User and maintenance manual for generating sets

R230U

33504078701NE_0_1

CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

If this product contains a gasoline engine

WARNING

The engine from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm

The state of California requires the above two warnings.

1. Preface

1.1. General recommendations

Thank you for choosing an electrical generating set from our company.

This manual has been designed to help you operate and maintain your electrical generating set correctly.
The information contained in this manual is taken from technical data available at the time of print. In line with our policy of continually improving the quality of our products, this information may be amended without warning.

Read the safety instructions attentively in order to prevent any accidents, faults or damage. These instructions must always be followed.

You are likely to encounter several warning symbols in this manual.

 Danger	This symbol indicates an immediate danger to human health and life in case of exposure. Failure to follow the corresponding advice entails serious consequences for human health and life in case of exposure.

 Warning	This symbol draws attention to the potential risks to human health and life in case of exposure. Failure to follow the corresponding advice entails serious consequences for human health and life in case of exposure.

 Important	This symbol indicates a dangerous situation if the warning is not heeded. Failure to follow the corresponding advice risks resulting in minor injury of personnel or damage to any other object in case of exposure.

In order to obtain optimum efficiency and the longest possible life for the electrical generating sets, maintenance operations must be carried out according to the periods indicated in the attached preventative maintenance tables. If the electrical generating set is used under dusty or unfavourable conditions, some of these periods will be shorter.

Ensure that all repairs and adjustments are carried out by personnel who have received appropriate training. Dealers have this qualification, and can answer all of your questions. They can also supply you with spare parts and other services.

The left and right sides can be seen from the back of the electrical generating set (the radiator is at the front).

Our electrical generating sets have been designed so that damaged or worn parts can be replaced by new or reconditioned parts thereby reducing the out of action period to a minimum.
For any replacement of parts, contact your nearest dealer for our company who will have the necessary equipment and can offer properly trained and informed staff to carry out maintenance, parts replacement and even total reconditioning of generating sets.

Contact your local dealer for the available repair manuals and to make the necessary arrangements for training personnel in implementation and maintenance.

 Important	Some user and maintenance manuals for the engines fitted to generating sets cover control units and include the start-up and shutdown procedures for the engines. As the generating sets are fitted with control units that are specific to the generating sets, only the information that appears in the documentation for the generating sets' control units should be taken into consideration. In addition, according to the manufacturing criteria of the generating sets, some engines may be fitted with specific electrical wiring different to that described in the engine documentation.

1.2. Pictograms and their meanings

Safety notices are clearly mounted on the equipment to draw the operator's or maintenance technician's attention to the potential dangers and explain the action to be taken in the interest of safety. These notices are reproduced in this publication for ease of identification by the operator.
Replace any notice that is missing or illegible.

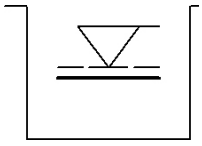
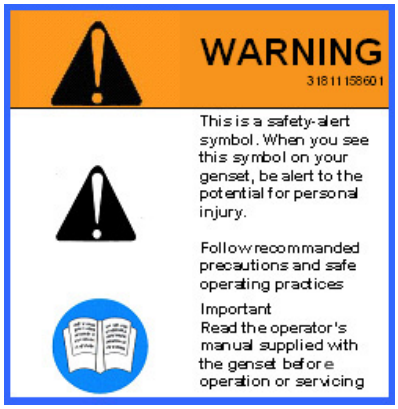
 Caution: danger	 Publications delivered with the generating set must be referred to	 Caution: risk of explosion
 Caution: risk of electric shock	 Protective clothing must be worn	 Naked flames and unprotected lights prohibited. No smoking
 Caution: toxic materials	 Eyes and ears must be protected	 Entry prohibited to non-authorised persons
 Caution: pressurised fluids	 Periodic maintenance must be carried out	 Jet washing prohibited
 Caution: high temperature, risk of burns	 Battery level must be checked	 Earth
 Caution: rotating or moving parts (risk of getting caught in the machinery)	 Lifting point must be used	 Caution: corrosive product
 Fork pockets for lifting	 Retention tank level high	
 ① ②	① Important: refer to the documentation accompanying the generating set. ② Important: emission of toxic exhaust gases. Do not use in a confined or badly ventilated area.	

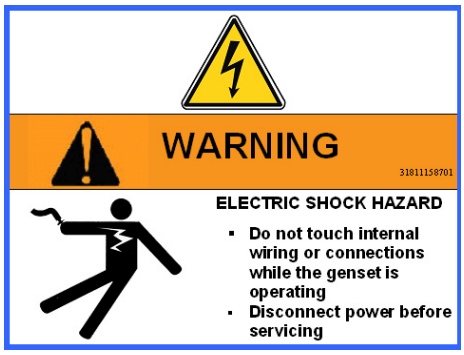
Figure 1.1 : Pictograms and their meanings



WARNING: DANGER

This symbol warns of a safety hazard. The presence of this symbol indicates a risk of injury.
Observe the safety instructions and precautions for use.

Important:
Carefully read the instructions supplied with the generating set before using or servicing the equipment.



WARNING: DANGER

Risk of electrocution
- Do not touch the cables or connections when the generating set is in operation.
- Switch off the generating set for maintenance operations.

DANGER

Use diesel fuel only.
- The fuel is highly flammable, handle with care. Do not smoke near the generating set or expose it to a naked flame or sparks.
- Shut down the generating set engine before filling the fuel tank. Fill with fuel outside.
- To prevent fire risks, clean the generating set regularly. Wipe away any dirt and traces of grease or fuel.

WARNING: DANGER

- The exhaust gases from the engine are toxic and can affect health or even cause death.
- Use the generating set outdoors only, in well ventilated areas, or fit an exhaust extension to discharge the exhaust gases outside.

Figure 1.2 : Pictograms and their meanings

WARNING: DANGER

- Hot coolant can cause serious burns.
- Switch off the engine. Do not remove the filler cap until it is completely cold.
- Do not open the radiator when it is hot.

DANGER

- Rotating parts can cause serious injury.
- Do not operate the generating set with the doors open.
- Do not remove the enclosures.
- Shut down the generating set before any maintenance or servicing operation.

DANGER

- Avoid any contact with the exhaust pipes, turbochargers and silencers. Keep flammable materials away from hot parts.
- Wait for the machine to cool down completely before touching it.

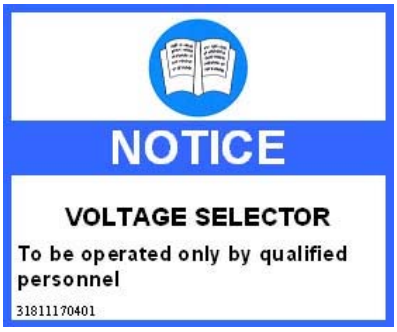
WARNING: DANGER

- The gas from the battery electrolyte is explosive. Keep the batteries away from any flames.
- The battery electrolyte (sulphuric acid) is toxic. Risk of poisoning.

Figure 1.2 (continued) : Pictograms and their meanings

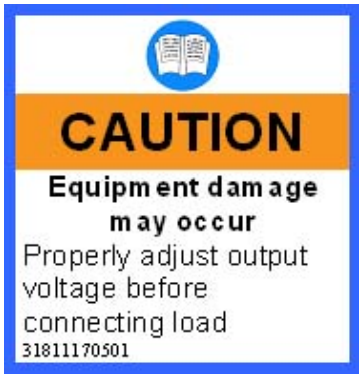
WARNING: DANGER

- A poor earth connection can lead to serious injuries or death.
- Always connect the earth terminal of the generating set to an external earth terminal.



WARNING

Voltage selector
This function should be used by qualified persons only.



WARNING

Adjust the output voltage correctly before connecting a load.

WARNING

The voltage selector must not be used when the generating set is operating.

Figure 1.2 (continued) : Pictograms and their meanings

1.3. Instructions and safety regulations

THESE SAFETY GUIDELINES ARE IMPORTANT

If you do not understand or have any questions about any point in this manual, contact your dealer who will explain it to you or give you a demonstration. A list of risks and precautionary measures to take follows. You should also refer to any local and national regulations that apply in accordance with your own jurisdiction.

KEEP THIS MANUAL

This manual contains important instructions which must be followed when installing or carrying out maintenance on a generating set or batteries.

1.3.1 General advice

Use

- ✓ The operating and safety instructions must be made known to operating personnel. They will be regularly updated.
- ✓ Read and understand the manuals provided with the generating set, pump unit or lighting column properly. The manufacturer's instructions must remain at the disposal of technicians, if possible in situ.
- ✓ The facility must be operated under the direct or indirect supervision of a person appointed by the operator, who is familiar with the operation of the facility, and the dangers and drawbacks of the products used or stored in the facility.
- ✓ Do not wear loose clothing, or get close to machines in operation. Note that the fans are not clearly visible when the engine is running.
- ✓ Warn personnel present to keep their distance during operation.
- ✓ Do not run the generating set, pump unit or lighting column without refitting the protective covers and closing all the access doors.
- ✓ Never let a child touch the generating set, pump unit or lighting column, even when shut down.
- ✓ Avoid operating the generating set, pump unit or lighting tower in the presence of animals (disturbance, scares, etc.).
- ✓ Engage the parking brake when the generating set or lighting tower on its trailer is installed on the operating site. When chocking the trailer on a slope; ensure that there is nobody in the path of the trailer.
- ✓ Never start the engine without an air filter or exhaust.
- ✓ Engine with turbocharger: never start the engine without fitting the air filter. The compressor wheel rotating inside the turbocharger may cause serious bodily injury. Foreign objects in the inlet pipe may cause mechanical damage.
- ✓ Engine with air preheating (starting components): never use a starting spray or any other similar starter assistance product. Upon contact with the starting component, an explosion may occur in the inlet tube, causing bodily injury.
- ✓ Do not touch the lighting column lights when they are switched on.

Maintenance

- ✓ Follow the maintenance table and its instructions.
- ✓ Always use tools in good condition which are suited to the work to be done. Ensure you have understood the instructions before beginning any operation.
- ✓ Goggles should be worn when carrying out maintenance operations and watches, bracelets etc. should be removed.
- ✓ Fit only original parts.
- ✓ Disconnect the battery and the pneumatic starter (if fitted) before undertaking any repairs, to prevent the engine from starting accidentally. Fit a panel over the controls to prevent any attempt to start.
- ✓ Only use the correct crankshaft turning techniques for turning the crankshaft manually. Do not try to turn the crankshaft by pulling it or levering the fan. This method may cause serious bodily or material damage, or damage the vanes of the fan, reducing the service life of the fan.
- ✓ Clean off any trace of oil, fuel or coolant using a clean cloth.
- ✓ Do not use a soapy solution containing either chlorine or ammonia, as these two chemicals prevent bubble formation.
- ✓ Never use petrol or other inflammable substances to clean the parts. Use only approved cleaning solvents.
- ✓ Do not use a high pressure cleaner for cleaning the engine and equipment. The radiator, hoses, electrical components, etc. may be damaged.
- ✓ Avoid accidental contact with parts at high temperatures (exhaust manifold, exhaust).
- ✓ Before any maintenance operation on a lighting column light, cut the electrical power supply and wait for the bulbs to cool down.

Consumables

- ✓ Observe regulations in force concerning use of fuel before using your generating set, pump unit or lighting tower.
- ✓ Under no circumstances use seawater or any other corrosive or electrolytic product in the cooling circuit.

Environment

- ✓ The operator must take the necessary measures to comply with the aesthetics of the site of use. The whole site must be maintained in a good state of cleanliness.
- ✓ The premises must be kept clean, and be regularly cleaned so as to avoid accumulation of dangerous materials or pollutants and dust, which could ignite or cause an explosion. The cleaning equipment must be suited to the risks posed by the products and dust.
- ✓ The presence of dangerous or combustible materials inside premises housing combustion devices shall be limited to the operating requirements.
- ✓ Facilities must be operated under the constant supervision of a qualified person, who must regularly check that the safety devices are operating correctly and ensure that the combustion devices have the correct fuel supply.
- ✓ Apart from the combustion devices, it is prohibited to use fire in any form. This restriction must be clearly displayed.
- ✓ Spreading of waste water, sludge and waste is prohibited.
- ✓ The fuels to be used must correspond to those featured in the declaration file and the specifications recommended by the combustion device manufacturer.
- ✓ The fuel is considered to remain in the same physical state as when it is introduced into the combustion chamber.
- ✓ Burning of waste in the open air is prohibited.
- ✓ Always protect your hands when checking for leaks. Pressurised liquids may penetrate body tissue and cause serious damage. Risk of blood contamination.
- ✓ Drain and dispose of engine oil in a specially provided container (fuel distributors can collect your used oil).
- ✓ Except by special agreement, once closed, the gas supply main unit must only be re-opened by the gas distributor. However, the user may access it under certain conditions. Check these for each site.

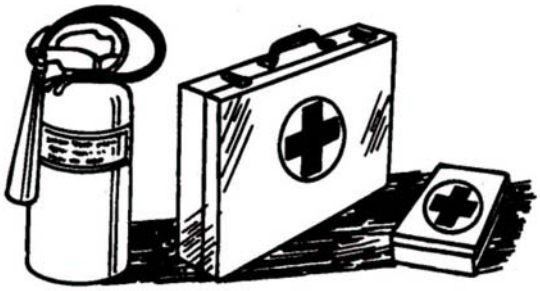
1.3.2 Risks related to exhaust gases and fuels

	The carbon monoxide present in exhaust gases may cause death if the concentration levels in the air breathed are too high. Always use generating sets, pump units or lighting towers in a well-ventilated place where gases cannot accumulate. In case of indoor use: ✓ Be sure to evacuate exhaust gases outdoors. ✓ Provide appropriate ventilation so that personnel present are not affected.
Danger	

- ✓ Observe the local regulations in force for generating sets, pump units or lighting towers, as well as local regulations for use of fuel (petrol, diesel fuel and gas) before using your generating set, pump unit or lighting tower.
- ✓ Fuel filling should be carried out when the engine is off (except for generating sets with an automatic filling system).
- ✓ Engine exhaust gases are toxic: do not run the generating set, pump unit or lighting column in unventilated premises. If installed in a ventilated room, additional requirements for fire and explosion protection must be observed.
- ✓ A leaking burnt gas exhaust may increase the sound level of the generating set, pump unit or lighting column. To check on its efficiency, regularly examine the burnt gas exhaust.
- ✓ Pipes must be replaced as soon as their condition demands it.

1.3.3 Risks related to toxic products

<table>
<tr><td>  </td><td rowspan="2">The corrosion inhibitor contains alkali.
Do not swallow it.
This substance should not come into contact with the eyes. In the event of contact with the eyes, rinse immediately with plenty of water for at least 15 minutes.
Avoid prolonged or repeated contact with the skin. In the event of contact with the skin, wash thoroughly with water and soap. CONSULT A DOCTOR IMMEDIATELY. KEEP THE PRODUCT OUT OF THE REACH OF CHILDREN.

The anti-rust product is toxic and dangerous if absorbed. Avoid all contact with the skin and eyes. Read the instructions on the packaging.</td><td rowspan="2">Glycol is a toxic product and dangerous if absorbed. Avoid all contact with the skin and eyes. Read the instructions on the packaging.
  </td></tr>
<tr><td>Warning</td></tr>
</table>

- ✓ Caution: fuels and oils are dangerous to inhale. Ensure proper ventilation, and use a protective mask.
- ✓ Never expose the equipment to liquid splashes or rainfall, and do not place it on wet ground.
- ✓ The battery electrolyte is harmful to skin and especially eyes. If splashes get into eyes, rinse immediately with running water and/or a 10% diluted boric acid solution.
- ✓ Wear protective eyewear and strong base resistant gloves for handling the electrolyte.

1.3.4 Risk of fire, burns and explosion

<table>
<tr><td>  </td><td rowspan="2">The engine should not be operated in environments containing explosive products. As not all of the electrical and mechanical components are shielded, there is a risk of sparks forming.</td></tr>
<tr><td>Danger</td></tr>
</table>




- ✓ Make sure not to create sparks or flames, and not to smoke near the batteries, as the electrolyte gases are highly flammable (especially if the battery is charging). Their acid also poses a risk to the skin, and in particular to the eyes.
- ✓ Never cover the generating set, pump unit or lighting tower with any material during operation or just after shutdown (wait for the engine to cool).
- ✓ Do not touch hot parts such as the exhaust pipe, or put combustible materials on it.
- ✓ Keep all flammable or explosive materials (e.g. petrol, oil, cloth, etc.) out of the way when the set is running.
- ✓ Proper ventilation is required for your generating set, pump unit or lighting column to work properly. Without this ventilation, the engine would very quickly rise to an excessively high temperature, causing accidents or damage to the equipment and to surrounding property.
- ✓ Do not remove the radiator cap if the engine is hot and the coolant is pressurised, due to risks of burns.
- ✓ Depressurise the air, oil and cooling circuits before removing or disconnecting all the fittings, pipes or connected components. Watch out for the possible presence of pressure when disconnecting a device from a pressurised system. Do not try to find pressure leaks by hand. Oil at high pressure can cause bodily damage.
- ✓ Some preservative oils are flammable. Also, some are dangerous to inhale. Ensure proper ventilation. Use a protective mask.
- ✓ Hot oil causes burns. Avoid contact with hot oil. Check that the system is no longer pressurised before carrying out any procedures. Never start or run the engine with the oil filler cap off (oil may splash out).
- ✓ Never coat the generating set, pump unit or lighting column with a thin layer of oil to protect it from rust.
- ✓ Never top up the oil or coolant if the generating set, pump unit or lighting column is running, or if the engine is hot.
- ✓ A generating set can only operate when stationary, and cannot be installed on a vehicle or other mobile equipment, without a prior study taking into account the various specific features of using the generating set.

1.3.5 Risks related to electrical networks

- ✓ The electrical equipment supplied with the generating set complies with standard NF C15.100 (France), or with the standards of the countries in question.
- ✓ The earth connection must be installed in accordance with the standards in force in each country in question, and with the neutral system sold.
- ✓ Read the manufacturer's identification plate carefully. The values for voltage, power, current and frequency are shown. Check that these values match the supply use.
- ✓ Never accidentally touch stripped cables or loose connections.
- ✓ Never handle a generating set with wet hands or feet.
- ✓ Maintain electrical wires and connections in good condition. Using equipment in poor condition can lead to electrocution and damage to equipment.

■

- ✓ Always disconnect the power to the equipment or facility (generating set voltage, battery voltage and network voltage) before any operation.
- ✓ The electrical connections must be made in accordance with current standards and regulations in the country of use.
- ✓ Do not use faulty, poorly insulated or provisionally connected wires.
- ✓ Never reverse the positive and negative terminals on batteries when connecting them. This could cause severe damage to the electrical equipment. Follow the wiring diagram supplied by the manufacturer.
- ✓ The generating set should not be connected to any other power sources, such as the mains supply network. In specific cases where there is to be a connection to existing electrical networks, this must only be installed by a qualified electrician, who should take the operating differences of the equipment into account, according to whether the mains supply network or generating set is being used.
- ✓ Protection against electric shocks is ensured by an assembly of specific equipment. If this needs to be replaced, it should be by components with identical nominal values and specifications.
- ✓ If the protective plates (blanking covers) need to be removed to route cables, the protector (blanking cover) must be refitted when the operations are finished.
- ✓ Due to high mechanical stresses, use only strong flexible wiring with rubber sheathing, compliant with IEC 245-4, or equivalent wiring.

1.3.6 Dangers presented by electric currents (first aid)

First aid

In the event of an electric shock, shut off the power immediately and activate the emergency stop on the generating set or lighting column. If the voltage has not yet been cut off, move the victim out of contact with the live conductor as quickly as possible. Avoid direct contact both with the live conductor and the victim's body. Use a dry plank of wood, dry clothes or other non-conductive materials to move the victim away. The live wire may be cut with an axe. Take great care to avoid the electric arc that will be generated by this.

Begin emergency procedures

Resuscitation

If breathing has stopped, begin artificial respiration at once in the same place the accident took place unless the victim or operator's life could be endangered by this.

In the event of cardiac arrest, carry out cardiac massage.

1.3.7 Risks related to moving the set

To unload the generating sets, pump units or lighting columns from their transport support brackets under optimum safety and efficiency conditions, you must ensure that the following points are observed:

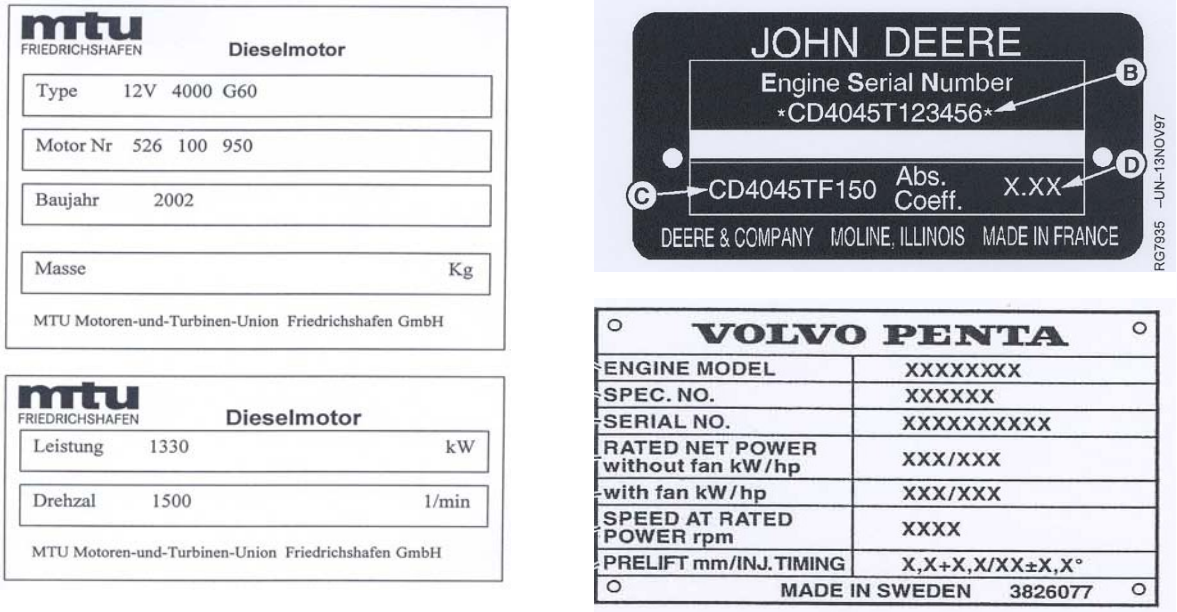
- ✓ The lifting machinery or equipment is suited to the work required, in good condition and with sufficient lifting capacity.
- ✓ The slings are positioned in the rings provided for this operation, the forklift arms are resting fully underneath all of the base frame cross-beams, or the lifting bars are inserted in the apertures provided for this purpose in the base to lift the entire generating set (according to models).
- ✓ For completely safe working conditions and to prevent damage to the components fitted on the upper edge of the set, pump unit or lighting column, the generating set, pump unit or lighting column must be lifted up with an adjustable boom. All the chains and cables must be parallel with each other, and as perpendicular as possible with the upper edge of the generating set, pump unit or lighting column.
- ✓ If other equipment fitted on the generating set, pump unit or lighting column alters its centre of gravity, special lifting devices may be necessary to maintain correct balance and completely safe working conditions.
- ✓ The ground must be able to withstand the load of the generating set, pump unit or lighting column and its lifting machinery without stress (otherwise, put down beams of sufficient strength in a stable configuration).
- ✓ Position the generating set, pump unit or lighting column as close as possible to its place of use or transport, in a clear space with free access.
- ✓ Never perform work on a generating set, pump unit or lighting tower just hanging from a lifting device.

1.4. Identifying sets

Generating sets and their components are identified by means of identification plates.
The precise rules for identifying each major component (engine, alternator etc.) are set out in each manufacturer's documents contained in this manual.

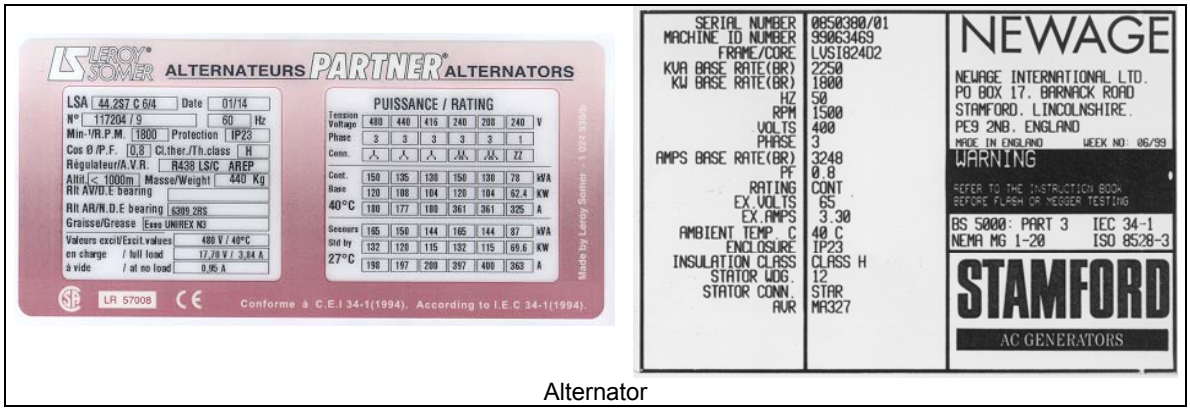
Examples of identification plates

Generating set

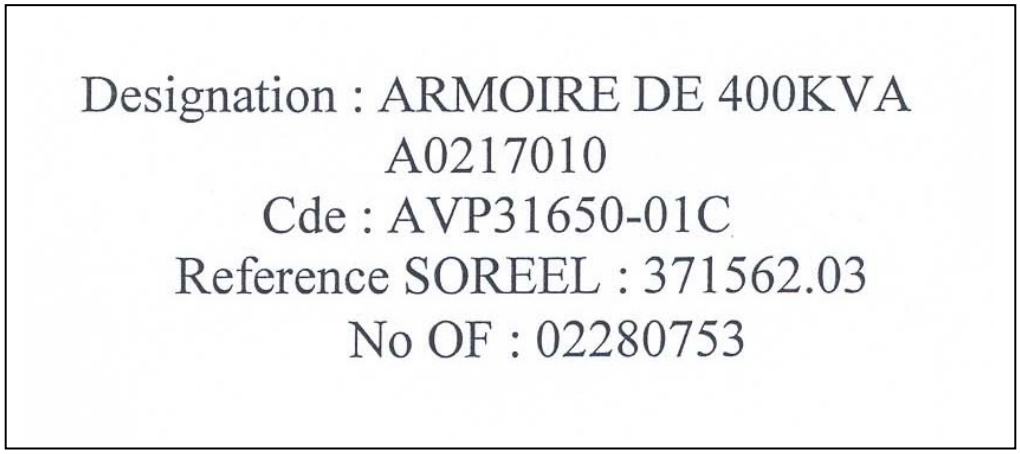


Engines

Figure 1.3 : Examples of identification plates



Alternator



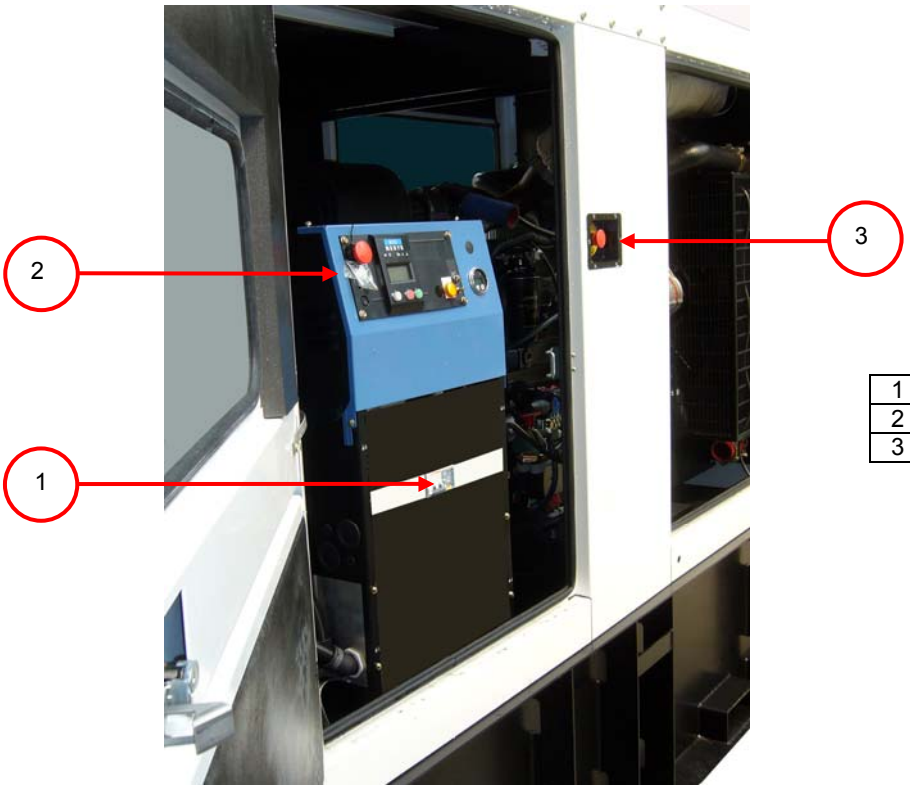
Cabinet

Figure 1.4 : Examples of identification plates

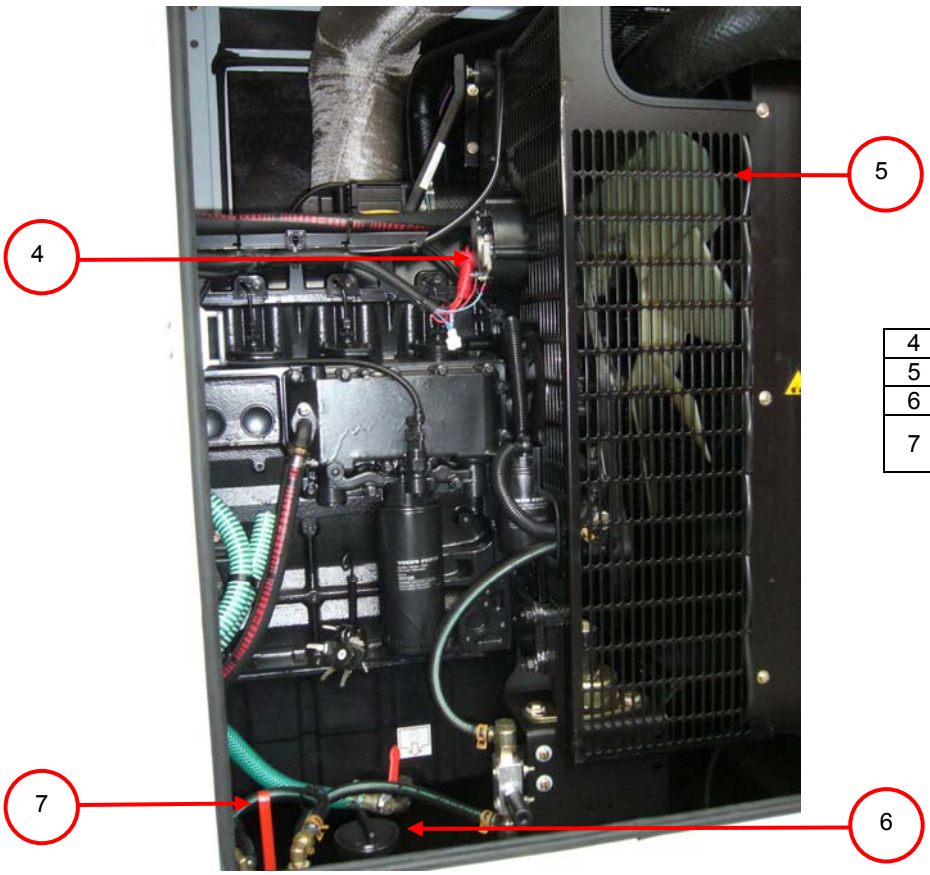
2. General description

2.1. Description

Overview

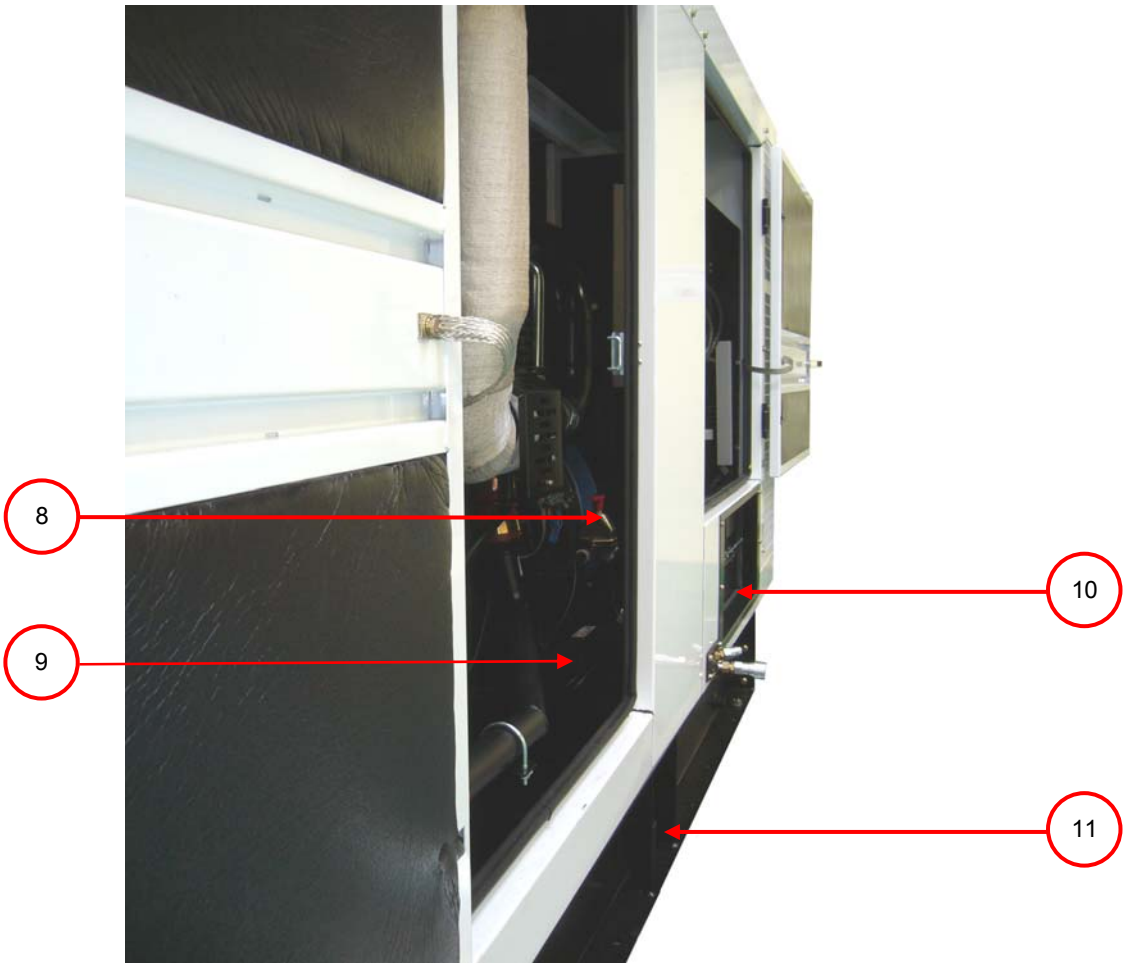


1	Circuit breakers
2	Control unit
3	External emergency stop



4	Battery charge alternator
5	Protective grilles
6	Filling with fuel
7	External fuel supply combined tap (optional)

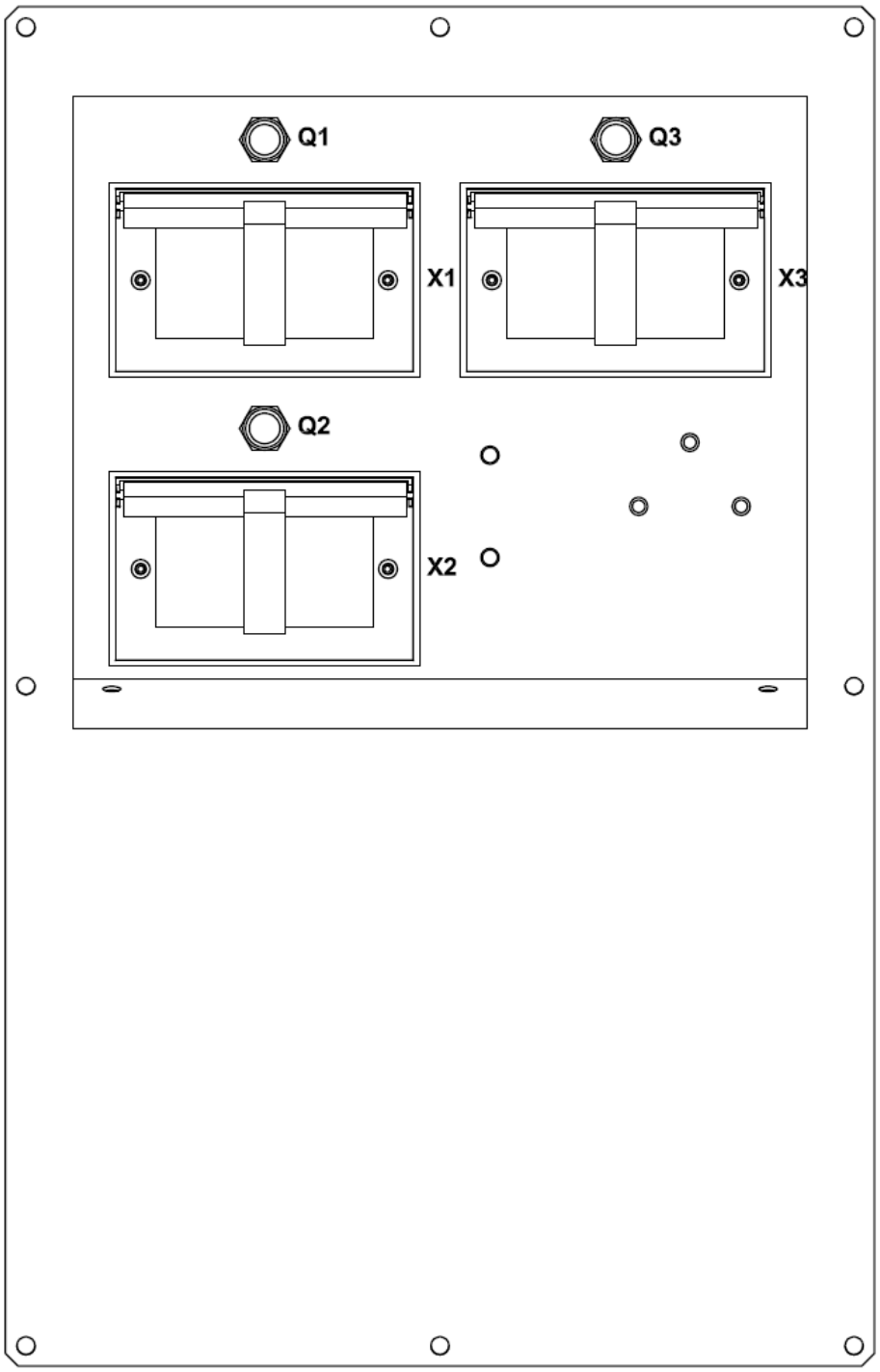
Figure 2.1 : General description of the generating set



8	Circuit breaker	10	Connection termination box
9	Starter battery	11	Chassis

Figure 2.1 (continued) : General description of the generating set

Sockets (voltage 208/120V)



X1 SOCKET / PRISE 20A 125V
Q1 CIRCUIT BREAKER / DIJONCTEUR 20A

X2 SOCKET / PRISE 20A 125V
Q2 CIRCUIT BREAKER / DISJONCTEUR 20A

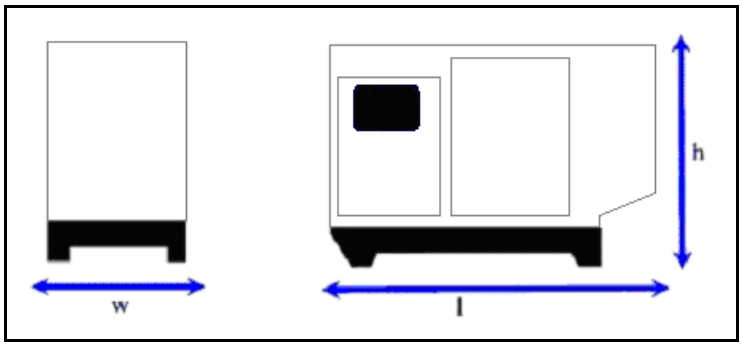
X3 SOCKET / PRISE 20A 125V
Q3 CIRCUIT BREAKER / DISJONCTEUR 20A

2.2. Technical specifications

Range / Generating set type	RENTAL POWER / R230U

Weights and Dimensions

Dimensions with standard tank



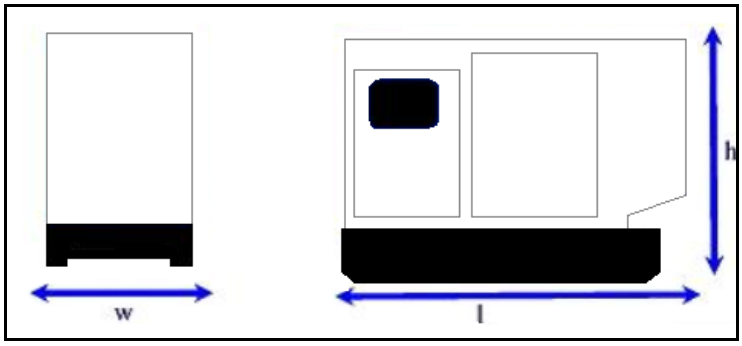
Dimensions l x w x h :
3508 mm x 1200 mm x 1830 mm

Weight :
2540 kg dry weight 2890 kg in operating configuration

Hood :
M226C

Noise level (measurement uncertainty) :
82 dB @ 1 m (0.70)
72 dB @ 7 m (0.70)

Dimensions with high autonomy tank



Dimensions l x w x h :
3560 mm x 1200 mm x 2182 mm

Weight :
2960 kg dry weight 3790 kg in operating configuration

Hood :
M226C-DW

Noise level (measurement uncertainty) :
82 dB @ 1 m (0.70)
72 dB @ 7 m (0.70)

Output

Voltage	Hz	Phase	Load factor	Current (A)	Emergency power [1] kW / kVA	Prime power [2] kW / kVA
480/277V	60	3	0,8	302	200.8 / 251	182,5 / 228,2
380/220V	60	3	0,8	381	304,8 / 381	182,6 / 228,2
220/127V	60	3	0,8	659	527,2 / 659	182,6 / 228,2
208/120V	60	3	0,8	669	532,2 / 669	175,3 / 219,1

(1) ESP: Stand-by output available for emergency use under variable charge up to 200hrs per year as per ISO 8528-1, no overload available under these service conditions.

(2) PRP: Main output available continuously under variable load for an unlimited time period per year as per ISO 8528-1, an overload of 10% one hour every 12 hours is available, as per ISO3046-1.

Engine data	
Manufacturer / model	VOLVO TAD733GE
Type	Turbo
Cylinder configuration	6 x L
Cubic capacity	7.15 L
Rotation speed	1800 Rpm
Max emergency/prime power at nominal speed	225 / 202 kW
Adjustment type	Electronical

Fuel consumption	
110 % (emergency power)	54.0 L/h
100 % main power	47.6 L/h
75 % main power	35.2 L/h
50 % main power	23.8 L/h

Fuel	
Fuel type	Diesel
Standard fuel tank	340 L
High autonomy fuel tank	868 L

Lubrication	
Oil capacity with filter	34 L
Min. Oil pressure	2 bar
Nominal oil pressure	4 bar
Oil consumption (100 % load)	0,09 L/h
Oil sump capacity	31 L
Type of lubricant	Genlub

Cooling	
Engine capacity with radiator	35,8 L
Max coolant temperature	105°C
Fan power	3,4 kW
Refrigerant type	Gencool
Thermostat	87-102°C

Alternator data	
● Compliant with NEMA MG21 standards, UTE NF C51.111, VDE 0530, BS 4999, IEC 34.1, CSA	● The alternator is protected against short circuits ● Vacuum impregnation, epoxy winding, IP23 protection rating
Type	LEROY SOMER LSA462M5
Number of phases	3
Power factor (cos Phi)	0.8
Number of poles	4
Excitation type	AREP
Voltage regulator	R450
Short-circuit current	3 IN
Number of bearings	1
Coupling	Direct

Control unit(s)	
NEXYS 	<u>Standard specifications</u>: Frequency meter, Voltmeter, Ammeter <u>Alarms and faults</u>: Oil pressure, Coolant temperature, Fail to start, Overspeed, Alternator min/max, Fuel level low, Emergency shutdown <u>Engine parameters</u>: Working hours counter, Engine speed, Battery voltage, Fuel Level, Air Preheating
TELYS 	<u>Standard specifications</u>: Voltmeter, Ammeter, Frequency meter <u>Alarms and faults</u>: Oil pressure, Water temperature, Start failure, Overspeed, Alternator min/max, Battery voltage min/max, Emergency stop <u>Engine parameters</u>: Timer, Oil pressure, Water temperature, Fuel level, Engine speed, Battery voltage

2.3. Fuel and consumables

All specifications (product features) are given in the motor and alternator maintenance manuals attached to this manual.
In addition, we recommend the consumables to be used in the "specifications" section.

2.3.1 Specifications

2.3.1.1. Oil grades

Engine		Oil	
Make	Type	Make	Type
John Deere	All	John Deere	John Deere PLUS-50
		GenPARTS	GENLUB TDX 15W40
MITSUBISHI	All	GenPARTS	GENLUB TDX 15W40
Volvo	All	GenPARTS	GENLUB TDX 15W40

GENLUB TDX 15W-40
Top-of-the-range lubricant recommended for diesel engines: for generating sets used under severe conditions.

USES:

- ✓ Particularly suited to more modern engines with or without turbochargers, *intercoolers*, or sophisticated injection systems (e.g. ***HEUI*****,** injector-pumps).
- ✓ **All types of use**: can cope with the most demanding applications.
- ✓ **Depolluted engines:** complies with EURO 2 and EURO 3 technology and can be used with all types of diesel fuel, especially ecological diesel with low sulphur content.

PERFORMANCE:

ACEA E3
API CH-4

- ✓ Meets level E3 of the specifications defined by European manufacturers in the ACEA standards 98 edition.

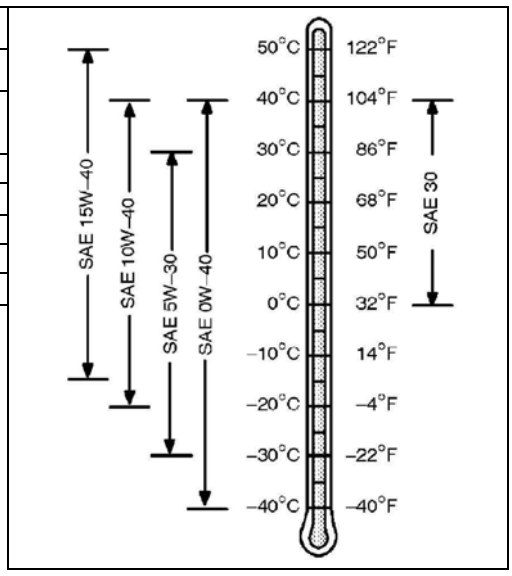
ADVANTAGES:

- ✓ **Less frequent oil services**: this product has been put to the test during thousands of hours of use on worksites under varying conditions, demonstrating its high quality.
- ✓ **Conformity with new environmental legislation**: adherence to new anti-pollution standards required for new EURO 2 and EURO 3 engines.

SPECIFICATIONS:

SAE Grade	15W-40	
Density at 15°C	0.883	
Cinematic viscosity at 40 °C Cinematic viscosity at 100 °C	105 14.1	mm^2/s (cSt) mm^2/s (cSt)
Viscosity index	140	
Dynamic viscosity at -15 °C	3000	mPa.s(cP)
Pour point	- 30	°C
Flash point	220	°C
Sulphated ash content	1.4	% weight

(Values given as examples only)



2.3.1.2. Specifications of coolants

Engine		Coolants	
Make	Type	Make	Type
John Deere	All	GenPARTS	GENCOOL PC -26°C
MITSUBISHI	All	Mitsubishi	LLC
		GenPARTS	GENCOOL PC -26°C
Volvo	All	GenPARTS	GENCOOL PC -26°C

GenCOOL PC -26
High-protection coolant, approved by manufacturers.
GenCOOL PC -26 is a ready-to-use, highly protective coolant which is produced from an antifreeze recommended by the majority of European manufacturers.

- It is made from antifreeze and G 48 inhibitors.
- It protects up to -26°C.
- It is free from nitrates, amines and phosphates.
- It is a clear, fluorescent orange liquid.

REFERENCES/APPROVALS (for the antifreeze):

HEAVY GOODS VEHICLE	LIGHTER VEHICLES
Approved by MTU, MERCEDES BENZ, MAN, KHD, GENERAL MOTORS	Approved by BMW, VOLKSWAGEN, MERCEDES, PORSCHE
Conforms with VOLVO, IVECO, VAN HOOL and STAYR TRUCK specifications	Conforms with VOLVO, OPEL, SEAT and SKODA specifications

Conforms with the NF R 15.601 standard

REINFORCED ANTI-CORROSION FEATURES:

- Protects **against high-temperature corrosion** by oxidisation of ethylene (cylinder head protection).
- Protects **against high-temperature cavitation** (top of cylinder and coolant pump protection).
- Non-corrosive for seals and hoses.
- Improves the **efficiency and longevity of the cooling system.**
- **GenCOOL PC -26** is especially recommended for engines fitted with aluminium or light alloy radiators.

HIGH TEMPERATURE SUITABILITY:

- Provides good conditions for thermal exchange.
- Perfect stability at high temperatures.
- **GenCOOL PC -26** is specially adapted for engines with high power densities.

LONG LASTING PROTECTION:

- High alkaline reserve/stability and longevity of corrosion inhibitors.
- Maintains its technical properties during prolonged use at high temperatures (neutralisation of acids).
- Ensures maximum heat transfer without the build up of deposits in the cooling system.
- **GenCOOL PC -26** ensures optimum protection against overheating and corrosion in extreme conditions of vehicle use.

PACKAGING/STORAGE:

- **GenCOOL PC -26** is supplied in 210 l metallic barrels with smooth interior linings.
- It can be stored for 2 years in its original container and packaging.
- Avoid zinc coated containers.

RECOMMENDATIONS FOR USE:

- Compatible with the original fluid.
- It is recommended that the cooling system is completely drained when replacing the fluid.

SPECIFICATIONS	UNITS	SPECIFIED VALUES	TRIAL METHODS
Density at 20°C	kg/m^3	**1,059 +/- 3**	R 15-602-1
pH	pH	**7.5 to 8.5**	NF T 78-103
Alkalinity reserve	ml	**>=10**	NF T 78-101
Boiling point	°C	**105 +/- 2**	R 15-602-4
Freezing point:	°C	**-26 +/- 2**	NF T 78-102
Glassware corrosion : (test with antifreeze)	mg/test piece		R 15-602-7
- Copper		**+/- 2.6**	
- Weld		**+/- 0.5**	
- Brass		**+/- 2.3**	
- Steel		**+/- 1.6**	
- Cast iron		**+/- 0.8**	
- Cast aluminium		**+/- 1.0**	
Corrosion on warm plate (test with antifreeze)	mg/(cm²week)	**+/- 0.17**	R 15-602-8

3. Installation

3.1. Unloading

3.1.1 Safety during unloading

To unload electrical generating sets from their transport supports under optimum safety and efficiency conditions, you need to ensure that the following points are observed:

- Lifting machinery or equipment appropriate to the work required.
- Slings positioned in the eyes provided for this operation or lifting arms resting fully underneath the chassis cross members.
- Ground able to take the load of the set and the lifting machinery without stress (otherwise lay down beams of sufficient strength and stability).
- Set put down as close as possible to its point of use or transportation, in a clear area with free access.

Example of equipment to be used:

- ✓ crane, slings, cross bar, safety catch, shackles.
- ✓ Fork lift truck.

3.1.2 Instructions for unloading

3.1.2.1. Slings

❶ Attach the lifting vehicle slings to the rings on the generating set designed for this procedure. Hang the slings carefully.

❷ Check that the slings are correctly attached and the equipment is solid.

❸ Lift the generating set carefully.

❹ Direct and stabilise the set towards the chosen position.

❺ Carefully set down the equipment while continuing to position it.

❻ Release the slings, then detach and remove the lifting rings.

3.1.2.2. Fork lift truck

❶ Position the forklift arms under the base frame (except with generating sets fitted with "forklift pockets", in which case position the forklift arms in these pockets), making sure that only its cross-members are resting on the arms.

❷ Lift the equipment, handling it gently.

❸ Set down the generating set in its unloading position.

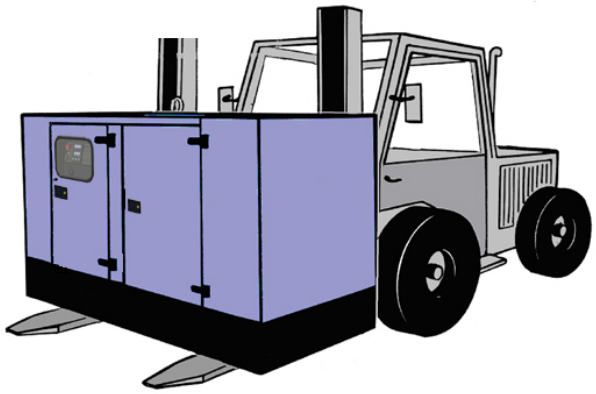


Figure 3.1 : Transporting a generating set using a forklift truck

3.2. Fluid retention

Any outflow of the fluids contained in the generating sets (fuel, oil and coolant, or rainwater or condensation) will be collected in a retention container if the generating set is fitted with this option.
The containers have a capacity which allows 110% of the fluids contained in the generating set fitted with this option to be collected.
Three different fittings are available.

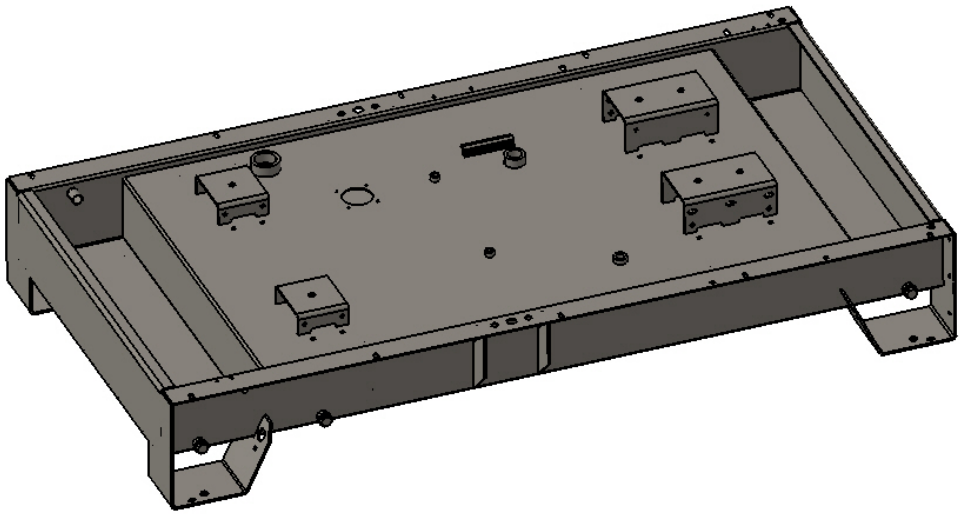


Figure 3.2 : Fluid retention container integrated into the tank chassis.

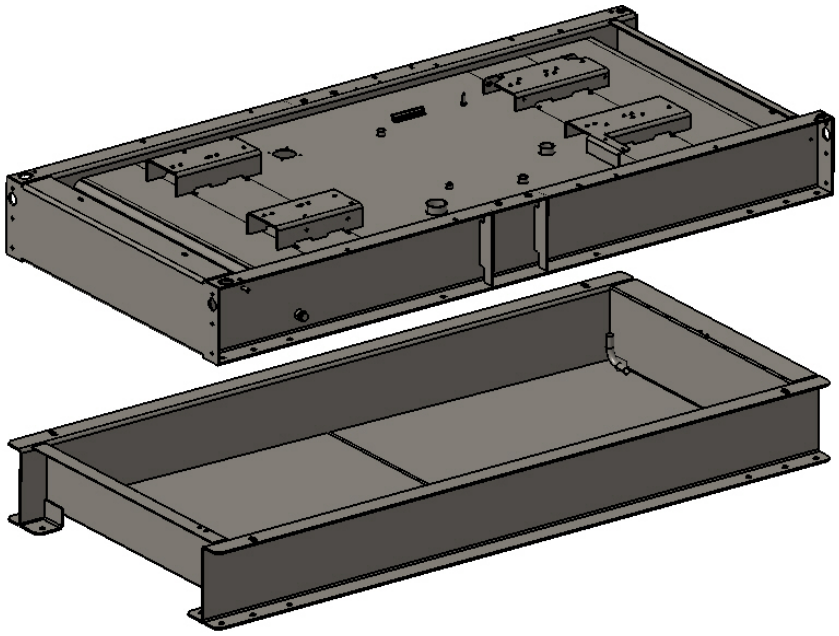


Figure 3.3 : Offset fluid retention container underneath the generating set chassis.

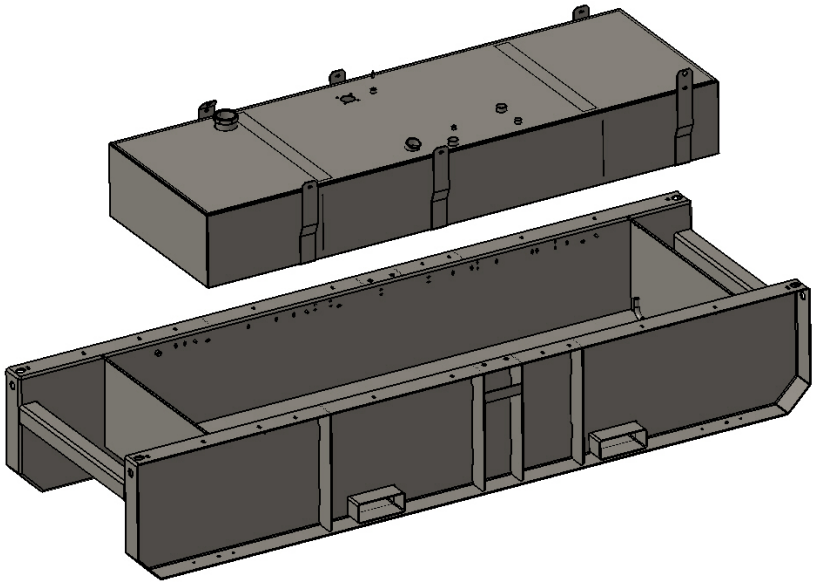


Figure 3.4 : Offset fluid retention container integrated into the chassis and tank.

Generating sets fitted with the offset tank option (DW) above also have a high level indicator in the retention container.

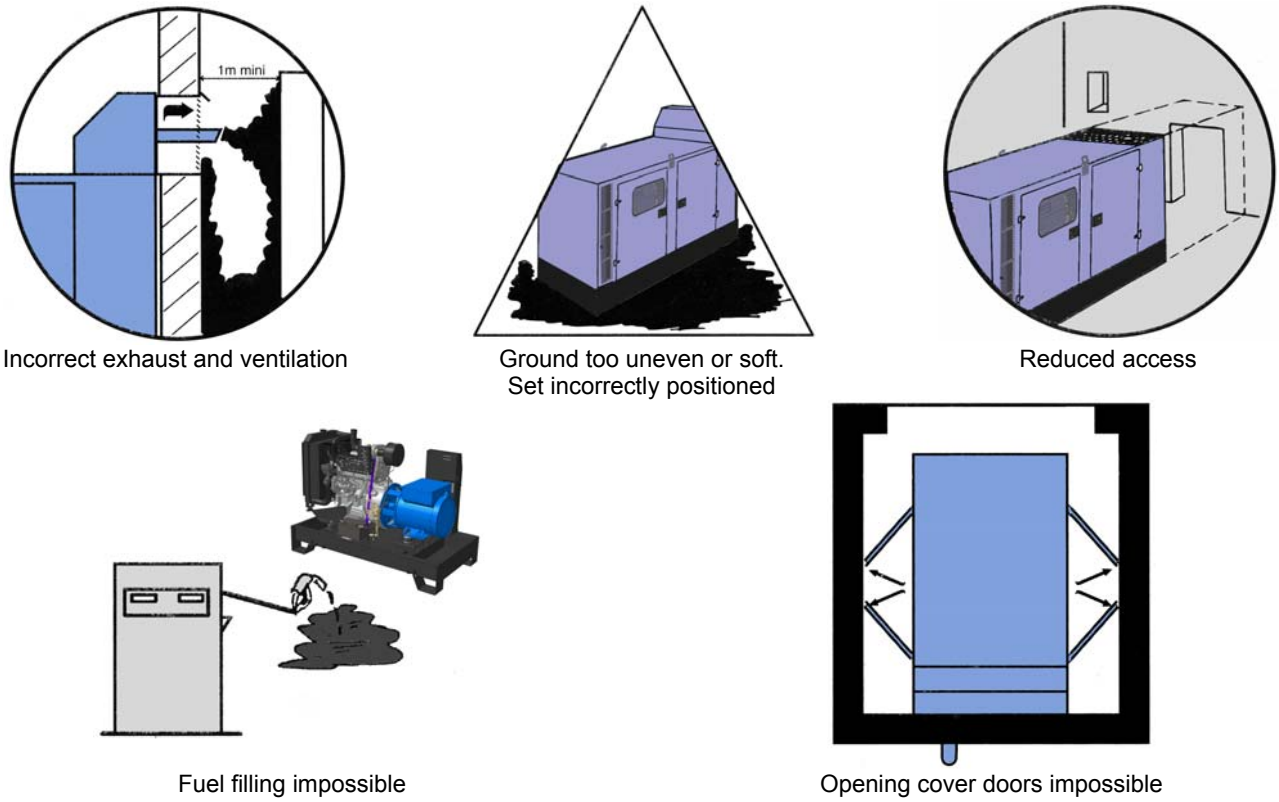
In all cases, the retention containers must be regularly checked to ensure they contain no fluid (fuel, oil and coolant, or rainwater or condensation). If necessary, drain the containers either via the drain port or by using the drain pump (for containers fitted with this pump).

- ✓ **Note** : Never allow these fluids to drain onto the ground; ensure they are collected in a designated container.

3.3. Choice of location

It should be determined on the basis of use. There are no specific rules governing the choice of location, other than proximity to the electric distribution panel and disturbances caused by the noise. However, fuel supply, burnt gas evacuation, and the direction of these gases and the noises emitted should be taken into account.
The choice of its position will be based on carefully considered compromise!

Examples of problems that may be encountered:



Incorrect exhaust and ventilation

Ground too uneven or soft.
Set incorrectly positioned

Reduced access

Fuel filling impossible

Opening cover doors impossible

Figure 3.5 : Examples of problems that may be encountered

3.4. Electricity

a) Connections - general information

As with low voltage electrical installations, use and maintenance is governed by standard NFC 15.100 (France) or by the standards in the relevant country, based on international standard IEC 60364-6-61.

They must also adhere to the regulations in the NFC 15.401 application guide (France) or to the regulations and standards in the relevant country.

b) Power cables

These can be unipolar or multipolar according to the power of the generating set.

Power cables should preferably be installed in ducts or on a cable tray for this purpose.

The cable cross-section and number of cables should be determined according to the cable type and the current standards to be observed in the country of installation. The choice of conductors must comply with international standard IEC 30364-5-52.

Three phase - Calculation hypothesis

Fitting method = wiring in cable runs or non perforated trays.
Permissible voltage drop = 5%
Multiconductors or single conductor joined when precision 4X…(1)
Cable type PVC 70°C (e.g. H07RNF).
Ambient temperature = 30°C.

Circuit breaker calibre (A)	Cable sizes		
	0 - 50m	51 - 100m	101 - 150m
	mm²/AWG	mm²/AWG	mm²/AWG
10	1.5 / 14	2.5 / 12	4 / 10
16	2.5 / 12	4 / 10	6 / 9
20	2.5 / 12	4 / 10	6 / 9
25	4 / 10	6 / 9	10 / 7
32	6 / 9	6 / 9	10 / 7
40	10 / 7	10 / 7	16 / 5
50	10 / 7	10 / 7	16 / 5
63	16 / 5	16 / 5	25 / 3
80	25 / 3	25 / 3	35 / 2
100	35 / 2	35 / 2	4X(1X50) / 0
125	(1) 4X(1X50) / 0	4X(1X50) / 0	4X(1X70) / 2/0
160	(1) 4X(1X70) / 2/0	4X(1X70) / 2/0	4X(1X95) / 4/0
250	(1) 4X(1X95) / 4/0	4X(1X150) / 2350MCM	4X(1X150) / 2350MCM
400	(1) 4X(1X185) / 0400MCM	4X(1X185) / 0400MCM	4X(1X185) / 0400MCM
630	(1) 4X(2X1X150) / 2x 2350MCM	4X(2X1X150) / 2x 2350MCM	4X(2X1X150) / 2x 2350MCM

Single phase - Calculation hypothesis

Fitting method = wiring in cable runs or non perforated trays.
Permissible voltage drop = 5%
Multiconductors.
Cable type PVC 70°C (e.g. H07RNF).
Ambient temperature = 30°C.

Circuit breaker rating (A)	Cable sizes		
	0 - 50m	51 - 100m	101 - 150m
	mm²/AWG	mm²/AWG	mm²/AWG
10	4 / 10	10 / 7	10 / 7
16	6 / 9	10 / 7	16 / 5
20	10 / 7	16 / 5	25 / 3
25	10 / 7	16 / 5	25 / 3
32	10 / 7	25 / 3	35 / 2
40	16 / 5	35 / 2	50 / 0
50	16 / 5	35 / 2	50 / 0
63	25 / 3	50 / 0	70 / 2/0
80	35 / 2	50 / 0	95 / 4/0
100	35 / 2	70 / 2/0	95 / 4/0
125	50 / 0	95 / 4/0	120 / 2250MCM

c) Battery cables

Install the battery or batteries in the immediate vicinity of the electric starter motor. The cables will be connected directly from the battery terminals to the starter motor terminals.

The primary instruction to follow is to ensure that the polarities between the battery and starter motor match. Never reverse the positive and negative battery terminals when connecting them. This could cause severe damage to the electrical equipment.

The minimum cross-section of the cables will be 70 mm^2. It varies according to the power of the starter motor but also the distance between the batteries and the set (voltage drops on the line).

d) Safety guidelines
References: NFC 15-100:2002 (France) - IEC: 60364-5-54

In order to protect personnel against electric shocks, this generating set is equipped with a differential residual current protector "factory" set to trigger instantly, with a sensitivity of 30 mA.

 Important	Any modification to this setting could endanger personnel. Any modification would render the user liable, and must only be performed by qualified and authorised personnel. When the generating set is disconnected from a facility after use, the master differential protector must be returned to its "factory" settings, and this must be checked by trained personnel.

For effective protection against electric shocks, the generating set needs to be earthed. To do this, use a copper wire, with a minimum cross-section of 25 mm^2 for a stripped cable and 16 mm^2 for an insulated cable, connected to the generating set earth socket and a galvanised steel earthing rod embedded vertically into the ground.

The earthing rod resistance value should comply with the values shown in the table below.
Note: use the highest differential setting from the installation as a guideline.

The resistance value is calculated in the following way: $R = \frac{Ul}{I\,\Delta n}$

Maximum resistance value of the earth socket R (Ω) according to the differential unit operational current (operation time should not be longer than 1 second).

I Δn differential	Earth R (Ω) Ul: 50 V	Earth R (Ω) Ul: 25 V
≤ 30 mA	500	> 500
100 mA	500	250
300 mA	167	83
500 mA	100	50
1A	50	25
3A	17	8
5A	10	5
10A	5	2.5

The Ul value: 25 V is required for work site installations, and livestock buildings, etc.

For a default voltage of 25 V and a default current of 30 mA, this rod must be of a minimum length of: see table below:

Nature of ground	Length of rod in metres	
Thick arable land, moist compact ballast	1	
Lean arable land, Gravel, coarse ballast	1	
Bare stony soils, dry sand, impermeable rock	3.6	To obtain an equivalent length, you can use several earthing rods connected in parallel and set apart by at least their length. Example: 4 interconnected 1 metre rods separated by 1 metre.

Note: For the United States (National Electrical Code reference NFPA-70).
The generating set must be earthed. To do this, use a copper wire with a minimum cross-section of 13.3 mm² (or AWG 6, at most) connected to the generating set earth socket and a galvanised steel earthing rod fully embedded into the ground vertically.
This earthing rod embedded fully in the ground must have a minimum length of 2.5 m.

3.5. Special arrangements

Generating sets are not fitted with protection against power surges caused by drops in atmospheric pressure or manoeuvring.
The company does not accept any responsibility regarding damage caused by these occurrences.
However, lightning conductors can be installed, on the understanding that this does not give total protection.

4. Trailer

4.1. Trailer linkage

Before attaching the trailer, check the trailer hook on the tow vehicle; it should fit the trailer ring perfectly.

 **Warning**	**Trying to tow a trailer with a non-matching device (bar, wires, cords, etc.) could lead to serious accidents.** **Also check:** **- no incipient fractures or excessive wear on the hitching system.** **- locking system is operating properly.**

To hitch the trailer, proceed as follows:

❶ Lock the wheels to stop the trailer from moving
❷ Lift up the rear trailer supports and lock them
❸ Release the parking brake
❹ Release the locking levers for the draw bar arms and adjust the ring to the same height as the vehicle hook
❺ Hitch the trailer, remove the locks on each side of the wheels then lift up the front wheel fully using its handle
❻ Connect the electrical circuit of the trailer to that of the tow vehicle
❼ Hook the handbrake safety wire onto the hook on the tow vehicle.

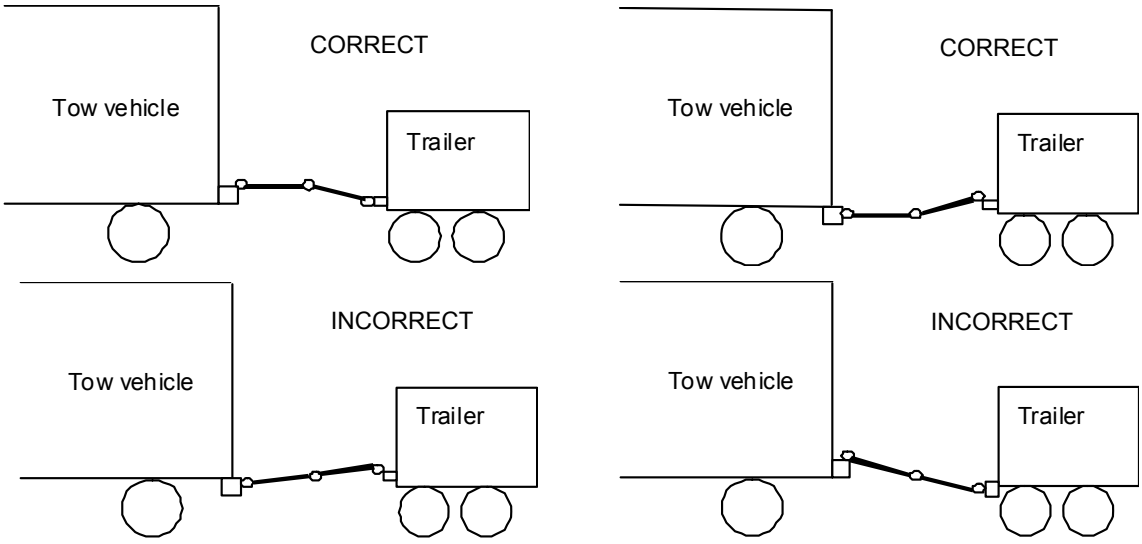


Figure 4.1 : Coupling a trailer

4.2. Check before towing

Before towing, check the following:
- ✓ Tightness of the generating set enclosure bolts.
- ✓ Wheel tightness.
- ✓ Hitching hook locked.
- ✓ Tyre pressure.
- ✓ Signalling lights working, for "on-road" trailers.
- ✓ Enclosure doors closed.
- ✓ Parking brake released, for "on-road" trailers.
- ✓ Guide wheels (jockey wheels) and stands lifted (if fitted).
- ✓ Towbar arm locking levers tightened and pinned (if fitted with an adjustable towbar).
- ✓ Brake test, for "on-road" trailers.
- ✓ Safety cable fitted, for "on-road" trailers.

4.3. Operation

"On-site" trailer

These trailers are not fitted with a main brake, and so cannot be braked in motion; the tyres allow for a maximum speed of 27 km/h. So it is absolutely prohibited to exceed this speed.

Nor are these trailers fitted with signalling lights. On-road use is prohibited.

"On-road" trailer

The driving speed must be suited to the condition of the road and the handling of the trailer.

Driving at high speed causes heating of the tyres; so it is important to stop from time to time, and check them. Excessive heating may cause a puncture, and therefore a serious accident. For reversing manoeuvres, remember to lock the inertia brake.

⚠ Warning	Particular attention must be paid to the tightness of the wheels on new vehicles. In the first few miles' driving, heating of the brake hubs and drums will actually reduce the wheel tightness. It is therefore essential to check the tightness every 6 miles (10 kilometres) until no further loosening is noted. Nonetheless the tightness must be checked whenever you are about to tow the trailer.

Lights/signalling (only for "on-road" trailers)

Warning lights are obligatory for on-road driving. Signalling must comply with regulations in force in the country of use.

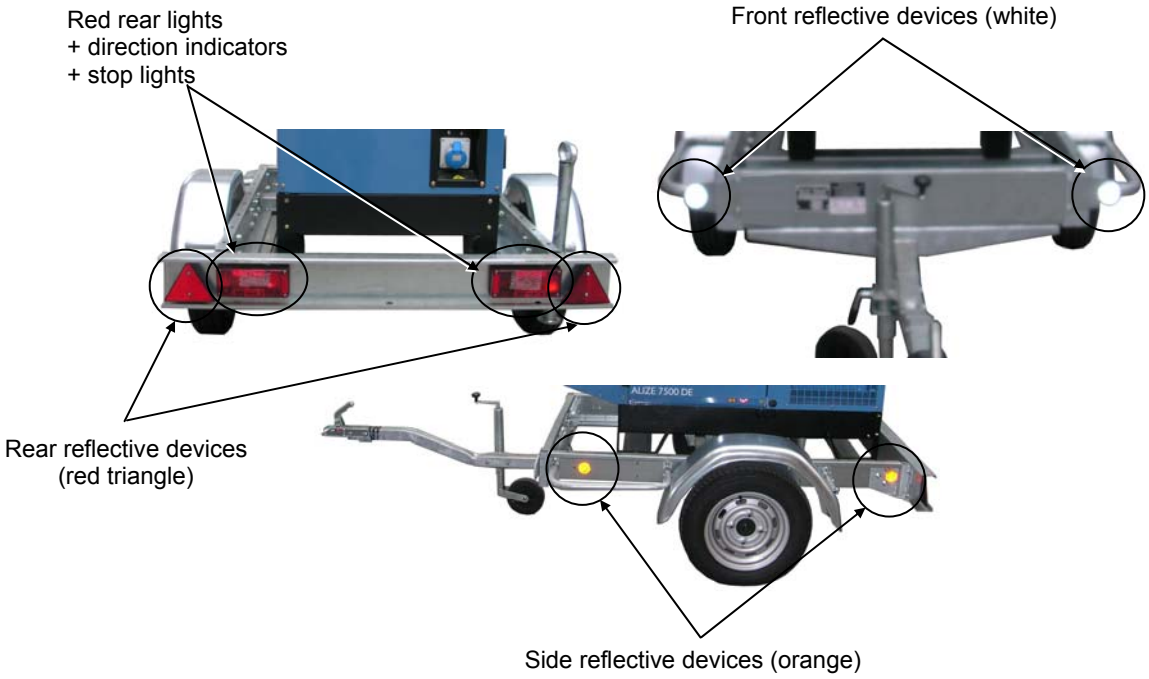


Figure 4.2: Example of French signalling

4.4. Unhitching the trailer

This operation should be carried out on horizontal, flat, stable ground.

❶ Lock the wheels

❷ Lower the front wheel

❸ Disconnect the road signals wire

❹ Refit the hitch using the wheel to release the hook ring from the tow vehicle,

❺ Release the tow vehicle

❻ Engage the handbrake.

4.5. Implementation for installation

Operations to be carried out:

❶ Ensure that the ground is strong enough for the assembly not to sink into it.

❷ Unhitch the trailer.

❸ Immobilise the trailer by placing chocks under the wheels.

❹ Fully engage the parking brake (if fitted).

❺ Using the front wheel, position the generating set as close to horizontal as possible.

❻ Lower the stands (if fitted), and lock them.

4.6. Break transmission adjustment

 Important	- The handbrake is used only as a parking brake. - Setting is carried out starting with the brakes moving to the brake control.

❶ After fitting the wheels on the axle, turn the wheels in the FORWARD direction (on all RA 2 type brakes, check that the adjustment screw 8 reaches the “FORWARD” stop on the brake backing plate).

❷ Adjust the brake setting using screw 8, with the cables not connected to the cross bar(s). The shoes should rub the drum slightly.

❸ Connect the brake cables to the cross bars(s) and tighten the nuts and lock nuts, leaving the end of the threaded end protruding by around 10 mm (Fig. 4.4).

IMPORTANT: Wherever possible, cables must cross over to achieve the highest possible gain curve (Fig. 4.5).

❹ Check that the parking lever 1 is in the ‘REST” position and that the compensating spring 4 is completely free on its rod (unscrew the nuts 5 fully).

❺ Check that the hook slide 2 is not compressed and the yoke 3 is in the pulled out position.

❻ Fit the transmission and adjust the assembly using the tensioner 6 until a gap (J1) of 1 mm max is obtained between the linkage 9 and slide 2.

❼ Adjust the compensating spring 4 at one end pressing it against the anchorage plate, and at the other end leaving a 2 mm gap (J2) max between the spring and nuts 5.

❽ Tighten all the lock nuts.

Checking the setting (trailer on axle stands):

❶ Pull the parking lever 2 notches - the wheels cannot turn in a FORWARD direction.
The wheels can turn in REVERSE (adjustment screw 8 switches to the REAR position).

❷ Pull the parking lever fully.
The wheels will not turn either in FORWARD or REVERSE and the cross bar(s) must remain parallel with the axle body.

- Check the transmission setting after 180 miles (300 km) (running in period) and if necessary adjust the gap (J1) using the tensioner.

Parking

- The lever must be fully pulled up, so that the compensating spring is fully compressed.
- Every 900 miles (1500 km), check the braking settings and distribution on all the wheels.

Important

- The brake controls are designed to draw trailers behind flexible suspension touring vehicles. If used behind an HGV, be sure to provide the fitted ball joint with a shock absorber to prevent premature wear.
- During any manoeuvres with the trailer coupled, do not turn more than 90° or force reverse.
- The specifications of our brake controls are indicated on a manufacturer's plate, and the items on this should be supplied to us when requesting replacement parts, in particular for the shock absorber, of a special type, approved by the Service des Mines to correspond to European standards (it is advisable to have a spare shock absorber to enable instant repairs).

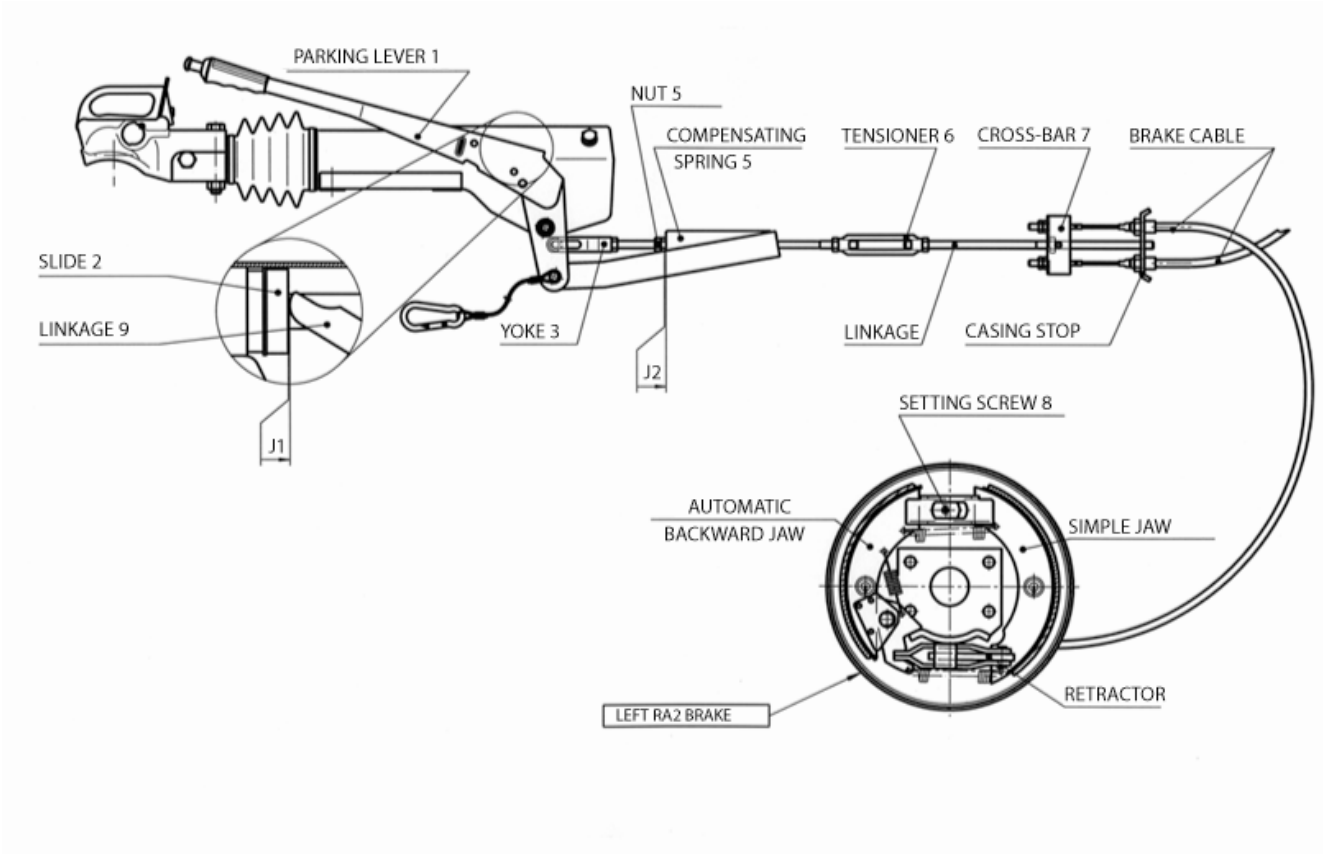


Figure 4.3 : Braking transmission

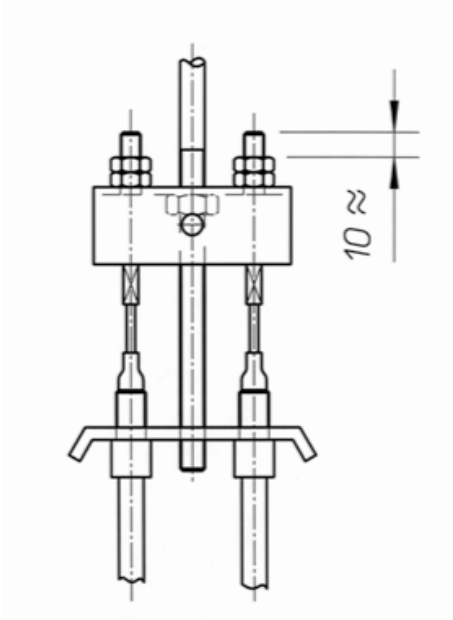


Figure 4.4 : Cross bar fitting

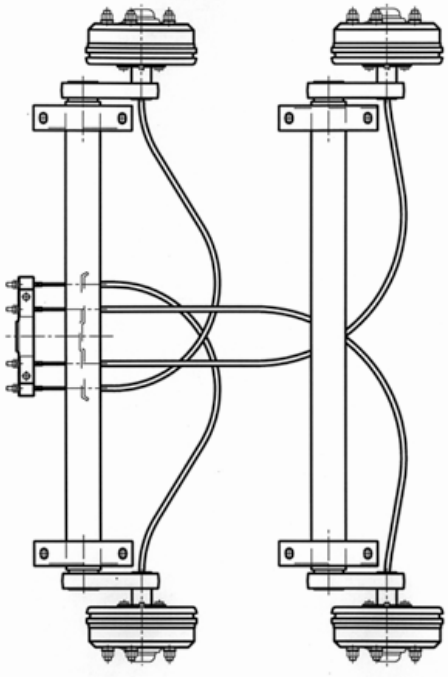


Figure 4.5 : Tandem bearing fitting

4.7. Faults and repairs

Fault observed	Origin	Solutions
Erratic braking of trailer	- Faulty shock absorber	Replace the shock absorber
Braking too weak	- Jaws worn	Replace the jaws
	- Jaws not run in	Fault will disappear only after running in
	- Incorrect linkage setting	Adjust the setting
	- Significant friction on the slide	Grease the sliding parts
	- Slide corrosion	Remove the corrosion and grease
	- Coupling height does not match that of the towing vehicle	Adjust the height so that the two parts are in the same horizontal plane
Drum temperature abnormally high	- Incorrect linkage setting	Adjust the settings
	- Incorrect brake setting	Adjust the settings
	- High levels of dust in the drums	Remove the dust
	- Jaws, springs, drums damaged	Replace the damaged parts
	- Brake cables or link rod damaged	Replace the damaged parts
Jerky braking	- Incorrect linkage setting	Adjust the settings
	- Interfering parts on the slide	Remove, clean and grease
	- Corroded slide	Remove the corrosion and grease
	- Damage to slide guide rings	Replace the rings (and possibly the slide) and grease
	- Faulty shock absorber	Replace the shock absorber
Trailer tending to swerve upon braking	- Cross-bar(s) not balanced	Adjust the cross-bar(s)
	- Different brake setting on the two sides	Adjust the brake settings
	- Cables damaged or incorrectly fitted	Replace the damaged parts Refit the cables
	- Poor load distribution	Check the load distribution
When starting the trailer holds back the towing vehicle	- Damage to slide or to guide rings	Replace the faulty parts and grease
	- Slide corrosion	Remove the corrosion and grease
	- Tie rod damaged	Replace the tie rod and adjust the settings
	- Linkage damaged or incorrectly set	Replace the damaged parts and adjust the settings
	- Brake on	Loosen the brake
Play in the coupling head	- Head worn (see wear indicator)	Replace the head
	- Ball joint worn	Replace the ball joint
Parking braking too weak	- Compensating spring incorrectly set	Adjust the setting
	- Braking system incorrectly set	Adjust the setting
	- Notched sector damaged	Replace the sector and adjust the setting
	- Lever ratchet worn	Replace the lever and adjust the setting
	- Cable ruptured	Replace the cable and adjust the setting

4.8. Electrical connection diagram

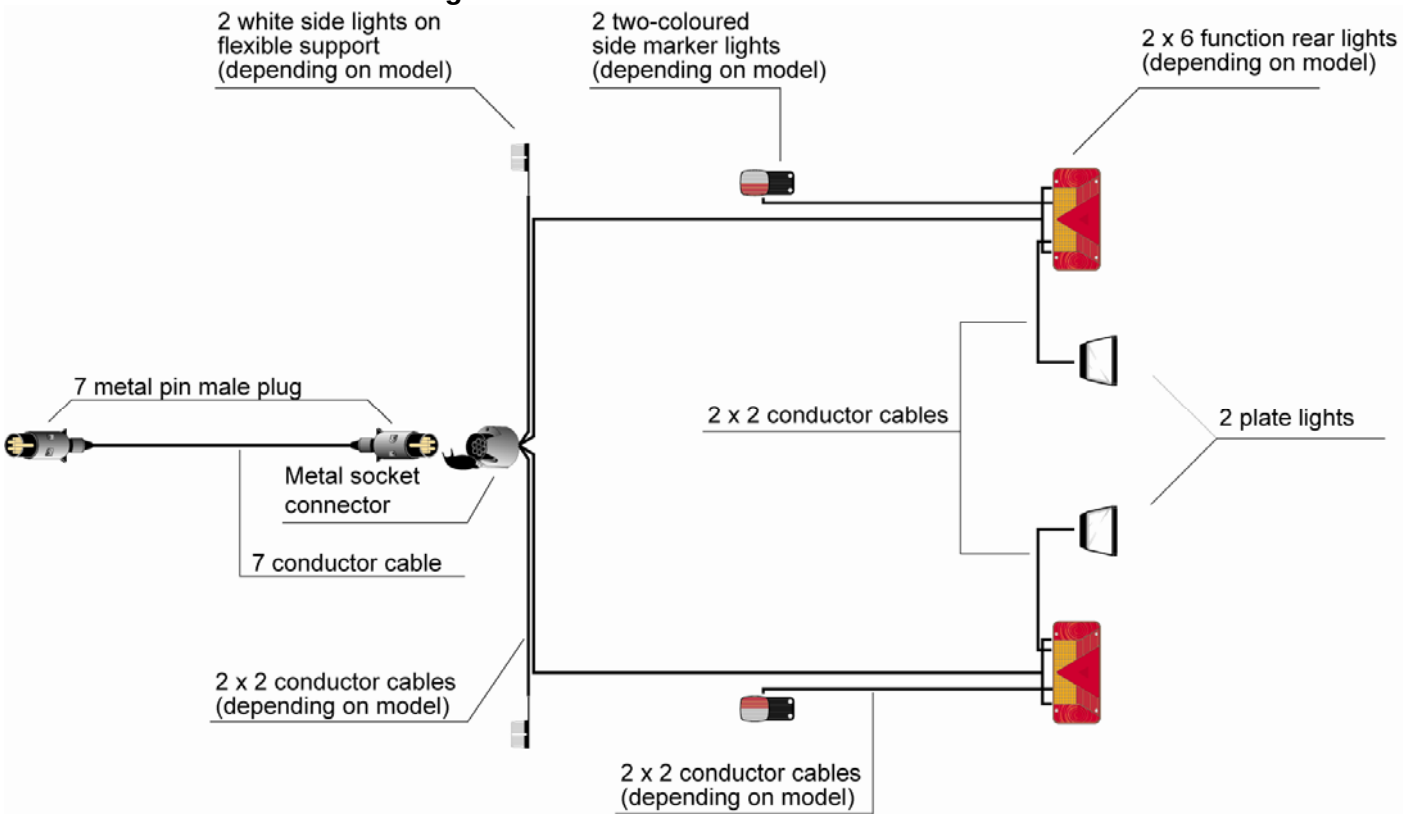


Figure 4.6 : Electrical connection diagram

4.9. Complete wheels technical information

TYRES					COMPLETE WHEELS	
Dimensions	Indices	Diameter (mm)	Cross section (mm)	Radius under load (mm)	Load (Kg)	Pressure (bar)
135 R 13	70 T	550	134	265	335	2.4
145 R 13	75 T	566	145	272	387	2.4
155 R 13	79 T	578	150	277	437	2.4
145/70 R 13	71 T	534	150	259	345	2.5
155/70 R 13	75 T	548	147	263	387	2.5
185/70 R 13	86 T	594	185	285	530	2.5
165 R 14 C	98 N	622	172	284	650	3.8
155/70 R12	100 N	525	155	244	650 (1) 800 (2)	6.25
185 R 14 C	102 P	650	188	316	675 (1) 850 (2)	4.5
195 R 14 C	106 P	666	198	32	950	4.5
195/50 x 10	98 N	450	190	-	750	6.0

(1) Wheel with 4 holes (2) Wheel with 5 holes

5. Preparation before operating the set

Danger	The inspections referred to in this section enable the electrical generator set to operate. Specific skills are required to carry out these operations. They must only be entrusted to personnel with the necessary skills. Failure to follow these instructions in any way could result in malfunction or very serious accidents.

5.1. Installation checks

- ✓ Check that the general recommendations given in the installation section (ventilation, exhaust, fluids, etc.) are observed.
- ✓ Carry out the level checks (oil, water, diesel fuel, battery).
- ✓ Check the generating set earth connection is earthed.
- ✓ Check that the electrical connections are in order.

5.2. Checks after starting the generating set

- ✓ Carry out the mechanical checks (oil pressure, water temperature, absence of noise etc.).
- ✓ Carry out the electrical checks (voltage and frequency).
- ✓ Carry out the safety checks (emergency stop, oil pressure, water temperature etc.).

6. Using the generator set

6.1. Pre-Start Inspection

Engine and engine compartment, general check

Visually check the engine and engine compartment before starting the engine and after stopping the engine.
Check:

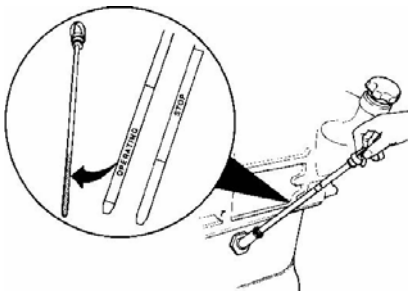
- ✓ There are no oil, fuel or coolant leaks.
- ✓ The screws are tightened.
- ✓ The condition of the belts (wear, tension).

Warning	Fuel, oil and grease deposits on the engine or in the engine compartment are always a fire hazard and must be removed as soon as they are noticed.

Important	If there are any oil, fuel or coolant leaks, locate the origin of the fault and repair it immediately before starting the engine.

Important	Never use a high pressure cleaner for cleaning the engine and equipment.

Oil level, check and top up



- ✓ The oil level must be checked every day before the first start-up.
- ✓ Check that it is between the MAX and MIN marks on the oil dipstick.
- ✓ If necessary, top up the oil through the filler opening, on the left-hand side of the engine.
- ✓ With the engine switched off, wait a few minutes for the oil to drain into the oil sump before checking the level.

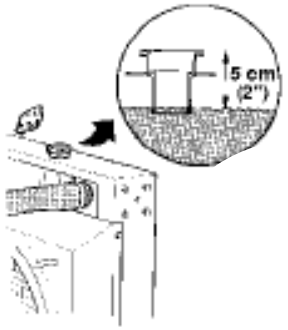
Important	Never fill oil past the maximum level. Only use oil of the recommended grade.

Coolant level, check

Warning	Do not open the filler cap when the engine is hot, except in an emergency. Boiling liquid or vapour may be ejected.

Important	The system must be filled up with liquid which has identical proportions to that already contained in the cooling system

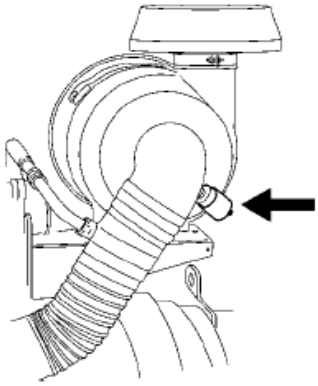
- ✓ Check the coolant level daily, before starting the equipment.
- ✓ Top up if necessary.
- ✓ The coolant level should be approximately 5 cm below the edge of the filler cap seal



Checking the air filter clogging indicator

Important	Special air filters must be used for extremely dusty conditions.

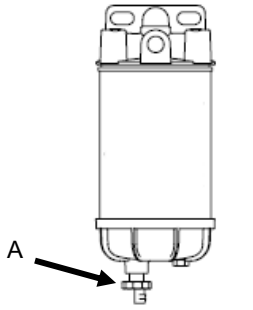
- ✓ The air filters must be replaced if the indicator remains in the red zone after the engine is stopped.
- ✓ After the filters have been replaced, press the button to reinitialise the indicator.



Checking the fuel pre-filter

Danger	**The fuel is highly flammable and its vapours are combustible.** **The fuel pre-filter must only be bled when the engine is stopped and cold.**

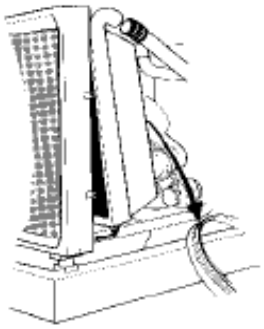
✓ Check that there is no water or sediment at the bottom of the pre-filter.
✓ If necessary, drain the pre-filter using the following procedure:



❶ Undo the drain plug (A) at the bottom of the pre-filter by two or three turns.
❷ Collect the water and/or sediment in a suitable container.
❸ When fuel starts to flow out, tighten the drain plug.
❹ Check that there are no leaks.
❺ If necessary, reprime the fuel circuit.

External check and cleaning of the radiator

Important	Do not use a high pressure cleaner to clean the radiator. Take care not to damage the radiator fins.



❶ Remove the guards to access the radiator.
❷ Clean with water and a gentle detergent. Clean using a soft brush.
❸ Refit the guards.

6.2. Generator set with NEXYS control panel

6.2.1 Control panel presentation

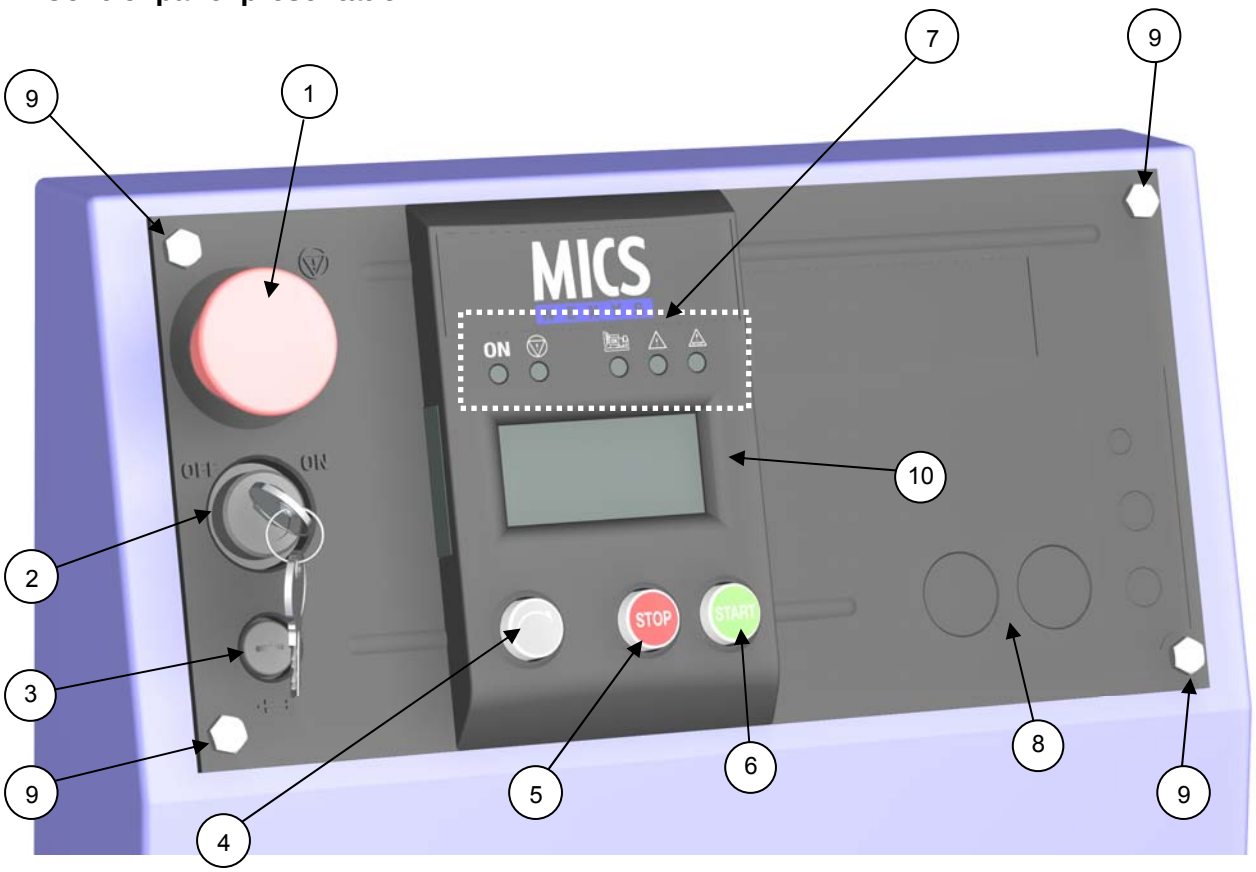


Figure 6.1 : View of the front side

① Emergency stop button for switching off the generating set in the event of a fault which could endanger personnel or damage equipment

② Key switch for starting up/shutting down the module and RESET function

③ Electronic card protection fuse

④ Screen-scroll button, press successively to access the various screens which are available

⑤ STOP button, press to switch off the generating set

⑥ START button, press to switch on the generating set

⑦ Normal operation LEDs and alarm and fault warning LEDs

⑧ Slot reserved for panel fascia options

⑨ Mounting bolt.

⑩ LCD for displaying alarms and faults, operating states, electrical and mechanical quantities

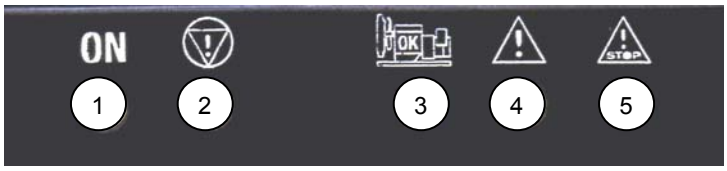


Figure 6.2 : Description of the LEDs

A lit LED indicates:

① Module being supplied (green, lights up and remains lit)

② Emergency stop activated (control panel or external emergency stop) (red, lights up and remains lit)

③ Visualisation of starting phase and speed/voltage stabilisation (flashing) and generating set operating OK or set ready to generate (green, lights up and remains lit)

④ General alarm (orange, flashing)

⑤ General fault (red, flashing).

6.2.1.1. Introduction to pictograms

The pictograms are as follows:

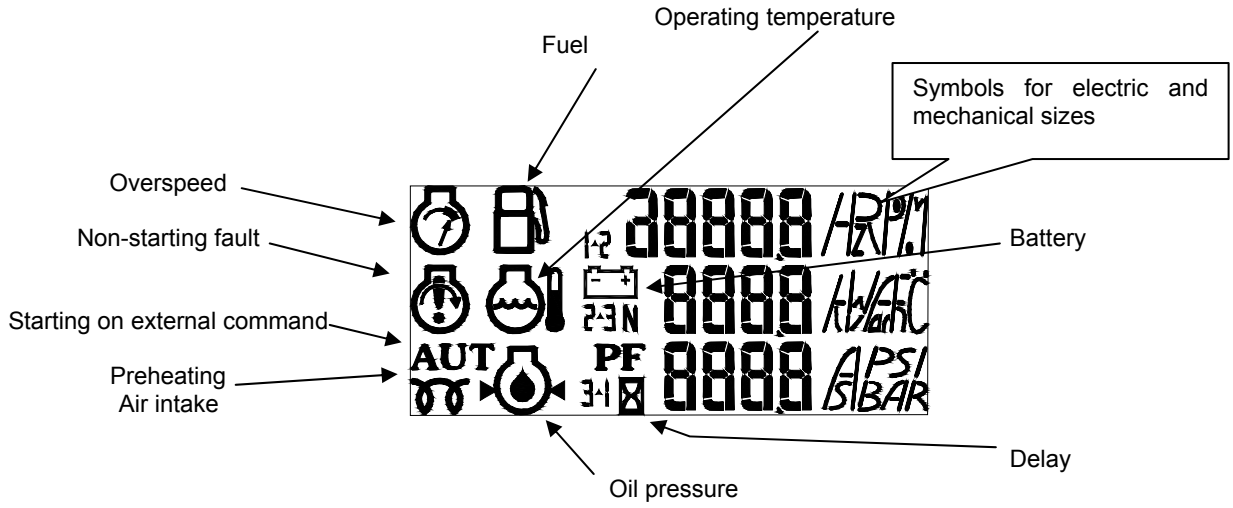


Figure 6.3: View of pictograms

- The "fuel level" pictogram is used to display the fault, the alarm and the fuel level.
- The "operating temperature" and "oil pressure" pictograms are used to display the fault and analog value
- The "overspeed" and "non-starting fault" pictograms are used to display the fault.
- The "battery" pictogram is used to display the "alternator charge" fault and to indicate the battery voltage.

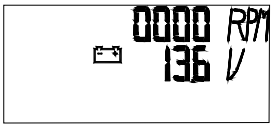
6.2.2 Manual starting

Danger	Check that the generating set circuit breaker has triggered.

❶ Connect the generating set battery.

❷ Turn the key switch to the ON position (without forcing it)

- ✓ All of the LEDs light up for 2 seconds, to confirm that they are operating correctly.
- ✓ If the LEDs do not light up, check the protection fuse and replace it if necessary.
- ✓ All the items on the screen are displayed for 2 seconds.
- ✓ Only the "ON" LED remains lit to indicate that the module is powered up.
- ✓ The following screen appears.

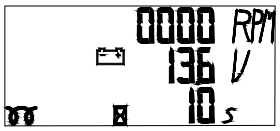


The first line displays the motor speed in RPM.
The second line displays the battery voltage in volts (V).

- ✓ Check the battery voltage (min. 12 V)

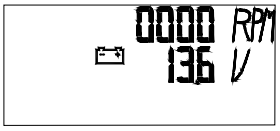
❸ Press (once briefly) the green "START" button.

- ✓ If the motor is equipped with an air preheating system, there is a 10-second delay before the motor starts (preheating activation period).
- ✓ The following screen appears

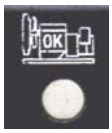


The third line displays the air preheating time remaining (with pictograms representing a resistor and an hourglass).

- ✓ If the motor is not fitted with an air preheating system or once the preheating delay has elapsed, the engine starts up (start of a cycle comprising 3 attempts to start up the engine).
- ✓ The following screen appears.



Warning	The number of successive and automatic starting attempts is limited to 3.

Note: the LED 

flashes as soon as the START button is pressed and continues to flash until the frequency stabilises if a "measurements" card has not been inserted and until the frequency and voltage stabilise if a "measurements" card has been inserted.

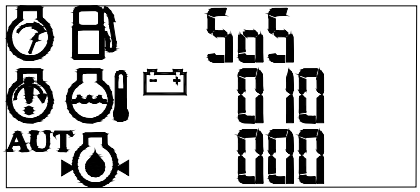
Following stabilisation, the LED light comes on continuously.

6.2.3 Switching off

❶ Trigger the circuit breaker located at the base of the centre console.
❷ Let the motor run under no load for 1 to 2 minutes to allow it to cool.
❸ Press the "STOP" button to stop the generating set.
❹ Switch off the MICS Nexys module by switching the key to "OFF" (without forcing it).

6.2.4 Alarms and faults

The appearance of a fault or an alarm causes the following screen to be displayed (one or more pictograms or a fault code along with the SOS message are displayed).



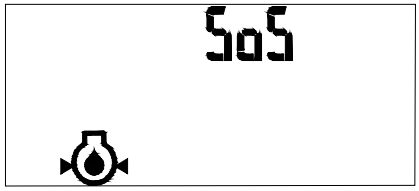
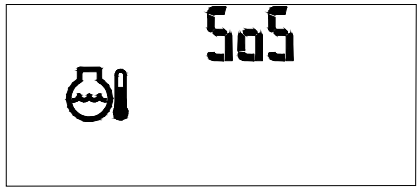
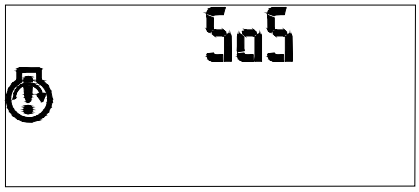
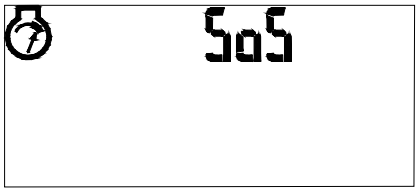
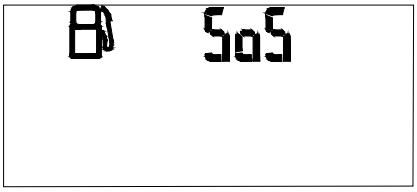
The user can access the following screens by pressing the key 

The fault or alarm screen will disappear once the fault or alarm has been removed.
Only one fault is displayed on this screen (the fault which caused the generating set to stop).
If one or more faults have appeared after the first fault, they can only be displayed after the first fault has been reset (press "Reset" as many times as the number of faults present).

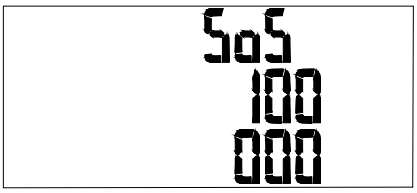
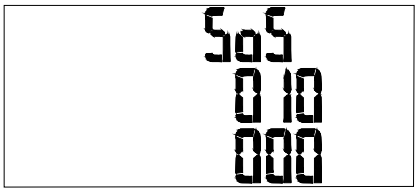
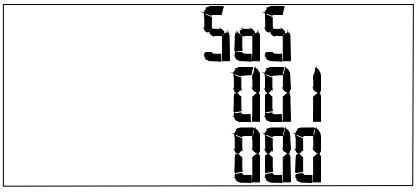
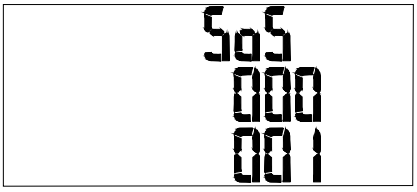
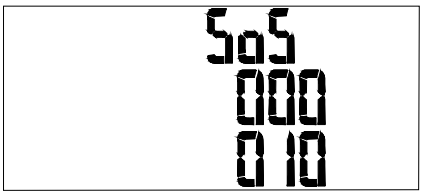
Note : an alarm can appear at the same time as a fault.

6.2.5 Faults and alarms - Details

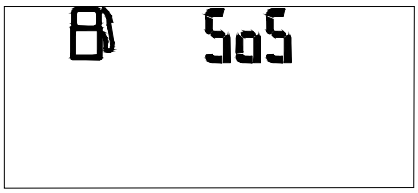
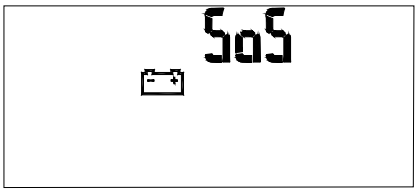
List of faults which will cause the generating set to stop and generate a pictogram

Oil pressure fault: Indicates that the oil pressure is incorrect	Associated pictogram 
Engine temperature fault: Indicates that the engine temperature is too high.	Associated pictogram 
Non-starting fault: Indicates that there have been three consecutive unsuccessful starting attempts.	Associated pictogram 
Overspeed fault: Indicates an excessive generating set running speed.	Associated pictogram 
Low fuel level fault: Indicates the need to top up the fuel.	Associated pictogram 

List of faults which will cause the generating set to stop and generate a fault code

Low coolant level fault: indicates that the level of coolant is low in the radiator (linked to a two second time delay). Or Overload or short-circuit fault (optional): with the circuit breaker SD contact closing (overload or short-circuit), the generating set switches off immediately also causing the main circuit breaker to be triggered.	Associated message 
Additional fault linked to message opposite: is displayed in the following two cases: ➢ Differential fault (1) ➢ insulation fault (2) (1) Differential fault (optional): with a differential fault causing the activation of the differential relay, the generating set stops immediately also causing the main circuit breaker to be tripped. (2) Insulation fault (optional): with an insulation fault causing the activation of the control unit performing insulation, the generating set stops immediately.	Associated message 
Underspeed fault: indicates an incorrect rotation speed (below 1000 rpm).	Associated message 
Emergency stop or external emergency stop fault	Associated message 
"STOP" fault activated if the "STOP" button is pressed whilst the "AUT" LED is flashing to indicate that the generating set is operating in automatic mode.	Associated message 

List of alarms associated with a pictogram

Low fuel level alarm: Indicates the need to fill up with fuel.	Associated pictogram 
"Alternator charging fault" alarm indicates a problem affecting the alternator charging rate.	Associated pictogram 

6.3. Generator set with TELYS control panel

6.3.1 Control panel presentation

6.3.1.1. View of the front panel

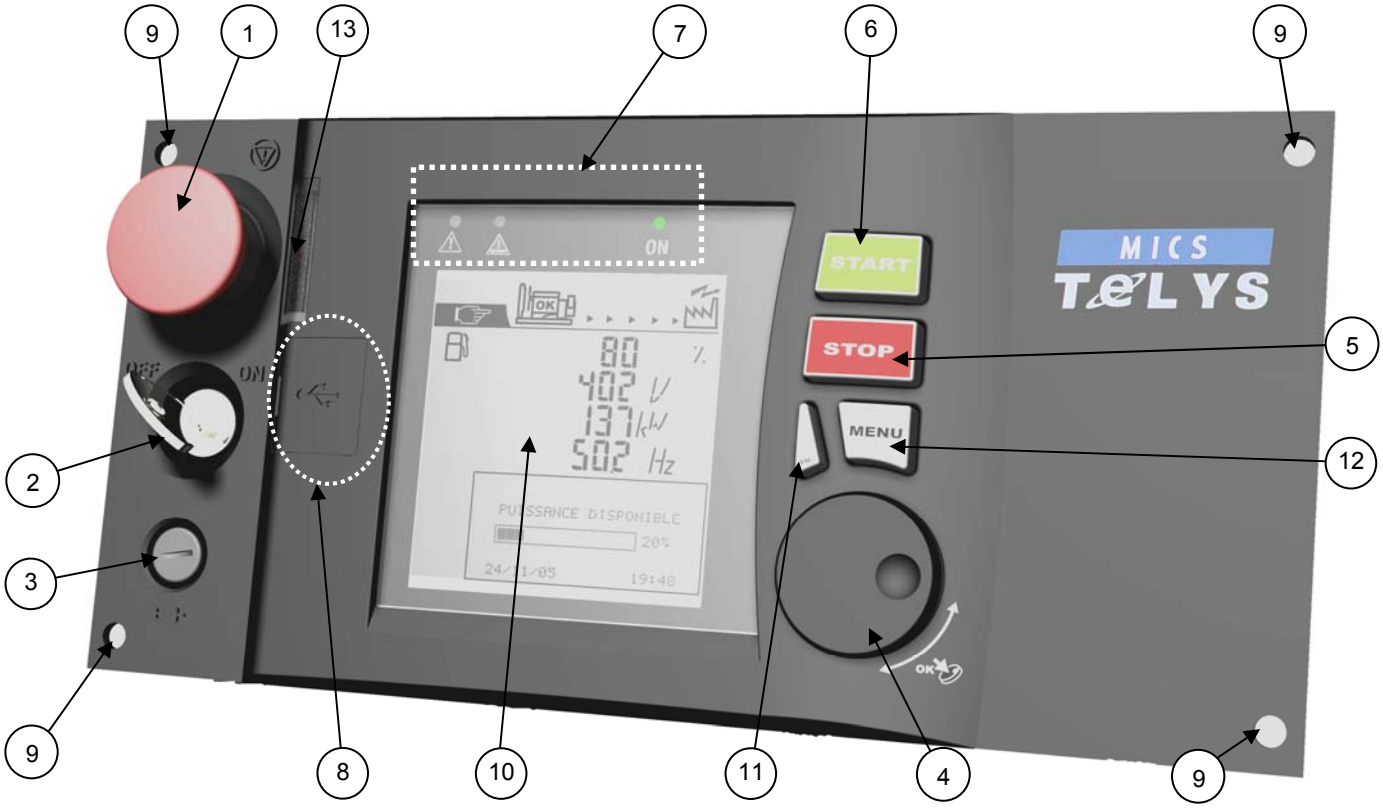


Figure 6.4 : View of the front panel

1 Emergency stop button (AU) for switching off the generating set in the event of a fault which could endanger personnel or damage equipment.
2 Key switch for switching the module on/off.
3 Electronic board protection fuse.
4 Scrolling and selection wheel for scrolling through the menus and screens and selecting items simply by pressing the wheel.
5 STOP button, press to switch off the generating set.
6 START button, press to switch on the generating set.
7 Power ON LEDs and alarm/fault warning LEDs.
8 Location of USB ports.
9 Mounting bolt.
10 LCD for displaying alarms and faults, operating statuses, electrical and mechanical quantities.
11 ESC button: for returning to the previous selection and for default RESET function.
12 MENU button for accessing the menus.
13 Lighting for the emergency stop button.

Figure 6.5 : Description of the LEDs

A lit LED indicates:

1 Alarm activated (flashing yellow).
2 Fault found (flashing red).
3 Module on (green, on continuously).

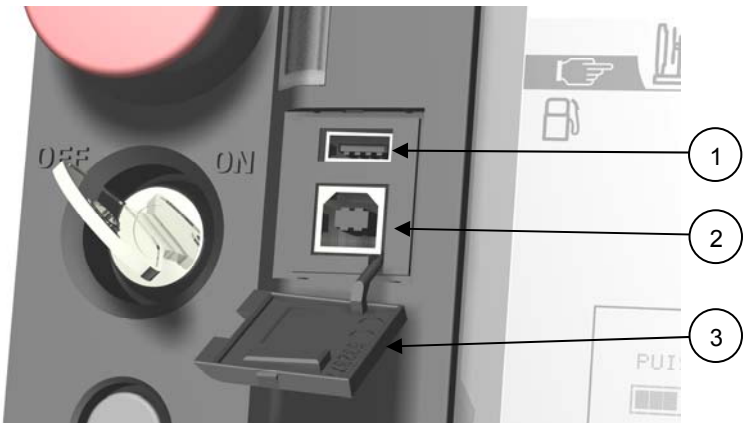


Figure 6.6 : Close-up of USB ports

1 USB key connection (HOST): file transfer between USB key and TELYS and vice versa.
2 Connection for microcomputer (DEVICE):
- file transfer between PC and TELYS and vice versa,
- main module power supply.

3 Protective cover.

6.3.1.2. Description of the screen

The screen is backlit and requires no contrast adjustments. This screen is divided into 4 zones.

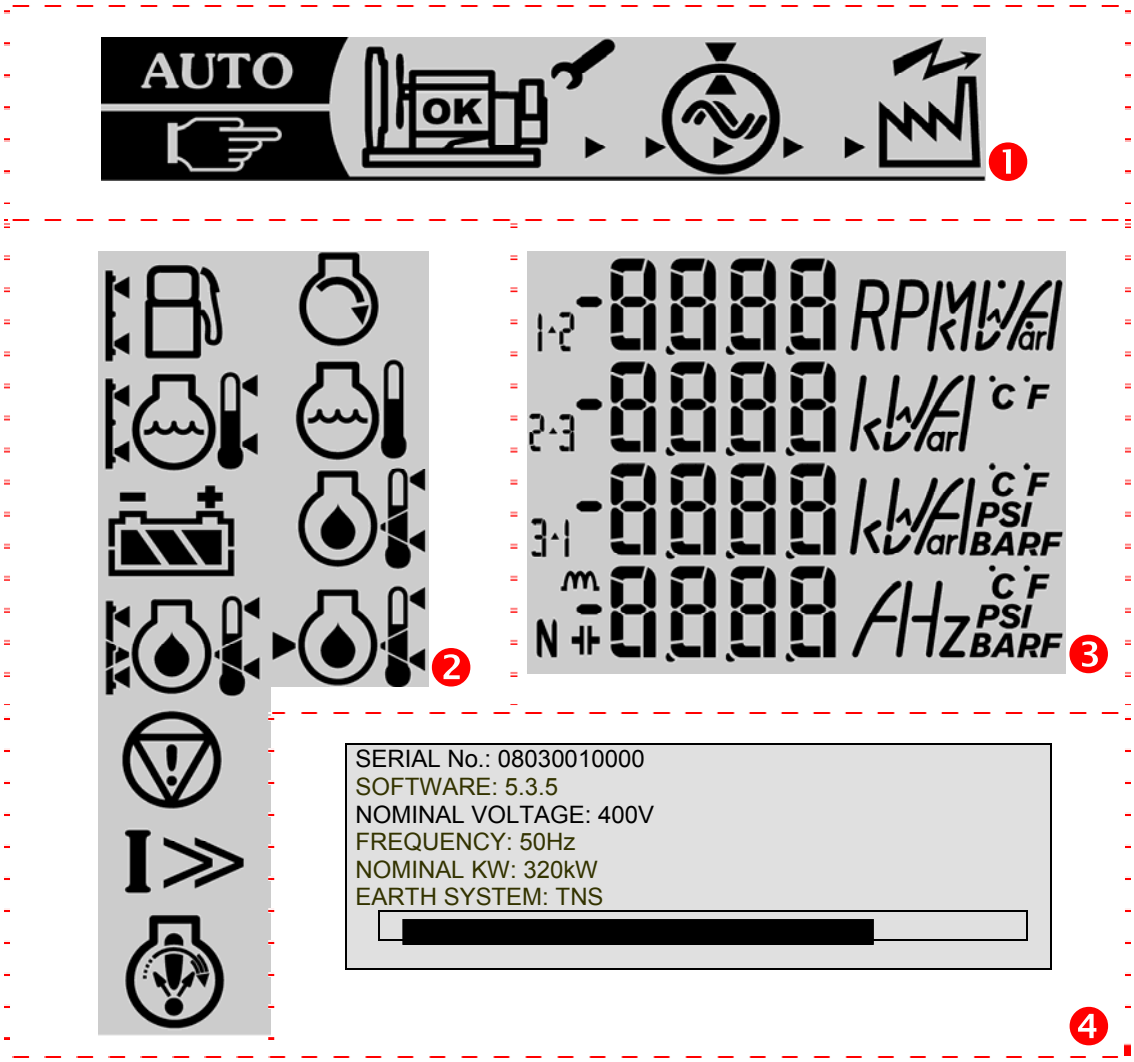


Figure 6.7 : Description of the screen (example)

❶ Zone 1 : in this zone, the status of the generating set is displayed

❷ Zone 2 : in this zone, pictograms relating to dimensions measured are displayed, as well as Alarm and Fault pictograms

❸ Zone 3 : in this zone, the measured values corresponding to the measured dimensions are displayed with the corresponding units of measurement

❹ Zone 4 : in this zone, messages relating to the control of the generating set and the menus are displayed.

Note : The information displayed on measurements, alarms and faults as well as messages and menus relating to control of the generating set will depend on the equipment level of each generating set. Certain screens may therefore not be present.

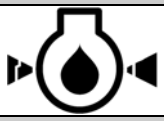
6.3.1.3. Description of the pictograms in zone 1

Pictograms in zone 1

Pictograms	Display	Activation conditions
 "MANU" Mode	Fixed	TELYS in manual mode (MANU)
	Flashing	For 5 seconds when switching from AUTO mode to MANU mode
 "AUTO" Mode	Fixed	TELYS in automatic mode (AUTO)
	Flashing	For 5 seconds when switching from MANU mode to AUTO mode
	Flashing	Generating set in start-up phase
	Fixed	Generating set started
	Fixed	Generating set stabilised (voltage and frequency)
	Flashing (appearance of constant movement from left to right)	The generating set is powering the installation
	Fixed	The installation is supplied
	Not used	
	Not used	

6.3.1.4. Description of the pictograms in zone 2

Alarm and fault pictograms in zone 2
All the pictograms in this zone are activated when TELYS is initialised.

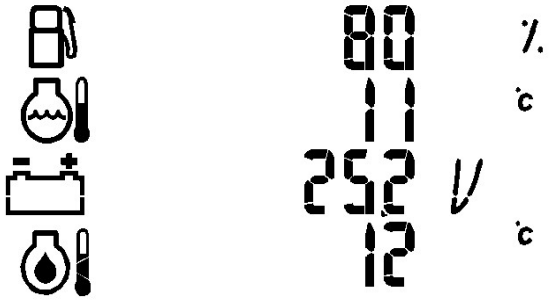
Data displayed			
Fuel level indicator			
Alarm / Fault low fuel level 		Alarm / Fault high fuel level 	
Coolant level / temperature indicator			
Alarm Low level fault 	High level fault alarm 	Alarm High temperature fault 	No preheating fault alarm 
Battery			
Min battery voltage (flashing) 	 Max battery voltage (flashing)		Battery charge indicator (flashing bars)
Oil pressure / temperature indicator			
Oil pressure Alarm / Fault 	High or low oil level Alarm / Fault 	 High or low oil temperature Alarm / Fault	
Emergency stop			
Emergency stop fault 			
Overload or short circuit			
Tripping of circuit breaker following an overload or short circuit 			
Engine speed			
Underspeed fault 	Overspeed fault 	Non-starting fault 	

6.3.1.5. Description of the pictograms in zone 3

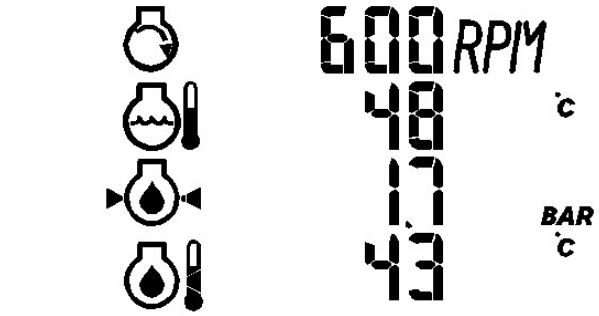
Pictograms in zone 3

All the pictograms in these zones are activated when TELYS is initialised. The pictograms below are given as examples.

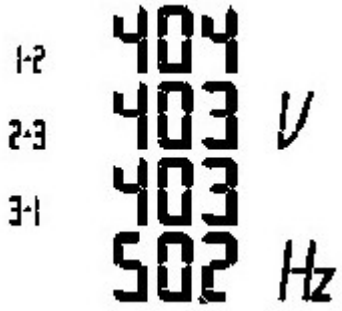
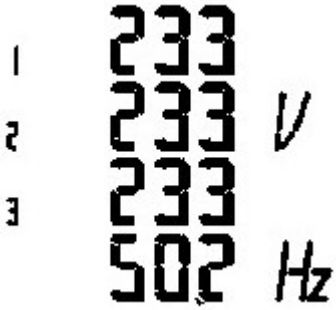
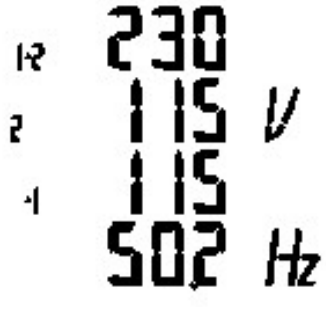
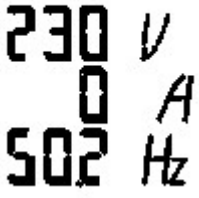
Generating set stopped

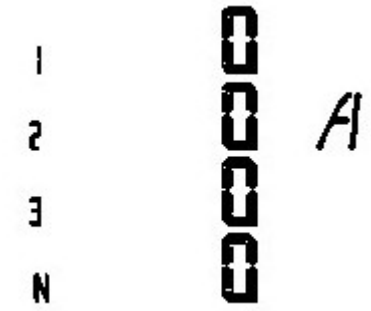
Screen no.	Pictograms	Data displayed
P1		Fuel Level Indicator Indication of Temperature of High Temperature coolant (HT) (units according to settings menu) Indication of Battery Voltage Indication of Oil Temperature (units according to settings menu)

Generating set start-up or generating set started or generating set switching off in progress

Screen no.	Pictograms	Data displayed
P2		Engine Speed Indication Indication of Temperature of High Temperature coolant (units according to settings menu) Indication of Oil Pressure (units according to settings) Indication of Oil Temperature (units according to settings menu)

Generating set started

Screen no.	Pictograms	Data displayed
P3 Default screen in operation		Fuel Level Indicator Alternator composite Voltage Indicator Total Active Power Indicator Alternator Frequency Indicator
P4		U12 Alternator composite Voltage Indicator U23 Alternator composite Voltage Indicator U31 Alternator composite Voltage Indicator Alternator Frequency Indicator
P5		V1 Alternator single Voltage Indicator V2 Alternator single Voltage Indicator V3 Alternator single Voltage Indicator Alternator Frequency Indicator
P6		U12 Alternator composite Voltage Indicator V2 Alternator single Voltage Indicator V1 Alternator single Voltage Indicator Alternator Frequency Indicator
P7		V1 Alternator single Voltage Indicator Single phase Alternator current indicator Alternator Frequency Indicator

Screen no.	Pictograms	Data displayed
P8		Single phase Alternator current indicator Two phase Alternator current indicator Three phase Alternator current indicator Neutral Alternator current indicator
P9		Total Active Power Indicator Total Reactive Power Indicator Total Effective Power Indicator Total Power Factor Indicator (lagging or leading)
P10		Fuel Level Indicator Indication of Battery Voltage Indication of Battery Amps

Screen order of appearance according to network type with the generating set on.

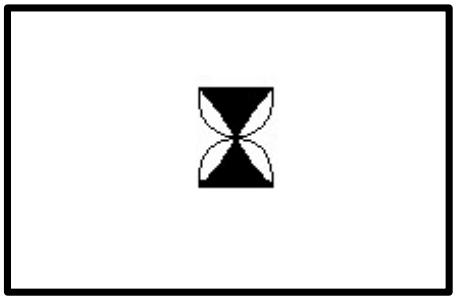
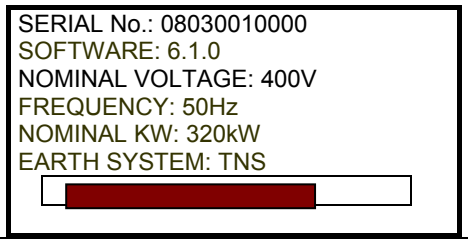
	Type of network			
Order of appearance	**3P+N**	**3P**	**2P+N**	**1P+N**
1	P3	P3	P3	P3
2	P4	P4	P6	P7
3	P5	P8	P8	P9
4	P8	P9	P9	P2
5	P9	P2	P2	P10
6	P2	P10	P10	
7	P10			

Change screens by using the scrolling and selection wheel.
When the wheel is rotated clockwise, the screens scroll upwards and vice-versa.
The screens scroll in a loop.
E.g.: On three-phase + neutral network, then screen 7, then screen 1 and vice-versa.

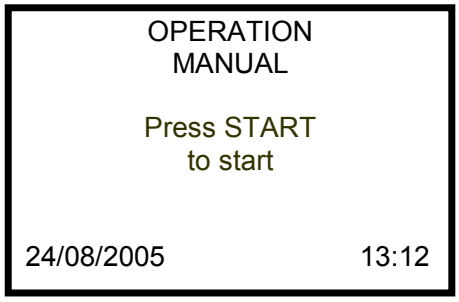
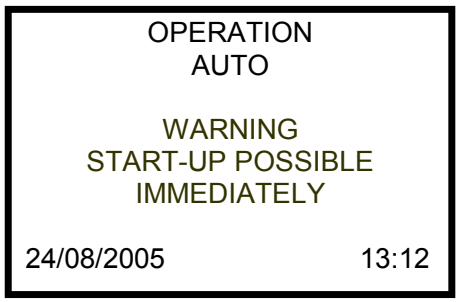
6.3.1.6. Display of messages in zone 4

The display (zone 4), among other things, displays messages relating to the operation of the generating set. The messages are as follows:

Initialisation of TELYS

Screen no.	Screen	Data displayed
G 1		Initialisation of TELYS when the power is switched on and/or when loading a configuration
G 2		Generating set serial no. Software version of TELYS Alternator Nominal Voltage Alternator Nominal Frequency Nominal Active Output Neutral Point Bar graph indicating the display delay of the screen

Generating set stopped

Screen no.	Screen	Data displayed
G 3		Operating mode - generating set in Manual Mode ready to start Date and time (depending on settings)
G 4		Operating mode - generating set in Auto Mode ready to start Date and time (depending on settings)
G 5		Operating mode - generating set in Auto Mode with programmed start Countdown to micro disconnection delay or EJP notice delay (for France only) Date and time (depending on settings)

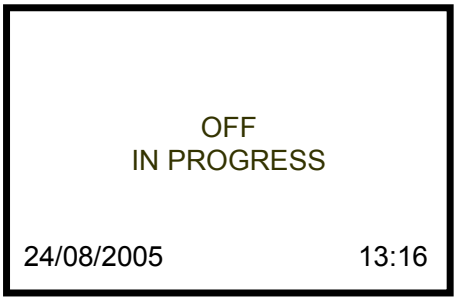
Generating set start-up

Screen no.	Screen	Data displayed
G 6	START-UP IN PROGRESS 24/08/2005 13:12	Operating phase - generating set in starting phase Date and time (depending on settings)
G 7	AIR PREHEATING 10 seconds 24/08/2005 13:12	Operating phase - air preheating prior to starting generating set Countdown for air preheating delay Date and time (depending on settings)

Generating set started

Screen no.	Screen	Data displayed
G 8 Default screen	AVAILABLE POWER 75% 24/08/2005 13:12	Operating phase – generating set in operation – stable voltage and frequency Available power Date and time (depending on settings)
G 9	AUTOMATIC STOP IN PROGRESS LOAD SUPPRESSION 1 min 30 sec 24/08/2005 13:12	Operating mode - operation in Auto Mode Opening of power supply device (motorised circuit breaker or source changeover switch controlled by TELYS) Countdown for the mains return delay OR the load test delay Date and time (depending on settings)
G 10	AUTOMATIC STOP IN PROGRESS COOLING DOWN 1 min 30 sec 24/08/2005 13:14	Operating mode - operation in Auto Mode Generation set cooling in progress Countdown for Engine Stop delay (cooling) OR Gradual Stop delay (Coolant temperature) OR Overload Gradual Stop delay OR OFF load test delay Date and time (depending on settings)

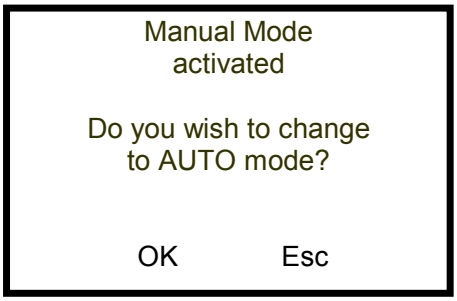
Generating setstop

Screen no.	Screen	Data displayed
G 11		Generating set stop in progress Date and time (depending on settings)

Operating mode changeover (switching from Manual Mode to Auto Mode following auto start demand)

Screen no.	Screen	Data displayed
G 12		Operating mode - operation in Manual Mode AUTOMATIC start demand

Generating set stop request due to fault or by pressing STOP in Auto Mode

Screen no.	Screen	Data displayed
G 13		Operating mode - operation in Auto Mode (generating set in operation) Warning message for switching to Manual Mode after the STOP button has been pressed or a fault has appeared

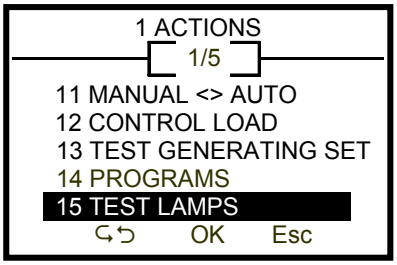
6.3.2 Starting

Danger	Check that the generating set circuit breaker has triggered.

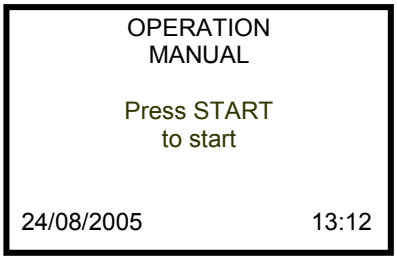
❶ Connect the generating set battery

❷ Turn the key switch to the ON position (without forcing it to the ON position), the ON lamp will light up (if the lamp does not light up, check and replace the fuse if necessary)

❸ Test the Alarm and Fault LEDs (menu 15 – TEST LAMPS)

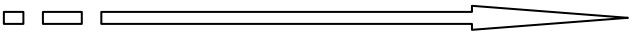


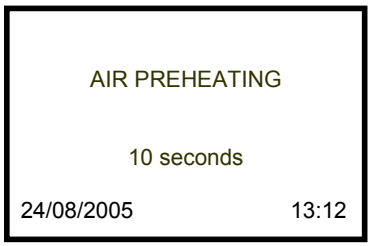
❹ Press "Esc" several times to return to the following home menu

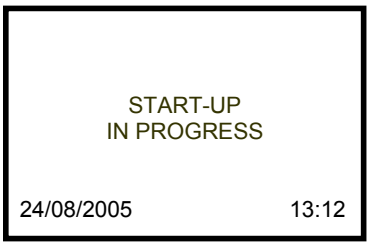


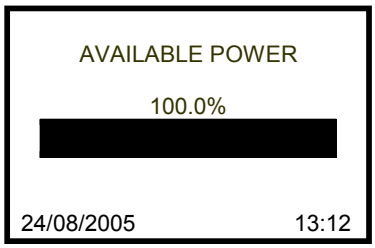
❺ Check the battery voltage 

❻ Press START:









- If the engine is equipped with an air preheating system, there is a delay (adjustable) before the engine starts (preheating activation period).
- If the motor is not fitted with an air preheating system or once the preheating delay has elapsed, the engine starts up (start of a cycle comprising 3 attempts to start up the engine).

Warning: the number of successive and automatic starting attempts is limited to 3.

The following pictogram will flash

The following pictogram is displayed

The following information is displayed

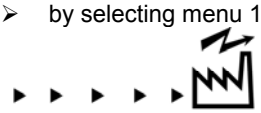
	Speed of rotation	
	Coolant temperature	Options
	Oil pressure	
	Oil Temperature	

6.3.3 Switching off

❶ Open the circuit breaker

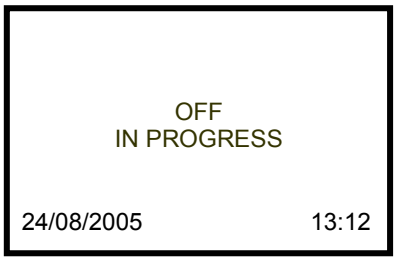
- manually OR
- by selecting menu 12 "CONTROL LOAD"

The following display will disappear (supply stopped)



❷ Press the STOP button

❸ The following screen is displayed and the generating set will stop



❹ Switch TELYS off by turning the key to "OFF" (without forcing it to the "OFF" position).

6.3.4 Alarms and faults

6.3.4.1. Viewing alarms and faults

Alarms and faults are displayed as follows:

① Alarms

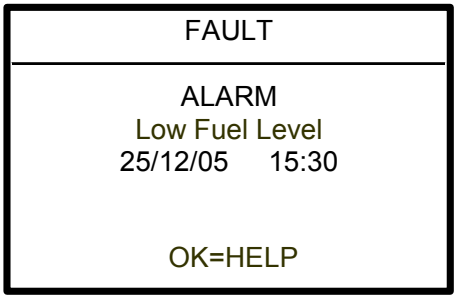
All alarms will cause:

- the yellow LED to flash "General alarm".

In conjunction with this LED:

- a flashing pictogram appears on the LCD screen representing the circuit affected by the alarm and the associated indicator, if present
  (example)

- message on graphic display
  (example)



② Faults

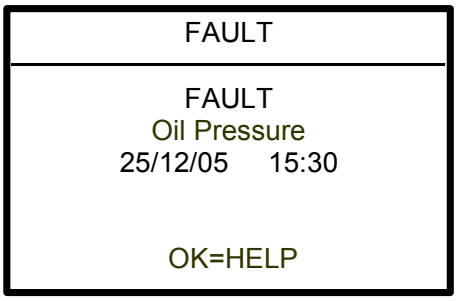
All faults will cause:

- **the generating set to stop: immediate or gradual stop (coolant temperature and overload or short circuit)**
- the red LED to flash "General fault".

In conjunction with this LED:

- a flashing pictogram appears on the LCD screen representing the circuit affected by the fault and the associated indicator, if present
  (example)

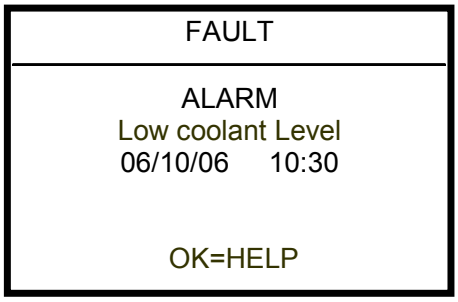
- message on graphic display
  (example)

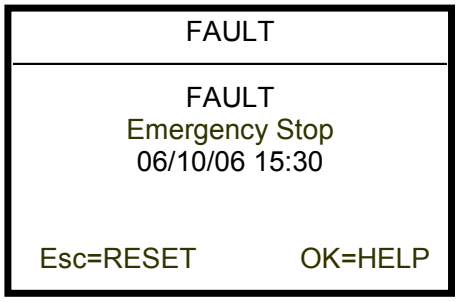


Faults have priority over alarms. Faults are displayed in the descending order of their appearance (from the most recent to the oldest).

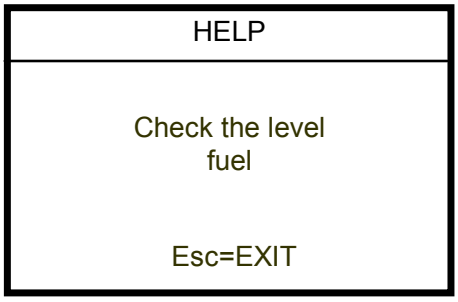
6.3.4.2. Activation of an alarm or fault

The appearance of an alarm **or** a fault causes the corresponding screen to be displayed (examples below)





Press OK (on the scrolling and selection wheel) to access the help message if it is available (example below)



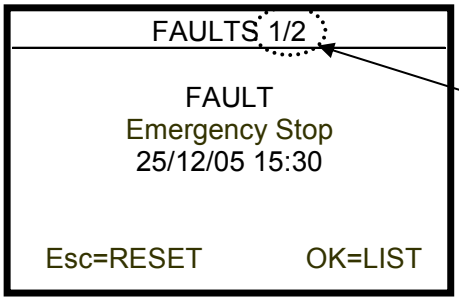
If the alarm is no longer active, it is reset automatically (cause disappears).
Press Esc to reset a fault:

- reset acknowledged if the cause of the fault has been removed
- reset not performed if the cause of the fault is still present.

6.3.4.3. Activation of an alarm and a fault

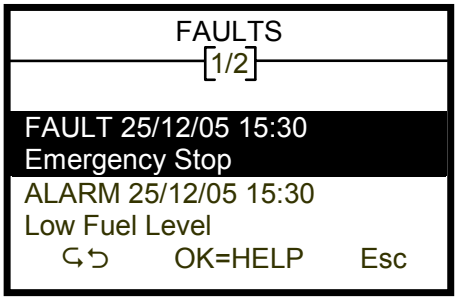
The appearance of an alarm **and** a fault causes:

- The yellow and red LEDs to flash
- the related screen to be displayed (example below)

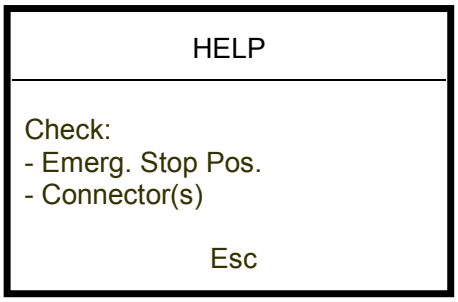


If several faults are present, the number of faults is displayed at the top of the screen.

The faults list can be accessed by pressing OK (of the scrolling and selection wheel) (examples below)



Press Esc to return to the previous screen.
Press OK to go to the HELP screen (help on the highlighted fault)
Use the scrolling and selection wheel to scroll through the list of faults.



If the alarm is no longer active, it is reset automatically (cause disappears).
Press Esc to reset a fault:

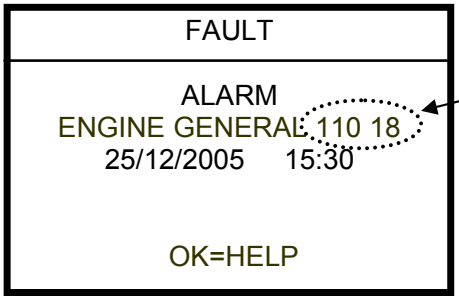
- reset acknowledged if the cause of the fault has been removed
- reset not performed if the cause of the fault is still present.

6.3.4.4. Engine fault codes display

Certain alarms and engine faults generate specific fault codes. These codes are standardised according to the J1939 and/or J1587 standards, except for MTU engines that have a specific transmission protocol (see appendix, if applicable).

Terminology used by the SAE CAN J1939 standard	
SPN: Suspect Parameter Number	This represents the system or component at fault, for example: SPN 100, indicates an oil pressure problem or a problem with the oil pressure sensor.
FMI: Failure Mode identifier	This represents the type of fault that has occurred. This may be an electrical, mechanical or equipment fault.
Terminology used by VOLVO	
SID: System Identifier	This term, used in the J1587 standard, has an equivalent in the J1939 standard (SPN). However, this term corresponds, more particularly, to an assembly of components, for example, the injection system.
PID: Parameter Identifier	This term, used in the J1587 standard, has an equivalent in the J1939 standard (SPN). However, this term corresponds, more particularly, to a specific component, for example, a sensor.
PPID: Parameter Identifier	This term, used in the J1587 standard, has an equivalent in the J1939 standard (SPN). PPID corresponds to PID, but is only used by VOLVO.
FMI: Failure Mode identifier	This represents the type of fault that has occurred. This may be an electrical, mechanical or equipment fault. VOLVO uses a SID-FMI or PID-FMI or PPID-FMI combination.
Terminology used by PERKINS	
CID: Component parameter	This term used by PERKINS has an equivalent in the J1939 standard (SPN).
FMI: Failure Mode identifier	This represents the type of fault that has occurred. This may be an electrical, mechanical or equipment fault.
Terminology used by JOHN DEERE	
SPN: Suspect Parameter Number	This represents the system or component at fault, for example: SPN 100, indicates an oil pressure problem or a problem with the oil pressure sensor.
FMI: Failure Mode identifier	This represents the type of fault that has occurred. This may be an electrical, mechanical or equipment fault.
Terminology used by MTU	
Displaying faults	The ADEC and MDEC general system faults are indicated on the equipment in the following way: fault code numbers (generated by the ECU - Engine control unit).

In the event of a fault, the screen will display the following message:



Engine fault code.
Pressing OK will display fault finding information.
In addition, appendix D indicate the meaning of the code. The checking and maintenance operations to carry out in order to solve the fault are included in the user and maintenance manuals of the engines supplied with the generating set documentation.

For JOHN DEERE (JD), PERKINS (PE) and VOLVO (VO) engines, the codes displayed are SPN and FMI codes.

6.3.4.5. Horn reset

Depending on the settings made (menu 363 - HORN), the activation of an alarm and/or a fault leads to the horn sounding and the following screen appearing:

This screen will display first any messages relating to the alarms and faults that appear as soon as OK is pressed.

7. Maintenance schedule

7.1. Reminder of use

The maintenance interval frequency and the operations to be carried out are outlined in the maintenance schedule, given as a guideline.
N.B. the environment in which the generating set is operating determines this schedule.
If the generating set is used in extreme conditions, shorter intervals between maintenance procedures should be observed
These maintenance intervals only apply to generating sets running on fuel, oil and coolant which conform to the specifications given in this manual.

7.2. Engine

Component	Operation	Before starting	First 100 - 200 hours	50 hrs	6 months	50 - 600 hrs	500 hrs
Engine	Check the sealing (1)	●					
Oil level	Check and Top up	●					
Coolant	Check the level	●					
Radiator	Check the outside and clean	●					
Air filter	Check the clogging indicator (1-2)	●					
Injectors	Tighten to 50Nm (36.88 lbf ft)*		●				
Valve clearance	Check/adjust *		●				
Batteries	Check the electrolyte level			●			
Fuel pre-filter	Drain the water and sediment			●			
Coolant filter	Replace (3)				●		
Engine oil	Drain (4)					●	
Oil filter	Replace					●	
Drive belts	Check the voltage						●

* Operation to be carried out by one of our agents.
(1) When operating continuously, the check must be carried out at least every 8 hours.
(2) The air filters must be replaced when the indicator stays in the red zone after the engine is stopped. Special air filters must be used for extremely dusty conditions.
(3) The filter must never be replaced when the coolant is drained.
(4) The oil service intervals vary depending on the oil grade and the fuel sulphur content (see engine appendix).

Component	Operation	1000 hrs	1500 hrs	2000 hrs	2400 hrs	3000 hrs	5000 hrs
Air ducts	Check that they are sealed	●					
Fuel filter	Replace	●					
Valve clearance	Check/adjust *		●				
Air filter	Clean (5)			●			
Engine and equipment	Carry out a general check*				●		
Turbocharger	Check*				●		
Injectors	Check*					●	
Coolant	Replace						●

* This operation should be carried out by one of our agents.
(5) In extremely dusty conditions, cleaning must be carried out more often.

7.3. Alternator

- ✓ After 20 hours in operation, check the tightness of all the mounting bolts, the general condition of the machine and the various electrical connections of the installation.
- ✓ The bearings fitted on the machine are greased for life to around the service life of the grease (depending on use) = 20 000 hours or 3 years.
- ✓ Regularly clean the inlet and outlet grid.

8. Battery

	Fit the battery so that it is properly ventilated. Maintenance should only be carried out by qualified personnel. If replacing the batteries, use the same type of batteries. Do not throw the old battery in the fire. Only use insulated tools (the operator should not be wearing a watch, chain or any metal object). Never use sulphuric acid or acid water to top up the electrolyte level. Use an approved battery fluid. Batteries release oxygen and hydrogen gas, which are flammable. Never bring flames or sparks near the battery (risk of explosion). Discharge any static electricity before handling the batteries by first touching an earthed metal surface. Do not use the battery when the fluid level is below the minimum required level Using a battery with a low electrolyte level could result in an explosion. Do not short the battery terminals with a tool or other metal object. When disconnecting battery cables, remove the cable from the negative (-) terminal first. When reconnecting the battery, connect the positive lead (+) first. Charge the battery in a well-ventilated place, with all the filler caps opened. Ensure that the battery terminals are correctly tightened. A loose cable clamp can cause sparks that could result in an explosion.
Danger	Before servicing electrical components or performing electric welding, set the battery switch to the [OFF] position or disconnect the battery negative cable (-) to cut off the electrical current. Electrolyte contains dilute sulphuric acid. Careless handling of the battery causing contact with sulphuric acid could damage your eyesight or cause burns. Wear safety goggles and rubber gloves when working with the battery (topping-up fluid, charging, etc.) If electrolyte comes into contact with your skin or clothes, wash it off immediately with plenty of water, then carefully wash the area with soap. If electrolyte comes into contact with your eyes, rinse immediately with plenty of water and seek medical attention as soon as possible. If electrolyte is accidentally swallowed, gargle with plenty of water and drink large quantities of water. Consult a doctor immediately. Large quantities of electrolyte should be rinsed off using a neutralising agent. A common method is to use a solution of 500g of bicarbonate of soda diluted in 4 litres of water. The bicarbonate of soda solution should be added until the reaction has finished (lather). The remaining liquid should be rinsed off with water and left to dry.

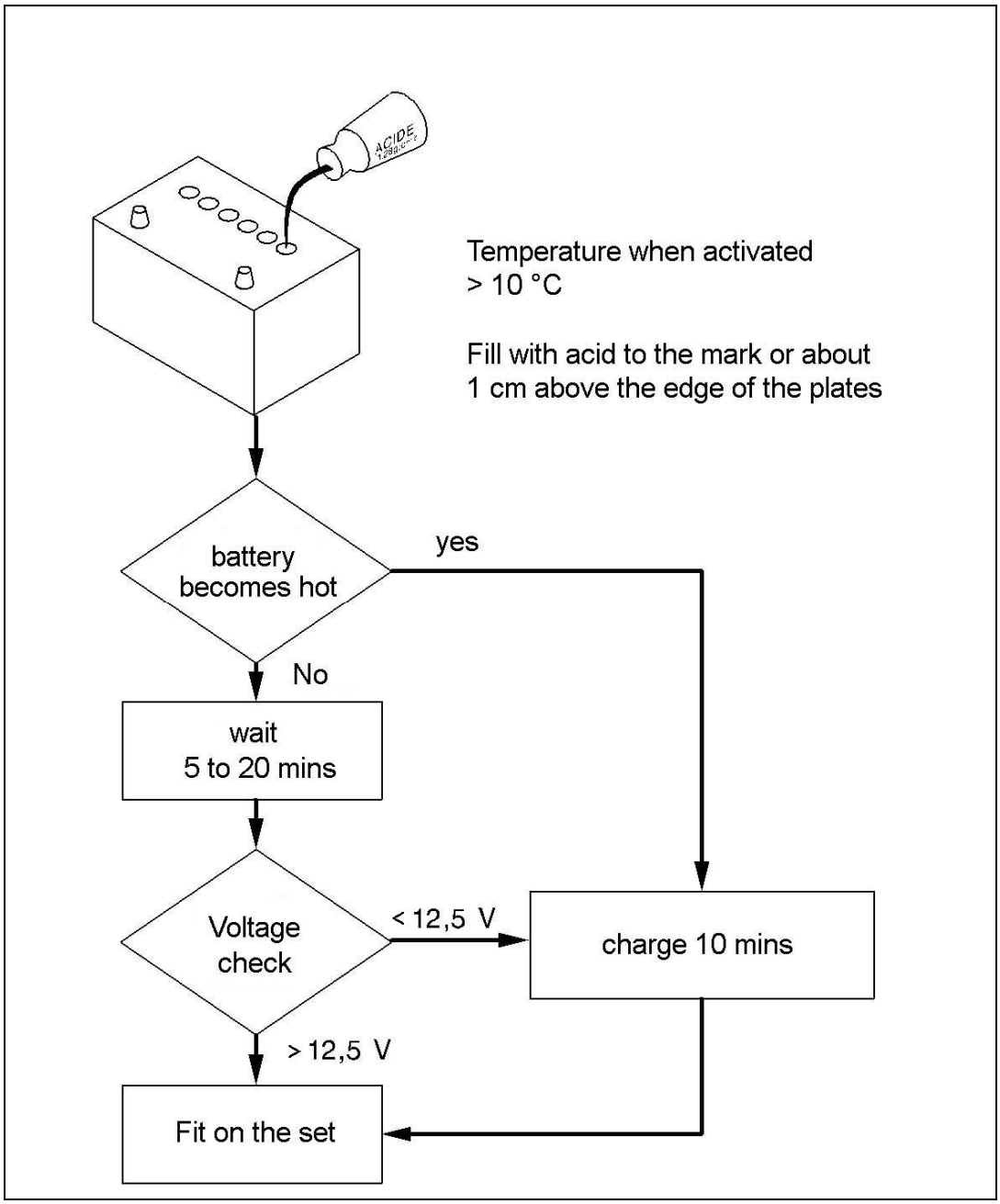
- ✓ Dry batteries do not require any servicing
- ✓ Batteries ready for use must be recharged at the latest when the acid density drops below 1.20.

8.1. Storage and transport

- ✓ Batteries ready for use must be stored in a cool and dry place (frost-free) protected from the sun (self-discharge).
- ✓ Batteries must be transported and stored vertically (risk of acid spillage)
- ✓ Leave the terminal cover on the positive terminal

8.2. Battery setting into service

- ✓ Batteries filled with acid have a density of 1.28 g/ml and are charged.
- ✓ In the case of dry batteries, fill each battery cell with acid up to the maximum level mark or to 15 mm above the plates. Let the battery rest for 20 minutes.
- ✓ Before fitting the battery, stop the engine and any power consumer, clean the terminals and give them a light coating of grease. When connecting, connect the positive terminal (+) first, and then the negative terminal (-).



8.3. Check

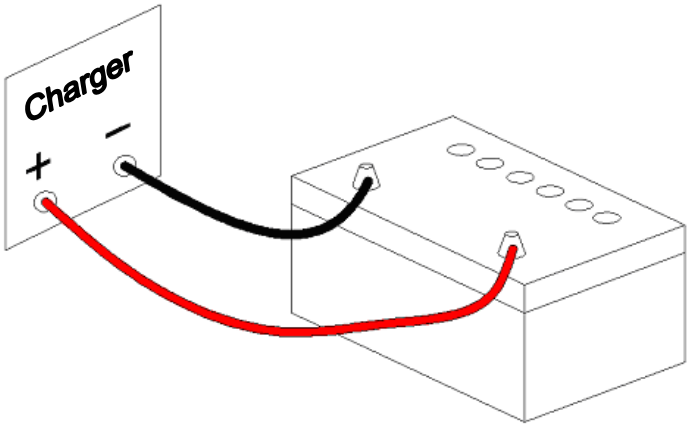
Acid density	Charge status	Voltage when idle	
1.27	100%	Above 12.60 V	
1.25	80%	12.54 V	
1.20	60%	12.36 V	**From 50 % recharge**
1.19	40%	12.18 V	**Risk of sulphation**
1.13	20%	Under 11.88 V	**Unusable**

8.4. Load preconization

✓ Highly discharged or sulphated batteries (formation of whitish lead sulphate deposit on the plates, which becomes hard and insoluble to acid; this deposit reduce the active surface of the plates, and increases their internal resistance) can no longer regenerate or be charged in a generating set.

Important	A discharged battery should be recharged immediately, or else it will suffer irreparable damage.

Battery charge



When several batteries are connected together, the following points should be checked:
✓ Are the batteries connected in series?
✓ Has the correct voltage been chosen? 1 battery x 12 V , 3 x 36V batteries.
✓ Adjust the charge current to the lowest battery.
✓ The power difference between the batteries must be as low as possible.

Example of charge:
✓ 12V 60 Ah battery = charging current 6 A.
✓ Charge status: 50% (acid density 1.21/voltage when idle 12.30V).
✓ The battery is short 30 Ah, and this must be recharged.
✓ Charge factor: 1.2.
✓ Ah x 1.2 = 36 Ah to be charged.
✓ Charging current: 6A approximately 6 hours charging required.

Recharging is complete when the battery voltage and the acid density stop increasing.

→ The charging current must always be $1/10^{th}$ of the nominal capacity of the battery.

The power of the charger must be suitable for the battery to be charged and the charging time available.
You need to use an automatic charger able to provide a sufficient voltage and charging current, as well as a compensation voltage to handle spontaneous battery discharge.

8.5. Faults and remedies

Fault observed	Probable origin	Measures or observations
The acid heats up when a new battery is filled	- Incorrect composition - Incorrect storage - Prolonged storage in a damp place	- Cool - Charge - Check the acid density
The acid escapes through the filler holes	- Battery overflow during filling	- Reduce the battery fluid level
Acid level too low	- Battery tray not leaktight - Significant gas formation caused by too high a charging voltage	- Replace the battery - Check the charger and repair if necessary.
Acid level too low Incorrect operation from start-up	- Insufficient charge - Short circuit in the current circuit - Consumption fault	- Recharge - Check the electrical installation
Acid density too high	- The battery has been filled with acid instead of water	- Reduce the acid level and fill with distilled water. Repeat the operation if need be.
Starting problems Starting test incorrect	- Battery empty - Battery used up or faulty - Capacity too low - Battery sulphated	- Recharge the battery - Fit a new battery
Battery terminals melted	- Incorrect electrical connection - Incorrect battery wiring	- Tighten the ends of the battery cables, or replace them if necessary
One or two cells release a lot of gas at high charge	- Cell(s) faulty	- Fit a new battery
The battery discharges very quickly	- Charge status too low - Short circuit in the current circuit - High self-discharge (for example: through electrolyte contamination) - Sulphation (storage of discharged battery)	- Check the charge - Replace the battery
Short service life	- Incorrect battery part no. - Too many repeated deep discharges - Battery stored too long without charge	- Define the correct battery part no. for the recommended use - Think about charging the battery using a regulator
High water consumption	- Overload - Charging voltage too high	- Check the charger (voltage regulator)
The battery explodes	- Spark after battery charging - Short circuit - Connection or disconnection during charging - Internal fault (for example: interruption) and low electrolyte level	- Replace the battery (beware of fire and sparks) - Ensure there is sufficient ventilation

9. Appendix

9.1. Appendix A – Engine user and maintenance manual

User's guide and maintenance manual

VOLVO

DIESEL ENGINE

TAD 733

33522077701_0_1

OPERATOR'S MANUAL

Generating set and industrial engines

4-7 liter (EDC 4)

Foreword

Volvo Penta industrial engines are relied upon throughout the world, in both mobile and stationary applications, under some of the most rigorous conditions imaginable. This is not by chance.

After more than 90 years of producing engines the name Volvo Penta has come to symbolize reliability, technical ingenuity, first-class performance and longevity. We believe that these characteristics are also ultimately your requirements and expectations for new Volvo Penta industrial engines.

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

Sincerely

AB VOLVO PENTA

Engine data

Engine designation ..... Product number .....

Serial number .....

Clutch, type/nr. .....

Nearest Volvo Penta service location

Name ..... Telephone .....

Address .....

Table of contents

Safety information

Read this chapter very carefully. It has to do with your safety. This describes how safety information is presented in the instruction book and on the product. It also gives you an introduction to the basic safety rules for using and looking after the engine.

Check that you heave received the correct instruction book before you read on. If not, please contact your Volvo Penta dealer.

Incorrect operation can lead to personal injury and damage to products or property. So read the instruction book through very carefully before you start the engine or do any maintenance or service work. If there is still something which is unclear or if you feel unsure about it, please contact your Volvo Penta dealer for assistance.

⚠ This symbol is used in the instruction book and on the product, to call your attention to the fact that this is safety information. Always read such information very carefully.

Safety texts in the instruction book have the following order of priority:

⚠ **WARNING!** Warns for the risk of personal injury, major damage to product or property, or serious malfunctions if the instruction is ignored.

⚠ **IMPORTANT!** Is used to call attention to things which could cause damage or malfunctions to product or property.

NOTE! Is used to call attention to important information, to facilitate work processes or operation.

This symbol is used on our products in some cases and refers to important information in the instruction book. Make sure that warning and information symbols on the engine are clearly visible and legible. Replace symbols which have been damaged or painted over.

Safety rules for operation and maintenance

⚠ Daily checks

Make it a habit to give the engine and engine bay a visual check before operating (**before starting the engine**) and after operation (**when you have stopped the engine**). This helps you to quickly discover whether any leakage of fuel, coolant, oil or any other abnormal event has happened, or is about to happen,.

⚠ Fuel filling

There is always a risk of fire and explosion during fuel filling. Smoking is not permissible, and the engine should be stopped.

Never over-fill the tank. Shut the tank cap securely.

Only use the fuel recommended in the instruction book. The wrong grade of fuel can cause malfunctions or stop the engine. In a diesel engine, it can also cause the injection pump to bind and the engine will over-rev, entailing a strong risk of personal injury and machinery damage.

⚠ Carbon monoxide poisoning

Only start the engine in a well- ventilated area. When operated in a confined space, exhaust fumes and crankcase gases must be ventilated.

⚠ Operation

The engine must not be operated in environments which contain explosive media since none of the electrical and mechanical components are explosion proof.

Going close to a running engine is a safety risk. Hair, fingers, loose clothes, or dropped tools can catch on rotating components and cause severe injury.

When engines are supplied without touch guards, all rotating components and hot surfaces must be protected after installation in their application, if necessary for personal safety.

⚠ Ignition lock

If the instrument panel does not have a key switch, the engine room must be lockable, to prevent unauthorized persons from starting the engine. Alternatively, a lockable main switch can be used.

⚠ Care and maintenance

Knowledge

The instruction book contains instructions for doing the most common service and maintenance tasks in a safe and correct manner. Read them carefully before starting work.

Literature for more major tasks is available from your Volvo Penta dealer.

Never do a job if you are not entirely sure about how to do it. Please contact your Volvo Penta dealer and ask for assistance instead.

Stop the engine.

Stop the engine before opening or removing the engine hatch/hood. Care and maintenance work should be done with the engine stopped unless otherwise specified.

Prevent the engine from being started by cutting the current with the battery isolator, or remove the cable from the battery positive pole before you start service work. Fix a notice by the operator’s seat to say that work is in progress.

Working with, or going close to a running engine is a safety risk. Hair, fingers, loose clothes, or dropped tools can catch on rotating components and cause severe injury. Volvo Penta recommends that all service work which requires the engine to be running should be done by a Volvo Penta authorized workshop.

Safety rules for operation and maintenance (contd.)

Lifting the engine

The existing lugs on the engine should be used for lifting. Always check that the lifting devices are in good condition and that they have the correct capacity for the lift (engine weight together with auxiliaries, if fitted). The engine should be lifted with an adjustable lifting boom for safe handling. All chains or cables should be parallel to each other and should be as square as possible to the top of the engine. Please note that auxiliary equipment installed on the engine could change its centre of gravity. Special lifting devices may then be needed to obtain the correct balance and safe handling. Never do any work on an engine which **just** hangs from a lifting devise.

Before starting

Re-install all guards which have been removed during service work, before re-starting the engine. Make sure that there are no tools or other objects left behind on the engine.

Never start a turbocharged engine without the air filter in place. The rotating compressor turbine in the turbocharger can cause severe injury. There is also a risk that foreign bodies could be sucked in and cause machinery damage.

⚠ Fire and explosion

Fuel and lubrication oil

All fuel, most lubricants and many chemicals are flammable. Always read and observe the advice on the packages.

Work on the fuel system must be done with the engine cold. Fuel leakage and spills on hot surfaces or electrical components can cause fires.

Store oil and fuel soaked rags and other flammable material in a fire-proof manner. Oil soaked rags can self-ignite in certain circumstances.

Never smoke when filling fuel, lubrication oil or close to fuel filling stations or the engine bay.

Non-original spare parts

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

The use of non-original spare parts can cause an explosion or fire.

Batteries

Batteries contain and give off an explosive gas, especially when charged. This gas is very flammable and highly explosive.

Smoking, open flames or sparks must never occur in or near to batteries or the battery locker.

Incorrect connection of a battery cable or start cable can cause a spark which can be sufficient, in its turn, to make the battery explode.

Start spray

Never use start spray or similar preparations to help in starting an engine with air pre-heating (glow plugs / starting heater). Explosions could occur in the inlet manifold. Danger of personal injury.

⚠ Hot surfaces and fluids

A hot engine always offers the risk of burns. Be on your guard against hot surfaces: the exhaust manifold, turbocharger, oil pan, charge air pipe, starting heater, hot coolant and hot lubricating oil in pipes, hoses etc.

⚠ Chemicals

Most chemicals, such as glycol, rust preventer, conservation oils, degreasers etc. are hazardous. Always read and observe the advice on the packages.

Some chemicals, such as conservation oils, are flammable and also hazardous to breathe. Ensure good ventilation and use a protective mask for spraying. Always read and observe the advice on the packages.

Store chemicals and other hazardous material out of the reach of children. Hand in surplus or used chemicals to a recycling station for destruction.

⚠ Lubrication system

Hot oil can cause burns. Avoid skin contact with hot oil. Make sure that the oil system is de-pressurized before starting work. Never start or run the engine with the oil filler cap removed, because of the risk of oil spillage.

⚠ Cooling system

Avoid opening the coolant filling cap when the engine is hot. Steam or hot coolant can spray out at the same time as the pressure built up is lost.

If the filler cap, coolant hose etc., still has to be opened or removed when the engine is hot, undo the filler cap slowly and carefully, to let the pressure out before removing the filler cap completely and starting work. Note that the coolant can still be hot and cause scalding.

⚠ Fuel system

Always protect your hands when searching for leaks. Fluids which leak under pressure can force their way into body tissue and cause severe injury. There is a risk of blood poisoning (septicemia).

Always cover the alternator if it is located beneath the fuel filters. Fuel spillage can damage the alternator.

⚠ Electrical system

Cut the current

Before any work is done on the electrical system, the engine must be stopped and the current cut by switching off the main switch(es). External current supply for engine heaters, battery chargers or other auxiliary equipment connected to the engine must be disconnected.

Batteries

Batteries contain a highly corrosive electrolyte. Protect your eyes, skin and clothes during charging and other handling of batteries. Always use protective goggles and gloves.

If acid comes into contact with your skin, wash at once with soap and a lot of water. If you get battery acid in your eyes, flush at once with a lot of cold water, and get medical assistance at once.

⚠ Electric welding

Remove the positive and negative cables from the batteries. Then disconnect all cables connected to the alternator.

Always connect the welder earth clamp to the component to be welded, and as close as possible to the weld site. The clamp must never be connected to the engine or in such a way that current can pass through a bearing.

When welding is completed: Always connect the alternator cables **before** the battery cables are put back.

Introduction

This instruction book has been prepared to give you the greatest possible benefit from your Volvo Penta industrial engine. It contains the information you need to be able to operate and maintain the engine safely and correctly. Please read the instruction book carefully and learn to handle the engine, controls and other equipment in a safe manner before you start the engine.

⚠ **IMPORTANT!** This instruction book describes the engine and equipment sold by Volvo Penta. Variations in appearance and function of the controls and instruments may occur in certain variants. In these cases, please refer to the instruction book for the relevant application.

Environmental responsibility

All of us want to live in a clean, healthy environment, where we can breathe clean air, see healthy trees, have clean water in lakes and seas, and be able to enjoy the sunlight without fearing for our health. Unfortunately, this is not self-evident these days, it is something all of us must work for.

As an engine manufacturer, Volvo Penta has particular responsibility and for this reason, environmental care is a self-evident foundation of our product development. Volvo Penta has a wide engine program these days, where considerable progress has been made in reducing exhaust fumes, fuel consumption, engine noise etc.

We hope that you will be want to preserve these values. Always observe the advice in the instruction book about fuel grades, operation and maintenance, to avoid unnecessary environmental impact. Please contact your Volvo Penta dealer if you notice any changes such as increased fuel consumption or increased exhaust smoke.

Please remember to always hand in hazardous waste such as drained oil, coolant, old batteries etc. for destruction at an approved recycling facility.

If we all pull together, we can make a valuable contribution to the environment together.

Running in

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

Use the engine in normal operation. Full load should only be applied for short periods. Never run the engine for a long period of time at constant speed during this period.

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

When an opening clutch is installed, this should be checked more carefully during the first days. Adjustment may need to be done to compensate bedding in of the friction plates.

Fuel and oils

Only use the fuels and oils recommended in the instruction book (please refer to the “Maintenance” chapter under the fuel and lubrication system headings). Other grades of fuel and oils can cause malfunctions, increased fuel consumption and eventually even shorten the life of the engine.

Always change the oil, oil filter and fuel filter at the specified intervals.

Maintenance and spare parts

Volvo Penta engines are designed for maximum reliability and long life. They are built to withstand a demanding environment, but also to have the smallest possible environmental impact. Through regular service and use of Volvo Penta original spare parts, these qualities are retained.

Volvo Penta has a world-wide network of authorized dealers. They are Volvo Penta product specialists, and have the accessories, original spares, test equipment and special tools needed for high quality service and repair work.

Always observe the maintenance intervals in the instruction book, and remember to note the engine/transmission identification number when you order service and spare parts.

Certified engines

If you own an emission certified engine, which is used in an area where exhaust emissions are regulated by law, it is important to be aware of the following:

Certification means that an engine type has been checked and approved by the relevant authority. The engine manufacturer guarantees that all engines made of the same type are equivalent to the certified engine.

This makes special demands on the care and maintenance you give your engine, as follows:

- Maintenance and service intervals recommended by Volvo Penta must be complied with.
- Only Volvo Penta original spares may be used.
- Service to injection pumps, pump settings and injectors must always be done by an authorized Volvo Penta workshop.
- The engine must not be converted or modified, except for the accessories and service kits which Volvo Penta has developed for the engine.
- No installation changes to the exhaust pipe and engine air inlet ducts may be done.
- No seals may be broken by unauthorized personnel.

The general advice in the instruction book about operation, care and maintenance applies.

⚠ **IMPORTANT!** Delayed or inferior care/maintenance, and the use of non-original spares, mean that AB Volvo Penta can no longer be responsible for guaranteeing that the engine complies with the certified version.

Damage, injury and/or costs which arise from this will not be compensated by Volvo Penta.

Warranty

Your new Volvo Penta industrial engine is covered by a limited warranty, under the conditions and instructions compiled in the Warranty and Service book.

Please note that AB Volvo Penta's liability is limited to the specification in the Warranty and Service book. Read it carefully, as soon as possible after delivery. It includes important information about warranty cards, service intervals, maintenance, which it is the responsibility of the owner to know, check and carry out. If this is not done, AB Volvo Penta may fully or partly refuse to honor its warranty undertakings.

Please contact your Volvo Penta dealer if you have not received a Warranty and Service book, or a customer copy of the warranty card.

Presentation

TD420VE, TAD420VE, TD520GE, TAD530/531GE and TAD520VE are in-line, direct injected, 4-cylinder industrial diesel engines.

TAD620VE, TD720GE, TAD730/731GE, TAD720VE, TAD732GE, TAD721VE, TAD733GE and TAD722VE are in-line, direct injected, 6-cylinder industrial diesel engines.

All engines are equipped with electronically controlled fuel management (EDC4), turbocharger, thermostatically controlled cooling systems and electronic speed control. All TAD engines are also equipped with an intercooler.

Technical description

Engine and engine block

– The engine block and cylinder head are manufactured of alloyed cast iron

– Five bearing, induction hardened crankshaft (TD420VE, TAD420VE, TD520GE, TAD530/531GE, TAD520VE, TAD532GE)

  Seven bearing, induction hardened crankshaft (TAD620VE, TD720GE, TAD730/731GE, TAD720VE, TAD732GE, TAD721VE, TAD733GE, TAD722VE)

– Replaceable wet cylinder liners (TD520GE, TAD530/531GE, TAD520VE, TD720GE, TAD730/731GE, TAD720VE, TAD732GE, TAD721VE, TAD733GE, TAD722VE, TAD532GE)

Replaceable dry cylinder liners (TAD620VE)

Liner-less (TD420VE, TAD420VE)

– Cast aluminum pistons with oil cooling

– Three piston rings, with a “keystone” type top ring

– Induction hardened overhead camshaft with valve lifters and push rods.

– Two valves per cylinder

– Replaceable valve seats and valve guides (does not apply to TD420VE, TAD420VE, TAD620VE)

Control unit

– Microprocessor based fuel supply control unit (EDC 4)

– Maximum ambient temperature 80° C

– Automatic sensing of 24 V or 12 V.

– Atmospheric pressure sensor for high altitude applications (option)

Fuel system

– Belt driven feed pump - BOSCH injection pump, one for each cylinder

– HEINZMANN actuator

– EDC 4 (Electronic Diesel Control). Please refer to a separate description.

Lubrication system

– Water cooled oil cooler.

– Crankshaft driven lube oil pump

– Full flow filter with bypass

Turbocharging system

– Turbocharger

Cooling system

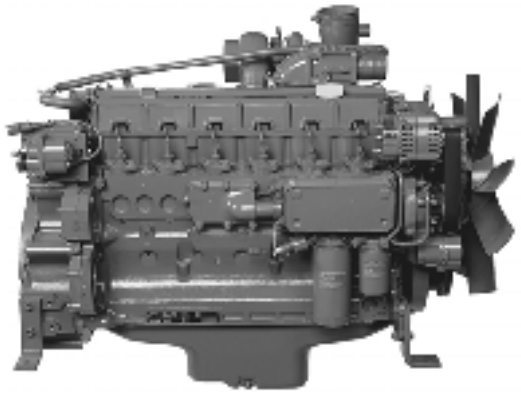
– Radiator with expansion tank

– Air cooled intercooler (TAD)

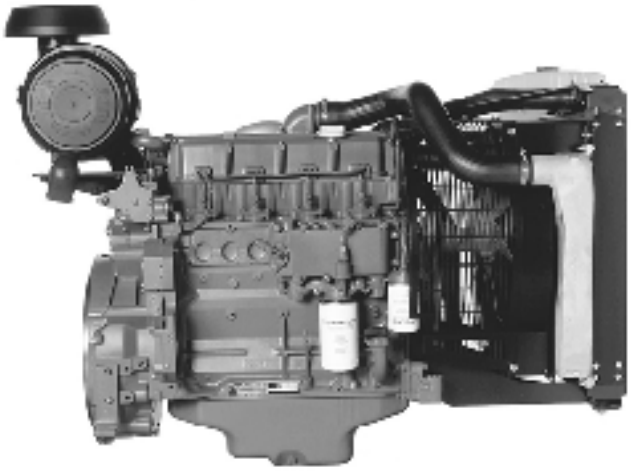
Electrical system

– 24 V (standard), 12 V (option)

TD420VE, TAD420VE, TAD620VE

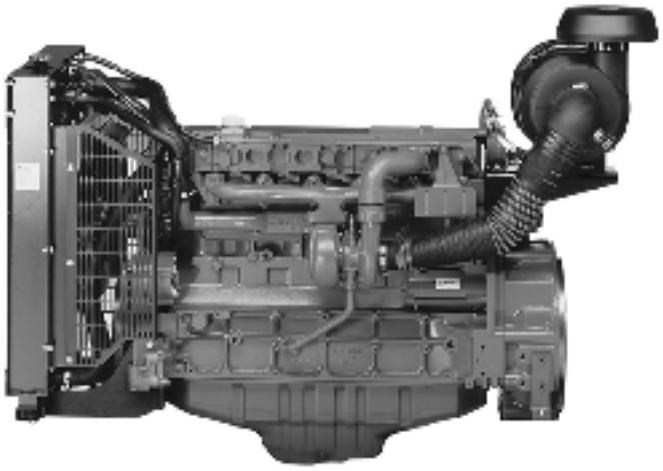


TD520GE, TAD530GE, TAD531GE, TAD532GE, TAD520VE



TD720GE, TAD730/731GE, TAD732/733GE

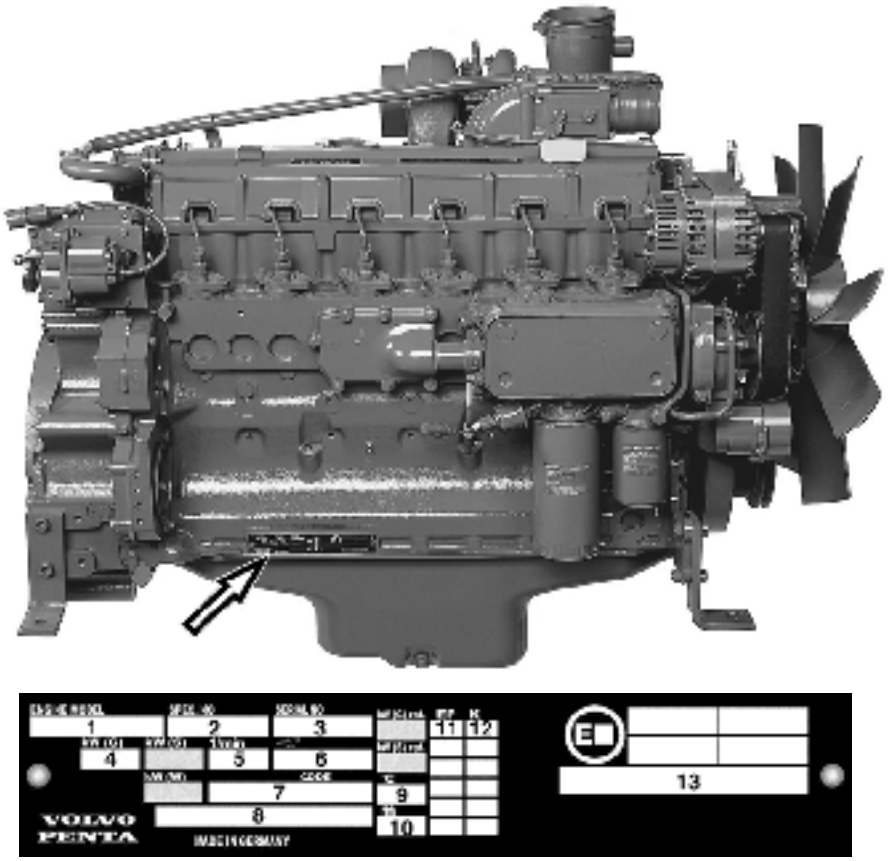
TAD720VE, TAD721VE, TAD722VE



Identification numbers

Location of engine signs

The engines are supplied with two engine signs, of which one is installed on the right side of the engine block.



Engine plate

1. Engine model
2. Engine specification number
3. Engine series number (10 digits)
4. Engine power, peak, without fan
5. Engine speed
6. Injection advance and type of camshaft
7. Manufacturer's identification code
8. Indication of standard and/or specification
9. Air temperature in °C (°F), in accordance with ISO 3046
10. Altitude above mean sea level, in accordance with ISO 3046
11. EP code for injection pump (cylinder 1 on top)
12. Piston class
13. Extra information

EDC 4

EDC 4 (Electronic Diesel Control) and is an electronic system with CAN (Controller Area Network) or potentiometer communication for diesel engine control. The system includes fuel management and diagnostic functions.

Summary

The system includes sensors, control unit and an engine speed regulator. The sensors send input signals to the control unit, which controls the control rod for the injection pumps in its turn, by means of an actuator in the engine speed regulator.

Input signals

The control unit receives input signals about engine operating conditions from the following components:

– speed sensor, camshaft
– coolant temperature sensor
– charge pressure sensor
– oil pressure sensor
– fuel temperature sensor
– coolant level sensor (the function is implemented in the control unit as standard, but no sensor is supplied with the engine as a standard feature)

Output signals

The control unit controls the following components on the basis of the input signals received:

– engine speed regulator (with position sensor for the control rod and acutator)
– electric air pre-heating (option)

Information from the sensors provides exact information about current operation conditions and allows the processor to calculate the correct fuel volume, check engine status etc.

Diagnostic function

The task of the diagnostic function is to discover and localize any malfunctions in the EDC 4 system, to protect the engine and to ensure operation in the event of serious malfunctions.

If a malfunction is discovered, this is notified by the diagnostic function, by warning lamps or via the CAN network. By pressing the diagnostic switch, the operator will receive a fault code as a guide for any fault-tracing. Fault codes can also be output via the CAN interface or with Volvo's VODIA tool (including the Penta EDC4 software) at an authorized Volvo Penta workshop.

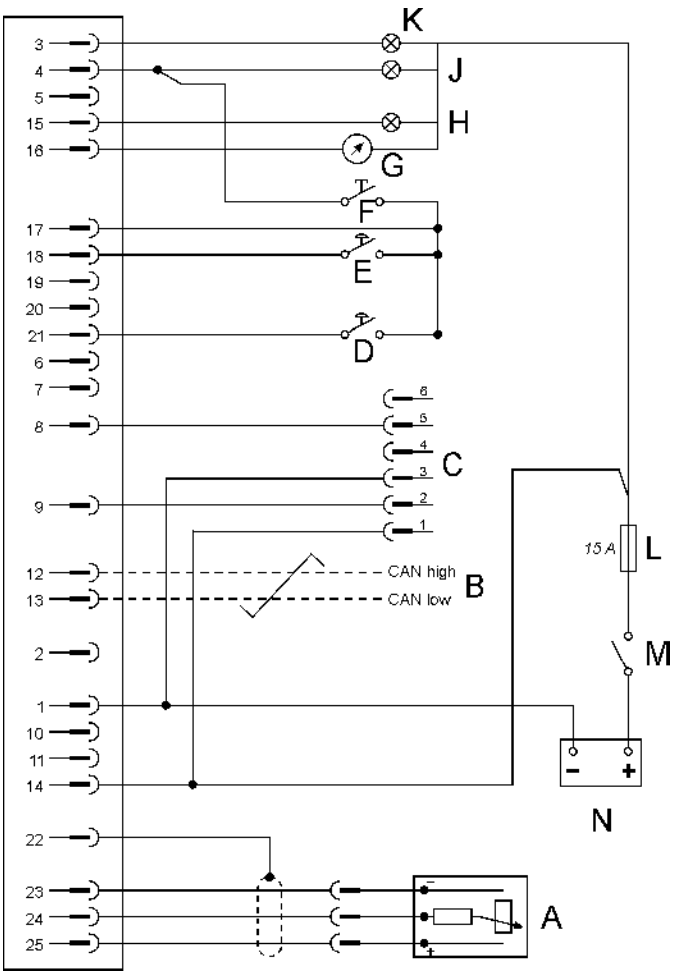
If there is a serious malfunction, the engine is shut down altogether. Yet again, fault codes can be output via diagnostic connector, the CAN interface or with Volvo's VODIA tool (including the Penta EDC4 software) at an authorized Volvo Penta workshop.

Instruments

The engines are not supplied with instruments and controls. The choice of instrument type and controls is made by the customer.

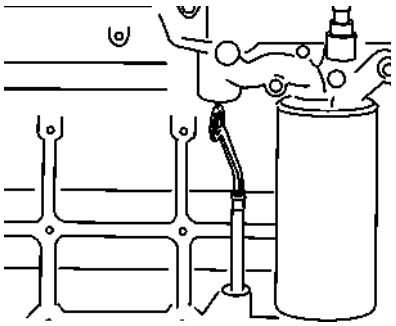
The functions available are described below.

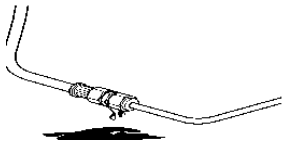
A. Engine speed potentiometer (throttle control)
B. CAN interface SAE J 1939
C. VODIA input
D. Droop contact
E. 1500 / 1800 rpm switch
F. Diagnostic button
G. Tachometer
H. Warning lamp, oil pressure
J. Diagnostic lamp
K. Warning lamp, high coolant temperature
L. Fuse 15 A
M. Main switch
N. Battery (24(12 V).

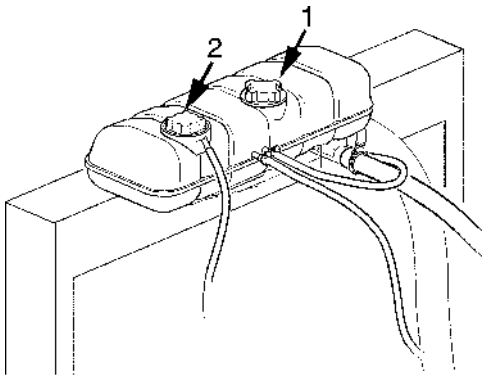


Starting the engine

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







Before starting

- Check that the oil level is between the MAX and MIN marks. Please refer to the “Maintenance, lubrication system” chapter:
- Open the fuel taps.
- Check that there is no leakage of oil, fuel or coolant.
- Check the air filter pressure drop indicator. Please refer to the “Maintenance, Engine, general” chapter:
- Check the coolant level and that the radiator is not blocked externally. Please refer to the “Maintenance, cooling system” chapter:

⚠ **WARNING!** Do not open the expansion tank cap when the engine is hot. Steam or hot fluid could spray out.

- Turn the main current on.

⚠ **IMPORTANT!** Never disconnect the current with the main switch(es) when the engine is running. This will damage the alternator.

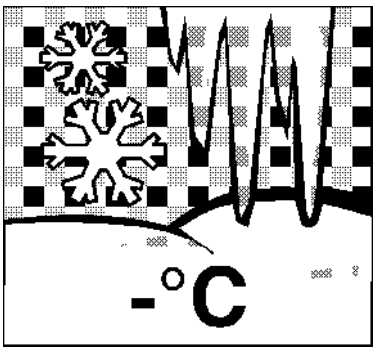
- Move the engine speed control to idle, and release the opening clutch/gearbox if installed.

Starting method EDC 4

The engine speed lever must always be in neutral before starting. The EDC4 system ensures that the engine always receives the correct amount of fuel **- even when the engine is cold!**

Start the engine.

If the engine is equipped with a pre-heater, the pre-heating time is adjusted to suit the engine temperature.



Starting in extreme cold

Certain preparations must be made to facilitate engine starting, and in some cases to make starting possible at all.

Use a winter grade fuel (of a well-known make) which has been approved for the relevant temperature. This reduces the risk of wax deposits in the fuel system. At extremely low temperatures, the use of a fuel heater is recommended.

For fully acceptable lubrication, a synthetic engine oil of recommended viscosity for the relevant temperature should be used. Please refer to the “Maintenance, lubrication system” chapter: Synthetic lubricants are able to manage a wider temperature range than mineral-based lubricants.

Pre-heat the coolant with a separately installed electric engine heater. In extreme cases, a diesel-burning engine heater may be needed. Ask your Volvo Penta dealer for advice.

⚠ **IMPORTANT!** Make sure that the cooling system is filled with a glycol mixture. Please refer to the “Maintenance, cooling system” chapter:

The batteries should be in good condition. Cold weather reduced battery capacity. Increased battery capacity may be necessary.

Never use start spray

⚠ **WARNING!** Never use start spray or similar products as a starting aid. Explosions could occur in the inlet manifold. The consequence could be personal injury.

Starting with auxiliary batteries

⚠ **WARNING!** Batteries (especially auxiliary batteries) contain hydrogen which is highly explosive in contact with air. A spark, which can be formed if the auxiliary batteries are wrongly connected, is enough to make a battery explode and cause damage.

1. Check that the auxiliary batteries are connected (series or parallel) so that the rated voltage corresponds to the engine system voltage.
2. First connect the red (+) jumper cable to the auxiliary battery, then to the flat battery. Then connect the black jumper cable (–) to the auxiliary battery, and lastly to a place **some distance from the flat batteries**, such as the negative cable by the main switch or the negative cable connection on the starter motor.
3. Start the engine.

⚠ **WARNING!** Do not move the connections when you attempt to start the engine (risk of arcing), and do not stand and lean over one of the batteries.

4. Remove the jumper cables in the reverse order from installation.

⚠ **WARNING!** The ordinary cables to the standard batteries must not be loosened on any condition.

Operation

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

Checking instruments

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

⚠ **IMPORTANT!** The lubrication oil level must be checked **every 8 hours** on engines which operate continuously. Please refer to the “Maintenance, lubrication system” chapter:

Fault indication

If the EDC4 system receives abnormal signals from the engine, the “Diagnostic lamp” will start to flash. By pressing the “Diagnostic button”, a fault code can be received which can guide fault tracing (or a fault code can be received via the CAN network).

More information about fault codes and fault tracing is found in the “Diagnostic function” chapter.

Effect on engine

The diagnostic function affects the engine in the following ways:

1. The diagnostic function has discovered a minor malfunction which does not damage the engine.

   Reaction: The engine is not affected. The diagnostic lamp lights up.

2. The diagnostic function has discovered a serious malfunction which will not immediately damage the engine (e.g. high coolant temperature):

   Reaction: The engine goes into “limp home” mode. The diagnostic lamp lights up.

3. The diagnostic function has discovered a serious malfunction which makes it impossible to control the engine.

   Reaction: The diagnostic lamp starts to flash. Engine is shut off.

Engine speed control

Avoid sudden and violent throttle opening.

Operation at low load

Avoid long-term operation at idle or at low load, since this can lead to increased oil consumption and eventually to oil leakage from the exhaust manifold, since oil will seep past the turbocharger seals and accompany the induction air into the inlet manifold at low turbo boost pressure.

One consequence of this is that carbon builds up on valves, piston crowns, exhaust ports and the exhaust turbine.

At low load, the combustion temperature is so low that full combustion of the fuel can not be ensured, which means that the lubrication oil can be diluted by diesel fuel, and the exhaust manifold will eventually leak oil.

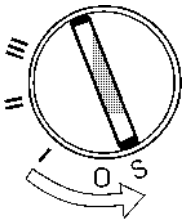
If the following points are done as a complement to normal maintenance, there will be no risk of malfunctions caused by operation at low load.

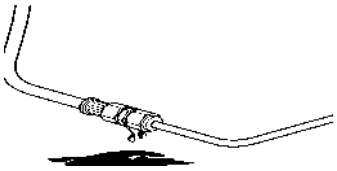
- Reduce operation at low load to a minimum. If the engine is regularly test run without load once a week, operation duration should be limited to 5 minutes.
- Run the engine at full load for about 4 hours once a year. This gives carbon deposits in the engine and the exhaust pipe a chance to be burned away.

Stopping the engine

During longer breaks in operation, the engine must be warmed up at least once every fortnight. This prevents corrosion damage in the engine. If you expect the engine to be unused for two months or more, it must be laid up: Please refer to the “Laying up” chapter.

⚠ **IMPORTANT!** If there is a risk of frost, the coolant in the cooling system must have sufficient frost protection. Please refer to the “Maintenance, cooling system” chapter: A poorly charged battery can freeze and burst.





Before stopping

Allow the engine to run for a few minutes without load before stopping it. This permits the temperature inside the engine to even up, “after-boiling” is avoided, at the same time as the turbocharger cools somewhat. This contributes to long service life without malfunctions.

Stop

- Disengage the clutch (if possible).
- Depending on the equipment installed; press the stop button and keep it depressed until the engine has stopped, or turn the key to the stop position. Release the key when the engine has stopped.

After stopping

- Check the engine and engine bay for leakage.
- Turn off the main switches before any long stoppage.
- Carry out maintenance in accordance with the schedule.

⚠ **WARNING!** Working with, or going close to a running engine is a safety risk. Watch out for rotating components and hot surfaces.

Maintenance schedule

General

It is important that the engine receives regular care & maintenance, to achieve maximum reliability and service life. By following the service recommendations, engine performance is sustained and unnecessary environmental impact is avoided.

MAINTENANCE SCHEDULE

⚠ **WARNING!** Before you start to do any maintenance work, read the “Maintenance” chapter carefully. This contains instructions for doing work in a safe and correct manner.

⚠ **IMPORTANT!** When both operation and calendar time are specified, do the maintenance job at the interval which is reached first. Maintenance points marked ☐ must be done by an authorized Volvo Penta workshop.

Daily, before first start

- Engine oil, level check [1] ..... page 23
- Coolant, level check ..... page 26
- Radiator, external checking and cleaning ..... page 28
- Air filter indicator, inspection [1, 2, 3] ..... page 20
- Leakage check, engine ..... not shown

[1] In continuous operation, checks should be done every 8 hours.
[2] The air filter should be changed when the indicator remains in the red field after the engine has been stopped.
[3] When operated in extremely dirty conditions, special air filters must be used.

After the first 100-200 hours

☐ Valve clearance, check ..... not shown
☐ Injectors, re-tighten 50Nm (36.88 lbf ft) ..... not shown

Every 50 hours

- Battery, checking the electrolyte level ..... page 32
- Release bearing, lubrication [1] ..... not shown

[1] Applies to a disconnection clutch with more than 15-20 clutch operations per day. Otherwise, every 400 hours.

Every 6 months

- Coolant filter, change [1] ..... not shown

[1] The filter should not be changed when the coolant is changed, however.

Every 50-600 hours or at least every 12 months

- Engine oil and oil filter, change [1] ..... page 22-23

[1] Oil change intervals vary, depending on oil grade and sulfur content of the fuel. page 26.

Every 500 hours

- Fuel tank (sludge trap), drain ..... not shown
- Drive belts, inspection/adjustment ..... page 21

Every 1000 hours

- Air hoses, leakage check ..... page 20
- Fuel filter, changing ..... page 29

Every 1500 hours

☐ Valve clearance, inspection/adjustment ..... not shown

Every 2000 hours or every 12 months

- Air filter for air compressor, change ..... not shown
- Air filter, clean (TAD engines) [1] ..... not shown

[1] When operated in extremely dirty conditions, it must be cleaned frequently.

Every 2400 hours

☐ Turbocharger, check ..... not shown
☐ Engine with equipment, general check ..... not shown

Every 3000 hours

☐ Injectors, check ..... not shown

Every 5000 hours or at least every 24 months

- Coolant, change ..... page 24-25

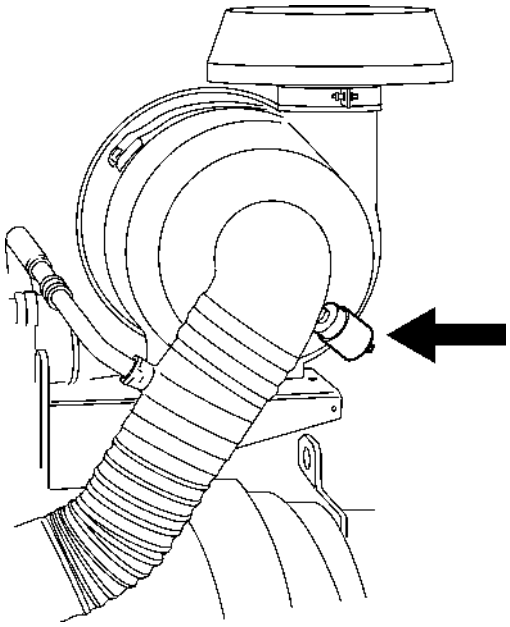
Maintenance

This chapter describes how the specified maintenance points should be done. Read them carefully before starting work. The times when maintenance points need to be attended to are given in the previous chapter: Maintenance schedule

⚠ **WARNING!** Read through the safety advice for care and maintenance work in the “Safety information” chapter before starting work.

⚠ **WARNING!** Care and maintenance work should be done with the engine stopped unless otherwise specified. Make it impossible to start the engine by removing the ignition key and cutting the system voltage with the main switch. Working with, or going close to a running engine is a safety risk. Watch out for rotating components and hot surfaces.

Engine, general



Air filter Check/change.

Change the air filters when the indicator remains in the red field after the engine has been stopped. Reinstate the pressure drop indicator after changing the filter, by pressing in the button.

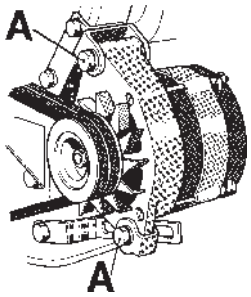
NOTE! The filters should not be touched until the indicator shows the red field. Scrap the old filters. No cleaning or re-use may be done.

⚠ **IMPORTANT!** In continuous operation, the filters should be checked every 8 hours.

When operated in extremely dirty conditions, such as coal mines, stone crushing mills etc., special filters are needed (not sold by Volvo Penta).

Air hoses. Leakage check.

Inspect the condition of the hoses, for cracks and other damage. Change as necessary. Test all hose clamps for tightness.



Drive belts. Inspection/adjustment

Inspection and any adjustment should be done after operation, when the belts are hot.

Loosen the screws (A) before tensioning the alternator belts. It should be possible to press the belts down about 10 mm (3/16 “) between the pulleys. Worn belts which operate in pairs should be changed together.

On TD420VE, TAD420VE and TAD620VE, the fan belts have an automatic belt tensioner and do not need to be adjusted.

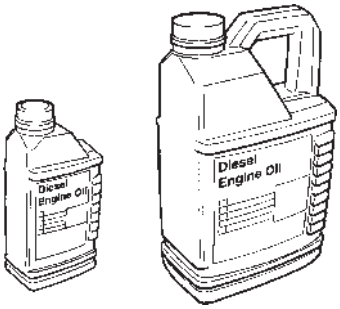
TD520GE, TAD530/531GE, TAD532GE, TAD520VE, TAD620VE, TD720GE, TAD730/731GE, TAD720VE, TAD732GE, TAD721VE, TAD733GE and TAD722VE have mechanical belt tensioners.

Always check the condition of the drive belts. Change as necessary.

Lubrication system

Oil change intervals can vary from **40 to 500 hours**, depending on oil grade and sulfur content of the fuel. **Note that oil change intervals must never exceed a period of 12 months.**

If you want longer oil change intervals than given in the table below, the condition of the oil must be checked by the oil manufacturers through regular oil testing.



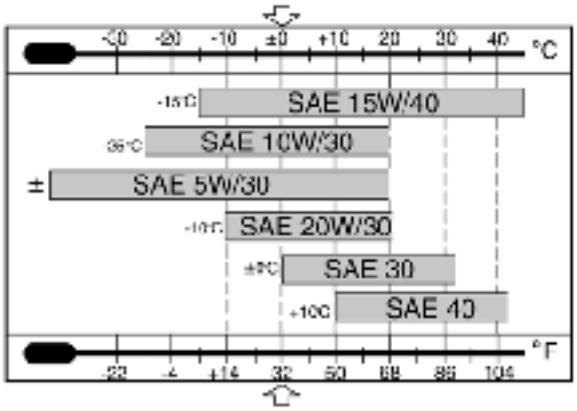
Engine	Oilgrade	Sulfur content in fuel, by weight		
		< 0,5 %	0,5 – 1,0 %	> 1,0 %[1]
		Oil change interval, reached first in operation		
T(A)D420-620VE **T(A)D520-721VE** **T(A)D520-731GE** **TAD532GE** **TAD732/733GE, open crankcase ventilation**	VDS-3 VDS-2 ACEA: E7, E5, E3 API: CI-4, CH-4, CG-4	**500** h / 12 months	**250** h / 12 months	**125** h / 12 months
TAD732/733GE, closed crankcase ventilation	ACEA: E4 API: CI-4, CH-4 **NOTE!** Fully synthetic oil must be used	**500** h / 12 months	**250** h / 12 months	**125** h / 12 months
TAD722VE power<200kW	ACEA: E4	**500** h / 12 months	**250** h / 12 months	**125** h / 12 months
power>200kW		**250** h / 12 months	**125** h / 12 months	**60** h / 12 months

NOTE! Mineral based oil, either fully or semi-synthetic, can be used on condition that it complies with the quality requirements above.

NOTE! For 6 and 7-liter engines equipped with low profile type oil pans, the oil change interval must be halved.

[1] If the sulfur content is > 1.0% by weight, use oil with TBN > 15
[2] The engine oil must fullfil **both** requirements. For markets outside Europe, API: CG-4 and CH-4 can be used instead of ACEA: E3.

VDS = Volvo Drain Specification
ACEA = Association des Constructeurs Européenne d'Automobiles
API = American Petroleum Institute
Global DHD = Global Diesel Heavy Duty
TBN = Total Base Number



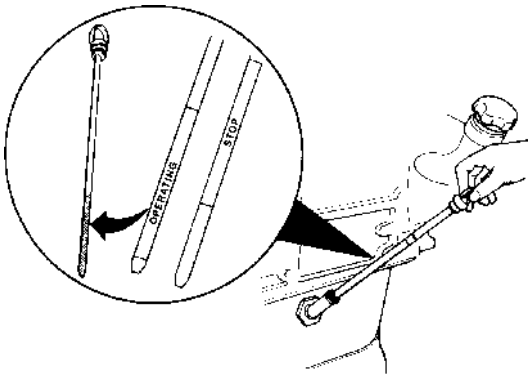
Viscosity

Select the viscosity from the table below, for the appropriate continuous ambient air temperature.

* Refers to synthetic or semi-synthetic oils.

Oil change volume

Please refer to the “Technical Data” chapter.

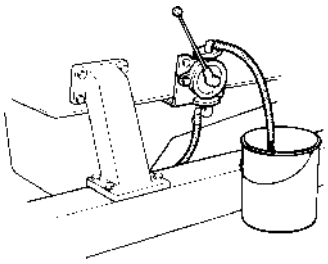


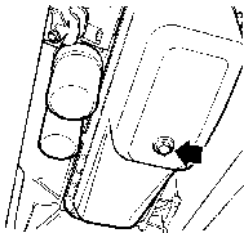
Oil level. Inspection

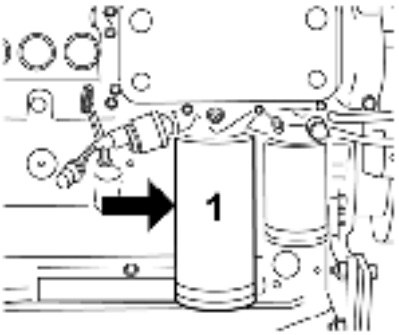
Make sure that the oil level is between the MAX and MIN marks.

⚠ **IMPORTANT!** In continuous operation, the oil level should be checked every 8 hours.

⚠ **WARNING!** Working with, or going close to a running engine is a safety risk. Watch out for rotating components and hot surfaces.







Oil and oil filters. Change

Always follow the recommended oil change interval and always change the oil filter during oil changes. On stationary engines, the bottom plug should **not** be removed. Use an oil drain pump to suck the oil up.

1. Clean the oil filter holder thoroughly to avoid dirt entry when the new filter(s) is/are installed.
2. Warm the engine up.

   ⚠ **WARNING!** Hot oil and hot surfaces can cause burns.
3. Remove the bottom plug. Drain the oil.
4. Install the bottom plug with a new gasket.
5. Remove the filer (1). Check that the gasket has not been left behind on the engine.
5. Fill the new filters with engine oil and wipe oil on the gaskets. Screw the filters on by hand until the gaskets just touch the mating surface. Then turn the filter a further half turn. **Not more!**
6. Fill up with oil to the correct level. **Do not fill over the MAX level.**
7. Start the engine and let it idle. Check that the oil pressure is normal.
8. Stop the engine. Check that no oil leakage occurs around the filters. Top up with oil as necessary.

Collect the old oil and old filters and hand them to a re-cycling station for destruction.

Cooling system

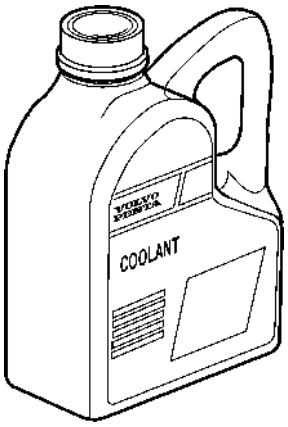
The cooling system ensures that the engine operates at the correct temperature. It is a closed circuit system and must always be filled with a mixture of at least 40 % concentrated coolant and 60 % water to protect against internal corrosion, cavitation and damage caused by freezing.

We recommend that you use **"Volvo Penta Coolant, Ready Mixed"**, alternatively **"Volvo Penta Coolant"** (concentrated) mixed with **pure** water according to spec, see "Coolant. Mixture". Only coolant of this quality is suited too and approved by Volvo Penta.

The coolant should contain ethylene glycol of a good quality with a suitable chemical consistency for an adequate protection of the engine. Using anti-corrosion aditive exclusively is not permitted in Volvo Penta's engines. Never use water by itself as coolant.

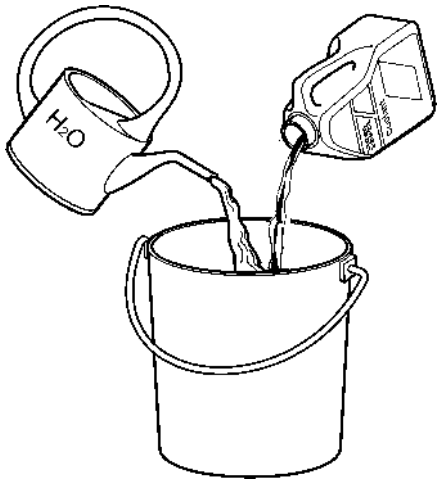
⚠ **IMPORTANT!** Coolant, with a sutiable consistency, must be used all year round. This applies even if there is never any risk for frost , to ensure that the engine has an adequate protection against corrosion.
Future warranty claims on the engine and additional equipment may be rejected if an unsuitable coolant has been used or if the instructions concerning coolant mixing have not been followed.

NOTE: The anti-corrosive agents become less effective after a time, which means that the coolant must be replaced, see "Service schematic". The cooling system should be flushed out at the same time as the coolant is replaced, see "Cooling system. Flushing".



"Volvo Penta Coolant" is a concentrated coolant that is to be mixed with water. It has been developed to function optimally with Volvo Penta's engines and provides excellent protection against corrosion, cavitation and frost damage.

"Volvo Penta Coolant, Ready Mixed" is a ready-mixed coolant, 40% "Volvo Penta Coolant" and 60% water. This concentration protects the engine against corrosion, cavitation damage and freezing conditions down to -28 °C (18°F).



Coolant. Mixture

⚠ **WARNING!** All glycol is hazardous and harmful to the environment. Do not consume! Glycol is flammable.

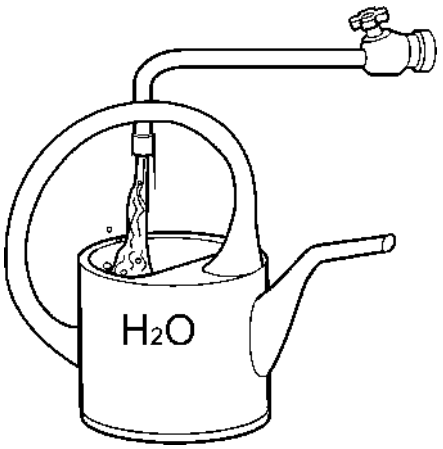
⚠ **IMPORTANT!** Ethylene glycol must not be mixed with other types of glycol.

Mix:
40 % "Volvo Penta Coolant" (conc. coolant)
60 % water

This mixture protects the engine against internal corrosion, cavitation and frost damage down to -28 °C (18°F). (Using 60 % glycol lowers the freezing point to -54 °C (65°F)). Never mix more than 60 % concentrate (Volvo Penta Coolant) in the cooling liquid, this will give reduced cooling effect and increase the risk of overheating, and will give reduced freezing protection.

⚠ **IMPORTANT!** Coolant must be mixed with **pure** water, use **distilled - de-ionized water**. The water must fulfill the requirements specified by Volvo Penta, see "Water quality".

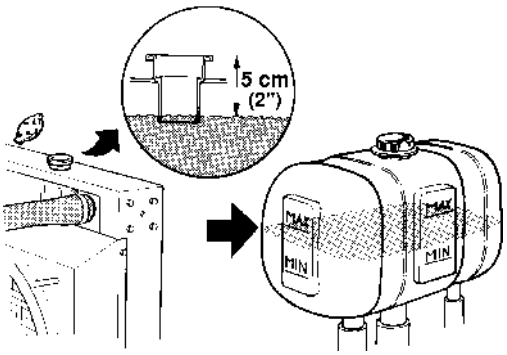
⚠ **IMPORTANT!** It is extremely important that the correct concentration of coolant is added to the system. Mix in a separate, clean vessel before adding into the cooling system. Ensure that the liquids mix properly.



Water quality

ASTM D4985:

Total solid particles	< 340 ppm
Total hardness:	< 9.5° dH
Chloride	< 40 ppm
Sulfate	< 100 ppm
pH value	5,5–9
Silica (acc. ASTM D859)	< 20 mg SiO_2/l
Iron (acc. ASTM D1068)	< 0.10 ppm
Manganese (acc. ASTM D858)	< 0.05 ppm
Conductivity (acc. ASTM D1125)	< 500 µS/cm
Organic content, COD_{Mn} (acc. ISO8467)	< 15 mg $KMnO_4$/l



Coolant. Checking and filling

⚠ **WARNING!** Do not open the filler cap when the engine is warm, except in emergencies. Steam or hot fluid could spray out.

Check the coolant level daily before starting. Top the coolant up as necessary. The level should be about 50 mm (2") below the sealing plane of the filler cap, or between the MIN and MAX markings, if a separate expansion tank is installed.

⚠ **IMPORTANT!** Topping up should be done with the same type of mixture as is already in the cooling system.

Filling a completely empty system
Check that all drain points are closed.

The location of drain and vent taps is shown overleaf.

Filling should be done with the engine stationary. Fill up slowly, to allow the air to flow out.

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

Fill up with coolant to the correct level. **Do not start the engine until the system is vented and completely filled.**

Start the engine and warm it up until the thermostats are fully open (about 20 minutes). Open any venting taps some while after starting, to allow shut-in air to escape. Check the coolant level and top up as necessary.

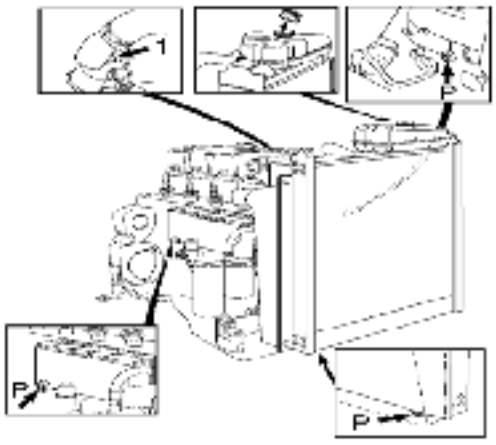
Coolant. Draining.

The engine must be stopped before draining, and the filler cap unscrewed.

⚠ **WARNING!** Do not open the filler cap when the engine is warm, except in emergencies. Steam or hot fluid could spray out.

Open the drain taps and remove the drain plugs (positions are shown below). Unscrew and empty the coolant filter if installed.

⚠ **IMPORTANT!** Deposits, which must be cleared away, may be found inside the drain plugs/taps. Check that all coolant really does drain out.



Drain/vent taps. Location

Drain plugs (P):

– under the radiator
– beside cyl. 3 or cyl. 5 (4 or 6-cylinder engines)
– under the oil cooler

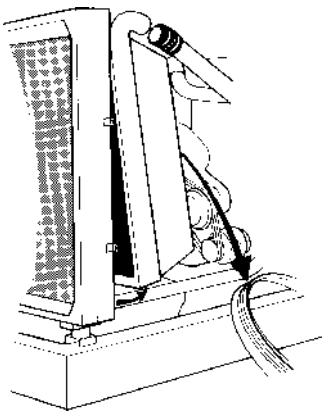
Vent tap (1):

– On the coolant pump

Cooling system Flushing

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

1. Drain the coolant, as in the description on the previous paragraph.
2. Insert a hose into the filler hole in the radiator, and flush with fresh water until the water which runs out is completely clear.
3. Close the drain taps and plugs. Fill up with fresh coolant, as in the instructions in the chapter entitled “Coolant. Checking and filling”.



Radiator (air cooled intercooler TAD). External cleaning

Remove guards as necessary, to access the radiator.

Clean with water and a mild detergent. Use a soft brush. Be careful not to damage the radiator matrix. Re-install the components.

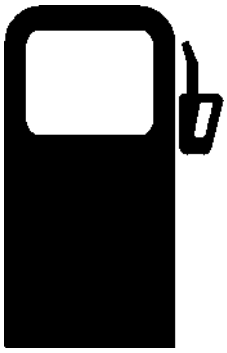
⚠ **IMPORTANT!** Do not use a high pressure power washer.

Fuel system

Only use the grades of fuel recommended in the fuel specification below. Always observe the greatest cleanliness during re-fueling and work on the fuel system.

All work on the injection system of the engine must be done by an authorized workshop. **If the seal on the injection pump is broken by an unauthorized person, all warranties are void.**

⚠ **WARNING!** Fire hazard. Work on the fuel system must be done with the engine cold. Fuel spills on hot surfaces or electrical components can cause fires. Store fuel-soaked rags in a fire-proof manner.



Fuel specification

The fuel must comply with national and international standards for commercially supplied fuels, such as:

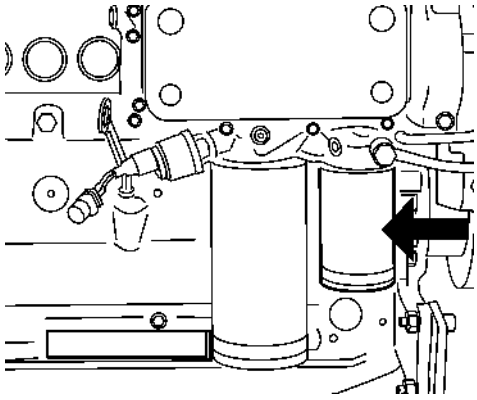
EN590 (with nationally adapted environmental and cold requirements)

ASTM-D 975-No 1-D and 2-D.

JIS KK 2204

Sulfur content: Complying with legal requirements in each country. If sulfur content exceeds 0.5% by weight, the **oil change intervals** must be changed, please refer to the “Lubrication system” heading.

Extremely low sulfur content fuel (urban diesel in Sweden and city diesel in Finland) can cause a loss of up to 5% of power and an increase in fuel consumption of about 2–3 %.



Fuel filter. Change

Cleanliness! No dirt must be allowed to get into the fuel system.

⚠ **WARNING!** Fuel filters must be changed when the engine is cold, to avoid the risk of fire due to spilled fuel on hot surfaces.

Remove the filters. Wipe a film of oil on the gaskets of the new filters. Screw the filters on by hand until the gaskets just touch the mating surface. Then tighten a further half turn, **no more**. Vent the fuel system. **Hand old filters in to an authorized waste processing facility for destruction.**

Start the engine and make sure that no leakage occurs.

Fuel system. Venting

The fuel system must be vented after a filter change, if the fuel tank has been run dry, after a long-term stoppage etc.

Use the hand pump, if fitted, to vent the fuel system. In other cases, vent the system by operating the starter motor.

Electrical system

⚠ **WARNING!** Before any work is done on the electrical system, the engine must be stopped and the current cut by switching off the main switch. Battery chargers or other auxiliary equipment installed on the engine must be disconnected.

Fuses

No fuses or circuit breakers are supplied with the engine. Customers have to install the electrical system on the side of the vehicle themselves.

Fuses cut the current if the electrical system is overloaded.

If the engine can not be started, or if the instrument stop working during operation, a fuse or circuit breaker can have tripped. Check and replace fuses or re-set circuit breakers.

⚠ **IMPORTANT!** Always investigate the reason for the overload!

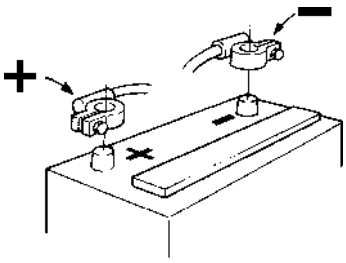
Main switch

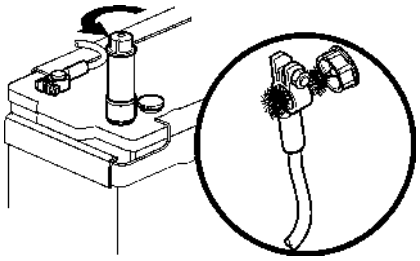
The main switch must never be disconnected before the engine has been stopped. If the circuit between the alternator and the battery is disconnected when the engine is running, the alternator can be damaged.

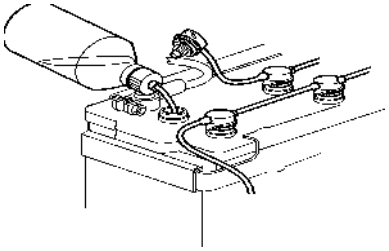
⚠ **IMPORTANT!** Never disconnect the current with the main switch when the engine is running.

Electrical connections

Check that electrical connections are dry, free from oxide and that they are securely tightened. Spray these connections as necessary with water-repellent spray (Volvo Penta universal oil).







Battery. Maintenance

⚠ **WARNING!** Fire and explosion hazard. Batteries must never be exposed to open flames or sparks.

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

⚠ **WARNING!** Battery electrolyte is highly corrosive. Always protect your eyes, skin and clothes when handling batteries. Always use protective goggles and gloves. If acid comes into contact with your skin, wash at once with soap and a lot of water. If you get battery acid in your eyes, flush at once with a lot of water, and get medical assistance at once.

Connection and disconnection

When you connect batteries, first connect the + cable (red) to the + pole on the battery. Then connect the - cable (black) to the - pole on the battery

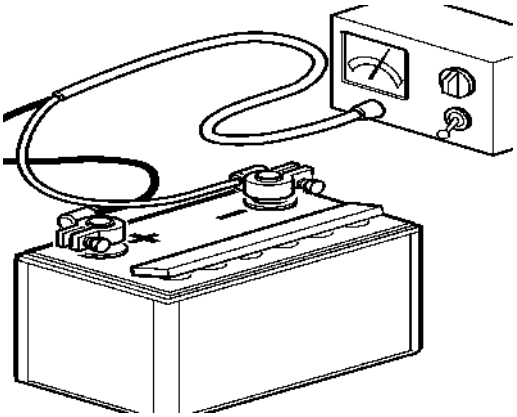
When you disconnect batteries, connect the - cable (black) first, then the + cable (red).

Cleaning

Keep the batteries dry and clean. Contamination and oxide on the batteries and battery poles can cause stray currents, voltage drop and discharge, especially in wet weather. Clean oxidation from the battery poles and terminals, using a copper brush. Tighten the terminals securely and grease them with terminal grease or Vaseline.

Filling

The electrolyte level should be 5-10 mm (0.2-0.4”) above the cell plates in the battery. Top up with **distilled water** as necessary. After filling, the battery should be charged for at least 30 minutes by running the engine at fast idle. NOTE! Some maintenance-free batteries have special instructions, which must be observed.



Batteries, charging

⚠ **WARNING!** Explosion risk! Hydrogen is given off when batteries are charged. This forms an explosive mixture with air. A short circuit, open flame or spark could cause a violent explosion. Ventilate well.

⚠ **WARNING!** Battery electrolyte is highly corrosive. Protect your eyes, skin and clothes. Always use protective goggles and gloves. If acid comes into contact with your skin, wash at once with soap and a lot of water. If you get battery acid in your eyes, flush at once with a lot of cold water, and get medical assistance at once.

Charge batteries if they have become discharged. If the engine is not used for a longer period of time, the batteries should be fully charged, then possibly trickle charged (please refer to the battery manufacturer's recommendations). Batteries are damaged by being left discharged, and can also freeze and burst easier in cold weather.

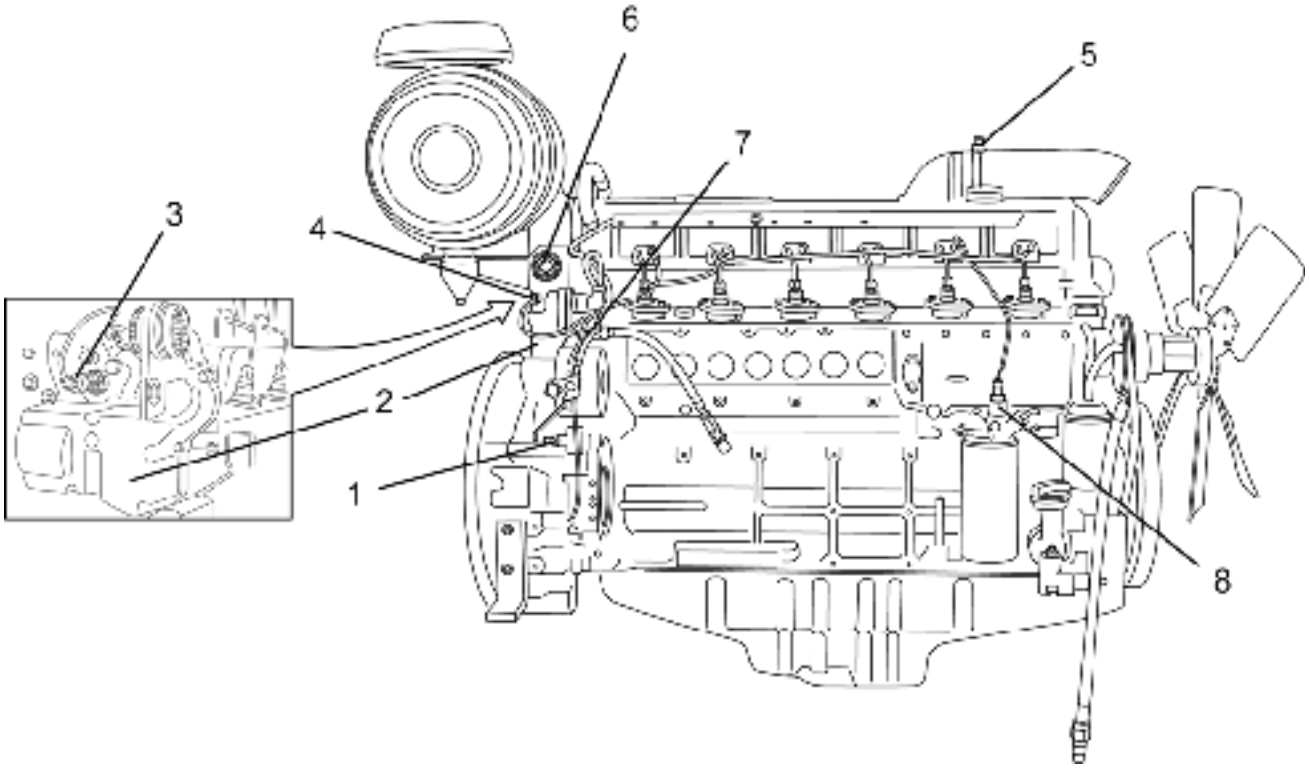
⚠ **IMPORTANT!** Observe the instruction manual for the battery charger carefully. To avoid the risk of electrochemical corrosion when an external charger is connected, the battery cables should be removed from the batteries before the charger is connected.

During charging, unscrew the cell plugs but leave them in the plug holes. Ventilate well, especially if the batteries are charged in an enclosed space.

⚠ **WARNING!** Always switch off the charge current **before** undoing the charging clamps. Never confuse the positive (+) and negative (-) poles on the batteries. This can cause serious arcing and can cause an explosion.

Special instructions apply to so-called **quick charging**. Quick charging can shorten battery life, and should therefore be avoided.

Component location



1. Speed sensor, camshaft
2. Speed regulator / Actuator
3. Coolant temperature sensor
4. Charge pressure sensor, 3 pin*
5. Charge pressure sensor, 4 pin*
6. Connection to control unit
7. Fuel temperature sensor
8. Oil pressure sensor

* Only one type of sensor is used.

Laying up

The engine must be laid up to prevent damage if it is not used for two months or more. It is important that this is done in the correct manner, and nothing is forgotten. For this reason, we have compiled a check list of the most important points.

Before laying up for a long period of time, an authorized Volvo Penta workshop should check over the engine and other equipment. Have any faults and deficiencies attended to, so that the equipment is in order, ready for the next start.

⚠ **WARNING!** Before you start to do any maintenance work, read the “Maintenance” chapter carefully. This contains instructions for doing work in a safe and correct manner.

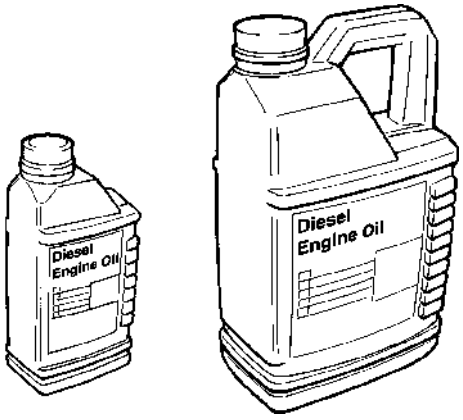
Conservation

- Change engine oil and oil filter.
- Change the fuel filter. Also change the primary fuel filter, if fitted.
- Warm the engine up.
- Check that the coolant offers sufficient frost protection. Top up as necessary.

  ⚠ **IMPORTANT!** Anti-corrosion mixture does not offer any protection against frost. If there is any risk of frost, the system must be drained.
- Drain any water and contamination from the fuel tank. Fill the fuel tank completely, to avoid condensation.
- Clean the outside of the engine. Do not use a power washer. Touch up paint damage with Volvo Penta original paint.
- Disconnect the batteries. Clean and charge the batteries. NOTE! A poorly charged battery can freeze and burst.
- Spray the components of the electrical system with water-repellent spray.

Removing conservation preparations

- Check the oil level in the engine. Top up as necessary. If special conservation oil has been put in, this must be changed together with the oil filter. For the correct grade: Please refer to the “Maintenance, lubrication system” chapter:
- Close/tighten drain taps/plugs.
- Check the drive belts.
- Check the condition of all rubber hoses, and retighten the hose clamps.
- Check the coolant level and anti-freeze. Top up as necessary.
- Connect the fully charged batteries.
- Start the engine. Check that there is no leakage of oil, fuel, coolant or exhaust gas, and that all controls function normally.



Fault tracing

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

⚠ **WARNING!** Read through the safety advice for care and maintenance work in the “Safety information” chapter before starting work.

Symptoms and possible causes

☼ The diagnosis button lamp flashes.	Please refer to the “Diagnostic information” chapter.
Engine can not be stopped.	2, 4
Starter motor does not rotate	1, 2, 3, 4, 5, 6, 7, 24
Starter motor rotates slowly	1, 2
Starter motor rotates normally but engine does not start	8, 9, 10, 11
Engine starts but stops again	8, 9, 10, 11, 13
Engine does not reach correct operating speed at full throttle	9, 10, 11, 12, 13, 21, 25, 26
Engine runs roughly	10, 11, 27
High fuel consumption	12, 13, 15, 25
Black exhaust smoke	12, 13
Blue or white exhaust smoke	14, 15, 22
Too low lubrication oil pressure	16
Excessive coolant temperature	17, 18, 19, 20
Too low coolant temperature	20
No, or poor charge	2, 23

1. Flat batteries
2. Poor contact/open circuit in cables
3. Main switch turned off
4. Faulty ignition lock
5. Faulty main relay
6. Faulty starter motor relay
7. Faulty starter motor/solenoid
8. Lack of fuel:
   – fuel taps closed
   – fuel tank empty/wrong tank connected
9. Blocked fuel filter/pre-filter (because of contamination, or paraffin fraction separation in fuel at low temperature).
10. Air in the fuel system
11. Water/contamination in fuel
12. Faulty injection pumps
13. Insufficient air supply to engine:
   – blocked air filter
   – air leakage between turbocharger and engine inlet pipe.
   – fouled compressor section in turbocharger
   – faulty turbocharger
   – poor engine bay ventilation
14. Excessive coolant temperature
15. Too low coolant temperature
16. Too low oil level
17. Coolant level too low
18. Air in the coolant system
19. Faulty circulation pump
20. Defective thermostat
21. Blocked intercooler
22. Too high oil level
23. Alternator drive belt slips
24. Water entry into engine
25. High back pressure in exhaust system
26. Break in “Pot+” cable to pedal
27. Incorrectly set engine speed regulator / actuator

Diagnostic function

The diagnostic function monitors and checks that the EDC 4 system functions normally.

Diagnostic function

The diagnostic function has the following tasks:

- Discover and localize malfunctions.
- Notify that malfunctions have been discovered.
- Give advice in fault finding.
- Protect the engine and ensure continued operation when serious malfunctions are discovered.

Malfunction message

If the diagnostic function discovers a malfunction in the EDC 4 system, this is notified via the CAN bus or the diagnostic lamp lights up or starts to flash. At the same time, the fault is stored in the control unit memory. As soon as the fault has been attended to and the ignition is turned off and on, the fault code lamp goes out. Both rectified (passive) and un-rectified (active) faults are stored in the control unit and can be read by an authorized workshop.

Fault tracing guide

If the diagnostic button is depressed (for 1-3 seconds) and then released, a fault code is flashed out from the diagnostic lamp. The fault code is found in the fault code list, with information about the reason, reaction and measures to be taken. Please refer to the “Fault codes” chapter.

Effect on engine

The diagnostic function affects the engine in the following ways:

1. The diagnostic function has discovered a minor malfunction which does not damage the engine.

   Reaction: The engine is not affected. The diagnostic lamp lights up.

2. The diagnostic function has discovered a serious malfunction which makes it impossible to control the engine.

   Reaction: The diagnostic lamp starts to flash. Engine is shut off.

Operation

During starting

When the ignition is turned on, the diagnostic lamp lights up for two seconds, together with the warning lamps for oil pressure and coolant. This is to check the lamp function.

If the diagnostic lamp flashes after the two seconds, this indicates a serious fault and the engine can not be started. One or more fault codes can then be flashed out.

If the diagnostic lamp is lit, there are one or more less serious faults. One or more fault codes can then be flashed out.

During operation

If the diagnostic lamp starts to flash during operation:

1. Reduce engine speed to idling.
2. Press the diagnostic button (for 1-3 seconds).
3. Release the diagnostic button and make a note of the diagnostic trouble code (DTC) that is flashed out. Please refer to “Reading fault codes” below.
4. Look up the fault code in the fault code list and take the necessary measures. Please refer to the “Fault codes” chapter.

If the diagnostic lamp starts to flash, the engine will be emergency stopped.

⚠ **IMPORTANT!** In VE engines, there is a function in the system which makes it possible to start the engine again and run it for about 25 seconds. This is so that the vehicle can be moved from a railway level crossing etc.

Reading fault codes

Fault codes can either be read via:

- The VODIA tool (including the Penta EDC4 software). Please refer to the “VODIA User’s Guide” for advice on use.
- Diagnostic lamp
- CAN

Diagnostic lamp

If the diagnostic lamp is illuminated or flashes, a fault code can be read by pressing the diagnostic button (for 1-3 seconds) and then releasing it. The diagnostic lamp goes out, and a fault code is then flashed out.

The fault code consists of three groups of flashes, separated by a pause of two seconds.

The first and third group consist of short flashes (0.4 s). The second group consists of long flashes (0.8 s).

A fault code is obtained by counting the number of flashes in each group.

Example: ☀ ☀ (2 short) pause ☀ ☀ (2 long) pause ☀ (1 short) = Fault code 2.2.1

The fault code is stored and can be read as long as the fault remains. You can find information about cause, reaction and actions in the fault code list. Please refer to “Fault codes”.

Read as follows:

1. Press the diagnostic button (for 1-3 seconds).
2. Release the diagnostic button and make a note of the fault that is flashed out.
3. Repeat items 1-2. A new fault code is flashed out if more are stored. Repeat until the first fault code is repeated.

NOTE! When the first fault code is repeated, all fault codes have been read out.

When all faults have been rectified:

1. Turn the ignition on and off.
2. Press the diagnostic button (for 1-3 seconds) to check whether any faults remain.
3. If there are no active faults, the diagnostic lamp will give two short flashes, in other cases the remaining non-rectified faults will be flashed out again.

Fault codes

⚠ **WARNING!** Read through the safety advice for care and maintenance work in the “Safety information” chapter before starting work.

Code 2.0.0 No faults

There are no active faults.

PID 190, Code 2.1.1 Engine speed sensor, camshaft

Reason: Faulty sensor, connector, cables or incorrect distance to cam wheel. High frequency interference.

Reaction: Engine is shut off.

Action:

- Check that the engine speed sensor is installed with the correct distance to the camshaft.
- Check the cables for the engine speed sensor for breaks and short circuits.
- Check the connector for poor contact.
- Check engine speed sensor function. Change the sensor as necessary.

PID 190, Code 2.1.4 Overspeed

Reason: The engine speed is or has been higher than the permissible limit.

Reaction: Fuel injection ceases and the fault code lamp lights up until the engine speed falls below the permissible limit again.

Action:

- Check the control rod for the injection pumps.
- Check the actuator, replace it if necessary.
- Check the cables for the actuator for breaks and short circuits.
- Check the number of teeth on the camshaft wheel.
- For VE engines, it may be necessary to check the function of the “limp home” mode

PID 91, Code 2.2.1 Accelerator pedal sensor

Reason: Faulty sensor, connector or cable.

Reaction: The engine goes into “limp home” mode.

Action:

- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.

PID 102, Code 2.2.3 Charge pressure sensor

Reason: Faulty sensor, connector or cable.

Reaction: A fault code is generated.

Action:

- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.

PID 100, Code 2.2.4 Oil pressure sensor

Reason: Faulty sensor, connector or cable.

Reaction: A fault code is generated.

Action:

- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.

PID 110, Code 2.2.5 Temperature sensor, coolant

Reason: Faulty sensor, connector or cable.

Reaction: A fault code is generated.

Action:

- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.

PID 174, Code 2.2.7 Fuel temperature sensor

Reason: Faulty sensor, connector or cable.

Reaction: A fault code is generated.

Action:

- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.

PID 100, Code 2.3.1 Warning, oil pressure

Reason: Oil pressure below specified limit value (depends on engine speed).

Reaction: A fault code is generated. The fault code disappears when the oil pressure exceeds the recuperation value.

Action:

- Check the oil level and oil pump.
- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.
- Check the limit value for oil pressure warning.

PID 110, Code 2.3.2 Warning, coolant temperature

Reason: Excessive coolant temperature

Reaction: A fault code is generated. The fault code disappears when the coolant temperature falls below the recuperation value.

Action:

- Check the coolant.
- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.

PID 111, Code 2.3.5 Warning, coolant level

Reason: Coolant level too low

Reaction: A fault code is generated.

Action:

- Check the coolant level.
- Check the sensor cable for breaks and short circuits.
- Check sensor function (if installed). Change the sensor as necessary.

NOTE! The engine is supplied without a coolant level sensor.

PID 190, Code 2.3.6 Overspeed in limp home mode

Reason: When the limp home mode is activated and the engine speed is or has been higher than the permissible limit value.

Reaction: GE: Engine is shut off. A fault code is generated.

VE: Fuel injection ceases when the control rod returns to its home position and the fault code lamp lights up until the engine speed falls below the permissible limit again.

Action:

- Check the control rod for the injection pumps.
- Check the actuator, replace it if necessary.
- Check the cables for the actuator for breaks and short circuits.
- Check the number of teeth on the camshaft wheel.
- For VE engines, it may be necessary to check the function of the “limp home” mode

PID 174, Code 2.3.7 Warning, fuel temperature

Reason: Excessive fuel temperature.

Reaction: A fault code is generated. The fault code disappears when the fuel temperature falls below the recuperation value.

Action:

- Check the fuel.
- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.

PID 100, Code 2.3.1 Emergency stop, oil pressure

Reason: Oil pressure below specified limit value.

Reaction: Engine is emergency stopped.

Action:

- Check the oil level and oil pump.
- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.
- Check the limit value for engine shut-off due to oil pressure.

PID 110, Code 2.3.2 Emergency stop, coolant temperature

Reason: Excessive coolant temperature

Reaction: Engine is emergency stopped.

Action:

- Check the coolant.
- Check the sensor cable for breaks and short circuits.
- Check sensor function. Change the sensor as necessary.
- Check the limit value for engine shut-off due to coolant pressure.

PID 111, Code 2.3.5 Emergency stop, coolant level

Reason: Low coolant level

Reaction: The engine is emergency stopped and can not be re-started until the fault is rectified.

Action:

- Check coolant level.
- Check the sensor cable for breaks and short circuits.
- Check sensor function (if installed). Change the sensor as necessary.

NOTE! The engine is supplied without a coolant level sensor.

SID 24, Code 2.5.1 Control rod position sensor

Reason: Actuator not connected. Faulty value from control rod position sensor in actuator.

Reaction: Engine is emergency stopped. Actuator can not be controlled.

Action:

- Check the actuator. Change as necessary.
- Check the cables for the actuator for breaks and short circuits.

SID 24, Code 2.5.1 Control rod position sensor, reference

Reason: Actuator not connected. Faulty value from control rod position sensor in actuator.

Reaction: Engine is emergency stopped. Actuator can not be controlled.

Action:

- Check the actuator. Change as necessary.
- Check the cables for the actuator for breaks and short circuits.

SID 23, Code 2.5.1 Control rod position sensor, difference

Reason: Injection pump/actuator has got stuck or is not connected. Difference between control rod current value and nominal value exceeds 10%.

Reaction: A fault code is generated. The fault code disappears when the difference between control rod current value and nominal value falls below 10%.

Action:

- Check the control rod for the injection pumps.
- Check the actuator, control rod and injection pumps. Change as necessary.
- Check the cables for the actuator for breaks and short circuits.

SID 23, Code 2.5.2 Injection pump, auto calibration

Reason: Automatic actuator equalization is not possible. Faulty calibration.

Reaction: The engine is emergency stopped and can not be re-started until the fault is rectified. The regulator can not be activated.

Action:

- Check the actuator. Change as necessary.
- Check the actuator cables.
- Turn the ignition off and on, and check if the fault code remains.

SID 231, Code 2.7.1 Communication fault, CAN bus

Reason: CAN controller for CAN bus is faulty.

Reaction: --

Action:

- Check the cables.
- Check the control unit.

SID 252, Code 2.8.1 Parameter programming

Reason: Memory fault

Reaction: The engine is emergency stopped and can not be re-started until the fault is rectified.

Action:

- Turn the ignition off and on, and check if the fault code remains.

SID 240, Code 2.8.1 Cyclical program test

Reason: Memory fault

Reaction: The engine is emergency stopped and can not be re-started until the fault is rectified.

Action:

- Turn the ignition off and on, and check if the fault code remains.

PID 158, Code 2.9.1 Control unit, voltage supply

Reason: Voltage supplied to actuator exceeds permissible limit values.

Reaction: A fault code is generated. The fault code disappears when the voltage returns to within the permissible limit values.

Action:

- Turn the ignition off and on, and check if the fault code remains.

PID 158, Code 2.8.2 Reference voltage 1

Reason: Reference voltage for actuator exceeds permissible limit values.

Reaction: A fault code is generated. The fault code disappears when the voltage returns to within the permissible limit values (5 V).

Action:

- Check the voltage supplied.
- Turn the ignition off and on, and check if the fault code remains.

PID 158, Code 2.8.2 Reference voltage 2

Reason: Reference voltage for actuator exceeds permissible limit values.

Reaction: A fault code is generated. The fault code disappears when the voltage returns to within the permissible limit values (5 V).

Action:

- Check the voltage supplied.
- Turn the ignition off and on, and check if the fault code remains.

PID 158, Code 2.8.2 Reference voltage 3

Reason: Reference voltage for actuator exceeds permissible limit values.

Reaction: A fault code is generated. The fault code disappears when the voltage returns to within the permissible limit values (5 V).

Action:

- Check the voltage supplied.
- Turn the ignition off and on, and check if the fault code remains.

PID 48, Code 2.9.2 Atmospheric pressure

Reason: Air pressure is outside permissible values.

Reaction: A fault code is generated. The fault code disappears when the pressure returns to normal. Monitoring function for air pressure is activated.

Action:

- Turn the ignition off and on, and check if the fault code remains.

SID 253, Code 2.10.1 Parameter fault

Reason: No data or incorrect data (fault only occurs during parameter setting or reset).

Reaction: Engine can not be started.

Action:

- Check parameter settings.
- Turn the ignition off and on, and check if the fault code remains.

SID 240, Code 2.10.1 Stack overflow

Reason: Internal calculation fault.

Reaction: The engine is emergency stopped and can not be re-started until the fault is rectified.

Action:

- Turn the ignition off and on, and check if the fault code remains.

Technical data

General

Type designation	**TD420VE**	**TAD420VE**	**TAD620VE**
Direction of rotation (seen from flywheel)	Anti- clockwise	Anti- clockwise	Anti- clockwise
No. of cylinders	4	4	6
Cylinder bore mm (inch)	101 (3.97”)	101 (3.97”)	98 (3.86”)
Stroke mm (inch)	126 (4.96”)	126 (4.96”)	126 (4.96”)
Cylinder volume liter (inch ^{3})	4.04 (246.5)	4.04 (246.5)	5.7 (347.8)
No. of valves	8	8	12
Compression ratio:			
EPA 1	19:1	19:1	18.4:1
COM 2, EPA2	19:1	19:1	18.4:1
Injection sequence	1-3-4-2	1-3-4-2	1-5-3-6-2-4
Engine power kW (hp)	75 (102)[1)]	103 (140)[1)]	155 (211)[1)]
Max torque Nm (lbf.ft)	373 (275)	477 (352)	680 (501)
At engine speed rpm	1800	1800	1800
Low idle rpm	800	800	800
Highest full load speed rpm	2000 – 2500 [1)]	2000 – 2500 [1)]	2000 – 2500 [1)]
Weight, dry (lb)	380 (838) [2)]	380 (838) [2)]	495 (1091) [2)]

Type designation	**TAD520VE**
Direction of rotation (seen from flywheel)	Anti- clockwise
No. of cylinders	4
Cylinder bore mm (inch)	108 (4.25”)
Stroke mm (inch)	130 (5.12”)
Cylinder volume liter (inch ^{3})	4.76 (290)
No. of valves	8
Compression ratio:	
EPA 1	18.1:1
COM2, EPA2	19:1
Injection sequence	1-3-4-2
Engine power kW (hp)	118 (160))
Torque Nm (lbf.ft)	552 (407)
At engine speed rpm	1800
Low idle rpm	800 – 950
Highest full load speed rpm	2000 – 2300 [1)]
Weight, dry (lb)	432 (952) [2)]

[1)] See engine plate for specifications.
[2)] Weight according to DIN 70020-A
[3)] Extra weight TAD520GE SAE 2 (1800 rpm) 36 kg (80 lb)
[4)] Including clutch and frame

Type designation	**TAD720VE**	**TAD721VE**	**TAD722VE**
Direction of rotation, seen from flywheel:	Anti- clockwise	Anti- clockwise	Anti- clockwise
No. of cylinders	6	6	6
Cylinder bore mm (inch)	108 (4.25”)	108 (4.25”)	108 (4.25”)
Stroke mm (inch)	130 (5.12”)	130 (5.12”)	130 (5.12”)
Cylinder volume liter (inch ^{3})	7.15 (436.3)	7.15 (436.3)	7.15 (436.3)
No. of valves	12	12	12
Compression ratio:			
EPA1	18.4:1	18.4:1	—
COM2, EPA2	19.0:1	19.0:1	19.0:1
Injection sequence	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Engine power kW (hp)	174 (237)[1)]	195 (265)[1)]	200 (272)[1)]
Torque Nm (lbf.ft)	817 (603)	897 (661)	981 (724)
At engine speed rpm	1800	1800	1800
Low idle rpm	800 – 950	800 – 950	800 – 950
Highest full load speed rpm	2000 – 2300 [1)]	2000 – 2300 [1)]	2100 – 2300 [1)]
Weight, dry (lb)	572 (1261) [2)]	572 (1261) [2)]	680 (1496) [2]

Type designation	**TD520GE**	**TAD530GE**	**TAD531GE**	**TAD532GE**
Direction of rotation (seen from flywheel)	Anti- clockwise	Anti- clockwise	Anti- clockwise	Anti- clockwise
No. of cylinders	4	4	4	4
Cylinder bore mm (inch)	108 (4.25”)	108 (4.25”)	108 (4.25”)	108 (4.25”)
Stroke mm (inch)	130 (5.12”)	130 (5.12”)	130 (5.12”)	130 (5.12”)
Cylinder volume liter (inch ^{3})	4.76 (290)	4.76 (290)	4.76 (290)	4.76 (290)
No. of valves	8	8	8	8
Compression ratio:				
EPA1	17.5:1			
EPA2	17.5:1			18.0:1
EU2		18.0:1	18.0:1	
Injection sequence	1-3-4-2	1-3-4-2	1-3-4-2	1-3-4-2
Engine power:				
At 1500 rpm kW (hp)	85 (116)[1)]	89 (139)[1)]	102 (139)[1)]	129 (139)[1)]
At 1800 rpm kW (hp)	89 (121)[1)]	95 (150)[1)]	110 (150)[1)]	136 (150)[1)]
Torque Nm (lbf.ft)	541 (399)	567 (479)	649 (479)	821 (479)
At engine speed rpm	1500	1500	1500	1500
Torque Nm (lbf.ft)	472 (348)	504 (430)	584 (430)	722 (430)
At engine speed rpm	1800	1800	1800	1800
Low idle rpm	800 – 950	800 – 950	800 – 950	800 – 950
Highest full load speed rpm	1500/1800 [1)]	1500/1800 [1)]	1500/1800 [1)]	1500/1800 [1)]
Weight, dry (lb)	550 (1213) [2)]	575 (1268) [2,3)]	575 (1268) [2,3)]	575 (1268) [2,3)]
Gross weight, dry (lb)	580 (1279) [2)]	606 (1336) [2,3)]	606 (1336) [2,3)]	606 (1336) [2,3)]

[1)] See engine plate for specifications.
[2)] Weight according to DIN 70020-A
[3)] Extra weight TAD530/31/32GE SAE 2 (1800 rpm) 36 kg (80 lb)
[4)] Including clutch and frame

Type designation	**TD720GE**	**TAD730GE**	**TAD731GE**	**TAD732GE**	**TAD733GE**
Direction of rotation (seen from flywheel)	Anti- clockwise	Anti- clockwise	Anti- clockwise	Anti- clockwise	Anti- clockwise
No. of cylinders	6	6	6	6	6
Cylinder bore mm (inch)	108 (4.25”)	108 (4.25”)	108 (4.25”)	108 (4.25”)	108 (4.25”)
Stroke mm (inch)	130 (5.12”)	130 (5.12”)	130 (5.12”)	130 (5.12”)	130 (5.12”)
Cylinder volume liter (inch ^{3})	7.15 (436.3)	7.15 (436.3)	7.15 (436.3)	7,15 (436)	7,15 (436)
No. of valves	12	12	12	12	12
Compression ratio:					
EPA1	17.1:1		17.1:1		
EPA2	17.1:1	17.1:1	17.1:1	18,0:1	18,0:1
EU2		18.0:1			
Injection sequence	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Engine power:					
At 1500 rpm kW (hp)	128 (174)[1)]	129 (208)[1)]	153 (208)[1)]	201 (273)[1)]	201 (273)[1)]
At 1800 rpm kW (hp)	134 (182)[1)]	136 (222)[1)]	163 (222)[1)]	225 (306)[1)]	225 (306)[1)]
Torque Nm (lbf.ft)	815 (601)	821 (718)	974 (718)	1280 (944)	1280 (944)
At engine speed rpm	1500	1500	1500	1500	1500
Torque Nm (lbf.ft)	711 (524)	722 (638)	865 (638)	1193 (880)	1193 (880)
At engine speed rpm	1800	1800	1800	1800	1800
Low idle rpm	800 – 950	800 – 950	800 – 950	800 – 950	800 – 950
Highest full load speed rpm	1500/1800 [1)]	1500/1800 [1)]	1500/1800 [1)]	1500/1800[1)]	1500/1800[1)]
Weight, dry (lb)	750 (1653) [2)]	760 (1674) [2)]	760 (1674) [2)]	785 (1731)[2)]	785 (1731)[2)]
Gross weight, dry (lb)	790 (1742) [2)]	804 (1773) [2)]	804 (1773) [2)]	826 (1821)[2)]	826 (1821)[2)]

[1)] See engine plate for specifications.
[2)] Weight according to DIN 70020-A
[3)] Extra weight TAD530/31/32GE SAE 2 (1800 rpm) 36 kg (80 lb)
[4)] Including clutch and frame

Lubrication system

Oil

Change volume, including filter change,

TD420VE/TAD420VE:	10 liter (2.64 US gal)
TD520GE/TAD530/531GE/TAD520VE,TAD532GE:	13 liter (3.43 US gal)
TAD620VE:	16 liter (4.22 US gal)
TAD720VE/TAD721VE/TD720GE/TAD730/731GE:	20 liter (5,28 US gal)
TAD722VE:	23 liter (6.07 US gal)
TAD732GE/TAD733GE:	34 liter (8.97 US gal)

Oil pressure with engine oil at operating temperature (min 120°C)

At rated engine speed:

TD520GE//TD720GE:	400 kPa (58 psi)
TD420VE/TAD420VE/TAD620VE/TAD520VE/ TAD720VE/TAD721VE/TAD722VE:	450 kPa (65 psi)
TAD530/531GE, TAD532GE:	450-480 kPa
TAD730/731GE/TAD732/733GE:	480-520 kPa

Idle (800 rpm), min:

TD420VE/TAD420VE/TAD620VE/TAD520VE/ TAD720VE/TAD732GE/TAD721VE/TAD733GE/ TAD722VE, TD720GE/TAD730/731GE:	80 kPa (11.6 psi)
TD520GE/TAD530/531GE/TD720GE/ TAD532GE:	90 kPa (13 psi)

Automatic stop at pressure less than:

TD420VE/TAD420VE/TAD620VE/ TAD520VE/TAD720VE/TAD721VE/TAD722VE:	50kPa (7.2 psi)
TD520GE/TAD530/531GE/TD720GE/TAD730/731GE/ TAD732GE/TAD733GE/:	200kPa (29 psi)

Oil grade ..... Please refer to the specification under “Maintenance.
Viscosity ..... Please refer to the specification under “Maintenance.

Oil filter, full flow filter:
Quantity 1
(tighten ½ - ¾ turn after it just touches)

Lubrication oil pump
Type ..... Gear driven oil pump

Fuel system

Injection sequence

TD420VE/TAD420VE/TD520GE/ TAD530/531GE/TAD520VE,TAD532GE:	1-3-4-2
TAD620VE/TD720GE/TAD730/731GE/ TAD720VE/TAD732GE/TAD721VE/TAD733GE TAD722VE:	1-5-3-6-2-4

Feed pump

Supply pressure:	0.5 MPa (72.5 psi)
Supply pressure after fuel filter at 1500 rpm: Min	0.28 MPa (40.6 psi)

By-pass valve

Opening pressure	360–440 kPa (52.2–63.8 psi)

Fuel specification

The fuel must comply with national and international standards for commercially supplied fuels, such as:

EN 590 (with nationally adapted environmental and cold requirements)

ASTM D 975 No 1-D and 2-D.

JIS KK 2204

Sulfur content: Complying with legal requirements in each country.

Low density fuel (urban diesel in Sweden and city diesel in Finland) can cause a loss of up to 5% of power and an increase in fuel consumption of about 2-3%.

Cooling system

Type ..... Pressurized, sealed

Pressure cap, max. opening pressure:
TD420VE/TAD420VE/TAD620VE/
TD520GE/TAD530/531GE/
TAD520VE/TAD720VE/TAD732GE
TAD721VE/TAD733GE/TAD722VE: ..... 90 kPa (13 psi)[1)]
TD720GE/TAD730/731GE, TAD532GE: ..... 60 kPa (8.7 psi)

[1)] Refers to VE engines which are not equipped with a pressure valve at the factory.

Volume (engine)
TD420VE/TAD420VE: ..... 4,7 liter (1.24 US gal)
TAD620VE: ..... 6 liter (1.58 US gal)
TD520GE/TAD530/531GE/TAD520VE: ..... 7,2 liter (1.9 US gal)
TAD720VE/TD720GE/TAD730/731GE/
TAD732GE/TAD721VE/TAD733GE/TAD722VE: ..... 9,8 liter (2.59 US gal)

Volume (engine + radiator and hoses)
TD520GE: ..... 17,5 liter (4.62 US gal)
TAD530/531GE: ..... 19,7 liter (5.2 US gal)
TD720GE ..... 22 liter (5.8 US gal)
TAD730/731GE, TAD532GE ..... 23,8 liter (6.3 US gal)
TAD732GE/TAD733GE ..... 27,3 liter (7.2 US gal)

Thermostat

Quantity and type ..... 1 piston thermostat

Opening temperature
TD420VE/TAD420VE/TAD620VE/
TD520GE/TAD530/531GE/
TD720GE/TAD730/731GE, TAD532GE: ..... 83° C (181° F)
TAD520VE/TAD720VE/TAD732GE/
TAD721VE/TAD733GE/TAD722VE: ..... 87° C (189° F)

Fully open at
TD420VE/TAD420VE/TAD620VE/
TD520GE/TAD530/531GE/
TD720GE/TAD730/731GE, TAD532GE: ..... 95° C (203° F)
TAD520VE/TAD720VE/TAD732GE/
TAD721VE/TAD733GE/TAD722VE: ..... 102° C (216° F)

Coolant filter

Quantity 1

Electrical system

System voltage ..... 24 V (standard), 12 V (option)

Notes

Notes

Notes

ENG

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

Yes please,

I would like an operator's manual in English at no charge.

Publication number: 7745131

Name

Address

Country

Please note that this offer is valid for 12 months from the date of delivery of the engine, after this it is subject to availability.

VOLVO PENTA

42200/615001/155099900192

GER

Schicken Sie den Coupon per Post oder als Fax an:
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Ja,

ich will kostenlos eine Betriebsanleitung in deutscher Sprache erhalten.

Publikationsnummer: 7745203

Name

Anschrift

Land

Bitte beachten Sie, dass das Angebot für die Dauer von 12 Monaten ab dem Lieferdatum des Motors gilt, danach nur noch bis zum Aufbrauchen des Lagerbestandes.

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42200/615001/155099900192

FRE

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Oui merci,

Je souhaite recevoir un manuel d'instructions gratuit en français.

Numéro de publication: 7745204

Nom

Adresse

Pays

Noter que l'offre est valable 12 mois à partir de la date de livraison du moteur, puis seulement dans la mesure des stocks disponibles.

VOLVO PENTA

42200/615001/155099900192

SPA

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Sí gracias,

deseo recibir gratuitamente un libro de instrucciones en español.

Número de publicación: 7745205

Nombre

Dirección

País

Observe que la oferta es válida durante 12 meses a partir de la fecha de entrega del motor. A partir de la fecha de finalización de la oferta, la misma es válida siempre que haya existencias.

42200/615001/155099900192

VOLVO PENTA

ITA

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Sì, grazie,

desidero ricevere gratuitamente un manuale d'istruzioni in lingua italiana.

Public. No.: 7745206

Nome e Cognome

Indirizzo

Paese

Notare che la validità dell'offerta è garantita solo per 12 mesi dalla consegna del motore, dopodiché si procederà fino ad esaurimento scorte.

42200/615001/155099900192

VOLVO PENTA

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Beställningen kan även göras via internet:
http://www.volvopenta.com/manual/coupon

Ja tack,

jag vill kostnadsfritt ha en instruktionsbok på svenska.

Publikationsnummer: 7745201

Namn

Adress

Land

Observera att erbjudandet gäller i 12 månader från motorns leveransdatum, därefter endast i mån av tillgång.

42200/615001/155099900192

VOLVO PENTA

DUT

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Ja graag,

Ik wil kosteloos een instructieboek in het Nederlands ontvangen.

Publicatienummer: 7745208

Naam

Adres

Land

Denk eraan dat de aanbieding geldt tot 12 maanden na levering van de motor, daarna nog slechts indien beschikbaar.

42200/615001/155099900192

VOLVO PENTA

FIN

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Tilauksen voi tehdä myös Internetissä:
http://www.volvopenta.com/manual/coupon

Kyllä kiitos,

haluan suomenkielisen ohjekirjan veloituksetta.

Julkaisunumero: 7745207

Nimi

Osoite

Maa

Ota huomioon, että tarjous on voimassa 1 vuoden ajan moottorin luovutuspäivämäärästä, sen jälkeen vain tuotteen saatavuuden perusteella.

42200/615001/155099900192

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POR

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Sim, obrigado(a)!

Gostaria de receber gratuitamente um manual de instruções em português.

Número de publicação: 7745209

Nome

Endereço

País

Notar que a oferta é válida por um período de 12 meses a partir da data de entrega do motor. Depois desse período, a oferta é válida consoante a disponibilidade.

42200/615001/155099900192

VOLVO PENTA

GRE

Ταχυδρομήστε αυτό το κουπόνι στην παρακάτω διεύθυνση ή στείλτε το με φαξ στον παρακάτω αριθμό φαξ:

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

Ναι,

Θα ήθελα ένα αντίτυπο του εγχειριδίου χρήσης στην αγγλική γλώσσα χωρίς καμιά χρέωση.

Αριθμός έκδοσης: 7745210

Όνομα

Διεύθυνση

Χώρα

Παρακαλούμε σημειώστε ότι αυτή η προσφορά ισχύει για 12 μήνες από την ημερομηνία παράδοσης της μηχανής. Μετά θα είναι θέμα διαθεσιμότητας.

VOLVO PENTA

42200/615001/155099900192

RUS

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Да, пожалуйста,

Я бы хотел иметь бесплатное руководство оператора на русском языке.
Номер издания: 7745212

Имя

Адрес

Страна

К Вашему сведению, это предложение действительно в течение 12 месяцев от даты поставки двигателя; в дальнейшем оно зависит от наличия.

VOLVO PENTA

42200/615001/155099900192

9.2. Appendix B - Alternator user and maintenance manual

User guide and maintenance manual

LEROY SOMER

Alternator

LSA46.2 L6 - L9
LSA46.2 M3 - M5
46-2 SHUNT & AREP & PMG

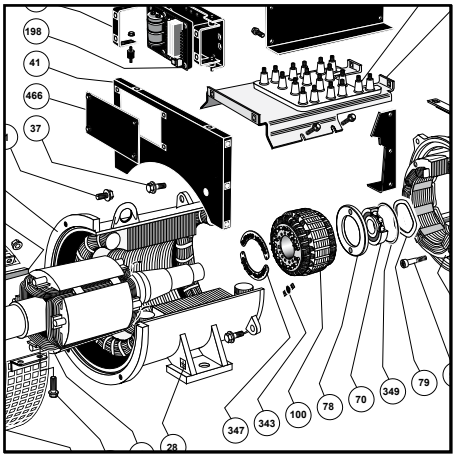
3856 h
01/03/2012

33522061001_8_1

LEROY SOMER

3856 en - 2011.01 / h

This manual is to be given to the end user



LSA 46.2 - 4 POLES

ALTERNATORS

Installation and maintenance

LSA 46.2 - 4 POLES
ALTERNATORS

This manual concerns the alternator which you have just purchased.

We wish to draw your attention to the contents of this maintenance manual.

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various operations described in this manual are accompanied by recommendations or symbols to alert the user to the potential risk of accidents. It is vital that you understand and take notice of the different warning symbols used.

WARNING

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

Warning symbol for general danger to personnel.

Warning symbol for electrical danger to personnel.

WARNING SYMBOLS

We wish to draw your attention to the following 2 safety measures which must be complied with:

a) During operation, do not allow anyone to stand in front of the air outlet guards, in case anything is ejected from them.

b) Do not allow children younger than 14 to go near the air outlet guards.

A set of self-adhesive stickers depicting the various warning symbols is included with this maintenance manual. They should be positioned as shown in the drawing below once the machine has been fully installed.

WARNING
The alternators must not be put into service until the machines in which they are to be incorporated have been declared compliant with Directives EC and plus any other directives that may be applicable.

Note: LEROY-SOMER reserves the right to modify the characteristics of its products at any time in order to incorporate the latest technological developments. The information contained in this document may therefore be changed without notice.

LSA 46.2 - 4 POLES
ALTERNATORS

CONTENTS

LSA 46.2 - 4 POLES
ALTERNATORS

1 - RECEIPT

1.1 - Standards and safety measures

Our alternators comply with most international standards.
See the EC Declaration of Incorporation on the last page.

1.2 - Inspection

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

1.3 - Identification

The alternator is identified by means of a nameplate fixed on the machine (see drawing).
Make sure that the nameplate on the machine conforms to your order.
The machine name is defined according to various criteria, for example :
LSA 46.2 M5 C6/4 -
- LSA : name used in the PARTNER range
  M : Marine
  C : Cogeneration
  T : Telecommunications
- 46.2 : machine type
- M5 : model
- C : excitation system
  (C : AREP / J : SHUNT or PMG / E : COMPOUND)
- 6/4 : winding number / number of poles.

1.3.1 - Nameplate

So that you can identify your machine quickly and accurately, we suggest you write its specifications on the nameplate below.

1.4 - Storage

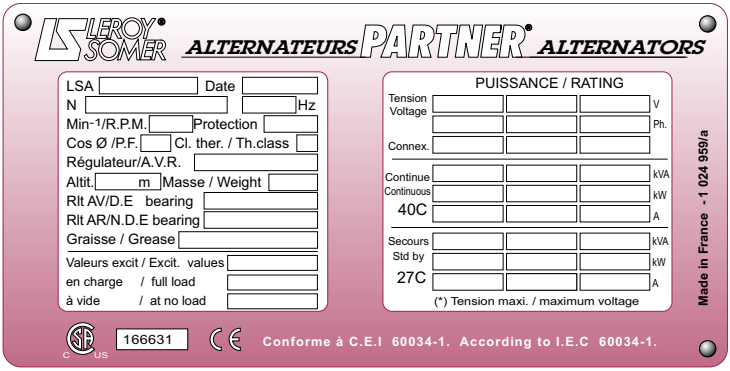
Prior to commissioning, machines should be stored :
- Away from humidity (< 90%); after a long period of storage, check the machine insulation (section 3.2.1). To prevent the bearings from becoming marked, do not store in an environment with significant vibration.

1.5 - Application

These alternators are mainly designed to produce electricity in the context of applications involving the use of generators.

1.6 - Contraindications to use

Use of the machine is restricted to operating conditions (environment, speed, voltage, power, etc) compatible with the characteristics indicated on the nameplate.



LSA 46.2 - 4 POLES
ALTERNATORS

2 - TECHNICAL CHARACTERISTICS

1.1 - Electrical characteristics

The LSA 46.2 alternator is a machine without sliprings or revolving armature brushes, wound as “2/3 pitch”, 6 or 12-wire, with class H insulation and a field excitation system available in either SHUNT, AREP or «PMG» version (see diagrams and AVR manuals).

2.1.1 - Electrical options

- Stator temperature detection sensors
- Bearing sensors (PTC, PT100, etc)
- Space heater

Interference suppression conforms to standard EN 55011, group 1, class B (Europe).

2.2 - Mechanical characteristics

- Steel frame
- Cast iron end shields
- Protected ball bearings, greased for life
- Mounting arrangements:

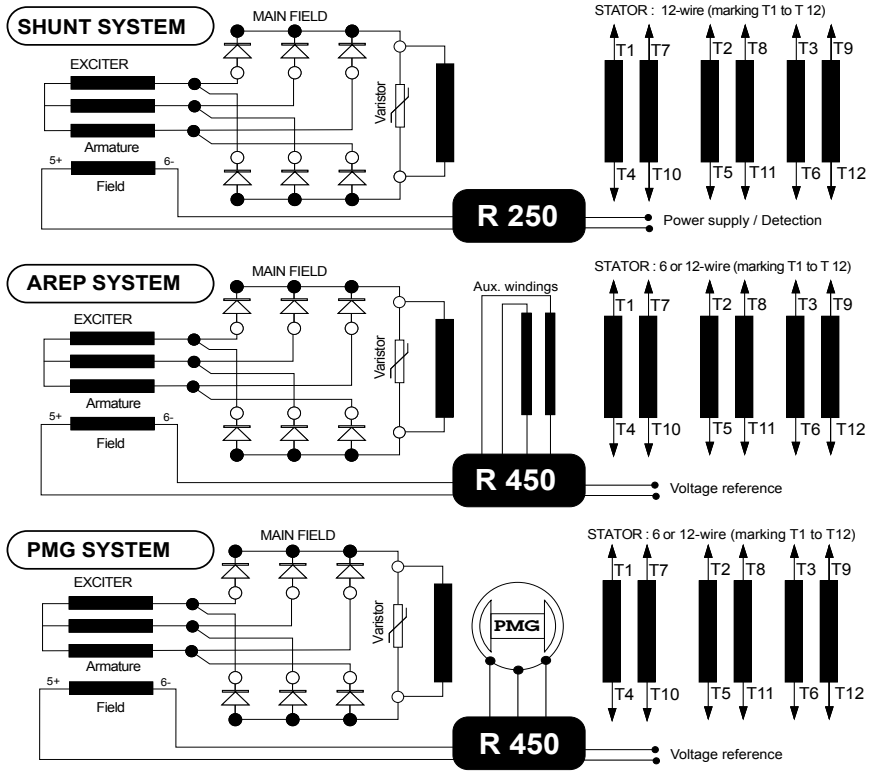
IM 1201 (MD 35) foot and flange mounted, single-bearing with SAE coupling disc.

IM 1001 (B 34) double-bearing with SAE flange and standard cylindrical shaft extension.

- Drip-proof machine, self-cooled
- Degree of protection: IP 23

2.1.1 - Mechanical options

- Air inlet filter
- Regreasable ball bearings
- IP 44 protection



LSA 46.2 - 4 POLES
ALTERNATORS

3 - INSTALLATION

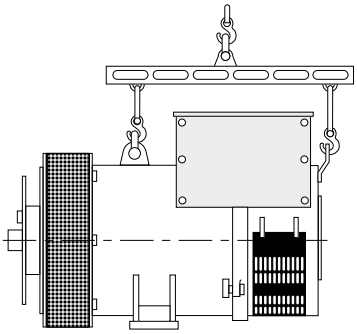
Personnel undertaking the various operations indicated in this section must wear personal protective equipment appropriate for mechanical and electrical hazards.

3.1 - Assembly

All mechanical handling operations must be undertaken using suitable equipment and the machine must be horizontal. Check how much the machine weighs (see 4.8.3.) before choosing the lifting tool.

3.1.1 - Handling

The generously-sized lifting rings are for handling the alternator alone. They must not be used to lift the genset. The choice of lifting hooks or handles should be determined by the shape of these rings. Choose a lifting system which respects the integrity and the environment of the alternators.



During this operation, do not allow anyone to stand under the load.

3.1.2 - Coupling

3.1.2.1 - Single-bearing alternator

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

When coupling the alternator to the prime mover, do not use the fan to turn the alternator or rotor.
The holes of the coupling discs should be aligned with the flywheel holes by cranking the engine.
Make sure the alternator is securely bedded in position during coupling.
Check that there is lateral play on the crankshaft.

3.1.2.2 - Double-bearing alternator

- Semi-flexible coupling

Careful alignment of the machines is recommended, checking that the lack of concentricity and parallelism of both parts of the coupling do not exceed 0.1 mm.
This alternator has been balanced with a 1/2 key.

3.1.3 - Location

The room where the alternator is placed must be ventilated to ensure that the ambient temperature cannot exceed the data on the nameplate.

3.2 - Checks prior to first use

3.2.1 - Electrical checks

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

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There are 2 possible methods for restoring the above minimum values.
a) Dry out the machine for 24 hours in a drying oven at a temperature of 110 °C (without the regulator).
b) Blow hot air into the air intake, having made sure that the machine is rotating with the exciter field disconnected.
Note : Prolonged standstill: In order to avoid these problems, we recommend the use of space heaters, as well as turning over the machine from time to time. Space heaters are only really effective if they are working continuously while the machine is stopped.

WARNING

Ensure that the alternator has the degree of protection matching the defined environmental conditions.

3.2.2 - Mechanical checks

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

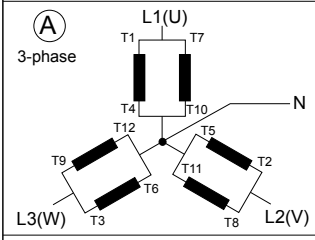
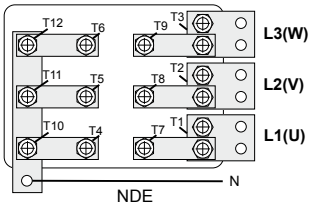
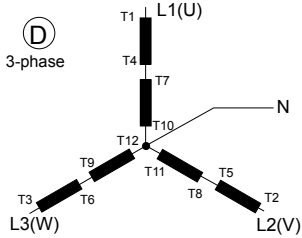
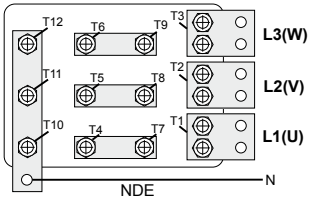
3.3 - Terminal connection diagrams

To modify the connection, change the position of the stator cables on the terminals. The winding code is specified on the nameplate.

3.3.1 - Terminal connection: 12 wire

The connection accessories are detailed in section 5.3.3.

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

Connection codes	Voltage L.L			Factory connection
	Winding	50 Hz	60 Hz	
	6	190 - 208	190 - 240	
	7	220	-	
	8	-	190 - 208	
	R 250 voltage detection : 0 => (T8) / 110 V => (T11) R 450 voltage detection : 0 => (T3) / 220 V => (T2)			
	Winding	50 Hz	60 Hz	
	6	380 - 415	380 - 480	
	7	440	-	
	8	-	380 - 416	
	R 250 voltage detection : 0 => (T8) / 110 V => (T11) R 450 voltage detection : 0 => (T3) / 380 V => (T2)			
	9	500	600	
	Winding 9 : R 450 voltage detection + transformer (See specific diagram AREP or SHUNT)			

In case of reconnection, ensure that AVR voltage detection is correct !
The factory can supply a set of flexible shunts and special connection links as an option for making these connections. (*).

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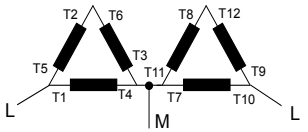
Connection codes

FF

1 phase



Voltage LM = 1/2 voltage LL

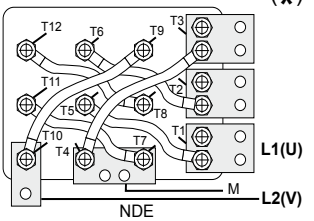
Voltage L.L

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

⚠ R 250 voltage detection :
0 => (T4) / 110 V => (T1)
R 450 voltage detection :
0 => (T10) / 220 V => (T1)

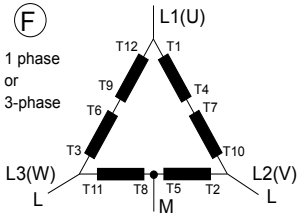
Factory connection

(*)



F

1 phase
or
3-phase

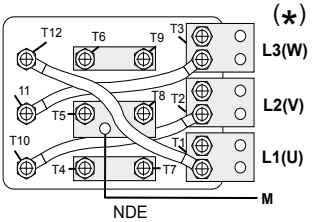


Voltage LM = 1/2 voltage LL

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

⚠ R 250 voltage detection :
0 => (T8) / 110 V => (T11)
R 450 voltage detection :
0 => (T3) / 220 V => (T2)

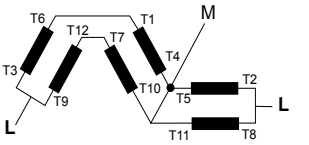
(*)



Operating phases L2 (V), L3 (W) single phase

G

1 PH

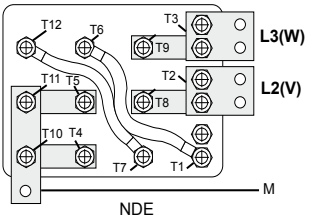


Voltage LM = 1/2 voltage LL

Winding	50 Hz	60 Hz
6	220 - 240	220 - 240
7	250 - 260	-
8	200	220 - 240

⚠ R 250 voltage detection :
0 => (T8) / 110 V => (T11)
R 450 voltage detection :
0 => (T3) / 220 V => (T2)

(*)



⚠ In case of reconnection, ensure that AVR voltage detection is correct !
The factory can supply a set of flexible shunts and special connection links as an option for making these connections. (*).

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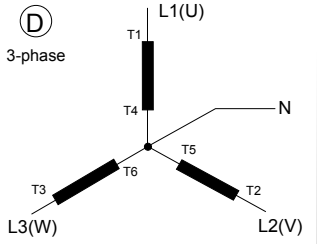
3.3.2 - Terminal connection: 6 wire (not possible with the R 250)

Connection codes



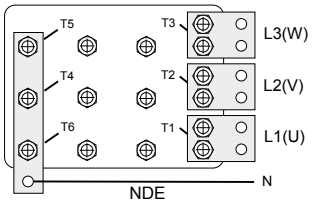
Voltage L.L

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

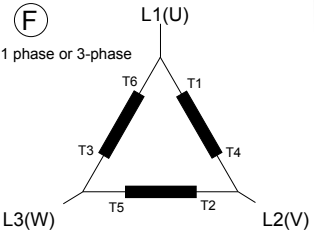
⚠ R 450 voltage detection :
0 => (T3) / 380 V => (T2)

9S	-	600

Factory connection

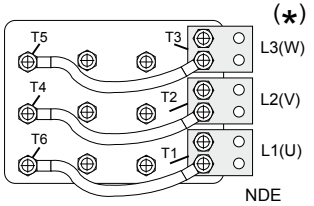


Winding 9 : R 450 voltage detection + transformer (See specific diagram)



Winding	50 Hz	60 Hz
6S	220 - 240	220 - 277
7S	240 - 254	-
8S	-	220 - 240

⚠ R 450 voltage detection :
0 => (T3) / 220 V => (T2)

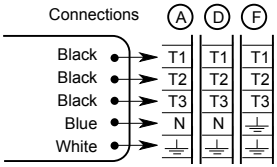


Operating phases : L2 (V), L3 (W) single phase

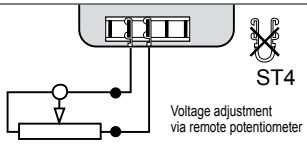
⚠ In case of reconnection, ensure that the AVR voltage detection is correct !
The factory can supply a set of flexible shunts and special connection links as an option for making these connections. (*).

3.3.3 - Option connection diagram

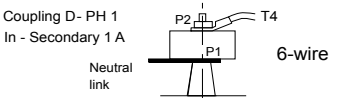
R 791 T interference suppression kit (standard for CE marking)

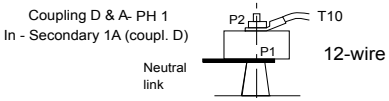


Remote voltage potentiometer

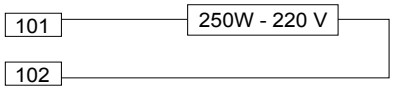


Current transformer connection (optional)

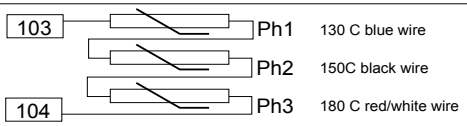




Anti condensation heater



Thermistor (PTC) temperature

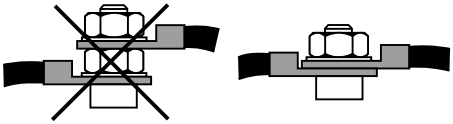


3.3.4 - Connection checks

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

Check that:

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



3.4 - Commissioning

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

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

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

3.5 - Setting up

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

Ensure that the drive speed specified on the nameplate is reached before commencing adjustment.

After operational testing, replace all access panels or covers.

The AVR is used to make any adjustments to the machine.

4 - SERVICING - MAINTENANCE

4.1 - Safety measures

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

All such operations performed on the alternator should be undertaken by personnel trained in the commissioning, servicing and maintenance of electrical and mechanical components, who must wear personal protective equipment appropriate for mechanical and electrical hazards.

Before any intervention on the machine, ensure that it cannot be started by a manual or automatic system and that you have understood the operating principles of the system.

4.2 - Routine maintenance

4.2.1 - Checks after start-up

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

4.2.2 - Bearings

As standard, the alternator is fitted with permanently greased bearings. As an option, they may be regreasable. It is advisable to lubricate the alternator during operation. Time intervals and quantity of grease are given in the table below.

NDE/DE bearing	6316 C3	6315 C3
Quantity of grease	33 g	30 g
Regreasing interval	4000 H	4500 H

Lubrication intervals are given for grease type: LITHIUM - standard - NLGI 3.

In the factory, the grease used for lubrication is: ESSO - Unirex N3.

Before using another grease, check for compatibility with the original one. Monitor the temperature rise in the bearings (see section 4.4).

4.2.3 - Electrical servicing

Commercially-available volatile degreasing agents can be used.

WARNING

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

These operations must be performed at a cleaning station, equipped with a vacuum system that collects and flushes out the products used.

The insulating components and the impregnation system are not at risk of damage from solvents. Avoid letting the cleaning product run into the slots.

Apply the product with a brush, sponging frequently to avoid accumulation in the housing. Dry the winding with a dry cloth. Let any traces evaporate before reassembling the machine.

4.2.4 - Mechanical servicing

WARNING

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

Degreasing: Use a brush and detergent (suitable for paintwork).

Dusting: Use an air gun.

If the machine is fitted with air inlet and outlet filters, the maintenance personnel should clean them routinely at regular intervals. In the case of dry dust, the filter can be cleaned using compressed air and/or replaced if it is clogged.

After cleaning the alternator, it is essential to check the winding insulation (see sections 3.2 and 4.8).

4.3 - Fault detection

If, when commissioned, the alternator does not work normally, the source of the malfunction must be identified (see sections 4.4 and 4.5).

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4.4 - Mechanical defects

Fault		Action
Bearing	Excessive temperature rise in one or both bearings (bearing temperature more than 80 °C) with or without abnormal bearing noise	- If the bearing has turned blue or if the grease has turned black, change the bearing - Bearing not fully locked (abnormal play in the bearing cage) - Check the end shield alignment (flange not properly fitted)
Abnormal temperature	Excessive temperature rise in the alternator housing (more than 40° C above the ambient temperature)	- Air flow (intake-outlet) partially clogged or hot air is being recycled from the alternator or engine - Alternator operating at too high a voltage (> 105% of Un on load) - Alternator overloaded
Vibration	Excessive vibration	- Misalignment (coupling) - Defective mounting or play in coupling - Rotor balancing fault (Engine - Alternator)
	Excessive vibration and humming noise coming from the machine	- Phase imbalance - Stator short-circuit
Abnormal noise	Alternator damaged by a significant impact, followed by humming and vibration	- System short-circuit - Mis-paralleling Possible consequences: - Broken or damaged coupling - Broken or bent shaft extension - Shifting and short-circuit of revolving field winding - Fan fractured or coming loose on shaft - Irreparable damage to rotating diodes, AVR, surge suppressor

4.5 - Electrical faults

Fault	Action	Effect	Check/Cause
No voltage at no load on start-up	Connect a new battery of 4 to 12 volts to terminals E- and E+, respecting the polarity, for 2 to 3 seconds	The alternator builds up and its voltage is still correct when the battery is removed	- Lack of residual magnetism
		The alternator builds up but its voltage does not reach the rated value when the battery is removed	- Check the connection of the voltage reference to the AVR - Faulty diodes - Armature short-circuit
		The alternator builds up but its voltage disappears when the battery is removed	- Faulty AVR - Field windings open circuit (check winding) - Revolving field coil open circuit (check the resistance)
Voltage too low	Check the drive speed	Correct speed	Check the AVR connections (AVR may be faulty) - Field windings short-circuited - Rotating diodes burnt out - Revolving field coil short-circuited - Check the resistance
		Speed too low	Increase the drive speed (do not touch the AVR voltage pot. (P2) before running at the correct speed)
Voltage too high	Adjust AVR voltage potentiometer	Adjustment ineffective	Faulty AVR
Voltage oscillations	Adjust the AVR stability potentiometer	If no effect: try normal or fast stability modes (ST2)	- Check the speed: possibility of cyclic irregularity - Loose connections - Faulty AVR - Speed too low when on load (or AVR LAM set too high)
Voltage correct at no load and too low when on load	Run at no load and check the voltage between E+ and E- on the AVR	Voltage between E+ and E- (DC) SHUNT / AREP / PMG < 10V	- Check the speed (or AVR LAM set too high)
		Voltage between E+ and E- SHUNT / AREP / PMG > 15V	- Faulty rotating diodes - Short-circuit in the revolving field coil. Check the resistance. - Faulty exciter armature. Check the resistance.
Voltage disappears during operation	Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components	The voltage does not return to the rated value	- Exciter winding open circuit - Faulty exciter armature - Faulty AVR - Revolving field coil open circuit or short-circuited

4.5.1 - Checking the winding

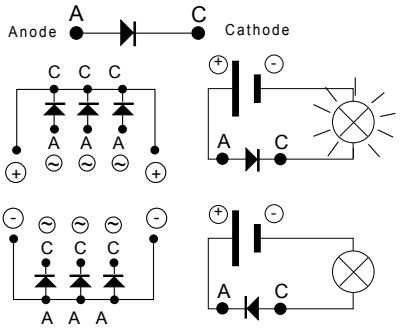
You can check the winding insulation by performing a high voltage test. In this case, you must disconnect all AVR wires.

WARNING

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

4.5.2 - Checking the diode bridge

A diode in good working order should allow the current to flow only in the anode-to-cathode direction.

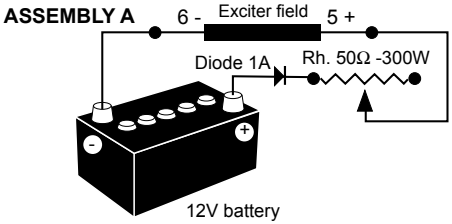


4.5.3 - Checking the windings and rotating diodes using separate excitation

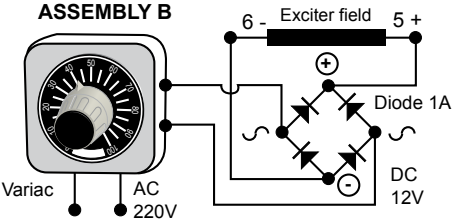
During this procedure, make sure that the alternator is disconnected from any external load and inspect the terminal box to check that the connections are fully tightened.

1) Stop the unit, disconnect and isolate the AVR wires.
2) There are two ways of creating an assembly with separate excitation.

Assembly A: Connect a 12 V battery in series with a rheostat of approximately 50 ohms - 300 W and a diode on both exciter field wires (5+) and (6-).



Assembly B: Connect a "Variac" variable power supply and a diode bridge on both exciter field wires (5+) and (6-).
Both these systems should have characteristics which are compatible with the field excitation power of the machine (see the nameplate).
3) Run the unit at its rated speed.
4) Gradually increase the exciter field current by adjusting the rheostat or the variac and measure the output voltages on L1 - L2 - L3, checking the excitation voltage and current at no load (see the machine nameplate or ask for the factory test report). When the output voltage is at its rated value and balanced within 1% for the rated excitation level, the machine is in good working order. The fault therefore comes from the AVR or its associated wiring (ie. sensing, auxiliary windings).



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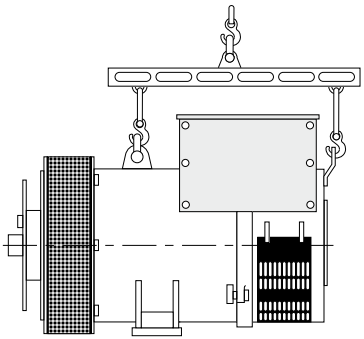
4.6 - Dismantling, reassembly (see sections 5.4.1. & 5.4.2.)

WARNING

During the warranty period, this operation should only be carried out in an LEROY-SOMER approved workshop or in our factory, otherwise the warranty may be invalidated.
Whilst being handled, the machine should remain horizontal (rotor not locked in position). Check how much the machine weighs (see 4.8.3) before choosing the lifting method.



4.6.1 - Tools required

To fully dismantle the machine, we recommend using the tools listed below:
- 1 ratchet spanner + extension
- 1 torque wrench
- 1 set of flat spanners: 8 mm, 10 mm, 18 mm
- 1 socket set: 8, 10, 13, 16, 18, 21, 24, 30 mm
- 1 socket with male ferrule: 5 mm
- 1 puller

4.6.2 -Screw tightening torque

See section 5.4.

4.6.3 - Access to diodes

- Open the air intake grille (51).
- Disconnect the diodes.
- Check the 6 diodes, change the diode bridges if necessary.

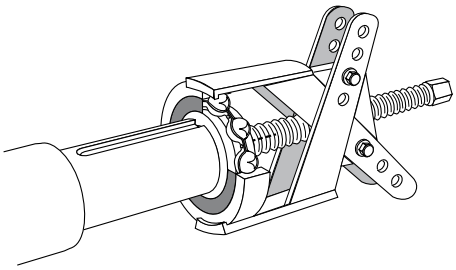
4.6.4 - Access to connections and the regulation system

Access directly by removing the top of the cover (48) or the AVR access door (466).

4.6.5 - Replacing the NDE bearing

- Remove the box lid (48) and the NDE panel (365) and remove the 2 screws from the part (122).
- Disconnect the stator outputs (T1 to T12).
- Disconnect the auxiliary winding wires AREP (X1,X2,Z1,Z2).
- Disconnect the exciter wires (5+,6-).
- Remove the air inlet louvre (51).

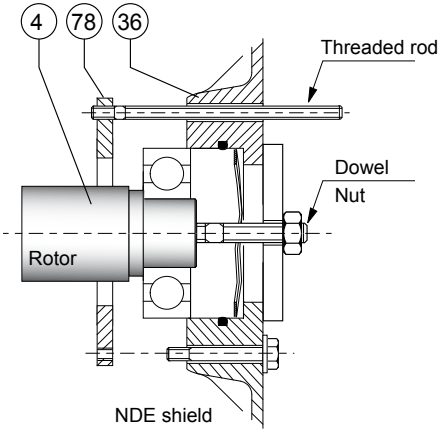
If using a single-bearing or double-bearing machine with the regreasable bearing option:
- Remove the bearing (78) thrust screws (72).
- Remove all 4 screws (37).
- Remove the shield (36).
- Take out the antifriction bearing (70) using a puller with a central screw (see drawing below).



- Fit the new antifriction bearing onto the shaft after heating it by induction to approximately 80 °C.
- Mount the new preloading (wavy) washer (79) + the new “O” ring seal (349) in the shield (36) and coat the bearing seat with adhesive paste (see After Sales Service).

If using a single-bearing or double-bearing machine with the regreasable bearing option:
- Screw a threaded rod into the thrust bearing (78).
- Refit the end shield on the machine using a dowel and nut in the shaft extension (see drawing).

- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).



- Fit the thrust bearing screws (78), remove the threaded rod, fit the other screw and tighten up the assembly.
- Tighten the 4 bearing screws (37).
- Reconnect wires.
- Fit the 2 support screws (122).
- Fit the air inlet louvre (51).
- Replace the cover.

WARNING

When dismantling the shields, you will need to change the antifriction bearings, the "O" ring seal, the preloading (wavy) washer and adhesive paste.

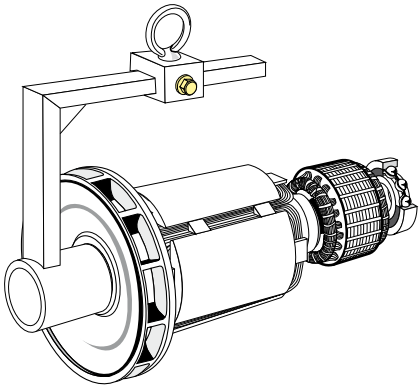
4.6.6 - Replacing the DE bearing

- Remove the air outlet grille (33).
- Remove the 6 screws (31) from the DE shield and the 3 screws (62) from the inner bearing retainer.
- Remove the shield (30).
- Take out the ball bearing (60) using a puller with a central screw (see section 4.6.5).
- Fit the new bearing, after heating it by induction to approximately 80 °C.
- Screw a threaded rod into the thrust bearing (68).
- Refit the shield (30) on the machine.
- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).
- Tighten the bottom thrust bearing screws (78), remove the threaded rod and fit the other screws.
- Tighten the 6 shield screws (31).
- Refit the air outlet grille (33).

4.6.7 - Dismantling the rotor assembly

- Remove the NDE shield (36) as described in section 4.6.5.
- Remove the DE shield (30) as described in section 4.6.6 if it is a double-bearing machine.
- Support the DE rotor (4) with a strap or with a support constructed in accordance with the following drawing.
- Move the strap as the rotor moves in order to distribute the weight over it.

WARNING



When dismantling the rotor involves changing parts or rewinding, the rotor must be rebalanced.

4.6.8 - Reassembling the machine

- Mount the rotor (4) in the stator (1) (see drawing above) taking care not to knock the windings.

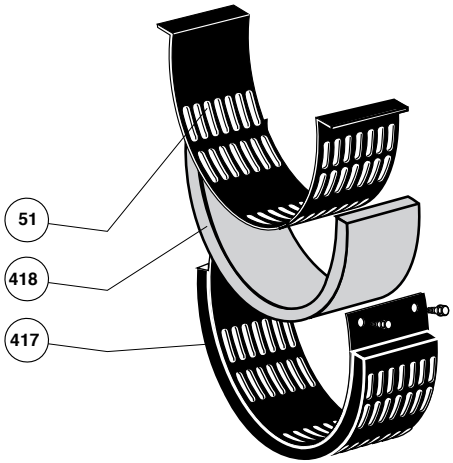
If using a single-bearing or double-bearing machine with the regreasable bearing option:
- Mount the new preloading (wavy) washer (79) + the new “O” ring seal (349) in the shield (36).
- Screw a threaded rod into the thrust bearing (78).
- Refit the shield (36) on the machine using a dowel and nut in the shaft extension (see diagram).
- Slide the threaded rod into the shield hole to make it easier to assemble (see diagram).
- Fit the thrust bearing screws (78), remove the threaded rod, fit the other screw and tighten up the assembly.
- Tighten the 4 bearing screws (37).
- Reconnect exciter wires E+, E-.
- Finish reassembling the cover.
- Refit the flange (30) on the stator (1).
- Tighten the screws (31).

If using a double-bearing machine:
- Mount the new preloading (wavy) washer (79) + the new “O” ring seal (349) in the shield (36).
- Refit the shield (36) on the machine using a dowel and nut in the shaft extension (see diagram).
- Tighten the 4 shield screws (37).
- Reconnect exciter wires E+, E-.
- Finish reassembling the cover.
- Screw a threaded rod into the thrust bearing (68).
- Refit the shield (30) on the machine.
- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).
- Fit the thrust bearing screws (68), remove the threaded rod, fit the other screw and tighten up the assembly.
- Tighten the 6 shield screws (31).
- Refit the air outlet grille (33).
- Check that the machine assembly is correctly mounted and that all screws are tightened.

4.6.9 - Dismantling and reassembly of the filters

- Remove the grille (417) then take out the filter (418). Change the filter if necessary; please refer to section 4.2.5 for cleaning the filter.

To replace, follow the instructions in reverse order.



4.7 - Installation and maintenance of the PMG

For the LSA 46.2, the PMG reference is: PMG 2.
See the PMG manual ref : 4211.

4.8 - Table of characteristics

Table of average values
Alternator - 4 poles - 50 Hz - Standard winding No. 6.
(400V for the excitation values)
The voltage and current values are given for no-load operation and operation at rated load with separate field excitation.
All values are given to within ± 10% and may be changed without prior notification (for exact values, consult the test report).

4.8.1 - LSA46.2 average values

Resistances at 20 °C (Ω)

LSA 46.2	Stator L/N	Rotor	Field	Armature
M3	0.022	0.23	8.8	0.035
M5	0.0182	0.24	8.8	0.035
L6	0.0148	0.264	8.8	0.035
L9	0.012	0.295	8.8	0.035
VL12	0.0085	0.343	10	0.037

Resistance of AREP auxiliary windings at 20 °C (Ω)

LSA 46.2	Auxil wdg: X1, X2	Auxil wdg: Z1, Z2
M3	0.24	0.4
M5	0.215	0.36
L6	0.185	0.36
L9	0.19	0.32
VL12	0.17	0.32

Field excitation current i exc (A)
Symbols : “i exc”: excitation current of the exciter field

LSA 46.2	No load	At rated load
M3	1.1	4
M5	1.1	3.8
L6	1.1	4.1
L9	1.2	4
VL12	1.1	3.5

For 60 Hz machines, the “i exc” values are approximately 5 to 10 % lower.

4.8.2 - Voltage of auxiliary windings at no load

LSA 46.2	Auxil wdg: X1, X2	Auxil wdg: Z1, Z2
50 Hz	70 V	10 V
60 Hz	85 V	12 V

4.8.3 - Table of weights

(values given for information only)

LSA 46.2	Total weight (kg)	Rotor (kg)
M3	600	250
M5	700	260
L6	800	290
L9	850	320
VL12	1000	380

After operational testing, it is essential to replace all access panels or covers.

5 - SPARE PARTS

5.1 - First maintenance parts

Emergency repair kits are available as an option.
They contain the following items:

Emergency kit SHUNT	ALT 472 KS 001
AVR R 250	-
Diode bridge assembly	-
Surge suppressor	-

Emergency kit AREP	ALT 461 KS 001
AVR R 450	-
Diode bridge assembly	-
Surge suppressor	-

Single-bearing kit	ALT 471 KB 002
Non drive end bearing	-
«O» ring	-
Preloading (wavy) washer	-

Double-bearing kit	ALT 471 KB 001
Non drive end bearing	-
Drive end bearing	-
«O» ring	-
Preloading (wavy) washer	-

5.2 - Technical support service

Our technical support service will be pleased to provide any additional information you may require.

When ordering spare parts, you should indicate the complete machine type, its serial number and the information given on the nameplate.

Address your enquiry to your usual contact.

Part numbers should be identified from the exploded views and their description from the parts list.
Our extensive network of service centres can dispatch the necessary parts without delay.

To ensure correct operation and the safety of our machines, we recommend the use of original manufacturer spare parts.

In the event of failure to comply with this advice, the manufacturer cannot be held responsible for any damage.

5.3 - Accessories

5.3.1 - Space heater for use when stopped

The space heater must run as soon as the alternator stops. It is installed at the rear of the machine. Its standard power is 250W with 220V or 250W with 110V on request.

Warning: the power supply is present when the machine has stopped.

5.3.2 - Temperature sensors with thermistors (PTC)

These are thermistor triplets with a positive temperature coefficient installed in the stator winding (1 per phase). There can be a maximum of 2 triplets in the winding (at 2 levels: warning and trip) and 1 or 2 thermistors in the shields.
These sensors must be linked to adapted sensing relays (supplied optionally).
Cold resistance of cold thermistor sensors: 100 to 250 Ω per sensor.

5.3.3 - Connection accessories

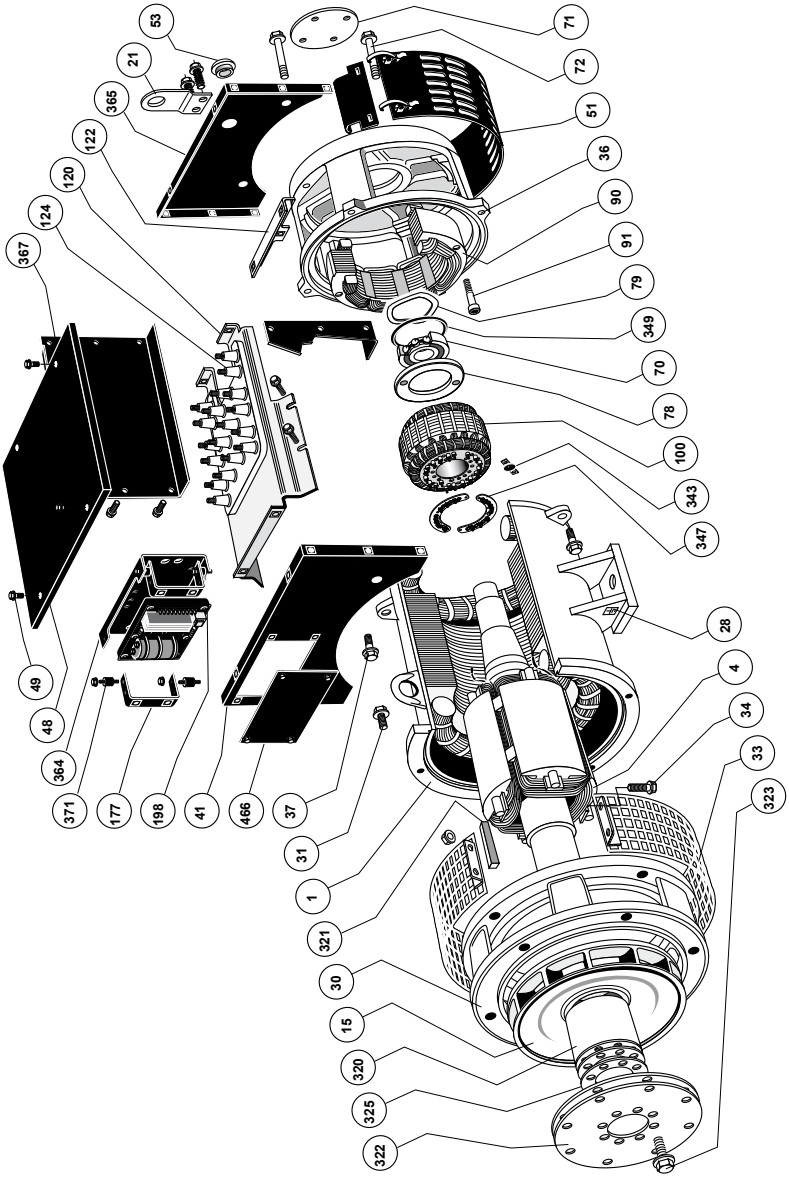
- 6-wire machines : coupling (F)
- 12-wire machines : coupling (A), (F .F), (F)

After operational testing, it is essential to replace all access panels or covers.

LSA 46.2 - 4 POLES
ALTERNATORS

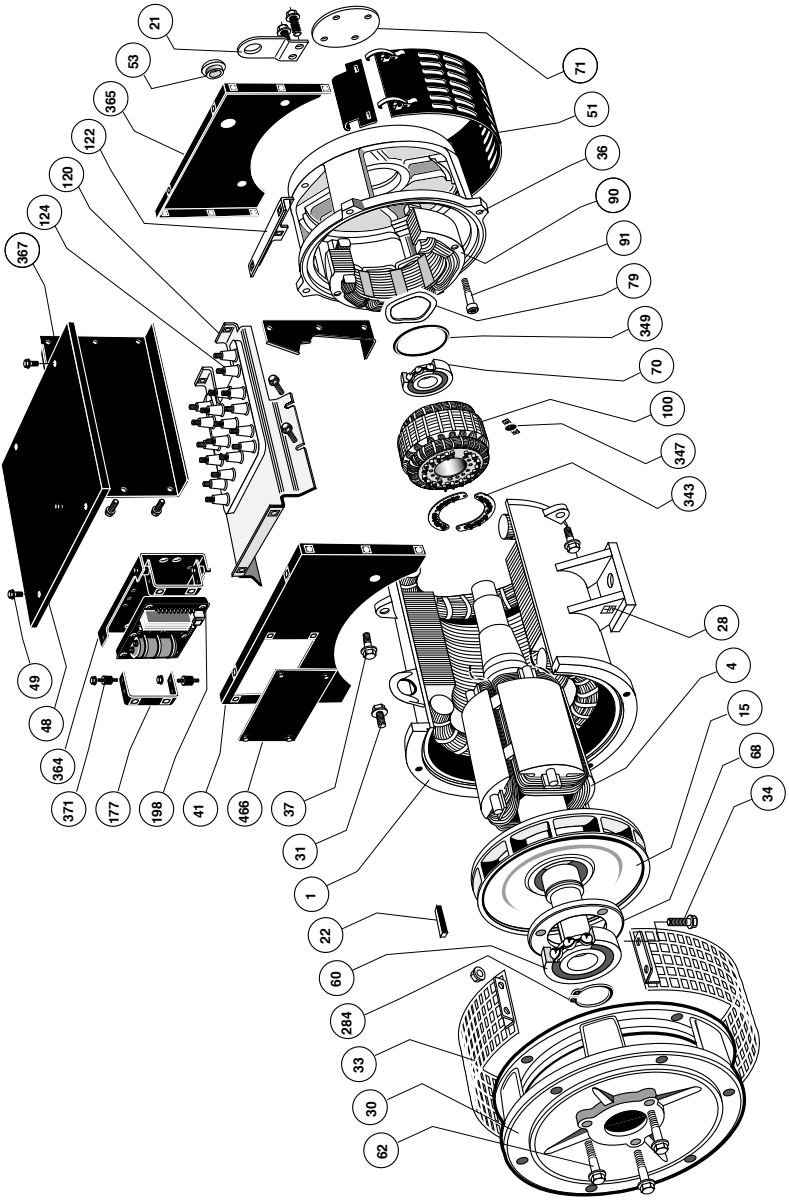
5.4 - Exploded view, parts list and tightening torque

5.4.1 - LSA 46.2 single-bearing



LSA 46.2 - 4 POLES
ALTERNATORS

5.4.2 - LSA 46.2 double-bearing



LSA 46.2 - 4 POLES
ALTERNATORS

Ref.	Qty	Description	Screw Ø	Torque N.m	Ref.	Qty	Description	Screw Ø	Torque N.m
1	1	Stator assembly	-	-	90	1	Exciter field	-	-
4	1	Rotor assembly	-	-	91	4	Fixing screws	M6	10
15	1	Fan	-	-	100	1	Exciter armature	-	-
21	1	Lifting ring	-	-	120	1	Terminal plate support	-	-
22	1	Shaft extension key	-	-	122	1	Plate support	-	-
28	1	Earth terminal	M10	20	124	1	Terminal plate	M12	35
30	1	Drive end shield	-	-	177	2	AVR support bracket	-	-
31	6 or 4	Fixing screws	M14	80(*)	198	1	Voltage regulator (AVR)	-	-
33	1	Protective grille	-	-	284	1	Circlips	-	-
34	2	Fixing screws	M6	5	320	1	Coupling sleeve	-	-
36	1	Exciter end shield	-	-	321	1	Sleeve key	-	-
37	4	Fixing screws	M12	50	322	3	Coupling disc	-	-
41	1	Cover front panel	-	-	323	6	Fixing screw	M16	230
48	1	Cover top panel	-	-	325	-	Spacer shim	-	-
49	-	Cover screws	M6	5	343	1	Diode bridge assembly	M6	4
51	1	Air intake grille	-	-	347	1	Protection varistor (+ PCB)	-	-
53	1	Plug	-	-	349	1	“O” ring	-	-
60	1	Drive end bearing	-	-	364	1	AVR support	-	-
62	3 or 4	Fixing screws	M8	20	365	1	Cover rear panel	-	-
68	1	Inner bearing retainer	-	-	367	2	Side panel	-	-
70	1	Non drive end bearing	-	-	371	4	Damper	-	-
71	1	Cover	-	-	416	1	Filter	-	-
72	2	Fixing screws	M8	20	417	1	Filter support	-	-
78	1	Inner bearing retainer	-	-	466	2	AVR inspection door	-	-
79	1	Preloading (wavy) washer	-	-					

(*) 80 N.m in M / 190 N.m in L, VL

Electric Power Generation Division

Declaration of CE compliance and incorporation

This Declaration applies to the generators designed to be incorporated into machines complying with the Machinery Directive Nr 2006/42/CE dated 17 May 2006.

MOTEURS LEROY-SOMER
Boulevard Marcellin Leroy
16015 ANGOULEME
France

MLS HOLICE STLO.SRO
SLADKOVSKEHO 43
772 04 OLOMOUC
Czech Republic

MOTEURS LEROY-SOMER
1, rue de la Burelle
Boite Postale 1517
45800 St Jean de Braye
France

Declares hereby that the electric generators of the types LSA 36 – 37– 40 – 42.2 – 43.2 – 44.2 – 46.2 – 47.2 – 49.1 – 50.2 – 51.2, as well as their derivatives, manufactured by Leroy Somer or on Leroy Somer's behalf, comply with the following International Standards and Directive :

- EN and IEC 60034 -1 and 60034 -5
- ISO 8528 – 3 " Reciprocating internal combustion engine driven alternating current generating sets. Part 3. Alternating current generators for generating sets "
- Low Voltage Directive Nr 2006/95/CE dated 12 December 2006.

Furthermore, these generators, designed in compliance with the Machine Directive Nr 2006/42, are therefore able to be incorporated into Electrical Gen-Sets complying with the following International Directives :

- Machinery Directive Nr 2006/42/CE dated 17 May 2006
- EMC Directive Nr 2004/108/CE dated 15 December 2004, as intrinsic levels of emissions and immunity are concerned

WARNING :

The here above mentioned generators should not be commissioned until the corresponding Gen-Sets have been declared in compliance with the Directives Nr 2006/42/CE et 2004/108/CE, as well as with the other relevant Directives.

Leroy Somer undertakes to transmit, in response to a reasoned request by the national authorities, relevant information on the generator.

Technical Managers
P Betge – J.Begué

4152 en – 2010.11 / d

LSA 46.2 - 4 POLES
ALTERNATORS

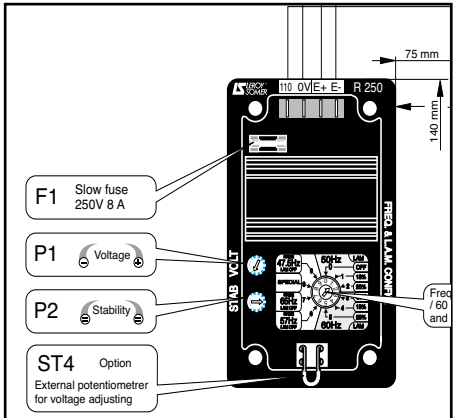
LEROY-SOMER 16015 ANGOULÊME CEDEX - FRANCE
338 567 258 RCS ANGOULÊME

www.leroy-somer.com

LEROY SOMER

4067 en - 2009.05 / b

This manual is to be given to the end user



R250

A.V.R.

Installation and maintenance

161/209

R250
A.V.R.

This manual concerns the alternator A.V.R. which you have just purchased.

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

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various operations described in this manual are accompanied by recommendations or symbols to alert the user to potential risks of accidents. It is vital that you understand and take notice of the following warning symbols.

WARNING

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

Warning symbol for general danger to personnel.

Warning symbol for electrical danger to personnel.

Note : LEROY-SOMER reserves the right to modify the characteristics of its products at any time in order to incorporate the latest technological developments.
The information contained in this document may therefore be changed without notice.

R250
A.V.R.

SUMMARY

Any maintenance or breakdown operations on the A.V.R. are to be done by personnel trained on commisioning, servicing and maintenance for the electrical and mechanical elements.

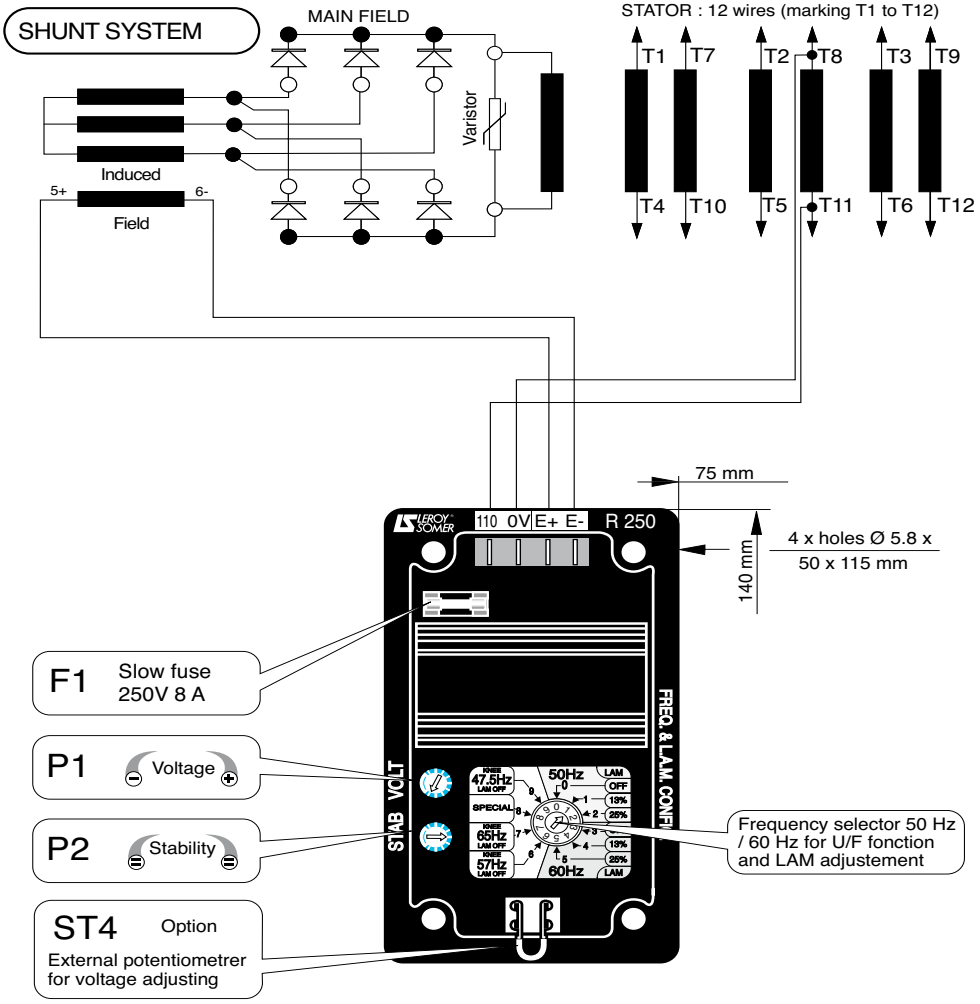
The R250 is an IP00 product. It must be installed inside a unit so that this unit's cover can provide IP20 minimum total protection (it must only be installed on LS alternators in the appropriate location so that when viewed externally, it has a higher degree of protection than IP20).

1 - SUPPLY

1.1 - SHUNT excitation system

The SHUNT excitation alternator is auto-excited with a **R 250** voltage regulator.

The regulator controls the excitation current according to the alternator's output voltage. With a very simple conception, the SHUNT excitation alternator does not have a short circuit capacity.



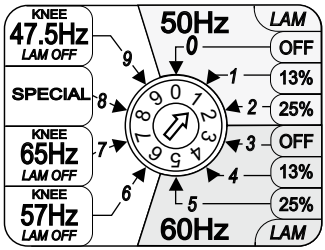
2 - R250 A.V.R.

2.1 - Characteristics

- Storage: -55°C; +85°C
- Operation: -40°C; +70°C
- Voltage regulation: around ± 0,5 %.
- Supply range/voltage detection 85 to 139 V (50/60Hz).
- Rapid response time (500 ms) for a transient voltage variation amplitude of ± 20 %.
- Voltage setting **P1**.
- Stability setting **P2**.
- Power supply protected by 8 A fuse, replacement product: Ferraz-Shawmut T084013T fast-blow fuse, 8 A FA 250 V, breaking capacity 30 kA.

2.2 - U/F Fonction and LAM

The threshold position (50 Hz - 60 Hz) to action the U/F fonction as well as the LAM setting type is selected using the potentionmeter.



WARNING: The jumper settings must correspond to the rated operating frequency (see the nameplate on the alternator).
Risk of destruction for the alternator.

The threshhold position and LAM fonction settings are done with the jumper.

Operating at 50 Hz: (U/F gradient)

0: threshold at 48 Hz without LAM for impacts between 30 and 40% of the rated load.

1: threshold at 48 Hz with LAM 13% for impacts between 40 and 70% of the rated load.

2: threshold at 48 Hz with LAM 25% for impacts > 70% of the rated load.

Operating at 60 Hz: (U/F gradient)

3: threshold at 58 Hz without LAM for impacts between 30 and 40% of the rated load.

4: threshold at 58Hz with LAM 13% for impacts 40 and 70% of the rated load.

5: threshold at 58Hz with LAM 25% for impacts > 70% of the rated load.

Specific operating

6: threshold at 57Hz without LAM for speed variations at a steady state > 2 Hz

7: threshold at 65Hz without LAM for variable speed and tractelec / gearlec (U/F gradient).

8: special: the factory setting 48Hz 2U/F gradient ; a special programme is possible on request. This programme must be specified before ordering, during the project study.

9: threshold at 47.5 Hz without LAM for speed variations at a steady state > 2 Hz.
For hydraulic applications, it is advisable to select:
- position 0 for 50 Hz
- position 3 for 60 Hz

2.3 - R250 A.V.R. option

Potentiometer for voltage setting, 1000 W / 0,5 W min: setting range ± 5 %.
- Remove the **ST4** jumper.

For wiring up the external potentiometer; the "earth" wires must be isolated as well as the potentiometer terminals (wires at the same voltage as the power).

2.4 - LAM characteristics (Load Acceptance Module)

2.4.1 - Voltage drop

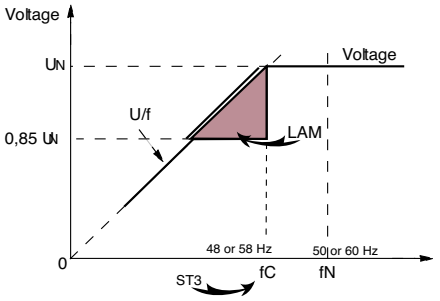
The LAM system is integrated in the A.V.R. It is active as standard. It can be adjusted to 13% or 25%.

- Role of the «LAM» (Load Adjustment Module):

On application of a load, the rotation speed of the generator set decreases. When it passes below the preset frequency threshold, the LAM causes the voltage to drop by approximately 13% or 25% and consequently the amount of active load applied is reduced by approximately 25% to 50%, until the speed reaches its rated value again.

Hence the "LAM" can be used either to reduce the speed variation (frequency) and its duration for a given applied load, or to increase the applied load possible for one speed variation (turbo-charged engines).
To avoid voltage oscillations, the trip threshold for the "LAM" function should be set approximately 2 Hz below the lowest frequency in steady state.

It is advised to use the "LAM" at 25% for load impacts > at 70% of the genset rated power.

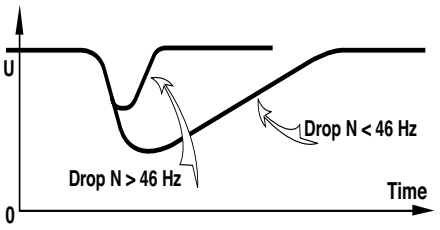


2.4.2 - Gradual voltage return function

During load impacts, the function helps the genset to return to its rated speed faster thanks to a gradual increase in voltage according to the following principles:

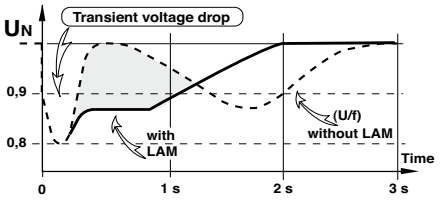
- if the speed drops between 46 Hz and 50 Hz, the rated voltage follows a fast gradient as it is restored.

- if the speed drops below 46 Hz, since the engine needs more help, the voltage follows a slow gradient as it returns to the reference value.

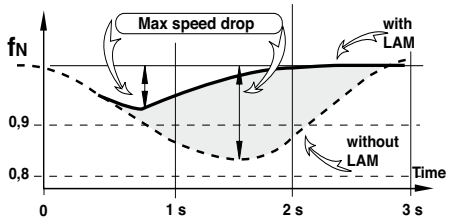


2.5 - Typical effects of the LAM with a diesel engine or without a LAM (U/F only)

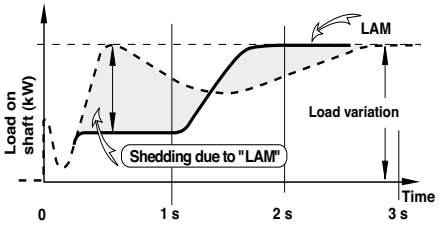
2.5.1 - Voltage



2.5.2 - Frequency



2.5.3 - Power



3 - INSTALLATION - COMMISSIONING

3.1 - Electrical checks on the AVR

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

- Check that the position of the jumper corresponds to the operating frequency.

- Check whether the ST4 jumper or the remote adjustment potentiometer have been connected.

3.2 - Settings

The different settings made during the trial are to be done by qualified personnel. Respecting the load speed specified on the nameplate is vital in order to start a settings procedure. After operational testing, replace all access panels or covers.
The only possible settings on the machine are to be done with the A.V.R.

3.2.1 - R250 settings (SHUNT system)

Initial potentiometer positions

- voltage setting potentiometer **P1** for the A.V.R.: full left

- remote voltage setting potentiometer: in the middle.

Operate the alternator at its rated speed: if the voltage does not rise it is necessary to re-magnatise the magnetic circuit.

- slowly adjust the voltage potentiometer of the A.V.R. **P1** until the output voltage reaches its rated value.

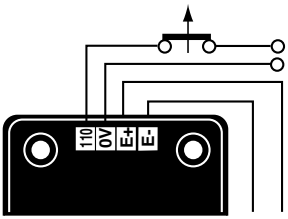
- Stability setting with **P2**.

3.2.2 - Special type of use

WARNING

Excitation circuit E+, E- must not be left open when the machine is running: A.V.R. damage will occur.

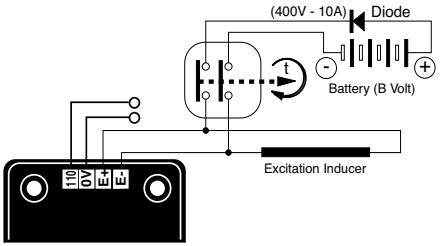
3.2.2.1 - R250 field weakening (SHUNT)



The exciter is switched off by disconnecting the A.V.R. power supply (1 wire - 0 or 110V).
Contact rating: 16A - 250V AC

Do not reclose the power supply until the voltage has reached a value ≤15% of the rated voltage (approximately 5 seconds after opening)

3.2.2.2 - R250 field forcing



The battery must be isolated from the mass.

Exciter field may be at line potential.

3.3 - Electrical faults

Fault	Action	Effect	Check/cause
No voltage at no load on start-up	Connect a new battery of 4 to 12 volts to terminals E- and E+ respecting the polarity for 2 to 3 seconds	The alternator starts up and its voltage is still correct when the battery is removed.	- Lack of residual magnetism
		The alternator starts up but its voltage does not reach the rated value when the battery is removed.	- Check the connection of the voltage reference to the A.V.R. - Faulty diodes - Induced short circuit
		The alternator starts up but its voltage disappears when the battery is removed	- Faulty A.V.R. - Exciter field short-circuited - Short-circuit in the main field. Check the resistance
Voltage too low	Check the drive speed	Correct speed	Check the A.V.R. connections (A.V.R. may be faulty) - Field windings short-circuited - Rotating diodes burnt out - Main field winding short-circuited - Check the resistance
		Speed too low	Increase the drive speed (Do not touch the A.V.R. pot (P1) before returning to the correct speed.)
Voltage too high	Adjust A.V.R. potentiometer	Adjustment ineffective	- Faulty A.V.R. - 1 faulty diode
Voltage oscillations	Adjust A.V.R. stability potentiometer		- Check the speed: possibility of cyclic irregularity - Loose terminals - Faulty A.V.R. - Speed too low on load (or U/F gradient set too high)
Voltage correct at no load and too low when on load (*)	Run at no load and check the voltage between E+ and E- on the A.V.R.		- Check the speed (or U/F gradient set too high)
			- Faulty rotating diodes - Short-circuit in the main field. Check the resistance - Faulty induced excitaion
(*) Warning: For single-phase operation, check that the sensing wires coming from the A.V.R. are correctly connected to the operating terminals (see the alternator manual).			
Voltage disappears during operation	Check the A.V.R., the surge suppressor, the rotating diodes and replace any defective components	The voltage does not return to the rated value	- Exciter winding open circuit - Faulty induced excitation - Faulty A.V.R. - Main field open circuit or short-circuited

Warning: after setting-up or trouble-shooting, replace all access panels or covers.

4 - SPARE PARTS

4.1 - Designation

Description	Type	Code
A.V.R.	R 250	AEM 110 RE 019

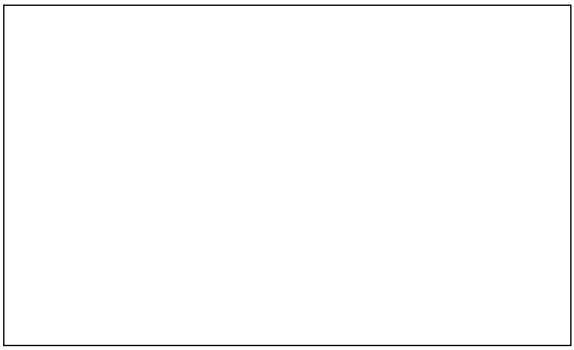
4.2 - Technical support service

Our technical support service will be pleased to help you with any information needed.

For replacement part orders, it is necessary to indicate the type and the code number of the A.V.R.

Please contact your usual correspondant.

An extensive network of service centres is available to rapidly supply any necessary parts.
In order to ensure the correct operation and safety of our machines, we strongly recommend that original manufacturer's spare parts are used.
Failure to do so, will discharge the manufacturer from liabilty in the case of damage.



MOTEURS LEROY-SOMER 16015 ANGOULÊME CEDEX - FRANCE

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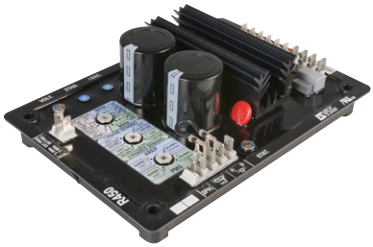
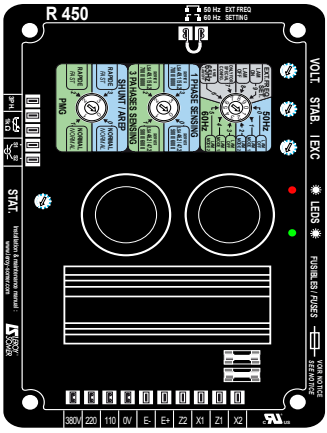


This manual is to be given to the end user



R 450

AVRs

Installation and maintenance

173/209

R 450
AVRs

This manual concerns the alternator AVR which you have just purchased.

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

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various interventions described in this manual are accompanied by recommendations or symbols to alert the user to potential risks of accidents. It is vital that you understand and take notice of the various warning symbols used.

WARNING

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

Warning symbol for general danger to personnel.

Warning symbol for electrical danger to personnel.

Note: LEROY-SOMER reserves the right to modify the characteristics of its products at any time in order to incorporate the latest technological developments. The information contained in this document may therefore be changed without notice.

R 450
AVRs

CONTENTS

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

R 450
AVRs

1 - GENERAL INFORMATION

1.1 - Description

The R450 AVR is supplied in a casing designed to be mounted on a panel with dampers.

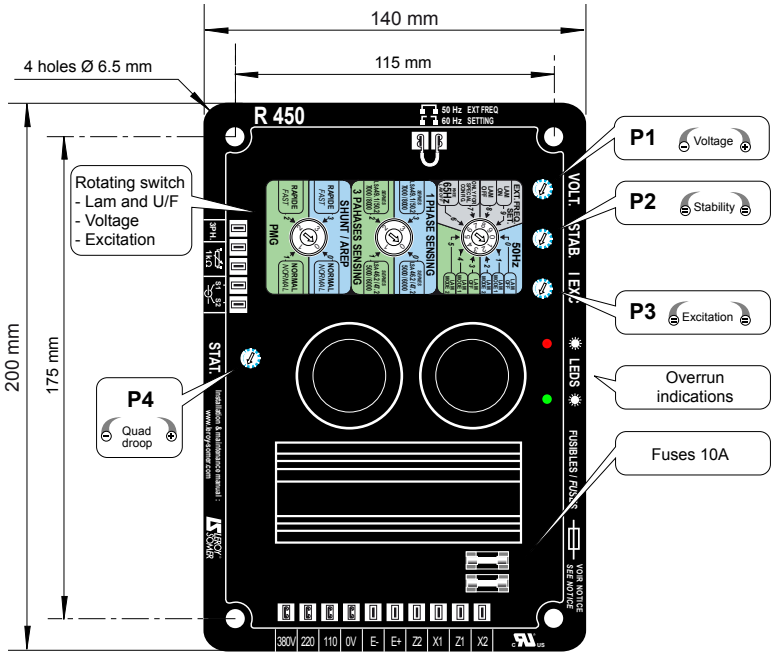
- Operating temperature: - 30°C to + 65° C.
- Storage temperature: - 55°C to + 85°C.
- Shocks on the base: 9 g depending on the 3 axes.
- Vibrations: less than 10 Hz, 2 mm half-peak amplitude 10 Hz to 100 Hz: 100 mm/s, above 100 Hz: 8 g.

WARNING

The AVR is IP00, it must be incorporated in an environment which ensures it a IP20 protection.

1.2 - Characteristic

The connection is realised by “Faston” connectors and the voltage sensing is single - phase.



2 - POWER SUPPLY

Both the SHUNT/AREP & PMG excitation systems are controlled by the AVR.

2.1 - AREP excitation system

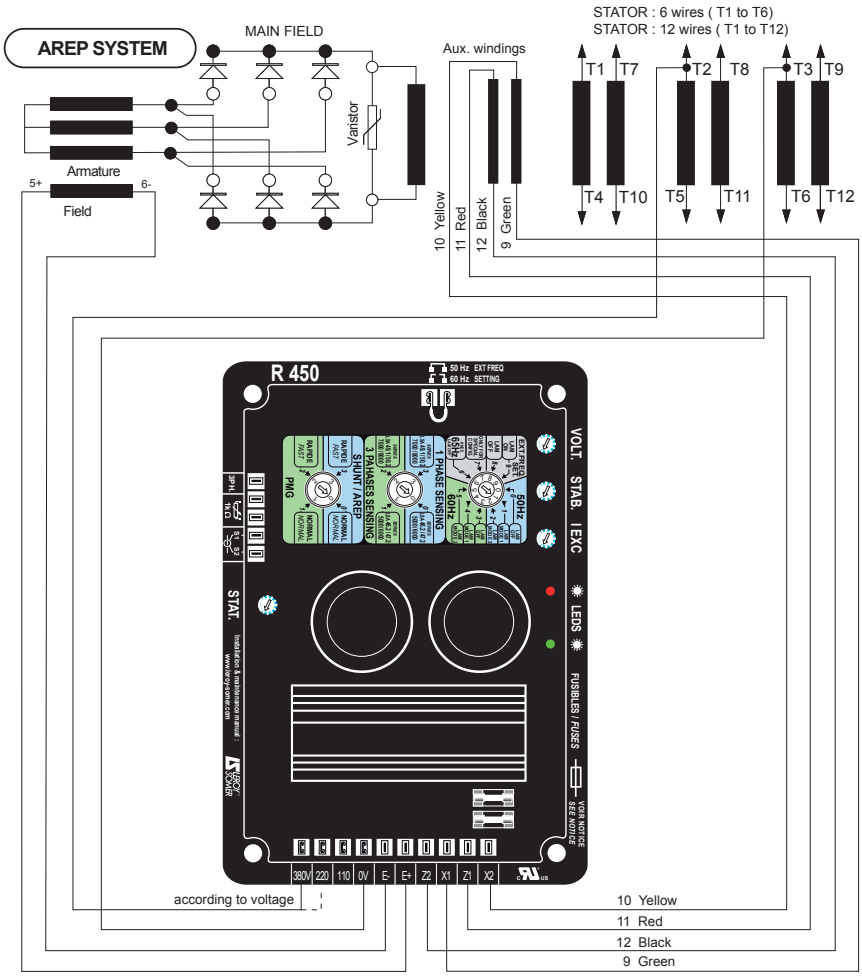
With **AREP** excitation, the electronic AVR is powered by two auxiliary windings which are independent of the voltage sensing circuit.

The first winding has a voltage proportional to the alternator main voltage (Shunt characteristic), the second one has a voltage proportional to the stator current (compound characteristic : Booster effect).

The power supply voltage is rectified and filtered before being used by the AVR monitoring transistor.

This system provides the machine with a short-circuit current capacity of 3 IN for 10 s.

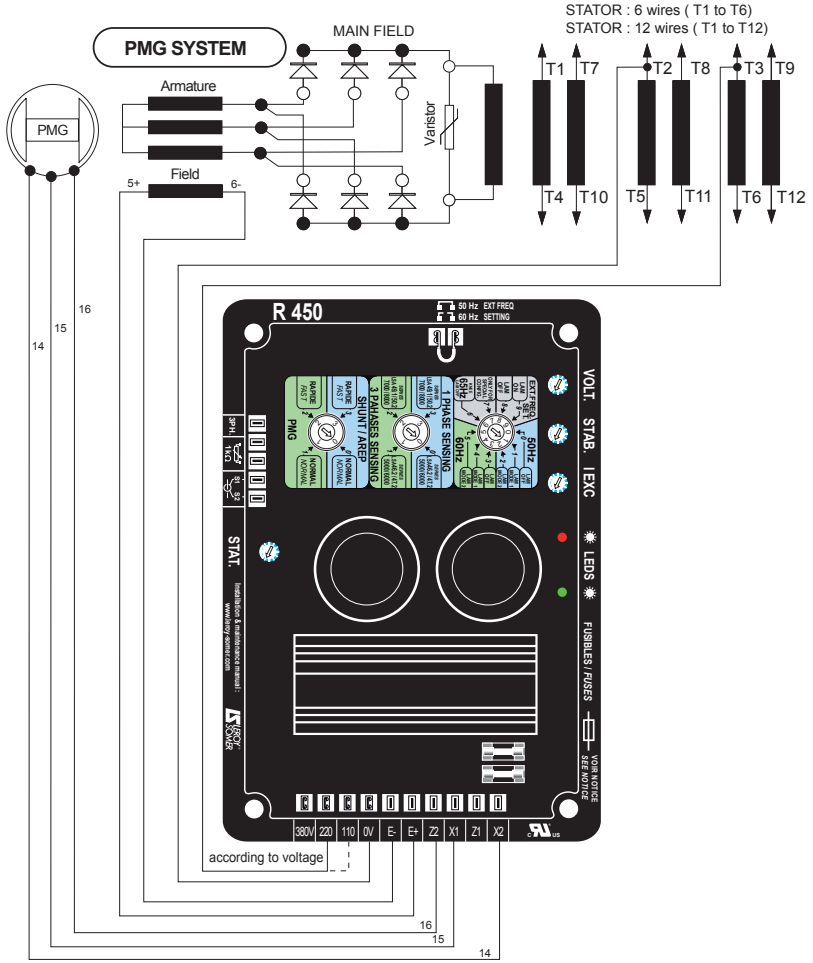
The rotating switch should be in the AREP position (see 3.2.3).



2.2 - PMG excitation system

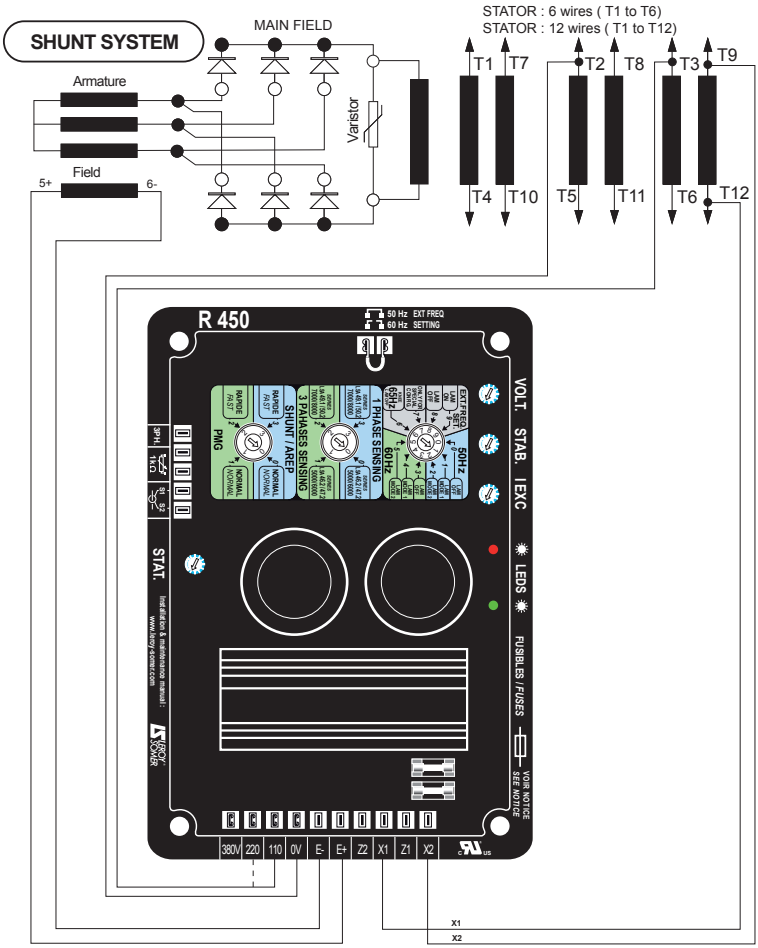
With **PMG** excitation, a permanent magnet generator (PMG) added to the alternator supplies the AVR with voltage which is independent of the main alternator winding. This system provides the machine with a short-circuit current capacity of 3 IN for 10 s.

The AVR monitors the alternator output voltage by adjusting the excitation current. The rotating switch should be in the PMG position (see 3.2.3).



2.3 - SHUNT or separate excitation system

With SHUNT excitation, the AVR is powered by the main winding (100V to 140V - 50/60 Hz) by using X1, X2 on the AVR.
The rotating switch should be in the SHUNT/ AREP position (see 3.2.3).



3 - TECHNICAL CHARACTERISTICS

3.1 - Electrical characteristics

- maximum power supply: 150V - 50/60 Hz
- Rated overload current: 10 A - 10 s
- Electronic protection:

- In the case of a short-circuit, the excitation current is reduced to a value less than 1A after 10 s

- In the event of loss of voltage reference, the excitation current is reduced to a value less than 1A after 1s for AREP/SHUNT, 10 s for PMG.

- In the event of overexcitation, the current is reduced as indicated in the next diagram (see 3.2.1.4).

- Fuses: F1 on X1 and F2 on Z2 10A, 250V.
- Voltage sensing
  - 0-110 V terminals = 95 to 140 V
  - 0-220 V terminals = 170 to 260 V
  - 0-380 V terminals = 340 to 528 V

For other voltages, a transformer should be used.

- Voltage regulation:± 0.5%.
- Current sensing: (parallel operation): input S1, S2 intended for 1 C.T. < 2.5 VA cl1, secondary 1 A or 5 A.

3.2 - Configurations:

3.2.1 - Settings

3.2.1.1 - Voltage

Voltage adjustment via potentiometer **P1** in the ranges described in the table below:

For 50 and 60 Hz	Max.
High range	320V < Un ≤ 530 V
Low range	80 V ≤ Un ≤ 320 V

WARNING

The allowed adjustment range is ±5%; when the setting exceeds these limits, please check that it is conform with the power table.

3.2.1.2 - Quadrature droop:

Quadrature droop adjustment via potentiometer **P4** within a range :

- from 0 to 8% with a PF=0.8 for 400V applications.
- From 0 to 14% with a PF=0.8 for 240V applications.
- From 0 to 8% for 110V applications with a step-up transformer (ratio of 4) placed on the voltage reference.

The potentiometer **P4** has a non linear response. Then, when a 1A secondary CT is connected the effective range starts from the the second 1/3 of **P4** range and in the case of a 5A secondary CT the effective range starts from the first 1/3.

When a 5A CT is used, the adjustment range is higher, so **P4** must be set to the first 1/4 (anti-clockwise) and then progressively increase it.

WARNING

The CT must be connected.

3.2.1.3 - Stability:

Stability adjustment via potentiometer **P2.** Selection of rotating switch according to the machine type and the response time as indicated in paragraph 3.2.3.

3.2.1.4 - Excitation limitation:

Excitation limitation adjustment via potentiometer **P3** as described below.

The excitation current limitation threshold in steady state is set by a potentiometer at 110% of the rated value. The adjustment is made by the operator during the on-load test at rated power by tuning the potentiometer.

When the excitation current exceeds this value, a counter is activated at the speed of one record per second for 90 s. When this time is elapsed, the current is reduced to the value of the rated excitation current. If in the meantime the excitation current drops below the threshold value, the counter counts down at the same speed.

WARNING

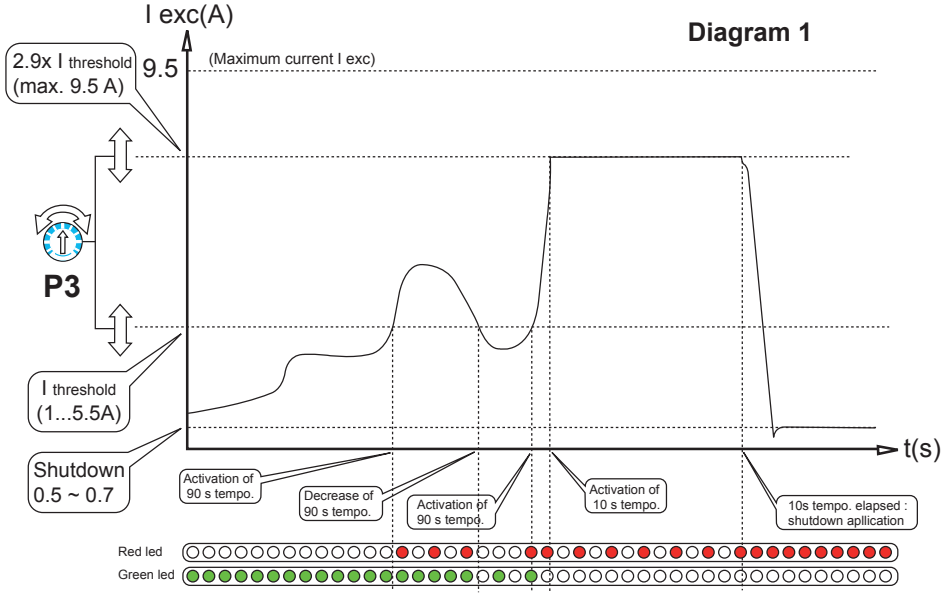
The limitation threshold must be adjustable between 1 and 5.5 A. The genset breaker must be open during the short circuit. If the genset is restarted in short circuit, there is a excitation build up during 10s again at the maximum value.

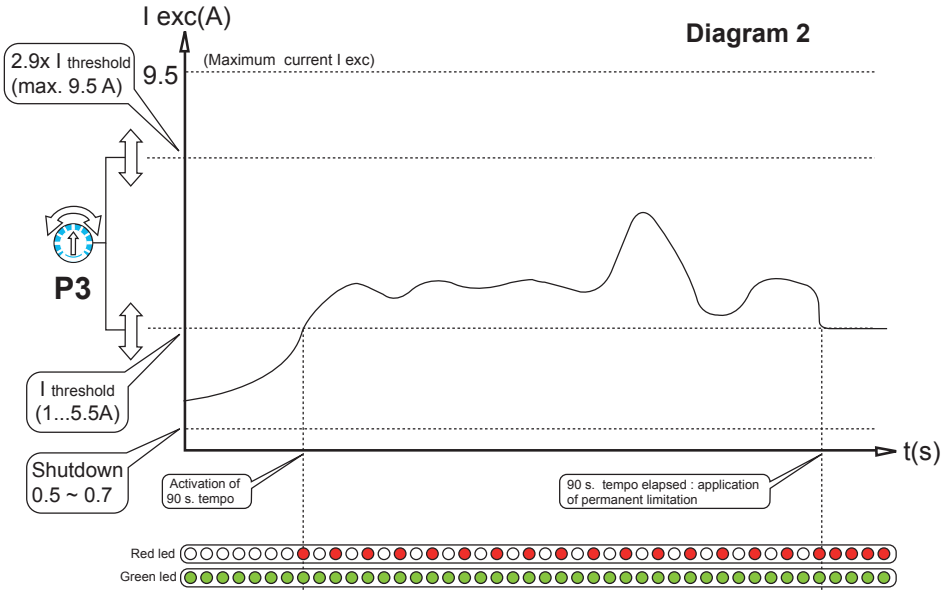
Operation between 3 and 6 In when short-circuited:
The excitation current ceiling during a short-circuit equals 2.9 times the fixed threshold when setting the permitted excitation ceiling in continuous operation. When the threshold is exceeded for a period = 10 s the current is reduced to a value between 0.5 and 0.7 A (shutdown).
In all operating conditions the maximum excitation current must be limited to 9 A ± 0.5 A.

Overrun indications:

One green LED:
- Lights up when the excitation current is below the continuous operation threshold
It signals the AVR normal operation.
- Turns off when the excitation current ceiling used to obtain short-circuit operation is reached and when the excitation current is reduced to the shutdown value.
- Flashes when the over excitation counter is decrementing.
NB: After an obvious short-circuit, the voltage is limited to 70% of the rated voltage. This avoids overvoltages on machines whose no-load excitation current is below the “lower current” threshold (only in AREP).

Diagram 1





One red LED:
- Lights up simultaneously with the green led when the continuous operation threshold is reached for more than 90 s and the excitation current is reduced to the continuous operation threshold. It is used to set the excitation current ceiling
- Turns off when the excitation current is less than the setting value (< 110% In)
- Flashes when the excitation current is above the continuous operation threshold during less than 90 s.

Green LED stays on,
- flashes when the excitation current has reached the ceiling in < 10s with PMG excitation.
- ftays on if Iexc = I Shutdown.

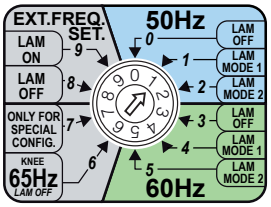
WARNING

If the overload protection is activated, a voltage drop possibly exceeding 10% of the reference voltage will be observed.

The AVR does not provide undervoltage protection. The customer will need to make sure that their installation is correctly protected against under-voltages.

During load shedding, an overvoltage is observed, which will disappear in a few seconds.

3.2.2 - Rotating switch selection: LAM and U/F

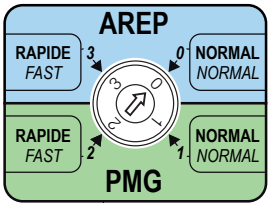


- Pos 0: Change in the voltage according to the U/F ratio, knee-point position at 48 Hz.
- Pos 1: Change in the voltage according to the 2U/F, knee-point position at 48 Hz.
- Pos 2: Change in the voltage according to the self auto-adaptating LAM combined with 2U/F, knee-point position at 48 Hz.
- Pos 3: Change in the voltage according to the U/F ratio, knee-point position at 58 Hz
- Pos 4: Change in the voltage according to the 2U/F, knee-point position at 58 Hz.
- Pos 5: Change in the voltage according to the self auto-adaptating LAM combined with 2U/F, knee-point position at 58 Hz.
- Pos 6: Change in the voltage according to the U/F ratio, knee-point position at 65 Hz (Tractelec application and variable speed above 1800 rpm).
- Pos 7: Special (not used).
- Pos 8: Change in the voltage according to the U/F ratio, knee-point position at 48 Hz or 58 Hz according to selection of the frequency by an external contact.
- Pos 9: Change in the voltage according to LAM 1, knee-point position at 48 Hz or 58 Hz according to selection of the frequency by an external contact

WARNING

For Pavers and hydraulic applications, select positions 0 (50 Hz) or 3 (60 Hz).

3.2.3 Rotating switch: excitation type and time response



0: AREP excitation and normal time response.

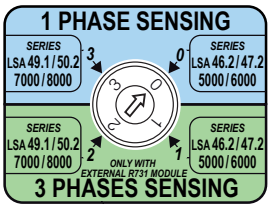
3: AREP excitation and fast time response.

1: PMG excitation and normal time response.

2: PMG excitation and fast time response.

For SHUNT applications, AREP excitation must be selected.

3.2.4 Rotating switch: voltage sensing



0: Single phase sensing
- LSA46.2/47.2 series.

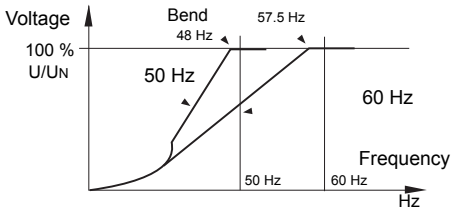
3: Single phase sensing
- LSA49.1/50.2 series.

1: Three-phase sensing with optional module R731
- LSA46.2/47.2 series.

2: Three-phase sensing with optional module R731
- LSA49.1/50.2 series.

3.3 - U/F and LAM function

3.3.1 - Frequency variation compared with voltage (without LAM)



3.3.2 - LAM (Load Acceptance Module) characteristics

3.3.2.1 - Voltage drop

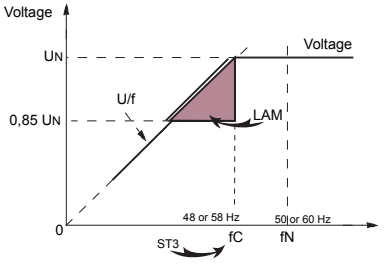
The LAM system is integrated in the AVR. As standard it is active.

Role of the LAM:

On application of a load, the genset rotation speed decreases. When it falls below the preset frequency threshold, the LAM causes the voltage to drop proportionately to the frequency (LAM1) or to the active power (LAM2) depending the the rotating switch position. This reduces the active load scale applied until the speed returns to its rated value.

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

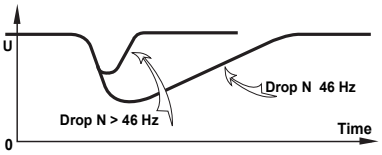
To avoid voltage oscillations, the trip threshold for the LAM function should be set approximately 2 Hz below the rated frequency.



3.3.2.2 - Soft voltage recovery function

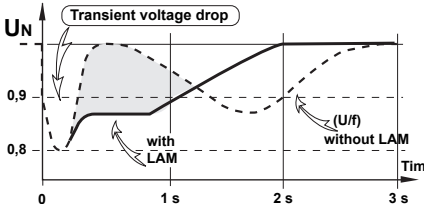
During load impacts, the function helps the genset to return to its rated speed faster with a gradual increase in voltage according to the principle:

- If the speed drops between 46 and 50 Hz (in 50Hz operation), the rated voltage is recovered by following a fast gradient.
- If the speed drops below 46 Hz, since the engine needs more help, the voltage follows a slow gradient as it returns to the reference value.

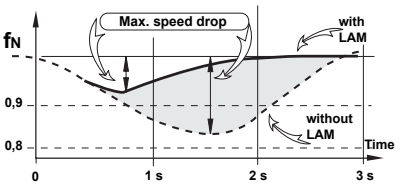


3.4 - Typical effects of the LAM with a diesel engine with or without a LAM (U/F only)

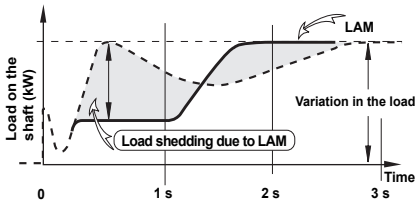
3.4.1 - Voltage



3.4.2 - Frequency



3.4.3 - Power



3.5 - AVR options

- Current transformer for parallel operation of...../1 A or 5 A according to the potentiometer P4 position.

- Voltage transformer (adaptation)

- Remote voltage adjustment potentiometer.
For a range of variation:
± 5% : 470 Ω
± 10% : 1 kΩ
the power of the potentiometer can be 0.5 W, 2 W or 3 W.

The potentiometer input must be isolated. Do not connect it to the ground.

- R 731 module: 3-phase voltage sensing 200 to 500 V, compatible with parallel operation in balanced installations.

- R 734 module: 3-phase current and voltage sensing for parallel operation on unbalanced installations (unbalance > 15%).

- R 726 module: regulation system changed to “4 - function” (see the maintenance manual and connection diagram).
- PF regulation (2F) .
- Equalization of voltages before paralleling (3 F).
- Possibility of coupling to the mains of alternators already running in parallel (4F).

- R729 module: same as R726 with additional functions.
- Detection of a diode fault.
- 4-20 mA input.
- Possibility of kVAR regulation.

- Voltage control: with an **isolated** D.C. current source applied to the terminals used for the external potentiometer:
- Internal impedance 1.5 kΩ.
- A variation of ± 0.5 V corresponds to a voltage adjustment of ± 10%.

4-INSTALLATION-COMMISSIONING

4.1 - Electrical checks on the AVR

- Check that all connections have been made properly as shown in the attached wiring diagram.
- Check the rotating switches selections
  - frequency,
  - type of alternator,
  - normal position (response time),
  - external potentiometer,
  - rated voltage,
  - secondary current of the CT used,
  - type of excitation.
- R450 optional operating modes

4.2 - Setting up

The various adjustments during tests must be made by a qualified engineer. It is essential that the drive speed specified on the nameplate is reached before commencing adjustment. After operational testing, replace all access panels or covers.

The AVR is used to make any adjustments to the machine.

4.2.1 - Setting up the R450

Before using the AVR, make sure that the rotating switches have been correctly configured with AREP/SHUNT or PMG excitation

a) Initial potentiometer settings (see table below)

Action	Factory setting	Pot.
Voltage minimum fully anti-clockwise	400 V - 50 Hz	
Stability	Not set (centre position)	
Excitation ceiling - Factory-sealed	10 A maximum	
Voltage quadrature droop (// operation with C.T.) - 0 quadrature droop fully anti-clockwise	Not set (fully anti-clockwise)	

Stability adjustments in standalone operation

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

c) Check the rotating switch selection.

d) Voltage potentiometer P1 at minimum, fully anti-clockwise.

e) Stability potentiometer P2 around 1/3 in from the anti-clockwise stop.

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

g) Set the output voltage to the desired value using P1.
- Rated voltage U_N for solo operation (eg. 400 V)
- Or U_N + 2 to 4% for parallel operation with C.T. (eg. 410 V -)

If the voltage oscillates, use P2 to make adjustments (try both directions), observing the voltage between F+ and F- (approx. 10 V D.C.). The best response time is obtained at the limit of the instability. If no stable position can be obtained, try selecting the fast position.

h) Check LAM operation: depending on the rotating switch selection.

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

j) Readjust the speed of the genset to its rated no-load value.

Adjustments in parallel operation
Before starting work on the alternator, make sure that the speed droop is identical for all engines.

k) Preset for parallel operation (with C.T. connected to S1, S2)
- Potentiometer **P4** (quadrature droop) in 1/4 position in the case of 5A CT and at 1/2 position in the case of 1A CT.
Apply the rated load (PF = 0.8 inductive).
The voltage should drop by 2 to 3% (400 V).
If it increases, check that neither V and W nor S1 and S2 have been reversed.

l) The no-load voltages should be identical for all the alternators intended to run in parallel.
- Couple the machines in parallel.
- By adjusting the speed, try to obtain 0 kW power exchange.
- By altering the voltage setting P1 on one of the machines, try to cancel (or minimise) the current circulating between the machines.
- From now on, do not touch the voltage settings.

m) Apply the available load (the setting is only correct if a reactive load is available)
- By altering the speed, match the kW (or divide the rated power of the units proportionally)
- By altering the quadrature droop potentiometer **P4**, match or divide the currents.

4.2.2 - Max. excitation adjustment (excitation ceiling)

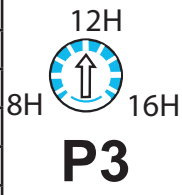
In standard setting, the potentiometer P3 is in maximum position.

However, for applications requiring an overload protection (see 3.2.1.4), the excitation ceiling must be adjusted by using the following procedures in AREP and PMG.

Method 1 :
-Connect the AVR to the alternator
-apply load to 110% of rated machine rated at PF=0.8, the green led is on and the red one is off.
-record the excitation current value
-adjust P3 until obtaining the red led flashing, the green one is always on.
-decrease the load to 100% and make sure that the red led is off.
- Increase the load at 115%, check that the red LED flashes during 90 seconds and that the excitation current is brought back to the above adjusted value ($I_{ex\ adjusted}$).

Method 2 :
The rated excitation current (see machine plate) must be multiplied by 1.1 and the obtained value is used to set the potentiometer P3 at the right position.
The following table must be used.

Position of P3	I exc (A)
8h	1
9h	1.55
10h	1.95
11h	2.5
12h	3.15
13h	3.65
14h	4.25
15h	4.7
16h	5.15



NB: In the case of a permanent short-circuit, the excitation current must reach 2.9 x I_{ex} adjusted (limited to 9.5A), during 1 second in AREP or 10 seconds in PMG and shuts down to a value less than 1A.

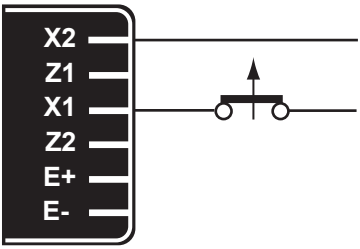
When the excitation current is set to the rated value, a voltage dip is observed in excitation current limit when the limitation is activated and the current limit is reached.

4.2.3 - Special type of use

WARNING

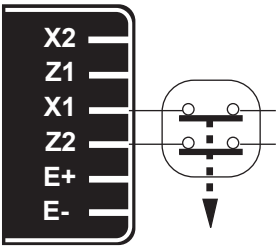
The excitation circuit F+, F- must not be left open when the machine is running: this will irreparably damage the AVR.

4.2.3.1 - R450 (SHUNT) field weakening



The exciter is switched off by disconnecting the AVR power supply (1 wire - X1 or X2) Contact rating: 16 A - 250 V A.C.

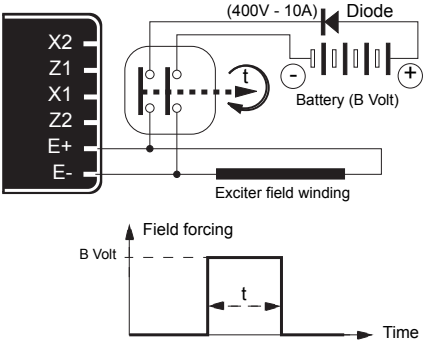
4.2.3.2 - R450 (AREP/PMG) field weakening



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

If field weakening is used, provide field forcing.

4.2.3.3 - R450 field forcing



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

4.3 - Electrical faults

Fault	Action	Measurements	Check/Cause
No voltage at no load on start-up	Connect a new battery of 4 to 12 V to terminals F- and F+, respecting the polarity, for 2 to 3 seconds	The alternator builds up and its voltage is still correct when the battery is removed	- Lack of residual magnetism
		The alternator builds up but its voltage does not reach the rated value when the battery is removed	- Check the connection of the voltage reference to the AVR - Faulty diodes - Armature short-circuit
		The alternator builds up but its voltage disappears when the battery is removed	- Faulty AVR - Field windings disconnected - Revolving field coil open circuit. Check the resistance
Voltage too low	Check the drive speed	Correct speed	- Check the AVR connections and settings (AVR faulty) - Field windings short-circuited - Rotating diodes burnt out - Revolving field coil short-circuited - Check the resistance
		Speed too low	Increase the drive speed (Do not touch the AVR voltage pot. (P1) before running at the correct speed)
Voltage too high	Adjust AVR voltage potentiometer	Adjustment ineffective	- Faulty AVR - 1 faulty diode
Voltage oscillations	Adjust AVR stability potentiometer	If no effect: try normal/fast recovery modes	- Check the speed: possibility of cyclic irregularity - Loose connections - Faulty AVR - Speed too low when on load (or U/F knee-point set too high)
Voltage correct at no load and too low when on load (*)	Run at no load and check the voltage between F+ and F- on the AVR	Voltage between F+ and F- AREP/PMG < 10 V	- Check the speed (or U/F knee-point set too high)
		Voltage between F+ and F- AREP/PMG > 15 V	- Faulty rotating diodes - Short-circuit in the revolving field coil. Check the resistance - Faulty exciter armature
(*) Caution: For single-phase operation, check that the sensing wires coming from the AVR are correctly connected to the operating terminals.			
Voltage disappears during operation (**)	Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components	The voltage does not return to the rated value	- Exciter winding open circuit - Faulty exciter armature - Faulty AVR - Revolving field coil open circuit or short-circuited - Overload (see LED)
(**) Caution: Internal protection may be activated (overload, open circuit, short-circuit)			

Caution: After operational testing or troubleshooting, replace all access panels or covers.

5 - SPARE PARTS

5.1 - Designation

Description	Type	Code
Voltage regulator (AVR)	R 450	AEM 110 RE 031

5.2 - Technical support service

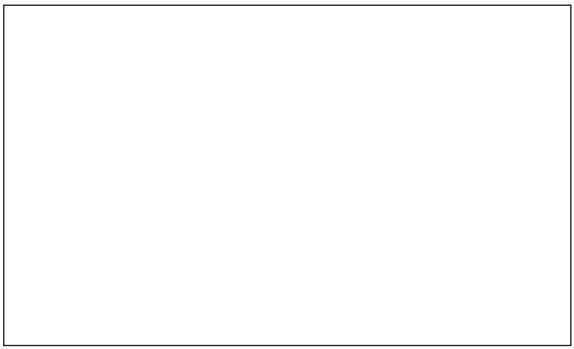
Our technical support service will be pleased to provide any additional information you may require.

When ordering spare parts, you should indicate the AVR type and code number.

Address your enquiry to your usual contact.

Our extensive network of service centres can dispatch the necessary parts without delay.
To ensure correct operation and the safety of our machines, we recommend the use of original manufacturer spare parts.
In the event of failure to comply with this advice, the manufacturer cannot be held responsible for any damage.

LEROY SOMER



www.leroy-somer.com

9.3. Appendix C - Common spare parts

GenPARTS

R230U
Rental Power

VOLVO
TAD733GE

ENGINE

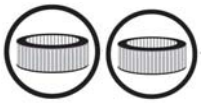
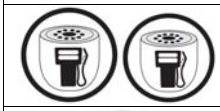
Starter relay	330052259	X 1
Radiator cap	31802000304	X 1
Starter motor brush holder	330052260	X 1
Alternator belt	330051895	X 1
Fan belt	330051887	X 1
Thermostat	330051879	X 1
Thermostat seal	330051876	X 1
Oil pressure switch	330052271	X 1
Temperature sensor	330052075	X 1
Tachometric control	330052262	X 1
Sensor	330052269	X 1
Temperature sensor	330052261	X 1
Turbo air temperature sensor	330052258	X 1
Alarm oil pressure sensor	330051863	X 1
Alarm water temperature sensor	330052506	X 1

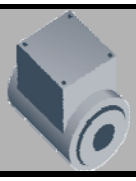
GENLUB

x 20 L	330910115	X 1
x 208 L	330910095	

GENCOOL

x 20 L	330910098	X 1
x 60 L	330910099	
x 210 L	330910100	

	330570107 + 330570108	X 1
	330560196 + 330510016	X 1
	330560039	X 1



LEROY-SOMER LSA46.2M5

ALTERNATOR

Diode bridge	330410126	X 1
Varistor	330410109	X 1

Note:	For all technical assistance or spare part requests, contact your nearest SDMO agent.

9.4. Appendix D - List of John Deere - Volvo and Perkins fault codes

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
28									**Throttle #3 Position**	
					3	■			Throttle Voltage high, short to V+	Short to V+
					4	■			Throttle Voltage low, short to V-	Short to V-
29									**Throttle #2 Position**	
					3	■			Throttle Voltage high, short to V+	Short to V+
					4	■			Throttle Voltage low, short to V-	Short to V-
					14	■			Throttle voltage out of range	
84									**Vehicle speed**	
					2	■			Vehicle invalid or missing	Not possible with Genset application
					31	■			Vehicle speed mismatch	
91	**91**		**91**	**132**			■		**Accelerator pedal position**	**FMI not determined for all VOLVO's**
					3	■			Throttle Voltage high, short to V+	Not possible with genset application, codes declared by the CAN J1587 for VOLVO.
					4	■			Throttle Voltage low, short to V-	
					7	■			Throttle calibration invalid	
					8	■		■	PWM throttle abnormal pulse width	
					9	■			Throttle invalid (CAN value)	
					10	■			Throttle voltage out of range low	
					13	■			Throttle calibration aborted	
					14	■			Throttle voltage out of range	
94			**94**				■		**Fuel rail pressure sensor**	
					1	■	■		Fuel supply pressure extremely low	
					3	■	■		Fuel rail pressure input voltage high	Short to V+
					4	■			Fuel rail pressure input voltage low	Short to V-
					5		■		Fuel rail pressure sensor open circuit	
					10	■			Fuel rail pressure lost detected	
					13	■			Fuel rail pressure higher than expected	
					16	■			Fuel supply pressure moderately high	
					17	■			Fuel rail pressure not developed	
					18	■			Fuel supply pressure moderately low	
97			**97**				■		**Water in fuel sensor**	
					0	■	■		Water in fuel continuously detected	
					3	■	■		Water in fuel input voltage high	Short to V+
					4	■			Water in fuel input voltage low	Short to V-
					16	■			Water in fuel detected	
					31	■			Water in fuel detected	
98			**98**				■		**Oil level sensor**	
					1		■		Oil level value below normal	
					3		■		Oil level sensor input voltage high	Short to V+
					4		■		Oil level sensor input voltage low	Short to V-
					5		■		Oil level sensor open circuit	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
100	**100**		**100**				■		**Oil pressure sensor**	
					1	■	■		Engine oil pressure extremely low	
					3	■	■	■	Oil pressure sensor input voltage high	Short to V+
					4	■		■	Oil pressure sensor input voltage low	Short to V-
					5		■		Oil pressure sensor open circuit	
					17			■	Engine oil pressure low	
					18	■		■	Engine oil pressure moderately low	
					31	■			Oil pressure detected, motor stopped	
102	**273**		**102**				■		**Manifold air pressure sensor**	
					0		■		Manifold air pressure above normal	
					1		■		Manifold air pressure below normal	
					2	■			Incoherent measurement of the oil pressure	
					3	■	■	■	Manifold air pressure sensor input voltage high	Short to V+
					4	■	■	■	Manifold air pressure sensor input voltage low	Short to V-
					15			■	Manifold air pressure moderately low	
					16			■	Manifold air pressure low	
103									**Turbo speed sensor**	
					0	■			Turbo speed too high	
					5	■			Turbo speed sensor circuit open	
					6	■			Sensor shorted to earth	Short to V-
					8	■			Speed signal invalid	
					31	■			Intermittent problem with speed information	
105			**105**				■		**Manifold air temperature sensor**	
					0	■	■		Manifold air temperature extremely high	
					3	■			Manifold air temperature sensor input voltage high	
					4	■	■		Manifold air temperature sensor input voltage low	
					5		■		Manifold air temperature sensor open circuit	
					15	■			Air temperature very high.	
					16	■			Manifold air temperature moderately high	
106			**106**				■		**Air inlet pressure sensor**	
					0		■		Air inlet pressure above normal	
					3		■		Air inlet pressure sensor input voltage high	
					5		■		Air inlet pressure sensor open circuit	
107			**107**				■		**Air filter differential pressure sensor**	
					0	■	■		Air filter restriction high	
					3		■		Air filter differential pressure sensor input voltage high	
					4		■		Air filter differential pressure sensor input voltage low	
					5		■		Air filter differential pressure sensor open circuit	
					31	■			Air filter restriction high	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
108	**274**		**108**				■		**Barometric pressure sensor**	**Not use with EDC III and EMS2**
					2	■			Air pressure invalid	
					3			■	High barometric pressure sensor short to high	
					4			■	High barometric pressure sensor short to low	
					17			■	High barometric pressure	ECM option, sensor not connected
110	**110**		**110**				■		**Coolant temperature sensor**	
					0	■	■	■	Coolant temperature extremely high	
					3	■	■	■	Coolant temperature sensor input voltage high	
					4	■	■	■	Coolant temperature sensor input voltage low	
					5		■		Coolant temperature sensor open circuit	
					15	■		■	Coolant temperature high least severe	
					16	■		■	Coolant temperature moderately high	
					17	■			Water temperature very low	
					31	■			Coolant temperature high	
111			**111**						**Coolant level sensor**	
					0		■		Engine coolant level low	
					1	■			Engine coolant level low	
					3	■	■		Coolant level sensor input voltage high	
					4	■			Coolant level sensor input voltage low	
153			**153**						**Crankcase pressure sensor**	
					0		■		Value above normal	
					3		■		Crankcase pressure sensor input voltage high	
					5		■		Crankcase pressure sensor open circuit	
157									**Fuel pressure sensor in the common rail**	
					1	■			Fuel pressure too low	
					3	■			Input voltage of the pressure sensor high	Short to V+
					4	■			Input voltage of the pressure sensor low	Short to V-
					10	■			Loss of fuel pressure detected	
					16	■			Fuel pressure moderately high	
					17	■			Fuel ramp pressure not reached	
					18	■			Oil pressure moderately low	
158			**158**						**Battery voltage sensor**	
					1		■		Voltage above normal	
					17	■			ECU power down error	
160									**Wheel speed sensor**	
					2	■			Wheel speed input noise	
164		**164**							**Injection pressure control**	
168	**168**								**Electrical system voltage**	
					2			■	Electrical system voltage low	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
172	**172**		**172**						**Ambient air temperature sensor**	**Inlet air temperature sensor for PERKINS**
					3			■	Ambient air temperature sensor input voltage high	Inlet air temperature sensor input voltage high
					4		■	■	Ambient air temperature sensor input voltage low	Inlet air temperature sensor input voltage low
					5		■		Ambient air temperature sensor open circuit	
					15			■		High Inlet air temperature alarm-warning
					16			■		High Inlet air temperature alarm-action alert
174	**174**								**Fuel temperature sensor**	
					0	■			Fuel temperature high most severe	
					3	■		■	Fuel temperature sensor input voltage high	
					4	■		■	Fuel temperature sensor input voltage low	
					15	■		■	Fuel temperature high	
					16	■		■	Fuel temperature moderately high	
					31	■			Fuel temperature sensor faulty	
175			**175**						**Oil temperature sensor**	
					0		■		Oil temperature extremely high	
					3		■		Oil temperature sensor input voltage high	
					4		■		Oil temperature sensor input voltage low	
					5		■		Oil temperature sensor open circuit	
177									**Transmission oil temperature sensor**	
					9	■			Transmission oil temperature invalid	Not possible with Genset application
189									**Rated engine speed**	
					0	■			Engine speed de rated	
					31	■			Engine speed de rated	
190	**190**		**190**				■		**Engine speed sensor**	
					0	■		■	Overspeed extreme	
					2			■	Engine speed sensor data intermittent	
					9			■	Engine speed sensor abnormal update	
					11			■	Engine speed sensor signal lost	
					12			■	Engine speed sensor signal lost	
					15			■	Overspeed	
					16	■		■	Overspeed moderate	
228	**261**								**Speed sensor calibration**	
					13			■	Engine timing abnormal calibration	
252	**252**								**Software**	
					11			■	Incorrect engine software	
234	**253**								**Check system parameters**	
					2			■	Incorrect parameters	
281	**281**								**Action alert output status**	
					3			■	Action alert output open/short to B+	
					4			■	Action alert output short to ground	
					5			■	Action alert output open circuit	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
282	**282**								**Overspeed output status**	
					3			■	Overspeed output open/short to B+	
					4			■	Overspeed output short to ground	
285	**285**								**Coolant temperature output status**	
					3			■	Coolant temperature lamp open/short to B+	
					4			■	Coolant temperature lamp short to ground	
286	**286**								**Oil pressure output status**	
					3			■	Oil pressure output open/short to B+	
					4			■	Oil pressure output short to ground	
					5			■	Oil pressure output open circuit	
323	**323**								**Shutdown output status**	
					3			■	Shutdown output open/short to B+	
					4			■	Shutdown output short to ground	
					5			■	Shutdown output open circuit	
324	**324**								**Warning output status**	
					3			■	Warning output open/short to B+	
					4			■	Warning output short to ground	
					5			■	Warning output open circuit	
412									**Temperature sensor in the EGR valve.**	
					0	■			Temperature in the EGR extremely high	
					3	■			Input voltage of the temperature sensor high	Short to V+
					4	■			Input voltage of the temperature sensor low	Short to V-
					15	■			Temperature in the EGR high	
					16	■			Temperature in the EGR moderately high	
443	**443**								**ENGINE RUN output status**	
					3			■	Engine run output open/short to B+	
					4			■	Engine run output short to B-	
523									**Gear selection**	
					9	■			Gear selection invalid	Not possible with Genset application
608		**250**				■			**Data link faulty J1587 Start/Stop redundancy / J1939 communication bus**	
608				**132**		■			**Redundancy of the accelerator**	
608				**98**		■			**Redundancy of the Stop/start information**	
611									**Injector wiring status**	
					3	■			Injector wiring shorted to power source	
					4	■			Injector wiring shorted to ground	
620	**262**	**232**					■		**5 Volt sensor power supply**	**FMI not informed by VOLVO**
					3	■		■	Sensor power supply open/short to B+	
					4	■		■	Sensor power supply short to ground	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
626			**45**				■		**Start enable device (intake heater and ether)**	
					3		■		Start enable device output short to B+	Not used, the control panel is in charge of managing the start enable device
					4		■		Start enable device output short to ground	
					5		■		Start enable device output open circuit	
627									**Power supply**	
					1	■			Injector supply voltage problem	For 6125HF070 only
					4	■			ECU unswitched power missing	For 6068HF275 VP44 only
					18	■			Battery voltage below the operating voltage	For John DEERE Tiers III
628		**240**					■		**Memory fault in EMS2**	
629		**254**					■		**ECU status/controller error**	**CIU module status**
					2		■		RAM cell test failure	
					8		■		CPU watchdog reset test failure	
					11		■		Main and fuelling ASIC test fail	
					12	■	■		RAM address test failure	
					13	■	■		Watchdog trip failure	
					19	■			ECU to injection pump communication error	Possible only with 6068HF475 VP44
630		**253**					■		**Data set memory EEPROM**	
632									**Injection status**	
					2	■			Fuel shutoff error	
					5	■			Fuel shutoff non-functional	
636		**21**							**Pump position sensor/Cam position sensor/Speed sensor CAM**	Pump position or CAM position in function of the type of injection
					2	■	■		Pump position sensor/cam position sensor input noise	
					3		■		Permanent loss of signal	
					5	■			High impedance of the position sensor or circuit open	
					6	■			Sensor short to ground	
					8	■	■		Pump position sensor/cam position sensor input missing	
					9		■		Not informed by VOLVO	
					10	■			Pump position sensor/cam position sensor input pattern error	
637		**22**							**Crank position sensor/Speed sensor flywheel**	
					2	■	■		Crank position input noise	
					3		■		Permanent loss of signal	
					5	■			High impedance of the position sensor or open circuit	
					6	■			Sensor short to ground	
					7	■			Crank position/Cam position out of synchronisation	
					8	■	■		Crank position input missing	
					9		■		Not informed by VOLVO	
					10	■			Crank position sensor input pattern error	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
639	**247**	**231**							**Communication status**	
					2		■		Bus Off error	
					9		■		Passive bus error	
					11		■		Data registers read back failure	
					12		■		Loss of message error	
					13	■			Bus CAN error	
640									**Engine shutdown vehicle status**	
					11	■			Engine shutdown vehicle request invalid	
					31	■			Engine shutdown vehicle request	
641									**Status of the Turbo with variable geometry**	
					4	■			Supply voltage of the Turbo actuator low	
					12	■			Error in communication between the ECU and the TGV actuator	
					13	■			Error in position of the TGV	
					16	■			Temperature of the actuator moderately high.	
647									**Fan supply**	
					3	■			Short circuit to earth	
					5	■			Open circuit	
651	**1**	**1**	**651**				■		**Cylinder #1 injector status**	
					0	■			Injector outside specifications	Recalibration of the injectors required
					1	■			Injector outside specifications	Recalibration of the injectors required
					2		■		Short circuit high side to B+	
					3		■		Short circuit high side to low side or low side to B+	
					4		■		Short circuit high or low side to ground	
					5	■	■		Cylinder #1 circuit open	
					6	■			Cylinder #1 circuit shorted	
					7	■	■	■	Cylinder #1 balancing error/mechanical failure	
					11		■	■	Cylinder #1 unknown error/mechanical failure	
652	**2**	**2**	**652**				■		**Cylinder #2 injector status**	
					0	■			Injector outside the specifications	Recalibration of the injectors required
					1	■			Injector outside the specifications	Recalibration of the injectors required
					2		■		Short circuit high side to B+	
					3		■		Short circuit high side to low side or low side to B+	
					4		■		Short circuit high or low side to ground	
					5	■	■		Cylinder #2 circuit open	
					6	■			Cylinder #2 circuit shorted	
					7	■	■		Cylinder #2 balancing error/mechanical failure	
					11		■		Cylinder #2 unknown error/mechanical failure	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
653	**3**	**3**	**653**				■		**Cylinder #3 injector status**	
					0	■			Injector outside the specifications	Recalibration of the injectors required
					1	■			Injector outside the specifications	Recalibration of the injectors required
					2		■		Short circuit high side to B+	
					3		■		Short circuit high side to low side or low side to B+	
					4		■		Short circuit high or low side to ground	
					5	■	■		Cylinder #3 circuit open	
					6	■			Cylinder #3 circuit shorted	
					7	■	■	■	Cylinder #3 balancing error/mechanical failure	
					11		■	■	Cylinder #3 unknown error/mechanical failure	
654	**4**	**4**	**654**				■		**Cylinder #4 injector status**	
					0	■			Injector outside the specifications	Recalibration of the injectors required
					1	■			Injector outside the specifications	Recalibration of the injectors required
					2		■		Short circuit high side to B+	
					3		■		Short circuit high side to low side or low side to B+	
					4		■		Short circuit high or low side to ground	
					5	■	■		Cylinder #4 circuit open	
					6	■			Cylinder #4 circuit shorted	
					7	■	■	■	Cylinder #4 balancing error/mechanical failure	
					11		■	■	Cylinder #4 unknown error/mechanical failure	
655	**5**	**5**	**655**				■		**Cylinder #5 injector status**	
					0	■			Injector outside the specifications	Recalibration of the injectors required
					1	■			Injector outside the specifications	Recalibration of the injectors required
					2		■		Short circuit high side to B+	
					3		■		Short circuit high side to low side or low side to B+	
					4		■		Short circuit high or low side to ground	
					5	■	■		Cylinder #5 circuit open	
					6	■			Cylinder #5 circuit shorted	
					7	■	■	■	Cylinder #5 balancing error/mechanical failure	
					11		■	■	Cylinder #5 unknown error/mechanical failure	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
656	**6**	**6**	**656**				■		**Cylinder #6 injector status**	
					0	■			Injector outside the specifications	Recalibration of the injectors required
					1	■			Injector outside the specifications	Recalibration of the injectors required
					2		■		Short circuit high side to B+	
					3		■		Short circuit high side to low side or low side to B+	
					4		■		Short circuit high or low side to ground	
					5	■	■		Cylinder #6 circuit open	
					6	■			Cylinder #6 circuit shorted	
					7	■	■	■	Cylinder #6 balancing error/mechanical failure	
					11		■	■	Cylinder #6 unknown error/mechanical failure	
676		**39**							**Glow plug relay status**	
					3	■			Glow plug relay voltage high	
					5	■			Glow plug relay voltage low	
677		**39**		**3**					**Start relay status**	
					3		■		Start relay control short circuit to high	
					4		■		Start relay control short circuit low	
					5		■		Start relay control open circuit	
678	**41**								**8 Volt power supply**	
					3			■	ACM 8 Volt DC supply open/short to B+	
					4			■	ACM 8 Volt DC supply open/short to ground	
679		**42**				■			**Regulation sensor of the injection pressure control**	
723	**342**								**Secondary speed sensor**	
					2			■	Secondary engine speed sensor data intermittent	
					11			■	Secondary engine speed sensor loss of signal	
					12			■	Loss of signal/sensor failure	
729		**70**							**Inlet air heater signal/Preheat detection**	
					3	■			Inlet air heater signal high	
					5	■			Inlet air heater signal low	
810									**Vehicle speed**	
					2	■			Calculated vehicle speed input noise	Not possible with Genset application
861	**861**								**Diagnostic output status**	
					3			■	Diagnostic output open/short to B+	
					4			■	Diagnostic output short to ground	
898									**CAN throttle status**	
					9	■			Speed value invalid or missing	
970				**6**					**Auxiliary engine shutdown switch status EMS**	
					2	■			Auxiliary engine shutdown switch signal invalid	Not used
					31	■			Auxiliary engine shutdown switch active	
971									**External engine de rate switch status**	
					31	■			External engine de rate switch active	Not used

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
1069									**Tire size status**	
					2	■			Tire size error	Not possible with Genset application
					9	■			Tire size invalid	
					31	■			Tire size error	
1075									**Feed pump of the fuel circuit**	
					5	■			High impedance at the terminals of the pump or open circuit	
					6	■			Pump coil short to ground	
					12	■			Pump defective	
1076							■		**Fuel Injection pump status**	
					0	■			Pump control valve closure too long	Injection DE10
					1	■			Pump control valve closure too short	Injection DE10
					2	■			Pump detected defect	Injection VP44
					3	■			Pump solenoid current high	Injection DE10
					5	■			Pump solenoid circuit open	Injection DE10
					6	■			Pump solenoid circuit severely shorted	Injection DE10
					7	■			Pump control valve closure not detected	Injection DE10
					10	■			Pump solenoid circuit moderately shorted	Injection DE10
					13	■			Pump current decay time invalid	Injection DE10
1077									**Fuel injection pump controller status**	
					7	■			Attempting to fuel without command	
					11	■			Pump supply voltage out of range	
					12	■			Pump self test error	
					19	■			Pump detected communication error	
					31	■			Pump initiated engine protection	
1078									**ECU/Pump timing status**	
					7	■			ECU/Pump timing moderately out of synchronisation	
					11	■			ECU/Pump timing speed out of synchronisation	
					31	■			ECU/Pump timing extremely out of synchronisation	
1079		**232**							**Sensor supply voltage (+5 Volt)**	**Analog throttle reference**
					3	■			Sensor supply voltage high	> 5,5 Volt
					4	■			Sensor supply voltage low	< 4,44 Volt
1080		**211**							**Sensor supply voltage (Oil pressure, Coolant temp, fuel pressure)/+5V sensor supply 2**	
					3	■			Sensor supply voltage high	> 5,5 Volt
					4	■			Sensor supply voltage low	< 4,40 Volt
1109									**Engine/ECU status**	
					31	■			Engine shutdown warning	
1110									**Engine status**	
					31	■			Engine shutdown	
1111	**268**								**Check parameters**	
					2			■	Programmed parameter fault	
1136				**55**			■		**ECU Temperature**	
					0	■			ECU temperature extremely high	
					16	■			ECU temperature moderately high	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
1172									**Input temperature of the TGV compressor**	
					3	■			Input voltage of the temperature sensor high	Short to V+
					4	■			Input voltage of the temperature sensor low	Short to V-
1180									**Input temperature of the TGV turbine**	
					0	■			Turbine temperature extremely high	Short to V+
					16	■			Turbine temperature moderately high	Short to V-
1184			**173**						**Exhaust gas temperature sensor**	
1239				**96**			■		**Status of the pressure system of the common rail**	
1347									**Pump control valve status**	**Pump control valve #1 status for 6081HF070**
					3	■			Pump control valve current high	
					5	■			Pump control valve error/mismatch	
					7	■			Fuel rail pressure control error	
					10	■			Pump control valve fuel flow not detected	
1348									**Pump control valve #2 status**	**Only for 6081HF070**
					5	■			Pump control valve #2 error/mismatch	
					10	■			Pump control valve #2 fuel flow not detected	
1485			**1485**	**5**					**Pump power relay status**	**ECU main relay of VOLVO EMS/EDC**
					2	■			Pump power relay fault	
					3		■			ECU main relay short circuit high
1568									**Torque curve selection**	
					2	■			Torque curve selection invalid	
					4	■			Torque curve input voltage high	
					9	■			Torque curve selection missing	
1569									**Fuel supply status**	
					31	■			Fuel de rate	
1639									**Fan speed**	
					1	■			Fan speed zero or absent	
					2	■			Fan speed signal erratic	
					16	■			Fan speed more than 300 rpm above its setpoint for at least 180s	
					18	■			Fan speed more than 300 rpm below its setpoint for at least 180s	
2000									**ECU status**	
					6	■			Vehicle ID missing	
					13	■			Security violation	
2630									**Air temperature at the air cooler outlet**	
					0	■			Air temperature extremely high	
					3	■			Sensor input voltage high	Short to V+
					4	■			Sensor input voltage low	Short to V-
					15	■			Air temperature high	
					16	■			Air temperature moderately high	

SPN	CID	SID	PID	PPID	FMI	John Deere	Volvo	Perkins	Description	Comment
2659									**Flow level of the EGR valve**	
					2	■			Calculated EGR flow not valid	
					15	■			Calculated EGR flow rather high	
					17	■			Calculated EGR flow rather low	
2790									**Air temperature at turbo compressor outlet**	
					16	■			Temperature at compressor outlet moderately high	
2791				**19**			■		**Statuses of the EGR valve**	
					2	■			Valve position signal not valid	
					3	■			Input voltage of the position sensor high	Short to V+
					4	■			Input voltage of the position sensor low	Short to V-
					7	■			Inability of the EGR valve to reach the expected position	
					13	■			The EGR valve is out of calibration	
					31	■			Error in position of the EGR valve	
2795									**Position of TGV actuator**	
					7	■			The actuator does not respond or is not in the expected position	
3509									**Common supply voltage of the sensors, output #1**	
					3	■			Supply voltage of the sensor too high	Exceeding +5 volts
						■			Supply voltage of the sensor shorted to ground	
3510									**Common supply voltage of the sensors, output #2**	
					3	■			Supply voltage of the sensor too high	Exceeding +5 volts
						■			Supply voltage of the sensor shorted to ground	
3511									**Common supply voltage of the sensors, output #3**	
					3	■			Supply voltage of the sensor too high	Exceeding +5 volts
						■			Supply voltage of the sensor shorted to ground	
3512									**Common supply voltage of the sensors, output #4**	
					3	■			Supply voltage of the sensor too high	Exceeding +5 volts
						■			Supply voltage of the sensor shorted to ground	
3513									**Common supply voltage of the sensors, output #5**	
					3	■			Supply voltage of the sensor too high	Exceeding +5 volts
						■			Supply voltage of the sensor shorted to ground	
520192				**8**			■		**Cooling status of the piston**	
520194				**4**			■		**Status of the starting request input**	
520195				**6**			■		**Stop request on CIU**	

FMI=0—DATA VALID BUT ABOVE NORMAL OPERATIONAL RANGE - MOST SEVERE LEVEL
The signal communicating information is within a defined acceptable and valid range, but the real world condition is above what would be considered normal as determined by the predefined most severe level limits for that particular measure of the real world condition (*Region e* of the signal range definition) Broadcast of data values is continued as normal. Broadcast of data values is continued as normal.

FMI=1—DATA VALID BUT BELOW NORMAL OPERATIONAL RANGE - MOST SEVERE LEVEL
The signal communicating information is within a defined acceptable and valid range, but the real world condition is below what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (*Region e* of the signal range definition). Broadcast of data values is continued as normal.

FMI=2—DATA ERRATIC, INTERMITTENT OR INCORRECT
Erratic or intermittent data includes all measurements that change at a rate that is not considered possible in the real world condition and must be caused by improper operation of the measuring device or its connection to the module. Broadcast of data value is substituted with the “error indicator” value.
Incorrect data includes any data not received and any data that is exclusive of the situations covered by FMIs 3, 4, 5 and 6. Data may also be considered incorrect if it is inconsistent with other information collected or known about the system.

FMI=3—VOLTAGE ABOVE NORMAL, OR SHORTED TO HIGH SOURCE
a. A voltage signal, data or otherwise, is above the predefined limits that bound the range (*Region e* of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
b. Any signal external to an electronic control module whose voltage remains at a high level when the ECM commands it to low. Broadcast of data value is substituted with the “error indicator” value.

FMI=4—VOLTAGE BELOW NORMAL, OR SHORTED TO LOW SOURCE
a. A voltage signal, data or otherwise, is below the predefined limits that bound the range (Region e of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
b. Any signal external to an electronic control module whose voltage remains at a low level when the ECM commands it to high. Broadcast of data value is substituted with the “error indicator” value.

FMI=5—CURRENT BELOW NORMAL OR OPEN CIRCUIT
a. A current signal, data or otherwise, is below the predefined limits that bound the range (Region e of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
b. Any signal external to an electronic control module whose current remains off when the ECM commands it on. Broadcast of data value is substituted with the “error indicator” value.

FMI=6—CURRENT ABOVE NORMAL OR GROUNDED CIRCUIT
a. A current signal, data or otherwise, is above the predefined limits that bound the range. (*Region e* of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
b. Any signal external to an electronic control module whose current remains on when the ECM commands it off. Broadcast of data value is substituted with the “error indicator” value.

FMI=7—MECHANICAL SYSTEM NOT RESPONDING OR OUT OF ADJUSTMENT
Any fault that is detected as the result of an improper mechanical adjustment or an improper response or action of a mechanical system that, with a reasonable confidence level, is not caused by an electronic or electrical system failure. This type of fault may or may be directly associated with the value of general broadcast information.

FMI=8—ABNORMAL FREQUENCY OR PULSE WIDTH OR PERIOD
To be considered in cases of FMI 4 and 5. Any frequency or PWM signal that is outside the predefined limits which bound the signal range for frequency or duty cycle (outside *Region b* or the signal definition). Also if the signal is an ECM output, any signal whose frequency or duty cycle is not consistent with the signal which is emitted. Broadcast of data value is substituted with the “error indicator” value.

FMI=9—ABNORMAL UPDATE RATE
Any failure that is detected when receipt of data via the data link or as input from a smart actuator or smart sensor is not at the update rate expected or required by the ECM (outside *Region c* of the signal range definition). Also any error that causes the ECM not to send information at the rate required by the system. This type of fault may or may be directly associated with the value of general broadcast information.

FMI=10—ABNORMAL RATE OF CHANGE
Any data, exclusive of the abnormalities covered by FMI 2, that is considered valid but whose data is changing at a rate that is outside the predefined limits that bound the rate of change for a properly functioning system (outside *Region c* of the signal range definition). Broadcast of data values is continued as normal.

FMI=11—ROOT CAUSE NOT KNOWN
It has been detected that a failure has occurred in a particular subsystem but the exact nature of the fault is not known. Broadcast of data value is substituted with the “error indicator” value.

FMI=12—BAD INTELLIGENT DEVICE OR COMPONENT
Internal diagnostic procedures have determined that the failure is one which requires the replacement of the ECU, used here to mean the packaged unit that includes some microprocessor and its associated components and circuits. It can be assumed that the communications subsystem is not the part that has failed, and the manufacturer has determined that there is no serviceable component smaller than the ECU involved in the failure. Broadcast of data value is substituted with the “error indicator” value if appropriate, as there may or may not be any broadcast involved. This error is to include all internal controller trouble codes that can not be caused by connections or systems external to the controller.

FMI=13—OUT OF CALIBRATION
A failure that can be identified to be the result of not being properly calibrated. This may be the case for a subsystem which can identify that the calibration attempting to be used by the controller is out of date. Or it may be the case that the mechanical subsystem is determined to be out of calibration. This failure mode does not relate to the signal range definition as do many of the FMIs.

FMI=14—SPECIAL INSTRUCTIONS
“Special Instructions” is the FMI to be used when the on-board system can isolate the failure to a small number of choices but not to a single point of failure. When the FMI is used, there is clear necessity for the service technician to take some action to complete the specific diagnosis, and the manufacturer has provided instructions for the completion of that diagnosis. There are two cases where this will be used: 1. for emission-related diagnostics where the particular failure cannot be separated between a sensor out of range and the case where the actual value is at the edge of a diagnostic region, and 2. for the older SPN 611 to 615 where the problem is in determining which of two or more circuits (which may interact) is the one that needs repair.
SPNs 611 through 615 are defined as “System Diagnostic Codes” and are used to identify failures that cannot be tied to a specific field replaceable component. Specific subsystem fault isolation is the goal of any diagnostic system, but for various reasons this cannot always be accomplished. These SPNs allow the manufacturer some flexibility to communicate non-“specific component” diagnostic information. Since SPNs 611-615 use the standard SPN/FMI format it allows the use of standard diagnostic tools, electronic dashboards, satellite systems and other advanced devices that scan Parameter Groups containing the SPN/FMI formats. Because manufacturer defined codes are not desirable in terms of standardization, the use of these codes should only occur when diagnostic information cannot be communicated as a specific component and failure mode.
Possible reasons for using a System Diagnostic Code include:

1. Cost of specific component fault isolation is not justified, or
2. New concepts in Total Vehicle Diagnostics are being developed, or
3. New diagnostic strategies that are not component specific are being developed.

Due to the fact that SPNs 611-615 are manufacturer defined and are not component specific, FMIs 0-13 and 15-31 have little meaning. Therefore, FMI 14, “Special Instructions”, is usually used. The goal is to refer the service personnel to the manufacturer's troubleshooting manual for more information on the particular diagnostic code. This failure mode does not relate to the signal range definition as do many of the FMIs. This type of fault may or may be directly associated with the value of general broadcast information.

FMI=15—DATA VALID BUT ABOVE NORMAL OPERATING RANGE - LEAST SEVERE LEVEL
The signal communicating information is within a defined acceptable and valid range, but the real world condition is above what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (*Region i* of the signal range definition). Broadcast of data values is continued as normal.

FMI=16—DATA VALID BUT ABOVE NORMAL OPERATING RANGE - MODERATELY SEVERE LEVEL
The signal communicating information is within a defined acceptable and valid range, but the real world condition is above what would be considered normal as determined by the predefined moderately severe level limits for that particular measure of the real world condition (*Region k* of the signal range definition). Broadcast of data values is continued as normal.

FMI=17—DATA VALID BUT BELOW NORMAL OPERATING RANGE - LEAST SEVERE LEVEL
The signal communicating information is within a defined acceptable and valid range, but the real world condition is below what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (*Region h* of the signal range definition). Broadcast of data values is continued as normal.

FMI=18—DATA VALID BUT BELOW NORMAL OPERATING RANGE - MODERATELY SEVERE LEVEL
The signal communicating information is within a defined acceptable and valid range, but the real world condition is below what would be considered normal as determined by the predefined moderately severe level limits for that particular measure of the real world condition (*Region j* of the signal range definition). Broadcast of data values is continued as normal.

FMI=19—RECEIVED NETWORK DATA IN ERROR
Any failure that is detected when the data received via the network is found substituted with the “error indicator” value (i.e. FE16, see J1939-71). This type of failure is associated with received network data. The component used to measure the real world signal is wired directly to the module sourcing the data to the network and not to the module receiving the data via the network. The FMI is applicable to *Region f* and *g* of the signal range definition. This type of fault may or may be directly associated with the value of general broadcast information.

FMI=20-30—RESERVED FOR SAE ASSIGNMENT

FMI=31—CONDITION EXISTS
Used to indicate that the condition that is identified by the SPN exists when no more applicable FMI exists or in cases when the reported SPN name spells out the component and a non-standard failure mode. This type of fault may or may be directly associated with the value of general broadcast information. This FMI will mean “not available” when the associated SPN is also “not available” as when the remainder of the packet is filled with binary ones after all data has been transmitted.