GREAVES POWER

NEW GENERATION POWER SOLUTIONS

GREAVES
SINCE 1859

GENSET USER MANUAL

For G1 Series (10-30 kVA)

Reliable. Economical. Total Solution.

Diesel Generator Set
CPCB-II Compliant

SMS GENSET TO 56767
(For sales enquiries)

Toll Free No.: 1800 266 0670
(For service and support)

Greaves Cotton Limited
Auxiliary Power Business

Dear Customer,

Welcome to Greaves family.

The DG set you have purchased incorporates the latest in Diesel GENSET technology with all the elements viz. Engine, Generator, Controls and Canopy integrated in an optimal way. The outcome is a product engineered to deliver round the clock service of prime, stand-by, and continuous supply of electric powerhouse whenever you need it.

Needless to say, that the performance of the equipment is dependent on adherence to good practices of Installation, operation & maintenance. In order to facilitate this, we have included installation guidelines and O & M instructions in this user manual. We strongly recommend that the users need to thoroughly go through the contents of this manual & ensure that the guidelines & instructions are followed, so that you can enjoy many years of trouble-free performance from your DG set.

Please feel free to speak with any of our Regional offices or HO for additional information.

Once again we thank you for buying a Greaves Power DG set and will look forward to hearing your valuable feedback in near future.

With Best Wishes,
For Greaves Cotton limited
Auxiliary Power Business

While asking for assistance to our Authorized Service Dealer, please provide the following information.

- Engine Serial Number
- GENSET Site Location
- Name of the Company
- Your Name, Detailed Address, and Phone / Mobile Number
- General Description of Assistance required

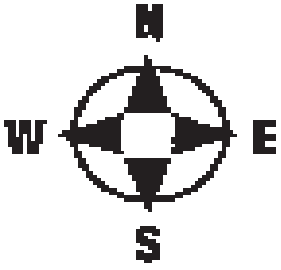
Greaves Toll Free No. 1800-266-0670

For Emergency Contact

AGM-Service, HO Greaves Cotton Limited,
Engine Business, Chinchwad, Pune-411 019
Phone: +91-20-67308260 Mobile: +91-9923201928

Regional Service Manager
Express Building Annexe, 9-10,
Bahadur Shah Zafar Marg,
New Delhi- 110 002
Mobile: +91-9810770502

Regional Manager
Engine Business,
Chinchwad, Pune-411 019
Phone: +91-9923201868



Regional Service Manager
Akash Tower, 5th Floor, 781,
Anandpur, Kolkata-700 107
Phone: +91-9836886517

Regional Service Manager
Lakshmi Chambers, No. 30,
Anna Salai Little Mount,
Saidapet, Chennai-600 015
Phone: +91-9176832884

GENSET Model and Sr. No:

.....

Engine Model and Sr. No:

.....

Alternator Sr. No. Make & Type:

.....

Control Panel Sr. No. Make & Type:

.....

First Service Check Details:

.....

Second Service Check Details:

.....

Service Dealer Stamp & Signature:

.....

Important Notice

1. This warranty is applicable for Greaves Power GENSET manufactured by Auxiliary Power Business division of Greaves Cotton Limited. Before commissioning of the said GENSET, please go through the contents of this section carefully.

2. For details of Greaves authorised service dealer for your GENSET, please contact either your supplier of GENSET or nearest Greaves area office.

3. For availing the warranty services, please ensure following:
    a. Produce this warranty / user manual booklet to Greaves authorized service dealer, when requested.

    b. Carry out first service check through Greaves authorized service dealer within 7 days of installation, followed by second service check within 500 Hrs. or 6 months from the date of first service check, whichever is earlier.

    c. Use recommended grade or lube oil and ensure periodic change of lube oil, as recommended by the Greaves authorised service dealer.

    d. Use genuine air filter elements, lube oil filter elements, fuel filter elements, coolant and additives, sourced from Greaves authorised service dealer.

    e. Please maintain the log-book for the GENSET at your end. The suggested format for log-book is provided below along with all the service coupons.

    f. Carry out repairs of GENSET only through Greaves authorised service dealer only.

    g. The performance of GENSET depends on the quality and grade of lube oil and periodic or preventive maintenance. To ensure the originality of oil, Greaves has launched the lube oil branded as Greaves Maxtherm. Please use this lube oil and genuine filters sourced through Greaves authorised parts and service dealer and avail extended warranty.

Please provide following details to our Authorised service dealer. It will help them for quick restoration of your GENSET.

GENSET Model and Serial No:	……
Engine Serial No.	……
Detailed Site Address	…… …… ……
Contact Person Name & Telephone/ Mobile No.	…… ……
No. of Hrs. ran till date	……
Nature of Failure	…… …… ……

Revisions in User Manual #P21190060187

Revision No.	Modification Summary	Date
00	New Release	09-10-2014

Warranty Policy

Greaves Cotton Diesel GENSET

1. **Warranty Policy (Diesel GENSET):**

   Greaves Cotton Ltd. warranty for the GENSET is limited to its defective materials/ components and/or workman-ship and is valid until a period of 30 months from the date of invoice OR a period of 24 months from the date of commissioning at site or completion of 5000 hours of operation, whichever event shall occur first provided the user of the GENSET uses recommended genuine spare parts including "Greaves Maxtherm" Lube Oil & Coolant wherever applicable and use of genuine Air Filter element and Lube Oil Filter element purchased only from authorized dealers of Greaves Cotton Ltd.

   The foregoing warranty is not applicable in the event of, if:

   a. The GENSET has been stored improperly and not protected from adverse weather conditions of any nature.
   b. The GENSET has not been installed strictly as pe r the recommendations of Greaves Cotton Ltd. and not operated in accordance with the instructions contained in this user manual.
   c. The defective/improper fuel, lubricants, coolants and any of their associated systems are utilized.
   d. Unauthorized person carries out repairs and alterations.
   e. The maintenance of the GENSET is not strictly done as pe r the procedure detailed in Greaves Cotton Ltd. operator's handbook/instruction manual.
   f. Improper tools and equipment's are utilized at any stage during erection, commissioning and maintenance.
   g. During operation, the GENSET is subjected to misuse, negligence, accident, or by-passing safety systems.
   h. Failure in any way results from use of components / parts not manufactured or not authorized by us for use on our GENSET.

2. **Terms & Conditions for Warranty**

   a. The components having shelf life like rubber components, belts, hoses and replacement filters / consumables which are normally maintenance spares are not covered within the scope of this warranty.
   b. In cases of complaints which are proprietary bought out items, our warranty is limited to the extent of warranty of the manufacturer to us.

c. If the GENSET is improperly stored beyond period of six months without recommended long storage treatment and used without recommended de-preservation.

d. All goods are supplied on the condition that under no circumstances we undertake liability for the indirect or consequential loss or damage of any nature.

e. The warranty shall not apply to normal wear and tear of the individual components or damages due to the negligence or improper handling by the purchaser or his employees or agents or due to damage by any cause beyond our control.

f. The warranty does not apply to defect arising due to default in periodic/ preventive maintenance and lapse in the use of recommended genuine spare parts including "Greaves Maxtherm" Lube Oil and Coolant wherever applicable and use of genuine Air Filter element and Lube Oil Filter element and also subject to adequate quantity of lubricating oil / coolant in respective circuits.

g. Claim under warranty shall be summarily rejected if the defects are not notified within warranty period specified above and lodged within 3 days of the expiry of the warranty period.

h. The new or repaired part(s) will be delivered free of Ex-works cost of Chinchwad/Chakan Pune. Any additional delivery cost to be borne by the purchaser / customer.

i. In respect of any warranty claim accepted by us, we shall arrange to replace or repair relevant and respective parts free of cost to the customer. If parts are replaced, the defective part shall be property of Greaves Cotton Ltd. In any case, wherever the parts are supplied with free charges, Greaves Cotton Ltd. shall not be liable for any fitment and / or other charges.

j. Greaves Cotton Ltd. shall not be responsible for replacement of the complete unit under any circumstances. In case of any warranty claim, the responsibility of Greaves Cotton Ltd. shall be limited to the extent of replacement or supply of defective parts.

3. **Warranty Policy (Producer Gas, Bio Gas, and Compressed Natural Gas)**

Greaves Cotton Ltd. warranty for the GENSET is limited to its faulty design, defective materials/ components and/or workman-ship and is valid until a period of 15 months from the date of dispatch of GENSET from its Works/Warehouse or 12 months from the

date of commissioning or completion of 3500 hours of operation, whichever event shall occur first provided the user of the GENSET uses recommended genuine spare parts including "Greaves Maxtherm " Lube Oil & Coolant wherever applicable and use of genuine Air Filter element and Lube Oil Filter element purchased only from Authorized Dealers of Greaves Cotton Ltd. Our above warranty policy for engines / DG Sets operated on Producer Gas, Bio Gas, and CNG like gaseous fuel should have minimum of following characteristics.

Characteristics	Producer Gas	Bio Gas	CNG
Methane	≤ 1.5 %	≤ 65.0 %	> 85.0 %
H_2S Content	-	≤ 0.15 %	-
Moisture Content	1.0 %	≤ 1.0 %	-
Dust Content	≤ 0.5 %	≤ 0.5 %	-
Calorific Value	> 1200 kCal/m^3	> 5600 kCal/m^3	> 9600 kCal/m^3

a. Our above warranty clause will not be applicable for the components coming under direct contact of gaseous fuel. Wear & tear of parts like Piston(s), Piston rings, Liners, Bearings & Bearing bushes since these components are prone to the reaction with undesirable gaseous contents.
b. To establish the performance / load capacity of the engine/GENSET it will be the responsibility of the customers to the produce the certificate of gas composition and calorific value from Government approved laboratory.
c. In case of Dual-fuel application diesel replacement is guaranteed up t o maximum of 70%.
d. Maintenance intervals may be reviewed by Greaves Cotton Ltd. as pe r the actual composition of the gas at site which is to be followed by the customer.

For Auxiliary Power Business
Greaves Cotton Limited,
Chinchwad, Pune

LOG SHEET [Sample for Use]

The user is requested to maintain a separate log book registering the following mentioned parameters in the table. Following tables are meant for providing a reference to you.

Engine Model		**HP Rating**		**RPM**	

Date						
Daily use in Hours						
Hour Meter Reading						
Cooling Water Temperature (°C)						
Lube Oil	Pressure (Kg/cm3)					
	Temp (°C)					
Fuel added (Litres)						
Lube Oil added (Cubic Cms.)						
Engine (RPM)	No Load					
	Full Load					
Current (Amp) 3-phase						
Voltage (Volts)						
Frequency (Hz)						
PF & kW if provided						
kWH meter reading if provided						
Remarks – Record events of maintenance/repairs						

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Lube Oil added (Cubic Cms.)						
Engine (RPM)	No Load					
	Full Load					
Current (Amp) 3-phase						
Voltage (Volts)						
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kWH meter reading if provided						
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Lube Oil	Pressure (Kg/cm3)					
	Temp (°C)					
Fuel added (Litres)						
Lube Oil added (Cubic Cms.)						
Engine (RPM)	No Load					
	Full Load					
Current (Amp) 3-phase						
Voltage (Volts)						
Frequency (Hz)						
PF & kW if provided						
kWH meter reading if provided						
Remarks – Record events of maintenance/repairs						

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SECTION C	DIESEL ENGINE
SECTION D	ALTERNATOR
SECTION E	CONTROL PANEL
SECTION F	DRAWINGS

SECTION A

GENERAL

SECTION A - GENERAL			
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Chapter 1 Introduction

This manual after reading it thoroughly ensures the user that, user would be able use the GENSET efficiently and safely. The manual is an integral part of the machine and must be kept in the immediate vicinity of the same and accessible at any point of time for the user/personnel. The personnel must have carefully read and understood this manual before starting any associated work. The basic prerequisite for the safe working is compliance with all the safety and handling instructions stated in this manual. Furthermore, the local accident prevention regulations and general safety conditions for the application of the machine are also applicable. Illustrations in this manual are merely provided for basic understanding and can be different from the actual.

1.1 Explanation of the Symbols

This topic describes the various types of symbols that are used in this manual.

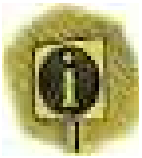
1.1.1 Safety Information

Safety information in this manual is identified using symbols. The safety information is introduced using signal words (shown in Table A1.1) which expresses the scale of the hazard. Always comply with the safety instructions and act cautiously in order to avoid accidents, injuries to persons and damage to property.

	**DANGER!** Points out a directly dangerous situation which results in death or severe injuries if it is not avoided.
	**WARNING!** Points out a potentially dangerous situation which can result in death or severe injuries if it is not avoided.
	**CAUTION!** Points out a potentially dangerous situation which can result in minor/slight injuries or damage to property if it is not avoided.

Table A1.1

1.1.2 Tips & Recommendations

	**Note!** Highlights the useful tips, recommendations and information for efficient and trouble free operation.

1.2 Limitation on Liability

All information and instructions for use in this manual have been compiled meticulously taking into account the applicable standards & regulations, latest state of the art technology and our many years of expertise, knowledge and experience. However, the manufacturer accepts no liability for damage resulting due to:

- Non-Observance of the Instructions
- Improper usage of the product
- Use of Untrained Personnel
- Unauthorized Modifications
- Technical Changes
- Use of Non-Original Spare Parts

The actual scope of delivery/supply can be different from the explanations and illustrations stated herein, due to the latest technical changes. The agreed obligations in the supply contract, the general terms & conditions and the delivery conditions of the manufacturer and the applicable legal regulations in force at the time of the conclusion of the contract are applicable. We reserve the right to make technical modifications in order to improve usability.

1.3 Copyright

This manual is protected by copyright law and exclusively to be used for intended purpose. Passing this manual on to third parties, duplication of any kind even in the form of excerpts as well as t he use and/or disclosure of the contents without the written consent of the manufacturer is not permitted, except for internal purposes. Violations oblige to compensation. The right for further claims remains reserved.

1.4 Warranty Terms

The warranty terms are provided in the manufacturer's terms and conditions.

1.5 Customer Service

Please refer to our website www.greavescotton.com or contact us on +91-20-67308260 or +91-9923201928 for a list of our sales and service partners. Also, we request you in sharing the new information and experience arising out of usage of the product, which can be valuable for the development of the same.

Chapter 2 Safety

This chapter provides an overview of all important safety aspects for optimal protection of personnel as well as safe and trouble-free operation of the GENSET. Disregarding this manual and safety regulations specified herein may result in considerable danger.

2.1 Customer's Responsibility

The GENSET system is used commercially. The owner of the machine is thus subjected to the legal obligations for health and safety at work. As well as the operational safety instructions laid out in this user manual, the applicable safety, accident prevention and environmental regulations for the application must also be complied with. The following particularly apply:

a) The owner must educate himself/herself about the applicable health and safety conditions and also determine hazards arising out, from the special operating conditions at the site of location of the GENSET for risk analysis. He / She must implement this in the form of operating instructions for the operation of the machine.

b) During the complete usage / running time of the GENSET, the owner must check whether the operating instructions created by him correspond with the current status of the regulations and must adapt those if necessary.

c) The owner must clearly regulate and specify the responsibilities for installation, operation, maintenance and cleaning.

d) The owner must ensure that all employees involved with the GENSET have read and understood the operating instructions. He /She must also train the personnel and inform them about the dangers at regular intervals.

e) The owner must provide the necessary protective equipment / apparels for the personnel.

f) The owner is also responsible for maintaining the GENSET in proper working condition. Therefore, he / she should strictly observe the following:

   i. The owner must ensure that the maintenance intervals specified in this manual are complied with.

   ii. The owner must arrange for all safety equipment to be checked regularly for functionality and completeness.

   iii. The owner must ensure that antifreeze is filled for engines with radiators.

   iv. Explosive and easily flammable substances must always be kept away from the engine as the engine can become very hot during operation.

v. No one touch rotating parts while the GENSET is running.
vi. Only fill with fuel when the GENSET is switched off. Do not fill in the vicinity of naked flames or ignitable sparks, do not smoke and do not spill any fuel.
vii. This operator's manual must be kept in the immediate vicinity of the system and must be accessible at any time to all persons working on and with the system.
viii. The system must only be operated if it is in proper working condition.
ix. In the case of doubt, always contact the nearest Greaves Diesel service dealer before starting the GENSET.
x. Only regular maintenance in accordance with the information in this operator's manual maintains the operational readiness of the GENSET.
xi. Perform maintenance and cleaning work only when the GENSET is switched off.
xii. Strictly observe all the information in the operator's manual.
xiii. Observe all warning and information signs on the system and keep these in legible condition. If a warning or information sign should be lost or difficult to read, always request a replacement from the nearest Greaves authorised service dealer.

2.2 Personnel Requirements

The due consideration should be given to following statements while employing the operator.

a) **Trained person** should be instructed by the owner about the tasks assigned to him/her and possible dangers in the case of improper behaviour.
b) **Technical personnel** are persons who on the basis of their professional training given by Greaves, experience and knowledge of the relevant conditions can perform the work assigned to them using the operating and repair instructions and can recognize and avoid possible dangers themselves.
c) Only persons who are expected to perform their tasks reliably are permitted as personnel.
d) Persons whose reaction capability is impaired, for example, through drugs, alcohol or medication are not permitted.
e) When selecting the personnel, the stipulations regarding age, qualification and employment history must be observed scrupulously.

	**WARNING!** Danger of injury for unqualified personnel! Improper handling can result in severe personal injury and/or material damage. Therefore ensure that all jobs concerned with GENSET are carried out by qualified personnel only.

2.3 Appropriate Use

The system is designed and constructed exclusively for the intended purpose described in this manual. Any other use is considered to be improper. Greaves Cotton Ltd. accepts no liability for any danger and damage resulting out of misuse. The risk would be solely borne by the user / owner of the GENSET. The installation must be made so that all applicable safety regulations for the operation of GENSET are complied with. Proper use also means compliance with all the information contained in this operator's manual. Any use beyond the intended use and/or other types of use is considered misuse and can result in dangerous situations.

	**WARNING!** Danger due to misuse! Misuse can result in dangerous situations. Any types of claims for damage arising out of improper use are excluded. Refrain particularly from the following uses of the system: • Operation of the GENSET while it is not in the installed condition. • Operation of the GENSET without sufficient safety devices. • Operation of the GENSET with non-approved fuels.

2.4 Personnel Protective Equipment

Wearing of personnel protective equipment is required when working to minimize the health hazards. Always wear the protective equipment that is necessary for the respective task when working. Follow the instructions on personal protective equipment that is posted in the work area. Also refer the Table A2.1 (a) & (b), which enlists the some of accessories / protective equipment's.

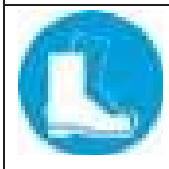
For General Operation / Use	
	**Protective Clothing:** It's a closely stitched apron with low resistance to tearing, narrow sleeves, and n o protruding parts. It mainly provides the protection against being entangled by moving machine parts. Don't wear jewellery item.
	**Safety Boots:** To protect against heavy parts falling down on feet or probability of slipping on slippery ground.

Table A2.1 (a)

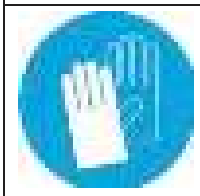
For Special Operation / Use	
	**Ear Defenders:** To protect the against hearing damage / impairment.
	**Hard Hat:** To protect head against parts and materials falling down and flying around.
	**Gloves:** To protect the hand against friction, graze punctures or deep cuts as well as contact with hot surfaces.
	**Safety Goggles:** To protect the eyes against parts flying around or squirts of fluids.

Table A2.1 (b)

2.5 Specific Dangers

The following lists the residual risks that have been determined by the risk assessment team. Notice the safety instructions listed here and the warnings in subsequent chapters of this manual, to reduce the possibility of health hazards and to avoid dangerous situations.

	**Warning! Rotating Parts**: Risk of injury due to rotating parts. Rotating parts can cause severe damage / injury to your body. Therefore: • Do not reach into or work on rotating parts during operation. • Do not open or remove covers / shields during operation. • Pay attention to the run-on time after switching off the GENSET. • Ensure that there are no parts still moving or the GENSET is not running before opening the covers. • Wear close-fitting clothing / apron while operating or servicing.

	**Warning! Substances Harmful to Health:** Danger of poisoning, skin rashes and allergies. Fuels, antifreeze and l ubricants contain substances harmful to health and can result in severe poisoning and skin rashes or allergies. Therefore: • Observe the safety data sheet of the manufacturer of fuels, antifreeze and lubricants. • Avoid spilling fuels and fog formation. • In the case of inhalation, bring affected person into the open air immediately and contact a doctor. • Contact doctor immediately in the case of swallowing but rinse mouth thoroughly with water as first aid treatment. • Avoid direct skin and eye contact. But, in the case of contact with the skin or eyes, rinse immediately with adequate amount of water. Then, contact a doctor to get the medication / advice. • Apply suitable skin protection cream before working on tanks, piping or supply equipment. • Wear protective gloves made of plastic or rubber during the work. • Follow proper disposal of contamination in accordance with environmental regulations. Fuels, antifreeze and lubricants must not get into the sewer system. • Do not eat, drink or smoke when working in the vicinity of GENSET.

	**Warning! Highly Flammable Substances:** Fire hazard due to presence of highly flammable substances. Highly flammable substances include liquids or gases which may catch fire causing serious and even fatal injuries. Therefore: • Do not smoke within the danger zone and the immediate vicinity. Avoid using open flames or ignition sources. • Keep a fire extinguisher ready all the time. • Report suspicious materials, liquids or gases immediately to the person in charge. • Suspend any work activities in case of fire. • Leave the danger zone until the all clear signal is given by authorized means.

	**Warning! Hot Operating Parts:** Risk of burn involved due to hot operating parts. Operating parts can reach high temperatures during operations and can cause burns in case of contacts. Therefore: • Check whether operating parts are hot before handling them. • If necessary let them cool down to ambient temperature.

	**Caution! Hot Surfaces of GENSET Components/Parts:** Contact with hot surfaces can cause burns. Therefore: • Always wear protective clothing and protective gloves for all work in the vicinity of hot parts. • Ensure that all parts have cooled down to the ambient temperature before operating GENSET.

	**Warning! Antifreeze:** Danger of poisoning, skin rashes, and allergies. Antifreeze contains substances harmful to health and can result in severe poisoning and skin rashes or allergies. Therefore: • Observe the safety data sheet of the antifreeze manufacturer. • Wear rubber gloves when handling antifreeze. • Never mix different types of antifreeze. • Contact a doctor immediately in the case of swallowing. Rinse mouth thoroughly with water. • Avoid direct contact of antifreeze with bare skin and eye. • Wear protective gloves made of plastic or rubber during the work. • Collect drained coolant from the engine in a suitable container and dispose of in accordance with the environmental regulations.

	**Warning! Risk of injury due to non-functional safety devices:** Safety is only ensured if the safety devices are intact. Therefore: • Check whether the safety devices are functional and correctly installed before starting work. • Never deactivate safety devices.

2.6 Behaviour in Case of Emergency & Accidents

2.6.1 Preventive Measures

a) Always be prepared with necessary equipment's for facing the unforeseen circumstances like fire hazard and/or accidents.
b) Keep first aid equipment {first aid kit, blankets etc.) and fire extinguishers ready at designated places.
c) Familiarize personnel with accident reporting, first aid and r escue equipment by conducting the drill periodically.
d) Keep access routes clear for rescue vehicles.

2.6.2 Actions in the Case of Accident

a) Operate the EMERGENCY STOP button on the GENSET immediately.
b) Initiate first aid actions.
c) Rescue people from the danger zone.
d) Inform the responsible person at the usage location.
e) Notify the rescue services.
f) Keep access routes clear for rescue vehicles.

2.7 Environmental Protection

	**Caution! Danger to the environment due to mishandling:** Significant environmental damage can occur, particularly for incorrect disposal, if environmentally hazardous operating materials are mishandled. Therefore: • Always follow the recommended instructions. • Take immediate action if environmentally hazardous materials reach the environment. • Inform the responsible local government authorities about the damage caused to the environment in the case of doubt / ambiguity.

The following environmentally hazardous substances are used in GENSET: Lubricant, Coolant, Antifreeze, and Diesel contain toxic substances. They must not reach the environment. The disposal of the same must be performed by a specialist disposal company.

SECTION B

GENSET

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Chapter 1 General Description of GENSET

Your new Greaves Power GENSET is a h igh performance and low maintenance product. It is ruggedly designed so as to minimize breakdowns and interruption in the supply of power to your applications. The GENSET consists of an Engine closely coupled with an Alternator along with a Control Panel, all housed within a Canopy. The Canopy is an acoustic enclosure that attenuates the GENSET sound within ARAI norms.

The engine is Escort Make G1 series, water-cooled, four-stroke, and multi-cylinder incorporated with direct injection compression ignition. In addition to these features, the engine designers have paid special attention to ease of maintenance, ease of assembly and dis-assembly, reliability and standardization.

The alternator is of Crompton Greaves / Stamford make, with state-of-the-art self-excited, self-regulated and brushless design. Automatic Voltage Regulator (AVR) gives excellent voltage regulation along with under speed and over excitation protections.

The Control Panel could be of Deep Sea make, PROCOM make, or DATAKOM make which is fitted with an Electronic Controller for display and protections.

1.1 Name Plate Details

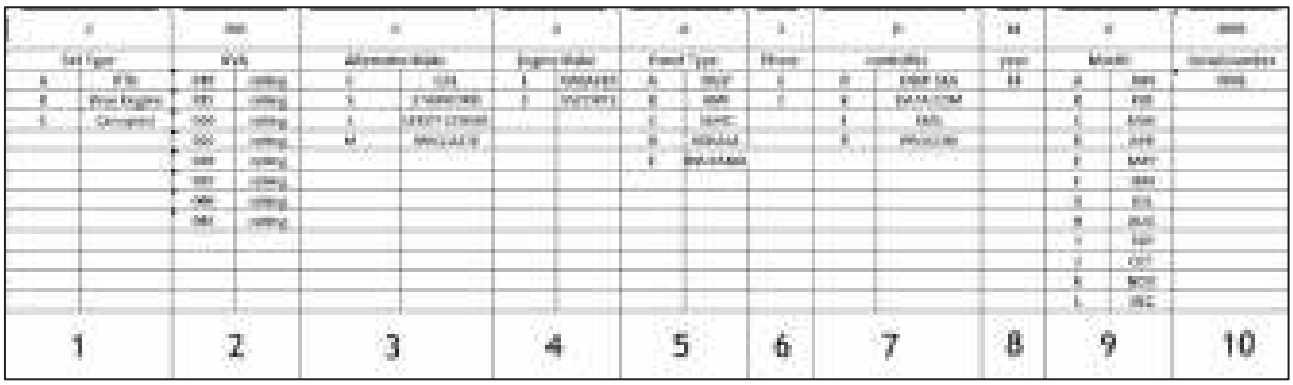

Fig. B1.1 IVR Component Detail

Fig. B1.2 Name Plate Photograph Image

1	**Set Type**	5	**Panel Type**
	A: RTU		A: SRCP
	B: Base Engine		B: AMF
	C: Canopied		C: SUNC
2	**kVA Rating**		D: KERALA
	045: 45 kVA		E: INS Panel
	040: 40 kVA	6	**Phase**
	250: 250 kVA		1: Single Phase
3	**Alternator Make**		3: Three Phase
	C: Crompton Greaves Limited	7	**Controller**
	S: Stamford		D: Deep Sea
	L: LEROY SOMER		K: DATAKOM
	M: MECCALTE		E: EMS
4	**Engine Make**		P: PROCOM
	1: Greaves	8	**Year of Manufacturing**
	2: Escorts		14: 2014
		9	**Month of Manufacturing**
			A: January
			B: February
			C: March
		10	**Serial No.**
			0001

Table B1.1 GENSET Nomenclatures

1.2 GENSET Rating Matrix

No.	GENSET Model	GENSET Rating	Engine Model	GENSET Dim. L × W × H	Open Set Dim.
1	GPWII-10	10 kVA	G15-II	2000 × 950 × 1400	N/A
2	GPWII-15	15 kVA	G15-II	2000 × 950 × 1400	N/A
3	GPWII-20	20 kVA	G20-II	2000 × 950 × 1400	N/A
4	GPWII-25	25 kVA	G30-II	2300 × 1000 × 1370	N/A
5	GPWII-30	30 kVA	G30-II	2300 × 1000 × 1370	N/A
6	GPWII-40	40 kVA	G40-II	Not Available	N/A

Table B1.2 GENSET Rating Matrix

1.3 Brief Description of the GENSET Package

The GENSET package includes an engine, alternator, exhaust system, cooling system and a control system. The GENSET consists of an Engine closely coupled with an Alternator along with a Control Panel, all housed inside a canopy. The engine is ESCORT make G1 Series, water-cooled, four-stroke, multi-cylinder and direct injection compression ignition. In addition to the performance parameters, the engine designers have paid special attention to ease of maintenance, ease of assembly and dis-assembly, reliability and standardization. The alternator is either Crompton Greaves make or Stamford make, with state-of-the-art self-excited, self-regulated and brushless design. The Control Panel is fitted with an Electronic Controller for display and protections.

1.3.1 Engine

The engine incorporated in the GENSET is of proven reliability and specifically designed to operate in conjunction with an alternator. The engine is of heavy-duty, industrial type 4-stroke compression ignition and fitted with all necessary accessories.

1.3.1.1 Engine Governor

The primary function of the governor system is to maintain the engine speed in relation to varied load requirements. The governor senses the engine speed and controls the engine fuel rate in order to maintain practically constant speed. As the alternator load increases, the engine speed tends to reduce. The governor maintains engine speed within limits regardless of the load on the alternator. To maintain this constant speed the governor increases fuel flow to

the engine. This adjusts the horse power to a point sufficient to maintain the engine speed and compensate for the load change. Same principal is applied when the load decreases. As the load is reduced the speed would increase, the governor will then reduce fuel delivery thus decreasing the horse power to maintain the constant speed.

1.3.1.2 Engine Silencer & Exhaust System

The Exhaust Silencer is provided to reduce noise emission from the engine and designed to direct exhaust gases to areas where they will not be objectionable. The silencer is of residential type fitted in the canopy with flange fitting at the outlet to enable discharge of exhaust gases at desired location, through extension piping, as required.

Fig. B1.3 Exhaust Piping Arrangement

1.3.1.3 Engine Cooling System

The engine cooling system is offered through Radiator Cooling system. The details of the same are as mentioned below.

(a) Radiator Cooled

The engine cooling system comprises of a radiator, a high capacity pusher/sucker fan and thermostat. The engine-alternator is close coupled and the assembly is arranged such that the alternator is the first component to come into contact with the cool air as it passes over the GENSET. As the air flow passes over the engine, the fan pushes it through the radiator. This method of cooling allows the alternator fan to pull a portion of the cooling air through the alternator. Both the engine and alternator are therefore kept at their proper operating temperature. Fig. B1.4 below shows the radiator cooling system arrangement. For 10 to 15 kVA GENSET the radiator would be provided by Escort, whereas, from 20 to 30 kVA the radiator would be provided by Greaves Cotton Limited.

Fig. B1.4 Radiator Cooling System

1.3.2 Alternator

The alternator used is of self-excited, self-regulated, brushless design. The alternator is provided with an Automatic Voltage Regulator (AVR) that gives excellent voltage regulation and also protects the alternator from under speed and o ver excitation. On most alternators, current is supplied through twelve leads connections, enabling the operator to reconnect the GENSET to obtain a t hree phase voltages up to 480 V. On reconnection, you can also get a single phase voltages from 120 V to 240 V.

1.3.3 Fuel Tank & Base Frame

The design of the base frame incorporates a removable fuel tank with a c apacity of approximately 8 hours operation. The base frame is manufactured from heavy gauge sheet steel and welded to form a rigid assembly.

1.3.4 Vibration Isolator

The GENSET is fitted with vibration isolators in the form of anti-vibration mountings that are designed to reduce the vibration being transmitted from the rotating mass of the GENSET to the foundation on which the GENSET is mounted. The anti-vibration mountings selected to suit the particular duty and are fitted between with the engine, alternator feet and t he base frame.

1.3.5 Control Panel

The Control Panel is mounted inside the canopy. The canopy is provided with toughened glass cover opening for viewing the controls on the Control Panel. The Control Panel is fitted with an Electronic Controller and suitable switchgear and controls to operate and control the GENSET.

Chapter 2 Installation of G1 Series GENSET

This chapter lays down the procedure of installing your G1 Series GENSET. You are requested to follow these guidelines for safe operations and reliable performance.

2.1 Location

Selecting a location for the GENSET is very important part of installation procedure. Always locate the GENSET in an area that will provide adequate ventilation and physical protection for the unit. For the purpose of simplifying maintenance and inspection requirements it will also be important to place the GENSET in such a position so as to allow easy movement around it without overcrowding. Generally, 1.5 to 2.0 meters space all around the GENSET should be ensured. The location should be clean, dry and have good drainage capabilities. Should the location be outdoors, protect the GENSET with a weatherproof enclosure i.e. Canopy (available as an optional retrofit item).

Another point to keep in mind is the space required to undertake major overhaul or service operations. In some cases doors must be sized to allow for access in and out for the complete GENSET and major accessories. Air inlet and outlet vents can often be made removable to provide an access. For acoustic enclosures ensure that the openings provided for fresh air inlet and outlet are not blocked.

2.2 Foundation

The foundation should be made of cement concrete block. Following are the recommended details of the concrete block:

- If the soil is loose, then soling should be done before making the concrete block.
- The depth of the concrete block should be 600 mm with 100 mm above the floor level.
- The concrete block should be extended by at least one meter on all sides. For GENSET dimensions, refer GENSET Ratings Matrix.
- Surface of concrete block should be in one water level

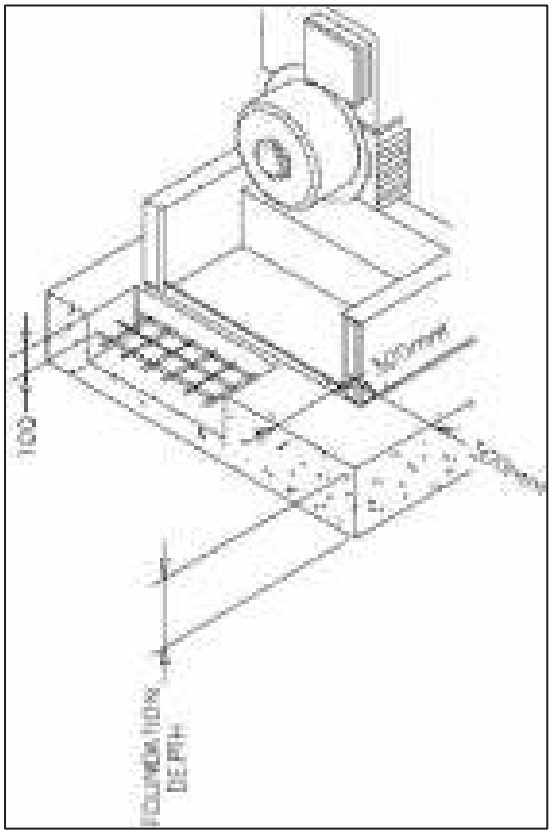

Fig. B2.1 Typical Foundation Detail of GENSET

2.2.1 Isolation

It is advisable that the principal foundation of each GENSET rests on bedrock or solid earth completely independent of other foundations, cement work, walls or operating platforms.

2.2.2 Vibration

The design of the GENSET is such that only minimal vibration is transmitted to the foundation. Anti-vibration mounts are fitted between engine, alternator and base frame or in larger capacity GENSET vibration isolators are mounted below the base frame. If generator rooms are situated on upper floors special attention to vibration isolation is necessary. Often spring type vibration isolators will be needed. It is necessary to ensure that building structures are capable of supporting the GENSET, fuel storage and accessories.

2.2.3 Grounding (Indian Electricity Rules)

Grounding should be done in accordance with applicable National, Local Code or Regulation.

2.2.4 Air Inlet

Engine inlet air must be clean and as cool as possible. These conditions will drastically affect both engine life and performance. Normally the inlet can be taken from the area surrounding the installation site. However, in some cases the condition of the air surrounding the GENSET may permit ducting the air from outside or another room. When it does become necessary to duct air in, the air filter should remain mounted to the engine as opposed to a remote mounting (such as on a roof or in another room). This will eliminate the possibility of dirt leaking through the duct work upstream of the air filter.

2.3 Cooling & Ventilation

It is recommended that the GENSET should be installed in open air. However, if it is installed inside a room, special attention should be paid towards its ventilation. Following figure B2.2 shows the air flow over of the GENSET.

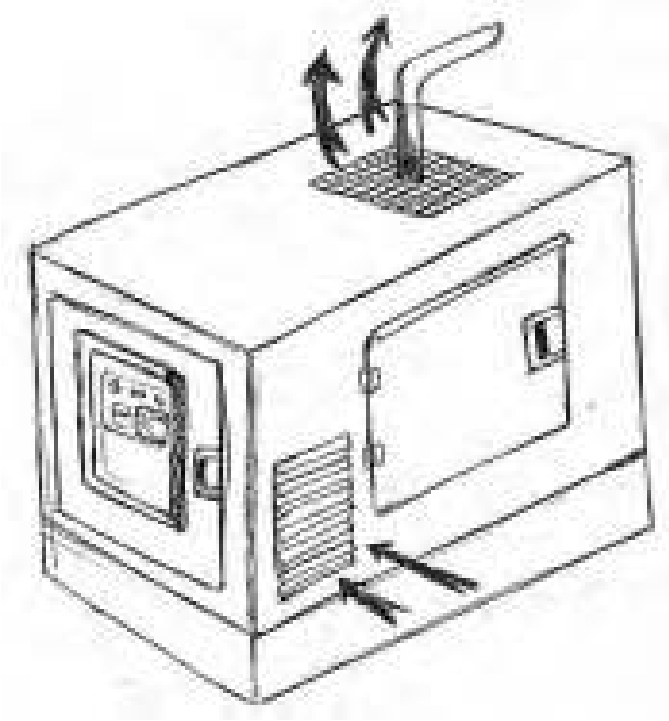

Fig. B2.2 Typical Air Flow over the GENSET

Windows must be provided in line on either side walls one for hot air to go out of the room and the other for letting in the atmospheric air without any restriction between window & canopy. Recommended window size = 1.5 X Frontal area of air passage of the canopy. Fig. B2.3 shows typical exhaust fan arrangement.

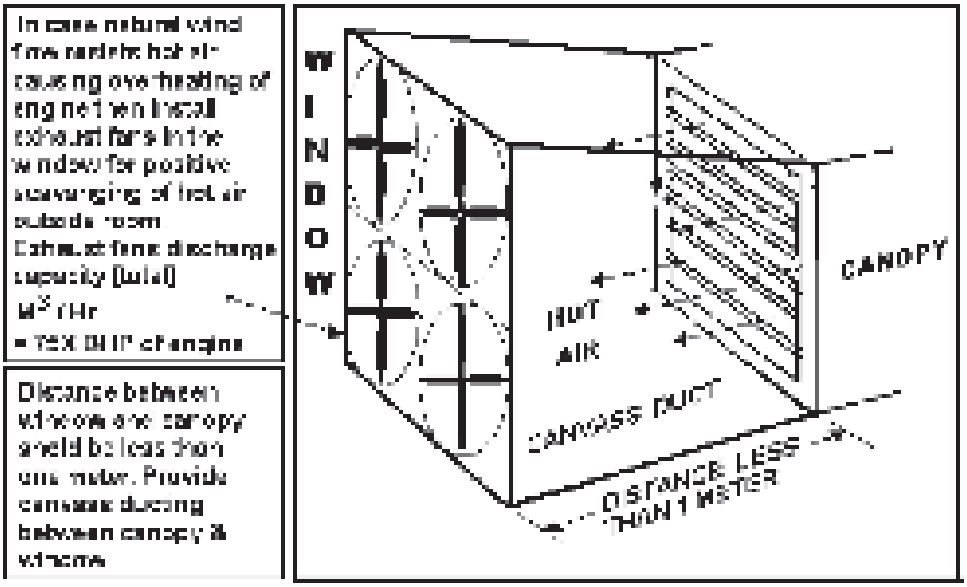

Fig. B2.3 Typical Exhaust Fan Arrangement

2.4 Exhaust Piping Arrangement

The exhaust system is used to direct exhaust gases to non-confined areas and reduce the noise to tolerable levels. When designing a system the main objective is to minimize back pressure. Excessive back pressure in an exhaust system will create horsepower loss and increase the engine operating temperature, and emissions. The installation of exhaust piping is usually required when the GENSET is placed inside a room. This is to direct the exhaust gases out of the room. Thereby, ensure that all the pipes are well supported and that springs or other dampers are used at points of high vibration. Due to the heat radiation of the exhaust pipes, it is recommended that all the pipes be located at least 250 mm from any combustible material. Wrapping the exhaust pipes with high temperature insulator or installing fitted insulated sections will aid in preventing excessive heat radiation within the room. Following are the recommendations for exhaust piping installation:

i. Piping should have minimum bends and the bends should be smooth.
ii. Silencer and exhaust piping should be insulated by asbestos rope to reduce radiated heat.
iii. Inner diameter of the exhaust pipe should be the same as that of engine exhaust outlet for the first 5 meters length of pipe with one smooth bend. Smooth bend means bend which has radius equal to 2.5 times diameter of the pipe.
iv. When length of pipe is more, calculate the exhaust pipe ID by following method.
    a. Before actually doing installation of exhaust piping, decide how it should be routed and number of bends required?

b. Always use smooth bends and keep number of bends to minimum.
c. Below table shows equivalent length of pipe for each type of bend. For example, one sharp bend gives a back pressure equal to back pressure caused by 10 meter straight pipe.
d. After noting number of bends and t ype of bends involved calculate total equivalent length. As the equivalent length increases, increase Inner Diameter of exhaust pipe as mentioned below:

For first 5 Meters	Keep same diameter available on engine exhaust outlet [Nominal size]
From 5 to 15 meters	Increase Inner Diameter by 20%. [ID. (minimum) = 1.2 X Nominal size]
From 15 to 25 meters	Increase Inner Diameter by 40% [ID. (minimum) = 1.4 X Nominal size]

Table B2.1

	**CAUTION!** Total exhaust system assessment should be done by competent personnel. If planned exhaust piping length is crossing 50 meters, then we recommend the use of soot arrestor blower.

Sr No	Type of bend	Equivalent length
1	Sharp bend	10 Meters
2	Smooth bend	1 Meter
3	Semi smooth bend	5 Meters
4	Semi smooth fabricated bend	4 Meters
5	Straight pipe	Actual length

Fig. B2.4

2.4.1 Location of Silencer

Always install the silencer near the engine, recommended within the first 5 meters, inside or outside the canopy. By doing so, you will be able to minimize the noise in the exhaust piping.

2.4.2 Support to Exhaust Piping

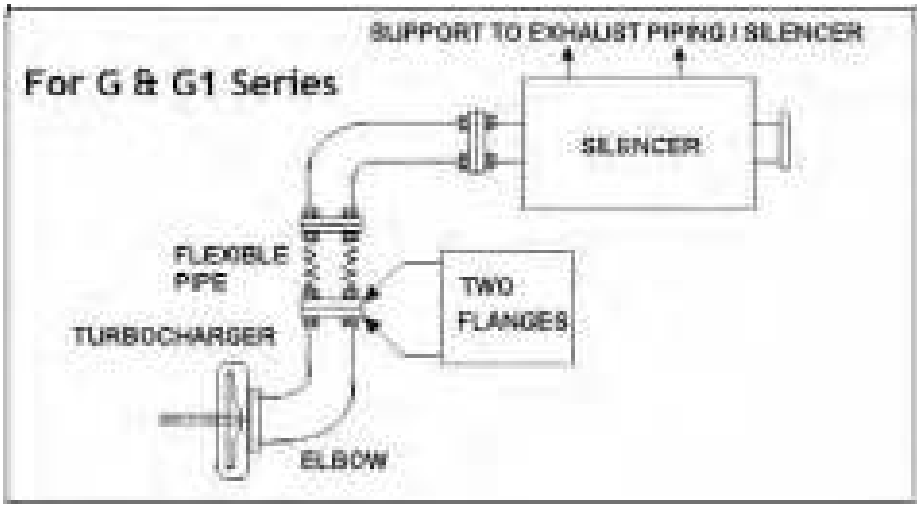

Fig. B2.5

As shown in the above figure B2.5, put bolts in the holes of two flanges above, with gasket in between. Engage two threads of nuts, but do not tighten them. See that alignment of piping is proper. Give support to exhaust piping / silencer such that there is about 5 mm gap between the two flanges. Tighten the nuts. Flexible pipe will get elongated and make a perfect joint. This ensures that the load of exhaust piping does not come on the turbocharger.

2.4.3 Protection of Tail End of Exhaust Pipe

When tail end is horizontal, a 45° downward cut should be given at the end of the pipe. When the tail end is vertical, a rain cap should be provided. Coarse wire mesh at the end of the pipe should be provided otherwise birds can build nest. Refer Fig. B2.6

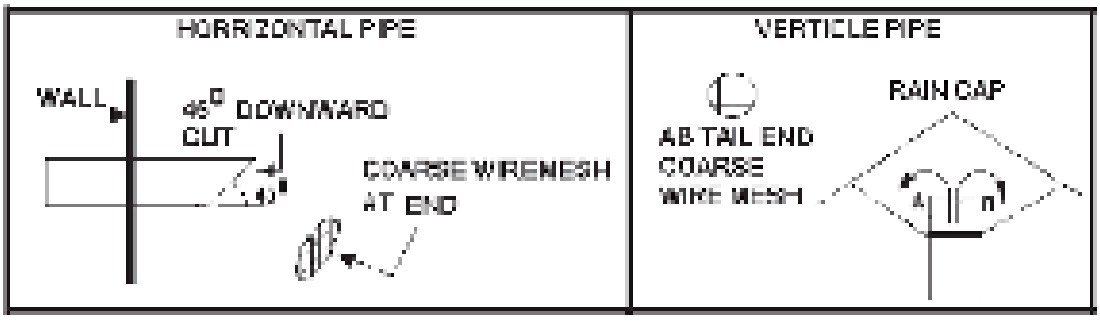

Fig. B2.6

2.4.4 Flexible Connections

The exhaust piping should be connected via a flexible joint located on the engine exhaust outlet. This connection serves the following three purposes.

i. It relieves some of the weight of the exhaust piping from the engine.
ii. It isolates the exhaust system from vibration.
iii. It allows for some movement of either the GENSET or exhaust system components.

Long piping runs should be divided into sections separated by additional flexible connections. This will also compensate for the expansion and contraction of the piping itself due to temperature change. Any insulation material used for a flexible connection should allow for the expansion and c ontraction of the connections, due to temperature changes. Generating sets with acoustic enclosure are provided with exhaust outlets having connecting flanges. Exhaust gases from the outlet can be routed away to desired location. For up to 3 meter distance exhaust pipe size same as provided on the outlet can be used. For longer lengths total exhaust system assessment should be done by competent personnel. In no case, exhaust back pressure should exceed 50 mm of Hg, when measured at exhaust manifold of engine, at rated load.

2.5 Fuel System

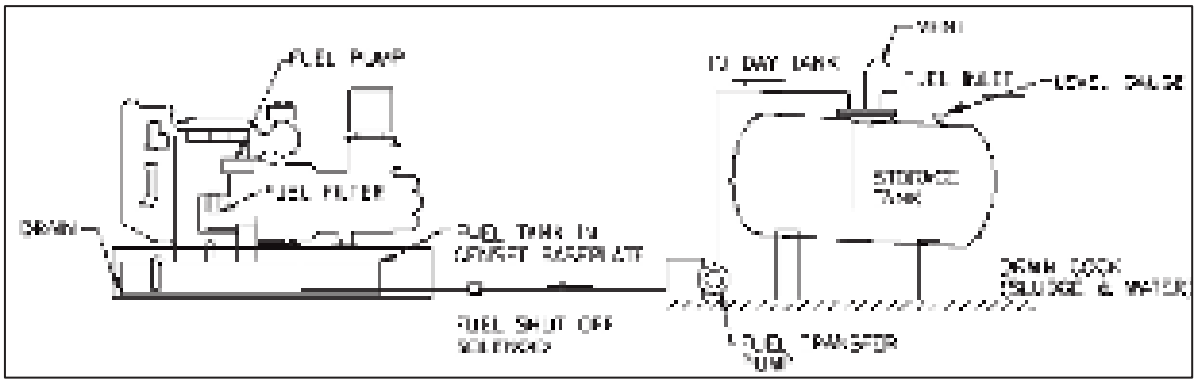

Fig. B2.6 Typical Fuel Installation

The fuel system must be capable of delivering to the engine a clean and continuous supply of fuel. When designing a fuel system, always incorporate the requirements of Local, State, or National Codes, which may pertain to either the fuel system or the electrical apparatus utilized by the system.

2.5.1 Diesel Fuel Bulk Storage

Bulk fuel storage is the most preferable method of providing fuel supply. This method allows bulk fuel purchases which will minimize dirt and contamination possibilities, especially when the fuel is seldom used. The bulk storage tank may be located either above or below the ground. A vent must be installed on the main tank to relieve the air pressure created by filling the tank as well as preventing a vacuum within tank as fuel is consumed. The tank bottom should be rounded and placed on a 2 degree tilt to assure a concentrated settling of both water and sediments. At the low point of the tank a drain valve should be installed to remove water that may accumulate due to condensation. Underground tanks must be pumped periodically to remove this water. This is best done by placing a tube through the filter pipe to the low end of the tank. For these reasons it is imperative that the tank be placed in or on stable ground to assure that eventual settling does not change the location of the low point of the tank. Burying the tank below the frost line will help in avoiding seasonal settling. Another consideration to be made when locating the main tank is the height difference between it and the auxiliary tank (day tank). The maximum vertical lift capability of a standard electric motor driven fuel transfer pump is 5m. Do not place either tank at a level that would exceed the pump lift capabilities. Also keep in mind the possibilities of pressure drop created by excessive horizontal distances and pipe work bends.

The fuel delivery line carrying fuel to the engine and the fuel return line for carrying excessive fuel back to the tank should be no smaller than the fitting sizes on the engine. For longer runs or extremely low ambient temperatures increase the size of these lines to ensure adequate flow. The fuel lines can be made of any fuel compatible material such as steel pipe or fuel line tube that will tolerate ambient conditions. Overflow piping should be of the same material and one size larger. The fuel return line should enter the tank at the top and contain no shut-off valve. This line should be designed with a minimum amount of bends or dips to prevent an air lock in the system. The fuel delivery line should pick up the fuel from the point no lower than 20mm from the bottom of the tank. If at all possible locate this line at the end of the tank opposite to that of the return line and at the high end of the tank. Flexible fuel lines should be used at a point between the tank and engine (preferably adjacent to the GENSET) to avoid the potential damage that could be created by vibration.

2.5.2 Day Tanks

Auxiliary tanks or day tanks as they are commonly referred to are recommended. Refer figure B2.6 for typical fuel tank installation. All standard GENSETS with acoustic enclosure are provided with tank fitted in the base frame. This day tank will produce a ready fuel supply.

2.5.2 Filter & Traps

Clean fuel will aid in attaining maximum engine life and dependability. Primary filters are recommended for use between the engine filters and the transfer pump. Water and sediment traps should also be included upstream of the transfer pump. However, on border line pump installations do not increase fuel line restrictions to a point exceeding the capabilities of the pump.

2.6 Fire Precautions

When performing a GENSET installation the following points should be noted:

i. The room should be designed so that there is an easy escape route for operating personnel in the event of fire within the room.
ii. A recommended type of fire extinguisher or fire extinguishing system should be provided.
iii. Gravity operated fire valves operated by fusible links, mounted above the engine, can be installed in the fuel lines.
iv. The room should be kept clean and free from accumulated rubbish things which can be a fire hazard.

2.7 Starter Batteries

Resistance in the starting circuit has a significant effect on the starting ability of the engine. Therefore, the batteries should be located as close as possible to the GENSET (batteries should be accessible for servicing). Maintenance procedures should be carried out rigorously since the batteries have to be in perfect condition to start the diesel engine.

	**Warning!** Batteries emit highly inflammable gases. Do not smoke or create sparks or naked flames adjacent to batteries.

2.8 Electrical Connections

Only fully qualified and experienced electrical technicians should be allowed to carry out electrical installation work. The electrical connection to the GENSET should be made with flexible cable to prevent the transmission of vibration and possible damage to the alternator or circuit breaker terminals. If it is not convenient to use flexible cable throughout then a link box can be installed close to the set with a flexible connection between it and the set.

The cable may be laid in a duct or on cable tray. When bending cable, reference must be made to the recommended minimum bending radius. No rigid connection should be made between the set and the cable support system, e.g. cable tray. When single core cables are used the gland plates must be of non-ferrous material, e.g. aluminium, brass or a non-metallic material such as Teflon. The cable must be suitable for the voltage being used and adequately sized to carry the rated current with allowances made for ambient temperature, method of installation, proximity of other cables, etc. All electrical work should be carried out in accordance with any applicable National, Local Standards, Codes or Regulations. 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 auto transfer switch, or if the machine is to be paralleled.

2.8.1 Protection

The cables connecting the GENSET with the distribution system should be protected by means of a circuit breaker, fuses or other means to disconnect the GENSET in case of overload or short circuit.

2.8.2 Loading

When planning your distribution system it is important to ensure that, a balanced load is presented to your GENSET. If loading on one phase is excessive in comparison to the other two phases it will cause overheating in the alternator windings, imbalance in the phase to phase voltage output and possible damage to sensitive 3 phase equipment connected to the system. Ensure that no phase current exceeds that of the current rating of the GENSET. It may be necessary to reorganize the electrical distribution system if a GENSET is to be connected to an existing installation.

2.8.2.1 Linear Loads

Linear Loads can be identified from the following characteristics:

i. Load impedance is always constant regardless of the applied voltage.

ii. The load current increases proportionately as the voltage increases and decreases as the voltage decreases.

Examples of linear loads are motor, incandescent lighting and heating loads.

2.8.3 Power Factor

The power factor (COSΦ) of the connected load should be determined. Power factor below 0.8 will overload the generator. The GENSET will provide its kilowatt rating and will operate satisfactorily from 0.8 to unity power factor. Particular attention must be given to installation with automatic or manual power factor correction equipment to ensure that a leading power factor is not present under any conditions. This will lead to voltage instability on the generator output and may result in damaging over voltages.

2.8.4 Grounding Requirements

Regulations vary and advice should be sought from the local power supply body. The factory connects the frame of the alternator to the frame of the GENSET therefore the complete mass of the GENSET is at the same potential. The connection if required of the generator winding star point / neutral to earth is the responsibility of the installation technicians.

	**Warning! Never attempt to work on live wiring.** Always stop the GENSET and open the circuit breaker on the load cables before working on the alternator or its connectors.

2.8.5 Start-up

Before attempting to start the GENSET refer Topic 2.4 of this Section.

2.9 Noise Control

Your GENSET can be supplied with accessories and components to reduce noise emissions. Typically available noise controllers are residential and super critical silencers, acoustic louvers and splitter vents, fan silencers and acoustically treated enclosures. The requirements for each site vary enormously and for any critical installation we recommend you consult your dealer at an early stage. The information needed to select acoustic equipment is:

i. The model and capacity of the GENSET
ii. The location and overall site plan
iii. The designed noise level at a fixed distance, normally 1m or 7m
iv. Environmental conditions, ambient temperature, etc.

Noise emissions from diesel GENSET (without acoustic treatment) are at sound pressure levels of between 100 dB (A) and 110 dB (A) at 1m. Greaves GENSET with acoustic enclosures have a typical noise pressure level of 75 dB (A) or less (average) at a distance of 1 meter from the enclosure. Intermediate levels of treatment will prove more economic and are often satisfactory depending only on the nature and type of installation. Hospital Care Areas will require more attention than the normal commercial / industrial installation.

Chapter 3 Maintenance

3.1 General

The periodical maintenance is the key to long GENSET life. Below is a schedule that should keep your GENSET in top running condition. Also included in this schedule are routine maintenance operations required for the engine and alternator (see Engine Maintenance and Alternator Maintenance Sections).

It is good practice to have all of the maintenance and service operations performed by trained personnel familiar with the GENSET maintenance. This, along with a good service records system, should aid in developing an efficient maintenance program. The service records of each GENSET should include information such as complete nameplate data with model and serial numbers, all drawing and wiring diagrams, spare parts stock lists, as well as a service schedule and a copy of this manual. These records will allow quick reference and may help to diagnose a problem in the future.

3.1.1 Daily Maintenance or At Each Start-up

Standby applications may lengthen these requirements to weekly.

i. Make a visual check of the entire GENSET. Watch for signs of potential leaks from the engine fuel system, cooling system or lubrication seals.
ii. Check the alternator for obstructions in the cooling air ventilation screens.
iii. Check the alternator and control box for heavy accumulation of dust and di rt. Clean any heavy accumulations as e lectrical hazards or cooling problems could arise.
iv. Check the air filter. Clean or replace the same if necessary.
v. Check the fuel level.
vi. Check the engine coolant level.
vii. Be sure that the radiator air flow is not obstructed.
viii. Check the condition of the fan and alternator belts and their tension.
ix. Check all the hose connections and hose conditions.
x. Check the engine oil level.
xi. Check the battery terminals for corrosion.
xii. Check the battery electrolyte level and fill it with distilled water if necessary.

xiii. Refer to the engine maintenance section for specific engine maintenance requirements.
xiv. Start the GENSET after all the checks have been made.
xv. Drain condensate traps in the exhaust system, if so equipped, and check for exhaust leaks.
xvi. Check for any abnormal noise or vibration.
xvii. Check for fluid leakage or high temperature.
xviii. Dispose of any unnecessary items in the vicinity of the GENSET that may inhibit operation or represent cause of potential injury.
xix. Check the control panel for indications of abnormal operation.

3.1.2 Maintenance Every 6 Months or 500 Hrs. of Operation

Apart from repeating the daily requirements, do the following.

i. Check all safety devices by electrically simulating a fault to ensure that all systems will function properly in the event of a fault.
ii. Check all rubber components, such as hoses, AVM's for wear, cracks and replace them if necessary.
iii. Clean all battery cap vents.
iv. Start the GENSET and observe the instrument panel to ensure that all the gauges and meters are operating properly.
v. Tighten all exhaust connections.
vi. Tighten all electrical connections.
vii. Refer to the engine maintenance section, for further details.

3.2 Alternator Unit Cleaning

The alternator unit should be cleaned inside-out on a regular basis. The frequency of such cleanings depends on the environmental conditions of the operating site. The following procedure should be applied when cleaning is necessary:-

Disconnect all power. Wipe dust, oil, water or any other liquids from the external surfaces of the alternator unit. All of these materials can work their way into the windings and may cause overheating or insulation breakdown. Remove these same materials from the ventilation screens around the circumferences of the unit.

Do not permit such material to accumulate on these screens as this will obstruct air flow. Such debris is best removed with a vacuum cleaner as a vacuum cleaner will not redeposit these materials on other parts of the equipment. DO NOT USE COMPRESSED AIR, STEAM OR HIGH PRESSURE WATER CLEANER. A vacuum cleaner should also be used to clean the windings of the alternator unit. This will remove dust from the coils that cannot be reached with a wiping cloth.

3.3 Radiator Maintenance

The radiator supplied with your generator set is designed and constructed to give many years of trouble free operation in industrial environments. There are, however, several points of maintenance that will ensure trouble free operation.

3.3.1 General Operating Notes

Corrosion in the radiator can be a prime cause of failure. This is stimulated by air in the water. Always ensure pipe connections are free of leaks and bleed air from top of the radiator regularly to keep the 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. Whenever possible, radiators should be filled with distilled or naturally soft water, and 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 been cooled down. Do not work on the radiator or remove any guarding while the fan is in motion.

3.3.2 Cleaning

The external and internal cleaning techniques are as mentioned below.

3.3.2.1 External Cleaning of Radiator

In dusty or dirty conditions the radiator fins can get 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 stream jet. More difficult deposits may need a detergent with a low pressure hot water hose. Stubborn deposits, which cannot be removed by the above methods, may require removal of the radiator and immersion in a heated alkali degreasing solution for about 20 minutes and then washing off with a hot water hose.

3.3.2.2 Internal Cleaning of Radiator (By Expert Personnel)

If, due to leaky joints for instance, or 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 call GREAVES authorised service dealer. The procedure for the same is as follows:

i. Drain the water system and disconnect and bank off the pipe connections to the engine.
ii. Prepare a 4% solution of inhibited acid solvent and fresh water. Add the acid to the water, never vice versa.
iii. Allow several minutes for mixing, then heat the solution to 49°C (120°F) maximum.
iv. Run the solution slowly into the radiator via the filler cap or a branch in the manifold.
v. Foaminess will occur; when it ceases, fill the radiator completely with the heated solvent.
vi. Allow to stand for several minutes; then drain the solvent back into the original container through the bottom manifold or drain plug.
vii. Examine the interior of the headers. If scale remains, repeat the process outlined above with the solvent strength increased to 8%.
viii. After descaling the acid solution has to be neutralized as follows:-
    a. 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 litres water (1 lb. soda to 4 gallons water). Fill the radiator with this solution, and then drain it back into the container.
    b. 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.
    c. 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.
    d. Prior to re-commissioning, the coolant must be dosed with any necessary corrosion inhibitors and/or the correct proportion of antifreeze.

SECTION C

DIESEL ENGINE

SECTION C – DIESEL ENGINE			
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Chapter 1 General

1.1 Safety

Safety of your personnel, property and e quipment should be the first priority during installation, operation, maintenance of your engine and equipment. The engine can cause harm in the following ways against which your personnel have to guard. Refer Table C1.1 for more details.

Sl. No.	Hazard	Example
1	Rotating Parts	Flywheel, Pulleys, Radiator Fan
2	High Temperature	Exhaust related Parts, Exhaust Gases, Water, Oil
3	Hot or Hazardous Sprays	Fuel, Lube Oil, Water, Exhaust Leaks or Hose/Pipe Bursts
4	Electrical Shocks/Sparks	Alternators, Starters, Control Panels, Battery Wirings
5	Loose Objects	Loose parts flying out (likelihood after maintenance)
6	Poison	Additives, diesel, lube oil, exhaust gases can cause damage if consumed or inhaled

Table C1.1

i. Never get near the engine while it is running wearing loose items like tie, long chains, scarf, long loose clothes, tags with mobile phones etc.
ii. Display safety instruction clearly in the operating area.
iii. Make the operating persons aware of the safety related issues.
iv. Provide necessary safety equipment to the operating persons.
v. Follow all applicable safety related regulations and laws.

1.2 Operation Guidelines

i. It is assumed that the reader and the user of these operating instruction is familiar with the basic mode of operation of four stroke combustion engine and is able to follow technical issues reasonably well. The text has been kept therefore as short as possible for clarity and is backed by photographs and sketches.
ii. Read the instructions carefully before installation of the engine or equipment.
iii. In case of any doubt or difficulty, seek help from authorized Greaves service dealers.
iv. Your engine needs clean air, clean fuel, clean lube oil and clean coolant.

v. Giving attention to these factors improves the life of your equipment, reduces the running costs, and also increases the mean time between failures.

1.3 Maintenance Guidelines

i. Please read the maintenance instructions. Seek services of authorized Greaves service dealers if needed.
ii. Follow maintenance schedules.
iii. Plan your maintenance.
iv. Always use genuine spare parts, listed lube oil, listed additives and unadulterated fuel from reputed agency.
v. Always use correct tools.
vi. Always carry out maintenance in a clean area.
vii. Follow good engineering practices during maintenance.

Chapter 2 Escort Engine

2.1 Engine Picture

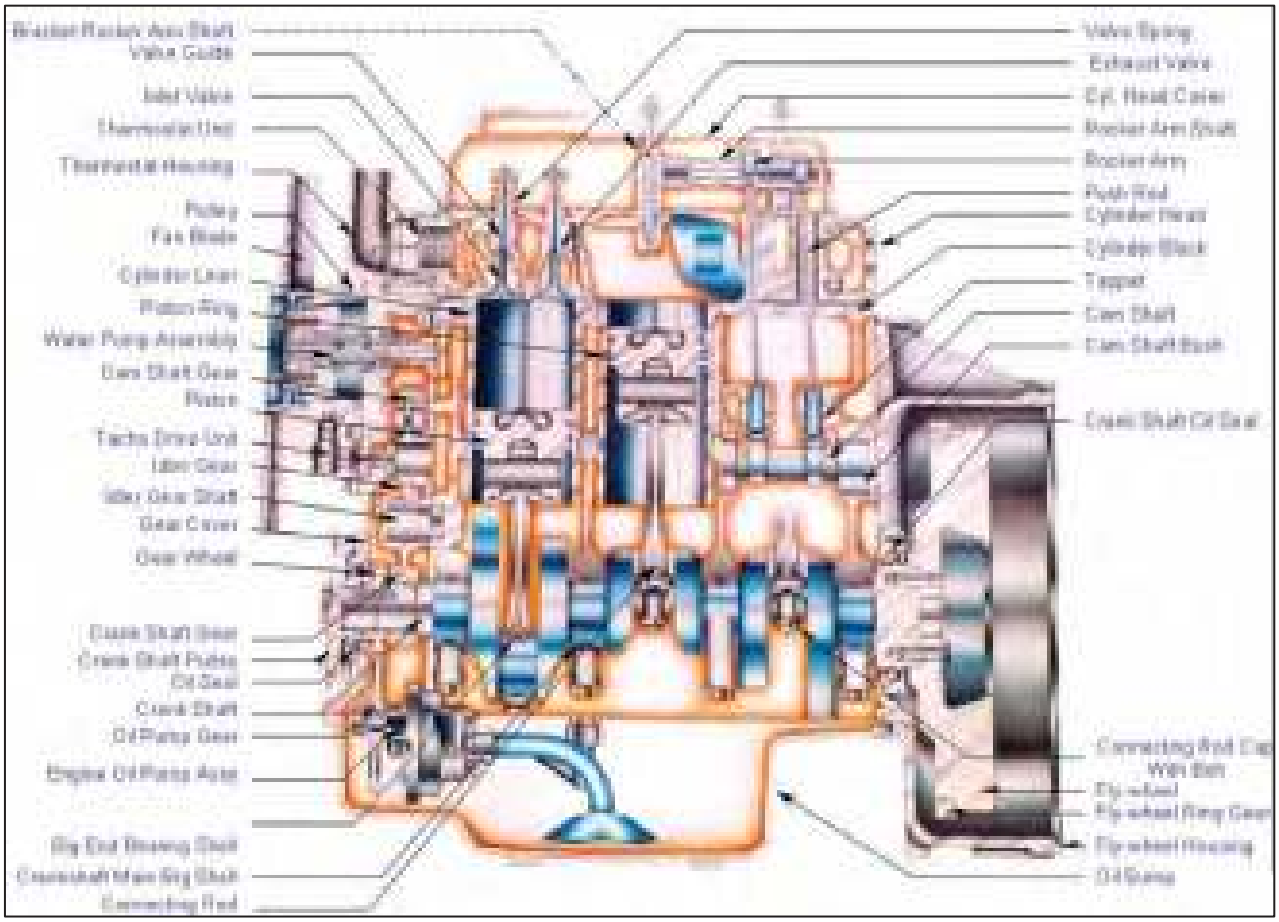


Fig. C2.1 Escort Engine Picture in Full Cross Section

2.2 Specification of GENSET Engine [of Escort Make] as per CPCB-II

Sl. No.	Description / Parameter	Unit	G12-II	G15-II	G20-II	G25-II	G30-II	G40-II
1	**Power**							
1.1	Gross Engine Power Output - BHP	HP	18	23	27.6	37	46	58
1.2	Type / Class of Governing		Mech/A1					
1.3	Fan - BHP	HP	0.75	0.75	0.75	2	2	2
1.4	Battery Charging Alternator – BHP	HP	0.1	0.1	0.1	0.1	0.1	0.1
1.5	Total Auxiliary Horse Power Consumed	HP	0.85	0.85	0.85	2.1	2.1	2.1
1.6	Nominal / Typical Electrical Output	kW	9.6	12	14.4	20	24	32
1.7	Nominal / Typical Electrical Output (Declared)	kVA	12	15	18	25	30	40
1.8	Nominal Alternator Efficiency @ Rated Output (min)	%	80	80	80	80	80	80
2	**General Engine Data** **(Note: * NA = Naturally Aspirated; T = Turbocharged; TA = Turbocharged & After cooled; TCI = Turbocharged & Intercooled)**							
2.1	No. of Strokes		4					
2.2	No. of Cylinders		2	2	3	3	3	4
2.3	Configuration		Inline					
2.4	Aspiration Type*		NA	NA	NA	TCI	TCI	TCI
2.5	Engine Firing Order (as viewed from engine front)		1-2	1-2	1-3-2	1-3-2	1-3-2	1-3-4-2
2.6	Bore	mm.	91	95	91	91	91	91

Sl. No.	Description / Parameter	Unit	G12-II	G15-II	G20-II	G25-II	G30-II	G40-II
2	**General Engine Data (continued)**							
2.7	Stroke	mm.	110	110	110	110	110	110
2.8	Displacement	cc.	1430	1560	2145	2145	2145	2860
2.9	Compression Ration		17.5:1					
2.10	Dry Weight with Standard Accessories	kg	248	248	320	350	350	450
2.11	Wet Weight with Standard Accessories	kg	260	260	340	370	370	470
3	**Engine Dimensions with Standard Accessories (Approximate)**							
3.1	Length	mm.	840	840	865	976	976	1097
3.2	Width	mm.	700	700	680	964	964	964
3.3	Height	mm.	980	980	1080	1180	1180	1180
4	**Air Intake System**							
4.1	Air Cleaner Model		Dry Type					
4.2	Air Cleaner Duty Type		Light Duty					
4.3	Number of Air Cleaners per Engine		1					
4.4	Number of Elements per Air Cleaner		2					
4.5	Maximum Allowable Intake Air Restriction	mbar	25 (with Clean Element)					
4.6	Maximum Allowable Intake Air Restriction	mbar	30 (with Dirty Element)					
4.7	Typical Element Cleaning (normal operating condition)	Hrs.	250					

Sl. No.	Description / Parameter	Unit	G12-II	G15-II	G20-II	G25-II	G30-II	G40-II
5	**Exhaust System**							
5.1	Recommended Exhaust Back Pressure (Max.)	mbar	50	50	60	60	60	60
5.2	Minimum Exhaust Pipe Size	mm.	40	40	40	40	40	40
6	**Coolant System**							
6.1	Coolant Capacity (Engine Only)	Litres	2.8	2.8	4.5	4.5	4.5	6.0
6.2	Coolant Capacity with Radiator	Litres	7.1	7.1	10.9	14.5	14.5	16.0
6.3	Start of Opening Temperature of Thermostat Range	Deg. C	$80^{+4/-2}$					
6.4	Full Opening Temperature of Thermostat Range	Deg. C	90±3					
6.5	Cooling System Pressure Cap	kg/cm^2 (kPa)	0.9 (88.26)					
6.6	Maximum Allowable Top Tank Temperature	Deg. C	103					
6.7	Radiator Core Area (H × W)	(mm. × mm.)	406 × 441	406 × 441	545 × 548	645 × 548		
6.7.1	Fan Diameter	mm.	406.5	406.5	406.5	480.6	480.6	480.0
6.7.2	Fan Type		Pusher – Sheet Metal					
6.7.3	No. of Fan Blades		6					
6.8	High Water Temperature Safety Limits (Trip)	Deg. C	100-103					
6.9	Recommended Water		Clean tap water/Distilled/Deionised					
6.10	Coolant		Greaves Premix Cool					

Sl. No.	Description / Parameter	Unit	G12-II	G15-II	G20-II	G25-II	G30-II	G40-II
7	**Lube Oil System**							
7.1	Min. Lube Oil Pressure @ Idle Speed	Bar	1.0	1.0	1.0	1.0	1.0	1.0
7.2	Lube Oil Pressure @ Rated Speed	Bar	2.0-6.0	2.0-6.0	2.0-6.0	2.0-6.0	2.0-6.0	2.0-5.0
7.3	Lube Oil Temperature Operating Range	Deg. C	85-120	85-120	85-120	85-120	85-120	85-120
7.4	Lube Oil Sump Capacity (high – low)	Litres	5	5	6	6	6	8
7.5	Lube Oil System Capacity inclusive of Bypass Filter	Litres	5.5	5.5	6.5	6.5	6.5	8.5
7.6	Lube Oil Filter Type		Full flow, spin on, Throw away, Paper element/Replaceable					
7.7	Lube Oil Filter Quantity per Engine		1					
7.8	Lube Oil Consumption @ Rated Speed Max.	% of Fuel	0.1					0.15
7.9	Low Lube Oil Pressure Safety Limits (Trip)	Bar	$1.2^{+0.3}$					
7.10	Lube Oil Recommended		Greaves Maxtherm					
7.11	Lube Oil Change Interval	Hrs.	First change at 100 Hrs., thereafter every 300 Hrs. of operation					
7.12	Full Flow Lube Oil Filter Element Change Period	Hrs.	Along with Oil Change					

Sl. No.	Description / Parameter	Unit	G12-II	G15-II	G20-II	G25-II	G30-II	G40-II
8	**Fuel System**							
8.1	Make / Type of Injection System		MICO/BOSCH, Inline					
8.2	Fuel Filter Type		Primary-Cloth, Secondary - Paper					
8.3	Fuel Filters Quantity per Engine		1,Dual Element					
8.4	Fuel Filter Change Period	Hrs.	Primary @ every 600, Secondary @ every 900					
8.5	Recommended Fuel		High Speed Diesel					
9	**Electrical Starting System**							
9.1	System Voltage & Type		12 V, Electrical					
9.2	Battery Charging Alternator							
9.2.1	Make		LUCAS (TV)/PNPS					
9.2.2	Current @ Rated Speed	Ampere	35 Amps/23Amp					
9.3	Electrical Starter							
9.3.1	Make		LUCAS – TVS/AUTO LEK					
9.3.2	Quantity per Engine		1					
9.3.3	Voltage (DC)	Volts	12					
9.3.4	kW Rating	kW	2.2					
9.4	No. of Teeth on Flywheel Ring Gear		128					
9.5	No. of Teeth on Starter Motor		11					

Note: Lube Oil Consumption based on recommended oils with specific gravity of 0.89

Sl. No.	Description / Parameter	Unit	G12-II	G15-II	G20-II	G25-II	G30-II	G40-II
9.6	Battery Capacity	Ampere-Hrs.	100					
9.7	Recommended Batteries Quantity per Engine		1					
10	**Performance Data**							
10.1	Governed Engine Speed	RPM	1490-1500					
10.2	Engine Idle Speed	RPM	650-700					
11	**Performance Data for Prime Rating**							
11.1	Gr. Engine Power Output – 10% Overloading	BHP	18	23	29.6	37	45.8	58
11.2	Exhaust Gas Temperature @ 100% Load	Deg. C	550	550	550	550	550	550
12	**SFC (+ 5% Tolerance)**							
12.1	@ 100% Rated Output	gms/bhp-hr.	170±5	170±5	170±5	165+5	165+5	160+5
13	**Fuel Consumption for Nominal kVA with Radiator**							
	@ 100% Rated Output	Litre/Hour	3.4	3.7	5.3	6.8	7.8	10.9
14	**Gaseous Emissions as per ISO8178-5 Mode Cycle**		Meets New CPCB-II Norms					

Sl. No.	Description / Parameter	Unit	G12-II	G15-II	G20-II	G25-II	G30-II	G40-II
15	Deration due to Altitude, Temp., and Humidity		As per ISO 3046 / BS 5514					
16	Inlet Tappet Clearance (cold condition)	mm.	0.3	0.3	0.3	0.3	0.3	0.3
17	Exhaust Tappet Clearance (cold condition)	mm.	0.4	0.4	0.4	0.4	0.4	0.4

Note:

i. **All data is based on engine operating with fuel system, water pump, lubricating oil pump, air cleaner, and exhaust silencer. Not included are optional driven equipment's.**

ii. **Data specified represent gross engine performance capabilities and corrected in accordance with ISO 3046 conditions of 100 kPa (29.53 inch Hg) barometric pressure and 27 Deg. Celsius air intake temp.**

iii. **Data with recommended diesel fuel of 0.825 Sp. Gravity and 4200 kJ/kg of lower calorific value.**

iv. **Fuel consumption values are within 0 to 5% tolerance. (Refer ISO3046 for detail rating guidelines)**

v. **Prime power is applicable for supplying electrical power in lieu of commercially purchased power.**

Sl. No.	Torque	Unit	G12-II	G15-II	G20-II	G25-II	G30-II	G40-II
18.1	Main Bearing Bolts	kg-m	24-26	24-26	24-26	24-26	24-26	24-26
18.2	Big-end Bearing Bolts	kg-m	6.5-7.5	6.5-7.5	6.5-7.5	6.5-7.5	6.5-7.5	6.5-7.5
18.3	Cam Shaft & Cam Shaft Gear Assembly	kg-m	8-10	8-10	8-10	8-10	8-10	8-10
18.4	Cam Shaft, Flange, & Block Assembly	kg-m	2	2	2	2	2	2
18.5	Idler Gear and Shaft Assembly	kg-m	3	3	3	3	3	3
18.6	Hub & FIP Assembly	kg-m	8.5±0.5	8.5±0.5	8.5±0.5	8.5±0.5	8.5±0.5	8.5±0.5
18.7	Hub & FIP Gear Assembly	kg-m	2	2	2	2	2	2
18.8	TG Housing, TG Cover & Cylinder Block Assembly	kg-m	2.5	2.5	2.5	2.5	2.5	2.5
18.9	Crank Pulley & Crank Shaft Assembly	kg-m	4-4.5	4-4.5	6.5	6.5	6.5	6.5
18.10	Pipe Lube Oil Section & Lube Oil Sump Assembly	kg-m	2	2	4-4.5	4-4.5	4-4.5	4-4.5
18.11	Lube Oil Sump & Cylinder Block Assembly	kg-m	6.5	6.5	2	2	2	2
18.12	Rocker Arm & Rocker Shaft Assembly	kg-m	6.5	6.5	6.5	6.5	6.5	6.5
18.13	Cylinder Head Bolts & Cylinder Block Assembly	kg-m	13-14	13-14	13-14	13-14	13-14	13-14
18.14	Flywheel Housing & Cylinder Block Assembly	kg-m	12.5-13.5	12.5-13.5	12.5-13.5	12.5-13.5	12.5-13.5	12.5-13.5
18.15	Flywheel & Crankshaft Assembly	kg-m	10-12	10-12	10-12	10-12	10-12	10-12
18.16	Oil Sump & Cylinder Block Assembly	kg-m	4.5	4.5	4.5	4.5	4.5	4.5
18.17	Exhaust Manifold & Cylinder Head Assembly	kg-m	4.5	4.5	4.5	4.5	4.5	4.5
18.18	Intake Manifold & Cylinder Head Assembly	kg-m	4.5	4.5	4.5	4.5	4.5	4.5
18.19	Cylinder Head Cover Assembly	kg-m	2	2	2	2	2	2

2.3 Features & Benefits of AVL Designed ADI Engine

The engines of G20-II, G25-II & G30-II are developed by AVL, Austria which are highly fuel efficient, capable of high pulling power and meet all emission norms of international & domestic requirement.

The following improvements are incorporated in engine to make it world class.

i. Helical Intake air passage.
ii. Re-entrant combustion chamber in piston crown.
iii. Ring carrier Piston with modified ring design.
iv. Side drain in pistons.
v. Three ring pack with two compression rings and one
vi. Conformable oil control ring.
vii. Cross flow design.
viii. Injector – 'P' (with V.C.O) type nozzle.
ix. High-pressure pump.

2.3.1 Helical Air Intake Passage

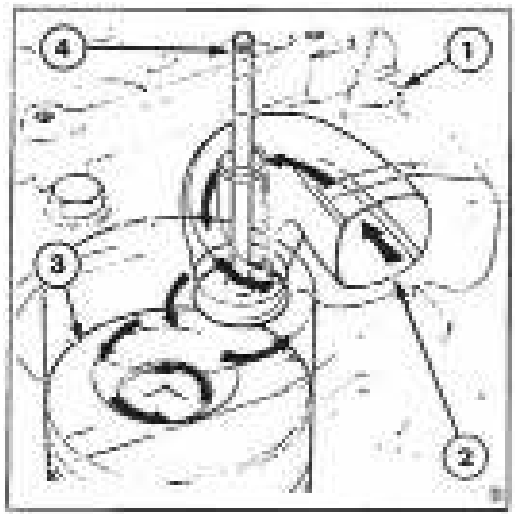


Fig. C2.2 Helical Air Intake Passage

Feature	Advantage	Benefit
Helical Intake Air Passage	Increased Swirl	For optimum mixing of fuel, air, & smokeless combustion

2.4 Re-entrant Combustion Chamber

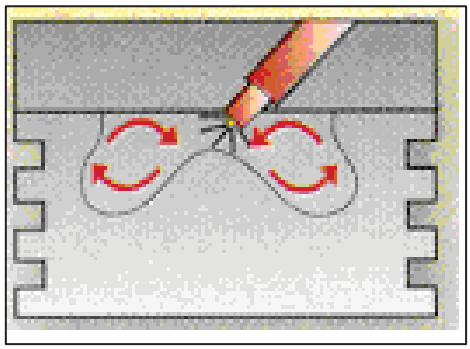


Fig. C2.3

Feature	Advantage	Benefit
Re-entrant Combustion Chamber	i. Fuel efficiency & low emission Level ii. Low NOx emission iii. Lower smoke, especially at lower speed iv. Lower fuel consumption at same NOx level v. Lower noise (up to 2.5db)	Less diesel consumption & No smoke

2.4.1 Ring Carrier / Three Ring Pack / Side Train in Pistons

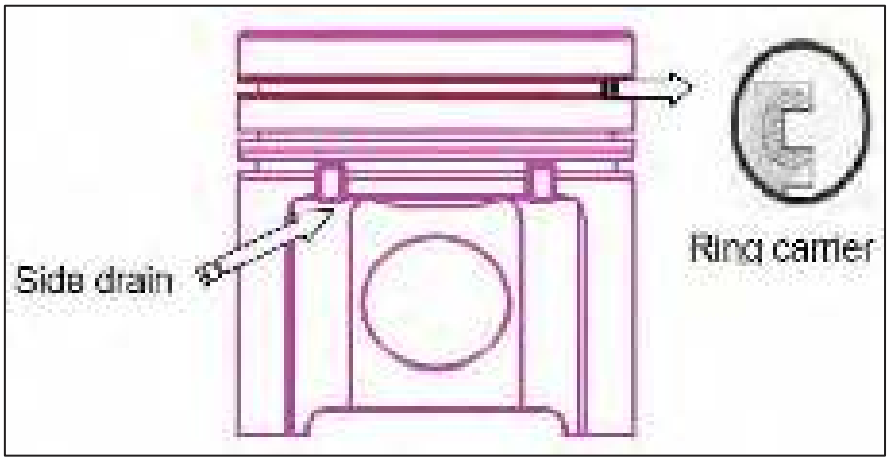


Fig. C2.4

Feature	Advantage	Benefit
i. Ring carrier piston with modified ring design. ii. Three ring pack with two compression rings and one conformable oil control ring iii. Side drain in pistons.	i. Increased piston ring life. ii. Reduced friction losses & Oil Consumption due to conformable oil control ring iii. Drain excess oil to reduce oil consumption.	i. Reduced maintenance cost ii. More output & less oil consumption iii. Reduced operational cost

2.4.2 Cross Flow Design

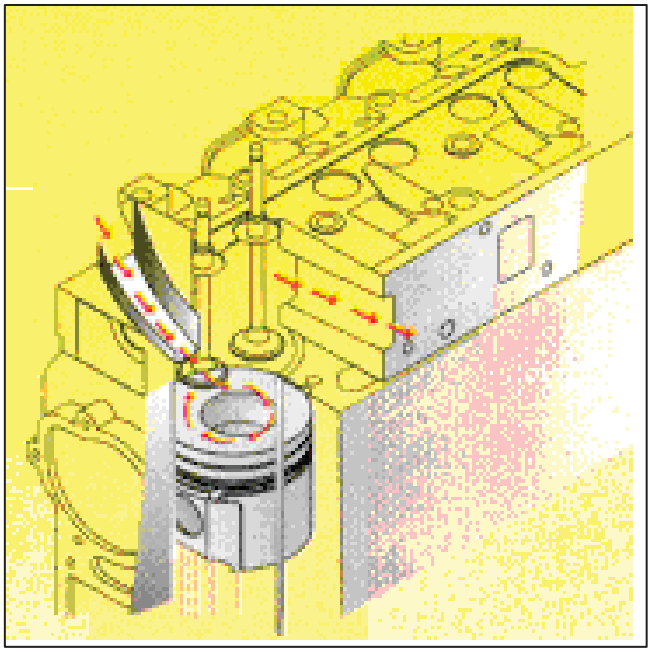


Fig. C2.5

Feature	Advantage	Benefit
Cross Flow Design	Cross flow design in cylinder head helps to reduce the heating effect of the exhaust on incoming air, hence, the air remains cool and dense.	Complete combustion apart from less smoke and fuel combustion.

2.4.3 Fuel Injection System

i. High pressure pump to match the injector pressure
ii. 'P' type injectors for emission control.
iii. Valve Covered Orifice (VCO) in nozzles in 'P' type to reduce HC.
iv. Multi-hole nozzles for better spray of diesel.
v. High Injection pressure.
vi. Double fuel filter for better fuel filtration.

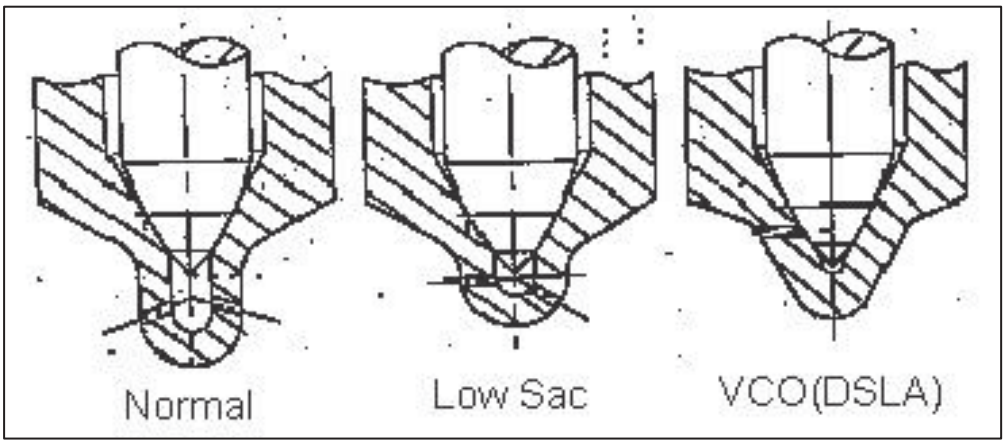


Fig. C2.6

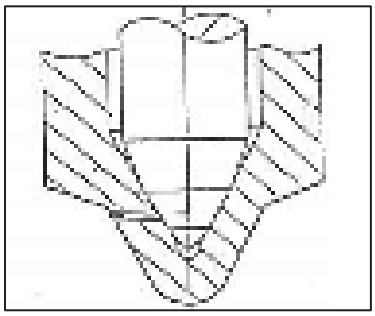


Fig. C2.7 'P' Type Nozzle

Feature	Advantage	Benefit
i. Reduced SAC Volume (VOC) ii. Spray holes covered by needle.	i. Reduced hydrocarbon emission ii. No dripping & higher injection pressure	i. Controls the NO_x ii. Less smoke and fuel consumption

2.5 Engine Inspection & Assembling Procedure

2.5.1 Cylinder Block

1. Before checking the dimensions of the bore, clean the bore thoroughly. Then with the help of bore gauge measure the bore.

Note: Taper is determined by comparing dimension A/B and C /D. Ovality is determined by comparing dimension A/C and B/D.

Fig. C2.8

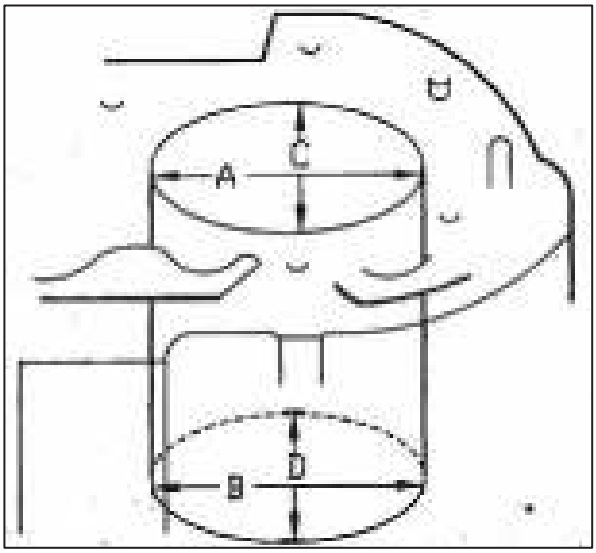


Fig. C2.9

a. Cylinder liner bore diameter (standard):
   G15: 102 mm
   G20: 91-91.025mm
   G25 & G30: 105-105.025mm
b. Maximum permissible cylinder liner wears:
   G15: 0.35 mm.
   G20, G25 & G30: 0.30 mm
c. Maximum permissible ovality of cylinder:
   G15: 0.03 mm.
   G20 : 0.015 mm
   G25 & G30 : 0.02 mm

d. Taper of cylinder bore:

G15: 0.03 mm.

G20, G25 & G30 : 0.02 mm

2. Check the cylinder block surface flatness with straight edge and feeler gauge as shown in figure C2.10

a. Cylinder block surface flatness:

G15 : 0.03 mm

G20, G25 & G30: 0.04 mm in Full length

Fig. C2.10

Fig. C2.11

3. Stroke Length

G15: 120 mm

G20: 110 mm

G25 & G30: 120 mm

4. Removal of Cylinder Liner: In Powertrac/Escort engines the cylinder liner is wet type for ease of serviceability. SST EO 2500 is used to remove the same as shown in fig. C2.11

2.5.2 Piston

1. Clean the piston ring grove with grove cleaner as shown in the Figure C2.12

Fig. C2.12

2. Check the following dimensions in the piston as shown in fig. C2.13
   a. Skirt to cylinder wall clearance

      G15 : 0.140 – 0.180 mm

      G20 : 0.101 – 0.144 mm

      G25 & G30 : 0.103 – 0.142 mm

   b. Grading diameter of the piston at right angles to the piston pin

      G15 : 101.881 – 101.899 mm

      G20 : 90.881 – 90.899 mm

      G25 & G30: 104.883 – 104.897 mm

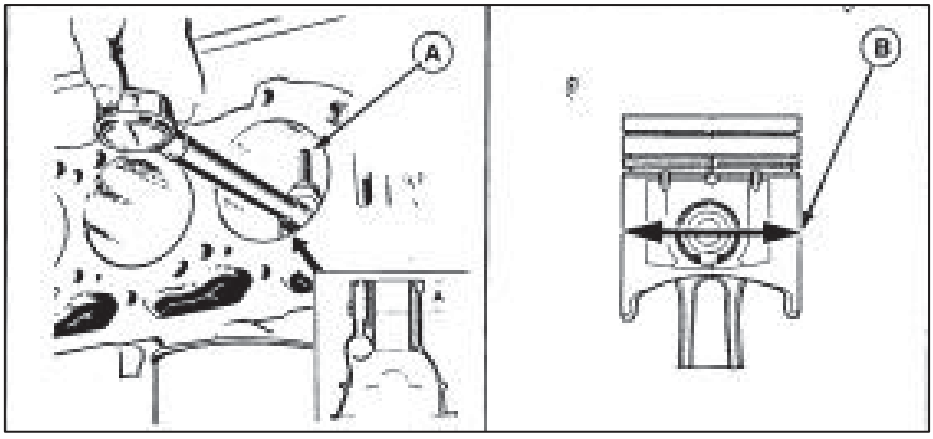


Fig. C2.13

A-B = Bore Clearance; A-Bore Diameter; B-Piston Diameter

3. Place the rings in the un-worn area of the cylinder bore and measure the butt clearance

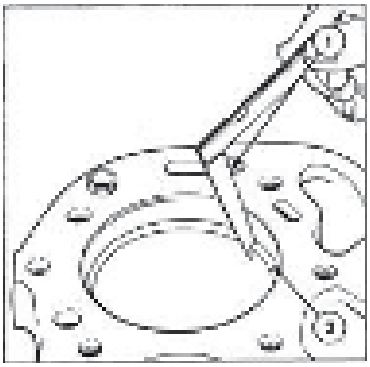


Fig. C2.14

1. Feeler Gauge; 2. Piston Ring

a. 1st ring butt clearance (compression ring)

   G15 : 0.35 – 0.55 mm

   G20 : 0.30-0.55 mm

   G25 & G30: 0.40-0.65mm

b. 2nd ring butt clearance (compression ring)

   G15 : 0.40 – 0.60 mm

   G20 : 0.30-0.55 mm

   G25 & G30 : 0.40-0.65mm

c. 3rd ring butt clearance (conformable oil ring)

   G15 : 0.40 – 0.60 mm

   G20: 0.30–0.65mm

   G25 & G30: 0.30–0.60mm

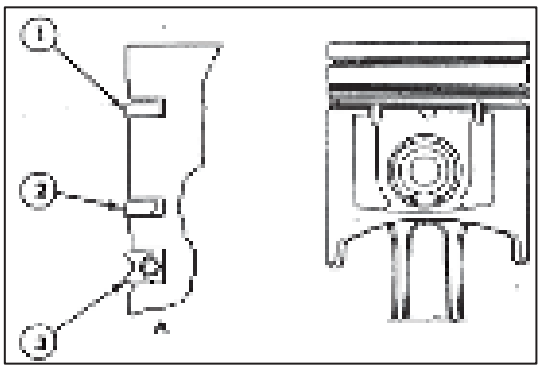


Fig. C2.15 Piston Ring Assembly with Re-entrant Combustion Chamber & Side Oil Drain

1. 1st Compression Ring; 2. 2nd Compression Ring; 3. Conformable Oil Control Ring

4. Check the land clearances of the rings by using a feeler gauge as shown in the fig. C2.16

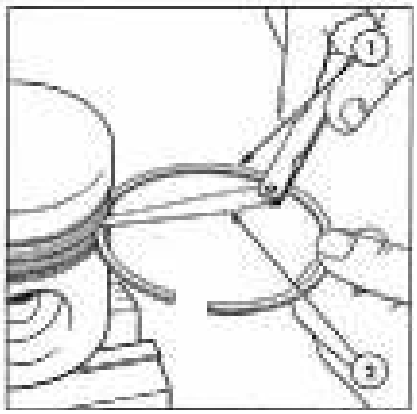


Fig. C2.16 Checking the Land Clearance

a. 1st ring land clearance (compression ring)

   G15 : 0.065 – 0.012 mm

   G20 : 0.110 – 0.150 mm

   G25 & G30 : 0.110 – 0.142 mm

b. 2nd ring butt clearance (compression ring)

   G15 : 0.050 – 0.082 mm

   G20 : 0.060 – 0.100 mm

   G25 & G30 : 0.060 – 0.092 mm

c. 3rd ring butt clearance (conformable oil ring)

   G15 : 0.035 – 0.080 mm

   G20 : 0.030 – 0.070mm

   G25 & G30 : 0.030 – 0.065mm

5. Install all the rings in their respective position by using a ring expander as shown in fig. C2.17

Fig. C2.17

6. Install the piston assembly into the cylinder by using a ring compressor as shown in the Fig. C2.18

   Note: The dimple on Connecting rod & cut/arrow mark on piston should be kept towards the front of the engine in both FT & PT.

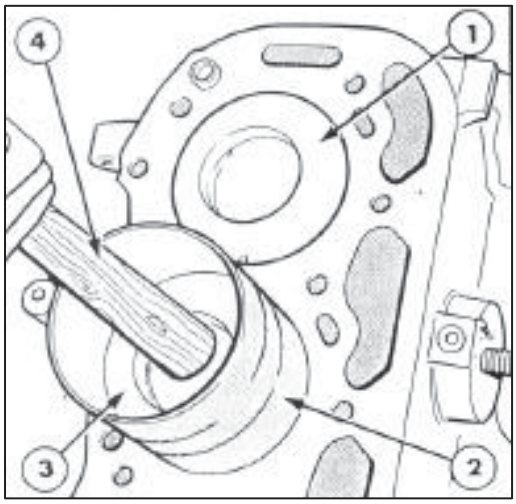


Fig. C2.18

1. Installed Piston; 2. Piston Ring Compressor; 3. Piston; 4. Hammer Wooden Handle

7. Check the protrusion of the piston above cylinder block surface by using a dial gauge and magnetic stand as shown in fig. C2.19

Fig. C2.19

a. Protrusion of the Piston

   G15: 0.01 – 0.16 mm

   G20: 0.325 – 0.575 mm

   G25 & G30 : 0.175 – 0.425 mm

2.5.3 Tappets

1. Check the tappet diameter.
    a. Tappet diameter
       G15 & G20 : 15.966-15.984 mm
       G25 & G30 : 23.972–23.993 mm
    b. Permissible tappet guiding portion cylindricity
       G15 & G20 : 0.006 mm
       G25 & G30 : 0.004 mm
2. Check the tappet bore in the block with telescopic gauge and measure with micrometre.
    a. Tappet bore
       G15 & G20 : 16.000-16.018 mm
       G25 & G30 : 24.000-24.021 mm

2.5.4 Crankshaft

Fig. C2.20

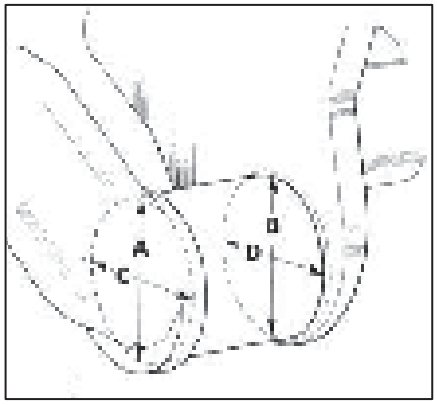


Fig. C2.21 Crankshaft Journal Wear Checks

To determine condition of main bearing and big end bearing journals, measure each crankshaft journal as indicated.

Journal Ovality: Compare A to C and B to D

Journal Taper: Compare A to B and C to D

1. Check the dimensions of the crankshaft as shown in Figure. C2.21
    a. Main Journal diameter
       G15: 80.150 – 80.170 mm
       G20: 57.981-58.00 mm
       G25 & G30: 85.15-85.17 mm

b. Big end journal diameter

G15 : 74.925-74.905 mm

G20 : 51.981-52.00mm

G25 & G30 : 65.981-66.00mm

c. Main journal wear limits

G15 & G20 : 0.150 mm

G25 & G30: 0.150 lower than group size

d. Radius (fillet)

G15 & G20 : 3.0-3.5mm

G25 & G30: 3.5-4.0 mm

e. Crank shaft rear oil seal journal diameter

G20: 99.953-99.988 mm

G25 & G30: 99.965-100.00 mm.

2. Check the run-out of the crankshaft as shown in Fig. C2.22

Fig. C2.22 Checking Run out of the Crankshaft

a. Run-out of the crankshaft

G15: 0.03 mm

G20, G25 & G30: 0.02 mm

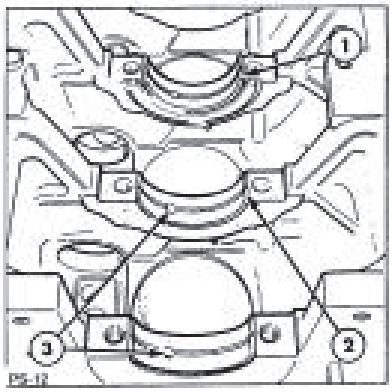


Fig. C2.23 Bearing Shell Installation (FT)
1. Centre Bearing Shell; 2. Bearing Shell;
3. Oil Hole Aligned with Oil Galleries

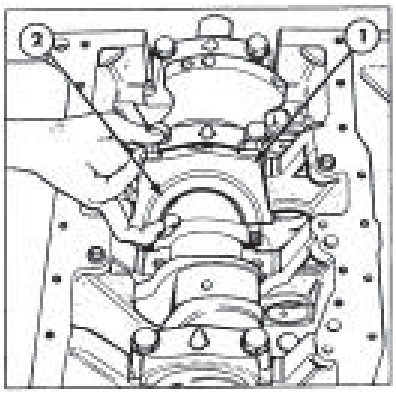


Fig. C2.24 Main Bearings Cap Installation
1. Centre Main Bearing Cap; 2. Centre Bearing Shell with Integral Thrust

3. Fix the main bearing caps to the cylinder block and torque the bolts and check the main bearing shell inside diameter (std.)

   G15 : 80.221-80.271mm

   G20 : 0.046-0.103 mm

   G25 & G30 : 0.045-0.115 mm

   G15, G20, G25 & G30 Wear limit: 0.19 mm

Fig. C2.25 Checking the Main Bearing Bore Diameter with Bore Gauge

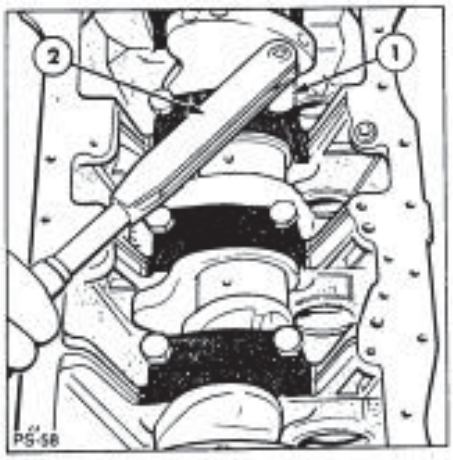


Fig. C2.26 Torqueing Main Bearing Cap Bolts

4. Check the end float of the crankshaft as shown in fig. C2.27

a. Endplay

G15 : 0.12 – 0.37 mm

G20 : 0.2-0.47 mm

G25 & G30: 0.22-0.49 mm

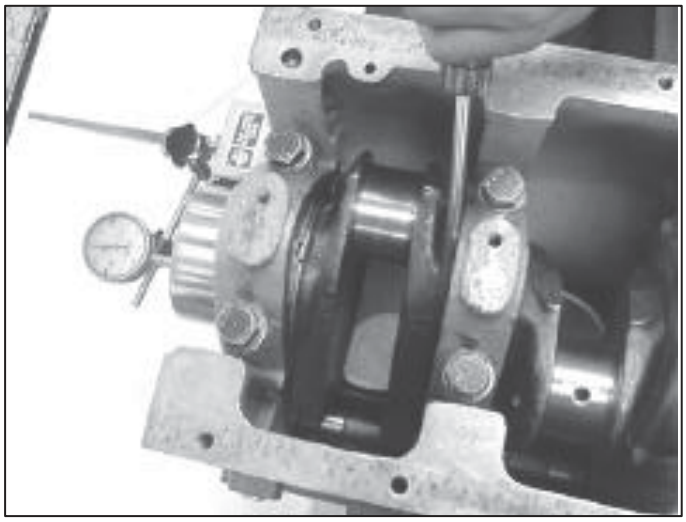


Fig. C2.27 Measuring Crankshaft End Play with Dial Gauge & Magnetic Stand

5. Fitment of Oil Seal by using S.S.T. no. EO0101in G25/30 as shown in the Figure. C2.28

Fig. C2.28 Installing Rear Main Oil Seal

It should be within 0.38 mm for G15, G20, G25, and G30.

6. Fix the flywheel to the crankshaft and check the run out of the flywheel by using dial gauge and magnetic stand as shown in fig. C2.29.
    a. Run-out of Flywheel

       0.15 mm for G15, G20, G25, and G30

Fig. C2.29

2.5.5 Camshaft

1. Check the camshaft bush diameter using bore gauge and micrometre.
    a. Cam bush inner diameter

       G15 : 50.000 – 50.025 mm

       G20 : 46.985-47.040mm

       G25 & G30 : 52.990-53.080mm

    b. Bearing clearance

       G15: 0.1 mm max.

       G20 : 0.025–0.096mm

       G25 & G30 : 0.020–0.129mm
2. Check the camshaft run-out

       Run out 0.05 mm for G20, G25 & G30

       Run out 0.035 mm for G1

3. Check the camshaft journal diameter as shown in fig. C2.30

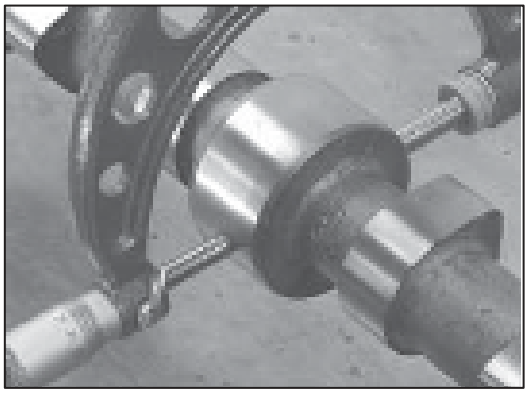


Fig. C2.30 Measuring the Camshaft Journal

a. Camshaft journal diameter

G15 : 49.925 – 49.950 mm

G20 : 46.944–46.960 mm

G25 & G30 : 52.951–52.970 mm

4. Check the camshaft end float as shown in fig. C2.31

a. End float

G15 : 0.04 – 0.28 mm

G20 : 0.070–0.195 mm

G25 & G30: 0.270–0.445 mm

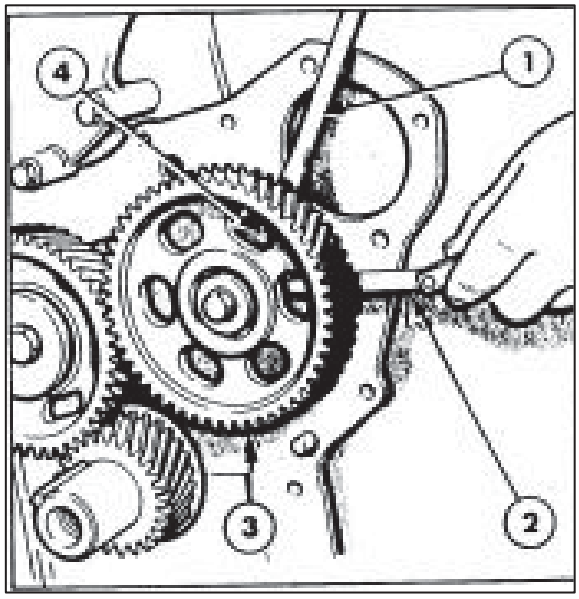


Fig. C2.31 Measuring the Camshaft End Float

2.5.6 Connecting Rod

Fig. C2.32

1. Check the internal diameter of big end and small end bearing bushes.
    a. Small end bush internal diameter

       G15 : 38.020 – 38.014 mm

       G20 : 28.020–28.033mm

       G25 & G30 : 34.025–34.050mm

    b. Clearance between bush to piston pin

       G15 : 0.014 – 0.026 mm

       G20 : 0.020 – 0.039 mm

       G25 & G30 : 0.025 – 0.056 mm

    c. Big end bearing bush internal diameter (std.)

       G15 : 79.000 – 79.013 mm

       G20, G25 & G30: 66.026-66.115 mm
2. Check the connecting rod for twist and bend.
    a. Checking for max. twist

       0.05 mm for G20

       G15, G25 & G30 : 0.06 mm

    b. Checking for max. bend

       0.04 mm for G15, G25 & G30

       0.05 mm for G20

3. Check the piston pin diameter in the centre with the help of a micrometre. Replace it if worn out.
    a. Piston pin diameter
       G15 : 37.994 – 38.000 mm
       G20 : 27.994 – 28.000 mm
       G25 & G30: 33.994 – 34.000 mm

2.5.7 Oil Pump

1. Measure the clearances of the pump by using feeler gauge as shown in the following figure 2.33
    a. Oil pump drive gear backlash
       G15 & G20 : 0.15 mm
       G25 & G30 : 0.20 – 0.34 mm
    b. Oil pump driving gear backlash
       G20 : 0.126 – 0.210 mm
       G15, G25 & G30: 0.09 – 0.20 mm

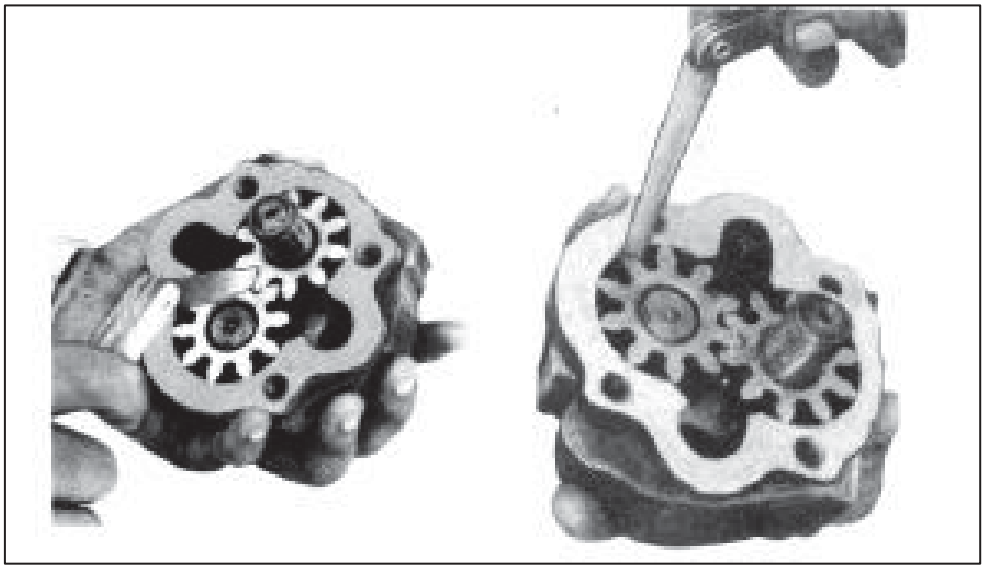


Fig. 2.33 Driving Gear Backlash Measurement

2.5.8 Water Pump

The play between the impeller and pump body face should amount to 0.4 – 1.5 mm for **G15, G20, G25, andG30.**

Fig. C2.34 Removal of Water Pump Pulley with SST #EF0300

2.5.9 Timing Gears

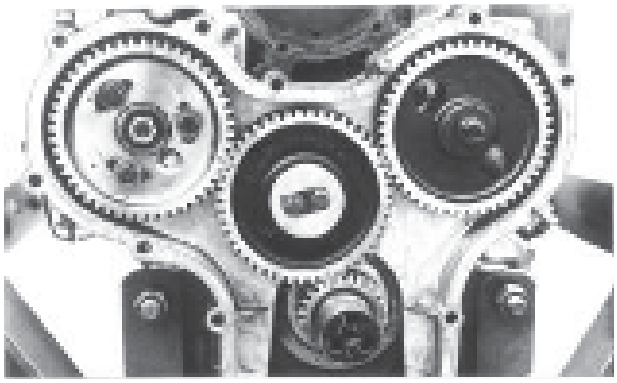


Fig. C2.35 Timing Gear Setting

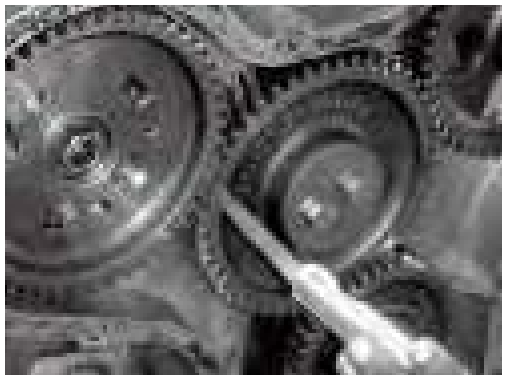


Fig. C2.36 Checking the Backlash with the help of Feeler Gauge

Assemble the camshaft gear and F.I. pump gear by aligning the punch marks in the idler gear of Farmtrac as shown in the Figure. C2.35. Assemble the cam shaft gear and F.I. Pump gear by aligning the 'S' & punch marks on the intermediate gear of Escort/Powertrac as shown in Figure. C2.35

1. Check the backlash between the gears by using the feeler gauge as shown in the fig. C2.36
    a. Backlash between idler gear to crankshaft gear
       G15 : 0.09 – 0.264 mm
       G20, G25 & G30 : 10 – 0.30 mm

b. Backlash between idler gear to camshaft gear

G15 : 0.09 – 0.264

G20 G25 & G30 : 0.10 – 0.30 mm

c. Backlash between idler gear to F.I. Pump gear

G15 : 0.09 – 0.208 mm

G20, G25 & G30: 0.10 – 0.30 mm

2.5.10 Idler Gear

Check the idler gear bush inside diameter. It should be, 38.000 – 38.025 mm for G15, G20, G25, and G30. Check the adapter outside diameter. It should be 37.950 – 37.975 mm for G15, G20, G25, and G30.

2.5.11 Cylinder Head

The valves are removed by compressing the valve spring away from the tip of the valve stem and removing the locks, the retainer and the spring. Refer fig. C2.37

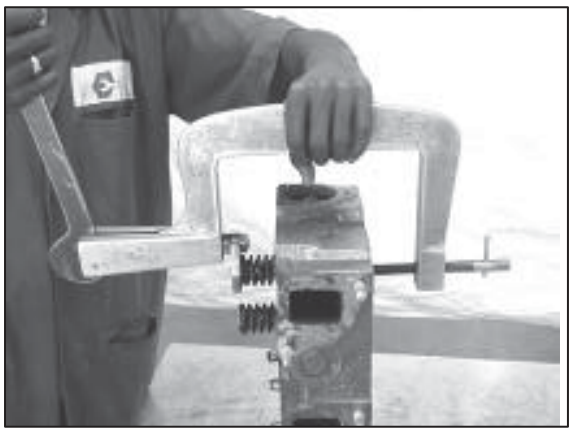


Fig. C2.37

1. Check the cylinder head surface with straight edge and feeler gauge as shown in the fig. C2.38

   Flatness of cylinder head: 0.02 mm for G15, G20, G25 & G30

2. Check depth / protrusion from valve face to cylinder head surface by using dial gauge as shown in the fig. C2.39

   G15: Inlet: 0.9 – 1.3 mm (Protrusion); Exhaust: 0.9 – 1.3 mm (Protrusion)

   G20: Inlet: 0.3 – 0.7 mm (Protrusion); Exhaust: 0.3 – 0.7 mm (Protrusion)

   G25 & G30: Inlet: 0.7 – 1.0 mm (Depth); Exhaust: 1.0 – 1.3 mm (Depth)

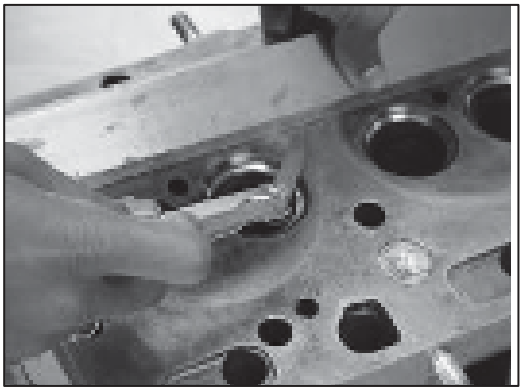


Fig. C2.38 Checking Cylinder Head Flatness

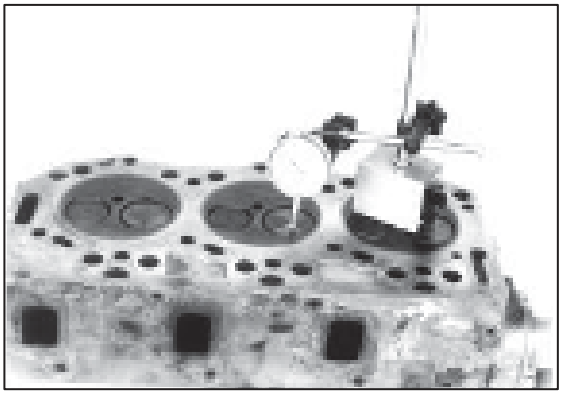


Fig. C2.39

2.5.12 Valve and Guides

Fig. C2.40 Measuring the Valve Stem Diameter

1. Check the diameter of the valve stem by using micrometre as shown in the Figure C2.40
   a. Inlet valve stem diameter
      G15 : 8.940 – 8.960 mm
      G20 : 7.95-7.97 mm
      G25 & G30 : 8.95-8.970mm
   b. Exhaust valve stem diameter
      G15 : 8.930 – 8.950 mm
      G20 : 7.93-7.95 mm
      G25 & G30 : 8.93 – 8.95 mm
2. Measure the valve guide bore diameter by using bore gauge as shown in the figure C2.41

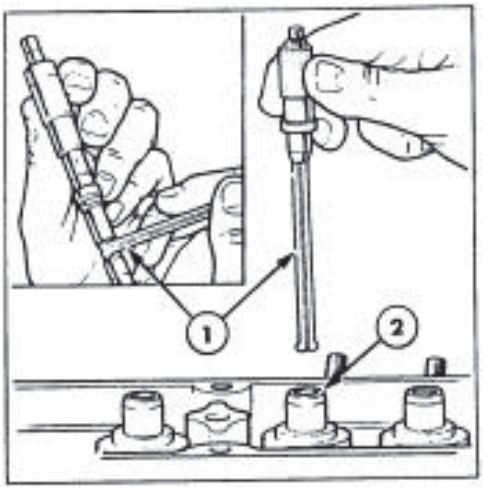


Fig. C2.41 Measuring the Valve Guide Bore

   a. Valve guide inner diameter
      G15 : 9.000 – 9.015 mm
      G20 : 8.000 – 8.015 mm
      G25 & G30 – 9.000 – 9.015 mm
   b. Clearance between valve stem and guide
      G15 – 9.000 – 9.015 mm (inlet)
      G20 – 0.030 – 0.065 (inlet)
      G25 & G30 – 0.050 – 0.082 (inlet)
      G15, G25 & G30 – 0.050 – 0.085mm (exhaust)
      G20 – 0.050 – 0.078 mm (exhaust)

Note: Valve guides in Escort / Powertrac are replaceable. To remove and replace use SST No. E00200

3. Check the valve seat angle as shown in the fig. C2.42

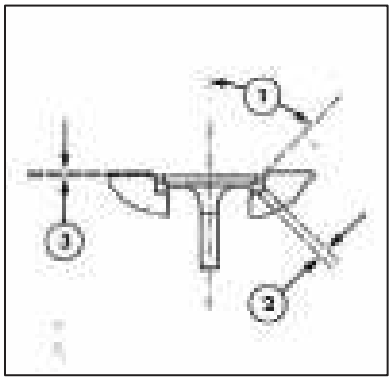


Fig. C2.42

G20: Inlet: 45°00’ Exhaust: 45°00’

G15, G25 & G30: Inlet: 30°00’ Exhaust: 45°00’

2.5.13 Valve Spring

Fig. C2.43

1. Check the valve spring tension by using spring tester as shown in the Fig. C2.43

Outer spring:

Spring primary deflection at

14.5 kg load is

G20 :42.6 mm

G15, G25 & G30 : 49.0 mm

Spring free length:

G20 : 55.3 mm

G15,G25 & G30 : 60 mm

Inner Spring:

Spring primary deflection at 14.5 kg load

G25 & G30 :52 mm

Spring free length:

G25 & G30 : 63 mm

2. Check the square ness of the spring by using try square as shown in the fig. C2.44

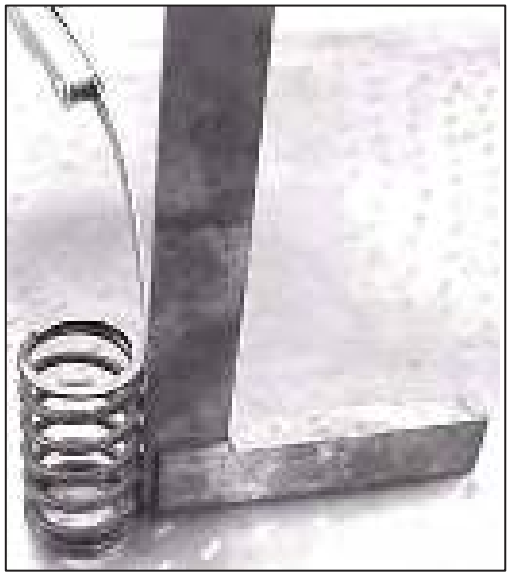


Fig. C2.44

Maximum out of square ness for G15, G20, G25 & G30: 1.5 mm

2.5.14 Push Rod

Check the push rod for straightness with a feeler gauge as shown in the Figure C2.45

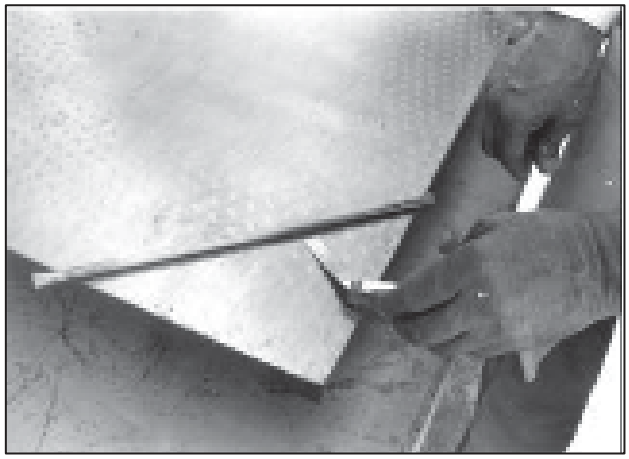


Fig. C2.45

2.5.15 Rocker Arm Shaft

1. Check the rocker arm shaft dia. by using micrometre as shown in the Figure C2.46

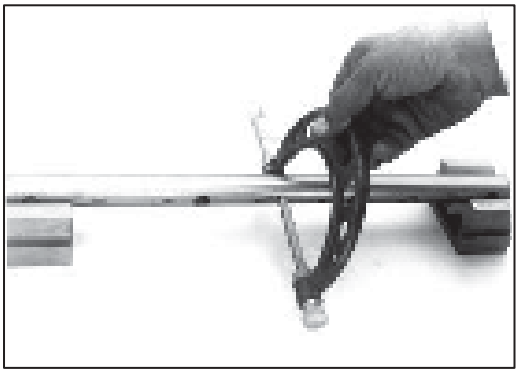


Fig. C2.46 Measuring the diameter of Rocker Shaft

a. Rocker arm shaft diameter
   G15: 15.982 – 16.000 mm
   G20, G25 & G30: 21.959 – 21.980 mm

2. Check the bore of rocker arm by using telescopic gauge and micrometre as shown in the fig. C2.47

Fig. C2.47

a. Rocker arm bush inner diameter
   G15 : 16.034-16.026
   G20, G25 & G30: 22.000 – 22.021 mm
b. Rocker arm bracket inner diameter
   G15, G20, G25 & G30: 22.000 --22.033 mm.
c. Rocker arm bush and shaft clearance
   G15: 0.1 max
   G20, G25 & G30: 0.020 – 0.062 mm

2.6 Oil Distribution

2.6.1 Oil Distribution for G20, G25, and G30

Refer fig. C2.48

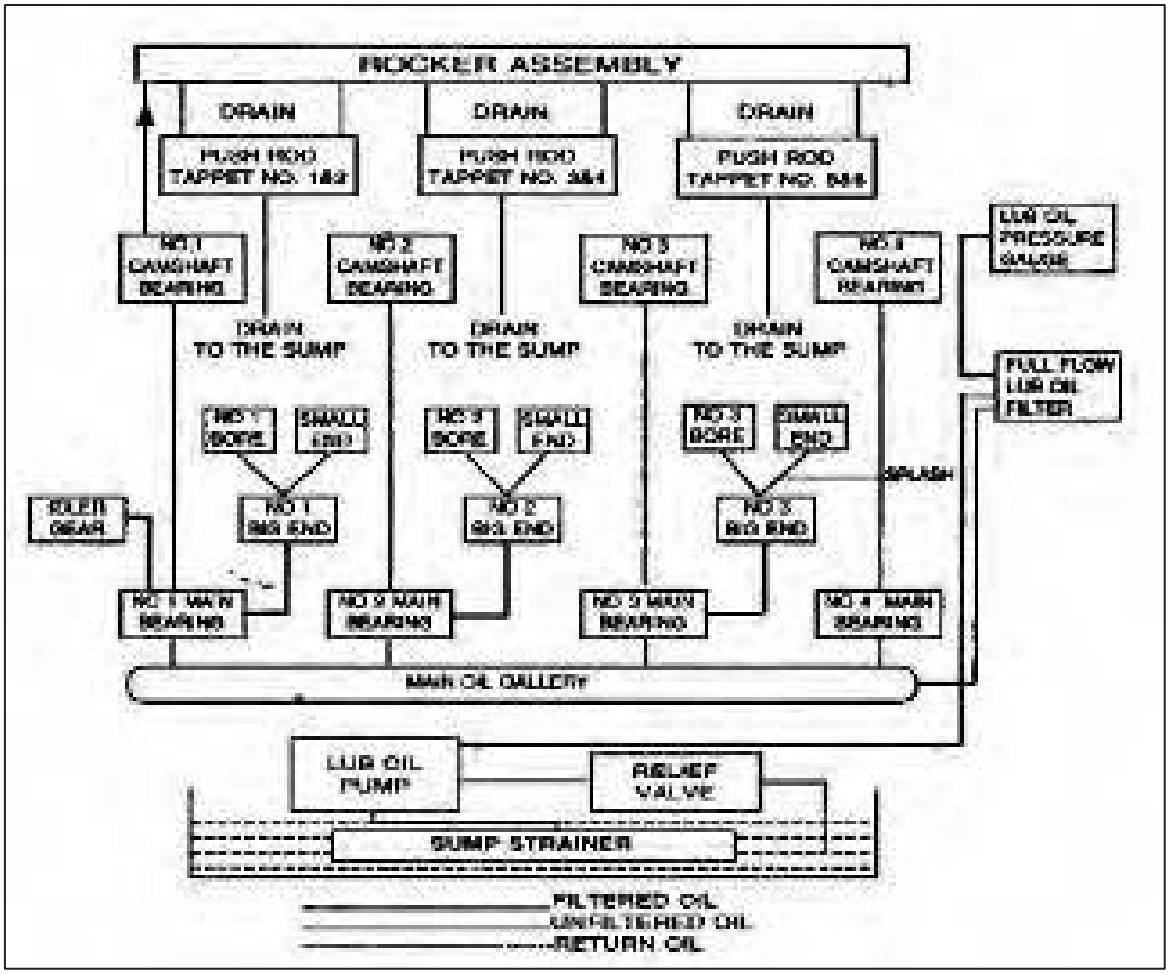


Fig. C2.48

2.6.2 Oil Distribution for G15

Refer fig. C2.49

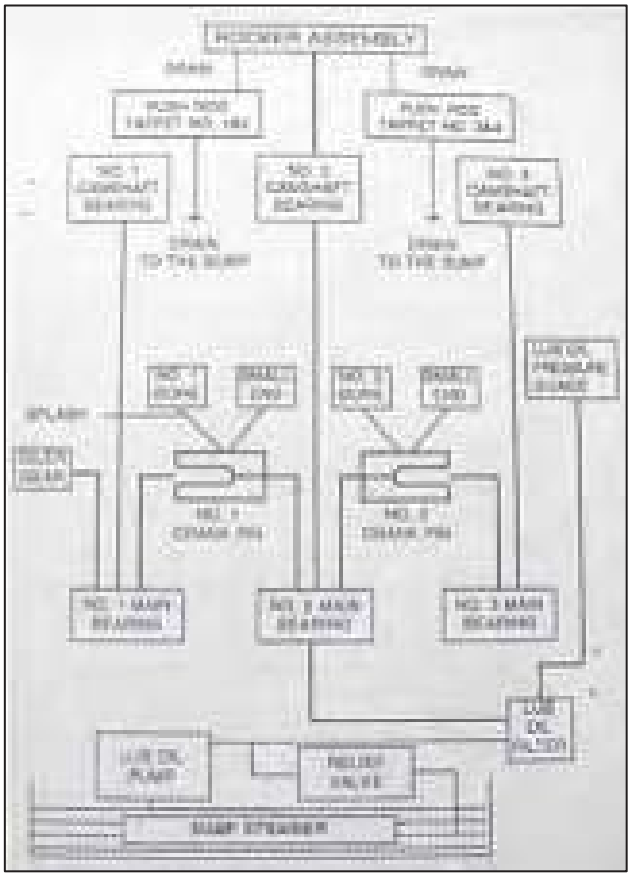


Fig. C2.49 Oil Distribution in G15

2.7 Water Cooling System

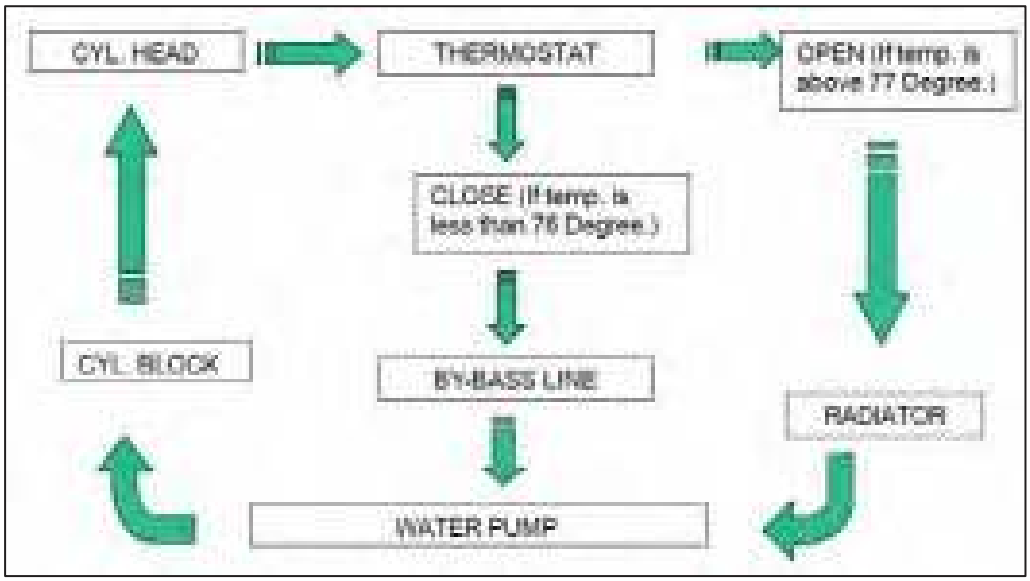


Fig. C2.50 Water Cooling System

2.8 Compression Test

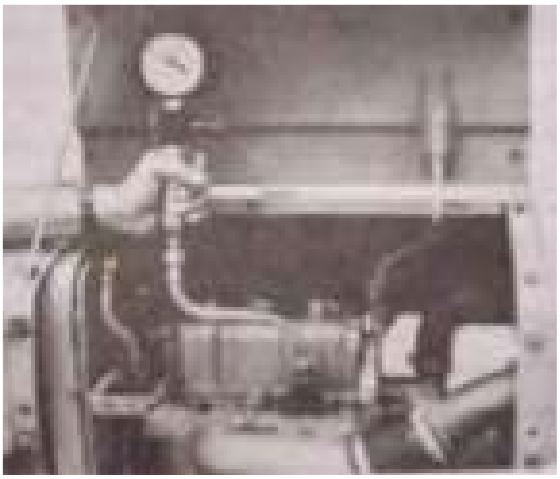


Fig. C2.51

Check Battery & Self-starter are in good condition. Check Cylinder head bolt torque. Adjust the valve clearance as per specifications. Then warm up the engine to operating temperature. Remove all injectors. Fit dummy Injector (SST No. EF1900). Connect compression gauge with flexible pipe to the dummy injector. Tighten the vent knob of gauge. Crank engine with starter motor (Cranking Speed approx. 150-200 rpm) and read compression pressure on the dial.

Then loosen compression gauge knob to vent the gauge and ensure that the needle return to zero position. Tighten vent knob again. Crank the engine and take a second reading. Repeat the operation for the remaining cylinders. Note down the compression pressure for each cylinder. The Compression pressure should be G20, G25 & G30: 22.85 +3.5 Kg/cm^2. The maximum variation in compression pressure of the cylinders should not exceed 1.5 Kg/cm^2.

To ascertain whether the leakage of compression is from the valves or from the Piston Rings, pour a small amount of clean engine oil into the defective cylinder and recheck the compression pressure as described above. If compression pressure improves wear in piston ring indicated. If compression pressure is unaltered it indicates leakage past the valves. If compression pressure of two adjacent cylinders read on the lower side it may be due to blown cylinder head gasket.

2.9 F.I. Pump Timing

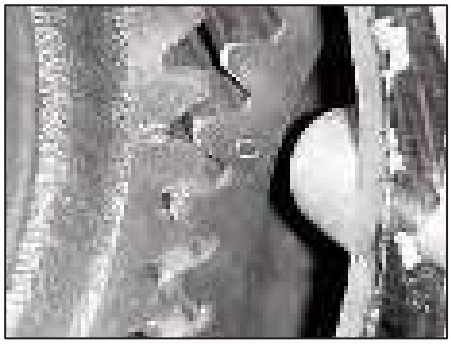


Fig. C2.52

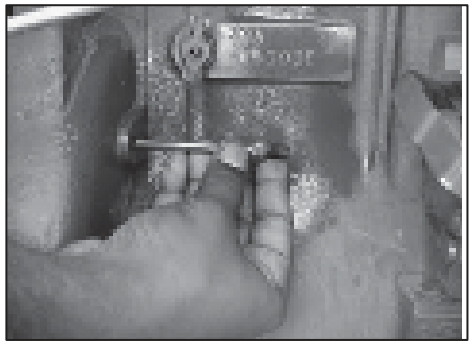


Fig. C2.53

Fig. C2.54

Fig. C2.55

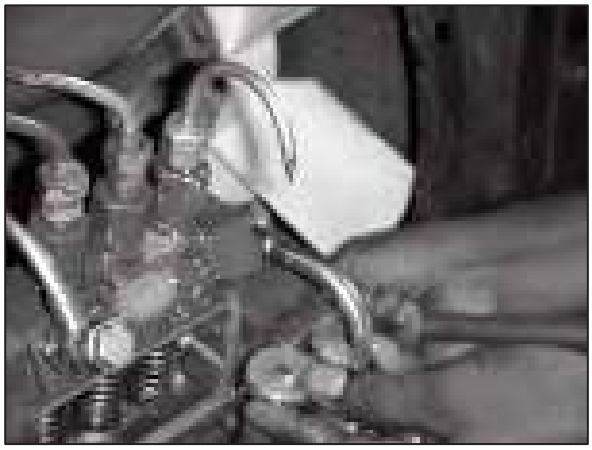


Fig. C2.56

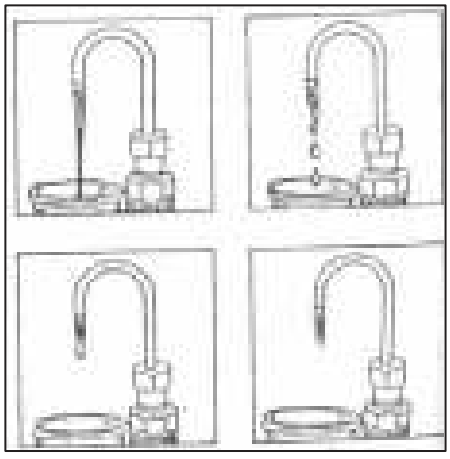


Fig. C2.57

More accurate fuel injection timing is set by fuel-cut-off method using swan neck pipe on number 1 delivery valve holder after removing the delivery valve spring and peg.

1. Remove the timing gear inspection cover and the timing pin from the flywheel housing.

2. Rotate the engine clockwise and observe the 'O' mark on the fuel injection pump gear teeth. When the 'O' mark on pump gear and intermediate gear teeth are about little away from meshing, insert the longer end of the timing pin in the flywheel housing. Now slowly rotate the engine clockwise to the point where the timing pin goes fully into the first hole in the flywheel and slides easily. Refer Fig.C2.52 & C2.53.
3. Remove the 1st cylinder high-pressure pipe and the delivery valve holder after loosening the holder clamp. Remove the delivery valve spring, peg, and refit the delivery valve holder. Fit the swan neck pipe. Refer fig. C2.54.
4. Insert a piece of cloth in the timing inspection hole towards the intermediate gear to protect against any part or tool falling in the timing housing accidentally. Loosen the three-pump gear mounting bolts. Refer Fig. C2.55.
5. Rotate the pump shaft hub clockwise.
6. Keep operating the hand-priming pump. A stream of diesel will flow through the swan neck pipe. A point will come when the diesel stream will reduce to drops. Carefully turn the pump shaft hub further clockwise till the point where drops fall at an interval of about 15 seconds. Holding the pump hub at this position, tighten the pump gear mounting bolts securely. Check, the zero on the gear of F I pump aligning with the cut of the hub. Refer fig. C2.56
7. Recheck timing by first taking out the timing pin and then turning the crankshaft anticlockwise. Drops will appear from swan neck pipe. Now turn the shaft clockwise till the drops reduce again to a drop every 15 seconds. (Ref fig. C2.57) Insert the pin in the flywheel hole to ascertain the correct timing.
8. Complete the job and refit the F.I pump Gear cover.

2.10 Tappet Setting

2.10.1 Tappet Setting for G15

1. Bring first piston to TDC in compression stroke. This can be achieved by inserting a locating pin in the second hole of the flywheel.
2. Adjust the Valve Tappet Nos. 1&2.
3. Rotate the Crankshaft by 360 degree and adjust the Tappet nos. 3&4.

   Inlet 0.2 mm; Exhaust 0.2 mm

Fig. C2.58

2.10.2 Tappet Setting for G20, G25, G30

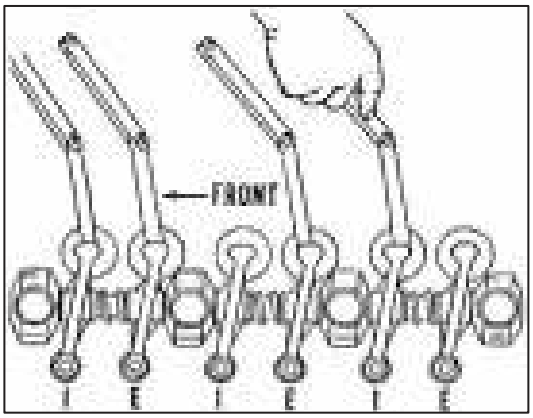


Fig. C2.59

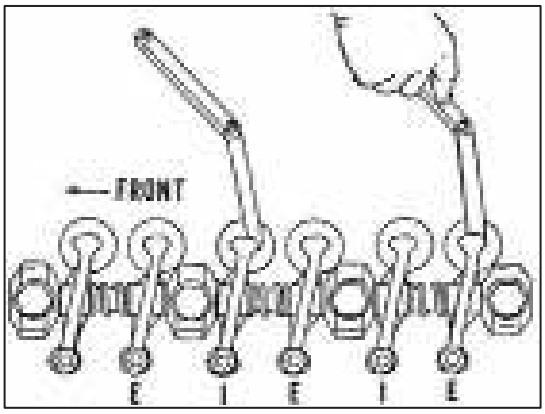


Fig. C2.60

1. Bring first piston to TDC in compression stroke. This can be achieved by inserting a locating pin in the second hole of the flywheel. At this position, adjust tappets 1, 2, 4, and 5 as shown in the figure C2.59.
   Inlet 0.3 mm; Exhaust 0.4 mm
2. Bring first piston to TDC in exhaust stroke. This can be achieved by repeating the same procedure as mentioned above. At this position adjust tappets 3 and 6 as shown in the figure C2.60.

2.11 Cylinder Head Bolt Torqueing Sequence

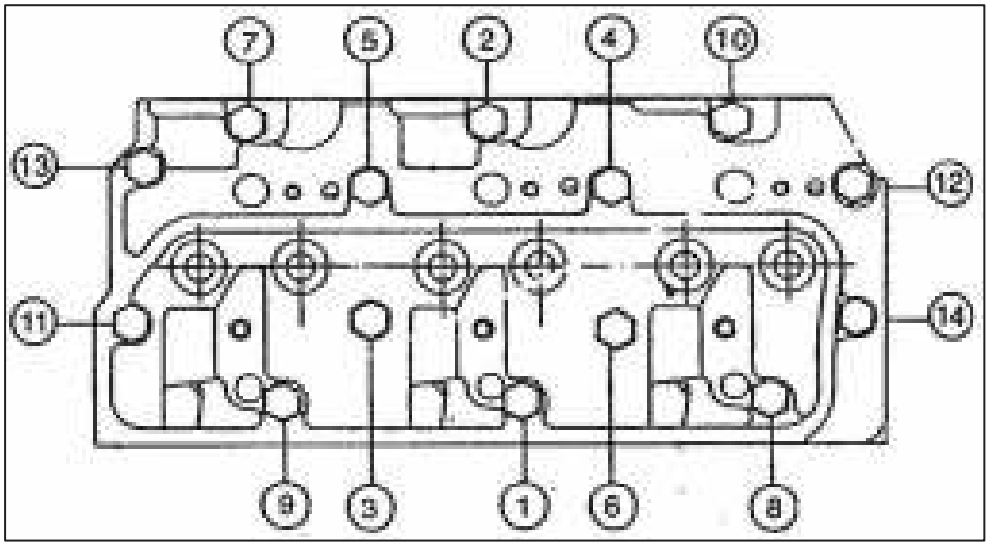
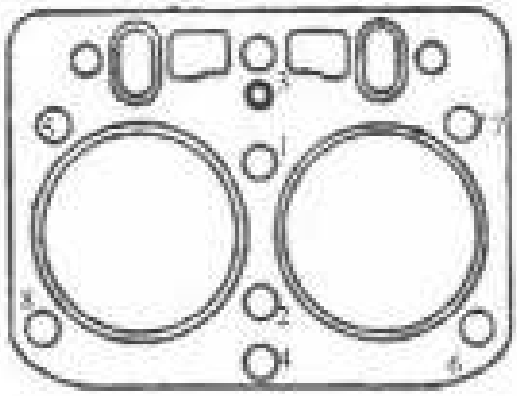


Fig. C2.61

Model	1st Step	2nd Step
G20	10-11 kg-m	13-14 kg-m
G25/G30	12-13 kg-m	18-19 kg-m



Model	1st Step	2nd Step	3rd Step
G15	20 kg-m	22 kg-m	24 kg-m

Important:

i. Warm up the engine.

ii. Tighten the cylinder head nuts in the above shown sequence, in three stages and up to recommended torque using a calibrated torque wrench of a reliable make.

iii. Do not over tighten the nuts.

iv. Warm up the engine and re-torque the cylinder head nuts in the same sequence, if cylinder head gasket is replaced.

2.12 Piston Fitment

2.12.1 Piston Fitment for G15

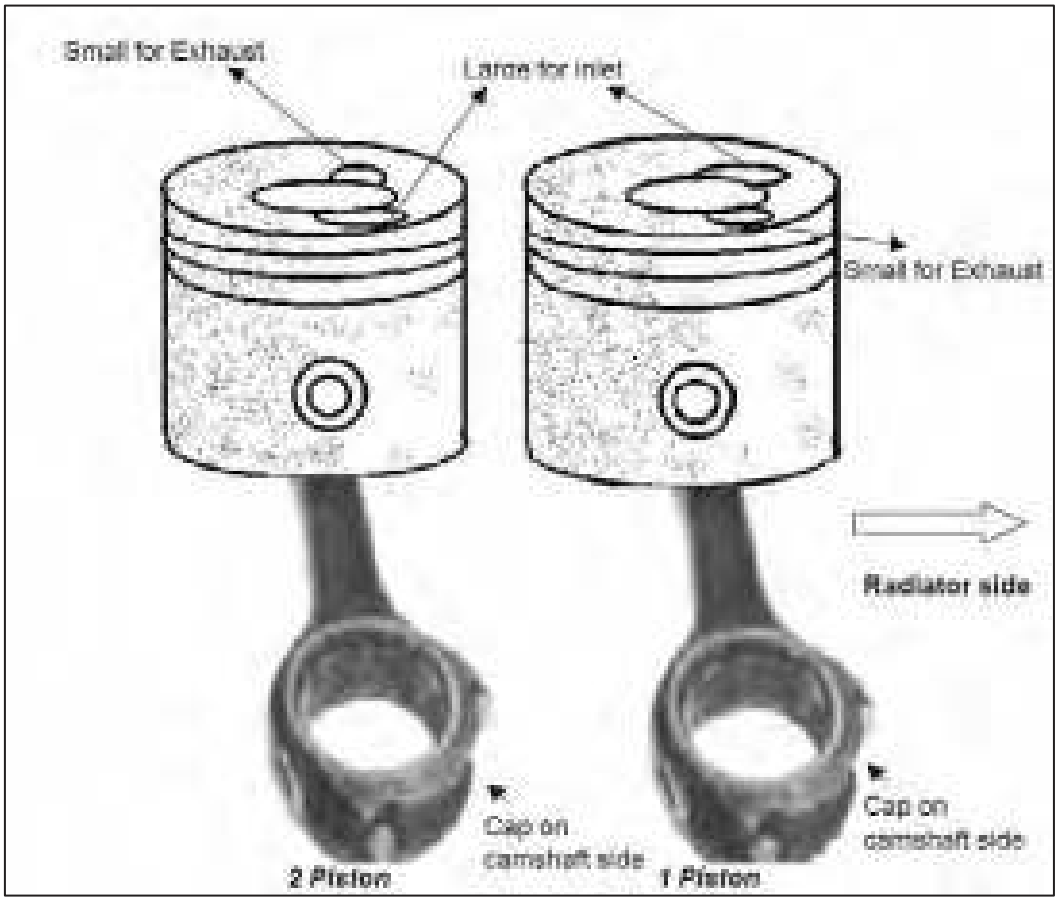


Fig. 2.62 Piston Fitment for G15

2.12.2 Piston Fitment for G20, G25, and G30

Cut or arrow mark and dimple mark on the connecting rod should be kept towards radiator side. Refer fig. C2.63

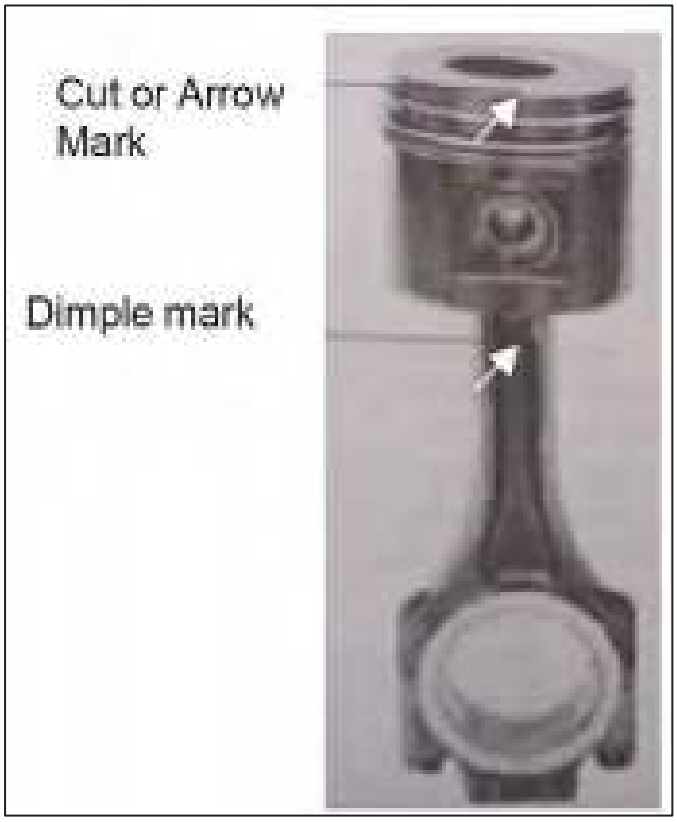
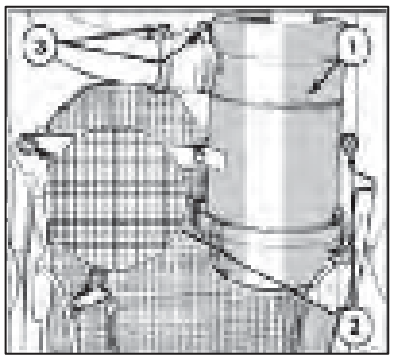


Fig. C2.63

2.13 Lubrication and Maintenance Chart

The numbers in the second column refer to the Operation numbers contained in the following pages of this section. In some instances, illustrations are not considered necessary in order to carry out the service operation and are therefore omitted.

Hours Operated	No.	Service Requirements	Check	Clean	Lubricate	Change	Adjust	Drain
Every 10 Hrs. or Daily	01.	Engine Oil Level 	×				×	
	02.	Radiator Coolant Level 	×				×	
	03.	Radiator Matrix/Fins 		×				
	04.	Lube Oil Pressure	×					
	05.	Fuel Filters						×

Hours Operated	No.	Service Requirements	Check	Clean	Lubricate	Change	Adjust	Drain
Every 100 Hrs.	06.	Battery Electrolyte Level	×				×	
	07.	Fuel Injection Pump-Oil Level 			×			
	08.	Fuel Injection Pump – Pre-filter Element 	×					
	09.	Engine Oil & Filter				×		
	10.	Fan / Alternator Belt Tension	×				×	
	11.	Radiator Fins		×				
	12.	Fuel Tank Sediment/Water Trap						×
	13.	Fuel Injection Pump Sediment Bowl		×				
	14.	Fuel Filter Bowls						×
Every 400 Hrs.	15.	Engine Oil & Filter				×		
	16.	Air Cleaner Element	×	×				
	17.	Cylinder Head Bolts Tightening	×				×	
	18.	Starter Motor Pinion	×		×			
	19.	Valve Tappet Clearance	×				×	
	20.	Fan/Alternator Belt Tension	×				×	
	21.	Fuel Tank Sediment / Water Trap	×					

Hours Operated	No.	Service Requirements	Check	Clean	Lubricate	Change	Adjust	Drain
Every 400 hrs.	22.	Fuel Filter Bowls 						×
Every 700 hrs.	23.	Engine Oil & Filter				×		
	24.	Oil Bath Air Cleaner	×	×		×		
	25.	Cylinder Head Bolts Tightening	×				×	
	26.	Valve Tappet Clearance	×	×				
	27.	Fan/Alternator Belt Tension	×				×	
	28.	Fuel Tank Sediment / Water trap	×					
	29.	Fuel Filter Bowls	×					
	30.	Fuel Tap Strainer 		×				
	31.	Fuel Filter (Primary)				×		

Hours Operated	No.	Service Requirements	Check	Clean	Lubricate	Change	Adjust	Drain
Every 1000 Hrs.	32.	Engine Oil & Filter				×		
	33.	Oil Bath Air Cleaner	×	×		×		
	34.	Secondary Diesel Filter Element				×		
	35.	Tappet Clearance	×				×	
	36.	Cylinder Head Bolt Tightening	×				×	
	37.	Fan Belt Tension	×				×	
	38.	Diesel Pump Sediment Bowl						×
	39.	Fuel Cock Strainer		×				
Every 1300 Hrs.	40.	Fuel Injectors	×	×		×		
	41.	Bleeding the Fuel System					×	
	42.	Alternator Bushes					×	
	43.	Fuel Injection Pump Oil				×		

2.14 Troubleshooting Chart

Symptom	Probable Cause	Remedy	Observations
1. Starting Trouble			
Starter motor does not crank the engine	Battery discharge or aged	Recharge/replace battery	
	Dynamo or voltage regulator defective	Repair dynamo, voltage regulator	
	Starter motor or switch defective	Repair or replace	
Starter motor cranks the engine at insufficient speed	Battery discharged or aged	Recharge or replace	
	Dynamo or voltage regulator defective	Repair or replace	
	Electrical connections loose, battery terminals corroded	Tighten electrical connections, clean battery connections, apply petroleum jelly	
	Engine partially seized	Get the engine repaired	Engine noisy when it was stopped earlier
	Lubricating oil too thick for the season	Use the correct grade of lube oil	
Starter motor cranks at sufficient speed, but still engine does not start	Insufficient / no fuel in the tank	Fill up tank	
	Fuel tank breather hole blocked	Clean	
	Low pressure pipes blocked	Clean or replace	
	Air in fuel system (air lock)	Rectify leakage, bleed the system	Once started, engine may stop again
	Filter insert(s) clogged	Replace	
	Overflow valve leaky	Replace	

Symptom	Probable Cause	Remedy	Observations
1. Starting Trouble (continued)			
Starter motor cranks at sufficient speed, but still engine does not start	Pump drive shaft coupling broken	Replace	
	Governor stop-lever not fully disengaged	Rectify	
	Governor linkages loose or broken or restricted	Rectify	
Engine cranking satisfactory, Engine starts with great difficulty	Pump timing wrongly set	Re-adjust	Once the engine starts, there may be knocking sound, overheating, etc.
	Starting delivery from pump insufficient	Get the pump recalibrated/ overhauled	
	Nozzle spray-holes clogged, nozzles sticky, spray unsatisfactorily	Get the nozzles cleaned/reconditioned/ replaced	
	Cold starting / excess fuel device defective	Rectify	
	Engine tappet adjustment incorrect	Re-adjust	
	Air cleaner clogged	Replace/rectify	Black smoke at high loads
	Engine compression low	Get the engine overhauled	Blue smoke at all engine speeds
2. Engine races after starting (speed uncontrollable)			
	Accelerator linkages sticky	Rectify	
	Pump control-rack sticky	Rectify	
	Governor linkages broken	Replace & recalibrate the pump	
	Excess fuel-device button not snapping back to normal position after starting	Rectify/Replace	

Symptom	Probable Cause	Remedy	Observations
3. Engine runs erratically (Surge, Misfire)			
Fuel System	Water in fuel	Replace fuel	Accompanied by engine missing
	Air in fuel	Rectify leakage and bleed the system	
	Restriction in fuel pipes	Clean/ replace	Accompanied by loss of power
	Filter inserts clogged	Replace	
	High pressure pipe leaky /broken	Rectify/replace	
	Idling speed setting not correct	Adjust	Hunting only at idling speed
	Pump timing too retarded	Re-adjust	
	Fuel delivery between cylinders uneven, phasing incorrect	Recalibrate/overhaul the pump	
	Pump control-rack/ toothed quadrants worn out	Replace and recalibrate the pump	
	Injector opening pressure uneven	Re-set the opening pressure	
	Nozzle sticky, spray holes clogged, poor spray	Clean /recondition/replace nozzle	
Engine Problems	Air filter exhaust system clogged	Clean/replace	
	Valves sticky/valve spring broken	Repair/replace	
	Tappet clearance incorrect	Re-adjust	
	Engine compression poor/ uneven	Get the engine overhauled	

Symptom	Probable Cause	Remedy	Observations
4. Knocking-sound in the engine			
Mechanical knocks	Piston rings sticky/seized, engine cylinders/pistons worn out	Get the engine overhauled	Accompanied by loss of power, blue smoke
	Big end/main bearings of engine worn out	Get the engine overhauled	Lubricating oil pressure low
	Tappet clearance excessive	Re-adjust	
	Crankshaft end thrust excessive	Re-adjust	
	Flywheel pressure plate loose	Tighten fixing bolts	
Combustion knocks	Pump timing too much advanced	Re-adjust	Accompanied by erratic running of the engine
	Pump delivery valve spring(s) broken	Replace and recalibrate	
	Pump delivery valve(s) stuck in open position	Replace and recalibrate	
	Injector opening pressure high	Reset	
	Nozzle needle(s) stuck in, open position or nozzle holder spring broken	Replace and test	Excessive whitish smoke from the engine exhaust
	Air cleaner oil level high	Correct the level	
	Engine overheating	Refer point 8	
	Excessive carbon deposits in combustion chamber	Decarbonize	

Symptom	Probable Cause	Remedy	Observations
5. Loss of Power			
Fuel System	Fuel adulterated/wrong grade	Use correct fuel	
	Air in fuel system	Rectify leakage and bleed	
	Water in fuel	Replace fuel	
	Restriction in fuel supply lines	Clean/replace	
	Filter insert(s) clogged	Replace	
	Overflow valve sticky/leaky	Replace	
	Fuel supply from feed pump insufficient	Clean preliminary filters, get the feed pump repaired	
	High pressure pipe leaky/ broken	Rectify/replace	
	Pump timing retarded	Re-adjust	
	Full load/course of delivery less	Recalibrate/overhaul Pump	
	Governor cutting-in speed too low	Re-adjust	
	Injector opening pressure incorrect	Reset	
	Nozzle spray-holes clogged, nozzles sticky, spray pattern unsatisfactory	Clean/recondition/ replace nozzle	

Symptom	Probable Cause	Remedy	Observations
5. Loss of Power (continued)			
Engine Problems	Pump Control lever does not butt against full load delivery /maximum Speed stop screw	Rectify	
	Valve clearance incorrect	Re-adjust	
	Valve sticky, valve springs broken	Rectify, replace	
	Air filter / exhaust system clogged	Replace/Rectify	
	Engine internal friction high, probably due to partial seizure	Get it rectified	Accompanied by engine overheating
	Engine compression low	Get the engine overhauled	Accompanied by blue smoke from exhaust
	Engine overloaded	Avoid overloading	Accompanied by loss of power
6. Fuel Consumption High			
Fuel System	Fuel leaking	Rectify leakage	Black smoke from exhaust
	Pump timing too advanced	Re-adjust	
	Idling speed setting too high	Re-adjust	
	Full load delivery setting too high	Recalibrate / Overhaul the pump	
	Adaption travel incorrect	Recalibrate / overhaul the pump	
	Injector opening pressure low	Re-set	
	Nozzle spray-holes clogged, nozzle sticky, spray unsatisfied	Clean / recondition / replace	
	Nozzle needle lift excessive	Replace nozzles	

Symptom	Probable Cause	Remedy	Observations
6. Fuel Consumption High (continued)			
Engine	Valve clearance incorrect, valves Sticky	Readjust / rectify	
	Air cleaner / exhaust clogged	Clean / Replace	
	Engine internal friction high	Rectify	Accompanied by starting trouble
	Engine compression low	Get the engine overhauled	
7. Excessive Smoke from the Engine Exhaust			
7. (a) Black Smoke			
Smoke at full load at all engine speeds	Full load delivery from pump too high	Recalibrate pump	
	Injector opening pressure too low	Reset	
	Excess fuel device not snapping back to normal position after starting	Rectify	
Smoke at full load and high speed	Adaption travel incorrect	Recalibrate	
	Pump timing retarded	Re-adjust	Engine quieter than normal
	Nozzle lift excessive	Replace nozzle	
Smoke at full load and low speed	Pump timing too advanced	Re-adjust	Engine noisier than normal
Smoke at full load and high speed accompanied by loss of power	Nozzle spray-holes clogged	Clean	
	Air cleaner clogged	Clean/Replace	
	High pressure pipes of incorrect length, bore or deformed end nipples	Change the pipes with those of the correct type	
Intermittent puffing smoke	Nozzle stuck in open position	Clean and reset	Accompanied by knocking
	Nozzle holder spring broken	Replace and reset	

Symptom	Probable Cause	Remedy	Observations
7. Excessive Smoke from the Engine Exhaust (continued)			
7. (b) Blue / Greyish white Smoke			
Blue smoke when accelerating only	Valve guides worn out	Replace	
Blue smoke at all speeds and loads	Worn out piston, piston rings engine bore, etc.	Get the engine overhauled	Accompanied by starting trouble / loss of power
Blue smoke at maximum speed	Oil level in air cleaner high	Correct the level	
Blue or whitish smoke when cold and when starting; changes to black when hot (at all speeds and loads)	Nozzle sprays impinging on cylinder head due to strong fitment	Remove the extra nozzle-sealing washers used. Position the injectors correctly.	
8. Overheating (Check first the temperature-gauge)			
Overheating at high speeds and loads	Full load delivery quantity too high	Recalibrate	Accompanied by Black smoke
	Nozzle needle lift excessive	Replace nozzle	
Cooling system problems	Cooling system leaky, insufficient water	Rectify/replenish	
	Fan belt loose, broken or greasy	Tighten/replace	
	Thermostat stuck	Replace	
Engine	Valve timing incorrect	Re-adjust	
	Pump timing retarded	Re-adjust	
	Piston/piston rings/bearings tight due to wrong assembly or partial seizure	Rectify	
	Valve clearance incorrect	Re-adjust	
	Cylinder head gasket leaky	Replace	
	Exhaust system clogged	Clean	

Symptom	Probable Cause	Remedy	Observations
9. Oil pressure low (Check first with a master oil pressure gauge)			
Oil Problem	Engine oil level low	Top-up as necessary	
	Wrong grade of oil	Drain and refill with correct grade of oil	
Lubricating system problem	Blocked oil pump Strainer	Clean pump screen	
	Oil filter clogged	Replace filter	
	Oil pressure relief valve stuck in open	Repair/replace Plunger	
	Worn gear teeth of oil pump	Replace gear	
	Main/big-end-bearing Worn out	Get the Engine overhauled	
10. Excessive oil consumption			
Oil problem	Engine oil level too high	Reduce oil level	
	Wrong grade of oil	Drain and refill correct grade of Oil	
	External oil leak from Engine	Replace gasket seals where necessary. Check mating surfaces for damage or distortion	
	Worn valves and guides or seals	Replace	
	Head gasket not sealing	Replace gasket, check head for damage or distortion	
	Oil loss past piston and rings	Replace rings replace liners	Blow-bye

Chapter 3 Engine Preservation

3.1 Engine Preservation during Prolonged Period of Non-usage

If the period between engine dispatch from Greaves and the installation is more than six months or if engine is to be non-operational for more than twelve months, the engine has to be preserved to avoid damage due to corrosion, dust, and other factors. Preferably a preserved engine should be covered in plastic sheet and stored in cool dry, shaded place.

Following instructions are to be followed for engine preservation:

i. Run the engine with clean fuel at rated speed at no load for about 10 minutes. This warms up the engine and the lube oil is circulated all over inside the engine.
ii. Stop the engine and immediately drain the oil. Fill up the engine with one of the preservative oils to the low level mark on dipstick. Choose preservative oil from the list given below.
iii. Run the engine at rated speed with no load for 5 minutes.
iv. Make a clean solution of preservative oil and diesel (1: 5 ratio) and connect the mixture to the fuel pump inlet by gravity feed.
v. Drain the coolant from cooling system. Rinse the system thoroughly with clean water. Fill the cooling system with mixture of water and any of the coolant additives listed in the requisite ratio.
vi. Crank the engine and run it at rated speed with no load for half a minute. Stop the engine.
vii. Remove air cleaner, fuel filter and lube oil filter, pack them separately.
viii. Drain preservative oil from sump and refit the drain plug. Drain Water-preservative mixture from cooling circuit. Treat all unpainted open surfaces with rust preventive coats.
ix. Seal all openings with caps, plastic sheets or waterproof paper. Seal the dipstick with the tape.
x. After this point do not rotate the engine.
xi. Remove belts and store separately.
xii. The battery should be disconnected. Ensure electrolyte level. Charge the battery at regular intervals.
xiii. Put a mark on the engine indicating date of preservation.

xiv. Periodically inspect the engine for corrosion, effects of humidity and dirt.

xv. The above procedure has to be repeated after every 12 months.

Manufacturer	Rust Preventive	Cooling System	Lube Oil and Fuel Circuit
Bharat Petroleum	Bharat Rustol 152	Bharat Sherol B emulsion with water (1: 20 ratio)	Bharat Preserve oil 30
Indian Oil Corporation	Servo RP 125	Servo Cut S 20% Emulsion with water	Servo preserves 30. Servo Run-N oil 30
Hindustan Petroleum	Rustop 274	Koolkit 40.5% emulsion with water	Auto run T 120
Veedol	Veedol Rustop IT	Veedol Amulkut 4 Emulsion with water 1:15	Veedol 30/40

Table C3.1 Recommended Preservatives

3.2 Putting a preserved engine back into operation

a. Remove all seals. Clean up the engine. Remove rust preventive coat.
b. Fit air cleaner, fuel filter, Lube oil filter, and belts.
c. Use new filter elements. Apply correct tension to the belts.
d. If rubber components (Hoses, belts, etc.) are cracked or have become brittle, then replace them.
e. Fill up correct grade lube oil up to the high level mark on dipstick.
f. Fill up coolant. Remove trapped air.
g. Connect supply of clean fuel. Remove trapped air.
h. Fit a charged battery. Check the electrical connections.
i. Run the engine at rated speed at no load for 5 minutes. Observe and look for any irregular noise, vibration, etc. If some irregular behavior is observed take corrective actions or call authorized service dealer.
j. If everything found operative and functional then start the engine and put it into service.

SECTION D

ALTERNATOR

SECTION D – ALTERNATOR			
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Chapter 1 Crompton Greaves Alternator

1.1 General Information

The Crompton Greaves Alternator's incorporate advanced European technology and are designed for optimum performance using the most accurate methods of design, manufacturing and testing. If the alternators are used as per recommendations in this manual, you are ensured with a continuous working and a prolonged trouble-free life of the alternator.

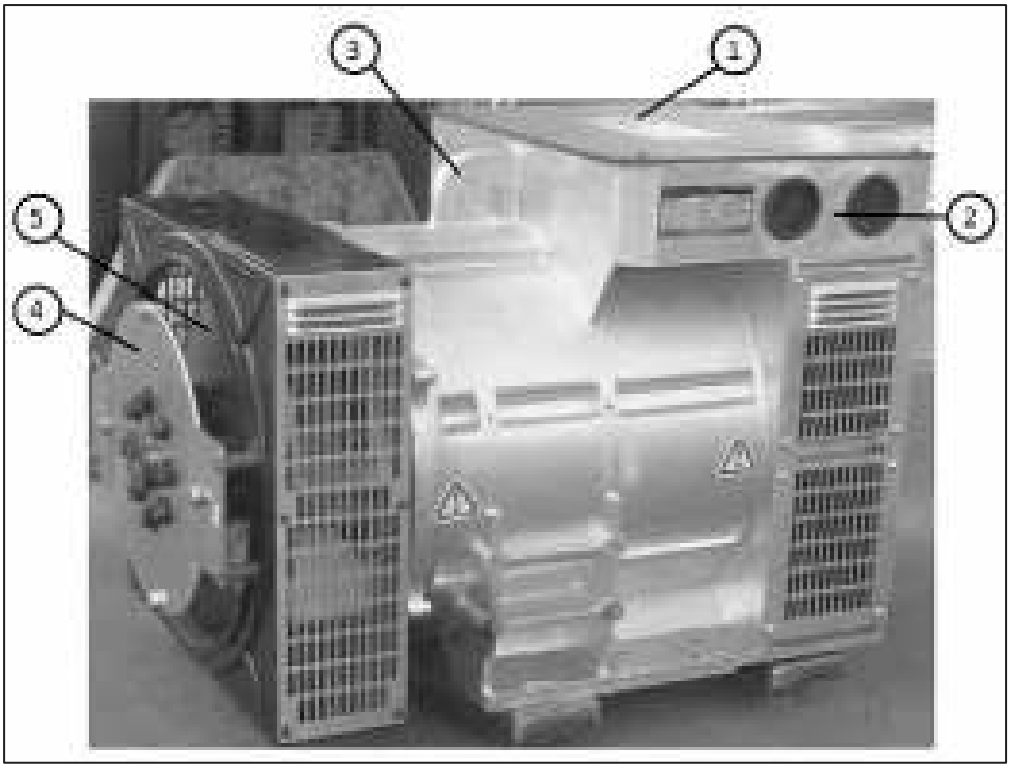


Fig. D1.1 Illustration of Crompton Greaves Alternator

1	Terminal Box Cover	4	Coupling Disk
2	Terminal Board	5	Fan
3	Eye Bolt		

1.2 Specifications

Specifications	Standard	Optional
Rated Voltage	415 V in 3 phase 240 V in 1 phase	Up to 600 V in 3 phase Up to 300 V in 1 phase
Terminals	6 leads	Reconnectable 12 leads
Voltage Regulation	±1%	-
Speed	1500 rpm	1800, 3000, 3600 rpm
Insulation Class	Class 'H'	Class 'F'
Type of Mounting	B3, B2	SAE No.: 0, 1, 2, 3, 4, 5 Disc: 18", 14", 11.5", 10", 8", 7.5"
Degree of Protection	IP 21	IP 23
Duty Rating	Continuous (S1)	-
10% Overload	1 Hr. in 12 Hrs.	-
Parallel Operation provision	> 200 KVA	< 200 KVA
Harmonic Distortion Factor NL L-L	< 2.5%	-
Max. Unbalanced Load	25%	-
TVD at Full Load 0.8 p.f.	15-20%	-
TVR at Full Load 0.8 p.f.	20-25%	-

Table D1.1 Alternator Specification (CG Make)

1.3 Operating Conditions

The alternator is rated for maximum ambient temperature of 40°C and altitude of 1000 meters above sea level. If the ambient temperature exceeds 40°C, a deration factor of 4% should be applied for every 5°C rise in temperature. If the altitude is higher than 1000 meters, a deration factor of 4% should be applied for every 500 meters increase in altitude.

1.4 Ratings Chart

Single Phase Series			
Brushless AC Generators – Voltage Regulation ± 1%			
kVA	Frame (G2R/G1R)	% Efficiency	
		FL	3/4 FL
1 Phase, 230V, 50 Hz, 4 Pole, 1500 RPM, 0.8 pf			
10	160S1B	82.5	83.0
12.5	160SB	82.3	82.8
15	160S2C	84.0	84.5
15	160MC	87.0	87.2
20	160M2R	85.5	85.9
25	200SF	86.0	86.3
30	200SB	87.0	87.5
35	200SC	85.5	86.2
40	200SD	86.0	86.7
Three Phase Series			
Brushless AC Generators – Voltage Regulation ± 1%			
kVA	Frame (G2R/G1R)	% Efficiency	
		FL	3/4 FL
3 Phase, 415V, 50 Hz, 4 Pole, 1500 RPM, 0.8 pf			
10.0	132MC	83.8	84.5
12.5	160S1A	81.0	81.2
15.0	160S1B	83.5	84.5
20.0	160SB	85.5	86.1
25.0	160SC	86.9	87.5
30.0	160M2A	88.5	89.0
35.0	200SE	87.9	88.4
40.0	200SE	88.1	88.8
45.0	200SA	89.0	89.7
50.0	200SB	88.5	89.2
62.5	200SC	90.6	90.9

1.5 Features

1.5.1 Mechanical Features

i. Aluminium frame die-cast stator up to 200 KVA and steel stator for higher frames.
ii. Sturdy cast iron end shields fixed on to the stator frame by 8.8 class high tensile screws.
iii. High quality steel shafts are amply designed to take care of overload and short circuit condition.
iv. Sturdy, dynamically balanced rotors are designed for withstanding the runaway engine speed and ar e with continuous damper cage for high performance under strenuous conditions of parallel operations and non-linear (thyristor) and unbalanced loads.
v. Aluminium fans for effective cooling extend the winding life.
vi. Screens or louvered covers on all openings for safety.
vii. Easy mount SAE Adaptors are offered with single bearing AC Generators to simplify coupling with all popular engines.

1.5.2 Termination

i. Integral terminal box is provided for higher reliability.
ii. Top terminal box with side cable entry ensures wiring flexibility.
iii. Spacious terminal box accommodates all types, including aluminium cables.
iv. Anti-loosening fasteners ensure stable cable terminations.
v. Standard 6 leads for rated voltage and optional reconnectable 12 leads for different voltages in three phase AC Generators.

1.5.3 Automatic Voltage Regulator (AVR)

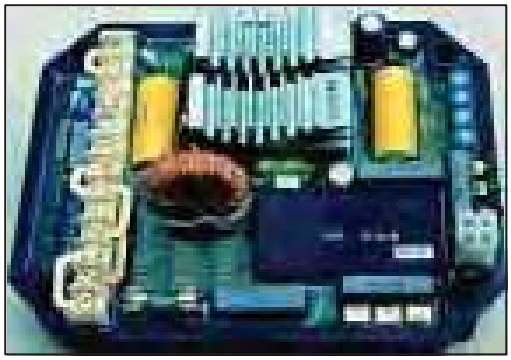


Fig. D1.1 Automatic Voltage Regulator (AVR)

i. Under speed protection with LED indicator.
ii. Over excitation protection with LED indicator.
iii. Designed for thyristor load without additional filter circuits.
iv. Moulded construction for protection against shocks, vibrations and adverse atmospheric conditions.
v. Under speed protection in AVR, protects both the Alternator and the v/f sensitive loads. The AVR has provision for setting the frequency below which voltage dropping occurs linear to speed. This feature also enables the engine to recover the speed faster during motor starting.

1.5.4 Winding and Insulation System

The armature coils of the stator main winding are made from dual coated, class H copper wires. Single layer concentric winding with 2/3rd pitch offers simplicity, reduced overhangs, neat look while reducing voltage distortion and superior capability to cope with non-linear loads. The auxiliary winding in stator provides power to the AVR, improving the motor starting capability of the AC Generator.

The insulation system is class H. All wound components are impregnated in an unsaturated polyester resin of 200 class temperature. The impregnation provides much needed rigidity and protection against the harsh environment, typical for the AC Generators applications. With high mechanical strength provided to the rotating components, the AC Generators withstand over speed of 2250 rpm for 2 minutes.

1.5.5 Radio Interference

The alternator has negligible Radio Frequency interference and meets in general the limits permitted by VDE 0875 (N).

1.5.6 Waveform

The alternator is designed to give an excellent output waveform. The total harmonic content of line-to-line voltage waveform on no load is less than 5%, as per the limits specified by IEC/IS standards.

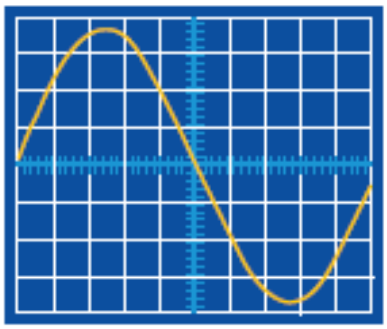


Fig. D1.2 Alternator Waveform

1.5.7 Overload

The alternator is capable of delivering an overload of 10% for one hour after every six hours of running.

1.5.8 Motor Starting Duty

Each kVA of AC Generator is capable of starting 1 HP of Induction Motor on direct on line starting.

1.5.9 Transient Voltage Dip

Sudden application of full load at 0.8 p.f. (lag) results in 15-20% dip in terminal voltage.

1.6 Safety Requirements

i. Before any cleaning, lubrication or maintenance operation, ensure that the GENSET is stationary and disconnected from power supply.

ii. While stopping the GENSET, ensure the compliance with the procedure for stopping the engine (prime mover).

iii. Before installing the alternator, arrangements must be made to earth the machine in compliance with relevant electrical regulations.

iv. For handling unpacked alternators, always use ropes having suitable carrying capacity and do not lift the alternator too much from the floor (max. 30 cm.)

v. The alternator should be securely connected and perfectly aligned with the engine; otherwise unsafe vibrations may occur resulting in alternator bearing failure.

vi. The alternator is designed to ensure the rated output when it is installed in an environment having maximum ambient temperature of 40ºC and at an altitude of 1000 meters. In case of deviation in any of these conditions, appropriate deration should be applied.

vii. The operators in charge of the installations must be skilled technicians who know the characteristics of GENSETS.

viii. The operator must always wear work gloves and safety shoes. In case the alternator or whole GENSET is to be lifted from the floor, the operators must wear safety helmet.

ix. Make sure the GENSET foundation is suitable to bear the combined weight of the alternator and engine.

x. No person should wear fluttering clothes (such as stoles etc.) near the machine and any such garment must be fastened with elastic bands at its ends.

xi. Alternator must never and for no reason is run with following guards removed:
    a. Terminal box cover
    b. Rear cover
    c. Fan ventilation guard

xii. Alternators produce heat proportional to the output. Therefore, do not touch it if you do not wear anti scorch gloves, after switching it off, do not touch until it is cooled down.

xiii. Even if all machine components are protected, keep away from the GENSET. Do not to lean or sit on the alternator for whatever reason.

xiv. The alternator should be cleaned only when it is not live and is at room temperature. It can be cleaned from the outside using compressed air.

xv. Never use liquids or water for inside cleaning.

1.7 Electrical Checks

Before starting kindly make sure,

i. The terminal nuts are properly tightened.

ii. The control panel protection equipment is correctly set.

iii. There is no short circuit due to wrong connections either/or in between the terminals of the alternator and the power switch or breaker (this part of the circuit is not protected by the breaker).

1.7.1 Checking the Insulation Resistance

If the alternator has been stored under damp conditions or has taken a l engthy time in shipment, the insulation resistance must be checked. To check the insulation resistance follow the below mentioned procedure:

i. Remove all external connections including neutral to earth link, if any from the alternator.
ii. Connect a Megger of 500 V DC between any one AC output terminals and the magnet frame.
iii. In case the test reveals an insulation resistance less than 2.0 MΩ (IR value at room temperature); identify the weak winding or component by step by step isolation.

Warning! If the Insulation Resistance (IR) is less than 2 MΩ then the alternator should not be operated.

1.8 Do's and Don'ts

1.8.1 Do's

i. Tighten the foot mounting bolts.
ii. Ensure that the alternator is properly grounded.
iii. Ensure the tightness of terminal bolts.
iv. Check that the body and neutral earthing is perfect.
v. Check that the rating of alternator is matching the load requirement.
vi. Check the voltage and phase sequence during commissioning.
vii. All covers and guards should be fitted before starting the generator.
viii. After servicing the alternator, make sure the connections are as per connection diagram.
ix. Maintain and operate the GENSET correctly.
x. Run the GENSET daily for at least 5-10 minutes on no load.

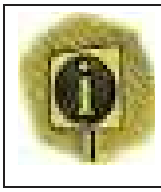
1.8.2 Don'ts

i. Do not load the alternator more than its capacity mentioned on the nameplate.
ii. Do not operate the alternator at a power factor less than 0.8.
iii. Do not start the GENSET on load.
iv. Do not operate the GENSET without covers.
v. Do not block the air inlet and outlet of the GENSET.
vi. Do not keep excessive wiring lengths at the load end.
vii. Do not expose the alternator to moist conditions.
viii. Do not use under rated and low grade cables.
ix. Do not operate the alternator if its Insulation Resistance is less than 2 Mega Ohms.
x. Do not apply capacitive load.
xi. Do not operate the GENSET with the field pole fasteners loose.

1.9 Maintenance

1.9.1 General

The frequency of maintenance depends largely on the site conditions. Frequent maintenance of approximately once a week should be practiced initially and the period extended as experience is gained.



Important Note! The alternator should be completely isolated from all electrically live wires before any electrical or rotating part is touched.

1.9.2 Cleaning

The alternator including the excitation unit should be cleaned internally by blowing out with a blow of dry air and by wiping away any deposits of grease and carbon dust with a clean dry cloth. All fasteners, especially the connectors should be inspected for tightness at regular intervals.

1.9.3 Bearings

The bearings used in the alternator are of sealed type and from reputed manufacturers. Thus they don't require greasing. The bearings are designed for approximately 40,000 hours of operation and should be replaced after that. However, in case high bearing noise is observed or leakage of grease is noticed, it is strongly recommended that the bearing to be checked and replaced immediately to prevent failure during running, as this could cause irreversible damage to the GENSET.

1.10 Troubleshooting

1.10.1 Electrical Failure Troubleshooting

When an electrical failure occurs, following should be checked:

i. In order to find out if the failure has o ccurred in the alternator itself or in the regulation system, you should test the alternator on no load (at nominal speed), exciting the exciter stator directly using an external DC source.

ii. When applying DC voltage to the exciter stator, you should comply with following polarities: apply negative (-) polarity of the auxiliary source to the negative terminal and positive polarity of auxiliary source to the positive terminal of exciter field.

iii. Verify that when feeding the winding according to the excitation data at no load, the voltage supplied by the alternator is almost the rated one.

1.10.2 Troubleshooting Chart

Fault	Cause	Repair
No Voltage build-up	Insufficient residual voltage	Excite the rotor using a battery
	Improper connection	Correct the connection
	Low speed	Reset the speed to nominal
	Faulty winding	Check the winding resistance and rewind if required
	Rotating Rectifier failure	Replace the rotating rectifier
	Faulty AVR	Replace the AVR
Low Voltage on No Load	Low speed	Reset the speed to nominal
	Faulty rotating rectifier	Replace the rotating rectifier
	Faulty winding	Check the winding resistance and rewind if required

Fault	Cause	Repair
Low Voltage on Load	Low speed at full load	Set the rated speed of the engine
	Faulty AVR	Replace the AVR
	Faulty rotor winding	Check the winding resistance and rewind if required
	Overload on alternator	Operate on specified load
High Voltage on Load	Capacitors on the load side	Disconnect Power Factor improvement capacitors
	Faulty AVR setting or AVR faulty	Correct the setting/Replace the AVR
Too High Voltage on No Load	Excessive speed	Adjust the revolving speed
	Faulty AVR setting	Correct the setting/replace the AVR
Voltage Oscillations	Incorrect AVR setting	Set the AVR stability pot
	Thyristor load more than specified limits	Reduce the Thyristor load
Unbalanced Voltage	Unbalanced load	Correct the load
	Loose connections	Tighten the connections
	Stator winding faulty	Check the winding resistance and rewind if required
Excessive overheating of one or both bearings (temperature of bearings over 80°C) (with or without noise)	Set misalignment	Align the set properly
	Bearing loose in end shield housing	Replace the faulty end shield

Fault	Cause	Repair
Excessive overheating of alternator frame	Air flow (inlet/outlet) partially clogged or hot air is being circulated either from alternator or engine	Clean the inlet/outlet of the alternator
	Alternator operating at high voltage on load	Set the voltage at rated value
	Alternator overloaded	Operate at specified load
	Load power factor less than 0.8 lag	Correct the load power factor
Excessive vibrations	Defective mounting or play in the coupling	Replace the coupling and c heck the alignment. Reset the speed to nominal.
Excessive vibrations and humming noise coming from the alternator	Three phase alternator is loaded on one phase in excess of acceptable limits	Check and correct the load
	Start up w ith no load: if humming persists, faulty stator winding	Rewind the stator
Smoke, sparks or flames coming from the alternator	Short circuit in the external circuit (including wiring between alternator and control panel)	Stop the set immediately and rectify the short circuit
	Object fallen into the alternator causing short circuit or flash in the stator winding	Stop the set immediately and remove the object and check the alternator for further problems caused by the object

Table D1.2 Alternator (CG Make) Troubleshooting

Chapter 2 Stamford Alternator

2.1 General Information

This topic explains Stamford BC16/18 range alternators that are of brushless rotating field design, self-excited and self-regulated AVR controlled. However, optionally, as per requirement you can also order for alternators with any of the following variations:

a. Double bearing
b. Brush type
c. Transformer controlled
d. Class 'F' winding
e. With PMG

Fig. D2.1 Stamford Alternator

2.2 Specifications

Specifications	Standard	Optional
Rated Voltage	415 V in 3 phase 230 V in 1 phase	Up to 690 V in 3 phase
Terminals	6 leads	Reconnectable 12 leads
Voltage Regulation	±1.5%	-
Speed	1500 rpm	1800, 3000, 3600 rpm
Insulation Class	Class 'H'	Class 'F'
Degree of Protection	IP 23	-
Duty Rating	Continuous	-
10% Overload	1 Hr. in 12 Hrs.	-
Harmonic Distortion Factor NL L-L	< 3%	-
Max. Unbalanced Load	15%	-
TVD at Full Load 0.8 p.f.	15% max at linear load	-
TVR at Full Load 0.8 p.f.	15% max at linear load	-

2.3 Ratings Chart

The alternator is rated for maximum ambient temperature of 40°C and altitude of 1000 meters above sea level.

Single Phase Series		
Brushless AC Generators – Voltage Regulation ± 1%		
kVA	Frame	% Efficiency @FL
1 Phase, 230V, 50 Hz, 4 Pole, 1500 RPM, 0.8 pf		
10	PI044H	76.4
12.5	PI144E	78.1
15	PI144E	78.1
20	PI144H	81.5
25	PI144K	82.4
30	UCI224D	77.6
35	UCI224E	79.0
40	UCI224E	79.0
45	UCI224F	81.2
Three Phase Series		
Brushless AC Generators – Voltage Regulation ± 1%		
kVA	Frame	% Efficiency
3 Phase, 415V, 50 Hz, 4 Pole, 1500 RPM, 0.8 pf		
10.0	PI044E	80.8
12.5	PI044F	82.3
15.0	PI044G	82.1
20.0	PI144D	85.3
25.0	PI144E	85.2
30.0	PI144G	86.7
35.0	Not Available	N/A
40.0	PI144K	88.1
45.0	UCI224D	88.5
50.0	UCI224D	88.5
62.5	UCI224E	89.1

2.4 Construction

2.4.1 Stator Frame

The Stator frame is made of sheet metal which reduces the overall weight of the machine and is aesthetically better. The sheet metal enclosures are fixed on the steel bars welded on the stator core.

2.4.2 Stator Core

The stator core is made of high quality low content silicon steel stampings with C-4 coating for better welding of core packs. These are oriented 90 deg. After every one fourth length for better magnetic properties. The slots are skewed to reduce the tooth ripples in the voltage wave form.

2.4.3 Stator Winding

The armature coils are made from dual coated, class 200 copper wire & wound with a 2 /3 pitch. The $2/3^{rd}$ pitch winding eliminates the effect of triple n harmonics. This reduces the voltage distortion and increases the capability of the alternator to cope with non-linear loads.

2.4.4 Stator / Insulation System

The insulation system is class H. All wound components are impregnated in an unsat urated polyester resin with processes designed specifically to provide protection against the harsh environment encountered in the generator applications. Resins are selected and developed to provide the high build required for static windings and the high mechanical strength required for the rotating components. The rotating components can withstand on over speed of 2250 rpm for three minutes.

2.4.5 Rotor Core

The Rotor core is made of high quality low content silicon steel stampings. The poles carry continuous damper windings to facilitate parallel operation.

2.4.6 End Shields

End shields are of cast iron construction and are fixed by easily accessible high tensile bolts.

2.4.7 Bearings

The bearings used are of sealed bearing type. The bearing life is 30,000 hours of operation and is subject to working conditions and environment. High axial vibration from the engine or misalignment of the set will also stress the bearing reducing its life.

2.4.8 Shaft

The shaft is made of high quality grade steel. The shaft is liberally designed for overload and short- circuit conditions.

2.4.9 The Rotating Rectifier Assembly

The rotating rectifier consists of the rectifier hub made of dough moulding compound, the rectifier fins and the rectifier diodes which is specially designed to withstand the centrifugal forces during rotation. The surge suppresser fitted across the field ensures the protection of the diodes in case of surges.

2.4.10 Terminals and Terminal Box Assembly

Standard generator is 3 phase reconnectable with 12 ends brought to the terminals. AVR is fitted on the NDE panel of the terminal box as a standard supply. The terminal box has removable panels for easy access.

2.4.11 Enclosure

IP23 is standard for all industrial generators. The machine is protected against spraying water i.e. water falling as a spray at an angle upto 600 from the vertical shall have no harmful effect. Air filters are available as an option for all generators at reduced rating (5% de-rate).

2.4.12 Balancing

All generator rotors are dynamically balanced to better than Grade 2.5 (BS 6861: Part 1) for minimum vibration in operation.

2.4.13 Radio Interference

The absence of brush gear and the high quality of AVR design ensure low levels of interference with radio transmission. Additional RFI suppression kit can be supplied if required.

2.4.14 Step Load Capability

Additional function controls of DIP and D WELL are provided to enable the load acceptance capacity of the generator set to be optimised. The Dip feature is available in SX421, MX341 & MX321 AVR's & the DWELL feature in MX321 AVR. The Dip feature helps to reduce the block load coming on the engine & the DWELL introduces a time delay in the recovery of voltage to allow the engine to have an improved speed recovery.

2.5 Operating Principle

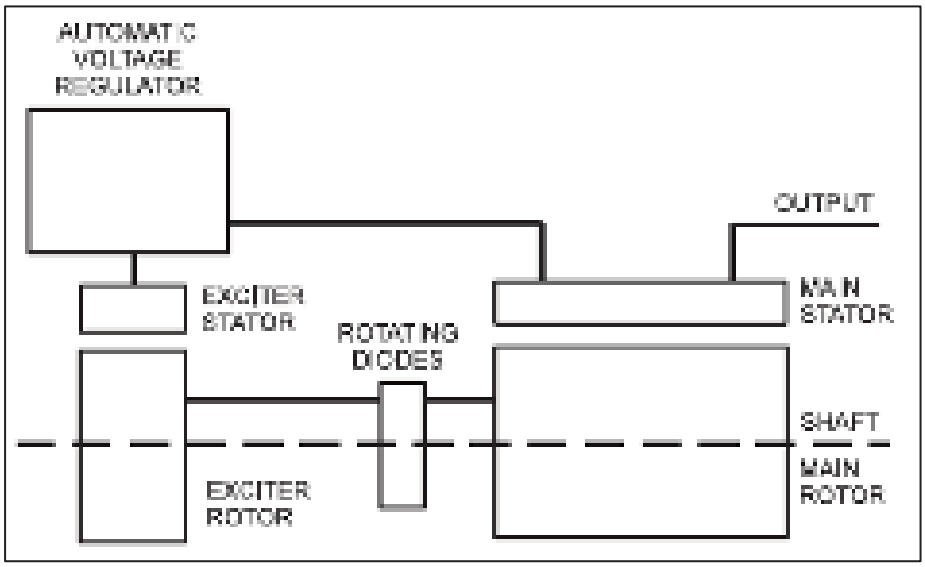


Fig. D2.2 Operating Principle

The main stator provides power for excitation of the exciter field via the SX460 (SA465) AVR which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage sensing signal derived from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature.

The AVR senses average voltage on two phases ensuring close regulation. In addition to this it detects engine speed and provides voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and so ftening the effect of load switching to relieve the burden on the engine.

2.6 Automatic Voltage Regulator (AVR) – SX460

AVR is a controlling device, which governs the level of excitation provided to the exciter field. The AVR responds to a voltage sensing signal derived from the main stator winding. AVR senses average voltage on two phases ensuring close regulation. In addition to this, it detects engine speed and provides voltage fall off with speed, below pre-selected speed setting, preventing over- excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine. The AVR is fully encapsulated to withstand humid and corrosive atmospheric conditions.

2.6.1 Technical Specifications of AVR

Input Parameters	**Description / Value**
Voltage	Jumper Selectable 95 – 132 V AC or 190 – 264 V AC
Frequency	50 – 60 Hz nominal
Phase	1
Output Parameters	**Description / Value**
Voltage	Max. 90 V DC or 207 V AC
Current	Continuous 4 A DC Intermittent 6 A for 10 sec
Resistance	15 ohms minimum
Regulation	+/-1.0 %
External voltage adjustment	+/-10 % with 1 KΩ 1 watt trimmer
Under frequency protection	Yes
Set Point	97% of 50 Hz
Build up voltage	4 V @ AVR Terminals
Environmental Parameters	**Description / Value**
Operating Temperature	-40° to +70°C
Storage Temperature	-55° to +80°C
Relative Humidity 0 – 70°C	95%

2.6.2 AVR Connections

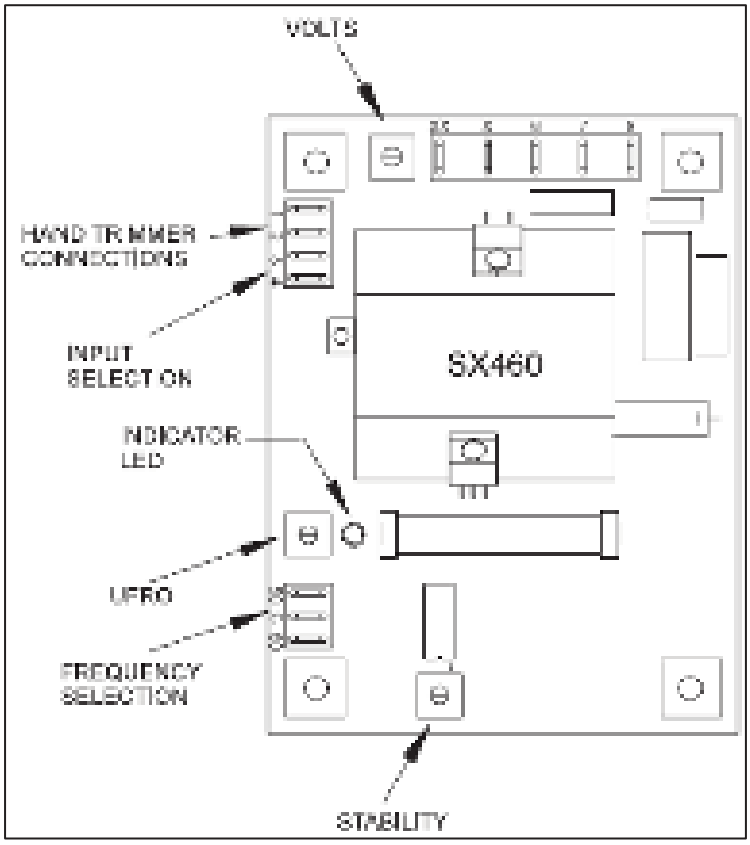


Fig. D2.3 SX460 AVR Connection Diagram

The following 'jumper' connections on the AVR should be checked to ensure that they are correctly set for the generating set application.

i. **Frequency Selection**
   a. 50 Hz operation – LINK C-50
   b. 60 Hz operation – LINK C-60

ii. **External Hand Trimmer Selection**
   a. No external hand trimmer – LINK 1-2
   b. External hand trimmer – REMOVE LINK 1-2 & connect trimmer across terminals 1 & 2

iii. **AVR Input Selection**
   a. High Voltage (220/240 V) – INPUT No Link
   b. Low Voltage (110/120 V) – INPUT Link 3-4

2.6.3 AVR Settings

Most of the AVR adjustments are factory set in positions which will give satisfactory performance during initial running test. Subsequent adjustments may be required to achieve optimum performance of the set under operating conditions. Following potentiometer settings are provided on the AVR:

i. **Volt**

This potentiometer is used to adjust the output voltage of the alternator. Start the generator and run it on no load at nominal frequency. Slowly turn VOLTS potentiometer clockwise until rated voltage is reached.

ii. **Stability**

The STABILITY control potentiometer is preset and sho uld normally not require adjustments, but should this be required, usually identified by oscillations of the voltmeter, proceed as follows:

a. Run the generator on no load and check that the speed is correct and stable.
b. Turn the STABILITY control potentiometer clockwise; then turn slowly anti-clockwise until the generator voltage starts becoming unstable. The correct setting is slightly clockwise from this position. (i.e. the machine volts are stable but close to the unstable region)

iii. **Under Frequency Roll Off (UFRO)**

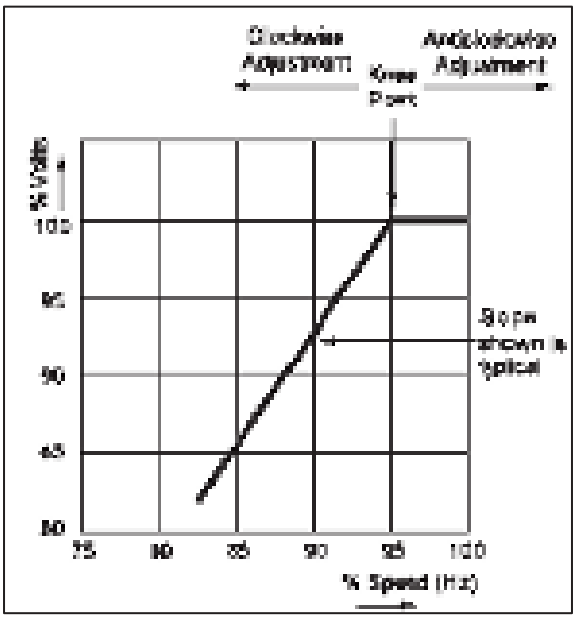


Fig. D2.4 Graph Illustrating Under Frequency Roll Off

The UFRO control potentiometer sets the “Knee point”. Symptoms of incorrect settings are:

a. The LED indicator just above the UFRO control potentiometer, being permanently lit when the generator is on load.
b. Poor voltage regulation on load, i.e. operation on the sloping part of the characteristics.

Clockwise adjustment lowers the frequency (speed) setting of the “Knee point” and extinguishes the LED. For optimum setting the LED should illuminate as the frequency falls just below the nominal frequency, i.e. 47 Hz on a 50 Hz generator.

2.7 Typical Single Bearing Alternator Exploded View

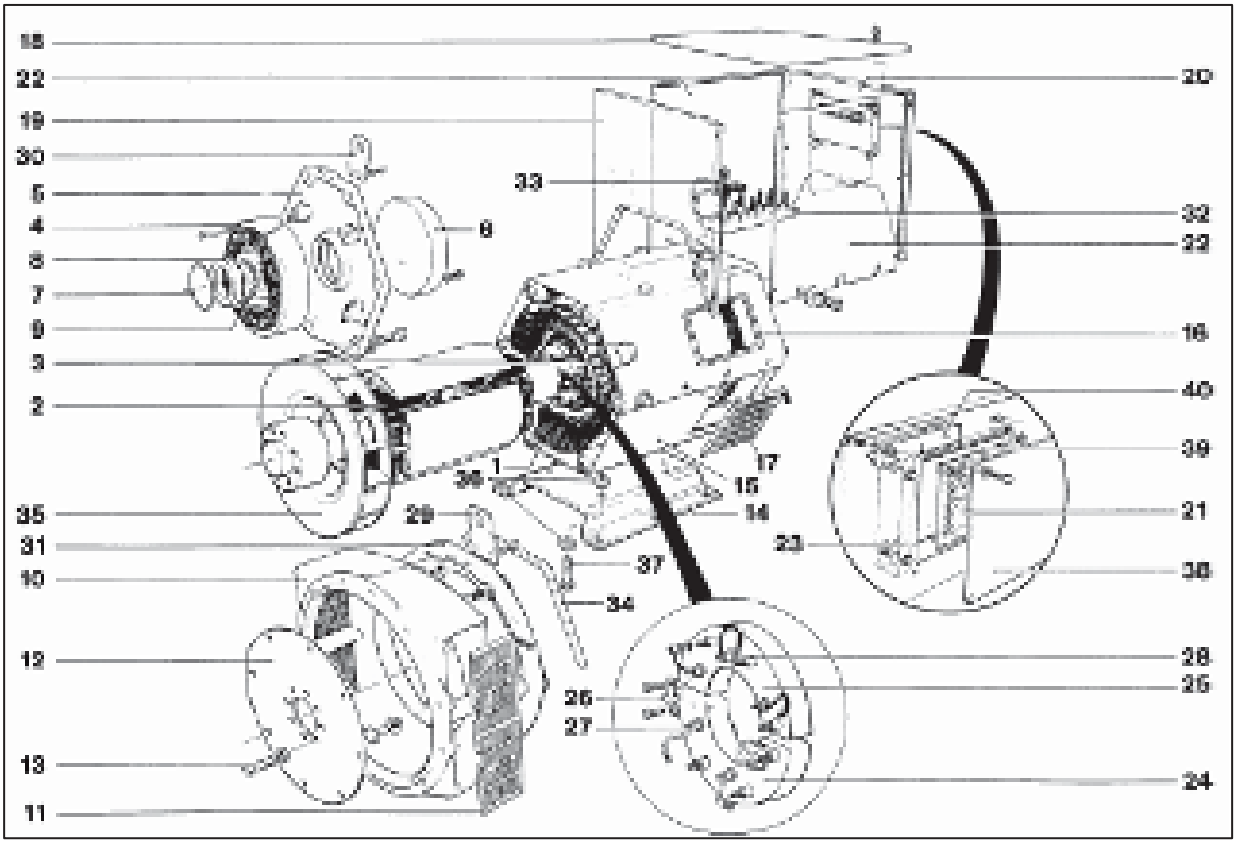


Fig. D2.5 Typical Single Bearing Generator / Alternator Exploded View

Note: Below mentioned is the description of acronym used in the part list of single bearing alternator.

1. N.D.E. – Non Driven End
2. D.E. – Driven End
3. AVR – Automatic Voltage Regulator

Ref. No.	Description	Ref. No.	Description
1	Stator	21	AVR
2	Rotor	22	Side Panel
3	Exciter Rotor	23	AVR Mounting Bracket
4	Exciter Stator	24	Main Rectifier Assembly-Forward
5	N.D.E. Bracket	25	Main Rectifier Assembly-Reverse
6	Cover N.D.E	26	Varistor
7	Bearing 'O' Ring N.D.E.	27	Diode-Forward Polarity
8	Bearing N.D.E	28	Diode-Reverse Polarity
9	Bearing Circlip N.D.E.	29	Lifting Lug-D.E.
10	D.E. Bracket/Engine Adapter	30	Lifting Lug-N.D.E.
11	D.E. Screen	31	Frame to End Bracket Adaptor Ring
12	Coupling Disc	32	Main Terminal Panel
13	Coupling Bolt	33	Terminal Link
14	Foot	34	Edging Strip
15	Frame Cover Bottom	35	Fan
16	Frame Cover Top	36	Foot Mounting Spacer
17	Air Inlet Cover	37	Cap Screw
18	Terminal Box Lid	38	AVR Access Cover
19	End Panel D.E.	39	AVR Anti Vibration Mounting Assembly
20	End Panel N.D.E.	40	Auxiliary Terminal Assembly

Table D2.1 Part List of Typical Single Bearing Generator

2.8 Maintenance

2.8.1 General

The machine should be stopped and isolated from all supplies before any electrical or rotating part of it is touched. The frequency with which maintenance is required depends to a large extent upon the site conditions. Frequent maintenance (say once a week) should be practiced at first and the period extended as experience is gained.

2.8.2 Cleaning

The alternator and excitation unit should be periodically cleaned internally by blowing out with a jet of dry air and by wiping away any deposits of grease and carbon dust with a clean dry cloth. At less frequent intervals, all nuts and screws should be checked to ensure that they are tight, especially the connections.

2.8.3 Pre-Running Checks

1. **Insulation Checks:**

   Before starting the GENSET, both after completing assembly and after installation of the set, test the insulation resistance of the windings. To check the insulation resistance follow the procedure as below:

   a. Disconnect all electronic components, AVR, electronic protection equipment etc.
   b. Short the diodes on the rotating rectifier assembly.
   c. Disconnect any earthing conductor connected between neutral and earth.
   d. Connect one terminal of the Megger earth.
   e. Connect other terminal to the winding terminal.
   f. The measured value of insulation resistance for all windings to earth and phase to phase should be minimum 1 MΩ.

2. **Voltage and Frequency:**

   Check that the voltage and frequency levels required for the GENSET application are as indicated on the alternator nameplate.

2.8.4 Residual Voltage Check (Field Flashing)

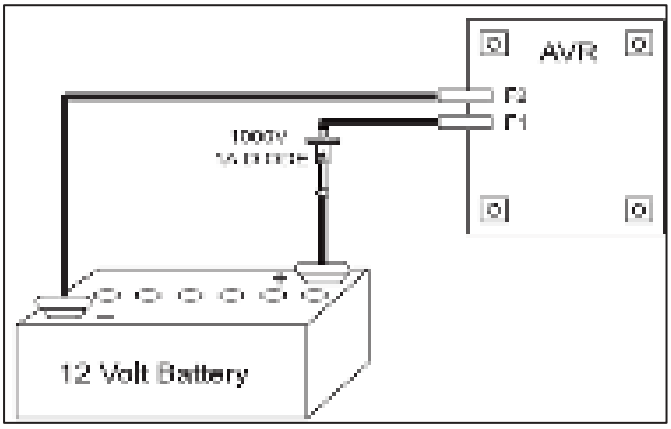


Fig. D2.6 Illustration of Residual Voltage Check

To check the residual voltage, follow the below mentioned procedure:

i. With the GENSET stationary, remove the AVR access cover and leads F1 and F2 from the AVR.
ii. Start the set and measure the voltage across AVR terminals 7-8. A minimum level of 5 V is required at these terminals.
iii. If the voltage is less than 5 V, stop the GENSET because it will be necessary to carry out Field Flashing.

To carry out the field flashing, follow the below mentioned procedure:

i. Replace leads F1 and F2 terminals on the AVR with 12 V DC battery supply. Connect battery negative to F2 and from battery positive through a diode to F1.
ii. Start the GENSET and no te the output voltage from the main stator. It should be approximately the nominal voltage, or voltage at AVR terminals 7 & 8 which should be between 170 and 250 V.
iii. Stop the GENSET; remove the battery supply from terminals F1 and F2.
iv. Restart the GENSET. The GENSET should now operate normally.
v. If no voltage builds up is obtained it can be assumed that a fault exists either in the alternator of AVR circuit.
vi. Follow separate excitation procedure to check the alternator windings, rotating diodes and AVR.

2.8.5 Separate Excitation Test Procedure

The alternator windings, diode assembly and AVR can be checked using appropriate procedures given in this section.

2.8.5.1 Checking Alternator windings and rotating diodes:

The procedure mentioned below is carried out with leads F1 and F2 disconnected at the AVR and using a 12 Volt DC supply to leads F1 and F2.

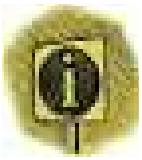
a. Start the set and run at rated speed, on no-load.
b. Measure the voltages at the main output terminals U, V and W. These should be balanced and within 10% of the generator nominal voltage.

1. **Balanced Main Terminal Voltage:** If all voltages are balanced with 1% at the main terminals, it can be assumed that all exciter windings, main windings and main rotating diodes are in good order, and the fault is in the AVR. If voltages are balanced but low, there is a fault in the main excitation windings or rotating diode assembly. Proceed as follows to identify:
    a. **Rotating Diodes:** The diodes on the main rectifier assembly can be checked with a multi-meter. The flexible leads connected to each diode should be disconnected at the terminal end, and the forward and reverse resistance checked. A healthy diode will indicate a very high resistance (infinity) in the reverse direction, and a low resistance in the forward direction. A faulty diode will give a full deflection reading in both directions with the test meter on the 10,000 ohms scale, or an infinity reading in both directions. On an electronic digital meter a healthy diode will give a low reading in one direction, and a high reading in the other.
    b. **Replacement of Faulty Diodes:** The rectifier assembly is split into two plates, the positive and negative, and the main rotor is connected across these plates. Each plate carries 3 diodes, the negative plate carrying negative biased diodes and the positive plate carrying positive biased diodes. Care must be taken to ensure that the correct polarity diodes are fitted to each respective plate. When fitting the diodes to the plates they must be tight enough to ensure a good mechanical and electrical contact, but should not be over tightened. The recommended torque tightening is 4.06 – 4.74 Nm (36-42 lb-in).

c. **Surge Suppressor:** The surge suppressor is a metal–oxide varistor connected across the two rectifier plates to prevent high transient reverse voltages in the field winding from damaging the diodes. This device is not polarized and will show a virtually infinite reading in both directions with an ordinary resistance meter. If defective this will be visible by inspection, since it will normally fail to short circuit and show signs of disintegration. Replace if found faulty.

d. **Main Excitation Winding:** If after establishing and correcting any fault on the rectifier assembly the output is still low when separately excited, then the main rotor, exciter stator and exciter rotor winding resistances should be checked, as the fault must be in one of these windings. The exciter stator resistance is measured across leads F1 and F2 . The exciter rotor is connected to six studs which also carry the diode lead terminals. The main rotor winding is connected across the two rectifier plates. The respective leads must be disconnected before taking the readings. Incorrect resistances indicate faulty windings and component replacement is necessary.

2. **Unbalanced Main Terminal Voltage:** If voltages are unbalanced, this indicates a fault on main stator winding or main cables to the circuit breaker. Measure insulation resistance between sections and each section to earth. Unbalanced or incorrect winding resistances and/ or low insulation resistances to the earth indicate rewinding or the stator will be necessary.

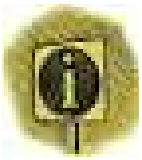
	**Important Note!** Faults on the stator winding or cables may also cause noticeable load increase on the engine when excitation is applied. Disconnect the main cables and separate the winding leads U1-U2, U4-U6, V1-V2, V5-V6, W1-W2, and W5-W6 to isolate each winding section.

2.8.5.2 Excitation Control Test:

AVR function test procedure is as mentioned below:

i. Remove exciter field leads F1 & F2 from the AVR terminals F1 & F2.
ii. Connect a 60W, 240V household lamp to AVR terminals F1 & F2.
iii. Set the AVR Volts control potentiometer fully clockwise.
iv. Connect a 12 V; 1.0 A DC supply to the exciter field leads F1 & F2 with F1 to the positive.
v. Start the generating set and run at rated speed.
vi. Check that the generator output voltage is within ± 10% of rated voltage.
vii. Voltage at AVR terminals 7-8 should be between 170 and 250 volts. If the generator output voltage is correct but the voltage on terminal 7-8 found low, check auxiliary leads and connections to main terminals.

The lamp connected across F1-F2 should glow. In the case of this AVR the lamp should glow continuously. Failure to turn off indicates faulty protection circuit and the AVR should be replaced. Turning the 'VOLTS' control potentiometer fully anti-clockwise should turn off the lamp. If the lamp failed to light, the AVR is faulty and must be replaced.

	**Important Note!** After excitation control test turn the VOLTS control potentiometer anti-clockwise.

2.9 Troubleshooting Chart

Fault	Cause	Repair
No Voltage build-up when starting the set	Low speed	Check speed
	No residual voltage	Check residual voltage, follow separate excitation procedure to check the alternator and AVR
Unstable voltage either on no load or with load	Unstable speed	Check speed stability, Check stability setting
High voltage either on no load or with load	Low speed	Check speed
	Capacitive load (leading power factor)	Remove capacitive load
High voltage on load	Capacitors on the load side	Disconnect Power Factor improvement capacitors
	Faulty AVR setting or faulty AVR	Correct the setting/Replace the AVR
Low voltage on no load	Low speed	Check speed, Check link 1-2 or external hand t rimmer leads for continuity

Chapter 3 Standard Reference Conditions

3.1 Temperature

The Alternators are designed for an am bient temperature of 40°C. Outputs are normally quoted at 40°C. These outputs must be multiplied by the following factors for higher ambient temperatures. (Refer table D3.1)

Temperature in Deg. Celsius	Multiplier
45	0.97
50	0.94
55	0.91
60	0.88

Table D3.1

3.2 Altitude

Above 1000 m, the effectiveness of the air is reduced sufficiently to make derating necessary. For altitudes above 1000 m, outputs must be multiplied by the following factors. (Refer table D3.2)

Altitude in Meters	Multiplier
1500	0.97
2000	0.94
2500	0.91
3000	0.88
3500	0.85
4000	0.82

Table D3.2

Chapter 4 Optional Equipment

4.1 Anti-Condensation Heaters (Space Heaters)

Space Heaters are recommended in areas of high humidity. In such areas, condensation or dew forms on surfaces that are cooler than ambient temperature. To avoid this, space heaters can be fitted which ensure that the winding temperature remains few degrees above the ambient temperature, thus avoiding condensation. Note that the space heaters should be ON only when the GENSET is off and they should be turned off when the GENSET is in use. The space heaters can be retrofitted at site.

4.2 Air Filters

At site conditions where the air may be heavily loaded with fine dust or sand, it is strongly recommended that an air filter be fitted at the alternator air inlet. The sizing of these air filters is important to avoid airflow restrictions and advice should be sought from authorized Greaves Sales and Service dealer.

Chapter 5 General Comments on the Load Conditions

It is advisable to forward a completed copy of specification (if available) to the works for study of the actual requirement for which the GENSET is required. As a result of such an assessment, it is sometimes possible to incorporate design changes to provide a more economic system that will meet your specifications. There are two basic conditions that should be checked while sizing the machines:

I. The Steady-State Condition, and
II. The Transient Condition

Steady state condition is mainly concerned with normal operation of the machine within temperature rise limits for specified class of insulation.

The transient condition refers to terminal voltage variations during sudden application of high current loads like induction motor starting, etc.

It is essential that both these conditions are checked, as so metimes a r ating sufficient for steady state condition is not large enough to meet the motor starting or voltage dip requirements.

5.1 Selection of Generator for different Load Applications

The GENSET'S should be capable of supplying sufficient power to different types of loads that exist at the sites. For this, a suitable rating generator selection is very important. The types of loads that generally exist at sites can be broadly classified under following categories:

i. Linear Loads
ii. Motor Loads (Part of Linear load, considered separately)
iii. Non-Linear Loads
iv. Special Loads

5.1.1 Linear Loads

Linear Loads can be identified from the following characteristics:

iii. Load impedance is always constant regardless of the applied voltage.

iv. The load current increases proportionately as the voltage increases and decreases as the voltage decreases.

Examples of linear loads are motor, incandescent lighting and heating loads.

5.1.1.1 Selection of Alternator for Linear Loads

To select the rating of Alternator for linear loads, the maximum connected load and the base load which is always connected is to be considered. In arriving at a total load figure it is always advisable to select the standard rating larger than that estimated, despite the fact that all the loads may not be operating at the same time hence a smaller machine could have been selected. Future operating conditions and future growth requirement is very difficult to estimate. An allowance of 15% to 20% excess capacity is in general recommended to accommodate the future growth in power requirement.

5.1.1.2 Power Factor

The nature of applied load dictates the system power factor.

i. **Unity Power Factor:** The loads which operate at or are very close to unity (1.0) power factor include most forms of lighting, heating elements and rectifier type loads.

ii. **Lagging Power Factor:** For all remaining loads, some knowledge on their operating power factor is required. For induction motors, the operating power factor is lagging and it depends on their size and load conditions.

iii. **Leading Power Factor:** For Capacitor loads, the power factor is leading.

The Crompton Greaves alternators are designed for 0.8 lag operating power factor of load. Also, these alternators can operate satisfactorily at any power factor in the range of 0.8 to unity, but care should be taken for engine rating for pure resistive loads to operate the GENSET on its full capacity. Under leading power factor loads, these alternators will not perform satisfactorily and the terminal voltage may shoot up or oscillate. Hence care should be taken to disconnect the power factor improvement capacitors or to compensate with inductive loads such that the overall operating power factor lies between unity to 0.8 lag.

5.1.2 Motor Loads

Induction motors are the most commonly used loads. During the starting of an induction motor, a very large current is demanded from the power source which is known as the starting or locked rotor current. For sizing alternators which have to cater motor loads, following guidelines can be referred as detailed out in table D5.1.

Method of Starting	Starting Current
Direct on Line (DOL)	6 to 7 times full load of motor (if starting current is not given, starting KVA is 7 times the HP rating of the motor)
Star/Delta	2 to 2.5 times full load of motor
Rotor/Transformer Starting	
40% tapping	1.2 times full load current
60% tapping	4 times full load current
80% tapping	4.5 times full load current

For Motor starting following information should be furnished:

i. Rating of the motors(s)
ii. Type of motor (slip ring/squirrel cage)
iii. Method of starting
iv. Rated full load current
v. Starting power factor
vi. Any restriction on Transient Voltage Dip (Details of the same)
vii. Frequency of starting
viii. Base load at the time of starting induction motor
ix. Any other load apart from the motor loads (Details thereof)
x. Sequence of starting the motors

5.1.3 Non Linear Loads

Non-linear loads are generally electronic loads such as Rectifier loads, Thyristor controlled drives, UPS, Battery chargers etc. The basic characteristics of non-linear loads are:

i. The load current is not proportional to the instantaneous voltage. Often load current is not continuous.
ii. These are essentially electronic loads such as Computers, UPS equipment, variable speed drives etc.

5.1.3.1 Effects of Non-Linear Loads

i. Non-linear loads generate harmonics in their current waveform which in turn leads to distortion of the Generator waveform. This results in excessive heating of the magnetic cores because of heavy hysteresis and eddy current losses.
ii. Odd order of harmonics cause overload of neutral conductors.
iii. These create problem of hunting of terminal voltage, which makes paralleling of generators difficult or at times impossible.
iv. Non-Linear loads cause damage of the power factor improvement capacitors.
v. Correct measurement of electrical parameters like voltage, current etc. becomes difficult.
vi. Depending on the degree of voltage waveform distortion, non-linear loads can lead to instability of the excitation system and impact other loads that are powered by the GENSET.

5.1.3.2 General Guidelines on Duration for Non-Linear Loads

Load Type	Deration Factor
Fluorescent lamps	No deration required
UPS & Telecom load controlled by a 12 pulse thyristor bridge plus a filter	Non-Linear Load should not exceed 90% of alternator rating
UPS & Telecom load controlled by a 6 pulse thyristor bridge plus a filter	Non-Linear Load should not exceed 66% of alternator rating
UPS & Telecom load controlled by a 3 pulse thyristor bridge plus a filter	Non-Linear Load should not exceed 66% of alternator rating
Variable speed 6 pulse thyristor bridge controlled drive	Non-Linear Load should not exceed 50% of alternator rating

Table D5.1

The above percentage figures mentioned in table D5.1 are merely guidelines. Better sizing of the GENSET is possible on considering the following parameters:

i. Number of pulses of Thyristor drive: 3, 6 or 12
ii. What is the level of current distortion produced by the non-linear load?
iii. What is the maximum acceptable level of voltage distortion the non-linear load can accept?
iv. What is the operating voltage and frequency?
v. If non-linear load power requirement is stated in kW, then some guidance regarding operating power factor and system efficiency is required to establish the alternator load.

5.1.4 Special Loads

Apart from Linear and Non-Linear loads there are certain types of loads which needs consideration during the alternator selection. Some of these are explained below:

5.1.4.1 Computer Loads

Computer loads are very sensitive to the characteristics such as voltage variation, harmonic contents, voltage unbalance etc. of the power supply. If these characteristics do not match with the stipulated figures, malfunctioning of the computers may result. For this reason, the selection of alternator for this application required careful study. It is recommended to have separate GENSET'S for computer loads.

Following information should be supplied for selecting a suitable alternator for computer loads:

i. Total kVA rating of the computer load and its operating power factor.
ii. Acceptable steady state and transient state voltage and frequency variation.
iii. Details of other types of loads existing.

5.1.4.2 Welding Loads

Welding loads draw heavy intermittent current from the alternator. Most of the welding loads are designed for single phase 240 V or two phase 415 V. Welding loads stress the alternator because of their low power factor.

Following information should be supplied for selecting a suitable alternator for welding loads:

i. kVA rating (Name plate details)
ii. Rated power factor
iii. Whether single phase (240 V) or two phase (415 V)
iv. Primary rated transient current
v. Details of other voltage sensitive loads, if any.

SECTION E

CONTROL PANEL

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Chapter 1 Control System and Operation

1.1 Control System

The Control System consists of:

i. A Control Panel providing a means of starting and stopping the GENSET, monitoring its operation and output, and causing the engine to automatically shut down in the event of a circuit fault condition arising from any of the protection controls such as low oil pressure, high coolant temperature, over speed, etc.

ii. An Alternator Circuit Breaker providing a means of switching the Generator output, and automatically disconnecting the load in event of short circuit.

1.2 Operation

The operation of the control panel involves preparing for operation, initial start-up, normal start-up, and normal shutdown. They are described below:

1.2.1 Preparing for Operation

i. Before starting your GENSET be sure that it is positioned on a levelled surface so that, proper liquid levels can be maintained. Check engine oil, radiator coolant, battery electrolyte and fuel levels.

ii. Be sure that the GENSET will be operated in a well-ventilated area with all exhaust fumes piped away.

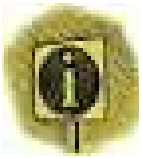
iii. Before connecting batteries, ensure that the control panel is switched off.

	**WARNING!** Prolonged inhalation of exhaust fumes may result in serious illness or death.

iv. Prolonged exposure to the noise levels of a diesel engine can impair hearing unless proper ear protection is worn.

v. Before any attempt is made to operate the machine, be sure that engine and alternator are properly earthed.

vi. Local and national regulations for the grounding of GENSET should be adhered to, as well as those regulations which describe the methods of connection and minimum sizes of grounding conductors based on the size of the load cables.

	**Important Note!** Adequate grounding of the GENSET is necessary for both stationary and wheel mounted units to prevent the possibility of injury or death in the event of electrical fault.

vii. When filling the fuel tank, do not smoke or use an open flame in the vicinity. Also the tank should never be filled when the GENSET is operating or while the engine is hot. Spilled or vaporized fuel could get ignited easily.

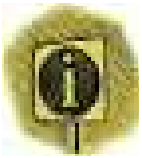
viii. Never attempt to disconnect a l oad connection or perform maintenance while the GENSET is in operation.

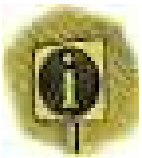
ix. To avoid an ac cidental start of the engine, always disconnect the battery when performing major operations.

x. As the battery system is negative earth. The negative connection should be disconnected first and reconnected last.

xi. The door of the control panel should not be removed while the GENSET is in operation. Otherwise, you will be exposed to live electrical connections.

xii. Maintenance on the control panel should only be carried out by a qualified technician.

	**Important Note!** Always shut down the GENSET and switch off circuit breaker prior to connecting, or disconnecting load cables. Only restart when a sound connection has been made.

	**Important Note!** Procedure disclosed henceforth in topic *1.2.2 Initial Start-up*, *1.2.3 Normal Start-up*, and *1.2.4 Normal Shutdown*, is most generic in nature. However, user is expected to read either of the chapter 2, 3, 4, and 5 of Section E to get operational details of the concerned Controller provided in their GENSET.

1.2.2 Initial Start-up

The following procedure should be used when starting the GENSET for the first time or when it has been out of service for a long time. These steps are critical and must be followed closely to avoid complications in operating the GENSET. To start-up the GENSET follow the procedure as mentioned below:

i. Check the engine oil and coolant levels and replenish if necessary.

ii. Fill the fuel tank.

iii. Prime the fuel system using the hand priming pump and bleed entrapped air from the fuel filter. See Section C on Diesel Engine for more details in this regard.

iv. Ensure the circuit breaker is switched OFF.

v. Connect the batteries to the engine with correct polarity.

vi. Turn the Control switch to ON position.

vii. Wait for until the controller displays READY. The READY state implies that the engine and alternator parameters are as expected. If the conditions are not as expected, an appropriate warning or alarm is displayed on the controller. The warning or alarm condition must be cleared before the GENSET can be started.

viii. Press the START button on control panel till engine starts or press start button momentarily on controller. The controller will perform following sequence as follows:

a. FUEL-ON

i. If ETR (Energise to Run) fuel control is configured, the controller will control the fuel output and display FUEL ON and proceed to the CRANK state.

ii. For ETS (Energise to Stop) the sequence does not activate the output but proceeds immediately to the CRANK state.

b. CRANK

i. The crank output is deactivated when the unit has detected a speed signal above the crank disconnect speed specified in the settings, or has detected oil pressure above the minimum oil pressure specified in the settings or Excitation is present.

ii. If the GENSET does not start, the LCD will show 'Stopping', controls the Fuel and Crank outputs accordingly, and return to READY. No retries are done.

iii. If the unit loses power due to battery voltage drop during cranking, and the engine fires, then on regaining adequate battery voltage, the unit will continue to allow the engine to run.

c. RUN UP

i. When the engine starts, the display shows 'Run Up' with a countdown in seconds. This allows the engine measurement system to stabilize. Over speed and loss of speed signal are the only parameters checked during Run Up.

d. WARM UP
    i. Allows the engine to stabilize at full speed before going on load. Oil pressure and Over-speed are monitored. The display shows 'Warm Up' with a countdown time.
e. RUNNING
    i. The display shows 'RUNNING'. Operating parameters are scrolled onto the display.

ix. After the engine is started, check for any abnormal noise or vibration.
x. Check fluid leakage or high temperature.
xi. Check the control panel for indications of abnormal operation, in particular above normal engine temperature or below normal oil pressure.
xii. Once the engine reaches full operating speed check that the GENSET voltage has reached the correct operating level. The voltage is factory set on the voltage regulator and needs no further adjustment. Should the output voltage be incorrect, adjustment of the voltage should only be carried out by a qualified technician. Voltage adjustment is achieved by varying the setting of a potentiometer mounted inside the automatic voltage regulator which is fitted in the alternator terminal box.
xiii. The frequency of the output should also be checked. No load frequency should be approximately 52 Hz for a 50 Hz system.
xiv. After the voltage and frequency checks have been made, shut down the GENSET by pressing the STOP push button provided on the control panel.

1.2.3 Normal Start-Up

To start the GENSET for subsequent loading operation, follow the procedure as mentioned below.

i. Make a visual check of the entire GENSET. Watch for leaks in the fuel system, cooling system and lubrication system.
ii. Be sure that no dust/ sand remain on the air inlet side of the canopy.
iii. Be sure that all tools and any loose items are removed from the canopy.
iv. Check the engine oil, fuel and coolant levels, replenish if necessary.
v. Check the battery terminals for corrosion, clean them if necessary. Also check the battery electrolyte level and if necessary, fill it with distilled water.
vi. Turn the Control switch to ON position.

vii. Wait for until the controller displays READY. The READY state implies that the engine and alternator parameters are as expected. If the conditions are not as expected, an appropriate warning or alarm is displayed on the controller. The warning or alarm condition must be cleared before the GENSET can be started.

viii. Press the START button on the controller momentarily. The controller will perform following sequence as follows:

a. FUEL-ON
   i. If ETR (Energise to Run) fuel control is configured, the controller will control the fuel output and display FUEL ON and proceed to the CRANK state.
   ii. For ETS (Energise to Stop) the sequence does not activate the output but proceeds immediately to the CRANK state.

b. CRANK
   i. The crank output is deactivated when the unit has detected a speed signal above the crank disconnect speed specified in the settings, or has detected oil pressure above the minimum oil pressure specified in the settings or excitation is present.
   ii. If the GENSET does not start, the LCD will show 'Stopping', controls the Fuel and Crank outputs accordingly, and return to READY. No retries are done.
   iii. If the unit loses power due to battery voltage drop during cranking, and the engine fires, then on regaining adequate battery voltage, the unit will continue to allow the engine to run.

c. RUN UP
   i. When the engine starts, the display shows 'Run Up' with a countdown in seconds. This allows the engine measurement system to stabilise. Over speed and loss of speed signal are the only parameters checked during Run Up.

d. WARM UP
   i. Allows the engine to stabilize at full speed before putting on load. Oil pressure and Over-speed are monitored.
   ii. The display shows 'Warm Up' with a countdown time.

e. RUNNING

i. The display shows 'RUNNING'. Operating parameters are scrolled onto the display.

ix. Run the GENSET on no load for at least 2-4 minutes.

x. Turn on the Main Circuit Breaker. The GENSET output is available to the load. Load may be now applied on the GENSET.

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

1.2.4 Normal Shutdown

To shut down the GENSET at the end of the operation, follow the procedure as mentioned below.

i. Turn off the load using the circuit breaker.

ii. Press the STOP push button on the controller. The controller will perform following stopping sequence:

a. STOPPING

i. The display will show 'STOPPING'.

ii. If ETR (Energise to Run) fuel control has been configured, consequently the fuel output will be de-energised.

iii. If ETS (Energise to Stop) fuel control has been selected then the fuel output will be energised for the Max Fuel Time or until the engine stops. The stopping process will retry if the engine fails to stop for the first time. During the 'ETS Rest period' the Fuel output is deactivated.

iv. The fuel output is controlled until the engine stops rotating and oil pressure decays. If the Oil Pressure has not been reduced by the end of the 'Max Fuel Time', the fuel output is deactivated and the controller waits until the oil pressure reduces, or for the rest of the 'Stop Time'. The speed must remain zero and the oil pressure must be below the alarm set point for the 'Stop Rest Time' before the engine is considered stopped.

v. If the GENSET does not stop then the alarm output is activated and 'STOP FAIL' is displayed on the LCD.

b. READY

i. Once the engine stops, READY icon will be displayed on the LCD indicating the engine is ready to start again.

Chapter 2 PROCOM Controller

2.1 Introduction

The PROCOM controller comes with a state of art microcontroller based system with 16 bit RISC (Reduced instruction set computing) featuring in it. Controller is built up with Back lit LCD display for easy reading of quantitative measure and acts as an interface while setting the parameters. There is no need to refer or revert back to user manual of the controller while programming the unit.

Procom controller requires 4 Volt power supply for full functioning, also it can withstand voltage dip up to 0V for a period of 1 sec. All the parameters concerned to performance of a GENSET are user defined in nature. It can hold the record of 20 failures in its memory. This controller is designed to meet versatile needs of the customer and suitable for any type of engine.

2.2 Major Parts of PROCOM Controller

The major parts of PROCOM controller are explained in two aspects, which are as mentioned below.

2.2.1 Components on the Door of Control Panel

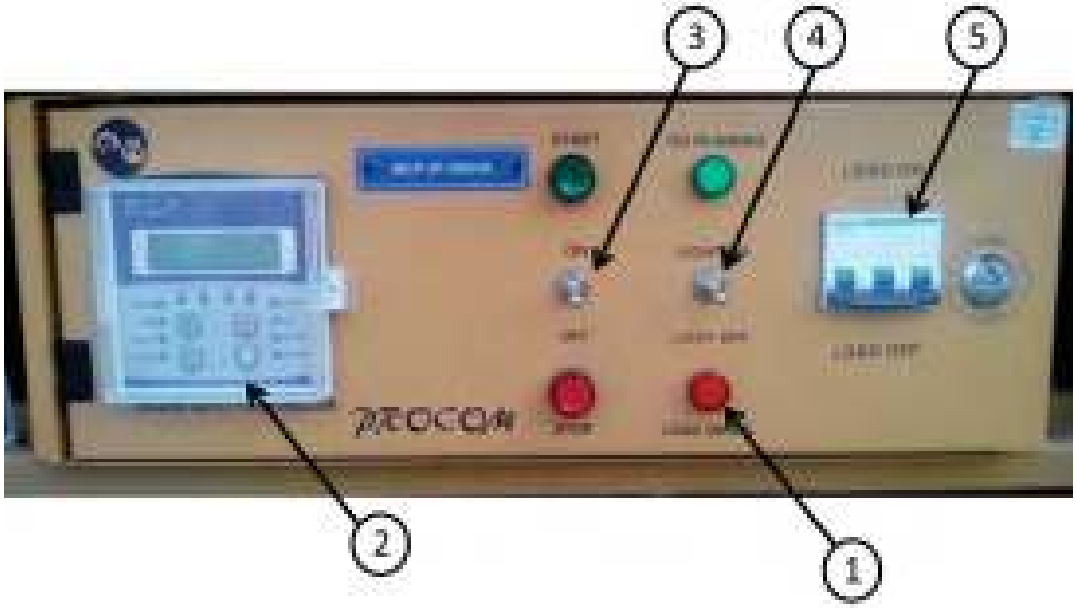


Fig. E2.1 Exterior Illustration of PROCOM Control Panel

Ref. No.	Description of Part	Ref. No.	Description of Part
1	Load on the GENSET	4	Canopy Light Switch
2	PROCOM Controller	5	Power MCB
3	Control ON		

Table E2.1 Part List for External Components of PROCOM Control Panel

1) Load on GENSET Indication Lamp: The green indication lamp turns on when the supply is available to the load.

2) Procom Controller: The electronic controller is provided to operate the system. It also contains an LCD display that that displays various GENSET parameters, faults, status, etc.

3) Control ON selector switch: When this switch is turned on, control supply is turned on and provided to the controller and other control components.

4) DG Light switch: It is provided to turn on the lamp inside the GENSET canopy.

5) Power MCB: This is the main circuit breaker between the alternator output and load. The breaker will carry the rated current continuously. In case of a short circuit or even if over current flows for specified amount of time, the breaker will trip. The breaker must then be moved to “OFF” position before re-closing.

2.2.2 Components inside the Control Panel

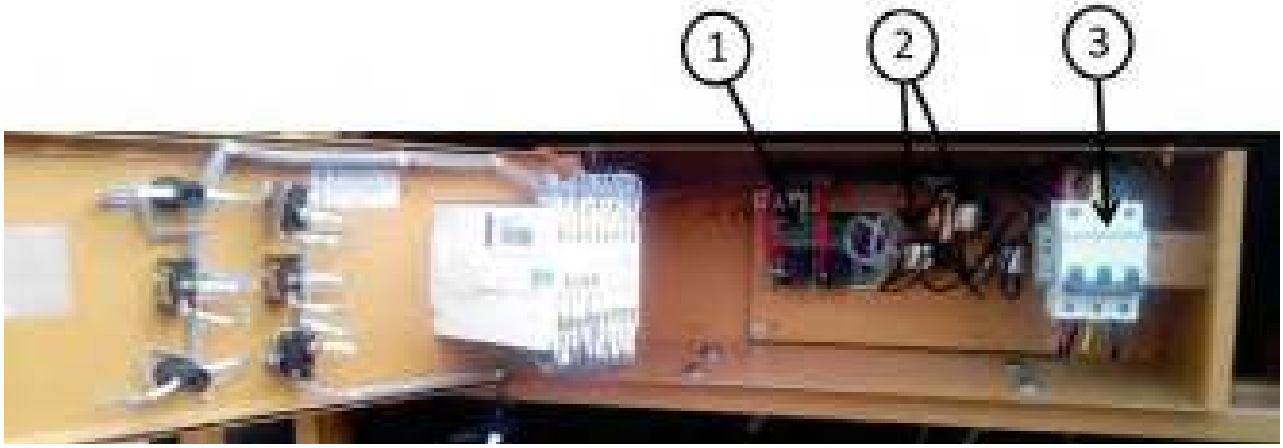


Fig. E2.2 Interior Illustration of PROCOM Control Panel

Ref. No.	Description of Part	Ref. No.	Description of Part
1	3-C Relay Board	4	Battery Charger (Optional) Not Shown
2	Current Transformers		
3	3 Pole MCB		

Table E2.2 Part List for Internal Components of PROCOM Control Panel

1) Control MCB: A three pole control MCB is provided for protection of the control circuit.

2) Power Relay Board: The power relay board consists of three power relays on each for the fuel solenoid, crank solenoid, and the hooter.

3) Current Transformers: Three current transformers, one for each phase, are provided for sensing current.

2.3 Protection & Supervision Salient Features

i. Voltage monitoring and protection for under/over voltage and over speeding.
ii. Oil Pressure
iii. HWT
iv. Canopy Temperature/RWL
v. Over Load
vi. Emergency
vii. Low Fuel
viii. Charging Alternator Fail/V-Belt
ix. Fan Fault protection(1Ph model B)

2.4 Measurement and Display

PROCOM's DES-11 controller is equipped with LCD display and it displays following:

i. Generator voltage (Ph-N, Ph-Ph)
ii. Generator Frequency
iii. Generator Current
iv. Fan Current(1Ph Model B)
v. Battery Voltage
vi. Generator Run Hour
vii. RPM
viii. Oil Pressure in KG/cm
ix. Radiator Temperature in degree centigrade(Model –A)
x. Fuel Level
xi. Programmed settings
xii. kW, PF, & kWh

Normally the display auto scrolls and displays a set of parameter for 10 seconds, but any time the Next key can be pressed to select the next parameter window.

2.5 Annunciations

PROCOM's DES-11 controller is equipped with the following annunciations for system status and faults finding:

i. LLOP
ii. HWT(Model A)
iii. HCT (Model B)

iv. Fuel
v. RWL (Radiator Water Level-Model A)
vi. Canopy Temperature (Model –B)
vii. DG Under Voltage
viii. DG Over Voltage
ix. DG Over/Under Frequency
x. Charging Alternator/ V-Belt
xi. DG Overload
xii. Emergency

2.6 Contacts

The following digital Output is provided. Annunciation contacts are available in models requested with Annunciation features.

i. Crank (NO Contact)
ii. Solenoid (NO Contact)
iii. Hooter (NO Contact)
iv. Electrical Feed for Charger ON (+12V)

2.7 Timers

PROCOM's DES-11 controller is equipped with the following timers:

i. Generator voltage supervision timer
ii. Generator over speed supervision timer
iii. Generator Over load supervision time
iv. Stop Solenoid on time
v. Fuel supervision time
vi. LLOP supervision time
vii. HWT supervision time (Model-A)
viii. RWL supervision time (Model-A)
ix. HCT supervision time (Model-B)
x. Canopy Temperature Time (Model-B)
xi. Hooter Reset Time
xii. Service Time
xiii. Charging Alternator contact on time
xiv. Crank Timer

2.8 Switches Description

Four switches are provided on front panel of DES-11. Switch can have more than one function assigned to it. The exhibit table E2.3 below describes the operation of these.

S.No.	Switch Symbol	Switch Function	Description
1	↑	Next	**Normal operation mode:** In this mode, it is used to change the parameters being displayed on LCD. **Programming Mode:** Next key is used to select the next parameter to be programmed.
2	+	Increment	**Programming Mode:** It is used to increment the value of the parameters under programming. **Normal operation mode:** It is used to Start the Engine
3	-	Decrement	**Programming Mode:** It is used to decrement the value of the parameter under programming. **Normal operation mode:** It is used to Stop the Engine
4	R	Reset	Reset key resets the Hooter and Fault signals. The first press shall reset the hooter and next shall reset the faults. A long press of 1 Sec shall reset both.
5	R & ↑	Programming Mode Entry	Press "R" Key and than press "↑" while the "R" Key is pressed to enter the programming mode.

Exhibit Table E2.3

2.9 Operations

DES-11 is an engine monitoring and supervisor unit. The engine can be Started/Stopped from the front panel of DES-11 or externally by means of key Switch, etc. The start / stop from the front or remote is one touch operation, meaning that once the switch is pressed the start /stop command shall be operational till the "Crank time or DG start detection / Stop Sol Time", as programmed, has expired . DES-11 automatically detects that the engine on conditions by monitoring the generator voltage and st arts monitoring the engine for under/over voltage, LLOP, HWT and emergency faults. On detection of any of these faults for the pre-programmed duration the engine is automatically shut down and fault along with run hour is recorded in non-volatile memory. The run hour time of engine is recorded in internal non-volatile memory.

2.10 Setting Procedure

DES-11 has pr ovision to program the operating parameters, resetting the service hours and viewing the last 20 fault history.

Press R & ⬆ switches simultaneously.

The LCD shall display, “Enter Para Mode”

To enter parameter setting mode press ⬆

To go to next menu press ✚

The LCD shall display “View Fault Records”.

This menu can be entered by pressing ⬆

To go to next menu press ✚

This menu can be entered by pressing ⬆

Pressing ✚ shall reset the service hours. Pressing ▬ shall terminate the menu.

2.10.1 Parameter Mode

Sl. No.	Display	Explanation of Parameter	Factory Setting	Setting Range
1	Generator O/V	Max permissible voltage, above this the voltage is treated unhealthy & the Generator is stopped.	270 V	80-300 V
2	Generator U/V	Min permissible voltage, below this the voltage is treated unhealthy & the Generator is stopped.	180 V	80-300 V
3	Gen Sup Delay	The time for which the Generator voltage should, continuously be unhealthy to generate a fault condition.	10 Sec	1-999 Sec
4	CT Ratio	Available in models having provision for /5 CTs. Not required for Procom Make CT’s	1	1-999
5	Generator O/C*	Max permissible current, above this the Current is treated unhealthy & the Generator is stopped.	6 (For /5 A CT) 42A (For Procom CT)	1-999 (For /5 A CT) 1-199 A (For Procom CT)

Sl. No.	Display	Explanation of Parameter	Factory Setting	Setting Range
6	Gen O/C Delay	The time for which the Generator Current should, continuously be unhealthy to generate a fault condition.	5Sec	1-999 Sec
7	Generator S/C*	Max permissible current, above this the Current is treated unhealthy & the Generator is stopped.	6(For /5 A CT) 42A(For Procom CT)	1-999 (for /5 A CT) 1-199 A (for Procom CT)
8	Gen S/C Delay	The time for which the Generator Current should, continuously be unhealthy to generate a fault condition.	5Sec	1-999 Sec.
9	Generator O/F*	Over frequency setting	65 Hz	40 – 80 Hz
10	Gen O/F	Delay Monitoring time for Over frequency	5 Sec	1-999Sec
11	Generator U/F*	Under frequency setting	45 Hz	40 – 80 Hz
12	Gen U/F Delay	Monitoring time for Under frequency	10 Sec	1-999Sec
13	Available Sensor	This selects the installed sensors in the GENSETS. The display shall only display the parameters for the sensor installed and uninstalled sensor data shall not be displayed. The protection for the function with no measurement sensor installed shall be through switch. E.g. If Oil pressure sensor is not installed the unit shall provide protection for LLOP through oil pressure switch and not through the oil pressure sensor (linear measurement)	All sensors	All sensors, Fuel &HWT, Fuel & LLOP, LLOP & HWT, Fuel Only, HWT Only, LLOP Only, No sensor

Sl. No.	Display	Explanation of Parameter	Factory Setting	Setting Range
14	Fuel < Level in %	Level of fuel at which the audio visual warning is issued without initiating shut down.	25% Sec	10-100%
15	Fuel < delay	Monitoring time of Fuel Fault	5 Sec	1-999 Sec
16	Fuel< < Level in %	Level of fuel at which the Engine shall shut down	15% Sec	10-100%
17	Low Lube Oil Pressure	Level of LLOP at which the Engine shall shut down	2.0 Kg /Cm^2	0-8.5 Kg /Cm^2
18	High Water Temperature	Temperature of water at which the Engine shall shut down	80º C	0-150º C
19	Sensor Type	A : For engines other than SDEC B : SDEC Engine	A	A,B
20	Fuel << delay	Monitoring time of Fuel << Fault	5 Sec	1-999 Sec
21	LLOP delay	Monitoring time of LLOP Fault	5 Sec	1-999 Sec
22	HWT delay	Monitoring time of HWT Fault	5 Sec	1-999 Sec
23	Radiator Water Delay	Monitoring time of RWL Fault	5 Sec	1-999 Sec
24	Charging Delay*	Time delay after which the charging Alternator/V-Belt fault shall be activated.	5 Sec	1-999 Sec
25	Hooter Reset Time	Time for which the Hooter is active if not reset manually	30 Sec	1-999 Sec
26	Stop Solenoid On Time	Time for which the fuel solenoid is activated for shutting the engine	30 Sec	1-100 Sec
27	Emergency Solenoid Time	This setting is to protect the fuel solenoid in case the Stop button or Emergency key is kept pressed. In such a case the solenoid shall be released after this time.	40 Sec	1-100 Sec

Sl. No.	Display	Explanation of Parameter	Factory Setting	Setting Range
28	Gen. Pick-up Voltage	Voltage of generator above which the generator is assumed to be ON	100 V	80-150 V
29	Service Time Hrs.	Time, in hours, after which the service is due	250 Hrs.	1-999 Hrs.
30	Display Auto Scroll	Setting ON will enable Auto Scroll of display. OFF: No scroll and ne xt parameter can be viewed by pressing next	ON/OFF	ON
31	Voltage Display Format	DES-9A Can display either Phase to Phase OR Phase to Neutral Voltage	Phase-Neutral	Phase-Neutral, Phase-Phase
32	Engine RPM	Engine RPM selection	1500	1500/3000
33	Charging Alternator Relay Time	Time for which the magnetizing relay of charging alternator will be switched on after the engine has started.(Model A only)	5 Sec	5-100 Sec
34	Crank Time	Maximum duration for which the crank is activated after the start command is given	5Sec	1-25Sec
35	Communication 232 Or SMS	Selection of communication mode either on RS232, Or SMS via GSM modem	RS232	RS232/SMS
36	Start SMS	Activated only in SMS communication mode for activating / disabling the SMS communication	Disable	Enable / Disable
37	Crank Cut Method	Only Voltage based / Voltage or LOP based	Voltage	Voltage/ LOP Or Voltage

Table E2.4

* This parameter can be disabled while programming.

2.10.2 Fault History

To view the last 20 fault histories, enter in this mode as explained above. Maximum of last 20 faults along with Run Hour stamp shall be displayed on the LCD. The first row shall display the fault and the next row shall display the run hour at which the fault has occurred. The next fault can be viewed by pressing “NEXT”. The mode shall exit to normal mode after the last fault recording is displayed. Absence of any fault recoding shall not display any fault data.

2.10.3 Resting Service Hours

Service due, warning is issued by DES-11, by flashing the Service LED. This LED shall keep flashing till it is not reset by entering this mode.

2.10.4 Programming Solenoid Mode

For changing the solenoid mode first press (R) (reset) button, than press + button while the reset button is pressed.

Fuel Solenoid: In this mode fuel solenoid contact changes from Open to close at the time of cranking and remains close till the GENSET is running. For stopping the generator this contact opens.

Stop Solenoid: In this mode fuel solenoid contact remains open at the time of cranking and till the GENSET is running. For stopping the generator this contact closes for a user programmed time.

Don’t change the mode while generator is running. It’s a good practice to switch OFF and then switch ON the battery supply after changing this mode.

2.11 Faults

There are two categories of faults, v.i.z.

i. Internal Faults
ii. External Faults

2.11.1 Internal Faults

Internal faults are the faults, which do not need any external signals and are detected by the system itself. They are:

i. Generator Voltage Unhealthy
ii. Generator Over & under frequency.
iii. Generator Over Load
iv. LLOP
v. Fuel
vi. HWT (Model –A)

2.11.2 External Faults

Those faults which cannot be sensed by the unit itself (these faults are not reflected by the generator voltage) and are to be provided externally. They are:

i. Canopy Temperature (Model-B)
ii. RWL (Model-A)
iii. HCT (Model-B)

2.11.3 Fault Reset

All internal faults can be reset by pressing (R) switch after the generator is stopped. In case the engine fails to stop "STOP KEY" can be pressed for manual attempt to stop engine.

2.12 Communication Setup

DES-11 can be used in 2 modes of communication:

a) RS232 mode: For connection to a PC or a MODEM.
b) SMS Mode: If a GSM modem, with SIM, is connected to the RS232 link of the unit, the unit shall be able to send alarm through SMS. The GENSET can also be controlled remotely via SMS.

2.12.1 SMS Operation

DES-11 can store up to five GSM enabled telephone numbers. In case of any fault, or starting/stopping of the generator, a SMS shall be send to all the active telephone numbers. This SMS shal l include the fault details, the engine running/not running information, the voltage, current, battery voltage and run hour information. The owner of the first 2 telephone numbers can, on demand, access the above information through SMS by sending an SMS to AC3. The SMS is "STATUS", without quotes and all capital.

2.12.2 Feeding Telephone Numbers

Up to five telephone numbers can be stored in DES-11.

To feed the numbers switch off DES-11, press the Reset and ⬆ Switch and w hile they are pressed power on the unit.

The display shall display

X C. No

+91ZZZZZZZZZ

The first row “X” indicates the cursor position.

The second row displays the telephone number.

The first number is always +.

If the next digit is 0. It signifies that this particular number is not in use.

The digit at the cursor positions can be modified by pressing ▬ key. The digits shall change from 0-9 and blank.

The blank digit signifies the end of the telephone number. The digits after this shall be discarded.

To go to next digit press ✚ key.

Continue till the desired number is programmed.

Make sure that the last digit after the valid number is a blank.

To go to next telephone number press ⬆ Key.

The process can be terminated and all previous programmed numbers can be stored by pressing R (Reset) Key

2.13 Terminal Description

Terminal Number	Description
1	Generator R Phase Voltage
2	Generator Y Phase Voltage
3	Generator B Phase Voltage
4	Generator neutral
5	LLOP Sensor
6	HWT Sensor (Model-A), HCT Logic Level Low (Model-B)
7	Fuel Sensor
8	RWL / Canopy Temperature
9	Charging Alternator Input
10	Auxiliary supply + VE
11	Auxiliary supply - VE
12	Crank NO Contact
13	Solenoid NO Contact
14	Charging Alternator On
15	Hooter
16	Common for All Contacts
17	Remote Start
18	Remote Stop
19,20	R Phase CT (For /5 Unit. 5Amps Unit)
21,22	Y Phase CT (For /5 Unit. 5Amps Unit)
23,24	B Phase CT (For /5 Unit. 5Amps Unit)
19	R Phase CT (For Whole Current Unit with Procom Make CT's)
20	Y Phase CT (For Whole Current Unit with Procom Make CT's)
21	B Phase CT (For Whole Current Unit with Procom Make CT's)
22	Common Point Of CTs (For Whole Current Unit with Procom Make CT's)
20-22	Fan Current input for Single Phase Model-B

Table E2.5 Terminal Description

2.14 Specifications

AC Voltage withstand	330 VAC (Phase to neutral)
Measurement Accuracy	
Voltage & Current	1%
Power & KWh	2%
Surge 1.2/50Usec	2.5KV
Battery Voltage	Suitable for 12V/24 VDC System
Min. voltage to power on	9V
Min Running Voltage after Power on	4V
Max. Battery Voltage	35V
DC Interruption time	1 Sec.
Digital Output	+ 12V
Cut out Dimensions	92mm X 92mm
Depth	120mm
Digital Input Level which is battery supply	Battery Voltage (Negative) except Charging Alt,

Table E2.6

Chapter 3 Deep Sea 4520 Controller

3.1 Introduction

The Deep Sea (DSE4520) Controller is designed to provide differing levels of functionality across a common platform. This allows the generator OEM greater flexibility in the choice of controller to use for a specific application.

The DSE4520 controller has been designed to allow the operator to start and st op the generator, and if required, transfer the load to the generator either manually or automatically. Additionally, the DSE4520 automatically starts and stops the generator set depending upon the status of the mains (utility) supply. The user also has the facility to view the system operating parameters via the LCD display. The said controller monitors the engine, indicating the operational status and fault conditions, automatically shutting down the engine and giving a true first up f ault condition of an engine failure by the LCD display. The powerful ARM microprocessor contained within the module allows for incorporation of a r ange of complex features:

i. Icon based LCD display
ii. True RMS Voltage
iii. Current and Power monitoring (Not applicable to the DSE45xx-01 variant)
iv. USB Communications
v. Engine parameter monitoring
vi. Fully configurable inputs for use as alarms or a range of different functions
vii. Engine ECU interface to electronic engines

Using a PC and the DSE Configuration Suite software allows alteration of selected operational sequences, timers, alarms and operational sequences. Additionally, the module's integral front panel configuration editor allows adjustment of this information. A robust plastic case designed for front panel mounting houses the module. Connections are via locking plug and so ckets. Access to critical operational sequences and t imers for use by qualified engineers, can be protected by a se curity code. Module access can also be protected by PIN code. Selected parameters can be changed from the module's front panel. The module is housed in a robust plastic case suitable for panel mounting. Connections to the module are via locking plug and sockets.

3.2 Major Parts of Deep Sea (DSE4520) Controller

The major parts of Deep Sea (DSE4520) control panel & power panel are explained in two aspects, which are as mentioned below.

3.2.1 Components on the Door of Control Panel & Power Panel

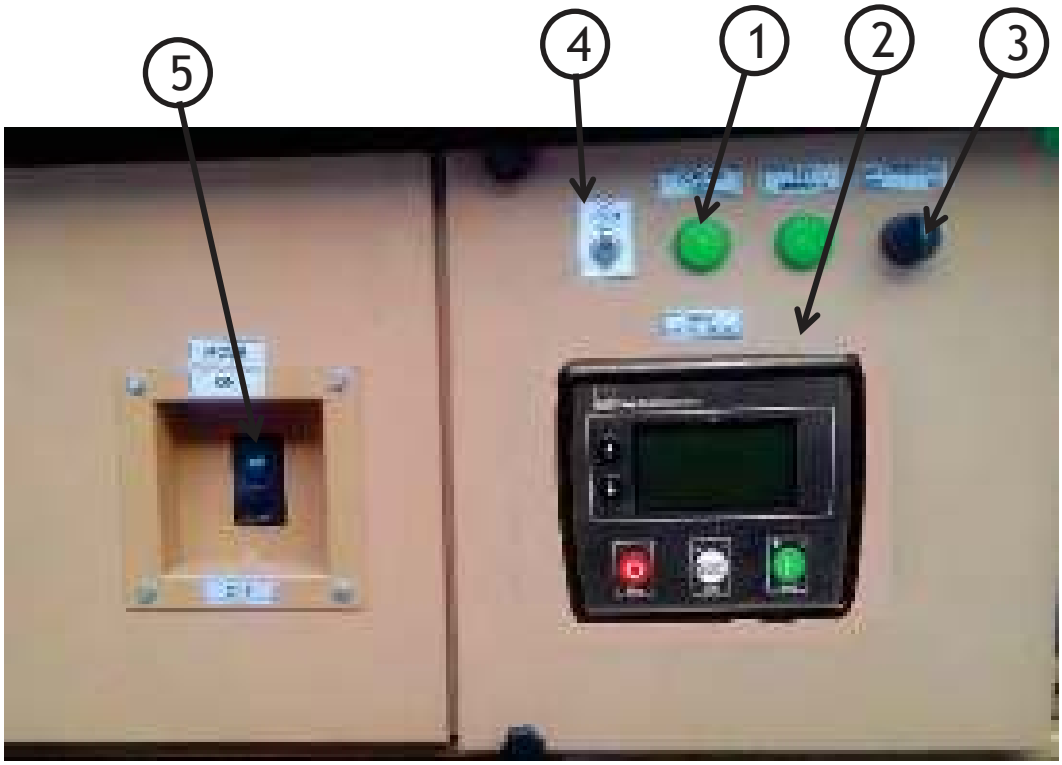


Fig. E3.1 Exterior Illustration of DSE4520 Control Panel

Ref. No.	Description of Part	Ref. No.	Description of Part
1	Load ON GENSET	4	Canopy Light Switch
2	Deep Sea (DSE4520) Controller	5	Power MCB / MCCB
3	Control Switch (ON/OFF)		

Table E3.1 Part List for External Components of DSE4520 Control Panel & Power Panel

1) Load ON GENSET Indication Lamp: The green indication lamp turns on when the supply is available to the load.

2) Deep Sea (DSE4520) Controller: The electronic controller is provided to operate the system. It also contains an LCD display that that displays various GENSET parameters, faults, status etc.

3) Control ON Selector Switch: When this switch is turned on, control supply is turned on and provided to the controller and other control equipment's.

4) DG Light switch: Provided to turn on the DG lamp inside the canopy.

5) Power MCB/ MCCB: This is the main circuit breaker between the alternator output and load. The breaker will carry the rated current continuously. In case of a short circuit or if over current flows for specified amount of time, the breaker will trip. The breaker must then be moved to "OFF" position before re-closing.

3.2.2 Components inside the Control Panel & Power Panel

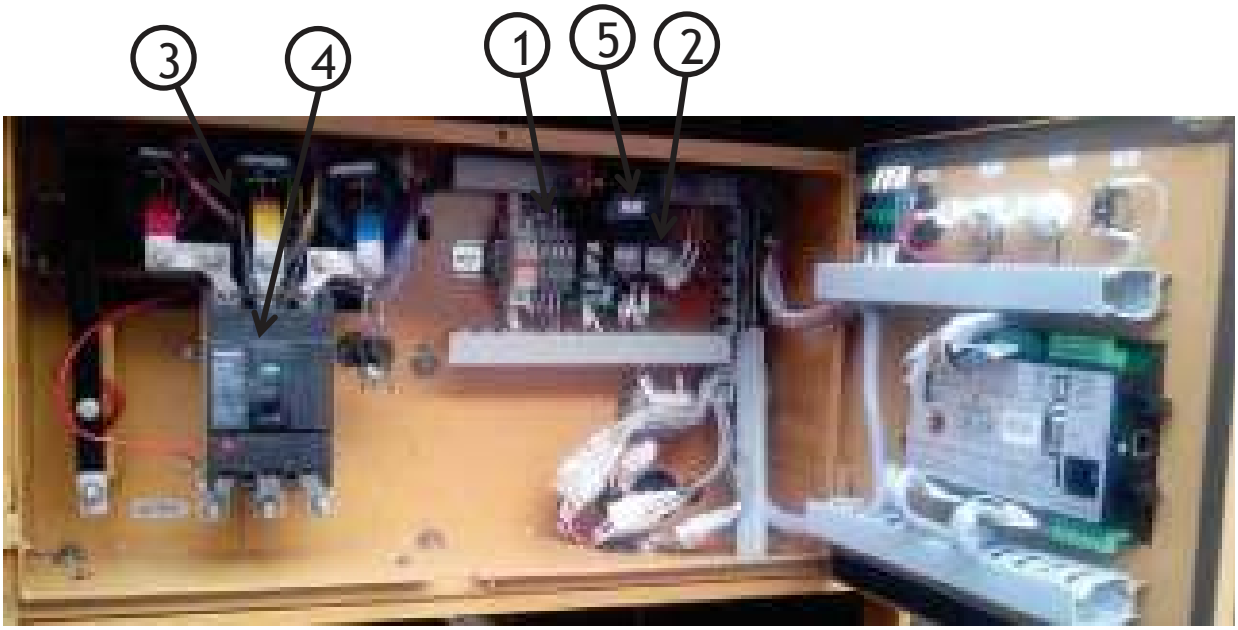


Fig. E3.2 Interior Illustration of DSE4520 Control Panel

Ref. No.	Description of Part	Ref. No.	Description of Part
1	Control MCB/Fuse	4	Power MCB/MCCB
2	Power Relay Board	5	Hooter
3	Current Transformers		

Table E3.2 Part List for Internal Components of DSE4520 Control Panel & Power Panel

1) Control MCB / Controller: A single pole control MCB is provided for protection of the control circuit.

2) Power Relay Board: The power relay board consists of three power relays, on each for the fuel solenoid, crank solenoid and hooter.

3) Current Transformers: Three current transformers, one for each phase, are provided for sensing current.

4) Hooter: The hooter operates in case of any fault is sensed by the controller.

3.3 Specifications

3.3.1 Short Names

DSE4500, DSE45xx	All modules in the DSE4500 range
DSE4520	DSE4520 module/controller

3.3.2 Operating Temperature

DSE45xx	-30ºC to +70ºC (-40ºC to +70ºC for variants fitted with display heaters)

3.3.3 Power Supply Requirements

Minimum Supply Voltage	8V continuous
Cranking Dropouts	Able to survive 0V for 100ms providing the supply was at least 10V before the dropout and recovers to 5V afterwards.
Maximum Supply Voltage	35V continuous (60V protection)
Reverse Polarity Protection	-35V continuous
Maximum Operating Current	96mA at12V 85mA at 24V
Maximum Standby Current	51mA at 12V 47mA at 24V
Maximum Current When In Sleep Mode	35mA at 12V 32mA at 24V
Maximum Current When In Deep Sleep Mode	Less than 10µA at 12V Less than 10µA at 24V

Table E3.3 Power Supply Requirements

3.3.3.1 Module Supply Instrumentation Display

Range	0V-70V DC (note Maximum continuous operating voltage of 35V DC)
Resolution	0.1V
Accuracy	1% full scale (±0.7V)

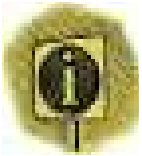
Table E3.4 Module Supply Instrumentation Display

3.3.4 Voltage & Frequency Sensing

Measurement Type	True RMS conversion
Sample Rate	5kHz or better
Harmonics	Up to 11th or better
Input Impedance	300k_ phase to neutral
Phase To Neutral	15V (minimum required for sensing frequency) to 415V AC (absolute maximum) Suitable for 345V nominal (±20% for under/overvoltage detection)
Phase To Phase	25V (minimum required for sensing frequency) to 720V AC (absolute maximum) Suitable for 600V nominal (±20% for under/overvoltage detection)
Common Mode Offset From Earth	100V AC (max)
Resolution	1V AC phase to neutral 2V AC phase to phase
Accuracy	±1% of full scale phase to neutral ±2% of full scale phase to phase
Minimum Frequency	3.5 Hz
Maximum Frequency	75.0 Hz
Frequency Resolution	0.1 Hz
Frequency Accuracy	±0.2 Hz

Table E3.5 Voltage & Frequency Sensing

3.3.5 Current Sensing

	**Important Note!** Current Sensing is not available on the DSE45xx-01 variant.

Measurement Type	True RMS conversion
Sample Rate	5KHz or better
Harmonics	Up to 10th or better
Nominal CT Secondary Rating	5A
Maximum Continuous Current	5A
Overload Measurement	3 x Nominal Range setting
Absolute Maximum Overload	50A for 1 second
Burden	0.25VA (0.01_ current shunts)
Common Mode Offset	±1V peak plant ground to CT common terminal
Resolution	0.5% of 5A
Accuracy	±1% of Nominal (5A) (excluding CT error)

Table E3.6 Current Sensing

3.3.6 Inputs

3.3.6.1 Digital Inputs

Number	4 configurable digital inputs (7 when Analogue Inputs are configured as digital inputs)
Arrangement	Contact between terminal and ground
Low Level Threshold	3.2 V minimum
High Level Threshold	8.1 V maximum
Maximum Input Voltage	+60 V DC with respect to plant supply negative
Minimum Input Voltage	-24 V DC with respect to plant supply negative
Contact Wetting Current	6 mA typical
Open Circuit Voltage	15 V typical

Table E3.7 Digital Inputs

3.3.6.2 Analogue Inputs

3.3.6.2.1 Oil Pressure

Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement	Current 11mA ±10%
Full Scale	240 Ω
Over Range / Fail	270 Ω
Resolution	0.1 Bar (1-2 PSI)
Accuracy	±2% of full scale resistance (±4.8 Ω) excluding transducer error
Max Common Mode Voltage	±2V
Display Range	0 bar - 17.2 bar (0PSI - 250PSI) subject to limits of the sensor

Table E3.8

3.3.6.2.2 Coolant Temperature

Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	11mA ±10%
Full Scale	480 Ω
Over Range / Fail	540 Ω
Resolution	1°C (2°F)
Accuracy	+/-2% of full scale resistance (±9.6 Ω) excluding transducer error
Max Common Mode Voltage	±2V
Display Range	0°C - 250°C (32°F - 482°F) subject to limits of the sensor

Table E3.9

3.3.6.2.3 Fuel Level Sensor

Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	11mA ±10%
Full Scale	480 Ω
Over Range / Fail	540 Ω
Resolution	1%
Accuracy	+/-2% of full scale resistance (±9.6 Ω) excluding transducer error
Max Common Mode Voltage	±2V
Display Range	0% - 250% subject to limits of the sensor

Table E3.10

3.3.6.2.3 Flexible Sensor (When Configured)

Number	1 when Fuel Level Sender is configured as a flexible
Measurement Type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement Current	11mA ±10%
Full Scale	480 Ω
Over Range / Fail	540 Ω
Resolution	1%
Accuracy	+/-2% of full scale resistance (±9.6 Ω) excluding transducer error
Max Common Mode Voltage	±2V
Display Range	0% - 250%, 0°C - 250°C (32°F - 482°F) or 0 bar - 17.2 bar (0 PSI - 250 PSI) subject to limits of the sensor and sensor configuration

Table E3.11

3.3.6.3 Charge Fail Input

Minimum Voltage	0V
Maximum Voltage	35V (plant supply)
Resolution	0.2V
Accuracy	± 1% of max measured voltage
Excitation	Active circuit constant power output
Output Power	2.5W nominal at 12V and 24V
Current	At 12V 210mA
Current	At 24V 105mA

Table E3.12

The charge fail input is actually a combined input and output. Whenever the generator is required to run, the terminal provides excitation current to the charge alternator field winding. When the charge alternator is correctly charging the battery, the voltage of the terminal is close to the plant battery supply voltage. In a failed charge situation, the voltage of this terminal is pulled down to a low voltage. It is this drop in voltage that triggers the charge failure alarm. The level at which this operates and whether this triggers a warning or shutdown alarm is configurable using the DSE Configuration Suite Software.

3.3.7 Outputs

3.3.7.1 DC Outputs A & B (Fuel & Start)

Type	Normally used as Fuel & Start outputs. Fully configurable for other purposes if the module is configured to control an electronic engine.
Rating	10A resistive for 10secs, 5A resistive continuous at 35V

Table E3.13

3.3.7.2 Configurable DC Outputs C & D

Type	Fully configurable, supplied from DC supply terminal 2.
Rating	2A resistive continuous at 35V

Table E3.14

3.3.7.3 Configurable DC Outputs E & F (DSE 4520 Only)

Type	Fully configurable, supplied from DC supply terminal 2.
Rating	2A resistive continuous at 35V

Table E3.15

3.3.8 Dimensions and Mounting

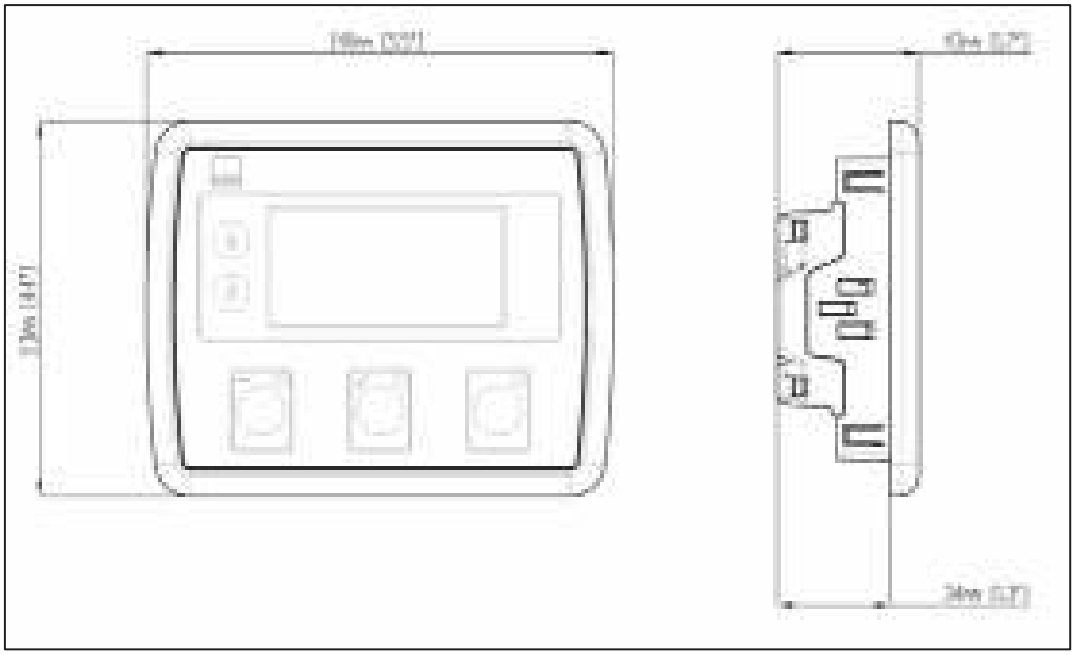


Fig. E3.5

3.3.8.1 Dimensions

140.0mm x 113mm x 43mm (5.5” x 4.4” x 1.7”)

3.3.8.2 Panel Cut-out

118mm x 92mm (4.6” x 3.6”)

3.3.8.3 Weight

0.16kg (0.35lb)

3.3.8.4 Fixing Clips

The module is held into the panel fascia using the supplied fixing clips.

i. Withdraw the fixing clip screw (turn anticlockwise) until only the pointed end is protruding from the clip.
ii. Insert the three 'prongs' of the fixing clip into the slots in the side of the module case.
iii. Pull the fixing clip backwards (towards the back of the module) ensuring all three prongs of the clip are inside their allotted slots.
iv. Turn the fixing clip screws clockwise until they make contact with the panel fascia.
v. Turn the screws a little more to secure the module into the panel fascia. Care should be taken not to over tighten the fixing clip screws.

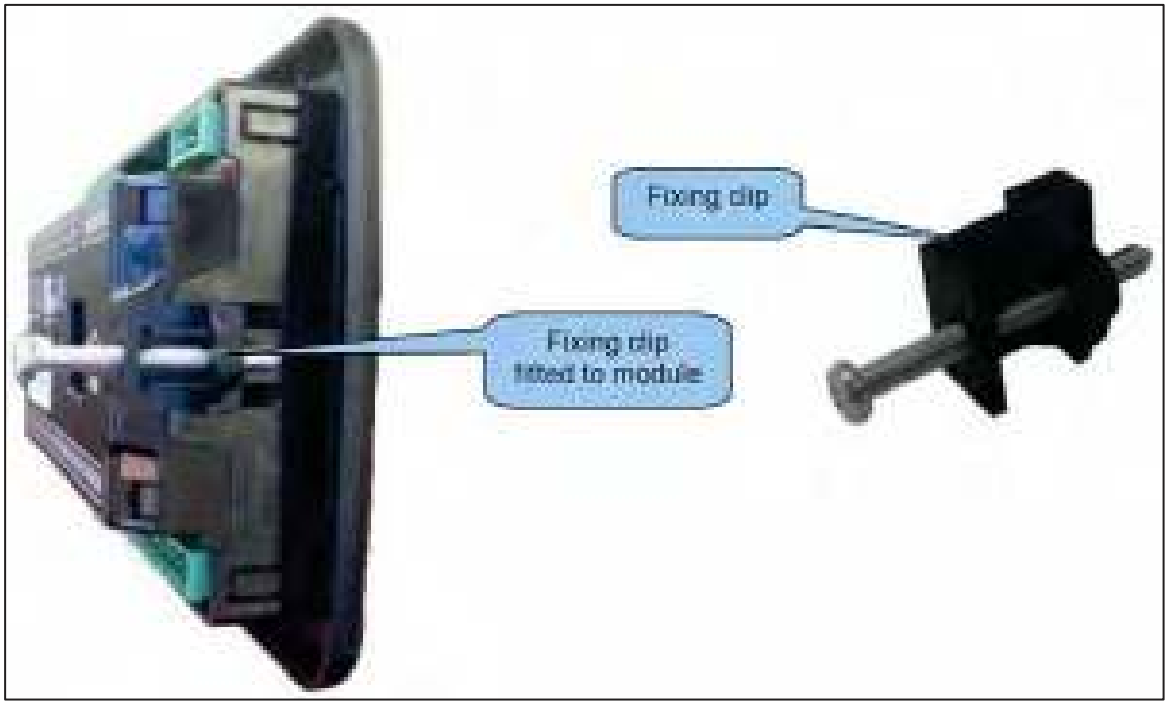
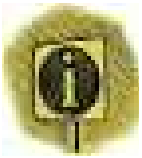


Fig. E3.6

	Important Note! In conditions of excessive vibration, mount the module on suitable anti-vibration mountings.

3.3.8.5 Silicon Sealing Gasket

	**Important Note!** For purchasing an additional silicon gasket from DSE, please see the chapter entitled Maintenance, Spares, Repair and Servicing in this Section E.

The optional silicon gasket provides improved sealing between module and the panel fascia. The gasket is fitted to the module before installation into the panel fascia. Take care to ensure the gasket is correctly fitted to the module to maintain the integrity of the seal.

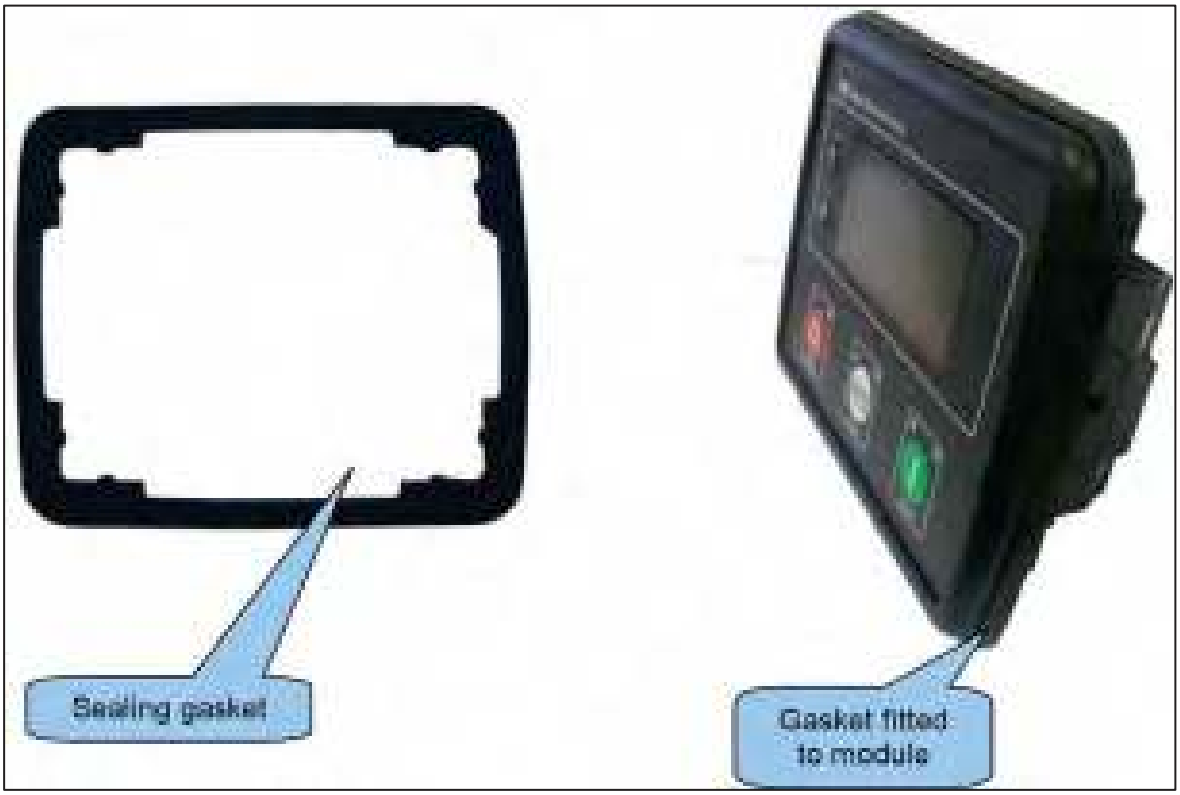


Fig. E3.7

3.4 Installation

The module is designed to be mounted on the panel fascia. For dimension and m ounting details, see the topic entitled Specifications, Dimension and mounting in this chapter.

3.4.1 Terminal Description

To aid user connection, icons are used on the rear of the module to help identify terminal functions. An example of this is shown below.

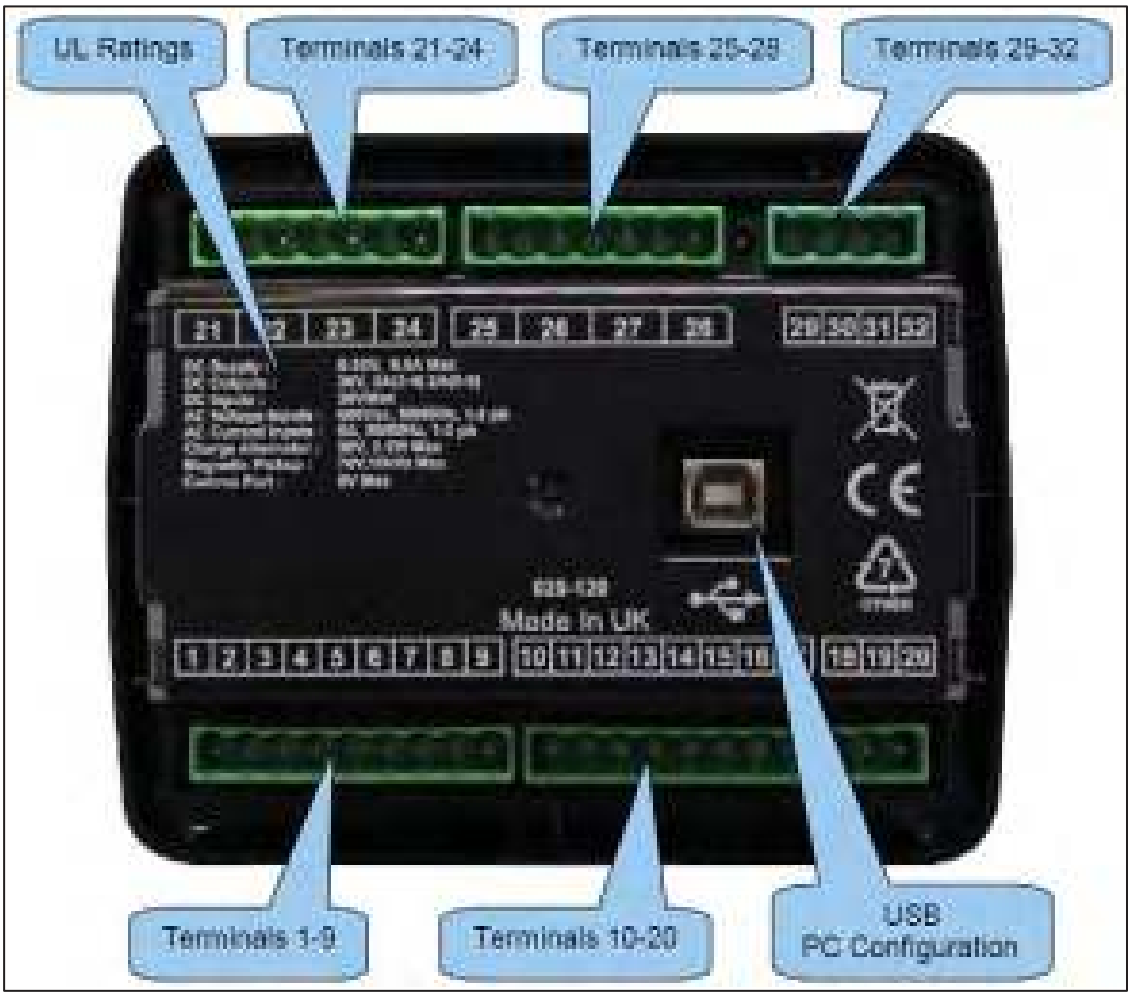


Fig. E3.8

3.5 Description of Controls

	Important Note! The following descriptions detail the sequences followed by a module/controller containing the standard 'factory configuration'. Always refer to your configuration source for the exact sequences and t imers observed by any particular module/controller in the field.

Control of the module is via push buttons mounted on the front of the module with Stop/Reset Mode, Auto Mode, and Manual/Start Mode functions. For normal operation, these are the only controls which need to be operated. Details of their operation are provided later in this document.

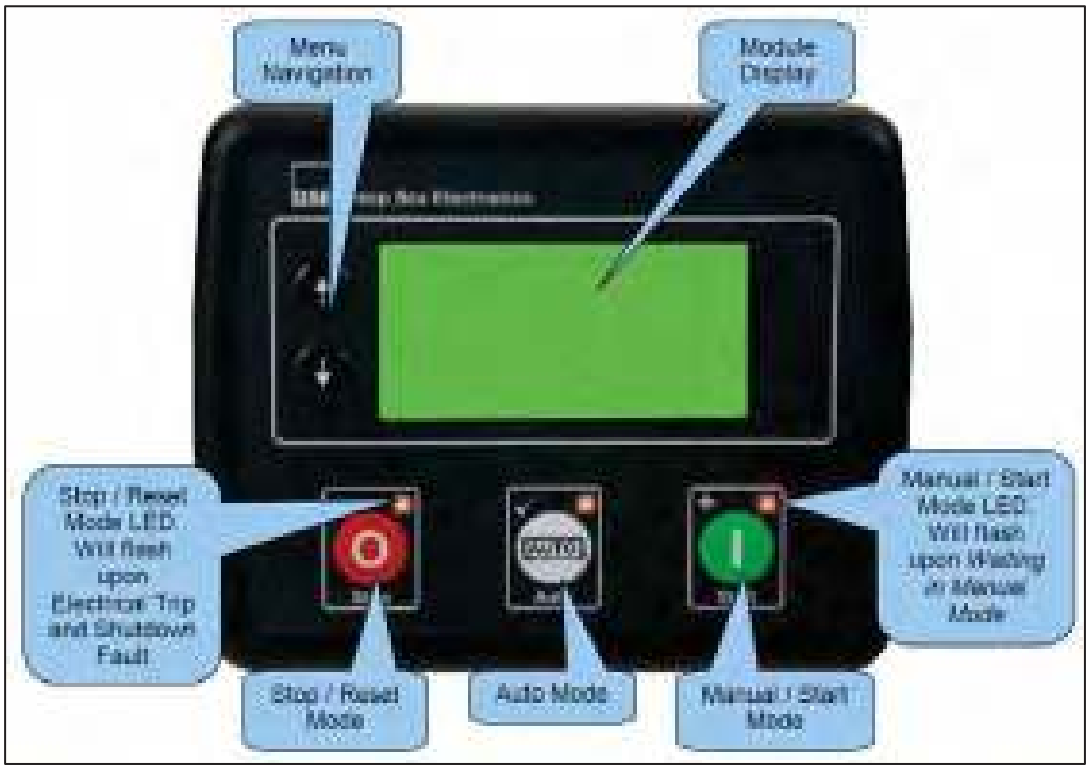
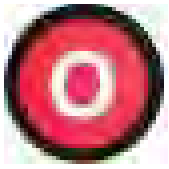


Fig. E3.9 Illustration of DSE4520 Module / Controller

	CAUTION! The module may instruct an e ngine start event due to external influences. Therefore, it is possible for the engine to start at any time without warning. Prior to performing any maintenance on the system, it is recommended that steps are taken to remove the battery and isolate supplies.

3.5.1 Control Push-Buttons

Icon	Description
	**Stop / Reset Mode** This button places the module into its **Stop/Reset Mode**. This will clear any alarm conditions for which the triggering criteria have been removed. If the engine is running and the module is put into Stop mode, the module will automatically instruct the generator to unload (**'Close Generator' and 'Delayed Load Output 1, 2, 3 & 4'** become inactive (if used)). The fuel supply de-energises and the engine comes to a standstill. Should any form of **remote start** signal be present while operating in this mode, a start will not occur.
	**Auto Mode** This button places the module into its **Auto Mode**. This mode allows the module to control the function of the generator automatically. The module will monitor the remote start input and battery charge status and once a start request is made, the set will be automatically started and placed on load (**'Close Generator' and 'Delayed Load Output 1, 2, 3 & 4'** become active in order from lowest to highest (if used)). Upon removal of the starting signal, the module will remove the load from the generator and shut the set down observing the stop delay timer and cooling timer as necessary (**'Close Generator' and 'Delayed Load Output 1, 2, 3 & 4'** become inactive at once (if used)). The module will then await the next start event. For further details, please see the more detailed description of 'Auto operation' elsewhere in this manual.
 	**Menu Navigation** Used for navigating the instrumentation, event log and configuration screens.

Icon	Description
	**Manual / Start Mode** This button will start the engine and run off load. To place the generator on load, digital inputs are required to be assigned to perform this function. If the engine is running off-load in **Manual/Start Mode** button and a **remote start signal** becomes present, the module will automatically instruct the changeover device to place the generator on load (**'Close Generator' and 'Delayed Load Output 1, 2, 3 & 4'** becomes active (if used)). Upon removal of the Remote Start Signal, the generator remains on load until either selection of the **Stop/Reset Mode** or **Auto Mode.**

Table E3.16

3.5.2 Instrumentation Icons

Icon	Details
	The default home page which displays generator voltage and mains voltage (DSE4520 only)
	Generator voltage and frequency instrumentation screen
	Mains voltage and frequency instrumentation screen (DSE4520 only)
	Generator current instrumentation screen
	Mains current instrumentation screen (DSE4520 only when CT in load location)
	Load power instrumentation screen
	Engine speed instrumentation screen
	Hours run instrumentation screen
	Battery voltage instrumentation screen
	Oil pressure instrumentation screen
	Coolant temperature instrumentation screen
	Flexible sender instrumentation screen
	Appears when the event log is being displayed
	Current time held in the unit
	The current value of the scheduler run time and duration
	ECU diagnostic trouble codes
	Oil Filter maintenance timers
	Air Filter maintenance timers
	Fuel Filter maintenance timers

Exhibit Table E3.17 Instrumentation Icons

3.5.3 Mode Icons

An icon is displayed in the Mode Icon section to indicate the mode the controller is currently in.

Icon	Details
	Appears when the engine is at rest and the unit is in stop mode.
	Appears when the engine is at rest and the unit is in auto mode.
	Appears when the engine is at rest and the unit is waiting for a manual start.
	Appears when a timer is active, for example cranking time, crank rest etc.
	Appears when the engine is running, and all timers have expired, either on or off load. The animation speed is reduced when running in idle mode.
	Appears when the unit is in the front panel editor.
	Appears when a USB connection is made to the controller.
	Appears if either the configuration file or engine file becomes corrupted.

Exhibit Table E3.18 Mode Icons

3.5.4 Load Switching Icons

An icon is displayed in the Load Switching Icon section to indicate the current operation status of the controller.

Icon	Details
	Appears when the generator is at rest or not available and when the generator breaker is open.
	Appears when the generator is at rest or not available and the generator breaker has failed to open.
	Appears when the generator is available and the generator breaker is open.
	Appears when the generator is available and the generator breaker is closed.
	Appears when the mains supply is not available and the mains breaker is open. (DSE4520 Only)
	Appears when the mains supply is not available and the mains breaker is closed. (DSE4520 Only)
	Appears when the mains supply is available and the mains breaker is open. (DSE4520 Only)
	Appears when the mains supply is available and the mains breaker is closed. (DSE4520 Only)

Exhibit Table E3.19 Load Switching Icons

3.5.5 Backlight

The LCD backlight is on if the unit has sufficient voltage while the unit is turned on, unless the unit is cranking for which the backlight is turned off.

3.5.6 Warning Alarm Icons

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

By default, warning alarms are self-resetting when the fault condition is removed. However enabling 'all warnings are latched' will cause warning alarms to latch until reset manually. This is enabled using the DSE Configuration Suite in conjunction with a compatible PC.

Icon	Fault	Description
	Auxiliary Inputs	The module detects that an auxiliary input which has been user configured to create a fault condition has become active.
	Analogue Input Configured As Digital	The analogue inputs can be configured to digital inputs. The module detects that an input configured to create a fault condition has become active.
	Fail To Stop	The module has detected a condition that indicates that the engine is running when it has been instructed to stop. **NOTE: 'Fail to Stop' could indicate a faulty oil pressure sensor. If engine is at rest check oil sensor wiring and configuration.**
	Charge Failure	The auxiliary charge alternator voltage is low as measured from the W/L terminal.
	Low Fuel Level	The level detected by the fuel level sensor is below the low fuel level pre-set pre-alarm setting.
	High Fuel Level	The level detected by the fuel level sensor is above the high fuel level pre-set pre-alarm setting.
	Battery Under Voltage	The DC supply has fallen below or risen above the low volts pre-set pre-alarm setting.
	Battery Over Voltage	The DC supply has risen above the high volts pre-set pre-alarm setting.
	Generator Under Voltage	The generator output voltage has fallen below the pre-set pre-alarm setting after the Safety On timer has expired.
	Generator Over Voltage	The generator output voltage has risen above the pre-set pre-alarm setting.

Exhibit Table E3.20 (a) Warning Alarm Icons

	Generator Under Frequency	The generator output frequency has fallen below the pre-set pre-alarm setting after the Safety On timer has expired.
	Generator Over Frequency	The generator output frequency has risen above the pre-set pre-alarm setting.
	CAN ECU Fault	The engine ECU has detected an alarm.
	CAN Data Fail	The module is configured for CAN operation and does not detect data on the engine Can data link.
	Immediate Over Current	The measured current has risen above the configured trip level.
	Delayed Over Current	The measured current has risen above the configured trip level for a configured duration.
	Oil Filter Maintenance Alarm	Maintenance due for oil filter.
	Air Filter Maintenance Alarm	Maintenance due for air filter.
	Fuel Filter Maintenance Alarm	Maintenance due for fuel filter.

Exhibit Table E3.20 (b) Warning Alarm Icons

3.5.7 Electrical Trip Alarm Icons

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

Electrical trips are latching alarms and to remove the fault, press the Stop/Reset Mode button on the module.

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

Icon	Fault	Description
	Auxiliary Inputs	The module detects that an auxiliary input which has been user configured to create a fault condition has become active.
	Analogue Input Configured As Digital	The analogue inputs can be configured to digital inputs. The module detects that an input configured to create a fault condition has become active.
	Low Fuel Level	The level detected by the fuel level sensor is below the low fuel level pre-set alarm setting.
	High Fuel Level	The level detected by the fuel level sensor is above the high fuel level pre-set alarm setting.
	Delayed Over Current	The measured current has risen above the configured trip level for a configured duration.
kW	kW Overload	The measured kW has risen above the configured trip level for a configured duration.

Exhibit Table E3.21 Electrical Trip Alarm Icons

3.5.8 Shutdown Alarm Icons

Shutdown alarms are latching and i mmediately stop the Generator. On initiation of the shutdown condition the module de-energises all the 'Delayed Load Output' and the 'Close Gen Output' outputs to remove the load from the generator. Once this has occurred, the module shuts the generator set down immediately to prevent further damage. The alarm must be accepted and cleared, and the fault removed to reset the module.

Shutdowns are latching alarms and to remove the fault, press the Stop/Reset Mode button on the module.

Icon	Fault	Description
	Auxiliary Inputs	The module detects that an auxiliary input which has been user configured to create a fault condition has become active.
	Analogue Input Configured As Digital	The analogue inputs can be configured to digital inputs. The module detects that an input configured to create a fault condition has become active.
	Fail To Start	The engine has failed to start after the configured number of start attempts.
	Low Oil Pressure	The module detects that the engine oil pressure has fallen below the low oil pressure pre-alarm setting level after the Safety On timer has expired.
	Engine High Temperature	The module detects that the engine coolant temperature has exceeded the high engine temperature pre-alarm setting level after the Safety On timer has expired.
	Under Speed	The engine speed has fallen below the under speed pre alarm setting.
	Over Speed	The engine speed has risen above the over speed pre alarm setting.
	Charge Failure	The auxiliary charge alternator voltage is low as measured from the W/L terminal.

Exhibit Table E3.22 (a) Shutdown Alarm Icons

Icon	Fault	Description
	Generator Under Frequency	The generator output frequency has fallen below the pre-set alarm setting after the Safety On timer has expired.
	Generator Over Frequency	The generator output frequency has risen above the pre-set alarm setting.
	Delayed Over Current	The measured current has risen above the configured trip level for a configured duration.
	kW Overload	The measured kW has risen above the configured trip level for a configured duration.
	CAN ECU Fault	The engine ECU has detected an alarm – CHECK ENGINE LIGHT Contact Engine Manufacturer for support.
	CAN Data Fail	The module is configured for CAN operation and does not detect data on the engine Can data link.
	Emergency Stop	The emergency stop button has been depressed. This failsafe (normally closed to emergency stop) input and immediately stops the set should the signal be removed.
	Oil Sender Open Circuit	The oil pressure sensor has been detected as being open circuit.
	Coolant Temperature Sender Open Circuit	The coolant temperature sensor has been detected as being open circuit.
	Oil Filter Maintenance Alarm	Maintenance due for oil filter.
	Air Filter Maintenance Alarm	Maintenance due for air filter.
	Fuel Filter Maintenance Alarm	Maintenance due for fuel filter.
	Low Fuel Level	The level detected by the fuel level sensor is below the low fuel level pre-set alarm setting.
	High Fuel Level	The level detected by the fuel level sensor is above the high fuel level pre-set alarm setting.
	Generator Under Voltage	The generator output voltage has fallen below the pre-set alarm setting, after the Safety On timer has expired.
	Generator Over Voltage	The generator output voltage has risen above the pre-set alarm setting.

Exhibit Table E3.22 (b) Shutdown Alarm Icons

3.5.8 Navigation Menu Icons

Icon	Description
	Generator and mains voltage instrumentation (DSE4520 only)
	Generator instrumentation
	Mains instrumentation (DSE4520 only)
	Current and load instrumentation (Not available in on the DSE45xx-01 variant)
	Engine instrumentation
	Module information
	Engine DTCs (Diagnostic Trouble Codes) if active
	Event Log

Exhibit Table E3.23 Navigation Menu Icons

3.5.9 ECU Alarm Icons (Engine DTC [Diagnostic Trouble Codes])

Icon	Fault	DTC Description
	Check Engine Fault	The engine ECU has detected a fault not recognised by the DSE module, contact engine manufacturer for support.
	Low Oil Pressure	The engine ECU has detected that the engine oil pressure has fallen below its configured low oil pressure alarm level.
	Under Speed	The engine ECU has detected that the engine speed has fallen below its configured under speed alarm level.
	Over Speed	The engine ECU has detected that the engine speed has risen above its configured over speed alarm level.
	Charge Failure	The engine ECU has detected that the engine's charge alternator output has fallen below its configured alarm level.
	Low Fuel Level	The engine ECU has detected that the engine's fuel level has fallen below its configured low fuel level alarm.
	Battery Under/Over Voltage	The engine ECU has detected that the engine's DC supply has fallen below or risen above its configured alarm level.

Exhibit Table E3.24 ECU Alarm Icons and DTC Description

3.5.10 Event Log

This module's/controller's event log contains a list of the last 15 record electrical trip or shutdown events and the engine hours at which they occurred. Once the log is full, any subsequent electrical trip or shutdown alarms overwrites the oldest entry in the log. Hence, the log always contains the most recent shutdown alarms. The module logs the alarm, along with the engine running hours.

3.6 Operation

3.6.1 Quick Start Guide

This sub-topic provides a quick start guide to the module's/controller's operation.

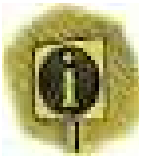
3.6.1.1 Starting the Engine

Fig. E3.10

3.6.1.2 Stopping the Engine

Fig. E3.11

3.6.2 Stop/Reset Mode

	**Important Note!** If a digital input configured to panel lock is active, changing module modes will not be possible. Viewing the instruments and event logs is NOT affected by panel lock.

Stop/Reset Mode is activated by pressing the Stop/Reset Mode button.

The Stop/Reset icon is displayed to indicate Stop/Reset Mode operations.

In Stop/Reset Mode, the module removes the generator from load (if necessary) before stopping the engine if it is already running. If the engine does not stop when requested, the FAIL TO STOP alarm is activated (subject to the setting of the Fail to stop timer). To detect the engine at rest the following must occur:

i. Engine speed is zero as detected by the CAN bus ECU
ii. Generator AC Voltage and Frequency must be zero
iii. Engine Charge Alternator Voltage must be zero
iv. Oil pressure sensor must indicate low oil pressure

When the engine has stopped, it is possible to send configuration files to the module from DSE Configuration Suite PC software and to enter the Front Panel Editor to change parameters.

Any latched alarms that have been cleared are reset when Stop/Reset Mode is entered.

The engine is not started when in Stop/Reset Mode. If remote start signals are given, the input is ignored until Auto Mode is entered.

When left in Stop/Reset Mode with no presses of the fascia buttons and configured for Power Save Mode, the module enters Power Save Mode. To 'wake' the module, press any fascia control buttons or activate Digital Input A. The same is true for Deep Sleep Mode.

Fig. E3.12

3.6.3 Automatic Mode

Auto Mode is activated by pressing the Auto Mode button. The Auto Mode icon is displayed to indicate Auto Mode operations if no alarms are present. Auto mode allows the generator to operate fully automatically, starting and stopping as required with no user intervention.

3.6.3.1 Waiting in Auto Mode

If a starting request is made, the starting sequence begins.

Starting requests can be from the following sources:

i. Activation of an auxiliary input that has been configured to remote start
ii. Activation of the inbuilt exercise scheduler

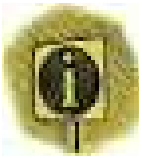
3.6.3.2 Starting Sequence

To allow for 'false' start requests, the start delay timer begins.

Should all start requests be removed during the start delay timer, the unit returns to a stand-by state.

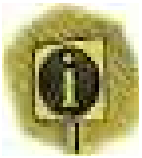
If a start request is still present at the end of the start delay timer, the fuel relay is energised and the engine is cranked.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the crank rest duration after which the next start attempt is made. If this sequence continues beyond the set number of attempts, the start sequence is terminated and the display shows fail to start.

	**Important Note!** If the unit has been configured for CAN, compatible ECU's receive the start command via CAN and transmit the engine speed to the DSE controller.

3.6.3.3 Engine Running

Once the engine is running and all starting timers have expired, the animated Engine Running icon is displayed. The generator is placed on load if configured to do so. If all start requests are removed, the stopping sequence will begin.

	**Important Note!** The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

3.6.3.4 Stopping Sequence

The return delay timer operates to ensure that the starting request has be en permanently removed and isn't just a short term removal. If another start request is made during the cooling down period, the set returns on load.

If there are no starting requests at the end of the return delay timer, the load is removed from the generator to the mains supply and the cooling timer is initiated. The cooling timer allows the set to run off load and cool sufficiently before being stopped. This is particularly important where turbo chargers are fitted to the engine. After the cooling timer has expired, the set is stopped.

3.6.4 Manual/Start Mode

3.6.4.1 Waiting in Manual Mode

To begin the starting sequence, press the Manual/Start Mode button. If 'protected start' is disabled, the start sequence begins immediately.

If 'Protected Start' is enabled, the Waiting in Manual Mode icon is displayed and the LED above the Manual/Start Mode button flashes to indicate Waiting in Manual Mode. The Manual/Start Mode button must be pressed once more to begin the start sequence.

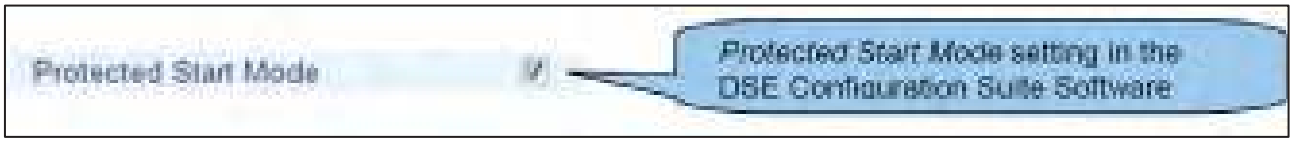
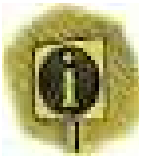


Fig. 3.13

3.6.4.2 Starting Sequence

	**Important Note!** There is no start delay in this mode of operation. If the unit has been configured for CAN, compatible ECU's receives the start command via CAN.

The fuel relay is energised and the engine is cranked.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the crank rest duration after which the next start attempt is made. If this sequence continues beyond the set number of attempts, the start sequence is terminated and the display shows fail to Start.

When the engine fires the starter motor is disengaged. Speed detection is factory configured to be derived from the main alternator output frequency.

Additionally, rising oil pressure can be used disconnect the starter motor (but cannot detect under speed or over speed).

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

3.6.4.3 Engine Running

Once the engine is running and all starting timers have expired, the animated Engine Running icon  is displayed.

In manual mode, the load is not transferred to the generator unless a ‘loading request’ is made. A loading request can come from a number of sources.

i. Activation of an auxiliary input that has been configured to Remote Start on Load or Auxiliary Mains Fail.
ii. Activation of the inbuilt exercise scheduler if configured for ‘on load’ runs.

Once the generator has been placed on load, it is not automatically removed. To manually remove the load either:

i. Press the Auto Mode  button to return to automatic mode. The set observes all auto mode start requests and stopping timers before beginning the Auto Mode Stopping Sequence.
ii. Press the Stop/Reset Mode  button to remove load and stop the generator.
iii. Activation of an auxiliary input that has been configured to Generator Load Inhibit.

3.6.4.4 Stopping Sequence

In manual/start mode the set will continue to run until either:

i. The Stop/Reset Mode button  is pressed – The delayed load outputs are de-activated immediately and the set immediately stops.
ii. The Auto Mode button  is pressed. The set observes all auto mode start requests and stopping timers before beginning the Auto Mode Stopping Sequence.

3.7 Front Panel Configuration

This configuration mode allows the operator to fully configure the module through its display without the use of the DSE Configuration Suite PC Software. Use the module's facia buttons to traverse the menu and make value changes to the parameters:

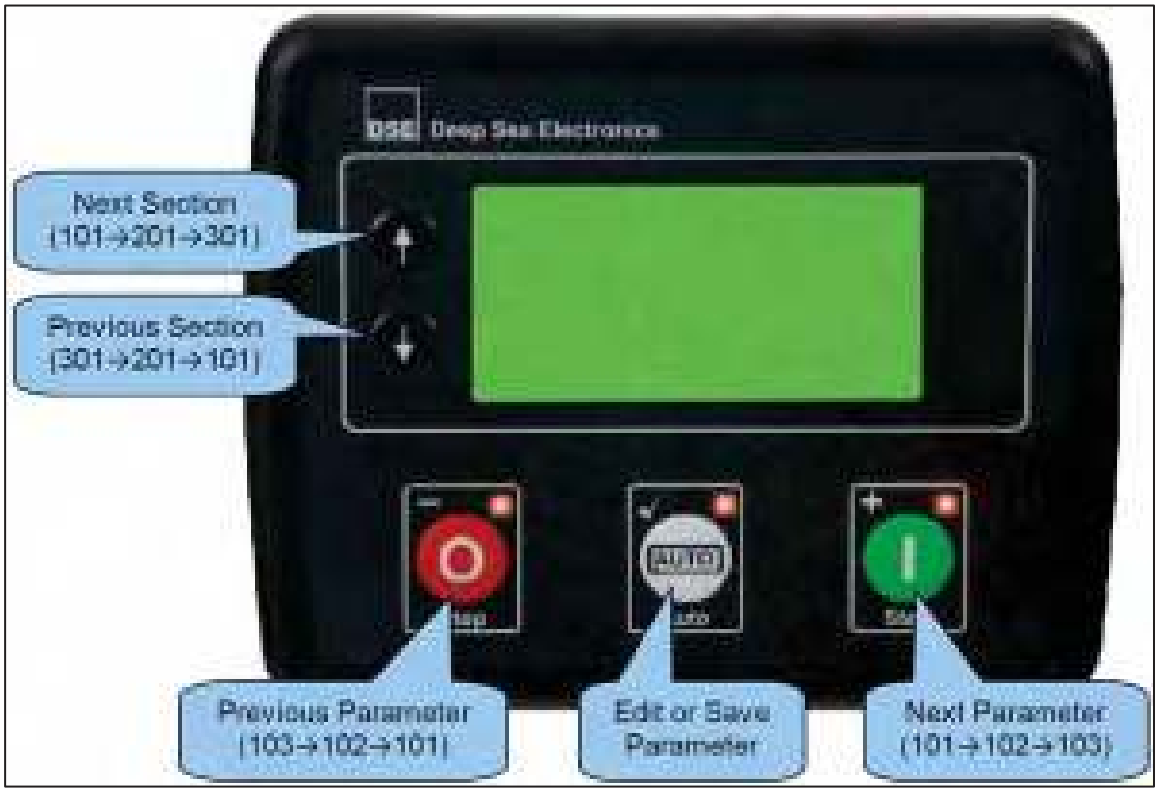


Fig. E3.14

3.7.1 Accessing the Front Panel Configuration Editor

Press the (-) and (✔) buttons together to enter the editor mode.

Press or navigation buttons to cycle through the front panel editor to select the required page in the configuration tables.

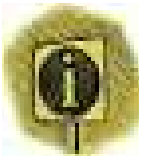
Press the (+) to select the next parameter or (-) to select the previous parameter within the current page.

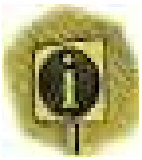
When viewing the parameter to be edited, press the (✔) button, the value begins to flash.

Press the (+) or (-) buttons to adjust the value to the required setting.

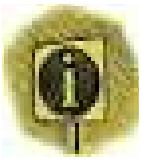
Press the (✔) button the save the current value, the value ceases flashing.

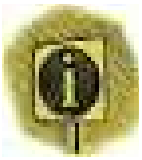
Press and hold the (✔) button to save and exit the editor, the configuration icon is removed from the display.

	**Important Note!** Pressing and holding the (+) or (-) buttons will give auto-repeat functionality. Values can be changed quickly by holding the buttons for a prolonged period of time.

	**Important Note!** The editor automatically exits after 5 minutes of inactivity to ensure security.

	**Important Note!** The PIN number is not set by DSE when the module leaves the factory. If the module has a PIN code set, this has been affected by your generator supplier who should be contacted if you require the code. If the code has been 'lost' or 'forgotten', the module must be returned to the DSE factory to have the module's code removed. A charge will be made for this procedure. ***NB - This procedure cannot be performed away from the DSE factory***.

	**Important Note!** The PIN number is automatically reset when the editor is exited (manually or automatically) to ensure security.

	**Important Note!** More comprehensive module configuration is possible via PC configuration software. For further details of module configuration, refer to DSE Publication: 057-172 DSE45xx configuration software manual.

3.8 Fault Finding

3.8.1 Starting

Symptom	Possible Remedy
Unit is inoperative. Read/Write configuration does not operate.	Check the battery and w iring to the unit. Check the DC supply. Check the DC fuse.
Unit shuts down	Check DC supply voltage is not above 35 Volts or below 9 Volts. Check the operating temperature is not above 70°C. Check the DC fuse.
Fail to Start is activated after pre-set number of attempts to start.	Check wiring of fuel solenoid. Check fuel. Check battery supply. Check battery supply is present on the Fuel output of the module. Check the speed-sensing signal is present on the module's inputs. Refer to engine manual.
Continuous starting of generator when in the Auto Mode	Check that there is no signal present on the "Remote Start" input. Check configured polarity is correct. Check the mains supply is available and within configured limits.
Generator fails to start on receipt of Remote Start signal.	Check Start Delay timer has timed out. Check signal is on "Remote Start" input. Confirm correct configuration of input is configured to be used as "Remote Start". Check that the oil pressure switch or sensor is indicating low oil pressure to the controller. Depending upon configuration, then set will not start if oil pressure is not low.
Pre-heat inoperative	Check wiring to engine heater plugs. Check battery supply. Check battery supply is present on the Pre-heat output of module. Check pre-heat configuration is correct.
Starter motor inoperative	Check wiring to starter solenoid. Check battery supply. Check battery supply is present on the Starter output of module. Ensure oil pressure switch or sensor is indicating the "low oil pressure" state to the controller.

Table E3.25 Fault Finding during Starting

3.8.2 Loading

Symptom	Possible Remedy
Engine runs but generator will not take load.	Check Warm up t imer has t imed out. Ensure generator load inhibit signal is not present on the module inputs. Check connections to the switching device. Note that the set will not take load in manual mode unless there is an active load signal.
Incorrect reading on Engine Gauges Fail to stop alarm when engine is at rest	Check engine is operating correctly. Check that sensor is compatible with the module and t hat the module configuration is suited to the sensor.

Table E3.26 Fault Finding while Loading

3.8.3 Alarms

Symptom	Possible Remedy
Low oil Pressure fault operates after engine has fired.	Check engine oil pressure. Check oil pressure switch/sensor and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sensor is compatible with the module and is correctly configured.
High engine temperature fault operates after engine has fired.	Check engine temperature. Check switch/sensor and w iring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sensor is compatible with the module.
Shutdown fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Electrical Trip fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Warning fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
CAN ECU WARNING CAN ECU SHUTDOWN	This indicates a fault condition detected by the engine ECU and transmitted to the DSE controller.
CAN DATA FAIL	Indicates failure of the CAN data link to the engine ECU. Check all wiring and termination resistors (if required).

Symptom	Possible Remedy
Incorrect reading on Engine gauges Fail to stop alarm when engine is at rest.	Check engine is operating correctly. Check sensor and wiring paying particular attention to the wiring to terminal 10 (refer to appendix). Check that sensor is compatible with the module and that the module configuration is suited to the sensor.

Table E3.27 Fault Finding during Alarms

3.8.4 Communications

Symptom	Possible Remedy
CAN DATA FAIL	Indicates failure of the CAN data link to the engine ECU. Check all wiring and termination resistors (if required).

Table E3.28 Fault Finding in Communications

3.8.5 Instruments

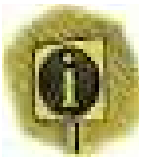
Symptom	Possible Remedy
Inaccurate generator measurements on controller display	Check that the CT primary, CT secondary and VT ratio settings are correct for the application. Check that the CTs are wired correctly with regards to the direction of current flow (p1,p2 and s1 ,s2) and additionally ensure that CTs are connected to the correct phase (errors will occur if CT1 is connected to phase 2). Remember to consider the power factor (kW = kVA x power factor). The controller is true RMS measuring so gives more accurate display when compared with an 'averaging' meter such as an analogue panel meter or some lower specified digital multi-meters. Accuracy of the controller is better than 1% of full scale. Generator voltage full scale is 415V ph-N, accuracy is ±4.15V (1% of 415V).

Table E3.29 Fault Finding in Instruments

3.8.6 Miscellaneous

Symptom	Possible Remedy
Module appears to 'revert' to an earlier configuration	When editing a configuration using the PC software it is vital that the configuration is first 'read' from the controller before editing it. This edited configuration must then be "written" back to the controller for the changes to take effect. When editing a configuration using the fascia editor, be sure to press the Auto Mode ( ) button to save the change before moving to another item or exiting the fascia editor.

Table E3.30 Miscellaneous Fault Finding

	**Important Note!** The above fault finding is provided as a guide check-list only. As the module/controller can be configured to provide a wide range of different features, always refer to the source of your module/controller configuration if in doubt or speak to Greaves authorized service personnel.

3.9 Maintenance, Spares, Repair and Servicing

The controller is Fit and Forget. As such, there are no user serviceable parts within the controller. In the case of malfunction, you should contact your original equipment manufacturer (OEM).

3.9.1 Purchasing Additional Connector Plugs From DSE

If you require additional plugs from DSE, please contact our Sales department using the part numbers below.

3.9.1.1 Pack of Plugs

Module Type	Plug Pack Part Number
4510-01	100-400-41
4520-01	100-400-42
4510-02, 4510-03 & 4510-04	100-400-47
4520-02, 4520-03 & 4520-04	100-400-46

Table E3.31

3.9.1.2 Individual Plugs

Module Terminal Designation	Plug Description	Part No.
1-9 DSE4520 Only	9 way 5.08mm	007-166
1-7 DSE4510 Only	7 way 5.08mm	007-155
10-20	11 way 5.08mm	007-451
21-24	4 way 10.16mm	007-003
25-28 DSE4520 Only	4 way 10.16mm	007-003
29-32 Not fitted on 45xx-01	4 way 5.08mm	007-282
	PC Configuration interface lead (USB type A – USB type B)	016-125

Table E3.32

3.9.2 Purchasing Additional Fixing Clips from DSE

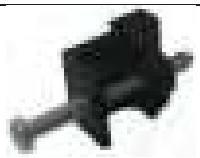
Item	Description	Part No.
	Module Fixing Clips (Packet Of 2)	020-406

Table E3.33

3.9.3 Purchasing Additional Sealing Gasket from DSE

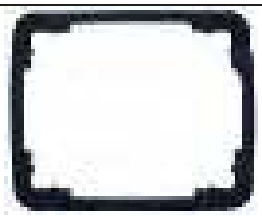
Item	Description	Part No.
	Module Silicon Sealing Gasket	020-282

Table E3.34

Chapter 4 Deep Sea 6123 Controller

4.1 Introduction

The DSE 6100 series module has been designed to allow the operator to start and stop the engine/generator, and if required, transfer the load. The user also has the facility to view the system operating parameters via the LCD display. The DSE 6100 module / controller monitors the engine, indicating the operational status and fault conditions, automatically shutting down the engine and giving a true first up fault condition of an engine failure. The LCD display indicates the fault.

The powerful microprocessor contained within the module allows for incorporation of a range of enhanced features:

i. Text based LCD display
ii. True RMS Voltage monitoring.
iii. Engine parameter monitoring.
iv. Fully configurable inputs for use as alarms or a range of different functions.
v. Engine ECU interface to **electronic engines** (specify on ordering)
vi. Magnetic pickup interface for engine only applications (specify on ordering)

Using a PC and the 6000 series configuration software allows alteration of selected operational sequences, timers and alarm trips.

Additionally, the module's / controller's integral fascia configuration editor allows adjustment of this information.

A robust plastic case designed for front panel mounting houses the module. Connections are via locking plug and sockets.

4.2 Major Parts of Deep Sea (DSE6123) Controller

The major parts of Deep Sea (DSE6123) control panel & power panel are explained in two aspects, which are as mentioned below.

4.2.1 Components on the Door of Control Panel & Power Panel

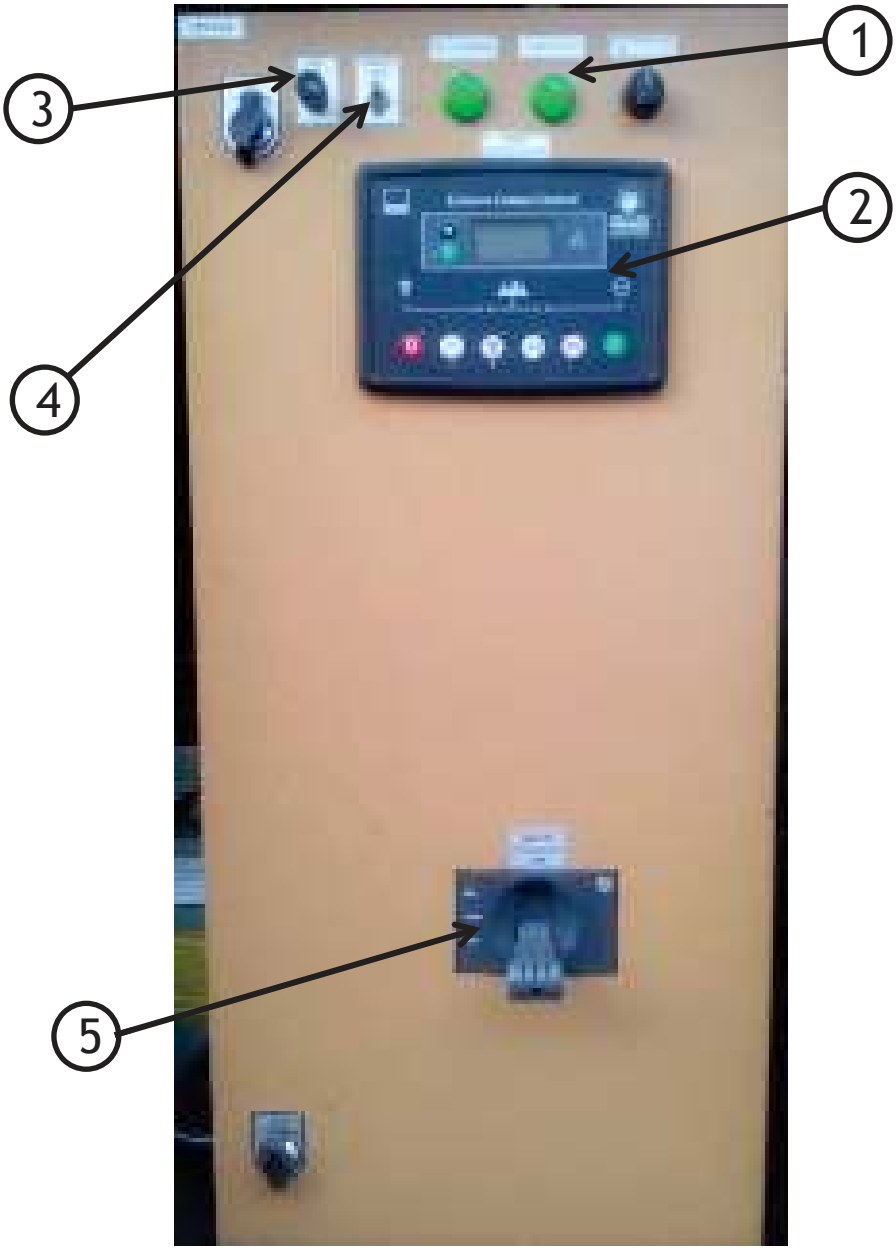


Fig. E4.1 Exterior Illustration of DSE6123 Control Panel

Ref. No.	Description of Part	Ref. No.	Description of Part
1	Load ON GENSET	4	Canopy Light Switch
2	Deep Sea (DSE6123) Controller	5	Power MCCB
3	Control Switch (ON/OFF)		

Table E4.1 Part List for External Components of DSE6123 Control Panel & Power Panel

1) Load ON GENSET Indication Lamp: The green indication lamp turns on when the supply is available to the load.

2) Deep Sea (DSE6123) Controller: The electronic controller is provided to operate the system. It also contains an LCD display that that displays various GENSET parameters, faults, status etc.

3) Control ON Selector Switch: When this switch is turned on, control supply is turned on and provided to the controller and other control equipment's.

4) DG Light switch: Provided to turn on the DG lamp inside the canopy.

5) Power MCCB: This is the main circuit breaker between the alternator output and load. The breaker will carry the rated current continuously. In case of a short circuit or if over current flows for specified amount of time, the breaker will trip. The breaker must then be moved to "OFF" position before re-closing.

4.2.2 Components inside the Control Panel & Power Panel

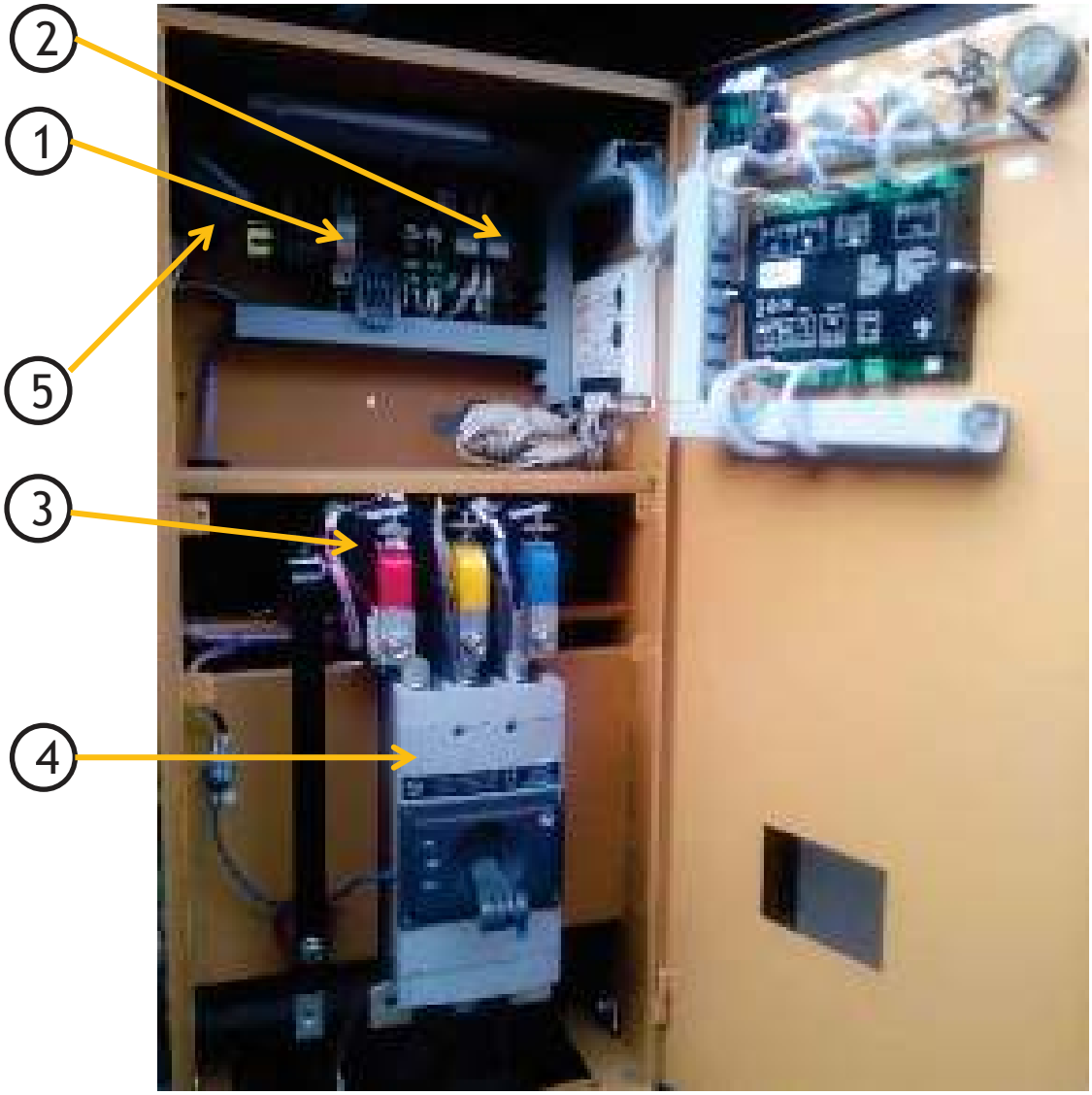


Fig. E4.2 Interior Illustration of DSE6123 Control Panel

Ref. No.	Description of Part	Ref. No.	Description of Part
1	Control MCB/Fuse	4	Power MCCB
2	Power Relay Board	5	Hooter
3	Current Transformers		

Table E4.2 Part List for Internal Components of DSE6123 Control Panel & Power Panel

1) Control MCB / Controller: A single pole control MCB is provided for protection of the control circuit.

2) Power Relay Board: The power relay board consists of three power relays, on each for the fuel solenoid, crank solenoid and hooter.

3) Current Transformers: Three current transformers, one for each phase, are provided for sensing current.

4) Hooter: The hooter operates in case of any fault is sensed by the controller.

4.3 Specifications

4.3.1 Short Names

61xx	DSE 6100 series control module
61x0-xxx-01	DSE6100 series control module (Magnetic pickup version)
61x0-xxx-02	DSE6100 series control module (CAN bus version)

4.3.2 Power Supply Requirements

Minimum supply voltage	8V continuous
Cranking dropouts	Able to survive 0V for 50mS providing the supply was at least 10V before the dropout and recovers to 5V afterwards. This is more than sufficient to allow the module to operate during engine cranking where the battery supply often falls as low as 4V (on a 12V system!) This is achieved without the need for internal batteries or other external requirements.
Maximum supply voltage	35V continuous (60V protection)
Reverse polarity protection	-35V continuous
Maximum operating current	160mA at 24V; 340mA at 12V
Maximum standby current	80mA at 24V; 160mA at 12V
Current when in Sleep Mode	50mA @ 12V; 32mA @ 24V

4.3.2.1 Plant Supply Instrumentation Display

Range	0V-70V DC (note Maximum continuous operating voltage of 35V DC)
Resolution	0.1V
Accuracy	±1% full scale (±0.7V)

4.3.3 Generator Voltage/Frequency Sensing

Measurement type	True RMS conversion
Sample Rate	5KHz or better
Harmonics	Up to 11th or better
Input Impedance	300K Ω ph-N
Phase to Neutral	15V to 333V AC (max)
Phase to Phase	25V to 576V AC (max)
Common mode offset from Earth	100V AC (max)
Resolution	1V AC phase to neutral 2V AC phase to phase
Accuracy	±1% of full scale phase to neutral ±2% of full scale phase to phase
Minimum frequency	3.5Hz
Maximum frequency	75.0Hz
Frequency resolution	0.1Hz
Frequency accuracy	±0.2Hz

4.3.4 Inputs

4.3.4.1 Digital Inputs

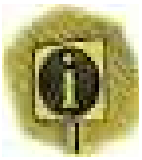
Number	6
Arrangement	Contact between terminal and ground
Low level threshold	40% of DC supply voltage
High level threshold	60% of DC supply voltage
Maximum input voltage	DC supply voltage positive terminal
Minimum input voltage	DC supply voltage negative terminal
Contact wetting current	2.5mA @12V typical; 5mA @ 24V typical
Open circuit voltage	Plant supply

4.3.4.2 Charge Fail Input

Minimum voltage	0V
Maximum voltage	35V (plant supply)
Resolution	0.2V
Accuracy	± 1% of max measured voltage
Excitation	Active circuit constant power output
Output Power	2.5W Nominal @12V and 24V
Current at 12V	210mA
Current at 24V	105mA

4.3.4.3 Magnetic Pick-up

Type	Single ended input, capacitive coupled
Minimum voltage	0.5V RMS
Max common mode voltage	±2V
Maximum voltage	Clamped to ±70V by transient suppressers, dissipation not to exceed 1W.
Maximum frequency	10,000Hz
Resolution	6.25 RPM
Accuracy	±25 RPM
Flywheel teeth	10 to 500



Important Note! DSE can supply a suitable magnetic pickup device, available in two body thread lengths :
DSE Part number 020-012 - Magnetic Pickup probe 5/8 UNF 2½" thread length
DSE Part number 020-013 - Magnetic Pickup probe 5/8 UNF 4" thread length

Magnetic Pickup devices can often be 'shared' between two or more devices. For example, one device can often supply the signal to both the DSE6100 series module and the engine governor. The possibility of this depends upon the amount of current that the magnetic pickup can supply.

4.3.5 Outputs

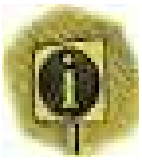
4.3.5.1 Outputs A & B (Fuel & Start)

Type	Fuel (A) and Start (B) outputs. Supplied from DC supply terminal 2. Fully configurable when CAN engine is selected.
Rating	2A @ 35V
Protection	Protected against over current & over temperature. Built in load dump feature.

4.3.5.2 Configurable Outputs C, D, E, & F

Type	Fully configurable, supplied from DC supply terminal 2.
Rating	2A @ 35V
Protection	Protected against over current & over temperature. Built in load dump feature.

4.3.6 Accumulated Instrumentation



Important Note! When an ac cumulated instrumentation value exceeds the maximum number as listed below, it will reset and begin counting from zero again.

Engine hours run	Maximum 99999 Hrs. 59 minutes (approximately 11yrs 4months)
Number of starts	1,000,000 (1 million)

The number of logged Engine Hours and Number of Starts can be set/reset using the DSE Configuration Suite PC software. Depending upon module configuration, this may have been PIN number locked by your generator supplier.

4.3.7 Dimensions & Mounting

4.3.7.1 Dimensions

216mm x 158mm x 42mm
(8.5” x 6.2” x 1.6”)

4.3.7.2 Panel Cut-out

182mm x 137mm
(7.2” x 5.4”)

4.3.7.3 Weight

510g (0.51kg)

4.3.7.4 Fixing Clips

The module is held into the panel fascia using the supplied fixing clips.

i. Withdraw the fixing clip screw (turn anticlockwise) until only the pointed end is protruding from the clip.
ii. Insert the three ‘prongs’ of the fixing clip into the slots in the side of the 6000 series module case.
iii. Pull the fixing clip backwards (towards the back of the module) ensuring all three prongs of the clip are inside their allotted slots.
iv. Turn the fixing clip screws clockwise until they make contact with the panel fascia.
v. Turn the screws a little more to secure the module into the panel fascia. Care should be taken not to over tighten the fixing clip screws.

Fig. E4.5 Fixing Clips

4.3.7.5 Optional Silicon Sealing Gasket

The optional silicon gasket provides improved sealing between the 6000 series module and the panel fascia. The gasket is fitted to the module before installation into the panel fascia. Take care to ensure the gasket is correctly fitted to the module to maintain the integrity of the seal.

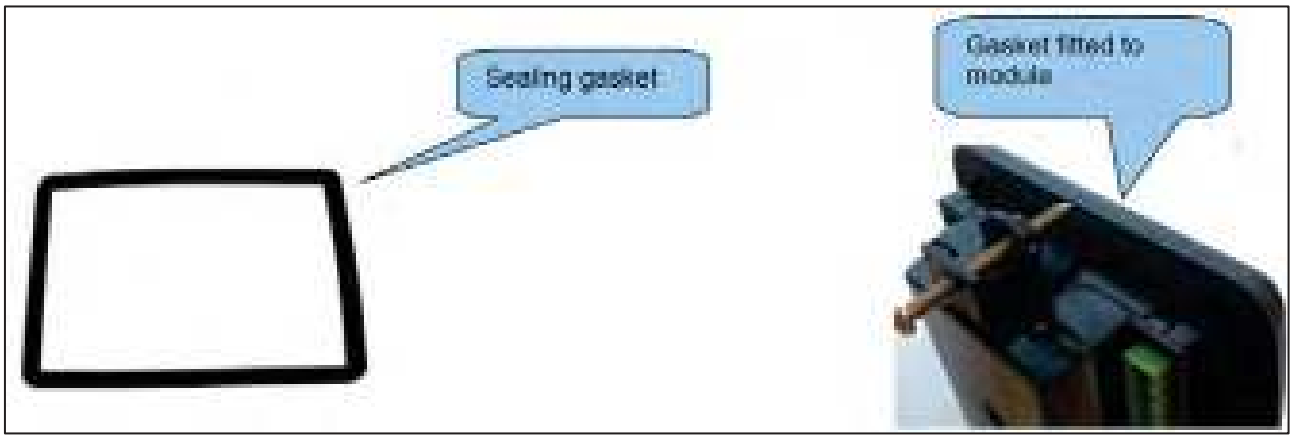


Fig. E4.6

4.4 Installation

The DSE6000 Series module/controller is designed to be mounted on the panel fascia. For dimension and mounting details, see the topic entitled Specification, Dimensions and mounting in this chapter.

4.4.1 Terminal Description

4.4.1.1 DC Supply, Fuel, and Start Outputs

	**Important Note!** When the module/controller is configured for operation with an electronic engine, FUEL and START output requirements may be different. Avail advice in this regard from Greaves expert technical team.

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
	1	DC Plant Supply Input (Negative)	2.5mm² AWG 13	
	2	DC Plant Supply Input (Positive)	2.5 mm² AWG 13	(Recommended Maximum Fuse 15A anti-surge) Supplies the module (2A anti-surge requirement) and all output relays
	3	Emergency Stop	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated.
	4	Output A	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated. Normally used for FUEL control.
	5	Output B	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated. Normally used for START control.
D+ W/L	6	Charge fail / excite	2.5mm² AWG 13	Do not connect to ground (battery negative). If charge alternator is not fitted, leave this terminal disconnected.
	7	System Earth	1.0mm² AWG 18	
	8	Output C	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated. Normally used for Generator load switch control.
	9	Output D	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated. Normally used for Mains load switch control (CBE6120)
	10	Output E	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated.
	11	Output F	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated.

Exhibit Table E4.3

4.4.1.2 Generator / Mains Voltage Sensing

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
~	19	Generator L1 (U) voltage monitoring	1.0mm² AWG 18	Connect to generator L1 (U) output (AC) (Recommend 2A fuse)
	20	Generator L2 (V) voltage monitoring	1.0mm² AWG 18	Connect to generator L2 (V) output (AC) (Recommend 2A fuse)
	21	Generator L3 (W) voltage monitoring	1.0mm² AWG 18	Connect to generator L3 (W) output (AC) (Recommend 2A fuse)
	22	Generator Neutral (N) input	1.0mm² AWG 18	Connect to generator Neutral terminal (AC)
	23	Mains L1 (R) voltage monitoring	1.0mm² AWG 18	Connect to Mains L1 (R) output (AC) (Recommend 2A fuse)
	24	Mains L2 (S) voltage monitoring	1.0mm² AWG 18	Connect to Mains L2 (S) output (AC) (Recommend 2A fuse)
	25	Mains L3 (T) voltage monitoring	1.0mm² AWG 18	Connect to Mains L3 (T) output (AC) (Recommend 2A fuse)
	26	Mains Neutral (N) input	1.0mm² AWG 18	Connect to Mains Neutral terminal (AC)

Exhibit Table E4.4

4.4.1.3 Digital Inputs

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
	32	Configurable digital input A	0.5mm² AWG 20	Switch to negative
	33	Configurable digital input B	0.5mm² AWG 20	Switch to negative
	34	Configurable digital input C	0.5mm² AWG 20	Switch to negative
	35	Configurable digital input D	0.5mm² AWG 20	Switch to negative
	36	Configurable digital input E	0.5mm² AWG 20	Switch to negative
	37	Configurable digital input F	0.5mm² AWG 20	Switch to negative

Exhibit Table E4.5

4.5 Description of Controls

The following section details the function and meaning of the various controls on the module.

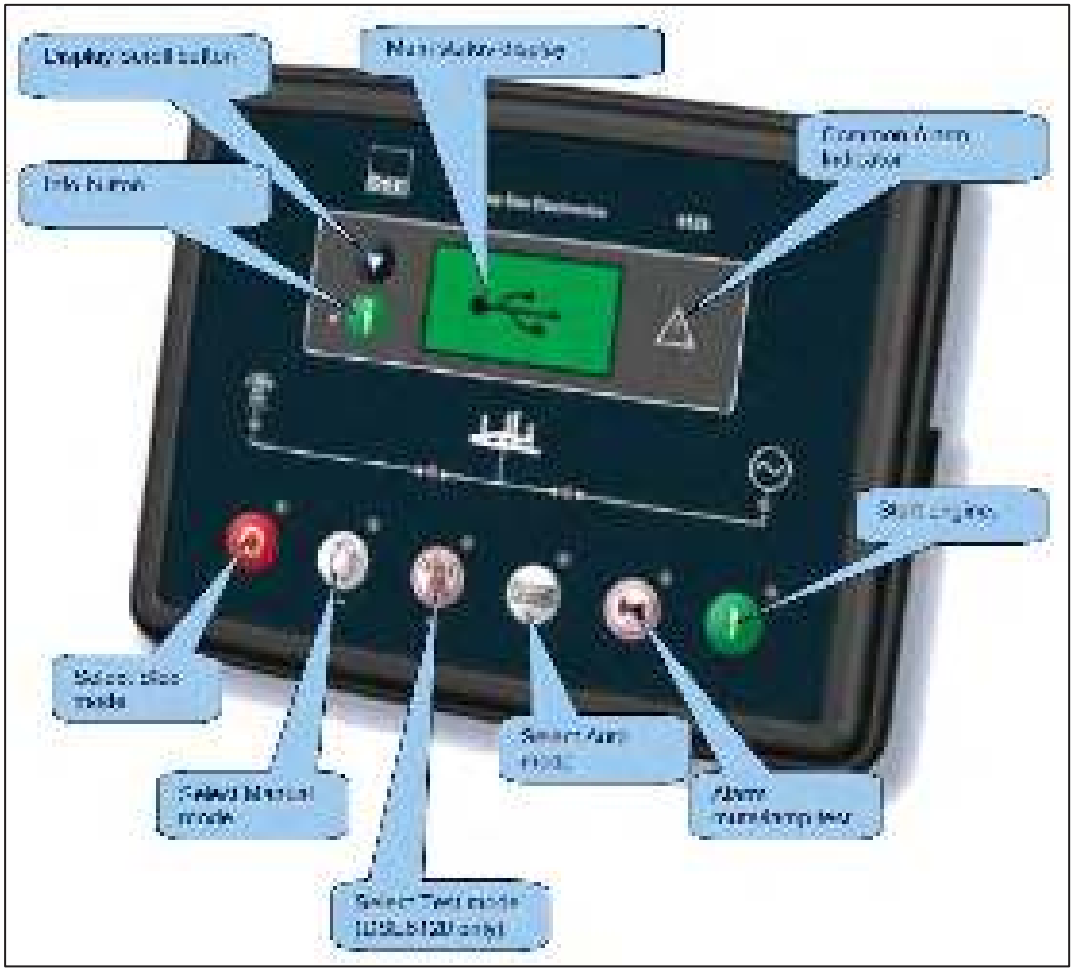


Fig. E4.7

4.5.1 Quick Start Guide

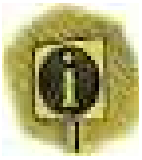
This topic provides a quick start guide to the module's operation.

4.5.1.1 Starting the Engine

Fig. E4.8

4.5.1.2 Stopping the Engine

Fig. E4.9

	**Important Note!** For further details, see the topic entitled 'OPERATION' in this chapter.

4.5.2 Graphical Display

i. 4-Line, 64 x 132 small Graphic Display with LED Backlight
ii. Icon and numeric display. Switch to select 'Icon' or 'English' display
iii. Software controlled contrast
iv. Mimic of Text insert / 4x indicators required via LCD

4.5.3 Controls

Icon	Description
	**Stop / Reset Mode** This button places the module into its Stop/Reset mode. This will clear any alarm conditions for which the triggering criteria have been removed. If the engine is running and the module is in Stop mode, the module will automatically instruct the changeover device to unload the generator ('Close Generator' becomes inactive (if used)). The fuel supply de-energises and the engine comes to a standstill. Should a remote start signal be present while operating in this mode, a remote start will not occur.
	**Manual** This mode allows manual control of the generator functions. Once in Manual mode the module will respond to the start  button, start the engine, and run off load. If the engine is running off-load in the Manual mode and a remote start signal becomes present, the module will automatically instruct the changeover device to place the generator on load ('Close Generator' becomes active (if used)). Upon removal of the remote start signal, the generator remains on load until either selection of the 'STOP/RESET' or 'AUTO' modes. For further details, please see the more detailed description of 'Manual operation' elsewhere in this chapter.

Icon	Description
	**Auto Mode** This button places the module into its 'Automatic' mode. This mode allows the module to control the function of the generator automatically. The module will monitor the remote start input and mains supply status and once a start request is made, the set will be automatically started and placed on load. Upon removal of the starting signal, the module will automatically transfer the load from the generator and shut the set down observing the stop delay timer and cooling timer as necessary. The module will then await the next start event. For further details, please see the more detailed description of 'Auto operation' elsewhere in this manual.
	**Start** This button is only active in STOP/RESET  or MANUAL  mode. Pressing this button in manual or test mode will start the engine and run off load (manual) or on load (test). Pressing this button in STOP/RESET mode will turn on the CAN engine ECU (when correctly configured and fitted to a compatible engine ECU)
	**Mute / Lamp Test** This button silences the audible alarm if it is sounding and illuminates all of the LEDs as a lamp test feature/ When correctly configured and fitted to a compatible engine ECU, pressing this button in STOP/RESET mode after pressing the START  button (to power the ECU) will cancel any "passive" alarms on the engine ECU.
	**Scroll** This buttons scrolls through the instrument display pages.

4.6 Operation

4.6.1 Stop Mode

STOP mode is activated by pressing the button.

In STOP mode, the module will remove the generator from load (if necessary) before stopping the engine if it is already running.

If the engine does not stop when requested, the FAIL TO STOP alarm is activated (subject to the setting of the Fail to stop timer). To detect the engine at rest the following must occur:

i. Engine speed is zero as detected by the Magnetic Pickup or CAN bus ECU (depending upon module variant).
ii. Generator frequency must be zero.
iii. Oil pressure switch must be closed to indicate low oil pressure (MPU version only)

When the engine has stopped, it is possible to send configuration files to the module from DSE Configuration Suite PC software and to enter the Front Panel Editor to change parameters.

Any latched alarms that have been cleared will be reset when STOP mode is entered.

The engine will not be started when in STOP mode. If remote start signals are given, the input is ignored until AUTO mode is entered.

When configured to do so, when left in STOP mode for five minutes with no presses of the fascia buttons, the module enters low power mode. To 'wake' the module, press the button or any other fascia control button.

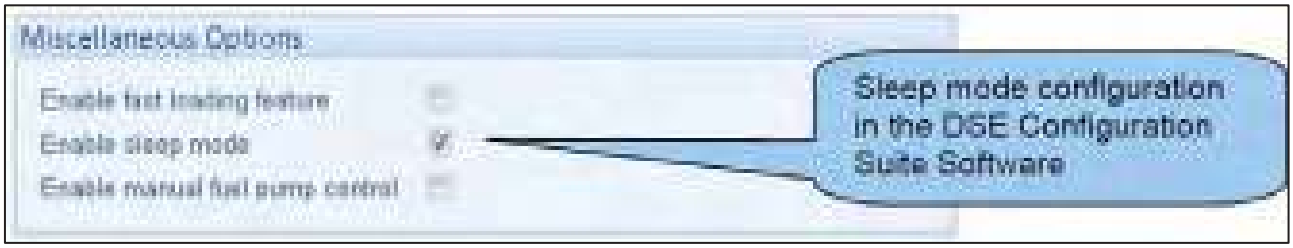
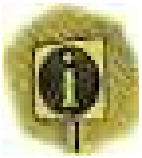
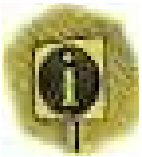


Fig. E4.10

4.6.1.1 ECU Overdrive

	**Important Note!** ECU Override function is only applicable to the CAN variant of the 6100 series controller.

	**Important Note!** Depending upon system design, the ECU may be powered or unpowered when the module is in STOP mode. ECU override is only applicable if the ECU is unpowered when in STOP mode.

When the ECU powered down (as is normal when in STOP mode), it is not possible to read the diagnostic trouble codes or instrumentation. Additionally, it is not possible to use the engine manufacturers' configuration tools.

As the ECU is usually unpowered when the engine is not running, it must be turned on manually as follows:

i. Select STOP  mode on the DSE controller.

ii. Press and hold the START  button to power the ECU. As the controller is in STOP mode, the engine will not be started.

iii. Continue to hold the start button for as long as you need the ECU to be powered.

iv. The ECU will remain powered until a few seconds after the START button is released.

This is also useful if the engine manufacturer's tools need to be connected to the engine, for instance to configure the engine as the ECU needs to be powered up to perform this operation.

4.6.2 Automatic Mode

	**Important Note!** If a digital input configured to panel lock is active, changing module modes will not be possible. Viewing the instruments and event logs is NOT affected by panel lock.

Activate auto mode by pressing the pushbutton. The icon is displayed to indicate Auto Mode operation if no alarms is present.

Auto mode will allow the generator to operate fully automatically, starting and stopping as required with no user intervention.

4.6.2.1 Waiting in Auto Mode

If a starting request is made, the starting sequence will begin. Starting requests can be from the following sources:

i. Mains failure
ii. Activation of an auxiliary input that has been configured to remote start
iii. Activation of the inbuilt exercise scheduler

4.6.2.2 Starting Sequence

To allow for 'false' start requests, the start delay timer begins.

Should all start requests be removed during the start delay timer, the unit will return to a stand-by state.

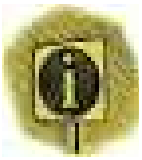
If a start request is still present at the end of the start delay timer, the fuel relay is energised and the engine will be cranked.

	**Important Note!** If the unit has been configured for CAN, compatible ECU's will receive the start command via CAN.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the crank rest duration after which the next start attempt is made. If this sequence continues beyond the set number of attempts, the start sequence will be terminated and the display shows fail to Start.

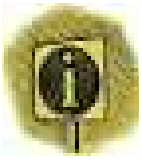
When the engine fires the starter motor gets disengaged. Speed detection is factory configured to be derived from the main alternator output frequency but can additionally be measured from a Mag netic Pickup mounted on the flywheel (Selected by PC using the 3000 series configuration software). Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect under speed or over speed).

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

	**Important Note!** If the unit has been configured for CAN, speed sensing is via CAN.

4.6.2.3 Engine Running

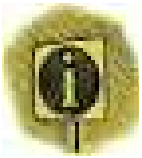
Once the engine is running and al l starting timers have expired, the animated icon is displayed. If all start requests are removed, the stopping sequence will begin.

	**Important Note!** The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

4.6.2.4 Stopping Sequence

The return delay timer operates to ensure that the starting request has be en permanently removed and isn't just a short term removal. Should another start request be made during the cooling down period, the set will return on load. If there are no starting requests at the end of the return delay timer, the load is removed from the generator to the mains supply and t he cooling timer is initiated. The cooling timer allows the set to run off load and cool sufficiently before being stopped. This is particularly important where turbo chargers are fitted to the engine. After the cooling timer has expired, the set is stopped.

4.6.3 Manual Mode

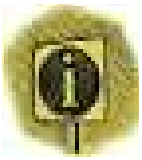
	**Important Note!** If a digital input configured to panel lock is active, changing module modes will not be possible. Viewing the instruments and event logs is NOT affected by panel lock.

Manual mode allows the operator to start and stop the set manually, and if required change the state of the load switching devices. Module mode is active when the  button is pressed.

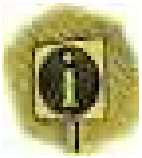
4.6.3.1 Waiting in Manual Mode

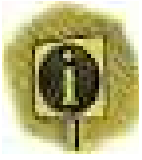
To begin the starting sequence, press the  button. If 'protected start' is disabled, the start sequence begins immediately. If 'Protected Start' is enabled, the  icon is displayed to indicate Manual mode and the manual LED flashes. The  button must be pressed once more to begin the start sequence.

4.6.3.2 Starting Sequence

	**Important Note!** There is no start delay in this mode of operation.

The fuel relay is energised and the engine is cranked.

	**Important Note!** If the unit has been configured for CAN, compatible ECU's will receive the start command via CAN.

	**Important Note!** If the unit has been configured for CAN, speed sensing is via CAN.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the crank rest duration after which the next start attempt is made. If this sequence continues beyond the set number of attempts, the start sequence will be terminated and the display shows **fail to start**.

When the engine fires the starter motor is disengaged. Speed detection is factory configured to be derived from the main alternator output frequency but can additionally be measured from a Magnetic Pickup mounted on the flywheel (Selected by PC using the 3000 series configuration software).

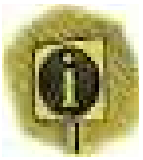
Additionally, rising oil pressure can be used disconnect the starter motor (but cannot detect under speed or over speed).

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

4.6.3.3 Engine Running

In manual mode, the load is not transferred to the generator unless a ‘loading request’ is made. A loading request can come from a number of sources.

i. Detection of mains failure
ii. Activation of an auxiliary input that has been configured to remote start on load
iii. Activation of the inbuilt exercise scheduler if configured for ‘on load’ runs.

	**Important Note!** The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

Once the load has been transferred to the generator, it will not be automatically removed. To manually transfer the load back to the mains either:

i. Press the auto mode button to return to automatic mode. The set will observe all auto mode start requests and stopping timers before beginning the Auto mode stopping sequence.

ii. Press the stop button

iii. De-activation of an auxiliary input that has been configured to remote start on load.

4.6.3.4 Stopping Sequence

In manual mode the set will continue to run until either:

i. The stop button is pressed – The set will immediately stop

ii. The auto button is pressed. The set will observe all auto mode start requests and stopping timers before beginning the Auto mode stopping sequence.

4.7 Front Panel Configuration

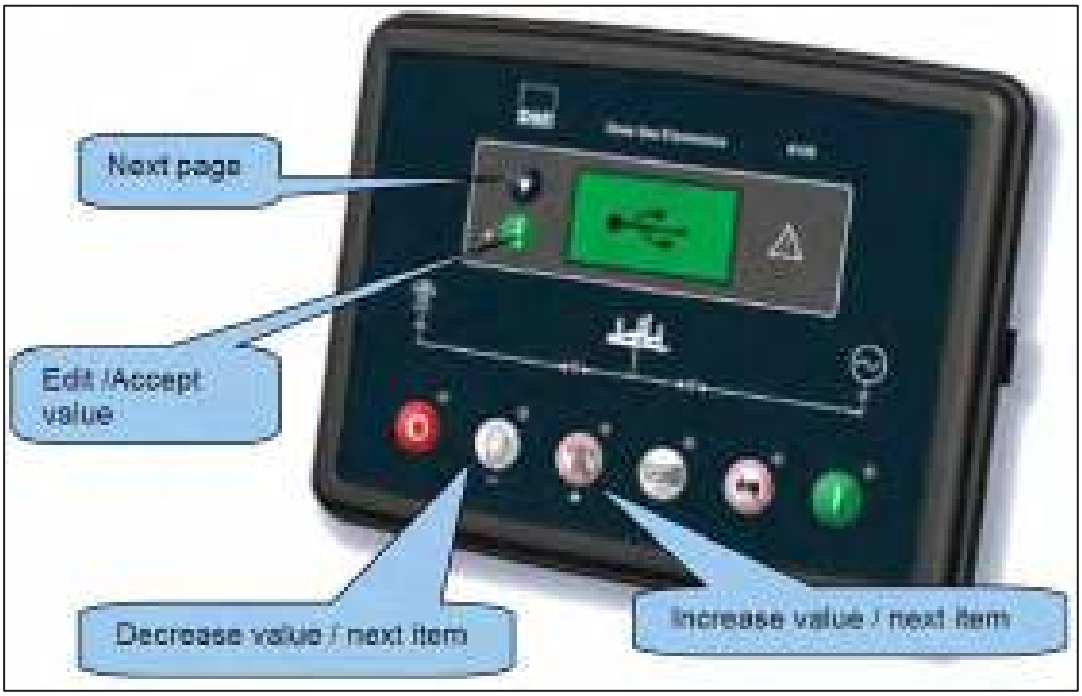


Fig. E4.11

This configuration mode allows the operator limited customising of the way the module operates. Use the module's navigation buttons to traverse the menu and make value changes to the parameters.

4.7.1 Accessing the Front Panel Editor (FPE)

The module must be in STOP mode with the engine at rest before configuration mode can be accessed. To enter the 'configuration mode' press the INFO and STOP buttons together.

4.7.1.1 Entering the Configuration Editor PIN Number

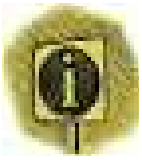
If the module PIN number has be en set, the PIN number request is then shown. The configuration cannot be viewed or changed until the PIN number is correctly entered.

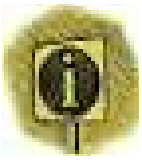
Enter either the 'main' PIN or the application PIN.

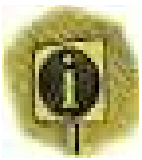
	The first * is flashing. Press (+) or (-) buttons to adjust it to the correct value for the first digit of the PIN number. Press ✓ when the first digit is correctly entered. The entered digit will turn back to a * to maintain security.
	The second * is now flashing. Press (+) or (-) buttons to adjust it to the correct value for the second digit of the PIN number. Press ✓ when the second digit is correctly entered. The entered digit will turn back to a * to maintain security.
	The third * is now flashing. Press (+) or (-) buttons to adjust it to the correct value for the third digit of the PIN number. Press ✓ when the third digit is correctly entered. The entered digit will turn back to a * to maintain security.
	The fourth * is now flashing. Press (+) or (-) buttons to adjust it to the correct value for the fourth digit of the PIN number. Press ✓ when the fourth digit is correctly entered. The entered digit will turn back to a * to maintain security.

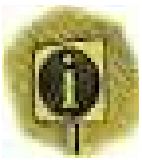
Table E4.6

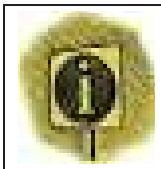
If the Configuration PIN has been entered successfully (or the PIN number has not been set in the module) the first configurable parameter is displayed.

	**Important Note!** When is ✓pressed after editing the final PIN digit, the PIN is checked for validity. If the number is not correct, the editor is automatically exited. To retry you must re-enter the editor as described above.

	**Important Note!** To exit the front panel configuration editor at any time, press and hold the (✓) button. Ensure you have saved any changes you have made by pressing the ✓button first.

	**Important Note!** When the editor is visible, it is automatically exited after 5 minutes of inactivity to ensure security.

	**Important Note!** If the Application Menu PIN is entered, then only the Application Menu is displayed. If the Full Configuration PIN is entered, the entire configuration menu is displayed including the Application Menu.

	**Important Note!** The PIN number is automatically reset when the editor is exited (manually or automatically) to ensure security.

4.7.1.2 Editing a Parameter

Enter the editor as described above.

Press  to select the required 'page' as detailed below.

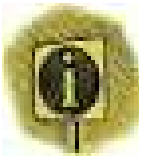
Press  (+) to select the next parameter or  (-) to select the previous parameter within the current page.

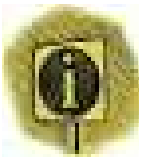
When viewing the parameter to be changed, press the (✓) button. The value begins to flash.

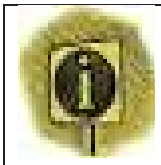
Press (+) or (-) to adjust the value to the required setting.

Press (✓) the save the current value, the value ceases flashing.

Press and hold the (✓) button to exit the editor.

	**Important Note!** Values representing pressure will be displayed in Bar. Values representing temperature are displayed in degrees Celsius.

	**Important Note!** When adjusting values in the FPE a press and hold of the increment button will cover the full range of the item being adjusted (min to max) in less than 20 seconds.

	**Important Note!** When the editor is visible, it is exited after 5 minutes of inactivity to ensure security.

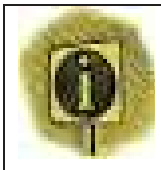
4.8 Fault Finding

Symptom	Possible Remedy
Unit is inoperative Read/Write configuration does not operate	Check the battery and wiring to the unit. Check the DC supply. Check the DC fuse.
Unit shuts down	Check DC supply voltage is not above 35 Volts or below 9 Volts. Check the operating temperature is not above 70°C. Check the DC fuse.
Unit locks out on Emergency Stop	If no Emergency Stop Switch is fitted, ensure that a DC positive signal is connected to the Emergency Stop input. Check emergency stop switch is functioning correctly. Check Wiring is not open circuit.
Intermittent Magnetic Pick-up sensor fault	Ensure that Magnetic pick-up screen only connects to earth at one end, if connected at both ends, this enables the screen to act as an aerial and will pick up random voltages. Check pickup is correct distance from the flywheel teeth.
Low oil Pressure fault operates after engine has fired	Check engine oil pressure. Check oil pressure switch/sensor and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sensor is compatible with the 3310 Module and is correctly configured.
High engine temperature fault operates after engine has fired.	Check engine temperature. Check switch/sensor and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sensor is compatible with the 6000 series module.
Shutdown fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Warning fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.

Symptom	Possible Remedy
Fail to Start is activated after preset number of attempts to start	Check wiring of fuel solenoid. Check fuel. Check battery supply. Check battery supply is present on the Fuel output of the module. Check the speed-sensing signal is present on the 6000 series module inputs. Refer to engine manual.
Continuous starting of generator when in AUTO	Check that there is no signal present on the "Remote Start" input. Check configured polarity is correct.
Generator fails to start on receipt of Remote Start signal.	Check Start Delay timer has t imed out. Check signal is on "Remote Start" input. Confirm correct configuration of input is configured to be used as "Remote Start". Check that the oil pressure switch or sensor is indicating low oil pressure to the controller. Depending upon configuration, the set will not start if oil pressure is not low.
Pre-heat inoperative	Check wiring to engine heater plugs. Check battery supply. Check battery supply is present on the Pre-heat output of module. Check pre-heat configuration is correct.
Starter motor inoperative	Check wiring to starter solenoid. Check battery supply. Check battery supply is present on the Starter output of module. Ensure that the Emergency Stop input is at Positive. Ensure oil pressure switch or sensor is indicating the "low oil pressure" state to the 6000 series controller.
Engine runs but generator will not take load	Check Warm up timer has timed out. Ensure generator load inhibit signal is not present on the module inputs. Check connections to the switching device. Note that the set will not take load in manual mode unless there is an active remote start on load signal.

Symptom	Possible Remedy
Incorrect reading on Engine gauges Fail to stop alarm when engine is at rest	Check engine is operating correctly. Check sensor and wiring.
Module appears to 'revert' to an earlier configuration	When editing a configuration using the PC software it is vital that the configuration is first 'read' from the controller before editing it. This edited configuration must then be "written" back to the controller for the changes to take effect. When editing a c onfiguration using the Front Panel Editor, be sure to press the Save button to save the change before moving to another item or exiting the Front Panel Editor.
Set will not take load	Ensure the generator is available. Check that the output configuration is correct to drive the load switch device and that all connections are correct. Remember that the set will not take load in manual mode unless a remote start on load input is present.
Inaccurate generator measurements on controller display	The 3000 series controller is true RMS measuring so gives more accurate display when compared with an 'average' meter such as an analogue panel meter or some lower specified digital multi-meters. Accuracy of the controller is better than 1% of full scale. Gen volts full scale is 333V ph-n so accuracy is ±3.33V (1% of 333V).

Table E4.7 Fault Finding

	**Important Note!** The above fault finding is provided as a g uide check-list only. As the module can be configured to provide a wide range of different features, always refer to the source of your module configuration if in doubt or avail assistance from Greaves Technical Team.

4.9 Maintenance, Spares, Repair, and Servicing

The DSE6000 Series controller is designed to be Fit and Forget. As such, there are no user serviceable parts within the controller. In the case of malfunction, you should contact your original equipment supplier (OEM).

4.9.1 Purchasing Additional Connector Plugs from DSE

If you require additional plugs from DSE, please contact our Sales department using the part numbers below.

4.9.1.1 DSE6123

8130 series terminal designation		Plug description	Part No.
1-11	D+ W/L	11 way 5.08mm	007-451
12-18		4 way 5.08mm	007-464
16-18	CAN	3 way 5.08mm	007-174
19-26		8 way 7.62mm	007-454
27-31		5 way 5.08mm	007-445
32-37		6 way 5.08mm	007-446

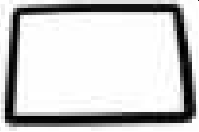
Exhibit Table E4.8

4.9.2 Purchasing Additional Fixing Clips from DSE

Item	Description	Part No.
	6000 series fixing clips (packet of 4)	020-294

4.9.3 Purchasing Additional Sealing from DSE

The optional sealing gasket is not supplied with the controller but can be purchased separately.

Item	Description	Part No.
	6000 series silicon sealing gasket	020-389

Chapter 5 DATAKOM D-500 Controller

5.1 Introduction

The DATAKOM D-500 is a next generation GENSET control unit combining multi-functionality and wide communication possibilities together with a reliable and low cost design. The unit complies and mostly exceeds world's tightest safety, EMC, vibration and environmental standards for the industrial category. Software features are complete with easy firmware upgrade process through USB port. The Windows based PC software allows monitoring and programming through USB, RS-485, Ethernet and GPRS. The PC based Rainbow Scada software allows monitoring and control of an unlimited number of GENSET's from a single central location.

5.1.1 Installation Instruction

Before installation:

i. Read the user manual carefully, determine the correct connection diagram.
ii. Remove all connectors and mounting brackets from the unit, and then pass the unit through the mounting opening.
iii. Put mounting brackets and tighten. Do not tighten too much, this can break the enclosure.
iv. Make electrical connections with plugs removed from sockets, then place plugs to their sockets.
v. Be sure that adequate cooling is provided.
vi. Be sure that the temperature of the environment will not exceed the maximum operating temperature in any case.

Below conditions may damage the device:

i. Incorrect connections.
ii. Incorrect power supply voltage.
iii. Voltage at measuring terminals beyond specified range.
iv. Voltage applied to digital inputs over specified range.
v. Current at measuring terminals beyond specified range.
vi. Overload or short circuit at relay outputs
vii. Connecting or removing data terminals when the unit is powered-up.
viii. High voltage applied to communication ports.

ix. Ground potential differences at non-isolated communication ports.

x. Excessive vibration, direct installation on vibrating parts.

	**Warning!** Current Transformers must be used for current measurement. No direct connection allowed.

Below conditions may cause abnormal operation:

i. Power supply voltage below minimum acceptable level.

ii. Power supply frequency out of specified limits.

iii. Phase order of voltage inputs not correct.

iv. Current transformers not matching related phases.

v. Current transformer polarity incorrect.

vi. Missing grounding.

5.2 Components of DATAKOM Controller

The major parts of DATAKOM control panel & power panel are explained in two aspects, which are as mentioned below.

5.2.1 Components on the Door of Control Panel & Power Panel

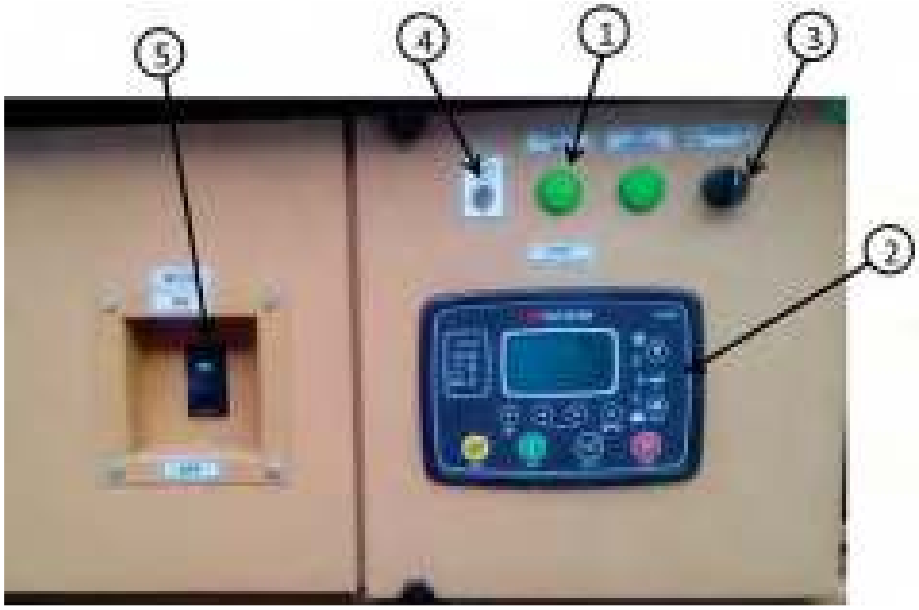


Fig. E5.0(a) Exterior Illustration of DATAKOM Control Panel & Power Panel

Ref. No.	Description of Part	Ref. No.	Description of Part
1	Load ON GENSET	4	Canopy Light Switch
2	DATAKOM Controller	5	Power MCCB
3	Control Switch (ON/OFF)		

Table E5.0 (a) Part List for External Components of DATAKOM Control Panel & Power Panel

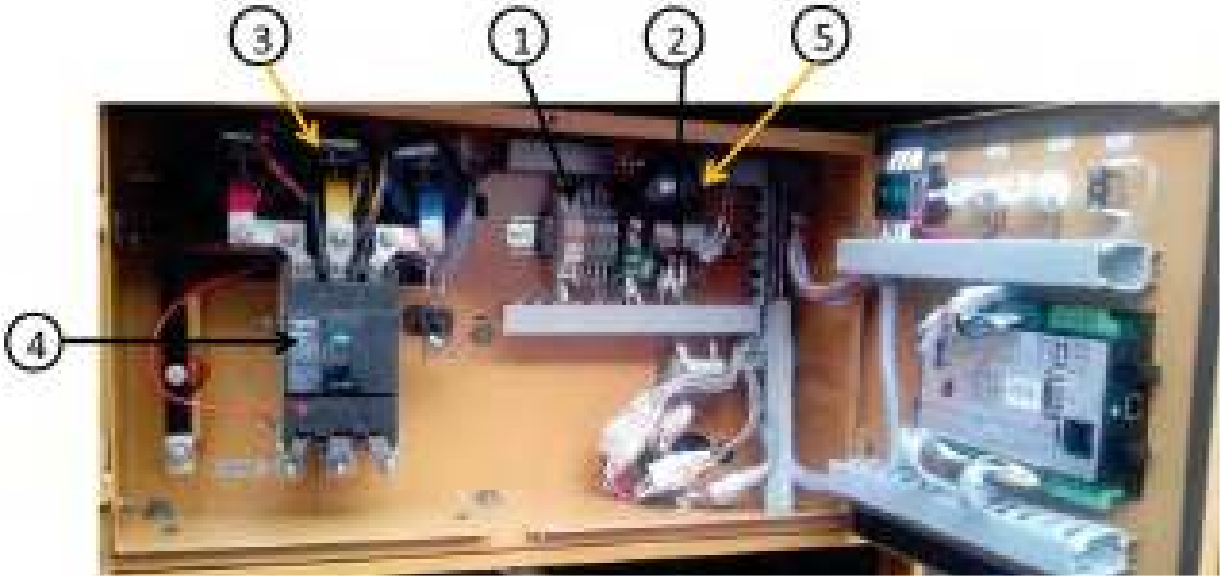


Fig. E5.0 (b) Interior Illustration of DATAKOM Control Panel & Power Panel

Ref. No.	Description of Part	Ref. No.	Description of Part
1	Control MCB/Fuse	4	Power MCCB
2	Power Relay Board	5	Hooter
3	Current Transformers		

Table E5.0 (b) Part List for Internal Components of DATAKOM Control Panel & Power Panel

5.3 Mounting

5.3.1 Dimensions

Dimensions:

200x148x47mm

(7.9”x5.8”x1.9”)

Panel Cut-out:

176x121mm

minimum

(7.0”x4.8”)

Weight:

450g

(1 lb)

Fig. E5.1 DATAKOM Controller Fascia

The unit is designed for panel mounting. The user should not be able to access parts of the unit other than the front panel. Mount the unit on a flat, vertical surface. Before mounting, remove the mounting brackets and connectors from the unit, then pass the unit through the mounting opening. Place and tighten mounting brackets.

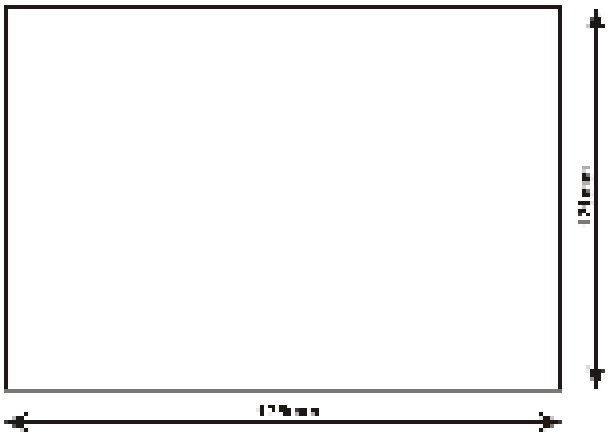


Fig. E5.2 Schematic Illustration of Panel Cut-out

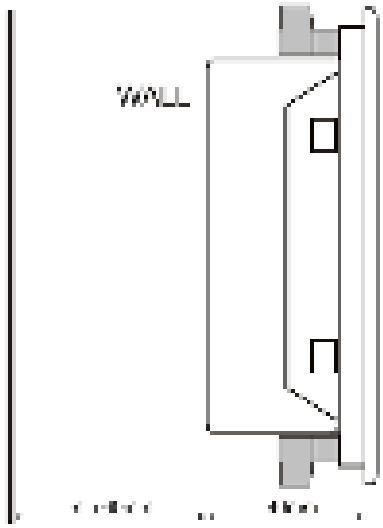


Fig. E5.3 Schematic Illustration of Required Panel Depth

Two different types of brackets are provided, which are as illustrated below in Fig. E5.4 and E5.5; also the installation illustration is provided for the same.

Fig. E5.4 Screw Type Bracket

Fig. E5.5 Self Retaining Bracket

Fig. E5.6 Installation of Screw Type Bracket

Fig. E5.7 Installation of Self Retaining Type Bracket

	**Warning!** Do not tighten the screw too much, this may break the unit.

5.3.2 Sealing, Gasket

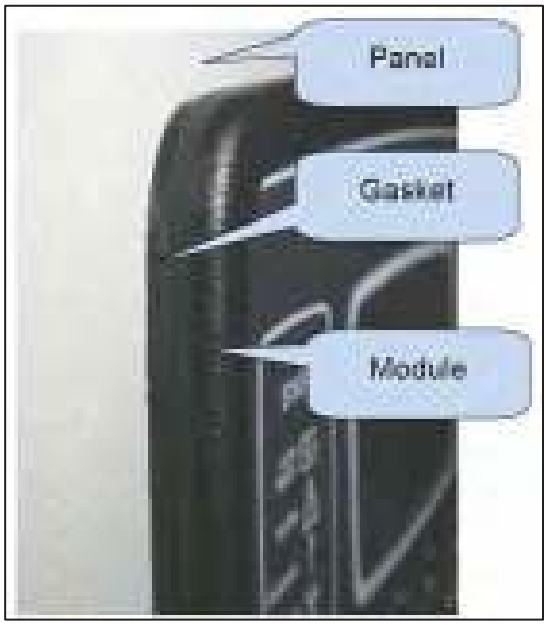


Fig. E5.8

The rubber gasket provides a watertight means of mounting the module to the GENSET panel. Together with the gasket, IEC 60529-IP65 protection can be reached from the front panel. A short definition of IP protection levels is given below.

1st Digit

0 Not protected

1 Protected against solid foreign objects of 50 mm diameter and greater

2 Protected against solid foreign objects of 12.5 mm diameter and greater

3 Protected against solid foreign objects of 2.5 mm diameter and greater

4 Protected against solid foreign objects of 1.0 mm diameter and greater

5 Protected from the amount of dust that would interfere with normal operation

6 Dust tight

2nd Digit

0 Not protected

1 Protected against vertically falling water drops

2 Protected against vertically falling water drops when enclosure is tilted up to 15°

3 Protected against water sprayed at an angle up to 60° on either side of the vertical

4 Protected against water splashed against the component from any direction

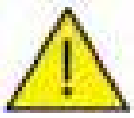
5 Protected against water projected in jets from any direction

6 Protected against water projected in powerful jets from any direction

7 Protected against temporary immersion in water

8 Protected against continuous immersion in water, or as specified by the user

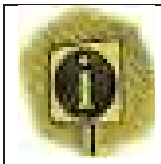
5.3.3 Electrical Installation

	**Warning!** Do not install the unit close to high electromagnetic noise emitting devices like contactors, high current bus bars, switch mode power supplies and the like.

Although the unit is protected against electromagnetic disturbance, excessive disturbance can affect the operation, measurement precision and data communication quality.

i. Always remove plug connectors when inserting wires with a screwdriver.
ii. Fuses must be connected to the power supply and phase voltage inputs, in close proximity of the unit.
iii. Fuses must be of fast type (FF) with a maximum rating of 6A.
iv. Use cables of appropriate temperature range.
v. Use adequate cable section, at least 0.75mm2 (AWG18).
vi. Follow national rules for electrical installation.
vii. Current transformers must have 5A output.
viii. For current transformer inputs, use at least 1.5mm2 section (AWG15) cable.
ix. The current transformer cable length should not exceed 1.5 meters. If longer cable is used, increase the cable section proportionally.

	**Warning!** The engine body must be grounded. Otherwise faulty voltage and frequency measurements may occur.

	**Important Note!** For the correct operation of the exerciser and weekly schedule programs, adjust the real time clock of the unit through programming menu.

5.4 Terminal Description

5.4.1 Battery Voltage Input

Supply voltage:	9 to 33VDC
Cranking dropouts:	Survives 0VDC during 100ms. The voltage before surge should be 9VDC minimum
Overvoltage protection:	Withstands 150VDC continuously.
Reverse voltage:	-33VDC continuous
Maximum operating current:	500mA @ 12VDC. (All options included, digital outputs open.) 250mA @ 24VDC. (All options included, digital outputs open.)
Typical operating current:	250mA @ 12VDC. (all options passive, digital outputs open) 125mA @ 24VDC. (all options passive, digital outputs open)
Measurement range:	0 to 36VDC
Display resolution:	0.1VDC
Accuracy:	0.5% + 1 digit @ 24VDC

5.4.2 AC Voltage Inputs

Measurement method:	True RMS
Sampling rate:	8000 Hz
Harmonic analysis:	up to 31th harmonic
Input voltage range:	14 to 300 VAC
Minimum voltage for frequency detection:	15 VAC (Ph-N)
Supported topologies:	3 ph 4 wires star 3 ph 3 wires delta 3ph 4 wires delta 2ph 3 wires L1-L2 2ph 3 wires L1-L3 1 ph 2 wires
Measurement range:	0 to 330VAC ph-N (0 to 570VAC ph-ph)

Common mode offset:	Max 100V between neutral and BAT
Input impedance:	4.5M-ohms
Display resolution:	1VDC
Accuracy:	0.5% + 1 digit @ 230VAC ph-N (±2VAC ph-N) 0.5% + 1 digit @ 400VAC ph-ph (±3VAC ph-ph)
Frequency range:	DC to 500Hz
Frequency display resolution:	0.1 Hz
Frequency accuracy:	0.2% + 1 digit (±0.1 Hz @ 50Hz)

5.4.3 AC Current Inputs

Measurement method:	True RMS
Sampling rate:	8000 Hz
Harmonic analysis:	up to 31th harmonic
Supported topologies:	3 ph 3 CTs 3 ph 2 CTs L1-L2 3 ph 2 CTs L1-L3 2 ph 2 CTs L1-L2 2 ph 2 CTs L1-L3 1 ph 1 CT
CT secondary rating:	5A
Measurement range:	5/5 to 5000/5A minimum
Input impedance:	15 mili-ohms
Burden:	0.375W
Maximum continuous current:	6A
Measurement range:	0.1 to 7.5A
Common mode offset:	Max 5VAC between BAT- and any CT terminal.
Display resolution:	1A
Accuracy:	0.5% + 1 digit @ 5A (± 4.5A @ 5/500A full range)

5.4.4 Digital Inputs

Number of inputs:	8 inputs, all configurable
Function selection:	from list
Contact type:	Normally open or normally closed (programmable)
Switching:	Battery negative or battery positive (programmable)
Structure:	47 k-ohms resistor to battery positive, 110k-ohms to battery negative.
Measurement:	Analog voltage measurement
Open circuit voltage:	70% of battery voltage
Low level threshold:	35% of battery voltage
High level threshold:	85% of battery voltage
Maximum input voltage:	+100VDC with respect to battery negative
Minimum input voltage:	-70VDC with respect to battery negative
Noise filtering:	yes

5.4.5 Analog Sender Inputs and Sender Ground

Number of inputs:	4 inputs, all configurable, additional sender ground input
Function selection:	from list
Structure:	667 ohms resistor polarizing to 3.3VDC
Measurement:	Analog resistor measurement.
Open circuit voltage:	+3.3VDC
Short circuit current:	5mA
Measurement range:	0 to 5000 ohms.
Open circuit threshold:	5000 ohms.
Resolution:	1 ohms @ 300 ohms or lower
Accuracy:	2 %+1 ohm (±7 ohms @300 ohms)
Common mode voltage range:	± 3VDC
Noise filtering:	yes

5.4.6 Charge Input Terminal

The Charge terminal is both an i nput and output. When the engine is ready to run, this terminal supplies the excitation current to the charge alternator. The excitation circuit is equivalent to a 2 W lamp. The threshold voltages for warning and shut down alarm are adjustable through program parameter.

Structure:	battery voltage output through 20 ohm PTC voltage measurement input
Output current:	160mA @ 12VDC 80mA @ 24VDC
Voltage measurement resolution:	0.1VDC
Voltage measurement accuracy:	2% + 0.1V (0.9V @30VDC)
Charge Fail Warning Threshold:	adjustable
Charge Fail Shutdown Alarm Threshold:	adjustable
Open circuit voltage:	battery positive
Overvoltage protection:	> 500VDC continuous, with respect to battery negative
Reverse voltage protection:	-30VDC with respect to battery negative

5.4.7 Magnetic Pickup Input

Structure:	Differential frequency measurement input
Input impedance:	50 k-ohms
Input voltage:	0.5VAC-RMS to 30VAC-RMS
Max common mode voltage:	± 5VDC
Frequency range:	10Hz to 10 kHz
Resolution:	1 rpm
Accuracy:	0.2% + 1 rpm (±3rpm @1500 rpm)
Flywheel teeth range:	1 to 500

	**Warning!** Do not share MPU with other devices.

5.4.8 Mains Contactor Output

Structure:	Relay output, normally closed contact. One terminal is internally connected to mains phase L1 input.
Max switching current:	12A @250VAC
Max switching voltage:	440VAC
Max switching power:	3000VA

5.4.9 Generator Contactor Output

Structure:	Relay output, normally open contact. One terminal is internally connected to GENSET phase L1 input.
Max switching current:	16A @250VAC
Max switching voltage:	440VAC
Max switching power:	4000VA

5.4.10 Digital Outputs

The unit offers 6 digital outputs with programmable function, selectable from list.

Structure:	Negative pulling protected semiconductor output. One terminal is connected to battery negative.
Max continuous current:	1.0 ADC
Max switching voltage:	33 VDC
Overvoltage protection:	40 VDC
Short circuit protection:	> 1.7 ADC
Reverse voltage protection:	500 VDC

5.4.11 Input Output Extension

The module provides resources for 32 additional digital inputs and 32 additional digital outputs. Digital inputs can be extended using **DKG-188 Digital Input Extension** modules, each one providing 8 inputs. Digital inputs are programmable through the main controller. The switching

characteristic is not programmable and must be battery negative. Any function can be assigned to digital inputs. Digital outputs can be extended using DKG-186 FET Extension modules, each one providing 8 outputs. Digital outputs have the same electrical characteristics as on board outputs. They have programmable functions through the main controller. Any function can be assigned to any output. Input and output extension modules are connected to the main controller in a cascade structure, in any order. The connection cable is provided with each extension module.

Fig. E5.9

Fig. E5.10

5.4.12 RS-485 PORT

Structure:	RS-485, non-isolated
Connection:	3 wires (A-B-GND). Half duplex
Baud rate:	2400-115200 bauds, selectable
Data type:	8 bit data, no parity, 1 bit stop
Termination:	External 120 ohms required
Common mode voltage:	-0.5 VDC to +7VDC, internally clamped by transient suppressors.
Max distance:	1200m @ 9600 bauds (with 120 ohms balanced cable) 200m @ 115200 bauds (with 120 ohms balanced cable)

The RS-485 port features MODBUS-RTU protocol. Multiple modules (up to 128) can be paralleled on the same RS-485 bus for data transfer to automation or building management systems.

	Important Note! The MODBUS register list is available at DATAKOM technical support.

The RS-485 port provides also a good solution for distant PC connection where Rainbow Plus program will enable programming, control and monitoring.

	Important Note! For more details about programming, control and monitoring through RS-485 port please refer to Rainbow Plus user manual.

5.4.13 J-1939 CANBUS Port

Structure:	CANBUS, non-isolated
Connection:	3 wires (CANH-CANL-GND).
Data rate:	250 kbps
Termination:	Internal 120 ohms provided
Common mode voltage:	-0.5 VDC to +15 VDC, internally clamped by transient suppressors.
Max distance:	200m with 120 ohm balanced cable

5.4.14 Ethernet Port

Fig. E5.11

Fig. E5.12 Standard Ethernet Cable

Description:	IEEE802.3 compliant, 10/100 Base-TX RJ45 Ethernet port with indicating LED's
Data Rate:	10/100 M bits/s, auto detecting
Connector:	RJ45
Cable Type:	CAT5 or CAT6
Isolation:	1500 VAC, 1 minute
Max. Distance:	30 m
Functionality:	Embedded TCP/IP, Web Server, Web Client, SMTP, email, SNMP, MODBUS, TCP/IP

LED FUNCTIONS:

GREEN: This led turns on when the Ethernet link is established (connector inserted)

YELLOW: This led blinks when data transfer occurs inwards or outwards. Periodic blinking will witness data flow.

5.4.15 USB Device Port

Fig. E5.13

Fig. E5.14

Description:	USB 2.0, not-isolated HID mode
Data Range:	Full Speed 1.5/12 M bits/s, auto detecting
Connector:	USB-B (printer connector)
Cable Range:	Max 6m
Functionality:	Modbus, FAT32 for firmware upgrade (boot loader mode only)

The USB-Device port is designed to connect the module to a PC. Using the Rainbow Plus software, programming, control of the GENSET and monitoring of measured parameters are achieved. The Rainbow Plus software can be downloaded from www.datakom.com.tr website. The connector on the module is of USB-B type. Thus A to B type USB cable should be used. This is the same cable used for USB printers. For more details about programming, control and monitoring please refer to Rainbow Plus user manual.

	Important Note! The battery voltage must be connected.

	Important Note! If USB-Device is plugged then USB-Host port will not function.

5.4.16 USB Host Port (Optional)

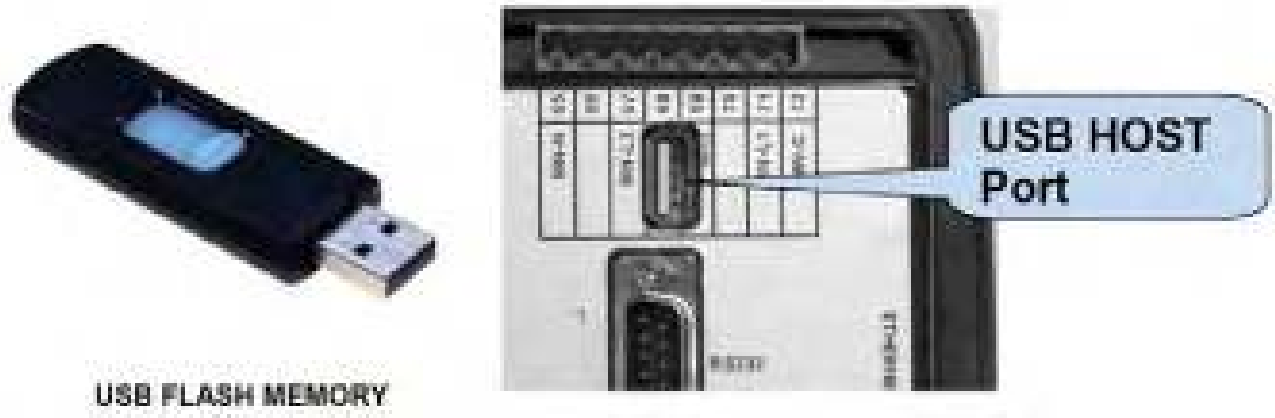
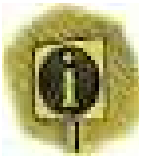


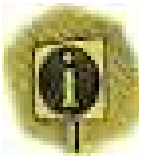
Fig. E5.15

	**Important Note!** The USB-Host port is available in units with COMM option.

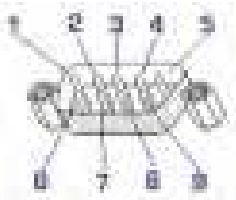
Description:	USB2.0, not-isolated
Power Supply Output:	5V, 300mA Max.
Data Rate:	Full Speed 1.5/12 M bits/s, auto detecting
Connector:	USB-A (PC type connector)
Cable Length:	Max. 1.5 m
Functionality:	USB memory, FAT32, data recording
Memory Capacity:	All USB flash memories

The USB-Host port is designed for detailed data recording. The period of recording is adjustable through program parameter. As soon as a USB flash memory is inserted, the unit will start data recording and continue until the memory is removed. For more details about data recording please review chapter “Data Recording”.

	**Important Note!** Micro-SD memory card has priority for data recording. If both micro-SD and USB-Flash memories are inserted, data will be recorded on micro-SD memory.

	**Important Note!** If USB-Device is plugged then USB-Host port will not function.

5.4.17 RS-232 Port (Optional)

Description:	RS-232, non-isolated		
Functionality:	External GSM modem, external PSTN modem		
Connector:	DB-9 (9 pins male)		
Connection:	5 wires (Rx-Tx-DTR-CxD-GND). Full duplex.		
Baud rate:	2400-115200 bauds, selectable		
Data type:	8 bit data, no parity, 1 bit stop		
Max distance:	15m		
Cable type:	Standard modem cable		
Terminal description:	1: CxD input	6: NC	
	2: Rx input	7:NC	
	3: Tx output	8: NC	
	4: DTR output	9: NC	
	5: GND		

5.4.18 Micro-SD Memory Card Slot (Optional)

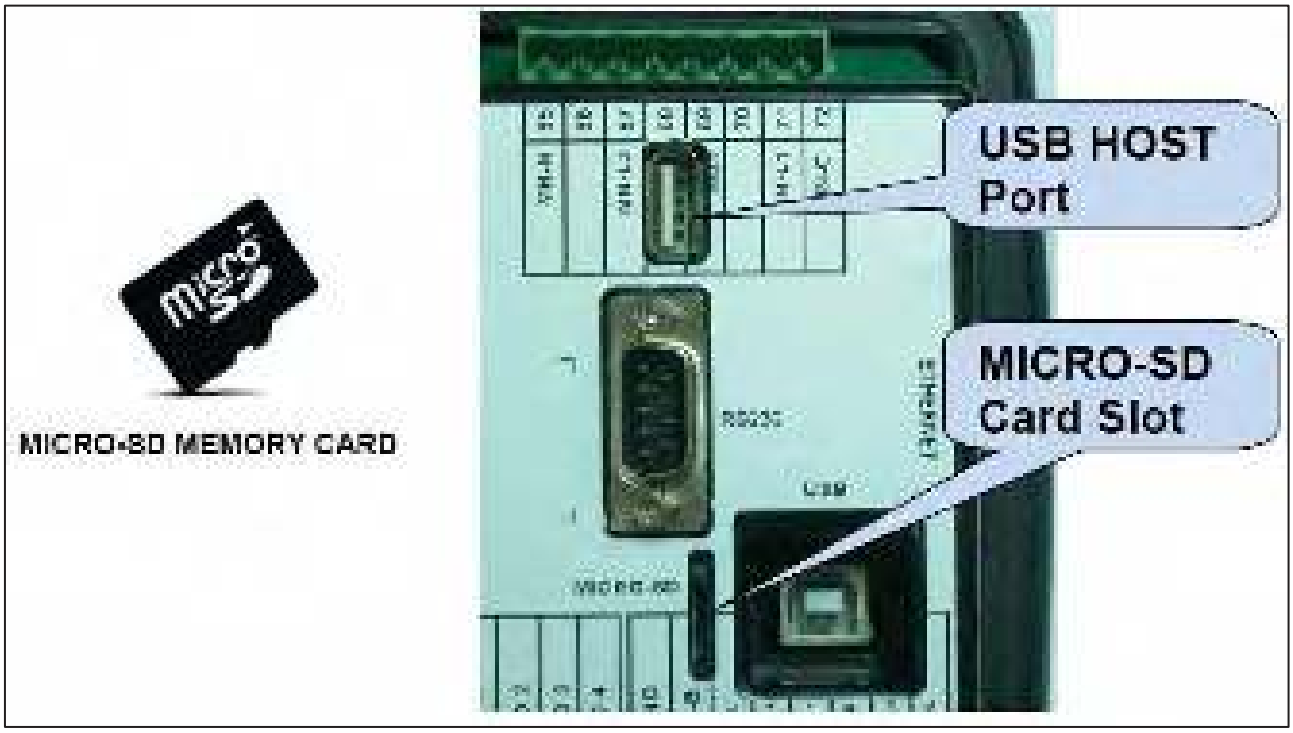
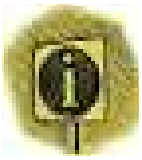


Fig. E5.16

The micro-SD card slot is available in units with COMM option. The slot is of push-in push-out type. When pushed in, the card is firmly held by its connector.

Description:	Micro-SD card reader
Data rate:	serial 10Mb/s
Functionality:	Flash memory, FAT32, data recording
Memory capacity:	Micro-SD card, any capacity

The micro SD card slot is designed for detailed data recording. The period of recording is adjustable through program parameter. As soon as a micro-SD memory card is inserted, the unit will start data recording and continue until the memory card is removed. For more details about data recording please review chapter “Data Recording”.



Important Note! Micro-SD memory card has priority for data recording. If both micro-SD and USB-Flash memories are inserted, data will be recorded on micro-SD memory.

5.4.19 GSM (Optional)

The optional internal GSM modem offers the advantage of being internally powered and is fully compatible with the unit. It does not require any special setup. The 1800/1900 MHz magnetic antenna together with its 2 meter cable is supplied with the internal modem option. The antenna is intended to be placed outside of the GENSET panel for the best signal reception.

The module requires a GPRS enabled SIM card for full functionality. Voice-only type SIM cards will usually not function properly. Please refer to GSM Modem Configuration Guide for more details.

Fig. E5.17

Fig. E5.18 SIM Card Extraction

Fig. E5.19 SIM Card Extraction/Insertion

Fig. E5.20 SIM Card Replacement

Description:	Quad-band GSM/GPRS 850/900/1800/1900MHz module. GPRS multi-slot class 10/8 GPRS mobile station class B Compliant to GSM phase 2/2+ - Class 4 (2W @ 850/900 MHz) - Class 1 (1W @ 1800/1900MHz)
Functionality:	Web Client, SMTP, Modbus TCP/IP (client), SMS, e-mail
Operating temp:	-40°C to +85 °C
Data speed:	Max. 85.6 kbps (download), 42.8 kbps (upload)
SIM card type:	external SIM 3V/1.8V, GPRS enabled
Antenna:	Quad band, magnetic, with 2m cable
Module certificates:	CE, FCC, ROHS, PTCRB, GCF, IC, ICASA, REACH

5.5 Functionalities

The same unit provides different functionalities through parameter setting. Thus a single stock item will fulfil various duties, minimizing stock cost.

5.5.1 CT Location Selection

CTs may be placed at alternator or load bus bars. The CT location selection is configured with **Controller Configuration > CT Location parameter**. When CTs are located at the alternator side, them mains current and power parameters will not be displayed. When CTs are located at load side, then both mains and GENSET currents and power parameters will be displayed, based on contactor positions. Please review AMF functionality connection diagrams for CT connection details.

5.5.2 AMF Functionality

When AMF functionality is selected, the unit will monitor mains voltages, provide mains and GENSET contactor control, run the engine and provide engine and alternator instrumentation and fault monitoring. The unit features both MPU and J1939 CANBUS inputs. Thus both mechanical and electronic engines are supported. The unit provides control outputs for both contactors and motorized circuit breakers.

5.5.3 ATS Functionality

When ATS functionality is selected, the unit will monitor mains voltages, provide mains and GENSET contactor control and issue a Remote Start signal to the engine controller. It will provide alternator instrumentation and fault monitoring. Engine instrumentation and protection will be insured by the engine controller.

5.5.4 Remote Start Functionality

When the Remote Start functionality is selected, the unit will wait for a Remote Start signal from external controller. Upon reception of this signal, it will run the engine, and provide engine and alternator instrumentation and fault monitoring. The GENSET contactor/MCB control functionality will be available. The unit features both MPU and J1939 CANBUS inputs. Thus both mechanical and electronic engines are supported.

5.5.5 Engine Controller Functionality

When the Engine Controller functionality is selected, GENSET electrical measurements and protections will be disabled. The unit is supposed to control an engine without alternator. When the Engine Control Mode is activated:

i. The unit will not display GENSET AC parameters (volts, amps, kW and pf).
ii. GENSET voltage and frequency protections are disabled. However engine rpm protections will be active.

Note that the engine controller functionality is compatible with both AMF and Remote Start modes. When AMF and Engine controller modes are selected, the unit will monitor the mains and will run the engine upon mains failure.

This functionality is useful for the backup electric motor driven systems during mains failures, like fire pump or irrigation systems. When Remote Start and Engine controller modes are selected, the unit will start and stop the engine with external signal only. The unit features both MPU and J1939 CANBUS inputs. Thus both mechanical and electronic engines are supported.

	**Important Note!** It is strongly recommended to wire speed detection through MPU or J1939-CANBUS and enter correct low and high rpm limit values in order to preserve engine speed protection.

5.5.6 Remote Display Unit Functionality

The unit is able to become the remote display and control panel of another identical module. The connection between two modules is done through RS-485 ports. For the best results, a 120 ohms balanced, low capacitance cable should be used. The data rate between modules is selectable between 2400 and 115200 bauds. A high data rate offers better synchronization between modules, but the distance will be limited. Typically at 115200 bauds and with adequate cable, the distance will be 200m maximum. At 9600 bauds and adequate cable the distance can go up to 1200m. Below settings are necessary:

PARAMETER	MAIN UNIT	REMOTE DISPLAY UNIT
Annunciator Mode	0	1
RS-485 Enable	1	1
RS-485 Baud Rate	any	same as main unit
Modbus Slave Address	any	same as main unit

	**Warning!** The remote display panel should be powered up with an isolated voltage source, like a wall adapter. Otherwise damages due to ground potential differences may occur.

5.5.7 400Hz Operation

The standard unit is also 400 Hz enabled. The nominal frequency setting accepts up to 500Hz usual low and high limits will apply without any special setting. The measurement system of the unit allows frequencies up to 1000 Hz to be measured precisely. However the display is limited to 650Hz. Frequencies over 650 Hz will be displayed as 650 Hz.

The bandwidth of the harmonic analyser is limited to 1800Hz. Thus in case of a 400Hz system, only the 3rd harmonic will be displayed. The waveform display of a 400Hz signal will be represented with 10 points. It will not be as accurate as 50/60Hz signals. For more details please read topic: “Waveform Display & Harmonic Analysis”.

5.6 Connection Diagram

5.6.1 AMF Functionality, CT’s at Load Side

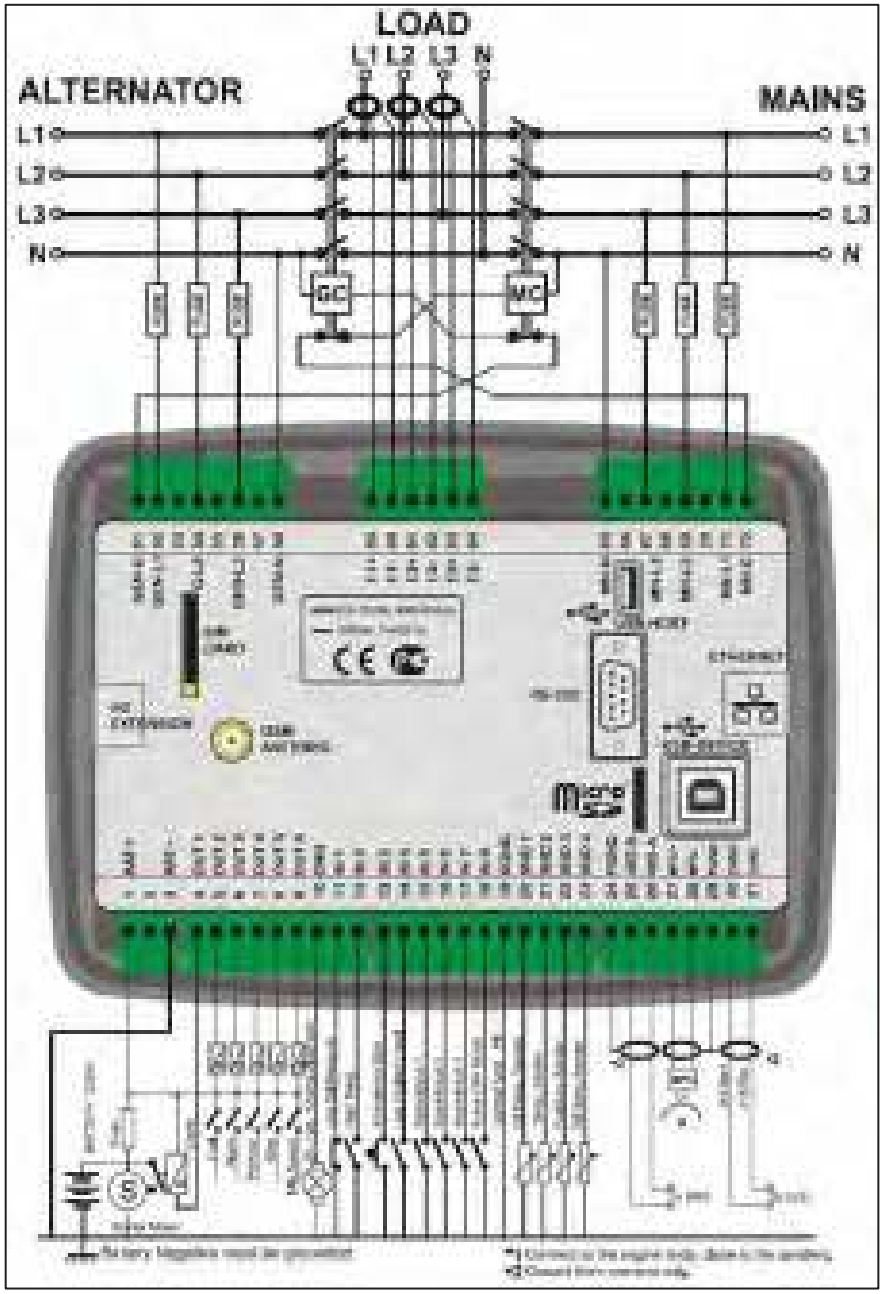


Fig. E5.21 Connection Diagram for AMF Functionality, CT’s at Load Side

5.6.2 AMF Functionality, CT's at Alternator Side

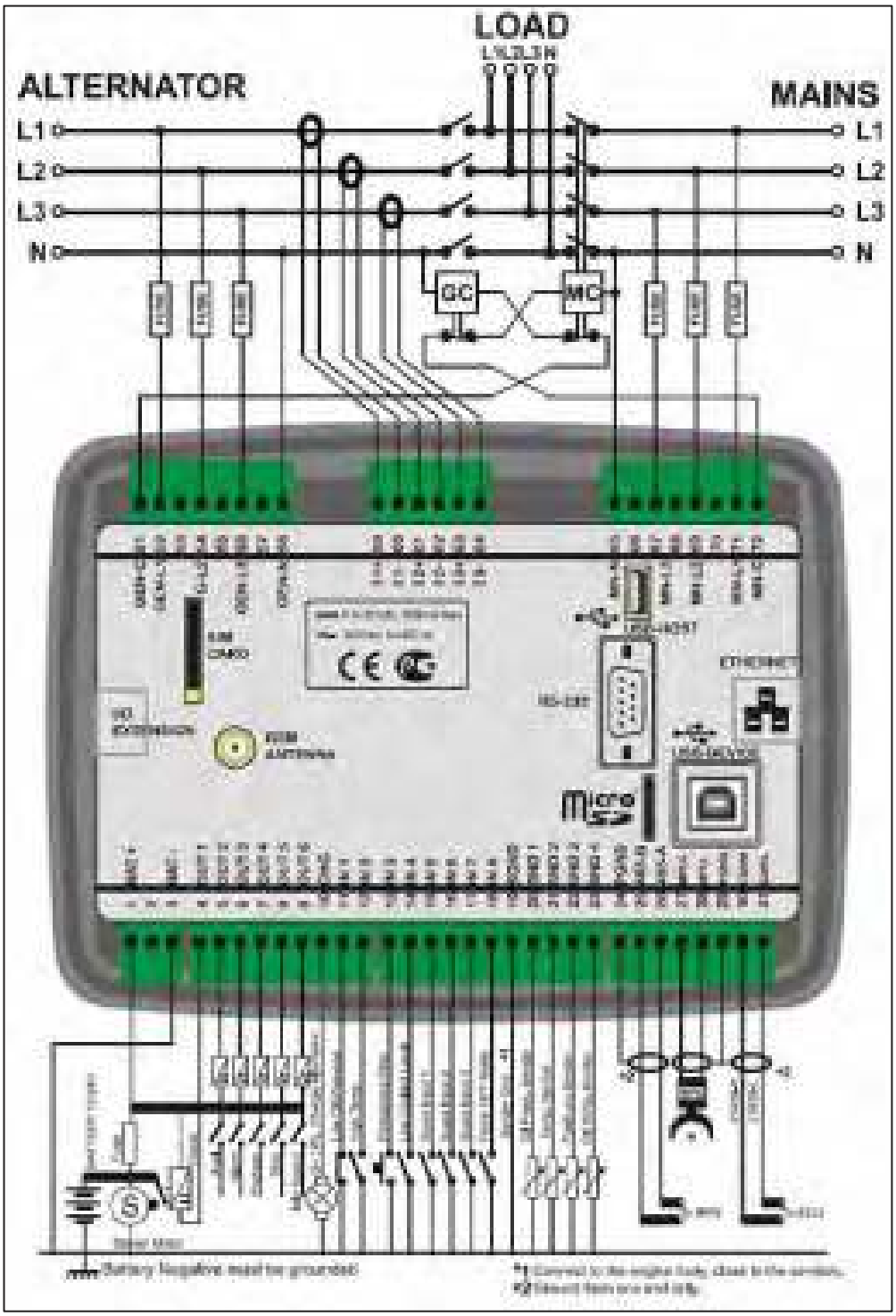


Fig. E5.22 Connection Diagram for AMF Functionality, CT's at Alternator Side

5.6.3 ATS Functionality

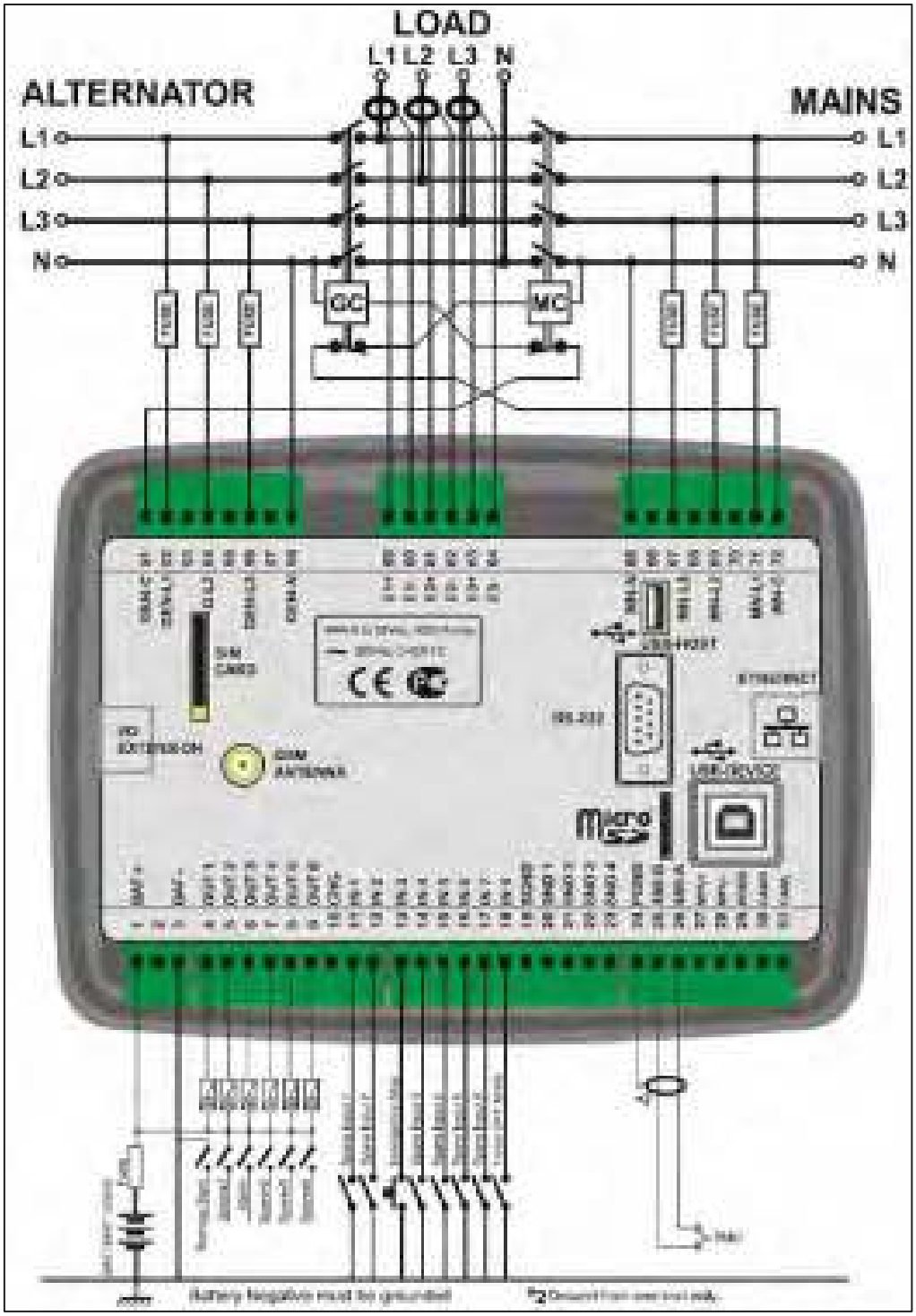


Fig. E5.23 Connection Diagram for ATS Functionality

5.6.4 Remote Start Functionality

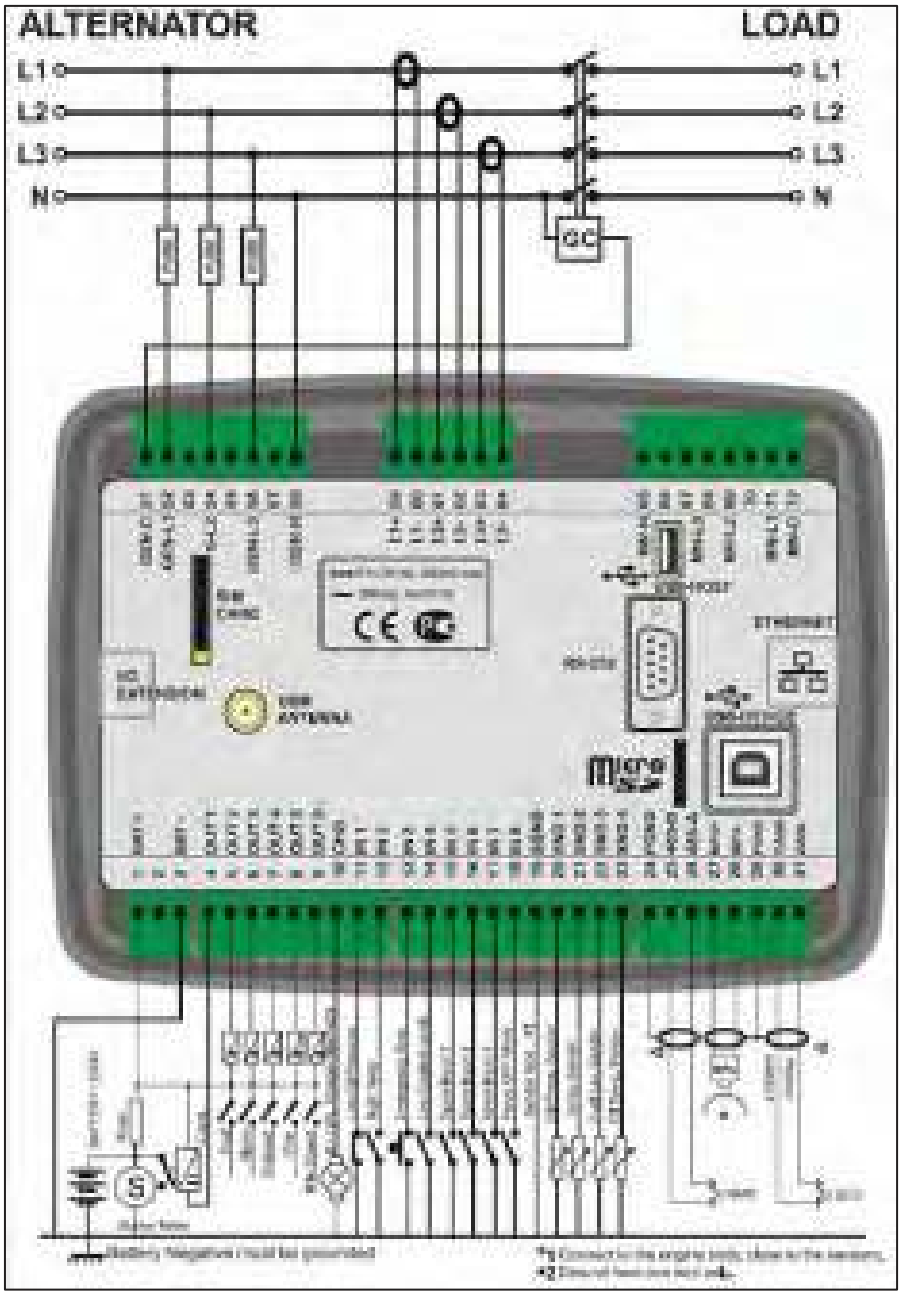


Fig. E5.24 Connection Diagram for Remote Start Functionality

5.6.5 Engine Control Functionality

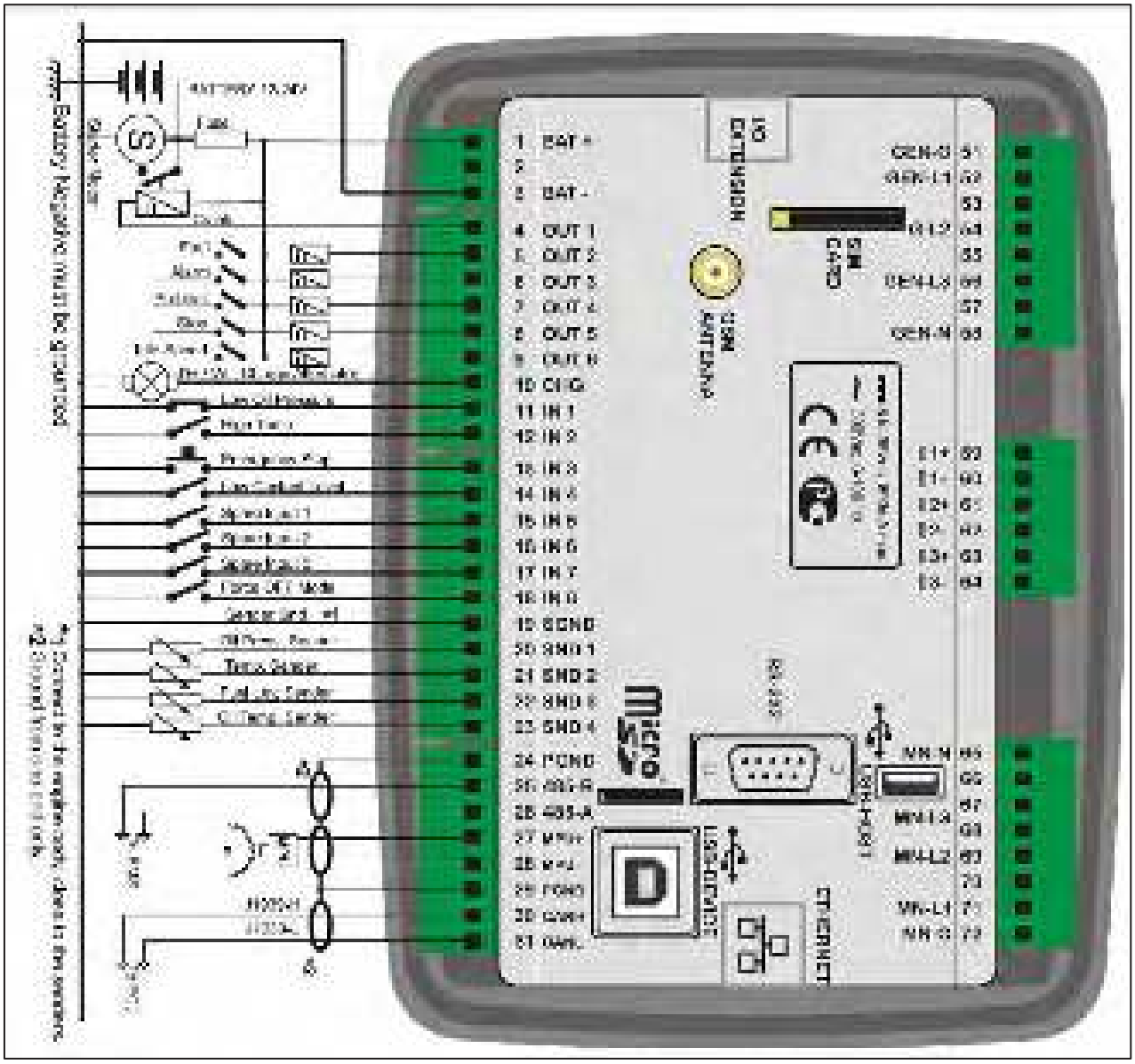


Fig. E5.25 Connection Diagram for Engine Control Functionality

5.6.6 Remote Display Panel Functionality

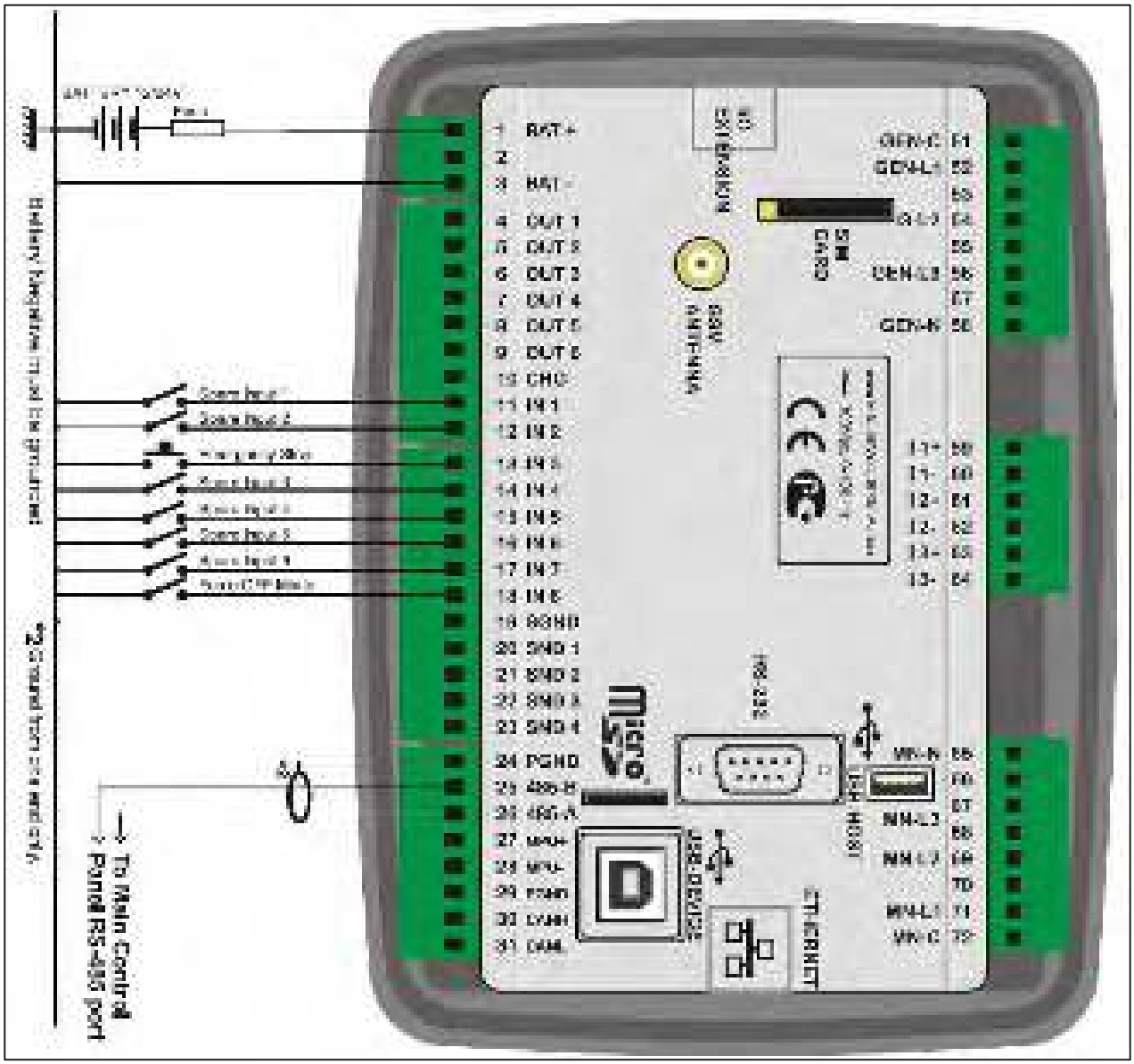


Fig. E5.26 Remote Display Panel Functionality

5.7 Terminal Description

Term	Function	Technical data	Description
1	BATTERY POSITIVE	+12 or 24VDC	The positive terminal of the DC Supply.
2	-	-	Do not connect this terminal.
3	BATTERY NEGATIVE	0 VDC	Power supply negative connection.

Term	Function	Technical data	Description
4	DIGITAL OUTPUT 1	Protected Semiconductor Outputs 1A/28VDC	This relay has programmable function, selectable from a list. Factory set as CRANK output.
5	DIGITAL OUTPUT 2		This relay has programmable function, selectable from a list. Factory set as FUEL output.
6	DIGITAL OUTPUT 3		This relay has programmable function, selectable from a list. Factory set as ALARM output.
7	DIGITAL OUTPUT 4		This relay has programmable function, selectable from a list. Factory set as PREHEAT output.
8	DIGITAL OUTPUT 5		This relay has programmable function, selectable from a list. Factory set as STOP output.
9	DIGITAL OUTPUT 6		This relay has programmable function, selectable from a list. Factory set as IDLE SPEED output.
10	CHARGE	Input and output	Connect the charge alternator's D+ terminal to this terminal. This terminal will supply the excitation current and measure the voltage of the charge alternator.
11	DIGITAL INPUT 1	Digital inputs, 0-30Vdc	The input has programmable function. Factory set as LOW OIL PRESSURE SWITCH.
12	DIGITAL INPUT 2		The input has programmable function. Factory set as HIGH TEMP SWITCH.

Exhibit Table E5.1

Term	Function	Technical data	Description
13	DIGITAL INPUT 3		The input has programmable function. Factory set as EMERGENCY STOP.
14	DIGITAL INPUT 4		The input has programmable function. Factory set as LOW COOLANT LEVEL SWITCH
15	DIGITAL INPUT 5		The input has programmable function. Factory set as SPARE INPUT-1.
16	DIGITAL INPUT 6		The input has programmable function. Factory set as SPARE INPUT-2.
17	DIGITAL INPUT 7		The input has programmable function. Factory set as SPARE INPUT-3.
18	DIGITAL INPUT 8		The input has programmable function. Factory set as FORCE OFF MODE.
19	SENDER GROUND		Ground potential for analog senders. Connect to the engine body, close to senders.
20	ANALOG SENDER 1 (OIL PRESSURE SENDER)		Connect to the oil pressure sender. Do not connect the sender to other devices.
21	ANALOG SENDER 2 (COOLANT TEMP. SENDER)		Connect to the coolant temperature sender. Do not connect the sender to other devices.
22	ANALOG SENDER 3 (FUEL LEVEL SENDER)		Connect to the fuel level sender. Do not connect the sender to other devices.
23	ANALOG SENDER 4 (OIL TEMP SENDER)		Connect to the oil temperature sender. Do not connect the sender to other devices.

Term	Function	Technical data	Description
24	PROTECTION GROUND	Output 0Vdc	Connect the protective shield of the RS-485 cable to this terminal, from one end only.
25	RS-485 B	Digital communication port	Connect the A-B data lines of the RS-485 link to these terminals.
26	RS-485 A		
27	MPU +	Analog input, 0.5 to 30V-AC	Connect the MPU unit to these inputs. Use a twisted cable pair or coaxial cable for best results.
28	MPU -		
29	PROTECTION GROUND	Output 0Vdc	Connect the protective shield of the MPU and CANBUS-J1939 cables to this terminal, from one end only.
30	CANBUS-H	Digital communication port	Connect the J1939 port of an electronic engine to these terminals. The 120 ohm terminating resistors are inside the unit. Please do not connect external resistors. Use a twisted cable pair or coaxial cable for best results.
31	CANBUS-L		

Exhibit Table E5.2

Term	Function	Technical data	Description
51	GENERATOR CONTACTOR	Relay output, 16A-AC	This output provides energy to the generator contactor. If the generator phases do not have acceptable voltage or frequency values, the generator contactor will be de-energized. In order to provide extra security, the normally closed contact of the mains contactor should be serially connected to this output.
52 54 56	GEN-L1 GEN-L2 GEN-L3	Generator phase inputs, 0-300V-AC	Connect the generator phases to these inputs. The generator phase voltages upper and lower limits are programmable.
58	GENERATOR NEUTRAL	Input, 0-300V-AC	Neutral terminal for the generator phases.

Term	Function	Technical data	Description
59 60	CURR_1+ CURR_1-	Current transformer inputs, 5A-AC	Connect the generator current transformer terminals to these inputs. Do not connect the same current transformer to other instruments otherwise a unit fault will occur. Connect each terminal of the transformer to the unit's related terminal. Do not use common terminals. Do not use grounding. Correct polarity of connection is vital. The rating of the transformers should be identical for each of the 3 phases. The secondary winding rating shall be 5 Amperes. (ex: 2000/5 Amps).
61 62	CURR_2+ CURR_2-		
63	CURR_3+		
64	CURR_3-		

Term	Function	Technical data	Description
65 67	MAINS NEUTRAL MAINS-L3	Input, 0-300V-AC Mains phase inputs, 0-300V-AC	Neutral terminal for the mains phases. Connect the mains phases to these inputs. The mains voltages upper and lower limits are programmable.
68	MAINS-L2		
71	MAINS-L1		
72	MAINS CONTACTOR	Relay output, 16A-AC	This output provides energy to the mains contactor. If the mains phases do not have acceptable voltages, the mains contactor will be de-energized. In order to provide extra security, the normally closed contact of the generator contactor should be serially connected to this output.

Exhibit Table E5.3

5.8 Technical Specifications

DC Supply Range: 9.0 to 33.0 V DC

DC power consumption:

i. 250 mA-DC typical @12V-DC
ii. 125 mA-DC typical @24V-DC
iii. 500 mA-DC max. @12V-DC
iv. 250 mA-DC max. @24V-DC

Alternator voltage: 0 to 330 V-AC (Ph-N), 0 to 570V Ph-Ph

Alternator frequency: 0-500 Hz

Mains voltage: 0 to 330 V-AC (Ph-N) , 0 to 570V Ph-Ph

Mains frequency: 0-500 Hz.

Current Inputs: from current transformers /5A

CT Range: 5/5A to 5000/5A

VT Range: 0.1/1 to 6500 / 1

kW Range: 0.1kW to 65000 kW

Accuracy:

i. Voltage: 0.5%+1digit
ii. Current: 0.5%+1 digit
iii. Frequency: 0.5%+1 digit
iv. Power (kW, kVAr):1.0%+2digit
v. Power factor: 0.5 %+1digit

Digital inputs: input voltage 0 to 36 V-DC

Analog input range: 0-5000 ohms.

Mains and genset contactor outputs: 16Amps@250V

DC Outputs: Protected mosfet semiconductor outputs, rated 1Amp@28V-DC

Cranking dropouts: survives 0V for 100ms. Magnetic pickup voltage: 0.5 to 30V-RMS. Magnetic pickup frequency: 10 to 10000 Hz.

Charge Alternator Excitation: 160mA @12VDC, 80mA @24VDC

Ethernet Port: 10/100 Mbits

USB Device: USB 2.0 Full speed

USB Host: USB 2.0 Full speed

RS-485 Port: selectable baud rate

RS-232 Port: selectable baud rate

Operating temperature: -20°C to 70°C (-4 to +158 °F) Storage temperature: -40°C to 80°C (-40 to +176°F).

Maximum humidity: 95% non-condensing

IP Protection: IP54 from front panel, IP30 from the rear

Dimensions: 200 x 148 x 46mm (W × H × D)

Panel Cut-out Dimensions: 176 x 121 mm minimum

Weight: 450 g (approx.)

Case Material: High Temperature, non-flammable, ROHS compliant ABS/PC

Mounting: Flush mounted with rear retaining plastic brackets

EU Directives Conformity

i. -2006/95/EC (low voltage)
ii. -2004/108/EC (electro-magnetic compatibility)

Norms of reference:

i. EN 61010 (safety requirements)
ii. EN 61326 (EMC requirements)

UL Compatibility: UL 508 - Industrial Control Equipment

CSA Compatibility: CAN/CSA C22.2 No. 14-2005 – Industrial Control Equipment

5.9 Description of Controls

5.9.1 Description of Controls

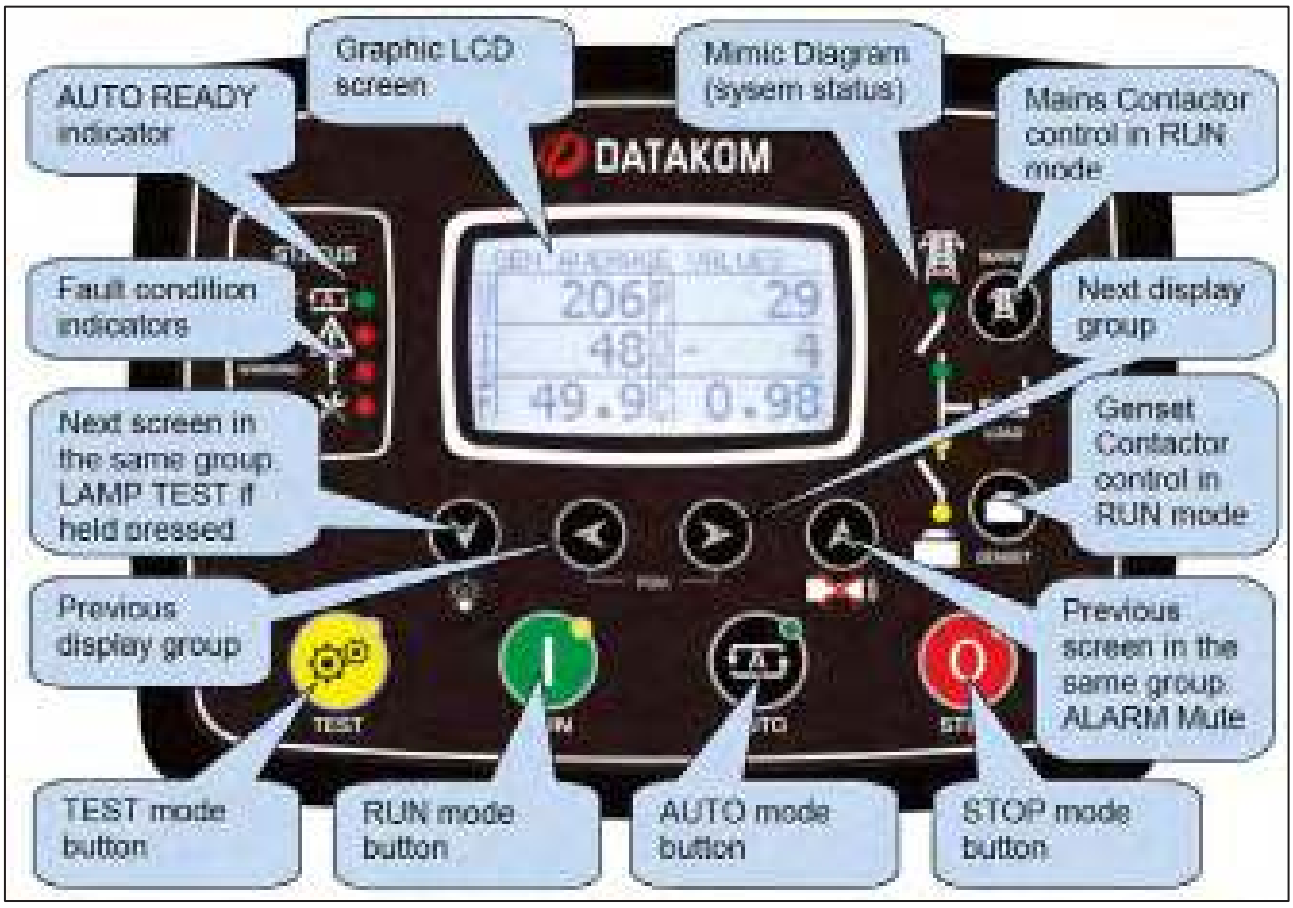
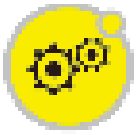
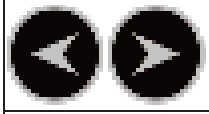
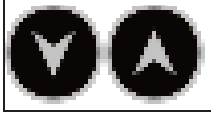


Fig. E5.27

When the engine hours OR the time limit is over, the Service Request LED (red) will start to flash and the service request output function will be active. The service request can also create a fault condition of any level following parameter setting. The service request output function may be assigned to any digital output using Relay Definition program parameters. Also relays on an extension module may be assigned to this function.

	Important Note! To turn off the SERVICE REQUEST led, and reset the service period, press together the ALARM MUTE and LAMP TEST keys for 5 seconds.

5.9.2 Pushbutton Functions

BUTTON	FUNCTION
	Selects TEST mode. The GENSET runs and takes the load.
	Selects RUN mode. The GENSET runs off-load.
	Selects AUTO mode. The GENSET runs when necessary and takes the load.
	Selects OFF mode. The GENSET stops.
	Selects next display screen in the same display group. LAMP TEST when held pressed.
	Selects previous display group.
	Selects next display group.
	Selects previous display screen in the same display group. Resets the ALARM RELAY.
	Manual MAINS CONTACTOR control in RUN mode.
	Manual GENSET CONTACTOR control in RUN mode.
	When held pressed for 5 seconds, enters PROGRAMMING mode.
	Makes factory reset.
	When held pressed for 5 seconds, resets service request counters.

5.9.3 Display Screen Organization

The unit measures a large number of electrical and engine parameters. The display of the parameters is organized as PARAMETER GROUPS and items in a group.

Navigation between different groups is made with  and  buttons.

Each depression of the  button will cause the display to switch to the next group of parameters. After the last group the display will switch to the first group.

Each depression of the  button will cause the display to switch to the previous group of parameters. After the first group the display will switch to the last group.

Navigation inside groups is made with  and  buttons.

Each depression of the  button will cause the display to switch to the next parameter in the same group. After the last parameter the display will switch to the first parameter.

Each depression of the  button will cause the display to switch to the previous parameter in the same group. After the first parameter the display will switch to the last parameter.

Below is a basic list of parameter groups:

GENSET Parameters: GENSET voltages, currents, kW, kVA, kVAr, pf etc.

Engine Parameters: Analog sender readings, rpm, battery voltage, engine hours, etc.

J1939 Parameters: Opens only if the J1939 port is enabled. The unit is able to display a long list of parameters, under the condition that the engine sends this information. A complete list of available readings is found at chapter J1939 CANBUS ENGINE SUPPORT.

Mains Parameters: Mains voltages, currents, kW, kVA, kVAr, pf etc. Mains currents and power parameters are displayed only when CT Selection is made as LOAD SIDE. Otherwise mains current and power related parameters will not be displayed.

Synchronization Display: A graphical synchroscope is displayed. The synchroscope display is updated 10 times a second in order to have smooth sweep.

Scopemeter Display: This group display waveforms of voltages and currents as an oscilloscope. All Ph-N and Ph-Ph voltages as well as phase currents are available. This feature is especially useful to investigate waveform distortions and harmonic loads.

Graphical Harmonic Analysis Results: This group displays harmonic composition of voltages and currents. All Ph-N and Ph-Ph voltages as well as phase currents are available. This feature is especially useful to investigate the harmonic caused by complex loads. Only harmonics above 2% are represented in the graphics because of the display resolution. In order to see all harmonic levels please use the Alphanumerical Harmonic Analysis Results.

Alphanumerical Harmonic Analysis Results: This group displays harmonic composition of voltages and currents with 0.1% resolution. All Ph-N and Ph-Ph voltages as well as phase currents are available. This feature is especially useful to investigate the harmonic caused by complex loads.

Alarm Display: This group displays all existing alarms, one screen per alarm. When there is no more alarm to display it will show “END OF ALARM LIST”.

GSM Modem Parameters: Signal strength, counters, communication status, IP addresses etc.

Ethernet Parameters: Ethernet connection status, counters, IP addresses etc.

Status & Counters Groups: This group includes various parameters like GENSET status, service counters, date-time, firmware version etc.

5.9.4 Automatic Display Scroll

The unit will automatically scroll all Mains, GENSET and Engine measurements with programmable interval. The scroll period setting can be performed using the Rainbow Plus program through Module > Screen options.

Fig. E5.28

Eventually the same parameter can be modified through the front panel programming menu. The related parameter is Controller Configuration > Screen Scroll Timer.

	Important Note! If the Screen Scroll Timer is set to zero, then scrolling will be disabled.

	Important Note! When a front panel button is pressed, the scrolling is suspended during 2 minutes.

	Important Note! If a fault condition occurs, the display will automatically switch to the ALARM LIST page.

5.9.5 LED Lamps

Fig. E5.29

STATUS LEDS:

i. **AUTO READY**: Turns on when the AUTO mode is selected and there is no condition preventing engine start.

ii. **ALARM:** Turns on when a shutdown alarm or load dump condition exists.

iii. **WARNING:** Turns on when a warning condition exists.

iv. **SERVICE REQUEST:** Turns on when at least one of the service counters has expired.

MODE LEDS: Each led turns on when the related mode is selected, either locally or remotely.

MIMIC DIAGRAM LEDS:

i. **MAINS AVAILABLE:** This led turns on when all mains phase voltages and the mains frequency are within limits. If enabled, the mains phase rotation order must be also right. When any digital input is defined as Remote Start, this led will reflect the status of the input. When a Simulate Mains signal is present, then mains status will become “available”. When a Force to Start signal is present, then the mains status will become “not available”.

ii. **MAINS CONTACTOR ON:** Turns on when the mains contactor is activated.

iii. **GENSET CONTACTOR ON:** Turns on when the GENSET contactor is activated.

iv. **GENSET AVAILABLE:** This led turns on when all GENSET phase voltages and the GENSET frequency are within limits. If enabled, the GENSET phase rotation order must be also right.

	Important Note! If a Remote Start input is defined, then the Mains LED will reflect the input status. Simulate Mains and Force to Start signals will also affect this LED.

5.10 Wave Form Display & Harmonic Analysis

The unit features waveform display together with a precision harmonic analyser for both mains and GENSET voltages and c urrents. Both phase to neutral and phase to phase voltages are available for analysis, thus 18 channels in total are possible.

	Important Note! In order to enable display and analysis of mains currents, current transformers must be placed at load side.

Available channels are:

Mains volts: V1, V2, V3, U12, U23, U31

Mains currents: I1, I2, I3

GENSET volts: V1, V2, V3, U12, U23, U31

GENSET currents: I1, I2, I3

Fig. E5.30 Scopemeter Display

The waveform display memory is of 100 samples length and 13 bit resolution, with a sampling rate of 4096 s/s. Thus one cycle of a 50Hz signal is represented with 82 points. The vertical scale is automatically adjusted in order to avoid clipping of the signal.

The waveform is displayed on the device screen, and with more resolution on PC screen through the Rainbow Plus program. The display memory is also available in the Modbus register area for third party applications. For more details please check chapter "MODBUS Communications". The waveform display is updated twice a second. All channels may be scrolled using scroll buttons.

The harmonic analyser consists on a Fast Fourier Transform (FFT) algorithm which is run twice a second on the selected channel. The sample memory is 1024 samples length and 13 bits resolution with a sampling rate of 4096 s/s.

The theory says that a periodic signal may have only odd multiples of the main frequency. Thus in a 50Hz network, harmonics will be found only at 150, 250, 350, 450 Hz etc. The unit is able to analyse up to 1800Hz and up to 31th harmonic, whichever is smaller. Thus in a 50Hz system all 31 harmonics will be displayed, but in a 60Hz system only 29 harmonics will come to the screen. In case of a 400Hz system, only the 3rd harmonic will be displayed.

Fig. E5.31 Graphical Harmonic Table

Fig. E5.32 Alpha-Numeric Harmonic Table

Harmonic are represented by 2 different ways on the device display. The first one is a graphical representation allowing one sight perception of the harmonic structure. Because of the display resolution, only harmonics above 2% are displayed.

The second display is alphanumeric, thus all harmonics are displayed with 0.1% resolution in order to provide more detailed information. On Rainbow Plus program, harmonics and waveform are displayed on a single screen with more resolution.

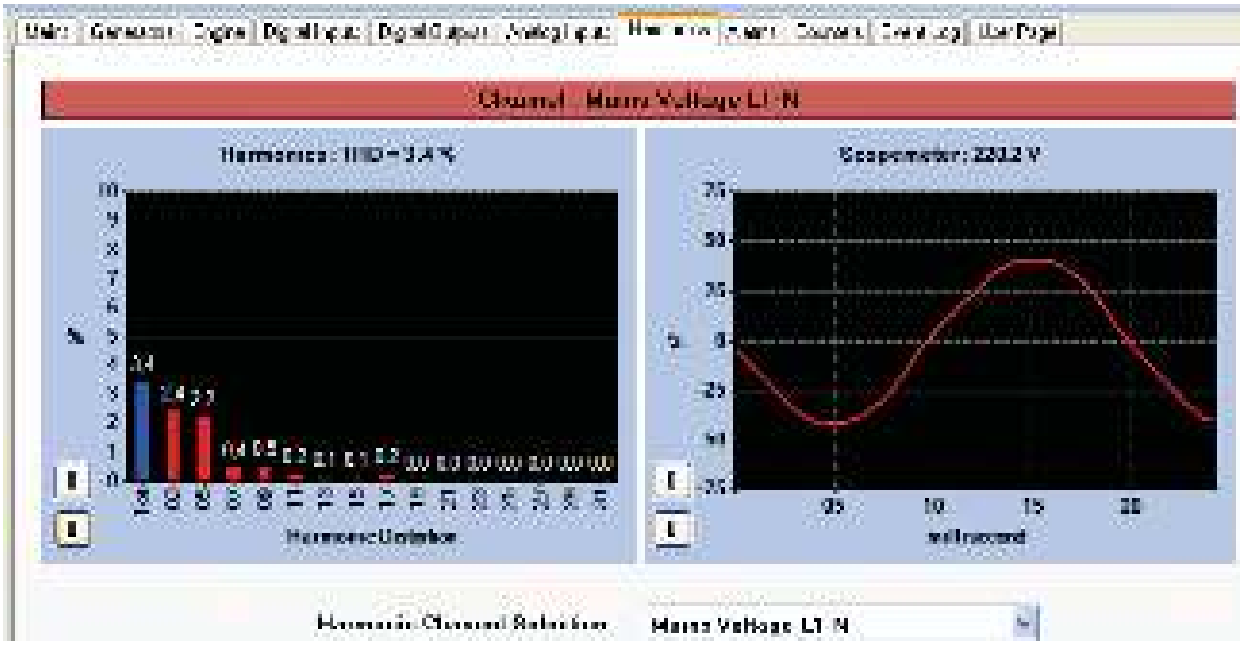


Fig. E5.33 Rainbow Plus Scada section: Harmonic Analysis and Waveform Display

5.11 Operation of the Unit

5.11.1 Quick Start Guide

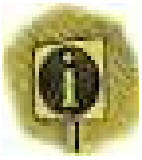
Stopping the Engine: Press STOP button.

Starting the Engine: Press RUN button

Manual Load Transfer: Use MAINS and GENSET buttons.

Load Test: Press TEST button. The GENSET will run and take the load.

Automatic Operation: Press AUTO button. Check that **AUTO READY** led is illuminated.

	**Important Note!** Mode can be changed anytime without negative effect. Changing the operation mode while the GENSET is running will result into a BEHAVIOR suitable for the new operating mode.

5.11.2 Stop Mode

The STOP mode is entered by pressing the  button.

In this mode, the GENSET will be in a rest state. When STOP mode is selected, if the GENSET is running under load, then it will be immediately unloaded. The engine will continue to run during **Cool down Timer** and will stop afterwards. If the STOP button is pressed again, then the engine will immediately stop. If the engine fails to stop after the expiration of **Stop Timer,** then a **Fail to stop** warning will occur. In this mode, the mains contactor will be energized only if mains phase voltages and frequency are within the programmed limits. If enabled, the mains phase order is also checked. If a **Remote Start** or **Force to Start** signal arrives in STOP mode, the GENSET will not start until AUTO mode is selected.

5.11.3 Auto Mode

The AUTO mode is entered by pressing the  button.

The AUTO mode is used for the automatic transfer between GENSET and mains. The controller will constantly monitor the mains availability. It will run the engine and transfer the load when a mains failure occurs.

The mains availability evaluation sequence is below:

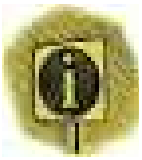
i. If at least one of the mains phase voltages or the mains frequency is outside limits, the mains will be supposed failing. Otherwise mains would be available.
ii. If a Simulate Mains signal is present, then mains are made available.
iii. If a Force to Start signal is present, then mains are unavailable.
iv. If a Remote Start input is defined, then this signal decides of mains availability.

When mains are evaluated as "unavailable" then an engine start sequence begins:

i. The unit waits during Engine Start Delay for skipping short mains failures. If the main is restored before the end of this timer, the GENSET will not start.
ii. The unit turns on the fuel and preheat glow plugs (if any) and waits for preheat timer.
iii. The engine will be cranked for programmed times during crank timer. When the engine fires, the crank relay will be immediately deactivated. See section **Crank Cutting** for more details.
iv. The engine will run at idle speed during Idle Speed Timer.
v. The engine will run unloaded during engine heating timer.
vi. If alternator phase voltages, frequency and phase order are correct, the unit will wait for the generator contactor period and the generator contactor will be energized.

When mains are evaluated as "available" again then an engine stop sequence begins:

i. The engine will continue to run for the mains waiting period to allow mains voltages to stabilize.
ii. Then the generator contactor is deactivated and the mains contactor will be energized after mains contactor timer.
iii. If a cool down period is given, the generator will continue to run during the cool down period.
iv. Before the end of cool down, the unit will reduce the engine speed to idle speed.
v. At the end of cool down, the fuel solenoid will be de-energized, the stop solenoid will be energized for Stop Solenoid timer and the diesel will stop.
vi. The unit will be ready for the next mains failure.

	**Important Note!** If the operation of the GENSET is disabled by the weekly schedule, then the AUTO led will flash, and the operation of the GENSET will be as in the OFF mode.

5.11.4 Run Mode Manual Control

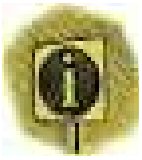
The RUN mode is entered by pressing the  button.
When the RUN mode is selected, the engine will be started regardless of the mains availability.

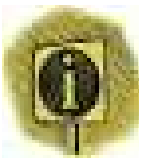
The starting sequence is as described below:

i. The unit turns on the fuel and preheat glow plugs (if any) and waits for preheat timer.
ii. The engine will be cranked for programmed times during crank timer. When the engine fires, the crank relay will be immediately deactivated.
iii. The engine will run at idle speed during Idle Speed Timer.
iv. The engine will run unloaded until another mode is selected.

The RUN mode allows also manual contactor control through MC  and GC  buttons.
When a contactor button is pressed, the related contactor will change position. Thus if it was on, then it will turn off. If it was off then it will turn on.

If the other contactor was on, then it will turn off, the controller will wait for the related contactor timer and the contactor will turn on. This will prevent manual closure of both contactors.

	**Important Note!** If uninterrupted transfers are allowed, then the unit will check the synchronization. If synchronization is complete, then it will make an uninterrupted transfer, where both contactors will be on for a short while.

	**Important Note!** If Emergency Backup mode is enabled and if the mains are off, then the mains contactor will be deactivated and the generator contactor will be activated. When the mains are on again, a reverse changeover to the mains will be performed, but the engine will be kept running unless another mode is selected.

In order to stop the engine press  button or select another mode of operation.

5.11.5 Test Mode

The TEST mode is entered by pressing the  button.

The TEST mode is used in order to test the GENSET under load.

Once this mode is selected, the engine will run as described in the AUTO mode, regardless of the mains availability and the load will be transferred to the GENSET.

The GENSET will feed the load indefinitely unless another mode is selected.

5.12 Protection and Alarms

The unit provides 3 different protection levels, being warnings, load dumps and shutdown alarms.

SHUTDOWN ALARMS: These are the most important fault conditions and cause:

i. The **ALARM** LED to turn on steadily,
ii. The GENSET contactor to be released immediately,
iii. The engine to be stopped immediately,
iv. The **Alarm** digital output to operate.

LOAD DUMPS: These fault conditions come from electrical trips and cause:

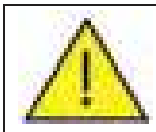
i. The **ALARM** led to turn on steadily,
ii. The GENSET contactor to be released immediately,
iii. The engine to be stopped after Cool down period,
iv. The **Alarm** digital output to operate.

WARNINGS: These conditions cause:

i. The **WARNING** led to turn on steadily,
ii. The **Alarm** digital output to operate.

5.12.1 Disabling All Protection

The unit allows any digital input to be configured as **"Disable Protections"**. This input configuration is used in cases where the engine is required to run until destruction. This may be the case under critical conditions like fire fighting or other emergency cases. This input should be configured as a "Warning". Thus when protections are disabled, a warning message will immediately appear on the screen. When protections are disabled, all shutdown alarms and load dumps will become warnings. They will appear on the screen, but will not affect GENSET operation. The input may be constantly activated, or preferably it may be activated by an external key activated switch in order to prevent unauthorized activation.



Warning! Disabling protections will allow the GENSET run until destruction. Place written warnings about this situation in the GENSET room.

5.13 Program Parameter List

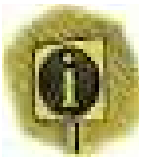
5.13.1 Ethernet Parameters

Parameter Definition	Factory Set	Description
Network IP Address	0.0.0.0	This is the IPv4 (internet protocol version 4) address that the unit will require from the DHCP (dynamic host control protocol) server. If this parameter is set to 0.0.0.0 then the unit will require any IPv4 address from the DHCP server. If you are not an IP professional please leave this address as "0.0.0.0".
Gateway IP Address	0.0.0.0	This is the router IPv4 address. If the Network IP address and Gateway IP Address are set to "0.0.0.0" then the unit will get the gateway address automatically. If you are not an IP professional please leave this address as "0.0.0.0".
Subnet Mask	255.255.255.0	Reserved for IP professionals. If you are not an IP professional please leave this address as "255.255.255.0".
User IP Mask 1 (2) (3)	255.255.255.255 0.0.0.0 0.0.0.0	These 3 registers control the IPv4 access to the unit. The remote IPv4 address is logical AND'ed with these IP addresses. If the result gives the remote IP address, then access is enabled. Thus access may be limited to the same LAN members (x.x.x.255) or strictly to predefined IPv4 addresses.
Domain Name	d500.dyndns-ip.com	This string is used in "Dynamic DNS" feature. The unit will register itself to the dynamic DNS server under this name. For more detailed information please review chapter on "**Dynamic DNS Feature**" and the document "**Dynamic DNS Account Setting**".
Membership Address	members.dyndns.org	This string is used in "**Dynamic DNS**" feature. This is the address used in registering to the dynamic DNS server. For more detailed information please review chapter on "**Dynamic DNS Feature**" and the document "**Dynamic DNS Account Setting**".
Username/Password		These strings are used in "**Dynamic DNS**" feature while registering to the dynamic DNS server. For more detailed information please review chapter on "**Dynamic DNS Feature**" and the document "**Dynamic DNS Account Setting**".
Ping Address	www.google.com	This internet address is regularly accessed in order to check the availability of internet access. The access period is defined in parameter **Controller Configuration-Ping Period**.
IP Confirmation Address	checkip.dyndns.org	This internet address is regularly accessed in order to read the IPv4 address of the unit.
Rainbow Address-1 Rainbow Address 2	-	These parameters accept both internet addresses (like http://rainbow.com.tr) and IPv4 addresses (like 78.192.238.116). Information for remote monitoring is sent to these addresses. The port information of these addresses are found in Controller Configuration group.

Exhibit Table E5.4 Ethernet Parameters

Parameter Definition	Factory Set	Description
Mail Account Name	d500_a	This is the account name appearing in the "from" tab of the e-mail recipient. (ex: datakom-d500@gmail.com)
Mail Account Password	d500_1234	This is the e-mail password of above e-mail account.
Mail Server Address	smtp.mail.yahoo.com	This is the Outgoing Mail Server Address of the above e-mail account (ex: smtp.gmail.com)
E-mail Address-1 E-mail Address-2 E-mail Address-3	- - -	These are e-mail recipient addresses where the unit is intended to send e-mail messages. Up to 3 e-mails can be sent at once.

Exhibit Table E5.4 Ethernet Parameters (continued)

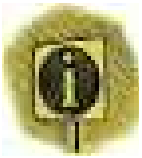


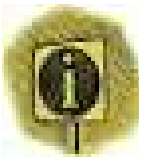
Important Note! Below ETHERNET related parameters are found in the Controller Configuration group.

Parameter Definition	Unit	Min	Max	Factory Set	Description
Web Programming Enable	-	0	1	0	0: Web programming disabled 1: Web programming enabled
Web Control Enable	-	0	1	0	0: Web control disabled 1: Web control enabled
Web Refresh Rate	sec	0	240	5	The unit will refresh the web page with this interval.
Ping Period	min	0	240	0	The unit will check the availability of the internet connection with this interval.
Rainbow Refresh Rate	sec	0	65535	5	The unit will update the discant monitoring terminal with this rate.
Rainbow Address-1 Port	-	0	65535	0	This is the port number of the first monitoring terminal address.
Rainbow Address-2 Port	-	0	65535	0	This is the port number of the second monitoring terminal address.
Web Server Port	-	0	65535	80	This is the port number of the internal web server. The unit will answer queries to this port only.
Modbus TCP Port	-	0	65535	502	This is the port number of the internal Modbus TCP/IP terminal. The unit will answer Modbus requests to this port only.
SMTP Port	-	0	65535	587	This is the port number used for e-mail sending.
Ethernet Enable	-	0	1	1	0: ethernet port disabled 1: ethernet port enabled
E-mail on IP Change	-	0	1	0	This parameter controls e-mail sending when IP address of GPRS or ethernet connection is changed. No warnings generated. 0: no e-mail on IP change 1: e-mail sent on IP change

Exhibit Table E5.4 Ethernet Parameters (continued)

5.14 SMS Commands

	**Important Note!** SMS messages are accepted only from phone numbers recorded in the Communication>GSM>Message Numbers tab. Answers to SMS m essages will be sent to all phone numbers in the list.

	**Important Note!** SMS messages must be written exactly as be low, without any preceding blanks. Only UPPERCASE characters are permitted.

COMMAND	DESCRIPTION	ANSWER
GET IP	If GPRS connection is active, the controller will reply by an SMS message indicating the IP address of the GSM modem.	IP: 188.41.10.244
GPRS 1	Activates the GPRS connection	GPRS enabled!
GPRS 0	Stops the GPRS connection	GPRS disabled!
RESET ALARMS	Clears alarms of the controller. The operating mode is not modified	Alarms cleared!
REBOOT	Performs a hard reset on the controller	no answer
MODEM RESET	Performs a hard reset on the modem	no answer
GET INFO	Returns the alarm list and actual measured values	ALARMS (if exists) GEN: Vavg/iAVG/kWtot/pf/Freq MAINS: Vavg/iAVG/kWtot OIL_PR/TEMP/FUEL%

Exhibit Table E5.5 SMS Commands

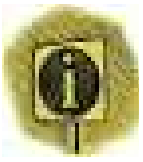
COMMAND	DESCRIPTION	ANSWER
MODE STOP	Puts the controller into STOP mode. Alarms are also cleared.	Unit forced to STOP!
MODE AUTO	Puts the controller into AUTO mode. Alarms are also cleared.	Unit forced to AUTO!
MODE MANUAL	Puts the controller into MANUAL (RUN) mode. Alarms are also cleared.	Unit forced to RUN!
MODE TEST	Puts the controller into TEST mode. Alarms are also cleared.	Unit forced to TEST!
OUT1 ON	Sets remote controlled output #1 to active state	OUT 1 = ON
OUT1 OFF	Sets remote controlled output #1 to passive state	OUT 1 = OFF
OUTxx ON	Sets remote controlled output #xx to active state (xx denotes any number between 1 and 18).	OUT xx = ON
OUTxx OFF	Sets remote controlled output #xx to passive state (xx denotes any number between 1 and 18).	OUT xx = OFF

Exhibit Table E5.5 SMS Commands (continued)

5.15 Data Recording

5.15.1 Data Recording Media

Data can be recorded in USB flash memory or MICRO-SD memory card. Both options are available. As soon as a USB flash memory or a MICRO-SD card is inserted, the unit will start data recording and continue until the memory is removed.

	**Important Note!** The USB-Host port and MICRO-SD card slot are available with COMM option.

	**Important Note!** Micro-SD memory card has priority for data recording. If both micro-SD and USB-Flash memories are inserted, data will be recorded on micro-SD memory.

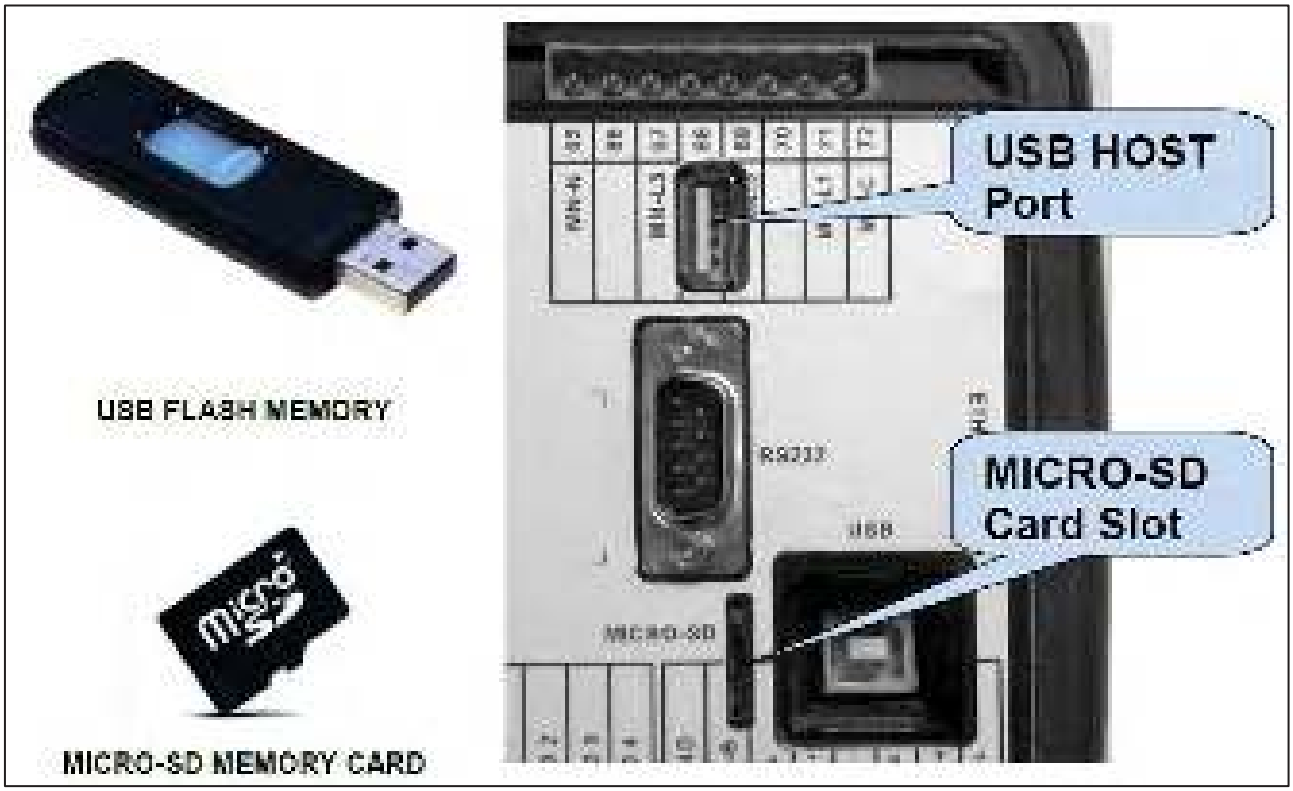


Fig. 5.34 Illustration of Data Recording Media

	Important Note! If USB-Device is plugged then USB-Host port will not function.

5.15.2 Directory Structure

The unit will record data in either an USB-Flash memory or a micro-SD flash memory card. The record structure is the same in both cases.

The unit will record data in a di rectory named with the first 11 characters of its site-id parameter. In order to avoid confusion between records, it is highly recommended to configure the site-id parameter accordingly to the GENSET installation place. Thus the same memory module may be used for recording in different controllers. Inside the <SITE-ID> directory, the unit will open a separate directory for each year of recording. The directory will be simply named by the year, like 2012, 2013 etc.

Inside the year directory, the controller will record data in a different file for each day of recording. The record file will be named YYYYMMDD like “20120331” representing March ’31, 2012. Thus alphabetical listing will produce a sorted list by date of recording.

The recorded file is of CSV (comma separated values) type. This is a text file which can be directly opened with Microsoft Excel program without any loss of information. It can be also opened with any text editor (like Notepad program).

Inside the file, each record consists of a line including a large set of measured parameters. The recorded parameters list is not adjustable. The controller records all practically necessary parameters.

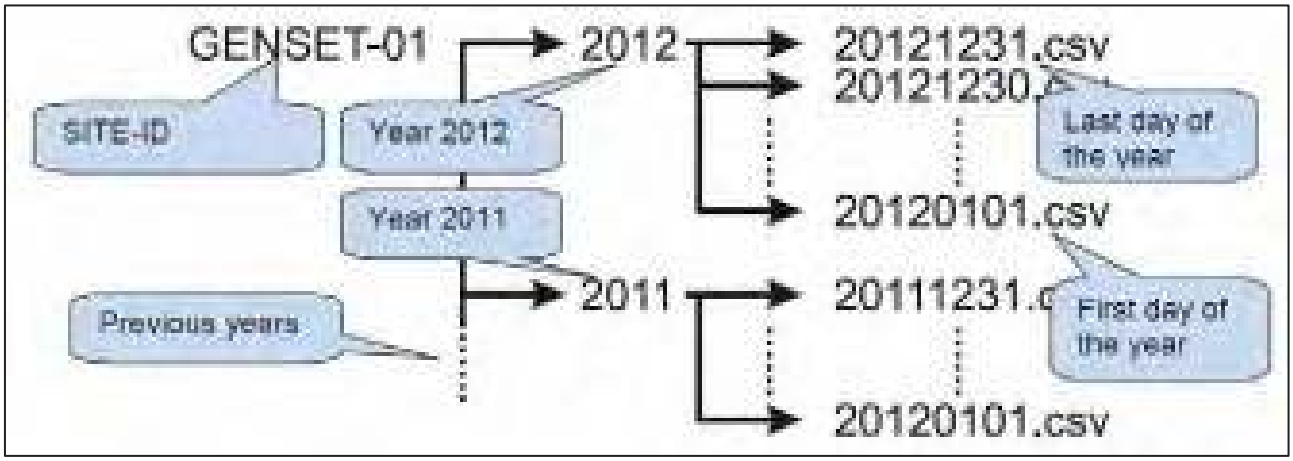


Fig. E5.35 Illustrative Representation of Directory Structure

5.15.3 Understanding the CSV Format

The “.csv” file is basically a text file format. Thanks to this, it can be opened by any text editor in any operating system. When opened with the Microsoft Excel program, the values will appear in tabulated form, enabling application of formulas, graphs and other features of Excel program.

5.16 Software Features

5.16.1 Automatic Exerciser

The unit offers 7 independent automatic exercisers. The exercise operation may be done on a weekly or monthly basis.

The start day and time of the exercise is programmable as well as its duration. The exercise may be done with or without load following programming. Program parameters related to the exerciser are:

i. Exercise start day and hour
ii. Exercise duration
iii. Exercise off load/on load

Please refer to the programming section for a more detailed description of the above parameters. When the start day and hour of exercise has come, the unit will automatically switch to either **RUN** or **TEST** mode. The engine will run. If the on load exercise is selected then the load will be transferred to the GENSET.

If a mains failure occurs during the off-load exercise, the load will not be transferred to the GENSET unless the **Emergency Backup Operation** is allowed by setting the related program parameter to 1. Thus it is highly recommended that the Emergency Backup mode enabled with off-load exerciser.

At the end of the exercise duration, the unit will switch back to the initial mode of operation. If any of the mode selection keys are pressed during exercise, then the exercise will be immediately terminated.

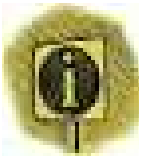
Using the weekly exercise mode and with suitable parameter setting, the unit may feed the load from the GENSET during predefined hours of each day. This operation may be used in high tariff periods of the day.

5.16.2 Weekly Operation Scheduler

In most applications, the GENSET is requested to operate only in working hours. Thanks to the weekly program feature, unwanted operation of the GENSET may be prohibited.

The scheduler is active only in AUTO mode. When the scheduler prevents GENSET operation in AUTO mode, the AUTO led will flash.

The scheduler consists of 144 programmable parameters, one for each hour in a week. Thus every hour of the week may be independently selected as ON or OFF times. These programmable parameters allow the genset to operate automatically only in allowed time limits. The unit has a battery backed-up precision real time clock circuit. The real time clock circuit will continue its operation even in power failures. The real time clock is precisely trimmed using the Real Time Clock Adjust program parameter. For more details check the programming section.

	**Important Note!** When the scheduler prevents GENSET operation in AUTO mode, the AUTO LED will flash.

5.16.3 Engine Heating Operation

Especially on engines without a body heater, or with a failing one, it may be desired that the GENSET should not take the load before reaching a suitable temperature. The unit offers 2 different ways of engine heating.

1) **Timer controlled heating:** This operation mode is selected when the Engine Heating Method parameter is set to 0. In this mode, the engine will run during parameter Engine Heating Timer, and then the GENSET will take the load.
2) **Timer and temperature controlled heating:** This operation mode is selected when the Engine Heating Method parameter is set to 1. In this mode, at first the engine will run during parameter Engine Heating Timer, then it will continue to run until the measured coolant temperature reaches the limit defined in parameter Engine Heating Temperature. When the requested temperature is reached, the load will be transferred to the GENSET. This operation mode may be used as a backup to the engine body heater. If the engine body is warm the heating will be skipped.

5.16.4 Engine Idle Speed Operation

It may be required that the engine runs at the idle speed for a programmed duration for engine heating. The idle operation duration is adjusted with the parameter Idle Speed Timer. The idle speed will be set by the governor control unit of the engine. Any digital output may be assigned as IDLE output using Relay Definition program parameters.

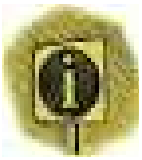
The Idle speed operation is performed both in engine start-up and cool-down sequences. Low speed and low voltage protections are disabled during idle speed operation.

5.16.5 Engine Block Heater

The unit is able to provide a digital output in order to drive the block heater resistor. The temperature reference is the coolant temperature measured from the analogue sender input. The block heater output function may be assigned to any digital output using Relay Definition program parameters. The engine body temperature limit is adjusted using the parameter Engine Heating Temperature. The same parameter is used for engine heating operation. The relay will become active if the body temperature falls to 4 degrees below the limit set by Engine Heating Temperature. It turns off when the body temperature exceeds Engine Heating Temperature.

5.16.6 Pre-Transfer Signal

The controller is able to provide a pre-transfer digital output function. This function is designed for elevator systems, in order to bring the cabin to a floor and open cabin doors before transfer. The duration where this output is active is adjusted with the Pre-Transfer Delay parameter.

	**Important Note!** If the Pre-transfer Delay parameter is not zero, this will delay transfers by the same amount.

5.16.7 Charging the Engine Battery

The controller offers an automatic charge cycle for the engine battery. When the engine battery weakens, the GENSET will run automatically during programmed period in an unloaded state in order to charge the engine battery, protecting it from total discharge when the GENSET has not run for a long time. Related parameters are as follows:

i. **Battery Charge Run Voltage:** If this parameter is different from zero and the engine battery voltage falls below this limit then the controller will run the engine unloaded, in order to charge engine battery. The running duration is determined by the Battery Charge Run Timer parameter.

ii. **Battery Charge Run Timer:** This parameter determines the engine battery charge running duration. The minimum run time is 2 minutes.

iii. **Emergency Backup:** If this parameter if activated and the mains fail during engine battery charging run, then the GENSET will take the load.

5.16.8 Externally Controlled Digital Outputs

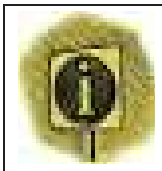
The controller offers 16 externally controllable digital output functions. These output functions have no effect in the operation of the unit; however they can be redirected to any digital output, allowing remote control of functions or external devices. The remote controls of these outputs are enabled through Modbus, Modbus TCP/IP and Rainbow Scada remote control functions. The outputs are in 16 bits of the same Modbus register, placed at address 11559d.

5.16.9 Externally Controlled Digital Outputs

The controller offers a combat mode input function. When a digital input is defined as Combat Mode and signal applied to this input, the controller will turn off all led lamps and the backlight illumination 10 seconds after any key is pressed. When a button is pressed, the illumination will be enabled for 10 seconds.

5.17 MODBUS Communications

	**Important Note!** This topic is a brief description of the Modbus properties of the controller. For a complete documentation please use “D- 500 D-700 Modbus Application Manual”.

	**Important Note!** Each device in the same RS-485 serial network must be assigned a different slave address. Otherwise the Modbus communications will not be performed.

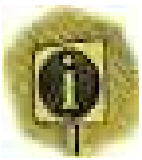
The unit offers the possibility of MODBUS communication through below carriers:

i. RS485 serial port, with adjustable baud rate between 2400 and 115200 bauds
ii. MODBUS-TCP/IP through Ethernet port (10/100Mb)
iii. MODBUS-TCP/IP through GPRS (85/42kb), client mode through Rainbow Scada only

The MODBUS properties of the unit are:

i. Data transfer mode: RTU
ii. Serial data: selectable baud rate, 8 bit data, no parity, 1 bit stop
iii. Modbus-TCP/IP: Ethernet 10/100Mb or GPRS Class 10.
iv. Supported functions:
v. Function 3 (Read multiple registers)
vi. Function 6 (Write single register)
vii. Function 16 (Write multiple registers)

Each register consists of 2 bytes (16 bits). A larger data structure will contain multiple registers. The Modbus communications requires a slave address to be assigned to each device in the Modbus network. This address ranges between 1 and 240 and allows the addressing of different slave devices in the same network.

	**Important Note!** Devices using Modbus-TCP/IP with different IP or port addresses may use any slave address. It is advised to set these slave addresses to the default setting which is 1.

5.17.1 Parameters Required for RS-485 MODBUS Operation

Modbus Slave Address: may be set between 1 and 240

RS-485 Enable: must be set to 1 (or checkbox enabled)

RS-485 Baud Rate: selectable between 2400 and 115200 bauds. All devices in the same network must use the same Baud Rate.

The complete RS-485 port specifications are found in the D-500/700 User Manual. Selecting a higher baud rate will allow faster communication, but will reduce the communication distance. Selecting a lower baud rate will increase the communication distance, but will cause slower response times. Typically 9600 bauds will allow 1200m distance with special balanced 120 ohms cable.

5.17.2 Parameters Required for RS-485 MODBUS TCP/IP via Ethernet

Modbus Slave Address: may be set between 1 and 240. If only one unit is available in the same IP address, it is advised to keep the default address (1).

Ethernet Enable: This parameter should be set to 1 (or checked) in order to enable the Ethernet port. Modbus TCP/IP Port: The usual setting is 502. However the unit is able to work on any port address. User IP Mask: There are 3 mask registers available. The uses of the registers are emphasized in the D- 500/700 User Manual. Please set the first mask as 255.255.255.0 for the proper operation.

Ethernet Network IP: May be left as 0.0.0.0 for automatic address claim or set to a value in order to claim a defined address.

Ethernet Gateway IP: Should be set in accordance with your local switch configuration.

Ethernet Subnet Mask: Should be set in accordance with your local switch configuration. The complete Ethernet port specifications are found in the D-500/700 User Manual. Please review the document Ethernet Configuration Guide for D-500/700 for more details about the Ethernet port setup.

Chapter 6 Optional Equipment

6.1 Introduction

The standard panels may be supplied with a variety of optional equipment to meet specific requirements. The panel may contain one or more of the following options as per your requirement.

6.2 AMF (Auto Mains Failure) Panel

The GENSET can be supplied with an AMF Panel for operation in Auto start mode. This panel includes following parts:

i. Mains sensing module
ii. Timer modules
iii. Relay module
iv. Load transfer contactor
v. Mode selector switches
vi. Indications

6.3 Battery Trickle Chargers

These chargers are designed to ensure that the starter batteries maintain their charge even if the generator is not operated for long periods. These chargers are available in two sizes viz. 5 A and 10 A nominal rating. These chargers require an auxiliary supply of 220/240 VAC.

6.4 Fuel Transfer Pumps

A fuel transfer pump is optionally provided where there is a requirement of transferring fuel from bulk storage tanks to the GENSET tanks. These pumps are operated on 220/240 VAC.

6.5 Meters

Where more information is required as regards generator loading, the following meters may be added.

i. Kilowatt (kW) meter: These are generally three phase unbalanced load moving coil meters. The meter is fitted on the panel front, with the transducer mounted on the chassis. This provides accurate readings of the load being supplied by the engine.
ii. Digital RPM and Hour meter: This is optional to the standard frequency meter.

6.6 Gauges

To give further information on engine performance the following gauges may be fitted.

i. Oil Temperature Gauge: This gauge displays the lubricating oil temperature when the engine is operating.

ii. Ammeter for Engine Driven Charger: This gauge displays the current flow to and from the battery. It is primarily used to observe the charging current being supplied from the engine driven battery charging alternator.

6.7 Speed /Voltage Control

To allow minor adjustments of voltage to be made from the control pane, a single turn 5kΩ potentiometer can be fitted. This allows an adjustment of up to 5% about the rated voltage.

6.7.1 Speed Adjust Potentiometer

This option can only be used when the engine speed is being controlled by an electronic governor. The engine speed/ frequency can be varied using this potentiometer.

6.8 Alarm Signalling

A set of volt free contacts which changeover in the event of a generator fault is provided. These contacts remain in the alarm condition until the fault is reset.

6.9 Remote Start

GENSET remote starting facility can be provided as per requirements.

Chapter 7 Batteries

7.1 Safety

ALWAYS ensure battery charging is carried out in a well-ventilated area away from sparks or naked flames. A clear notice should be displayed stating "NO SMOKING OR NAKED LIGHTS PERMITTED IN THIS AREA".

i. NEVER operate the charger where unprotected from rain or snow. The charger should not be used near water. Ensure that the mains supply has been correctly terminated and the GREEN/YELLOW lead MUST be connected to a good earth.
ii. ALWAYS switch charger off before disconnecting battery and ensure that there is no sparking or naked flames, as concentration of fumes in the area can cause the battery to explode.
iii. NEVER group batteries close together around the charger as damage and premature failure to components will be caused by the corrosive fumes.
iv. ALWAYS handle batteries with care and wash hands after contact to prevent the possibility of acid burns. Wear suitable protective clothing and display first aid notices.
v. NEVER permit unauthorized personnel in the battery charging area except under supervision.

7.2 Charger & Battery Connections

Ensure that secure and proper connections are made to a suitable mains plug with the following colour code:

MAIN IS		
LIVE	Marked L	Brown Red
NEUTRAL	Marked N	Blue Lead
EARTH	Marked E	Green/Yellow Lead
BATTERY		
Positive (+)	Red	
Negative (-)	Black	

Table E7.1

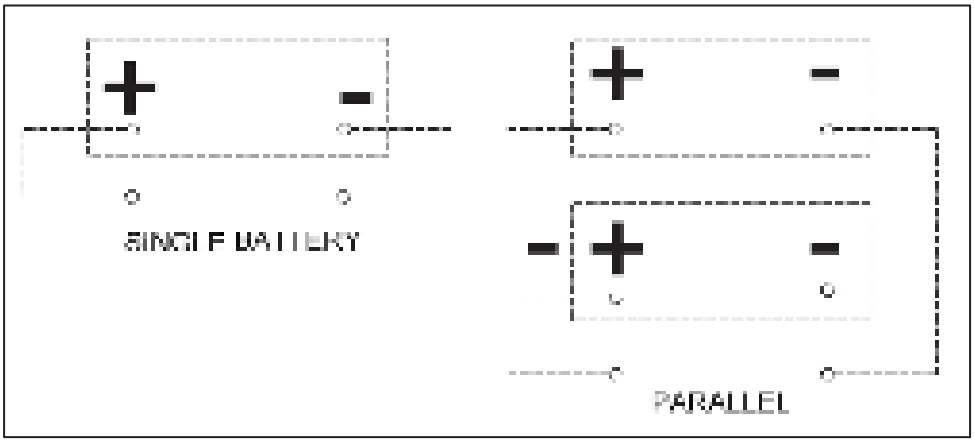


Fig. E7.1 12V Battery Connection in Series & Parallel

7.3 Charger Operation

7.3.1 General

i. Follow the safety recommendations outlined in the Safety section above.

ii. Check battery and charger are connected as described in Charger and Battery Connections section.

iii. Remove the battery filler caps or vent cover during charging. Check electrolyte level and adjust if necessary, following the procedures in Battery Maintenance section.

iv. Switch on charger and observe charge rate for normal operation. If any problem is encountered refer to Fault Finding topic.

7.3.2 State of Charge

Allow the battery to settle for a short period with charger switched off before checking the specific gravity of each of the battery cells. Using a hydrometer, the reading should be approximately 1.27 for each cell at a nominal temperature of +15°C.

7.3.3 Charging Rate

The charging rate depends on the Ampere-hour capacity (its size) of the battery, the condition of the battery and the level of charge present. The initial charging current will decrease as the battery starts charging and the charging current will continue to decrease (or taper) as the battery voltage rises.

7.4 Battery Maintenance

7.4.1 General

The “battery” is an assembly of cells containing a number of positive and negative electrodes or “plates” immersed in an electrically conductive fluid or electrolyte (sulphuric acid). The electrical, energy released during discharge is derived from the chemical reactions taking place within the cells. These reactions are reversible which means the battery can be repeatedly charged and discharged.

7.4.2 Topping Up & Filling

7.4.2.1 Water

The most suitable water to use when preparing electrolyte is distilled water. This is also true for routine water additions to the battery. Generally, any water that is safe to drink (excluding mineral waters) is safe to use in a battery. Do not use water of a known high mineral content. Avoid the use of metallic containers (except lead or lead lined containers). Metal impurities in the water will lower the performance of the battery. Procedure for topping up distilled water is as mentioned below:

i. Clean top of battery to avoid contamination and remove the vent plugs.
ii. Add distilled water until level is 5-10 mm above the top edge of the separators.
iii. Replace and tighten vent plugs.
iv. Dry the top of battery.

7.4.2.2 Electrolyte

The electrolyte in a lead-acid storage battery is a dilute sulphuric acid solution. A battery with a fully charged specific gravity of 1.265 corrected to 80°F (26.7°C) contains an electrolyte with approximately 36% sulphuric acid by weight or 25% volume. The remainder of the electrolyte is water. Pure (concentrated) sulphuric acid has a specific gravity of 1.835. The sulphuric acid in the electrolyte is one of the necessary ingredients in the chemical actions taking place inside the battery. It supplies the sulphate (804) which combines with the active material of the plates. It is also the carrier for the electric current as it passes from plate to plate. When the battery terminals are connected to an external load, the sulphate combines with the active materials of the positive and negative plates forming lead sulphate (PbS04) and releasing electrical energy. Electrons flow from the negative terminal to the load (such as fuel solenoid) and back to the positive terminal.

Specific gravity is a unit of measurement for determining the sulphuric acid content of the electrolyte. The recommended fully charged specific gravity of most 12- Volt batteries today is 1.265 corrected to 80°F (26.7°C). Water has arbitrarily been assigned a value of 1.000, therefore, electrolyte with a specific gravity of 1.265 means it is 1.265 times heavier than pure water.

If it should become necessary to dilute concentrated sulphuric acid to a lower specific gravity always pour the acid into the water - do this slowly - never pour water into acid. A dangerous "spattering" of the liquid would result. This is caused by extreme heat which is generated whenever strong acid is mixed with water. Stir the liquid continually while acid is being added.

The procedure for filling up of electrolyte is mentioned below:

i. Add electrolyte until level is 5 to 10 mm above the top edge of the separators.
ii. Allow battery to stand for 20 minutes.
iii. Check and adjust level as necessary.
iv. Replace and tighten vent plugs.

7.4.3 Hydrometer Description and How to Use

The state-of-charge of a lead acid battery can be determined by the specific gravity of the electrolyte (its weight compared to water). The specific gravity can be measured directly with a hydrometer or determined by the stabilized voltage.

A hydrometer is a bulb-type syringe which will extract electrolyte from the cell. A glass float in the hydrometer barrel is calibrated to read in terms of specific gravity. A common range of specific gravity used on these floats is 1.160 to 1.325. Do not assume a battery will not take a charge because you have been charging it for a time and the float will not rise. The battery may have been fully discharged and will require considerable charging before reaching the minimum specific gravity on the float such as 1.160 (approximately 1/4 charged). The lower the float sinks in the electrolyte, the lower its specific gravity. The barrel must be held vertically so the float is not rubbing against the side of it. Draw an amount of acid into the barrel so that with the bulb fully expanded, the float will be lifted free, touching neither the side, top or bottom stopper of the barrel. Your eye should be on a level with the surface of the liquid in the hydrometer barrel.

Disregard the curvature of the liquid where the surface rises against the float stem and the barrel due to surface tension. Keep the float clean. Make certain it is not cracked. The following table illustrates typical specific gravity values for a cell in various stages of charge with respect to its ability to crank an engine. A fully charged specific gravity-of 1.265 corrected to 80°F (26.7°C) is assumed.

Typical Open Circuit Voltage and Specific Gravity Values:

Charge Level	Specific Gravity	Voltage
100%	1.265	12.7
75%	1.225	12.4
50%	1.190	12.2
25%	1.155	12.0
Discharged	1.120	11.9

Table E7.2

Never take a hydrometer reading 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. If a reading is being taken immediately after the battery has been subjected to prolong cranking, it will be higher than the true value. The water formed in the plates during the rapid discharge has not had time to mix with the higher specific gravity acid above the plates.

7.4.4 Initial Charging

Within 24 hours of filling, or if battery stands inactive for more than 6 months, charge for at least 2 hours at the approximate current in amperes shown above. This charge will have to be carried out on a workshop type charger.

7.4.5 Climate

Most batteries used in temperate climates have a fully charged specific gravity in the 1.250 to 1.280 range. A fully charged electrolyte specific gravity of 1.210 to 1.230 is used in tropical climates. A tropical climate is considered one in which water never freezes. This milder strength electrolyte does not deteriorate the separators and grids as much as the higher strength electrolyte. This increases the service life of the battery. The lower specific gravity decreases the electrical capacity of the battery, especially the cold cranking performance. However, these losses are offset by the fact that the battery is operating at warm temperatures where it is more efficient and cold cranking performance is not required.

The following chart shows the approximate specific gravity values of batteries at various states of charge. One column shows values for batteries whose electrolyte specific gravity has been prepared for use in a temperate climate; the other column for batteries prepared for use in a tropical climate. It illustrates that batteries may be fully charged and yet have different values of specific gravity. The values shown are for a cell in various states of charge with respect to its ability to crank an engine at 80°F (26.7°C). The specific gravity values shown will vary depending on the ratio of electrolyte volume to active material and the battery construction.

State of Charge	Specific Gravity @ Ambient Climates	Specific Gravity @ Tropical Climates
Fully charged	1.265	1.225
75% charged	1.225	1.185
50% charged	1.190	1.150
25% charged	1.155	1.155
Discharged	1.120	1.080

Table E7.3

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

7.4.6 Electrolyte

Use only pure dilute sulphuric acid of the correct specific gravity to suit temperature of operation:

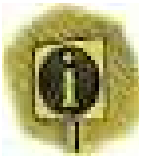
Ambient Climate	Tropical Climate
1.270kg/L	1.230 kg/L

Check specific gravity with a g ood quality hydrometer and correct readings as follows. If electrolyte temperature differs from the hydrometer's calibrated temperature:

i. For each 10°C above, add 0.007 to observed reading.
ii. For each 10°C below, subtract 0.007 from observed reading.
iii. For each 10°F above, add 0.004 to observed reading.
iv. For each 10°F below, subtract 0.004 from observed reading.

(This can make a substantial difference at extreme temperatures).

v. Adjust specific gravity using distilled water.



Important Note! For safety always add acid to distilled water.

7.4.7 Temperature Correction

Hydrometer floats are calibrated to give a true reading at one fixed temperature only. A correction factor must be applied for any specific gravity reading made when the electrolyte temperature is not 80°F (26.7°C). Some standard hydrometers use a reference temperature of 60°F (15.5°C). A temperature correction must be used because the electrolyte will expand and become less dense when heated. The float will sink lower in the less dense solutions and give a lower specific gravity reading. The opposite occurs if the electrolyte is cooled. It will shrink in volume, becoming denser. The float will rise higher and read too high.

Regardless of the reference temperature used as a standard a correction factor of 0.004 specific gravity (sometimes referred to as 4 "points of gravity") is used for each 10°F (5.5°C) change in temperature. Four "points of gravity" (0.004) are added to the indicated reading each 10°F (5.5°C) increment above 80 °F (26.7°C). This correction is important at extremes of temperature because it can become a substantial value.

The thermometer should be of the mercury-in-glass type with a scale reading as high as 125°F (52°C). The smaller the club immersion the better, but it should not exceed 1" (25 mm). The electrolyte should be drawn in and out of the hydrometer barrel a few times to bring the temperature of the hydrometer float and barrel to that of the electrolyte in the cell.

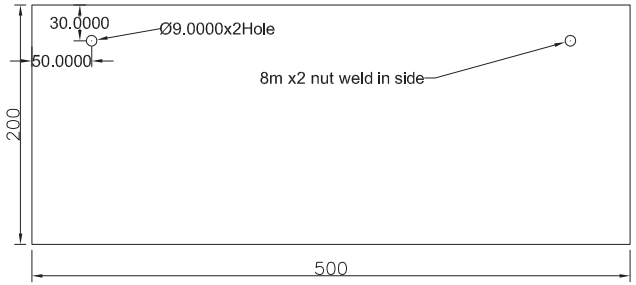
7.5 Fault Finding

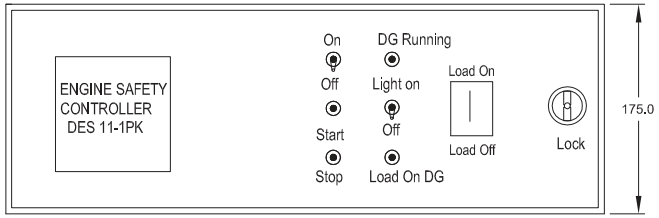
Symptom	Possible Fault	Remedy
No Charging Current	Incorrect or bad battery connections.	Check connections and clean the battery terminals
	Old or sulphated battery with very low terminal voltage	Remove the battery and charge on a specialist equipment
Charging Rate too Low	Low input voltage	Check the input supply voltage
	Loose connections	Check and tighten the connections
Charging Clamps get hot	Faulty connections to the battery terminals	Clean and remake the battery connections
	Loose screws on clamps	Clean and tighten the screws in charging
Charging rate does not taper	Old or damaged battery	Check the battery and replace if necessary

Table E7.4

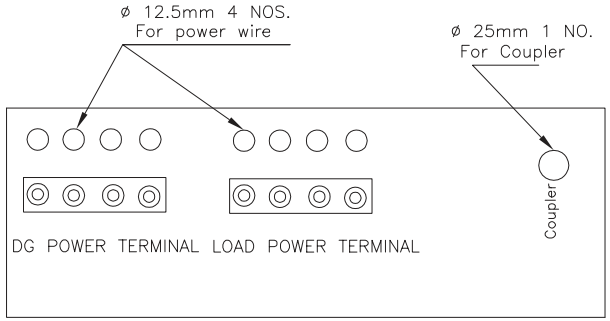
SECTION F

DRAWINGS

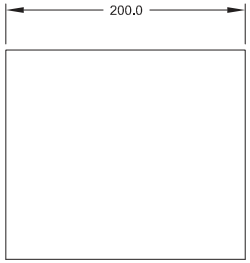




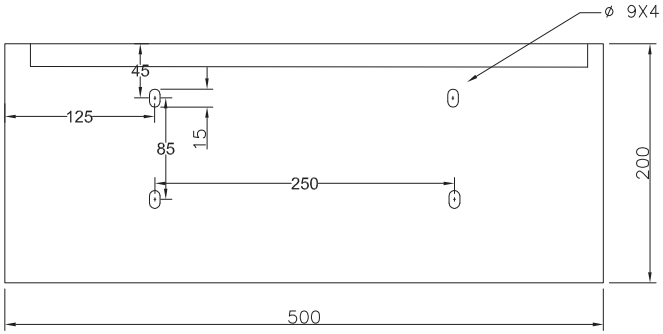
FRONT VIEW



BACK SIDE



RHS/LHS SIDE VIEW



BOTTOM VIEW

SR.NO.	KVA RATING	PART NUMBER
1	10	000207762355
2	12.5	000207762356
3	15	000207762357
4	20	000207762358
5	25	000207762359
6	30	000207762360

NOTE:
1. ALL DIMENSIONS ARE IN MM.
2. FABRICATION : 1.6mm THICK CRCA.
3. PANEL TO BE MOUNTED INSIDE CANOPY.
4. PAINT SHADE: PP SAND STONE YELLOW TEXTURE FINISH.

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0'30'	±0'20'	±0'10'	±0'5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
01	ERN:13:0129	-	MOUNTING DETAILS PROVIDED	16.11.13	-
00	ERN:13:0117	-	NEW DRAWING RELEASED	13.09.13	-

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ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

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UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–
NO BURR, SHARP EDGES PERMITED	
COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.	

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		13.09.13
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APPROVED	SAP		13.09.13
CAD REF.-			

SCALE 1:1

TITLE :

10 - 30 KVA 3 Ph. Manual Control Panel Drawing (PROCOM)

DRAWING. NO.

0 0 0 2 0 7 7 6 2 3 – –

ENGINE : "ESCORT"

SHEET 01 OF04

SIZE A3

Bill Of Material						
Sr.No.	NOM.	Item Description	Make	Rating	Qty.	Unit
1	PCE	Powder Coated Encolsure	Reputed make	500x200x175mm.	1	No.
2	ESC	Engine Safety Controller	MRM Procom	DES11-3PK-6500T	1	No.
3	RC	3 Relay Card	MRM Procom	12V DC	1	No.
4	CT	Current Transformer	Indotech/Reputed	6500T	3	No
5	TS	Toggle Switch	Gillard/Soynia/Raj/Repu.	6A	2	No
6	PBS1	Push Button Start-Green	Gillard/Soynia/Raj/Repu.	6A	1	No.
7	PBS2	Push Button Stop-Red	Gillaed/Soynia/Raj/Repu.	6A	1	No.
8	TP MCB	Three Pole MCB for Load On-Off	LS/Schneider/ABB	Refer Table A	1	No.
9	PT	Power terminal	Reputed make	63A FP	2	No.
10	CC	Coupler 10 Pin-Female without lock	Reputed	6 Amp	1	No.
11	CC	Coupler 4 Pin-Female without lock	Reputed	6 Amp	1	No.
12	CC	Coupler 4 Pin-male with lock	Reputed	6 Amp	1	No.
13	CC	Coupler 2 Pin-Female without lock	Reputed	16 Amp	1	No.
14	DL	Door Locks	Reputed	-	1	No.
15	CW	Control Wire	ESC/ECKO/Repu.	0.75sq.mm	As Req.	Meter
16	CW	Control Wire	ESC/ECKO/Repu.	2.5sq.mm	As Req.	Meter
17	PC	Power Cable	Teflon/Uniyvin/Fluflex/repu.	Refer Table A	As Req.	Meter
18	LUGS	Thimbles/Lugs	Action/Braco/Repu.	Refer Table A	As Req.	No.
19	IL	Indicating Light	Reputed.	230 VAC	2.	No.

Table-A MCB, Power Cable & Power Thimble Selection Chart			
Rating(KVA)	MCB(TP)	Power Cable(Sq. mm.)	Power Thimble(Sq. mm.)
10	16A	4.0	4.0
12.5/15	25A	4.0	4.0
20	32A	4.0	4.0
25	40A	6.0	6.0
30	63A	6.0	6.0

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768-1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5-3	3-6	6-30	30-120	120-400	400-1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0'30'	±0'20'	±0'10'	±0'5'	

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UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

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MATERIAL :

WEIGHT : --

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APPROVED	SAP		13.09.13
CAD REF.-			

SCALE NTS

TITLE :

10 - 30 KVA 3 Ph. Manual Control Panel Drawing (PROCOM)

DRAWING. NO.

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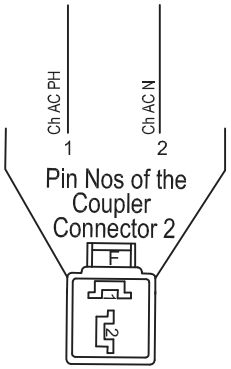
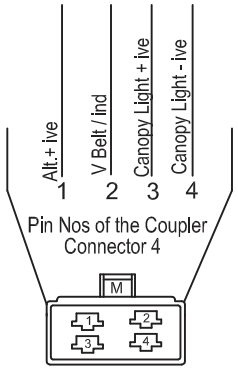
ENGINE : "ESCORT"

SHEET 04 OF04

SIZE A3



COUPLER -1



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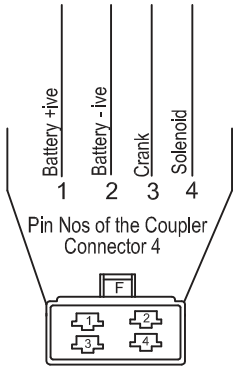
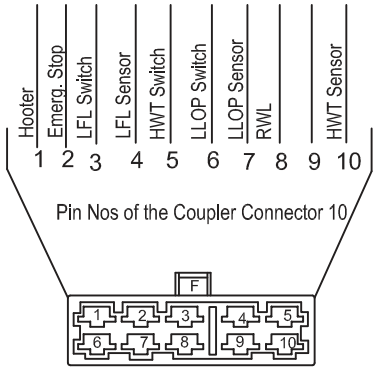


COUPLER -3



COUPLER -3

COUPLER CONNECTOR DETAIL

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
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BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
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00	ERN:13:0117	-	NEW DRAWING RELEASED	13.09.13	-

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UNDERCUT	–

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MATERIAL :

WEIGHT : --

2013	NAME	SIGN	DATE
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SCALE NTS

TITLE :

10 - 30 KVA 3 Ph. Manual Control Panel Drawing (PROCOM)

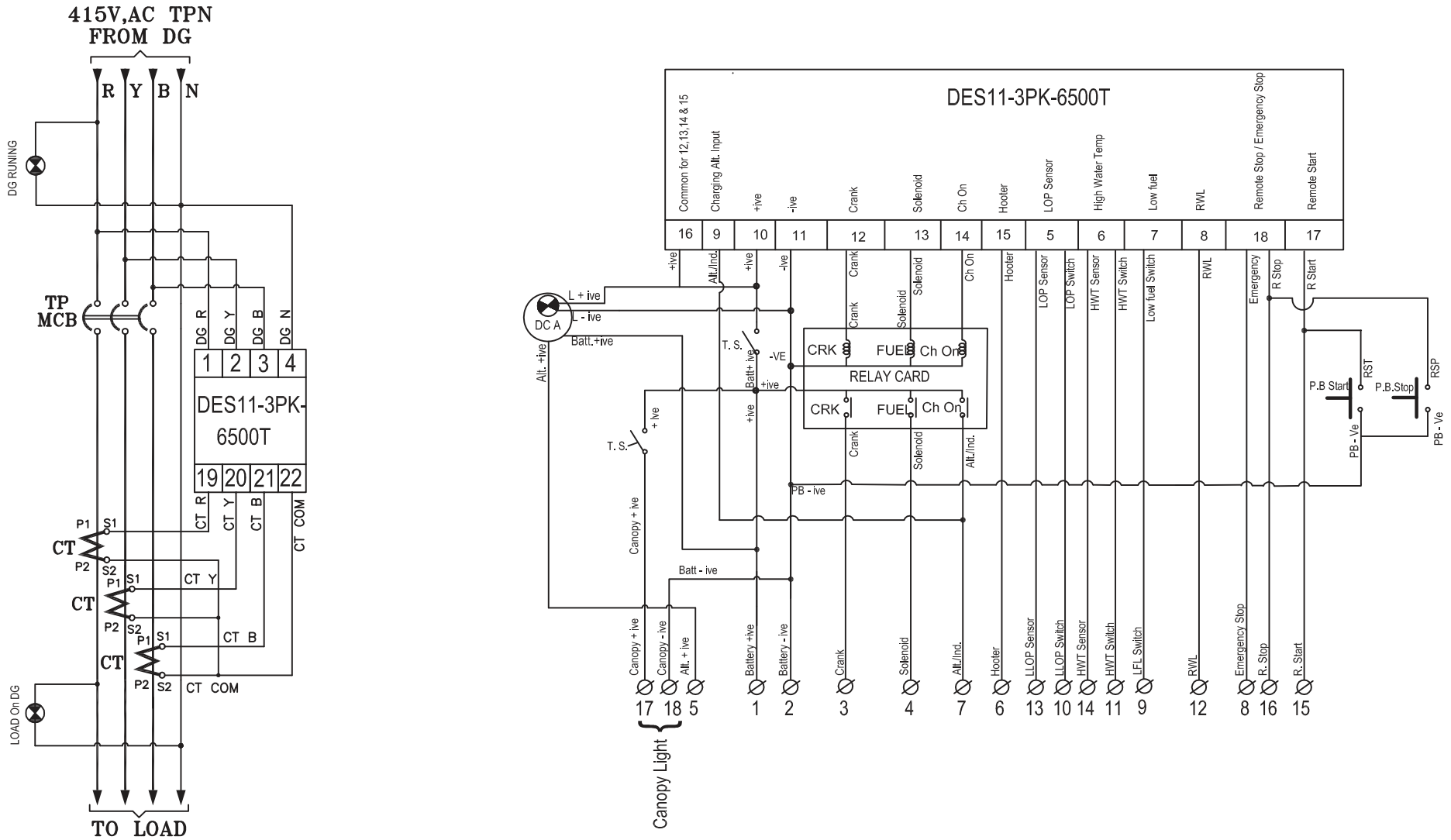
DRAWING. NO.

0 0 0 2 0 7 7 6 2 3 – –

ENGINE : "ESCORT"

SHEET 03 OF04

SIZE A3



Load R	Load Y	Load B	Neutral

POWER TERMINAL BLOCK

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
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BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
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00	ERN:13:0117	-	NEW DRAWING RELEASED	13.09.13	-

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COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL :

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		13.09.13
CHECKED	ASW		13.09.13
APPROVED	SAP		13.09.13
CAD REF.-			

SCALE
NTS

TITLE :

10 - 30 KVA 3 Ph. Manual Control
Panel Drawing (PROCOM)

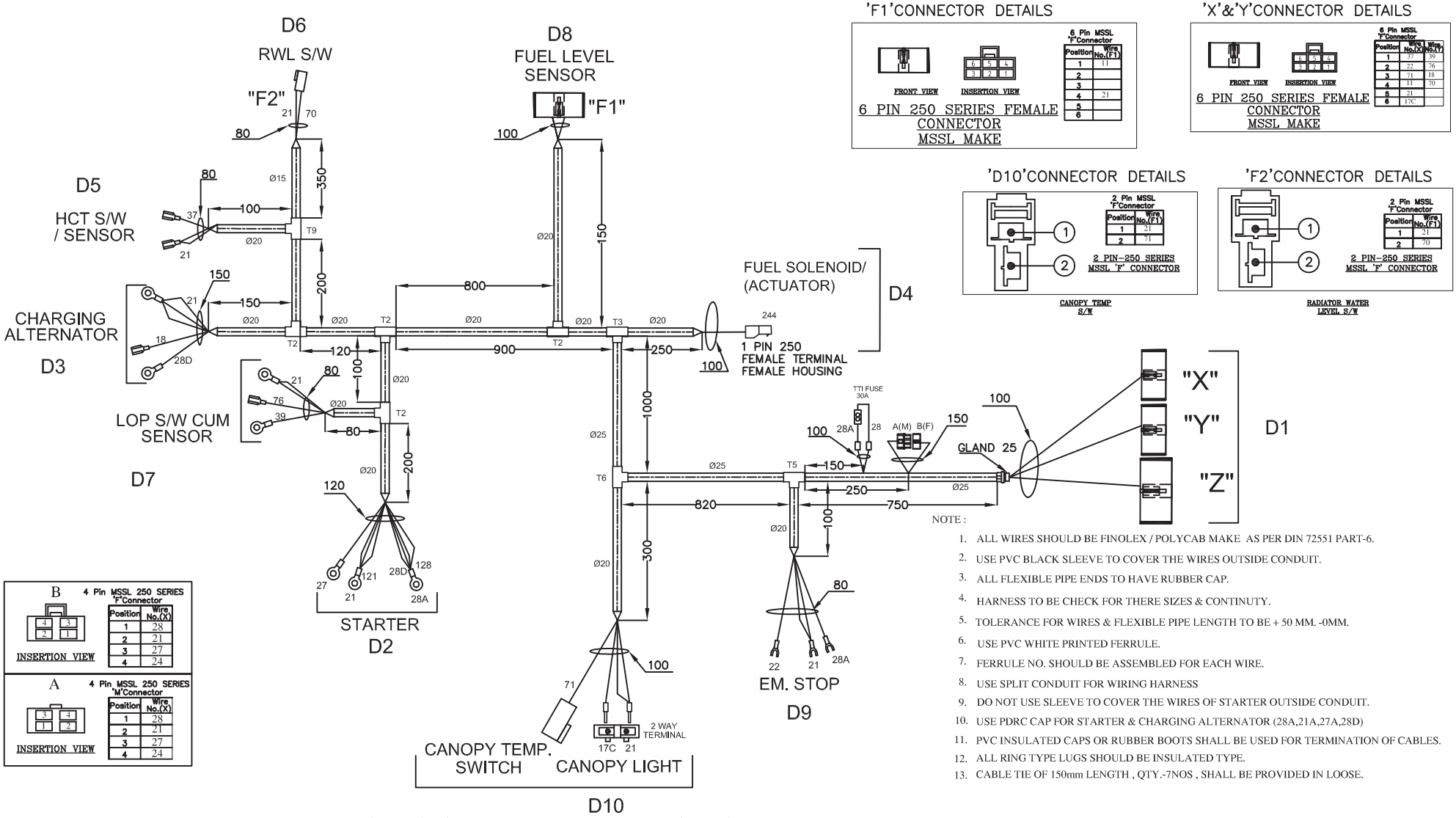
DRAWING. NO.

0 0 0 2 0 7 7 6 2 3 – –

ENGINE : "ESCORT"

SHEET 02 OF04

SIZE A3



'F1'CONNECTOR DETAILS

FRONT VIEW INSERTION VIEW

6 PIN 250 SERIES FEMALE CONNECTOR MSSL MAKE

Position	Wire No.(F1)
1	11
2	
3	
4	21
5	
6	

'X'&'Y'CONNECTOR DETAILS

FRONT VIEW INSERTION VIEW

6 PIN 250 SERIES FEMALE CONNECTOR MSSL MAKE

Position	Wire No.(X)	Wire No.(Y)
1	37	39
2	22	76
3	71	18
4	11	70
5	21	
6	17C	

'D10'CONNECTOR DETAILS

2 PIN–250 SERIES MSSL 'F' CONNECTOR

CANOPY TEMP S/W

Position	Wire No.(F1)
1	21
2	71

'F2'CONNECTOR DETAILS

2 PIN–250 SERIES MSSL 'F' CONNECTOR

RADIATOR WATER LEVEL S/W

Position	Wire No.(F1)
1	21
2	70

B 4 Pin MSSL 250 SERIES 'F'Connector

INSERTION VIEW

Position	Wire No.(X)
1	28
2	21
3	27
4	24

A 4 Pin MSSL 250 SERIES 'M'Connector

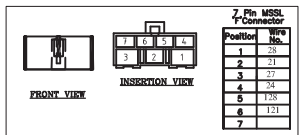
INSERTION VIEW

Position	Wire No.(X)
1	28
2	21
3	27
4	24

NOTE :

1. ALL WIRES SHOULD BE FINOLEX / POLYCAB MAKE AS PER DIN 72551 PART-6.
2. USE PVC BLACK SLEEVE TO COVER THE WIRES OUTSIDE CONDUIT.
3. ALL FLEXIBLE PIPE ENDS TO HAVE RUBBER CAP.
4. HARNESS TO BE CHECK FOR THERE SIZES & CONTINUTY.
5. TOLERANCE FOR WIRES & FLEXIBLE PIPE LENGTH TO BE + 50 MM. -0MM.
6. USE PVC WHITE PRINTED FERRULE.
7. FERRULE NO. SHOULD BE ASSEMBLED FOR EACH WIRE.
8. USE SPLIT CONDUIT FOR WIRING HARNESS
9. DO NOT USE SLEEVE TO COVER THE WIRES OF STARTER OUTSIDE CONDUIT.
10. USE PDRC CAP FOR STARTER & CHARGING ALTERNATOR (28A,21A,27A,28D)
11. PVC INSULATED CAPS OR RUBBER BOOTS SHALL BE USED FOR TERMINATION OF CABLES.
12. ALL RING TYPE LUGS SHOULD BE INSULATED TYPE.
13. CABLE TIE OF 150mm LENGTH , QTY.-7NOS , SHALL BE PROVIDED IN LOOSE.

'Z'CONNECTOR DETAILS



FRONT VIEW INSERTION VIEW

2+5 PIN HYBRID FEMALE CONNECTOR MSSL MAKE

Position	Wire No.
1	28
2	21
3	27
4	24
5	128
6	121
7	

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0'30'	±0'20'	±0'10'	±0'5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN_13:0172	-	NEW DRAWING RELEASED	09.12.13	-

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CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SBP		09.12.13
CHECKED	ASW		09.12.13
APPROVED	SAP		09.12.13
CAD REF.-			

SCALE NTS

TITLE :

10–30KVA ESCORT ENGINE HARNESS(DSE6123)

DRAWING. NO. 0 0 0 1 0 7 7 6 0 0 5 9

ENGINE : "ESCORT" SHEET 01 OF 04

SIZE A3

SR. NO.	FROM					TO					WIRE COLOUR	WIRE SIZE (sq. mm.)
	Designator	Cavity Posn	End Type Connector	Supplier	Supplier Part No.	Designator	Cavity Posn	End Type Connector	Supplier	Supplier Part No.		
1	D1	22	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D9	22	FORK LUG	3D/DOWELLS/AMP.	RSI 7926	GRAY	1.00
2	D1	11	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D8	11	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	GRAY	1.00
3	D1	17C	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D10	17C	PIN LUG	TEL MAC./AMP/LAPP	DZ5CE010	GRAY	1.00
4	D1	39	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D7	39	ROUND LUG	3D/DOWELLS/AMP.	RSI 7062	GRAY	1.00
5	D1	76	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D7	76	AUTO LUG	3D/DOWELLS/AMP.	2-520183-2	GRAY	1.00
6	D1	21	2+5PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D1	21	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	4.00
7	D1	70	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D6	70	2 PIN MALE	MSSL/TT/AMP/UVS	FEMALE PIN	GRAY	1.00
8	D5	37	AUTO LUG	AMP/T.T/LAPP	2-520183-2	D1	37	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	GRAY	1.00
9	D3	18	AUTO LUG	AMP/T.T/LAPP	2-520183-2	D1	18	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	YELLOW	1.00
10	D3	28D	ROUND LUG	3D/DOWELLS/AMP.	RSI 7094	D2	28D	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	RED	4.00
11	D4	244	1PIN 250 SERIES (FEMALE)	MSSL/EQUI.	FEMALE PINS	A	24	4 PIN CONN.(M)	MSSL/TT/AMP/UVS	MALE PIN	GRAY	4.00
12	B	24	4 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PINS	D1	24	2+5PIN CONN(F)	MSSL/TT/AMP/UVS	FEMALE PIN	GRAY	4.00
13	D2	121	ROUND LUG	3D/DOWELLS/AMP.	RS 7121	D1	121	2+5PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	1.50
14	D2	128	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D1	128	2+5PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	RED	1.50
15	D1	28	2+5PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	B	28	4 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	RED	4.00
16	A	28	4 PIN CONN.(M)	MSSL/TT/AMP/UVS	MALE PIN	D2	28A	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	RED	4.00
17	D1	21	2+5PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	B	21	4 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	4.00
18	A	21	4 PIN CONN.(M)	MSSL/TT/AMP/UVS	MALE PIN	D2	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7121	BLACK	4.00
19	D1	27	2+5PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	B	27	4 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	GRAY	4.00
20	A	27	4 PIN CONN.(M)	MSSL/TT/AMP/UVS	MALE PIN	D2	27	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	GRAY	4.00

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768-1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5-3	3-6	6-30	30-120	120-400	400-1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN_13:0172	-	NEW DRAWING RELEASED	09.12.13	-

GREAVES SINCE 1859

GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SBP		09.12.13
CHECKED	ASW		09.12.13
APPROVED	SAP		09.12.13
CAD REF.-			

SCALE NTS

TITLE :

10-30KVA ESCORT ENGINE HARNESS(DSE6123)

DRAWING. NO.

0 0 0 1 0 7 7 6 0 0 5 9

ENGINE : "ESCORT"

SHEET 02 OF 04

SIZE A3

SR. NO.	FROM					TO					WIRE COLOUR	WIRE SIZE (sq. mm.)
	Designator	Cavity Posn	End Type Connector	Supplier	Supplier Part No.	Designator	Cavity Posn	End Type Connector	Supplier	Supplier Part No.		
21	D2	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7121	D3	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	BLACK	2.50
22	D3	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	D7	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7073	BLACK	1.00
23	D3	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	D5	21	AUTO LUG	3D/DOWELLS/AMP.	3-350819-2	BLACK	1.00
24	D5	21	AUTO LUG	3D/DOWELLS/AMP.	3-350819-2	D6	21	2 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	1.00
25	D7	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7073	D8	21	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	1.00
26	D8	21	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D10	21	PIN TYPE LUG	TEL MAC./AMP/LAPP	DZ5CE025	BLACK	1.00
27	D10	21	PIN TYPE LUG	TEL.MAC/AMP/LAPP	DZ5CE025	D9	21	FORK LUG	3D/DOWELLS/AMP.	RSI 7928	BLACK	1.00
28	D10	71	2 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D1	71	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	GRAY	1.00
29	D9	21	FORK LUG	3D/DOWELLS/AMP.	RSI 7928	D10	21	2 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	1.00
30	D2	28A	LUGS	3D/DOWELLS/AMP.	RS 7030	D9	28A	LUGS	3D/DOWELLS/AMP.	RSI 7926	RED	1.0 sq.mm.

NOTE: *12. USING DSE4520 CONTROLLER, WIRE NO. 21 TO BE CONNECTED AT D9 (EM STOP) LOCATION WHEREAS 28A TO BE
INSULATED AND INSERTED BACK INTO CONDUIT.
*13. USING DSE6123 CONTROLLER, WIRE NO. 28A TO BE CONNECTED AT D9 (EM STOP) LOCATION WHERE
AS 21 TO BE INSULATED AND INSERTED BACK INTO CONDUIT.

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768-1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5-3	3-6	6-30	30-120	120-400	400-1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0'30'	±0'20'	±0'10'	±0'5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN_13:0172	-	NEW DRAWING RELEASED	09.12.13	-

GREAVES SINCE 1859
GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SBP		09.12.13
CHECKED	ASW		09.12.13
APPROVED	SAP		09.12.13
CAD REF.-			

SCALE NTS

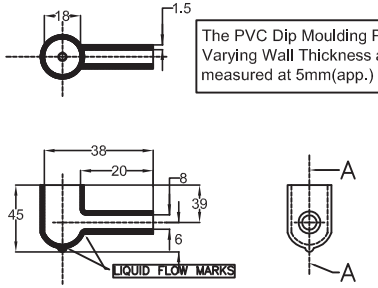
TITLE : 10-30KVA ESCORT ENGINE HARNESS(DSE6123)

DRAWING. NO. 0 0 0 1 0 7 7 6 0 0 5 9

ENGINE : "ESCORT" SHEET 03 OF 04

SIZE A3

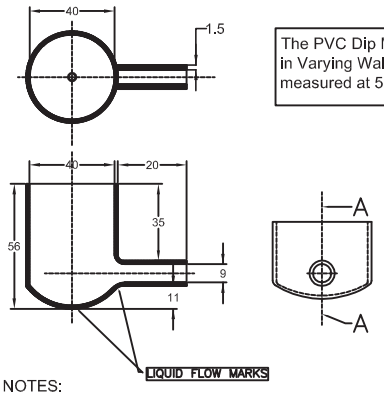
RUBBER BOOT FOR HCT SENSOR WIRE 37



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

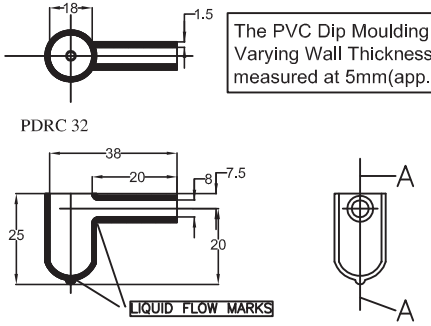
RUBBER BOOT FOR LOP SWITCH CUM SENSOR



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

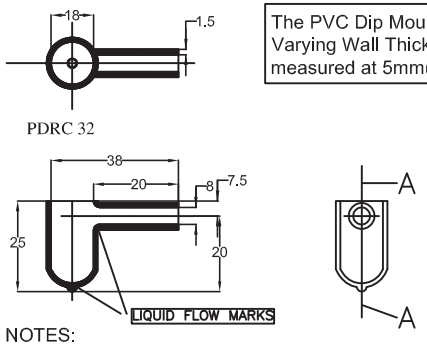
RUBBER BOOT FOR CHARGING ALT. +VE WIRE 28D & -VE WIRE 21 (i.e. 01 NO. RED & 01 NO. BLACK)



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

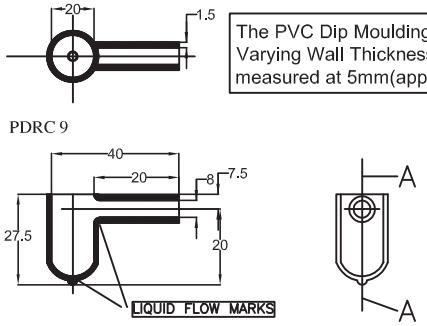
RUBBER BOOT FOR STARTER'S WIRE NO. 27



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

RUBBER BOOT FOR STARTER'S WIRE NO. 28 & 21,(i.e. 1 NO. RED COLOR & 01 NO. BLACK)



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768-1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5-3	3-6	6-30	30-120	120-400	400-1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN_13:0172	-	NEW DRAWING RELEASED	09.12.13	-

GREAVES SINCE 1859
GREAVES COTTON LTD.
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UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SBP		09.12.13
CHECKED	ASW		09.12.13
APPROVED	SAP		09.12.13
CAD REF.-			

SCALE NTS

TITLE :

10-30KVA ESCORT ENGINE HARNESS(DSE6123)

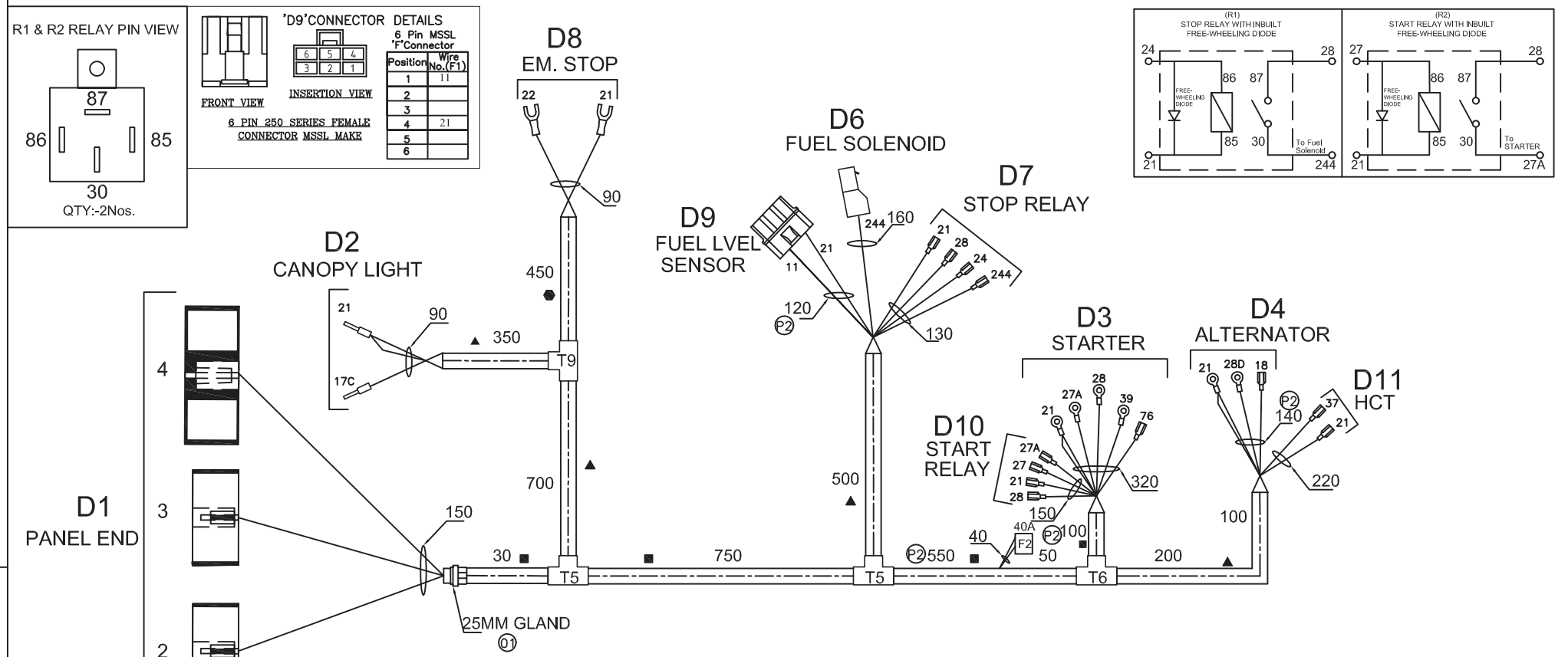
DRAWING. NO.

0 0 0 1 0 7 7 6 0 0 5 9

ENGINE : "ESCORT"

SHEET 04 OF 04

SIZE A3



COUPLER-4

1	7B	6	39
2	22	7	76
3	-	8	-
4	11	9	-
5	-	10	37

4PIN MALE CONN. A1 MAKE

COUPLER-3

1	28
2	21
3	27
4	24

2PIN MALE CONN. ULTRA WIRING MAKE

COUPLER-2

1	28D
2	18
3	17C
4	-

2PIN FEMALE CONN. ULTRA WIRING MAKE

NAME	MARK	MAT.	COLOUR	SIZE IN mm	MAKE
'T' CONNECTION	T5	PVC	BLACK	25X20X25	UNITECH
'T' CONNECTION	T9	PVC	BLACK	20X20X15	UNITECH
'T' CONNECTION	T6	PVC	BLACK	25X25X20	UNITECH
FLEX. PIPE	■	PVC	BLACK	25.0	ALOK
FLEX. PIPE	▲	PVC	BLACK	20.0	ALOK
FLEX. PIPE	⬢	PVC	BLACK	15.0	ALOK

01

NOTE :

1. ALL WIRES SHOULD BE FINOLEX / POLYCAB MAKE AS PER DIN 72551 PART-6.
2. USE PVC BLACK SLEEVE TO COVER THE WIRES OUTSIDE CONDUIT WHEREVER SPECIFY.
3. ALL FLEXIBLE PIPE ENDS TO HAVE RUBBER CAP.
4. HARNESS TO BE CHECK FOR THERE SIZES & CONTINUTY.
5. TOLERANCE FOR WIRES & FLEXIBLE PIPE LENGTH TO BE + 50 MM. -0MM.
6. USE PVC WHITE PRINTED FERRULE.
7. FERRULE NO. SHOULD BE ASSEMBLED FOR EACH WIRE.
8. USE SPLIT CONDUIT FOR WIRING HARNESS
9. DO NOT USE SLEEVE TO COVER THE WIRES OF STARTER OUTSIDE CONDUIT.
10. USE PDRC CAP FOR STARTER & CHARGING ALTERNATOR (28A,21A,27A,28D)
11. PVC INSULATED CAPS OR RUBBER BOOTS SHALL BE USED FOR TERMINATION OF CABLES.
12. CABLE TIE OF 150mm LENGTH , QTY.-7NOS , SHALL BE PROVIDED IN LOOSE.
13. RELAY WITH INBUILT FREEWHEELING DIODE 12V, BGR-210-MAKE BAGLA MAKE-2NOS. TO BE USED FOR START AND STOP RELAY.
14. WIRE NO. 28 OF RELAY R1 & R2 TO BE CONNECTED DIRECTLY FROM BATTERY.

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
P2	ECN:14:122	-	DIM 140MM WAS 120MM, 100MM WAS 50MM, DIM 120MM WAS 90MM,550MM WAS 450MM.	26.08.14	SDK
01	ECN:13:106	-	ADDED LENGTH FOR WIRES OUTSIDE CONDUIT NON INSULATED FORK LUGS REPLACED BY INSULATED. CONDUIT AND TEE SIZES ARE SHOWN.	13.08.14	SDK
00	ERN:13:0104	-	NEW DRAWING RELEASED	29.08.13	SDK

GREAVES SINCE 1859
GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

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UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		26.08.14
CHECKED	ASW		26.08.14
APPROVED	SAP		26.08.14
CAD REF.-			

SCALE NTS

TITLE : 25–30KVA PROCOM PANEL HARNESS

DRAWING. NO. 0 0 0 1 0 7 7 6 0 0 5 7

ENGINE : "ESCORT"

SHEET 01 OF 03

SIZE A3

SR. NO.	FROM						TO						WIRE COLOUR	WIRE SIZE (sq. mm.)	
	Designator	Cavity Posn	Ferrule No.	End Type Connector	Supplier	Supplier Part No.	Designator	Cavity Posn	Ferrule No.	End Type Connector	Supplier	Supplier Part No.			
1	D1–2	3	17C	4 PIN CONN.(F)	ULTRA WIRING	–	D2	–	17C	PIN TYPE	TEL MAC./AMP/LAPP	DZ5CE010	GRAY	1.00	
2	D1–2	1	28D	4 PIN CONN.(F)	ULTRA WIRING	–	D4	–	28D	ROUND LUG	3D/DOWELLS/AMP.	RSI 7094	GREEN	4.00	
3	D1–2	2	18	4 PIN CONN.(F)	ULTRA WIRING	–	D4	–	18	AUTO LUG	AMP/T.T/LAPP	2–520183–2	YELLOW	1.00	
4	D1–3	1	28	4 PIN CONN.(M)	ULTRA WIRING	–	D3	–	28	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	RED	4.00	
5	D1–3	2	21	4 PIN CONN.(M)	ULTRA WIRING	–	D3	–	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	BLACK	4.00	
6	D1–3	3	27	4 PIN CONN.(M)	ULTRA WIRING	–	D10	–	27	TTI(BGR RELAY)	–	–	GRAY	4.00	
7	D1–3	4	24	4 PIN CONN.(M)	ULTRA WIRING	–	D7	–	24	TTI(BGR RELAY)	–	–	GRAY	4.00	
8	D1–4	2	22	10 PIN CONN.(M)	A1	–	D8	–	22	FORK LUG	3D/DOWELLS/AMP.	RSI 7926	GRAY	1.00	01
9	D1–4	4	11	10 PIN CONN.(M)	A1	–	D9	1	11	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	GRAY	1.00	
10	D1–4	6	39	10 PIN CONN.(M)	A1	–	D3	–	39	ROUND LUG	3D/DOWELLS/AMP.	RSI 7062	GRAY	1.00	
11	D1–4	7	76	10 PIN CONN.(M)	A1	–	D3	–	76	AUTO LUG	AMP/T.T/LAPP	2–520183–2	GRAY	1.00	
12	D1–4	10	37	10 PIN CONN.(M)	A1	–	D11	–	37	AUTO LUG	AMP/T.T/LAPP	2–520183–2	GRAY	1.00	
13	D3	–	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D4	–	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	BLACK	4.00	
14	D3	–	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D10	–	21	TTI(BGR RELAY)	–	–	BLACK	4.00	
15	D3	–	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D7	–	21	TTI(BGR RELAY)	–	–	BLACK	4.00	
16	D7	–	21	TTI(BGR RELAY)	–	–	D9	4	21	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	1.00	
17	D9	4	21	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D2	–	21	PIN TYPE	TEL MAC./AMP/LAPP	DZ5CE010	BLACK	1.00	
18	D2	–	21	PIN TYPE	TEL MAC./AMP/LAPP	DZ5CE010	D8	–	21	FORK LUG	3D/DOWELLS/AMP.	RSI 7926	BLACK	1.00	01
19	D4	–	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	D11	–	21	AUTO LUG	AMP/T.T/LAPP	2–520183–2	BLACK	1.00	
20	D3	–	28	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D10	–	28	TTI(BGR RELAY)	–	–	GRAY	4.00	
21	D3	–	28	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D7	–	28	TTI(BGR RELAY)	–	–	GRAY	4.00	
22	D10	–	27A	TTI(BGR RELAY)	–	–	D3	–	27A	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	GRAY	4.00	
23	D7	–	244	TTI(BGR RELAY)	–	–	D6	–	244	1PIN 250 SERIES (FEMALE)	MSSL/EQUI.	FEMALE PINS	GRAY	4.00	

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
P2	ECN:14:122	-	DIM 140MM WAS 120MM, 100MM WAS 50MM, DIM 120MM WAS 90MM,550MM WAS 450MM.	26.08.14	SDK
01	ECN:13:106	-	ADDED LENGTH FOR WIRES OUTSIDE CONDUIT NON INSULATED FORK LUGS REPLACED BY INSULATED. CONDUIT AND TEE SIZES ARE SHOWN.	13.08.14	SDK
00	ERN:13:0104	-	NEW DRAWING RELEASED	29.08.13	SDK

GREAVES SINCE 1859

GREAVES COTTON LTD.

DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

SCALE: NTS

TITLE :

25–30KVA PROCOM PANEL HARNESS

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		26.08.14
CHECKED	ASW		26.08.14
APPROVED	SAP		26.08.14
CAD REF.-			

DRAWING. NO.

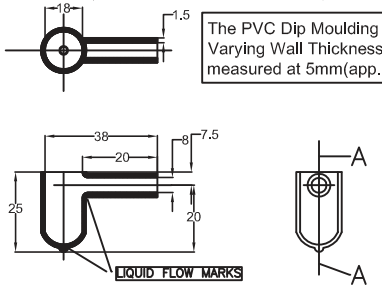
0 0 0 1 0 7 7 6 0 0 5 7

ENGINE : "ESCORT"

SHEET 02 OF 03

SIZE A3

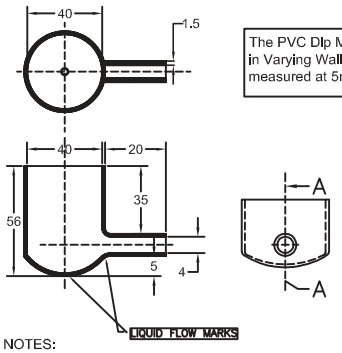
RUBBER BOOT FOR STARTER'S WIRE NO. 28 & 21,(i.e. 1 NO. RED COLOR & 01 NO. BLACK) & FOR CHARGING ALT. +VE WIRE 28D & -VE WIRE 21 (i.e. 01 NO. RED & 01 NO. BLACK)



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

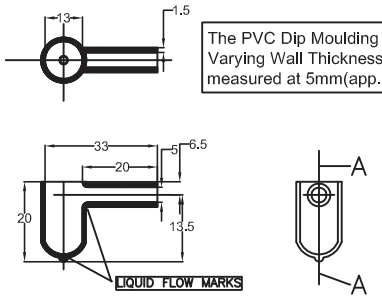
RUBBER BOOT FOR LOP SWITCH CUM SENSOR



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

RUBBER BOOT FOR STARTER'S WIRE NO. 27



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
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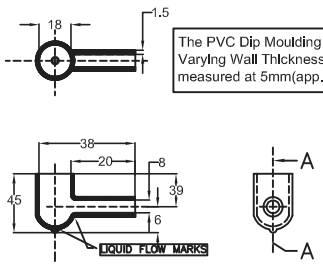
2. UNSPECIFIED TOLERANCES ±0.2mm.

RUBBER BOOT FOR HCT SENSOR WIRE 37



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0'30'	±0'20'	±0'10'	±0'5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
P2	ECN:14:122	-	DIM 140MM WAS 120MM, 100MM WAS 50MM, DIM 120MM WAS 90MM,550MM WAS 450MM.	26.08.14	SDK
01	ECN:13:106	-	ADDED LENGTH FOR WIRES OUTSIDE CONDUIT NON INSULATED FORK LUGS REPLACED BY INSULATED. CONDUIT AND TEE SIZES ARE SHOWN.	13.08.14	SDK
00	ERN:13:0104	-	NEW DRAWING RELEASED	29.08.13	SDK

GREAVES
SINCE 1859
GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

SCALE NTS

TITLE :
25–30KVA PROCOM
PANEL HARNESS

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		26.08.14
CHECKED	ASW		26.08.14
APPROVED	SAP		26.08.14
CAD REF.-			

DRAWING. NO.
0 0 0 1 0 7 7 6 0 0 5 7

ENGINE : "ESCORT"

SHEET 03 OF 03

SIZE A3

R1 & R2 RELAY PIN VIEW

QTY:-2Nos.

'D9'CONNECTOR DETAILS

6 PIN 250 SERIES FEMALE CONNECTOR MSSL MAKE

6 Pin MSSL 'F'Connector

Position	Wire No.(F1)
1	11
2	
3	
4	21
5	
6	

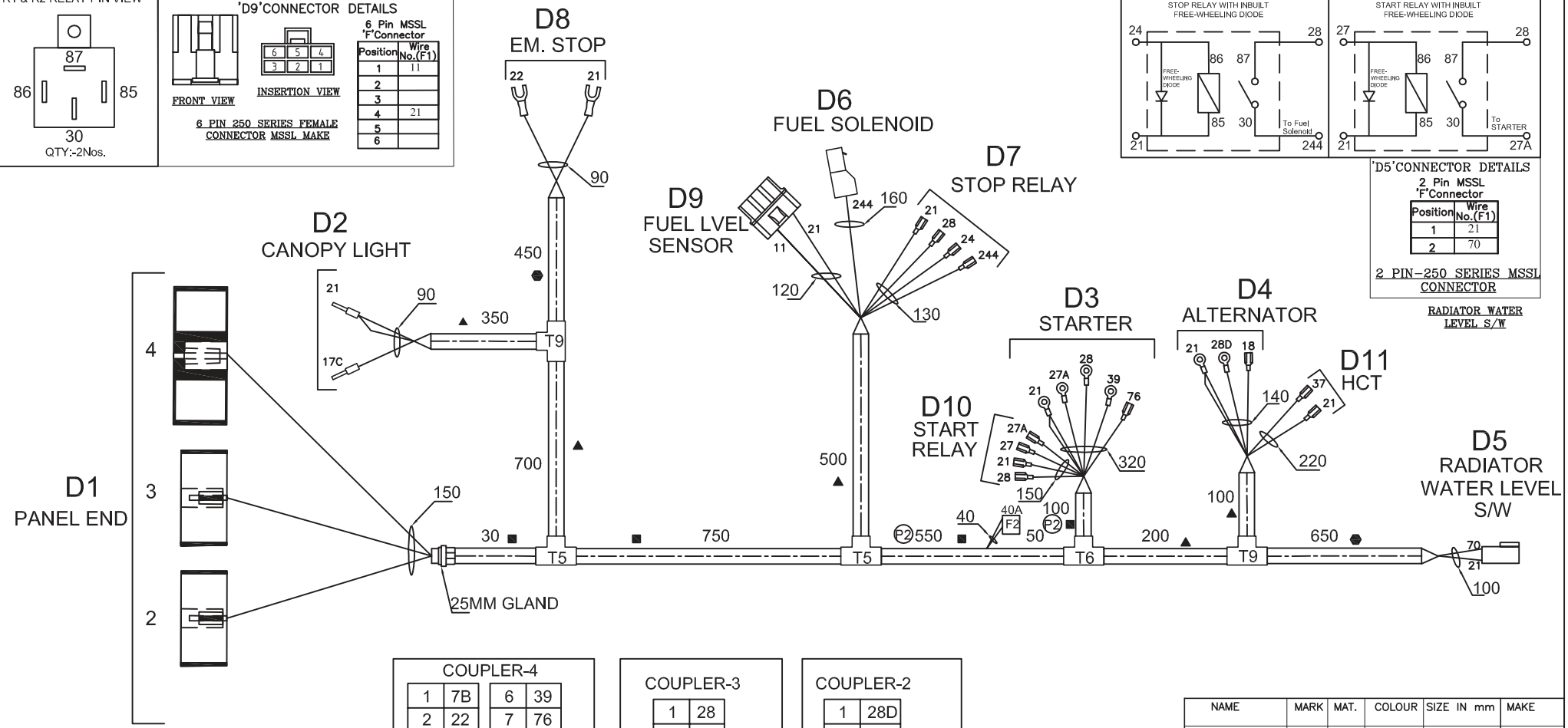
'D5'CONNECTOR DETAILS

2 Pin MSSL 'F'Connector

Position	Wire No.(F1)
1	21
2	70

2 PIN-250 SERIES MSSL CONNECTOR

RADIATOR WATER LEVEL S/W



COUPLER-4

1	7B	6	39
2	22	7	76
3	-	8	70
4	11	9	-
5	-	10	37

4PIN FEMALE CONN. A1 MAKE

COUPLER-3

1	28
2	21
3	27
4	24

2PIN MALE CONN. ULTRA WIRING MAKE

COUPLER-2

1	28D
2	18
3	17C
4	-

2PIN FEMALE CONN. ULTRA WIRING MAKE

NAME	MARK	MAT.	COLOUR	SIZE IN mm	MAKE
'T' CONNECTION	T5	PVC	BLACK	25X20X25	REPUTED
'T' CONNECTION	T9	PVC	BLACK	20X20X15	REPUTED
'T' CONNECTION	T6	PVC	BLACK	25X25X20	REPUTED
FLEX. PIPE	■	PVC	BLACK	25.0	REPUTED
FLEX. PIPE	▲	PVC	BLACK	20.0	REPUTED
FLEX. PIPE	⬢	PVC	BLACK	15.0	REPUTED

NOTE :

1. ALL WIRES SHOULD BE FINOLEX / POLYCAB/ REPUTED MAKE AS PER DIN 72551 PART-6.
2. USE PVC BLACK SLEEVE TO COVER THE WIRES OUTSIDE CONDUIT WHEREVER SPECIFY.
3. ALL FLEXIBLE PIPE ENDS TO HAVE RUBBER CAP.
4. HARNESS TO BE CHECK FOR THERE SIZES & CONTINUTY.
5. TOLERANCE FOR WIRES & FLEXIBLE PIPE LENGTH TO BE + 50 MM. -0MM.
6. USE PVC WHITE PRINTED FERRULE.
7. FERRULE NO. SHOULD BE ASSEMBLED FOR EACH WIRE.
8. USE SPLIT CONDUIT FOR WIRING HARNESS
9. DO NOT USE SLEEVE TO COVER THE WIRES OF STARTER OUTSIDE CONDUIT.
10. USE PDRC CAP FOR STARTER & CHARGING ALTERNATOR (28A,21A,27A,28D)
11. PVC INSULATED CAPS OR RUBBER BOOTS SHALL BE USED FOR TERMINATION OF CABLES.
12. CABLE TIE OF 150mm LENGTH , QTY.-7NOS , SHALL BE PROVIDED IN LOOSE.
13. RELAY WITH INBUILT FREEWHEELING DIODE 12V, BGR-210-MAKE BAGLA MAKE-2NOS. TO BE USED FOR START AND STOP RELAY.
14. WIRE NO. 28 OF RELAY R1 & R2 TO BE CONNECTED DIRECTLY FROM BATTERY.

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768-1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5-3	3-6	6-30	30-120	120-400	400-1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
P2_2	ECN:14:145		CONNECTOR -4 ,10PIN MALE CONNECTOR A1 MAKE NEEDS TO MODIFIED INTO FEMALE,STARTER I/D SIZE 21 NO.WIRE CHANGED TO 10AGAINST 8 I/D, T& FLEXIBLE PIPE MAKE CHANGED TO REPUTED	15109.14	ASW
P2_1	ECN:14:145	-	COLOUR CODING OF WIRES CHANGED	11.09.14	ASW
P2	ECN:14:122	-	DIM 140MM WAS 120MM, 100MM WAS 50MM, DIM 120MM WAS 90MM,550MM WAS 450MM.	26.08.14	SDK
01	ECN:13:106	-	ADDED LENGTH FOR WIRES OUTSIDE CONDUIT NON INSULATED FORK LUGS REPLACED BY INSULATED. CONDUIT AND TEE SIZES ARE SHOWN.	13.08.14	SDK
00	ERN:13:0104	-	NEW DRAWING RELEASED	29.08.13	SDK

GREAVES SINCE 1859

GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

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ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

SCALE NTS

TITLE :

10-20KVA PROCOM PANEL HARNESS

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		15.09.14
CHECKED	ASW		15.09.14
APPROVED	SAP		15.09.14
CAD REF.-			

DRAWING. NO.

0 0 0 1 0 7 7 6 0 0 5 6

ENGINE : "ESCORT"

SHEET 01 OF 04

SIZE A3

SR. NO.	FROM						TO						WIRE COLOUR	WIRE SIZE (sq. mm.)
	Designator	Cavity Posn	Ferrule No.	End Type Connector	Supplier	Supplier Part No.	Designator	Cavity Posn	Ferrule No.	End Type Connector	Supplier	Supplier Part No.		
1	D1–2	3	17C	4 PIN CONN.(F)	ULTRA WIRING	–	D2	–	17C	PIN TYPE	TEL MAC./AMP/LAPP	DZ5CE010	RED	1.00
2	D1–2	1	28D	4 PIN CONN.(F)	ULTRA WIRING	–	D4	–	28D	ROUND LUG	3D/DOWELLS/AMP.	RSI 7094	GREEN	4.00
3	D1–2	2	18	4 PIN CONN.(F)	ULTRA WIRING	–	D4	–	18	AUTO LUG	AMP/T.T/LAPP	2–520183–2	YELLOW	1.00
4	D1–3	1	28	4 PIN CONN.(M)	ULTRA WIRING	–	D3	–	28	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	RED	4.00
5	D1–3	2	21	4 PIN CONN.(M)	ULTRA WIRING	–	D3	–	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7032	BLACK	4.00
6	D1–3	3	27	4 PIN CONN.(M)	ULTRA WIRING	–	D10	–	27	TTI(BGR RELAY)	–	–	BLUE	4.00
7	D1–3	4	24	4 PIN CONN.(M)	ULTRA WIRING	–	D7	–	24	TTI(BGR RELAY)	–	–	YELLOW	4.00
8	D1–4	2	22	10 PIN CONN.(M)	A1	–	D8	–	22	FORK LUG	3D/DOWELLS/AMP.	RSI 7926	RED	1.00
9	D1–4	4	11	10 PIN CONN.(M)	A1	–	D9	1	11	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	WHITE	1.00
10	D1–4	6	39	10 PIN CONN.(M)	A1	–	D3	–	39	ROUND LUG	3D/DOWELLS/AMP.	RSI 7062	GREY RED	1.00
11	D1–4	7	76	10 PIN CONN.(M)	A1	–	D3	–	76	AUTO LUG	AMP/T.T/LAPP	2–520183–2	GREY BLACK	1.00
12	D1–4	8	70	10 PIN CONN.(M)	A1	–	D5	2	70	2 PIN FEMALE	MSSL/TT/AMP/UVS	FEMALE PIN	BLUE	1.00
13	D1–4	10	37	10 PIN CONN.(M)	A1	–	D11	–	37	AUTO LUG	AMP/T.T/LAPP	2–520183–2	GREY	1.00
14	D3	–	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D4	–	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	BLACK	4.00
15	D3	–	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D10	–	21	TTI(BGR RELAY)	–	–	BLACK	4.00
16	D3	–	21	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D7	–	21	TTI(BGR RELAY)	–	–	BLACK	4.00
17	D7	–	21	TTI(BGR RELAY)	–	–	D9	4	21	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	1.00
18	D9	4	21	6 PIN CONN.(F)	MSSL/TT/AMP/UVS	FEMALE PIN	D2	–	21	PIN TYPE	TEL MAC./AMP/LAPP	DZ5CE010	BLACK	1.00
19	D2	–	21	PIN TYPE	TEL MAC./AMP/LAPP	DZ5CE010	D8	–	21	FORK LUG	3D/DOWELLS/AMP.	RSI 7926	BLACK	1.00
20	D4	–	21	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	D11	–	21	AUTO LUG	AMP/T.T/LAPP	2–520183–2	BLACK	1.00
21	D11	–	21	AUTO LUG	AMP/T.T/LAPP	2–520183–2	D5	1	21	2 PIN FEMALE	MSSL/TT/AMP/UVS	FEMALE PIN	BLACK	1.00
22	D3	–	28	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D10	–	28	TTI(BGR RELAY)	–	–	RED	4.00
23	D3	–	28	ROUND LUG	3D/DOWELLS/AMP.	RS 7030	D7	–	28	TTI(BGR RELAY)	–	–	RED	4.00
24	D10	–	27A	TTI(BGR RELAY)	–	–	D3	–	27A	ROUND LUG	3D/DOWELLS/AMP.	RSI 7084	BLUE	4.00
25	D7	–	244	TTI(BGR RELAY)	–	–	D6	–	244	1PIN 250 SERIES (FEMALE)	MSSL/EQUI.	FEMALE PINS	YELLOW	4.00

NOTE:-
BRACO/JAINSON LUGS CAN BE USED
IN CASE OF NON AVAILABITY OF 3D LUGS
WHICH SHOULD BE SIMILAR TO SUPPLIER
PART DESCRIBED.

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0'30'	±0'20'	±0'10'	±0'5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
P2_2	ECN:14:145		CONNECTOR –4 ,10PIN MALE CONNECTOR A1 MAKE NEEDS TO MODIFIED INTO FEMALE.STARTER I/D SIZE 21 NO.WIRE CHANGED TO 10AGAINST 8 /D. T& FLEXIBLE PIPE MAKE CHANGED TO REPUTED	15109.14	ASW
P2_1	ECN:14:145	-	COLOUR CODING OF WIRES CHANGED	11.09.14	ASW
P2	ECN:14:122	-	DIM 140MM WAS 120MM, 100MM WAS 50MM, DIM 120MM WAS 90MM,550MM WAS 450MM.	26.08.14	SDK
01	ECN:13:106	-	ADDED LENGTH FOR WIRES OUTSIDE CONDUIT NON INSULATED FORK LUGS REPLACED BY INSULATED. CONDUIT AND TEE SIZES ARE SHOWN.	13.08.14	SDK
00	ERN:13:0104	-	NEW DRAWING RELEASED	29.08.13	SDK

GREAVES
SINCE 1859
GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

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IF IN DOUBT ASK

UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		15.09.14
CHECKED	ASW		15.09.14
APPROVED	SAP		15.09.14
CAD REF.-			

SCALE
NTS

TITLE :
10–20KVA PROCOM
PANEL HARNESS

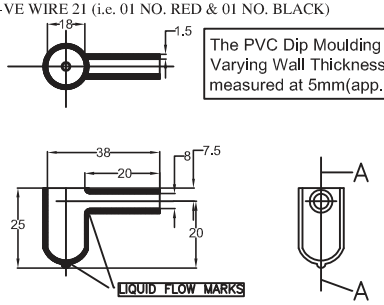
DRAWING. NO.
0 0 0 1 0 7 7 6 0 0 5 6

ENGINE : "ESCORT"

SHEET 02 OF 04

SIZE A3

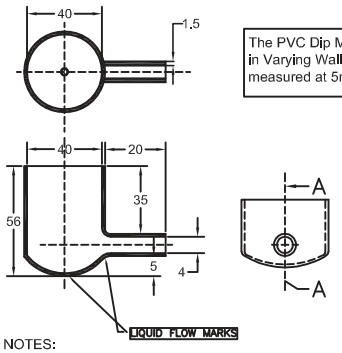
RUBBER BOOT FOR STARTER'S WIRE NO. 28 & 21,(i.e. 1 NO. RED COLOR & 01 NO. BLACK) & FOR CHARGING ALT. +VE WIRE 28D & -VE WIRE 21 (i.e. 01 NO. RED & 01 NO. BLACK)



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

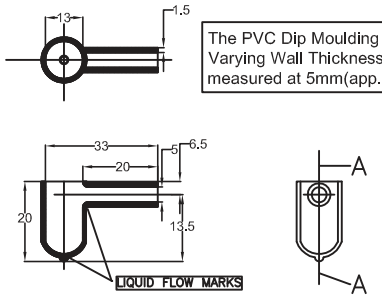
RUBBER BOOT FOR LOP SWITCH CUM SENSOR



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

RUBBER BOOT FOR STARTER'S WIRE NO. 27



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
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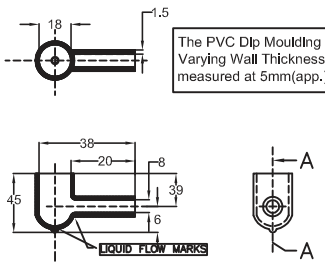
2. UNSPECIFIED TOLERANCES ±0.2mm.

RUBBER BOOT FOR HCT SENSOR WIRE 37



The PVC Dip Moulding Process Results in Varying Wall Thickness and is to de measured at 5mm(app.) from open ends.

NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. UNSPECIFIED TOLERANCES ±0.2mm.

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0'30'	±0'20'	±0'10'	±0'5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
P2_2	ECN:14:145		CONNECTOR -4 ,10PIN MALE CONNECTOR A1 MAKE NEEDS TO MODIFIED INTO FEMALE.STARTER I/D SIZE 21 NO WIRE CHANGED TO 10AGAINST 8 I/D, T& FLEXIBLE PIPE MAKE CHANGED TO REPUTED	15109.14	ASW
P2_1	ECN:14:145	-	COLOUR CODING OF WIRES CHANGED	11.09.14	ASW
P2	ECN:14:122	-	DIM 140MM WAS 120MM, 100MM WAS 50MM, DIM 120MM WAS 90MM,550MM WAS 450MM.	26.08.14	SDK
01	ECN:13:106	-	ADDED LENGTH FOR WIRES OUTSIDE CONDUIT NON INSULATED FORK LUGS REPLACED BY INSULATED. CONDUIT AND TEE SIZES ARE SHOWN.	13.08.14	SDK
00	ERN:13:0104	-	NEW DRAWING RELEASED	29.08.13	SDK

GREAVES
SINCE 1859
GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		15.09.14
CHECKED	ASW		15.09.14
APPROVED	SAP		15.09.14
CAD REF.-			

SCALE
NTS

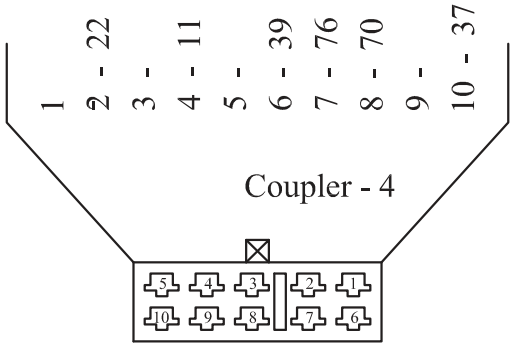
TITLE :
10–20KVA PROCOM
PANEL HARNESS

DRAWING. NO.
0 0 0 1 0 7 7 6 0 0 5 6

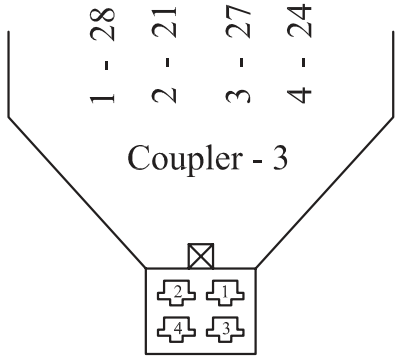
ENGINE : "ESCORT"

SHEET 03 OF 04

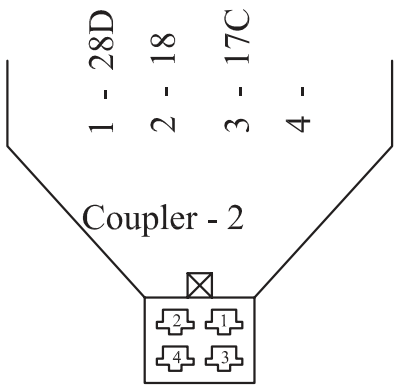
SIZE A3



10 Pin Female Connector



4 Pin Female Connector



4 Pin Male Connector

Coupler Connector Detail

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000						
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768-1:1989) MEDIUM GR.						
BASIC SIZE RANGE (IN mm)	0.5-3	3-6	6-30	30-120	120-400	400-1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8
BASIC SIZE RANGE (IN mm)	0.5 TO 3		3 TO 6		OVER 6	
DEVIATION FOR BROKEN EDGES.	±0.2		±0.5		±1	
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400	
DEVIATION FOR ANGULER DIMN.	±1°	±0'30'	±0'20'	±0'10'	±0'5'	

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
P2_2	ECN:14:145		CONNECTOR -4 ,10PIN MALE CONNECTOR A1 MAKE NEEDS TO MODIFIED INTO FEMALE.STARTER I/D SIZE 21 NO WIRE CHANGED TO 10AGAINST 8 I/D. T& FLEXIBLE PIPE MAKE CHANGED TO REPUTED	15109.14	ASW
P2_1	ECN:14:145	-	COLOUR CODING OF WIRES CHANGED	11.09.14	ASW
P2	ECN:14:122	-	DIM 140MM WAS 120MM, 100MM WAS 50MM, DIM 120MM WAS 90MM,550MM WAS 450MM.	26.08.14	SDK
01	ECN:13:106	-	ADDED LENGTH FOR WIRES OUTSIDE CONDUIT NOIN INSULATED FORK LUGS REPLACED BY INSULATED. CONDUIT AND TEE SIZES ARE SHOWN.	13.08.14	SDK
00	ERN:13:0104	-	NEW DRAWING RELEASED	29.08.13	SDK

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CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED	
RADII.	–
CHAMFER	–
UNDERCUT	–

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : --

WEIGHT : --

2013	NAME	SIGN	DATE
DRAWN	SDK		15.09.14
CHECKED	ASW		15.09.14
APPROVED	SAP		15.09.14
CAD REF.-			

SCALE NTS

TITLE :

10-20KVA PROCOM
PANEL HARNESS

DRAWING. NO.

0 0 0 1 0 7 7 6 0 0 5 6

ENGINE : "ESCORT"

SHEET 04 OF 04

SIZE A3

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN:14:092	-	NEW DRAWING RELEASED	28.06.14	SDK

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000

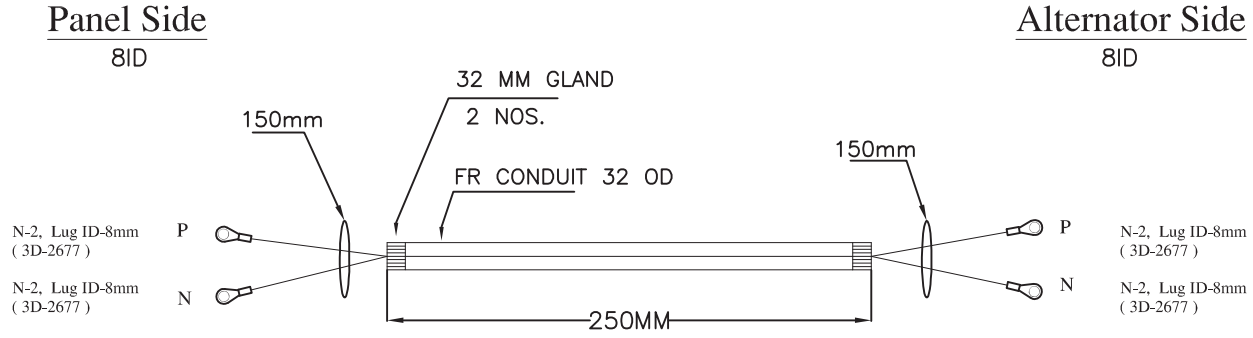
UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.

BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8

BASIC SIZE RANGE (IN mm)	0.5 TO 3	3 TO 6	OVER 6
DEVIATION FOR BROKEN EDGES.	±0.2	±0.5	±1

BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'

25-30 kVA 1PH POWER CABLE ASSEMBLY



NOTE:

1. TOLERANCE FOR Uninyvin WIRES & FR CONDUIT/FLEXIBLE PIPE LENGTH TO BE + 30MM.- 0 MM
2. USE HEAT SHRINKABLE SLEEVE ON LUG
3. ALL WIRES SHOULD BE MIRACLE MAKE
4. ALL LUGS SHOULD BE DOWELL'S/3D /EQUI MAKE
5. GLANDS ARE LOCKED USING CABLE TIE.
6. N-## >> Uninyvin Cable.
7. ALL HEAT SHRINK SLEEVE Are Length Of 50mm EACH Lug

(Phase.R=Red) (Phase.Y=Yellow) (Phase.B= Blue) (Neutral.N=Black)

Crimp Pull Load	
Cable Size	Load in Kg(Min)
N-0000,(109.0sqmm)	205, Kg
N-000, (84.2 sqmm)	159, Kg
N-00, (68.3 sqmm)	137, Kg
N-0, (53.0 sqmm)	114, Kg
N-1, (40.7 sqmm)	91, Kg
N-2, (33.3 sqmm)	82, Kg
N-4, (21.5 sqmm)	63, Kg
N-6, (13.3 sqmm)	46, Kg
N-8, (8.76 sqmm)	41, Kg
N-10, (5.33 sqmm)	37, Kg
N-12, (3.22 sqmm)	32, Kg
N-14, (2.05 sqmm)	23, Kg

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DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	— —
CHAMFER	— —
UNDERCUT	— —

MATERIAL : — —

WEIGHT : — —

2014	NAME	SIGN	DATE
DRAWN	SDK		28.06.14
CHECKED	ASW/SBP		28.06.14
APPROVED	SAP		28.06.14
CAD REF.-			

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

SCALE
NTS

TITLE :
25/30KVA 1PH POWER CABLE FOR CANOPISED GENSET–CPCB–II

DRAWING. NO.
0 0 0 2 4 7 7 6 2 1 0 3

ENGINE : "G-SERIES"

SHEET 1 OF 1

SIZE A4

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN:13:0184	–	NEW DRAWING RELEASED	13.01.14	–

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000

UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.

BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8

BASIC SIZE RANGE (IN mm)	0.5 TO 3	3 TO 6	OVER 6
DEVIATION FOR BROKEN EDGES.	±0.2	±0.5	±1

BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'

SPECIFICATION FOR POWER CABLE ASSEMBLY FOR SINGLE PHASE CANOPISED GENSET APPLICATION.

CABLE – Single core, uninyvin flexible, Copper conductor, unarmoured, 1.1KV grade
Make – Any ISI mark, refer following chart for size, length of cable.

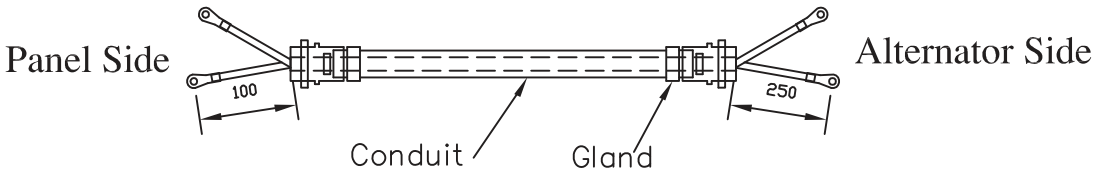
LUG'S – Lugs to be provided at both the ends of cable, refer chart for size, Make–DOWELLS/3D.

CABLE GLANDS – Compressible cable glands with Fire Retardant conduit to be provided along with the assbly, refer chart for size & type. Quantity of cable glands is two Nos per power cable assbly.

LUGS MUST BE CRIMPED & DIP SOLDERED.

NOTE:–Cable tie, Spiral of appropriate size (if required) to be supplied with cable assembly.

CABLE TIE,TIE SUPPORT, SPIRAL OF APPROPRIATE SIZE TO BE SUPPLIED WITH CABLE ASSEMBLY



kVA	FOR 1PHASES		LENGTH OF EACH CABLE	LUG Type No	Gland Size	CODE NO.
	CABLE SIZE–P/N	QTY	PHASE/NEUTRAL	PHASE/NEUTRAL		FOR ASSLY.
10	N8	01	0.8mtrs	3D–2645 (8–ID)	1"	000247762093
12.5/15	N6	01	0.8mtrs	3D–2655 (8–ID)	1"	000247762094
20	N4	01	0.8mtrs	3D–2666 (8–ID)	1"	000247762095
25–30	N2	01	0.8mtrs	3D–2677 (8–ID)	1¼"	000247762096
35	N0	01	0.8mtrs	3D–2689 (8–ID)	1¼"	000247762097

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CHINCHWAD PUNE – 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	––
CHAMFER	––
UNDERCUT	––

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : ––

WEIGHT : ––

2014	NAME	SIGN	DATE
DRAWN	SDK		12.01.14
CHECKED	ASW		12.01.14
APPROVED	SAP		12.01.14
CAD REF.–			

SCALE NTS

TITLE :
ESCORT 1PH POWER CABLE ASSLY–ESCORT

DRAWING. NO.
0 0 0 2 4 7 7 6 2 0 –

ENGINE :"ESCORT"

SHEET 1 OF 1

SIZE A4

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN:13:0184	–	NEW DRAWING RELEASED	13.01.14	–
P2	ECN:14:122	–	P2 RELEASE	26.08.14	SDK

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000

UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.

BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8

BASIC SIZE RANGE (IN mm)	0.5 TO 3	3 TO 6	OVER 6
DEVIATION FOR BROKEN EDGES.	±0.2	±0.5	±1

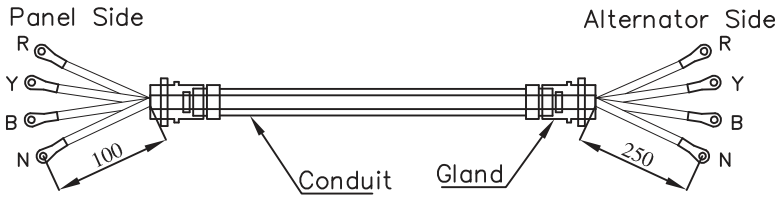
BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'

SPECIFICATION FOR UNINYVIN CABLE ASSEMBLY FOR THREE PHASE CANOPISED GENSET APPLICATION.

CABLE – Miracle NYVIN cables are single Core, Annealed Tinned Copper Conductor, Heat Resistance 1050C Poly Vinyl Chloride (HR–PVC)insulation cables with Fiber Glass, Nylon Braided Nylon Lacquering.
Make – MIRACLE CABLES, refer following chart for size, length of cable.

LUG'S – Lugs to be provided at both the ends of cable, refer chart for size, Make–DOWELLS/3D.

CABLE GLANDS – Compressible cable glands with Fire Retardant conduit to be provided along with the assbly, refer chart for size & type. Quantity of cable glands is two Nos per power cable assbly.



kVA	FOR 3PHASES		FOR NEUTRAL		LENGTH OF EACH CABLE		LUG Type No		Gland Size	CODE NO. FOR ASSLY.
	CABLE SIZE	QTY	CABLE SIZE	QTY	PHASE	NEUTRAL	PHASE	NEUTRAL		
10	N16	03	N18	01	0.8mtrs	0.8Mtr	3D–2629 (8–ID)	3D–2629 (8–ID)	1"	000247762089
12.5/15	N16	03	N18	01	0.8mtrs	0.8Mtr	3D–2629 (8–ID)	3D–2629 (8–ID)	1"	000247762090
20	N12	03	N16	01	0.8mtrs	0.8Mtr	3D–2633 (8–ID)	3D–2629 (8–ID)	1"	000247762091
25–30	N10	03	N14	01	0.8mtrs	0.8Mtr	3D–2637 (8–ID)	3D–2629 (8–ID)	1"	000247762092

NOTE: –
CABLE TIE,TIE SUPPORT, SPIRAL OF APPROPRIATE SIZE TO BE SUPPLIED WITH CABLE ASSEMBLY

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CHINCHWAD PUNE – 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	––
CHAMFER	––
UNDERCUT	––

MATERIAL : ––

WEIGHT : ––

2014	NAME	SIGN	DATE
DRAWN	SDK		26.08.14
CHECKED	ASW		26.08.14
APPROVED	SAP		26.08.14
CAD REF.–			

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

SCALE NTS

TITLE : POWER CABLE ASSLY 3PH–ESCORT–ENGINE

DRAWING. NO. 0 0 0 2 4 7 7 6 2 0 – –

ENGINE :"ESCORT"

SHEET 1 OF 1

SIZE A4

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN:14:001	-	NEW DRAWING RELEASED	01.01.14	SDK
01	ECN:14:037	-	LENGTH 150 WAS 200 & 250 WAS 200MM.	12.04.14	SDK
02	ECN:14:086	-	PANEL SIDE NEUTRAL WIRE LUG CHANGED FROM PIN TYPE TO RING TYPE TOTAL LENGTH OF CABLE NOW 1600MM	17.07.14	ASW

REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000

UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.

BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8

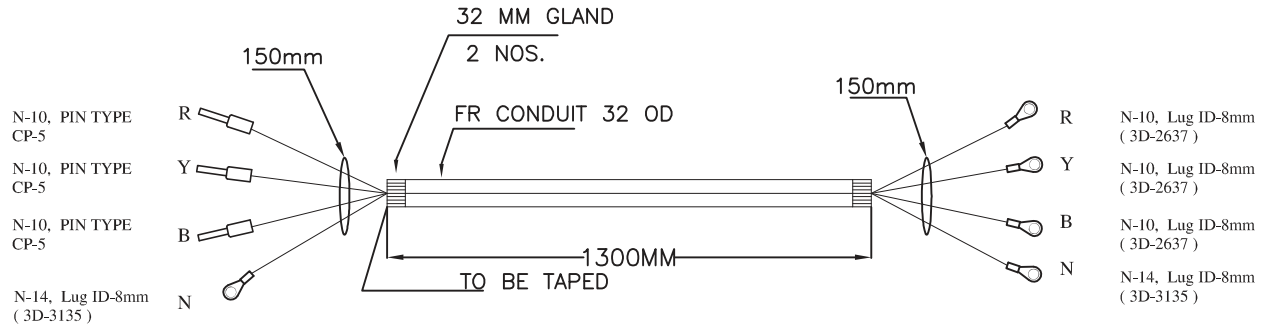
BASIC SIZE RANGE (IN mm)	0.5 TO 3	3 TO 6	OVER 6
DEVIATION FOR BROKEN EDGES.	±0.2	±0.5	±1

BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'

25-30 Kva POWER CABLE ASSEMBLY

Panel Side

Alternator Side



NOTE:

TOLERANCE FOR Uninyvin WIRES & FR CONDUIT/FLEXIBLE PIPE LENGTH TO BE + 30MM.- 0 MM

2. USE HEAT SHRINKABLE SLEEVE ON LUG
3. ALL WIRES SHOULD BE MIRACLE MAKE
4. ALL LUGS SHOULD BE DOWELL'S/3D /EQUI MAKE
5. GLANDS ARE LOCKED USING CABLE TIE.
6. N-## >> Uninyvin Cable.
7. ALL HEAT SHRINK SLEEVE Are Length Of 50mm EACH Lug

(Phase.R=Red) (Phase.Y=Yellow) (Phase.B= Blue) (Neutral.N=Black)

Crimp Pull Load	
Cable Size	Load in Kg(Min)
N-0000,(109.0sqmm)	205, Kg
N-000, (84.2 sqmm)	159, Kg
N-00, (68.3 sqmm)	137, Kg
N-0, (53.0 sqmm)	114, Kg
N-1, (40.7 sqmm)	91, Kg
N-2, (33.3 sqmm)	82, Kg
N-4, (21.5 sqmm)	63, Kg
N-6, (13.3 sqmm)	46, Kg
N-8, (8.76 sqmm)	41, Kg
N-10, (5.33 sqmm)	37, Kg
N-12, (3.22 sqmm)	32, Kg
N-14, (2.05 sqmm)	23, Kg

GREAVES SINCE 1859

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CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	— —
CHAMFER	— —
UNDERCUT	— —

MATERIAL : — —

WEIGHT : — —

year	NAME	SIGN	DATE
DRAWN	ASW		17.07.14
CHECKED	ASW		17.07.14
APPROVED	SAP		17.07.14
CAD REF.-			

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

SCALE NTS

TITLE : 25–30KVA POWER CABLE FOR CANOPISED GENSET

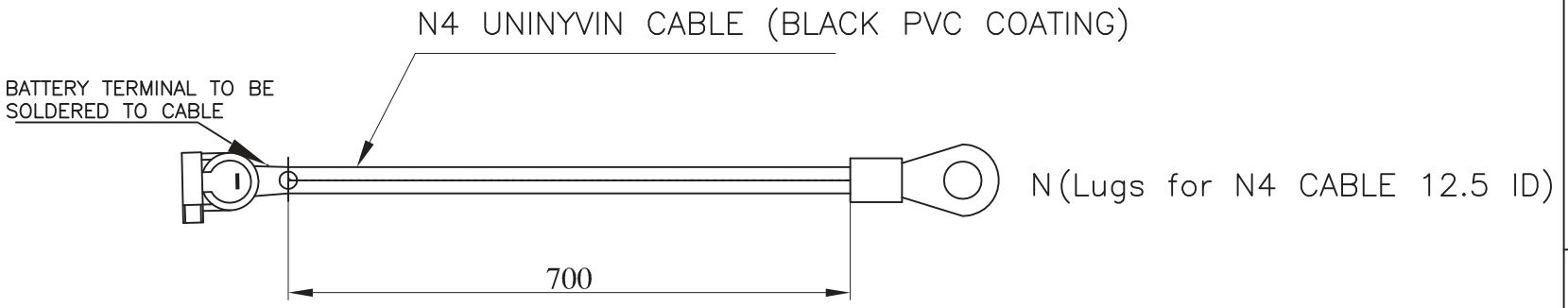
DRAWING. NO. 0 0 0 2 4 7 7 6 2 0 8 1

ENGINE : "G-SERIES"

SHEET 1 OF 1

SIZE A4

CODE NO 0 0 0 2 0 7 5 3 0 3 1 7 SHEET 1 OF 1



NOTE:

1) WIRES SHOULD BE UNINYVIN CABLE MAKE .
2) USE HEAT SHRINKABLE BLACK SLEEVE ON LUG.
3) USE PVC CAPS ON BATTERY TERMINALS FOR +VE & −VE.
4) TOLERENCE FOR CABLE LENGTH +10/−0MM
5) ALL LUGS SHOULD BE DOWELLS / 3D MAKE.

ALL DIMENSIONS IN MILLIMETERS

THIRD ANGLE PROJECTION

		DATE	INITIAL
W.O.NO			
DATE			
BIN NO		DRN	25/08 SBP
GENERAL TOLERANCE 0.015 (0.38 mm) SHAFT − 0.015" (0.38 mm) BORE + 0.015" (0.38 mm)		CHD	25/08 ASW
		APPR	25/08 SAP
		SCALE	NTS

APPROX. WT KGS

ALTERATION	APPR	ZONE	ISSUE	DATE	ECN No.	DCN No.
P2 RELEASE			P2	25.08.14	ECN:14:120	
NEW DRAWING RELEASED			00	11.01.13	ERN:13:0182	

COMPO NO — ENGINE --- — OP NO

COMPO DESCRIPTION — NO. OFF PER

DEBURR AND REMOVE SHARP CORNERS

GREAVES SINCE 1859

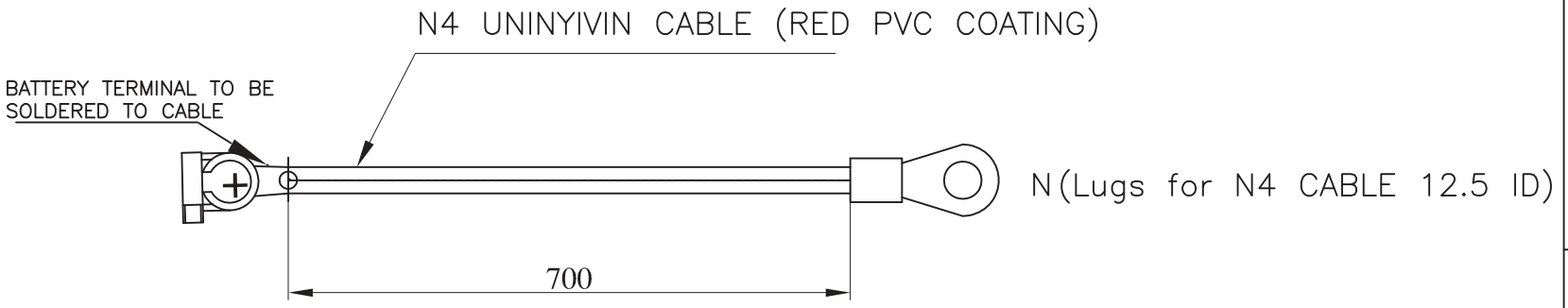
GREAVES COTTON LIMITED
DIESEL ENGINES UNIT
CHINCHWAD PUNE − 411019

DRG DESCRIPTION
NEGATIVE BATTERY CABLE FOR UNINYVIN CABLE

SHEET 1 OF 1 CODE NO 0 0 0 2 0 7 5 3 0 3 1 7

WS7/D:USER/ELECTRICAL/00020753

CODE NO 0 0 0 2 0 7 5 3 0 3 1 6 SHEET 1 OF 1



NOTE:

1) WIRES SHOULD BE UNINYVIN CABLE MAKE .
2) USE HEAT SHRINKABLE SLEEVE RED ON LUG.
3) USE PVC CAPS ON BATTERY TERMINALS FOR +VE & −VE.
4) TOLERENCE FOR CABLE LENGTH +10/−0MM
5) ALL LUGS SHOULD BE DOWELLS / 3D MAKE.

ALL DIMENSIONS IN MILLIMETERS

THIRD ANGLE PROJECTION

		DATE	INITIAL
W.O.NO			
DATE			
BIN NO			
GENERAL TOLERANCE 0.015 (0.38 mm) SHAFT − 0.015" (0.38 mm) BORE + 0.015" (0.38 mm)	DRN	25/08	SBP
	CHD	25/08	ASW
	APPR	25/08	SAP
	SCALE	NTS	

APPROX. WT KGS

ALTERATION	APPR	ZONE	ISSUE	DATE	ECN No.	DCN No.
P2 RELEASE			P2	25.08.14	ECN:14:120	
NEW DRAWING RELEASED			00	11.01.13	ERN:13:0182	

COMPO NO — ENGINE --- — OP NO

COMPO DESCRIPTION — NO. OFF PER

DEBURR AND REMOVE SHARP CORNERS

GREAVES SINCE 1859

GREAVES COTTON LIMITED
DIESEL ENGINES UNIT
CHINCHWAD PUNE − 411019

DRG DESCRIPTION
POSITIVE BATTERY CABLE FOR USING UNINYVIN CABLE

SHEET 1 OF 1 CODE NO 0 0 0 2 0 7 5 3 0 3 1 6

WS7/D:USER/ELECTRICAL/00020753

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN:14:046	-	NEW DRAWING RELEASED	11.03.14	SDK
01	ECN:14:053	-	ADDED PART NOS. 141190771047,57,67,77.	24.04.14	SDK
P2	ECN:14:120	-	P2 RELEASE	25.08.14	SDK

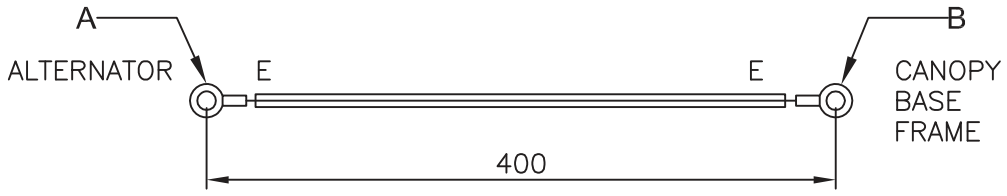
REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000

UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768-1:1989) MEDIUM GR.

BASIC SIZE RANGE (IN mm)	0.5-3	3-6	6-30	30-120	120-400	400-1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8

BASIC SIZE RANGE (IN mm)	0.5 TO 3	3 TO 6	OVER 6
DEVIATION FOR BROKEN EDGES.	±0.2	±0.5	±1

BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'



CP TO BASE FRAME	TERMINAL A	TERMINAL B	TERMINAL MAKE	WIRE SIZE	WIRE MAKE	PART NO.
10KVA-100KVA	M12	M12	3D/DOWELL'S	N6	UNINYVIN	141190771047
125KVA	M12	M12	3D/DOWELL'S	N4	UNINYVIN	141190771057
160 / 180 / 200KVA	M12	M12	3D/DOWELL'S	N0	UNINYVIN	141190771067
250KVA	M12	M12	3D/DOWELL'S	N0	UNINYVIN	141190771067
320KVA	M12	M12	3D/DOWELL'S	N00	UNINYVIN	141190771077
380 / 400 / 500KVA	M12	M12	3D/DOWELL'S	N000	UNINYVIN	141190770957

GREAVES
SINCE 1859

GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	— —
CHAMFER	— —
UNDERCUT	— —

MATERIAL : — —

WEIGHT : — —

	NAME	SIGN	DATE
DRAWN			
CHECKED			
APPROVED			
CAD REF.-			

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

SCALE
NTS

TITLE :

ALTERNATOR TO CANOPY BASE FRAME EARTH LINK

DRAWING. NO.

1 4 1 1 9 0 7 7 — — — —

ENGINE :

SHEET 1 OF 1

SIZE A4

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN:14:046	-	NEW DRAWING RELEASED	11.03.14	SDK
P2	ECN:14:120	-	P2 RELEASE	25.08.14	SDK

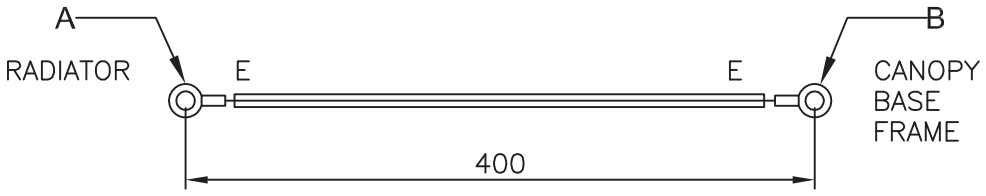
REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000

UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768-1:1989) MEDIUM GR.

BASIC SIZE RANGE (IN mm)	0.5-3	3-6	6-30	30-120	120-400	400-1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8

BASIC SIZE RANGE (IN mm)	0.5 TO 3	3 TO 6	OVER 6
DEVIATION FOR BROKEN EDGES.	±0.2	±0.5	±1

BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'



RADIATOR TO BASE FRAME	TERMINAL A & B	MAKE	WIRE SIZE
	M12	UNINYVIN	N12

GREAVES
SINCE 1859

GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

UNMENTIONED

RADII.	— —
CHAMFER	— —
UNDERCUT	— —

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

MATERIAL : — —

WEIGHT : — —

	NAME	SIGN	DATE
DRAWN	SDK		25.08.14
CHECKED	ASW		25.08.14
APPROVED	SAP		25.08.14
CAD REF.-			

SCALE
NTS

TITLE :
RADIATORTO CANOPY BASE FRAME
EARTH LINK

DRAWING. NO.
1 4 1 1 9 0 7 7 0 9 4 7

ENGINE :- --

SHEET 1 OF 1

SIZE A4

INDICE	ECN NO.	ZONE	DESCRIPTION	DATE	SIGN
00	ERN:14:046	–	NEW DRAWING RELEASED	11.03.14	SDK
01	ECN:14:053	–	ADDED PART NOS. 141190771087 & 1097	24.04.14	SDK
P2	ECN:14:120	–	P2 RELEASE	25.08.14	SDK

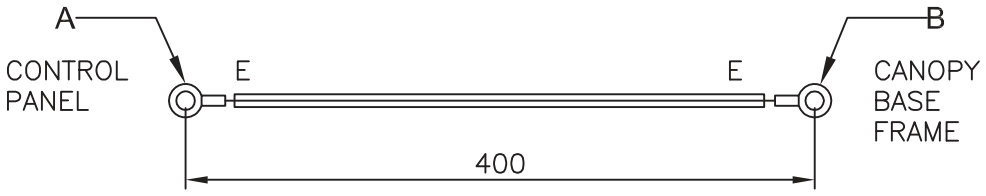
REFERANCE DRAWING & TOLERANCING STDS. BIS 696 & BIS 8000

UNMENTIONED TOLERANCES (BIS 2102:1993/ISO 2768–1:1989) MEDIUM GR.

BASIC SIZE RANGE (IN mm)	0.5–3	3–6	6–30	30–120	120–400	400–1000
DEVIATION IN LINER DIMN.	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8

BASIC SIZE RANGE (IN mm)	0.5 TO 3	3 TO 6	OVER 6
DEVIATION FOR BROKEN EDGES.	±0.2	±0.5	±1

BASIC SIZE RANGE (IN mm)	UP TO 10	10 TO 50	50 TO 120	120 TO 400	OVER 400
DEVIATION FOR ANGULER DIMN.	±1°	±0°30'	±0°20'	±0°10'	±0°5'



CP TO BASE FRAME	TERMINAL A	TERMINAL B	TERMINAL MAKE	WIRE SIZE	WIRE MAKE	PART NO.
10-40KVA	M6	M12	3D/DOWELL'S	N12	UNINYVIN	141190771087
45 / 50 / 62.5 / 75 / 82.5 / 100 / 125KVA	M8	M12	3D/DOWELL'S	N12	UNINYVIN	141190771097
160 / 180 / 200/ 250 / 320 / 380 / 400KVA	M8	M12	3D/DOWELL'S	N12	UNINYVIN	141190771097
500KVA	M10	M12	3D/DOWELL'S	N12	UNINYVIN	141190770937

GREAVES
SINCE 1859

GREAVES COTTON LTD.
DIESEL ENGINES UNIT
CHINCHWAD PUNE - 411019

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED

IF IN DOUBT ASK

MATERIAL : ––

WEIGHT : ––

UNMENTIONED

RADII.	––
CHAMFER	––
UNDERCUT	––

	NAME	SIGN	DATE
DRAWN	SDK		25.08.14
CHECKED	ASW		25.08.14
APPROVED	SAP		25.08.14
CAD REF.-			

NO BURR, SHARP EDGES PERMITED

COMPONENT TO BE APPROPRIATELY PACKED FOR PROTECTION AGAINST CORROSION AND TRANPORTATION, HANDLING, STORAGE DAMAGE.

SCALE
NTS

TITLE :
CONTROL PANEL TO CANOPY BASE FRAME EARTH LINK

DRAWING. NO.
1 4 1 1 9 0 7 7 – – – –

ENGINE :- --

SHEET 1 OF 1

SIZE A4

GREAVES POWER

NEW GENERATION POWER SOLUTIONS

Greaves Cotton Limited
Auxiliary Power Business
Chinchwad, Pune - 411 033. Tel: 020 - 67308200 Fax: 020 - 27472276
Email: enquiry.apb@greavescotton.com; sales.APB@greavescotton.com
Website: www.greavescotton.com

Corporate Office: Industry Manor, Appasaheb Marathe Marg, Prabhadevi, Mumbai - 400 025 | Tel: (91-22) 24307575 | Fax: (91-22) 24379555

NORTH : Regional Office - New Delhi: Tel: 91-11-23730554 | **Branch Offices - Chandigarh:** Tel: 91-172-2630368, **Lucknow:** Tel: 91 522 2202900, **Jaipur:** Tel: 91-141-2379583

SOUTH: Regional Office - Chennai: Tel: 91-44-22304000 | **Branch Offices - Hyderabad:** Tel: 91-40-23314037, **Bangalore:** Tel: 91 80 22261501, **Coimbatore:** Tel: 91-422-2543570, **Kochi:** Tel: 91-484-2359035

EAST : Regional Office - Kolkata: Tel: 91-33-40030912| **Branch Offices - Patna:** 91-612-2320154, **Ranchi:** Tel: 91-651-2360315, **Guwahati:** 91-361-2735426, **Bhubaneshwar:** 0674-2564579

WEST : Regional Office - Mumbai: Tel: 91-22-25264646 | **Branch Offices - Mumbai:** Tel: 91-22-25264646, **Ahmedabad:** Tel: 91-79-26582861, **Nagpur:** Tel: 91-712-2423991, **Bhopal:** Tel: 91-755-2551396, **Indore:** Mob: 91-9303922244