 (473)	9 1/2 (241)	1 1/8 (29)
		4	F-1219MP/FMP		16 11/16 (424)	20 5/8 (524)	8 3/4 (222.25)	6 1/8 (155.57)



FRONT VIEW



RIGHT SIDE VIEW



BOTTOM VIEW

CABINET DIMENSIONS						
CABINET	A	B	C	D	E	F
F-1216MP	62 (1575)	24 (610)	20 1/2 (521)	15 1/2 (394)	18 (457)	22 (559)
F-1217MP	70 (1778)	30 (762)	20 1/2 (521)	15 1/2 (394)	24 (610)	28 (711)
F-1219MP/FMP	70 (1778)	40 (1016)	20 1/2 (521)	--	--	--
F-1238MP	46 (1168)	24 (610)	15 (381)	--	18 (457)	
F-1392MP	24 (610)	18 (457)	12 (305)	--	12 (305)	--
F-1395MP	36 (914)	24 (610)	15 (381)	--	18 (457)	--
F-1459MP	24 (610)	21 (533)	12 (305)	--	15 (381)	--

NOTES:

1. MATERIAL:
   A. 12 GA. STEEL .104(3) REF. (F-1216MP, F-1217MP)
   B. 14 GA. STEEL .074(2) REF. (F-1220MP, F-1395MP, F-1459MP)
   C. 18 GA. STEEL .0598(1.5) REF. (F-1392MP)
   UNLESS OTHERWISE NOTED.
2. FINISH: CATERPILLAR 82 BAKED GREY ENAMEL
3. ALL DIMENSIONS ARE FOR REFERENCE ONLY AND SHOWN IN INCHES(MILLIMETERS).

THIRD ANGLE PROJECTION

THIS DOCUMENT AND THE DETAILS EMBODIED THEREIN CONSTITUTE CONFIDENTIAL AND PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF CATERPILLAR, INC. AND IS NOT TO BE USED OR REPRODUCED BY ANY PART EXCEPT AND TO THE EXTENT IN THE MANNER AUTHORIZED BY CATERPILLAR, INC.

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH ✓
AutoCad Generated

SIGNATURES		DATE
MODEL	EC	11/01/00
DETAIL		
CHECKED		
ENGRG	SB	11/01/00
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 52c-1035-k-2.dwg
MODEL / ASSEMBLY FILE: CTG(D)(2/3/4)-80 (40-800A)
CTOs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

CATERPILLAR®

TITLE
TRANSFER SWITCHES
NEMA 3R ENCLOSURE

FIRST MADE FOR:
SIZE B | CAGE CODE | DWG NO 52C-1035
SCALE: - | SHEET 2 OF 4

REVISIONS

REV.	DESCRIPTION		DATE	APPROVED
B	S-7911-2	REVISED DWG	3/4/03	GG FS

CTGA SERIES WITH MX150 MICROPROCESSOR-BASED CONTROL PANEL AUTOMATIC TRANSFER SWITCH (ATS) 40-4000 A

FOR USE ON EMERGENCY OR STANDBY SYSTEMS - RATED FOR TOTAL SYSTEM & MOTOR LOAD

A. LEGEND

Relay/Transformer Box

- CCE........ Control Relay, Close Source 2
- CCN........ Control Relay, Close Source 1
- XE1,XE2........ Control Transformer, Source 2
- XN1,XN2........ Control Transformer, Source 1

Power Panel

- N1,2,3,(N)........ Source 1 Line
- E1,2,3,(N)........ Source 2 Line
- T1,2,3,(N)........ Load Connections
- BR........ Bridge Rectifier (400 Amp)
- CA........ CN/CE Capacitor (200-260 Amp)
- CE........ Source 2 Transfer Operator (600-4000 Amp)
- CE2........ Source 2 Transfer Operator (4000 Amp)
- CN........ Source 1 Transfer Operator (600-4000 Amp)
- CN2........ Source 1 Transfer Operator (4000 Amp)
- CNE........ Main Transfer Operator (400 Amp)
- CN/CE........ Main Transfer Operator (40-260 Amp)
- GND........ Ground
- NB........ Neutral Bar (if required)
- RE........ Bridge Rectifier, CE (1600-4000 Amp)
- RN........ Bridge Rectifier, CN (1600-4000 Amp)
- SCE,SCN........ CNE Limit Switches (400 Amp)
- SE........ Source 2 Position Limit Switch
- SN........ Source 1 Position Limit Switch

Interconnect Plugs

- J1, J2, J4, J5, J6, J7 and J8 J9 and J10........ For Panel Mounted Optional Accessories

B. OPERATION

When Source 1 line drops below the preset dropout point, the Source 1 voltage sensing circuit initiates the engine start circuit.

When Source 2 line voltage and frequency reach the preset pickup point, the MX control panel energizes the CCE control relay to operate the main transfer operator. The load is now transferred to the Source 2 line. The transfer switch is mechanically locked. SN limit switch awaits the next operation to Source 1.

When Source 1 line voltage reaches the preset pickup point, the MX control panel energizes the CCN control relay to operate the main transfer operator. The load is now re-transferred back to the Source 1 line. The transfer switch is mechanically locked. SE limit switch awaits the next operation to Source 2.

Test Switch
The Test Switch simulates source 1 line failure when activated.
To test, activate the Test Switch, thus allowing the transfer switch to transfer to the Source 2 position. Deactivate the Test Switch. The transfer switch will reset to the Source 1 position.
Testing at least once a month is recommended. For hospital emergency systems, test once a week.

C. MSTDG OPTION PACKAGE

- 6 Test Switch, Momentary.
- A3 Auxiliary Contact Closed when the switch is in Source 2 position.
- A4 Auxiliary Contact Closed when the switch is in Source 1 position.

CALIBRATE
Source 1 & Source 2 Calibrate capabilities for voltage a frequency.

- CDT Load. One event exerciser with adjustable Engine exercise timer. Exercise duration can be set between 5 and 60 min. in 1 min. increments. Can be configured to run every 1, 7, 14 or 28 days. Factory Default is 20 min. When exerciser is impending ("E") appears in the upper right hand corner of LCD screen. Configured via CFG. Set via SET menu.
- DS Disconnect Switch. Inhibits transfer to either direction when in Inhibit. (600-4000 Amp Units).
- E Engine Start Contacts.
- EL/P Event Log: Sequentially Numbered Log of 16 events that track date, time, reason and action taken
  System Data: Total Life Transfers (N2P)
  Days Powered Up
  Total Transfers to S2
  Total S1 Failures
  Total S1 available in Hrs
  Total S2 available in Hrs. (NIP)
- KP Frequency, Indication S1 & S2
- L Indicating LED lights
  - L1 Indicates Switch in Source 2 position.
  - L2 Indicates Switch in Source 1 position.
  - L3 Indicates Source 1 available.
  - L4 Indicates Source 2 available.
  - LN center-off position LCD-indicator.
- N1 Running Time indicator.
- N2 Operation Counter indicator.
- P Time Delay Source 2 Start. Adjustable 0-10 seconds. Standard setting in 3 seconds. Adjust via SET menu.
- Q2 Peak Shave / Remote Load Test: Input for Peak Shave or Remote Load Test. Includes automatic return to Source 1 if Source 2 fails and Source 1 present. Energize Q2 to Peak shave/Load test.
- R50 In-Phase Monitor. Prevents transfer until two sources are in-phase.
- S13 Transfer Commit or no Commit to transfer upon Engine start.
- T Time Delay (S1) source 1 Stable Timer. To delay transfer to Source 1.
- U Source 2 Stop Delay Timer.
- W Time Delay (S2) Source 2 Stable Timer. To delay transfer to Source 2.
- YEN Bypass Timers Key utilizing keypad. When applicable, the system prompts the user to press a button to bypass (T) or (W) Timers should the user so desires.

D. MEXEG OPTION PACKAGE

In addition to the Features Listed under the MSTDG package, this package includes the following Features.

- A3 Auxiliary Contact: closed when switch is in Source 2 positing.
- A4 Auxiliary Contact: closed when switch is in Source 1 positing.
- VI Voltage Imbalance (Three Phase) User Configured On or Off.
  Range: 5% to 20% of Nominal voltage 10 to 30 seconds, user adjustable.
  Resolution: 1% Increments
  Minimum Differential: 2% minimum between "Fail" and "Restore" settings.
  Factory default: 5% "Fail", 3% "Restore", 30 seconds.
- CDP Clock Exerciser Load/No Load: allows the Generator to start and run unloaded or to simulate a power failure, start Generator and run under load.
  Can be configured by end user for 1, 7, 14, 28, 356 day cycle.

E. OPTIONAL ACCESSORIES

- 6A Test Switch, Maintained/Momentary.
- 6AP Test Switch Maintained/Momentary Utilizing Keypad.
- A62 Sequential Universal Motor load Disconnect Circuit. Normally closed Auxiliary contacts for motor disconnect loads. Open 0-60 seconds prior to transfer, after transfer or both in either direction then reclose in timed sequence after transfer
- A1 Auxiliary Contact, Operates on Source 1 line failure.
- A1E Auxiliary Contact, Operates on Source 2 line failure.
- A3 Auxiliary Contacts Closed when the transfer switch is in Source 2 position.
- A4 Auxiliary Contacts Closed when the transfer switch is in Source 1 position.
- B9 Battery charger.
- CTAP Alarm Panel on transfer to Source 2 with Silence button.
- DS Disconnect Switch: Permits transfer in "AUTO" position and inhibits transfer in "INHIBIT" position
- F Fan contact, operates when generator is running.
- HT Heater and Thermostat.
- M80 Digital Power Meter with Display: Amps, Bolts and Frequency.
- M82 Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc.
- M83A Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Modbus RS485 port.
- M83B Digital Meter w/Display of Amps, Watts, Volts, Frequency, KVA, KVAR, PF, etc. Plus THD capability w/ Ethernet.
- Q3 Inhibit Transfer to Source 2: Input Circuit to inhibit transfer to Source 2.
- T3/W3 Elevator Pre-Signal Auxiliary Contacts: Open 0-60 s prior to transfer to either direction, re-closes after transfer.
- UMD Universal Motor Load Disconnect Circuit: Auxiliary Contact opens 0-60 s (adjustable, 1 second increments) prior to transfer in either direction, re-closes after transfer Can be configured by end user for Pre-transfer, Post-transfer or both. Factory default 5 s Timers are not bypassed when transferring from dead source.
- ZNET Network Communication Interface Card.

NOTES:

1. ⚠ CAUTION: In using a 3 phase, 4 wire delta or open delta power supply (usually 120/240 V, sometimes listed as 120/208 V) with one leg having a grounded center tap, one line will be 160 to 208 V to ground. When such a system is used it is necessary to connect the high leg to N2. DO NOT CONNECT 120 V LOAD CIRCUIT TO THE HIGH LEG.
2. GROUNDING TERMINAL: A grounding terminal (GND) is provided. When installing open type switches connect this terminal to the metal enclosure or an equivalent earth ground.
3. ⚠ WARNING - TO ENSURE AGAINST SHOCK OR ACCIDENT HAZARD, DISCONNECT ALL SOURCES OF SUPPLY BEFORE SERVICING.
4. ON SINGLE PHASE UNITS WHERE THE EMERGENCY SOURCE IS A UTILITY LINE, CONNECT EMERGENCY LINE SO THAT MINIMUM VOLTAGE IS MEASURED FROM N1 TO E1.
5. ON SINGLE PHASE (2 POLE) UNITS, CENTER POLE IS NOT SUPPLIED. RIGHT-HAND POLE IS NOT SUPPLIED ON 400 AMP UNITS.

THIS DOCUMENT AND THE DETAILS EMBODIED THEREIN CONSTITUTE CONFIDENTIAL AND PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF CATERPILLAR, INC., AND IS NOT TO BE USED OR REPRODUCED BY ANY PART EXCEPT AND TO THE EXTENT IN THE MANNER AUTHORIZED BY CATERPILLAR, INC.

THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO
APPLIED PRACTICES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL DECIMALS ± .020
3 PL DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH ✓
AutoCad Generated

SIGNATURES		DATE
MODEL	GG	2/13/03
DETAIL		
CHECKED		
ENGRG	FS	
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 70a-0900-b-1.dwg
MODEL / ASSEMBLY FILE: CTGM-400 (40-4000 A)
CTQs ⊖ CRITICAL TO QUALITY CHARACTERISTIC

CATERPILLAR®

TITLE: LEGEND, OPERATION, AND ACCESSORIES

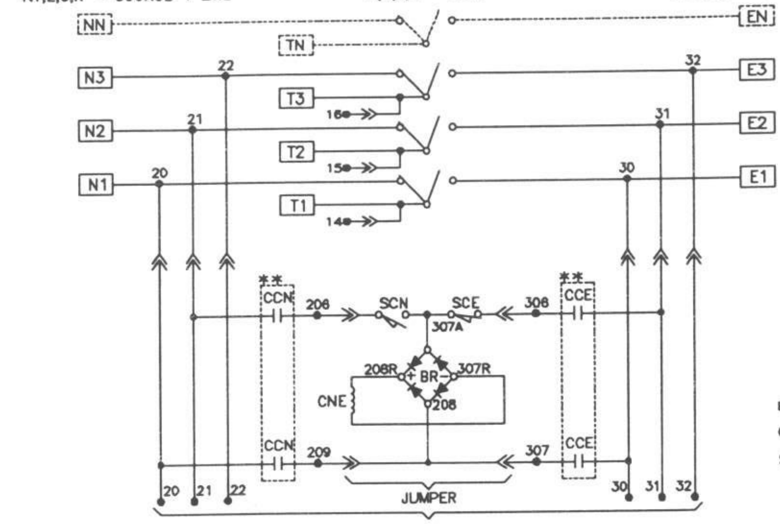
FIRST MADE FOR:
SIZE: B | CAGE CODE: | DWG NO: 70A-0900
SCALE: -
SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8001 REVISED DWG.	07/15/03	GG KL

ATS POWER CIRCUIT SCHEMATIC

N1,2,3,N – SOURCE 1 LINE
T1,2,3,N – LOAD
E1,2,3,N – SOURCE 2 LINE

* SWITCHED OR SOLID NEUTRAL AS SPECIFIED FOR 4 WIRE SYSTEMS.

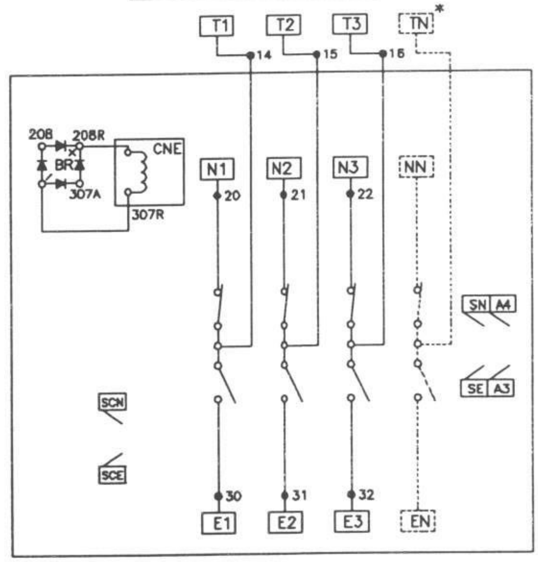


BR – BRIDGE RECTIFIER
CNE – MAIN TRANSFER OPERATOR
SCN/SCE – CNE LIMIT SWITCHES

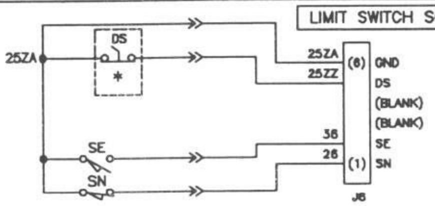
TO RELAY/TRANSFORMER BOX SCHEMATIC – SHEET 2

AUXILIARY CONTACTS

ATS POWER PANEL LAYOUT



LIMIT SWITCH SCHEMATIC



TO MX SERIES CONTROL PANEL

SE – SOURCE 2 POSITION LIMIT SWITCH
SN – SOURCE 1 POSITION LIMIT SWITCH
DS – DISCONNECT SWITCH ON MX150

LEGEND	REFERENCE	NOTES
—●— WIRE CONNECTION —○— WIRE ON TERMINAL BLOCK →>— WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/ TRANSFORMER BOX.	LEGEND, OPERATION, AND ACCESSORIES: 70A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUGS – SEE SHT 2. MX150 CONTROLLER – 70A-0500.	ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE.

THIS DOCUMENT AND THE DETAILS EMBODIED THEREIN CONSTITUTE CONFIDENTIAL AND PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF CATERPILLAR, INC., 4016 NINE MCFARLAND DRIVE, ALPHARETTA, GA., 30004 U.S.A., AND IS NOT TO BE USED OR REPRODUCED BY ANY PART EXCEPT AND TO THE EXTENT IN THE MANNER AUTHORIZED BY CATERPILLAR, INC.

THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO	SIGNATURES		DATE
	DESIGN	GG	10/31/02
	DETAIL		
TOLERANCES ON:	CHECKED		
2 PL DECIMALS ± .020			
3 PL DECIMALS ± .005	MFG		
ANGLES ± 1°	QUALITY		
FRACTIONS ± 1/64	ISSUED		
FINISH ✓	DRAWING FILE: 70a-1000-d-1.dwg		
	MODEL / ASSEMBLY FILE: ZTG(2/3) (40-260A)		
AutoCAD Generated	# CTQs	CRITICAL TO QUALITY CHARACTERISTIC	

CATERPILLAR®

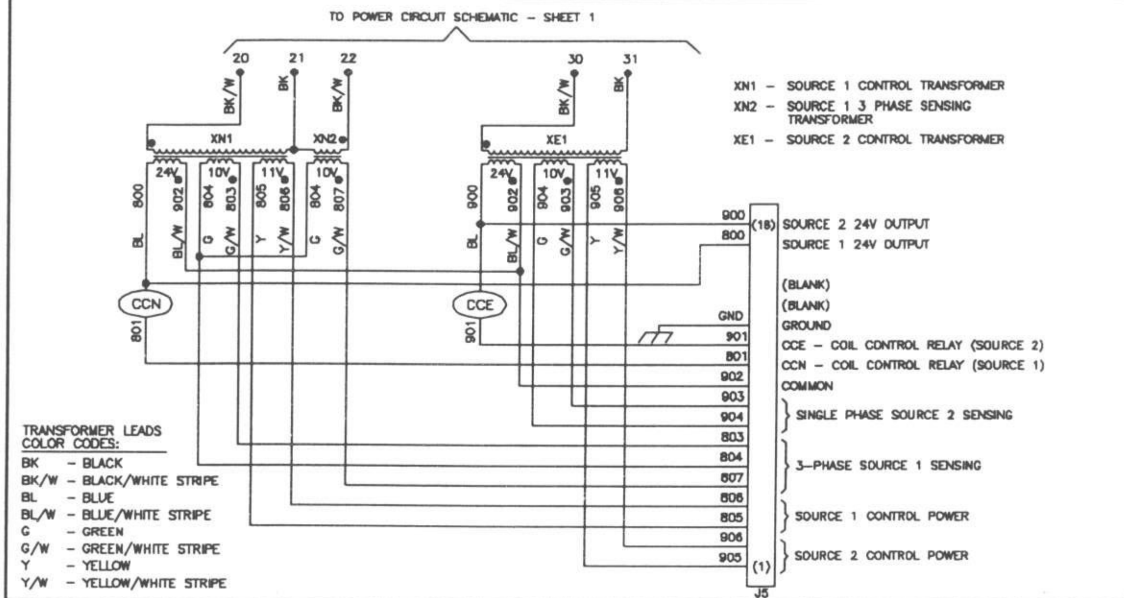
TITLE: ATS POWER CIRCUIT & LAYOUT

FIRST MADE FOR: 3, 4 POLES ZTG(2/3) (40-260A)

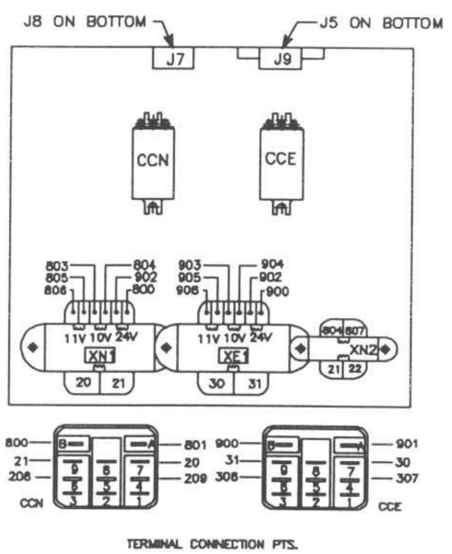
SIZE	CAGE CODE	DWG NO
B		70A-1000
SCALE: –		SHEET 1 OF 2

REV.	DESCRIPTION		DATE	APPROVED
REVISIONS				
D	S-8001	REVISED DWG	07/15/03	GG KL

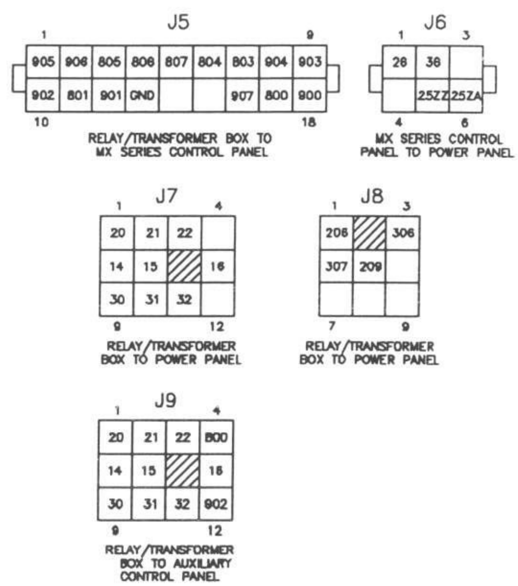
RELAY/TRANSFORMER BOX SCHEMATIC



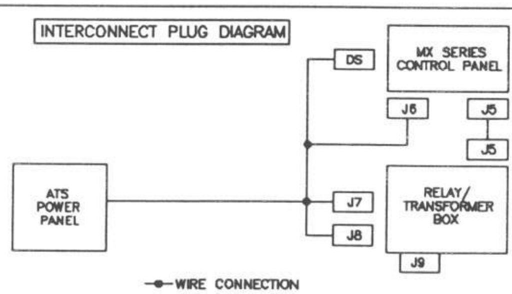
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



THIS DOCUMENT AND THE DETAILS EMBODIED THEREIN CONSTITUTE CONFIDENTIAL AND PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF CATERPILLAR, INC., 4016 NINE MCFARLAND DRIVE, ALPHARETTA, GA., 30004 U.S.A., AND IS NOT TO BE USED OR REPRODUCED BY ANY PART EXCEPT AND TO THE EXTENT IN THE MANNER AUTHORIZED BY CATERPILLAR, INC.

THIRD ANGLE PROJECTION

TOLERANCES ON:
2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH ✓

AutoCAD Generated

SIGNATURES		DATE
MODEL	GG	10/31/02
DETAIL		
CHECKED		
DESIGN		
MFG		
QUALITY		
ISSUED		

DRAWING FILE: 70a-1000-d-2.dwg
MODEL / ASSEMBLY FILE: ZTG(2/3) (40-260A)
CRITICAL TO QUALITY CHARACTERISTIC

CATERPILLAR®

TITLE
RELAY/XFR BOX & INTERCONNECT PLUGS

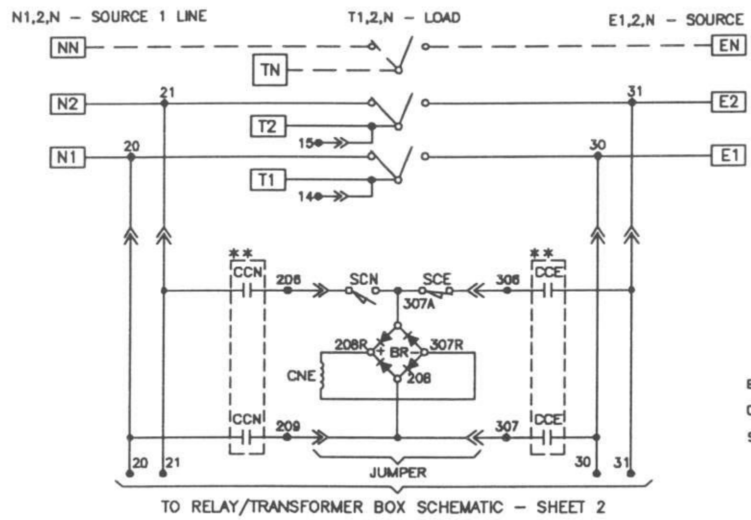
FIRST MADE FOR: 3, 4 POLES ZTG(2/3/4)(40-260A)

SIZE: B | CAGE CODE: | DWG NO: 70A-1000

SCALE: - | SHEET 2 OF 2

REVISIONS				
REV.	DESCRIPTION		DATE	APPROVED
d	S-8001	REVISED DWG	07/15/03	GG KL

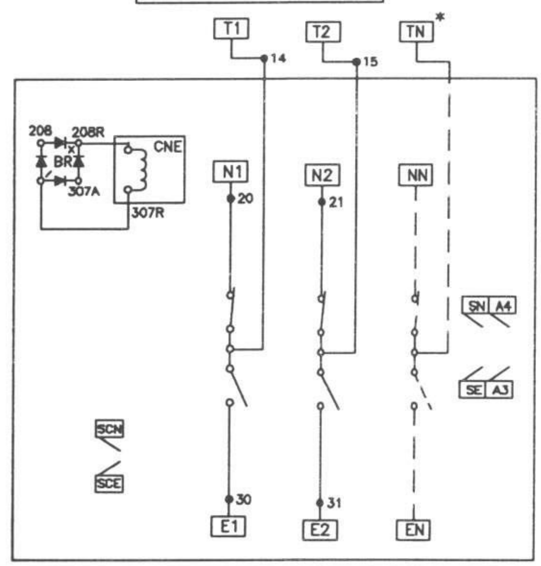
ATS POWER CIRCUIT SCHEMATIC



* SWITCHED OR SOLID NEUTRAL AS SPECIFIED FOR 3 WIRE SYSTEMS.

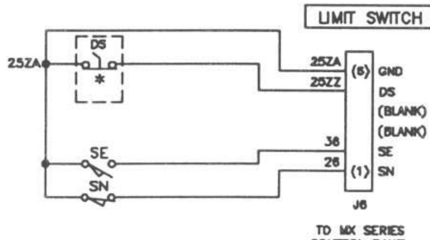
BR – BRIDGE RECTIFIER
CNE – MAIN TRANSFER OPERATOR
SCN/SCE – CNE LIMIT SWITCHES

ATS POWER PANEL LAYOUT



AUXILIARY CONTACTS

LIMIT SWITCH SCHEMATIC



SE – SOURCE 2 POSITION LIMIT SWITCH
SN – SOURCE 1 POSITION LIMIT SWITCH
DS – DISCONNECT SWITCH ON MX150

LEGEND	REFERENCE	NOTES
—●— WIRE CONNECTION —○— WIRE ON TERMINAL BLOCK —≫— WIRE IN INTERCONNECT PLUG * OPTIONAL ** LOCATED ON RELAY/TRANSFORMER BOX	LEGEND, OPERATION, AND ACCESSORIES: 70A-0900 FOR PRODUCTION ONLY: R/T BOX AND PLUGS – SEE SHT 2 MX150 CONTROLLER – 70A-0500	ATS SHOWN IN SOURCE 1 POSITION WITH NO POWER AVAILABLE.

THIS DOCUMENT AND THE DETAILS EMBODIED THEREIN CONSTITUTE CONFIDENTIAL AND PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF CATERPILLAR, INC., 4016 NINE MCFARLAND DRIVE, ALPHARETTA, GA., 30004 U.S.A., AND IS NOT TO BE USED OR REPRODUCED BY ANY PART EXCEPT AND TO THE EXTENT IN THE MANNER AUTHORIZED BY CATERPILLAR, INC.

THIRD ANGLE PROJECTION

FOR ADDITIONAL INFO REFER TO	SIGNATURES		DATE
	MODEL	GG	10/31/02
	DETAIL		
TOLERANCES ON:	CHECKED		
2 PL. DECIMALS ± .020	ENGR		
3 PL. DECIMALS ± .005	MFG		
ANGLES ± 1°	QUALITY		
FRACTIONS ± 1/64	ISSUED		
FINISH ✓	DRAWING FILE:	70a-1001-d-1.dwg	
	MODEL / ASSEMBLY FILE:	ZTG(2/3) (40-260A)	
AutoCAD Generated	# CTQs	⊖ CRITICAL TO QUALITY CHARACTERISTIC	

CATERPILLAR®

TITLE: ATS POWER CIRCUIT LAYOUT

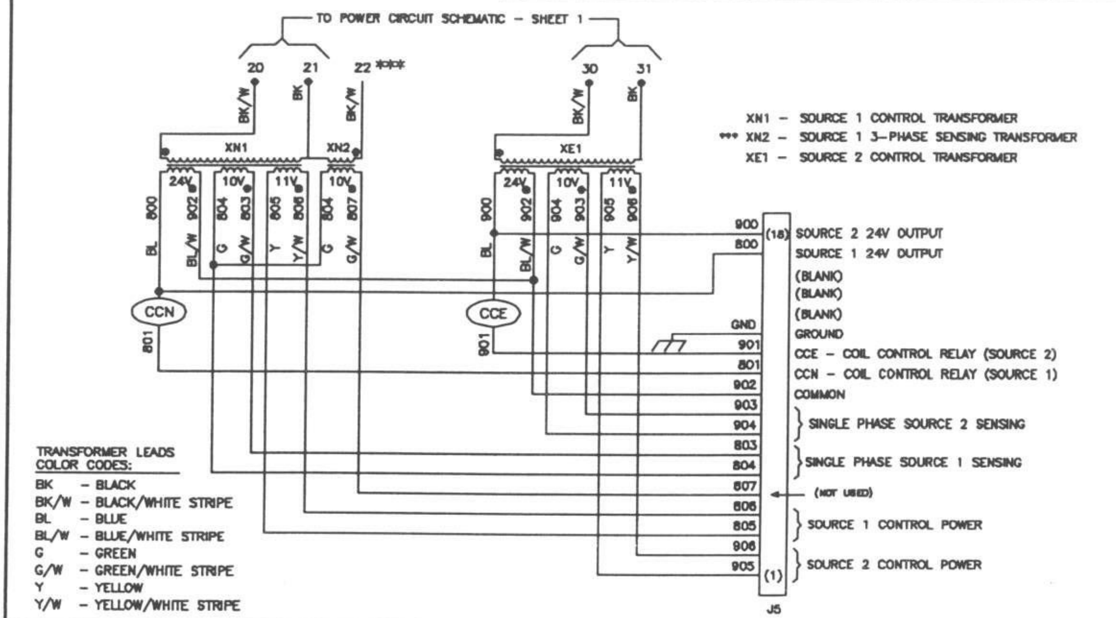
FIRST MADE FOR: 2 POLE ZTG(2/3/4)(40-260 A)

SIZE	CAGE CODE	DWG NO
B		70A-1001

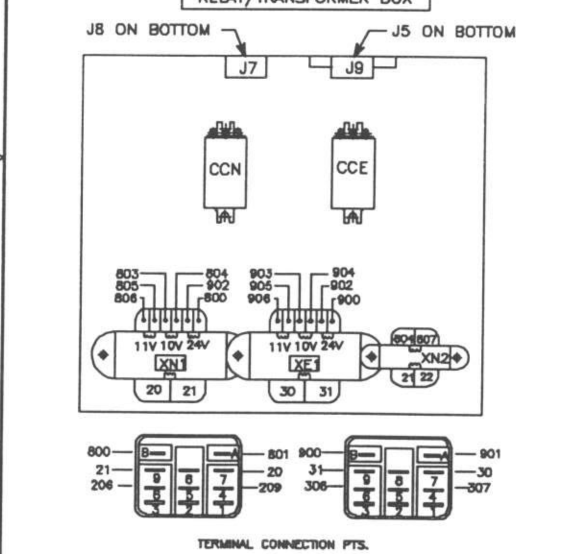
SCALE: NA — SHEET 1 OF 2

RELAY/TRANSFORMER BOX SCHEMATIC

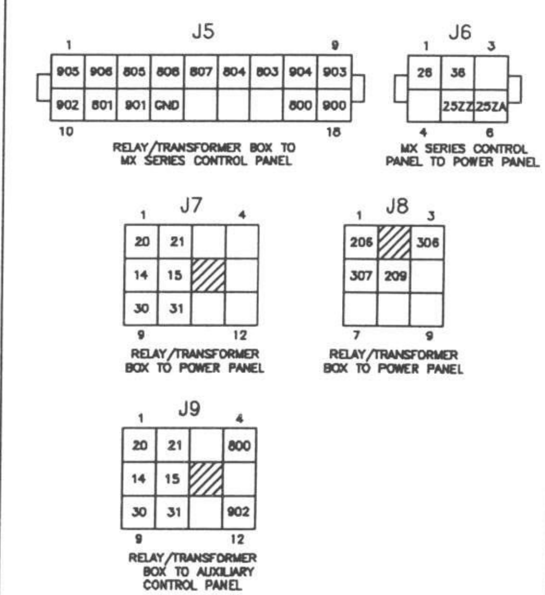
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
D	S-8001 REVISED DWG	07/15/03	GG KL



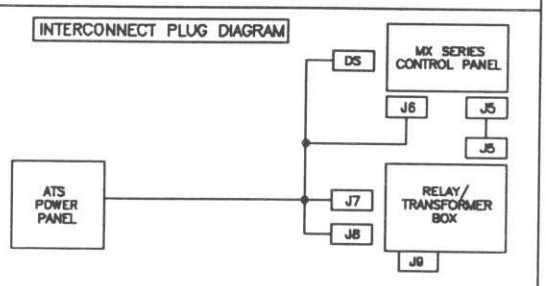
RELAY/TRANSFORMER BOX



INTERCONNECT PLUGS



INTERCONNECT PLUG DIAGRAM



LEGEND

- WIRE CONNECTION
- *** WIRE #22 REMAINS WIRED IN RELAY/TRANSFORMER BOX. WIRE #22 IS NOT CONNECTED TO ATS POWER PANEL.

THIS DOCUMENT AND THE DETAILS EMBODIED THEREIN CONSTITUTE CONFIDENTIAL AND PROPRIETARY INFORMATION WHICH IS THE PROPERTY OF CATERPILLAR, INC., 4016 NINE MCFARLAND DRIVE, ALPHARETTA, GA. 30004 U.S.A., AND IS NOT TO BE USED OR REPRODUCED BY ANY PART EXCEPT AND TO THE EXTENT IN THE MANNER AUTHORIZED BY CATERPILLAR, INC.

THIRD ANGLE PROJECTION

2 PL. DECIMALS ± .020
3 PL. DECIMALS ± .005
ANGLES ± 1°
FRACTIONS ± 1/64
FINISH ✓

AutoCAD Generated

SIGNATURES		DATE
DRAWN	SB	11/06/97

DRAWING FILE: 70a-1001-d-1.dwg
MODEL / ASSEMBLY FILE: ZTC(2/3) (40-260A)
CRITICAL TO QUALITY CHARACTERISTIC

CATERPILLAR®

TITLE: RELAY/XFR BOX & INTERCONNECT PLUGS

FIRST MADE FOR: 2 POLE ZTC(2/3/4) (40-260A)

SIZE	CAGE CODE	DWG NO
B		70A-1001

SCALE: – SHEET 2 OF 2